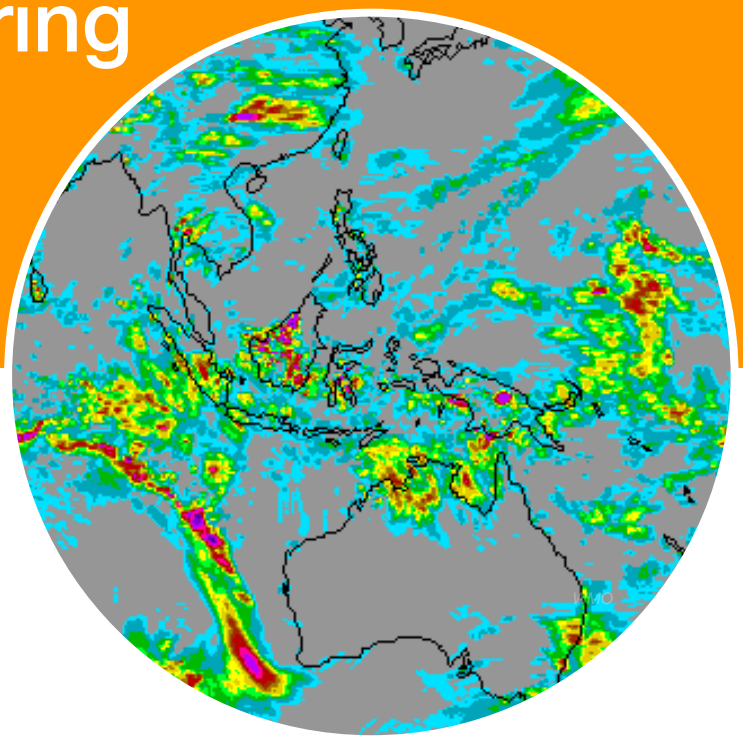
Space-based Weather and Climate Extremes Monitoring (SWCEM)



SUMMARY

Key Points

- Space-based rainfall estimates are valuable for persistent heavy rainfall and drought detection and monitoring with more than 20 years of climatology for anomaly analysis, especially for regions where rain gauge observations are limited or unavailable.
- The Space-based Weather and Climate Extremes Monitoring (SWCEM) project was implemented in WMO Regional Association II and Regional Association V, covering South-East Asia and the Western Pacific Ocean area.
- The JAXA GSMaP and NOAA/CPC CMORPH rainfall estimates provided by the SWCEM are used in WMO Regional Climate Centres and ASEAN Specialised Meteorological Centre (ASMC). In addition, drought monitoring in Australia utilizing the JAXA and the NOAA products was noted in the WMO Statement on the State of the Global Climate 2019.

Service

- Adaptation
- Agriculture
- Disaster risk reduction (DRR)
- Flood management

End users

- Government agencies
- Local communities

Intermediate User(s)

- WMO Regional Climate Centres (RCCs)
- National Meteorological and Hydrological Services (NMHSs)
- Other relevant institutes, specifically
- China Meteorological Administration (CMA)
- Badan Meteorologi, Klimatologi, dan Geofisika (BMKG, Indonesia weather agency)
- Philippine Atmospheric, Geophysical and Astronomical Services Administration (Philippine Weather Agency)
- Meteorological Service Singapore (MSS, Singapore Weather Agency), Australian Bureau of Meteorology (Australia Weather Agency)

Application(s)

Drought monitoring in Australia utilizing products from the GSMaP and the CMORPH in 2019 was noted in WMO Statement on the *State of the Global Climate 2019*. The GSMaP and CMORPH rainfall estimates are used in ASEAN Specialised Meteorological Centre (ASMC) for monthly weather review. A monitoring system has been developed based on the satellite-derived data in Beijing Climate Centres (BCC) and Southeast Asia Regional Climate Centre Network.

Essential Climate Variables

—Atmosphere

- Precipitation

Satellite algorithms

T. Kubota and co-authors, 2020: Global Satellite Mapping of Precipitation (GSMaP) products in the GPM era, Satellite precipitation measurement, Springer, vol. 67, pp.355-373. https://doi.org/10.1007/978-3-030-24568-9_20.

T. Tashima, T. Kubota, T. Mega, and T. Ushio, and Riko Oki, 2020: Precipitation extremes monitoring using the near-real-time GSMaP product, IEEE J. Sel. Topics Appl. Earth Observ. Remote Sens., https://doi.org/10.1109/JSTARS.2020.3014881.

