The EUMETSAT Network of Satellite Application Facilities

H SAF Support to Operational Hydrology and Water Management

EUMETSAT-H SAF soil moisture for monitoring flood and drought periods 2011 to 2018 in Central Europe

bfg Bundesanstalt für Gewässerkunde

Introduction

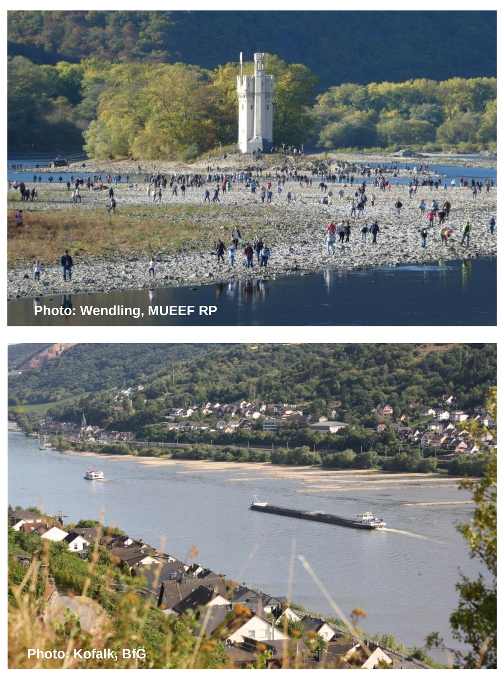
In recent years Central Europe was faced by a long lasting drought period. The peak was reached in 2018 leading to a severe agricultural drought, long lasting low water periods in all rivers of Central Europe and serious economic losses. On the other side the dry spells were interrupted by some large river flood events as well as a series of very intense convective events leading to flash floods. It became obvious that there is an increasing need for improving drought and flood monitoring as well as short term to seasonal meteorological and hydrological forecasting services.

The soil moisture products of EUMETSAT Satellite Application Facility on Support to Operational Hydrology and Water Management (H SAF) offers a wide range of data products which support this increasing demands with regard to soil moisture. Examples for the monitoring and validation issues of H SAF SM-DAS-2 and SM-DAS-3 with regard to the drought period 2018 are given.

Soil Moisture Data

	SM-DAS 2 – H14	SM-DAS 3 – H27
Product	Soil Moisture Index (SMI) [-] 0 - residual water content	1 - saturated water content
Instruments	ASCAT active radar scatterometer	ERS1/2* active microwave ASCAT-A surface soil moisture
Coverage and Cycle	global, daily	
Vertical Resolution	four soil layers (0-7 cm, 7-28 cm, 28-100 cm, 100-289 cm)	
Horizontal Resolution	~ 25 km	~ 16 km
Availability	2012 – on going	1992* – 2006* – 2014

The assimilation scheme propagates the satellite ASCAT microwave measured surface soil moisture towards the root region using Kalman Filter and the *Hydrology Tiled ECMWF Scheme for Surface Exchanges over Land* (H-TESSEL) [Albergel et al., 2012]. EUMETSAT provides free access to H SAF products and product information. (http://hsaf.meteoam.it/)



