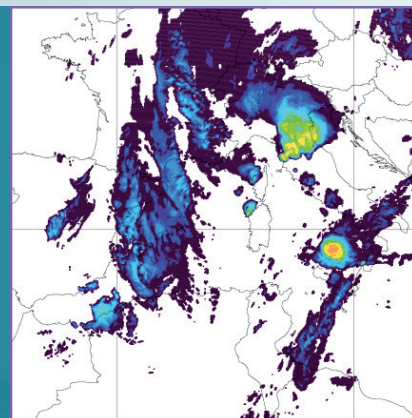


# H SAF

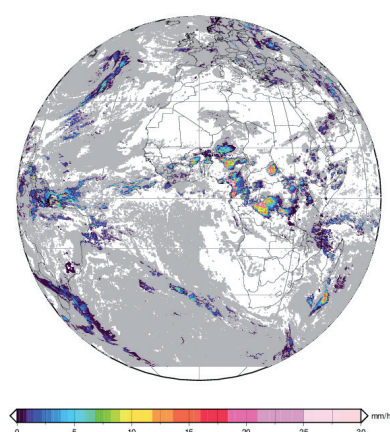
SATELLITE APPLICATION  
FACILITY ON SUPPORT TO  
OPERATIONAL HYDROLOGY  
AND WATER MANAGEMENT





# H SAF: SATELLITE PRODUCTS FOR OPERATIONAL HYDROLOGY

H SAF operationally provides high quality Precipitation, Soil Moisture and Snow products derived from Earth observation satellites, together with their continuous quality assessment.



*P-IN-SEVIRI: Instantaneous Rain Rate from IR-MW blended data*

H SAF is led by the Italian Air Force Meteorological Service (ITAF REMET) and carried on by a consortium of 23 members from 11 countries (see last page).

H SAF products and applications fit with the objectives of services, agencies, authorities and other initiatives which need information on water at the ground in order to monitor hazards and natural disasters such as flash floods, landslides and drought conditions, as well as to improve water management.

All products are available via EUMETSAT data delivery service (EUMETCast), or via ftp download; they are also published in H SAF website [h-saf.eumetsat.int](http://h-saf.eumetsat.int).

Archived data can be retrieved on demand placing an order through the dedicated section of the website.

## PRECIPITATION PRODUCTS

Precipitation is the most important variable in Earth hydrological budget being the major component of water cycle.

For this reason, the better understanding of the spatial and temporal distribution of precipitation, and its quantification, is fundamental for any hydrological and climatological application.

Although surface precipitation gauges are considered the standard devices for precipitation measurements, in many areas they are sparse or not available (e.g., ocean and remote regions). This, combined with the temporal and spatial variability of precipitation occurrence, phase, and intensity, makes monitoring and estimation of global precipitation very challenging.

Meteorological satellites provide a unique opportunity for global precipitation monitoring, and recent advances in Earth Observation technology allow to achieve accurate precipitation estimates at spatial and temporal scales useful for several applications.

Within H SAF precipitation products are mainly based on the exploitation of current (AMSU- MHS, SSMIS, ATMS, AMSR-2, GMI) and future, (e.g., MWI, MWS) microwave radiometers on board a constellation of Low Earth Orbit (LEO) satellites.

The goal is to achieve the best temporal and spatial coverage by converting microwave radiation measurements, directly related to emission/scattering properties of liquid/solid hydrometeors, into surface precipitation rates.

Gridded (Level 3) microwave-based precipitation products are also delivered. For near-real time monitoring and applications, another approach combines geostationary infrared observations with passive microwave (PMW) products. This kind of techniques provide precipitation estimation by merging higher quality, sparsely sampled precipitation estimates from LEO satellites with highly temporally and spatially sampled data from geostationary satellites.

An innovative technique, based on the optimal merging of PMW precipitation products and soil moisture-derived rainfall estimates, has been also proposed. The H SAF soil moisture product is used for such purpose.

H SAF precipitation products are operationally generated by ITAF COMet; development is realized by CNR-ISAC, CNR-IRPI, and ITAF COMet.

## CENTRAL SERVICES

Operational Services of Archiving, Dissemination, Monitoring, as well as User Services (help-desk, website, specific tools) are integrated and performed centrally by ITAF COMet. Support on Central services, Engineering and Management is provided by Telespazio.

