



# Plant-Soil Interaction in Landscape-DNDC

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# LandscapeDNDC: Objectives

## For plant covered terrestrial ecosystems:

- Trace gas exchange ( $\text{N}_2\text{O}$ , NO,  $\text{CH}_4$ , BVOC)
- Leaching ( $\text{NO}_3$ , DOC)

## Represents:

- Biomass production & vegetation development
- C-, N-,  $\text{H}_2\text{O}$  balances

## History:

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

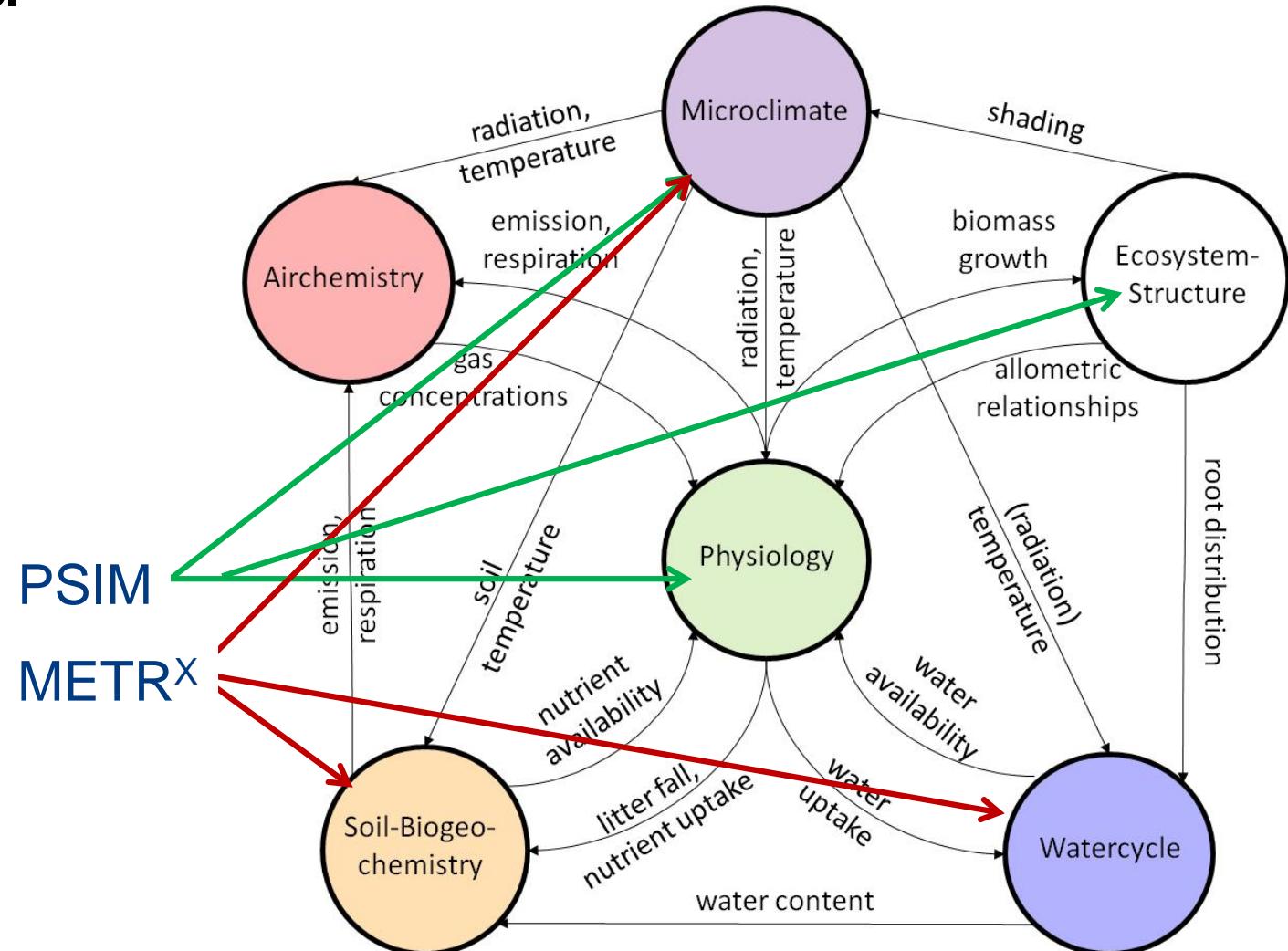
The screenshot shows a web browser window for the LandscapeDNDC website. The URL is [ldndc.imk-ifu.kit.edu](http://ldndc.imk-ifu.kit.edu/). The page features a large image of a mountainous landscape with green forests and blue skies. In the bottom left corner of the image, there is a portrait of a man with light hair and a beard, identified as Klaus Butterbach-Bahl. The top right of the page contains text about the team: "A process model for simulation of biosphere-atmosphere-hydrosphere exchange processes" and the names "Klaus Butterbach-Bahl, Ralf Kiese, Edwin Haas et al., Steffen Klatt et al., David Kraus et al., Rüdiger Grote et al.". Below the image, there is a caption: "Klaus Butterbach-Bahl, Dr. Edwin Haas, Dr. Ralf Kiese, Dr. David Kraus, Institute for Meteorology and Climate Research, Garmisch-Partenkirchen, Germany". The KIT logo is visible in the bottom right corner of the page.

<http://ldndc.imk-ifu.kit.edu/>

Klaus Butterbach-Bahl  
klaus.butterbach-bahl@kit.edu

## 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., ...

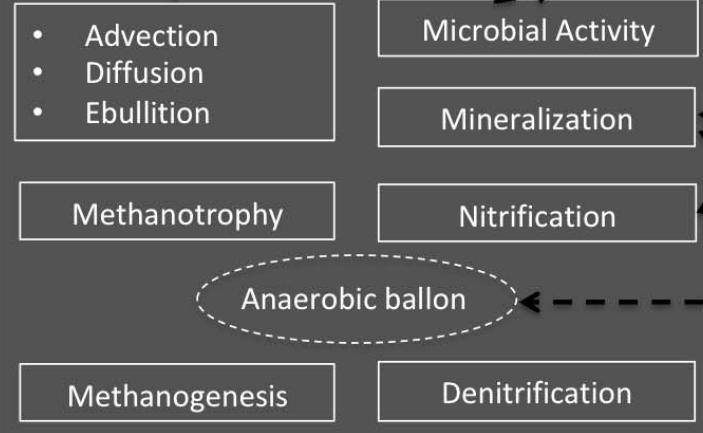
Soil: C & N, pH, ...

