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10th June 2021

Dr Valdimir RYABININ
Executive Secretary
Intergovernmental Oceanographic Commission – UNESCO
7 Place de Fontenoy
75352 Paris Cedex 07 SP
FRANCE

Dear Dr Ryabinin,

In June 2020 we wrote to you to outline the intent of the Committee on Earth Observation Satellites (CEOS) to fully support the important and ambitious UN Decade of Ocean Science for Sustainable Development (hereafter referred as the UN Decade). In that letter we agreed to provide further detailed information on how our CEOS Working Groups, Teams and Virtual Constellations could support the Decade and the work of the IOC. It is thus with pleasure that we write to you now to provide more detail.

Within its working structure, CEOS has two main initiatives that have a direct focus on the marine environment:

- COVERAGE (CEOS Ocean Variables Enabling Research and Applications for GEO), *and*
- CEOS-COAST (Coastal Observations, Applications, Services, and Tools).

In addition, CEOS supports other relevant activities within its Working Groups and Virtual Constellations, most notably within the:

- Joint CEOS-CGMS Working Group on Climate (WGClimate),
- Ocean Colour Radiometry Virtual Constellation (OCR-VC),
- Ocean Surface Topography Virtual Constellation (OST-VC),
- Ocean Surface Vector Winds Virtual Constellation (OSVW-VC), *and*
- Sea Surface Temperature Virtual Constellation (SST-VC).

COVERAGE

The CEOS Ocean Variables Enabling Research and Applications for GEO (COVERAGE) is a collaborative initiative within CEOS being advanced as a cumulative CEOS contribution to the UN Decade. COVERAGE seeks to provide improved access to select multi-agency, multiparameter remote sensing data from the four Ocean Virtual constellations listed above (OCR, OST, OSVW and SST) that are also better integrated with *in situ* observations in support of marine science and applications for societal

benefit. COVERAGE focuses on implementing technologies, including emerging cloud-based solutions, to provide an advanced yet accessible data rich, web-based platform for synergistic ocean data delivery, access, and use: multi-parameter observations, easily discoverable and usable, organized thematically, complemented by a set of value-added data services. COVERAGE development is characterized by a phased, user-driven, open source approach, emphasizing FAIR data principles and organized around priority application use cases identified by agency partners, including GEO-MBON and GEO-Blue Planet, in support of UN-Sustainable Development Goal 14 and CEOS Open Science and Data priorities. Further information on COVERAGE and access to its prototype web portal capabilities at the conclusion of its Phase-B project is available at https://coverage.ceos.org or by direct communication with its project leads, Dr Vardis Tsontos and Dr Jorge Vazquez (NASA).

COVERAGE has been submitted as an Ocean Shot to the UN Decade. For your information, an overview of the related COVERAGE ocean-shot concept, "Next Generation Data Service Infrastructure in Support of a Digitally Integrated Ocean Observing System", submitted to Ocean Decade U.S. and presented at their recent launch meeting, can be found at https://t.co/ZinD4WSAEK.

COAST

Leveraging the expertise and capacity in its agency partners, cross-cutting working groups and virtual constellations as outlined previously, CEOS is now tackling the frontier of integrated coastal zone observations and supporting the UN Decade outcome of 'a predictable ocean', among others, through the CEOS COAST (Coastal Observations, Applications, Services, and Tools) initiative, which sits within the CEOS structure as an *ad hoc* Team (https://ceos.org/ourwork/ad-hoc-teams/ceos-coast/). The COAST initiative comprises representatives from over a dozen international space agencies and their partners in developed and developing nations and is leveraging their collective and extensive observing and information system capabilities to focus on crucial transboundary and transdisciplinary issues, challenges, and opportunities in the coastal zone and contribute to societal benefits. These include support for human health and safety by providing essential information on coastal hazards such as inundation and flooding events. Likewise, COAST is enabling new and improved user-driven information about coastal ecosystems and their invaluable goods and services by providing routine and synoptic assessments of terrestrial loadings of nutrients and sediments along with other contaminants. Intended outcomes of COAST include linking the aquatic and terrestrial domains across the land-sea interface, coupling physical and biological/biogeochemical data, coupling multi-sensor satellite data with *in situ* measurements, ensuring interoperability and integration of coastal products through analysis ready data (ARD) approaches, and, perhaps most crucial, transferring technology and building global capacity for sustainable development of all coastal regions.

