Sentinel-2-based fractional cover time series reveal drought impacts on Central European grasslands

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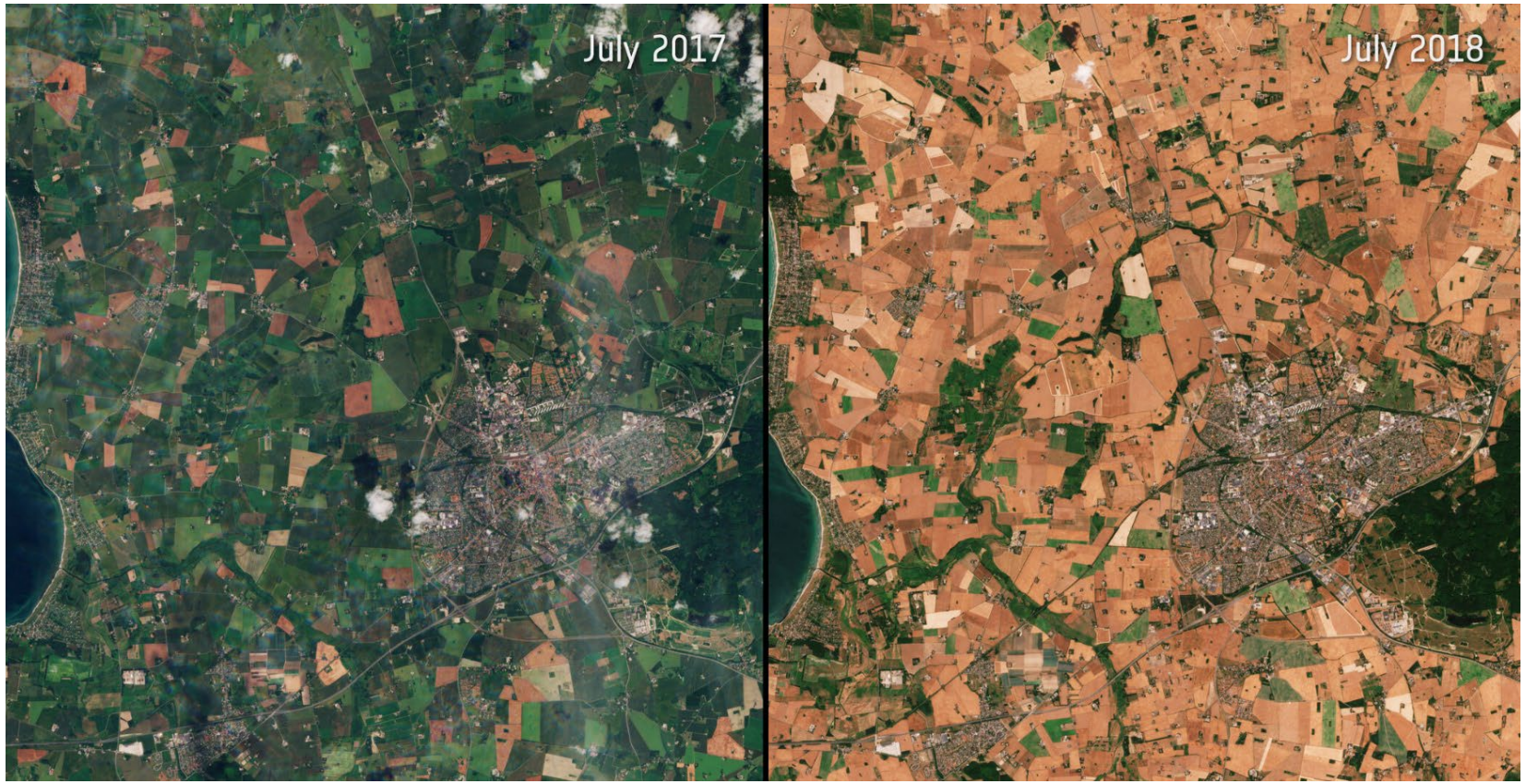
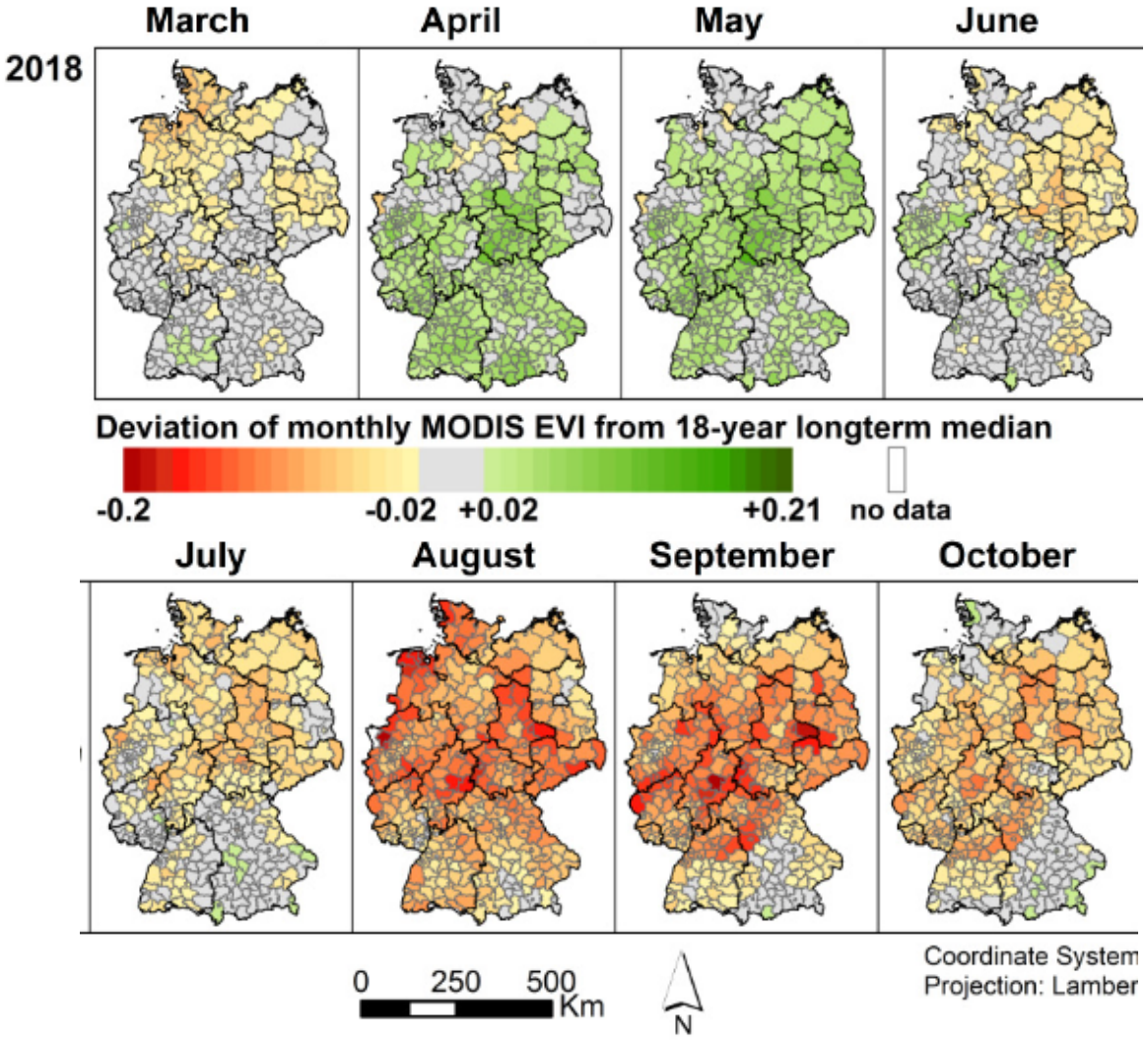
Grasslands in Central Europe

