TERENO
Terrestrial Environmental Observatories

KIT-Campus Alpin
IMK-IFU: Atmosphärische Umweltforschung

KIT
Karlsruhe Institute of Technology

Impact of climate change on C and N cycling of grassland ecosystems - a climate sequence study

R. Kiese, H. Lu, J. Fu, E. Diaz-Pines, R. Gasche, M. Dannenmann, Z. Chen, K. Butterbach-Bahl

Graswang (860m)

Rottenbuch (750m)

Fendt (600m)

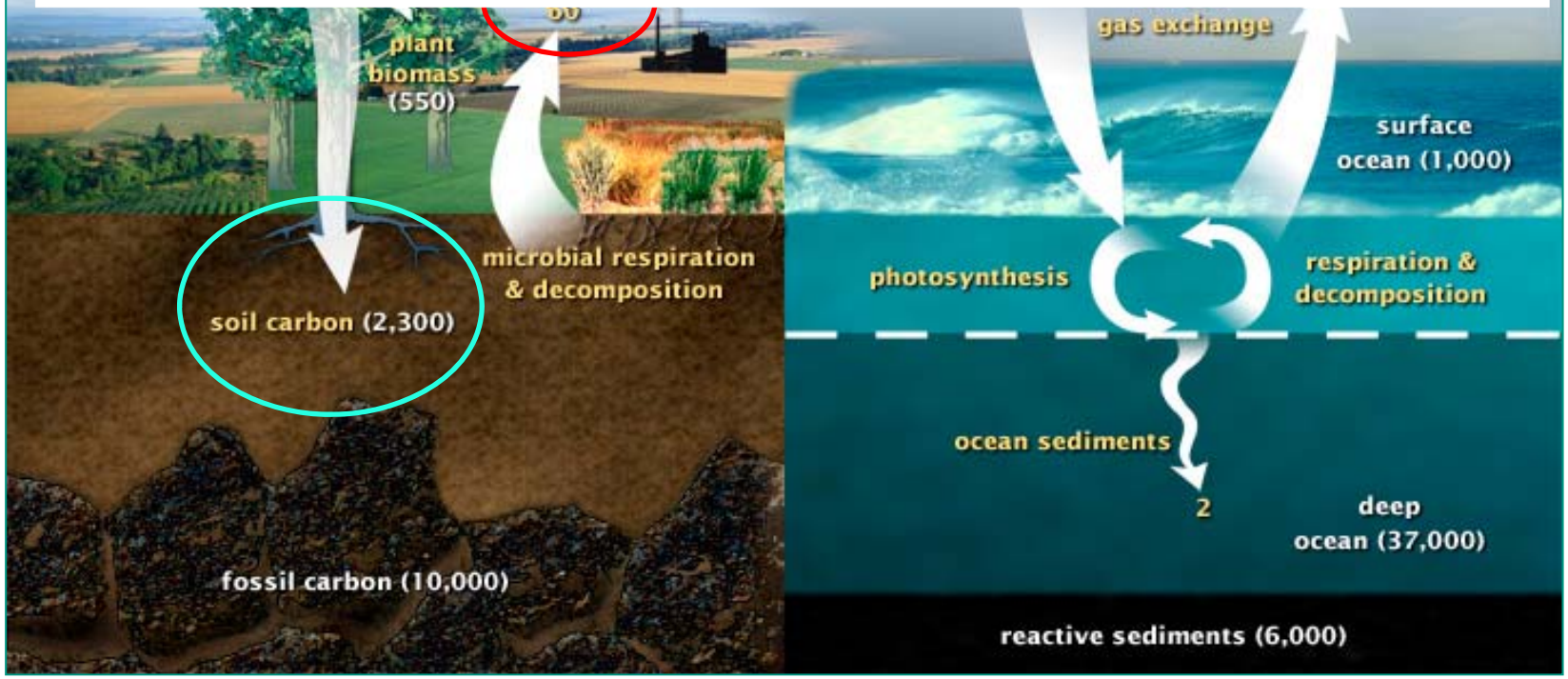
KIT-Campus Alpin
IMK-IFU: Atmosphärische Umweltforschung

Motivation

Hypothesis

Climate change will…

accelerate soil C-/N- turnover and associated soil emission of CO_2 and N_2O as well as leaching of C and N compounds



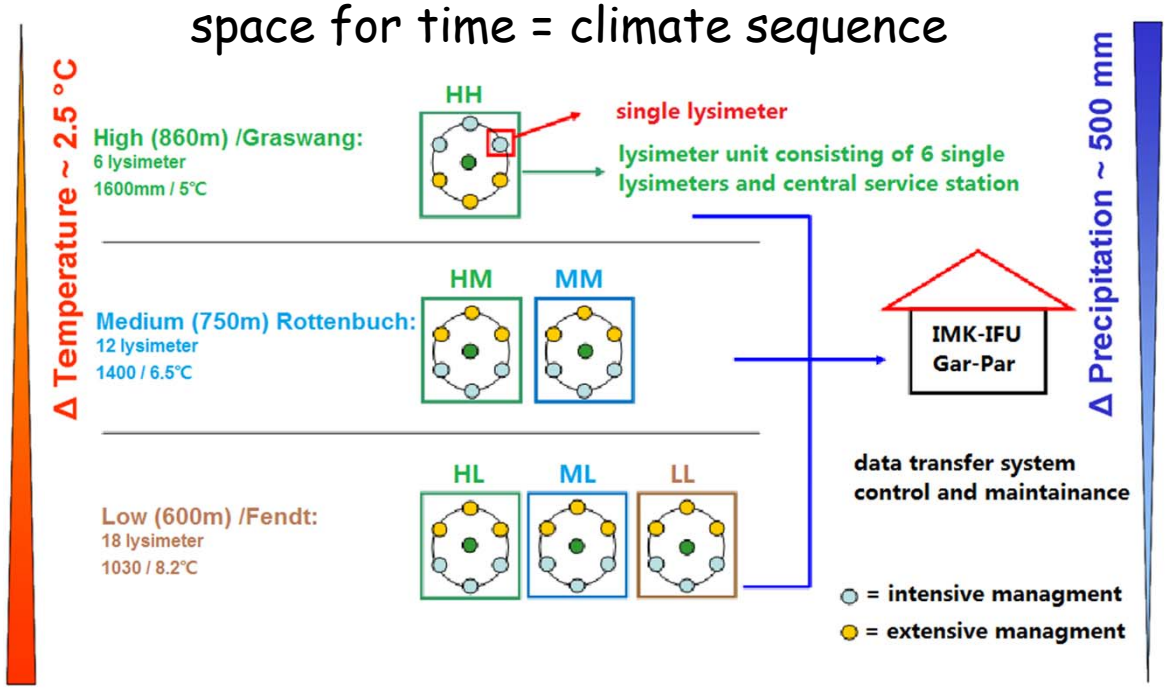
http://earthobservatory.nasa.gov/Features/CarbonCycle/

ralf.kiese@kit.edu

TERENO lysimeter field setup

Lysimeter excavation

space for time = climate sequence



ralf.kiese@kit.edu

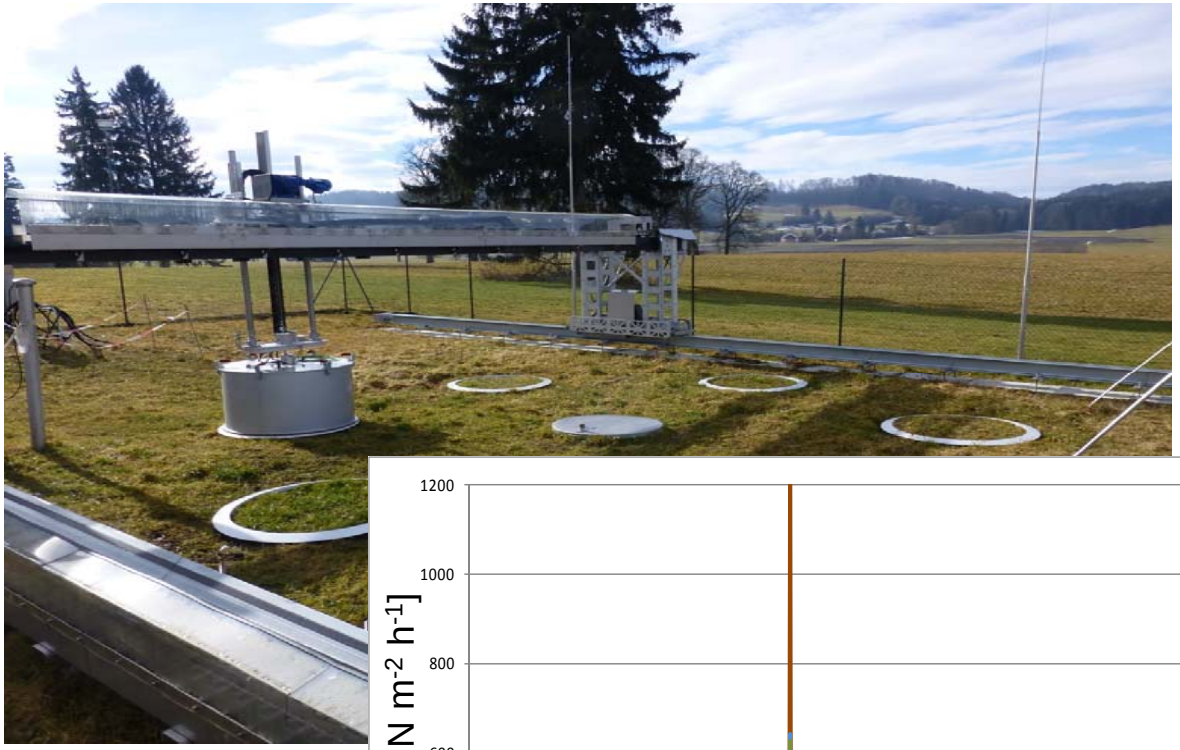
KIT-Campus Alpin
IMK-IFU: Atmosphärische Umweltforschung

Main Objectives

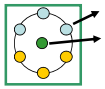
Characterization and quantification of climate change effects on ...

