Leibniz Centre for
Agricultural Landscape Research
(ZALF)

National-scale assimilation of satellite-based information into a grassland model

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4) German Weather Service
5) VISTA Remote Sensing in Geoscience
6) FarmFacts

Challenge

Permanent grasslands, as one of the widespread vegetation types in Germany, significantly contribute to food security. A timely monitoring of their system is required to maximize grassland productivity. Remote Sensing (RS) data and agroecosystem models are two complementary sources to provide better information for understanding grassland ecosystem. However, both sources suffer from large uncertainties.

Research Goals

Our goal is to:
1) design and implement a robust monitoring scheme to assimilate RS data into grassland models to improve grassland ecosystem simulations;
2) reduce the existing uncertainties in RS and model parameters; and increase the accuracy in biomass prediction;

Approach

Step 1: Grassland area were identified using land cover map derived from intra-annual reflectance composites of Sentinel-2 and Landsat time series [1]. The number and time of mowing events were detected from the same 10-day composite time series [2].

Step 2: The MONICA model [3] was used for simulating grasslands across Germany. The model was calibrated using Multi-objective Sequential Uncertainty fitting algorithm [4]. Fig. 1 shows the best simulated and observed Leaf Area Index (*LAI*) in different experimental case studies selected for this project. The prediction uncertainty band has been expressed using two indicators of *p-factor* and *r-factor*.

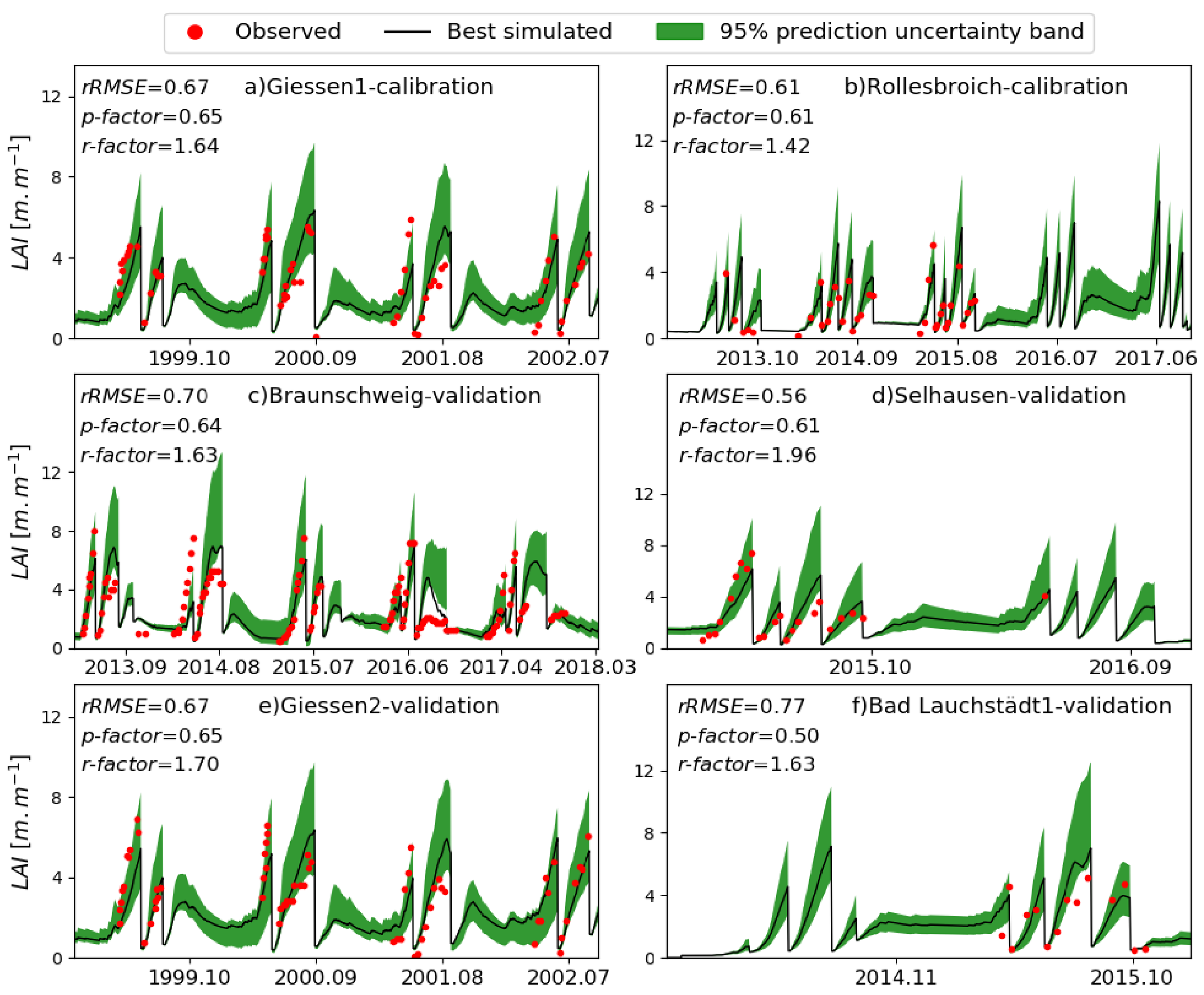

Fig. 1: MONICA simulations of Leaf Area Index (*LAI)* dynamics based on at the calibration (a, b) and validation (c-f) sites, after the model has been calibrated. The *p-factor* and *r-factor*, relative root mean square error (*rRMSE*) are given as performance indicators.

