Progress report by the Committee on Earth Observation Satellites (CEOS) and the Coordination Group for Meteorological Satellites (CGMS) on a coordinated response to UNFCCC needs for global observations

Developed by CEOS and CGMS and submitted to the United Nations Framework Convention on Climate Change (UNFCCC) Subsidiary Body on Scientific and Technological Advice (SBSTA)

* October 2015

Executive Summary

At the 20th session of the Conference of the Parties (COP) to the United Nations Framework Convention on Climate Change (UNFCCC) in 2014, the 41st session of the Subsidiary Body for Scientific and Technological Advice (SBSTA) invited the Committee on Earth Observation Satellites (CEOS) and the Coordination Group for Meteorological Satellites (CGMS) to provide, for SBSTA-43 and the COP-21 in November–December 2015, an updated report on progress made by Space Agencies in providing global observations relevant to the convention.

Since the last report presented to SBSTA-41 CEOS and CGMS have made the following relevant progress:

Sensing – Data from an Essential Climate Variable inventory has been analysed to provide information complimentary to existing CEOS data bases.

Climate Record Creation and Preservation – A quantitative assessment of compliance of GCOS Essential Climate Variables using GCOS guidelines for data set preparation has been made. This analysis will help quantify the level of maturity of data sets, ensure openness and transparency, and help users judge the utility of the data set for their application.

Application – CEOS and CGMS have provided GCOS with a final report on Space Agency actions carried out in the 2011–2015 period in response to the GCOS 2010 Implementation Plan and 2011 Satellite Supplement. This input has been used in the GCOS 2015 status report that will be presented to SBSTA-43.

Decision Support – CEOS and CGMS joined the World Meteorological Organization and European Union Joint Research Center on a new report on case studies for climate services.

Since the last report CEOS has also made progress on implementation of its response to the Group on Earth Observations carbon strategy and water cycle strategies. A draft report on the water strategy is nearing completion and is expected to be finalized at the CEOS Plenary in November 2015 in time for COP-21.

1. Introduction

1.1. Purpose of the Report

This report responds to the UNFCCC invitation to CEOS/CGMS, from SBSTA-41, specifically:

“The SBSTA expressed its appreciation to CEOS and CGMS for their updated report on the progress made by space agencies providing global observations in their coordinated response to relevant needs of the Convention. It noted the importance of continuing and sustaining satellite observations on a long-term basis and welcomed the efforts to develop an architecture for climate monitoring from space. It invited CEOS to report on progress made at SBSTA-43, and at subsequent sessions, as appropriate.”

The goal of the CEOS/CGMS work is to improve the systematic availability of Climate Data Records through the coordinated implementation and further development of the architecture for climate monitoring from space. This work is accomplished through the Joint Working Group on Climate (WGClimate). More specifically, this coordination was designed to achieve three main objectives:

- Provision of a structured, comprehensive, and accessible view as to what Climate Data Records are currently available from satellite missions of CEOS and CGMS members;
- Creation of the conditions for delivering additional Climate Data Records, including multi-mission Climate Data Records, through best use of available data to fulfill GCOS requirements; and
- Optimization of the planning of future satellite missions and constellations to expand existing and planned Climate Data Records, both in terms of coverage and record length, and to address possible gaps with respect to GCOS requirements.

2. Progress on implementation of the architecture of climate observations from space

Progress is being measured against four main criteria identified in the *Strategy Towards an Architecture for Climate Monitoring from Space* as illustrated in Figure 1.

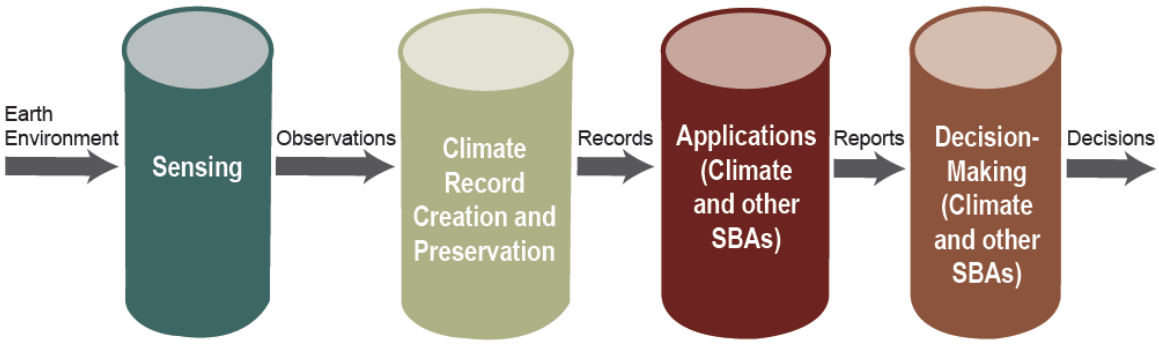

Figure 1. Schematic of the logical architecture of climate observations from space.

