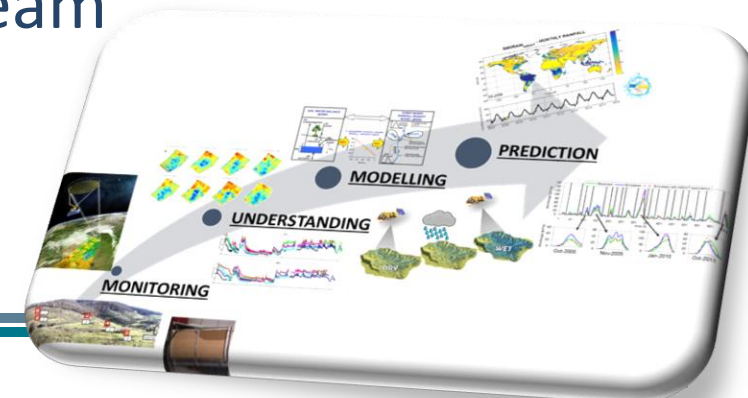


Soil moisture products for agricultural drought monitoring

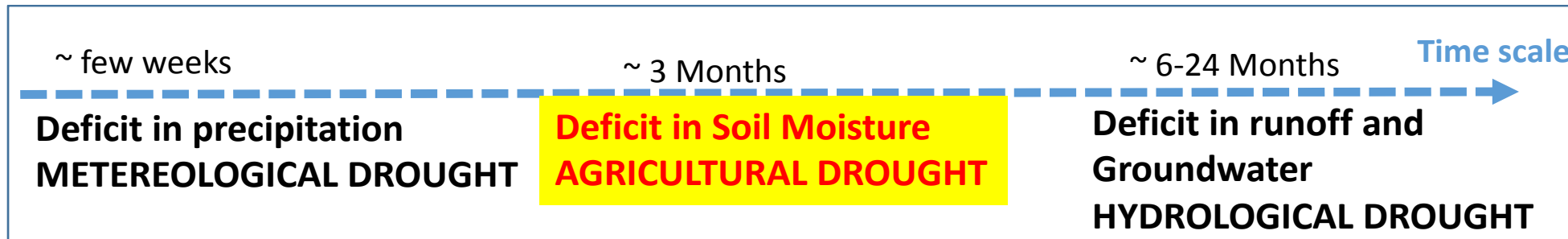
Introduction



Stefania Camici and the Hydrology Team
IRPI CNR

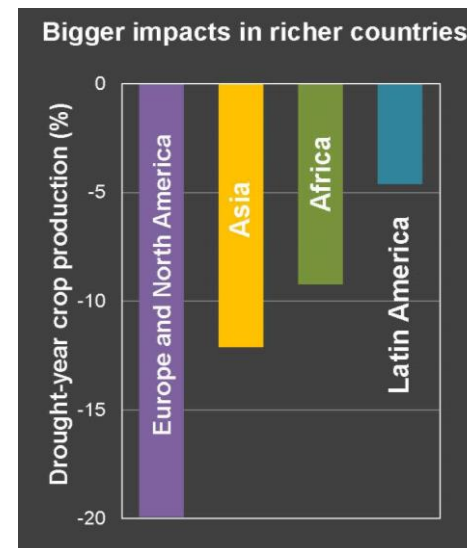


A **DROUGHT** is a period of below-average precipitation in a given region, resulting in prolonged shortages in the water supply, whether atmospheric, surface water or ground water



CONSEQUENCES:

“3 billion tonnes of lost harvest since 1964 (about three years of global maize harvests)”
(Lesk et al., 2016, Nature)

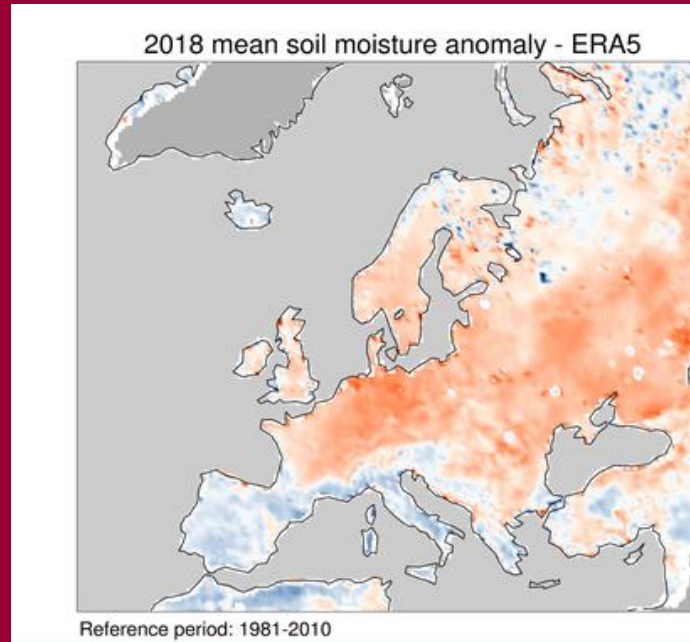


Ground-based Soil Moisture measurements?
ISMN (Dorigo et al., 2015)

