Evolution of H SAF near real-time rainfall products derived from soil moisture observations

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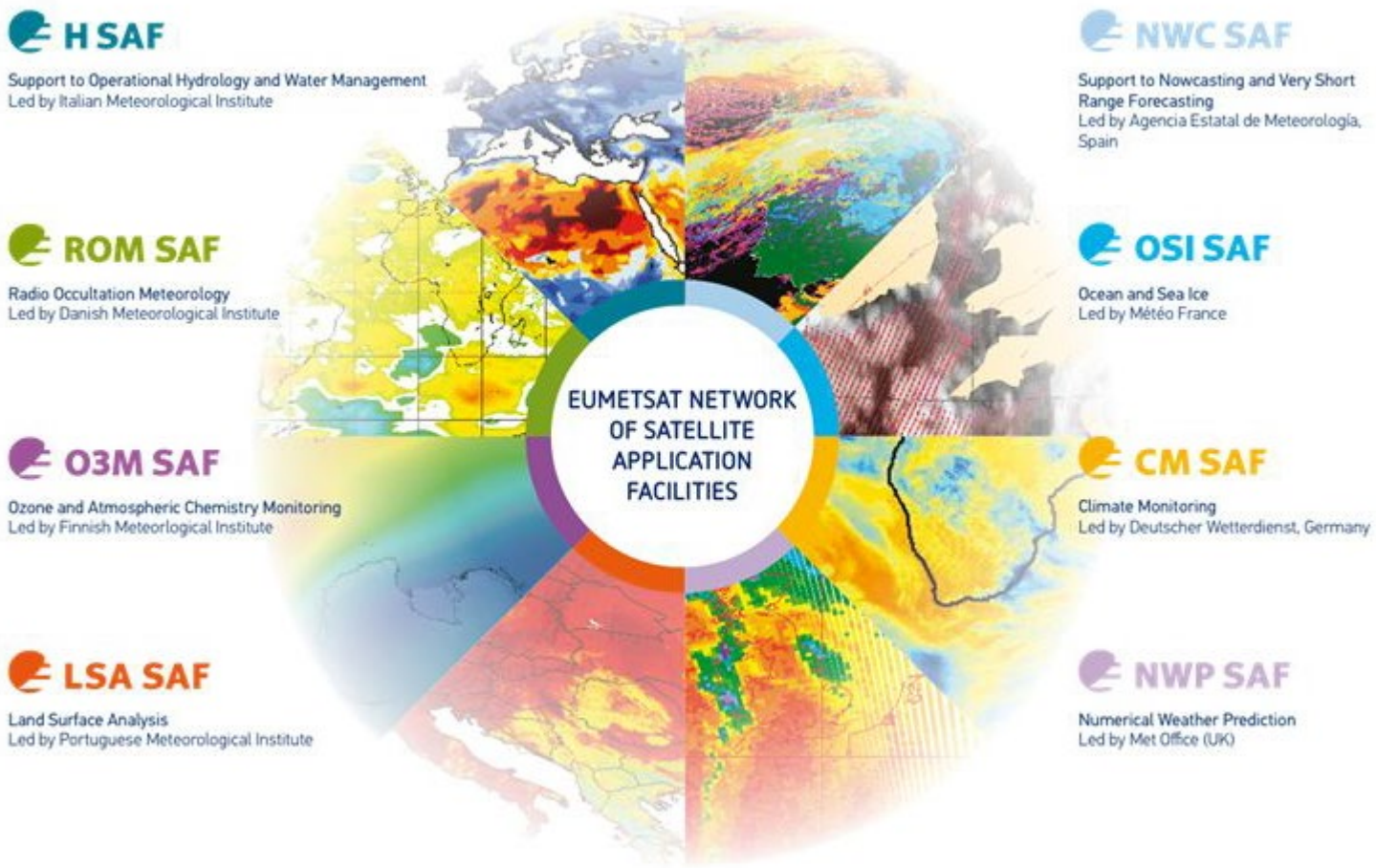
EUMETSAT H SAF

outline

- Introduction to H SAF
- SM2RAIN algorithm
- Product development and next steps

Introduction to H SAF

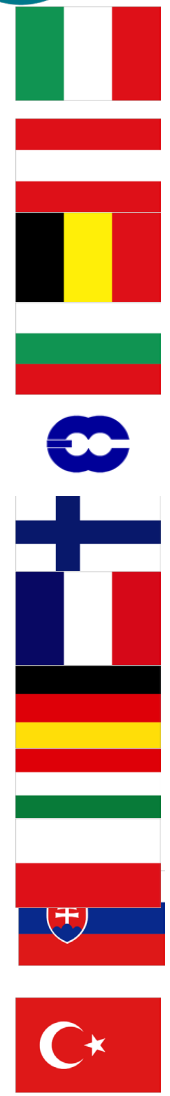


The "EUMETSAT Satellite Application Facility on Support to Operational Hydrology and Water Management (H SAF)" started on 2005 as part of the **EUMETSAT SAF Network**

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

EUMETSAT
H SAF

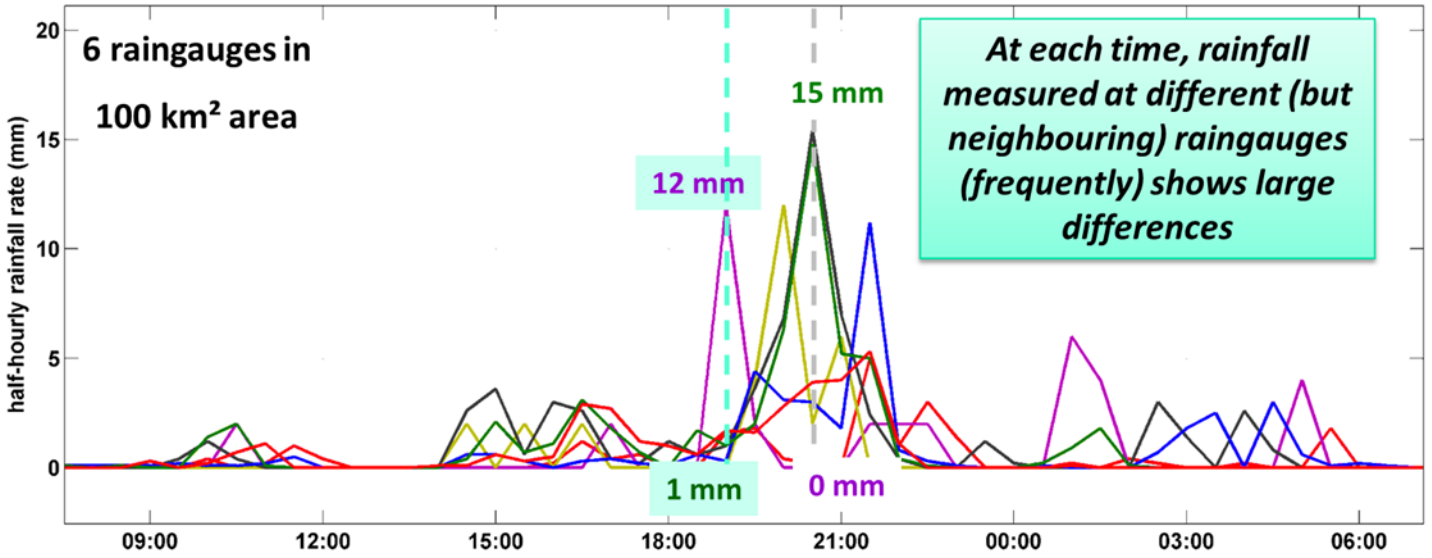
Introduction to H SAF



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

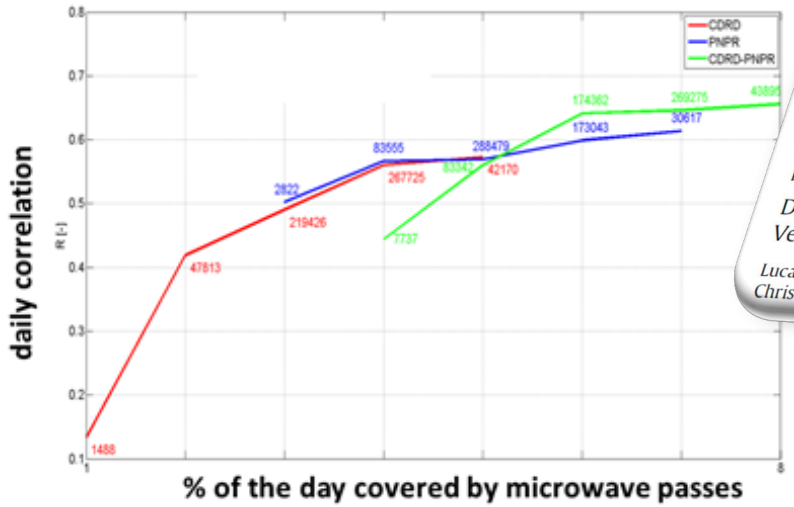
More than 50 researchers are involved in the project.