2.1. Sensing

CEOS has an existing data base entitled the Mission, Instruments, and Measurements (MIM). This online data base is updated annually and provides details on the instruments relevant to the GCOS Essential Climate Variables (ECV). The Essential Climate Variable inventory of CEOS/CGMS contains new and expanded information and is compatible with the existing MIM. In particular the inventory supports the requirement to understand whether a quality-controlled time-series of sensor data, called fundamental climate data records, is available. Such data will

have undergone extensive testing and reprocessing to ensure consistency and monitor calibration for the entire data record.

2.2. Climate Data Record Creation and Preservation

The ECV inventory is the first attempt to gather comprehensive information on all aspects of the Space Agencies' physical architectures. The CEOS/CGMS has made significant progress in the past year to conceive and implement a generic process (Figure 2) for:

- Assessment of completeness and consistency of record entries,
- Gap analysis, and
- Development of a coordinated action plan (not yet completed).

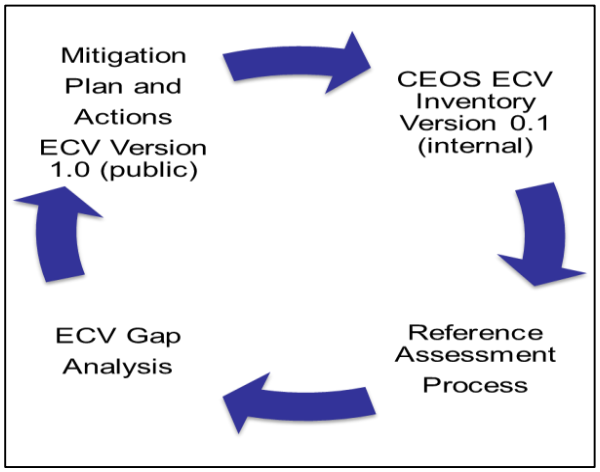

Figure 2. ECV Inventory cycle of activities.

This cycle of activities has proven more time consuming and complex than originally thought and so CEOS/CGMS have decided to do a few select ECV records as a trial of this approach. Most of this activity has also been applied to CDR creation and preservation. A reference assessment process and a gap analysis have been devised and applied to the select set of ECV reports. The mitigation plan and actions have not yet been developed.

Assessment of ECV/CDR Completeness

To conduct the assessment step, we used the *Guideline for the Generation of Datasets and Products Meeting GCOS Requirements* issued by GCOS in 2010 (GCOS-143) to prepare a set of questions used to populate the ECV inventory and assess the answers provided in the inventory by Space Agencies. It is important to note that it:

"… is intended to help all producers of climate-relevant datasets (e.g., meteorological services, research institutions, oceanographic centres, environmental agencies, space agencies, universities) in the way they document, assess the quality of, and publicize their work related to the generation, processing and analysis of climate datasets and derived products (i.e., Fundamental Climate Data Records and Essential Climate Variable products), based on observations from surface-based, airborne and satellite-based instruments.

Adherence to this guideline should help to:

- Facilitate the self-assessment of quality by data producers;
- Ensure transparency in the generation of climate datasets and products; and thereby
- Enable users to judge the quality and fitness for purpose of climate datasets and products.

In addition, complying with this guideline can help producers of climate datasets and products to demonstrate that they aspire to address GCOS requirements for data quality, completeness and transparency."

There are 12 questions in the GCOS guideline and many of the questions are multi-part. The response to each question was scanned for either an answer of "yes" or provided content. If one or the other was found, credit was given for answering the question (i.e., it was rated as compliant with the guideline). The number of positive responses per questions was weighted by the total possible so each of the 12 questions has a normalized score of between 0 and 1. A compilation of survey scores is provided in the following table:

GCOS Guideline	**Atmospheric**	**Oceanic**	**Terrestrial**
1. Full description of all steps taken in the generation of FCDRs and ECV products, including algorithms used, specific FCDRs used, and characteristics and outcomes of validation activities	71%	75%	75%
2. Application of appropriate calibration/validation activities	74%	55%	66%
3. Statement of expected accuracy , stability and resolution (time, space) of the product, including, where possible, a comparison with the GCOS requirements	73%	72%	56%
4. Assessment of long-term stability and homogeneity of the product	50%	44%	48%
5. Information on the scientific review process related to FCDR/product construction (including algorithm selection), FCDR/product quality and applications	50%	48%	48%
6. Global coverage of FCDRs and products where possible	88%	92%	91%
7. Version management of FCDRs and products, particularly in connection with improved algorithms and reprocessing	100%	73%	95%
8. Arrangements for access to the FCDRs, products and all documentation	66%	69%	67%

