


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



**Algorithm Theoretical Baseline Document (ATBD)  
for product H03B – P-IN-GRU-SEVIRI**


**Precipitation rate at ground by GEO/IR  
supported by LEO/MW**

Reference Number:	SAF/HSAF/ATBD-03B
Issue/Revision Index:	1.2
Last Change:	08 September 2017

	<p>Algorithm Theoretical Baseline Document ATBD-3B (Product H03B – P-IN-GRU-SEVIRI)</p>	<p>Doc.No: SAF/HSF/ATBD-3B Rel. 1.2 Date: 08/09/2017 Page: 2/18</p>
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<b>DOCUMENT CHANGE RECORD</b>
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Issue / Revision	Date	Description
1.0	02/03/2015	Baseline version prepared for PCR
1.1	02/12/2015	<p>Version prepared for PCR close-out which acknowledges the outcomes of the review Following changes applied:</p> <ul style="list-style-type: none"> <li>• Area coverage specified (answer to RID 001 and 003)</li> <li>• Formulas updated (answer to RID 004)</li> <li>• Section 3.3 corrected (answer to RIDs 007 and 023)</li> <li>• Section 4 (Validation) improved (answer to RID 015, 025, 027, 029)</li> </ul>
1.2	08/09/2017	RIDs acknowledgement from ORR full disc

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# 1 Introduction to P-IN-GRU-SEVIRI

## 1.1 Principle of the product

Product H03B (P-IN-GRU-SEVIRI Precipitation rate at ground by GEO/IR supported by LEO/MW over the full disk area) is based on the IR images from the SEVIRI instrument on-board Meteosat Second Generation (MSG) satellites. The spatial coverage of the product included the H-SAF area (Europe and Mediterranean basin) and the Africa and Southern Atlantic Ocean. Thus the new geographic region covers the MSG area correspondent to 60°S – 67.5°N, 60°W – 60°E <sup>1</sup>. The extension of the spatial coverage with respect to H03A product was obtained with an update of the input parameters, but it did not require any modifications of the algorithm structure. The product is generated at the 15-min imaging rate of SEVIRI, and the spatial resolution is consistent with the SEVIRI pixel.

The P-IN-GRU-SEVIRI precipitation estimates are obtained by combining IR GEO equivalent blackbody temperatures ( $T_{BB}$ ) at 10.8  $\mu\text{m}$  with rain rates from PMW measurements (P-IN-OBA-SSMIS new rel. and P-IN-ONN\_AMSU). The algorithm is based on an underlying collection of time and space overlapping overpasses from GEO IR imagers and Low Earth Orbit (LEO) PMW sensors, which constitutes a look up table of geolocated relationships rain rate vs  $T_{BB}$ , updated as soon as new overlapping GEO IR and LEO PMW overpasses are available. The processing method is called “Rapid Update” (RU).

## 1.2 Main operational characteristics

The horizontal resolution ( $\Delta x$ ). The IFOV of SEVIRI images is 4.8 km at nadir, and degrades moving away from nadir, becoming about 8 km over Europe. Sampling distance at the sub-satellite point is  $\sim 3$  km. Conclusion:

- resolution  $\Delta x \sim$  from 4.8 to 8 km - sampling distance:  $\sim 3$  km at the sub-satellite point.

The observing cycle ( $\Delta t$ ). is defined as the average time interval between two measurements over the same area. In the case of P-IN-GRU-SEVIRI the product is generated soon after each SEVIRI new acquisition. Thus:

- observing cycle  $\Delta t = 15$  min - sampling time: 15 min.

The timeliness ( $\delta$ ).


- timeliness  $\delta \sim 15$  min.

The accuracy, is evaluated *a-posteriori* by means of the validation activity.

# 2 Processing concept

The P-IN-GRU-SEVIRI product is based on MW-derived precipitation estimates from P-IN-OBA-SSMIS

<sup>1</sup> It is noted that throughout this document the statement "full disc" is used in some cases as a simplified indication of the overall applicability of the product.

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new release and P-IN-ONN\_AMSU, and IR images from the SEVIRI sensor on board the geostationary MSG satellites.


SEVIRI is a 12-channel imager observing the Earth–atmosphere system. Eleven channels observe the Earth’s full disk with a 15-min repeat cycle. A high resolution visible (HRV) channel covers half of the full disk in the east–west direction and a full disk in the north–south direction. The high resolution visible channel has an IFOV of 1.67 km, and the oversampling factor is 1.67 that corresponds to a sampling distance of 1 km at nadir. The corresponding values for the eight thermal IR and the other three solar channels are 4.8 km IFOV, with an oversampling factor of 1.6 and a sampling distance of 3 km for nadir view. The SEVIRI time and spatial resolutions are thus especially suited for retrieving timely information on rapid weather development and routinely provide instantaneous or cumulated precipitation intensities on time scales consistent with the nature and development of the precipitating cloud systems.

