Concept Paper for Restructuring CEOS Virtual Constellations and Creation of a New Working Group
Addendum to *Strategic Directions and Partnerships for CEOS Discussion Paper, V1.021 March 2018)*

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AT SIT-34 in Miami, we will continue the discussion on the priorities we have focused on through our tenure as SIT Chair, and continuing the conversations held at the 2018 SIT Technical Workshop (SIT TW) in September and the 32nd CEOS Plenary in Brussels. As stated in the SIT-34 invitation letter and Agenda (available at http://ceos.org/meetings/sit-34/), among other business topics for CEOS, we will foster a robust discussion of the following:

- **Critical assessment results of the Virtual Constellations (VCs)**, including ongoing activities, tangible outputs, Constellation management, continuity, and VC proposals around leadership rotation (*Plenary Action CEOS-32-12*).
- Defining the **way forward for existing *ad hoc* Teams (AHTs)**, including consideration of options for continuity of CEOS activities in support of the Global Forest Observations Initiative (GFOI), GEO Global Agricultural Monitoring (GEOGLAM), and Sustainable Development Goals (SDG) (*Plenary Actions CEOS-32-13 and CEOS-32-11).*
- Drafting language to support **potential changes to CEOS Governance, Processes, and organization** resulting from discussions on VCs and AHTs and the formal processes CEOS will mandate for them. Consider proposals for further discussion at 2019 SIT TW, and possible recommendation for decision(s) at 33rd CEOS Plenary (*Plenary Action CEOS-32-15*).

  At SIT-34, we will present to the CEOS community for discussion and consideration, two specific changes to the CEOS Strategic Guidance Documents to take to the Hanoi Plenary. For the VC process, we will offer language indicating the requirement for a regular biannual (TBC) review and formal designation of VC leadership. For the AHT process, we will propose a two-year initiation cycle for standing up new AHTs. The two-year initial cycle will allow for defining the objective, evaluating the merit and value of the objectives, and determining the appropriate path forward for continued support within CEOS. Also at SIT-34, we will discuss the progress the three existing AHTs are making to define their end-state.

As we address these specific SIT and Plenary actions at SIT-34, throughout the agenda I will ask the community to consider how well the current VC/AHT/WG framing within CEOS supports CEOS Agency and external user needs. At the SIT-34, and in this paper, the SIT Chair will present two concepts that will be highlighted throughout the SIT 34 agenda, as we review and consider the 2019-2021 Work Plan, and the individual contributions and plans from all the CEOS working elements.

For discussion – not necessarily for decision – the two concepts to evolve the CEOS organization and ensure CEOS continues to provide benefit to its members and remains relevant to our external partners and the international community, are:

1) **Establish a new Working Group**, focused on *Information Provision*, to coordinate all activities related to user outreach and applications (*e.g.,* forests, agriculture, freshwater, land degradation, urban, biodiversity, and more in the future). The new WG would be added to the existing WGDisasters and WGClimate. The latter two would remain as separate WGs, reflecting their direct connection to the Paris Agreement (WGClimate) and Sendai (WGDisasters). The new WGIP (the name *Information Provision* is a placeholder only) would in effect do everything else and could be considered the CEOS response to satisfying the larger needs of the Sustainable Development Goals (SDGs), the third leg of the triad of externally (GEO) defined strategic objectives.
2) Consider broader thematic based Virtual Constellations organized around the land, ocean, and atmosphere themes. We propose to merge **the four current ocean-related VCs into a single Ocean VC** focused on creating an integrated and coordinated multi-variable picture of the oceans; and merging the AC-VC and P-VC into an **Atmosphere VC**. LSI-VC already follows this model, looking at a 'family' of variables that together provide an integrated picture of the land … i.e. ST, SR, backscatter, interferometric products, and it becomes the **Land VC**.

This concept paper describes the background and rationale for these two proposals.

Context

Each CEOS Member Agency is driven and defined by their national mission statements. All Members, by their decision to participate in CEOS, are invested in expanding the collective value of our individual observations through coordination and collaboration. CEOS is primarily concerned with finding more efficient methods to make our Earth observations (EO) more readily usable by the global community of users. Our organization and the thematic activities, the Working Groups (WG), Virtual Constellations (VC), and *Ad Hoc* Teams (AHT), are designed to advance these goals.

