THE PRECIPITATION PRODUCT VALIDATION SERVICE DEFINED DURING THE DEVELOPMENT PHASE OF THE HYDROLOGICAL SAF

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Abstract

The development phase (2005- 2010) of the Hydrological Satellite Application Facilities (H-SAF) was closed the 31st of August of this year. Several precipitation products with different time and spatial resolution have been developed into the H-SAF project during that period. The precipitation retrieval methods developed use geostationary and polar satellite data with different instruments as AMSU-MHS, SSM/I-SSMIS and SEVIRI. During the development phase a Precipitation Product Validation (PPV) Service has been realized in order to give support to end-users and precipitation product developers. The H-SAF PPV group is composed by experts from the National Meteorological and Hydrological Institutes of Belgium, Germany, Hungary, Italy, Poland, Slovakia and Turkey. Hydrologists, meteorologists and radar and rain gauge experts are involved in this activity. The validation activity consists of a COMMON METHODOLOGY and CASE STUDIES ANALYSIS. The common validation methodology is based on comparison of satellite product with rain gauges and radar data. The error is calculated on multi categorical and continuous statistics evaluated on daily and seasonal bases. Coast/ sea/ land classification is considered in the validation exercises. The precipitation classes of the multi categorical statistics were defined following the hydrologist experiences. Each Institute in addition to the common validation methodology has developed a specific validation methodology for case studies only, based on its own knowledge and experience. The Institutes have decided whether to introduce use of lightning data, numerical weather prediction and nowcasting products for the analysis of specific case studies.
The results obtained were discussed inside the validation group and with product developers by email and annual meeting, reported in the project documents and published in the H-SAF web page section dedicated to the validation.

Precipitation Product Validation Group

Precipitation products validation group
Leader: Italy (DPC)

Belgium IRM | Germany BfG | Hungary OMSZ | Italy UniFe | Poland IMWM | Slovakia SHMÚ | Turkey ITU

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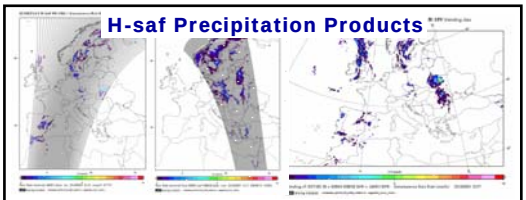
H-saf Precipitation Products



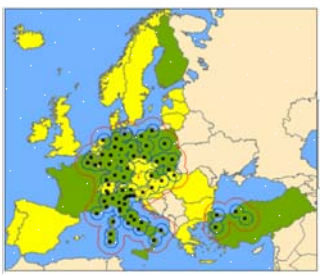
Code	Acronym	Product name	Responsible of algorithm
H-01	PR-OBS-1	Precipitation rate at ground by MW conical scanners (with indication of phase)	Italy, CNR-ISAC
H-02	PR-OBS-2	Precipitation rate at ground by MW cross-track scanners (with indication of phase)	Italy, CNR-ISAC
H-03	PR-OBS-3	Precipitation rate at ground by GEO/IR supported by LEO/MW	Italy, CNR-ISAC
H-04	PR-OBS-4	Precipitation rate at ground by LEO/MW supported by GEO/IR (with flag for phase)	Italy, CNR-ISAC
H-05	PR-OBS-5	Accumulated precipitation at ground by MW+IR and MW only	Italy, CNMCA
H-06	PR-ASS-1	Instantaneous and accumulated precipitation at ground computed by a NWP model	Italy, CNMCA

Common Validation activity

Ground data: radar and rain gauge networks

PPV Rain gauge network is composed by **4100** telemetric stations:

Data Sources	raingauges
Instrument characteristics	Telemetric
time domain	Near real time
time resolution	5,10, 15, 30 min
spatial distribution	whole national territory
number of station	~4100



PPV Radar network: 42 C-band and 1 Ka-band:

Data Sources	radars
Instrument characteristics	C-band, Ka band,
time domain	near real time
time resolution	5, 15, 30, 1h, 24h
spatial distribution	Whole national territory
number of station	42 C band +1 Ka band
operational/ for research only	Operational
data quality check	Permanent ground clutter monitoring of electronic calibration

Methodology

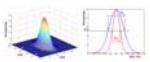
To produce a large statistical analysis of the H-SAF Precipitation Products was necessary to define a '**common validation methodology'.** This is based on:

- the **'ground truth'** is represented by **radar** and **rain gauge data**;
- the **precipitation products** are **evaluated on the satellite native grid**;
- pixel by pixel comparison;
- **multi category** and **continuous statistics** are **monthly evaluated**;

In order to **make comparable the results obtained by several institutes** and to better understand their meanings it was necessary:

- **introduction of quality filter**;
- **standardization of the up-scaling techniques** of ground data vs satellite native grid

The radar and rain gauge data were up-scaled taking into account the satellite scanning geometry and IFOV resolution of AMSU-B scan, SSMI and SEVIRI.



- **development and sharing of software packages**: Two codes were developed by the validation group for upscaling ground data vs AMSU-B and SSMI IFOV.

All institutes involved in PP validation activity use these two codes developed in collaboration by University of Ferrara and RMI with PP developers.

BELGIUM -RMI | GERMANY -BFG | HUNGARY -HMS | ITALY -Uni. Fe | POLAND -IMWM | SLOVAKIA SHMU | TURKEY -ITU, TSMS

comparison national radar and rain gauge data with precipitation products on satellite native grid

Evaluation of the monthly continuous statistical scores (CS) and contingency tables (CT) for precipitation classes; Evaluation of Probability Density Function (PDF)

CS and CT numerical files
PDF numerical files

ITALY -DPC: The PP validation leader collects all the validation files (CS, CT and PDF files), verifies the consistency of the results and evaluates the monthly common statistical results

Precipitation classes:

CLASS	RAIN RATE (RR) PRODUCTS
Class 1	RR <0.5 mm/h
Class 2	0.5 mm/h < RR < 5 mm/h
Class 3	5 mm/h < RR < 10 mm/h
Class 4	10 mm/h < RR

CLASS	CUMULATED RAIN (CR) PRODUCTS
Class 1	CR < 1 mm
Class 2	1 mm< CR < 20 mm
Class 3	20 mm< CR < 50 mm
Class 4	50 mm < CR < 100 mm
Class 5	100 mm< CR < 150 mm
Class 6	150 mm < CR

The statistical scores monthly, seasonal and yearly evaluated for LAND and COAST area:

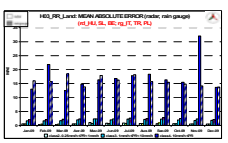
BELGIUM -RMI | GERMANY -BFG | HUNGARY -HMS | ITALY -Uni. Fe | POLAND -IMWM | SLOVAKIA SHMU | TURKEY -ITU, TSMS | ITALY: DPC TOTAL

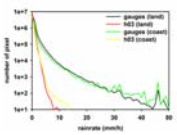
MC statistic:
- ACCURACY
- POD
- FAR
- BIAS
- ETS
- OR
- HSS

CS statistic:
- Number of points
- observed Mean rain (rate or cumulated)
- Satellite Mean rain (rate or cumulated)
- Observed Maximum rain (rate or cumulated)
- Satellite Maximum rain (rate or cumulated)
- Mean error
- Multiplicative bias
- Mean absolute error
- Root mean square error
- correlation coefficient
- Standard deviation

