

Webinar on "Remote sensing of forest disturbances" - 11.5.2022

Large-scale early-wilting response of Central European forests to the 2018 extreme drought

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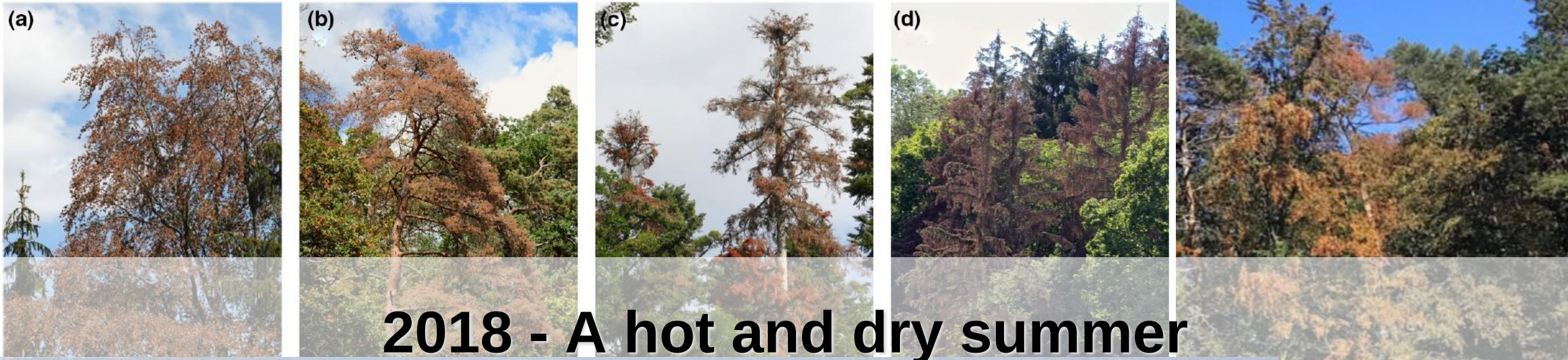