When the Virtual Constellations were initiated in 2006, CEOS was responding to the emerging concept of a Global Earth Observing System of Systems (GEOSS), which highlighted the potential of a truly integrated global observatory focused on providing information for decision-makers. The VCs were ultimately tasked with identifying potential gaps in critical measurements and missions that existed around the disciplines of land imaging, precipitation, altimetry, and atmospheric chemistry. As recapped in the 2013 VC Process paper, the VCs were developed to:

- Extract a clear and common statement of requirements from the target user communities as the basis for planning by CEOS space agencies.
- Look to the GEO process and the GEOSS 10-Year Implementation Plan as the reference for many of these requirements (referencing SBAs).

- Each Constellation would be the focus for the planning and coordination by CEOS agencies individually and collectively, and each definition would serve as a guide to all agencies as to the characteristics of the space and ground segment for their mission which would best satisfy the needs of the agreed users.

We now have seven VCs, created in three waves: in 2006 OST-VC, AC-VC, LSI-VC, and P-VC, in 2008 OSVW-VC and OCR-VC, and in 2011 the SST-VC.

On the topic of coordination, the VCs have been successful in defining and championing satellites constellations and observation continuity. Examples include the OST-VC with the Jason series, Saral-Altika, Envisat, Sentinel-3 and others; OSVW-VC with Metop/ASCAT, ScatSat and Oceansat; and LSI-VC with Landsat, Sentinel-2, CBERS, and others. Through the discussion of and advocacy for constellations, the space agency investment needs have been and are being addressed. The proliferation of satellite systems over the past 10 years have significantly lowered the risk of gaps in major satellite measurements. These contributions include the Copernicus Programme, NASA's Decadal Survey and Venture work, ESA's EO Program, the multiple broad-based meteorological advances by NOAA, EUMETSAT, JMA and others, and the collective contributions from new entrants and from the commercial sector.

Over time, the productivity from the VCs has varied, sometimes for understandable reasons. The coordination and collaboration within measurement genres has become routine "best practices" for satellite agencies as we develop and exploit our missions. The VCs continue to coordinate closely with the many thematic international science teams in a productive and ongoing process. When agency Principals haven't required additional specific products, VC deliverables to CEOS have diminished.

Recalling that the other driving idea for the creation of VCs within CEOS was to better support the GEOSS Societal Benefit Areas (SBAs) and global community needs for EO information, the environment now is very different in 2019 than it was in 2006. The global observing system, as mentioned above, is much more capable and the information management systems deliver more and better products. Also, the community awareness of the potential value of EO data to meet diverse user objectives has grown significantly, and the demands by the users for ready-to-use information continues to increase. While we included support for SBAs in the VCs initial scope of work, the VCs have been most effective in establishing the consistency and quality of their observations and constellations.

CEOS has used the *Ad Hoc* Team (AHT) process, or variations of it, to consider how best to support emerging needs and apply new capabilities where a permanent CEOS mechanism does not exist. To date, CEOS has initiated as many as nine activities since 2008 to consider emerging needs. Of these, at least four have been dispositioned, three into existing CEOS Working Groups, and twice with the creation of new groups, WGClimate and WGDisasters.

We note that the three existing AHTs all focus on external user information and service delivery, in a class with the existing Working Groups on Disasters, Climate, and Capacity Building and Data Democracy. This expansion of such focused groups reflects the growing demand by the global community for specific, refined information products from CEOS and CEOS Agencies for operational decision-making. We should expect this interest to continue to

expand, and have already seen outreach from other GEO activities such as Agriculture, Biodiversity, and Land Degradation Neutrality for more involved CEOS coordination.

VCs … AHTs … WGs

Our VCs have been successful with the first part of their original design. In coordination with very strong international science teams, they have matured their measurement disciplines and advanced the coordination and consistency of the Virtual Constellations. Working with the CEOS Working Groups WGCV and WGISS, they continue to improve the cross-disciplinary consistency of their observations and their approaches to storing and disseminating data.

We have also seen growing interest in greater interoperability between observations from multiple VCs. The DataCube concept merging multiple LSI-VC datasets that has been received so well should demonstrate even greater promise as new data are added. Output from the multiple ocean VCs should follow this trend, and commit to a cross VC consistency and interoperability of their datasets, eventually to be a part of a greater DataCube: effectively a *Digital Earth*. I suggest there is great promise in realigning the current seven VCs into super constellations covering Atmosphere, Land, and Oceans (see figure 1). This higher level of satellite data coordination, done by the satellite agencies before developing tailored system information deliveries for individual user groups (like GEOGLOWS, GEOGLAM, and LDN), will make the integrated observations more user ready, and the work will be done early in the data processing pipeline, at Level 1 product level.[1]

