# Use of (H-SAF) satellite data in the European Flood Awareness System

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European Flood Awareness System (EFAS)

- **EFAS fully operational:** EFAS is fully operational since September 2012 under the Copernicus Emergency Management Service.

- **4 EFAS Centers:** EFAS Computational Center (ECMWF) – EFAS Dissemination Center (SMHI, RWS, SHMU) – EFAS Hydrological Data Collection Center (REDIAM, ELIMCO) – EFAS Meteorological Data Collection (JRC)
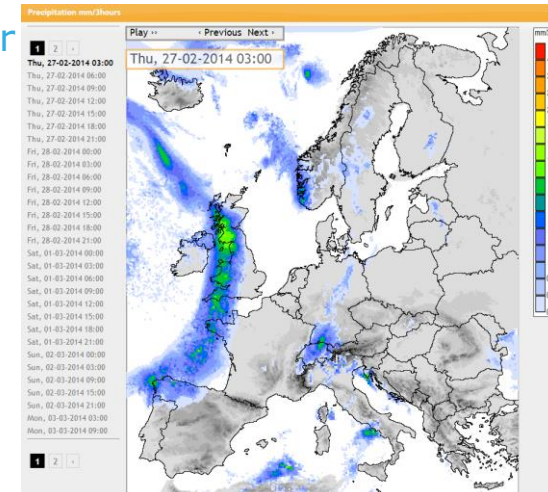
- **Objectives of EFAS:**

  - ✓ Provide complementary flood forecasting information to national services

 - ✓ Provide European scale overview to the ERCC

- **EFAS partners:** national/regional hydrometeorological authorities; currently more than 35 partners (EU & non-EU)
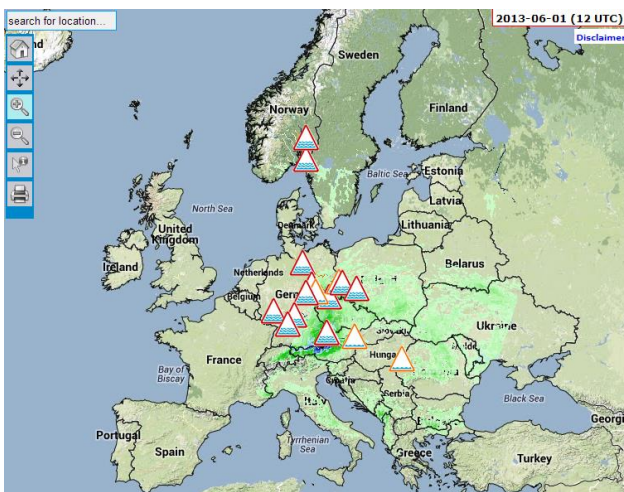
EFAS technical set up:

- Distributed hydrological model (LISFLOOD)

- Spatial extent: **Europe**

- Grid Resolution **5 km x 5 km**

- Temporal resolution forecasts: **6 hourly with exception ECMWF EPS (daily)**

- Temporal resolution IC: **daily**

- Sources for meteorological forecasts: German Weather Service, ECMWF, COSMO Consortium

- Forecast update at 12:00 and 00:00UTC. A total of **138 forecasts are produced daily**!

