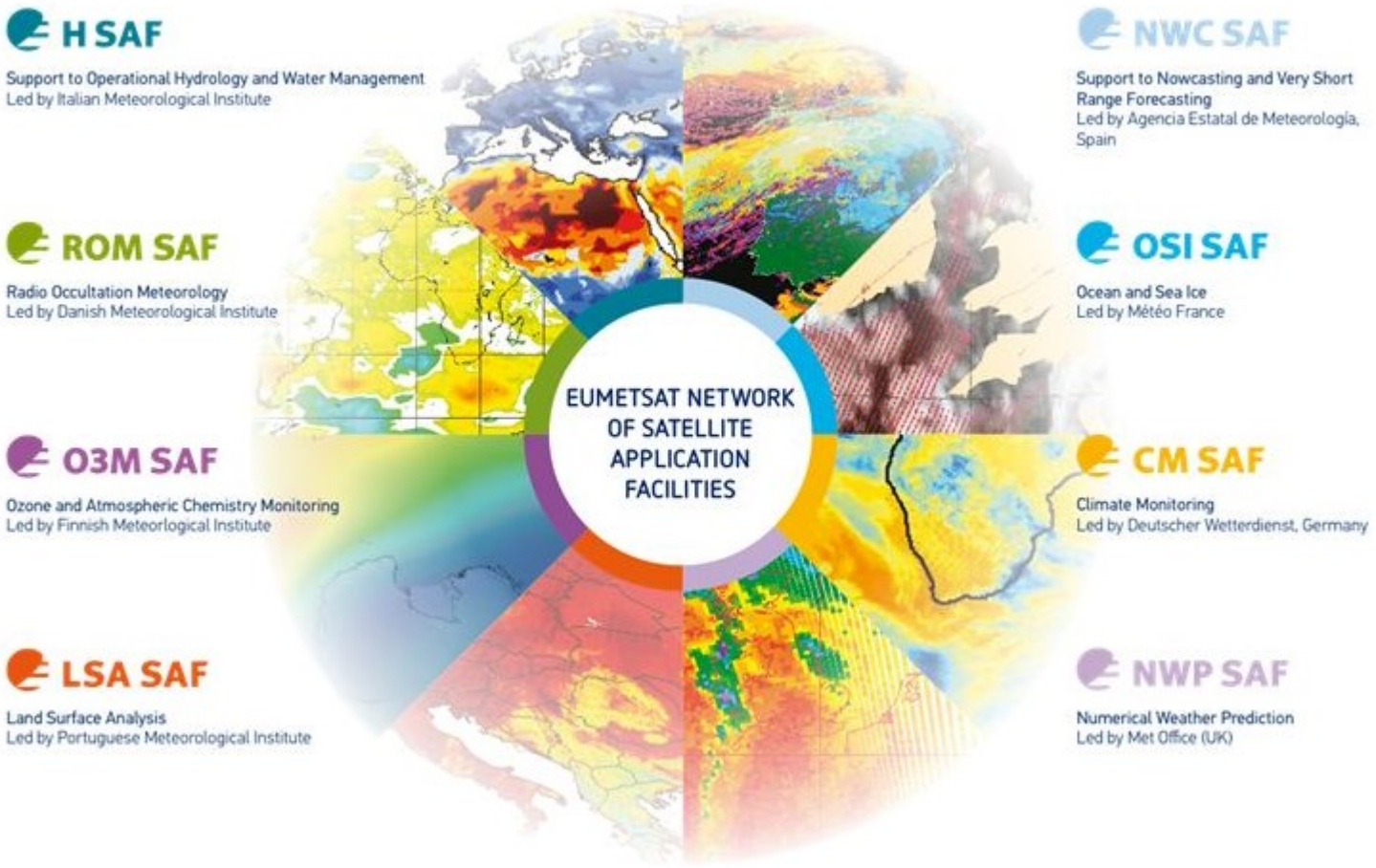
Precipitation Products from EUMETSAT Satellite Application Facility on Support to Operational Hydrology and Water Management (H SAF) – applications and case studies

Luca Ciabatta on behalf of the H SAF consortium

outline

- Introduction to H SAF
- H SAF products
- Applications

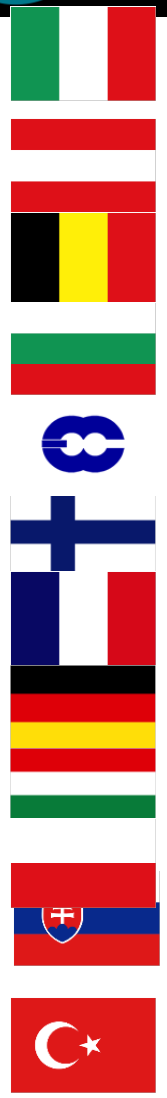
Introduction to H SAF



The "EUMETSAT Satellite Application Facility on Support to Operational Hydrology and Water Management (H SAF)" started on 2005 as part of the **EUMETSAT SAF Network**

In March 2022 the Programme entered its Fourth Continuous Development and Operation Phase (CDOP-4) which will last until February 2027.

Introduction to H SAF



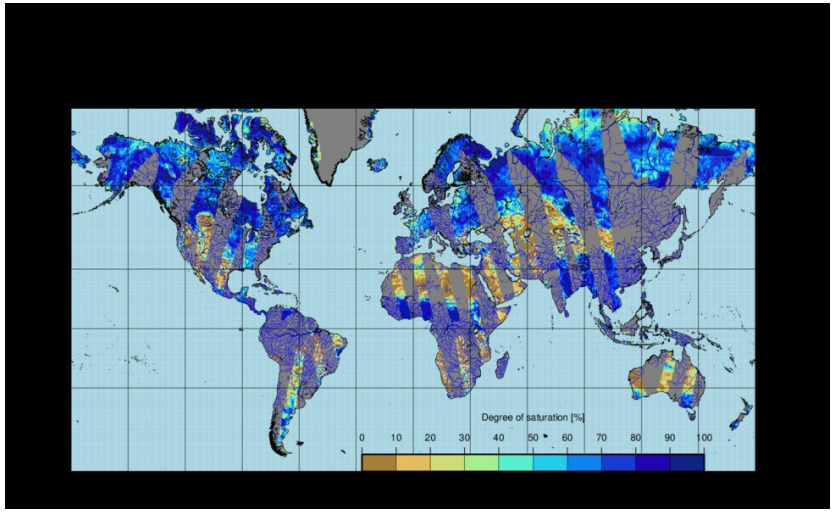
The consortium is composed by 11 countries:
Austria, Belgium, Bulgaria, Finland, France, Germany, Hungary, Italy, Poland, Slovakia, Turkey and ECMWF.

More than 50 researchers are involved in the project.

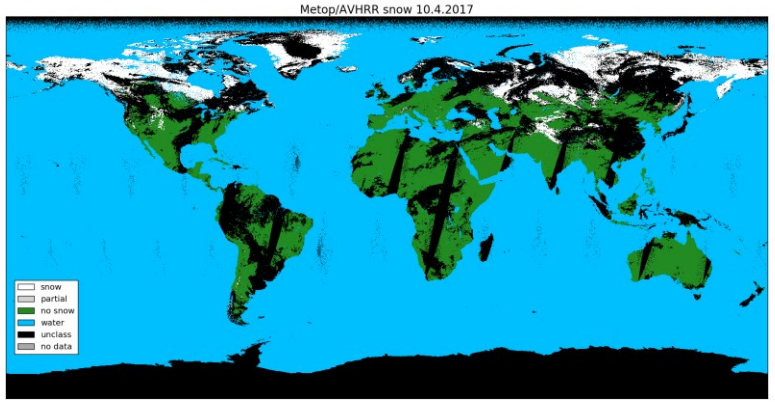
H SAF

Satellite Application Facilities in Support to Operational Hydrology and Water Management

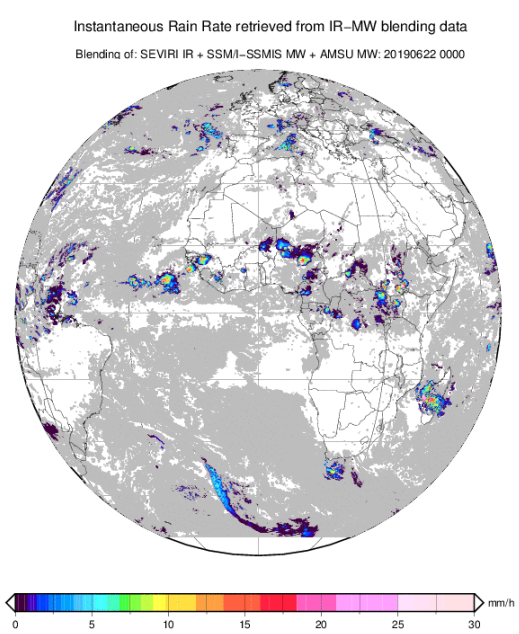
SOIL MOISTURE
surface and root zone



SNOW
cover, melting condition, water equivalent



PRECIPITATION rate and accumulated



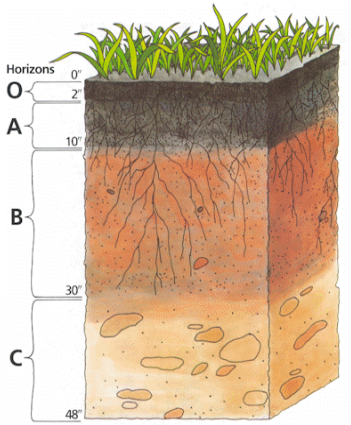
NRT products (EUMETCAST and H SAF ftp)

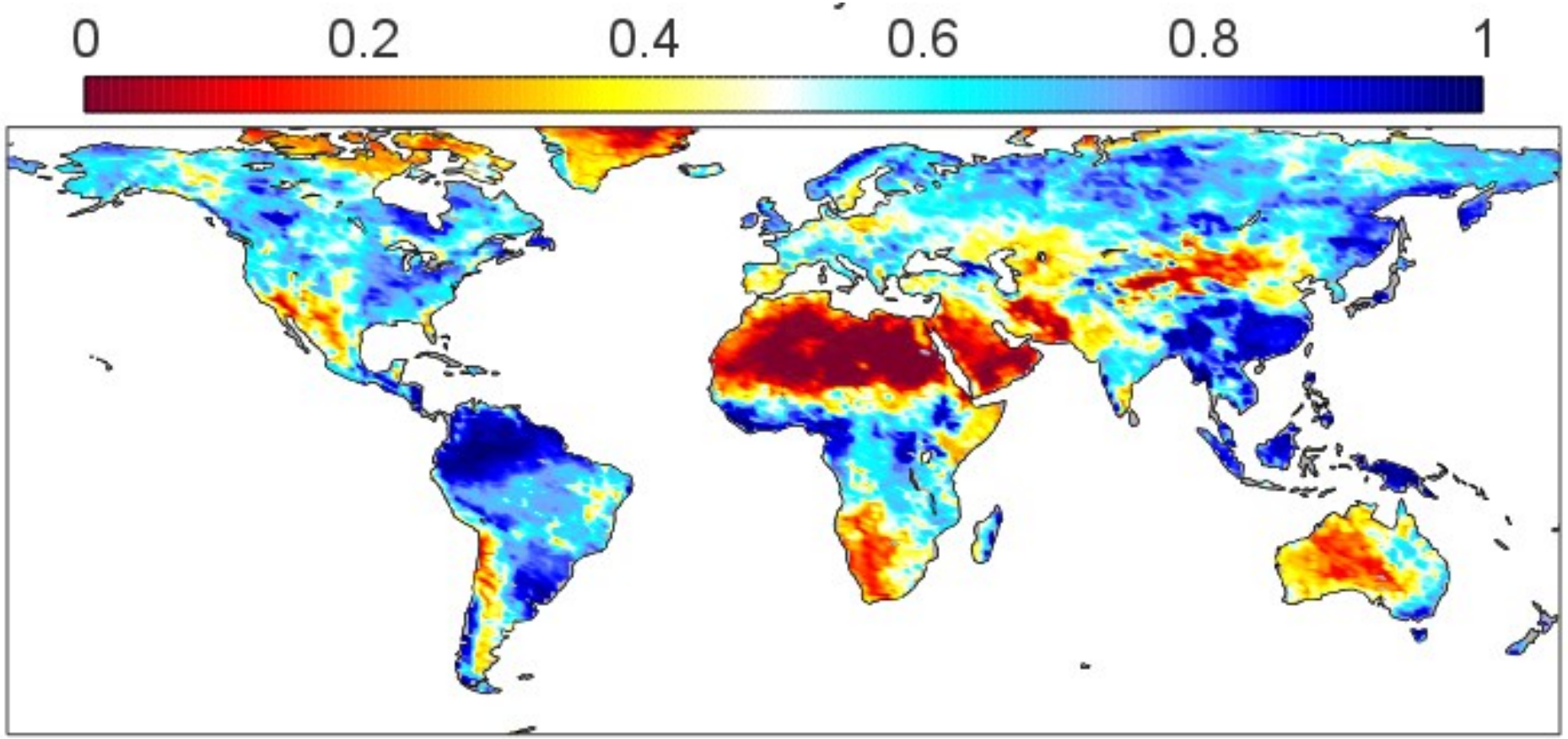
Data record for soil moisture are available from 1997

H SAF Soil Moisture products:

ASCAT Surface Soil Moisture

- SSM is expressed in soil saturation (0-100%) representing the topmost soil layer (< 5 cm)
- **(Sub-)daily observations,**
- **Near Real Time Products (Latency 2 hours) :** Spatial sampling **25 Km → 12.5km → 6.25 km → 1 Km** (disaggregated**)**
- **Data Record: from 2007,** with spatial sampling **12.5 km.**





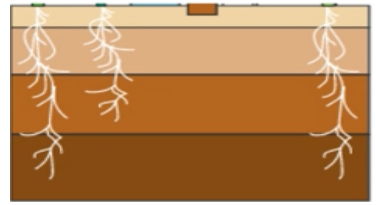
Wagner et al. 2013 (METZET)

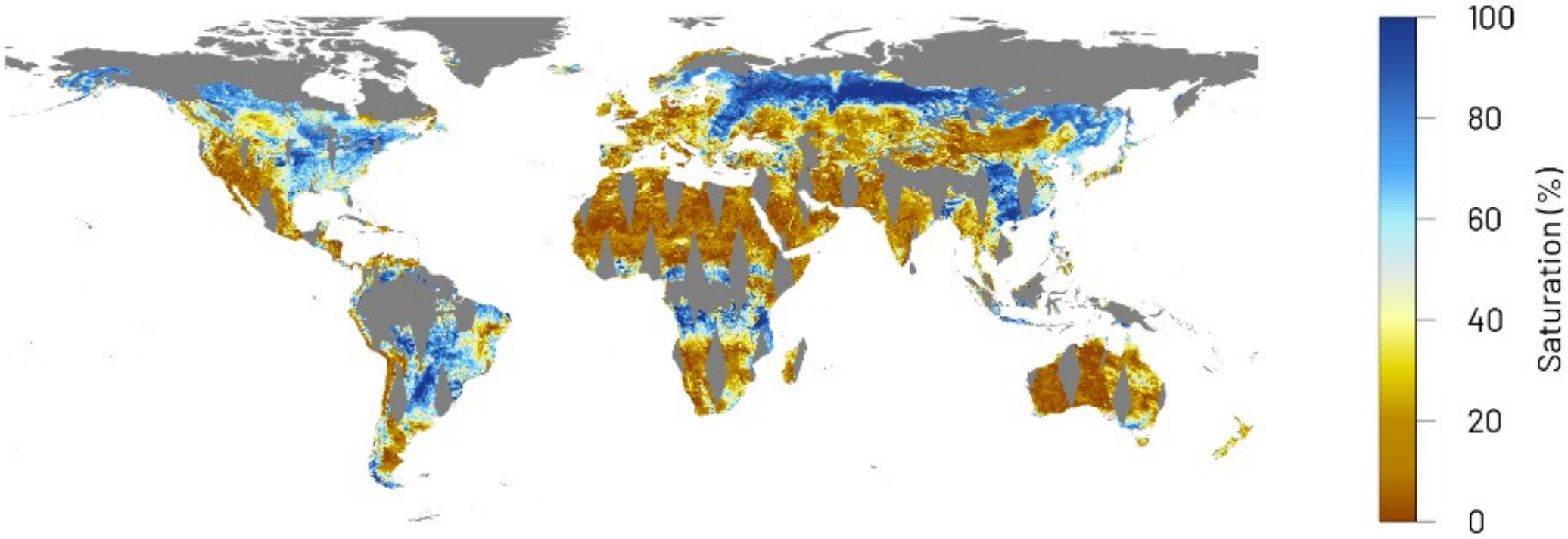
H SAF Soil Moisture products:

Root Zone Soil Moisture

- **RZSM is** expressed **as liquid soil wetness index at 4 layers;**
- **Daily observations (00 UTC);**
- **Near Real Time Products: 10 km spatial sampling**
- **Data Record: from 1992,** with spatial sampling **10 km.**

SM analysed over first 3 layers in H-TESSEL:
Layer 1: 0-7 cm
Layer 2: 7-28 cm
Layer 3: 28-100 cm
Layer 4 (not analysed): 100-289 cm





De Rosnay et al. 2013 (QJRMS)
Fairbairn et al. 2019 (JHM)

H SAF Snow products

Daily EPS Snow Cover: presence of snow over land.

