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H-SAF future developments on Convective Precipitation Retrieval

Francesco Zauli[1], Daniele Biron[1], **Davide Melfi**[1], Antonio Vocino[1], Massimiliano Sist[2], Michele De Rosa[2], Matteo Picchiani[2], De Leonibus Luigi[3]

1 - Centro Nazionale di Meteorologia e Climatologia Aeronautica
2 - GEO-K s.r.l.
3 - Ufficio Generale Spazio Aereo e Meteorologia (USAM)

H-SAF and HEPEX workshops on coupled hydrology

3-6 November 2014, Reading, United Kingdom

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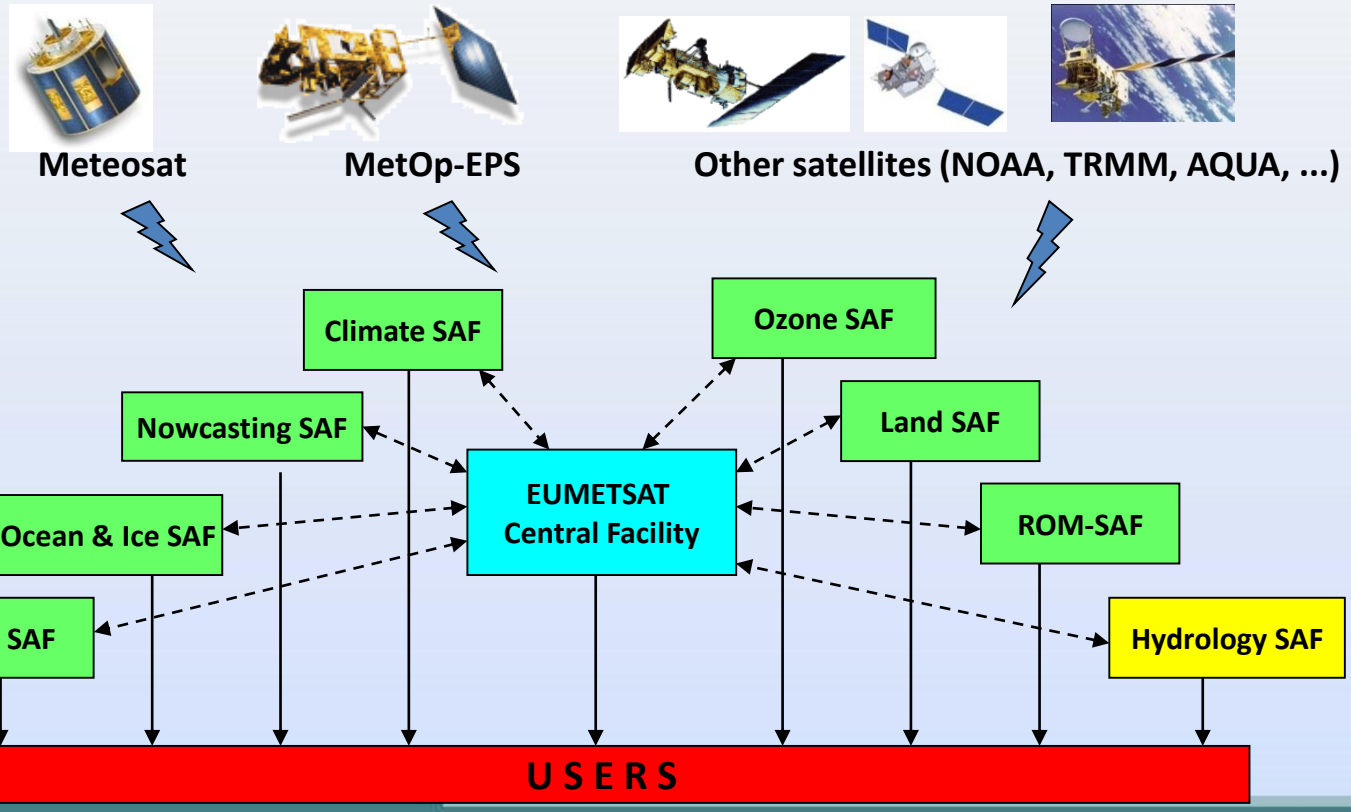
Outline

- H-SAF overview
- H-SAF Precipitation Products
- H15 algorithm
- H15 developments

H-SAF overview

The "EUMETSAT Satellite Application Facility on Support to Operational Hydrology and Water Management (H-SAF)" was established by the EUMETSAT Council on 3 July 2005, and kicked-off on 16 September 2005, as part of the EUMETSAT SAF Network.



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H-SAF objectives

- to provide satellite-derived products from existing and future satellites with sufficient time and space resolution to satisfy the needs of operational hydrology; 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);

- 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/retrieved fields to basin level;
  - ✓ fusion of satellite-derived measurements with data from radar and rain gauge networks;
  - ✓ assimilation of satellite-derived products in hydrological models;
  - ✓ assessment of the impact of the new satellite-derived products on hydrological applications.

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H-SAF Precipitation Products

Product identifier	Product acronym	Product name
H-01	PR-OBS-1	Precipitation rate at ground from MW conically-scanning radiometers (SSM/I, SSMIS) on LEO satellites
H-02	PR-OBS-2	Precipitation rate at ground by MW cross-track scanning radiometers (AMSU -MHS) on LEO satellites
H-03	PR-OBS-3	Precipitation rate at ground by GEO/IR supported by LEO/MW (Rapid Update)
H-04	PR-OBS-4	Precipitation rate at ground by LEO/MW supported by GEO/IR (CMORPH)
H-05	PR-OBS-5	Accumulated precipitation at ground by blended MW+IR
H-15	PR-OBS-6	Blended SEVIRI Convection area/ LEO MW Convective Precipitation (NEW)

See the poster ***"EUMETSAT Hydrological Satellite Application Facility, Precipitation Products Generation System at C.N.M.C.A."***

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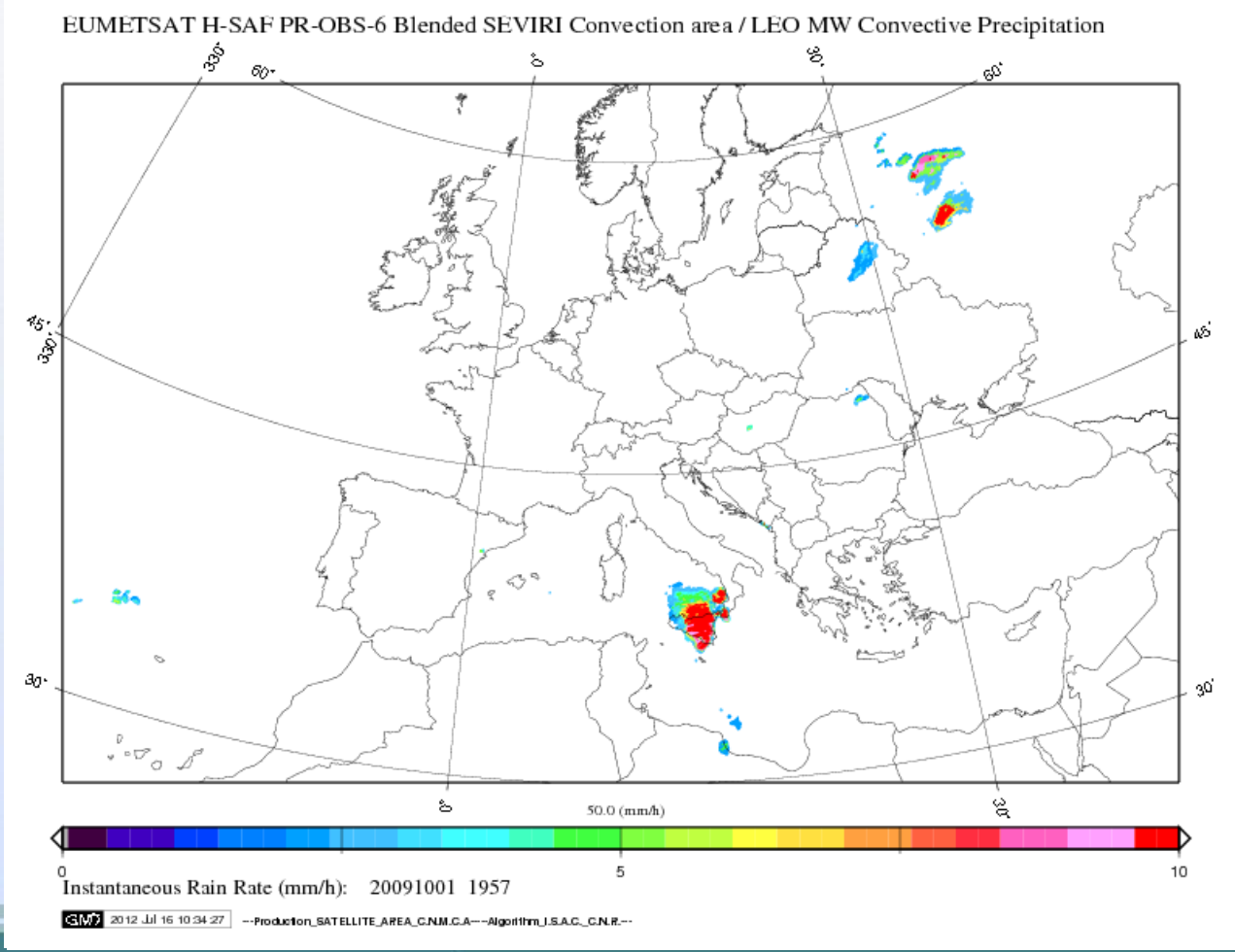
H15 Algorithm

