

Proposed CEOS Initiative for 2017

CEOS Ocean Variables Enabling Research and Applications for GEO (COVERAGE)

Sponsoring Agency: NASA

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Introduction

The earth science enterprise relies on the integration of multivariate data from diverse observational platforms. Whether for satellite mission cal/val, science or decision support applications, the coupling of remote sensing and *in situ* field data is also integral to oceanographic workflows. Despite increased availability of oceanographic data online and improved interoperability standards, protocols and tools for access, the inherent heterogeneity of resulting data and the disparate, distributed systems that serve them complicates their effective utilization. This presents a barrier to realizing the true potential of earth observation data and satellite derived information to enhance understanding of the ocean ecosystems and promote informed management of marine natural resources for societal benefit.

The importance of accessing and representing multivariate, multi-platform ocean observations efficiently, thematically organized and in a common frame, including those from the 4 CEOS ocean virtual constellations (VCs), in support of GEO and its Blue Planet initiative in particular is a CEOS objective and work plan element. The mission of GEO-Blue Planet is to advance and exploit synergies among the many observational programs devoted to ocean and coastal waters sustained development and use of ocean and coastal observations for the benefit of society via: 1) the increased integration of and access to *in situ* and remote sensing ocean observation data, 2) the conception, promotion and end-to-end ocean information services, 3) the support of interdisciplinary research critical to climate science by providing ocean remote sensing parameters on a common spatial and temporal grid. CEOS has committed to supporting components and associated priority actions identified by GEO Blue Planet Initiative^{1,2}. To this end CEOS ocean VCs will play a role in the sustainment/continuation/harmonization of essential ocean variables and will continue to develop experimental and operational coordinated, multi-sensor ocean products and services to explore optimal utility of developing a collocated, readily accessible dataset package with fit-for-purpose latency for applied, industrial, and research uses. The COVERAGE concept (CEOS Ocean Variables Enabling Research and Applications for GEO) was developed to address this need. Its proposed formal adoption as a CEOS initiative for 2017 will provide a coherent, focal point activity and mechanism promoting the advancement of the aforementioned CEOS programmatic objectives. We invite the interest and participation of other CEOS agencies in this effort.

COVERAGE Overview & Status

COVERAGE was conceived at the CEOS-SIT technical workshop meeting in Pasadena in 2013³. It was a direct response to perceived needs of the CEOS and GEO communities but also reflected significant interest by the GHRSSST community at that time in near real time products for applications and interdisciplinary research. The intent then was to use the GHRSSST model to implement the near real time distribution of multi-product data sets in common format suitable for interoperability. COVERAGE's intent is to build a project that brings together 4 CEOS ocean VCs, enables broad international participation, facilitates more widespread access and use of ocean satellite data by a broader user community via the Internet, leveraging also "Big Data" technologies where applicable. The longer term objective is to provide a data rich Web-based "fusion" platform for global multivariate ocean data from diverse, distributed providers, in near-real-time where possible, in support of CEOS and GEO.

The COVERAGE initiative aims to:

- Provide a focal activity within CEOS serving to unify the 4 CEOS ocean virtual constellations (Sea Surface Height, Sea Surface Temperature, Color, Vector Winds, but also potentially Salinity and Ocean Currents) within the COVERAGE “virtual collection”, enabling broader use of ocean satellite data in support of research and applications.
- Achieve international collaboration via CEOS and GEO-Blue Planet engagement for global extension of COVERAGE involving a priority-set of use cases and requirements upon which implemented capabilities will be based.
- Assemble and present satellite and *in situ* ocean data in a compelling web-based format to demonstrate the value added of multivariate ocean data integration in support of science, applications, and public engagement.
- Develop a data rich platform (utilizing both established standards/protocols but also emerging data management and cloud technologies where necessary) for integrated ocean data delivery and access:
 - multi-parameter observations, easily discoverable and usable, thematically organized, available in near real-time, collocated to a common grid and including climatologies.
 - complemented by a set of value-added data services available via the COVERAGE portal including: an advanced Web-based visualization interface, subsetting/extraction, data collocation/matchup and other relevant on demand processing capabilities (eg. trend analysis, anomaly detection, dynamic processing/regridding).
 - establish technical interfaces and data delivery and aggregation pipelines.

The CEOS COVERAGE initiative will leverage outcomes from a regional COVERAGE-Sargasso Sea (SS) pilot application that has been undertaken over the past 1.5 years by NASA in collaboration with the Sargasso Sea Commission ([SSC](#)), a network of international partners led by the Government of Bermuda, including UK, USA and intergovernmental agencies (IUCN, ISA) aiming to advance the recognition of the importance of the Sargasso Sea and promote the protection of this high seas, data poor region in accordance with the Law of the Sea Convention. Despite this being a low level effort, the outcomes, culminating in a NASA-sponsored [workshop](#) hosted by the SSC in Key West (FL), March, 2016 involving the participation of 36 members of the scientific community (including NASA and NOAA agency representatives), the private sector, as well as the Sargasso Sea Commission and representatives of 6 governments, were invaluable. Workshop objectives included:

- Exposing the COVERAGE-SS pilot project to peer review and comment to ensure effective, user-driven development.
- Examining the utility of COVERAGE-SS to illuminate the relationship between ocean conditions and uses of the Sargasso Sea.
- Identifying high-priority applications and system requirements for COVERAGE to enable use cases for possible future implementation.