2018 - A hot and dry summer

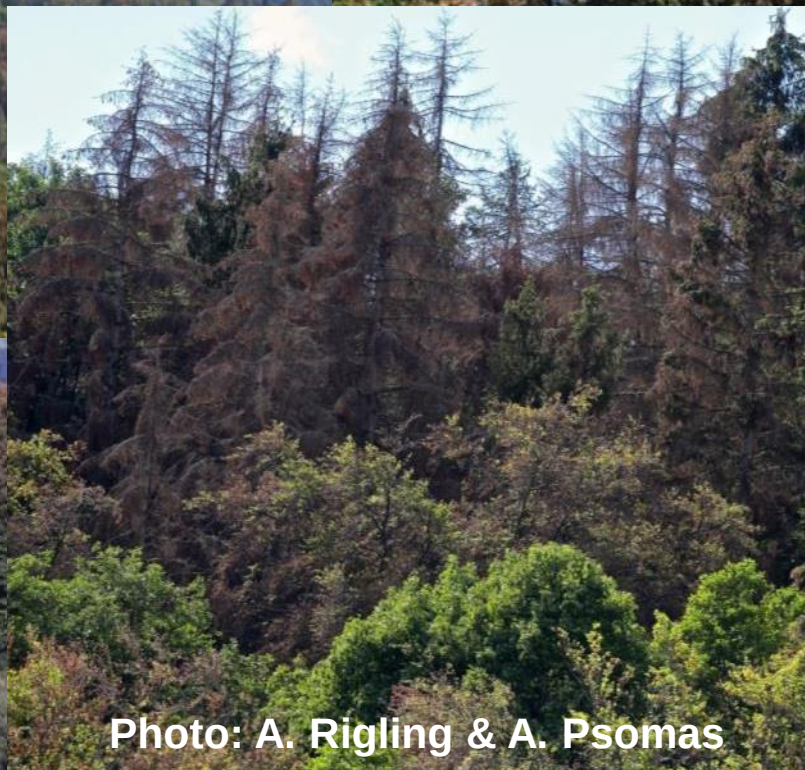
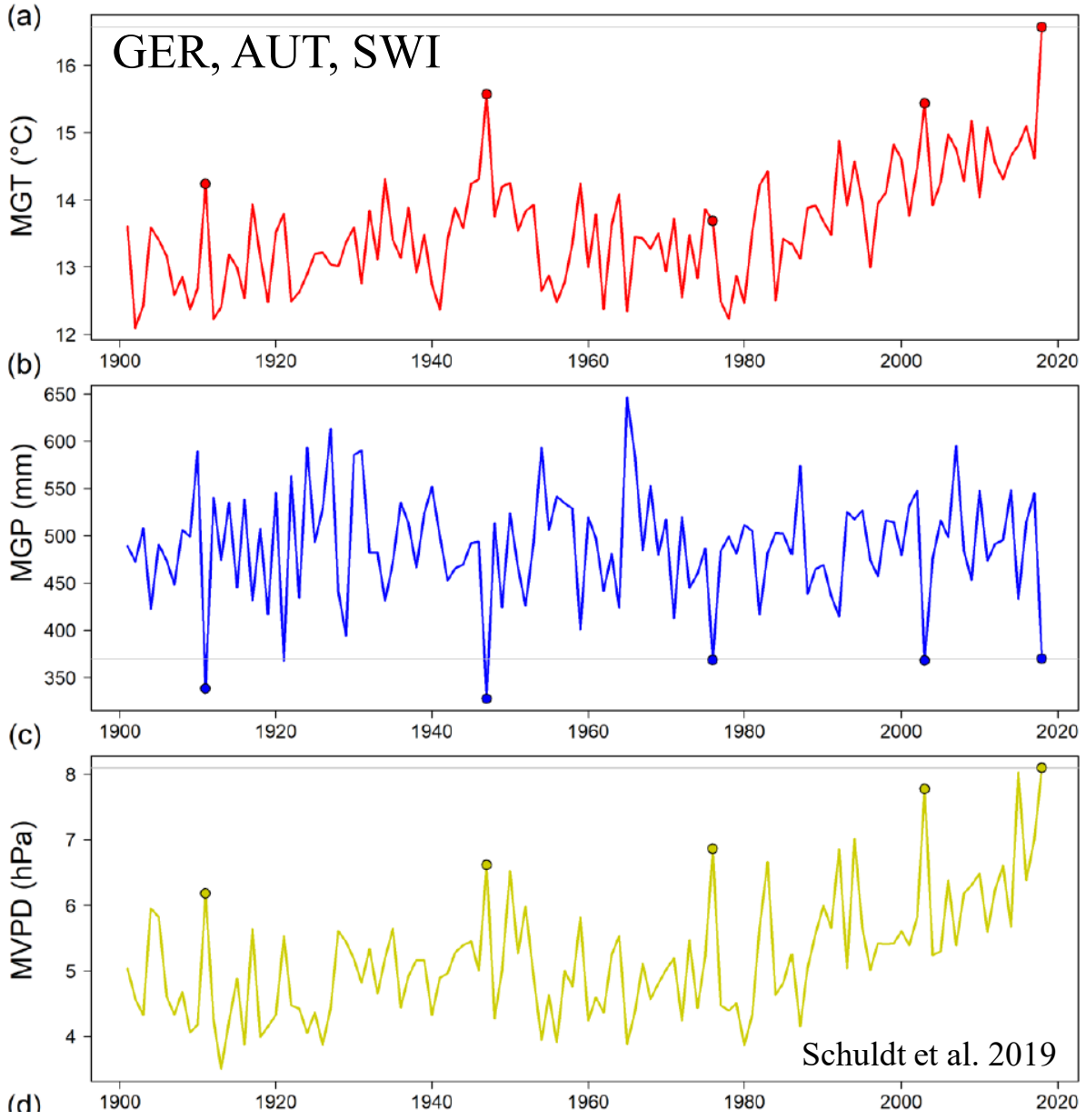
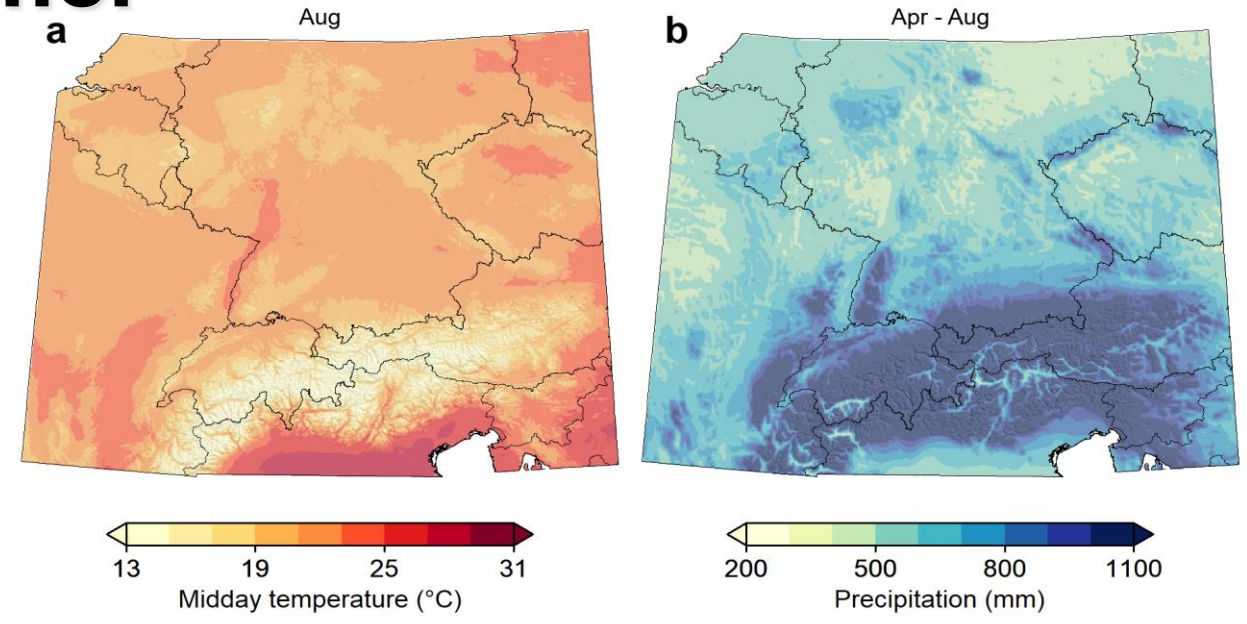
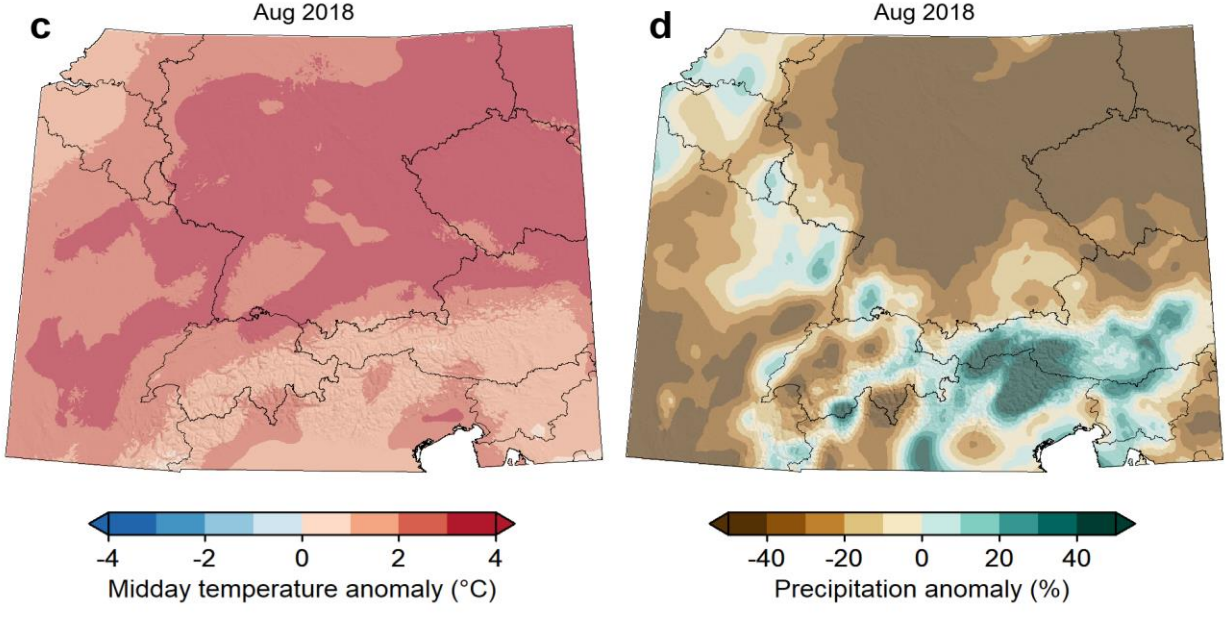


