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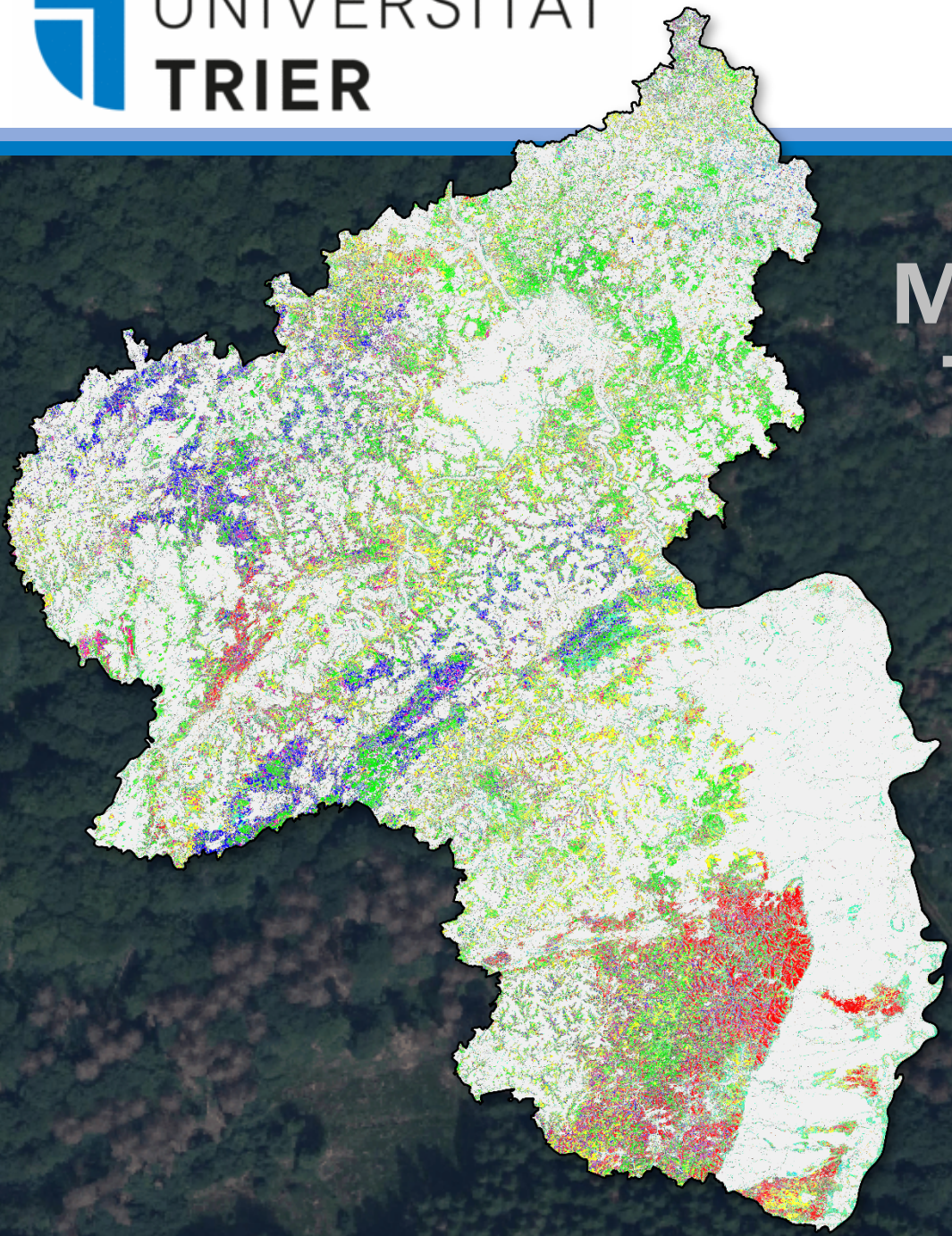
Geoinformatics Spatial Data Science



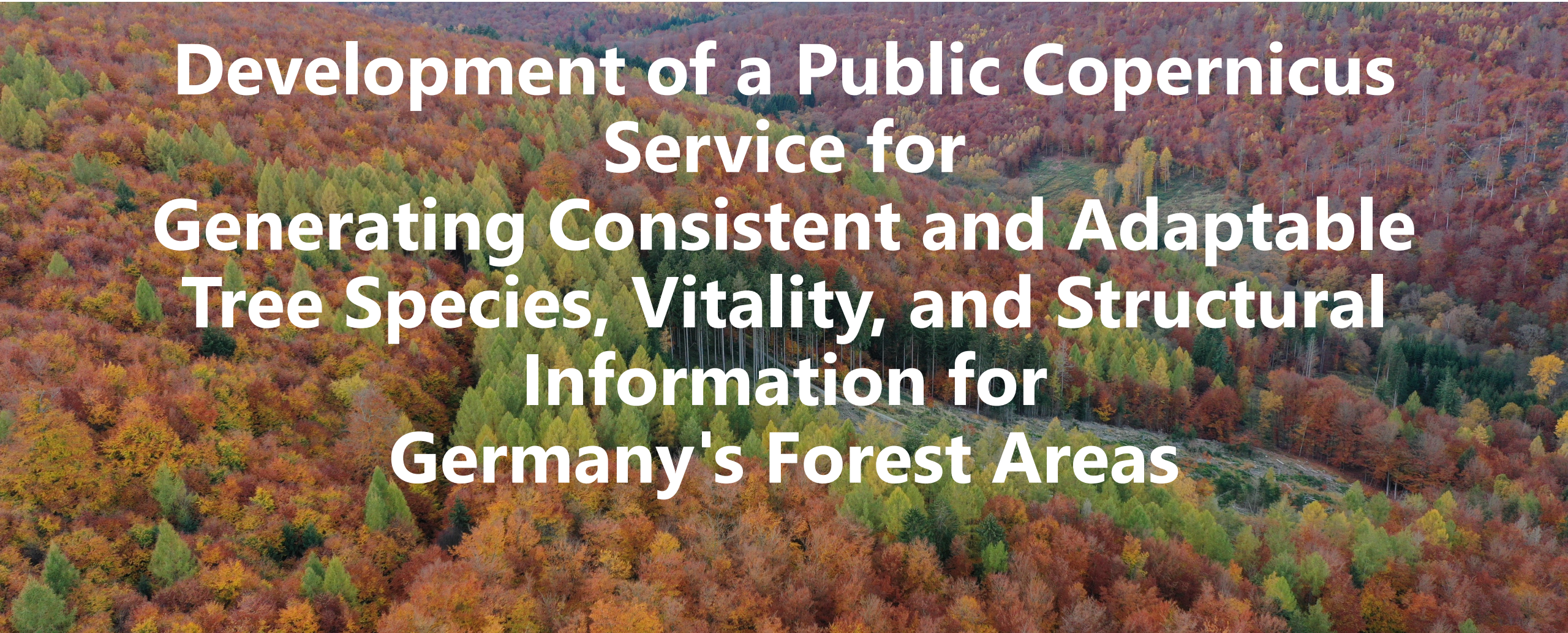
Mapping Tree Species Fractions in Temperate Mixed Forests Using Sentinel-2 Time Series and synthetically mixed time series