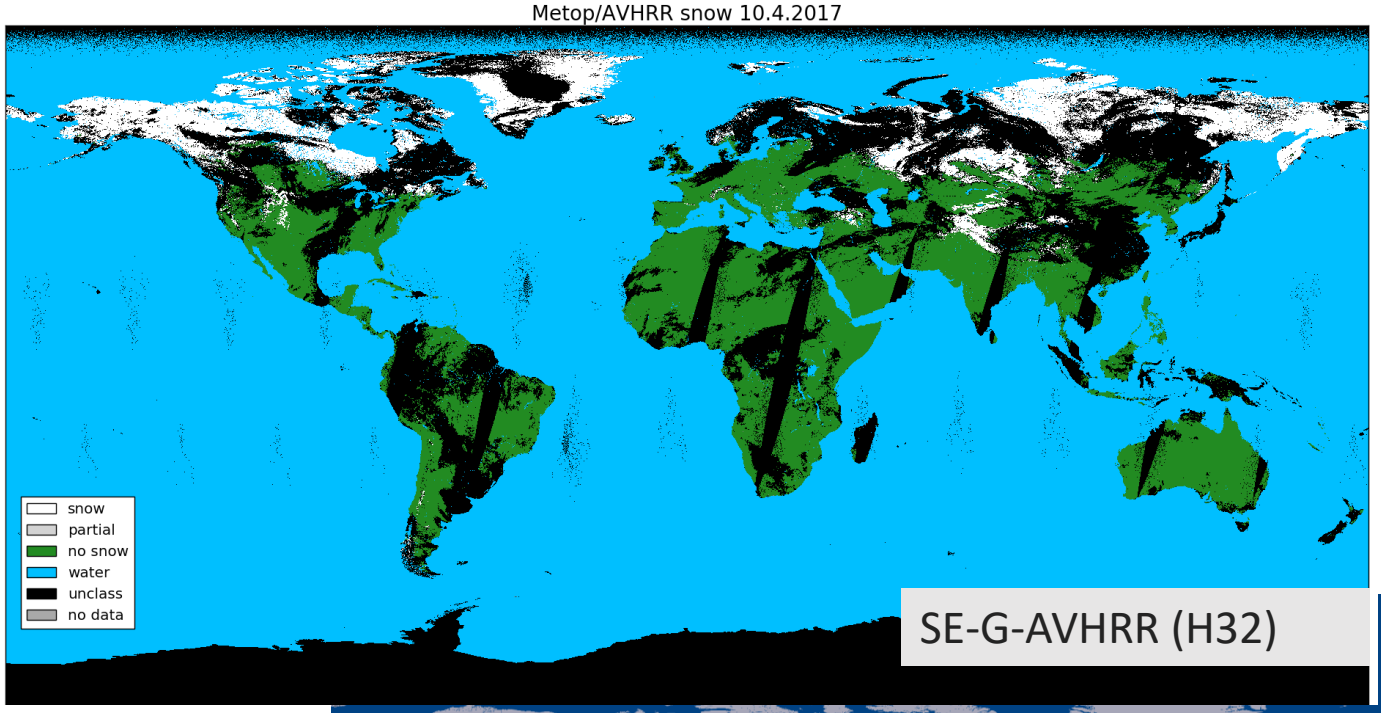
- Sub-daily : Four products (integrals over 3, 6, 12 and 24 h) every three hours (rolling)
- Near Real Time Products (3 hours): spatial sampling 10 Km

Snow detection (snow mask) by VIS/IR radiometry:

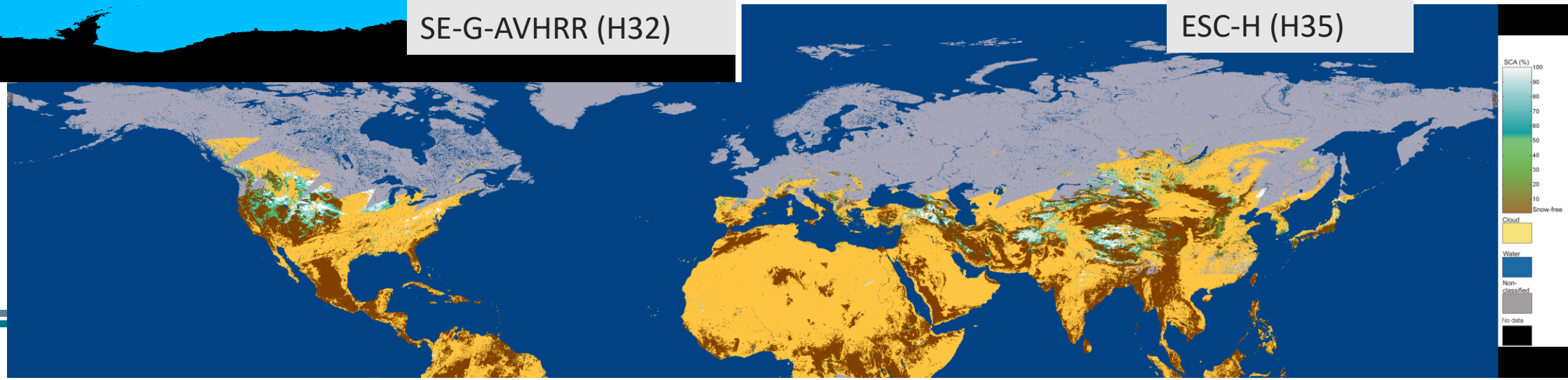
- Daily , Near Real Time Products (6 hours): SEVIRI Resolution

Effective snow cover by VIS/IR radiometry

- Daily, Near Real Time Products (6 hours): spatial sampling 10 Km



SE-G-AVHRR (H32)

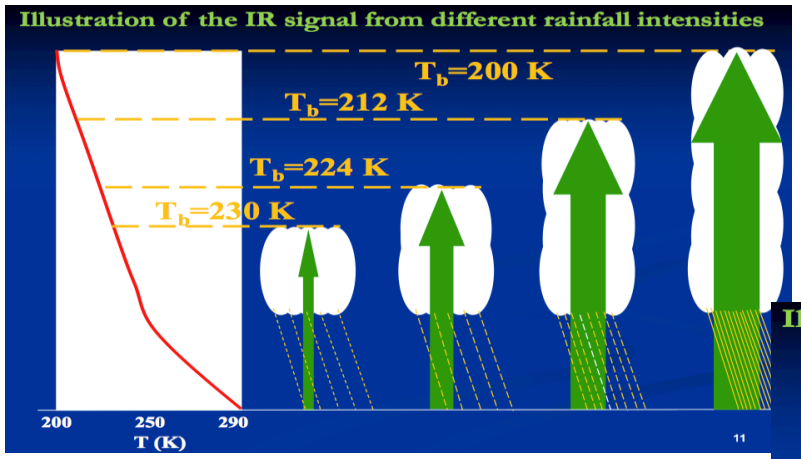


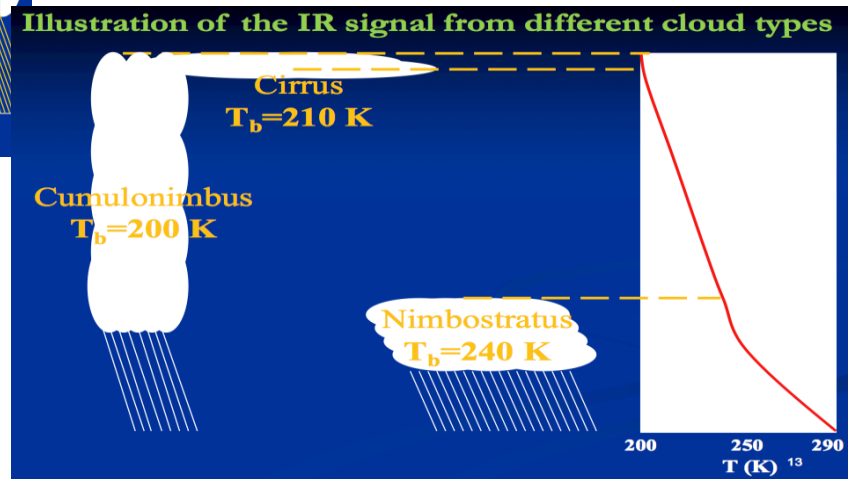
ESC-H (H35)

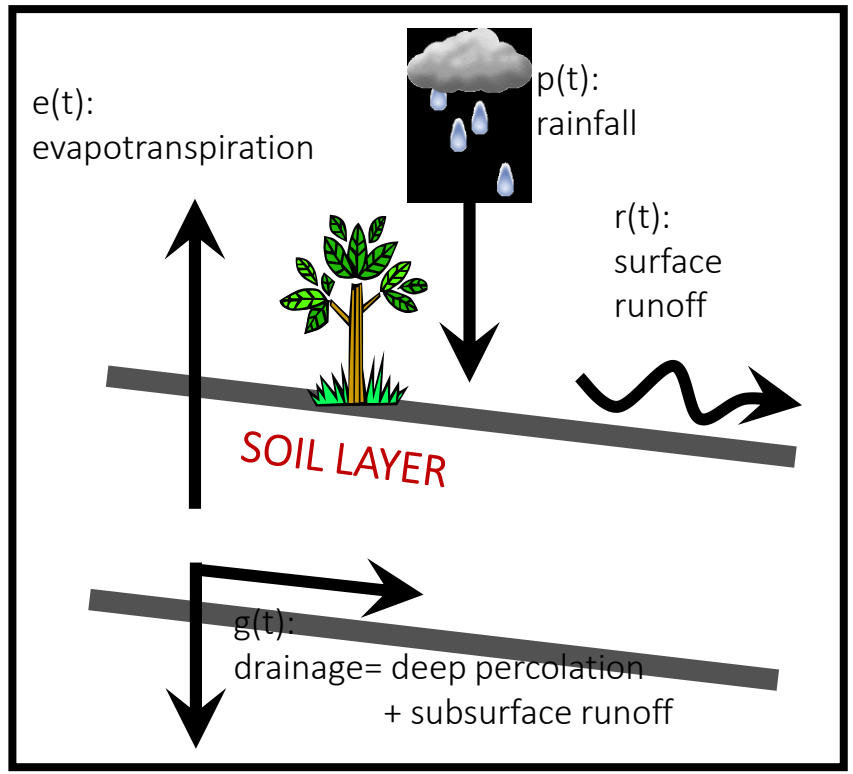
H SAF precipitation products

Two approach:

- **Top - down**
- **Bottom - up**



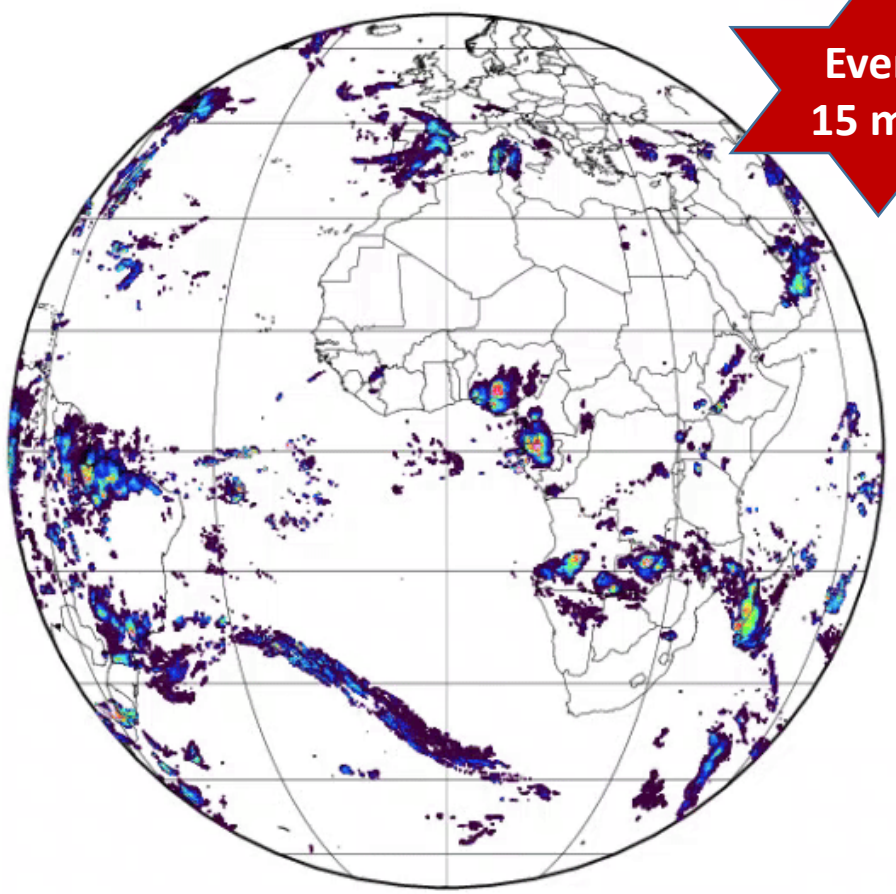




H SAF Precipitation Products: IR and MW precipitation products

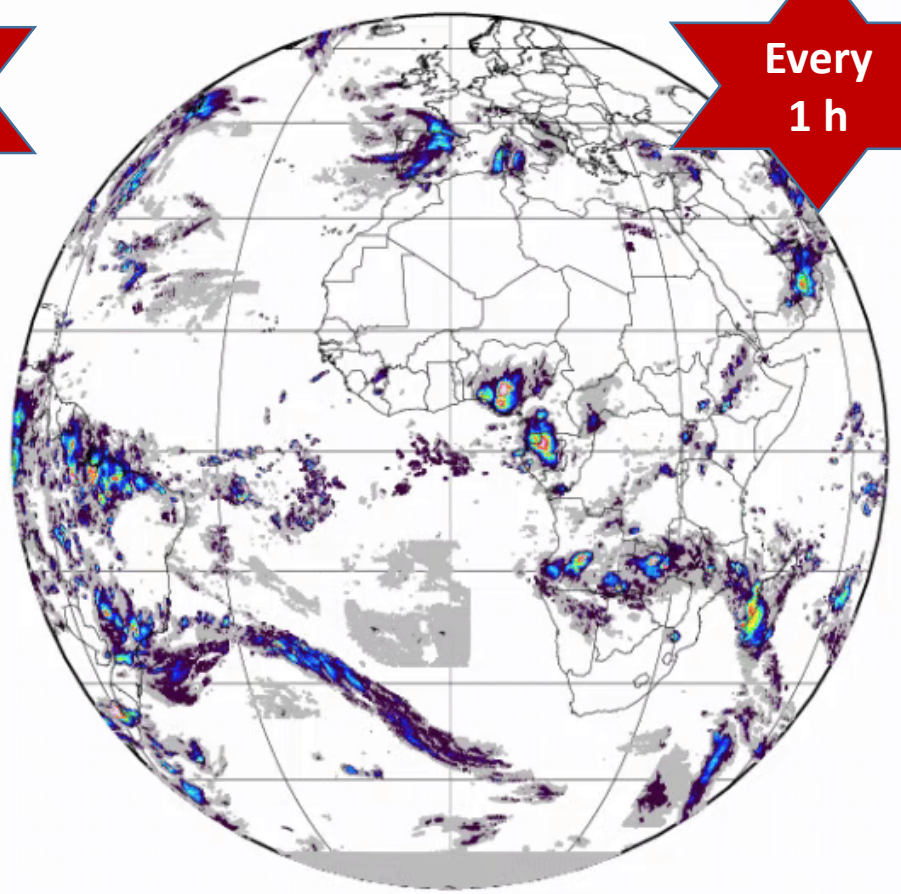
Main features
MSG Full-disk area
Every 15 min
3 Km s.s.p. ~8 km over Europe
Within 10 minutes
EUMETCast
NetCDF

