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SUSTAINED COORDINATED PROCESSING OF ENVIRONMENTAL SATELLITE DATA FOR CLIMATE MONITORING (SCOPE-CM)

Progress with the Sustained Co-Ordinated Processing of Environmental satellite data for Climate Monitoring (SCOPE-CM) has been made on several fronts. Progress with the five ongoing pilot projects, as well as with the development of a maturity index for satellite products has been made this year. Discussions are being held to encourage one or more additional pilot projects which would address an oceanic and/or another terrestrial Essential Climate Variable (ECV), and additional participation is being sought from the research space agencies in order to better address the research to operations transition for satellite products.

Action/Recommendation proposed:

Recommendation: CGMS Members, including research space agencies, are invited to participate in SCOPE-CM and propose additional pilot projects for the sustained and coordinated processing of environmental satellite data, in particular for the oceanic and/or terrestrial ECVs.

SUSTAINED COORDINATED PROCESSING OF ENVIRONMENTAL SATELLITE DATA FOR CLIMATE MONITORING (SCOPE-CM)

1 INTRODUCTION

Three major initiatives are being pursued by the WMO Space Programme, in partnership with satellite operating agencies, as a part of the WMO strategy to respond to GCOS requirements for satellite data and products for climate:

- Enhancing the space-based component of the Global Observing System (GOS) through fostering a “Vision for the GOS in 2025” ; the Vision was finalized by the fourteenth session of the WMO Commission for Basic Systems and adopted in June 2009 by the WMO Executive Council: (See: http://www.wmo.int/pages/prog/www/OSY/WorkingStructure/documents/CBS-2009_Vision-GOS-2025.pdf);
- Implementing a Global Space-based Inter-calibration System (GSICS), that is now in a well-advanced pre-operational stage (<http://gsics.wmo.int>); and
- Implementing Sustained Co-Ordinated Processing of Environmental satellite data for Climate Monitoring (SCOPE-CM), formerly named R/SSC-CM, which is the subject of this report.

The retrieval of geophysical products from satellite data requires important resources and expertise, considering all the steps needed to make the products available, including algorithm development and validation, operational processing, quality control, data archiving and stewardship. Each of these activities would benefit from increased international cooperation and collaboration, and SCOPE-CM is intended to do just that in order to ensure its sustainability.

2 BACKGROUND

Although it was called something else at the time, the concept of Sustained Co-Ordinated Processing of Environmental satellite data for Climate Monitoring (SCOPE-CM) was first discussed in January 2006 at the WMO Consultative Meetings on High-level Policy for Satellite Matters (CM-6). Further discussions took place one year later when EUMETSAT presented a proposal for a high-level concept of a global network of specific centres of excellence for the thematic area of operational climate monitoring. An important feature of the network was that it would be largely based on, and would exploit, existing infrastructure and activities. The network would utilize data from both environmental R&D satellites as well as operational meteorological satellites and would benefit from the operational activities of the Global Space-based Inter-calibration System (GSICS).

It was agreed that the overall goal of a global network would be the sustained and operational provision of high quality products relevant to the Essential Climate Variables (ECVs) on a global scale and hence would directly address the

requirements of the Global Climate Observing System (GCOS) as specified in the GCOS Implementation Plan and its Satellite Supplement. Participants were urged to work toward the development and approval of an Implementation Plan in time for the GEO Ministerial Summit in 2007.

The Implementation Plan was developed and adopted in 2007. The current version of the Implementation Plan is available online at: <http://www.wmo.int/pages/prog/sat/SCOPE-CM.html>. The initial organizations who committed their participation to the SCOPE-CM global network included: the China Meteorological Administration (CMA), EUMETSAT, the Japan Meteorological Agency (JMA), the National Oceanic and Atmospheric Administration (NOAA), and the United States Geological Survey (USGS); furthermore, the Committee on Earth Observation Satellites (CEOS), the Coordination Group for Meteorological Satellites (CGMS), GCOS and WMO agreed to provide overall guidance and facilitate coordination with relevant initiatives. EUMETSAT was nominated as the SCOPE-CM Secretariat.

