TERENO
Terrestrial Environmental Observatories

KIT-Campus Alpin
IMK-IFU: Atmosphärische Umweltforschung

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3 years of N_2O and CH_4 exchange of intensive and extensive managed pre-alpine grassland ecosystems: current vs. climate change conditions

R. Kiese, H. Lu, E. Diaz-Pines, B. Wolf, M. Dannenmann, Z. Chen, W. Xing, K. Butterbach-Bahl

Graswang (860m) | Rottenbuch (750m) | Fendt (600m)



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The TERENO Observatories

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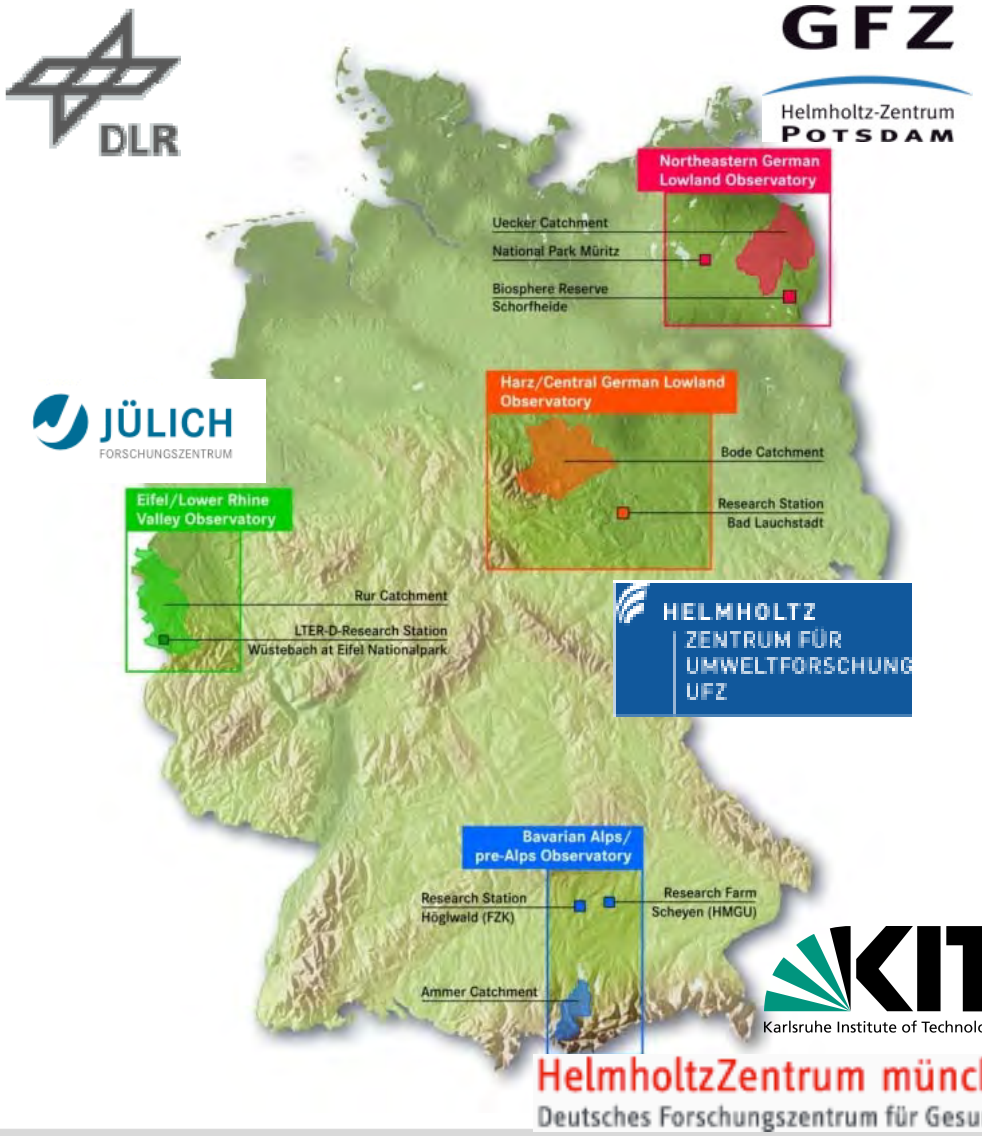
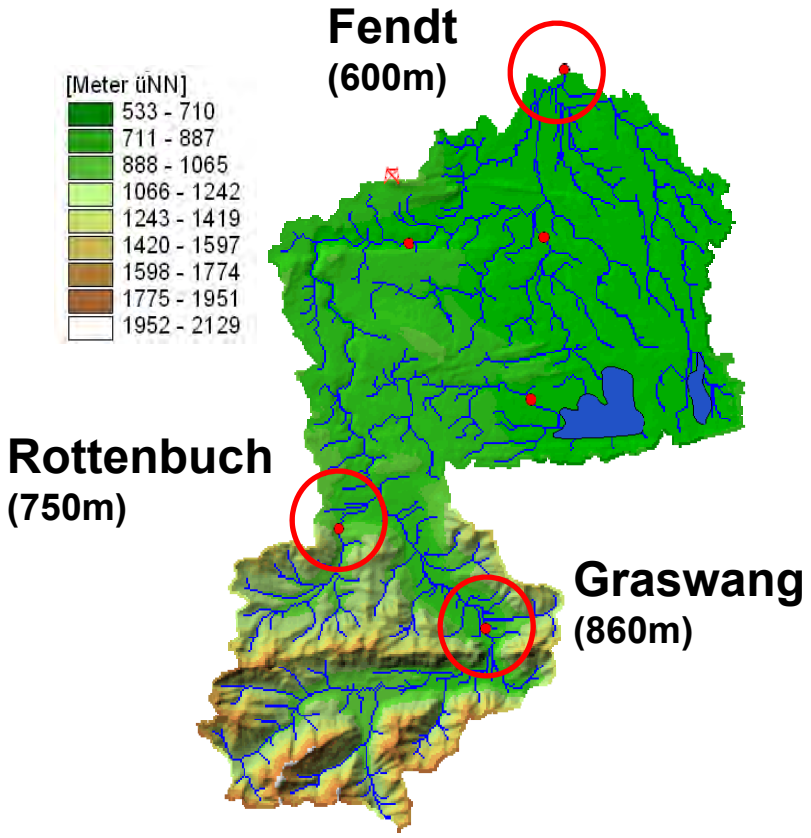
TERRESTRIAL ENVIRONMENTAL OBSERVATORIES



Ammer Catchment



http://teodoor.icg.kfa-juelich.de/

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TERENO lysimeter field setup

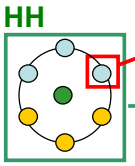
space for time =
climate sequence

High (860m) / Graswang:

6 lysimeter

1285mm / 6.6°C

(1209-1386 / 5.9-7.4)



single lysimeter

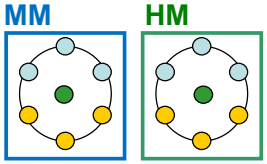
lysimeter unit consisting of 6 single lysimeters and central service station

Medium (750m) / Rottenbuch:

12 lysimeter

1121mm / 8.2°C δ 164mm / 1.6°C

(972-1255 / 7.5-9.0)

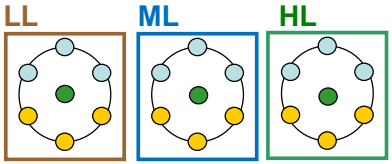


Low (600m) / Fendt:

18 lysimeter

959mm / 8.6°C δ 326mm / 2°C

(879-1035 / 7.9-9.4)



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Garmisch-Part.

data transfer

system control and maintainance

○ = intensive management ○ = extensive management

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Hypothesis

Climate change will…

accelerate soil C-/N- turnover and associated soil emission of N_2O, CH_4 (and CO_2) as well as leaching of N (/C) compounds

Main Objectives

Characterization and quantification of climate change effects on ...

