KIT-Campus Alpin
IMK-IFU: Atmosphärische Umweltforschung

Karlsruhe Institute of Technology

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

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Graswang (860m)

Rottenbuch (750m)

Fendt (600m)

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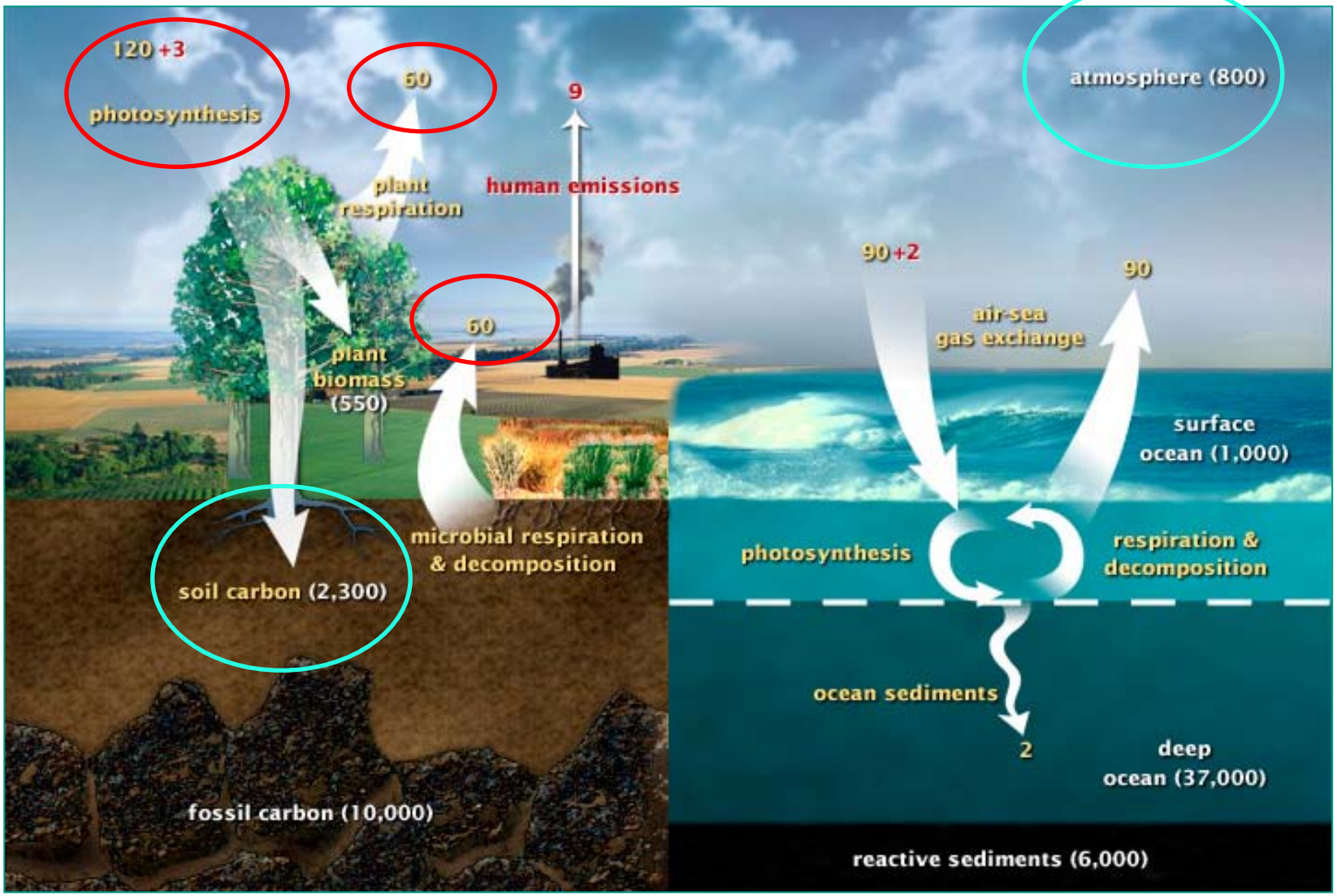
Motivation



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

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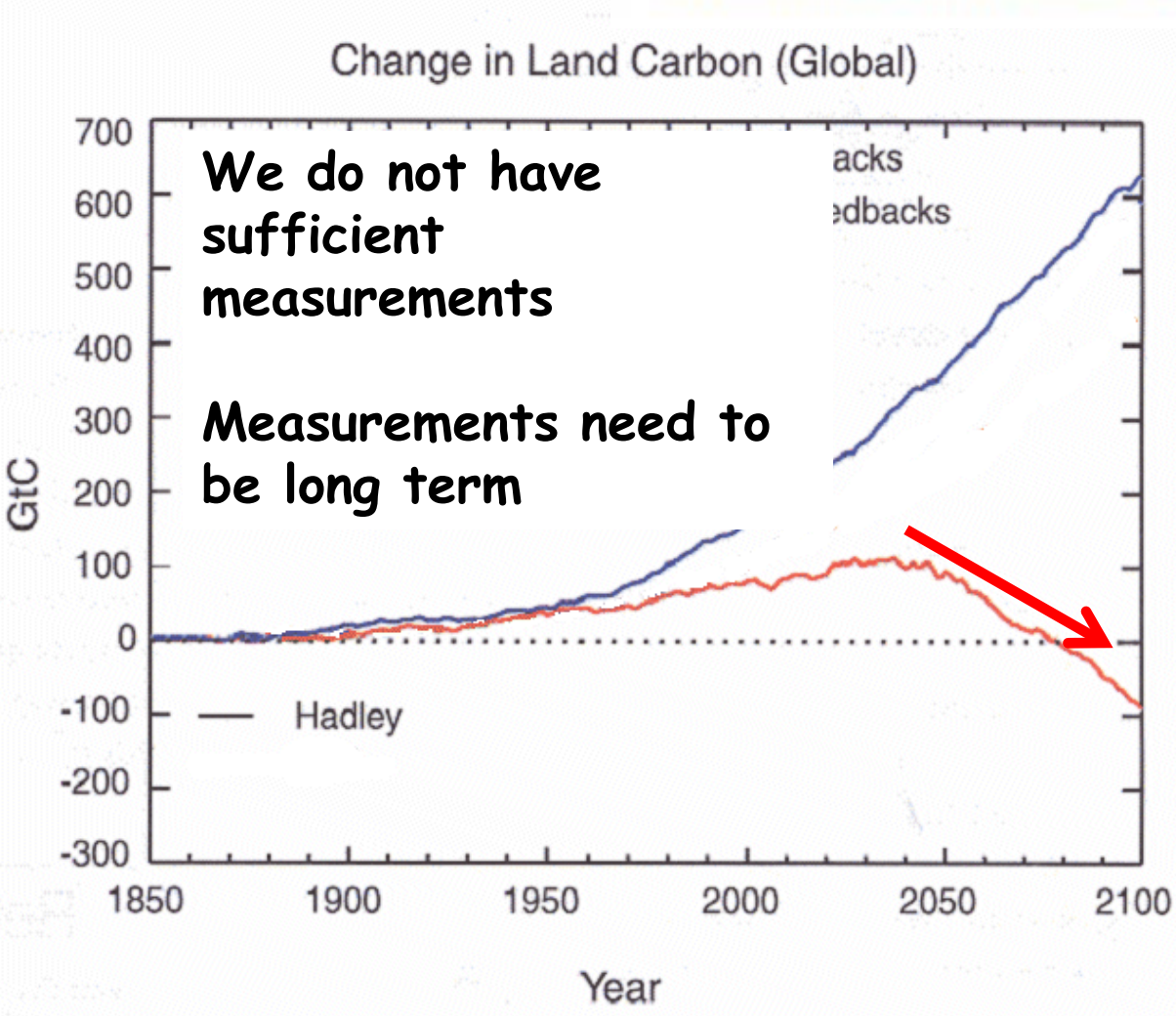
Motivation

