Recent advances in usgin satellite soil moisture and precipitation for flood and landslide prediction in the Mediterranean basin

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OUTLINE

RATIONALE

SM-PRECIPITATION

FLOODS

LANDSLIDES

WHY IN THE MEDITERRANEAN?

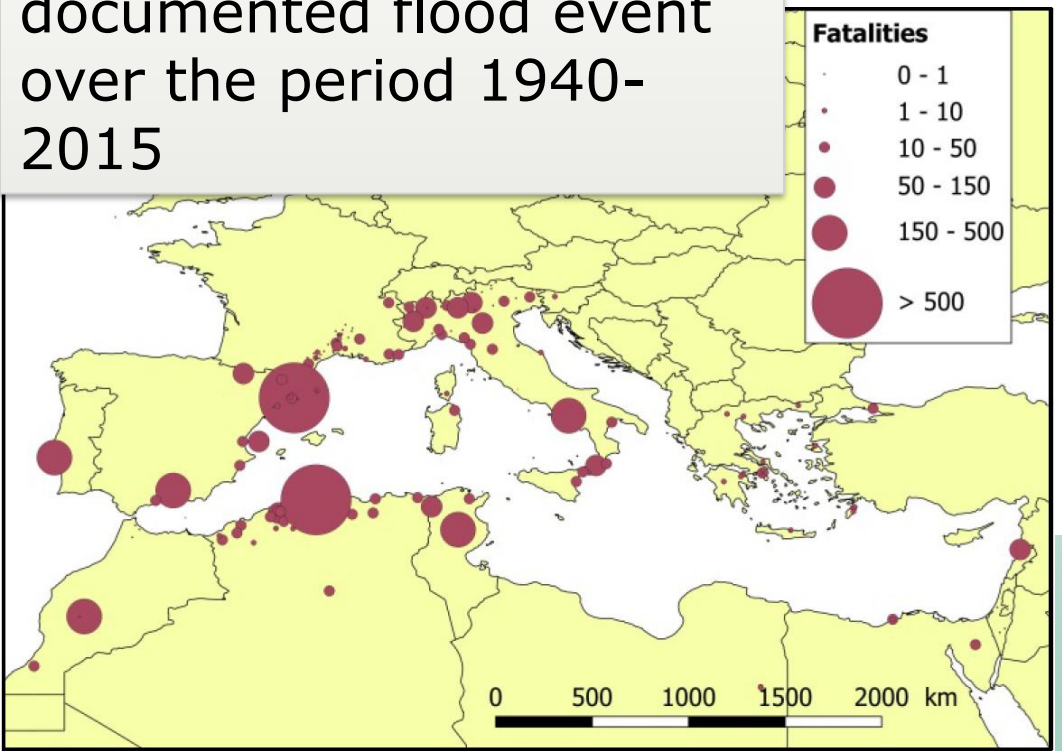
- disastrous **floods** and **landslides** are much more frequent in some parts of the Mediterranean region than in the rest of Europe
  - local climate: prone to short intense bursts of **precipitation** → active convection
  - population growth: particularly high along the coasts → rapid increase in population exposed to flooding
- Hydro-meteorological events in the Mediterranean region are strongly influenced by **soil moisture** (e.g., 30% increase of soil moisture produces a 8-fold increase of peak discharge)

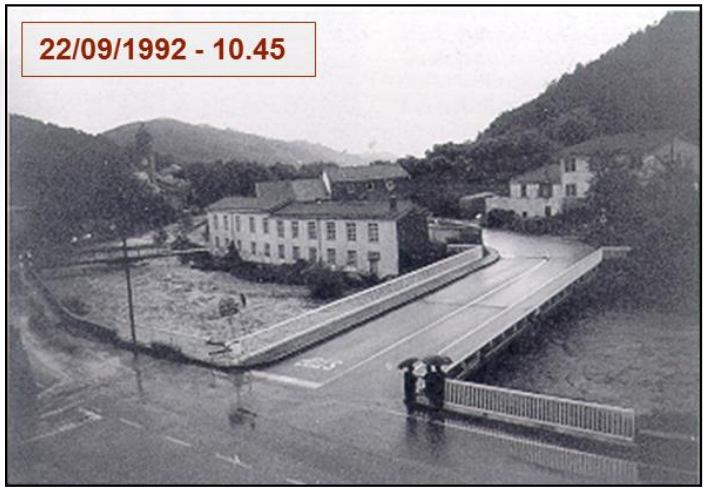
WHY IN THE MEDITERRANEAN?

1.3.4. Mediterranean extreme floods and flash floods

Eric Gaume, Hydrologist, IFSTTAR, France.
Marco Borga, Hydrologist, University of Padoua, Italy.
Maria Carmen Llasat, Paleoclimatologist, University of Barcelona, Spain.
Said Maouche, Geophysicist, CRAAG, Bouzareah, Algiers, Algeria.
Michel Lang, Hydrologist, IRSTEA, France.
Michalis Diakakis, Hydrologist, University of Athens, Greece.

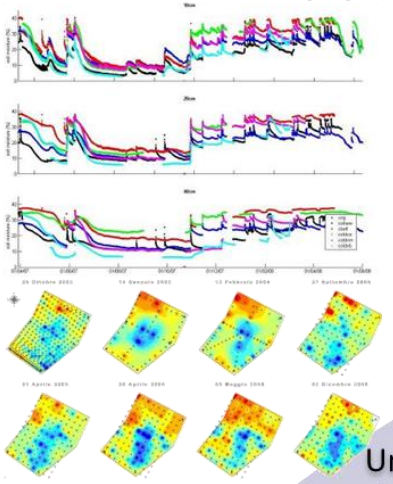
Number of people reported killed in each documented flood event over the period 1940-2015

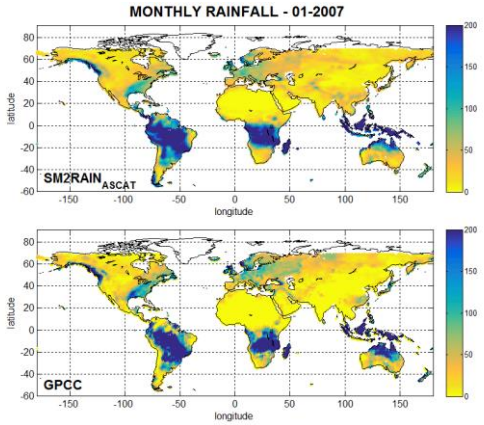




SOIL MOISTURE AND PRECIPITATION

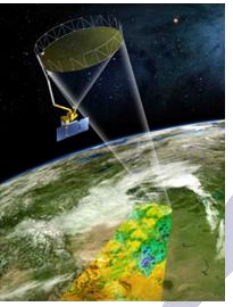
2005 — 2007 JoH paper — 2010 HESS paper — 2014 JGR paper — 2015



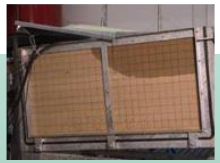


Soil moisture and precipitation are the two key variables for predicting flood and landslide events

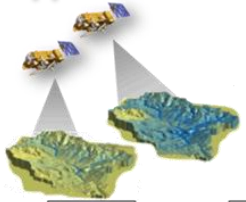
Soil moisture **monitoring** with in situ and remote sensing

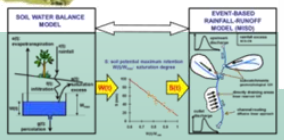


Understanding the spatial-temporal **variability** of soil moisture at different spatial scales



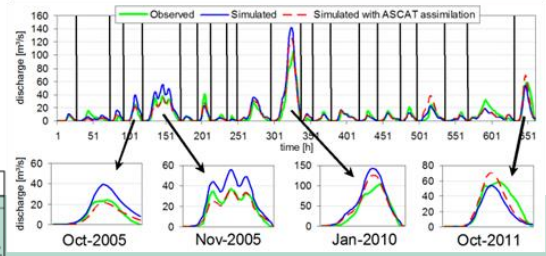
Assimilation of in situ and remote sensing soil moisture measurements for **hydrological applications**