BLENDING Technique + NEFODINA

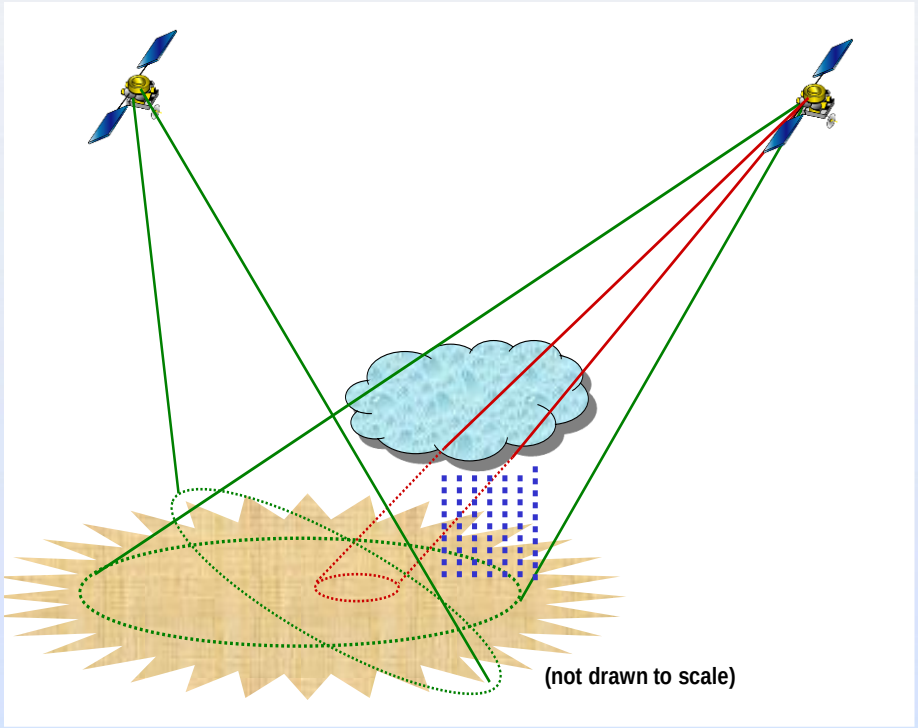


H15 Algorithm

BLENDING Technique

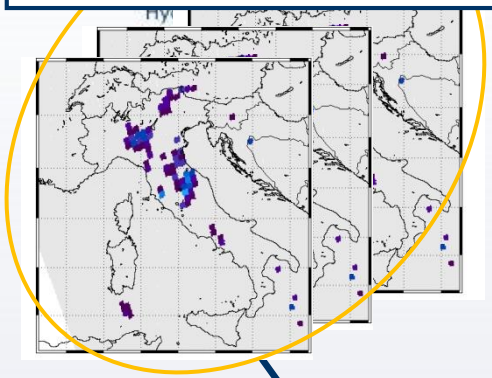
Multi-platform algorithm allows to compute **instantaneous rain intensities at the ground at the geostationary time-space scale** (Turk et al. 2000, Torricella et al. 2007).

The **technique correlates, by means of the *statistical probability matching*, brightness temperatures measured by the IR geostationary sensors and PMW-estimated precipitation rates at the ground.**

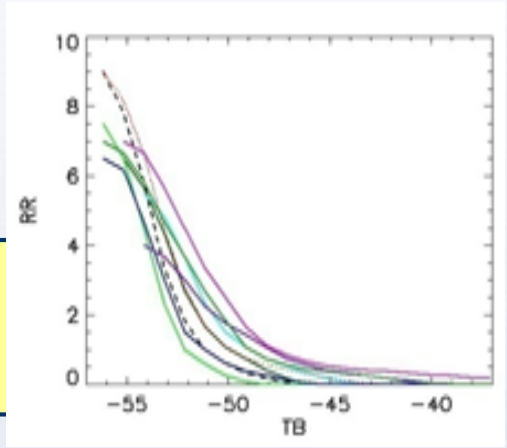


H15 Algorithm

Rain intensity maps from PMW data



The process is restarted for each IR slot



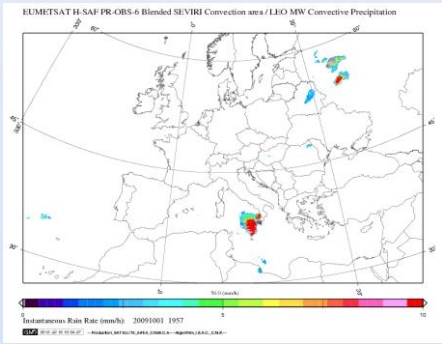
Extract space and time coincident locations from IR and MW data

Create dynamical geolocated statistical relationships RR-T_b

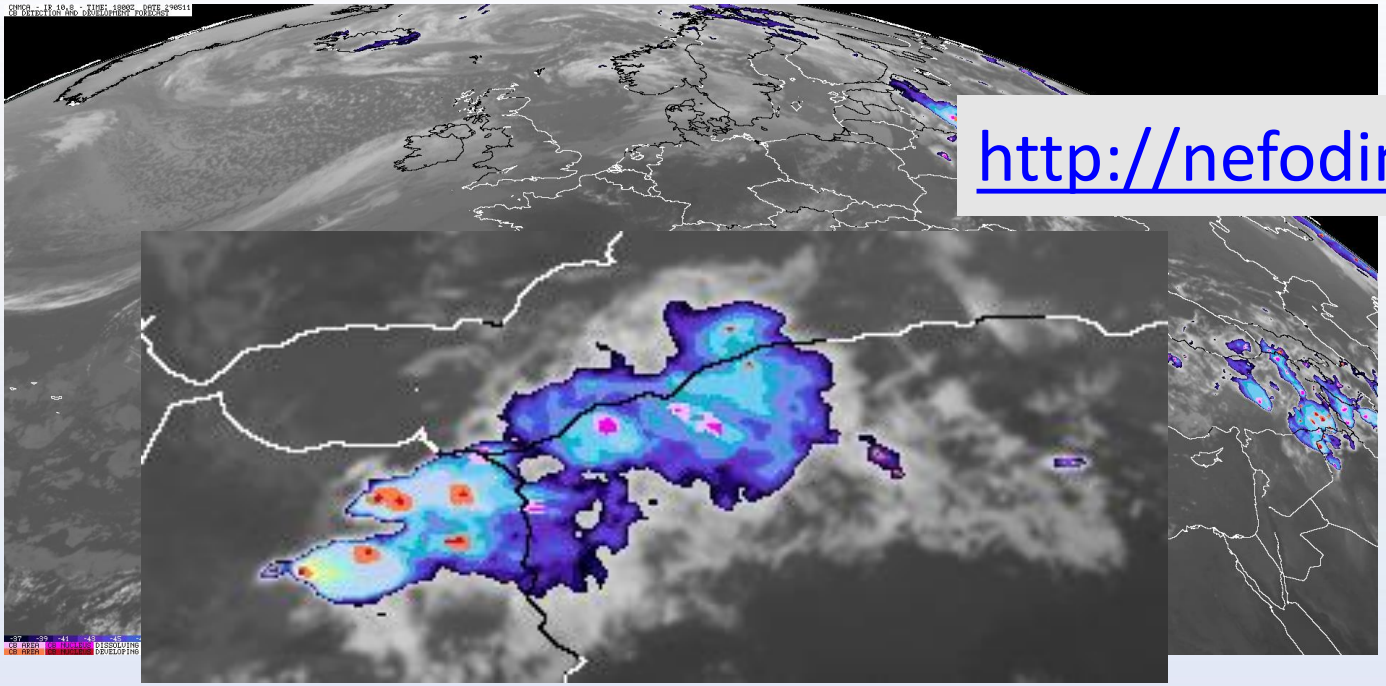
MSG- SEVIRI IR brightness temperatures at 10.8 µm

Assign RR at every IR pixel

Produce instantaneous rain intensity maps at the geostationary time/space resolution



NEFODINA software



http://nefodina.meteoam.it

- With red shades are indicated the cloud top of the detected convective cell in growing phase
- With pink shades are indicated the cloud top of the detected convective cell in decreasing phase.

The Satellite "Beam filling" Problem

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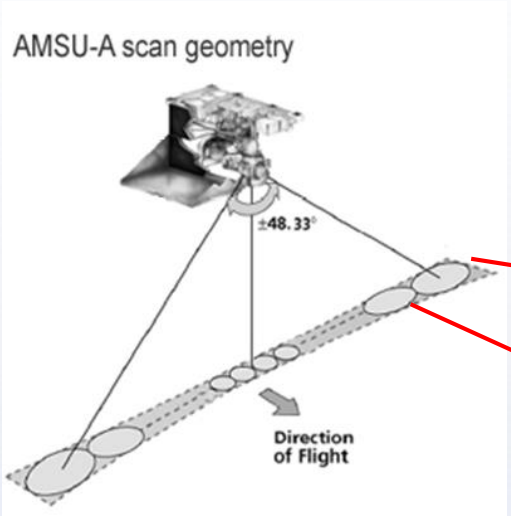
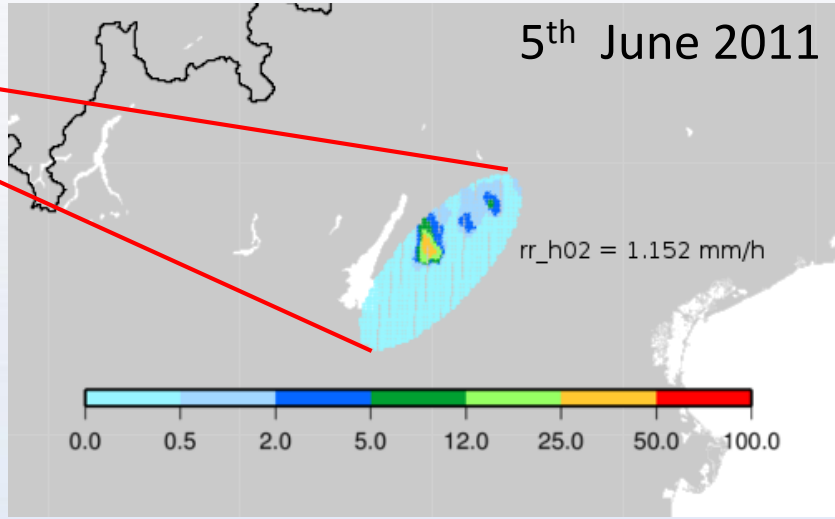
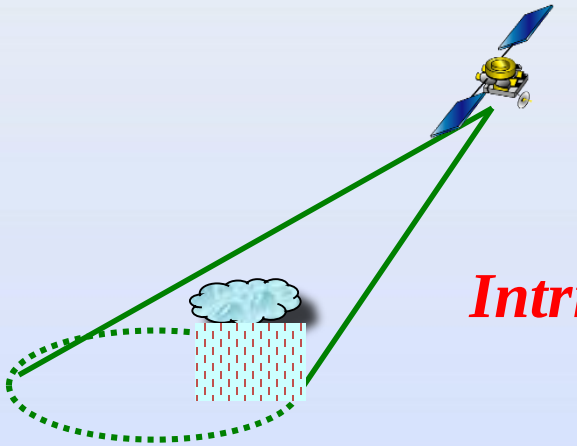
Comparison between precipitation retrieval by microwave sensor on polar satellite (AMSU) and radar.