- changes of coupled C-/N-cycles/ storage of grassland ecosystems
- biosphere-atmosphere exchange of greenhouse gases
- vegetation and microbial biomass and biodiversity
- terrestrial hydrology, C and N losses via seepage water

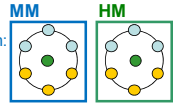
Results: N_2O emission



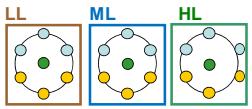
High (860m) / Graswang:
6 lysimeter
1600mm / 5°C

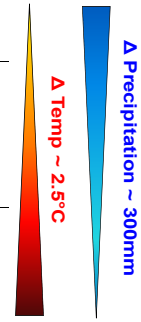


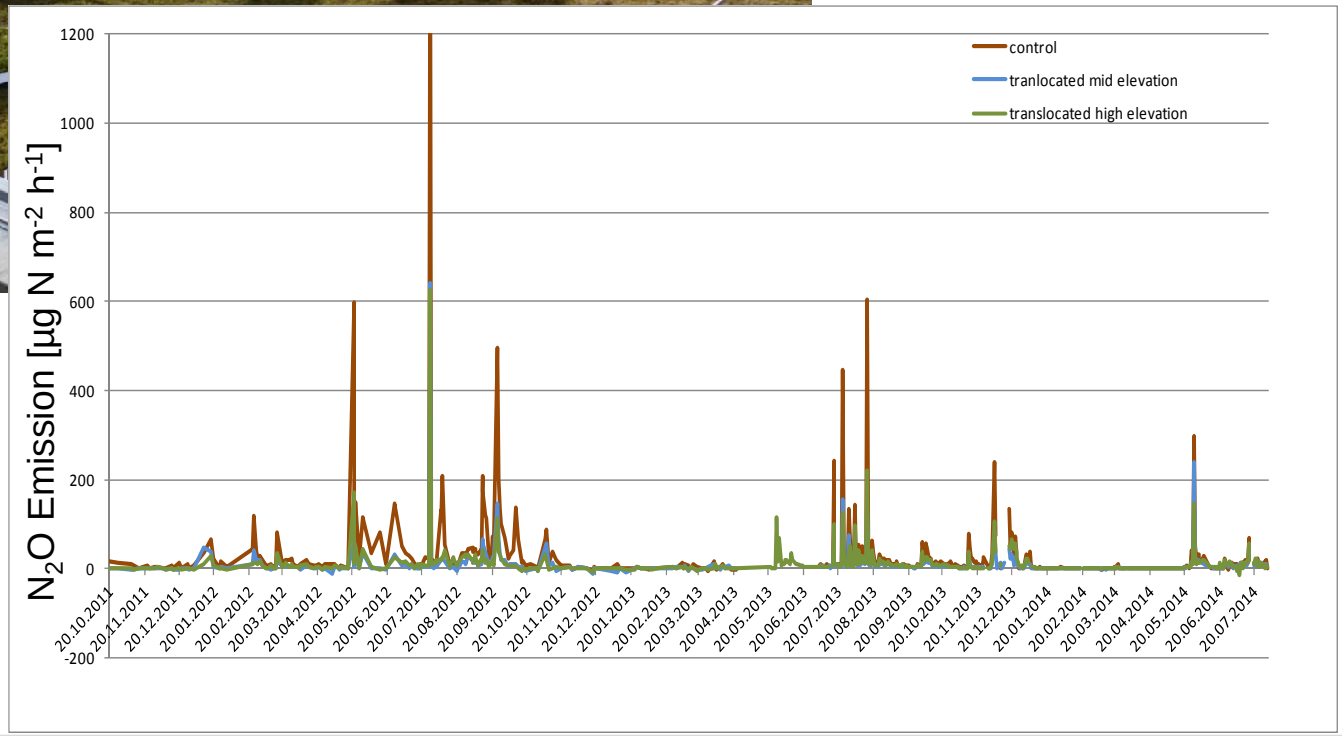
Medium (750m) / Rottenbuch:
12 lysimeter
1400mm / 6.5°C



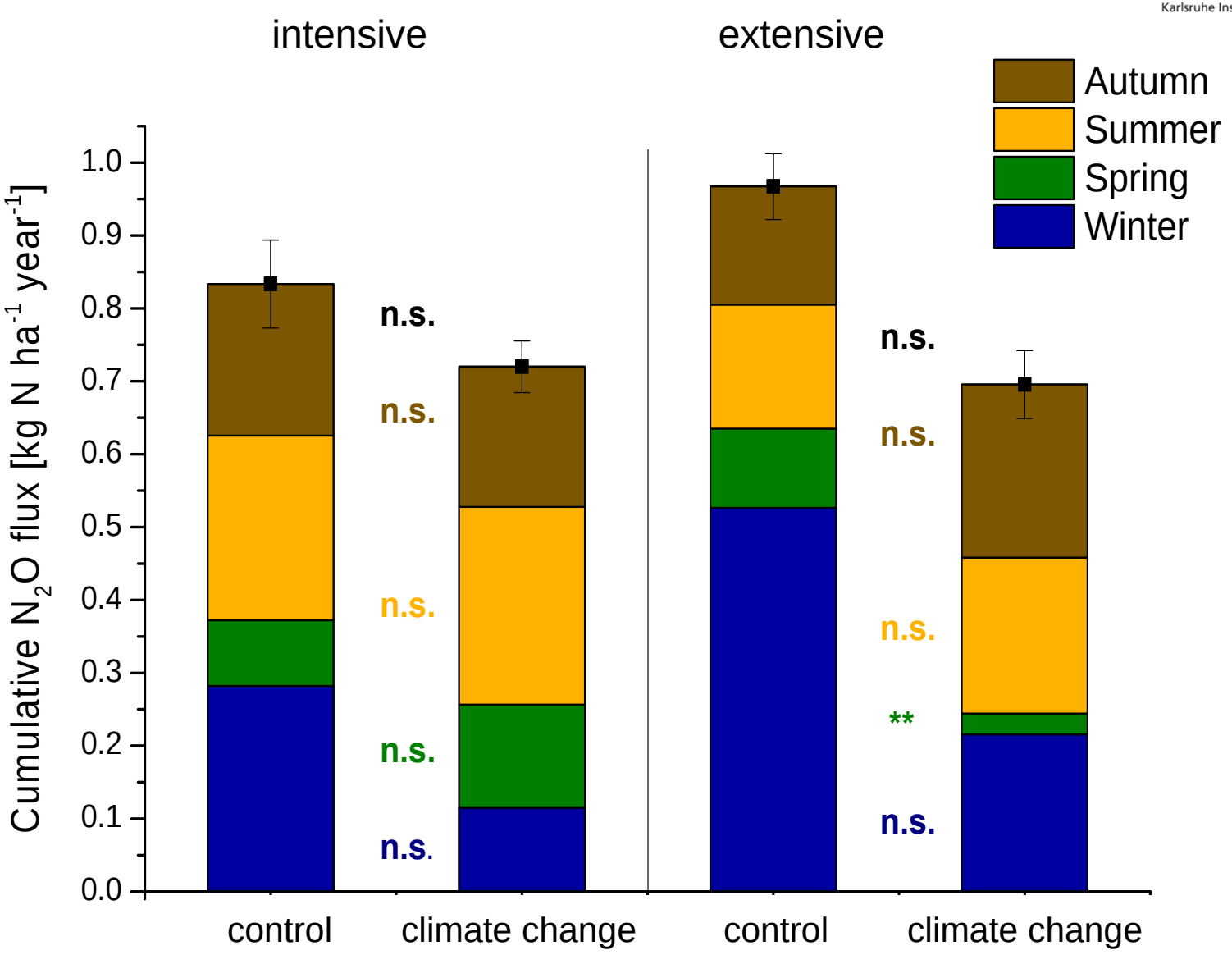
Low (600m) / Fendt:
18 lysimeter
1030mm / 8.2°C



