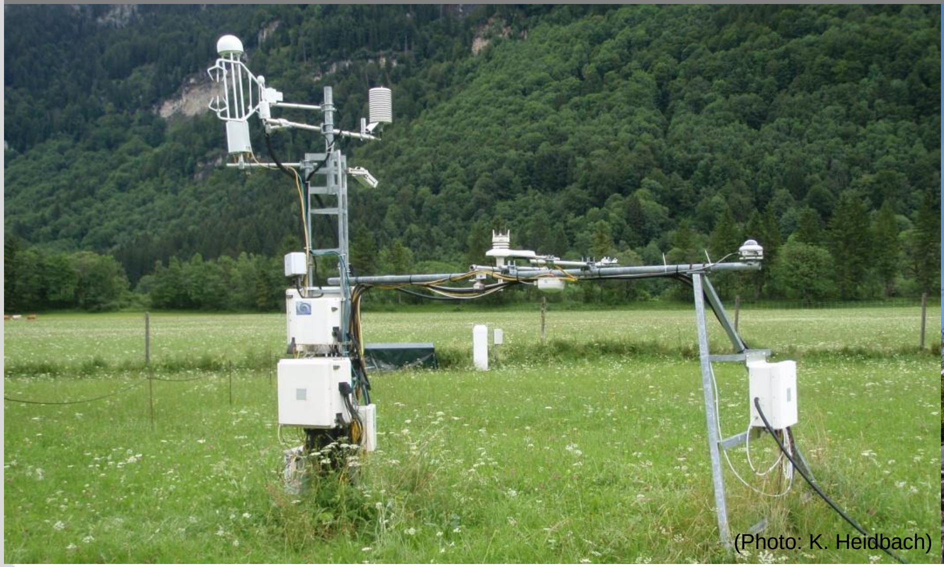
Treibhausgasdynamik in montanen gestörten Ökosystemen

Studien in besonders klimasensitiven Regionen mittlerer Höhenlagen

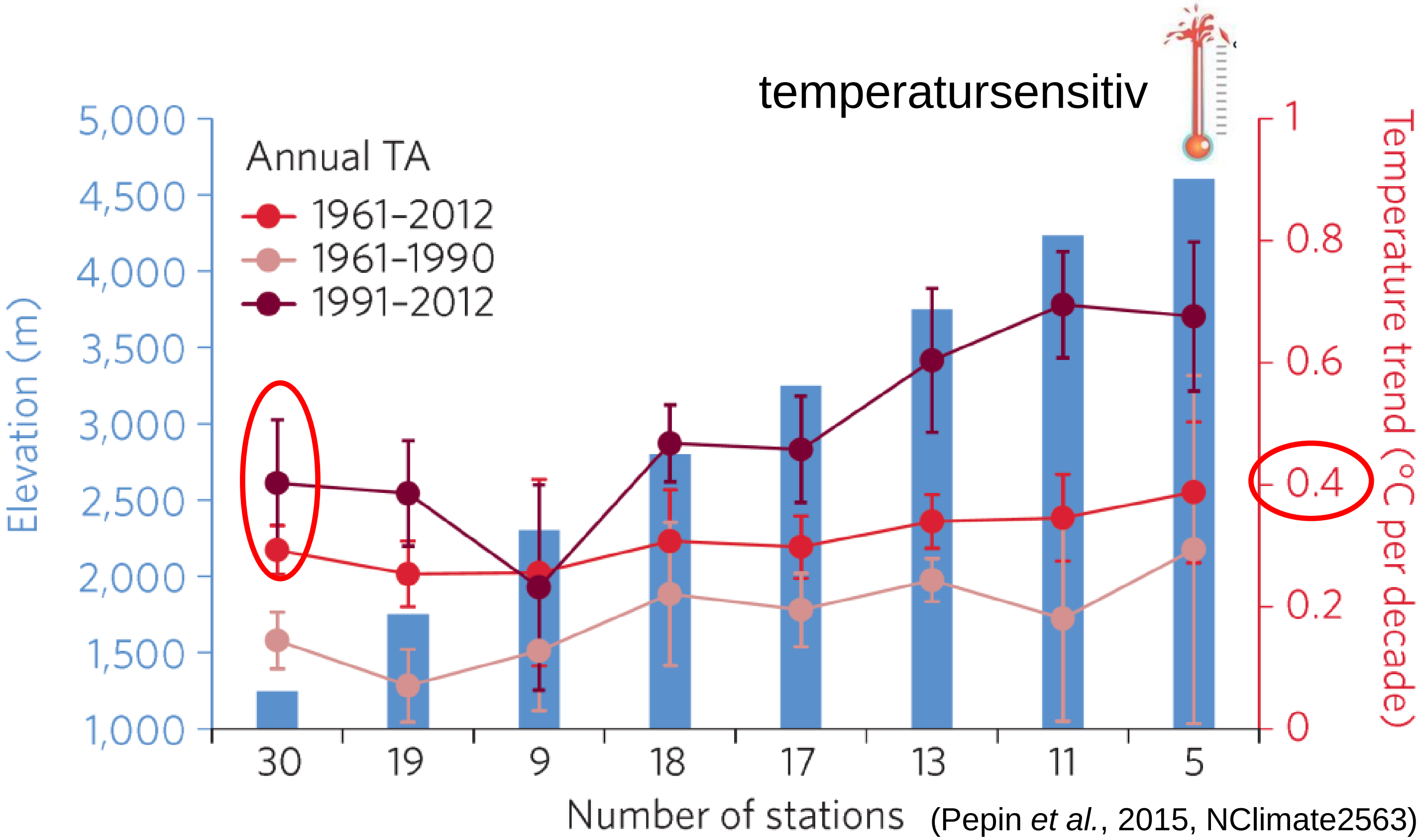
INSTITUT FÜR METEOROLOGIE UND KLIMAFORSCHUNG, ATMOSPHÄRISCHE UMWELTFORSCHUNG, IMK-IFU
Rainer Steinbrecher, Janina Hommeltenberg, HaPe Schmid *et al*.