TERENO
Terrestrial Environmental Observatories



Biosphere turns into CO_2 source

Cox et al (2000)
Nature 408,184-187

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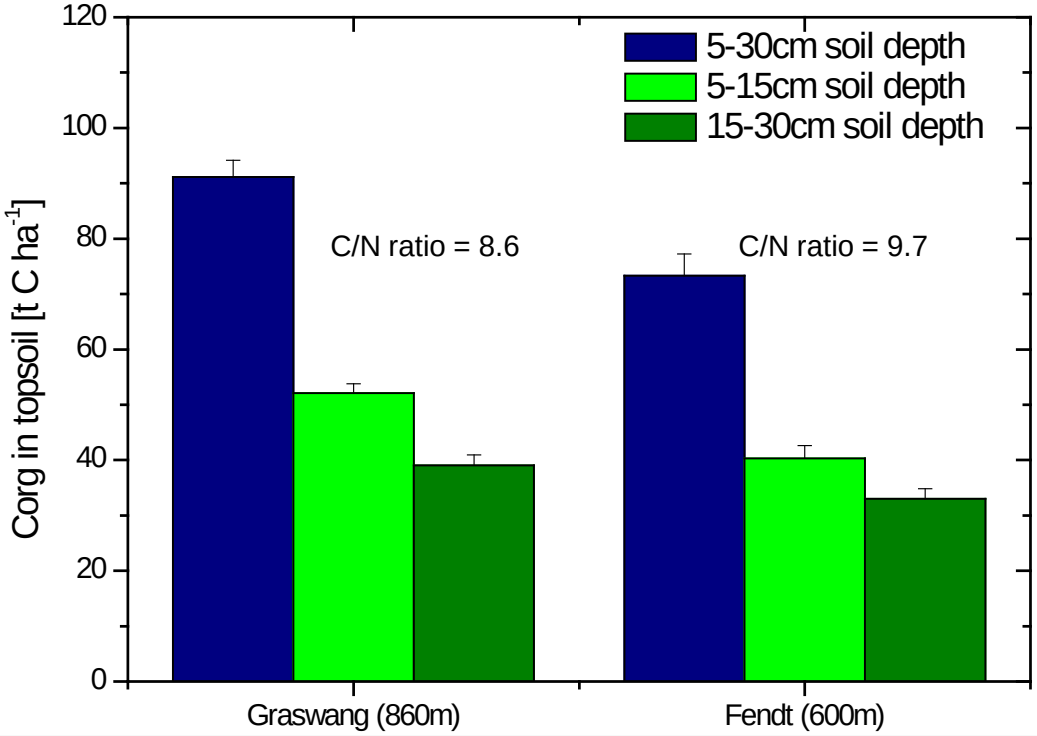
Hypothesis

Climate change will…

accelerate soil C-/N- turnover and associated soil emission of CO_2 and N_2O but will have less impact on soil CH_4 uptake

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



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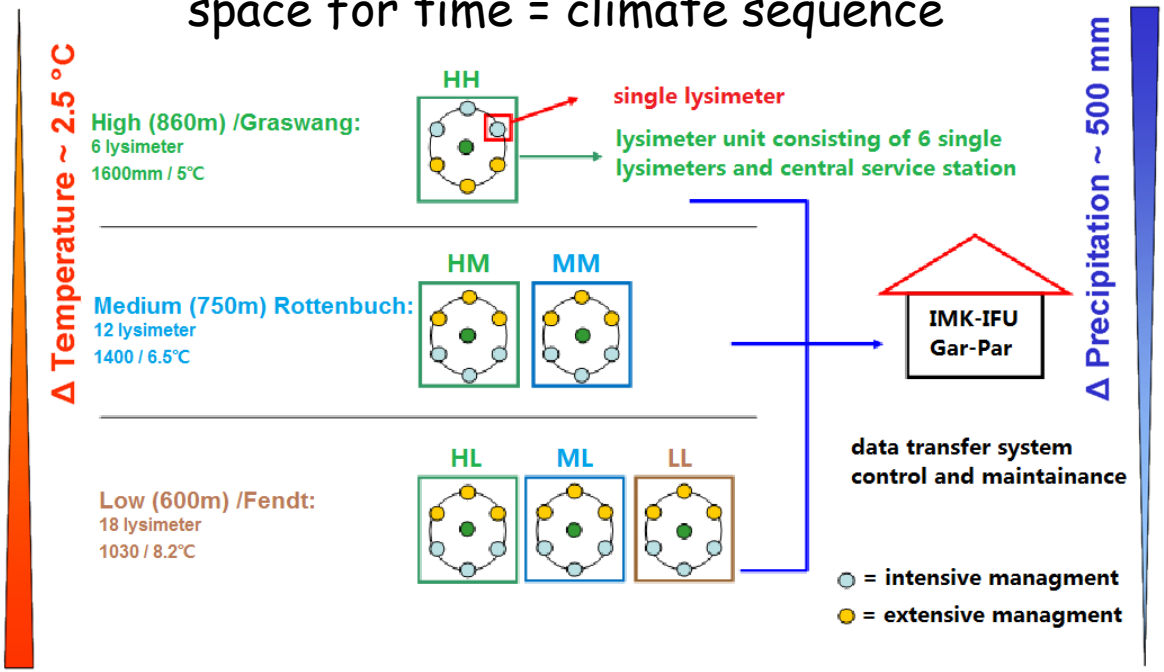
TERENO lysimeter field setup

Lysimeter excavation

space for time = climate sequence



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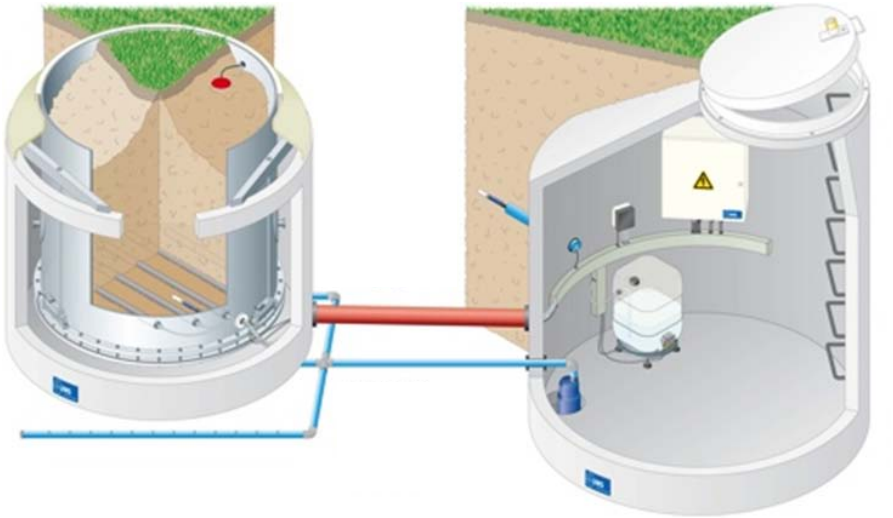
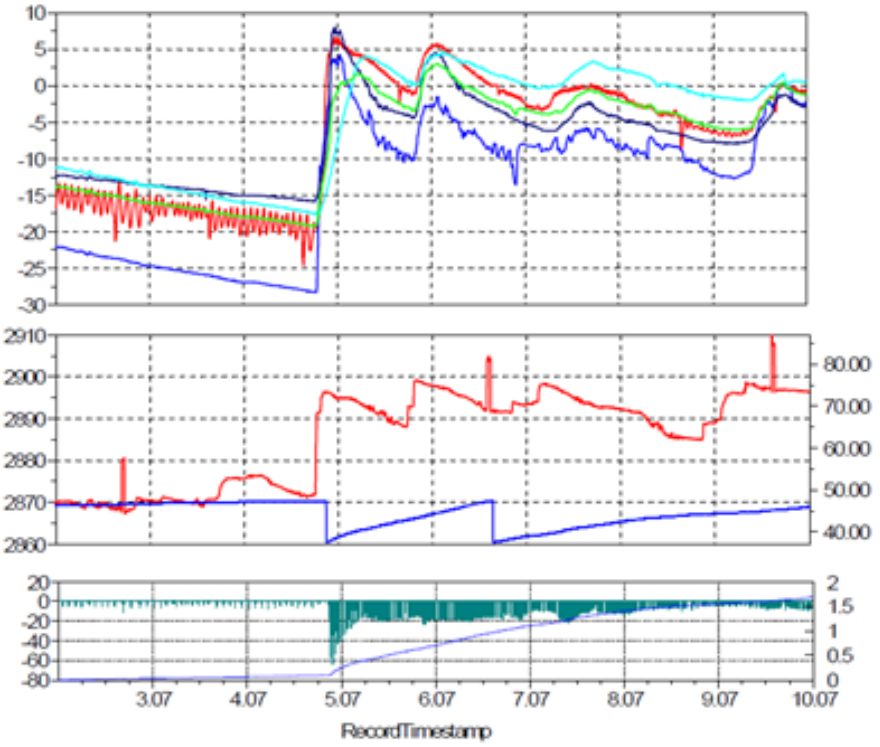
Main Objectives

