Recent developments on rainfull estimation in H SAF (EUMETSAT Satellite Application Facility in Support to Operational Hydrology and Water Management)

Davide **MELFI**[1], Francesco **ZAULI**[1], Marco **GALLI**[1], Valentina **ROSATI**[1], Stefano **DIETRICH**[2], Giulia **PANEGROSSI**[2], Paolo **SANÒ**[2], Anna Cinzia **MARRA**[2], Luca **BROCCA**[3], Luca **CIABATTA**[3], Christian **MASSARI**[3], Stefano **SEBASTIANELLI**[4]

1 - Centro Operativo per la Meteorologia
Via Pratica di Mare, 45 c/o Aeroporto M. De Bernardi
00071 Pomezia (RM)
ITALY

2 - Istituto di Scienze dell'Atmosfera e del Clima (ISAC - CNR)
Roma

3 - Istituto di Ricerca per la Protezione Idrogeologica (IRPI - CNR)
Perugia

4 - GEO-K
http://www.geo-k.co/it/
Roma

THE EUMETSAT H-SAF

The "*EUMETSAT Satellite Application Facility on support to Operational Hydrology and Water Management*" (H-SAF) was established by the EUMETSAT Council on July 3, 2005 and started activity at the official date of September 1, 2005 as part of the EUMETSAT SAF Network.

The H-SAF objectives are:

- ❑ to provide new satellite-derived products from existing and future satellites with sufficient time and space resolution to satisfy the needs of operational hydrology, by mean of the following identified products:
  - precipitation (liquid, solid, rate, accumulated);
  - soil moisture (at large-scale, at local-scale, at surface, in the roots region);
  - snow parameters (detection, cover, melting conditions, water equivalent);
- ❑ to perform independent validation of the usefulness of the new products for fighting against floods, landslides, avalanches, and evaluating water resources.

H SAF
Support to Operational Hydrology and Water Management

THE PRECIPITATION CLUSTER

The poster is focused on the H SAF work program of the "Precipitation" Cluster for the actual phase the Third Continuous Development and Operations Phase (CDOP-3), whose period of duration is from 1st of March 2017 to 28th of February 2022.

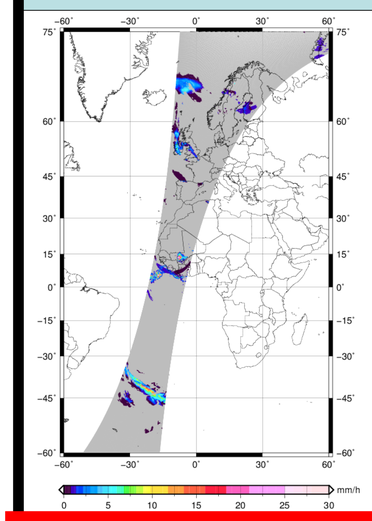
The precipitation products in HSAF are delivered for operational hydrological applications, near-real time precipitation monitoring, and water management.

They are founded on:

- ✓ the use of passive microwave (PMW) radiometric data available from Low Earth Orbit (LEO) platforms, most effective for remote sensing of precipitation because of the direct interaction of the radiation with cloud microphysical structure and precipitation;
- ✓ exploitation of all LEO MW cross-track and conically scanning radiometers orbiting around the Earth for high temporal sampling of the precipitation at all latitudes;
- ✓ combined use of infrared (IR) radiances from geostationary (GEO) images and PMW precipitation retrievals to overcome the low spatial resolution of PMW measurements and provide precipitation estimates at the temporal/spatial resolution and with the timeliness needed for operational hydrology and near-real time applications.