KIT-Campus Alpin
IMK-IFU: Atmospheric Environmental Research

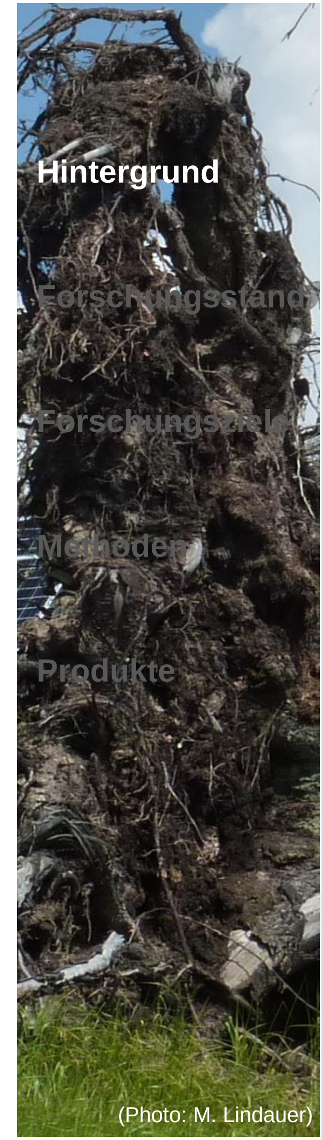

(Photo: K. Heidbach)


(Photo: M. Lindauer)

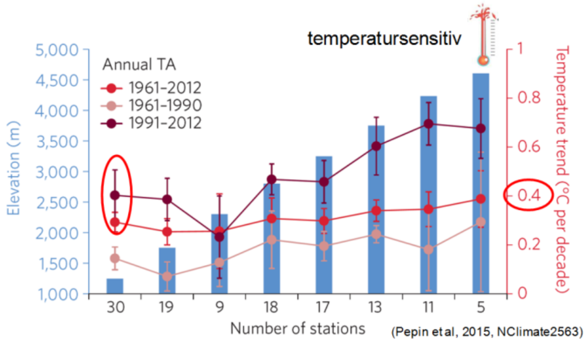
Klimawandel in mittleren Höhenlagen

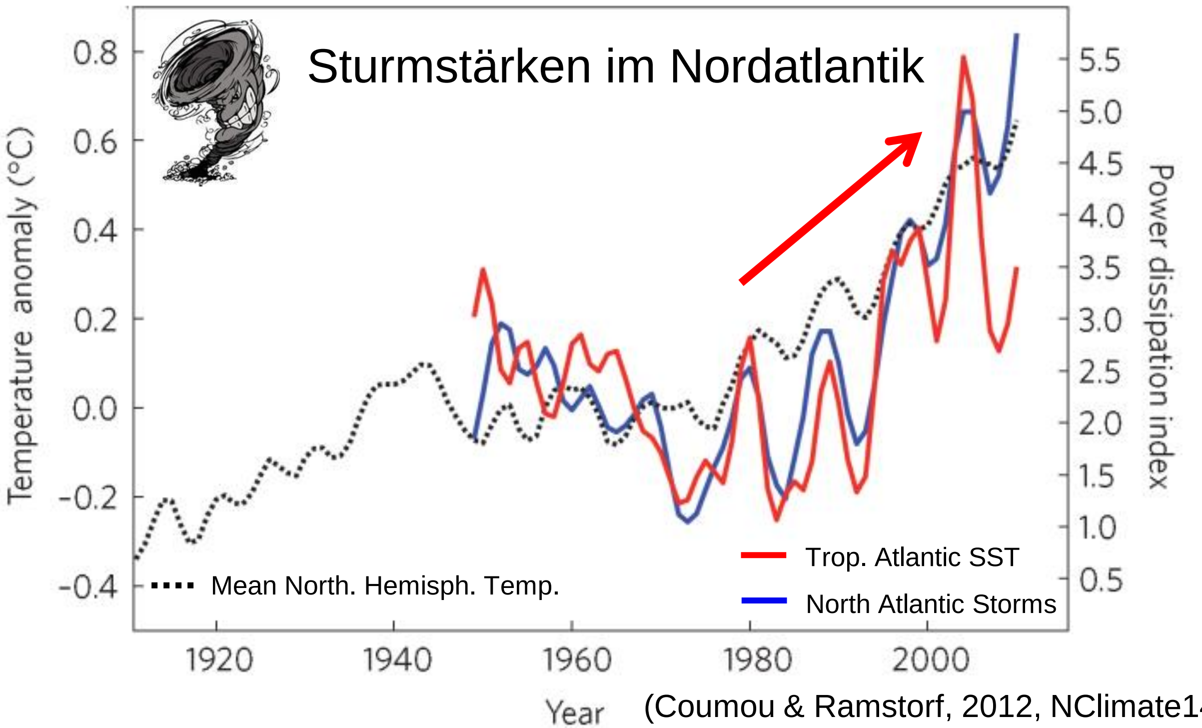


(Pepin *et al.*, 2015, NClimate2563)



Klimawandel in mittleren Höhenlagen





(Coumou & Ramstorf, 2012, NClimate1452)

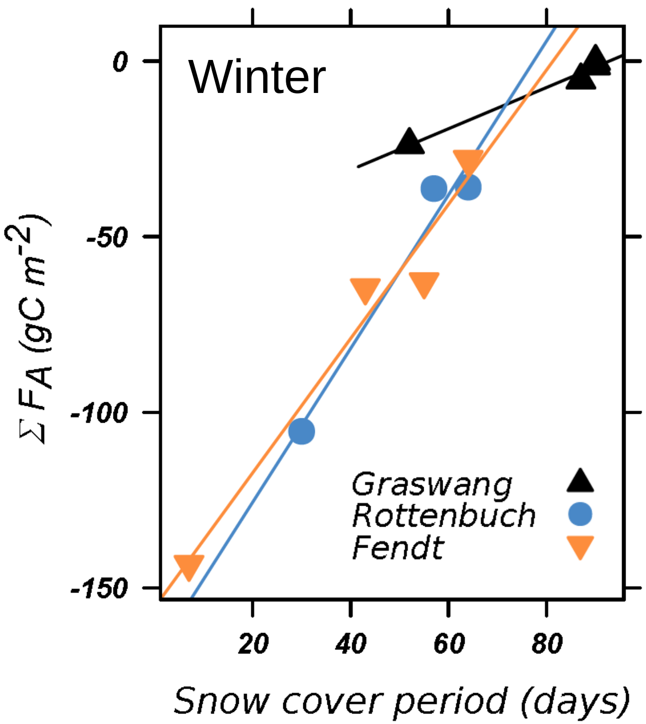
(Photo: M. Lindauer)

