

# WMO Space-based Weather and Climate Extremes Monitoring (SWCEM) for East Asia and Western Pacific (SWCEM-EAWP)

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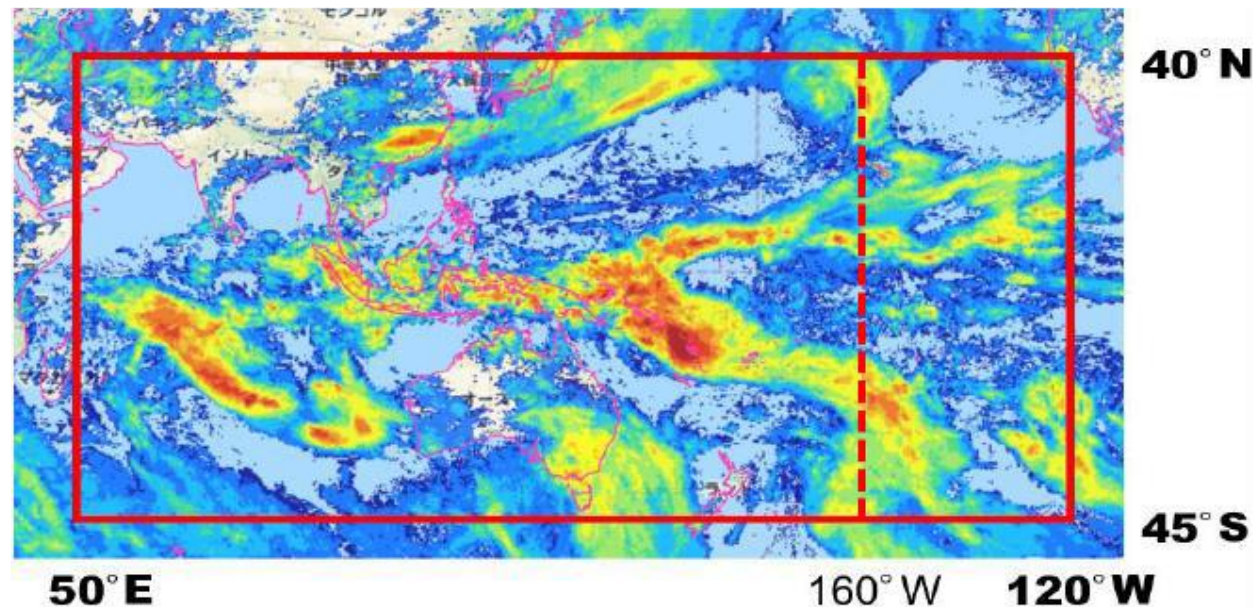
# History of SWCEM



The Workshop on Operational Space-based Weather and Climate Extremes Monitoring (SWCEM) was held in Geneva, Switzerland on 15-17 February, 2017

- Recognizing high impact of weather and climate extremes on society, the WMO established the Space-based Weather and Climate Extremes Monitoring (SWCEM) International Initiative.
- Provision of timely and accurate information on monitoring extreme events helps to build greater resilience of society against drought, floods, storms and other hydro-meteorological hazards.

# SWCEM Demonstration Project in WMO RA-II and V



- The first SWCEM demonstration project was successfully implemented in WMO Region II (Asia) and Region V (the South-West Pacific) in 2018-2019.
- The project was focused on monitoring **drought** and **heavy precipitation**
- Implemented in geographical domain which covers the **South-East Asia** region and the **Western Pacific Ocean** area from 40°N to 45°S; 50°E to 120°W.

# Structure of SWCEM-EAWP

## Global Satellite-derived Products Providers (GP-SAT)

- Japan Aerospace Exploration Agency ([JAXA](#))
- National Oceanic and Atmospheric Administration ([NOAA](#))

## WMO RCCs in RA-II

- RCC Beijing ([BCC](#))

## WMO RCCs in RA-V: SEARCC-Network

- Indonesia ([BMKG](#))
- Philippines ([PAGASA](#))
- Singapore ([Meteorological Service Singapore](#))

## WMO RCCs in RA-V: Pacific RCC-Network

- Australia ([RMIT](#) & [BoM](#))

## WMO NMHSs in RA-II

## WMO NMHSs in RA-V

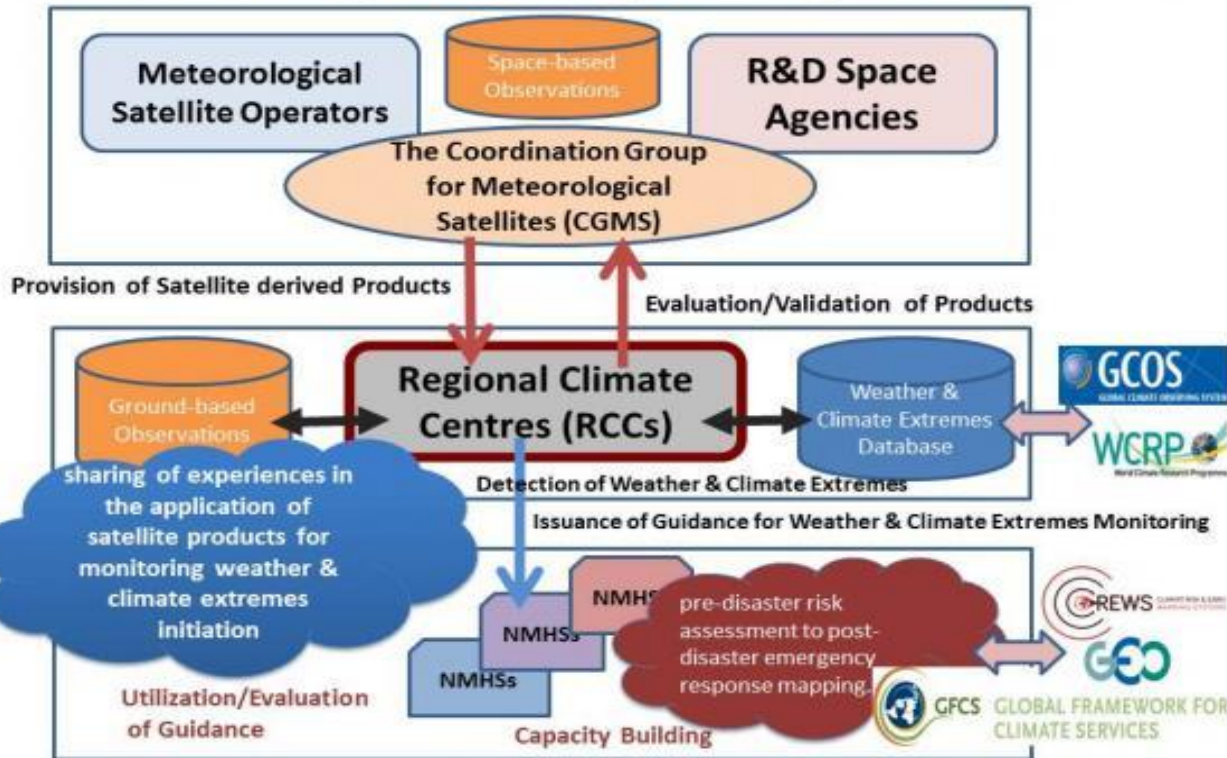
- Malaysia ([MetMalaysia](#))

## Associated Members

- WCRP ([Grand Challenge on Weather and Climate Extremes](#))

## WMO Secretariat

### A Cross-cutting Scheme for Implementing SWCEM



# Global Satellite-derived Product Providers (JAXA)

- JAXA provides the Global Satellite Mapping of Precipitation (GSMaP; Kubota et al. 2007\*) data for detecting extreme precipitation
- GSMaP data are available from January 1998; thresholds for detecting the extreme events are calculated using the GSMaP data during 24 years(1998 - 2022)
- GSMaP data can be viewed graphically on Web Site;  
“JAXA Climate Rainfall Watch” ([https://sharaku.eorc.jaxa.jp/GSMaP\\_CLM/](https://sharaku.eorc.jaxa.jp/GSMaP_CLM/))  
“JAXA Realtime Rainfall Watch” ([https://sharaku.eorc.jaxa.jp/GSMaP\\_NOW/index.htm](https://sharaku.eorc.jaxa.jp/GSMaP_NOW/index.htm))

\*Kubota T, Shige S, Hashizume H, Aonashi K, Takahashi N, Seto S, Hirose M, Takayabu YN, Ushio T, Nakagawa K, Iwanami K, Kachi M & Okamoto K. Global Precipitation Map Using Satellite-borne Microwave Radiometers by the GSMaP Project: Production and Validation. IEEE Transactions on Geoscience and Remote Sensing. 2007: 45(7, part2): 2259-2275. DOI: 10.1109/TGRS.2007.895337

# Global Satellite-derived Product Providers (NOAA)

- NOAA/CPC provides products using the Climate Prediction Center morphing technique (CMORPH; Xie et al. 2017\*); satellite precipitation estimates are available from 1998.
- In addition to precipitation estimates, NOAA provides vegetation indices; the NDVI and the VHI for the SWCEM region.

## **NOAA / NESDIS / STAR Web Site**

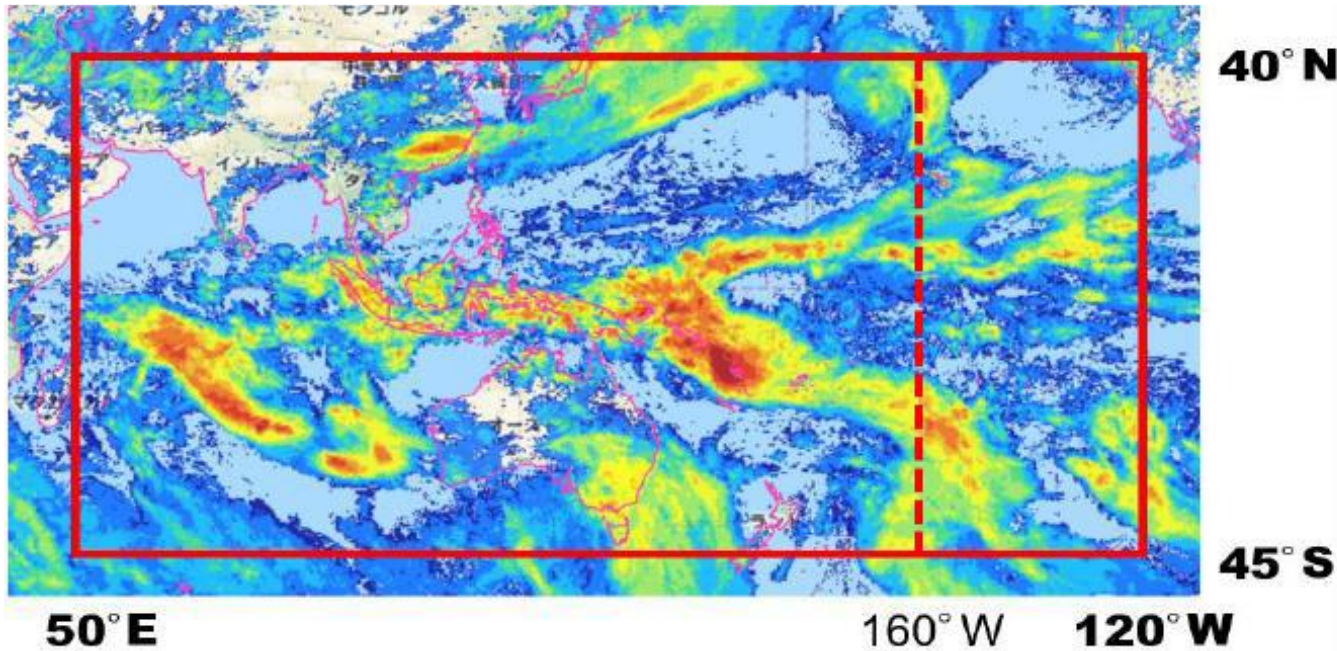
[https://www.star.nesdis.noaa.gov/jpss/EDRs/products\\_bledned\\_cmorph.php](https://www.star.nesdis.noaa.gov/jpss/EDRs/products_bledned_cmorph.php)

## **NOAA / CPC ftp site**

<https://ftp.cpc.ncep.noaa.gov/precip/CMORPH2/CMORPH2NRT/>

\*Xie P, Joyce R, Wu S, Yoo S-H, Yarosh Y, Sun F & Lin R. Reprocessed, Bias-Corrected CMORPH Global High-Resolution Precipitation Estimates from 1998. Journal of Hydrometeorology. 2017: 18(6): 1617-1641. DOI: 10.1175/JHM-D-16-0168.1.

