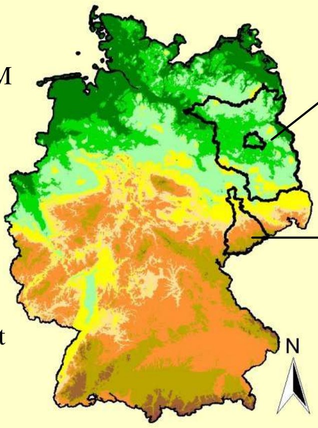
Simulation of carbon fluxes in agro- and forest ecosystems at the river basin and regional scale

Joachim Post, Dr. Valentina Krysanova and Dr. Felicitas Suckow
Potsdam Institute for Climate Impact Research, Germany

AIMS AND TARGETS

- Implementation of a robust approach for Soil Organic Matter (SOM) turnover into the eco-hydrological river basin model SWIM taking into account model complexity and regional available data for the model parametrization.
- Validation and sensitivity analysis of carbon fluxes regarding spatial and temporal representation of carbon fluxes.
- Evaluation of the effects of agricultural management practices on carbon fluxes.
- Assessment of soil respiration and vulnerability of agro- and forest ecosystems with respect to carbon storage in soil and under expected climate and land use change.

STUDY AREA



Regional scale: State of Brandenburg, East Germany: ~ 29600 km^2, sub-continental climate, 400–700 mm precipitation, sandy-loamy soils, 25 % arable land, forest dominated by Scots Pine.

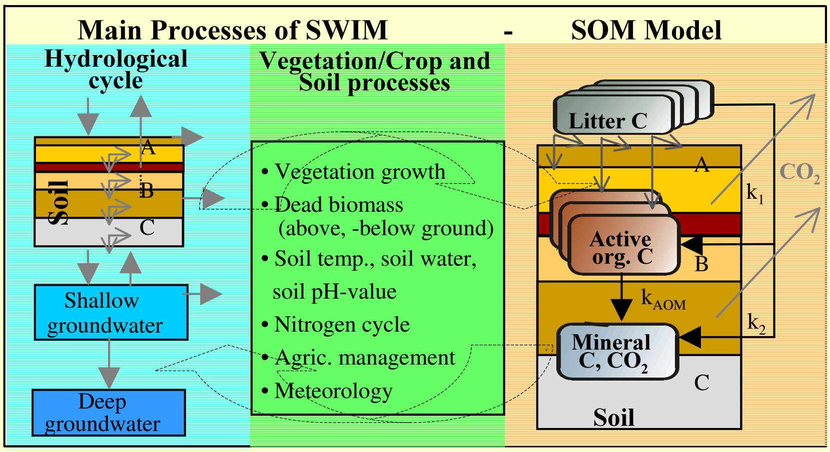
River basin scale: River Mulde, East Germany: ~ 6200 km^2, 600–1200 mm precipitation, loamy soils, 55% arable land, 26% deciduous forest.

Gradient (N-S): pleistocene lowlands-loess region - mountain range.

SWIM

- **S**oil and **W**ater **I**ntegrated **M**odel (Krysanova et al. 1998).
- Continous-time spatially distributed model (HRU'S).
- Able to simulate land use, land management and climate change effects.

MODEL INTEGRATION



SOM MODEL

- **S**oil **O**rganic **M**atter Model, submodel of the forest model 4C (Grote et al. 1999).
- C turnover is described by a reaction kinetic of the first order with reaction coefficients k_1, k_2 and k_{AOM}.
- C turnover depends on soil moisture, soil temperature and pH – value.
- Dead biomass (for each land cover) is assigned to 4 primary organic matter fractions (litter).
- *3 C pools:* primary -, active organic matter and mineral C pool.

RESULTS AND VALIDATION

Litter decomposition

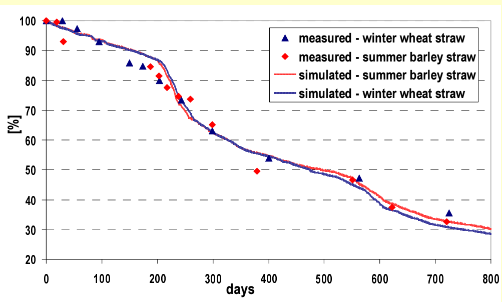


Fig. 1: Comparison of measured and simulated decomposition of winter wheat and summer barley straw. Measured values adopted from *Henriksen & Breland* (1999).

Soil respiration

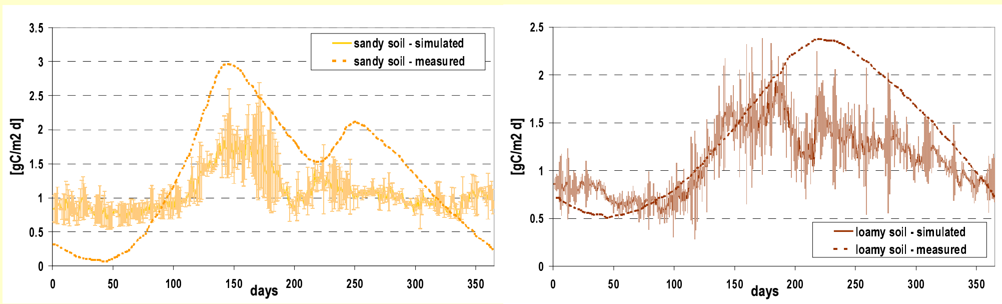


Fig. 2: Comparison of measured and simulated soil respiration in crop fields on sandy (left) and loamy (right) soils. Measured values adopted from *Richter* (1986), representing idealized soil respiration values. Simulations are 15 years average mean values, shown with the respective standard deviation.

Organic carbon

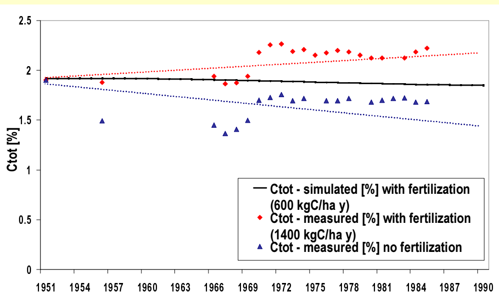


Fig. 3: Comparison of measured and simulated total organic carbon in the soil profile. Measured values adopted from *Franko* (1989).

First validation shows:
Ability to simulate carbon pools and fluxes in right magnitudes and temporal behaviour.

Tab. 1: Comparison of simulated yearly soil respiration (SR) values for 3 land cover types with literature cited values.

Land cover	SR [g/m²/y] simulated	SR [g/m²/y] measured	Reference
Crop	295 - 840	410 - 660	Beyer (1991)
Forest, deciduous	100 - 375	475	Beyer (1991)
Forest, evergreen	300 - 525	292 - 710	Buchmann (2000)

OUTLOOK

- Extensive validation of spatial and temporal behaviour through incorporation of long term field surveys within the study area.
- Performance of sensitivity and uncertainty studies.
- Evaluation of effects of agricultural management practices (crop rotations, fertilization, tillage) on soil respiration and humus dynamics.
- Climate change impact studies.