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Committee on the Peaceful Uses of Outer Space

Report on the United Nations/France/International Astronautical Federation Workshop on Space Technology for Socioeconomic Benefits: “Access to Space for All: bridging the space divide”

(Paris, 16 and 17 September 2022)

I. Introduction

1. The Office for Outer Space Affairs of the Secretariat, the Government of France and the International Astronautical Federation (IAF) jointly organized the United Nations/France/International Astronautical Federation Workshop on Space Technology for Socioeconomic Benefits, on the theme “Access to Space for All: Bridging the Space Divide”. This workshop series is one of the long-standing activities of the Office and is held immediately prior to the International Astronautical Congress. Thanks to the Office’s collaboration with IAF, the Congress registration fee is waived for sponsored Workshop participants. The Workshop of 2022 – the twenty-ninth in the series – was held over the course of two full days.

2. The workshops in this series have traditionally been aimed at raising awareness of opportunities to use space science, technologies and applications in support of sustainable economic, social and environmental development. The aim of the Workshop of 2022, which was organized within the framework of the Access to Space for All initiative, was to provide insights into enablers of access to space; science, technology and innovation policy; and activities in the areas of hypergravity and microgravity, satellite development and operations, and space exploration, corresponding to the three tracks of the Access to Space for All initiative.

II. Background and objectives

3. The United Nations/International Astronautical Federation workshops are focused on innovative themes with a view to responding to societal needs, and showcase the socioeconomic benefits of space. Over the years, they have enabled cooperation and interaction among more than 2,000 participants from different backgrounds.

4. Following on from the discussions held during the last edition of the Workshop, and taking into account the importance of the Access to Space for All initiative as a tool for the fulfilment of the “Space2030” Agenda, as recalled in the implementation plan for the Agenda, the 2022 Workshop provided a forum for discussion as to how



space science, technologies and applications could support sustainable economic, social and environmental development. The Workshop also touched on the development of science, technology and innovation policies related to space and how leveraging the Access to Space for All initiative could create opportunities.

5. The specific objectives of the Workshop were to:

(a) Bring together policymakers and decision makers and the research and academic communities to help integrate space into policy and the decision-making process;

(b) Raise awareness of the activities of international and national entities, space agencies, industry and civil society relating to innovation and the socioeconomic benefits of space activities;

(c) Raise awareness of capacity-building efforts relating to activities aimed at enabling access to space, and discuss synergies and common areas of work;

(d) Raise awareness of the efforts of the international space community with regard to international cooperation and partnerships involving space industries and emerging space nations.

6. In order to achieve the aforementioned objectives, and given the time available, the Workshop included a panel session, presentation sessions, virtual poster sessions and an online platform to facilitate exchanges among the attendees and encourage questions.

III. Attendance

7. A total of 753 individuals from 139 countries registered for the event; of that total, 202 (111 women and 91 men) were selected by the programme committee and invited to participate. The final number of participants was 180, the participation of 29 of whom was funded by the Office for Outer Space Affairs (16 women and 13 men), including with contributions from the European Space Agency (ESA) and IAF. A follow-up questionnaire indicated an overall satisfaction rating of 4.8 out of a maximum score of 5.

8. Funding support was provided to participants from the following countries: Argentina, Brazil, Cameroon, Colombia, Gabon, Guatemala, Egypt, Ethiopia, India, Kenya, Mexico, Nepal, Nigeria, Pakistan, Philippines, South Africa, Tunisia, Uzbekistan and Venezuela (Bolivarian Republic of).

9. Applicants from the following countries were invited to participate: Angola, Argentina, Australia, Azerbaijan, Bahrain, Bhutan, Brazil, Cameroon, Canada, Colombia, Costa Rica, Egypt, Ethiopia, France, Gabon, Germany, Greece, Guatemala, Hungary, India, Indonesia, Ireland, Italy, Japan, Kenya, Latvia, Malaysia, Mexico, Morocco, Nepal, Netherlands, Nigeria, Pakistan, Paraguay, Philippines, Poland, Portugal, Republic of Korea, Romania, Russia Federation, Saudi Arabia, South Africa, Spain, Sweden, Switzerland, Tunisia, Türkiye, Ukraine, United Kingdom of Great Britain and Northern Ireland, United States of America, Uzbekistan, Venezuela (Bolivarian Republic of) and Zimbabwe.

