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

The EUMETSAT Network of Satellite Application Facilities

H SAF
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

Reference Number:	SAF/HSAF/PUM-11/1.2
Issue/Revision Index:	1.2
Last Change:	21 October 2013

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

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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 AMSR-E microwave radiometer being flown on EOS-Aqua. In case of failure of AMSR-E or of EOS-Aqua, SSM/I and SSMIS flown on the DMSP satellites will be used (with much worse resolution). 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):

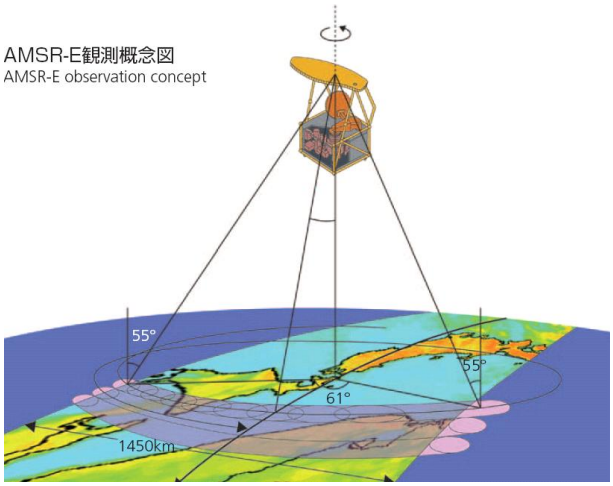

Figure 1 Geometry of conical scanning for AMSR-E

Also, 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 10 km, dictated by the satellite velocity on the ground and the scan rate. Along scan, the sampling rate is 10 km for all channels except 89 GHz where it is 5 km.

The AMSR-E frequencies more sensitive to snow are 18.7 and 36.5 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).

The EOS-Aqua satellite is managed by NASA. Direct reception is possible, but AMSR-E data are generally acquired by ftp from NASA archives. The delay from the observation time is around 6 h, with considerable fluctuations due to the availability of the NASA ftp server.

The SN-OBS-2 product has been developed in the TKK, 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	expected ≥ 2010	705 km	13:30 a	Operational	AMSR-E
DMSP-F15	12 Dec 1999	expected ≥ 2010	845 km	05:40 d	Secondary Operation	SSM/I (defective) [backup in H-SAF]
DMSP-F16	18 Oct 2003	expected ≥ 2010	855 km	07:10 d	Secondary Operation	SSMIS [backup in H-SAF]
DMSP-F17	4 Nov 2006	expected ≥ 2011	855 km	05:30 d	Primary Operation	SSMIS [backup in H-SAF]
DMSP-F18	18 Oct 2009	expected ≥ 2014	857 km	07:55 d	Primary Operation	SSMIS [backup in H-SAF]

Table 1 Current status of EOS-Aqua and DMSP satellites (as of March 2010)

Next table collects the main features of the AMSR-E instrument. Similar tables for SSM/I and SSMIS are spared. If necessary, they can be found in PUM-01 (Product User Manual for PR-OBS-1, *Precipitation rate at ground by MW conical scanners*).

AMSR-E	Advanced Microwave Scanning Radiometer for EOS
Satellite	**EOS-Aqua**
Status	**Operational** - Utilised in the period: 2002 to ~ 2010
Mission	Multi-purpose MW imager
Instrument type	Multi-purpose imaging MW radiometer - 6 frequencies / 12 channels
Scanning technique	Conical: 55° zenith angle; swath: 1450 km - Scan rate: 40 scan/min = 10 km/scan
Coverage/cycle	Global coverage once/day
Resolution	Changing with frequency, consistent with an antenna diameter of 1.6 m
Resources	Mass: 314 kg - Power: 350 W - Data rate: 87.4 kbps

Central frequency (GHz)	Bandwidth (MHz)	Polarisations	Accuracy (NEΔT)	IFOV	Pixel
6.925	350	V, H	0.3 K	43 x 75 km	10 x 10 km
10.65	100	V, H	0.6 K	29 x 51 km	10 x 10 km
18.7	200	V, H	0.6 K	16 x 27 km	10 x 10 km
23.8	400	V, H	0.6 K	14 x 21 km	10 x 10 km
36.5	1000	V, H	0.6 K	9 x 14 km	10 x 10 km
89.0	3000	V, H	1.1 K	4 x 6 km	5 x 5 km

Table 2 Main features of AMSR-E

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.

