



# Plant-Soil Interaction in Landscape-DNDC

26.04.2018

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# LandscapeDNDC: Objectives

## For plant covered terrestrial ecosystems:

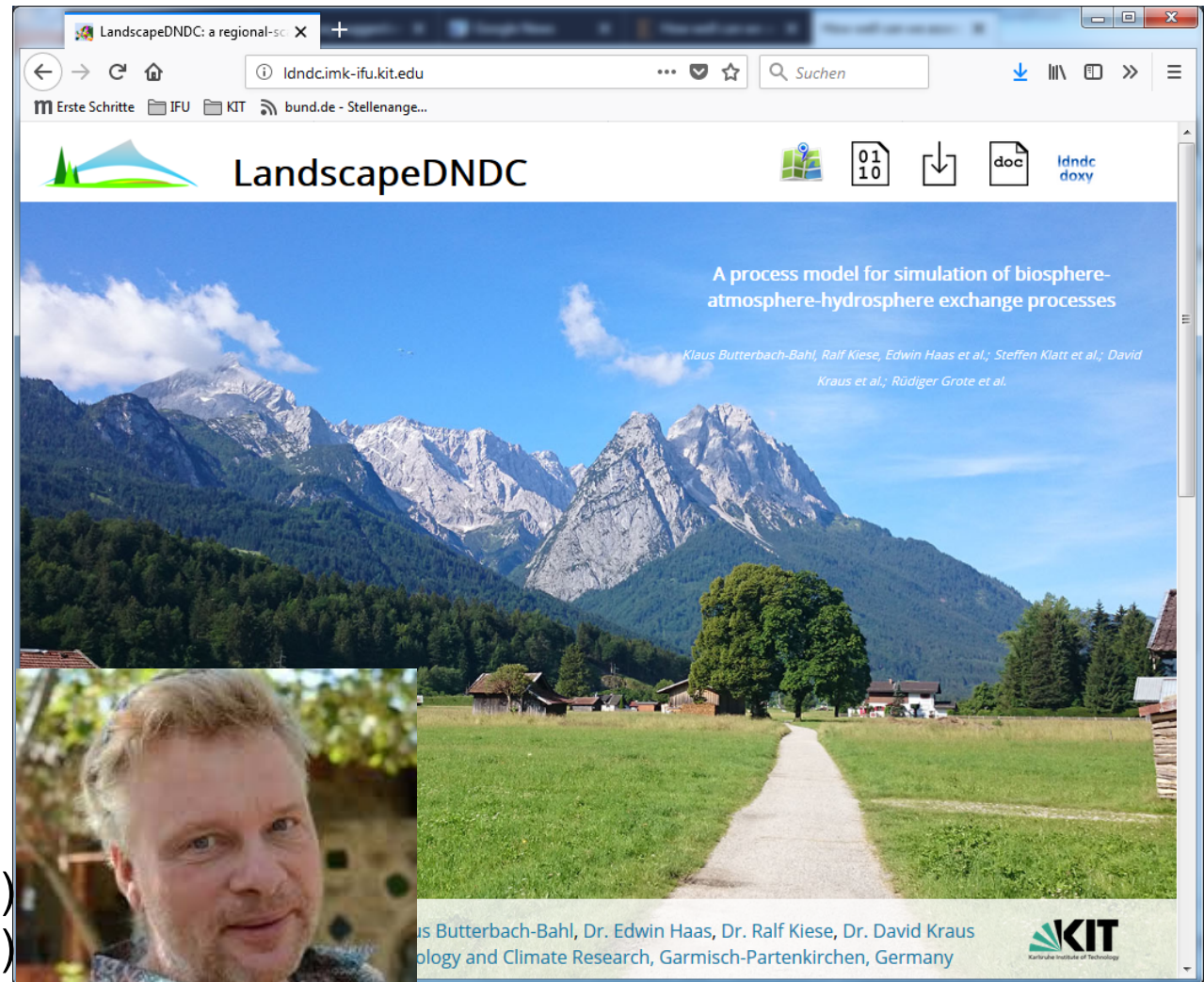
- Trace gas exchange ( $N_2O$ ,  $NO$ ,  $CH_4$ , BVOC)
- Leaching ( $NO_3$ , DOC)

