Linking Sentinel-2 and Sentinel-1 time series to national forest inventory data to map tree species at the national level

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Motivation

Why map tree species?

- **Growth and yield predictions** (Haara et al., 2019)
- **Sustainable forest management** (Gamfeldt et al., 2013; Lehtomäki et al., 2015; Vihervaara et al., 2017)
- Research and implementation of **climate adaptation** strategies (Hof et al., 2017)
- Differentiating **forest disturbance types**

Research Aims

1) Which **accuracies** can be achieved on a national scale when combining **NFI observations with Sentinel-1 and Sentinel-2** time series data for **mapping major tree species groups**?

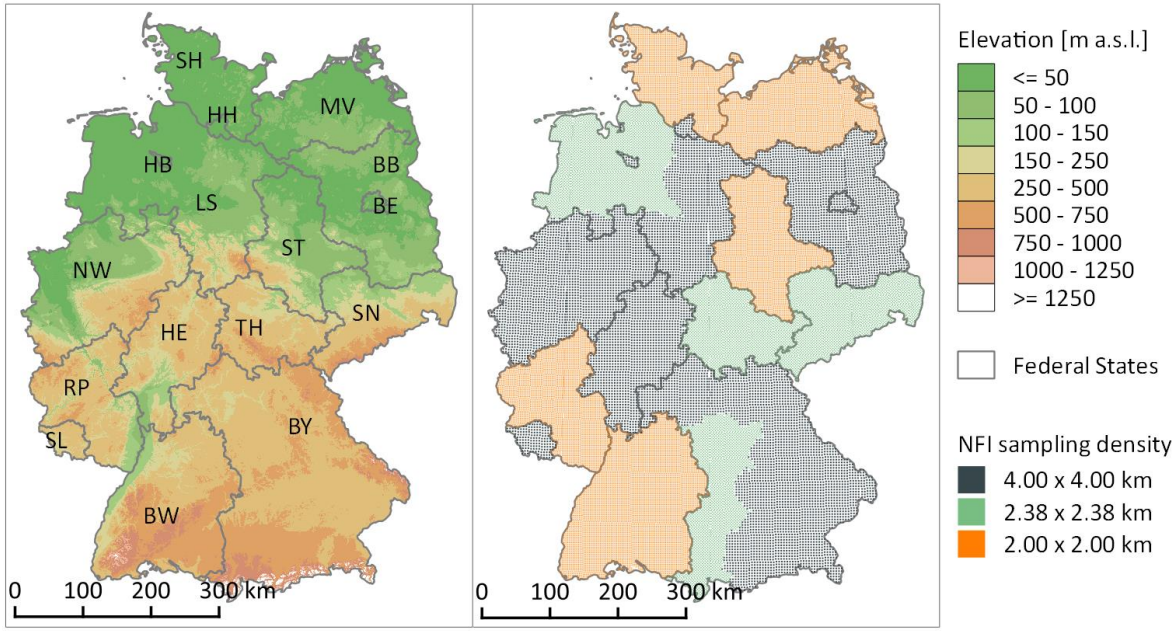
2) How strongly do **achieved accuracies differ** between homogenous **single species** stands and **mixed species forest** stands?

National Forest Inventory - Germany

- German-wide **2-4 km sampling density** (~21,000 sample clusters)
- Data collections are performed at **4 locations per cluster**
- For tree species mapping we use data **recorded through Angle Count Sampling** (ACS)

Major Challenges:

- Data coverage for **rare species and stands with mixed species composition**
- **ACS-Method**
- **Positional accuracy of GNSS measurements**



Input Data

Frantz (2019): FORCE – Landsat + Sentinel-2 Analysis Ready Data and beyond.

Sentinel-2

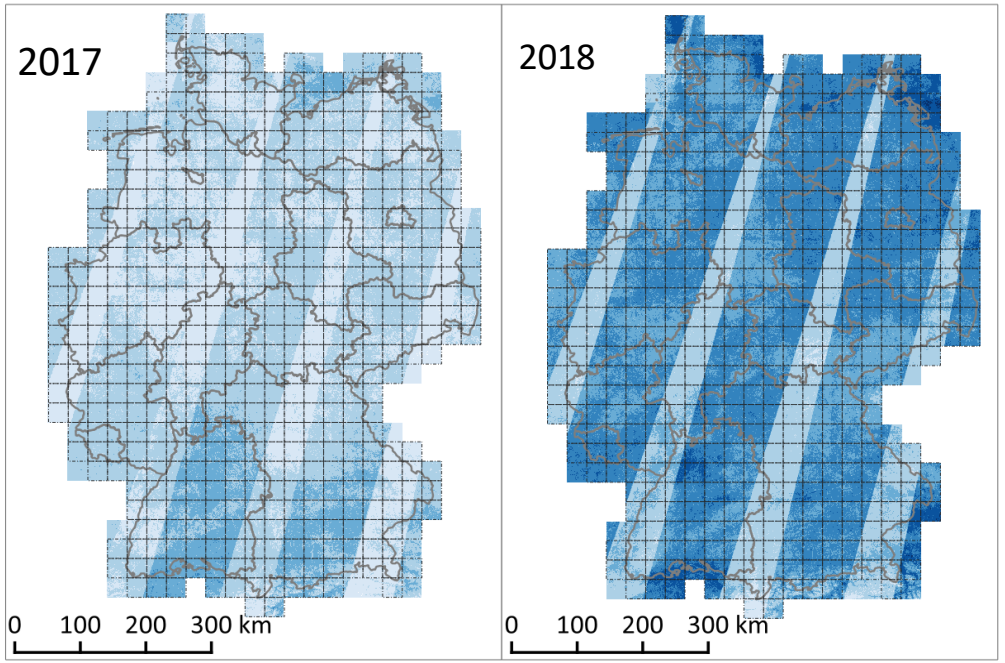
- **Mar. – Nov. 2017/2018**
- **Preprocessing through FORCE**
- Temporal 5-day **interpolation through RBF filter ensemble** (Schwieder et al., 2016)