Klimawandel(extreme) und Rückkopplungen auf den C-basierten THG Austausch

Voralpines genutztes Grünland

Bsp. Ammertal

CO_2

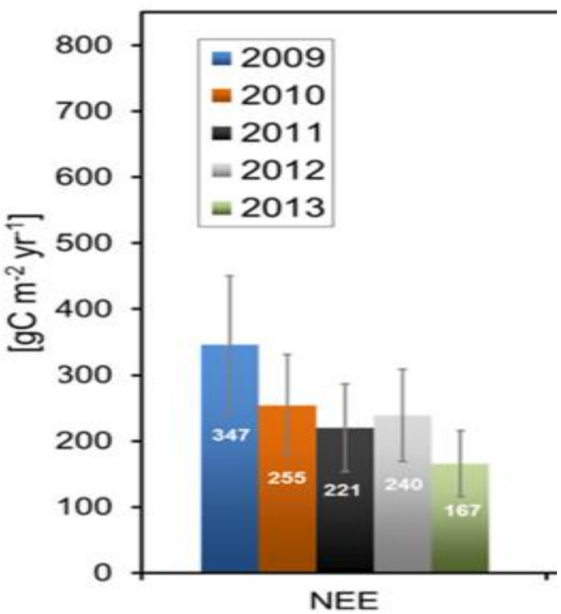


(Zeeman *et al.*, 2015, in Vorbereitung)

Wälder in Mittelgebirgen mit Windwurf

Bsp. Bayerischer Wald

CO_2

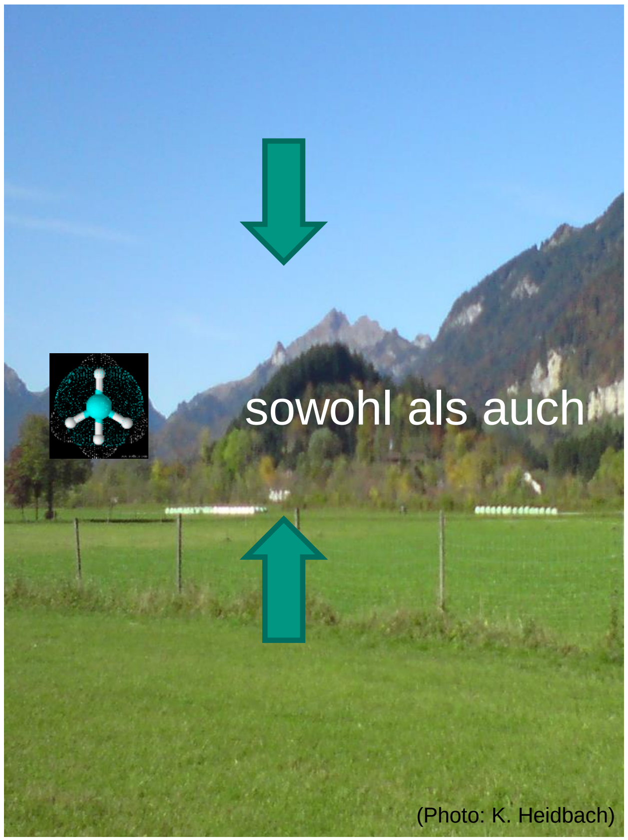


(Lindauer *et al.*, 2014, AgrForMet., 197)

Klimawandel(extreme) und Rückkopplungen auf den C-basierten THG Austausch

Grünland

CH_4

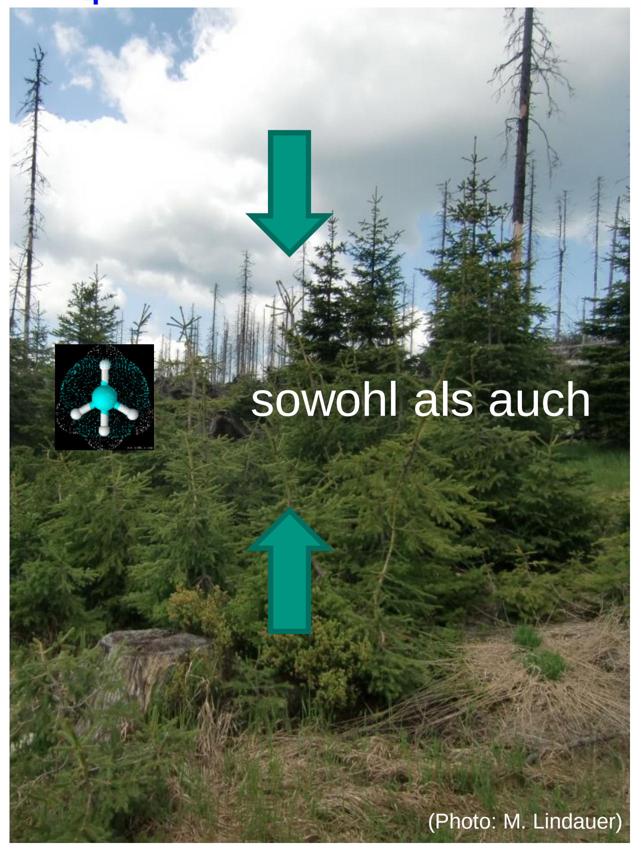


(Photo: K. Heidbach)

(Hoertnagl *et al.*, 2014, Biogeoscience, 11;
Wie *et al.*, 2015, Global Change Biol., 21)

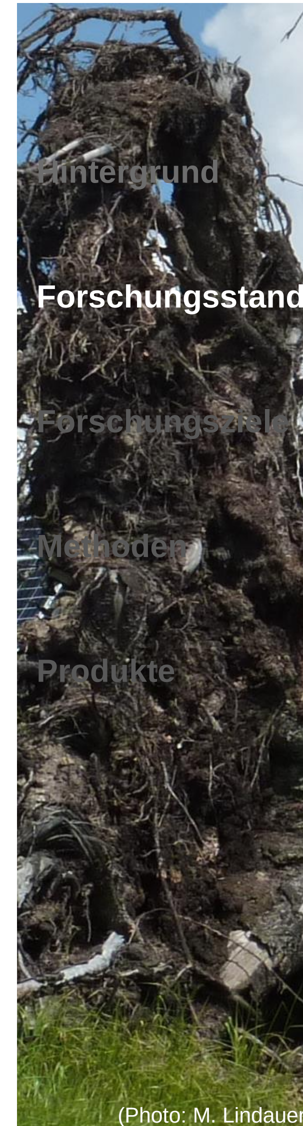
Wälder

CH_4



(Photo: M. Lindauer)

(Krause *et al.*, 2013, AgrForMet., 161;
Ueyama *et al.*, 2013, AgrForMet., 178)