Photo: A. Rigling & A. Psomas

2018 - A hot and dry summer



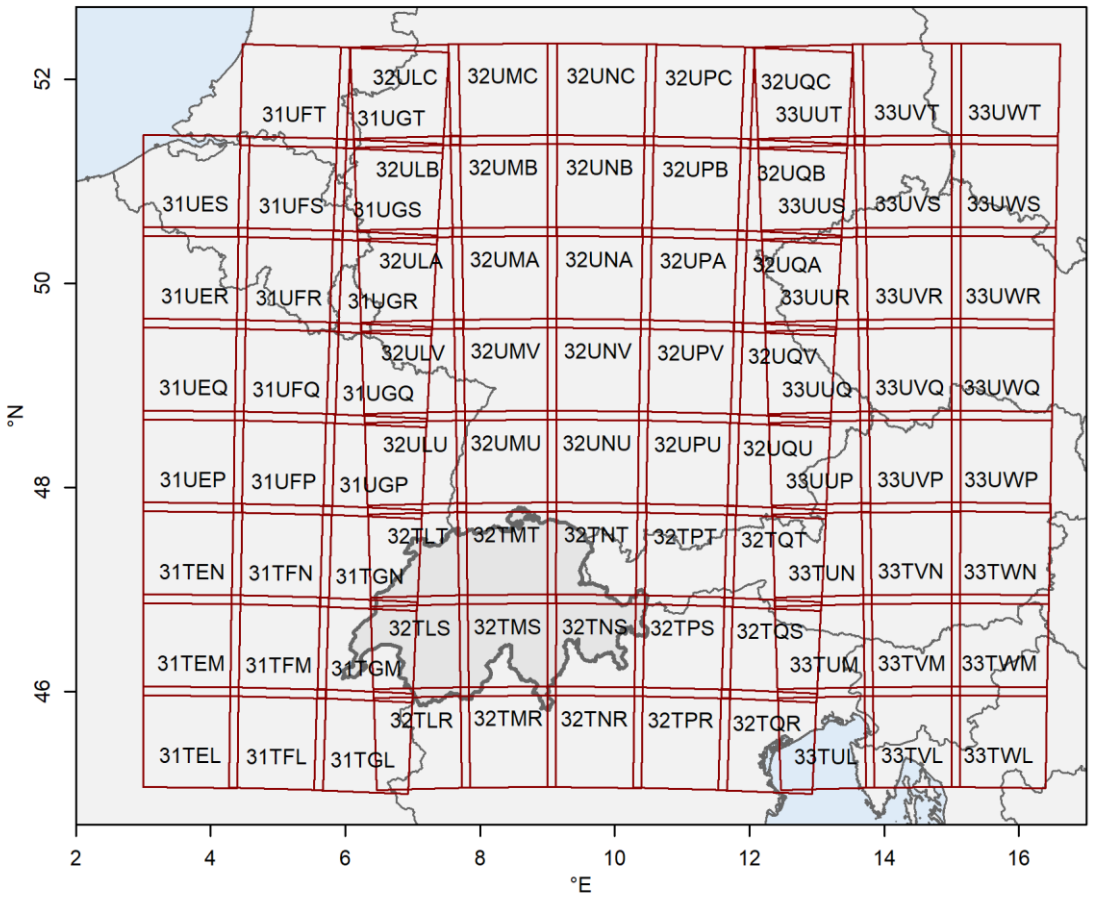




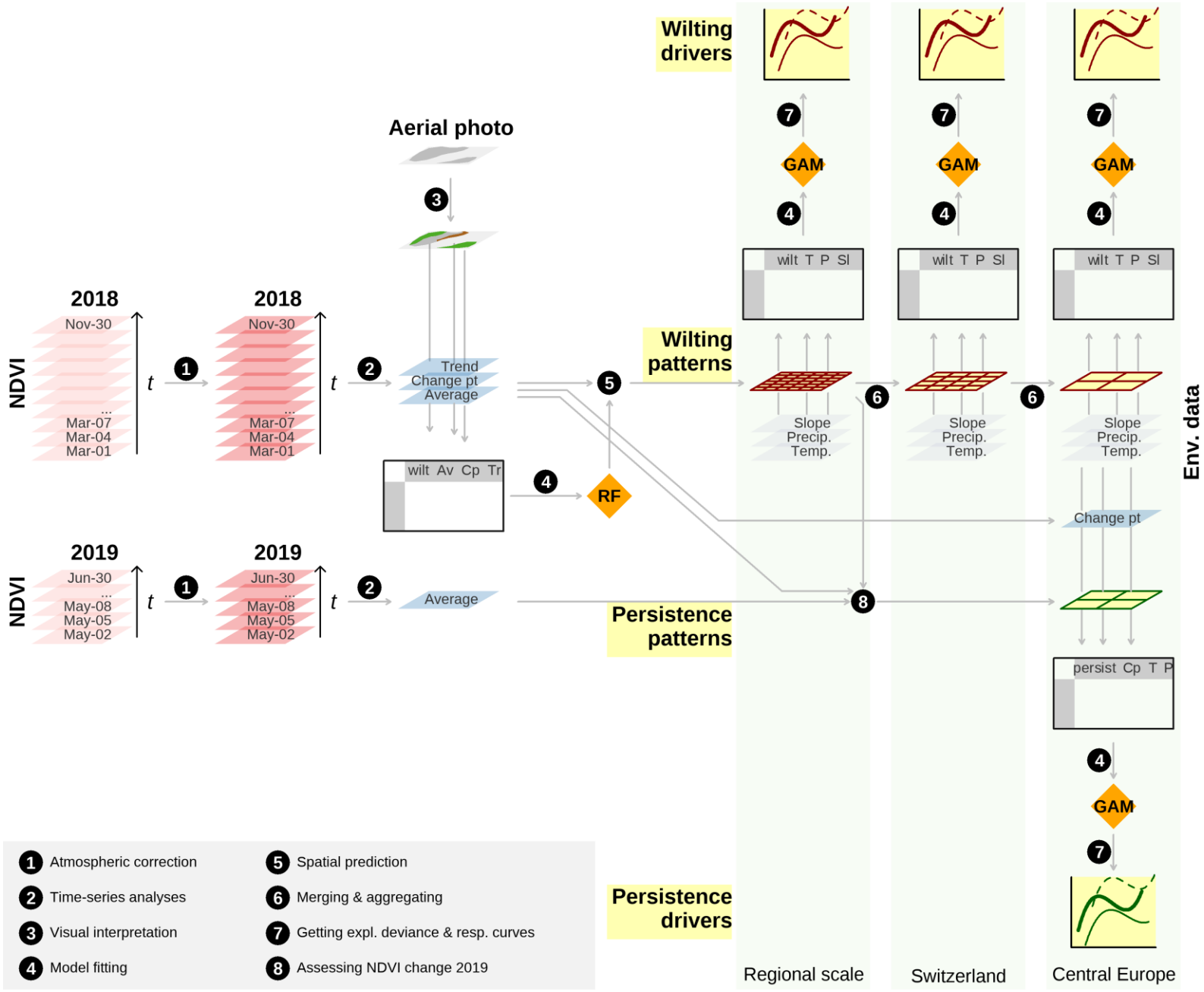
Research questions

RQ1 What were the *spatial* and *temporal* **patterns** of early wilting across Central Europe?

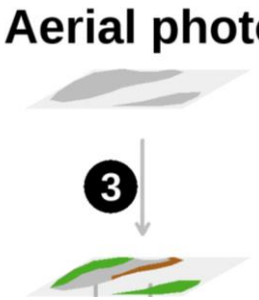
Study area



Approach


Aerial photo
2018
Nov-30
...
Mar-07
Mar-04
Mar-01
NDVI
t
2019
Jun-30
...
May-08
May-05
May-02
Trend
Change pt
Average
wilt Av Cp Tr
RF
Wilting drivers
Wilting patterns
Persistence patterns
Persistence drivers
GAM
wilt T P Sl
Slope
Precip.
Temp.
Change pt
persist Cp T P
Env. data
Regional scale
Switzerland
Central Europe
1 Atmospheric correction
2 Time-series analyses
3 Visual interpretation
4 Model fitting
5 Spatial prediction
6 Merging & aggregating
7 Getting expl. deviance & resp. curves
8 Assessing NDVI change 2019

Response data – Visually classified patches



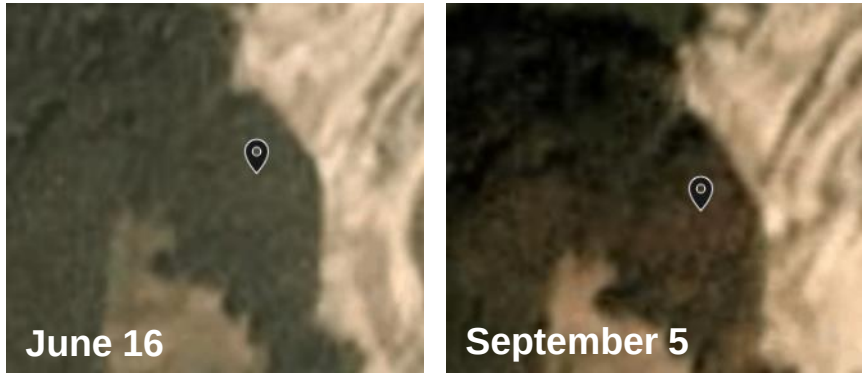
planet

- 3-5 m resolution
- Daily images
- RGB and NIR bands
- Heterogeneous sensor quality

Google Earth

- High resolution areal images
- Few images from late August (Northern CH, southern Germany)

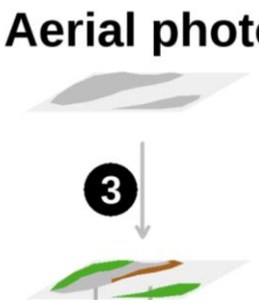
Planet observations Oberriet SG

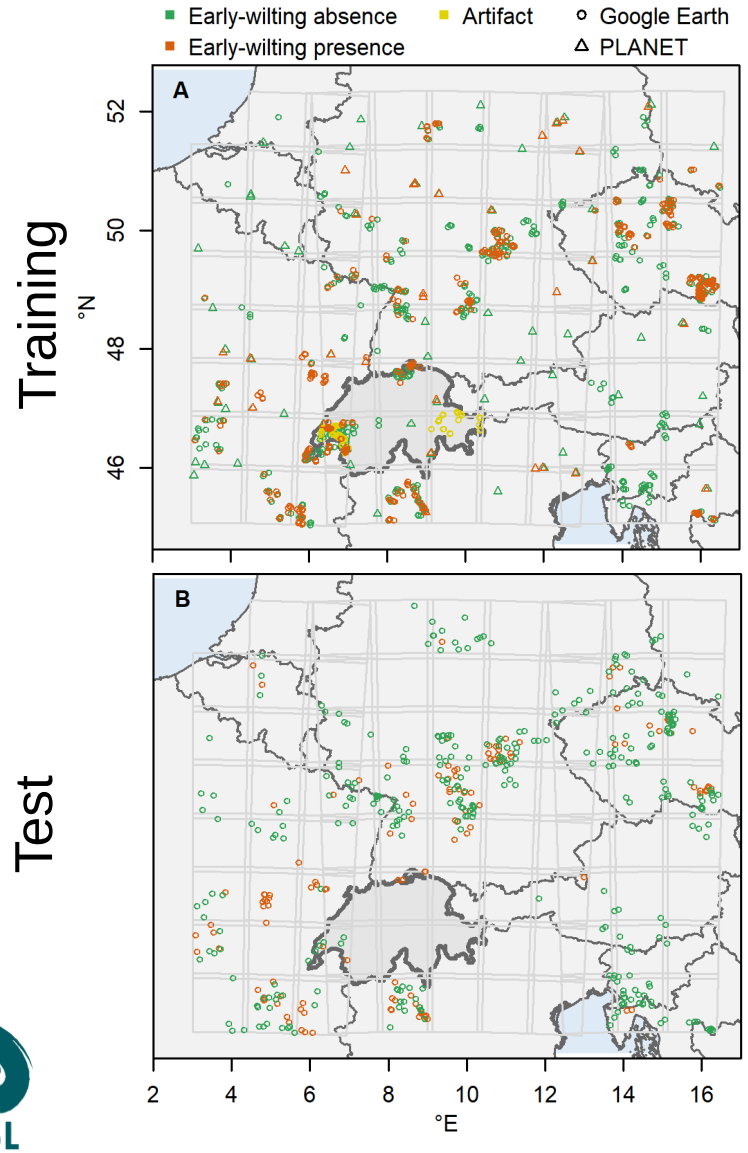


Google Earth observations Küssaberg (GER)