## Represents:

- Biomass production & vegetation development
- C-, N-,  $H_2O$  balances

## History:

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



Klaus Butterbach-Bahl

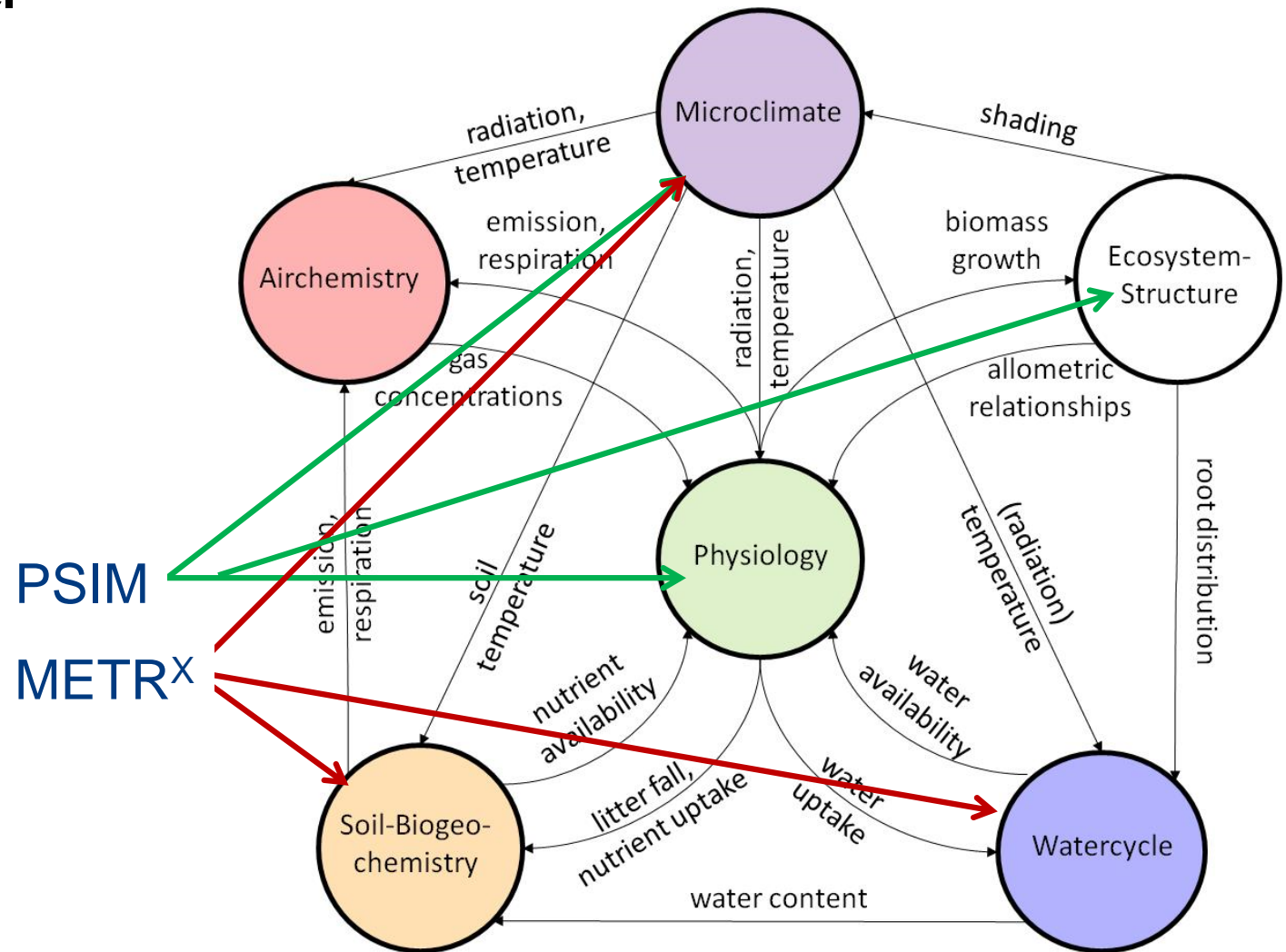
klaus.butterbach-bahl@kit.edu

<http://ldndc.imk-ifu.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