David Klehr
Johannes Stoffels, Andreas Hill, Vu-Dong Pham,
Sebastian van der Linden, David Frantz

Held by Marvin Bock

AK Fernerkundung 2025 | 29.09 – 30.09

ForestPulse



Development of a Public Copernicus Service for Generating Consistent and Adaptable Tree Species, Vitality, and Structural Information for Germany's Forest Areas

ForestPulse in a nutshell

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ForestPulse

Main Innovations and Core Elements of the Service

- **Temporal, spatial, and thematic consistency** of all information layers
- Moving away from the mere provision of fully processed, static products
- **Active user control** for generating individualized results (integration of own reference data)
- **Provision of generated products** for further processing and integration into internal process chains
- Generation of additional **validation and quality information** as metadata

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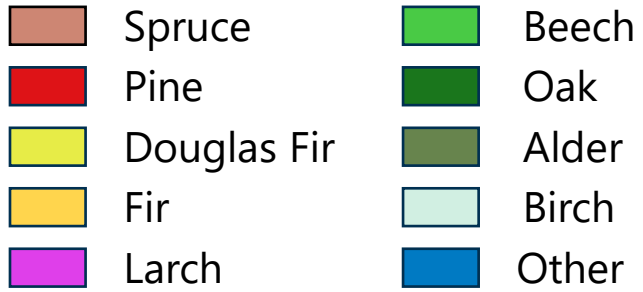
Tree Species Classification – Species Mixture

Problems with conventional tree species classification approaches:

- Temperate mixed forest is often highly mixed (at the **sub-pixel level**) and heterogeneous
- Crown layer is not always closed
- Pixel size barely matches the crown size and distribution



Blickensdörfer et al. 2024

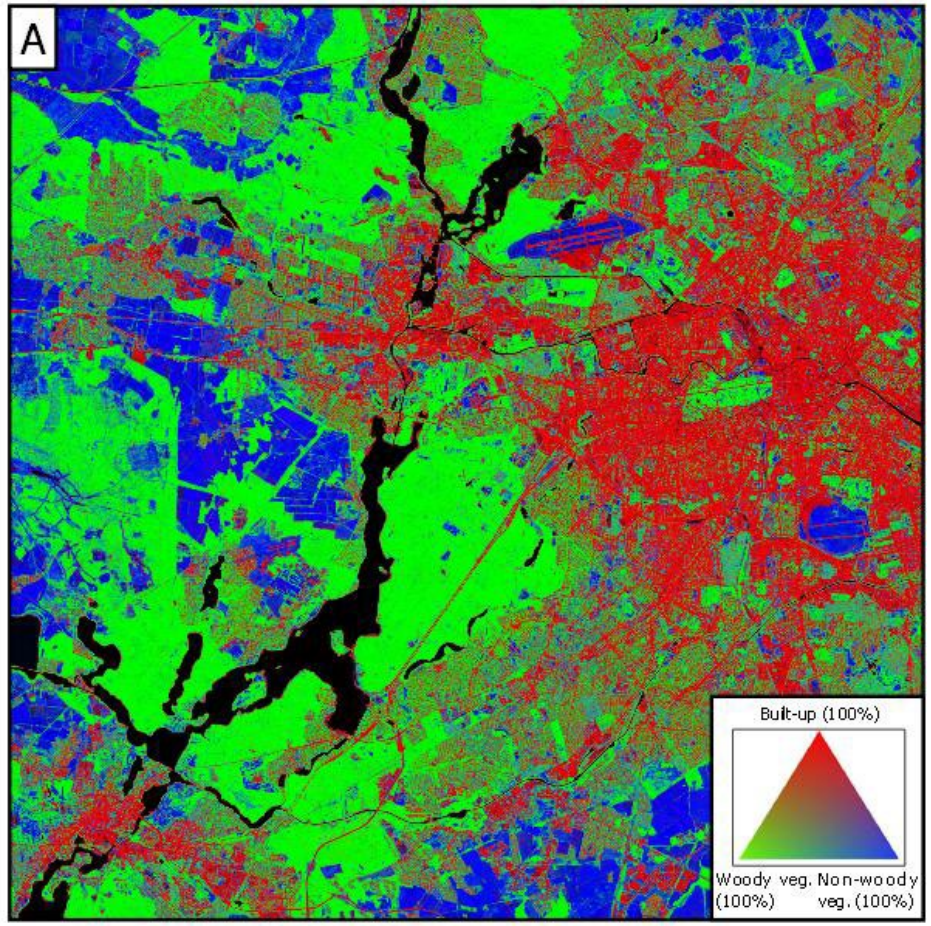
Idea of the tree species fraction mapping

Land Cover Fraction Mapping:

- Endmember e.g.:
  - Settlement, Vegetation (woody, non woody), bare soil, water, etc.