The SM2RAIN Algorithm



The retrieval approach used in **state-of-the-art** precipitation products (e.g., GPM) is (*mainly*) based on a **"top-down"** approach providing an estimate of the **INSTANTANEOUS RAINFALL RATE** at the satellite overpass

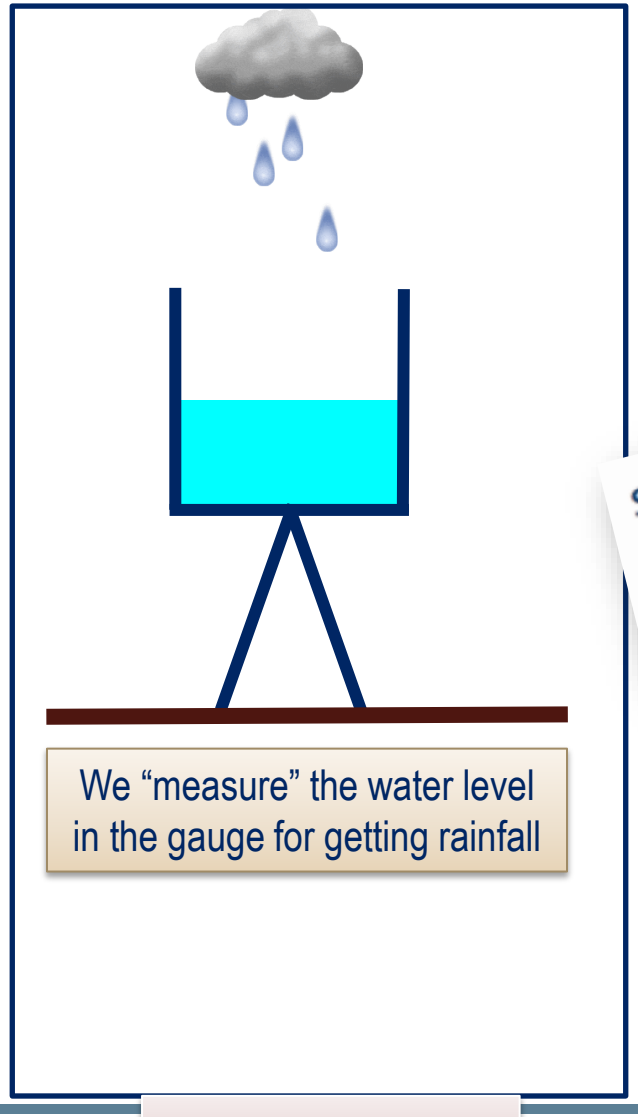
At least, 10 passes per day are needed for obtaining satisfactory performance in estimating 1-day rainfall



Ciabatta, L. et al. (2017) Journal of Hydrology 545, 436-450

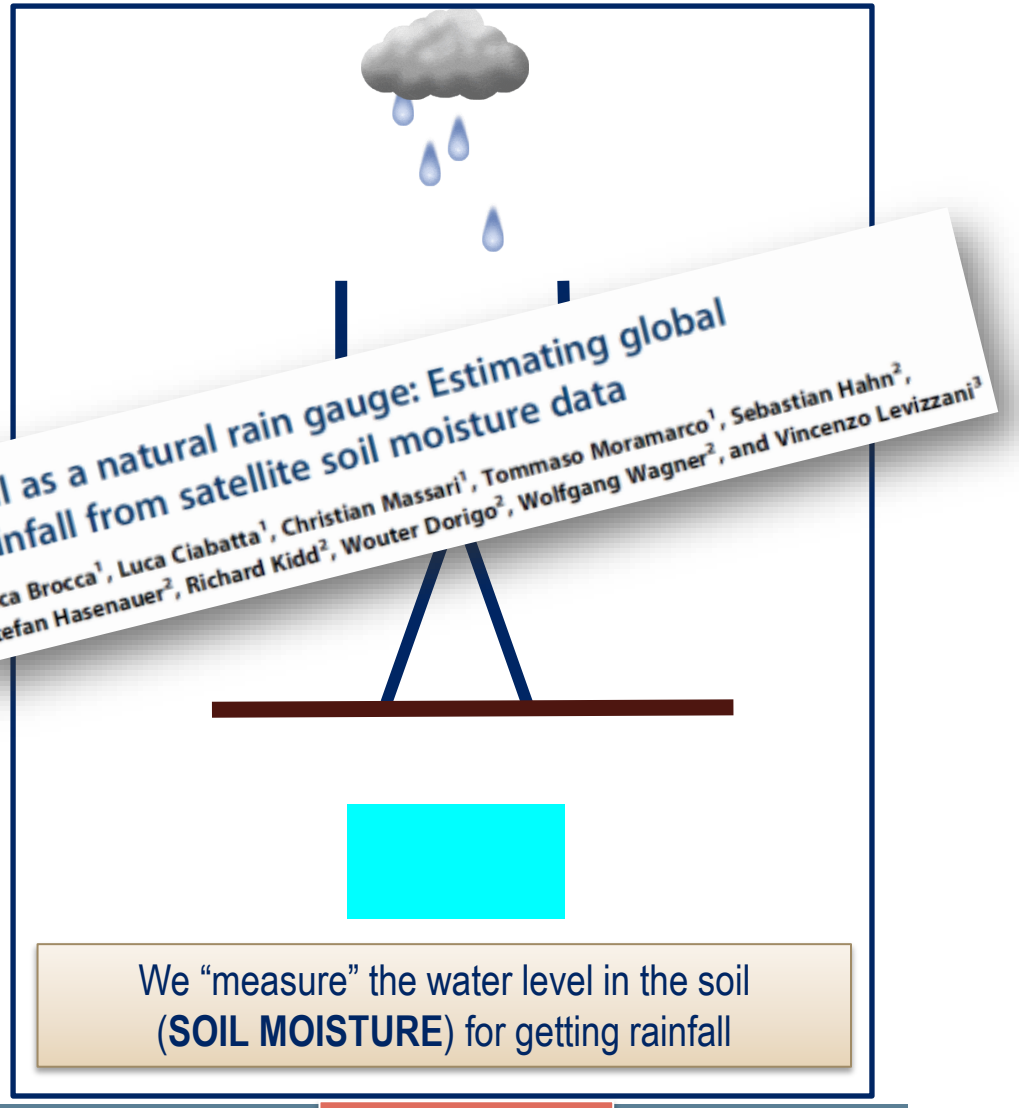
The SM2RAIN Algorithm

HOW DO WE MEASURE RAINFALL?



