

Predicting fractional cover of standing deadwood at landscape level based on long short-term memory networks and Sentinel time series

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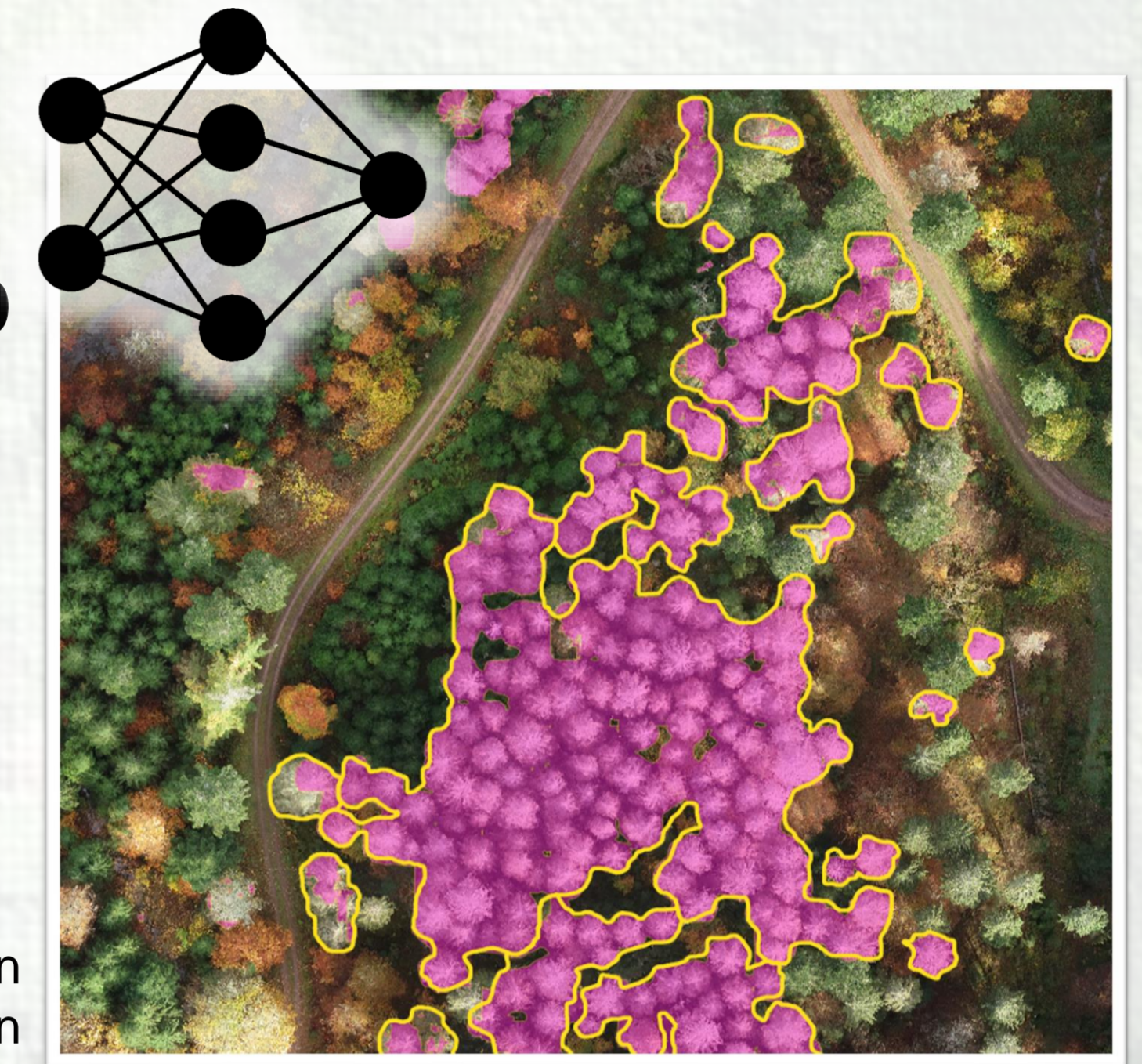
? Can CNN-predictions from UAV-imagery serve as reference data to accurately predict fractional cover of standing deadwood at landscape level with Sentinel data?

