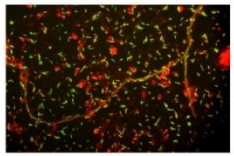
University of Innsbruck - Faculty of Biology

Institute of Microbiology

Effects of land use, abiotic and biotic soil properties on *in situ* CH_4 flux in montane and subalpine forests and grasslands

Katrin M. Hofmann, Sieglinde Farbmacher and Paul Illmer

Annual Conference of the ASSS 2014
"Burning Issues In Soil Science"

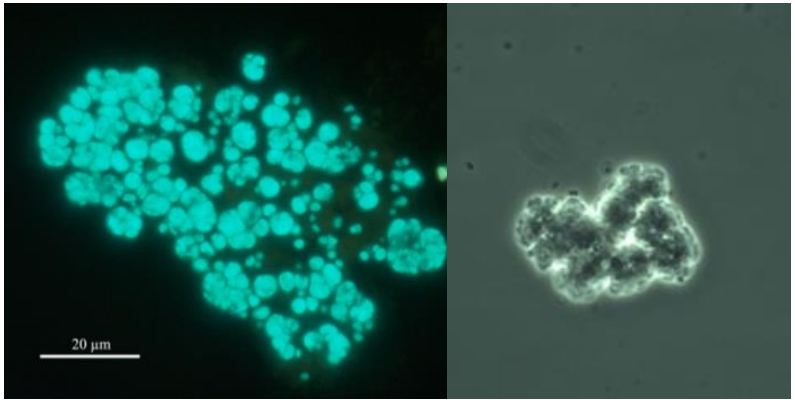


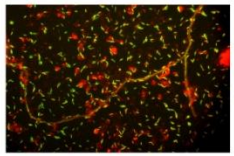

1. Introduction – Climatic impact of CH_4

- CH_4 second most important greenhouse gas after CO_2 (accounts for 20 to 30% of the global warming effect)

- **preindustrial:** 0.75 ppm
  today: 1.8 ppm
  predicted (by 2050): 2.55 ppm

- GWP (global warming potential) of CH_4 26 to 41 times higher compared to CO_2






1. Introduction – Origin and fate of CH_4

- sources: 500-600 Tg y^{-1}
- anthropogenic and natural sources
- 69% biological origin

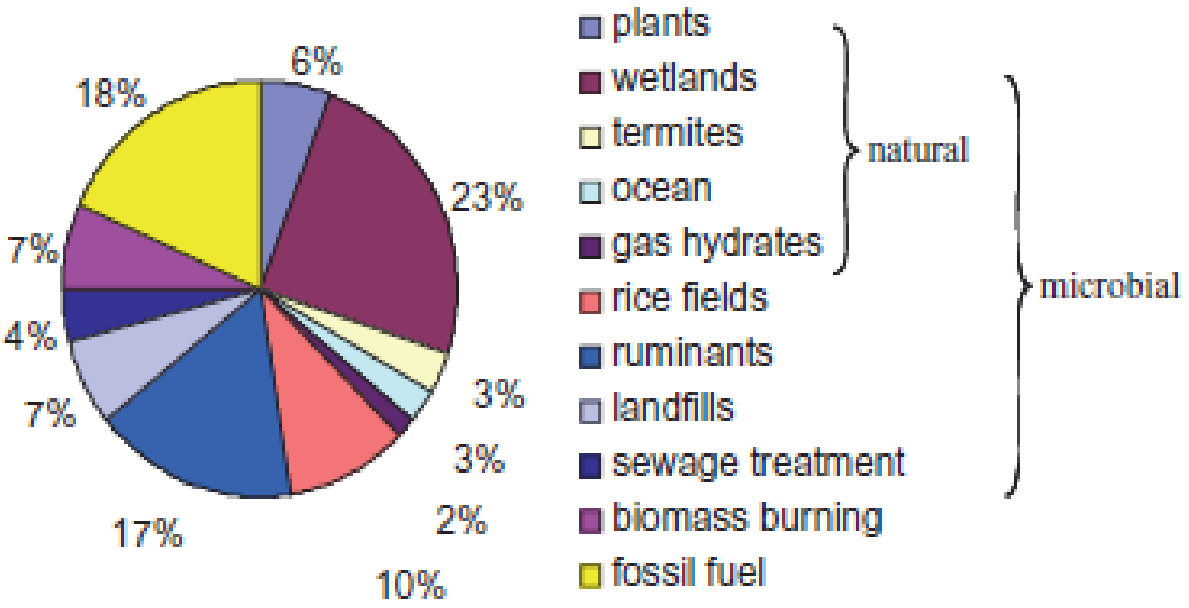
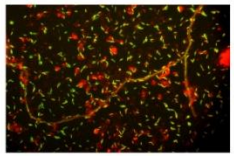
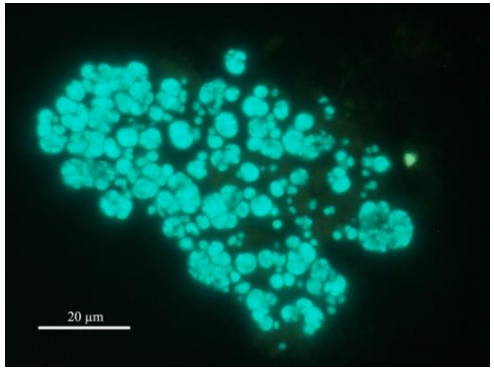


