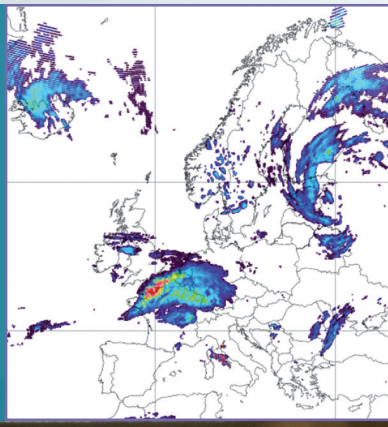
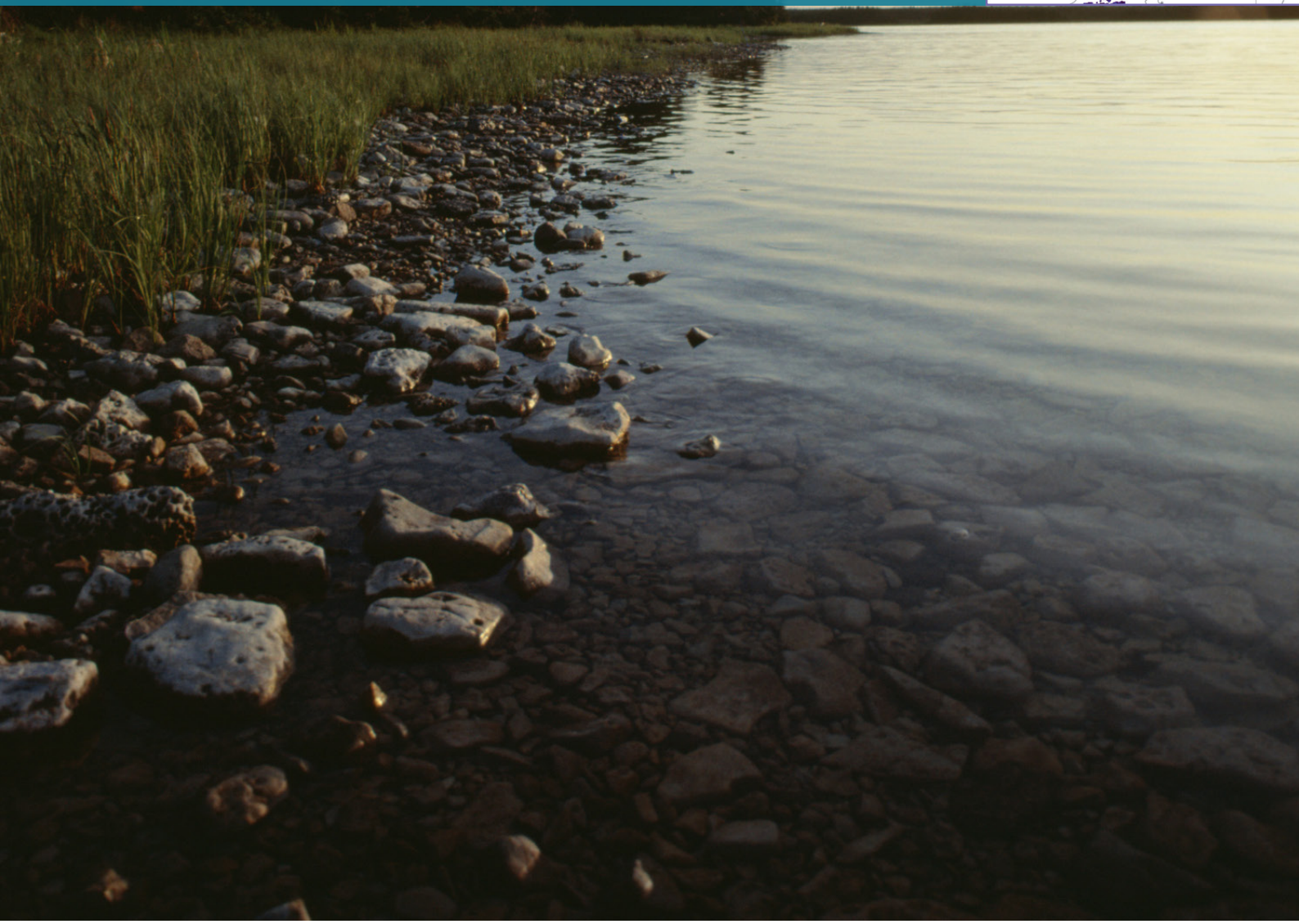
H SAF

