Improved modeling of vegetation photosynthesis under highly variable ambient conditions by use remote sensing observations

Wieneke[1], S., Ahrends, H.E.[1,2], Schween, J.[1], Schickling, A.[2], Crewell, S.[1], Rascher,U.[2]

[1] Institute of Geophysics and Meteorology, University of Cologne, [2] Research Center Jülich, Institute of Chemistry and Dynamics of the Geosphere-Phytosphere, Jülich

1. Motivation

- Spatial and temporal patterns of photosynthesis depend on dynamic plant-specific adaptation strategies and highly variable atmosphere and surface conditions
- Currently, dynamics of photosynthesis are not correctly parameterized in local, regional and global carbon models (Hilker et al. 2008)
- Hyperspectral sensors are successfully used for monitoring chlorophyll fluorescence (Meroni et al. 2009)
- Fluorescence was successfully related to vegetation light use efficiency and used as a proxy for carbon assimilation (Damm et al 2010)
- Objectives:

  → Assimilation of remotely sensed fluorescence into the Community Land Model (CLM4)

  → Improvement of parameterization for photosynthesis modeling

2. Upcoming Field Measurements

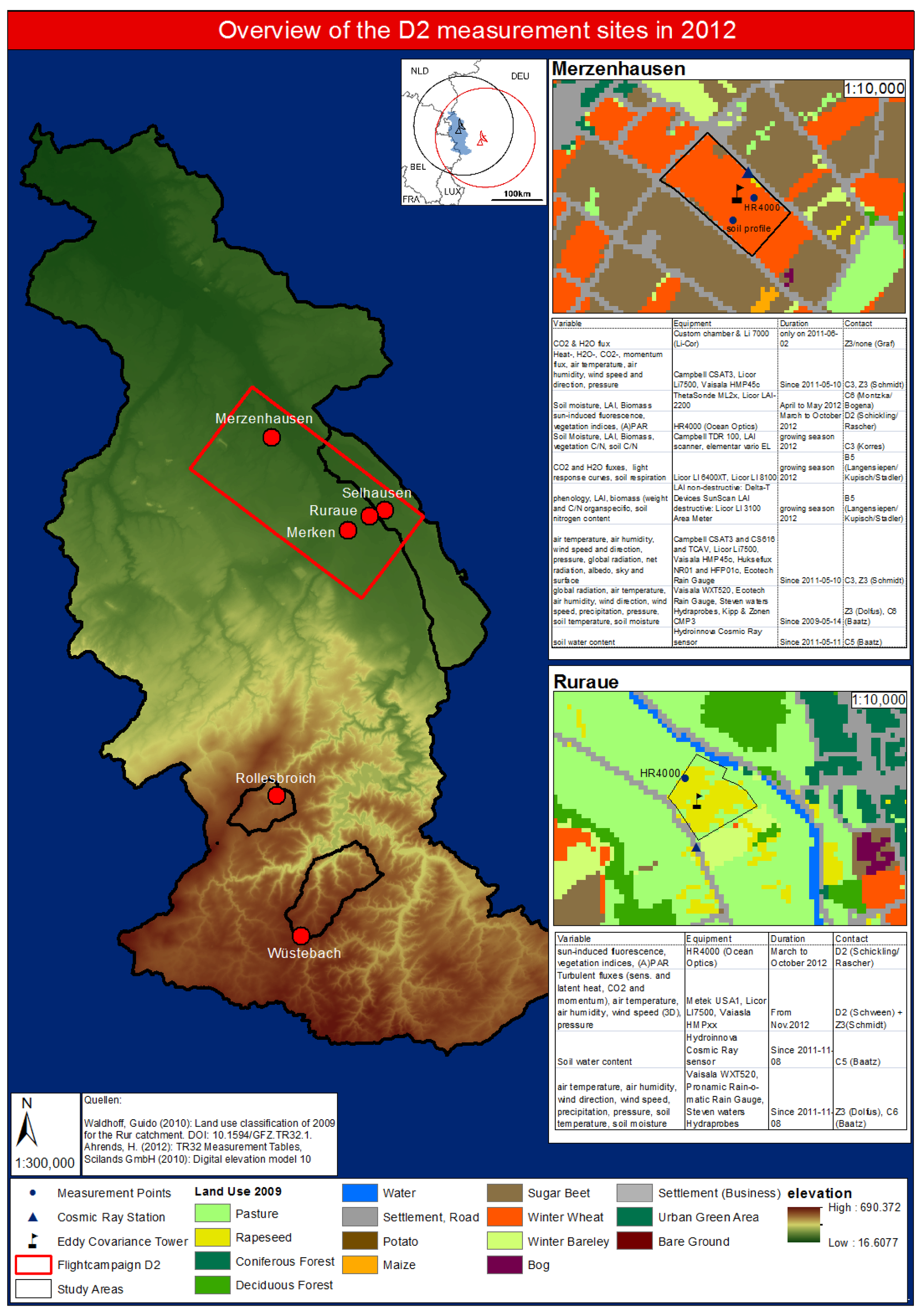

Fig. 1: Overview of D2 measurement sites in 2012 for the rur catchment

Measurement of sun-induced chlorophyll fluorescence:

- Automated hyperspectral measurements in spring 2012 on sitescale

  a) Crop site (sugar beet, winter wheat) in Merzen-hausen

  b) Grassland site in Ruraue
- Aircraft campaign in summer 2012 with novel fluorescence imager application (HYPLANT)
- Further TR32 sites will be used for model evaluation

3. The Community Land Model

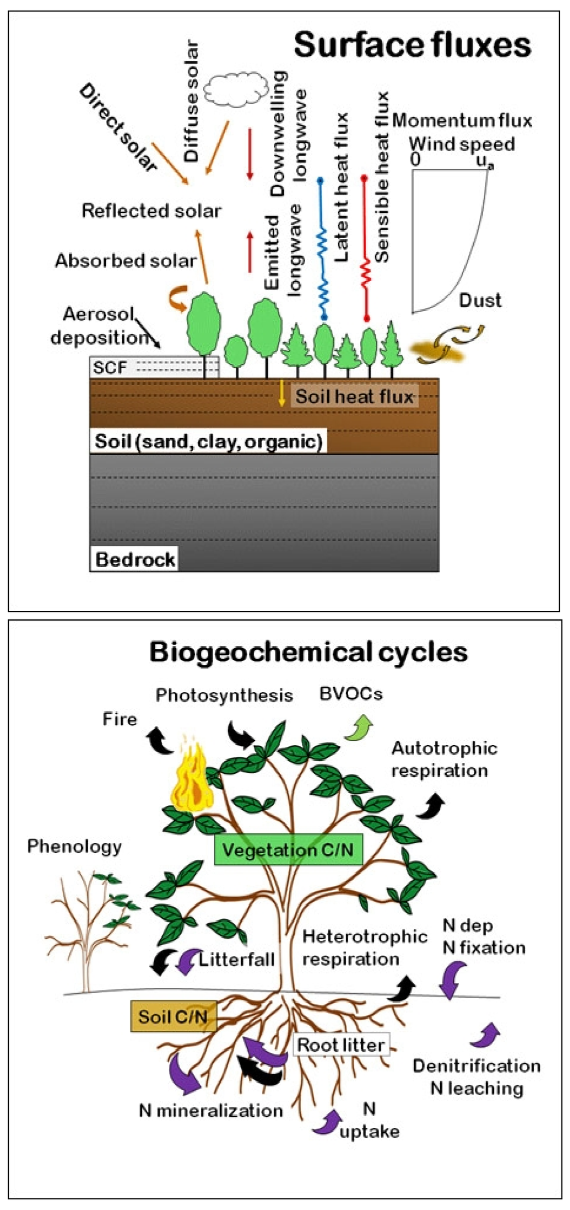

Fig. 2 & 3: The biophysical and the biogeochemical modules of the CLM4
Source: CLM Homepage

- Developed by National Center for Atmospheric Research (NCAR)
- In TR32 coupled with the atmosphere model COSMO and the hydrology model PARFLOW
- Photosynthesis is "the" driving factor for carbon fixation
- Important factor for the water vapour flux calculation
- Equation for calculating photosynthesis highly depends on plant functional type (PFT) constants
- Optimization of photosynthesis calculation by reparameterization and assimilation of remote sensing data
- Implemention of new crop type PFTs