Sentinel-1

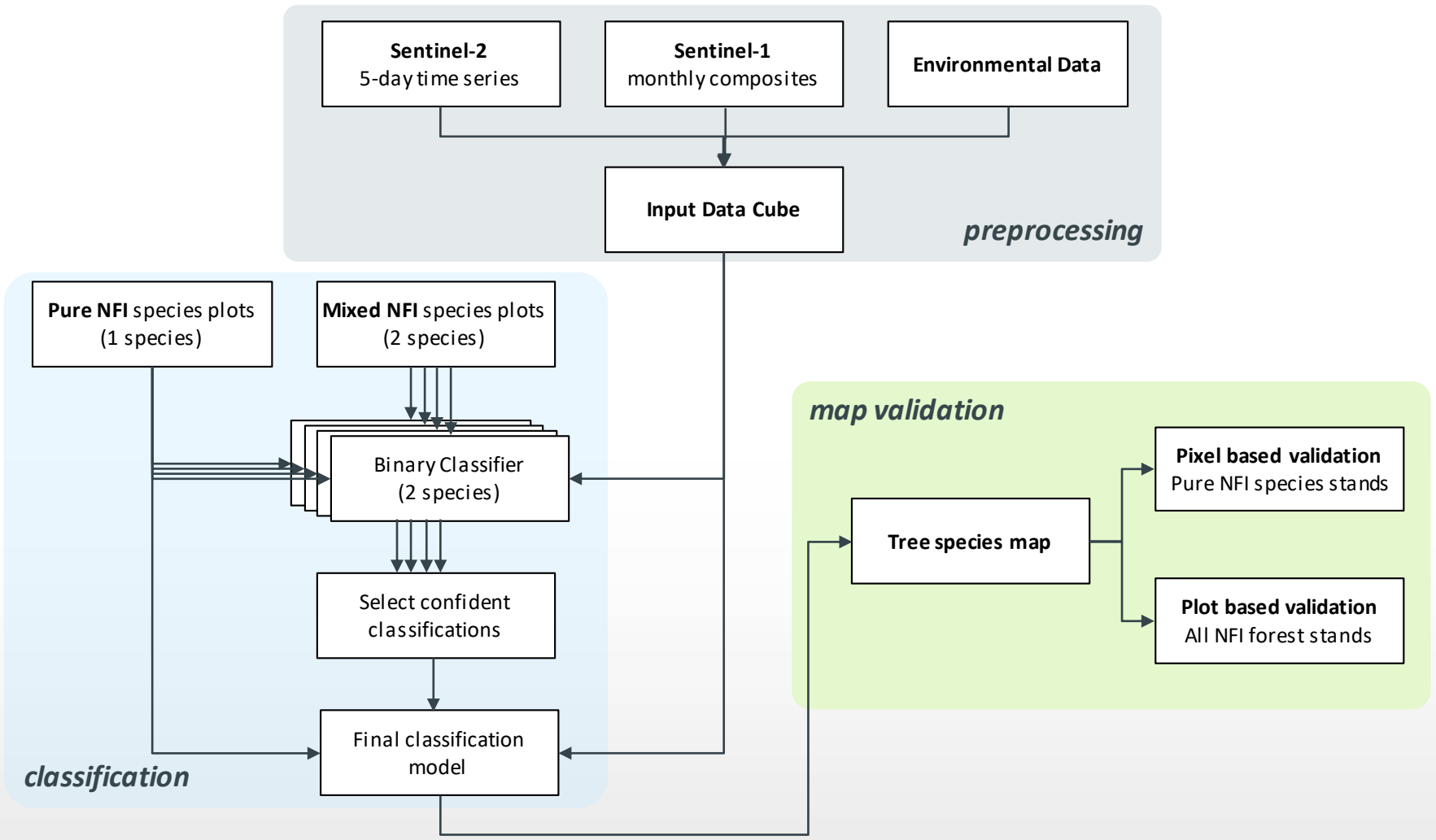
- Monthly **VH- und VV-backscatter composites** from 2017 und 2018 (Benz et al., 2020)
- Rada vegetation index **RVI and VH/VV-Ratio**