WSL

Response data – Visually classified patches

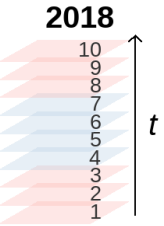


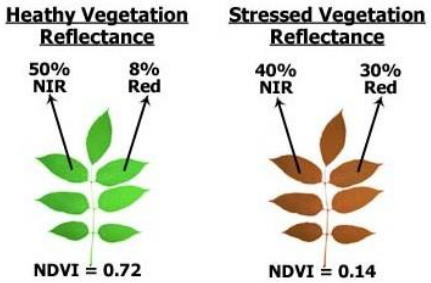


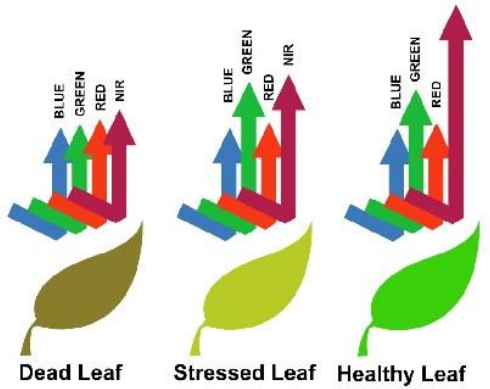
	Origin	Class	Polygons (#)	Pixels (#)
Training	Opportunistic (Google Earth)	Presence	401	13’276
		Absence	407	176’129
		Artifact	74	3560
	Spatially stratified (GE & Planet)	Presence	54	9418
		Absence	86	101’904
Test	Spatially stratified (Google Earth), 3 ppl	Presence	0	209
		Absence	0	501

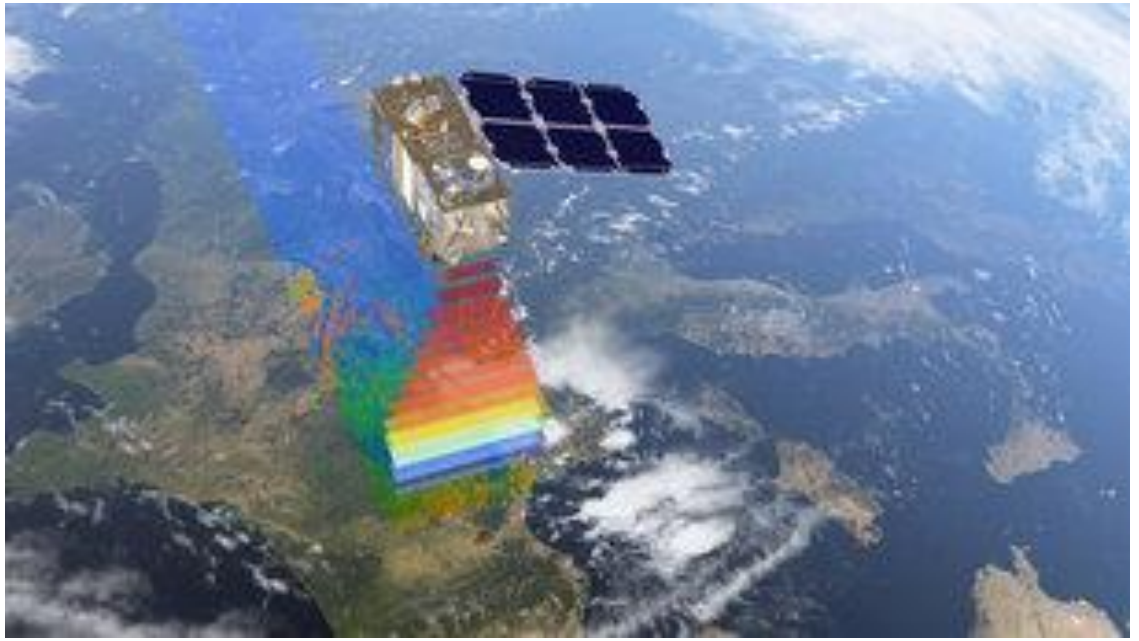
Predictor data – Time-series summaries of Sentinel-2 NDVI data

- Raw data: 10 × 10m spatial resolution every 3-5 days
- May-September (overall trend analysis & change point analysis with two linear trends)
  - Time of change point
  - Magnitude of change
  - Overall mean
  - Overall trend
  - Significance overall trend
  - Mean absolute error
- Spring/Fall (basic statistics)
  - Minimum March-April 2018
  - Maximum March-April 2018
  - Minimum October-November 2018
  - Maximum October-November 2018