# SWCEM-EAWP Operational Products



## Mean precipitation estimates

- hourly
- daily (00-23UTC)
- pentad (5-day)
- weekly (Monday–Sunday)
- 10-days
- monthly

## Statistics:

- Climate normal
- 90th ~ 99th Percentiles
- Percentage of rainy days ( $\geq 1$ mm/day) in a month

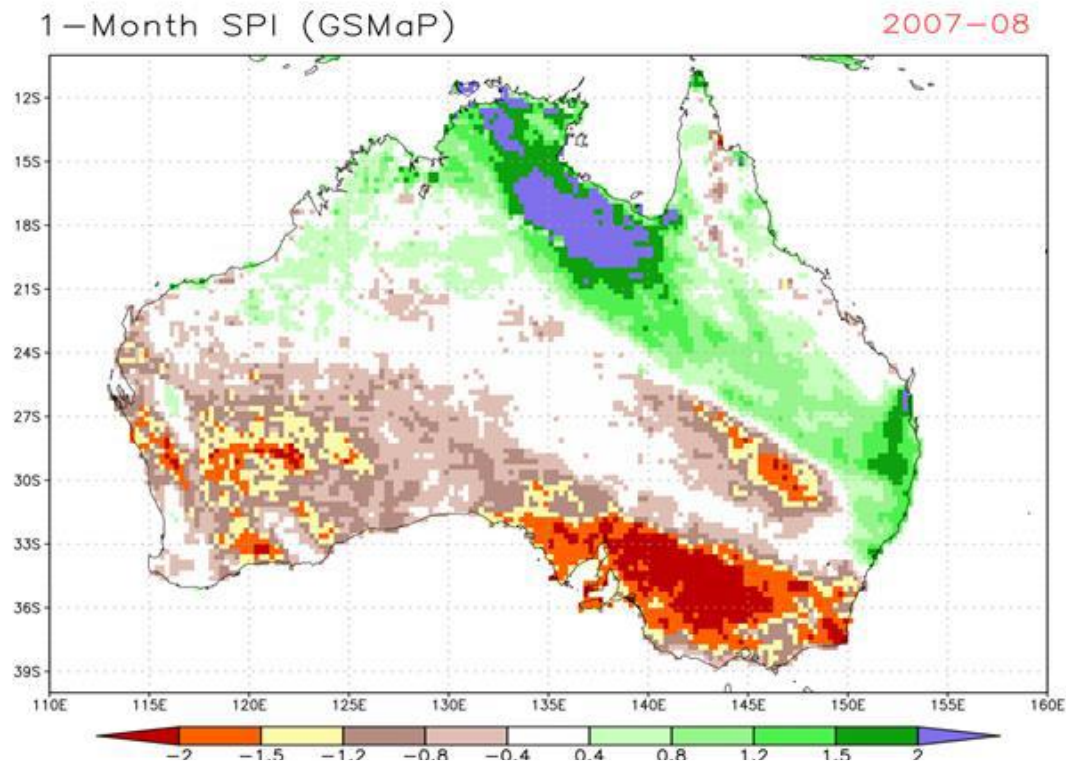
**Indices:** SPI, NDVI, VHI

**Spatial Resolution:** 0.1 X 0.1 degrees

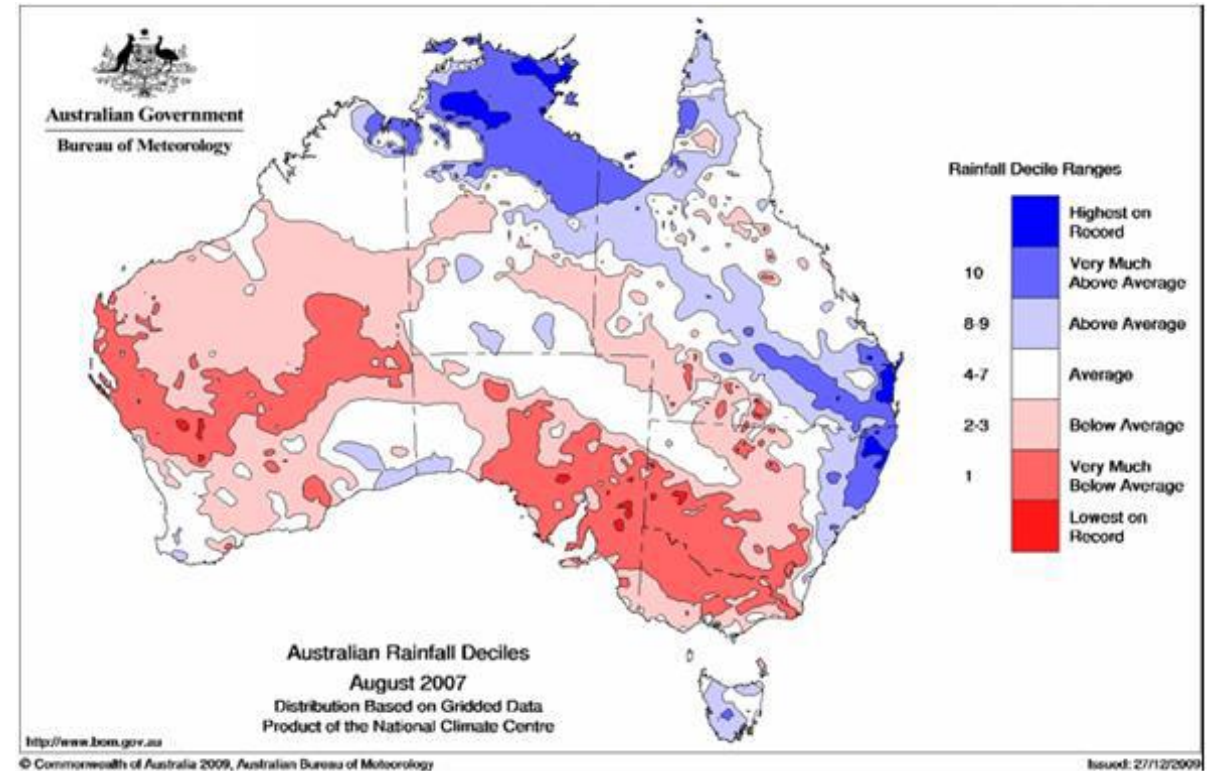
**Coverage:** from 40°N to 45°S; 50°E to 120°W

SWCEM precipitation products include mean precipitation estimates for hourly, daily, pentad, weekly, 10days and monthly precipitation. In addition, statistics for daily, pentad and weekly extreme precipitation and percentage of rainy days in a month is provided.