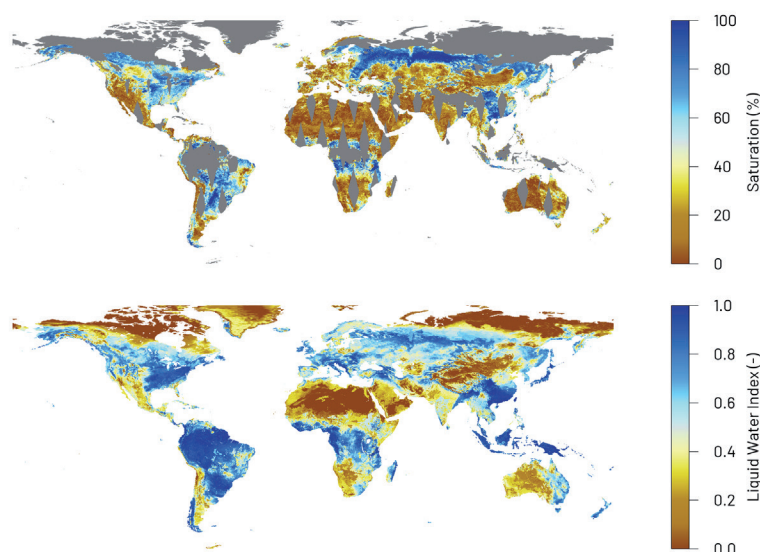
## SOIL MOISTURE PRODUCTS

Soil moisture is a key parameter for environmental (e.g. flood, drought, fire) and weather prediction systems. The following EUMETSAT H SAF products give information on both surface and root zone soil moisture. The products are generated by EUMETSAT/ZAMG (surface) and ECMWF (root zone). Product development is performed by TU Wien (surface) and ECMWF (root zone).

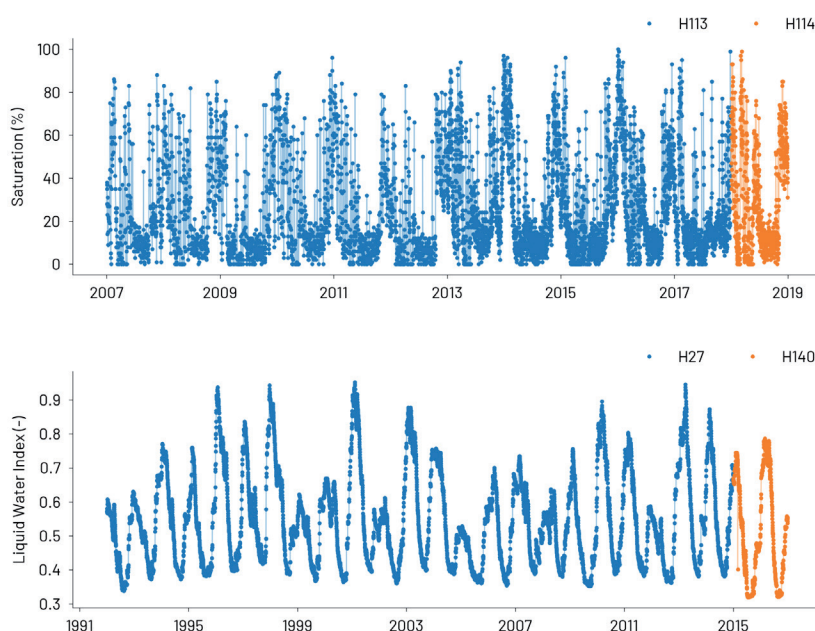
The ASCAT Surface Soil Moisture (SSM) products (H16, H101, H102, H103) are produced globally in near real-time since May 2009 and represent the water content in the upper soil layer (< 2 cm) expressed in degree of saturation. The SSM products are distributed in two spatial resolutions (25/50 km) for each Metop satellite via EUMETSAT's data delivery services. In addition, a disaggregated SSM product (H08) results from post-processing of H16 downscaling SSM at 0.5 km sampling and is available since August 2009 over Europe.

Beginning of every year a new Metop ASCAT Surface Soil Moisture (SSM) Climate Data Record (CDR) is generated by reprocessing all historic Metop ASCAT data in a consistent manner. During the year an offline extension of the latest ASCAT SSM CDR is also made available for users. The Metop ASCAT SSM CDR products (H25, H109, H111, H113), as well as their offline extensions (H108, H110, H112, H114) are distributed in time series format on a fixed Earth grid with 12.5 km sampling.

The ASCAT Root-zone Soil Moisture (RZSM) near real-time product (H14) is expressed as a liquid water index and is based on the assimilation of the ASCAT SSM products in near real-time (H102/H103) within the ECMWF/H SAF land data assimilation system. It is a global product available daily at 25 km resolution for four layers of soil. Reprocessed versions of H14 are the multi-year time series RZSM CDR products (H27, H140) covering the ERS/



Example of H16/H101 (top) and H14 (bottom) on 7 May 2019



Example of H113/H114 (top) and H27/H140 (bottom) in Spain (41.4 N, 5.4 E)

ASCAT scatterometer data record for the time period 1992-2016. An enhanced 10 km resolution near real-time RZSM product (H26) and the corresponding CDR product (H141) covering 1992-2018 are in development.