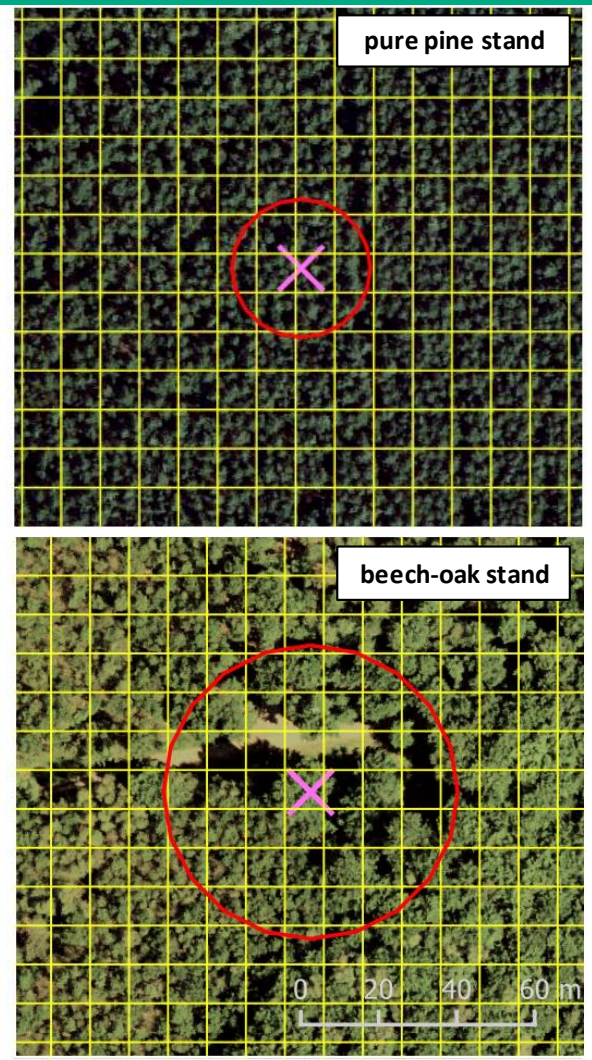
Environmental Variables

- Topography
- Climate
- Meteorology



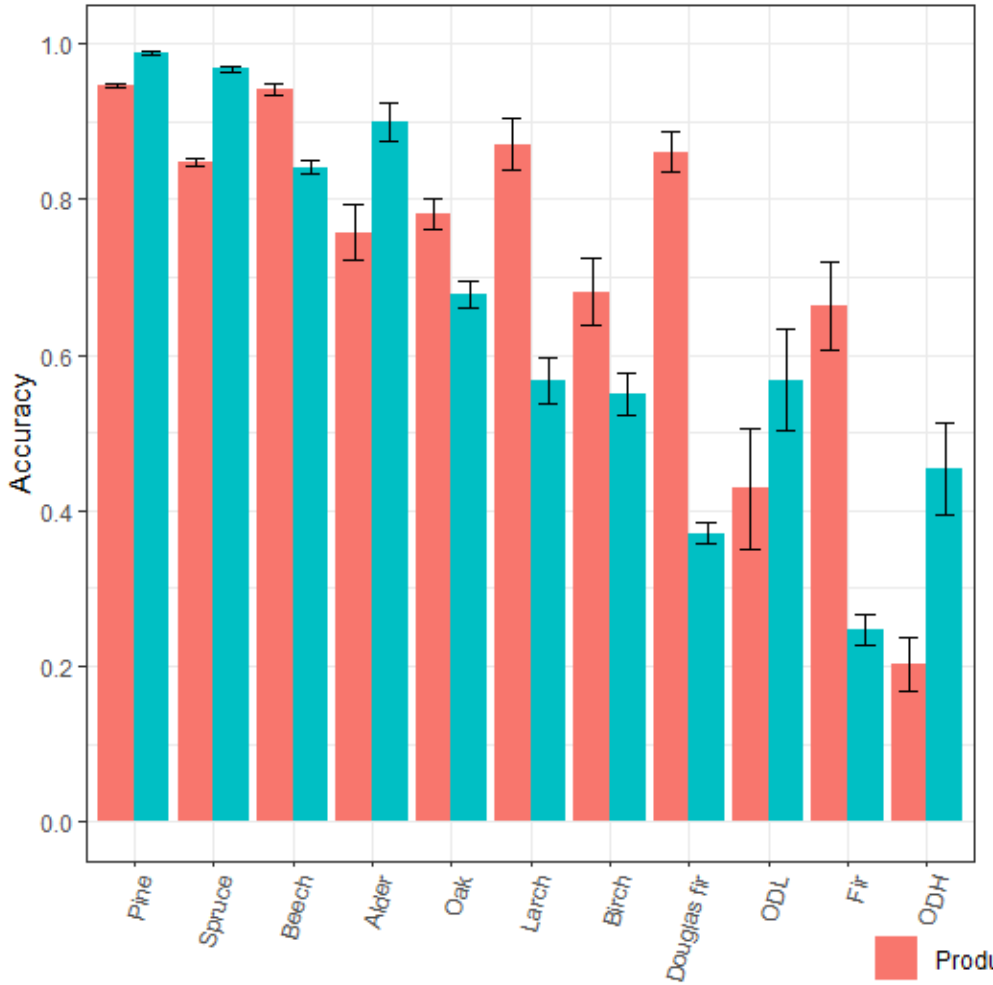
Classification Workflow



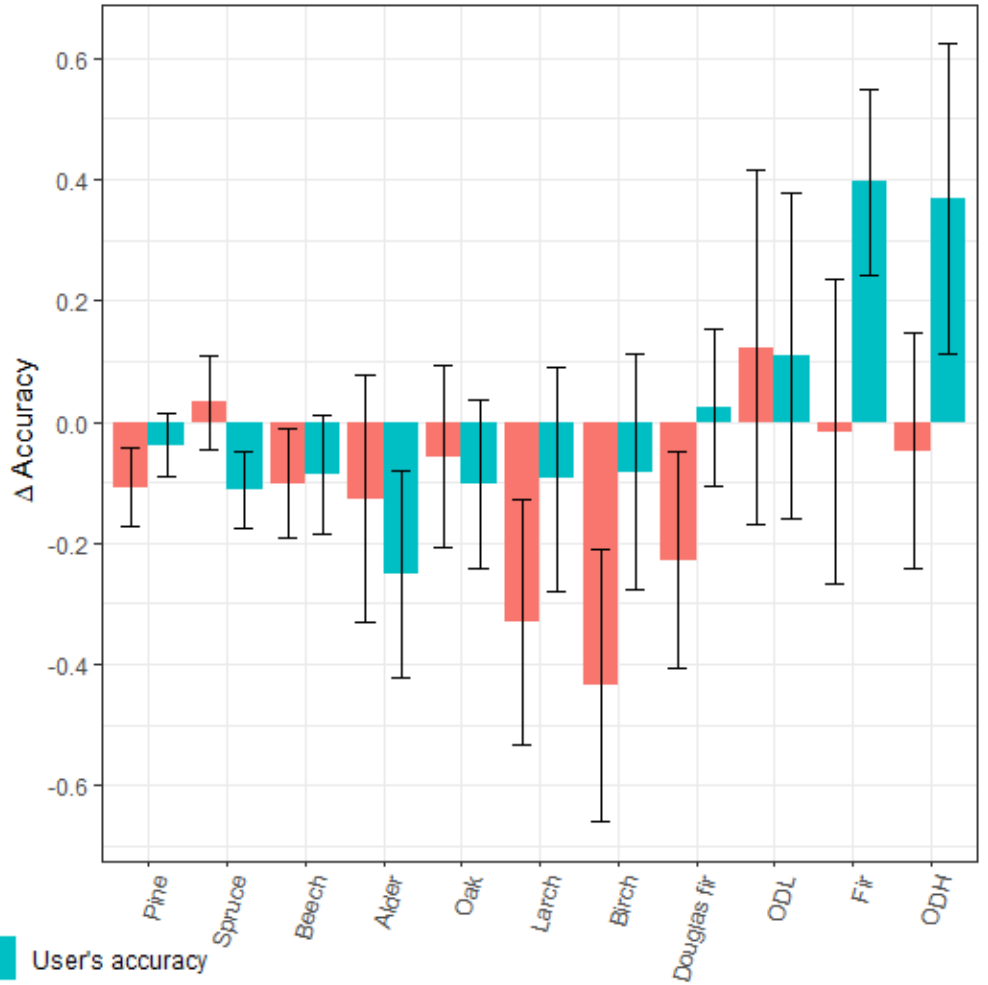