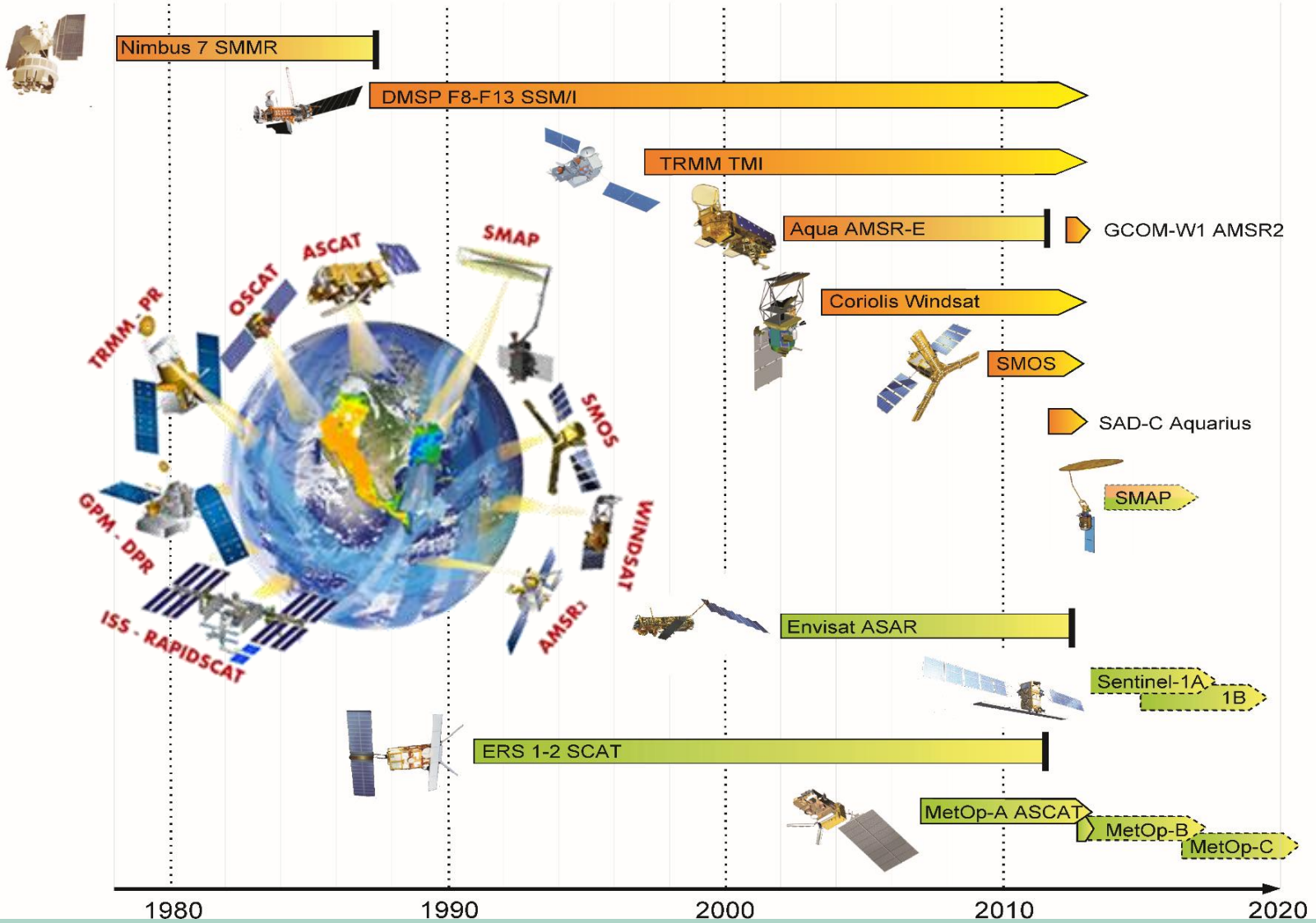


Detecting rainfall from the bottom up: using soil moisture observations for measuring rainfall (**SM2RAIN**)

Brocca, L., Ciabatta, L., Massari, C., Camici, S., Tarpanelli, A. (2017). **Soil moisture for hydrological applications: open questions and new opportunities**. *Water*, 9(2), 140.



REMOTE SENSING OF SOIL MOISTURE

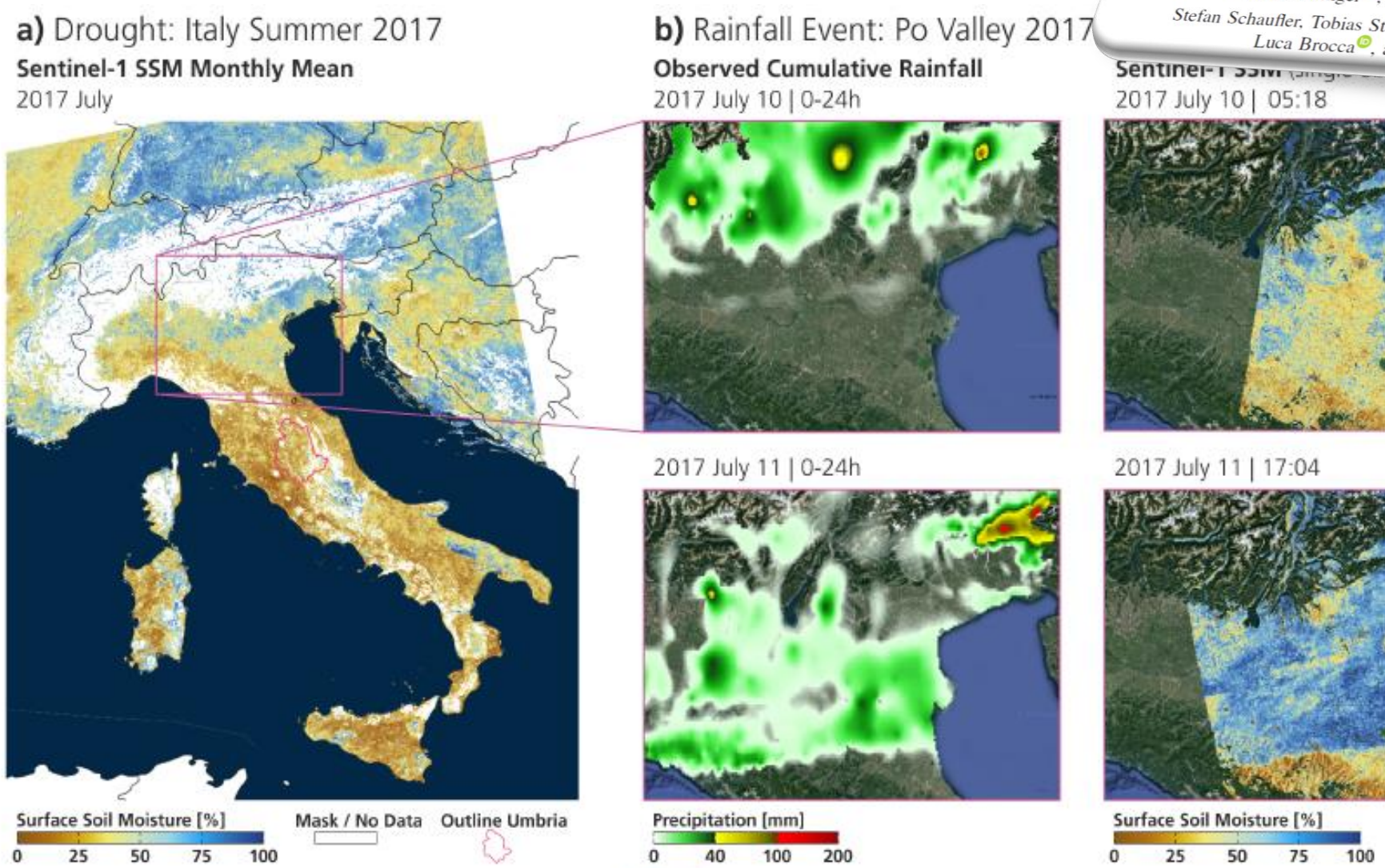


- A constellation of satellite sensors for measuring soil moisture is available
- High temporal and spatial resolution only recently:
  - Sentinel-1
  - CYGNSS
- future missions:
  - FSSCat
  - L-band SAR
  - G-CLASS (EE10)