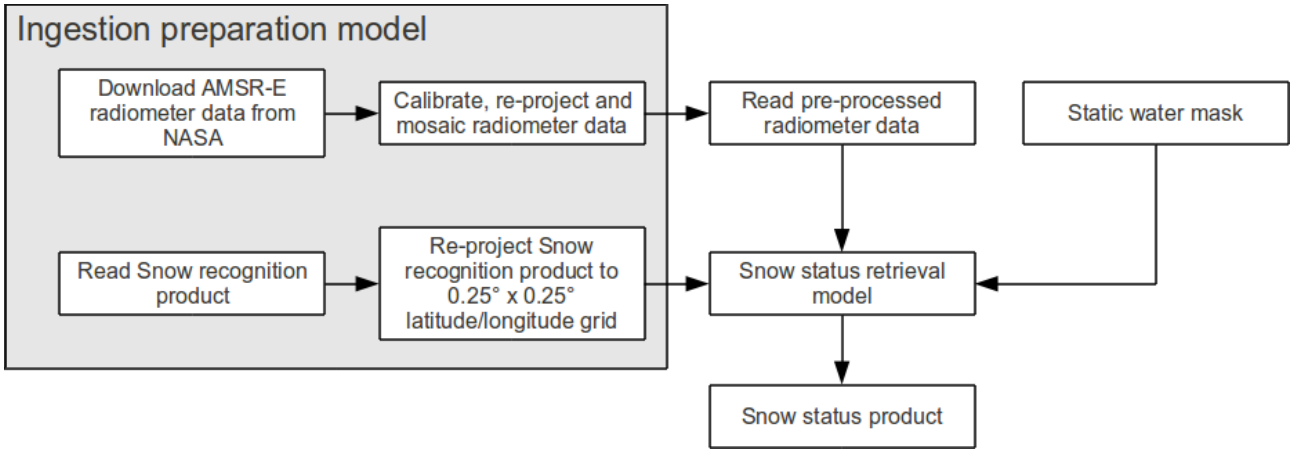

Figure 2 Flow chart of the snow status recognition processing chain

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, AMSR-E radiometer data are processed. After each new radiometer swath that is downloaded from NASA 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 used to fill in the gaps between different satellite overpasses.

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 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:

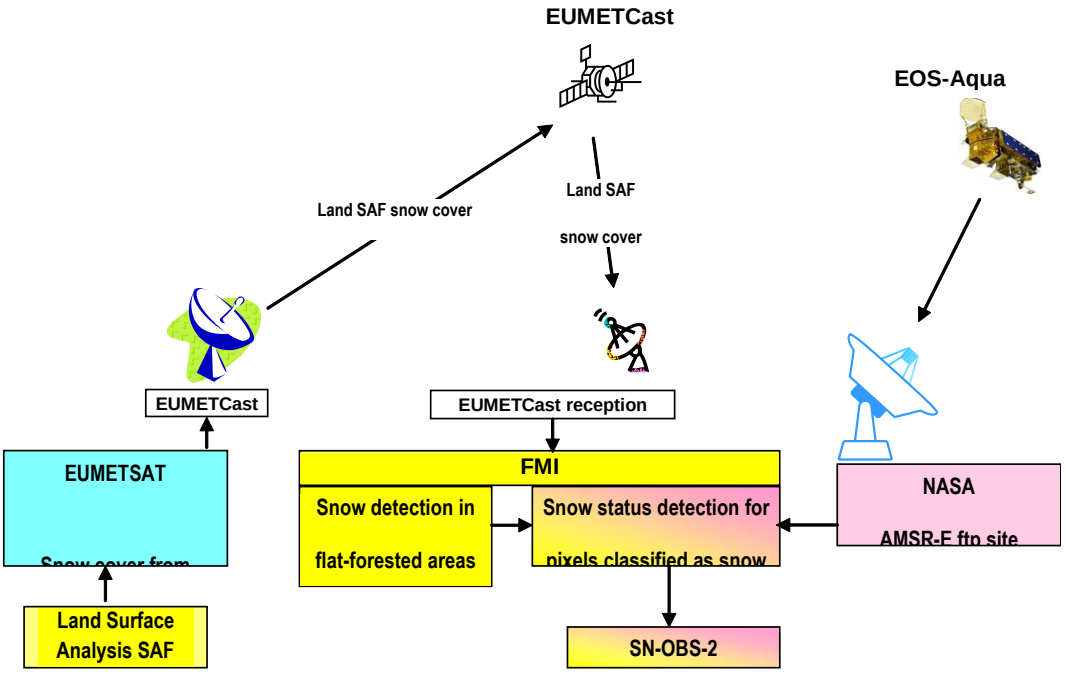

Figure 3 Conceptual architecture of the SN-OBS-2 chain

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 EOS-Aqua pass (being AMSR-E all-weather and available night and day), in practice has to follow the SN-OBS-1 generation rate, i.e. 24 hours. Anyway, the retrieval of data from the NASA archive introduces delays of several hours.

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.