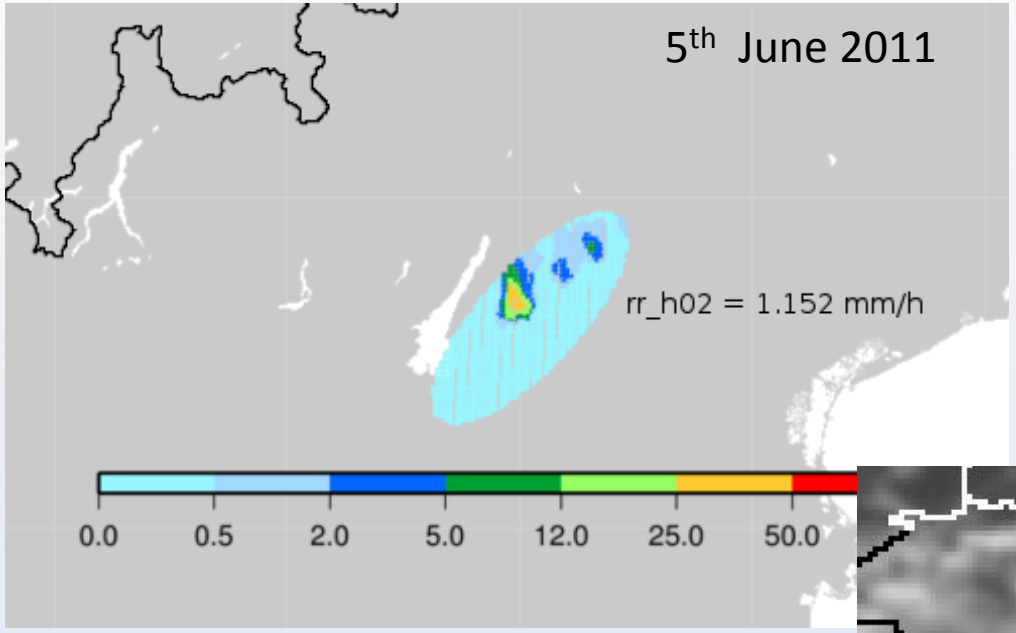




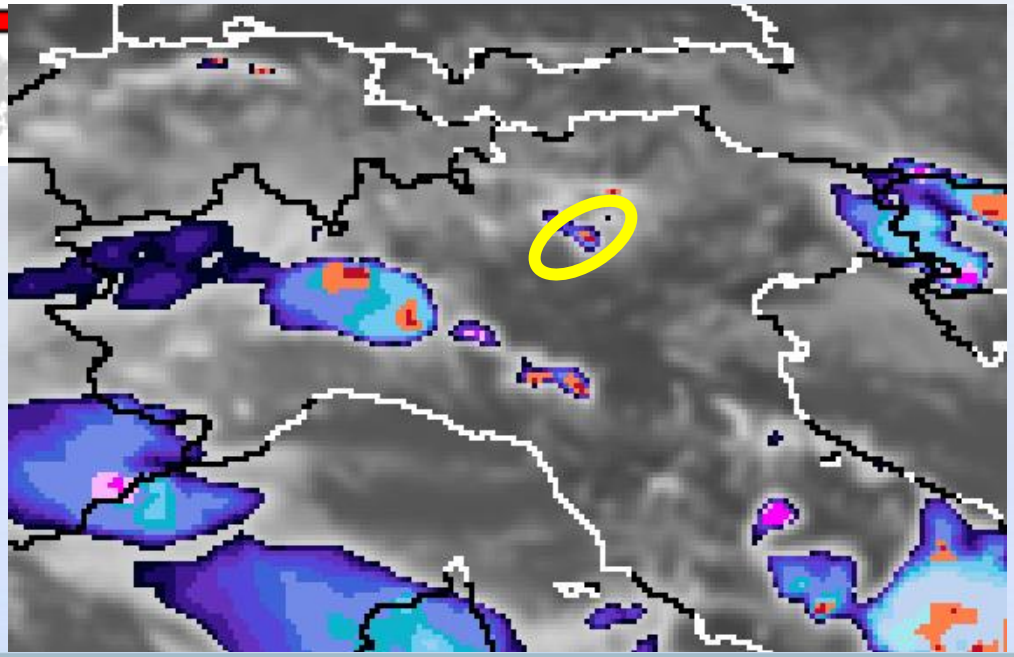


Intrinsic Underestimation

NEFODINA software



Rain redistribution based on convective cell's area



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Case study: 1st October 2009

Accumulated precipitation in the previous 3 hours: 20091001 2100

CDOP2 – Next steps

- March 2015: ORR1 Part 5 to be declared Operational

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	CDOP-2 Project Plan (Annex I)	Doc. No: SAF/HSAF/CDOP2/PP/1.0 Issue: Version 1.0 Date: 11/12/2012 Page: 7/48

Objectives and tasks:
Development of H15B precipitation product, performing the enlargement of H15A product from H-SAF area to full disc.

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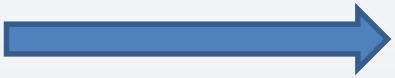
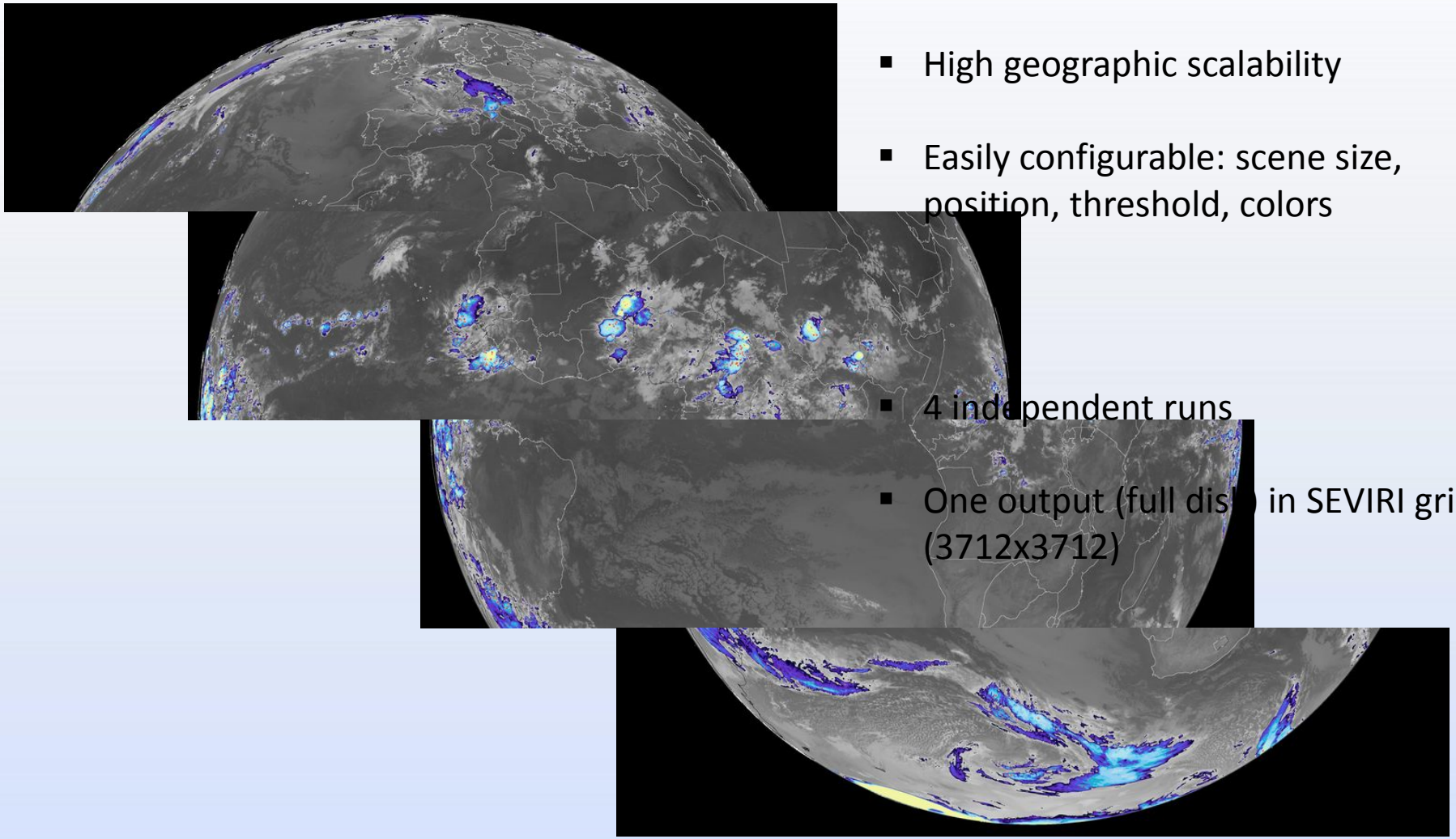
H15 developments