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

Soil Hydrology and water quality





- Soil temperature
- Soil moisture (vol%, water tension)
- Matrix potential (Tensiometers)
- Suction cups for soil water sampling

in 10, 30, 50,140cm

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GHG measurements (CO_2, N_2O, CH_4)

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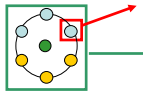
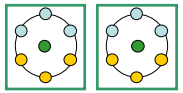
Graswang: 6 lysimeter
860m / 1600mm / 5°C



single lysimeter

lysimeter unit consisting of 6 single lysimeters and central service station

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



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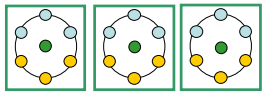
Garmisch-Part.

data transfer

system control and maintainance

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



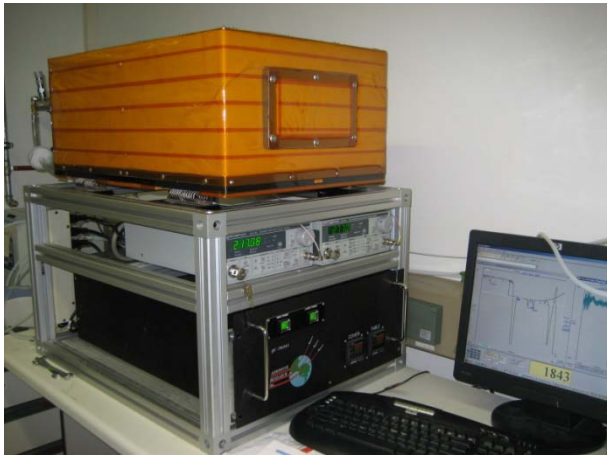
= intensive manure treatment

= extensive manure treatment

Manual chambers

Automatic chamber system

Dual QCL-System Aerodyne



Gas chromatograph

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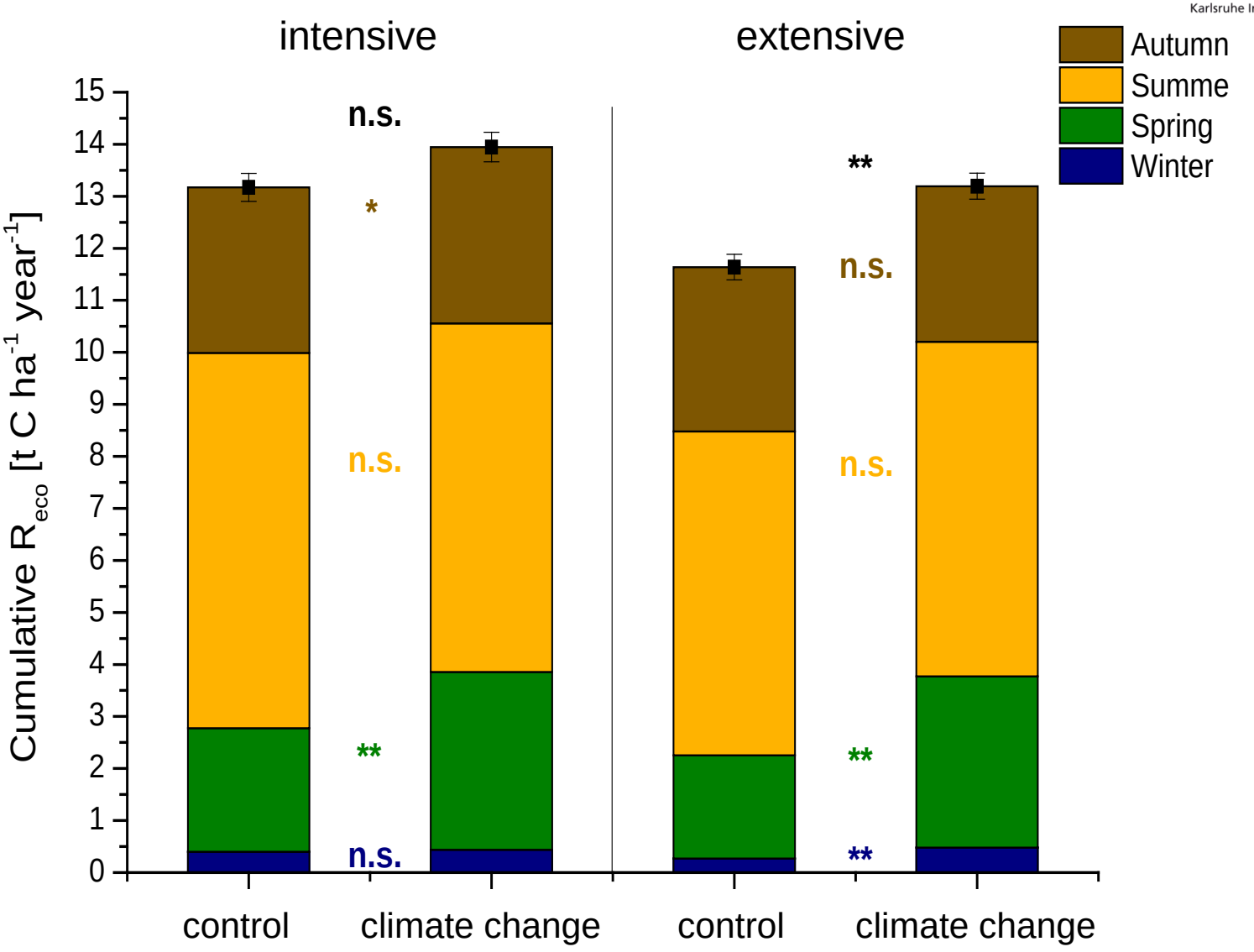
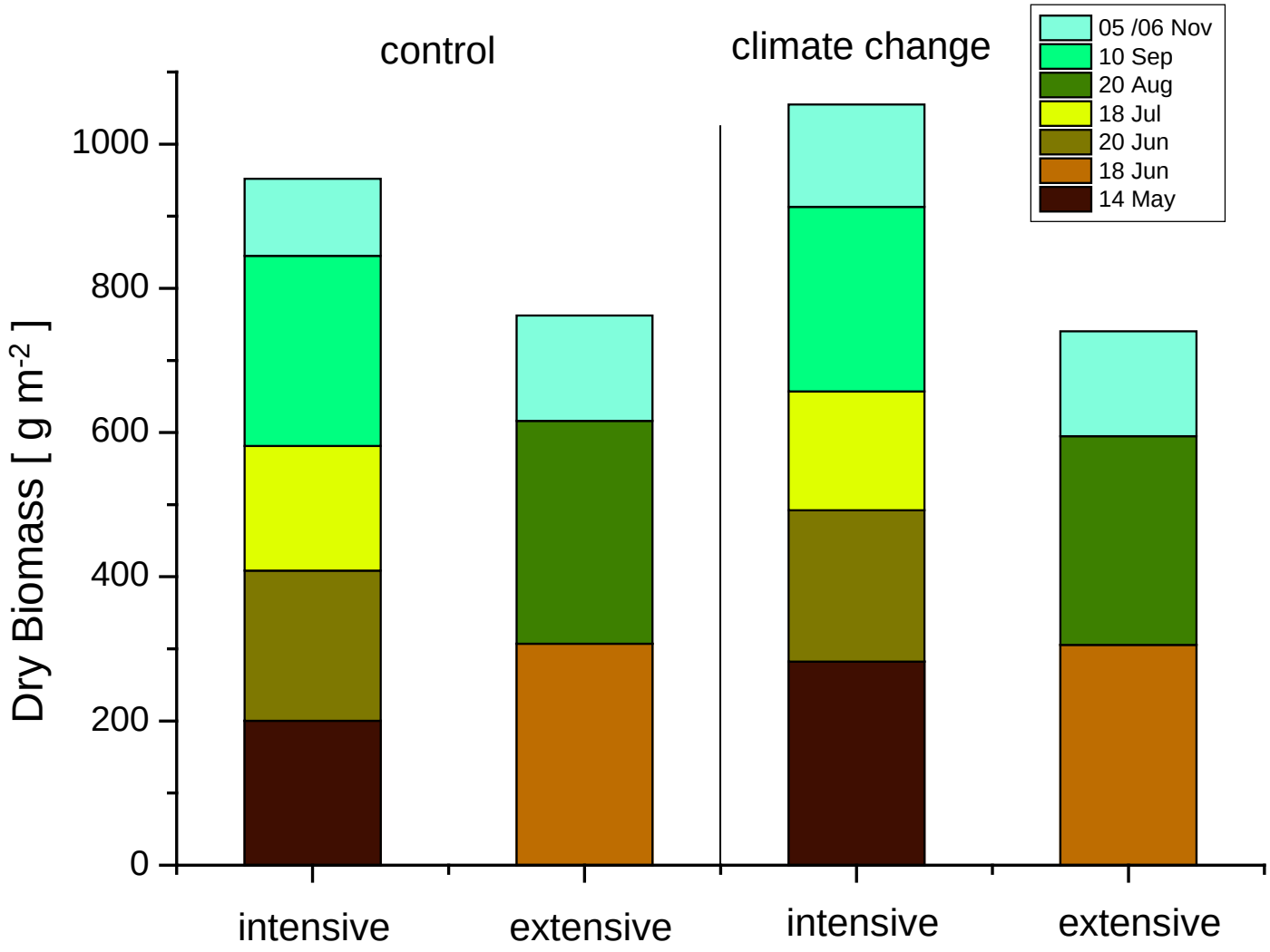
Results: Soil respiration