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

GHG measurements (CO_2, N_2O, CH_4)

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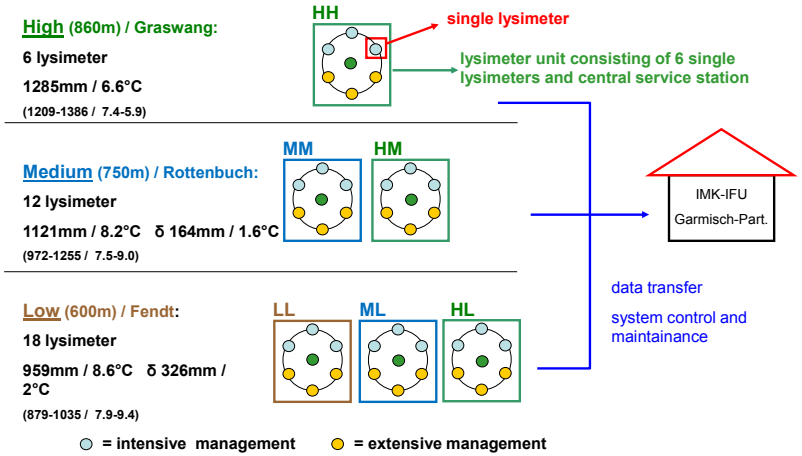
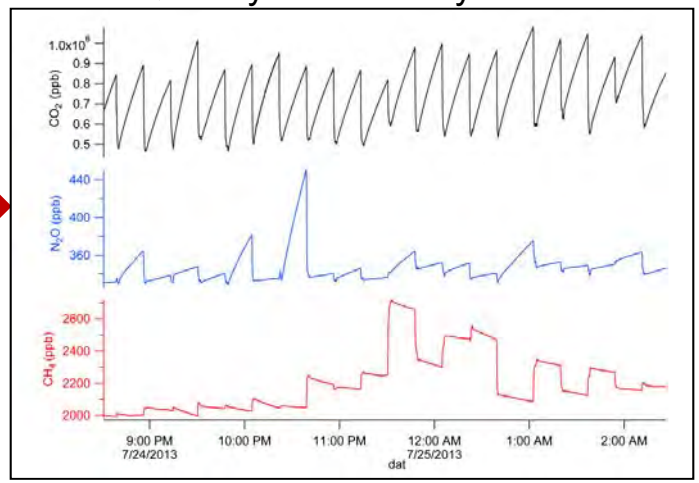


