The use of blending techniques in H SAF

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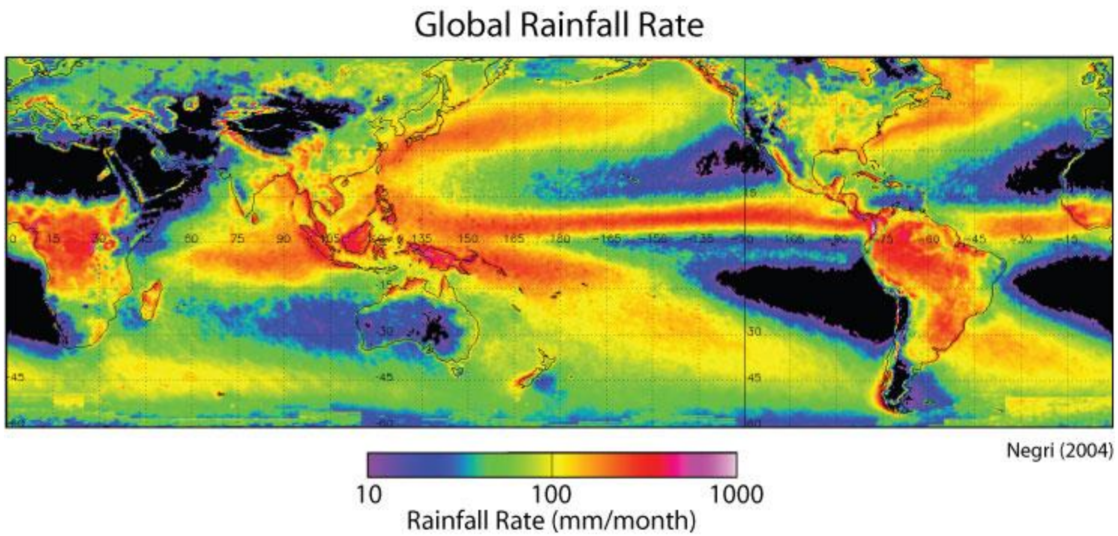
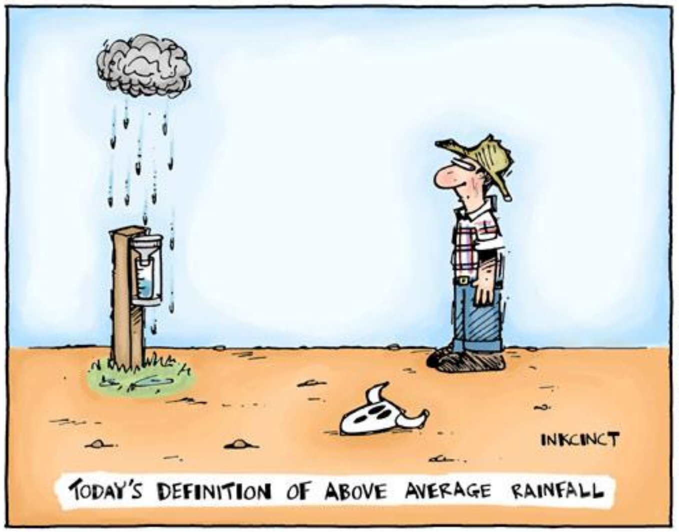
Precipitation Event Week
EUMETrain, 14-18 December 2020

Satellite Rainfall Estimation

Meteorological satellite provide a unique opportunity for monitoring the precipitation for regions where ground measurement is limited and consistent with the accuracy required by hydrologists.



Mandate of H SAF



- 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);

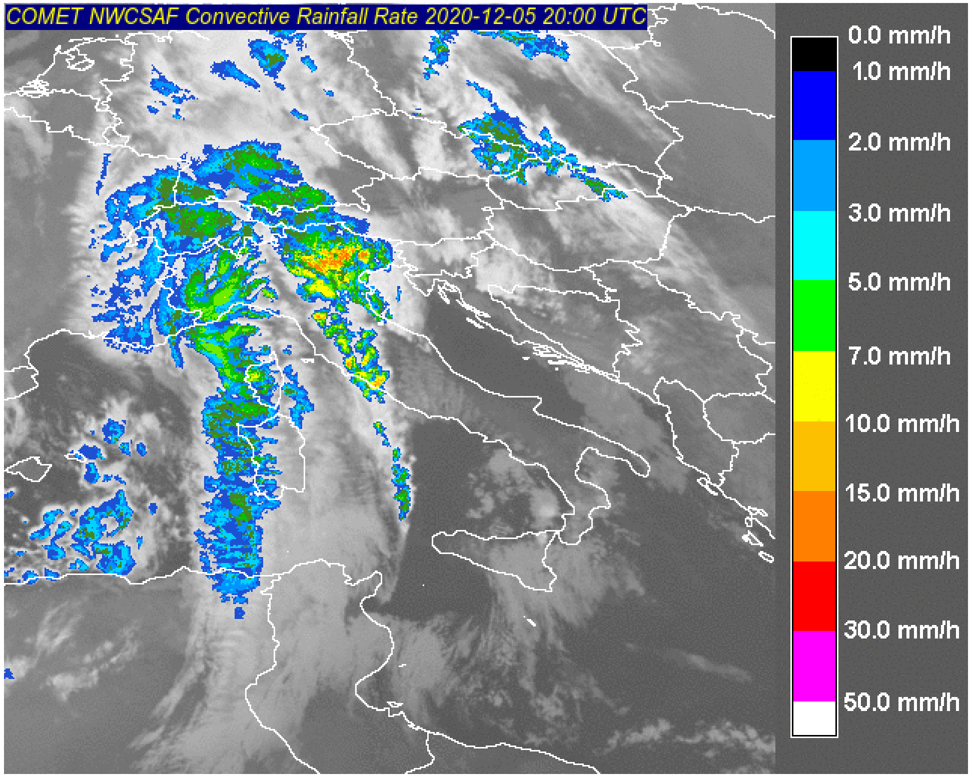
- to perform independent validation of the usefulness of the new products for fighting against floods, landslides, avalanches, and evaluating water resources; the activity includes:
  - ✓ downscaling/upscaling modelling from observed/retrieved fields to basin level;
  - ✓ fusion of satellite-derived 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.

Satellite Rainfall Estimation

Techniques for estimating precipitation from infrared and/or visible satellite data have existed almost as long as the data have been available.

Rainfall rates are generally derived from cloud-top infrared (IR) brightness temperature, which is related to cloud-top height for optically thick clouds below the tropopause.

