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Estimation of Daytime Ecosystem Respiration to determine Gross Primary Production of a Mountain Meadow

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Gross primary production (FGPP) may be calculated from net ecosystem CO2 exchange (FNEE), measured, for example, by means of the eddy covariance method, provided an estimate of daytime ecosystem respiration is available. The latter is now often estimated by extrapolating functional relationships between nighttime FNEE, when FGPP is zero, and temperature to daytime conditions. The present paper deals with one problem associated with this approach, namely the reduction of leaf respiration in light relative to darkness, which causes an overestimation of daytime ecosystem respiration, and hence FGPP. The overestimation of FGPP is quantified for a mountain meadow in the Austrian Alps using a coupled model of the reduction of leaf dark respiration as a function of light intensity and within-canopy radiative transfer. For the two study years analysed in the present paper, model simulations suggest a reduction of FGPP by 11-13% and 13-17%, for a low and a high estimate of the maximum leaf-level reduction of dark respiration, respectively. This reduction is shown to be most sensitive to the ratio between FGPP and total ecosystem respiration, as well as to the ratio between leaf and total ecosystem respiration. The largest factors of uncertainty in this modelling approach are the cause for and the actual level of the reduction of leaf dark respiration in light. The significance of the present findings for estimating FGPP of other sites is discussed.