# Drought Monitoring Using SWCEM Product (SPI\*)



**SPI** for Australia in August 2007  
derived from JAXA GSMaP data

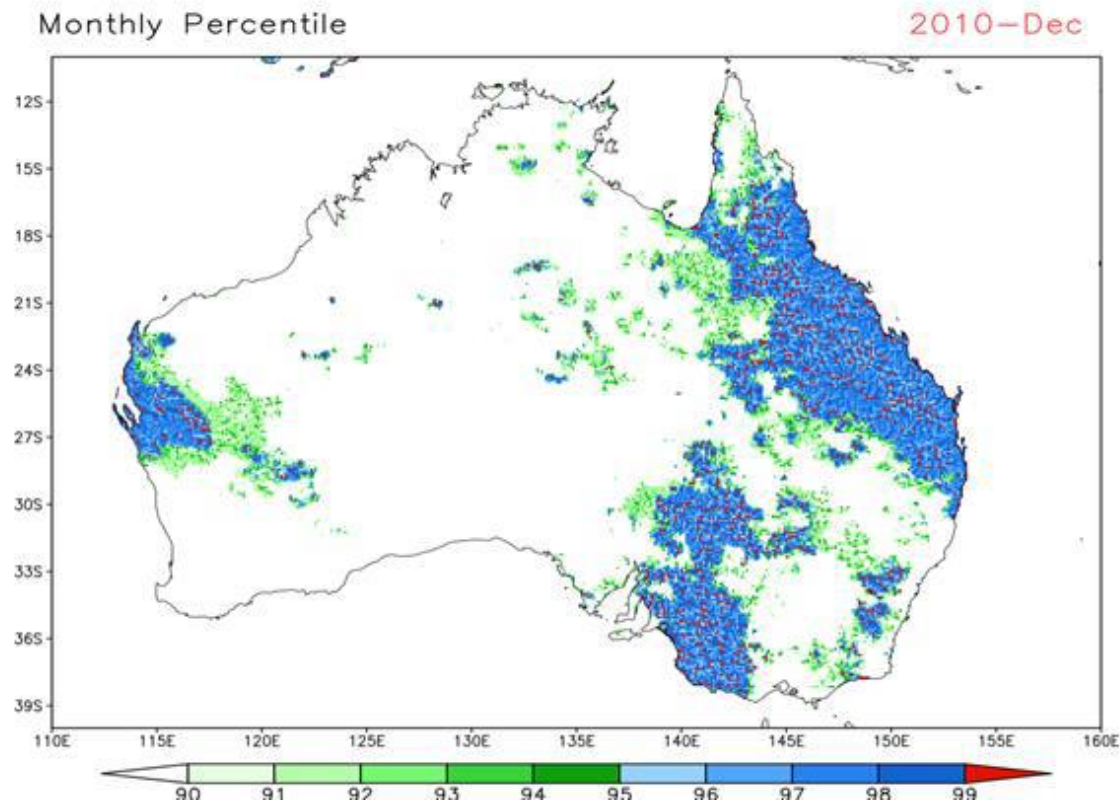


**Rainfall Deciles** for Australia in August 2007  
BoM rain gauge observations.

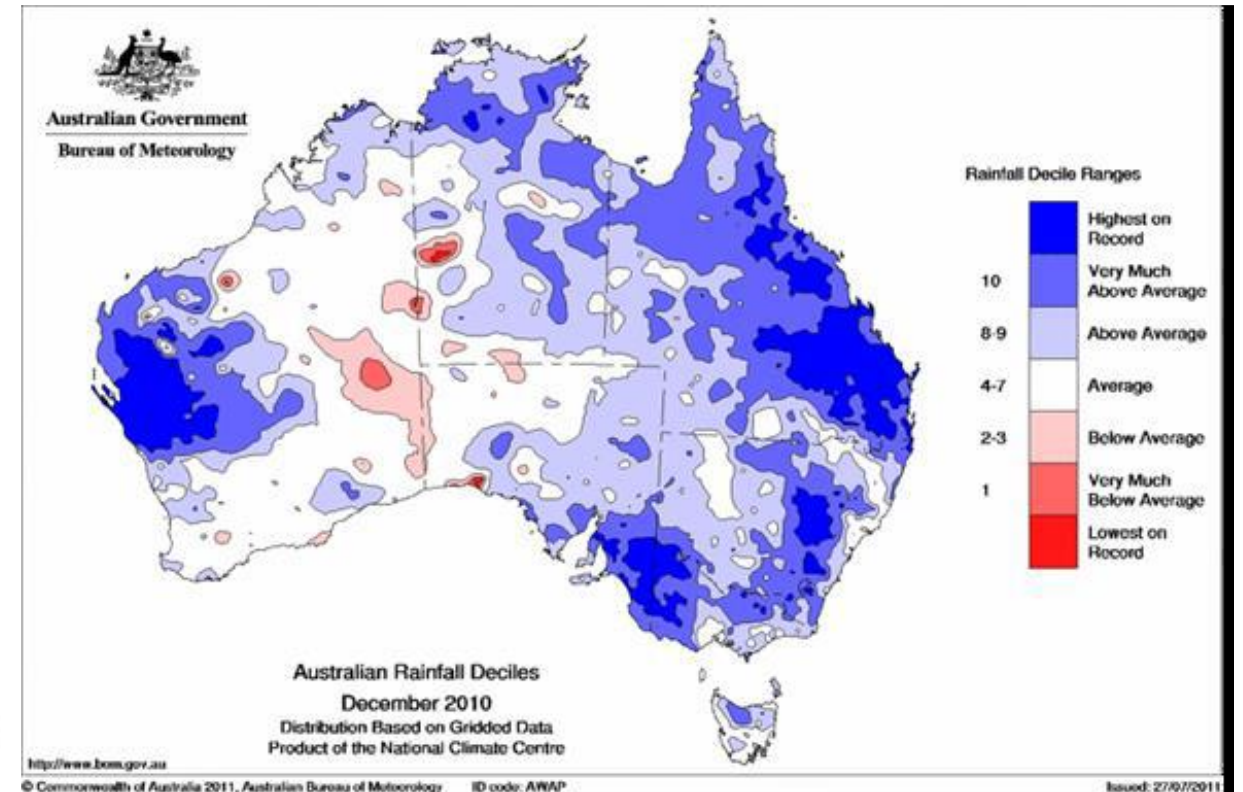
\* **Standardized Precipitation Index (SPI)** is a widely used index to characterize meteorological drought on a range of timescales. On short timescales, the SPI is closely related to soil moisture, while at longer timescales, the SPI can be related to groundwater and reservoir storage. (<https://climatedataguide.ucar.edu/climate-data/standardized-precipitation-index-spi>)



# Heavy Precipitation Monitoring Using SWCEM Product (Monthly Rainfall Percentile)



JAXA GSMaP Rainfall Percentile over Australia  
for December 2010



Australian Rainfall Deciles for December 2010  
BoM rain gauge observations

# SWCEM-EAWP in Operations

- The Eighteenth World Meteorological Congress (Cg-18) in 2019 - recognizing significant achievements of SWCEM in Asia -Pacific, adopted project implementation plan for 2020 - 2021
- Cg-18 - to progress with the implementation of the SWCEM regional **operational** subproject in East Asia and Western Pacific
- Cg-18 - to consider the possibility of implementing similar projects in Africa (RA I) and South America (RA III)

# Steering Group for SWCEM-EAWP (SG-SWCEM-EAWP)

The Terms of Reference for the SWCEM-EAWP Steering Group (SG-SWCEM-EAWP) are defined as follows:

- (i) Guide the implementation of the project;
- (ii) Monitor the progress and, if needed recommend adjustments as needed;
- (iii) Recommend the integration of new tools, techniques and data into the SWCEM;
- (iv) Promote synergies and collaboration with other programmes and initiatives;
- (v) Encourage the participation and/or contribution of other Regional Climate Centres (RCCs) and NMHSs not directly involved in the implementation of SWCEM activities;
- (vi) Review and make recommendations on the scope of the cascading weather and climate extreme event monitoring process.

SG	Date & Location
1 <sup>st</sup> Session	<a href="#">31 October - 1 November 2018</a> , Kuala Lumpur, Malaysia
2 <sup>nd</sup> Session	<a href="#">21 - 23 August 2019</a> , Tokyo Japan
3 <sup>rd</sup> Session	<a href="#">8 October 2020</a> (online)
4 <sup>th</sup> Session	<a href="#">23-24 March 2022</a> (online)
 5 <sup>th</sup> Session	<a href="#">27-28 July 2023</a> (online)

# **Achievements presented in SG-SWCEM-EAWP-5 (27-28 July 2023)**

# JAXA: Reprocessing for the GSMaP new version (V8)

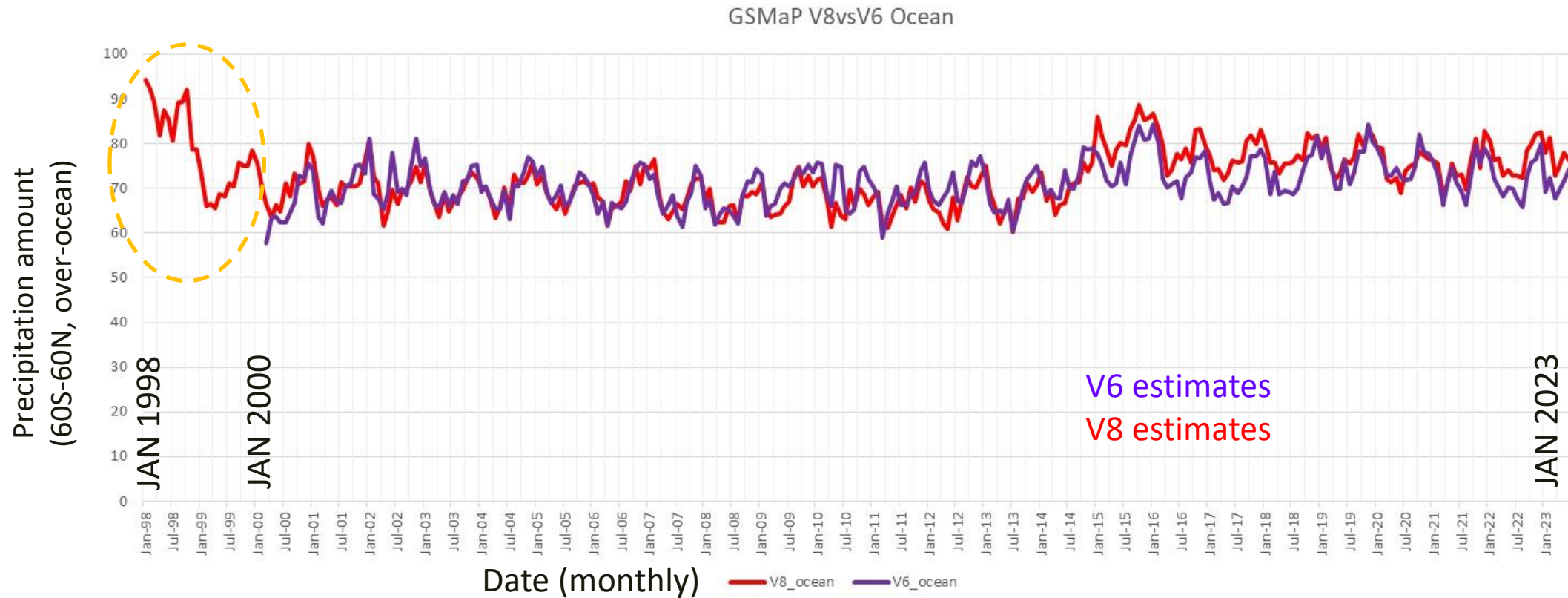


- GSMaP had a major update in Dec. 2021 (Algorithm V8), and re-processing of the GSMaP products was completed in July 2023.
- Past GSMaP products did not cover the first 2 years of TRMM era (1998 - Mar. 2000) due to lack of CPC-4km Global IR dataset (Janowiak et al. 2001).
- In the new version of the GSMaP, **GridSat-B1 data** (Knapp et al. 2011) were used to fill the lack of period as follows (Kubota et al. 2023).
  - GridSat-B1 during a period from Jan. 1998 to Jan. 2000
  - GridSat-B1 & CPC-4km during Feb. 2000
  - CPC-4km after Mar. 2000
- The new version of the GSMaP is available during a period of the **last 25 years since Jan. 1998.**
  - Janowiak J. E., R. J. Joyce, and Y. Yarosh, 2001: A Real-Time Global Half-hourly Pixel-Resolution Infrared Dataset and Its Applications. (Bull. Amer. Meteor. Soc., vol. 82, No.3., 205-217.)
  - Knapp, K. R., S. Ansari, C. L. Bain, M. A. Bourassa, M. J. Dickinson, C. Funk, C. N. Helms, C. C. Hennon, C. D. Holmes, G. J. Huffman, J. P. Kossin, H.-T. Lee, A. Loew, and G. Magnusdottir, 2011: Globally gridded satellite (GridSat) observations for climate studies. *Bulletin of the American Meteorological Society*, 92, 893-907. [doi:10.1175/2011BAMS3039.1](https://doi.org/10.1175/2011BAMS3039.1)
  - Kubota, T., M. K. Yamamoto, and M. Yamaji, 2023: Reprocessing of Global Satellite Mapping of Precipitation (GSMaP) Product, AOGS2023, AS02-A019, Singapore.

# JAXA: Monthly time series of GSMaP: V6 vs V8



- Precipitation estimates for the period during 1998-2000 are **available only in the V8 (Red line)**.
- We're now processing calculation of statistics (climatology, percentile values and so on) and the drought index using 25 yr-GSMaP data for the SWCEM users.



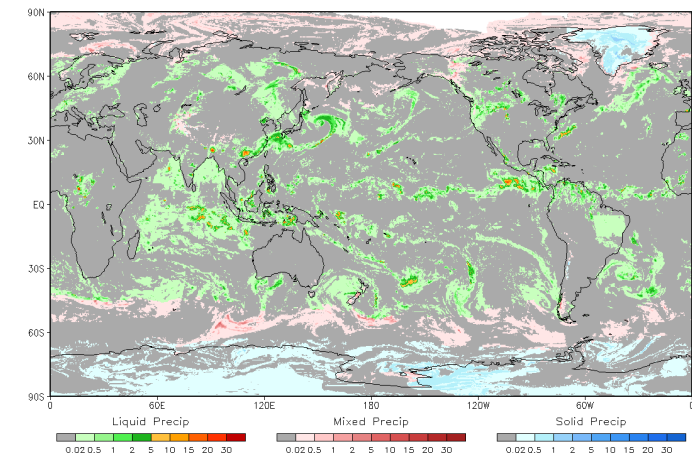
The 13th Asia-Oceania Meteorological Satellite Users' Conference  
6-9 November 2023, Busan, Republic of Korea

# NOAA/CPC: 2<sup>nd</sup> Generation CMORPH Overview

## Main Features of CMORPH-2

- High spatial / temporal resolution (*0.05°lat/lon/30-min*) infused with PMW retrievals from LEO satellites and IR observations from LEO & GEO platforms
- Complete global coverage (*90°S-90°N*)
- Low production latency (*One hour, updated once every 30-min until 12-hour latency*)
- Greatly improved representation of cold season precipitation (snowfall) thanks to the SFR retrievals from NESDIS/STAR;
- In addition to the total precipitation, *fraction of solid precipitation also estimated* (quantitative estimation of snowfall)