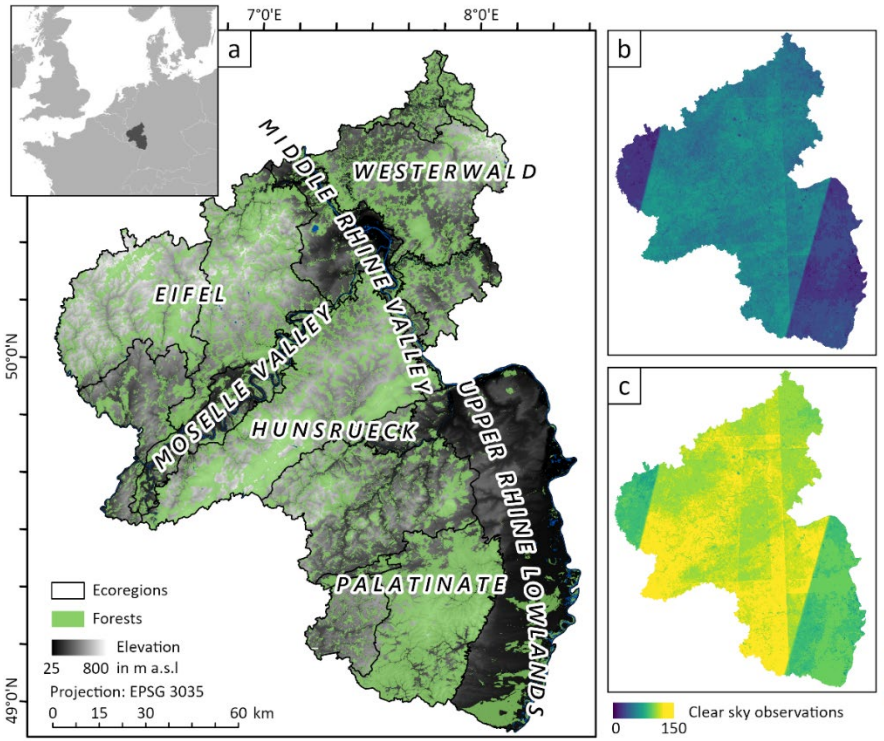
Tree Species Fraction Mapping:

- Endmember e.g.:
  Spruce, Beech, Oak, etc.



FORCE documentation – Figure by Franz Schug

Data: Sentinel 2 – Spline reconstruction



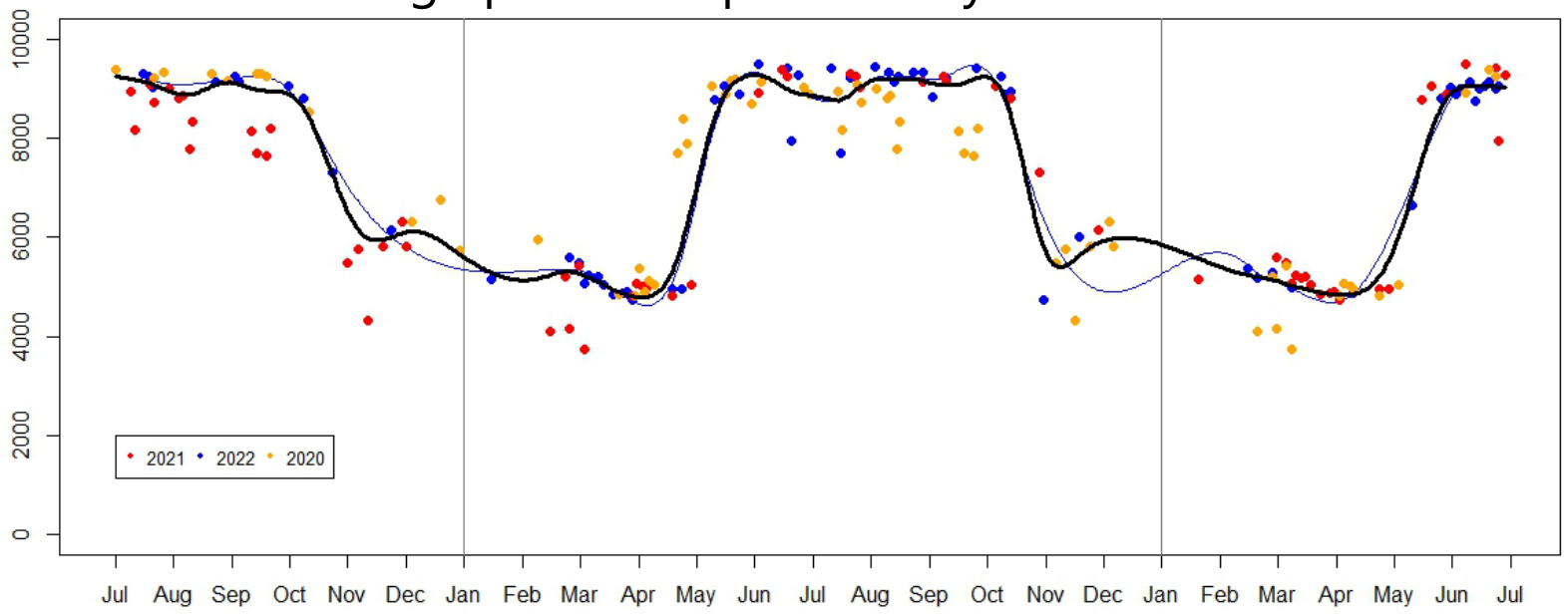
Klehr et al. (2025)