Human Impact: Thinning, Grazing, ...

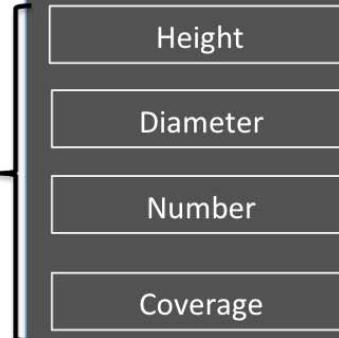
## Microclimate /Hydrology



Soil



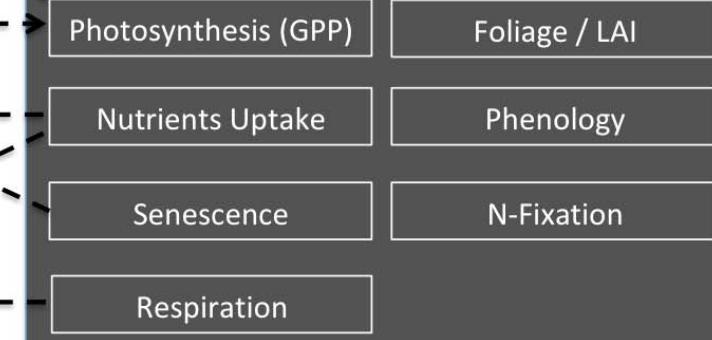
## Structure



## Events

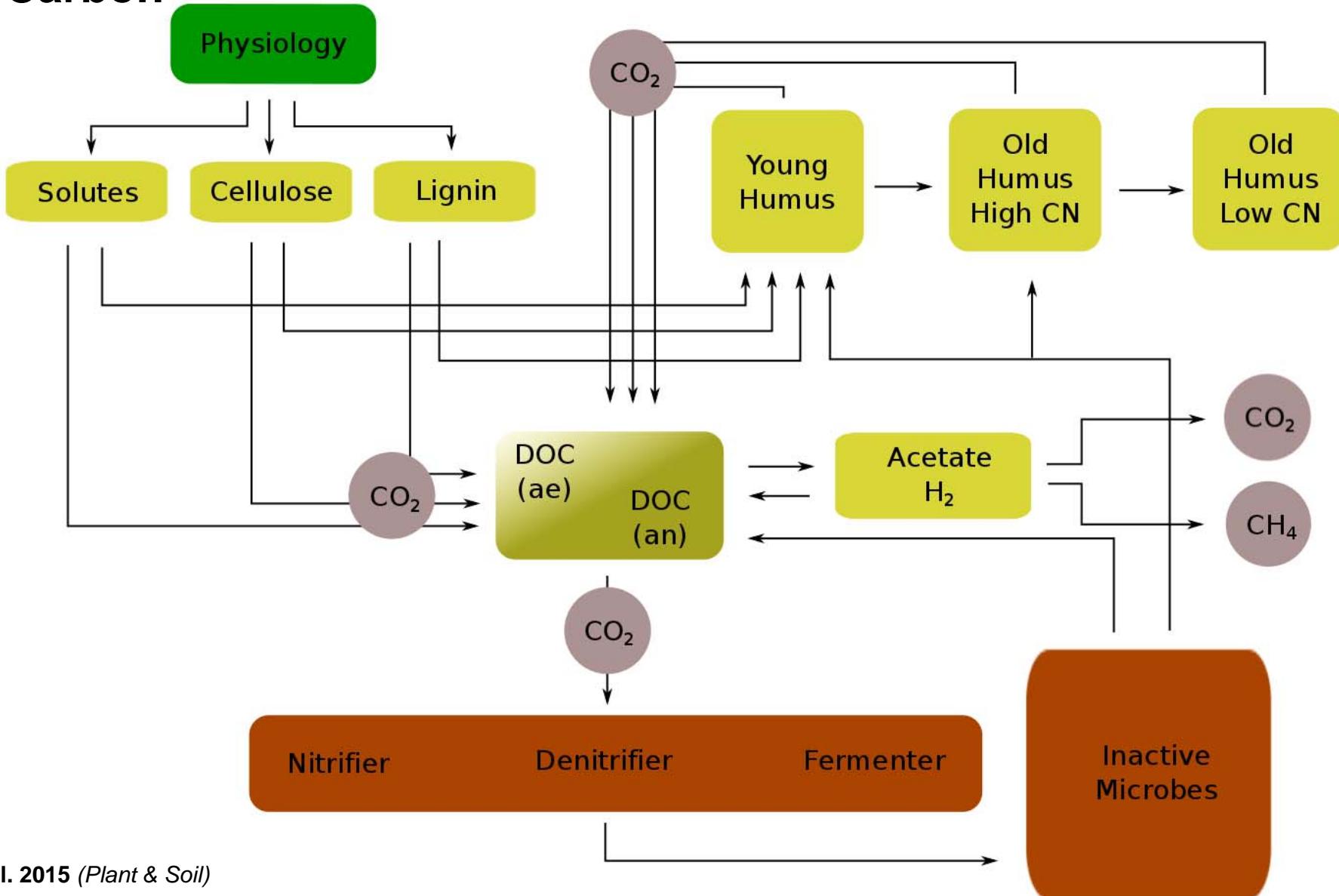


## Physiology



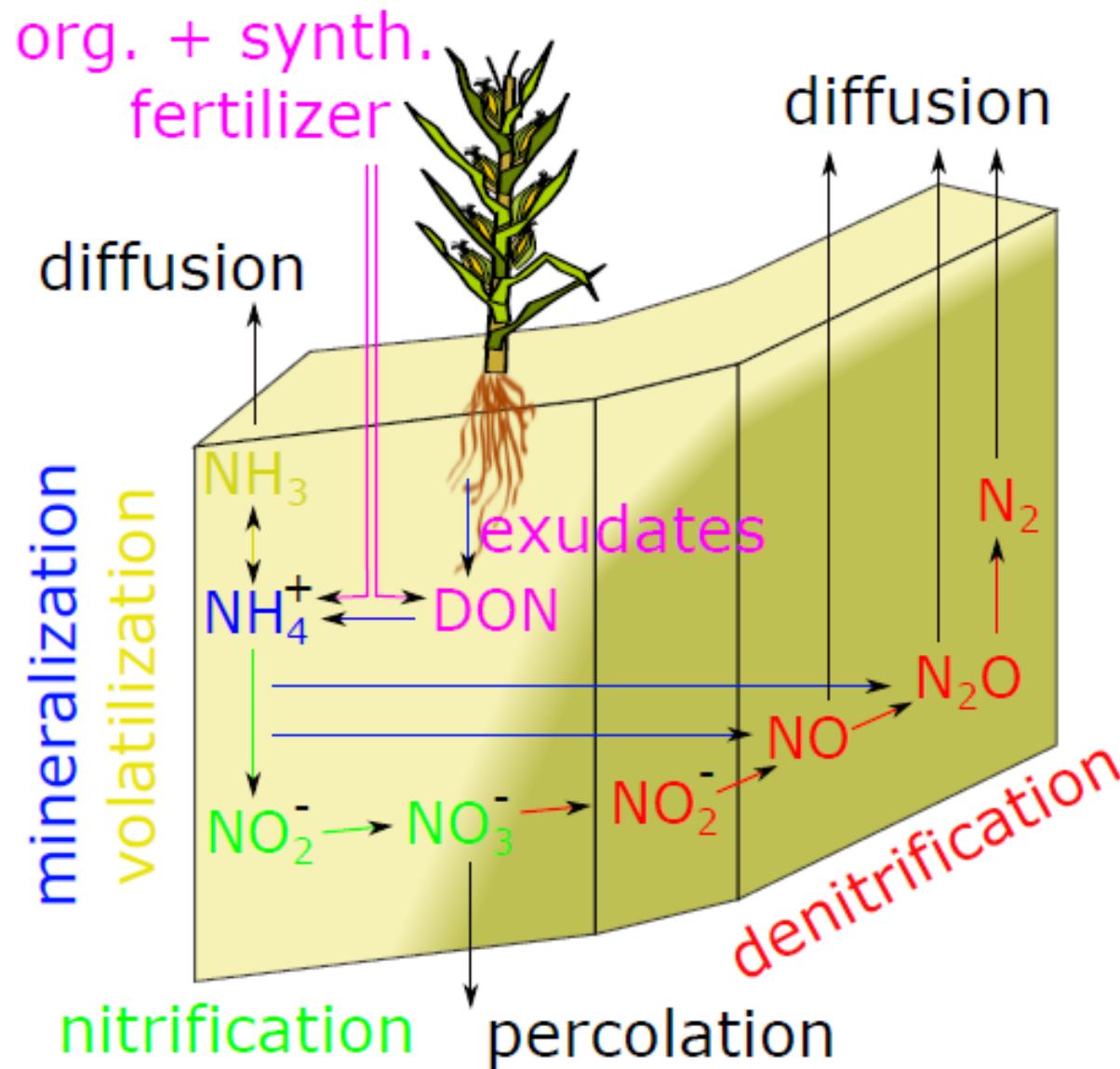
Matter Fluxes: NO, N<sub>2</sub>O, N<sub>2</sub>, NH<sub>3</sub>, NO<sub>3</sub>, CO<sub>2</sub>, CH<sub>4</sub>, Water, Energy, Crop Yields, Timber, ...

