



**INTERNATIONAL  
ASTRONAUTICAL  
FEDERATION**

# IAF HIGHLIGHTS

# 2023



*Connecting @ll Space People  
for a sustainable future* 

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# Abbreviations

3G	Geography, Generation, Gender	JAXA	Japan Aerospace Exploration Agency
AEB	Brazilian Space Agency	JPL	Jet Propulsion Laboratory
AI	Artificial Intelligence	JWST	James Webb Space Telescope
AIAA	American Institute of Aeronautics and Astronautics	LCNS	Lunar Communication and Navigation Service
ALCE	Latin American and Caribbean Space Agency	LCRD	Laser Communications Relay Demonstration
API	Application Programming Interface	LEO	Low-Earth Orbit
ASI	Italian Space Agency	LTS	Long-term Sustainability
CLIODN	Committee for Liaison with International Organisations and Developing Nations	MMoP	International Meeting for Ministers and Members of Parliaments
CNSA	China National Space Administration	MMX	Martian Moons eXploration
COSO	Committee of Sponsoring Organizations	MTG	Meteosat Third Generation
COPUOS	Committee on the Peaceful Uses of Outer Space	NASA	National Aeronautics and Space Administration
CSA	Canadian Space Agency	NEO	Near-Earth Object
CNES	Centre National d'Etudes Spatiales	NLP	Natural Language Processing
DART	Double Asteroid Redirection Test	NOSA	Norwegian Space Agency
DLR	German Aerospace Center	NSIL	NewSpace India Limited
EO	Earth Observation	OSAM	On-orbit Servicing, Assembly, and Manufacturing
ESA	European Space Agency	PNT	Positioning, Navigation and Timing
ESOC	European Space Operations Centre	PPP	Public-Private Partnerships
EVAs	Extravehicular Activities	QKD	Quantum Key Distribution
FAA	Federal Aviation Administration	R&D	Research and Development
GNSS	Global Navigation Satellite System	SAR	Search and Rescue
GPS	Global Positioning System	SDGs	Sustainable Development Goals
GRC	Governance, Risk and Compliance	SDR	Software Defined Radio
HSF	Human Spaceflight	SLS	Space Launch System
IADC	Inter-Agency Space Debris Coordination Committee	SOCA	Space Operations Committees Alumni
IAF GNF	Global Networking Forum	SpS	Special Sessions
ISEP	IAF Space Economic Platform	SRM	Solid Rocket Motor
ISO	International Organization for Standardization	STEM	Science, Technology, Engineering and Mathematics
ISRO	Indian Space Research Organisation	SWOT	Surface Water and Ocean Topography
ISS	International Space Station	TC	Technical Committee
ISU	International Space University	UN	United Nations
ITU	International Telecommunication Union	WG	Working Groups

# Welcome Message



Clay Mowry  
President,  
International Astronautical Federation (IAF)

The IAF is continuously growing and this year the Federation had the pleasure of welcoming 55 new members and we now officially surpassed 500 members! Today the International Astronautical Federation proudly represents 513 members from 77 different countries on all continents. This showcases the importance of the Federation in bringing together the international space community to collaborate and advance scientific knowledge.

2023 was also a year with outstanding events, the IAF organized its Global Conference in Norway, the International Astronautical Congress in Azerbaijan and the International Space Forum was held in Panama.

The IAF Global Space Conference on Climate Change (GLOC 2023) was the first conference of its kind. It was organized together with the Norwegian Space Agency (NOSA) in Oslo, Norway 23 – 25 May 2023. During the three days more than 600 delegates from 45 different countries gathered in Oslo to discuss this critical matter that will hugely impact our future on Earth. Many of the sessions were also streamed online with over 4000 viewers connecting from all over the world! GLOC 2023 served as a dynamic platform for connecting the international community and fostering a meaningful dialogue among diverse stakeholders, both space and non-space actors. I am convinced that together, we can harness the power of space to create a more sustainable and resilient future for our planet.

In October, the IAC returned to Baku after 50 years. The 74<sup>th</sup> International Astronautical Congress in Baku, Azerbaijan was a resounding success and proved to be the most diverse event in Federation history! Our host Azercosmos, the Space Agency of the Republic of Azerbaijan, worked tirelessly to organize an incredible Congress attended by 5385 delegates from 132 countries. Under the theme “*Global Challenges and Opportunities: Give Space a Chance*”, the focus during IAC 2023 was on sustainability, security, and international collaboration. We had the pleasure to connect the IAF World Space Award Winner, Elon Musk, virtually to the IAC, for an exciting talk on future plans for SpaceX’s Starship project. The virtual talk was a huge success and has been viewed 49 million times since the live webcast. Also, for the first time as part of the IAF International Astronauts Chapter, IAC brought together 17 International Astronauts covering space flights from 1969 to 2023.

Next year we are looking forward to inviting you to Milan, Italy for the 75<sup>th</sup> International Astronautical Congress on 14 – 18 October 2024. It is a pleasure organizing this event with our host and longstanding IAF member, the Italian Association of Aeronautics and Astronautics (AIDAA) and the two co-hosts Italian Space Agency (ASI) and Leonardo. While this is the fifth IAC taking place in Italy, it is the first IAC ever to be organized in the city of Milan. The theme for 75<sup>th</sup> International Astronautical Congress is “*Responsible Space for Sustainability*”, our intention is to highlight the importance of Space as an environment that must be kept secure and open to exploration, peaceful use, and international co-operation by present and future generations in the interests of the planet and all nations, regardless of their level of development and without discrimination of any kind.

Finally, I would like to wish everyone a magical holiday season, and a happy new year filled with Space!

# IAF 2023

## Events Overview



# IAF General Assembly Report 2023

The International Astronautical Federation General Assembly has gathered during the International Astronautical Congress, IAC 2023 in Baku, Azerbaijan in two sessions (Monday, 2 October 2023, and Friday, 6 October 2023).

## 2023 Elections of IAF Officers

Four new Vice-Presidents have been elected by the General Assembly:



**Michal BRICHTA**, Head of the Slovak Investment and Trade Development Agency (SARIO) - Slovak Space Office, has been appointed as IAF VP for **Global Membership Development and Financial Matters**



**Daming LI**, President, China Academy of Space Technology (CAST), has been appointed as IAF VP for **Societies and Museums**



**Geraldine NAJA**, Director for Commercialisation, Industry and Procurement, European Space Agency (ESA), has been appointed as IAF VP for **Industry Relations and Space Economy**



**Asanda SANGONI**, Acting Managing Director, Earth Observations, South African National Space Agency (SANSA), has been appointed as IAF VP for **Honors and Awards**

In addition, President Clay Mowry has nominated the following Special Advisors:



**Gabriella ARRIGO**, Director International Affairs, Italian Space Agency (ASI), as **Special Advisor to the President on the International Space Forum (ISF)**



**Joe LANDON**, Lockheed Martin Corporation, as **Special Advisor to the President on the Sustainability, Investment and Security (SIS) Agenda**



**Dominique TILMANS**, President, EURISY, as **Special Advisor to the President on Parliamentary and Ministerial Relations**



**Masami ONODA**, Director Washington Office, Japan Space Exploration Agency (JAXA), as **Special Advisor to the President on the IAF Hub**



**Giorgio SACCOCCIA**, Advisor, European Space Agency (ESA), as **Special Advisor to the President on the IAF Hub**

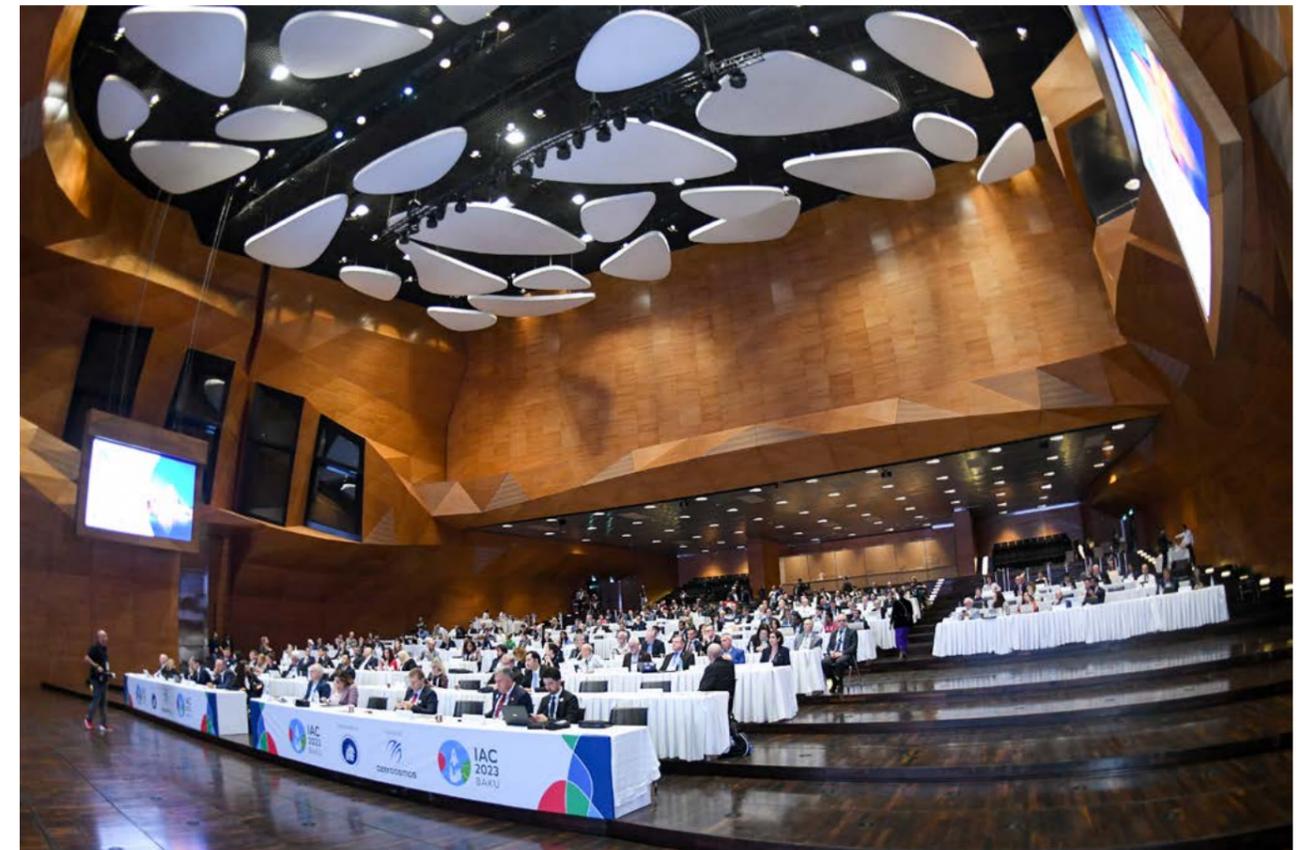


## Selection of Host City for IAC 2024

The IAF General Assembly at its second session on 6 October 2023, selected Antalya, Türkiye as Host City for IAC 2026. The Hosting Organization is the Turkish Space Agency (TUA), an IAF member since 2021.

## IAF Finance

The IAF has also approved the **final accounts 2022 and Auditor's Statement 2022** and the **revised budget and preliminary accounts 2023** and the **Proposed Budget 2024**.



## New IAF Members

The IAF General Assembly also approved the applications of **55 new Member Organizations**. With this, the IAF Membership comprises **513 Member Organizations** from **77 countries**, bringing 2 new countries in the Federation Members' community, Ghana and Uzbekistan, re-confirming IAF's position as a truly global Federation.

The New IAF Members are:

Organization	Category	Region	Country
Académie de l'air et de l'espace - Air and Space Academy - AAE	Association & Professional Society	Europe	France
ADA SPACE CO., LTD.	Industry	Asia	China
All Nations University	University	Africa	Ghana
Asociacion Civil Universidad de Ciencias y Humanidades	University	Latin America & Caribbeans	Peru
Association for Astronautics and Space Technologies (UAST)	Association & Professional Society	Europe	Croatia
Baku State University	University	Asia	Azerbaijan
CAS Space (Guangzhou Zhongke Aerospace Exploration Technology Co., Ltd.)	Industry	Asia	China
CubeSpace Satellite Systems RF	Industry	Africa	South Africa
Deep Space Exploration Laboratory (Tiandu Laboratory)	R&D Organization	Asia	China
Dynamic Genesis	Industry	Europe	Sweden
Edrive Space Technology Co., Ltd	Industry	Asia	China
EMROD	Industry	Europe	Germany
EUROLAB Laboratory	R&D Organization	Asia	Türkiye
Geostudios Ingenieria SAS	R&D Organization	Latin America & Caribbeans	Colombia
Hong Kong Polytechnic University	University	Asia	China
ICEYE	Industry	Europe	Finland
Indian Technology Congress Association	Association & Professional Society	Asia	India
Innovation Academy for Microsatellites, Chinese Academy of Sciences	R&D Organization	Asia	China
J.Denavaut communications-smart Lda	Industry	Europe	Portugal
Korea Advanced Institute of Science and Technology (KAIST)	University	Asia	Republic of Korea
Leanspace	Industry	Europe	France
Leonardo Spa	Industry	Europe	Italy
Miprons	Industry	Europe	Italy
Mission Control Space Services Inc.	Industry	North America	Canada
Mission Space	Industry	Europe	Luxembourg

Organization	Category	Region	Country
Monacosat S.A.M.	Industry	Europe	Monaco
National University of Science and Technology	University	Asia	Pakistan
NeuraSpace, SA	Industry	Europe	Portugal
OffWorld	Industry	North America	United States
Orbit Fab Ltd	Industry	Europe	United Kingdom
Orbital Space Technologies	Industry	Latin America & Caribbeans	Costa Rica
Poznan University of Technology	University	Europe	Poland
Remred Ltd.	Industry	Europe	Hungary
ReOrbit	Industry	Europe	Finland
ROKETSAN Roket Sanayi ve Ticaret A.S.	Industry	Asia	Türkiye
SARS Technology and Innovation Private Limited	R&D Organization	Asia	India
Satellite Research Center, Nanyang Technological University (NTU)	University	Asia	Singapore
SMARTCIRCUITS INNOVATION Private Limited	Industry	Asia	India
Solar MEMS Technologies S.L	Industry	Europe	Spain
Space Latam	Industry	Latin America & Caribbeans	Paraguay
Space Sustainability Rating	Association & Professional Society	Europe	Switzerland
SpaceBrainx	R&D Organization	Europe	France
SpaceNav, LLC	Industry	North America	United States
SPACETIDE Foundation	Association & Professional Society	Asia	Japan
Starfire 7 LLC	Industry	North America	United States
Technische Universität Dresden	University	Europe	Germany
The Astro Ben Podcast	Industry	Europe	United Kingdom
The Space Research and Technology Agency under the Ministry of digital technologies of the Republic of Uzbekistan (Uzbekspace agency)	Space Agency and Office	Asia	Uzbekistan
Trapp Networks PR Social Media GmbH	Industry	Europe	Germany
TURKSAT AS	Industry	Europe	Türkiye
TUW Technische Universität Wien	University	Europe	Austria
United States Accreditation, Inc.	Association & Professional Society	North America	United States
Universitas Telkom	University	Asia	Indonesia
University of Trento, Department of Physics, National PhD in Space Science and Technology	University	Europe	Italy
WeSpace Technologies Limited	Industry	Asia	Israel



# IAF Spring Meetings 2023

28-30 March 2023 | Paris, France



From 28 – 30 March 2023, the Bureau and members of the International Astronautical Federation (IAF) gathered in Paris, France for its annual Spring Meetings. Various events took place during the three days, including the selection of abstracts for IAC 2023; IAF “3G” Diversity events; committees’ meetings including two sessions of the IAF Bureau; and IAF GNF sessions.

The IAF Global Networking Forum featured inspiring sessions on Europe’s Space Ambition, IAC 2024, GLOC 2023 and the importance of bringing together the global space community despite political, societal, and geographical challenges. This was followed by the traditional IAF Cocktail. The IAF Spring Meetings finished off with a Press Conference on Wednesday afternoon.





# IAF Global Space Conference on Climate Change

23-25 May 2023 | Oslo, Norway





# GLOC 2023

# Opening Ceremony

The IAF Global Space Conference on Climate Change 2023 kicked off with a sense of urgency as space leaders from around the world met to discuss how space technologies can play a critical role in the fight against climate change in a first of its kind conference hosted by the Norwegian Space Agency (NOSA) in Oslo, Norway.

“Scientists are predicting that there’s a 66% chance that we will pass that threshold between now and 2027,” said opening ceremony moderator and BBC journalist Ru Kermani, referencing the 1.5 degree Celsius global warming limit set by the 2015 Paris Agreement. However, she added optimistically, “scientists also said that there’s still time to restrict global warming by cutting emissions sharply.”

IAF President Clay Mowry echoed this mission in his welcome remarks, stating “I can’t think of a more important and pressing topic than climate change.” He emphasized that without satellite data, “we wouldn’t understand the impact of climate change.” Mowry announced plans to make climate a focus of future IAF conferences as part of his sustainability agenda.

During his opening remarks the local host, NOSA Director General Christian Hauglie-Hanssen, challenged attendees to translate technical prowess into real-world impact. “Does launching yet another satellite solve the challenges of climate change?” he asked. “We want to provide useful insights to our politicians and decision makers,” he said, in

“Scientists are predicting that there’s a 66% chance that we will pass that threshold between now and 2027, (...) scientists also said that there’s still time to restrict global warming by cutting emissions sharply.”

order to “help them in their endeavor of making changes fulfilling the Paris Agreement. It’s really quite a thrill to be here at the first ever conference of its kind.”

Norway’s Minister of Climate and Environment Espen Barth Eide, built on Hauglie-Hanssen’s remarks during his keynote address to the GLOC attendees. “Spaceship Earth is in deep trouble,” Eide said, calling climate change “the most existential challenge of our time.” He stressed the need for space observation and insights to “inform Mission



GLOC 2023 - Opening Ceremony



Control” and help world leaders take appropriate climate action. Over half the data underpinning climate models comes from space, he noted, calling space capabilities “an increasingly important tool in the toolbox” for understanding and addressing the “triple planetary crisis” of climate change, biodiversity loss, and pollution.

Central themes of Eide’s keynote included the climate impact of deforestation and the role of satellites in monitoring forests, given their importance as carbon sinks. Eide touted his country’s International Climate and Forest Initiative, a 15-year global effort which utilizes space data to increase transparency around forest preservation. “We simply need to move to a net-zero world,” he said, noting that “the work that you’re doing here is incredibly important” for reaching that goal.

Eide’s remarks were followed by a special greeting to the conference from Emirati astronaut Sultan Al Neyadi from aboard the International Space Station. “We’re looking down at our beautiful planet from up here, we see no borders, but unfortunately we see the effect of climate change on our precious planet,” Al Neyadi said, stressing that “coordinated effort” between the space community and political decision makers is paramount for making progress on climate change.

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“ We simply need to move to a net-zero world, (...) the work that you’re doing here is incredibly important.”

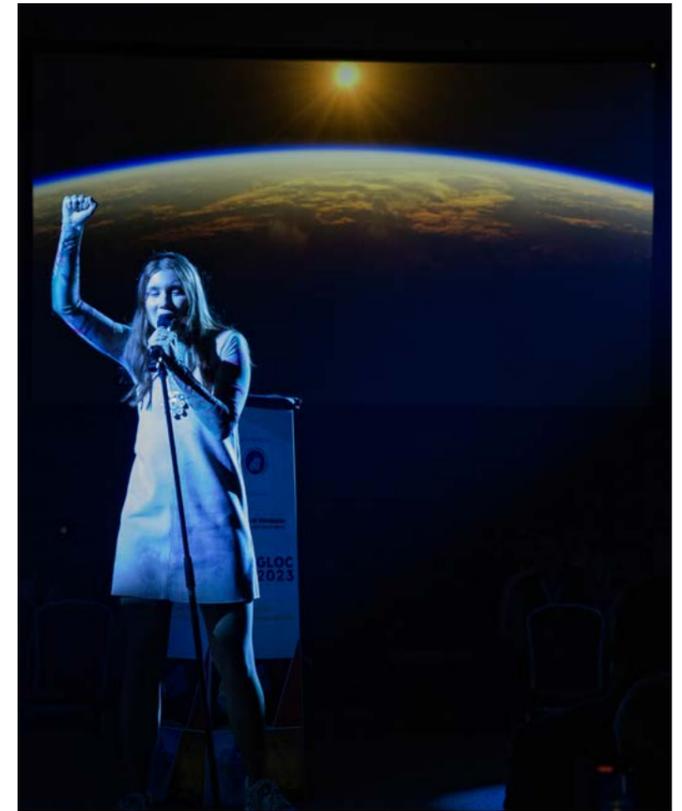
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Following Al Neyadi’s comments, Mowry announced that the joint Earth Observation Dashboard created by NASA, ESA, and JAXA was the winner of the new IAF Special Award on Space for Climate Protection. IAF Vice President for Honors and Awards Anthony Tsougranis explained that the award recognizes the project’s crucial role in translating complex scientific data into accessible information to “make space relevant to all of us.”

ESA Director General Josef Aschbacher accepted the award and dedicated it to the Dashboard team. “This is exactly what [the Dashboard] does - show the potential and power of Earth observation for humankind,” he said. NASA Chief of Staff Susie Perez Quinn thanked the NASA team, but also the end users applying the Dashboard’s vital data to “take action and inform themselves.” JAXA Vice President Koji Terada conveyed appreciation from JAXA President Hiroshi Yamakawa for recognizing their “effort to address global environmental challenges.”

The opening ceremony highlighted the critical need for space leaders to work together across borders and agencies to leverage space technology and data for the good of humankind. With climate change an existential threat, the conference aimed to catalyze tangible action plans to present at the International Astronautical Congress in Baku later in the year.





# GLOC 2023 Plenaries



## High-Level Plenary: Fire and Ice - Current State and Prospects for our Home Planet

In a thought-provoking plenary session titled “Fire and Ice: Current State and Prospects for Our Home Planet,” a diverse panel of experts examined the critical role of the space industry in understanding and addressing climate change. The session was moderated by BBC journalist Ru Kermani, who set the stage by invoking Greta Thunberg’s rallying cry for action that underscored the urgency of the climate crisis. Throughout the session, each panelist provided unique insights on the current status of the climate crisis and examined various ways that the space industry could help mitigate the fallout from this generation-defining challenge through collaboration.

“I think with space, we have a unique tool that can really help not only the developed countries, but really every single nation”

The first speaker was Richard Spinrad, Undersecretary of Commerce for Oceans and Atmosphere at NOAA, who offered a comprehensive overview of the Earth’s current state and the threats posed by climate change. Despite these threats, Spinrad expressed confidence in humanity’s ability to become climate realists and effectively mitigate and adapt to the changing environment. With advanced space technologies helping to provide a deeper understanding of the planet, he emphasized that we have the tools necessary to address the crisis, but it is imperative for the space industry—and the public at large—to turn these insights into effective action.

Norway’s Minister of Climate and Environment Espen Barth Eide highlighted the sense of urgency that governments feel in tackling climate change. “It’s late in the day,” Eide said. “We should have done this 30 years ago because we already knew enough, but there is much more action now.” While he acknowledged the progress made in recent years, he recognized the critique voiced by younger generations that it is still not enough. Eide stressed the importance of technology accessibility, particularly for emerging countries, to ensure global progress in reducing emissions.





Susie Perez Quinn, Chief of Staff at The National Aeronautics and Space Administration (NASA), shared her experience in persuading the US Senate to take action on climate change. She underscored the progress made in energy policy but emphasized the need for improved communication and visualization of space-related data. Quinn stressed the importance of engaging and inspiring people effectively by bridging the gap between scientific findings and public understanding.

Josef Aschbacher, Director General of the European Space Agency (ESA), discussed the joint approach of the European Union and ESA in the Copernicus program. He described the program's impact on our understanding of the planet and how it demonstrated the importance of international

cooperation among space agencies in tackling climate change. Aschbacher also highlighted the accessibility of Copernicus data, which is available free of charge to anyone in the world so that it can foster global collaboration on climate issues. "I think with space, we have a unique tool that can really help not only the developed countries, but really every single nation," Aschbacher said.

Koji Terada, Vice President of the Japanese Aerospace Exploration Agency (JAXA), shed light on international collaborations in addressing climate-related disasters, particularly in the Asia-Pacific region. He emphasized the significance of utilizing space technologies, such as Earth observation satellites, to respond effectively to disasters. Terada shared examples of international cooperation in providing satellite data for disaster management to showcase the power of collaboration.

In the second half of the session, the panelists shifted their focus to the role of regulation in the space sector, the integration of artificial intelligence (AI) in climate change data analysis, and the challenges and opportunities associated with technology accessibility.

Kermani initiated the discussion by questioning the need for improved regulatory frameworks in the space sector, particularly with the entry of commercial entrepreneurs. Quinn agreed. She highlighted the necessity of thoughtful regulation due to the increasing complexity and crowding of space. She acknowledged the immense benefits brought by commercial activity in terms of improved space access and strategies for ensuring conflict-free launches in an increasingly busy space environment.

Spinrad delved into the role of AI and machine learning in climate change research. While recognizing the potential of AI in prioritizing investments and enhancing prediction capabilities, he emphasized the importance of regulation in preventing potential misuse of AI technologies. Terada celebrated AI as a powerful tool capable of processing vast amounts of observation data. However, like Spinrad he emphasized the need for responsible AI use.

"AI is a powerful and convenient technology to deal with a huge amount of observational data," Terada. "On the other hand, we need to avoid the potential risk of misinformation, especially intentionally created misinformation. To mitigate the risk we should do inter-verification of information produced by different AI systems."

As the plenary drew to a close, the panelists underscored the significant challenges and opportunities in leveraging space technology to address climate change. In particular, they stressed the importance of data accessibility, international collaboration, and the involvement of diverse stakeholders—especially from younger generations—to tackle the global challenge of climate change. While the speakers celebrate all the progress that has been made to date, they all recognized the need for ongoing efforts to combat climate change and ensure a sustainable future for generations to come.

## High-Level Plenary: Understanding Needs, Bridging Gaps

In the battle against climate change, satellite data has emerged as a crucial weapon, providing scientists and policymakers with invaluable insights into Earth's changing ecosystems and atmospheric conditions. In a thought-provoking plenary session titled "High-Level Plenary: Understanding Needs, Bridging Gaps," a group of distinguished speakers delved into the challenges and opportunities surrounding the utilization of satellite data for climate action. In a discussion moderated by Spacewatch.global Editor in Chief Emma Gatti, the panelists sought to bridge the disconnect between climate change researchers and decision-makers.

The first speaker was Tom Gardner, the Head of Strategic Partnerships at the Maldives Space Research Organization, who drew attention to the unique hurdles faced by small island nations such as the Maldives. Gardner highlighted the inadequacy of existing open data platforms for small islands due to their size limitations. He stressed the urgent need for higher resolution and more frequent data to effectively combat issues like coastal erosion monitoring, biodiversity conservation, and precision agriculture.

"The beauty and the and the tragedy with satellite applications in the Maldives is these islands are small, with an average size of around one to two kilometers," Gardner said. "I think one thing that's really missing is small island nation voices in the failure to have open data that is actually usable."

Nicole Keanu Evans, the Deputy Director of Crimes that Affect the Environment Program at the United Nations Office on Drugs and Crime, focused on the challenges of using satellite data to combat deforestation and timber trafficking. Evans emphasized the importance of capacity building within law enforcement agencies to enable them to analyze and act upon the data effectively. Additionally, she underscored the importance of improved communication and collaboration between law enforcement and civil society to facilitate streamlined information exchange and foster trust.

Julian Fox, the Team Leader for National Forest Monitoring (MRV), and Platforms at the United Nations' Food and Agriculture Organization, discussed forest monitoring and restoration efforts. Fox highlighted the positive impact of satellite data in supporting highly-forested countries' endeavors to combat deforestation and track progress. However, like Gardner he also pinpointed gaps in data accessibility, capacity to utilize the data, and linking the data to decision-making processes. To address these gaps, Fox stressed the importance of improved data dissemination, involvement of adjacent sectors, and institutionalization of efforts to ensure long-term sustainability.





Harshbir Sangha, the Director of Missions and Capabilities Delivery at the UK Space Agency, underscored the need to understand the specific requirements of satellite data end-users, including adjacent sectors like water companies, and to ensure effective data dissemination. He also announced a new climate services goal aimed at comprehending the data needs of consultants working with water companies, exemplifying the agency's commitment to collaboration and inclusivity.

Although each speaker brought a unique perspective to the challenges and opportunities around using satellite data to combat climate change, each participant underscored the need to address gaps in data usability, capacity building, collaboration, and involvement of civil society and adjacent sectors. Higher resolution and more frequent data were recognized as indispensable for informed decision-making. Additionally, improving data dissemination and establishing the right infrastructure and responsibilities at the national level were emphasized as crucial steps in harnessing the potential of satellite data.

"The challenge we face is dissemination of data," Sangha said. "Not just dissemination to climate academics or end

users, but to adjacent sectors that also have a huge role to play, whether that's the financial sector or legal and regulatory sector. How do we make sure that everyone is engaged at the right time and at the right level?"

One of the key themes of the panel was the importance of collaborating with a diverse group of stakeholders to make the most effective use of satellite data. In particular, the panelists urged increased engagement with local communities, in order to understand their needs and incorporate their expertise into climate action strategies.

The dialogue revealed the complexities of bridging the gap between the commercial world and climate change action. It emphasized the necessity of effectively communicating the value of data and the potential for commercialization. Making climate action commercially viable and rewarding countries for their conservation efforts were identified as crucial steps in driving sustainable change. The speakers acknowledged the multifaceted nature of the issue and highlighted the significance of political will, capacity building, and technological advancements as integral components of the solution.

"I think it's important to start with a step-by-step approach," Evans said. "That's bringing the right stakeholders together, bringing the space community to the local communities and starting a dialogue but at the same time not overwhelming them. It's not a process that can happen overnight. It's a slow process that depends on many factors."

Recognizing the need to involve non-space companies and actors in the dialogue, the speakers highlighted the importance of clear communication, diversifying the supply chain, and implementing regulatory frameworks that encourage industry primes to play a more active role. The session provided a compelling platform for diverse perspectives and emphasized the significance of collaboration, local context, effective communication, and a step-by-step approach in addressing climate change. Despite the challenges at hand, the speakers expressed unwavering optimism in finding solutions through collective efforts, forging a path towards a more sustainable future.

“The challenge we face is dissemination of data. Not just dissemination to climate academics or end users, but to adjacent sectors that also have a huge role to play, whether that’s the financial sector or legal and regulatory sector. How do we make sure that everyone is engaged at the right time and at the right level?”

## High-Level Plenary: Space as a Toolbox for Climate Action Now

In an era marked by escalating climate challenges, space technologies have emerged as a vital ally in the battle against environmental degradation. From satellite observations to cutting-edge remote sensing systems, these high-tech tools are revolutionizing our understanding of Earth's climate and aiding in the development of targeted strategies to mitigate its impact. In a riveting plenary, "Space as a Toolbox for Climate Action Now," a distinguished panel of experts converged to shed light on the pivotal role of space technologies in combating climate change.

The plenary was moderated by Emma Gatti, the Editor in Chief of [spacewatch.global](http://spacewatch.global), who set the tone by underscoring the pressing nature of climate crises and the potential of space technologies to provide concrete solutions. She stressed the vital importance of understanding the needs of end users and fostering seamless communication between space agencies and local communities.

Throughout the session, each speaker shared their unique insights and perspectives on the subject. Phil Evans, Director General at EUMETSAT, drew attention to the overwhelming amount of data that end users often grapple with. He emphasized the criticality of providing actionable information that facilitates decision-making on the ground.

"Our end users are very often drowning in data and starving for information," Evans said. "In crises and emergency events, more information does not make decision making quicker, easier, or better. There's a critical issue for the space community to start with the decisions that people are making and think about how we can support those decisions in the best possible way."

Anke Kaysser Pyzalla, Chair of the German Aerospace Center (DLR) Executive Board, provided compelling examples of how space data has proven instrumental in responding to emergencies like floods and wildfires. She emphasized the significance of collaboration and training with authorities to ensure the effective utilization of space data in emergency response efforts.

Eric Laliberte, Director General for Space Utilization at the Canadian Space Agency (CSA), spoke passionately about the need for improved communication between space agencies and end users. Describing space agencies as "space solution architects," he underscored the importance of understanding the specific needs and goals of end users to design and implement effective solutions. Laliberte highlighted communication, partnerships, and user-centric approaches as essential factors in these implementations.

“Our end users are very often drowning in data and starving for information”

"It's not just about information, it's about the right information," Laliberte said. "We need to understand what the end user is going to use the data for and then we can do a better job at making sure we go forward with the right solutions."

The discussion also delved into the delicate balance between national interests and global collaboration. Einar Bjorgo, the Director of the United Nations Satellite Centre, stressed the importance of capacity development and collaboration at the national level to create a meaningful local impact.





Meanwhile, Lionel Suchet, the Chief Operating Officer at the Centre National d'Etudes Spatiales (CNES), acknowledged the competitiveness in the space sector, but highlighted the urgent need for cooperation, especially when tackling the shared challenge of climate change.

At its core, the discussion illuminated the dire need for a better understanding of end user needs, enhanced communication and collaboration, and a holistic approach to leverage space technologies and data in addressing climate emergencies. "The golden rule here is that you have to be able to understand the user needs and there's no one size fits all," Bjorgo said.

Christian Hauglie-Hanssen, Director General of the Norwegian Space Agency (NOSA), contributed to the conversation by emphasizing the importance of cooperation and data sharing among nations, particularly in the field of Earth observation. He questioned why high-resolution data is not readily available to countries like the Maldives, hinting at the necessity for international collaboration and support in accessing such vital information.

The lively conversation not only showcased concrete examples of how space technologies can tackle climate-related challenges, but also underscored the need for clear communication and honesty regarding the capabilities and limitations of these technologies. Monitoring emissions, pinpointing sources of emissions, and taking effective action on Earth were also highlighted as crucial endeavors in need of further development.

Laliberte further advocated for a balanced approach that encompasses commercial sources, international

partnerships, and sovereign systems. He cited CSA's Smart Earth program as an exemplary initiative focusing on applications that support the public good and government needs. Suchet emphasized the importance of both global and local perspectives in understanding and addressing climate change. He discussed the crucial role of space-based monitoring, the necessity of data verification, and the potential of space technologies in tracking progress made under the Paris Agreement.

Evans highlighted the power of satellite imagery in appealing to the hearts and minds of individuals, creating awareness about the severe impacts of climate change. He also stressed the significance of reducing barriers for data discovery and application to facilitate collaboration and meet the diverse needs of users. Bjorgo concluded the panel discussion by emphasizing the significance of capacity development and training in utilizing space technologies for climate action. He strongly advocated for collaboration with governments and the value of developing tools that directly support the needs of end users.

The plenary illuminated the dire need for effective communication, collaboration, and data sharing to harness the full potential of space technologies in combating climate change. The panelists collectively underscored the importance of understanding local needs, closely monitoring emissions, engaging end users, and developing concrete solutions to confront the multifaceted challenges posed by climate emergencies. As the world grapples with the climate crisis, it is increasingly evident that space is not merely the final frontier, but a vital toolbox for safeguarding our planet's future.

## From Earth Observation Data to Successful Climate Policy - the Role of the Space Industry

In the age of abundant space data, bridging the gap between scientific insights and actionable policy has become paramount in the battle against climate change. As satellite observations and remote sensing technologies unveil the intricate workings of our planet, translating this wealth of information into effective policies holds the key to driving meaningful climate action. In a high-level plenary session, space industry leaders discussed how collaboration, education, and communication can help bridge the gap between different sectors and fully utilize the space industry's crucial data and analytics to address climate challenges.

Niels Wielaard, CEO of Satelligence, emphasized the challenges caused by the language barrier between different sectors. He pointed out that corporations, despite their potential, often lack the capacity to understand the significance of Earth observation data. This disconnect hinders progress, leaving a large gap between the private and public sectors.

"There are still many companies that don't have monitoring and don't take action," Wielaard said. "Most of us are still living in parallel universes. We're all living in silos, and silos hamper progress."

Rolf Skatteboe, President and CEO of Kongsberg Satellite Services, highlighted the power of communication and transparency in driving policy change. Skatteboe shared a remarkable example of how the mere announcement that activities were being monitored had a profound impact on behavior. The knowledge that "big brother is watching" led to a reduction in illegal fishing and oil spills. Skatteboe stressed the importance of publicizing the data and letting the world know that actions are being observed.

Dyveke Rogan, Deputy Director of Norway's International Climate and Forest Initiative, discussed how the country's international climate and forest initiative, NICFI, has played a pivotal role in combatting climate change and preserving biodiversity by supporting tropical forest



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countries in protecting rainforests. Through the provision of free access to high-resolution satellite imagery, NICFI has enabled improved monitoring of these forests, empowering users from 158 countries to analyze the data and contribute to the global effort against deforestation. This collaborative effort between public and private actors showcases the potential of data accessibility and analysis in addressing the pressing climate and nature crises.

Will Marshall, CEO of Planet, discussed the transformative potential of data publication in driving policy change. Marshall presented the case of coral reef monitoring, where the publication of satellite data not only provided critical information but also sparked policy action. He emphasized that having the data out there, accessible to all, changed policy and heightened awareness. Marshall’s vision extended beyond satellite data, as he emphasized the growing importance of analytical services and artificial intelligence in extracting value from Earth observation data.

Julian Fox, team leader of National Forest Monitoring, MRV and Platforms at the UN Food and Agriculture Organization (FAO), shed light on the need for data sources like the NICFI satellite to support deforestation-free commodities. Fox stressed the importance of continuous data availability and emphasized the value of satellite data in benchmarking production cycles. With upcoming regulations on deforestation-free commodities, the NICFI program’s capacity and data have become critical for forest countries to comply and reduce deforestation while ensuring food security.

