CEOS Strategy for Carbon Observations from Space

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CEOS WGCV-37
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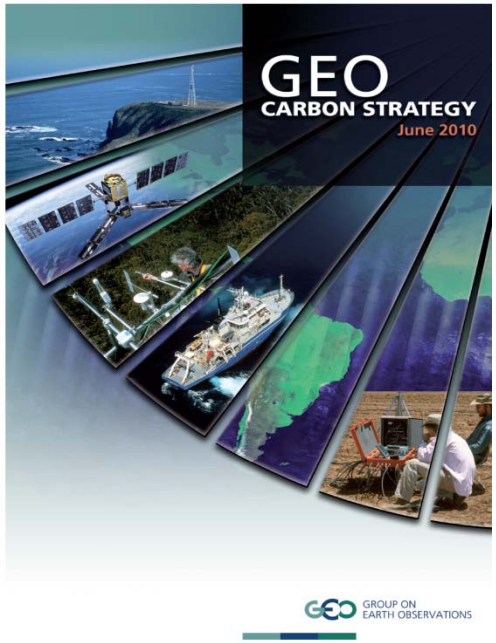
CEOS Response to the GEO Carbon Strategy



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**

CEOS Strategy for Carbon Observations from Space

Current Status of Report

- *CEOS Strategy for Carbon Observations from Space* is in final revision
  - Open review period October - early December 2013
  - Response to reviewers comments nearly completed; major revision of actions/recommendations still in process
    - CEOS Actions
    - Challenges that CEOS can acknowledge
- Report is on agenda for consideration at SIT-29; CTF has been requested to circulate final draft by end of February 2014

Report Structure and Chapter Leads

CEOS Strategy for Carbon Observations from Space

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

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, Landsat)**
- **Ocean colour, sea surface temperature, and microwave sensor observations 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_{CO2} and X_{CH4} (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 of 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_{CO2} and X_{CH4}**
- **A constellation of passive GEO satellites measuring X_{CO2} and X_{CH4}**

Summary of Actions: Data Products

The report indentifies actions to improve and enhance the utility of many remote sensing data products. In some cases, individual space agencies may be able to take the action, but most will require the international coordination, cooperation, and agreement. Of particular note are:

- Development of protocols for the generation of products and enforcement of requirements for clarity and traceability in product generation
- Development of guidelines for the specification of errors and uncertainties
- Intercomparison of similar products from existing and new missions to ensure globally consistent products and enable integrated products
- Efforts to make remote sensing data products consistent within domains, across domains, and with the requirements of intended uses
- Efforts to ensure long-term continuity, consistency and archiving of their data and 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**
- **Merged time series products (same variable from differing sensors and platforms), using a product-based approach**
- **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:

- Encourage national agencies to provide ground reference data for calibration and validation; CEOS should support efforts to establish, coordinate, and maintain observational networks (land, ocean and atmosphere) for this purpose
- Assess the quality of validation and coverage for data products in each domain and develop a strategy for improvement
- CEOS WGCV to establish a subgroup for validation of ocean carbon products analogous to the land product validation group
- CEOS WGCV to expand the number of land variables being addressed by the land validation subgroup
- CEOS should coordinate the cross calibration of all current and future satellites to measure atmospheric CO_2 and CH_4

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 GEO carbon community of practice to understand science needs and priorities for missing measurements that satellites could provide beyond 2020**

Major Action Regarding Implementation

- **CEOS will establish a group to be responsible for carbon activities within CEOS and for advancing the findings of this report. This group will take responsibility for overseeing, coordinating, and reporting on the actions identified in this report. It is recommended that CEOS establish a Carbon Subgroup within the CEOS Working Group on Climate as a most efficient way of implementing this action. The Carbon Subgroup will report to (and through) the WG Climate. It will establish strong working relationships with the relevant Virtual Constellations and other CEOS Working Groups, especially the Working Group on Calibration and Validation.**

Actions from Land Chapter for WGCV

- **Carbon-L-3: Continue (and initiate if necessary) programs for systematic inter-comparison of land data products that are generated from data collected by new remote sensing systems as they are launched.**

  → **CEOS WGCV and its relevant subgroups will organize and coordinate data product intercomparison activities as they are identified as priorities for CEOS action.**

- **Carbon-L-8: The Working Group on Calibration and Validation to expand the number of land variables currently being addressed by the land product validation sub-group.**

  → **The CEOS WGCV's Land Product Validation (LPV) subgroup will continue its work to validate satellite land data products and expand the number of land variables addressed as priorities are identified and available resources permit.**

Actions from Oceans and Inland Waters Chapter

- **Carbon-OIW-6: CEOS to encourage member agencies to include components of the ocean carbon pool among products from satellite data, and to ensure that they are validated appropriately. Link to CEOS Working Group on Cal/Val activities. Link to GEO Blue Planet initiative, which brings together communities engaged in satellite as well as *in situ* observations.**

  → The CEOS Working Group on Calibration and Validation (WGCV), in close consultation with the relevant VCs (that are doing some of this work now), will establish a subgroup dealing with validation and error characterization of ocean carbon products analogous to the Land Product Validation subgroup.