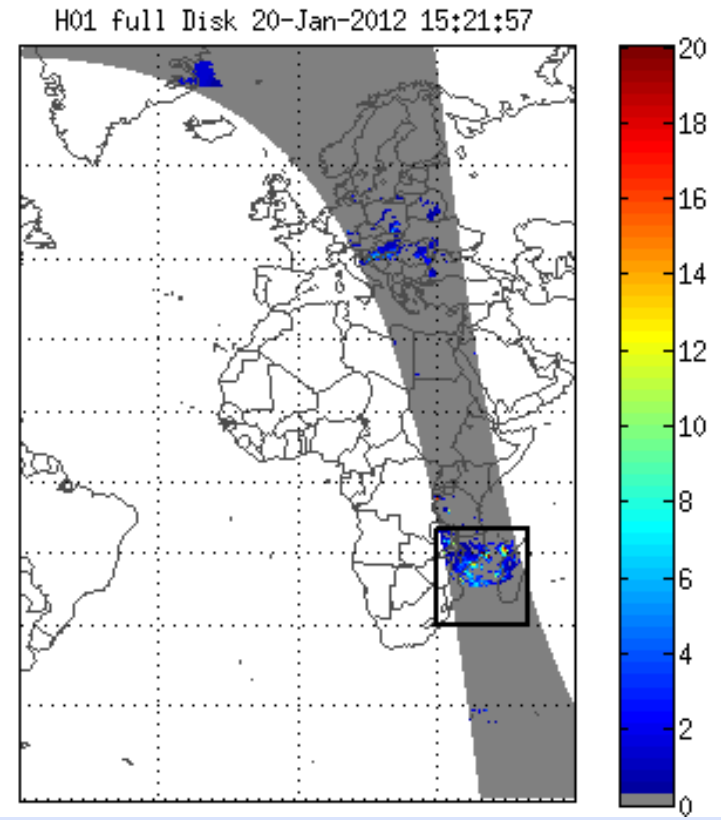
- Software  Full Disk
- Algorithm
- Inputs
- Convection Mask

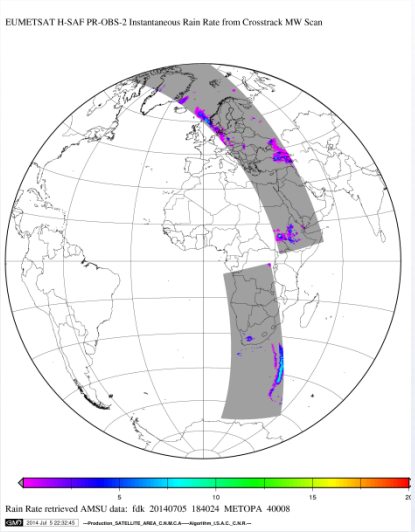
H15 – Full disk

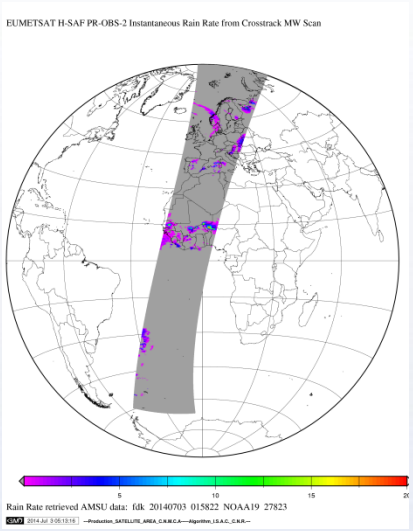


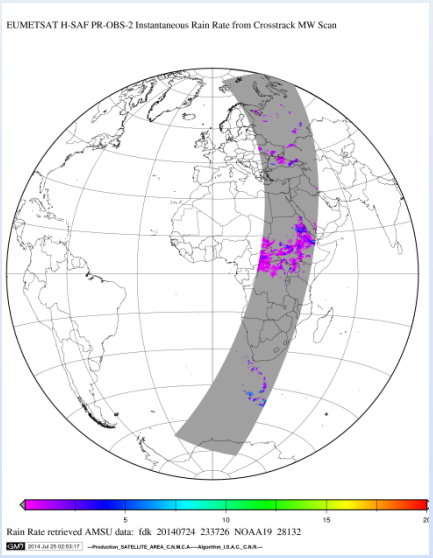
- High geographic scalability
- Easily configurable: scene size, position, threshold, colors
- 4 independent runs
- One output (full disk) in SEVIRI grid (3712x3712)

H15 – Full disk



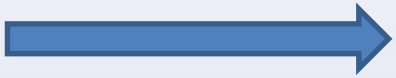






H15 developments

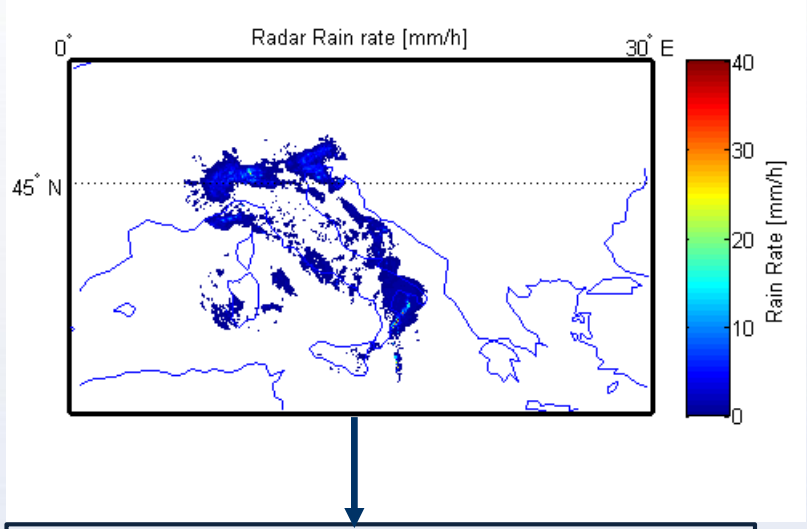
- Software
- Algorithm
- Inputs
- Convection Mask



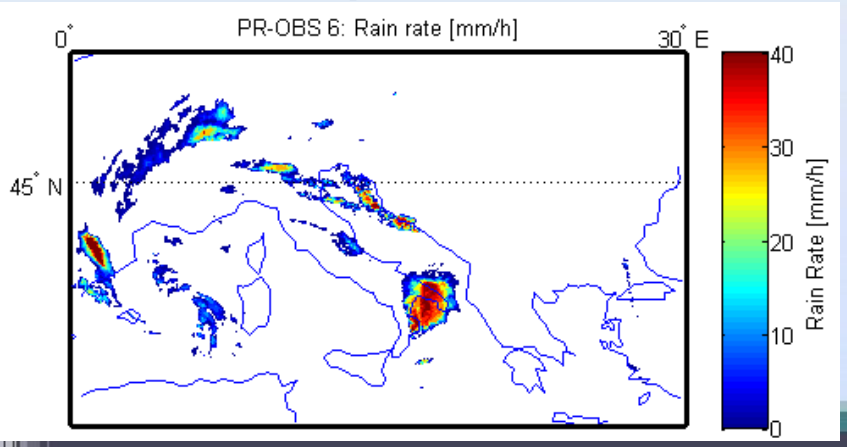
Calibration Campaign

Tor Vergata University

H15 calibration



Cost function based on Rain Rate: F=RMSE(Radar;H15*)



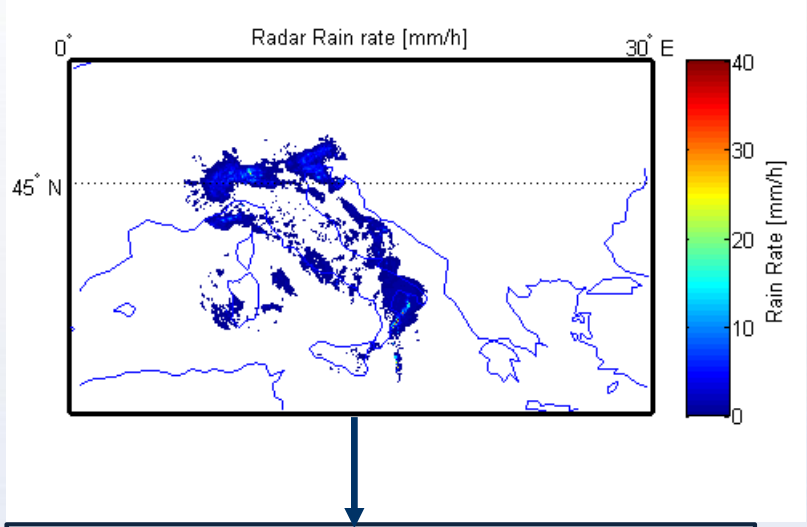
Simulated Annealing Approach

- ***Regularization algorithm to find a functional***
- ***Minimization is based on cost functions F considering rain rates [R.R.] (radar)***
- ***Different F definitions have been tested***