SENTINEL-1 SOIL MOISTURE

Toward Global Soil Moisture Monitoring With Sentinel-1: Harnessing Assets and Overcoming Obstacles

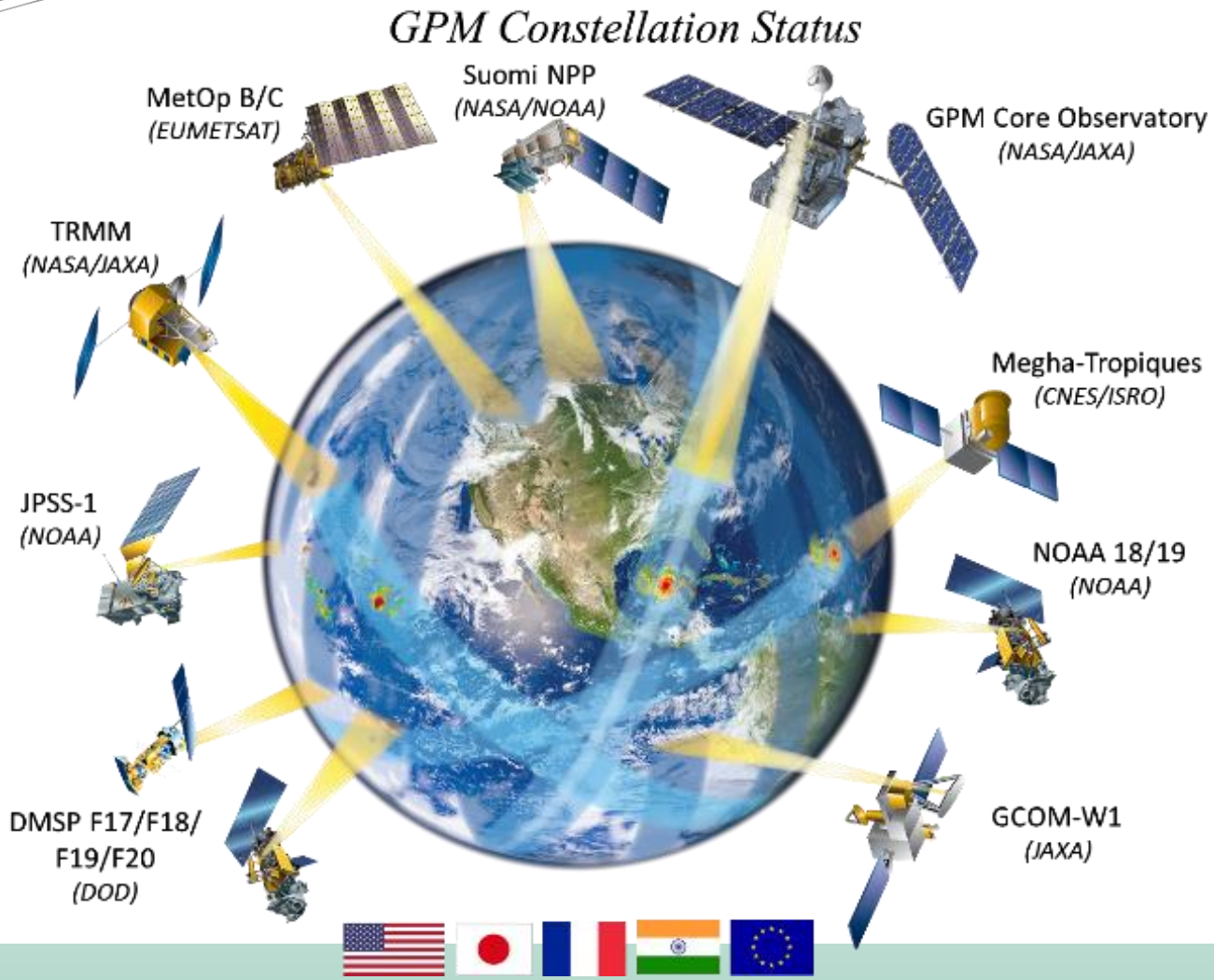
Bernhard Bauer-Marschallinger, *Member, IEEE*, Vahid Freeman, Senmao Cao, Christoph Paulik, Stefan Schaufler, Tobias Stachl, Sara Modanesi, Christian Massari, Luca Ciabatta, Luca Brocca, and Wolfgang Wagner, *Senior Member, IEEE*



Sentinel-1 Soil Moisture

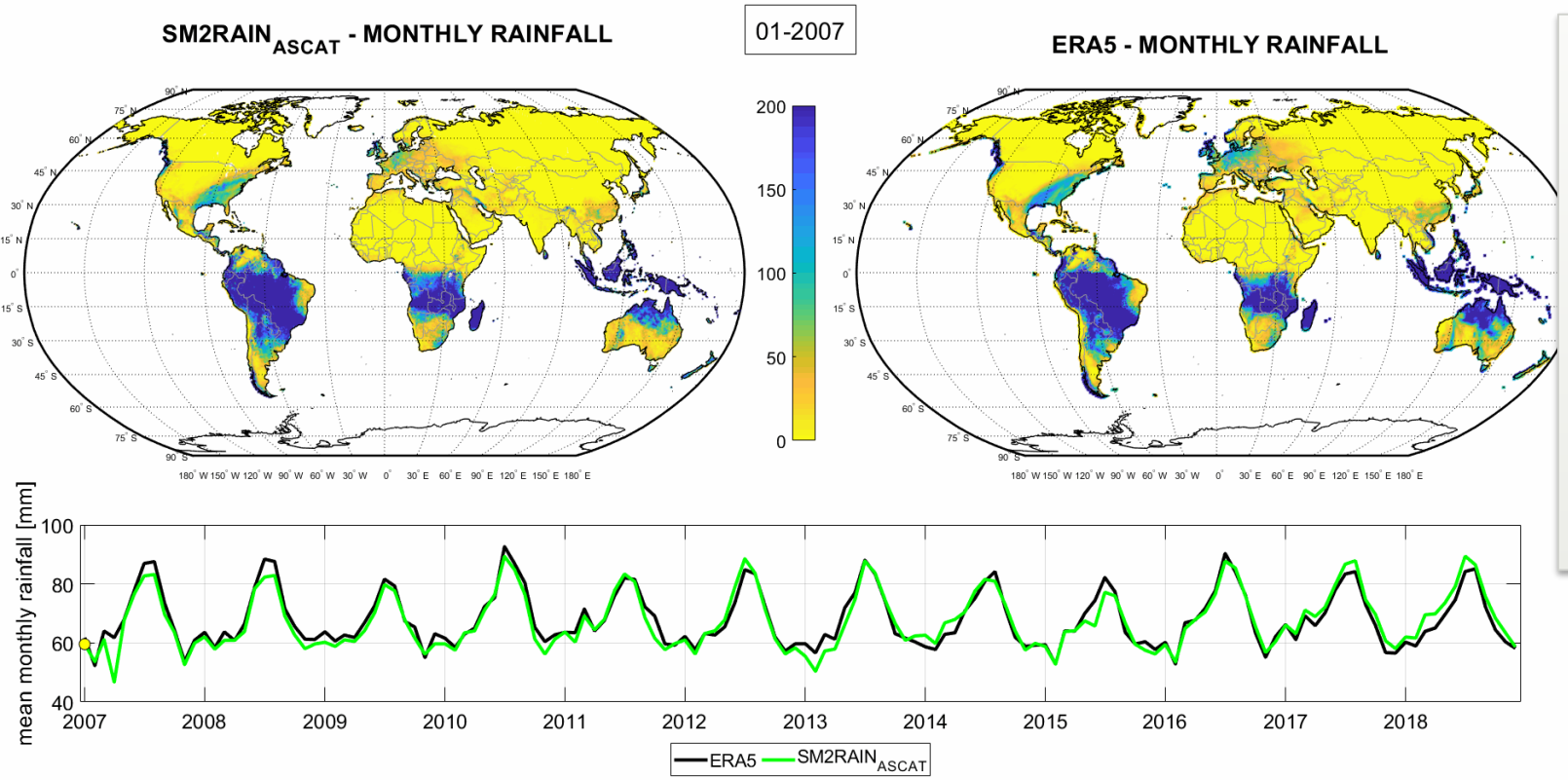
B. B. M.'s talk – Thursday 9:15, room B

REMOTE SENSING OF PRECIPITATION



- GPM is an international satellite mission to unify and advance precipitation measurement from space
- 10 km/0.5 hours spatial/temporal resolution
- 3 products (early, late and final run)

