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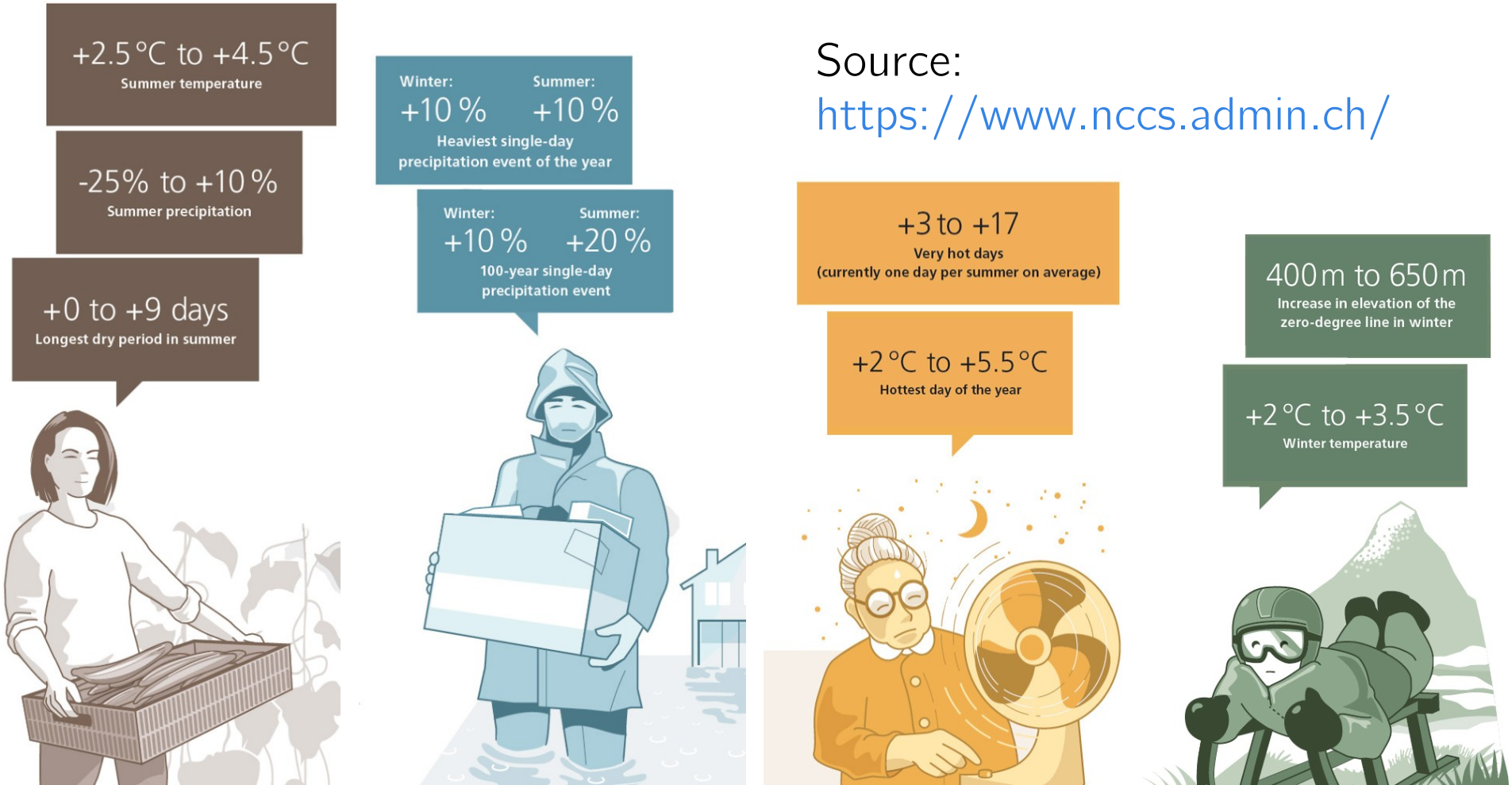
Federal Department of Economic Affairs,
Education and Research EAER
Agroscope

Integrating Sentinel-2 information into a growth model for assessing Alpine grassland dynamics under climate change

Kevin Kramer, Fabio Oriani, Manuel Schneider, Helge Aasen, Pierluigi Calanca

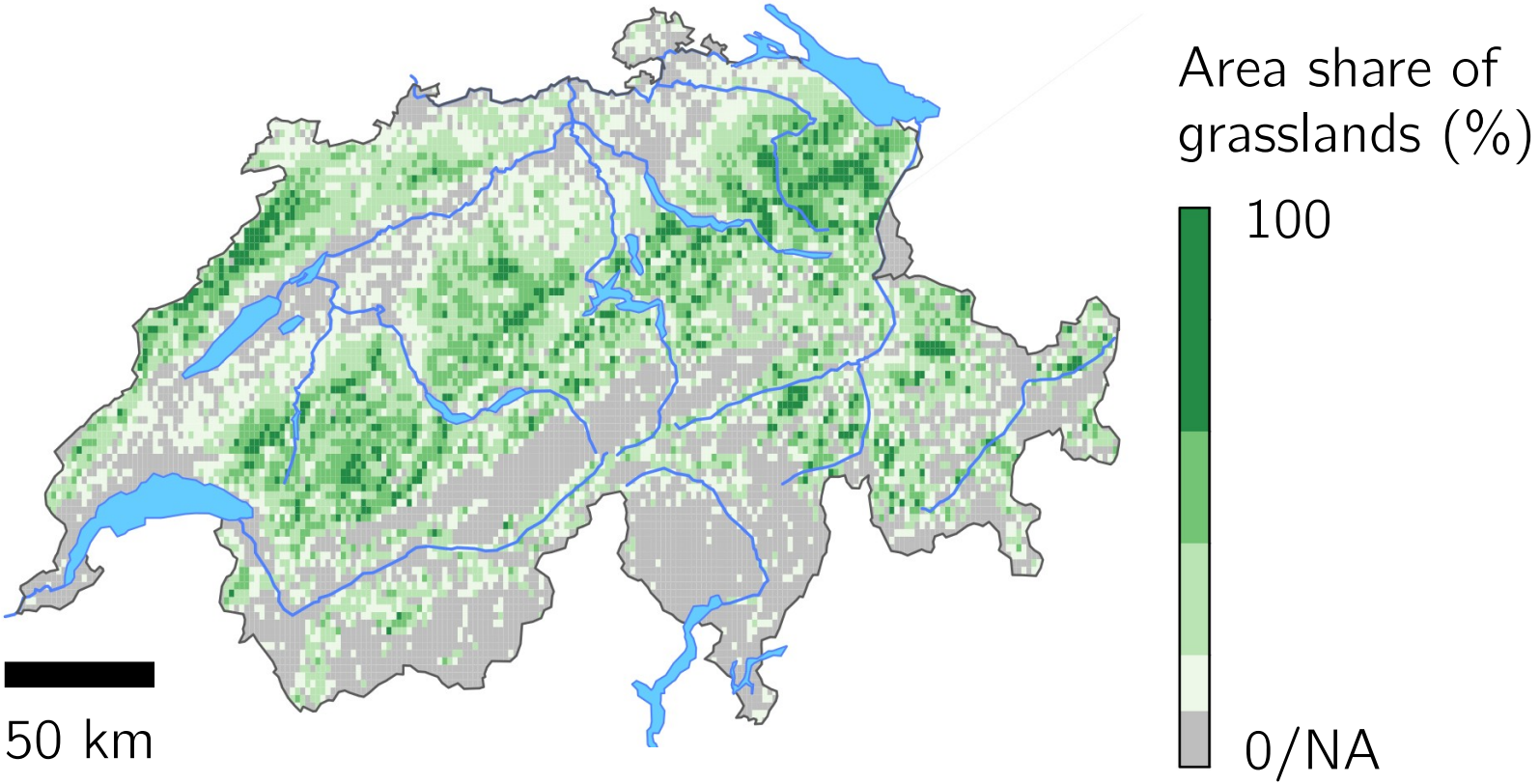
EGU, 2024-04-15

Climate Change in Switzerland: Key Messages



Source:
https://www.nccs.admin.ch/

Switzerland Is a *Grass Land*



Map courtesy of Pierluigi Calanca. Data source:
https://www.bfs.admin.ch/bfs/en/home/services/geostat/swiss-federal-statistics-geodata/land-use-cover-suitability/swiss-land-use-statistics.assetdetail.20104753.html

Grass Growth Model: ModVege

- ✔ Few inputs required, understandable mechanisms
- ✔ Verified for Central Europe
  - Jouven, M. *et al*. Grass and Forage Science 61, no. 2 (2006): 112–24.
  - Calanca, P. *et al.* Field Crops Research 187 (2016): 12–23.

☞ Published as R package on CRAN
https://kuadrat.github.io/growR/

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Model Calibration and Validation: Experimental Sites