Results and Discussion

Single-species stands:



All forest stands:



Producer's accuracy User's accuracy

Results and Discussion

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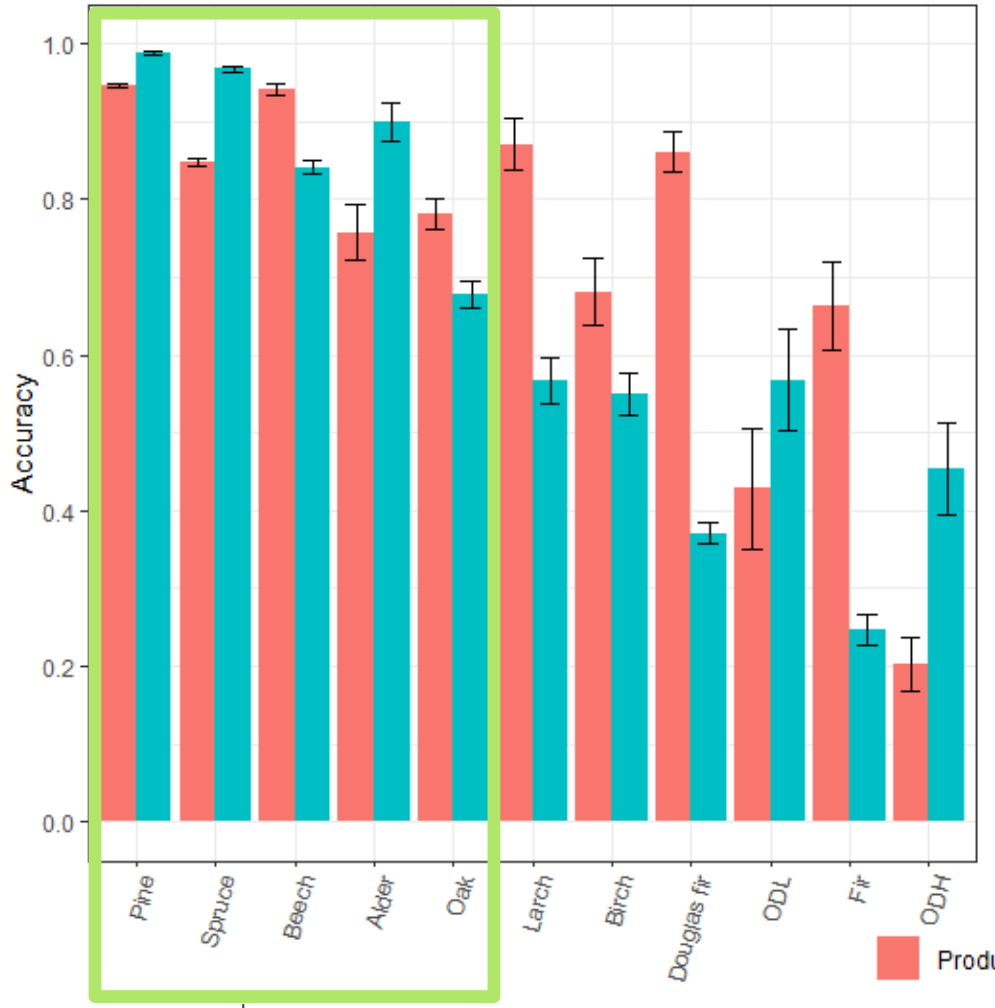