10. Sixty speakers presented their entities' activities, including representatives of 20 national space agencies: Bolivian Space Agency, Bolivarian Agency for Space Activities, Brazilian Space Agency, Egyptian Space Agency, Ethiopian Space Science and Technology Institute, Gabonese Agency for Space Studies and Observation, German Aerospace Center, Italian Space Agency, Japan Aerospace Exploration Agency, Kenya Space Agency, Korea Aerospace Research Institute, Mexican Space Agency, National Aeronautics and Space Administration (NASA) of the United States of America, National Centre for Space Studies of France (CNES), National Commission on Space Activities of Argentina, National Space Research and Development Agency of Nigeria, National Space Science Agency of Bahrain, Paraguay Space Agency, Philippine Space Agency and Space Research and

Technology Agency of Uzbekistan. The following regional and international organizations were also represented: Agency for Air Navigation Safety in Africa and Madagascar, ESA, European Union Agency for the Space Programme, International Telecommunication Union (ITU), Latin American and Caribbean Space Agency (ALCE), Organisation for Economic Co-operation and Development (OECD) and World Intellectual Property Organization (WIPO). Lastly, representatives of Governments, academia and non-profit and non-governmental organizations also attended. Ten space agencies were represented at head of agency or director level. The International Space Exploration Coordination Group (ISECG) was also represented at the space exploration session.

IV. Programme of activities

11. The programme consisted of three main sessions, the first one a panel discussion with the participation of heads of governmental space actors on innovation, international cooperation and socioeconomic benefits of space. Session 2 focused on Access to Space for All enablers from three different perspectives and session 3 focused on how the areas covered by the three Access to Space for All tracks could be used as a basis for science, technology and innovation policies. In addition, each session included a virtual poster session for which posters prepared by participants that had not been allocated a speaking slot were published online.

A. Opening ceremony

12. The opening keynote speech by the Acting Director of the Office for Outer Space Affairs centred on the topic of bridging the space divide and stressed the importance of fostering international cooperation, inclusiveness and diversity through such initiatives as the Access to Space for All initiative and the Space Law for New Space Actors project, which had provided support to emerging space nations. The Acting Director expressed the hope that such efforts would continue to limit or reduce the space divide. He highlighted that space-based solutions were key to ensuring sustainable development on Earth and the peaceful use and exploration of outer space, and that space applications such as Earth observation, telecommunications and global navigation strengthened economic growth and promoted technological advancements. He concluded by thanking IAF for its long-standing cooperation in respect of and contribution to the workshop series.

13. The President of IAF highlighted the importance of the series, which had been made possible by the ongoing cooperation between the Office for Outer Space Affairs and IAF. The Workshop had gained recognition in recent years and was now high on the agendas of heads of space agencies, giving both emerging and established space nations the opportunity to share their perspectives on the relevance of space technology for socioeconomic benefits. The workshops were organized back-to-back with the International Astronautical Congress, which brought together several thousands of attendees every year to discuss a range of topics, from technical to policy-related issues. The Office for Outer Space Affairs and IAF worked together closely each year to establish a nexus between the theme of the Workshop and that of the Congress.

14. The Strategy Director of CNES, stressing the importance of the space sector for the French economy, provided an overview of some of the activities carried out by CNES. CNES was supporting the development of the space economy in different sectors, such as the launch sector – including the Guiana Space Centre, Europe's spaceport – and the Earth observation sector, the latter playing a vital role in supporting data-driven policymaking and decision-making. CNES was also the Chair of the Committee on Earth Observation Satellites and was leading the international Space Climate Observatory initiative in cooperation with the Office for Outer Space Affairs.

B. Setting the scene

15. The “setting the scene” segment provided an overview of the structure and objectives of the Workshop. It included presentations by the programme committee, which comprised representatives of the Office for Outer Space Affairs, IAF, the IAF Committee for Liaison with International Organizations and Developing Nations and the IAF Committee on Developing Countries and Emerging Communities.

16. A representative of the Office for Outer Space Affairs presented the Workshop agenda and objectives and explained the event’s connection with other activities carried out by the Office, in particular the Access to Space for All initiative.

17. A representative of IAF reinforced the importance of the workshop series for developing countries and its connection with the International Astronautical Congress, at which various aspects of space exploration were covered. The presentation also underlined the importance of face-to-face networking. The Workshop of 2022 would build on the outcomes of the Global Conference on Space for Emerging Countries held in Quito in May 2022, as part of which the Office for Outer Space Affairs and the IAF Committee for Liaison with International Organizations and Developing Nations had organized a panel on space technologies for emerging space nations at which the need of such countries for capacity-building had been highlighted. At the end of the presentation, the representative invited all participants to join the Global Space Conference on Climate Change, to be held in May 2023 in Oslo, and to take part in the International Astronautical Congress in Baku in 2023.

18. The representative of the IAF Committee for Liaison with International Organizations and Developing Nations explained the Committee’s work and its role in providing advice to the President of IAF, particularly with regard to relations with international organizations and opportunities to foster international cooperation in implementing space programmes. Every year, the Committee worked with the Office for Outer Space Affairs on the preparation of the Workshop programme.

19. The representative of the IAF Committee on Developing Countries and Emerging Communities explained the Committee’s close ties with the IAF Committee for Liaison with International Organizations and Developing Nations. The work of the Committee on Developing Countries and Emerging Communities was focused on supporting developing countries and emerging communities by providing knowledge and expertise to ensure that those countries and communities could use space to gain socioeconomic benefits. The Committee had participated in defining the programme of the Workshop.

