Effects of Rain-Pulses on CO_2, CH_4 and N_2O Fluxes on a Swiss Grassland

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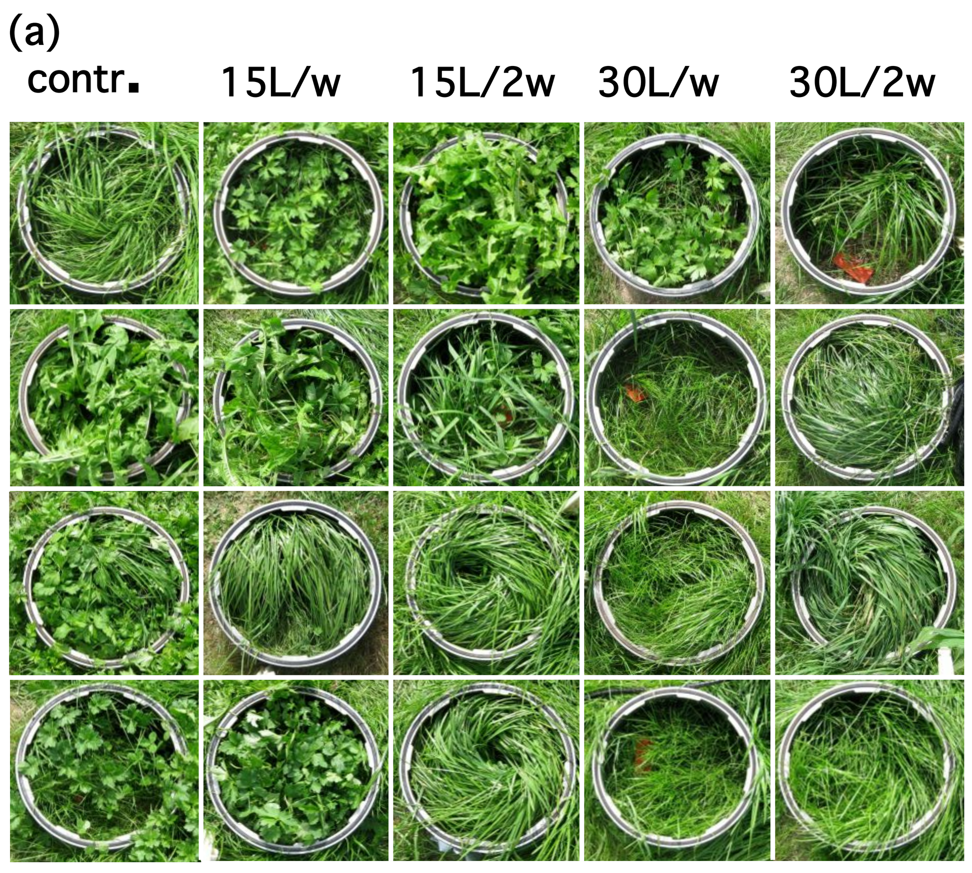
GHG EUROPE
Greenhouse gas management in European land use systems

Motivation

The influence of soil water content (SWC) fluxes of carbon dioxide from terrestrial ecosystems is well known (Birch effect). Due to alterations of the soil water content root as well as microbial activity might be either be enhanced or reduced, resulting in higher or lower respiratory fluxes, respectively. A sudden increase of SWC during/after a heavy rain event might result in a burst of carbon dioxide only via the physical displacement of the soil air fraction. In semi-arid ecosystems the latter phenomenon is well known as the *Birch-effect*. The length of the dry period before a rain event is of key importance for the strength of the carbon dioxide burst. We were interested whether this effect was observed in the dry year 2011. Moreover we try to assess the impact of rain-pulses on other greenhouse gases (GHGs), methane and nitrous oxide.