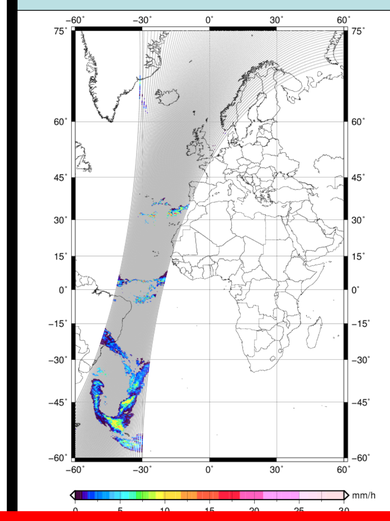
THE HSAF PRECIPITATION PRODUCTS CATALOGUE

H01 – P-IN-SSMIS



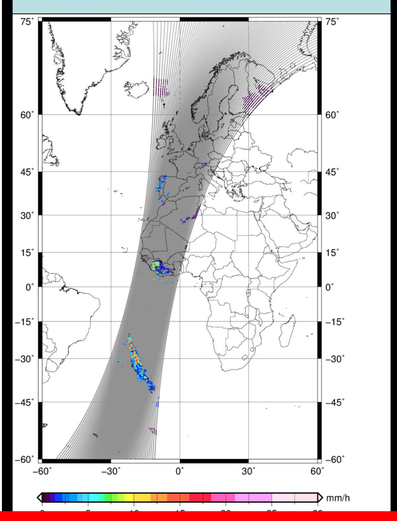
H01 is based on SSMIS instrument flown on DMSP satellites. These conical scanners provide images with constant zenith angle, that implies constant optical path in the atmosphere and homogeneous impact of the polarisation effects, and constant resolution across the image, though changing with frequency, IFOV are elliptical (11X16 Km^2). SSMIS data are made available to Europe and COMet via EUMETCast with a delay of around 90 minutes.

H02 – P-IN-MHS



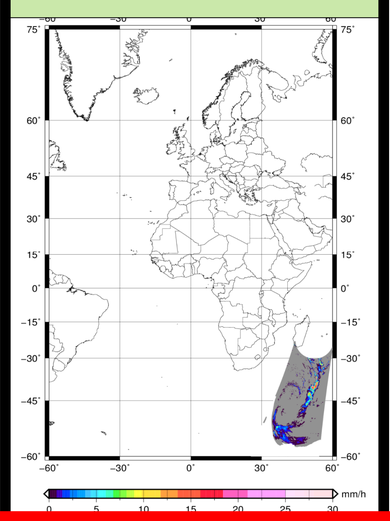
H02 is based on the AMSU-A and AMSU-B or MHS instruments flown on NOAA and METOP satellites. These cross-track scanners provide images with constant angular sampling: IFOV elongates as beam moves from nadir to edges of the scan; at nadir it is: 16X16 Km^2; at edge: 27X50 Km^2. Since the incidence angle changes moving cross-track, the effect of polarisation also changes, and frequencies are observed in V or H single polar.

H18 – P-IN-ATMS



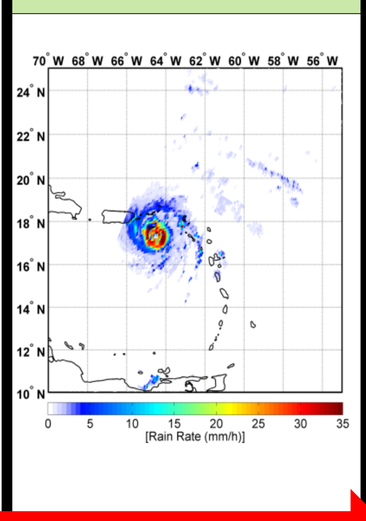
H18 represents an evolution, for ATMS applications, of previous H02 (PNPR) algorithm based on a NN approach, developed at ISAC-CNR for precipitation rate estimation using AMSU/MHS observations. A significant point in the design of PNPR is the choice of the TB differences in the water vapour absorption band channels at 183 GHz as input to the neural network. Originally designed to retrieve water vapour profiles due to their different sensitivity to specific layers of the atmosphere, these channels have shown great potentials for precipitating cloud characterization and for precipitation retrieval.

H-AUX-17



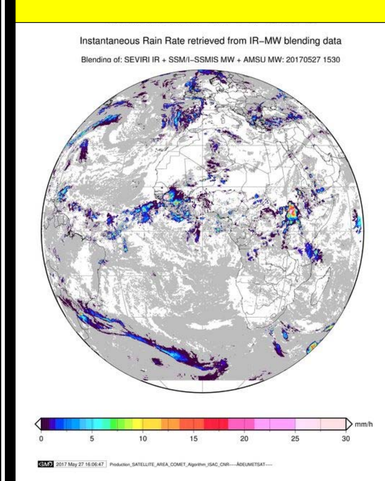
H17 ingests selected channels measured from the AMSR-2 radiometer as disseminated by EUMETCast and two ancillary dynamical-thermodynamical-hydrological (DTH) parameters T2m and TCW from the ECMWF High-resolution forecast model. Canonical Correlation Analysis (CCA) Pseudo-Channels are calculated and casted. CCA-Pseudo-Channels and DTH parameters are the input of the detection of precipitation module. The data are re-arranged in order to build maps of estimated instantaneous rain rates, Bayesian variance, and quality index.