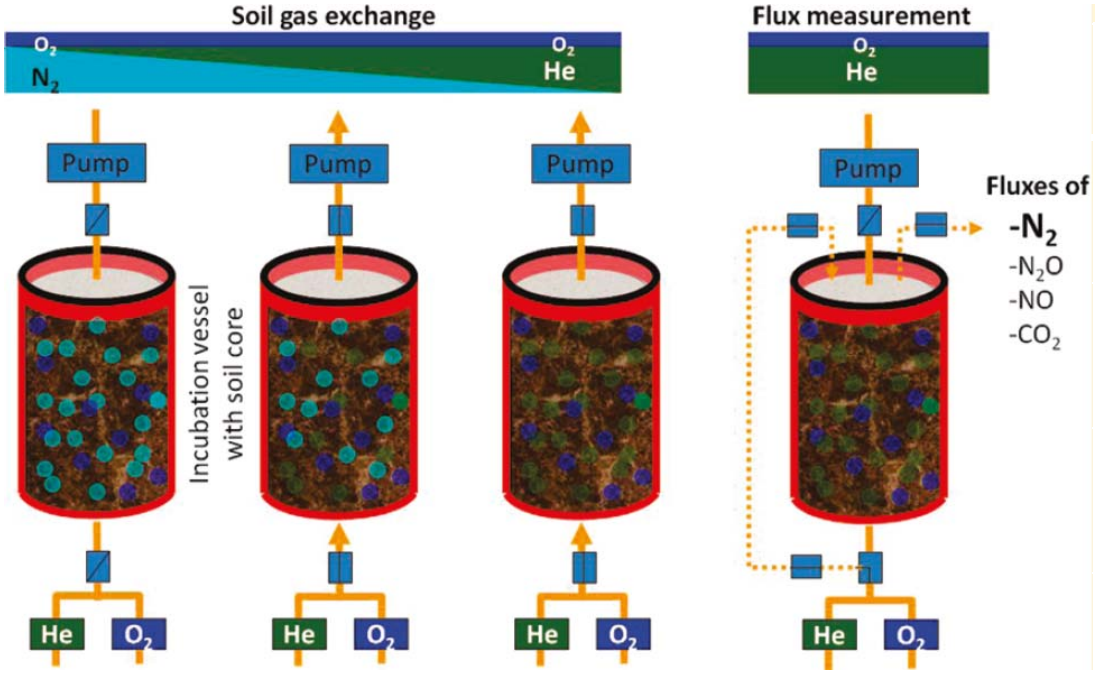




Results: N_2O emission



Results: N_2O vs. N_2 emission

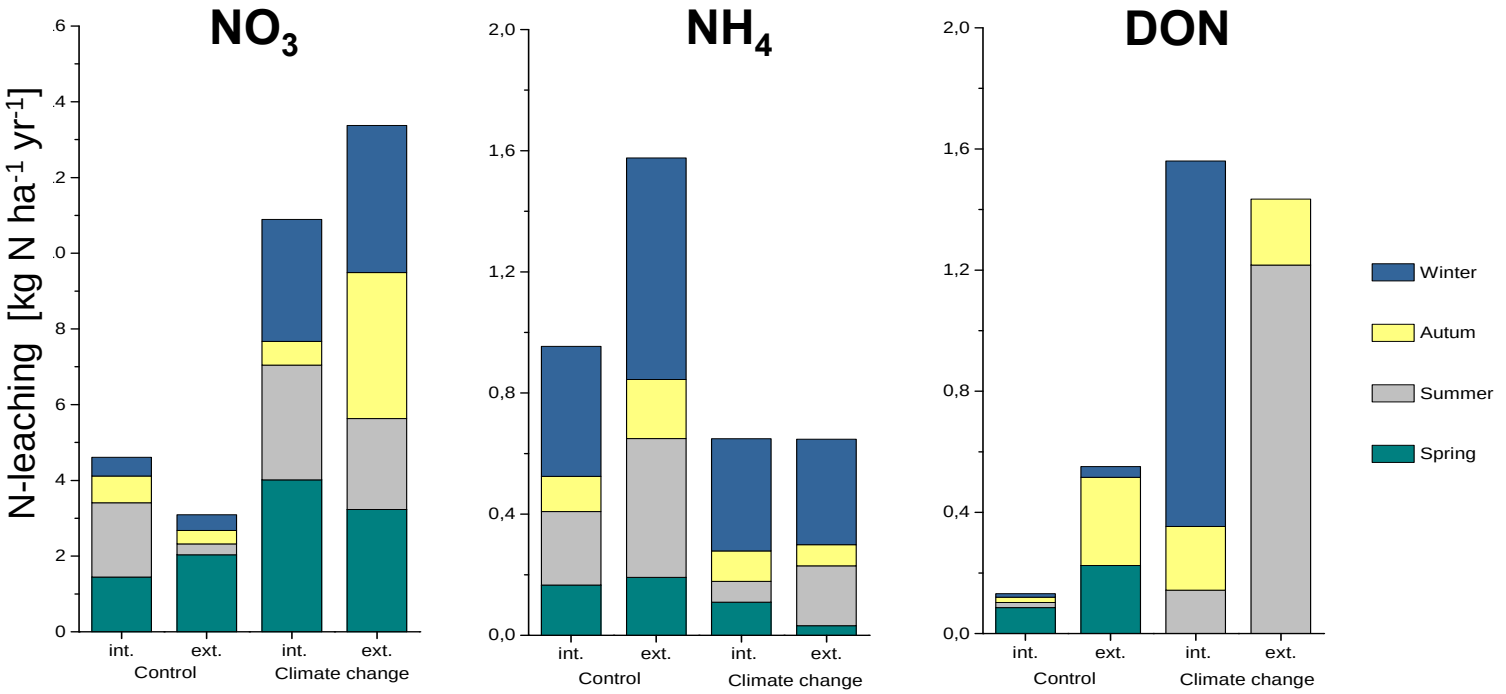


Wang et al. 2011, Environmental Science and Technology

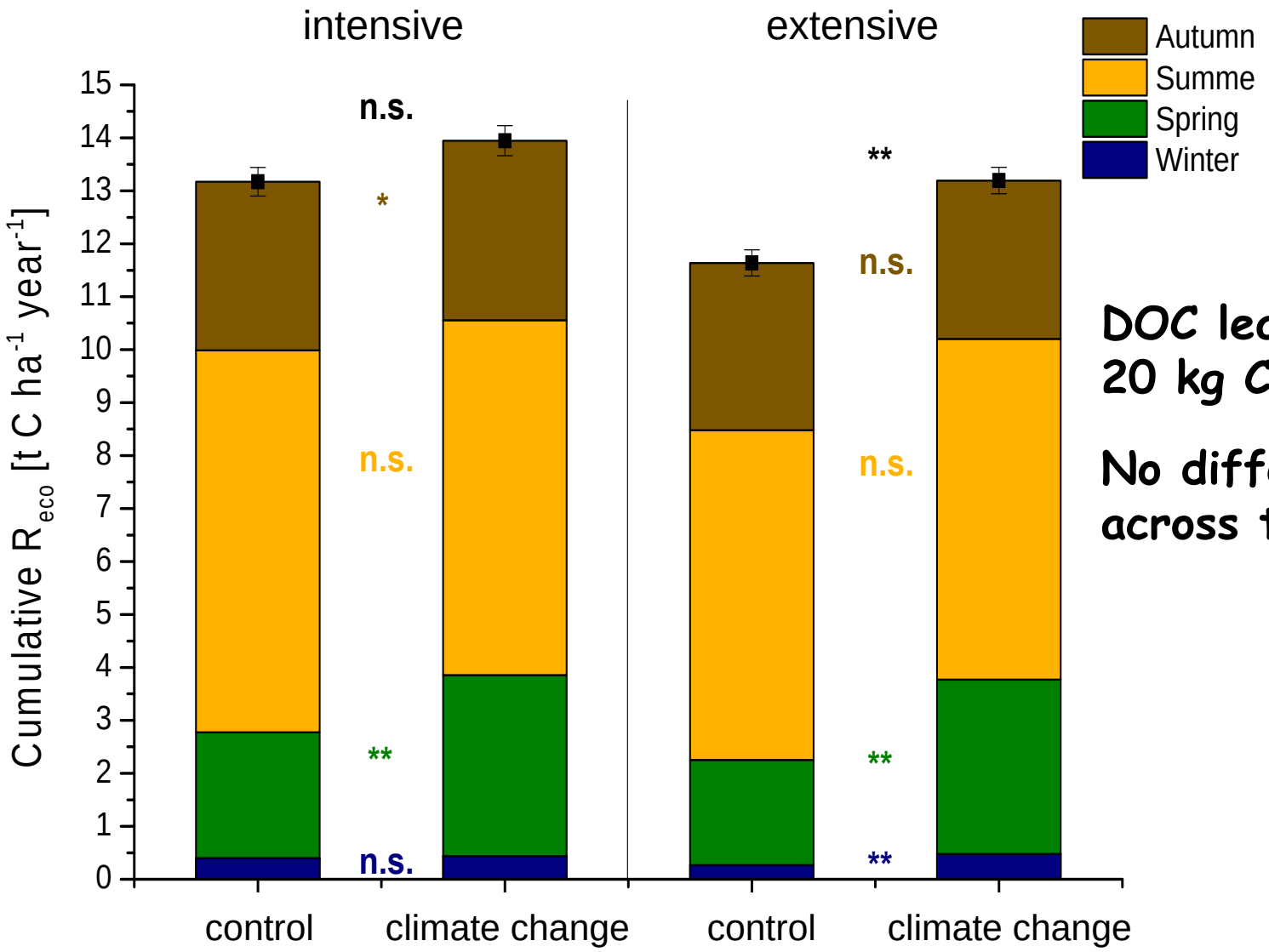
Site	N loss(kg N ha^{-1})
Control N_2	28.61
Climate Change N_2	57.01
Control N_2O	< 1.0
Climate Change N_2O	<1.0