## Soil Carbon

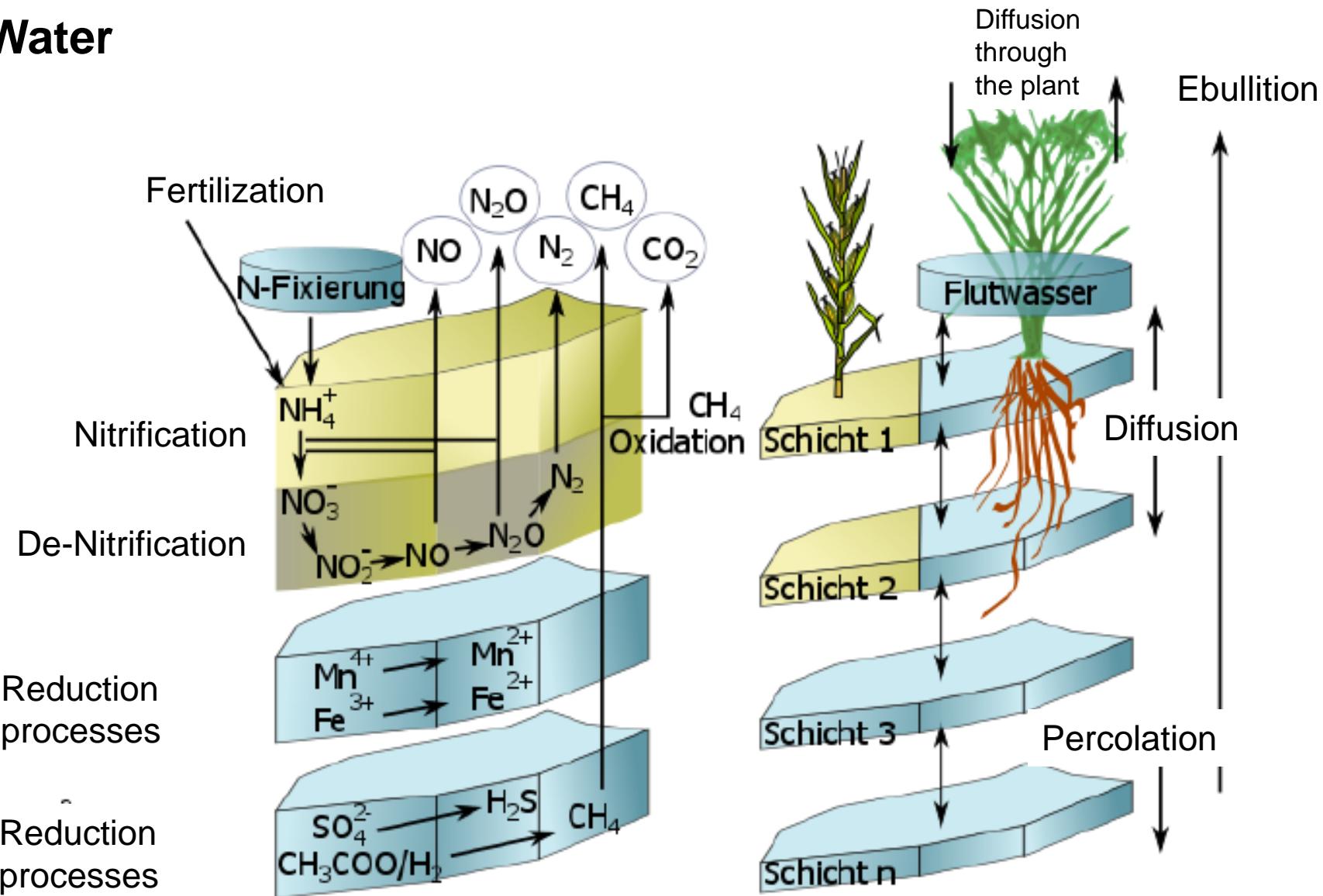


Kraus et al. 2015 (*Plant & Soil*)

