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

Product User Manual (PUM)
for product H11 – SN-OBS-2

SN-OBS-2 - Snow status (dry/wet) by MW radiometry

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DOCUMENT CHANGE RECORD

Issue / Revision	Date	Description
1.0	16/05/2011	Baseline version prepared for ORR1 Part 2. Obtained by PUM-11 delivered during the Development Phase.
1.1	30/09/2011	Updates, acknowledging ORR1 Part 2 review board recommendation
1.2	21/10/2013	Version prepared for ORR1 Part4
1.3	06/04/2018	Updated version for ORR H11.H12 Close-out • Updated all flow charts and other references to satellite instrument to one used currently i.e. SSMIS. • Product images updated with mountain mask implemented

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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-2

1.2.1 Principle of sensing

Product SN-OBS-2 (*Snow status (dry-wet) by MW radiometry*) is based the SSMIS microwave radiometer being flown on DMSP series of 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 (see next figure):

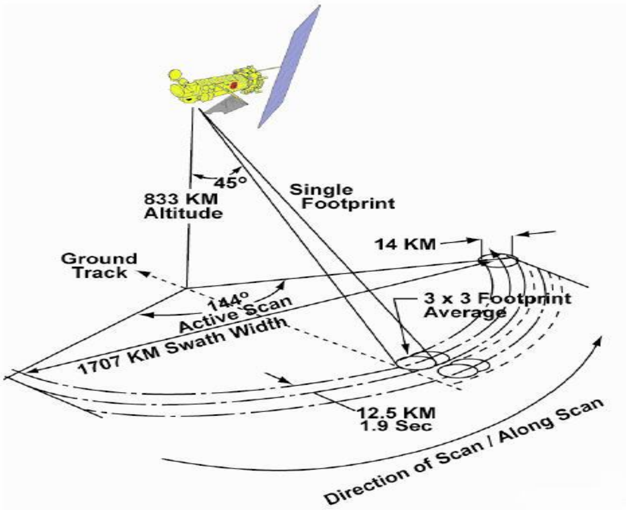

Figure 1 Geometry of conical scanning for SSMIS

In addition, conical scanning provides constant resolution across the image, though changing with frequency. It is noted that the IFOV is elliptical, with major axis elongated along the viewing direction and the minor axis along-scan, approximately 2/3 of the major. As for the 'pixel', i.e. the area subtended as a consequence of the bi-dimensional sampling rate, the sampling distance along the satellite motion, i.e. from scan line to scan line, is invariably 12.5 km, dictated by the satellite velocity on the ground and the scan rate. Along scan, the sampling rate varies by purpose of the band. For imaging channels used for SN-OBS-2, along scan sampling rate is 25 km.

The SSMIS frequencies more sensitive to snow are 19.3 and 37.0 GHz. As a matter of fact, the algorithm is just a linear combination of these two channels. However, for shallow snow thickness, wet snow cannot be discriminated from the underlying soil, thus preventive recognition of snow existence by means of SN-OBS-1 is necessary before assigning snow status (wet or dry).

SSMIS satellites are operated by the Defense Meteorological Satellite Program (DMSP) and are part of NASA's Pathfinder Program. SSMIS data is received via ftp from UK Met office Exeter and further processed and archived at CNMCA.

The SN-OBS-2 product has been developed in the TKK (now Aalto University), and the software was thereafter integrated in the operational environment of FMI. SN-OBS-2 has a long-standing heritage in Finland where it was validated since long. The H-SAF generation chain extended the coverage to the whole H-SAF area (Turkey is not active with SN-OBS-2), ma the product is not tuned to mountainous situations.

1.2.2 Status of satellites and instruments

The current status of EOS-Aqua and of the backup DMSP satellites is shown in next table:

Satellite	Launch	End of service	Height	LST	Status	Instrument used in H-SAF
EOS-Aqua	4 May 2002	October 4, 2011	705 km	13:30 a	out of comission	AMSR-E
DMSP-F15	12 Dec 1999	expected ≥ 2010	845 km	05:40 d	Degraded	SSM/I (defective) [backup in H-SAF]
DMSP-F17	4 Nov 2006	expected ≥ 2011	855 km	05:30 d	Operational	SSMIS [backup in H-SAF]
DMSP-F18	18 Oct 2009	expected ≥ 2014	857 km	07:55 d	Operational	SSMIS [backup in H-SAF]

Table 1 Current status of EOS-Aqua and DMSP satellites (as of March 2018)

Next table collects the main features of the SSMIS instrument.