9. Timeliness of data release to the user community to enable monitoring activities	47%	46%	52%
10. Facility for user feedback	100%	69%	77%
11. Application of a quantitative maturity index if possible	4%	0%	0%
12. Publication of a summary (a webpage or a peer-reviewed article) documenting point-by-point the extent to which this guideline has been followed	68%	52%	61%

In general, we find high compliance with guidelines for reporting generation steps, documentation of calibration and validation, expected accuracy, global coverage, version control, and publication. Few respondents reported using a maturity index, but first peer-reviewed documentation on the maturity concept for data sets only appeared 2012. Many ECV data records were generated to support research activities and were not aimed at supporting routine climate monitoring with high timeliness.

This first attempt to quantify processes for documenting and preserving information on climate data sets is best viewed as a way to begin an ongoing conversation that helps data set producers and users ensure openness and transparency. The CEOS/CGMS is providing detailed reports to all Space Agencies who provided information, and the group would like to repeat the assessment and expand it to additional data sets in the future. Data sets produced for routine monitoring should be assessed on a regular basis and their producers should seek to improve areas where scores are low.

Gap Analysis

CEOS and CGMS have developed a gap analysis approach over the last year.

In particular, the approach:

- Focuses on the Climate Data Record needs;
- Capitalizes on the Climate Architecture via a link with the ECV Inventory;
- Systematically identifies and treats gaps.

This gap analysis approach is currently described in a working document and the initial analysis will be posted to the WGClimate web page.

2.3. Application

In preparation for the GCOS 2015 status report on the observing system, CEOS/CGMS have updated its 2012 document detailing progress on promised deliverables and responses to all 47

Space Agency actions identified in the GCOS 2010 Implementation Plan. The cycle and interaction of agencies is illustrated in Figure 3.

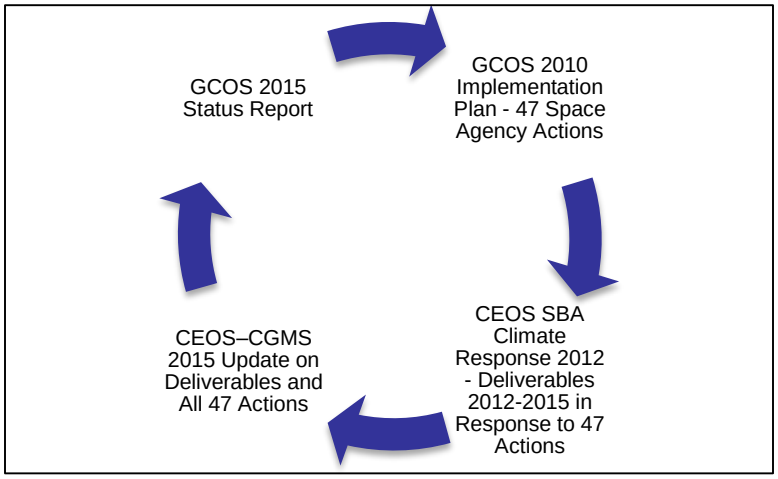

Figure 3. Cycle of GCOS and CEOS/CGMS contributions.

For this update, CEOS/CGMS have kept the original 2012 report format and updated appropriately each of the 47 GCOS actions. Since many factors influenced the ability of Space Agencies to respond, some responses are more complete than others. The updates have been provided by subject matter experts. As the responses are intended as input to the 2015 GCOS assessment, no attempt is made in the report to assess the overall status of Space Agency contributions to the climate observing system. The complete report is available on the WGClimate web site.

CEOS/CGMS have participated in relevant applications-oriented meetings. These include the *Implementation Coordination of GFCS* in September–October 2014 and the *GCOS Workshop on Enhancing Observations to Support Preparedness and Adaption in a Changing Climate – Learning from IPCC AR5* held in Bonn (GCOS-191).

2.4. Decision Support

The field of climate services continues to mature as the Global Framework for Climate Services begins to be implemented. In order to understand better how satellite observations are currently being used in decision support, the WMO Commission for Basic Systems (CBS) Inter-Programme Expert Team on Satellite Utilization and Products (IPET-SUP) and CEOS/CGMS collaborated on a report: *Climate Service Support from Space: Establishing an Architecture for Climate Monitoring from Space through Climate Service Case Studies*.