## Soil Nitrogen



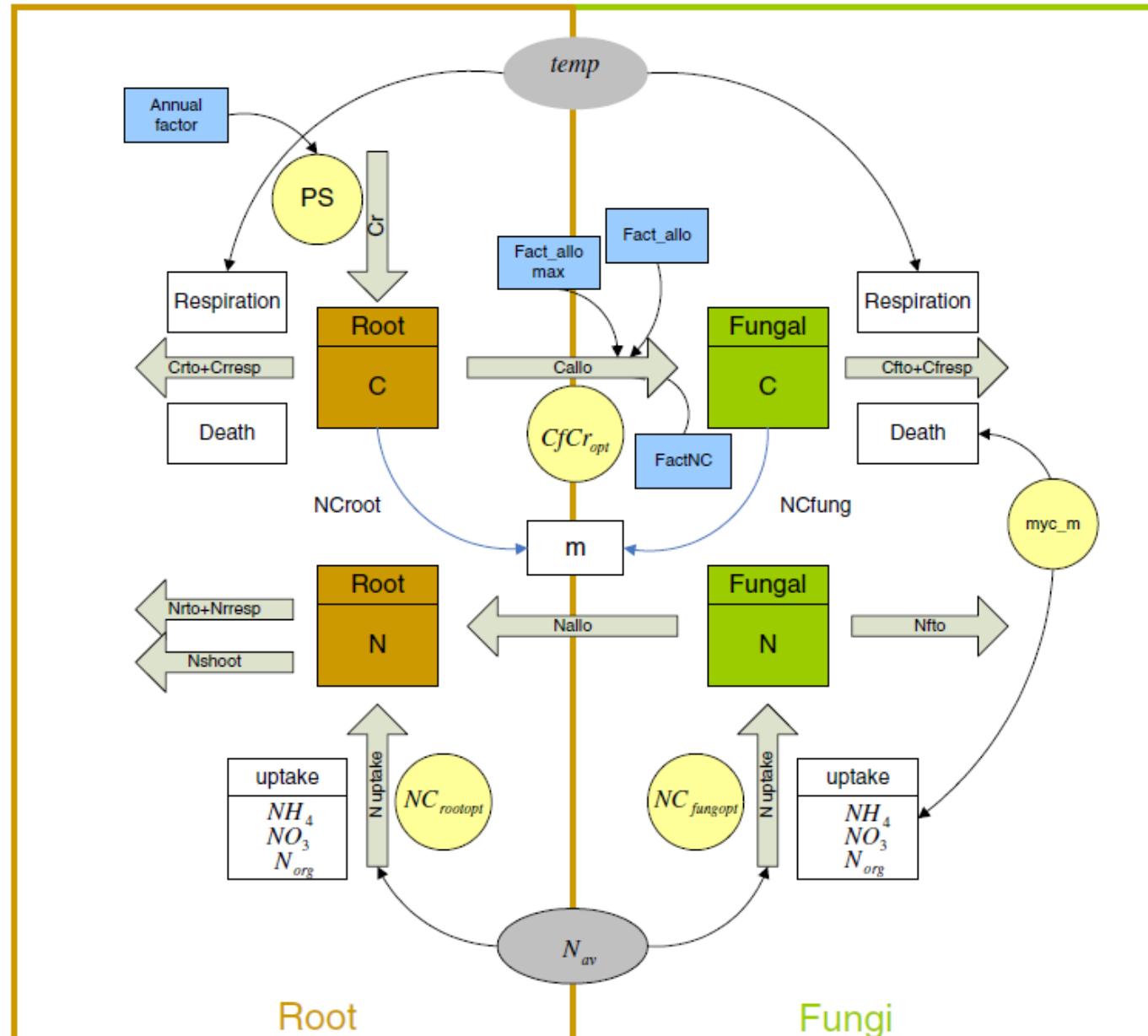
## Soil Water



## Mycorrhiza

### Mycorrhiza (the Mycofon model):

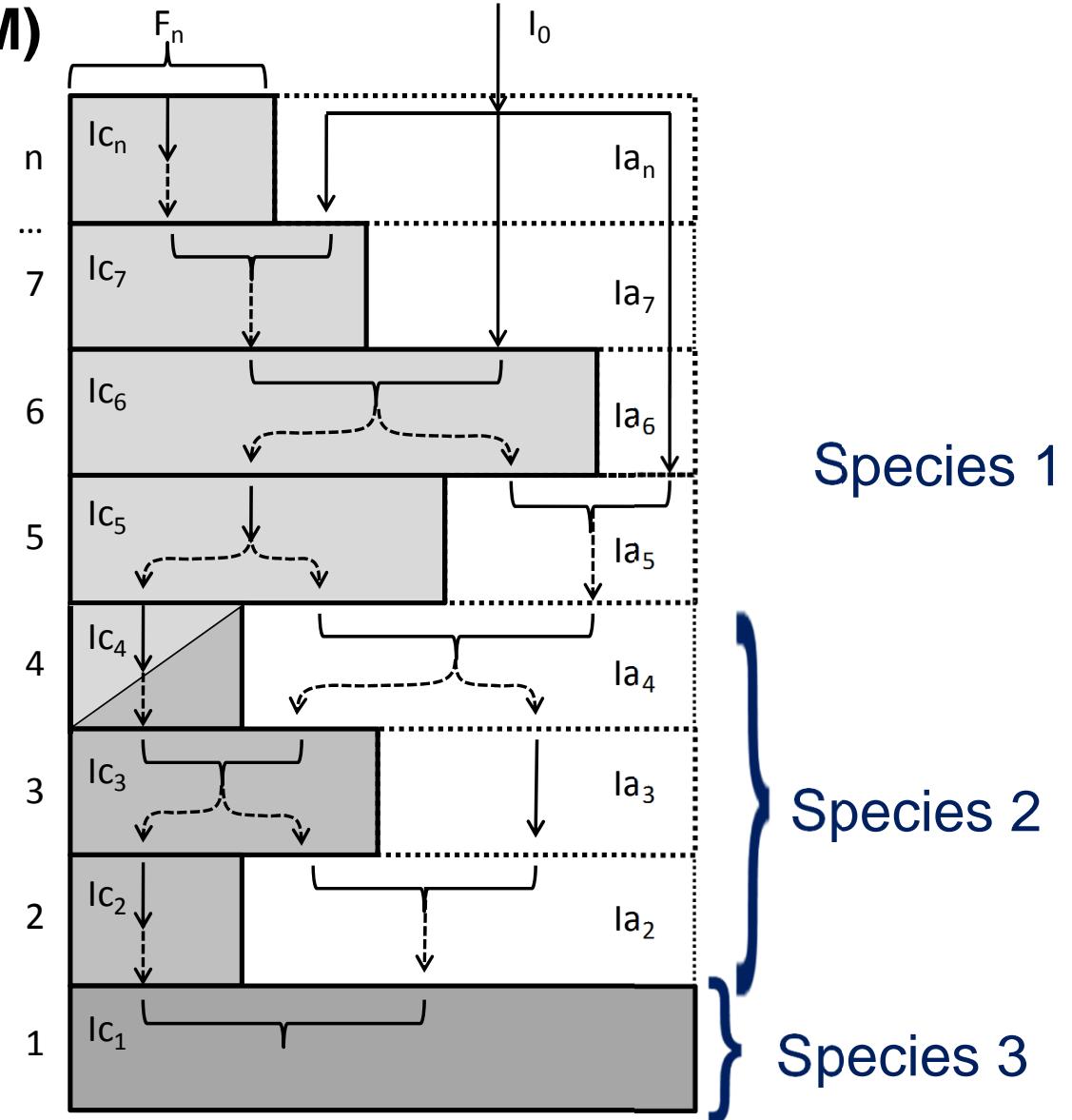
- Benefits from more efficient nutrient uptake
- Costs from carbon supply to fungi
- Not usually used