Pictures indicating low water situation at „Middle Rhine“, Germany, August 2018

Hydrometeorological Conditions 2018

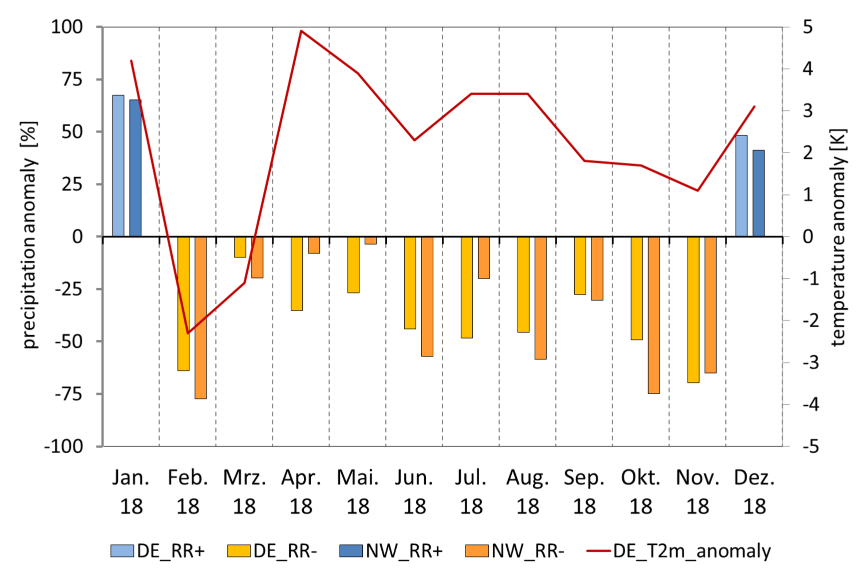


Figure1: Monthly precipitation (RR) and temperature (T2m) anomalies for Germany (DE) and the location of the BfG – Lysimeter Station (NW) in 2018