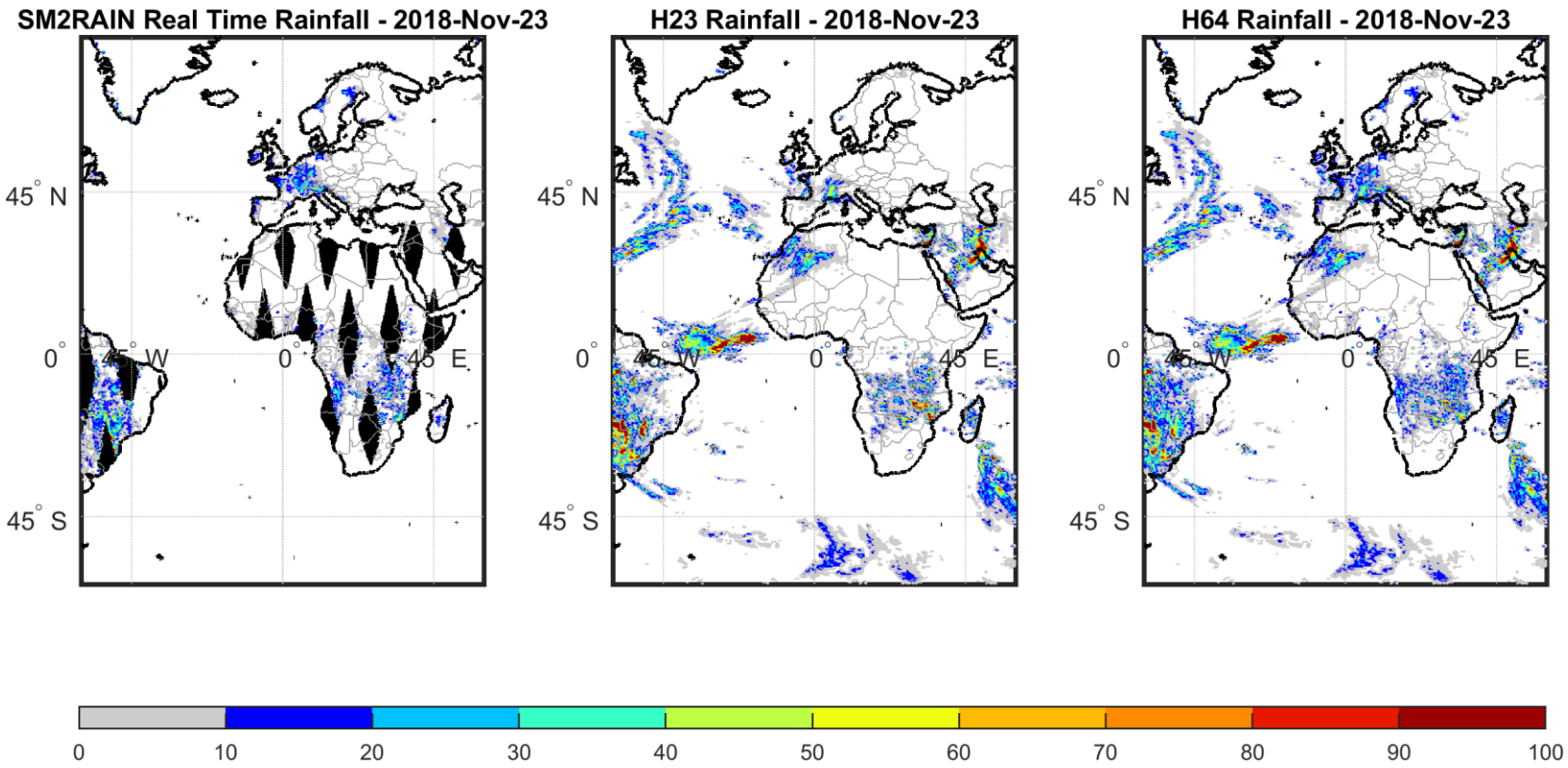
SM2RAIN-ASCAT



- SM2RAIN applied to MetOp A & B SSM data
- 12.5 km/daily spatial/temporal resolution
- Available at the global scale since 2007

Freely available @Zenodo https://doi.org/10.5281/zenodo.2591215

SM2RAIN-ASCAT in NRT



- SM2RAIN applied to MetOp A & B H16 and H101 H SAF products
- 0.25°/daily spatial/temporal resolution
- Integrated with H23 MW rainfall product
- Potentially available in NRT

The EUMETSAT Network of Satellite Application Facilities

H SAF
Support to Operational Hydrology and Water Management

hsaf.meteoam.it

Luca Ciabatta – Tuesday 16:15, Hall X5

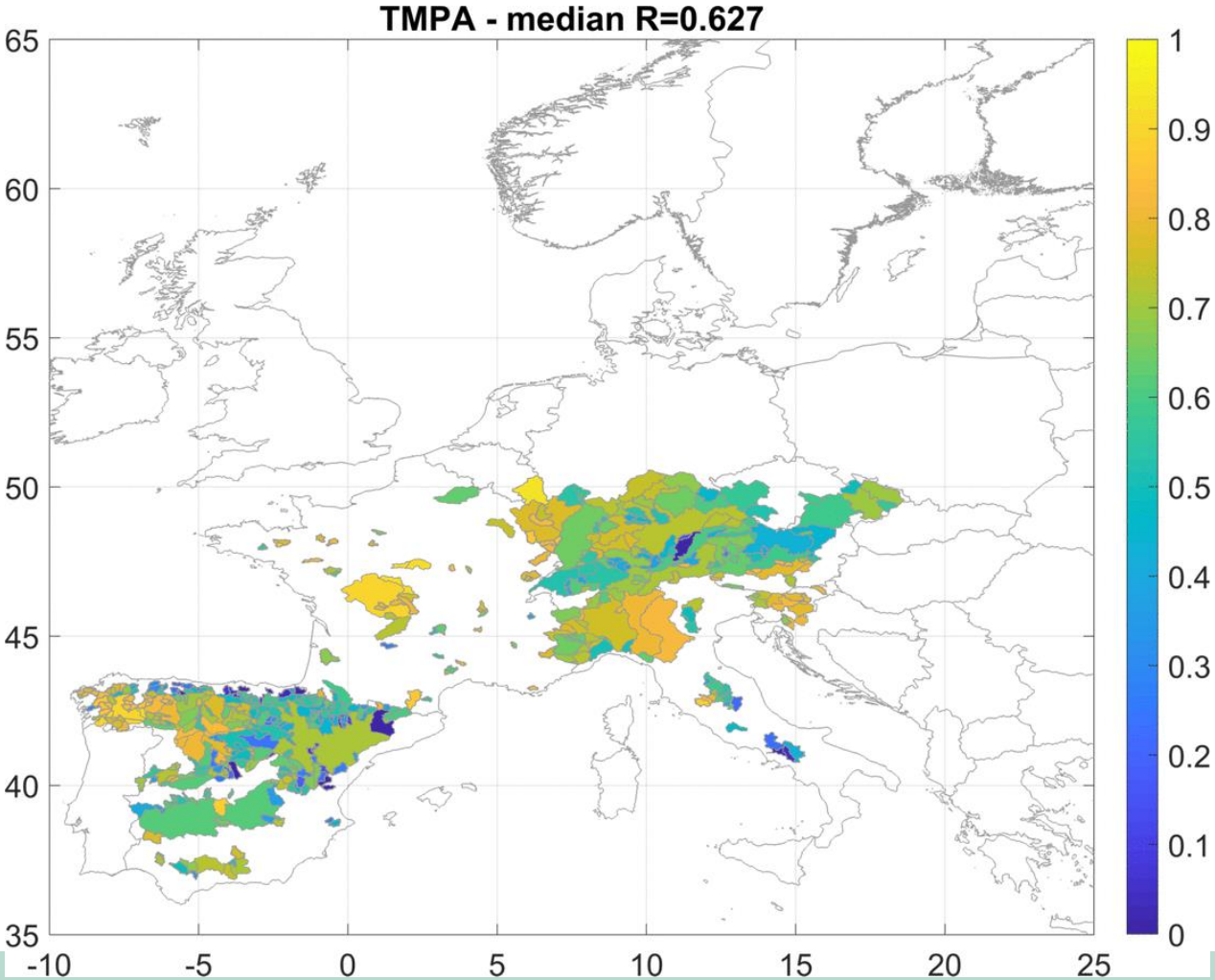
HOW MANY PEOPLE ARE USING SATELLITE SOIL MOISTURE AND PRECIPITATION IN OPERATION?