MONTHLY STATISTICAL SCORES	INSTITUTES	FOR LAND year 2009	FOR LAND year 2010	FOR COAST year 2009	FOR COAST year 2010
RADAR	BELGIUM	tab	tab	tab	tab
	BULGARIA	tab	tab	tab	tab
	GERMANY	tab	tab	tab	tab
	HUNGARY	tab	tab	tab	tab
	ITALY	tab	tab	tab	tab
	POLAND	tab	tab	tab	tab
	SLOVAKIA	tab	tab	tab	tab
	TURKEY-ITU	tab	tab	tab	tab
	TURKEY-METU	tab	tab	tab	tab
		tab	tab	tab	tab
	TOTAL	PLOT	PLOT	PLOT	PLOT
RAIN GAUGE	BELGIUM	tab	tab	tab	tab
	BULGARIA	tab	tab	tab	tab
	GERMANY	tab	tab	tab	tab
	HUNGARY	tab	tab	tab	tab
	ITALY	tab	tab	tab	tab
	POLAND	tab	tab	tab	tab
	SLOVAKIA	tab	tab	tab	tab
	TURKEY-ITU	tab	tab	tab	tab
	TURKEY-METU	tab	tab	tab	tab
		tab	tab	tab	tab
	TOTAL	PLOT	PLOT	PLOT	PLOT

Some plots:





Case studies analysis

Each Institute, in addition to the common validation methodology, developed a more **specific Validation Methodology** based on the knowledge and experience of the Institute itself. This activity is focused on case studies analysis. Each institute decides whether to use ancillary data such as lightning data, SEVIRI images, the output of numerical weather prediction and nowcasting products.

The main steps are:
- description of the meteorological event;
- comparison of ground data and satellite products;
- visualization of ancillary data deduced by nowcasting products or lightning network;
- discussion of the satellite product performances;
- Indications to Developers;

Some examples are here reported.

PRODUCT NAME: **PR-OBS-03v1.2**

CASE STUDY PERIOD: 20 April 2009 15:25 UTC and 16:25 UTC

METEOROLOGICAL EVENT:- sometimes heavy rainfall from the wet air moving into the Carpathian Basin from the South

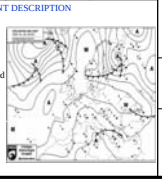
VALIDATION INSTITUTE: OMSZ-Hungarian Meteorological Service — Responsible: Eszter Lábó — Contact point: labo.e@met.hu

PRODUCT DEVELOPER INSTITUTE:CNR- ISAC — Developers: Laviola S., Cattani E. — Contact point: s.laviola@isac.cnr.it

OPERATIONAL CHAIN INSTITUTE:CNMCA — Responsables: Zauli F, Melfi D. — Contact point: zauli@meteoam.it

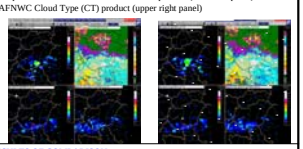
METEOROLOGICAL EVENT DESCRIPTION

High-pressured area prevails from Great Britain to the Black Sea, almost no clouds there. But the weather in the Carpathian Basin is influenced by wet airmass coming from The Mediterranean.



DATA/PRODUCTS USED

Precipitation rate information from the Hungarian radar network at its original resolution (lower right panel) with the colouring scale of H03 data
Precipitation rate information from the H02 product (lower left panel)
SAFNWC Cloud Type (CT) product (upper right panel)



RESULTS OF COMPARISON

H03 detects well rainy spots. The intensity is overestimated in the South of Hungary, probably due to the very high-level clouds in the SAFNWC Cloud Type image. It is the same for the 15:25 UTC and 16:25 UTC image, although for 16:25 UTC the intensity is diversified.

COMMENTS

Note that the shape of the white cloud in Cloud Type image and the yellow-green rain intensity is the same, but H03 gives it more to the North! It is a general feature.

Indications to Developers

The localization of the H03 product should be revisited in order to tell why it is shifted compared to the CT product.
Rainy areas are very well recognized in this case, probably due to the scattered characteristic of the rainy spots.