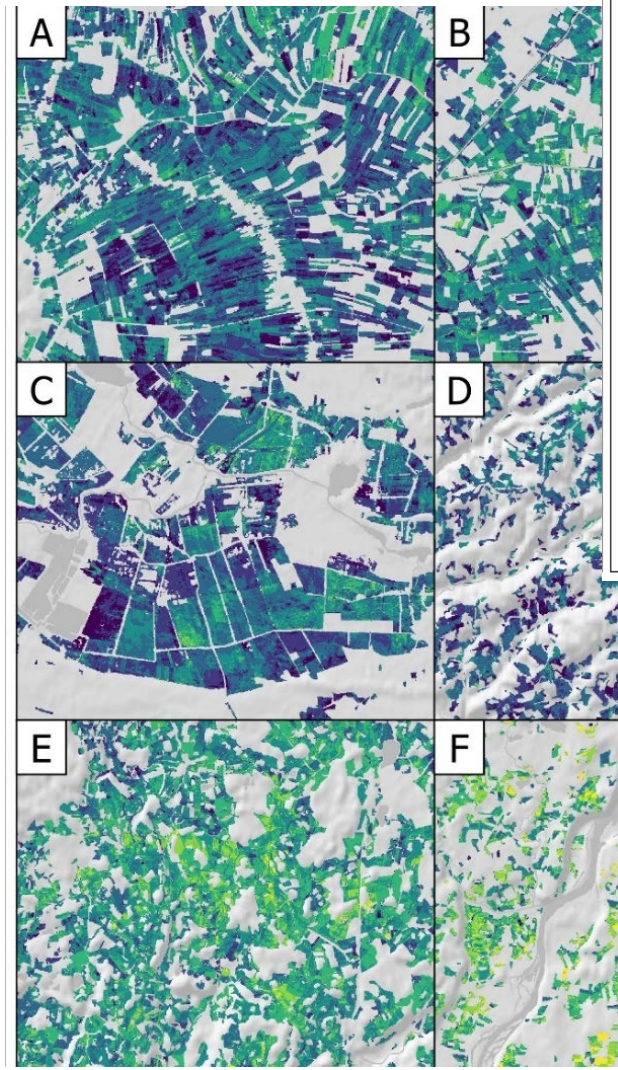
- Widespread drought impacts on grasslands in recent years
  (Buras et al. 2020, Reinermann et al. 2019)