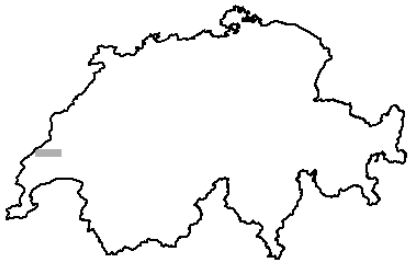


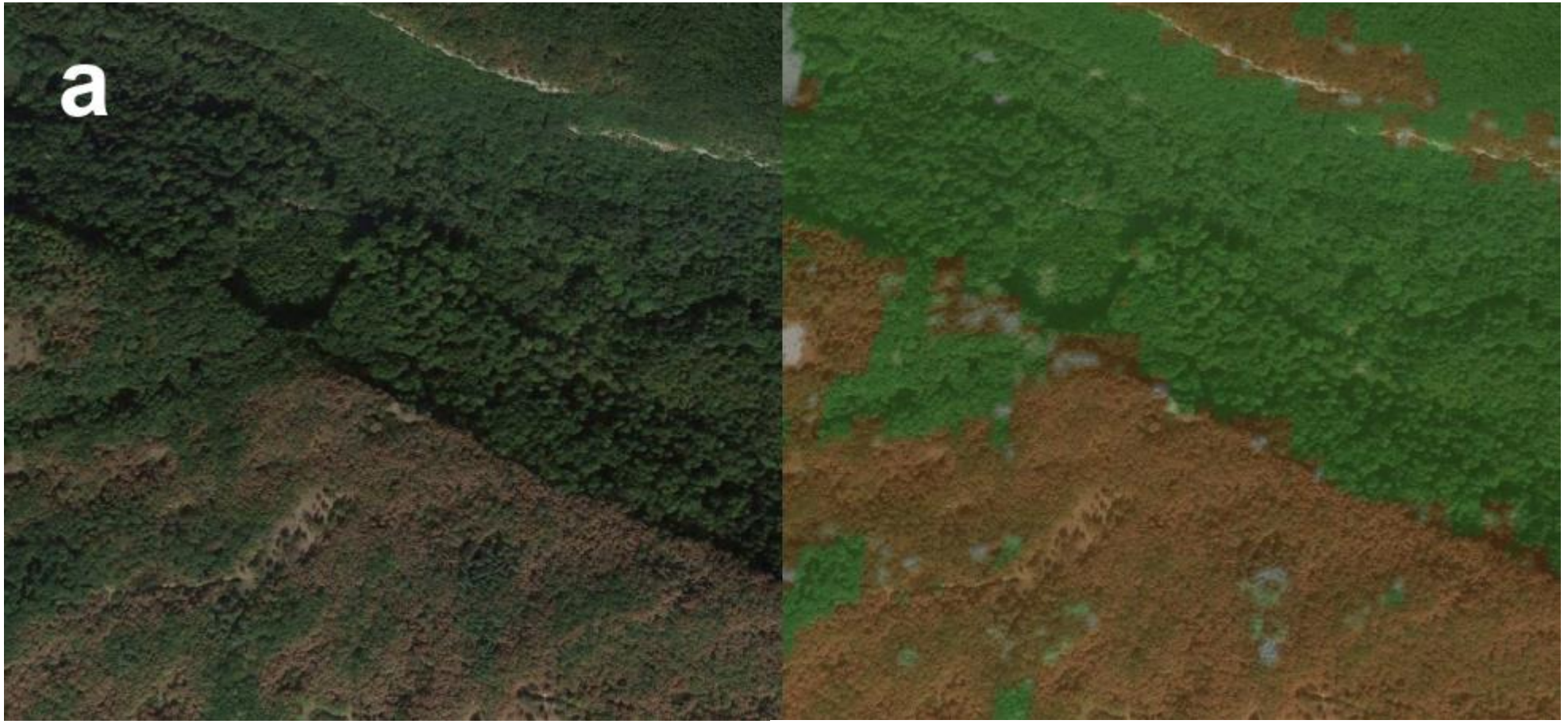




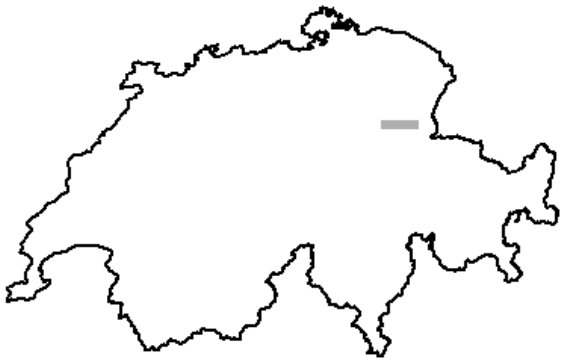


RQ1 Local patterns- La Sarraz





RQ1 Regional patterns - Walensee



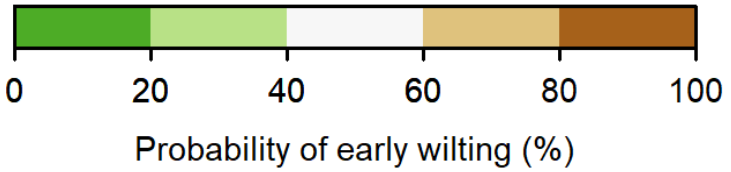
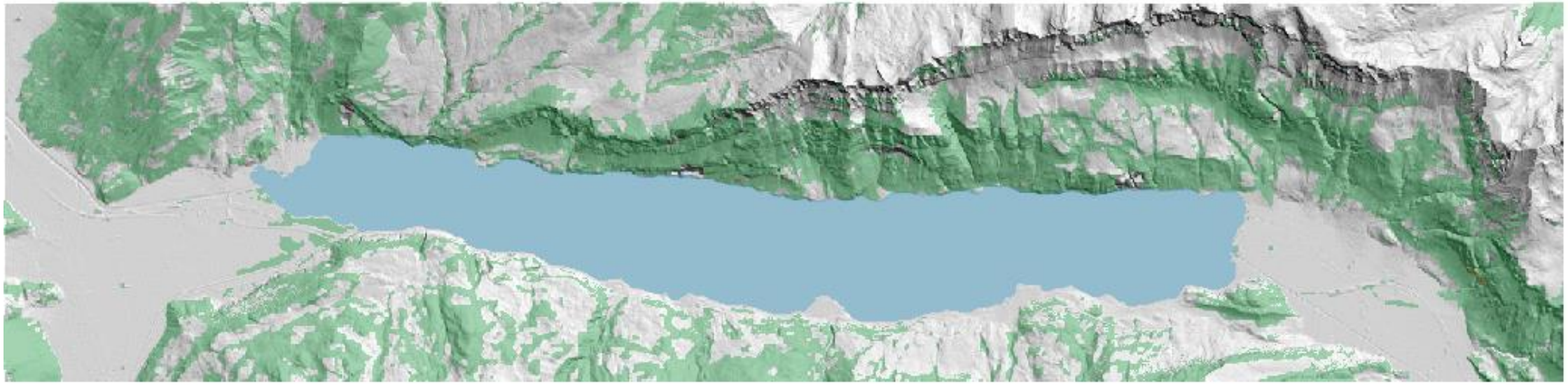
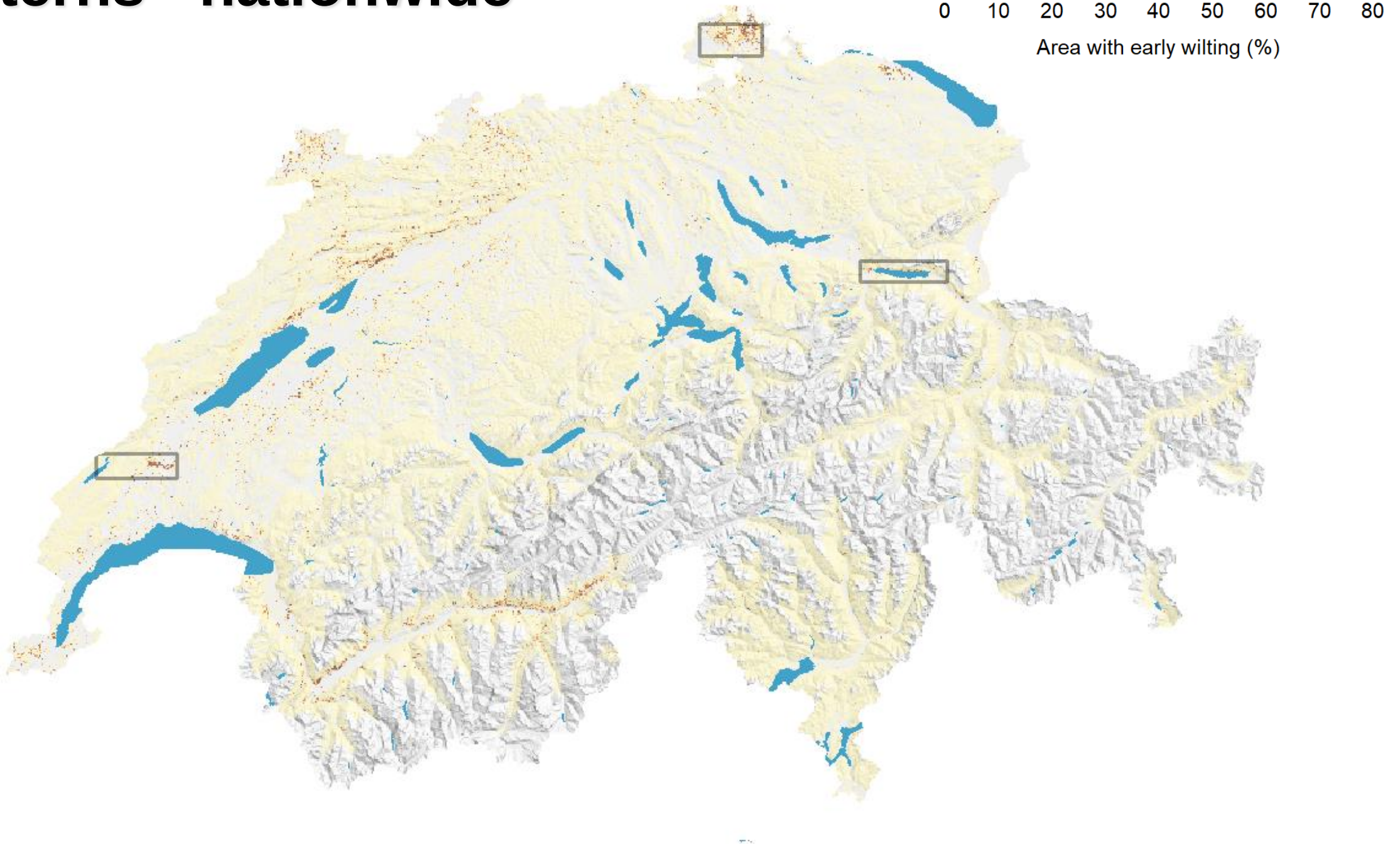


