Plant-Soil Interaction in Landscape-DNDC

26.04.2018

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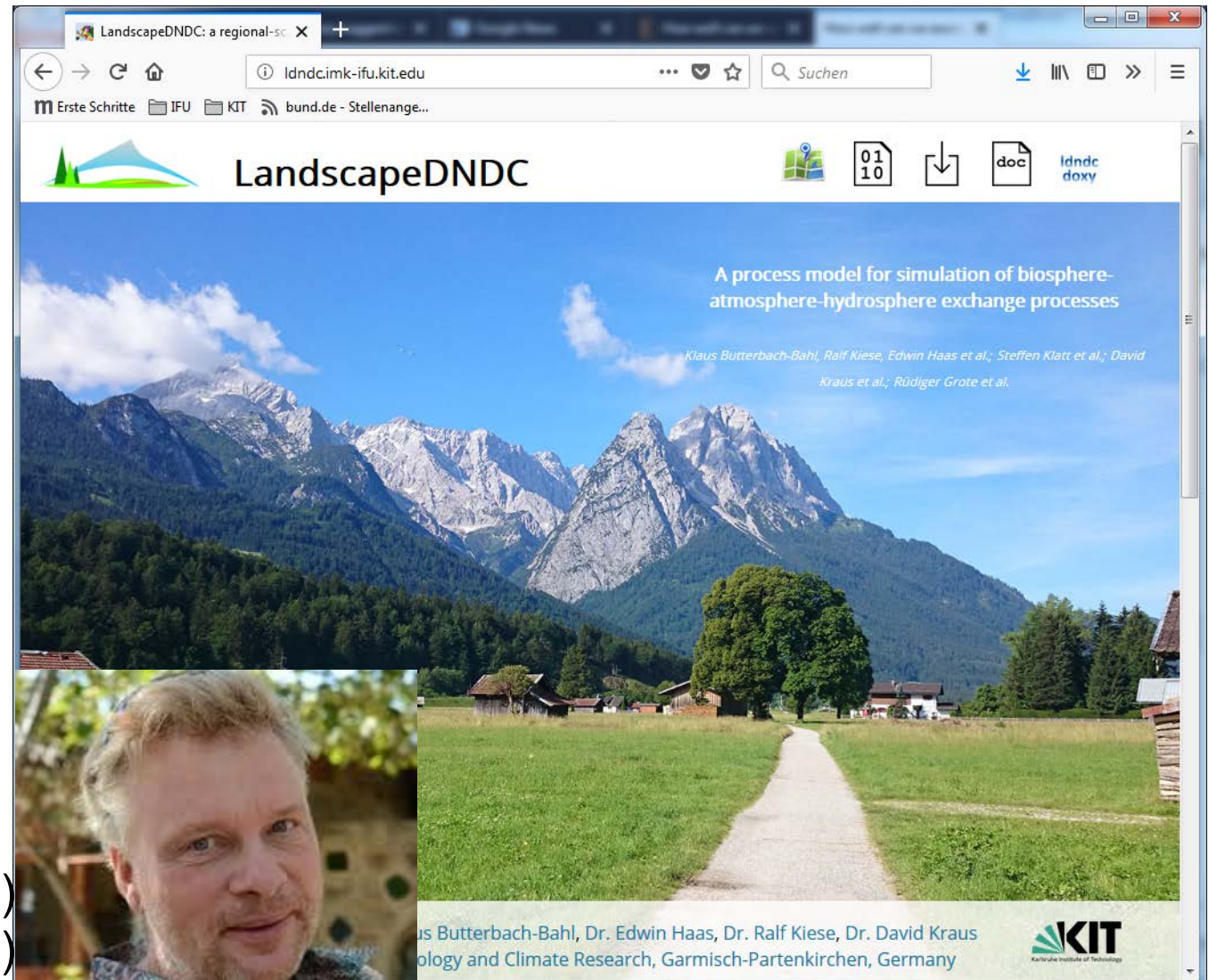# LandscapeDNDC: Objectives

For plant covered terrestrial ecosystems:
- Trace gas exchange
  (N_2O, NO, CH_4 , BVOC)
- Leaching
  (NO_3, DOC)

Represents:
- Biomass production
  & vegetation development
- C-, N-, H2O balances

History:
- DNDC (Li et al. 1992)
- Forest-DNDC (Stange et al. 2000)
- MoBiLE-DNDC (Grote et al. 2009)
- LandscapeDNDC (Haas et al. 2013)

A process model for simulation of biosphere-atmosphere-hydrosphere exchange processes

Klaus Butterbach-Bahl, Ralf Kiese, Edwin Haas et al.; Steffen Klatt et al.; David Kraus et al.; Rüdiger Grote et al.

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LandscapeDNDC: Design

Coupled ecosystem model

- Variable time steps
- Variable vertical (one dimensional) structure
- Modular process groups
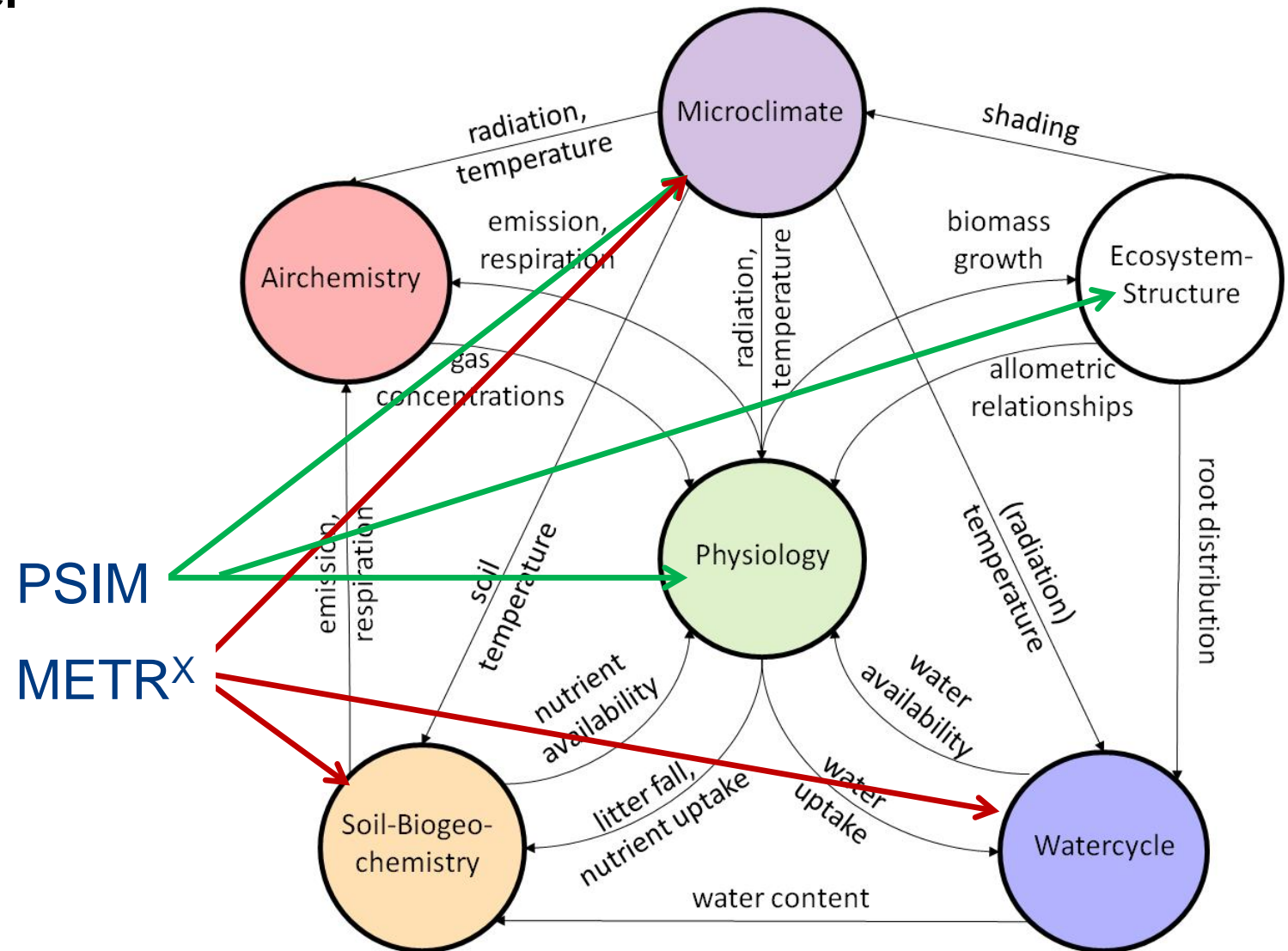
Grote et al. 2011 *(Forest Systems)*