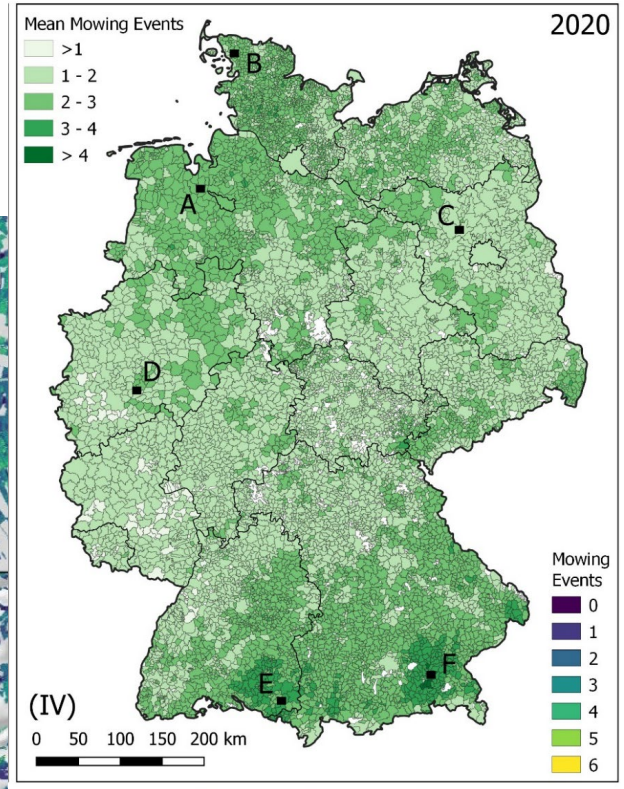


Denmark captured by Sentinel-2 (image by ESA)

Grassland monitoring using dense time series







Reinermann et al. 2019

Schwieder et al. (in review)

Grassland monitoring with fractional cover

- Fractional cover of
  - PV (green veg.)
  - NPV (dry, dead veg.)
  - soil

  as universal framework for grassland mapping and monitoring
  (e.g. Guerschman et al. 2009, Numata et al. 2007, Lewińska et al. 2020)

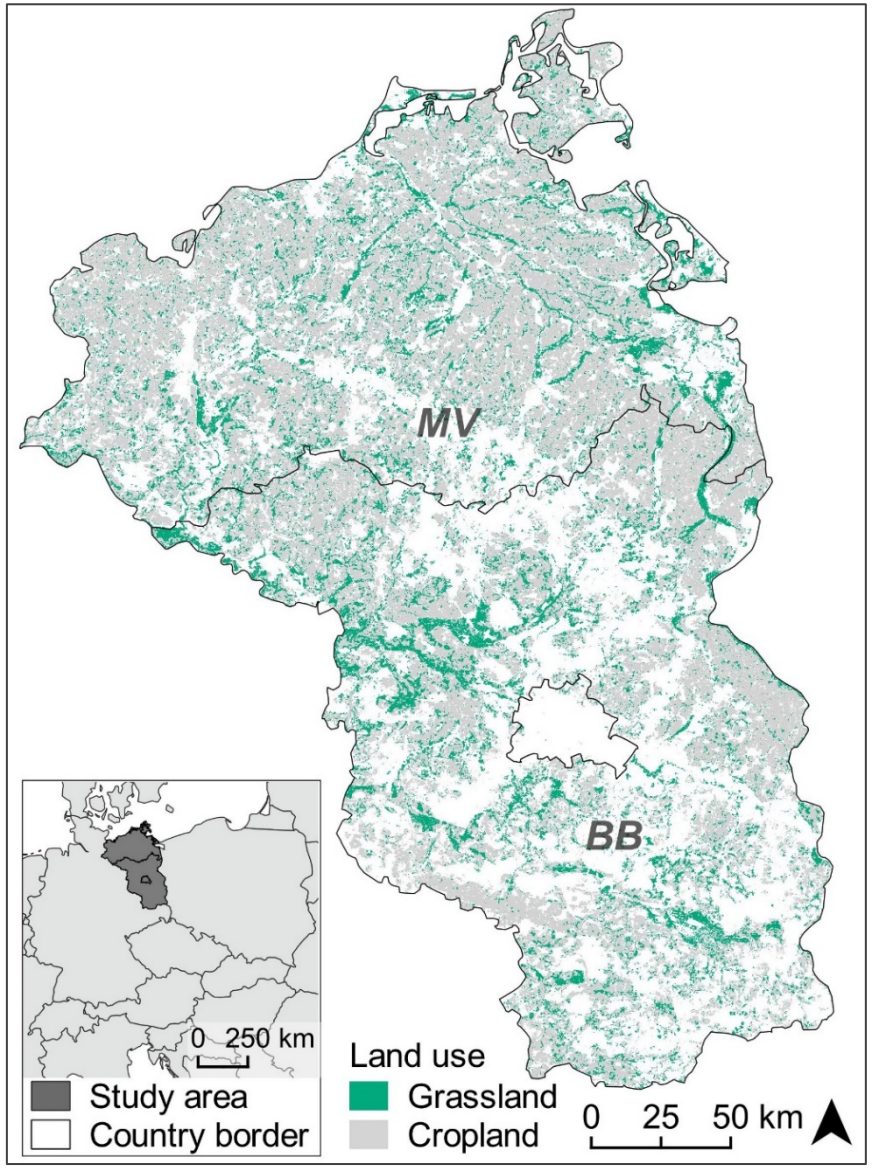
- Grassland monitoring benefits from NPV estimates during dry periods