ECMWF

COSMO
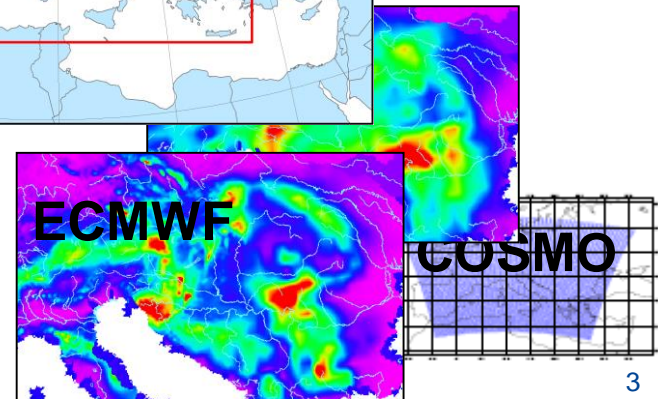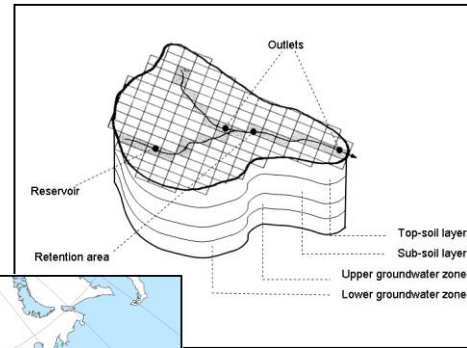
EFAS technical set up:
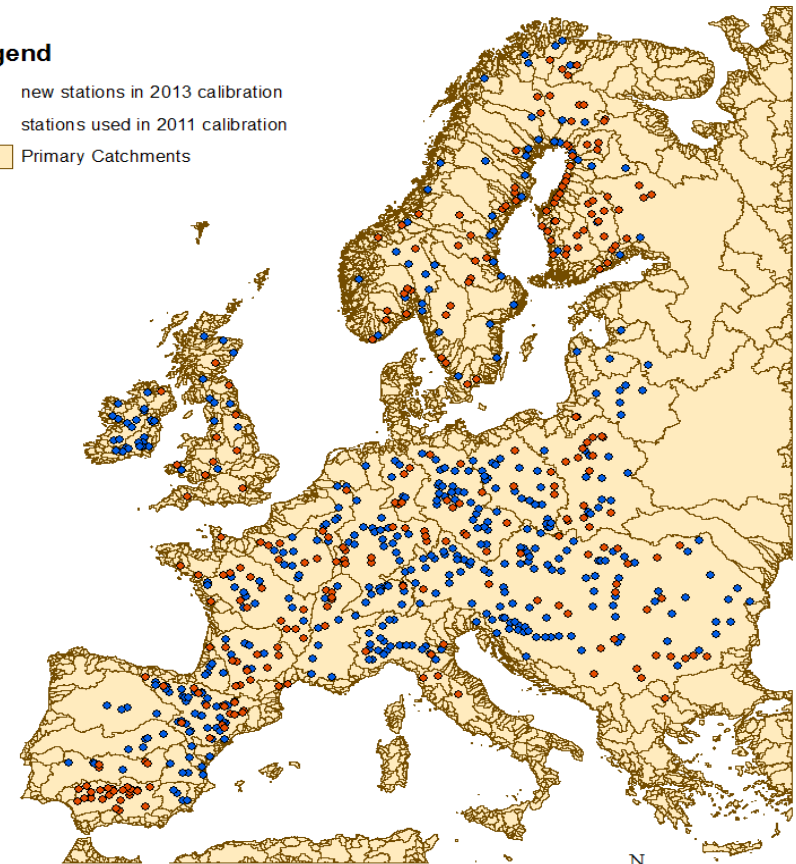
- 693 sub-catchments calibrated (incl. 34 reservoirs)

- More than 8000 near real time meteorological observations

Legend
- new stations in 2013 calibration
- stations used in 2011 calibration
- Primary Catchments