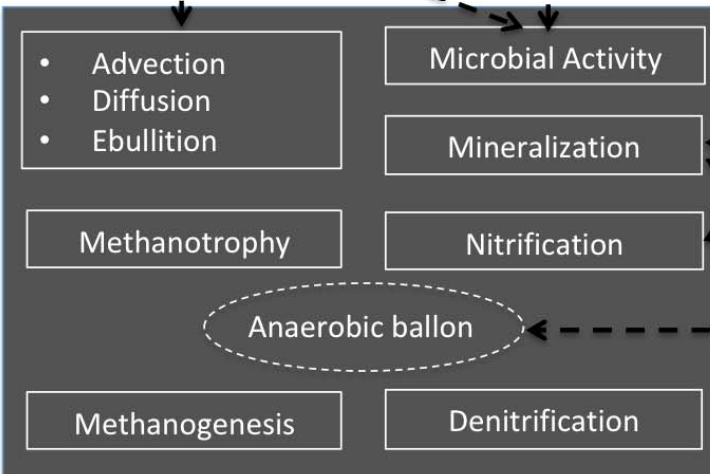
## Structure



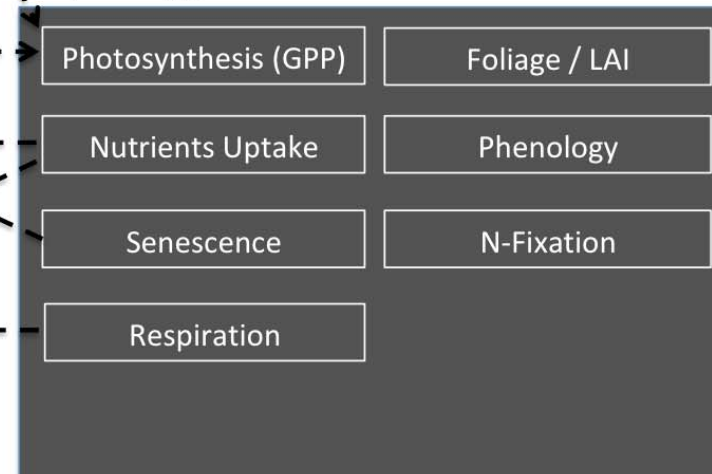
## Events



## Soil



## Physiology

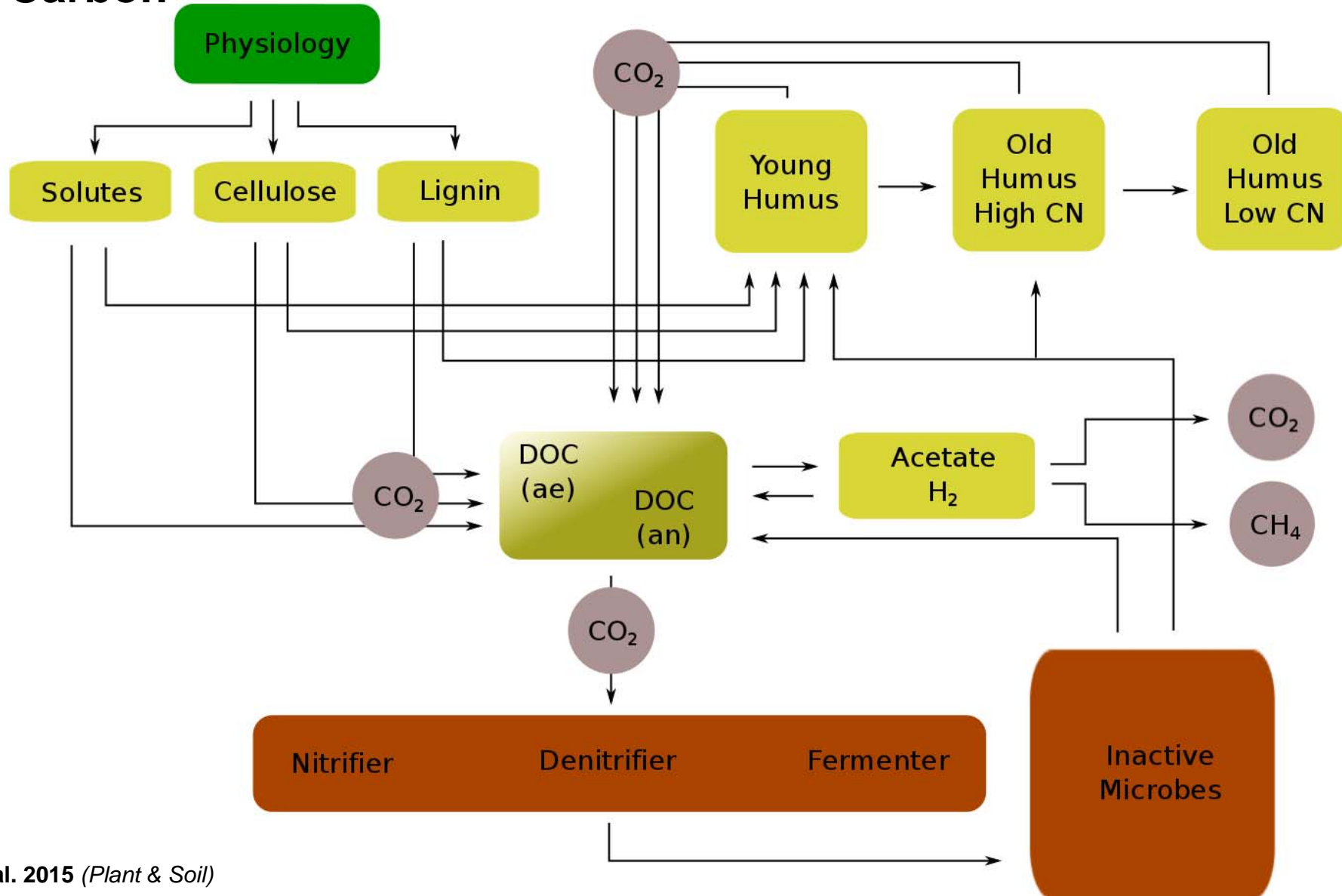


Matter Fluxes: NO, N<sub>2</sub>O, N<sub>2</sub>, NH<sub>3</sub>, NO<sub>3</sub>, CO<sub>2</sub>, CH<sub>4</sub>, Water, Energy, Crop Yields, Timber, ...



