Drivers of Regional Variability of Grassland CO_2 Fluxes in Tyrol/Austria

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Background The FLUXNET project aims at quantifying the magnitude and controls on the CO_2, H_2O and energy exchange of terrestrial ecosystems. Ideally, the various biomes of the Earth would be sampled in proportion to their spatial extent - in reality, however, study site selection is usually based on other (more practical) criteria so that a bias exists towards certain biomes and ecosystem types. This may be problematic because FLUXNET data are used to calibrate/parameterize models at various scales – if certain ecosystems are poorly replicated this may bias model predictions. Here we present data from a project in Tyrol/Austria where we have been investigating the CO_2, H_2O and energy exchange of five grassland sites during 2005-2007. The five permanent grassland sites (Fig. 1) were exposed to similar climate, but differed slightly in management. In a FLUXNET style approach, any of these sites might have been selected for making long-term flux measurements – the aim of this project was to examine the representativeness of these sites and, if evident, elucidate the causes for and controls on differences in the net ecosystem CO_2 exchange between sites.

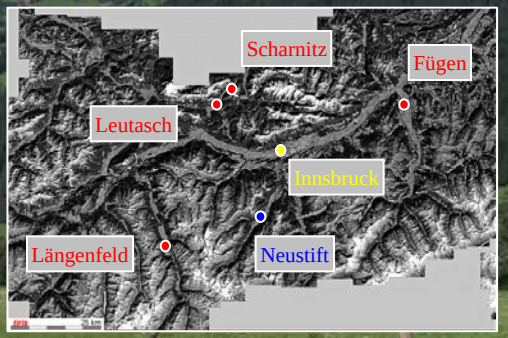

Figure 1 Location of study sites in Tyrol/Austria.

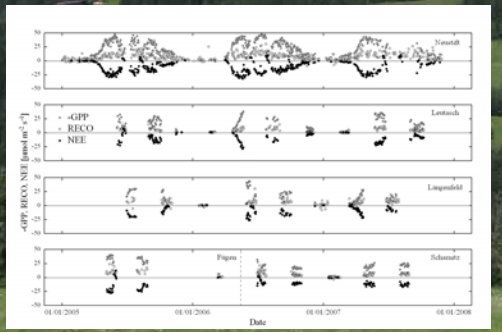

Figure 2 Seasonal variability of midday average values of NEE, GPP and RECO at the five investigated mountain grasslands.

Methods Continuous eddy covariance flux measurements were conducted at one (anchor) site, and episodic, month-long flux measurements at the four additional sites using a roving eddy covariance tower (Fig. 2). These data were complemented by measurements of environmental drivers, above-ground phytomass and basic data on vegetation and soil type, as well as management. Data are subject to a rigorous statistical analysis in order to quantify significant differences in the drivers of CO_2, H_2O and energy exchange between the sites and to identify the factors which are responsible for these differences.

		Dependent variables		
		NEE	GPP	RECO
Site (general)	intercept	**1.77***	**1.16***	0.11
Independent variables	T_{soil}	**0.22***	**0.19***	**1.00***
	T_{air}	**0.23***	**0.47***	0.06
	PAR	**2.26***	**1.52***	x
	$F_{diffuse}$	**0.65***	**0.51***	x
	SWC	**0.25***	**0.15***	0.02
	VPD	**1.46***	**0.67***	0
	GAI	**3.42***	**3.77***	0.04
Site (specific)	site	**0.77***	**0.35***	0.34
Interaction terms	site x T_{soil}	0.4	**0.41***	**0.45***
	site x T_{air}	0.35	0.19	0.14
	site x PAR	**0.53***	**0.31***	x
	site x $F_{diffuse}$	**0.51***	**0.31***	x
	site x SWC	0.41	0.23	0.4
	site x VPD	**0.51***	**0.44***	0.37
	site x GAI	**1.29***	**0.31***	**0.9***

Figure 3 Analysis of variance (ANOVA).

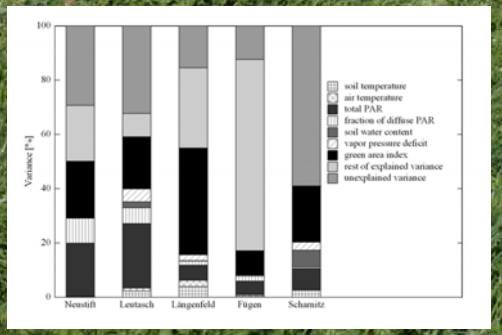

Figure 4 Unique variance of NEE.

Results & Conclusions Our major findings (Figs. 2-4) are that (i) site-identity of the surveyed grassland ecosystems was a significant factor for the net ecosystem CO_2 exchange (NEE), somewhat less for gross primary production (GPP) and not for ecosystem respiration (RECO), (ii) GPP and NEE depended mainly on the amount of incident photosynthetically active radiation and the amount of green plant matter, the scale of influence of these two predictors varying by factors 3-5 between the sites, somewhat on the vapour pressure deficit, and little on the soil available water, (iii) RECO was mainly affected by the soil temperature and the amount of green plant matter, which is understood as a proxy for productivity, (iv) the NEE was mainly influenced by GPP and to a lower extent by RECO. Taken together our results indicate that even within the same ecosystem type exposed to similar climate and land use, site selection may strongly affect the resulting NEE estimates.

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