20. The following summary does not follow the chronological order of the programme but, rather, reflects the themes covered at the Workshop, focusing on key aspects and on the observations and recommendations made by participants. The final programme and Workshop presentations are available on the website of the Office for Outer Space Affairs.

C. Session 1. Panel of heads of governmental space actors on innovation, international cooperation and socioeconomic benefits of space

21. Nine space agencies were represented at head of agency or director level on the panel: Aboubakar Mambimba Ndjoungui, Gabonese Agency for Space Studies and Observation; Yeshurun Alemayehu, Ethiopian Space Science and Technology Institute; Jean-Marc Astorg, CNES; Marglad Bencomo Noguera, Bolivarian Agency for Space Activities; Rodrigo da Costa, European Union Agency for the Space Programme; Christyl Johnson, NASA; Charles Mwangi, Kenya Space Agency; Giorgio Saccoccia, Italian Space Agency; and Sherif Mohamed Sedky, Egyptian Space Agency.

22. It is important to note that the panel discussion was also attended by the following high-level participants: the General Director of the Angolan National Space Programme Management Office, the Strategy Director of the South African National Space Agency and the Principal Deputy Assistant Secretary of State in the Bureau of Oceans and International Environmental and Scientific Affairs of the United States Department of State.
23. The panel discussion was divided into two parts, the first dedicated to exploring the role of space in supporting decision-making and the second devoted to exploring space agencies' relationships with industry and academia.
24. During the first part, the discussion focused on the concept of the space divide and on international cooperation. Cooperation between developed and emerging space nations was highlighted as playing a key role in bridging the divide, and access to services, data and infrastructure was said to offer possible solutions. It was noted that since one of the challenges was to justify investment in space activities, it would be helpful if high-level decision-makers supported and took part in events designed specifically for them. Examples of socioeconomic benefits were given, and panellists referred to the work that would be presented during the other sessions as clear and concrete examples of such benefits. Space was also recognized as a tool for scientific diplomacy and international cooperation, as an example of which the International Space Station was cited.
25. Some panellists highlighted the importance of establishing a space agency, a step that, while challenging, was key to demonstrating the benefits of space activities and creating a stable point of contact. The need to establish a value proposition for such an agency and link its activities to national priorities was highlighted. It was also said that financial limitations were a barrier that was difficult for some countries to overcome. One of the panellists suggested that a global civilian space agency could help to demonstrate those benefits, while other panellists argued that existing mechanisms, such as the Committee on the Peaceful Uses of Outer Space, should be leveraged.
26. Brain drain was cited as a factor increasing the space divide. Some speakers mentioned that in some countries the budget for fellowships had been drastically cut because recipients might not return to their home countries.
27. All panellists agreed that work remained to be done to raise awareness of the benefits of space activities, in particular, socioeconomic returns.
28. The second part of the discussion was devoted to space agencies' relationships with industry and academia. One of the panellists gave the example of agencies that had set up dedicated teams to support start-ups. Other panellists expressed the view that governmental actors should create an enabling environment to support the development of the private sector while avoiding competition with it.
29. Panellists mentioned the role of Governments in providing access to adequate infrastructure that fostered the development of the private sector and academia. In that respect, the Access to Space for All initiative was mentioned as a model that integrated various opportunities to access infrastructure, space facilities and information with the end goal of creating specific capabilities.
30. All panellists agreed that the success of the industry essentially depended on the availability of well-trained individuals. Capacity-building was therefore extremely important and efforts in that area at the regional, national and local levels were needed.

D. Session 2. Access to Space for All enablers

31. This session was divided into three parts. The first part focused on tools made available by international organizations to foster access to space. The second part highlighted regional and national uses of space and international cooperation among

space agencies, while the third part showcased other activities carried out in support of space science, technology and innovation policy and access to space.

Session 2a. Access to Space for All enablers – tools provided by international organizations

32. This part of the session focused on tools provided by international organizations to promote the development of space activities. Presentations were given by speakers from the Office for Outer Space Affairs, ITU, WIPO and OECD.

33. The speaker from the Office for Outer Space Affairs stressed the need for national space law and policy as an enabler of access to space. She gave examples of regulatory frameworks and of tools that aided in their development, such as the Office's schematic overview of national regulatory frameworks for space activities, and presented the Office's Space Law for New Space Actors project, which provided advisory services to countries requesting support and helped them to develop national space policies and laws in conjunction with government focal points over a 12-month period.

34. The presentation by the representative of ITU provided an overview of the Union's history and mandate and described the principles and processes which drive its work, such as equitable access to frequency resources and the avoidance of harmful interference. The speaker described the way in which ITU processes had evolved to become more cooperative and inclusive as a means of achieving space for all, taking into account the increasing volume of satellite network filings.

35. The speaker from WIPO gave a presentation on intellectual property as an enabler of access to space, starting with a brief introduction to the mandate of WIPO as an international forum for intellectual property discussions, the provision of global intellectual property services and capacity-building. She described the WIPO patent system, the purposes of which were to stimulate investment in knowledge creation and to encourage the broad dissemination of knowledge. WIPO was encouraging access to space through technology-sharing, capacity-building efforts in the area of intellectual property and the protection of inventions by means of limited exclusive patent rights.