There was overwhelming consensus by the group on usefulness of COVERAGE-SS pilot as an accessible data integration platform. Priority thematic areas identified for possible future development in the Sargasso context: “Fisheries, Organisms & the Environment” “*Sargassum Ship Interactions*,” “Regional early warning system for *Sargassum* inundation events”. Further datasets for inclusion and the development of strategic partnerships with the [UN-IOC Ocean Biogeographic Information System](#) (OBIS), represented at the meeting, was recommended. Detailed feedback from participants on tool functionality and the need for automated data pipelines was also obtained. The perceived value of COVERAGE to the SSC has since resulted in a presentation of the COVERAGE-SS prototype application at an event at UN-HQ

on 31 Aug.2016 in the margins of the [Preparatory Committee meeting \(PREPCOM2\)](#) for negotiation of a [new marine biodiversity treaty for areas beyond national jurisdiction \(ABNJ\)](#). In addition to supporting GEO-Blue Planet efforts and pilot applications, it is clear that COVERAGE could serve to facilitate possible future ABNJ instruments or other emerging applications involving ecosystem-based fisheries management and marine spatial planning of high seas or other areas by consolidating, better integrating and rendering more broadly accessible available data assets.

Alignment with CEOS Strategic Goals

This initiative supports the following goals specified in the CEOS Strategic Guidance document¹:

- *Achieve better integration across the full range of Earth observations*, including partnerships with organizations responsible for space-based, airborne, ground-based, and *in situ* data in coordination with GEO.
- *Promote Data Democracy by improving access to and use of CEOS Agency data*. To facilitate open and easy access to Agency data for maximal societal benefit, CEOS must coordinate and improve discovery, interoperability, coordinated data access portals in specific topical areas, and promote the use of open-source tools.
- *Remain responsive to Earth observation users' needs globally*, forging partnerships with the increasingly diverse Earth observation user community, including CEOS Associates and stakeholders such as GEO's Communities of Practice.

COVERAGE also complements several activities outlined in the CEOS 2016-2018 Work Plan²:

- *3.6 Capacity Building, Data Access, Availability and Quality:*
 - II. Explore potential for CEOS Agencies to leverage [future data architectures](#) to unlock the value of space Earth observations addressing outstanding obstacles to data access/usage and "Big Data" challenges.* Significantly lower the technical barriers to exploitation of space data and ensure more societal benefit can be delivered from space agency investments, particularly as the need for regional and global solutions to cross-cutting 'big challenges' increases.
 - III. Support WGISS in the development and operationalization of the GEOSS Common Infrastructure (GCI) and its related elements by CEOS agencies:* foster implementation and enhancement of the GCI through continued development and coordination of tools that improve discovery, interoperability, and access to satellite data from CEOS Virtual Constellations via supported standards.
- *3.8 Support to Other Key Stakeholder Initiatives:*

I. CEOS contribution and leadership in the GEO Blue Planet Initiative:

Blue Planet⁶ is an Initiative within the Group on Earth Observations (GEO)⁷ that aims to ensure the sustained development and use of ocean and coastal observations for the benefit of society. Its mission is to advance and exploit synergies among the many observational programs devoted to ocean and coastal waters; to improve engagement with a variety of users for enhancing the timeliness, quality and range of services delivered; and to raise awareness of the societal benefits of ocean observations at the public and policy levels. Core objectives include: 1) Increase integration of and access to *in situ* and remote sensing ocean observation data, 2) Conceptualize, promote and facilitate the development of end-to-end ocean information services. Current pilot projects focus on fisheries monitoring and decision support applications. CEOS will support components and associated priority actions identified by GEO Blue Planet Initiative². CEOS ocean VCs will play a role in the sustainment/continuation/harmonization of essential ocean variables to develop coordinated, multi-sensor/parameter ocean products. *CEOS will continue to develop experimental and operational data, products, and services to explore optimal utility of developing a collocated, readily accessible dataset package with fit-for-purpose latency for applied, industrial, and research uses.*

Potential synergies between the proposed COVERAGE initiative and CEOS-WGISS objectives and activities as described in its 5-year work plan⁴:

- Enable Earth observation data and information best practices and services to be more accessible and usable to data providers and data users world-wide through international coordination and interoperability standards.
- Enhance the complementarity, interoperability and standardization of Earth observation data and information management and services with other types of geospatial data such as *in situ* data.
- Be responsive to the requirements of the Group on Earth Observation (GEO)
- Monitor and investigate developments of new technologies and encourage their use
- Data and information management (3.2)
- User services and Applications Support: WGISS coordinates the provision of a range of global services and support for EO applications. (3.3)