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

Joyce, R. J., J. E.Janowiak, P. A.Arkin, and P.Xie, 2004: CMORPH: A method that produces global precipitation estimates from passive microwave and infrared data at high spatial and temporal resolution. J. Hydrometeor., 5, 487–503, doi:https://doi.org/10.1175/1525-7541(2004)005<0487:CAMTPG>2.0.CO;2.

Climate Data Records

The JAXA (GSMaP) and the NOAA (CMORPH) are now applying for the ECV Inventory. JAXA already submitted the ECV Inventory list to the Office, and Data record identifier:

- JAXA_CDR11707_GSMaP and
- JAXA_CDR11708_GSMaP

are the JAXA's precipitation data used in the SWCEM.

Agencies

- JAXA: GSMaP (April 2000 to latest)
- NOAA/CPC: CMORPH (January 1998 to latest)

Satellite Observations

Passive microwave sensors such as

- GPM Core GMI,
- TRMM TMI
- AQUA AMSR-E
- GCOM-W AMSR2
- DMSP-F13/F14/F15 SSM/I
- DMSP-F16/F17/F18/F19 SSMIS
- NOAA-N15/N16/N17/N18/N19 MHS
- MetOp-A/-B/-C MHS
- Geostationary Meteorological Satellites IR

Sustainability

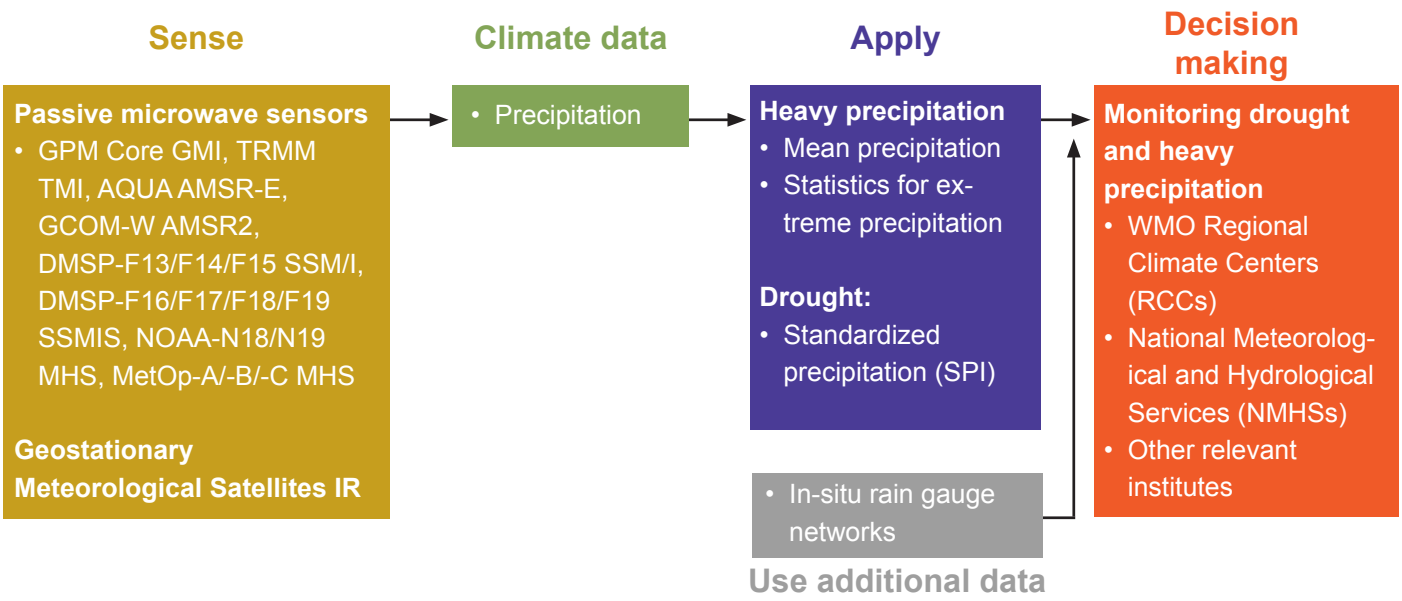
- The Service of providing Satellite rainfall data to the WMO RCCs, the NMHSs and other relevant institutes are operated in the JAXA and the NOAA/CPC

Precipitation data from the JAXA and the NOAA are available and open to the RCCs and the NMHSs from the following URLs: https://public.wmo.int/en/programmes/wmo-space-programme/swcem and, more directly, https://public.wmo.int/en/programmes/wmo-space-programme/swcem#-bootstrap-panel--3

DESCRIPTION

Recognizing the need to better utilize and improve monitoring of weather and climate extremes from space, WMO initiated the Space- based Weather and Climate Extremes Monitoring (SWCEM) project. This project is focused on monitoring drought and heavy precipitation. It was implemented in the WMO Regional Association II and Regional Association V; its geographical domain covers Southeast Asia and the Western Pacific Ocean area. Below is an information flow chart of the SWCEM.