The panel also emphasized the importance of continuity, timeliness, and resolution in data collection. The need for collaboration and breaking down silos emerged as a recurring theme. The speakers called for increased communication and understanding between sectors, with the private sector playing a pivotal role in bridging the gap. Government support and flexible procurement mechanisms were also highlighted as crucial for accommodating the fast pace of technological change.

“We’re in a climate and nature emergency here and we can’t be in our silos,” Marshall said. “This is why these public private partnerships are exactly what we need, I think to break out. The private sector has some data to offer. The public sector has some ways of driving new mechanisms and markets.”

The key takeaways from the discussion were clear: collaboration, education, and communication are essential for leveraging Earth observation data to address climate challenges. The space industry, with its advanced satellite technology and innovative approaches, has the power to revolutionize climate policy. However, to maximize its impact, the industry must “get out of its space head” and focus on real-world applications and solutions. By working together and leveraging the power of space technology, the panelists agreed that we can unlock the full potential of Earth observation data and make significant strides in mitigating climate change.

## Progress on Measuring Critical Climate Variables – and What More Needs to be Done

Accurate measurements of climate change variables using space technologies have emerged as a critical tool in understanding and addressing the complex challenges of a warming planet. From monitoring greenhouse gas emissions to tracking sea level rise, these precise measurements enable scientists and policymakers to make informed decisions and implement targeted strategies in the fight against climate change.

In a high-level plenary session Earth observation leaders from several national space agencies gathered to discuss the strides made in measuring critical climate variables and the path forward for Earth observation. The plenary panel focused on international collaboration and cutting-edge space-based technology, the discussion shed light on the urgent need for accurate data and advanced monitoring systems to address climate change effectively.

The plenary was moderated by Karen St. Germain, NASA’s Director for Earth Sciences, who opened the session by highlighting the tremendous advancements made in the field over the past three decades. She emphasized the pivotal role of space-based observations in expanding our understanding of the water cycle and how water moves across the planet. With ground-based instruments providing limited insights, space agencies have played a crucial role in elevating our knowledge to new heights.

The discussion progressed to sea-level rise, where Selma Cherchali, Head of the Earth Observation Department, Centre National d’Etudes Spatiales, and Simonetta Cheli, Director of Earth Observation Programmes at ESA, underscored the historical partnerships and collaborations that have enabled accurate measurements. Missions like TOPEX/Poseidon, Jason, and Copernicus Sentinel-6 were instrumental in detecting sea level variations. Both Cherchali and Cheli stressed the significance of international cooperation, harmonizing data, and calibration to ensure the accuracy and reliability of the findings.

St. Germain also introduced the Surface Water Ocean Topography (SWOT) mission, highlighting its significance in monitoring smaller-scale ocean dynamics and the effects of climate change on coastal zones. Because SWOT’s global observations occur at a finer resolution, she predicted that they will revolutionize our understanding of water-related phenomena in the broader context of climate change.

The focus then shifted to ice and glaciers, with Godela Rossner, Head of Earth Observation Department at DLR, and Francesco Longo, Head of the Earth Observation Division at the Italian Space Agency (ASI), highlighting missions such as GRACE and GRACE Follow-On. These

“It’s really important not only to have this view of the past 20 years, but also to prolong it into the future. Earth observation puts us in the place to have a very holistic understanding of each and every process of the planet.”





missions provided critical insights into ice melting, particularly in Greenland, and its implications for rising sea levels. Both Rossner and Longo emphasized the need for continuous long-term observations to monitor ice changes and their impact on our planet.

“It’s really important not only to have this view of the past 20 years, but also to prolong it into the future,” Rossner said. “Earth observation puts us in the place to have a very holistic understanding of each and every process of the planet.”

The conversation also touched upon the decline in Arctic sea ice observed through space-based measurements. Koji Terada, the Vice President, Japan Aerospace Exploration Agency (JAXA), stressed the importance of continuous monitoring in polar regions using microwave imagers to track sea ice changes accurately. Terada also delved into the subject of precipitation, discussing the international cooperation between NASA, JAXA, and other agencies. By understanding convective systems and vertical velocity, Terada said, researchers aim to improve the accuracy of precipitation measurements, addressing a significant source of uncertainty in climate studies.

Throughout the discussion, the speakers reiterated the progress made through international collaborations and advanced space-based observations. Eric Laliberte, Director General for Space Utilization at the Canadian

Space Agency, pointed to the critical role of Canada’s consortium of universities in understanding climate variables and using them to take action. “Science is important for understanding, but the next step is making sure that the information can be transformed into usable data and for policymaking,” Laliberte said.

The panelists also stressed the need for continuous monitoring, long-term observations, and improved accuracy to better comprehend and address the challenges posed by climate change. Longo, for example, highlighted the significance of water prediction for flood events and the use of hyperspectral data to monitor water quality, while Rossner stressed the role of hyperspectral information in understanding biochemical processes in water ecosystems.

The plenary showcased the remarkable progress made in measuring critical climate variables through international collaborations and cutting-edge space-based observations. While the progress is encouraging, the panelists all acknowledged that there is still a lot of work to be done in further improving the accuracy of these measurements. In particular they highlighted the need for continuous monitoring, improved accuracy, and user-friendly data access to address the challenges of climate change effectively. But one thing was clear: by working together, the world’s national space agencies are rapidly enhancing our understanding of climate change and laying the foundation for a sustainable future.

## Planning for a Future with a Changing Climate

In the face of a changing climate, the space industry emerges as a key ally in preparing humanity for an uncertain future. From monitoring Earth’s vital signs to enabling advanced modeling and forecasting, space technologies provide invaluable tools that help us understand, adapt to, and mitigate the challenges posed by a shifting climate, empowering us to build resilience and safeguard our planet for generations to come.

In a dynamic and engaging discussion moderated by Sarah Gallagher, the Director of the Institute for Earth and Space Exploration at the University of Western Ontario, a broad range of experts representing several national space agencies underscored the crucial role of space technology and Earth observations in addressing the challenges of climate change and disasters.

Katherine Calvin, Chief Scientist and Senior Climate Advisor at NASA, opened the session by shedding light on several science gaps in climate modeling, including limited understanding of mineral dust’s impact on warming and the imperfect knowledge of cloud and aerosol effects on climate sensitivity. She pointed to ongoing and upcoming missions aimed at filling these gaps, such as the atmosphere observing system and the surface water and ocean tomography mission (SWOT). “By using satellite information from EMIT or some of these future missions we can improve those models and improve our understanding of potential future emissions,” Calvin said.

Prakash Chauhan, Director of India’s National Remote Sensing Centre, focused on the challenges faced by tropical countries like India, especially concerning water and agriculture. He shared insights into the upcoming Trishna satellite mission, a collaborative effort between India and Canada. This mission aims to provide valuable information on evapotranspiration and crop water demands, enabling better agricultural practices. Chauhan also emphasized the need for improved humidity and temperature profiling in the tropics, along with capturing wind information over land to comprehensively understand Earth systems.

Rune Floberghagen, Head of Science, Applications, and Climate Department at European Space Agency (ESA), highlighted the potential of Earth observation data and space technology in facilitating a green transition and achieving global objectives in mitigating climate change. She emphasized the importance of collaboration, co-development, and co-ownership among various stakeholders, including space agencies, businesses, and governments. “What we are doing here is actually to come up first of all with practical examples that show to the world, to governments, what space can do beyond what it has traditionally done,” Floberghagen said. “Everybody can support these things and some of the applications that in the beginning



are initiated by space technology will get scaled by these other organizations and businesses that would like to support it.”

John Moores, Science Advisor to the President at the Canadian Space Agency (CSA), highlighted the significance of capturing the entire water cycle and discussed potential collaboration among different facilities to achieve this feat. He highlighted the game-changing SWOT mission, which is instrumental in monitoring lakes, particularly in remote regions like the Canadian Arctic. Additionally, he highlighted the Terrestrial Snowmass mission (TSM) and its potential in enhancing our understanding of snowpack and its water equivalent mass.

During the session, the panelists addressed the benefits and drawbacks of competition in the space sector. They emphasized the value of multiple approaches and diverse perspectives, which drive innovation and enhance understanding. However, they also stressed the need for coordination and collaboration to maximize the potential of space technology in planning for a climate-changed future.



# GLOC 2023

## Highlight Lectures



### Earth Observation for Building a Climate Ready Society

In the battle against climate change, remote sensing has emerged as a powerful weapon, providing a bird's-eye view of our planet's changing dynamics. From monitoring deforestation and tracking greenhouse gas emissions to assessing the health of ecosystems, this technology enables scientists and policymakers to make informed decisions and implement targeted strategies for a more sustainable future. In a captivating highlight lecture, Richard Spinrad, the Undersecretary of Commerce for Oceans and Atmosphere at the US National Oceanic and Atmospheric Administration (NOAA), presented a comprehensive overview of how remote sensing and data analysis can empower individuals, policymakers, and industries to make informed decisions in the face of climate change.

Spinrad opened his lecture by underscoring the sense of urgency in combating climate change. "The wolf is no longer at the door, the wolf is in the house," he said. "We are all feeling the impacts of climate change right now. This is no longer a theoretical consideration for our children and our grandchildren."

Spinrad drew attention to the interconnectedness of climate-related challenges, which link everything from insurance to the basic need for sustenance. Every aspect of our lives, Spinrad said, is linked to climate change. To build a climate-ready society, Spinrad emphasized the need for accurate and reliable data that can be transformed into actionable intelligence. "You don't want to go shopping for who can sell you the cheapest climate products and services, you want to know that what you're getting is authoritative, reliable, and accessible," he said.

As an example of what this looks like in practice, Spinrad highlighted NOAA's vast portfolio of assets used to collect data from the surface of the sun to the bottom of the ocean. These capabilities enable scientists to measure various physical parameters, including sea surface temperature,

atmospheric chemistry, tsunami detection, and coral reef health. But data alone is not enough. Spinrad stressed the importance of translating the collected data into meaningful products and services. "Unless we can start demonstrating what this data is doing for us, it's nothing more than pretty pictures," he said.

As an example, Spinrad discussed NOAA's Climate Mapping for Resilience and Adaptation (CAMERA) product, which it developed in collaboration with ESRI. This online tool enables users to assess their local climate risks and make informed decisions based on accurate and up-to-date data. By providing such information, NOAA empowers decision-makers and communities to respond proactively to climate-related challenges.

In addition to highlighting the achievements and capabilities of NOAA, Spinrad emphasized the importance of partnerships and international collaboration. He acknowledged the role of organizations like the International Astronautical Federation (IAF) and the Group on Earth Observations (GEO) in driving innovation and addressing global climate issues. Working together, these entities can shape the future of climate-related products and services, such as those focused on global drought and heat health.

Spinrad concluded his lecture by emphasizing the need to support decision-making at all levels of society. As climate-related disasters become more frequent and severe, the demand for accurate and accessible data becomes critical. The goal is not only to create a climate-ready nation but also a climate-ready globe. By harnessing the power of Earth observation, individuals, industries, and policymakers can navigate the challenges of climate change and build a more resilient and sustainable future. "You all are part of the solution," Spinrad said. "It's important to ensure we not only have climate-ready nations, but also a climate-ready globe."



“We are all feeling the impacts of climate change right now. This is no longer a theoretical consideration for our children and our grandchildren.”

## Operational Products and Services

Amidst the urgent global climate crisis, the imperative to align national and global priorities and solutions has taken center stage. As nations grapple with the interconnected challenges of rising temperatures, extreme weather events, and dwindling resources, collective action and cooperation become paramount in charting a sustainable path forward for the well-being of both present and future generations. Rodrigo Da Costa, the Executive Director of the European Union Agency for the Space Program (USPA), dove into these issues in the context of the space sector in a highlight lecture titled “Operational Products and Services.”

Da Costa’s lecture drew on his experience at USPA to shed light on the European Union’s efforts to align its climate strategy with global initiatives such as the United Nations 2030 agenda, the Paris Agreement, and other sustainable development goals. Da Costa began by providing an overview of the USPA and its activities, including its support of satellite navigation systems such as Galileo, which has over three and a half billion users worldwide, and EGNOS, which plays a vital role in aviation and other areas with a direct impact on the climate.

Another crucial aspect of the USPA’s work is the Copernicus program, which generates a vast amount of Earth observation data. Da Costa noted that the USPA is also involved in activities related to secured communications and space situational awareness, among others. He emphasized that while the USPA is the EU agency for the space program, it works in close partnership with the European Commission, the European Space Agency, industry, and academia to bring its program to fruition.

During his lecture, Da Costa described three key pillars of USPA’s work: exploitation, security, and fostering market uptake. Regarding exploitation, the agency operates and maintains satellite-based capabilities like Galileo and EGNOS, providing services to users around the clock. The security aspect involves ensuring the satellites and systems are protected from cyber threats and physical damage, while also making the services and data available for use in the security domain.

But it is USPA’s focus on fostering market uptake that is perhaps most critical for ensuring a return on the European Union’s substantial investment in space activities. Da Costa stressed the agency’s commitment to aligning its priorities with those of the European Union, which include implementing the European Green Deal, driving digitalization, and promoting a stronger and more collaborative Europe. He emphasized that space data and services are indispensable for achieving the Green Deal objectives, such as efficient transport, precision agriculture, energy management, and smart cities.



“I think it will be very difficult, if not impossible, to attain the Green Deal objectives without space data and without space services,” Da Costa said. “As you can imagine, this is a massive investment for the European Union and I think it’s fair that people want to see a return, and that return comes in the form of adoption so we’re doing lots of market development activities with end users.”

Regarding the role of businesses, Da Costa underscored the European Union’s commitment to fostering innovation and entrepreneurship. He mentioned financing initiatives like Horizon Europe and the Cassini program, which support startups and entrepreneurs in developing innovative climate products and applications. Da Costa also touched upon the forthcoming report on how the EU space sector can contribute to supporting a world that now has 8 billion people, emphasizing its focus on precision farming, efficient transport, and other key areas. “We have been using quite a lot of our means to promote innovation and promote entrepreneurship that leads to development of innovative climate applications,” Da Costa said.

In response to audience questions, Da Costa addressed the agency’s collaboration with the European Space Agency, emphasizing the strong partnership between the two entities. “Collaboration and partnerships are crucial,” he said, highlighting their shared objectives and the collaborative work they undertake in areas such as Galileo.

As Da Costa concluded his lecture he underscored the European Union’s commitment to leveraging space data and services in addressing climate change and achieving sustainable development goals. With a strong focus on climate action and innovation, Da Costa said, the USPA aims to create a sustainable and resilient future for the European Union and beyond.

## How Humans are Changing Earth

In a captivating highlight lecture, Katherine Calvin, Chief Scientist and Senior Climate Advisor at The National Aeronautics and Space Administration (NASA), shed light on the profound impact of human activity on Earth’s climate. With her expertise and a trove of data from NASA’s extensive satellite fleet, Calvin presented a compelling case for urgent action to address the consequences of climate change. Throughout her lecture, Calvin emphasized the importance of understanding the current state of our planet, predicting future changes, and devising effective strategies to mitigate and adapt to the evolving climate crisis.

Calvin commenced her lecture by highlighting NASA’s pivotal role in Earth observation. With over two dozen satellites and instruments orbiting the planet, including those on the International Space Station, NASA has been diligently monitoring Earth for decades. These satellites provide a comprehensive global perspective that enable scientists to study diverse phenomena such as vegetation, ice sheet changes, carbon dioxide levels, precipitation patterns, and more. Calvin emphasized that all this valuable information is publicly accessible, which

empowers communities worldwide to assess the state of their environment.

“We need to think about how to make the data accessible and easier to use so people around the world have what they need when they need it,” Calvin said. “Some of that involves more training, moving data to the cloud, thinking about data formats, and just trying to increase participation in our science so that the science has broader reach.”

During the lecture, Calvin delved into the most pressing issue facing our species: the warming of Earth’s climate. She presented a captivating animation depicting surface temperature observations since the late 1800s. The visualization unequivocally demonstrated that our planet is warming, with 2022 ranking as the fifth warmest year on record. Startlingly, the last nine years have been the warmest since modern record-keeping began. Calvin pointed out that while temperatures are rising globally, the warming is more pronounced over land and at higher latitudes. She underscored the need to recognize the severity of this trend and its implications for the future.



“We are innovating both in terms of new understanding as well as in new technologies,” Calvin said. “A big part of what we do is share everything we have with everyone around the world so that what we know can benefit all of humanity.”

Carbon dioxide, a major greenhouse gas, is well known as a key driver of global warming and Calvin showcased an animation of carbon dioxide concentrations derived from satellite observations. The data demonstrates how human activity is primarily responsible for the rising levels of carbon dioxide in the atmosphere. She explained that while carbon dioxide concentrations exhibit seasonal variations due to plant responses, the overall upward trend is alarming and continues to amplify the greenhouse effect that significantly contributes to the warming of our planet.

Beyond carbon dioxide, Calvin emphasized the role of methane, another potent greenhouse gas, in exacerbating climate change. She presented a captivating visualization of global methane concentrations, showcasing the sources and intensity of methane emissions. Calvin emphasized that while methane accounts for a smaller proportion of current warming compared to carbon dioxide, its warming potential is significantly higher. As Calvin pointed out, methane emissions originate from various sources, including agriculture and energy production, and understanding and mitigating these emissions is crucial to comprehensive climate change solutions.

“Methane is a very potent greenhouse gas depending on the timescale,” Calvin said. “So in 20 years, it’s about 80 times the warming potential of carbon dioxide and in 100 years it’s about 25 times.”

Calvin further explored the impacts of climate change on Earth’s systems, focusing on key areas such as ice sheets, sea level rise, extreme weather events, and changes in land use. Utilizing satellite data from NASA’s GRACE and Landsat missions, she provided visualizations that vividly illustrated the irreversible loss of ice sheets, resulting in rising sea levels. Calvin emphasized the urgency of recognizing these long-term irreversible changes and their consequences for coastal regions worldwide.

“When you’re actually thinking about these impacts, it’s not global changes that people relate to. It’s what’s happening where I live,” Calvin said. “And it’s not just what’s happened until now, but what might happen in the future. How can I use that information to plan? So NASA

has provided information like that so you can look at how much the sea level has risen in your coastal area.”

As part of her lecture, Calvin also addressed extreme weather events, including hurricanes, droughts, and wildfires. She showcased satellite data that revealed an increase in the intensity and frequency of extreme precipitation events, as well as shifts in hurricane tracks, which have devastated global agriculture, water resources, and vulnerable ecosystems. Calvin underscored the need for proactive measures to manage these evolving climatic conditions effectively.

While outlining the alarming trajectory of climate change, Calvin emphasized the importance of action and the role NASA plays in developing innovative solutions. For example, she discussed NASA’s collaboration with the aviation industry to reduce energy use and emissions associated with air travel and the agency’s contributions to sustainable agriculture and resource management, which includes research on crop cultivation in space that has led to advancements in LED lighting, fertilizer optimization, and water management in agriculture. These innovations have the potential to revolutionize farming practices on Earth, improving efficiency and reducing environmental impact.

“We are innovating both in terms of new understanding as well as in new technologies,” Calvin said. “A big part of what we do is share everything we have with everyone around the world so that what we know can benefit all of humanity.”

Calvin’s highlight lecture served as a wake-up call to the pressing realities of human-induced climate change. Through NASA’s extensive satellite fleet and cutting-edge research, Calvin provided compelling evidence of Earth’s warming, rising greenhouse gas concentrations, and the resulting impacts on our planet’s systems. She stressed the need for swift and decisive action to mitigate and adapt to climate change, while also highlighting NASA’s contributions in developing innovative technologies and fostering open science. The lecture was a call to action as we face a critical juncture in safeguarding our planet’s future.



## GLOC 2023

# IAF Global Networking Forum (IAF GNF)



## IUU Fishing - Using Space Technology to Address Organized Crime in the Global Fishing Industry

As the demand for seafood continues to rise, the global fishing industry finds itself ensnared in a web of illegal activity and organized crime, undermining conservation efforts and jeopardizing the sustainability of marine ecosystems. A diverse collection of speakers came together during a Global Networking Forum session to discuss the innovative use of space technology to combat organized crime within the global fishing industry. The speakers represented organizations such as Blue Justice Initiative, BarentsWatch, and Kongsberg Satellite Services and shed light on the challenges posed by illegal, unreported, and unregulated (IUU) fishing and the powerful role satellite data plays in addressing this pressing issue.

The session was moderated by Martin Skedsmo, a Key Account Manager of EO Sales at Kongsberg Satellite Services, who kicked off the discussion with a video featuring Gavin Bellamy, CEO of the National Fisheries Authority in Jamaica, who described the destructive impact of illegal, unreported, and unregulated (IUU) fishing. Bellamy highlighted several dire consequences of these activities including depleted fish stocks, ruined marine habitats, distorted competition, weakened coastal communities, and the violation of local and international laws. In the recorded address, Bellamy stressed the crucial role of satellite information in empowering targeted enforcement efforts and called for a unified global effort to combat organized fishing crimes.

Gunnar Stolsvik, Director of the Blue Justice Initiative, elaborated on the organization's mission to support countries in the global south in combating fishing crime. Stolsvik highlighted the need for enhanced interagency cooperation and collaboration to effectively tackle the challenges posed by IUU fishing. In particular, he discussed the instrumental role of satellite and space technology in the organization's fight against illegal fishing, which enables them to better monitor fishing activities around the globe.

"The main problem we're seeing globally is that this is transnational organized crime," Stolsvik said. "Organized criminals are experts at reorganization and we as governments have to have structures that make us adaptable so we can face these new challenges and changing modus operandi."

Nina Buvang Vaaja, the Director of BarentsWatch, delved into the Norwegian model of interagency cooperation exemplified by the organization. BarentsWatch is a groundbreaking platform that gathers data from diverse sources and provides a comprehensive digital service to enhance situation awareness and coordination among government

agencies. Its resounding success in Norway prompted its adoption for the international fight against organized crime at sea through the Blue Justice Initiative.

Marte Indegard, Chief Commercial Officer of Kongsberg Satellite Services, discussed the vital role of ground station services and satellite data in maritime monitoring.



“The main problem we’re seeing globally is that this is transnational organized crime. Organized criminals are experts at reorganization and we as governments have to have structures that make us adaptable so we can face these new challenges and changing modus operandi.”

She stressed the importance of fast access to information and the integration of various sensors, including signals from ESA's Automatic Identification System (AIS) satellite and advanced artificial intelligence mapping tools. Indegard also emphasized the significance of collaboration and discussed some promising advancements in satellite technology that could further protect the world's oceans from IUU fishing.

Throughout the discussion, the panelists collectively underscored the significance of space technology, including satellite data and artificial intelligence, in combating IUU fishing and addressing organized crime in the fishing industry. Some recurring themes revolved around the dire need for interagency cooperation, global solutions, and improved access to information to facilitate effective enforcement and protection of marine resources.

"For all coastal states, it's a challenge to control the ocean areas because you cannot be at all places at all times," Vaaja said. "The technology alone is not enough, you also need the interagency cooperation."

Stolsvik, for example, emphasized the adaptability of governments and the necessity of structures capable of responding to the ever-changing modus operandi of organized criminals. He championed the Blue Justice Initiative and the BarentsWatch tool as enablers of interagency cooperation and providers of crucial information for combating economic crime and human trafficking. Vaaja shed light

on the success criteria of BarentsWatch, highlighting the strong political initiative behind its establishment and its mandate to work beyond traditional bureaucratic limitations. The tool's focus on end users' needs and its agile development methodology were key factors contributing to its success.

Drawing from the success of the NICFI satellite program in rainforest preservation, Indegard discussed the potential for establishing a similar program to address IUU fishing. However, the endeavor requires additional information and funding to enhance existing platforms like BarentsWatch and ensure their effectiveness in aiding third-party countries. At the same time, it is critical that these programs uphold privacy rights and build trust between the industry and governments. This, the panelists agreed, is key to fostering a robust partnership to combat IUU fishing.

The GNF panel brought to the forefront the remarkable potential of space technology in fighting organized crime within the fishing industry. The path ahead requires further advancements in technology, increased funding, and the unwavering dedication of all stakeholders in this critical endeavor. But with satellite data, interagency cooperation, and innovative platforms, the panelists were optimistic that governments, industry players, and end users can collaboratively protect our oceans and preserve marine ecosystems from the devastating impact of illegal fishing.

## Fire - Addressing Climate Change Measurement and Impacts in the Tropics

As the world faces the escalating challenges of climate change, the insights shared in this session provide a foundation for informed decision-making and policy formulation. The availability and utilization of space data, coupled with ongoing research and collaboration, offer hope that we can preserve our planet's invaluable tropical forests and mitigate the devastating effects of climate change in these regions.

In a thought-provoking IAF GNF session moderated by Andrea Vena, the Chief Climate and Sustainability Officer at ESA, a panel of esteemed experts delved into the pivotal role of space data in understanding and combating the adverse effects of deforestation, forest degradation, and wildfires. With an emphasis on the tropics, these discussions shed light on the urgent need for action and the transformative potential of leveraging data and technology.

Julian Fox, the Team Leader of National Forest Monitoring, MRV, and Platforms at the Food and Agriculture Organization of the United Nations, underscored the progress made in the REDD+ process, which aims to reduce emissions from deforestation and forest degradation in developing countries. He highlighted the invaluable use

of space data from platforms such as NASA's Landsat and ESA's Copernicus in establishing reference levels for forests and monitoring changes in their ecosystem.

"One thing we found really powerful for using space data is open data catalogs and source tools so countries can interact with space data, create really locally relevant data, and also participate in international mechanisms," Fox said.

Dominic Fawcett, an Earth Observation Scientist and Research Fellow in the Landscape and Ecosystem Dynamics Group at the University of Exeter, shared his expertise in estimating deforestation and forest degradation levels using space data. His work focuses on employing top-down approaches that utilize satellite observations to track above-ground carbon stocks, complemented by bottom-up modeling to comprehend the intricate processes of degradation and recovery.

Karen St. Germain, the Director for Earth Science at NASA, stressed the significance of space data in monitoring and predicting wildfires in tropical regions. By leveraging mid and thermal infrared channels and global nightlights, her team can effectively track wildfires in real-time using the



the environmental impact of fires, including the measurement of burned areas and fire radiative power. These satellite-derived observations contribute to a comprehensive understanding of the climate effects and the subsequent destruction of critical carbon sinks.

Alessia Tricomi, a Senior Remote Sensing Data Scientist at E-Geos, emphasized the crucial role of space data in monitoring fires, deforestation, and forest disturbances. Her focus on utilizing hyperspectral and synthetic aperture radar (SAR) data has yielded valuable insights for emergency management, fuel type assessment, and specific regional monitoring. By harnessing these technological advancements, projects under the Ur-Clinic initiative have been able to deploy effective responses to environmental challenges.



A key theme that emerged from this session was the indispensability of tropical forests in the context of climate change. These lush regions play a pivotal role in absorbing and storing carbon, making their preservation crucial to mitigating global warming. The panelists also emphasized the pressing need for institutionalizing data-driven solutions at the national level and addressing challenges such as limited public finances and regulatory compliance.

Another crucial aspect discussed was the importance of early detection and prediction of wildfires. The experts underscored the value of diverse data sources, including hyperspectral and thermal measurements, in understanding pre-fire conditions and associated risks. By harnessing the power of these observations, scientists and policymakers can proactively manage forests and prevent devastating wildfires.



"I think that it's evident that it's important to exploit different types of data from different types of sources," Tricomi said. "Local communities are also crucially important. We can use their knowledge of the territory and validation data."

Finally, the panelists stressed the importance of involving local communities in these efforts because they are often the first to be impacted by climate change. These communities possess invaluable knowledge about their territories and can provide vital validation data for monitoring efforts. Moreover, the participation of development institutions was recognized as a critical factor in providing resources and fostering a global perspective in addressing these particular climate challenges.

FireCast tool. This cutting-edge technology, developed in collaboration with Conservation International, enables timely alerts and informed decision-making to mitigate the impact of wildfires.

"We don't want to be in a reactive posture, we want to actively manage forests," St. Germain said. "It's bringing together more types of data that can inform us about the entirety of the conditions so you can really start to get to the kinds of services that that managers need before they're in a crisis."

Suzanne Mecklenburg, Head of the ESA Climate Office, shed light on the measurement of CO2 emissions from fires and the consequential effect on the atmosphere. She highlighted the essential role of space data in evaluating

The session concluded with a call to action, urging stakeholders to combine data from various sources intelligently to gain a holistic understanding of the carbon, water, and energy cycles. Recognizing the uncertainties inherent in data, effective communication and transparency were deemed crucial to ensure the accurate interpretation and utilization of space-derived insights. The IAF GNF session showcased the transformative power of space data and emphasized the need for collaborative efforts to protect our invaluable natural resources for generations to come.

## Communicating about Climate Change: Can the Space Industry Tell Our Story Better?

As our planet faces the formidable challenges posed by climate change, the space industry has a pivotal role to play in communicating the gravity of the crisis and galvanizing collective action. By embracing innovative communication strategies and bridging the gap between science and public understanding, the space industry can unleash its full potential to drive meaningful change. During a panel session titled “Communicating about Climate Change: Can the Space Industry Tell Our Story Better?” explored how to leverage effective communication techniques to convey the realities of climate change and inspire action.

The session was moderated by Krystal Azelton, Director of Space Applications Programs, Secure World Foundation (SWF), who set the tone by emphasizing the urgent need to broaden understanding and appreciation of space among policymakers, end users, and the general public. Azelton drew attention to the prevailing misconception that space-related news predominantly revolves around the billionaire space race, rather than the practical applications of space technologies that can combat climate change. She also stressed the importance of crafting effective communication strategies that address the younger

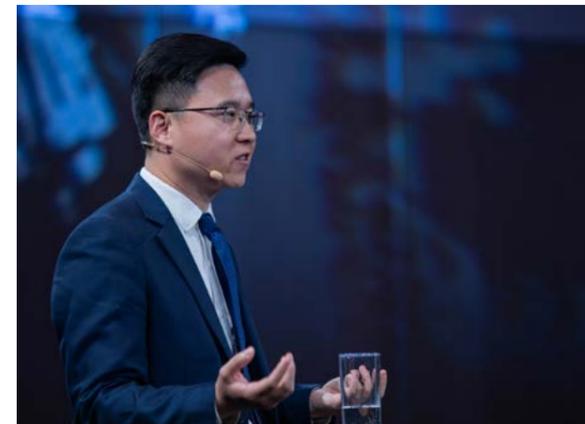
generation’s concerns about climate change and sustainability, capturing their attention and inspiring them to take action.

Wu Lei, a Producer and Senior Space Correspondent at CGTN, underscored the power of various media platforms in engaging audiences. They highlighted the influence of social media influencers in sharing captivating stories about space missions and their impact on climate change. Scientists, engineers, and influencers are using social media platforms and personal channels to communicate the importance of addressing climate change and how satellites can help in solving related problems. Ultimately, he said, collaboration between companies, media outlets, and tech reporters was emphasized as a means to enhance communication efforts and broaden the reach of climate change narratives.

“You need to tell the public that your products really matter for humanity,” Lei said. “This is especially true for the younger generations, but today they don’t watch TV or read papers. They just use cell phones and everything is on social media. So we need to tell them through social media programs.”



Aravind Ravichandran, the founder of TerraWatch Space, underscored the multidisciplinary nature of the space industry and its vast potential for addressing climate change. He emphasized the importance of visualizing satellite data and creating captivating content that transcends simple images and graphs. “We’re collecting so much data now that if we want to communicate about the impact of climate change we need to visualize it better,” Ravichandran said. Through engaging storytelling and compelling visuals, the space industry can effectively communicate the impact of climate change, enabling individuals to grasp the urgency and magnitude of the crisis.



Emma Gatti, the Editor in Chief of Spacewatch.global, delved into the delicate balance between simplification and accuracy in science communication. She also highlighted the information overload from public sector institutions and the lack of captivating communication from private companies as additional hurdles in effectively conveying the importance of space in addressing climate change. Recognizing the need to engage the public, Gatti highlighted the value of lighter and more artistic approaches, integrating various forms of art to create a new language of communication. By appealing to emotions and harnessing the power of art, the space industry can bridge the gap between scientific jargon and public understanding, captivating a wider audience and inspiring collective action.

Camille Bergin, Senior Business Development at Vast, shed light on the perception that the space industry is not seen as environmentally conscious, potentially dissuading younger generations from pursuing careers in this field. She noted the discrepancy between positive coverage of astronomy and negative or frivolous coverage of private aerospace activities. To bridge this gap, Bergin emphasized the necessity of meeting the expectations of the younger generation and improving communication efforts to showcase the space industry’s sustainability initiatives. By doing so, the industry can inspire young minds to become future stewards of our planet.

Controversy and politics within the space industry were not overlooked by the panelists. Lei emphasized the importance of collaboration, urging the industry to find effective solutions despite controversies. Gatti, meanwhile, emphasized the vital role of data and factual information in addressing controversies, ensuring that public discourse is grounded in scientific evidence.

In their closing remarks, the panelists collectively stressed the urgency of addressing climate change and translating discussions into concrete actions. They highlighted the immense potential of the space industry in combating climate change and called for enhanced communication efforts to effectively engage the public.

Despite their differing perspectives, the panelists agreed that effective communication about space and its benefits in addressing climate change requires finding new ways to merge scientific content with storytelling that engages and fulfills the public. By harnessing the power of compelling stories, impactful visuals, and aligning with people’s values and aspirations, the space industry can effectively convey the importance of addressing climate change and achieving sustainable climate solutions that benefit the entire planet.

“You need to tell the public that your products really matter for humanity.”

## Carbon Footprint of Monitoring Climate Change from Space

Satellite technologies and space-based observations are invaluable in monitoring climate patterns and aiding mitigation efforts, but it is crucial that the space industry addresses its own environmental impact, ranging from rocket emissions to space debris, in the quest for a sustainable future. During a GNF Session titled “Carbon Footprint of Monitoring Climate Change from Space,” experts from the space industry came together to discuss the carbon footprint associated with monitoring climate change from space. The panel included representatives from both private and public sector organizations such as the European Space Agency (ESA), ArianeGroup, Thales Alenia Space, Airbus Defence and Space, and SES. The conversation centered on the urgency of addressing the carbon footprint of space activities and the collective effort required to reduce it.

The session was moderated by International Space University President Pascale Ehrenfreund, who began by discussing the importance of recognizing the impact of space-related operations on carbon emissions, including satellite manufacturing, testing, and launches. As the space sector experiences unprecedented growth, it has become more important than ever to examine the environmental consequences and identify measures to minimize its carbon footprint.

Aurélie Gallice Tanguy, Climate and Sustainability Officer at ESA, shed light on the organization’s commitment to decarbonization. ESA has set ambitious targets to increase its positive impact on sustainable development and decrease its negative footprint through environmentally responsible management. By aiming for a 46% reduction in carbon emissions by 2030, ESA is taking a proactive stance in mitigating its environmental impact.

Thomas Marceau, the Head of Sustainability and Corporate Support at ArianeGroup, stressed the need to address the global space sector’s carbon footprint. He emphasized the significance of action aligning with rhetoric to uphold the sector’s credibility. Marceau advocated for a comprehensive approach that examines not only carbon emissions but also other ecological impacts from space activity such as effects on biodiversity and space debris.

“We’ve been hearing a lot about all the advantages that space can bring in order to fight against climate change, but that shouldn’t prevent us from taking care about our own impact,” Marceau said. “Because when we talk about space in public society, they don’t think about the satellites that help them navigate through the cities, they don’t think about all the satellite applications that help with climate change. Think about the impact.”

Cedric Balty, Director of Innovation and Chief Sustainability Officer at Thales Alenia Space, emphasized the holistic nature of sustainability in the space sector. Like Marceau, he highlighted the importance of considering climate effects beyond carbon emissions, including impacts on biodiversity and the handling of space debris. Balty also expressed Thales Alenia Space’s commitment to employee engagement, circularity, and exploring the potential of space technology to tackle global challenges.



Matthieu Derrey, Space Products Sustainability Manager at Airbus Defence and Space, shared insights into several sustainability initiatives undertaken by the company. He outlined the different contributors to carbon emissions, and described the company’s focus on reducing emissions in operations, facilities, and transportation. Airbus is also actively working on product footprints and engaging with suppliers through responsible procurement practices.

Sabrina Alam, Head of Space Sustainability and ESG Program Manager at SES, discussed the complexity of sustainability, which encompasses environmental, social, and governance aspects. She stressed the importance of collective action and partnerships to address sustainability challenges within the space sector. “I think there’s a common myth that tackling sustainability or climate change is easy,” Alam said. “We’re always asked why don’t you just do it? But it’s not simple, it’s a journey.” For example, Alam described how SES has devoted itself to space sustainability, climate action, and impact assessment, with the goal of making a positive impact on the planet while minimizing negative effects.

During the discussion, the panel acknowledged the need for regulations and guidelines to ensure consistent and comparable calculations of carbon footprints in the space sector. As an example, Tanguy described an initiative at ESA that provides guidelines and datasets for lifecycle assessments and eco-design in the space sector. The

“I think there’s a common myth that tackling sustainability or climate change is easy. We’re always asked why don’t you just do it? But it’s not simple, it’s a journey.”

panel also recognized the existence of data gaps, particularly in understanding atmospheric impacts of space activity, and highlighted ongoing efforts to improve data availability.

Overall, the panel emphasized the commitment of organizations in the space industry to reduce the carbon footprint associated with monitoring climate change from space. It underscored the importance of collaboration, shared methodologies, education, and government support in achieving sustainability goals. By fostering collective action, the space industry can make significant strides in mitigating its environmental impact while contributing to a more sustainable future.

## Global Methane Observing System

As the climate crisis intensifies, the critical role of monitoring and reducing methane emissions has come into sharper focus. While carbon dioxide receives significant attention, methane, a potent greenhouse gas, demands equal scrutiny as its short-term impact on global warming exacerbates the urgency for targeted mitigation efforts, making it a crucial component in the fight against climate change. Issues related to methane monitoring were addressed during a IAF GNF Session featuring speakers from a variety of space sectors who shed light on different approaches to methane monitoring and importance of collaboration, data accessibility, and trust-building among stakeholders in this mission.

The session was moderated by Barbara Ryan, Executive Director of the World Geospatial Industry Council, who began by underscoring the importance of accurate greenhouse gas information systems. She stressed that agencies like NASA, NOAA, and EPA play a crucial role in providing reliable, actionable, and freely accessible information to combat the climate crisis effectively.

Manfredi Caltagirone, Head of the United Nations Environment Program (UNEP) International Methane Emissions Observatory, emphasized the importance of

advanced economies taking the lead in addressing methane emissions. Caltagirone stressed the need for capacity building and ensuring that reliable information is accessible to everyone. To tackle the overwhelming challenge of methane emissions, he highlighted the importance of clear and trustworthy data that engenders confidence among stakeholders.

“We know enough to act and we know that companies and governments should take action,” Caltagirone said. “We believe that there is an important element related to transparency in climate action and that we need to give the information to those who can act on it and also provide the information to the general public so that we can reward concrete actions rather than just punish lack of action.”

Jean-Francois Gauthier, Vice President of Measurements and Strategic Initiatives at GHGSAT, discussed the organization’s successful approach of collaborating directly with industry to address methane emissions. By providing companies with accurate data on their emissions, they can prioritize actions to mitigate leaks and prevent future emissions. Gauthier emphasized the effectiveness of this approach, which empowers companies to take action based on a scalable assessment of their emissions.

Throughout the session, trust-building was highlighted as a crucial factor in the adoption of satellite data and observations. For example, Gauthier discussed the importance of cross-correlating data from various platforms to address the lack of trust in satellite data. By demonstrating the accuracy of satellite data, stakeholders from both the public and private sectors can build confidence in the information provided. Independent testing, validation, and transparency were also recognized as essential elements to reinforce the credibility of satellite data.

Steven Hamburg, the Executive Manager of MethaneSAT, emphasized the significance of converting concentration data into policy-relevant flux data to drive effective action. He stressed the importance of maintaining global data quality and ensuring independent testing and validation to increase confidence in satellite-based measurements. This emphasis on data quality and accuracy underscores the necessity of robust scientific capabilities and advanced technology to monitor methane emissions accurately.

Mackenzie Huffman, Director for Strategy and Partnerships at Carbon Mapper, discussed the crucial role of satellite technology in providing global coverage and integrating data from various sources. She stressed the need for more satellites and advanced technologies to achieve real-time and accurate monitoring of methane emissions. “More eyes in the sky will lead to more granularity and building toward a global monitoring system that enables transparency and supports accountability,” she said. Huffman also emphasized the power of partnerships between nonprofits, commercial sectors, and governments in collectively addressing the challenge of methane emissions.

Antoine Benoit, a Product Manager at Kayrros, emphasized the need for public awareness and journalism to draw attention to methane emissions. He cited regulations and legal frameworks from the United States and the European Union as examples that can drive action. Collaborative efforts across sectors and the potential for increased funding and technological advancements were also highlighted as key factors in tackling methane emissions effectively.

Throughout the session, the panelists reiterated the importance of collaboration and urgency in addressing methane emissions to combat climate change. They expressed optimism about the potential impact of this work over the next 20 years, envisioning significant reductions in methane emissions that would result in a drastic decrease in global warming rates. Achieving these outcomes would require enhanced scientific capabilities, technological advancements, and increased global awareness and action. The work will be challenging, but by harnessing the power of satellite observations, governments, industries, and organizations can work together to address methane emissions effectively and pave the way towards a more sustainable future.

“More eyes in the sky will lead to more granularity and building toward a global monitoring system that enables transparency and supports accountability.”



## Polycrisis Linked to Climate Change: from Shortages to Socio-Economic Impacts on Future Generations

As the effects of climate change continue to reverberate worldwide, a global polycrisis has unfolded, encompassing a range of interconnected challenges spanning from food shortages to socio-economic disruptions. With extreme weather events, shifting agricultural patterns, and rising sea levels among the many consequences, the urgency to address this multifaceted crisis has become paramount for nations and communities alike.

In a powerful IAF GNF session titled “Polycrisis Linked to Climate Change: from Shortages to Socio-Economic Impacts on Future Generations,” space industry leaders came together to address the pressing challenges posed by climate change. Organized by the European Space Agency (ESA), the session covered a wide range of topics, including education, sustainability efforts, water management, and the responsibilities of space agencies in fostering sustainability.

The discussion was moderated by Maria Gabriella Sarah of ESA’s Strategy and Foresight Department, who set the stage for the session by stressing the urgency of addressing the climate crisis and its far-reaching socio-economic impacts on future generations.

Laetitia Thirion, Professor in Remote Sensing, Specialist in Forest Fires at the Centrale Supélec Engineering School, kicked off the discussion by underscoring the importance of preparing the new generation for climate change. She highlighted her university’s efforts in empowering students through practical training and research on climate-related issues, and also emphasized the need for increased support and resources to educate more students and integrate sustainability into engineering courses.

“It’s our responsibility to be coherent and to be reliable,” Thirion said. “Otherwise, the young generation will just run away from us.”

Thomas Marceau, Head of Sustainability and Corporate Support at ArianeGroup, shared concrete actions his company has taken to address climate-related events impacting their operations. He emphasized the significance of raising awareness among employees and cultivating a culture of adaptation and mitigation. Risk analysis and awareness programs were key focal points to bring about meaningful change in employees’ personal and professional lives.

Jean Francois Donzier, Secretary General and Former General Director of the International Office for Water at the Global Alliance for Water and Climate, shed light on

the global water crisis exacerbated by climate change. He stressed the urgent need for integrated water resources management, calling for increased political will, financial resources, and technological innovation to tackle water shortages worldwide. Accurate data and robust information systems were identified as crucial for effective decision-making.



Hilde Roed, Senior Vice President of Climate and Sustainability at Equinor, highlighted her company’s commitment to sustainability, including efforts to reduce emissions and transition to renewable energy sources. Acknowledging the challenges faced by the industry, she emphasized the importance of transparency and accountability in reporting progress and fostering open discussions.

Laurence Monnoyer-Smith, Head of Sustainable Development at the Centre National d’Etudes Spatiales, expressed concerns about the space industry’s carbon footprint and urged greater transparency and action. She challenged the industry to prioritize sustainability, reduce emissions, and align activities with planetary boundaries. Monnoyer-Smith stressed the urgency of addressing the climate crisis and the need for collective decision-making.

“I’m going to be really straightforward: we are from doing what is necessary,” Monnoyer-Smith said. “How many of us have seriously planned to decrease our carbon emissions? I’m afraid very little. The space industry has a very important role to play, but it also has a footprint and needs to be net zero by 2050. We cannot be in denial.”

Throughout the session, the panelists made it clear that collective action, increased political will, and transparent

reporting are essential to effectively address the polycrisis linked to climate change. The speakers emphasized the significance of education, sustainable practices, innovation, and collaboration in creating a sustainable future for generations to come.

“I think that space will not save the planet, but the planet will not be saved without space,” Marceau said. “So I think we definitely should reflect on that and make sure that space is the right tool and a sustainable tool in itself to save the planet.”

As the session concluded, Sarah asked each panelist to provide a message of hope for the next generation. Roed emphasized the importance of collaboration, while Donzier highlighted the existence of tools to address water-related challenges. Marceau expressed his belief that space is crucial for saving the planet, and Thirion discussed the success of international collaboration in addressing the ozone hole. Monnoyer-Smith rounded out the session by noting that more people are actively seeking ways to contribute to positive change and that this is a powerful reason to be optimistic about the future. Together the panelists offered a message of hope that the collective action of governments, industries, and individuals can mitigate the impacts of the climate-fueled polycrisis and build a sustainable future for all.

## From Analysis to Action: Bridging Gap to Secure Climatically Vulnerable Communities

In the face of escalating climate threats, harnessing space data has become vital in safeguarding climatically vulnerable communities. By providing invaluable insights into changing weather patterns, natural disasters, and long-term climate trends, space technologies empower policymakers and stakeholders to implement proactive measures that enhance resilience and protect those most at risk.

Strategies for bridging the gap between analysis and action were discussed by experts from various space sectors during a GNF session dedicated to securing climatically vulnerable communities. The session focused on the devastating flooding in Pakistan, and aimed to explore how space capabilities can assist these at-risk populations. The panel was moderated by Bruce Chesley, a Senior Associate at Teaching Science and Technology Inc., and included representatives from government agencies, academia, and industry.

Grzegorz Wrochna, President of the Polish Space Agency, emphasized the need to bridge the gap between space capabilities and end users, particularly local communities

and authorities. "I believe that it's very important to share the experience and the ideas we have because in every country we have some brilliant ideas and some really novel solutions," Wrochna said. "So sharing this experience will create real added value." As an example he discussed Poland's plan to build a national satellite information system that collects data from various sources and provides interfaces for companies and universities to develop applications and services for end users.

Magdalena Gutowska, Principal Lead Climate and Energy Portfolio at the Polytechnic University of Turin, stressed the role of universities in addressing climate change and supporting vulnerable communities. "Europe has been touched recently by many crises," Gutowska said. "However, if we think of it globally there are particular challenges that universities can help address to reach the truly marginalized and vulnerable communities of the world." In particular, she emphasized the need for universities to educate the younger generation and collaborate with local authorities to address societal needs. Gutowska also discussed sustainable transition initiatives at the

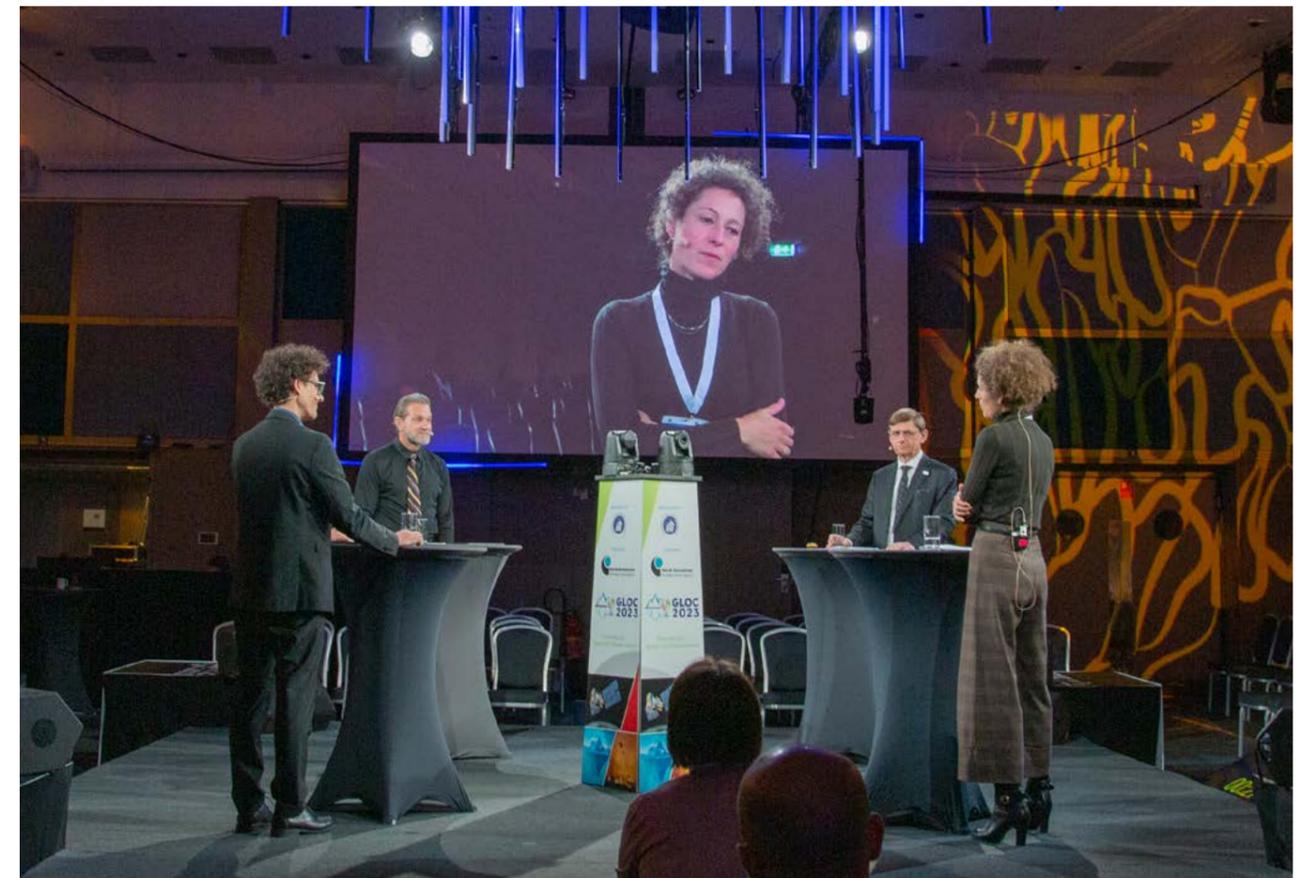


Polytechnic University of Turin, which aim to innovate in education and connect with government and industry to drive rapid adaptation.

Sebastian Tailhades, Domain Manager of Earth Observation at OHB System, highlighted the industry's role in providing tools and services to support vulnerable communities. He emphasized the use of space-based data, such as Copernicus and Landsat, for effective decision-making. Tailhades also called for international cooperation, funding, and agreements to implement global solutions. "I believe that this is a problem that cannot be solved at government agencies," Tailhades said. "This is really an international problem."



The panel recognized the importance of alignment across sectors and the need for incentives to drive action. They discussed the evolving role of space agencies in integrating research, government needs, and industry innovation. Emphasizing international cooperation, funding, and support from intergovernmental agencies, the panel underscored the significance of bridging gaps between industry, academia, and government to implement effective climate solutions that benefit the world's most at-risk populations. As the devastating effects of climate change continue to impact communities worldwide, the panelists all agreed that a comprehensive and collaborative approach is needed to overcome these challenges and secure a better future.



## Global Action in Space for Disasters within a Changing Climate and the Role of The International Charter for Space and Major Disasters

As climate disasters intensify, the role of the space industry in mitigating their impacts has taken on a new level of significance. From satellite monitoring to advanced weather forecasting, the space sector provides crucial tools and technologies that enable early detection, accurate prediction, and effective response strategies, ultimately saving lives and minimizing the devastating consequences of climate-related disasters.

In a captivating IAF GNF session moderated by Sarah Jane Gill, Head of International Relations at the UK Space Agency, experts convened to discuss the critical role of the space sector in managing disasters within an ever-changing climate. With a focus on the International Charter for Space and Major Disasters, the session shed light on the challenges faced by communities worldwide and how space agencies are adapting to provide effective solutions.

The importance of earth observation data emerged as a key theme throughout the discussion, showcasing its significance in disaster management and mitigation. Eric Laliberte, Director General for Space Utilization at the Canadian Space Agency, stressed the need for adaptation and improved preparedness, while Godela Rossner, Head of Earth Observation Department at the DLR, emphasized the crucial role of services like the Copernicus Emergency Management System and the International Charter on Space and Major Disasters in providing support and data to vulnerable communities around the globe.

“With disaster management I think it’s pretty clear that we cannot work without Earth observation,” Rossner said. “In the end, it’s all about people. So we have to talk with the people involved in all these different parts of the system to make sure that we make the most out of Earth observation that we can.”

Prakash Chauhan, Director at National Remote Sensing Centre at the Indian Space Research Organization, shared India’s experience with diverse disasters and outlined how the ISRO utilizes satellite data to establish early warning systems and facilitate disaster response. Harshbir Sangha, Missions and Capabilities Delivery Director at the UK Space Agency, further underscored the vital role of space agencies in effectively communicating critical information to the public and collaborating with other government bodies to ensure efficient disaster management.

“Of course, space cannot solve everything, but it can provide support to the policymakers and the people

working on the ground in disaster scenarios,” Chauhan said. “We cannot reduce the fury of nature, but what we can do is adapt to it and try to mitigate the impacts of these disaster situations.”



“Of course, space cannot solve everything, but it can provide support to the policymakers and the people working on the ground in disaster scenarios. We cannot reduce the fury of nature, but what we can do is adapt to it and try to mitigate the impacts of these disaster situations.”

The panelists all stressed the importance of partnerships with relevant institutions and authorities responsible for disaster management, leveraging space-based data to inform and assist the public. The Canadian approach of coordinating with public safety agencies, Germany’s collaboration with the International Charter, and India’s national disaster emergency database were cited as notable examples of this approach in practice.

The session culminated with an emphasis on collaboration as the cornerstone of addressing climate change and disasters. Space agencies were recognized for their pivotal role in

providing timely and accurate data. Effective communication, capacity building, and learning from past experiences were identified as crucial components in mitigating the impacts of disasters and ensuring a resilient future.

As the world grapples with the increasing frequency and intensity of disasters, the GNF session demonstrated the importance of collaborative efforts among space agencies in protecting communities and ensuring a sustainable future. By harnessing the power of space technology and data, nations can better prepare, respond, and recover from the devastating impacts of climate change.



# GLOC 2023

## Next Gen Event

### Saving our Future on Earth through our Presence in Space: A Generational Exchange on the Role of Space in the Fight Against Climate Change

During a unique two-part session titled “Saving our Future on Earth through our Presence in Space: A Generational Exchange on the Role of Space in the Fight Against Climate Change,” a large panel of distinguished experts and rising leaders convened for an illuminating discussion on the pivotal role of space technology in the battle against climate change.

The session opened with some brief remarks from IAF President Claw Mowry, who discussed the importance of “3G” diversity, which encompasses generation, geography, and gender. This IAF initiative has provided a platform for the next generation to voice their ideas and concerns and has more than doubled in size over the past few years. “We’re really proud to partner with the Space Generation Advisory Council (SGAC) and bring the next generation forward to focus on workforce issues associated with the future of space,” Mowry said. To emphasize this point, Mowry and Davide Petrillo, IAF Vice President for Education Workforce Development, recognized several exceptional students and young professionals who were

attending the conference. “They will be the ones inheriting and running this planet,” Petrillo said. “Their insights are crucial for our collective future.”

Next the session turned to two keynote speakers, Julia Bordacchini and Sahba El Shawa, co-leads of the Space for Climate Action program at SGAC, who presented the findings of the council’s report on climate change. The report, which emerged from collaboration with a diverse group of young professionals and students, aimed to define a unified space policy position on climate action. “Interdisciplinarity is key in solving this problem,” El Shawa said. “We need to engage stakeholders from academia, government, and commercial industries.”

The SGAC report addressed multiple facets of climate change and space activities, including the environmental impacts of space projects and the imperative to decouple defense-related space activities from adverse social and environmental consequences. Bordacchini emphasized the importance of stakeholder engagement and innovation

within the space industry. Furthermore, she stressed the importance of leveraging adjacent markets and emerging technologies such as additive manufacturing, quantum technology, and artificial intelligence. Bordacchini and El Shawa also emphasized the importance of learning from indigenous knowledge systems and ensuring that space activities do not perpetuate the same ideologies that led to the climate crisis. They called for breaking down barriers, both geopolitical and societal, to ensure inclusivity and diverse participation in space discussions and decision-making processes.

Following the keynote address, the session transitioned to a panel discussion titled “Are We Doing Well? Space Science and Technology for Climate Action.” The panel was moderated by Professor Tanja Masson-Zwaan, Vice President of Science and Academic Relations at the IAF and Deputy Director of the International Institute of Air and Space Law at Leiden University, who described the session as “a bridge between generations, combining the wisdom and experience of senior professionals with the fresh perspectives and innovative thinking of the next generation.” This intergenerational dialogue aimed to explore innovative solutions and evaluate the effectiveness of current space science and technology initiatives in combating climate change.

The panel delved into several pressing issues, including the role of space technology in mitigating climate change, the importance of global cooperation, and the ethical and policy considerations associated with space exploration,

sparking a dynamic exchange of ideas and perspectives between experienced professionals and the next generation of space leaders.

The discussion kicked off with Lew Topfer, the German UN Youth Delegate to the General Assembly, who highlighted the interconnectedness of space, climate, and youth. Lew emphasized the need for collaboration and localized solutions to address the challenges ahead. “The impact of these topics on future generations is huge and the decisions we make now will impact us forever,” Topfer said. “We are the biggest young generation of all time. There are 1.8 billion people under 25 years old right now. So discounting them in discussions, either in space and climate would just be strategically unwise.”

Agnieszka Lukaszczyk, Vice President for Government Affairs of Europe, the Middle East, and Africa at Planet, shared her experiences working with governments in the region. While she acknowledged the increasing openness of governments towards space technology and climate-related issues, she also emphasized the necessity of long-term thinking and global cooperation beyond political agendas. “A lot of policymakers are not thinking long term, they’re thinking of their next election,” Lukaszczyk said. “That’s not going to solve global problems that will affect future generations.”

Sahba El Shawa, the Ethics and Human Rights and Space for Climate Action Lead at the Space Generation Advisory



Council, underscored the need for ethical considerations and outreach in addressing climate change. Throughout her remarks, El Shawa emphasized sustainability in space technology and bridging the gap between space exploration and sustainable development. Drawing from her work in Jordan, she highlighted the importance of involving local communities and indigenous perspectives in shaping solutions.

Allison Lightner, NASA program manager for climate and resilience, brought her extensive experience working with public and private sectors to leverage NASA's resources for climate-related decision-making. Lightner praised the unique perspectives and multidisciplinary thinking that early-career researchers and professionals bring to the table. She also emphasized the significance of collaboration between different fields and the implementation of sustainable solutions to tackle the climate crisis effectively. "Science is a collaborative process," Lightner said. "I think having all of these different perspectives is key to building a better sense not only of the challenges, but the solutions."

Milica Milosev, the winner of the UN's Space4Youth competition, shed light on the challenges faced by emerging space faring countries. While acknowledging the lack of a space agency and space-related education in her home country of Serbia, Milosev stressed the importance of education and outreach to introduce space science and technology to developing nations. She expressed hope for a future where space agencies and programs empower countries to

benefit from space-based solutions."I think that we should definitely get youth more involved in the decision-making processes because this planet and everything that we're doing will stay with them," she said.

Throughout the session the panelists underscored the urgency of incorporating space technology into climate change mitigation and adaptation efforts. They agreed that climate issues know no borders and require collective global action between governments, academia, civil society, and industry to work together to address climate challenges effectively. As nations and communities grapple with the repercussions of climate change, the transformative power of space technology, interdisciplinary collaboration, and leveraging the unique perspectives of young professionals can provide the much-needed solutions and inspire a shift towards a more sustainable future for all.

While the first panel highlighted successes of intergenerational and international collaboration among space industry players in the fight against climate change, the second part of the session focused on opportunities for improvement. Joe Landon, Special Advisor to the President on the Sustainability, Investment and Security Agenda at the IAF and CEO of Crescent Space, highlighted the broader benefits of space exploration and its contributions to our understanding of Earth. He pointed out the significance of exploring celestial bodies like the Moon and Mars, as they provide invaluable insights into adapting to a changing climate. Landon also emphasized the role of space technology in identifying and mitigating threats beyond

climate change, such as near-Earth objects and asteroids that could potentially impact our planet.

Satish Raj V. Periasamey, a young Malaysian environmental advocate and student, shared his personal motivations and experiences that led him to climate advocacy. He called for collaboration, transparency, and accountability within the space industry to effectively address climate change. "We must acknowledge the shortcomings within our industry and reflect upon the extent that we are complicit," Periasamey said. "I think being real with ourselves and fostering more collaborations with grassroots movements and frontline stakeholders will be the way forward."

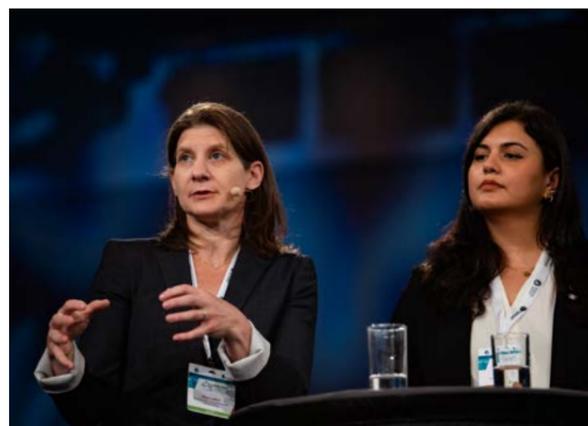
Dominique Tillmans, Special Advisor to the President on Parliamentarian and Ministerial Relations at IAF and President EURISY, presented a compelling narrative about our place in the universe. She stressed the need to recognize our responsibility and the uniqueness of Earth within the vastness of space. Tillmans urged the space industry to reflect on its practices, foster collaboration, and contribute to a better future by integrating sustainable approaches. She highlighted the importance of dialogue between scientists and politicians to drive effective climate action.

Anna Raposo, a space applications engineer at ESA, emphasized the need for space technology to extend beyond its own bubble and address the challenges faced by different sectors. She underscored the role of space in providing insights and solutions to industries such as agriculture, finance, and energy. Raposo also emphasized

the importance of understanding the needs and challenges of end-users and fostering collaboration between the space sector and other industries to achieve tangible outcomes."Users don't really care about where data comes from," Raposos said. "They want the information they want and the insights that it provides."

Sabine Von der Recke, a Board Member for Communication and Political Relations at OHB Systems, focused on the space industry's responsibility in addressing climate change. She highlighted the industry's commitment to sustainability and the importance of working with customers, partners, and scientists to develop innovative solutions. Von der Recke stressed the need for the space industry to be a role model and inspire other industries to prioritize climate action.

Throughout the session, the panelists each emphasized the significance of effective communication, collaboration, and practical action. They acknowledged that space technology alone cannot be the sole remedy for climate change, but stressed its crucial role in providing valuable data and insights that lead to effective climate solutions. The speakers called for collective efforts, breaking down silos, and finding common ground between generations to tackle the climate crisis effectively. The session underscored the vital importance of amplifying young voices within the space community to drive the adoption of sustainable practices. By bridging generational divides, the space industry can play a pivotal role in safeguarding our planet and building a brighter future for generations to come.



# GLOC 2023

## High Level Summary Session

Climate change continues to be one of the most urgent challenges of our time. As temperatures rise, extreme weather events become more frequent, and ecosystems face unprecedented threats, the need for immediate and effective action has never been greater. In the fight against climate change, space technology has emerged as a powerful tool, offering valuable insights and innovative solutions. But cutting-edge space technologies alone are not sufficient. If the space industry is going to leverage its unique capabilities in this fight, it is imperative that it does so in the spirit of open international and inter-generational collaboration.

This was the central theme of the IAF's first Global Space Conference on Climate Change, which brought together over 500 registered participants, including scientists, industry leaders, and policymakers to delve into the critical issue of climate change and its relationship with the space sector. The format of GLOC departed from traditional conference formats, and was thoughtfully designed to foster meaningful discussions and create a lasting impact focused on action. The unique circular configuration, with speakers and participants gathered in an inclusive setup, encouraged engagement and collaboration. The conference concluded with a high-level summary session, where key themes of GLOC and future directions for climate action within the space industry were discussed.

The summary session was moderated by Christian Hauglie-Hanssen, Director General of the Norwegian Space Agency, and featured a diverse set of panelists who had presented throughout the conference. James Graf, Director of Earth Science and Technology at NASA's Jet Propulsion Laboratory, kicked off the summary session by vividly harkening back to Richard Spinrad's vivid analogy likening climate change to a wolf in our house. As climate-related

events increase in frequency and severity, Graf said, it is crucial to leverage the assets and capabilities of the space industry to better understand and address this pressing issue.

"We can't avoid this, it's already upon us," Graf said. "We have to either mitigate it or adapt to it, but it is going to control us if we don't control it."

One of the central themes that emerged during the summary session was the importance of effective communication. Emma Gatti, Editor in Chief of Spacewatch.global, stressed the need to tell compelling stories that resonate with the general public and move beyond technical jargon. If we want to bridge the gap between the space community and the general public, Gatti said, then it is imperative to convey the human and climate impact of space technology in accessible, relatable terms.

"If we keep telling the story from our perspective, from the tool perspective, from the satellite perspective, we will never win," Gatti said. "Because the external world doesn't know anything about the satellite, and is not really interested in knowing something about the satellite. It is interested in knowing about life, about emotions, about inspirations, about dreams, and about impact. So this is how we should start to craft our story."

Ole Morten Olsen, Director of Enterprise Development and Innovation at the Norwegian Space Agency, summarized the key takeaways from GLOC's technical sessions, which provided a platform to discuss advancements in space technology and their applications in climate change mitigation and adaptation. He highlighted the rapid progress in satellite technology, data accessibility, and the increasing involvement of the private sector in space-based climate

“We can't avoid this, it's already upon us. We have to either mitigate it or adapt to it, but it is going to control us if we don't control it.”



initiatives. "I'm optimistic that we are about to get into an area where we really can predict things in the future," Olsen said. "I think that will make it easier for us to communicate things to the general public and to decision makers."

The conference also emphasized the importance of collaboration and the integration of global and local efforts. Accessible data and the involvement of small local communities were identified as crucial factors in effectively tackling climate change. Barbara Ryan, Executive Director of the World Geospatial Industry Council, stressed the need for better coordination and collaboration among institutions and governments, calling for an integrated Earth observing system that transcends political boundaries and fosters collaboration across domains.

Engaging the next generation emerged as another crucial aspect of addressing climate change. BBC journalist Ru Kermani highlighted the concerns of young children about the future of the planet and stressed the need to provide reassurance and engage them in finding solutions. "I think that for young children space, and everything it stands for is all about inspiration, but at the moment it's all scary news: the planet is overheating, we're all going to die," Kermani said. "No one's really bringing solutions to them." Gatti echoed these sentiments, emphasizing the importance of integrating the next generation's perspectives and calling for genuine commitment from senior leaders to engage with young professionals.

The summary session also discussed the conference's objectives and outcomes, with IAF Executive Director Christian Feichtinger outlining the efforts to connect the space community with decision-makers from outside the sector. Despite the progress made, Feichtinger identified stronger participation from political leaders as a necessary step forward. Engaging the general public through media and communication was also emphasized as a means to bridge the gap between space technology and climate change action.

Graf built on these comments to underscore the need for concrete action and emphasized the importance of "measuring globally and implementing locally," and identified collaboration and personal commitment as key ingredients for achieving lasting change. While all the panelists acknowledged the challenges of climate emergencies and the evolving nature of data, they remained optimistic about the future. They cited the growing ability to predict future outcomes and the potential to communicate effectively with the general public and decision-makers as reasons for hope.

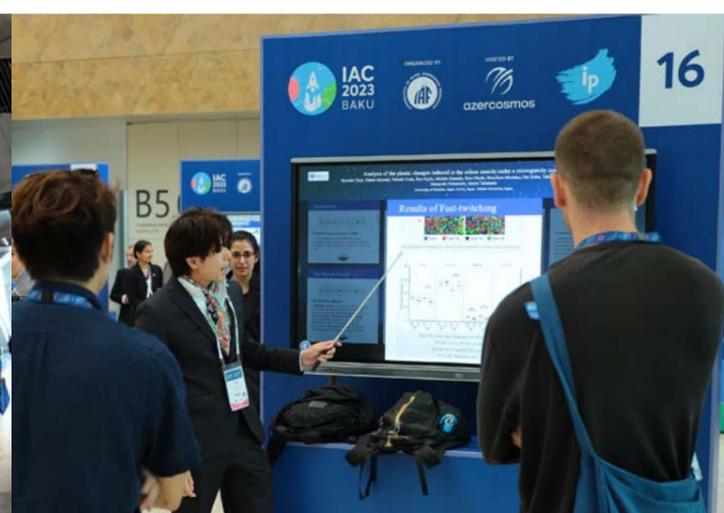
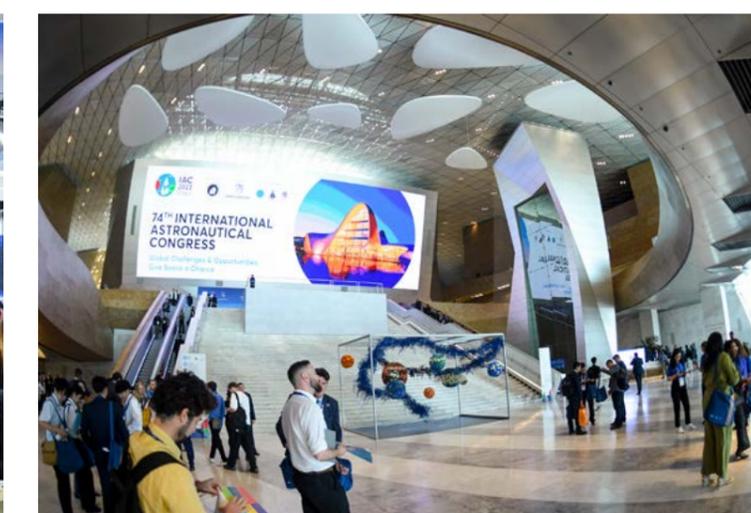
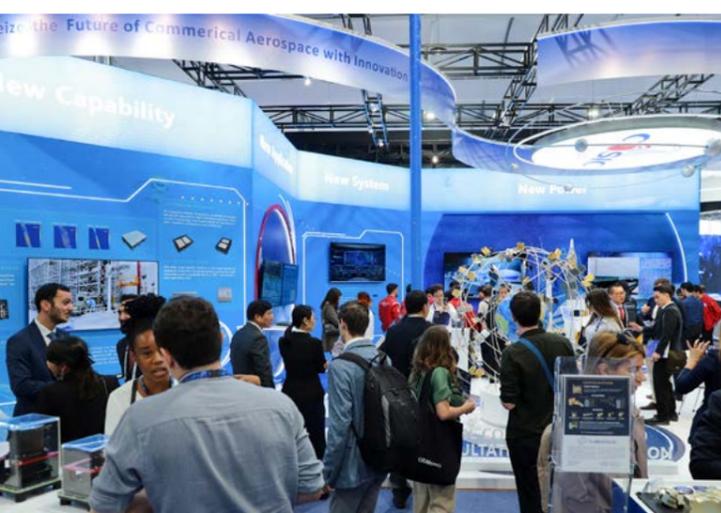
The IAF Global Space Conference on Climate Change was a call to action, said Feichtinger, and highlighted the importance of engaging the next generation, collaboration, and personal commitment in confronting the pressing issue of climate change. It emphasized that space technology alone cannot save the planet, but when combined with concrete action and the dedication of diverse stakeholders, offers a bright ray of hope for building a more sustainable and resilient future.





# International Astronautical Congress

2-6 October 2023 | Baku, Azerbaijan



# IAC 2023

## Opening Ceremony

The 74<sup>th</sup> International Astronautical Congress in Baku, Azerbaijan, kicked off in grand style with a series of dance and musical performances from local artists. Following this energizing warmup, the International Astronautical Federation (IAF) President Clay Mowry welcomed the attendees of the congress. “It’s a great honor for me to address you on this very special occasion,” said Mowry. He emphasized that the IAC provides a unique opportunity for the international space community to come together, collaborate, and advance scientific knowledge.

Mowry thanked the local host and recognized the IAF’s partner organizations - the International Academy of Astronautics (IAA), the International Institute of Space Law (IISL), and the Space Generation Advisory Council (SGAC). He also acknowledged the congress’ sponsors from organizations around the world. “Our appreciation goes to all the sponsors who make the IAC the incredible event it is every year,” said Mowry.

Mowry reflected on the IAF’s growth since its founding in 1951 with just 10 member organizations. Today, the

Federation counts 468 members from 75 countries. “We will reach 500 members by the end of this week,” he proudly announced. Mowry noted how space has been extremely active over the past year. Highlights include stunning new images from the James Webb Space Telescope; China completing its Tiangong space station, which is now permanently crewed; and the successful Artemis I test flight bringing NASA closer to returning humans to the Moon.

During the opening session, attendees were also greeted with remarks from astronauts aboard the Tiangong space station and the International Space Station. “As you look up to the skies tonight we will wave back at you,” said NASA astronaut Jasmin Moghbeli, alongside crewmate Laurel O’Hara.

During the ceremony, Azerbaijani President Ilham Aliyev welcomed conference participants from more than 100 countries to Baku for the second time, after first hosting the Congress 50 years prior. He emphasized Azerbaijan’s pride in developing its space industry over the past decade, highlighted by its current operation of three telecommunications satellites providing services to 45 countries.



President Aliyev reiterated Azerbaijan’s commitment to “creating a broad international cooperation in our region” through projects like the Baku Process intercultural dialogue. “For us geography means opportunity,” said President Aliyev. “Hosting for the second time this important event is a big honor for us.”

Next, IAF Vice President for Honours and Awards Anthony Tsougranis presented the prestigious IAF World Space Award to SpaceX Founder Elon Musk. Accepting on his behalf, SpaceX’s Senior Director of Commercial Sales Stephanie Bednarek said Musk showed that “anything is possible” in space through achievements like docking Dragon to the ISS, reusing Falcon 9 rockets, and returning human spaceflight to the U.S. “Never let anybody tell you what you can’t do,” said Bednarek.

The World Space Award for teams went to the NASA/ESA/CSA James Webb Space Telescope team, represented by NASA Deputy Administrator Pam Melroy. She called Webb “the world’s premier space science observatory” providing globally shared data to transform our understanding of the universe. Former NASA Associate Administrator Thomas Zurbuchen received the IAF Excellence in International Cooperation Award for promoting global engagement in space. “Going into the space industry means having friends all over the world,” said Zurbuchen, adding that ambitious goals require collaborating “across boundaries across different continents.”

The ceremony concluded with an electrifying speech by the world-renowned historian and philosopher Yuval Noah Harari on the promise and potential perils of artificial intelligence (AI). “We have just met this alien intelligence here on Earth,” Harari remarked. “And within a few decades, it might take over our planet.” While AI offers humanity great benefits like space exploration and medical advances, it also poses existential threats, he noted. AI has no innate drive, only intelligence. “Consciousness is the ability to feel things like pain, and pleasure, love and hate,” Harari

emphasized, capacities AI lacks. “If human consciousness goes extinct, and our planet, or even the Milky Way galaxy fall under the dominion of super intelligence, but entirely nonconscious entities, that would be extremely sad and dark and to the story of life, it would be an empire of total darkness.”