Fig. 1. Global methane sources in per cent of the total budget of about 500–600 Tg CH_4 per year.

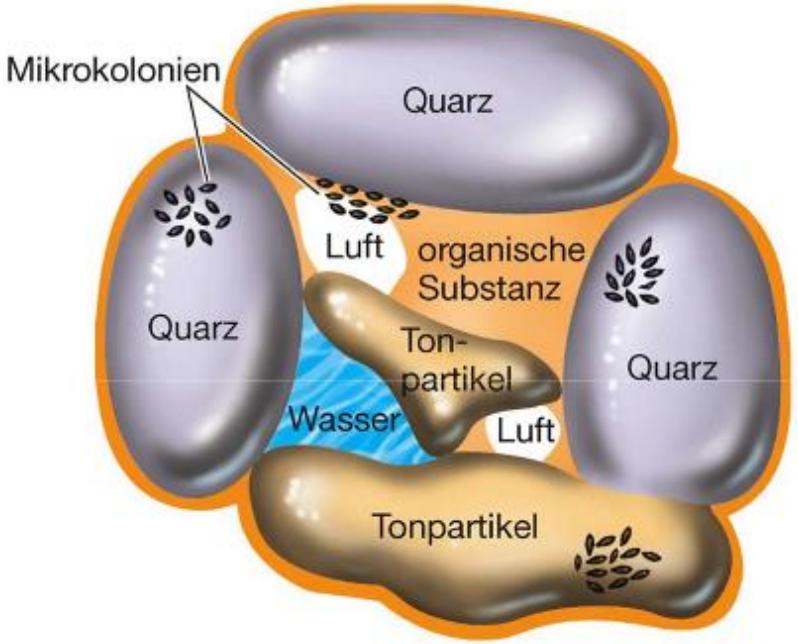
(Conrad, 2009)

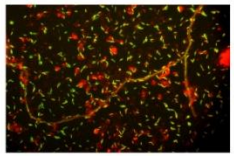



1. Introduction – Methanogenesis in aerated soils



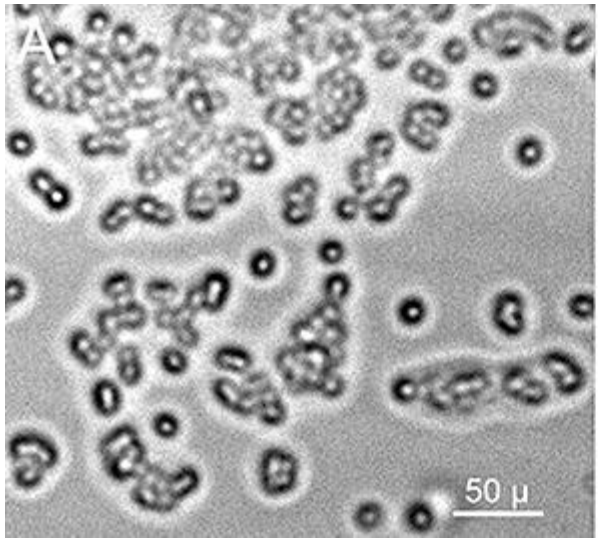
- methanogenic Archaea as part of anoxic food chain
- **traditional view:** methanogens restricted to anoxic habitats
- tolerance (catalases)?
  anoxic micro-niches (O_2 depletion)?

