Japan Geoscience Union Meeting 2010
(May 23-28 2010 at Makuhari, Chiba, Japan)

ACG031-08 Room: 301B Time: May 28 10:58-11:11

Regional assessment of carbon fluxes of larch forests in north-eastern Eurasia

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The northern high latitude region is currently undergoing rapid and drastic warming. The terrestrial ecosystems in this region have responded to the warming climate through various feedback processes. Larch forests are widely distributed in these regions, and expected to play an important role in global carbon and water cycles. Although a number of studies based on the ecosystem models have predicted the carbon cycle in this region, a lack of sufficient validations limited its applicability until recently. In this study, a process-based terrestrial biosphere model, BIOME-BGC, was tested to larch forests at six AsiaFlux sites, and used to identify important environmental factors on the carbon and water cycles in both temporal and spatial scales.

In this study, we extended the BIOME-BGC model to incorporate the soil freezing and thawing dynamics, dynamic allocation for new fine root C to new leaf C constrained by the climate of annual air temperature and precipitation. The model was validated at six tower sites in larch forests distributed from boreal Siberia to cool temperate regions (Ueyama et al., 2009). For the spatial analysis, we used climate data from 1979 to 2008 at 0.2x0.2o spatial resolution using JRA-25 climate data. To validate the model performance of both default and improved models at the regional scale, we conducted the correlation analysis at the spatial and temporal scales; correlation coefficients between climate variables and satellite-derived NDVI (AVHRR-GIMMS) were examined from 1982 to 2006, and then compared with the correlation between climate variables and the simulated GPP, assuming that the satellite-derived NDVI could be surrogate for anomalies of GPP.

Using observed fluxes as a calibration data, the modified BIOME-BGC model successfully simulated the carbon fluxes at daily, monthly, and annual time scales. In the stand and regional scale analyses, (1) the calibrated model by the observed data was significantly improved in both stand and spatial scales, (2) anomalies in satellite derived normalized difference vegetation index (NDVI) may explained by interannual variations of air temperature, and (3) the sensitivity of gross primary productivity (GPP) to weather conditions was seasonally changed; radiation controlled GPP in summer, and temperature limit GPP during spring. According to the regional simulation, GPP and RE in mature larch forests in northern Eurasia to East Asia is 851 and 838 g C m-2 y-1 between 1979 and 2008, indicating that the forest acted as a small carbon sink of 13 g C m-2 y-1.

Ueyama, M. et al. (2009), Simulating carbon and water cycles of larch forests in East Asia by the BIOME-BGC model with AsiaFlux data, Biogeosciences Discussion, 6, 8311-8357.

Keywords: larch, carbon flux, AsiaFlux, BIOME-BGC, satellite remote sensing, CarboEastAsia