



CEOS Strategy for Carbon Observations from Space

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The *GEO Carbon Strategy* states:

“a key reason for our lack of understanding of the global carbon cycle is the dearth of global observations,” and calls for

“an increased, improved and coordinated observing system for observing the carbon cycle as a prerequisite to gaining that understanding.”

The Committee on Earth Observation Satellites (CEOS) is well positioned to meet this challenge and provide needed coordination for the space-based observations called for in the *GEO Carbon Strategy*.

CEOS established a Carbon Task Force (CTF) to coordinate the response from the space agencies to the GEO Carbon Strategy.

- Take into account information requirements of both the UNFCCC and IPCC and consider how future satellite missions will support them
- Also take account of, and be consistent with, the GCOS and GEO Implementation Plans.
- Help definition of next generation missions for individual agencies (provide a long-term outlook, 2013-2028).
- Provide a basis for systematic observation and reporting of progress towards satisfying society's carbon information needs

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Report Structure and Chapter Leads



CEOS Strategy for Carbon Observations from Space

Executive Summary	(Nakajima, Wickland, Plummer)
Chapter 1: Introduction	(Nakajima, Wickland, Plummer, and Ward)
Chapter 2: Land	(Schmullius and Dubayah)
Chapter 3: Oceans and Inland Waters	(Sathyendranath)
Chapter 4: Atmosphere	(Moore)
Chapter 5: Integration	(Plummer)
Chapter 6: Way Forward	(Wickland, Nakajima, Plummer)
References	
Appendices	



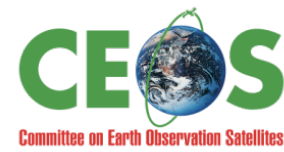
Outline for Domain Chapters



- 1. Key Information and Observation Needs**
 - 2. The Role for Satellite Observations, with assessment of adequacy of current and planned observations**
 - 3. Recommendations and Actions for CEOS**
- **The balance of content and emphasis within each of the domain chapters differs as a result of the maturity and diversity of space-based carbon and carbon-related observations currently available and planned for that domain.**
 - **CEOS Actions focus on what can be achieved through better coordination as well as those improvements that require additional resources and/or mandates beyond the present capacity of space agencies.**



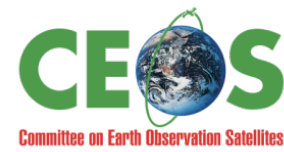
Major Cross-Cutting Themes



- A need for improved understanding of the global carbon cycle
- A need for an integrated approach to carbon observations – an Earth system approach, not a disciplinary one
- A need for greater clarity in requirements to support climate policy
- A need for greater coordination of existing and planned satellite observations
- A need to do more with the data we have (within and across domains), and to make that data available and ‘fit for purpose’ (transparency in method, documentation, consistency, long time series)
- A recognition that satellite-based approaches cannot succeed without key *in situ* observations and vice versa (Oliver Phillips – wood density)



Summary of Actions: Continuity Missions

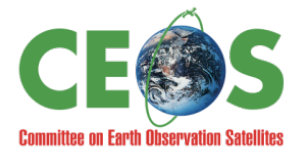


The report calls for CEOS agencies to assign high priority to continuing the following types of measurements for carbon:

- **Moderate resolution land remote sensing data (e.g., MODIS)**
- **Medium resolution land remote sensing data (e.g., SPOT, SAR, Landsat)**
- **Observations (e.g. Ocean colour, sea surface temperature) that are adequately calibrated and have sustained calibration/validation operations.**
- **Ocean colour measurements with resolution and frequency of coverage adequate for coastal waters**
- **Measurements with sufficient spatial resolution and sensitivity for inland water bodies (e.g., Landsat 8 and Sentinel-2 type measurements)**
- **Atmospheric column measurements of X_{CO_2} and X_{CH_4} (e.g., GOSAT)**



Summary of Actions: New Missions

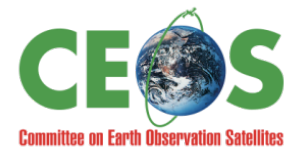


The report calls for the CEOS member agencies to deploy new missions to acquire high priority, new observations for carbon. These high priority missions are:

- **A lidar mission to measure forest canopy height and vertical structure**
- **Geostationary observations of ocean colour with high temporal resolution for coastal waters**
- **An ocean salinity mission with higher spatial resolution than current missions**
- **A constellation of passive and active LEO satellites measuring X_{CO_2} and X_{CH_4}**
- **A constellation of passive GEO satellites measuring X_{CO_2} and X_{CH_4}**



Summary of Actions: Data Products



The report identifies actions to improve and enhance the utility of many remote sensing data products. These will require the international coordination, cooperation, and agreement. Of particular note are:

- **Development of protocols for the generation of products with enforcement of requirements for clarity and traceability**
- **Development of guidelines for the specification of errors and uncertainties**
- **Inter-comparison of similar products to ensure global consistency from existing and new missions**
- **Efforts to make remote sensing data products consistent within domains and across domains**
- **Efforts to ensure long-term continuity and consistency and to facilitate joint agency activities, where appropriate**



Summary of Actions: New Data Products

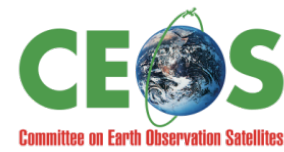


The report also called for CEOS to encourage the development of new data products from existing missions. These include:

- **Maps of wetlands, inundated areas and small water bodies**
- **Ocean colour-type products for inland water bodies**
- **Ocean carbon pool products**
- **River discharge and sediments**
- **Estimates of anthropogenic emissions**



Summary of Actions: Calibration/Validation



The report calls for CEOS actions to ensure satellite data are well calibrated and data products are validated. Specific actions called for include:

- **To encourage national agencies to provide ground reference data for calibration and validation;**
- **To support efforts to establish, coordinate, and maintain observational networks (land, ocean and atmosphere) for this purpose where relevant**
- **To assess the quality of validation and coverage for data products in each domain and develop a strategy for improvement**
- **To establish a subgroup for validation of ocean products analogous to the existing land product validation group**
- **To coordinate the cross calibration of all current and future satellites to measure atmospheric CO₂ and CH₄**



Summary of Actions: Institutional Linkages



The report contains several recommendations for CEOS and its member agencies to engage with other groups and the carbon science community in order to improve communications and optimally address actions. These include:

- Interactions with the GEO Carbon Community of Practice and the GEO Blue Planet initiative to advance work on new products and data product intercomparisons**
- Interactions with the carbon and climate modeling communities and CEOS Working Group on Climate in support of data-model intercomparisons**
- Interactions with the carbon community through GEO to understand science needs and priorities for missing measurements that satellites could provide beyond 2020**



Oversight, Implementation and Reporting

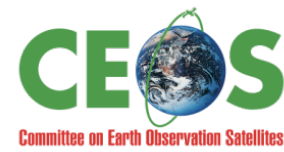


The report recommends:

- **CEOS establish a Carbon Subgroup under the CEOS Climate Working Group to coordinate carbon activities undertaken already by CEOS Working Groups/member agencies.**
- **CEOS implement its *Strategy for Carbon Observations from Space* through a series of actions which are tracked and reported regularly to CEOS management bodies and every 2 years to UNFCCC as appropriate (e.g. CEOS Response to the GCOS Implementation Plan (IP)).**



Interacting with User Communities



The strategy is designed to address the needs of the international carbon cycle community (including UNFCCC, UN-REDD and other policy organizations). To implement this CEOS must establish strong and sustained interactions with these stakeholders. In particular:

- Regular communications with the carbon science community through e.g. GEO Carbon Community of Practice, Global Carbon Project.**
- Identify and work closely together with GEO on shared tasks for carbon (e.g., currently the GEO CL-02 Task) including relevant workshops, conferences, and special activities.**
- Making sure information from space-based observations are made readily available in clear and understandable ways to the policy makers developing and implementing climate mitigation and adaptation policies.**



CEOS Strategy for Carbon Observations from Space has entered the review process

- Feedback from CEOS Technical Workshop side meeting on September 10, 2013
- **Presentation and request for feedback/review at GEO Carbon Conference in Geneva on October 1-2, 2013**
- Open CEOS and carbon community review in October-November 2013

Report will be revised based on review comments received and presented to CEOS by the end of 2013 for acceptance.



Our Request: Please Review the Draft Report!



***CEOS Strategy for Carbon Observations from Space* will be available for review through ~November 25, 2013.**

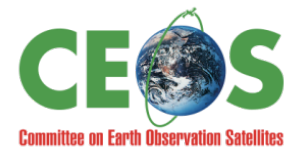
Both CEOS and GEO Carbon are making the report available, with instructions for how to submit comments, suggestions, specific changes, etc.

Please take the time to review all or parts of this document and tell us how it can be improved!

→ **But if you read only parts, please note there is an **Integration Chapter** and that the **Introduction** and **The Way Forward** Chapters will help you to understand the detailed content!**



Policy-Relevant Recommendations



- **Understanding and coping with global environmental change requires global observations:**
 - to assess impacts,
 - monitor the efficacy of adaptation and mitigation actions,
 - and understand the integrated global trajectory of change.
- **Satellites are expensive, but the information they can provide will be worth the investment.**
- **Improved coordination among nations can make those investments go farther, but additional resources will be needed to achieve an Integrated Global Carbon Observing System.**
- ***In situ* observations are complementary but our *in situ* observing systems and the international coordination mechanisms for them are in desperate need of strengthening (e.g., GTOS).**



Thank you!