SATELLITE APPLICATION FACILITY ON SUPPORT TO OPERATIONAL HYDROLOGY AND WATER MANAGEMENT



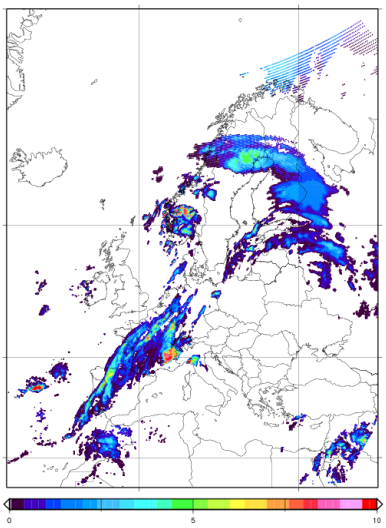


EUMETSAT NETWORK OF SATELLITE APPLICATION FACILITIES

H SAF

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.



H03: Instantaneous Rain Rate from IR-MW blended data

H-SAF is lead by the Italian Air Force Meteorological Service (ITAF USAM) and carried on by a consortium of 21 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 the H-SAF website hsaf.meteoam.it.

PRECIPITATION PRODUCTS

Precipitation is the most important variable in the hydrological budget of the Earth being the major component of water cycle. For this reason, the better understanding of the spatial and temporal distribution of precipitation is fundamental for any hydrologic and climatic application. Although surface precipitation gauges are considered the standard for measuring precipitation, in many areas their use is not feasible (ocean and remote lands). Thus, the lack or sparse presence of ground measurement combined with the non-homogeneity of temporal and spatial distribution of rainfall makes the precipitation a difficult parameter to quantify.

Meteorological satellites provide a unique opportunity for monitoring the precipitation for regions where ground measurement is limited, and consistent with the accuracy required by hydrologists.

Techniques for estimating precipitation from satellite fall into two categories: the first one estimates precipitation from infrared and/or visible satellite data; here the rainfall rates are indirectly derived from cloud-top infrared (IR) brightness temperature, which is related to cloud-top height for optically-thick clouds below the tropopause. The second category makes use of microwaves and their capability to "see" through the clouds to form precipitation estimates: here the measurement is directly related to emission/scatter of microwave radiant energy of liquid/solid hydrometeors.

As these last sensors belong to the payload of polar orbiting satellites, the precipitation rate is estimated, for the same limited area, one or two times per day per satellite. In this sense, the global monitoring of the precipitation requires the full exploitation of as many as possible overpasses of satellites carrying passive microwave (PMW) radiometers on board.

In H-SAF the instantaneous precipitation rate is estimated (or is already planned to be) from almost all of present and future MW instrument in particular AMSU, MHS, SSMIS, ATMS, AMSR-2 and GMI.

A common approach is to combine geostationary and low orbital satellite imagery and sounder. In H-SAF two of these multi-platform algorithms (blending and morphing techniques) are also used to provide global precipitation estimation merging high-quality (physically direct detection), sparsely sampled data from the GPM constellation with continuously sampled data from METEOSAT geostationary satellites.

Precipitation products are generated by Italian NMS ITAF CNMCA; development is realized by CNR-ISAC and ITAF CNMCA.

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-CNMCA.

Support on Central services, Engineering and Management is provided by Telespazio.

SOIL MOISTURE PRODUCTS

Soil moisture is a key parameter for flood forecast and numerical weather prediction systems. Following EUMETSAT H-SAF products give information on both surface and root zone soil moisture.

The Metop ASCAT Level 2 soil moisture product (SM-OBS-1/H16; precursor version SM-OBS-1/H07), generated in near real-time by EUMETSAT since May 2009, represents the water content in the upper soil layer (< 2 cm) in relative units . It is distributed in two spatial resolutions (25-34 km,50 km) via EUMETSAT's data delivery services.

The small scale surface soil moisture product (SM-OBS-2/H08) results from post-processing of the H16 and represents a disaggregated soil moisture product at 1 km resolution in relative units. It is available since August 2009 over Europe and distributed via FTP from H-SAF.