We “measure” the water level in the gauge for getting rainfall

RAIN GAUGE



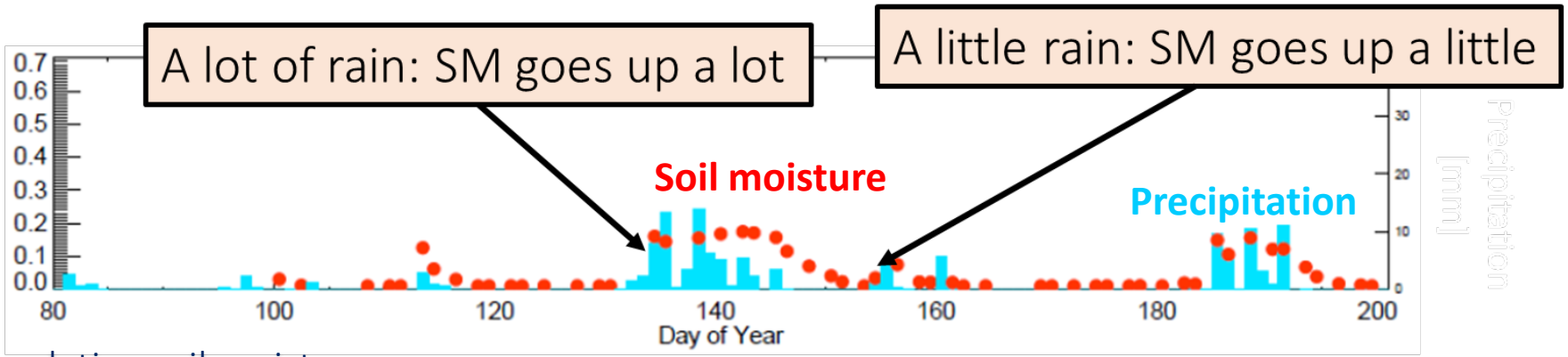
Soil as a natural rain gauge: Estimating global rainfall from satellite soil moisture data

Luca Brocca[1], Luca Ciabatta[1], Christian Massari[1], Tommaso Moramarco[1], Sebastian Hahn[2], Stefan Hasenauer[2], Richard Kidd[2], Wouter Dorigo[2], Wolfgang Wagner[2], and Vincenzo Levizzani[3]

We “measure” the water level in the soil (**SOIL MOISTURE**) for getting rainfall