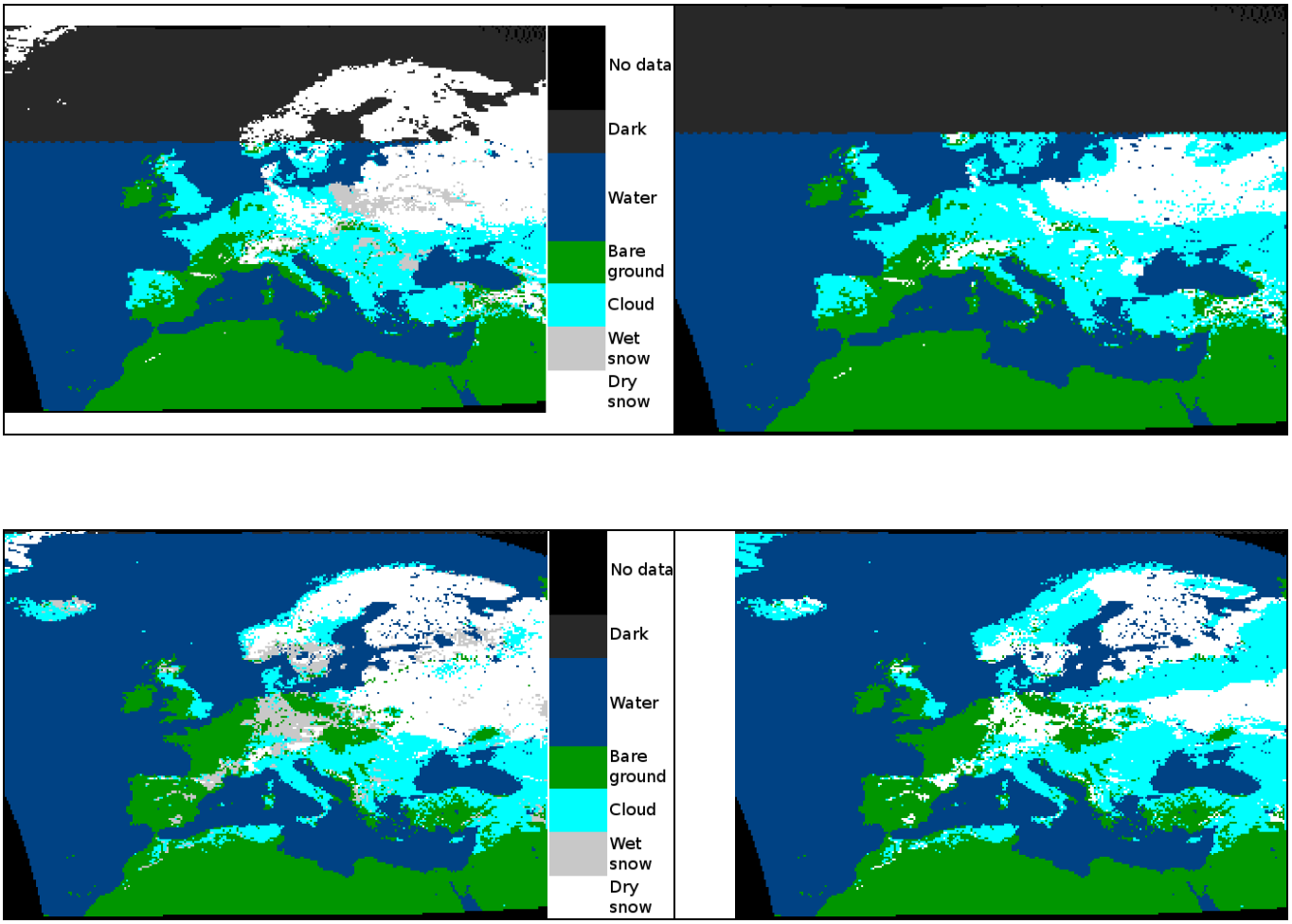

Figure 4 Snow map as in SN-OBS-2 (upper left) from AMSR-E and SN-OBS-1 (upper right) from SEVIRI. 24-h composite. 22 January 2010. Snow map as in SN-OBS-2 (lower left) from AMSR-E and SN-OBS-1 (lower right) from SEVIRI. 24-h composite. 09 March 2010

1.3 Comparison between H10 (SN-OBS-1) and H11 (SN-OBS-2)

This section present s a summary of accuracy and sampling limitations of H10 and H11, for short comparison between the two products.
The results here showed are obtained from the last validation cycle, winter 2009/2010 (i.e. 1st October 2009 - 31 March 2010).

The score are presented as follows:

- POD: Probability of Detection
- FAR: False Alarm Rate
- CSI: Critical Success Index (needed to compare different POD / FAR combinations)
- PODF: Probability Of False Detection
- ACC: Fraction correct Accuracy
- HSS: Heidke Skill Score.

Scores refer only to non-mountainous areas.

Score	H10 (SN-OBS-1)	H11 (SN-OBS-2)
N. samples	10437	220331
POD	0.50	0.75
FAR	0.10	0.03
CSI	0.48	0.74
POFD	0.24	0.02
ACC	0.55	0.86
HSS	0.15	0.72

Table 3 Comparison between H10 and H11: summary table

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 18.7 and 36.5 GHz, thus the resolution is that one of AMSR-E at 18.7 GHz, i.e. ***Δx ~ 20 km***. Sampling is made at 0.25-degree intervals, i.e., again ***~ 20 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 Figure 9. In the case of LEO, the observing cycle depends on the instrument swath and the number of satellites carrying the addressed instrument.

AMSR-E is available only on one satellite, and its swath is 1450 km, thus in principle provides global coverage every 24 h. Independently on the actual AMSR-E 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).

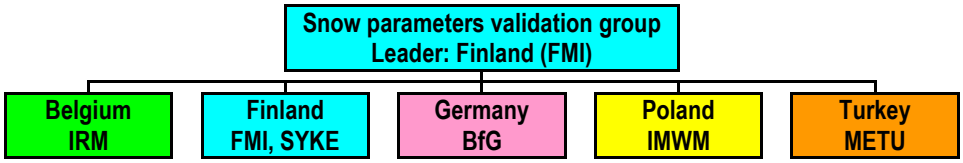

Figure 5 - Structure of the Snow products validation team

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 information to read the GRIB-2 is provided in the FMI site, sub-directory "*products*", folder "*utilities*", file "*snobs2_grib_to_ascii.tar.gz*". In addition, the output description of SN-OBS-2 is provided in Appendix.

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.

URL: ftp://ftp.meteoam.it	username: *contact Help Desk*	password: *contact Help Desk*	directory: *products*	folder: *h11*
Product identifier: *h11*. Folders under h11:	h11_cur_mon_data h11_cur_mon_png			
Files description:	h11_cur_mon_data	h11_yyyymmdd_day_FMI.grib2 h11_yyyymmdd_QC_day_FMI.grib2	digital data	
	h11_cur_mon_png	h11_yyyymmdd_day_FMI.png	image data	
yyyymmdd: year, month, day day: indicates that the product results from multi-temporal analysis over 24 hours (in daylight) QC: 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.				

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

URL: ftp://ftp.fmi.fi	username: *contact Help Desk*	password: *contact Help Desk*	directory: *HSAF*	folder: *products*
Product identifier: *h11*. Folders under h11:	h11_yyyymm_data h11_yyyymm_images		digital data monthly packages image data monthly packages	
Files description:	h11_yyyymm_data	h11_yyyymmdd_day_FMI.grib2 h11_yyyymmdd_QC_day_FMI.grib2	digital data	
	h11_yyyymm_images	h11_yyyymmdd_day_FMI.png	image data	
yyyymm: year, month yyyymmdd: year, month, day day: indicates that the product results from multi-temporal analysis over 24 hours (in daylight) QC: 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.				