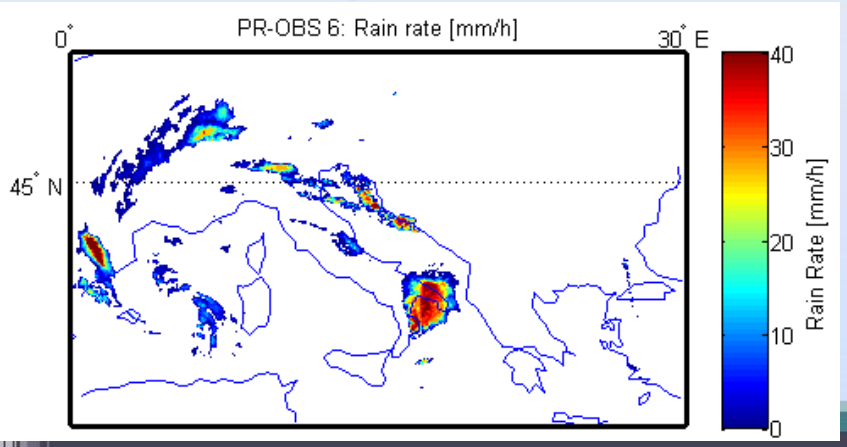
Training Set	Validation Set(*)	Test Set
2013-05-03	*2013-12*	*2013-11-19*
2013-06-24	*2013-01*	
2013-06-25	*2013-02*	
2013-11-18		
2013-11-19		

(*) full month considered

H15 calibration



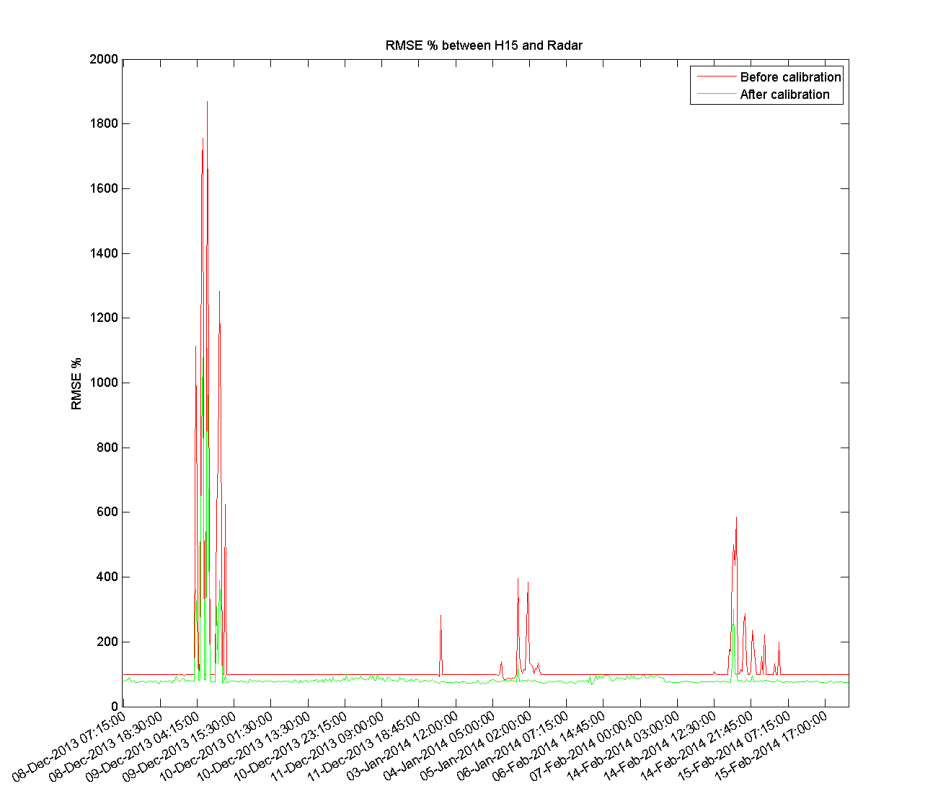
Cost function based on Rain Rate:
F=RMSE(Radar;H15*)



Best performance with exponential correction

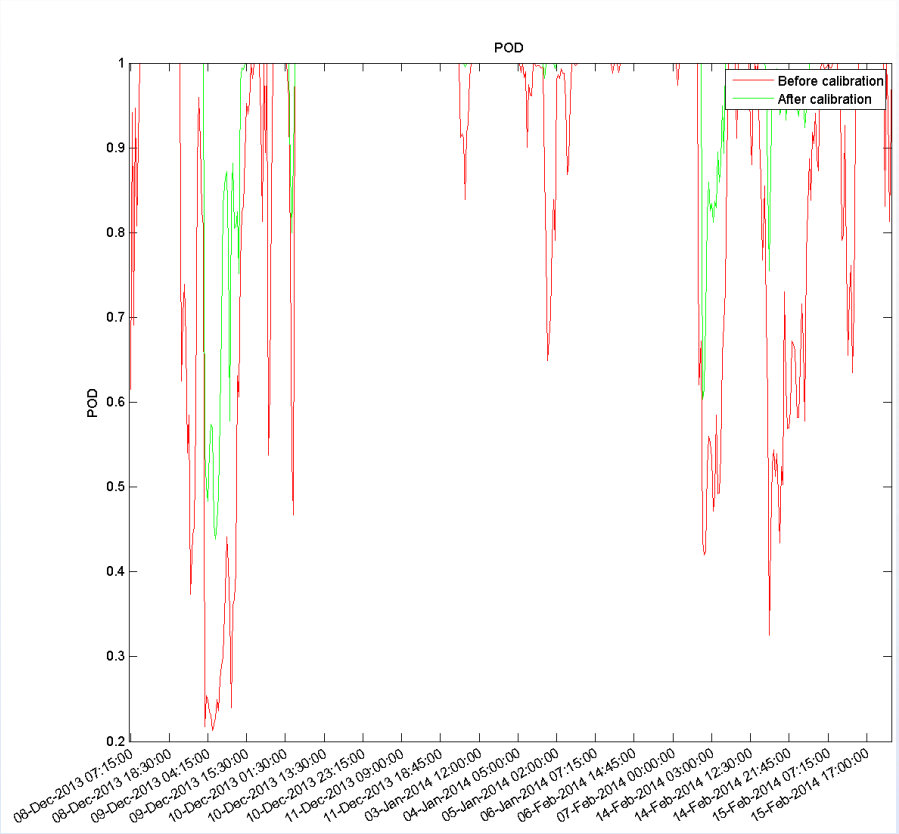
$$H15^{*}=e^{(H15 \cdot m + q)}$$

Statistical evaluation on validation set



$$RMSE\,\% = \sqrt{\frac{1}{N}\sum_{k=1}^{N}\frac{(sat_k - true_k)^2}{true_k^2}} \cdot 100$$

Range: 0 to ∞. Perfect score: 0



$$POD = \frac{hits}{hits + misses} - \frac{hits}{observed\ yes}$$

Range: 0 to 1. Perfect score: 1
hit: event observed from satellite and also observed from ground.
miss: event not observed from satellite but observed from ground.
Observed yes: total of correctly observed event from satellite.

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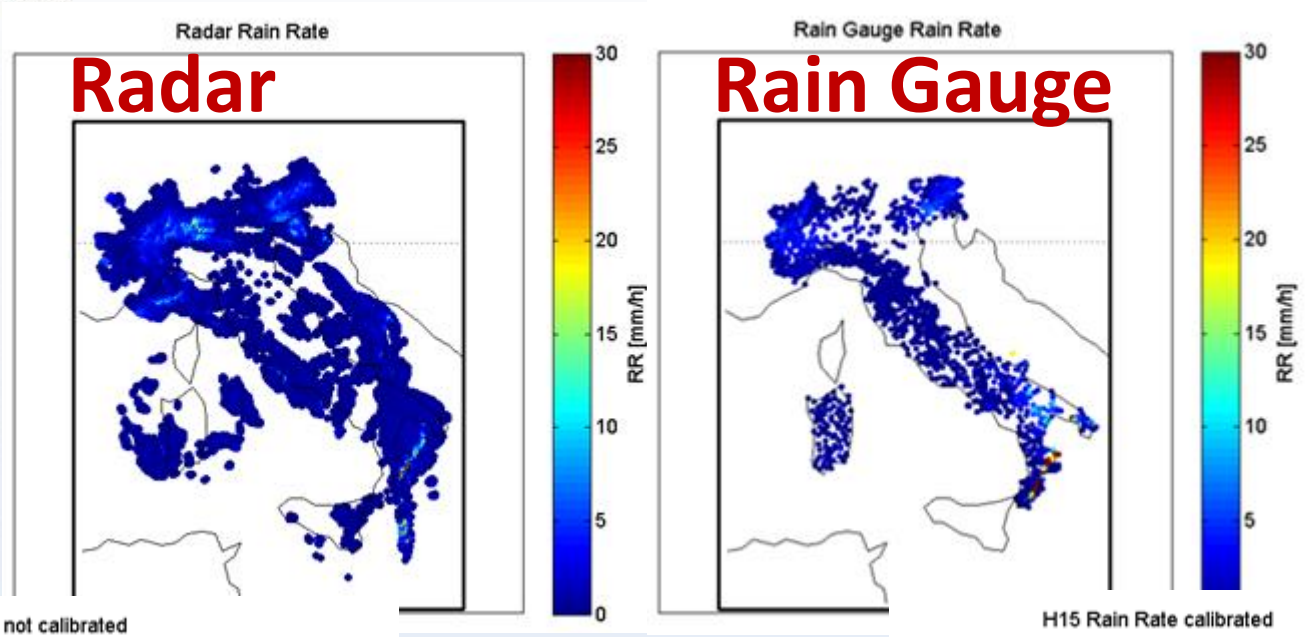
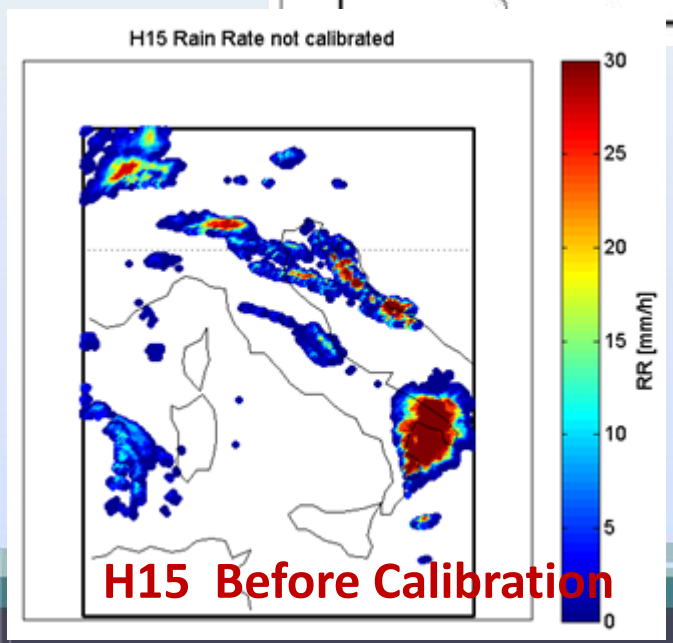
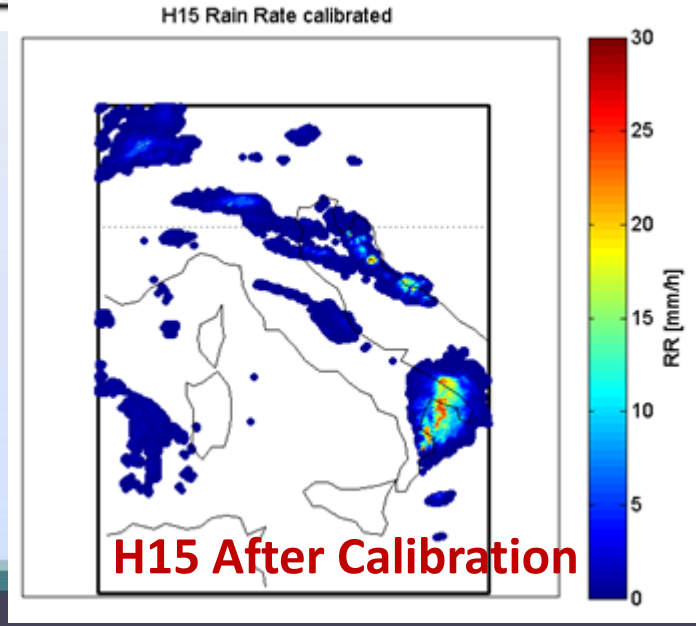
Test Date: 19-11-2013 07:27





