Reply to reviewer #2:

Reviewer #2: General comments

Reviewer #2: The authors present a well written paper on seven years of static chamber NEE data from six grassland sites, differing in management and altitude. Gas exchange measurement campaigns were conducted in 3-4 week intervals. Management practices range from a meadow with three cuts per year at the valley bottom, via subalpine, seasonally grazed, low nutrient pasture and abandoned pasture to a site under afforestation near the altitudinal forest line. The data collected include biomass, LAI, photon flux density (PFD), soil- and air temperature. The hypotheses announced to be tested in the Introduction are (1) that GPP and (ecosystem) R are 'controlled by PFD, temperature, LAI, biomass and canopy physiology, and decrease from meadows to pastures and a nutrient-poor abandoned grassland' and that (2) 'there is a close relationship between GPP, R and LUE (light use efficiency) across seasons and study sites.' In the following the authors exactly do what the hypothesis testing requires. The problem is that these hypotheses are neither controversial nor new. Instead, the factors under investigation and their relationships are rather well established. Also, once one of these factors is found to be correlated, the rest of them must follow automatically, since they are all extremely tightly coupled to the progress of seasons during the course of the year.

Reply : We will try to refocus our hypothesis in order to more clearly address the issue of how land use affects NEE, as follow: We tested the hypotheses that (1) differences in NEE and its component processes GPP and R between differently managed mountain grassland ecosystems are primarily driven by differences in the amount of photosynthetically active leaf area and its CO_2 assimilation potential, that (2) NEE and its component processes thus decrease as management intensity (in particular fertilisation) decreases (meadows>pastures>abandoned grasslands), and that (3) theses changes occur in a similar manner for all component processes, which results in conservative ratios between carbon uptake and release.

Understanding how land use affects NEE requires understanding how the corresponding drivers change and the relationship between the drivers and NEE. While it is correct that relationships between LAI, LUE, PFD and NEE, GPP, R have been published in many

studies, even for mountain grassland ecosystems, we look at these relationships from a land-use perspective and this, to our best knowledge, is novel. While our paper shows that many of the investigated factors are correlated, this was not to be expected *a priori* and thus represents an original result of our study.

Reviewer #2: The Results section is full of qualitative rankings. The authors should quantify and contrast results more clearly.

Reply: We will address this problem in the revision and try to avoid qualitative statements.

Reviewer #2: For example Fig. 1 data clouds need much more integration to be accessible to the reader. Possible lumping of data includes e.g. NEE of comparable PFD grouped by site plotted over time (months/years?) / water availability / temperature / Climate dependency.

Reply: The aim of this figure was to provide an impression of the distribution and variability of the available data, and how they reflect changes in light availability, season and type of grassland. Relationships with climatic data are dealt with by a multiple linear regression analysis. Furthermore, Figures 2 - 4 show integrated results that are hopefully accessible to the reader. In the revised version we will include a new figure showing the seasonal course of daily average NEE across all sites, thereby directly addressing the effect of land use on the CO_2 source/sink strength of these mountain grassland ecosystems in a semi-quantitative way.

Reviewer #2: In the Discussion the authors do not reveal how the results of their study relate to the very interesting issue they refer to in the Introduction: What do the contrasts contained in the different study sites teach us on the grassland carbon cycle and its feedback on the atmospheric greenhouse budget? The general deficiency of the ms is its lack of addressing this question quantitatively.

Reply: By the means of the above-mentioned new figure, the newly focussed hypotheses and by rewriting the discussion we will try to address this issue more clearly.

Reviewer #2: As it is, the ms is more a 'technical paper' confirming textbook physiology. On the other hand, extremely valuable information on the feedback of mountain grasslands to the greenhouse gas budget may result, if the authors would take the analysis one step further.

Reply: We are not aware of a textbook providing the information we show in our paper and we thus disagree on the technical character of the paper. As mentioned above, we will however try to focus the paper more on the effects of land use effects.

Reviewer #2: I therefore suggest to reanalyse the data and focus on a (semi-) quantitative comparison of C sink/source properties of different grasslands under different management and climate (years). Even assuming some time gaps in the measurement campaigns, this data set likely represents a true treasure of information. Effects of management (e.g. nutrient supply, species composition, canopy structure), successional stages (grazed pasture / abandoned grassland / regrowing subalpine forest) and climate/altitude (temperature, soil moisture, length of growing period) on the ecosystem C source/sink properties apparently wait to be contrasted and discussed.