LandscapeDNDC: Design

Climate: T, Prec., Rad., ... Soil: C & N, pH, ... Human Impact: Thinning, Grazing, ...
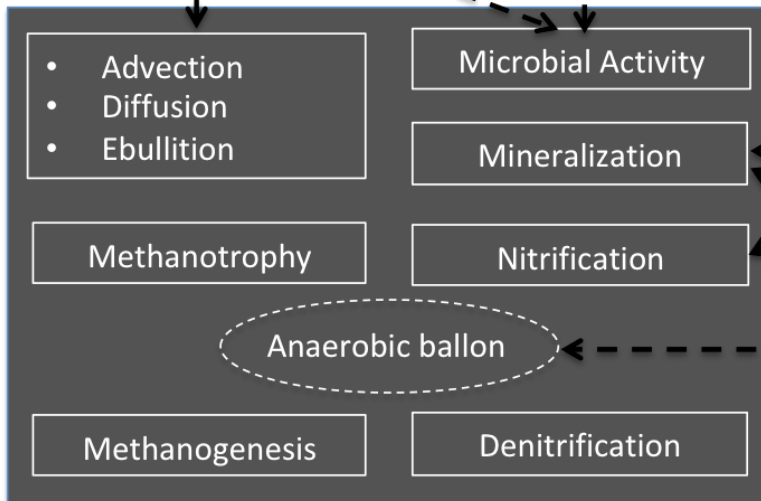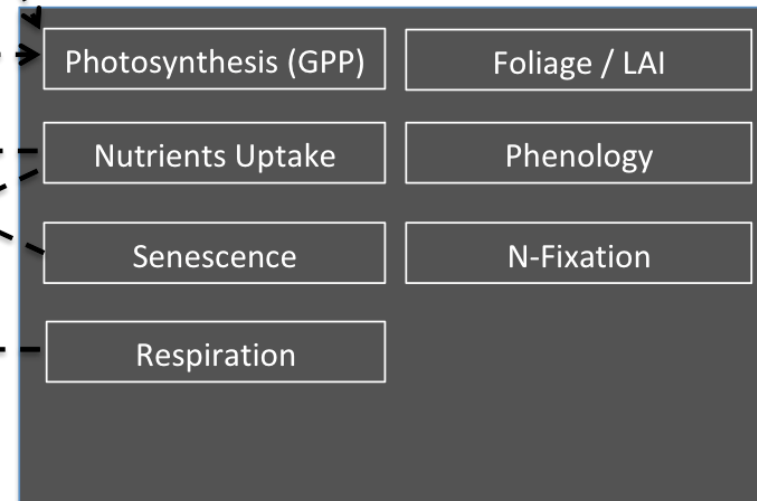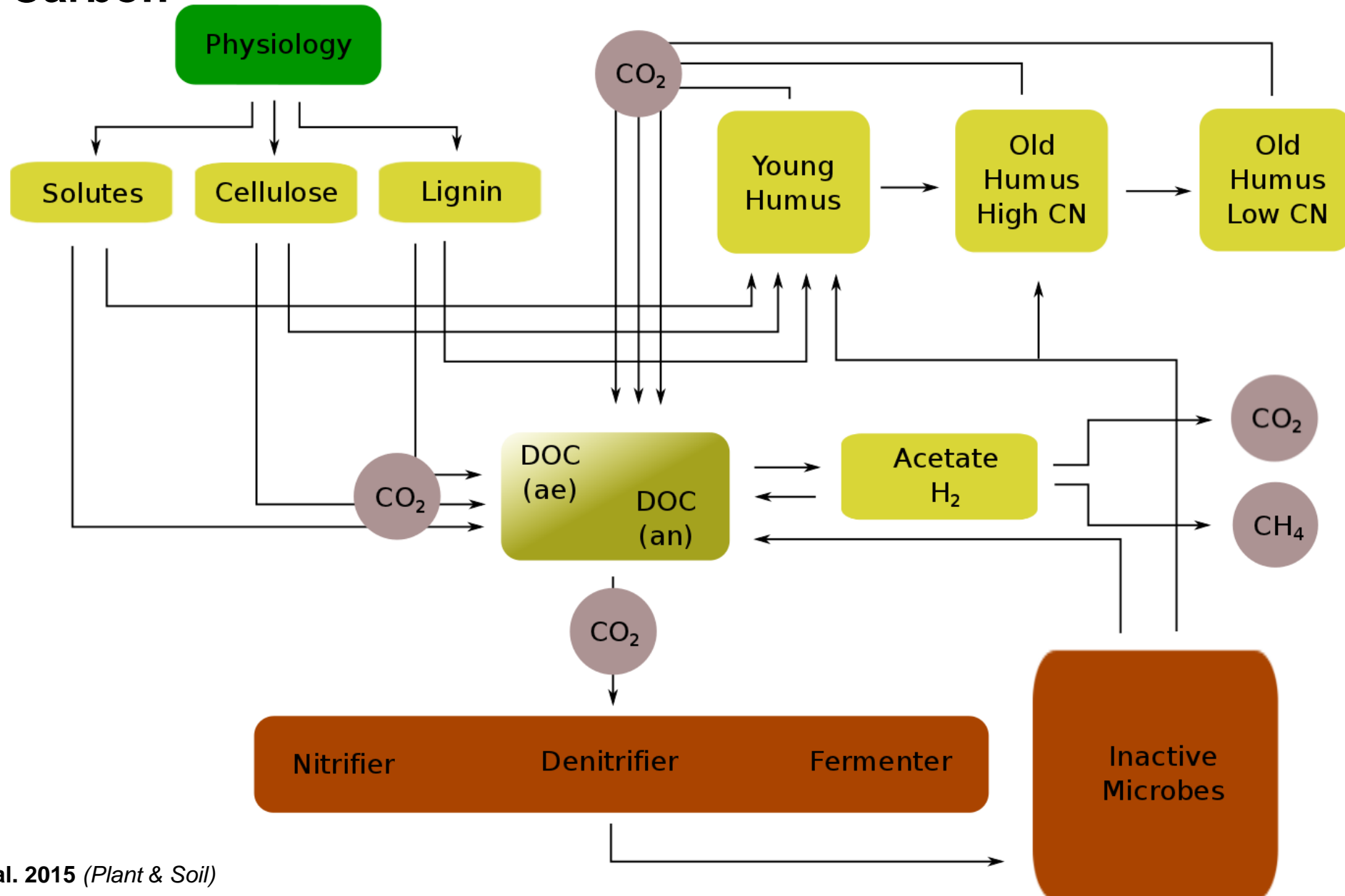
Microclimate /Hydrology

Rain & Snowfall	Canopy & Soil Temp.
Interception	Radiation
Evapotranspiration	Albedo
Soil water	Soil Temp.

