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EUMETSAT

H-SAF precipitation products: general overview and areas of potential collaboration with GPM

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ISAC/CNR, Italy

and the H-SAF Precipitation Product team

H-SAF : Satellite Application Facility on Support to Operational Hydrology and Water Management

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EUMETSAT SAF Historical overview 1997-2012

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Composition of the H-SAF Consortium

Country	Units in the Country (responsible unit in bold)	Role in the Project
Austria	- **Zentral Anstalt für Meteorologie und Geodynamik** - Technische Univ. Wien, Inst. Photogrammetrie & Fernerkundung	**Leader for soil moisture**
Belgium	- **Institut Royal Météorologique**	
Bulgaria	- **National Institute of Meteorology and Hydrology**	
ECMWF	- **European Centre for Medium-range Weather Forecasts**	Contributor for "core" soil moisture
Finland	- **Finnish Meteorological Institute** - Helsinki Technical University, Laboratory of Space Technology - Finnish Environment Institute	**Leader for snow parameters**
France	- **Météo-France** - CNRS Centre d'Etudes Spatiales de la BIOsphere - CNRS Centre d'études des Environnem. Terrestres et Planétaires	
Germany	- **Bundesanstalt für Gewässerkunde**	
Hungary	- **Hungarian Meteorological Service**	
Italy	- **Italian Meteorological Service** - Department for Civil Protection - CNR Institute of Atmospheric Sciences and Climate - Ferrara University, Department of Physics - CIMA Research Foundation - University of Rome "La Sapienza", Dept. of Electrical Engineering	**Host + Leader for precipitation**
Poland	- **Institute of Meteorology and Water Management**	**Leader for Hydrology**
Slovakia	- **Slovenský Hydrometeorologický Ústav**	
Turkey	- **Turkish State Meteorological Service** - Middle East Technical University, Civil Engineering Department - Istanbul Technical University, Meteorological Department - Anadolu University	Contributor for "core" snow parameters

H-SAF Precipitation Product Program

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H-SAF Development Phase (2005-2010) completed on August 31, 2010.

Continuous Development and Operation Phase (CDOP) (2010-2017):

- proposed in March 2010:
- The first part (CDOP-1) (2010-2012) ended in March 2012.

  Main goal: improving algorithms and processing scheme for H-SAF area (25°N to 75°N lat - 25°W to 45°E lon) ;
- The second part (CDOP-2) March 2012 – February 2017.

  Main goal: extend algorithms and validation to *Full Disk* area and to new satellites – in particular to *GPM* and MTG.

All precipitation products are generated routinely at the
CNMCA, Italian Meteorological Service, Italy
CNMCA also manages the Data service for all H-SAF products
http://hsaf.meteoam.it

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H-SAF Precipitation Products:

Developing team

ISAC/CNR

V. Levizzani, S. Dietrich

Leaders of ISAC/CNR Precipitation Product Developing Team

D. Casella, E. Cattani, S. Laviola, G. Panegrossi, M. Petracca, P. Sanò, and A. Mugnai

Passive Microwave Precipitation Products

Combined IR-MW products – Cloud classification - Snowfall

ITAF MET Service

D. Biron, L. De Leonibus, D. Melfi, A. Vocino, F. Zauli

Convective Precipitation – MTG LI

ISAC

AERONAUTICA MILITARE SERVIZIO METEOROLOGICO 1923

CNMCA

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Current Precipitation Products

Identifier	Product Description	Algorithm	Resp. Inst.	Status
H01 PR-OBS-1	Precipitation rate at ground by MW conical scanners	Bayesian CDRD	ISAC-CNR Rome	Operational
H02 PR-OBS-2	Precipitation rate at ground by MW cross-track scanners	Neural Network	ISAC-CNR Rome	Operational
H03 PR-OBS-3	Precipitation rate at ground by GEO/IR supported by LEO/MW	Blending	ISAC-CNR Bologna	Pre-operational
H04 PR-OBS-4	Precipitation rate at ground by LEO/MW supported by GEO/IR	Morphing	ISAC-CNR Bologna	Pre-operational
H05 PR-OBS-5	Accumulated precipitation at ground by blended MW and IR	Time integration	CNMCA	Pre-operational
H06 PR-OBS-6	Blended SEVIRI Convection area / LEO MW precipitation -	Blending + NEFODINA	CNMCA	In development

All precipitation products are generated routinely at the CNMCA, Italy [Note: CNMCA also manages the Data service for all H-SAF products].

Development of PR-OBS-1 (operational)

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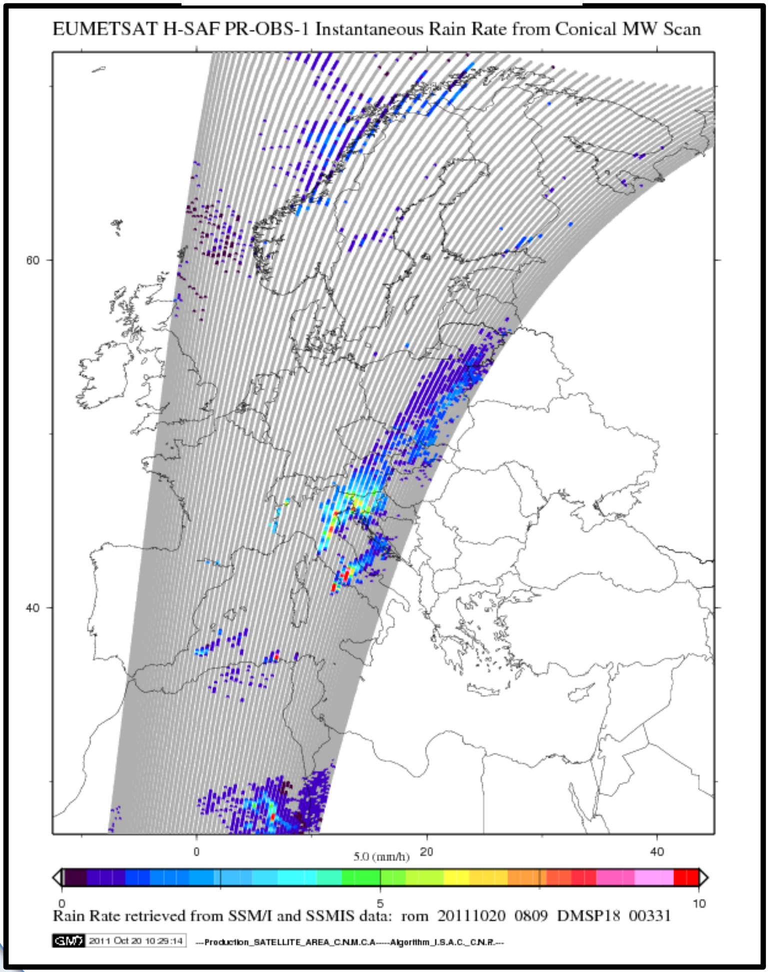
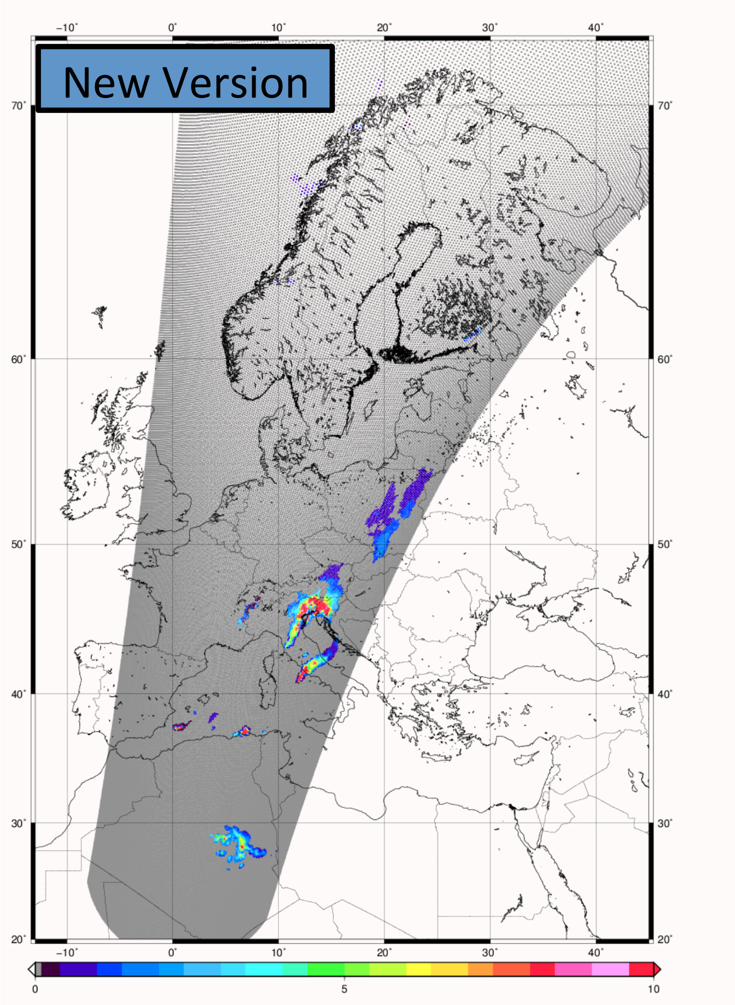
Precipitation rate at ground from MW conical scanners (SSMIS)

(Sanò et al., 2013, Casella et al., 2013, IEEE , Mugnai et al., 2013 , NHESS)

30 km horiz. resol.



12.5 km horiz. Resol.



Rome, Italy Flash Flood 20 Oct 2011

8:09 UTC
SSMIS F18

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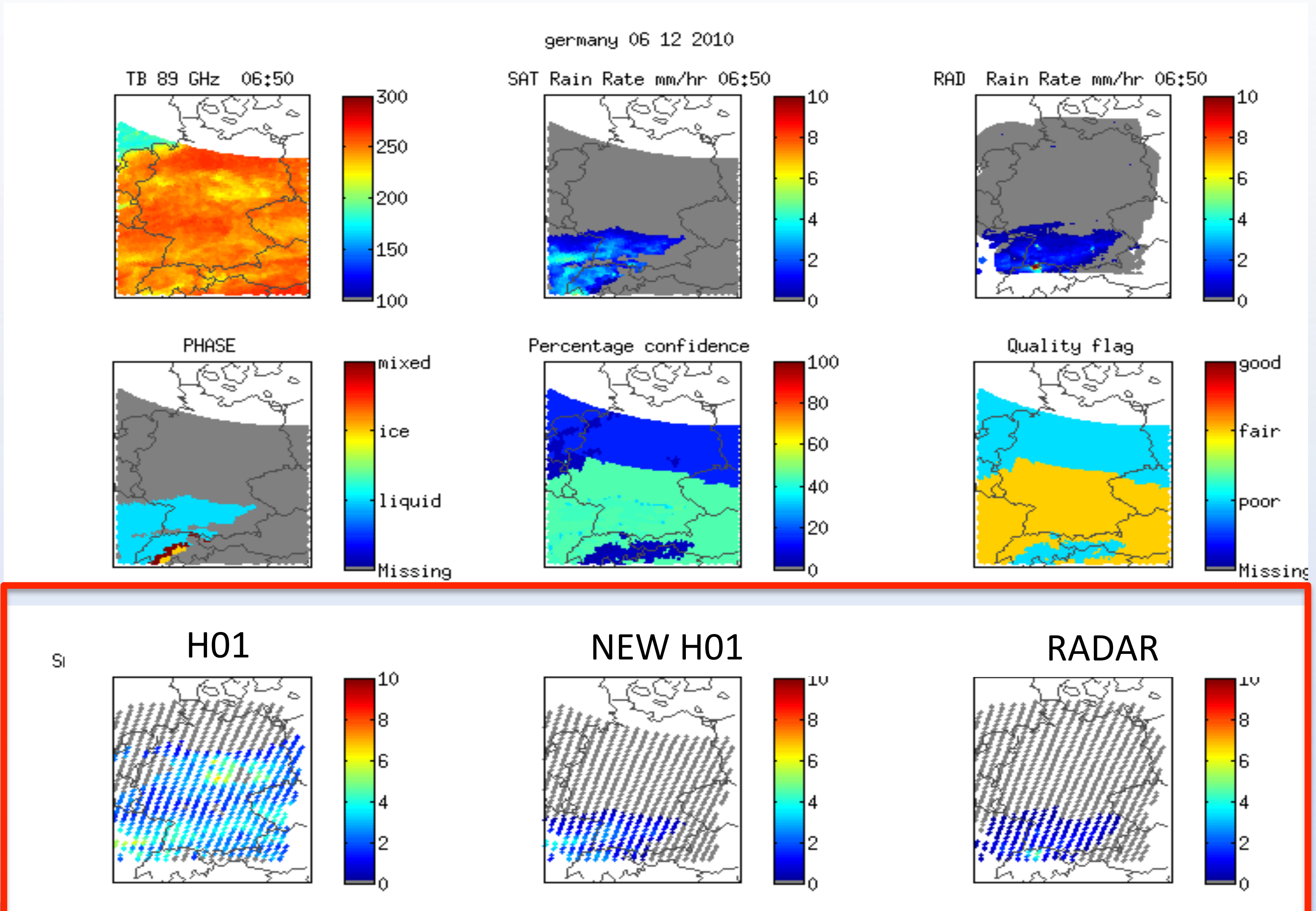
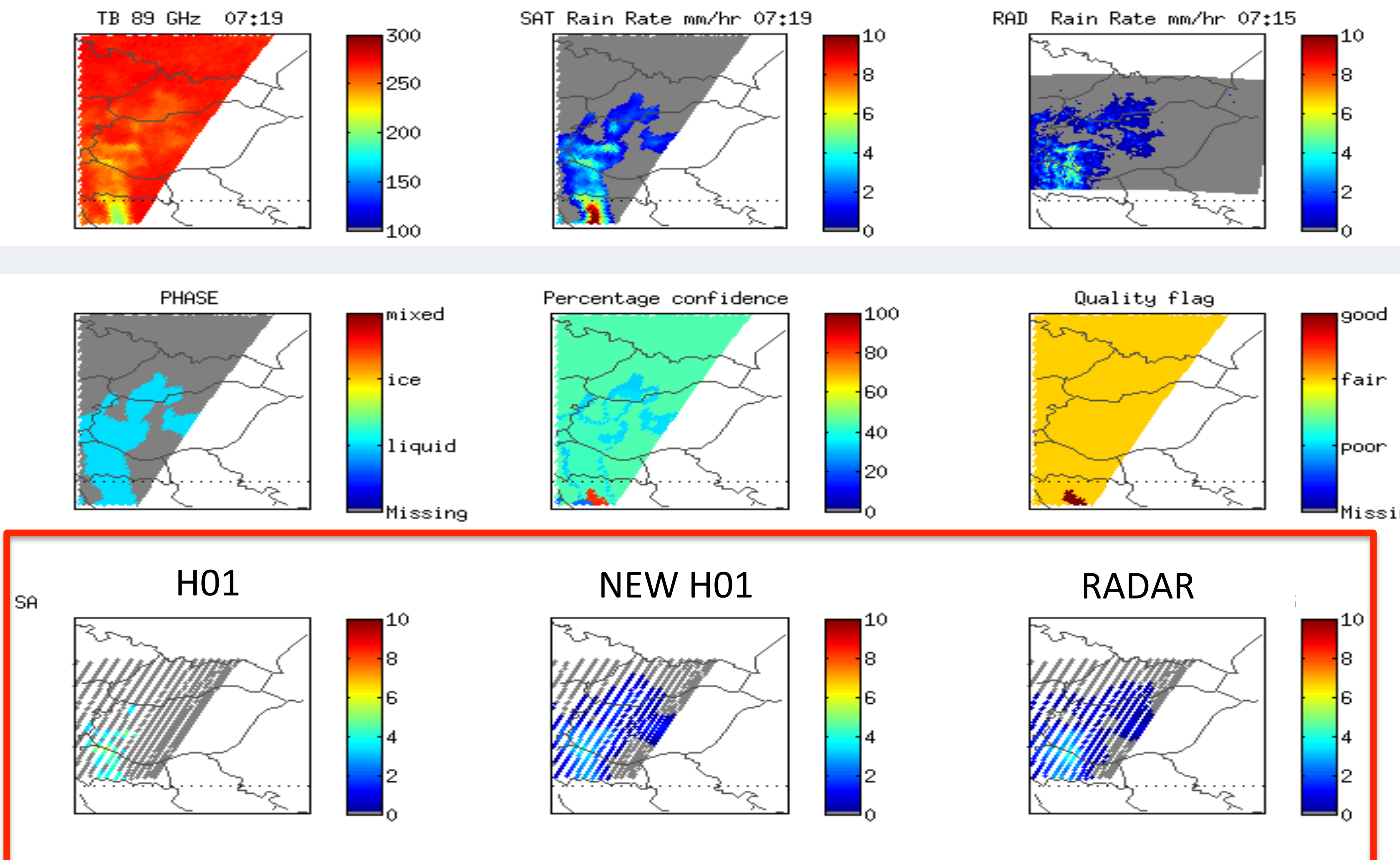
H01: improvement of screening and snow detection

GERMANY 6 December 2010 – Winter frontal precipitation



H01: improvement of detection and retrieval of light rain

HUNGARY 1 December 2009 – Frontal precipitation/light rain



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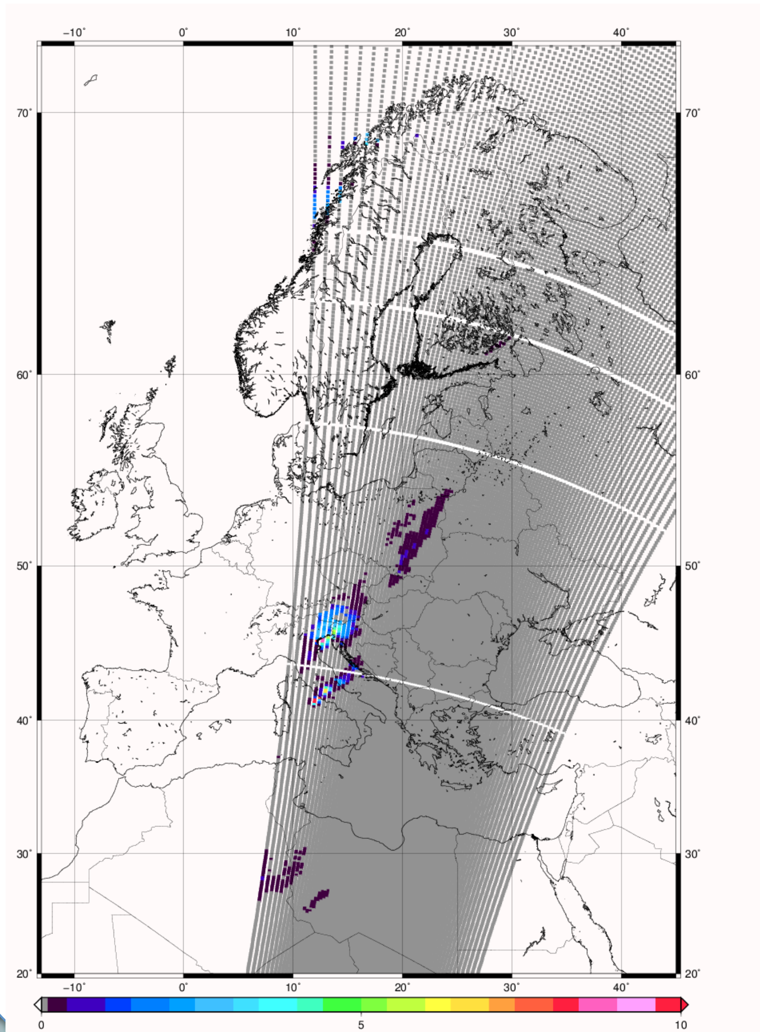
Development of PR-OBS-2 (operational)

Precipitation rate at ground by MW cross-track scanners (AMSU/MHS)

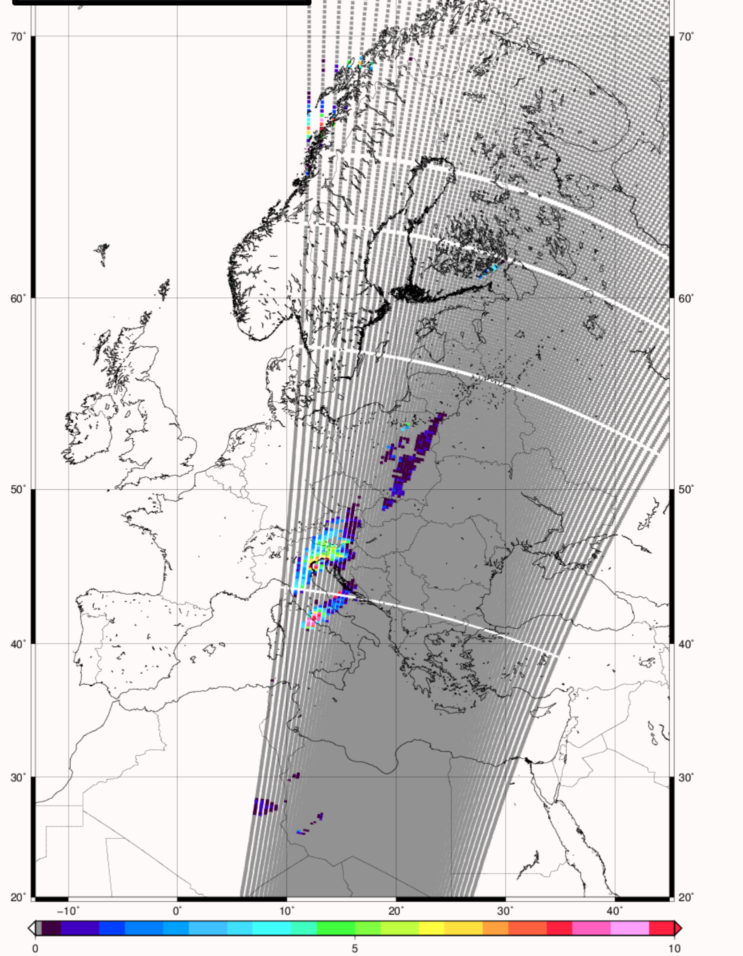
(Mugnai et al., 2013, NHESS, Sanò et al., 2013)

ANN from Global database



New ANN from H-SAF area database

New Version



Rome, Italy
Flash Flood
20 Oct 2011

8:20 UTC
MetOp-A
AMSU/MHS

Consistency between retrievals from cross-track and conical scanning radiometers

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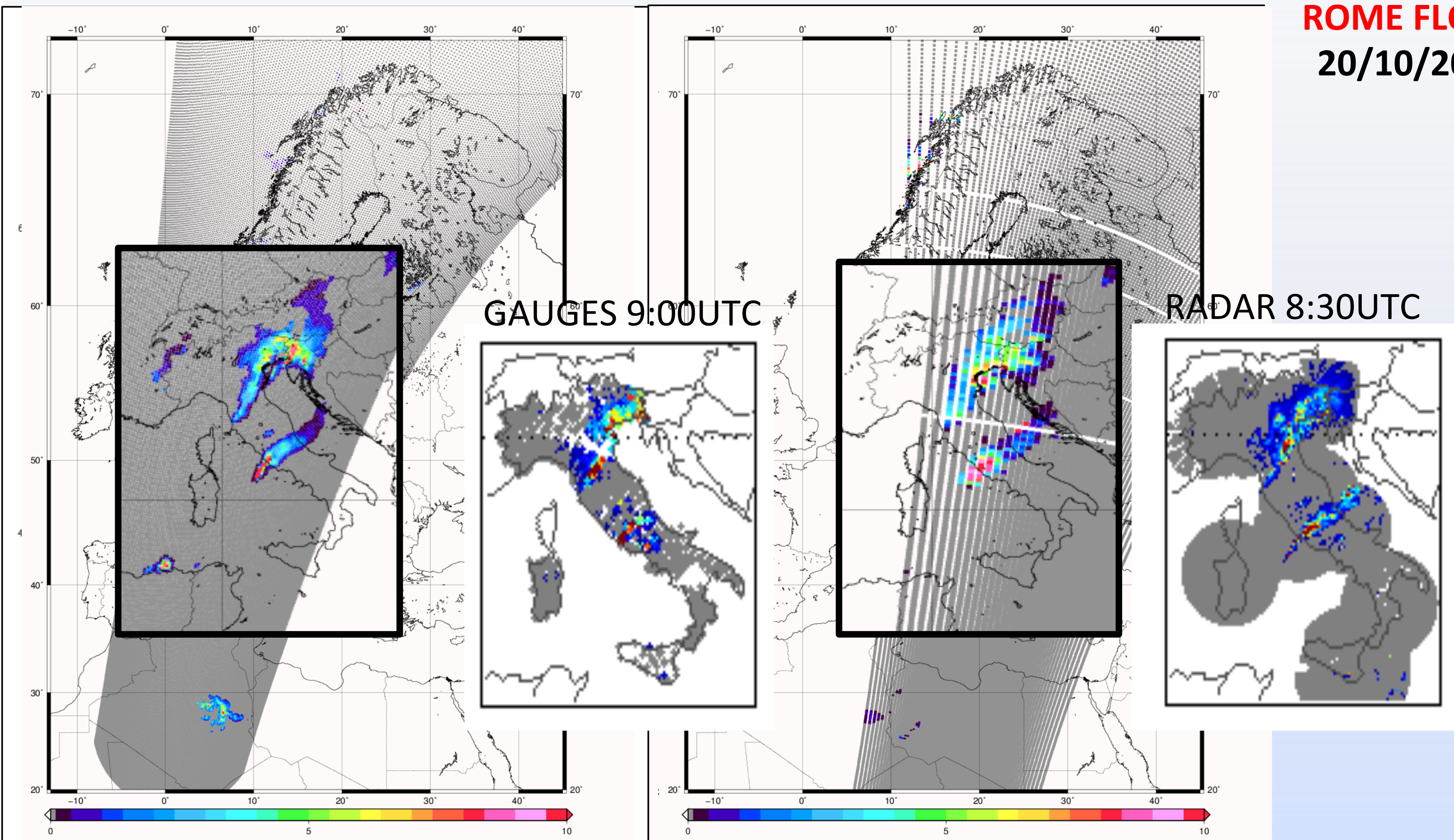
ROME FLOOD
20/10/2011