The next table collects the main features of SSMIS	Special Sensor Microwave - Imager/Sounder
Satellites	DMSP-F16, DMSP-F17, DMSP-F18, DMSP-S19, DMSP-S20
Status	Operational - Utilised in the period: 2003 to ~ 2019
Mission	Multi-purpose imagery with temperature/humidity sounding channels for improved precipitation
Instrument type	Multi-purpose imaging MW radiometer - 21 frequencies, 24 channels
Scanning technique	Conical: 53.1° zenith angle, swath 1700 km – Scan rate: 31.9 scan/min = 12.5 km/scan
Coverage/cycle	Global coverage once/day
Resolution (constant)	Changing with frequency, consistent with an antenna diameter of 61 x 66 cm
Resources	Mass: 96 kg - Power: 135 W - Data rate: 14.2 kbps

Central frequency (GHz)	Bandwidth (MHz)	Polarisations	Accuracy (NEΔT)	IFOV	Pixel
19.35	356	V, H	0.34 K	43.5 x 73.6 km	25.0 x 12.5 km
22.235	407	V	0.45 K	43.5 x 73.6 km	25.0 x 12.5 km
37.0	1580	V, H	0.24 K	43.5 x 73.6 km	25.0 x 12.5 km
50.3	380	H	0.21 K	37.7 x 38.8 km	37.5 x 12.5 km
52.8	389	H	0.20 K	37.7 x 38.8 km	37.5 x 12.5 km
53.596	380	H	0.21 K	37.7 x 38.8 km	37.5 x 12.5 km
54.4	382	H	0.20 K	37.7 x 38.8 km	37.5 x 12.5 km
55.5	391	H	0.22 K	37.7 x 38.8 km	37.5 x 12.5 km
57.29	330	RC	0.26 K	37.7 x 38.8 km	37.5 x 12.5 km
59.4	239	RC	0.25 K	37.7 x 38.8 km	37.5 x 12.5 km
60.792668 ± 0.357892 ± 0.050	106	RC	0.38 K	72.5 x 75.0 km	75.0 x 12.5 km
60.792668 ± 0.357892 ± 0.016	29.4	RC	0.37 K	72.5 x 75.0 km	75.0 x 12.5 km
60.792668 ± 0.357892 ± 0.006	10.4	RC	0.58 K	72.5 x 75.0 km	75.0 x 12.5 km
60.792668 ± 0.357892 ± 0.002	5.2	RC	0.86 K	72.5 x 75.0 km	75.0 x 12.5 km
60.792668 ± 0.357892	2.7	RC	1.18 K	72.5 x 75.0 km	75.0 x 12.5 km
63.283248 ± 0.285271	2.7	RC	1.23 K	72.5 x 75.0 km	75.0 x 12.5 km
91.655	2829	V, H	0.19 K	13.2 x 15.5 km	12.5 x 12.5 km
150	3284	H	0.53 K	13.2 x 15.5 km	12.5 x 12.5 km
183.31 ± 6.6	1025	H	0.56 K	13.2 x 15.5 km	12.5 x 12.5 km
183.31 ± 3.0	2038	H	0.39 K	13.2 x 15.5 km	12.5 x 12.5 km
183.31 ± 1.0	3052	H	0.38 K	13.2 x 15.5 km	12.5 x 12.5 km

Table 2 Main features of SSMIS

1.2.3 Highlights of the algorithm

The baseline algorithm for SN-OBS-2 processing is described in ATDD-11. Only essential elements are highlighted here.

Here below it is illustrated the flow chart of the SN-OBS-2 processing chain at FMI.