SM2RAIN

The SM2RAIN Algorithm



relative soil moisture

precipitation

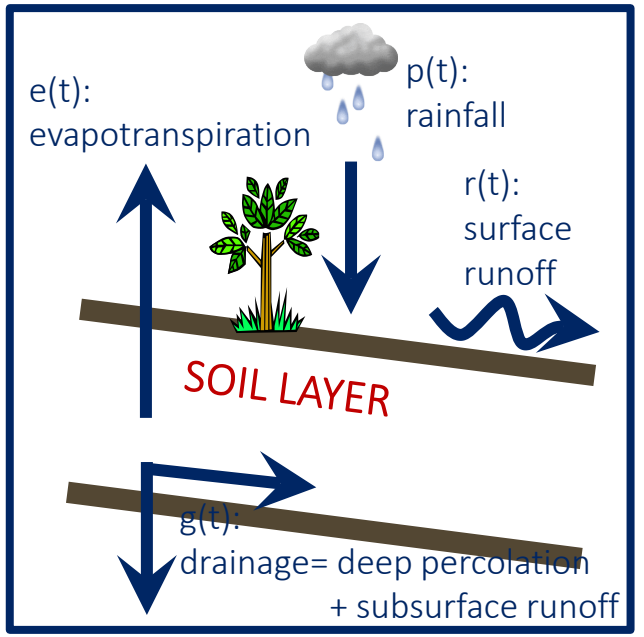
surface runoff

drainage

$$Z^*ds(t)/dt=p(t)-r(t)-e(t)-g(t)$$

soil water capacity = soil depth X porosity

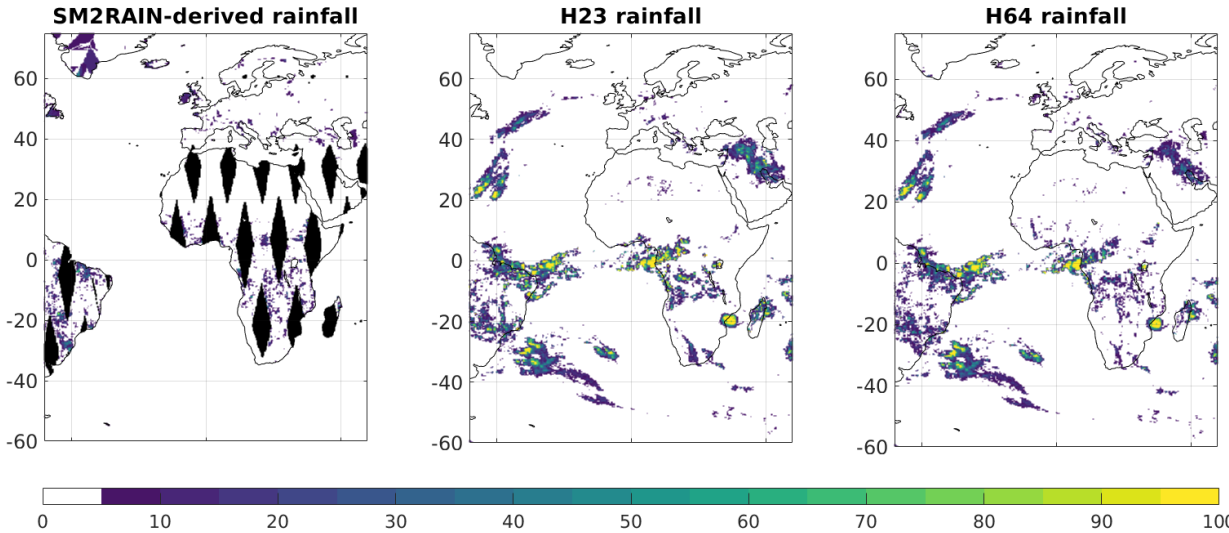
evapotranspiration

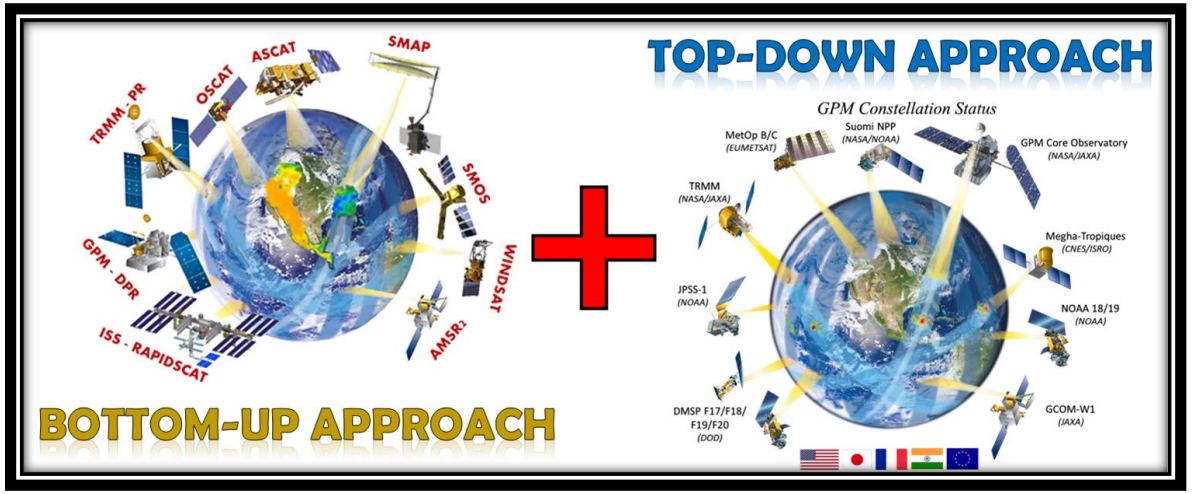


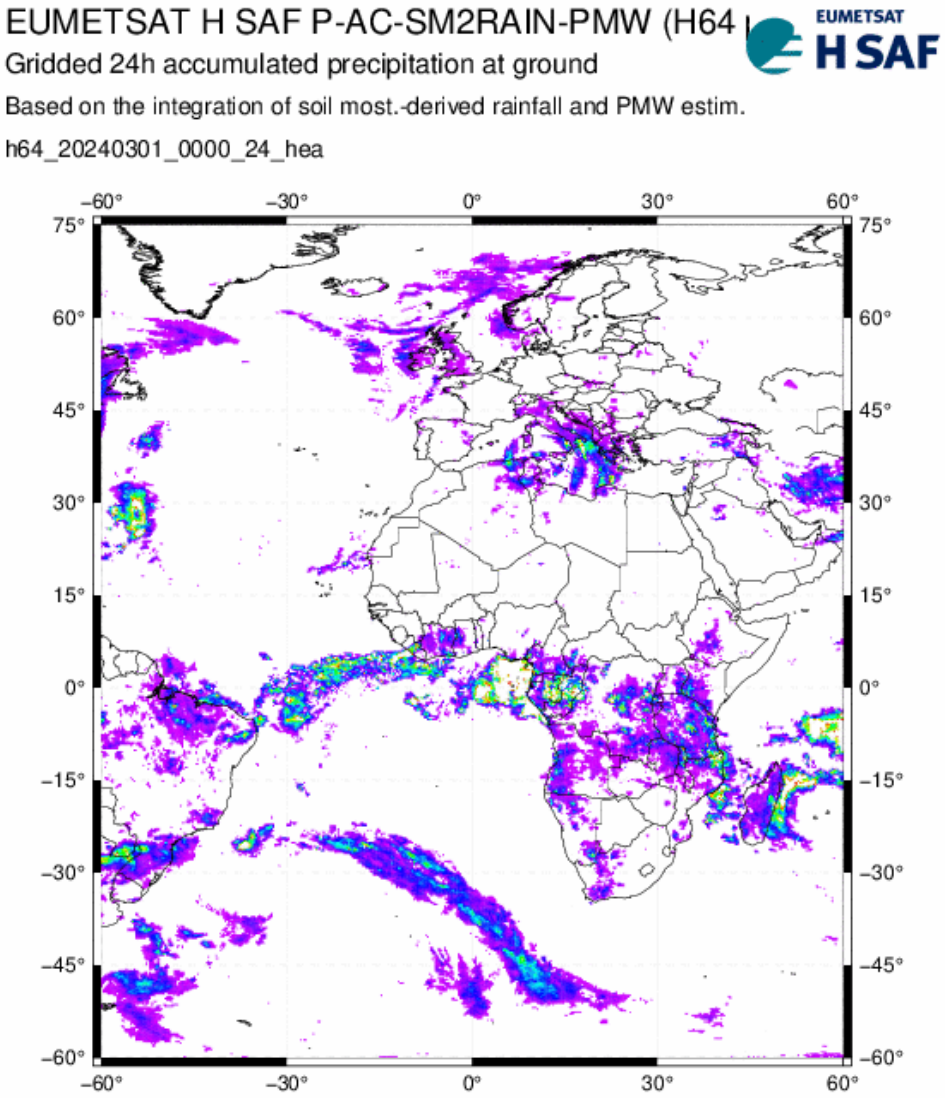
During rainfall, surface runoff and evapotranspiration are assumed to be negligible $g(t)=as(t)^b$ $r(t)=0$ $e(t)=0$

$$p(t)=Z^*ds(t)/dt+as(t)^b$$

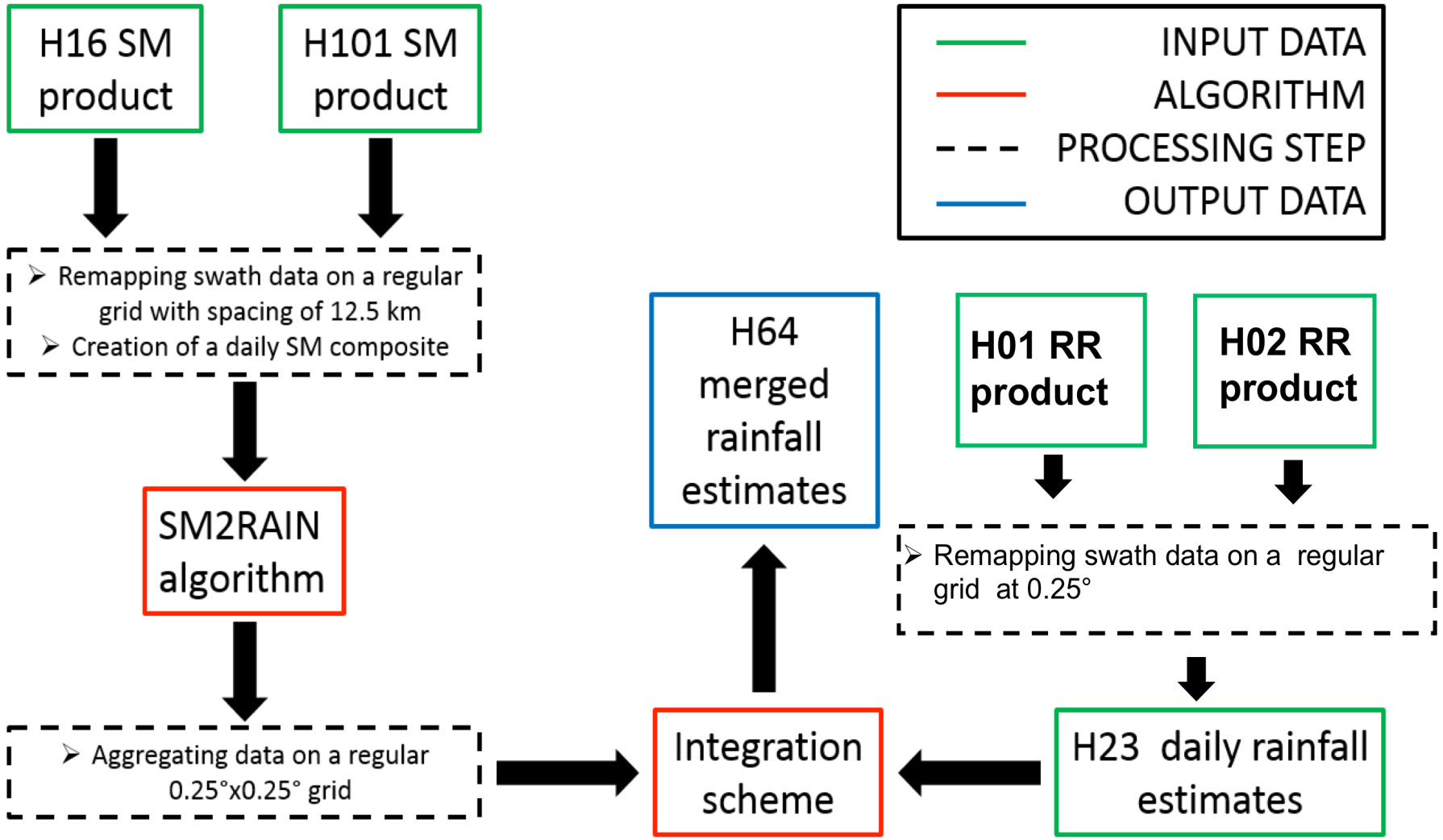
H SAF Precipitation Products: soil moisture-derived and Passive Microwave (H64)