Structure

Height

Diameter

Number

Coverage

Events

Thinnig

Grazing

Cutting

Soil

- Advection
- Diffusion
- Ebullition

Microbial Activity

Mineralization

Methanotrophy

Nitrification

Anaerobic ballon

Methanogenesis

Denitrification

Physiology

Photosynthesis (GPP) Foliage / LAI

Nutrients Uptake Phenology

Senescence N-Fixation

Respiration

Matter Fluxes: NO, N_2O, N_2, NH_3, NO_3, CO_2, CH_4, Water, Energy, Crop Yields, Timber, ...

LandscapeDNDC: Design

Soil Carbon

Kraus et al. 2015 *(Plant & Soil)*
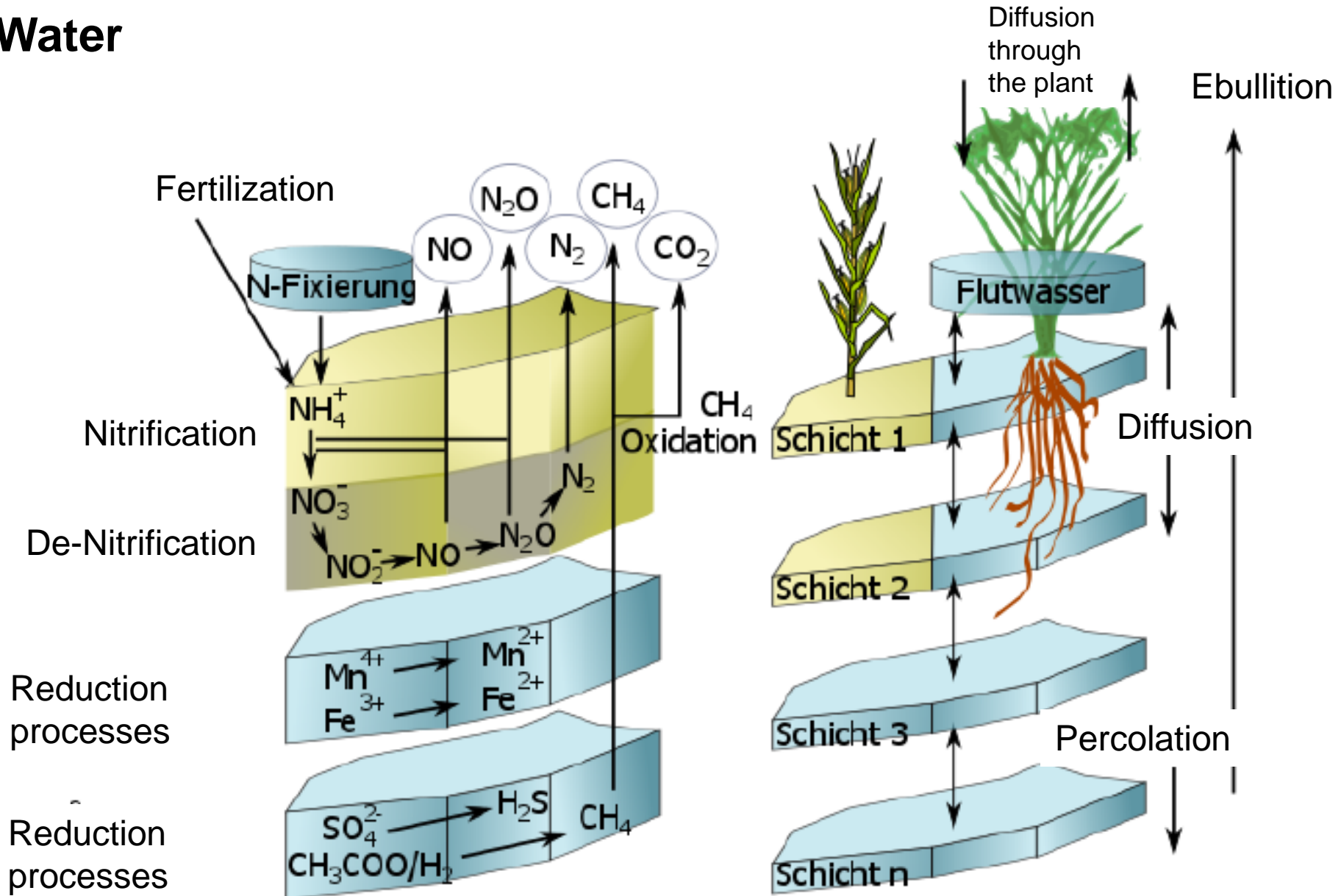
Soil Nitrogen
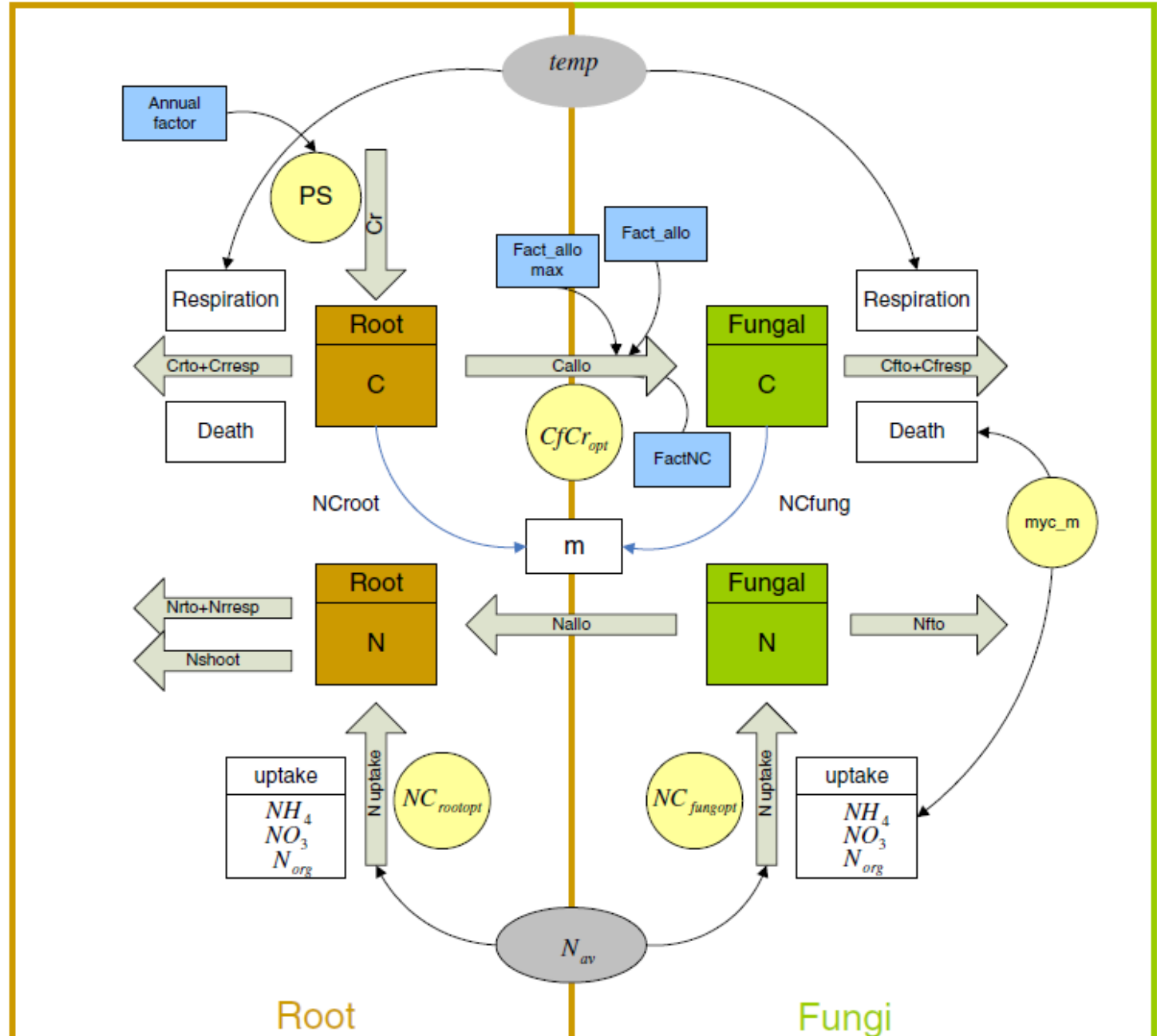
LandscapeDNDC: Design
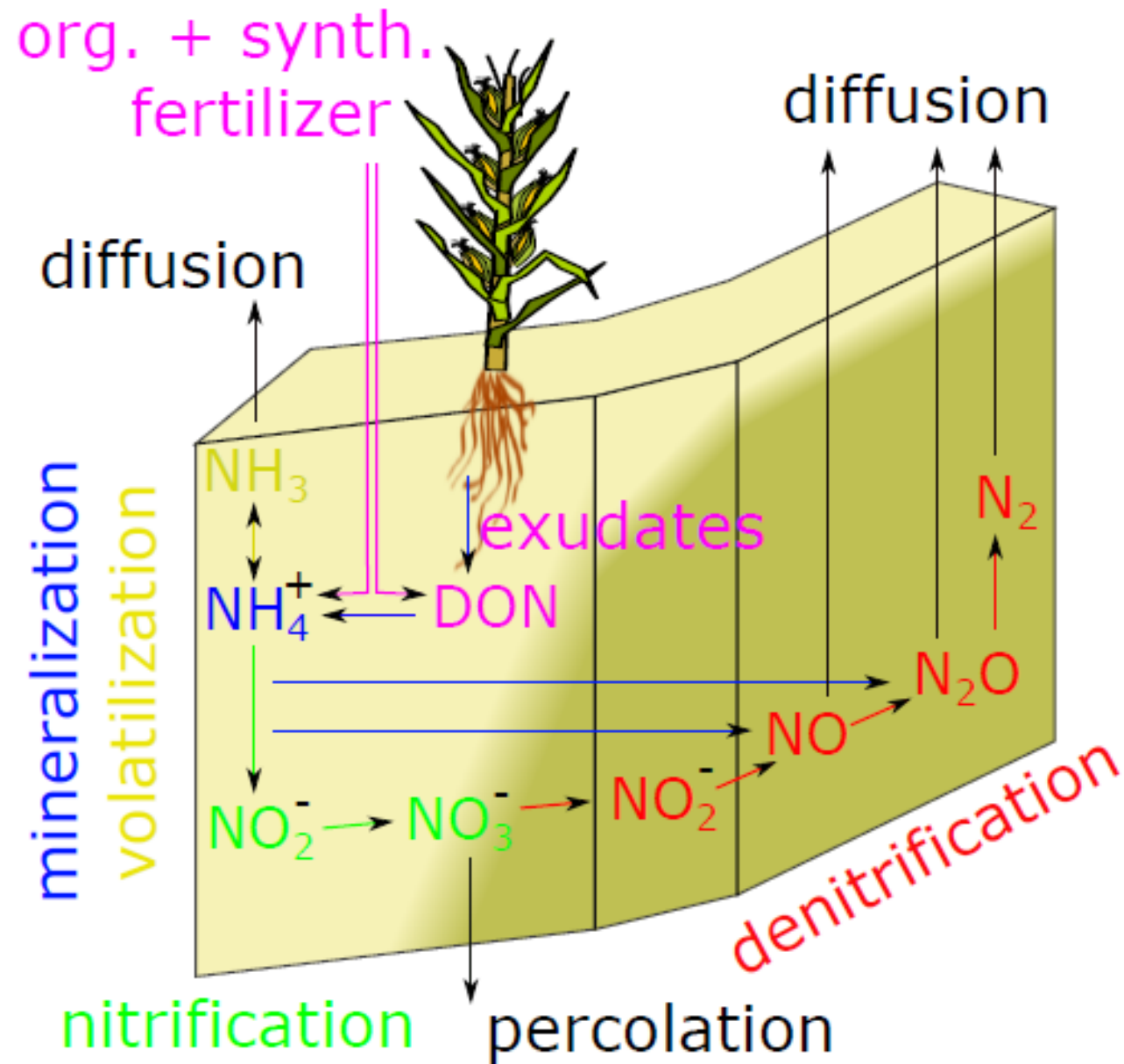
Soil Water

