Bundesministerium für Bildung und Forschung

TERENO
TERRESTRIAL ENVIRONMENTAL OBSERVATORIES

CT Pedosphere

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Die *TERENO*-Standorte wurden weiter ausgebaut:

- Konzentration auf die Beobachtung und Vorhersage gekoppelter Stoffflüsse in terrestrischen Systemen in einem integrierten Ansatz

- Ziel:

  1. Bereitstellung langfristiger Datenreihen für die Validierung mathematischer Modelle

  2. Entwicklung neuer Technologien zur Erfassung wichtiger Systemzustände

  3. Entwicklung von Adaptationsstrategien im Rahmen des Klima- und Landnutzungswandels

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Fluxes, heterogeneity - Pedosphere

- Pedosphere interlinks all terrestrial environmental processes.

- Pedosphere is dynamic in function of time and space.

- Pedosphere is affected by climate change, landuse and land management changes.

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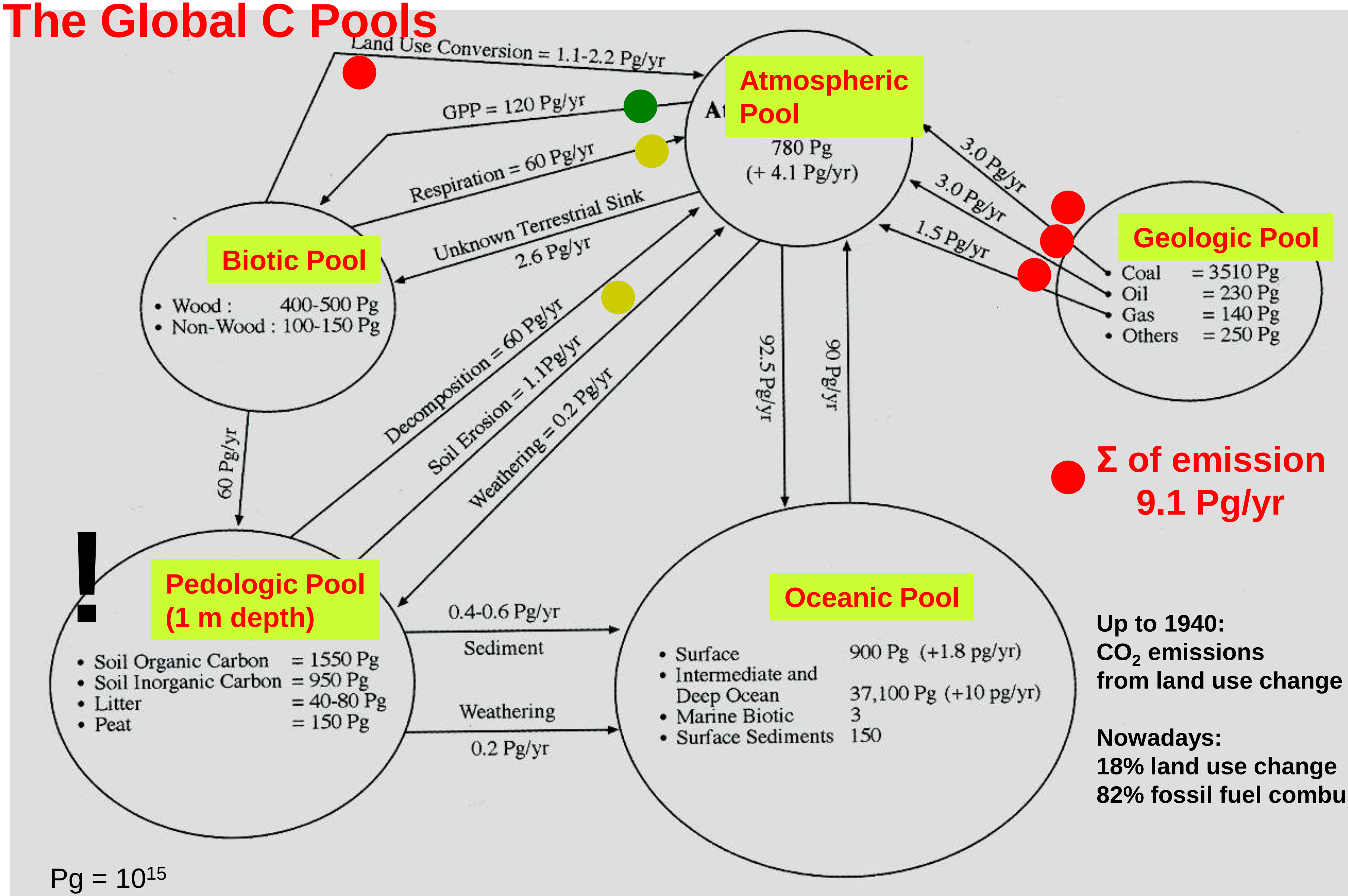
Three examples about reseach activities:

1. Necessities to increase the precision in mapping soil heterotrophic respiration at field scale

2. GHG (CO2, N2O, CH4) measurements at TERENO (Sub) Alpin Lysimeters in the Ammer catchment

3. Geophysical measurements at Schäfertal

The Global C Pools



Σ of emission 9.1 Pg/yr

Up to 1940:
CO_2 emissions from land use change

Nowadays:
18% land use change
82% fossil fuel combustion

after Lal, R.: Energy Environ. Sci., 2008, 1, 86-100

3. Necessities to increase the precision in mapping soil heterotrophic respiration at field scale

Goals:

- generate the ‚most realistic' spatial pattern of soil respiration at field scale from point measurements
  1. spatial estimation using covariates
  2. conditional stochastic simulation using covariates
- identify an optimum set of covariates and to quantify the resulting improvement of the spatial estimation of respiration
- quantify the improvement in the spatial estimation using soil carbon fractions and not just C_{org} as covariates

Source: A geostatistical approach to the field-scale pattern of heterotrophic soil CO_2 emission using covariates.