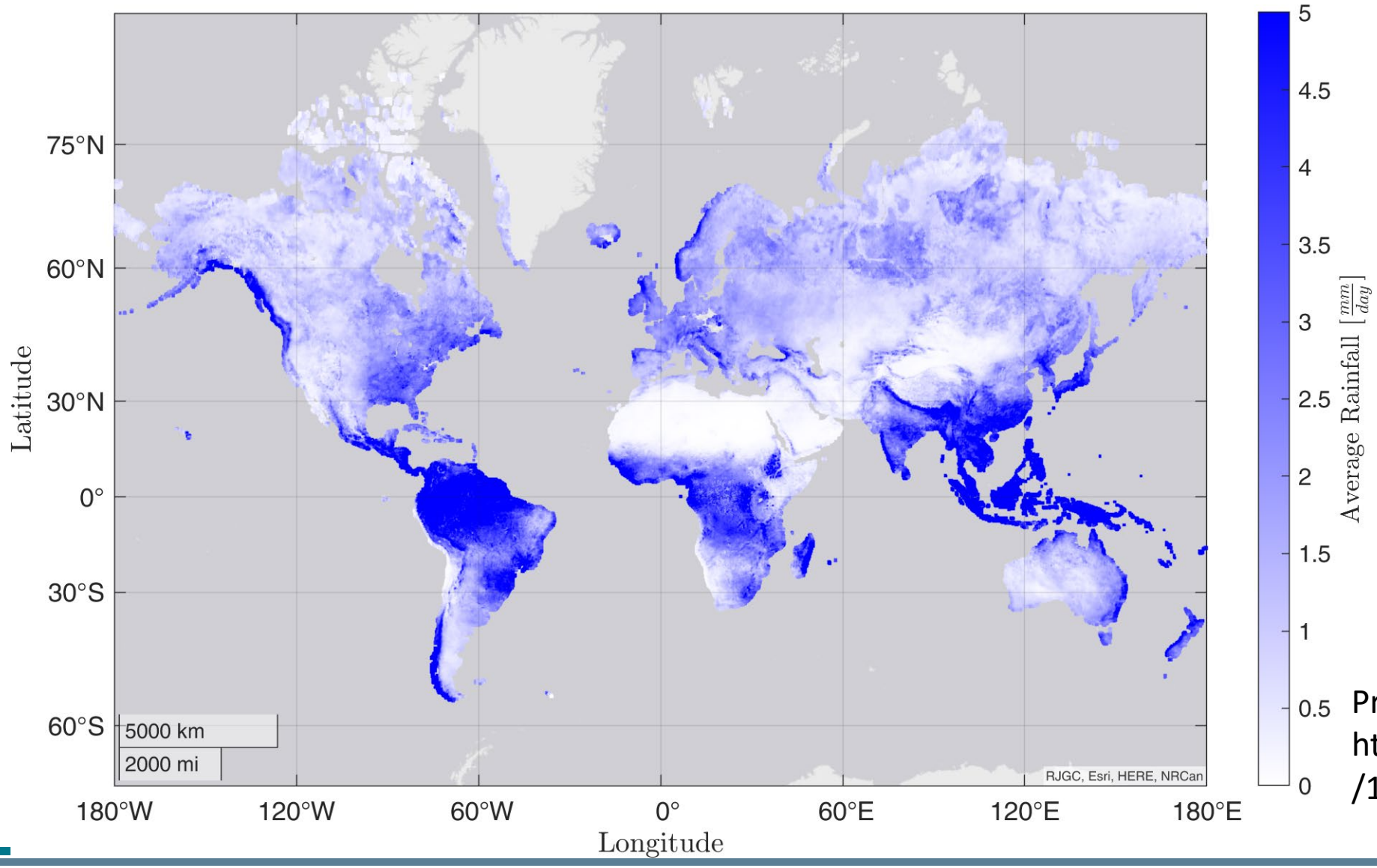


Main features
MSG Full-disk area
Every 24h
0.25° over a regular grid
15h
H SAF FTP
netCDF



H64 processing chain

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

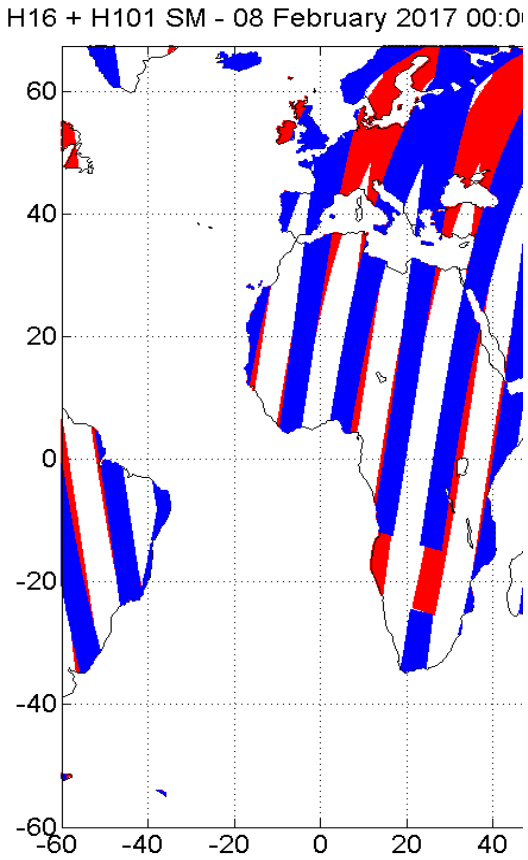


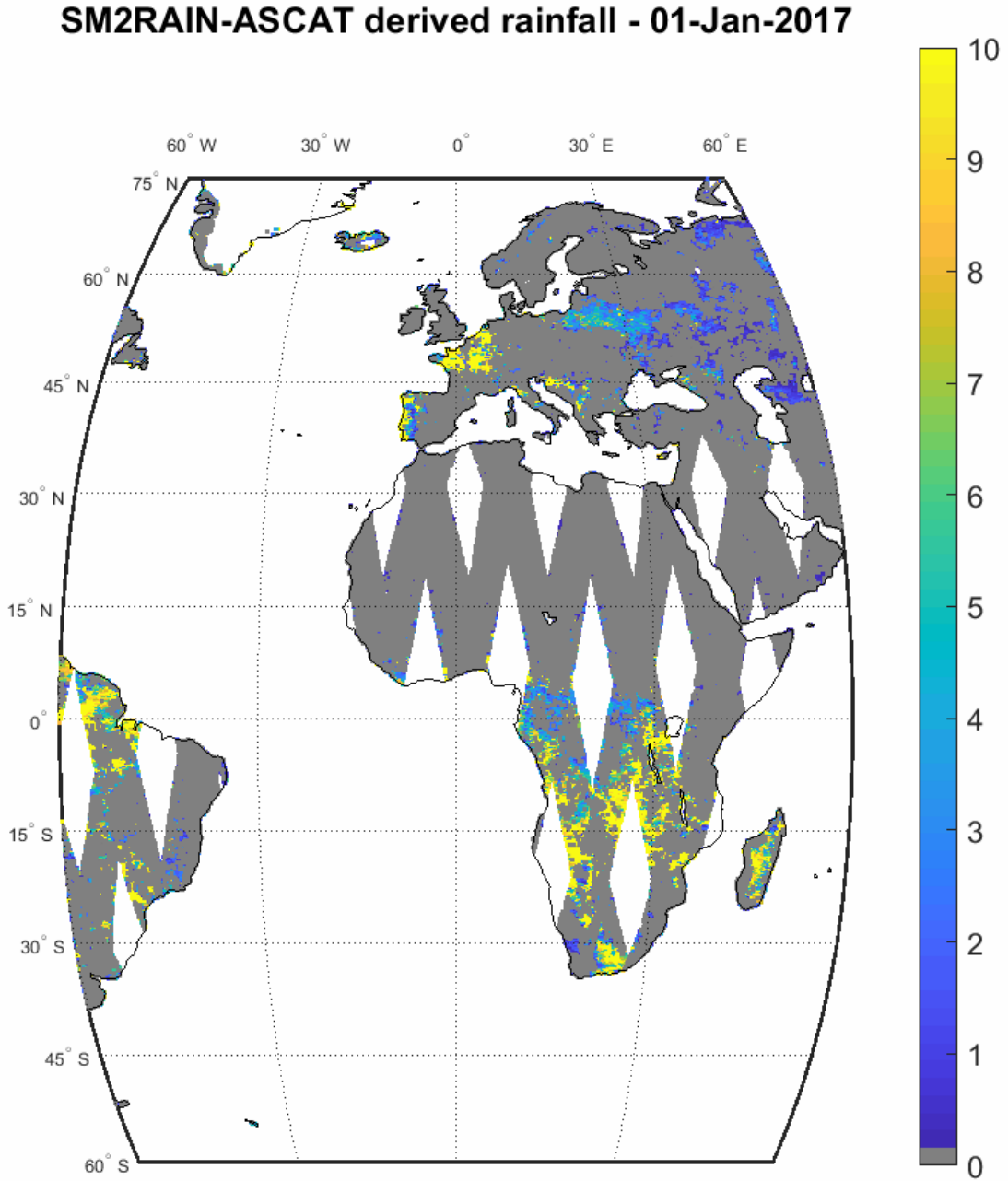
Main features
Global
Daily
10 km
Offline product Updated on a weekly basis
H SAF FTP
netCDF