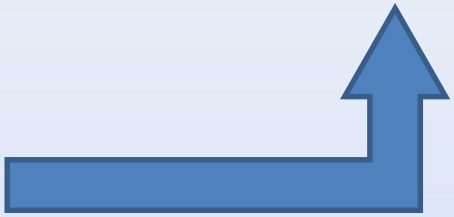


H15 developments

The reliability of these products strongly depends on three factors:

1) accuracy of the PMW precipitation retrievals;
2) temporal frequency of PMW observations
3) consistency among the precipitation estimates obtained from the different PMW sensors.

- Software
- Algorithm
- Inputs
- Convection Mask



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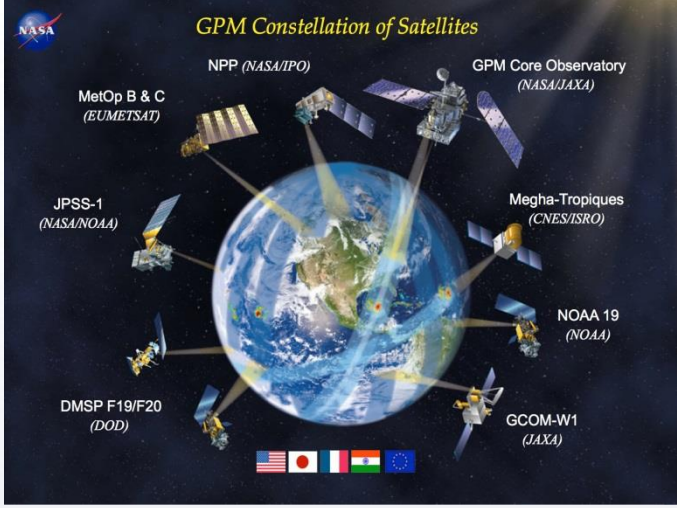
New inputs



Suomi NPP ATMS - We propose to develop a new **H18** product for the cross-scanning radiometer Advance Technology Microwave Sounder (ATMS) on board the NASA/NOAA Suomi NPP satellite. The product will be based on the Neural Network approach used for H02B product.

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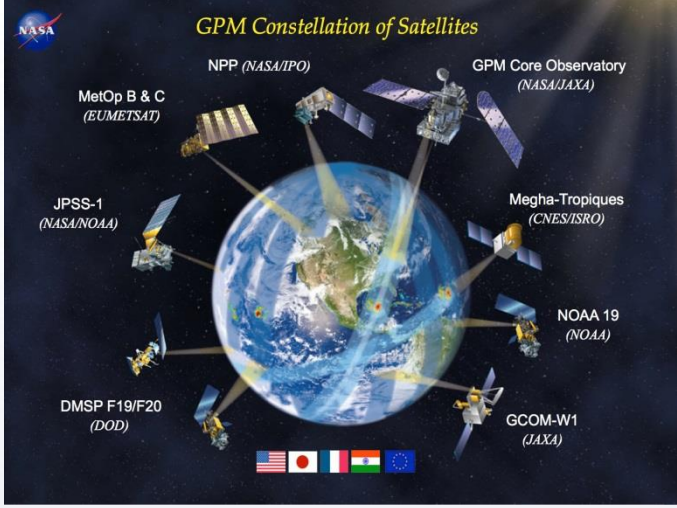
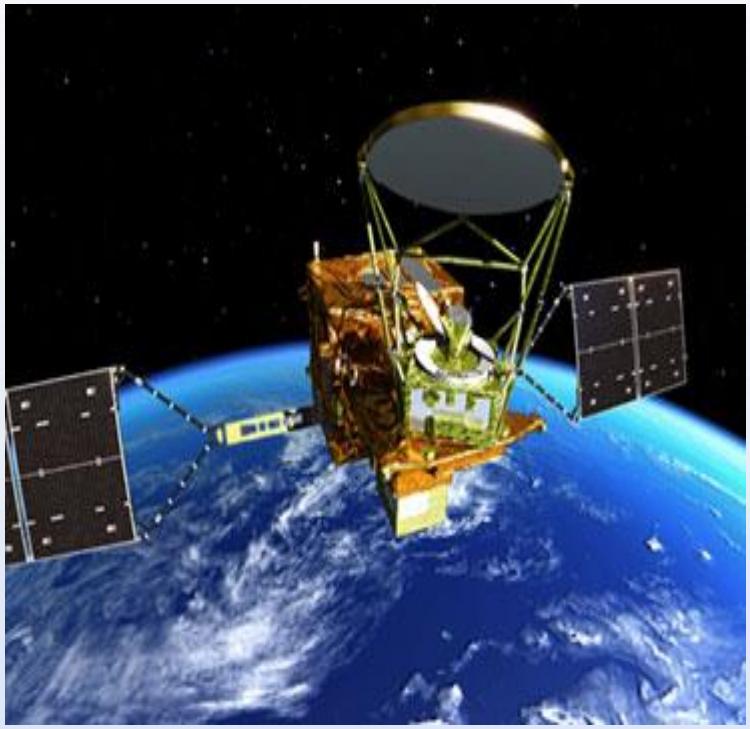
New inputs





G-COMW1 AMSR-2 - We propose to develop a new **H17** product for the conical scanning radiometer AMSR-2. The algorithm will be based on the Bayesian technique (PR-OBS-1) and on the use of the Cloud Dynamical Radiation Database (CDRD) used for H01, but adapted to the AMSR-2 radiometer characteristics (i.e., channel frequencies and polarization, viewing geometry, horizontal resolution, etc.). The product delivery is subject to the availability of AMSR-2 data in near-real time via Eumetcast.

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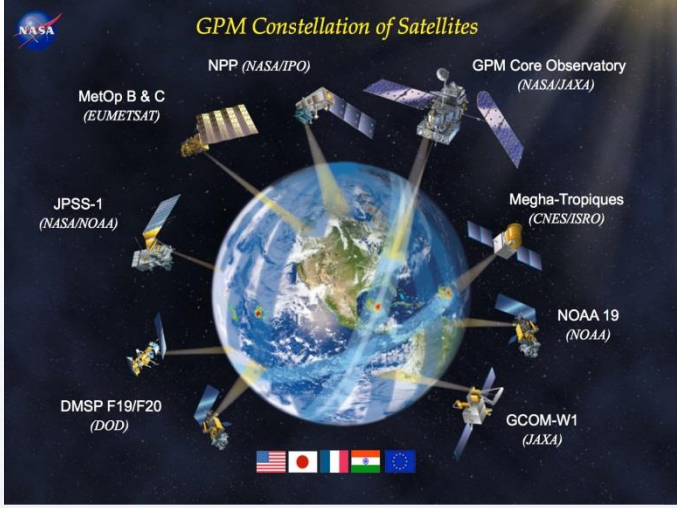
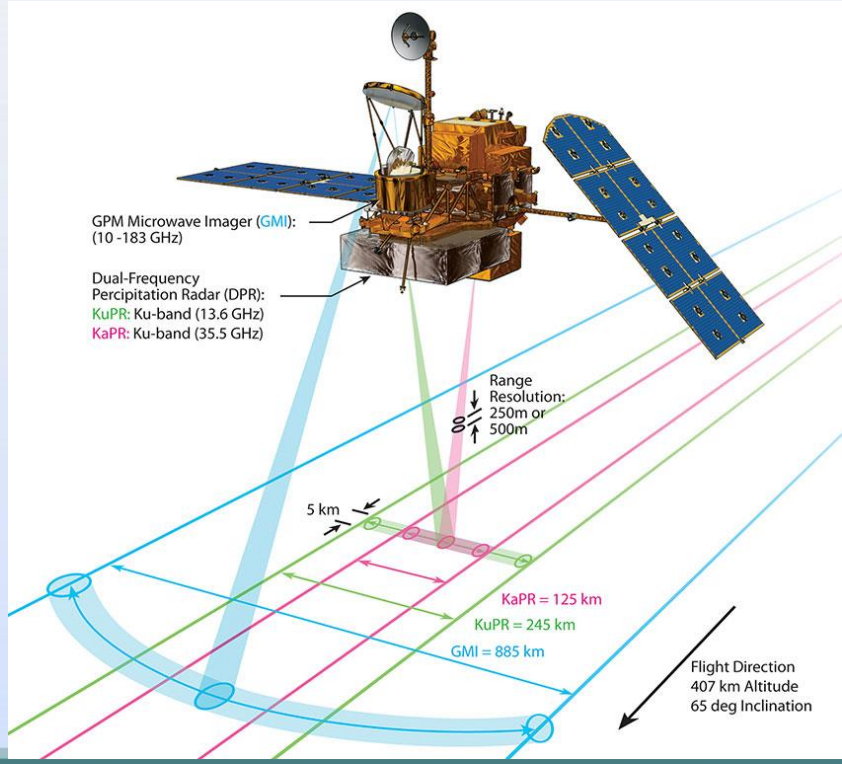
New inputs



