Earth Observation Data for Agricultural Drought Monitoring in the Pannonian Basin

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Pannonian Basin

One of the largest agricultural regions in Europe

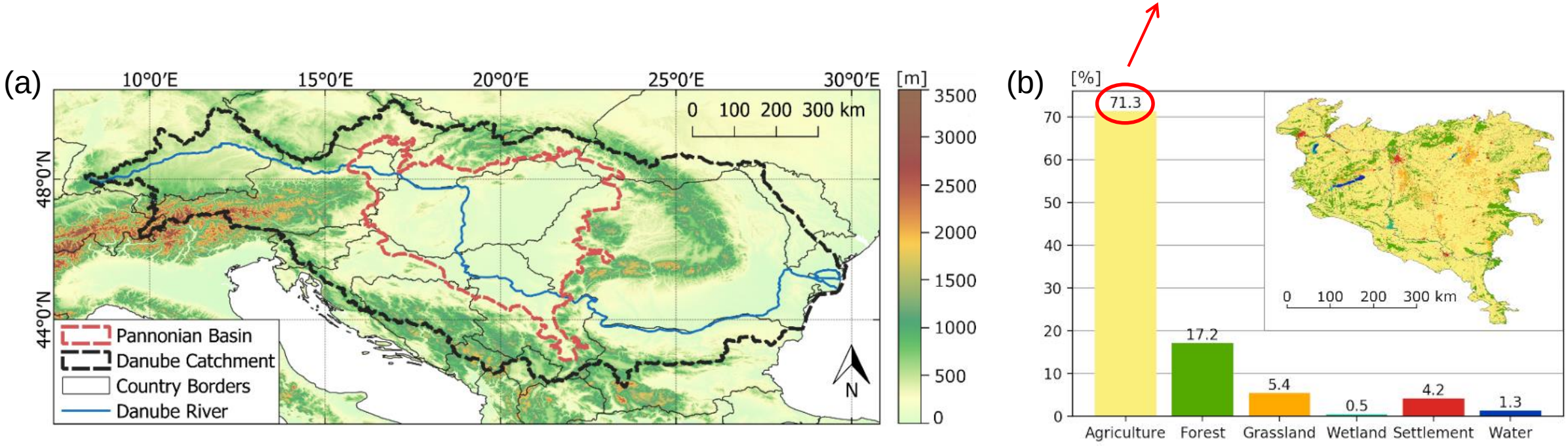

Fig. 1 (a) Topography of the Pannonian Basin, (b) Percentage of land cover for the Pannonian Basin for the year 2015 based on the ESA CCI land cover map (version 2.0.7)

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Recent Drought Events in the Pannonian Basin

In recent decades, the Pannonian Basin has experienced several drought episodes, leading to severe impacts on the environment, society, and economy.