H01 new version SSMIS 8:09 UTC

H02 new version AMSU/MHS 8:20 UTC



Consistency between retrievals from cross-track and conical scanning radiometers

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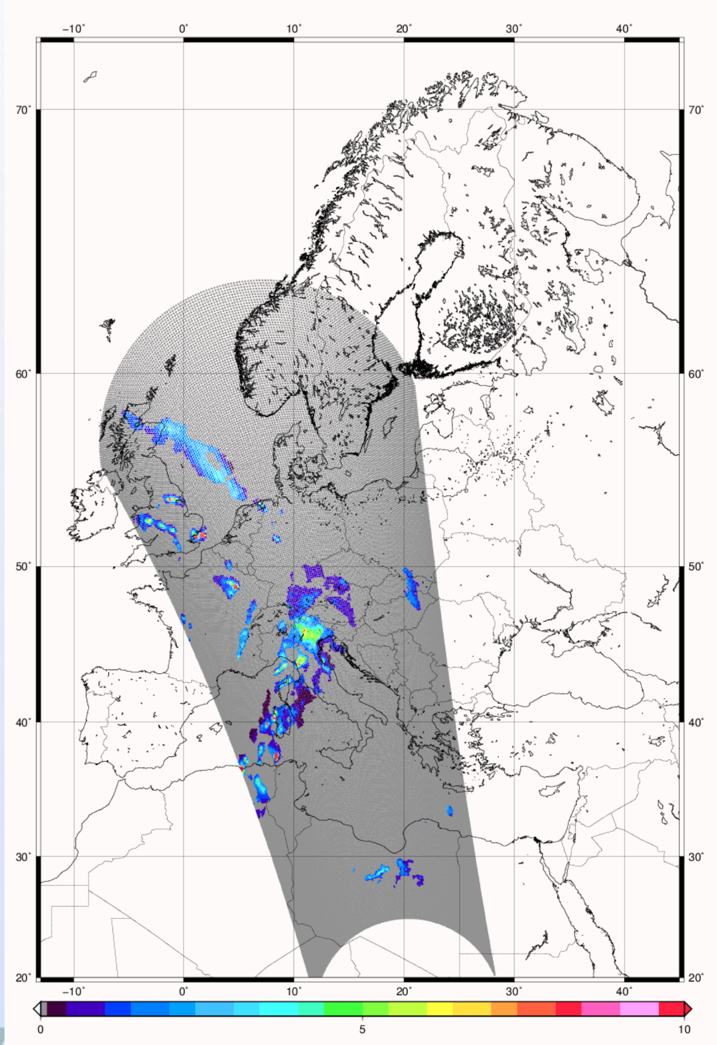
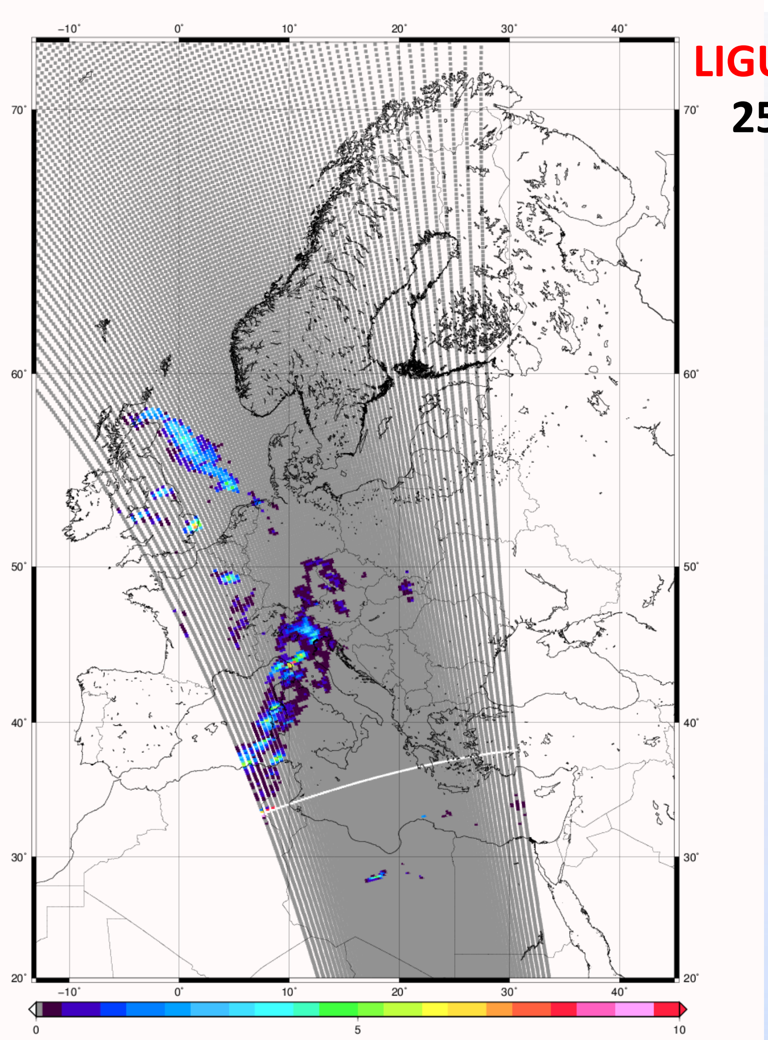
H01 new version SSMIS 18:39 UTC



H02 new version AMSU/MHS 18:18 UTC



LIGURIA FLOOD
25/10/2011

PR-OBS3 / H03 Current status (IR-MW Blending Technique)

(Turk et al. 2000, Torricella et al. 2007)

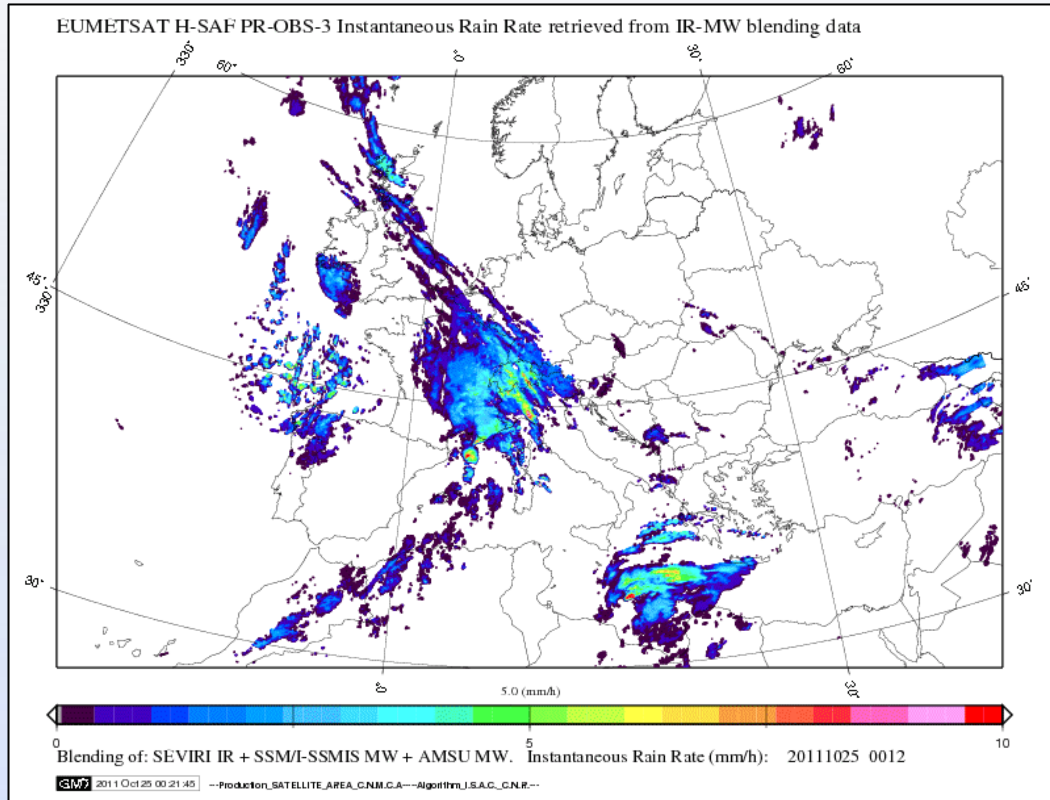
Precipitation rate at ground by LEO/MW supported by GEO/IR

Input: geolocated IR **10.8µm from MSG-SEVIRI** and PMW precipitation rates

It is based on a blended MW-IR technique that correlates, by means of the *statistical probability matching*, brightness temperatures measured by the IR geostationary sensors and PMW-estimated precipitation rates at the ground.

Pre-Operational
Timeliness: 15 min
Time resolution: 15 min
Hor. Resolution: 8 km
Sampling: 5 km

LIGURIA FLOOD 25/10/2011



NRL Blending Algorithm & MW (SSM/I – SSMIS + AMSU/MHS) + IR (SEVIRI)

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Development of PR-OBS3

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

(Turk et al. 2000, Torricella et al. 2007)

CDOP-1	Ver. 1 Pre-Operational	H03	• Blending MW/IR algorithm based on the NRL Rapid Update technique; • Techniques for preventive cloud classification: - Implementation of a scattering index from the channels of PMW sensors using the 183-WSL algorithm (CNR). - Implementation of a cloud classification by means of the combined use of Nefodina (CNMCA) and NWC-SAF Cloud Type products (CNMCA) • Parallax correction of MSG data using the Cloud Top Height (CTH) product from the NWC-SAF • Updated along with the updates and changes of MW-derived precipitation products.
CDOP-2	Ver.1	H03A	H-SAF Area (*operational*)
	Ver.1	H03B	Full Disk Area (*exp. op. 2014*)
	Ver.2	H40A	**MTG-Flexible Combined Imager** (**FCI**) H-SAF Area (*dev.*)
	Ver.2	H40B	**MTG-FCI** Full Disk Area (*dev.*)

PR-OBS4 / H04 Current status (IR-MW Morphing Technique)

(Joyce et al., 2004)

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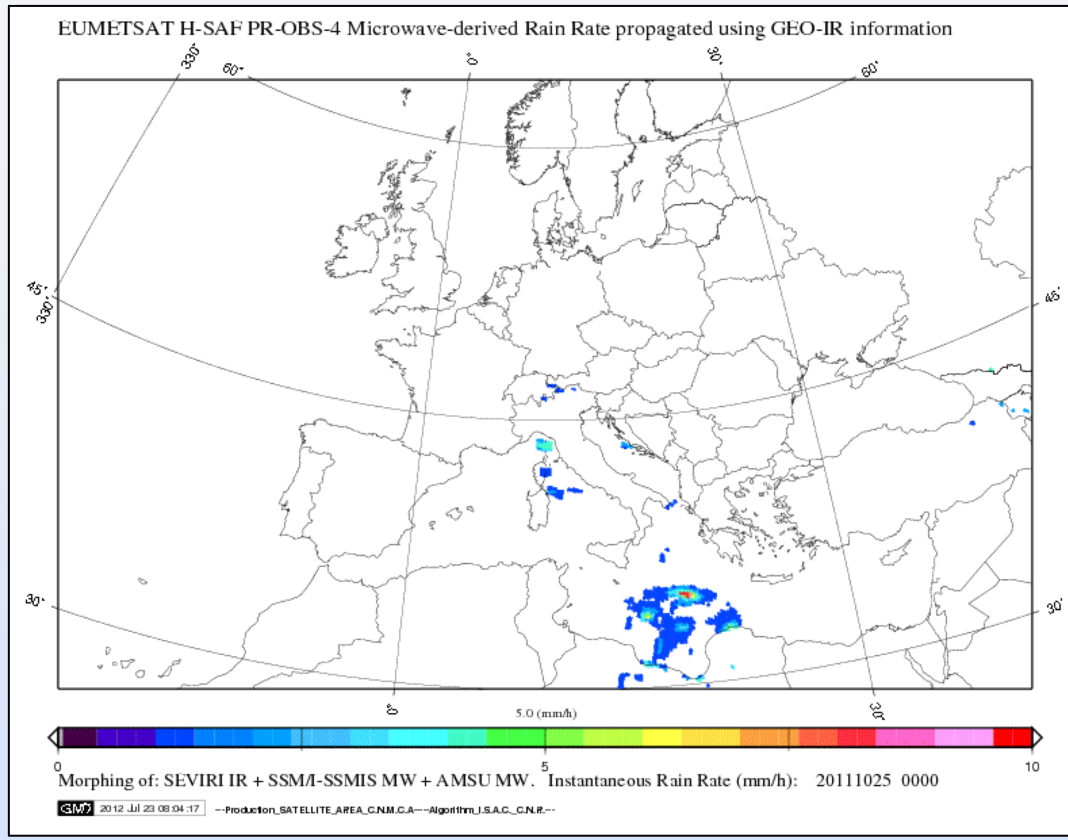
Precipitation rate at ground by LEO/MW supported by GEO/IR

Input: geolocated IR **10.8μm from MSG-SEVIRI** and PMW precipitation rates

Timeliness: 4 hr
Time resolution: 30 min
Hor. Resolution: 8 km
Sampling: 8 km

Propagation vector matrices are produced by computing spatial lag correlations over successive images of GEO/IR and then used to propagate the MW-derived precipitation estimates in time and space when updated MW data are unavailable.



CMORPH Algorithm MW (SSM/I – SSMIS + AMSU – MHS) + IR (SEVIRI)

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Development of PR-OBS-04

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

(Joyce et al., 2004)

CDOP-1	Ver. 1 Pre-operational		Instantaneous precipitation maps at **8-km** & **30-minute** space-time resolution generated by a combined IR-MW morphing algorithm using the PMW precipitation estimates time-interpolated by exploiting the dynamical information from the MSG IR images Updated along with the updates and changes of MW-derived precipitation products.
CDOP-2	Ver.1	H04A	H-SAF Area (*operational*)
	Ver.1	H04B	Full Disk Area (*exp. op. 2014*)
	Ver.2	H41A	**MTG-Flexible Comibned Imager** (**FCI**) H-SAF Area (*dev.*)
	Ver.2	H41B	**MTG-FCI** Full Disk Area (*dev.*)

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Development of PR-OBS-05

Accumulated precipitation at ground by blended MW and IR

CDOP-1	Ver. 1 pre-operational		Updated along with the updates and changes of MW-IR blending precipitation products and MW derived products.
CDOP-2	Ver.1	H05A	H-SAF Area (*exp. op. 2014*)
	Ver.1	H05B	Full Disk Area (*exp. op. 2014*)
	Ver.2	H42A	**MTG-FCI** H-SAF Area (*dev.*)
	Ver.2	H42B	**MTG-FCI** Full Disk Area (*dev.*)

Development of PR-OBS-06

Blended SEVIRI convection area/LEO MW Convective precipitation

CDOP-1	Ver. **1** Pre-operational		Updated along with the updates and changes of LEO MW derived products.
CDOP-2	Ver.2	H15A	H-SAF Area (*exp. op. 2014*)
	Ver.2	H15B	Full Disk Area (*exp. op. 2014*)

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Development of NEW Products in CDOP-2

GPM Algorithms (ISAC)

H-19 (PR-OBS-7) Instantaneous precipitation maps from GMI Bayesian algorithm (exp. op. 2017)

- Instantaneous precipitation maps generated from GMI on board the GPM Core Observatory satellite;
- H01 and H-17 **CDRD Bayesian** retrieval strategy adapted to characteristics of GPM;
- Exploitation of DPR in the common swath and dynamical/meteorological tags as further constrain

H-20 (PR-PBS-8) Instantaneous precipitation maps from GMI Artificial Neural Network algorithm (exp. op. 2017)

- ANN approach using DPR together with GMI;
- ANN algorithm trained using coincident GMI brightness temperatures measurements and DPR derived rainfall profiles;
- Geographical/seasonal/environmental factors will be included in the process;
- At least 1 year of GPM observations is necessary to build up the product.