Photo: A. Rigling, 16.8.18

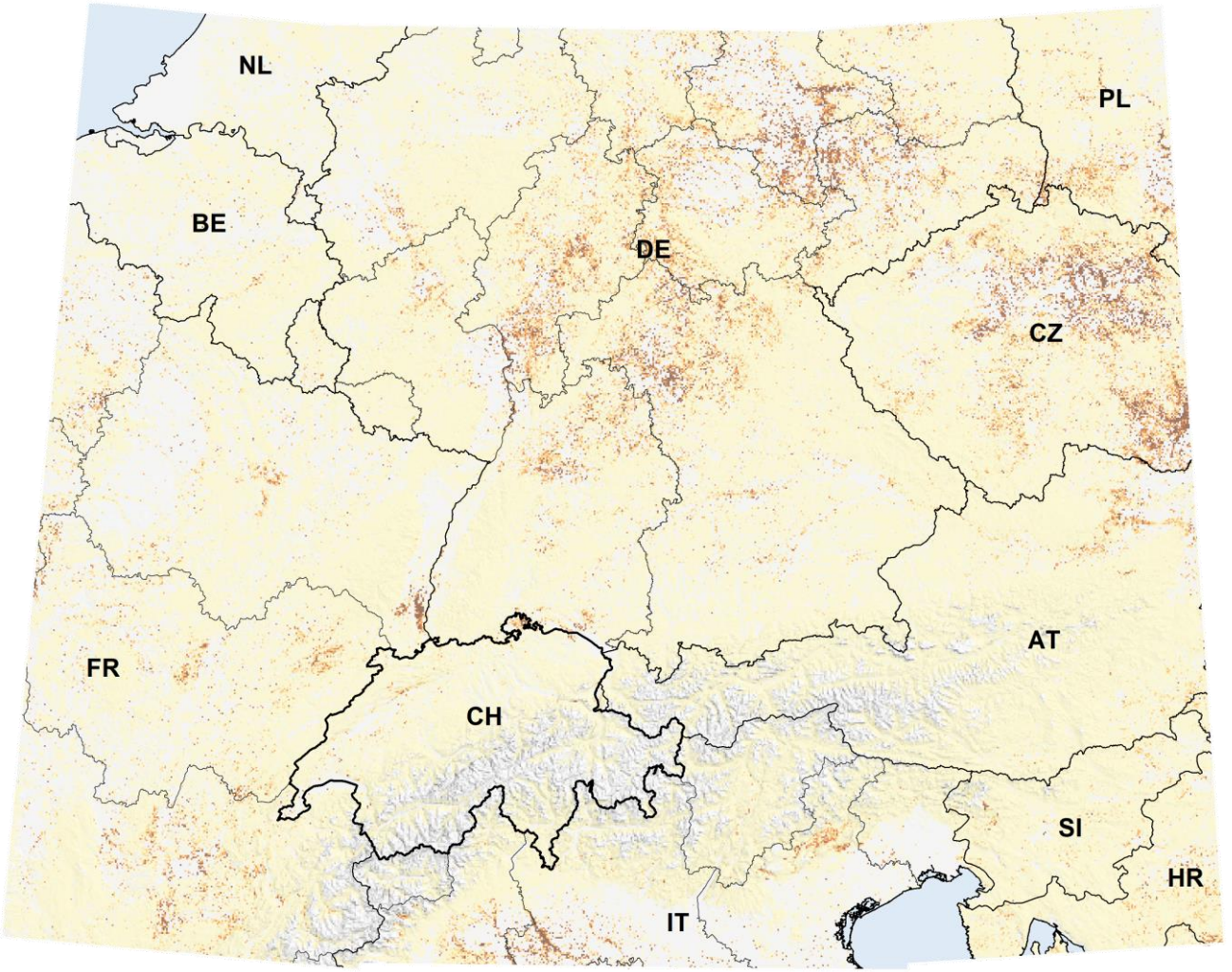
2018-06-14

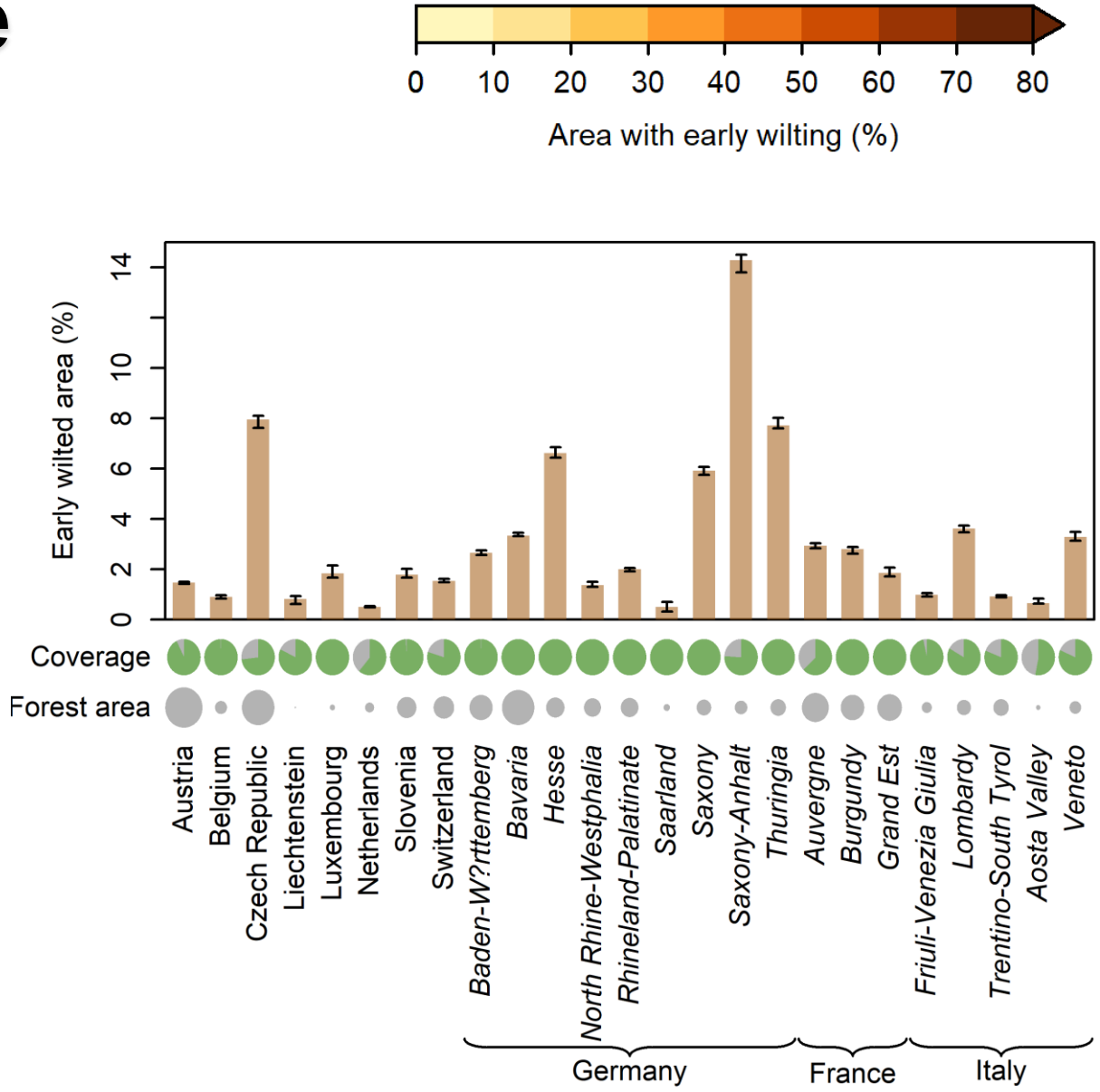


RQ1 Patterns - nationwide



RQ1 Patterns – Central Europe

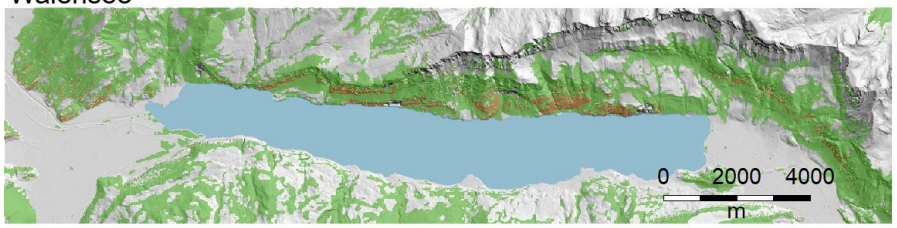




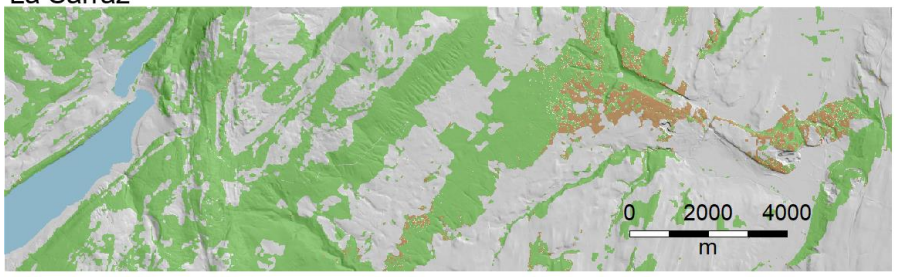
- **21’500 ± 2’800 km² affected**
- **11% of forests**