The imaging is performed by combining satellite spin and rotation (stepping) of the scan mirror. The images are taken from south to north and east to west. The E-W scan is achieved through the rotation of the satellite with a nominal spin rate of 100 revolutions/min. The spin axis is nominally parallel to the north–south axis of the Earth. The scan from south to north is achieved through a scan mirror covering the Earth’s disk with about 1250 scan lines; this results in 3750 image lines for channels 1-11 since three detectors for each channel are used for the imaging three parallel lines. A complete image, i.e. the full disk of the Earth, consists of nominally 3712 x 3712 pixels for channels 1-11. A nominal repeat cycle is a full-disk imaging of about 12 min, followed by the calibration of thermal IR channels. Then the scan mirror returns to its initial scanning position.

The instantaneous field of view (IFOV) corresponds to the area of sensitivity for each picture element. Since the aperture angle for each IFOV is constant, it follows that the corresponding area at the surface varies with satellite-viewing angle. The image acquisition is based on a constant angular stepping, that is, the subtended angle for each pixel remains constant; hence, the spatial resolution of a pixel at the surface degrades with increasing off-nadir viewing angle.

For the aim of ingesting SEVIRI data into the processing chain of blended algorithm it is necessary to extract from the available image files the information needed by the algorithm. Very briefly, the essential data needed to process SEVIRI image data are:

- the starting and ending date and time of acquisition (UTC) for each image data or area subset;
- the latitude and longitude coordinates for the geo-location of each pixel in the area;
- the Channel 9 (10.8  $\mu\text{m}$ ) equivalent blackbody temperature (K) for each pixel. The digital counts are converted into radiances by means of the calibration coefficients distributed along with each image data. Then, radiances are converted into equivalent blackbody temperature (TBB) by means of regression relationships and the corresponding coefficients;
- the satellite zenith angle of observation for each pixel (deg);
- the acquisition time of each pixel (or line of pixels) measured in seconds from the starting time of acquisition;
- nominal line and column number for each pixel.

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### 3 Algorithms description

The following sections describe the principal characteristics of the various software modules that compose the P-IN-GRU-SEVIRI generation chain. The methodology implemented for the P-IN-GRU-SEVIRI product is the same adopted for H03A.

#### 3.1 The “Rapid-Update” processing chain

The adopted blended technique (Turk et al. 2000 a and b), called RU, has been originally developed at the Naval Research Laboratory in Monterey (CA). In the past, ISAC adapted the original operational set-up of the software (global, automatic, real time, using a suite of MW and IR observations) to the task of analysing test case studies (Torricella et al. 2007).

Key to the RU blended satellite technique is a real time, underlying collection of time and space overlapping pixels from operational geostationary IR imagers and LEO MW sensors. Rain intensity maps derived from MW measurements are used to create geo-located rain rate (RR) vs  $T_{BB}$  relationships, that are renewed as soon as new co-located data are available from both geostationary and MW instruments. In the software package these relationships are called histograms. To the end of geo-locating histogram relationships, the study area is subdivided in equally spaced lat-lon boxes ( $2.5^\circ \times 2.5^\circ$ ).

As new input datasets (MW and IR) are available in the processing chain, the MW-derived RR pixels are paired with their time and space-coincident geostationary  $10.8\text{-}\mu\text{m}$  IR  $T_{BB}$  data, using a 10-minute maximum allowed time offset between the pixel acquisition times and a maximum space offset of 10 km between the pixel coordinates. Each co-located data increments histograms of  $T_{BB}$  and RR in the nearest  $2.5^\circ$  latitude-longitude box, as well as the eight surrounding boxes (this overlap ensures a fairly smooth transition in the histogram shape between neighbouring boxes). The rationale behind these threshold values for time collocation and box size is discussed by Turk et al. 2002.