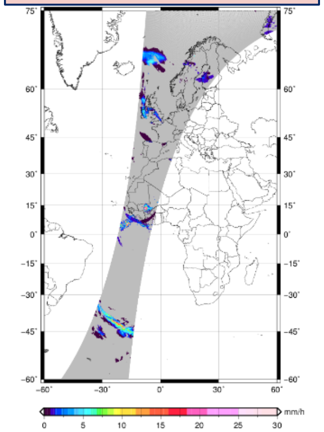
Visible cloud reflectance can be used as supplementary information



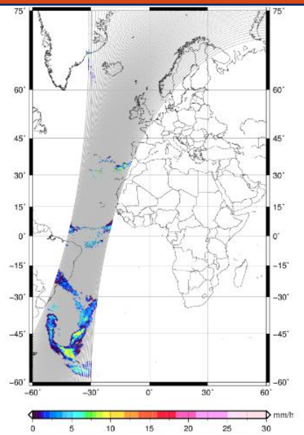
Satellite Rainfall Estimation

Microwave instruments have been shown to yield more reliable information concerning instantaneous precipitation rates on account of their ability to penetrate precipitating clouds and interact with its liquid and iced hydrometeors

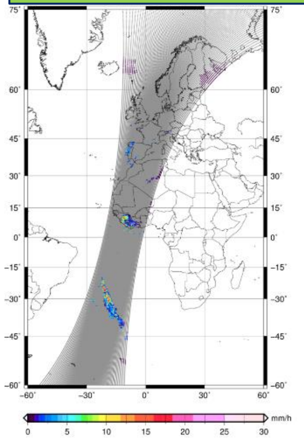
H01 – P-IN-SSMIS



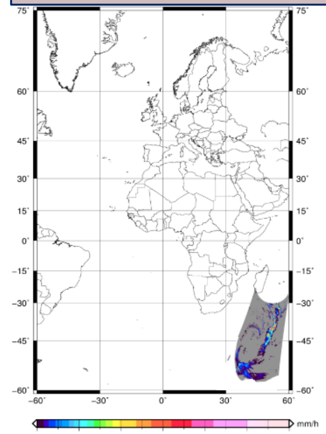
H02 – P-IN-MHS



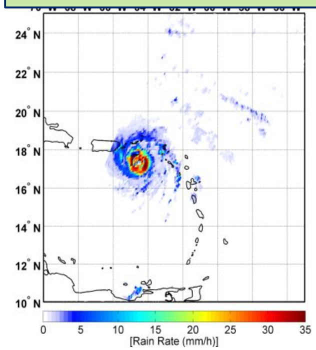
H18 – P-IN-ATMS



H-AUX-17 (AMSR2)



H-AUX-20 (GMI)

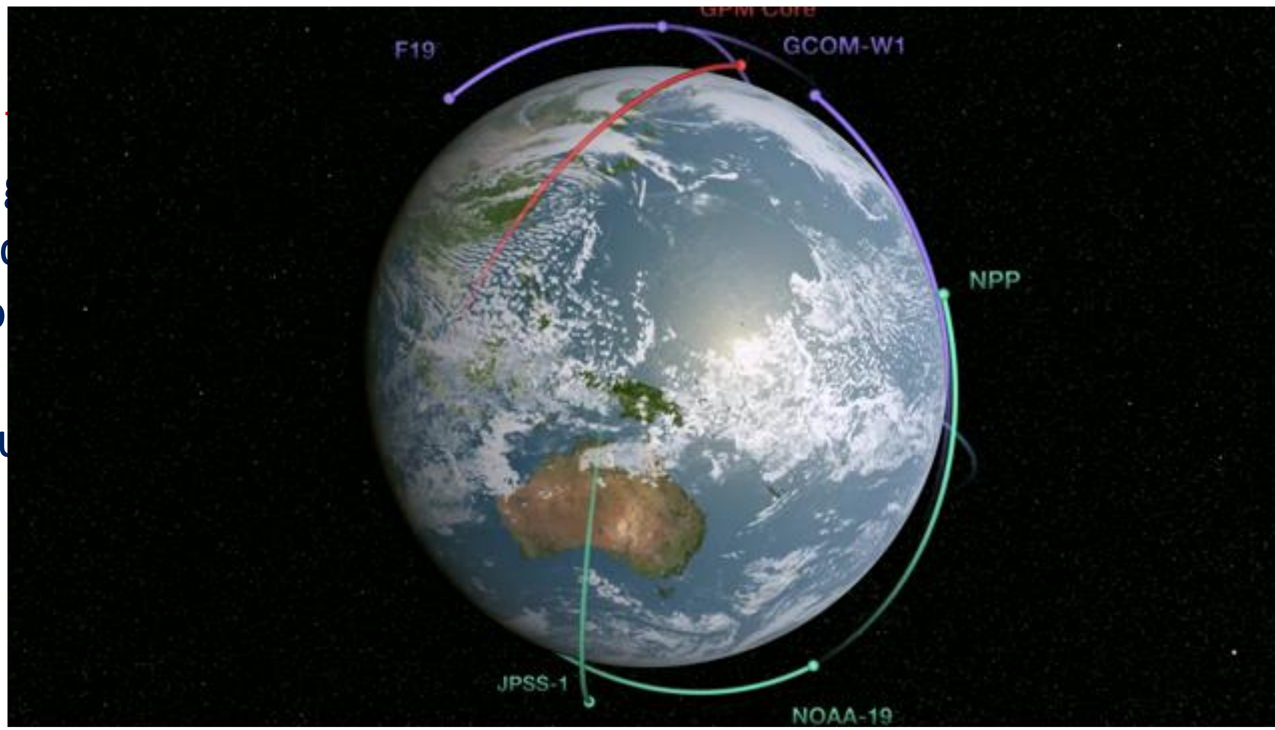


Satellite Rainfall Estimation

However, as microwave instruments are currently only available on-board satellites in Low Earth Orbit (LEO), they do not provide a continuous monitoring of rainfall over a given location.

Exploitation of all PMW radiometers (conically and cross-track scanning)

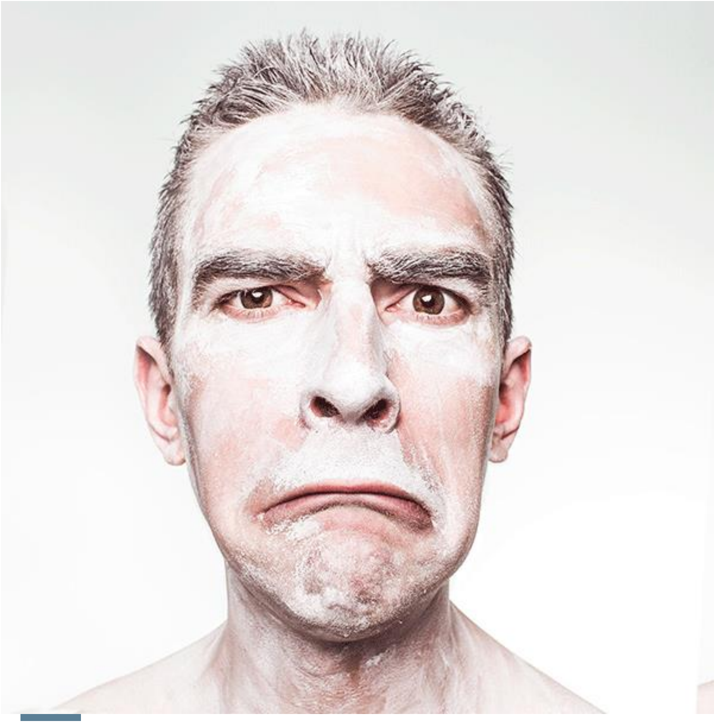
Blending
combine
This kin ... pitation
estimatio ... th orbit
satellites ... al) with
continuou ...).