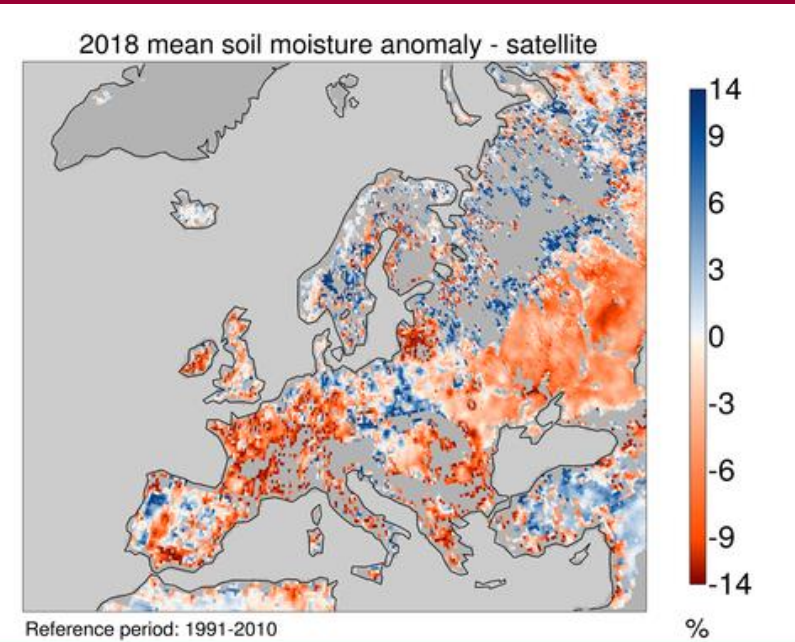


- ✓ Scarcity
- ✓ Short available time series

Model-based Soil Moisture estimates



Satellite-based Soil Moisture observations



Copernicus Climate Change Service
European State of the Climate | 2018

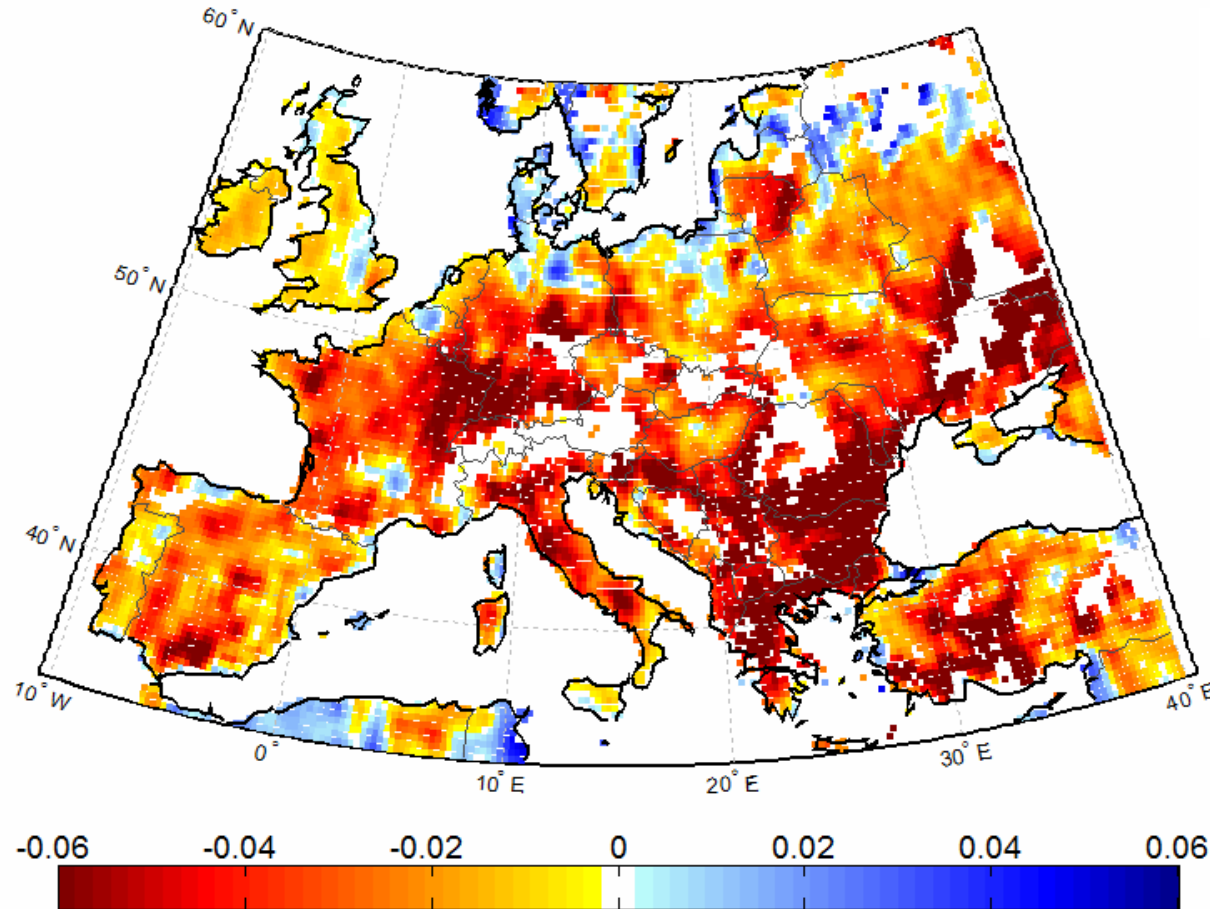


Copernicus
European State of the Climate

IMPLEMENTED BY
ECMWF

Copernicus
Climate Change Service
climate.copernicus.eu

C3S Soil Moisture Anomalies: 01-10/01/2017

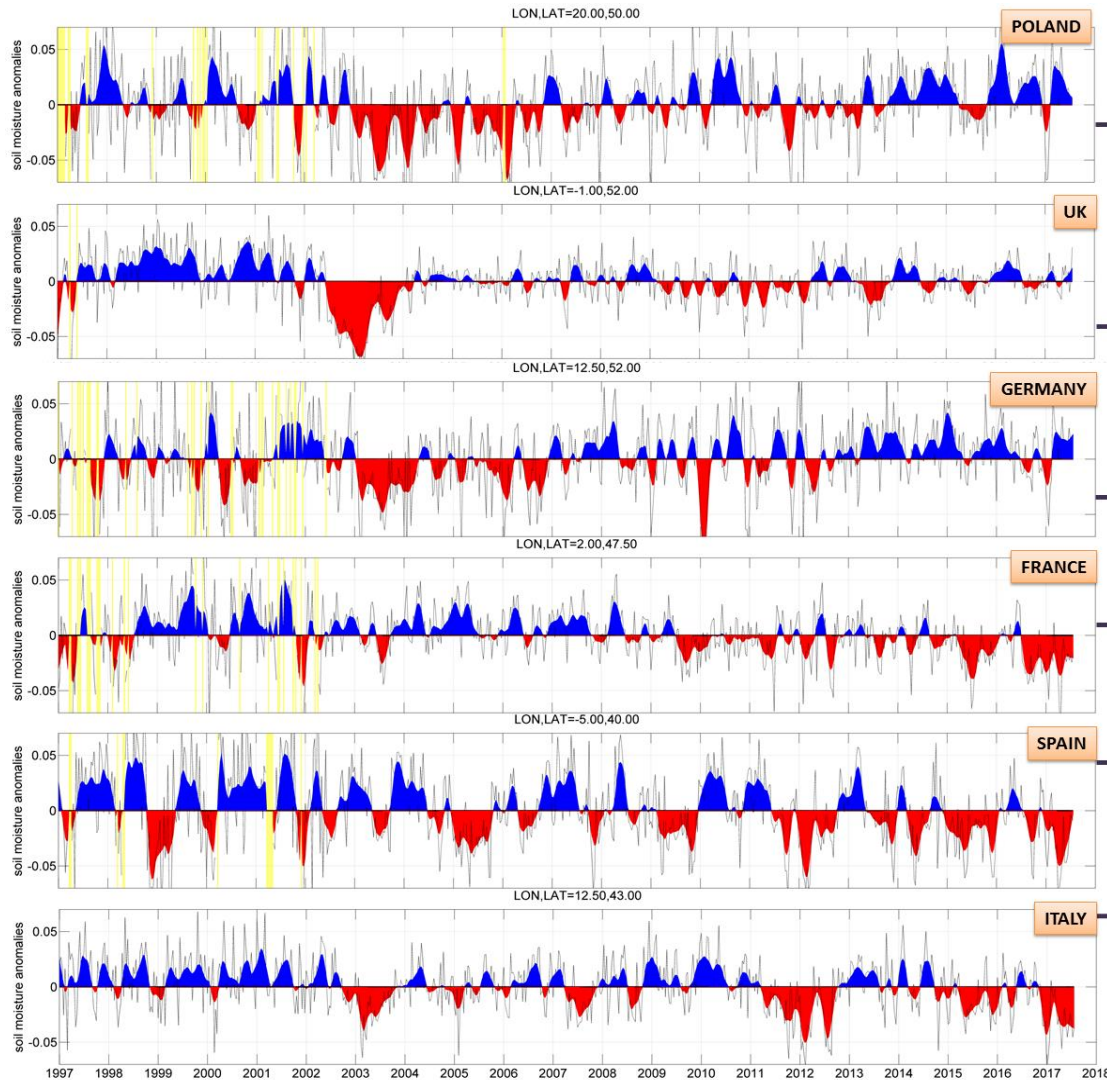


Satellite soil moisture anomalies in 2017

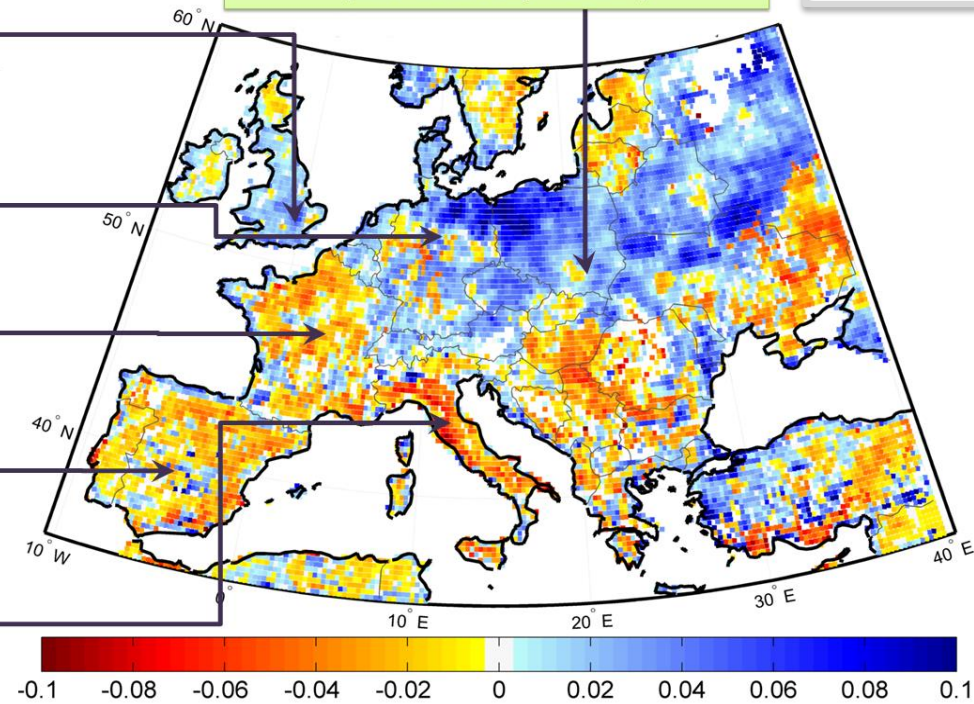
A dry year in the southern Europe countries

RED AREAS: WATER SCARCITY

Why Soil Moisture for drought?



C3S Soil Moisture Anomalies
(21-31 July 2017)

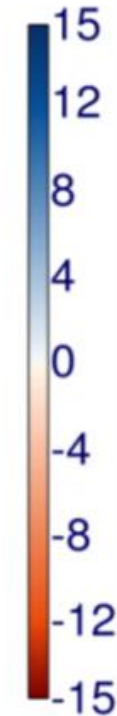
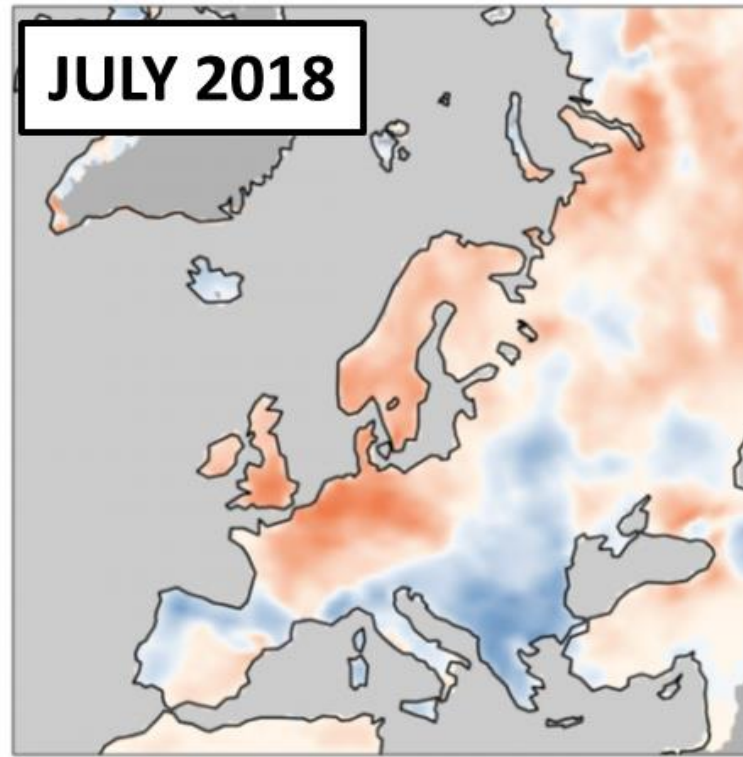
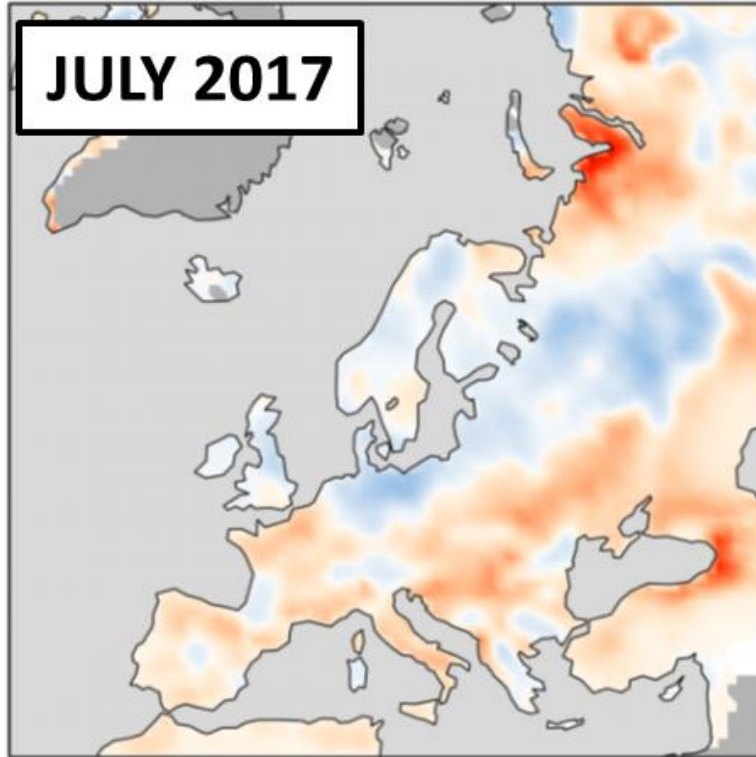


2017 was a dry year in the south and wet in the north-east of Europe

Soil moisture anomalies in Europe, Copernicus Climate Service (C3S)

0-7cm volumetric soil moisture (%)

0-7 cm volumetric soil moisture (%)