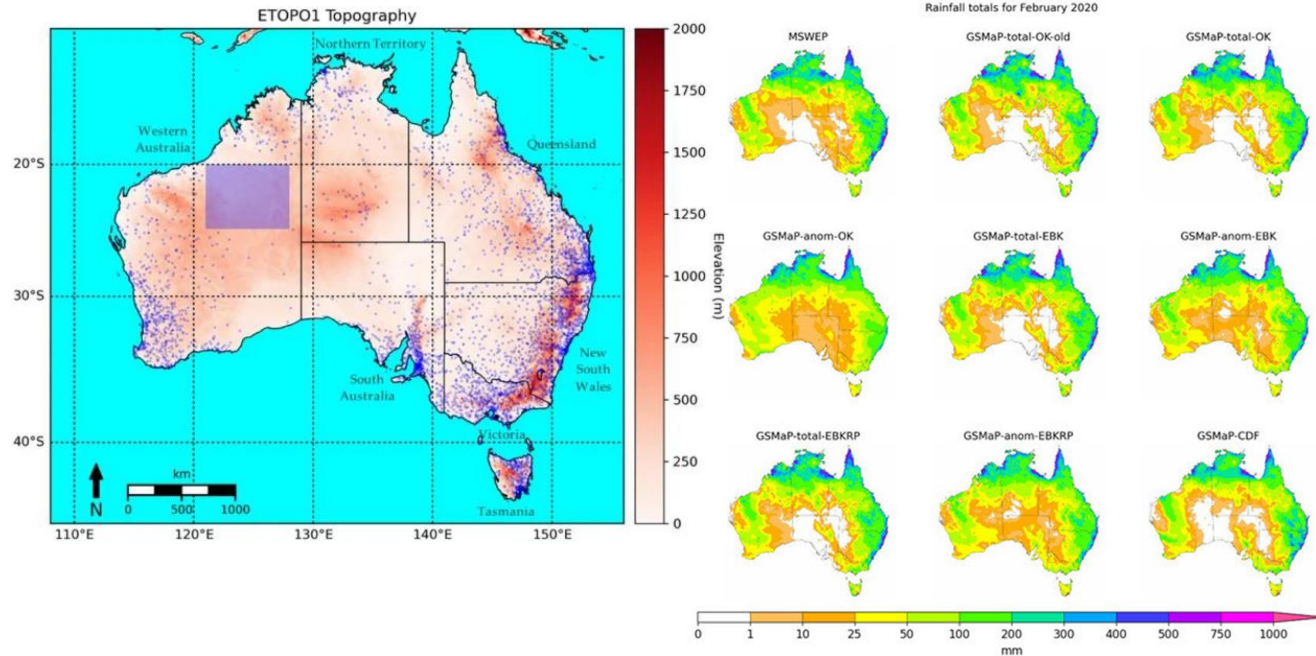
CMORPH-2 Precip Rate @ 2022.06.12 22:30Z (mm/hr)



- The NOAA/Climate Prediction Center (CPC) has initiated operational real-time routine production of CMORPH-2 products since Jan 2023;
- Real-time CMORPH2 is now constructed on an NWS 7/24 operational environment
- Real-time CMORPH2 shows good skills in estimating cold season precipitation as well as in capturing severe rainfall storms;
- Bias correction further improves the performance of CMORPH2, especially in accurately quantifying the magnitude of precipitation;
- Real-time data are accessible thru NESDIS/STAR webpage or CPC ftp site;
- NOAA/CPC are in process of:
  - Implementing the bias correction procedures to the operational production;
  - Improving the representation of orographic rainfall;
  - Constructing retrospective analysis of CMORPH2 for a 30+ year period

# Operational Data Services: Australia BoM

## Rainfall Monitoring



- Rain gauge network of over 6,000 stations
- Spatial distribution of the station is not uniform
- Performance of a gauge-based analysis for rainfall estimation can be severely limited over regions with low gauge density.
- Australian station data along with the JAXA GSMaP and the BOM Australian Gridded Climate Dataset (AGCD) rainfall analysis are combined to develop an improved satellite-gauge rainfall analysis.
- Satellite observations of rainfall were used as the background field instead of station climatology to produce improved monthly rainfall analyses.

- The performance of these monthly datasets was evaluated over the Australian domain from 2001 to 2020.

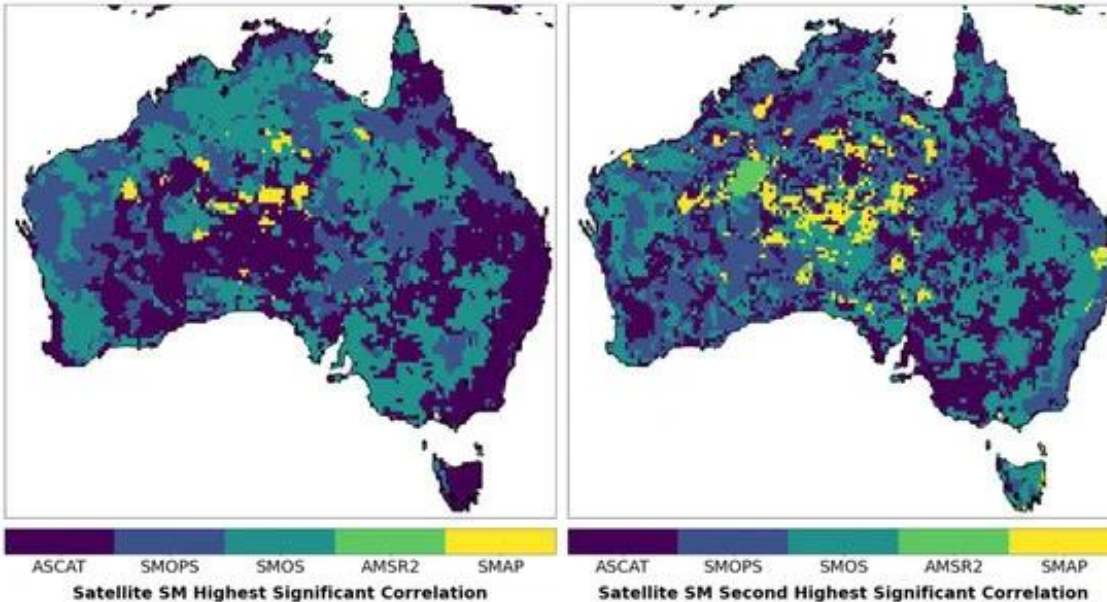
- Evaluated over the entire national domain, the satellite-based SI datasets had similar to slightly better performance than the station climatology-based SI datasets with some individual months being more realistically represented by the satellite-SI datasets.

- However, over gauge-sparse regions, there was a clear increase in performance.





# Operational Data Services: Australia BoM Soil Moisture (SM) Monitoring



BoM investigated the performance of

- Soil Moisture Active Passive (**SMAP**),
- Soil Moisture and Ocean Salinity (**SMOS**),
- Soil Moisture Operational Products System (**SMOPS**),
- SM from the Advanced Microwave Scanning Radiometer 2 (**AMSR-2**)
- SM from the Advanced Scatterometer (**ASCAT**).

- Soil moisture (SM) is critical in monitoring the time-lagged impacts of agrometeorological drought.
- In Australia and several south-west Pacific Small Island Developing States (SIDS), there are a limited number of in situ SM stations that can adequately assess soil-water availability in a near-real-time context.
- Satellite SM datasets provide a viable alternative for SM monitoring and agrometeorological drought provision in these regions.
- ASCAT and SMOS were consistently superior in their performance.
- The case study of the 2015 El Niño and Positive Indian Ocean Dipole-induced drought in Papua New Guinea shown that ASCAT is a valuable dataset indicative of agrometeorological drought for the nation as an early warning of drought in data-sparse regions.



# CMA/NCC as WMO RCCs in RA-II: Basin Climate Center (BCC)

## The Meteorological Disaster Management Operational System in BCC



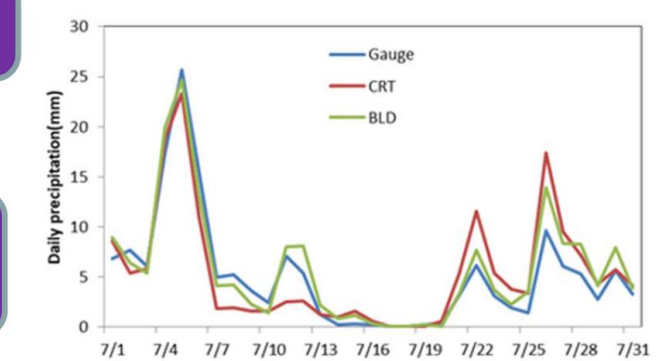
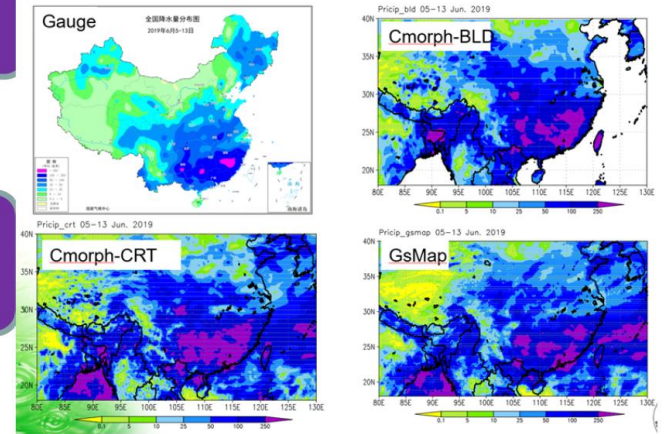
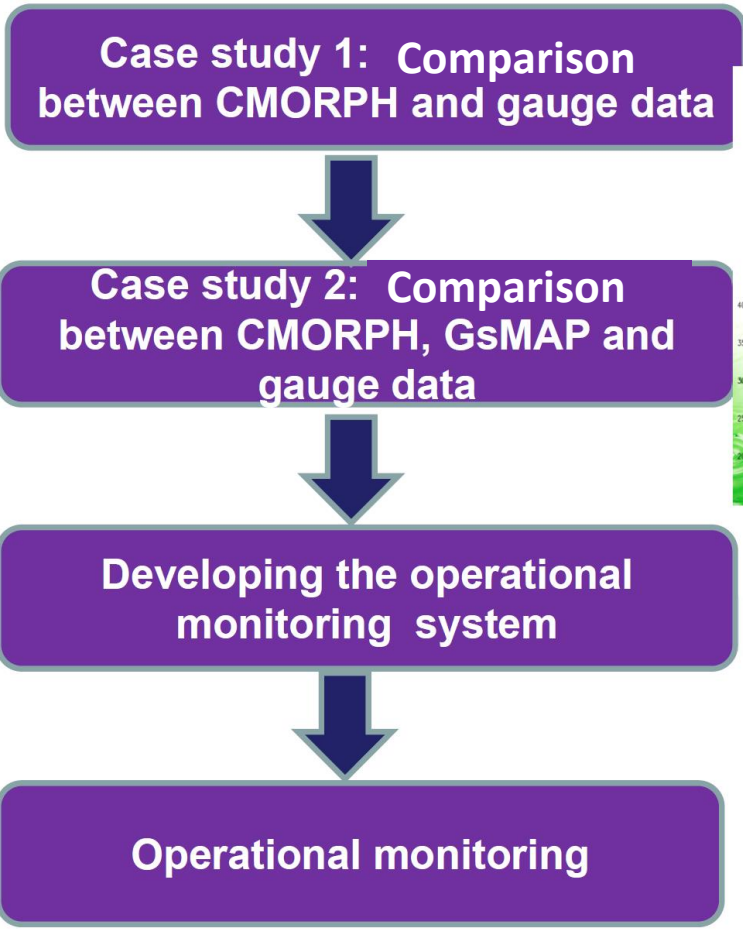
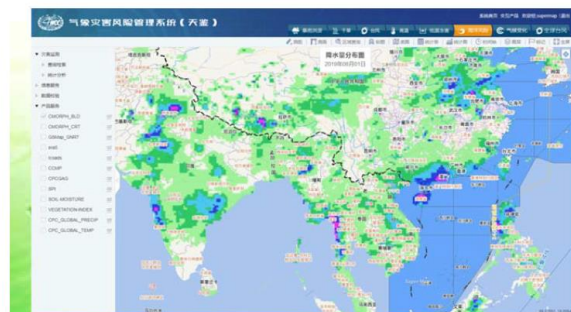
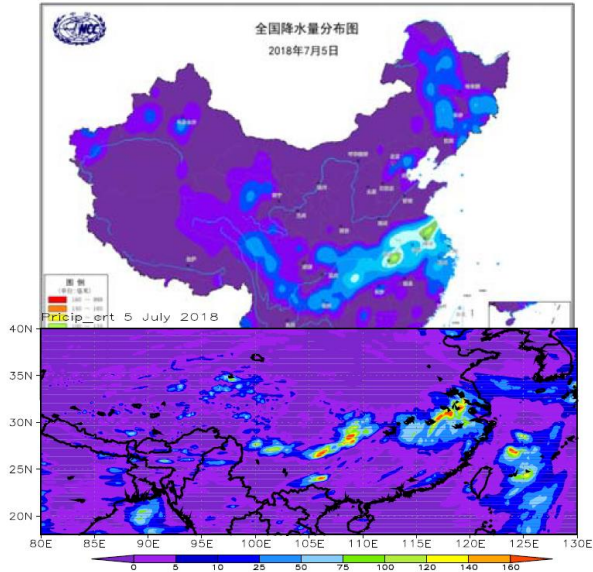
- The operational system in BCC for meteorological disaster monitoring and assessment
- A real-time and interactive system

- CMORPH and GsMaP data are updated everyday.
- Spatial and temporal analysis tools based on the satellite-derived data have been developed.