- Combination with intra-annual time series

Research questions

I. How well do fractional cover time series reveal drought effects between years?

II. How did drought effects on grasslands vary spatially in 2018 and 2019?

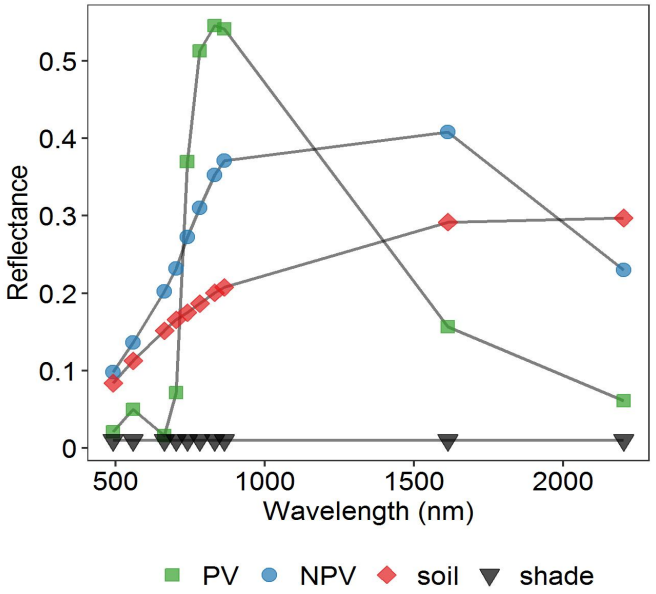


Methods – Estimating fractional cover

Sentinel-2 data 2017-2019

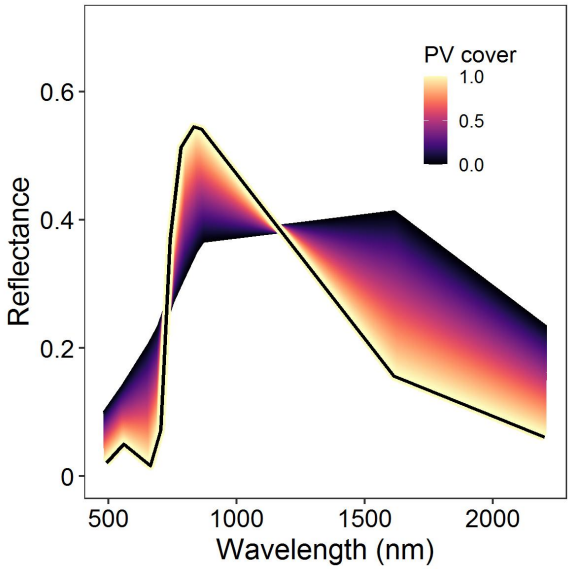
- Preprocessing: FORCE (Frantz 2019)

Spectral library

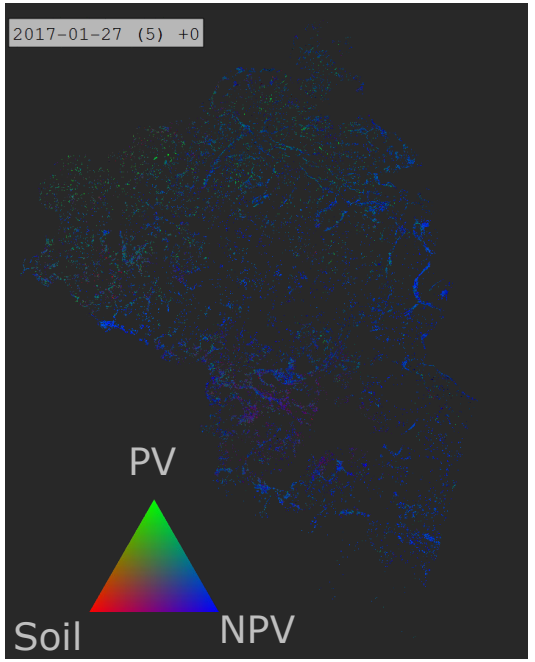


Training data

Linear synthetic mixtures (0-100%)



