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Interactive comment on "Positive feedback of elevated CO_2 on soil respiration in late autumn and winter" *by* L. Keidel et al.

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Referee 1: Dear referee, thank your very much for your comments and effort. We appreciate your feedback and suggestions to improve our manuscript. P8571 L22 Given this oscillation should FACE experiments also include oscillation in eCO2 levels? Have any experiments done this?

Answer: In the Giessen FACE experiment the seasonal oscillation/variation of the atmospheric CO2 concentration was also transferred to the elevated CO2 treatment, as this FACE facility adds always plus 20 % CO2 to actually measured ambient CO2 concentration during the daily course as well as over the year.

P8759 L10 Are there seasonal differences in the relationship between soil temperature

and respiration?

Answer: We analyzed the relationship between soil temperature and soil respiration separately for each season. Due to the fact that in some seasons there were not enough data points, statistical power was not sufficient (R^2=0.2) to justify this kind of analysis. Therefore, we did not include this analysis in the manuscript. However, we plotted the temperature relationship of soil respiration of the complete dataset, visualizing the different seasons. Fig. 5b indicates that soil respiration during autumn imposed a different relationship to soil temperature than during other seasons. During autumn, soil temperatures were within the same range as during spring and summer, but soil respiration was on average lower. We will include our approach in "methods" of the manuscript.

P8763 L15 Why is the relationship between respiration and moisture content not investigated? Although the rainfall is low, Fig 2a suggests that the soil is rather wet, and the authors mention the high water table. It would be useful to calculate wilting point and field capacity from the soil texture as this would help to identify periods when respiration is limited by high or low soil moisture levels.

Answer:

It is generally difficult to establish a clear moisture relationship, large effects are only expected and were detected at the dry end of the spectrum (Moyano et al., 2012; Guntinas et al., 2013; Rodrigo et al., 1997). During the investigation period, volumetric water content ranged from 20 to 80 vol.% at the GiFACE site. Thus, based on previous studies the soil moisture effect is likely not to be large. Therefore, we focused in our study on the soil temperature effect. Moreover, we did not detect differences in soil moisture between the elevated and ambient FACE rings, and the differences in soil respiration between these treatments cannot be explained by soil moisture. Thus we omitted this factor in the current study. We will elaborate on this aspect in the discussion of the revised paper.

P8762 L1 Can the authors give more insight as to why other studies report different results?

Answer: We have added further information in italic. Raich and Schlesinger (1992) estimated much lower rates of annual soil respiration, reporting 400 to 500 g C m−2 yr−1 for temperate grasslands. Annual soil respiration sums from a sandstone and serpentine grassland were 485 and 346 g C m−2 yr−1 (Luo et al., 1996). These soil respiration rates were lower than those from the wet grassland site investigated here due to the larger net primary productivity of the wet temperate grassland with a year-round more or less moist climate, compared e.g. to a seasonally dry Mediterranean-type grassland. A lower net ecosystem productivity (NEP) will automatically result in lower overall soil respiratory C losses. Methodological differences may have been to a lesser extent been responsible, because the studies of Luo et al. (1996) and Raich and Schlesinger (1992) may have overestimated rather than underestimated the annual soil respiration. Their measurements did not exceed 2 years in duration and soil respiration was less frequently measured for a portion of the year. Other recent studies reported higher rates of annual soil respiration which are closer to our estimates; however climatic factors are different to the wet grassland site investigated here: In a tallgrass prairie in Oklahoma annual soil respiration rates were 1131 and 877 g C m−2 yr−1 in 2002 and 2003 respectively (Zhou et al., 2006). In a Texas grassland annual soil respiration rates increased with annual precipitation and were 1600, 1300, 1200, 1000, 2100 and 1500 g C m−2 yr−1 in 1993 through 1998 respectively (Mielnick and Dugas, 2000). At the Texas grassland site measurements were conducted year-round with a high time resolution. Consequently annual rates could be estimated by more measured (than gap-filled) data than in other studies. However the most important factors were likely the annual precipitation, its distribution over the year and the annual mean temperature:High annual rainfall, a long growing season and large soil organic C contents explained the higher soil respiration rates (as a consequence of a higher NEP) at the Texas study site. Mean annual precipitation at the GiFACE study site (562 mm) was close to the mean precipitation reached in 1995 at the Texas grassland with

657 mm, when annual soil respiration averaged 1200 g C m−2 yr−1.

Referee 2: Dear referee, thank your very much for your comments and effort. We appreciate your feedback and suggestions to improve our manuscript. 87558 L 26 it my believe that using phenology and management practices is a nice conceptual framework, however there is consistency that should be taking into account.

Answer: The seasonality in this temperate grassland ecosystem is a dominating and crucial aspect which is directly affected, by air and soil temperature and soil moisture, all affecting respiratory processes. Management practices, such as fertilization and harvest are also playing an important role for these processes and are directly related to the phenological states of grassland plants.

8758 L 25 will you define it is a season or a period ? Either way the use a same nomenclature will help clarify for instance Figure 1 and 3 mention season. In addition winter sometimes is wintertime (8765 L10, 8766 L9).

Answer: We agree and change the wording “period” always into “season”. Moreover we checked that we use “winter” consistently for the defined winter season. Thanks for pointing out this inconsistency.

8768 L 22-26 this is very interesting, should we further think in how soil moisture at different layers influence CO2 dynamics. Would a soil moisture threshold taking into account the seasonality influence the diffusion of CO2? For this particular grassland what is a dry condition/ high soil moisture? And what is a deep layer? Figure 6 missing legend.

Answer: Based on previous studies on this grassland (e.g.Müller et al., (2004) it was shown that during summer, when soil moisture content was relatively low (0.3 cm^3 cm-3) in the main rooting zone (top 10 cm) of the GiFACE site, the site of production for gaseous emissions (e.g. N2O) occurred at deep soil layers (20-50 cm depth) where soil moisture content was still high(0.6 cm^3 cm-3). The production of N2O at deep soil layers seem coincided with the production of CO_2 during summer, which was also indicated by a homogenous δ $^{13}CO_2$ profile during vegetation period at our study site (Lenhart, 2008). However, a detailed investigation on layer specific CO_2 production was beyond the scope of this study. Moreover, s in this study, we were interested in the differences of soil respiration between ambient and elevated CO_2 plots. We did not detect any differences in soil moisture between ambient and elevated FACE rings, thus, we focused in the current study on the soil temperature effect. Moreover, the water regime in this wet grassland is predominantly in the range where the soil moisture effect was not considered to have a large impact (see also comments above; (Moyano et al., 2012; Guntinas et al., 2013; Rodrigo et al., 1997). However, to identify in more detail the specific site of CO_2 production under elevated CO_2 further studies will be required, taking into account differing soil moisture conditions. We have now added the missing legend in Fig.6, thanks for pointing this out.

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