Methodology



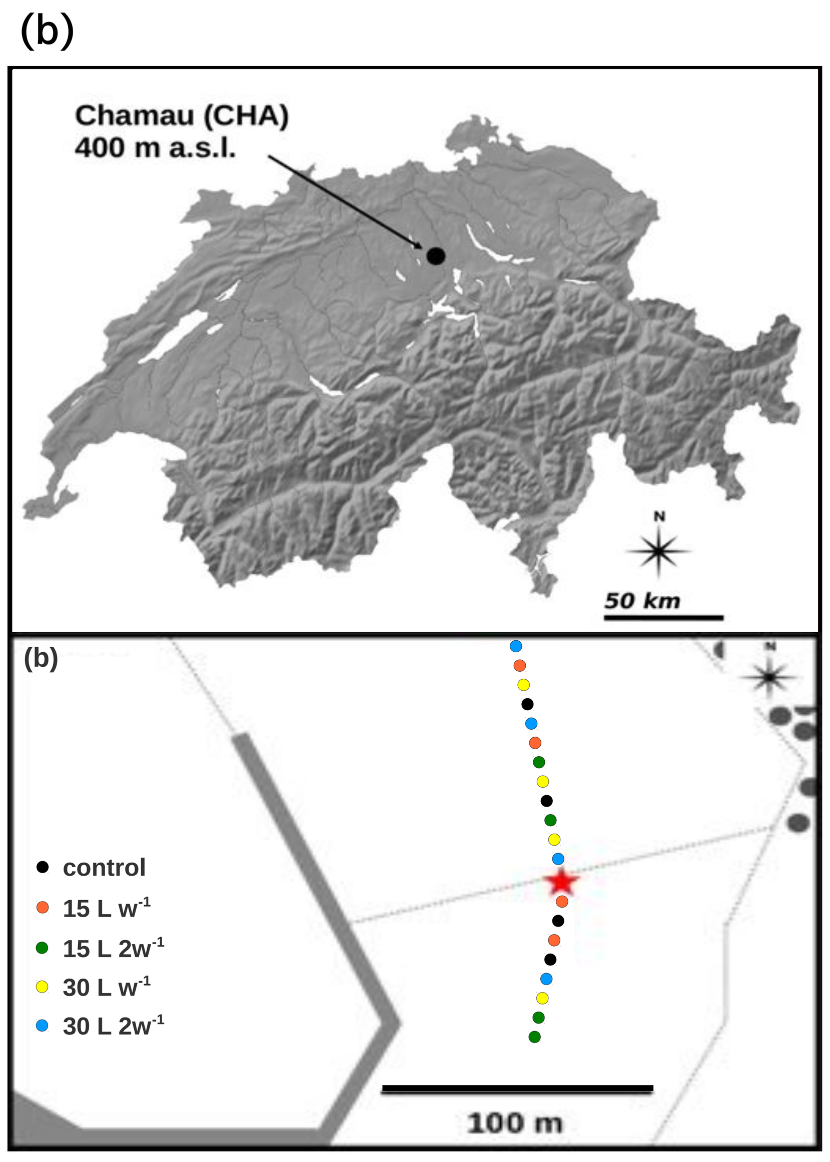


Fig 1: (a) shows the heterogeneity of the chambers' species composition. (b) shows the positioning of the site within Switzerland and the site set-up. The red star indicates the eddy covariance tower and the colored dots the respective chamber treatments.

Eddy covariance:

The net ecosystem exchange of carbon dioxide was measured using the eddy covariance technique. Filtered fluxes were gap-filled and partitioned into gross primary production and ecosystem respiration.

Soil chambers:

Five treatments were established (n=4) to simulate different rain-pulse intensities and frequencies (see figure 1). The treatments were assigned randomly. Treatments included: A **control**, 15 Liters / Week (L/w), 15 L/2w, 30 L/w, 30 L/2w. Samples were drawn with syringes at three times a day over a period of three weeks.