Matthias Drusch (ESA ESTEC): "In a meeting with 35 flood forecasting centres in Europe, I recognized that only one of them is using satellite observations…34 out 35 is not using any satellite observation!!!"

Can we use satellite soil moisture data for setting the initial conditions of flood (and landslide) modelling? Which approach?

Are satellite precipitation products accurate to simulate floods? Flash floods? Landslides?

ESA WACMOS-MED: FLOOD PREDICTION WITH SATELLITE PRECIPITATION



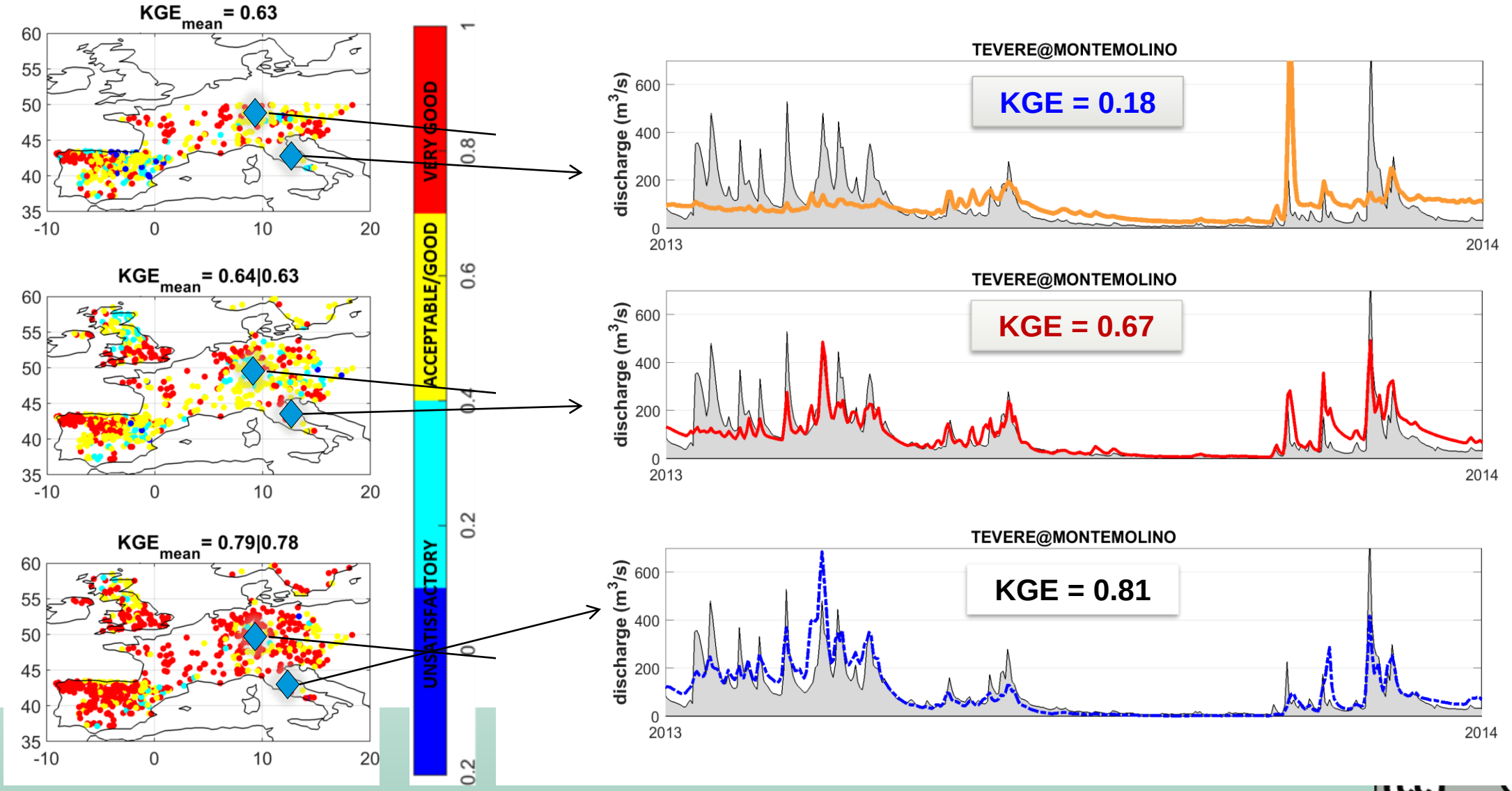
- Flood simulation through rainfall-runoff modelling over 720 basins throughout Europe
- Use of different satellite precipitation products, including SM2RAIN-derived products
- Performance assessment in comparison with in situ observations of river discharge
- Data period 2011-2014