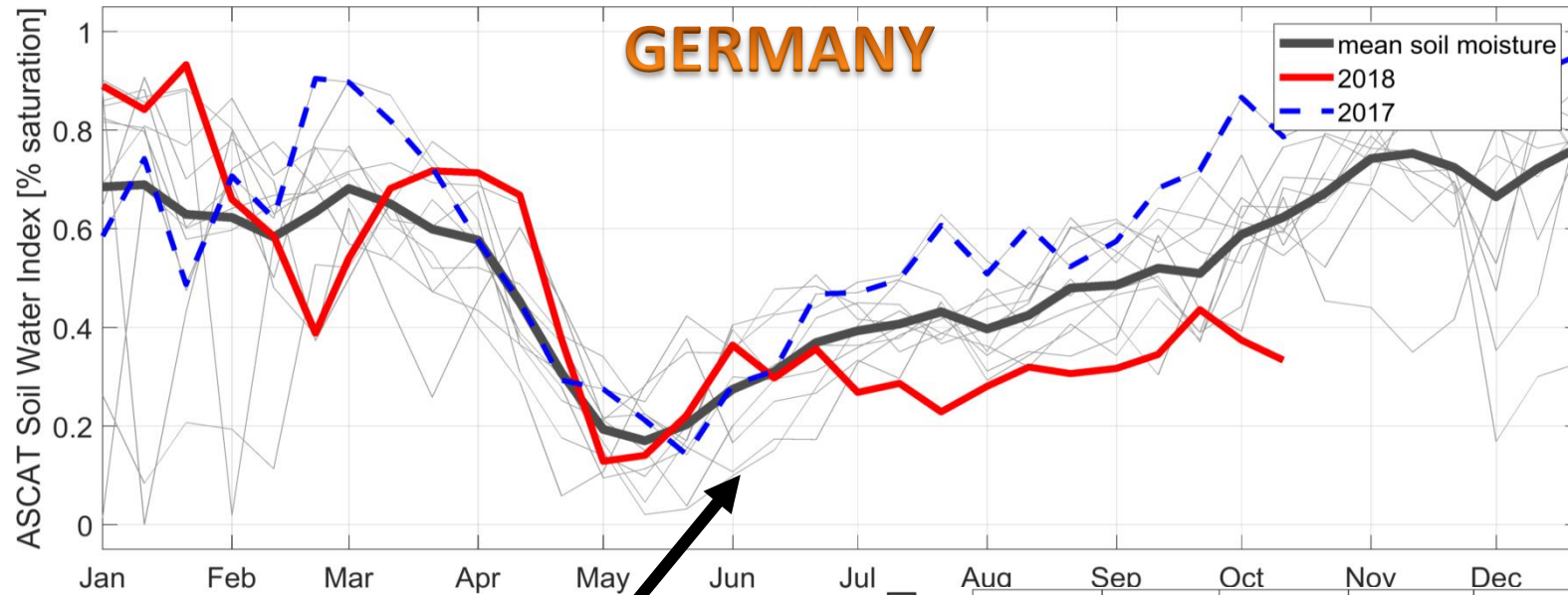


RED AREAS: drought conditions → WATER SCARCITY

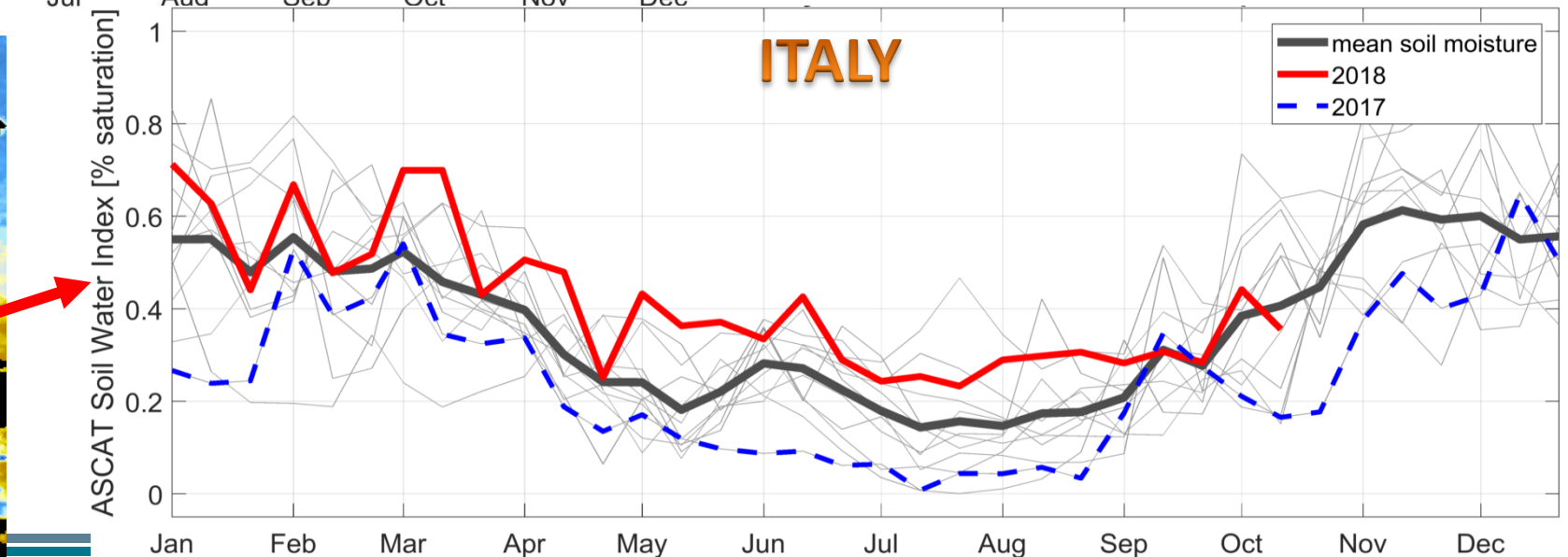
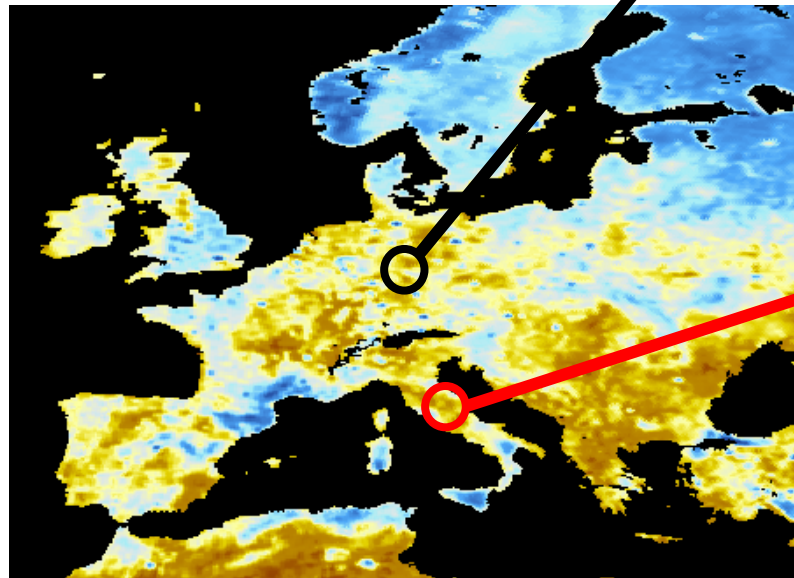
ERA-Interim soil moisture anomalies

In 2018 north-eastern countries suffer water scarcity

Why drought?



Soil moisture conditions in 2018 and 2017 compared with previous years (grey lines) and the long-term (11-year) averaged soil moisture



Drought Indices

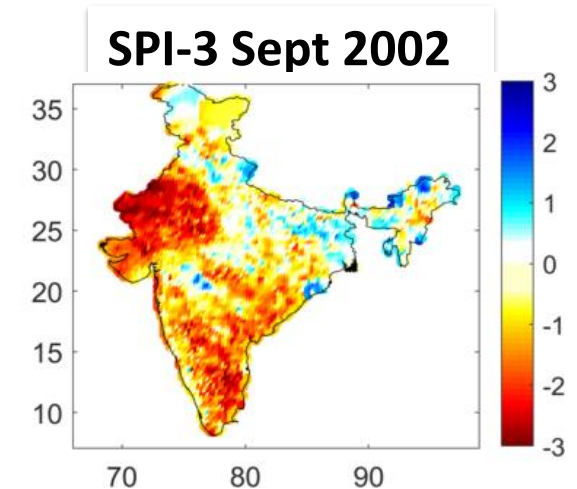
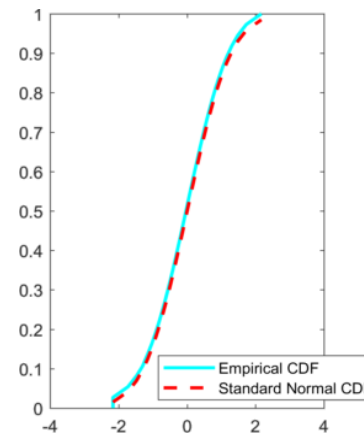
The simplest ones are founded on the concept of anomaly, that is the deviation with respect to the past (i.e., the mean) of an observed variable (at a desired time scale) normalized with its standard deviation

(see Zargar et al., 2011 for a review)



Standardized Precipitation Index (SPI) (McKee et al. 1993)

1. Long-term record of Precipitation are sorted;
2. Time scale: 1, 3, 6, 12, 24 months;
3. Probabilistic distribution fitting
4. Standard normal cumulative distribution function estimation



- ✓ Meteorological Drought index (WMO)
- ✓ SPI3 months often used for Agricultural Drought

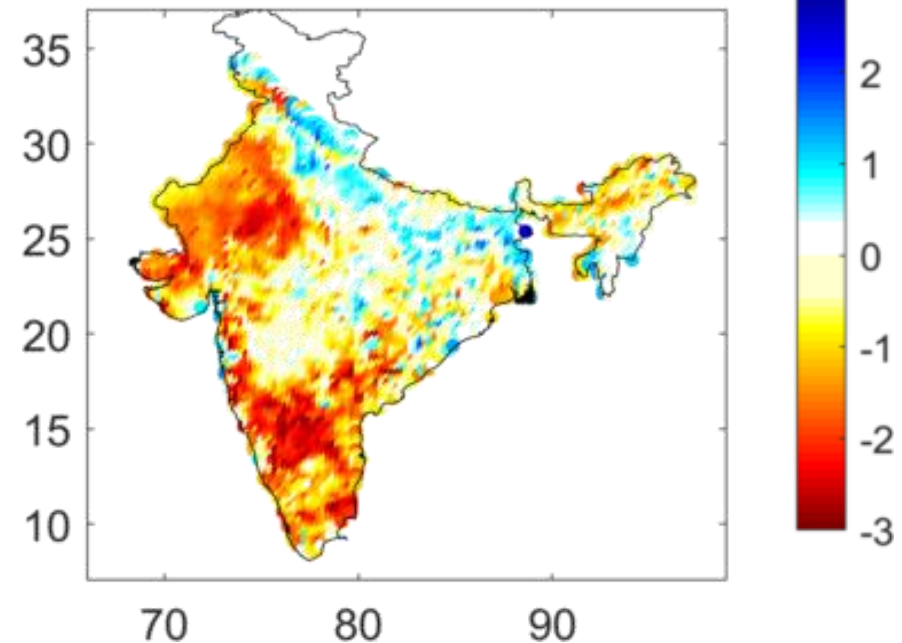
Standardized Soil Moisture Index SSI similar to SPI

1. Long-term record of **Soil Moisture observations** are sorted;
2. Time scale: 1, 3, 6, 12, 24 months;
3. Probabilistic distribution fitting (i.e. non-parametric, gamma distributions)
4. Standard normal cumulative distribution function estimation

SSI 1-month time
scale used for
Agricultural drought



SSI-1 Sept. 2002



SSI < 0: DROUGHT

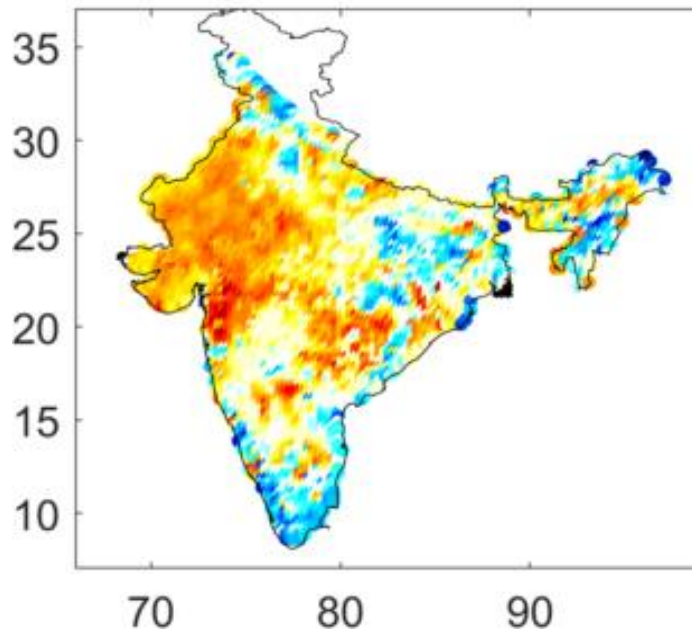
Monsoonal drought event of 2002



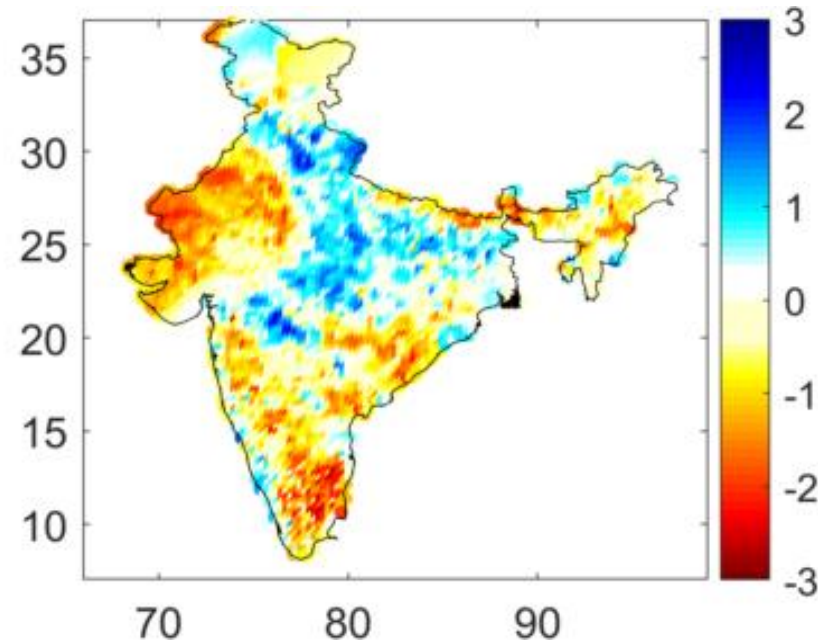
Seasonal rainfall deficit from July to September

In October the situation is still critical (especially for SSI)

