An Introduction of the WMO Space based Weather and Climate Extremes Monitoring (SWCEM) Project

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Outline

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- The WMO Space based Weather and Climate Extremes Monitoring (SWCEM) Project
- The SWCEM Demonstration Project (SEMDP)
- NOAA/CPC's Involvements
- Summary

Background

[1] Technology Push and User Pull

Technology Push

- Technology development in recent decades enabled quantitative documentation of weather and climate with improved quantitative accuracy and at a refined time / space resolution
- Example: Resolution of satellite based precipitation estimates have been reduced from 2.5°lat/lon / pentad (GPCP/CMAP) in the 1990s to ~0.1°lat/lon / 30-minutes (CMORPH/IMERG/GsMAP) currently

User Pull

- Users at regional, national, and local levels intend to improve their monitoring of weather and climate with in situ as well as remote sensing data (radar, satellite)
- Satellite based monitoring especially important to developing countries with extensive territory of complex topography

Background [2] Movements from the WMO

• The People

Toshiyuki Kurino (操野年之) chief, Space-based Observing System Division Space Programme Office World Meteorological Organization (WMO)



- Key Activities
 - Aug. 2016: Checking with experts on feasibility to establish a new framework for satellite-based climate extremes monitoring
 - Sep. 2016: Developing concept on the implement of a project on 'Operational Space-based Weather and Climate Extremes Monitoring (SWCEM)'
 - Dec.2016: Preparing a workshop on the SWCEM Project

The WMO/SWCEM Project [1] The WMO SWCEM Workshop [1/3]

- Time / Location:
 - 15-17 Feb., 2017, Geneva, Switzerland
- Objective:

to match "technology push" by providers of satellite data and products (satellite operators and RCCs), with "user pull" by NMHSs (including RCCs) and other users regarding the monitoring of selected weather and climate extremes. Specifically the workshop intends to

- Present use cases for satellite-derived products focusing on monitoring extreme events with regard to 'accumulated high precipitation' and 'drought (e.g., indicated by precipitation deficit, land surface temperature anomaly, vegetation state)', including an indication of their fitness-for-purpose;
- Understand and document the needs by RCCs for monitoring weather and climate extremes in operations, with focus on 'accumulated high precipitation' and 'drought';
- Derive general lessons for the formulations of weather and climate extremes-related needs and satellite-specific responses, and formulate a preliminary response by RCCs to the identified needs;
- Assess the feasibility of demonstration of space-based weather and climate extremes monitoring in operations for strengthening the capacity of NMHSs in developing countries including least developed countries (LDCs) and Small Island Developing States (SIDSs); this will enable these NMHSs to deliver better information on extreme events to save lives and livelihoods, and protect property and infrastructure.

The WMO/SWCEM Project [2] The WMO SWCEM Workshop [2/3]

- Activities
 - Presentations by WMO programmes, satellite products developers as well as users (RCCs, NMHSs)
 - Break-out discussions on key topics
 - Dr. P. Xie made presentations on
 - a) Use of satellite products at NOAA/CPC; and
 - b) Possible use of CMORPH in the monitoring of weather / climate extremes



The WMO/SWCEM Project [3] The WMO SWCEM Workshop [3/3]

- Recommendations (to WMO):
 - Develop a process to determine RCC product needs for monitoring weather and climate extreme events...
 - Develop a regional demonstration study to be done over the next 1-2 years that includes ... RCC's and BMKG and satellite providers, with a focus on RA II / RA V (East Asia/ Western Pacific Region), as a proof-of-concept.

The WMO/SWCEM Project

[4] WMO EC-69 Adopted the Recommendation on SWCEM

- 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;
- Requests:
 - 1)

The presidents of the Commission for Climatology (CCl) 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.

The SWCEM Demonstration Project [1] Preparing for the Demonstration Project (SEMDP) [1/2]

- WMO decided to start the SWCEM Demonstration Project (SEMDP) for South Asia and the Pacific in early 2018;
- To this effect, WMO invited a small group of experts to have a preparatory meeting discussing technical details and implementation plan for the SEMDP;

- Dates: Sept. 25-29, 2018
- Venue: WMO HQ



The SWCEM Demonstration Project [2] Preparing for the Demonstration Project (SEMDP) [2/2]

- Invitees, contents and format of the Kick-off workshop early 2018 in Indonesia;
- Draft implementation plan for the SEMDP (3-level structure)
 - Global Centers for Satellite Information
 - to provide the satellite derived products,
 - to enrich the guidance assessed by the WMO RCCs;
 - to examine the requirements of the WMO RCCs and to propose a way to make the requested products available;