FLOOD PREDICTION WITH SATELLITE PRECIPITATION

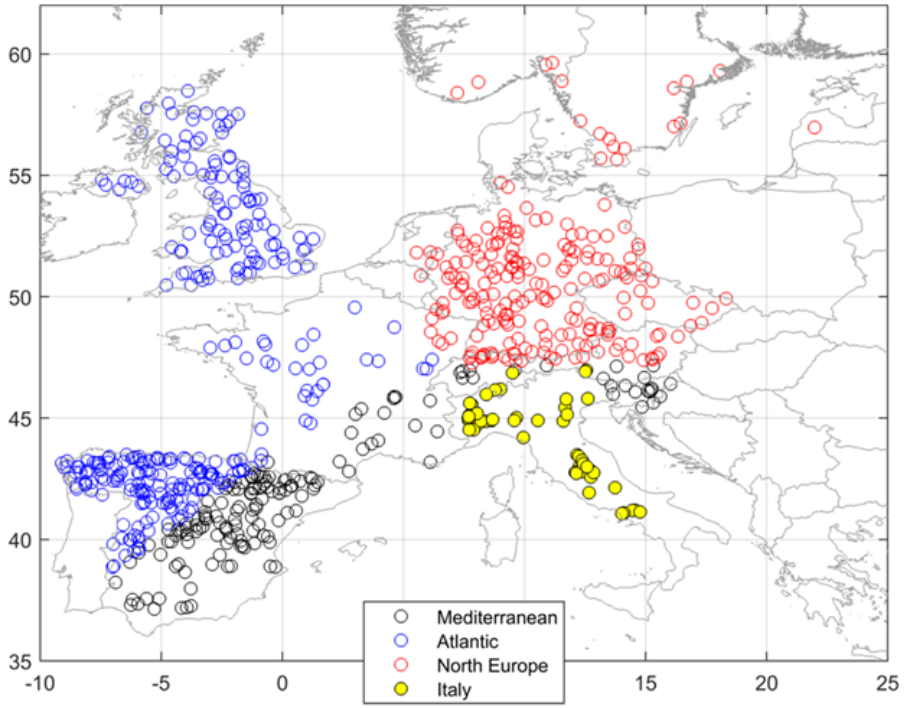
TMPA

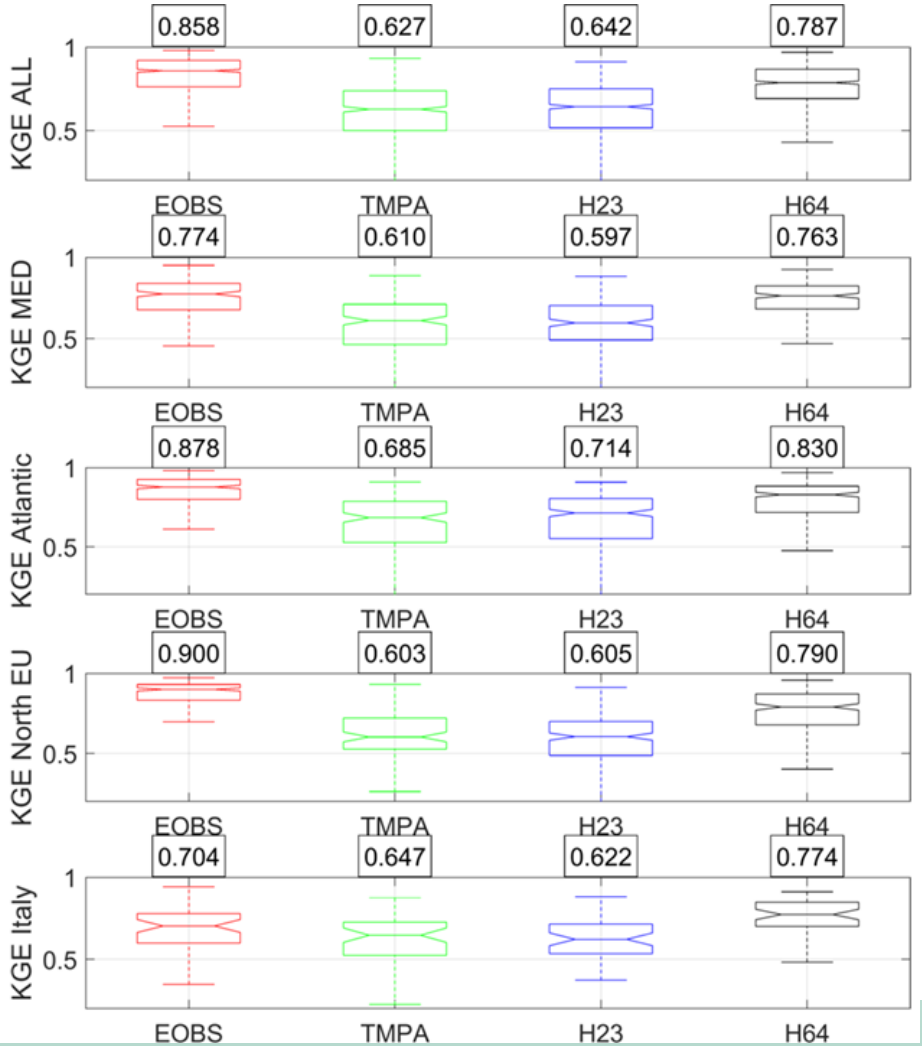
H SAF

H SAF + SM2RAIN



FLOOD PREDICTION WITH SATELLITE PRECIPITATION – TAKE HOME MESSAGE

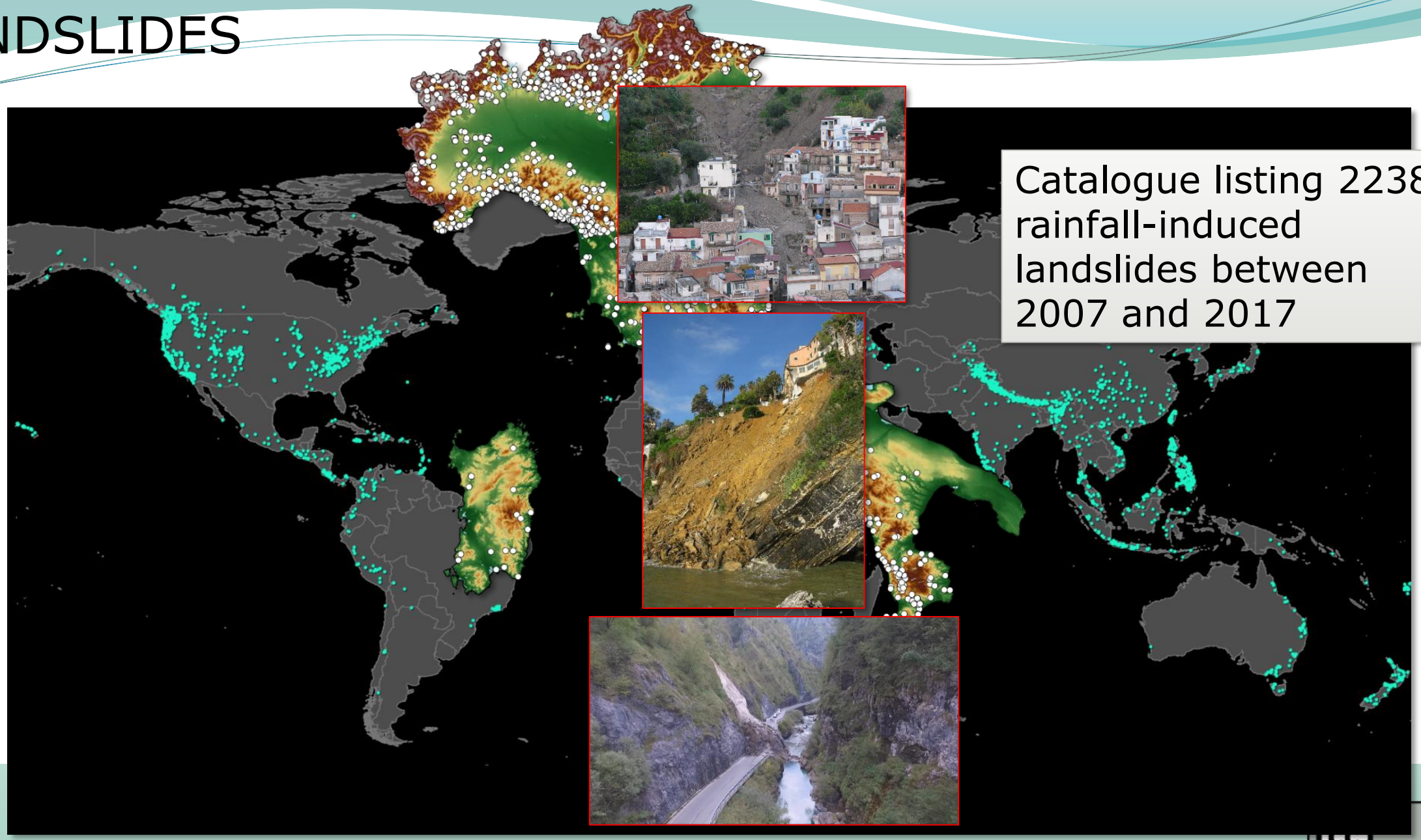




Over the Mediterranean area the performance of satellite precipitation products (including SM2RAIN) are similar, and even better in Italy, than those obtained through gauge-based data

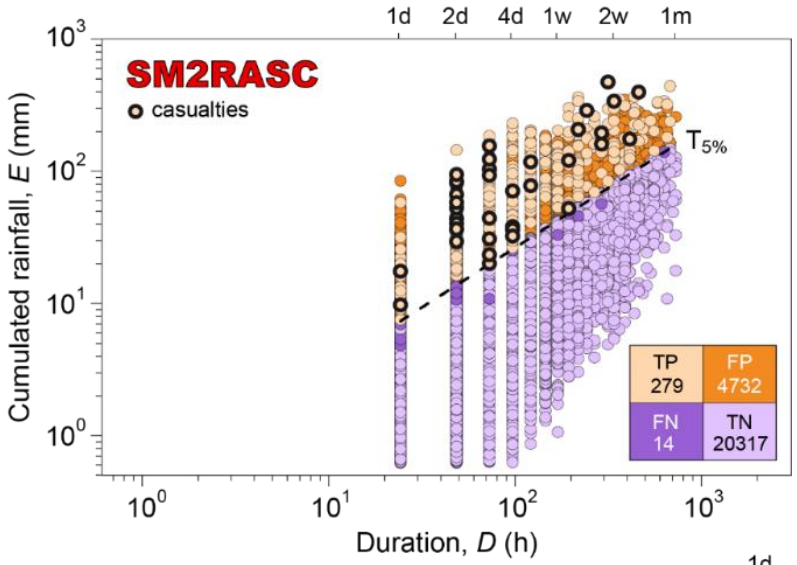
Stefania Camici's talk – Thursday 9:45, room 2.31