0   275   550   1,100 Kilometers
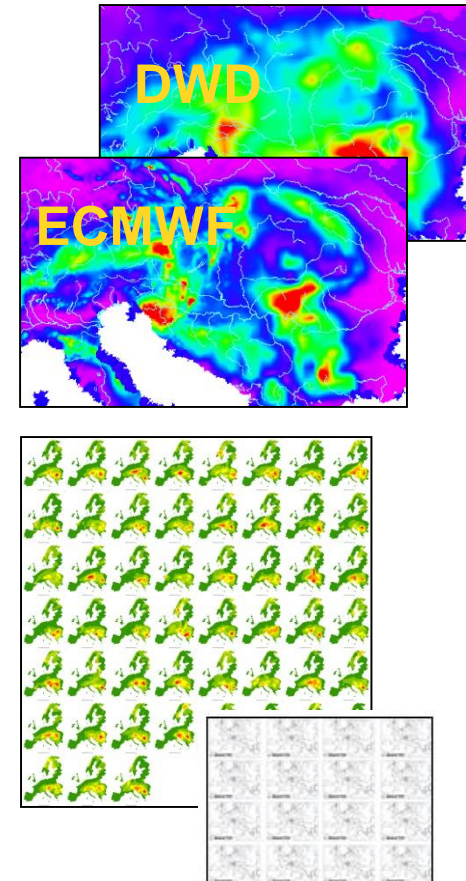
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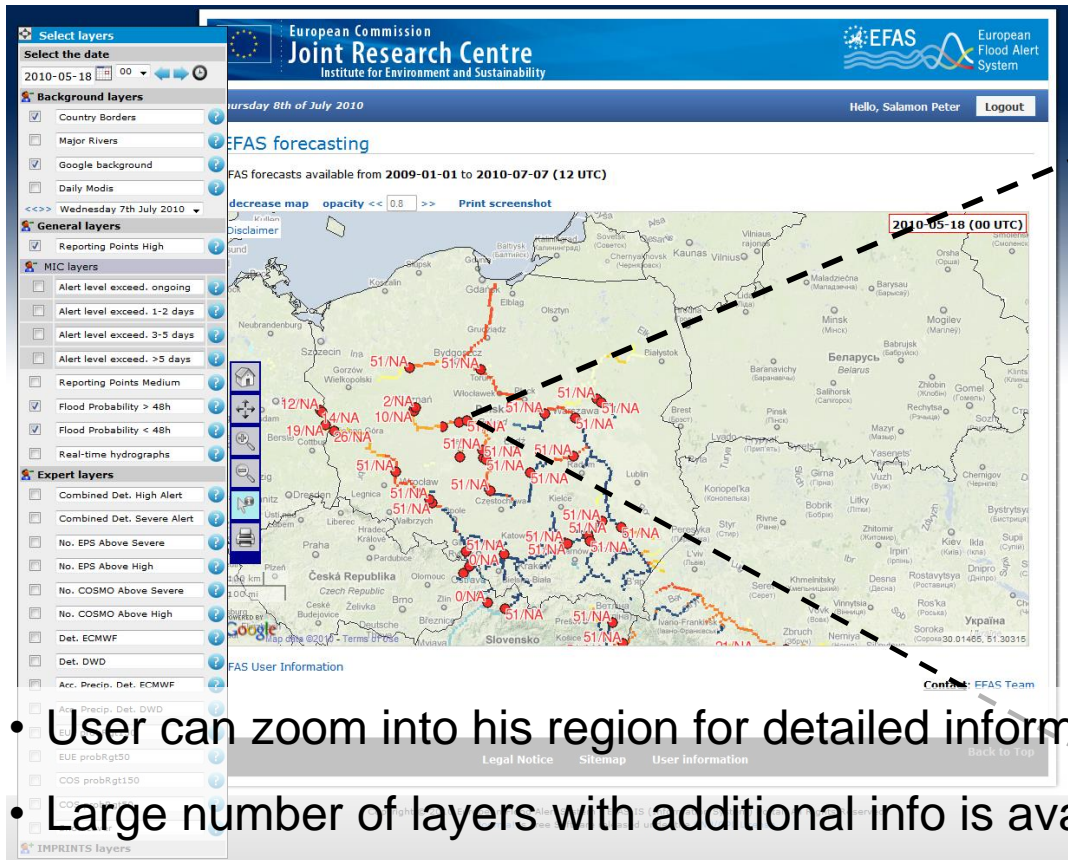
Weather forecasts in EFAS

Deterministic
- DWD – 7 days, ~ 7 km (Day 1 – 3), ~ 30 km (day 4 - 7), twice daily
- ECMWF, 10 days, ~16 km, twice daily