INFORMATION FLOW



The SWCEM Demonstration Project (SEMDP) for East Asia and Western Pacific regional subproject (SEMDP-EAWP) began in 2018 with a duration of 2 years. For the Demonstration Project's users in Asia-Pacific, JAXA and NOAA/CPC provided mean precipitation at temporal resolutions of hourly, daily (00-23UTC), pentad (5 days), weekly (Monday–Sunday), 10 days, and monthly precipitation with spatial resolution of 0.1° latitude/longitude grid box. In addition, statistics for daily, pentad, and weekly extreme precipitation (90th to 99th percentiles) and percentage of rainy (≥1mm/day) days in a month were provided. As an example of the product, Figure 1 shows monthly rainfall percentiles for December of JAXA GSMaP in December 2010.

For drought monitoring, the Standardized Precipitation Index (SPI; 1-month, 2-month, and 3-month) for grid boxes over land with spatial resolution of 0.25°latitude/longitude grid box was provided. These data are available within a few hours of their observation. As an example of the SPI product, Figure 2 shows a horizontal distribution of the 3-month SPI for June–July–August 2007 derived from the JAXA GSMaP. In addition to the SPI, the NOAA/CPC provided weekly normalized differential vegetation index (NDVI) and the vegetation health index (VHI).

The invited WMO RCCs and NMHSs in the SEMDP regional subproject have validated satellite-derived products with rain gauge data for monitoring persistent heavy/light rainfall and drought. The goal is to monitor heavy rainfall over relatively short periods from pentads (5 days) up to a month. It is noted that currently, extreme events are usually diagnosed on a monthly basis by most of the RCCs. For drought events, a period of about one month is considered.

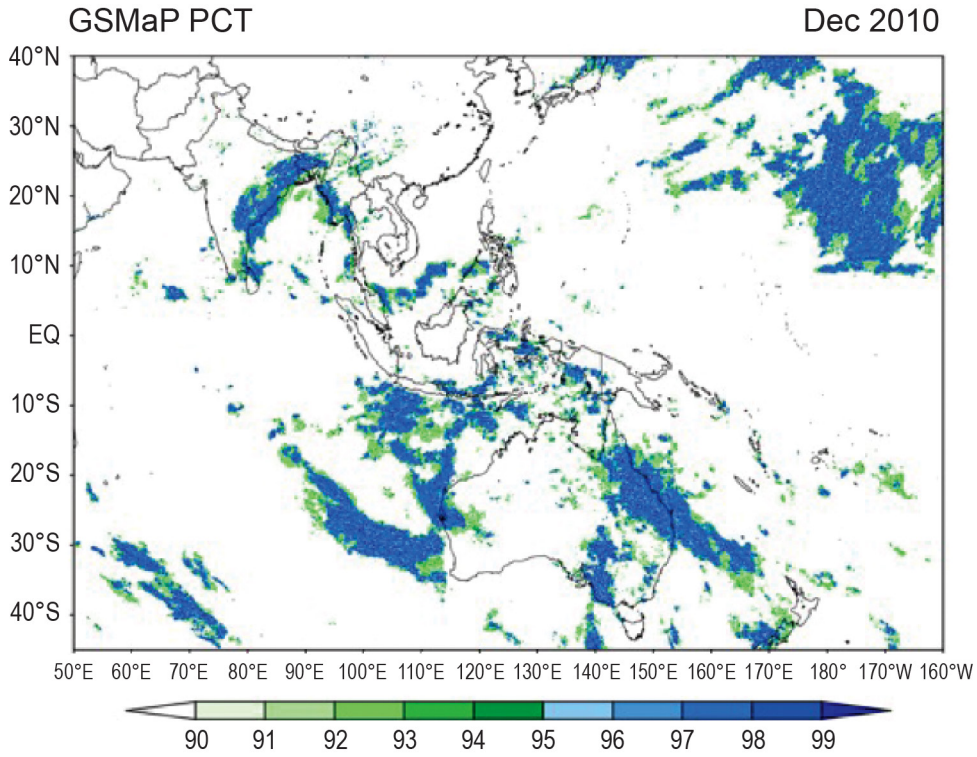


Figure 1. Monthly rainfall percentiles for December of JAXA GSMaP in December 2010.