Step 1: CNN-based segmentation of standing deadwood (*local level*)

- RGB-imagery from UAVs
- Structure from Motion orthomosaic
- Spatial resolution < 2 cm
- 2017-2021
- 176 sites / ~ 200 ha
- Heterogeneous forests (South-western/central/eastern Germany, Finland)



- U-net CNN architecture
- Independent, pixel-based evaluation: **F1-Score = 0.89**
- Iterative optimization of co-registration with Sentinel-2 based on spectral band correlations

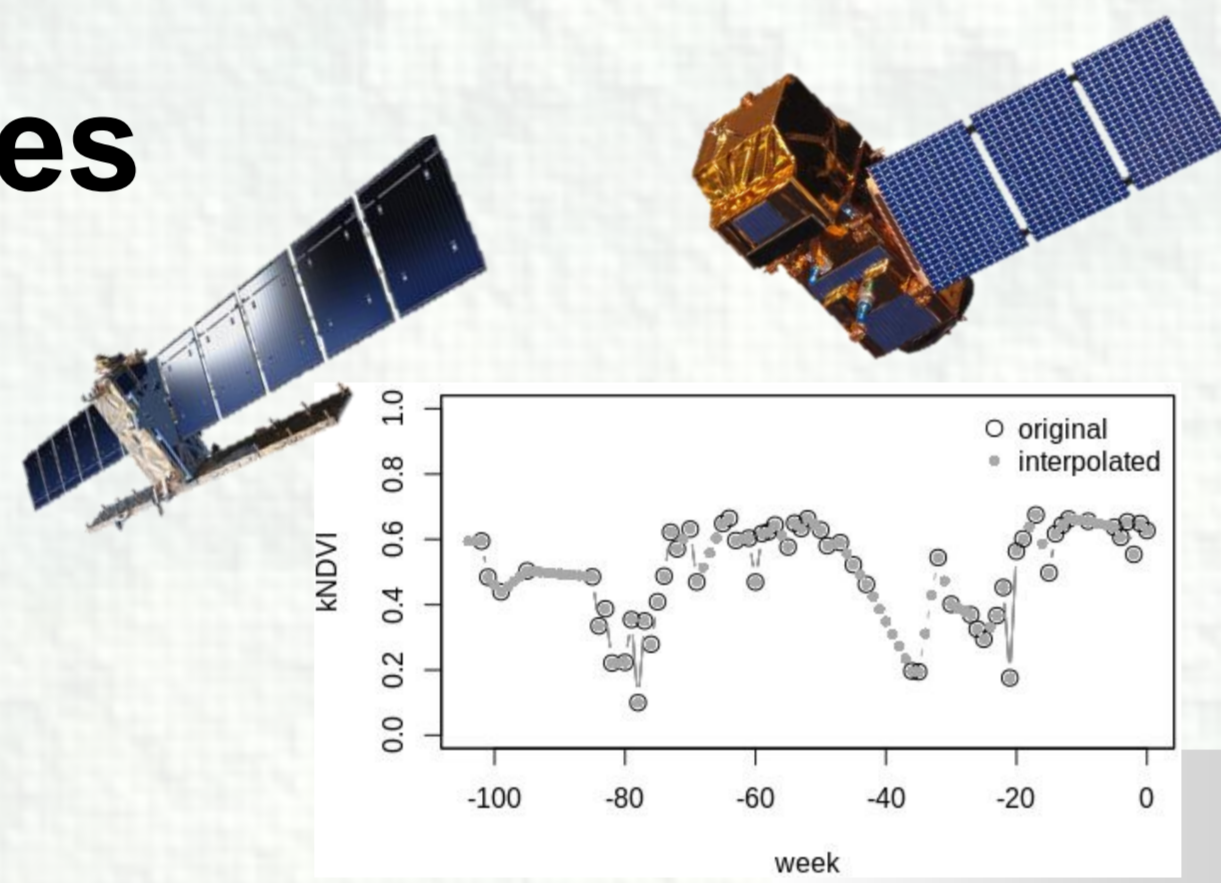


— delineation
■ CNN prediction

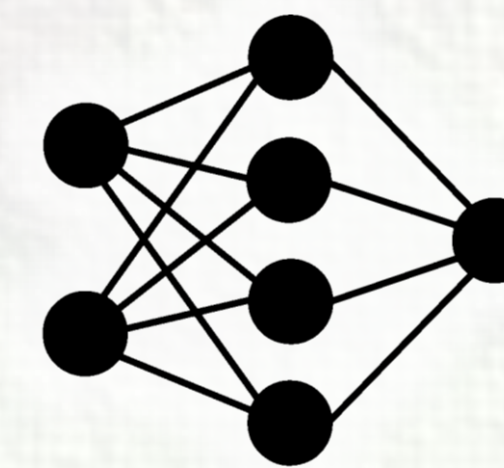
Step 2: Mapping fractional cover of standing deadwood from Sentinel time series (*landscape level*)

Satellite time series

- Sentinel-2 Level-2A
 - BOA (sen2cor)
 - Cloud filter < 70%
 - 11 bands + kNDVI
- Sentinel-1 Level-2
 - Terrain corrected backscatter (CARD-BS)
 - Interferometric coherence (CARD-COH6)
- 2-years time series
- Linear interpolation of missing values
- Aggregation to 7-day intervals