PRECIPITATION RATE H60



Every 15 min

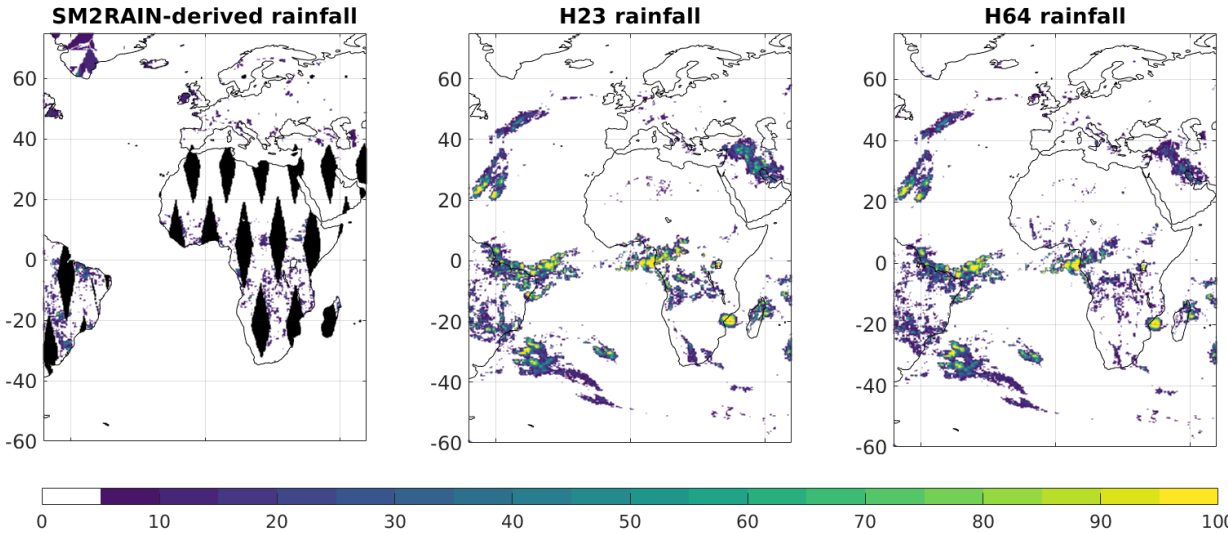
ACCUMULATED PREC H61

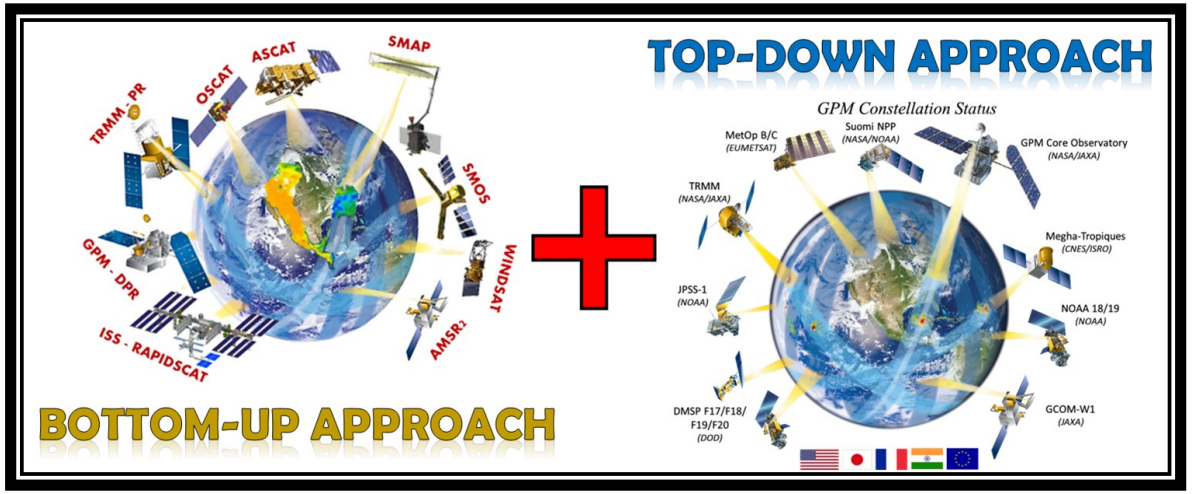


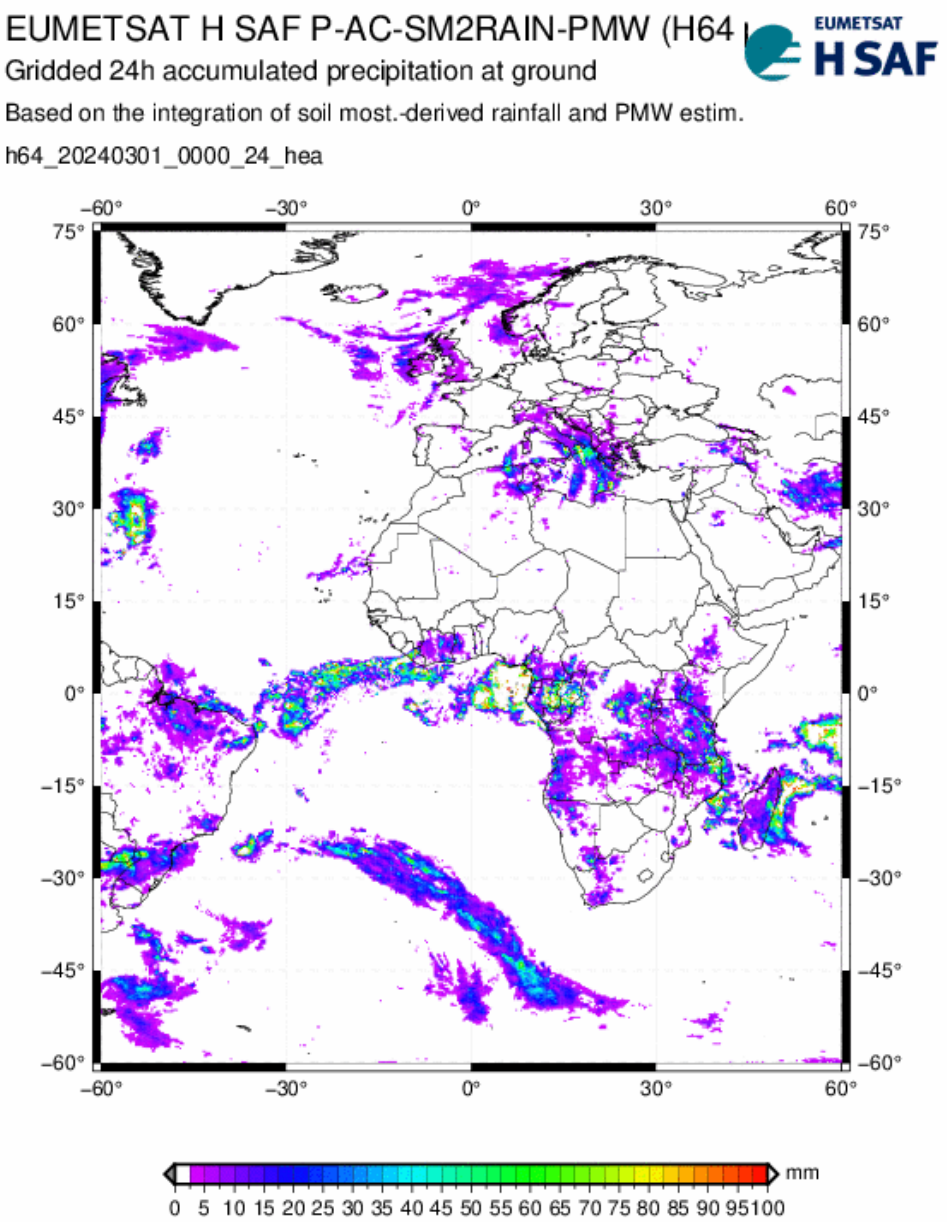
Every 1 h

Main features
MSG Full-disk area
Every hour / 1 hrs
3 Km s.s.p. ~8 km over Europe
Within 20 minutes
EUMETCast
NetCDF

H SAF Precipitation Products: soil moisture-derived and Passive Microwave (H64)

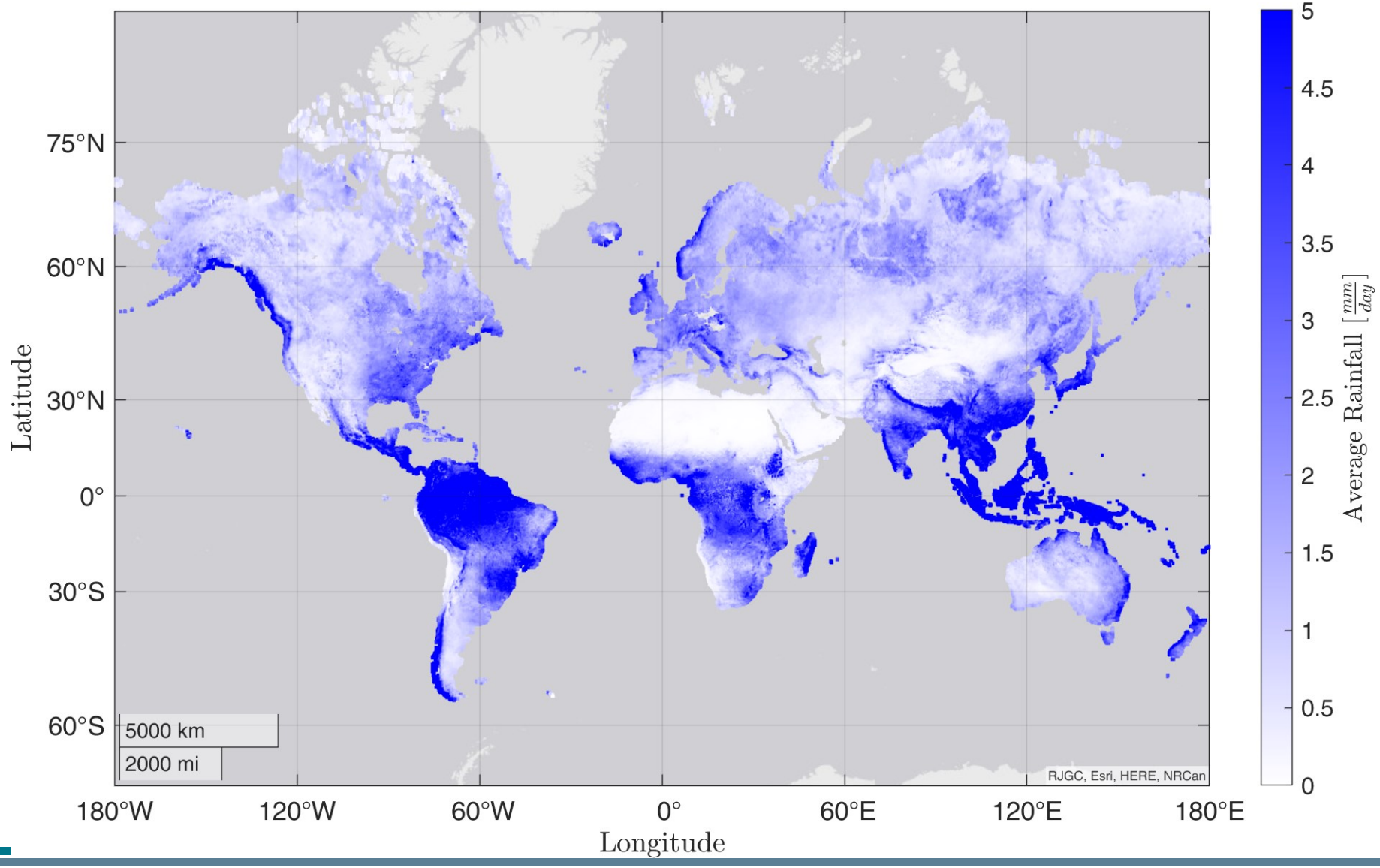






Main features
MSG Full-disk area
Every 24h
0.25° over a regular grid
15h
H SAF FTP
netCDF

H SAF Precipitation Products:
Soil moisture-derived rainfall data record (H87)

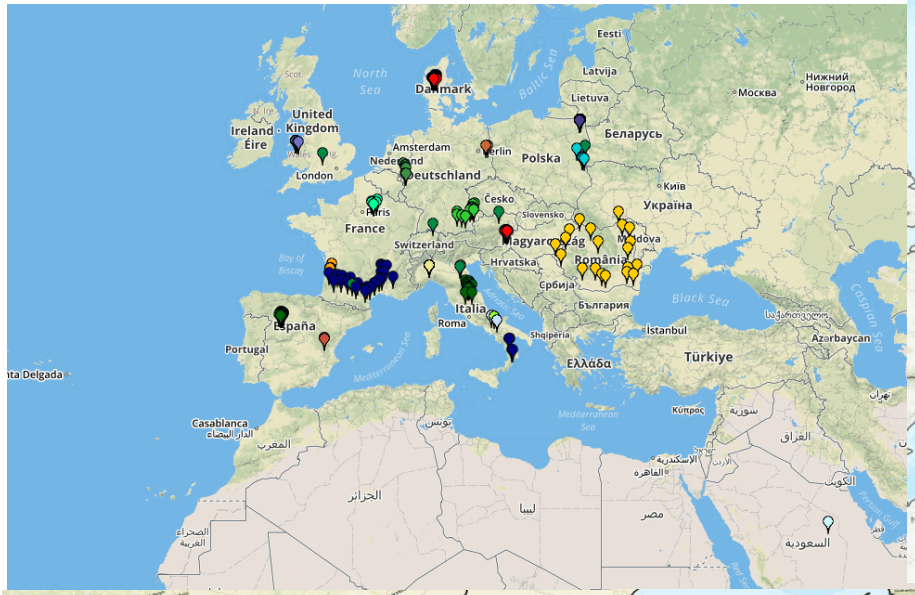


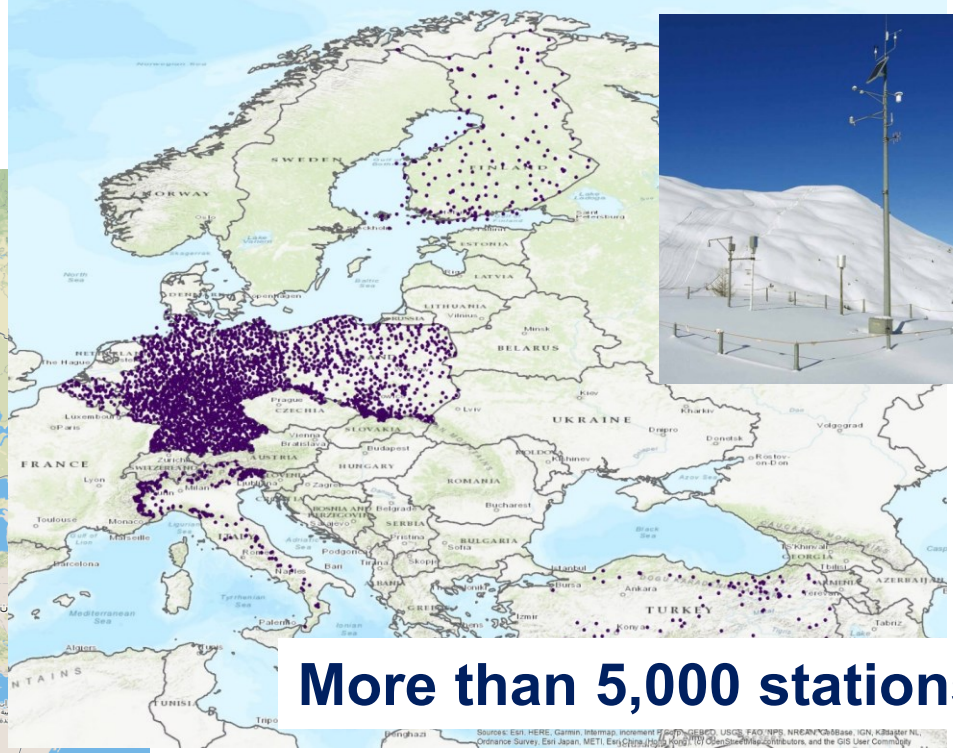
Main features
Global
Daily
10 km
Offline product Updated on a weekly basis
H SAF FTP
netCDF