36. The speaker from OECD described some of the socioeconomic foundations for space programmes, presenting some of the indicators from the OECD Handbook on Measuring the Space Economy. Emphasizing the need to invest in research and development activities in the context of space activities, she also drew attention to key trends in relation to space sector employment, such as slow generational change, underrepresentation of women and the advent of automation. Those factors were predicted to drive demand for evaluations and impact assessments aimed at establishing effective value propositions for the industry, in which respect the OECD Handbook could provide guidance.

Session 2b. Access to Space for All enablers – regional and national perspectives

37. The second part of the "Access to Space for All enablers" session was devoted to regional and national perspectives on and examples of the use of space as a basis for science, technology and innovation policies. Speakers from ALCE, the Mexican Space Agency, the Paraguay Space Agency, the Philippine Space Agency, the Egyptian Space Agency and the Space Research and Technology Agency of Uzbekistan presented their views at this session.

38. The speaker from ALCE introduced the Agency's activities and mandate and described the importance of the ALCE Accession Agreement, some of the challenges relating to the implementation of the Agreement and key activities to be undertaken. Those activities included steps to improve communication in the sector, enhance training, increase the integration of the younger generation into the space economy and improve the production of required materials. With respect to the latter point, a

proposal for free trade in raw materials for the space economy within ALCE countries was to be drawn up.

39. The speaker from the Mexican Space Agency presented the Agency's strategic programmes and projects, the national programme for space activities, space exploration activities and opportunities, challenges and international partnerships, noting that international partnerships helped to foster capacity-building. The Agency raised public awareness of the socioeconomic benefits of space activities.

40. The speaker from the Paraguay Space Agency underscored the benefits of space for humankind and their contribution to attainment of the Sustainable Development Goals. She described the first Paraguayan satellite, which had been created through a strategic alliance, and presented the country's space policy and the links between that policy and the Agency's objectives. She concluded by emphasizing that international cooperation was vital in promoting education as part of the space programme.

41. The speaker from the Philippine Space Agency described the Agency's establishment, its key development areas and its various activities, which included microsatellite projects, experimental satellites for capacity-building, flagship projects and other initiatives aimed at nurturing a culture of research and innovation. Capacity-building and international cooperation were key areas for the Agency.

42. The speaker from the Egyptian Space Agency provided an overview of the Agency's space objectives, capacity-building activities and infrastructure. Other activities, such as workshops for pre-university students and summer training, were also presented.

43. The speaker from the Space Research and Technology Agency of Uzbekistan provided an overview of the Agency's establishment (2017–2019) and goals. The Agency's work focused on Earth observation and satellite communication and navigation. In addition, the Agency had developed a State space monitoring programme and several international cooperation programmes. It was also working to build a strong space ecosystem through a combination of programmes on education and space, space sector regulations and business incubators. The speaker concluded by inviting participants to attend the space technology conference to be held in Uzbekistan from 25 to 27 April 2023.

Session 2c. Access to Space for All enablers – additional tools

44. The speaker from the Working Group on Disasters of the Committee on Earth Observation Satellites presented the Recovery Observatory as a tool for assessing post-disaster needs and providing evidence and support once disaster management efforts had concluded. Examples of the use of the Recovery Observatory were presented, including associated capacity-building efforts. The speaker invited decision-makers to contact the Recovery Observatory team for additional information.

45. The speaker from the United States Department of State focused on the importance of making space accessible to all and identifying areas of collaboration and possible partners for space projects, and the need for space activities to be conducted in a sustainable manner. She also highlighted the importance of inspiring and promoting scientific collaboration, citing as an example the Artemis programme, as part of which NASA planned to land the first woman and first person of colour on the Moon. The programme represented the future of space exploration, diversity, peaceful and transparent exploration and collaboration with other nations.

46. The speaker from ESA described the Agency's catalogue of solutions for the Sustainable Development Goals, a portfolio of ESA programme activities and services that was intended to facilitate understanding of new space technologies and their relationship with socioeconomic benefits. The catalogue included applications in fields such as telecommunications, human space flight, and positioning and navigation, linking those applications to the Sustainable Development Goals.

47. The speaker from the Agency for Air Navigation Safety in Africa and Madagascar described how the European Geostationary Navigation Overlay Service and space-based augmentation systems were used. In particular, he drew attention to the Augmented Navigation for Africa programme, which was aimed at establishing a continental augmentation system, in line with the African Space Policy. The services provided through the programme were being implemented in stages: a demonstration service had been launched in 2020, L1-band services were to be rolled out in 2025 and dual-frequency multi-constellation positioning services were to be provided by 2030. Those services would provide substantial socioeconomic benefits beyond aviation to the African economy and were a key enabler for the navigation and positioning component of the African Space Policy.

