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

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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

Measurement of sun-induced chlorophyll fluorescence:
- Automated hyperspectral measurements in spring 2012 on sitescale
  a) Crop site (sugar beet, winter wheat) in Merzenhausen
  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

- 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
- Equations for calculating photosynthesis highly depend on plant functional type (PFT) constants
- Optimization of photosynthesis calculation by reparameterization and assimilation of remote sensing data
- Implementation of new crop type PFTs

4. Data Assimilation

- 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. ensemble adjustment Kalman filter)
  - Provides many enhancements to basic filtering algorithms (adaptive inflation, localization)

5. Roadmap

- Building input database based on site measurements
- Identifying sensitive parameter in respect of photosynthesis
- New crop type PFT parameterization
- Site scale modeling
- Parametrization 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 comparison (GECROS model) (Yin & van Laar 2005)

References:


