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Diffuse vs. direct radiation effects on the ecosystem CO_2 exchange of a mountain grassland: a combined theoretical and experimental study

G. Wohlfahrt, A. Hammerle, A. Haslwanter, M. Bahn, U. Tappeiner, A. Cernusca
Institute of Ecology, University of Innsbruck, Austria (georg.wohlfahrt@uibk.ac.at)

During the past couple of years, several publications have shown that the net ecosystem CO_2 exchange of terrestrial ecosystems is sensitive to the diffuse fraction of the incoming photosynthetically active radiation – diffuse radiation being used more effectively for carbon gain and thus resulting in a draw-down of atmospheric CO_2 concentrations. Here we use a multi-layer canopy radiative transfer model coupled to a leaf photosynthesis model to critically re-examine the processes underlying this sensitivity. Guided by the simulation results we then use seven years of net ecosystem CO_2 exchange data from a temperate mountain grassland in the Stubai Valley (Austria) to test the validity of the simulation analysis. Deviations from the expected responses are examined in a residual analysis and discussed in relation to other meteorological drivers affecting ecosystem-scale net ecosystem CO_2 exchange.