48. The speaker from the Massachusetts Institute of Technology presented the work carried out by the Institute's Space Enabled research group, in particular, the Environment-Vulnerability-Decision-Technology Framework developed by the group, giving several examples of the Framework's use.

49. The speaker from the University Space Engineering Consortium-Global introduced the Consortium's range of academic programmes relating to satellites and aerospace engineering, noting that only 20 years ago such activities and technologies had either not existed or had not been widely available. The Consortium's goal was to facilitate and promote hands-on space activities for university-level students. In Japan, more than 60 picosatellites, nanosatellites and microsatellites had been built by universities and 11 practical training sessions had been held for students as part of the CanSat Leader Training Programme, which is aimed at training teachers and trainers in order to increase knowledge and experience.

50. The speaker from the International Space University addressed the issue of space debris as a challenge to the sustainability of the space economy, not only as an immediate threat but also in terms of socioeconomic impacts in the long term. Technology and policy actions were cited as possible solutions.

51. The speaker from the Space Generation Advisory Council presented the Council's role as an enabler of access to space for all, providing an overview of the various activities carried out by the Council to ensure that the voices of the young generation were heard and taken into account in space-related decisions with implications for the future.

52. The speaker from SpaceBuzz presented the work of the foundation, whose objective was to enable children worldwide to experience the "overview effect" (the effect caused by seeing the Earth from space) as if they were astronauts and inspire them to become ambassadors of planet Earth. Participants were invited to experience the "overview effect" in the facility that SpaceBuzz would be exhibiting at the International Astronautical Congress.

53. The speaker from the Office for Outer Space Affairs introduced the Access to Space for All initiative, which was a joint initiative aimed at facilitating access to space research facilities, infrastructure and information in order to develop technical know-how, engineering processes and infrastructure in United Nations Member States. The initiative offered hands-on opportunities, tools and educational content in the areas of hypergravity and microgravity, satellite development and space exploration and was intended to serve as an information hub. The speaker also highlighted the impact of the initiative, including the fact that four countries had launched their first satellite into space. There were nine hands-on opportunities, for which 27 awardees had been selected to date, including individual institutions and consortiums from developed and emerging space nations.

54. The speaker from Antarikchya gave a presentation on building the space infrastructure and space community of Nepal from the ground up through a structured public-private partnership approach. He provided an overview of the organization's role and the challenges experienced in Nepal in terms of infrastructure, logistics, customs, basic manufacturing capabilities and governmental financing mechanisms

and payment systems. The speaker had benefited from the support of the Office for Outer Space Affairs through the Access to Space for All initiative and had received a fellowship to pursue postgraduate studies on nanosatellite technologies at the Kyushu Institute of Technology, Japan, while Antarikshya itself had been awarded the Payload Hosting Initiative opportunity, in partnership with the Mohammed Bin Rashid Space Centre.

55. The speaker from Spaceside stressed the importance of inclusive outreach, explaining that social media specialists were needed to promote the benefits of space. He also emphasized the need to promote diversity, highlighting the importance of each individual's role and of education in science, technology, engineering, arts and mathematics (STEAM). He concluded by drawing attention to the importance of designing outreach for specific audiences, reaching the unreached and conducting outreach both online and offline, and to the fact that greater impact could be achieved through localized approaches (involving local role models and local languages) and education and capacity-building activities that targeted not only children and students but also teachers, professors and parents.

Session 2 virtual poster session

56. Four posters were submitted for the “Access to Space for All enablers” session and are available on the Workshop website:

- (a) “Workshop: How to catalyse a space industry locally”, by SpaceBase Limited;
- (b) “Space outreach and human health”, by the Irish Defence Forces and Space Medicine Ireland;
- (c) “Launching Generation Next into space”, by SpaceBuzz;
- (d) “World Space Week”, by the World Space Week Association.

E. Session 3. Science, technology and innovation and Access to Space for All

57. Session 3 focused on how the areas covered by the three Access to Space for All tracks – hypergravity and microgravity, satellite development and space exploration – could be used as a basis for science, technology and innovation policies.

Session 3a. Science, technology and innovation relating to hypergravity and microgravity experimentation

58. The speaker from the German Aerospace Center gave a presentation on microgravity research relating to spaceflight-associated neuro-ocular syndrome, which was experienced by two-thirds of astronauts and had become a significant concern for long-term space missions. He described ways to monitor and mitigate the syndrome and presented the tools that had been developed for eye monitoring as part of related research, highlighting that the technology used for such monitoring in astronauts was inexpensive, durable and easy to transport and could be used to monitor various eye diseases in remote areas where there were few specialized physicians.

59. The speaker from the University of Agricultural Sciences, Dharwad, India, discussed the utility of hypergravity as a novel tool for improving crops of special relevance for agriculture. Research showed that hypergravity enhanced root growth and drought tolerance in seedlings and delayed leaf senescence under greenhouse conditions. Hypergravity also played a prominent role in increasing chlorophyll content, auxin biosynthesis, cell transport and cell-wall constituent synthesis. Those improved traits in plants exposed to hypergravity might be heritable and could be used to create more resistant yields.