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

## Ecosystem canopy model (PSIM)

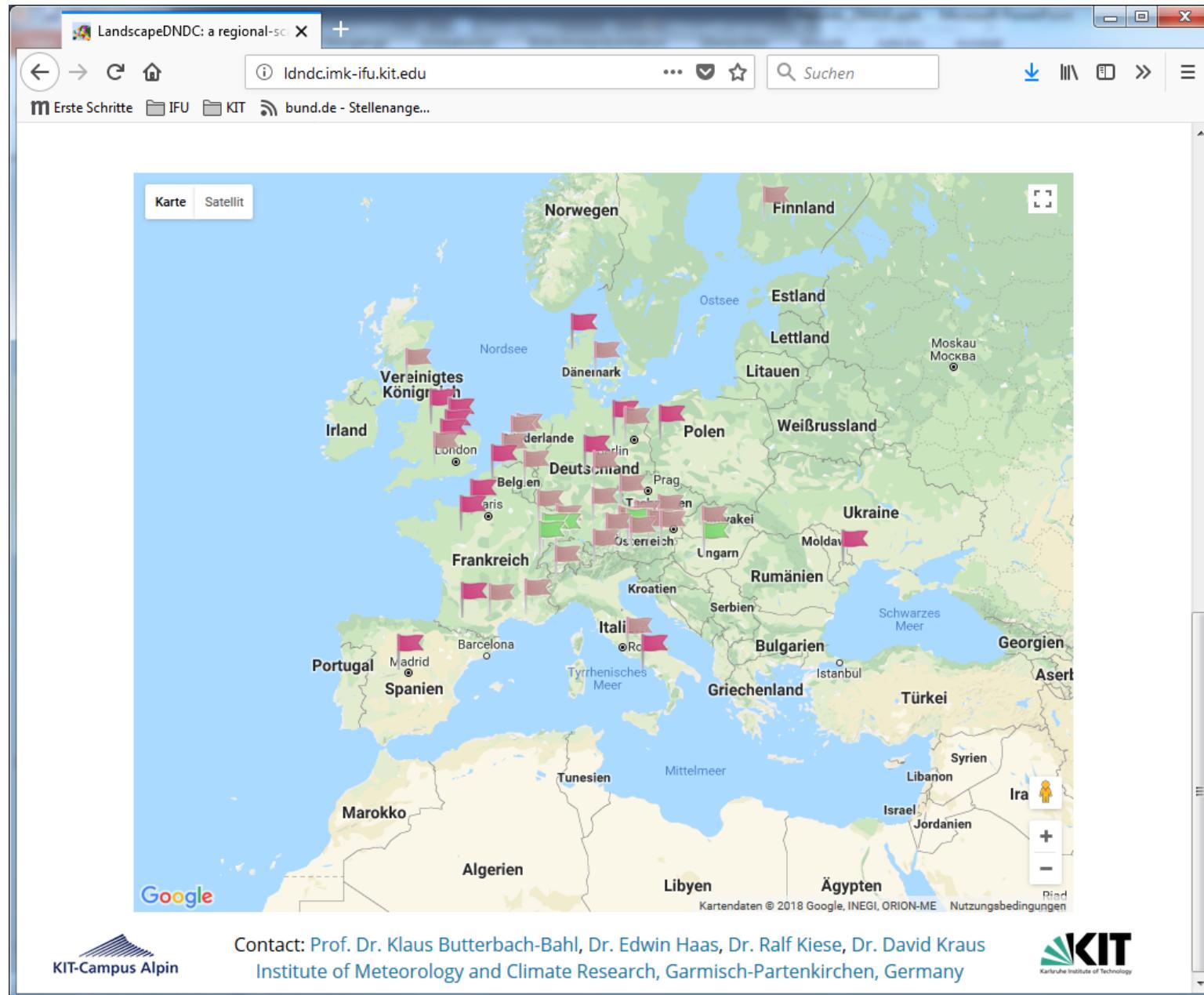
- 2D canopy (accounts for gaps!)
- Vertically layered (explicit species position)
- Each layer with separate pools, fluxes and properties