Sentinel 2 datacube by

FORCE

Framework for Operational Radiometric Correction for Environmental Monitoring

Enhancing Spline Interpolation by Bolton et al. 2021



Tree Species Fraction Mapping

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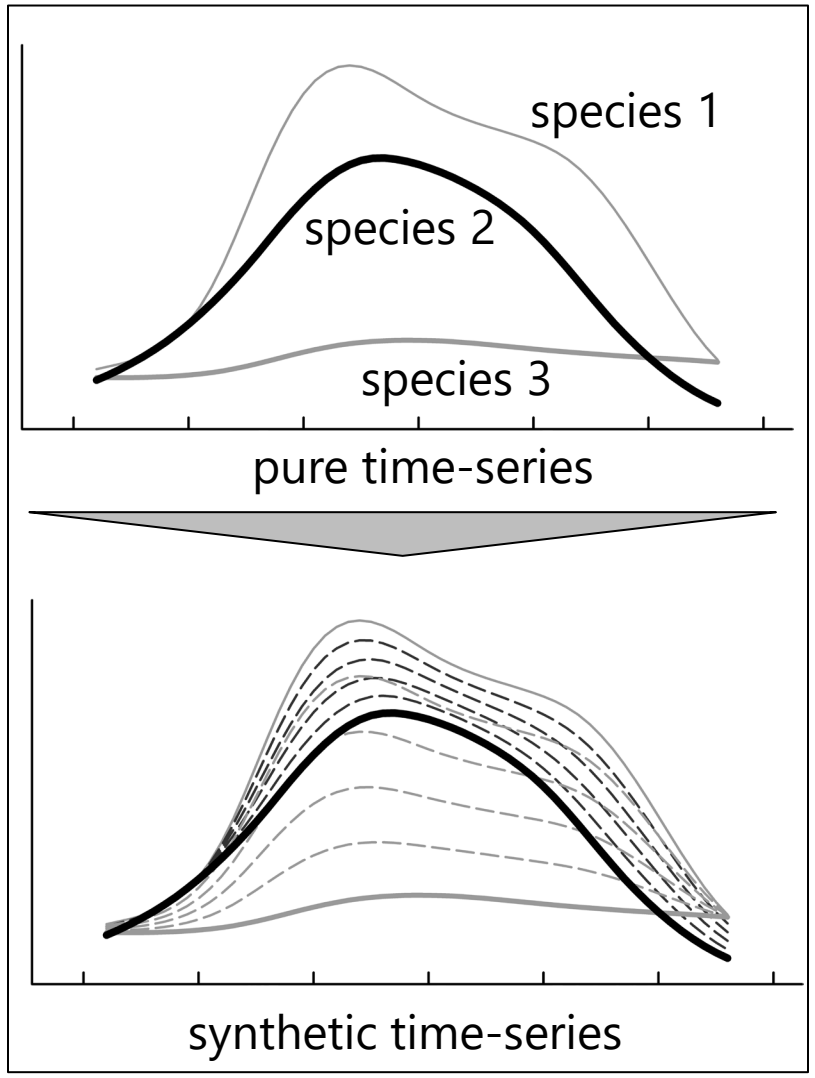
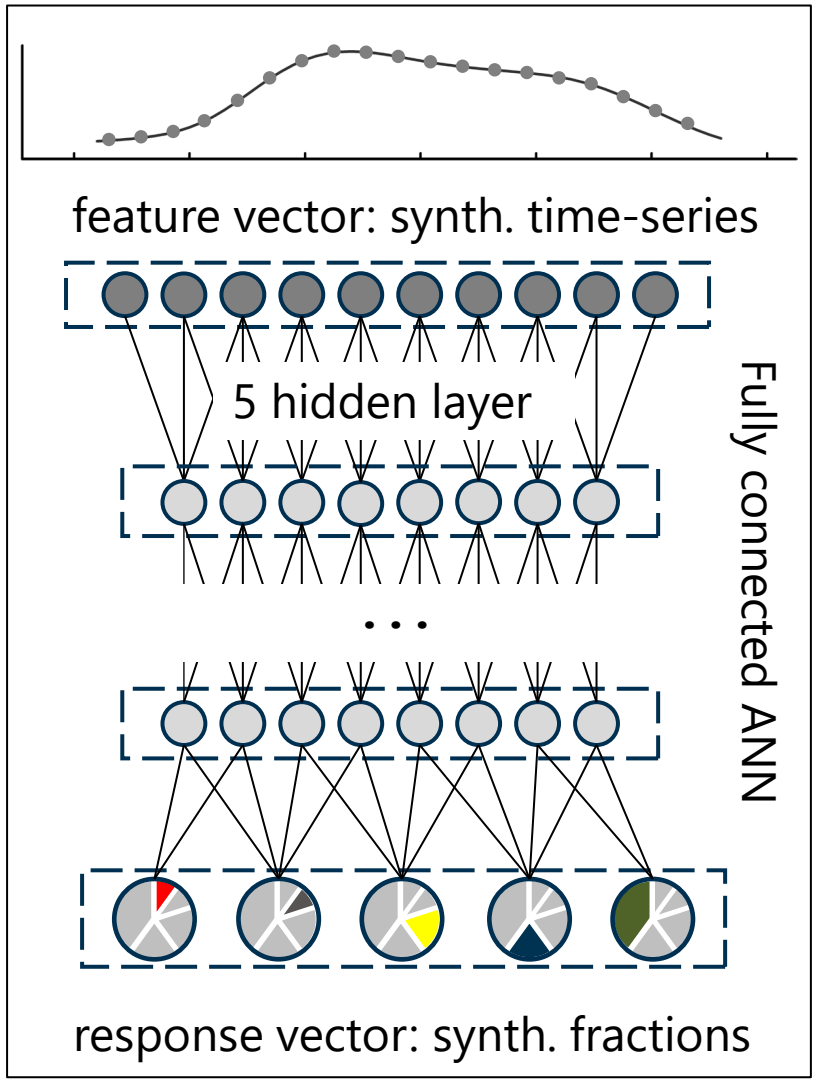
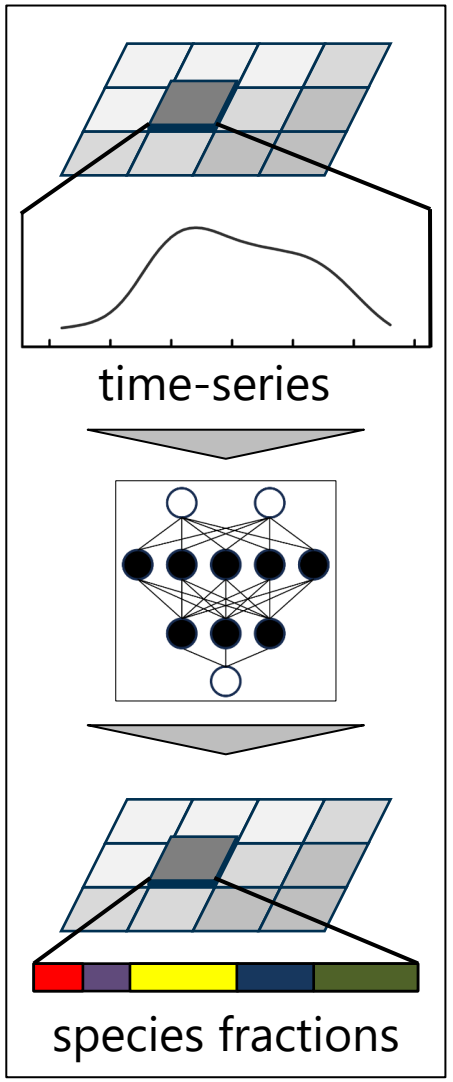
1. Building a spectral library