Step 3: The calibrated model was then used to estimate Above Ground Biomass (*AGB*) under four cutting regimes as: 2-cut, 3-cut, 4-cut, 5-cut per growing season (Fig. 2).

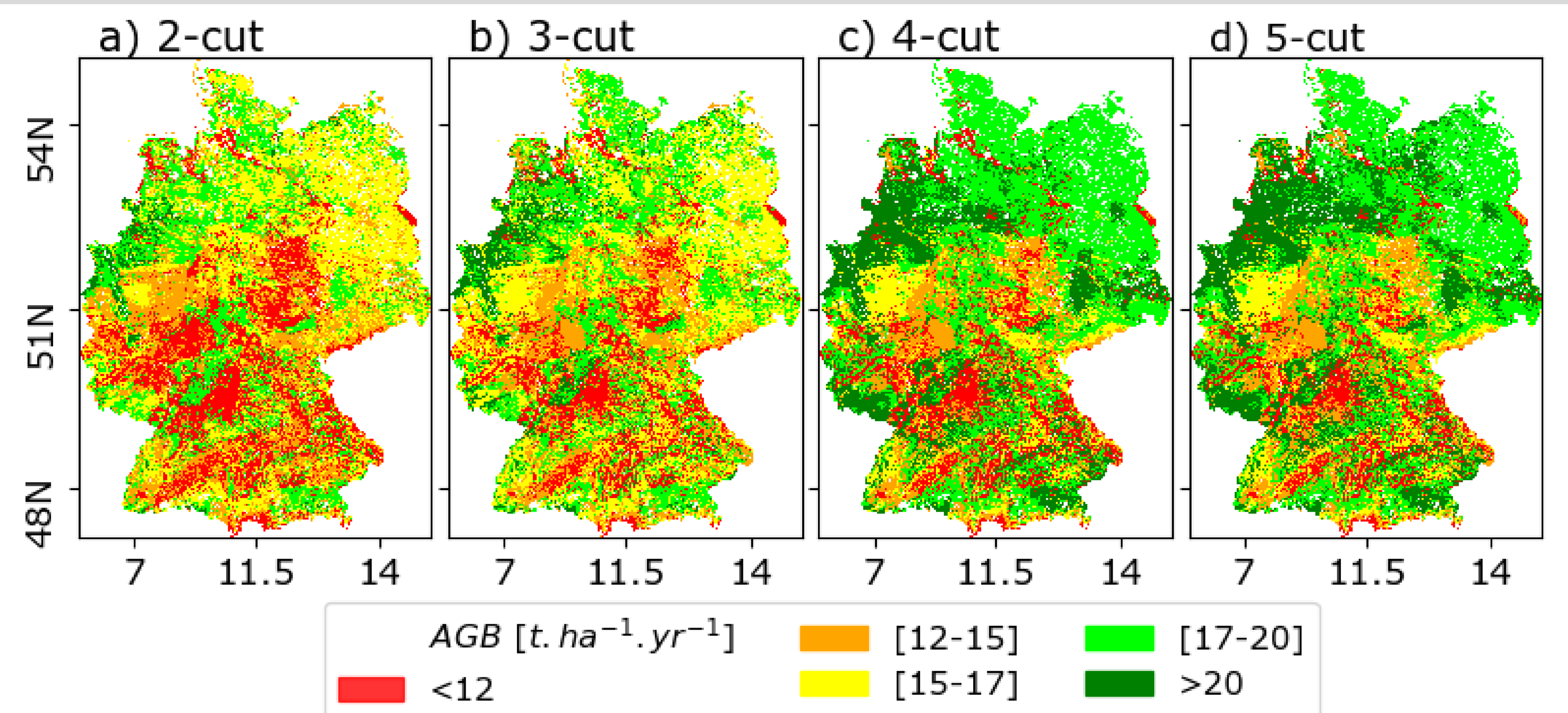

Fig 2. Spatial distribution of the average above ground biomass (*AGB*) during historic period 1990-2018 under four cutting regimes, 2-cut, 3-cut, 4-cut. And 5-cut

Step 4: We assimilate the RS data into MONICA in two steps. First, we assimilated grassland phenology (start of growing season, mowing events) of each grassland grid cell into MONICA using Forcing methods (Fig. 3). The derived information help to identify when the vegetation variables reaches their peaks. Next, we assimilate *LAI* obtained from Sentinel 1 & 2, and Landsat into MONICA using Particle Filtering (Fig. 3)