Harari urged humanity to focus its attention on this threat, and stop conflicts over “hills” when the whole planet is at stake. Regulation of AI advances will require unprecedented global cooperation, he said. “Given the pace at which AI is developing, it is impossible to anticipate and regulate in advance all the potential hazards.” Flexible institutions are key, Harari advised, along with “strong self-correcting mechanisms.” No one is infallible, and the stakes are too high to presume otherwise. Harari left the crowd with an urgent appeal: “It is the responsibility of all of us to prevent this.” As humanity stands at the dawn of an artificial intelligence revolution, the choice between uplifting advancement and existential catastrophe remains in our hands. But if we wish to choose wisely, we must recognize that intelligence devoid of feeling may create a future utterly devoid of light. To underscore Harari’s point, Mowry welcomed a musical interlude, and invited the audience to get to their feet and dance to usher in the new conference. After all, Mowry said, “what’s more human than music?”

The opening ceremony of the 74<sup>th</sup> International Astronautical Congress in Baku set the stage for a week of vibrant exchange and cooperation to advance humanity’s future in space. With record attendance from the global space community, remarks from astronauts aboard the ISS and China’s Tiangong station, and a sobering keynote on artificial intelligence’s promise and perils by historian Yuval Noah Harari, the congress kicked off on an inspirational yet thoughtful note. As IAF President Clay Mowry said, the shared passion for space brings people together across boundaries. If humanity is to choose the path of light over darkness, the collaborative spirit embodied by the IAC will be essential.





## One-To-One With Global Space Leaders

At the opening plenary of the 74<sup>th</sup> International Astronautical Congress, heads of major space agencies discussed increasing international collaboration and using space to benefit humanity. From expanding lunar exploration to combating climate change, they outlined bold visions for the future. Christian Feichtinger, the Executive Director of the International Astronautical Federation (IAF), served as the Master of Ceremonies for the plenary, and Samaddin Asadov, Chairman of the Board of Azercosmos, welcomed attendees to the congress in Baku. "We are very much open to any kind of collaboration," he stated, emphasizing Azerbaijan's commitment to cooperation.

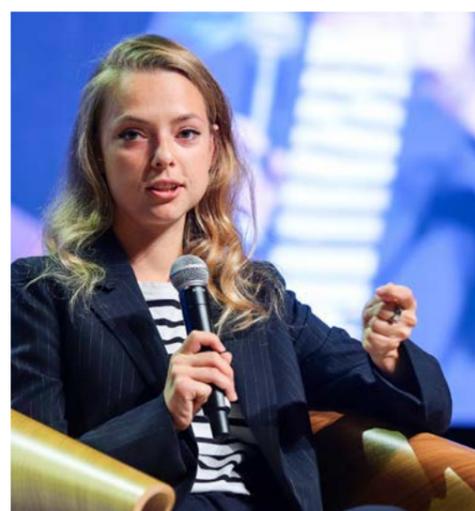
Administration (NASA); S. Somanath, the Chairman of the Indian Space Research Organisation (ISRO); Teodoro Valente, the President of the Italian Space Agency (ASI); and Hiroshi Yamakawa, the President of the Japan Aerospace Exploration Agency (JAXA).

NASA Deputy Administrator Pamela Melroy later highlighted new consortiums like the Lunar Surface Innovation Consortium (LSIC) that allow global collaboration on lunar exploration for the Artemis program. "We were absolutely astounded at the response," she said of LSIC's 900 organizations across 57 countries.

Melroy called NASA a "climate agency" as well as a space agency, noting the unique insights Earth observation satellites provide into climate change. She added that expanding commercial and international partnerships, like those enabling the commercial crew programme, will be vital for NASA's lunar plans. For example, she highlighted programs like the Lunar Surface Innovation Consortium (LSIC), which allows global collaboration on lunar exploration for the Artemis program. Today, LSIC has 900 partner organizations across 57 countries, and Melroy said NASA was "astounded by the response" to the program, and points to the need for similar efforts in the future.

# IAC 2023

# Plenaries



Li outlined the China National Space Administration's extensive lunar ambitions, which includes launching multiple sample return and south pole landing missions before establishing an International Lunar Research Station by 2040. "This program is totally open," Li said, saying China welcomes partners on missions like Chang'e 6, 7 and 8, emphasizing that international cooperation is essential to China's lunar aspirations.

Al Amiri charted her country's rapid space sector growth, which she said was enabled by deliberate government investments. She highlighted funds supporting startups and developing capabilities from satellites to Mars exploration as key to the UAE's rapid ascendance as a space-faring nation. "A lot of our space fund...is going towards supporting private businesses and individuals in establishing their space sector presence," Al Amiri said.

Valente described Italy's plans to strengthen its role across space sectors, including exploration. "In the sector of space exploration, we have a growing interest in sending humans to explore the moon, Mars and beyond," he said. He described how Italy's growing space capabilities are backed by an increased budget, European partnerships, and agreements with space agencies globally that can support these goals. "International cooperation will be paramount in shaping our collective journey into space," he said.

Yamakawa described the bold missions underway at JAXA, which range from Martian moon sampling to a collaboration with India on a lunar rover. While Yamakawa was optimistic about the future of space exploration that is enabled by global partnerships and new national and private space actors, he warned that space sustainability is threatened by crowded orbits. "The next step, we would like to actively refine the low Earth orbit environment with active space

debris removal," he said, calling for global coordination on this increasingly urgent issue.

Borisov reaffirmed Russia's commitment to the International Space Station until 2028, but said Russia is already designing a successor orbital station. He also echoed Yamakawa's concerns about the space debris problem and highlighted Russia's new debris monitoring program as a potential solution due to its "global, universal character."

Somanath discussed India's lunar landing mission, which he said has inspired youth towards science careers, which is critical to fostering the next generation of space talent in the country and enabling India to take ever bolder steps into the cosmos. He also outlined ambitious exploration goals that build on successes like India's Mars orbiter. "We have programs coming for looking at planets like Venus and continuing to explore the moon," Somanath said.

While each country and space agency brought unique capabilities and goals to the table, the overarching theme of the plenary was that space exploration works best when nations cooperate. International partnerships have enabled monumental achievements like the International Space Station. Building off this model, agencies aim to further push boundaries with collaborative lunar bases, asteroid missions, Mars exploration, and more. However, alongside seizing exciting opportunities, the space agency leaders also acknowledged pressing challenges like space sustainability that require global coordination. With debris congesting Earth orbit and interest in space rapidly expanding worldwide, ensuring the safe and sustainable use of space was identified as an urgent priority issue. Overall, the panelists conveyed a spirit of optimism about expanding partnerships between nations and the private sector to push forward into a new era of space exploration, inspire youth, benefit life on Earth, and unlock the cosmos for exploration.

**“In the sector of space exploration, we have a growing interest in sending humans to explore the moon, Mars and beyond. (...) International cooperation will be paramount in shaping our collective journey into space.”**



## Space 2030: Policies And Strategies In Global Space Economy

The second plenary at IAC 2023 focused on the rapidly expanding global space economy, which is projected to reach over \$1 trillion by 2030. Moderator Dunay Badirkhanov led a discussion between space agency leaders from Azerbaijan, Kazakhstan, Israel, and Turkey, who offered insights into key drivers propelling more countries to pursue space capabilities and shape future government roles.

The panel "Space 2030: Policies And Strategies In Global Space Economy," was moderated by Dunay Badirkhanov, Vice-Chairman of Azercosmos and featured several officials representing space agencies around the world including Samaddin Asadov, Chairman of the Board of Azercosmos; Olzhabekeov Malik, the Vice-Minister of Digital Development, Innovations and Aerospace Industry of the Republic of Kazakhstan; Uri Oron, the Director of the Israel Space Agency (ISA); and Serdar Hüseyin Yildirim, Chairman of the Board and President of the Turkish Space Agency (TUA).

Badirkhanov opened by citing the space economy's growth to \$424 billion in 2022, with dozens of countries launching satellites and establishing space agencies. Panelists identified several key drivers propelling this trend. Asadov pointed to more accessible, cost-effective technologies like small satellites and improved launch capabilities that enable wider participation. Countries now view space capabilities as vital for national security, using satellites for telecommunications, observation, and early warning systems. International cooperation has also raised awareness and interest.

Oron concurred that "huge technological acceleration" in the space sector over 20 years has been pivotal to enabling this new space age. Satellite miniaturization and plummeting launch costs have opened space to more actors. Space is now indispensable for modern economies and addressing scientific questions. Without the reductions in launch costs, innovations in satellites and miniaturization, and improved communications, countries would not have the same accessibility and affordability of space, Oron noted.



Olzhabekov added that space technologies have become commercially attractive, underpinning everyday applications like navigation and communications. New companies are entering a hospitable market, with launch costs dropping dramatically. This was also affirmed by Asadov, who cited three key factors driving countries' interest in space: advancements in affordable, small satellite technologies and launch capabilities; security motivations to have independent satellite capabilities; and growing international cooperation and awareness of opportunities in space. Regarding future government roles, Asadov said Azerbaijan's strategy involves major satellite investments and industry partnerships through 2030, viewing space expenditures as investments in innovation. He outlined the country's plans to invest over \$1 billion in space activities by the end of the decade, including purchasing observation satellites from Israel Aerospace Industries to build local capabilities.

Yildirim emphasized that space contributes to the prestige and strategic influence of nations. Launching satellites demonstrates technological competence while space services like intelligence gathering strengthen national security. This is why, he said, countries must work together to establish sustainable space policies because "space is the future" and space systems are essential for sustainability on Earth. He also stressed that international collaboration spreads costs: "technologically it is that much easier, timewise much quicker and much cheaper, when we shared the costs."

Yildirim predicted the space economy will exceed \$1 trillion by the end of the decade, noting that while governments have led space activities in the past, their role should evolve. He advocated governments focusing more on issues like space traffic management and security while the private sector and academia drive commercial and scientific progress. This perspective was supported by Oron who stressed space must provide clear national value to justify budgets. Governments should focus on establishing national space strategies, supporting private sector growth by being anchor clients, using space to meet their own needs, and enabling cooperative frameworks.

Despite some differing perspectives on the role of government in the future of space exploration, the panelists unanimously agreed that accessibility and falling costs have enabled the new space age, with launch and satellite innovations allowing more nations to afford independent space programs. This drives prestige and security interests. While governments pioneered space activities historically, their role should shift towards establishing national space strategies, supporting private sector growth as anchor clients, addressing issues like space traffic management, and enabling international cooperation frameworks. With the space economy anticipated to exceed \$1 trillion soon, government policies and international collaboration will be instrumental to sustaining growth.



## Infrastructures From Leo To Moon Surface: The Commercial Side Of Exploration

The commercialization of space is accelerating rapidly, with private companies taking the lead in developing new low Earth orbit destinations and advanced space transportation systems. During the third plenary panel of IAC 2023, representatives from three pioneering companies—Axiom Space, Airbus Defence and Space, and The Exploration Company—shared their ambitious visions for ushering in a new era of commercial activity in space. Axiom and Airbus officials discussed their plans for developing privately funded space stations to replace the International Space Station, and the cofounder of the Exploration Company unpacked the company's plans to create reusable launch vehicles to provide frequent and affordable access to space. All three panelists agreed that expanding the commercial utilization of space will drive innovations such as in-space manufacturing that have the potential to deliver broad benefits to humanity back on Earth.

The third plenary of the IAC, "Infrastructures From Leo To Moon Surface: The Commercial Side Of Exploration," was moderated by Carlo Mirra, Chair of IAF Industry Relations Committee, and featured an international panel of executives at private space companies including Jon Reinjneveld,

the Co-Founder and Chief Engineer at the Exploration Company; Manfred Jaumann, Head of Low Earth Orbit and Suborbital Programs In-Space Systems at Airbus Defence and Space; and Christian Maender, Executive Vice President of In-space Solutions at Axiom Space, who gathered to discuss their visions for humanity's future in low Earth orbit and beyond.

Maender started the session by discussing Axiom Space's vision to build the "world's first commercial space station." Maender described how the modular station will attach to the current ISS before ultimately becoming a free-flying platform and noted that Axiom is already providing private astronaut missions to the ISS. "We'll increase the capacity of the ISS by an additional crew of eight," said Maender. Once the ISS retires, Axiom's modules will detach to form an independent station with research facilities, crew quarters, and the world's largest window in space. He argued that now is the right time for commercial companies to provide services as governments want to retire the International Space Station and reallocate those funds towards exploration. "It's not enough to just serve the government," he said. "We really have to develop new applications and markets."



“It's not enough to just serve the government. We really have to develop new applications and markets.”

Jaumann described how Airbus Defence and Space is collaborating with Voyager Space on the “Starlab” space station and elaborated on how Starlab takes a “different approach” to building a private space station. In contrast to Axiom’s station, which will be assembled in phases, Starlab will launch fully assembled within one large module that can support four crew for 30 years of operations. Jaumann emphasized the need for low-cost structures and new manufacturing techniques to make commercial space endeavors profitable. He highlighted the company’s partnership with startup Voyager Space as an example of combining Airbus’ space expertise with a startup’s speed and agility to deliver innovative solutions faster. “This synergy and learning from each other is of utmost importance,” Jaumann said.

While Axiom and Airbus focus on destinations, The Exploration Company provides “the vehicle to get you there” with its reusable spaceplanes, said co-founder Jon Reinjneveld, who envisioned the spacecraft being used for affordable and sustainable transportation to LEO and the Moon. Reinjneveld highlighted the company’s first reentry demonstrator, Nyx Mission Possible, set to launch in 2024, followed by an LEO spaceplane, Nyx Earth, in 2026.

Reinjneveld also highlighted the many additional benefits of affordable access to space, such as its ability to accelerate innovation across a wide range of fields and in

pharmaceutical research in particular. He emphasized the need to “look outside the box” for commercial applications that can benefit humanity on Earth, a sentiment that was echoed by Maender. “Taking gravity out of the equation, you can fundamentally change the way physics behaves in space,” Maender said, underscoring the massive opportunity ahead for in-space manufacturing.

Jaumann rounded out the session by discussing how Airbus is exploring in-situ resource utilization, which will be a critical part of in-space manufacturing and lunar exploration. He described how Airbus is already developing systems to produce oxygen and metal alloys from lunar dust, techniques that may have spinoff potential for sustainable manufacturing on Earth.

The plenary highlighted the ambitious and innovative paths companies are taking to open up space for commercial activities that can benefit life on Earth. With Axiom and Airbus developing new low Earth orbit destinations, and The Exploration Company designing reusable launch vehicles for affordable transportation, critical pieces are falling into place to make commercial space endeavors economically viable. All three panelists expressed a profound optimism about the future economic opportunities enabled through low-cost space access and how innovations like in-space manufacturing can directly benefit life on Earth.



## The Era Of Lunar Exploration Has Begun

The recent launch of NASA’s Artemis I mission in November 2022 marks the start of an exciting new chapter in lunar exploration. After years of preparation, the uncrewed test flight of the Orion spacecraft and Space Launch System rocket represents a milestone achievement for NASA and its international partners. At the fourth plenary of the International Astronautical Congress 2023 a panel of leaders from space agencies around the world reflected on the lessons and implications of Artemis I while previewing ambitious plans to return humans to the lunar surface.

The fourth plenary of IAC 2023, “The Era Of Lunar Exploration Has Begun,” was moderated by Nujoud Merancy, the Strategy & Architecture Lead For Exploration Systems Development Mission Directorate at NASA, and featured a panel of speakers that included Sharmila Bhattacharya, Program Scientist for Space Biology in the Biological and Physical Science Division at NASA; James Free, the Associate Administrator for the Exploration Systems Development Mission Directorate at NASA; Miguel Bello Mora, the Director of the Spanish Space Agency; and Hiroshi Sasaki, the Vice President and Director General for Human Spaceflight Technology Directorate at the Japan

Aerospace Exploration Agency (JAXA), who discussed the successes and lessons learned from Artemis I, as well as the future of the Artemis program.

Free started the panel by reflecting on the flawless launch and orbit of the uncrewed Artemis I test flight. This mission demonstrated the capabilities of NASA’s new Space Launch System rocket and Orion spacecraft in preparation for future crewed flights. Free outlined the series of increasingly complex Artemis missions planned, culminating in regular trips between Earth and lunar orbit, and the critical necessity of international collaboration as the foundation for achieving these ambitious goals.

Free emphasized that Artemis I successfully tested Orion’s systems ahead of crewed flights. “The biggest lesson learned was the heat shield’s performance during reentry,” he said. While temperatures were fine, some mechanical aspects need work since the “skip entry” cross range maneuver put demands on the shield. Artemis II will test systems in Earth orbit before a lunar mission. Meanwhile, work progresses on Gateway, spacesuits, and lunar landers. “We’ll continue to add new capabilities with each mission,” said Free.





Bhattacharya described the wealth of scientific experiments and payloads onboard Artemis I, noting that science is central to every Artemis mission and highlighting the important role played by international and commercial partnerships in Artemis science. Bhattacharya highlighted upcoming opportunities for science on the lunar surface and Gateway station, such as the upcoming Artemis III lunar lander platforms that can deliver payloads across the Moon's surface. Despite the importance of robotic exploration in the Artemis missions, however, Bhattacharya acknowledged the critical role that human astronauts will play in future missions. "Having the human element has been very important for science," she said.



Sasaki outlined JAXA's contributions to Artemis so far and its future plans. This includes developing key technologies for the Gateway station, a pressurized lunar rover, and lunar landers to enable sustainable surface exploration. To date, JAXA has developed two cubesats that launched on Artemis I and is preparing for forthcoming Artemis missions with its SLIM lander and LUPEX polar exploration mission. "The government strongly supports R&D to send Japanese astronauts to the moon by the end of 2020," he said. "JAXA hopes to meet these expectations with our best technology."



Mora described how Spain is contributing technology to the Lunar Gateway, European Service Module, and other areas like guidance, navigation, instruments, and in-situ resource utilization. He acknowledged that while Spain's space agency is young, the country has a long history in space and is drawing on that heritage to contribute to humanity's return to the moon. More underscored the importance of crewed exploration in shaping the public's perception of space, which is crucial to drumming up government support for future missions. "We need political support to finance these activities, he said.

As the Artemis program races ahead toward a crewed landing in the not-so-distant future, free concluded the panel by underscoring the importance of international and industry collaboration, noting that "insight, not oversight" guides NASA's relationships with commercial partners SpaceX and Blue Origin on the Human Landing System program. Sasaki also stressed the value of sharing knowledge and data globally, noting an upcoming JAXA mission to return samples from the Martian moon Phobos as an example of synergies from combining technologies. "Science itself is a common goal for humankind," he said, a point that was echoed by Bhattacharya. "Science is a team sport," she said.

The successful launch of Artemis I and the optimistic vision for future missions outlined by the IAC panelists demonstrate that the era of renewed lunar exploration truly has begun. Powered by international cooperation, the Artemis program promises to open up scientific, technological, and economic opportunities on and around the Moon. As long as space agencies can sustain government support and public enthusiasm, Artemis has the potential to establish a permanent human presence on the lunar surface and catalyze a new age of space exploration.

“Science itself is a common goal for humankind. Science is a team sport”

## Emerging Technologies on Natural Disaster Detection - Turkey Syria Earthquake And Remote Sensing Applications

The devastating earthquakes that struck Turkey and Syria in February 2023 underscored the critical role that space technology plays in responding to natural disasters. The fifth plenary of IAC 2023 brought together experts to discuss how satellite imagery, remote sensing data, and advanced analytics can support search and rescue efforts on the ground drawing upon lessons learned from the recent earthquake. Speakers from organizations like Planet, the United Nations, and technology startups shared insights from the frontlines of the Turkey-Syria earthquake response. They highlighted how space assets were mobilized to assess damage rapidly and enable data-driven decision making by emergency responders and aid agencies. However, they also identified areas for improvement, from turning raw satellite data into actionable information to streamlining coordination between space agencies and local authorities.

Senior Propulsion and Space Researcher at the Technology Innovation Institute and featured a panel of speakers including Luca Dell'oro, the Chief of the Disaster Risk Management and Climate Resilience Section at the United Nations Satellite Centre; Rene Griesbach, the Regional Manager Pre-Sales in EMEA at Planet; Remco Timmermans, Content Marketer at SpaceSide, and Daria Stepanova, the CEO and Co-Founder of Airmo, who discussed using space technology to support disaster response, with a focus on the recent earthquakes in Turkey.

Kara opened by reflecting on the devastation caused by the February 2023 earthquakes in Turkey, which impacted over 12 provinces and claimed thousands of lives. He highlighted the critical role of space technology in responding to the disaster, from satellite imagery to assess damage to maintaining communications when electricity failed. "It was a situation that affected my life and changed my life perspective," Kara remarked. "People were united only to help the people who were in the emergency zone. Space technology supported us a lot during this disaster."

The plenary, titled "Emerging Technologies On Natural Disaster Detection - Turkey Syria Earthquake And Remote Sensing Applications," was moderated by Ozan Kara, a



Griesbach recounted his experience visiting Ankara after the earthquake to assist emergency response teams. Griesbach explained how Planet immediately tasked satellites to collect high-resolution imagery of affected regions. This allowed responders to make data-driven decisions and deliver aid faster. “Time is critical, especially in such disaster situations,” he said, while also noting that “having fresh, up-to-date information is key for decision making.” While imagery collection cannot be sped up significantly, machine learning can help rapidly process images to identify damaged buildings and potential casualties.

Stepanova shared how remote sensing technologies like micro-LiDAR can be used to detect and predict natural disasters by mapping terrain changes over time. “Altimetry is a very interesting technology that can support us with using cameras and visual spectrum,” she said. “Fusing these two datasets together can help us learn how the terrain behaves and in that way we can possibly understand what’s going to happen in the future.” She advocated for partnerships between startups and space agencies to develop and deploy these solutions rapidly when disasters strike, noting that “Startups are quite agile and quick in adjusting to new use cases.”

Timmermans emphasized the need to turn space data into “actionable information” that on-the-ground emergency responders can use immediately. He called for greater awareness and communication between the space sector and local authorities to make this happen faster during time-sensitive emergency situations. As Timmermans stated, “We talk a lot about space data. And space data is not what these rescue relief teams and authorities need. They need actionable information.”

Dell’oro highlighted the complexity of coordinating humanitarian response in Syria given over a decade of conflict. He shared that UNICEF was activated within hours of the first earthquake to provide vital satellite imagery analysis to estimate damage, which “was an especially big challenge with humanitarian access” in Syria where information was lacking and where millions of people are already displaced.

While space technology is already making great improvements in terms of natural disaster response on Earth, the panelists also noted that there is a lot of room for improvement. Griesbach cited the COPERNICUS satellite system as a major asset, providing crucial imagery to first responders within hours of acquisition. “In Turkey, we decided to give rescue teams direct access to our image archives so data could be utilized immediately,” he explained. However, prompt tasking of satellites relies heavily on emergency response protocols. “Streamlining this bureaucracy could significantly decrease timelines,” he said.

In the wake of disasters like the Turkey-Syria earthquakes, space technology has demonstrated its clear utility and ability to save lives if deployed rapidly. But the panelists agreed that gaps remain in turning space data into actionable insights, communicating with on-the-ground responders, and navigating complex logistics of international coordination. Griesbach cited the Copernicus satellite system as a major asset, providing crucial imagery to first responders within hours of acquisition. “In Turkey, we decided to give rescue teams direct access to our image archives so data could be utilized immediately,” he explained. However, prompt tasking of satellites relies heavily on emergency response protocols. “Streamlining this bureaucracy could significantly decrease timelines,” he said.

The devastating earthquakes in Turkey and Syria underscored the invaluable role of space technology in responding to natural disasters, but also revealed gaps to be addressed. While satellite imagery and data supported search and rescue efforts on the ground, speakers at IAC 2023’s plenary on emerging technologies for disaster detection highlighted needs to turn raw data into actionable insights rapidly, streamline coordination between space agencies and local authorities, and deploy technologies like micro-LiDAR more widely. By leveraging lessons learned from this tragedy and forming new partnerships, the space community can enhance their vital support to emergency responders when the next crisis inevitably strikes.

“We talk a lot about space data. And space data is not what these rescue relief teams and authorities need. They need actionable information.”



## Strategic Direction of Emerging Space Nations

The sixth plenary session at the 74<sup>th</sup> International Astronautical Congress brought together leaders of emerging space nations to discuss the strategic direction and progress of their burgeoning space programmes. While their nations’ space agencies are less than 15 years old, the leaders outlined ambitious plans underway to launch satellites, send astronauts to space, and collaborate internationally—all with the aim of driving economic growth and improving life on Earth. They also highlighted the scientific heritage, economic priorities and national pride shaping their varied approaches.

The plenary, titled “Strategic Direction Of Emerging Space Nations,” was moderated by Asanda Sangoni, the Acting Managing Director of Earth Observations at the South African National Space Agency (SANSA), and featured a distinguished group of space agency leaders including Michal Brichta, the Head of the Slovak Investment and Trade Development Agency in the Slovak Space Office; Natavan Hasanova, the Strategy and Business Development Director at Azercosmos; Humbulani Mudau, the CEO of the South African National Space Agency (SANSA); Zolana Rui Joao, the General Manager of the National Space Program Management Office of Angola; and Grzegorz Wrochna, the President of the Polish Space Agency (POLSA).

Joao kicked off the session by discussing the first decade of Angola’s space agency. “We started our space programme in 2013 and have achieved meaningful results,” he said. “Last year we successfully launched our first geostationary satellite.” He acknowledged failures along the way, calling space “very expensive for African countries,” but said Angola is now focused on building its ecosystem by engaging the private sector.

Mudau built on Joao’s comments, noting how despite South Africa’s space agency only being 12 years old, the country has long contributed to space activities. He then outlined South Africa’s mandate to coordinate space activities and build capabilities for industry growth, research, human capital and infrastructure. “It’s critical for us to have a viable and sustainable space programme,” he said.

Wrochna called Poland’s “relatively young” agency an example of the country’s renewed space ambitions. After joining the European Space Agency 11 years ago, Poland has launched 16 satellites and contributed to over 80 ESA and NASA missions. “Our ambitions are growing,” he said, citing plans to develop Polish satellites and send a second Polish astronaut to space.





The panelists acknowledged it is challenging to build space sectors from scratch. Hasanova pointed out Azercosmos' international collaborations across 42 countries as a way that Azerbaijan has overcome this challenge, which was echoed by Joao who called ecosystem-building essential. Brichta agreed, noting that for emerging space ecosystems, "combination of potential and motivation" is key. He said each country's scientific heritage, sectors like software and entrepreneurship, and aspirations shape its approach. Slovakia, for example, aims to provide opportunities for companies and use space to advance its knowledge economy.

Each of the panelists also highlighted the way that their national space activities are benefiting life on earth. As Hasanova explained Azerbaijan's focus on information security and sustainability, launching telecom satellites when its TV and radio were transmitted by third parties. Now Azerbaijan provides satellite services to Africa, the Middle East, Central Asia and Europe. The country also launched an earth observation satellite in 2014 for crop monitoring to inform government policies. "Space creates value and has long term benefits for all humankind," she said.

Joao highlighted using space to diversify the oil-dependent economy. With only 30% internet access nationally, Angola invested in satellites to address the digital divide. Natural resource management is also a priority, using satellites to counter illegal fishing and mining. Mudau also emphasized how space technology drives industrialization and contributes to economic development and meeting social needs. As for Poland, Wrochna said both national pride and need for telecommunications and earth observation capabilities drive the nation's space programmes.

The sixth plenary session of the International Astronautical Congress 2023 provided insight into the strategic direction and progress of emerging space nations. Despite their space agencies being less than 15 years old, the session's distinguished panelists outlined their nation's ambitious plans to drive economic growth, meet social needs, and foster national pride through space activities. Though building space sectors from scratch brings challenges, each country is leveraging its heritage and priorities to develop capabilities. The panelists highlighted how, by providing services regionally and contributing to international missions, these emerging space nations are benefiting all of humankind.



“We started our space programme in 2013 and have achieved meaningful results. Last year we successfully launched our first geostationary satellite.”

## The Open-Source Revolution and Space Data Accessibility

The seventh and final plenary of IAC 2023, "The Open Source Revolution and Space Data Accessibility," was moderated by James Green, the Chief Executive Officer and Chairman of Space Science Endeavors, and featured a mix of entrepreneur and research panelists, including Mohammad Iranmanesh, Space Systems Engineer and Co-Founder of Lide.space; Emma Louden, a PhD Candidate at Yale University; Oné Mikulskytė, Science and Organization Lead of Team Tumbleweed; Maheen Parbhoo, Innovation Analyst at the Research Institute for Innovation and Sustainability; and Anthony Yuen, Former Assistant Professor at Weill Cornell Medicine, who discussed how open data is transforming space science and technology.

In an opening video introduction, the panelists highlighted the democratizing effect of open data. Parbhoo explained how the Africa Earth Observation Challenge provides African startups access to satellite data to develop innovative solutions. This not only serves underdeveloped communities but also stimulates economic growth on the continent. Louden, who studies exoplanet systems using only open-source data from NASA and ESA, discussed how these shared databases "really democratize astrophysics" by allowing worldwide access.

However, speakers cited frustrations with current data structures. Louden noted the challenges of getting different archives to interface. Iranmanesh built on this point by lamenting the "relentless cycle of reinvention" in the space industry because companies cannot build on each other's elementary tests and data. He said he co-founded LightSpace to encourage greater data sharing through a new microgravity platform. "To accelerate the pace of innovation, we have to share and collaborate more," he said. "We have to think very thoughtfully about how to build archives that can interact with one another well."

Mikulskytė, who works as a researcher at Stanford University's Space Rendezvous Laboratory, introduced the concept of using "tumbleweeds" to explore the Martian surface. These lightweight sensor platforms free-fall and tumble across Mars, carried by the wind. Mikulskytė explained that by deploying a fleet of tumbleweeds instead of relying on a single spacecraft, "we're now able to distribute the mission risk across an entire fleet of tumbleweeds and entire swarm. It's really as simple as not putting all of your eggs in one basket." She believes distributing many low-cost tumbleweed sensors can



“transform the seven minutes of terror into a decade of triumph.” She added that standardizing engineering data helps new space actors develop capabilities by building on existing knowledge, creating a “chain reaction” of innovation.

Parbhoo, meanwhile, focused the discussion on how open satellite data is enabling African countries to address challenges like food insecurity through precision agriculture. She gave an example of Rwanda using satellite data to help evacuate nearly 1 million people before a volcanic eruption. Parbhoo also explained how the African Earth Observation Challenge has helped startups apply open satellite data to local challenges, and how award winners gained access to higher resolution data to enhance their solutions.

Toward the end of the panel, Mikulskytė emphasized the importance of iterative problem-solving, stating “we take a problem and make sure we’re able to solve it by doing it over and over again until it works.” By reducing data costs, benefits can be dispersed more widely among stakeholders beyond major agencies. Green raised the critical issue of not just accessing online data, but having the right information to find relevant datasets, a point that Loudon expanded on by explaining that documentation helps researchers understand meanings and units. She suggested learning from software practices like standardized Python package documentation to improve space data archives.

All the panelists agreed that personal interactions remain invaluable for identifying rich datasets. Green encouraged senior researchers to attend conferences and assist early career scientists in making connections. Regarding

data rights, Mikulskytė advocated openness to reduce costs and distribute data wider. Loudon also noted that initial researcher proprietary periods can be beneficial before public release for finding quality data, Iranmanesh recommended contacting authors directly—many gladly share additional data beyond publications. And finally, Mikulskytė and Iranmanesh both highlighted the importance of using data to reach students through open images and small space project designs. As an example, Loudon pointed out archives like the Exoplanet Archive have both technical and public-friendly interfaces to spark interest.

The IAC 2023 plenary on open space data highlighted both the tremendous benefits and remaining challenges of the open data revolution. As the panelists described, open access to space data enables worldwide scientific collaboration, stimulates technology innovation, and helps address global issues like food insecurity. However, current inconsistencies between archives and incomplete documentation can still hinder researchers. Moving forward, the space community can expand the impact of open data by improving standardization, metadata, and interactive tools for non-expert users. Most importantly, senior researchers should actively mentor the next generation of scientists to help them navigate datasets and forge collaborations.

By strengthening open data practices, space agencies and the broader community can accelerate discovery and maximize the value of their investments for the world. Ultimately, the democratization of space hinges on participatory data structures. Through collaboration and iteration, open data can empower worldwide problem-solving and inspire future generations to reach for the stars.



“To accelerate the pace of innovation, we have to share and collaborate more. We have to think very thoughtfully about how to build archives that can interact with one another well.”



## IAC 2023

# Highlight Lectures



# Pioneering A Sustainable Earth-Moon Ecosystem

The 74<sup>th</sup> International Astronautical Congress featured an illuminating Highlight Lecture from leaders at the lunar exploration company ispace, who provided updates on their mission to accomplish the first fully private lunar landing. Although the company's first mission in late 2022 did not complete a lunar landing, the mission demonstrated remarkable progress in private sector deep space capabilities. The company also previewed its forthcoming Missions 2 and 3, reiterating ispace's commitment to sustainable lunar exploration and their vision of constructing infrastructure to enable humanity's expansion into space.

The first Highlight Lecture of IAC 2023, "Pioneering A Sustainable Earth-Moon Ecosystem: The ispace Journey to The Moon Location" featured an introduction from ispace founder and CEO Takeshi Hakamada and two distinguished ispace engineers: Yoshitsugu Hitachi, the Lander System Engineering Group Manager, and Janelle Wellons, a Spacecraft Operations Engineer. The team provided updates on their monumental Mission 1, the first ever fully private lunar landing attempt, and their vision for building a lunar economy in the coming years.

Hakamada opened the session by explaining how he wants to "expand the planet" by enabling sustainable economic

activity in space. He sees lunar resources, especially water ice, as the key to lowering launch costs and making space economically viable. ispace aims to have 1,000 people working and living on the moon by around 2040. The company is currently working on three simultaneous lunar missions using private funding. Hakamada said diversity and international cooperation are critical for lunar exploration, reflected in ispace's global workforce of 250 people.

Hitachi provided an update on ispace's Mission 1, the first entirely commercial lunar landing attempt. The mission successfully launched in December 2022 and achieved 8 out of 10 mission milestones, including 4.5 months of deep space flight before missing the final landing on the moon. While ultimately unable to complete a soft lunar landing, the mission's success advancing private lunar exploration will inform upcoming Missions 2 and 3. "Hitachi walked through the six phases of the "complex but really beautiful" landing sequence for Mission 1, explaining that all went smoothly until the very end when the lander essentially halted its descent thinking it had reached the surface, even though it was still 5 kilometers aboveground. "Achieving eight milestones out of 10 is still a really great achievement that greatly contributes to our ongoing missions," he said. "This was a really precious experience and this is the precious data that we got."



Wellons shared insights from behind the scenes during the Mission 1 landing attempt. With team members located around the world, Wellons said she and her colleagues at ispace worked tirelessly leading up to the launch, including holidays and weekends. Shortly after launching, the team encountered a major issue when communication with the lander was lost, putting them in a race against time before the battery drained. Drawing on their diverse expertise, the team quickly identified the root cause and recovered the spacecraft's orientation, saving the mission in an impressive display of skill and dedication. Given all that ispace had done to reach the Moon, for Wellons, who led the landing operation, the ultimate outcome was heartbreaking. But, she said, support from across the world was uplifting. "Your support really meant the world to me and my team," she said. "We really worked hard. And we really gave it our all."

Though falling just short of their ultimate objective, Mission 1 proved private companies can reach the Moon. The rapid follow-on missions demonstrate ispace's commitment to sustainable lunar exploration. "I believe the continuity our team is gathering from all over the world, literally, is now bringing us to the next stage, the sustainable stage of the lunar exploration," said Hakamada. With missions spanning years, not just days, he said ispace aims to construct the infrastructure enabling humanity's expansion into the cosmos. Wellons echoed this sentiment, telling the audience that for ispace, "this is just chapter one, this is just the beginning."

Hitachi rounded out the lecture by describing progress on the company's Mission 2, slated to launch in 2024. This mission will use the same lander as Mission 1, which attempted to land on the moon in 2022 but ended unsuccessfully. Mission 2 aims to demonstrate soft landing capabilities and deploy a micro rover built by ispace's European office. Hitachi also previewed Mission 3, planned for launch in 2026, which will use a new 1-ton capacity lander called APEX to deliver a 300-500 kg payload to the lunar surface. Reflecting on lessons from Mission 1, Hitachi said the attempt transformed the team from a group of individuals to a cohesive unit: "We got the feeling that we completed our mission together finally. We have a feeling that we are one team now and that anything is possible."

The highlight lecture from ispace showcased remarkable progress and perseverance in private lunar exploration. Although failing to complete the first ever fully private moon landing on Mission 1, ispace achieved numerous milestones demonstrating deep space capabilities far surpassing past private efforts. Undeterred by their final landing mishap, ispace continues forging ahead with Missions 2 and 3, aiming to deliver scientific payloads and eventually establish permanent infrastructure enabling sustainable economic activity on the Moon. ispace's bold vision, diverse workforce, and rapidly improving technologies promise to open up the lunar frontier for humanity.



“Your support really meant the world to me and my team. We really worked hard. And we really gave it our all.”

# Fire And Ice - Space For Climate Action High Level Summary Of GLOC 2023 Findings And Recommendations

The second highlight lecture of IAC 2023, "Fire And Ice - Space For Climate Action High Level Summary Of GLOC 2023 Findings And Recommendations," was a discussion between moderator Harry Cikanek, the Chair of the IAF Earth Observations Committee, and James Graf the Director of Earth Science and Technology at NASA. During the session, Graf recounted the results from the IAF's first ever Global Space Conference on climate change held in Norway in May 2023.