Reply: This is a helpful suggestion, we have taken it as far as appeared reasonable to us by Fig. R1, which integrates C fluxes across all sites and a series of 10 day time windows throughout the growing season. Based on this more (semi-) quantitative comparison, we will elaborate C sink/source properties by dissecting the components of NEE, GPP and R, in response to seasonal and management changes. This will be shown and discussed in detail in the revised manuscript. Thus, the comment of Ref #2 has been very helpful in improving our approach to contrasting effects of management and abandonment (i.e. early successional stages) more consistently. However, we feel that other, certainly just as interesting issues, such as climate and length of growing period, cannot be sufficiently well addressed with the current dataset. These should and will doubtlessly be rewarding topics for future experimental and related model-data integration efforts.
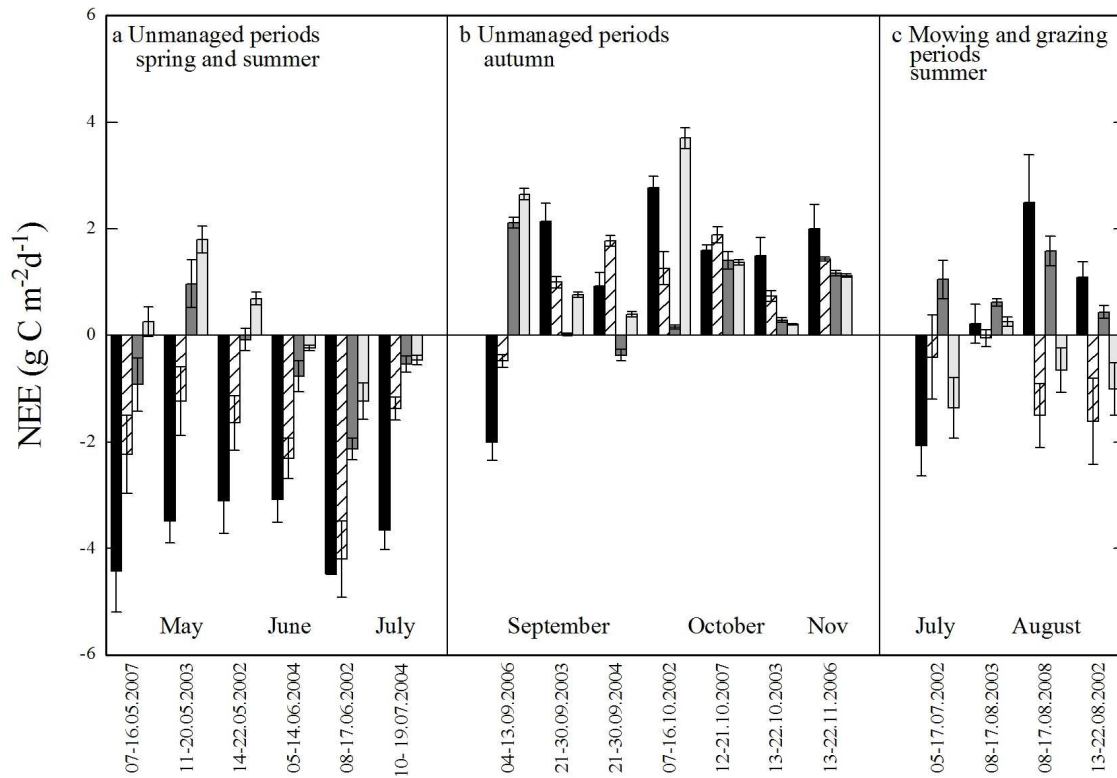
Figure R1: Daily integrated net ecosystem exchange of CO_2 (NEE) (g C $m^{-2}s^{-1}$) of (A, B) unmanaged, and (C) mowing and grazing periods from 2002 to 2008. Each time period refers to the same 10 days for all sites. NEE was calculated using a rectangular hyperbolic model, based on 10 day period during which 1-2 days of chamber measurements were available, and using the site-specific microclimatic conditions. Sites are indicated by black bars (valley bottom meadow), criss-cross bars (mountain meadow), dark grey bars (pastures) and light grey bars (abandoned). Error bars represent standard errors (n = 10).