Development of NEW Products in CDOP-2

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H-21 (PR-OBS-9) High frequency MW delineation of cloudy areas with new development of hydrometeors (ISAC)

- Clouds and precipitation product based on new TB thresholding algorithm based on MHS window and water vapour absorption bands.
- Devoted to the identification of *low-intensity* precipitation areas and to the delineation of the areas of hydrometeor formation around precipitating clouds.
- Based upon calibration with an appropriate radar data set;
- The product is suited for high and mid latitudes.

H-22 (PR-OBS-10) Snowfall (ISAC)

- A high-frequency passive microwave algorithm producing snow detection and snowfall;
- Based on channel combinations in the window and water vapor absorption bands of MHS, with classification of the cloud scene;
- The algorithm is designed to produce its own snow cover map (wet and dry snow).
- The product will need extensive calibration and is very experimental.
- High latitudes over continental Europe, the UK, the Baltic countries and Scandinavia.

H-50 (PR-OBS-11) Rainfall intensity from LI on MTG (CNMCA)

- It is based on a rainfall retrieval technique that uses geostationary satellite Infrared (IR) observations and lightning information

H-SAF Precipitation Products:

Validation

Leader: Silvia Puca
National Department of Civil Protection, Italy

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Precipitation Products Validation Group (PPVG) Leader : DPC (Italy)

Belgium IRM	Bulgaria NIMH	Germany BfG	Hungary OMSZ	Italy Uni Fe	Poland IMWM	Slovakia SHMU	Turkey ITU TSMS

The PRECIPITATION PRODUCT VALIDATION GROUP is composed by experts in hydrology, rain gauge data, radar data, and meteorology coming from 8 countries.

Silvia Puca (Leader)	Dipartimento Protezione Civile (DPC)	Italy
Emanuela Campione	Dipartimento Protezione Civile (DPC)	Italy
Gianfranco Vulpiani	Dipartimento Protezione Civile (DPC)	Italy
Alexander Toniazzo	Dipartimento Protezione Civile (DPC)	Italy
Angelo Rinollo	Dipartimento Protezione Civile (DPC)	Italy
Emmanuel Roulin	Institut Royal Météorologique (IRM)	Belgium
Pierre Baguis	Institut Royal Météorologique (IRM)	Belgium
Gergana Kozinarova	NIMH-BAS	Bulgaria
Georgy Koshinchanov	NIMH-BAS	Bulgaria
Peter Krahe	Bundesanstalt für Gewässerkunde (BfG)	Germany
Judit Kerenyi	Hungarian Meteorological Service (OMSZ)	Hungary
Federico Porcu'	Ferrara University, Department of Physics (UniFe)	Italy
Lisa Milani	Ferrara University, Department of Physics (UniFe)	Italy
Bozena Lapeta	Institute of Meteorology and Water Management (IMWM)	Poland
Monika Pajek	Institute of Meteorology and Water Management (IMWM)	Poland
Rafal Iwanski	Institute of Meteorology and Water Management (IMWM)	Poland
Ján Kaňák	Slovenský Hydrometeorologický Ústav (SHMÚ)	Slovakia
Ľuboslav Okon	Slovenský Hydrometeorologický Ústav (SHMÚ)	Slovakia
Mariàn Jurasek	Slovenský Hydrometeorologický Ústav (SHMÚ)	Slovakia
Ahmet Öztopal	Istanbul Technical University (ITU)	Turkey
Ibrahim Sonmez	Turkish State Meteorological Service (TSMS)	Turkey
Aydin Gurol Erturk	Istanbul Technical University (ITU)	Turkey

H-SAF Validation strategy

For **all** products generated within the project, the product validation cluster is responsible for:

- **monitoring the progress** of product quality evaluating statistical scores and case study analysis through comparison between satellite products and ground data (radar and rain gauges);
- **providing a validation service to end-users** publishing on the **H-SAF web-page** the statistical scores evaluated and the case studies analysis;
- **providing online quality** control to end-users generating NRT quality maps;
- **monitoring operational features** of the products as actual arrival, timeliness, intelligibility, etc.;
- **providing a ground data service** inside the project for algorithm calibration and validation activities.

PPV Raingauge network is composed by **4100** stations:

Data Sources	Raingauges
Instrument characteristics	Telemetric and mechanic
Time domain (near real time/ case studies)	Near real time, case studies
Time resolution (15 min, 30 min)	10 – 30 min (telemetric), 3 – 24 h (mechanic)
Spatial distribution (whole national territory/ limited area)	Whole national territory
Number of stations	~390 mechanic (RMI) + 12 telemetric (RMI) + 4160 telemetric (SETHY)
Operational/ for research only	Operational (RMI) + research (other networks)
Data quality check	Telemetric: automatically checked / mechanic: autom. + manually checked

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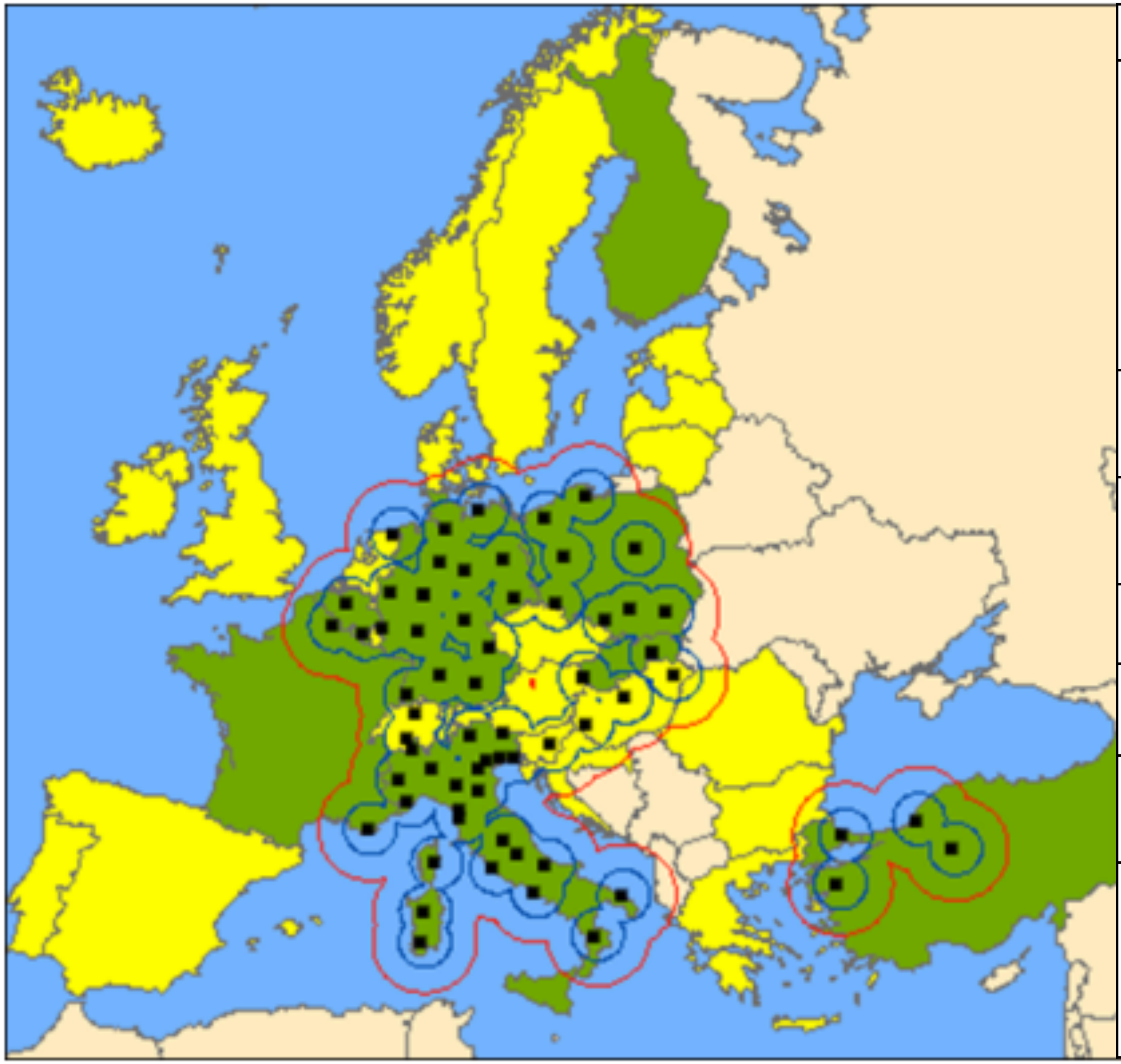
PPV Radar network is composed by **54 C-band** and **1 Ka-band** radars:



Data Sources	Radars
Instrument characteristics	Beam width ~1°, max range ~150 Km, 250m, C-band, single polarization, Doppler polarimetric
Time domain	Near real time/ case studies
Time resolution	5 min, 15 min, 30 min, 1h, 24h
Spatial distribution	Whole national territory
Number of stations	54 C band +1 Ka band
Operational/ for research only	Operational
Data quality check	Permanent ground clutter removed; monitoring of electronic calibration

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PPVG quality assessment

- A common validation procedure has been identified and implemented for most products.
- It is based on ground data (radar and rain gauge) comparisons to produce large statistics (continuous and multi-categorical), and case study analysis.
  - For full disk product **TRMM PR** and **GPM DPR** will be used for large statistics and for case studies.
- Both components are considered complementary in assessing the accuracy of the implemented algorithms.
  - Large statistics helps identifying the existence of “pathological” behaviors; selected case studies are useful in identifying the origins of such behaviors, when present.
- User requirements are reported in the Service Spec. documents; when requirements are met product becomes operational;

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"The ground truth problem"

- Radar and rain gauge rainfall estimation is influenced by several error sources that should be carefully handled and characterized before using these data as reference for ground validation of any satellite-based precipitation products.
  - Radar: Attenuation; Beam blocking; viewing geometry; inversion technique; snowfall; inter-calibration.
  - Rain gauges: snowfall; sparse data in some regions;
- An inventory of the precipitation ground networks, instruments and data available inside the PPVG is available in order to highlight the main error sources and to present a possible methodology for selecting the ground data that are more reliable.
- It is important to evaluate the limits of the available ground reference, to estimate the errors of the data used to validate the satellite products and to understand if a direct comparison of the product requirements with the result of validation is completely correct.
- **DPR onboard GPM will be important also for quality assessment of ground radar data in H-SAF among different PPVG member countries.**

Hydrological Validation
Leader: IMWM, Poland

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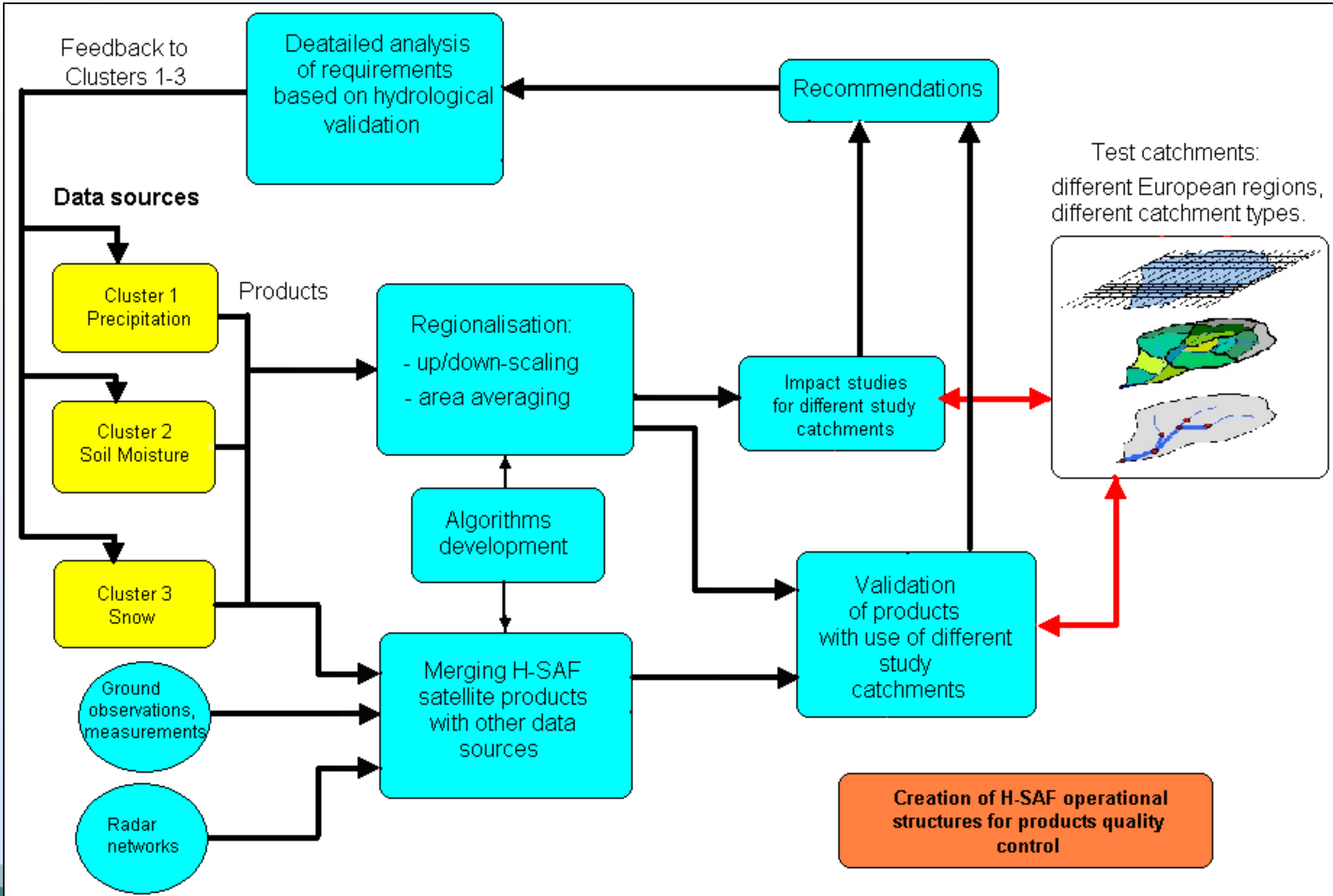