At a planning meeting held in April 2008, five topics were selected, addressing areas of mutual interest, to serve as pilot projects, without precluding other subjects to be addressed in the future. These topics (which subsequently became pilot project proposals) are:

- 1: AVHRR based data set of cloud and aerosol properties
- 2: SSM/I: total column water vapour, precipitation, liquid water path
- 3: Surface albedo, clouds + aerosols from geostationary satellites
- 4: Atmospheric Motion Vectors (AMV) + clear sky radiance
- 5: Upper tropospheric humidity

A request for proposals for sustainable generation of climate products on these topics was issued by WMO to the potentially participating agencies (CMA, EUMETSAT, JMA, NOAA, USGS) and to CEOS for further communication to relevant CEOS Member agencies.

3 PROGRESS SINCE CGMS-36

The SCOPE-CM Executive Panel, with representatives nominated by participating agencies as well as CEOS, CGMS, GCOS and WMO is as follows:

- CEOS
- EUMETSAT
- GCOS
- GSICS and CGMS
- JMA
- NOAA
- WMO
- Ivan Petiteville
- Lorenzo Sarlo
- Stephan Bojinski
- Mitch Goldberg
- Toshiyuki Kurino
- John Bates
- Barbara Ryan

The Executive Panel held its first meeting in February 2009 where the pilot project proposals corresponding with the five areas of interest identified at the planning meeting were submitted, reviewed and ultimately approved for implementation. Additionally, in order to ensure cooperation and collaboration with the research community, representatives from the World Climate Research Programme (WCRP) were invited and attended this first SCOPE-CM Executive Panel meeting.

It was noted that SCOPE-CM should offer an opportunity to advance the transition from research to operations of ECV product generation; and therefore determined that it was essential to liaise with the relevant science communities and bodies such as the WCRP/GEWEX. In this regard, a joint meeting of the SCOPE-CM Executive Panel, representatives from the five pilot projects and the GEWEX Radiation Panel took place on 15-16 October 2009 in Rostock, Germany.

Recent work by NOAA and NASA on a Maturity Index (and later matrix) for Satellite Products has been introduced as one of the deliverables from SCOPE-CM. Pilot projects have been asked to apply the Index to their respective efforts as a preliminary test of the concept and of the construct. Progress on development of the maturity index/matrix, and feedback from the pilot projects on its application will be briefed at the upcoming Consultative Meeting on High-level Policy for Satellites Matters, 28-29 January 2010.

Lastly, in response to an action foreseen in the SCOPE-CM Implementation Plan, the GCOS Joint Planning Office communicated the "Guideline for the Generation of Satellite-based Datasets and Products meeting GCOS Requirements" to the SCOPE-CM Executive Panel (see Appendix). The Executive Panel decided that in addition to the maturity index/matrix, the GCOS Guidelines should be used as a basis for the assessment of existing and intended SCOPE-CM products.

4 CHALLENGES AND OPPORTUNITIES

SCOPE-CM can play a key role in addressing the requirements of GCOS for climate products related to the ECVs as specified in the GCOS Implementation Plan and its Satellite Supplement. If successful, this effort could represent one of the most important and tangible contributions of space-based Earth observations to the study of global climate change.

There remain, however, some challenges and, of course, some opportunities that, if addressed, would increase the likelihood of success of the SCOPE-CM concept and implementation. The Consultative Meetings and the SCOPE-CM Executive Panel emphasized two of these challenges:

- *The role of research agencies in the SCOPE-CM process -- We often speak of the research to operations (R2O) transition for satellite missions and instruments, but as referenced above, the generation of climate-related products can go through a similar transition. A lot is being done on the derivation of climate products from satellite data, though mainly within research-funded programmes. As with the R2O transition for satellites and instruments, the R2O transition for climate-related products would involve both research and operational teams. Once the product has reached a*

proper maturity level, an agency should take lead responsibility and commit for the generation of a stable product for a long period in an operational fashion. To date, the participating agencies in the SCOPE-CM process are primarily operational. Increased collaboration among research and operational agencies is certainly desirable. The Maturity Index for Satellite Products is also envisioned as a useful measure for monitoring and guiding this transition.