Table 5 Summary instructions for accessing SN-OBS-2 data at the FMI site

Annex 1. SN-OBS-2 Output 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 Organisation for the Exploitation of Meteorological Satellites (EUMETSAT)*". The application ground segment consists of a "*Central Application Facility (CAF)*" and a network of eight "*Satellite Application Facilities (SAFs)*" dedicated to development and operational activities to provide satellite-derived data to support specific user communities. See next figure:

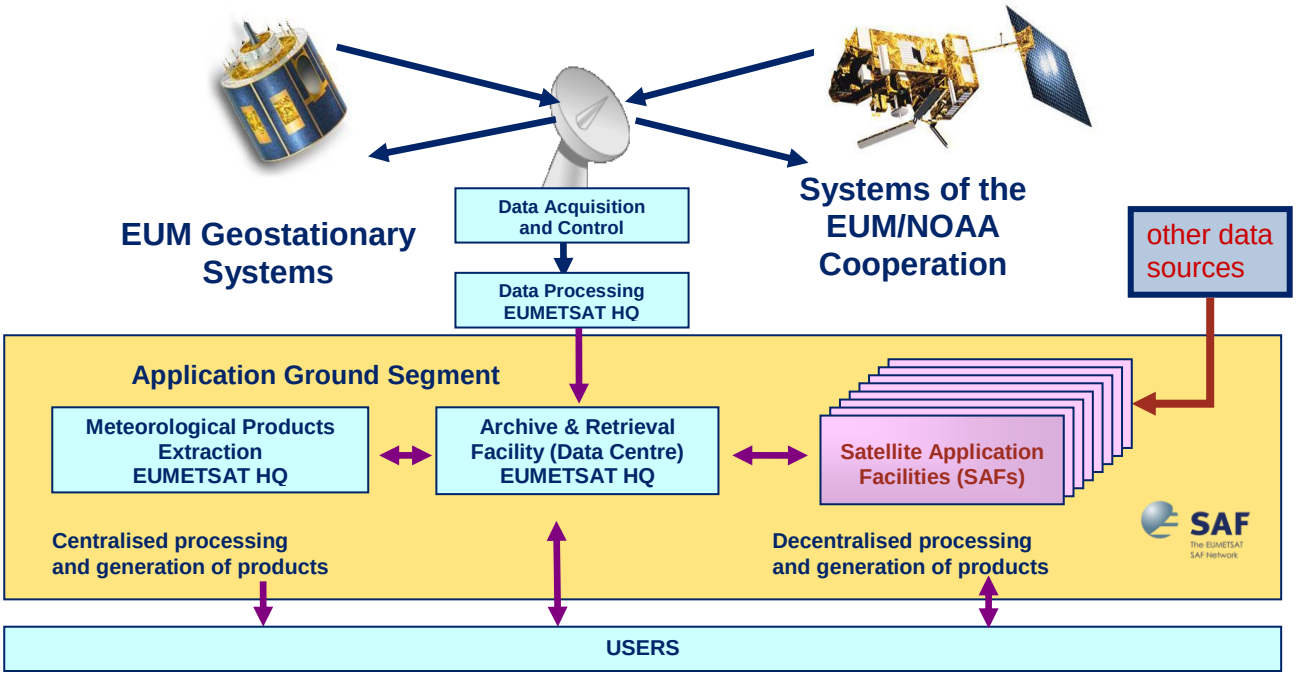

Figure 6 Conceptual scheme of the EUMETSAT Application Ground Segment

Next figure reminds the current composition of the EUMETSAT SAF network (in order of establishment).

NWC SAF	OSI SAF	O3M SAF	CM SAF	NWP SAF	GRAS SAF	LSA SAF	H SAF
Nowcasting & Very Short Range Forecasting	Ocean and Sea Ice	Ozone & Atmospheric Chemistry Monitoring	Climate Monitoring	Numerical Weather Prediction	GRAS Meteorology	Land Surface Analysis	Operational Hydrology & Water Management

Figure 7 Current composition of the EUMETSAT SAF Network (in order of establishment)

H-SAF objectives and products

The H-SAF was established by the EUMETSAT Council on 3 July 2005; its Development Phase started on 1st September 2005 and ended on 31 August 2010. The SAF is now in its first Continuous Development and Operations Phase (CDOP) which started on 28 September 2010 and will end on 28 February 2012.