Partnerships are essential for COAST, e.g., with GOOS to link *in situ* with satellite data; with CoastPredict to transition data products into actionable information and forecasts; and with the GEO Blue Planet initiative to link with global coastal stakeholders. Toward this integrated framework, COAST was submitted as a potential UN Ocean Decade Program by the U.S. government on behalf of the respective CEOS agencies that comprise the COAST team. Further details on the initiative, including terms of reference, project white papers and implementation plan are available at https://ceos.org/ourwork/ad-hoc-teams/ceos-coast/documents/. COAST is co-chaired by Dr Paul DiGiacomo (NOAA) and Dr Raj Kumar (ISRO), and we encourage you to engage directly with them to ensure the necessary linkages are made between CEOS, IOC/GOOS, GEO, UN Environment and other community partners to help promote and facilitate sustainable development in global coastal zones.

WGClimate

The WGClimate, established in CEOS in 2010 and joined by CGMS in 2013, is at the heart of CEOS's contribution to climate change monitoring from space. Through this group, space agencies continue to advance and evolve their systematic observation of the Earth's climate system by implementing the Architecture for Climate Monitoring from Space published in 2013. This group coordinates and promotes joint activities of the world's major space agencies to systematically improve and sustain the availability of climate data from space.

The WGClimate facilitates the implementation and exploitation of Essential Climate Variable (ECV) time-series, as defined by GCOS. It developed a web-based Inventory (https://climatemonitoring.info/ecvinventory/) of existing and planned climate data records of GCOS Essential Climate Variables (ECV) observable from space and this is updated annually. Currently it holds information on approximately 1100 (133 for ocean variables) data records and provides a rich resource to find the right data for climate applications. The WGClimate is using the inventory content to identify measurement gaps in Earth observation that may appear in the future, thus potentially interrupting the continuity of climate data records. Space agencies use this resource to inform their planning for both mission and product generation to preempt such gaps in the future. WGClimate proactively collects show case studies of climate data records users which demonstrate its value for decision and policy making as, for example, in a use case with UNFCCC to support the Global Stocktake.

In strong collaboration within CEOS and with CGMS, the WGClimate developed a roadmap to implement a monitoring system for atmospheric carbon dioxide (CO2) and methane (CH4) concentrations, as well as their natural and anthropogenic fluxes from space. This system helps to maximise contributions to the Transparency Framework and the achievement of Nationally Determined Contributions, and also for stocktaking as outlined in the Paris Agreement. Oceans form an important part of the global carbon cycle and Global Ocean Biogeochemical Models, driven by a combination of in situ surface and buoy observations and satellite data of the ocean surface, are used to simulate elements of the carbon cycle. These need to be included in any comprehensive study of the global carbon cycle. Many relevant actions are currently being prepared through the UN Decade of Ocean Science for Sustainable Development and these form valuable inputs to CEOS.

Virtual Constellations

Four of the CEOS Virtual Constellations have a marine focus:

- **Sea Surface Temperature Virtual Constellation (SST-VC)**

The SST-VC provides a forum for collaboration on the production and coordination of sea surface temperature products across the international spectrum of remote sensing instruments including infrared and microwave sensors on polar orbiting and geostationary platforms.

- **Ocean Surface Topography Virtual Constellation (OST-VC)**

The OST-VC's goal is to implement a sustained, systematic capability to observe the surface topography of global oceans. OST-VC links the different agencies, the Ocean Surface Topography Science Team (OSTST), CEOS and the altimetry user community. It is suited to discuss constellation-wide programmatic issues and high-level constellation user requirements.

- **Ocean Colour Radiometry Virtual Constellation (OCR-VC)**

The goal of the OCR-VC is the monitoring and forecasting of Earth's living aquatic environments. The OCR-VC provides information in three major application areas: Climate, Carbon and Water Quality. The OCR-VC is also developing a coordinated multi-

mission basis for OCR cal/val, including System Vicarious Calibration infrastructures and protocols for bio-optical *in situ* measurements.

- **Ocean Surface Vector Wind Virtual Constellation (OSVW-VC)**

The OSVW-VC encourages the provision of high-quality ocean surface vector wind data for various applications through active international collaborations and scientific innovation. It aims to achieve a more active engagement and coordination between nations involved in development of satellite ocean surface vector wind sensors and the international wind vector community, and acts as the formal link between CEOS and the scientific community represented by the International Ocean Vector Winds Science Team (IOVWST).

In addition to that detailed above, many scientists across the CEOS membership are engaged in further work as contributions to the UN Decade through their agencies or organisations. As a collective, CEOS is keen to lend its support to the UN Decade and we encourage the IOC to engage directly and actively with us in its current capacity as an Associate member to CEOS. We look forward to improving links and increasing the efficacy of our partnership as the UN Decade develops.

Sincerely,

Adam Lewis and Alex Held
Co-chairs of the CEOS Strategic Implementation Team