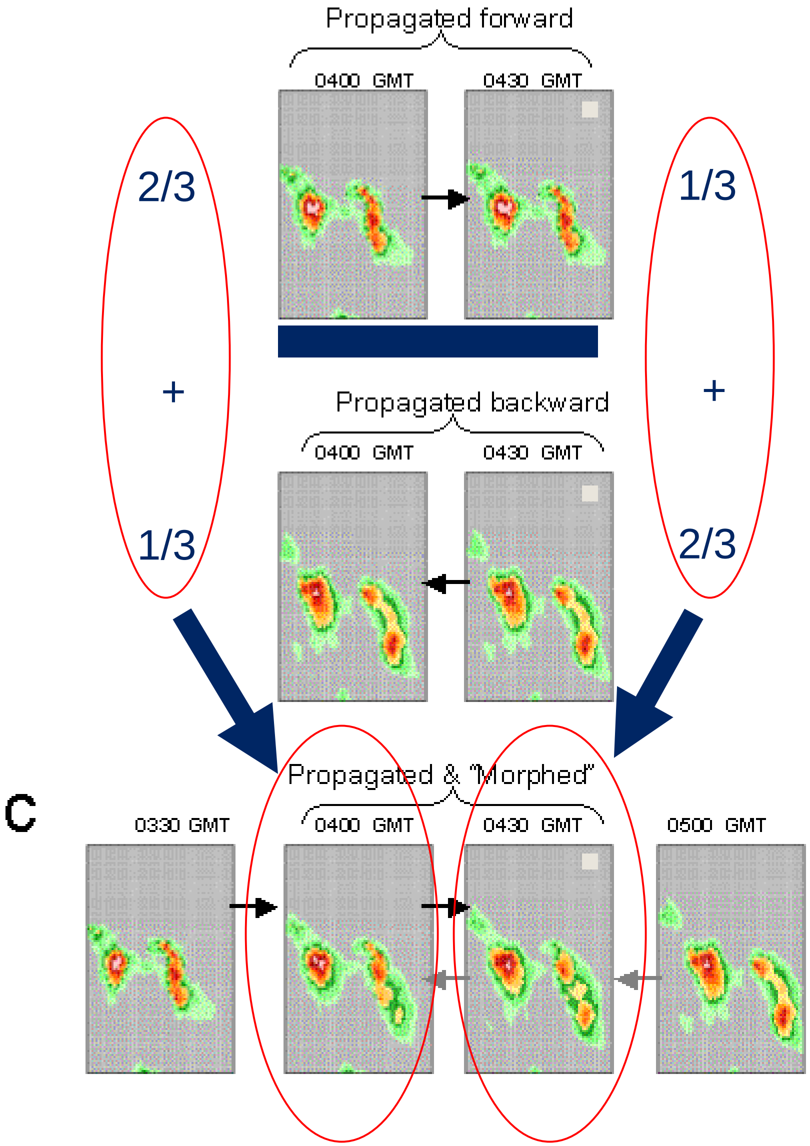


Blending technique - CMORPH

LEO + GEO Satellite Merging

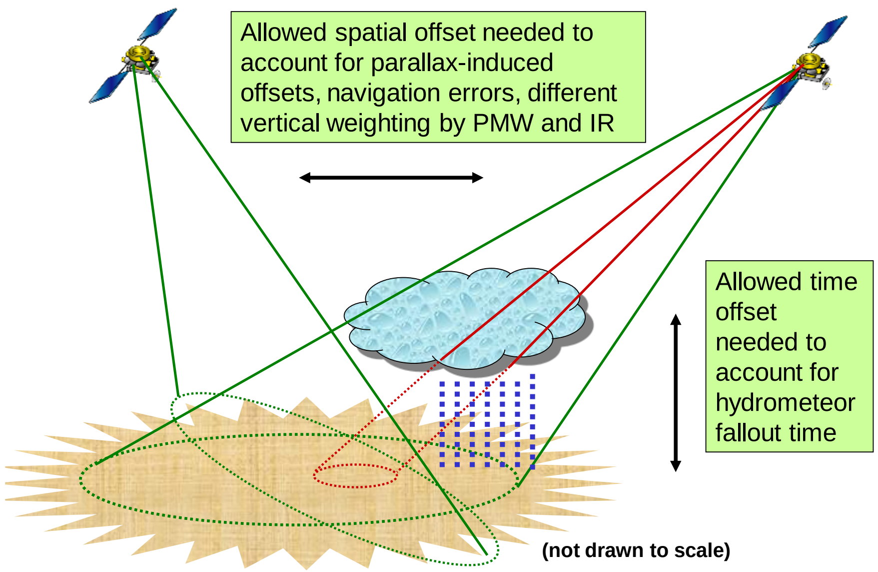
TRANSPORT METHOD

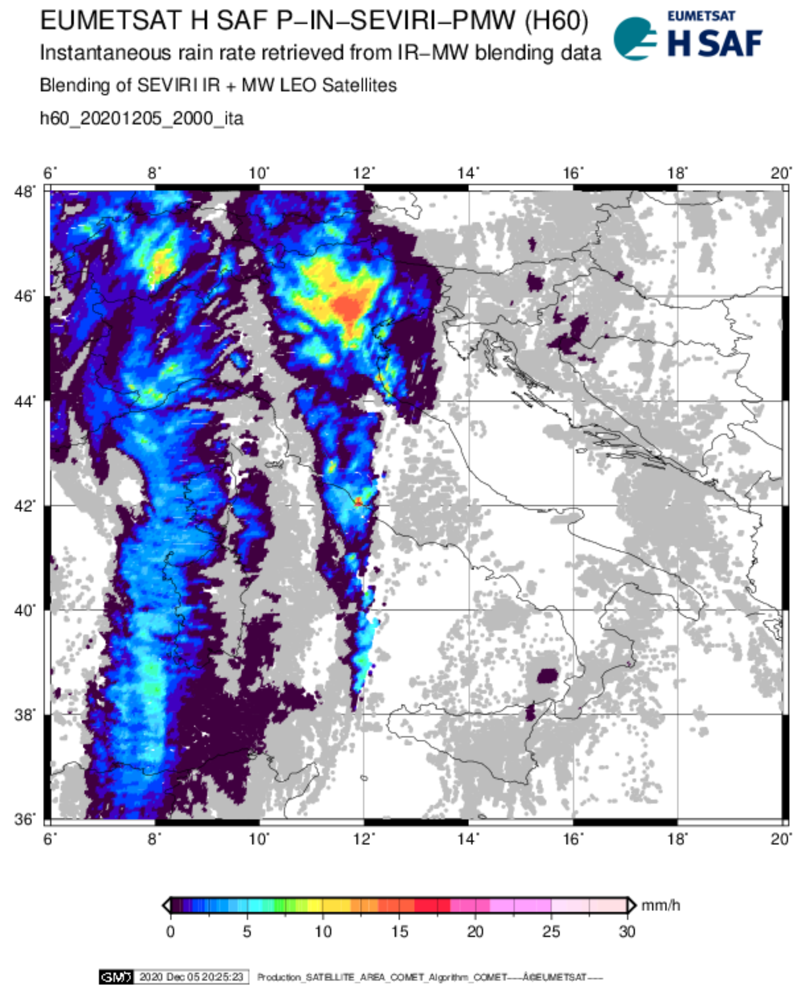




Blending technique – Rapid Update

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.