ralf.kiese@kit.edu

Results: Leaching of N compounds



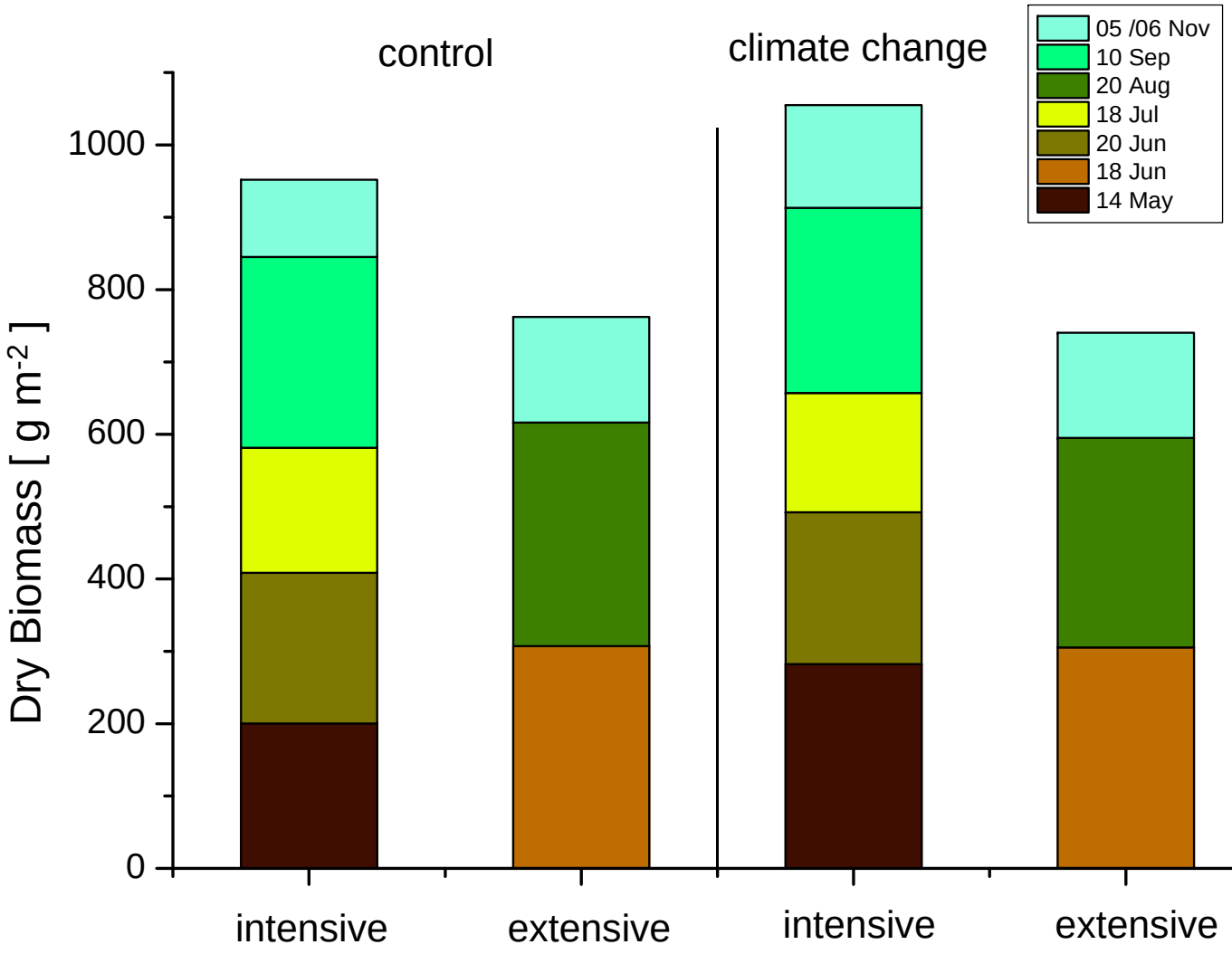
Results: CO_2 emission



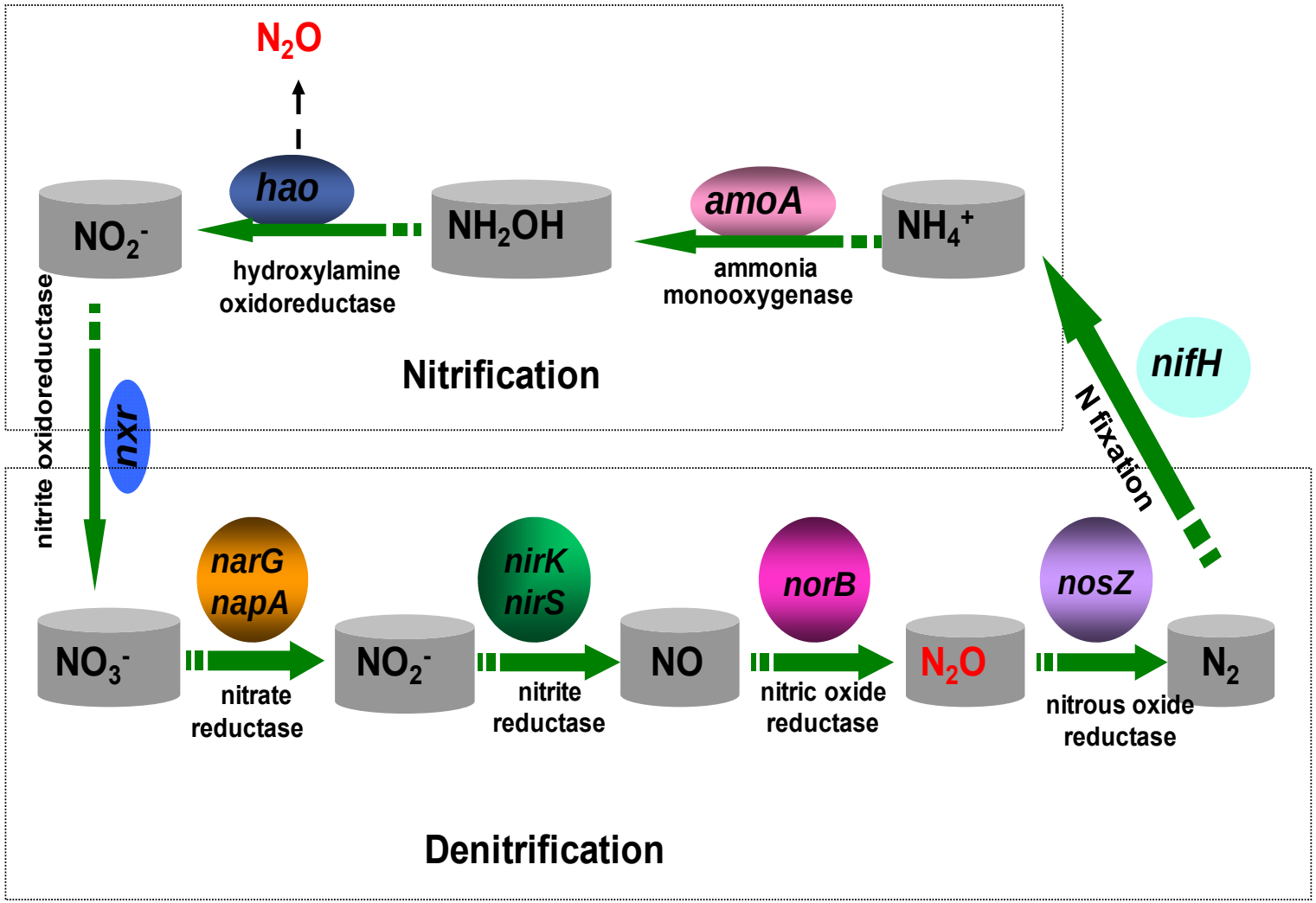
DOC leaching about 20 kg C ha^{-1} yr^{-1}

