

**SPACE-BASED WEATHER AND CLIMATE EXTREMES MONITORING (SWCEM)**

HLPP Reference: 5.1.9

The purpose of this paper is to report to CGMS on the WMO initiative entitled 'Toward an Operational Space-based Monitoring of Weather and Climate Extremes (SWCEM)'. It is proposed to start the SWCEM with a 'SWCEM Demonstration Project', called SEMDP. The SEMDP should begin in 2018 with a duration of two years. It is also envisaged to involve selected WMO Regional Climate Centres (WMO RCCs) in the SEMDP and to initially confine the project to space-based monitoring of heavy precipitation events over periods of a pentad or a week up to month. For drought events monitoring, a period of about a month is considered. CGMS is asked to comment on the proposed project and to place actions on members and the IPWG and also CEOS-CGMS WG Climate to support the realization of the SEMDP.

**Actions proposed:**

- *NOAA/NESDIS is kindly requested to support the project by providing satellite observations of heavy precipitation events, and land surface parameters for monitoring droughts. The observations are required with a short latency of about one day. Furthermore the project requires the creation of climate reference data sets which will be used by the RCCs to classify observations as extreme event or not. (Due date: December 2017);*
- *JAXA is kindly requested to support the project by providing a short-term (from 5-day up to monthly) climate normal from GSMaP data archives as a reference precipitation data set for the initial SEMDP areas, i.e. East Asia and Western Pacific regions. JAXA is also requested to set-up the on-line environment to provide GSMaP data with short latency to be utilized in the SEMDP (Due date: December 2017);*
- *CGMS requests IPWG (i.e. the co-chairs and the rapporteur) to provide guidance on the estimation of uncertainties and representativeness of the short-latency precipitation products;*
- *CEOS/CGMS Working Group on Climate is asked to provide feedback on the proposed definition for ICDR<sup>1</sup>.*

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<sup>1</sup> (originally from CM-SAF reiterated at SWCEM): "Interim Climate Data Record is a CDR regularly updated with an algorithm / system having maximum consistency to TCDR generation algorithm / system. The update cycle depends on the user needs for climate extremes and might range from pentad to monthly."

# TOWARD AN OPERATIONAL SPACE-BASED WEATHER AND CLIMATE EXTREMES MONITORING (SWCEM)

## 1 INTRODUCTION

Climate projections anticipate more intense precipitation and also longer dry spells without or insufficient precipitation. Those imply increased risks of flooding and drought which pose major challenges for societies at large and those who have to manage water resources (Trenberth and Asrar, 2014). Uneven spatial and temporal distribution of precipitation leading to increased risks of flooding and drought with a clear impact to social and economic sectors (e.g. forestry, agriculture, food supply). Flood and drought set out major challenges for decision makers with regard to manage water resources

These kind of extreme events bear high risks for natural disasters. The use of remote sensing observations for monitoring and assessment of drought is justified on the basis that vegetation vigour is closely related to moisture conditions. Extreme events of that nature are also known to bear high risks for disaster. Opportunities and initiatives for managing risks of weather- and climate-related disasters do exist or can be developed. The purpose of this paper is to report to CGMS on the WMO initiative entitled 'Operational Space-based Monitoring of Weather and Climate Extremes (SWCEM)'. It is proposed to start the SWCEM with a 'SWCEM Demonstration Project' called SEMDP. The SEMDP should begin in 2018 with a duration of two years. It is envisaged to designate selected WMO Regional Climate Centres (WMO RCCs) to the SEMDP. Initially the project will be confined to space-based monitoring of heavy precipitation events and droughts.

The paper provides the background in section 2 and summarizes the main outcomes of a dedicated workshop held from 15 - 17 February 2017 in Geneva in section 3. Section 4 recalls decisions requested from the 69<sup>th</sup> WMO Executive Council (EC-69) in May 2017. Section 5 outlines the initial steps of the SEMDP. The final section 6 requests CGMS-45 to place actions in order to support the realization of the project.

## 2 BACKGROUND

It is recognized that there is a need to better utilize and improve the monitoring of weather and climate extremes from space. Stakeholders to pursue this objective include satellite operators, WMO Regional Climate Centres (RCCs), National Meteorological and Hydrological Services (NMHSs) and other relevant institutes. The pivotal role to be played by WMO was the reason to give visibility of the SWCEM to WMO member states by requesting endorsement and decision from the WMO EC in May 2017.