M. Herbst, L. Bornemann, A. Graf, G.Welp, H. Vereecken, W. Amelung: Biogeochemistry

DOI 10-1007/s10533-011-9661-4

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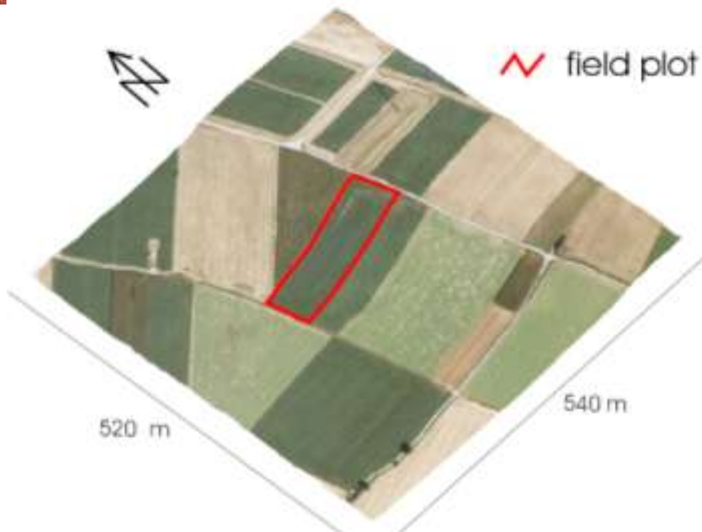
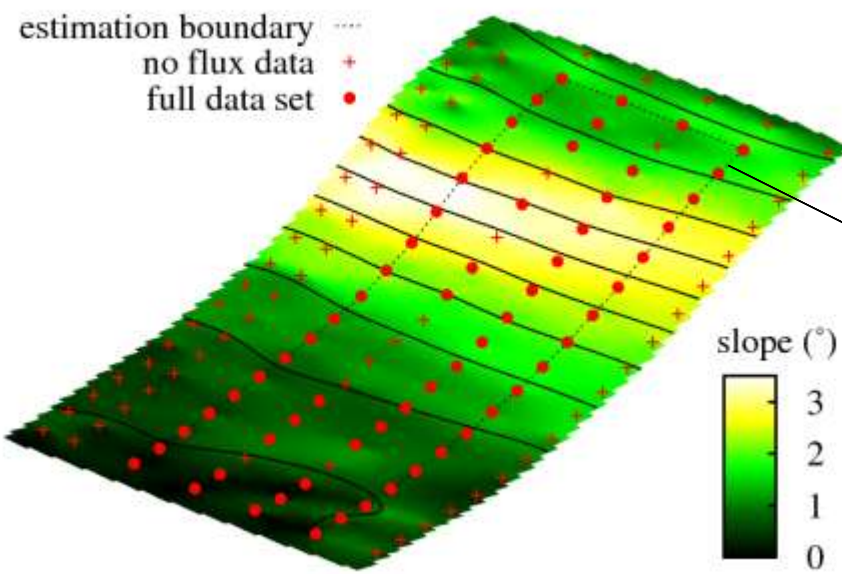
Sampling: field site ‚Selhausen‘