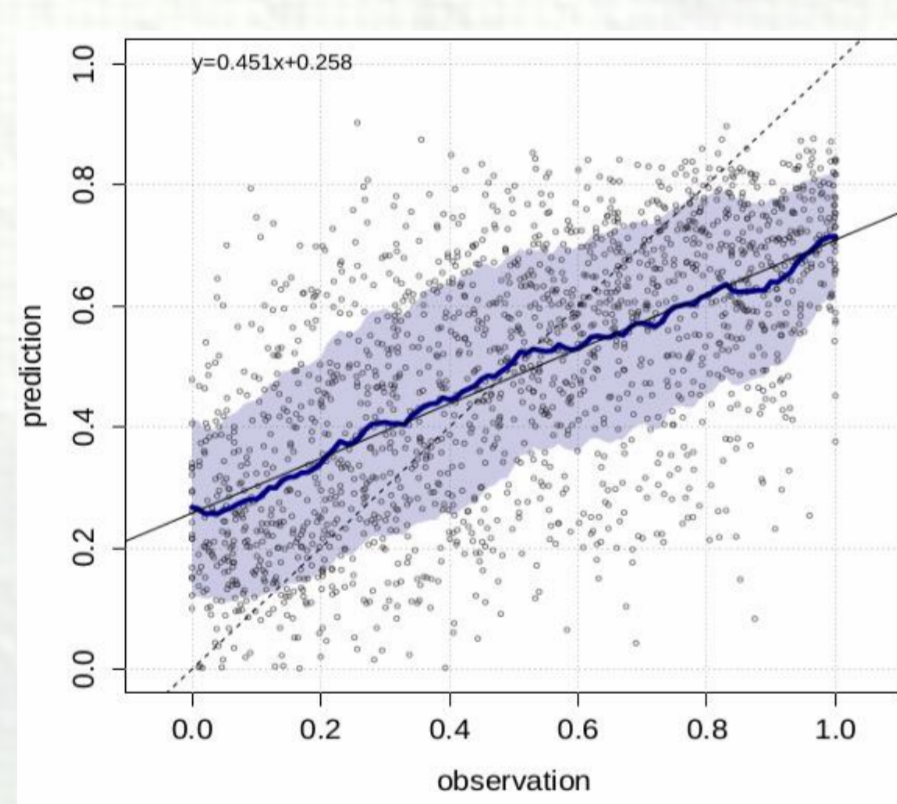