Gas chromatograph

Automatic chamber systems

Dual QCL-System Aerodyne



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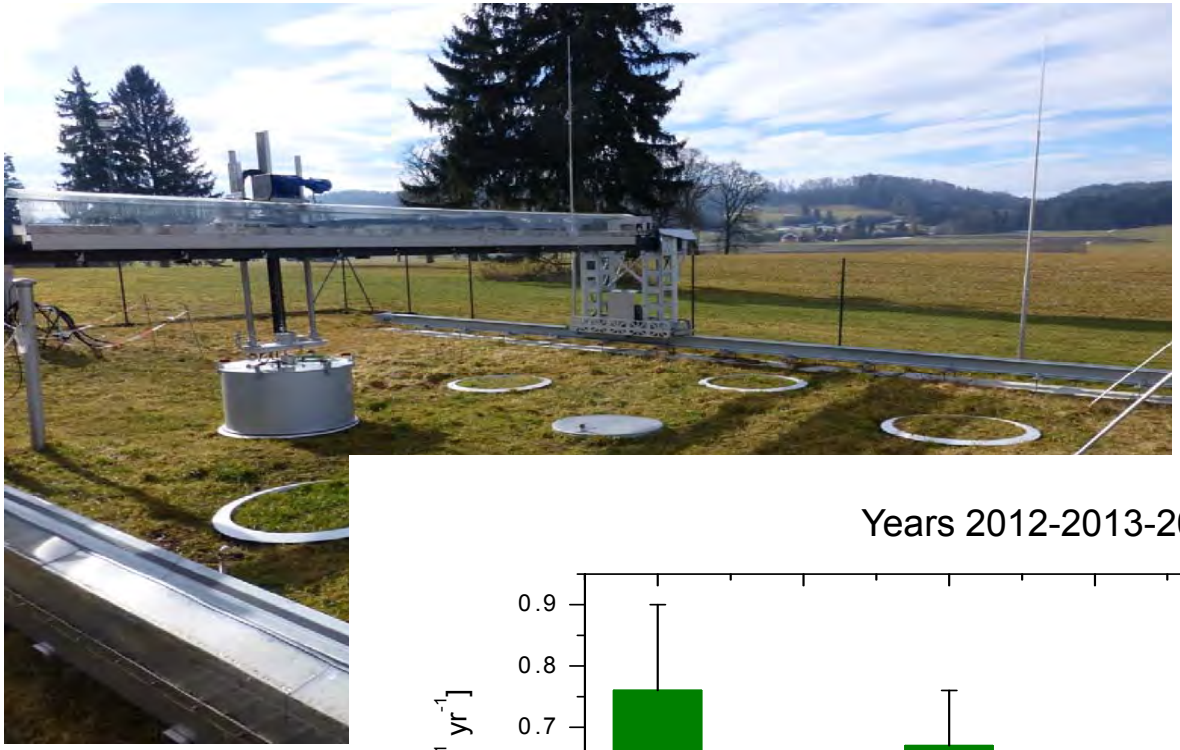
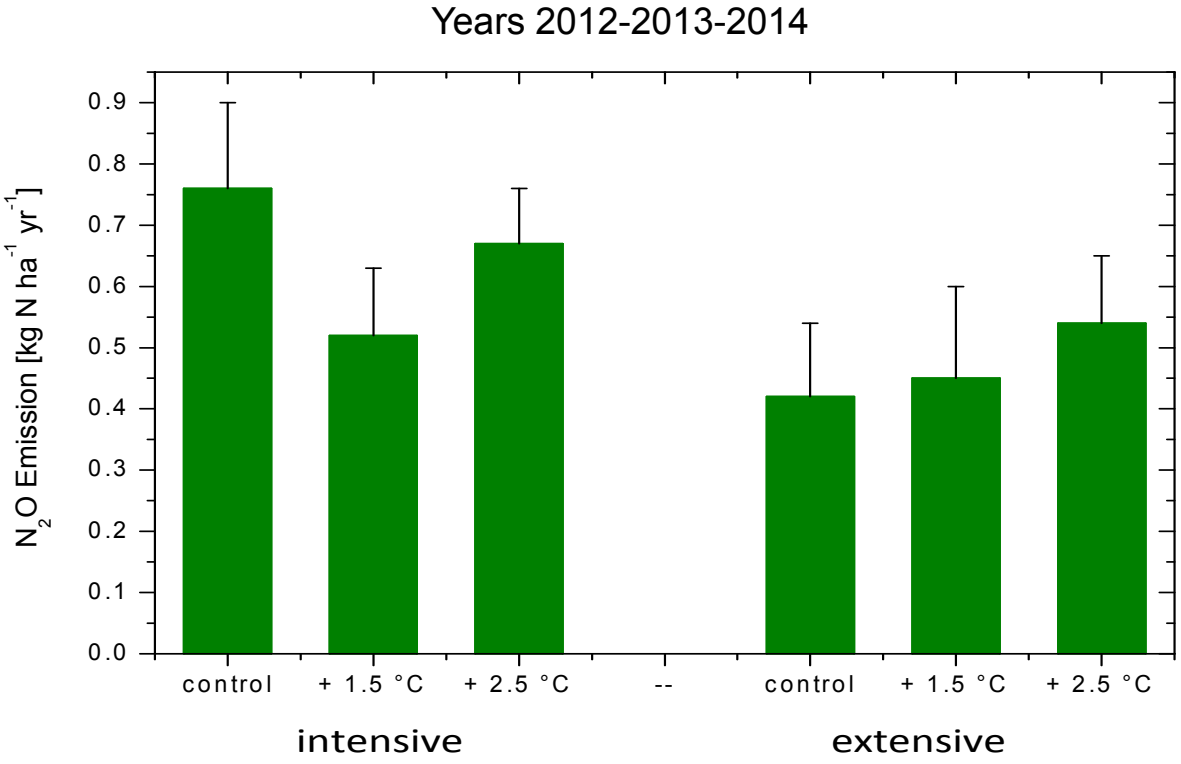
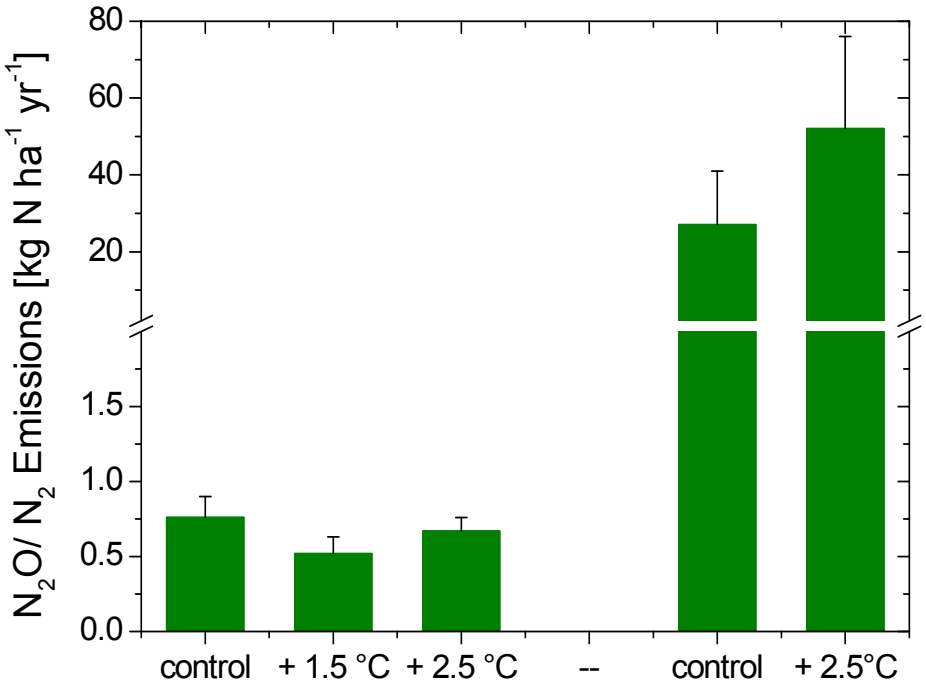
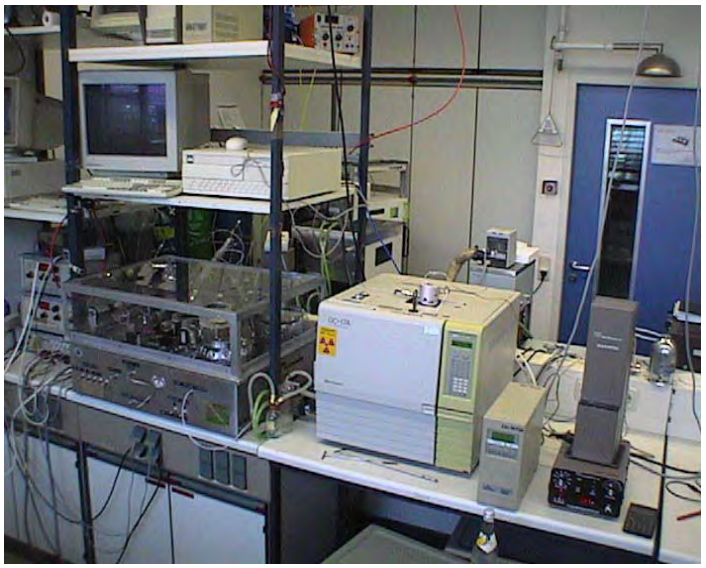
Results: N_2O emission