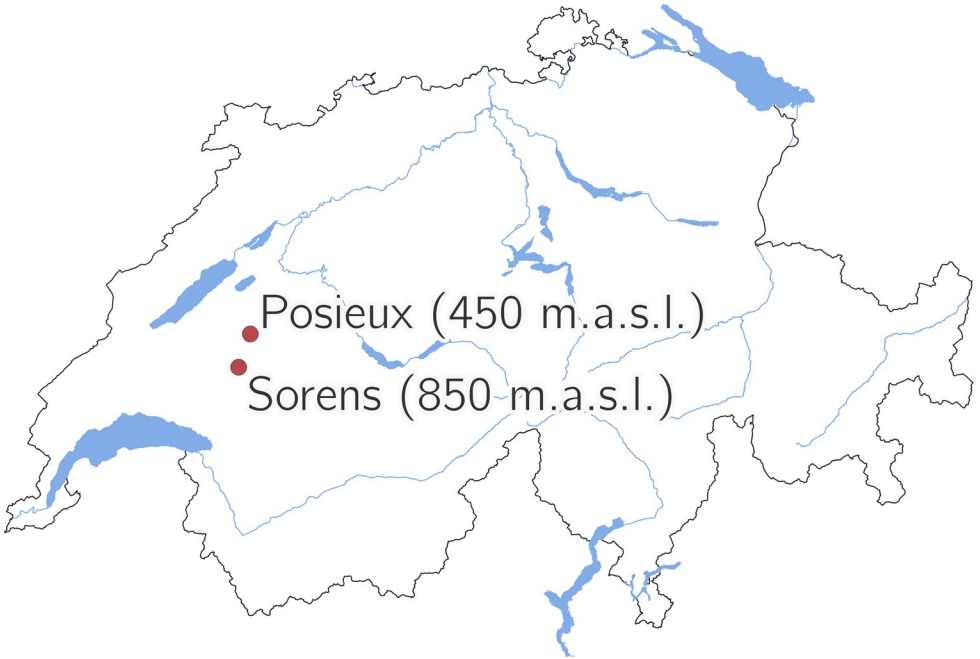
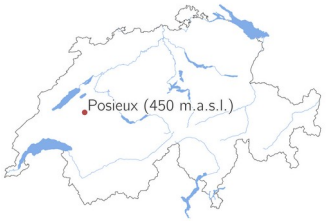
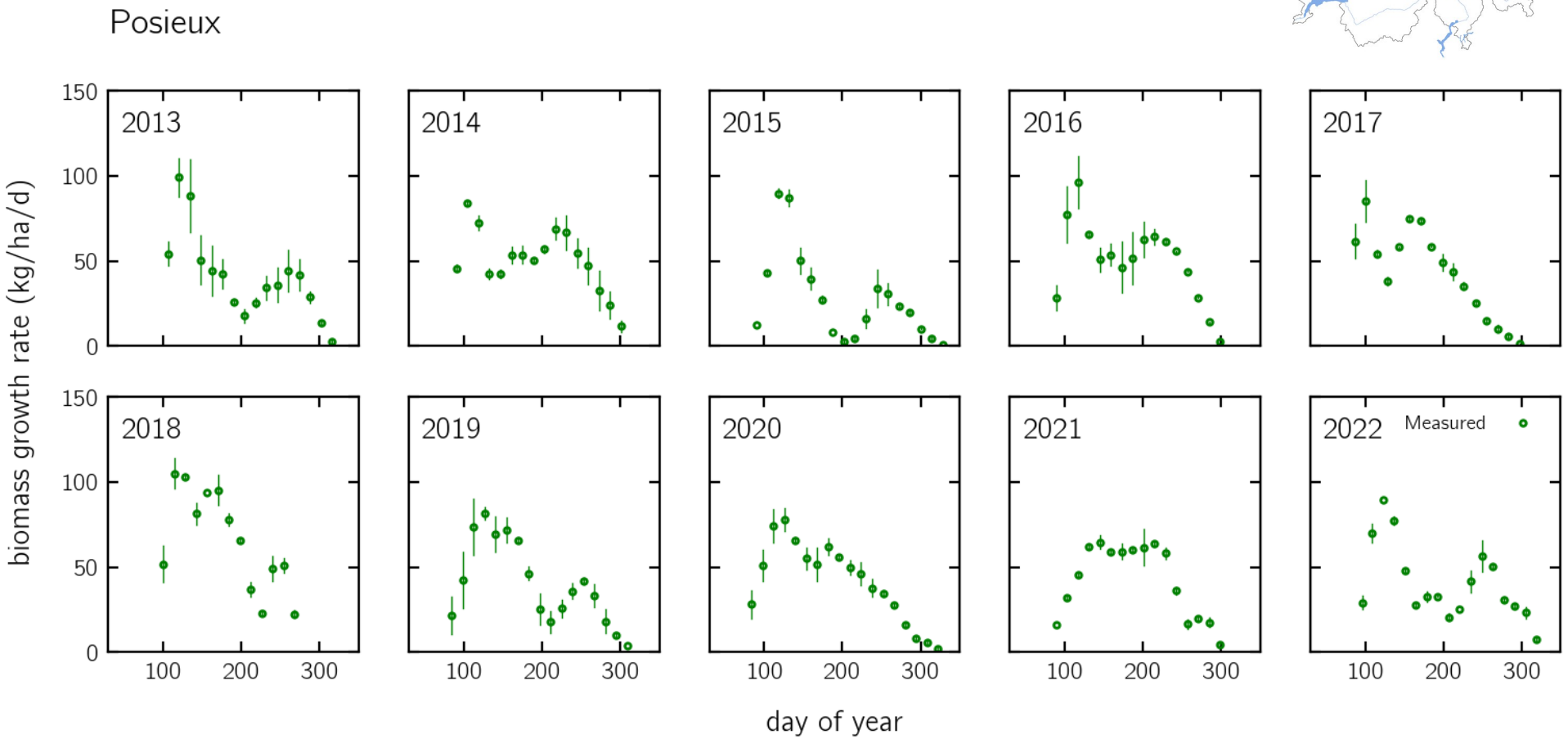


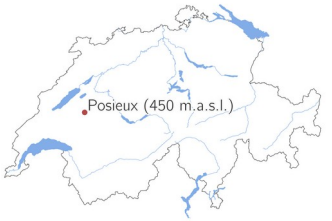
Image and data kindly provided by Fredy Schori:
https://www.agroscope.admin.ch/agroscope/de/home/services/dienste/futtermittel/weidemanagement/graswachstum.html

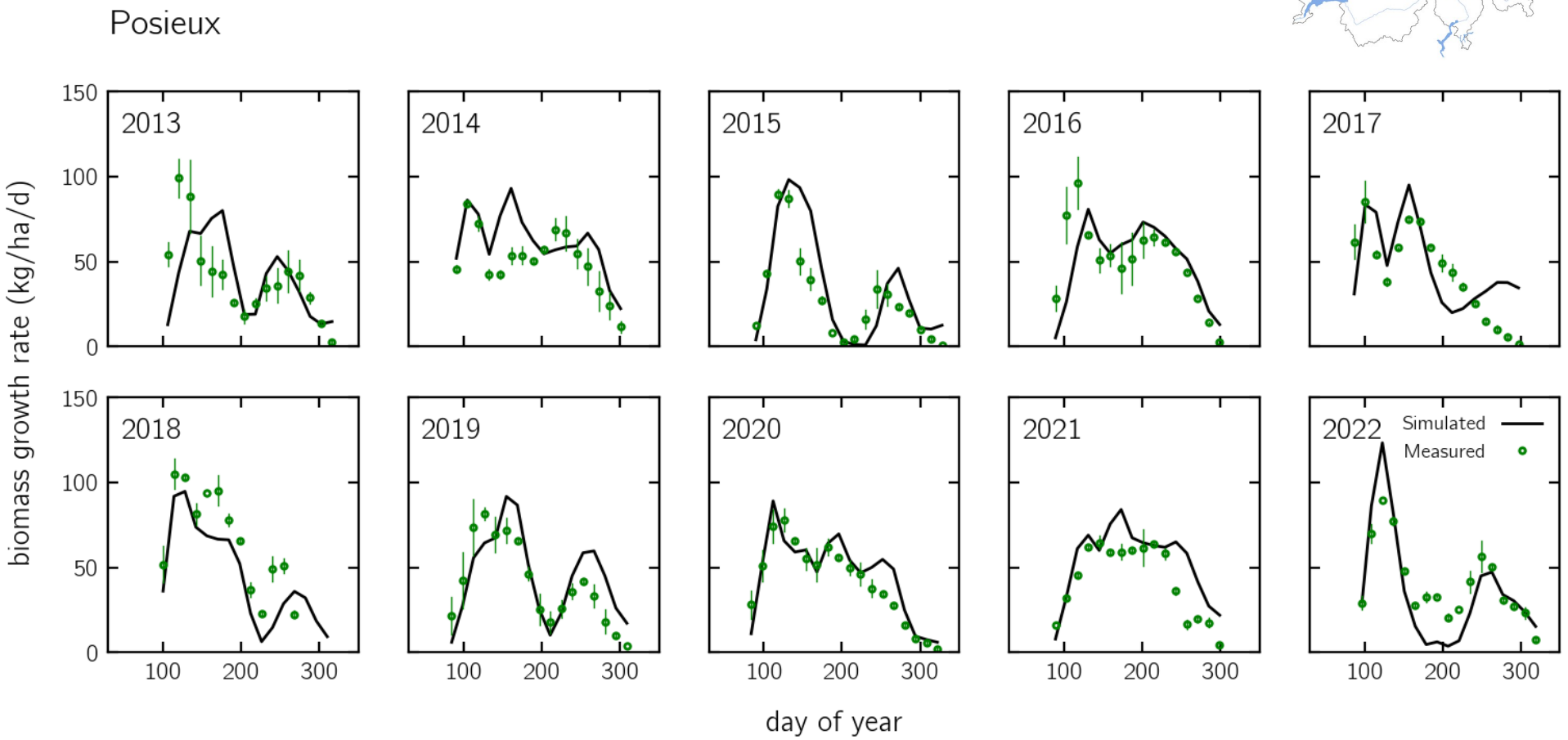
Model Validation



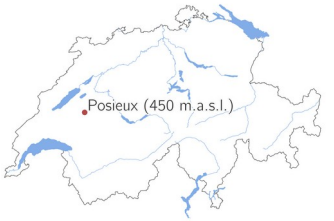


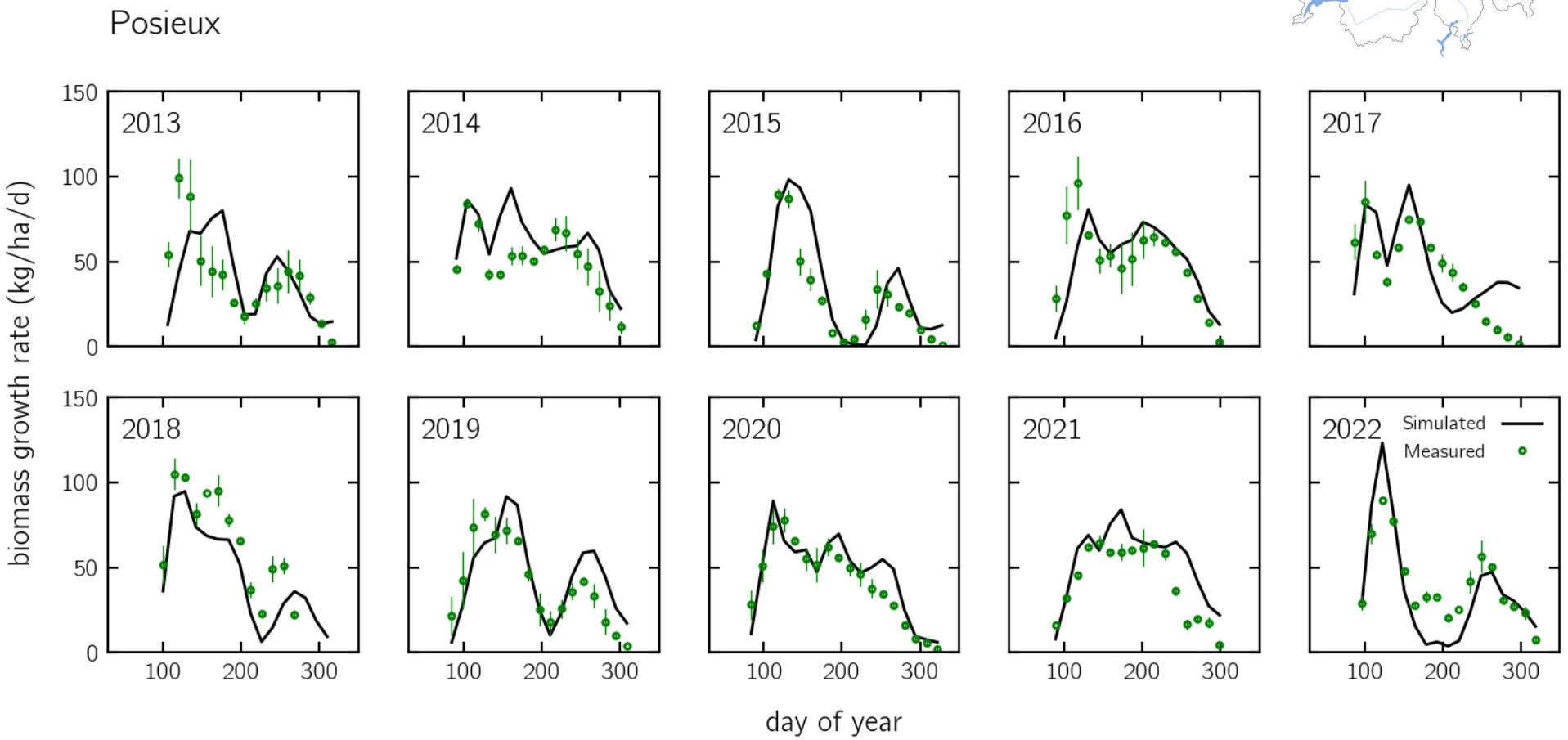
Model Validation





Model Validation





→ Calibrated model captures grass growth dynamics very well.