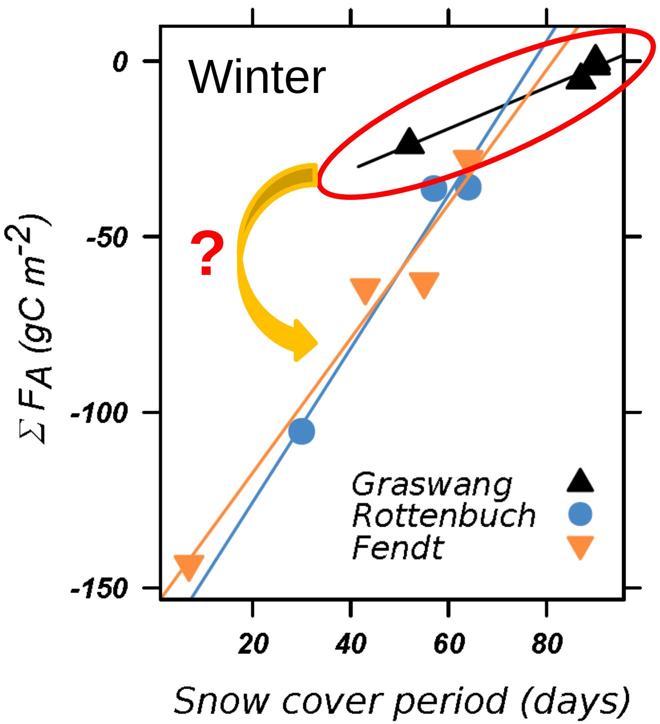
(Photo: M. Lindauer)

Klimawandel(extreme) und Rückkopplungen auf den C-basierten THG Austausch

Voralpines genutztes Grünland

Bsp. Ammertal

CO_2

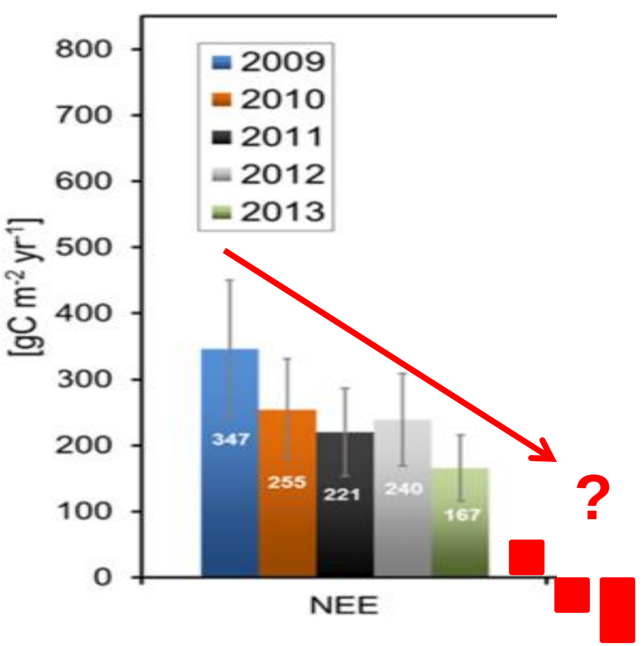


(Zeeman *et al.*, 2015, in Vorbereitung)

Wälder in Mittelgebirgen mit Windwurf

Bsp. Bayerischer Wald

CO_2



(Lindauer *et al.*, 2014, AgrForMet., 197)

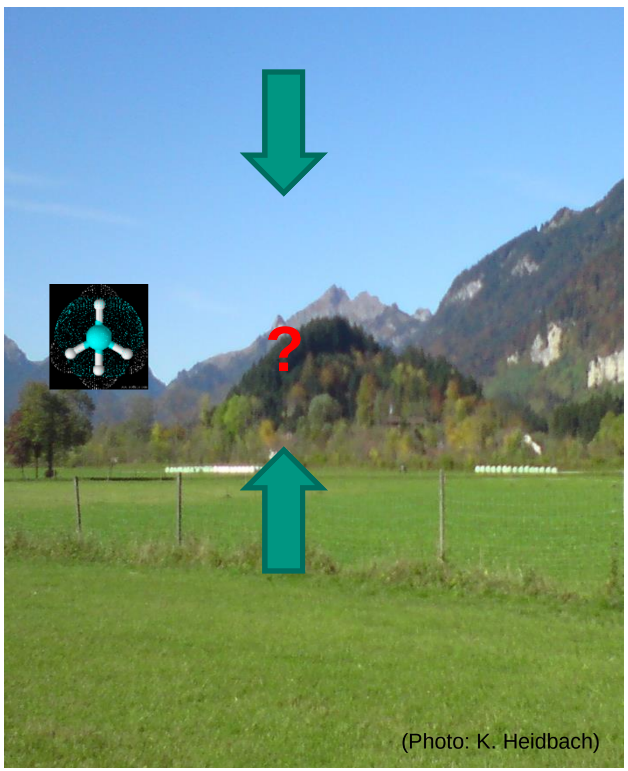
Klimawandel(extreme) und Rückkopplungen auf den C-basierten THG Austausch

Karlsruher Institut für Technologie

Voralpines genutztes Grünland

Bsp. Ammertal

CH_4

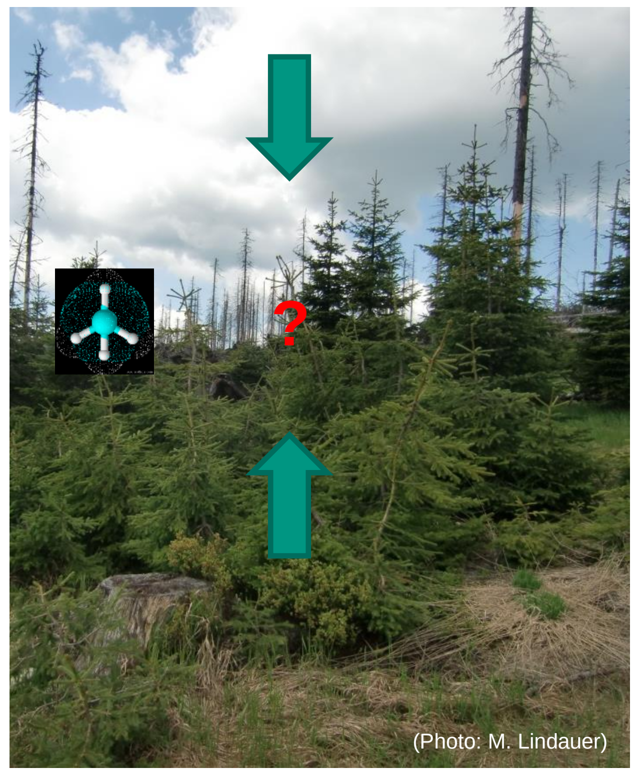


(Photo: K. Heidbach)

Wälder in Mittelgebirgen nach Störung

Bsp. Bayerischer Wald

CH_4



(Photo: M. Lindauer)

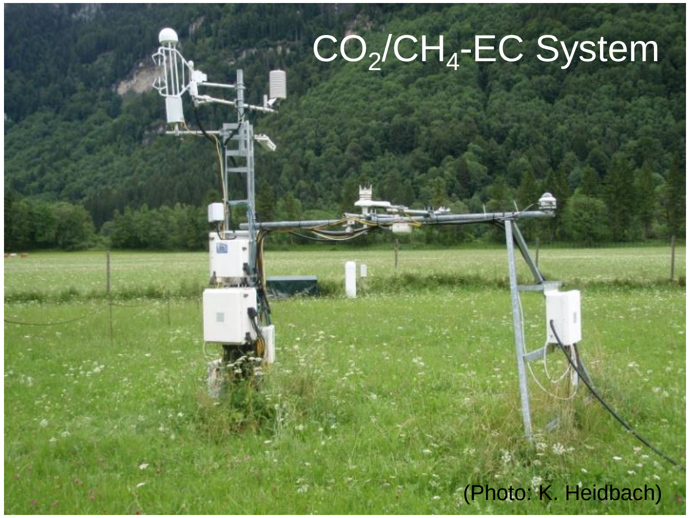
(Photo: M. Lindauer)

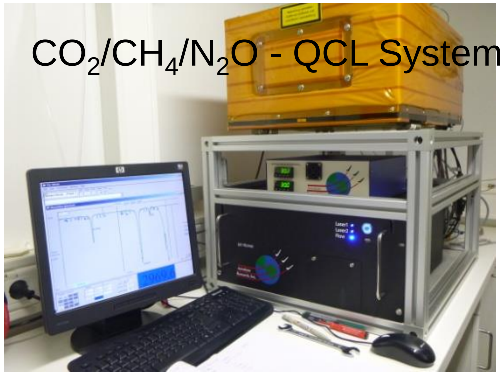
Treibhausgasaustausch in montanen gestörten Ökosystemen

Karlsruher Institut für Technologie

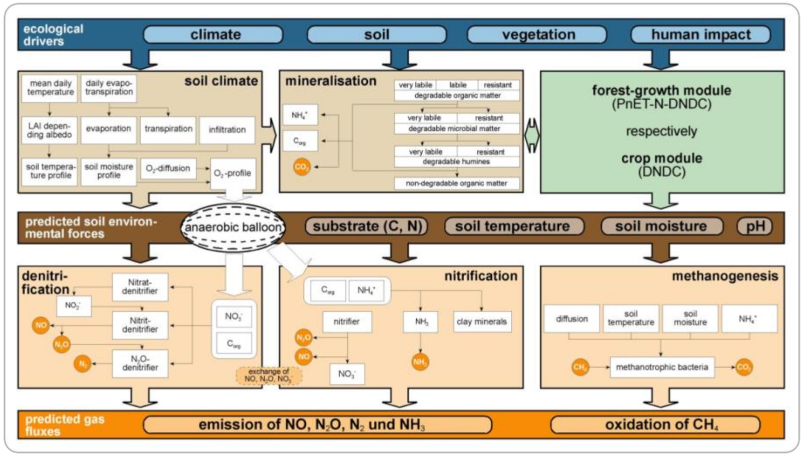
Studien in besonders klimasensitiven Regionen mittlerer Höhenlagen

Eddy-Kovarianztechnik, optische Messverfahren, meteorologische und ökologische Begleitparameter, Modellierung