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Drought Monitoring – 2018

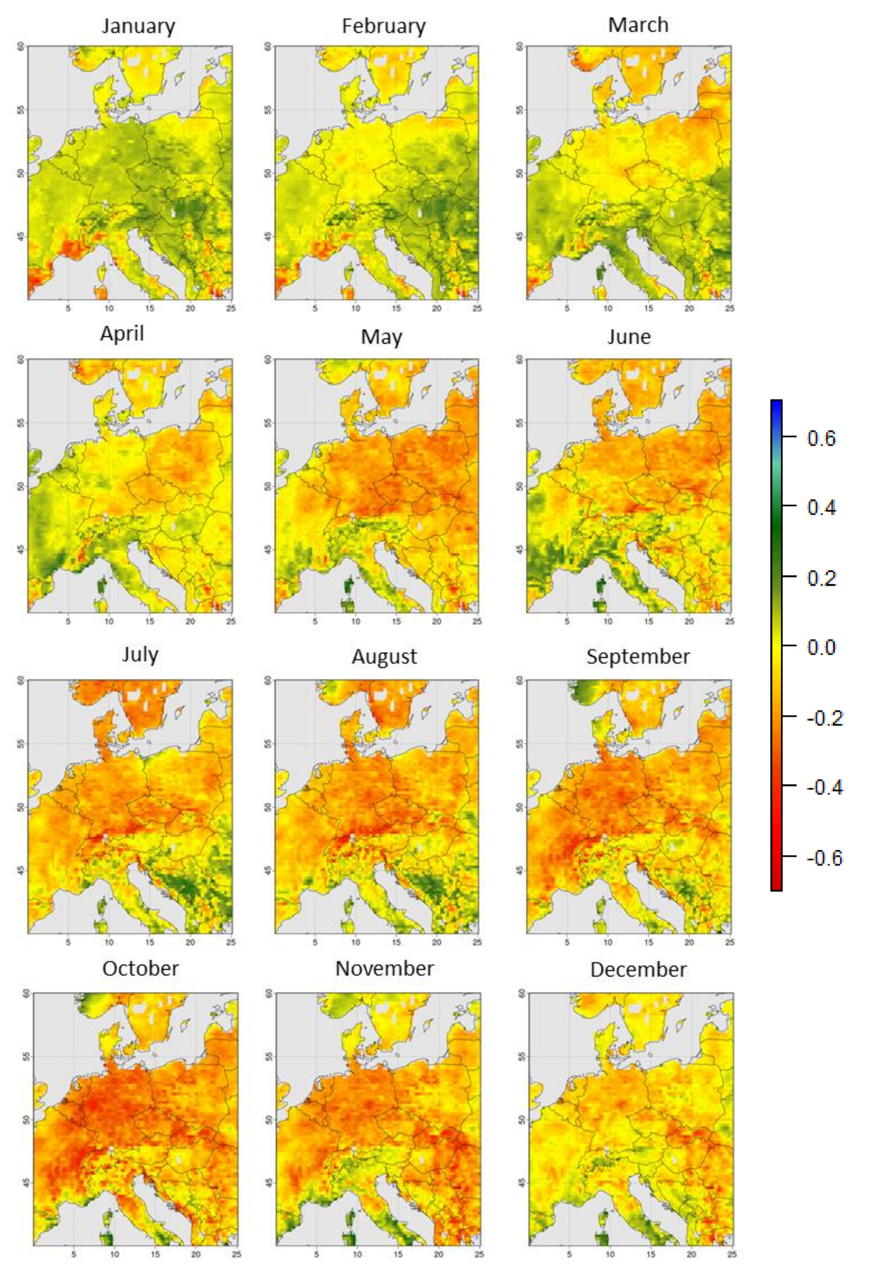

Figure 2: SMI anomalies ($A_{D,d}$) in 2018, integrated to 100 cm soil depths with H27 climatology (1992 to 2014), snapshot on the 15[th] of each month

Method

Soil moisture anomalies ($A_{D,d}$) were calculated by combining H14 SMI product with the long term climatology of H27 SMI (1992 – 2014).

- Bilinear interpolation of H27 to H14 grid resolution
- linear bias correction
- $A_{D,d} = \frac{SMI_{D,d}}{SMI_{D,clim}} - 1, [-]$
  - where $A_{D,d}$ is the anomaly at depth D and day d
  - $SMI_{D,clim}$ is the SMI at depth D and climate reference
- Weighted mean between layer 1 to 3
- Temporal development of drought as percentage of affected area according to [Zink et al., 2016]

Literature

Albergel C., et al. (2012): Evaluation of remotely sensed and modelled soil moisture products using global ground-based in situ observations, Remote Sensing of Environment, 10.1016/j.rse.2011.11.017, 118, 215–226

Matthias Zink et al (2016): The German drought monitor, Environ. Res. Lett.11 074002

H14 versus LARSIM

Method

- Large Area Simulation Model (LARSIM)
- 5 x 5 km² raster cells
- River Rhine basin between gauge Basel and gauge Lobith (123,999 km²)
- daily time step
- Aggregation to monthly means and river basins (mean area 1107, 214 up to 6583 km²)
- Calculation of monthly means of H14 layer 1 to 3 and aggregation to river basins
- Calculation of standard H SAF statistical metrics (see Fig 5)

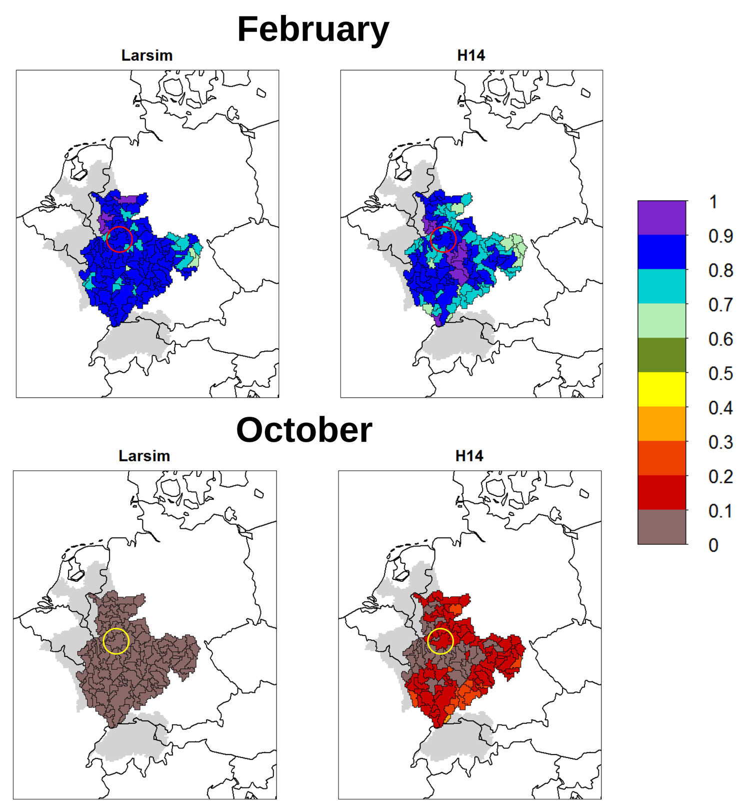

Figure 4: Monthly means of standardized LARSIM SM (left) and standardized H14 SMI (integrated 0 – 100 cm depths, right) aggregated to subcatchment