# LandscapeDNDC: Design

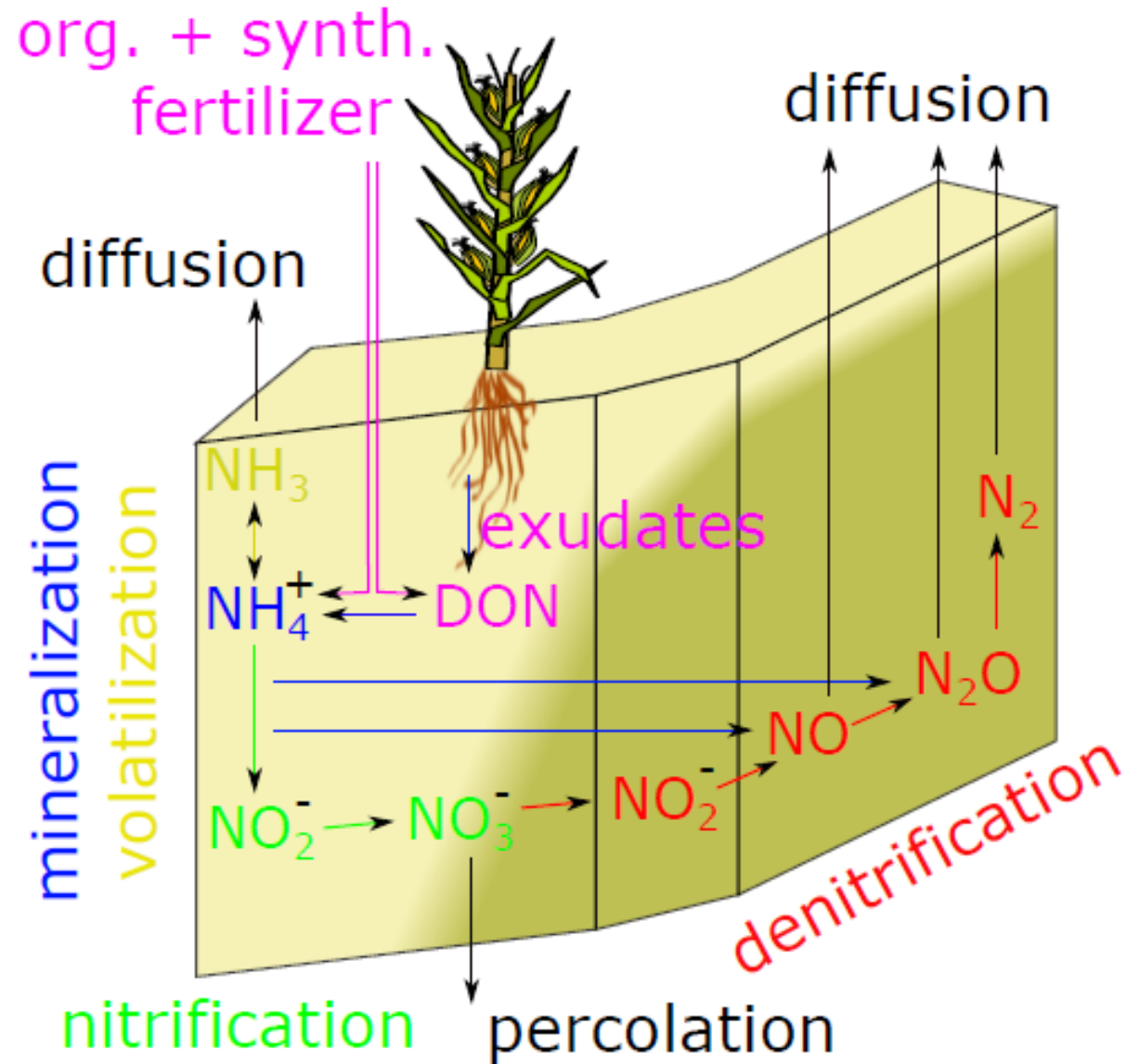
## Soil Carbon



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



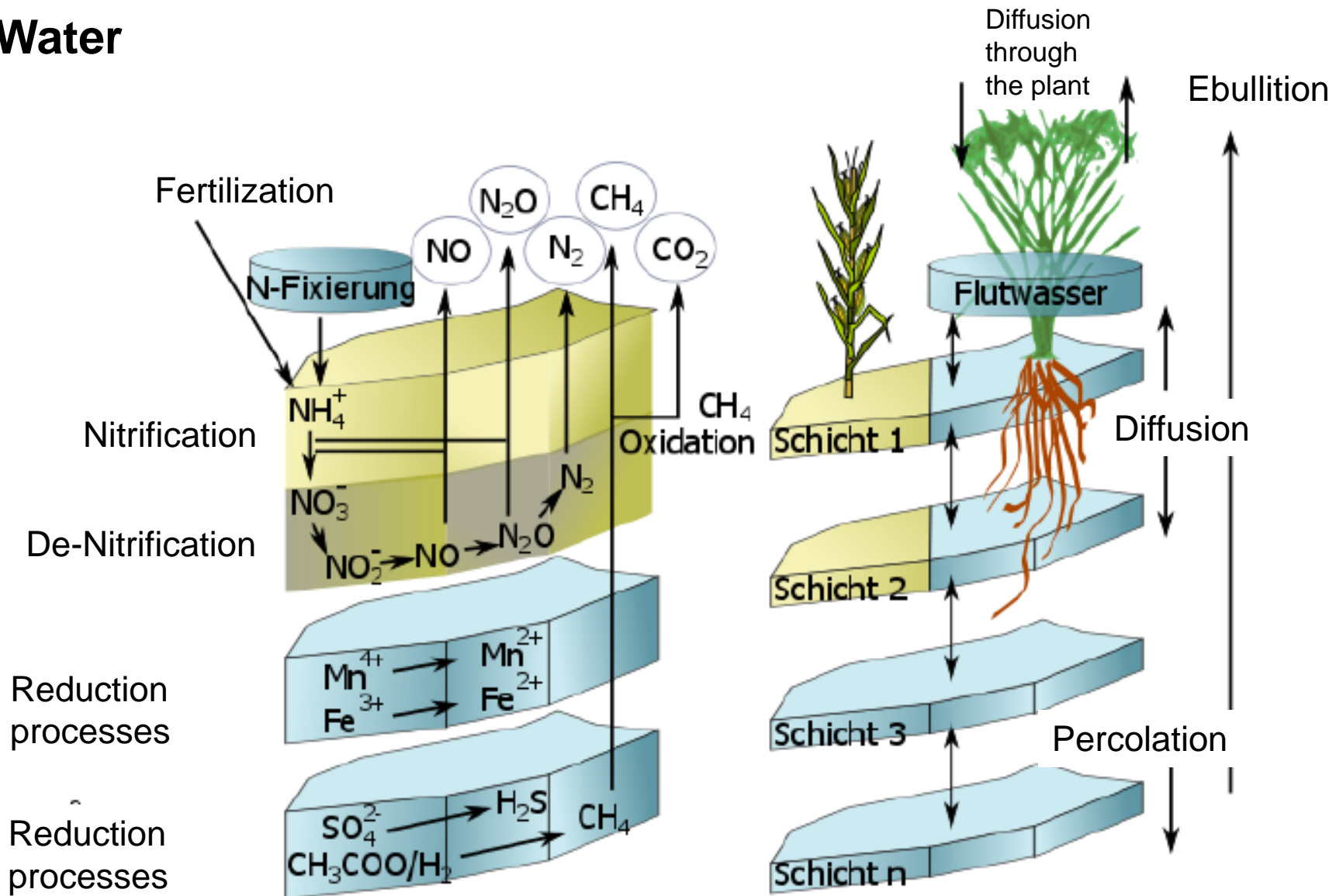
