Geophysical Research Abstracts,
Vol. 10, EGU2008-A-11552, 2008
SRef-ID: 1607-7962/gra/EGU2008-A-11552
EGU General Assembly 2008

Water use efficiency and carbon dioxide fluxes of Siberian natural steppe and old field ecosystems

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Carbon dioxide and water vapour fluxes were monitored by eddy covariance towers between the years 2002 and 2004 in the region of Hakassia (Russian Federation), over a natural steppe (Hak1) and two recovering grasslands (Hak2, Hak3), respectively 5 and 10 years after agricultural land use. Former agricultural fields were found to be characterized by a stronger capacity of carbon sequestration than the steppe ecosystem with the magnitude of the sink decreasing over time from the earlier successional stage towards the mature stage represented by steppe vegetation. Observed net ecosystem productivity (NEP) values ranged between 216.2 $gCm^{-2}yr^{-1}$ and 98.9 $gCm^{-2}yr^{-1}$ and scaled linearly with gross primary productivity (GPP) (R^2=0.94; P$<$0.05).

The evapotranspiration (E) over the steppe ecosystem cumulated during the growing season, from May to October of the three years, was found to balance approximately the limited amount of precipitation fallen during the same period, whereas it was found systematically lower over the old fields meaning that their higher carbon sequestration did not occur at the expense of larger water losses. The 10 day binned water use efficiency (WUE) in the May-October time window observed at Hak1 was 2.3 μmol CO_2/mmolH_2O both in 2002 and in 2003 while interestingly 2.6 μmol CO_2/mmolH_2O in summer 2004 after a fire run over the site possibly exerting a fertilizing effect on the vegetation. Old field ecosystems displayed on average 3.1 μmol CO_2/mmolH_2O for the early stage of succession (Hak2) and 2.7 μmol CO_2/mmolH_2O for the intermediate stage (Hak3).

In the steppe region, where primary productivity is constrained by a low water availability, WUE turned out to be an important parameter to explain differences in the

carbon uptake of different grassland communities.