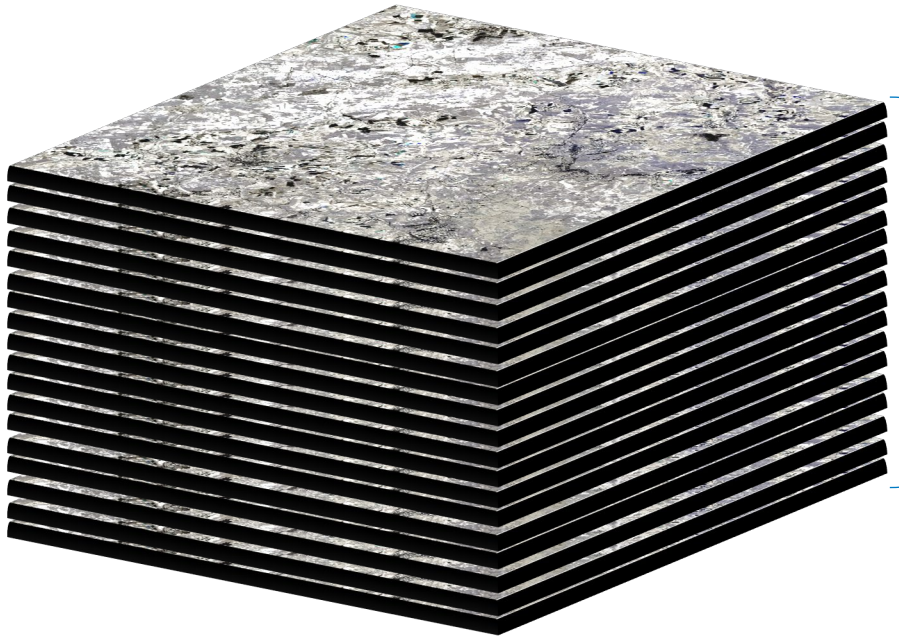
2. Train prediction model



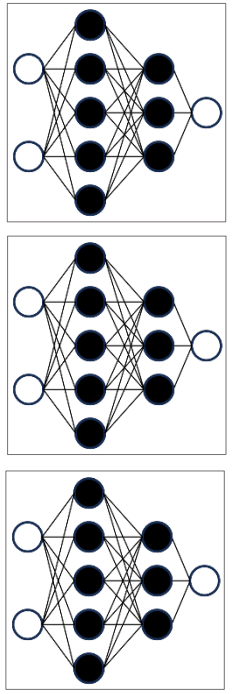
3. Apply model



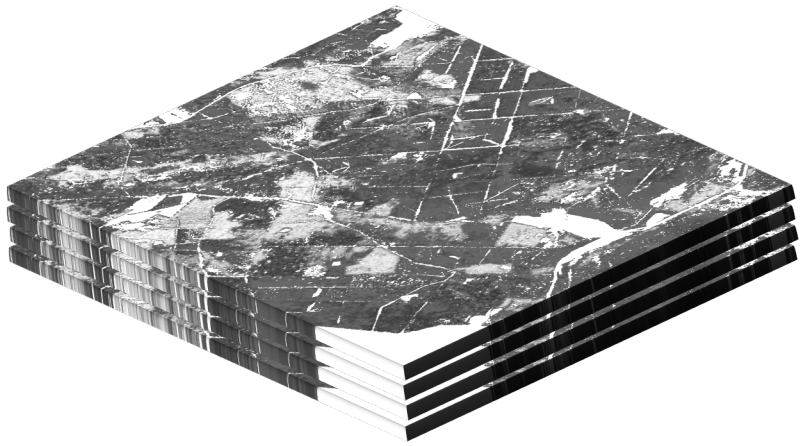
Tree Species Fraction Mapping



Time series datacube
(10 Sentinel 2 bands)