• WMO Regional Centers (RCCs)

- to develop and maintain updated monthly guidance documentation, taking into account the needs and requirements of participating countries;
- to contribute and participate in co-ordinating training opportunities from time to time;
- to develop and maintain reliable archiving processes for all daily guidance (for post mortem verification);

• National Meteorological and Hydrological Services (NMHSs)

- to develop suitable warning bulletins for DMCPA services (if not already implemented) and to agree with them on the feedback procedure
- to gather information to provide feedback on the products to regional and global centres

The SWCEM Demonstration Project [3] The WMO / SEMDP Kick-off Workshop [1/2]

- Dates : March 19 20, 2018
- Venue : BMKG, Jakarta, Indonesia
- Objective:
 - to kick off the SEMDP
 - to involve selected WMO Regional Climate Centres (WMO RCCs) in the SEMDP
 - to revise / expand the details of the demonstration projects



The SWCEM Demonstration Project [6] SEMDP Spatial Domain and Satellite Products

• Precipitation

- hourly, daily (00-00UTC), pentad (5-day), 10-day, weekly (Monday Sunday), and monthly statistics with climate normal from satellite observation;
- Data latency would be less than 4 hours
- Space resolution: 0.1 x 0.1 degrees for all, 0.25 x 0.25 degrees (monthly) with SPI calculation for grid boxes over land
- Archive at the ftp site: 1 year period

Other Satellite Products

- OLR
- Combined GEO TBB
- NDVI / VHI / Soil Moisture

Climatology

- climate normal
- percentiles (90th, 95th, 99th)
- percentage of rainy (>=1mm/day) days in a month



The SWCEM Demonstration Project [7] Global Centers Provided the Required Products to WMO

- JAXA, NOAA/NESDIS and NOAA/CPC created the satellite products as required by the SEMDP and provided to WMO
- WMO established a web portal with links to the satellite products
- JAXA and NOAA/CPC conducted illustration studies for the use of satellite products in the monitoring of three extreme precipitation cases over the SEMDP region
- WMO portal link:

http://www.wmo.int/pages/prog/sat/SEMDP/semdp_portal.html <u>Illustration</u>

The SWCEM Demonstration Project [8] Training Workshop [1/2]

- Dates: Oct.31 Nov.2, 2018
- Venue: Kuala Lumpur, Malaysia (held together with ASEANCOF-11)
- Objectives:
 - To introduce to RCCs and NMHSs of the products prepared by global providers
 - To present case study results
 - To exchange information on operational status of and needs / requirements for satellite products



The SWCEM Demonstration Project [9] Training Workshop [2/2]

- Personal Impression
 - Satellite products provide useful information in the monitoring of extreme weather and climate especially over regions of poor in situ networks
 - Satellite products are not used widely over most of the SEMDP NMHSs;
 - Global centers are quite active in providing their products
 - Level of involvement and technical capacity differ greatly from country to country over the SEMDP region
 - Must start with something simple to push for increased and improved applications of satellite products in the operational settings in the target regions;

The SWCEM Demonstration Project [10] SEMDP Steering Group (SG)

• Composed of WMO program managers and representatives of global products providers, RCCs, and selected NMHSs



The SWCEM Demonstration Project [11] Key Players of the SEMDP

















NOAA/CPC's Involvements [1] CPC's Unique Roles

- CPC is a pioneer in the applications of satellite products to climate (monitoring, diagnostics, verifications, forcing models);
- CPC also develops satellite-based products for climate applications when no appropriate products are available from satellite centers;
- Within WMO/SWCEM, CPC shares its experience in utilizing satellite products for climate monitoring and provides its own satellite products to the WMO project

NOAA/CPC's Involvements [2] CPC Satellite Products Provided to SEMDP

- Precipitation
 - CPC Daily Gauge Analysis
 - CMORPH bias corrected (CMORPH_CRT)
 - CMORPH blended with gauge (CMORPH_BLD)
 - SPI derived from the three precipitation products
 - Climatology associated with the three products
- Other Satellite Products
 - OLR (AVHRR, HIRS)
- Processed NESDIS/STAR soil moisture and vegetation index products for the SEMDP
- Made products available to WMO and anyone interested
 - In both NetCDF and GIF Graphics
 - Available through ftp at:
 - http://ftp.cpc.ncep.noaa.gov/precip/PORT/SEMDP/