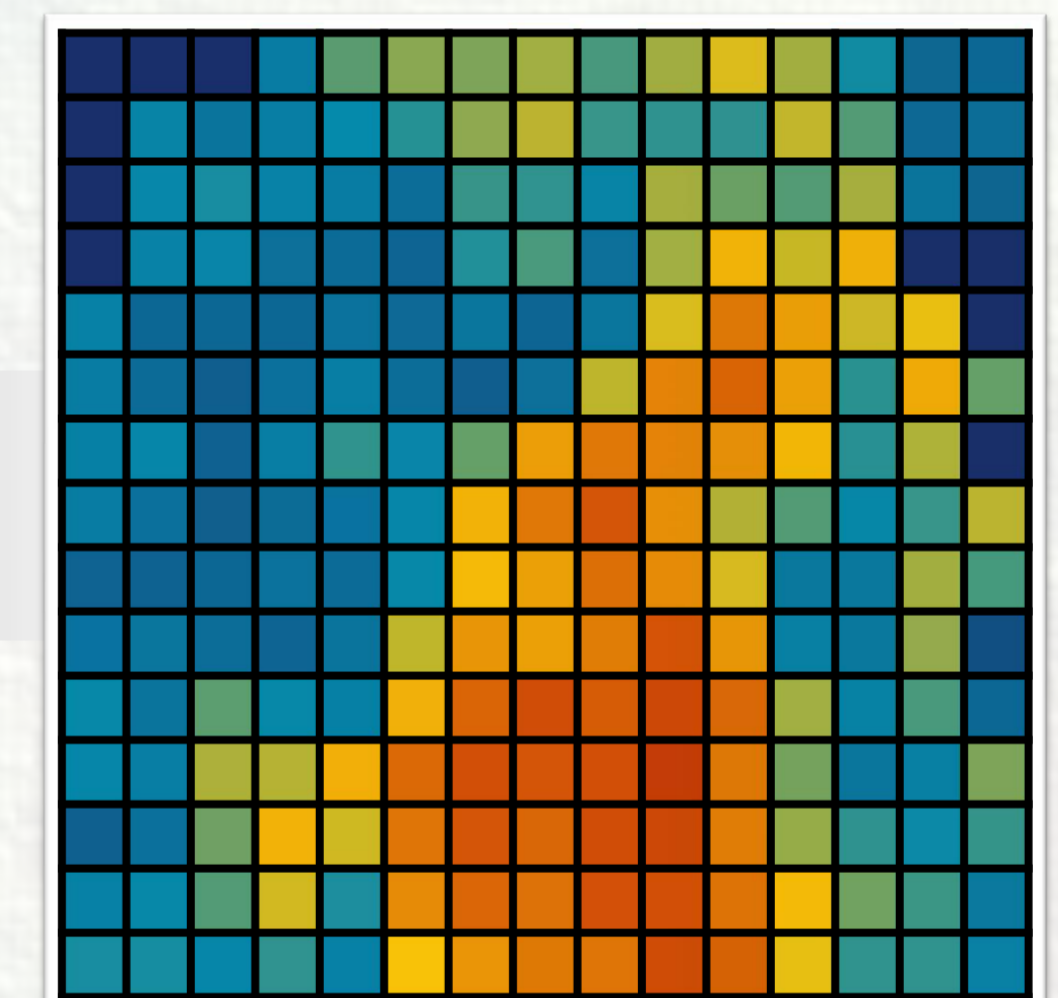