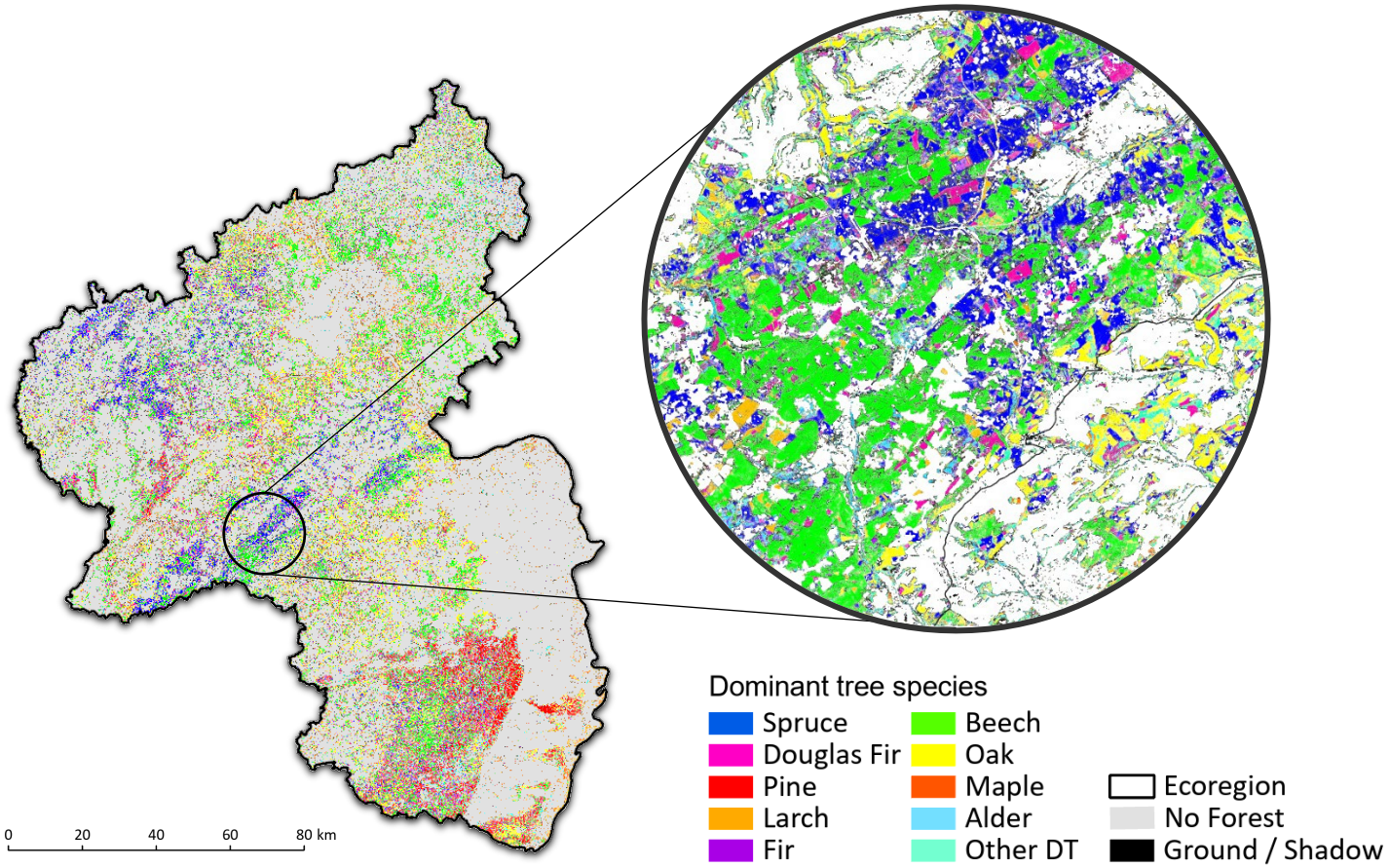


ensemble model approach



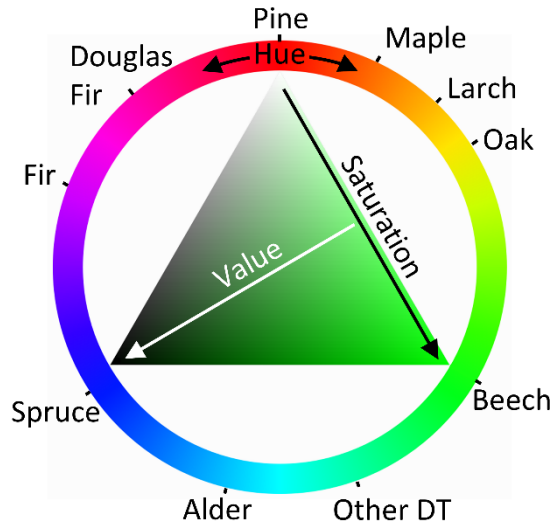
12-band (species) fraction raster

Results



Klehr et al. (2025)

Colorcoding:



Hue:
defined angle for dominant tree species

Saturation:
fraction of dominant tree species

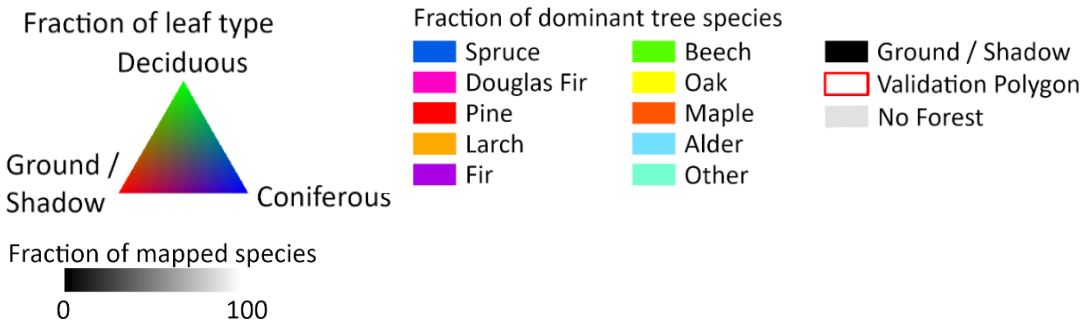
Value:
backgound (shadow+ground) fraction