Graf opened the session by quoting from a speech given at GLOC 2023 by Louis Spinrad of NOAA, who said that when it comes to climate change, "the wolf is in the house." Greenhouse gas emissions have peaked beyond pre-industrial levels and extreme weather events like floods and wildfires are increasing in intensity and frequency. "New predictive methods are needed as the old paradigms no longer apply," he said. As Graf explained, the goal of GLOC was to "explore how space capabilities can accelerate climate action, not just talk about climate problems." Evaluating public engagement and identifying gaps between capabilities and user needs were also key objectives. "We brought together space and non-space

communities in an unconventional conference to answer difficult questions on making an impact," he said.

On collaboration, Graf noted that agencies are sharing data but users need information. "Local users are getting lost, unable to access or process the data into useful information," he said. Adopting open science policies to provide algorithms and software to convert data into actionable information is key. Private sector and philanthropic groups are emerging both as space faring organizations and climate data users, but better tools to unlock insights are needed.

In terms of communicating the role that space places in tackling climate change, Graf recounted the critique of space leaders from BBC's Ru A. Kermani said they are too busy talking to themselves instead of translating capabilities into "why it matters" for citizens, policy makers and stakeholders. Closing knowledge gaps between space tech and climate impact for different sectors is also crucial. Graf urged the space sector to "go beyond data and technology and tell our story of how we contribute to addressing climate change."



In addition to improving the space community's communication abilities, Graf also highlighted another key theme from the GLOC 2023 conference: the crucial role played by industry. "We need to provide new business opportunities to harness philanthropic and commercial firms, in addition to augmenting traditional space activities," he said. For example, Graf explained how satellites can remotely measure greenhouse gas emissions worldwide, helping curb unchecked carbon pollution. Wildfire monitoring from space informs preventative action and post-fire recovery plans. While beneficial, Graf said these observation programs need sustained funding and data transparency between nations monitoring climate change.

The last point, said Graf, is critical. Satellites collecting climate data are only part of the solution. "We have to work with other agencies to get the data to local communities so they can act on it. That's the last mile," Graf noted. End-users worldwide stressed the need for space programs to convert raw data into actionable insights matching their regional needs. We must recognize we have a problem," Graf conceded regarding data access and utilization. He advocated data standards and translators so users are not burdened, plus partnering with domestic agencies to engage stakeholders. "That doesn't happen smoothly now," he said. Cikanek observed that establishing a community-wide data standard was a key conference recommendation. More user engagement and "marketing" is essential to understand and meet needs. "It's not in the charter and mission of everybody" Graf noted, but the space ecosystem must collaboratively solve this problem.

As the session concluded, Graf called the GLOC conference an "experiment" in bringing unconventional voices to critique and improve the space sector's climate contribution. But real success depends on getting users the data they need for action. "That," he said, "will decide if this experiment is successful. The intent of Fire and Ice was to explore and find ways to make a difference. This mission continues."

**“We have to work with other agencies to get the data to local communities so they can act on it. That’s the last mile. End-users worldwide stressed the need for space programs to convert raw data into actionable insights matching their regional needs. We must recognize we have a problem.”**



### Creating a More Exciting Future

The third and final highlight lecture of IAC 2023, "Creating A More Exciting Future," featured a conversation between IAF President Clay Mowry and SpaceX CEO and Founder Elon Musk, who called into the conference remotely. Speaking before a packed auditorium, Musk opened the conversation by marveling at the progress his company has made in 15 years, from its early Falcon 1 rocket capable of launching a 165 kg payload, to the towering 400 ft tall Starship system designed to lift 150 metric tons. "Falcon 1 looks like a child's toy," Musk said, noting Starship will have about 20 million pounds of thrust, three times that of the Saturn V moon rocket.

A critical goal is reusability, with both Starship's upper stage and Super Heavy booster designed to fly again rapidly after landing. Mowry called it "a truly profound revolution" to master reusable orbital rockets. "Rapidly reusable, reliable rockets are required for life to become multiplanetary," Musk said, echoing his vision to colonize Mars.

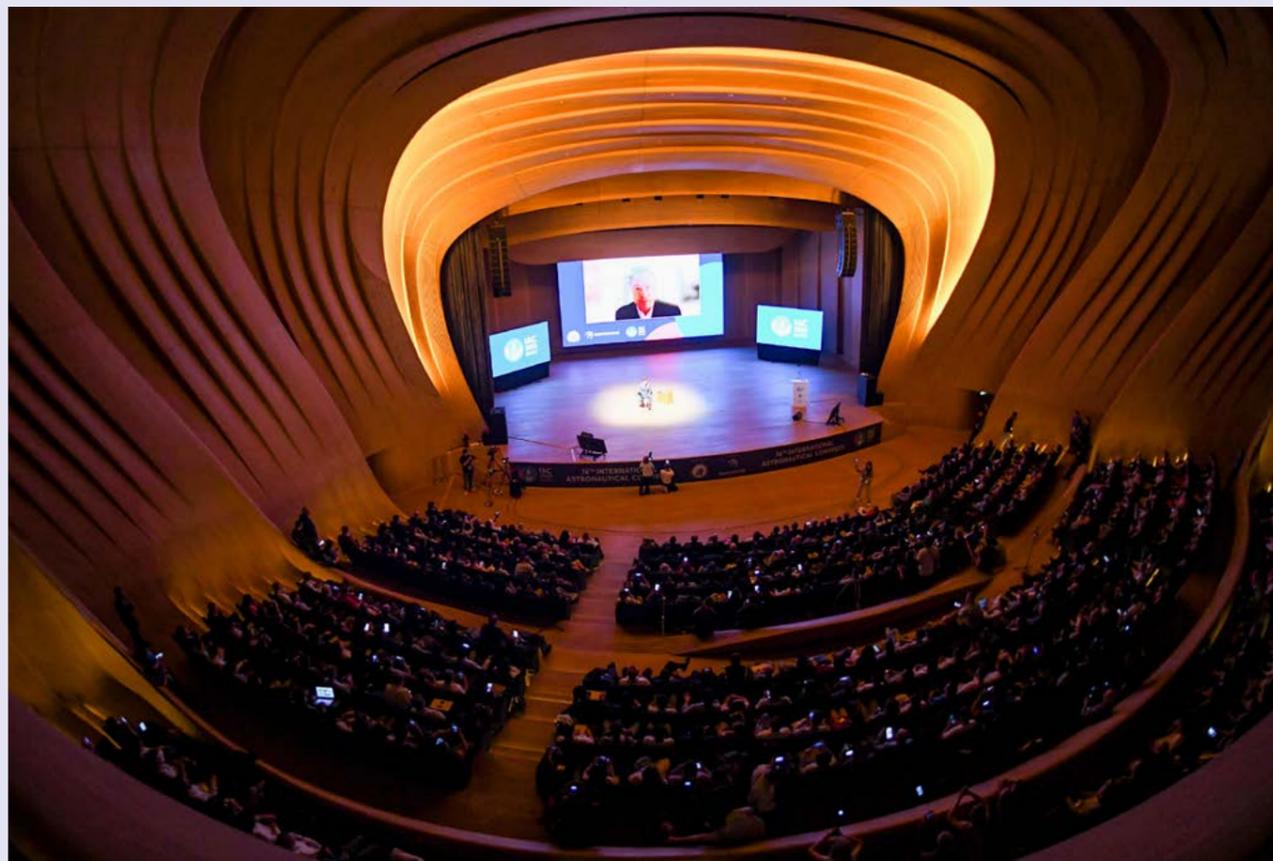
The current Starship test flight aims to test a new staging method Musk described as "hot staging," where the upper stage engines ignite while the booster engines are still firing. "This is actually, from a physics standpoint, the most efficient way to do stage separation," Musk noted. While

risky and unproven, success would demonstrate viability for future orbital missions.

Mowry asked what constitutes success for the upcoming launch. "I do want to set expectations not too high," Musk cautioned. "If the engines light, and the ship doesn't blow itself up during stage separation, then I think we've got a decent chance." The suborbital flight is intended to splash down in the Pacific near Hawaii, far from population.

Looking ahead, Musk hopes to catch future Starships and Super Heavy boosters using enormous mechanical arms on launchpad towers, possibly within a year. "It sounds insane...but in theory, it should work," he said. While still unproven, the rapid reusability could truly revolutionize space access.

Musk also predicted SpaceX could begin launching satellites using its giant Starship rocket within a year and land cargo on Mars in the next four years. "There's a good chance we will start deploying Starlink v3 satellites next year in roughly a year from now," Musk said. While solving for safe reentry and landing remains a challenge, Musk believes SpaceX can start launching satellites before perfecting Starship reusability.



With a diameter of 9 meters and 17.5 meters of usable payload volume, Starship offers incredible capacity unlike any rocket before it. "When you step into the Starship fairing payload volume, it looks like a cathedral," Musk remarked. This vast space enables new scientific capabilities, like a proposed 8-meter space telescope from UC Berkeley that would dwarf even the 2.4-meter Hubble Space Telescope.

To manufacture Starship at scale, SpaceX is constructing "a giant factory for a giant rocket" near its Texas launch facilities, Musk explained. While Starship's Raptor engines are still made in California, the public can view Starship manufacturing up close without any need for permission.

The impetus behind Starship's massive size is establishing a sustainable human presence on Mars, which Musk believes requires transporting around 1 million tons of cargo. This equates to about 5 million tons launched to Earth orbit annually, beyond Earth's current launch capacity.

Propellant transfer in orbit will be key to enabling longer journeys to Mars and beyond, Musk noted. While complex, this process of docking and transferring fuel between spacecraft is simpler than docking with the space station. Eventually, Musk envisions optimized Starship tanker vehicles transferring propellant to Starships bound for the Moon, Mars and other destinations.



“We’re talking about thousands of launches per year. To make life multiplanetary, you’ve got to be in this sort of hundreds of thousands to millions of tons of Earth orbit per year.”



Rapid reusability will also be critical for achieving the launch volumes required for Mars settlement. In the next few years, SpaceX aims to launch Starship from Texas and Florida frequently, transitioning eventually to ocean spaceports capable of hosting multiple daily launches.

“We’re talking about thousands of launches per year,” Musk said. “To make life multiplanetary, you’ve got to be in this sort of hundreds of thousands to millions of tons of Earth orbit per year.” To this end, he described SpaceX’s aim to launch up to 2500 tons into orbit next year—a 50% increase from 2022. He stressed that this exponential growth is imperative, saying “it’s either that or single planet species forever.”

Musk also spotlighted Starship, SpaceX’s next-generation reusable rocket, describing plans for point-to-point transportation on Earth. He envisions Starship offering supersonic

travel between major cities in under 30 minutes. “You could have breakfast in LA, lunch in London, and dinner in Singapore, and then be back in LA for bedtime,” he quipped, while acknowledging economic viability remains uncertain.

Musk concluded the session by discussing his vision for establishing a human settlement on Mars, stressing that abundant, low-cost propellant from the planet itself would be key. He described a hypothetical laser-based communication system with satellites positioned along the route for continuous connectivity. When asked for career advice for young space professionals, Musk expressed hope that humanity can expand the frontiers of consciousness and civilization. He described a fundamentally philosophical motivation: “I’m just curious as to the nature of reality.” As for the search for extraterrestrial life on the Red Planet, he observed wryly that so far, “We are the aliens as far as I can tell.”

## Late Breaking News: Chandrayaan-3: Initial Results from Exploring Lunar South Pole

India’s historic Chandrayaan-3 lunar mission successfully landed a rover on the Moon’s south pole in August, a remarkable achievement following the crash landing of its predecessor Chandrayaan-2 in 2019. During a Late Breaking News session at the International Astronautical Congress, four mission directors from the Indian Space Research Organisation (ISRO) gave exclusive details about the Chandrayaan-3 and India’s future lunar exploration plans.



“This is our return to the moon and the objectives were first to demonstrate safe landing, followed by rover deployment,” said Victor Joseph, Associate Scientific Secretary and Director of Technology Development and Innovation at the Indian Space Research Organisation. After detailing the “painful learning process” from Chandrayaan-2, Joseph explained improvements made to Chandrayaan-3’s guidance systems and ground testing regimes.

M.S. Anurup, Director of the Space Transportation Programme Office at the Indian Space Research Organisation, highlighted rigorous sensor tests conducted using helicopters and test chambers with simulated lunar

craters. “It was a painful process to devise new test beds and special tests including all conditions and distortions during the landing phase,” Anurup said.

Responsible for navigating Chandrayaan-3 from Earth orbit to its lunar destination, Anil Kumar, Associate Director of ISTRAC and Chief General Manager of Safe and Sustainable Space Operations Management at the Indian Space Research Organisation, described a series of five precision orbital burns before the separation of the lander Vikram Sarabhai on August 17<sup>th</sup>. “The landing site was chosen utilizing high resolution images from Chandrayaan-2’s orbiter,” Kumar noted, underlining the synergy between ISRO’s lunar missions.

“It’s not only a technology demonstration mission to go into the moon lander and rover there, but it’s also a suit of instruments. These instruments are carefully chosen to complement the observation of what we got earlier by our missions, and also some of the missions of our partner agencies.”



D. Gowrisankar, Director of the Office of International and Interagency Cooperation at the Indian Space Research Organisation, reported initial scientific discoveries from Chandrayaan-3 and discussed the details of two scientific instruments to analyze the polar region’s plasma environment and surface composition in situ for the first time.

“It’s not only a technology demonstration mission to go into the moon lander and rover there, but it’s also a suit of instruments,” said Gowrisankar, highlighting the importance of interagency cooperation in the success of the mission. “These instruments are carefully chosen to complement the observation of what we got earlier by our missions, and also some of the missions of our partner agencies.”

Among the scientific discoveries noted by Gowrisankar were a striking 60 C temperature difference from the top of the regolith to 10 cm below the lunar surface, which provides key insights into the thermal properties of the moon’s soil near the south pole. “The results from this instrument certainly can give vital input for us to choose the material when we are going to establish some infrastructure in the lunar surface,” Gowrisankar said.

The rover’s spectral profiler also identified several common minerals and unexpectedly detected sulfur in significant concentrations. In addition to sulfur, iron, aluminum, titanium, chromium, and calcium peaks were observed when laser pulses vaporized pinpoint locations on rocks scanned by the rover.

Gowrisankar noted that Chandrayaan-3’s suite of instruments will continue surveying the moon’s plasma, physical properties, mineral composition, and seismic activity around the lunar south pole and radio data back to ISRO. “The results from this mission will not be analyzed in isolation,” Gowrisankar said, noting correlations with findings from Chandrayaan-2’s orbiter. For instance, corroborating data from Chandrayaan-3’s in situ instruments will help refine models used to study lunar hydration and surface roughness through the previous mission’s observations.

Kumar closed the LBN session by noting that Chandrayaan-3 stands on the shoulders of complex international cooperation, with contributions from NASA and over 100 global aerospace companies. But by working together, the mission has already been able to greatly increase our understanding of the moon’s surface environment and collect data that will enable the next great era of lunar exploration.



# IAC 2023

## IAF Global Networking Forum (IAF GNF)



## Monday 2 October 2023

*On Monday, space leaders congregated for three IAF Global Networking Forum sessions that focused on several key challenges and opportunities ahead for the space sector as satellite mega-constellations proliferate, new space actors multiply, and national space agencies expand their lunar exploration ambitions.*

The first IAF GNF session, “Towards A Zero Debris Future,” was moderated by the European Space Agency’s Quentin Verspieren and included NASA Deputy Administrator Pamela Melroy, JAXA President Hiroshi Yamakawa, ISRO Chairman S. Somanath, UK Space Agency Chief Executive Paul Bate, SpaceX’s Michael Nicolls, and Inter-Agency Space Debris Coordination Committee’s Holger Krag.

Bate called space debris the industry’s “greatest challenge” and advocated for the creation of a broad, multi-sector international forum to coordinate action on the issue. Overall, the panelists largely agreed that voluntary guidelines alone cannot adequately curb debris. More binding regulations are needed but face difficulties keeping pace with technological change. “Achieving 100% debris mitigation is hard,” noted Krag. Nevertheless, private space actors have an important role to play in debris mitigation by holding themselves to high standards, a reality underscored by Nicholls, who highlighted SpaceX’s efforts to develop debris removal technologies and adhere to “collision avoidance standards are far stricter than industry norms.”

The second IAF GNF session, “International Lunar Research Station - International Science Project,” provided technological and scientific details for China’s upcoming Chang’e-8 lunar mission and highlighted opportunities for international collaboration on the mission. The session was moderated by CGTN’s Wu Lei and featured Qiong Wang, the Deputy Chief Designer of CLEP Chang’e-8 Mission at the China National Space Administration (CNSA); Xiangyu Xi, an



“We need to continue to use our power around the world to communicate and educate investor communities about space and space businesses. We need to redouble our efforts to communicate the social and economic value of space to everybody out there.”

engineer at System Research Institute in China’s Deep Space Exploration Laboratory; Serdar Hüseyin Yildirim, Chairman of the Board and President of the Turkish Space Agency (TUA); Dengyun Yu, the Deputy Director Of the Science and Technology Committee at the China Aerospace Science And Technology Corporation; and Thomas Zurbuchen, Professor and Director of Space Programs at ETH Zürich.

Yu initiated the session by giving an overview of the Chang’e-8 mission objectives, which includes plans to send multiple robotic missions that will culminate in a permanently crewed lunar base. Wang, meanwhile, highlighted opportunities for international partners, including collaborating at the mission, system, and payload levels. Zurbuchen discussed current U.S.-China cooperation in space science like the ICON mission as an example of what successful international collaboration in space can look like. Zurbuchen expressed optimism that international collaboration will “grow the pie” of space knowledge and help the world “transcend some of the boundaries and borders that separate us here on Earth.”

Monday’s third and final IAF GNF Session, “Maturing Space Investment,” into space sustainability from a financial lens. The session was moderated by Bhavya Lal, NASA’s former Associate Administrator for Technology, Policy, And Strategy and featured Kevin O’Connell, the Founder of Space Economy Rising; Dana Baki, the Chief Commercial Officer at The Exploration Company; and Carissa Christensen, the CEO of Bryce Space And Technology. During the session, the panelists emphasized profitability, diversified revenue streams and de-risking as key for attracting private capital to space firms, which is critical to fueling the space industry’s growth.

Christensen explained how space investment has transformed with an influx of funding from space-focused billionaires, enabling hundreds of startups and over \$60 billion in investment. However, she cautioned that most funding still focuses on satellites and launch vehicles rather than in-space activities. O’Connell, meanwhile, emphasized the importance of government signals to influence private markets and noted that almost \$300 billion has flowed into space companies in the last decade across diverse market verticals. Baki rounded out the session by discussing the challenges of attracting investors and the need for proving the uniqueness of space businesses, identifying executable use cases, and educating investors on game changing technologies like private space stations. “We need to continue to use our power around the world to communicate and educate investor communities about space and space businesses,” said Christensen at the conclusion of the panel. “We need to redouble our efforts to communicate the social and economic value of space to everybody out there.”

The three IAF GNF sessions on Monday provided an illuminating window into the opportunities and challenges confronting the rapidly evolving space industry. As the sessions demonstrated, ensuring the long-term sustainability of space will require strengthened international cooperation and regulation. At the same time, the promising plans outlined for Chang’e-8 and ongoing collaborations like ICON show that transcending divisions on Earth to work collectively in space is within reach. With sustained commitment from traditional and new space actors, the prospects look bright for maturing the still fledgling space economy into one that drives innovation while avoiding the pitfalls of debris and discord.



## Tuesday 3 October 2023

Tuesday featured four IAF Global Networking Forum (GNF) panels covering a broad spectrum of urgent topics for the space sector including overcoming economic headwinds, the opportunity ahead for private space stations, how international and public-private partnerships can spur deep space exploration, and the sustainable use of spectrum in using space assets to connect people around the world.

The first IAF GNF session, “Overcoming Adversities: Navigating Through Challenging Times,” was moderated by Kyle Acierno, the Managing Director of OffWorld Europe and featured a panel including Valeriya Barashkova, the Co-Founder of Aerospace Capital; Manny Shar, the Managing Director of Orbit Fab; Sita Sonty, the CEO of Space Tango; and Dylan Taylor, the Chairman and CEO of Voyager Space Holdings. Each brought their unique perspective on a number of solutions to challenges facing the private space sector, which ranged from technical challenges to unpredictable economic and political environments.



Taylor kicked off the session by describing his journey to space in 2021 on Blue Origin’s New Shepard rocket and how this experience has fueled his mission to provide broader access to space through commercial space stations. Sonty drew on her career as a US diplomat and space industry executive to make the case that space can enable technology transfer, serve economic goals, and be a powerful foreign policy tool, with the International Space Station as a primary example of what successful international collaboration looks like in practice. A unifying theme was overcoming adversity with resilience, creativity and community. Barashkova, meanwhile, highlighted the role of students and space education in overcoming current and future challenges in the space sector, citing Russia’s Space-B education program as a primary example. “It’s exciting to see how children and professionals work together across our whole big country in the space labs,” Barashkova said.



The second IAF GNF session, “Destinations In Low Earth Orbit, Sustaining Vital Research, Commerce, Exploration Through Private Space Stations,” was moderated by Scott Pace, the Director of the Space Policy Institute at George Washington University, and featured a panel composed of Robyn Gatens, the Director of the International Space Station at NASA, Masami Onoda, the Director of the Japan Aerospace Exploration Agency’s (JAXA) Washington D.C. Office; Steven Rutgers, the Chief Commercial Officer at Arianespace; and Eric Stallmer, Executive Vice President for Government Affairs and Public Policy at Voyager Space Holdings. The panelists drew on their diverse backgrounds in government and industry to provide insights into the future of low Earth orbit as the era of the government-run International Space Station gives way to privately operated commercial outposts.



“We’re moving from an era of owning and operating a government platform together with our international partners, to an era where governments are going to be purchasing services from commercially owned and operated platforms in low Earth orbit,” Gatens said. This transition, said Manbrer, presents the opportunity to pursue Manber “a variety of activities, a variety of opportunities that otherwise wouldn’t exist.” Nevertheless, that does not mean that government-run space stations would not have a role to play in the future, too. Onoda highlighted Japan’s vital contributions to the ISS through the Kibo module and logistics vehicles and announced JAXA’s commitment to extend Kibo operations through 2030 as part of the transition planning. Gatens said while the transition may be bumpy at first, NASA is working closely with researchers, international partners and the commercial sector to enable continuity. She was excited about the “wide range of capabilities” emerging from the private sector, a sentiment echoed by Manbrer who described it as a “new era” of robust public-private partnerships in space.

The third IAF GNF session, “Enabling Science And Exploration In Deep Space - Partnership And Infrastructure Opportunities,” was moderated by David Thomas, the Executive Director of the Milo Space Science Institute and featured a lively panel discussion about how investments in infrastructure and partnerships can further humanity’s ambitions in deep space between Ramon Blanco, the US Head Of Space at Added Value Solutions, A. C. Charania, the NASA’s Chief Technologist; Daniel Scheeres, a Distinguished Professor at the University of Colorado’s Center For Astrodynamics Research; and Aude Vignelles, the Chief Technologist at the Australian Space Agency.

Charania started the panel by highlighting how NASA draws on expertise from across the commercial space sector to support its Artemis program and future capabilities like quantum computing and AI. Vignelles, meanwhile, discussed how Australia’s “Moon to Mars” initiative is readying its industry for deep space while tackling Earthly challenges like remote asset management, and Scheeres offered the scientific end-user perspective and the advantages of small rapid missions to spur technology development. A theme across the forum was that ambitious deep space endeavors require cross-sector collaboration to succeed. No one nation or organization can go it alone. As Charania said, “the tools I have are partnerships,” a sentiment shared by Vignelles who emphasized collaboration’s particular importance as humanity prepares to return to the moon. “We cannot be on the moon alone,” Vignelles said. “We need to collaborate.”

Tuesday’s fourth and final IAF GNF session, “Space, Spectrum, And Sustainability: Pillars For Connecting People On Earth,” was moderated by Audrey L. Allison, the Senior Project Leader at the Aerospace Corporation’s Center For Space Policy And Strategy and featured distinguished panelists including Yohann Benard, the Head of EU Digital And Connectivity Public Policy at Amazon; Aarti Holla-Maini, Director of the United Nations Office For Outer Space Affairs; Holger Krag, the Head of ESA’s Space Debris Office; and Jorge Ciccorossi, a Senior Engineer at the ITU’s Space Systems Coordination Division. A key theme of the panel was how to build connections between people on Earth using space technology while also ensuring the sustainability of orbital resources, a complex problem that was greatly illuminated with the speakers’ diverse perspectives on the issue.

## Wednesday 4 October 2023



Allison opened the panel by underscoring the challenges faced by the 2.6 billion people globally who still lack internet access, a problem space technologies are well poised to address. As an example, Ciccorossi pointed to the International Telecommunication Union (ITU) efforts to close the connectivity gap through initiatives like its “Partnership to Connect” fund which has received millions in pledges from satellite companies. Benard, meanwhile, offered an industry perspective and discussed how satellite mega constellations like Amazon’s Kuiper Project can help deliver broadband internet access around the world, but he stressed the importance of updating spectrum use rules to foster technological innovation on these satellites. Krag, meanwhile, discussed challenges faced by regulators when it comes to coordinating spectrum allocation for space missions, an issue that will become increasingly urgent as new lunar missions use

parts of the spectrum that overlap with common terrestrial bands.

The four IAF GNF session on Tuesday offered thought-provoking discussions on overcoming adversity, transitioning to commercial space stations, enabling deep space exploration through partnerships, and connecting people on Earth sustainably using space technology. As the panelists made clear, realizing the full potential of the space sector in the years ahead while also ensuring its sustainability will require unprecedented levels of collaboration across nations, industries, and organizations. Whether it be navigating economic turbulence, building the orbital outposts of the future, pushing the boundaries of human space exploration, or connecting the unconnected sustainably through satellites, partnerships that bring together diverse expertise and capabilities will be key.

“The tools I have are partnerships. We cannot be on the moon alone. We need to collaborate.”

Wednesday featured five Global Networking Forum panels covering a broad range of topics including the scientific objectives of the Saudi SSA-HSF1 mission, updates on China’s space station development, the role of NASA’s Artemis mission in sustainable space development, methods for championing the importance of the space sector to life on Earth, and how to streamline collaboration between operators in an increasingly busy space ecosystem. Across these sessions, the speakers consistently emphasized that global cooperation, transparency, and thoughtful consideration of the ethical implications of space activity are imperative to expanding humanity’s presence in space.

The first IAF GNF session, “Science On Ssa-Hsf1 Mission: Exploring Experiments And Impact,” was moderated by Valanathan Munsami, Deputy CEO of the Saudi Space Agency and featured six leading researchers from Saudi Arabia’s space sector, including Khalid S. Abu Khabar, a Researcher at the King Faisal Specialist Hospital and Research Centre; Wijdan Ahmadi, a Researcher at the King Faisal Specialist Hospital and Research Centre; Ahmed Al-Ghofaili, the Sector Head of Space Exploration and Science at the Saudi Space Agency; astronaut Ali Al-Quarni; Ashraf Farahat, a Researcher at King Fahd University for Petroleum and Minerals; and Bader Shirah, a Researcher, at King Faisal Specialist Hospital and Research Centre.

evidence of China’s pledge to use the station peacefully for “the benefit of all humankind.”

The third IAF GNF session, “Going For Humanity: Creating A Responsible And Sustainable Universe,” featured a keynote address by Pam Melroy, the Deputy Administrator of NASA. Melroy explained how NASA’s Artemis program will establish a sustainable lunar presence and help us to learn how to live on another world in preparation for future missions to Mars. She noted that while the program’s 63 objectives focus on the technical details, there are also important recurring principles like conducting all activities peacefully and preserving the lunar environment. “Responsible

The second GNF session, “China Space Station Benefits Global Space Exploration,” was moderated by Linqi Zhu, the Director Of Asia Pacific Office of the IAF Select Committee on Satellite Commercial Applications and featured Hong Yang, the Chief Designer of the Chinese Space Station; Lei Wu, a Producer and Senior Space Correspondent at CGTN; Congmin Lyu, the Deputy Chief Designer of Space Utilization System of Manned Space Program at the Chinese Academy of Sciences; Nicolas Produit, a Research Scientist at the University of Geneva Astronomy Department; and Qiao Zhang, a Researcher at the China Academy Of Space Technology.

The panelists began the discussion by detailing China’s ambitious plans behind its new space station, which has a 15-year lifespan, capacity for six crew members, and robust science facilities. “China’s station provides the infrastructure for space exploration of large scale with humans on a long-term basis,” Zhang said. Congmin outlined the station’s extensive research facilities, which includes 40 equipment racks and numerous external attachment points. He noted that research will focus on four main areas—space life sciences, microgravity physics, space autonomy, and Earth observation—and that over 100 science projects have already begun onboard. All of the panelists emphasized China’s commitment to international cooperation on the station and highlighted ongoing research partnerships with the UN, ESA, and other global organizations as



behavior means more than just complying with laws,” Melroy said. “As we execute our Artemis missions, we need to consider the precedents we want to set for exploration.”

The Artemis Accords, signed by 29 nations so far, outline principles for cooperative and transparent lunar exploration. Melroy said the Accords are just a beginning, with much more work needed to address ethical and legal issues. The signatories reaffirmed their responsibility to provide opportunities for emerging space nations to engage in exploration as well. To begin addressing complicated topics beyond technical requirements, Melroy described a recent NASA workshop in partnership with social scientists and ethicists. Key takeaways included ensuring space exploration reflects our values and avoiding past mistakes. “We have got to avoid the mistakes of our human past. And be very clear as we go forward,” Melroy said.

The fourth IAF GNF session, “International Perspectives On Championing The Role That Space Places In The World,” was moderated by Anu Ojha, the Engagement, International, and Inspiration Director at the UK Space Agency and featured Agnieszka Łukaszczyk, the Vice President Government Affairs EMEA at Planet; Aarti Holla-Maini, the Director of the United Nations Office for Outer Space Affairs; and MEGANNE CHRISTIAN, a Reserve Astronaut / Exploration Commercialisation at the UK Space Agency, who emphasized the continued need to champion outer space at both the individual and institutional levels. Maintaining momentum, the panelists agreed, requires championing space across stakeholders.

Łukaszczyk recounted transitioning to the space sector and realizing its unappreciated societal impacts. Citing frequent skepticism from taxi drivers about “catching aliens,” Łukaszczyk stressed that the industry must better convey its Earthly benefits to the public. “We cannot assume that people know what we do and understand why it’s important,” she said, advocating more outward engagement beyond the space community. Holla-Maini highlighted space technology’s potential to advance the UN’s development goals and Christian described how the UK is championing space through holistic efforts fostering youth interest, workforce skills development, investment, and policy support. A key takeaway from the panel, Ojha said, is that “we have people in this sector who’ve still got a fire, a passion, burning in their bellies and what we need to do is tap into that and not be afraid of telling those stories.”

Wednesday’s fifth and final IAF GNF session, “Operator-To-Operator Collaboration And Coordination In Building Out A Sustainable And Safe Space Ecosystem,” was moderated by Tanja Masson-Zwaan, the VP of Science and Academic Relations at the IAF Bureau and featured a panel comprised of Jeffrey Apeldoorn, the Head of Government Solutions Europe at Iceye; Chris Blackerby, the Group COO and Director at Astroscale; Amber Charlesworth, the Senior Manager of Space Policy at Amazon’s Project Kuiper; and Catherine Doldirina, the General Counsel at D-Orbit; and Agnieszka Łukaszczyk, the Vice President of Government Affairs EMEA at Planet.

The focus of the panel was on the importance of collaboration among satellite operators to ensure the long-term sustainability and safety of the growing space ecosystem. A key part of that, said Doldirina, comes down to “exchanging needed information, having it centralized and consolidated by institutions, and analyzed and shared within the community.” Apeldoorn and Łukaszczyk both discussed how their respective companies—Iceye and Planet—handle collision avoidance at both a technical and process level, and emphasized that safety takes priority over commercial gain. “We all have to communicate,” said Łukaszczyk. “Space is a global common that doesn’t belong to anybody.”

The five Global Networking Forum sessions on Wednesday covered a diverse range of technical, scientific, and policy topics, but several overarching themes emerged: the critical importance of international cooperation and transparency, the need to act responsibly and sustainably as we expand humanity’s presence beyond Earth, and the role we all must play as ambassadors in conveying the societal benefits of space activity. As the global space ecosystem grows increasingly complex, forums for open dialogue and information exchange like these will only become more vital. The discussions underscored that realizing the full potential of space requires not just technical ingenuity, but also creative thinking about governance and our shared values.



**IAF Global Networking Forum**  
16:30 – 17:15

**OPERATOR-TO-OPERATOR COLLABORATION AND COORDINATION IN BUILDING OUT A SUSTAINABLE AND SAFE SPACE ECOSYSTEM**

**MODERATOR**  
Tanja MASSON-ZWAAN  
Assistant Professor and Deputy Director of the International Institute of Air and Space Law (IIASL), Leiden University

**SPEAKERS**

Jeffrey APELDOORN Head of Government Solutions Europe, Iceye	Chris BLACKERBY Group COO & Director, Astroscale	Amber CHARLESWORTH Senior Manager, Space Policy, Amazon, Project Kuiper	Catherine DOLDIRINA General Counsel, D-Orbit SpA	Agnieszka ŁUKASZCZYK Vice President Government Affairs, EMEA, Planet
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ORGANIZED BY IAF HOSTED BY azercosmos



“We all have to communicate. Space is a global common that doesn’t belong to anybody.”

## Thursday 5 October 2023

Thursday featured six IAF Global Networking Forum sessions where a diverse cast of leading policymakers, entrepreneurs, and researchers tackled challenges and opportunities for investment, security, sustainability and more in a rapidly evolving space sector. While perspectives differed, the panelists broadly agreed that ensuring the continued responsible and equitable growth of space exploration and development demands urgent, innovative global collaboration.

The first IAF GNF session, “Current Challenges In Space, What We Can Learn From Them,” was moderated by Heriberto Saldivar, the Head Of Strategy Department at the European Space Agency (ESA), and featured panelists Julien-Alexandre Lamamy, the Managing Director at Ispace Europe, and Anil Kumar, the Chief General Manager of Safe and Sustainable Space Operations Management at the Indian Space Research Organisation (ISRO). With representatives from both public and private space organizations, the panelists engaged in a dynamic conversation on the myriad challenges facing the expanding global space economy.

Kumar opened the session by discussing the technical and managerial hurdles overcome during India’s Chandrayaan-3 moon landing mission earlier this year following the heartbreaking crash of Chandrayaan-2 in 2019. Lamamy meanwhile, unpacked the challenges that arise from the lack of lunar cargo delivery options and how Ispace is applying learnings from its first moonshot in 2022. Both panelists underscored the importance of sustainability as commercial activity expands beyond Earth orbit to the moon and in his closing comments Lamamy highlighted the important role of emerging space powers like the UAE in forging partnerships with new commercial players in the space sector to accelerate their access to low Earth orbit and the moon.

The second IAF GNF session, “Gateway: Humanity’s Lunar Space Station,” was moderated by Tiffany Travis, NASA’s Gateway Strategic Communications Manager, and featured a panel with NASA’s Gateway International Program Managers Jon Olsen and Sean Fuller. Travis set the scene for the panel by describing Gateway as “humanity’s first lunar space station” that will enable sustained exploration of the Moon and beyond. Olsen then outlined Gateway’s origins and current status. He described it as a “home away from home” for astronauts exploring the lunar surface that can also facilitate deep space science. Fuller discussed how Gateway exemplifies the principles of the Artemis Accords, signed by 29 countries to date. He highlighted how contributions from international partners like the Canadian Space Agency and the European Space Agency will drive advances in areas like robotics, refueling, and life support critical for journeys to Mars.

The third GNF session, “Using Data From Earth Observation To Support Sustainable Development Goals: Analysis Of National Cases And Challenges For The Future,” was moderated by Fidan Behbudova, the Head of PR and Communication Unit at Azercosmos, and brought together Ismat Bakhishov, Director of GIS Center at Azercosmos; Sohail Elabd, the Director of International Strategies at ESRI; and Fani Kallianou De Jong, the Principal Manager at the European Bank for Reconstruction and Development to discuss how satellite imagery and earth observation data can help address major global challenges like food insecurity and climate change.



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Bakhishov opened the session by explaining how satellite imagery helps make agriculture more efficient and sustainable by providing real-time data on soil, weather, and vegetation. This data merged with farming practices leads to better land management, and is also crucial for countries to create climate adaptation and mitigation strategies. De Jong discussed how the EBRD is investing billions in green technologies like Earth observation to combat climate change, and Elabd trumped a “golden age” of remote sensing data that is helping help countries track progress on UN sustainability goals related to hunger, water access, poverty, and more like never before. All the panelists called for breaking down barriers to data-sharing and providing support so developing nations can build resilience in the face of accelerating climate change. While this space data cannot solve climate change on its own, it is key to maximizing the effectiveness of targeted adaptation and mitigation strategies.

The fourth IAF GNF session, “Success In Space Through Security, Investment, And Sustainability,” was moderated by Clay Mowry, President of the International Astronautical Federation (IAF) and Chief Revenue Officer at Voyager Space Holdings, and featured Nobu Okada, the Founder and CEO of Astroscale; Mariel Borowitz, Assistant Professor of International Affairs at Georgia Tech; and Ruvimbo Samanga, an Ambassador at the Milo Space Science Institute. Mowry opened the session by explaining how these three issues—security, investment, and sustainability—are interconnected, noting that sustainability requires major investment, while security enables long-term sustainability and encourages investment.

During the panel, each speaker highlighted actionable steps that could be taken today to bolster security, investment and sustainability in space. Samanga argued for adaptive governance with uniform standards, continuous stakeholder dialogue, and open participation policies to unite countries and sustain benefit sharing. Borowitz, meanwhile, highlighted risks from congested orbits and inadequate coordination. She argued civil, commercial and security interests are collectively enabling cislunar plans, requiring creative public-private cooperation. Okada focused on optimizing the investment cycle. While government budgets are increasing amid proven space infrastructure value, risks are rising from congestion. Despite their differing backgrounds and perspectives, the panelists agreed that proactive, collaborative policymaking and fresh thinking are urgently necessary to address the dynamic and rapidly changing challenges faced by the space sector.