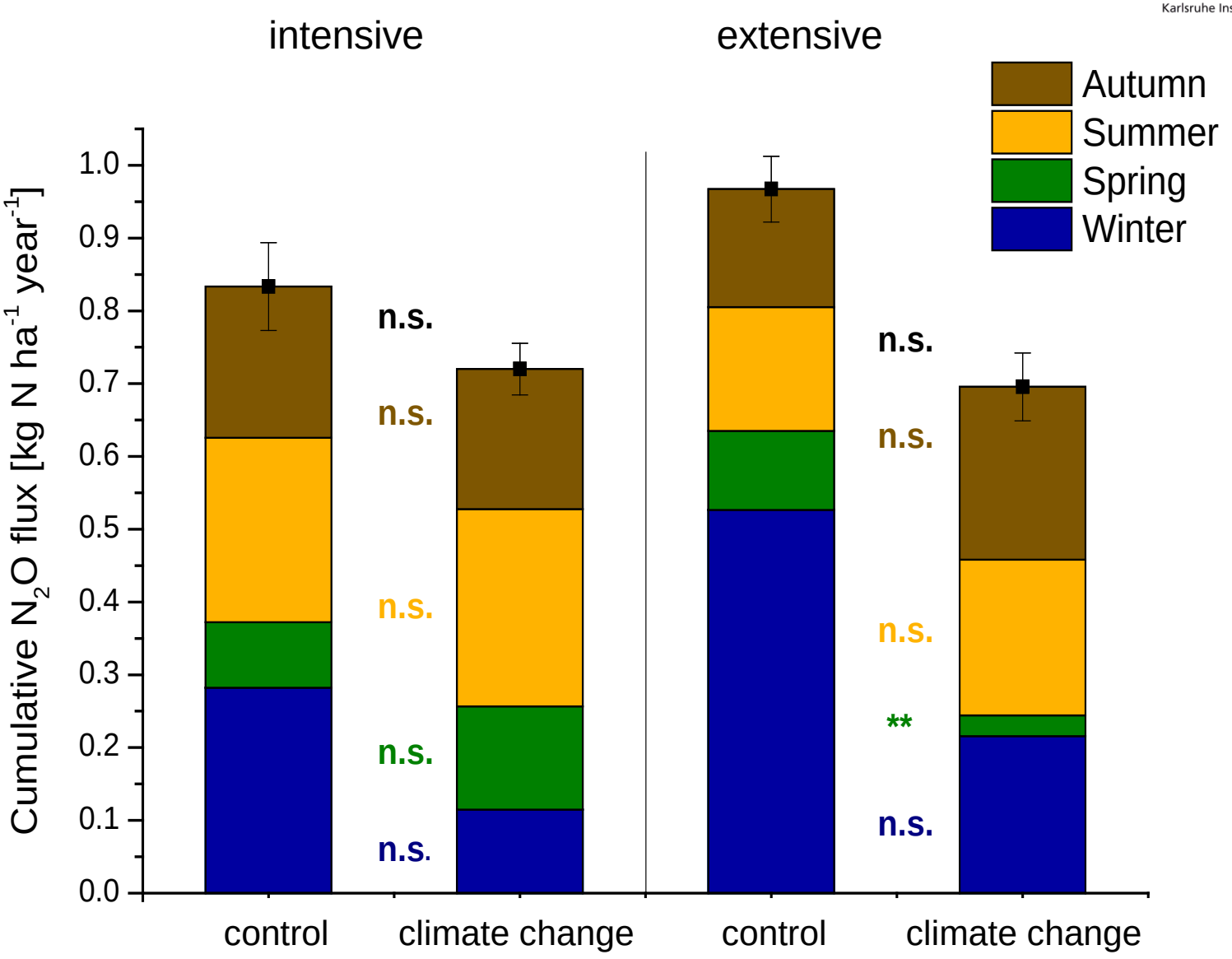


Results: Aboveground plant productivity

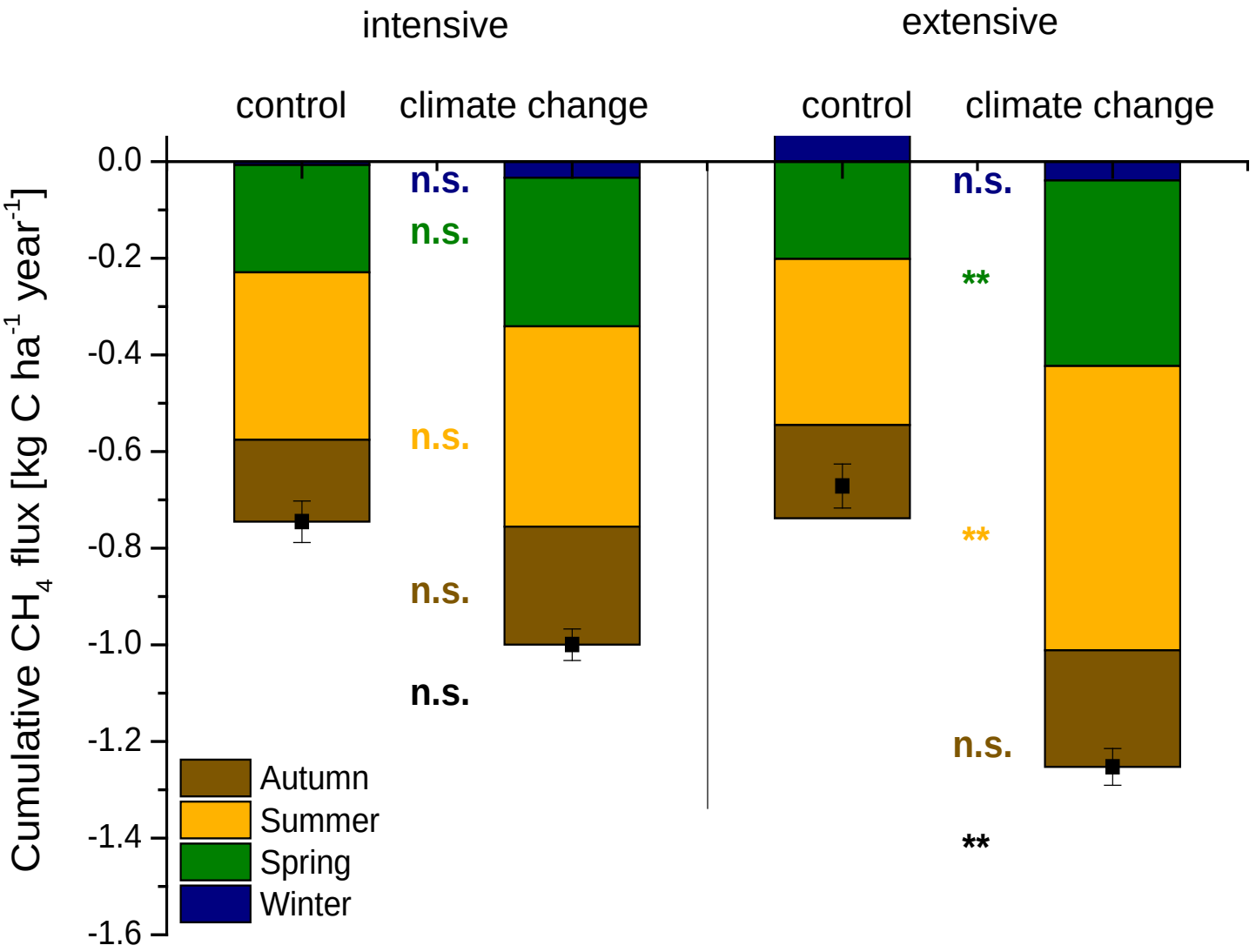


Fixation of 4-5 t C ha^{-1} intensive and 3.5 t C ha^{-1} extensive management

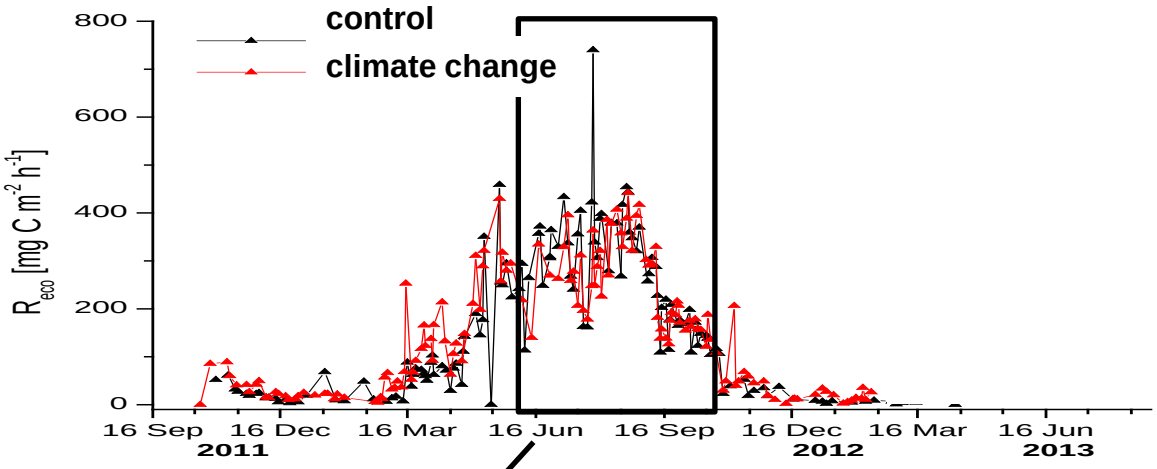