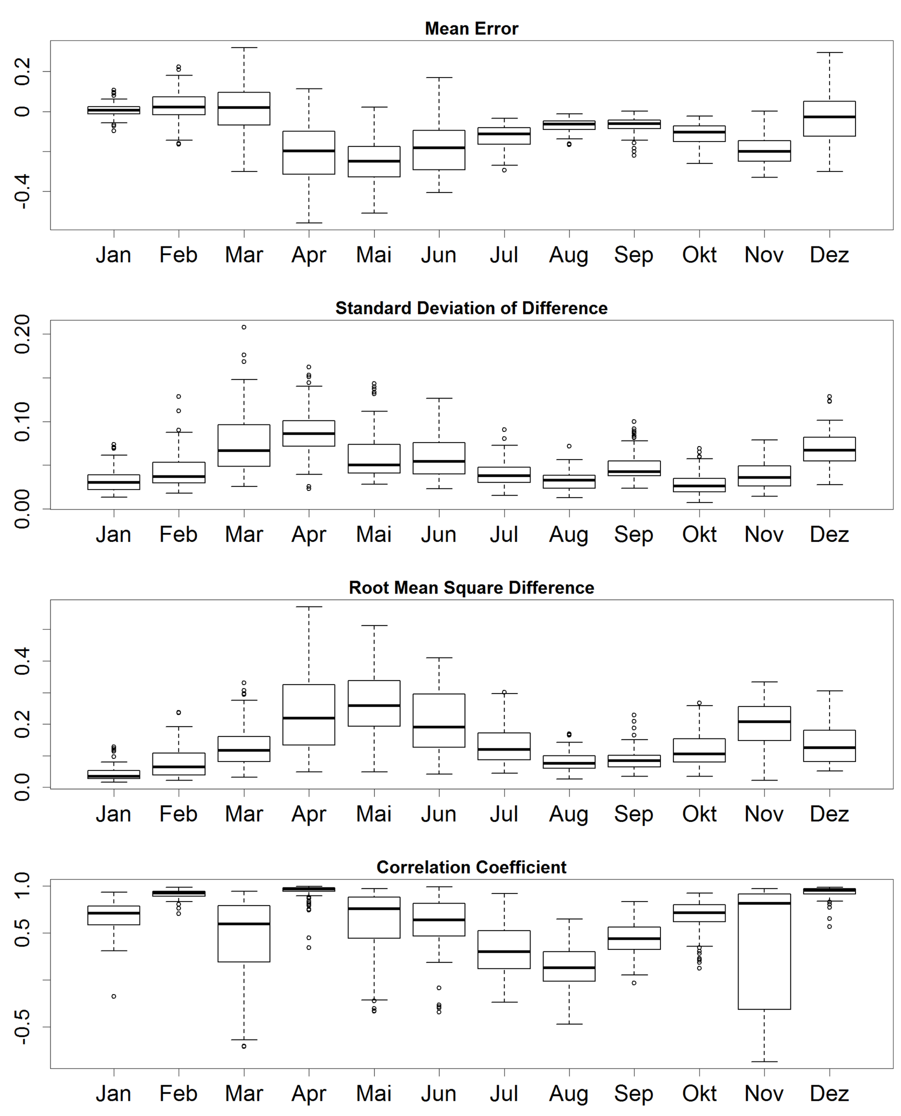

Figure 5: Monthly continuous validation statistics of standardized LARSIM and H14 SM data for 112 subcatchments of the River Rhine in 2018