Test catchments of the Hydrological Program

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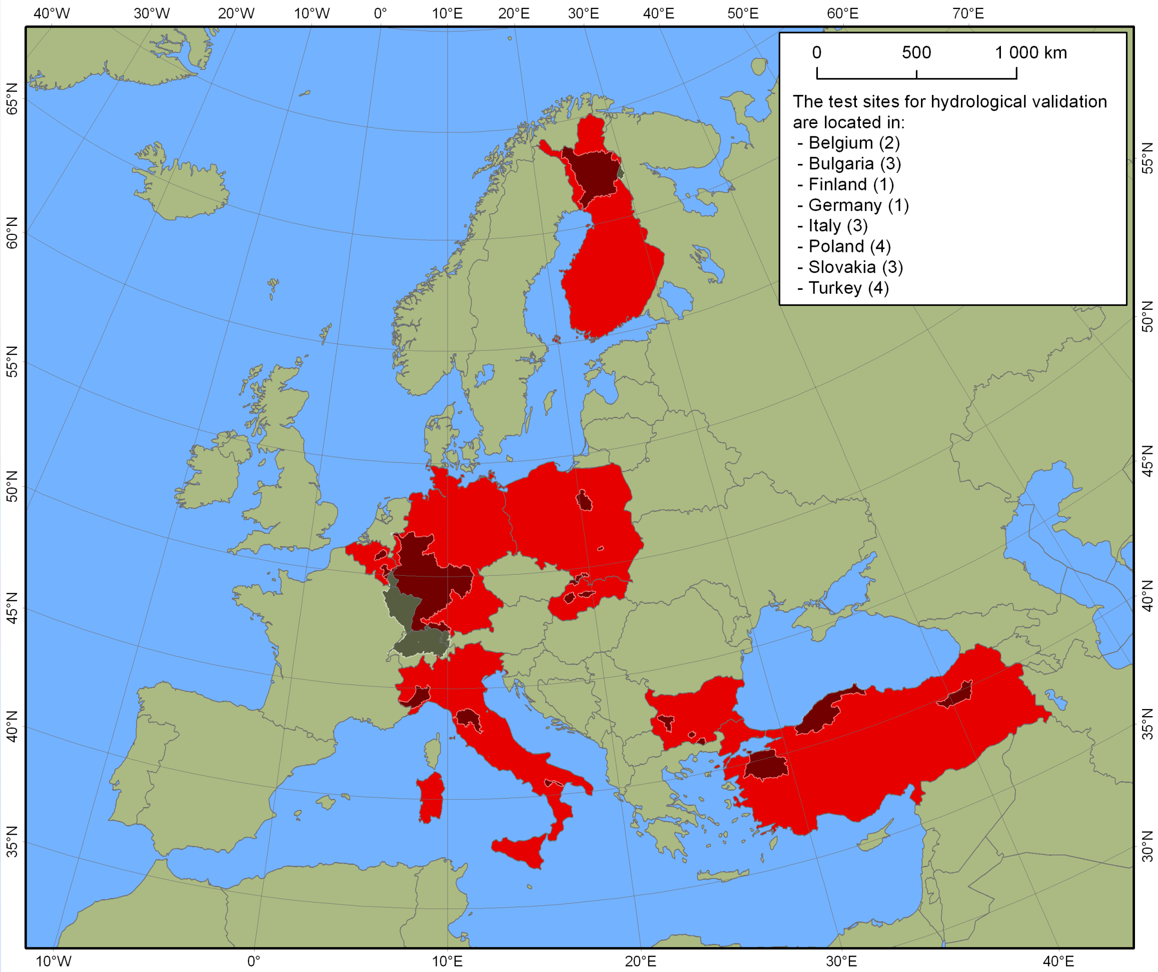
The validation is performed for 21 selected catchments in 8 countries using the operational hydrological models. 15 of them is used to validate precipitation products.

The river catchments selected for the Hydro-validation experiments represented all types of river systems present in Europe.

Selected river systems included catchments of different size characteristics and types of hydrological regime.



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Areas of potential collaboration with GPM

H-SAF development of products: towards GPM

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- Consistency of precipitation from cross-track and conical scanning radiometers (H01-H17, H02-H18:
  - Impact on derived products (PR-OBS-3, PR-OBS-4, PR-OBS-5)
  - Applications to Hydrology and Nowcasting techniques;
  - **Towards the use of GPM constellation of satellites**
- Improvement of detection of light rain with current (H01,H02) and new products (H21):
  - Reduced false alarm rate;
  - **GPM: high latitute applications**
- Efforts towards detection of snow with current and new products (H22) and snowfall retrieval in H-SAF :
  - Impact of derived products;
  - Hydrological application (reduce error in cold months);
  - **GPM: snowfall detection**
- Development of 2 different **GPM algorithms optimized for Europe/Mediterranean basin & with extension to MSG full disk**:
  - Validation: PPV vs. DPR validation; **use of GPM GV datasets for full disk products (?)**
  - Comparison with other PMW products and sensors (H01, H02, H17, H18, H21, H22)
- Future exploitation of other new satellites as they become available (MetOp, NPP, JPSS-1, EPS-SG, MTG): **Exploitation of GPM constellation**

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GPM and H-SAF common grounds

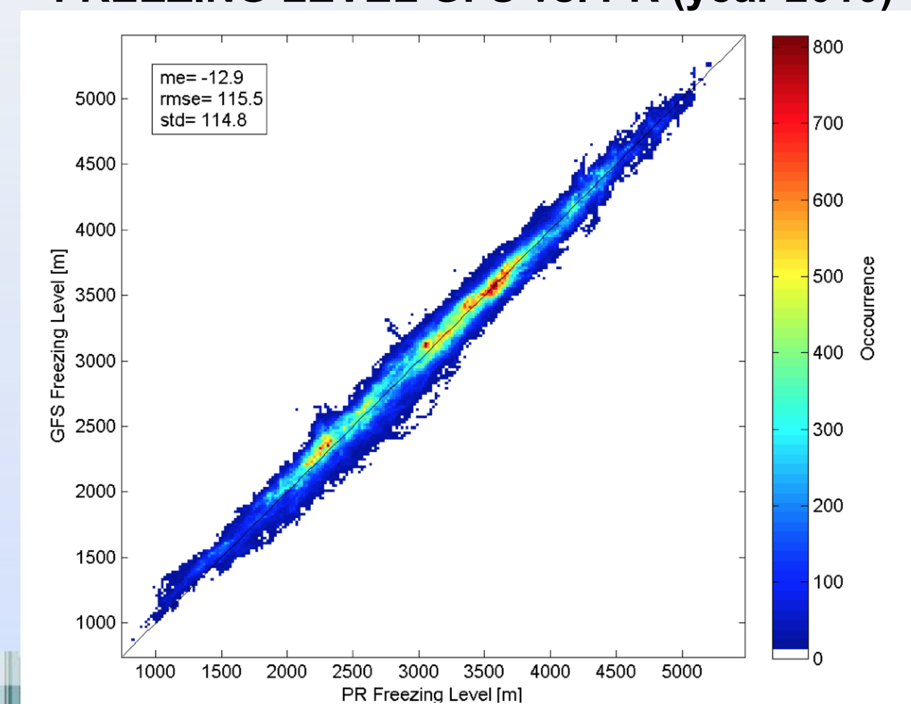
- Availability of PMW precipitation products from cross-track and conical scanning radiometers originally designed for Europe/Mediterranean basin could be very beneficial to GPM due to:
  - *Complex and variable surface background conditions;*
  - *Detection of light precipitation at mid-high latitudes;*
  - *Snowfall;*
  - *Presence of complex orography and coastlines.*
- Ground-based validation network with a consolidated team and validation strategy shared by different European countries could be very beneficial to GPM validation program.
- Hydrological validation: actual European end-user test for precipitation products.
- Use of TRMM PR, GPM DPR (and GPM GV datasets) for validation of full disk products.
- H-SAF snow cover and soil moisture products.
- Connection with NWC and Climate monitoring SAFs (J-PWG and P-SAG).
- **Constant effort to improve algorithms through verification of physical assumptions: exchange with other scientific comunities is crucial**

Verification study of CDRD using TRMM PR

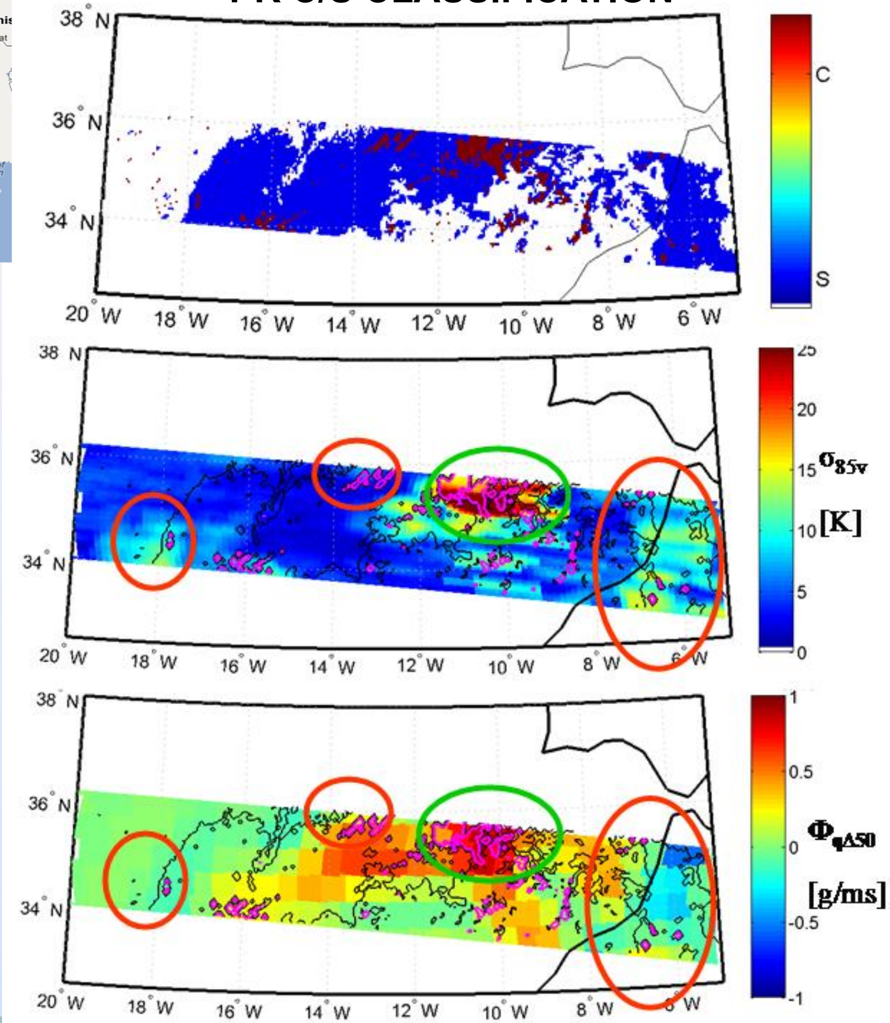
(Casella et al., 2012)

TRMM coverage in H-SAF area

FREEZING LEVEL GFS vs. PR (year 2010)



GFS MOISTURE FLUX vs. PR C/S CLASSIFICATION



Verification study of CDRD using TRMM PR

(Casella et al., 2012, Mugnai et al., 2013)

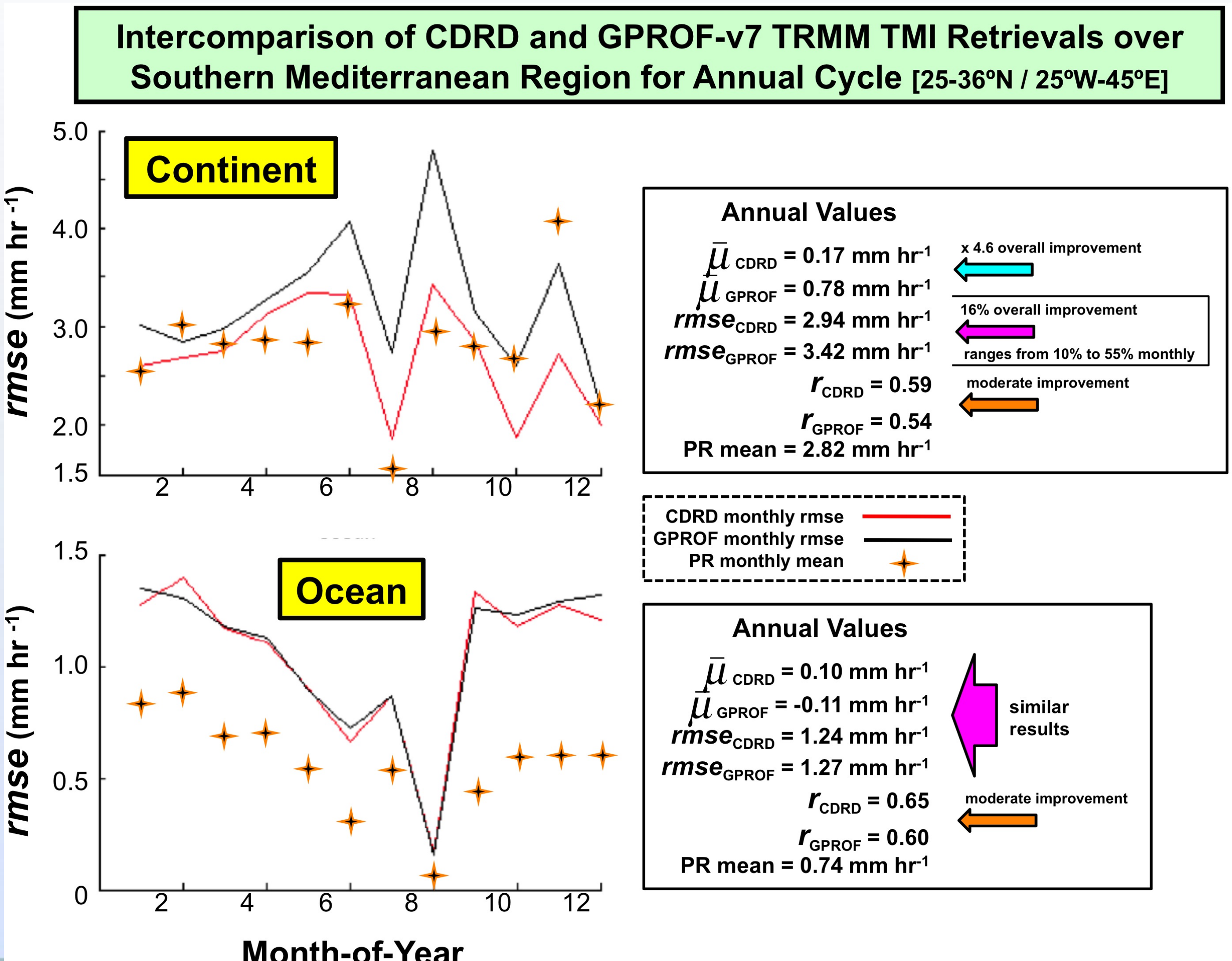
The DTH parameters used in this study:

H_{FL}: Freezing level [m]

ω_{700}: Omega (vertical wind) at 700 mb [mb/s]

$\Phi q_{\Delta 50}$: Vertical moisture flux 50 mb above the ground level [$g\ m^{-2}\ s^{-1}$]

CAPE [J/kg]



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Concluding remarks

- H-SAF is the main European concerted effort on precipitation. Other SAFs produce precipitation products, but H-SAF focus is largely on precipitation products from GEO+LEO satellites using MW and IR.
- H-SAF is an active member of IPWG.
- H-SAF produces operational products for hydrological applications, but also valid *per se*.
- H-SAF has adopted from its inception a validation strategy, which is now growing and reaching a critical mass necessary to validate operational and climate products.
- H-SAF has several years ahead to release advanced products and work with the next generation of EUMETSAT satellites, i.e. Post-EPS and MTG.
- An interSAF Joint Precipitation Working Group (J-PWG) has been set up for ensuring an adequate level of coordination of the activities between the SAFs (i.e., H-SAF, NWC-SAF and Climate Monitoring SAF)
- The H-SAF has a great interest in cooperating with the Global Precipitation Measurement (GPM) mission. H-SAF is the only Europe-wide entity that can devise a long-term partnership involving a continental structure on precipitation from space with international programs.

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THANK YOU!

Products and Documentation available at: http://hsaf.meteoam.it

References on H-SAF products

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- Sanò, P., et al.: Transitioning from CRD to CDRD in Bayesian retrieval of rainfall from satellite passive microwave measurements, Part 1: Algorithm description and testing, IEEE Trans. Geosci. Remote Sens., vol.PP, no.99, pp.1-25, doi: 10.1109/TGRS.2012.2227332, 2012
- Sanò P. et al., The Passive microwave Neural network Precipitation Retrieval algorithm (PNPR) for AMSU/MHS observations: description and application to European case studies, in preparation.

Back-up slides

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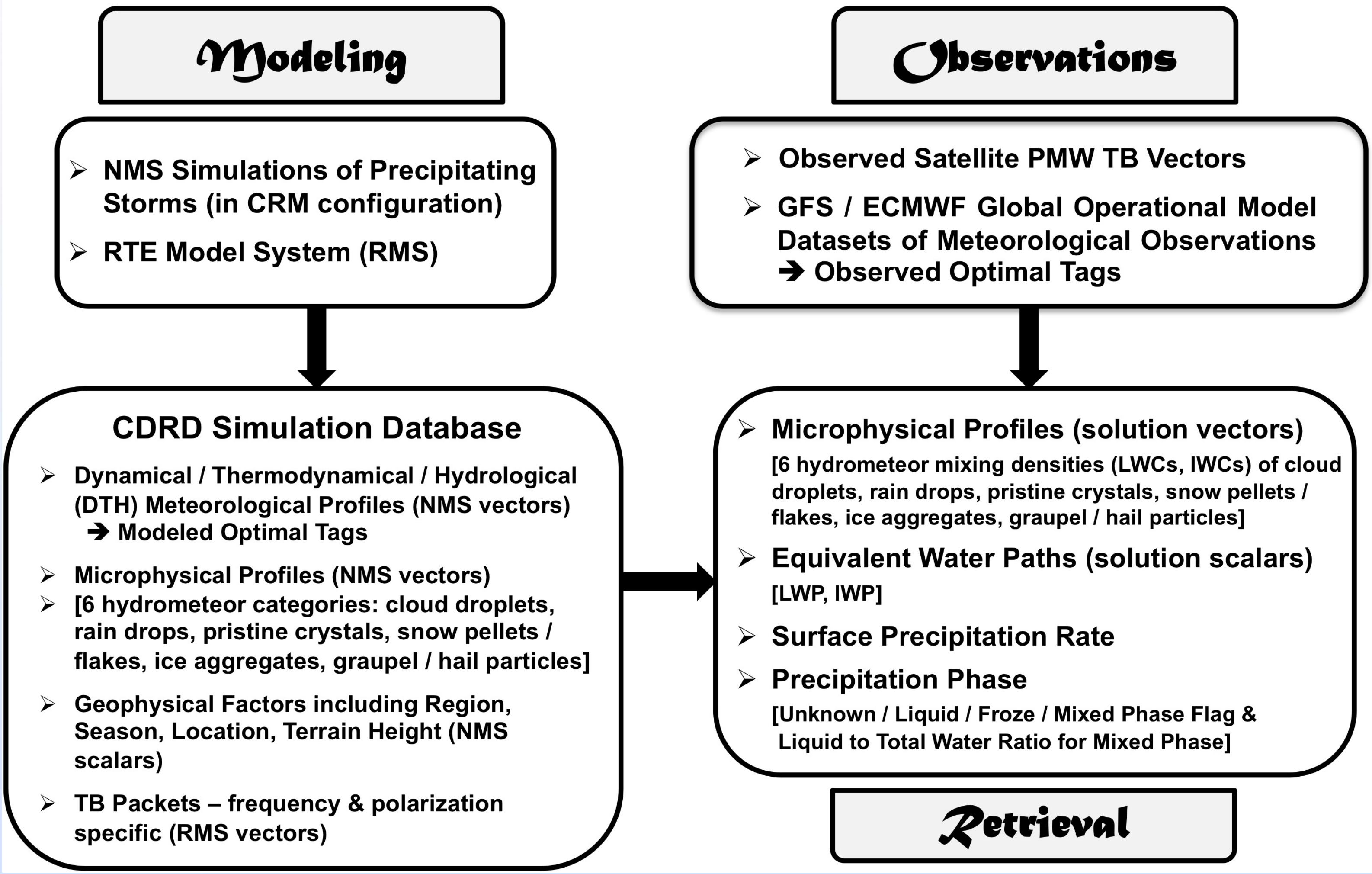
PR-OBS1 / H01 CDRD algorithm

Cloud Dynamics & Radiation Database (CDRD) Algorithm



(Mugnai et al., 2013, NHESS)

Development of PR-OBS-2

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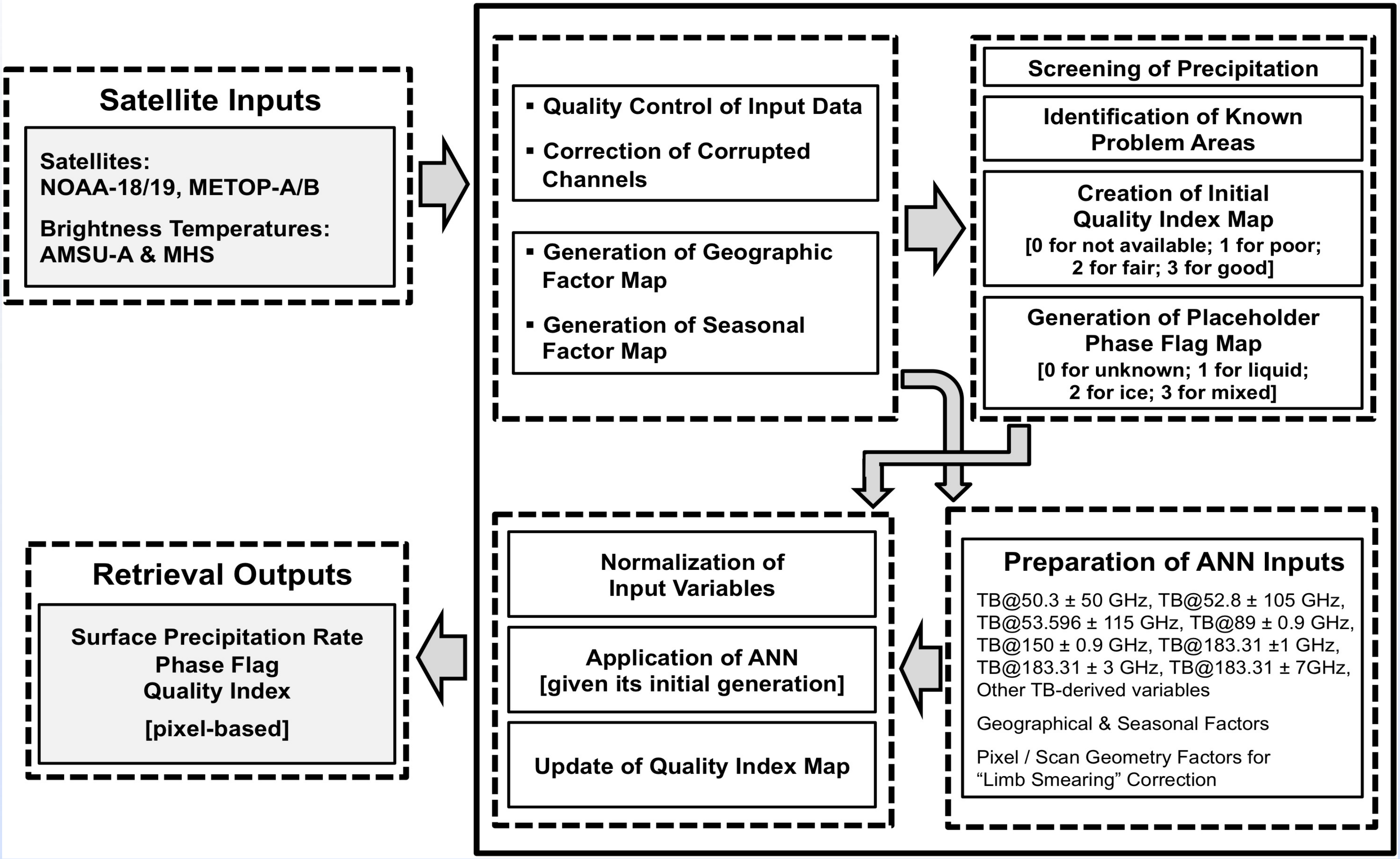
PMW Neural-net Precipitation Retrieval (PNPR) Algorithm



(Mugnai et al., 2013, NHESS)

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Quality flag for PR-OBS-1 and PR-OBS-2

- The quality flag summarizes the product quality and reliability;
- Provides end-users with a simple and immediate criterion for the evaluation of the products towards a correct selection and application of the precipitation estimates with respect to the analyzed scenario.
- This index is derived from the "Percentage of Confidence Index" (PCI), evaluated on the base of four different criteria:
  - ***Quality of input data*** (used sensor, type and number of channels used, horizontal resolution, corrupted channels);
  - ***Background surface index*** (type of surface, snowy background, presence of ice);
  - ***Event type index*** (snow storm, stratiform rain, convective cells) (Funatsu 2007, 2012);
  - ***Internal algorithm performance index*** (i.e., Bayesian variance of the retrieval for PR-OBS-1, scan viewing angle in PR-OBS-2)

Phase flag for PR-OBS-1 and PR-OBS-2

The phase flag is based on the studies on snow and ice detection of Surussavadee and Staelin (2009) and Rosencrantz (2003) and Grody et al. (2000). In these studies snowfall is detected by the use of TBs at 20.3 GHz, 50.3 GHz and 89 GHz , and on combinations of these channels.