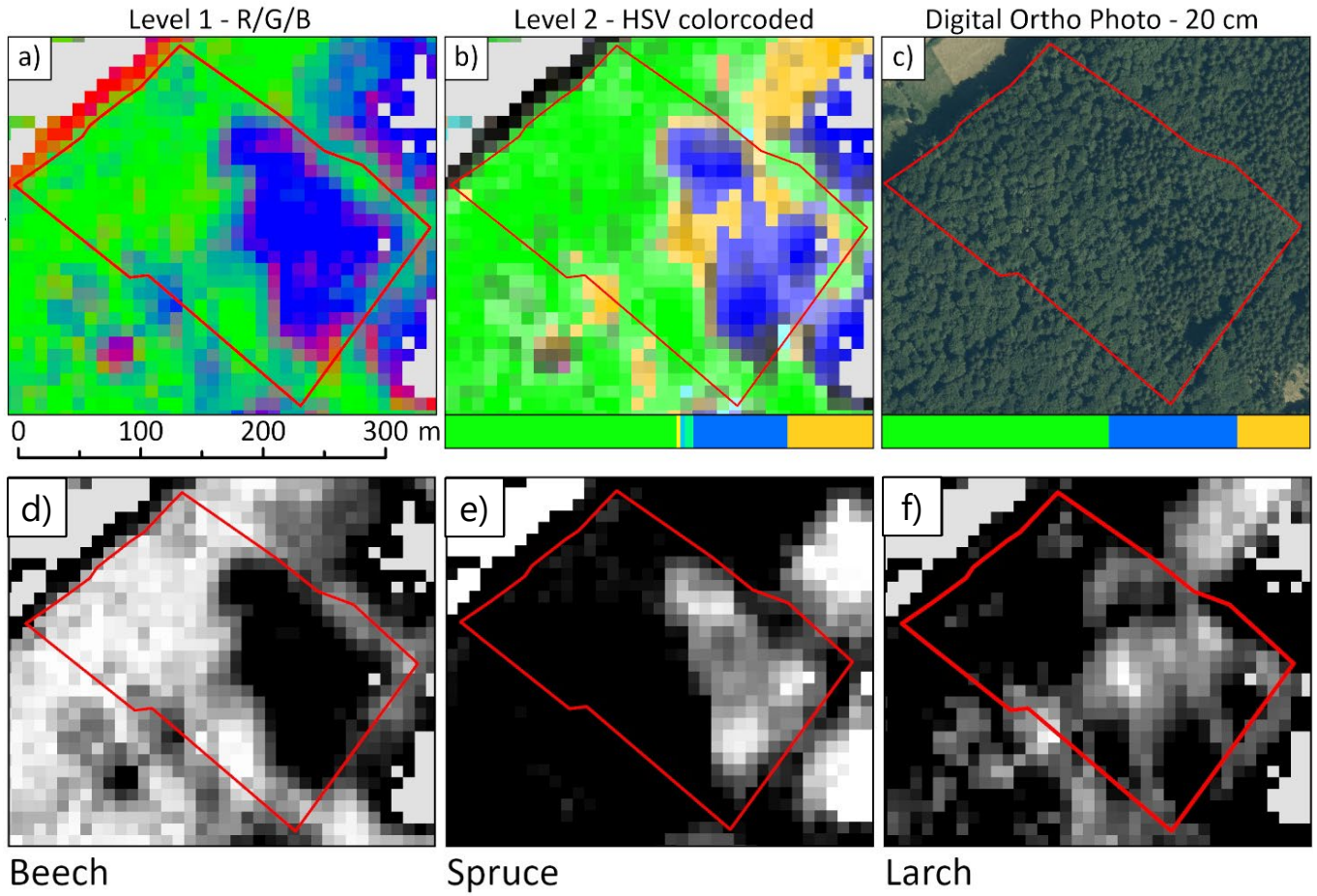
Results

Example:

- Conifers in the eastern part
  Larch and Spruce
- Beech everywhere else
- Shadow at the edge of the forest

- Clearer distribution, when we look at the individual species' fractions

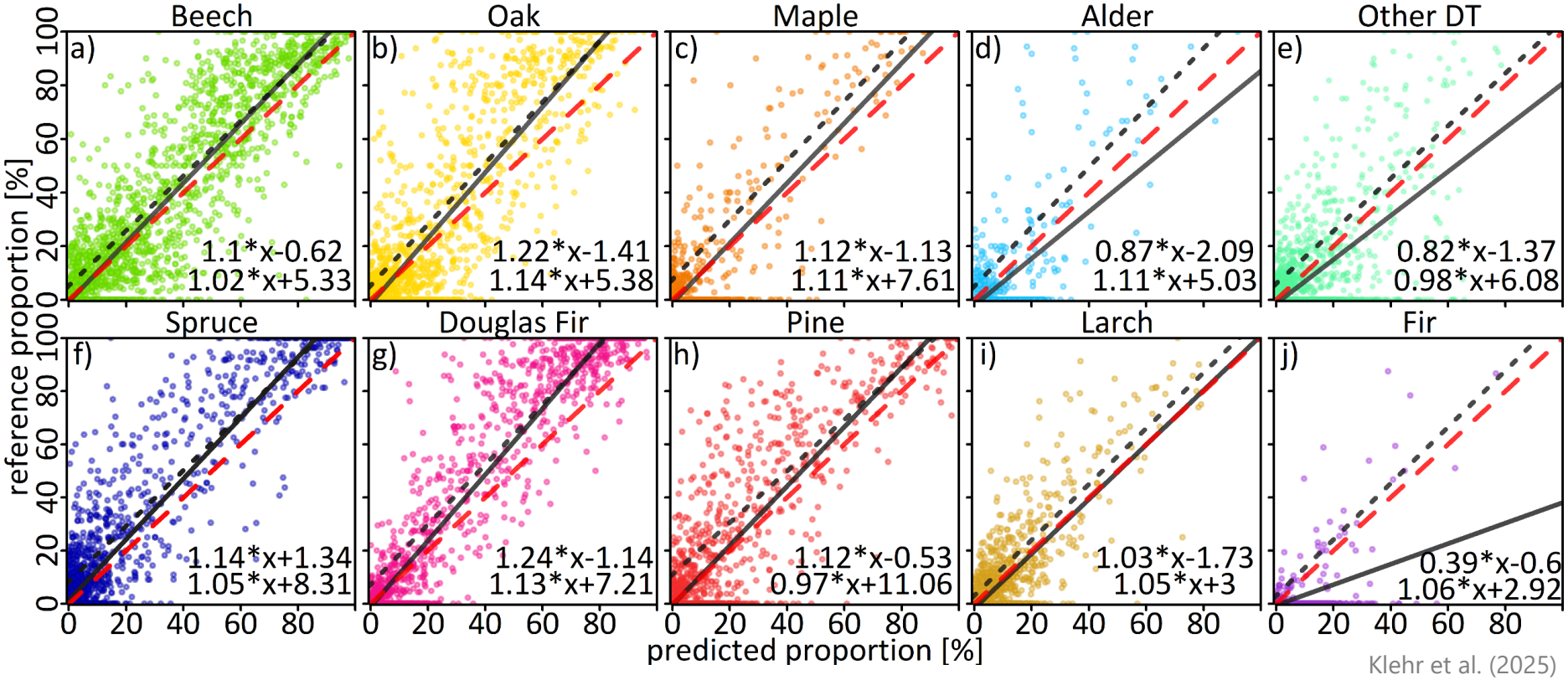




Klehr et al. (2025)