# The Meteorological Disaster Management Operational System of BCC



# Philippine PAGASA as WMO RCCs in RA-V: SEARCC-Network for Climate Monitoring

## Development of Extremes Monitoring System (SatREx) derived from GSMaP



### SatREx: Near-Real-Time Satellite Rainfall Extremes Monitoring System of the Philippines

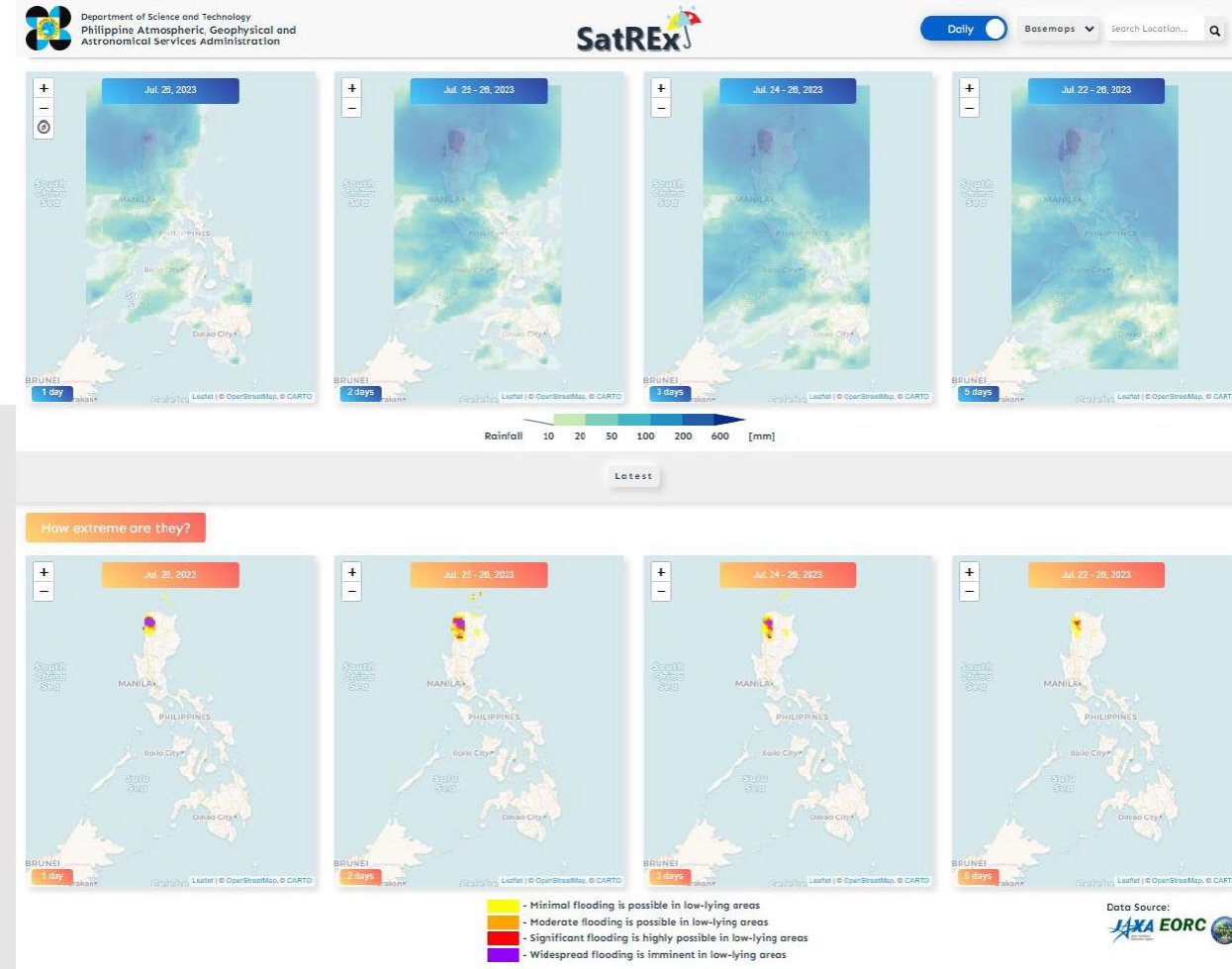
Marcelino Q. Villafuerte II\*, Mike A. Petaca, Wilmer Agustin, Charlie Ray Pascua, and Joanne Mae Adelino

Philippine Atmospheric, Geophysical and Astronomical Services Administration (PAGASA)

\*Email: [mvillafuerte@pagasa.dost.gov.ph](mailto:mvillafuerte@pagasa.dost.gov.ph)

- Provides near-real-time satellite rainfall estimates observed in the previous 1-, 2-, 3-, and 6-hour, as well as the previous 1-, 2-, 3-, and 5-day rainfall accumulations
- Translates observed rainfall relative to historical data
- Indicates areas possible to experience flooding

<https://rainx.pagasa.dost.gov.ph/daily>

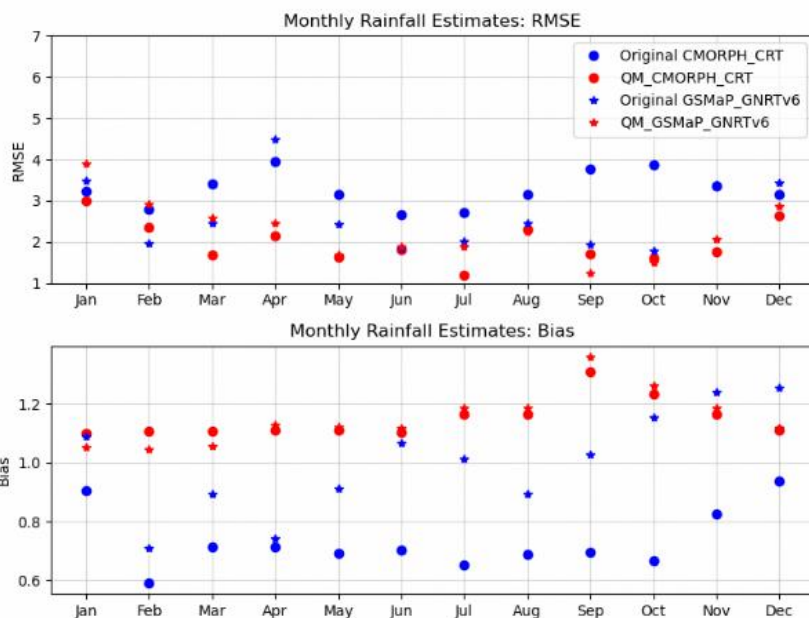




# MSS Satellite Rainfall Estimate Calibration

## Quantile Mapping Technique with Machine Learning Aided Categorization

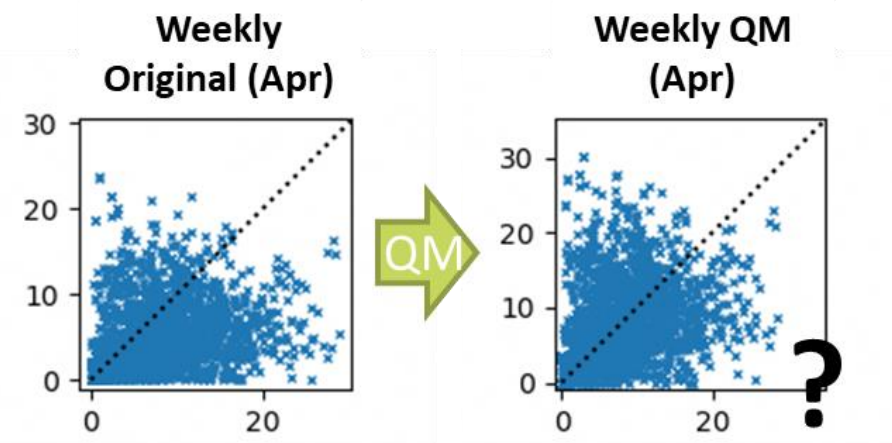
### Previous Evaluation with QM: Gauge vs Satellite Estimates (CMORPH CRT, GSMaP\_GNRTv6):



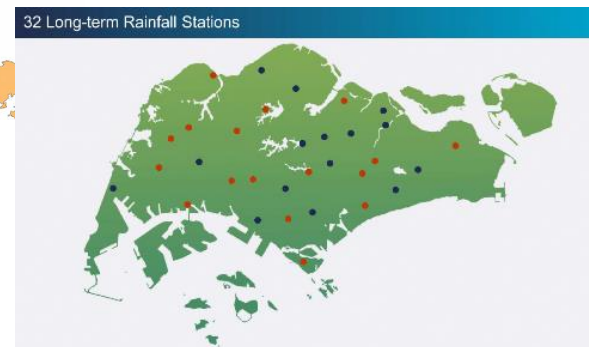
- Tested against rain gauge measurements over Singapore

Quantile Mapping (QM) calibration of SWCEM-EAWP rainfall products using rain gauges achieved fairly good results for longer time period (e.g. monthly rainfall total)

- While bias improved considerably for shorter time scale (e.g. weekly rainfall total), but less so for RMSE and MAE