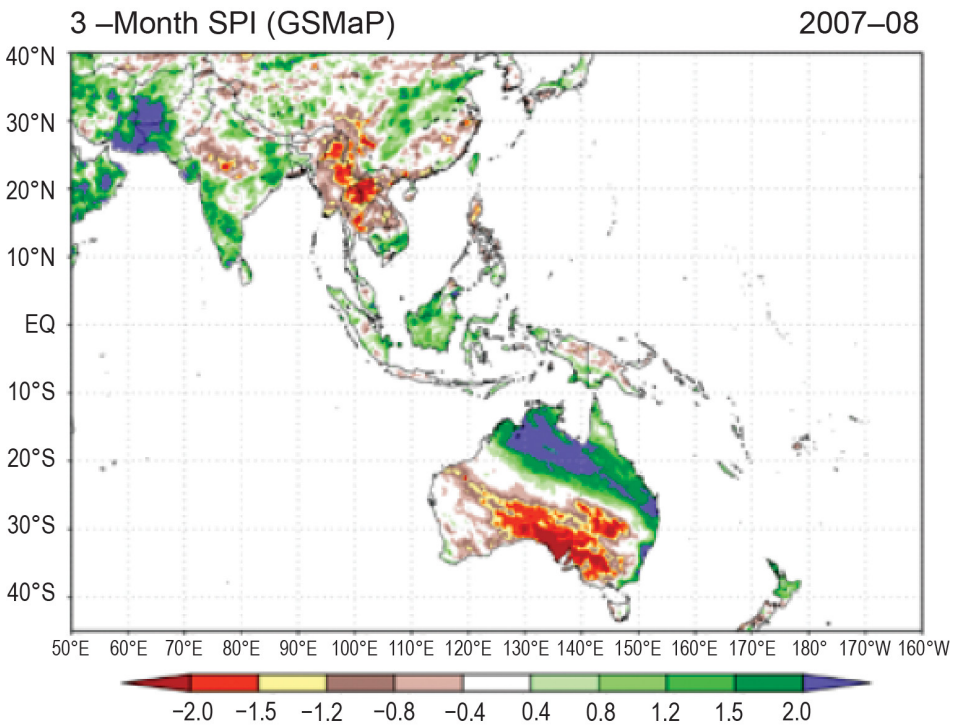


Figure 2. Three-months SPI for June-July-August 2007 derived from the JAXA GSMaP.

The 2-year SEMDP-EAWP has concentrated on products at national and regional levels and will focus on the following:

- Monitoring persistent heavy/light rainfall and droughts
- Making best use of existing and newly developed satellite derived products and time series
- Making best use of products that combine satellite observation with in-situ data

- Validating satellite derived products with surface-based observations
- Recommending practices for monitoring extreme weather and climate events
- Assessing these precipitation products and recommending the research products ready to be transitioned into operations

Summary of results in the SEMDP was published in the WMO Bulletin (Kuleshov et al. 2020). Kuleshov et al. (2020) concluded that initial results from SEMDP-EAWP demonstrate that space-based estimates of extreme precipitation are an effective solution to enhance the drought- and heavy rainfall-monitoring capacity of RCCs and NMHSs. Such capacity would enable service providers to assist Governments and local communities to make informed decisions regarding adaptation to climate variability and change. Recognizing the achievements of the Demonstration Project in assisting RCCs and NMHSs in East Asia and the Pacific, the Eighteenth World Meteorological Congress (Cg-18) recommended implementing SWCEM throughout Regions II and V and expanding it to other WMO Regions.

A couple of RCCs have already volunteered to pursue SEMDP-EAWP over a period of 2 years. After the demonstration phase, monitoring results using satellite-derived products were reflected in the SWCEM East Asia and Western Pacific regional operational subproject (SWCEM-EAWP). The Australian Bureau of Meteorology (BoM) evaluated percentile values derived from the satellite data with the long-term ground data and published results as Chua et al. (2020). The JAXA evaluated usefulness of satellite precipitation extremes monitoring in the East Asia and Western Pacific region with reference to long-term ground gauge data (Tashima et al. 2020). Tashima et al. (2020) also examined a drought in mainland Southeast Asia and clearly demonstrated the value of space-based rainfall estimates for drought detection and monitoring, especially for regions where rain gauge observations are limited or unavailable.

Currently, the GSMaP and CMORPH rainfall estimates provided by the SWCEM are used in ASEAN Specialised Meteorological Centre (ASMC). Figure 3 shows a homepage of the AMSC using the SWCEM products. Satellite rainfall estimates are used in the monitoring of monthly rainfall data in ASMC website for monthly weather review.

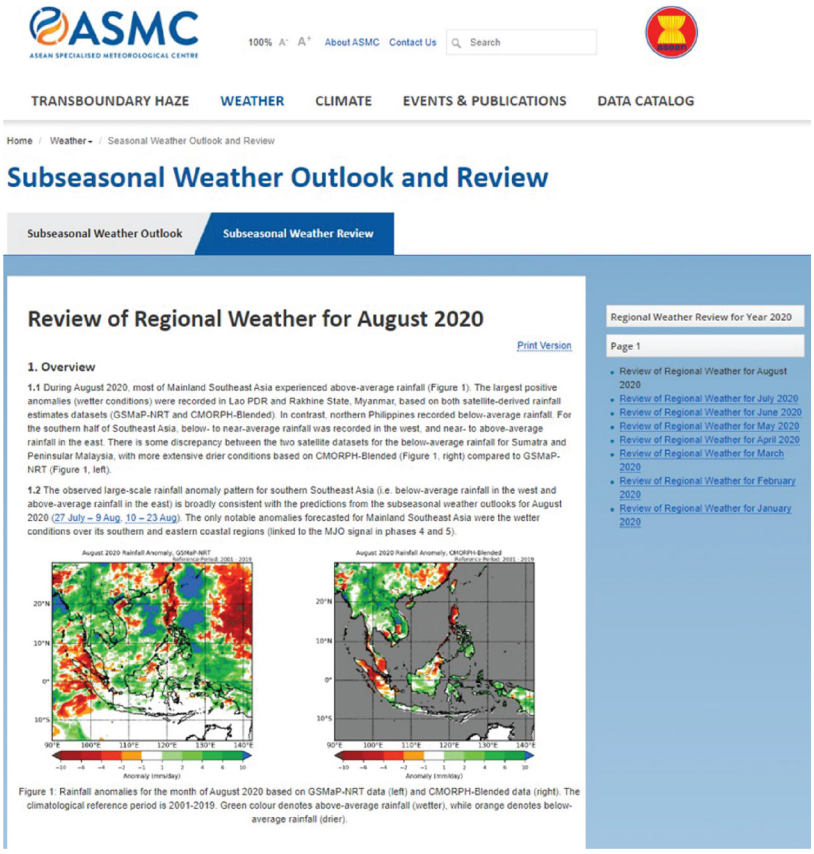


Figure 3: A homepage of ASEAN Specialised Meteorological Centre using the SWCEM productsrived from the JAXA GSMaP.

Australia frequently experiences extended periods of severe droughts which have a significant negative impact on populations and economy. To improve preparedness for drought, decision-support tools that provide comprehensive information about current dry conditions are essential. To disseminate drought risk to users, a Drought Risk Analyser (DRA)—a web-based information app used for drought -risk mapping—was developed using geographic information system (GIS). DRA is based on combining Drought Hazard/Vulnerability/Exposure Indices into a final Drought Risk Index (DRI) for a total of 542 Local Government Areas (LGA) in Australia. Drought indicators selected to compute drought hazard, i.e., the SPI, the Vegetation Health Index (VHI), and Soil Moisture, were obtained through the SWCEM international initiative.

For the further information of the SWCEM, please visit the following home page. https://public.wmo.int/en/programmes/wmo-space-programme/swcem

Surface-based observations (rain gauges) provide accurate point-based measurements of precipitation; however, data are restricted to the locations of meteorological observation stations. Over Australia, for example, the spatial distribution of rain gauges is not uniform: while the most densely populated regions are well covered, spatial coverage in other regions, such as western Tasmania and the interior of the country, is very poor. This issue of non-uniform spatial coverage is typical in the Asia-Pacific region, where rain gauge density in many areas is inadequate. Therefore, complementary rainfall estimates derived from space-based observations would better address various users' needs for precipitation information.

References:

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T. Tashima, T. Kubota, T. Mega, and T. Ushio, and R. Oki, 2020: Precipitation extremes monitoring using the near-real-time GSMaP product, IEEE J. Sel. Topics Appl. Earth Observ. Remote Sens. https://doi.org/10.1109/JSTARS.2020.3014881.