NOAA/CPC's Involvements [3] Sample products [1/3]



Animation of Real-time Updated CMORPH Hourly Precipitation

NOAA/CPC's Involvements [4] Sample products [2/3]



Animation of Real-time Updated CMORPH_BLD 30-day SPI

NOAA/CPC's Involvements [5] Sample products [3/3]



Animation of Real-time Updated NESDIS/STAR NDVI

NOAA/CPC's Involvements

[6] Weekly Summary in Both Digital and Graphics Format

- ESA/CCI is first adjusted against NOAA/NESDIS/CCI through PDF matching using overlapping data for 2015 – 2016
- Daily soil moisture climatology is defined using the adjusted CCI data for 1998 – 2014 and SMOPS for 2015 – 2017;

Weekly SMOPS

(2018.11.05.-2018.11.11.)



NOAA/CPC's Involvements [7] SEMDP Case Study [1/6]

Cases to be Examined

• Case 1

- Heavy rainfall
- Malaysia, Singapore, Thailand
- November December 2014
- *Case 2*
 - Heavy rainfall
 - Lao People's Democratic Republic
 - August 2016
- Case 3
 - Drought
 - Singapore, Malaysia, Indonesia
 - January March, 2014

NOAA/CPC's Involvements [8] SEMDP Case Study [2/6]

Cases to be Examined

- CPC Gauge Analysis
 - Grid analysis of daily precipitation produced through interpolation of GTS station reports
- CMORPH_CRT
 - Bias Corrected CMORPH satellite precipitation Through PDF matching against CPC Gauge Analysis
- CMORPH_BLD
 - Bias corrected CMORPH further blended with daily gauge analysis
- NDVI
 - NESDIS/STAR Vegetation Index
- VHI
 - NESDIS/STAR Vegetation Health Index
- SMOPS
 - NESDIS/STAR Satellite based Soil Moisture Product

NOAA/CPC's Involvements [9] SEMDP Case Study [3/6]

Cases 1 : Heavy Rainfall





Several episodes of heavy precipitation occurred over November and December of 2014, accumulated over 1000 mm rainfall over the eastern shore of Malaysia, part of Thailand and Singapore;

(top) time series of precipitation averaged over land are of (95°E-110°E; EQ-10°N) from CPC gauge analysis, CMORPH_CRT, and CMORPH_BLD;

(middle) Accumulated rainfall over Nov and Dec 2014 from CMORPH_CRT

(bottom) Same as (middle) but for CMORPH_BLD

NOAA/CPC's Involvements [10] SEMDP Case Study [4/6]

Cases 1 : Heavy Rainfall



Scatter plots between CPC gauge analysis (Y) and CMORPH satellite precipitation (X). Results for CMORPH_CRT and CMORPH_BLD are plotted in left and right panels, respectively. Only data pairs of daily precipitation over a 0.25°lat/lon grid box with at least one reporting gauge are included in the comparison.

Agreements are very good for both CMORPH_CRT and CMORPH_BLD in capturing heavy rainfall over tropics.

NOTE: CMORPH_BLD is NOT independent to the gauge analysis.

NOAA/CPC's Involvements [11] SEMDP Case Study [5/6]

Cases 2 : Drought / Week 7 (Feb.24-Mar.2, 2014]



Precipitation / SPI

(left-top) 30-day SPI(left-bottom) 60-day SPI(right-bottom) 90-day SPI



-10 -5 -1 -01 01 1 5 10



-10 -5 -1 -01 01 1 5 10

1 25 50 75 100 150 250 25

NOAA/CPC's Involvements [12] SEMDP Case Study [6/6]

Cases 2 : Drought / Week 7 (Feb.24-Mar.2, 2014]



Soil Moisture / Vegetation (left) Soil Moisture (right-top) NDVI (right-bottom) VHI Smoothed NDVI Weekry (201-0226-20140304) Vegetation Health Index Weekly (20140226-20140304)

Summary

- The Space based Weather and Climate Extreme Monitoring (SWCEM) is a WMO initiative to promote the use of satellite products in the operations of weather and climate monitoring;
- WMO EC-60 has approved to conduct a two-year demonstration project, called the SWCEM Demonstration Project (SEMDP), to test the concept in South Asia and Western Pacific regions;
- A Kick-off workshop and a training workshop have been held successfully;
- CPC is a pioneer in the applications of satellite product to climate research and climate operations;
- CPC has been actively involved in the WMO/SWCEM project