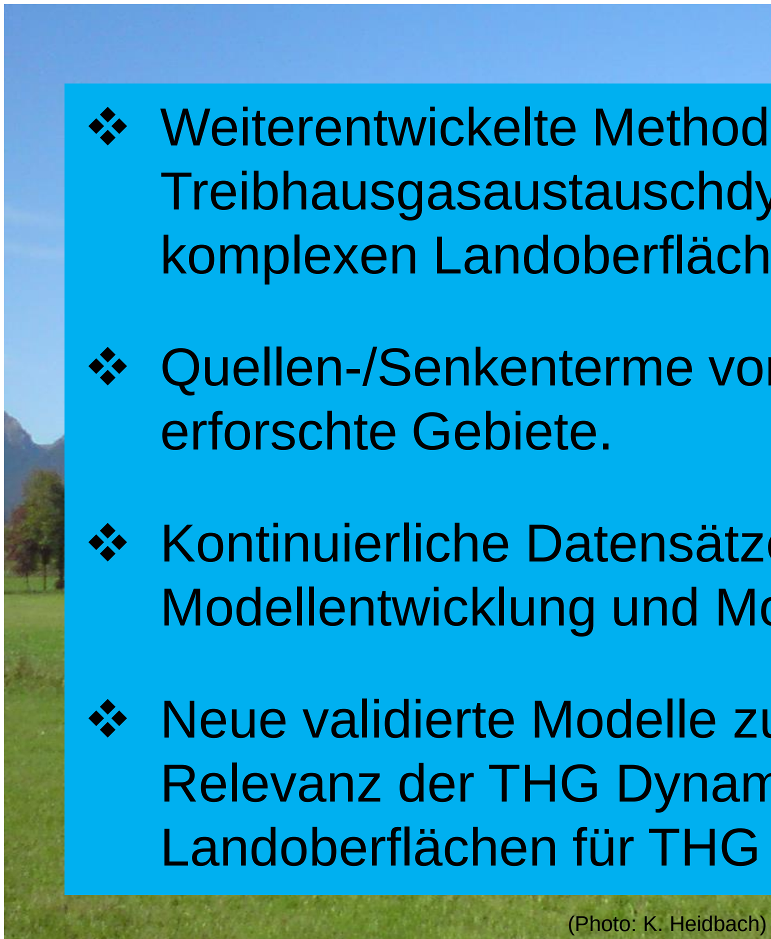
LandscapeDNDC Modell

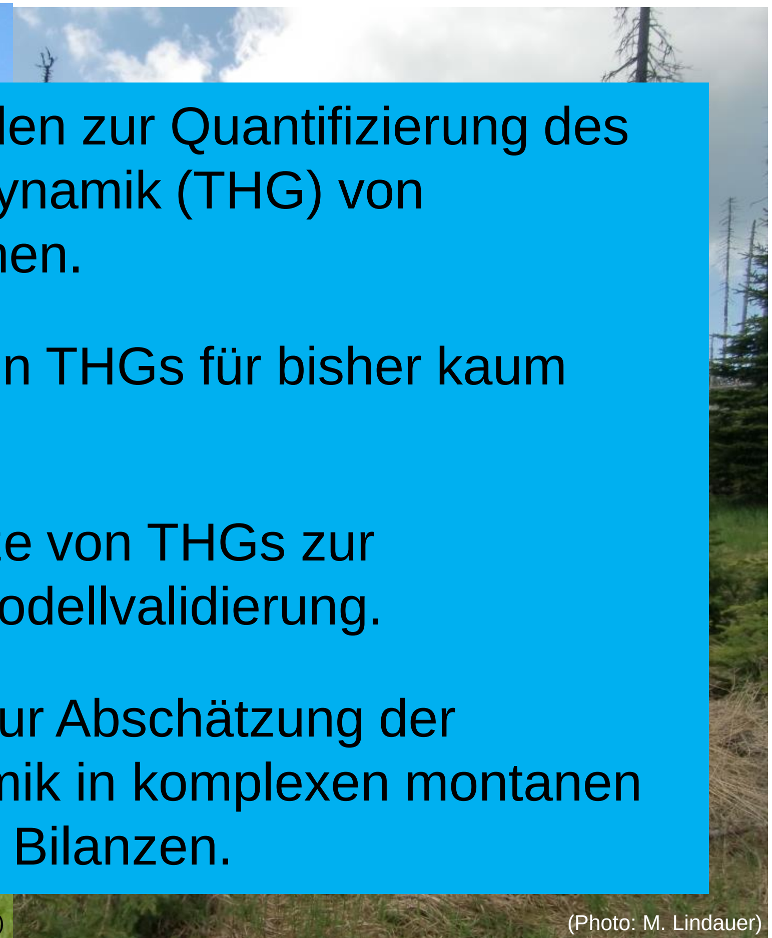


Treibhausgasaustausch in montanen gestörten Ökosystemen

Studien in besonders klimasensitiven Regionen mittlerer Höhenlagen

Grünland | Wälder

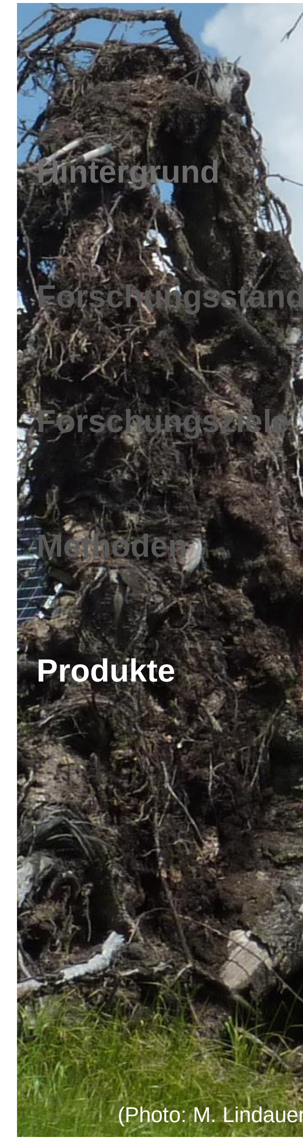




- Weiterentwickelte Methoden zur Quantifizierung des Treibhausgasaustauschdynamik (THG) von komplexen Landoberflächen.
- Quellen-/Senkenterme von THGs für bisher kaum erforschte Gebiete.
- Kontinuierliche Datensätze von THGs zur Modellentwicklung und Modellvalidierung.
- Neue validierte Modelle zur Abschätzung der Relevanz der THG Dynamik in komplexen montanen Landoberflächen für THG Bilanzen.

(Photo: K. Heidbach)

(Photo: M. Lindauer)



(Photo: M. Lindauer)

Treibhausgasdynamik in montanen gestörten Ökosystemen: Ein Projektvorschlag

Considerable *methane* uptake by alpine grasslands despite the cold climate: in situ measurements on the central Tibetan Plateau, 2008-2013

By: Wei, Da; Xu-Ri; Tenzin-Tarchen; et al.

GLOBAL CHANGE BIOLOGY *Volume: 21 Issue: 2 Pages: 777-788 Published: FEB 2015*

Close Abstract

The uptake of CH4 by aerate soil plays a secondary role in the removal of tropospheric CH4, but it is still highly uncertain in terms of its magnitude, spatial, and temporal variation. In an attempt to quantify the *sink* of the vast alpine grasslands (1400000km(2)) of the Tibetan Plateau, we conducted in situ measurements in an alpine steppe (4730m) and alpine meadow (4900m) using the static chamber and gas chromatograph method. For the alpine steppe, measurements (2008-2013) suggested that there is large interannual variability in CH4 uptake, ranging from -48.8 to -95.8g CH(4)m(-2)h(-1) (averaged of -71.5 +/- 2.5g CH(4)m(-2)h(-1)), due to the variability in precipitation seasonality. The seasonal pattern of CH4 uptakes in the form of stronger uptake in the early growing season and weaker uptake in the rainy season closely matched the precipitation seasonality and subsequent soil moisture variation. The relationships between alpine steppe CH4 uptake and soil moisture/temperature are best depicted by a quadratic function and an exponential function (Q(10)=1.67) respectively. Our measurements also showed that the alpine meadow soil (average of -59.2 +/- 3.7g CH(4)m(-2)h(-1)) uptake less CH4 than the alpine steppe and produces a similar seasonal pattern, which is negatively regulated by soil moisture. Our measurements quantified - at values far higher than those estimated by process-based models - that both the alpine steppe and alpine meadow are considerable CH4 sinks, despite the cold weather of this high-altitude area. The consecutive measurements gathered in this study also highlight that precipitation seasonality tends to drive the interannual variation in CH4 uptake, indicating that future study should be done to better characterize how CH4 cycling might feedback to the more extreme climate.

Methane and nitrous oxide exchange over a managed hay meadow

By: Hoertnagl, L.; Wohlfahrt, G.