EUMETSAT H SAF

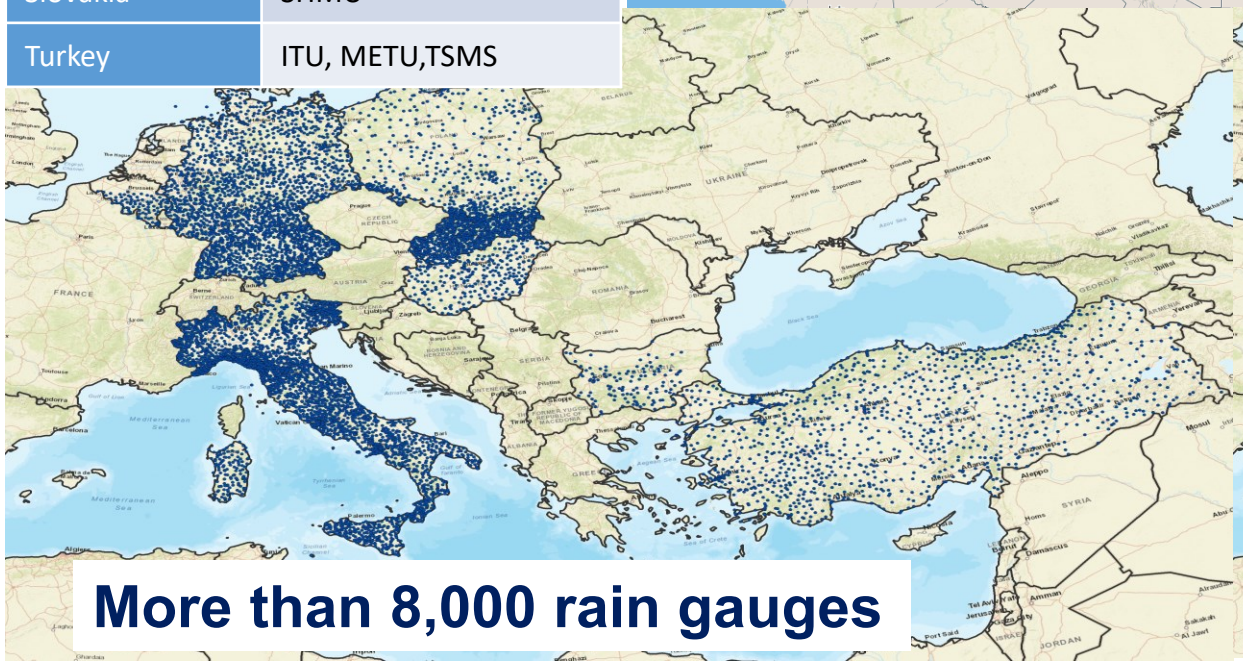
Ground network

Country	Institutes
Belgium	IRM
Bulgaria	NIMH
Finland	FMI
Germany	BfG
Hungary	OMSZ
Italy	DPC,
Poland	IMWM
Slovakia	SHMU
Turkey	ITU, METU,TSMS





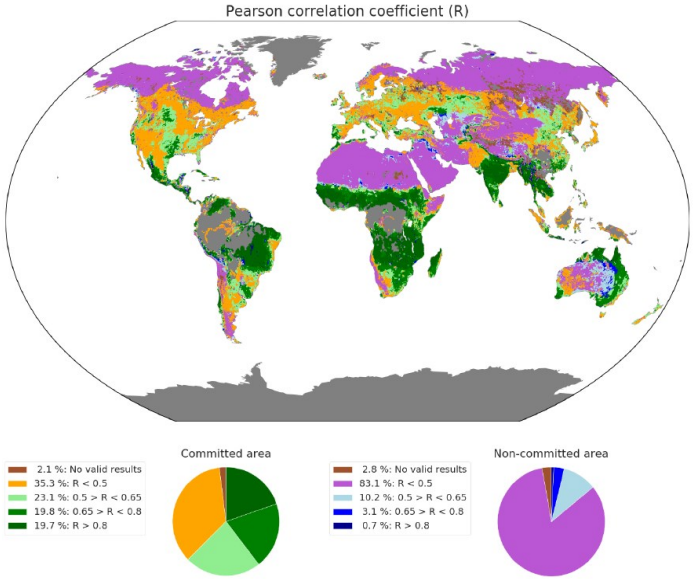
More than 5,000 stations



More than 8,000 rain gauges

71 C-band radars

Different techniques and different data

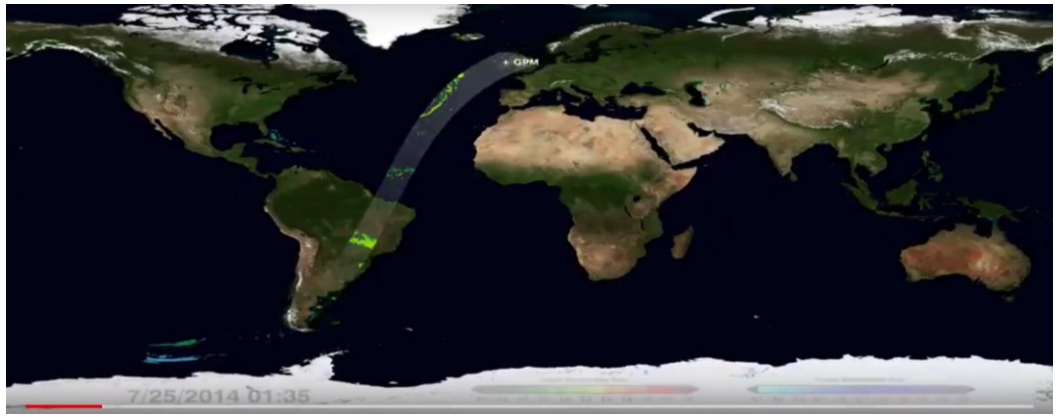


GPM Microwave Imager (GMI): 10-183 GHz

13 channels that provides an integrated picture of energy emitted by precipitation, including light to heavy rain to falling snow (Ball Aerospace)

Dual-frequency Precipitation Radar (DPR): Ku-Ka bands

Two different radar frequencies that can look at precipitation in 3-D throughout the atmospheric column (JAXA)

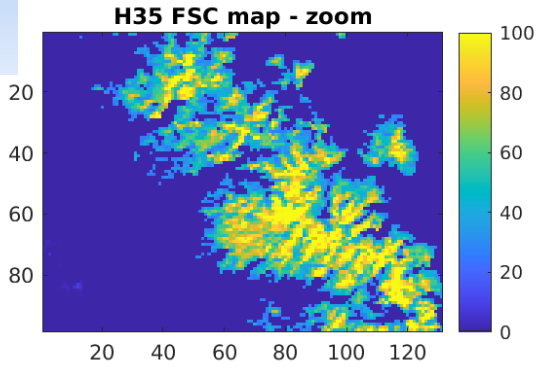


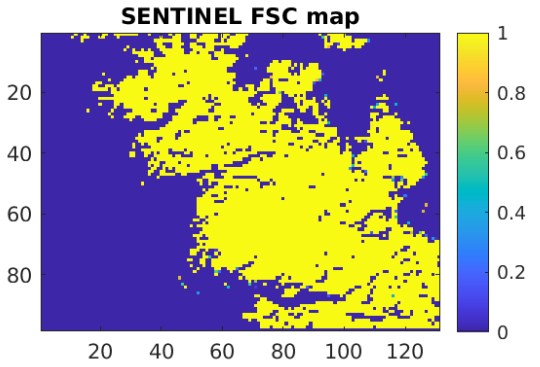
Global Triple Collocation

1) ASCAT products
2) CCI Passive Soil Moisture L3S SSMV V04.4
3) GLDAS NOAH L4 3 hourly 0.25 x 0.25 degree V2.1

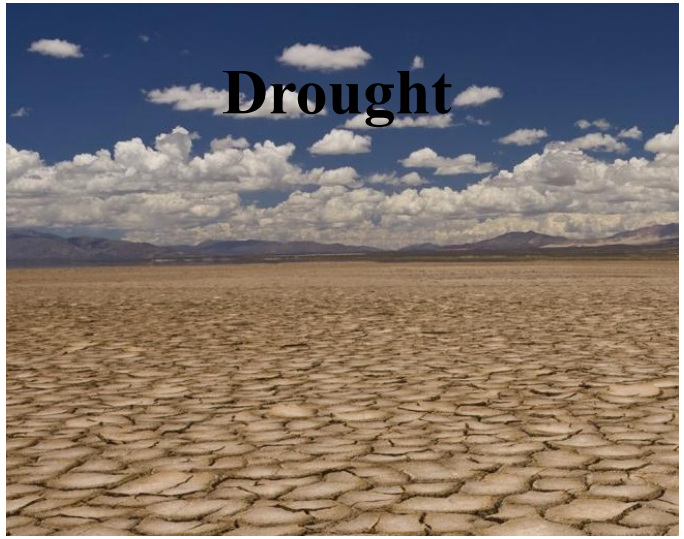
Sentinel 2

Qualitatively, snow patterns estimated by H35 and by Sentinel 2 are consistent.