The fifth IAF GNF session, “Indian Space Policy 2023: Emergence Of India As Global Space Hub,” was moderated by Pawan Goenka, Chairman of the Indian National Space Promotion Authorization Centre, and featured Valery Aksamentov, Director of International Programs for Space and Launch at the Boeing Company; Victor Joseph, the Associate Scientific Secretary and Director of Technology, Development and Innovation at the Indian Space Research Organization; Enrico Palemro, the head of the Australian Space Agency; and Marshall Smith, Vice President of Exploration and Acting CTO of Voyager Space Holdings, who had a lively discussion on India’s growing presence in the global space sector.

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Goenka opened the panel by outlining reforms in India that have enabled private companies to build rockets, satellites, provide services, and transfer ISRO technology. Akasamentov discussed Boeing's aviation partnership with India as a model for space collaboration and Palermo noted the similarities between India and Australia's experience with rapidly growing space sectors marked by a proliferation of startups, jobs, hardware, and international collaborations. Joseph, meanwhile, highlighted Israel's 50-year friendship with India in space development as an important contribution to Israel's mission to "bring space down to Earth" by connecting space inventions to terrestrial needs in agriculture, public health, and other domains.

Thursday's sixth and final GNF session, "Guardians Of The Galaxy: Charting A Secure Future In Space," was moderated by Steve Eisenhart, the VP of the IAF's Global Networking Forum, and featured panelists Uri Oron, the Director of the Israel Space Agency (ISA), and Anil Kumar, Chief General Manager of Safe and Sustainable Space Operations Management at the Indian Space Research Organisation (ISRO), who discussed major threats to the sustainability and responsible use of space.

Kumar opened the session by outlining three categories of threats: natural, intentional, and accidental. Natural threats include asteroids, comets and orbital debris that can damage satellites and spacecraft. Intentional threats are human-caused, like jamming signals and anti-satellite

weapons. Accidental threats arise from collisions and breakups that generate dangerous fragments in orbit. He emphasized the need for space situational awareness and capabilities to manage these multifaceted dangers.

Oron focused on defining "secure space" as the freedom for all actors to operate freely in space. He singled out cyber attacks as the most imminent threat that could hamper space activities, followed closely by uncontrolled growth of orbital debris. Effective space traffic management is critical to address these problems, he said, and stressed that mitigating risks is essential to avoid violent competition in space that could endanger the entire domain. With threats to the entire space sector mounting, both Oron and Kumar agreed on the urgent need for dialogue and action through groups like the International Astronautical Federation's Security Task Force, which can catalyze further collaboration within the global community.

The six IAF Global Networking Forum sessions on Thursday provided an illuminating survey of the opportunities and challenges confronting the rapidly expanding global space sector. Whether grappling with technical hurdles, sustainability goals, security threats, or investment strategies, the diverse group of leading voices from industry, government, and academia underscored the need for enhanced international cooperation and innovative policymaking to ensure the responsible, equitable and peaceful development of outer space for the benefit of all humanity.



## Friday 6 October 2023

*During the two IAF Global Networking Forum panels on the final day of the IAC 2023 Congress, astronauts, communications specialists, and space entrepreneurs came together to reflect on how new opportunities in the space industry, driven especially by private companies, are opening the cosmos to more diverse swathes of humanity and the urgent necessity for the space community must hone its storytelling to inspire public imagination about how broader participation in space exploration can improve life on Earth.*

The first IAF GNF session, "IAF-ASE Astronauts Session: Popularizing Space - Meet The Space People," was moderated by Reinhold Ewald, an astronaut and Professor of Astronautics at the University Of Stuttgart and featured an international panel of astronauts including Sara Sabry, the founder and CEO of the Deep Space Initiative; Victor Hespanha, an astronaut with Blue Origin; Tuva Atasever, an astronaut with the Turkish Space Agency; Anna Yuryevna Kikina, an astronaut at ROSCOSMOS; and John Bartoe, an astronaut with NASA.

The panelists opened the discussion by describing their journeys to becoming an astronaut. Kikina, selected in Russia's first open cosmonaut recruitment in 2012, said discovering the opportunity was a surprise since space-flight seemed reserved for an elite few. After 10 years of training, she flew on SpaceX's Crew-5 mission earlier this year. Bartoe, flying on the space shuttle in 1985, took a different path by proposing a solar telescope for flight. When NASA sought operator-astronauts, he volunteered.

For Hespanha, space seemed distant growing up in Brazil, 2000 kilometers from the nearest launch site. Investing in private space company Crypto Space Agency gave him the chance to be selected as their citizen-astronaut for a sub-orbital flight. "Space must be for everyone," he said. Similarly, Sabry's childhood in Egypt offered no clear path to space. But the rise of private space opened new opportunities. Selected by Space for Humanity, she is now their second citizen astronaut. Atasever's electrical engineering work on Turkey's first satellite rocket spurred her interest in space. When the newly formed Turkish Space Agency announced plans to send a citizen-astronaut to the ISS by 2023, she applied along with 35,000 others. After a rigorous selection process, she became one of the first two Turkish astronauts.

Each astronaut described the anticipation leading up to their first launch into space. For some, the transition from Earth's atmosphere to the blackness of space happened quicker than expected. Others were surprised by the visual cues like changing colors that signaled their departure



from Earth. Kikina found space travel went by quickly with many tasks, while Hespanha was recognized by people at home as a source of national pride and inspiration.

A common theme throughout the panel was how new private companies are democratizing space, and opening up opportunities to increase humanity's connectivity and relationship with the universe by exposing them to, for example, the overview effect. "It does break your reality," Sabry said, summarizing the powerful benefits of going to space. "It really puts things in perspective."

The final IAF GNF session of the 74<sup>th</sup> International Astronautical Congress, "Does Everyone Really Love Space Activities?: How Communications And Storytelling Play A Crucial Role In Gaining Policy Changes, Funding Support, And Workforce Development," was moderated by Ian Christensen, the Director of Private Sector Programs at the Secure World Foundation and featured a large panel including Camille Bergin, Senior Business Development Manager at Vast; Ksenia Ozkok, the Founder of the Re.Brand Academy; Sergey Stanovkin, the head of BBC Global News Commercial Representatives in Eurasia; Remco Timmermans, a Content Marketer and Social Media Specialist at Spaceside; and Lei Wu, a Producer and Senior Space Correspondent at CGTN.

The focus of the panel was how better communications and storytelling can help garner policy changes, funding, and talent for the space industry. Christensen opened the discussion acknowledging the challenges of conveying the societal value of space amid growing public skepticism driven by media narratives of "billionaire space races" and climate impacts, a challenge that was further discussed by Bergin who described pushback to space tourism as billionaires abandoning humanity. Timmermans, meanwhile, argued that effective communication has declined since the Apollo era. Today, he said, most readers think "space stories are boring, not engaging."

To overcome these challenges that accompany communicating about space, Ozok said space can now be positioned as essential to civilization's future and should strive to bring in diverse voices like Greta Thunberg to expand the message. Stanovkin also highlighted the need for visual storytelling and engaging emotions to captivate audiences beyond space fans. This takes investment in relationships and conversations on global issues relevant to people's lives. "It's not enough just to provide information...audiences [need] to feel them, to give them experience," he said. Lei agreed. While increased launches and missions generate interest, he said, more creative content is essential to convey meaning and benefits. In this respect, journalists and influencers translating science to the public is vital.

As the panelists noted, effective communication requires storytelling that taps into shared emotions and broader societal interests. While the democratization of space has opened new possibilities, skepticism remains. To secure funding and policy support, the space community must creatively engage diverse voices and help people viscerally experience how expanding humanity's presence in the cosmos can improve life on Earth.



# IAC 2023 Special Sessions



**Monday**  
2 October 2023

## A Bridge from the Lab to Orbit

The transition from the International Space Station (ISS) to commercial space stations provides a unique opportunity to improve access and experiences for researchers globally. Expert panelists discussed successes and challenges from over 20 years of research on the ISS across a space experiment lifecycle: legal, expertise, design, testing, logistical, implementation, and international access.

The session uncovered opportunities that might be enabled with future commercial space stations to improve the implementation of research experiments in LEO, the access and design of laboratories in LEO, experiment safety,

ground-based suborbital capabilities, the development of political support and funding streams for such activities, and to increase capacity-building for emerging space-faring nations. The ISS helped establish the foundation for what should be regulated, how a station should operate, and how to enable globally impactful research. New policies, institutions, hardware best practices, and more will emerge to support next generation research on commercial stations. Success will require a coordinated effort of government and commercial-led efforts to understand user needs for making access to low-Earth orbit for researchers easier, faster, and cheaper. To view the full report of challenges and opportunities, visit [interplanetary.asu.edu/iac-report](http://interplanetary.asu.edu/iac-report).



**Tuesday**  
3 October 2023

## Give Space a Chance for Climate Action

Over 50 participants from 20 countries participated in a global dialogue on the possibilities and big issues involved in space and climate. This session encouraged broad input to uncover new insights, connections, commonality, new areas of exploration, and conceptual differences. The session was successfully based upon the 'world café' technique, which once more demonstrated to be advantageous for brain-storming versus a traditional 'linear discussion' that can become narrowly focused within our areas of expertise. Seasoned experts in the field (including an ESA astronaut), emerging space leaders, and students came together for a free flow of ideas and discussions.

The purpose of this workshop was to tap the collective and diverse insight of the global space community to identify the big questions and most promising space contributions to monitoring and counteracting the effects of

climate change. The discussions centered on the areas of Space Sustainability, Monitoring and Remote Sensing, Geoengineering, Enabling Technologies (such as space solar power), and Other Great Ideas.

The inputs and ideas from the group discussions have been consolidated and distilled into themes to highlight what's important for further dialogue and cross-discipline collaboration. While there were no specific solutions, the commitment on all parties to continue the dialogue and learn from each other is essential. Creating more opportunities for purposeful dialogue on key questions is needed if the space community is to continue to expand its positive contributions to climate. The session was thought-provoking, interactive, and truly global in its impact, and we anticipate additional sessions to expand these dialogues in the future.



**Tuesday**  
3 October 2023

## Intelligent Space Sustainability: How Can AI Help Shape Sustainability in Space?

**T**rillium Technologies CEO and Founder James Parr initiated this special session by bringing together the events' speakers to set the context on the topic: how can AI help shape sustainability in space? Among the speakers were Carolyn Mercer, Chief Technologist at NASA SMD; Tejpal Bhatia, Chief Revenue Officer at Axiom Space; Allison Areias, Expert, Strategic Partnerships and Initiatives at UNOOSA; Anu Ojha, Director at UKSA; and Klaus Merz, Space Debris Analyst at ESA.

After the opening thoughts, workshop attendees were asked to split into groups based on different locations in the solar system where space sustainability could potentially become an issue, such as Earth, LEO, GEO, Cis-lunar space, L1, the Lunar poles and Mars. Each table was asked two questions: 1) What are the challenges in space sustainability?

Choose one and create a headline to represent it; and 2) How can AI help solve or avert that challenge?

After the first question was answered by each table, the workshop moderators introduced a twist: instead of answering question number two themselves, each table would pass their challenge to a neighboring table, who would have to answer it creatively from a new perspective. Problems do not exist in a vacuum; we are all affected by issues in space sustainability, and we all have a responsibility to take part in a solution.

Teams had twenty minutes to propose solutions to the given problem, and then each table shared out their problem and solution to the entire group. The event speakers shared reflections and closing thoughts to bring the special session to a close.



**Thursday**  
5 October 2023

## Could You Help Us with This Asteroid? A Planetary Defence Workshop to Save the World and Introducing The Schweickart Prize

**A** large asteroid is headed towards an impact in Western Africa 12 years from now if nothing is done. This is a realistic but entirely fictitious scenario from the 2023 Planetary Defence Conference (PDC) exercise, that is taking place every two years and brings together the world's planetary defence community.

The two main goals of this planetary defence themed Special Session (SpS) were to bring the exciting topic of the PDC to the audience of the IAC and to inspire students and young professionals to pursue a career in this field.

The participants of this workshop style SpS were in for a treat as the introduction to the topic was given by none other than Apollo 9 astronaut Rusty Schweickart! Rusty also announced the Schweickart Prize, open to students worldwide who advance the field of planetary defence. <https://www.schweickartprize.org/>

The participants then joined one of four groups and started discussing under the guidance of the experts:

- Science (Daniel Scheeres, University of Colorado): What do we need to know about the asteroid?
- Technology (Rusty Schweickart, Astronaut): What can we do about it?
- Legal (Frans von der Dunk, University of Nebraska-Lincoln): What are we allowed to do?
- Media/Communications (Anastasia Medvedeva, independent journalist): What and how are we telling the world?

The feedback from the participants was very positive.

The main outcome was that this is a complex, global, and interdisciplinary topic that requires more collaboration and communication.

Noteworthy was also Anastasia's approach dividing the media representatives into national news, international news, social media, even fake news and go get information from the other groups just like real media would. That stirred things up quite a bit and provided all participants with a newfound perspective on the needs and challenges of the media, demonstrating the power of mutual understanding.



Thursday  
5 October 2023

## Developing an Ecosystem to Prepare the Next Generation of Space-Oriented Citizens

The special session “Developing an ecosystem to prepare the next generation of space-oriented citizens” aimed to set the guidelines for a healthy space-traveling future society.

It was organized by a team of Israeli spacemen from several sectors – Space industry, the academy, and public organizations. The team presented various aspects that influence New-Space ecosystem, including “Space for all”, Space-Sustainability, New-Old space technologies, well-being, human connection, and Space Education.

The participants discussed these topics in a round-tables’ format, focusing on the questions: What are the main opportunities in this topic? What are the main challenges?

Finally, a concluding discussion was held to consolidate the insights and recommendations for the future.

The following are some of the insights raised during the discussion:

- People are not aware of the potential of space for earth. We need to talk to as many people in the world to show there is hope, and to inspire them.
- We have to give young children the sense of faith in space endeavors. It is important to connect children to sustainability on earth in order to connect them to sustainability in space.
- Ensuring a balanced work-life structure and providing opportunities for personal growth and development will be important for well-being.
- Space has the potential to connect between countries and people, as well as the opportunity for understanding our purpose on earth.



Friday  
6 October 2023

## Analysis of Due Diligence and Good Faith in Commercial Outer Space Activities

Approximately 50 people attended the “Analysis of Due Diligence and Good Faith in Commercial Outer Space Activities” Space Law Special Session, which had speakers from the United States, Azerbaijan, Türkiye, Luxembourg, and Switzerland. The session began with a crash course on the law of outer space which, at the international level, is focused largely on nation-controlled space exploration and, particularly with regard to commercial space activities, lacks both clear legal rules and enforcement mechanisms. Individual presentations followed and addressed due diligence in private space activities, the space-cyber military realm, export control compliance in commercial space endeavors, the potential for future regional space governance organizations, and establishing a liability regime for space.

Three core themes emerged from the individual presentations:

- Firstly, the overlap between commercial space products and national or military focused space assets is growing and private space companies need to increase their due diligence processes, best practices, and security systems, especially when it comes to communication.
- Secondly, the lack of certainty in our current international space legal system puts the burden on private space actors to truly act with “due diligence” in all of their extraterrestrial activities.

- Lastly, greater cooperation is needed, especially between established and emerging spacefaring countries, to create new legal systems for space that provide clarity as to the conduct of space activities. Such systems should build upon the principles of cooperation, due regard, good faith, and sustainability found in the Outer Space Treaty in order to ensure the continued growth of the commercial space industry for generations to come.

The session ended with several questions from the audience covering topics ranging from establishing contractual liability for satellites owned by non-launching nations to how best to encourage the inclusion of the next generation of legal practitioners in the creation of new international space law regimes.



# 13<sup>th</sup> IAF International Meeting for Ministers and Members of Parliaments



*On the second day of the International Astronautical Congress, parliamentary leaders from around the world gathered for the IAF's 13<sup>th</sup> IAF International Meeting for Ministers and Members of Parliaments to discuss space strategy and policy. In his opening remarks, IAF President Clay Mowry welcomed delegates to the "space Olympics," praising Azerbaijan for its burgeoning space program under the leadership of the late President Heydar Aliyev. Mowry highlighted how space provides solutions to challenges in climate, technology, education and the economy. "We go to space to benefit life here on Earth," Mowry said.*



Chairman Tahir Mirkishili of the Azerbaijani Parliament kicked off the session by welcoming participants to Baku, a historic hub of astronomy. He noted Azerbaijan's transformation into an "energy, transportation and communication hub," while upholding equality and human rights. Mirkishili emphasized space as a "great resource" that brings independence and sovereignty. "Space has always linked to big numbers, huge distances, long years, life cycles, billion year events and costly missions," he said. "But we are sure that it's not a luxury. It's a matter of independence, freedom and sovereignty."

Italian Ambassador Claudio Taffuri outlined Italy's growing investments in space over the last decade, amounting to 7 billion euros over the next five years. With a strong space agency and industry, Italy excels in satellite manufacturing, launch capabilities, and human spaceflight. "The space economy has never been more central to our everyday lives," Taffuri said. He invited all to Milan for the IAC in 2024.

In her address, IAF Special Advisor Dominique Tilmans called space "a key for the development of knowledge" and "a tool for monitoring, forecasting and concrete solutions on Earth." She challenged parliamentarians to make space "accessible and understandable for all" and share best practices. The goal is to inspire emerging nations to reap the economic and social benefits of space.

Building on Tilmans' remarks, former IAF President Jean-Yves Le Gall recounted the shifting "space ages," from early exploration to international cooperation and the rise of private companies. He warned that Russia's invasion of Ukraine threatens this cooperation, requiring new partnerships. Yet crises present opportunities. "Cooperation will be more than ever very important," Le Gall concluded. With delegations from over 100 countries, the Baku IAC represents a new dawn.

Salim Al Malik, Director General of the Islamic World Educational, Scientific and Cultural Organization, emphasized that "space exploration can offer creative answers to some of our planet's most pressing resource related problems." He highlighted how space-based Earth observation systems can monitor resources like forests and water sources. Al Malik called for international collaboration, stating that "it is through unity, that we shall summon the courage to embrace the challenges before us."

Secretary General Kubanychbek Omuraliev represented the Organization of Turkic States, and noted in his address that "outer space belongs to all humanity" and that space technology has "enormous reverence for human development." He outlined joint projects underway to develop satellites and space programs among member states, which are focused on applying space technology to "communication, agriculture, meteorology, and others." Omuraliev concluded that by working together, nations can "make a humble contribution to the development of space technologies."

“Space has always linked to big numbers, huge distances, long years, life cycles, billion year events and costly missions. But we are sure that it's not a luxury. It's a matter of independence, freedom and sovereignty.”



“Translation of knowledge into public work and industry is being made visible.”

Marius Humelnicu, President of the Communications and IT Committee in Romania’s Parliament, emphasized his country’s national space strategy focusing on “science and technology, services, and security.” The goal is utilizing space technology for public services like telemedicine, transportation, and border security. Humelnicu said that space solutions require “a strong and coherent whole of Parliament approach” to fully achieve their potential. He highlighted an upcoming meeting in Romania to select Earth observation satellites for the European Space Agency.

Malte Kaufmann, a member of the German Parliament discussed Germany’s extensive space industry and research facilities. He noted that space data should be better leveraged for public services through industry-friendly regulations and support for startups. Kaufmann advocated continued international cooperation, stating it is vital that “translation of knowledge into public work and industry is being made visible.” He provided examples of using satellites for agriculture, identifying crop needs and predicting swamp emergence.

Ahmed Fatih Kacir, Vice Minister of Industry and Technology for Turkey, noted satellites provide “precision” tracking of severe weather events, enabling authorities to make informed decisions and minimize damage through early warning systems. Kacir stressed that “accessing and sharing space data is critical” for effective international cooperation during disasters, which transcend borders. Governments, he said, must work together to facilitate data exchange and invest in robust space-based disaster monitoring.

Michal Brichta, Chairman of Poland’s Parliamentary Space Group, echoed the need to make space technology truly “accessible” for disaster responders through know-how and streamlined procedures. While satellites offer invaluable data, users on the ground must understand how to efficiently incorporate it into existing crisis management frameworks. Brichta advocated increased spending to “ensure the data from satellites is really effectively used” during disasters. Brichta also advocated for building domestic space capabilities as both a “user and creator” of disaster monitoring solutions, and suggested focusing on downstream applications leveraging satellite data provides an accessible entry point for companies and researchers.



Chris Schact, a former Australian Minister, highlighted how climate-driven catastrophes like bushfires and floods have battered his country in recent years. Schact underscored that satellite monitoring is a “major weapon” for predicting threats, enabling evacuations, and minimizing loss of life and economic damage. He warned that any “climate change deniers” should witness Australia’s unprecedented disasters firsthand. Azerbaijan MP Vugar Bayramov also noted how demining efforts rely heavily on space technologies to locate mines and create safe conditions for displaced citizens returning home. Bayramov called for expanded international support for using satellites to address this humanitarian crisis and enable resettlement.

Throughout the session, speakers emphasized that realizing the full potential of space-based solutions requires policymakers worldwide to prioritize investments in satellite infrastructure and user training. There was also consensus on the need for global collaboration to fully realize the benefits of space exploration and apply them to overcome shared challenges. Nations are pursuing national space programs while collaborating internationally toward the common goal of using space to improve life on Earth. The takeaway from the MMoP meeting was clear: with coordinated efforts, space technology can mitigate hazards, save lives, and build global resilience.

# IAC Hosts Summit - Tenth “Anniversary” Session

*This year’s IAC Hosts Summit celebrated its tenth anniversary and was unique in terms of both session topics and meeting format. The summit was arranged in fishbowl format, and the IAF Members had an unprecedented chance to explore and chart the courses for a successful IAC Bidding process.*



Christian Feichtinger, IAF Executive Director, kicked-off the meeting with a keynote by putting together the guiding principles on the most prominent challenge of the IAC Bidding Process: the strategy to win the great race for hosting the world’s premier global space event.

Each year, IAF Members who are joining the IAC bid competition try to find the right opportunities and craft a compelling proposal to increase their chances of winning the bid. Preparation is the main element of the strategic puzzle. IAC Bidders must not only demonstrate the ambition to host the IAC and the competitiveness of their proposal but should also build visibility and make a far-reaching impact by playing an active role during the

annual IACs. The cohesiveness of this strategy implies that each bidder must achieve a clear and compelling understanding of the IAC programme and build a strong network of supporting organizations. The financial backing, the anatomy of the bidding team, the legal structure, and the strong support from local and international organizations and the national government also play a relevant part in a winning bid strategy. Ultimately, efforts towards diversity and inclusion are powerful factors that make bidders stand out from the crowd in this harsh competition. Feichtinger concluded that getting it right the first time is an arduous journey. Bidding for an IAC must never be reduced to merely accepting the results; it is essential to take a chance but above all, to never, ever give up.

What followed the keynote was a session dedicated to the debatable topic on ethical standards for selecting an IAC Host. Ethical standards establish trust and accountability among IAF Members and strengthen the core missions and values of the Federation in that sense, that all members are welcome to become part of a broad space family, provided they uphold the ethical standards of inclusion and respect for diversity regardless of geographical, economic, and geopolitical boundaries. The implications of the dynamic nature of the geopolitical scene have recently led to a highly confrontational landscape when it comes to selecting an IAC Host. As a matter of fact, this phenomenon has also impacted the space community on different levels, first, by intensifying competition between great powers and, as we witnessed lately with the practical cases of the IAC Host Selection at the IAC 2022

or the context of preparations of IAC 2023 in Baku, when the discussions were driven by a confrontation of standards of geopolitical nature. The panelists shared their experience and views on the topic, and all agreed that, since space can remain peaceful during tension on Earth, the Federation shall continue enhancing its irreplaceable role of connecting all space people for the benefit of humanity.

The third part of the Hosts Summit programme featured the traditional pitch presentations from the bid candidates who applied for hosting the IAC in 2026: the Turkish Space Agency (TUA), representing Antalya, Türkiye and the delegation of Europe Space Foundation (ESF) for Poznań, Poland. We could see a clear focus in both bids on sustainability and affordability. Both had different approaches, and both clearly demonstrated what they wanted to achieve, following IAC 2026, by building their proposals into the long-term development plans of their city, region, and country.

The last session addressed the new driving forces behind the Federation's success: Sustainability, Investment and Security which have inspired the IAF President's SIS agenda as well as the themes of the most recent and upcoming IAF events. IAC Hosts and the Leaders of SIS Agenda Task Forces discussed the inspirational concepts behind the SIS, the IAC 2024 focusing on "Responsible Space for Sustainability" and the IAC 2025 which will be dedicated to "Sustainable Space, Resilient Earth". With that in mind, the upcoming IAF events aim at laying the foundations for more effective space cooperation that can deal with today's challenges.



# IAC 2023

## Closing Ceremony

The 74<sup>th</sup> International Astronautical Congress ended on a high note after a week of high-level discussions, presentations, and exhibitions related to space exploration in Baku, Azerbaijan. "It has been almost four years since the IAF General Assembly selected Baku as the host city for this IAC. And since 2019, we've been working side by side with Azercosmos, our host, to bring you another historic event," said IAF Executive Director Christian Feichtinger, who expressed hope that the IAC fostered constructive dialogue and cooperation in the space community. "Without this approach, the IAF would not be true to its core mission," he said.

IAF President Clay Mowry welcomed the robust global participation in the conference, which had more than 5,400 people registered from 132 countries. "This was a new record for us in terms of participation globally," Mowry said. He thanked Azercosmos, the IAF's member organizations, volunteers, speakers, and sponsors for making it a fantastic event. Mowry also noted the Congress' youthful energy, with 50% of attendees under age 35.

“This was a new record for us in terms of participation globally”

Mowry gave a high-level overview of the congress' technical programme, which featured 1,946 papers and over 500 interactive presentations spanning every facet of space exploration. He also announced the election of four new Vice Presidents to the IAF Bureau representing Slovakia, China, France, and, South Africa, and recognized outgoing IAF President Pascale Ehrenfreund for blazing a trail as the IAF's first female vice president and guiding the organization through the pandemic's challenges.



Feichtinger offered a strong message of gratitude to Azercosmos and its chair Samaddin Asadov for Azerbaijan's "invaluable support" in bringing the congress back to Baku. Asadov said it was an "honour to welcome the world" and thanked the IAF and partners for making it "a resounding success." He said the congress embodied "the power of human collaboration, innovation, and the boundless potential of space."

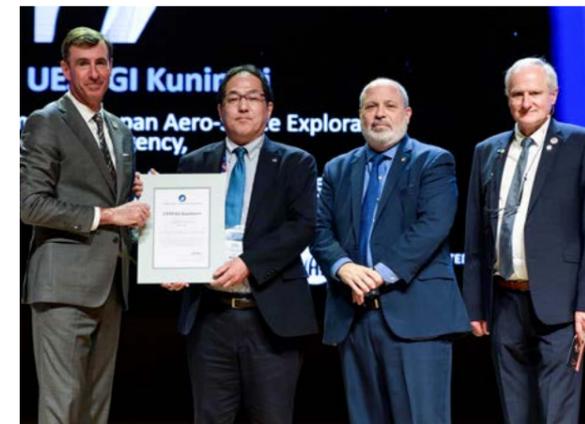
The closing ceremony also highlighted several standout achievements in the space sector that were honored during the conference's opening ceremony. The IAF World Space Award went to SpaceX founder Elon Musk for enabling "humanity's future through space." The IAF Excellence in International Cooperation Award recognized NASA's

Thomas Zurbuchen. Northrop Grumman and Astroscale won Excellence in Industry Awards. Diversity awards went to engineering organizations in Costa Rica and the U.S. The IAF also honored the next generation of space leaders. The Frank J. Molina Astronautics Medal went to educator Klaus Schilling for promoting astronautics education. Azerbaijan's Sonia Gulliver won the inaugural IAF Young Pioneer Award for advancing space education through geo-information technologies. Over 30 students won awards for presenting research papers and projects.

The ceremony concluded with the passing of the torch to next year's host city. Erasmo Carrera, President of the Italian Space Agency (ASI), enthusiastically introduced Milan as the destination for IAC 2024. "The Italian

community is very proud to host the 75<sup>th</sup> edition of the IAC in Milan," he said, noting Italy's legacy in space dating back to its first satellite launch in 1964. Carrera praised Azerbaijan for hosting an impressive congress under difficult circumstances. "It will be difficult for us to be better," he said, noting that planning for 2024 is already underway, with collaboration between past and future host cities. Mowry then joined Carrera on stage to sign the formal contract confirming Milan as the 2024 location. In a symbolic handoff, members of the Baku and Milan teams joined Mowry and Carrera to pass the IAF flag to next year's hosts. "You have a tough act to follow from Azercosmos here," said Mowry to Carrera. And with these final words, another successful International Astronautical Congress came to a close.

“The Italian community is very proud to host the 75<sup>th</sup> edition of the IAC in Milan”



### IAF Astrodynamics Committee

#### Introduction

The IAF Astrodynamics Committee was established more than four decades ago and currently includes 32 members. The Astrodynamics Symposium, coordinated by the Committee and conducted annually at IAC, is an international forum for recent advancements in the areas of guidance, navigation and control, mission design, optimization and operations, orbital and attitude dynamics.

#### Summary

In the context of orbital dynamics, works presented at IAC 23 propose classical as well as emerging techniques to deal with perturbed environments around the Earth and in cislunar space. Orbit resonances in multi-moon systems are exploited to design cyclers. Low-energy trajectories involving different aspects of libration point regimes and photo-gravitational effect are the focus of current transfer design methodologies. As for semi-analytical methods, new approaches have emerged for the determination of reachable domains, the probabilistic analysis of capture around minor bodies and complex computations in non-autonomous systems. Machine learning principles find extensive application in all areas.

The Astrodynamics Symposium at IAC 23 has also reflected the general interest in small satellites (including Cubesats and micro-satellites) primarily through the development of low-thrust techniques with wide implementation of modern mathematical methods for guidance and control. Mathematics guides interplanetary mission design via invariant manifolds and the restricted four-body problem, whereas formation flying has been extended to missions in the vicinity of libration points in the circular restricted three-body problem. The miniaturization of electrical propulsion pushes the development of motion control algorithms for satellite formation maintenance.

The ion-propelled Psyche probe, NASA's first mission designed to study a metal-rich asteroid, was launched on Oct. 13, 2023.

Prof. Mikhail Ovchinnikov from the Keldysh Institute of Applied Mathematics, Moscow, Russian Federation (in the photo with Prof. Kathleen Howell and Prof. Daniel Scheeres) received the Breakwell Award from the International Astronautical Federation (IAF) in recognition of his outstanding contributions in the field of Astrodynamics, in particular in Attitude Control of Small Satellites and Formation Flying.



The John V. Breakwell Memorial Lecture at IAC 23 – Prof. Mikhail Ovchinnikov (Keldysh Institute of Applied Mathematics – Moscow, Russian Federation)



The work by Ayush Ranjan titled *Trajectory Planning and Execution in a Hyper Redundant Continuum Manipulator for Satellite Docking* presented within the Astrodynamics Symposium during IAC 23 in Baku was selected as best Interactive Presentation of Category C (Technology).

#### Highlights

Current astrodynamics research is highly focused on the design of missions to the moon and cislunar space, small bodies in the solar system, and planetary satellites. Small body mission applications include the influential impact of asteroid Dimorphos by the DART mission, achieved using correction maneuvers and uncertainty quantification for trajectory optimization and navigation, as well as the successful sample return from asteroid Bennu as OSIRIS REx (now OSIRIS APEX) carries on with an extended mission to fly by Apophis. Similarly, preparations continue for Europa Clipper and for an orbiter and a lander for a mission to Enceladus. Low-thrust techniques are used to minimize fuel consumption and/or transfer time. In this context, an important breakthrough is the first rigorous formulation and solution of the minimum-time Earth-to-Moon transfer problem without any approximation. In the context of lander missions to asteroids, noticeable progress has been made in autonomous guidance also with the employment neural networks. These trends are also reflected in recent missions to the moon, namely the ispace MK1 landing attempt and the successful landing of IRSO's Chandrayaan-3 mission. The first scientific results of the latter were presented in a highlight lecture at IAC-23. Further topical keynote presentations included the Artemis cooperation as well as the ispace lunar landing attempt experience.

#### Future Outlook

The trends identified during this year's IAC clearly indicate that missions to lunar and cislunar space as well as minor bodies (asteroids, comets, and planetary moons) will drive

the development of astrodynamics techniques in the near future. A more and more extended use of machine learning and artificial intelligence for trajectory & attitude planning, navigation and control can be foreseen.

The ever-increasing number of missions to the moon has also triggered the study of infrastructure systems to ease access and boost the performance of single missions by providing communication and navigation services. This requires establishing satellite constellations around the moon (and Mars) as e.g. envisioned by JAXA's LNSS, ESA Moonlight and NASA's LCRNS programs.

To avoid Earth's space debris problem in the lunar environment ESA has introduced a new version of the ESA Space Debris Mitigation Requirements, which can have a significant impact on the lunar mission and trajectory design with the goal of avoiding any debris problem emerging in lunar space.

#### Committee Activities

The IAF Astrodynamics Committee is organizing the 12<sup>th</sup> edition of the International Workshop on Satellite Constellations and Formation Flying (IWSCFF 2024). The conference will be held by the Taiwan Space Agency in the last quarter of 2024 and the call for papers will be announced soon. This specialist workshop gathers experts and researchers from science, mathematics and engineering to discuss recent advances in the field of Astrodynamics applied to Satellite Constellations, Formation Flying and Proximity Operations. Starting in 1997, all the editions of this event have been organized by the IAF Astrodynamics Committee.

## IAF Commercial Spaceflight Safety Committee (CSSC)

### Introduction

The present brief has been prepared to provide an outlook of the major areas onto which the CSSC focused from the second part of 2023. The 74<sup>th</sup> IAC was successfully held on 2-6 October in Baku, Azerbaijan.



### Summary

**SPACEPORTS:** The 11<sup>th</sup> European Spaceport Forum (ESF) meeting was held at DLR, Braunschweig, Germany on 28-30 November 2023; the involved European Countries discussed their status on Spaceport development and relevant space access initiatives.

**REGULATORY:** Italy is pursuing the regulations for suborbital flights in the Country; the latest issue of the Italian Spaceport Regulatory System is posted on the Italian Civil Aviation Authority website, dated October 2022; activities continue for follow ups with regulatory aspects. Activities are going on by a selected Group of Companies to develop the design feasibility study for the Italian Spaceport of Grottaglie.

Last year, the FAA licensed a record 79 launches and 5 reentries. This year we could break that record again, just SpaceX alone is planning up to 100 launches in 2023, briefed to AST in February.

- SpaceX Private Astronaut Missions in 2023 – Axiom-2 and Polaris Dawn
- Starship-Super Heavy – the FAA is working with SpaceX to conduct the first test launch from Boca Chica, TX soon, pending FAA authorization.
- Blue Origin Mishap and New Shepard Return to Flight Blue Origin NS-23 Findings | Blue Origin
- Increasing responsibility and need for commercial space operators to coordinate international hazard area warnings (NOTAMs and NOTMARs), as operations are broadening their impact to more regions around the globe. Governmental agencies are playing a key role

in coordination and facilitation, and AST is working closely with the two entities mentioned below:

- NAVAREA coordinators have established a space maritime working group;
- FAA ATO is leading international airspace coordination through a new process;
- FAA did a virtual international workshop on Airspace Integration for 15 countries on February 16;
- About 30 companies are in early Pre-Application/initial discussions with FAA. This is an indicator of strong space investment and commercial space transportation activity;
- For 2023, FAA is planning on starting new Aerospace Rulemaking Committees (SpARC): 1) Financial Responsibility; and 2) Human Space Flight

The second School on Suborbital Flights took place in Taranto Italy at the Aragonese Castle on September 11-15, 2023, organized by the Polytechnic School of Bari, Italy.

The School had the purpose of fostering development in the field of modern spacecraft and launch systems, for which several technological challenges have to be tackled by providing an overview of the scientific, commercial, operational, and regulatory aspects of suborbital flight through seminars and panels by experts, institutional representatives and companies in the sector.

The SpaceLand network of low-cost Microgravity Flight Ports is getting started with a first Center of Excellence welcoming industry professionals, users and the public in an emerging aerospace park strategically located not far from Italy's Torino and the lake of Geneva, headquartering the management of the global network initially including a second location in Mauritius for Africa and the Indian Ocean Countries. Democratizing the Space Economy for All and for real, such Centers will be preparing people, STEM payloads and satellite components for unique Boeing 757-0G R&D and test flights in Microgravity, Moon-gravity, and Mars-gravity as well as initiating history-first aero-launching in Europe, at much lower costs, benefitting from a larger space and providing longer time and higher quality of microgravity with respect to current competitors.

Dawn Aerospace completed phase 1 of the Mk-II Aurora Jet and is progressing towards the preparation of Phase II, which includes progressive test campaigns under rocket power to reach the 100 Km Karman Line apogee. The commercial version of the MK-II remotely-piloted, reusable rocket plane is designed to fly multiple times a day from a runway. The Mk-II will take off horizontally, fly a parabolic trajectory at Mach 3+, and glide back to a horizontal landing at the originating site or downrange.



### Highlights

The number of licensed commercial flights is relevant and has the potential to increase in the USA. Europe is catching up with growing interest in Spaceports, infrastructures, regulatory aspects. Several spaceports in Europe are progressing with their activities to outfit proper gateways for access to space.

### Future Outlook

Increase the interest in Commercial Space Safety and the awareness of how this discipline is paramount to the development of Commercial Spaceflight; Increase the networking activities and foster mutual exchange of information and dialog, Monitor the current initiatives for commercial space access and their technological developments, Increase awareness on safety issues and provide advice to the community, Focus is now on preparation of the 75<sup>th</sup> IAC in Milan, Italy scheduled for 14-18 October 2024.