Two regions of study:  
Singapore and Johor, Malaysia

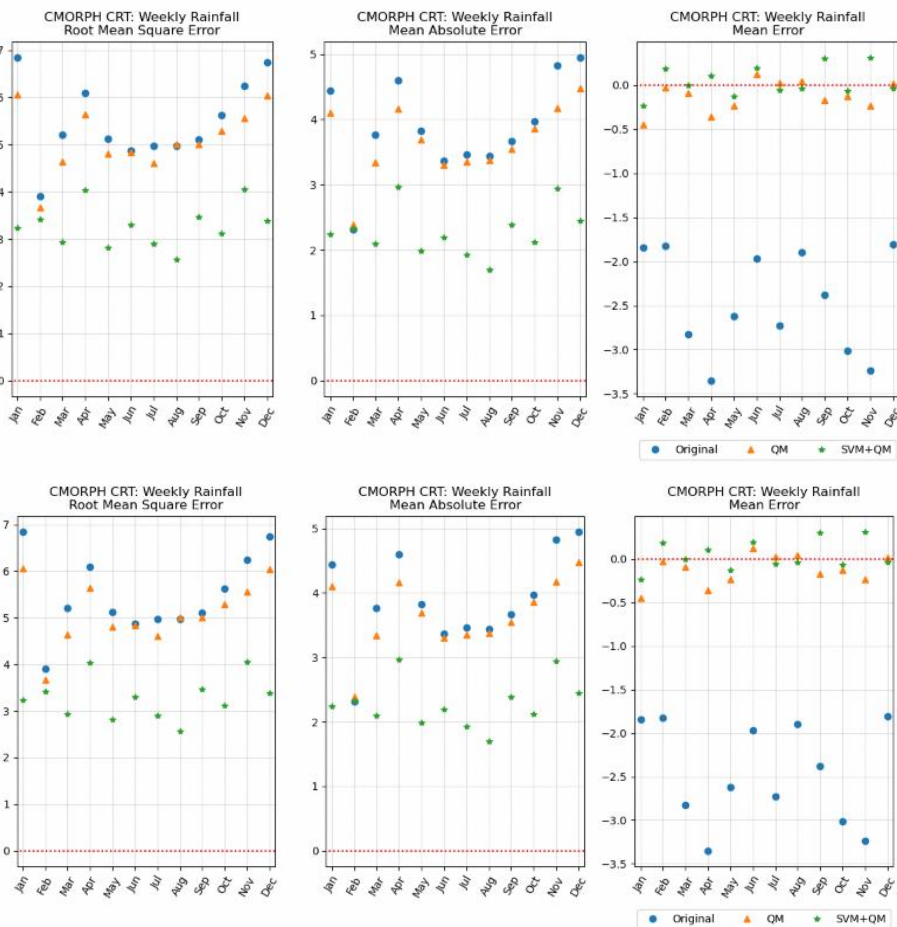




# MSS Satellite Rainfall Estimate Calibration

## Quantile Mapping Technique with Machine Learning Aided Categorization

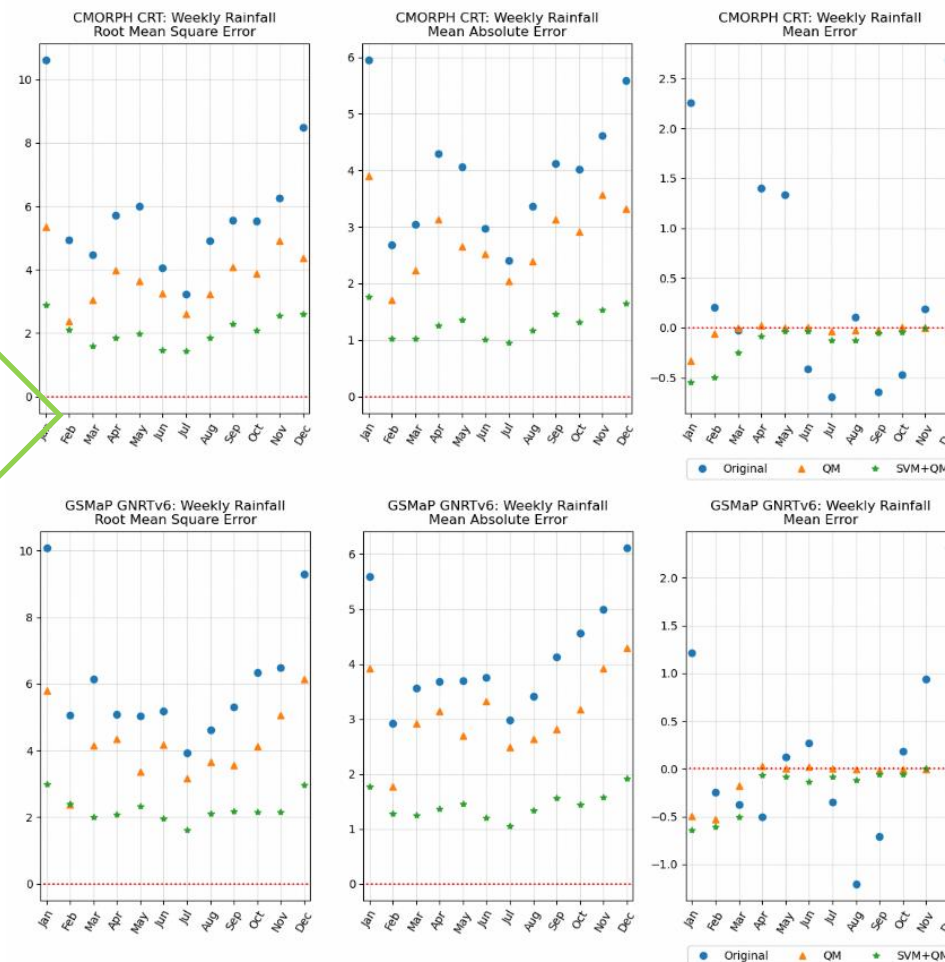
### QM without ML



### Concepts and Methodology

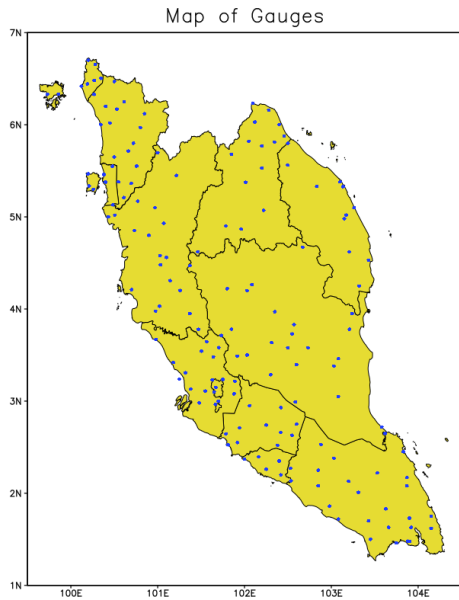
- Bias differences could be due to the rainfall type:
  - for shorter timescale (weekly), the scatter plot appears noisier with larger spread
- Through Machine-Learning (ML) (Support Vector Machine; SVM), achieve categorization of the rainfall estimate bias before applying Quantile Mapping (catQM)
- self-driven categorization without the need for other inputs
- gauge measurements for model learning and calibration

### ML-aided catQM

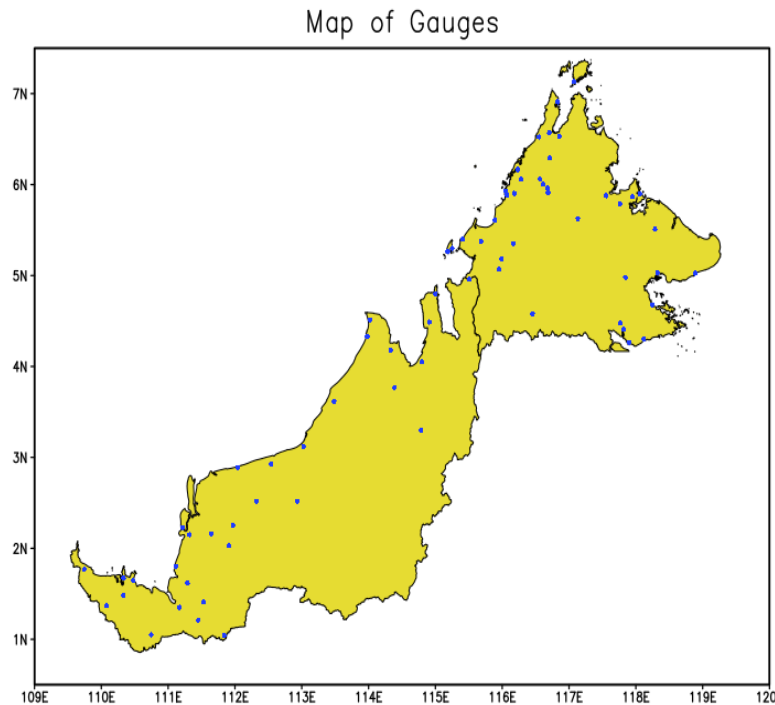


# Satellite Rainfall Datasets Evaluation: Malaysia

Two satellite rainfall datasets (GSMaP\_Now & PDIR-Now) were evaluated using three hundred and four (304) gauges from 01 November 2022 – 01 March 2023 corresponding to the Northeast Monsoon (NEM)



**Peninsular Malaysia**



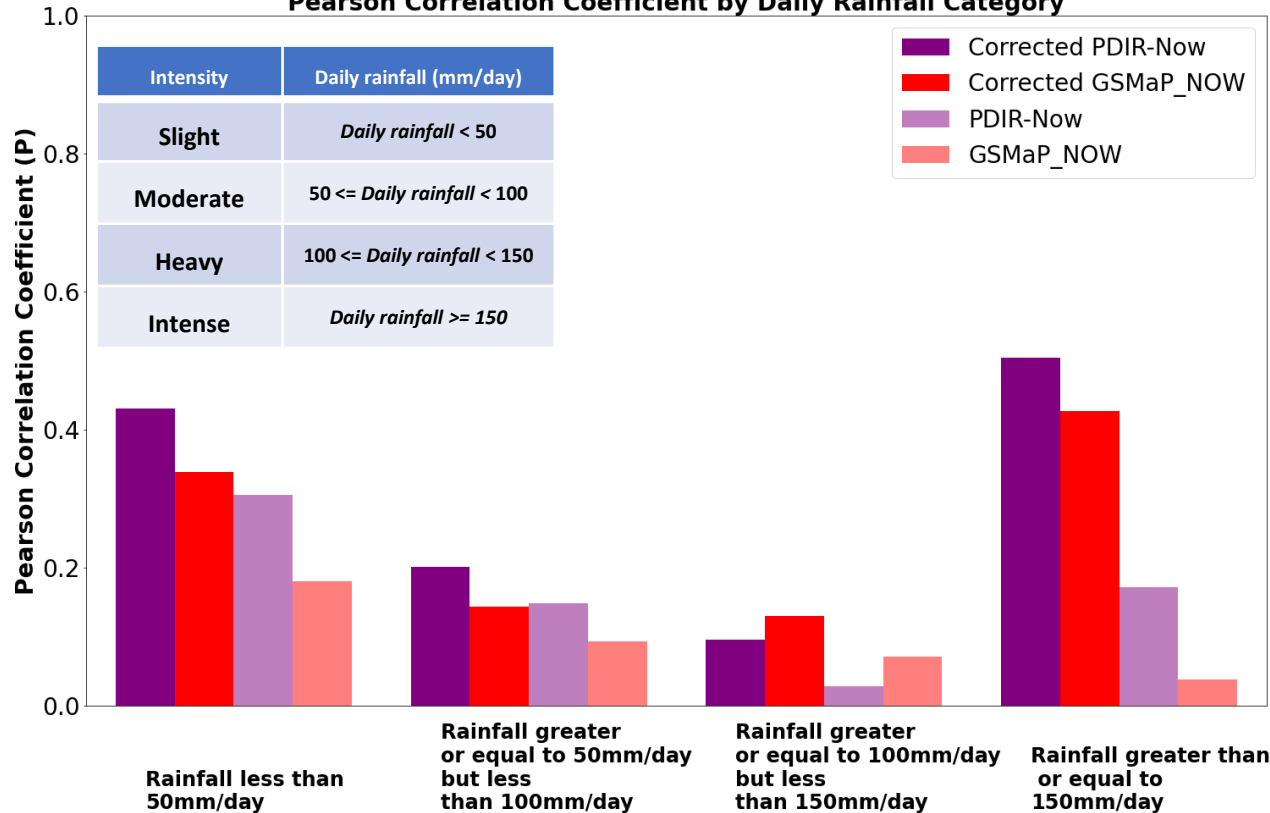
**Borneo**

1. PDIR-Now is based on infra-red (IR) measurements from geostationary satellites.
2. Rainfall rates are estimated from cloud types that are identified using self-organizing feature maps (SOFMs) trained using PMW dataset.
3. Cloud top precipitation rate ( $T_b - IR$ ) calibrated using monthly rainfall climatology data.
4. PDIR-Now has latency 15-60 minutes, spatial resolution of  $0.04^\circ$  (4km x 4km), one (1) hour rainfall (mm/hr).
5. Provided by the University of California, Irvine (UCI).
6. Refer to Nguyen et al., 2020\*.