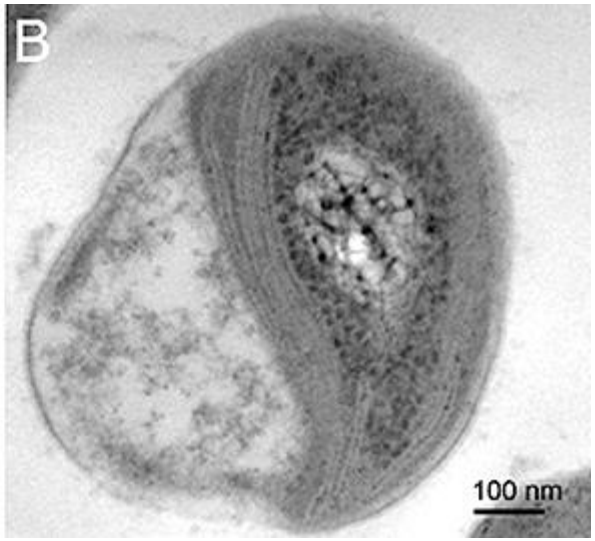


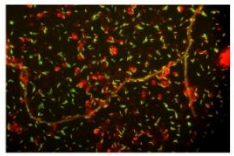



1. Introduction – Methane oxidation in soils

- only biological sink for CH_4 (30 Tg y^{-1})
- methanotrophs use CH_4 (carbon and energy supply)
  - *α-Proteobacteria*, *γ-Proteobacteria*
- low-affinity and high-affinity methane-oxidation

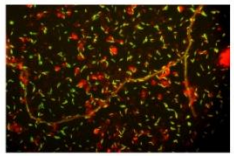






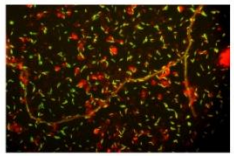
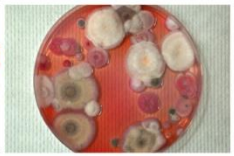

2. Aims

- determination of ***in situ*** **CH_4 flux** in well-aerated upland forest and grassland soils
  - Effect of **plant cover** on CH_4 flux in montane and subalpine soils
  - Effect of **basement rock** (calcareous vs. siliceous)
  - Change of flux rates according to **altitude**
  - **physicochemical and microbiological properties** of the soils are measured to embed the data into a broad biological context



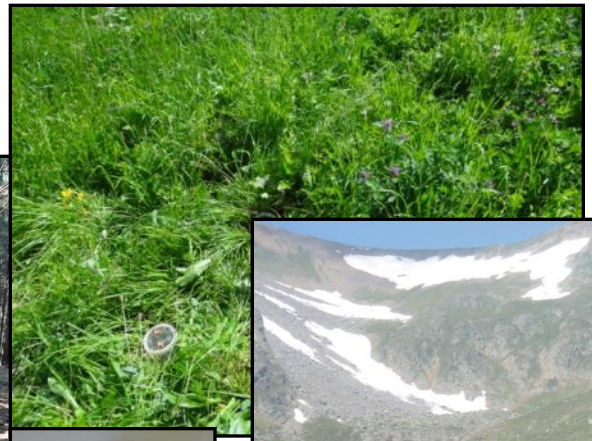
3. Materials & Methods – Soil sampling

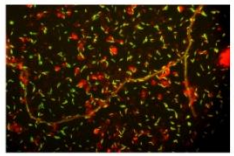
- 16 forest soils, 14 grassland soils
- 500, 1000, 1500, and 2000 m
- July 2013

3. Materials & Methods – CH_4 flux







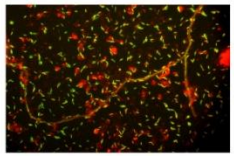

3. Materials & Methods – Abotic and biotic factors

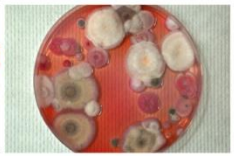
- pH
- Water content
- organic matter (OM)
- C_t, N_t
- MWHC
- NH_4^+, NO_3^-, P

Physicochemical factors

- Basal soil respiration
- DHA
- Microbial biomass (C_{mic})

