EUMETSAT Satellite Application Facility on
Support to Operational Hydrology and Water Management

EUMETSAT H SAF SUPPORT TO OPERATIONAL HYDROLOGY AND WATER MANAGEMENT

Product User Manual (PUM) for product H12 – SN-OBS-3

Effective snow cover by VIS/IR radiometry

Reference Number: SAF/HSAF/PUM-12
Issue/Revision Index: 1.2
Last Change: 06 April 2018

DOCUMENT CHANGE RECORD

Issue / Revision	Date	Description
1.0	20/01/2012	Baseline version prepared for ORR1 Part 3 Obtained by PUM-12 delivered during the Development Phase.
1.1	31/12/2012	Version delivered for ORR1 Part 3 close out.
1.2	06/04/2018	Updated version for ORR H11.H12 Close-out: Annex I updated

INDEX

List of Tables

List of Figures

1 Introduction

1.1 Purpose of the document

Product User Manuals are available for each (pre)-operational H-SAF product, for open users, and also for demonstrational products, as necessary for *beta-users*.

Each PUM contains:

- Product introduction: principle of sensing, Satellites utilized, Instrument(s) description, Highlights of the algorithm, Architecture of the products generation chain, Product coverage and appearance;
- Main product operational characteristics: Horizontal resolution and sampling, Observing cycle and time sampling, Timeliness;
- Overview of the product validation activity: Validation strategy, Global statistics, Product characterisation
- Basic information on product availability: Access modes, Description of the code, Description of the file structure

An annex also provides common information on Objectives and products, Evolution of H-SAF products, User service and Guide to the Products User Manual.

Although reasonably self-standing, the PUM's rely on other documents for further details. Specifically:

- ATDD (*Algorithms Theoretical Definition Document*), for extensive details on the algorithms, only highlighted here;
- PVR (*Product Validation Report*), for full recount of the validation activity, both the evolution and the latest results.

These documents are structured as this PUM, i.e. one document for each product. They can be retrieved from the CNMCA site on HSAF web page at User Documents session.

On the same site, to obtain user and password please contact the Help Desk) it is interesting to consult, although not closely connected to this PUM, the full reporting on hydrological validation experiments (*impact studies*):

- HVR (*Hydrological Validation Report*), spread in 10 Parts, first one on requirements, tools and models, then 8, each one for one participating country, and a last Part with overall statements on the impact of H-SAF products in Hydrology.

1.2 Introduction to product SN-OBS-3

1.2.1 Principle of sensing

Product SN-OBS-3 (*Effective snow cover by VIS/IR radiometry*) is based on multi-channel analysis of the AVHRR instrument onboard NOAA and MetOp satellites. The AVHRR radiometer has an IFOV of 1.1 x 1.1 km^2 at nadir degrading to ~ 2 x 6 km^2 at the edge of the 2900 km cross-track swath. Computing fractional cover would in principle require segmenting the image in arrays of pixels (typically ~ 32 x 32) and counting those classifies as snow. This would lead to unacceptable product resolution. For H-SAF, fractional cover is generated at pixel resolution, by exploiting the brightness intensity that is the convolution of the snow signal (highest) and the fraction of snow within the pixel ("effective" cover").

The retrieval algorithm is somewhat different for flat or forested area and for mountainous regions. SN-OBS-3 is generated in Finland by FMI and in Turkey by TSMS. The products from FMI and from TSMS both cover the full H-SAF area, but thereafter are merged at FMI by blending the information on flat/forested areas from the FMI product and that one on mountainous areas from the TSMS product, according to the mask shown here below:

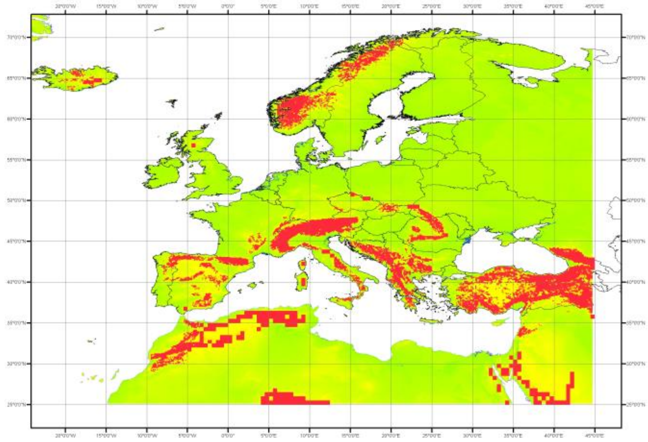


Figure 1 Mask flat/forested versus mountainous regions

The observing cycle of the complex of NOAA and MetOp satellites over Europe is about 3 h. For a single satellite pass, several areas in the scene would provide no useful measurements because of clouds. Therefore, the complex of passes is multi-temporally analysed to search for time instants of cloud-free conditions in a given time interval (e.g., 24 h). However, since short-wave channels play an essential role in the retrieval algorithm, the useful range of hours is in daylight.

1.2.2 Status of satellites and instruments

The current status of NOAA and MetOp satellites is shown in table below, that also records the status of satellites carrying MODIS (EOS Terra and Aqua), that is used to support the computation of forest transmissivity.

Satellite	Launch	End of service	Height	LST or inclin.	Status	Instrument used in H-SAF
NOAA-18	20 May 2005	expected ≥ 2011	854 km	13:52 a	Operational	AVHRR/3
NOAA-19	6 Feb 2009	expected ≥ 2014	870 km	13:43 a	Operational	AVHRR/3
MetOp-A	19 Oct 2006	expected ≥ 2011	817 km	09:31 d	Operational	AVHRR/3
EOS-Terra	18 Dec 1999	expected ≥ 2010	705 km	10:30 d	Operational	MODIS
EOS-Aqua	4 May 2002	expected ≥ 2010	705 km	13:30 a	Operational	MODIS

Table 1 Current status of NOAA and MetOp satellites (as of March 2010)

Next two tables collect, respectively, the main features of the AVHRR/3 instrument and the main features of MODIS.

