Analyzing the Effects of Growing Season Length on the Net Ecosystem Production of an Alpine Grassland Using Model-Data Fusion

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Alpine ecosystems are, similar to arctic ecosystems, characterized by a very long snow season. Previous studies investigating arctic or alpine ecosystems have shown that winter CO2 effluxes can dominate the annual balance and that the timing and duration of the snow cover plays a crucial role for plant growth and phenology and might also influence the growing season ecosystem CO2 strength and dynamics. The objective of this study was to analyze seasonal and annual CO2 balances of a grassland site at an elevation of 2440 m a.s.l in the Swiss central Alps. We continuously measured the NEP using the eddy covariance method from June 2013 to October 2014, covering two growing seasons and one winter. We analyzed the influence of snow melt date on the CO2 exchange dynamics at this site, because snow melt differed about 24 days between the 2 years. To this end, we employed a process-based ecosystem carbon cycling model to disentangle the co-occurring effects of growing season length, environmental conditions during the growing season, and physiological/structural properties of the canopy on the ecosystem carbon balance. During the measurement period, the site was a net sink for CO2 although winter efflux contributed significantly to the total balance. The cumulative growing season NEP as well as mean and maximum daily CO2 uptake rates was lower during the year with the later snow melt, and the results indicated that the differences were mainly due to differing growing season lengths.

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