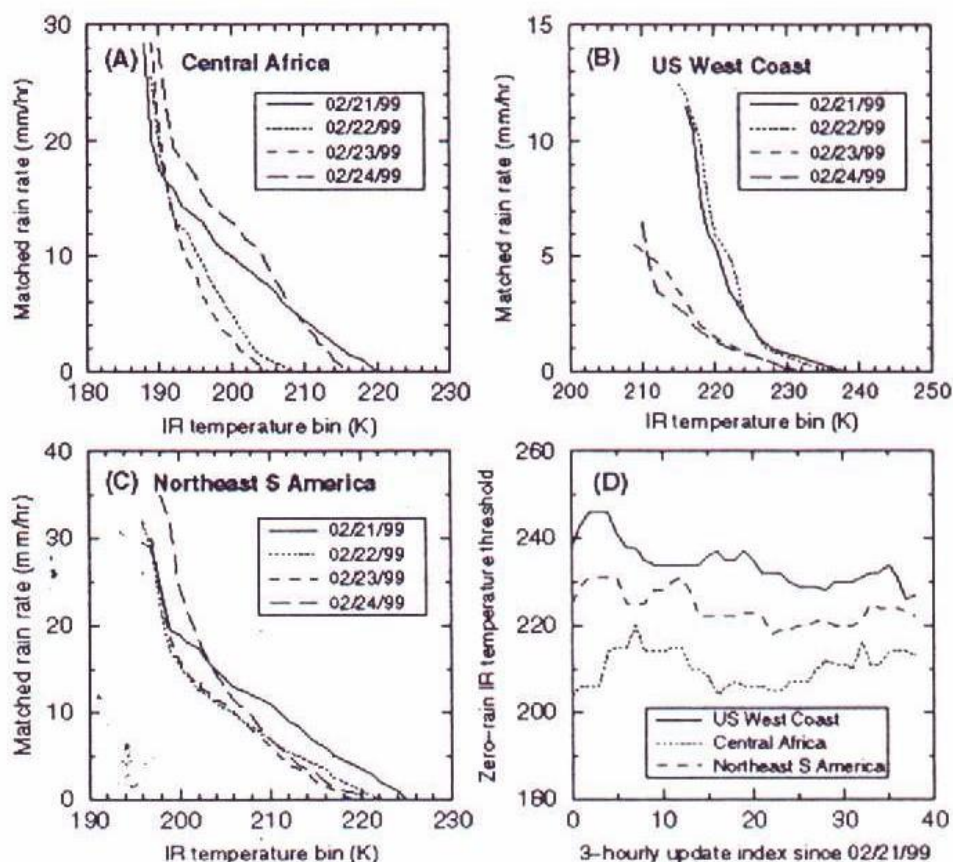
In order to set-up a meaningful statistical ensemble, the method can look at older MW-IR slot intersections (no older than 24 h), until a certain (75 %) box coverage is reached and a minimum number of coincident observations are gathered for a  $2.5^\circ \times 2.5^\circ$  region (at present 400 points, this is a tuneable parameter in the procedure). Thus RU requires an initial start-up time period ( $\sim 24$  h), to allow for establishing meaningful, initial relationships all over the study area.

As soon as a box is refreshed with new data, a probabilistic histogram matching relationship (Calheiros and Zawadzki 1987) is updated using the MW RR and IR  $T_{BB}$  probability distribution functions (PDF), and an updated lookup table (histogram file) is created. The matching is performed as follows:

$$\int_{R_T}^{R_i} p(R) dR = \int_{T_{BB(T)}}^{T_{BB(I)}} p(T_{BB}) dT_{BB},$$

where  $p(R)$  and  $p(T_{BB})$  are the PDF of RR and  $T_{BB}$  respectively, and  $R_T$  and  $T_{BB(T)}$  are the threshold values.

Examples of  $T_{BB}$  vs RR relationships (histogram) are presented in Fig. 4.



**Figure 4: Rain rate vs brightness temperature average relationships for the days and geographical areas marked. (D) presents the zero-rain thresholds as a function of time.**

The global histograms update process is constantly on-going along with the operational input of MW and geostationary datasets. The transfer of this “background” information to the stream of steadily arriving GEO data involves a computationally fast lookup table and interpolation process for each pixel in the geostationary datasets. For each SEVIRI pixel the RR is finally computed by interpolating the proper  $T_{BB}$  vs RR histogram, firstly smoothed using the relationships of the surrounding boxes in order to ensure a smooth transition in RR across box boundaries.

If any histogram is more than 24-hours old relative to the IR dataset time, that histogram is not used. In this case a conventional rain rate value = -1 is assigned to each pixel. However, in ordinary operations, the case is only theoretical since, considering the suite of MW data in input to the algorithm, a histogram more recent than 24 hours is nearly always available. In case of a prolonged interruption of the input data stream (either MW or IR data) the blended product cannot be produced and delivered. Moreover, it will require a start-up period of several hours to restart properly.

### 3.2 Processing steps overview

This section introduces the main processing steps, which are implemented in the P-IN-GRU-SEVIRI processor.

The package can be subdivided into four main parts, namely:

1) pre-processing: preparation and pre-processing of GEO data; preparation and pre-processing of PMW data; computation of rain rate maps at the LEO space-time resolution.

- 2) co-location: co-located GEO and LEO observations are collected for the selected study area and accumulated from oldest to newest;
- 3) set-up of geo-located statistical relationships applying the probability matching technique;
- 4) assign rain rate to each GEO pixel: production of rain-rate maps at the GEO space-time resolution.

The diagram in Fig. 5 describes the main functions of the general structure of the RU software package. The names of the executable programs and/or C shells that drive the data processing are emphasised in red.