Problem: Extension Across Switzerland

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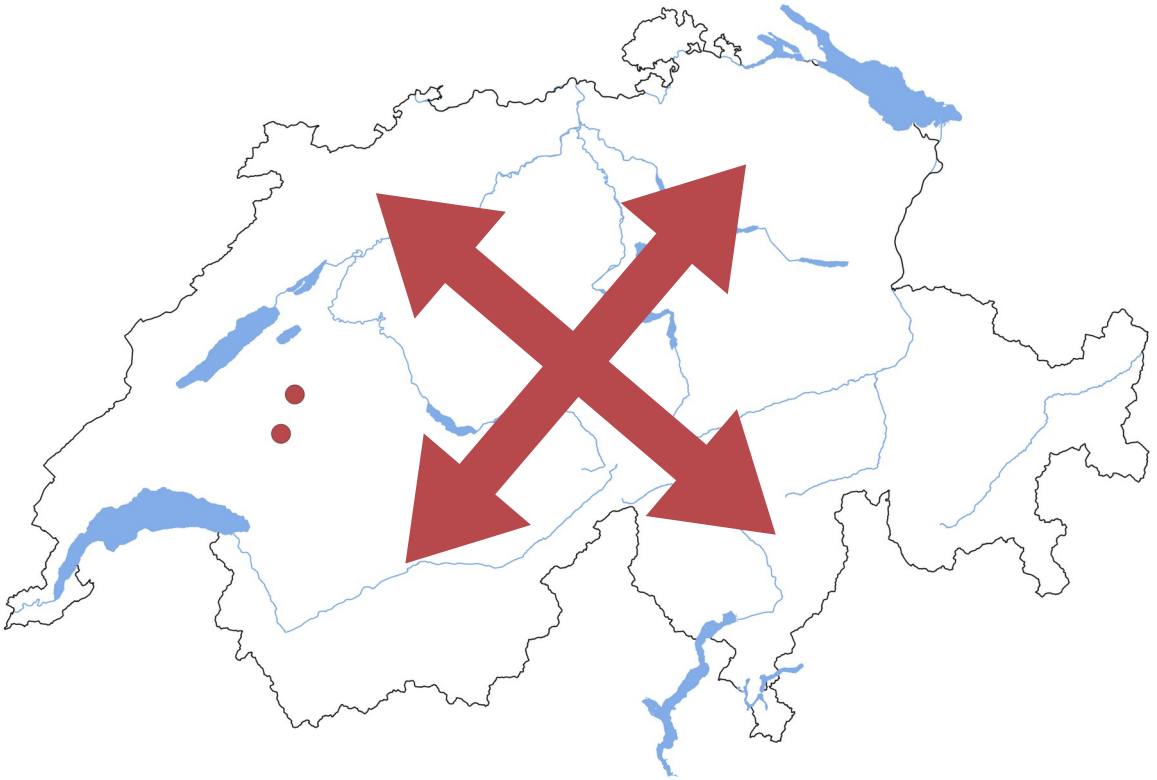


How to assess if the model works in biogeoclimatically different regions?

Enter Remote Sensing

Idea:

Use a growth proxy from satellite imagery to inform model calibration.

Enter Remote Sensing

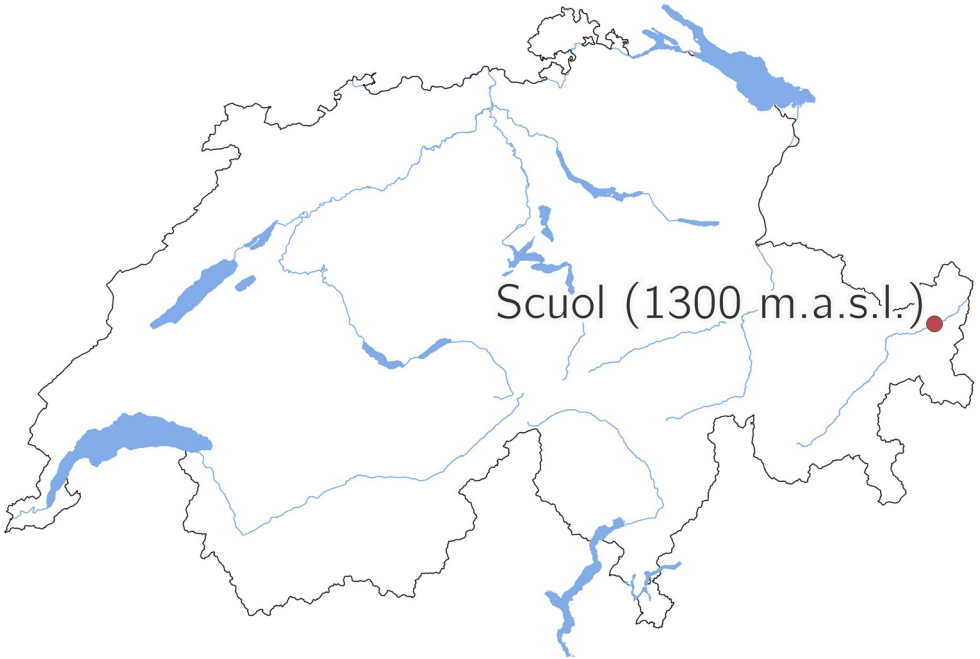
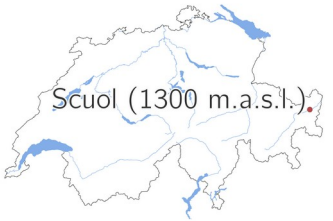
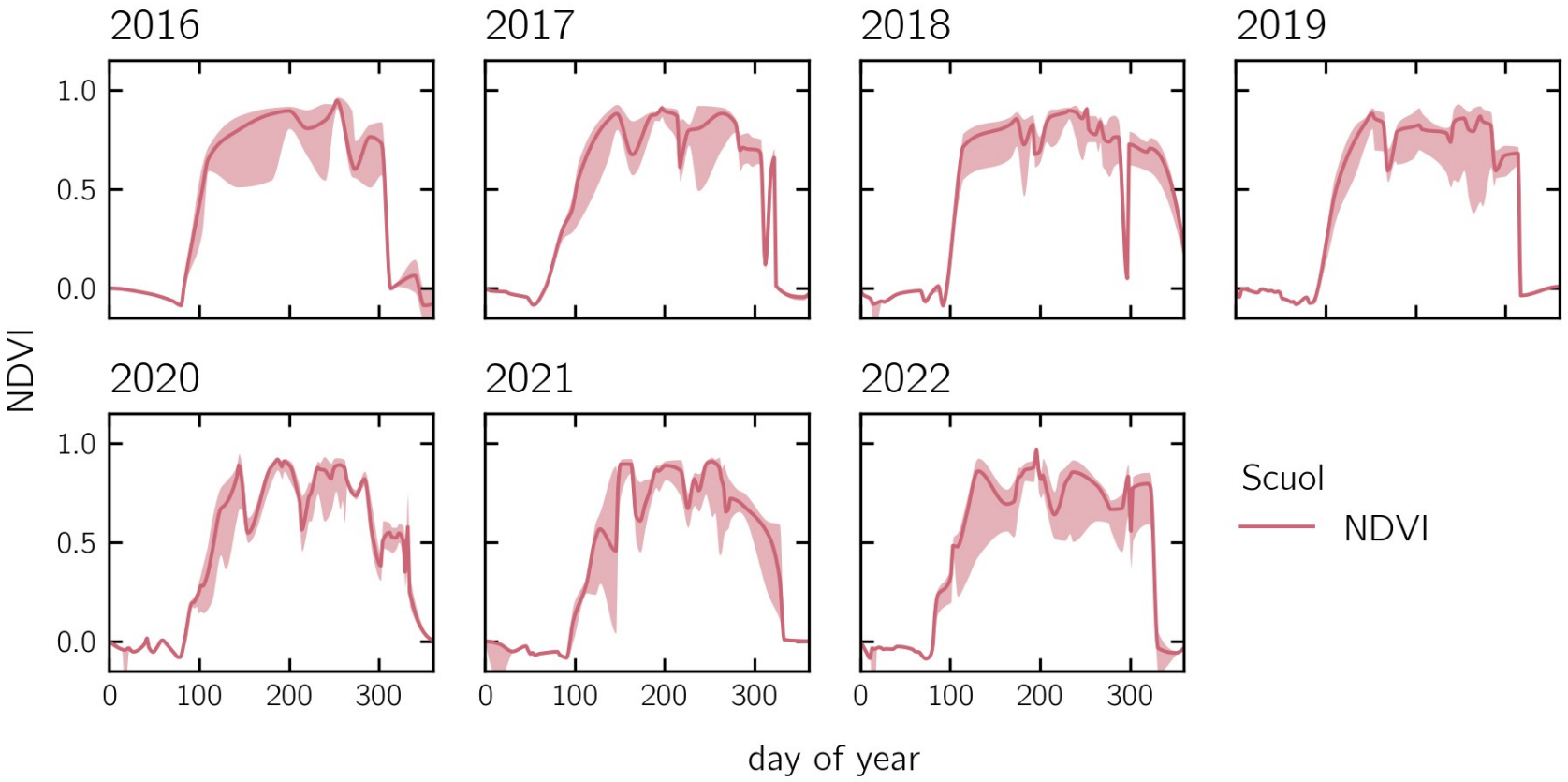


Image by Gabriela Braendle, kindly provided by Manuel Schneider.