Fractional cover time series

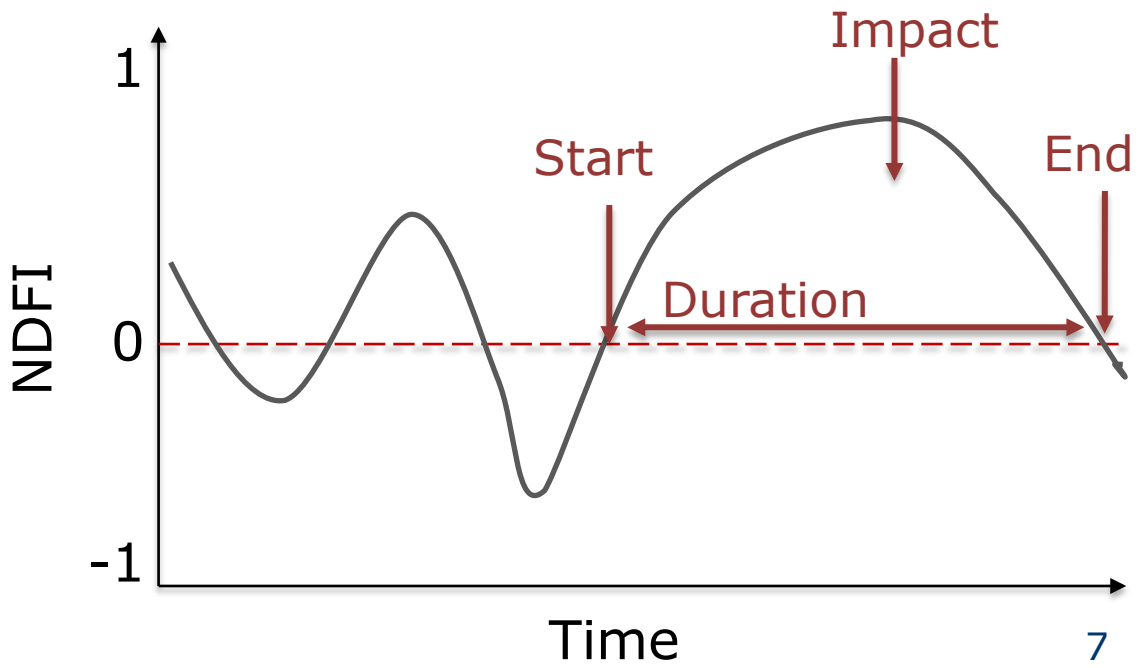


Methods – NDFI time series and metrics

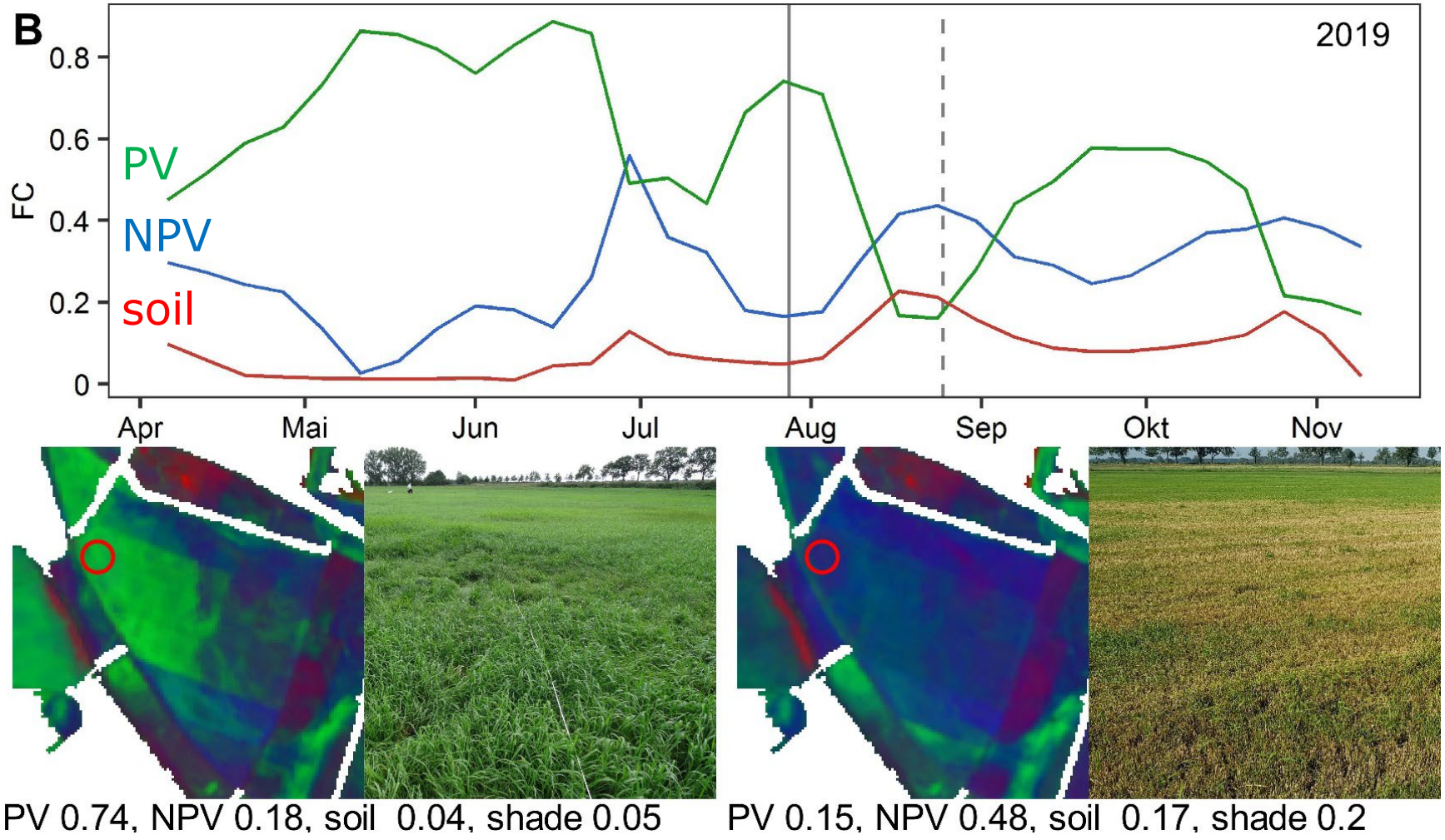
- Fractional cover index (Souza et al. 2005)