Here it is instructive to recall the definition an extreme weather and extreme climate events as provided in the IPCC 5th Assessment Report (WG 1 Glossary):

*'An extreme weather event is an event that is rare within its statistical reference distribution at a particular place. Definitions of 'rare' vary, but an extreme weather event would normally be as rare as or rarer than the 10th or 90th percentile. By definition, the characteristics of what is called extreme weather may vary from place to place.*

*An extreme climate event is an average of a number of weather events over a certain period of time, an average which is itself extreme (e.g. rainfall over a season)`.*

High-resolution products, potentially useful for the SWCEM, are available, often on a quasi-real time basis, e.g. for monitoring precipitation, land surface temperatures, soil moisture and vegetation. The existence and adequacy of such products provides opportunities to evaluate the products for monitoring weather and climate extremes on a short-term (pentad or weekly) basis. Although it is likely that current satellite products alone may be not fully adequate from the beginning, the quasi-operational use of the satellite products in a demonstration phase will, in conjunction with surface based observations, help to improve quality and contributions of the satellite products themselves.

To this end it is proposed to begin the SWCEM with Demonstration Projects called SEMDP to be conducted by WMO RCCs. A couple of RCCs have already volunteered to pursue individually such demonstration projects over a period of two years. After the demonstration phase the results and the performance of satellite products will be evaluated and can also be reported to CGMS.

It is noted that for some of the satellite products, e.g. precipitation products, guidance on improvements is needed. Those could be provided by experts from the IPWG. Therefore, CGMS is kindly requested to support the SWCEM project by placing an action on the IPWG co-chairs and the IPWG rapporteur (see section 6).

### **3 WORKSHOP ON OPERATIONAL SPACE-BASED WEATHER AND CLIMATE EXTREMES MONITORING**

A workshop on Operational Space-based weather and climate Extremes Monitoring was held from 15-17 February 2017 at WMO in Geneva. The aim of the workshop was to foster a dialogue among satellite operators and WMO RCCs, NMHSs and relevant institutes to stimulate the utilization of space-based observation data and products for monitoring selected 'Weather and Climate Extremes' on a routine basis ("in operations"), in response to current and future user requirements. The four objectives of the workshop were:

- (1) To present use-cases for satellite-derived products focusing on monitoring extreme events with regard to 'accumulated high precipitation' and 'drought' ("current provisions baseline and practices")
- (2) To understand and document the requirements from WMO RCCs and relevant institutes for monitoring weather and climate extremes in operations, with a focus on 'accumulated high precipitation' and 'drought' ; these requirements are not necessarily related to satellite data - many RCCs currently do not use space-based data ("current needs, requirements, practices")
- (3) To identify lessons learned in the formulation of weather and climate extremes-related requirements and satellite-specific responses, and to

formulate a preliminary response by RCCs and relevant institutes to the identified requirements (“looking forward - matching user needs and provisions”)

- (4) To assess the feasibility of a demonstration of space-based weather and climate extremes monitoring in operations, for strengthening the capacity of NMHSs (“looking forward: demonstration activity”)

The workshop concluded with several recommendations and the detailed report is available from: [http://www.wmo.int/pages/prog/sat/documents/SAT-GEN\\_Workshop-Monitoring-Extremes-Space-Feb2017.pdf](http://www.wmo.int/pages/prog/sat/documents/SAT-GEN_Workshop-Monitoring-Extremes-Space-Feb2017.pdf)

#### **4 DECISION REQUESTED FROM WMO EC-69**

After the successful workshop described in the previous section the WMO Secretariat brought the matter to the 69<sup>th</sup> WMO Executive Council (EC-69) in May 2017. The following provides quotes from the paper submitted to WMO EC-69:

##### **EC-69 noting:**

- (1) The increase in the frequency of extreme weather and climate events and their impact on the society is requiring the development and implementation of new tools for monitoring these phenomena using remote sensing techniques. Many countries need an adequate human and technological capacity to provide a good level of services and the transfer of knowledge from countries with greater technological developments is essential;
- (2) A workshop on Operational Space-based Weather and Climate Extremes Monitoring on 15 to 17 February 2017 in Geneva was attended by satellite operators, research and development space agencies, WMO Regional Climate Centres (RCCs) and National Meteorological and Hydrological Services (NMHSs) to stimulate enhanced utilization of space-based observation data and products for monitoring of weather and climate extremes over pentad (5-day), weekly and other periods of up to a month, in order to respond to current and future user requirements;
- (3) The workshop recognized that significant progress has been made in recent years in developing space-based observations in most geophysical fields, and that several high-resolution products were available on a quasi-real-time basis, enabling enhanced utilization for monitoring weather and climate extremes from space;

##### **Responses from EC-69 were as follows:**

**EC-69 decides** to support a demonstration project on space-based weather and climate extremes monitoring (SEMDP) in WMO Regions to the extent that resources are available;

##### **EC-69 requests:**

- (1) The presidents of the Commission for Climatology (CCI) and the Commission for Basic Systems (CBS), with the support of the other TCs and RAs, to:
  - (a) Establish a demonstration project on space-based weather and climate extremes monitoring (SEMDP) and decide on priority WMO Region(s) starting in 2018 for a two year duration;
  - (b) Identify the deliverables of the demonstration project, concentrating on products at national and regional levels:
    - i. Monitoring accumulated heavy precipitation and droughts;
    - ii. Making best use of existing and newly developed satellite derived products and time series of measurements;
    - iii. Making best use of products that combine satellite information with in situ and/or model reanalysis data;
  - (c) Assess the SEMDP products and other results, and recommend which should be transitioned from research to operations;
- (2) The Secretary-General to provide the necessary assistance and mobilize resources for the establishment of a pilot SEMDP in WMO Regions.

