Geophysical Research Abstracts
Vol. 19, EGU2017-7721, 2017
EGU General Assembly 2017

Role of advection for the ecosystem-atmosphere CO_2 exchange of alpine grasslands

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The neglect of the advection contribution could bring uncertainties to the estimation of the net ecosystem CO_2 exchange (NEE) between ecosystems and the atmosphere, especially in complex terrain and stable atmospheric conditions. In order to quantify the advection flux of CO_2, we carried out four monthly field campaigns at different grasslands in the mountainous areas of Italy, Austria, and Germany in 2015 and 2016. The measurement was based on the advection completed mass balance (ACMB) concept. A home-assembled solenoid valve system, together with multiple sampling inlets and a gas analyser, was used to measure CO_2 concentration online at three heights on the four sides of a control volume of 20 m by 20 m. Advection of CO_2 was then calculated from the measurement of wind components and CO_2 gradients. The turbulent flux of CO_2 was measured by the eddy-covariance technique. Three clear automatic chambers measured NEE as reference.

Results showed that both the horizontal and vertical advection contributed more significantly to CO_2 flux at night time than at daytime. At most sites, the horizontal advection played a more important role than the vertical advection. The above-canopy advection contributed more CO_2 flux than within-canopy advection due to the short canopy heights. Large variability of NEE measured by the three chambers indicates the challenge of comparing chamber and micrometeorological fluxes resulting from the heterogeneity of the surface.