AVHRR/3	**Advanced Very High Resolution Radiometer / 3**
Satellites	**TIROS-N, NOAA 6 to 14, NOAA-15, NOAA-16, NOAA-17, NOAA-18, NOAA-19, MetOp-A, MetOp-B, MetOp-C**
Status	**Operational** - Utilisation period: 1978 to ~ 2014 on NOAA, 2006 to ~ 2021 on MetOp
Mission	Multi-purpose imagery
Instrument type	Multi-purpose imaging VIS/IR radiometer - 6 channels (channel 1.6 and 3.7 alternative)
Scanning technique	Cross-track: 2048 pixel of 800 m s.s.p., swath 2900 km - Along-track: six 1.1-km lines/s
Coverage/cycle	Global coverage twice/day (IR) or once/day (VIS)
Resolution (s.s.p.)	1.1 km IFOV
Resources	Mass: 33 kg - Power: 27 W - Data rate: 621.3 kbps

Central wavelength	Spectral interval	Radiometric accuracy (NEΔT or SNR)
0.630 µm	0.58 - 0.68 µm	9 @ 0.5 % albedo
0.862 µm	0.725 - 1.00 µm	9 @ 0.5 % albedo
1.61 µm	1.58 - 1.64 µm	20 @ 0.5 % albedo
3.74 µm	3.55 - 3.93 µm	0.12 K @ 300 K
10.80 µm	10.3 - 11.3 µm	0.12 K @ 300 K
12.00 µm	11.5 - 12.5 µm	0.12 K @ 300 K

Table 2 Main features of AVHRR/3

MODIS	**Moderate-resolution Imaging Spectro-radiometer**
Satellites	**EOS-Terra, EOS-Aqua**
Status	**Operational** - Utilised in the period 1999 to ~ 2010
Mission	Multi-purpose imagery
Instrument type	Multi-purpose imaging VIS/IR radiometer - 36-channel VIS/IR spectro-radiometer
Scanning technique	Swath 2230 km. Whiskbroom scanning: a strip of 19.7 km width along-track is cross-track scanned every 2.956 s. The strip includes 16 parallel lines sampled by 2048 pixel of 1000 m s.s.p., or 32 parallel lines sampled by 4096 pixel of 500 m s.s.p., or 64 parallel lines sampled by 8192 pixel of 250 m s.s.p.
Coverage/cycle	Global coverage nearly twice/day (long-wave channels) or once/day (short-wave channels)
Resolution (s.s.p.)	IFOV: 0.25 km (two channels), 0.5 km (5 channels), 1.0 km (29 channels) – See table
Resources	Mass: 250 kg - Power: 225 W - Data rate: 6.2 Mbps

Central wavelength	**Bandwidth**	**Radiometric accuracy** (SNR or NEΔT at specified input spectral radiance	**IFOV at s.s.p.**
645 nm	50 nm	128 @ 21.8 W m^{-2} sr^{-1} μm^{-1}	250 m
858 nm	35 nm	201 @ 24.7 W m^{-2} sr^{-1} μm^{-1}	250 m
469 nm	20 nm	243 @ 35.3 W m^{-2} sr^{-1} μm^{-1}	500 m
555 nm	20 nm	228 @ 29.0 W m^{-2} sr^{-1} μm^{-1}	500 m
1240 nm	20 nm	74 @ 5.4 W m^{-2} sr^{-1} μm^{-1}	500 m
1640 nm	24 nm	275 @ 7.3 W m^{-2} sr^{-1} μm^{-1}	500 m
2130 nm	50 nm	110 @ 1.0 W m^{-2} sr^{-1} μm^{-1}	500 m
412 nm	15 nm	880 @ 44.9 W m^{-2} sr^{-1} μm^{-1}	1000 m
443 nm	10 nm	838 @ 41.9 W m^{-2} sr^{-1} μm^{-1}	1000 m
488 nm	10 nm	802 @ 32.1 W m^{-2} sr^{-1} μm^{-1}	1000 m
531 nm	10 nm	754 @ 27.9 W m^{-2} sr^{-1} μm^{-1}	1000 m
551 nm	10 nm	750 @ 21.0 W m^{-2} sr^{-1} μm^{-1}	1000 m
667 nm	10 nm	910 @ 9.5 W m^{-2} sr^{-1} μm^{-1}	1000 m
678 nm	10 nm	1087 @ 8.7 W m^{-2} sr^{-1} μm^{-1}	1000 m
748 nm	10 nm	586 @ 10.2 W m^{-2} sr^{-1} μm^{-1}	1000 m
870 nm	15 nm	516 @ 6.2 W m^{-2} sr^{-1} μm^{-1}	1000 m
905 nm	30 nm	167 @ 10.0 W m^{-2} sr^{-1} μm^{-1}	1000 m
936 nm	10 nm	57 @ 3.6 W m^{-2} sr^{-1} μm^{-1}	1000 m
940 nm	50 nm	250 @ 15.0 W m^{-2} sr^{-1} μm^{-1}	1000 m
1375 nm	30 nm	150 @ 6.0 W m^{-2} sr^{-1} μm^{-1}	1000 m