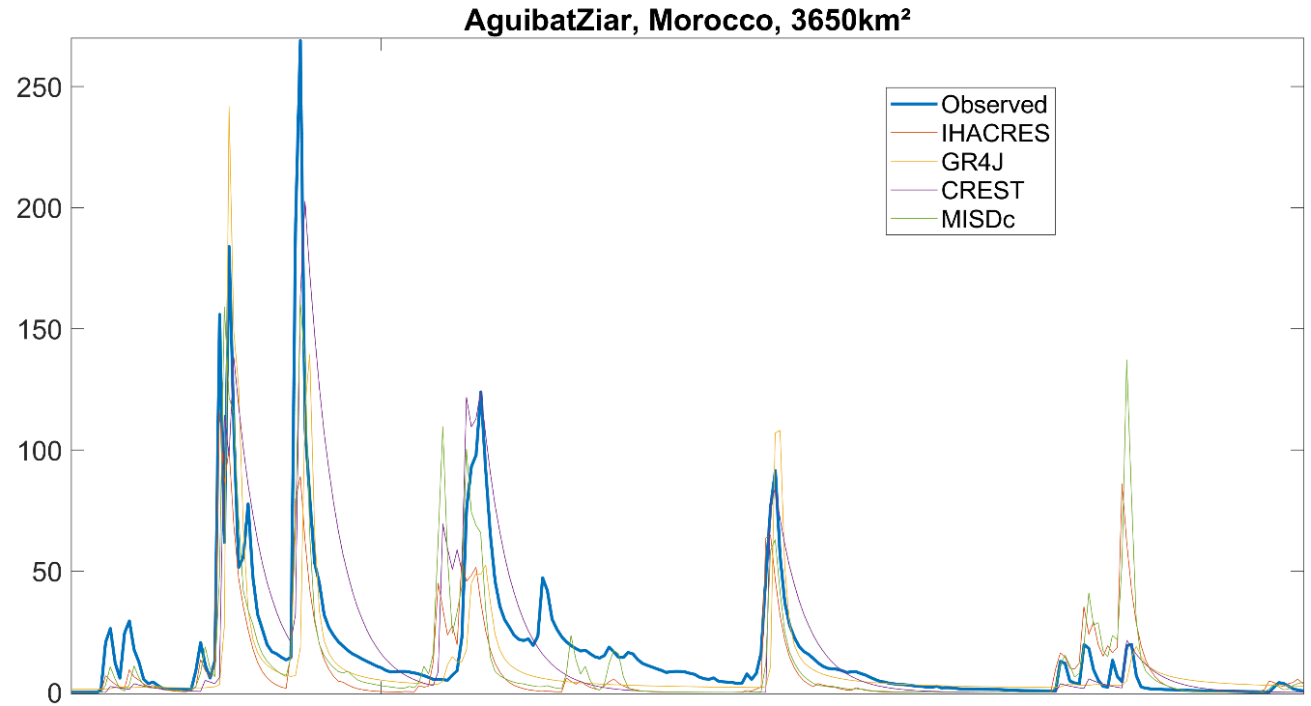


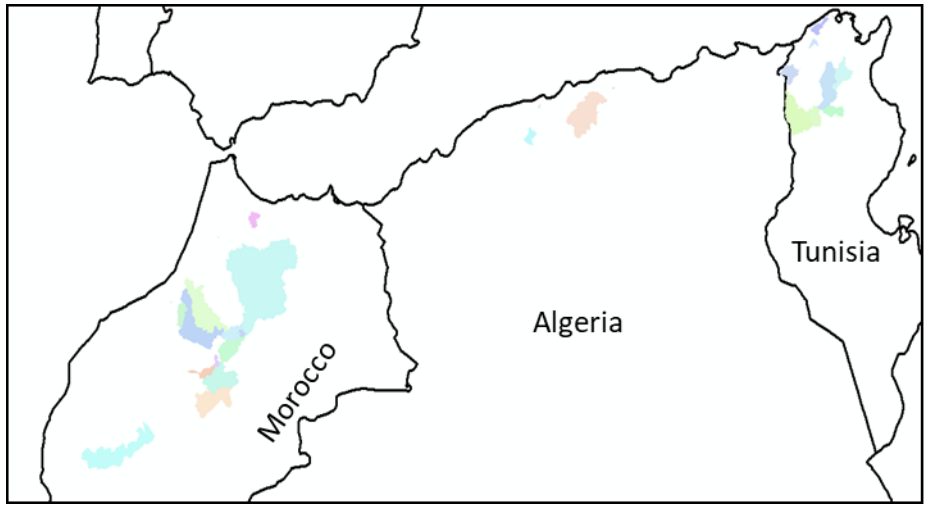


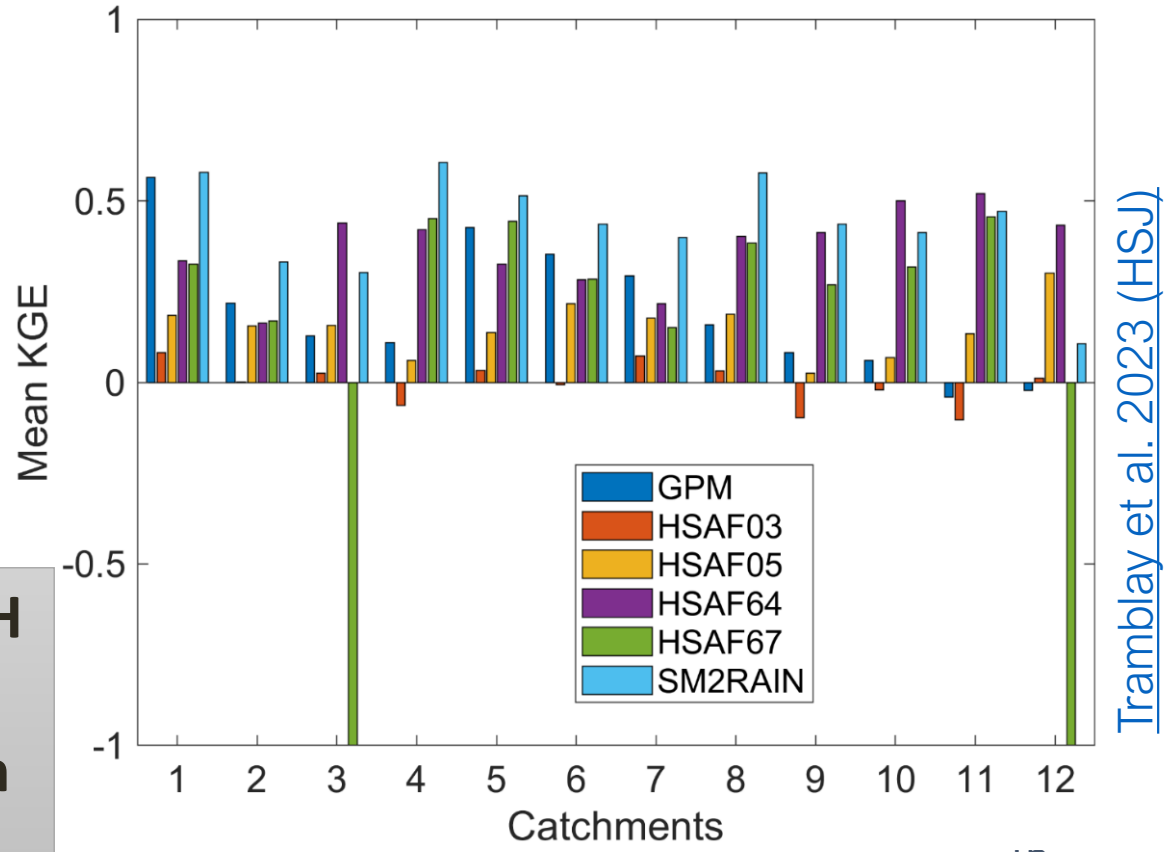
Extreme Events



Flood Prediction in North Africa



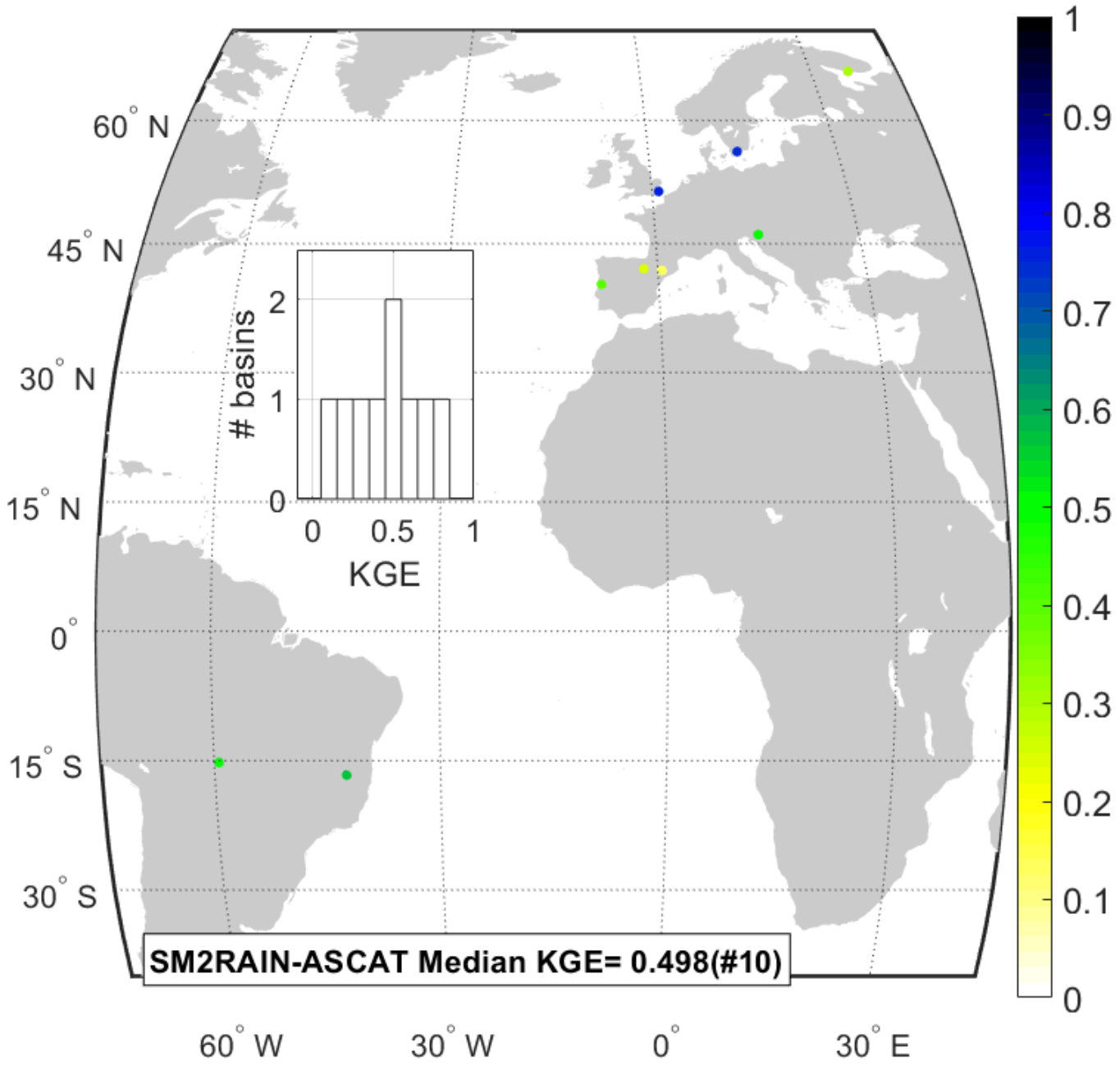




During an H SAF visiting scientist activity, different H SAF precipitation products were tested in 12 basins in northern Africa highlighting their good prediction capabilities in most of the basins.

SATELLITE PRECIPITATION FOR FLOOD PREDICTION

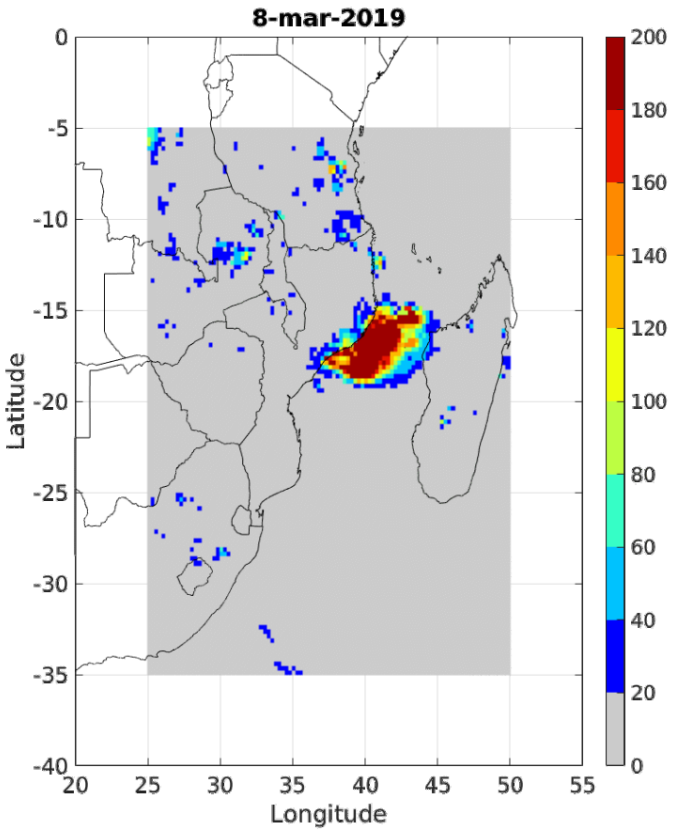
Integration of rainfall obtained from satellite soil moisture measurements with state-of-the-art rainfall observations allows significant improvement in flood forecasting. A total of 2273 basins were analysed on a global scale with good results particularly in south Brazil, west Africa, and in the Mediterranean region.

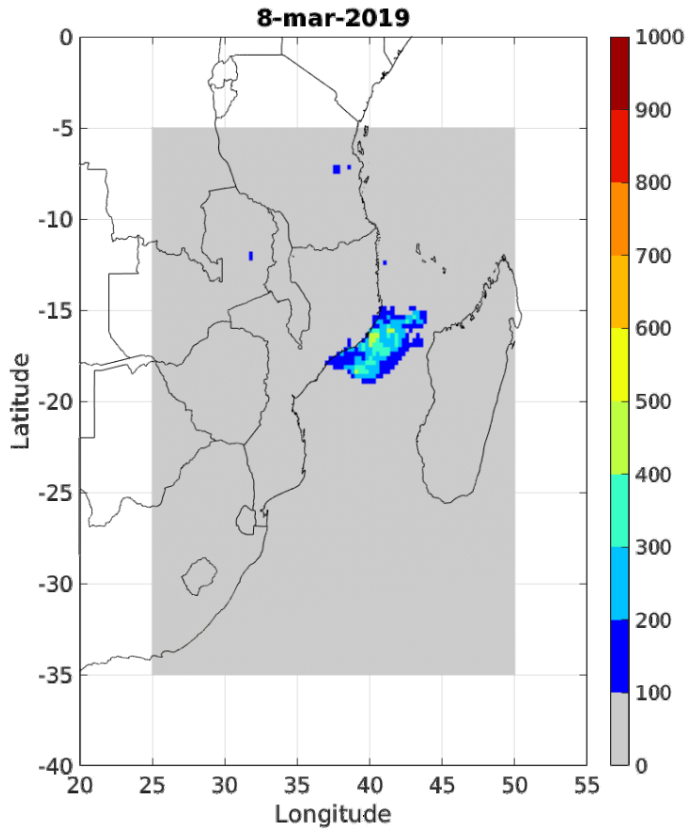


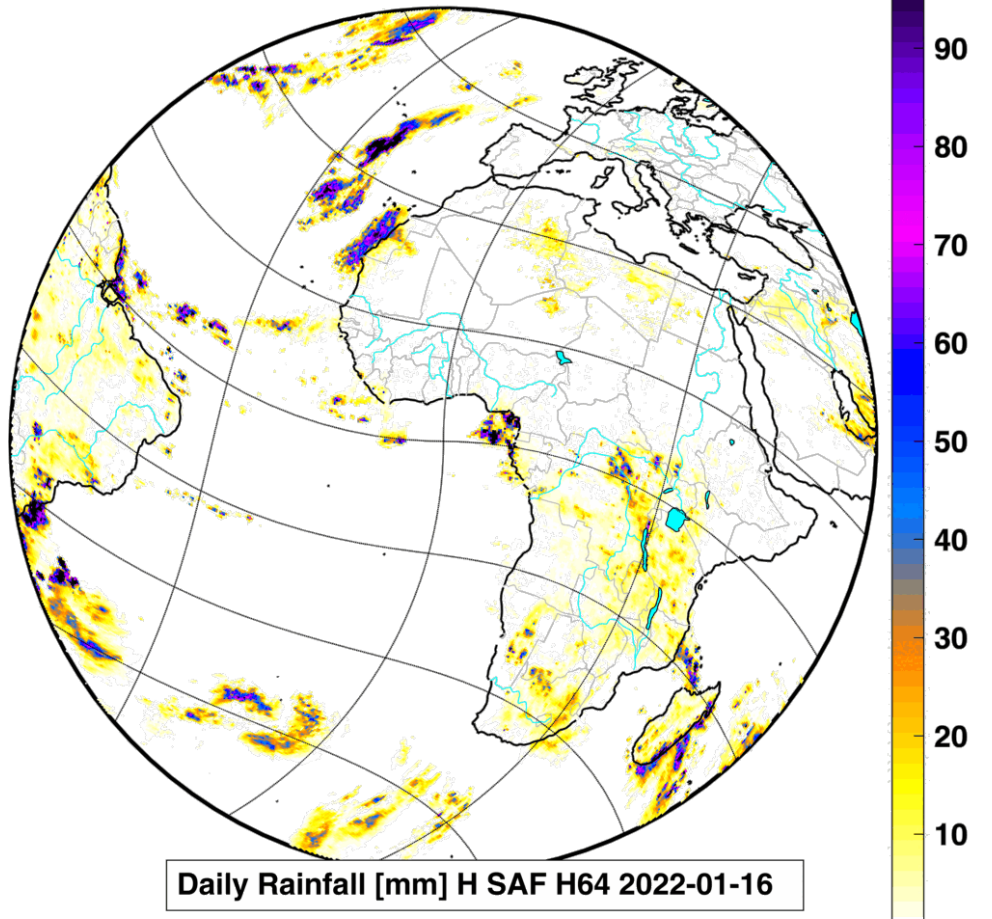
Camici et al (2018 JoH; 2020 HESS)
Brocca et al (2020 SREP); Almagro et al (2021 JoH)

EXTREME EVENT MONITORING – CYCLONE IDAI

March 2019



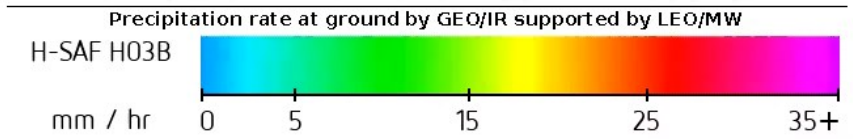




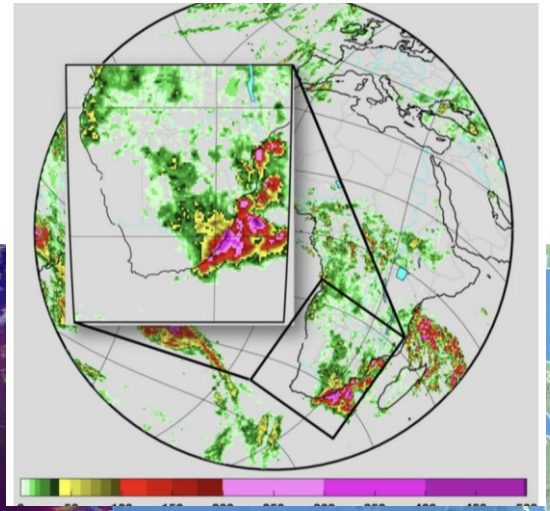
H SAF satellite precipitation products can be used to monitor extreme events (e.g., cyclone Idai, Madagascar and Mozambique in 2019)

Ciabatta et al (2017 JoH)

Flood in South Africa: 11 – 13 April 2022

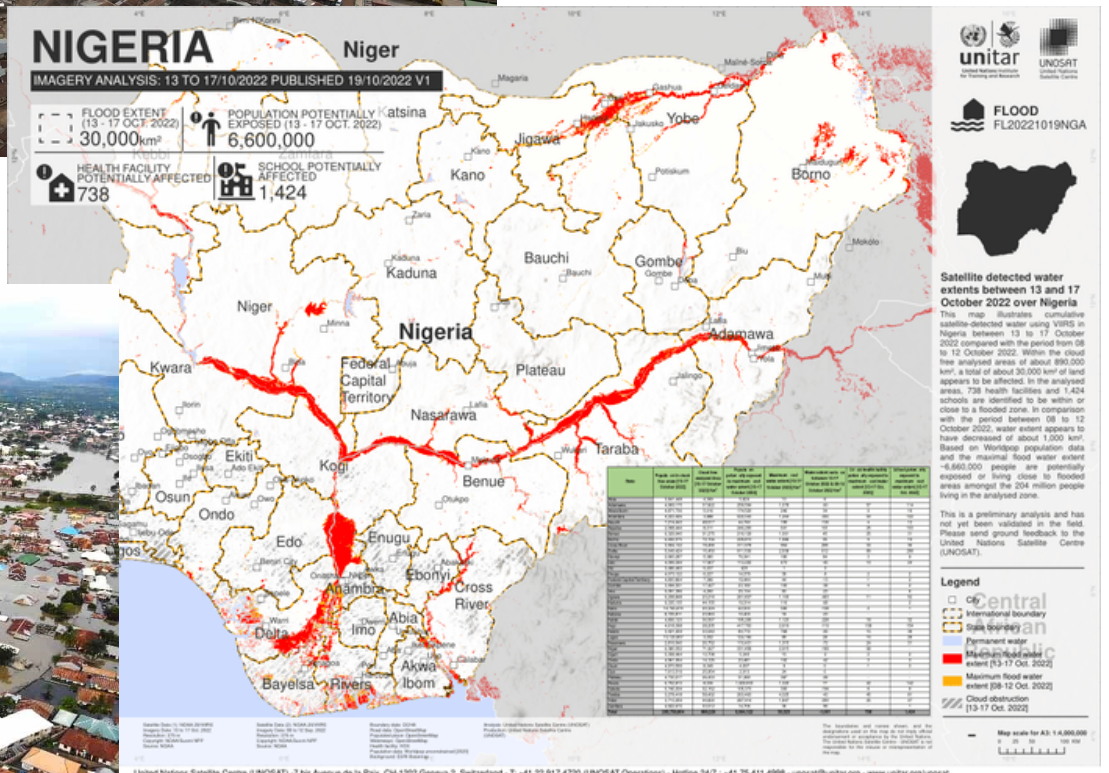


This is the flood occurred in Durban in the period 11-13th April 2022.
H61 product highlighted 300 mm of accumulated precipitation in 3 days.
We can see here H60 animation from EUMETview shows persistent precipitation over South Africa (11-12 April 2022).