BIOGEOSCIENCES Volume: 11 Issue: 24 Pages: 7219-7236 Published: 2014

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Full Text from Publisher

Full Text

View AbstractClose Abstract The methane (CH4) and nitrous oxide (N2O) exchange of a temperate mountain grassland near Neustift, Austria, was measured during 2010-2012 over a time period of 22 months using the eddy covariance method. Exchange rates of both compounds at the site were low, with 97% of all half-hourly CH4 and N2O fluxes ranging between +/- 200 and +/- 50 ngm(-2) s(-1), respectively. The meadow acted as a sink for both compounds during certain time periods, but was a clear source of CH4 and N2O on an annual timescale. Therefore, both gases contributed to an increase of the global warming potential (GWP), effectively reducing the sink strength in terms of CO2 equivalents of the investigated grassland site. In 2011, our best guess estimate showed a net greenhouse gas (GHG) sink of -32 gCO(2) equ. m(-2) yr(-1) for the meadow, whereby 55% of the CO2 sink strength of -71 gCO(2) m(-2) yr(-1) was offset by CH4 (N2O) emissions of 7 (32) gCO(2) equ. m(-2) yr(-1). When all data were pooled, the ancillary parameters explained 27 (42)% of observed CH4 (N2O) flux variability, and up to 62 (76)% on shorter timescales in-between management dates. In the case of N2O fluxes, we found the highest emissions at intermediate soil water contents and at soil temperatures close to 0 or above 14 degrees C.
In comparison to CO2, H2O and energy fluxes, the interpretation of CH4 and N2O exchange was challenging due to footprint heterogeneity regarding their sources and sinks, uncertainties regarding post-processing and quality control. Our results emphasize that CH4 and N2O fluxes over supposedly well-aerated and moderately fertilized soils cannot be neglected when evaluating the GHG impact of temperate managed grasslands.

Soil-atmosphere fluxes of the greenhouse gases CO_2, CH_4 and N_2O in a mountain spruce forest subjected to long-term N addition and to tree girdling
By: Krause, Kim; Niklaus, Pascal A.; Schleppi, Patrick
AGRICULTURAL AND FOREST METEOROLOGY Volume: 181 Pages: 61-68 Published: NOV 15 2013
Full Text from Publisher
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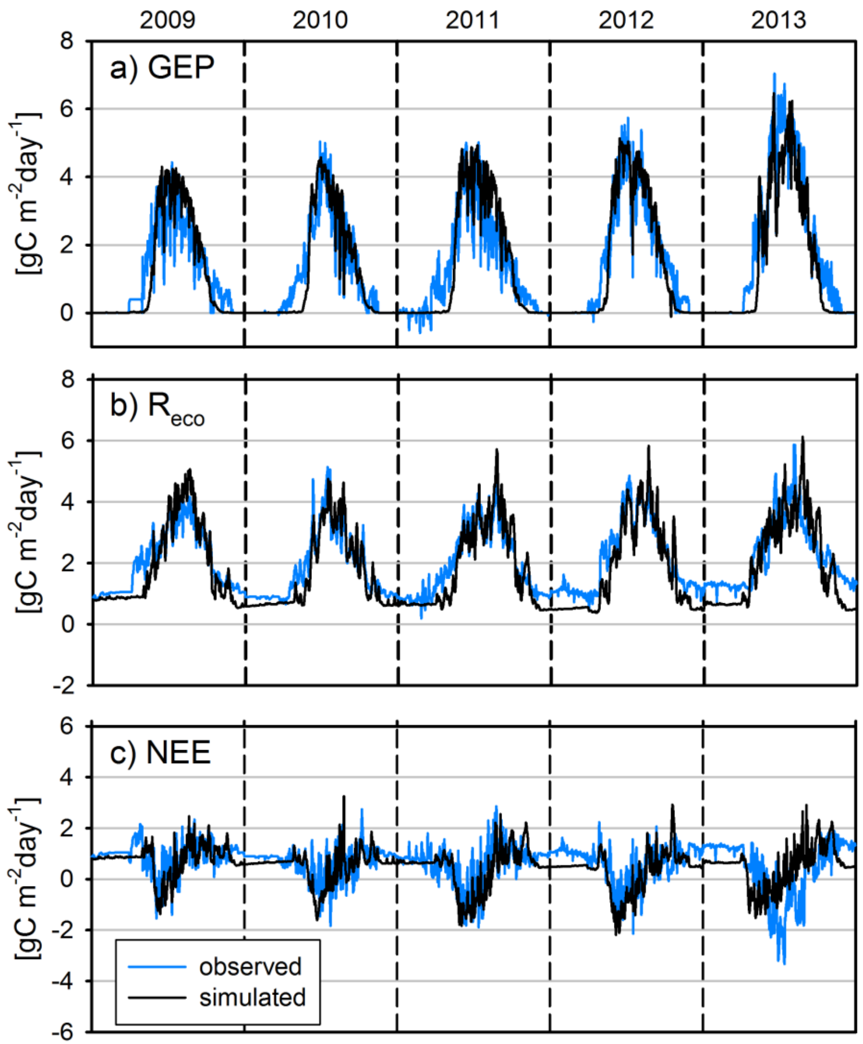
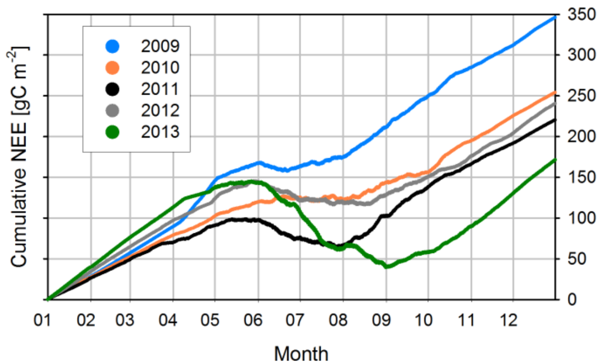
View AbstractClose Abstract At Alptal, Switzerland, nitrogen (N) has been applied as NH_4NO_3 since 1995 in low doses during rain events to realistically mimic increased N deposition to a mature mountain spruce stand. Five years of measurements in a replicated plot design showed that N_2O and CH_4 emissions from the soil to the atmosphere increased due to the N addition. For CH_4, this involved a shift from a net sink to a net source. CO_2 emissions did not change significantly, although they averaged lower rates under simulated N deposition. The girdling of 40% of tree basal area, followed by subsequent felling of the girdled trees, increased emissions of N_2O but reduced net emissions of CH_4 from soils. CO_2 and N_2O emissions depended on soil temperature and water table depth. Soil temperature did not affect CH_4 fluxes, whereas net CH_4 production was higher when the water table was closer to the soil surface. Our data highlights the need that future investigations should focus more on the allocation of assimilates to tree roots in order to better quantify the ecosystem's C balance. (C) 2013 Elsevier B.V. All rights reserved