Grote et al. 2011 (Forest Systems)



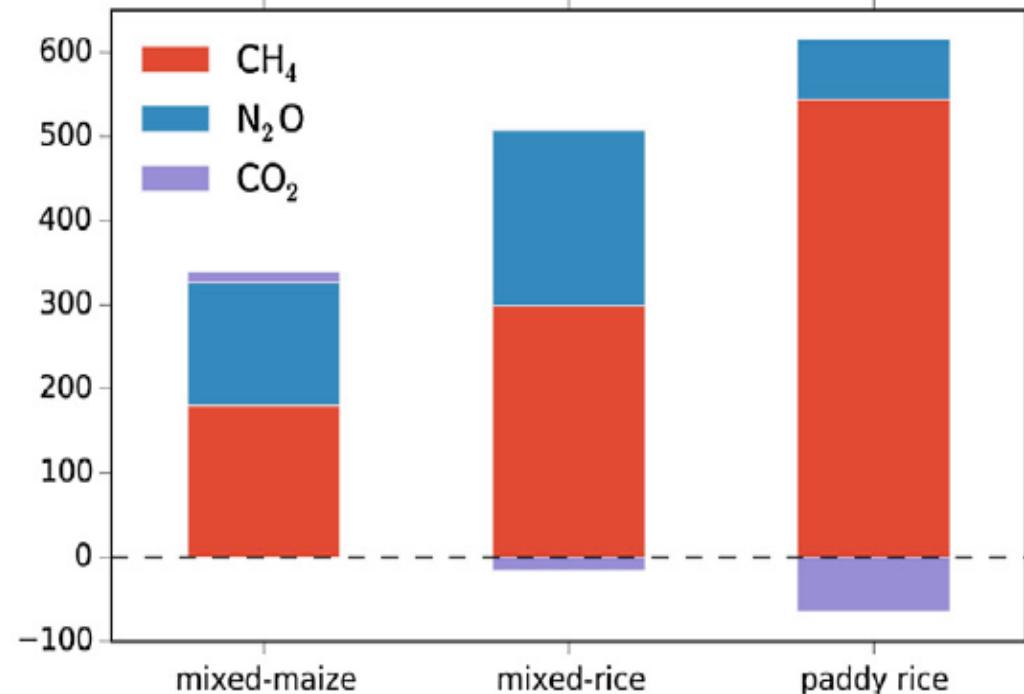
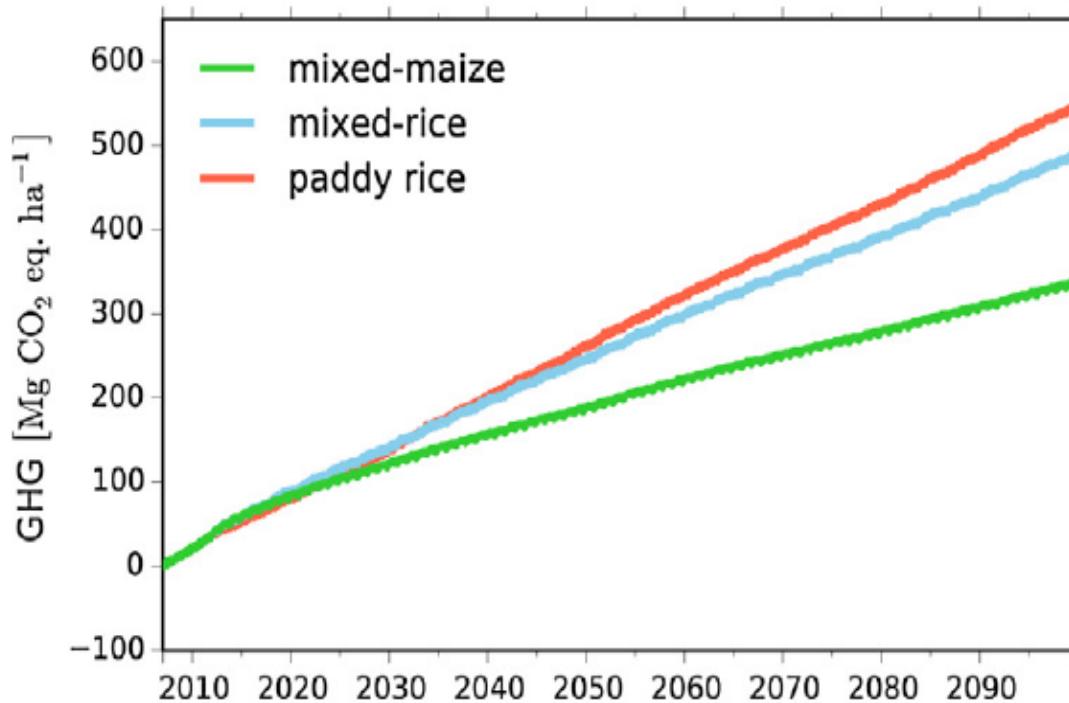
# LandscapeDNDc: Applications