October 2022

EXTREME EVENT MONITORING – NIGERIA FLOOD



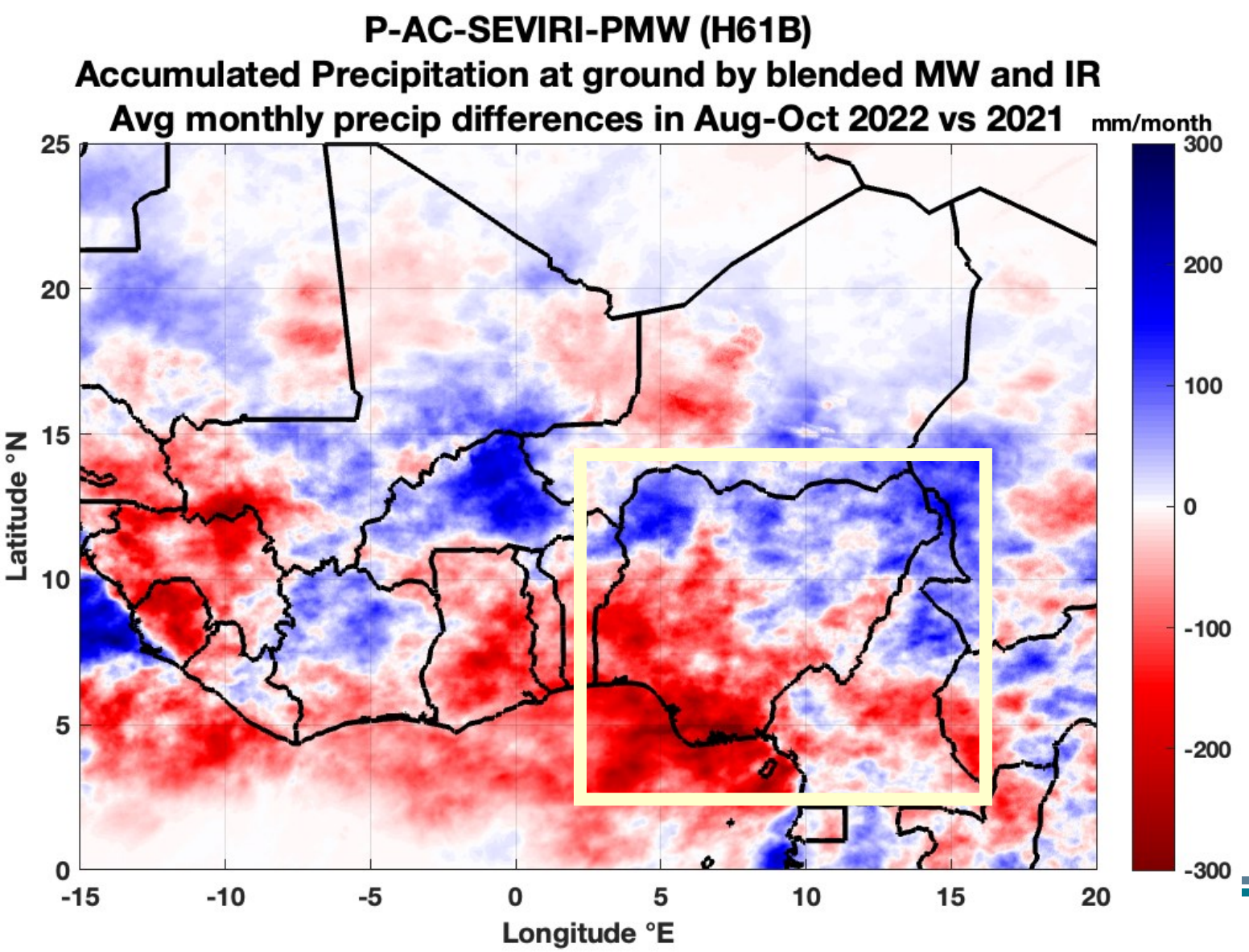
Transport
affected for 2+ weeks

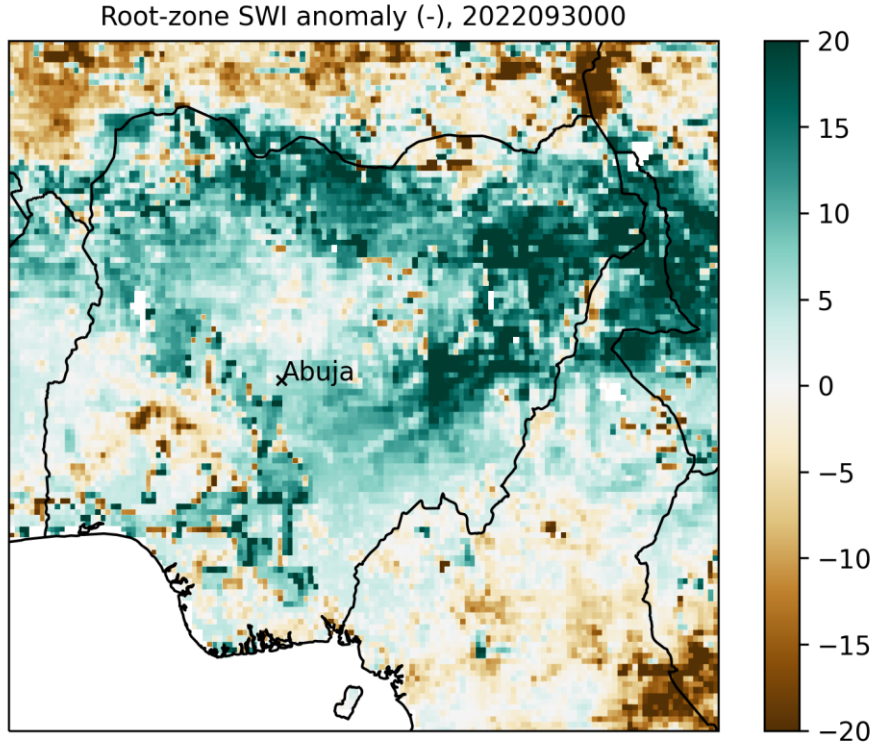
Flooding in
26 out 36 Nigerian states

600+ casualties

EXTREME EVENT MONITORING – NIGERIA FLOOD

October 2022

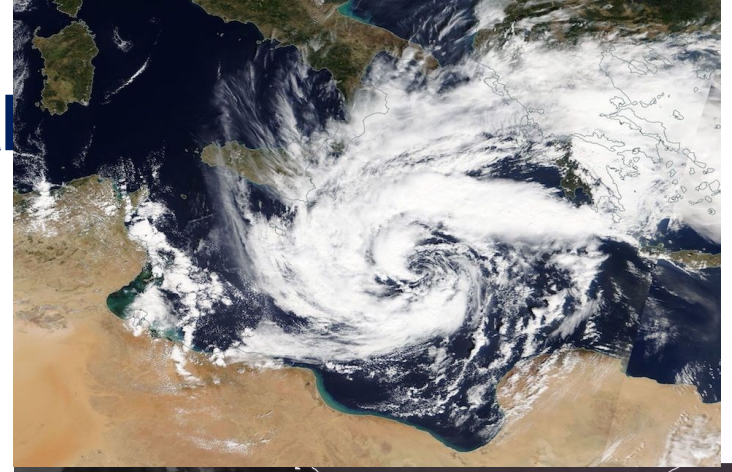


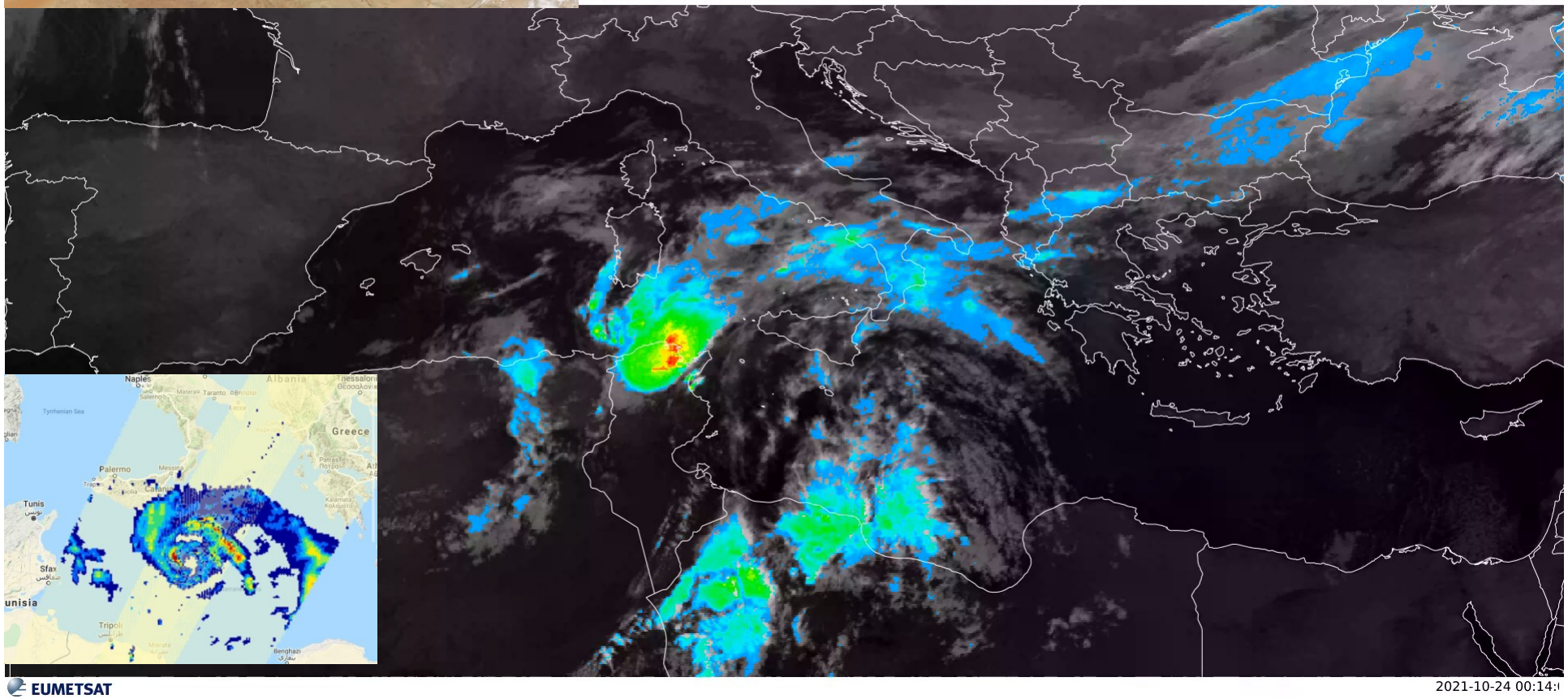


H SAF satellite soil moisture and precipitation anomalies are computed for September 2022, with positive values in the northern part of Nigeria and in Burkina Faso

Mediterranean Cyclone
October 25th, 2021

24th October, 2021 The movie shows the first moments of the beginning of the event that involved Sicily as observed by blending product. The estimated precipitation on the island is intense, particularly on the east coast, with maximum instantaneous values over 40 mm/h. Off the African coast it is possible to observe the first signs of a clear trend towards a cyclonic rotation, a fundamental characteristic before the formation of the cyclone itself.





Mediterranean Cyclone
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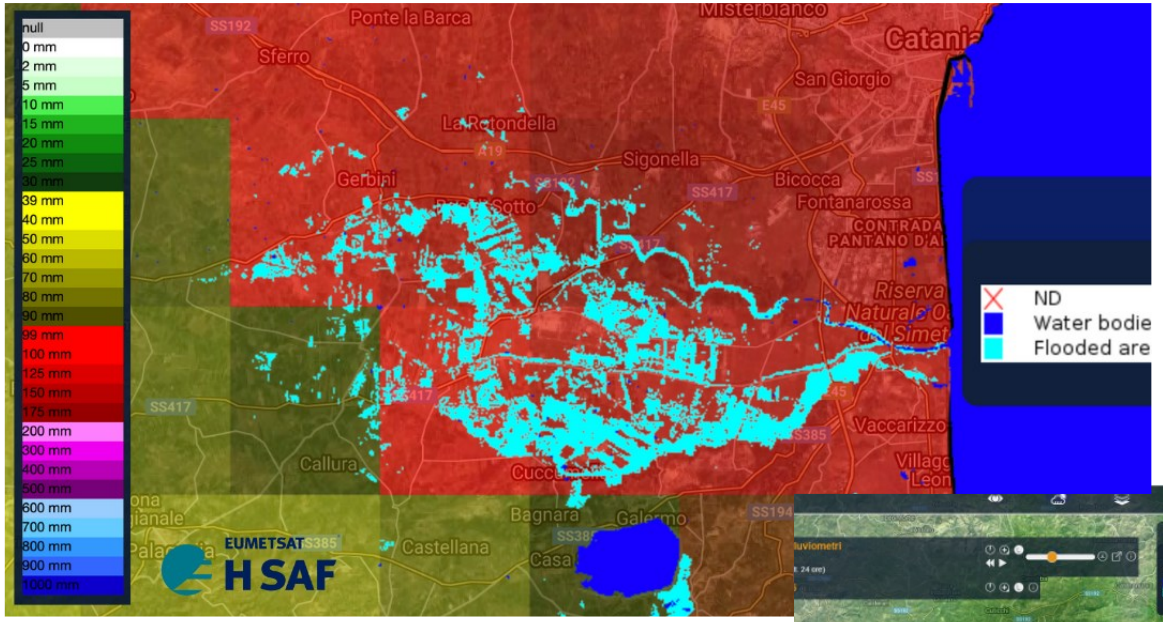
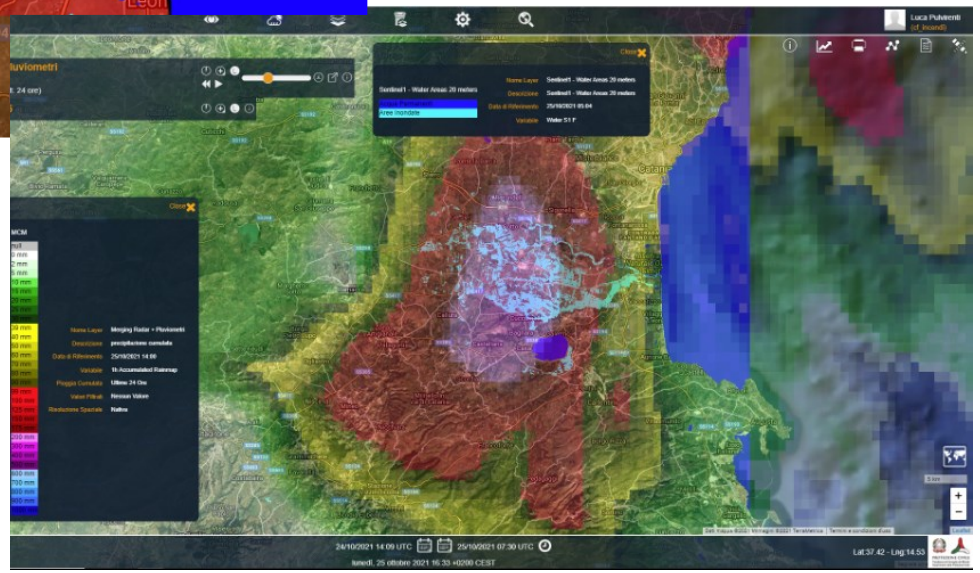


Overlap between flooded areas and accumulated precipitation estimated by H SAF P-AC-SEVIRI (H05) product.

