Multidisciplinary measurements of eddy fluxes of CO_2, H_2O and energy over a montane larch forest and stipa steppe along the Kherlen River of Mongolia

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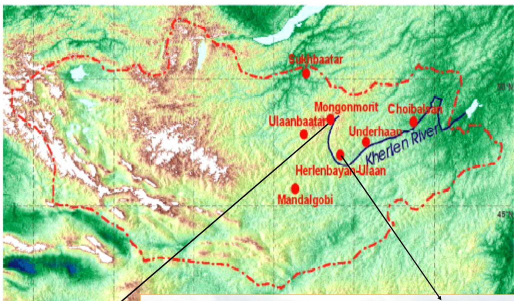
Abstract

We used eddy covariance technique, aircraft, scintillometer, and isotopic techniques to examine temporal and spatial dynamics of eddy fluxes of CO_2, H_2O and energy over a montane larch forest and *stipa* steppe along the Kherlen River of Mongolia. This study allows not only for a comparison among the approaches but also for quantifying the land surface-atmosphere interaction for Mongolian terrestrial ecosystems in response to climatic variability and anthropogenic disturbances.



Introduction

Like the Tibetan Plateau, the Mongolian Plateau plays a critical role in global climate, hydrological and biogeochemical cycles. Land surface measurements of CO_2, H_2O and energy fluxes provide a tool for quantifying and characterizing this role. As a part of the RAISE project, this study also has implications in establishing the benign harmonious relationship between land resources, climate and anthropogenic exploitation.

Fig. 1. site location

Material and Methods

Montane larch forest at is located at Mongomorit with T_a of -2.7 °C and PPT of 296 mm, and stipa steppe at Kherlenbayan-Ulaan with T_a of 1.2 °C and PPT of 196 mm (Fig. 1). Methods used for flux measurements include: eddy covariance (EC) technique; aircraft observations; isotopic techniques; and scintillometer approach.

Results and Conclusions

(1) One-year round measurements by the eddy covariance technique show that both montane larch forest and stipa steppe are sinks for the atmospheric CO_2. However, sink strength of the forest was twice that of the steppe (Fig. 2). It appeared that the dominant constraint over sink strength was temperature for the forest (Fig. 3) while it was water availability for the steppe (Fig. 4). The steppe was switched from a carbon sink to a carbon source under the conditions of drought stress (Fig. 5).

(2) The Keeling plot shows that 60-70% of total forest evapotranspiration was from larch tree transpiration (Fig. 6). Larch trees most used water from the upper 30-cm soil layer but used deeper water when there was water stress (Fig. 7).

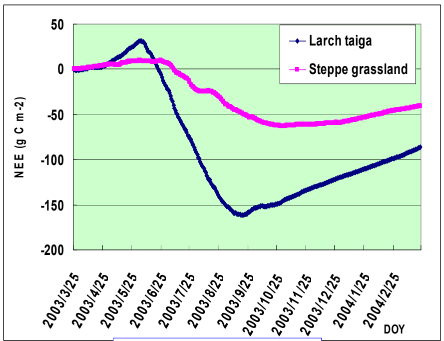


Fig. 3. T_a response

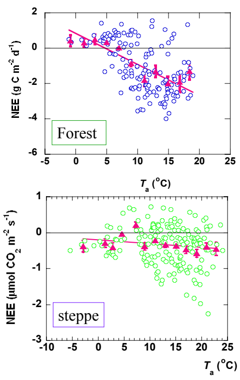


Fig. 3. T_a response

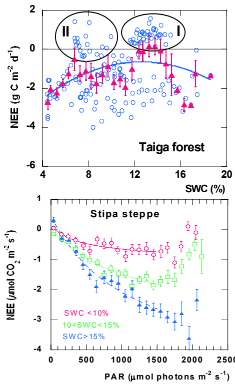


Fig. 4. SWC response

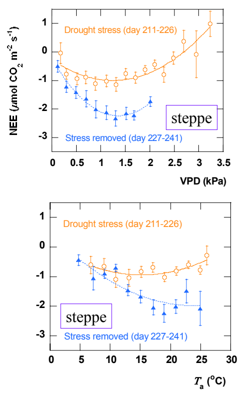


Fig. 5. drought stress

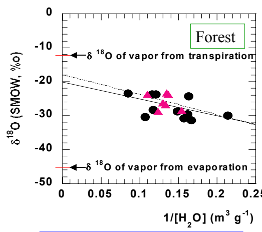


Fig. 6. Keeling plot

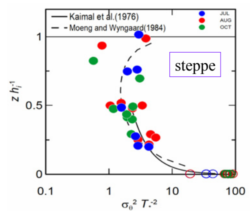


Fig. 8. profile of temperature variance

Results and Conclusions

(3) Flux measurements by the aircraft-based variance method show that vertical profiles of the second moment about the mean, i.e. the variance, of temperature were found to follow the functional forms proposed in previous studies (Fig. 8), and the sensible flux (H) was refined with EC-measured H indicating that RMSE between them was about 30 Wm^{-2} (Fig. 9).

(4) The scintillometer approach estimated the sensible heat flux over larger source area. And this estimate was compared to the flux measured by the eddy covariance method (Fig. 10).

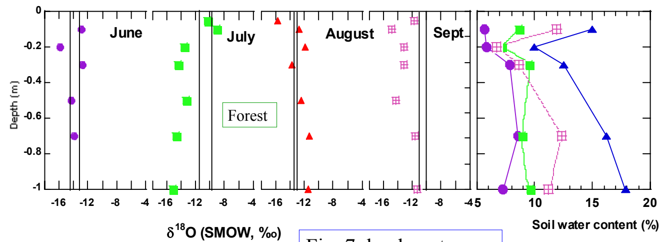


Fig. 7. larch water use

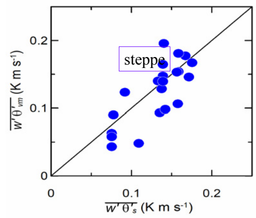
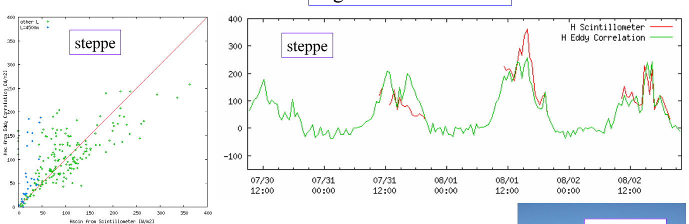


Fig. 9. H-comparison



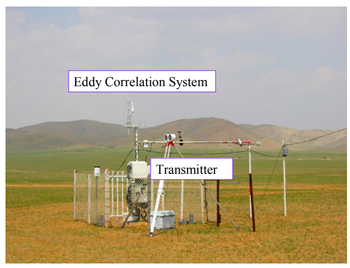


Fig. 10. H-comparison