NDVI and Model – Alpine Region





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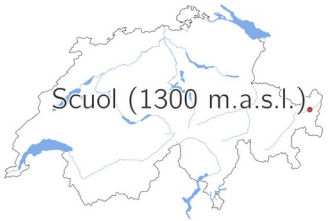
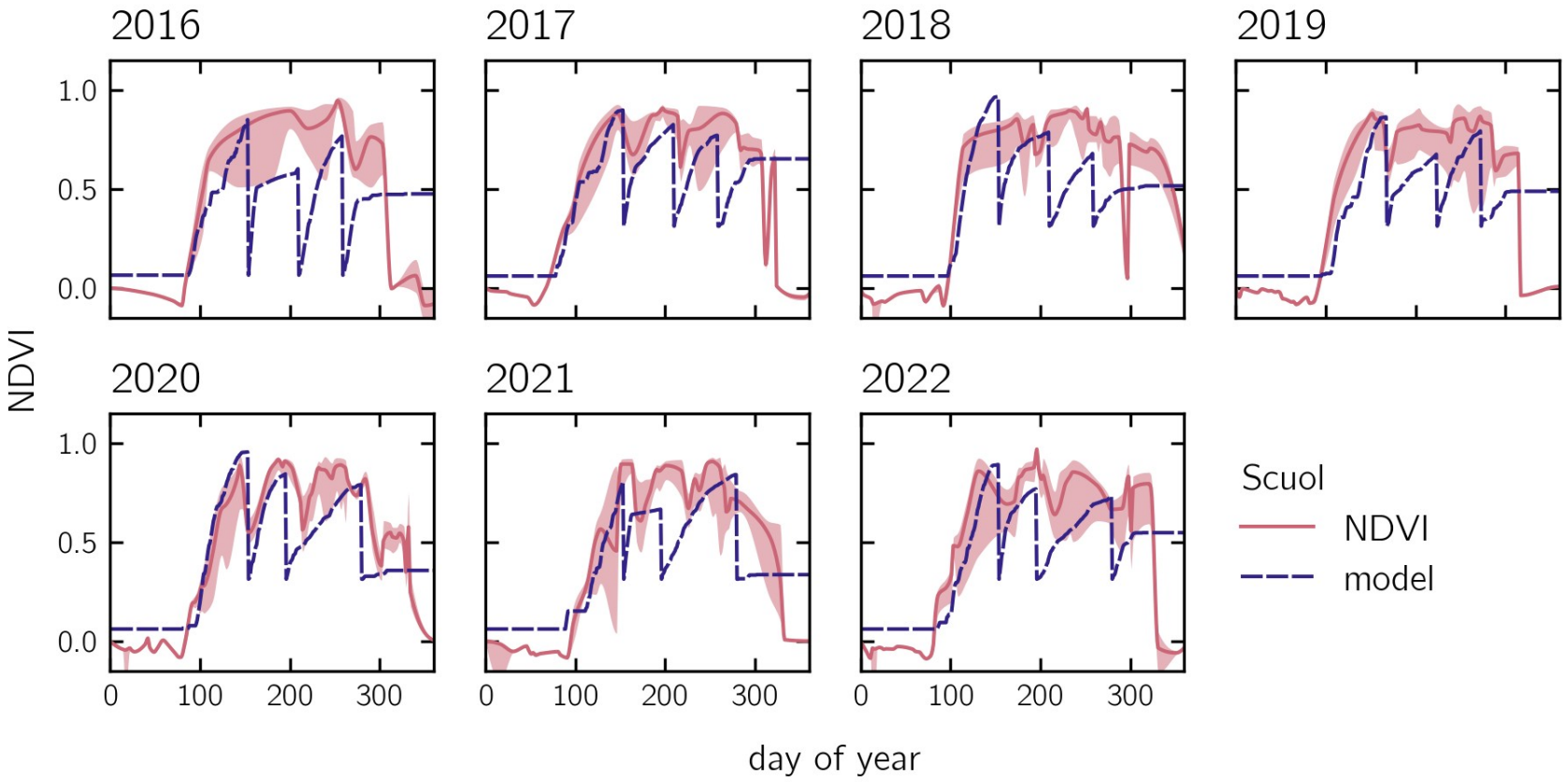
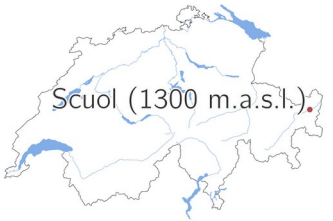
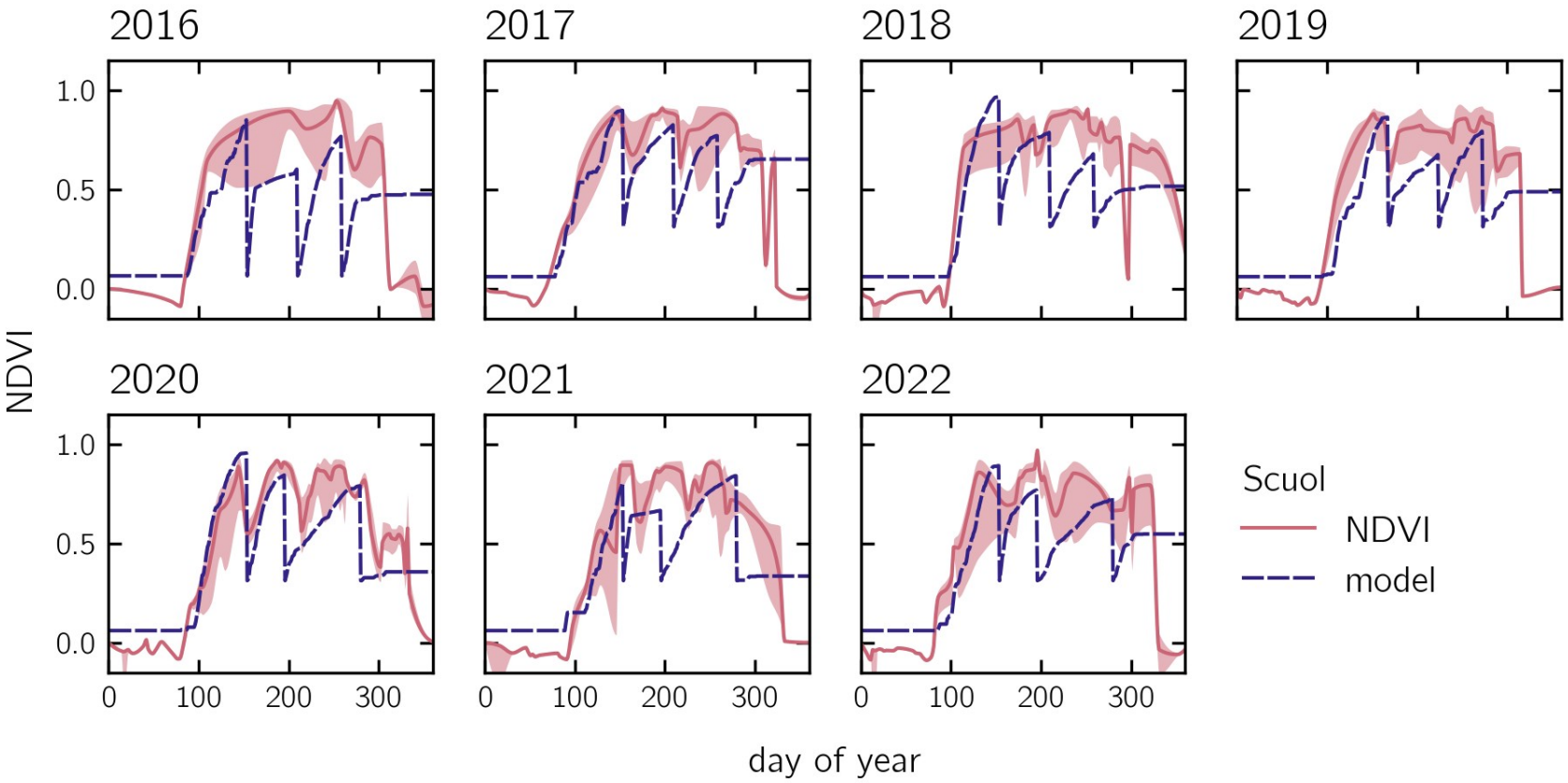




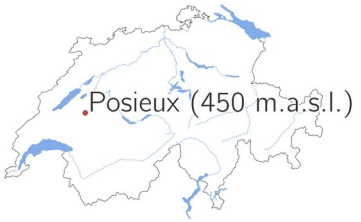
NDVI and Model – Alpine Region

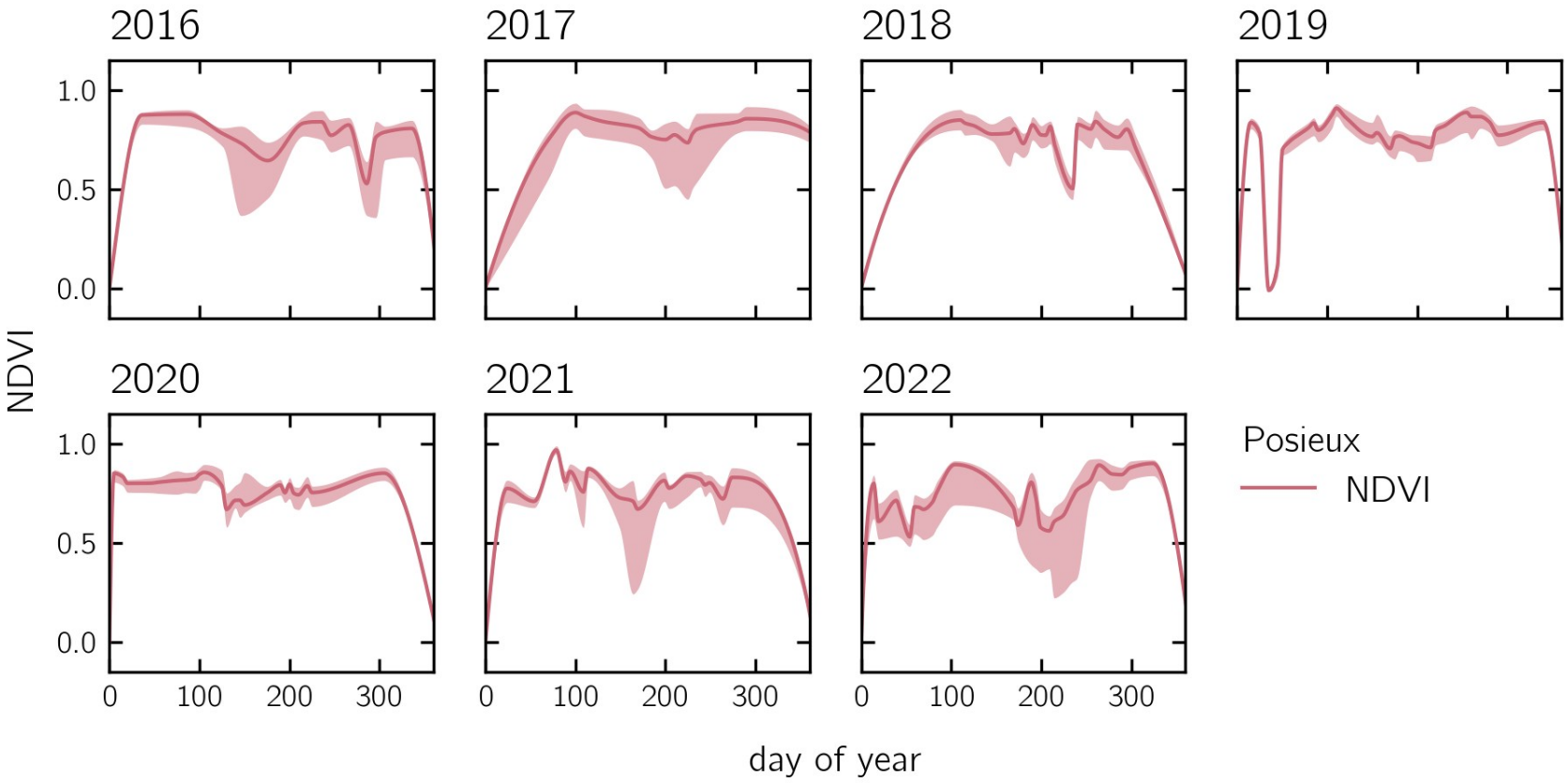




→ Clear correlations for important features.