3.750 μm	0.180 μm	0.05 K @ 0.45 W m^{-2} sr^{-1} μm^{-1}	1000 m
3.959 μm	0.060 μm	2.00 K @ 2.38 W m^{-2} sr^{-1} μm^{-1}	1000 m
3.959 μm	0.060 μm	0.07 K @ 0.67 W m^{-2} sr^{-1} μm^{-1}	1000 m
4.050 μm	0.060 μm	0.07 K @ 0.79 W m^{-2} sr^{-1} μm^{-1}	1000 m
4.515 μm	0.165 μm	0.25 K @ 0.17 W m^{-2} sr^{-1} μm^{-1}	1000 m
4.515 μm	0.067 μm	0.25 K @ 0.59 W m^{-2} sr^{-1} μm^{-1}	1000 m
6.715 μm	0.360 μm	0.25 K @ 1.16 W m^{-2} sr^{-1} μm^{-1}	1000 m
7.325 μm	0.300 μm	0.25 K @ 2.18 W m^{-2} sr^{-1} μm^{-1}	1000 m
8.550 μm	0.300 μm	0.25 K @ 9.58 W m^{-2} sr^{-1} μm^{-1}	1000 m
9.730 μm	0.300 μm	0.25 K @ 3.69 W m^{-2} sr^{-1} μm^{-1}	1000 m
11.030 μm	0.500 μm	0.05 K @ 9.55 W m^{-2} sr^{-1} μm^{-1}	1000 m
12.020 μm	0.500 μm	0.05 K @ 8.94 W m^{-2} sr^{-1} μm^{-1}	1000 m
13.335 μm	0.300 μm	0.25 K @ 4.52 W m^{-2} sr^{-1} μm^{-1}	1000 m
13.635 μm	0.300 μm	0.25 K @ 3.76 W m^{-2} sr^{-1} μm^{-1}	1000 m
13.935 μm	0.300 μm	0.25 K @ 3.11 W m^{-2} sr^{-1} μm^{-1}	1000 m
14.235 μm	0.300 μm	0.35 K @ 2.08 W m^{-2} sr^{-1} μm^{-1}	1000 m

Table 3 Main features of MODIS

1.2.3 Highlights of the algorithm

The baseline algorithm for SN-OBS-3 processing is described in ATDD-12. Only essential elements are highlighted here. It is noted that for forested areas it is essential to take accurate forest transmissivity into account, whereas for the mountainous areas, this has little effect (few trees). For mountainous areas the sun zenith and azimuth angles, as well as direction of observation relative to these are more limiting factors.

The processing concepts for products SN-OBS-3 applied in Finland (FMI) and Turkey (METU) are somewhat different. Figure 2 and Figure 3 illustrate the flow chart of the SN-OBS-3 processing chain at FMI and TSMS, respectively.

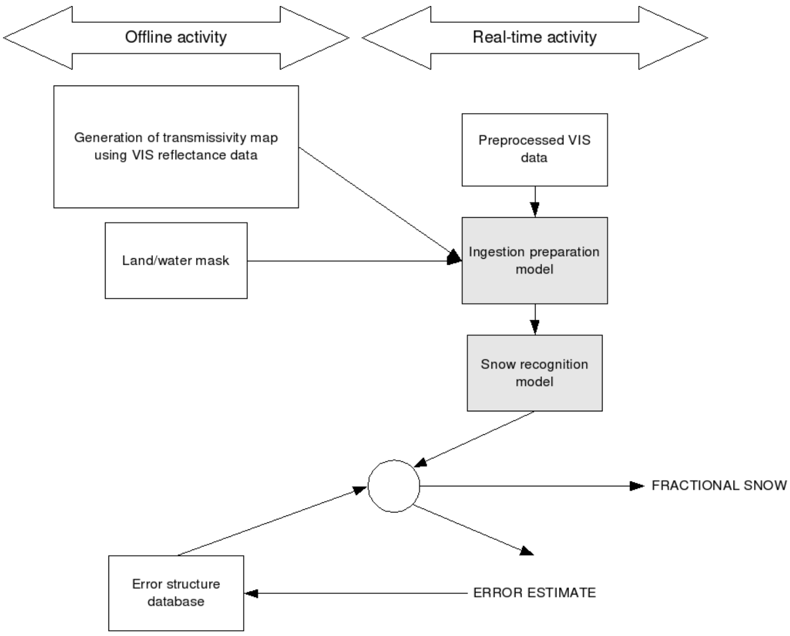


Figure 2 Snow covered area generation chain for flat/forested areas

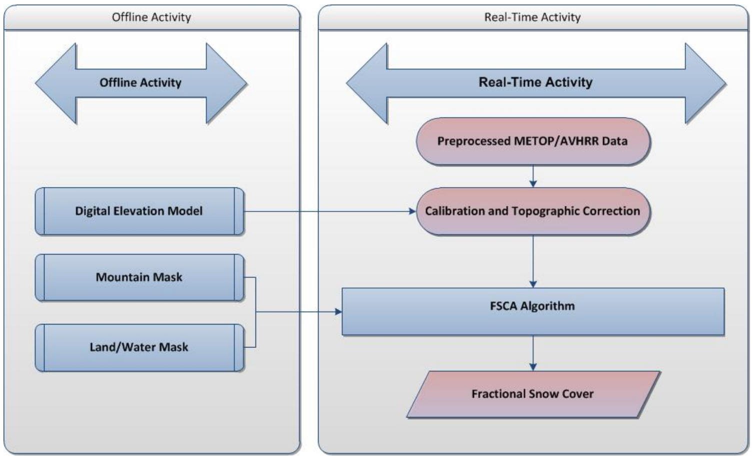


Figure 3 Snow covered area generation chain for mountainous areas

It is noted that the transmissivity map is essential input to the SCA-model, and has to be generated from reflectance data acquired at full dry snow cover conditions for each unit-area of the product. This is performed off-line by using MODIS.

For mountainous terrain three effects that caused by the topography can be listed: 1) Some areas receive exclusively diffuse irradiance due to cast shadows; 2) Shielding of the sky hemisphere reduces the diffuse irradiance; and 3) surrounding terrain reflects irradiance towards the observed ground area (Proy et al. 1989[1]). The shadowed areas become smaller on slopes facing the sun, while they increase on slopes oriented away from the sun.