## SNOW PRODUCTS

Monitoring and modelling of snow characteristics are important since snow cover is an essential climate variable directly affecting the Earth's energy balance. Snow cover has a number of important physical properties that exert an influence on global and regional energy, water and carbon cycles. Remote sensing provides a good understanding of snow cover and enable snow cover information to be assimilated into hydrological, land surface, meteorological and climate models for predicting snowmelt runoff, snow water resources and to warn about snow-related natural hazards.

Operational snow products namely H10 (Snow detection (snow mask) by VIS/IR radiometry), H11 (dry/wet by MW radiometry), H12 (Effective snow cover by VIS/IR radiometry AVHRR), H13 (Snow Water Equivalent by MW radiometry), H31 (Snow detection by VIS/IR radiometry), H32 (Effective snow cover by VIS/IR radiometry AVHRR), H34 (superseding H10 and H31), and H35 (superseding H12 and H32) have been developed since 2008 within H SAF.

Considering the different characteristics of snow for mountainous and flat areas, two different algorithms are used in producing the snow products for flat and mountainous areas, and then the products are merged to have a single snow product.

H10 product is retrieved from METEOSAT-SEVIRI and has 0.05° spatial resolution using the advantage of better temporal resolution of MSG. It is based on a multi-channel retrieval algorithm. It exploits the high reflectivity of snow in the visible spectrum and the low reflectivity at shorter wavelengths.

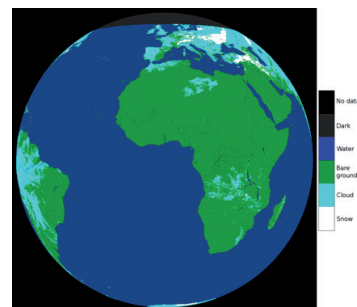
H12 product is generated from METOP-AVHRR and has 0.01° spatial resolution. The effective snow cover generation employs visible and shortwave near infrared data.

The algorithm for flat/forest areas assumes that in optical wave-lengths, the observed reflectance from a target is a sum of surface scattering from ground layer and volume scattering from forest canopy layer.

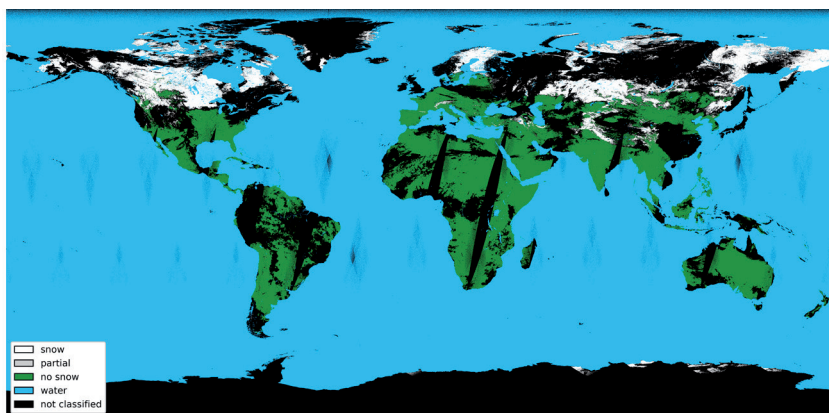
The algorithm for mountainous areas is based on a sub-pixel reflectance model.

H11 and H13 are the products obtained from microwave sensors namely SSMI/S and they have 0.25° spatial resolution. H13 retrieval is based on snow depth algorithm based on 19H and 37H microwave channels.

H13 algorithm uses the Helsinki University of Technology (HUT) snow emission model having slightly changes in the assimilation for flat/forest and mountainous areas.



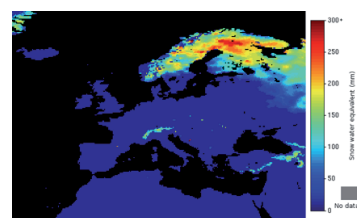
*H34 product  
for January 19, 2019*



*H32 product  
for March 22, 2019*

Validation studies indicate the optical snow products have large snow mapping accuracy with respect to ground snow observations, which varies between 69 and 94% in the winter seasons. Recent studies of H13 product give RMSE as 40 mm for flat areas and 45 mm for mountainous areas for annual snow season.

Snow products are generated by FMI (flat) and TSMS (mountainous); algorithm development of mountainous areas is carried on by METU.