H-AUX-20



This algorithm, based on the Passive microwave Neural network Precipitation Retrieval approach is designed to work with the conically scanning Global Precipitation Measurement (GPM) Microwave Imager (GMI). A new rain/no-rain classification scheme, provides different rainfall masks for different minimum thresholds and degree of reliability, making H-AUX-20 able to optimally exploit the GMI multi-channel response to different surface types and precipitation structures, in order to provide global rainfall retrieval in a computationally very efficient way.

H60 - P-IN-SEVIRI-PMW



The blending technique adopted for P-IN-SEVIRI-PMW is called "Rapid Update (RU)"; RU blended satellite technique is a real time, underlying collection of time and space-intersecting pixels from operational geostationary IR imagers and LEO MW sensors. Rain intensity maps derived from MW measurements are used to create global, geo-located rain rate (RR) and T_{BB} (equivalent blackbody temperature) relationships that are renewed as soon as new co-located data are available from both geostationary and MW instruments. Indeed, the production chain discriminates convective clouds and computes a different rain rate vs TBB relationships for Convective precipitation field. The convective areas are identified with NEFODINA2 (Melfi et al., 2012), an automatic tool running at COMet (Centro Operativo per la Meteorologia) dedicated to nowcasting applications.

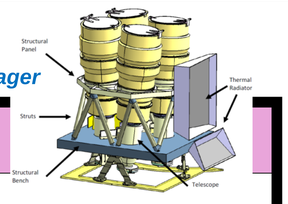
H23 – P-DM-PMW

H23 product has been proposed as a Level 3 (gridded) PMW precipitation product, i.e. as a gridded daily mean precipitation based on PMW instantaneous precipitation rate estimates.
The product will be provided on a regular grid at 0.25°x0.25° resolution on a daily basis over the MSG full disk area. It is not a NRT product, but it is processed off-line, and it is delivered once a day to provide the mean precipitation of the previous day (from 00 UTC to 24 UTC).

H64 – P-AC-SM2RAIN

The SM2RAIN approach together with the H-SAF rainfall product (based on PMW retrievals or integrating microwave and infrared observations) are the scientific background for the implementation of the precipitation-soil moisture integrated product. The soil moisture-derived rainfall, obtained through the application of SM2RAIN to the H16, H101 and H104 soil moisture products, is integrated with the H23 rainfall estimates.

MTG – Lighting Imager



OUTLOOKS

In CDOP-3 H SAF will contribute to the EUMETSAT MTG program by providing operational precipitation products for the high spatial/temporal/spectral resolution Flexible Combined Imager (FCI) (based on combined MW/IR techniques) and for the MTG Lightning Imager (LI).

Moreover, in view of the EUMETSAT EPS-SG satellite mission, day-1 precipitation products for the Microwave Sounder (MWS), and Microwave Imager (MWI) will be delivered to provide precipitation estimates on a global scale when the next generation of EUMETSAT polar orbiting satellites will be in orbit (a prototype for snowfall and light rainfall for combined MWI and ICI observations will be also developed). These products will contribute to the continuous delivery of PMW precipitation products by H SAF (started during CDOP-2) as new MW radiometers become available, aimed at guaranteeing the optimal precipitation monitoring, either based on combined MW/IR products or on PMW-only products (i.e., high latitudes)..

H61 - P-AC-SEVIRI-PMW

The product is derived by a time integration of product H60 (96 samples/day at 15-min intervals) over 3, 6, 12 and 24 hours.
Climatological thresholds are applied on the final products to avoid some outliers (quality control).

References: http://www.eumetsat.int http://hsaf.meteoam.it http://www.meteoam.it/

us_hsaf@meteoam.it