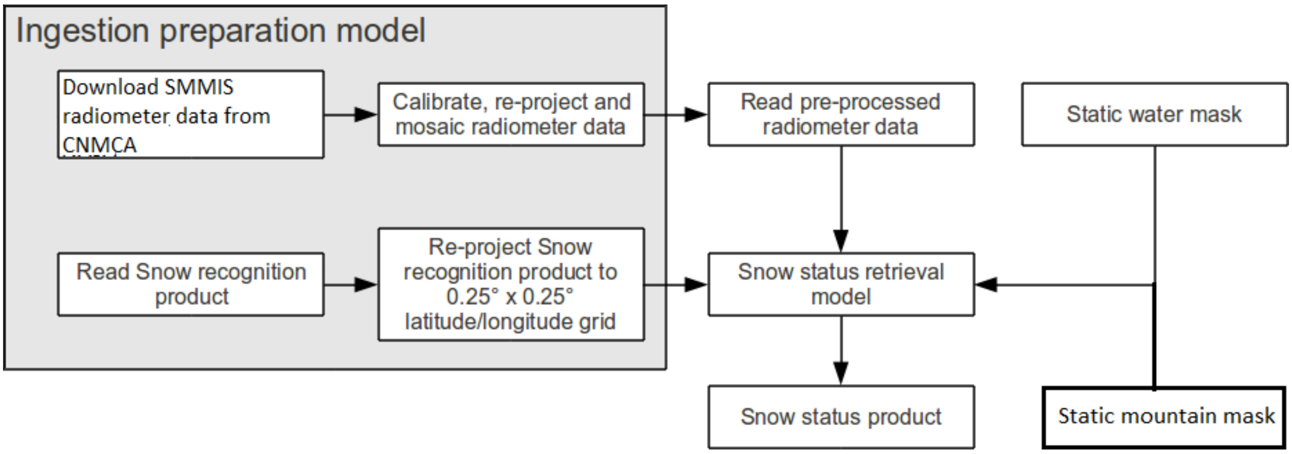

Figure 2 Flow chart of the snow status recognition processing chain

The base for the product is the snow recognition product (see Algorithm Theoretical Definition Document, ATDD-10), which is used as a marker to find snow regardless of the dryness or wetness. As the snow recognition product is in different projection, it is reprojected to the 0.25° x 0.25° equal latitude/longitude grid of the end product. In this stage, the product values "snow" in the snow recognition product is changed to "wet snow".

Parallel to this, SSMIS radiometer data are processed. After each new radiometer swath that is downloaded from CNMCA ftp, the data are rectified and mosaicked to cover the H-SAF domain. A watermask is included to the radiometer data, and this is used for the pixels having data. A static watermask is then used to fill in the gaps between different satellite overpasses. After this a static mountain mask is added to filter out terrain where retrieval is less certain, as result of algorithm not working very well for higher elevations, steep slopes or great variance of elevation within pixel.

These data are fed to the snow status retrieval model to retrieve the pixels with dry snow, and corresponding pixels in the output are updated to show this status.

In the microwave range, snow emissivity is substantially different for dry and wet snow, therefore snow status observation is a relatively straightforward application, also facilitated by the all-weather capability. The emissivity substantially increases when snow is wet, enabling detection of snow status. Middle frequencies are used (19.3 and 37 GHz). The recognition of dry snow for snow pack shallower than 80 mm is unreliable due to high penetration depth of microwaves in dry snow. The algorithm as stand-alone is unable to discriminate wet snow from bare ground (a problematic issue for mountainous regions), thus wet snow status is recorded only for those locations where Snow detection (product SN-OBS-1) has revealed snow or there has been dry snow in the preceding product.

1.2.4 Architecture of the products generation chain

The architecture of the SN-OBS-2 product generation chain is shown in next figure:

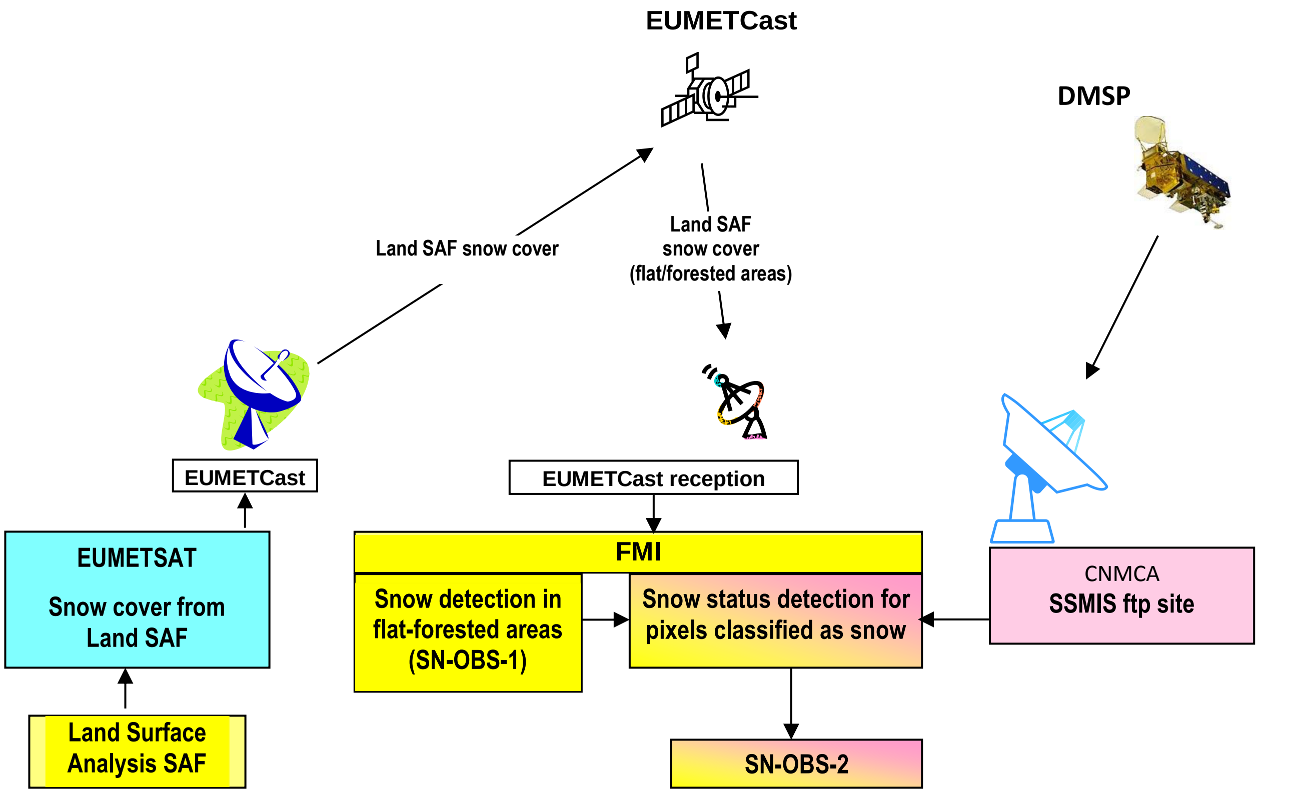

Figure 3 Conceptual architecture of the SN-OBS-2 chain.

It is noted that the dependence of product SN-OBS-2 from preventive classification by SN-OBS-1 implies that the product, although in principle possible to be generated after each DMSP pass (being SSMIS all-weather and available night and day), in practice has to follow the SN-OBS-1 generation rate, i.e. 24 hours.

Unlike the other H-SAF snow products, that are processed at two locations (FMI for flat/forested areas, TSMS for mountainous areas), SN-OBS-2 is produced only at FMI and, although covers the full H-SAF area, only the flat/forested areas are committed for nominal quality. The product is held on the FMI and CNMCA servers.

1.2.5 Product coverage and appearance

Next two couple of figures show examples of SN-OBS-2 products and corresponding SN-OBS-1. First one refers to "deep" winter, with mostly dry snow, second figure showing more melting. Maps are in *equal latitude/longitude grid* with sampling intervals of 0.25 degrees.