The H-SAF objectives 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; identified products:

- precipitation;
- soil moisture;
- snow parameters;

b. ***to perform independent validation of the usefulness of the new 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.

This document (the PUM, Product User Manual) is concerned only with the satellite-derived products. The list of products to be generated by H-SAF is shown in next table:

Acronym	Identifier	Name
PR-OBS-1	H-01	Precipitation rate at ground by MW conical scanners (with indication of phase)
PR-OBS-2	H-02	Precipitation rate at ground by MW cross-track scanners (with indication of phase)
PR-OBS-3	H-03	Precipitation rate at ground by GEO/IR supported by LEO/MW
PR-OBS-4	H-04	Precipitation rate at ground by LEO/MW supported by GEO/IR (with flag for phase)
PR-OBS-5	H-05	Accumulated precipitation at ground by blended MW and IR
PR-OBS-6	H-15	Blended SEVIRI Convection area/ LEO MW Convective Precipitation
PR-ASS-1	H-06	Instantaneous and accumulated precipitation at ground computed by a NWP model
SM-OBS-2	H-08	Small-scale surface soil moisture by radar scatterometer
SM-OBS-3	H-16	Large-scale surface soil moisture by radar scatterometer

Acronym	Identifier	Name
SM-DAS-2	H-14	Liquid root zone soil water index by scatterometer assimilation in NWP model
SN-OBS-1	H-10	Snow detection (snow mask) by VIS/IR radiometry
SN-OBS-2	H-11	Snow status (dry/wet) by MW radiometry
SN-OBS-3	H-12	Effective snow cover by VIS/IR radiometry
SN-OBS-4	H-13	Snow water equivalent by MW radiometry

Table 6 H-SAF Product List

The work of precipitation products generation is shared in the H-SAF Consortium as follows:

- Precipitation products (pre-fix: PR) are generated in Italy by the CNMCA, in its premises at Pratica di Mare (Rome).
- CNMCA also manages the Central Archive and the Data service.
- CNR develops and upgrades the algorithm.

Evolution of H-SAF products

One special requirement of the H-SAF work plan was that the Hydrological validation programme, that started downstream of products availability, lasts for a sufficient time There was therefore a need to make available as soon as possible at least part of the products, accepting that their status of consolidation was still incomplete, the quality was not yet the best, and the characterisation was still poor due to limited validation. According to EUMETSAT definitions, the status of development of a product is qualified as in next table:

Status	Description
In development	Products or software packages that are in development and not yet available to users
Demonstrational	Products or software packages that are provided to users without any commitment on the quality or availability of the service and have been considered by the relevant Steering Group to be useful to be disseminated in order to enabling users to test the product and to provide feedback
Pre-operational	Products or software packages with documented limitations that are able to satisfy the majority of applicable requirements and/or have been considered by the relevant Steering Group suitable for distribution to users
Operational	Products or software packages with documented non-relevant limitations that largely satisfy the requirements applicable and/or have been considered by the relevant Steering Group mature enough for distribution to users

Table 7 Definition of the development status of a product according to EUMETSAT

The need for early release of products to activate the Hydrological validation programme as soon as possible led to define a stepwise approach for H-SAF products development.
This is shown in next figure:

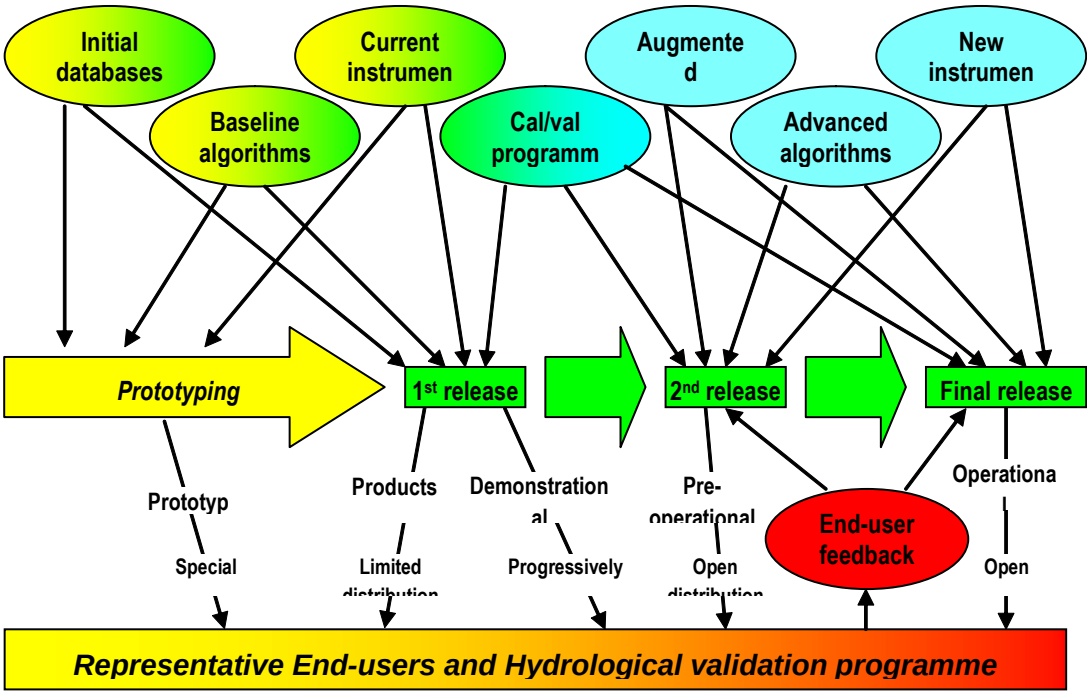

Figure 8 Logic of the incremental development scheme

The time reference for this work plan is as follows:

- after approximately 3 years from the start of the Project (i.e. starting from the nominal date of 1st January 2008) a substantial fraction of the products listed in Table 01 are released first as "in development" and then after, as soon as some validation is performed, as "demonstrational";
- in the next years the Hydrological validation programme builds up and grows. At the end of CDOP1 all products should become "operational" or demonstrational. Until the products are in the development status, their distribution is limited to the so-called *beta users*. Demonstrational, pre-operational and operational products have open distribution.

It is noted products can follow this schedule with different timeframes; therefore, the status of "in development", "demonstrational", "pre-operational" and "operational" will apply differently to the different products.

Product coverage

Figure of this section shows the required geographic coverage for H-SAF products.

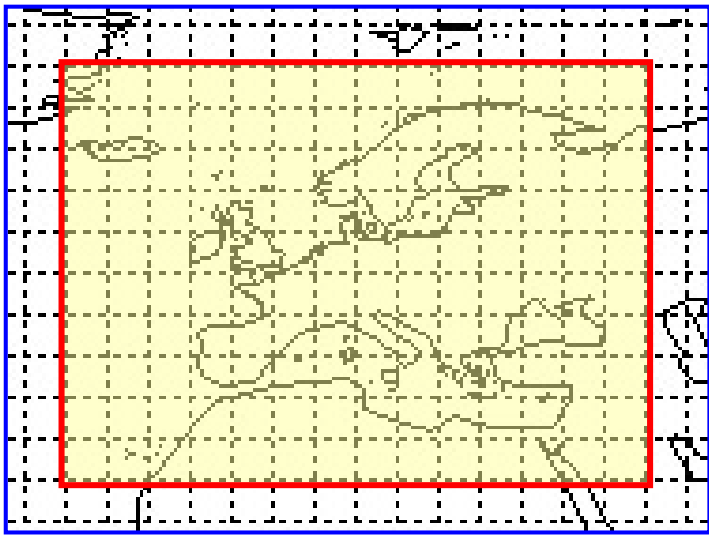

Figure 9 Required H-SAF coverage: 25-75°N lat, 25°W - 45°E

This area is fully covered by the Meteosat image (although the resolution sharply decreases at higher latitudes) each 15 min. For polar satellites, the area is covered by strips of swath approximately 1500 km (conical scanners) or 2200 km (cross-track scanners) at about 100 min intervals. Swaths intercepting the acquisition range of direct-read-out stations provide data in few minutes; for swaths outside the acquisition range the delay may be several tens of minutes if the satellite/instrument data are part of the EARS / EUMETCast broadcast, some hours otherwise (e.g., by ftp). The time resolution (*observing cycle*) is controlled by the number of satellites concurring to perform the observation, and the instrument swath.

Data circulation and management

Next figure shows the data circulation scheme in H-SAF. All products from the generating centres are concentrated at CNMCA (except that certain can go directly to the user by dedicated links: example, GTS, Global Telecommunication System connecting operational meteorological services). From CNMCA the data are sent to EUMETSAT to be broadcast by EUMETCast in near-real-time.