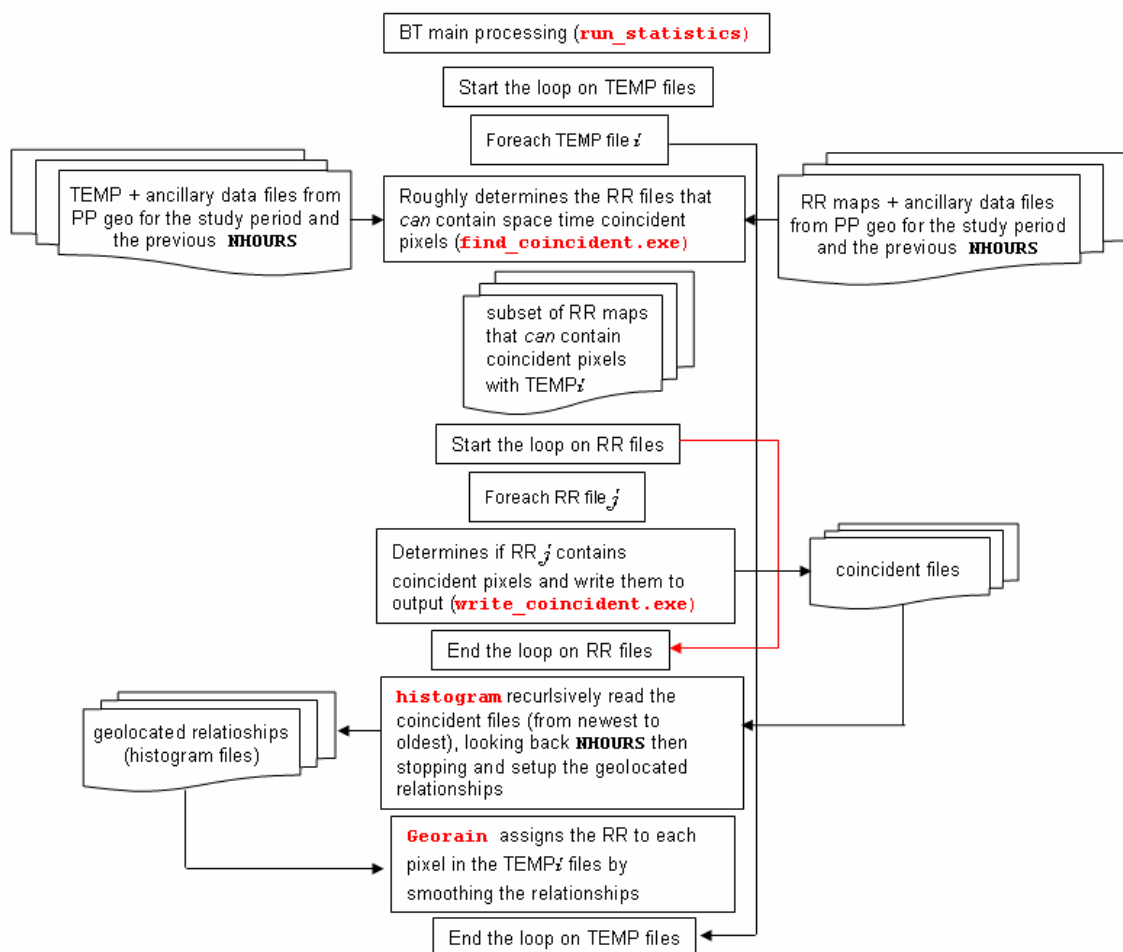



Figure 5: Main processing steps of the RU software package.

### 3.3 Additional developments

In the course of the H-SAF Development Phase, the RU algorithm was further developed in COMET at instances. Several implementations in the source code occurred, in particular:

- pre-screening of the IR data using the “Cloud Type” from NWC-SAF was added, that gives the possibility to clean the meteorological scene from cirrus, broken clouds and semitransparent clouds in general;
- parallel operational chain with a delay of 3 hours is implemented in order to include the polar MW inputs and to respect the expected timeliness.



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During the H-SAF Continuous Development Phase-2 (CDOP-2) a quality flag was conceived and associated to the precipitation output of the RU software package with the aim of providing the end-users with a simple and immediate criterion for the evaluation of the P-IN-GRU-SEVIRI product. Two aspects were taken into account for the generation of the quality flag:

1) **Quality of the input PMW precipitation products**

The P-IN-GRU-SEVIRI product is based on the availability of PMW precipitation estimates used for the calibration of IR brightness. Thus its quality is linked to the quality of the PMW rainfall estimation input to the algorithms. The P-IN-OBA-SSMIS new release and P-IN-ONN\_AMSU quality flags are ingested in terms of percentage values by the RU algorithm and propagated through the code up to the assignment of a quality flag to each  $T_{BB}$  vs RR relationship ( $QF_{mw}$ )