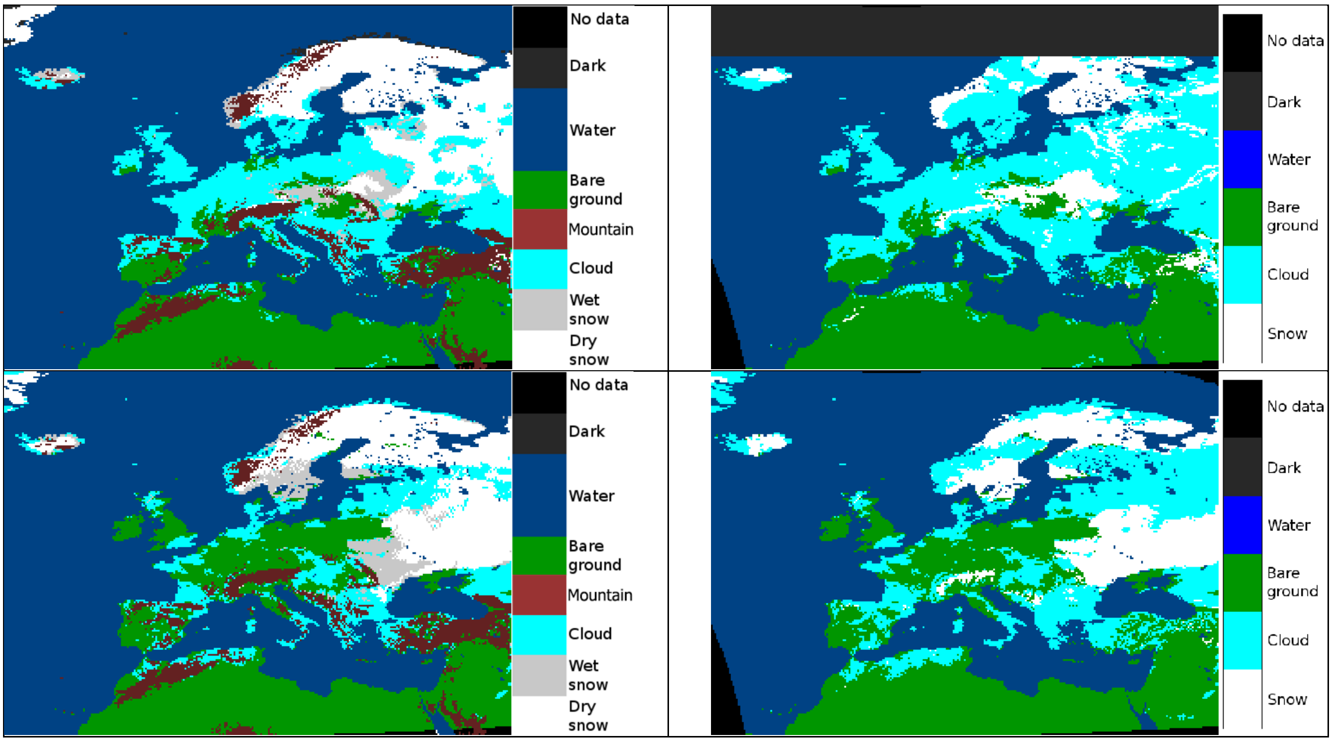

Figure 4 Snow map as in SN-OBS-2 (upper left) from SSMI/S and SN-OBS-1 (upper right) from SEVIRI. 24-h composite. 19 January 2018. Snow map as in SN-OBS-2 (lower left) from SSMI/S and SN-OBS-1 (lower right) from SEVIRI. 24-h composite. 25 March 2018

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).

For MW conical scanners the IFOV is constant in the image, but depends on the frequency channels utilised for building the product. Thick snow requires lower frequencies with higher penetration, that implies coarser resolution. In practise the current algorithm utilises the two frequencies 19.3 and 37.0 GHz, thus the resolution is that one of SSMIS at 19.3 GHz, i.e. ***Δx ~ 25 km***. Sampling is made at 0.25-degree intervals, i.e., again ***~ 25 km***.

2.2 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*).

2.3 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 **Errore. L'origine riferimento non è stata trovata.** (in annex 2). In the case of LEO, the observing cycle depends on the instrument swath and the number of satellites carrying the addressed instrument.

Independently on the actual SSMIS passes over the H-SAF area, the SN-OBS-2 product is generated at 24 hours intervals. Thus the observing cycle is ***Δt ~ 24 h***.

2.4 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 a product such as SN-OBS-2, resulting by assembling data collected until a fixed time of the day, the time of observation may change across the scene (some area may have been observed early in the time window, thus up to 24-h old at the time of dissemination; some very recently, just before product dissemination). The average timeliness is therefore ***δ = 12 h***.

3 Product validation

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-2, as any other H-SAF product, has been submitted to validation entrusted to a number of institutes (see next figure).

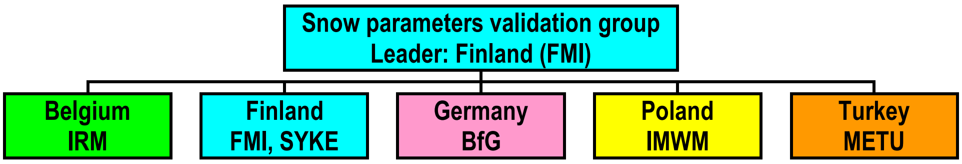

Figure 5- Structure of the Snow products validation team

The accuracy of the snow status 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-2 is provided as document:

- PVR-11: Product Validation Report for SN-OBS-2.

In this PUM-11 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).

4 Product availability

4.1 Sites

SN-OBS-2 will be available via EUMETCast (when authorized) and via FTP (after log in).

Currently SN-OBS-2 is available on the following FTP sites (to obtain user and password please contact the Help Desk):

a. CNMCA site:

  - URL: ftp://ftp.meteoam.it
  - directory: *products*

  only current data (at least two months, often more).

b. FMI site:

  - URL: ftp://ftp.fmi.fi
  - directory: *HSAF*
  - folder: *products*

  all data from April 2008 up to date.

Quick-looks of the last 3 days of SN-OBS-2 maps can be viewed on the H-SAF web site.

4.2 Formats and codes

Two type of files are provided for SN-OBS-2:

- the digital data, coded in GRIB-2
- the image-like maps, coded in PNG

  - The digital data can be read by ay GRIB-2 library or software. Definitions of the values are given in Tables 3. and 4. A program to convert SN-OBS2 GRIB-2 files to ASCII format is also provided in the

FMI site, sub-directory "*products*", folder "*utilities*", file "*snobs2_grib_to_ascii.tar.gz*". In addition, the description the program is provided in Appendix 1.