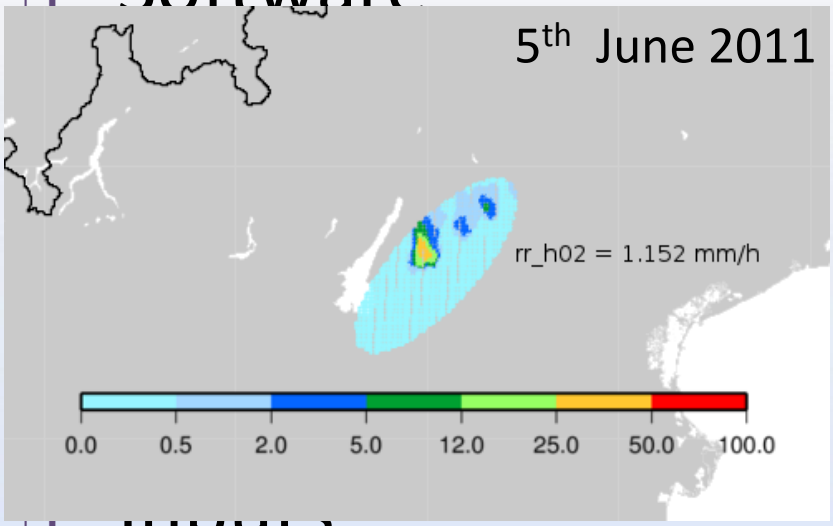
GMI - Two products (H19 and H20) had been already planned in the CDOP-2 proposal for the **GPM Microwave Imager**. However, due to the delay of the launch date (February 27, 2014) we propose a redefinition of the two products:

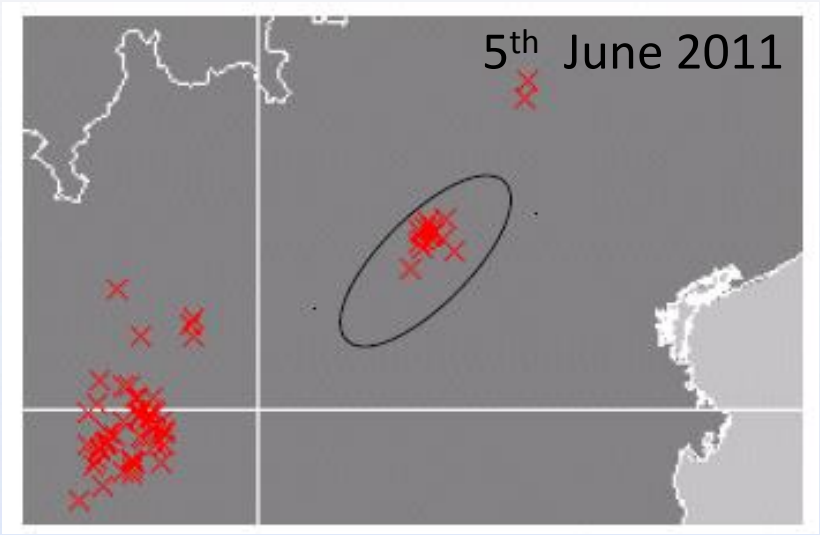
- ✓ H19: product for the MSG full disk area based on the a Neural Network approach and on the use of a cloud-radiation model database (as in H01), with the additional input provided by the DPR;
- ✓ H20: global product based on a Neural Network approach (as in H02), and on the use of an observational datasets built from DPR retrievals and GMI brightness temperatures coincidences.



H15 developments

- Software





- Inputs

- Convection Mask

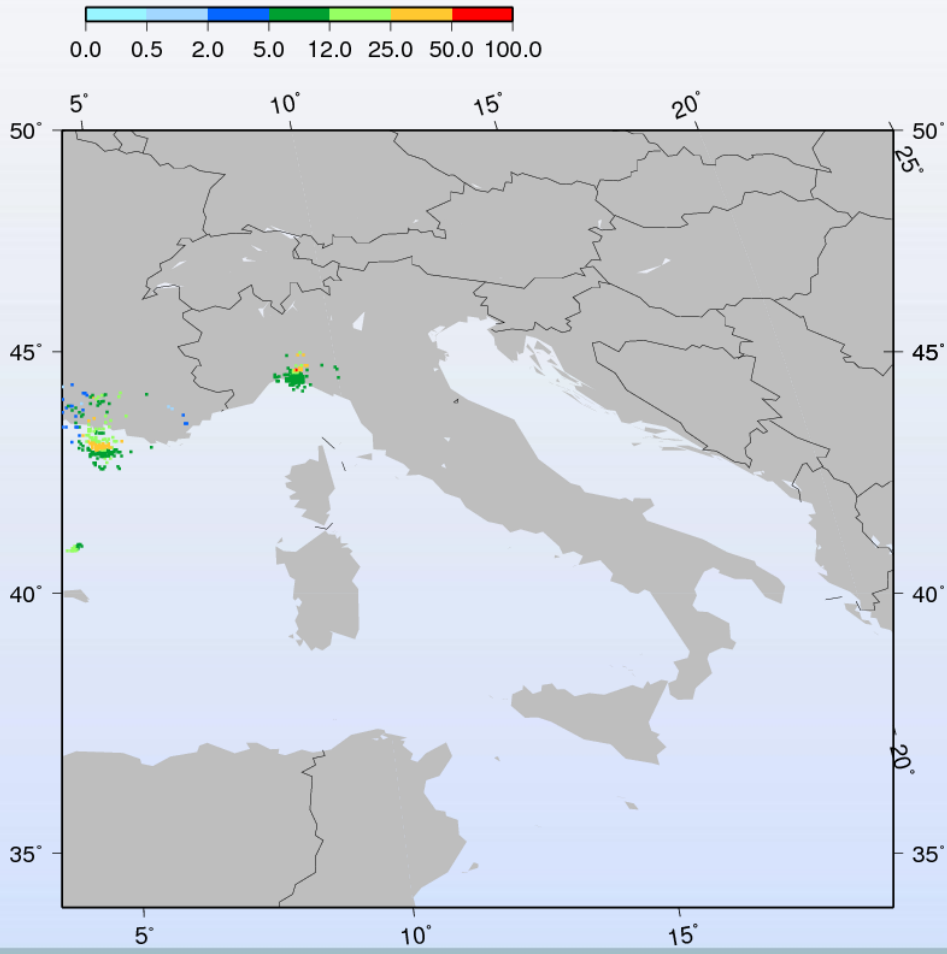
RELASE Software

Rainfall Estimation from Lightning And Seviri data

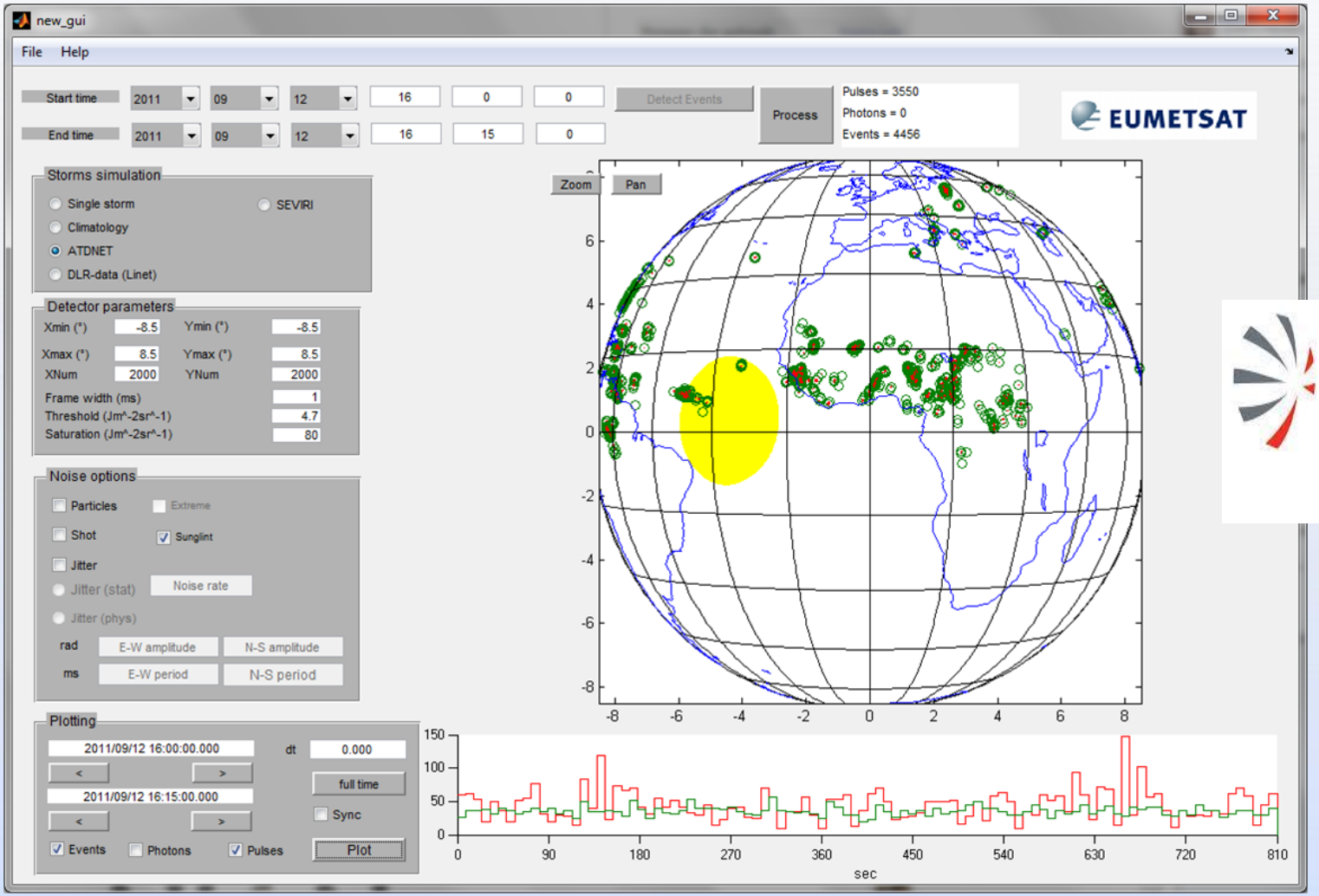
A rainfall retrieval technique that uses geostationary satellite Infrared (IR) observations and lightning information retrieved from LAMPINET (lightning network of the Italian Air Force Meteorological Service)