2) **Monitoring the PMW precipitation flux timeliness**

It is fundamental to monitor the flux of the PMW precipitation products used as inputs, by considering the time difference between the last PMW sensor overpass and the currently processing MSG slot ( $diff_{time}$ ). This time tells the user how old the calibrations  $T_{BB}$  vs RR are and thus how adequate they are to be used for the rain rate assignment. An index ( $QF_{time}$ ) was modeled to represent the downgrade of the product quality:

$$QF_{time} = \exp\left(-\frac{diff_{time}}{time\_limit}\right) \text{ with } time\_limit = 5h$$

The total quality flag ( $QF_{total}$ ), which summarizes the two aspects previously described, was generated as follows:

$$QF_{total} = \begin{cases} 0.5 * (QF_{time} + QF_{mw}) & \text{if } diff_{time} \leq 5h \\ 2/3 * QF_{time} + 1/3 * QF_{mw} & \text{if } diff_{time} \in ]5, 10]h \\ QF_{time} & \text{if } diff_{time} > 10h \end{cases}$$

## 4 Validation activities of P-IN-GRU-SEVIRI product

The validation methodology of the precipitation products in H-SAF area (European region) is composed by two components: one based on large statistics (multi-categorical and continuous), and one on selected case studies. Both components are considered complementary in assessing the accuracy of the implemented algorithms. Large statistics helps in identifying existence of pathological behaviour, selected case studies are useful in identifying the roots of such behaviour, when present.

During the CDOP-3 the availability of the satellite precipitation products over the full disk poses the problem of their validation outside Europe. In Africa there are few precipitation data derived by ground networks: the operational raingauges stations are sparse and the radar networks are often not fully operational or not available at all. For all these reasons the large statistic quality assessment in African region will be mainly focused on the comparison of H-SAF precipitation products with other satellite products as the Global Precipitation Mission (GPM) products derived by Dual-frequency (Ka-band and Ku-band) Precipitation Radar (DPR). While the cases study analysis will be performed using the DPR based products coupled with ground based precipitation measurements as the ones (rain gauge and radar) provided by the “Institut de Recherche pour le Développement” (IRD) in West Africa.

Which GPM product would be used, if one-band or dual-band together with the introduction of different analysis techniques, as triple collocation method, is still under discussion within the validation group.

The results of a validation study of RU during a three month summer interval indicative of summer monsoon conditions have been presented (Turk et al. 2009). The validation was based on the Automated Weather Station network operated by the Korean Meteorological Administration over the South Korean peninsula. The motivation for this effort was the belief that an analysis of the performance of the RU should be initiated with a validation system whose overall time sampling can resolve the precipitation scale and intensity over short accumulation windows (hours), and be appropriately centred about the observation time of instantaneous satellite overpasses. The space-time root mean square error, mean bias, and correlation matrices were computed using various time windows for the gauge averaging, centred about the satellite observation time. For  $\pm 10$  minute time window, a correlation of 0.6 was achieved at 0.1-degree spatial scale by averaging over 3 days; coarsening the spatial scale to 1.8 degrees produced the same correlation by averaging over one hour. Finer than approximately 24-hours and 1-degree time and space scales, respectively, a rapid decay of the error statistics were obtained by trading off either spatial or time resolution. Beyond a daily time scale, the blended estimates were nearly unbiased and with an RMS error of no worse than 1 mm/day.

The RU algorithm in its official implementation at the Naval Research Laboratory (NRLblend), is subject to a continuous effort of validation and intercomparison in different validation sites all over the world within the International Precipitation Working Group (IPWG) activities, in particular Fig.6 presents an examples of validation outputs over Japan and USA. The description of the operational set-up of the RU being validated and up-to-date results of the validation activity are available at the IPWG web site at <http://www.isac.cnr.it/~ipwg>.