LI-8100, 20 cm diameter

bare soil



30x170 m
62 CO_2 flux measurements

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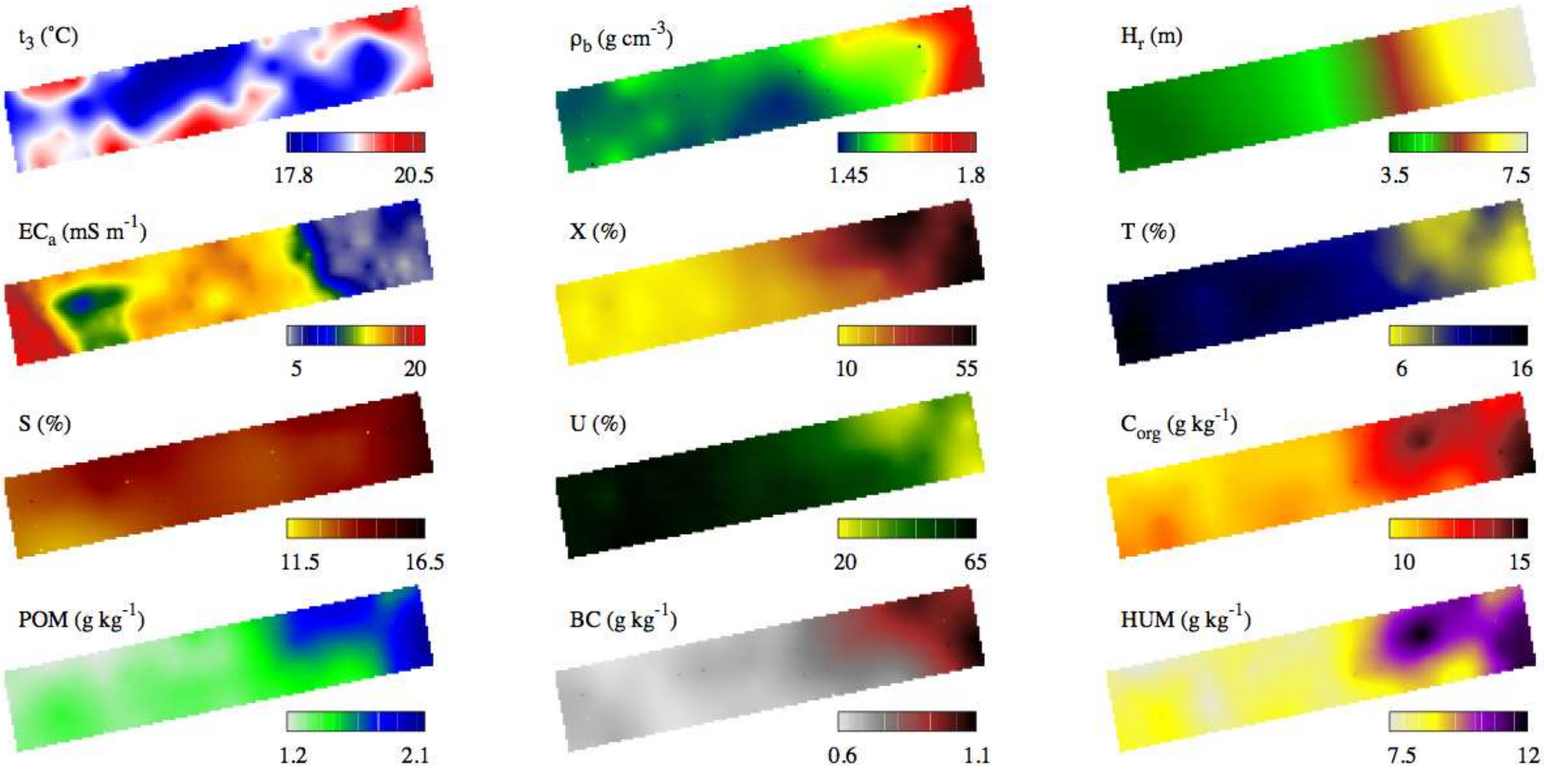
covariates

n=72
- soil temperature; simultaneously measured at 3 cm depth
- terrain slope and relative elevation, DEM
- soil bulk density (n=62)
- grain size distributions; X, S, U and T
- organic carbon content
- carbon fractions, POM, BC and HUM
- apparent electrical conductivity, EM38 (n=225)

Covariates (interpolated spatial patterns)



(Total POM: 53 – 2000µm; HUM smaller 20µm)

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correlation

	t_3	X	T	U	S	C_{org}	POM	BC	HUM	h_r	EC_a	β	ρ_b	R_s
t_3	1	0.20	-0.07	-0.23	0.06	-0.22	-0.17	-0.20	-0.20	0.15	-0.14	-0.08	0.28	-0.08
X		1	-0.95	-0.99	0.20	-0.85	-0.97	-0.90	-0.99	0.95	-0.83	0.63	0.71	-0.66
T			1	0.92	-0.22	0.83	0.92	0.88	0.95	-0.93	0.87	-0.70	-0.65	0.61
U				1	-0.32	0.87	0.96	0.88	0.98	-0.94	0.81	-0.59	-0.72	0.65
S					1	-0.36	-0.14	-0.11	-0.19	0.19	-0.20	0.01	0.18	-0.07
C_{org}						1	0.78	0.71	0.84	-0.82	0.75	-0.45	-0.66	0.55
POM							1	0.89	0.95	-0.92	0.79	-0.61	-0.69	0.63
BC								1	0.91	-0.84	0.75	-0.67	-0.58	0.58
HUM									1	-0.95	0.83	-0.64	-0.70	0.67
h_r										1	-0.86	0.69	0.67	-0.66
EC_a											1	-0.54	-0.59	0.61
β												1	0.29	-0.43
ρ_b													1	-0.45
R_s														1