4.3 Description of the files

In the two ftp sites the structure of the records is identical, but the hierarchy is slightly different.

Next two tables, respectively:

- summarises the instructions for accessing the data in the CNMCA site;
- refers to the FMI site.

<table>
<tr><td>URL: ftp://ftp.meteoam.it</td><td>username: contact Help Desk</td><td>password: contact Help Desk</td><td>directory: products</td><td colspan="2">folder: h11</td></tr>
<tr><td colspan="2" rowspan="2">Product identifier: h11.
Folders under h11:</td><td colspan="4">h11_cur_mon_data</td></tr>
<tr><td colspan="4">h11_cur_mon_png</td></tr>
<tr><td rowspan="2">Files description:</td><td colspan="2">h11_cur_mon_data</td><td colspan="2">h11_yyyymmdd_day_FMI.grib2
h11_yyyymmdd_QC_day_FMI.grib2</td><td>digital data</td></tr>
<tr><td colspan="2">h11_cur_mon_png</td><td colspan="2">h11_yyyymmdd_day_FMI.png</td><td>image data</td></tr>
<tr><td colspan="6">yyyymmdd: year, month, day
day: indicates that the product results from multi-temporal analysis over 24 hours (in daylight), as follows:
0 Dry snow
25 Wet snow
42 Cloud
85 Bare soil
128 Water (in the dark areas of the optical product)
170 Sea
212 Dark
233 No data
QC_day: quality control - it records the availability of each data type used in the production, as follows:
0 - Optical and microwave data have been available and used
1 - Radiometer data has not been available, thus it has not been possible to identify dry snow
2 - Optical data has not been available, thus it has not been possible to identify wet snow
3 - No data available, the product cannot be calculated for this location.</td></tr>
</table>

Table 3 Summary instructions for accessing SN-OBS-2 data at the CNMCA site

<table>
<tr><td>URL: ftp://ftp.fmi.fi</td><td>username: contact Help Desk</td><td>password: contact Help Desk</td><td>directory: HSAF</td><td colspan="2">folder: products</td></tr>
<tr><td colspan="2" rowspan="2">Product identifier: h11.
Folders under h11:</td><td colspan="2">h11_yyyymm_data</td><td colspan="2">digital data monthly packages</td></tr>
<tr><td colspan="2">h11_yyyymm_images</td><td colspan="2">image data monthly packages</td></tr>
<tr><td rowspan="2">Files description:</td><td colspan="2">h11_yyyymm_data</td><td colspan="2">h11_yyyymmdd_day_FMI.grib2
h11_yyyymmdd_QC_day_FMI.grib2</td><td>digital data</td></tr>
<tr><td colspan="2">h11_yyyymm_images</td><td colspan="2">h11_yyyymmdd_day_FMI.png</td><td>image data</td></tr>
<tr><td colspan="6">yyyymm: year, month
yyyymmdd: year, month, day
day: indicates that the product results from multi-temporal analysis over 24 hours (in daylight), as follows:
0 Dry snow
25 Wet snow
42 Cloud
85 Bare soil
128 Water (in the dark areas of the optical product)
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212 Dark
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QC_day: quality control - it records the availability of each data type used in the production, as follows:
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2 - Optical data has not been available, thus it has not been possible to identify wet snow
3 - No data available, the product cannot be calculated for this location.</td></tr>
</table>

Table 4 Summary instructions for accessing SN-OBS-2 data at the FMI site

Annex 1. SN-OBS-2 GRIB to ASCII converter description

How to convert H-SAF H11 products to ASCII

1) You need GRIB API library, freely available from http://www.ecmwf.int/products/data/software/download/grib_api.html
2) C++ compiler (tested with g++ versions 3.2.3, 4.1.3, 4.3.3)
3) Download snobs2_grib_to_ascii.tar.gz from ftp://ftp.fmi.fi
4) Uncompress the source code and compile the program with

```
tar -xzvf snobs2_grib_to_ascii.tar.gz
cd snobs2_grib_to_ascii
g++ -Wall *.cpp -o snobs2_grib_to_ascii -lgrib_api
```

Depending on the setup of the compilation environment and GRIB libraries, also libjasper may need to be linked to the program (eg. in Ubuntu based systems). If the GRIB and/or jasper libraries are not in system directories the installation directories need to be given (adjust to match your system):