Benefit to Internal & External Stakeholders

As described in the previous section, COVERAGE aligns well and has the potential of contributing valuably to a range of activities within CEOS, ranging from satellite-*in situ* interoperability/integration technology considerations and future data architecture developments to support of CEOS commitments to GEO and its Blue Planet initiative. COVERAGE provides agency participants with opportunities for data sharing, technical interchange, and potentially capacity building activities in the context of a focused, collaborative project aimed at developing a proof of concept, integrated ocean information system in support of Blue Planet priority application use cases. Technology developments at various levels from CEOS-COVERAGE should be of interest to a range of national and international ocean observations programs including UN-[GOOS](#). The emphasis of COVERAGE on ocean applications will facilitate the development of new strategic partnerships, data and technology exchanges with a broader range of data providers, including programs such as UN-OBIS, responsible for the management of global marine biodiversity data inventories.

Feasibility and Affordability

It is important to recognize that COVERAGE is not starting from ground zero. A prototype application focused on the Sargasso Sea region in support of the SSC was successfully demonstrated to a broad group of international stakeholders from various sectors. The next stage of COVERAGE development will leverage and further refine applicable technical capabilities, use cases, recommendations from the SSC pilot in designing and implementing the future system as part of CEOS initiative within a GEO-Blue Planet context. Additionally, a draft paper on the overall functionality, architecture and technology components for COVERAGE have been developed. This is based on a largely available software stack, including several open source developments, and support both established earth science data standards/protocols where best applicable and select emerging “Big Data” cloud-based technology solutions for intensive data computational and integration operations that been developed and implemented in a variety of project contexts at NASA/JPL. These complement tools, methodologies and ongoing efforts relating to *in situ*-satellite interoperability and integration at NOAA also in the context of [US-IOOS](#). Reuse and integration of these and other applicable capabilities potentially offered by CEOS participant agencies for COVERAGE will capitalize on relevant and successful project implementation models, such as [NASA’s Sea Level Change Portal](#) development. Thus, the active engagement of CEOS agency partners and GEO in several areas, from data sharing to collaboration on technology aspects to application development, is deemed critical to the successful future enhancement of COVERAGE and its sustainability longer term. The work proposed seeks to draw on available technical expertise and data resources from CEOS agencies in relevant areas,

but also complement and contribute positively to CEOS work plan elements, particularly those relating to WGISS and the Future Data Architecture (FDA) activities.

Expected Duration

COVERAGE is envisaged 3-year R&D commitment within CEOS towards an “operational” capability by the end of 2020. Development will be via a phased approach involving the following components:

- Initiative approval and acquisition of commitments on contributions from CEOS agencies interested in collaborating in COVERAGE.
- Collaboration with GEO-Blue Planet on use cases development for COVERAGE.
- Requirements analysis and design leveraging experience/technologies from recent COVERAGE prototype and ocean portal development activities.
- Ongoing engagement of CEOS and external stakeholders for the evaluation of prototypes during development, testing and integrations phases.
- Outreach on COVERAGE project stakeholders and the ocean observing community, and communication of promising technical advances to the broader earth science data community.

COVERAGE management and oversight will involve:

- An “Execution” Team from CEOS agencies and VC members and application representatives (early adopters).
- An “Oversight Board” that reviews progress through quarterly teleconferences comprised of the NASA lead, CEOS CEO, IOC-Blue Planet representative, 3 at-large members representing key application groups.

Initiative Next Steps

NASA is providing this paper for consideration by the CEOS-SEC in accordance with the CEOS new initiatives process⁵. We invite the interest and participation of other CEOS agencies in this effort.

Granted also SEC concurrence, suggested next steps would include:

- Brief presentation at the upcoming 2016 CEOS-SIT Technical Workshop.
- Circulation of paper within CEOS WGs and VCs to confirm support and in-principle contributions to the proposed activity.
- Possible updated proposal paper incorporating broader CEOS agency feedback and contributions circulated to Principals at least 2 weeks prior to Plenary (mid-Oct. 2016)
- Presentation and discussion at 30th CEOS Plenary, Brisbane, Oct-Nov, 2016 (as necessary)

References

1. *CEOS Strategic Guidance*, Version November 6, 2013, 9pp
2. *CEOS 2016-2018 Work Plan*, March 2016, 37pp
3. Lindstrom, E. 2013. CEOS Ocean Variables Enabling Research and Applications for GEO (COVERAGE). Presentation to the CEOS SIT Technical Workshop, Pasadena, CA, 11-12 September, 2013
4. CEOS WGISS 5-Year Plan, 4 November, 2009, 40pp
5. *CEOS New Initiatives Process paper*, May 20, 2013, 6pp
6. [GEO-Blue Planet website](#)
7. [GEO/GEOSS website](#)