n=62

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C_{org} only

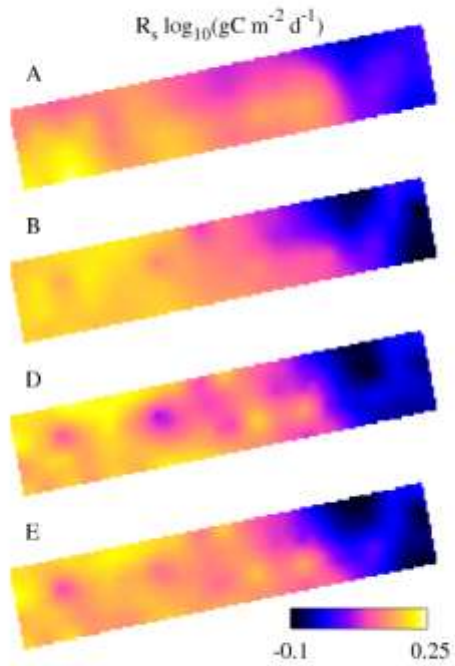
C fractions

regression

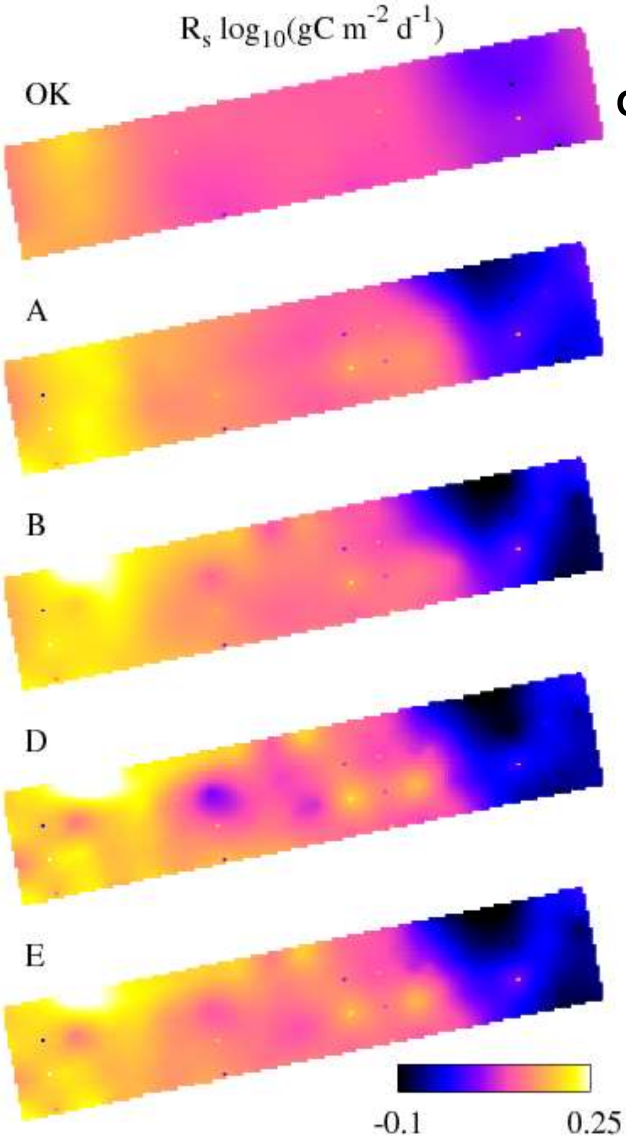
model		R^2	R^2_{adj}
A	$-0.45+0.066C_{org}$	0.307	0.295
B	$-0.31+0.0022POM-0.0027BC+0.009HUM$	0.449	0.421
D	$0.49041+0.021t_3+0.0069X-0.036T-0.0034U+0.011C_{org}+0.031POM-0.0029BC+0.02HUM-0.018h_r+0.0085EC_a-0.012\beta-0.0081\rho_b$	0.498	0.376
E	$-0.32-0.021T+0.0098HUM+0.0081EC_a$	0.470	0.443

full data set

optimum R^2_{adj}



External drift kriging

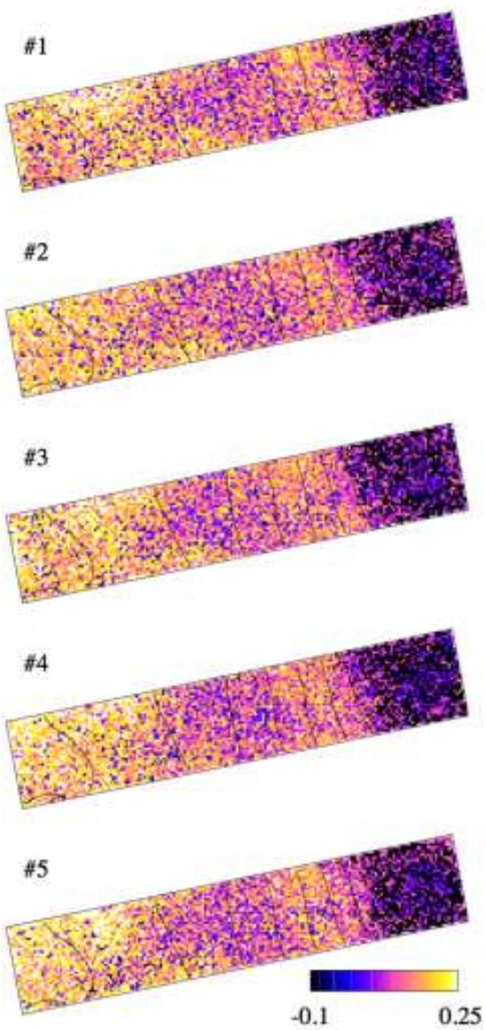


OK: ordinary kriging (without covariates), A,B,D,E with covariates

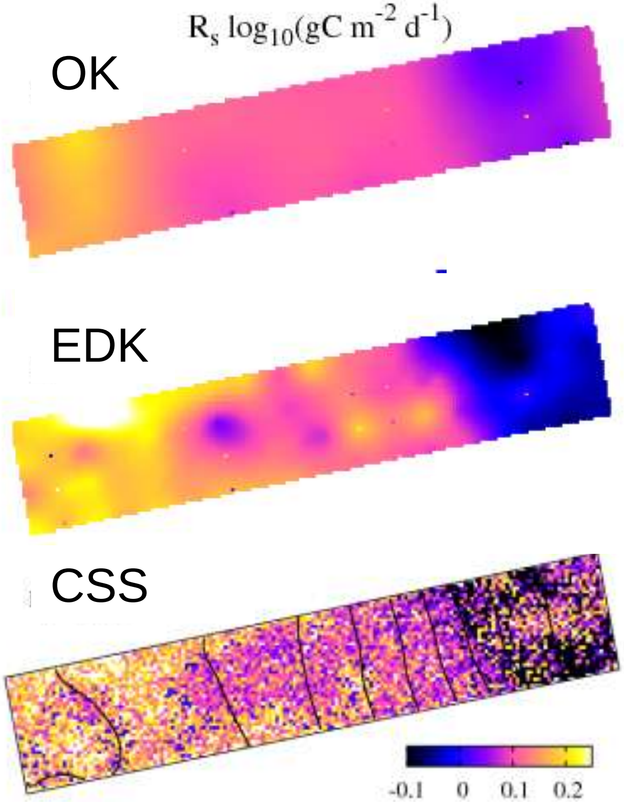
Relative improvement I_r of the mean absolute error (MAE) using different combinations of covariates for external drift kriging in relation to ordinary kriging