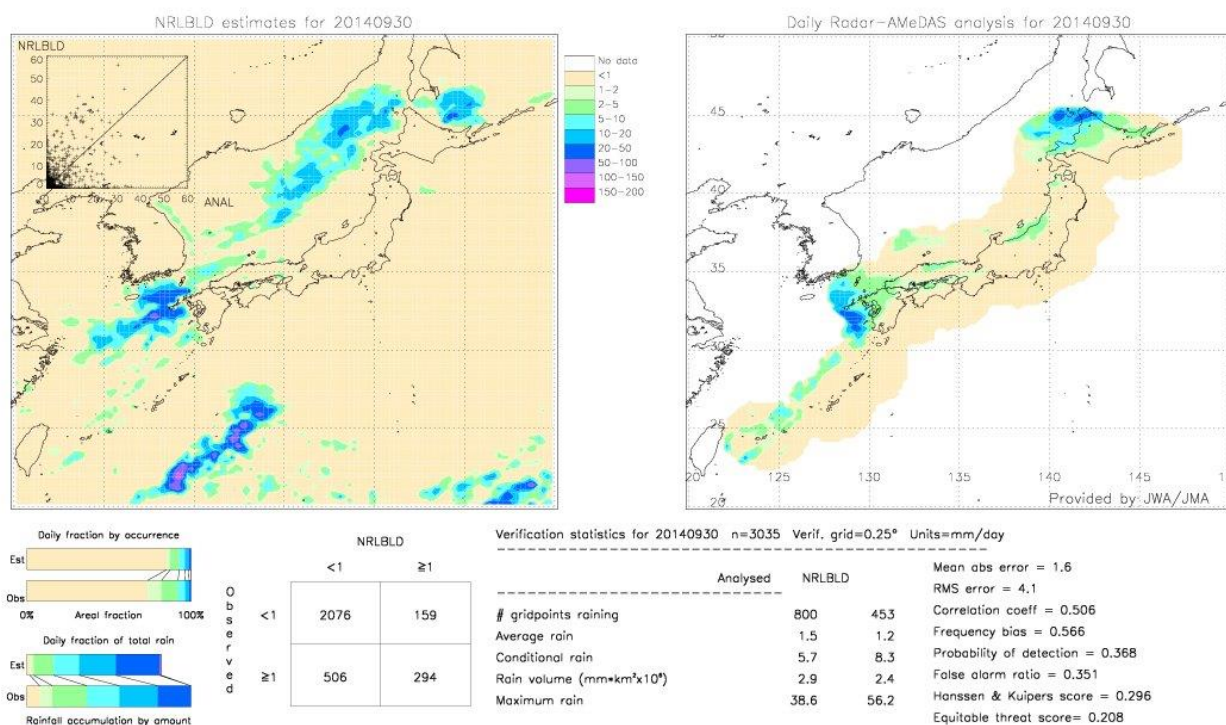



Figure 6. Example of IPWG validation results over Japan, 30 September 2014.

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## 5 Examples of P-IN-GRU-SEVIRI product

At the time of this writing, P-IN-GRU-SEVIRI is not yet generated on a regular basis. A prototype example is provided in Fig. 7.; the spatial coverage of the product is 60°S – 67.5°N, 60°W – 60°E.