No differences across treatments

Results: Aboveground plant productivity

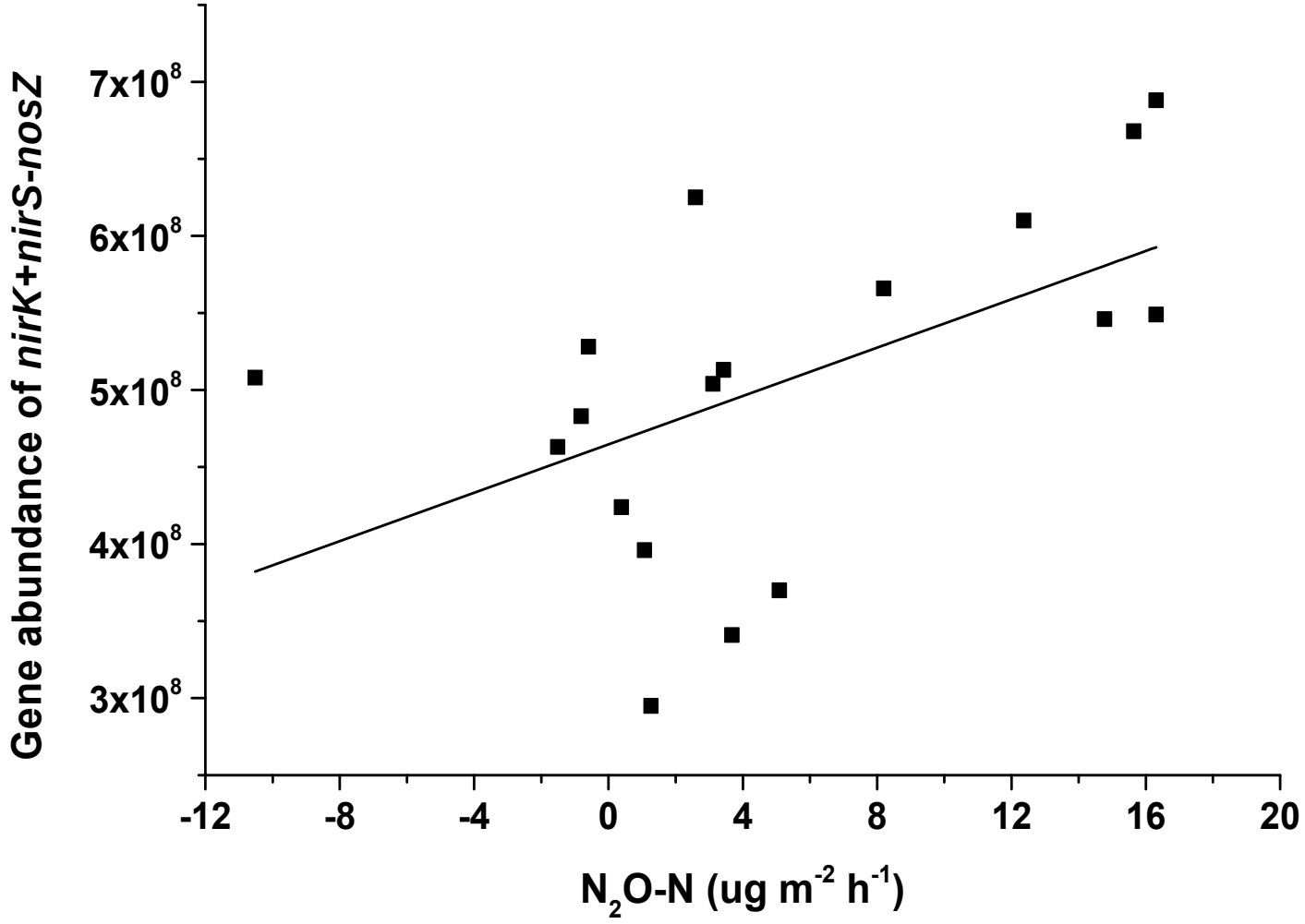


Soil microbes and N cycling



ralf.kiese@kit.edu

Soil microbes and N cycling



ralf.kiese@kit.edu

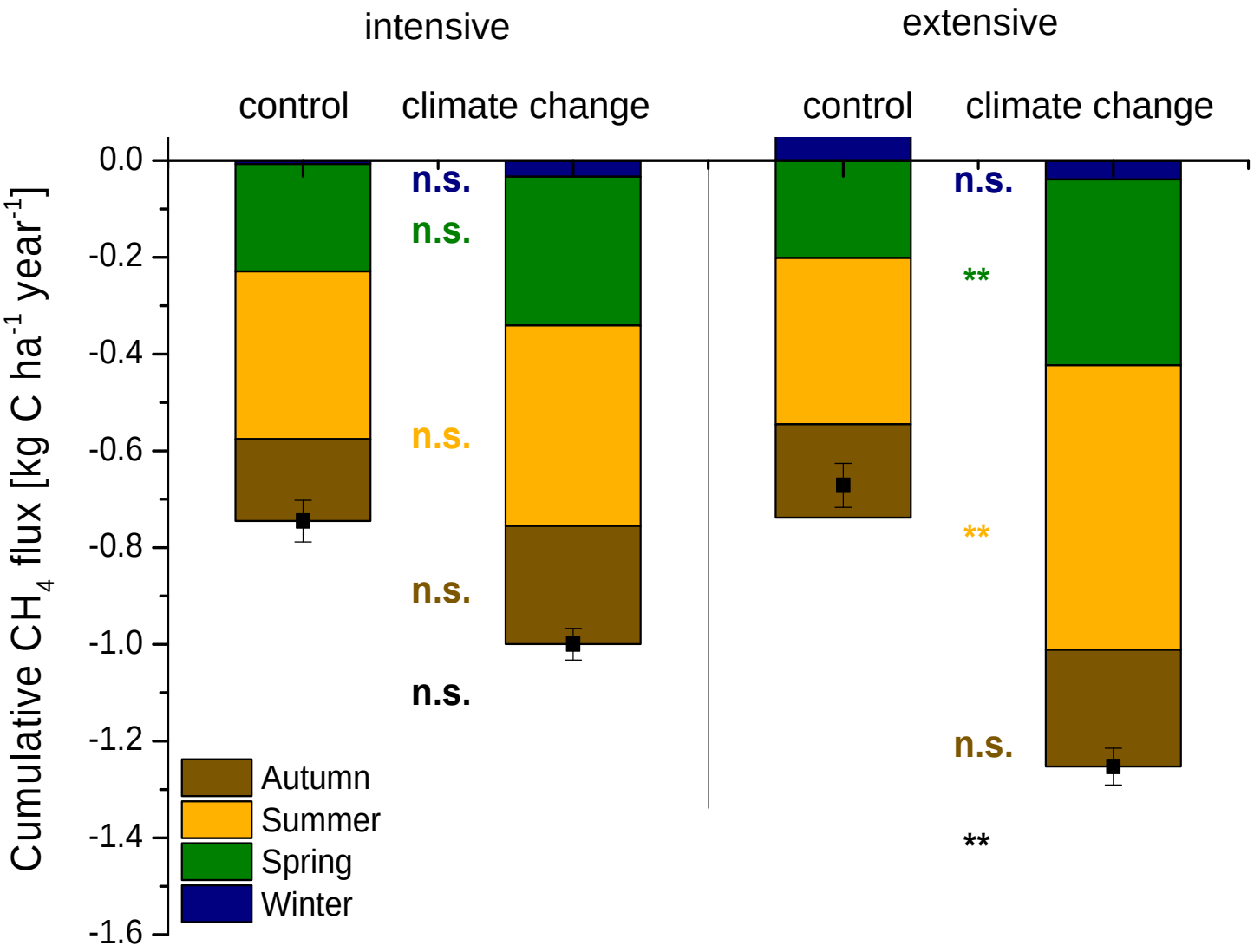
Conlcusions

- **Climate change/ Translocation (so far) lead to…**
- increase N_2O emission in spring-summer-autumn (fertilization)
- but can be higher in the contrl due to high contribution of winter emissions (freeze/ thaw events)
- significant increase N_2 emissions and nitrate leaching
- increase CH_4 uptake in all seasons
- increase CO_2 emission mainly in spring and autumn
- marginal changes in DOC leaching
- influence of climate change is more significant under extensive management
- changes in GHG balance are mainly driven by CO_2 emissions

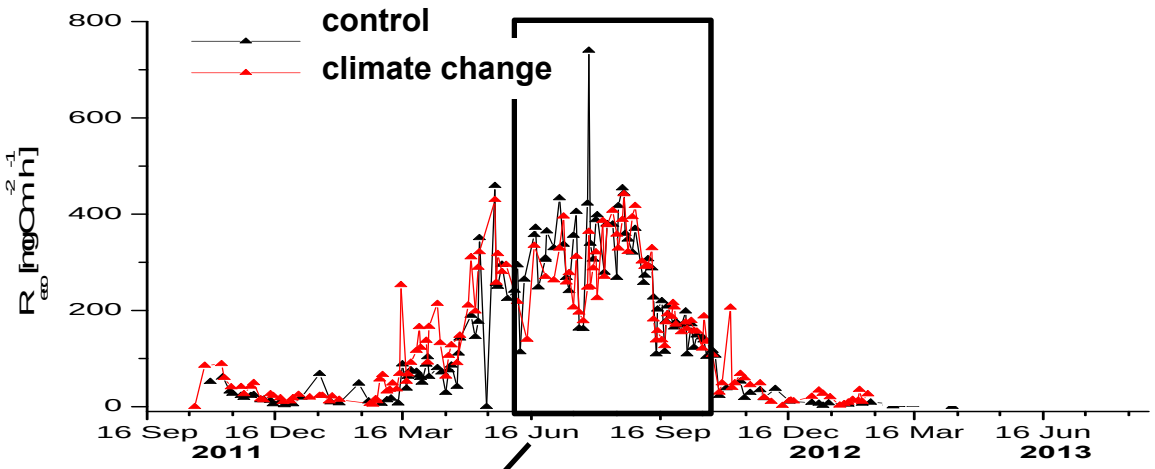
Thank you for your attention !