A quantitative relationship for rainfall estimation using lightning and Seviri data has been developed using a bivariate linear regression for the cluster's rain volume :

$$RR = (b_0 + b_1 S/N + b_2 T)N$$

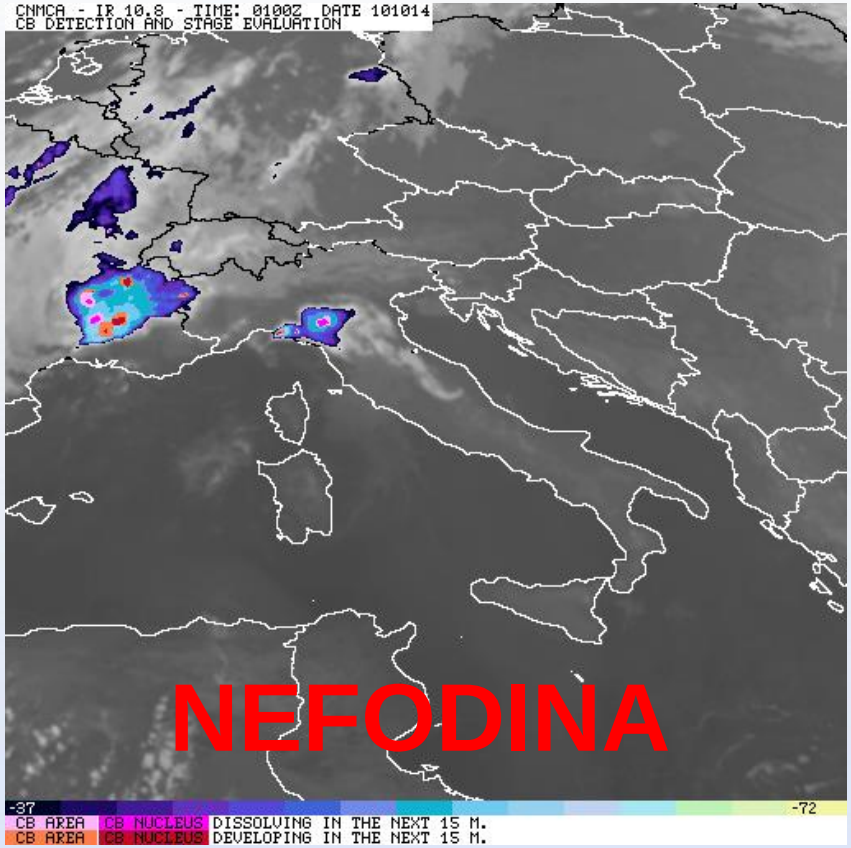


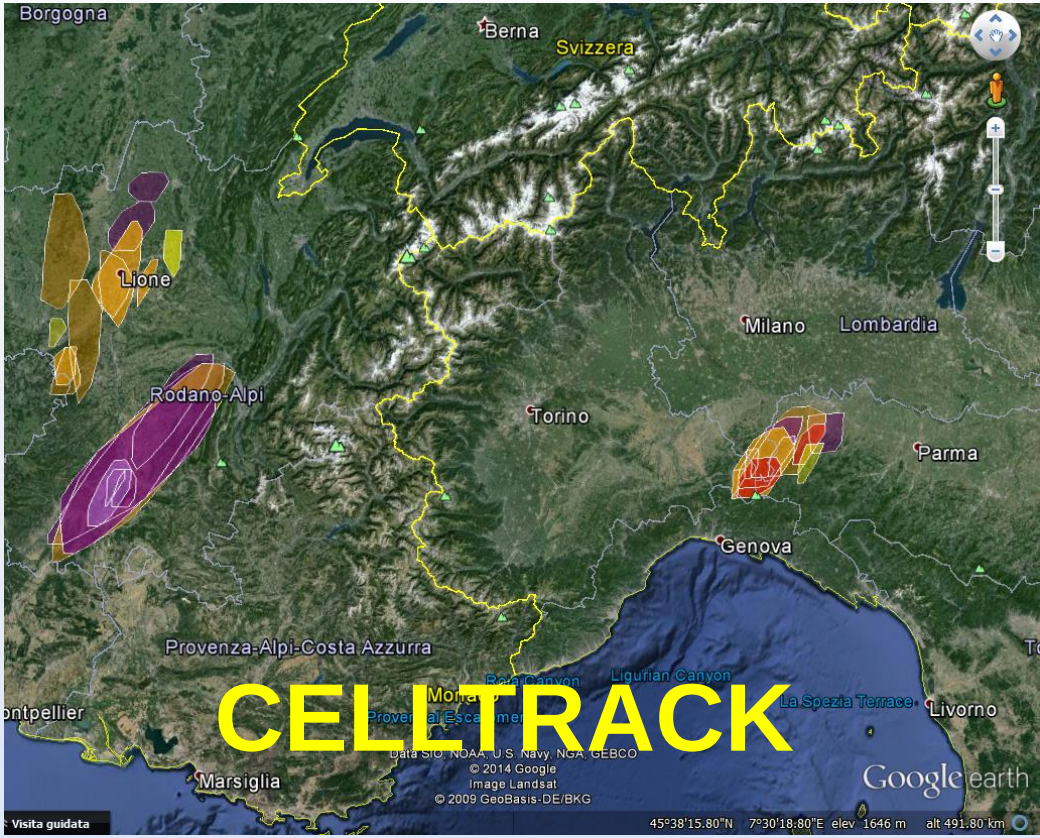
MTG-LI simulator



Selex ES
A Finmeccanica Company

Convection Mask





NEFODINA_2.0

The EUMETSAT Network of Satellite Application Facilities

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Support to Operational Hydrology and Water Management

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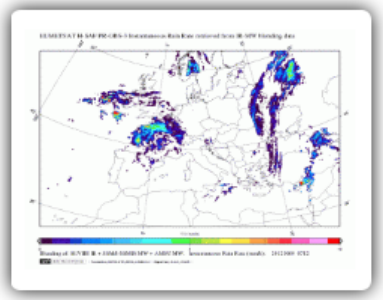
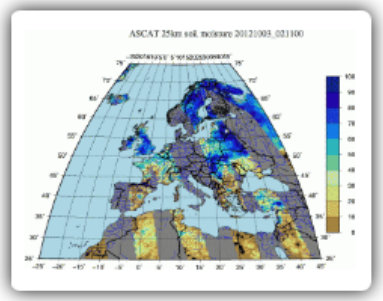


PRECIPITATION

Images | Descriptions | Quality Monitoring | User Documents | Visiting Scientist | References

PR OBS 1	PR OBS 2	PR OBS 3	PR OBS 4	PR OBS 5	PR ASS 1
Precipitation rate at ground by MW conical scanners (with indication of phase)	Precipitation rate at ground by MW cross-track scanners (with indication of phase)	Precipitation rate at ground by	Precipitation rate at ground by	Accumulated precipitation at	Instantaneous and
operational	operational				

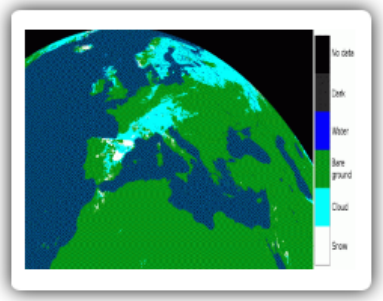
us_hsaf@meteoam.it



SOIL MOISTURE

Images | Descriptions | Quality Monitoring | User Documents | Visiting Scientist | References

SM OBS 1	SM OBS 2	SM ASS 1	SM DAS 2
Large scale surface soil moisture by radar scatterometer	Small scale surface soil moisture by radar scatterometer	Volumetric soil moisture (roots region) by scatterometer assimilation in NWP model	Profile Index in the roots region by scatterometer data assimilation
development	pre-operational	development	development



SNOW

Images | Descriptions | Quality Monitoring | User Documents | Visiting Scientist | References

SN OBS 1	SN OBS 2	SN OBS 3	SN OBS 4
Snow detection (snow mask) by VIS/IR radiometry	Snow status (dry/wet) by MW radiometry	Effective snow cover by VIS/IR radiometry	Snow water equivalent by MW radiometry
operational	development	development	development

Thank you for your attention!