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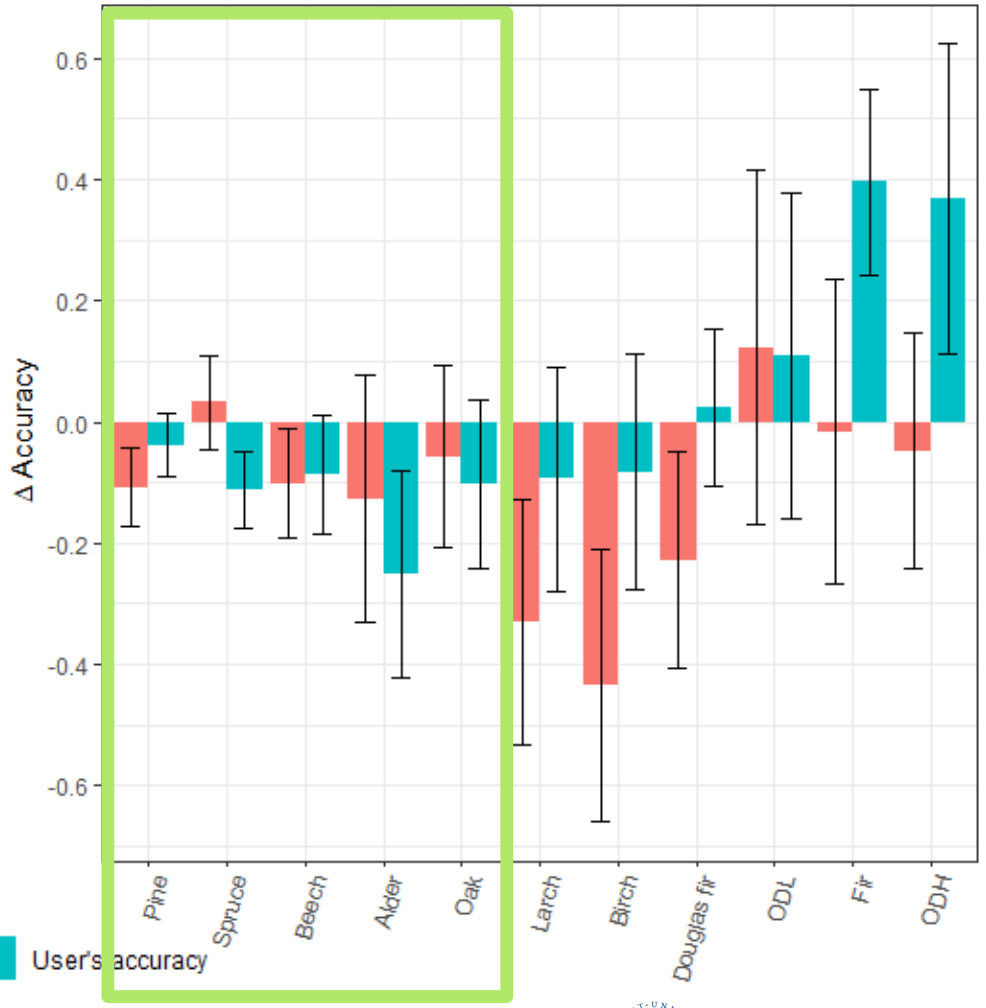