Microbial activities and biomass

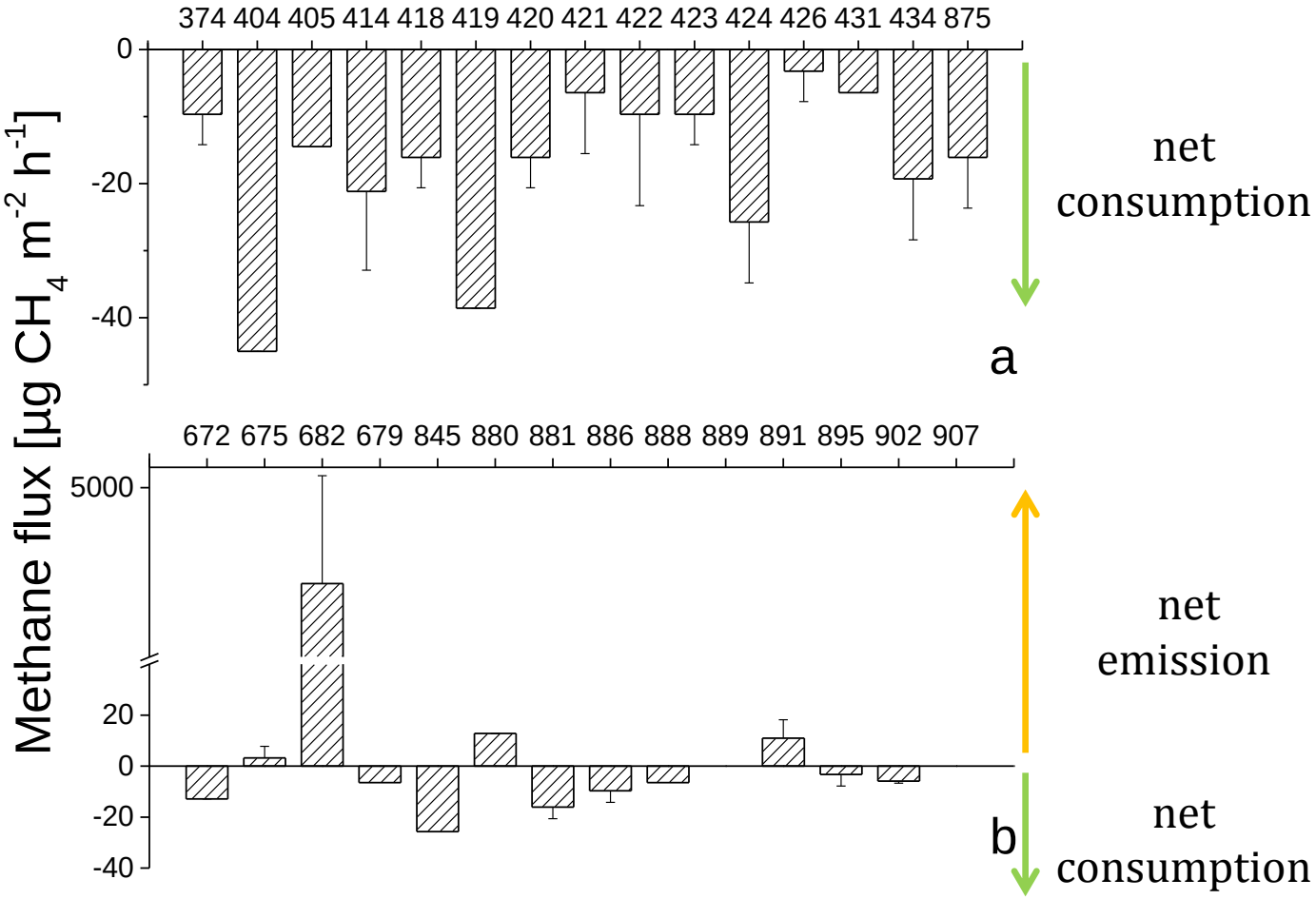


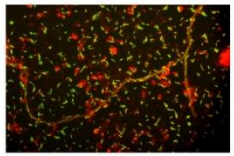


4. Results – CH_4 flux

forest

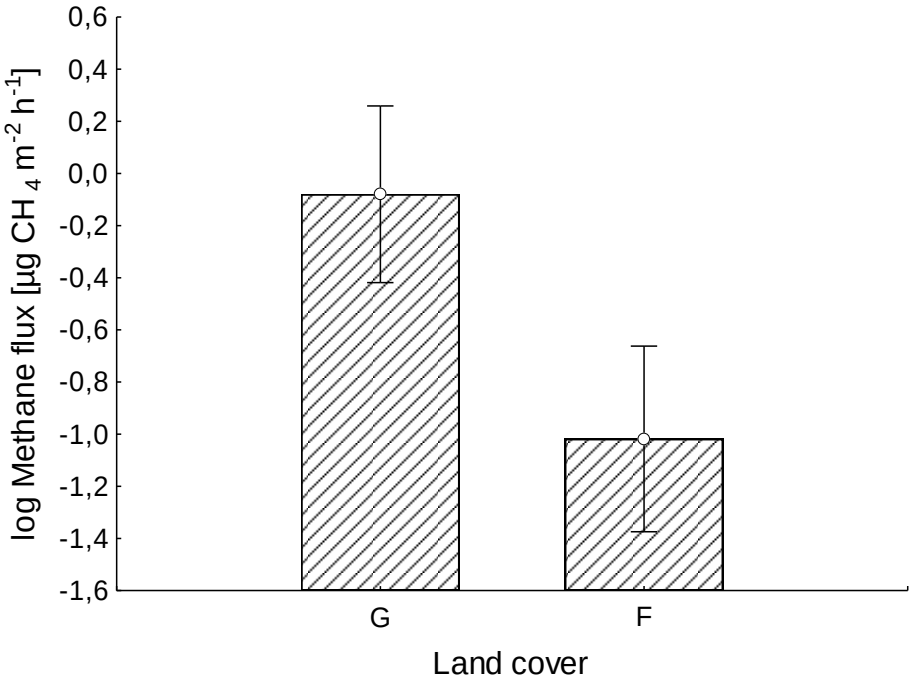
grassland

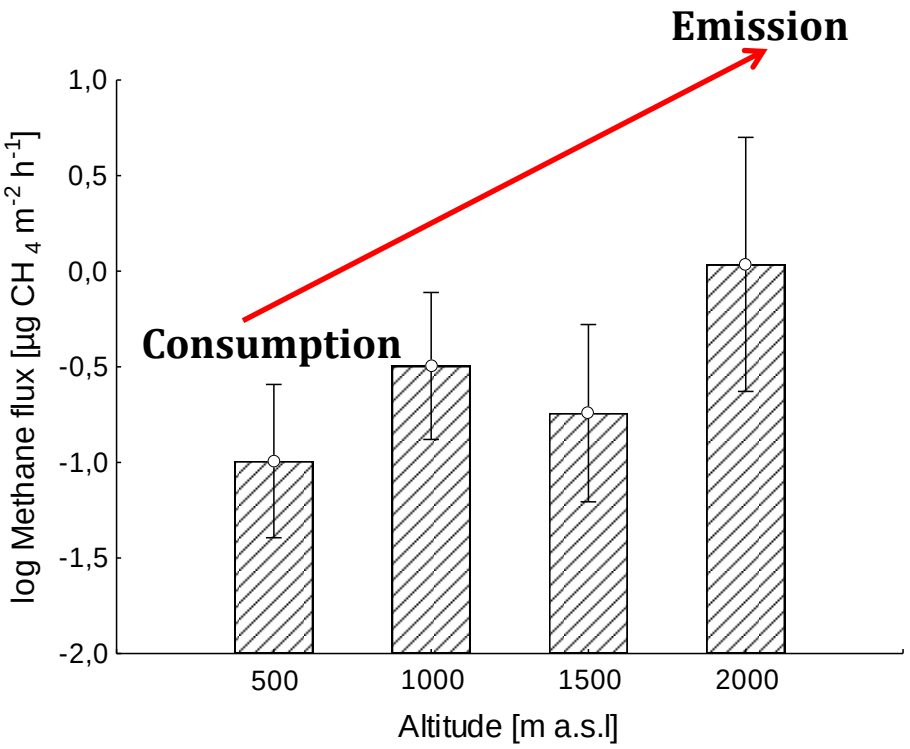


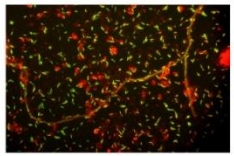


4. Results – CH_4 flux

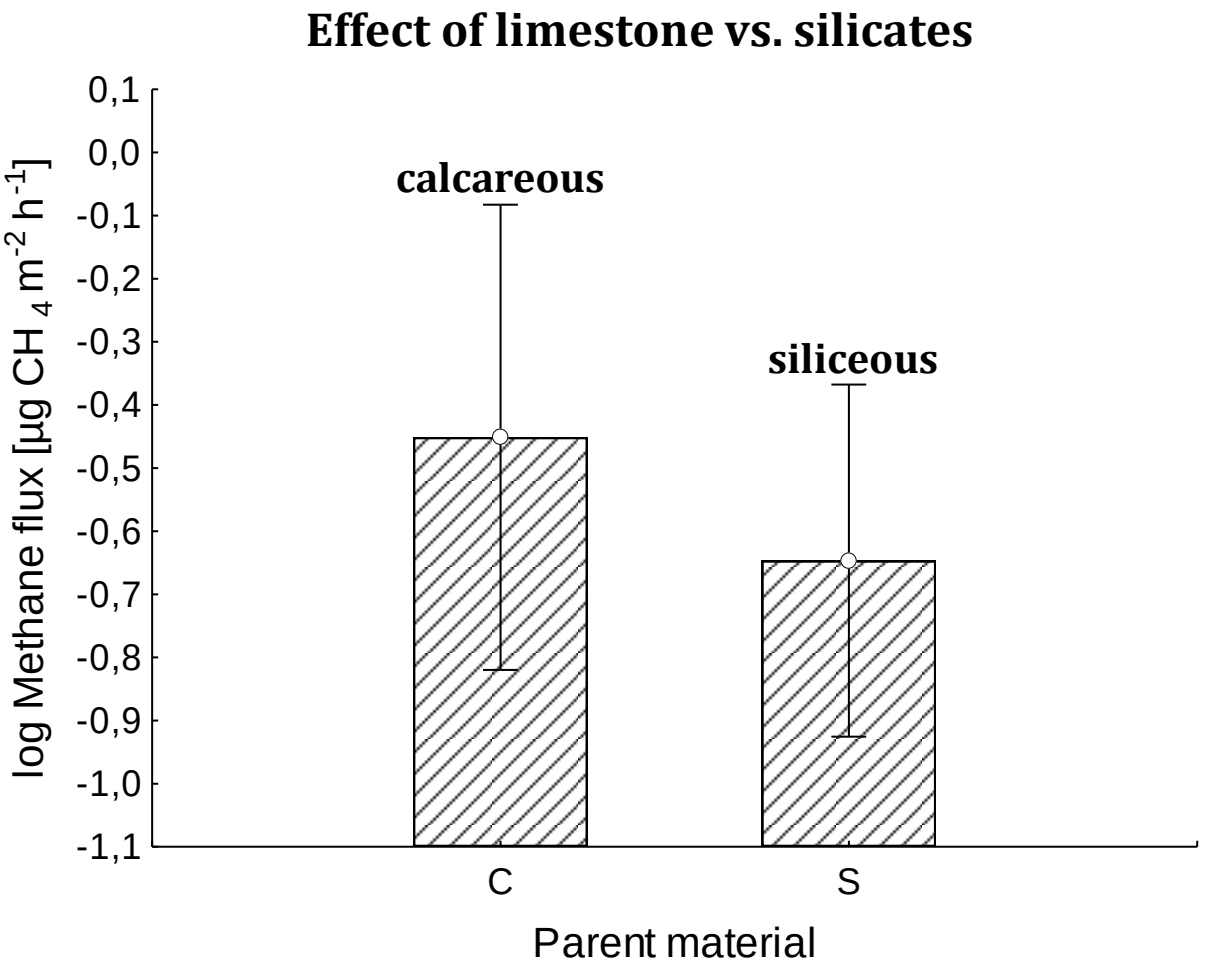
Effects of land cover and altitude

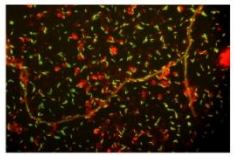




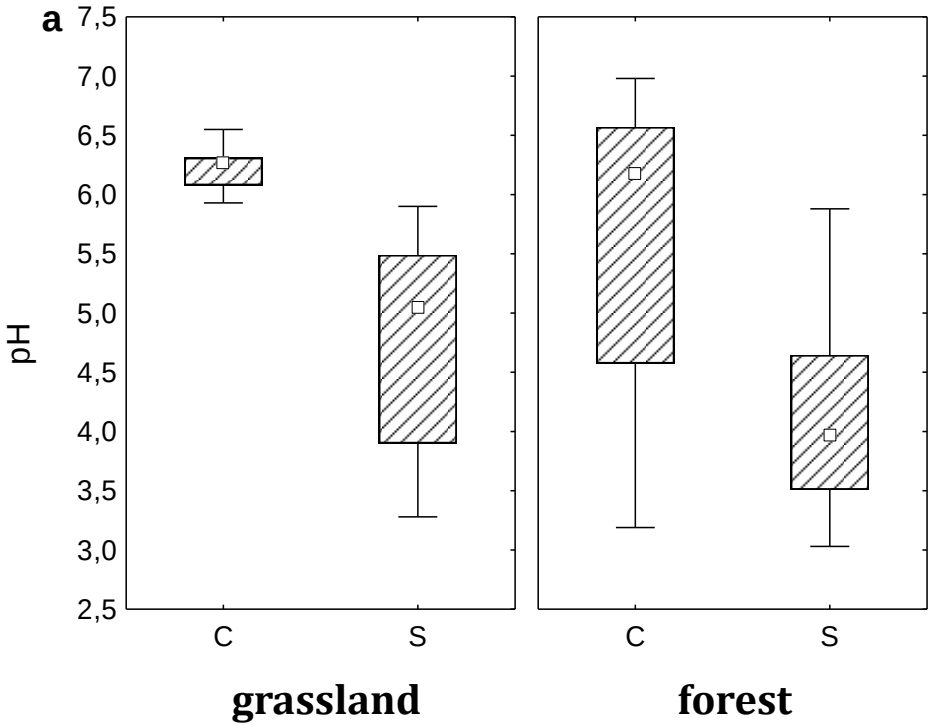


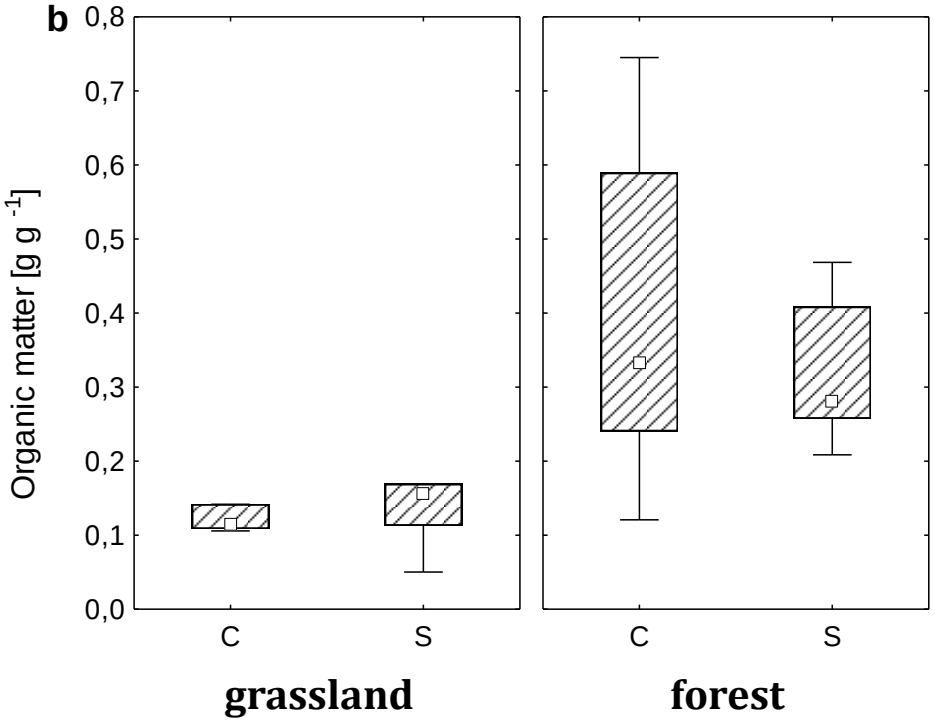
4. Results – CH_4 flux