Results: N_2O flux



Results: CH_4 flux



Results: manual vs. automatic measurements



dirunal flux patterns

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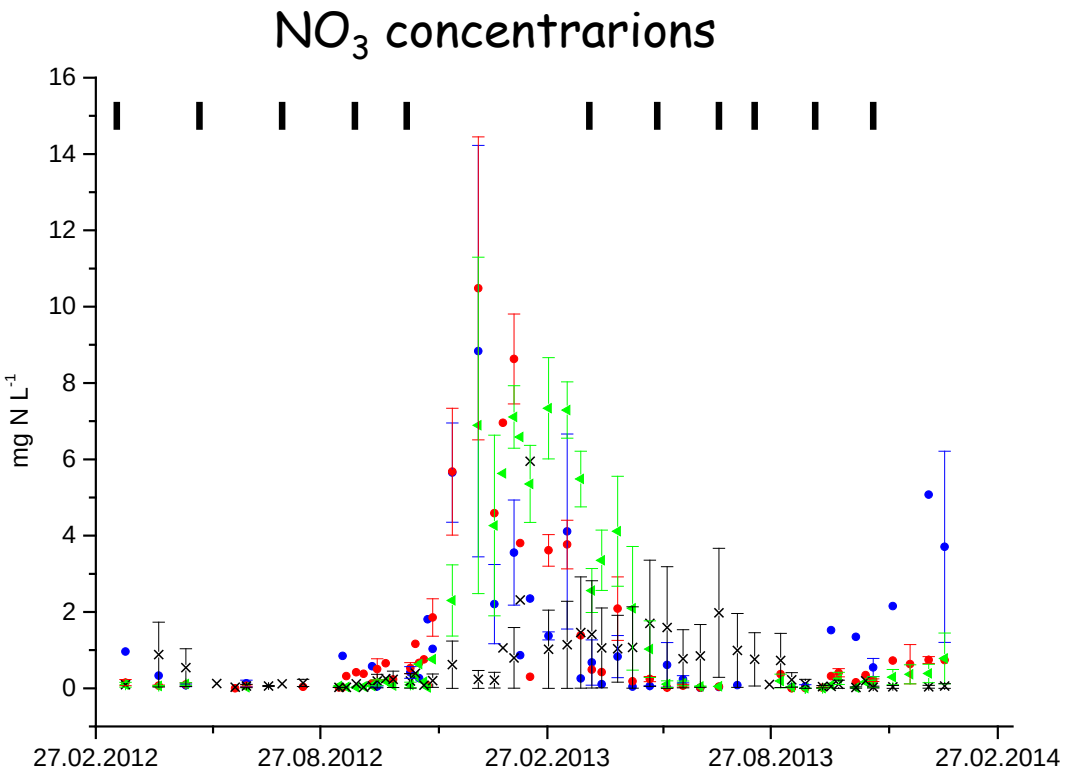
Soil water C and N concentrations