## EUMETSAT H-SAF PR-OBS-3

Instantaneous Rain Rate retrieved from IR-MW blending data

Blending of: SEVIRI IR + SSM/I-SSMIS MW + AMSU MW: 20170527 1530

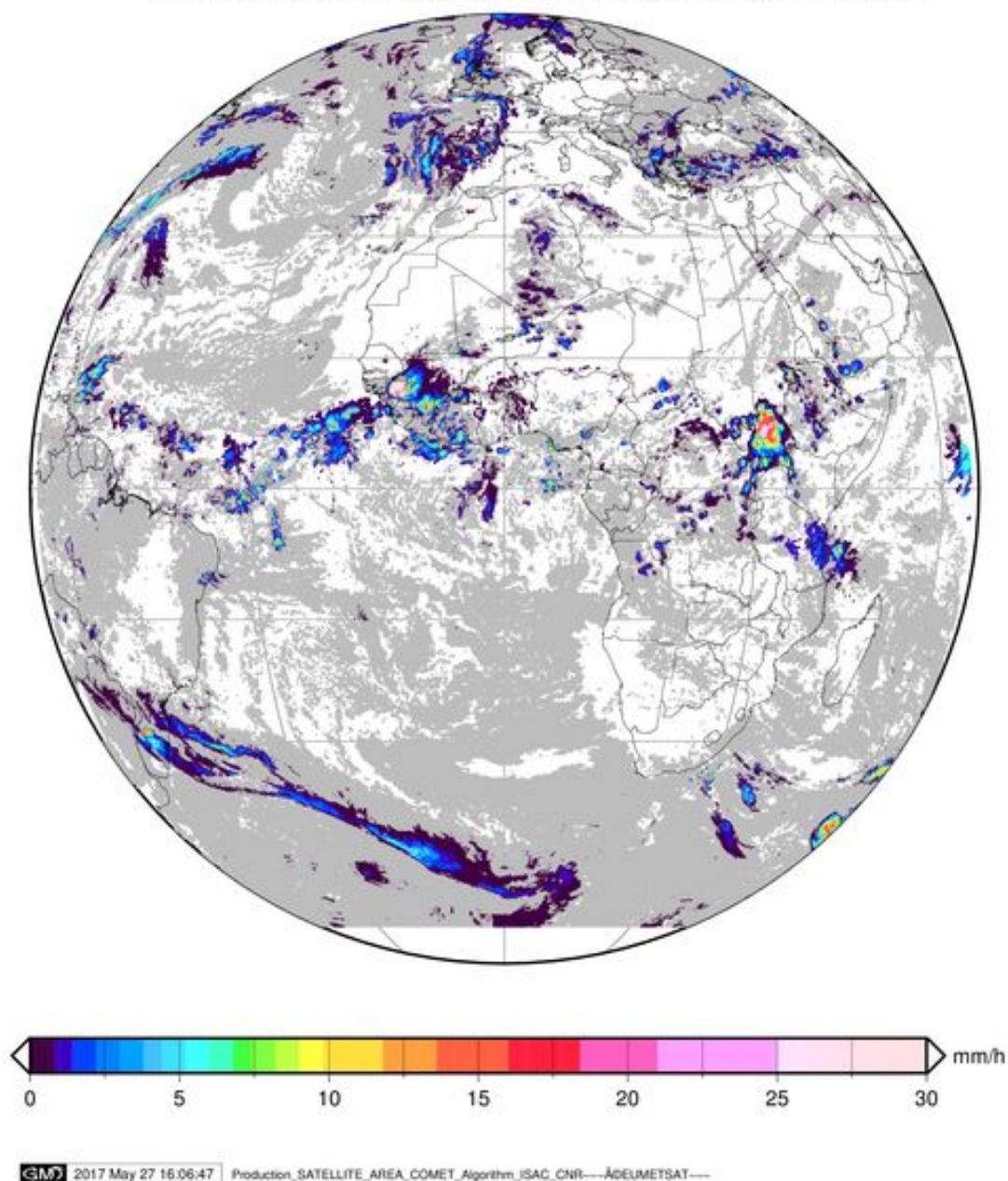



Figure 7: 2017-05-27 15:30 UTC: Example of product H03B – P-IN-GRU-SEVIRI. Grey colour means ZERO RAIN, white colour means NOT PROCESSED.



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## 6 Applicable documents

- 1- CDOP2 PRD – H-SAF CDOP2 Product Requirement Document Rel. 1.2,  
Ref: SAF/HSAF/CDOP2/PRD/1.2

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## 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 8):

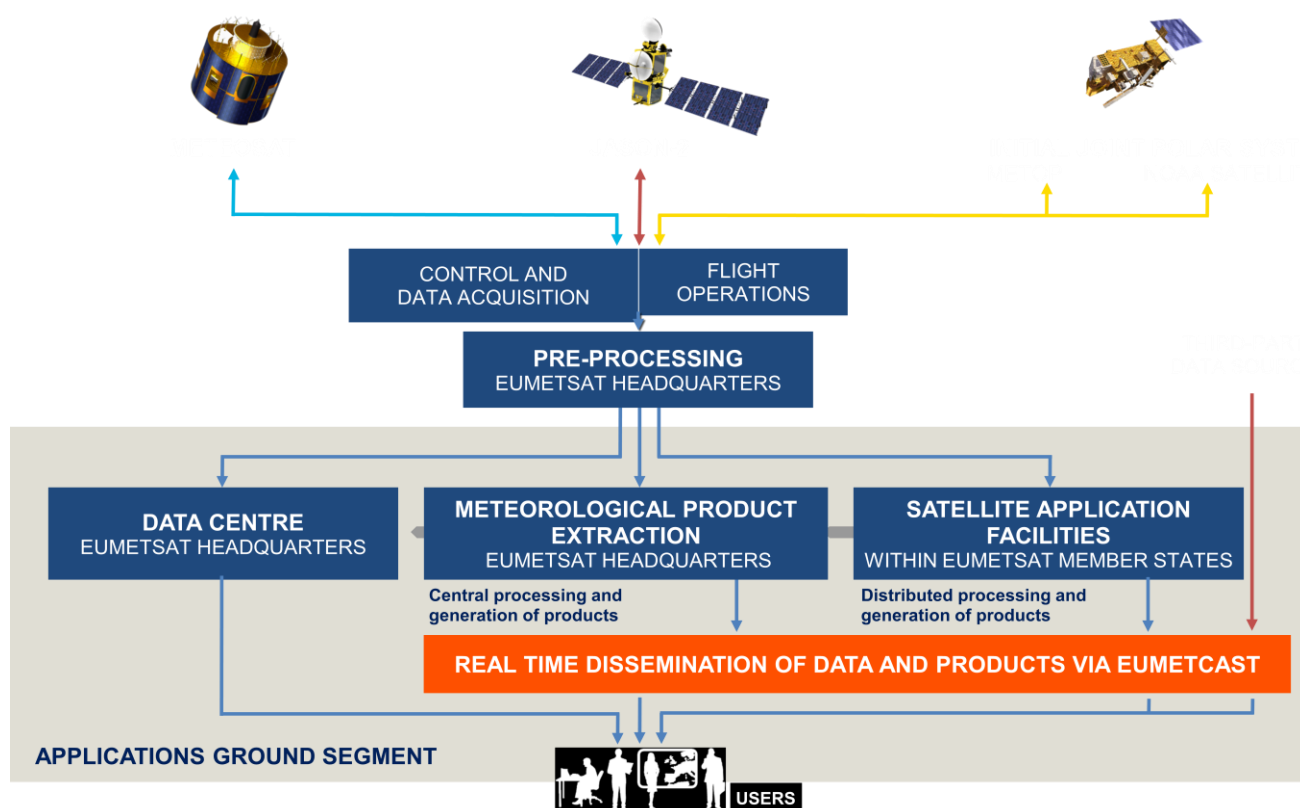


Figure 8: Conceptual scheme of the EUMETSAT Application Ground Segment

Figure 9 depicts the composition of the EUMETSAT SAF network, with the indication of each SAF's specific theme and Leading Entity.