Covariate	I_r (%)
Model	MAE
A	2.2
B	7.7
D	13.4
E	7.9

conditional stochastic simulation (CSS)



Five out of 100 realisations generated by simulated annealing for heterotrophic respiration (log$_{10}$ (gC m^{2} day^{-1})



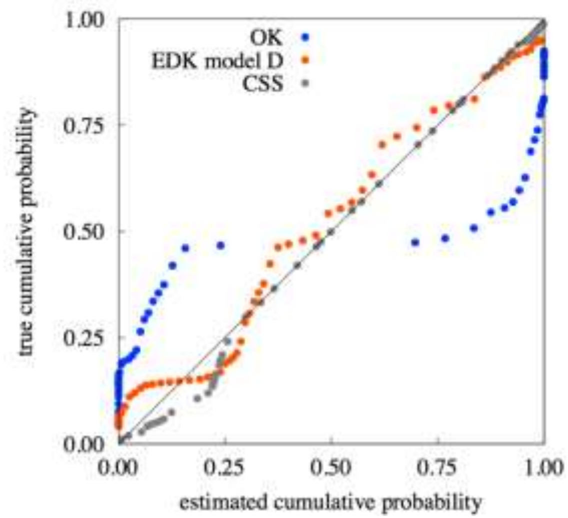
G-statistics

0.36

0.71

0.93

variogram of cumulative probability density functions (cpdf)



summary and conclusions

- due to the lack of variation in soil temperature it does not help to explain the spatial pattern of heterotrophic respiration

- a combination of clay content, apparent electrical conductivity (physical stabilisation of C, soil water content) and the humic carbon fraction shows the highest potential in explaining the spatial pattern of heterotrophic respiration

- the improvement in the mean absolute error (MAE) due to using covariates is rather small with up to 13%

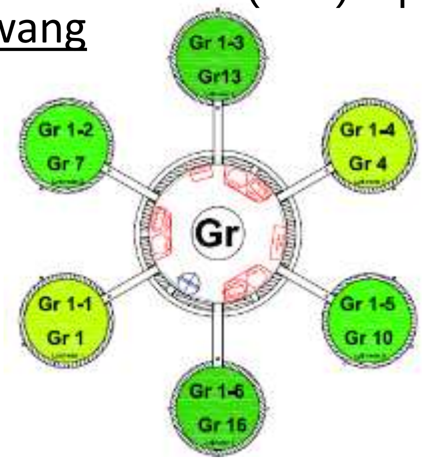
- the use of carbon fractions yields a significant impromevent compared to using just C_{org}

- multivariate conditional stochastic simulation (CSS) is seen as an appropriate tool since it preserved the cpdf and preserved the measured spatial structure

GHG (CO_2, N_2O, CH_4) measurements at TERENO (Sub) Alpin Lysimeters in the Ammer catchment

Campus-Alpin
IMK-IFU: Atmosphärische Umweltforschung

Graswang

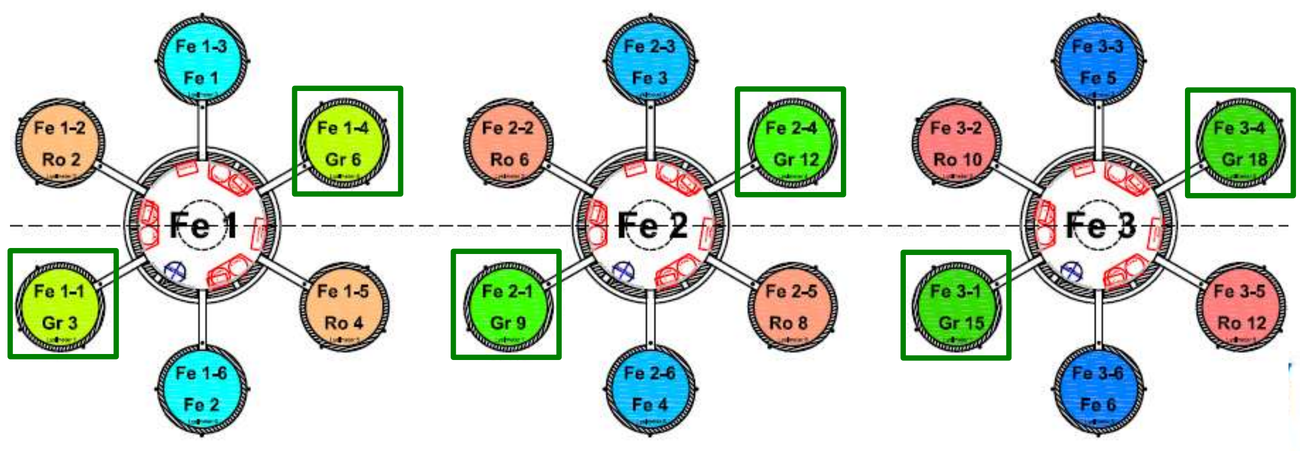


to better cover spatial variation at each elevation soil cores were sampled at 3 different locations e.g.