Several methods have been developed so far with the purpose of removing terrain effects from the measured pixel radiance. Widely used methods are the Lambertian cosine correction, the statistical-emprical correction, the C-correction and the Minnaert correction (Vikhmar et al. 2004[2]; Riano et al. 2003[3]). The general approach of these methods is to normalize the observed radiance from inclined surfaces (L_T) to flat (horizontal) surfaces (L_H) by modelling the local incidence angle to the terrain surface cos (i) for each. i (γi) is defined as the angle between the surface normal and the solar beam (see next figure). Using information about the solar position at the acquisition time for the satellite image and the local terrain relief, i can be calculated for a pixel by the formula (Smith et al. 1980[4]):

$$\cos i = \cos sz \cos tz + \sin sz \sin tz \cos (sa-ta)$$

where sz(θi) is the solar zenith angle, sa (ϕo)is the solar azimuth angle, tz(θp) is the surface normal zenith angle or the terrain slope and ta (ϕa) is the terrain azimuth angle.

[1] Proy C., D. Tanre and P.Y. Deschamps, 1989: "Evaluation of topographic effects in remotely sensed data". *Reomete Sensing of Environment*, 30, 21-32.

[2] Vikhamar D., R. Solberg and K. Seidel, 2004: "Reflectance Modeling of Snow-covered forests in hilly terrain" . *Photogrametric Engineering and Remote Sensing*, 70, 9, 1069-1079.

[3] Riano D., E. Chuvieco, J. Salas and I. Aguado, 2003: "Assessment of different topographic corrections in landsat-tm data for mapping vegetation types (2003)". *IEEE Trans. Geosci. Remote Sensing*, 41, 1056-1061.

[4] Smith J.A., T.L. Lin, and K.J. Ranson, 1980: "The Lambertian assumption and Landsat data", *Photogrametric Engineering and Remote Sensing*, 46(9), 1183-1189.

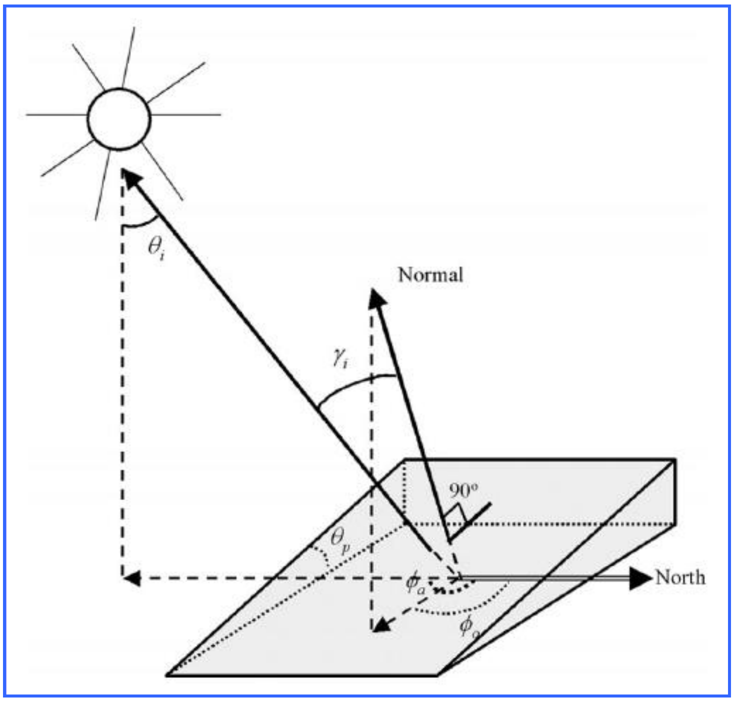


Figure 4 Angles involved in the computation of illumination angle (i)

1.2.4 Architecture of the products generation chain

The architecture of the SN-OBS-3 Product generation chain is shown in next figure:

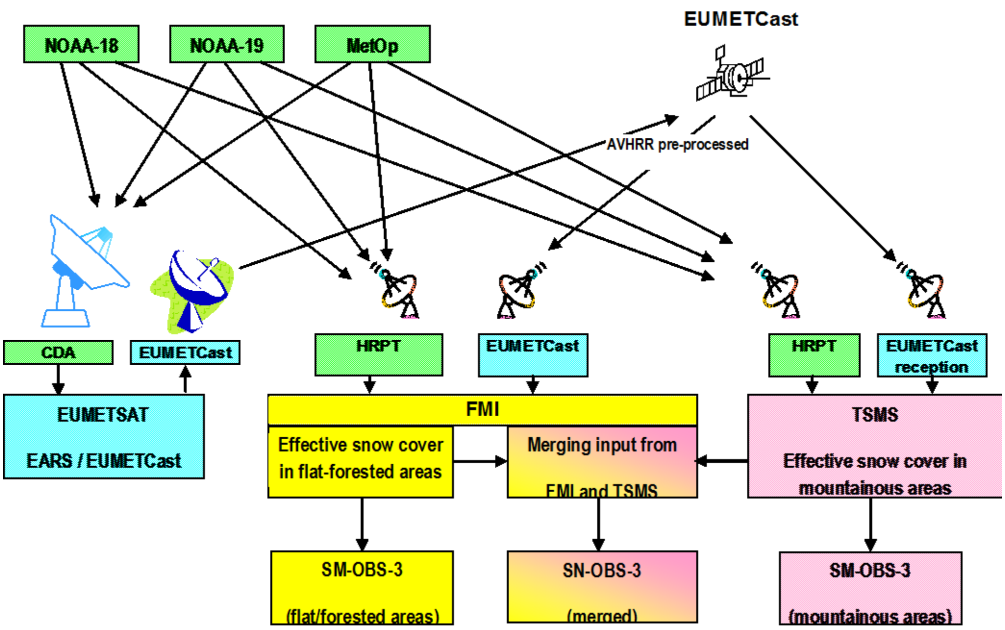


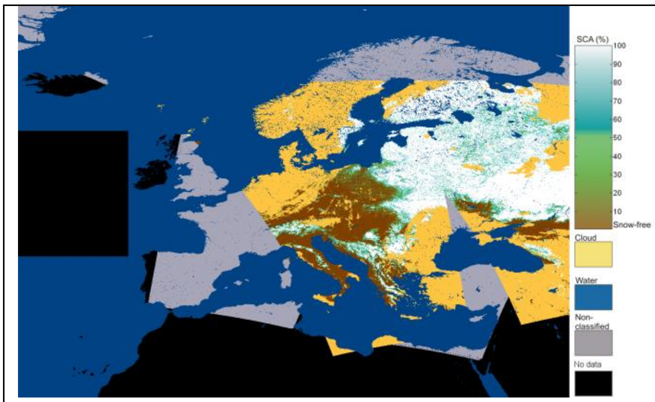
Figure 5 Conceptual architecture of the SN-OBS-3 chain

It is noted that the satellite data are acquired either by direct-read-out through the HRPT system, or via EUMETCast to cover H-SAF areas outside the acquisition range of the HRPT station. The product is generated both at FMI and at TSMS. The FMI product is tuned to flat/forested areas, that one from TSMS is tuned to mountainous areas. The TSMS data are delivered to FMI, that implements the merging of the two products.

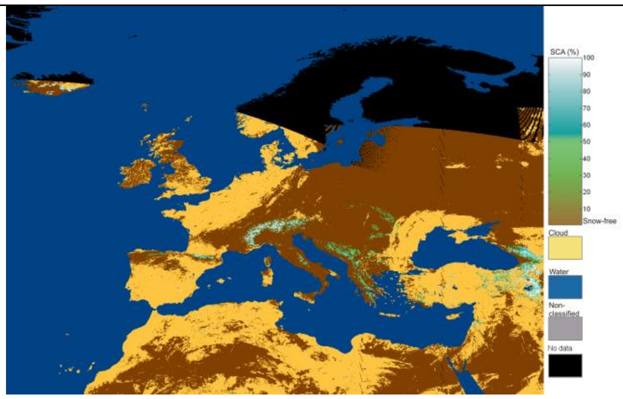
Currently, the products are held on the TSMS server (mountainous areas) and on the FMI and CNMCA servers (both flat/forested areas and merged). Eventually, only the merged product will be disseminated through EUMETCast.

1.2.5 Product coverage and appearance

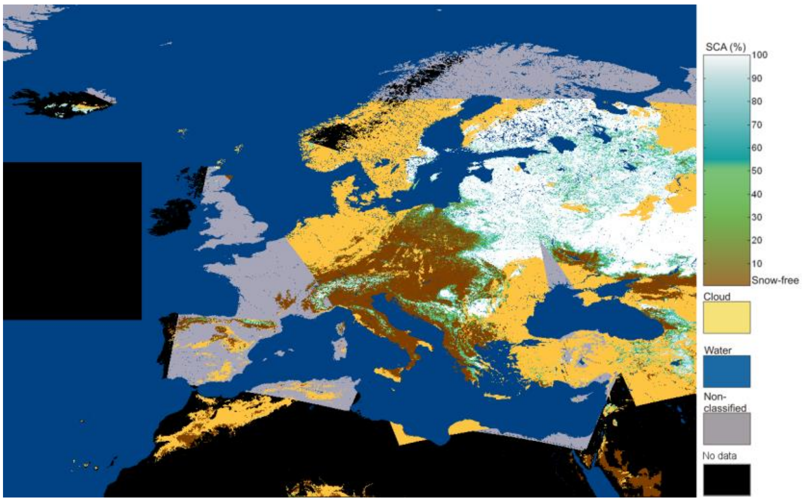
Next figure shows examples of SN-OBS-3 products generated at FMI (flat and forested areas), at TSMS (mountainous area), and merged, for the same day. Maps are in *equal latitude/longitude grid*.



Processed product from FMI, optimised for flat and forested areas.



Processed product from TSMS, optimised for mountainous areas.



Merged product from FMI and TSMS

Figure 3 Effective snow cover from NOAA and MetOp AVHRR - Time-composite maps over 24 hours, 9 March 2011

2 Product operational characteristics

2.1 Horizontal resolution and sampling

The *horizontal resolution (Δx)* is the convolution of several features (sampling distance, degree of independence of the information relative to nearby samples, …). To simplify matters, it is generally agreed to refer to the sampling distance between two successive product values, assuming that they carry forward reasonably independent information. The horizontal resolution descends from the instrument Instantaneous Field of View (*IFOV*), sampling distance (*pixel*), Modulation Transfer Function (*MTF*) and number of pixels to co-process for filtering out disturbing factors (e.g. clouds) or improving accuracy. It may be appropriate to specify both the resolution Δx associated to independent information, and the *sampling distance*, useful to minimise aliasing problems when data have to undertake resampling (e.g., for co-registration with other data).

In AVHRR the IFOV at the s.s.p. is 1.1 km, that degrades moving to the swath's edge for an average ~ 2 km. The product is sampled at 0.01-degree intervals. To simplify matters, we quote as resolution ***Δx ~ 2 km***, and sampling distance ***~ 1 km***.

2.1.1 Vertical resolution if applicable

The *vertical resolution (Δz)* also is defined by referring to the vertical sampling distance between two successive product values, assuming that they carry forward reasonably independent information. The vertical resolution descends from the exploited remote sensing principle and the instrument number of channels, or spectral resolution. It is difficult to be estimated *a-priori*: it is generally evaluated *a-posteriori* by means of the validation activity.

The only product in H-SAF that provide profiles (below surface) is SM-ASS-1 (*Volumetric soil moisture (roots region) by scatterometer assimilation in NWP model*).