PRODUCT NAME: **PR-OBS-02v2.2**

CASE STUDY PERIOD: 11 May 2009

METEOROLOGICAL EVENT: convection associated with frontal activity

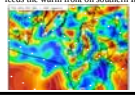
VALIDATION INSTITUTE: IMGW-Institute of Meteorology and Water Management — Responsible: B. Lapeta, R.Iwański — Contact point: bozena.lapeta@imgw.pl; rafal.iwanski@imgw.pl

PRODUCT DEVELOPER INSTITUTE: CNR- ISAC — Developers: Dietrich S., Di Paola F — Contact point: s.dietrich@isac.cnr.it; francesco.dipaola@artov.isac.cnr.it

OPERATIONAL CHAIN INSTITUTE: CNMCA — Responsible: Zauli F. — Contact point: zauli@meteoam.it

METEOROLOGICAL EVENT DESCRIPTION

In the Mediterranean area there are two similar low pressures (999 hPa). The first one is located on Corsica and it is the center of two different types of front: cold front that moves from Iberian peninsula to the central Mediterranean and a warm front along SE-NW direction.The second low system is placed over the Tunis Gulf and it feeds the warm front on southern Italy.

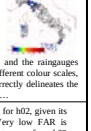


DATA/PRODUCTS USED :

Italian hourly raingauges network (provided by DPC), Ancillary data (used for case analysis): SEVIRI images (courtesy of University of Dundee – NEODAAS)Weather charts (courtesy of Wetterzentrale, NCEP andMETOFFICE)

RESULTS OF COMPARISON

This is a typical frontal structure in central Mediterranean, characterised by moderate precipitation with raingauge hourly peak of about 25 mmh-1, reduced to about 18 mmh-1 by spatial averaging over the IFOV size while h02 detects a precipitation maximum around 9 mmh-1. Statistical rain-no rain analysis show very low FAR (around 0.03), with a POD of about 0.3, the corresponding ETS is 0.17, indicating major difficulties of h02 to detect this kind of wintertime, stratified and moderate precipitation. The multi category HSS shows low values around 0.12 confirming that h02 is unable to fully catch the structure of such precipitating systems at the IFOV scale. The figures illustrate few peculiarity of h02, helping in understand the relatively low performances.



The precipitation map of the 15:42 UTC overpass (right) and the raingauges hourly cumulated precipitation at 16:00 UTC (left), with different colour scales, are shown. The precipitation patterns estimated by h02 correctly delineates the two warm front rain bands over northern Italy and Sicily. ……

COMMENTS This case study was particularly challenging for h02, given its characteristics of warm front, moderate precipitation. Very low FAR is unfortunately balanced by a rather low POD indicating that very often h02 fails even in detecting rain areas. The ability of h02 ……

Indications to Developers Further studies are needed in order to better describe these low precipitation events: it seems the detection of low rainrates is not well caught by the technique. Moreover, a closer analysis on what is happened over Sicily in this case is suggested.

Work done

- Common validation methodology has been defined: quality filter, up-scaling technique, comparison method, precipitation classes, multi-category and continuous statistical scores, file format output (numerical and plots);
- Common and Institute (Case Studies) methodologies have been applied on data set January 2008 – March 2010 for all precipitation products developed by the project;

All the validation results have been:
- discussed in the annual meeting with developers;
- reported in Project documents;
- reviewed by EUMETSAT ;
- published in H-saf web page: http://www.meteoam.it/modules.php?name=hsaf

analysis on:
- *Variability with geographical area;*
- *Variability with validation tool;*
- *Variability with season;*
- *Variability with precipitation type (or intensity);*
- *Overall observation on compliance with User requirements;*

The common validation methodology adopted has allowed to obtain consistent performances across the various institutes especially for heavy (> 10 mm/h) and medium precipitation (1-10 mm/h).

Some considerations

The "ground truth" does not exits. This work is based on the "hydrologist truth" (end users) constituted mainly by rain gauge and then by radar data. The aim of the work has been to compare the satellite derived precipitation products with both rain gauge and radar data for different geographical areas, seasons, and precipitation intensities. Therefore probably the errors evaluated are the largest errors which can be associated to these satellite precipitation products.

Future work

- 6 H-saf + 4 NWC-saf precipitation products will be validated;
- The activities of Validation service will be:
  - ✓OFF-LINE for accuracy evaluation:
    - -Common validation;
    - -Case studies;
    - -…
  - ✓NRT for QUALITY INDEX evaluation;
- •Web Page publication of NRT QI and OFF-LINE results.