*H13 product  
for March 26, 2019*



## THE QUALITY MONITORING AND HYDROVALIDATION PROGRAMME

### THE QUALITY MONITORING PROGRAMME

The Quality Monitoring Programme is established with the aim of providing a continuous quality assessment service for all the generated products, through dedicated activities performed in several countries by the participating Institutes, with the following objectives:

- monitoring the progress in product quality by evaluating statistical scores and case study analysis on the base of comparison between satellite products and ground data;
- providing validation service to end-users by publishing on the H SAF webpage the relevant statistical scores and case studies;
- providing online quality control to end users and generating near-real time quality maps;
- monitoring operational features such as actual arrival, timeliness, intelligibility;
- providing internal ground data service for algorithm calibration and validation activities;
- investigating the impact in end-user applications such as emergency management, precipitation event alerts, street monitoring, water balance evaluation, etc.

Hydrologists, meteorologists, as well as precipitation, snow and soil moisture ground data experts, coming from the countries involved, perform the validation activities making use of a common validation methodology, continuously refined and improved by dedicated working groups. The Quality Monitoring Programme is coordinated by the Italian Civil Protection Department (DPC). The DPC is an expert user of near-real time observations commonly used in the hydrological field, and has close links to national and local meteorological services. The DPC is involved as main user of national and international space projects.

### THE HYDROLOGICAL VALIDATION PROGRAMME

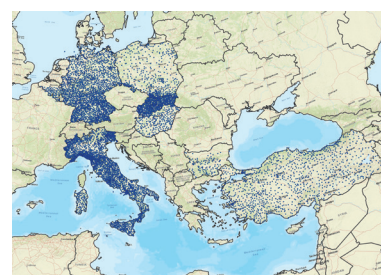
The purpose of the Hydrological Validation Programme is to assess the benefits of the novel H SAF satellite-derived data on practical hydrological applications and to improve products and their usability in operational hydrology, through the following activities:

- Product quality assessment and their continuous monitoring by product validation, evaluation and interfacing with hydrological models, performed through impact studies;
- Development: assimilation of satellite data in hydrological models, geospatial analysis, software tools, development of tools for the generation of blended satellite/in-situ products, incorporating available ground information to meet expectations of the hydrological community, providing combined products with accuracy and resolution meeting hydrological users' requirements;
- Research into possibility of novel satellite products application in operational hydrology;
- Incorporation of emerging user requirements into H SAF periodic assessment;
- Training activities, stimulating the use of satellite products in hydrology and water management.

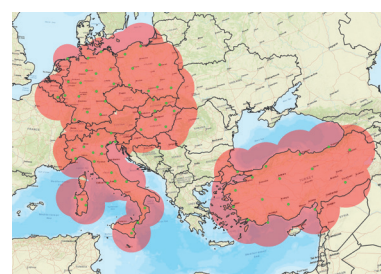
The Hydrological Validation Programme is coordinated by the Institute of Meteorology and Water Management – National Research Institute of Poland (IMGW-PIB)

### PARTICIPANTS

The Programmes are composed of experts from the national meteorological and hydrological Institutes of Austria, Belgium, Bulgaria, Finland, France, Germany, Hungary, Italy, Poland, Slovakia, Turkey, and from ECMWF.



*Raingauges network for product Validation*



*Radar network for product Validation*

## EUMETSAT NETWORK OF SATELLITE APPLICATION FACILITIES



Support to Nowcasting and Very Short Range Forecasting

Led by Agencia Estatal de Meteorología, Spain



Ocean and Sea Ice

Led by Météo France



Climate Monitoring

Led by Deutscher Wetterdienst, Germany



Numerical Weather Prediction

Led by Met Office (UK)



Land Surface Analysis

Led by Portuguese Meteorological Institute



Ozone and Atmospheric Chemistry Monitoring

Led by Finnish Meteorological Institute



Radio Occultation Meteorology

Led by Danish Meteorological Institute



Support to Operational Hydrology and Water Management

Led by Italian Air Force Meteorological Service



E-mail: [hsafcdop@meteom.it](mailto:hsafcdop@meteom.it)  
[us\\_hsaf@meteom.it](mailto:us_hsaf@meteom.it)  
 (user support)  
[h-saf.eumetsat.int](mailto:h-saf.eumetsat.int)



Eumetsat-Allee 1  
 64295 Darmstadt  
 Germany

Tel: +49 6151 807 3660/3770  
 Fax: +49 6151 807 3790  
 E-mail: [ops@eumetsat.int](mailto:ops@eumetsat.int)  
[www.eumetsat.int](http://www.eumetsat.int)

EUMETSAT also has established cooperation agreements with organisations involved in meteorological satellite activities, including the National Meteorological Services of Canada, China, India, Japan, Russia, South Korea and USA,



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 Meteorologie und  
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ECMWF