Mycorrhiza

**Mycorrhiza
(the Mycofon model):**

- Benefits from more efficient nutrient uptake
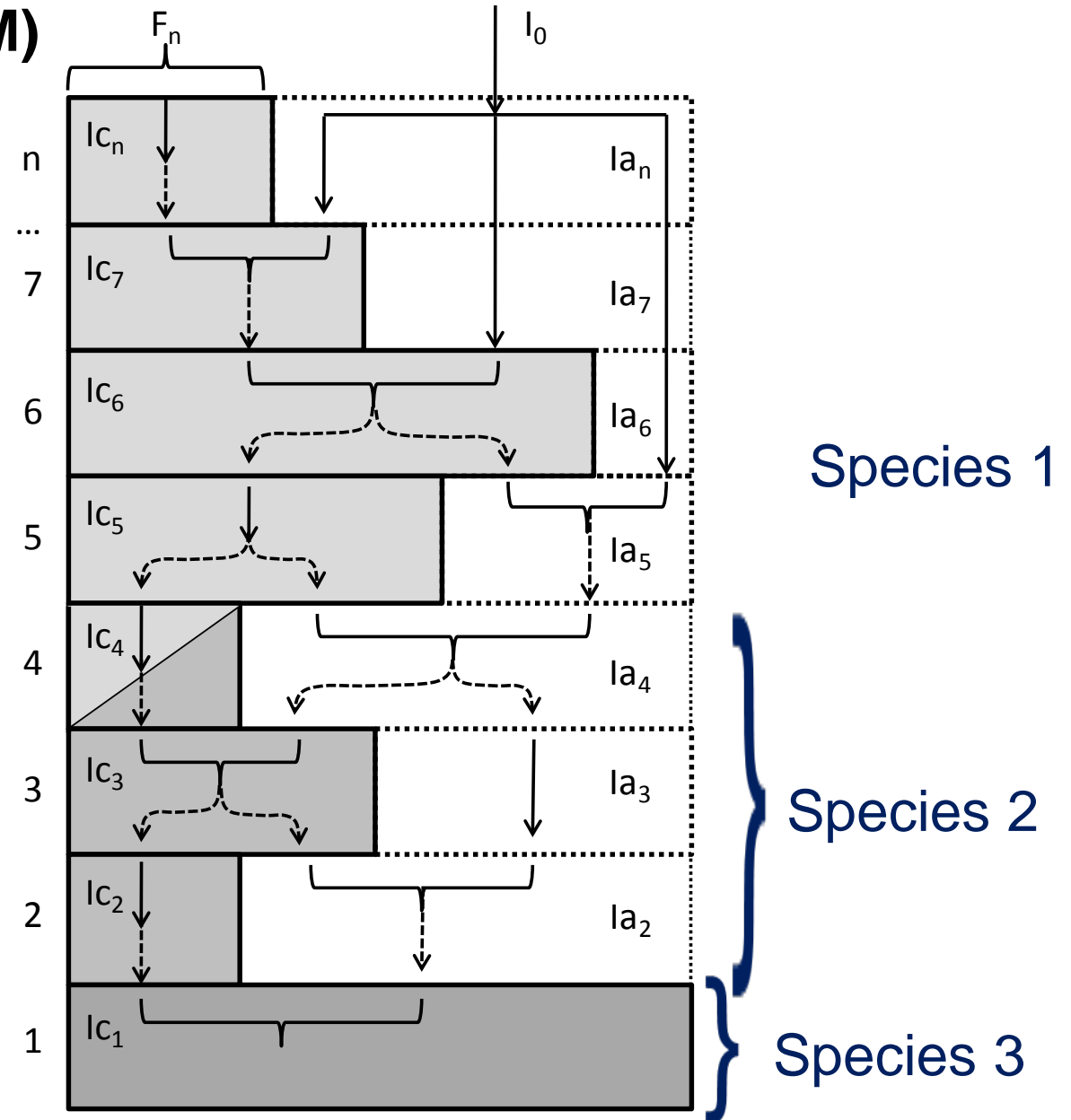- Costs from carbon supply to fungi
- Not usually used

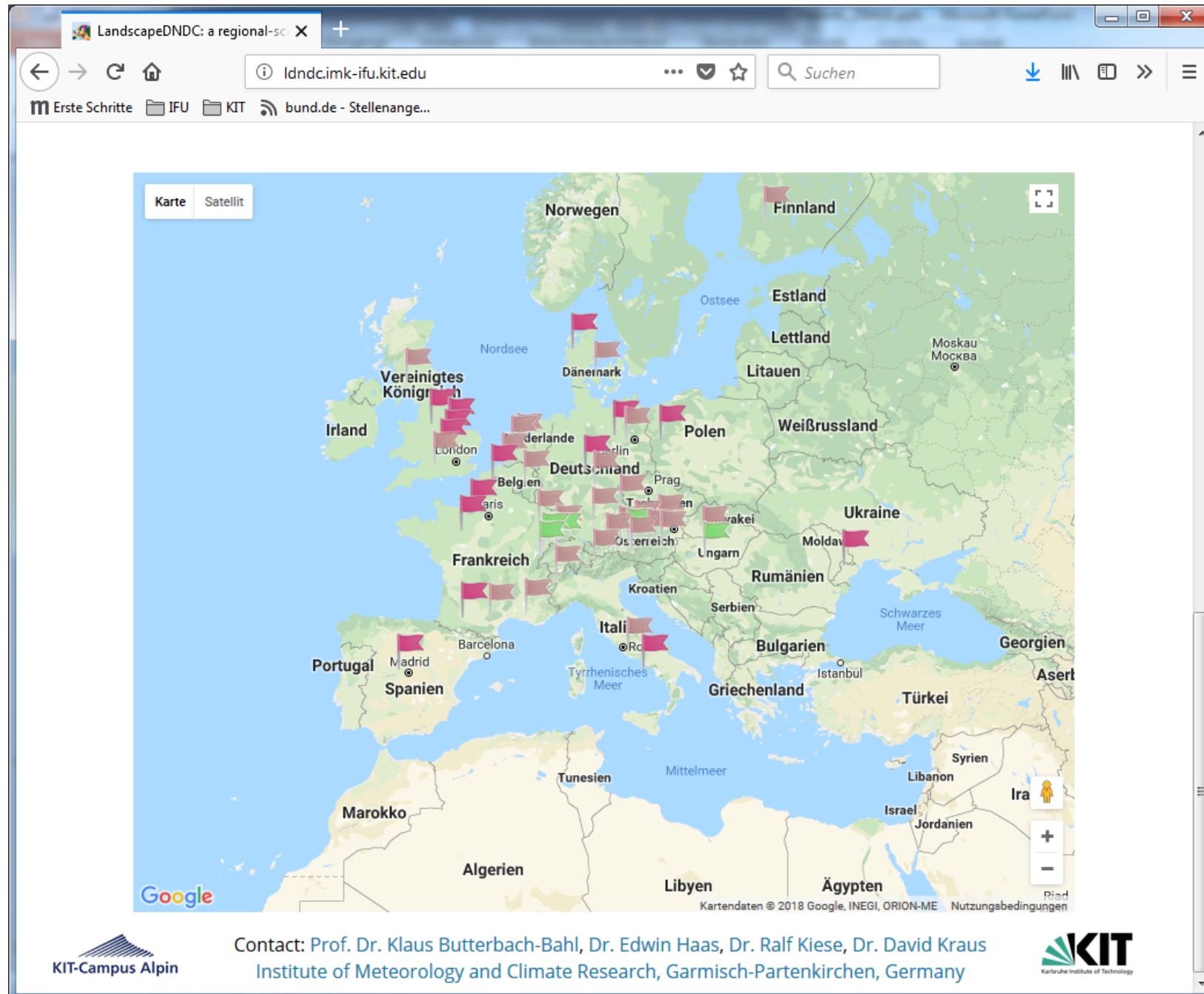**Meyer et al. 2012** *(Eur. J. For. Res.)*

Ecosystem canopy model (PSIM)

- 2D canopy
  (accounts for gaps!)
- Vertically layered
  (explicit species position)
- Each layer with separate pools,
  fluxes and properties