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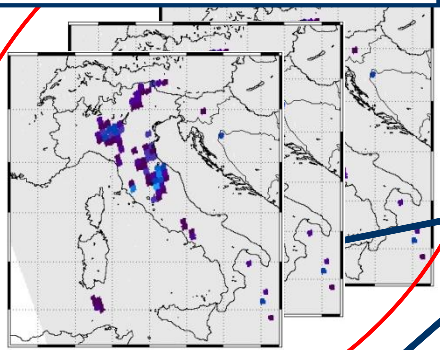
Blending technique – Rapid Update

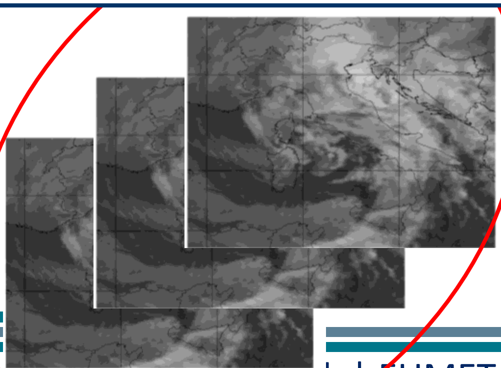
How it works

Rain intensity maps from PMW data

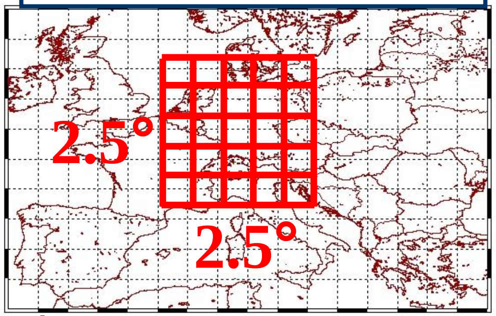


AT TIME t…

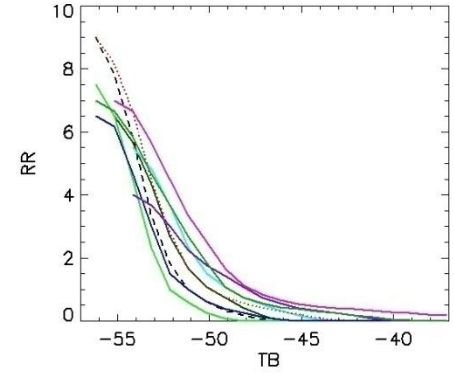
MSG- SEVIRI IR brightness temperatures at 10.8 μm



Extract space and time coincident locations from IR and MW data for each grid box



Create dynamical geolocated statistical relationships RR-T_b



Assign RR at every IR pixel

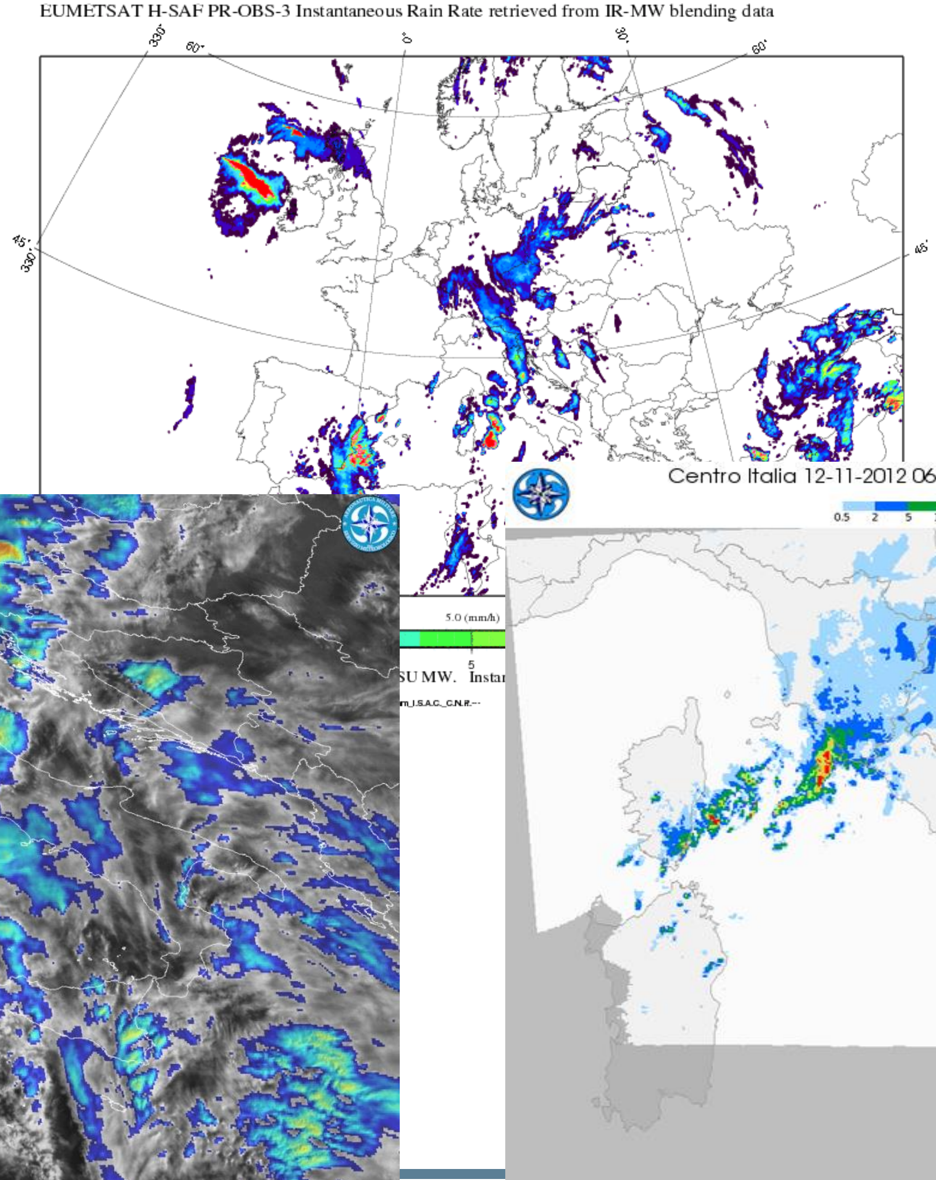
Produce instantaneous rain intensity maps at the geostationary time/space resolution