2.1.2 Observing cycle and time sampling

The *observing cycle (Δt)* is defined as the average time interval between two measurements over the same area. In general the area is, for GEO, the disk visible from the satellite, for LEO, the Globe. In the case of H-SAF we refer to the European area shown in Fig. 04. In the case of LEO, the observing cycle depends on the instrument swath and the number of satellites carrying the addressed instrument.

For product SN-OBS-3, with at least three available satellites (2-3 NOAA and 1 MetOp) and 2900 km instrument swath we have, at European latitudes, nearly full coverage each 3 hours. However, in order to collect as many cloud-free pixels as possible, multi-temporal analysis over 24 hours is performed. Thus the observing cycle is ***Δt = 24 h***.

2.1.3 Timeliness

The *timeliness (δ)* is defined as the time between observation taking and product available at the user site assuming a defined dissemination mean. The timeliness depends on the satellite transmission facilities, the availability of acquisition stations, the processing time required to generate the product and the reference dissemination means. In the case of H-SAF the future dissemination tool is EUMETCast, but currently we refer to the availability on the FTP site.

For SN-OBS-3, that results from multi-temporal analysis disseminated at a fixed time of the day, the time of observation may change pixel by pixel (some pixel may have been cloud-free early in the time window, e.g. in the early morning, thus up to 12-h old at the time of dissemination; some very recently, just before product dissemination in the late afternoon). The average timeliness is therefore ***δ = 6 h***.

3 Product validation

3.1 Validation strategy

Whereas the previous operational characteristics have been evaluated on the base of system considerations (number of satellites, their orbits, access to the satellite) and instrument features (IFOV, swath, MTF and others), the evaluation of accuracy requires validation, i.e. comparison with the ground truth or with something assumed as "true". SN-OBS-3, as any other H-SAF product, has been submitted to validation entrusted to a number of institutes (see next figure).

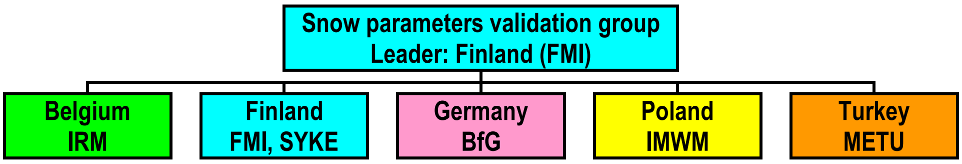


Figure 4 Structure of the Snow products validation team

The accuracy of the snow detection product has been assessed by comparison with meteorological bulletins and in-field measurements in properly equipped sites.

Detailed report of the product validation activity for product SN-OBS-3 is provided as document:

- PVR-12: Product Validation Report for SN-OBS-3.

In this PUM-12 only summary results are provided, mainly aiming at characterising the product quality under different geographical/climatological conditions (those in the countries of the participating validation Units) and different seasons.

4 Product availability

4.1 Site

SN-OBS-3 will be available via EUMETCast (when authorized) and via FTP (after log in).

The current access is via FTP at the following site:

- URL: ftp://ftp.meteoam.it
- to obtain user a password please contact the Help Desk.

In the FTP site there are three relevant directories:

- *products*, for near-real-time dissemination;
- *from_archive*, for previous months;
- *utilities*, for providing decoding tools.

4.1.1 Directory “*products*”

In this directory the products appear shortly after generation, consistently with the “timeliness” requirement. They are kept available for nominally 1-2 months, often more.

Quick-looks of the latest 3-5 SN-OBS-3 maps, covering some H-SAF areas, can be viewed on the H-SAF web site http://hsaf.meteoam.it

4.1.2 Directory “*from_archive*”

Currently “reprocessed_2010”. This directory holds the data of the previous months.

4.1.3 Directory “*utilities*”

This directory provides tools to decode and manage the digital data.

4.2 Formats and codes

Three types of files are provided for SN-OBS-3:

- the digital data from FMI and merged, coded in GRIB2
- the digital data from TSMS, coded in HDF5
- the image-like maps, coded in PNG

4.3 Description of the files

Current data

- Directory: *products*
- Sub-directory: *h12*
- Two folders:
  - h12_cur_mon_data
  - h12_cur_mon_png

In both directories *products* and *reprocess* the files have identical structures. Next table summarises the situation and provides the information on the file structure, including the legenda.

URL: ftp://ftp.meteoam.it	username: *hsaf*	password: *00Hsaf*	directory: *products*	folder: *h12*

<table>
<tr><td colspan="2">Product identifier: h12.
Folders under h12:</td><td colspan="2">h12_cur_mon_data
h12_cur_mon_png</td></tr>
<tr><td rowspan="2">Files description:</td><td>h12_cur_mon_data</td><td>h12_yyyymmdd_day_FMI_grib2.gz
h12_yyyymmdd_QC_day_FMI_grib2.gz
h12_yyyymmdd_day_merged.grib2.gz
h12_yyyymmdd_QC_day_merged.grib2.gz</td><td>digital data + quality flag</td></tr>
<tr><td>h12_cur_mon_png</td><td>h12_yyyymmdd_day_FMI.png
h12_yyyymmdd_day_merged.png</td><td>image data</td></tr>
<tr><td colspan="4">yyyymmdd: year, month, day
day: indicates that the product results from multi-temporal analysis over 24 hours (in daylight)
QC: Quality Control: number of observations of the surface, i.e. non-cloudy and during daytime</td></tr>
</table>

Table 4 Summary instructions for accessing SN-OBS-3 data

5 References documents

[RD1] Product Requirement Document, SAF/HSAF/PRD/1.3

Annex 1. Introduction to H-SAF

The EUMETSAT Satellite Application Facilities

H-SAF is part of the distributed application ground segment of the "*European Organization for the Exploitation of Meteorological Satellites (EUMETSAT)*". The application ground segment consists of a "*Central Application Facilities*" located at EUMETSAT Headquarters, and a network of eight "*Satellite Application Facilities (SAFs*)", located and managed by EUMETSAT Member States and dedicated to development and operational activities to provide satellite-derived data to support specific user communities (see Figure 5):