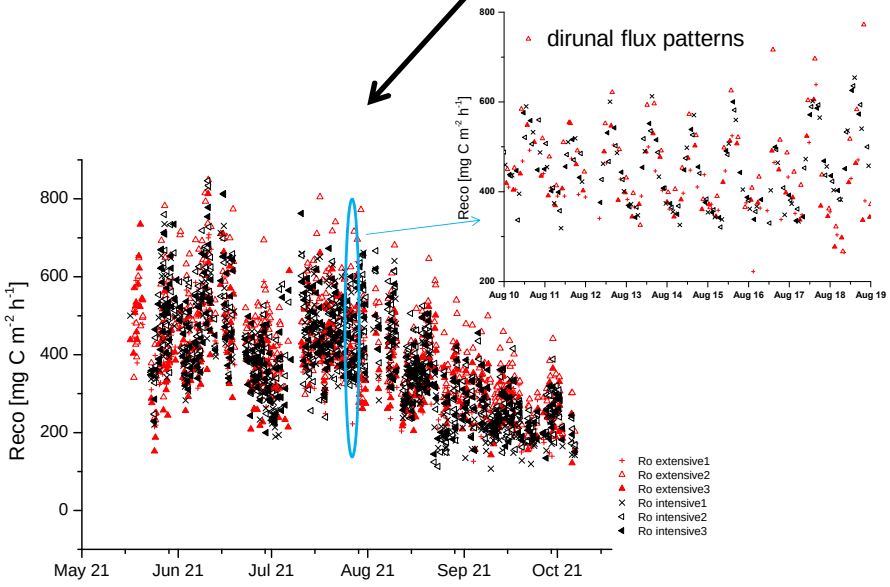
ralf.kiese@kit.edu

Results: CH_4 exchange



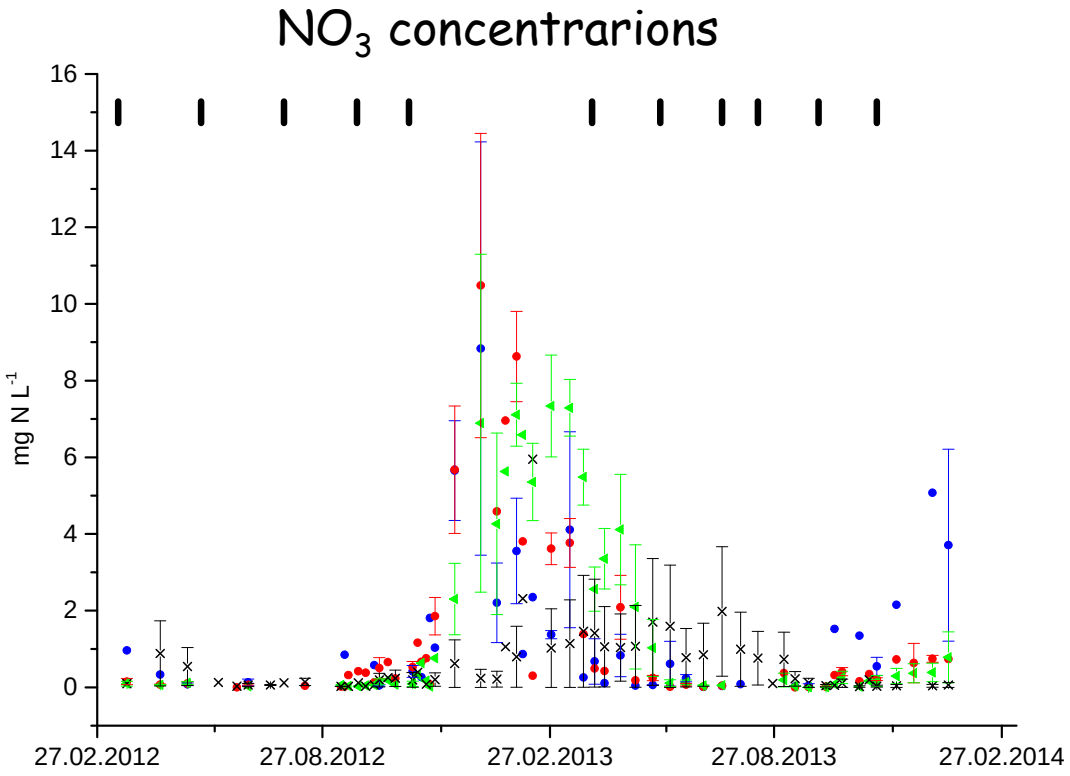
Results: manual vs. automatic measurements





ralf.kiese@kit.edu

Soil water C and N concentrations



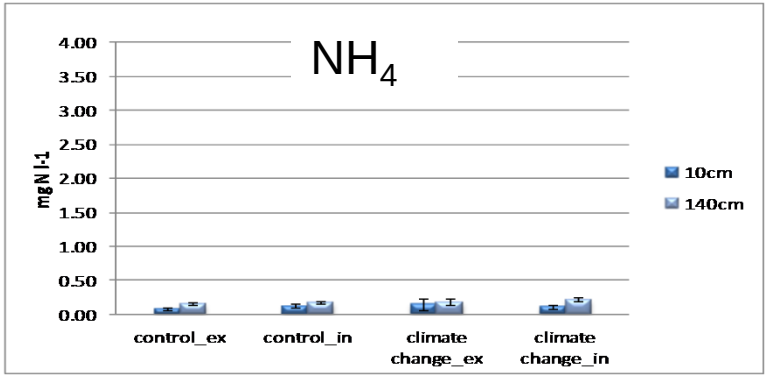
Suction cups for soil water sampling (bi-weekly)