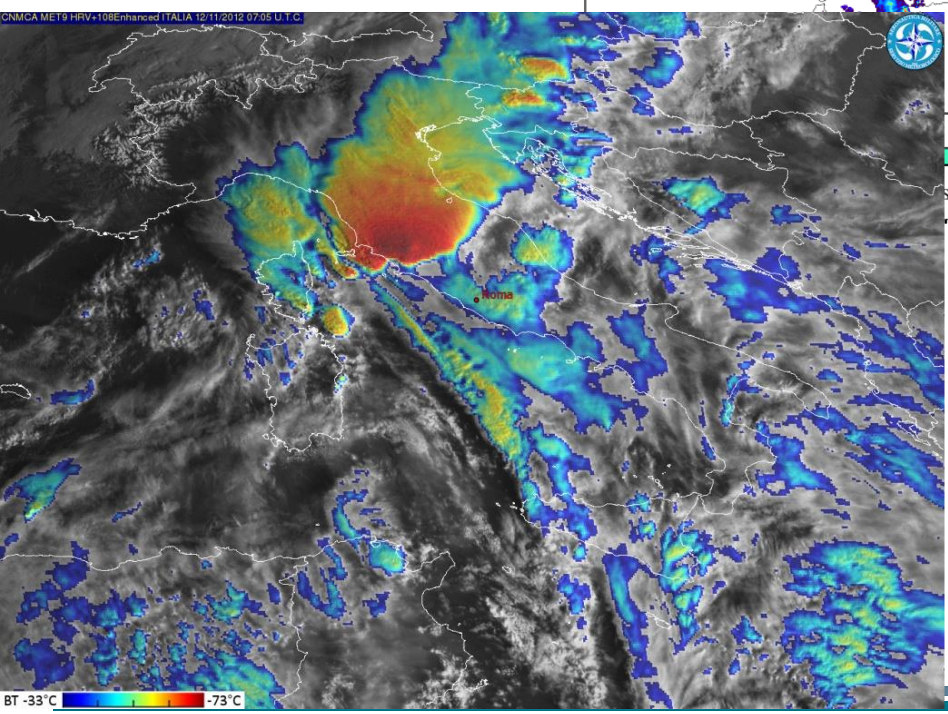
The process is restarted for each IR slot in the study period

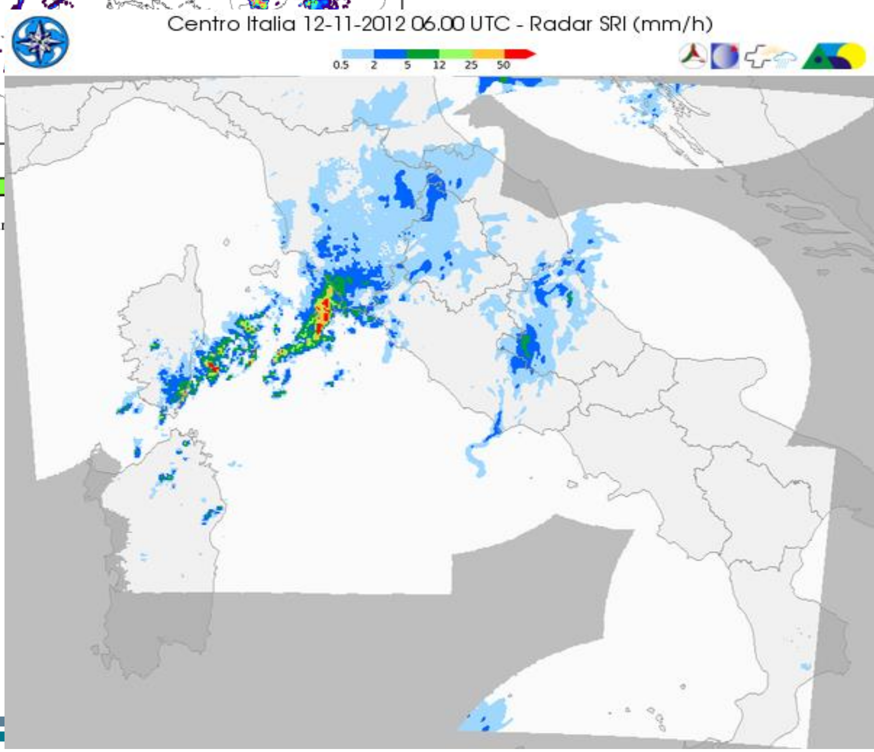
Blending technique – Rapid Update

Example

P-IN-SEVIRI/H03
Case study:
11-12 /11/ 2012
Grosseto (Italy)