60. The speaker from the National Space Research and Development Agency of Nigeria described the Agency's work on tomato and peanut crops, in particular on root development and biochemical characterization using clinostats. It had been found that microgravity enhanced root growth, nutritional values including protein content, mineral composition and antioxidants, and improved yield from peanut and tomato plants. The speaker concluded that microgravity could serve as an alternative tool for biofortification in harsh conditions, not only helping astronauts during long-term space missions but also offering solutions for future food security, environmental sustainability and the economy.

61. The speaker from Politecnico di Torino presented a project entitled "Protein crystallization for the benefit of people" (ProKryos), which had been carried out as part of the Space Studies Programme of the International Space University on the role of microgravity in supporting the advancement of technology in the fields of space pharma and space medicine. The project team had identified and developed applications of microgravity research, including the so-called ProKryos device, which related to unique protein crystal behaviours under microgravity conditions. The device was undergoing a series of steps for market distribution, namely the determination of its commercial viability, assessment of its utility in medical applications of proteins and the mass production of pharmaceuticals. The speaker concluded by drawing attention to various start-up funding opportunities.

62. The presentation by the speaker from the Translational Research Institute for Space Health at Baylor College of Medicine focused on commercial space activities as a platform offering opportunities for human health discoveries. The speaker explained the impact of spaceflight on human physiology and highlighted the in-depth investigations that were leading to new insights and discoveries in human health. She also presented the NASA-funded Enhancing Exploration Platforms and Analogue Definition (EXPAND) programme database, which contained the data of nine space flight participants and was publicly available. She concluded that biomedical research in collaboration with astronauts would create opportunities for novel human health discoveries, and stressed the importance of open science research in making such discoveries possible.

Session 3b. Science, technology and innovation relating to satellite development

63. The speaker from the University of Nottingham provided an overview of the evolution of the small satellite market and related applications, focusing on the advantages of small satellites and how they could be utilized to innovate at reduced cost and within shorter development times. Examples of small satellite applications included biomedical research aimed at developing new drugs and increasing knowledge in order to prevent diseases; data collection for disaster monitoring; livestock monitoring; and the provision of communication services to remote regions. Small satellites could be used as inexpensive test beds for technologies such as artificial intelligence for autonomous operations or failure detection. They were also beginning to be used in Moon and Mars exploration missions, an area of application that was becoming a point of entry into the space sector for emerging space nations and academia.

64. The speaker from the Higher School of Engineering and Applied Technology presented the activities carried out by the School following its selection in 2022 to participate in the Access to Space for All KiboCUBE programme, an achievement that had led to the creation of the School's Aerospace, Artificial Intelligence and Digital Centre. The selection had attracted considerable media attention as the cube satellite being developed would be the first university-built satellite in Tunisia. Thirty per cent of the satellite's components would be manufactured in Tunisia. Expected to be launched in 2023, the satellite would be used, inter alia, to capture images of Tunisia and to teach students about the management of space engineering projects. Through cooperation with the Office for Outer Space Affairs and the Japan Aerospace Exploration Agency, the School aimed to create a space engineering ecosystem in African countries.

65. The speaker from the Kyushu Institute of Technology presented the Institute's work and its various small satellite programmes, such as the Joint Global Multi-Nation Birds Satellite project, which by 2021 had deployed 19 small satellites. The speaker highlighted the importance of open-source solutions in promoting collaboration and benefiting from heritage and experience. In that spirit, the Institute had released the specifications of a satellite bus incorporating Birds satellite heritage.

66. The speaker from the National Space Science Agency of Bahrain presented the Agency's work and goals, which included building national capabilities, encouraging Bahrain to become a party to relevant international conventions, establishing cooperation and promoting space science. The Agency had been awarded the Payload Hosting Initiative (PHI) opportunity through the Access to Space for All initiative and was developing the first Bahraini payload in space with the objective of gaining experience and technical know-how while supporting six Sustainable Development Goals.

67. The speaker from Universidad del Valle de Guatemala described how working on a satellite project had helped her to develop passion for space science and enabled her to help others to pursue similar activities. The University had developed the Quetzal-1 satellite after being awarded a deployment opportunity as part of the Access to Space for All KiboCUBE programme. The speaker explained that the biggest impact of Quetzal-1 was the fact that it had changed the mindset of the country. The University had published related books and articles, which were featured in various media, and had received international awards following the deployment of the satellite. The project had also created opportunities for other international cooperation activities in the field of space technology.

68. The speaker from the Philippine Space Agency introduced the Philippine Space Act (Act No. 11363), through which both the Agency and the Philippine space development and utilization policy had been established. The Agency was working in six development areas: national security and development, space research and development, space awareness, space industry capacity-building, hazard management and climate studies, and international cooperation. The speaker presented the activities carried out to date, including a small satellite technology road map that built on past and ongoing projects.