Results: N_2O vs. N_2 emission



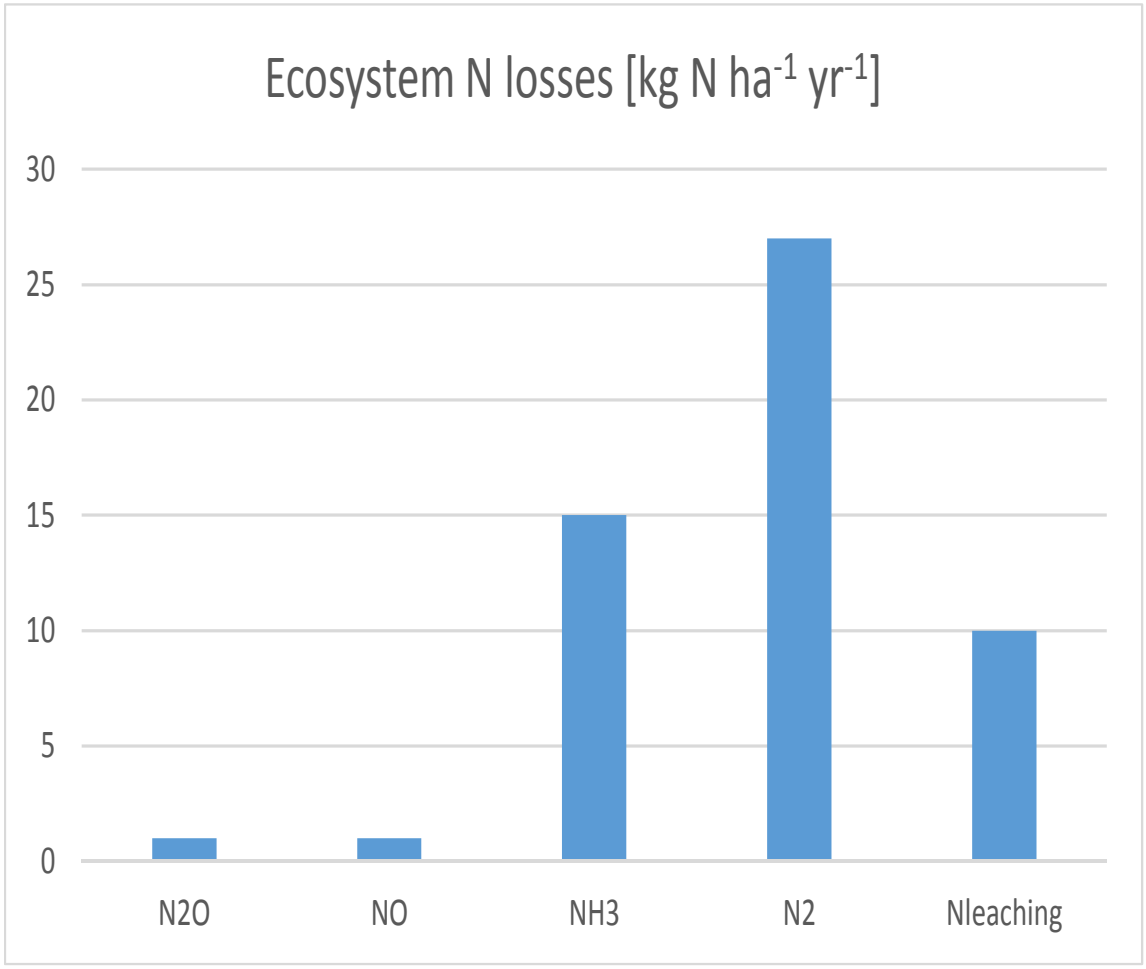


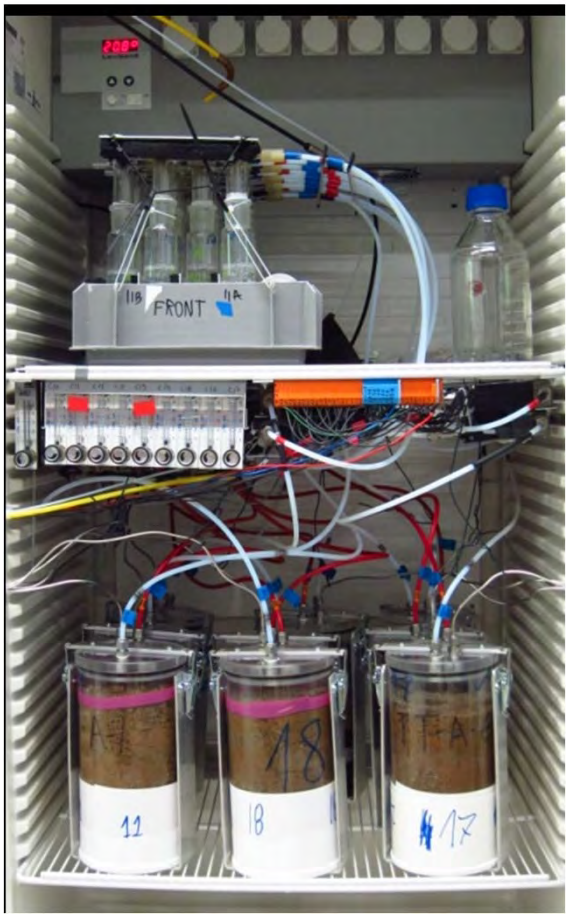
Wang et al. 2011, Environmental Science and Technology, Chen et al. 2015 Soil Biol. & Biochem.

Automatic soil core sampling system (N=18)