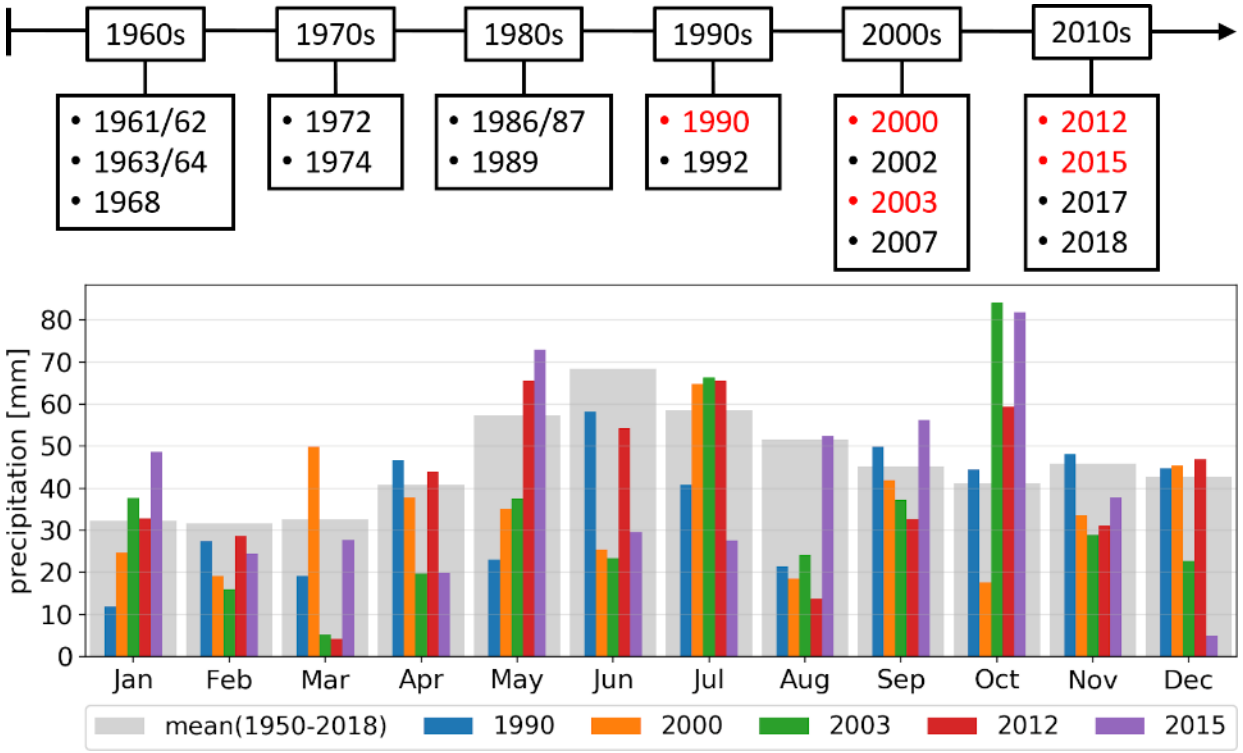

Fig. 2 Years of exceptionally strong droughts are highlighted in red. Monthly precipitation (based on E-OBS v19.0e data) averaged over the Pannonian Basin for the exceptionally strong drought years in contrast to the mean precipitation over the years 1950-2018

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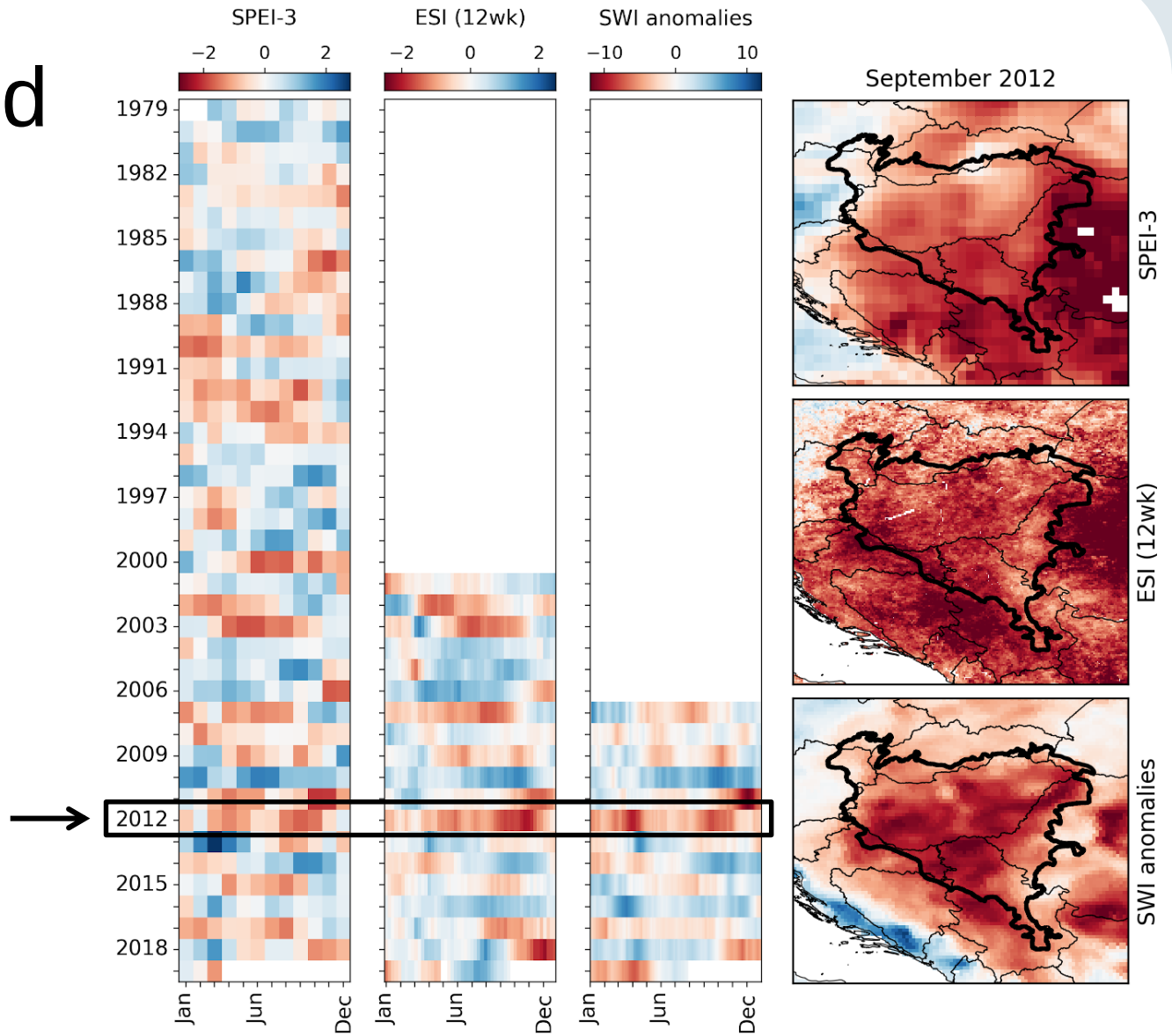
Earth Observation-based Drought Monitoring

