EUMETSAT'S ROLE IN THE PROVISION OF PRECIPITATION RELATED SATELLITE DATA

Thomas Heinemann and Volker Gärtner

EUMETSAT, EUMETSAT Allee 1, Darmstadt, Germany
e-mail: Thomas.Heinemann@eumetsat.int

ABSTRACT

During the last decade EUMETSAT developed its role further, from being purely a satellite operator which also provides satellite data and products from its own satellites, to a central distributor for all types of satellite related data for European and world wide users, focussing on the weather, climate, and hydrological community. In this context, EUMETSAT provides also precipitation related satellite data. This service includes already MW-sounder data from NOAA and EUMETSAT satellites as well as SSMIS data from the DMSP satellites. In the future data from the Megha-Tropiques mission and the GPM-core satellite will also be provided in the best possible timeliness. In cooperation with JAXA and NASA, EUMETSAT tries to make near-real time AMSR2 data available to the European users. The EUMETCast satellite data distribution system is EUMETSAT's fast and cost-effective approach to provide NRT data to European, African and South-American users. In co-operation with our partners in North-America and Asia, the GEONETCast co-operation was developed to foster the world-wide data exchange and data distribution.

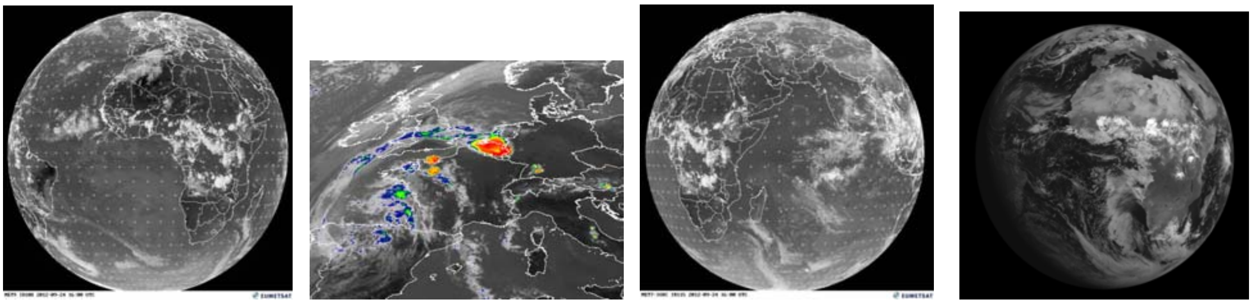
For the future EUMETSAT also plans to extend its contribution to the precipitation remote sensing efforts with new own satellite sensors. Therefore, the concept for the second generation of EUMETSAT's polar orbiting satellites, EPS-Second Generation, does not only include microwave sounding missions but also microwave imaging.

1. Precipitation related data from EUMETSAT satellites

Geo-stationary and polar-orbiting satellites together provide the essential data for local regional and global weather and climate observations. Both satellite types provide relevant information for precipitation remote sensing. Currently, EUMETSAT operates the geo-stationary Meteosat and the polar orbiting METOP satellites.

1.1 Meteosat geo-stationary satellites

Data from geostationary satellites still play a crucial role in the remote sensing of precipitation. The high temporal resolution reduces sampling errors and allows the derivation of atmospheric motion vectors which indicate the advection of precipitation fields in so-called morphing algorithms. EUMETSAT operates currently 4 geo-stationary satellites (Fig.1), Meteosat 7 to Meteosat 9 and MSG-3.



Meteosat-7 (MTP-1)	**Meteosat-8 (MSG-1)**	**Meteosat-9 (MSG-2)**	**MSG-3 (commiss.)**
Position: 57° E Coverage: full disc Repeat cycle: 30 min Spectral Channels: 3	Position: 9.5° E Coverage: 35°-65° N Repeat cycle: 5min Spectral Channels: 12	Position: 0° Coverage: full disc Repeat cycle: 15min Spectral Channels: 12	Position: 3.5° W Coverage: full disc Repeat cycle: 15min Spectral Channels: 12

Figure 1. IR (10.8 µm) images from the Meteosat geo-stationary satellites

1.2. METOP polar orbiting satellites

EUMETSAT's polar orbiting satellites METOP-A and METOP-B (in commissioning) carry various instruments like AVHRR, ASCAT, and IASI which are sensitive to precipitation. However, among the METOP instruments, the two microwave sounders AMSU-A and MHS (Fig. 2) allow the most direct assessment of precipitation parameters. In the context of the Initial Joint Polar System (IJPS), EUMETSAT also provides AMSU-A and MHS data from NOAA 19. In the future ATMS data from Suomi-NPP will be made available in Near Real Time (NRT).