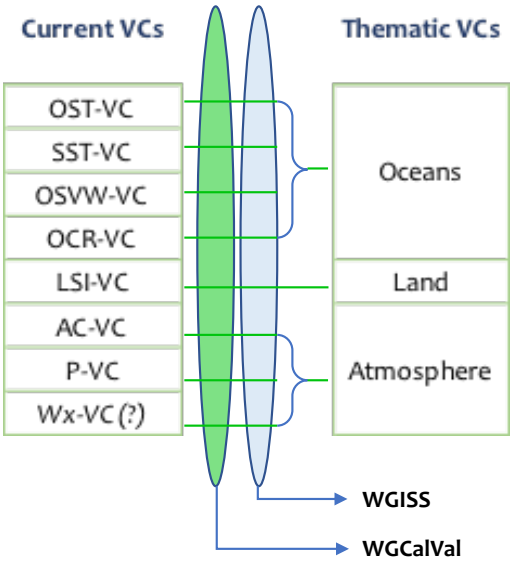

Figure 1: Possible Merged Structures for CEOS VCs

We must ensure that when we progress to a smaller subset of three VC as shown above that we do not lose sight of a primary driver for the VCs: the focused attention on continuity of critical satellite measurements through generations of satellites. The merged VC must address the need for all measurement types that will require continuity. The Oceans VC will by necessity consider continuity of several different measurement technologies and orbits,

[1] As the NOAA Principal, I am interested in seeing more integrated products by the CEOS community. I still expect the rigor and discipline by the various measurement communities, but the issues we address require an integrated view with all relevant data included. As an Agency, NOAA will continue to support the calibration and validation campaigns of our own and other satellites, conducting field campaigns as before, highlighted by the relevant international science team activities (GRSST, OSTST, etc.). As a CEOS Principal, I will look for a higher level of integration, and propose atmosphere/land/oceans provide the right level of interagency coordination at this time.

that were previously covered in the separate VCs. However, this is not significantly different from the many observation types considered now under the AC-VC and the LSI-VC. The LSI-VC now includes measurements from multi-spectral satellites at multiple resolutions: moderate (Landsat and Sentinel 2), mid-resolution (MODIS and VIIRS), and course (ABI and similar), along with synthetic Aperture Radars of different frequencies, from L-band to X-band.

The VCs have not been optimally supporting the growing customer user needs and expectations. The demand for cross-VC information products has led CEOS to organize well-supported activities centered around climate and carbon (WGClimate), disaster mitigation, assessment, and long-term response (WGDisaster), and training for how to handle CEOS information products (WGCapD). We have evaluated other such formations, and after study, we determined the assessment of data architecture fell under WGISS, and decided against freestanding structures for carbon and water issues.

Finally, we have struggled to find a sustained CEOS approach to meet the needs of GFOI and GEOGLAM. We continue to study effective methods to address SDGs, although we haven't been working on these as long.

We suggest these open activities, GEOGLAM, GFOI (including Biomass), SDGs, and soon LDN, Biodiversity and others, represent a consistent class of CEOS data and information users. Each different user community needs a selection of data and information products to address their needs. The desired data is drawn from multiple CEOS VCs, in addition as well to specialized non-satellite data, making it unlikely if not impossible for any single VC to meet all the user community needs. What these different activities share is a common expectation for CEOS to help them find and apply the right satellite observations datasets to address their operational needs. We propose CEOS consider a new Working Group designed to perform this filtering, definition and data product subsetting by working with the user communities to understand the needs, and by pulling appropriate data from any or all VCs.

Figure 2 provides a graphical presentation of this concept. On the left are the CEOS VCs. Each provides discipline-specific data and information, and all work with WGISS and WGCV to establish the appropriate level of consistency across CEOS. On the right and above are the user community activities, drawing data from selected VCs to meet their needs. The Working Groups provide the interface to the user communities to understand the intended use, and the satellite awareness and expertise to identify the best available data. In addition, the WG can provide feedback to the VCs and the agencies they support, potentially to alter and improve their information outputs to make the data more usable.