Suction cups for soil water sampling (bi-weekly)

in 10, 30, 50, 140cm

NH_4, NO_3, DON, DOC

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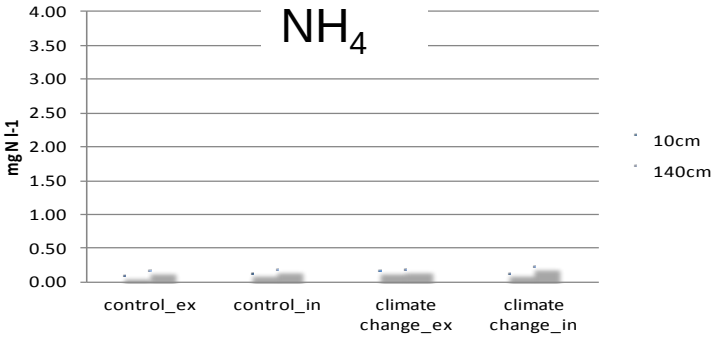
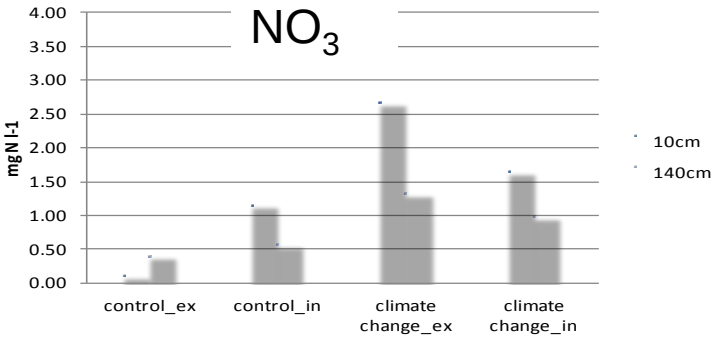
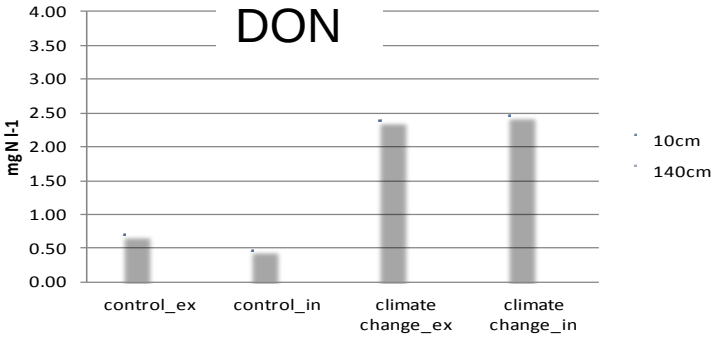
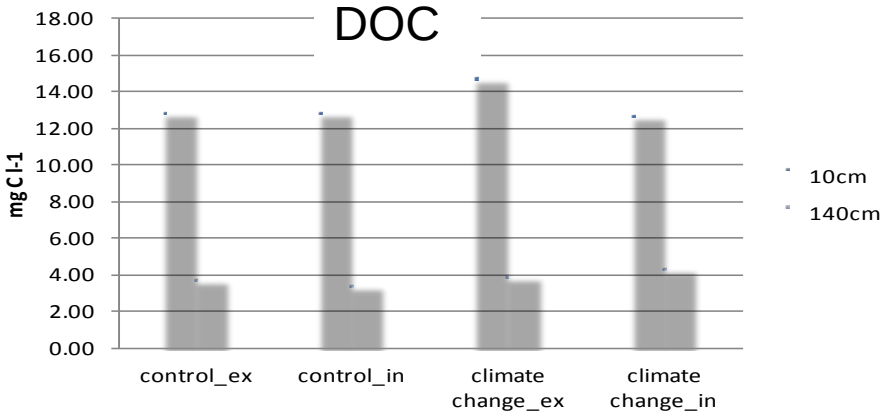
Soil water C and N concentrations









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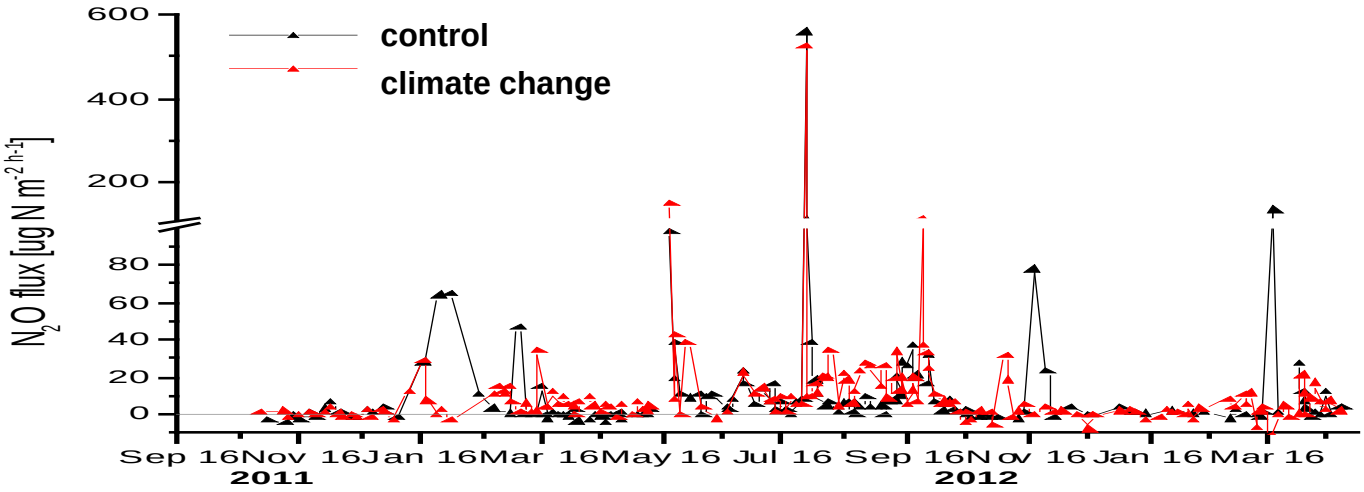
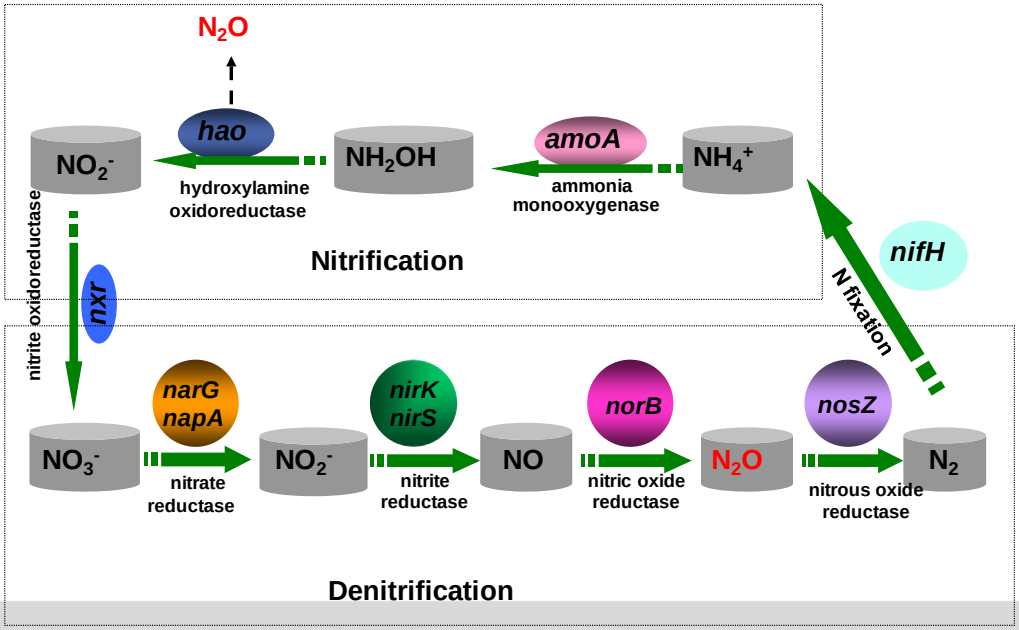
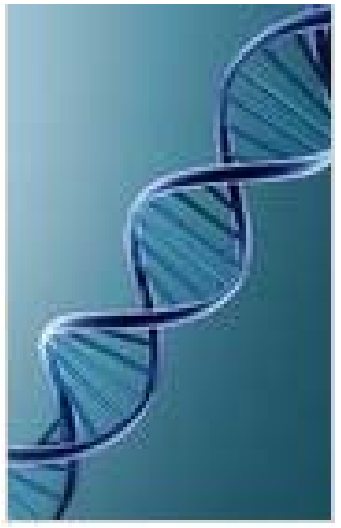
Enzymes involved in microbial N processes