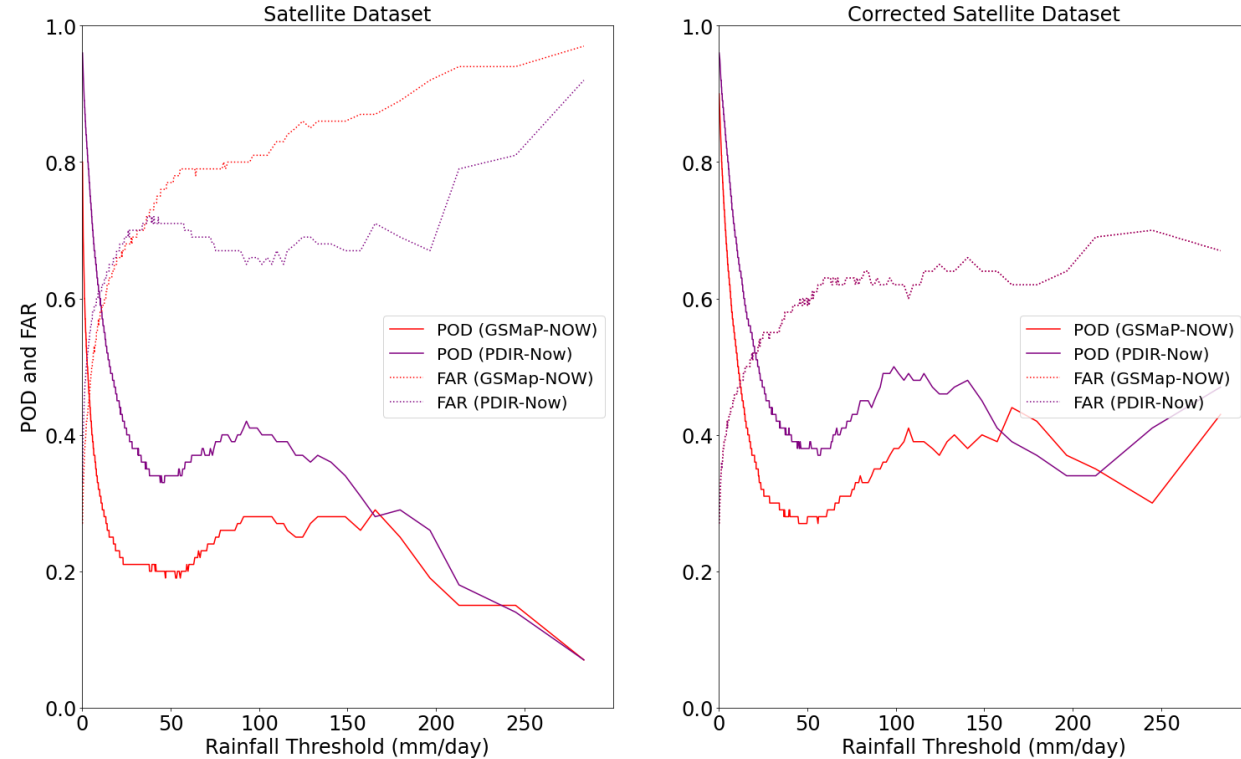
\*Nguyen, P. et al. (2020). Persiann dynamic infrared-rain rate (PDIR-Now): A near-real-time, quasi-global satellite precipitation dataset. *Journal of Hydrometeorology*, 21(12). pp. 2893 – 2906. DOI: 10.1175/JHM-D-20-0177.1

# Evaluation Results: Daily Rainfall

**Pearson Correlation Coefficient by Daily Rainfall Category**



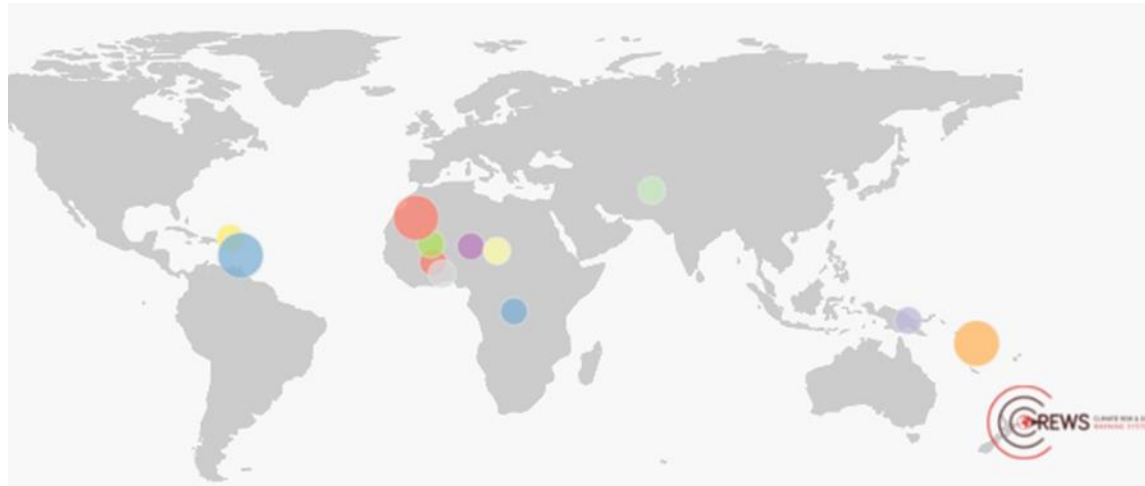
**POD and FAR Daily Rainfall (mm/day)**



- Rainfall estimation by PDIR-Now is more consistent with gauges than GSMaP\_NOW
- Corrected PDIR-Now (GSMaP\_NOW) can detect significant rainfall events at threshold 20.1 mm/day (11.9 mm/day) ;  $POD > 0.5$  &  $POD > FAR$



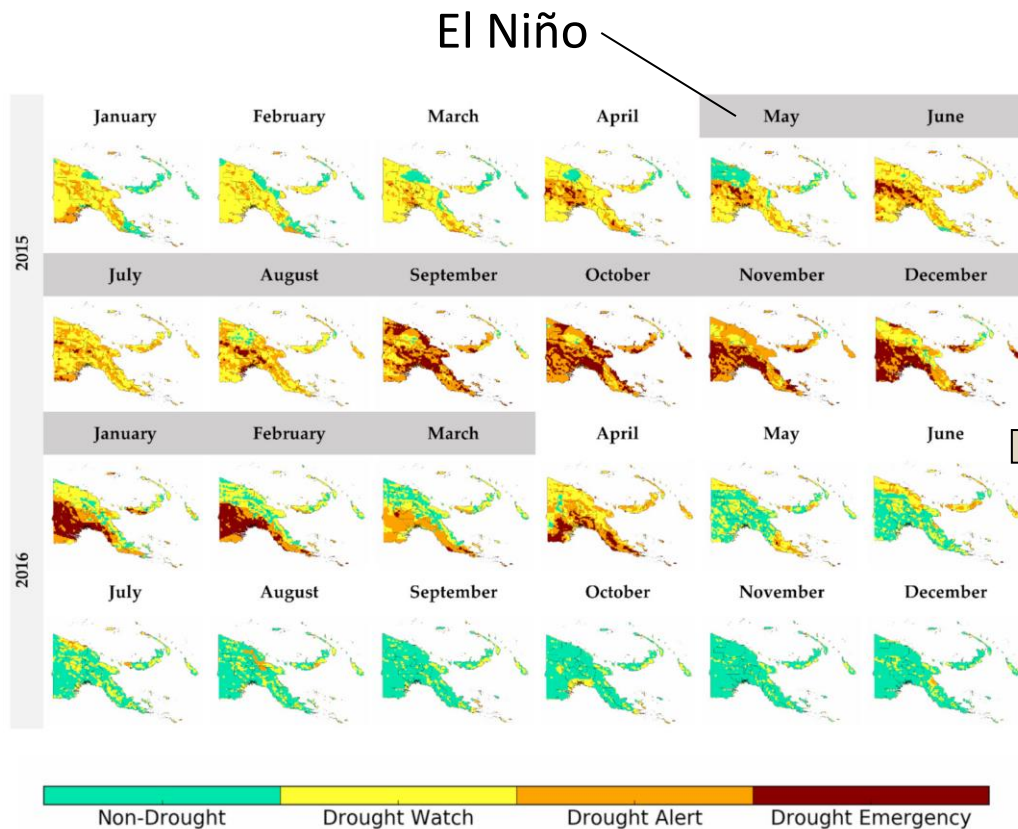
# SWCEM Contribution to CREWS



- Recognizing the urgency of enhancing early warning systems to assist vulnerable countries with climate change adaptation, the Climate Risk and Early Warning Systems (CREWS) international initiative has been established at COP-21 in Paris in 2015.
- Over 60 countries assisted through CREWS - 15 CREWS projects in operation - 9 country, 5 regional and 1 global.
- CREWS International Initiative helps SIDS (Small Island Developing States) and LDCs (Least Developed Countries) with climate change adaptation.
- Supporting CREWS with reliable observations of climate extremes is vital.
- Space-based observations provide valuable information on a global scale and complement surface-based observations - this is particularly important for SIDS and LDCs.
- Incorporate SWCEM satellite precipitation estimates and derived products to enhance drought monitoring and EWS.

# CREWS: Drought Monitoring Using SWCEM Products

## Drought EWS for PNG



### July 2023 Drought Update

Issued 13/07/2023

#### Key messages

Drought Critical no longer remains in parts of Enga and Southern Highlands provinces. Chimbu, Hela and Southern Highlands continues to remain on Drought Watch. Southern Highlands at Drought Watch with severe vulnerability and exposure levels. An El Niño Alert is now in place, when El Niño Alert criteria have been met in the past, an El Niño event has subsequently developed around 70% of the time.

#### Drought Early Warning Status (DEWS)

Derived from observed 3-month rainfall and vegetation health, along with 3-month forecasted rainfall.

- Drought conditions persist for parts of Bougainville, Hela, Chimbu and Southern Highlands at 3-month timescales.
- East New Britain, Eastern Highlands, Enga, Gulf, Iwika, West New Britain and Western Highlands have received well above average rainfall in recent months – easing drought conditions at 3-month timescales.
- At the **12-month rainfall timescale**, deficiencies linger for Bougainville, New Ireland, East New Britain and Manus as well as some areas in the Highlands and Momase provinces. Long term deficiencies will have different impacts to short term rainfall deficiencies. Low groundwater, brackish wells and reduced streamflow may be some impacts observed at this timescale.

#### 3-month timescale provincial summary

(A province's overall status is given by its majority status on the map and is presented in this [summary table](#))

<span style="color: yellow;">●</span> <b>Drought Watch</b>	<span style="color: orange;">●</span> <b>Drought Alert</b>	<span style="color: red;">●</span> <b>Drought Critical</b>
Below average rainfall or Stressed vegetation or Dry forecast	(Below average rainfall or Stressed vegetation) AND Dry forecast	Below average rainfall AND Stressed vegetation AND Dry forecast
Bougainville, Hela, Chimbu, Southern Highlands	No provinces	No provinces

#### 3-month DEWS inputs

**3-month Observed Rainfall**  
[Standardized Precipitation Index - 3 month](#)

**3-month Observed Vegetation Health**  
[Vegetation Health Index - 3 month](#)

**3-month Forecasted Rainfall**  
[Chance of below, near or above normal rainfall](#)

#### Links to other timescales:

- [1-month Drought Early Warning Status](#)  
Drought early warning status using 1-month rainfall, 1-month vegetation health and 3-month rainfall forecast.
- [1-month Standardized Precipitation Index](#)  
Rainfall over the last month.
- [1-month Vegetation Health Index](#)  
Vegetation health over the last month.
- [6-month Drought Early Warning Status](#)  
Drought early warning status using 6-month rainfall, 6-month vegetation health and 3-month rainfall forecast.
- [6-month Standardized Precipitation Index](#)  
Rainfall over the last 6 months.
- [6-month Vegetation Health Index](#)  
Vegetation health over the last 6 months.