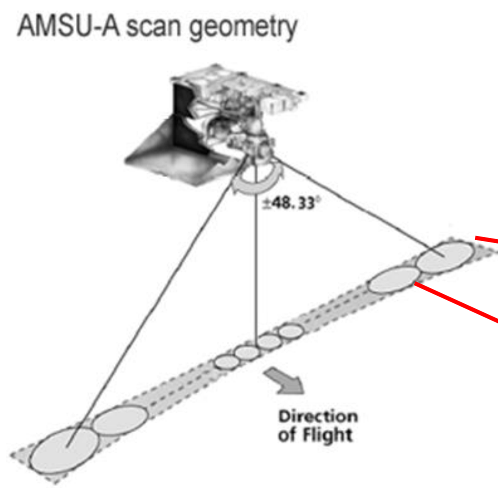


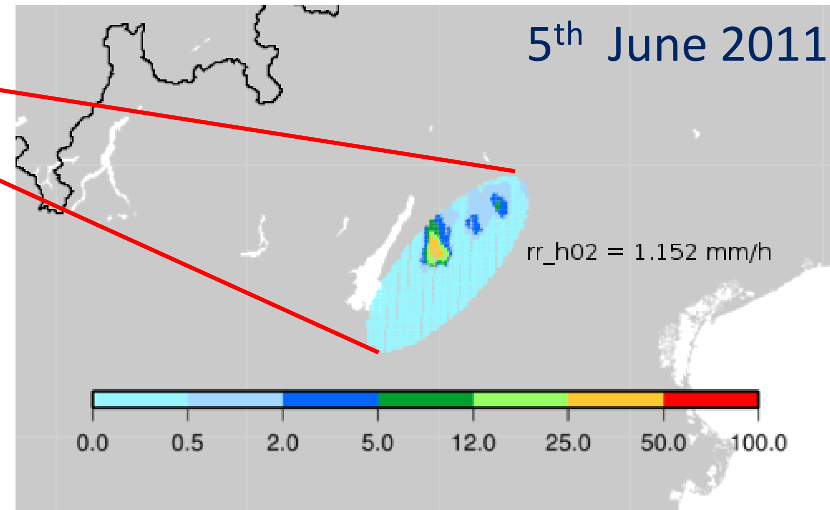


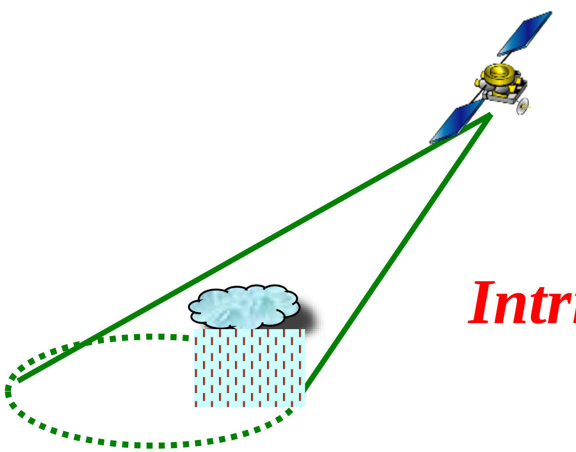


The Satellite "Beam filling" Problem

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

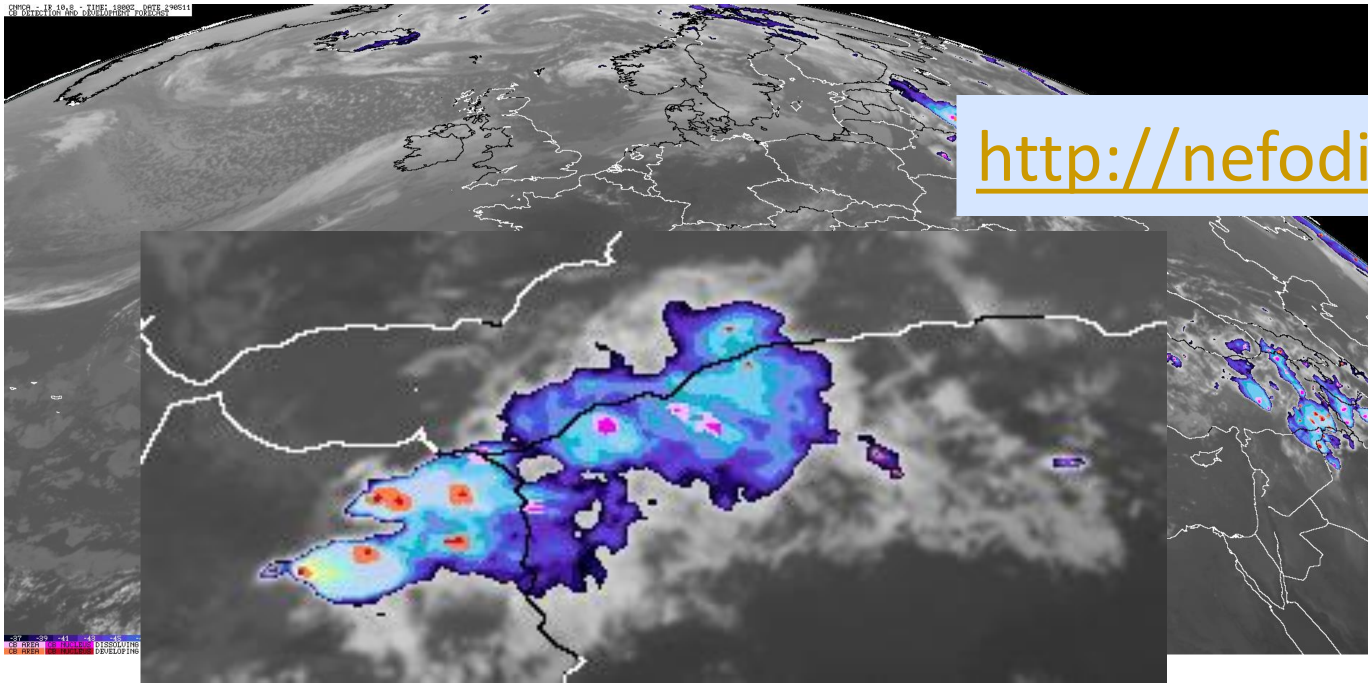






Intrinsic Underestimation

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.

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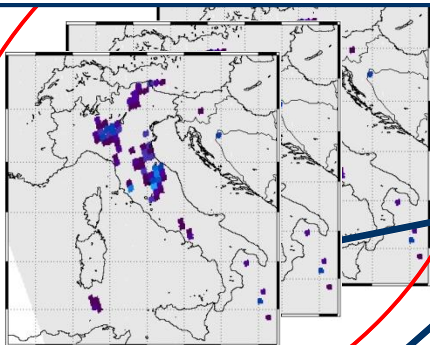
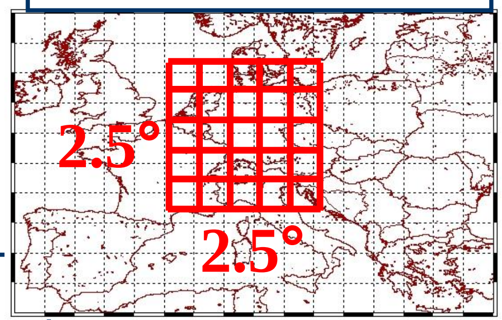
Blending technique – Rapid Update + Nefodina

Rain intensity maps from PMW data

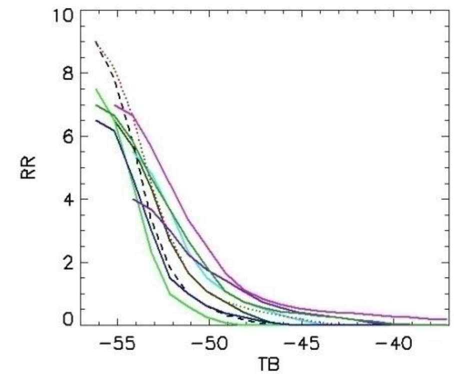


AT TIME t…

Extract space and time coincident locations from IR and MW data for each grid box