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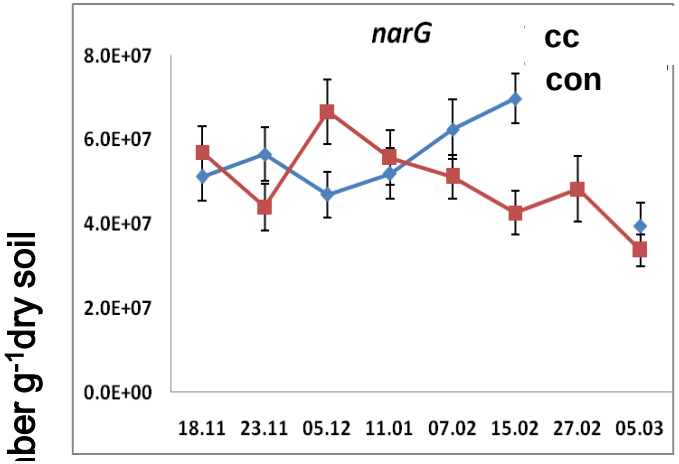
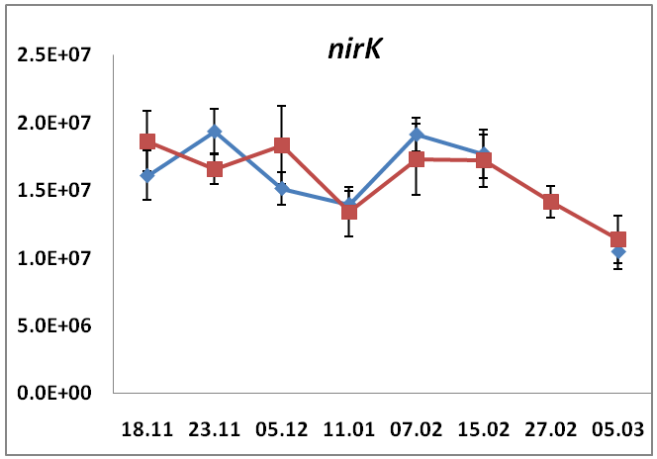
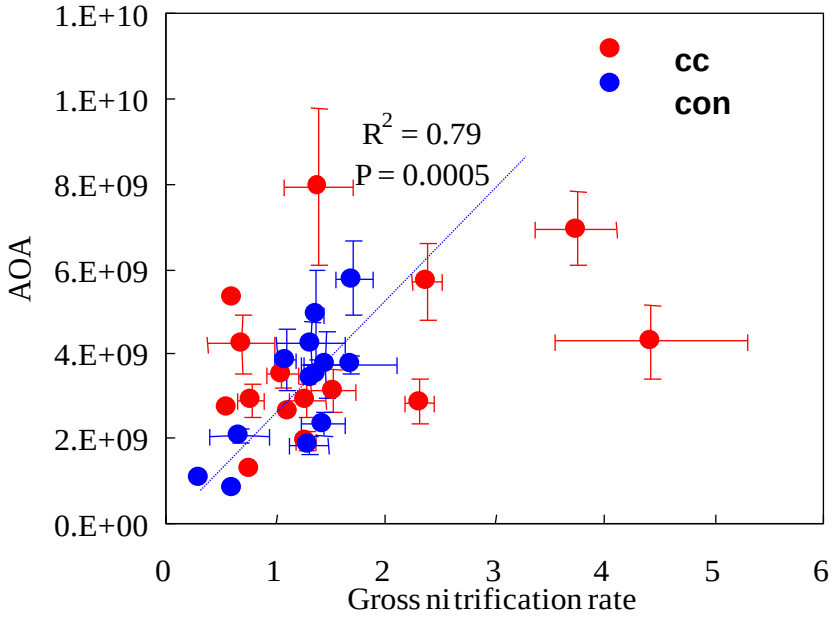
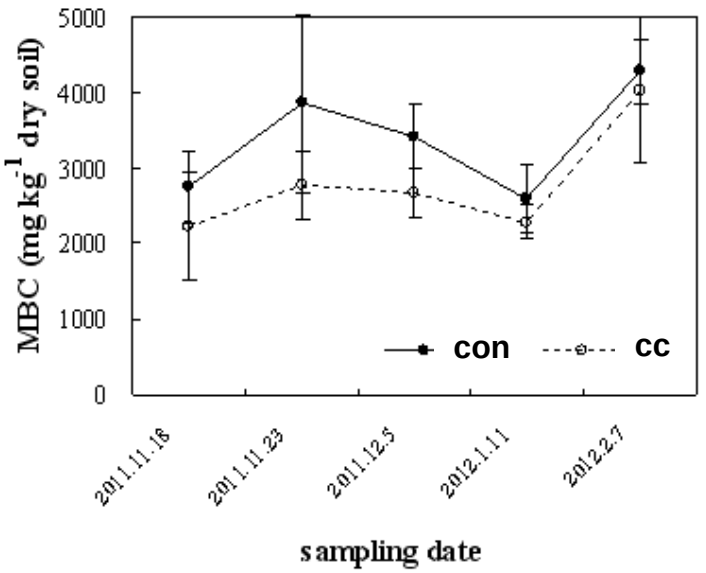
Denitrification enzymes / microbial biomass









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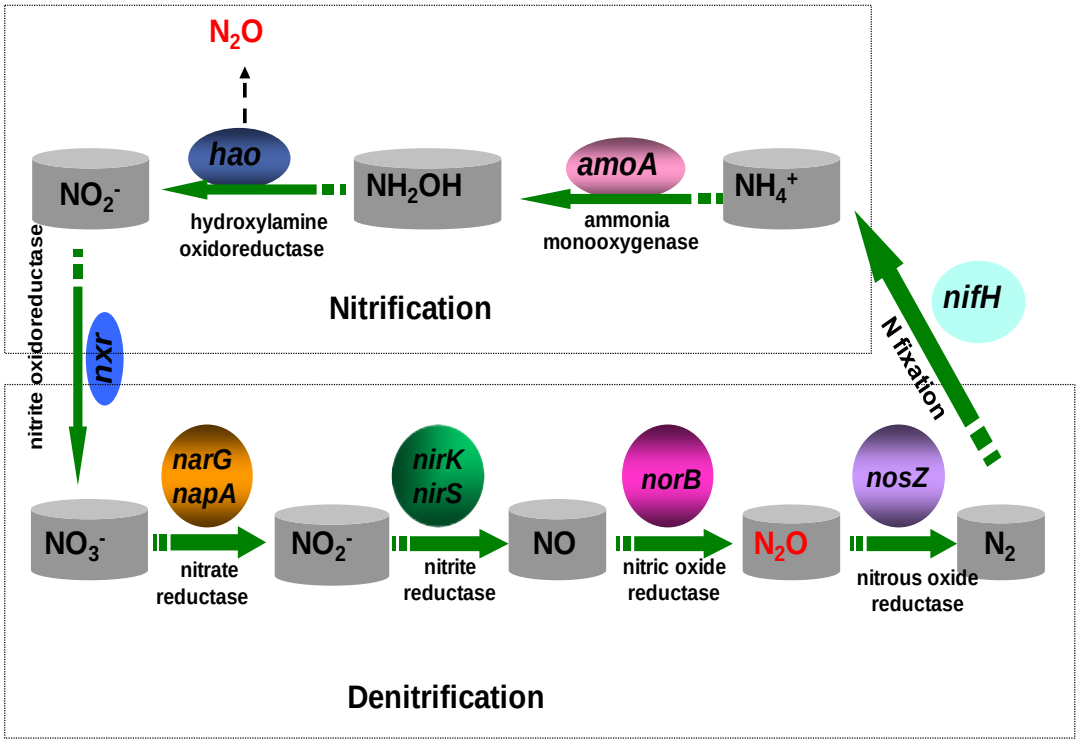
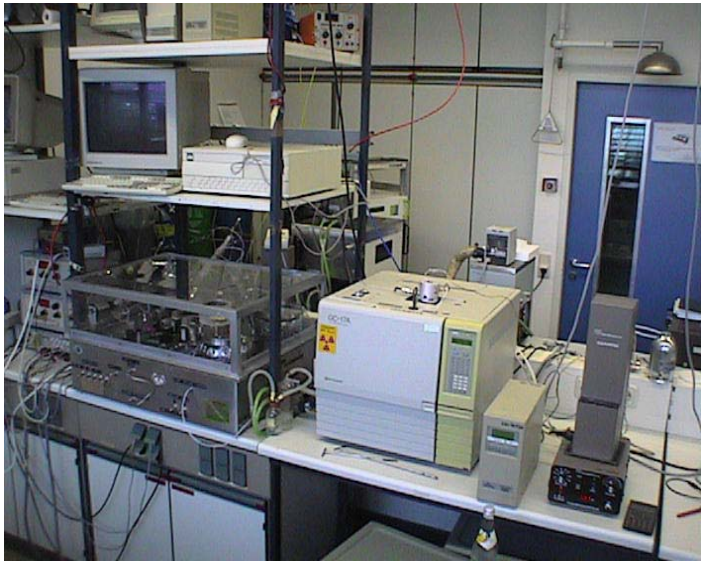
Helium incubation method to quantify N_2 and N_2O