Results & Conclusions

Eddy covariance

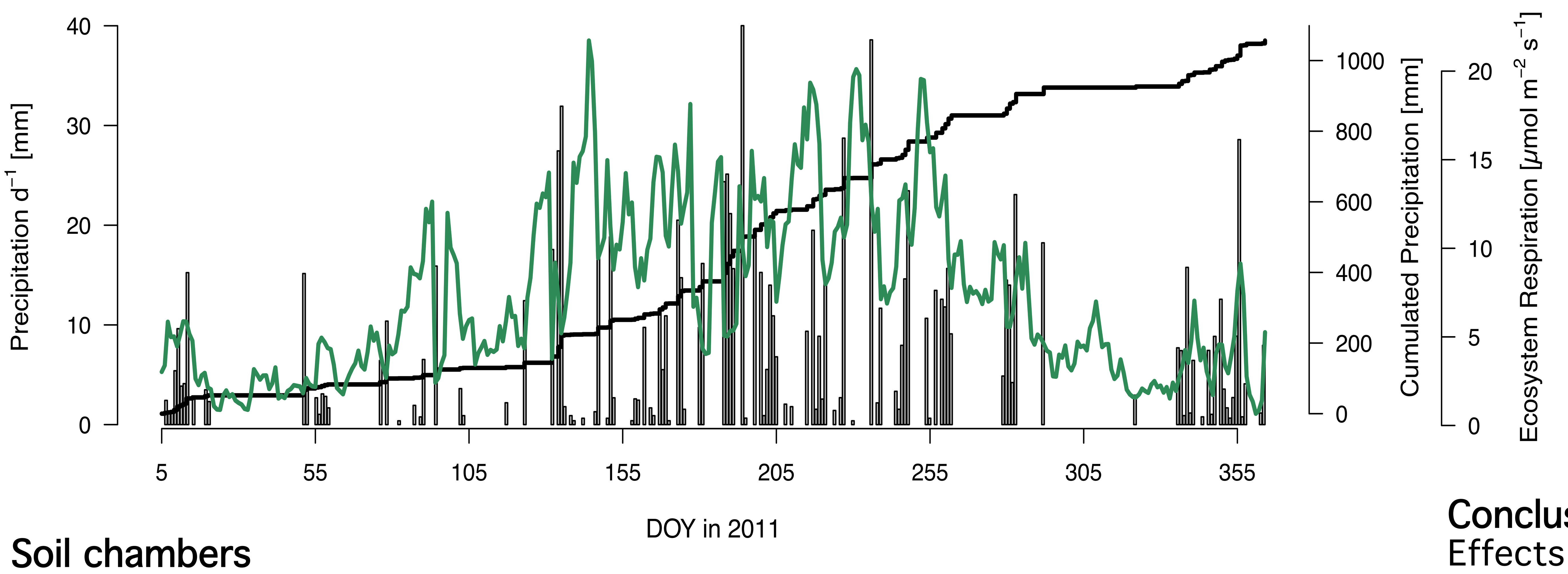


Fig 2: The annual distribution of precipitation (black bars) and ecosystem respiration (green line) as derived from long-term eddy covariance measurements at Chamau in 2011. The black line shows the cumulated annual sum of precipitation. One can observe higher respiration rates in correspondence with rain-pulses occurring after dry periods. This effect is more pronounced after the relatively long dry periods at the beginning and at the end of 2011.

Soil chambers

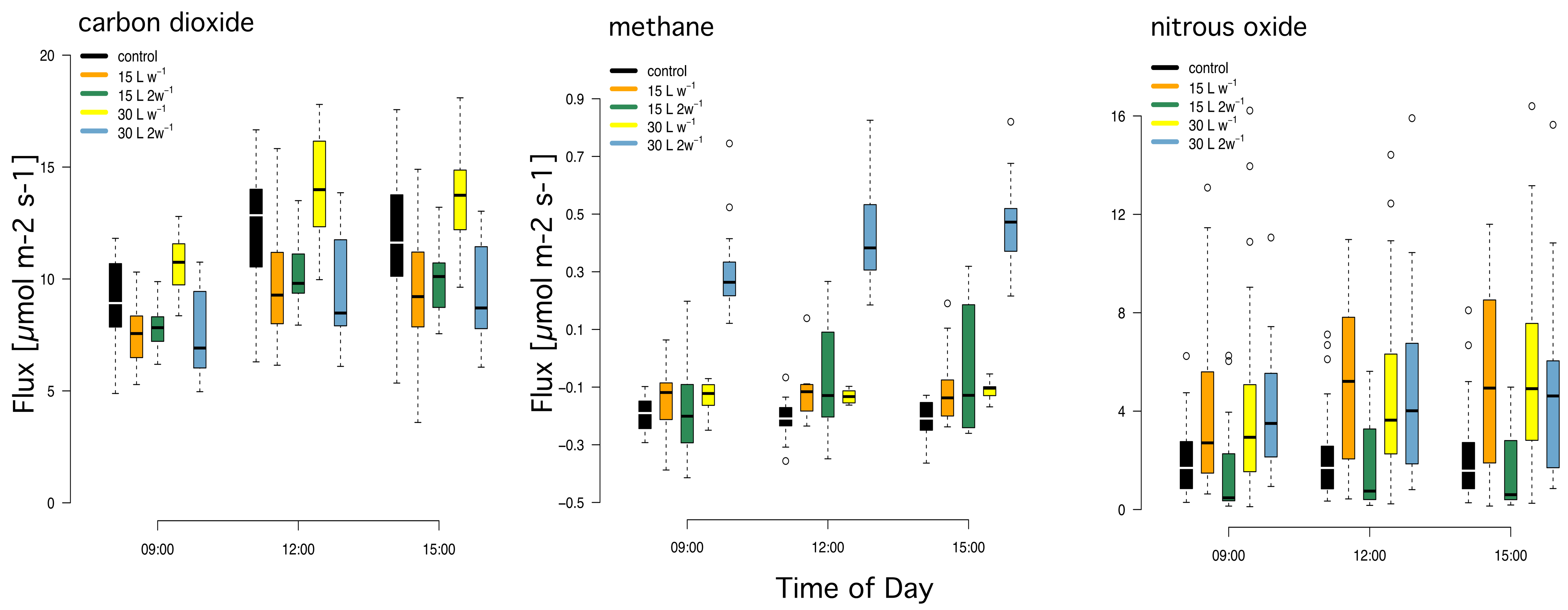


Fig 3: Differences in flux magnitudes of either GHG with respect to the treatment and the time of day. Boxplots represent the range of flux magnitudes over the entire period of the experiment (three weeks).

Conclusions:

Effects of rain-pulses were observed with both, eddy covariance (annual scale) and soil chambers (short-term scale) measurements. On the annual scale the response of respiration was pronounced after longer dry periods. The chamber experiment showed that especially fluxes of methane were susceptible for changes in SWC due to simulated rain-pulses. For carbon dioxide and nitrous oxide the pattern of the response in flux magnitude is somewhat less clear.

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