Comparison of the flooded areas and the precipitation accumulated in the 24h before the S1 acquisition



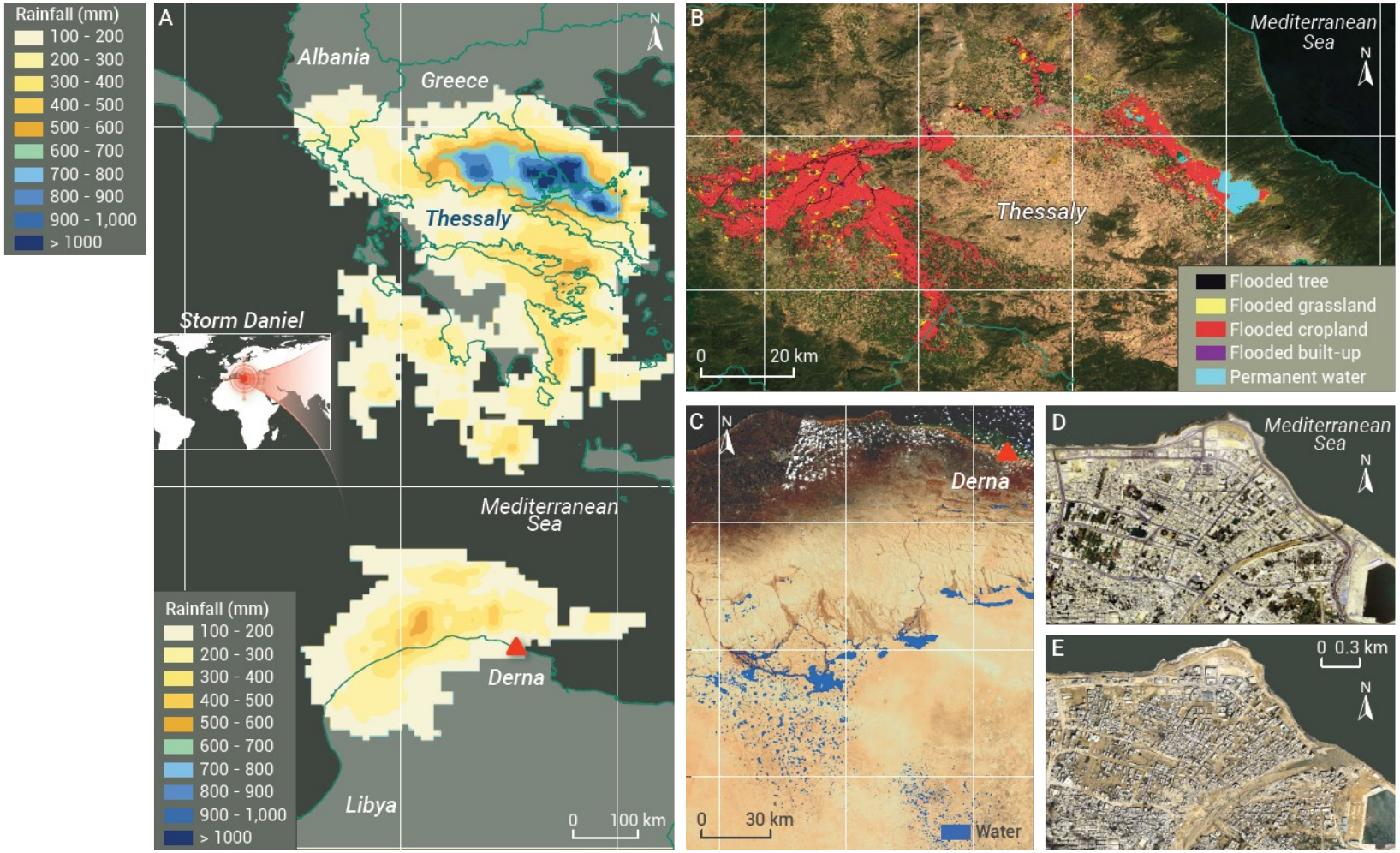
EXTREME EVENT MONITORING – STORM DANIEL

875 km² flooded area in Greece

¼ agricultural production wiped out

Flooding in the desert

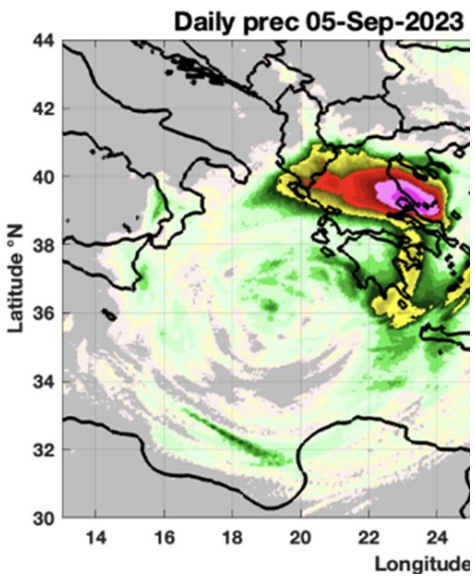
11,000 casualties (18-20,000 estimated)

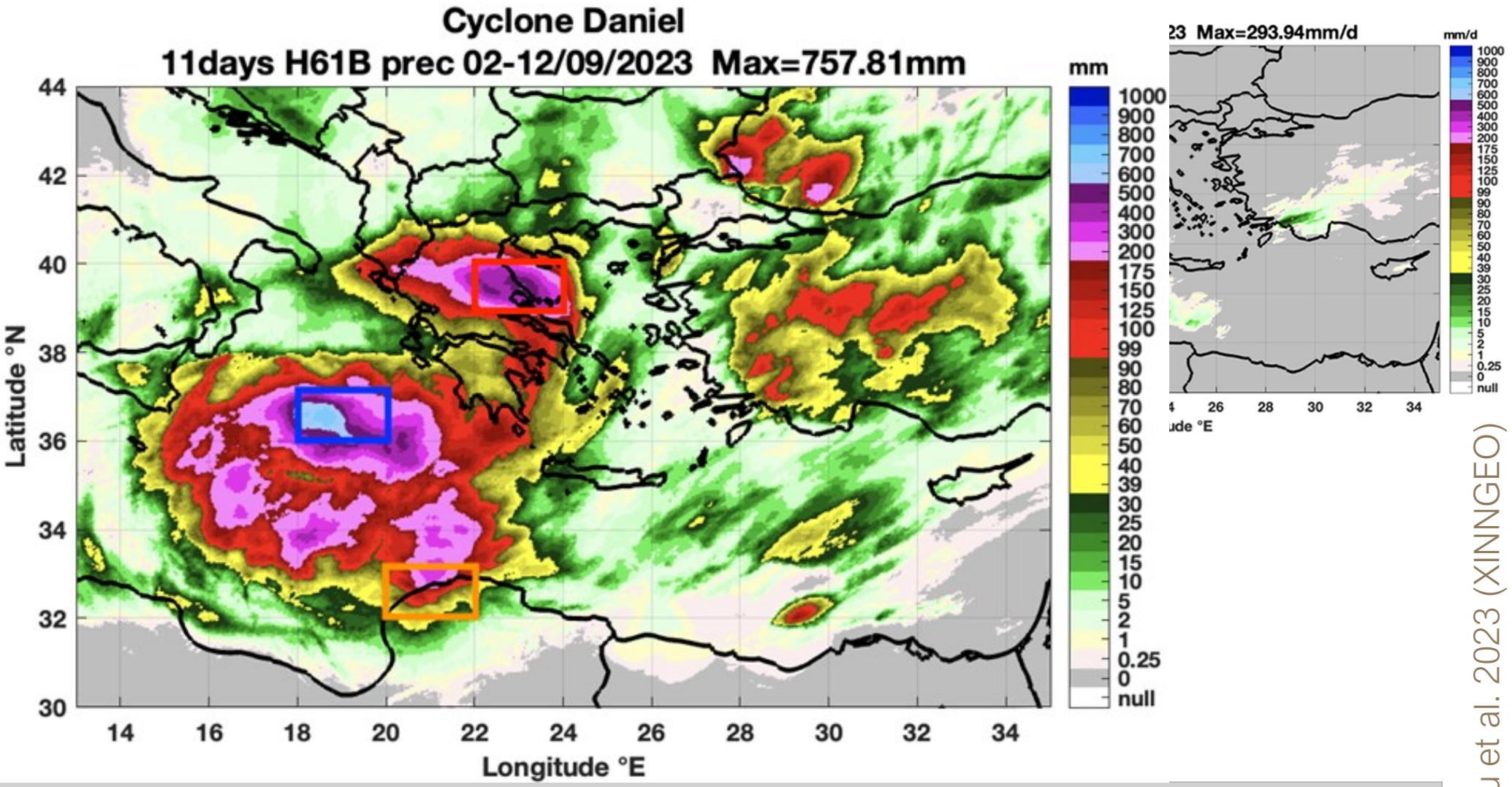


Qiu et al. 2023 (XINNGEO)

EXTREME EVENT MONITORING – STORM DANIEL

September 2023



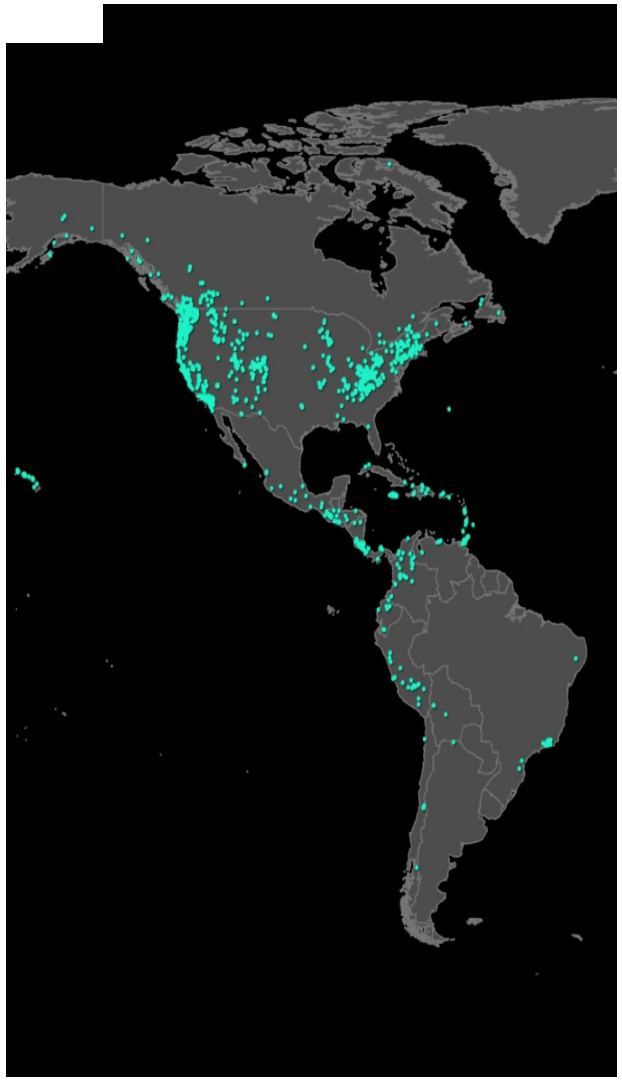


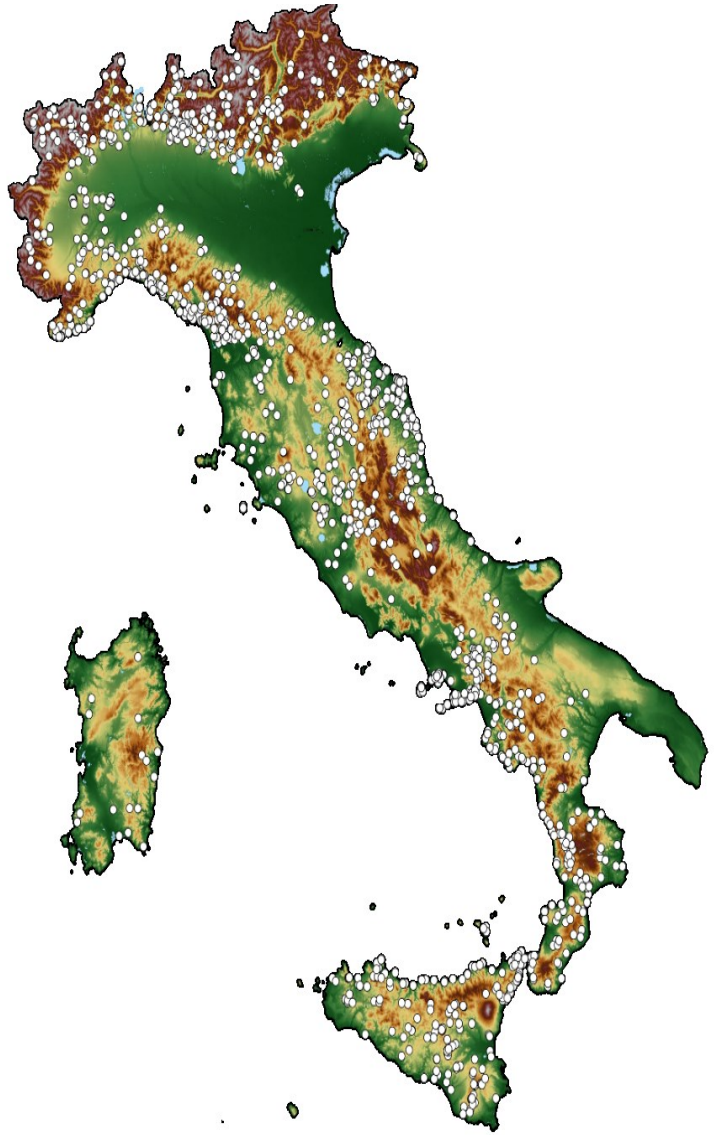
https://user.eumetsat.int/resources/case-studies/extreme-floods-in-libya-and-central-greece

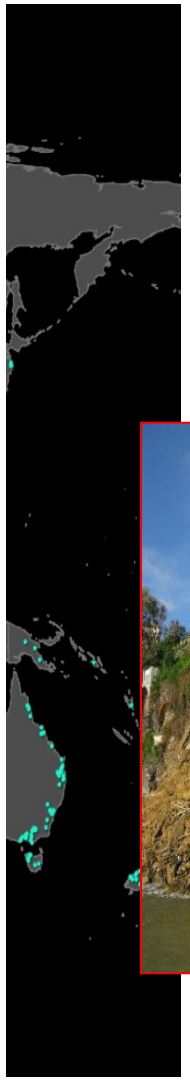
Qiu et al. 2023 (XINNGEO)

EUMETSAT
H SAF
SUPPORT TO OPERATIONAL HYDROLOGY AND WATER MANAGEMENT

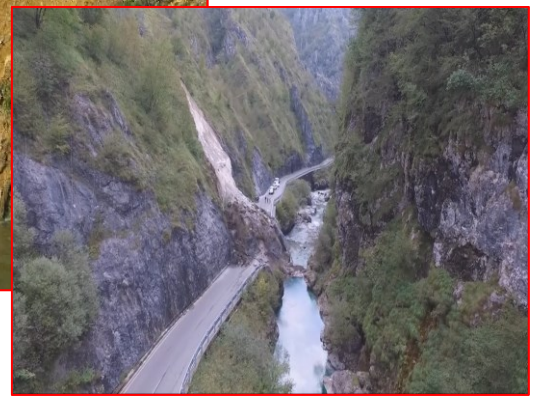
LANDSLIDES



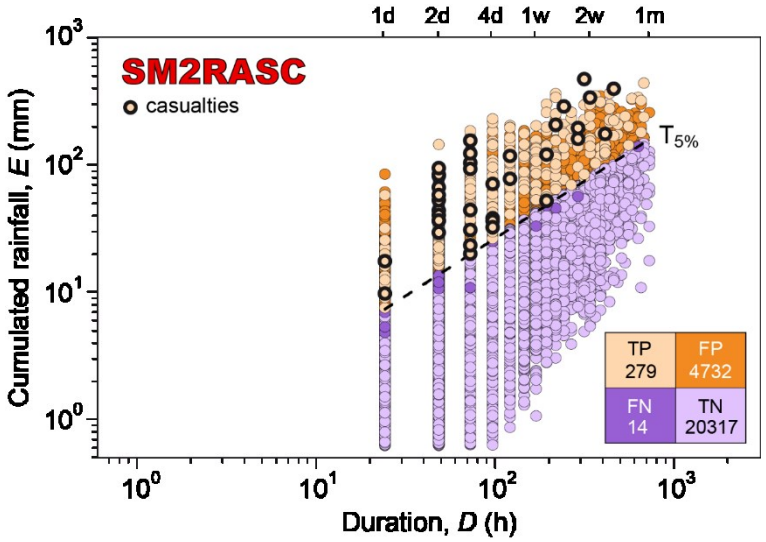


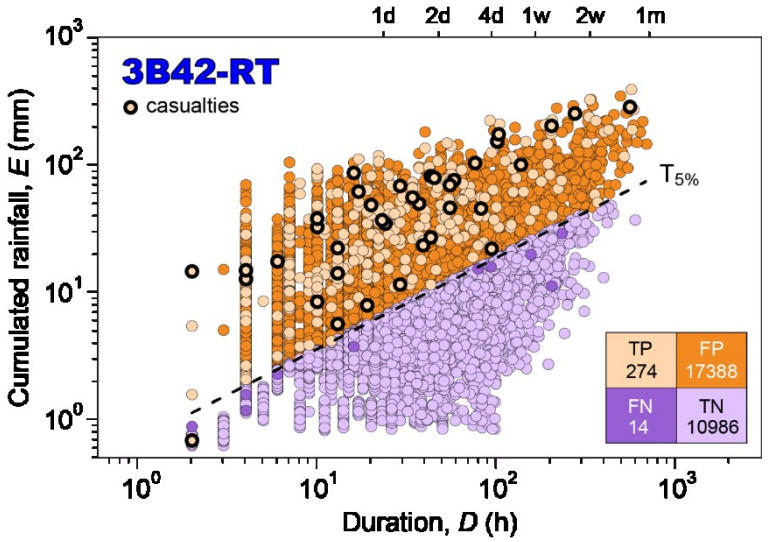


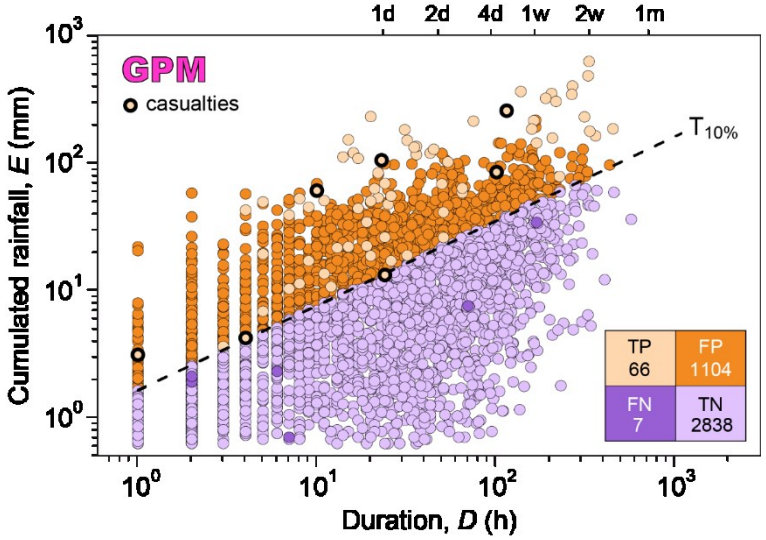
Catalogue listing 2238 rainfall-induced landslides between 2007 and 2017