$$NDFI = \frac{((f_{NPV} - f_{i_{NPVbase}}) + f_{soil}) - f_{PV}}{(f_{NPV} - f_{i_{NPVbase}}) + f_{PV} + f_{soil}}$$

- Comparison to common drought indices (SPEI03, SMI)
- Time series metrics (Duration/Onset/Impact/End)
- Soil types based on BUEK200



Results – time series of PV, NPV, and soil



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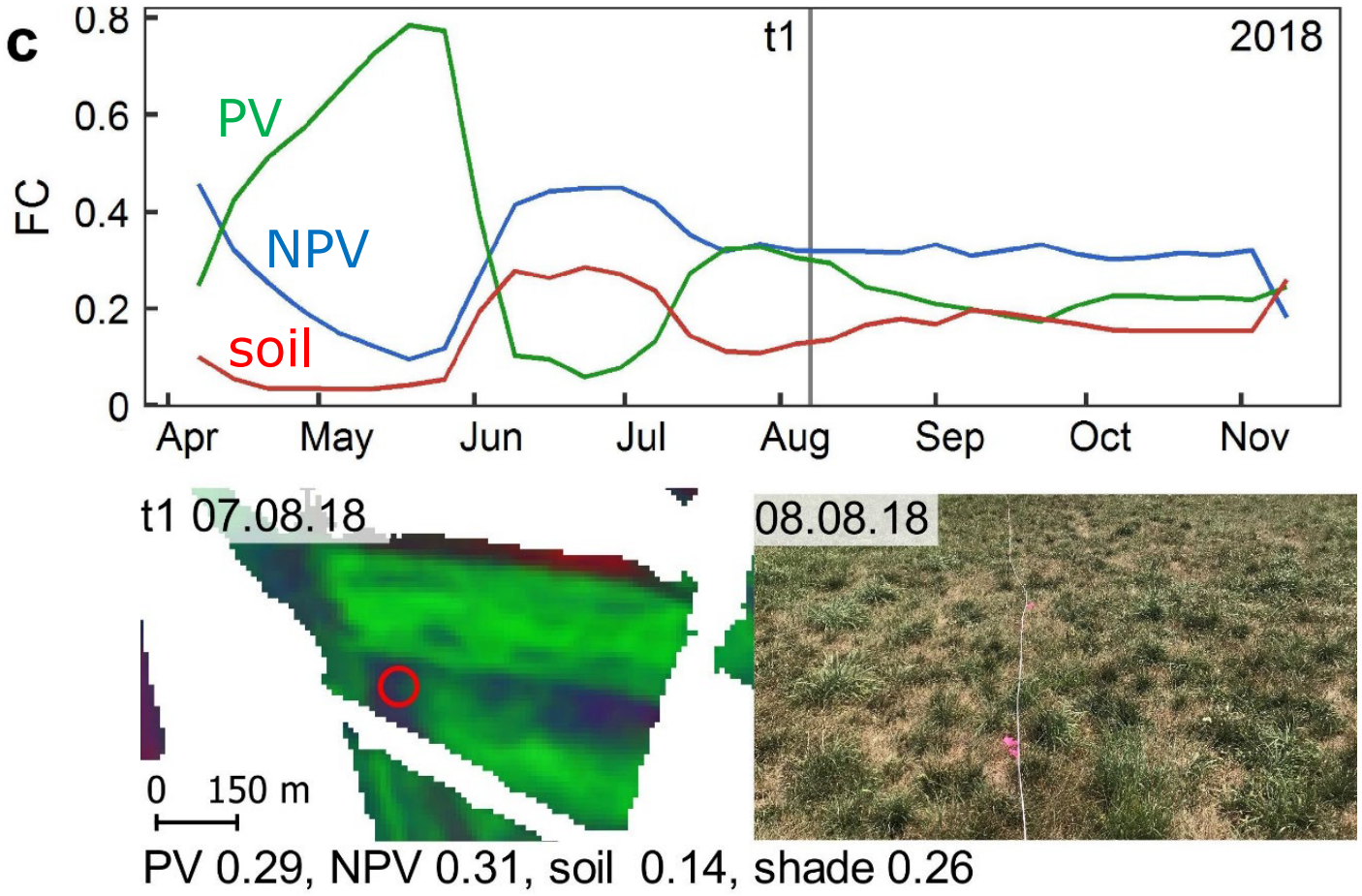
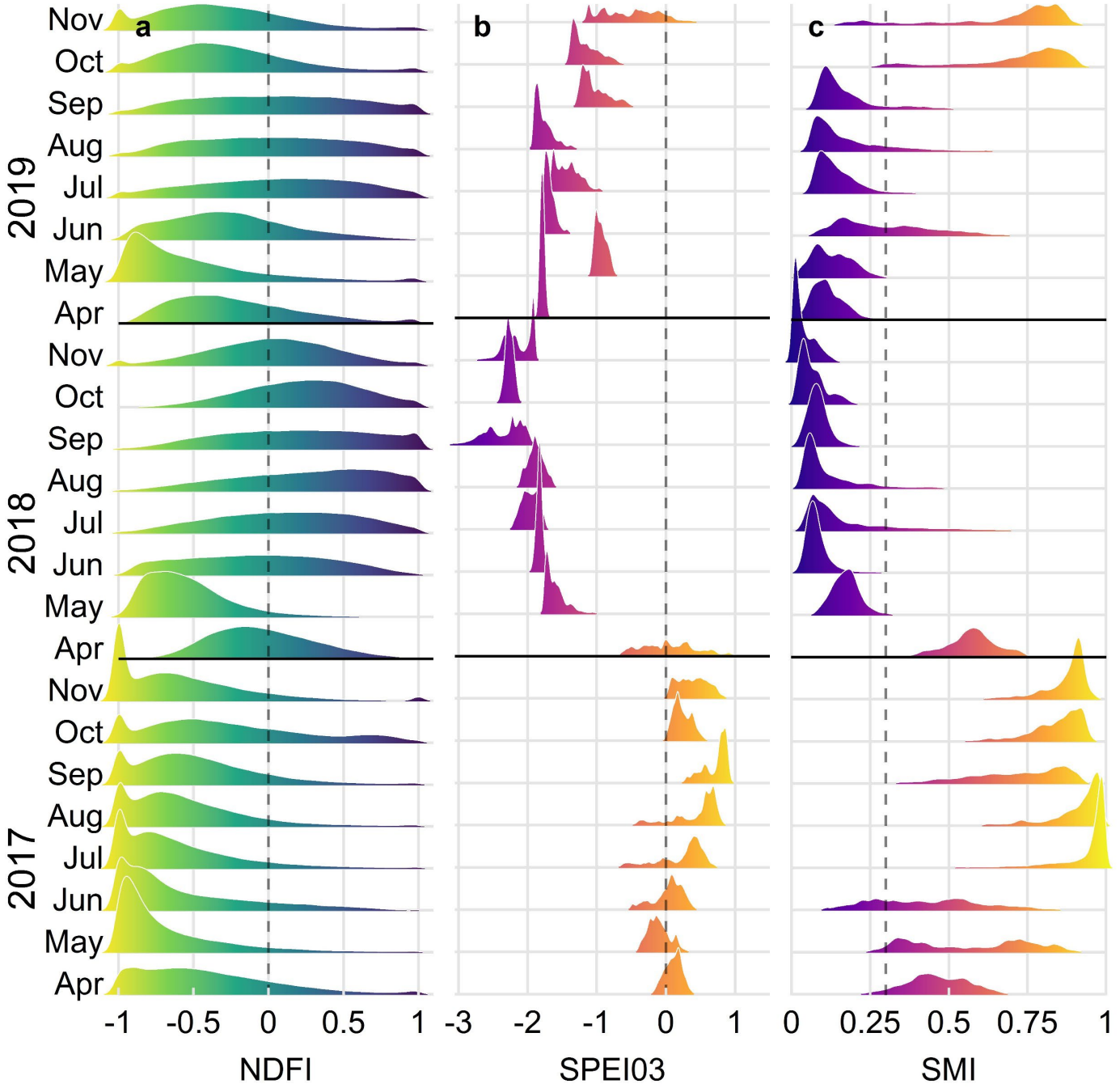