If the jasper libraries are not needed separately use the following:

```
GRIB_INCLUDES=/usr/local/grib_api/inc
GRIB_LIBRARIES=/usr/local/grib_api/lib
g++ -Wall *.cpp -I${GRIB_INCLUDES} -L${GRIB_LIBRARIES} -o snobs2_grib_to_ascii -lgrib_api
```

If jasper libraries are needed use the following:

```
GRIB_INCLUDES=/usr/local/grib_api/inc
GRIB_LIBRARIES=/usr/local/grib_api/lib
JASPER_INCLUDES=/usr/include/jasper
JASPER_LIBRARIES=/usr/lib/jasper
g++ -Wall *.cpp -I${GRIB_INCLUDES} -L${GRIB_LIBRARIES} -I${JASPER_INCLUDE}
        -L${JASPER_LIBRARIES} -o snobs2_grib_to_ascii -lgrib_api -ljasper
```

5) Install by typing

```
./install.sh
```

and follow instructions. The path where the program is installed has to be in, or added to, the users $PATH which tells where the operating system searches for executable programs.

Usage:

Change to the directory with the data wanted to be converted to ASCII, and issue command

```
snobs2_grib_to_ascii  -i <file_in.grib2> -o <file_out.txt>
```

where

file_in.grib2: H-SAF SN-OBS-2 GRIB2 data file
file_out.txt: filename to output the ASCII data

Examples:

- Show help:
  `snobs2_grib_to_ascii -h`
- Decode one file for the whole area:
  `snobs2_grib_to_ascii -i h11_20080318_day.grib2 -o h11_20080318_day.txt`
- Decode a given area subset (40 - 70 degrees latitude, -10 - +30 longitude)

snobs2_grib_to_ascii -i h11_20080318_day.grib2 -o h11_20080318_day.txt -N 70.0 -S 60.0 -W -10.0 -E 30.0

- Output also NODATA, SPACE and WATER pixels. Decoding with this option it is easier to combine the product with quality flags!
  snobs2_grib_to_ascii -a -i h11_20080318_day.grib2 -o h11_20080318_day.txt

Processing multiple files

Script is provided for processing all the files in the current directory. This script is installed in step 5). NOTE: if you want to output only a subset of the area, adjust the default values in the beginning of the script.

For example: cd $HSAF/snobs2/FMI/snobs2_grib_to_ascii_all.sh

Annex 2. 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 6):