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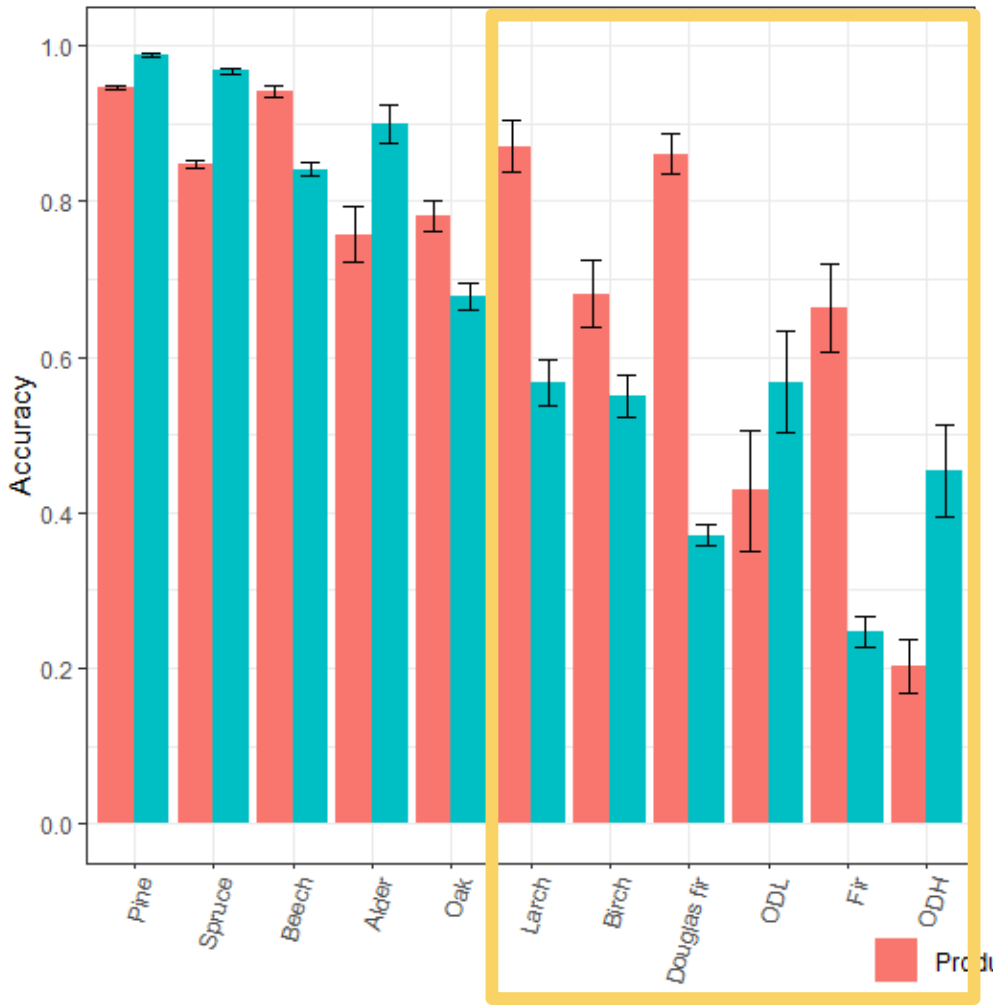

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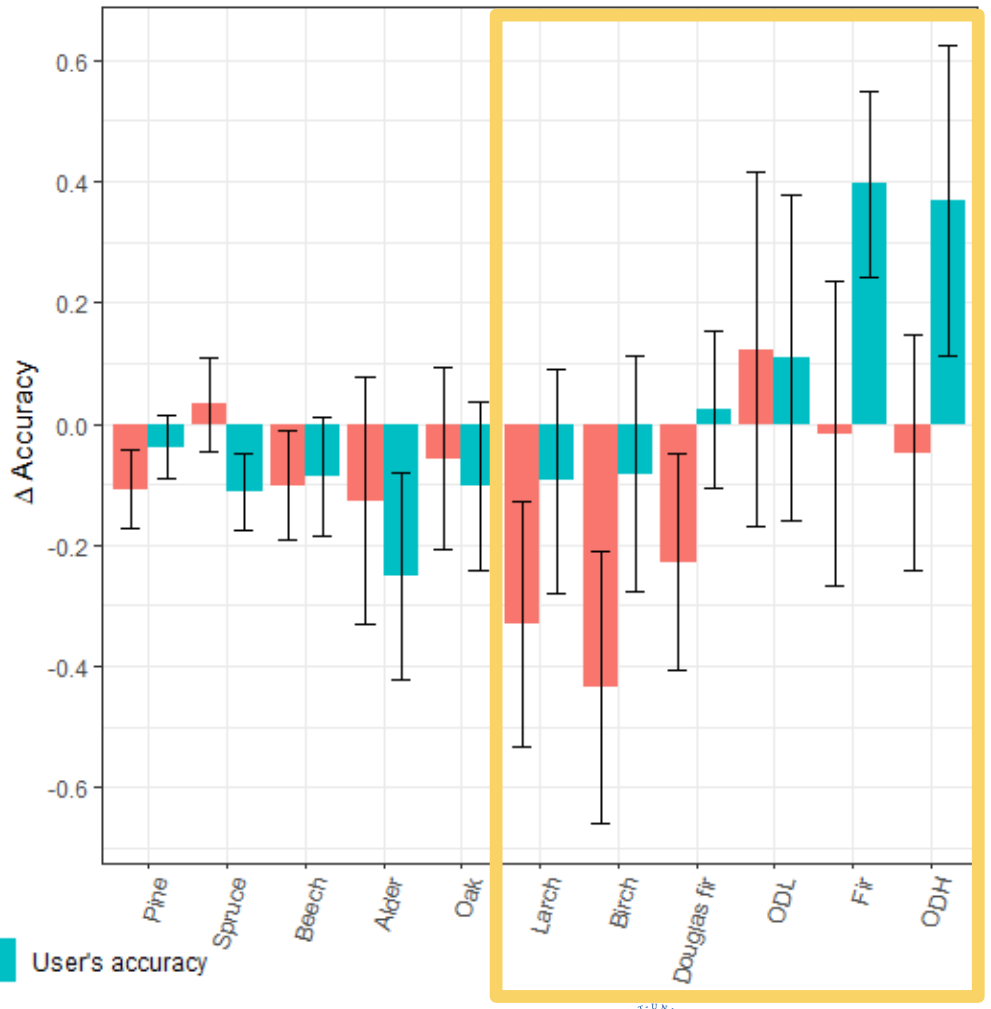