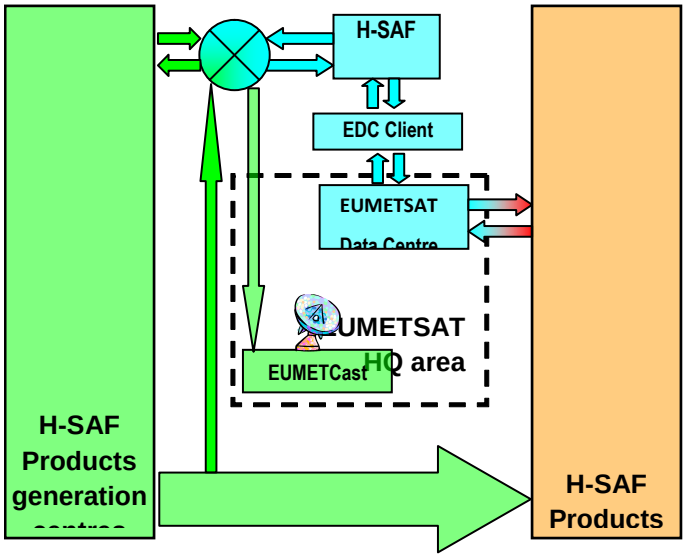

Figure 10 H-SAF central archive and distribution facilities

All data also go to the H-SAF Archive where they can be accessed through the EUMETSAT Data Centre via a Client. Therefore, the H-SAF products may be accessed:

- via EUMETCast in near-real-time (primary access mode);
- off-line via the EUMETSAT Data Centre (most common access mode for the scientific community).

It is noted that this scheme is valid only for pre-operational and operational products. For products in development disseminated to beta-users only, or demonstrational products, the distribution ordinarily utilises the ftp servers of the product generation centres, or the CNMCA server. CNMCA also re-disseminate the products generated in other centres, therefore all products can be retrieved from the CNMCA server.

The ftp dissemination stream will continue to be active even after the EUMETCast dissemination becomes effective, both for redundancy purpose, and for users not equipped for EUMETCast reception.

The H-SAF web site

The address of the H-SAF web site is: http://hsaf.meteoam.it/.

The web site provides:

- general public information on H-SAF
- H-SAF products description
- rolling information on the H-SAF implementation status
- an area for collecting/updating information on the status of satellites and instruments used in H-SAF
- an area to collect Education and Training material
- an area for “forums” (on algorithms, on validation campaigns, etc.)
- indication of useful links (specifically with other SAF’s)
- an area for “Frequently Asked Questions” (FAQ) to alleviate the load on the Help desk.

The web site supports operations by providing:

- daily schedule of H-SAF product distribution
- administrative messages on changes of product version (new algorithms, etc.).

The web site contains some basic H-SAF documents (the ATDD, Algorithms Theoretical Definition Document; this Product User Manual, …). However, most working documents (REP-3: Report of the Products Validation Programme; REP-4: Report of the Hydrological Validation Programme; etc.), programmatic documents (PP: Project Plan; URD: User Requirements Documents; etc.) and engineering documents are to be found in the CNMCA ftp server (restricted access; see later for the URL).

The User Support

For any question that cannot be solved by consulting the web site, users have two different possibilities:

- To send an email through the "Contact Us" functionality of the web-site, in charge of forwarding the request to an help desk. This functionality is also available to unregistered users ;
- To compose a specific question/request to the help-desk available only to registered users; in this case, the user should specify in the "Subject" one of the following codes:
    - MAN (management)
    - PRE (precipitation)
    - SOM (soil moisture)
    - SNO (snow)
    - HYD (hydrology)
    - ARC (archive)
    - GEN (general).

Condition for use of H-SAF products

All H-SAF products are owned by EUMETSAT, and the EUMETSAT SAF Data Policy applies. They are available for all users free of charge.

Users should recognise the respective roles of EUMETSAT, the H-SAF Leading Entity and the H-SAF Consortium when publishing results that are based on H-SAF products. EUMETSAT's ownership of and intellectual property rights into the SAF data and products is best safeguarded by simply displaying the words "**© EUMETSAT**" under each of the SAF data and products shown in a publication or website.

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)