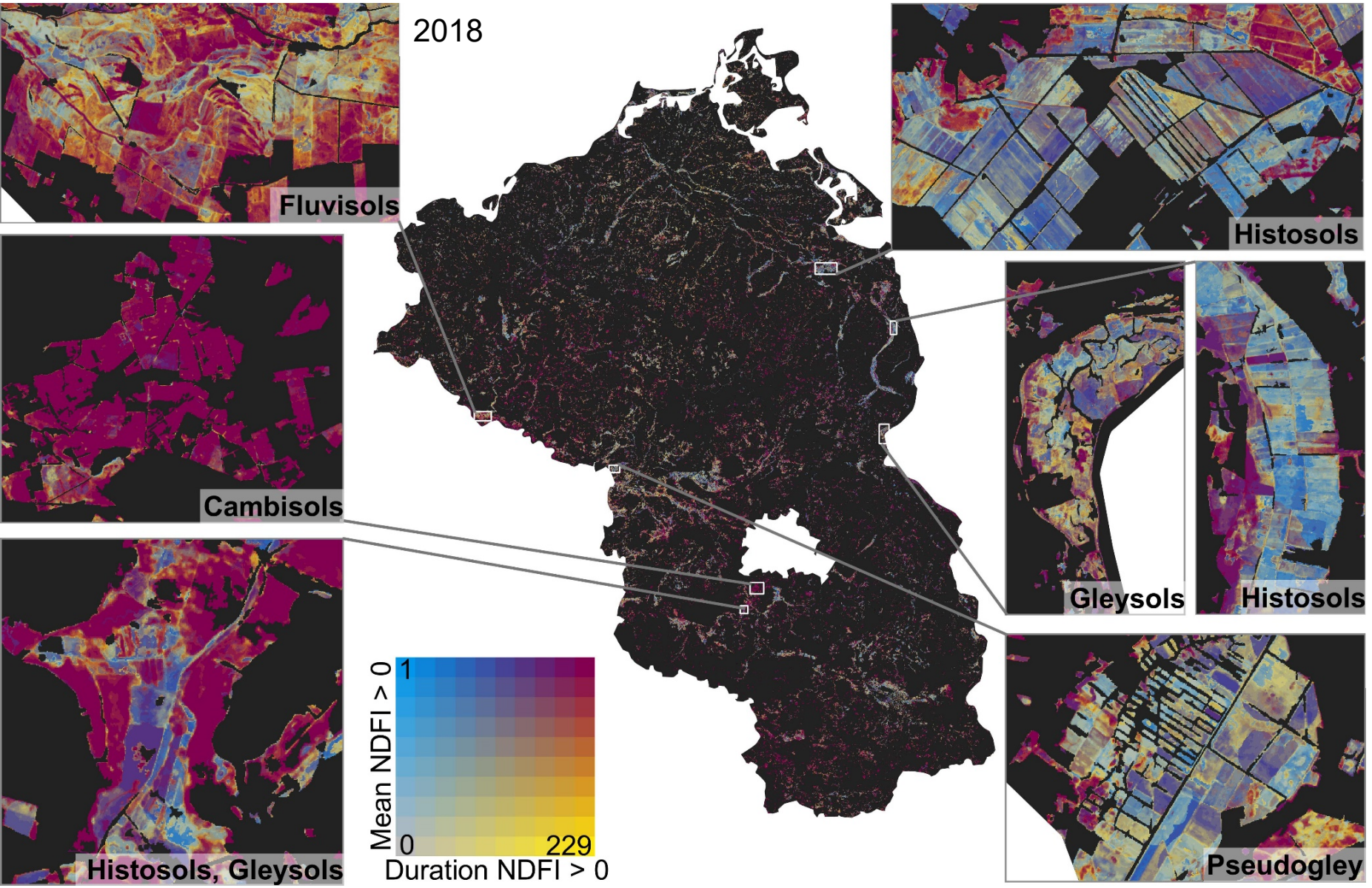


Results – seasonal drought effects

- Severe drought in 2018 and 2019 corroborated by all indices
- Grassland vegetation responds with time lag of 1-2 months
- Higher spatial variability of NDFI compared to meteorological indices



Results – drought impacts on different soil types



- Seasonal indicator for grassland response to drought stress
- Duration and intensity of drought impact varies locally
- Related to:
  soil type,
  ground water level,
  management

Conclusion

- NDFI time series tracked seasonal drought effects in line with meteorological drought indices
- S-2 mandatory to capture drought effects related to local management and soil types
- Severe drought impacts on least productive soil types indicate need for adaptation under changing climate

Thank you for your attention!