## **5 OUTLINE OF THE SWCEM DEMONSTRATION PROJECT (SEMDP)**

The outline of the initial steps and the key elements of the SEMDP are as follows:

- WMO Secretariat will draft an Implementation Plan (IP) for the SEMDP by September 2017. Experts from CBS and CCI will be requested to review the IP and provide comments.
- Finalization of the draft SEMDP Implementation Plan by WMO Secretariat by end of November 2017.
- The SEMDP will be conducted by WMO RCCs in East Asia and Western Pacific regions and those will also be asked to endorse the implementation plan.
- WMO will call for a workshop as kick-off for the SEMDP in early 2018.
- During the SEMDP the RCCS will validate satellite derived products with CLIMAT and/or SYNOP data for monitoring continuous heavy precipitation and drought. It is a goal to do the monitoring over relatively short periods from pentads (5-day) up to a month. It is noted that currently extreme events are diagnosed on monthly basis by most of RCCs.

The 2-year SEMDP will concentrate on products at national and regional levels. Items to be worked on include:

- (i) monitoring accumulated heavy precipitation and droughts;
- (ii) evaluating of temporal relationship between precipitation and vegetation condition at time-lag and cumulative rainfall intervals;

- (iii) making best use of existing and newly developed satellite derived products and time series of measurements;
- (iv) making best use of products that combine satellite information with in-situ and/or model reanalysis data;
- (v) recommendations as to which products should be transitioned from research to operations, including an assessment of those products.

A final report of the SEMDP will be compiled and reviewed. The next steps will then be based on the outcome of the demonstration phase.

## **6 FOR CONSIDERATION BY CGMS**

There are elements of the SEMDP which require action and CGMS can help on those issues. In the following those elements are summarized and actions are proposed:

- a) An important pre-requisite for the SEMDP is the availability of a climate reference data set which will be used for comparison in the near-real time monitoring. That means the reference data set will be decisive to judge whether an event is considered extreme. Such a reference data set for precipitation should be created from existing observations from satellites.
- b) Uncertainty estimates for the precipitation ICDRs being used in the SEMDP are crucial for the project. Expertise in product validation is required to provide good estimates of accuracies.
- c) Ideally the reference data sets should be recognized TCDRs (Thematic climate data record). De facto one would rather consider those as ICDRs (Intermediate Climate Data Record) requiring a reprocessing to become a TCDR. This begs the question whether the process for the derivation of the ICDR is in line with established procedures. It is suggested not to address this matter during the demonstration phase (SEMDP) because it may not crucially add to the outcome of the SEMDP (it is assumed that the ICDR will not be too far off from a final TCDR). However, at a later stage the adequacy of ICDRs needs to be addressed. The right body to check this matter would be the CEOS/CGMS Working Group Climate.

## **7 PROPOSAL FOR ACTIONS BY CGMS-45**

- *NOAA/NESDIS is kindly requested to support the project by providing satellite observations of heavy precipitation events, and land surface parameters for the monitoring droughts. The observations are required with a short latency of about one day. Furthermore, the project requires the creation of climate reference data sets which will be used by the RCCs to classify observations as extreme event or not. (Due date: December 2017);*
- *JAXA is requested to support the project by providing a short-term (from 5-day up to monthly) climate normal from GSMaP data archives as a reference precipitation data set for the initial SEMDP areas, i.e. East Asia and Western*

*Pacific regions. JAXA is also requested to set-up the on-line environment to provide GSMaP data with short latency to be utilized in the SEMDP (Due date: December 2017);*

- *CGMS requests IPWG (i.e. the co-chairs and the rapporteur) to provide guidance on the estimation of uncertainties and representativeness of the precipitation reference data sets (i.e. the precipitation ICDR);*
- *CEOS/CGMS Working Group Climate to provide feedback on the proposed definition for ICDR.*

## **REFERENCES**

Trenberth, K. E. and • G. R. Asrar, 2014: Challenges and Opportunities in Water Cycle Research: WCRP Contributions. *Surv. Geophys.*, 35:515–532 DOI 10.1007/s10712-012-9214-y

WMO (2017): Meeting Report: Workshop on Operational Space-based Weather and Climate Extremes Monitoring, Geneva, Switzerland, 15-17 February 2017 [http://www.wmo.int/pages/prog/sat/documents/SAT-GEN\\_Workshop-Monitoring-Extremes-Space-Feb2017.pdf](http://www.wmo.int/pages/prog/sat/documents/SAT-GEN_Workshop-Monitoring-Extremes-Space-Feb2017.pdf)