- *Linkages to other climate-related initiatives* -- With the renewed interest in climate change among policy makers worldwide, some major climate initiatives have recently received funding. Every effort should be made to establish linkages within our respective communities to ensure these climate-related initiatives and efforts are being optimized to the greatest extent possible, and that there is no duplication of effort.

3 CONCLUSIONS

SCOPE-CM can play a key role in addressing the requirements of GCOS for climate products related to the ECVs as specified in the GCOS Implementation Plan and its Satellite Supplement. If successful, SCOPE-CM could represent one of the most important and tangible contributions of space-based Earth observations to the study of global climate change by ensuring the sustained and coordinated processing of environmental satellite data for climate monitoring. The progress on the existing SCOPE-CM pilot projects is thus highly appreciated and the participating Organizations are encouraged to continue their effort on this matter.

Furthermore, the following recommendation is proposed:

CGMS Members, including research space agencies, are invited to participate in SCOPE-CM, as well as recommend additional pilot projects for the sustained and coordinated processing of environmental satellite data, in particular for the oceanic and/or terrestrial ECVs that are not addressed by the initial set of pilot projects.

APPENDIX

**Guideline for the Generation of
Satellite-based Datasets and Products
meeting GCOS Requirements**

March 2009

GCOS Secretariat

(Annexes not reproduced here; see for full document GCOS-128
<http://www.wmo.int/pages/prog/gcos/Publications/gcos-128.pdf>)

1. Introduction

This document provides a short summary of GCOS requirements for satellite-based climate monitoring that can serve as a guideline for the generation of satellite-based datasets and derived products in order to meet the requirements for climate monitoring and the long-term aspects of climate research.

These guidelines are intended to help space agencies and other relevant institutions in the way they process and analyze datasets obtained from satellite instruments, to subsequently generate Essential Climate Variable (ECV) products (cf. Annex I and III).

As noted in GCOS-107, satellite observing systems should, for the purpose of climate monitoring, adhere to the GCOS Climate Monitoring Principles (see Annex II) to the greatest extent possible. Datasets obtained from such satellite systems ("Fundamental Climate Data Records, FCDRs") will be of maximum value for monitoring the state of the Earth's climate, through, e.g., trend analyses, assimilation in climate models, use in reanalyses, and validation of model outputs. Satellite systems include both instruments with plans for sustained operation and continuity, as well as instruments mainly intended to support research interests of limited duration.

It is recognized that, given the complexity of some ECV-related products, additional expertise and guidance may be needed for the generation of FCDRs and ECV satellite products, depending on the specifics of each case and application.

2. Background

In 2006, GCOS provided supplemental detail to the space-based requirements of the *Implementation Plan for the Global Observing System for Climate in Support of the*

UNFCCC¹ (GCOS-92, October 2004, the 'GCOS Implementation Plan') by issuing the document *Systematic Observation Requirements for Satellite-based Products for Climate*² (GCOS-107, September 2006, hereafter called the 'Satellite Supplement').

The GCOS Steering Committee, at its 15th session in October 2007, requested "the GCOS Secretariat, in collaboration with the GCOS science panels, to develop guidelines for datasets and products meeting GCOS requirements, in response to the needs of [...] space agencies."

Before that, the GCOS Atmospheric Observation Panel for Climate, at its 13th session in April 2007, had recognized that "it could be beneficial for GCOS to develop a process through which it might formally or informally recognize products that meet the requirements expressed in the Second Adequacy Report and the Implementation Plan. As an example, it was suggested that a data set might be formally recognized once it had been described in the peer-reviewed literature and made freely available to users."