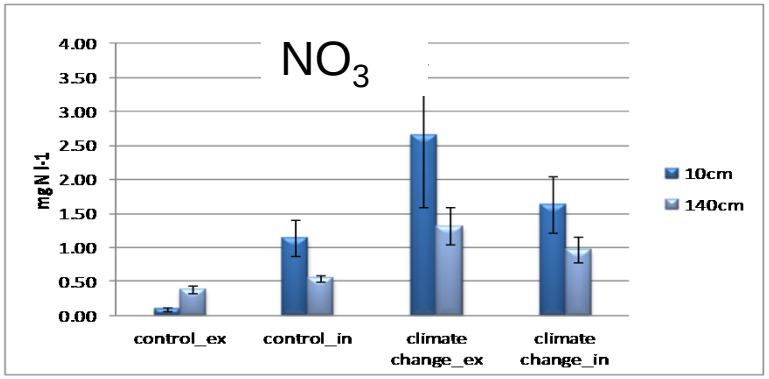
in 10, 30, 50, 140cm

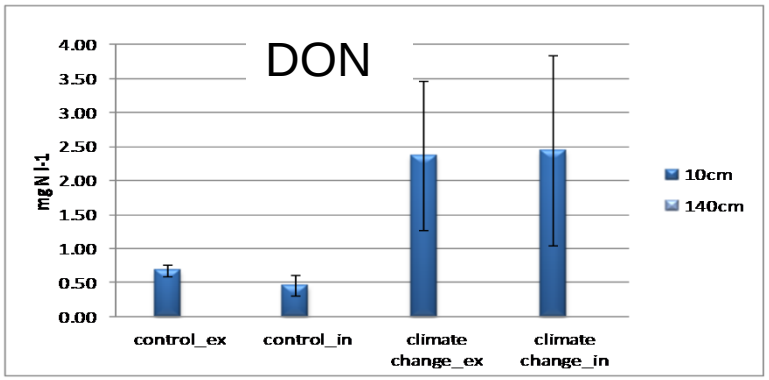
NH_4, NO_3, DON, DOC

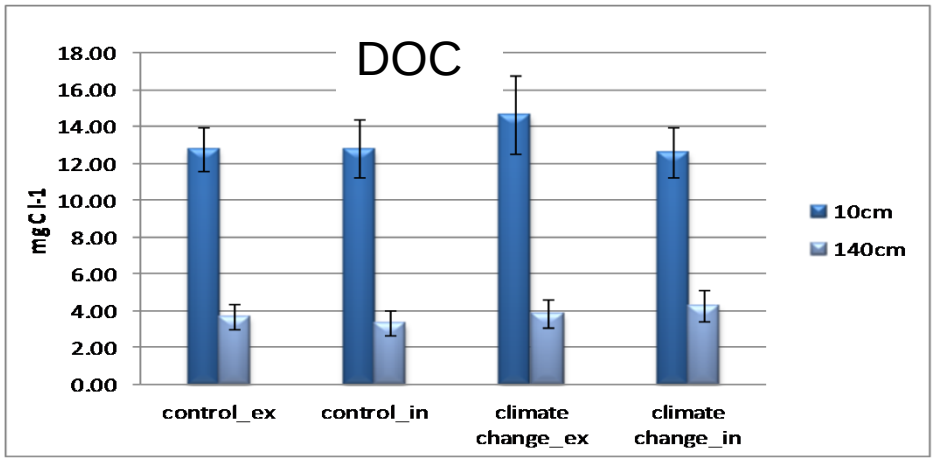
ralf.kiese@kit.edu

Soil water C and N concentrations



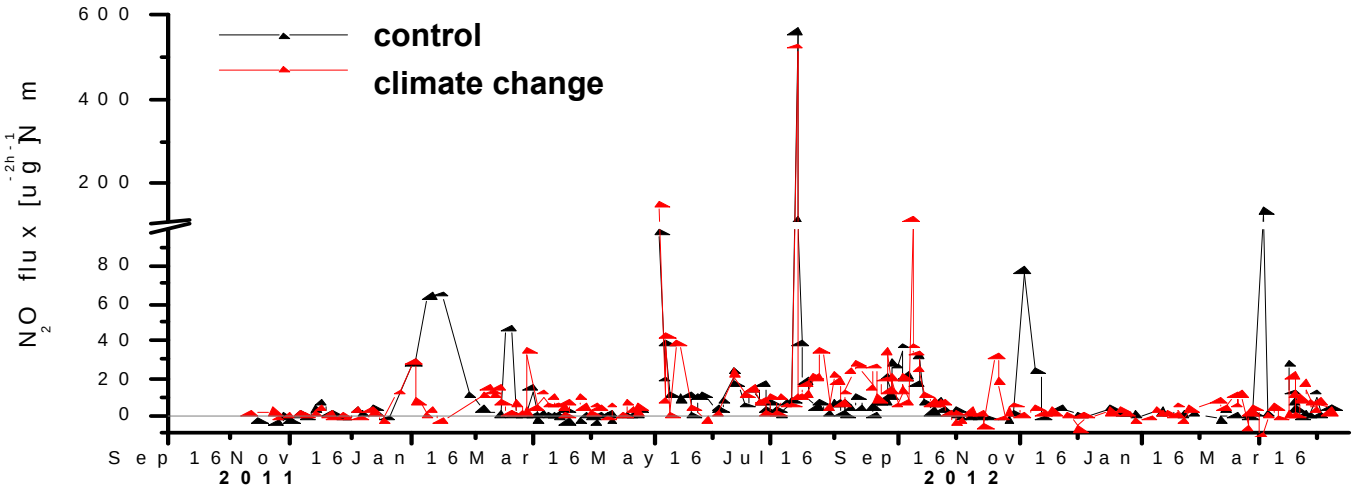


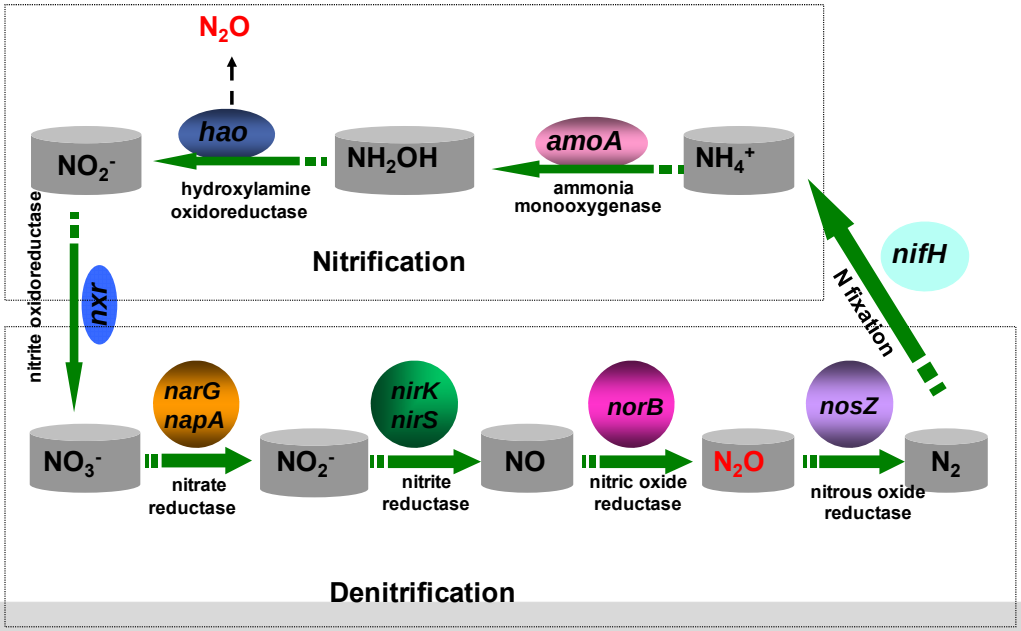




ralf.kiese@kit.edu

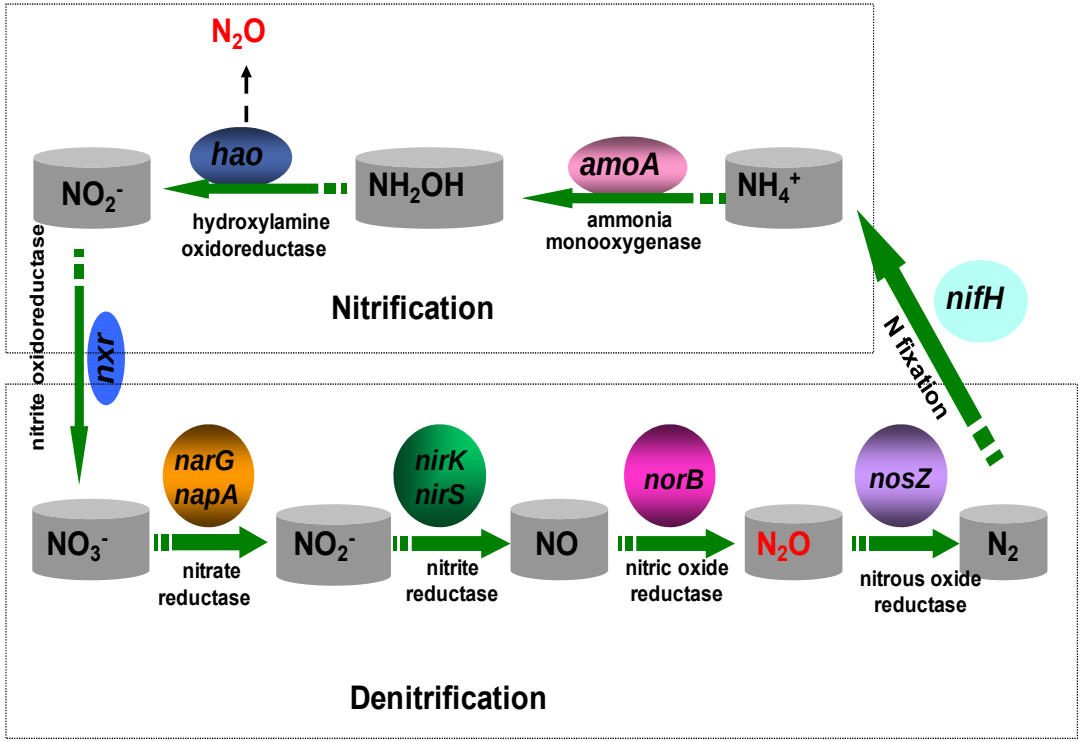
Enzymes involved in microbial N processes