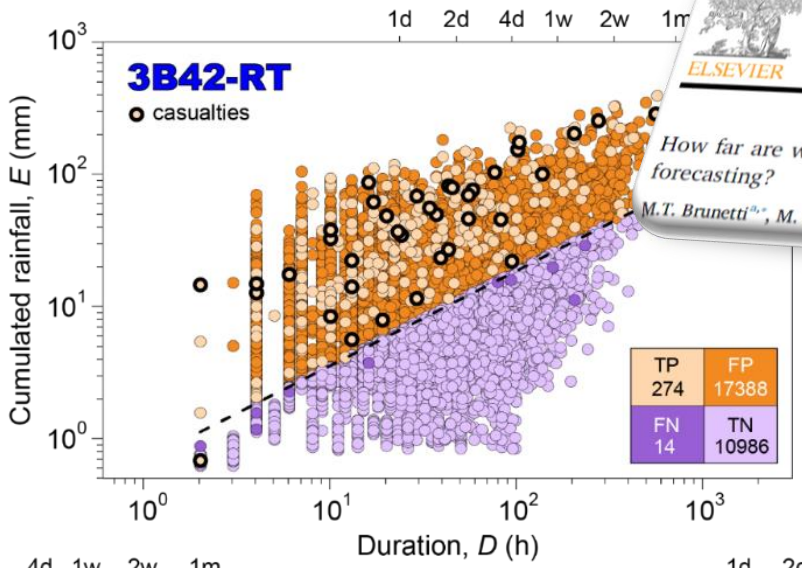
LANDSLIDES

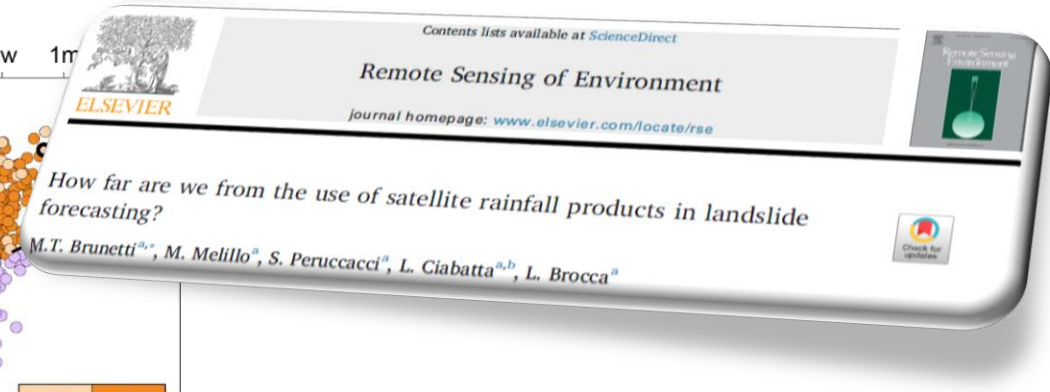


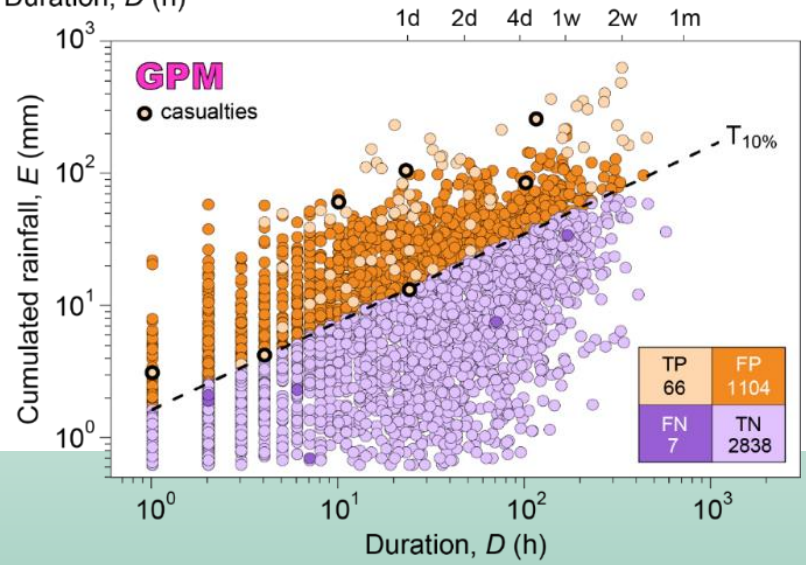
Catalogue listing 2238 rainfall-induced landslides between 2007 and 2017