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Internal Validation:

24 Case Studies

Rain gauges:
- All rain gauge stations within each IFOV are considered;

Radar:
- All availble radar estimates have been considered (no quality check has been carried out);

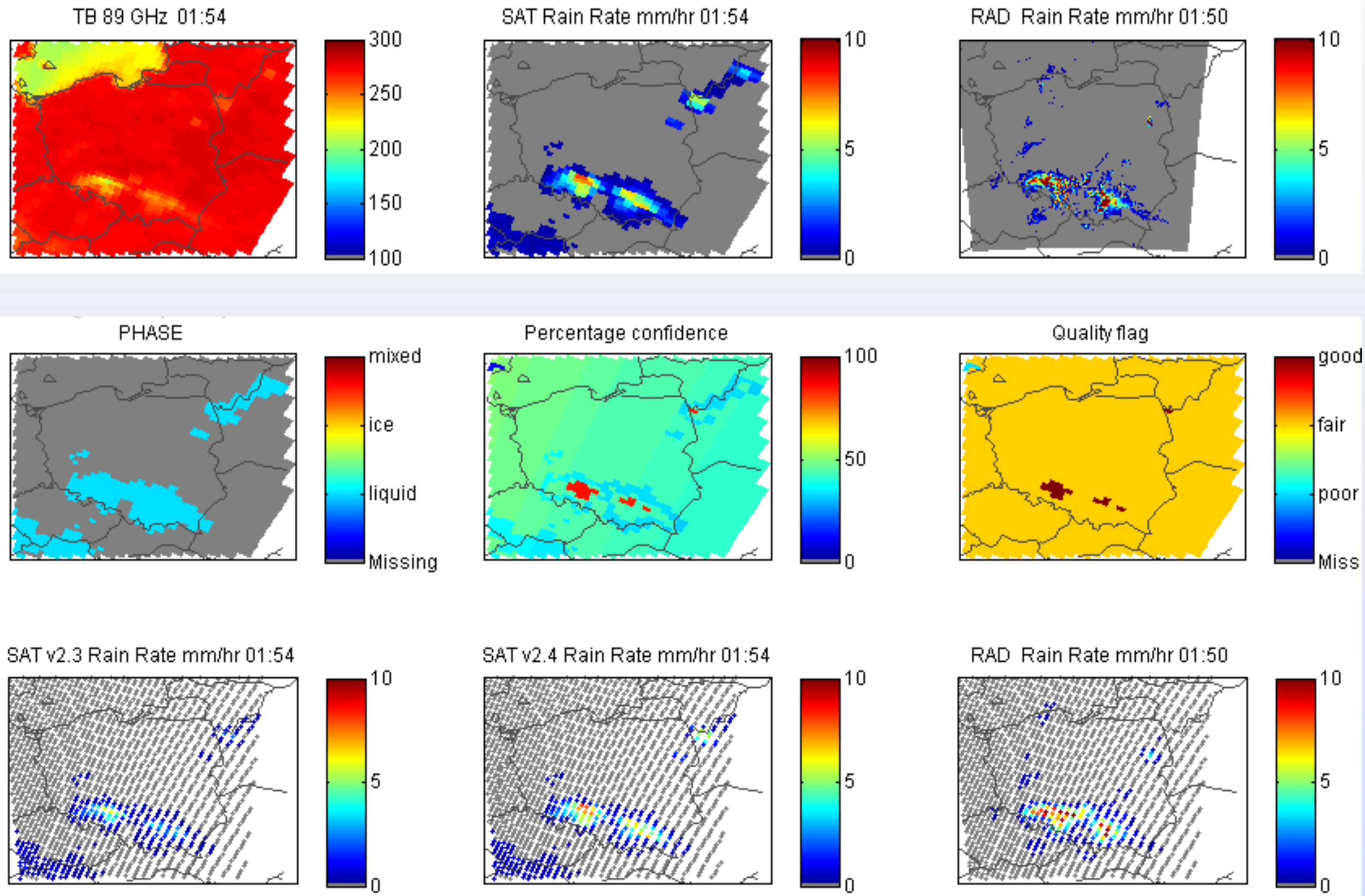
Satellite data within the radar/gauge area available have been considered for the validation procedure;

Raw gauge measurements and radar precipitation estimates have been averaged to product resolution using the attenna pattern (oriented according to scan angle and orbit orientation);

date	region	Brief description
10/20/2011	Italy	Rome Flood
10/25/2011	Italy	5 Terre Flood
11/4/2011	Italy	Genoa Flood
03-04/02/2012	Italy	Snow storm - Central Italy
10-11/02/2012	Italy	Snow storm – Central Italy
21-22/12/2009	Italy	Snow storm Northern Italy
1/20/2009	Italy	Stratiform
6/20/2009	Italy	Convective
1/14/2009	Italy	Frontal precipitation event-rain/snow
1/12/2009	Hu	Frontal precipitation-rain
10/2/2009	Hu	snowfall
17/9/2009	Hu	Light stratiform
10/9/2010	Hu	Severe Thunderstorm/Convection
23/6/2011	Hu	Convective
30/7/2011	Hu	Severe Thinderstorm
11/5/2009	PL	Convective
23/6/2009	Pl	New Case Study
7/6/2011	SK	Orografic Precipitation
23/12/2009	SK	Melting snow on frozen soil
28/11/2010	SK	snowfall
13/11/2010	BE	Winter stratiform heavy rain event
7/8/2010	GE	Convective
3/6/2010	GE	Convective
05-06/12/2010	GE	Winter frontal precipitation

H02: improvement of detection and retrieval for convective cells

POLAND 23 June 2009 – Convective precipitation



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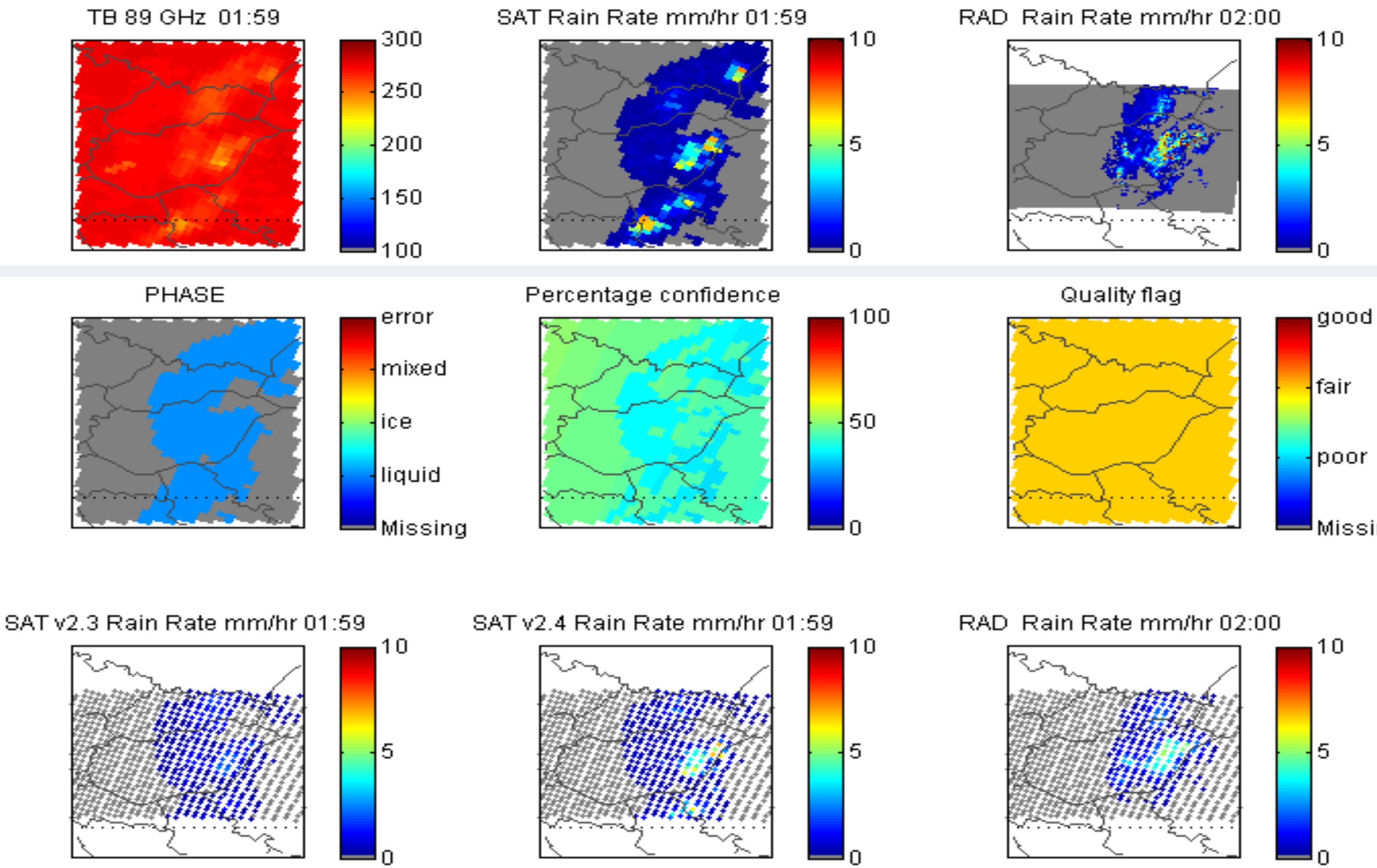
H02: improvement of detection and retrieval for convective cells

HUNGARY 30 July 2011– Severe Thunderstorm



H-SAF : Precipitation Products

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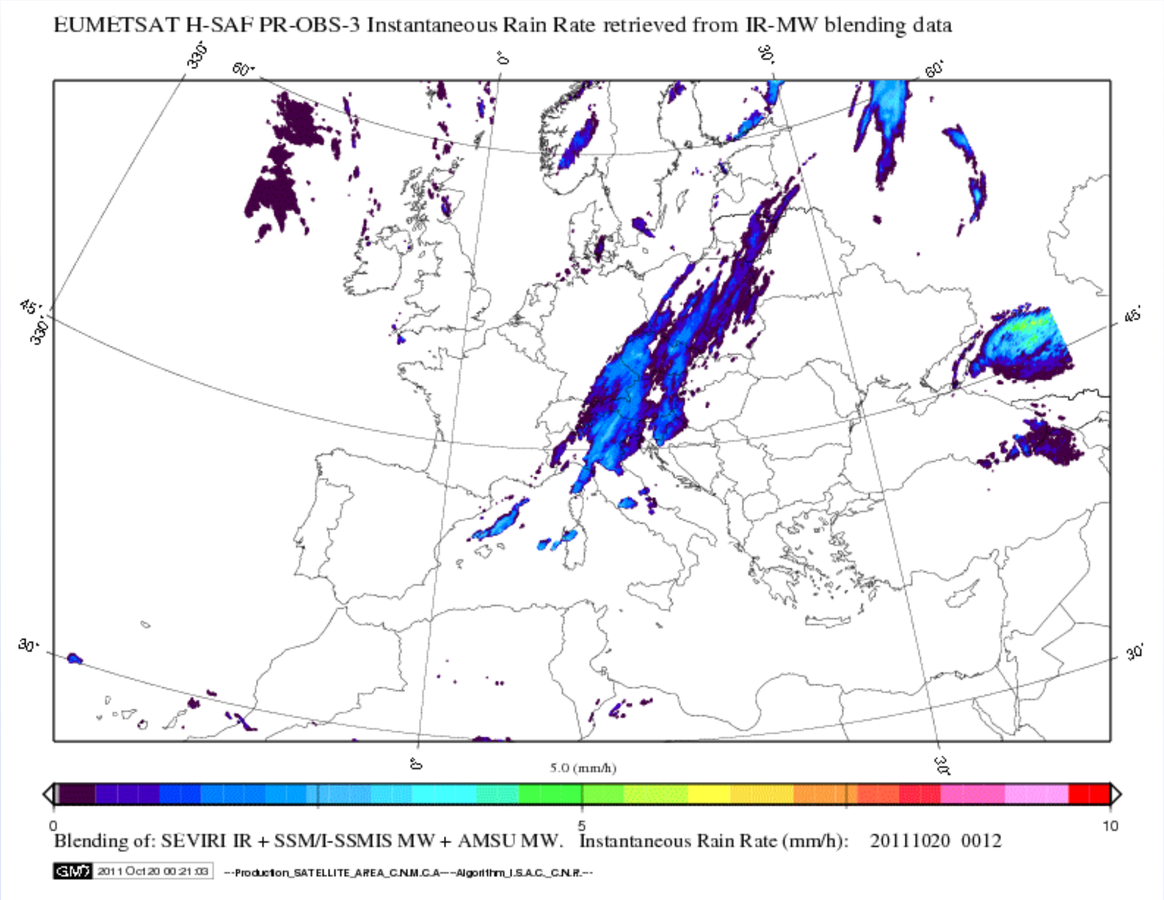
H-03 - Operational



Flash Flood Rome
20 October 2011

NRL Blending Algorithm & MW (SSM/I – SSMIS + AMSU – MHS) + IR (SEVIRI)

H-SAF : Precipitation Products

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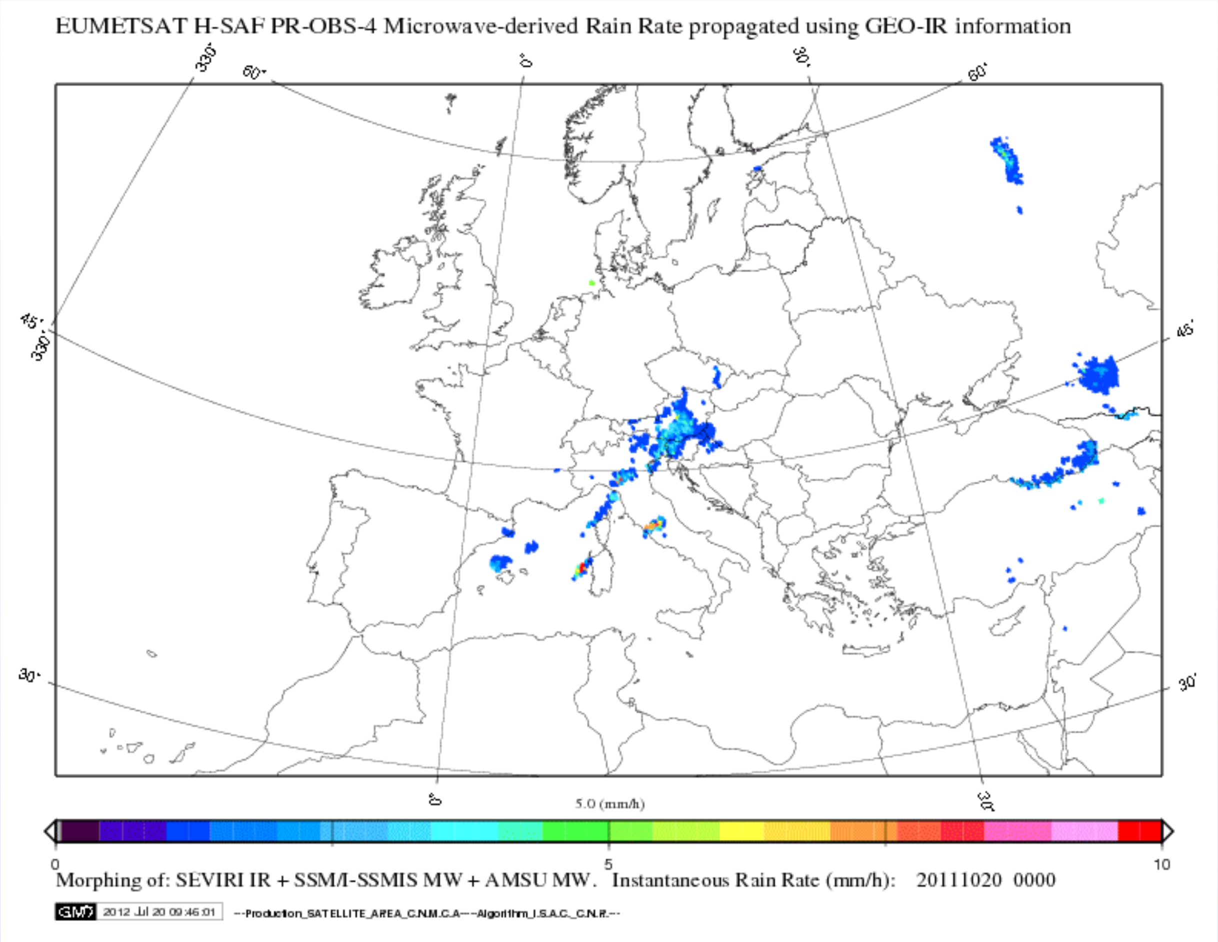
H-04 Pre-Operational