Wang et al. 2011, Environmental Science and Technology

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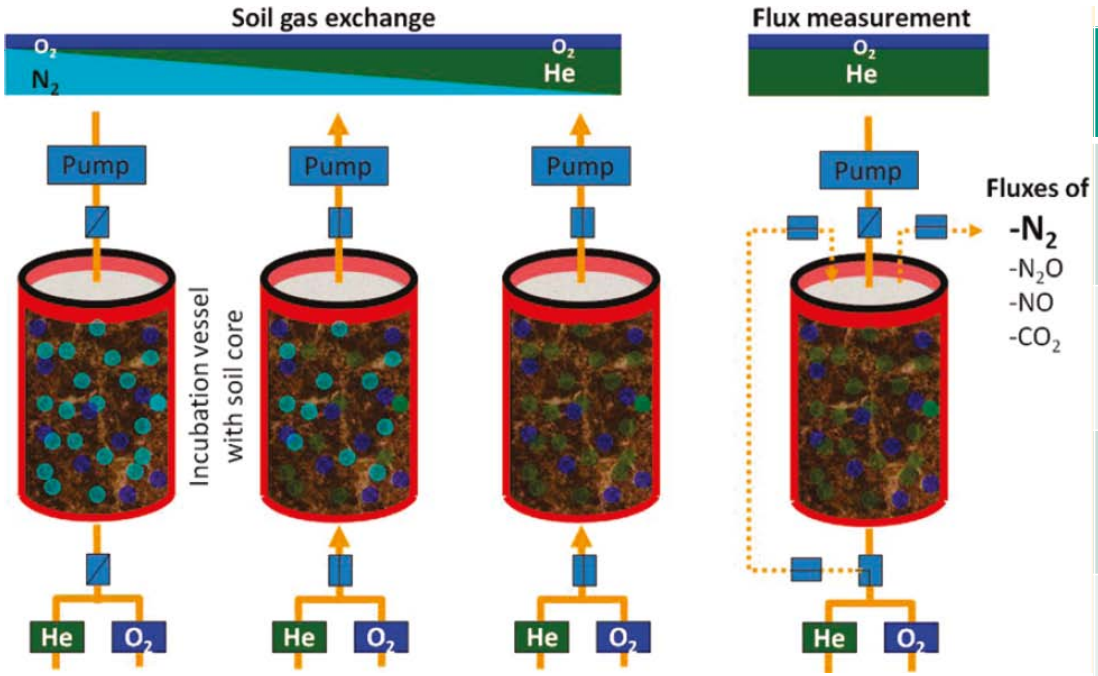

Wang et al. 2011, Environmental Science and Technology

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

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Conlcusions

- **Climate change/ Translocation leads to…**
- increase N_2O emission in spring-summer-autumn (fertilization)
- but overall higher in higher elevation due to importance 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

Note this is first year of data

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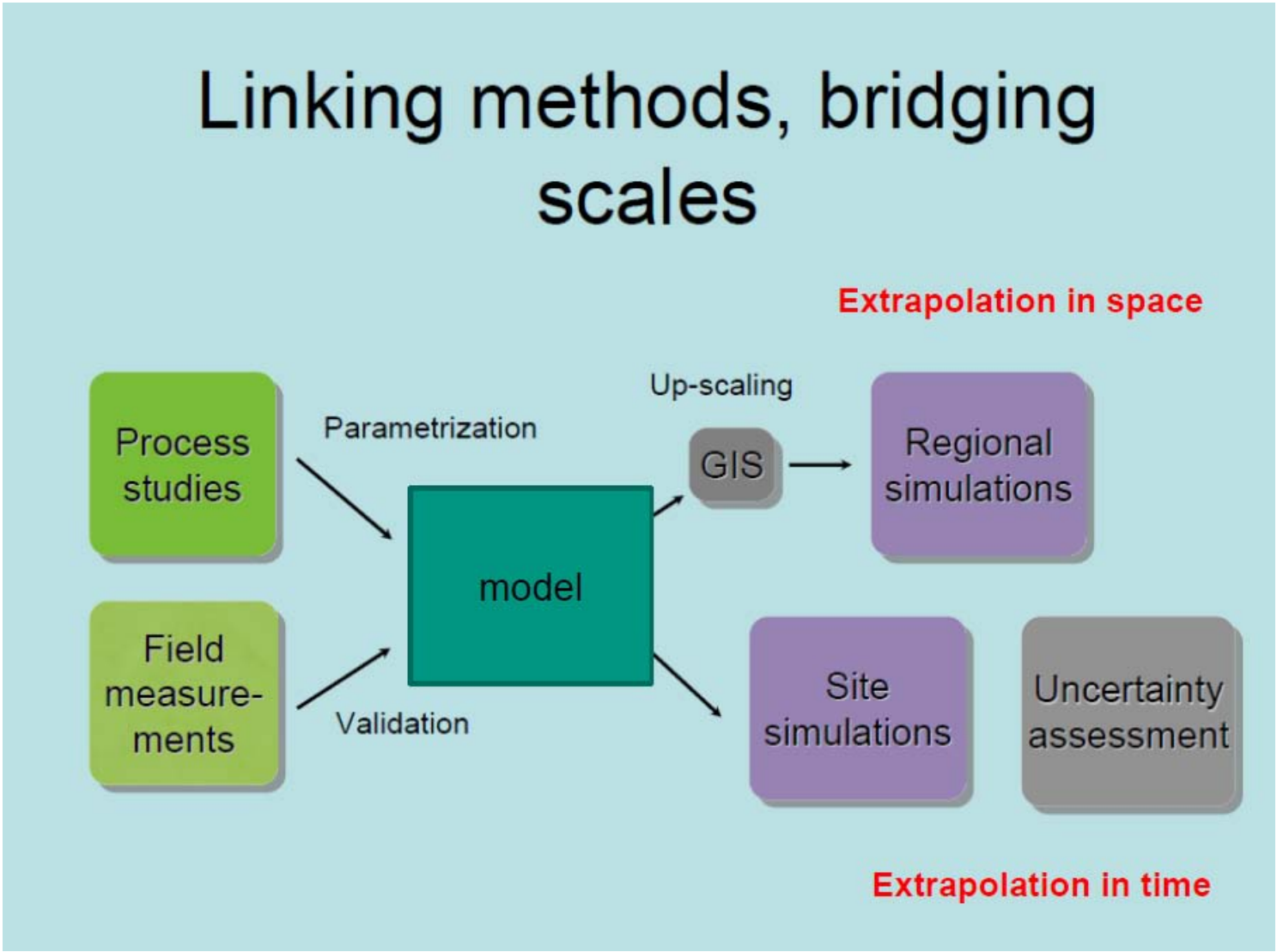
Conlcusions



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