Create dynamical geolocated statistical relationships RR-T_b

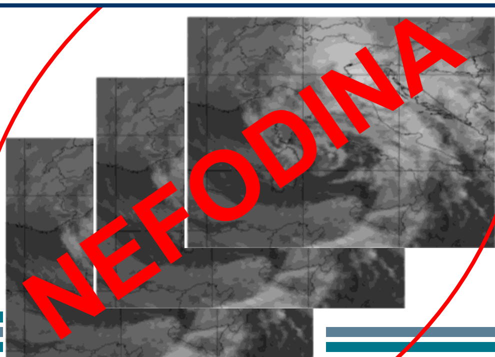


Assign RR at every IR pixel

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

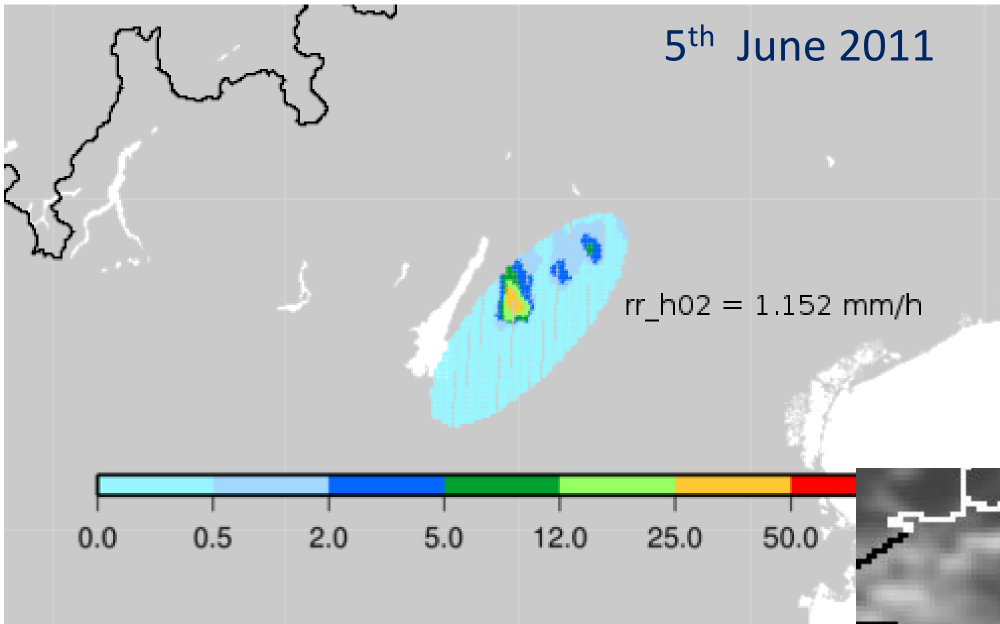
NEFODINA

MSG- SEVIRI IR brightness temperatures at 10.8 µm

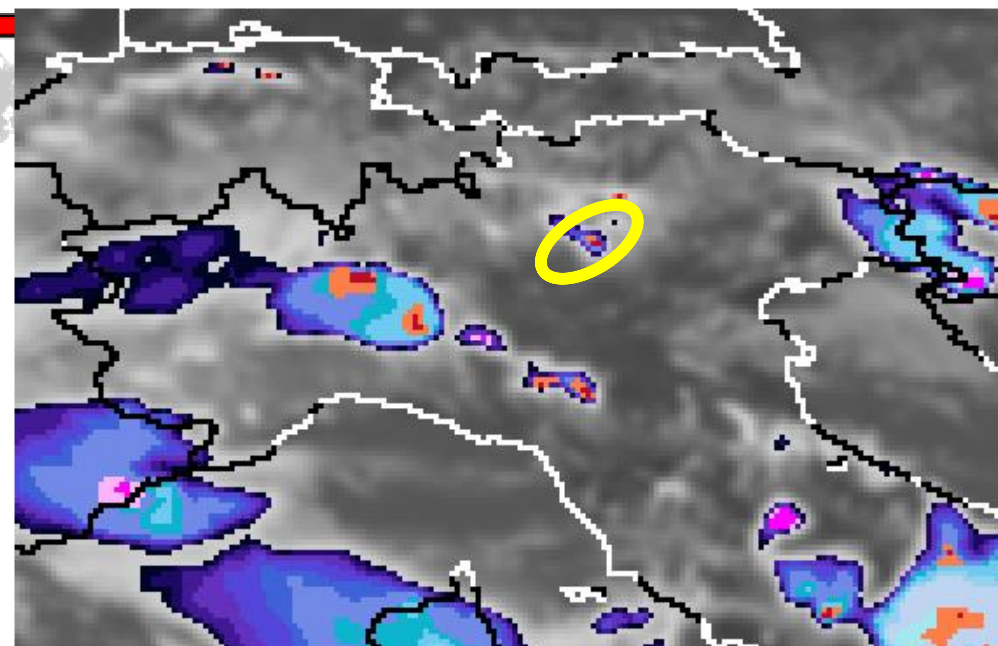


The process is restarted for each IR slot in the study period

NEFODINA software



Rain redistribution based on convective cell's area



Case study: 1st October 2009

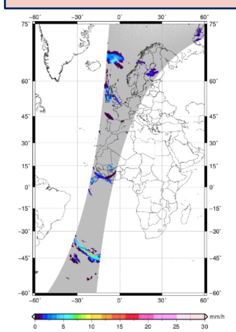
Accumulated precipitation in the previous 3 hours: 20091001 2100

EUMETSAT H SAF

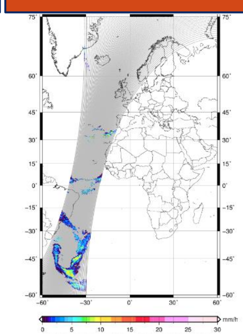
Current Operative Products

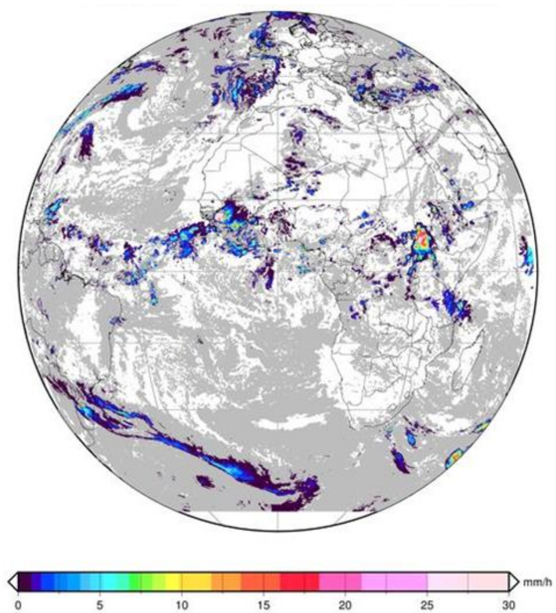
IDENTIFIER	PRODUCT DESCRIPTION	ALGORITHM
P-IN-SEVIRI H03	Precipitation rate at ground by GEO/IR supported by LEO/MW	Blending
P-IN-SEVIRI-CO H15	Blended SEVIRI Convection area / LEO MW precipitation	Blending + NEFODINA
P-AC-SEVIRI H05	Accumulated precipitation at ground by blended MW and IR	Time integration

H01 – P-IN-SSMIS



H02 – P-IN-MHS





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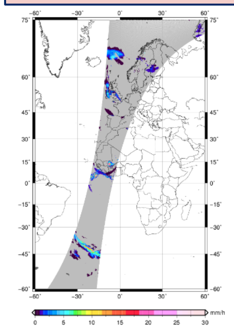
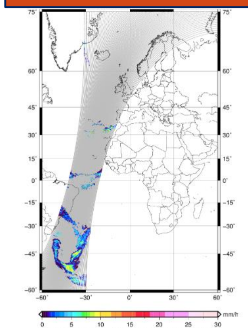
Near Future

IDENTIFIER	PRODUCT DESCRIPTION	ALGORITHM
P-IN-SEVIRI-PMW H60	Precipitation rate at ground by GEO/IR supported by LEO/MW	Blending + NEFODINA
P-AC-SEVIRI-PMW H61	Accumulated precipitation at ground by blended MW and IR	Time integration