SSI-1 Oct. 2002

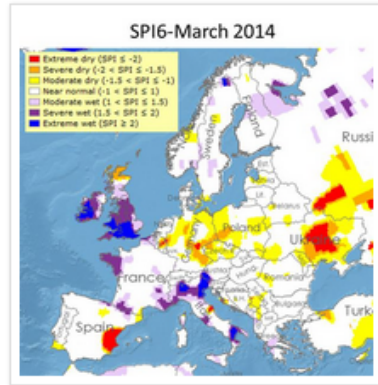


SPI-3 Oct. 2002

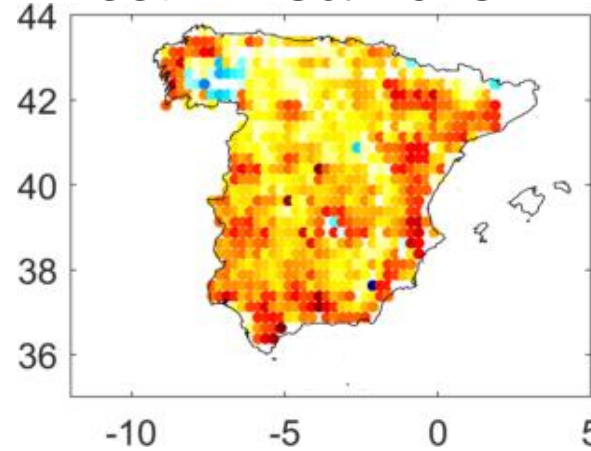


Exceptional drought in south-eastern Spain

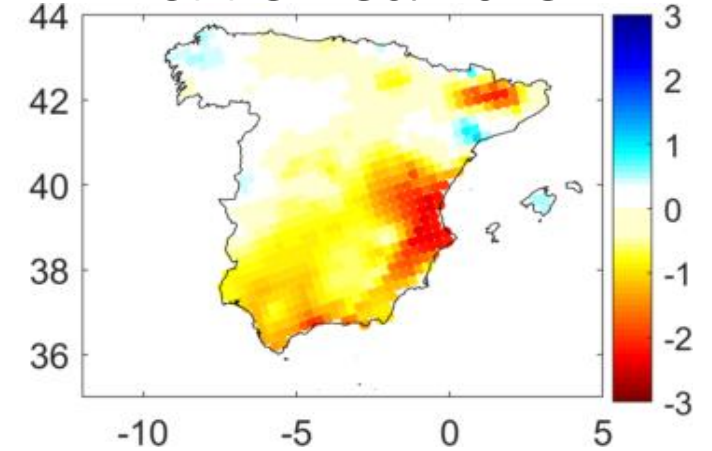
AUG 12 2014 Between October 2013 and July 2014, despite abundant rainfall in most of Europe, the south-eastern Iberian Peninsula (the Murcia and Valencia regions, and eastern Andalucía) was affected by mean and long-term precipitation deficits, leading to significant soil moisture deficits. In the same period, temporary rainfall shortages occurred also in France, Germany and Belgium, but their possible effects were likely insignificant due to subsequent rainfall events.



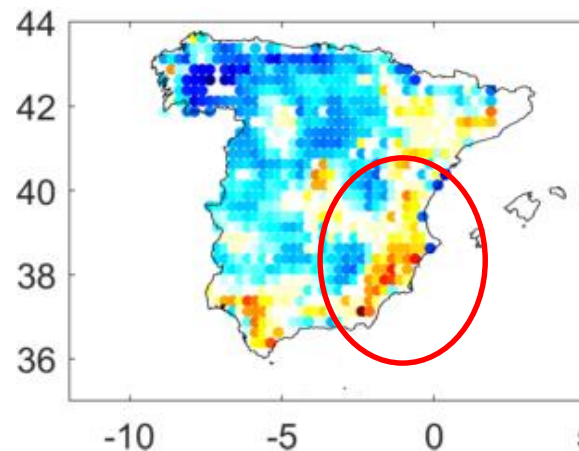
SSI-1 Dec. 2013



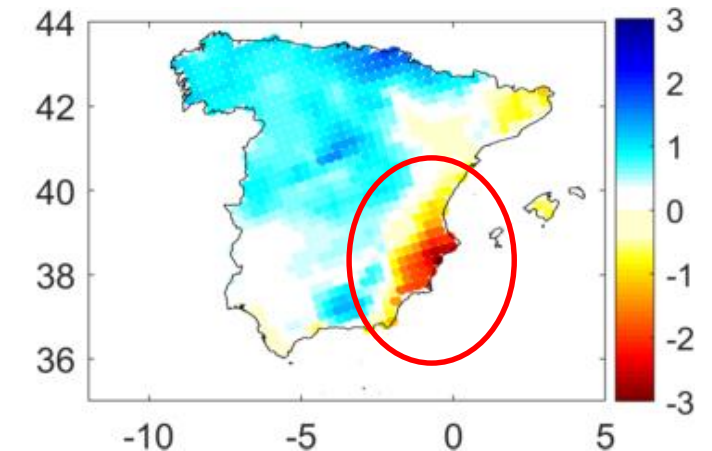
SPI-3 Dec. 2013



SSI-1 Mar. 2014



SPI-3 Mar. 2014



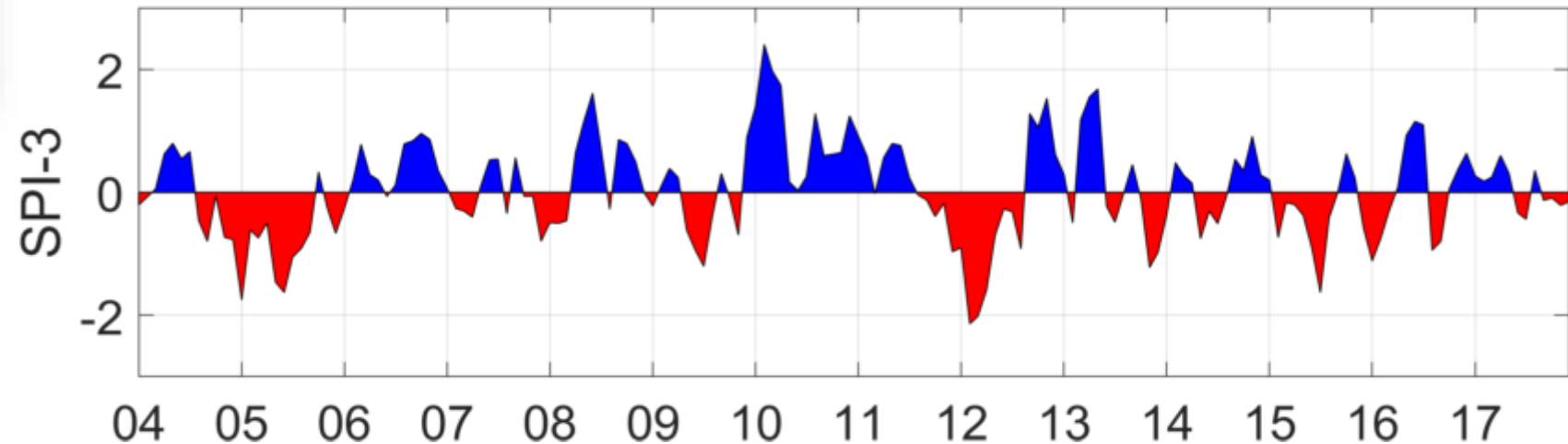
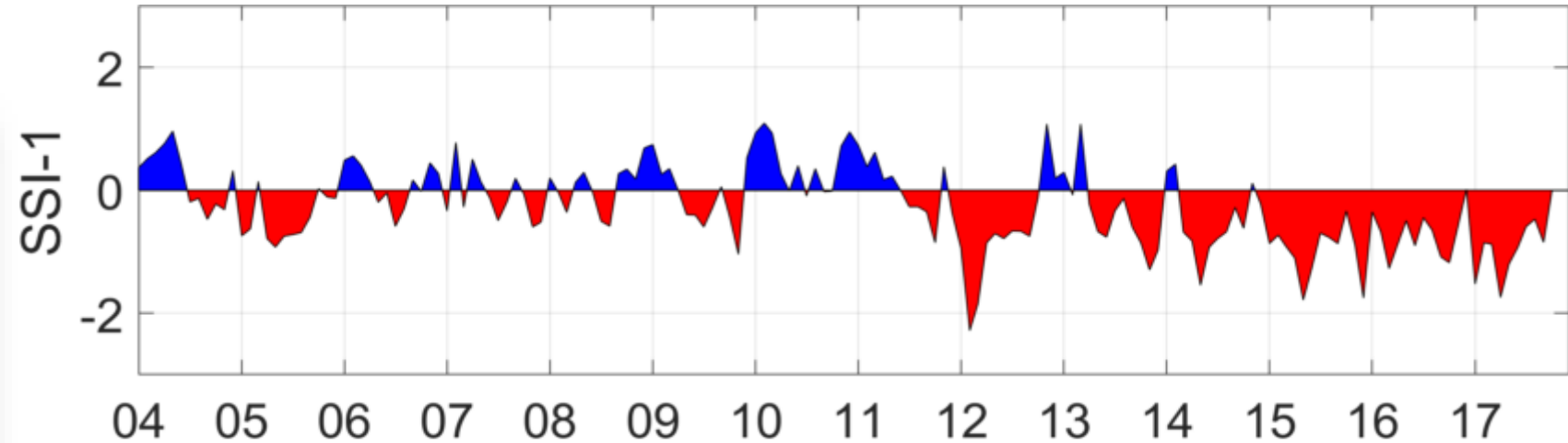
<https://ec.europa.eu/jrc/en/science-update/exceptional-drought-south-eastern-spain>

Andalusia (SPAIN):
 drought prone area



Soil moisture:

- higher persistence of drought conditions from 2013

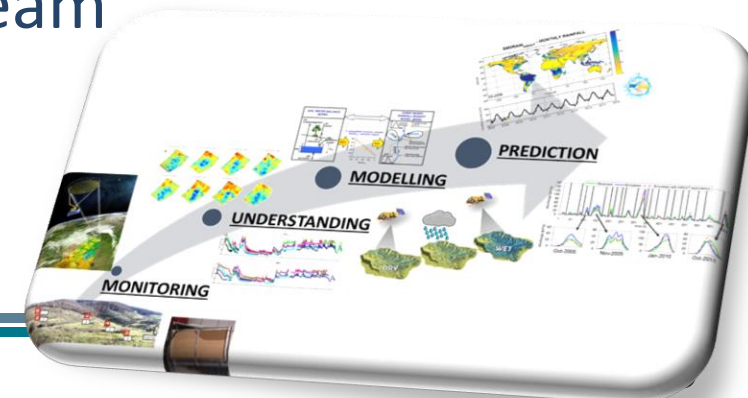


Soil moisture products for agricultural drought monitoring

Laboratory



Stefania Camici and the Hydrology Team
IRPI CNR



Soil Moisture Event Week

Drought monitoring through H SAF SM products

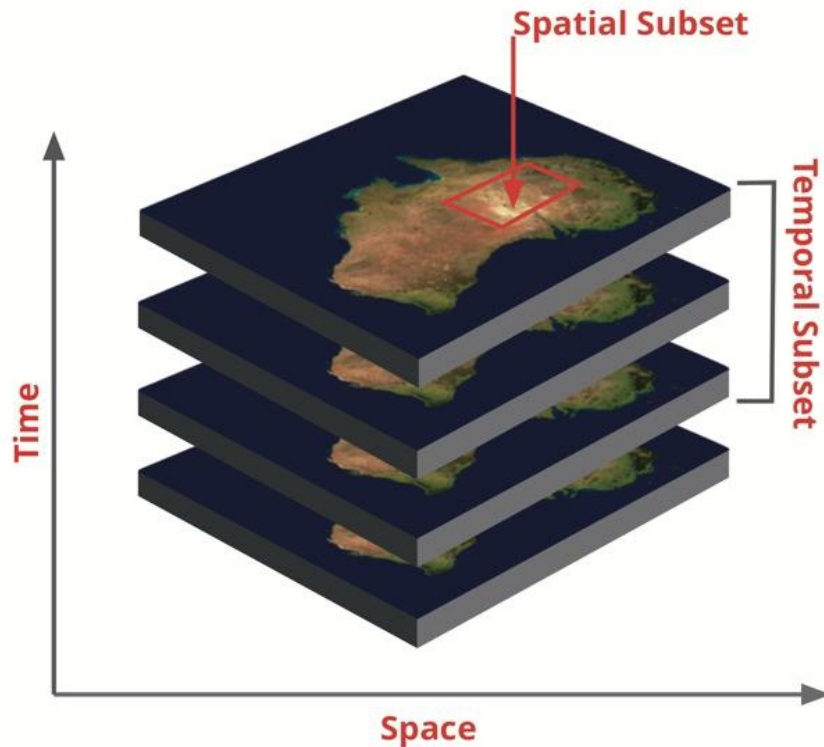
In this exercise we will:

- extract soil moisture and ERA5 rainfall time-series for the study basin (Tiber river basins)
- resample the time-series over the same grid (ASCAT) and aggregate the values at monthly time step
- Performing some analyses using soil moisture/rainfall time series and drought indexes

We will use two satellite-based soil moisture products:

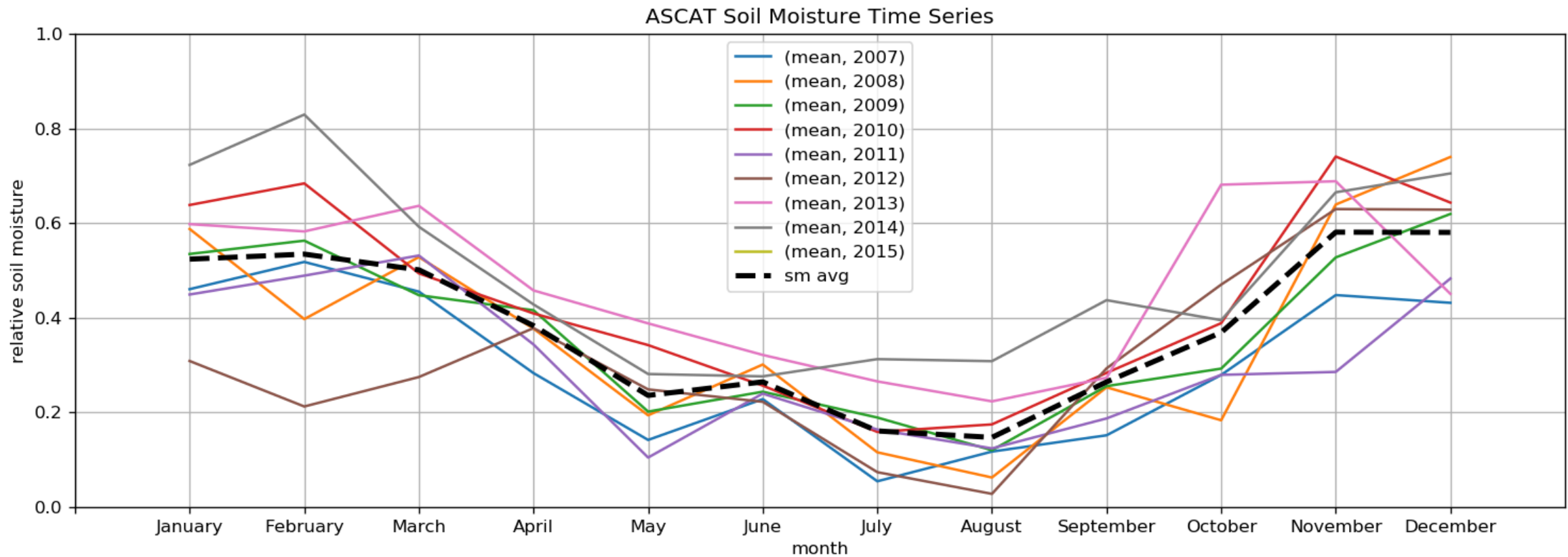
- H113 = surface soil moisture data record, based ONLY on satellite soil moisture data from ASCAT
- H27 = root-zone soil moisture obtained from the assimilation of ASCAT soil moisture into ECMWF IFS (Integrated Forecasting System)

Analyses performed using soil moisture/rainfall time series and drought indexes

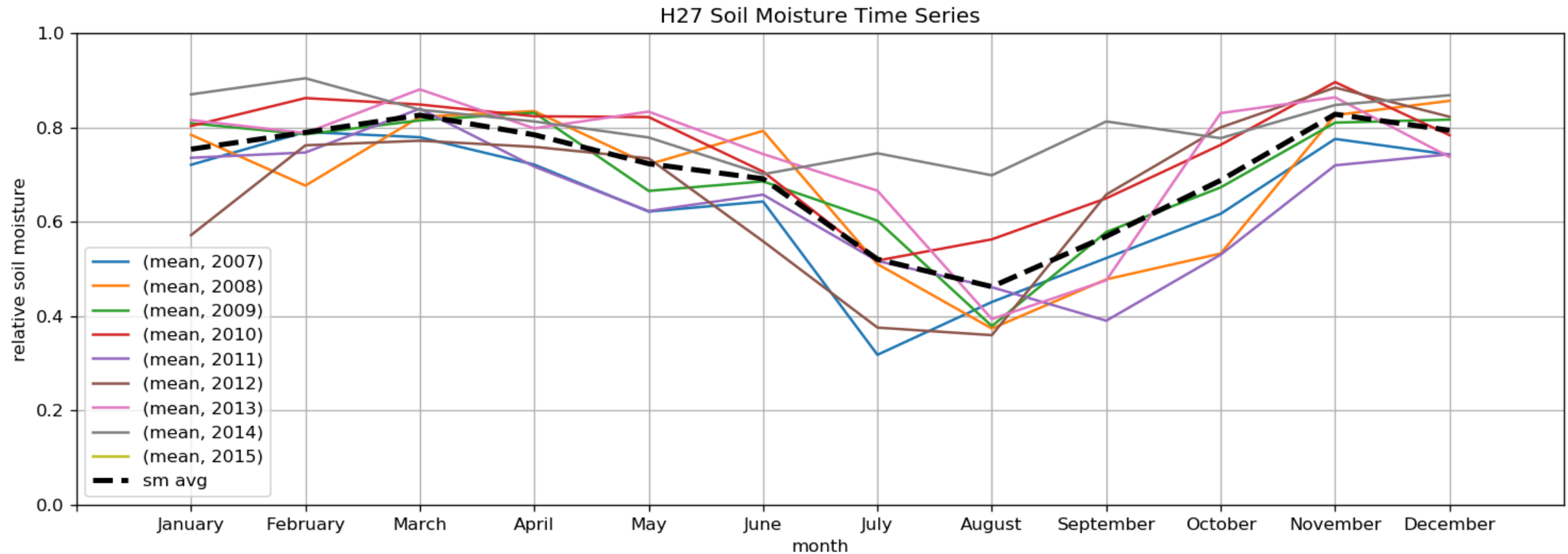


1. Computation of “seasonal” soil moisture
2. Computation of soil moisture anomalies averaged on the basin
3. Computation of Standardized Soil Moisture (SSI) drought index: time series averaged on the basin
4. SSI: Identification of drought characteristics (duration, magnitude)
5. Comparison of soil moisture (SSI) and precipitation (SPI) based drought indices
6. Drought in space: maps comparison

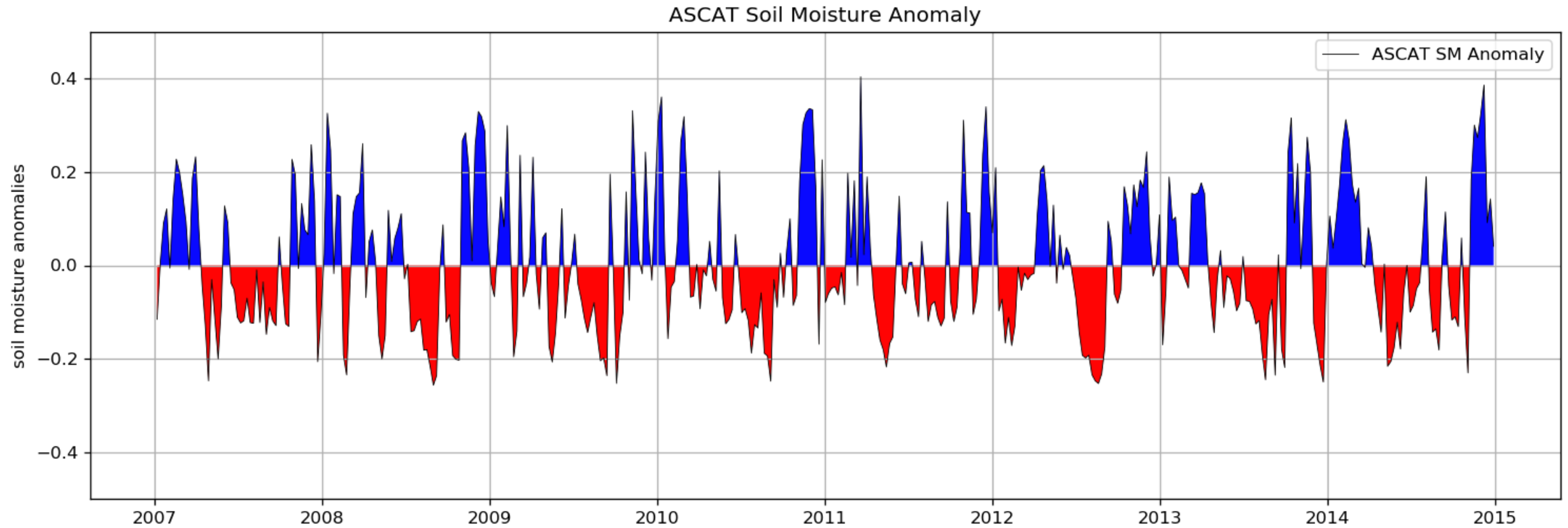
1. H113 inter-annual monthly soil moisture values averaged over the Tiber basin



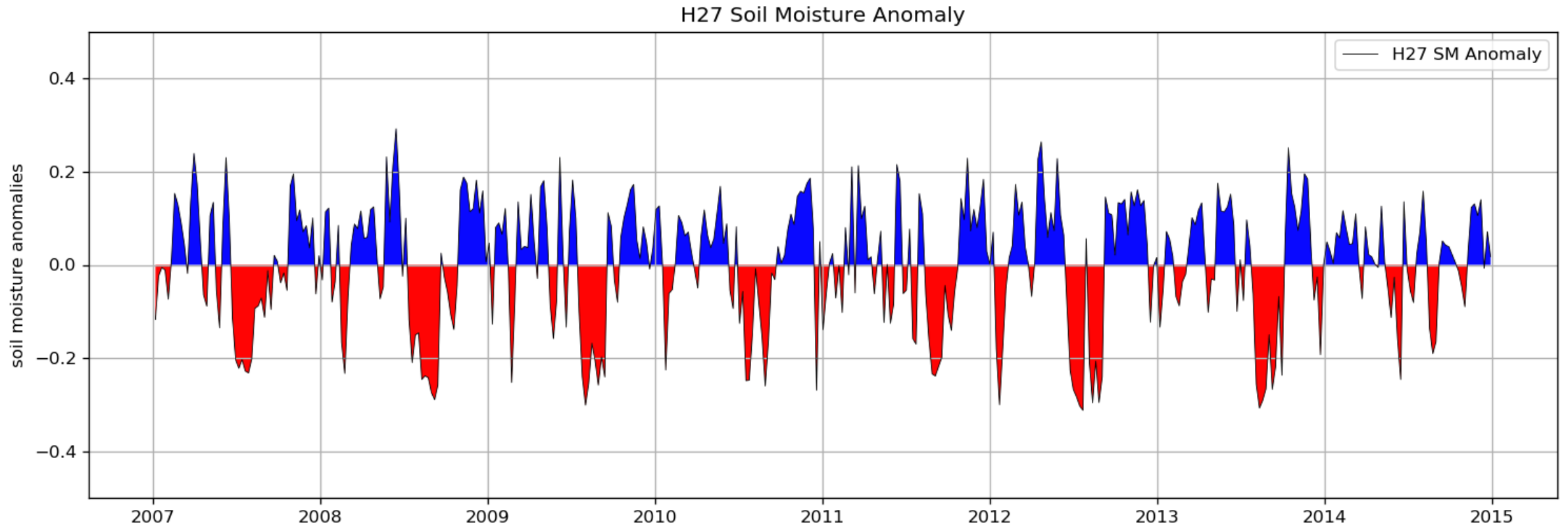
2. H27 inter-annual monthly soil moisture values averaged over the Tiber basin