Green: Grassland  
Light red: Forest  
Red: Agriculture

## Crops: Rice (Philippines)

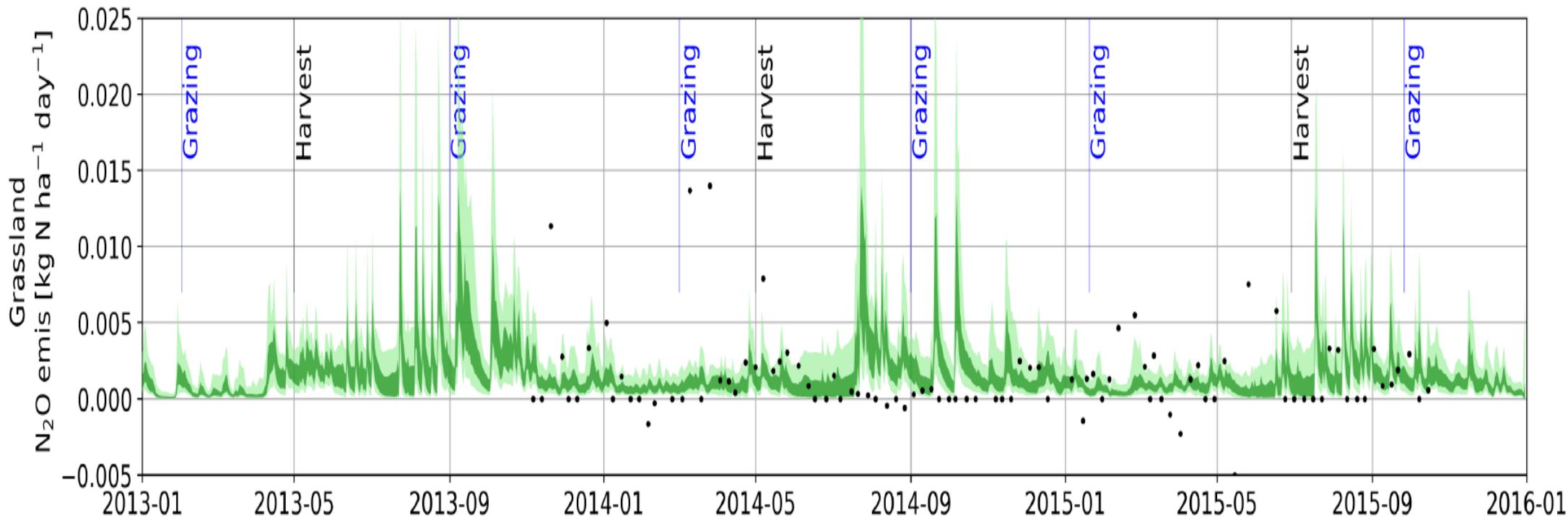
- Different management
- Annual quantification
- Scenario calculations



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

## Grassland (Germany, TERENO site)

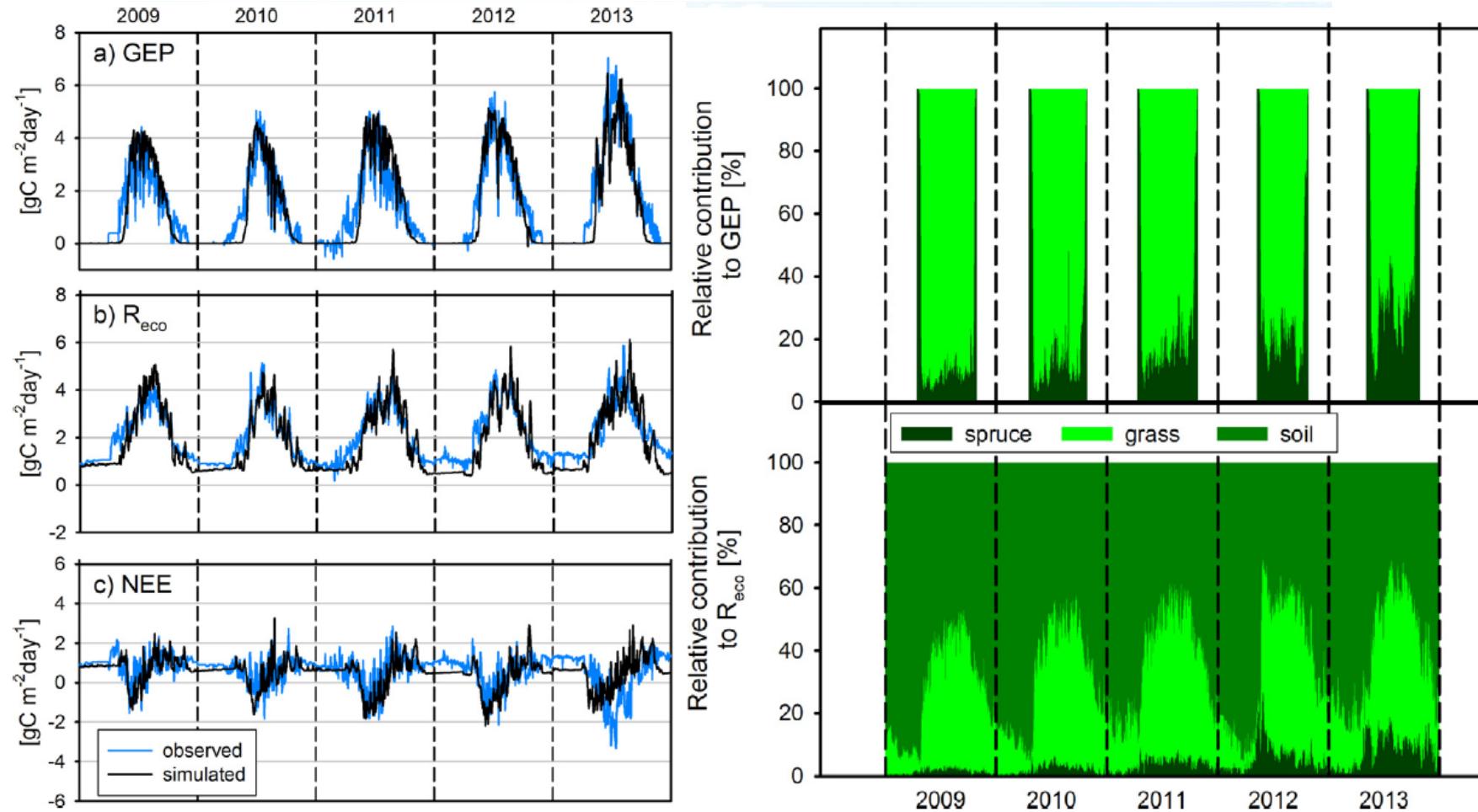
- Different management
- Different soil (adapted to different climate)



| Houska et al. 2017 (*Biogeoscience*)