69. The speaker from the National Commission on Space Activities of Argentina presented two capacity-building programmes: the 2Mp programme, which was aimed at transferring knowledge relating to the use of geospatial information, and CanSat Argentina, which challenged students to design CanSats and promoted a scientific and innovative culture among young people, inspiring them to pursue scientific and technology-related vocations. More than 45,000 students had registered for and participated in mandatory training on space engineering.

Session 3c. Science, technology and innovation relating to space exploration

70. This session built upon the following recommendations of the United Nations/United Arab Emirates/IAF Workshop on Space Technology for Socioeconomic Benefits, on the theme "Space exploration: a source of inspiration, innovation and discovery", held in Dubai, United Arab Emirates, from 22 to 24 October 2021 ([A/AC.105/1256](#)):

(a) International mechanisms related to space exploration should be utilized as widely as possible, namely, the agenda item of the Committee on the Peaceful Uses of Outer Space entitled "Space exploration and innovation", ISECG for discussions among space agencies on the coordination of space exploration missions, and the space exploration track of the Access to Space for All initiative to support triangular cooperation on this matter. Raising awareness among policymakers and decision makers of how space can support national priorities is also regarded as very important;

(b) Space exploration data and associated training materials should be disseminated as widely as possible to encourage the participation of a larger segment of the population, in particular in developing countries;

(c) Funding and international support should be given to capacity-building efforts relating to space exploration and space-related skills in general in order to ensure the availability of professionals in the near future;

(d) Awareness-raising efforts concerning inclusiveness and diversity should be increased (as only a few participants considered the matter of importance);

(e) Awareness-raising efforts concerning planetary protection should be increased (as participants in the breakout groups confused the term with planetary defence);

(f) The process of registration in the Register of Objects Launched into Outer Space should be automated so that the Register can be used as a real-time source of information to raise awareness of the number of objects and as a transparency and confidence-building measure.

71. At this session, in line with recommendations (a) and (e), speakers from ISECG, the Committee on Space Research Panel on Planetary Protection and the NASA Office of Planetary Protection made presentations. With respect to recommendation (d), representatives of space agencies, non-governmental organizations and civil society were invited to speak.

72. The Chair of ISECG provided an overview of the Group, whose membership comprised 27 space agencies, of which 13 had joined in the past three years, which reflected a growing interest in space exploration. The Group had established seven working groups covering the areas of communication, science, architecture, emerging space agencies, technology and commercialization. ISECG published the Global Exploration Roadmap, which reflected a coordinated international effort to prepare for space exploration at the global level. In order to engage emerging space agencies in space exploration and contribute to the formulation of the Roadmap, the Emerging Space Agencies Working Group had been established as a permanent working group within ISECG.

73. The second speaker from ISECG presented the vision and activities of the Emerging Space Agencies Working Group, describing new opportunities for emerging space agencies and inviting other emerging nations to join ISECG.

74. The speaker from the Mexican Space Agency spoke about the sustainable benefits of exploring the Moon, highlighting the economic and geopolitical advantages of such exploration while underscoring the need to promote regulatory frameworks in order to promote coordination and cooperation in a sustainable manner. The presentation concluded with a call to emerging space nations and non-spacefaring nations to play an active role in consensus-building for lunar coordination.

75. The speaker from the Brazilian Space Agency gave a presentation on the feasibility of making the benefits of space exploration widely accessible. She highlighted the importance of international cooperation in achieving that goal and providing opportunities to non-spacefaring nations, but noted that political, financial and other barriers remained, such as limited human resources and lack of infrastructure. She therefore proposed the creation of international funds for space exploration with the aim of supporting projects and opportunities for emerging space nations.

76. The speaker from ESA described Terrae Novae, which encompassed all ESA space exploration activities, and the Terrae Novae 2030+ Strategy Roadmap, one of the objectives of which was to create new opportunities in low Earth orbit for a sustained European presence in space following the decommissioning of the International Space Station. The Roadmap was also aimed at enabling the first European to explore the Moon's surface by 2030 as a step towards sustainable lunar

exploration in the 2030s, and at preparing to make Europe part of the first human mission to Mars.

77. The speaker from NASA presented the Transform to Open Science initiative and the designation by NASA of 2023 as the Year of Open Science. Open science was defined as science that was accessible, inclusive and reproducible and that brought publications, papers and platforms to the public.

78. The speaker from the Planetary Protection Panel of the Committee on Space Research explained that the Panel's primary objective was to develop, maintain and promote the Committee's Policy on Planetary Protection and associated requirements to prevent the harmful effects of forward and backward contamination. She explained the framework for planetary protection and shared the Committee's updated planetary protection policy requirements for the Moon.

79. The speaker from the NASA Office of Planetary Protection gave a presentation on the development of planetary protection requirements for space missions. NASA was working continuously to update its planetary protection policy and implementation approach in response to advances in scientific understanding of solar system targets and in the light of upcoming mission opportunities for exploration and sample return, and the private sector's emerging capability to plan missions to the Moon and Mars.