Prototype freely available@ https://zenodo.org/records/10376109

EUMETSAT H SAF

Daily SM maps through ASCAT



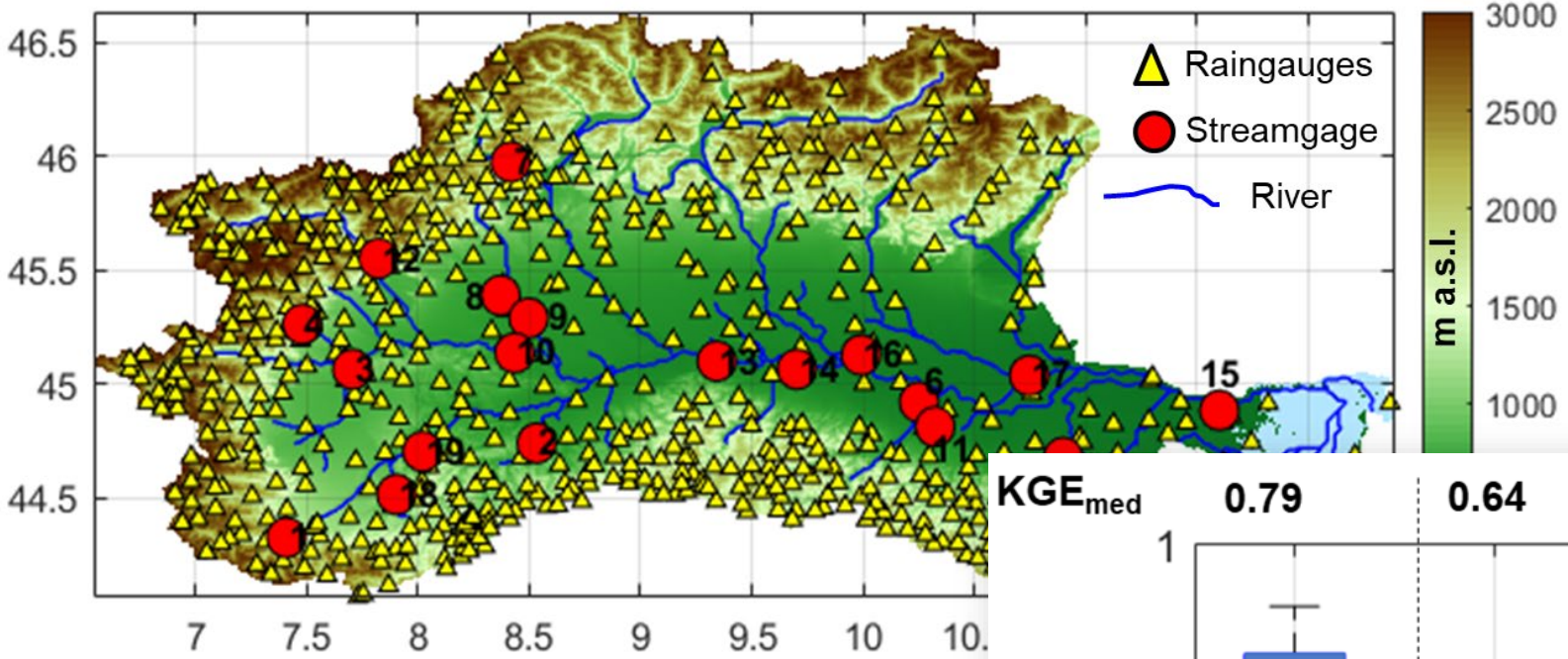


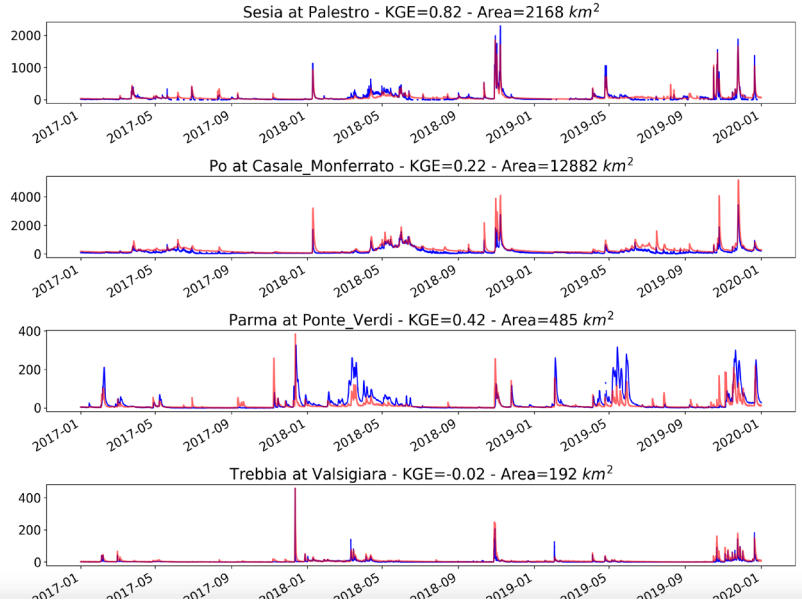
M2RAIN parameters alibrated through the use of I121 CDR product onsidering ERA5 rainfall as enchmark during the eriod 2007-2023

