Decadal variability of carbon fluxes over black spruce forests in Alaska detected by application of NOAA-AVHRR and climate data

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Satellite remote sensing is a promising tool to monitor the changes in the Arctic. We developed a satellite-based empirical model to detect decadal variability of regional carbon fluxes over black spruce forests in Alaska. The model parameters were derived from the eddy covariance data between 2003 and 2006, including sensitivity of carbon fluxes to air temperature, vapor pressure deficit, shortwave radiation, and normalized difference vegetation index (NDVI). In the stand scale validation, the model successfully reproduced observed gross primary productivity (GPP), ecosystem respiration (RE), and net ecosystem exchange (NEE). The 10-day average of model output was highly correlated with observed GPP (r^2=0.9), RE (r^2=0.9), and NEE (r^2=0.7).

We applied the model to estimate the regional carbon fluxes from 1982 to 2003 by using NDVI from NOAA-AVHRR and climate data. The regional analysis showed that the integrated GPP and RE were 2172, and 2008 g CO_2 m^{-2} y^{-1} over black spruce forests in Alaska, indicating that these forests acted as a small carbon sink of 164 g CO_2 m^{-2} y^{-1} during the past 22 years. Our model analysis showed that the GPP was mainly affected by spring air temperature, whereas RE was affected by summer air temperature, indicating that the sink strength of the black spruce forests was controlled by the seasonality in air temperature between spring and summer. Path analysis provided an insight that spring warming increased the carbon sink, but summer warming decreased the sink.