## Soil Nitrogen





# LandscapeDNDK: Design

## Soil Water



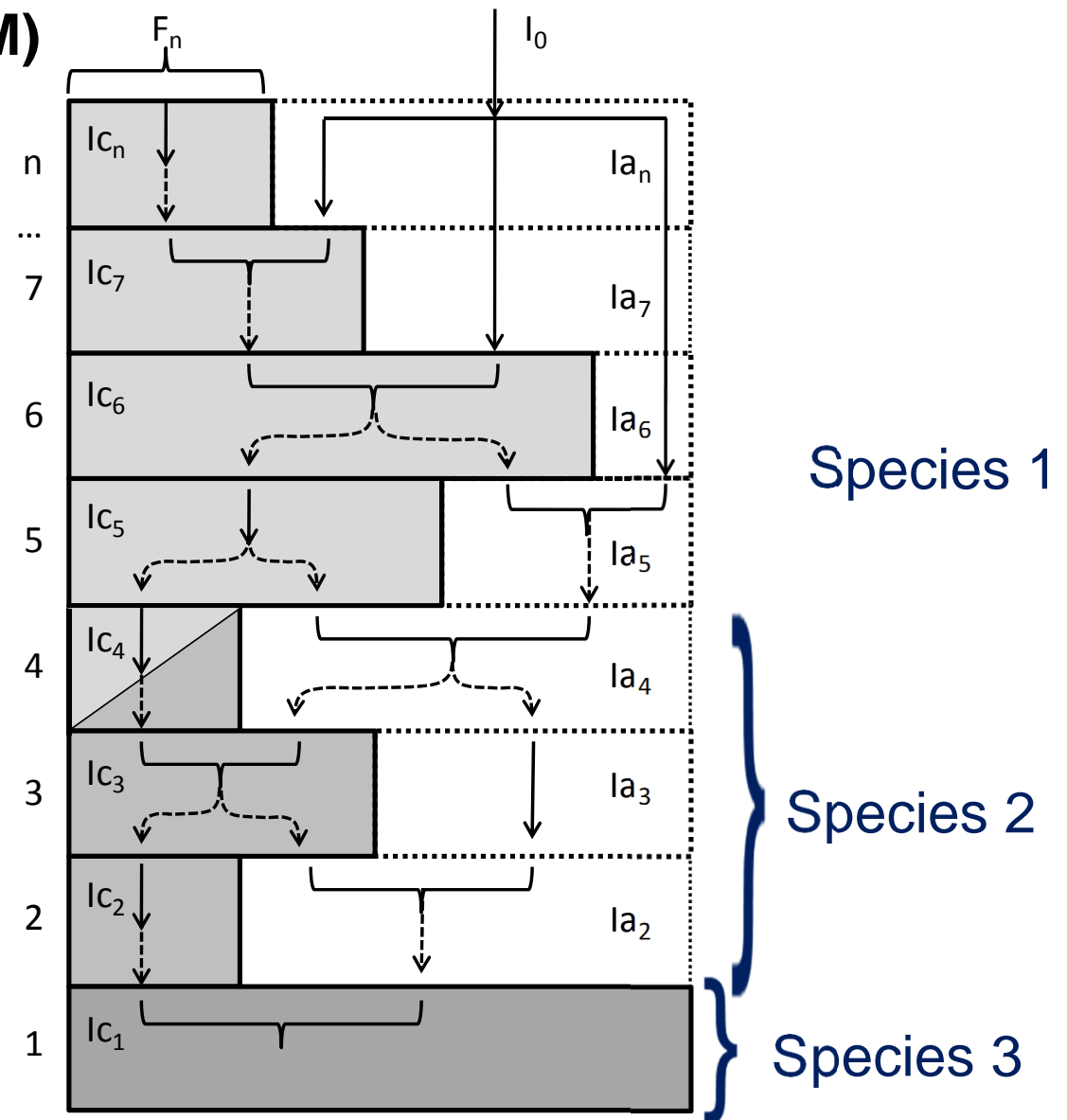






## Ecosystem canopy model (PSIM)

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



Grote et al. 2011 (*Forest Systems*)