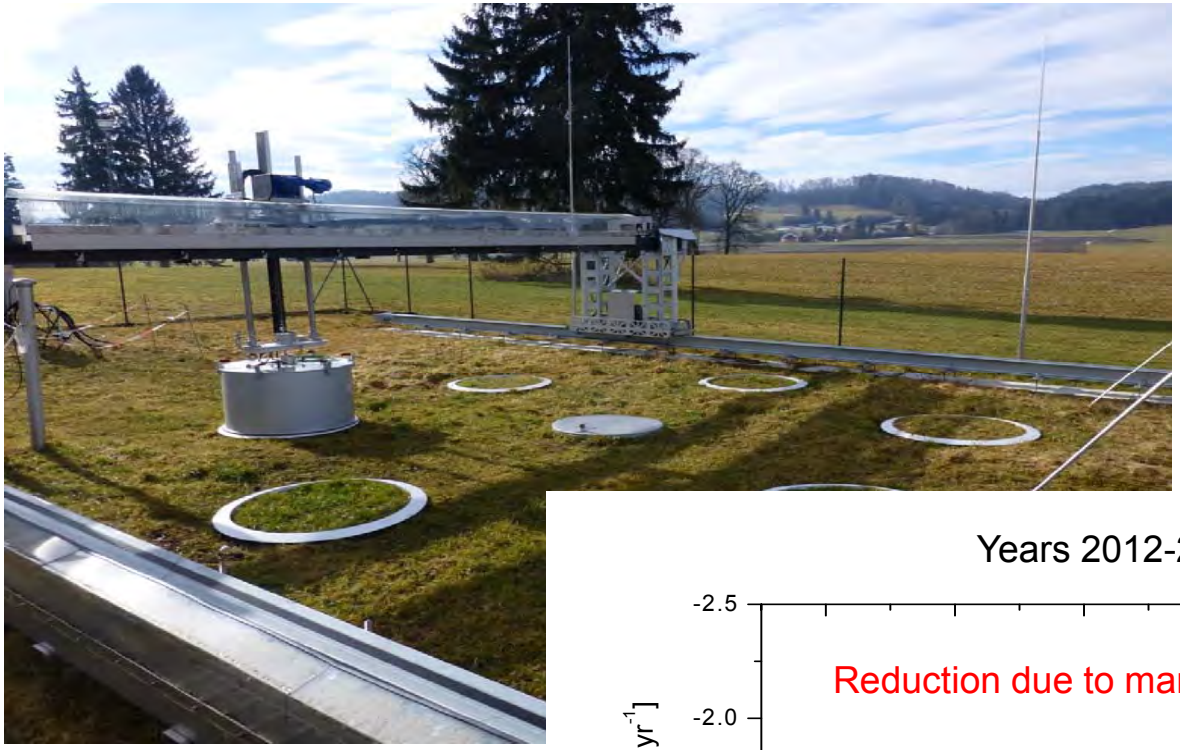
for CO_2, CH_4, N_2O, NO, NH_3 emission

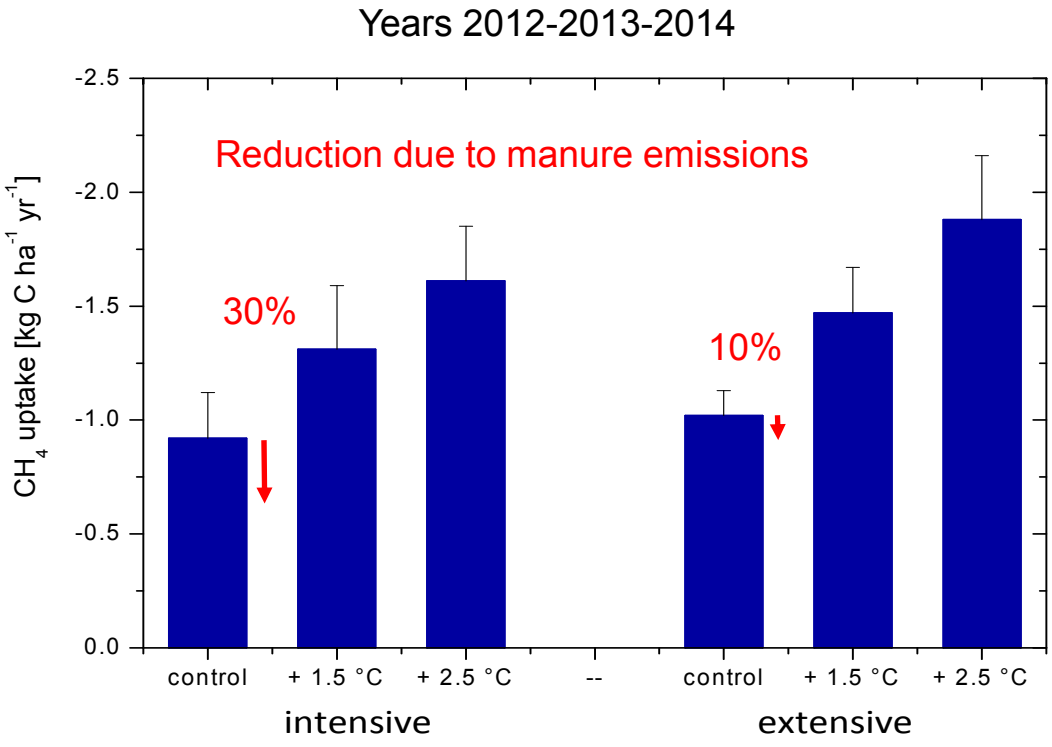
8 measurements per core per day





Results: CH_4 emission





Local methane sinks and sources

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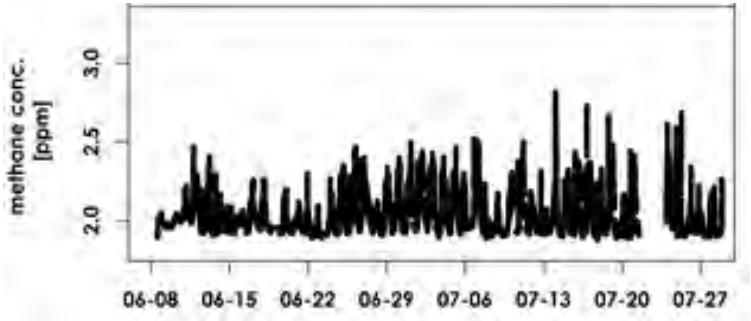
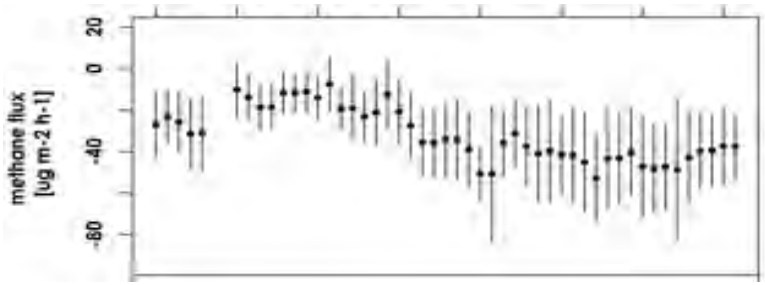
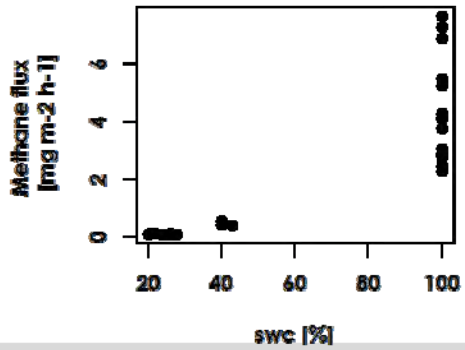
Atmospheric concentrations

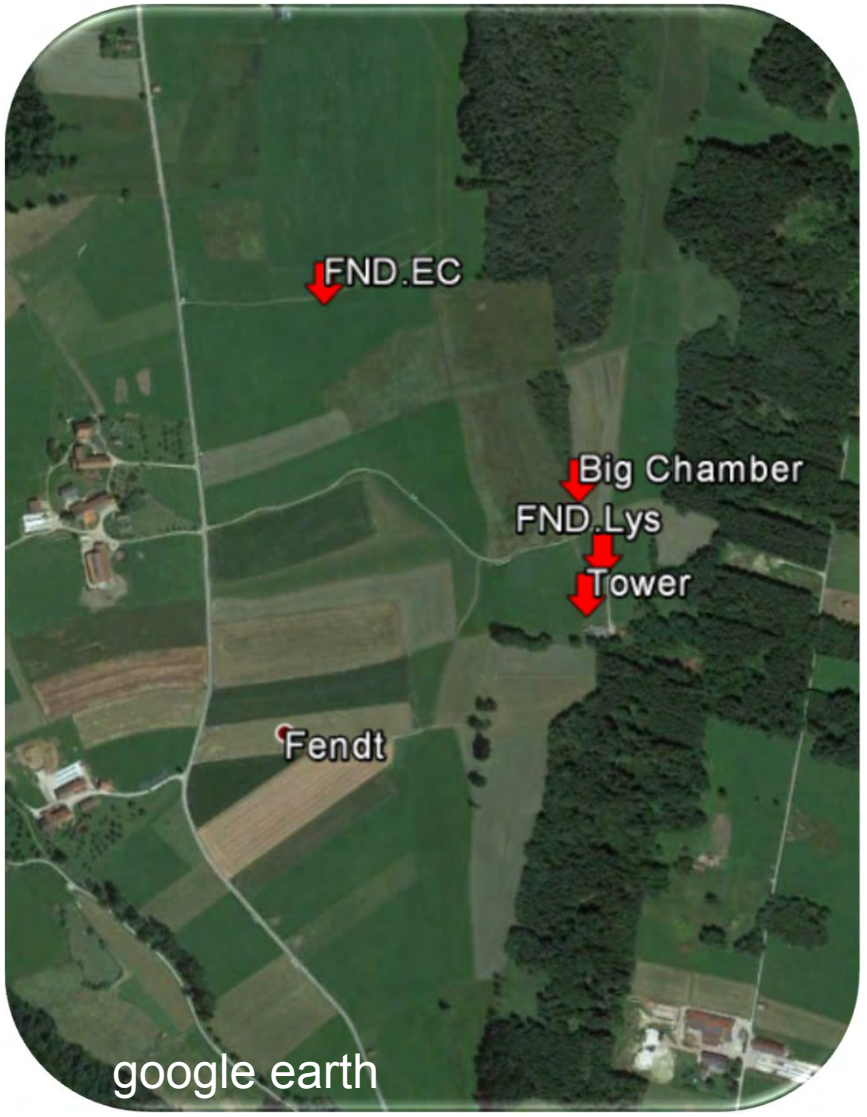


Grassland sink



Wetland source





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Local methane sinks and sources

