Space Science and Academy for Global Challenges": Contributions by The Netherlands

On behalf of the Minister of Economic Affairs of The Netherlands, Mr. Henk Kamp, I express our sincere gratitude to ASI, the IAA and IAF for organizing this first International Space Forum at the beautiful, historic city of Trento.

As to today's agenda, my country, the Netherlands has a worldwide leading position in satellite measurement of the chemical composition of the atmosphere, of paramount importance for the ozone layer, air quality and climate change. With our optical spectrometers SCIAMACHY, OMI and TROPOMI the Dutch designed and built excellent satellite instruments. On top of that, our Dutch scientific community has leading scientific positions for developing these these instruments (SCIAMACHY co-PI, OMI PI and TROPOMI PI ship, PI = Principal Investigator). So the Netherlands disposes of all knowledge from the design of the instrument to the scientific exploitation and operational use of the satellite data, which is rather unique to have in one (relatively small) country.

SCIAMACHY (2002-2012) measured a broad range of trace gases important for the ozone layer, air quality and climate change. It gave us a first unique look at the chemical composition of the Earth-atmosphere. SCIAMACHY enabled numerous contributions to our understanding of the atmosphere. Most notably are measurements of methane (CH_4) . The 10 year data set of methane is unique, and not available anymore since the ESA ENVISAT satellite carrying SCIAMACHY finished its operations.

OMI, launched in 2004 at the NASA satellite EOS-Aura, made unique contributions to the continuation of the ozone measurements of NASA by continuing the famous Ozone Hole series from the NASA/TOMS instrument. OMI is now one of the leading instruments that are used to determine the recovery of the ozone hole. The OMI total ozone measurements are used to control the effectiveness of the Montreal Protocol.
Further this instrument has the best world-wide ground pixel resolution. It is more sensitive to the lowest kilometres of the atmosphere than previous instrumentation, and provides unprecedented contributions to the measurements of air pollution and emissions. Due to the high resolution, emission sources can be better pinpointed by OMI than by any other satellite. OMI is used worldwide for monitoring the air pollution, for performing trend analyses that is used to check if our air pollution measures and environmental policies are successful and provides important information for countries that do not have a broad ground based network. For example in China the OMI measurements played a crucial role in identifying, understanding and monitoring the air pollution. The USA's Environmental Protecting Agency, traditionally only using ground based measurements, recently used OMI's NO_2 (an air pollutant) satellite measurements for the first time in their yearly reporting. OMI is still working very well after 12 years of operations.

As to the future: in spring of next year ESA will launch a new Dutch satellite instrument, TROPOMI on ESA's sentinel 5 precursor, that will have unprecedented spatial resolution of 7 x 7 km^2. This instrument will be even more capable of measuring separate emission sources. We expect to be able to distinguish the harbour of Rotterdam from the centre of Rotterdam. TROPOMI will be the only instrument worldwide which will have this high spatial resolution capability. Also TROPOMI will resume the unique methane measurements, the second most important greenhouse gas, from SCIAMACHY and by that continue the methane dataset. This is very important, since methane has a shorter lifetime than CO_2, and potentially plays a key role in reducing the greenhouse gas impact on the short term.

And the Netherlands is now already working on new satellite instrumentation, suitable for small and nano satelites, going towards 1 x 1 km^2 resolution for air pollution and emission measurements (TROPOLITE). At the same time, we elaborate a new type of aerosol measurements (SPEX). It's well known that aerosols are just another very important contributor to air pollution and climate change.

Also, the Netherlands has a strong international track record in the area of space research, with a focus on astrophysics and earth oriented science. Several university research groups working on space research were started in the early sixties of the last century, eventually leading to a national space research expertise institute, called SRON.

Moreover, the Netherlands is one of the founding members of the European Space Agency ESA and is very proud to host its largest research centre ESTEC at Noordwijk.

Focusing on astrophysics, the study of the Sun was a strong science driver in the Netherlands to become involved in space research. This culminated in 1980 with the contribution of an X-ray camera to the NASA-led Solar Maximum Mission. This mission produced images of solar flares at high energies with unprecedented detail. While solar physics is no longer a focal point in Dutch astrophysics, internationally this topic is still in the focus of the current ESA science programme, with the Solar Orbiter mission planned for launch in 2018.

The atmosphere of the Earth blocks significant parts of the infrared light that is emitted by objects in the universe and is completely opaque to the high energy X-ray and gamma-ray radiation. Space telescopes are essential in order to study the universe at these wavelengths. Over the past decades Dutch space researchers have established an internationally leading track record in both X-ray and infrared/sub-millimeter astronomy. This was possible due to the combination of very strong research groups at the universities, and a long term technology development programme allowing key contributions to large missions of NASA, ESA and JAXA.

At high energies, SRON Netherlands Institute for Space Research has led the development of X-ray spectrographs for both the NASA *Chandra* Great Observatory, and the ESA *XMM-Newton* telescope. Both missions have been in orbit since 1999 and are still producing ground breaking science today, for instance on the presence of hot gas in the universe and on the supermassive black holes in the centres of galaxies.

Similarly, at infrared wavelengths SRON has led the development of an infrared spectrograph for ESA's Infrared Space Observatory, and was principal investigator institute for the HIFI instrument on board of the Herschel Space Observatory, launched in 2009. HIFI has been designed to discover molecules in the universe. It has mapped water in the cradles of newly born stars and has shed light on the origin of water on Earth.

The Netherlands intends to continue its leading role in astrophysics by contributing to the next generation of space telescopes for IR and X-ray astronomy. NOVA, a collaboration of Dutch university astronomy institutes, has provided a contribution to MIRI, the mid-infrared imaging spectrograph on board of the James Webb Space Telescope, to be launched in 2018. SRON is leading a proposal for SPICA, a candidate for the M5 slot in the ESA Cosmic Vision programme. SPICA is a cooled large infrared telescope planned for launch at the end of the next decade.
SRON is also co-leading the development of the X-ray imaging spectrograph for Athena, which is the 2nd *flagship* mission of ESA's science programme. Athena, which was selected in 2014 and is planned for launch in 2028, will uncover the formation of the first black holes in the universe, and will map hot gas in clusters of galaxies.

So exciting scientific developments and contributions. The Netherlands looks forward to continue its close cooperation within the Science programme of ESA, as well as with other national space agencies and knowledge institutes. We intend to proceed the fruitful cooperation with the great range of inspiring scientists from many space countries!

Once again, many thanks for organizing this Space Forum and for your patience.

The Netherland, The Hague, 18 October 2016