# LandscapeDND: Applications

Google

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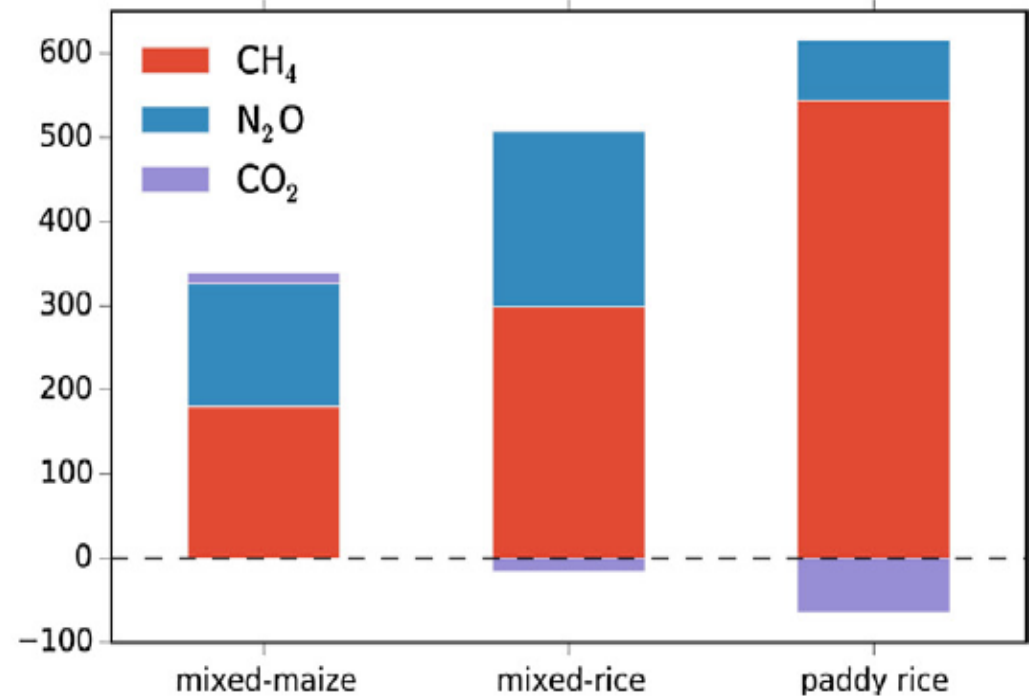
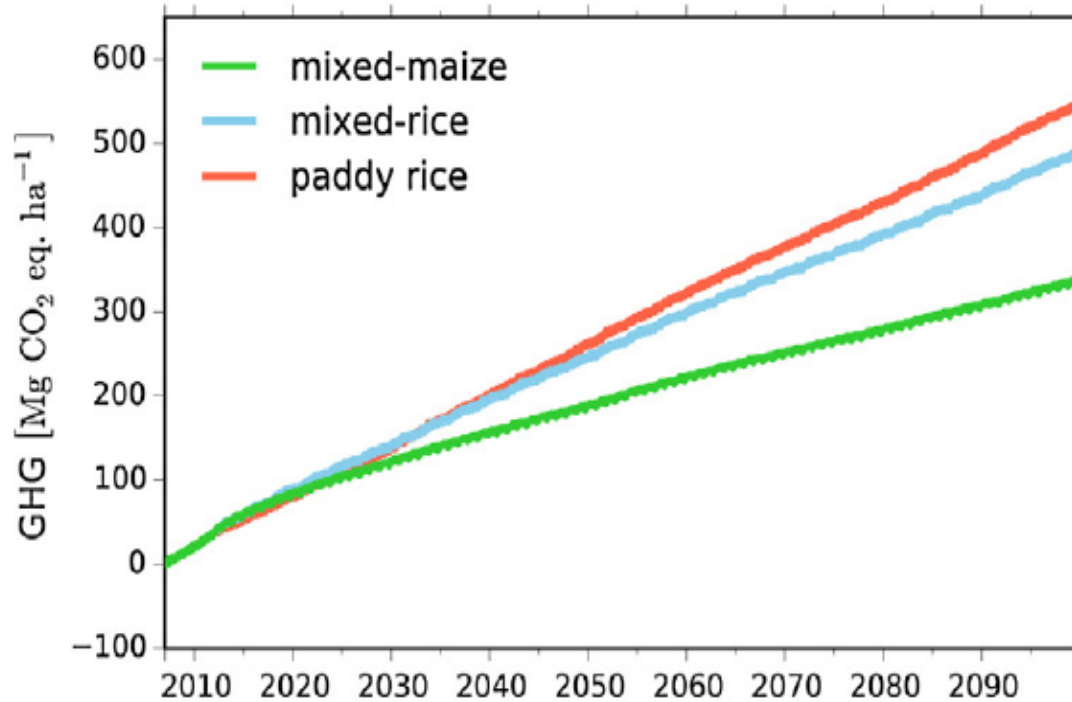
KIT-Campus Alpin

Contact: Prof. Dr. Klaus Butterbach-Bahl, Dr. Edwin Haas, Dr. Ralf Kiese, Dr. David Kraus  
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Green: Grassland  
Light red: Forest  
Red: Agriculture

## Crops: Rice (Philippines)

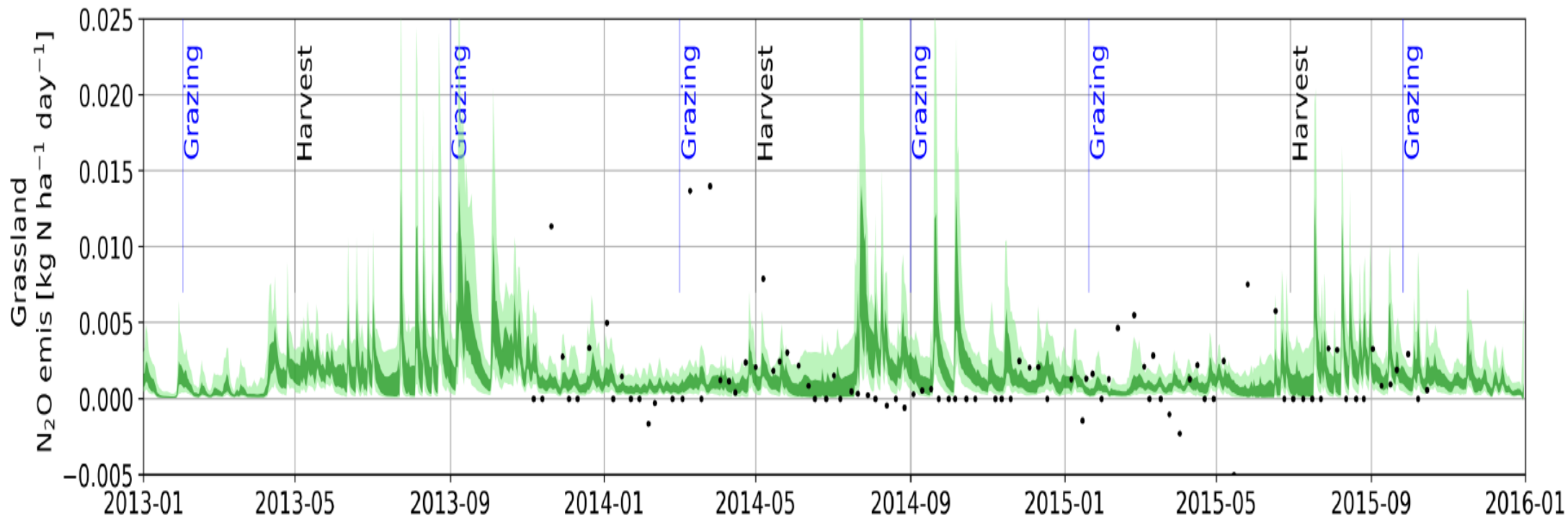
- Different management
- Annual quantification
- Scenario calculations