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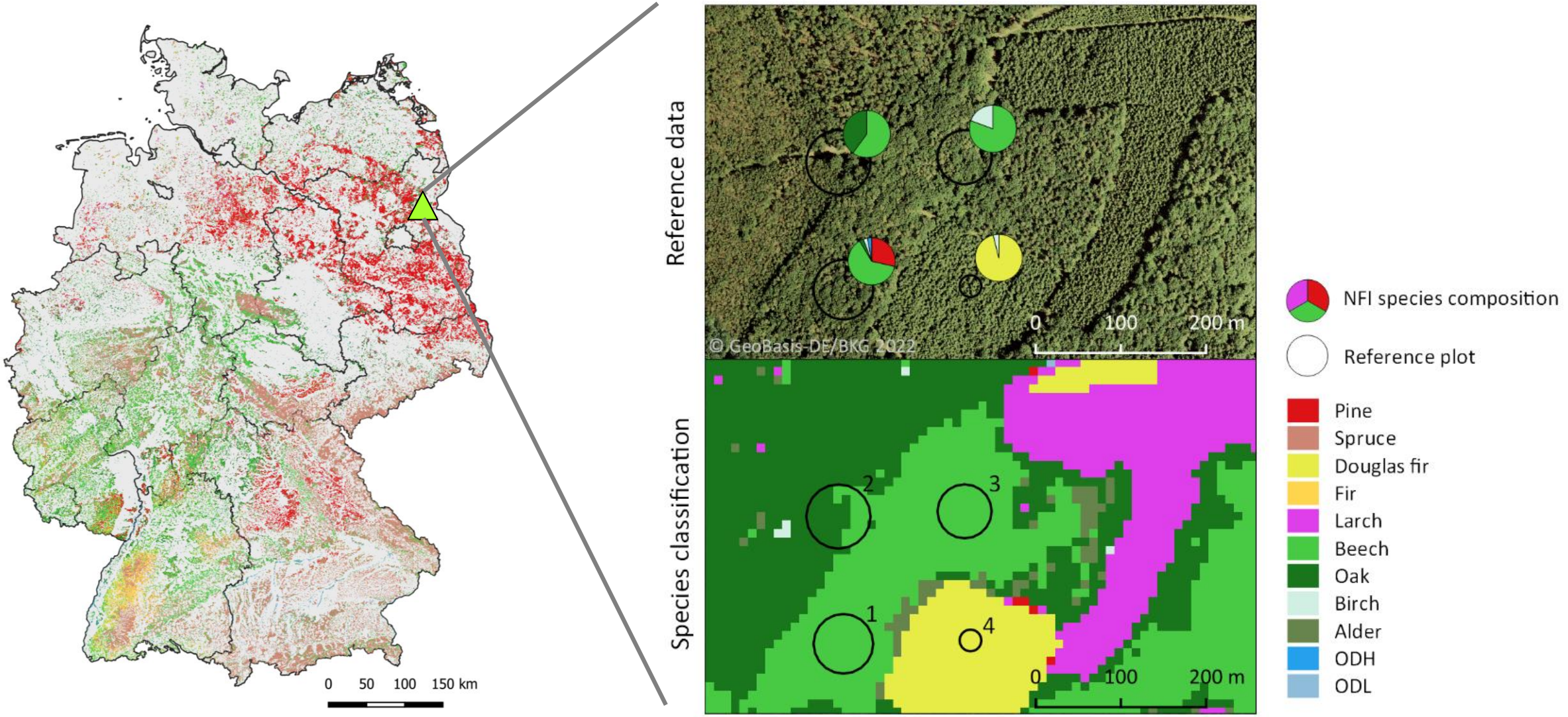

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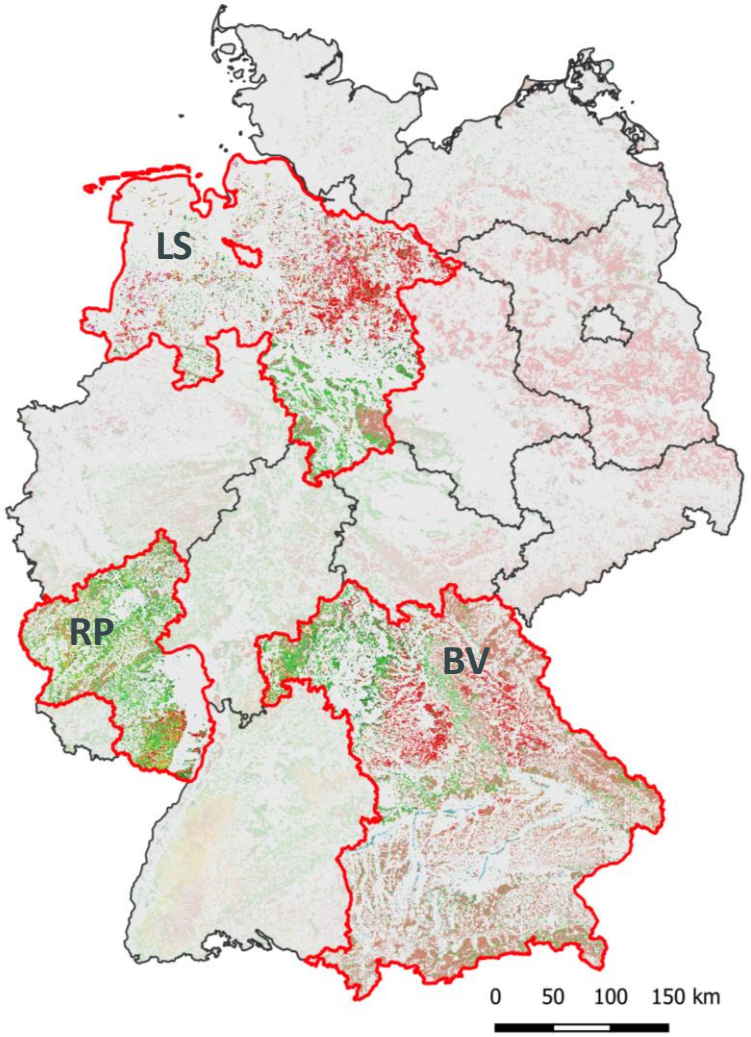

