CSQ-16 Summary

Question	Knowledge Advancement Objectives	Geophysical Observables	Measurement Requirements	Tools & Models	Policies / Benefits
How to develop the link with other communities	A) How EO observations can help to improve the models?	• Observations directly comparable with model variables • Observations characterizing sub-grid phenomena	Observables not resolved by the global models	• Specific high-resolution models resolving the sub-grid processes • Parameterization of sub-grid processes in global models	• To improve the link between satellite and model communities • To optimize the use of the huge quantity of space data • To benefit from the development of commercial space observations for scientific studies. • To promote the development of space observation-based services
	B) What Artificial intelligence can bring to EO science?	• Development of algorithms to fully exploit the huge quantity of space data • Combination of space and ground-based observations	Building data bases to train artificial intelligence	Artificial intelligence algorithms	
	C) How socio-economic aspects are considered taken in the EO strategy?	• How commercial satellites can provide data that complement the data from space agencies satellites • EO observations for climate risk assessments • Space observation-based services for transport logistics optimisation	To promote the use of public and private EO data	• Cooperation with private companies to exploit their data for science objectives • Development of tools to support the use of spatial data by private companies and public institutions	

CSQ-16 Narrative

1. **How EO observations can help to improve the models?**

Space observations and models are two essential components of the Earth climate system monitoring. Space observations provide the global view of geophysical variables but it is not possible to measure everywhere at any time. Models provide an estimate of these variables at any grid point and any time but they may be affected by biases due to an imperfect representation of physical processes taking place. The quality of space data assimilated in the models is also critical for the accuracy of model outputs. Space observations are highly needed to:

- Constrain and validate the models
- Improve the parametrization of sub-grid phenomena.

A reinforcement of the link between the satellite and the model communities is highly desirable at any stage of a space mission. During the definition of the mission the needs of the model community should be considered. During the phase of exploitation of the mission, regular exchanges between the two communities should be ensured to guarantee an optimised use of the space data to constrain and validate the models.

2. **What Artificial intelligence can bring to EO science?**

Earth observations provide a huge amount of data, increasing with time due to the progress in the resolution of the instruments and in the rate of data transmission. These data are very often not properly used due to a lack of knowledge of the users on the performances and limitations of the instruments. It is very important to guide users in order to correctly interpret the data.

The retrieval of geophysical variables from raw satellite data, for instance radiances at some spectral and spatial resolution, may be very difficult using classical methods if the physical forward model is too complex to be explicated. Artificial intelligence (AI) methods may be used to bypass the difficulty. Neural networks are often used to do that. A base of training is given to the neural network. These methods work well as long as observations stay within the limits of the training base but may fail when they are outside the limits. Furthermore, one has to be conscient that the neural network is used as a black box and does not help to provide physical information for the observed phenomena.

AI methods are widely used in satellite imagery. They combine space and ground data[6]. Machine learning-based detection and mapping systems are developed to extract the useful information from multi-spectral imagery with the help of ground-truth data.

Space-based EO makes an essential contribution to supporting the achievement of the Sustainable Development Goals (Anderson et al., 2017). They provide geospatial information needed for early warning, disaster risk management, loss and damage, climate risk assessment, ... AI will optimise the use of space-based EO in conjunction with other information sources such as ground-based EO and socio-economic data to construct disaster risk reduction indicators to inform decision makers.

3. **How socio-economic aspects are considered taken in the EO strategy?**

Several private companies are building EO satellites. These satellites are not driven by the science but by commercial interests and it does not exempt the space agencies from continuing to program scientifically driven EO satellites. However, these commercial satellites can provide data that complement the data from space agencies satellites and a good link with them then should be maintained. For instance, the commercial company Spire provides GNSS Radio occultation data useful for the meteorology and the space weather that complement the data from classical satellites (Bowler, 2020). Spire is now considered as an ESA's third-party mission.

With the cost increase of environmental disasters, the climate risk assessment becomes a high priority in the finance community. Satellite observations are essential to anticipate the risks, model the exposure to climate risks and find solutions to mitigate these risks.

Satellite observations can help to develop services to optimise transport and logistics processing, for instance to optimise the marine and aviation transport routes to reduce the CO_2 emissions.

References

Katherine Anderson, Barbara Ryan, William Sonntag, Argyro Kavvada & Lawrence Friedl (2017) Earth observation in service of the 2030 Agenda for Sustainable Development, Geo-spatial Information Science, 20:2, 77-96, DOI: 10.1080/10095020.2017.1333230

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