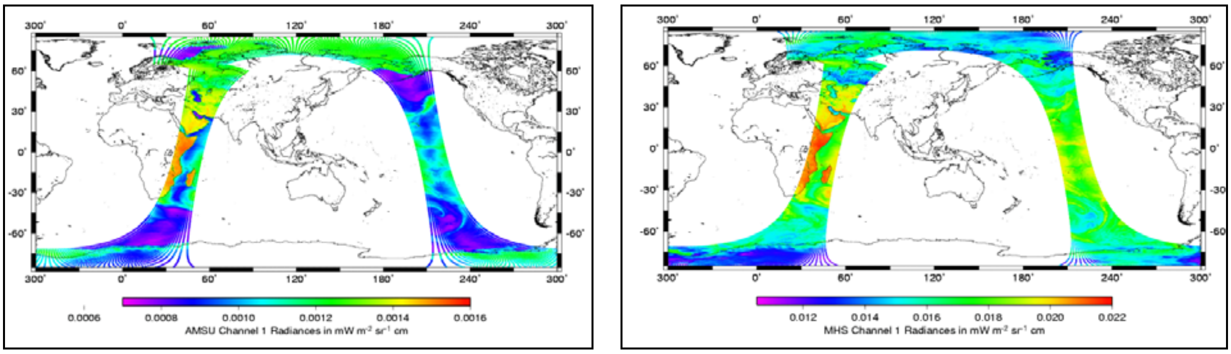


Figure 2. AMSU-A (left) and MHS on METOP-A, EBBT, channel 1

After the end of the commissioning of METOP-B, the two METOP satellites will deliver data from the same orbit with time a difference of around 50 minutes. This configuration will allow the application of algorithms which depend on the observation of the same point of the Earth twice, with a short delay. Such algorithms can currently be used only over the polar regions or for data from geo-stationary satellites. These approaches can also be useful for precipitation remote sensing. A potential application could be to derive global atmospheric motion vectors from the two subsequent overpasses and apply them to propagate precipitation fields derived from microwave data.

2. Precipitation products from EUMETSAT

Today, the development of precipitation algorithms and the generation of precipitation products from satellite data at EUMETSAT is mainly performed by the Satellite Application Facility (SAF) for the support to Nowcasting and Very Short Term Forecasting (NWC-SAF) and the SAF on Support to Operational Hydrology and Water Management (H-SAF). The NWC-SAF prepares software for local or regional processing of data from the MSG-satellites and for data from the AVHRR instruments onboard of METOP and NOAA satellites. Details can be found on the NWC-SAF webpage (NWC-SAF,2012)

The activities of the H-SAF have been presented during this working group meeting (Biron, 2012).

The EUMETSAT central facility still produces and disseminates two heritage products, the High resolution Precipitation Index (HPI) and the Multi-Sensor Precipitation Estimate (MPE) in near-real time to users. The MPE product is based on a classical blending algorithm (Heinemann, 2004, 2008). It combines passive microwave rain-rates from polar orbiting satellites (SSMIS) with IR data from geo-stationary satellites (Meteosat) to retrieve instantaneous rain rate data every 15-30 min in original Meteosat pixel resolution (Fig. 3).