Ensembles
- ECMWF EPS – 10 days , ~ 30 km, 51 members, twice daily
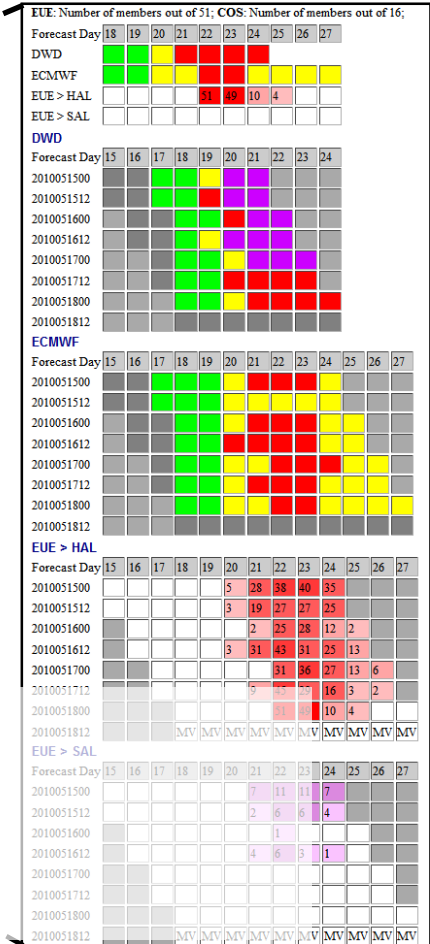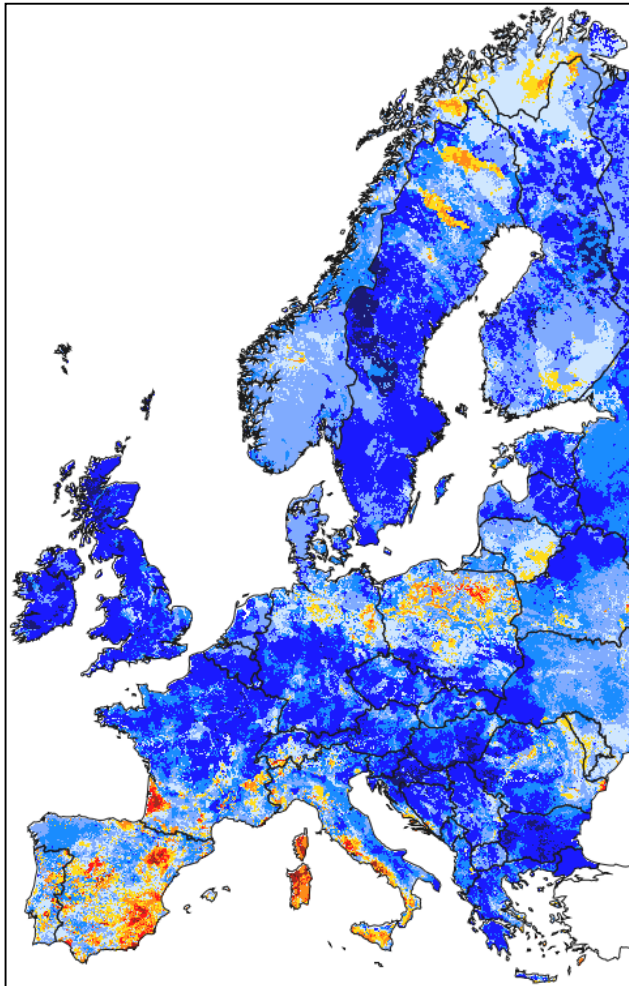- COSMO-LEPS - 5 days, ~ 7 km, 16 members

EFAS web interface:

- User can zoom into his region for detailed information

- Large number of layers with additional info is available

- www.efas.eu

EFAS & H-SAF data:

Rel. soil moisture LISFLOOD 31 Oct. 2014
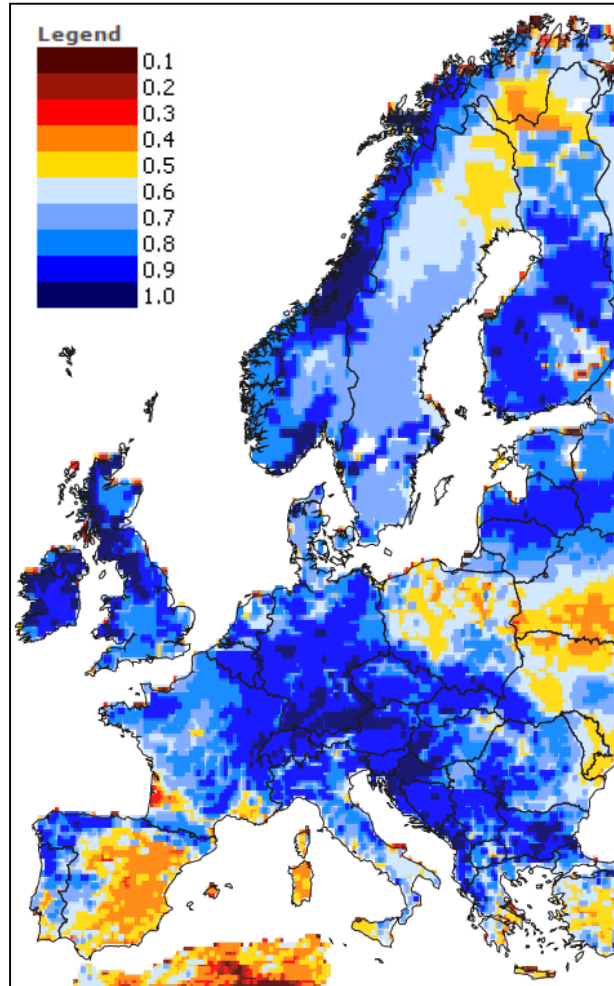
Rel. soil moisture H-SAF 31 Oct. 2014