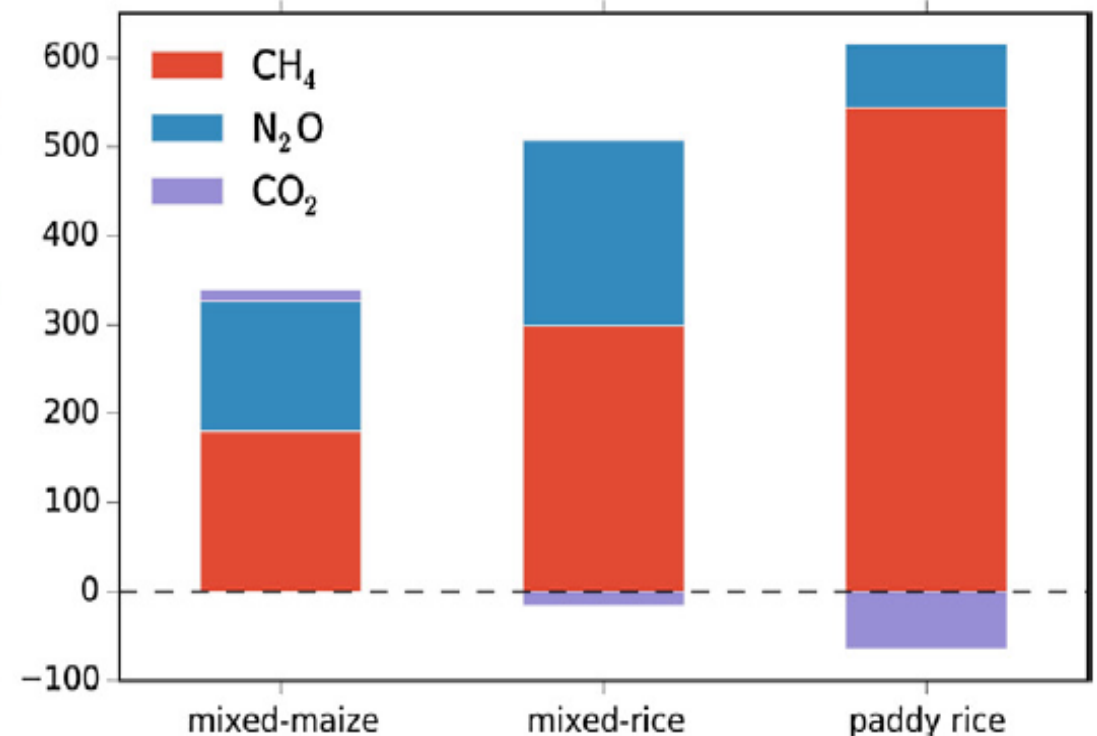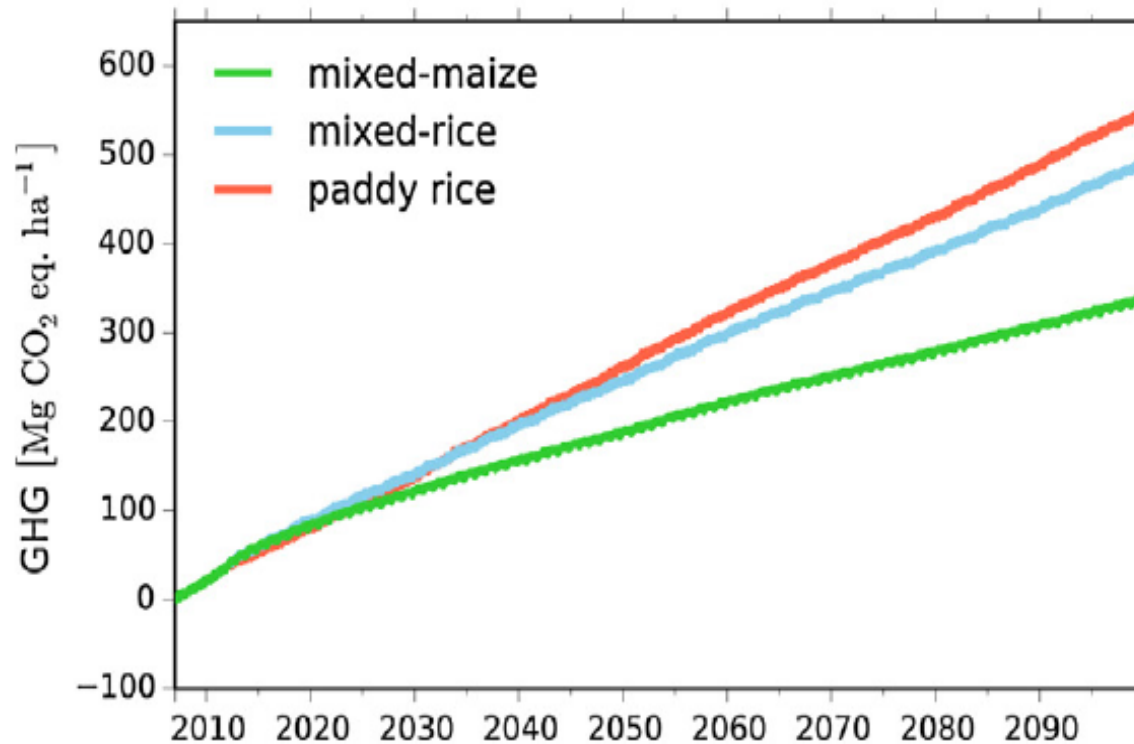

Grote et al. 2011 *(Forest Systems)*

LandscapeDNDC: Applications

Green: Grassland
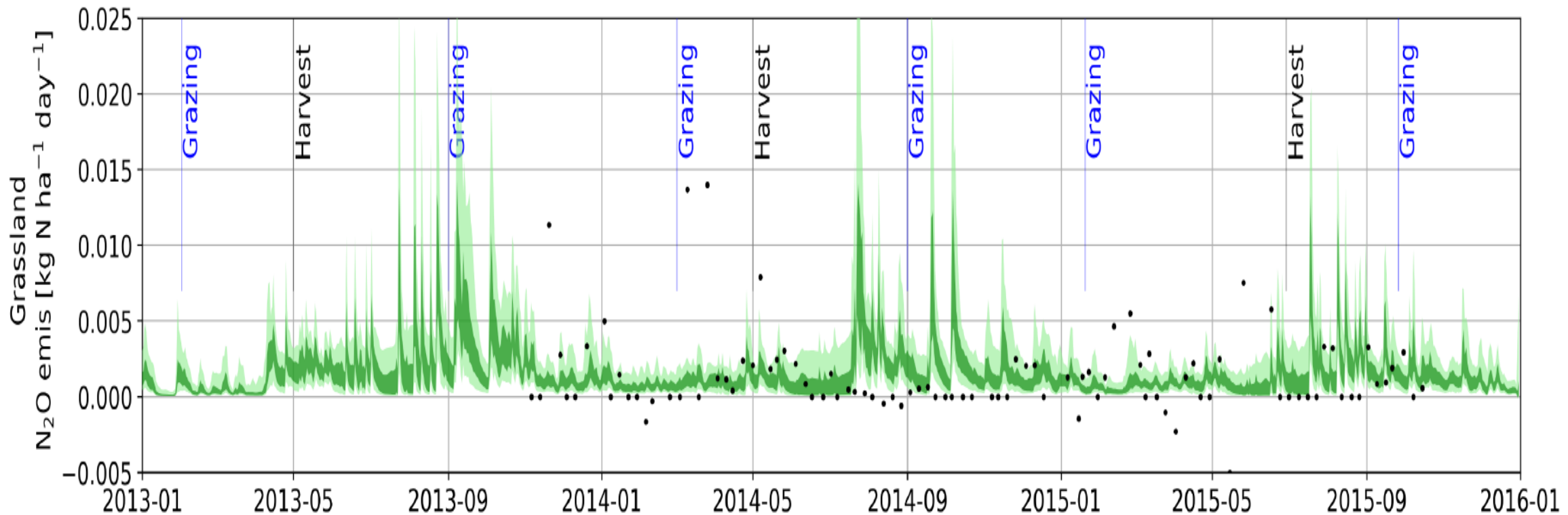Light red: Forest
Red: Agriculture