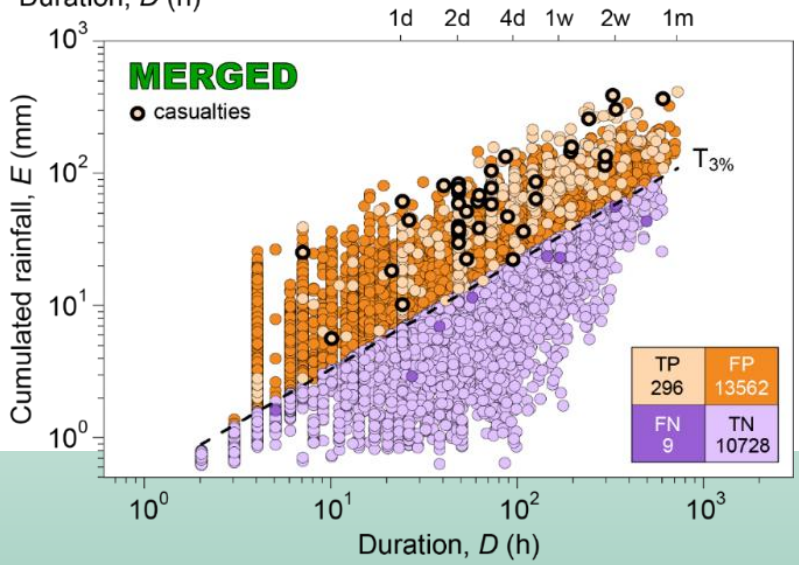
REMOTE SENSING RAINFALL THRESHOLD



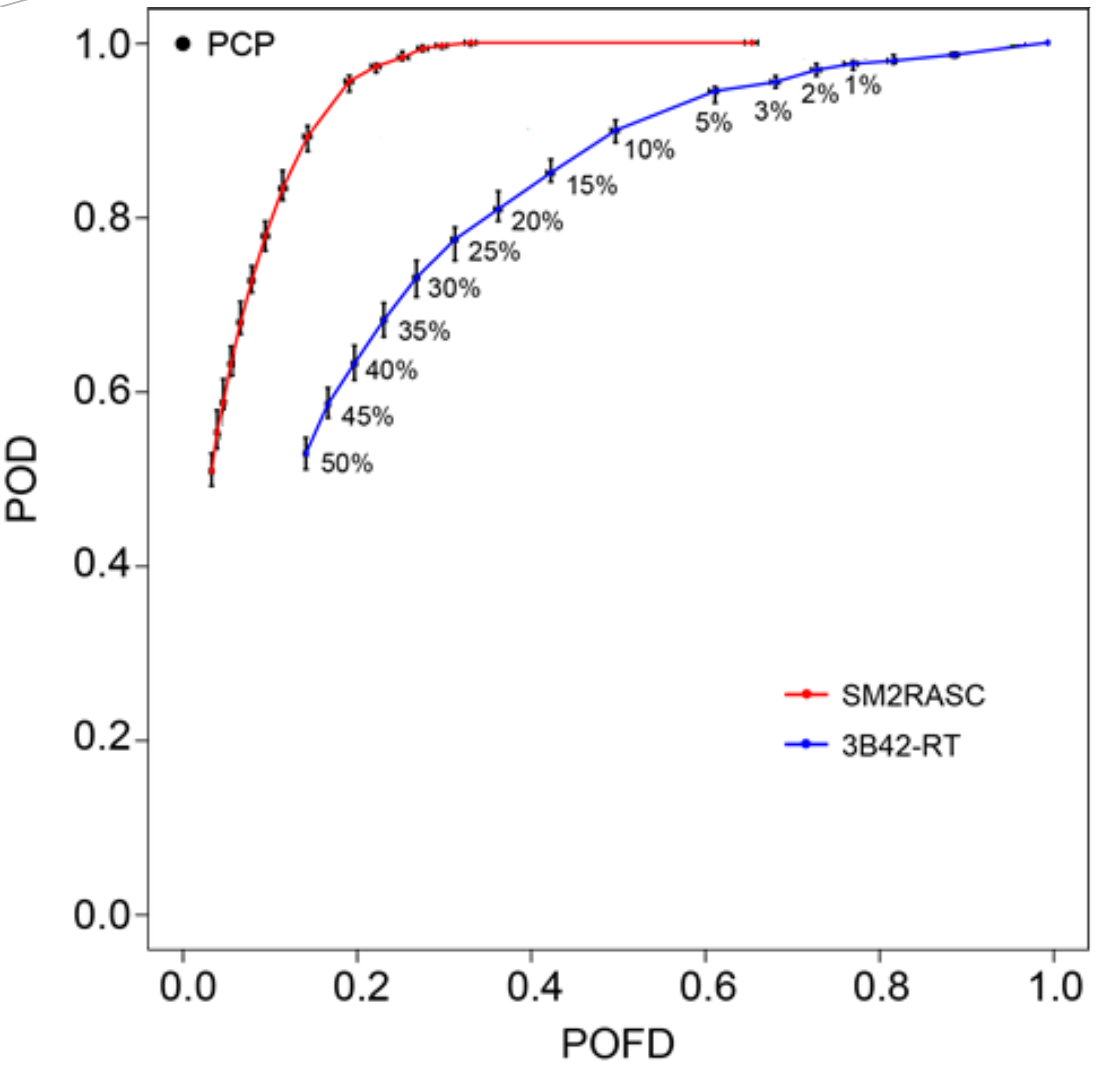








LANDSLIDES FORECASTING

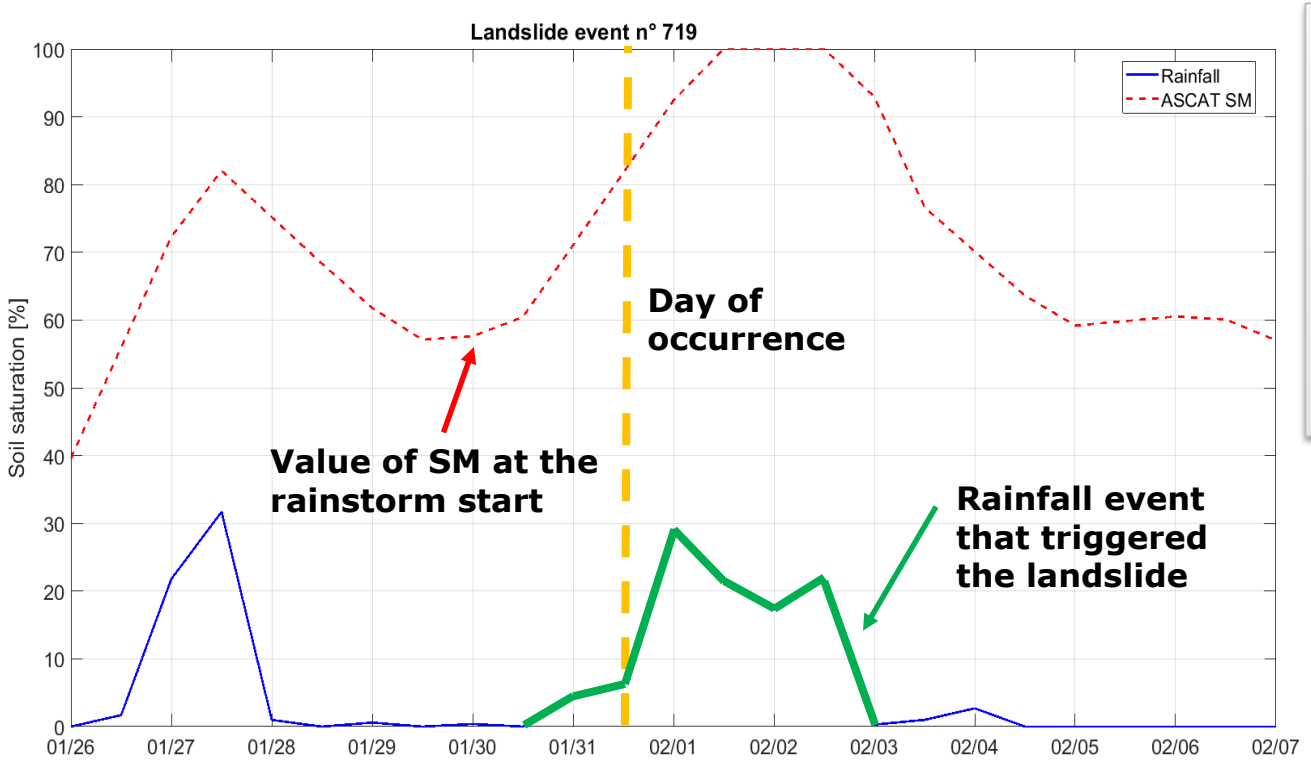


Satellite precipitation products can be used for landslide forecasting, and should be integrated with satellite soil moisture observations

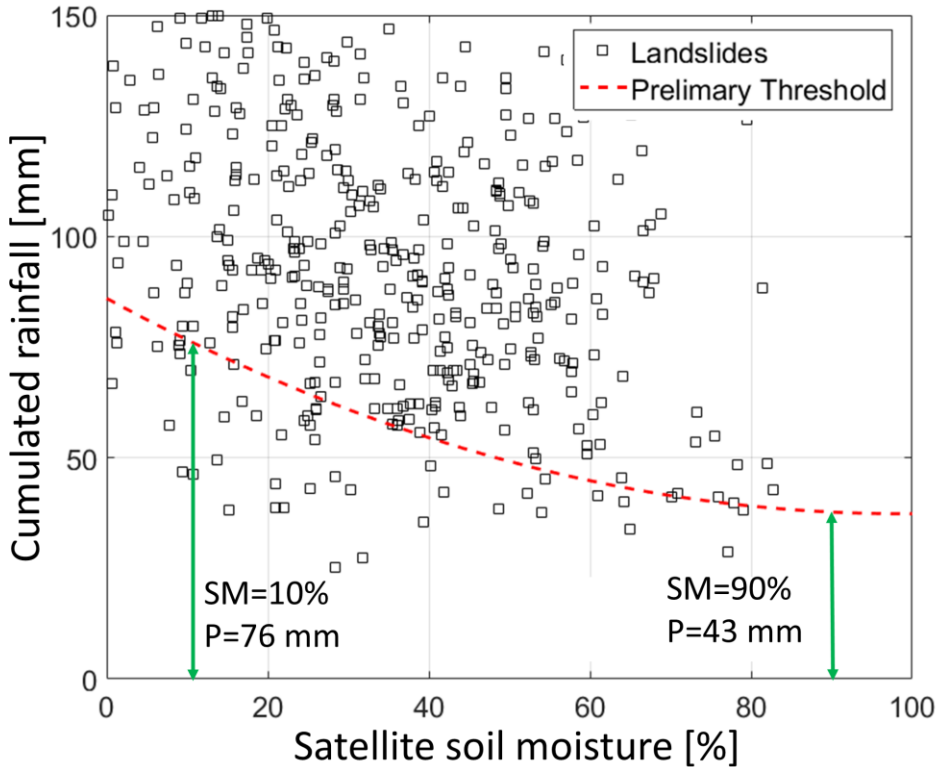
SM2RASC and GPM are found to be the best performing satellite rainfall products.

The obtained results will have a more important use in scarcely gauged regions (e.g., developing countries), and a global scale dedicated study will be the natural next step of this research.

LANDSLIDES FORECASTING



- 1184 landslide events between 2007 and 2014 over Italy
- ASCAT SM data 12.5 km/daily spatial/temporal resolution
- Observed rainfall from the Italian monitoring network



CONCLUSIONS

Satellite data can be used for hydrological modelling over the Mediterranean basin

Satellite products are characterized by high maturity and high spatio/temporal resolutions

Satellite products provided good results for flood modelling

Both rainfall and soil moisture satellite data can be used for landslide applications over large areas

Thank you for your attention