NDVI and Model – Lowlands





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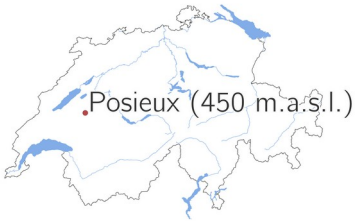
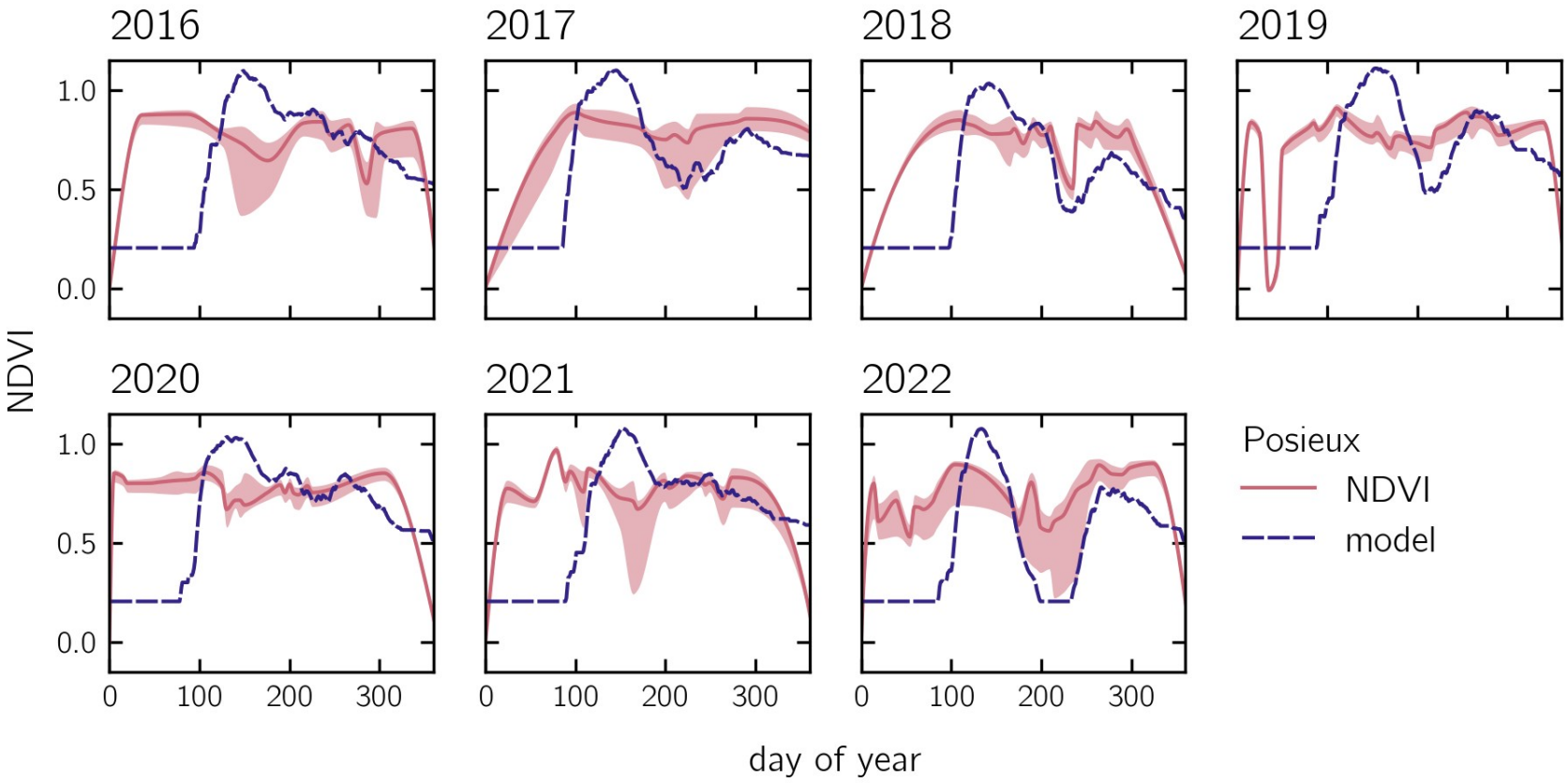
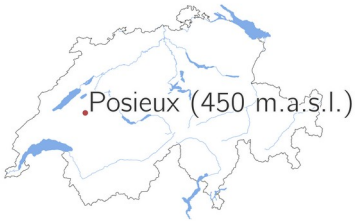
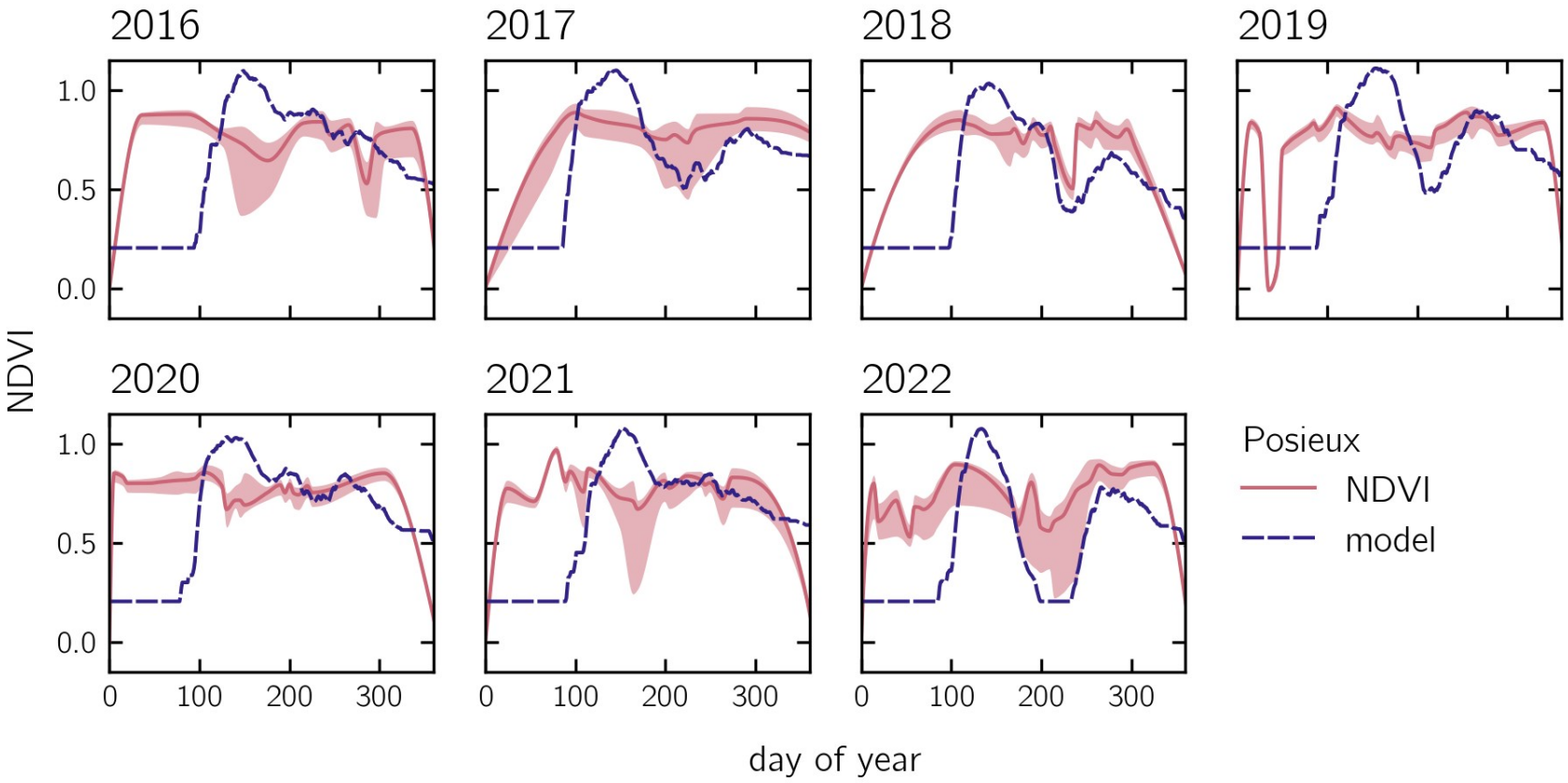




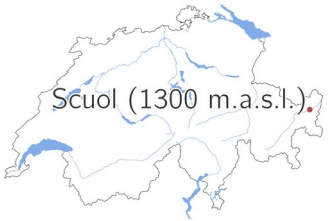
NDVI and Model – Lowlands

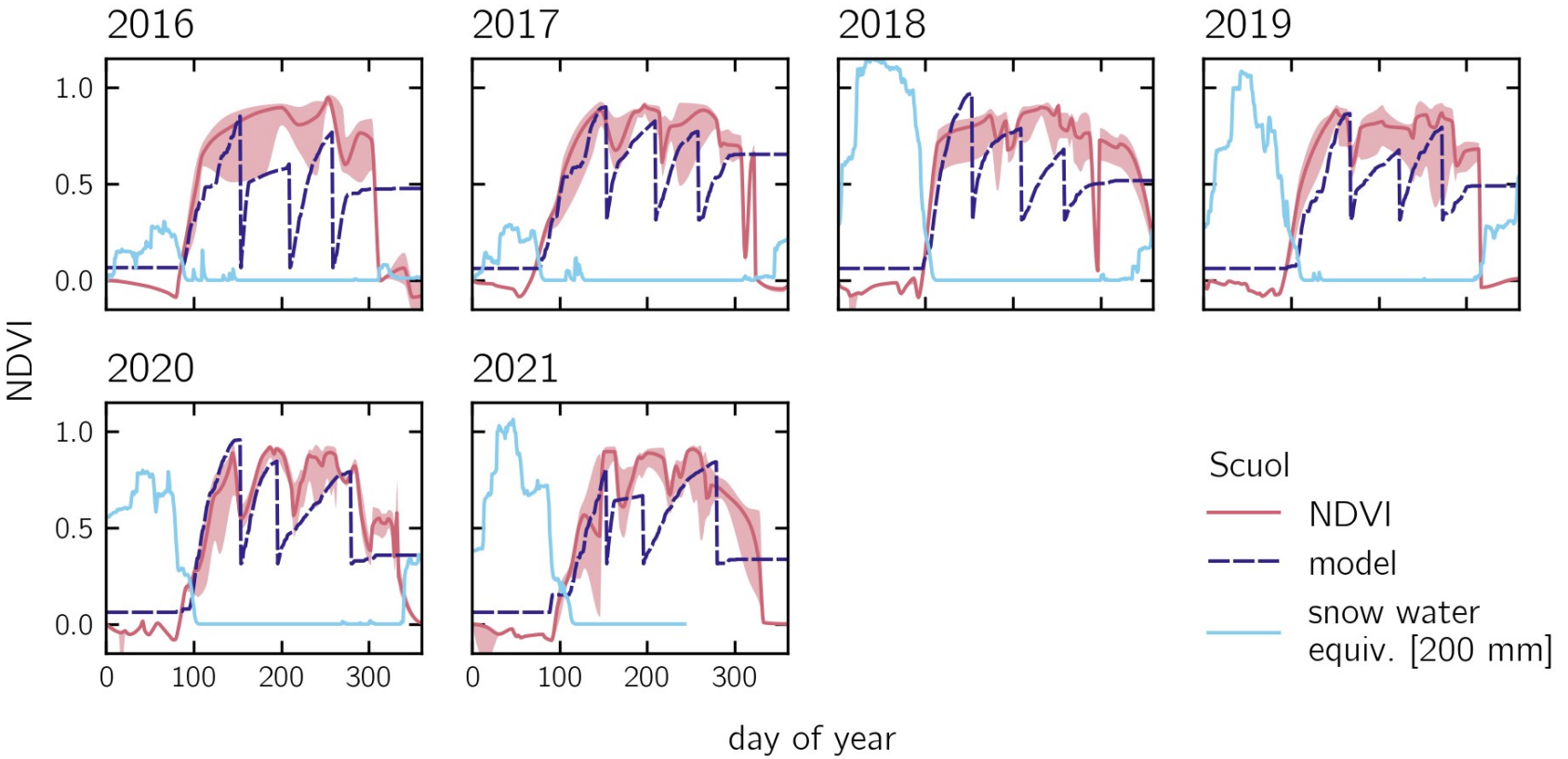




→ Start of growing season not captured at all by NDVI in lowlands.

