Monitoring and evaluation of carbon absorption in pasture areas near Ulaanbaatar and far from cities

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To obtain the ground observation data to verify the data products derived from the greenhouse gas observation technology satellite (GOSAT) series, this study targets the carbon emission and absorption in Mongolia. For this purpose, we have established two flux towers to monitor the greenhouse gas CO2 in the pastures near Ulaanbaatar (Nalaikh site) and a vast grassland area far from cities (Hustai site), where the net ecosystem exchange (NEE) has been monitored by the eddy correlation method since 2015. To guarantee the accuracy of the measurement data, the accuracy of the CO2 analyzer was calibrated regularly by using standard gas.

According to the meteorological data observed during 2016-2019, the daily average wind speeds at both sites are in the range of 1 to 10 m/s, but the annual averages are 2.4 m/s and 2.8 m/s at Hustai and Naliakh site, respectively. The temperature fluctuation range is -30 dgr. C to 30 dgr. C, and the annual fluctuation range is 60 dgr. C or more, but the annual average values are only 2.0 dgr. C and -1.6 dgr. C, respectively. Annual precipitation is 193.6 mm at the Hustai site and 165.7 mm at the Nalaikh site. Looking at the heat balance measured at both sites, we found that the net radiant flux (Rn) is in the range of -50 to 200 W m-2, and the annual average is 59.6 W m-2 at the Hustai site and 60.6 W m-2 at the Nalaikh site, which is almost the same. The soil heat flux is in the range of -30 to 30 W m-2, and the annual average values are 0.8 W m-2 and 1.9 W m-2, respectively. The annual averages of sensible heat are 28.1 W m-2 and 28.2 W m-2, respectively, which are almost the same, but the latent heat is 20.3 W m-2 and 25.6 W m-2, respectively.

Finally, the net ecosystem exchanges (NEE) measured at both sites were analyzed using EddyPro 7 and ToviTM which were jointly developed by LI-COR in the United States and the related research communities. These tools are developed for analyzing carbon absorption, so-called gross primary production (GPP), respiration by ecosystems (RECO) as well as net absorption (NEP=GPP-RECO). The results of daily variation of GPP, RECO, and NEP are shown in Fig. 1. Further analysis shows that, first, only looking into the growing seasons of grassland, GPP at Hustai and Nalaikh site is 527.2 gC m-2 y-1 and 599.2 gC m-2 y-1, respectively, and RECO are 457.2 gC m-2 y-1 and 446.2 gC m-2 y-1, respectively. As a result, the NEP are 87.4 gC m-2 y-1 and 152.5 gC m-2 y-1, respectively, which means both sites are carbon sinks, and about 1.7 times larger at the Nalaikh site than the Hustai site. On the other hand, when we count together both the growing seasons and the non-growing seasons, the annual GPP at two sites are 686.0 gC m-2 y-1 and 654.9 gC m-2 y-1, respectively, and RECO are 700.1 gC m-2 y-1 and 611.8 gC m-2 y-1, respectively. As a result, the annual NEP are -45.2 gC m-2 y-1 and 74.3 gC m-2 y-1, respectively, which means the grassland at the Nalaikh site is a carbon sink, but it is a carbon source at the Hustai site throughout the year. Here, the large uncertainty in the non-growing seasons may be influenced not only by the error of equipment due to freezing but also by the influence of carbon emissions from cities and residents nearby.

Keywords: carbon absorption, pasture area, Mongolia