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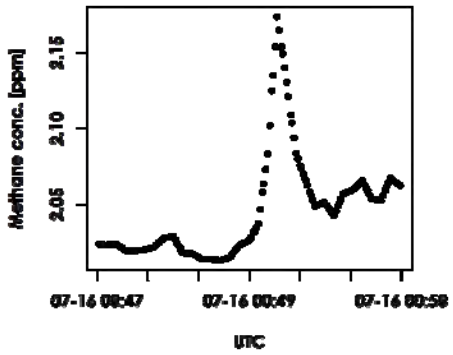
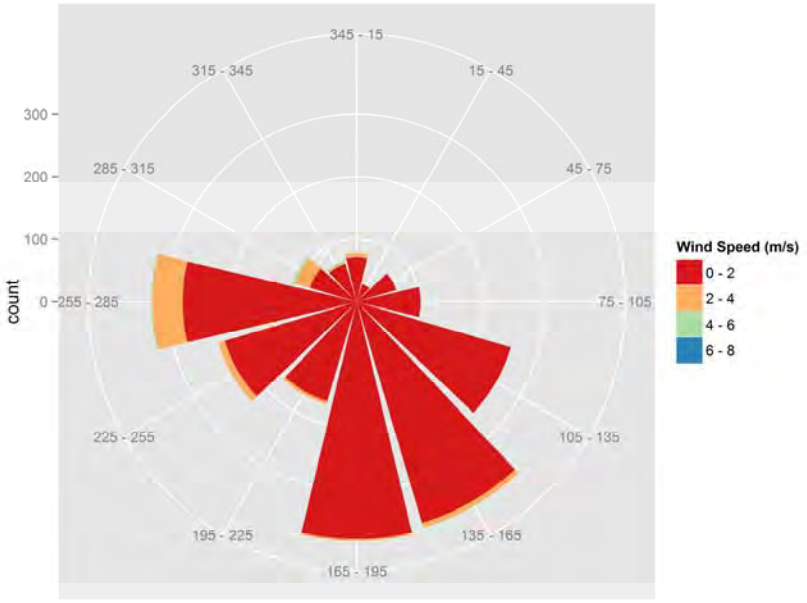
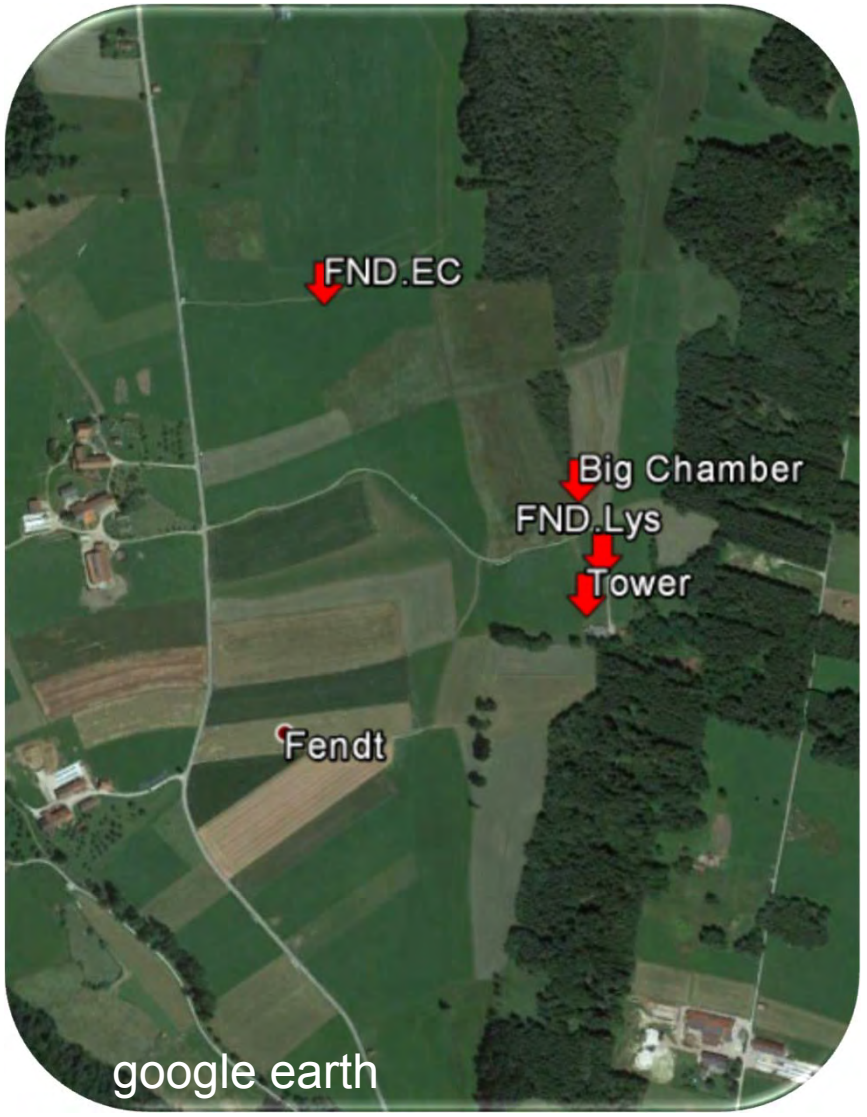
Plumes from dairy farms







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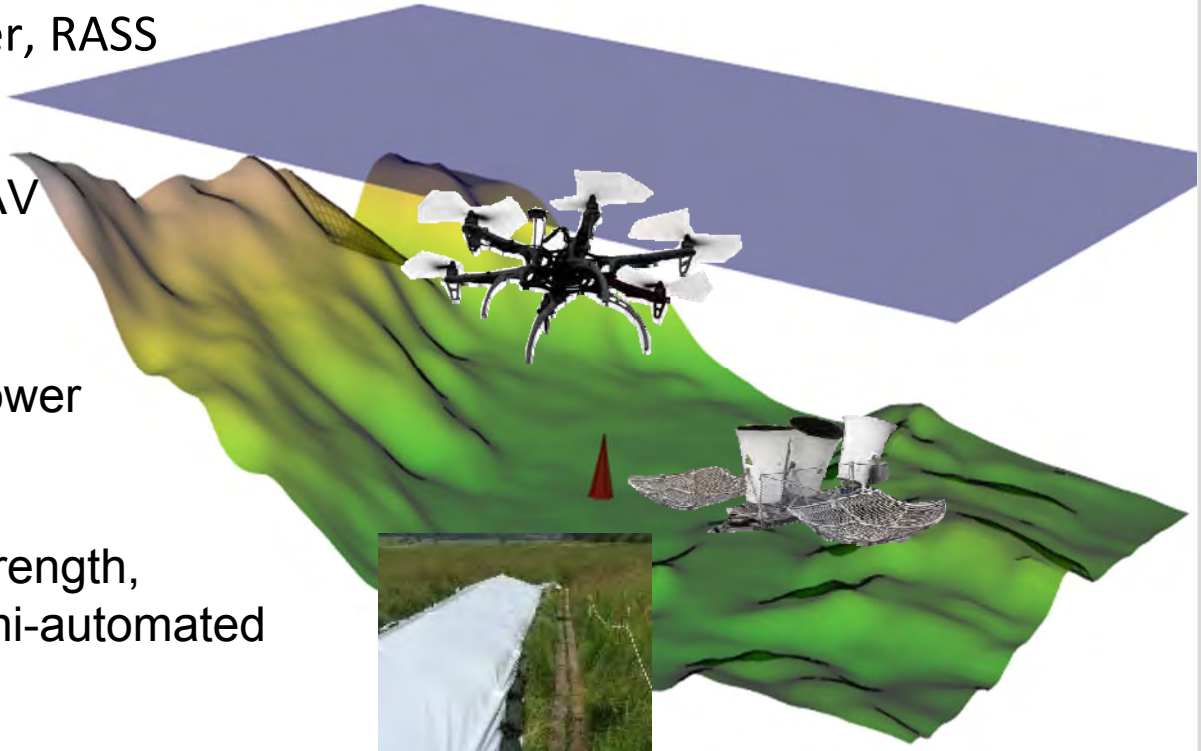
Trace gas budget and distribution in the nocturnal boundary layer (NBL) – ScaleX campaign