- Graswang location 1: 6 lysimeters (# 1-6)
- Graswang location 2: 6 lysimeters (# 7-12)
- Graswang location 3: 6 lysimeters (# 13-18)

Graswang lysimeter in Fendt

Fendt



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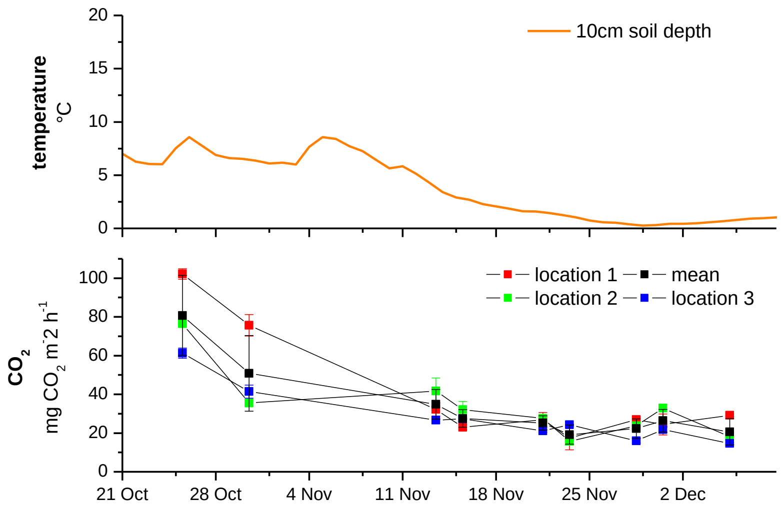
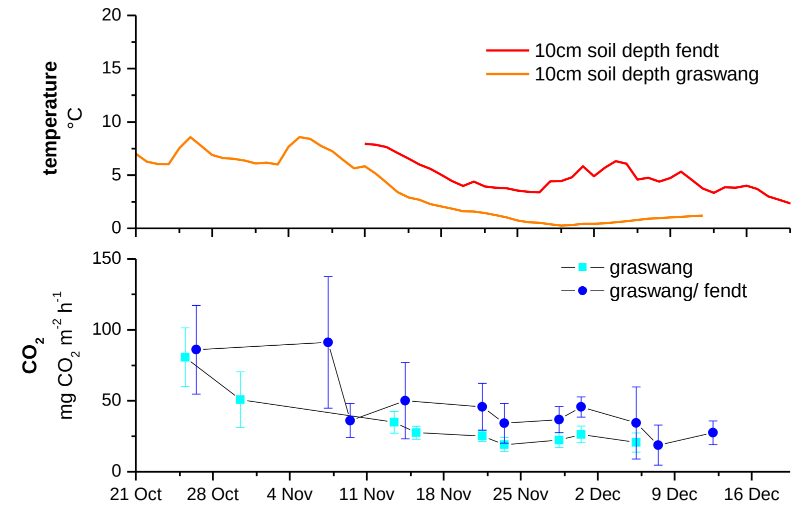
Graswang

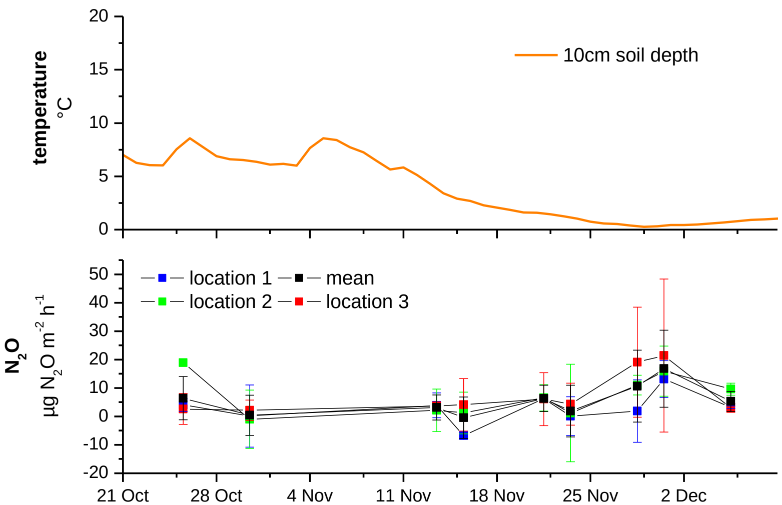
Fendt vs. Graswang translocated

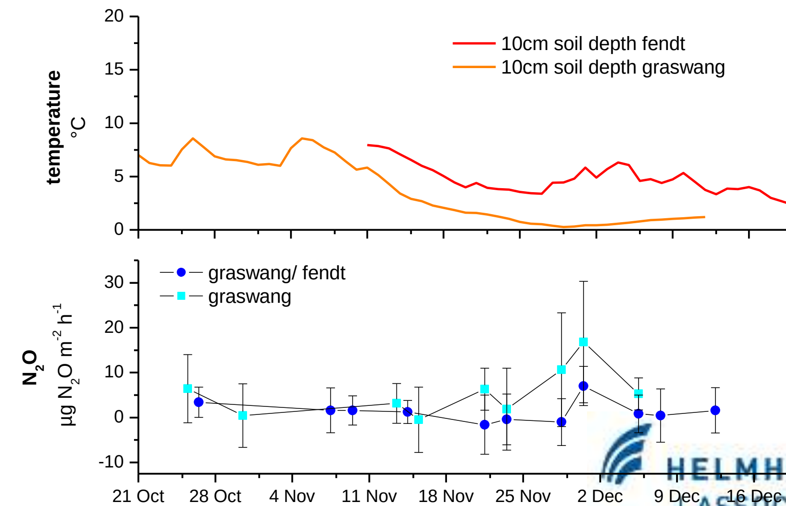
CO_2:





N_2O:





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Preliminary conclusion and remarks:

- automatic and manual GHG measurements at the elevation gradient running since October 2011

- observed temperature difference in 10cm soil depth of 3.4°C caused

    - higher CO_2 soil emissions of translocated grasland soils, but

    - higher N_2O emissions of control grasland soils, due to effects of frost-thaw which only occurde at the colder control site

The latter finding points towards the potential importance of frost-thaw driven N_2O emissions and (winter measurements) which could contradict the temperature effect of the translocation experiment

In 2012 GHG measurements will be continued and supported by nutrient leaching (DIN, DON, DIC and DOC) and NEE chamber/ biomass measurements for investigation of impacts of increased temperature on plant growth

3. Geophysical measurements at Schäfertal

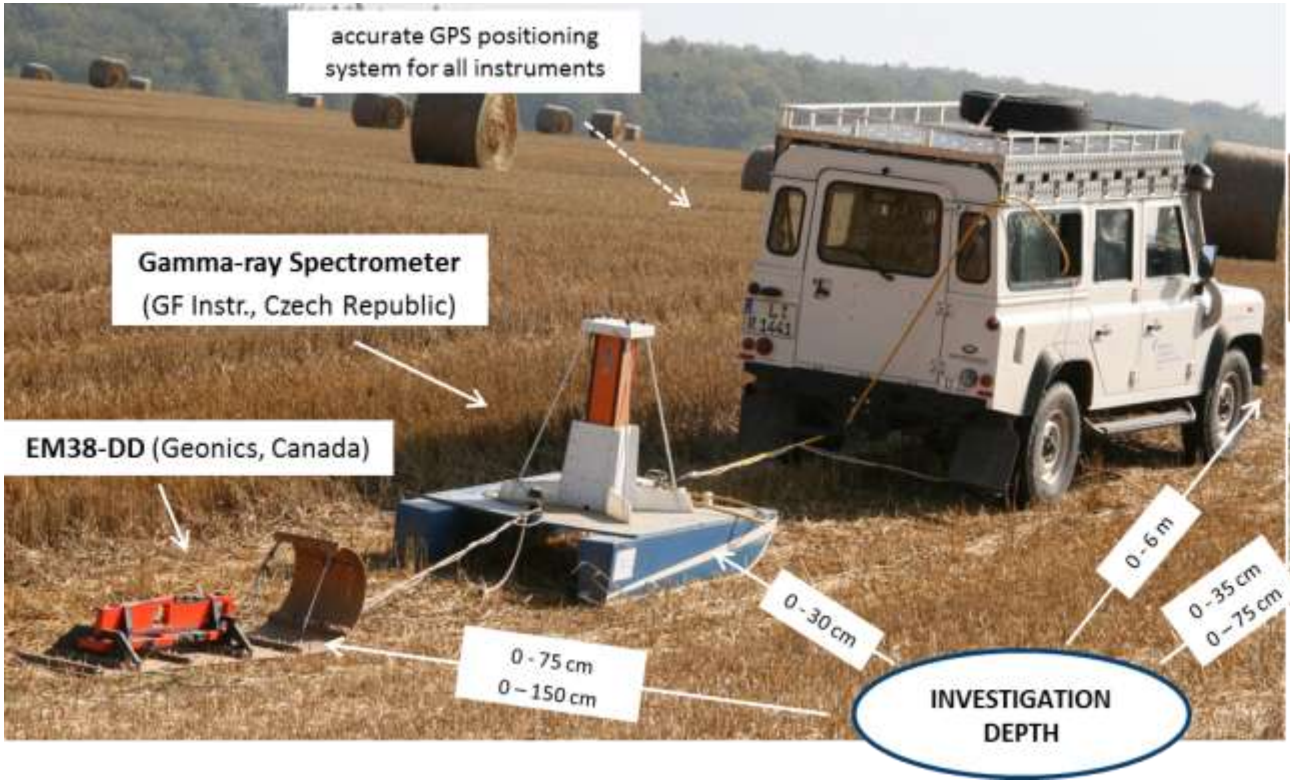
Electromagnetic Induction (EMI) sensors:

- measurement of apparent electrical conductivity (**ECa**) of soil at different depths
- proxy data e.g. for soil texture, clay content, soil salinity, soil water content ...