4. Data Assimilation

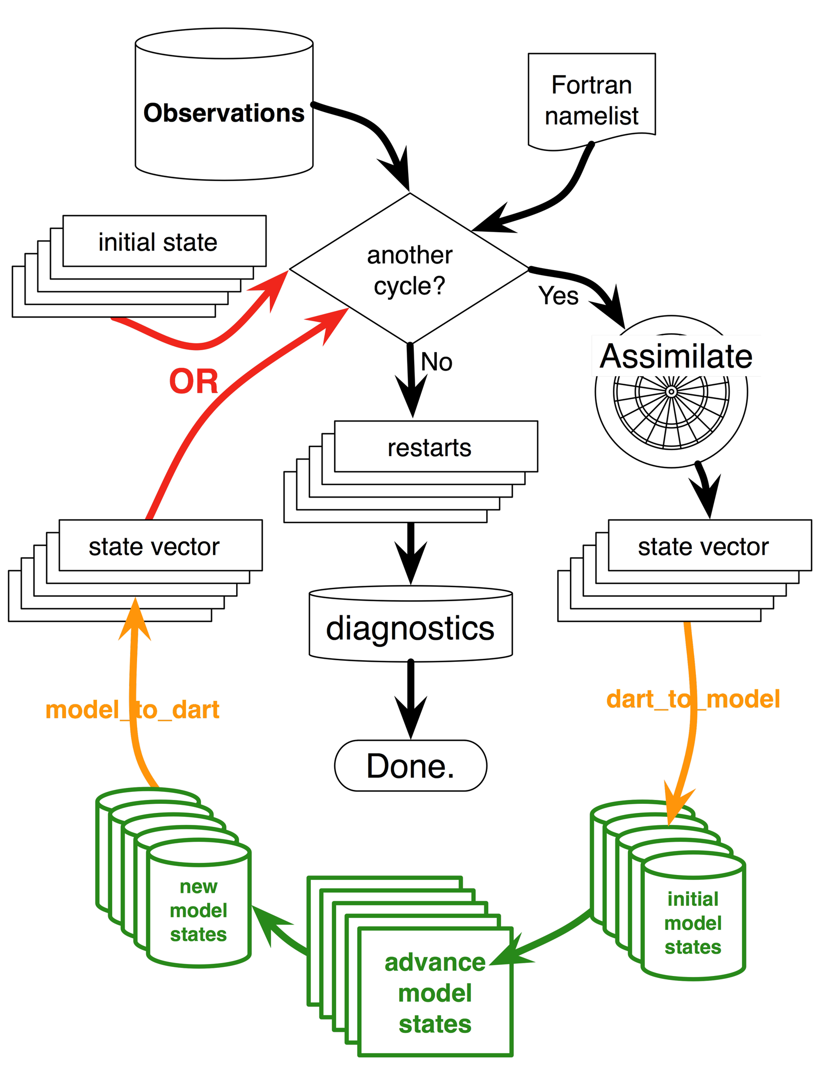

Fig. 4: Overview of Schematic of Ensemble Data Assimilation
Source: http://www.image.ucar.edu/DAReS/images/DART_flow_with_scripts.png

- systematic combination of observation and modeled data to achieve a more accurate understanding of the observed system.
- Data assimilation research testbed (DART):

  → Uses a variety of filters (e.g. ensamble adjustment Kalman filter)

  → Provides many enhancements to basic filtering algorithms (adaptive inflation, localization)