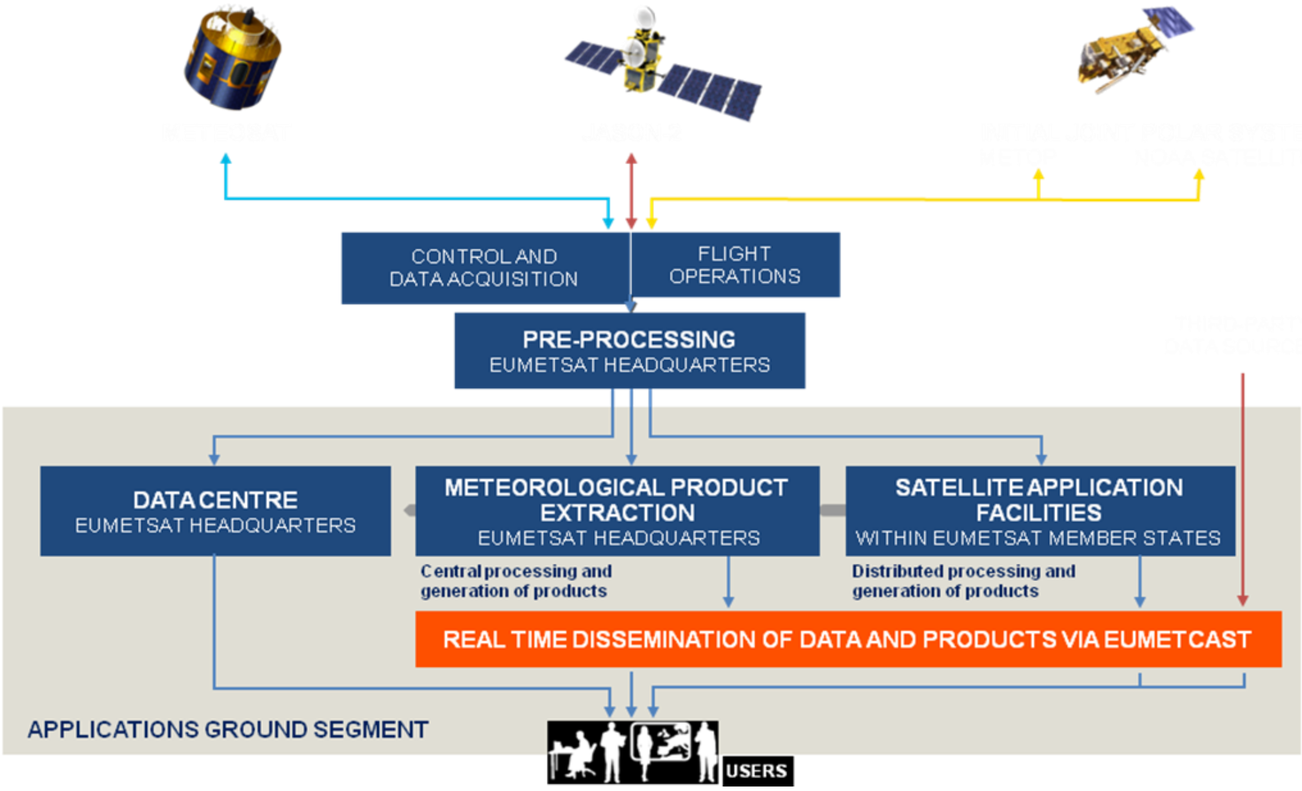


Figure 5: Conceptual scheme of the EUMETSAT Application Ground Segment

Figure here following depicts the composition of the EUMETSAT SAF network, with the indication of each SAF's specific theme and Leading Entity.

Figure 6: Current composition of the EUMETSAT SAF Network

Purpose of the H-SAF

The main objectives of H-SAF are:

a. ***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 generating, centralizing, archiving and disseminating the 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);

b. ***to perform independent validation of the usefulness of the products*** for fighting against floods, landslides, avalanches, and evaluating water resources; the activity includes:
   - downscaling/upscaling modelling from observed/predicted fields to basin level;
   - fusion of satellite-derived measurements with data from radar and raingauge networks;
   - assimilation of satellite-derived products in hydrological models;
   - assessment of the impact of the new satellite-derived products on hydrological applications.

Products / Deliveries of the H-SAF

For the full list of the Operational products delivered by H-SAF, and for details on their characteristics, please see H-SAF website hsaf.meteoam.it.

All products are available via EUMETSAT data delivery service (EUMETCast, http://www.eumetsat.int/website/home/Data/DataDelivery/EUMETCast/index.html), or via ftp download; they are also published in the H-SAF website hsaf.meteoam.it.

All intellectual property rights of the H-SAF products belong to EUMETSAT. The use of these products is granted to every interested user, free of charge. If you wish to use these products, EUMETSAT's copyright credit must be shown by displaying the words "copyright (year) EUMETSAT" on each of the products used.

System Overview

H-SAF is led by the Italian Air Force Meteorological Service (ITAF MET) and carried on by a consortium of 21 members from 11 countries (see website: hsaf.meteoam.it for details)

Following major areas can be distinguished within the H-SAF system context:

- Product generation area
- Central Services area (for data archiving, dissemination, catalogue and any other centralized services)
- Validation services area which includes Quality Monitoring/Assessment and Hydrological Impact Validation.

Products generation area is composed of 5 processing centres physically deployed in 5 different countries; these are:

- for precipitation products: ITAF COMET (Italy)
- for soil moisture products: ZAMG (Austria), ECMWF (UK)
- for snow products: TSMS (Turkey), FMI (Finland)

Central area provides systems for archiving and dissemination; located at ITAF COMET (Italy), it is interfaced with the production area through a front-end, in charge of product collecting.