- NBL height by ceilometer, RASS
  (Mauder, Emeis)
- GHG, T, q profiles by UAV
  (Junkermann, Brosy)
- GHG conc. profiles @ tower
  (Wolf)
- wetland GHG source strength,
  “big” chambers and semi-automated gas samplers
  (Schäfer, Diaz-Pines)
- CH_4 source strength @ farm
  open path sensors
  (Mauder)



Conclusions

- Soil N_2O are generally low but are slightly higher under intensive management
- Under climate change conditions N_2O emissions are elevated after fertilization events
- Overall N_2O are not affected by climate change due to constraining effects of frost-thaw events
- N_2 emissions dominate N-trace gas emissions and are significantly increased by climate change
- Soil CH_4 uptake is moderate but slightly higher under extensive management
- Under climate change conditions (+ soil temp, - lower soil moisture) soil CH_4 sink significantly increases
- Manure (application) is a significant CH_4 source significantly reducing the soil CH_4 sink
- Regionally, CH_4 budgets can be driven by strong emissions from dairy farms (and wetlands?) which may exceed the sink strength of grassland soils

to be continued in ScaleX campaign 2016 (benjamin.wolf@kit.edu)

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Ongoing:

- Temperature dependent determination of NBL height
- Classification of gradients in “early night” and “early morning”
- Assessment of “free diffusion timescale”
- Determination of source strength @ farm Jungwirth

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ScaleX subtopics for the campaign JJ 2015

- The impact of complex terrain on biosphere-atmosphere exchange processes (Zeeman, Mauder, Brugger, De Roo, Malchow, Emeis, Schäfer)
- Trace gas budget and distribution in the nocturnal boundary layer (Wolf, Schäfer, Brosy, Zeeman, Malchow, Emeis, Jahn, Diaz-Pines, Kiese, Dannenmann)

site scale / mesoscale observations and methods

- Patterns of precipitation and soil moisture across scales (Chwala, Reineke, Fersch, Völksch, Garvelmann, Kunstmann)
- Scaling canopy traits and phenology: From plants to the ecosystem and region (Rühr, Shupe, Zeeman, Mauder,)

site scale to regional scale observations and methods

- Closure of atmospheric and terrestrial water & energy cycles (Fersch, Junkermann, Chwala, Kunstmann, Mauder, Zeeman)
- Distributed modelling of water, energy and nutrient cycles

site scale / regional scale observations and modeling

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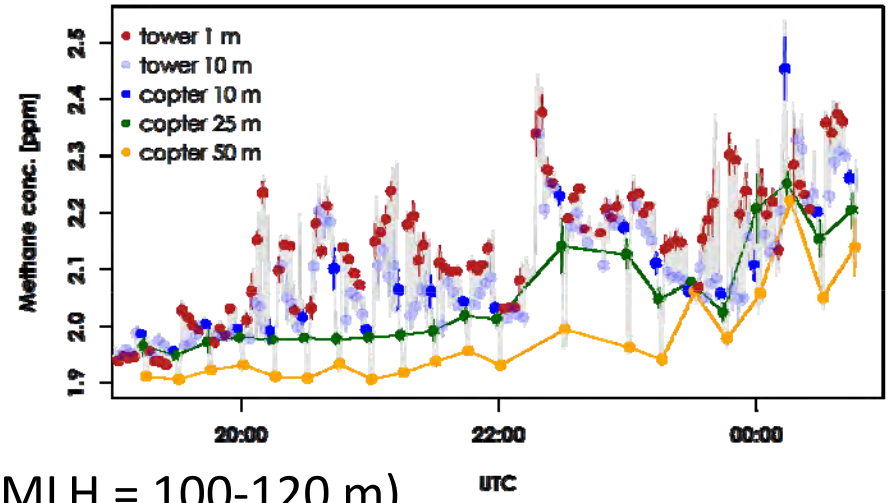
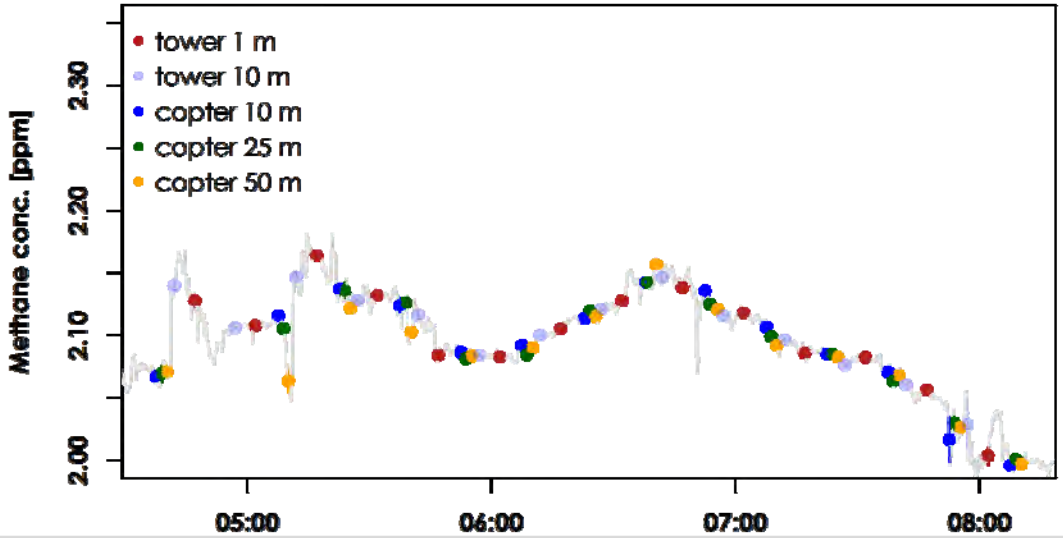
“well mixed” NBL?