Gamma-ray spectrometer:

•concentration of K, U, Th and dose rate

•proxy data for soil texture (good chance for organic carbon, pH, plant avaliable nutrients)

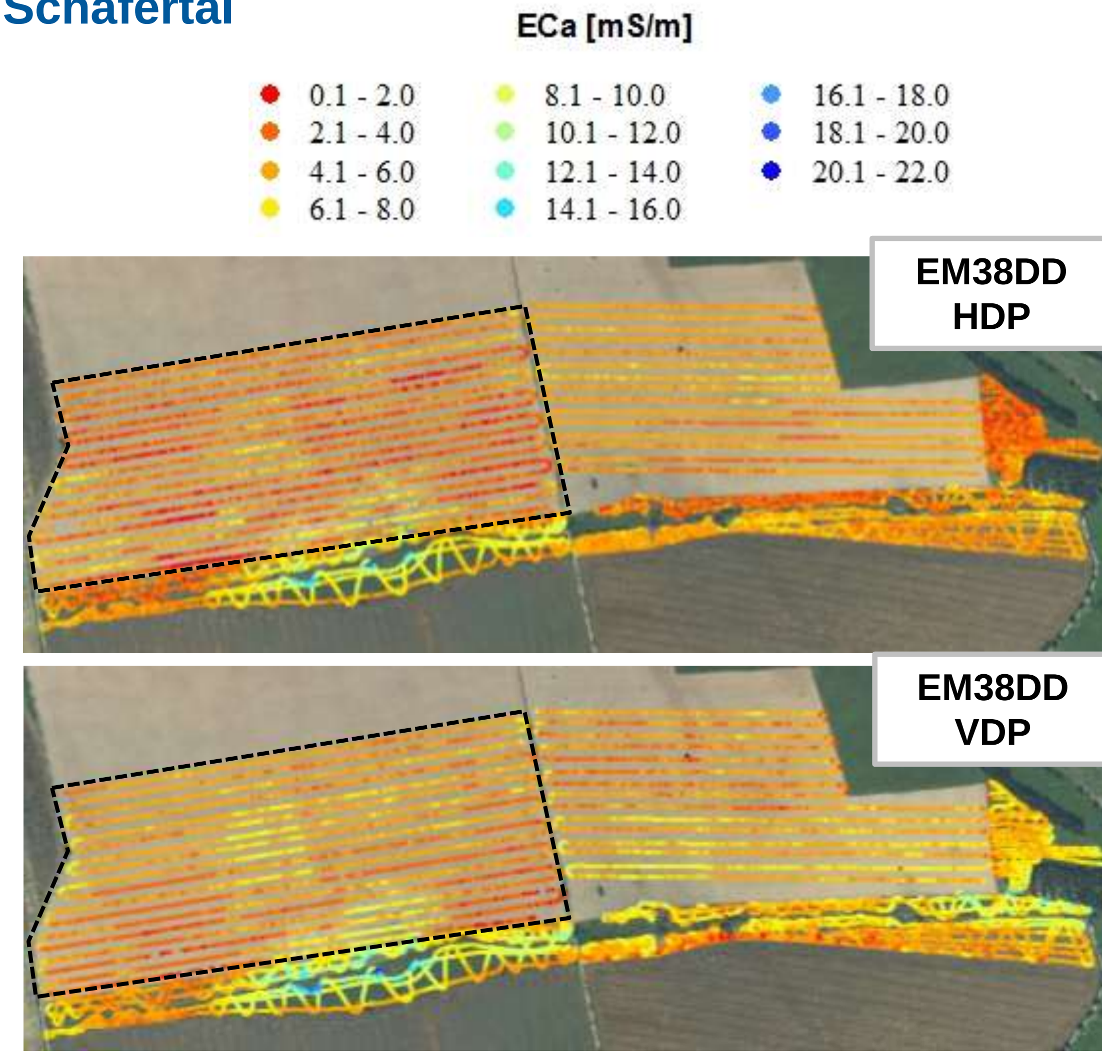


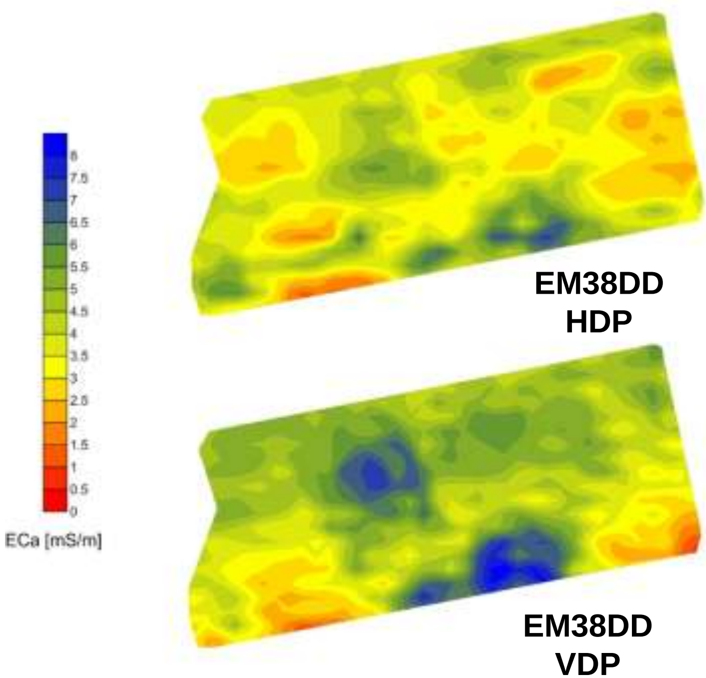
EM31-MK2 (Geonics, Canada)

EM38-MK2 (Geonics, Canada)

Geophysical measurements at Schäfertal

- investigation of the complete area
- multi-depth survey at the same time
- possibility of comparison between different EMI measurement depths
- ECa patterns are evident both in raw and interpolated maps





Danke für Ihre Aufmerksamkeit!