### Committee Activities

Foster mutual relationship and networking, engage young students in the Committee Activities, support industry with recommendations in the specific field, attract more participants in the Committee, spread the word for IAC 2024 in Milan, Italy. Encourage attendance to events organized by the International Association for the Advancement of Space Safety (IAASS), <https://iaass.space-safety.org/events/conferences/>

## IAF Committee on Planetary Defense and Near-Earth Objects (NEOs)

### Introduction

Planetary defense is the term used to encompass all the capabilities needed to detect and warn of potential asteroid or comet impacts with Earth, and to prevent and mitigate their possible effects. A Near-Earth object (NEO) is an asteroid or comet whose orbit brings it within about 50 million kilometers or less of Earth's orbit. The primary objective of the Technical Committee (TC) on Planetary Defense and Near-Earth Objects (NEOs) is to raise awareness among the global space community, particularly the IAC audience, about the ongoing work within the planetary defense community and to get more people, especially students and young professionals, interested and actively participating in the field.

### Summary

Planetary Defense remains a hot topic with several missions in flight, in preparation, being planned, or being repurposed after the main mission has been successfully accomplished. Workshops, conferences, and scientific meetings are being held and outreach activities such as Asteroid Day on 30 June are taking place.

The DART team keeps analyzing the data from the first actual impact deflection test in September 2022 on

Dimorphos, the small moon of the binary asteroid Didymos, to better understand its outcome and make predictions for what the ESA Hera mission will discover when reaching the Didymos system in fall 2026. A series of papers have been submitted in fall 2023 exposing the current understanding of the outcome and predictions to various journals, including those of the Nature and Science Groups.

### Highlights

OSIRIS-Rex, launched on 8 September 2016, is the first U.S. mission to collect a sample from an asteroid. It returned to Earth on 24 September 2023, to drop off material from asteroid Bennu. The spacecraft did not land, but continued on to a new mission, OSIRIS-APEX, to explore asteroid Apophis a few days after its closest passage to the Earth on 13 April 2029. The analysis of Bennu's sample will help scientists investigate how planets formed and how life began, as well as improve our understanding of asteroids that could impact Earth, noting that Bennu has still a non-zero, but yet very small, probability of impacting the Earth in 2182. While writing this report, the cylinder containing the sample was not opened yet, but 70 grammes were already collected surrounding the cylinder in the re-entry capsule, which is more than the minimum goal of 60 grammes. Carbon, water-bearing minerals, sulfide minerals as well as iron oxide mineral have already been identified.



The JAXA Hayabusa2 (# for Sharp, as Small Hazardous Asteroid Reconnaissance Probe) is on its way for a rendezvous to the small (30 m diameter) fast rotator (10 min spin period) 1998KY26, which will be the smallest NEO ever visited, in 2031. The object is a Tunguska-size object, and the knowledge of its properties will allow us to be best prepared if such a small object comes to Earth, which occurs on average every several hundred years.

## Future Outlook

In October 2024 (one week before the IAC in Milan), ESA's Hera mission will launch the same binary asteroid system that saw the DART impact in September 2022. After its rendezvous with the binary system at the end of December 2026, it will measure in detail the effect the impact had on Dimorphos as well as the physical and compositional properties of the asteroid, including for the first time the internal structure, which have great influence on the impact outcome. With DART, it will offer the first fully documented impact deflection test at the scale of an asteroid and improve greatly our understanding of the geophysics of near-Earth asteroids.

The RAMSES mission is under study at ESA to perform a rendezvous with the asteroid Apophis before its closest passage to the Earth on April 13, 2029, in order to characterize the properties of the asteroid before and during the passage and observe possible surface change due to Earth

tidal forces. The data can then be compared with those of NASA OSIRIS-APEX taken a few days after the closest passage, allowing to possibly observe long time effects. RAMSES relies on the platform developed for Hera and, if funded, would allow demonstrations that we can rapidly implement a space mission, noting that the launch needs to occur in April 2027 for a rendezvous, which is very short in current standards. Discussions are taking place with ESA delegations to get it funded, so that we do not miss the unique chance to have a mission around Apophis while more than 2 billion people can observe it from the Earth in Western Europe and North Africa with naked eyes, something that only occurs once in a millennium.

A group is also proposing to the UN that 2029 officially becomes the international year of planetary defense. The proposal is under finalization and the decision should take place in 2024.

## Committee Activities

During the Special Session organized by the committee at IAC 2023 in Baku, Apollo 9 astronaut Rusty Schweickart announced the Schweickart prize, open to students globally who contribute to planetary defense. The committee is supporting this initiative.

<https://www.schweickartprize.org/>

## IAF Earth Observations Committee

### Introduction

The IAF Earth Observations Committee (EOC) is responsible for organizing, curating, and coordinating EO-related activities at the IAF, namely running the Earth Observations Symposium during the IAC. The Symposium covers all aspects of Earth Observations from space, especially observations related to the Earth's environment, including mission planning, microwave and optical sensors and technologies, land, oceanographic, and atmospheric applications, and ground data-processing systems.

### Summary

Commercial Earth Observation continues to be a major trend with the vibrant sector fostering fast-moving innovations in technology, datasets and downstream applications. For example, ESA summarizes the overall state with 6 trends:

1) **Relatively small but ramping up:** the space economy as a whole has seen annual growth of 7% since 2017 and expected to continue up to 2031. A similar trajectory for the Earth observation data and service market is expected, increasing from US\$4.6 billion last year to US\$8 billion by 2032.

2) **The innovation and adoption horizon:** Technologies such as SAR, Hyperspectral, Edge Computing in Space and Thermal Infrared have created significant buzz in recent years, but remain in the early phases of development. In terms of application sectors, some of the significant areas on the rise are thought to be carbon monitoring, parametric insurance, climate risk reporting and pipeline monitoring, although adoption remains at an initial stage.

3) **Going backwards to move forward:** Earth observation is increasingly being seen as a strategic asset for organizations, giving rise to a process of backward steps leading to forward progress.

4) **The European Earth observation canvas:** The European Earth observation industry is dominated by SMEs (Small and Medium-sized Enterprises) which are mainly active in downstream activities. The rest of the world has a larger proportion of capital-intensive businesses, showing a more favorable mix of industrial maturity, together with a higher concentration of start-ups and LSIs (Large System Integrators) and larger average company sizes.

5) **The cash injection inflection:** As reported by Euroconsult at SEOB, private investment in commercial space grew from US\$1.4 billion worldwide in 2017 to a peak of US\$14.9 billion in 2021, only to fall back to US\$6.3 billion last year.

6) **Breaking down barriers:** Experts envisage several hurdles that need to be overcome for the European Earth observation market to continue to flourish. There is still demand which is not being met by current suppliers, and this is coupled with a need for market creation to take advantage of opportunities for diversified data and innovative services.

While the Earth Observation domain continues to grow, it still faces challenges such as the difficulty for different Earth Observation systems to exchange information easily. "The way we are interoperable today is messy and time-consuming and annoying to the end user," David Gauthier, National Geospatial-Intelligence Agency Source Commercial & Business Operations Group director, said Oct. 14 at the MilSat Symposium. As governmental users see more and more reliance on commercial observation systems, there is the need for something more like a hybrid space architecture with interoperability by design as the basis of that capability. Still, making government and commercial Earth observation systems interoperable remains a challenging endeavor.

### Highlights

The **European Union** and the **United Kingdom** have reached a deal that will allow the UK to resume participation in the EU elements of the **Copernicus Earth observation** program. The European Commission and the UK government announced Sept. 7 that they had completed an agreement to permit the UK to be a part of Copernicus as well as the **Horizon Europe** research funding program. The UK had been cut out of both programs after it completed its exit from the EU in 2020. Neither government disclosed how much the UK would contribute to the EU's portion of Copernicus. The European Commission said the UK would provide an average of nearly 2.6 billion euros (\$2.8 billion) a year to the combination of Copernicus and Horizon Europe, a much larger program. In 2021, ESA said the UK contribution to the EU aspects of Copernicus was valued at 750 million euros over several years.

**Ball Aerospace, Northrop Grumman, Orbital Micro Systems and Spire Global** won contracts, announced Aug. 31, to design microwave sounders for the **National Oceanic and Atmospheric Administration**. Under the contracts awarded by NASA on behalf of NOAA, the four companies will conduct studies and design sounders for the Near-Earth Orbit Network, or NEON, NOAA's next generation of polar-orbiting weather satellites. After the firms complete the 12-month studies, NASA and NOAA will decide whether to proceed with development and manufacturing of the sounder.

**THEOS-2** was successfully launched on a Vega rocket on 9 October 2023. The Geo-Informatics and Space Technology Development Agency on Thailand (GISTDA) mission carries a high-resolution imager built by Airbus Defence and Space. It will be joined in a constellation by THEOS-2A, which will also have the ability for video capture.

**FY-3F** launched on August 3 from Jiuquan Satellite Launch Centre. As the newest member among the FY meteorological satellites of the **China Meteorological Administration**, FY-3F will undertake the in-orbit operation of FY-3C. The collected data will serve weather forecasting, atmospheric chemistry and climate change monitoring. The satellite will operate in a sun-synchronous orbit, with an altitude of 830km and a local solar time at ascending node (LTAN) of 14:00.

On May 26<sup>th</sup>, a Soyuz rocket launched the **ROSKOSMOS** satellite **Kondor-FKA N-1**. The satellite hosts an S-Band Synthetic Aperture Radar (SAR) Instrument, which can image at resolutions up to 1m, and swaths as wide as 500 km across various modes. Kondor-FKA is the civilian counterpart to the commercial Kondor-E and military Kondor satellites.

**NASA's TEMPO** (Tropospheric Emissions: Monitoring of Pollution) instrument launched on April 7, as a payload onboard Intelsat 40E, a commercial GEO satellite. **TEMPO** is the first space-based instrument to provide hourly measurements of air quality over North America during the daytime and at spatial scales of several square miles.

Norway's **NORSAT** Tech Demonstration (**NORSAT-TD**) launched in April on SpaceX's Transporter 7 mission. A collaboration between **NOSA**, **NSO**, **ASI** and **CNES**, **NORSAT-TD** carries multiple advanced or experimental payloads, including an iodine propulsion system, a satellite tracking and navigation payload, a laser data downlink system, and an AIS receiver.

**China** added to its recent flurry of reconnaissance satellite launches in late November 2023, sending three new **Yaogan-39** spacecraft into orbit. Yaogan satellites are thought to variously carry optical, synthetic aperture radar (SAR) and other sensors. Some satellites are described generically as being for electromagnetic environment detection and related technical tests.

Smallsat developer **Open Cosmos** (UK) has raised \$50 million to expand the company and develop larger satellites and constellations focused on Earth observation.

**Satellogic** has received a remote sensing license in the United States, the Earth observation operator announced Nov. 21 as it moves operations to the country from Uruguay in search of more government business.

**Urban Sky**, a startup offering high-resolution imaging from small stratospheric balloons, has raised \$9.75 million in a Series A round.

## Future Outlook

The **Mass-change and Geoscience International Constellation (MAGIC)** of **ESA** and **NASA** will consist of a pair of satellites due to launch in 2032. NASA will lead the construction of the Mass Change Designated Observable mission (MCDO), while ESA will complement with the Next Generation Gravity Mission (NGGM). Together, they will form a constellation to accurately monitor the temporal variations of Earth's gravity field at high resolution in time, following on from the work of previous missions such as **GRACE**, **GOCE**, and **GRACE-FO**.

The **China National Space Administration (CNSA)** launched the BRICS Joint Committee on Space Cooperation on May 25, with the goal of cooperation in the remote sensing satellite observation and data sharing among China, Russia, India, Brazil and South Africa, the five nations that form an economic partnership called BRICS. The joint committee will guide cooperation on the BRICS Remote Sensing Satellite Constellation to better serve economic and social development in member countries.

**Canada's** newly announced plan to invest 1 billion Canadian dollars (\$739 million) over the next 15 years in the **Radarsat** mission is part of the federal government's climate resilience strategy. The **Radarsat** satellite series has been a pivotal component of Canada's climate change strategy and international disaster response. With the current Radarsat satellites aging, the new funding will serve a dual purpose. Firstly, **Radarsat+** will introduce a fourth satellite to complement the three existing ones in the **Radarsat Constellation Mission (RCM)**, which was developed by MDA and launched in 2019 and is expected to operate until 2026 without intervention. The addition of the fourth satellite will extend the timeline of the constellation.

Israel Aerospace Industries (IAI) signed an agreement to sell two EO satellites to **Azerbaijan** space agency Azercosmos.

NOAA announced selection of L3Harris to develop the GEO XO next generation Geostationary weather satellite imager in March 2023. NOAA announced selection of Ball Aerospace to develop the GEO XO Atmospheric Sounder in September 2011.

**Italy** thanks to the **Italian National Recovery and Resilience Plan** resources has invested in the very challenging **IRIDE Constellation** composed by 36 satellites of different types and sizes and that includes all components (upstream, downstream, and services) to provide geospatial services at the national and European levels, both to public administration and private customers and it is planned for completion by 2026. These innovative satellites also feature sophisticated operating modes to support high revisit rates, providing data that can be integrated with that from other existing or future programs and infrastructures, including COSMO-SkyMed Second Generation

and Prisma, as well as Europe's vast Copernicus Earth observation program.

**Thales Alenia Space has won in 2023** the contracts from the European Space Agency (ESA) to supply a first batch of **six small satellites** with synthetic aperture radars (SAR) and **one** satellite based on **optical technology**. Both the radar and optical satellites are built on the modular NIMBUS (New Italian Micro Bus) platform, weighing about 170 kilograms with the capacity to be produced rapidly. The optical payload is being developed by the Italian companies **Media Lario** and **TSD-space**, specialized in the creation of instruments and electronics for space. The context and scale of IRIDE's projects are such that they will generate numerous job opportunities for young talent, researchers and professionals working on space technologies.

**Finland's Kuva Space** won a 5-million euro European Commission contract to supply **hyperspectral data to the Copernicus Contributing Mission program**. Under the five-year contract Kuva Space will provide data for monitoring farms, forests, methane emissions, harmful algal blooms and other applications.

**Orbital Sidekick** is building a **constellation of hyperspectral satellites** to be launched by the end of this year, with a plan to build a total of 14 that will give the company the ability to map "every square inch of the globe multiple times a week with high res hyperspectral imagery." The company announced the launch of **the first two satellites of the constellation on April 17**.

**Airbus Defence and Space** announced an agreement for Angeo-1, an Airbus S250 optical satellite and the first very high-performance **Angolan Earth observation satellite**, to be manufactured in France, which strengthens the collaboration between the two countries. Angola has already developed various operational applications using satellite imagery from ADS, such as land use mapping, agriculture monitoring and maritime surveillance and also operates its own telecommunications satellite (Angosat-2). Once in operation, it will become the most advanced satellite in its class in the region, positioning Angola as a leading space power. This sovereign satellite will further foster the development of the country in many different sectors, improving the life of Angolan.

### Others:

- The Slovakian **Startup 3IPK and Thales Alenia Space** was awarded an ESA contract to implement **Innovative blockchain solution** for managing traceability and ensuring the integrity of Earth-observation data under its FutureEO program.
- The consortium, led by **Thales Alenia Space** with the partner **Serco**, was awarded an ESA contract to implement **DestinE Core Service Platform (DESP)**, a key element of the European Commission's flagship initiative Destination Earth (DestinE).

- **OHB Digital Services**, a subsidiary of the space group OHB, was awarded a contract worth €1.7M by the European Union Agency for the Space Programme to lead the "Copernicus Demonstrators - Mobility, Emergency and Infrastructures" project.
- **NASA selected seven EO companies to provide commercial data** as part of its Commercial Smallsat Data Acquisition Program - Airbus DS Geo, Capella Space, GHGSat, Maxar, PlanetiQ, Spire Global and Umbra will compete for contracts with a maximum value of \$476 million over five years.
- **Planetek Italia** won a contract from Saudi Arabia to provide monitoring services based on EO for afforestation initiatives in the Kingdom.
- **Planet** announced the launch of its Forest Carbon Diligence product - a global, 30-meter historical time series of forest carbon, as well as tree height and cover, expected to be used in carbon accounting projects;
- GHG monitoring firm **GHGSat**, which launched the first commercial CO2 sensor, is teaming up with aerospace firm Kairos Aerospace to demonstrate multi-scale methane emission monitoring for the energy sector;
- **EUSPA** and the **European Commission** announced the winners, during the EU Space Week 2023 in Sevilla (Spain), to detect and remove plastics from water bodies;
  - Coastal Marine Litter Observatory by SCIDRONES: Using an innovative combination of Copernicus multi-spectral data with high-resolution drone imagery and advanced AI-algorithms, this application helps differentiate between plastic pollution and natural debris sources such as driftwood and seaweed. Local authorities can use the application to guide their cleanup operations, allocating resources to those beaches and environments most affected by plastic pollution.
  - Eyes on Plastic by EOMAP: This data-driven web app combines Sentinel-2 optical imagery and commercial optical satellite imagery, on-site cameras, cloud-based big data processing chains, Earth Observation analytics and crowdsourcing to identify, map and monitor plastic pollution in near real-time. The solution looks to help governmental stakeholders meet their mandates for managing and reporting plastic pollution, including that found in rivers.
  - Ocean Plastic Alert and Tracking by GEOMATYS: Combining satellite images with meteorological and oceanographic models, this application is designed to detect debris at sea from space and predict its drift. By coupling ocean current and wind models with satellite observations, the solution can make forecasts both forwards and backwards in time. This allows coastal authorities to locate and predict where the front of plastic and debris is after a major weather crisis that causes navigational safety issues. It also optimises the collection of debris in collaboration with the likes of fishing boats.

Committee Activities

Earth Observations Committee had an extremely active period from April – October 2023. The first major activity was leadership of the IAF Global Space Conference on Climate Change (GLOC 2023), with two EOC members serving as two of three International Program Committee Co-Chairs and two more committee members as Co-Chair for the Technical Program and Co-Chair for the plenary program. EOC members also participated in development of the summary paper for GLOC. This was followed by a paper summarizing outcomes of GLOC 2023 published on the IAF website during IAC 2023 in Baku on the day of the Highlight Lecture conveying results of the GLOC 2023 to the broader IAC audience. EOC member Jim Graf gave the lecture, and EOC Chair Harry Cikanek served as moderator. The IAF has

also organized a high-level session dedicated to the GLOC 2023 findings and recommendations at the GEO Week and Ministerial in November 2023, in Cape Town, South Africa.

For IAC 2023, EOC had a very robust program of seven sessions and over 50 IP presentations, and conducted a Special Session (SpS) on wildfires supported by Agency Earth Science Directors. The session was extremely well attended with excellent audience engagement.

EOC and the GEOSS subcommittee plan to offer another robust program and set of proposals for IAC 2024 to showcase the challenges and progress addressing climate change, the continued expansion of commercial industry, and the many advances occurring in technology, missions, and associated science.

Highlights

The topic of interest deals with **black swans** – which are unpredictable events, such as COVID-19 and international conflicts – and their impact on **business continuity**, both in the Institutional Space Market and the New Space Market, with a focus on **supply chain risk** sensitivity.

By comparing case studies as well as a review of pertinent literature (such as the “Managing black swan risk in the space sector - observations from lessons learned based on insurance and contract practice” work from IAC 2022), the summary of findings can be outlined as shown in the next paragraph.

The **Institutional Space Market** presents an awareness of space issues, a management of risks which is well defined as well as knowledge about importance of the business continuity. On the other hand, **New Space Market** (which fundamentally means the rise of private companies in the space sector) has low awareness of space issues, does not have a mature approach to risk management and presents low awareness about the importance of knowing how to maintain continuity in space business.

This is primarily seen through a few cases, such as ExoMars 2022, which relied on the cooperation between ESA and ROSCOSMOS and was interrupted in 2022 following the Russian invasion of Ukraine. In this framework, the rover was meant to be delivered by ESA and lander was meant to be delivered by the ROSCOSMOS. After the cooperation was halted, business continuation was maintained thanks to ESA's new approach under Artemis, speaking to the strengths of the Institutional Space Market.

On the other hand, Virgin Orbit and Kleos Space are used as case study to point out the challenges faced by the New Space Market, after they both had to file for bankruptcy, the former after the setback of a failed rocket launch and the latter because of a lack of continued funding. Overall, the bankruptcy determined a loss of business continuity.

Virgin Orbit / Kleos Space files for bankruptcy



Failure of the launcher & bankruptcy.

Supply chain was interrupted, due to:

- Low risk acceptance
- No next financing rounds
- Loss of business continuity.

Future Outlook

Risk management in the space sector is crucial for all types of space markets, but a special focus will have to be for the New Space Market, which is particularly sensitive to risks to the supply chain, leading to higher chances of loss of continuity which, on the other hand, the Institutional Space Market has managed to avoid so far.

Committee Activities

The ERM committee will meet again both online and at the March 2024 Spring Meetings.

The prospect of having a special session at the IAC 2024 in Milan is under study, topics have been brought forward and new committee members have been welcomed at this session.

IAF Enterprise Risk Management Committee (ERMC)

Introduction

The ERM committee meeting took place on 4 October both remotely and on site in Baku during IAC 2023.

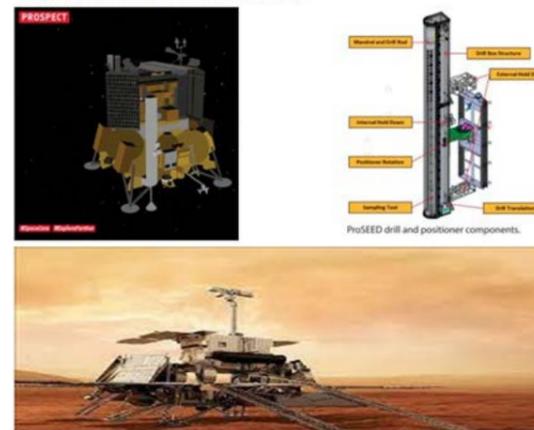
It gathered a total of 16 participants (4 present on site, and 12 online) to discuss latest developments in the field of enterprise Risk Management. We were honoured to have a special keynote presentation by Prof. Katarzyna Malinowska and Michał Szwejowski, from the Space Entrepreneurship Institute.

Summary

This year a special focus was made on **Supply chain risk management**, and the main findings, comparing both Institutional and new space markets, are presented below

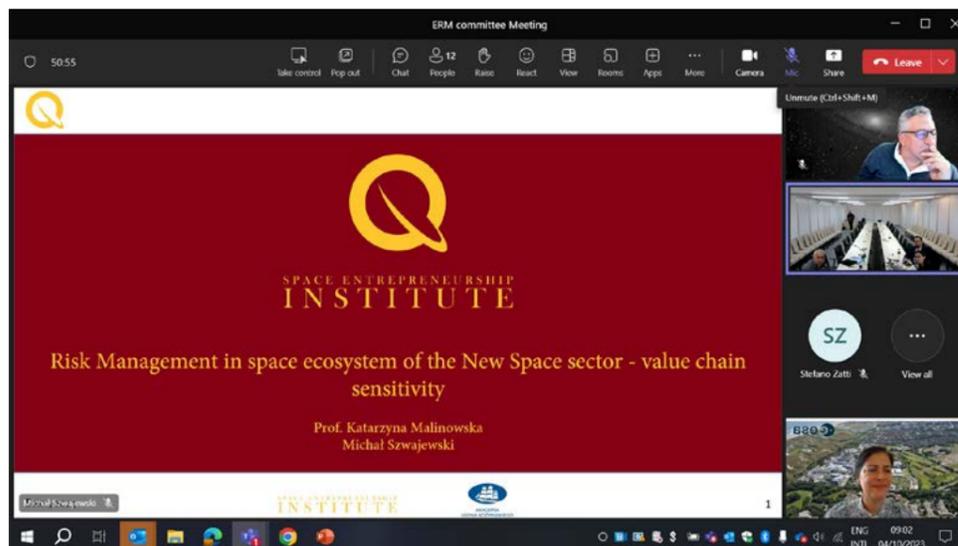
Institutional Space Market	New Space Market
Awareness of space issues	Low awareness of space issues
Well defined risks management approach	Not a mature approach to risk management
Knowledge about importance of the business continuity	Low awareness about the importance of know-how maintaining continuity in space business

EXOMARS 2022 , PROSPECT



Rover was meant to be delivered by ESA and the lander was meant to be delivered by the ROSCOSMOS.

- The supply chain was interrupted, however:
- ESA supports the continuation and delivery of flight models (FMs)
  - +
  - New Approach under the Artemis - Business Continuation maintained.



## IAF Human Spaceflight Committee

### Introduction

The IAF Human Spaceflight (HSF) Committee organizes the Human Spaceflight Symposium (B3) comprising a total of ten sessions. These sessions include the Overview session (B3.1) and multiple sessions focusing on relevant human spaceflight topics. The symposium invites papers on all aspects of on-going and planned human spaceflight including the design, development, operations, utilization, and future plans of space missions involving humans. The scope covers private and government past, present and planned space missions, and programmes in LEO and beyond. The Symposium also features discussions on preparations for the launch of new HSF capabilities and collaborative efforts of human and robotic systems and technologies. Special emphasis is applied to the peaceful use of HSF, fostering international cooperation, and the socio-economic benefit for all mankind.

- [Governmental Human Spaceflight Programmes \(Overview\)](#)
- [Commercial Human Spaceflight Programmes](#)
- [Utilization & Exploitation of Human Spaceflight Systems](#)
- [Flight & Ground Operations aspects of Human Spaceflight - Joint Session of the IAF Human Spaceflight and IAF Space Operations Symposia](#)
- [Astronaut Training, Accommodation, and Operations in Space](#)
- [Human and Robotic Partnerships in Exploration - Joint session of the IAF Human Spaceflight and IAF Exploration Symposia](#)
- [Advanced Systems, Technologies, and Innovations for Human Spaceflight](#)
- [Human Space & Exploration](#)
- [Human Spaceflight Global Technical Session](#)
- [Interactive Presentations - IAF HUMAN SPACEFLIGHT SYMPOSIUM \(two parts session\)](#)

### Summary

- In September 2023, 10 segments for the two side boosters of the SLS rocket that will be using to launch the Orion spacecraft with four humans on board for a trip around the Moon during Artemis II mission as early as November 2024 were assembled. Also, NASA is currently targeting December 2025 for launching a crewed landing mission to the lunar South Pole as part of its Artemis program. The crew modules for NASA's Artemis II, III, and IV missions have been stationed at NASA's Kennedy Space Center, with the three spacecraft undergoing different stages of production for their upcoming launch dates. NASA technicians installed the heat shield on the Artemis II Orion capsule.

- The second SpaceX Starship test took place on November 18, 2023, including a successful second stage separation, and Super Heavy flip and boost-back burn prior to breakup; the second stage reached a peak of 150km prior to losing telemetry after 8 minutes of flight.
- Rocket and Space Corporation Energia under the contract with "Roscosmos" completed Critical Design Review for the new Russian Orbiting Station (ROS) in polar Earth orbit (inclination 96.8 deg.) last summer.
- China in May and October 2023 sequentially launched Tianzhou6 cargo ship, Shenzhou16 and Shenzhou17 manned spaceships. Six Chinese astronauts have been sent into space and entered China Tiangong space station, which signifies the opening of new application and development stage of space station mission. This year marks the 20th anniversary of China's first manned space mission, and the step of Chinese human spaceflight is becoming more and more increasingly steady.
- NASA raised the possibility of extending operations at the ISS beyond 2030 versus accepting a gap in continuous human operations in LEO as the ISS is retired and commercial destinations become operational.
- The number of potential commercial LEO destinations continues to increase, with Axiom, Blue Origin, Voyager Space, Above Space, Vast, and Gravitics all proposing commercial space stations.
- Sierra Space is poised to deliver the first Dream Chaser spaceplane to NASA's Neil A. Armstrong Test Facility in Sandusky, Ohio, in preparation for its first planned mission to the International Space Station in 2024. The first crewed test flight of Boeing's CST-100 Starliner has been pushed back an additional month, to no earlier than mid-April 2024, NASA officials said in a release in October 2023. Axiom Space named the full crew of four people who will fly to the ISS on the Ax-3 mission using SpaceX's Crew Dragon spacecraft, no sooner than January 2024.

### Highlights



- SpaceX completed its second Starship test on 18 November 2023, including a successful second stage

- separation and Super Heavy flip and boost back burn prior to breakup.
- Artemis II is currently scheduled for a lunar fly-by no earlier than November 2024.
- NASA and Roscosmos will continue to cooperate under the agreement on cross-flights to the ISS.
- Roscosmos and Energia Corporation completed CDR for the new Russian Orbiting Station (ROS) in polar Earth orbit.
- Celebration of 25<sup>th</sup> anniversary of the International Space Station operation in orbit (20 November 1998).
- Celebration of the 20<sup>th</sup> anniversary of China's first manned space mission (15-16 October 2003).

### Future Outlook

- Roscosmos and NASA have agreed on an additional flight for an American astronaut on board Russia's Soyuz MS spacecraft. The flight is part of an agreement between Roscosmos and NASA on cross-flights to the ISS.
- China plans to send astronauts to the Moon, a space official said in May 2023. The overall goals are to realize China's first manned landing on the Moon before 2030, carry out scientific exploration and related technological demonstration and short term stay system for crews, and develop human-robot integrated testing

- and other key technologies. To realize this mission, all relevant systems will be researched and developed, including the Long March 10 new crew-carrying rocket, a lunar landing capsule and a lunar extravehicular suit.
- India's government announced in October 2023 that it intends to put astronauts on the Moon by 2040 and construct a space station in the middle of the next decade. A government statement "comes as India works towards developing independent human spaceflight capabilities and a first crewed flight in 2025."
- Trends and areas of focus:
  - Increased interagency and commercial collaboration for future missions;
  - Increasing commercial destinations in LEO;
  - Renewed commercial and agency interest for human lunar exploration;
  - Increased interest in developing the cis-lunar economy.

### Committee Activities

- Establishment of the subcommittees focused on Human Space Stations utilization in LEO and on Space Habitats
- IAC 2024: PE, Special Sessions (SpS), and IAF GNF planning has been announced. Committee members will propose ideas and potential sponsors for a session.

## IAF Materials and Structures Committee

### Introduction

The IAF Materials and Structures Committee was established more than three decades ago. The Materials and Structures Symposium, coordinated by the Committee, provides an international forum for recent advancements and assessment of the latest technology achievements in space structures, structural dynamics, and materials, classically concerning space transportation, space vehicles and orbital infrastructures. Currently, the IAF Materials and Structures Committee is composed of about 40 members, among which more than 30 are strictly involved in the annual organization of the IAC congresses.

### Summary

As the whole space sector, the field of materials and structures is undergoing constant evolution and advancements. Over the last years, an increasing trend towards further miniaturization of satellites and the development of small launchers has been observed. Cost-efficient, sustainable, and reusable space transportation solutions as well as in orbit manufacturing and assembling technologies have been discussed as prerequisite for a commercial use of

the LEO ecosystem. Lightweight design is continuously evolving through use of new materials, new production technologies and through advancements in computational optimization approaches. An evolution of the clean space initiative has been observed, involving advancements in efficient structures, mechanism designs as well as robotic orbital support services. Eco friendly designs and reusability play a key role for clean space.

The advancement of additive manufacturing techniques furthermore enabled the utilization of custom-tailored composites and engineered materials to maximize the performance of future structures and to enable their multi-functionality. At the same time, an ongoing growth in small satellite structures and mechanical devices has been noticed, including antennas booms, gravity gradient, stabilization, temperature control and solar panels.

### Highlights

One of the highlights in the field of materials and structures is the unlimited possibilities enabled by serial additive manufacturing and intelligent automation. This, for example, enables multi-scale optimization and

manufacturing of, for example, ultra-lightweight structures consisting of optimized macro geometries and tailored lattices on a meso-scale level. Combined with smart materials and deployment mechanisms, such innovative concepts and designs are currently being investigated for upcoming robotic landers and rovers. All these new developments have been widely presented and discussed in this year's IAF Materials and Structures symposium confirming their high importance to the space community.

**Future Outlook**

Rapid advancements and innovative developments in the space sector are constantly driving its evolution, leading to a shift in discussions around its key topics. The Materials and Structures Committee is actively keeping pace with these transformative changes and updated the Symposium organization with new topics in view of the next congress in Milan.

Session	Session Name	Focus
C2.1	Space Structures I Design, Development and Verification <i>(Launch Vehicles and Space Vehicles, including their Mechanical/Thermal/ Fluidic Systems)</i>	Design, development and verification of space launch structures and systems
C2.2	Space Structures II Development and Verification <i>(Orbital deployable and dimensionally stable structures, including mechanical and robotic systems / subsystems)</i>	All aspects of deployable and dimensionally stable structures
C2.3	Space Structures III Design, Development and Verification <i>(Orbital infrastructure for in orbit service &amp; manufacturing, Robotic and Mechatronic systems, including their Mechanical/Thermal/ Fluidic Systems)</i>	Orbital infrastructures design, development and verification, including their mechanical/ robotic/thermal/ fluidic systems
C2.4	Space Structures Control, Dynamics and Microdynamics	Dynamics, control, analysis and testing of space structures, including robotic/mechatronic systems
C2.5	Space Structures and Materials for Extreme Environment <i>(High-temperature and cryogenic-temperature applications including thermal insulation concepts)</i>	Extreme environments, including both cryogenic and high temperature applications in space related domains.
C2.6	Space Environmental Effects and Spacecraft Protection	Space environmental effects and spacecraft protection.
C2.7	Manufacturing and industrialization for Launch Vehicle and Space Vehicle Structures and components <i>(High volume production, industrialization, automatization and digitalization)</i>	Manufacturing, inspection and testing technologies to enable efficient high-volume production for launch vehicle and spacecraft structures.
C2.8	Advancements in Materials Applications, Additive Manufacturing, and Rapid Prototyping Manufacturing and Rapid Prototyping	Advancements in materials applications, rapid prototyping, and materials and processes for in space manufacturing and construction.
C2.9	Smart Materials and Adaptive Structures & Specialized Technologies, Including Nanotechnology	Application of smart materials, Specialized material and structures technologies

The Committee's aim is to organize a technical meeting or round table to introduce the new organization of the symposium to a broader audience.

**Committee Activities**



Each year the Materials and Structures Committee honors scientists or engineers for their outstanding research and innovations in the field of Materials and Structures for space applications through the Paolo Santini Memorial Lecture.

The Paolo Santini Memorial Lecture at the IAC 2023 in Baku was held by Professor Harijono Djojodihardjo.

The technical presentations presented in the Materials and Structures Symposium during the IAC Congresses have always reached a large audience in the scientific community, so much, that the Symposium is one of the most followed within the IAC. For the current year, the IAF Materials and Structures Committee will propose some initiatives to involve researchers and engineers from new emerging countries in the aerospace sector.

**IAF Microgravity Sciences and Processes Committee**

**Introduction**

The IAF Microgravity Sciences and Processes Committee counts 15 committee members. Among them, there are three persons from China who represents scientists and Chinese Academy of Science. The chair of A2 Committee, V. Shevtsova, being a member of 'International Collaborative Study on Evaporation and Phase Heat Transfer in Space (2021-2023)' has visited China, on 4-11 November on the occasion of an experiment being carried out aboard the space station in the framework of this project. She was invited by Prof. Liu Qiu Sheng, who is also active member of the IAF Microgravity Sciences and Processes Committee.

**Summary**

The visit proved to be both interesting and beneficial for someone who had participated in several European experiments aboard the International Space Station (ISS).

"I had the opportunity of visiting the Technology and Engineering Center for Space Utilization (CSU) at the Chinese Academy of Sciences, and be engaged in a meeting with the staff of the International Cooperation Office. The International Cooperation Office team offered us a guided tour of the gallery showing the creation history of the Chinese Space Station", said V. Shevtsova.



(left to right) Prof. Liu Qiu-Shen (A2 committee), DONG Miao (CSU), Prof. Shevtsova Vvalentina (Chair A2 committee), Prof. Bou-Ali M. (Mondragon, Spain), Chen Mengyun (CSU)

The space station, known as Tiangong, was built at a rather exceptional pace and was completed in just two years. The first module was launched on April 29, 2021, followed by the second on July 24, 2022, and the last module on October 31, 2022. Tiangong is currently designed with 14 experimental racks within an enclosed, pressurized environment. The primary objective is to provide opportunities

for space-based research. The accelerated development of the Chinese Space Station confirms China's determination to advance space exploration and research. The insights gained from our visit have deepened our understanding of the goals set by the Chinese space programme, particularly in promoting international cooperation and fostering innovation.

At present, the Chinese Space Station (CSS) is actively hosting scientific experiments within its available experimental racks. The scientific discussions in the Key Laboratory of Microgravity CAS revealed common scientific interests. The Chinese colleagues expressed openness and willingness to collaboration, which may involve the possibility of hosting our hardware in the Two-phase System Experiment Rack (TSER) rack or developing it jointly.

## Highlights

There are several interesting points to note.

During our visit, we had the opportunity to observe an evaporation experiment conducted in the Two-phase System Experiment Rack (TSER), managed by our Chinese colleague, Professor Liu Qiu-Sheng. The day before, visiting ground laboratory, we were impressed by the engineering model. Subsequently, we observed the flight model in operation in orbit. Both models were designed and developed by researchers of Professor Liu Qiu-Sheng's team itself in a one-year timeframe and then tested in the ground-based analogue of the space rack, the "Two-phase System Experiment Rack (TSER)". Additionally, the scientific team conducted the experiment a direct way itself for two days each week.

We were given access to the Payload Operation Center, where the real-time monitoring of experiments takes place. The entire team in the control room impressed us

with their youthful energy, with an average age of around 30 years. The only senior person present was the supervisor, who, at 42, led this dynamic team.

We had a privilege to be one of the first visitors of the microgravity experiment facility with electro-magnetic launch (MEFEL). The 40 m microgravity tower uses a linear motor to drive objects up and down, and provides the conditions of weightlessness for 4 s. Due to electromagnetic control, it can provide Moon and Mars conditions. The responsible person of MEFEL told us about an ambition plan to build the drop shaft of 800m.