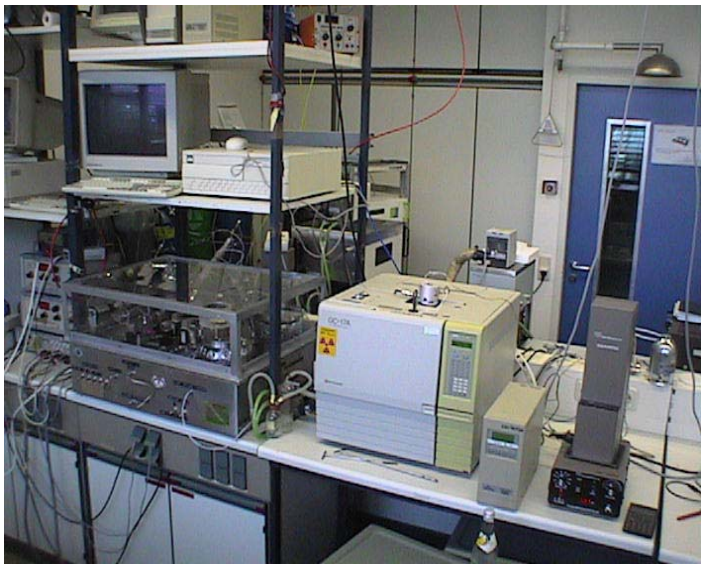




ralf.kiese@kit.edu

Helium incubation method to quantify N_2 and N_2O

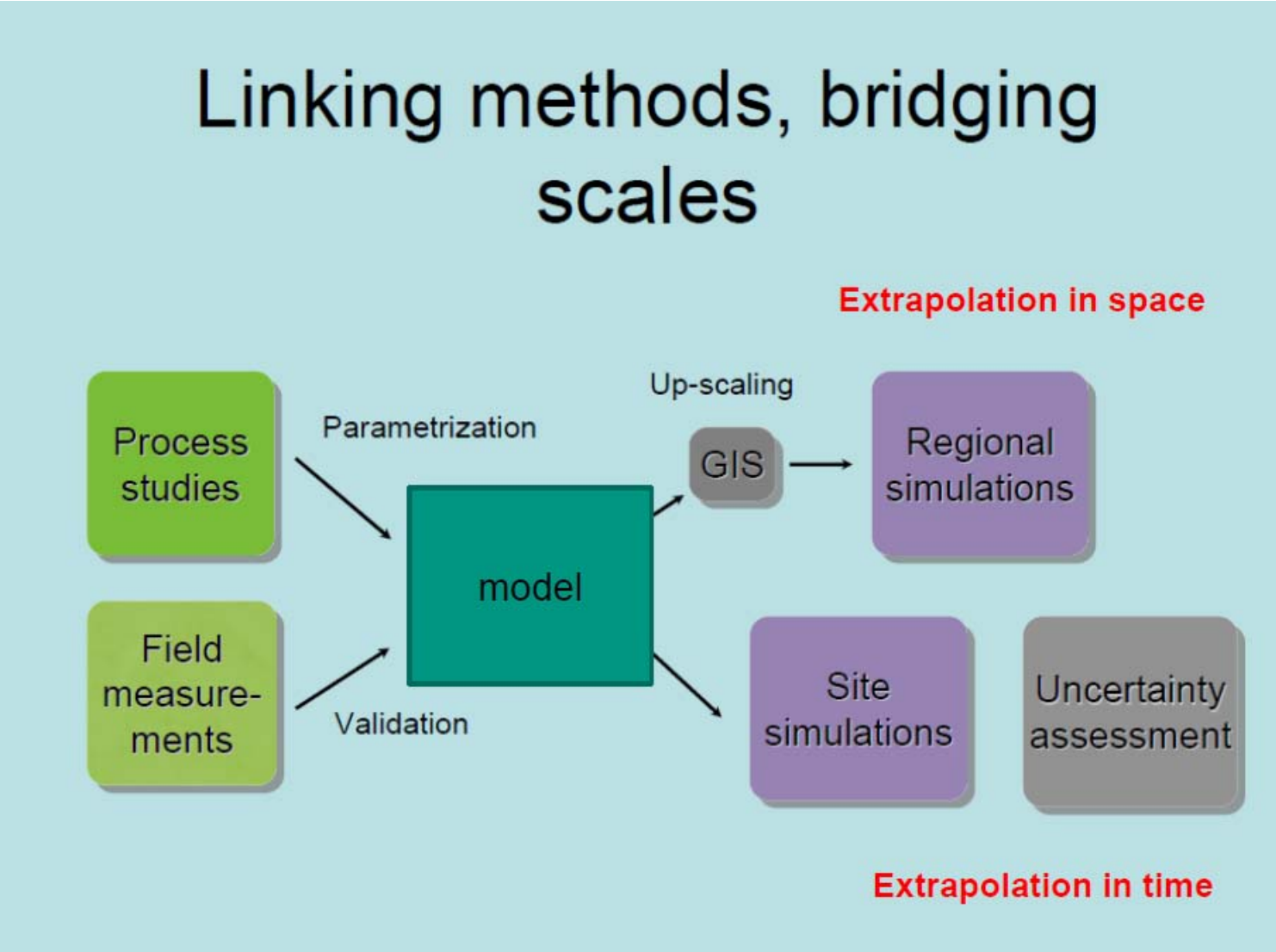




Wang et al. 2011, Environmental Science and Technology

ralf.kiese@kit.edu

Conlcusions



ralf.kiese@kit.edu

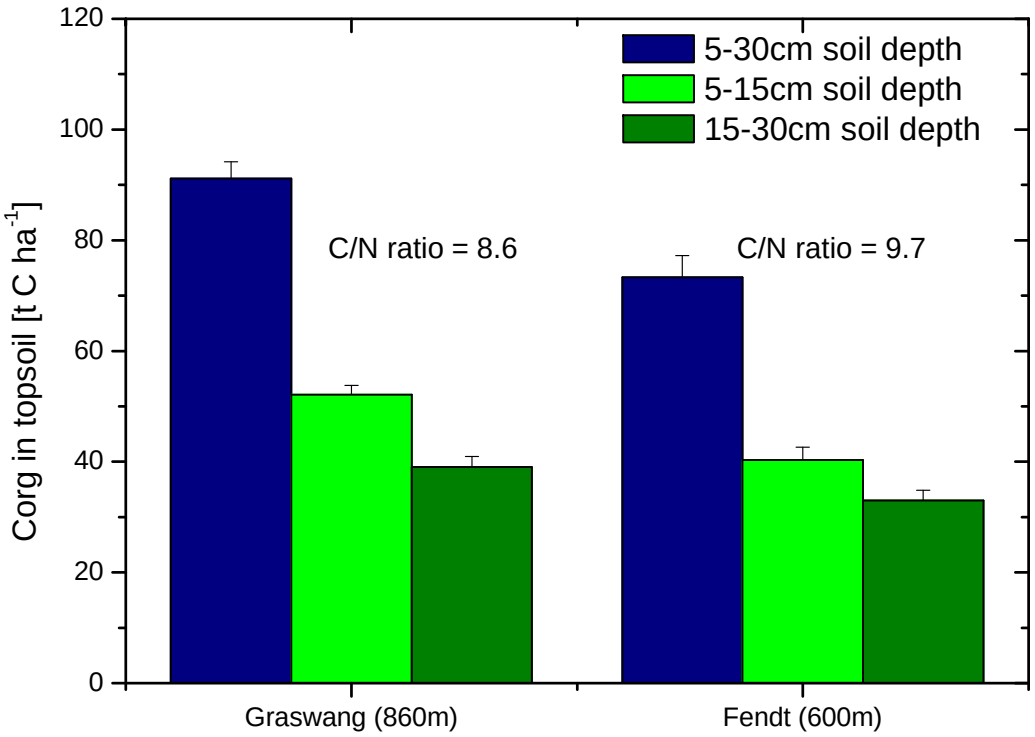
ralf.kiese@kit.edu

Hypothesis

Climate change will…

accelerate soil C-/N- turnover and associated soil emission of CO_2 and N_2O as well as leaching of C and N compounds

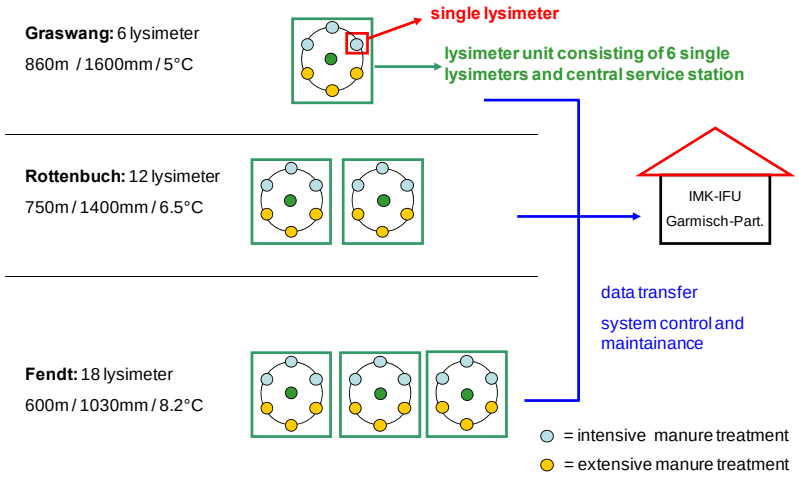
Why? ➟ 20% higher SOC/ N_{tot} in higher elevation



ralf.kiese@kit.edu

GHG measurements (CO_2, N_2O, CH_4)

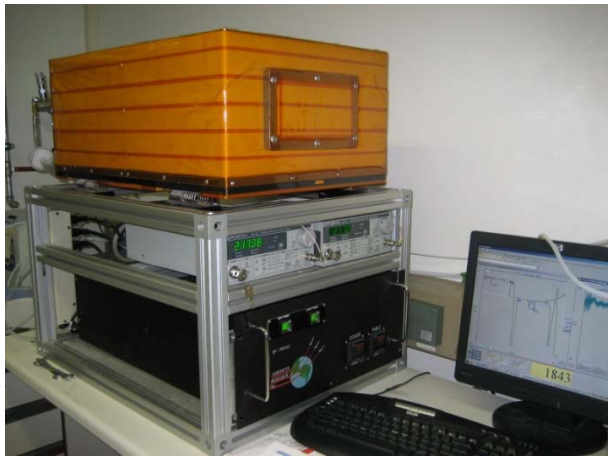
Karlsruhe Institute of Technology



Manual chambers

Automatic chamber system

Dual QCL-System Aerodyne



Gas chromatograph

ralf.kiese@kit.edu

KIT-Campus Alpin
IMK-IFU: Atmosphärische Umweltforschung