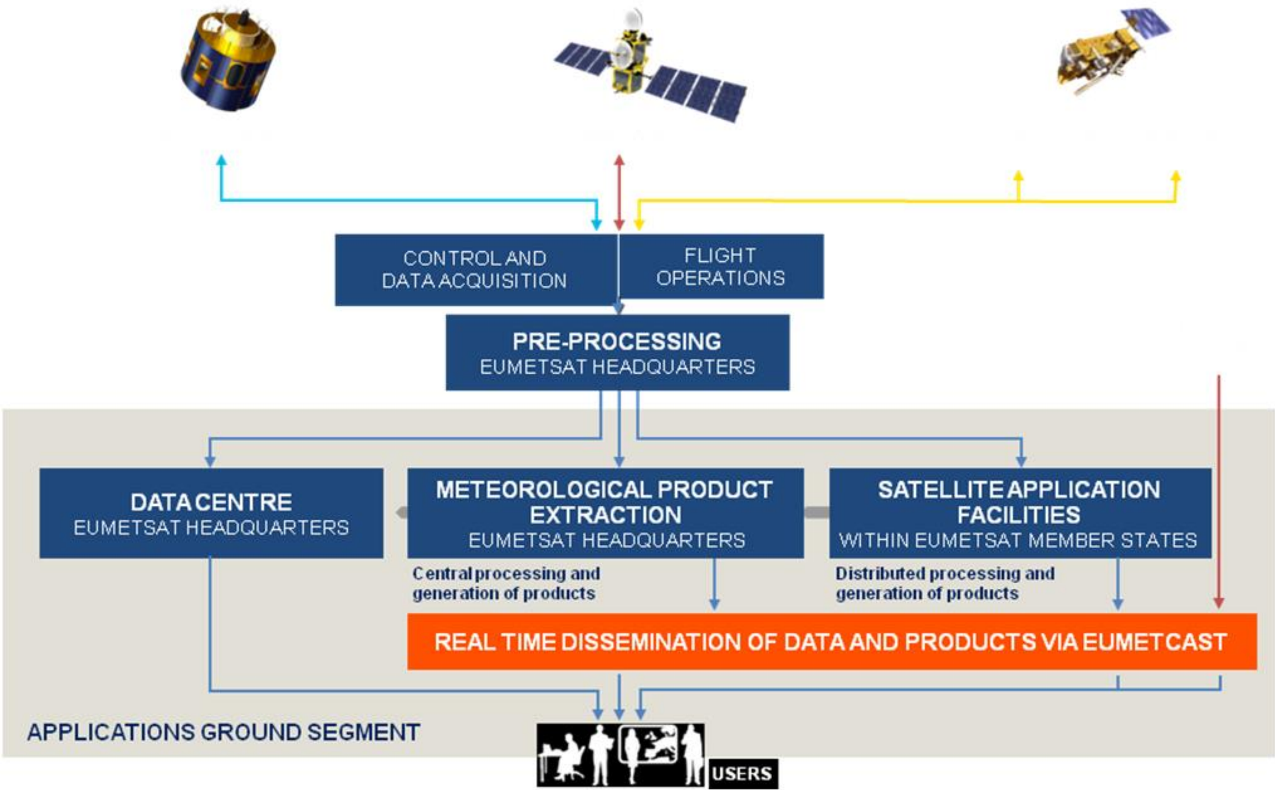

Figure 6: Conceptual scheme of the EUMETSAT Application Ground Segment

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

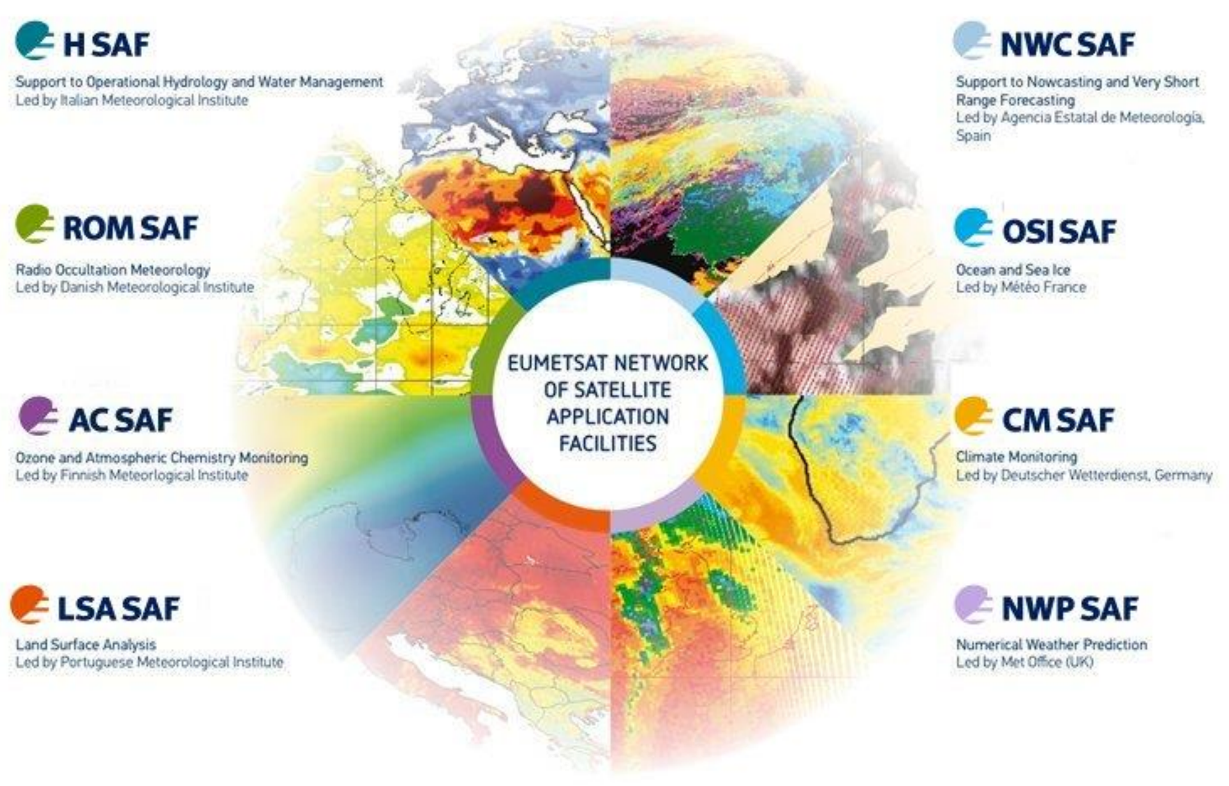

Figure 7: Current composition of the EUMETSAT SAF Network

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.

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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 3. 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)
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)
URD	User Requirements Document
UTC	Universal Coordinated Time
VIS	Visible
ZAMG	Zentralanstalt für Meteorologie und Geodynamik (of Austria)