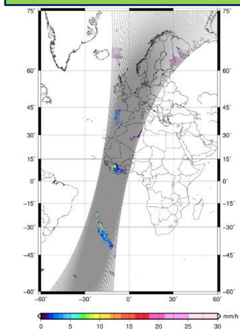
H01 – P-IN-SSMIS



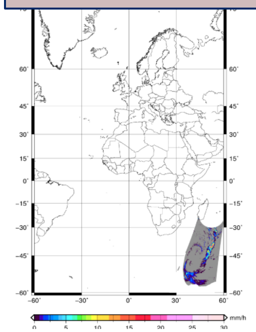
H02 – P-IN-MHS



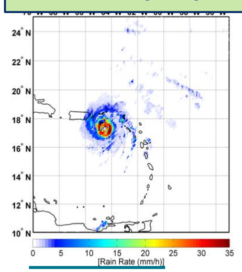
H18 – P-IN-ATMS

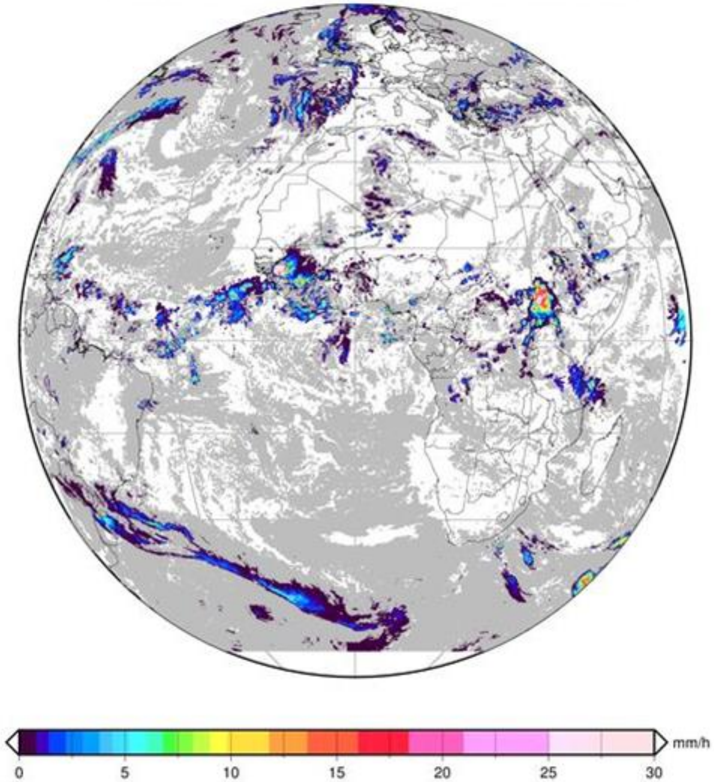


H-AUX-17 (AMSR2)



H-AUX-20 (GMI)



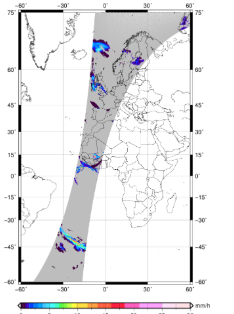


EUMETSAT H SAF

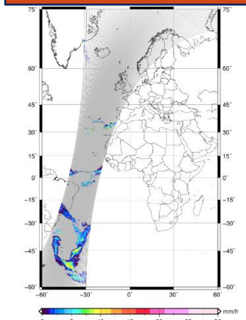
MTG evolution

IDENTIFIER	PRODUCT DESCRIPTION	ALGORITHM
P-IN-FCI H40	Precipitation rate at ground by GEO/IR supported by LEO/MW	Blending + NEFODINA
P-AC-FCI H42	Accumulated precipitation at ground by blended MW and IR	Time integration

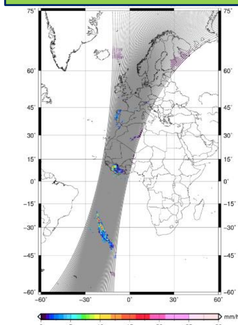
H01 – P-IN-SSMIS



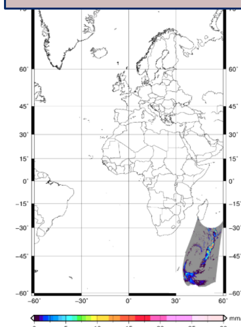
H02 – P-IN-MHS



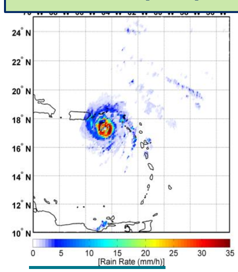
H18 – P-IN-ATMS



H-AUX-17 (AMSR2)

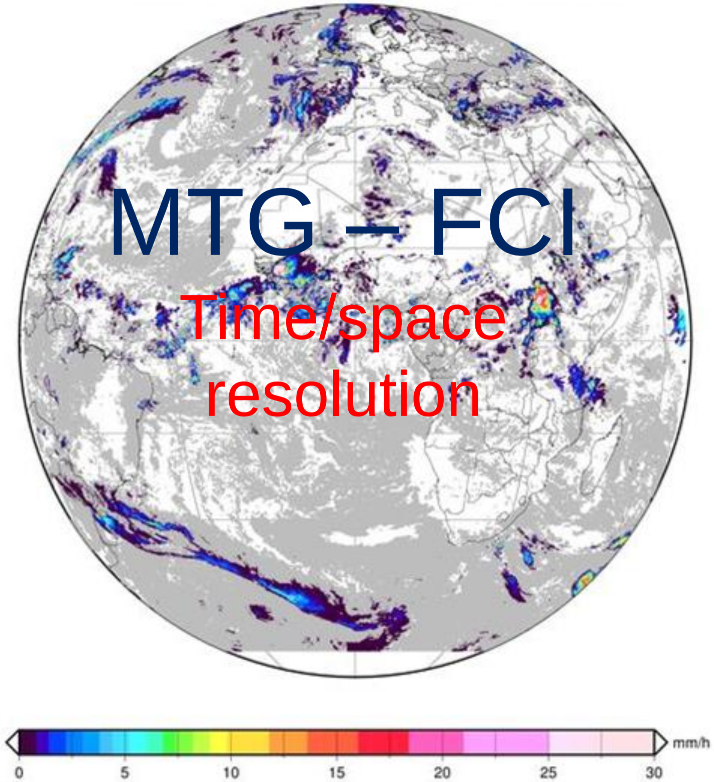


H-AUX-20 (GMI)



Microwave Imager (MWI)

Microwave Sounder (MWS)



MTG evolution
Blending technique – Artificial Intelligence

Machine Learning approach for MTG Day2 product (H45) – CDOP4

Module 1

- Parallax correction
- Preliminary analysis on clouds structure
- VIS-IR channels
- Testing of different ML approaches: Deep Learning, Convolutional Neural Network, Random Forest.

Module 2

Run 1

- Precipitation rate derived from a dataset of coincidence FCI TBs-DPR/GMI RR
- Testing of different ML approaches (ML1): Gradient Boosting, Artificial Neural Network, Genetic Algorithm.

Run 2

- Calibration of Run 1 outputs with the latest PMW-based (i.e. H68) precipitation rate.
- Testing of different ML approaches (ML2): Gradient Boosting, Artificial Neural Network, Genetic Algorithm.

Thanks to …

Francesco Zauli[1], **Davide Melfi**[1],
Dietrich Stefano[2], Panegrossi Giulia[2], Sanò Paolo[2], Leo Pio D’Adderio[2], Daniele Casella[2],
Luca Brocca[3], Luca Ciabatta[3], Christian Massari[3], Stefania Camici[3],
Puca Silvia[4] , Marco Petracca[4],
Claudio Giorgi[5]
and all the H-SAF team

1 - Centro Operativo per la Meteorologia (COMet)
2 - Istituto di Scienze dell'Atmosfera e del Clima (ISAC) / Consiglio Nazionale delle Ricerche (CNR), Roma
3 - Istituto di ricerca per la protezione idrogeologica (IRPI) / Consiglio Nazionale delle Ricerche (CNR), Perugia
4 - Dipartimento della Protezione Civile (DPC)/Presidenza del Consiglio dei Ministri
5 - Geo-k

… and you for your attention!

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