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Interannual variation in ecosystem CO_2 exchanges in a semiarid grassland of Mongolia

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In Mongolia, grassland covers approximately 80% of the country and comprises a major part of East Asian grasslands. The plants live in a semiarid climate, and have often suffered from droughts. Exchange of CO_2 between grassland ecosystems and the atmosphere is controlled by environmental parameters such as temperature, soil moisture, and plant biomass. Studies have indicated that the grasslands respond sensitively to changes in climate, suggesting that interannual climate variability can lead to major changes in the CO_2 exchanges between the atomosphere and ecosystem. The objectives of this study are to estimate interannual variability of ecosystem CO_2 exchanges and to examine its controlling factors.

Our study site was located in a grassland area (47^{o}02.6'N, 105^{o}57.1'E) in Bayan-Unjuul (BU) county in central Mongolia, which contain typical steppe vegetation that is grazed by livestock. Rates of gross primary production (GPP) and ecosytem respiration (Reco) were measured using a closed-chamber technique during the growing seasons of 2004, 2005, 2006, 2009, 2010, and 2011. Net ecosystem CO_2 exchange (NEE) has also deteremined by an eddy covariance (EC) method since 2008. We set up automated weather and ground observation systems at site BU in June 2004, and standard meteorological and soil parameters were continuously measured at 30-minute intervals. Live aboveground biomass (AGB) was measured by clipping green parts of the vegetation and oven-drying them at 80^{o}C for 48 hours for each point where the closed-chamber measurements were made. Based on the results of our measurements, we constructed an empirical model in which the rates of GPP and Reco are computed from the air and soil temperatures, vapor pressure deficit, photosynthetically active radiation, soil water content, and AGB. In this study, the half-houly rates of GPP and Reco during the growing season (May-September) from 2007 to 2011 at site BU were calculated from the observed meteorological and soil parameters. Since AGB was not continuously measured at site BU, temporal changes in AGB were estimated from a remotely sensed vegetation index (NDVI). The model was validated by comparing the observed NEE by EC technique and the calculated values. The comparizon demonstrated that our model was able to reproduce the carbon budget in the semiarid grassland with high accuracy. Cumulative rates of NEE during the growing seasons varied from -42 (carbon uptake) to 34 (carbon release) g C m^{-2}. This result suggested that semiarid grassland might be a net carbon source even during the growing season depending on climate conditions.

Keywords: carbon cycle, photosynthesis, ecosystem respiration, semiarid grassland, Mongolia