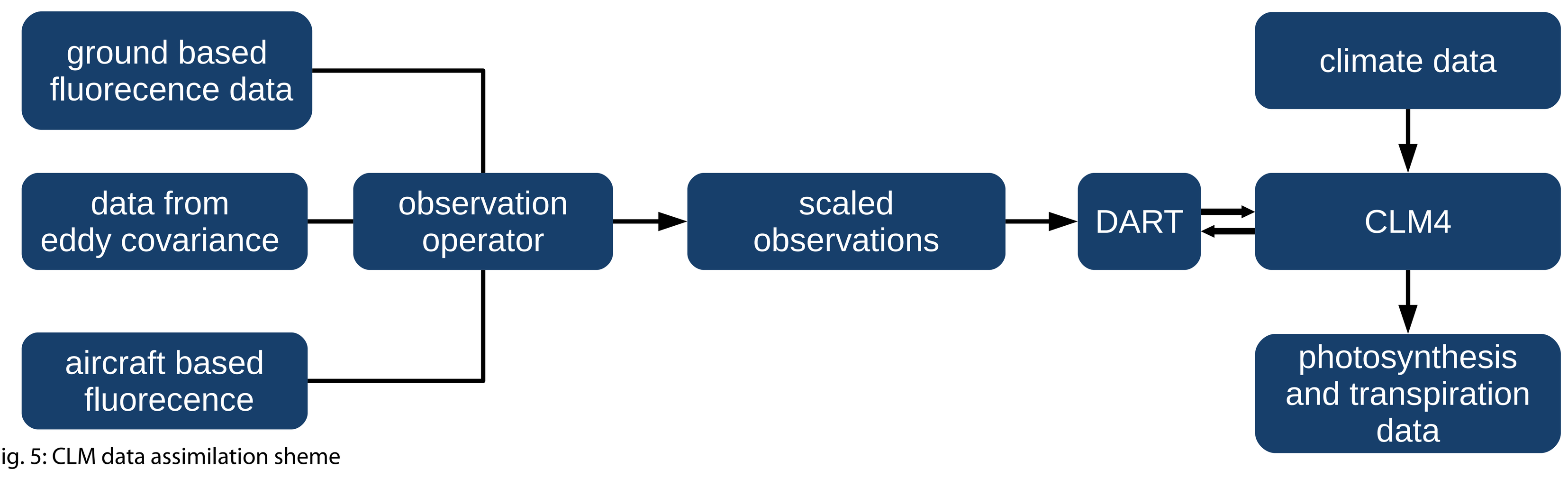

Fig. 5: CLM data assimilation sheme

5. Roadmap

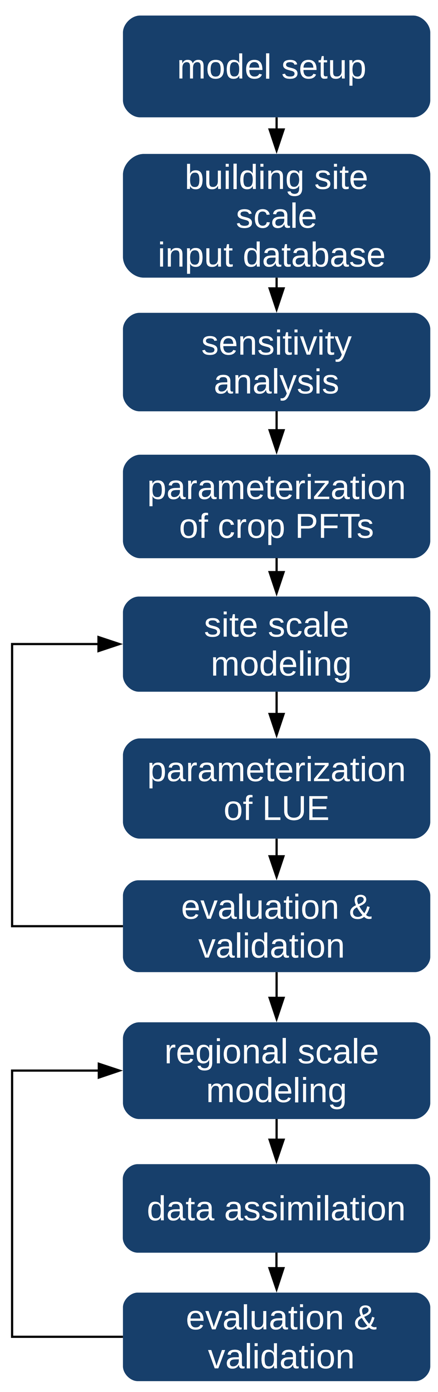

Fig. 6: Roadmap

- Building input database based on site measurements
- Identifying sensitive parameter in respect of photosynthesis
- New crop type PFT parameterization
- Site scale modeling
- Parametization of light use efficiency (LUE) factor based on fluorescence measurements
- Model evaluation and validation based on site measurements
- Regional scale modeling and data assimilation of fluorescence datasets
- Evaluation an validation based on site and regional measurements and model comparism (GECROS model) (Yin & van Laar 2005)

References:

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