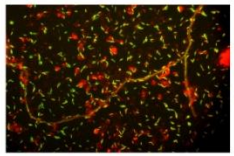


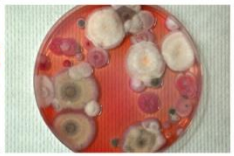
4. Results



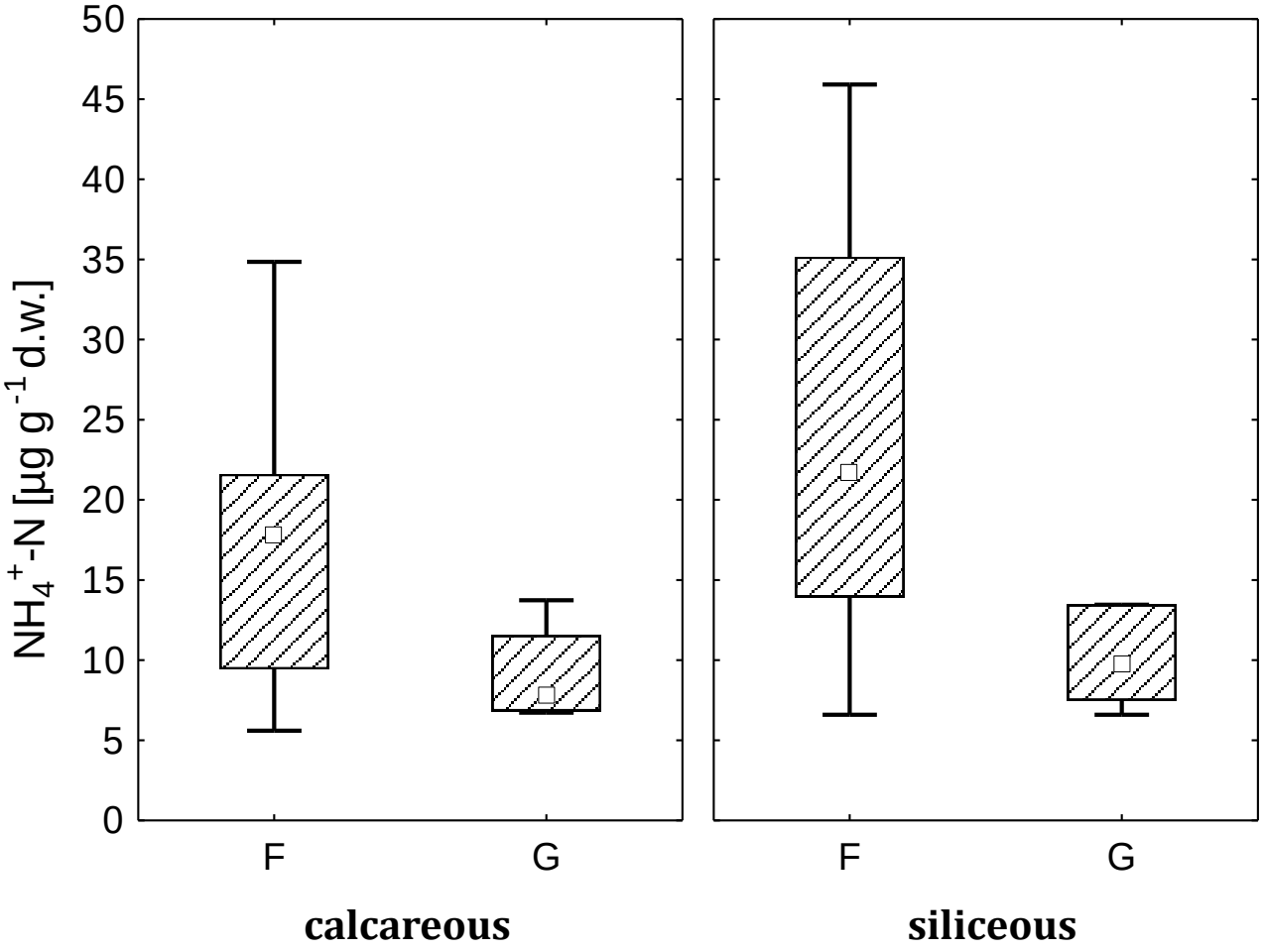


positive relationships between pH, OM and CH_4 flux

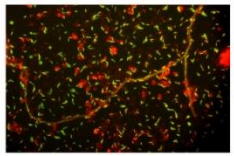




4. Results



positive relationship between NH_4^+ and CH_4 flux

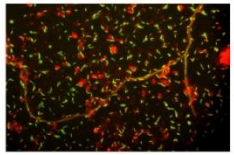
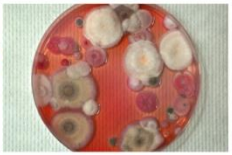



5. Summary

- CH_4 contributes to global warming
  - importance of understanding regulation of flux rates
  - collect data also from alpine regions