Discussion: Snow – Alpine Site





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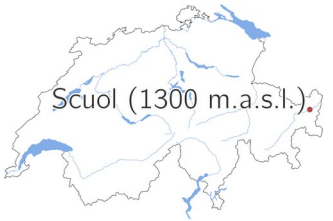
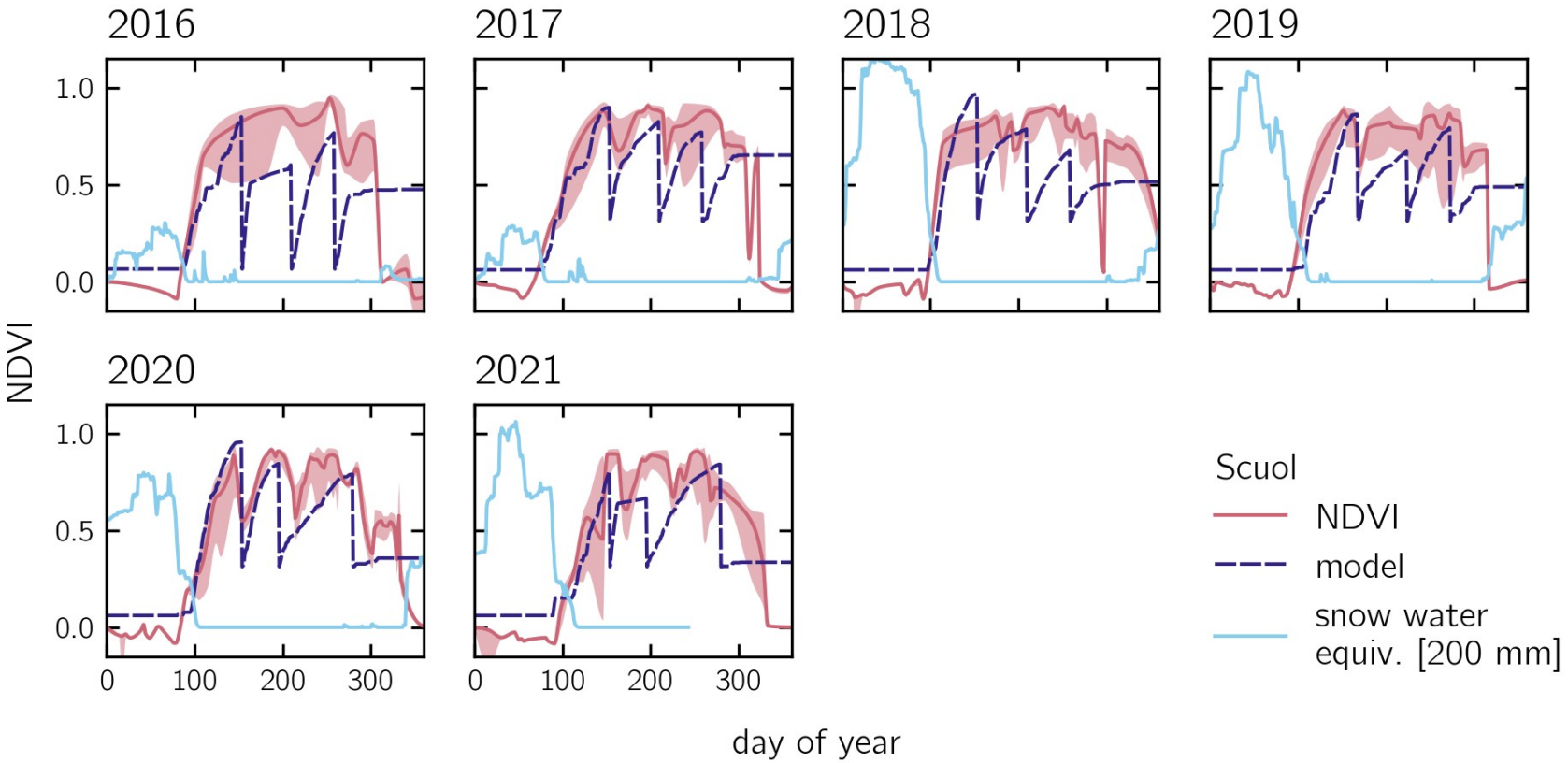
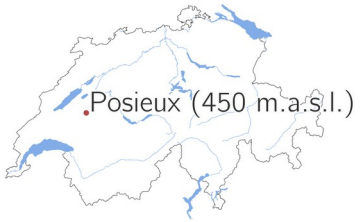
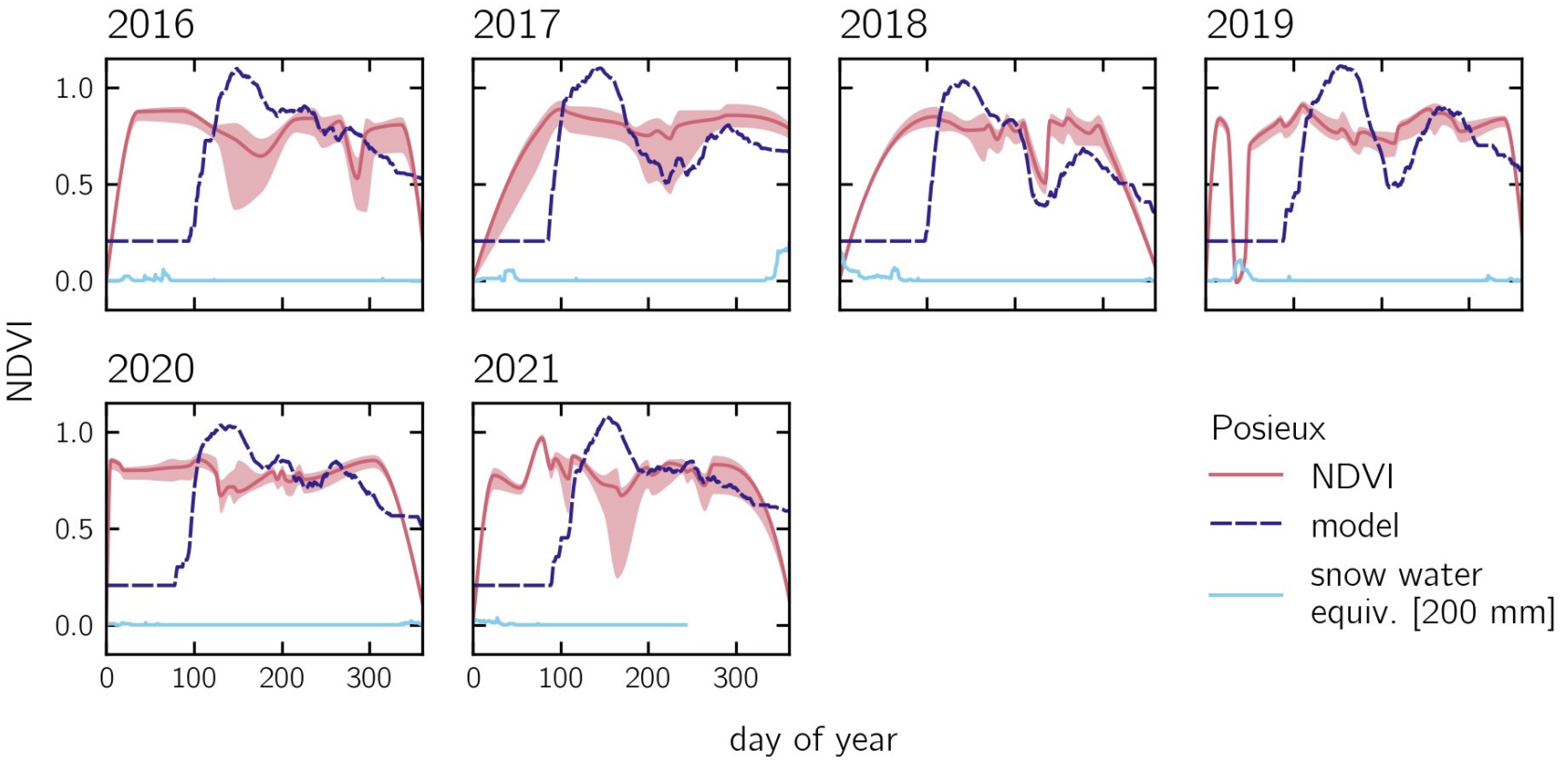




→ NDVI is highly sensitive to snow.

