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Estimating northern peatland CO2 exchange from MODIS time series data

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Satellite sensor-derived data have successfully been used in models of forest CO2 exchange. However, other land cover types should be included in large-scale estimations of CO2 exchange. In this study of one temperate and one boreal peatland in Sweden, three years of data were averaged for the 16-day composite periods of the Moderate Resolution Imaging Spectroradiometer (MODIS). Eddy covariance data were related to MODIS 250 m vegetation indices, MODIS 1 km land surface temperature (LST), and modeled photosynthetic photon flux density (PPFD). Double logistic curve fits were used to smooth out noise in the time series of the normalized difference vegetation index (NDVI) and the enhanced vegetation index (EVI). Since smoothed NDVI showed saturation during summer time and EVI generally gave better results in explaining gross primary productivity (GPP), EVI was used in the analyses. Strong linear relationships were found between GPP and the product of EVI and PPFD (R2 = 0.85 and 0.76), which were only slightly stronger than the relationships between GPP and the product of EVI and daytime LST (R2 = 0.84 and 0.71). One reason for these results should be that several controls on GPP were related to both modeled PPFD and daytime LST. Furthermore, ecosystem respiration (ER) was largely explained by diurnal LST in exponential relationships (R2 = 0.89 and 0.83). Based on these findings for GPP and ER, net ecosystem exchange (NEE) was directly related to the product of EVI and modeled PPFD in combination with diurnal LST in multiple exponential regressions (R2 = 0.81 and 0.71). The R2 values were slightly weaker for NEE, as compared to GPP and ER, but the RMSE values were much lower than if NEE would have been estimated as the sum of its components. The main conclusion is that satellite sensor-derived data and modeled PPFD can be used in regression models for estimating peatland CO2 fluxes.