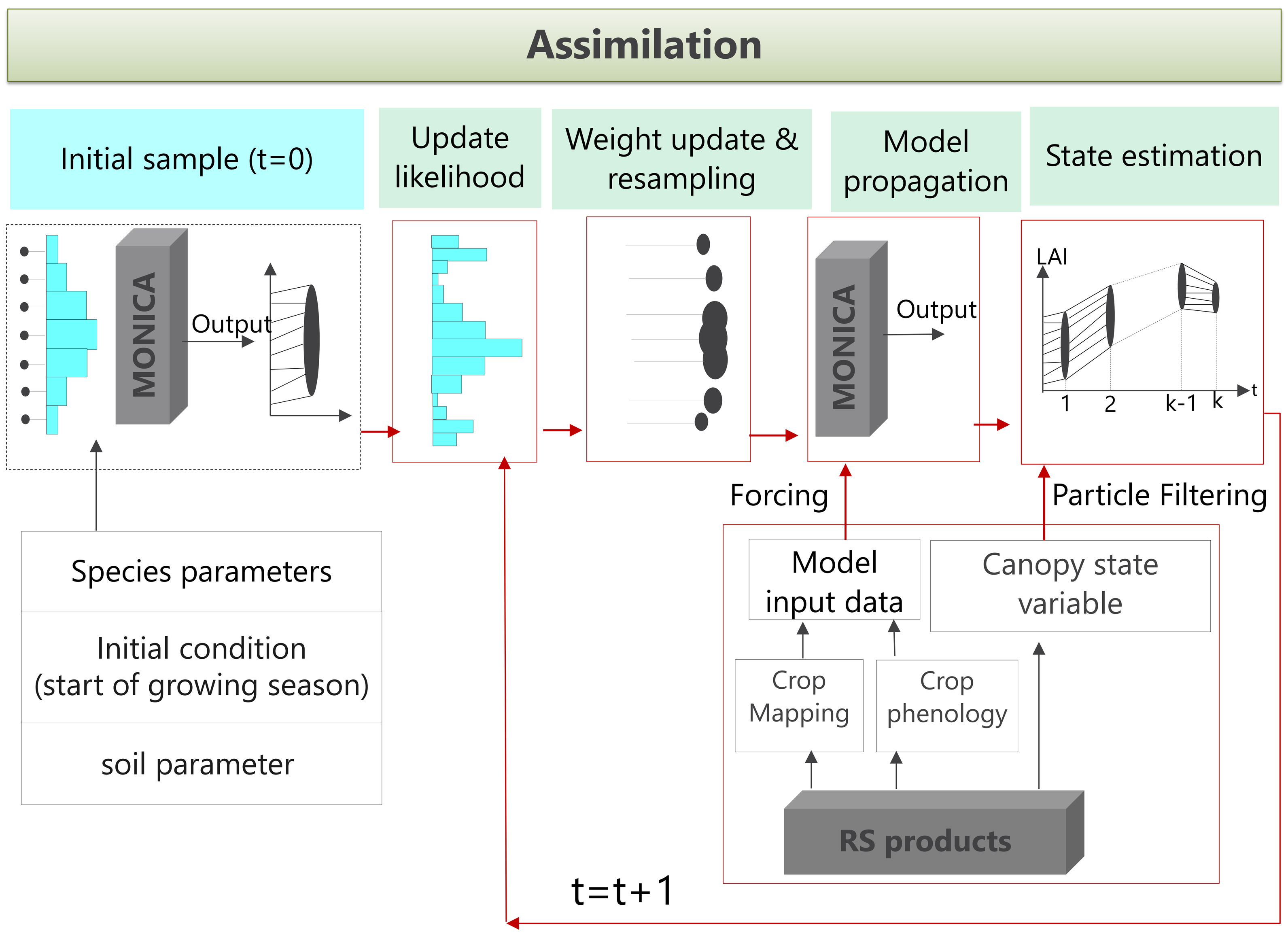

Fig 3: Data assimilation work flow.

Outlooks

Future research focuses on
- combining the observations from different sensors to derive environmental variables with higher accuracy on spatial heterogeneity
- joint assimilation of multiple RS-derived variables into agroecosystem models to capture the interaction among soil-plant-water dynamics;

Acknowledgements

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References

1) Griffiths, P., C. Nendel, P. Hostert (2019a): Remote Sens Environ 220, 135-151.
2) Griffiths, P., C. Nendel, J. Pickert., P. Hostert (2019b): Remote Sens Environ, 111124.
3) Nendel, C., M. Berg, K.C. Kersebaum, W. Mirschel, X. Specka, M. Wegehenkel, K.O. Wenkel, R. Wieland (2011): Ecol. Model. 222 (9), 1614–1625.
4) Kamali, B., K. Abbaspour, A. Lehmann, B. Wehrli, H. Yang (2018): Eur J Agron 2018, 93, 57–72.

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