Land use and phenology affect the net ecosystem exchange of CO_2 (NEE) in temperate mountain grassland

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INTRODUCTION

In mountain regions, land management especially in grasslands, which account for one third of the land area, are expected to affect ecosystem C sequestration potential. The primary management practises over the last 500 years in mountain regions have been mowing and grazing. The main land-use change over the last few decades has been abandonment. The overall objective of this study was to quantify the C sequestration potential of mountain grasslands under current and changed land-use practises. As a first step the aim of the work presented in this poster was to quantify how these land-use practises and phenology modulate the environmental controls of NEE.

METHODS

NEE of two meadows (at 1000 m and 1750 m a.s.l.), a pasture at 1950 m and two abandoned grasslands (at 1960 m and 2000 m) located in the Stubai Valley (Austrian Central Alps) was measured during the growing seasons 2002-2004 using portable temperature controlled ecosystem chambers (Fig. 1), which were cross-calibrated against an eddy-covariance system at one site (Fig. 2).

Figure 1: Portable, closed- dynamic ecosystem chamber for measuring NEE in complex terrain.

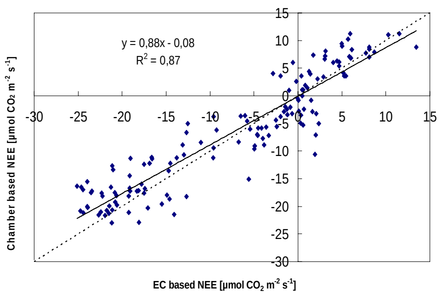

Figure 2: Eddy covariance- *versus* chamber- based fluxes of CO_2 at the valley bottom meadow.

RESULTS AND DISCUSSION

The diurnal and seasonal amplitudes of NEE decreased from the meadows to the pasture and a nutrient-poor abandoned grassland (Fig. 3). Diurnal courses of NEE were primarily affected by changes in photon flux density (daytime) and temperature (nighttime) (Fig. 4). Seasonal peak flux rates were largely determined by changes in the plant area index and the amount of canopy biomass. Mowing and grazing caused meadows to turn from sinks to short-term sources of CO_2. (Fig. 3)

Across the seasons and sites, maximum CO_2-uptake was closely coupled with maximum light-use efficiency (LUE). These parameters decreased from managed grasslands to the abandoned one (Fig. 5), where canopy nitrogen concentrations were lower.

Across all study sites there was a positive correlation between maximum rates of net CO_2-uptake (NEE_{min}) and ecosystem respiration (NEE_{max}) (Fig. 6). NEE_{min} and NEE_{max} of the managed grasslands were well in the range reported for other meadows and pastures on the globe, values for the pasture being somewhat lower values than those reported for pastures from lower altitudes.

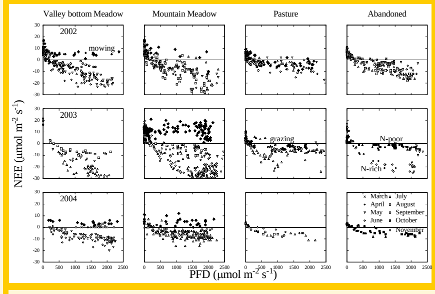

Figure 3: NEE in relation to photo flux density (PFD) during the growing season 2002-2004.

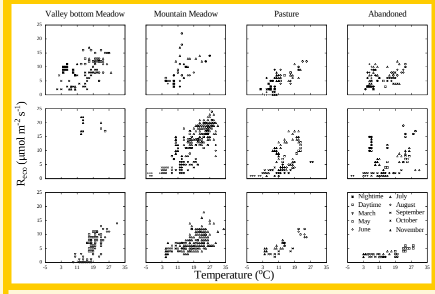

Figure 4: Ecosystem respiration in relation to temperature (°C) during the growing season 2002-2004.

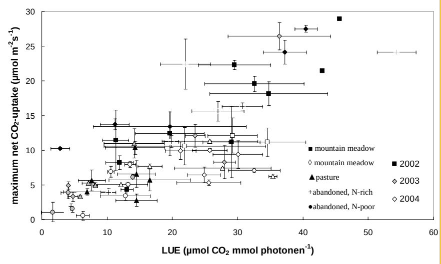

Figure 5: Relationship between maximum light-use efficiency (LUE) and maximum net CO_2 uptake.

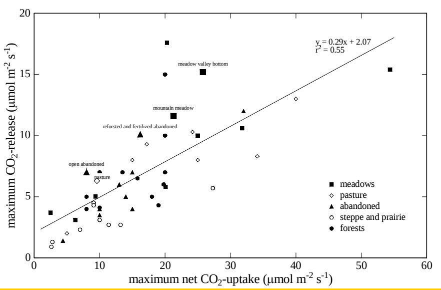

Figure 6: Relationship between maximum CO_2 release and maximum net CO_2 uptake for different ecosystems across the globe.

CONCLUSIONS

- Across different grasslands and times of the year NEE is largely controlled by light, temperature and biomass.
- There is a relationship between maximum rates of net CO_2 uptake and release, as well as light use efficiency.
- Land management has a major impact on these parameters and may thus affect the CO_2 source/sink function of mountain grasslands.