Fig. 3a Temporal variability of three drought indicators/indices averaged over the Pannonian Basin:

- **SPEI-3** computed at the time scale of three months from the ERA5 meteorological reanalysis
- **ESI** (12-week composite)
- **SWI anomalies** (T value=40) based on MetOp ASCAT

The right-hand side shows the spatial distribution of these variables for a drought in September 2012 throughout the Pannonian Basin.

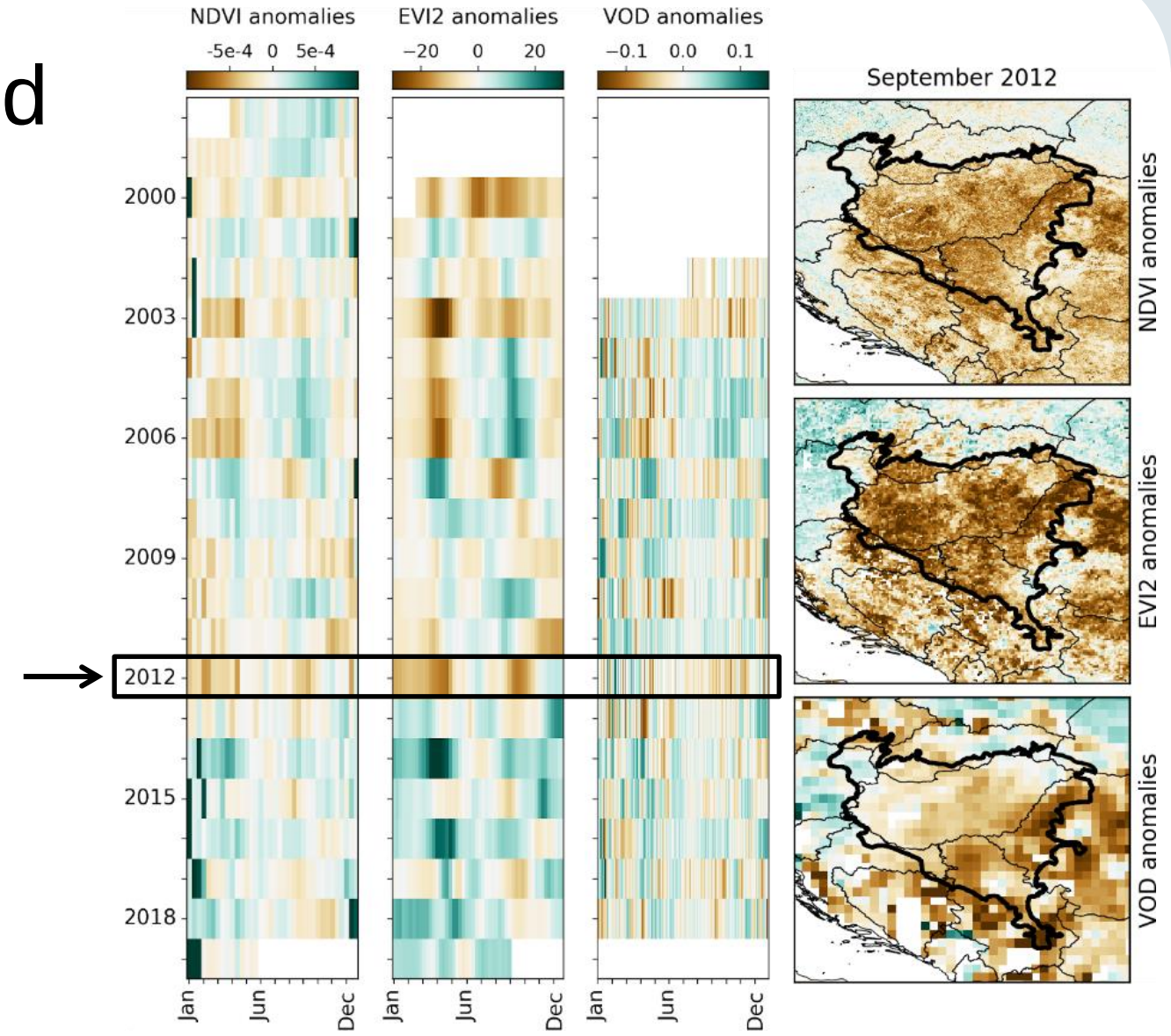


Earth Observation-based Drought Monitoring

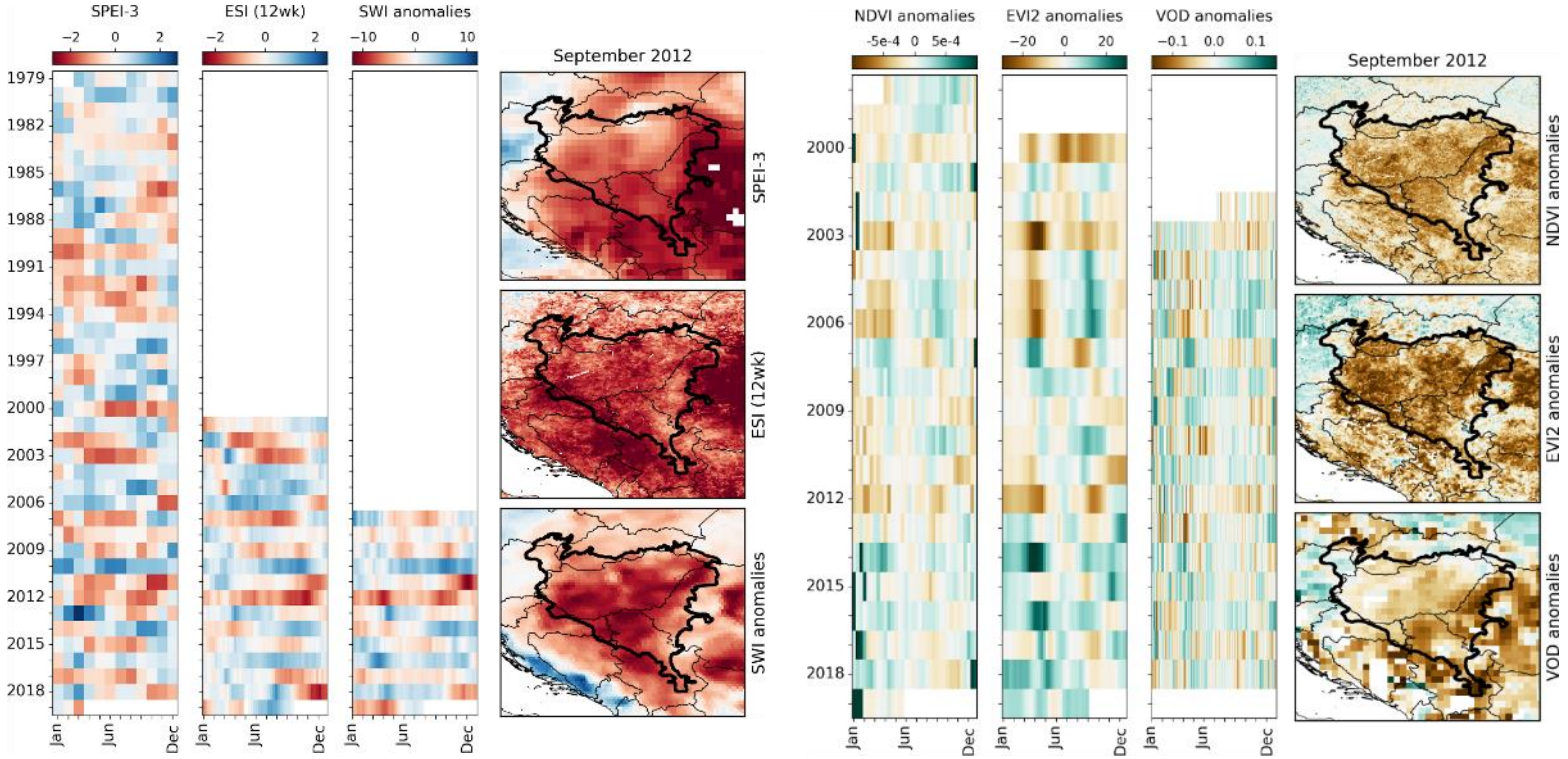
Fig. 3b Temporal variability of three drought indicators/indices averaged over the Pannonian Basin:

- **NDVI anomalies** (Copernicus Global Land Service's product)
- **EVI2 anomalies** based on TERRA retrievals
- **VOD anomalies** based on the VODCA C-Band product

The right-hand side shows the spatial distribution of these variables for a drought in September 2012 throughout the Pannonian Basin.



- Strong correspondence between water-related and vegetation-based drought indicators/indices
- Negative anomalies of water-related drought indicators/indices correlate with negative anomalies of vegetation based drought indicators/indices
- These remote-sensing based drought indicators/indices capture drought events (see Fig. 2) very well



Outlook: Drought Impact Forecasting

Aim: Predict near future vegetation anomalies from current and past vegetation and soil moisture states

Data: ESA CCI Soil Moisture Product (0.25°, daily)
MODIS FAPAR (0.25°, 8-daily)

Method: **Vector Auto Regression (VAR)**

- Multivariate forecasting algorithm
- Captures linear inter-dependencies among multiple time series

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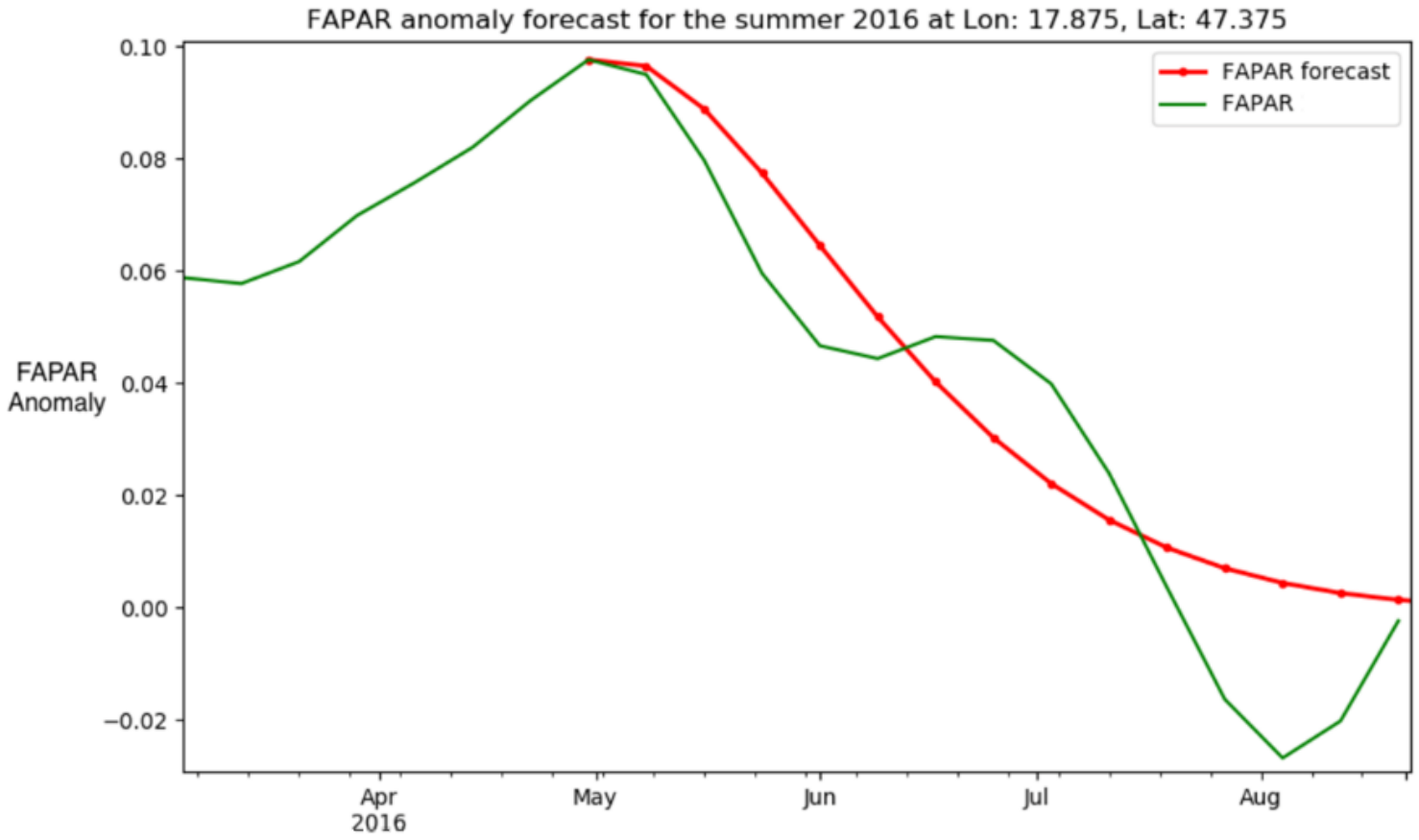
Outlook: Drought Impact Forecasting