- early night (MLH = 100-300 m)



- early morning (MLH = 100-120 m)



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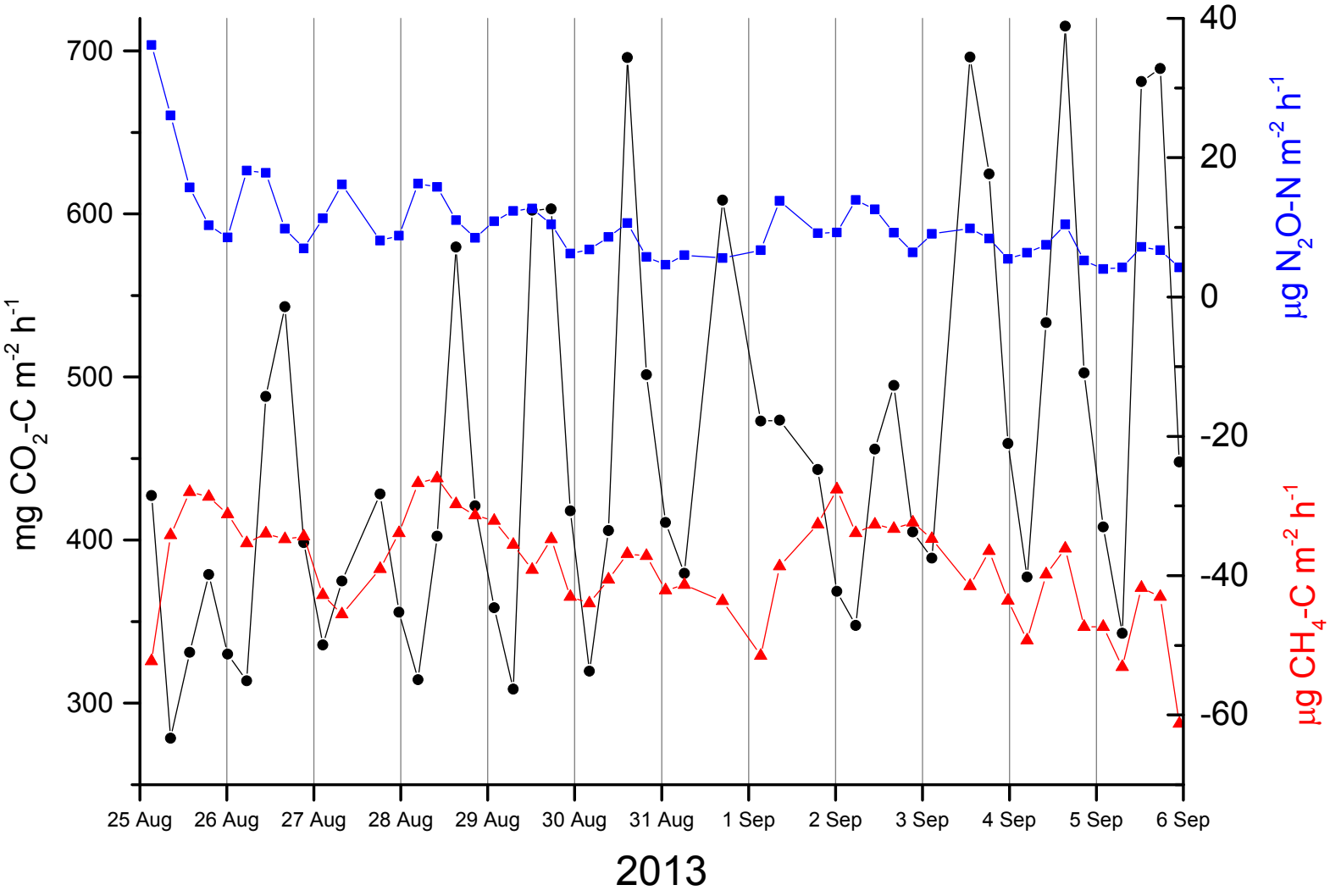
Results: diurnal patterns of GHG emissions



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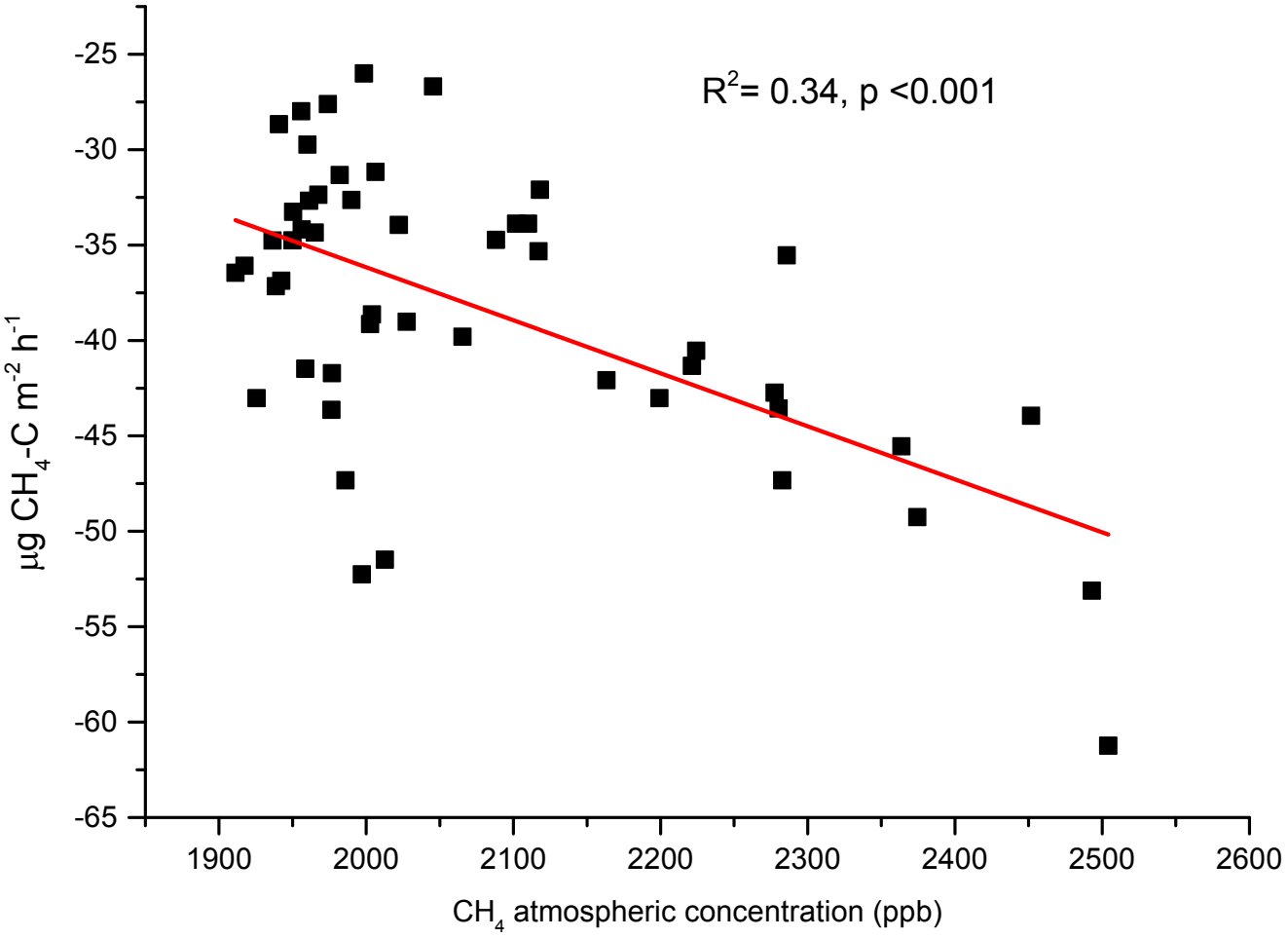
Results: CH_4 uptake and ambient conc.



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