RQ2 Drivers – multivariate explanatory power

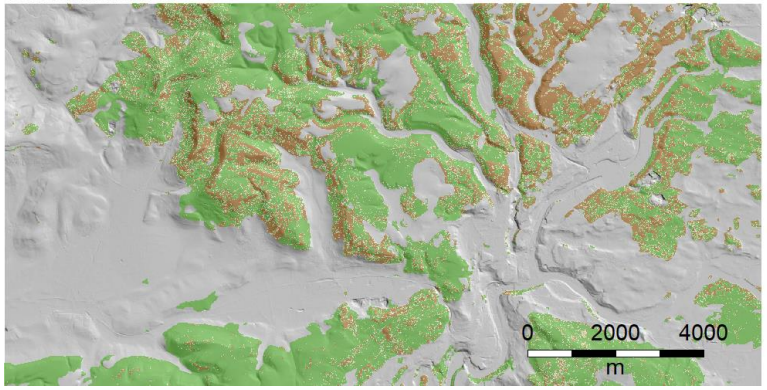
Walensee



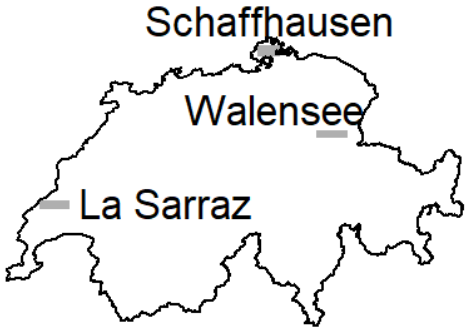
La Sarraz

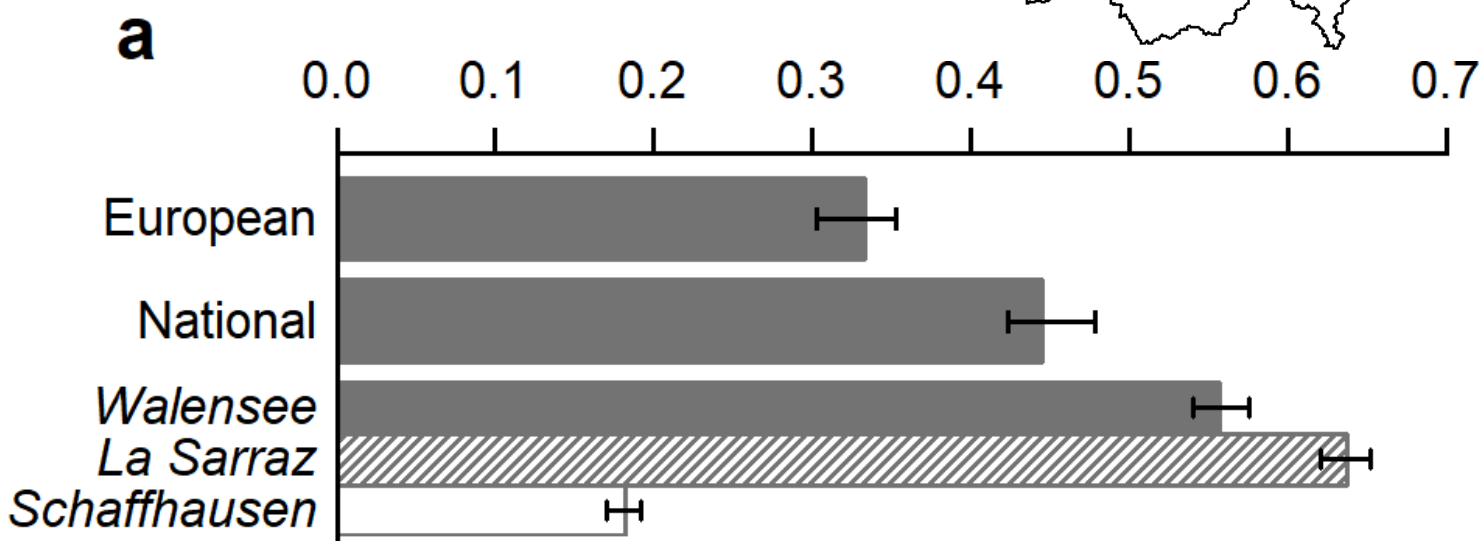


Schaffhausen

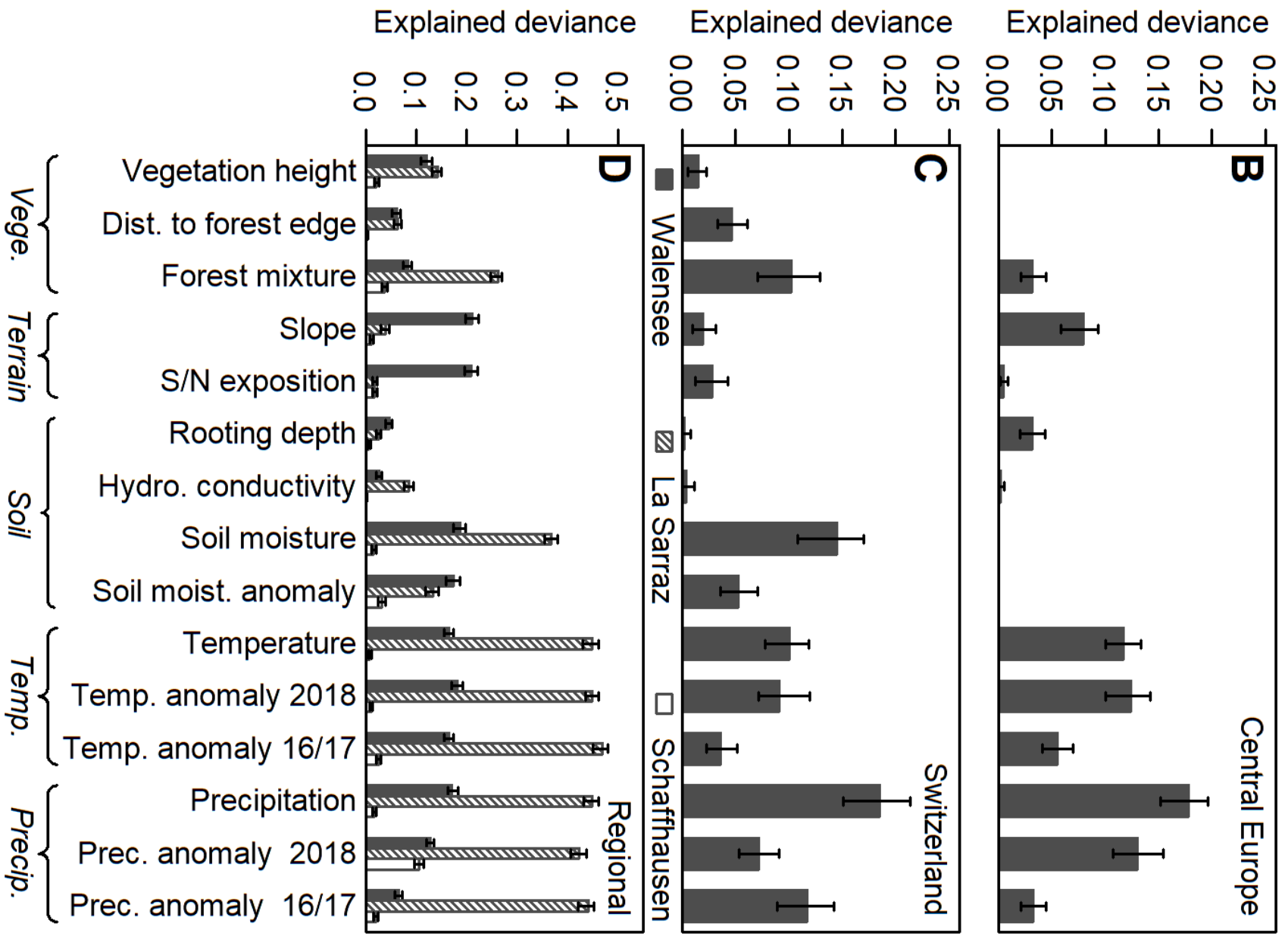


- GAMs, degrees of freedom of smooth terms ≤5
- 15 predictors (vegetation, terrain, soil, climate)
- Stratified subsampling
- 10’000 points × 100 replicates