Long short-term memory (LSTM) network

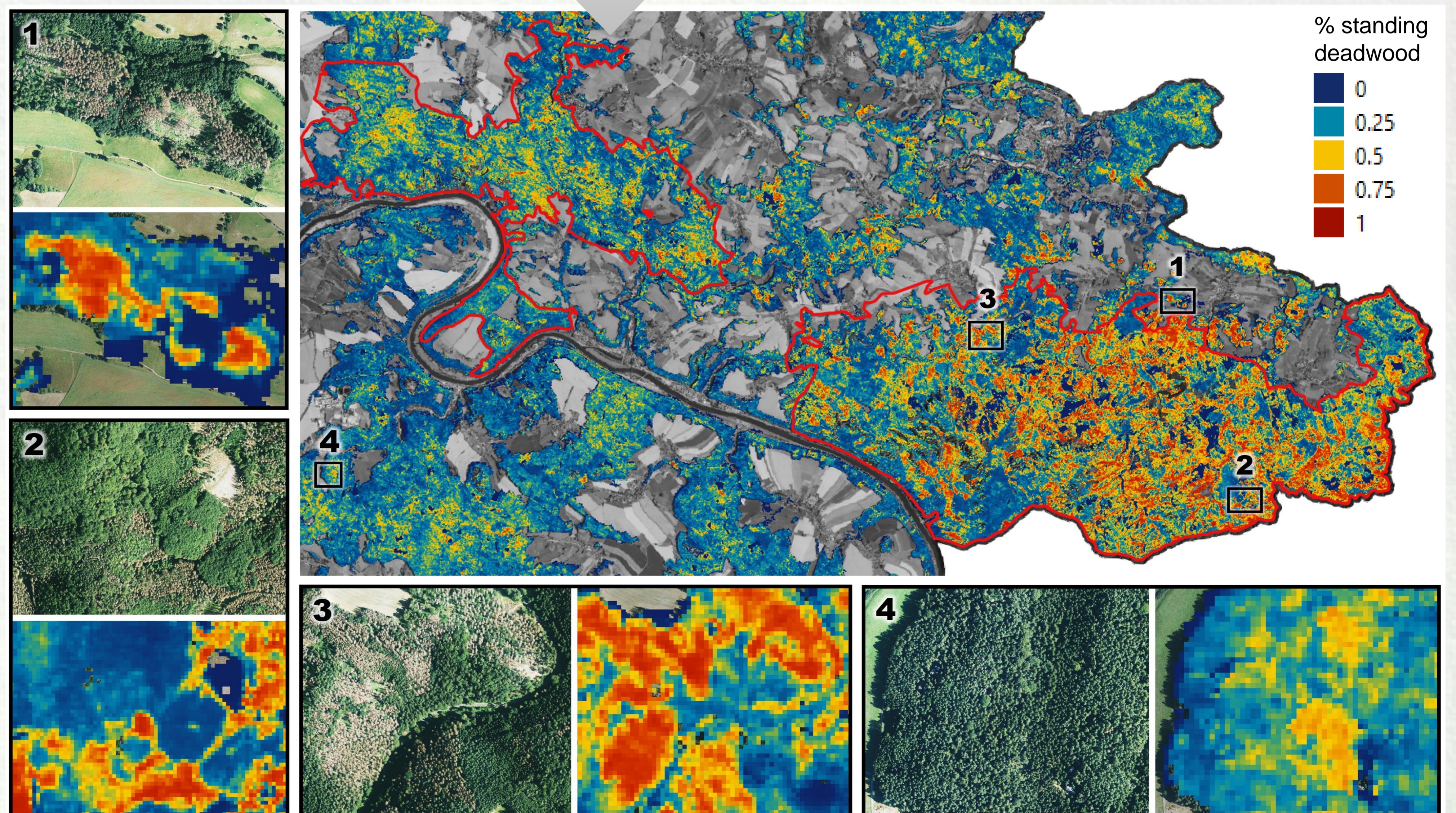


- 2 bidirectional LSTM layer
- 100 LSTM units each
- Sampled to equal distribution

UAV-derived reference data



- Best model with all S1 + S2 bands
- $R^2 = 0.38$ after 5-fold CV
- Model slope: $y = 0.45x + 0.26$
- Error equally distributed across range
- Optimization of co-registration improved results
- Robust across heterogeneous landscape and years



- !** Concerted use of CNN + UAV can close the gap in reference data scarcity
- Multitemporal, large-scale maps of standing deadwood with high spatial resolution (10 m)

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