*In front of MEFEL facility*

## Future Outlook

China's space station has made significant progress in its development, focusing on creating opportunities for space experiments and fostering a platform for scientific and technological innovation. Strengthening cooperation with China in the field of microgravity science is expected to be mutually beneficial. Moreover, the CSU office expresses its readiness to actively participate in the activities of the A2 committee.

hosted in the International Space Station. ILLUMA-T will allow for communications at 1.2 Gbps and showcase how missions in Low Earth Orbit (LEO) can benefit from laser communications.

ESA continues its work on Eagle-1, which will be the first sovereign European end-to-end space-based Quantum Key Distribution (QKD) system, and is a step toward future European quantum communications. Tesat joined SES's team in May and will manufacture the QKD payload comprising its SCOT80 optical communications terminal, which will establish a secure optical link from space to ground. Tesat will also manufacture the QKD module. An optical communications payload, TELEO, was successfully launched on 27 May and the optical feeder link experiments will start from November.

Major GNSS providers are in the process of stabilizing new services primarily for high accuracy, authentication, and safety-of-life. There is also increasing cooperation for providing signals for space service volume and for providing positioning and communications services in lunar orbit. Space-Based Augmentation Systems (SBAS) are moving towards dual-frequency multi-constellation capability.

## Highlights

2023 marks the 50<sup>th</sup> anniversary of initial approval of the GPS program, and the 30<sup>th</sup> anniversary of Full Operations. The program continues to launch GPS III satellites to replenish the constellation and add modernized capabilities. Galileo high accuracy service is declared operational, with 225+ registered users. NASA has released a draft version of the LunaNet interoperability specification document for review and feedback. India has launched the NVS-01 satellite under the NavIC programme. This satellite introduces interoperable civilian signals in the L1 frequency band. IEC has released 61108-6 standard for NavIC based maritime receiver equipment. Indian industry has designed and realized multi-GNSS chipsets with NavIC capability for location-based services.

On 13 October, the Deep Space Optical Communications (DSOC) demonstrator was launched onboard the Psyche spacecraft. DSOC is the first demonstration of optical communications beyond the Earth-Moon system by NASA and has the potential of setting the foundation for establishing high data throughput for future missions to Mars and beyond. The first light has been achieved to send data via laser to and from far beyond the Moon for the first time on 16 November.

Another achievement in the laser communications field occurred on 28 April when the mission TeraByte InfraRed Delivery system (TBIRD) achieved a record data transfer speed of 200 Gigabits per second, the highest space-to-ground transmission speed ever achieved with optical communications technology.

The last of Europe's heavy-lift rocket Ariane 5 lifted off July 7 taking onboard a French defense communications satellite, Syracuse 4B, and a German demonstration spacecraft called Heinrich Hertz whose mission is to test new satellite communications technologies for their suitability for space.

On 28 April and on 12 November, four additional SES O3b mPOWER satellites were successfully launched by pairs using SpaceX Falcon 9 rockets, joining the two first satellites of the O3b mPOWER constellation launched in December 2022. With the launches of this year, the system is already operational to offer high-performance network systems.

## Future Outlook

We expect to see increasing numbers of launches for constellations as well as different demonstrations for satellite-based Internet-of-Things and other non-terrestrial communication technologies. The convergence of terrestrial systems and satellite-based systems will continue under the framework of 6G.

The focus in space-based navigation will be on high accuracy services, open signal authentication, space service volume, and lunar PNT. Applications like precision agriculture, GNSS-based tolling, and disaster relief reduction are finding increasing adoption in various countries. It is expected that these applications will mature into operational nature in the near future. Integration of GNSS with terrestrial systems, especially 5G will become more profound. Studies are ongoing for utilizing signals of opportunity from broadband satellites and for having LEO based PNT services. There will be an increasing cooperation among space agencies and commercial industry in this domain. In the civil aviation domain, more airports will have operational procedures for SBAS services, thereby increasing SBAS adoption.

## Committee Activities

During the IAC 2023 committee meeting in Baku, the committee approved updated session descriptions for IAC 2024 B2 symposium, to improve the abstract selection process by helping authors to properly identify the specific session for their submission. The synergy between laser communication and optical fiber industries was discussed, and a workshop will be proposed in conjunction with IAC. The committee will also propose a Plenary or Special session to bridge the PNT and Space communities, to be sponsored jointly with B4 Small Sats.

The committee is still working on a playlist of SCAN-related YouTube videos, and the creation of individual 5-minute SCAN member introduction videos, both to be posted on the IAF site.

# IAF Space Communications And Navigation Committee

## Introduction

The Space Communications and Navigation Committee (SCAN) deals with all aspects of space-based systems, services, applications, and technologies for communication and navigation. This includes fixed, broadcast, high-throughput, mobile, optical, and quantum communications, as well as position, velocity, time determination and tracking for navigation. The Internet of Things (IoT) and Machine-to-Machine (M2M) topics as they relate to communication and navigation are also in the scope of this committee.

## Summary

The development of mega-constellations continued this year. Starlink's system consists of over 5000 mass-produced small satellites and offers services in an increasing number of countries.

Laser communications experiments in space continue following their roadmap to fulfill new phases of their development. On November 9, as part of NASA's Laser Communications Relay Demonstration (LCRD), the Integrated LCRD LEO User Modem and Amplifier Terminal (ILLUMA-T) was launched aboard a SpaceX Falcon 9 to be

## IAF Space Economy Committee

### Introduction

The IAF Space Economy Committee focuses on building a more complete and nuanced understanding of the economics of space activities. The term “space economy” refers to both in-space activities and their ground segments, as well as their connections and influence on terrestrial economic activity.

The Committee is founded on the principle that broad-based intellectual exchange and deliberation provides a deeper understanding of the impetuses and impacts of space activities, which when guided into the proliferation of shared norms and assumptions, will benefit all nations, both in their space activities as well as socioeconomic initiatives and activities writ large.

### Summary

While the space sector – and government and private investment - has been around since the 1950s, a systematic study of space economics as a discipline is only now emerging. The IAF Space Economy Committee is a major focus of this emerging discipline.

There are no established definitions of this discipline, but one can say that it encompasses the full range of activities and the use of resources that create value and benefits to human beings while exploring, researching, understanding, managing, and utilizing space. Current trends impacting the space economy include growing (see graphic below):

- public interest in space activities *worldwide*;
- government and private sector investment in space activities *worldwide*;
- business and technical innovation that is lowering the cost of entry and activity in space;
- diversity of participants involved *worldwide* in the sector;
- growing space industry revenues;
- expectations of further revenue growth as space is further integrated into the society and economy leading to more value creation and more socio-economic benefits;
- awareness that safety, sustainability and security concerns need to be better baked into space development related activities.

### Highlights

In the United States, NASA took on studies on space economy as a major priority. In 2023, it took on several studies examining the economics of debris mitigation and remediation. The first report from this initiative, published in March 2023, is the first ever study on the costs and

benefits of debris remediation: <https://www.nasa.gov/wp-content/uploads/2023/03/otps - cost and benefit analysis of orbital debris remediation - final.pdf>. Future reports on the topic are forthcoming.

Also, the US Bureau of Economic Analysis published new and revised statistics measuring the space economy. These space economy statistics provide estimates of the space economy’s contribution to U.S. current-dollar and chained-dollar (“real”) gross output and gross domestic product (GDP) by industry, as well as estimates of private employment and compensation.<sup>1</sup> The updated and revised statistics show that, in 2021, the U.S. space economy accounted for \$211.6 billion of gross output, \$129.9 billion (0.6 percent) of GDP, \$51.1 billion of private industry compensation, and 360,000 private industry jobs.

There is growing interest in the private sector to better understand the space economy. For example, in October 2023, The Economist hosted the first ever Space Economy Summit to connect the space industry with mainstream sectors showcasing latest developments and opportunities for growth in the space economy, and providing a platform to discuss how the industry can develop sustainably. The in-person day in Los Angeles brought together 79 speakers and 429 attendees, participating across 36 sessions. The virtual day brought together 67 speakers and 851 attendees, participating across 25 sessions.

In 2023, multiple organizations including McKinsey and Company, Deloitte, Euroconsult, and others have published increasingly sophisticated statistics on the space economy.

### Future Outlook

The potential for innovative space applications is immense, especially if established aerospace companies form partnerships with businesses that traditionally have not ventured into orbit. Pharmaceutical companies might establish a lab on a space station to study cell growth, for instance, or semiconductor companies might manufacture chips in extraterrestrial factories to determine whether any aspects of the space environment, such as the lack of gravity, improve the process. Such possibilities, which might have seemed like the stuff of science fiction a few years ago, could become an essential part of a business across multiple industries in the near future.

But how and when should companies take advantage of their greater access to space and pursue emerging use cases? And how can they decide what opportunities are most promising when the technology is so nascent? Although much remains uncertain, the area is ripe for independent analysis. In the coming years, we expect to see growing interest in crystallizing the disciple of space

economics. The IAF Space Economy Committee will be a major player in developing this field of study.

### Committee Activities

The committee will align with the intention of the IAC 2024 to ensure that we can use space to meet our needs without compromising the ability of future generations to meet their needs. The Space Economy committee will therefore focus this coming year on the economics of space sustainability.

One area that is especially amenable to economic analysis is congestion in Earth orbit. While our societies rely evermore on space applications (e.g., telecommunications, resource management, meteorology, and climate monitoring), Earth’s orbits are getting more congested with thousands of satellites, with growing risks linked to heavy space traffic and growing probability of collisions in orbit. NASA, ESA and other organizations are examining this risk quantitatively. The IAF Space Economy Committee will emphasize this topic in the E3 and E6 sessions of the IAC Technical Programme.

## IAF Space Education and Outreach Committee (SEOC)

### Introduction

The IAF Space Education and Outreach Committee (SEOC) promotes the development and delivery of quality learning and outreach opportunities for students, educators, and members of the IAF, and supports IAF activities focused on students and educators.

### Highlights

Two major trends were highlighted by our members this year:

- Open access to data and software as well as novel technologies are changing how education and outreach is conducted. For instance, a lot of outreach now happens through social media and content creation. In addition, new AI and mixed-reality technologies are impacting the way we gain knowledge and interact with others. Concerns for privacy, intellectual property and ethics are folded into this evolution, and these new technologies may change the way future space professionals work in the sector or preserve individual contributions to research and development.
- There is now globally an increased focus on more inclusive approaches to education and outreach to represent and engage with diverse perspectives and underrepresented communities.

These trends drove SEOC to revise its Education and Outreach Symposium, and informed decisions made in other areas such as the Next Generation Plenary.

### Future Outlook

SEOC is currently preparing for the 75<sup>th</sup> IAC, which will be held in Milan in 2024. The Call for Papers for both our Space Education and Outreach Symposium and our Student Competition Symposium are now open. Our Space Education and Outreach Symposium will feature a new session focused on diverse perspectives in education.

SEOC also plans to continue its Honours and Awards Programme alongside supporting the Next Generation Plenary, the Launchpad Mentorship, the Abstract Mentorship, Cross Cultural Workshop and other next generation focused programs at the IAF. SEOC Outreach is currently planning several outreach and public engagement activities both at IAC 2024 and outside of that event.

A particular area where we still have a long way to go is teacher engagement. In addition to the Educator Development Workshop organized by the International Student Education Board (ISEB), SEOC plans to explore new ways to accommodate involvement of teachers at IAC 2024. Bringing in teachers as well as their students will assist in triggering support and interest in space and find better ways to transfer knowledge to the next generation.

### Committee Activities

Throughout 2023, SEOC supported various initiatives, such as the IAF Abstract Mentor Programme and IAF Launchpad Mentorship Programme, with SEOC members acting as mentors in both programmes.

SEOC worked throughout 2023 to organize two symposia at the 74<sup>th</sup> International Astronautical Congress (IAC):

- The Space Education and Outreach Symposium (E1) showcased over 110 papers (selected from over 210 submissions) in 12 sessions around various topics in space education and outreach, workforce development and culture;
- The 51<sup>st</sup> Student Competition Symposium (E2) showcased 42 papers (selected from over 100 submissions) in 5 sessions, one of which was broadcast online as part of the Global Technical Symposium (GTS).

The committee will be seeking to increase the number of Keynote speakers in these Symposia and has restructured some sessions for 2024 to align better with changes in the education and outreach landscape.

SEOC Honours and Awards continued its great work this year, by awarding the following:

- The Frank J. Malina Astronautics Medal was awarded to Klaus Schilling, Professor and Chair of Robotics and Telematics, University Wuerzburg. This award recognizes an educator who has demonstrated excellence in taking the fullest advantage of the resources available to him/her to promote the student of astronautics and related space sciences. Professor Schilling was also a keynote speaker at the SEOC E1 Symposium.
- The Luigi G. Napolitano Award was awarded to Sona Guliyeva from Azerbaijan based on the paper “Advancing Space Education for Sustainable Development in Azerbaijan: Importance of Geoinformation Technologies”. This award is presented annually to a young scientist (below 30 years of age) who contributed significantly to the advancement of aerospace sciences and presents a paper on this contribution at the IAC.
- The IAF Student Awards recognize the best papers presented by students at the IAC:
  - The Undergraduate Category 3AF Gold Award was awarded to **Vint Lee**.
  - The Undergraduate Category Hermann Oberth Silver – IFR was awarded to **Guillaume Hueber** and **Jérémie Huser**.
  - The Graduate Category Hermann Oberth Gold – IFR and the British Interplanetary Society Prize for Best Technical Paper were awarded to **Miguel De Almeida Rebelo**
  - The Graduate Category 3AF Silver Award was awarded to **Afnan Malik**
  - The Hans von Muldau Team Award for the Best Team Project was awarded to **The Student Project FARGO - A Ferrofluid Experiment on the ISS**.
- SEOC members contributed to the selection of the IAF Emerging Space Leaders (ESL) Grants and Young Space Leaders (YSL) Award programme as well. We are happy

to see Bethany Downer of SEOC among the awardees of the YSL this year.

SEOC members (alongside the IAF WD-YPP and other committees) also supported the Next Generation Plenary (NGP) Programme as steering committee members. The NGP this year organized the Next Generation Plenary ‘The Open-source Revolution and Space Data Accessibility’, while also holding an additional panel titled ‘The 21st century’s Moonshot: Critical Technologies, Policies, and Business Models to thrive on the Moon’. Both sessions highlighted perspectives of the Next Generation as panelists were under the age of 35 and selected through a competitive process.

SEOC members also organized two special sessions at IAC 2023:

- Developing an Ecosystem to Prepare the Next Generation of Space-Oriented Citizens
- Emerging Technologies on Natural Disaster Detection: Turkey Syria Earthquake and Remote Sensing Applications

The SEOC Outreach team relaunched its activities this year, holding several outreach activities at different countries in the region prior to IAC. SEOC members also contributed to the activities of the International Space Education Board, which held several events for students and educators.

SEOC’s membership has been on the rise, reaching 66 members, 3 friends and 3 experts in 2023. The committee has explored new ways to engage incoming and prospective members to create more impact within the space community. This should result in new programs which will be unveiled in future years. We have also identified links and liaisons with different IAF Committees for better coordination of activities.



SEOC members at our two meetings at IAC 2023.



## IAF Space Exploration Committee

### Introduction

This brief gives an overview of the major achievements and of the most promising development in Space Exploration in 2023, and of the perspectives for the next decade. The coverage of those topics at IAC 2023 is also elaborated.

### Summary

The year 2023 has been very productive for Solar System Exploration. Amongst the most exciting events, we can highlight the launches of ESA’s JUICE mission to Jupiter and its icy Moons, of NASA’s Psyche mission to the metallic asteroid Psyche. NASA successfully returned to Earth an ample collection of samples from asteroid Bennu within the frame of the Osiris Rex mission. With the success of ISRO’s Chandrayaan 3 landing, India has become the 4<sup>th</sup> country to reach the surface of the Moon, where it deployed the small rover Pragyan which executed original scientific measurements over the entire daylight portion of a Moon Day. KARI started in January the operation of their pathfinder lunar orbiter, DANURI. JAXA launched their SLIM mission towards the Moon in September, and shall land with high accuracy a small rover in March 2024.

### Highlights

We are living through the age of mobile surface missions and sample return. The Chinese rover of the Tianwen 1 mission has navigated on Mars for a year between May 2021 and May 2022. NASA’s rovers Curiosity and Perseverance are still active on Mars, whereas the helicopter Ingenuity has cumulated 2 hours of flight time over 66 flights in the tenuous Mars atmosphere. Several innovative mobility and surface navigation techniques were presented at the IAC.

Samples from asteroids Ryugu and Bennu are being analyzed by the best facilities across the world. CNSA is preparing a similar asteroid sample, return mission for this decade, TianWen 2. We benefited at IAC 2023 from two exciting insights of JAXA’s Phobos Sample Return mission to be launched next year, and of the associated wheeled rover developed by CNES and DLR. Mars Sample Return is also the focus of ambitious technological developments in China, in the US and in Europe. Two detailed presentations of the Capture, Containment and Return System under development at NASA, and of the Planetary Protection constraints that have driven its design, were also given at the conference

In the field of Planetary Defense, the successful impact of asteroid Dimorphos by NASA’s DART probe has generated a set of effort intensive efforts to simulate the impact and

recreate analytically the deviation that has been measured. ESA is finalizing the development of the HERA probe which will be launched towards Dimorphos next year to characterize its surface and interior, and make detailed observations of the impact crater. The following target for Near Earth Asteroid reconnaissance should be Apophis which will pass 31 000 km above the Earth on 13 April 2029. The Earth gravity will modify its trajectory, its spin parameters and possibly redistribute some of its surface material. Two exciting mission concepts dedicated to Apophis were presented at the IAC.

The Lunar exploration and its recent commercial dimension was very well covered at the IAC by a Late Breaking News (LBN) presentation of Chandrayaan 3, two plenary presentations, and on Highlight Lecture which described the failed attempt of a new Space actor, iSpace to land softly on the Moon and deploy a rover. However, successful lunar orbit insertion and maneuvers were executed, and the lessons learnt will be essential for their next mission. In addition, the 3 technical sessions on Moon Exploration at IAC provided a key insight on the technological development and missions in preparation. Moon Exploration is at the center of many Space Agencies, companies and academia’ strategy which are developing a variety of landers, rovers or technologies to support those missions. In addition, terrestrial experiments such as analog missions are also paving the way for human Moon Exploration targeted in the next years. In parallel of such endeavors, the industry is also organizing itself through associations or consortiums in order to provide flexible solutions to the market. We look forward to the next Moon landing attempts of Astrobotic on 24 December 2023 (embarking NASA’s VIPER rover) and Intuitive Machines scheduled on 12 Jan<sup>uary</sup> 2024.

### Future Outlook

Mars Sample Return remains at the top of scientific priorities, both for geology and exobiology. We should know at the next IAC the new outline of the mission which is currently being re-considered by NASA and ESA. This campaign is now bound to happen at the beginning of the next decade. In the meantime, ESA will have launched to Mars in 2028 its Rosalind Franklin rover within the frame of the 2<sup>nd</sup> step of its ExoMars program.

The other major scientific priority, which is also very much supported by the quest for potential non terrestrial life, is the study of the icy Moons of the giant planets. Juice is on its way to the Jovian system, and it will dedicate the end of its mission to Ganymede, in ten years from now. NASA’s Europa Clipper will explore Europa in the same timeframe, and CNSA is preparing the Tianwen 4 mission towards

Jupiter, Callisto and Uranus. Titan shall also be explored in the mid-30s by the Dragonfly rotorcraft under development at NASA, which will study prebiotic chemistry and extraterrestrial habitability.

### Committee Activities

ESA's BepiColombo spacecraft has already flown-by Mercury three times, and will insert the Mercury Polar Orbiter around Mercury in December 2025, together with JAXA's probe Mio. Venus will be the target in the next

decade of a probe that will characterize its atmosphere, and of a duo of orbiters. The Space Exploration Committee will encourage at the next IAC papers about these missions to the inner planets which have received little attention at recent conferences.

The Space Exploration Committee shall continue and extend its collaboration with the IAF Committee on Planetary Defense and Near Earth Objects, with the IAA Symposium on small satellite missions, and with the Human Exploration Committee.

## IAF Space Propulsion Technical Committee

### Introduction

The Space Propulsion Committee addresses sub-orbital, Earth-to-orbit, and in-space propulsion. All types of propulsion are of interest to the committee: chemical and non-chemical/electric propulsion, but also advanced, unconventional, or air-breathing propulsion. The symposium sessions organized by the committee during the annual International Astronautical Congress includes: liquid systems (2 sessions); solid and hybrid systems (2 sessions); electric propulsion (2 sessions); small satellite propulsion; nuclear propulsion and power systems; propellantless

propulsion; air-breathing rocket propulsion; disruptive propulsion systems enabling new/visionary space missions.

The committee deals with component technologies as well as complete propulsion systems and their implementation in missions and spacecraft, but also welcomes discussions on dedicated test facilities and diagnostics for space propulsion testing. Special attention is given to New Space developments, including miniaturized propulsion systems for small spacecraft/launchers, or how combined technologies, such as chemical and electric propulsion, can be optimized for extending the range of feasible space missions.

### Highlights

#### Liquid Propulsion

Large rocket launchers/space vehicles were in the spotlight at the liquid propulsion sessions in the IAC 2023. In an interesting keynote talk, the Academy of Aerospace Propulsion Technology and the Xi'an Aerospace Propulsion Institute have presented a wide overview of the current liquid rocket engine developments for **heavy launch vehicles in China**, focusing among others on their 500-ton LOX-kerosene engine and the 220-ton and 25-ton LOX/LH<sub>2</sub> engines. AVIO (Italy) has shown the latest developments on the **M10 LOX-Methane engine** for the VEGA-E upper stage, including an experimental demonstration over a cumulative operational time of 1200 seconds. JAXA has presented the results of the qualification test campaign of the **LE-9 engine** for the H3 launch vehicle (LOX-LH<sub>2</sub>, 1471 kN thrust), successfully demonstrated with 61 firings on engineering models and 9 cumulative firings on the qualification model. Finally, ArianeGroup has illustrated the full range of equipment and subassemblies for the **propulsion system of the ORION European Service module**, specifically focusing on the RCS cluster (4x200 N thrusters, operating with MON and MMH as propellants).



Firing test of a 500-ton LOX-kerosene engine (courtesy Academy of Aerospace Propulsion Technology/Xi'an Aerospace Propulsion Institute)

In another interesting contribution from the T(H)RUST team in the Department of Mechanical and Aerospace Engineering of Sapienza University of Rome, examples of test results on high-frequency combustion instabilities, thrust chamber wall heat flux, cooling channels and nozzles were presented, in support to present and future developments in the field of liquid rocket engine propulsion.



Firing test of the M10 engine (courtesy AVIO S.p.A.)

During the conference, an overview of the finalization of the **new Rocket and Satellite Propulsion Laboratory Center** in Warsaw (Poland) was presented. The new facility specializes in green space propulsion research allowing green thruster and engine vacuum qualification for thrust levels of up to 500 N (and up to 5000 N for sea level R&D), with 4 hot fire test benches and extensive chemical laboratories. The opening of the center took place at Łukasiewicz – Institute of Aviation in Warsaw shortly after the IAC, in October 2023.

#### Solid/Hybrid Propulsion

Various experimental and numerical studies on new concepts and breakthroughs in solid and hybrid propulsion systems were presented at the IAC 2023. The Technology Innovation Institute (UAE) presented possible combinations for **in-situ propellant production for hybrid rocket propulsion**, utilizing materials available on Mars and the Moon. The reactive molecular dynamic simulation results presented by the Aeronautic Institute of Technology (Brazil) shed light on the mechanism underlying the **aluminium particles passivation** process, showing that better understanding of this mechanism could ensure long-term stability and performance of aluminium-based components in solid propellants. CAS Space (China) presented the conceptual design of a **permeable nozzle with thrust vectoring capability**. ISAE-SUPAERO (France) showed the results of the design and testing of a student-developed hybrid rocket engine using **H<sub>2</sub>O<sub>2</sub> and 3D-printed ABS** (Acrylonitrile Butadiene Styrene). Alpha Impulsion (France) presented the development of a deeply original **autophagy hybrid rocket engine**, revisiting an old concept for various combinations of liquid/powdered propellants and structural plastic propellants. Warsaw University of Technology (Poland) showed the results of the Twardowsky's engine test campaign, leading to flight qualification of a student hybrid rocket engine.

Tohoku University (Japan), in collaboration with ElevationSpace Inc. and other companies, presented the **ELS-R100 mission**, a re-entry technology demonstration from Low Earth Orbit using a hybrid thruster. Finally, Koc University and DeltaV Space Technologies (Turkey) reported interesting results on the **ablation resistance of graphite** and a hot-gas generator system based on hybrid rocket technology.

#### Electric Propulsion

The electric propulsion sessions at the IAC2023 have been, as usual, rich in presentations and developments in diverse fields. FOTEC (Austria) has presented the results of a 48000hour endurance test campaign on their **FEEP multi-emitter**, conducted under funding and supervision of the European Space Agency, which has demonstrated the viability of operating a FEEP emitter for extremely long durations and paving the way to using this type of propulsion also for very demanding deep-space missions. Berlin Space (Germany) has presented their advanced propulsion system for small satellites based on **2 mN Hall Effect Thrusters**, designed to work with Xenon or Krypton. Results from the first successful test campaign on an interesting concept of **multidirectional plasma thruster** have been presented by Advanced Propulsion Systems LLC (Russia). In the field of **numerical plasma simulations**, the universities of Bologna and Padova (Italy) have presented a novel coupling method for fluid/kinetic solvers, intended for use in the simulation of helicon plasma thrusters. Considering the comparisons presented by the University of Tokyo between on-orbit and ground thrust measurements, as detailed in the next section on small satellite propulsion, numerical plasma simulation results should be used very carefully for propulsion system integral characteristics assessment, such as thrust and specific impulse, since these numerical models are validated predominantly in laboratory environment and might show less accurate results for the actual in-space performance.

#### Small Satellite Propulsion

The IAC 2023 has confirmed that the small satellite propulsion scenario is extremely dynamic, with many ongoing developments worldwide. Papers have been presented on systems designed for actual missions, such as the **AQUARIUS** water propulsion system developed by the University of Tokyo and JAXA and successfully demonstrated in the EQUULEUS Lunar CubeSat, where it delivered a cumulative Delta-V of more than 17 m/s in multiple maneuvers. The in-space demonstration of AQUARIUS revealed 1.5 times higher thrust than ground test measurements, emphasizing the importance of the conditions under which ground tests are performed, especially for thrusters of small-form factor since their exhaust flow can be significantly affected by the environment in the vacuum test facility. The other system designed for an actual mission is the **IANUS** propulsion system developed and qualified by T4i (Italy) for the Milani CubeSat within the Hera mission, a 6DOF system based on cold gas thrusters in the 6-26 mN range, operating with R134a as propellant.

Other highlights from this session include the results of successful testing at 20-50 W of an **ambipolar plasma thruster** developed by TU Dresden (Germany), the

demonstration at 0.17 mN thrust and 2500 s specific impulse of a **porous emitter electrospray thruster** from the University of Southampton (UK), and the first results on a 50 mN **water resistojet** from Sapienza University of Rome (Italy). Finally, Bauman Moscow State Technical University (Russia) presented a study on the efficiency of a Pulsed Plasma Thruster (PPT) utilizing various propellants, showing the perspectives of using **low face carburization propellants** instead of the commonly used PTFE for enhancing the performance of PPT thrusters.

#### Hypersonic, Air-Breathing and Combined Cycle Propulsion

During this session at the IAC 2023, Beihang University (China) presented experimental and numerical results on **ramjet and scramjet** propulsion systems, including solid-propellant ducted rocket fuel supply and mixing. One of these studies dealt, in particular, with the numerical investigation of a **Mach 5 hypersonic ramjet with subsonic combustion**, demonstrating the feasibility of developing such a propulsion system and broadening the operational capabilities in terms of speed and spatial domain of subsonic ramjet engines. The Sapienza University of Rome (Italy) presented an investigation of fluid mechanics and heat mass transfer in the **HIFIRE-2 scramjet**, suggesting the need to investigate new configurations with swirling injectors, different injector's locations and angles and different cavity geometries, to reduce the total pressure losses without decreasing the mixing efficiency. Kyushu University (Japan) reported a numerical design optimization and analysis of **shock-induced mixing and combustion** via data-driven approaches, while Kanazawa Institute of Technology (Japan) proposed a simple numerical method to analyze the **flame holder flow field** of a typical hypersonic jet engine with minimum computational time.

#### Nuclear Power and Propulsion Systems, and Propellantless Propulsion

This session, organized jointly between the IAC Space Power and Space Propulsion symposia, hosted a variety of papers with topics ranging from solid-core Nuclear Thermal Propulsion (NTP), liquid-core NTP, Nuclear Electric Propulsion (NEP), solar sails and nuclear fusion propulsion systems. The session featured an interesting keynote from the University of Alabama in Huntsville (USA) describing the current research progress and development efforts on NTP in the United States, with a special focus on the joint DARPA and NASA project **Demonstration Rocket for Agile Cislunar Operations** (DRACO). The University of Alabama in Huntsville also presented a new methodology called Reliability-Driven Design and Test (ReDDT), which focuses on streamlining the nuclear engine test program through design and test planning for a given NTP system level reliability. Kyushu

University (Japan) presented the results of a demonstration of **axial pulsed magnetic nozzle** for nuclear propulsion systems, showing some discrepancy between numerical and experimental results which will require further investigation to understand its causes. The Keldysh Research Center (Russia) presented the design and applications of **high-power nuclear-powered propulsion systems** for space transportation to Moon, Mars and outer planets. Finally, Beihang University (China) presented an integrated adaptive control scheme to mitigate the inherent uncertainties of optical models for **solar sail** technology.

#### Disruptive Propulsion Concepts

In this session of the IAC conference, we mainly focus on systems and technologies which, although in principle they could also be presented in one of the other sessions, show particularly new and possibly disruptive features, making them promise to enable new, futuristic mission concepts. This year's session hosted a very interesting keynote from Nagoya University (Japan), showing the results of the flight demonstration, on a sounding rocket, of the **Rotating Detonation Engine** they are developing in collaboration with JAXA and other Academic partners. The tests were fully successful, demonstrating a thrust of more than 500 N and a specific impulse of 290 s for an oxygen-methane engine operated in space environment.



*In-space Rotating Detonation Engine demonstration (courtesy Nagoya University)*

Other highlights from this conference session were the developments on **Atmosphere-Breathing Electric Propulsion** of the universities of Bologna and Padova (Italy), who showed their design of a cathodeless radio-frequency plasma thruster; and a renewed interest in the study of propulsion options for **interstellar travel**, with two different papers on the topic presented during the session.

In the IAC 2023 Late Breaking Abstracts session, Khalifa University (UAE) presented a concept of **graphene-based laser ablation thruster**, including preliminary test results which will require further theoretical and experimental investigation to be confirmed.

## Committee Activities

The committee is currently made of 48 members from 15 countries, including 8 female members and 11 young professionals, with good distribution among geographical areas and categories (industry, Academia, agencies). In the second half of 2023, four new members have been welcomed in the committee: Heji Huang (Chinese Academy of Sciences), Jamila Mansouri (European Space Agency), Yuji Saito (Tohoku University), Andrei Shumeiko (Bauman Moscow State Technical University).

The committee is not only active in the organization of the International Astronautical Congress, but also fosters synergies with other relevant space propulsion conferences, such as the EUCASS (European Conference for Aeronautical and Space Sciences) and the biennial 3AF/ESA Space Propulsion conference. The committee members are also active in knowledge dissemination to the space propulsion scientific community through the publication of papers and books, such as the handbook on hybrid rocket design published in 2023 by Ashley Karp and Elizabeth Jens.

## IAF Space Security Committee

### Introduction

Space security has become one of the key topics in any discussion concerning space. The need to strengthen long-term sustainability, safety and security in space is shared by all nations. It is in the collective interest of all peaceful space-faring or space-using nations to encourage the responsible use of space and minimise orbital debris, in order to protect any in-orbit manoeuvring spacecraft from a risk of collision and to preserve the space environment.

At the same time, the peaceful use of Outer space, which prevailed in the past, is not to be taken for granted; we are facing a shift of paradigm with a contested and conflicting space domain. Today, close approach and proximity operations by foreign objects of satellite-inspection class are already a reality.

We acknowledge the increase of new comers and the diversification of space actors, the arrival of large constellations and the multiplication of small satellites, leading to a growing complexity of space operations. There are also developments towards active debris removal (ADR), on-orbit servicing (OOS), rendezvous and proximity operations (RPO), which can be perceived as dual use technologies. This combination of factors and trends brings many opportunities but it also means increasing risks of collisions and interferences, as space will become more and more dense and congested.

In this fast-changing environment, with an increase in both the risks and threats in space, the question of Space Situational Awareness (SSA) and Space Traffic Management (STM) is of the essence. Currently, and in the future, we will need to be able to detect, identify, characterise, understand, analyse, attribute and verify what is happening in outer space. An awareness of the highly dynamic and increasingly complex near-Earth space environment appears to be essential to safeguarding space-based assets, ensuring access to space and contributing to the safety, security and sustainability of space in the long run.

The IAF Space Security Committee focuses on a wide spectrum of topics concerned with security, safety and sustainability. More than a technical committee, the IAF Space Security Committee engages in high-level policy and strategy Committee welcoming highly distinguished speakers, and fascinating policy and industrial professionals and experts from around the globe. From national to international bodies and through multi-actors, the Space Security Committee offers a 360 degrees range of topics and discussions enlightening the space security community as well as the public to a topic that concerns us all.

### Summary

Thanks to its high-level members and distinguished speakers, the IAF Space Security Committee was able to discuss and exchange on a wide variety of topics including rules and principles of responsible behaviours, space security governance, Traffic Coordination System for Space and the U.S. work on space systems cybersecurity.

The Committee welcomed the IAF President Clay Mowry who presented the IAF Sustainability, Investment and Security (SIS) Agenda for 2022-2025. He explained that these topics are interlinked, sustainability has dual aspects, in space and on earth. The Chair, Pascal Faucher, highlighted that the SIS Agenda is at the heart of the work of the Committee and expressed his and the Committee's support to promote these three important topics.

Indeed, during our IAC 23 Meeting, **Ambassador Hellmut Lagos Koller**, Chair of the Open-Ended Working Group on Reducing Space Threats and debriefed with us the 4th Session that took place from 28 August to the 1 September. He highlighted the different innovative proposals and even cross-national initiatives. However, the atmosphere was not adequate to achieve consensus. The Chair of the OEWG reminded that even if it is the end of the OEWG, it is not the end of the dialogue on this complex subject. Finally, he highlighted the value of developing norms of responsible behaviours.

We had the pleasure to listen to **Guoyu Wang**, Dean of Air, Space Policy and Law of Beijing Institute of Technology, China, and Deputy Director of China National Space Administration Space Law Center, who shared the Chinese approach to space security governance or the road of rights in space, particularly about the to-be-observed principles for operators when facing the risks of in-orbit collision. The approach proposes to bring new legal concepts in space, such as right to access, passage right, priority right, and right of stay. Forming the Space Road Right (SRR) with the following recommended principles: Attribution of Burdens to Risks Maker Principle, Priority of Invaluable Project Principle, Priority of Space Mission for Public Interests Principle, Less Cost Principle (Efficiency Principle), Safety First Principle, and The Principle of Reciprocity and Comity. These principles would promote the development of International Space law, as well as provide a new tool to examine security matters.

During the IAC meeting, this past October, we had the chance to welcome **Richard DalBello**, director of the US Office of Space Commerce, who highlighted the TraCSS Program Objectives. The objectives are to relieve DoD of responsibility for SSA coordination of burgeoning global commercial space industry, provide 'Basic SSA Services' in a manner that promotes safer space operations, Encourage US Commercial SSA leadership and rely on commercial SSA providers, establish and maintain a resident space object data repository, conduct R&D activities that will advance the science and technology of SSA, and Promote global SSA standards and best practices.

His presentation was followed by the one of **Dick Buenneke**, Department of State, United States. It included the results of a White House space systems cybersecurity executive forum hosted by the Office of the National Cyber Director and the National Space Council:  
<https://www.whitehouse.gov/briefing-room/statements-releases/2023/03/28/readout-of-space-systems-cybersecurity-executive-forum-hosted-by-the-office-of-the-national-cyber-director-and-the-national-space-council/>

as well as subsequent outreach to the commercial space sector:

<https://s-isac.org/the-office-of-the-national-cyber-director-joins-space-isac-and-uccs-for-space-systems-cyber-security-roundtable/>

## Highlights

The IAF Space Security Committee discussions along the year 2023 have been highly insightful and we have recorded a high number of participants to our activities throughout the year. In fact, we welcomed in our last meeting alone 4 new Committee Members, highlighting the growing interest in space security amongst professionals. The Committee also had the pleasure to welcome the IAF President, who shared his enthusiasm for the Committee's support to promote the SIS Agenda through its activities and discussions.

## Future Outlook

The main focus of the Space Security Committee in the following years will be **Space Economy, Space Security and Space Sustainability**. Furthermore, the Committee suggested for its next meeting additional presentations on a more practical and operational approach for space traffic coordination and space situational awareness in more and more countries.

## Committee Activities

We will closely follow the path set out by Clay Mowry, believing that activities and exchanges centred on sustainability, investment and security are key to promote cooperation, share scientific knowledge, and meet urgent concerns facing spacefaring nations. The Space Security Committee will continue to invite and share its knowledge with high level experts and researchers in the field of Space Security, encompassing both, national and international bodies as well as multi actors. Continuing the study of the risk level update of space threat, and organizing sessions promoting the submission of our topics.

The IAF Alliance Programme is open to all IAF Members and aims to deepen the involvement of IAF Members in the Federation, enhance the prominence and visibility of their role within the Federation, complement the traditional sponsorship opportunities with strategic long-term partnerships, assure the sustainability of IAF operations in the interest of its Members; further improve the quality of the Federation's activities, and strengthen the Federation by fortifying the one-to-one relationships with its Members.

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