80. The speaker from the International Lunar Exploration Working Group described the work of the Group, which was a public forum sponsored by the world's space agencies to support international cooperation in developing a world strategy for the exploration and utilization of the Moon, and shared the Group's global exploration road map and analogue research activities.

81. The speaker from 100 Year Starship presented her organization's mission, which was to make the capability of human travel beyond the solar system a reality within the next 100 years. Interstellar flight called for radical leaps in knowledge and technology, and those same breakthrough applications could transform the quality of life for all on Earth. The speaker also presented the concept of "skyfie" (sky selfie), a picture of oneself with the sky, uploaded to a mobile phone application, to show that the sky was an element connecting all people.

Session 3 virtual poster session

82. Seven posters were submitted for the "Science, technology and innovation and Access to Space for All" session. The posters are available on the Workshop website:

(a) "Impact of MicroRNA-based biomarkers on the psychopathologies of depression under simulated space complex environmental model", by the Beijing Institute of Technology;

(b) "Low-cost experiment for microgravity research", by the Space Generation Advisory Council;

(c) "Project MUSA – Costa Rica second space mission", by Orbital Space Technologies;

(d) "Optical payloads and an innovative deployable hexagonal shape solar panel system for 1U CubeSat", by the Higher School of Engineering and Applied Technology;

(e) "Space is the future for communications on Earth", by OneWeb;

(f) "NSSA Aman payload", by the National Space Science Agency of Bahrain;

(g) "Analog astronauts in the COVID-19 pandemic", by the University of the Philippines and the Italian Space Agency.

F. Closing ceremony

83. At the closing ceremony, keynote speeches were made by the President of IAF, the Strategy Director of CNES and the Acting Director of the Office for Outer Space Affairs.

84. The President of IAF expressed appreciation for participants' engagement and emphasized the importance of the ongoing cooperation between his organization and the Office for Outer Space Affairs. She invited participants to take an active role in and take advantage of the opportunities offered by the International Astronautical Congress, and to participate in the Global Space Conference on Climate Change, on the theme of "Fire and ice – planetary extremes in a changing climate", in Oslo in 2023.

85. The Strategy Director of CNES welcomed the participants' active engagement during the Workshop, and the fact that their discussions had covered a wide range of topics related to science, technology and innovation policy and its importance in bridging the space divide. He expressed the hope that the discussions would be the starting point for collaboration and partnerships, and encouraged the attendees to actively continue the discussions after the Workshop.

86. The Acting Director of the Office for Outer Space Affairs noted with satisfaction that the Workshop had enabled interaction among emerging and developed space nations and among academia, civil society, international organizations, and space agencies. Stressing the importance of international cooperation, inclusivity and diversity in bridging the space divide, he thanked CNES and IAF for their efforts towards and commitment to achieving that goal.

V. Observations and recommendations

87. The following observations, conclusions and recommendations emerged from the discussions held during the sessions:

(a) It was noted that international cooperation played a key role in bridging the space divide and that the strengthening of efforts in that regard were appreciated by emerging and developed spacefaring nations alike. It was recommended that, following the Workshop, participants' feedback be sought as to whether the workshop had stimulated the creation of partnerships and other activities;

(b) Efforts to raise awareness of the socioeconomic benefits of space-related activities were welcomed and the examples showcased during the Workshop provided a broad perspective on the impact of hypergravity and microgravity experimentation, satellite development and space exploration. Participants recommended the further strengthening of awareness-raising and capacity-building efforts focused on how space could contribute to the achievement of national priorities. During the Workshop, examples were given of how microgravity and hypergravity experimentation could contribute to food security, good health and well-being;

(c) There was support for the view that the development of a space economy depended on an enabling environment and governmental support;

(d) Access for emerging space nations to research infrastructure and facilities was deemed very important in bridging the space divide. In that regard, participants welcomed the Access to Space for All initiative as a model that integrated a range of contributions so as to offer opportunities – with clear objectives – for accessing infrastructure, space facilities and information, and as a tool for the implementation of the "Space2030" Agenda;

(e) Participants expressed interest in continuing discussions on space debris and space sustainability, highlighting the need for further awareness-raising. It was noted with appreciation that the Access to Space for All initiative already incorporated those elements from both a technical and a practical point of view, and it was

recommended that efforts continue to be made to improve the practical implementation of the Space Debris Mitigation Guidelines and the Guidelines for the Long-term Sustainability of Outer Space Activities of the Committee on the Peaceful Uses of Outer Space;

(f) Participants reiterated that international mechanisms such as those relating to space exploration should be utilized as widely as possible, namely, the agenda item of the Committee on the Peaceful Uses of Outer Space entitled “Space exploration and innovation”; ISECG for discussions among space agencies on the coordination of exploration missions; and the space exploration track of the Access to Space for All initiative to support broader engagement and international cooperation on this matter. It was recommended that efforts to make space exploration more inclusive be strengthened. Participants also expressed interest in other existing cooperation mechanisms, such as the Recovery Observatory of the Committee on Earth Observation Satellites, which was also regarded as a tool for the implementation of the “Space2030” Agenda.