3. H113 soil moisture anomalies averaged over the Tiber basin

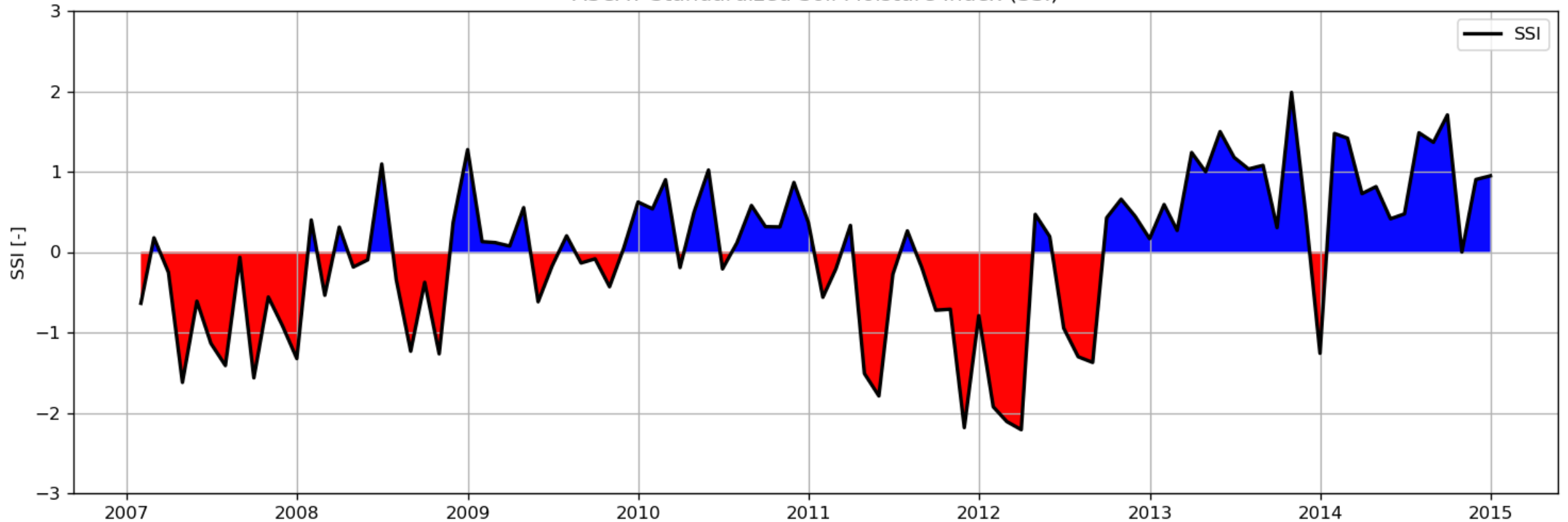


4. H27 soil moisture anomalies averaged over the Tiber basin

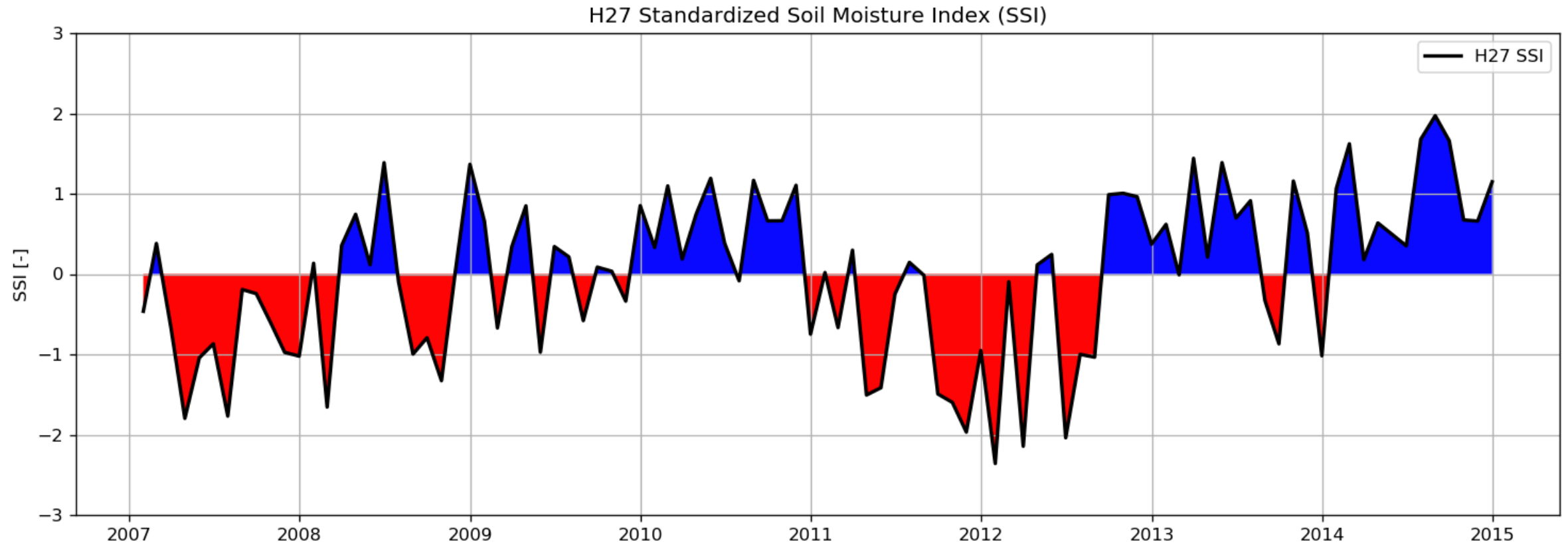


5. SSI index based on H113 soil moisture values averaged over the Tiber basin

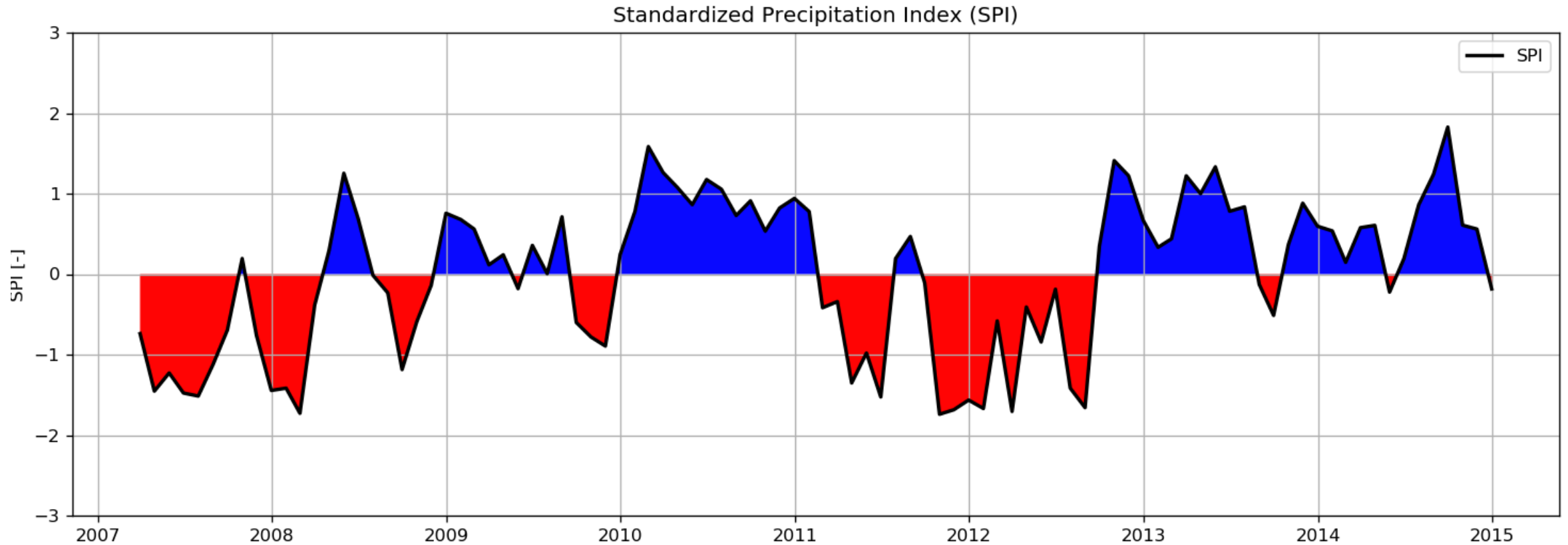
ASCAT Standardized Soil Moisture Index (SSI)