Drought EWS: drought status for 22 PNG provinces in June 2023 – four categories: “critical”, “alert”, “watch” and “non-drought”. (derived from 3-month SPI & VHI with seasonal rainfall forecast)

# A Possible Contribution of SWCEM to “Early Warnings for All” Initiative

At the 19th World Meteorological Congress (Cg-19) in 2023 the “Early Warnings for All” was recognised as the top priority for the WMO, and the SWCEM community is determined to assist the WMO with the task to enhance space-based observations for developing Early Warning Systems.

Considering priorities for the SWCEM for 2024 - 2027, SG-SWCEM recommended the following activities:

- (1) SWCEM satellite precipitation estimates as input into the “Early Warning for All” initiative, especially for the regions with limited rain gauge observations, capitalizing on the experience gained from PNG;
- (2) Strengthening collaboration with CREWS, tailoring SWCEM rainfall products from JAXA and NOAA to CREWS user needs and producing an extended set of products if needed;
- (3) Expanding the set of SWCEM products, including not only satellite precipitation estimates, SPI, and VHI, but also soil moisture (from SMOS/ASCAT);
- (4) Demonstrating the importance of SWCEM products not only for WMO Regional Climate Centres, but also for nowcasting applications;
- (5) Providing GSMaP satellite data for the CREWS project focused on the Southwest Indian Ocean region (CREWS-SWIO);
- (6) Providing CMORPH-2 products (at a latency of one hour) which show substantially improved quality compared to CMORPH-1;
- (7) Establishing SWCEM for Africa (WMO RA I);
- (8) Drafting the SWCEM Implementation Plan for 2024 – 2027.



WMO Space-based Weather and Climate Extremes Monitoring  
**SWCEM Newsletter**

September 2019

- Welcome
- Background
- SEMPD-EAWP
- SWCEP-EAWP in Operation
- SWCEM Portal

Contact Us  
Werner BAUGH  
WMO Space Programme  
Office: Observation and Information System Department  
Peer HECHLER  
Data Management Applications Division, Climate and Water Department

A Cross  
Meteo Satellite  
Provision of satellite monitoring to climate and weather  
Sharing of exp. from the satellite monitoring to climate and weather  
Utilisation of Guidelines

**1. Welcome**  
Welcome to the recognized that climate weather and climate extremes include National Meteorological Institutes. The possibility of the WMO (SWCEM) to WJ Plan approved in June 2019.

**1. EP-SWCEM-EAWP**  
Recognizing needs to b extremes from space i Weather and Climate SWCEM was launched

We started SWCEM w and were able to bri

**2. Global Satellite-derived products Providers (GP-SAT)**  
3.1. JAXA  
3.2. NOAA/CPC

**4. WMO Regional Climate Centres (RCCs)**  
4.1. Drafting monitoring in Australia based on WMO SWCEM products  
4.2. WMO Statement on the State of the Global Climate in 2019 (p.24)

**5. WMO Secretariat**  
1. WMO Statement on the State of the Global Climate in 2019 (p.24)

**2. WMO BULLETIN Vol. 69(1)-2020 (p.66-68)**

SWCEM Newsletter – Issue 1 | April 2020

**2. Backgr**

CPC/NOAA provides S Mapping of Precipita derived from GPMAP monthly precipitation precipitation and parc monitoring, the stanc available. These data a

CPC/NOAA provides S Prediction Center mo In addition to the SW

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# Sep. 2019

**1. UNITED NATION/ AND THE PACIF**  
Space Applications Activities and exampl

Rapid digital innovation providing Asia-Pacific a choice of tools to impl quality of geospatial in integrated geospatial in capacity and financial expertise, specific too

In view of this, the As Development (2018-20 Applications for Sustain gaps and challenges (I Action pdf). Since th implementation of the knowledge sharing, ca discussions and regiore resilience, management and climate change.

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Figure 2. Six priority the Sustainable Develop

SWCEM Newsletter – Issue 2 | July 2020

**1. WMO GLOBAL GMAS**  
Joben Luthar, James Owar Branch, Services Deparment

Early and authoritative produced by National M to be very effective in the foundation on which can be realized. As hyd vulnerable populations need for these warnings easily accessible on tim

The WMO Global Multi framework for robust warnings and informative water and climate even visible and accessible re (2) identifying gaps in ca and capacity develop global mobility; (4) imp including NMHS – b (5) harmonizing, and promoting cross-border

To achieve these objecti early warning systems governments, business advance of hazardous r risk knowledge based assessments; (2) detect possible consequences; of authoritative, timely, on likelihood and impact received. These four coordinated within and systems to work effect improvement. While th hazard cluster, multi-ha

SWCEM Newsletter – Issue 2 | July 2020

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**4. WMO Secretariat**  
4.1. 13<sup>th</sup> Asia-Oceania Meteorological Society (AOS) Annual Meeting

SWCEM Newsletter – Issue 3 | October 2020

# SWCEM NewsLetter

<https://public.wmo.int/en/programmes/wmo-space-programme/swcem>

**WORLD METEOROLOGICAL ORGANIZATION**  
WMO Space-based Weather and Climate Extremes Monitoring  
**SWCEM Newsletter**  
Issue 1 | April 2020

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**SWCEM Newsletter**  
Issue 8 | May 2023

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SWCEM Newsletter – Issue 3 | October 2020

**WORLD METEOROLOGICAL ORGANIZATION**  
WMO Space-based Weather and Climate Extremes Monitoring  
**SWCEM Newsletter**  
Issue 9 | September 2023

**1. Outcomes of the 5th Session of the WMO Steering Group for the SWCEM in East Asia and Western Pacific**

The Fifth Session of the WMO Steering Group for the Space-based Weather and Climate Extremes Monitoring in East Asia and Western Pacific (SG-SWCEM-EAWP-5) was held as a hybrid event on 27-28 July 2023.

During the welcome address, emphasis was placed on the fact that the 19th World Meteorological Congress had approved several resolutions related to the “Early Warnings for All” initiative. It was underscored that SWCEM should play a substantial role in the implementation of this initiative. Yuriy Kuleshov, the Chair of SG-SWCEM-EAWP, specifically highlighted that this theme aligns with the activities carried out by the SWCEM community, addressing the challenges posed by climate change through the utilization of space-based observations.

The key objectives of the session were to review the progress of the project since the last meeting of the SG-SWCEM-EAWP in March 2022 and to plan activities for the upcoming period.

Global Satellite-derived Product Providers (GP-SAT): JAXA and NOAA presented their progress reports.

The NOAA/NWS report indicated that since January 2023, the Climate Prediction Center (CPC) has initiated operational real-time routine production of CMORPH-2 products. These products are maintained around the clock, seven days a week, with a one-hour latency and updated every 30 minutes.

JAXA/ECDC introduced the GPMAP precipitation portal, which serves as a visualization platform for GPMAP products. This includes Climate Rainfall Watch, providing information on extreme heavy rainfall and drought, and the Realtime Rainfall Watch, offering information on current precipitation distribution. Notably, JAXA began distributing real-time GPMAP data to SWCEM members in June 2022 in response to the request from the SWCEM community.

The Chair of SG-SWCEM-EAWP specifically emphasized that the continuous efforts of satellite providers are bringing the satellite community closer to reaching the significant milestone of 30 years of satellite climate data records, a requirement in conventional climatology.

Global and Regional State of the SWCEM in East Asia and Western Pacific (SG-SWCEM-EAWP-5) was held as a hybrid event on 27-28 July 2023.

1. ON THE USE OF SP THE CLIMATE REPORT

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**2. The World Climate Research Programme's new Global Weather and Climate Extremes Platform (GEP)**

1. WMO Secretariat  
3.1.1. AOS  
3.1.2. AOS Outreach

**Links**  
SWCEM Portal  
SWCEM Help-desk

**WMO Annual Statements or**

**Key climate indicators**  
Monitoring of climate variability and climate change relies on climate observation systems, including data obtained by remote sensing, in particular by satellite sensors. A set of seven key indicators for global climate monitoring was developed by WMO which are a subset of essential climate variables (ECVs) established by the Global Climate Observing System (GCOS) with the aim to represent the state of the climate system as completely. These indicators include global mean surface temperature, global ocean heat content, state of

SWCEM Newsletter – Issue 8 | May 2023

**1. The Satellite Application Facility (CM SAF) of the European Meteorological Society**

The importance of climate monitoring is emphasized when they are (EMSAT) mandate is also to “1) and the detection of global clim within its Satellite Application Facility Climate Monitoring (CM SAF) Consortium comprises the Deuts partners from the Royal Meteorological Institute (FMI), the Swedish Meteorology Meteorological Society of Swat United Kingdom (UK MetOffice) (MNS) in RA II; MetService Members demonstrated v space based observations v

The report on CREWS was pr CREWS was established at C warning systems to assist v

It was highlighted that Meteorological Day the folk should be protect-ed by ear climate change”. WMO wa achieve this goal at the next UN climate conference in Egypt this November 2022. It was suggested adding a recommendation resulting from the SG-SWCEM-4 meeting SWCEM to contribute to the new UN target, which should be followed by developing a more specific action plan how SWCEM members can contribute to this initiative.

The complete report of the meeting is available from the WMO SWCEM Portal: <https://community.wmo.int/meeting/4th-session-wmo-steering-group-swcem-east-asia-and-western-pacific-eg-swcem-4>.

SWCEM Newsletter – Issue 7 | September 2022

**1. Climate Risk and Early Warning Systems (CREWS) Initiative**

Global Satellite-derived Products Providers (GP-SAT)

**2. JAXA**

**3. WMO Regional Climate Centres (RCCs)**  
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SWCEM Newsletter – Issue 6 | March 2022

**1. SWCEM and CREWS presents**

18<sup>th</sup> annual Society (AOS) in August 2021 Meteorological Society of Swat United Kingdom (UK MetOffice) (MNS) in RA II; MetService Members demonstrated v space based observations v

The meeting reviewed the Some of the actions and re (1) the survey on usefuln WMO Space-based Project for East Asia as 60 | <https://brav.wmo.int>

(2) It was recommended web pages for SE <https://public.wmo.int>

(3) Through coordinated the Australian BoM, SWCEM delivered at this session (see the table b four oral and one poster sessions of AOS) outstanding achievements of the WMO 5

The session “Climate Change and Tropical successfully conducted at 12 meetings sta change on climatic hazards in Asia Ocean based weather and climate change adapta concern are climate extremes such as tro (droughts and floods), sea level extremes, session are usually concerned with, but n historical trends in climate extremes, pre seasonal (QSO), inter-annual and longer recommendations how to plan current an when WMO established a new flagshi through the SWCEM and CREWS activities.

SWCEM Newsletter – Issue 4 | January 2022

**SWCEM Help-desk**  
For user feedback, contact: [sat-help-desk@wmo.int](mailto:sat-help-desk@wmo.int)

# Early Warning for All

UN unveils ambitious target to adapt to climate change and more extreme weather



**António Guterres**

Secretary-General of the United Nations



“

We must boost the power of prediction for everyone and build their capacity to act. On this World Meteorological Day, let us recognize the **value of early warnings and early action** as critical tools to reduce disaster risk and support climate adaptation.

”