Crops: Rice (Philippines)
- Different management
- Annual quantification
- Scenario calculations

**Kraus et al. 2016** *(Agriculture, Ecosystems & Environment)*

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Landscape-DNDC: Applications

Grassland (Germany, TERENO site)
- Different management
- Different soil (adapted to different climate)

Disturbance site (Germany, Lackenberg)
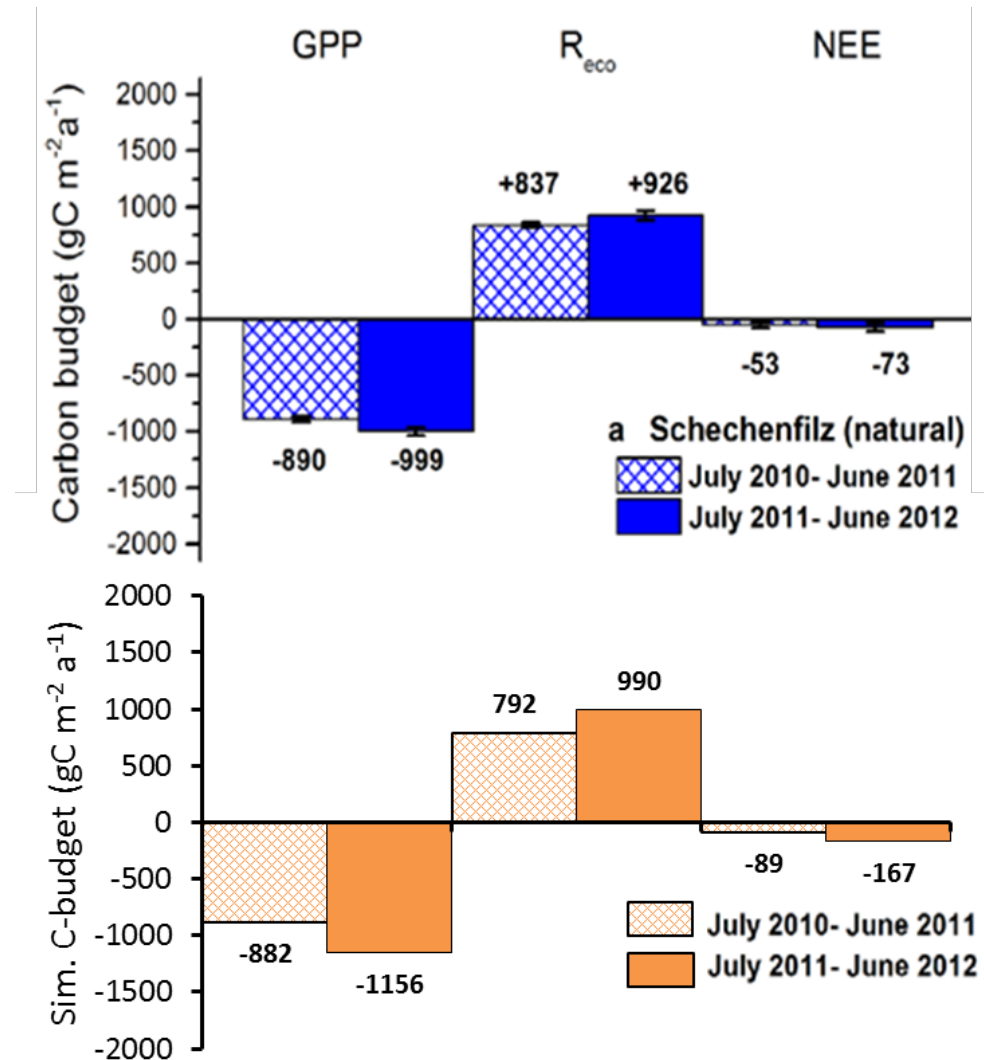
- Carbon balances after disturbance
- Competition of trees with ground vegetation
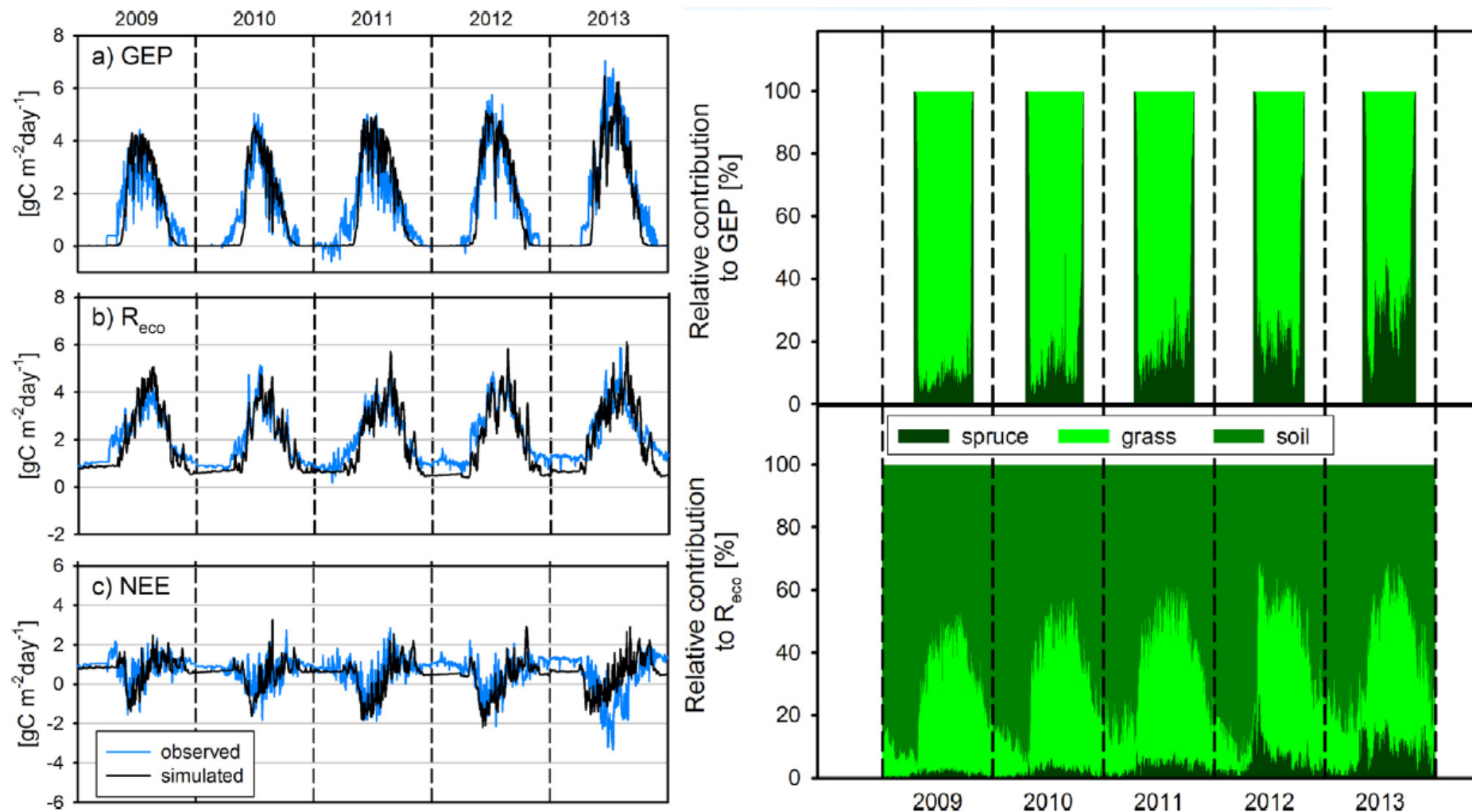
Lindauer et al. 2014 *(Agr. For. Meteorol.)*