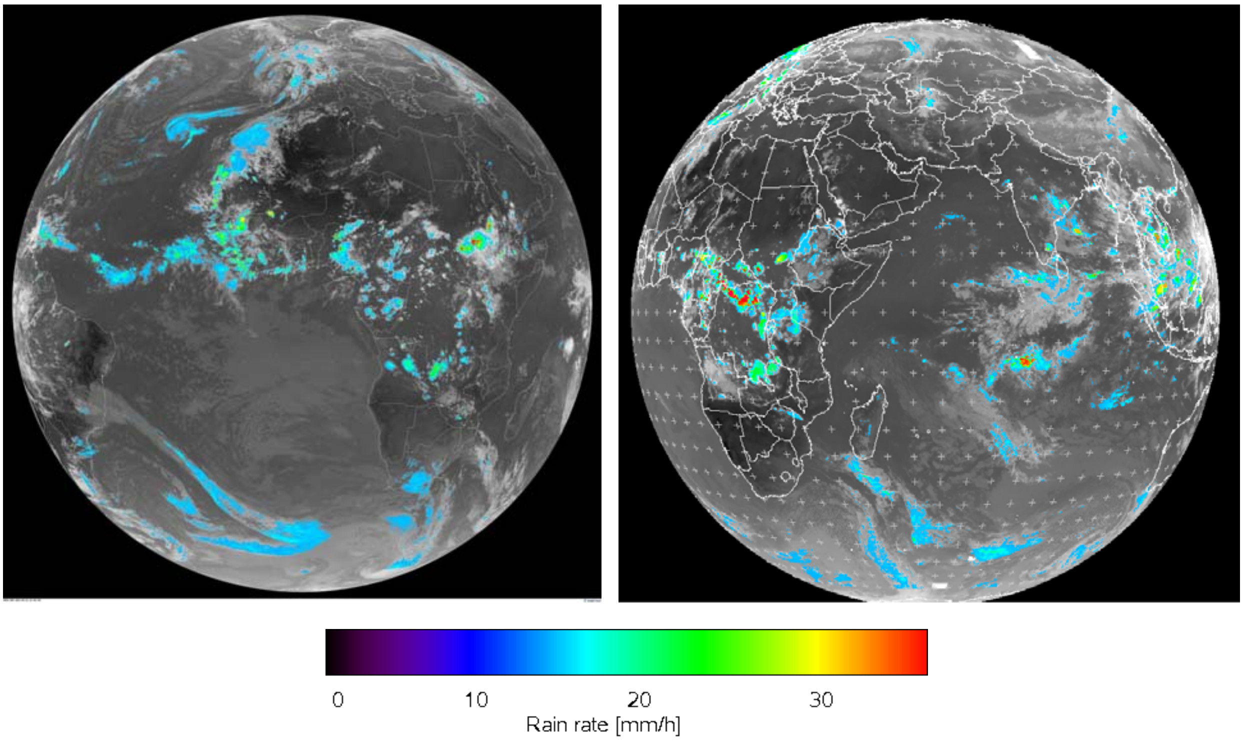


Figure 3. MPE instantaneous rain rate for Meteosat-9 (left) and Meteosat-7 (right), 24/09/2012, 15:00 UTC.

As a heritage product, MPE uses the same algorithm for the first and second generation of Meteosat satellites. The processing is done in near-real time mode with a time delay of less than 10 minutes between image acquisition and data dissemination. Data are provided on the internet and via EUMETCAST in GRIB-2 data format and in addition visualised on the EUMETSAT web-page. In large areas of the world, methods based on ground measurements or polar orbiting satellite products cannot fulfil the NRT requirements and a dense radar network is not available. MPE is intended for short-range forecasting and nowcasting in these regions, mainly in Africa and Asia.

3. Third party data and products

The EUMETCast system is EUMETSAT's primary dissemination mechanism for the near real-time delivery of satellite data and products generated by the EUMETSAT Application Ground Segment and a range of third-party products. EUMETCast is a multi-service dissemination system based on standard Digital Video Broadcast (DVB) technology. It uses commercial telecommunication geostationary satellites to multicast files (data and products) to a wide user community. Further, EUMETCast is the EUMETSAT contribution to GEONETCast. Table 1 shows the precipitation related satellite L1-data which are already available on EUMETCast.

Polar orbiting satellites: L1 data		Geo-stationary imagery	
Satellite	**Instrument**	**Satellite**	**Repeat Cycle**
Aqua	MODIS	GOES-E	1h / 3h
DMSP F-16	SSMIS	GOES-W	1h / 3h
DMSP F-17	SSMIS	MTSAT-2	1h
FY3A	MWTS	FY2D	1h (projected)
FY3A	MWHS	FY2E	1h (projected)
FY3B	MWTS		
FY3B	MWHS		

Table 1. Precipitation related Level 1 data on EUMETCast

In addition, the following precipitation data and products are or will be made available on EUMETCast:

- **TAMSAT** 2 Rainfall products for Africa
- **AMESD** 9 Rainfall products Southern Africa (partly still under implementation)
- **FEWSNET** Rainfall Estimate (Africa)
- NASA Short Term Precipitation Forecast (**MM5**, Central America)
- Megha-Tropiques: **MADRAS** and **SAPHIR** L1A2 data (2013, Q1)
- **GPM-Core**: TBD (Negotiations to become GPM partner ongoing)
- GCOM-W **AMSR2** : TBD (Negotiations with JAXXA and NASA)
- NOAA 15-18: **AMSU** + **AMSU-B/MHS** (2013, Q1)

4. Precipitation related data from future EUMETSAT satellites

The continuity of EUMETSAT's satellite programs is guaranteed by the follow-on missions for the current geo-stationary and polar satellites. These missions will improve the precipitation remote sensing by advanced and additional instruments.

4.1. Meteosat Third Generation (MTG)

The program for the third generation of Meteosat satellites is currently under development by ESA and EUMETSAT. The in orbit configuration will consist of two parallel positioned satellites, the MTG-I (imager) and the MTG-S (sounder) platforms. The MTG series will comprise six satellites, 4 MTG-I and 2 MTG-S, with the first spacecraft likely to be ready for launch from 2020. The total operational service lifetime of the program is planned to last 15-20 years.

The payload complement of the MTG-I Satellites will support also precipitation remote sensing applications. It will not only contain the Flexible Combined Imager (FCI), to continue and improve the provision of geo-stationary imagery but also a Lightning Imager (LI). This new instrument will allow the continuous detection/mapping of intra-cloud and cloud-groundstrokes at ~10km spatial resolution for 80% of the full disc.

4.2. EPS Second Generation (EPS-SG)

In November 2012, the EUMETSAT Council approved the preparatory program for the EPS-SG satellites. The system requirements foresee a concept based on a two satellites in orbit configuration: Metop-SG A, an optical imagery and sounding mission, and Metop-SG B, a microwave imaging mission. These satellites will provide the continuation of EUMETSAT's polar orbiting service from 2021 to 2042. The primary mission of the program will remain the provision and further improvement of observational inputs to Numerical Weather Prediction models. However, for the first time also operational hydrology has been identified as a major driver for the requirements. Therefore the Metop-SG B satellites will carry two instruments which are highly relevant for precipitation remote-sensing, the Microwave Imaging (MWI) and Ice Cloud Imaging (ICI) missions. Both will be developed by ESA.

The MWI instrument, dedicated to the retrieval of precipitation and cloud products as well as water vapour profiles, sea-ice, snow, and sea surface wind, should fulfil the following requirements:

- 18 channels: 18.7 – 183 GHz
- dual polarisation (V, H) up to 89 GHz
- V polarisation at higher frequencies
- radiometric accuracy: 1 K
- radiometric sensitivity: 0.6 – 1.2 K
- Footprint size: 10 – 50 km
- spatial sampling: 7 km
- conical scan

The ICI instrument will improve the retrieval of cloud products, in particular ice clouds, and the quantification of water-vapour profiles. In addition it will be designed to support the snowfall detection. The instrument requirements are:

- 11 channels: 183 – 664 GHz
- single polarisation (V) for all channels
- dual polarisation (V, H) at 243 and 664 GHz
- radiometric accuracy: 1 – 1.5 K
- radiometric sensitivity: 0.6 – 1.9 K
- Footprint size: 15 km
- spatial sampling: 7.5 km
- conical scan

5. References

Heinemann, (2004): Integration of the EUMETSAT Multi-sensor Precipitation Estimate (MPE) in an operational real-time processing environment, International Precipitation Working Group (IPWG) meeting, Monterey, CA, USA, September 2004

Heinemann T (2008): Quality indicators in an operational precipitation, International Precipitation Working Group (IPWG) meeting, Beijing, China, October 2008

Biron D (2012), D. Melfi, A. Vocino, M. Sist, L. Facciorusso, A. Agresta, F. Zauli, and L. De Leonibus: The EUMETSAT Hydrological Satellite Application Facility, the Precipitation Products Generation Suite at C.N.M.C.A., this issue.

NWC-SAF (2012): http://www.nwsaf.org

EUMETCast (2012): http://www.eumetsat.int/Home/Main/DataAccess/EUMETCast