Fig. 4: Forecast example for a pixel in the north-western part of the Pannonian Basin. The forecast (red line) starts in May and ends at the end of August. The green line are the observed FAPAR anomalies



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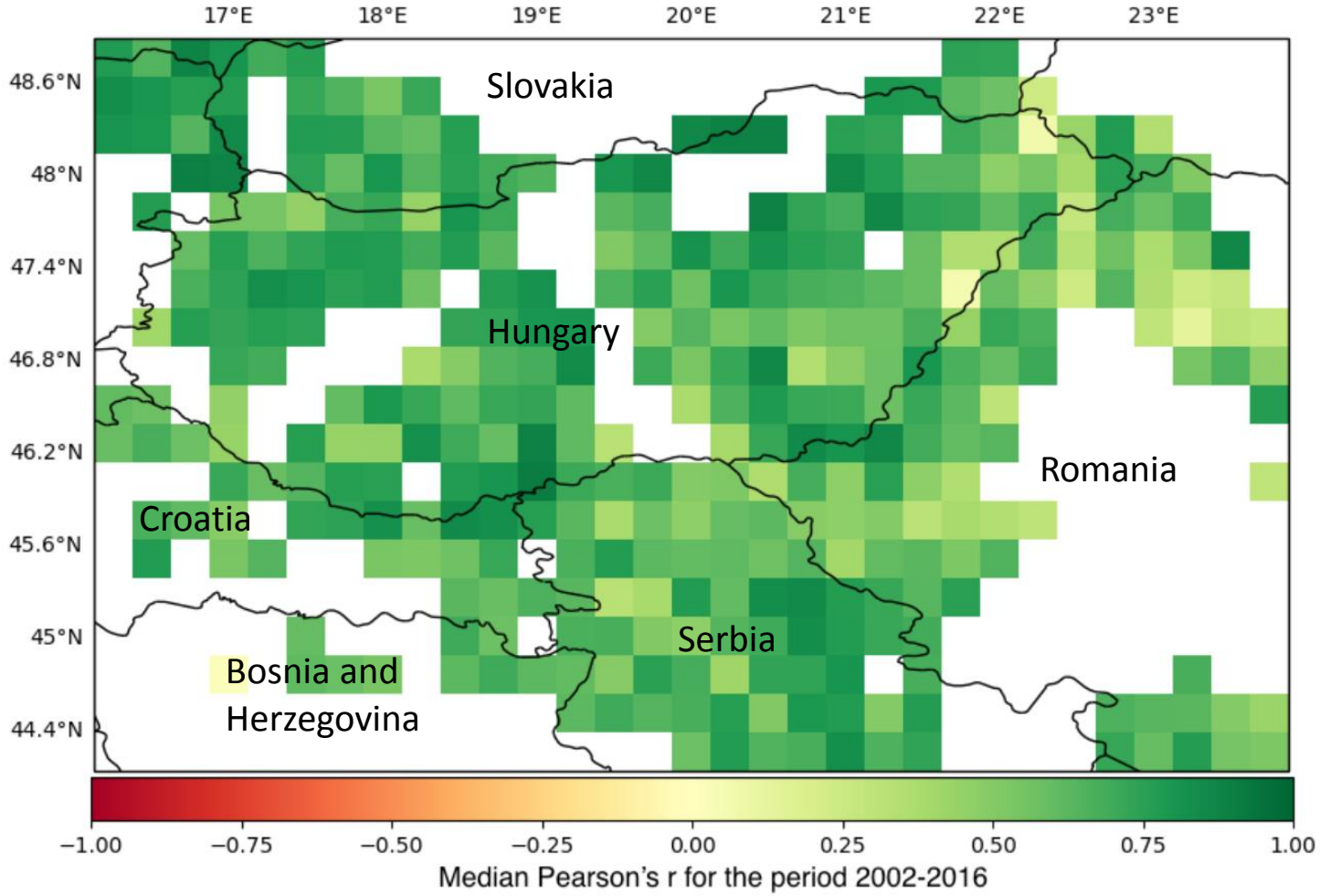
Outlook: Drought Impact Forecasting