## Disturbance site (Germany, Lackenberg)

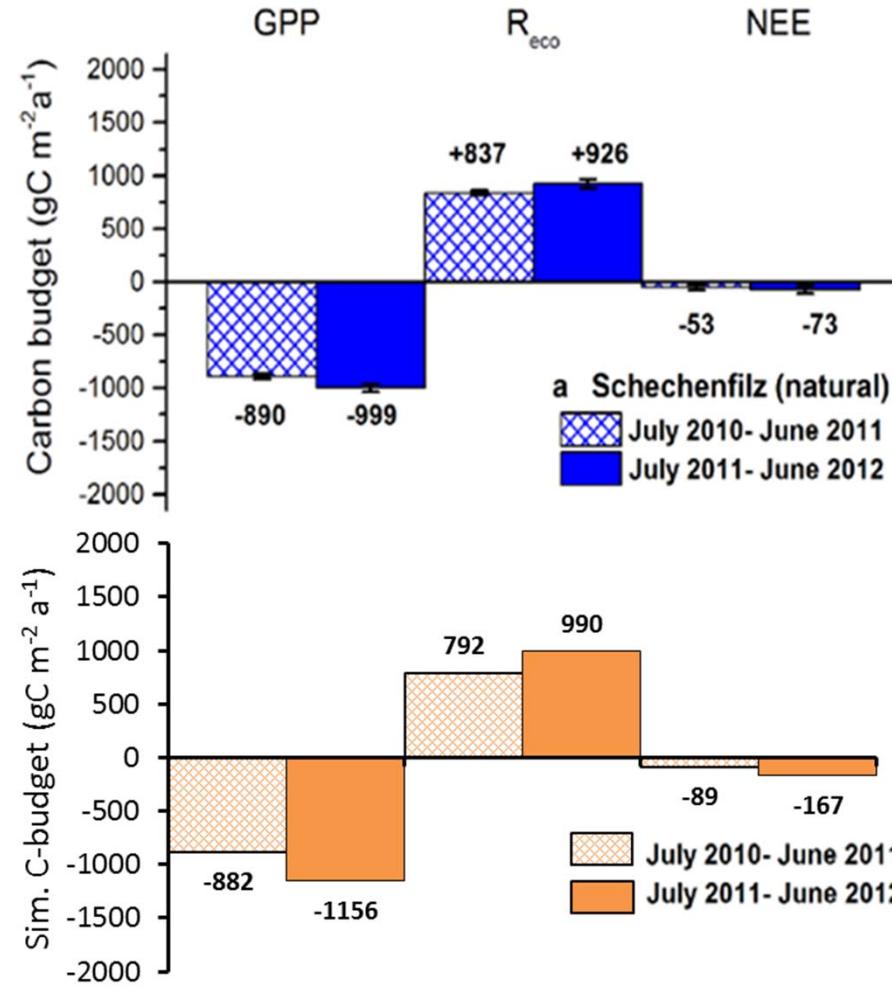
- Carbon balances after disturbance
- Competition of trees with ground vegetation



Lindauer et al. 2014 (*Agr. For. Meteorol.*)

## 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 exudation

- + included
- fixed fraction of root growth

### root distribution

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

### mycorrhization

- + potentially included
- not evaluated

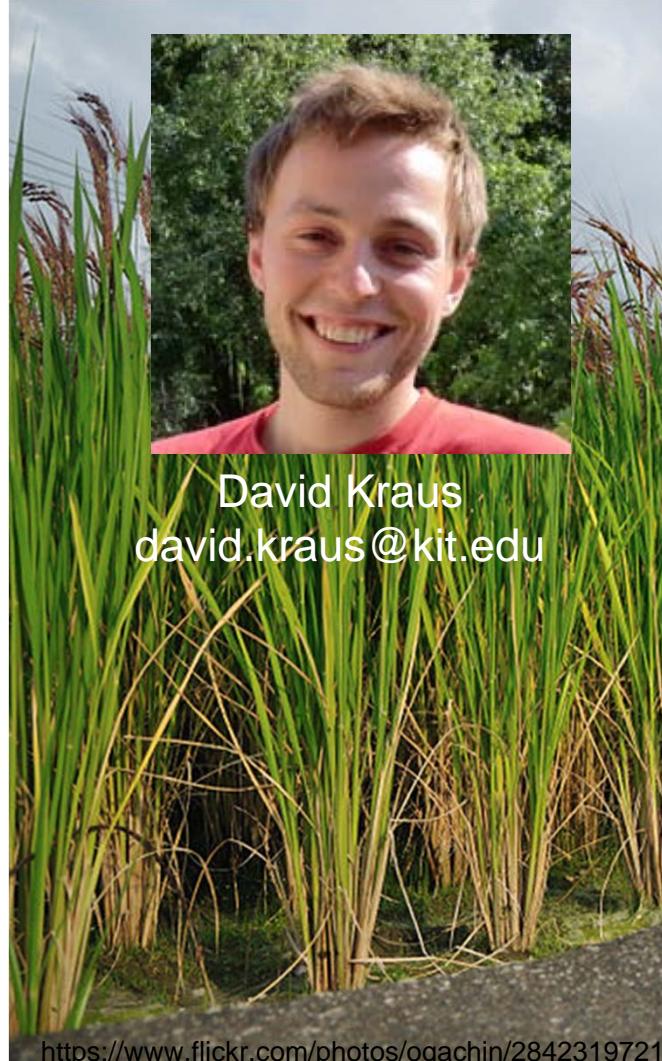


# Landscape-DNDC: Current Developer Contacts

[https://commons.wikimedia.org/wiki/File:Alpine\\_flora\\_logo\\_pass.jpg](https://commons.wikimedia.org/wiki/File:Alpine_flora_logo_pass.jpg)



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## Thank you for your attention