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Ecosystem CO_2 exchange during the snow-covered season in a boreal peatland, Sweden

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In high latitude areas, ecosystem CO_2 emission in the snow-covered season (SCS) is a crucial part of annual carbon budget, which may account for 33-90% of the summer uptake. As snow pack development is sensitive to the warming climate, the change of CO_2 flux in SCS is widely concerned, which, however, is still poorly understood. We used the 12-year CO_2 exchange data (2001-2012) from an eddy covariance system in a minerogenic mire in Sweden, where the snow-covered season lasts for about 6 months in a year, to evaluate inter-annual change of CO_2 flux in SCS and explore the underlying environmental controllers. Sum of net ecosystem CO_2 exchange (NEE) in SCS varied from 8.19 to 32.13 gC m-2 (CO_2 release), which accounted for 11-41% of the net CO_2 uptake during non-snow-covered period of each year. Over the studied years, the NEE during SCS performed a trend of decline (-1.58 gC m-2 year-1), which was attributed to the decreased daily NEE rather than the variation in the duration of SCS. However, we found no single environmental factor that was responsible for the trend. Over the whole SCS, snow depth did not show direct impact on the day-to-day variation of NEE but acted as an important role in insulating the environment below snow pack from the atmosphere. Daily NEE during the period with a deep snow cover (i.e. snow depth >30cm) was relatively lower and was not affected by air or soil temperature. In contrast, the period with a shallow snow cover (i.e. snow depth < 30cm), which was usually shorter, emitted more CO_2 and the NEE was influenced by both air and soil temperatures as well as photosynthetically active radiation. At the end of SCS, snow melt usually lasted for about a month and during this period, NEE was jointly driven by air temperature and photosynthetically active radiation. Given a trend of CO_2 emission decline in SCS over 2001-2012 and the influence of temperature on day-to-day NEE variation, our results suggest that winter time CO_2 flux is an important part of annual carbon balance in a boreal peatland and is vulnerable to changing climate.