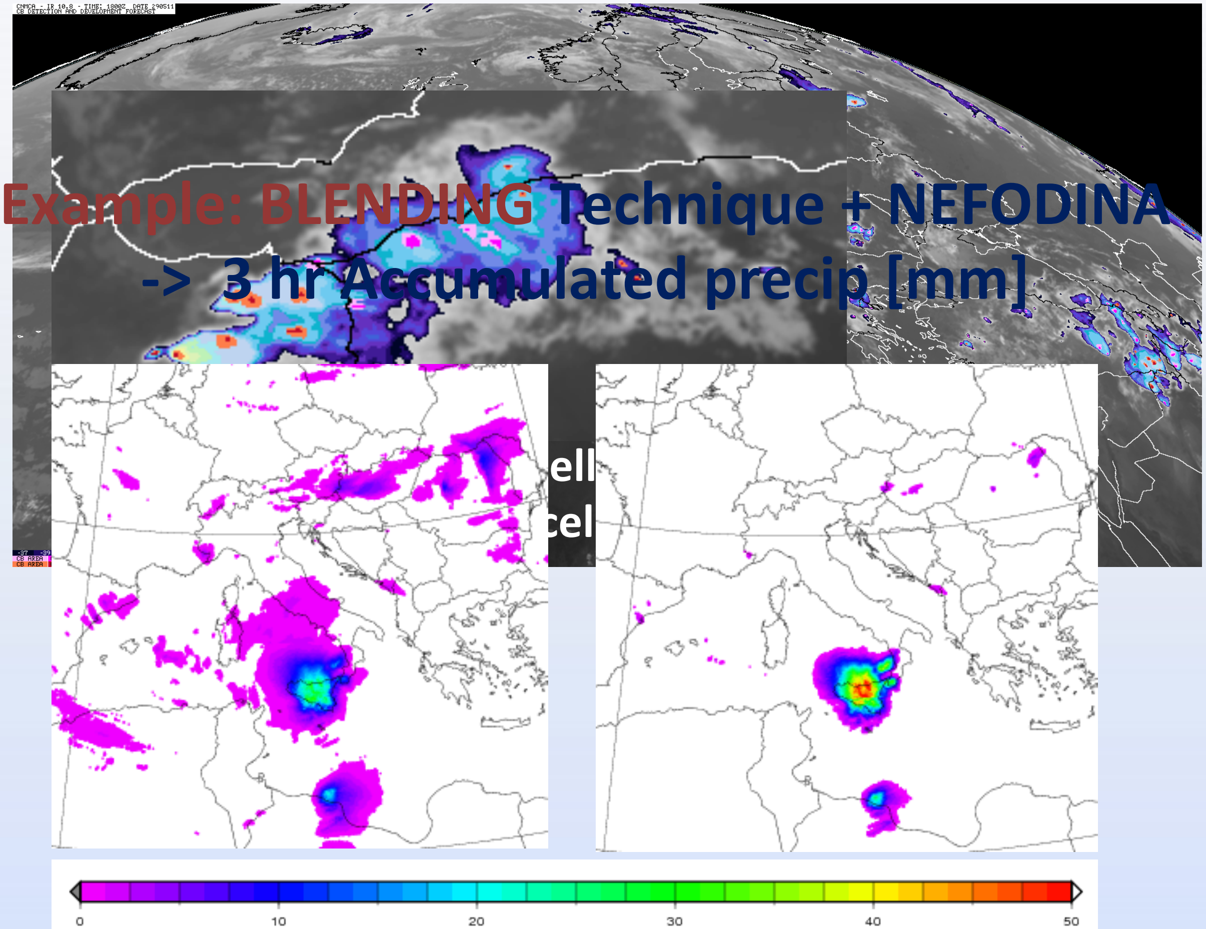
Flash Flood Rome
20 October 2011

CMORPH Algorithm MW (SSM/I – SSMIS + AMSU – MHS) + IR (SEVIRI)

PR-OBS-6/H15 – Current status

Blended SEVIRI Convection area / LEO MW precipitation

Example: BLENDING Technique + NEFODINA -> 3 hr Accumulated precip [mm]



Compensate for the intrinsic PMW underestimation of precipitation for *small* convective areas by taking into account convection development phase and detection from Nefodina software (based on IR and WV bands of SEVIRI-MSG).

Precipitation Product Validation results

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Between target and optimal	Between threshold and target	Threshold exceeded by < 50 %	Threshold exceeded by ≥ 50 %

From OR 31-08-2012

PR-OBS-1				Annual average of RMSE%	
Precipitation class	Requirement (RMSE %)			Radar	Gauge
	thresh	target	Optimal		
> 10 mm/h	90	80	25	94%	89%
1-10 mm/h	120	105	50	119%	118%
<1 mm/h	240	145	90	248%	261%

PR-OBS-2				Annual average of RMSE%	
Precipitation Class	Requirement (RMSE %)			radar	gauge
	thresh	target	optimal		
> 10 mm/h	90	80	25	72%	83%
1-10 mm/h	120	105	50	88%	95%

PR-OBS-3				Annual average of RMSE%	
Precipitation class	Requirement (RMSE %)			radar	gauge
	thresh	target	optimal		
> 10 mm/h	90	80	25	86%	88%
1-10 mm/h	120	105	50	110%	103%
<1 mm/h	240	145	90	252%	175%

What is the real meaning of this RMSE%?
Need of using more appropriate statistical indices

Quality assessment for the product:
"Precipitation rate at ground by MW conical scanners" H01
"Precipitation rate at ground by MW cross-track scanners" H02

Between target and optimal	Between threshold and target	Threshold exceeded by < 50 %	Threshold exceeded by ≥ 50 %

From OR 31-08-2012

PR-OBS-1				Annual average of RMSE%	
Precipitation class	Requirement (RMSE %)			Radar	Gauge
	thresh	target	Optimal		
> 10 mm/h	90	80	25	94%	89%
1-10 mm/h	120	105	50	119%	118%
<1 mm/h	240	145	90	248%	261%

PR-OBS-2				Annual average of RMSE%	
Precipitation Class	Requirement (RMSE %)			radar	gauge
	thresh	target	optimal		
> 10 mm/h	90	80	25	72%	83%
1-10 mm/h	120	105	50	88%	95%
<1 mm/h	240	145	90	140%	128%

Quality assessment for the product Precipitation rate at ground by GEO/IR supported by LEO/MW H03

Between target and optimal	Between threshold and target	Threshold exceeded by < 50 %	Threshold exceeded by ≥ 50 %

PR-OBS-3				Annual average of RMSE%	
Precipitation class	Requirement (RMSE %)			radar	gauge
	thresh	target	optimal		
> 10 mm/h	90	80	25	86%	88%
1-10 mm/h	120	105	50	110%	103%
<1 mm/h	240	145	90	252%	175%

For the class 2 (rain rate between 1-10 mm/h) statistical scores for H01, H02 and H03 evaluated by the PPVG show a good performance, reaching the threshold value stated in the user requirements, independent from the validation reference.
Lower performance are observed for lighter rainfall intensities.

Quality assessment for the product Precipitation rate at ground by LEO/MW supported by GEO/IR H04

Between target and optimal	Between threshold and target	Threshold exceeded by < 50 %	Threshold exceeded by ≥ 50 %

PR-OBS-4				Annual average of RMSE%		
Precipitation class	Requirement (RMSE %)			radar land	gauge land	gauge coast
	thresh	target	optimal			
> 10 mm/h	90	80	25	91%	92%	84%
1-10 mm/h	120	105	50	67%	103%	102%
= 1 mm/h	240	145	90	138%	115%	111%

Quality assessment for the product Blended SEVIRI Convection area / LEO MW precipitation H05

Between target and optimal	Between threshold and target	Threshold exceeded by < 50 %	Threshold exceeded by ≥ 50 %

Table 29 Simplified compliance analysis for product H12

PR-OBS-5				Annual average of RMSE%		
Cumulated Precipitation	Requirement (RMSE %)			radar land	gauge land	gauge coast
	thresh	target	optimal			
% (over 3 h)	120	80	25	117%	101%	101
% (over 24 h)	100	70	25	126%	162%	188

Precipitation products Hydrological Validation

Country	Test site	Hydrological model
Belgium	**Demer-Scheldt**	**SCHEME (SCHEldt and MEuse model)**
	Ourthe-Meuse	
Bulgaria	**Varbica**	**Mike-11/NAM (Nedbør-Afstrømmings Model) and Isba-Modcou model**
	Chepelarska	
	Iskar	**Artificial Neural Networks (ANN)**
Germany	**Rhine**	**HBV (Hydrologiska Byrans Vattenbalansavdelning model)**
Poland	**Wkra**	**HEC-HMS (The Hydrologic Engineering Center – The Hydrologic Modeling System)**
	Soła	
	Skawa	
	Czarna	
Slovakia	**Nitra**	**Hron-NAM (Hron rainfall and runoff conceptual model)**
	Kysuca	**HBV (Hydrologiska Byrans Vattenbalansavdelning model)**
	Hron	
Turkey	**Susurluk**	**HEC-HMS (The Hydrologic Engineering Center – The Hydrologic Modeling System)**
	Western Black Sea	

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Results: Kysuca River (Slovakia) H03

Rainfall amount in basin [mm per period]							
	VII 2011	VIII 2011	IX 2011	X 2011	XI 2011	XII 2011	VII-XII 2011
Psat	182.4	48.1	22.3	25.2	0.6	28.1	306.8
Pobs	210.6	52.1	20.3	31.9	0.7	77.6	393.2

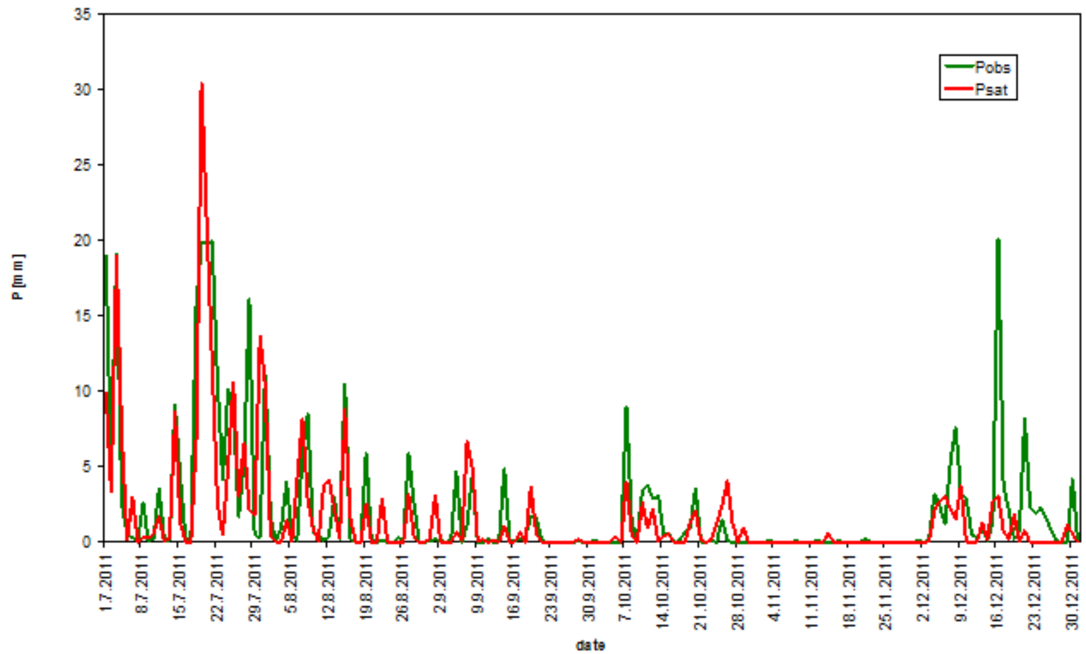
Basin precipitation plots

For each product separated plot with precipitation counted for a basin from ground and satellite data

Legend:

RED line: precipitation – satellite – Psat [mm]

GREEN line: precipitation – ground data – Pobs [mm]



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Results: Kysuca River (Slovakia) H03

Product validation plots

For each product separated plot with three lines (QsimSAT, QsimGD and Qobs)

Legend:

RED line: discharge simulated – satellite – QsimSAT [m^3/s]

GREEN line: discharge simulated – ground data – QsimGD [m^3/s]

BLUE line: observed discharge values – Qobs [m^3/s]