Discussion: Snow – Lowland Site





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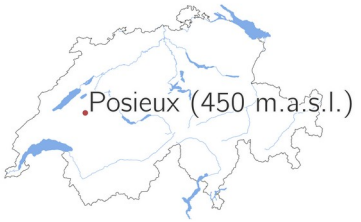
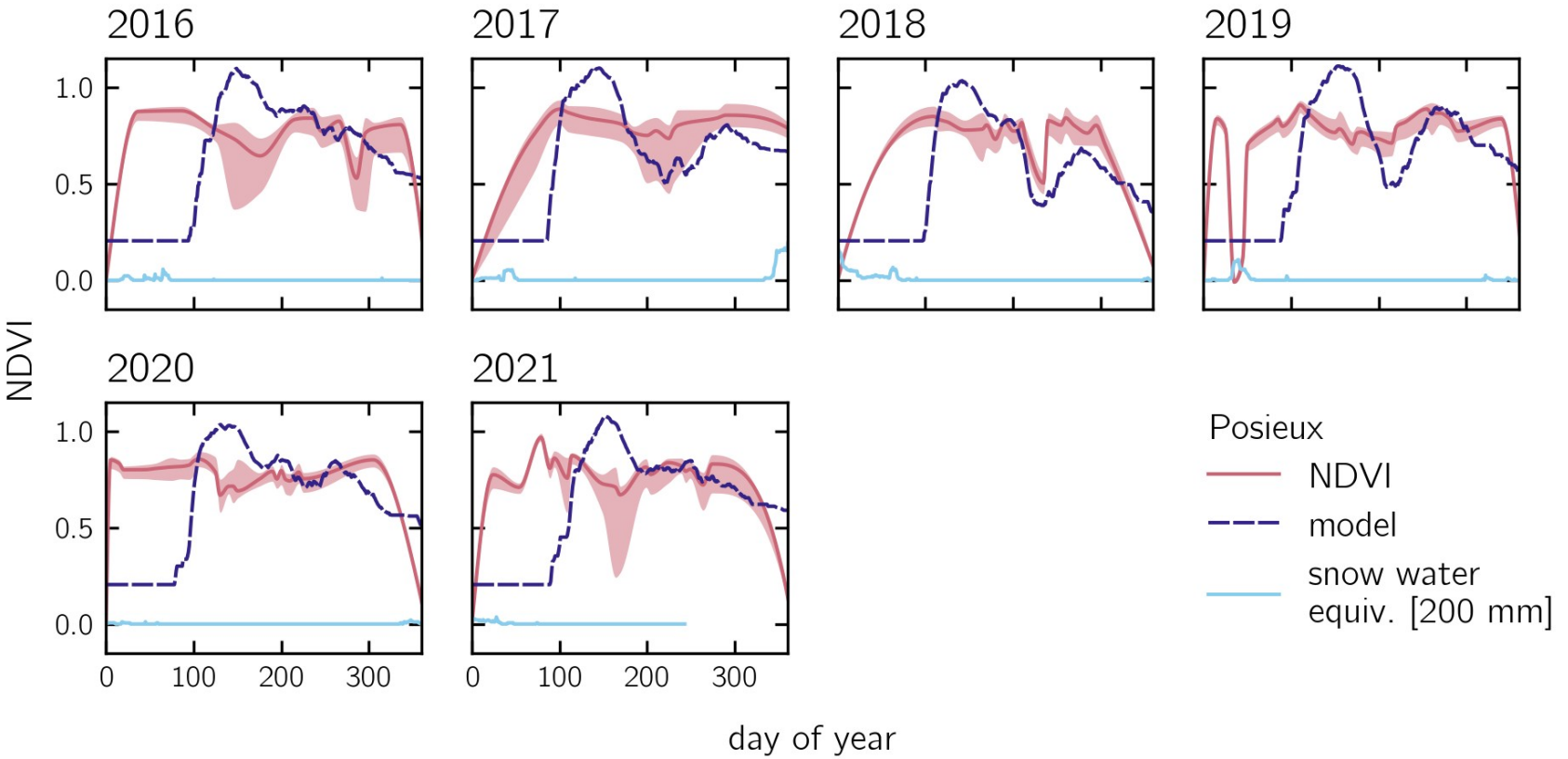
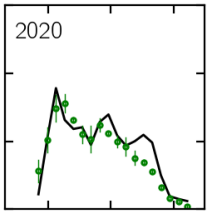




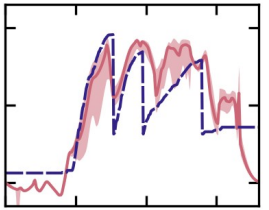
→ In lowlands, without snow, grass already looks green in January.

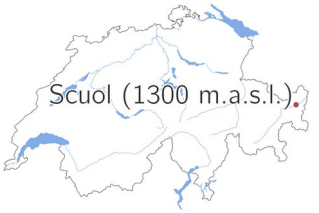
Summary

- Grass growth model reliably predicts dynamics.



- Strong agreement between model and NDVI in Alpine region.





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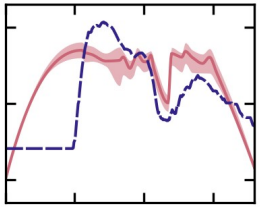

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Outlook

- Circumvent small scale of Swiss agriculture by aggregating over multiple grassland areas in a region.
- Go beyond simple indices (NDVI, EVI) and use all Sentinel-2 bands.

  $\rightarrow$ Radiative Transfer Models, other ML approaches
- Account for seasonal dependency in the LAI $\rightarrow$ VI correspondence function.

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Poster by
Sélène Ledain
Thursday!
X1.106

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Acknowledgements

Helge Aasen

Fabio Oriani

Manuel Schneider

Daria Larcher

Sélène Ledain

Pierluigi Calanca

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Acknowledgements

Helge Aasen

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Sélène Ledain

Pierluigi Calanca

Poster today! **X1.56**

Poster Thursday! **X1.106**

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Kevin Kramer

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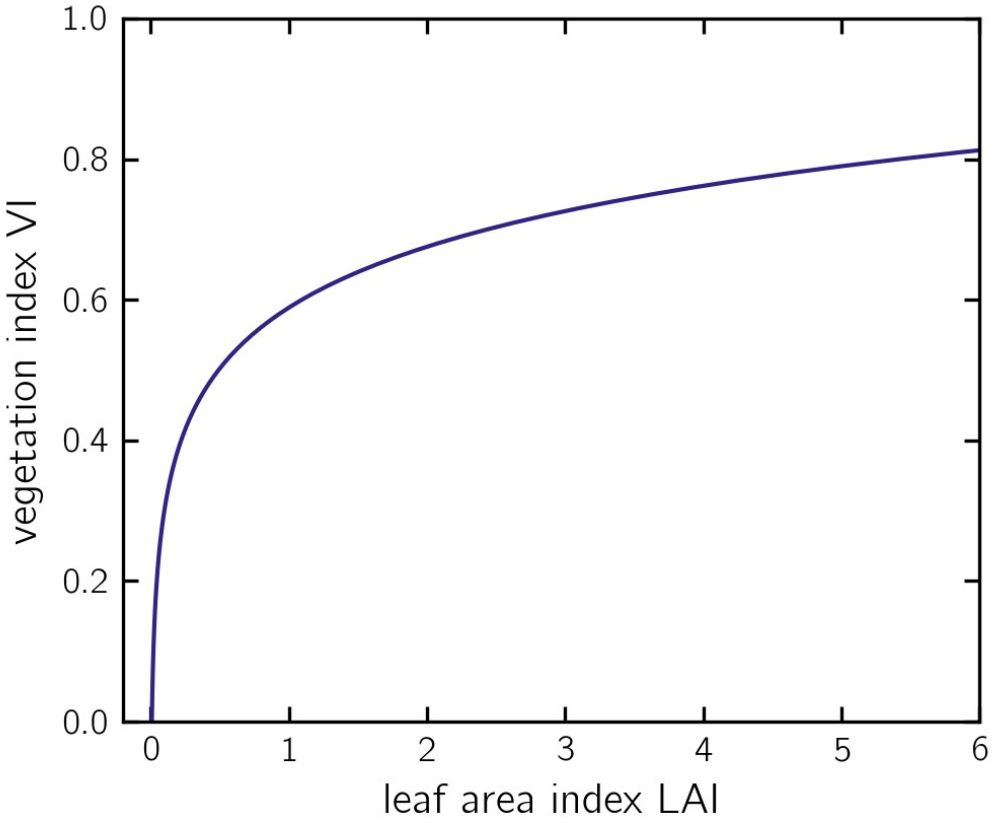
Transformation between modelled LAI to NDVI



$$LAI = s \cdot e^{\lambda \cdot VI}$$

$$s = 0.009$$

$$\lambda = 8$$

Inspired by Tanaka, S. et al. Remote Sensing 2015, 7 (5), 5329–5346.

Scale of Swiss Agriculture (Posieux)

1 km

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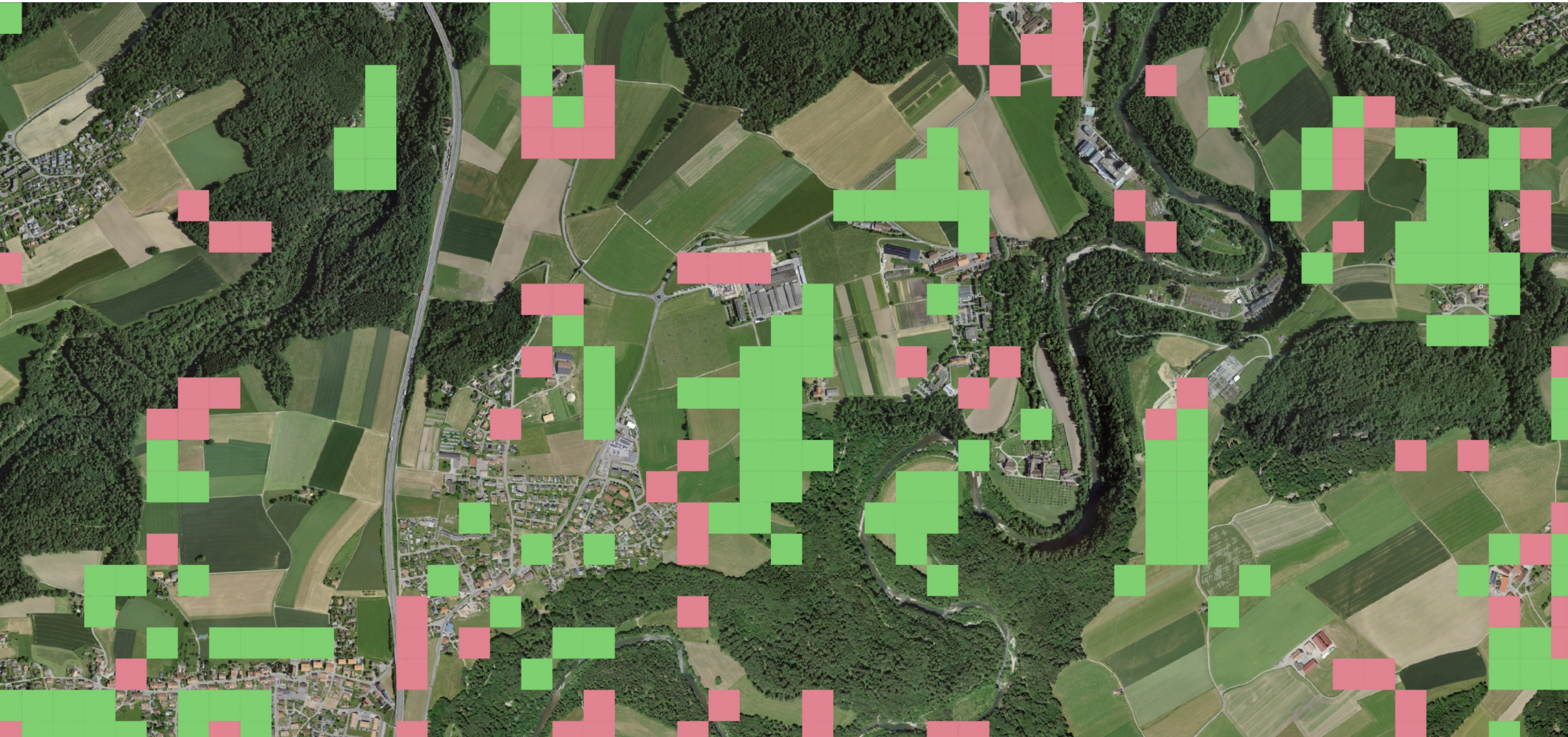
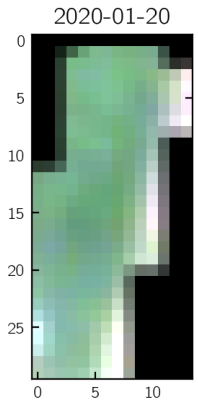
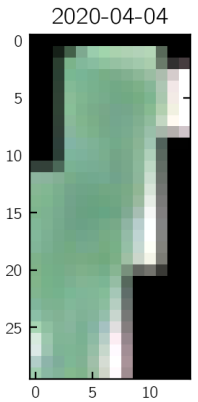
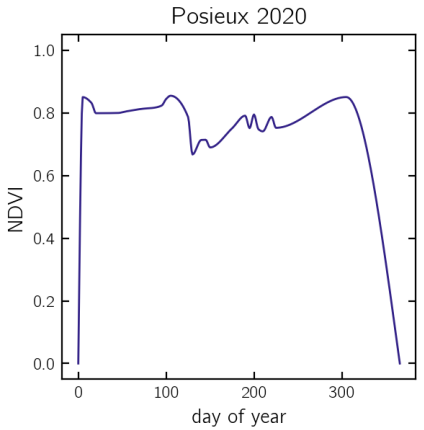
1 km