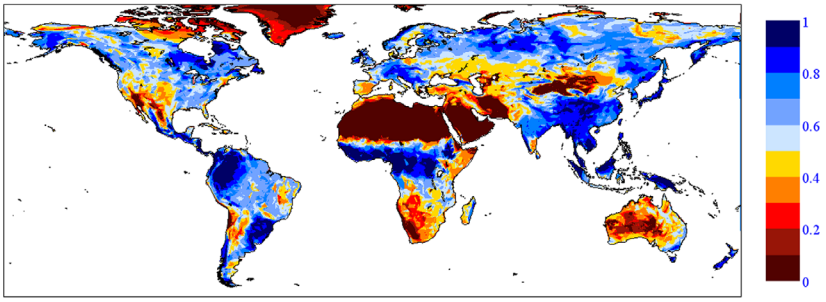
The Metop ASCAT soil moisture time series product (SM-OBS-4/H25) is derived from the same data source as H16, but distributed as time series on a global grid with 25-34 km spatial resolution and an irregular temporal sampling rate (every 1-2 days). The product is updated twice a year and distributed via FTP from H-SAF.

The ASCAT root zone soil moisture product (SM-DAS2/H14), based on assimilation of H16 in the ECMWF Land Data Assimilation System is a global product available daily at a spatial resolution of 25 km for four layers of soil (0-7, 7-28, 28-100 and 100-289 cm). Extensive evaluation showed very good skills to capture soil moisture dynamics at all seasons for a wide range of climatic and surface conditions.

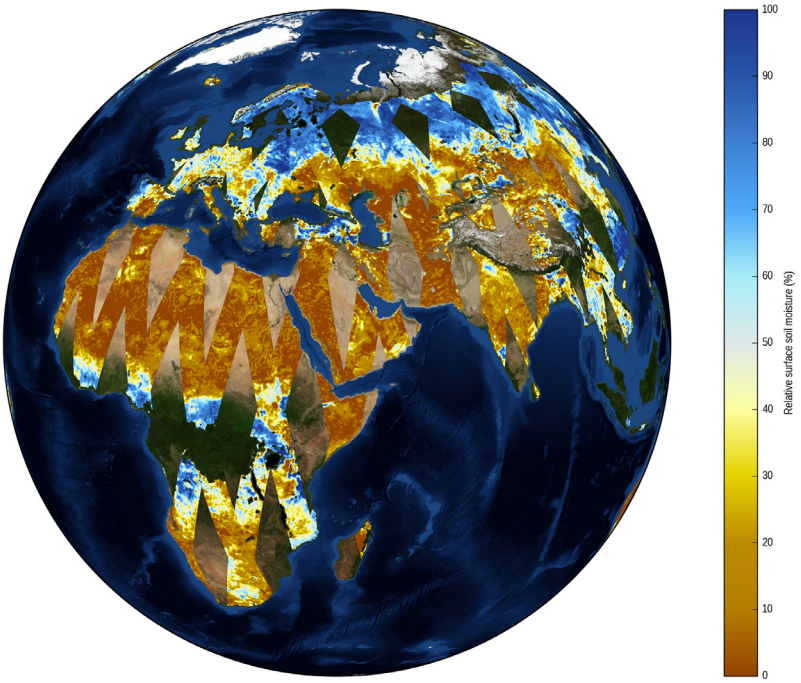
SM-DAS-3 (H27), a re-analysis of SM-DAS-2 covering the period 1992-2014, is under development at ECMWF.

Soil Moisture products are generated by ZAMG (surface) and ECMWF (root zone); development of surface product is performed by TU-WIEN.

H14, in the 28-100 cm soil layer expressed as liquid water index, on 8 October 2014



H16, expressed as degree of saturation, on 22 May 2014



SNOW PRODUCTS

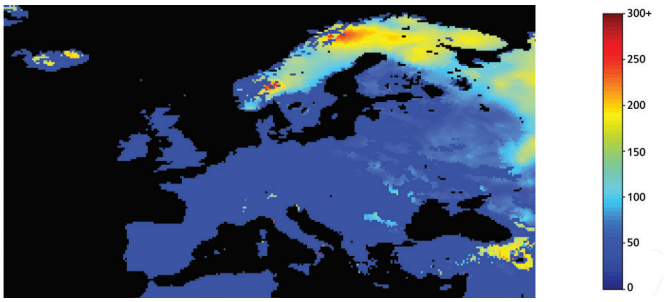
Monitoring and modeling of snow characteristics are important for many hydrological applications, including snowmelt runoff forecasting and water resources assessment using a range of techniques.The large spatial variability of snow cover, particularly in mountains, limits the use of ground-based snow observations.