Validation

Predicted vs reference proportions of **forest stock polygons**

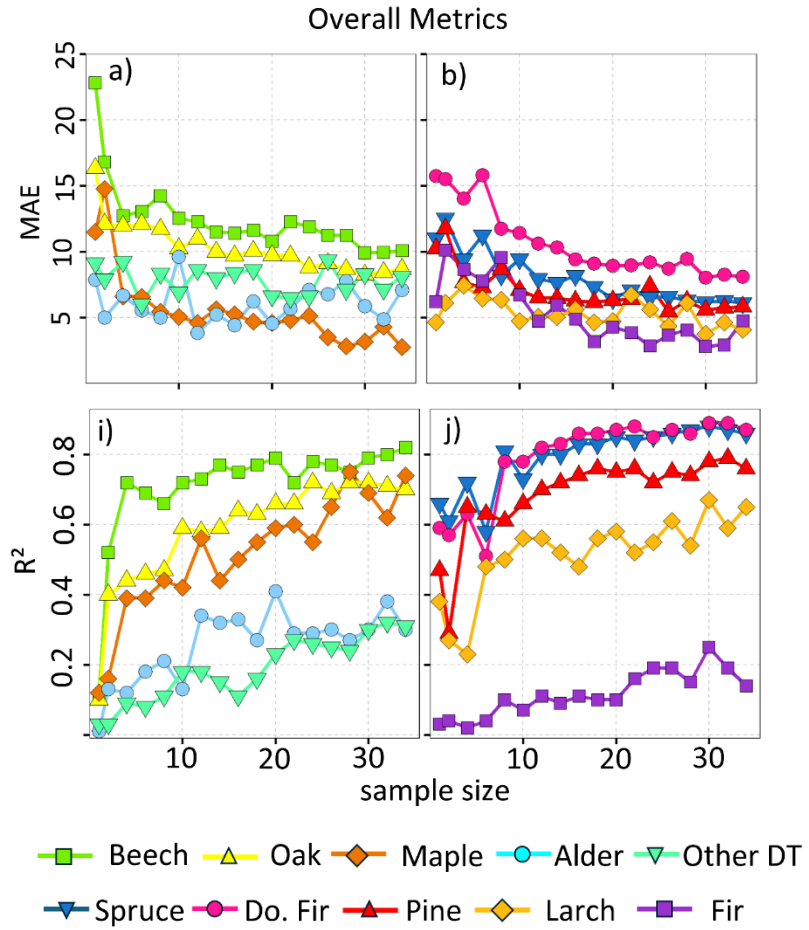


Klehr et al. (2025)

	MAE [%]	R^2
Beech	9.20	0.83
Oak	7.90	0.77
Maple	3.01	0.74
Alder	4.03	0.47
Other DT	6.82	0.42
Spruce	5.69	0.88
Douglas Fir	6.97	0.92
Pine	5.41	0.79
Larch	4.25	0.65
Fir	2.66	0.25

Training sample size

- High error values with a low number of pure training points, rapidly decreasing up to a number of 10
- Low R^2 with a low number of pure training points, increasing rapidly up to a number of 10 -15
- All spectra evolve to a maximum/ minimum between 20 and 30
  - Saturation at sample size of 30
- Still improving with higher sample numbers, but with little effect



Klehr et al. (2025)

Outlook

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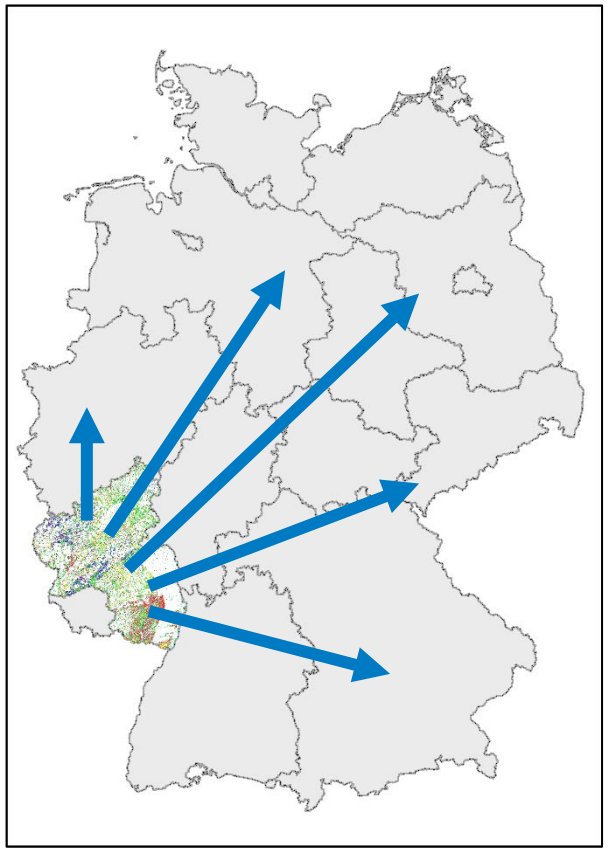
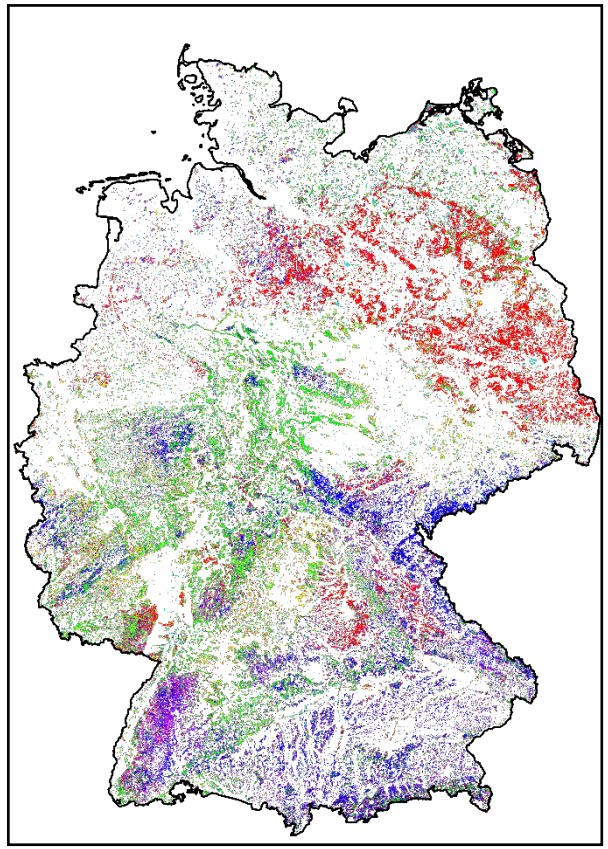
Apply to Germany





Dominant tree species

- Spruce
- Douglas Fir
- Pine
- Larch
- Fir
- Beech
- Oak
- Maple
- Alder
- Other DT
- Ecoregion
- No Forest
- Ground / Shadow

ForestPulse

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Questions?

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Thanks for Watching

Geoinformatics - Spatial Data Science

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Project Webpage
https://forestpulse.thuenen.de/

Open Development
https://github.com/ForestPulse

Publication

Gefördert durch:

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