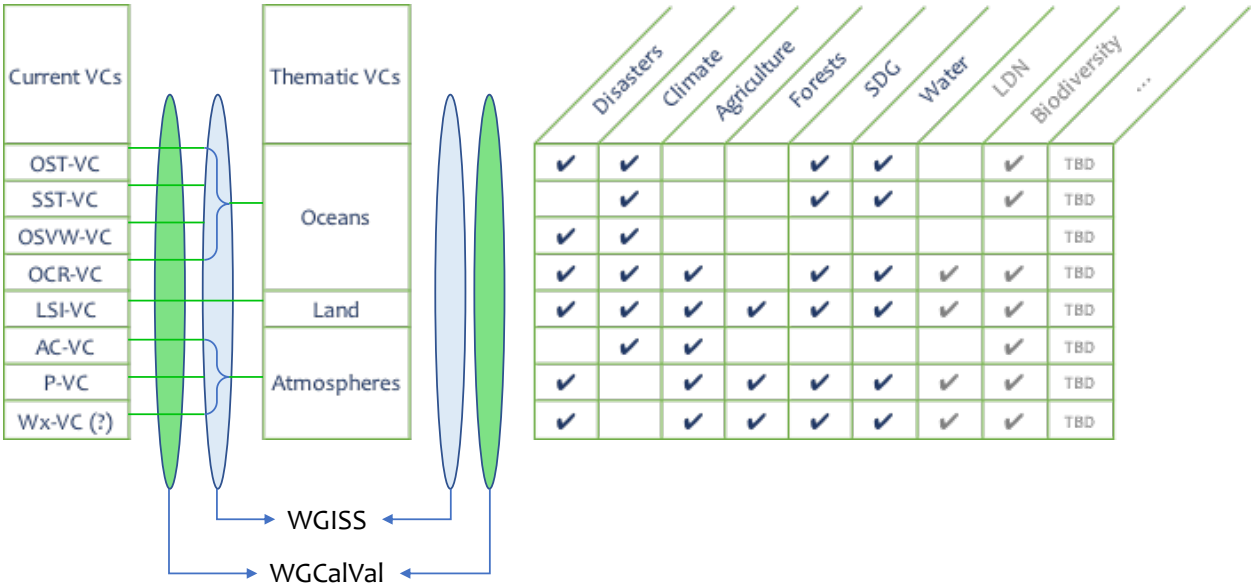

Figure 2: Translation from satellite observations to user-ready information products, with the conversion to Analysis Ready Data in the process.

In the diagonals on the upper right are our user-focused WGs. Already in place are WGClimate and WGDisasters, and we propose we create a new WGIP, for *Working Group on Information Provision* (*name is subject to change*). Within WGIP would be those AHT activities of GEOGLAM, GFOI, and SDG, identified in the figure as *Forest*, *Agriculture* and *SDG*, and could be expanded to others supporting as needed. Figure 3 shows a concept for how these different subspecialties could be addressed within the WGIP. This concept allows the secretariat functions of the WG to consolidate across several similar service provision activities – SDCG, GEOGLAM, etc. – to be consolidated within a single WG. This not only saves resources; it enables greater coordination and common practices to be executed across the activities.

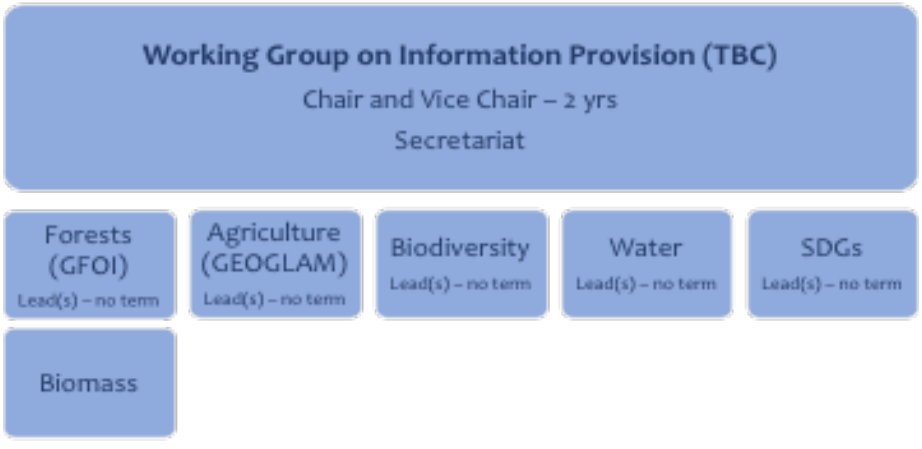

Figure 3: Notional concept for a Working Group on Information Provision

Conclusion

The proposals in this paper were developed through conversations with members of CEOS leadership, Virtual Constellations, Working Groups and the parent agencies, and it is from them that the most productive ideas came. As SIT Chair, I ask the CEOS Team to consider these proposals and to join in the discussion at the SIT-34 meeting in Miami, bringing your perspectives as Subject Matter Experts, as Constellation and Working Group members, and as representatives of your agencies. All viewpoints are valued as we consider approaches to better optimize the structures of CEOS to meet member and global needs.