The need for guidelines to support such a recognition process has been identified by space agencies, for example, in the context of the SCOPE-CM initiative (Sustained Coordinated Processing of Environmental Satellite Data for Climate Monitoring).

3. The Satellite Supplement (GCOS-107)

The Satellite Supplement stated requirements for datasets and products addressing 26 ECVs (see Annex I) with a major satellite component, as well as nine cross-cutting needs, for the purpose of systematic observation of climate from space. The document made indications in terms of expected accuracy, stability and resolution of ECV satellite products. It also included indications for the Fundamental Climate Data Records (FCDRs) required for the generation of products, relevant satellite instruments, necessary involvement of expert groups, supplemental needs for non-FCDR-type data records, and other application areas of ECV satellite products.

As such, the Satellite Supplement already provides a substantial body of guidance for the generation of datasets and products with the intention to meet GCOS requirements. These requirements are being updated by GCOS science panels on a regular basis, with involvement of relevant expert groups as appropriate. These updates are also provided to WMO as input to the Rolling Review of Requirements of the WMO Global Observing System (GOS)³. In addition, given the complexity of climate variability and, in part, limited knowledge of the expected variability of ECVs over space and time, several caveats apply to the use of requirements as such. For example, it is possible that a combination of data records from two satellite instruments, neither of which meeting any of the requirements given in the Satellite Supplement, could usefully meet the needs for climate monitoring if applied together in careful analysis.

4. Guideline

A guideline for the generation of FCDRs and derived ECV satellite products, and subsequent quality assessment by providers as well as users, is given by adherence to the following:

¹ GCOS (2004): *Implementation Plan for the Global Observing System for Climate in Support of the UNFCCC*, GCOS-92, October 2004, http://www.wmo.int/pages/prog/gcos/Publications/gcos-92_GIP.pdf

² GCOS (2006): *Systematic Observation Requirements for Satellite-based Products for Climate* – Supplemental details to the satellite-based component of the GCOS Implementation Plan, GCOS-107, September 2006, <http://www.wmo.int/pages/prog/gcos/Publications/gcos-107.pdf>

³ The WMO/CEOS database requirements, including those by GCOS, can be found at <http://www.wmo.int/pages/prog/sat/Databases.html#UserRequirements> (26 March 2009)

- Fundamentally, the GCOS Climate Monitoring Principles, in particular those specific to satellite systems (see Annex II)
- In expanded form, the Satellite Supplement (see Annex III); wherever target requirements for particular ECV satellite products are given in the Satellite Supplement, it is expected that the producer as well as the user of these products will be able to judge whether the product meets these requirements, provided adequate documentation (metadata etc.) is available

In line with the GCMPs and the Satellite Supplement, the GCOS Steering Committee recommends particular attention to the following needs related to the generation of ECV satellite datasets and products:

1. Full description of all steps in the generation of datasets and products, including algorithms used, specific FCDRs used, and characteristics and outcomes of validation activities
2. Information on publications in peer-reviewed journals, covering both the description and the application of datasets and products
3. Statement of expected accuracy, stability and resolution (time, space) of the product, including, where possible, a comparison with the requirements stated in the Satellite Supplement (or any subsequent revision)
4. Arrangements for access to the datasets, products and all documentation
5. Version management of datasets and products, particularly in connection with improved algorithms and reprocessing
6. Long-term stability and homogeneity of the product
7. Full application of all appropriate calibration/validation activities that would enhance product quality
8. Global coverage where appropriate
9. Timeliness of data release to the user community to enable monitoring activities
10. Facility for user feedback
11. Application of a quantitative maturity index if possible
12. Publication of a summary (preferably on-line) documenting point-by-point the extent to which this guideline has been followed

Experience with historical satellite data records has shown that continuous, cyclical improvement of the quality of datasets and product is generally needed, since historical records usually have challenges in terms of homogeneity. A one-time assessment of quality/maturity of datasets and products must not preclude this improvement over time.