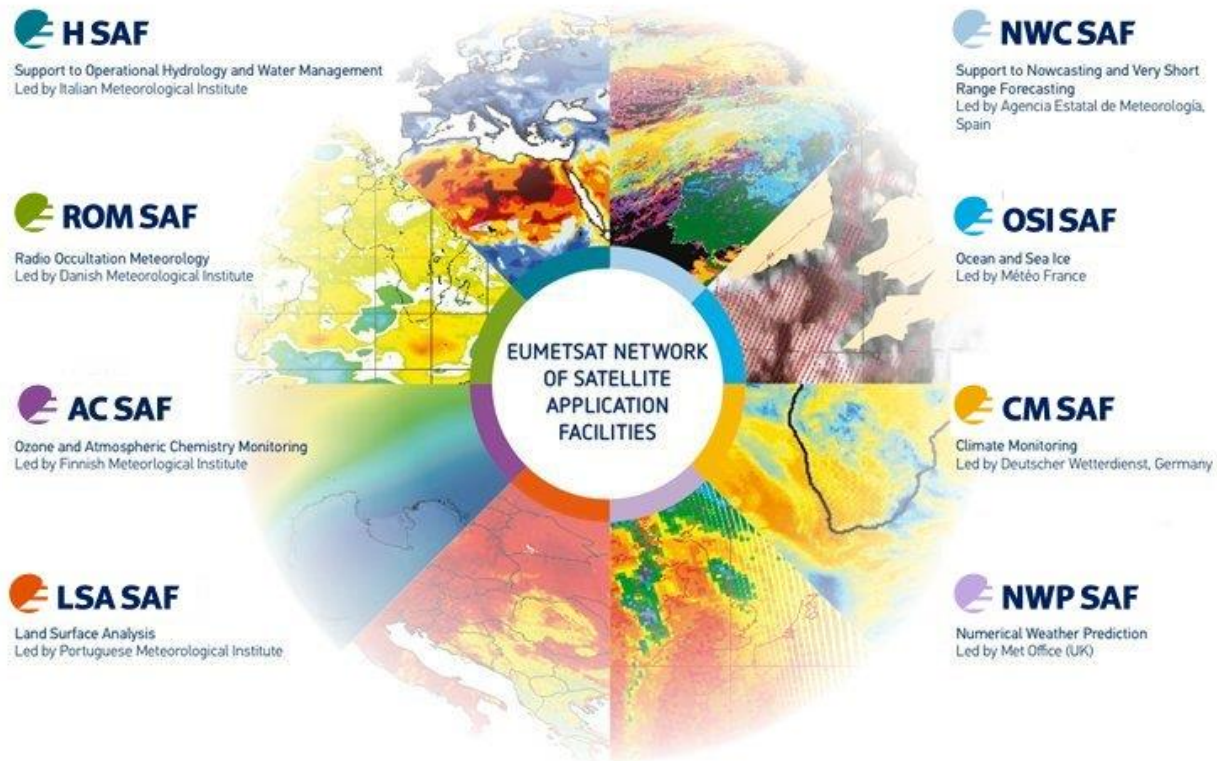



Figure 9: Current composition of the EUMETSAT SAF Network

### ***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.

	<p>Algorithm Theoretical Baseline Document ATBD-3B (Product H03B – P-IN-GRU-SEVIRI)</p>	<p>Doc.No: SAF/HSAF/ATBD-3B Rel. 1.2 Date: 08/09/2017 Page: 16/18</p>
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## ***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](http://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](http://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](http://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 Biosphère (of CNRS, in France)
CM-SAF	SAF on Climate Monitoring
COMET	Centro Operativo per la Meteorologia (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), now Department of Geodesy and Geoinformation
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
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
NESDIS	National Environmental Satellite, Data and Information Services
NMA	National Meteorological Administration (of Romania)
NOAA	National Oceanic and Atmospheric Administration (Agency and satellite)
NRT	Near real-time
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
PPF	Product Processing Facility
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 <sub>BB</sub>	Equivalent Blackbody Temperature (used for IR)
TKK	Teknillinen korkeakoulu (Helsinki University of Technology)
TMI	TRMM Microwave Imager (on TRMM)
TRMM	Tropical Rainfall Measuring Mission
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)