EUMETSAT H SAF

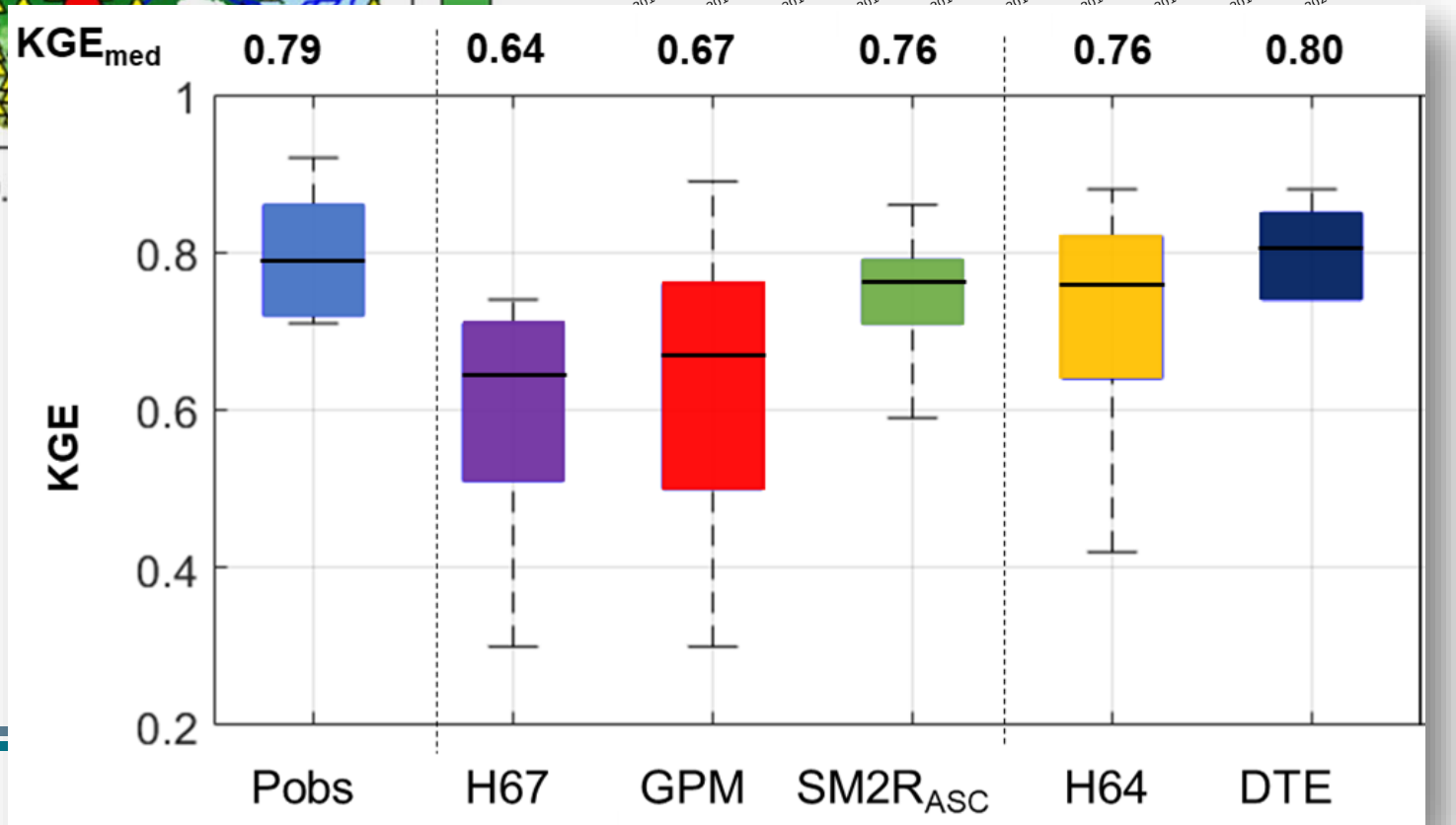
Product ID	Product Acronym	Product Type	Coverage	Spatial resolution	Temporal Resolution	Note
H64	P-AC-SM2R-PMW	Precipitation/Soil Moisture integrated product	Extended H SAF area (LAT 60°S – 75°N, LON 60°W – 60°E)	0.25°	Daily	Fully operational @ H SAF
H79	P-AC-SM2R-PMW	Precipitation/Soil Moisture integrated product	Global	0.25°	Daily	Extension of H64 on a global scale
H84	P-AC-SM2R-PMW-L	Gauge adjusted Precipitation/Soil Moisture integrated product	Global	0.25°	Daily	Gauge-corrected product with GPCC observations
H75	P-AC-SCA-SM2R	Soil Moisture-based product (SM2RAIN) for EPS-SG SCA	Global	6.25 km	Daily	Higher resolution Better accuracy
H87	P-AC-SM2R-DR	SM2RAIN-only rainfall product	Global	0.1°	Daily – updated weekly	Since 2007 – Available soon
Hxx	P-AC-SM2R	SM2RAIN-only nrt	Extended H SAF area (LAT 60°S – 75°N, LON 60°W – 60°E) – Global	0.1°	Daily	NRT product fully consistent with DR Available soon

EUMETSAT



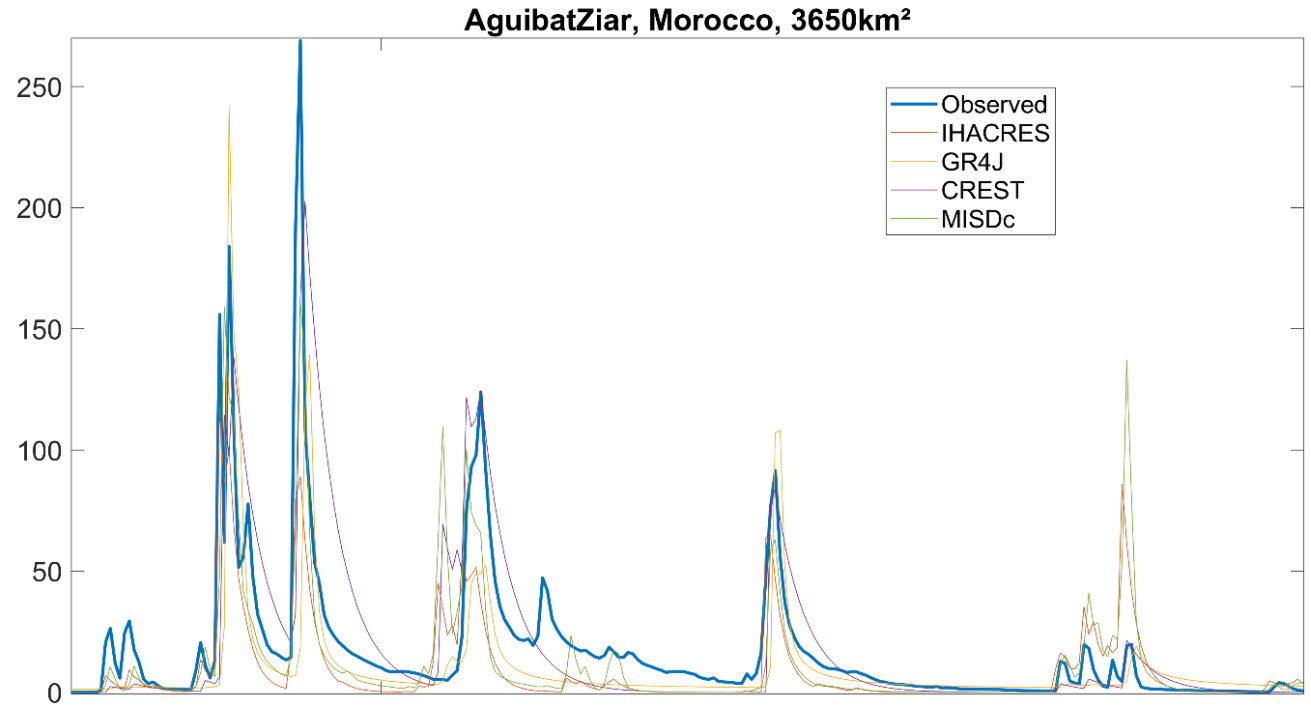


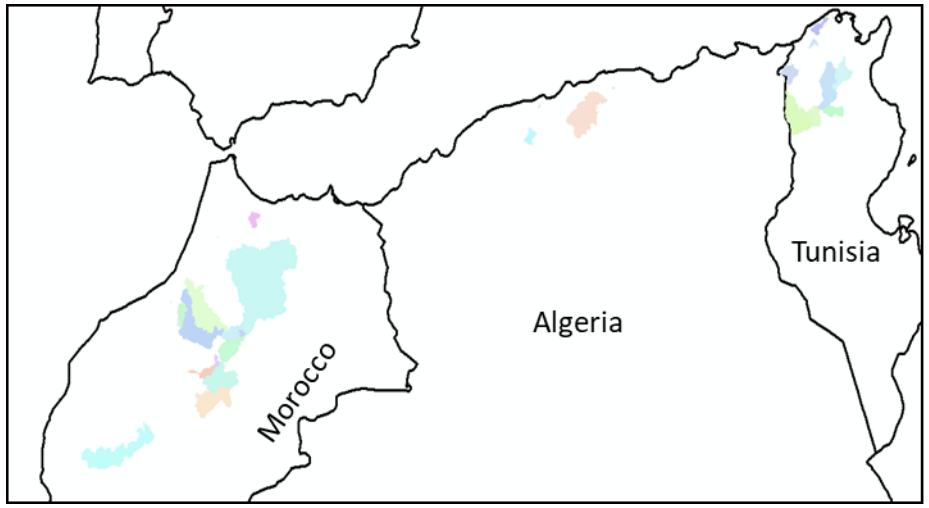
In a very densely gauged basins (642 stations/70000 km²), satellite rainfall data provide useful information for hydrological prediction