A central archive is aimed to the maintenance of the H-SAF products; it is also located at ITAF COMET. Validation services provided by H-SAF consists of:

- Hydrovalidation of the products using models (hydrological impact assessment);
- Product validation (Quality Assessment and Monitoring).

Both services are based on country-specific activities such as impact studies (for hydrological study) or product validation and value assessment.

Hydrovalidation service is coordinated by IMWM (Poland), whilst Quality Assessment and Monitoring service is coordinated by DPC (Italy): The Services' activities are performed by experts from the national meteorological and hydrological Institutes of Austria, Belgium, Bulgaria, Finland, France, Germany, Hungary, Italy, Poland, Slovakia, Turkey, and from ECMWF.

Annex 2. Acronyms

AMSU	Advanced Microwave Sounding Unit (on NOAA and MetOp)
AMSU-A	Advanced Microwave Sounding Unit - A (on NOAA and MetOp)
AMSU-B	Advanced Microwave Sounding Unit - B (on NOAA up to 17)
ATDD	Algorithms Theoretical Definition Document
AU	Anadolu University (in Turkey)
BfG	Bundesanstalt für Gewässerkunde (in Germany)
CAF	Central Application Facility (of EUMETSAT)
CDOP	Continuous Development-Operations Phase
CESBIO	Centre d'Etudes Spatiales de la BIOsphere (of CNRS, in France)
CM-SAF	SAF on Climate Monitoring
CNMCA	Centro Nazionale di Meteorologia e Climatologia Aeronautica (in Italy)
CNR	Consiglio Nazionale delle Ricerche (of Italy)
CNRS	Centre Nationale de la Recherche Scientifique (of France)
DMSP	Defense Meteorological Satellite Program
DPC	Dipartimento Protezione Civile (of Italy)
EARS	EUMETSAT Advanced Retransmission Service
ECMWF	European Centre for Medium-range Weather Forecasts
EDC	EUMETSAT Data Centre, previously known as U-MARF
EUM	Short for EUMETSAT
EUMETCast	EUMETSAT's Broadcast System for Environmental Data
EUMETSAT	European Organisation for the Exploitation of Meteorological Satellites
FMI	Finnish Meteorological Institute
FTP	File Transfer Protocol
GEO	Geostationary Earth Orbit
GRAS-SAF	SAF on GRAS Meteorology
HDF	Hierarchical Data Format
HRV	High Resolution Visible (one SEVIRI channel)
H-SAF	SAF on Support to Operational Hydrology and Water Management
IDL©	Interactive Data Language
IFOV	Instantaneous Field Of View
IMWM	Institute of Meteorology and Water Management (in Poland)
IPF	Institut für Photogrammetrie und Fernerkundung (of TU-Wien, in Austria)
IPWG	International Precipitation Working Group
IR	Infra Red
IRM	Institut Royal Météorologique (of Belgium) (alternative of RMI)
ISAC	Istituto di Scienze dell'Atmosfera e del Clima (of CNR, Italy)
ITU	İstanbul Technical University (in Turkey)
LATMOS	Laboratoire Atmosphères, Milieux, Observations Spatiales (of CNRS, in France)
LEO	Low Earth Orbit
LSA-SAF	SAF on Land Surface Analysis
LST	Local Satellite Time (if referred to time) or Land Surface Temperature (if referred to temperature)
Météo France	National Meteorological Service of France
METU	Middle East Technical University (in Turkey)
MHS	Microwave Humidity Sounder (on NOAA 18 and 19, and on MetOp)
MSG	Meteosat Second Generation (Meteosat 8, 9, 10, 11)
MVIRI	Meteosat Visible and Infra Red Imager (on Meteosat up to 7)
MW	Micro Wave
NEΔT	Net Radiation
NESDIS	National Environmental Satellite, Data and Information Services
NMA	National Meteorological Administration (of Romania)
NOAA	National Oceanic and Atmospheric Administration (Agency and satellite)
NWC-SAF	SAF in support to Nowcasting & Very Short Range Forecasting
NWP	Numerical Weather Prediction
NWP-SAF	SAF on Numerical Weather Prediction
O3M-SAF	SAF on Ozone and Atmospheric Chemistry Monitoring

OMSZ	Hungarian Meteorological Service
ORR	Operations Readiness Review
OSI-SAF	SAF on Ocean and Sea Ice
PDF	Probability Density Function
PEHRPP	Pilot Evaluation of High Resolution Precipitation Products
Pixel	Picture element
PMW	Passive Micro-Wave
PP	Project Plan
PR	Precipitation Radar (on TRMM)
PRD	Product Requirements Document
PUM	Product User Manual
PVR	Product Validation Report
RMI	Royal Meteorological Institute (of Belgium) (alternative of IRM)
RR	Rain Rate
RU	Rapid Update
SAF	Satellite Application Facility
SEVIRI	Spinning Enhanced Visible and Infra-Red Imager (on Meteosat from 8 onwards)
SHMÚ	Slovak Hydro-Meteorological Institute
SSM/I	Special Sensor Microwave / Imager (on DMSP up to F-15)
SSMIS	Special Sensor Microwave Imager/Sounder (on DMSP starting with S-16)
SYKE	Suomen ympäristökeskus (Finnish Environment Institute)
T_{BB}	Equivalent Blackbody Temperature (used for IR)
TKK	Teknillinen korkeakoulu (Helsinki University of Technology)
TMI	TRMM Microwave Imager (on TRMM)
TRMM	Tropical Rainfall Measuring Mission UKMO
TSMS	Turkish State Meteorological Service
TU-Wien	Technische Universität Wien (in Austria)
U-MARF	Unified Meteorological Archive and Retrieval Facility
UniFe	University of Ferrara (in Italy)
UTC	Universal Coordinated Time
VIS	Visible
ZAMG	Zentralanstalt für Meteorologie und Geodynamik (of Austria)