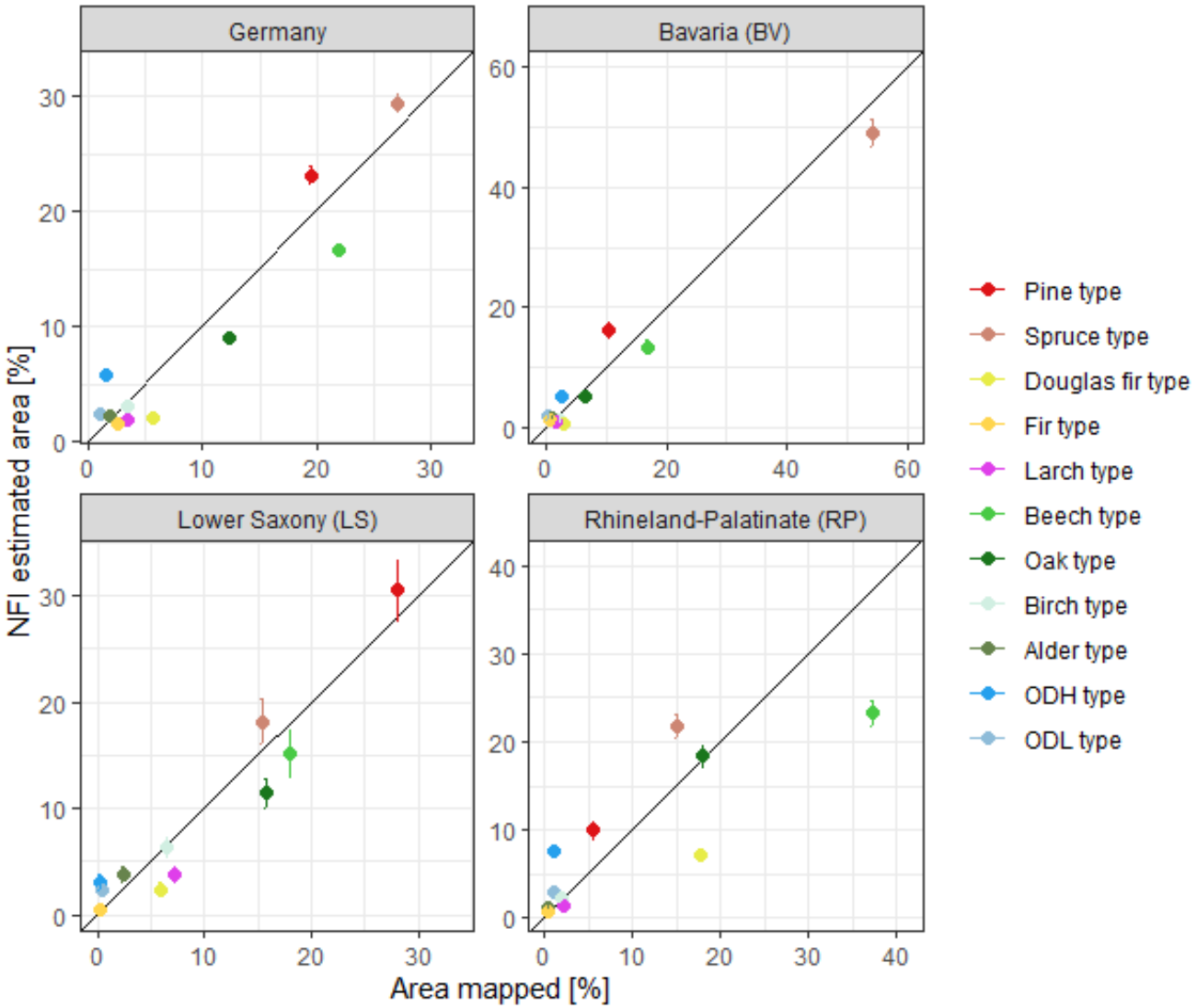

Where are we now?

- Dense time-series data enable **mapping of dominant tree species groups for large areas**
- Unique and large **NFI data sets** can be exploited as reference data source

- **Main sources of miss-classifications**
  - Phenologically and morphologically similar species
  - Mixed spectral signals due to *2D* and *3D* species mixtures
- **To improve mapping efforts, further research is needed on**
  - Complex-structured, mixed species stands
  - Species mostly occurring as minor admixture in forest stands

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Looking forward to discussions!
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