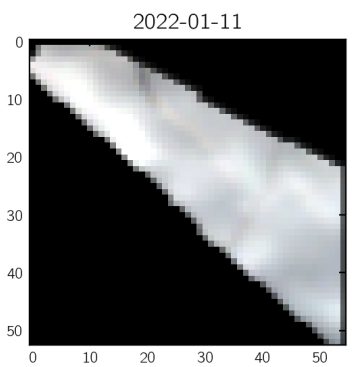
VIS Satellite Images

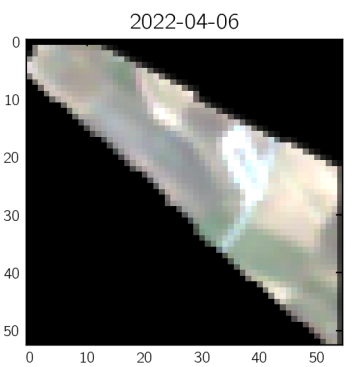


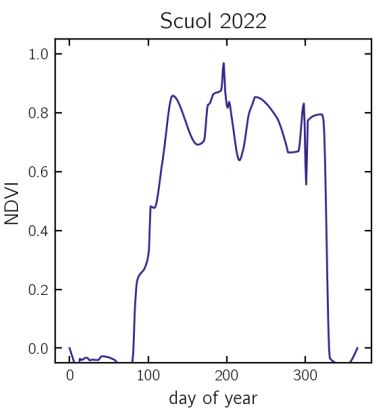




Just by eye, Posieux appears as green in January as it does in April







Meanwhile, Scuol is white (snow cover) in January.

Context: National Center for Climate Services (NCCS)

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NCCS Impacts

trans-sectoral knowledge basis
for decision making

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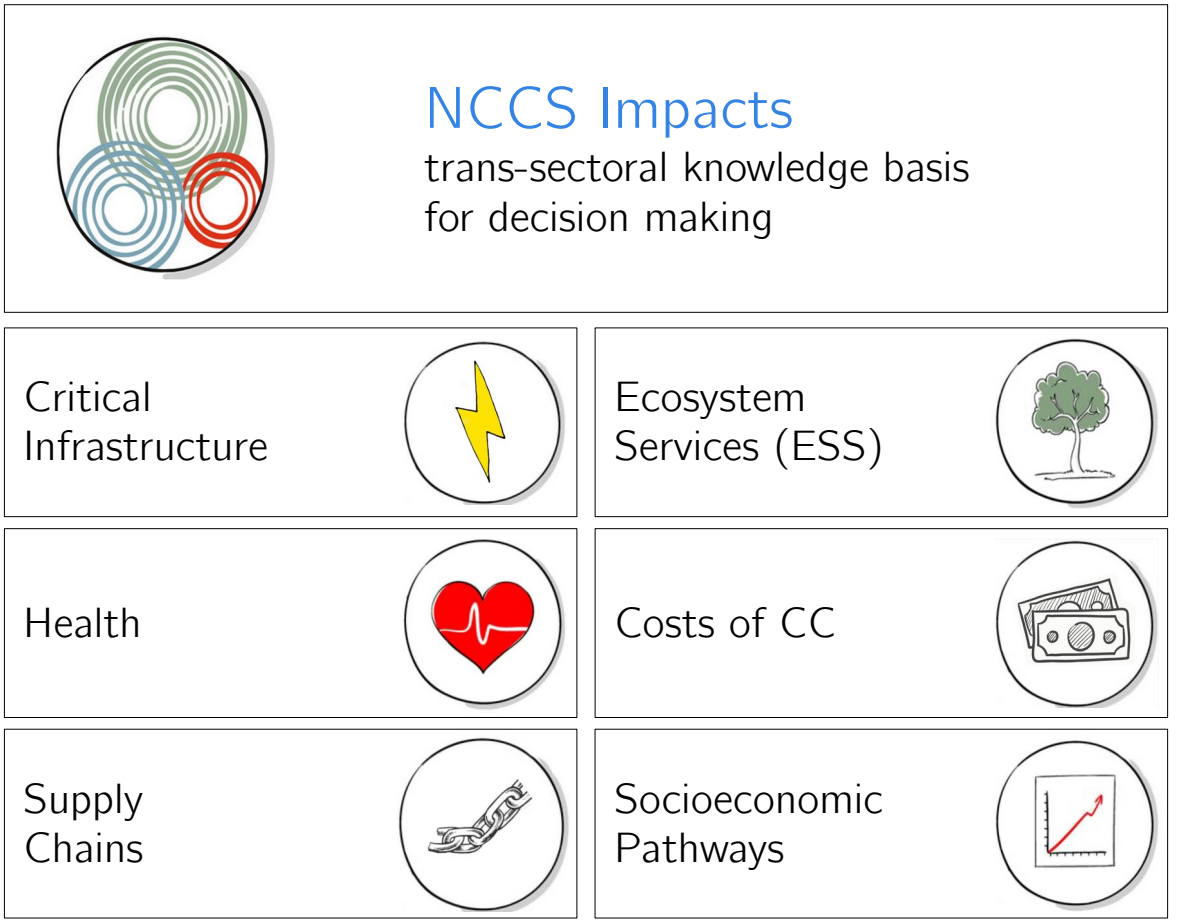
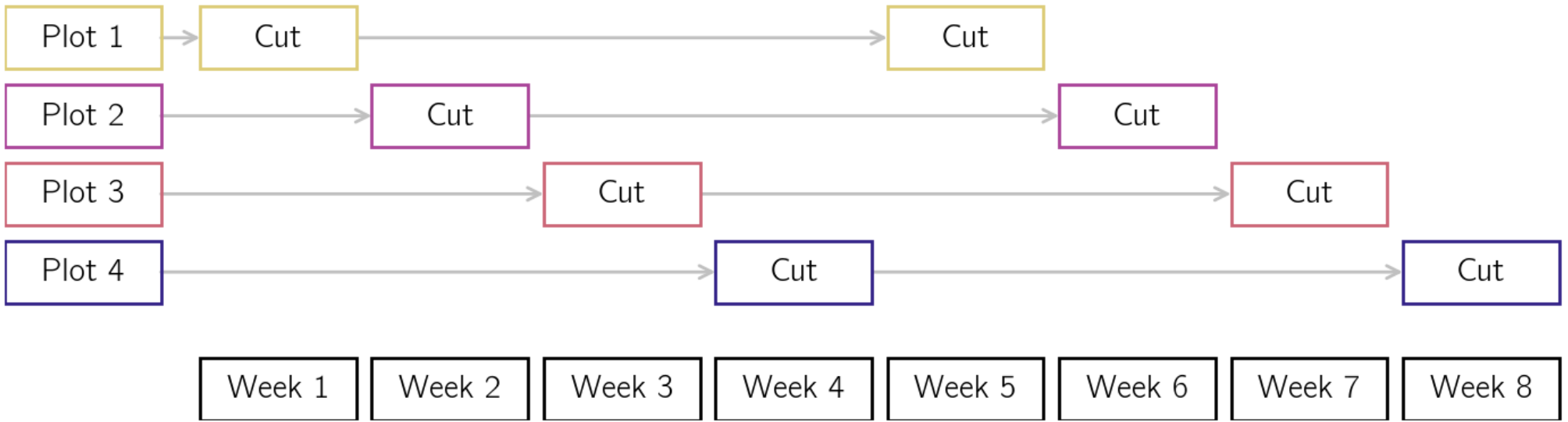
Context: National Center for Climate Services (NCCS)



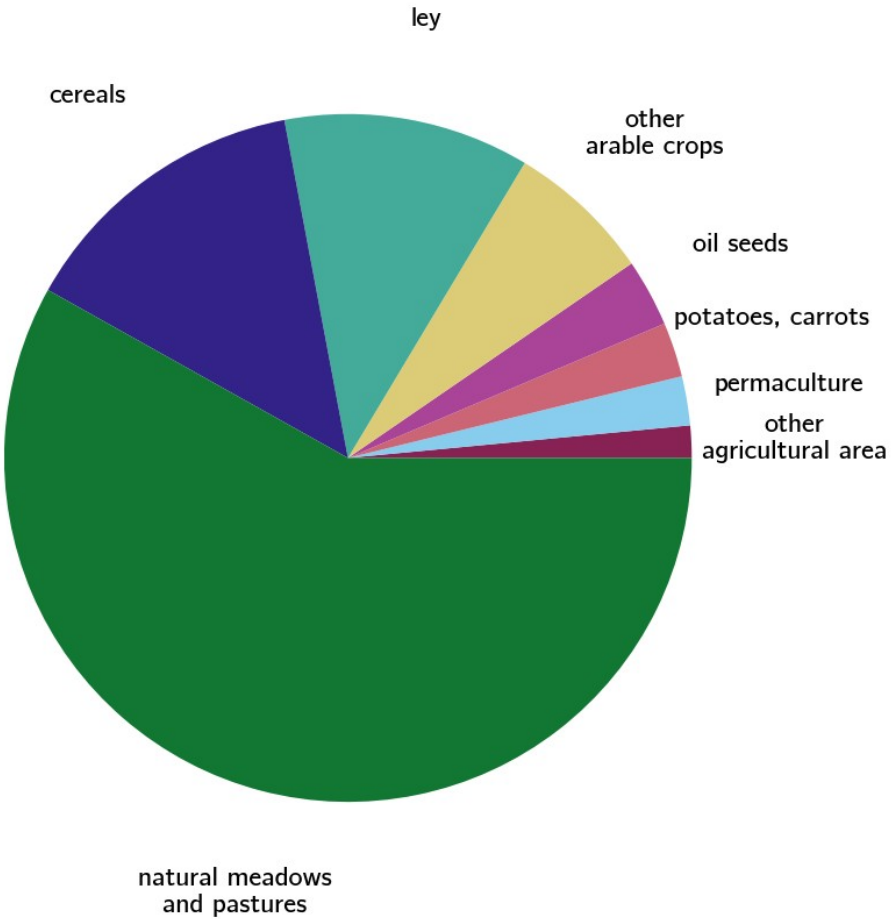
https://www.nccs.admin.ch/nccs/en/home/climate-change-and-impacts/nccs-impacts/projects.html

Validation Data: Measurement Procedure



https://www.agroscope.admin.ch/agroscope/de/home/services/dienste/futtermittel/weidemanagement/graswachstum.html
Corrall, A. J. and Fenlon, J. S., The Journal of Agricultural Science (1978), 91 (1), 61–67

Switzerland Is a *Grass Land*



https://www.bfs.admin.ch/bfs/de/home/statistiken/land-forstwirtschaft/landwirtschaft/strukturen.assetdetail.24925949.html