6. SSI index based on H27 soil moisture values averaged over the Tiber basin

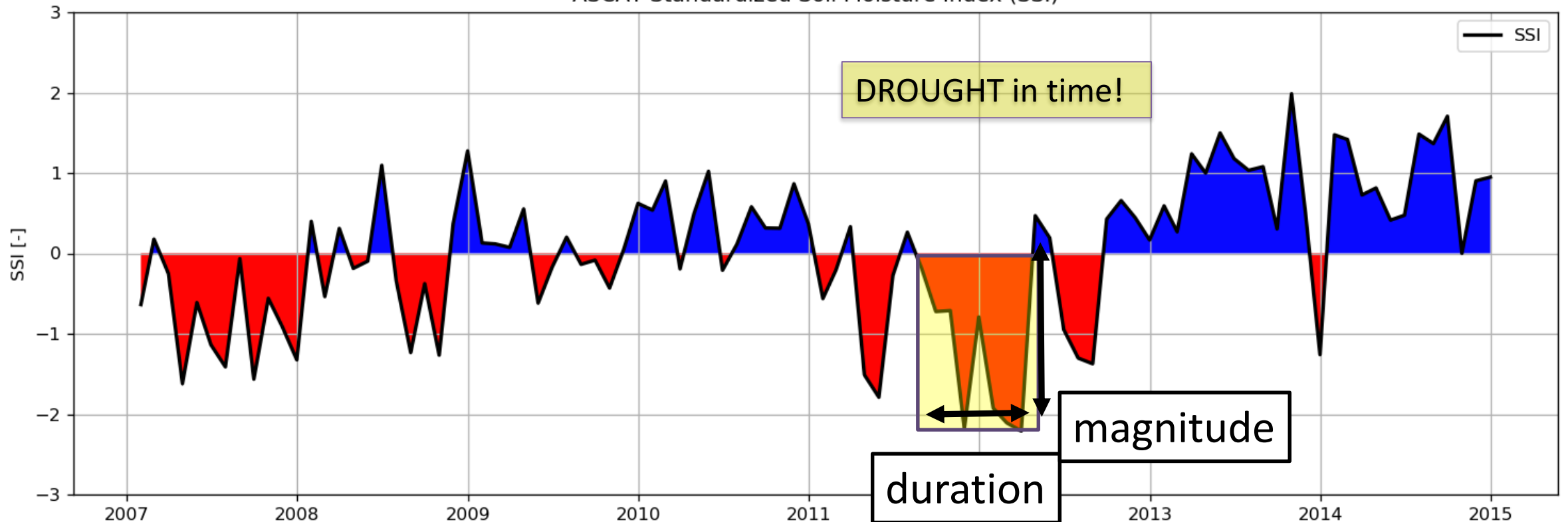


7. SPI index based on ERA5 rainfall values averaged over the Tiber basin



8. SSI identification of drought periods over the Tiber basin

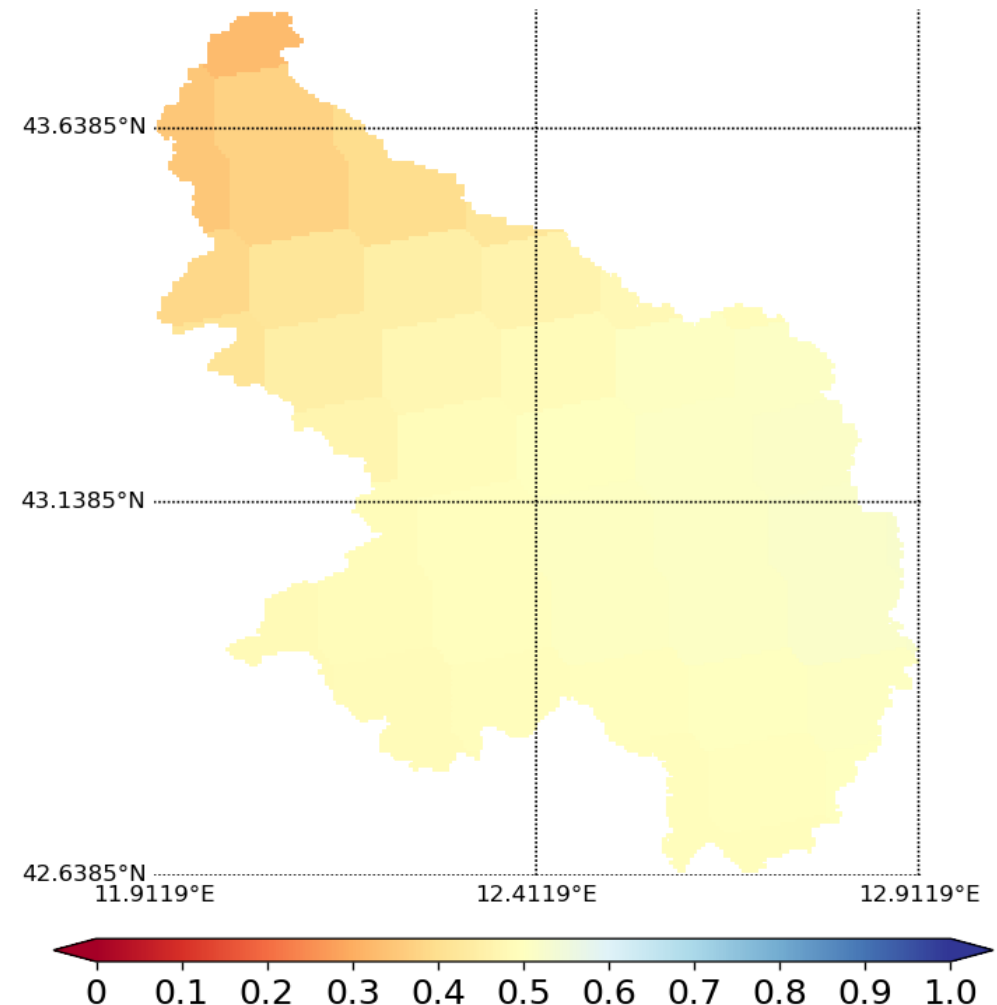
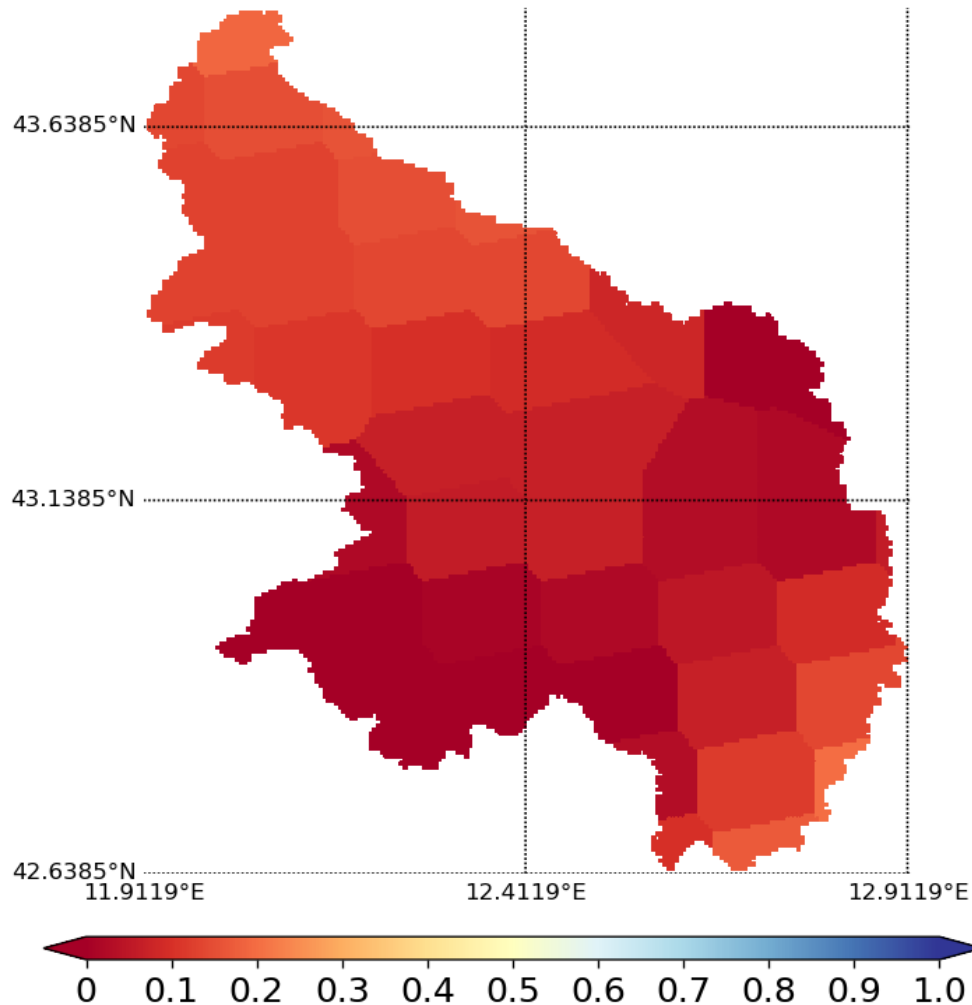
ASCAT Standardized Soil Moisture Index (SSI)



1. Map of H113 soil moisture

2. Map of H27 soil moisture

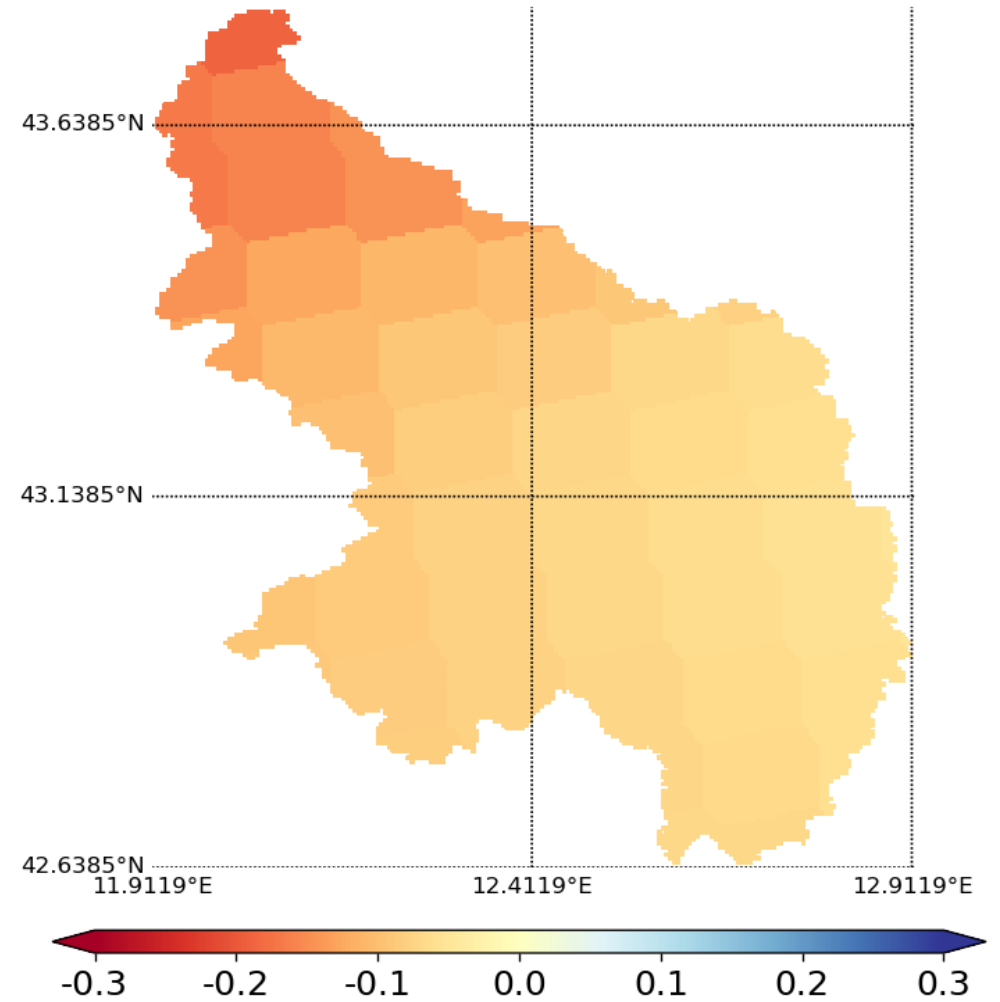
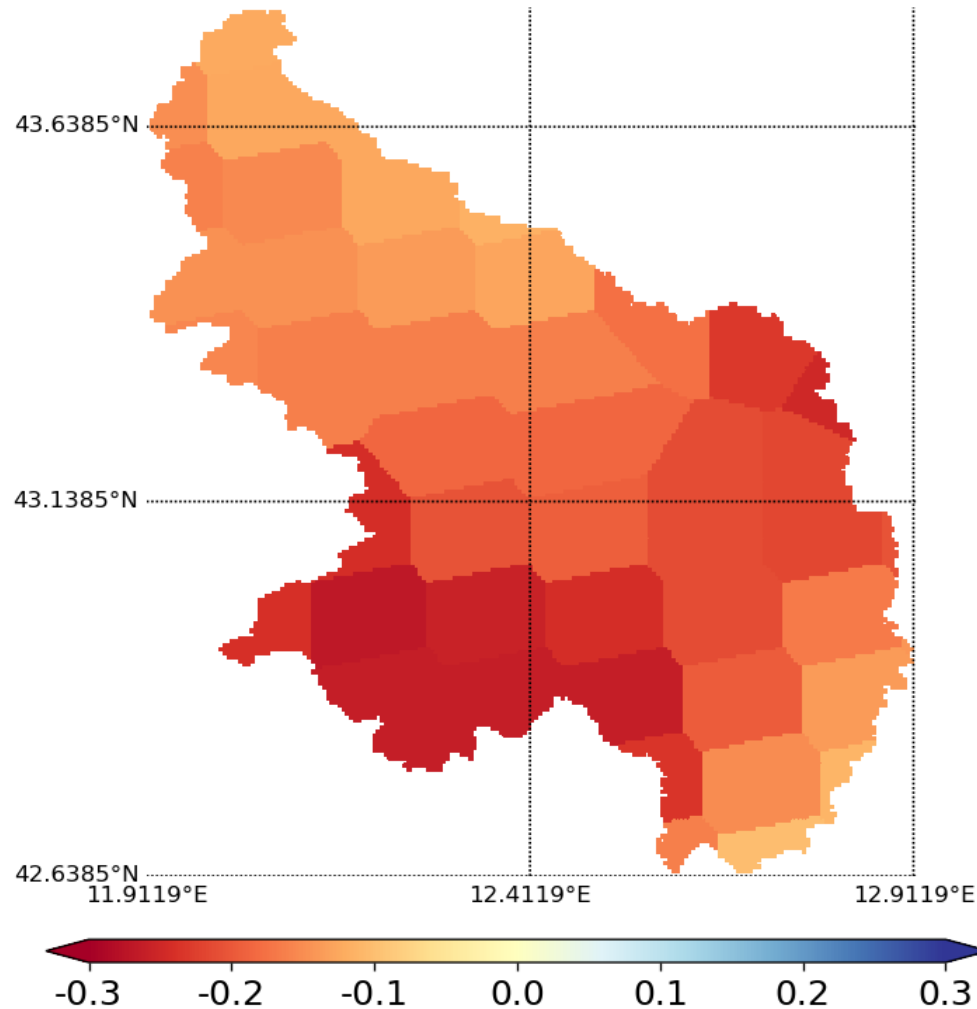
October 2011