Drought Monitoring – 2018

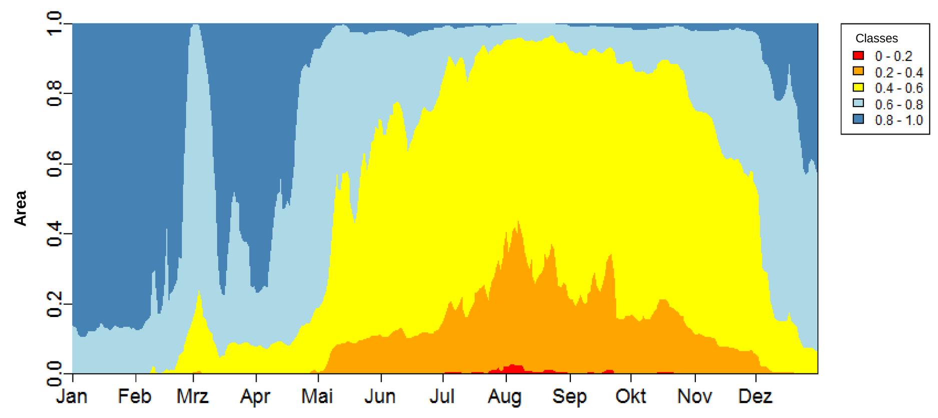

Figure 3: Temporal development of drought as percentage of affected area in Germany during the drought event 2018 in five SMI classes as seen by SM-DAS-2 H14 (soil layer 1 to 3)

H14 versus in-situ Measurements

Figure 6: Location of BfG - Lysimeter Station on River Rhine Island Niederwerth (near city of Koblenz) (50° 23´ 39´´ N, 7° 36´ 39“, 66 m a. s. l. , view to SSE). Four weightable and non-weightable lysimeters (Depth = 2 m, Volume = 2 m³) filled with alluvial clay (L1), loess loam (L2), high flood sand (L3), loamy pumice (L4)

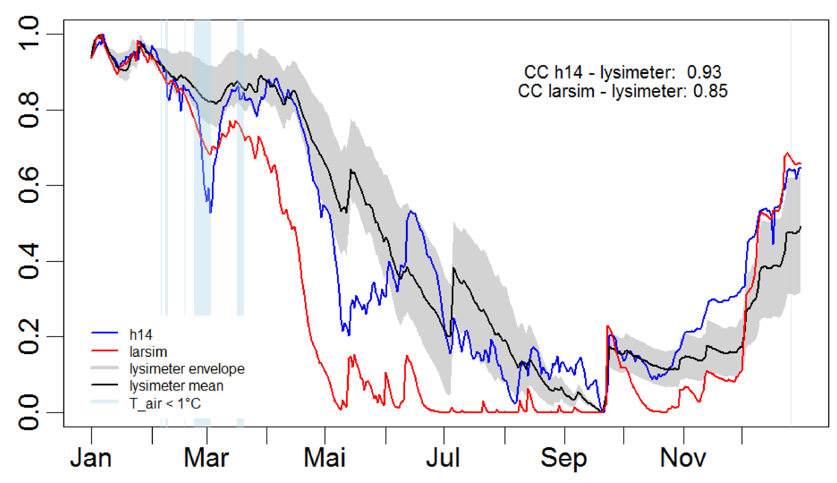

Figure 7: Standardized H14 SMI (integrated 0 to 100 cm) and modelled LARSIM SMI, compared to standardized weights of lysimeters L1 to L4 (grey band) and mean of lysimeter L1 to L4. Areal means of subcatchment surrounding Lysimeter Station are used for SMI's (2654 km²)

Discussion

- H SAF SM products deliver valuable information for hydrological monitoring as well as modelling and forecasting
- the user needs to be aware of the different characteristics of the satellite product and modelled soil moisture
- In combination with sophisticated data assimilation techniques data can be integrated into operational hydrological applications for forecasting and monitoring of hydrological extreme events
- Increase of in-situ locations for validation (e.g. lysimeters of German TERENO network and International Soil Moisture Network)