Thirteen case studies are described in this report and are intended to demonstrate use cases of satellite data for supporting climate services. As expected, integration of satellite data with surface-based observing systems, models, and socio-economic data is commonly used to generate the services. Case studies have been selected to provide representative coverage along

the following dimensions: services provided at global, regional, local scales; in developing and developed countries; and addressing research, applications, and policy levels. The case studies include, first, a description of the need for climate-related information in a particular area of socio-economic benefit; second, identification of the value added by satellite-based climate datasets for generating this information; and third, description of the observing system(s) required to generate these datasets. These attributes have been mapped to the climate monitoring architecture for each case study as shown in Figure 4.

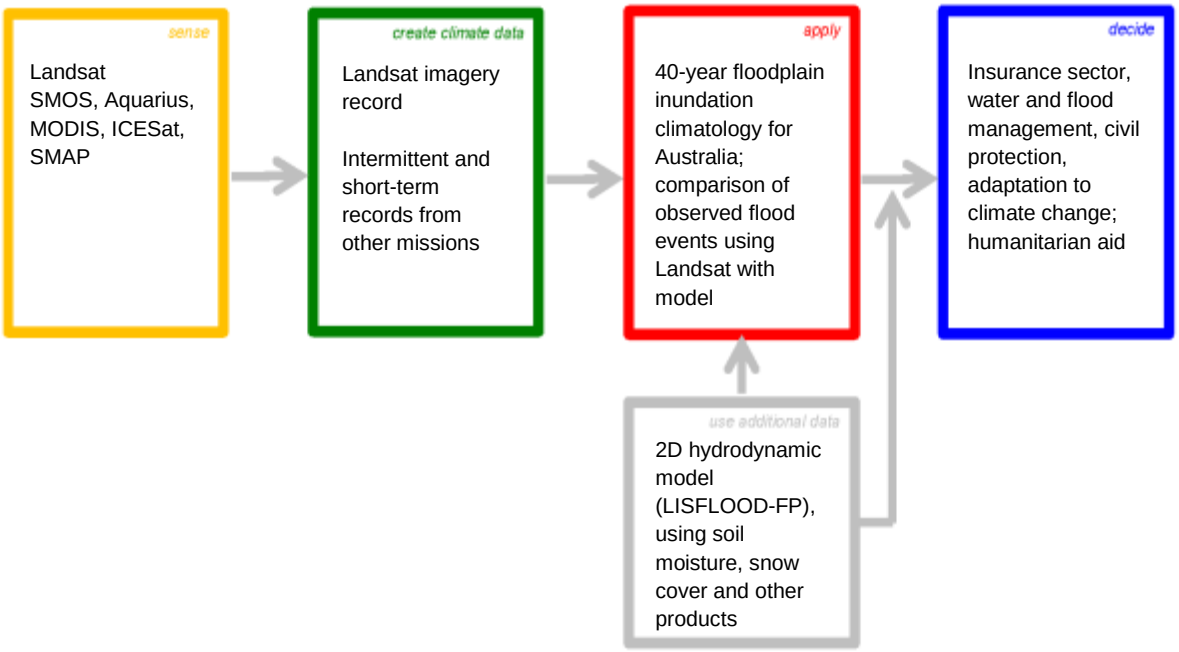

Figure 4. Illustration applying the architecture for climate observations to case studies of floods.

3. Carbon and Water cycles – Update of activities undertaken in the past year

CEOS Strategy for Carbon Observations from Space, was published in 2014 and reported to SBSTA-41. This report is available on the CEOS web site and is constantly updated as new data becomes available.

CEOS is also developing a response to the 2014 Group Earth Observation Water Strategy Report which is expected to be finalized at the CEOS Plenary in November 2015. It will then be published on the CEOS web site.

Conclusions

CEOS/CGMS has made significant progress in assessment and gap analysis of the Essential Climate Variable inventory. This progress will help ensure that production of ECVs is better documented, generation is more transparent, and data sets are accessible to the climate community.

Web sites for further information

CEOS/CGMS climate activities are organized through the Joint Working Group on Climate (WGClimate). For further information on the WGClimate please visit: http://ceos.org/ourwork/workinggroups/climate/

CEOS Mission, Instruments, and Measurements (MIM) data base that can be found online at http://database.eohandbook.com/

CEOS/CGMS final response to GCOS 2010 Implementation Plan can be found online at http://ceos.org/document_management/Working_Groups/WGClimate/WGClimate_The-CEOS/CGMS-Response-to-the-GCOS-2010-IP_Jun2015.pdf

Report on *Meeting on the Implementation Coordination of GFCS* can be found on the GFCS web site at http://www.wmo.int/gfcs/node/573

GCOS Workshop on Enhancing Observations to Support Preparedness and Adaption in a Changing Climate - Learning from IPCC AR5 held in Bonn (GCOS-191 at http://www.wmo.int/pages/prog/gcos/)