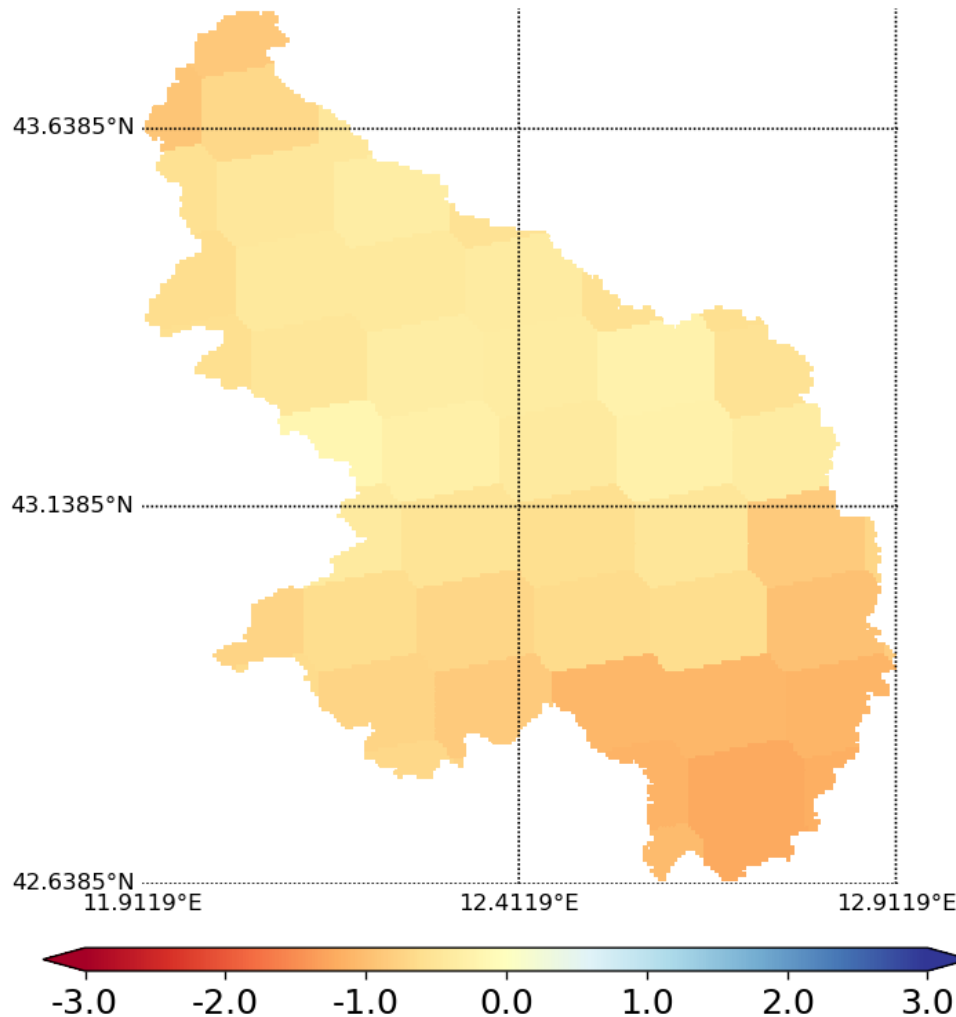
1. Map of H113 soil moisture anomalies

2. Map of H27 soil moisture anomalies

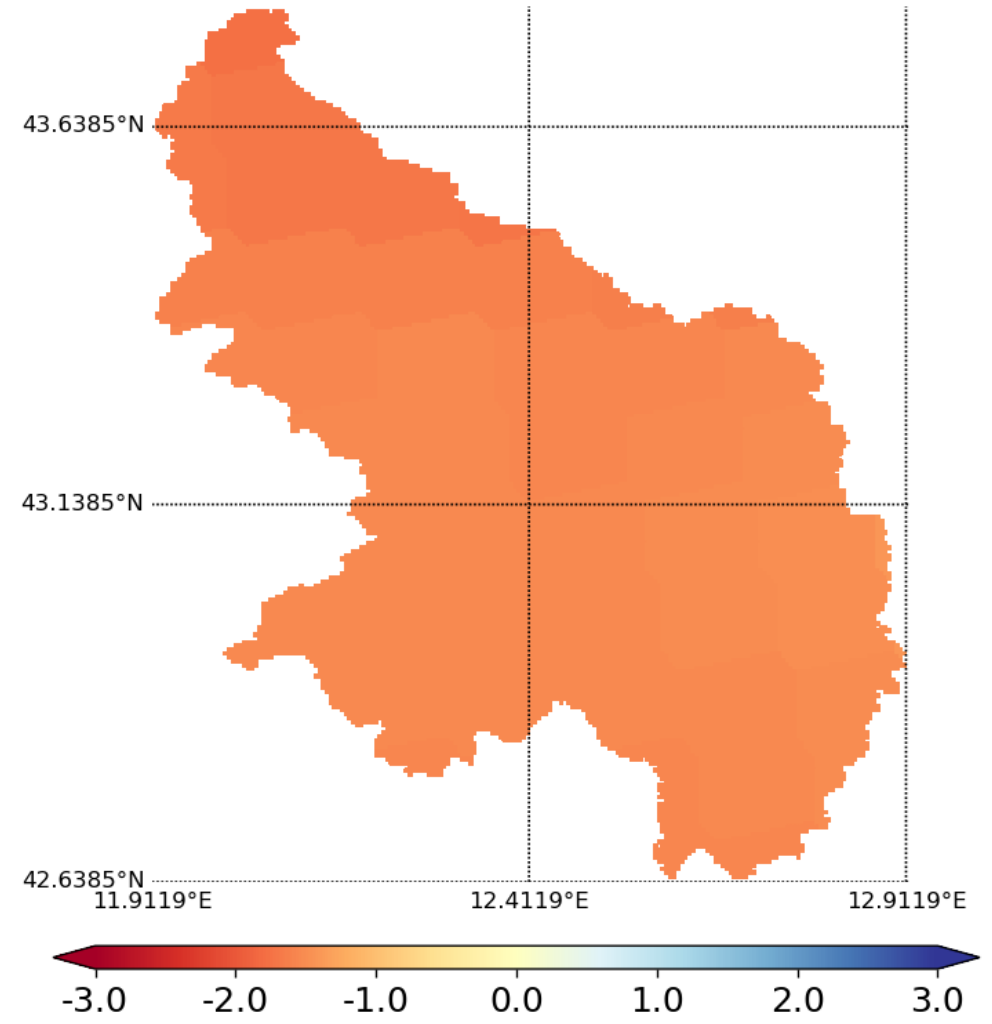
October 2011



1. Map of H113 SSI

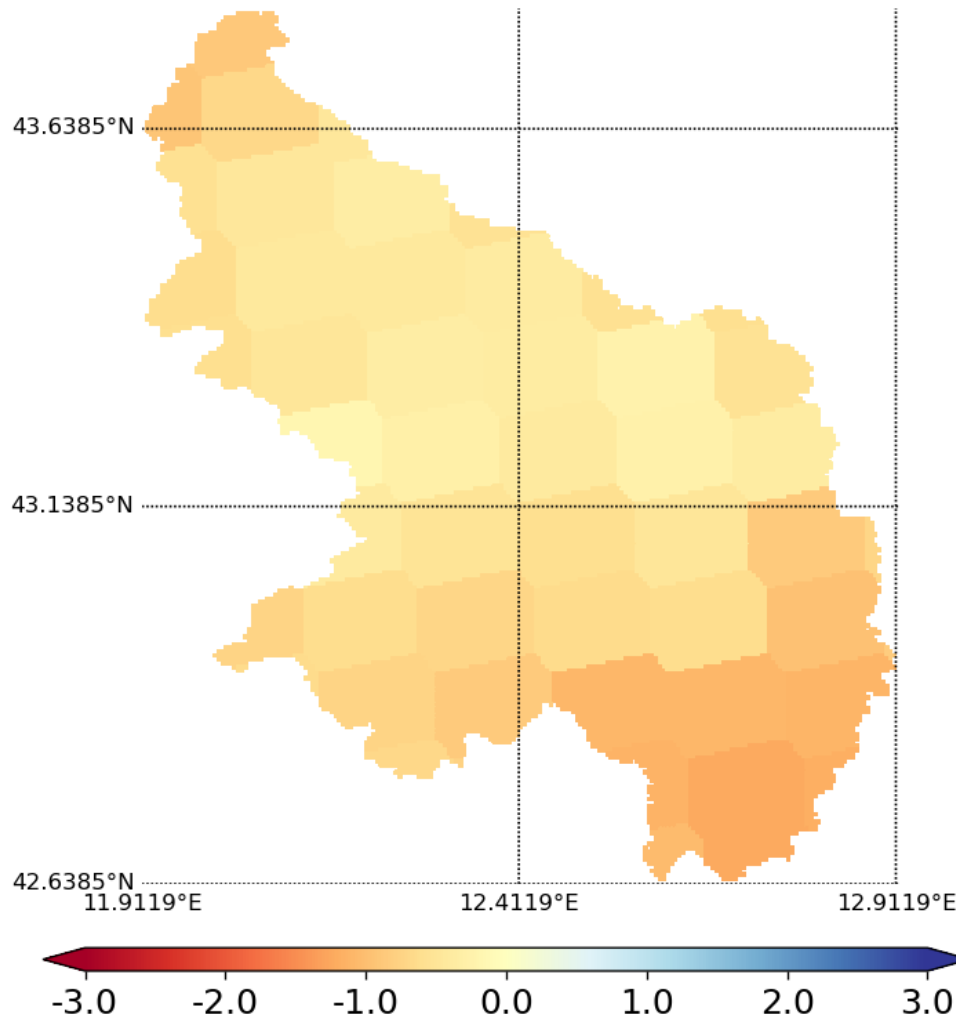


2. Map of H27 SSI

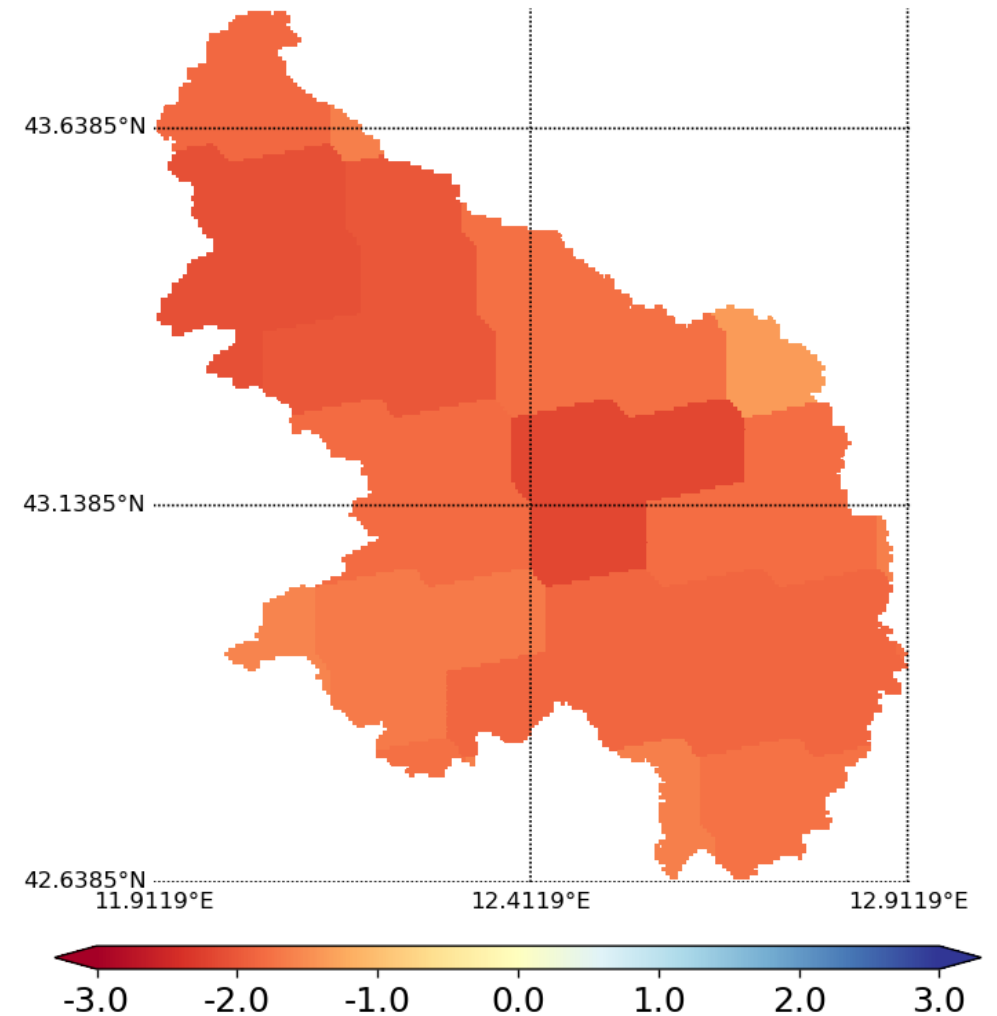


October 2011

1. Map of H113 SSI



2. Map of ERA5 SPI



October 2011

H SAF SOIL MOISTURE WEEK 2019

4-8 November 2019

Thank you for your attention

Stefania Camici and the Hydrology Team

IRPI CNR

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