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

## Grassland (Germany, TERENO site)

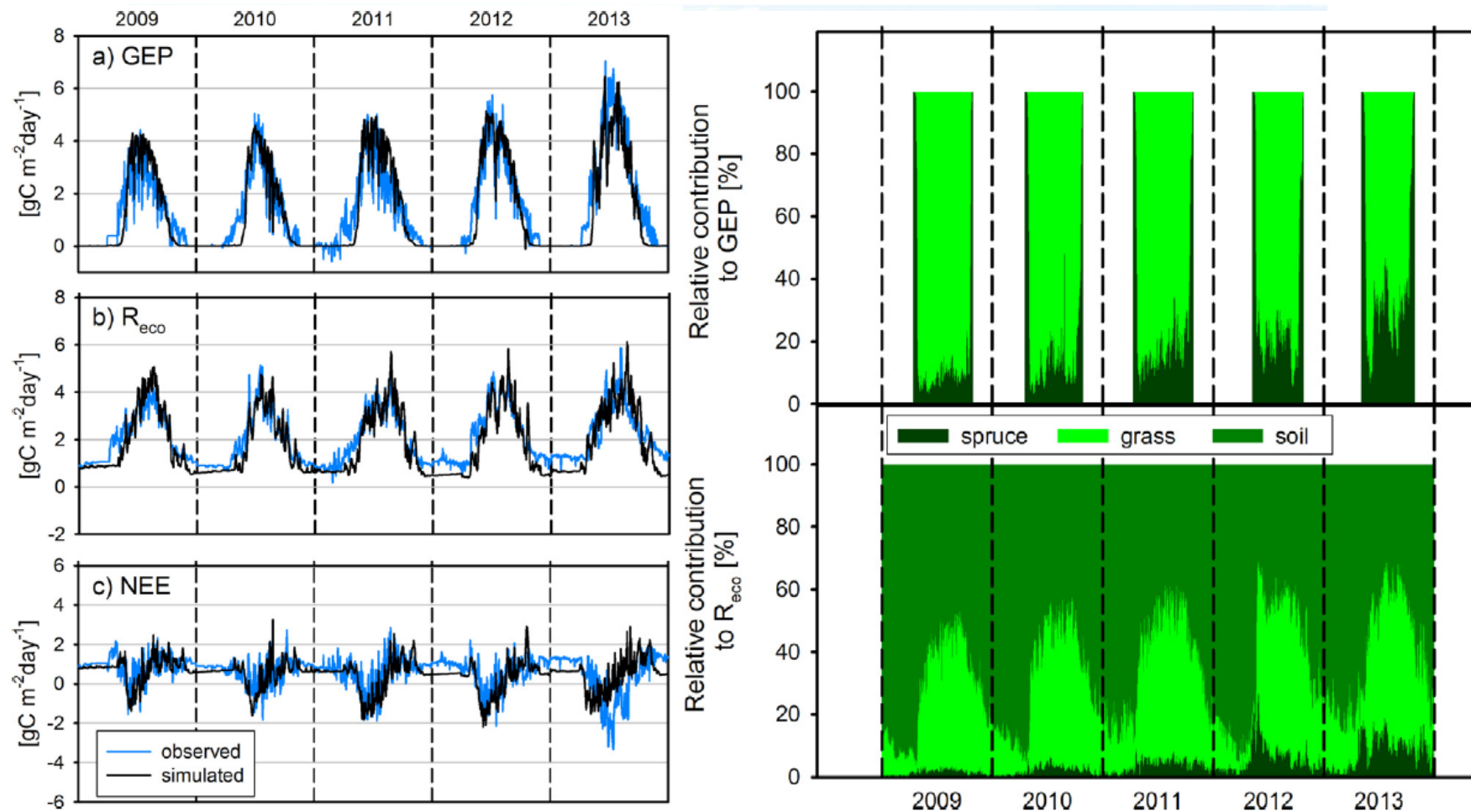
- Different management
- Different soil (adapted to different climate)



| Houska et al. 2017 (*Biogeoscience*)