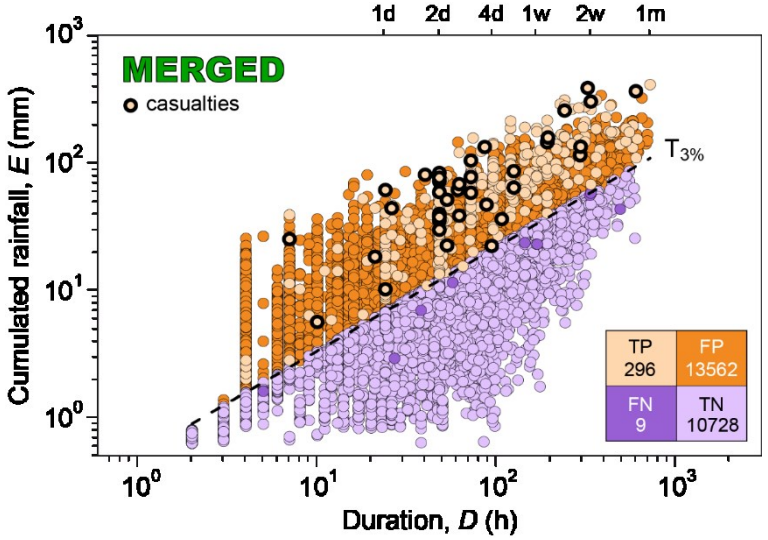


THRESHOLD VALIDATION: CASUALTIES

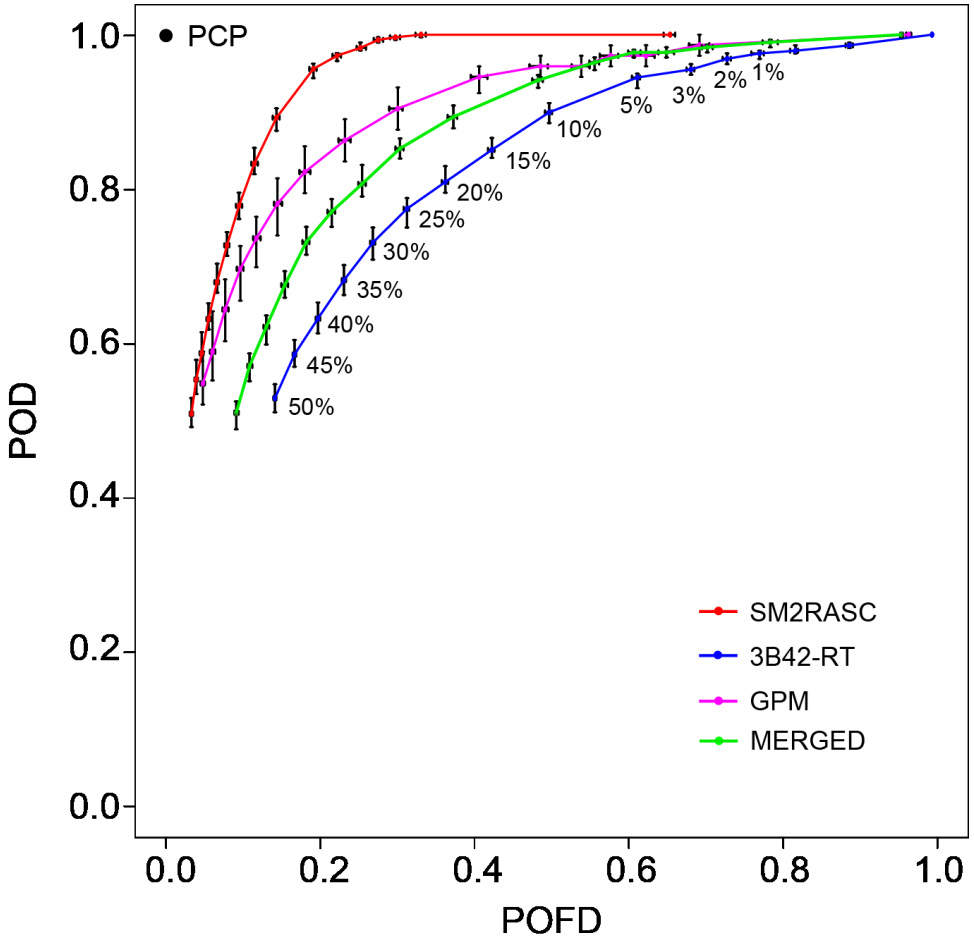








THRESHOLD VALIDATION: ROC



SM2RASC gives the best performance.
GPM is performing better than **MERGED**, while **3B42-RT** is the worst.

How to download data

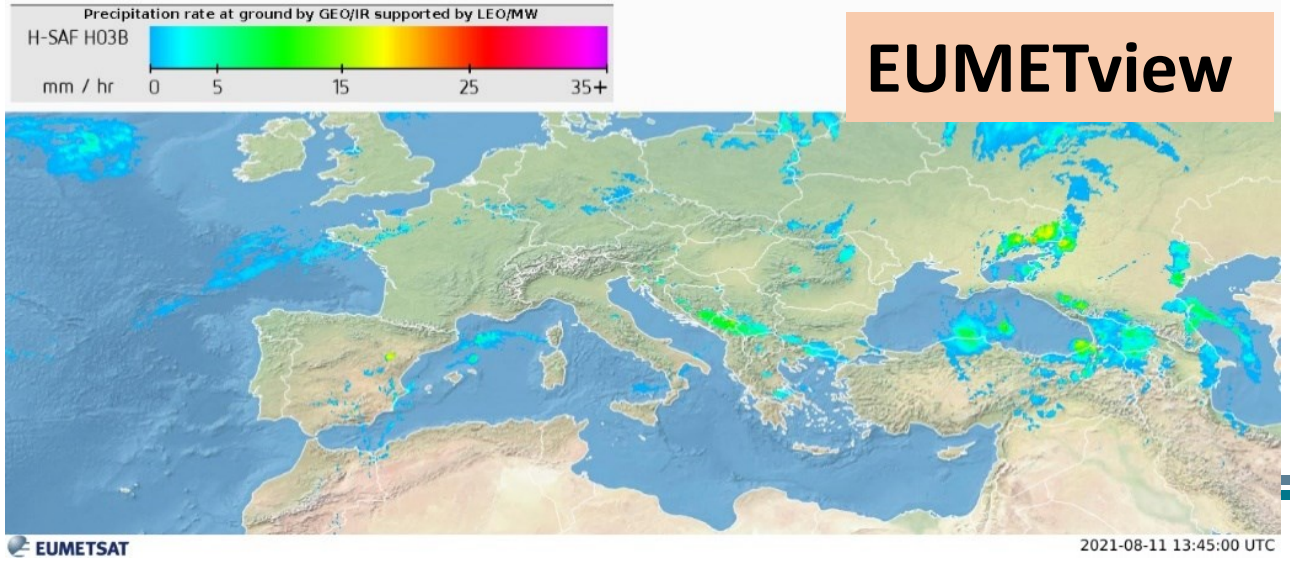
https://h-saf.eumetsat.int

EUMETCAST

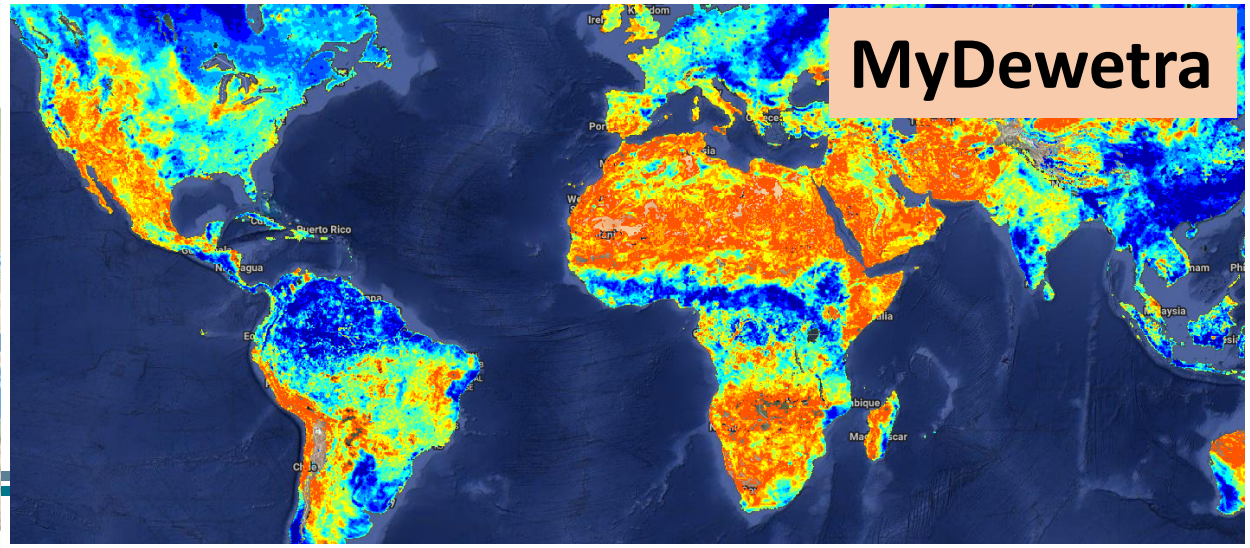
EUMETSAT DATA CUBE

http://hsaf.meteoam.it/User/UserSupport

1. Registration on the H SAF website.
2. Select product.
3. Select period and area of interest.
4. In few days you'll get an email to download the data.



EUMETview



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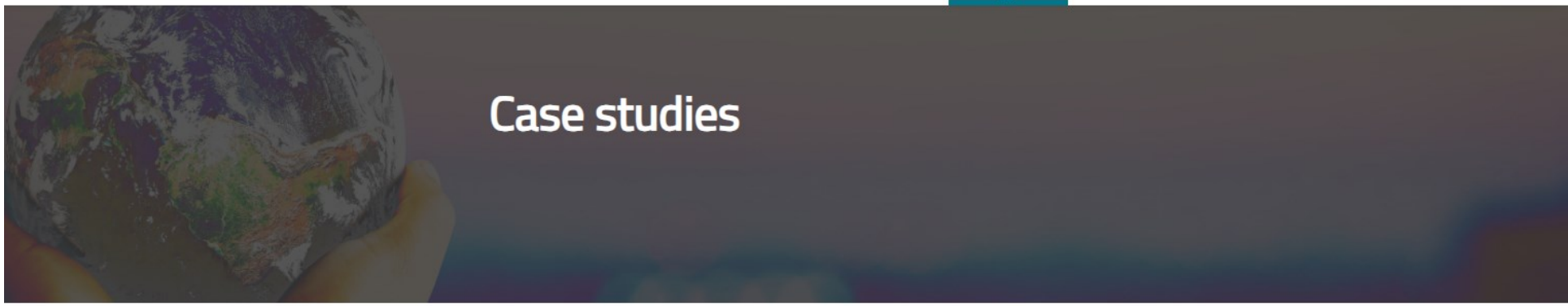
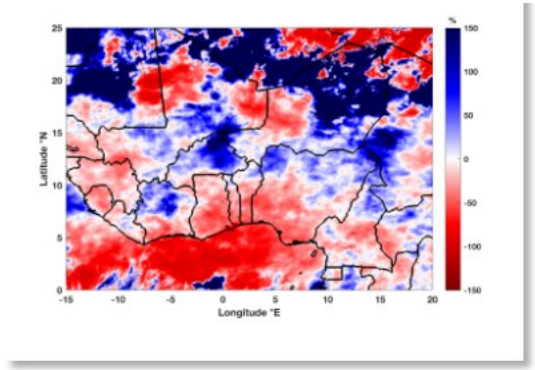


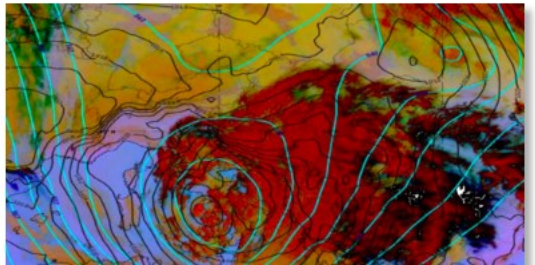
Case studies



Severe flooding in Nigeria

In October 2022, flooding in the country's south submerged homes and farmland, and displaced hundreds of thousands of people. After prolonged and intense rains, widespread flooding affected 27 out of the 36 Nigerian states, inundating houses and streets. Transport was affected for at least two weeks, and food and fuel supplies blocked. More than 500 casualties were reported.

READ MORE



Heavy rain and flooding event on 12-12-2021 in South Bulgaria

Assessment of 24h accumulated values of heavy rain in South Bulgaria through comparison between satellite products and measured data.

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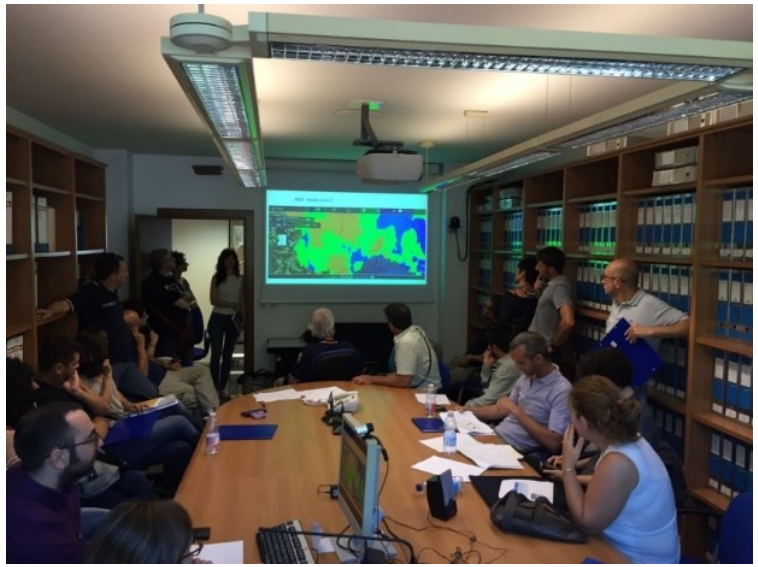
Training

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http://hsaf.meteoam.it/ @HydroSAF https://github.com/H-SAF

Thank you very much for your attention

luca.ciabatta@cnr.it