- well-aerated soils of the alpine regions are not exclusively sinks for CH_4
- forest soils markedly stronger removed CH_4
- altitudinal trend
- pH, organic matter, and NH_4^+ could be involved in the regulation of CH_4 flux
- soils with high pH values, OM contents, and NH_4^+ showed reduced capacities to act as sinks

University of Innsbruck - Faculty of Biology

Institute of Microbiology

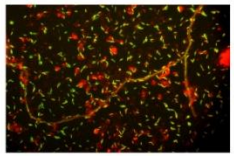
Sieglinde Farbmacher

Andreas Wagner

Mira Mutschlechner

Paul Illmer

Nadine Präg




References

Angel, R., Matthies, D., Conrad, R. (2011). Activation of methanogenesis in arid biological soil crusts despite the presence of oxygen. PloS One 6.

Bomberg, M., Montonen, L., Timonen, S. (2010). Anaerobic Eury- and Crenarchaeota inhabit ectomycorrhizas of boreal forest Scots pine. European Journal of Soil Biology 46, 356-364.

Conrad, R. (2009). The global methane cycle. *Environmental Microbiology* 1, 285-292.

Garcia, J.-L., Patel, B.K.C., Ollivier, B. (2000). Taxonomic, phylogenetic and ecological diversity of methanogenic archaea. *Anaerobe* 6, 205-226.

IPCC, 2007: Climate Change 2007: Synthesis Report. Contribution of Working Groups I, II and III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change [Core Writing Team, Pachauri, R.K and Reisinger, A. (eds.)]. IPCC, Geneva, Switzerland, 104 pp.

Madigan, M.T., Martinko, J.M., Dunlap, P.V., Clark, D.P. (2009). Brock Biology of Microorganisms. 12th edition, Pearson Education Inc., San Francisco.

Ottow, J.C.G. (2011). Mikrobiologie von Böden. Springer-Verlag, Berlin, Heidelberg.