## Disturbance site (Germany, Lackenberg)

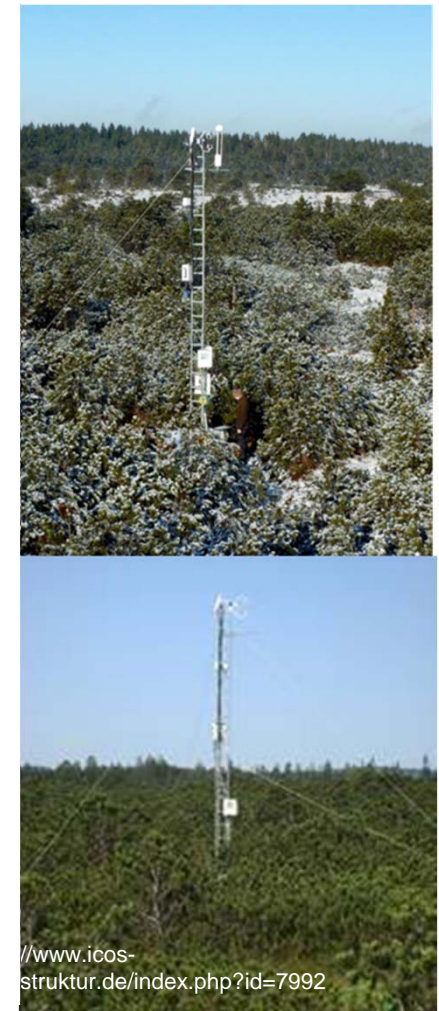
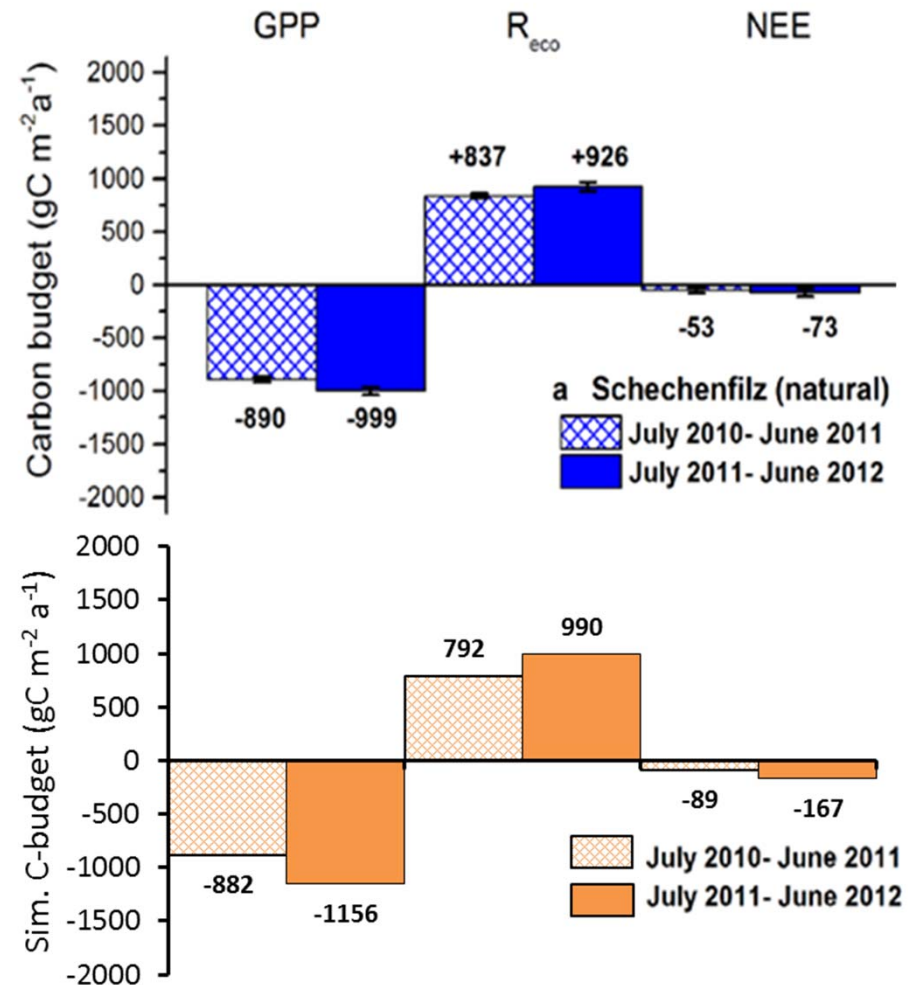
- Carbon balances after disturbance
- Competition of trees with ground vegetation



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

## Drained peatland site (Schechenfilz, Germany):

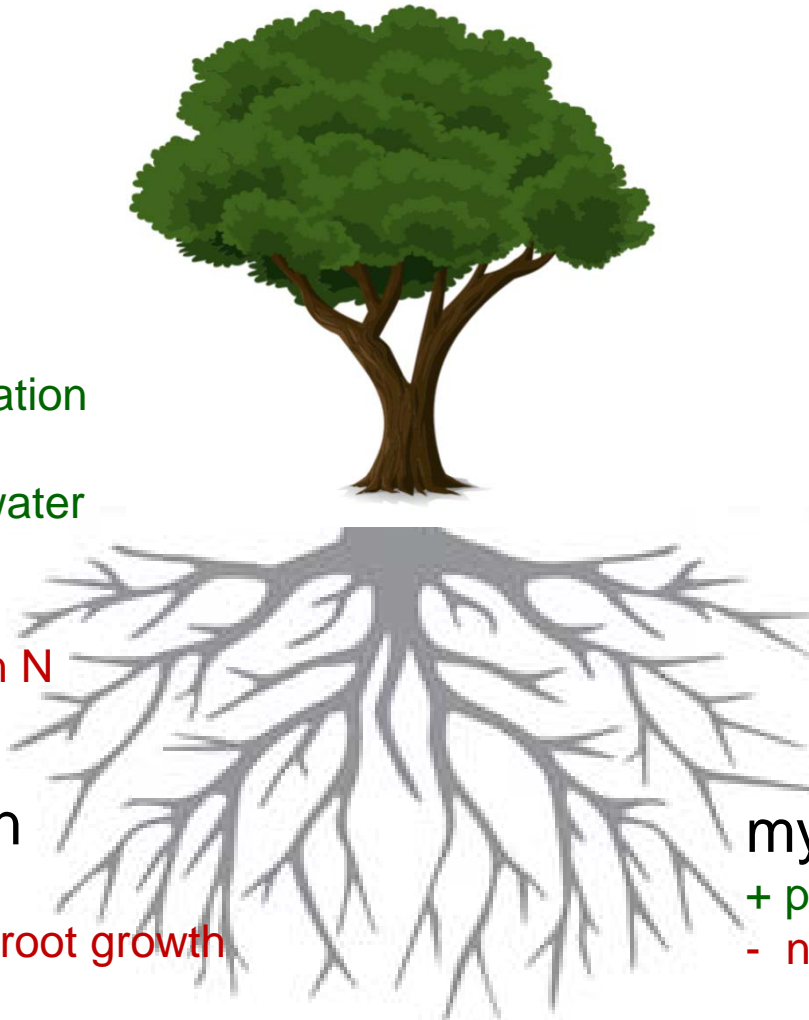
- High carbon content
- High water table



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\\_logan\\_pass.jpg](https://commons.wikimedia.org/wiki/File:Alpine_flora_logan_pass.jpg)



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## Thank you for your attention