Landscape-DNDC: Applications

Drained peatland site (Schechenfilz, Germany):

- High carbon content
- High water table

Measurements from: Hommeltenberg et al. 2014 *(Biogeosciences)*

… regarding the plant – soil interface
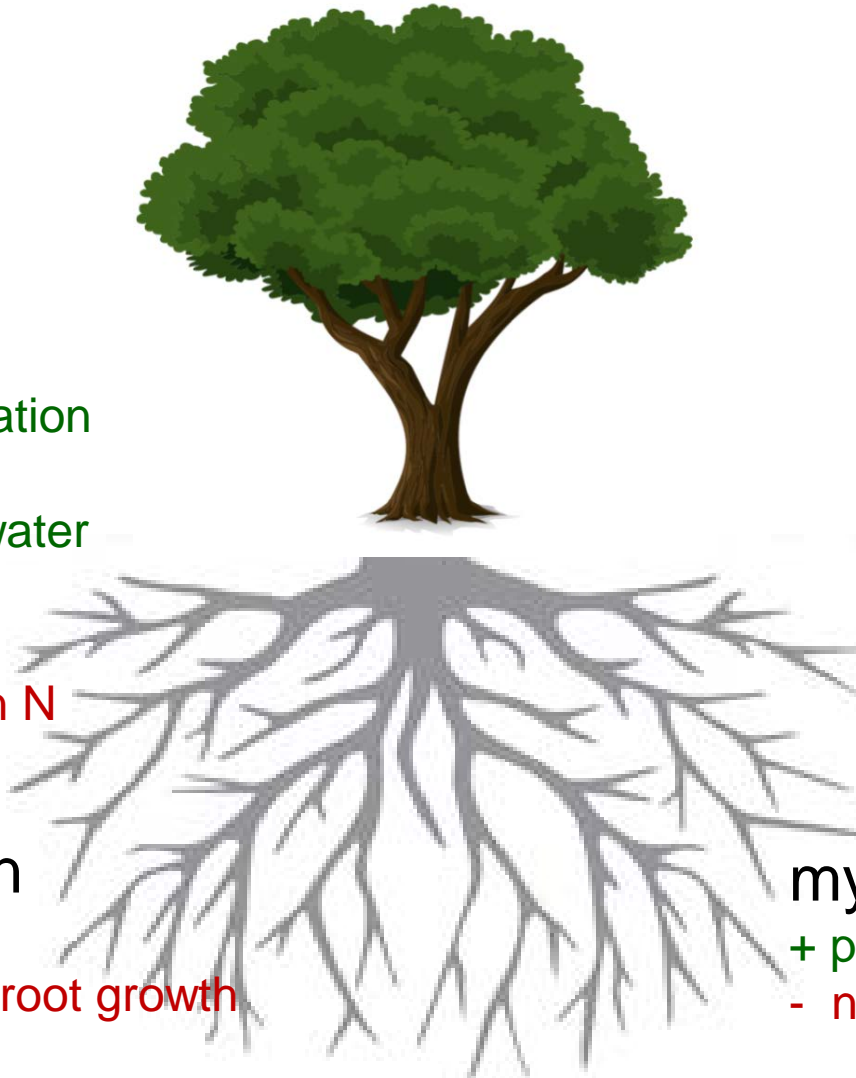
root growth
+ depends on carbon assimilation
+ related to nitrogen demand
+ includes temperature and water
  thresholds
- fixed turnover rate
- missing other nutrients than N

root distribution
+ root profile considered
+ depth growth related to height
  development
- no development according
  supply distribution
- no oxygen limitation

root exudation
+ included
- fixed fraction of root growth

mycorrhization
+ potentially included
- not evaluated

Landscape-DNDC: The Developers
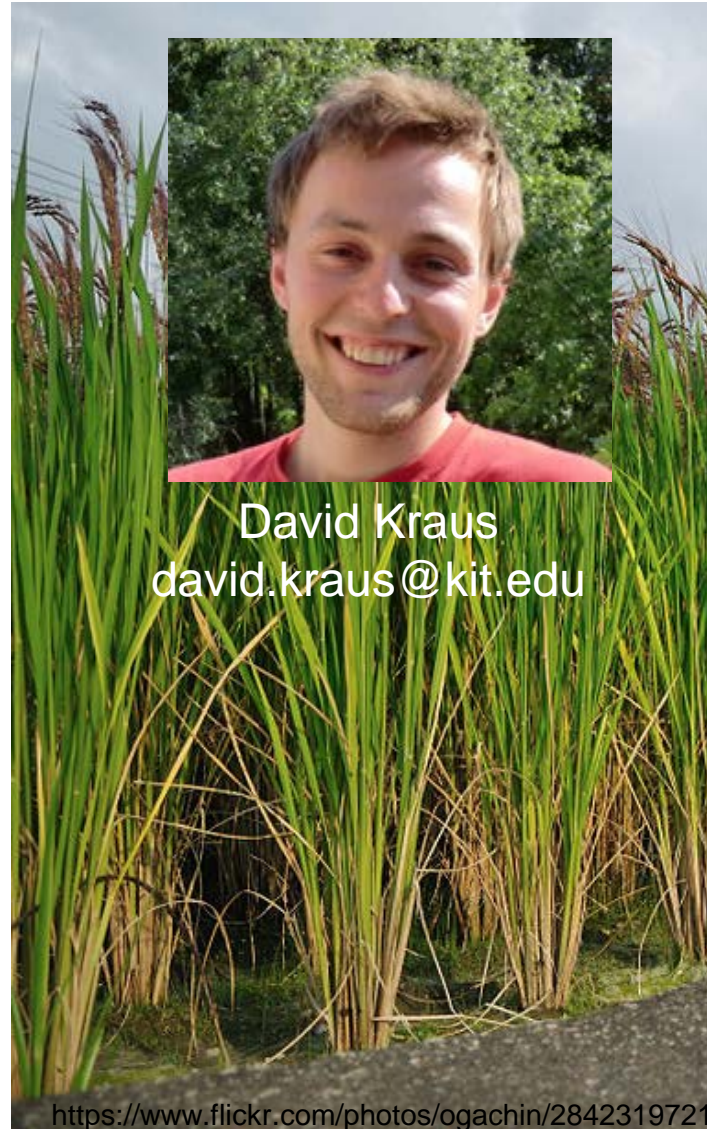
Thank you for your attention