Comparing model and satellite rel. soil moisture in near real time

- **Purpose I: added value information for the forecaster**

- **Purpose II: model validation in near real time**

- **Problem: Soil moisture ≠ soil moisture – products need to be made comparable first (parameterisation of soil layers)**

- **Available since May 2014**

EFAS & H-SAF data:

Snow water equivalent LISFLOOD 31 Oct. 2014

Snow water equivalent H-SAF 31 Oct. 2014

Legend:
- <10
- 10-25
- 25-50
- 50-75
- 75-100
- 100-125
- 125-150
- 150-200
- 200-250
- >250

Comparing model and satellite snow water equivalent in near real time
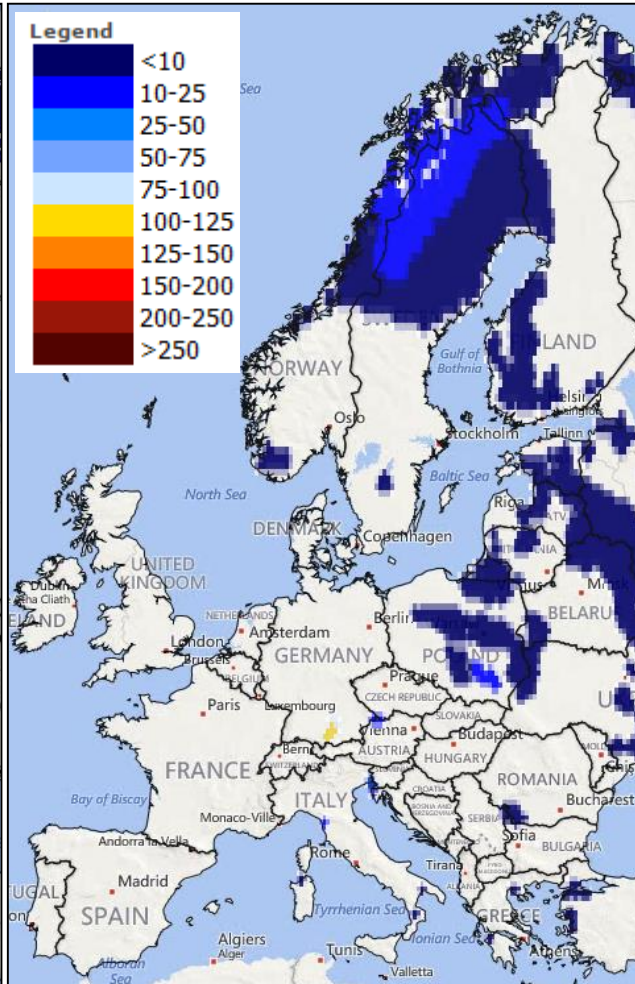
- **Purpose I: added value information for the forecaster**

- **Purpose II: model validation in near real time**

- **Problem: accuracy of satellite SWE (tentatively 20 mm)– quality of the product is dependent on the surface characteristics**

- **Available since May 2014**

EFAS & satellite data:

Comparing model and satellite anomalies in near real time

- **10 day average snow water equivalent anomaly**

- **highly valuable information for forecasting**

- **Problem: different reference periods (EFAS 1990 – 2012; FMI 1979 - 2010)**

10 day SWE anomaly LISFLOOD 28 Apr. 2014

10 day satellite SWE anomaly FMI 28 Apr. 2014

Legend

No snow
Highly less than normal (SSPI < -2)
Much less than normal (-2 <= SSPI <
Less than normal (-1.5 <= SSPI < -1)
Near normal (-1 <= SSPI < 1)
More than normal (1 <= SSPI < 1.5)
Much more than normal (1.5 <= SSPI
Highly more than normal (SSPI >= 2)

EFAS & satellite data:

H-SAF soil moisture anomaly?

Soil moisture anomaly LISFLOOD 12 May 2014

Comparing model and satellite anomalies in near real time

- **Soil moisture anomaly**

- **highly valuable information for forecasting**

EFAS & satellite data assimilation:

- **Assimilation of snow cover data into LISFLOOD**

- **Assimilation method: particle filter**

- **Data: MODIS snow cover data**

- **Conversion from snow cover into SWE: via snow depletion curves**

- **Test basin: Morava river basin**

- **Main findings: improvements for simulated snow cover in all cases but only improvements in discharge for smaller upstream basins – larger basins showed only limited improvements – effect on forecasts not tested**
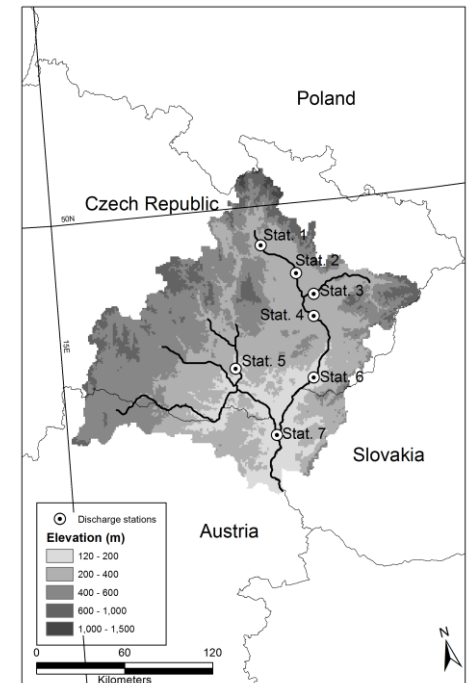
Thirel, G.; Salamon, P.; Burek, P.; Kalas, M.   Assimilation of MODIS Snow Cover Area Data in a Distributed Hydrological Model Using the Particle Filter. Remote Sens. 2013, 5, 5825-5850.

EFAS & satellite data assimilation:

- Assimilation of satellite soil moisture and discharge into LISFLOOD

- Data: SMOS/ASCAT/AMSR-E soil moisture & 7 discharge stations

- Assim. method: EnKF (300 ens)

- Required modification of LISFLOOD soil parameterisation

- Upper Danube (135 x 10^3km^2)

- Considering IC & forcing uncertainty during the experiment

- Hindcasting experiment from Dec 2010 – Nov 2011

- Results: soil moisture assimilation alone did not always improve discharge simulations – SM & discharge assim. improved forecasting skill
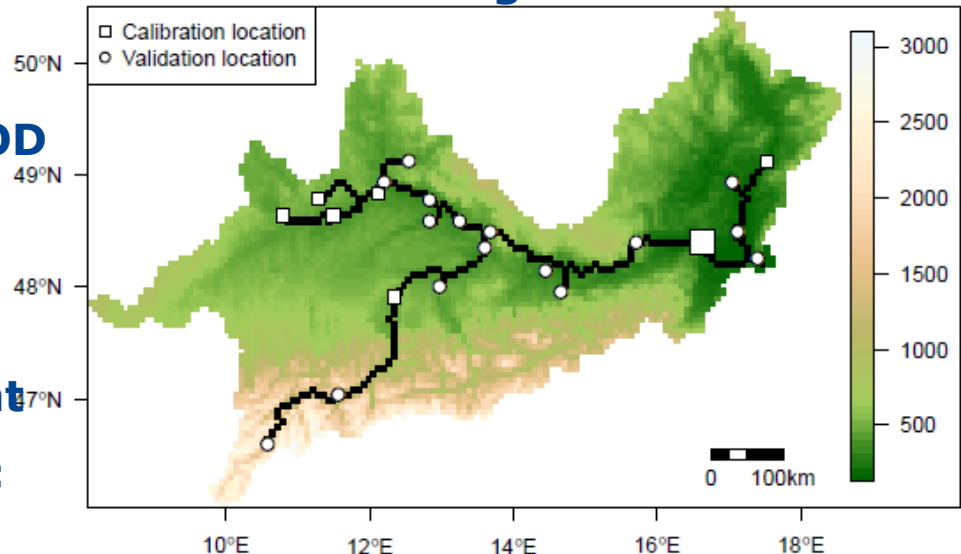
Wanders, N., Karssenberg, D., de Roo, A., de Jong, S. M., and Bierkens, M. F. P.: The suitability of remotely sensed soil moisture for improving operational flood forecasting, Hydrol. Earth Syst. Sci., 18, 2343-2357, doi:10.5194/hess-18-2343-2014, 2014.

European Commission

Joint Research Centre

Conclusions & challenges:

- **Satellite products provide valuable complementary information in near real-time for EFAS**

- **H-SAF satellite anomaly products would be highly appreciated**

- **H-SAF accumulated precip not used because it is not operational**

- **Satellite soil moisture in combination with discharge data assimilation seems most promising for EFAS, HOWEVER, great challenges still are ahead:**

  - ➢ **Testing of assimilation at continental scale**

  - ➢ **Feasibility study focusing on operational aspects of data assimilation (how many ensembles in the EnKF? Design of failure mechanisms, etc....)**

Questions?

Thank you for your attention!

For more info:

www.efas.eu