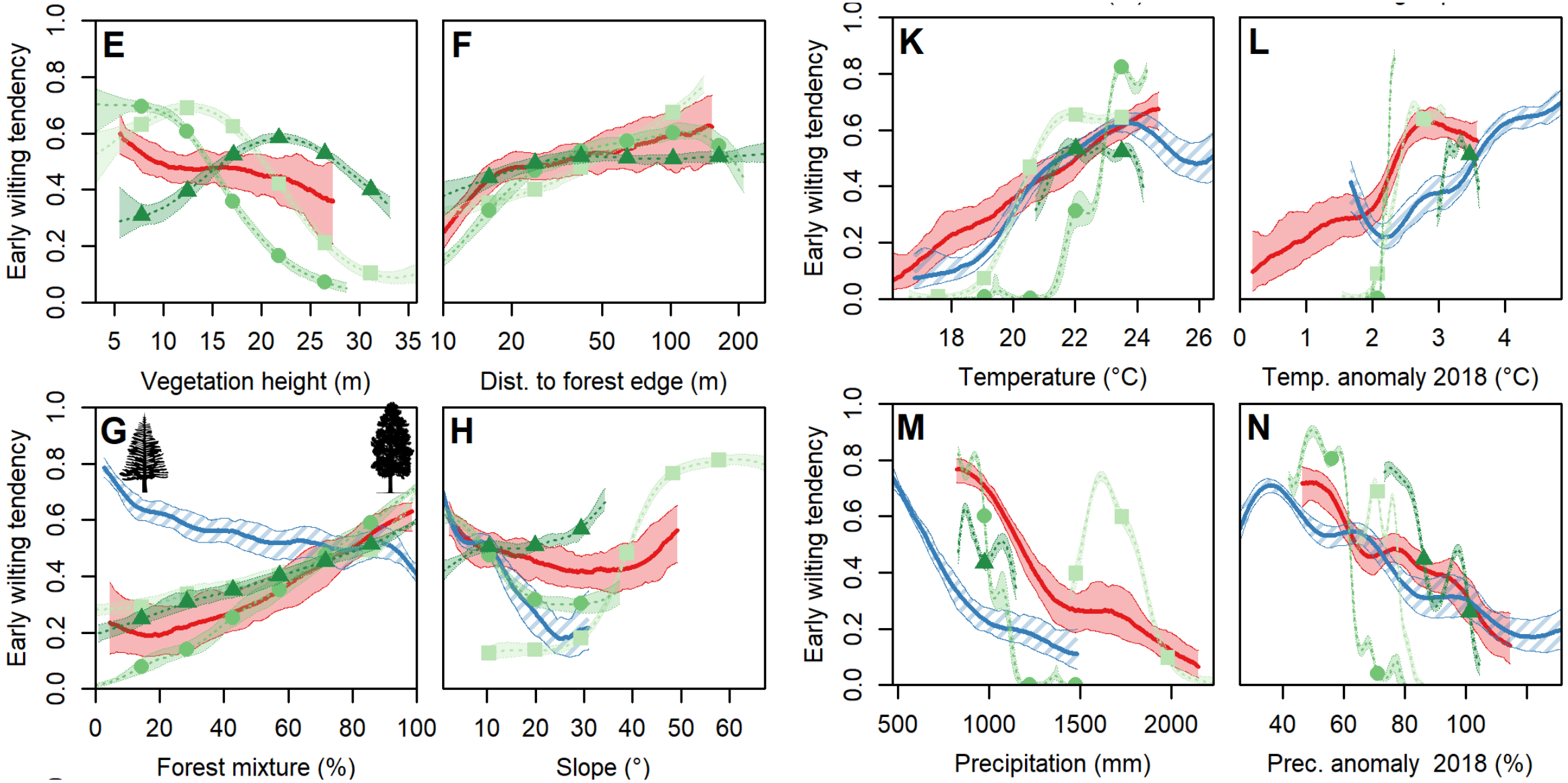


RQ2 Drivers – univariate explanatory power

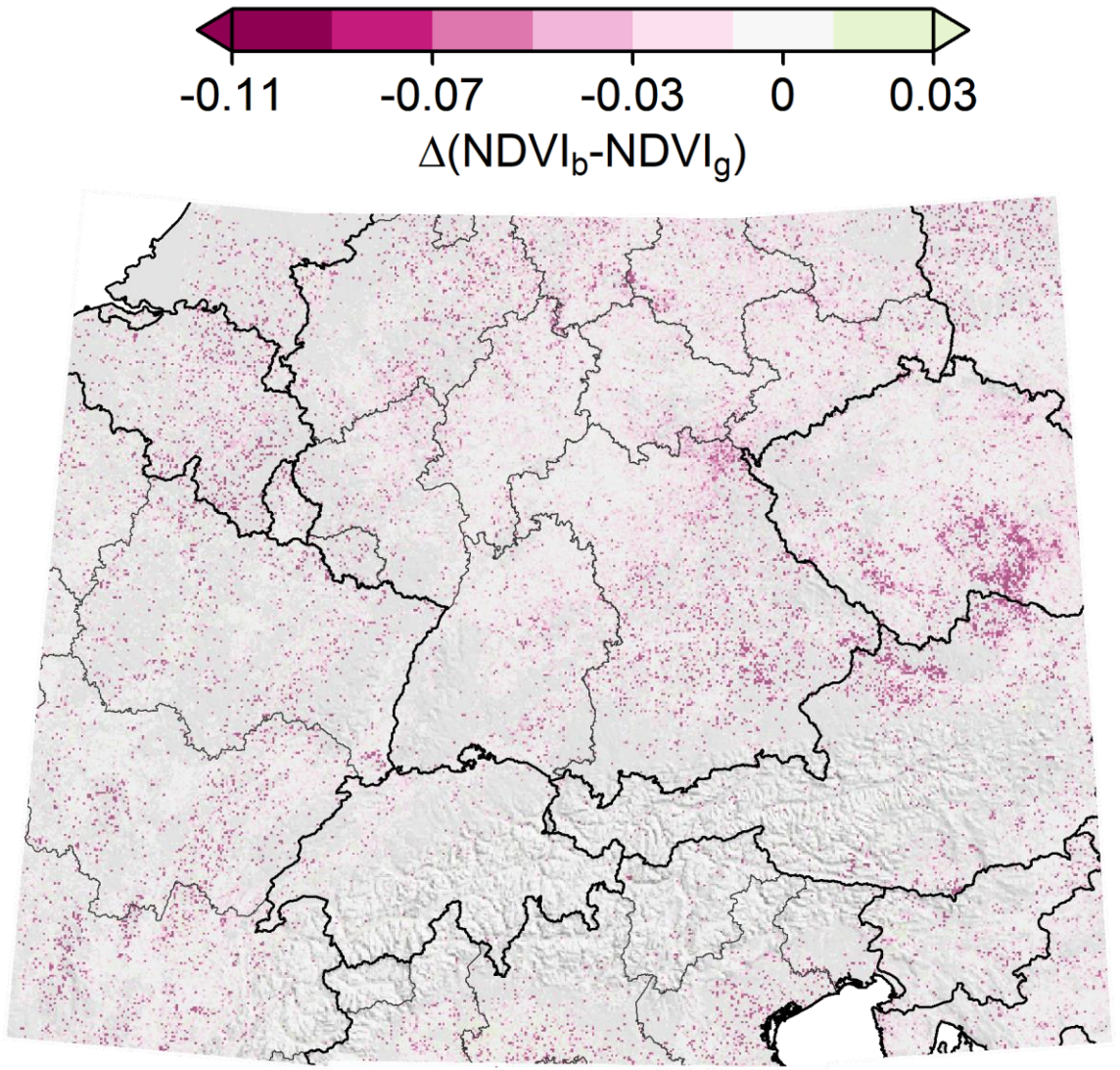


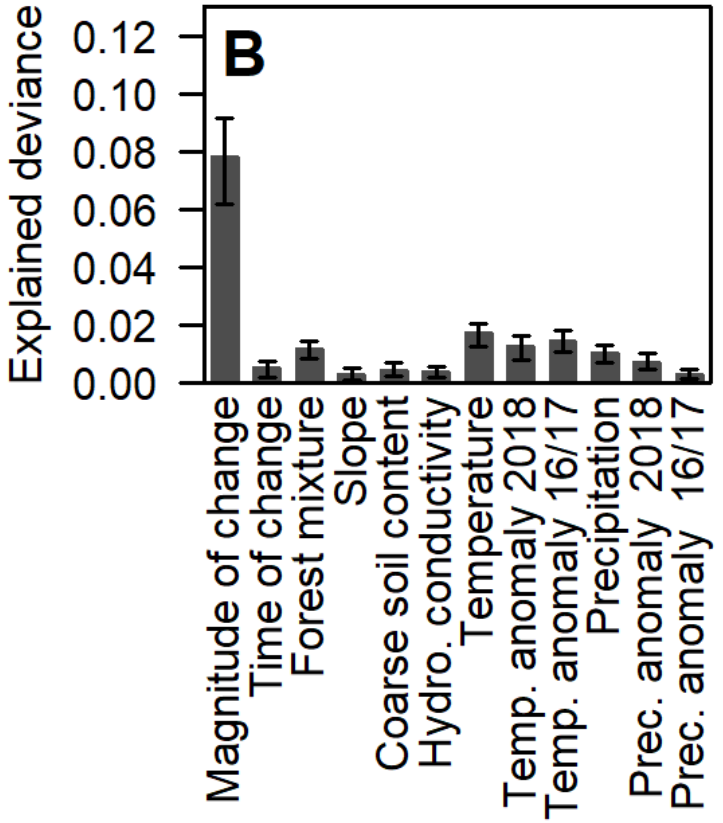
RQ2

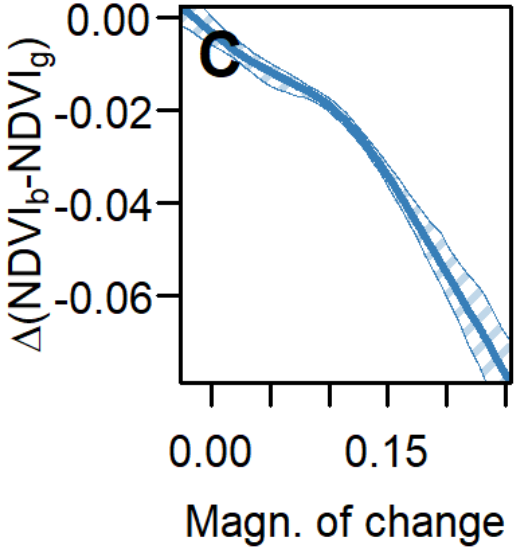
Drivers – response curves



RQ3 Persistence







Conclusions

- ☞ 11% of Central European forests responded with early wilting to the 2018 drought
- ☞ Central and Eastern Germany, and the Czech Republic were affected most heavily
- ☞ Large-scale patterns were best explained by high temperatures and low precipitation in August and their anomalies
- ☞ Important local risk factors were small- to medium-sized trees, steep slopes, and shallow soils
- ☞ Forest patches affected by early wilting showed distinctly reduced greenness in spring 2019