Satellite imagery is thus an attractive alternative, as the resolution and availability does not depend much on the terrain characteristics. Operation snow products namely H10 (Snow recognition), H11 (Snow status), H12 (Effective snow cover area) and H13 (Snow water equivalance) have been developed since 2008 within HSAF.

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 retreived 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 wavelengths, 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.



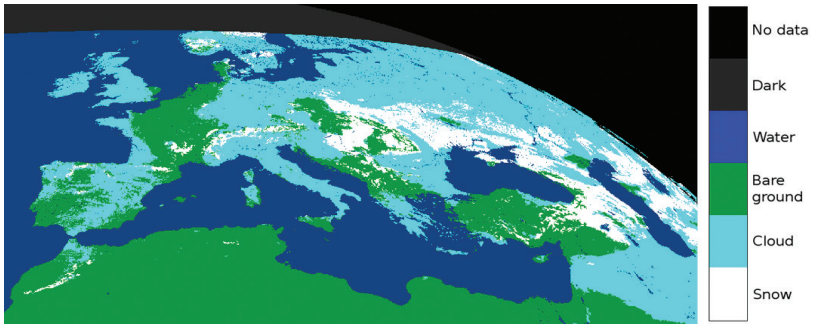
H13 product for March 5, 2014

H11 and H13 are the products obtained from microwave sensors namely SSMI/S and they have 0.25° spatial resolution. H11 retreival is based on snow depth algorithm based on 19H and 37H microwave channels. H13 algortihm uses the Helsinki University of Technology (HUT) snow emission model having slightly changes in the assimilation for flat/forest and mountainous areas.

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.

H10 product for March 3, 2014



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 web-page the relevant statistical scores and case studies;
- providing online quality control to end-users by generating near-real-time quality maps;
- monitoring operational features such as actual arrival, timeliness, intelligibility, etc..;
- 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 actually 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 benefit of the novel H-SAF satellite-derived data on practical hydrological applications, through the following activities:

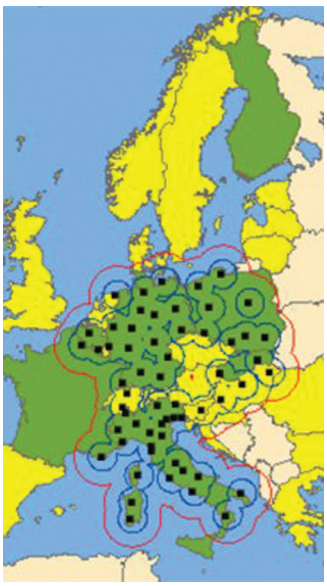
- Products quality assessment and their continuous monitoring by products validation, evaluation and interfacing with hydrological models, performed both through near real time and off-line impact studies;
- Development: proceed with satellite data assimilation to hydrological models, geospatial analysis, software tools, development of tools for generation of blended satellite/in-situ products, incorporating available ground information to meet expectations of hydrological community providing combined products of accuracy and resolution aligned with hydrological users' requirements;
- Research on the possibility of better satellite products' usage in operational hydrology,
- Contribution to H-SAF periodic assessment of emerging user requirements,
- Training activities, stimulating use of satellite products in hydrology and water management.

The Product Validation Programme is coordinated by the Institute of Meteorology and Water Management of Poland (IMGW).

PARTICIPANTS

The Quality Monitoring and Hydovalidation 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.

Radar network for product Validation



EUMETSAT NETWORK OF SATELLITE APPLICATION FACILITIES

NWC SAF

Support to Nowcasting and Very Short Range Forecasting

Led by Agencia Estatal de Meteorología, Spain

OSI SAF

Ocean and Sea Ice

Led by Météo France

CM SAF

Climate Monitoring

Led by Deutscher Wetterdienst, Germany

NWP SAF

Numerical Weather Prediction

Led by Met Office (UK)

LSA SAF

Land Surface Analysis

Led by Portuguese Meteorological Institute

O3M SAF

Ozone and Atmospheric Chemistry Monitoring

Led by Finnish Meteorological Institute

ROM SAF

Radio Occultation Meteorology (formerly GRAS SAF)

Led by Danish Meteorological Institute

H SAF

Support to Operational Hydrology and Water Management

Led by Italian Meteorological Institute

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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.

ITAF USAM · DPC · FMI · ZAMG

TSMS · ECMWF · IMGW

Telespazio A Finmeccanica/Thales Company · CNR-ISAC · UNIFE · TU WIEN · NIMH · SHMÙ

BfG · METU · AU · ITU · OMU · Météo-France · OMSZ · RMI