Fig. 5: Median Pearson's correlation coefficient between forecasted FAPAR anomalies and the corresponding observed FAPAR anomalies. Grid points with less than 50% crop share are masked (white areas)



References

Review paper under preparation: Crocetti et al. 2020 - *Earth Observation for Agricultural Drought Monitoring in the Pannonian Basin: current state and future directions*

Wild et al. 2020 – *Seasonal Prediction of Drought-Related Vegetation Stress on Ecosystems in the Pannonian Basin using long-term satellite datasets and vector autoregression (VAR)*

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https://www.eodc.eu/esa-drypan/

APPENDIX

Standardized Precipitation Evapotranspiration Index (SPEI)

BACK

The SPEI is a common used drought index that is based on precipitation and temperature data. It can be calculated for different time scales.

Vicente-Serrano et al. (2009) – *A Multiscalar Drought Index Sensitive to Global Warming: The Standardized Precipitation Evapotranspiration Index* (https://doi.org/10.1175/2009JCLI2909.1)

Evaporative Stress Index (ESI)

BACK

The ESI quantifies anomalies in the ratio of actual to potential ET.

Anderson et al. (2011) – *Evaluation of Drought Indices Based on Thermal Remote Sensing of Evapotranspiration over the Continental United States* (https://doi.org/10.1175/2010JCLI3812.1)

Anderson et al. (2013) – *An Intercomparison of Drought Indicators Based on Thermal Remote Sensing and NLDAS-2 Simulations with U.S. Drought Monitor Classifications* (https://doi.org/10.1175/JHM-D-12-0140.1)

Soil Water Index (SWI)

BACK

The SWI provides an estimate of the moisture content in the soil profile from surface measurements. The SWI is available for different T-values which can be associated with various depths in the soil.

Paulik et al. (2014) – *Validation of the ASCAT Soil Water Index using in situ data from the International Soil Moisture Network* (https://doi.org/10.1016/j.jag.2014.01.007)

Wagner et al. (1999) – *A Method for Estimating Soil Moisture from ERS Scatterometer and Soil Data* (https://doi.org/10.1016/S0034-4257(99)00036-X)

Normalized Difference Vegetation Index (NDVI)

BACK

NDVI is an indicator of the greenness of the biomes.

Tucker et al. (1979) – *Red and photographic infrared linear combinations for monitoring vegetation* (https://doi.org/10.1016/0034-4257(79)90013-0)

Enhanced Vegetation Index 2 (EVI2)

BACK

EVI2 is the 2-band EVI without a blue band. EVI is a feedback-based soil and atmospheric resistant vegetation index that provides improved sensitivity in high biomass regions while minimizing soil and atmosphere influences

Jiang et al. (2008) – *Development of a two-band enhanced vegetation index without a blue band* (https://doi.org/10.1016/j.rse.2008.06.006)

Vegetation Optical Depth (VOD)

BACK

VOD is an indicator to detect changes in vegetation that is based on space-borne microwave observations

Moesinger et al. (2019) – *The Global Long-term Microwave Vegetation Optical Depth Climate Archive VODCA* (https://doi.org/10.5194/essd-12-177-2020)