Actions from Atmosphere Chapter

- **Carbon A-3: Cross calibrate all of these sensors, coordinate their observations, and cross validate their X_{CO2} and X_{CH4} products against accepted international standards, so that they can be integrated into single continuous global climate record.**

  → The CEOS Atmospheric Composition Virtual Constellation, in cooperation with the CEOS Working Group on Calibration and Validation, will provide coordination and support for the cross calibration of all XCO2 and XCH4 sensors, coordinate their observations, and cross validate their XCO2 and XCH4 products against accepted international standards, so that they can be integrated into single continuous global climate record.

Actions from Integration Chapter

- **Carbon-I-12: Develop (with WG Climate and WGCV) effective protocols for the generation of products from individual satellites and platforms and implement these to ensure long-term consistent datasets relevant to carbon cycle community needs. This shall include accounting for ancillary data dependence (land cover, aerosol, cloud, DEM et al) such that there is consistency across individual products and variables.**

  → CEOS, working through its WG Climate and WGCV, will develop effective protocols for the generation of products from individual satellites and platforms and encourage their implementation by Member Agencies to ensure long-term consistent datasets relevant to carbon cycle community needs. This work shall include accounting for ancillary data dependence (land cover, aerosol, cloud, DEM, et al.) such that there is consistency across individual products and variables.

Actions from Integration Chapter

- **Carbon-I-16: Establish a CEOS community effort to ensure individual space agencies inter-compare products of relevance to the carbon cycle in collaboration with major inter-comparison activities (model-data, data-data, multiple data-stream).**
  - → **CEOS will reinforce the mechanisms already in place in CEOS for all domains (WGCV, and VCs, and WG Climate) and clarify their responsibilities to ensure intercomparison activities are effective.**
  - → **CEOS WGCV and its relevant subgroups will organize and coordinate data product intercomparison activities as they are identified as priorities for CEOS action.**

Actions from Integration Chapter

- **Carbon-I-18: Strengthen mechanisms within CEOS and at individual space agency level, in particular investment as part of satellite development, for product validation to establish validation methodologies, protocols and benchmark datasets. This must be guaranteed on timescales relevant for key science and policy problems and should be closely coordinated with the *in situ* observation community to ensure *in situ* data are accessible to the satellite community e.g. GAW, Argos, Fluxnet, RAINFOR, . . .).**
  - → **The CEOS WGCV's Land Product Validation (LPV) subgroup will continue its work to validate satellite land data products and expand the number of land variables addressed as priorities are identified and available resources permit.**
  - → **The CEOS Working Group on Calibration and Validation (WGCV), in close consultation with the relevant VCs (that are doing some of this work now), will establish a subgroup dealing with validation and error characterization of ocean carbon products analogous to the Land Product Validation subgroup.**
  - → **The CEOS Atmospheric Composition Virtual Constellation, in cooperation with the CEOS Working Group on Calibration and Validation, will provide coordination and support for the cross calibration of all XCO2 and XCH4 sensors, coordinate their observations, and cross validate their XCO2 and XCH4 products against accepted international standards, so that they can be integrated into single continuous global climate record.**
  - → **CEOS through its WGCV and relevant VCs will strengthen its mechanisms for product validation by establishing validation methodologies, protocols and benchmark datasets.**

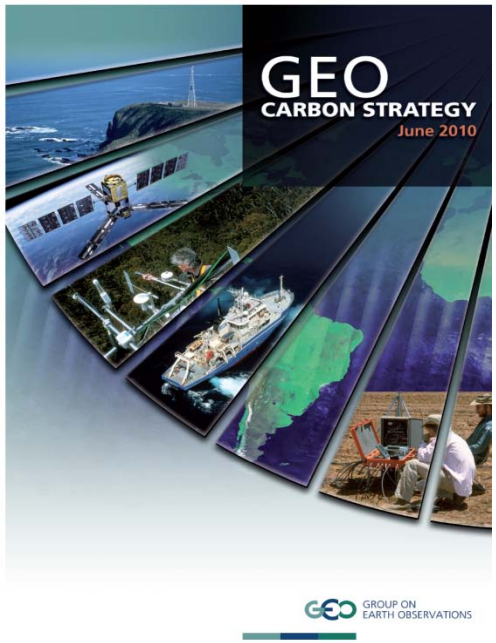
Actions from Integration Chapter

- **Carbon-I-18: Strengthen mechanisms within CEOS and at individual space agency level, in particular investment as part of satellite development, for product validation to establish validation methodologies, protocols and benchmark datasets. This must be guaranteed on timescales relevant for key science and policy problems and should be closely coordinated with the *in situ* observation community to ensure *in situ* data are accessible to the satellite community e.g. GAW, Argos, Fluxnet, RAINFOR, . . .).[CONT.]**
  - → **For each of the relevant variables in each of the domains assess the current provision of validation data in terms of quality (defined by protocols e.g. WGCV LAI protocol and or Maturity matrices e.g. WG Climate) and spatial and temporal coverage. Identify potential additional sources and develop a strategy to improve global in situ data distributions in relation to satellite validation and model parameterization. Exploit existing infrastructures to develop key intensive collection sites.**

Actions from Way Forward Chapter

- **Carbon WF-2: The CEOS Working Group on Calibration and Validation to support the CEOS agencies working to produce long time series data records across multiple sensors and platforms by encouraging and coordinating the calibration and validation activities essential to making those multiple data streams intercomparable.**

  → [same revised actions as for Carbon-I-18]



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