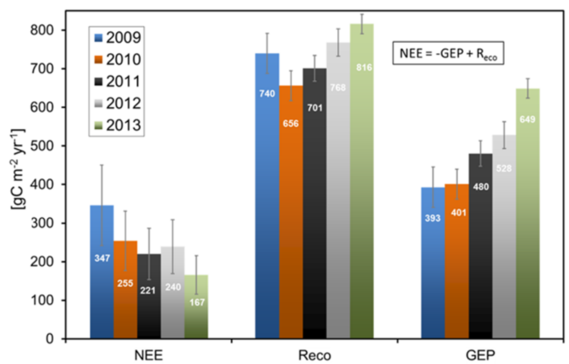
High-precision measurements of the methane flux over a larch forest based on a hyperbolic relaxed eddy accumulation method using a laser spectrometer
By: Ueyama, Masahito; Takai, Yuriko; Takahashi, Yoshiyuki; et al.
AGRICULTURAL AND FOREST METEOROLOGY Volume: 178 Pages: 183-193 Published: SEP 15 2013
Full Text from Publisher
Full Text
View AbstractClose Abstract The precision of current micrometeorological techniques has restricted their applications in measuring small methane (CH_4) fluxes in forest ecosystems. In this study, we continuously measured CH_4 fluxes using a state of the art laser-based gas analyzer and a hyperbolic relaxed eddy accumulation (HREA) method. The precision of the half-hourly fluxes was estimated at 2.93 nmol m(-2) s(-1). The HREA method also contained uncertainties associated with scalar dissimilarity of 1.26 nmol m(-2) s(-1). The precision was higher than those obtained in previous eddy covariance studies, because the HREA system did not require density fluctuation and high-frequency attenuation corrections. The observed CH_4 uptake decreased with increases in soil water content during the summer months. The estimated annual methane sink was 673 mg CH_4 m(-2) yr(-1) with uncertainties of +/- 231 mg CH_4 m(-2) yr(-1). This annual methane sink increased to 868 mg CH_4 m(-2) yr(-1) with the application of friction velocity (u*) filtering. The uncertainties in gap-filling, storage correction, and scalar dissimilarity were less important than the uncertainties in the u* filtering. Our technique using the HREA method is a suitable tool for measuring small CH_4 fluxes in forest ecosystems, especially in remote sites where frequent maintenance is not practical. (C) 2013 Elsevier B.V. All rights reserved.



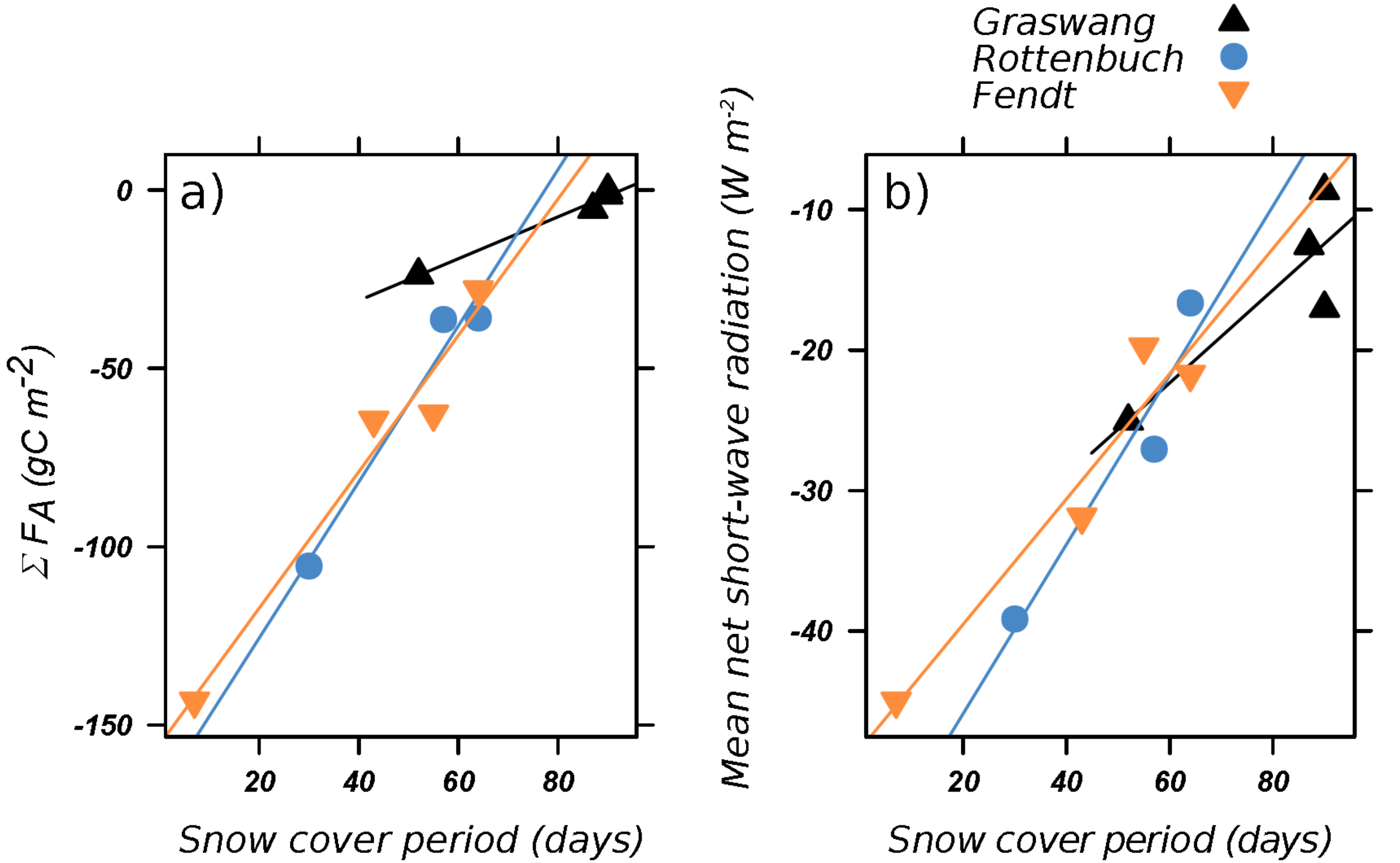
2009
2010
2011
2012
2013
a) GEP
b) R_{eco}
c) NEE
[gC m-2day-1]
[gC m-2day-1]
[gC m-2day-1]
observed
simulated



Cumulative NEE [gC m-2]
2009
2010
2011
2012
2013
350
300
250
200
150
100
50
0
01 02 03 04 05 06 07 08 09 10 11 12
Month



[gC m-2 yr-1]
2009
2010
2011
2012
2013
NEE = -GEP + Reco
800
700
600
500
400
300
200
100
0
347
255
221
240
167
740
656
701
768
816
393
401
480
528
649
NEE
Reco
GEP


Graswang
Rottenbuch
Fendt
a)
b)
0
-50
-100
-150
-10
-20
-30
-40
20
40
60
80
Σ F_A (gC m^-2)
Mean net short-wave radiation (W m^-2)
Snow cover period (days)
Snow cover period (days)