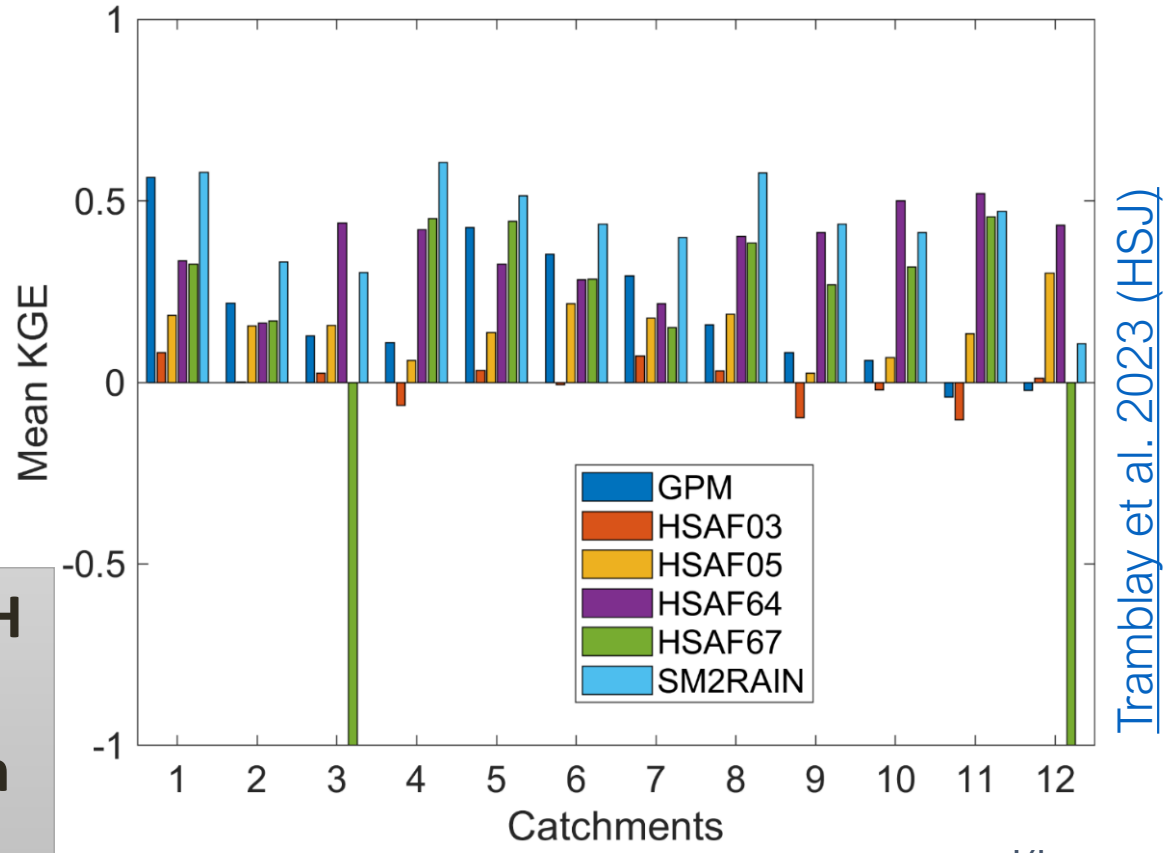


Camici et al. 2021 (EUMETSAT)

Flood Prediction in North Africa



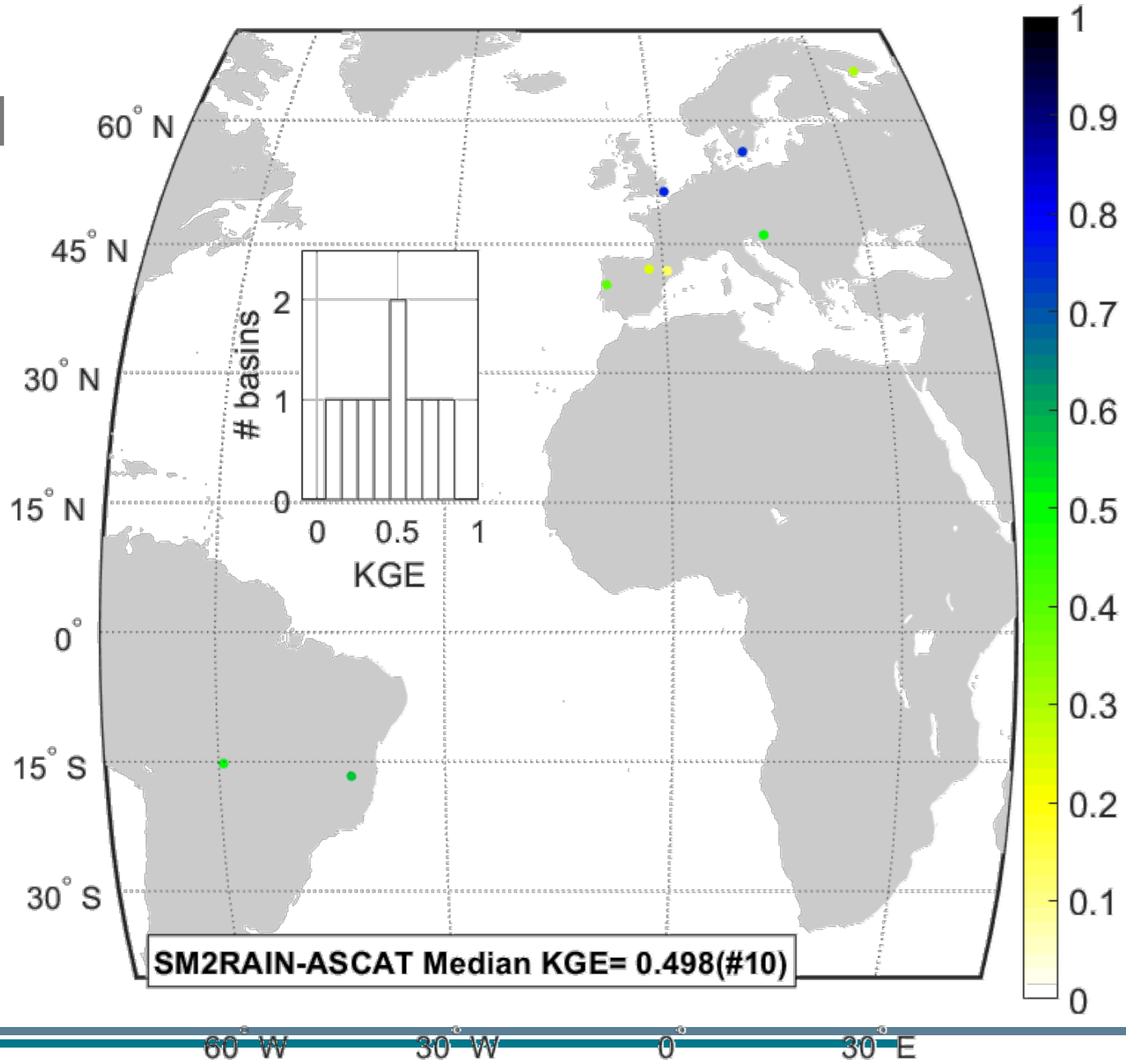




During an H SAF visiting scientist activity, different H SAF precipitation products were tested in 12 basins in northern Africa highlighting their good prediction capabilities in most of the basins.

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)

TAKE HOME MESSAGE

Satellite soil moisture data can be used with benefits for rainfall estimation

H SAF is providing operational rainfall products derived through SM observations that are characterized by good skills in hydrological applications

The availability of long term SM dataset will allow the generation of a global rainfall dataset

The availablity of the data in NRT will also allow to release rainfall estimates with low latency ready to be used operationally

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

Thank you very much for your attention

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