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Importance of long-term and ground truth observations on the regional carbon budget evaluation by Satellite RS

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We are conducting tower-based flux observations and ground truth measurements over boreal forests in Interior Alaska. Disturbances by wildfire and environmental stresses have affected the carbon budget of boreal forests. The accurate estimation of regional carbon budget is important issue, and satellite remote sensing (RS) is a powerful tool to reveal the change in vegetation status regionally under current global warming. However, there are still problems to apply RS data for these estimations, because the available ground truth data and long-term datasets have been limited.

Observations are conducted at a mature black spruce forest in UAF's campus (UAF-site, 10 years observation records), and two burned forests (PF-site: 8th year after wildfire with 5 years observation records, and CR-site: 2nd year after wildfire with 2 years observation records). Observed gross primary productivity (GPP) at each site was related empirically with satellite derived parameters such as, fraction of absorbed PAR (FPAR), and enhanced vegetation index (EVI), in order to apply the light-use efficiency (E) model for regional GPP estimation. E and other parameters of the model are determined for both cases of disturbed and undisturbed forests by synthesizing the long-term datasets by field observations, ground truth, and satellite data. The scaling factor among tower-based flux, LANDSAT (30m grids) and MODIS (250m grids) was also determined by fine ground truth observations for regional RS application.

The determined relationships on parameters reproduced RS-products (PAR, FPAR, and EVI) well for both PF- and CR- sites. GPP at PF-site was estimated by the light-use efficiency model with determined parameters, MOD02-band1, MOD13-EVI and NCEP/NCAR weather data. The model outputs reproduced the seasonal variations in GPP for PF-site, and the daily/seasonal amounts were well agreed to those observed over snow-free periods in both 2010 and 2011. Comparing to original GPP estimation, the accuracy of the GPP estimation was improved by the well parameterized E and other RS parameter-observation relationships.

The model with determined parameters were applied to obtain GPP-distribution over black spruce forests in Alaska. GPP was estimated lower at disturbed area and the regional average including fire-disturbance was 5.62 $gCm^{-2}d^{-1}$ in late June, 2011, while that was 6.08 $gCm^{-2}d^{-1}$ for excluding the fire-disturbance. Estimated regional average GPP was about 8% lower for the case including the disturbance-effect. Within the disturbed area, estimated GPP was higher at pixels where wildfire occurred during 1960 and 1990 than those burned recently, which suggested the vegetation changes such as growth of deciduous trees and/or shift to black spruce. The surface change during vegetation recovery processes after wildfire could be detected well as combination of MOD13-EVI and other MODIS products. The results show better performances of satellite based model for carbon budget estimation regionally. Another important result in this study is that the ground truth indexes were well parameterized with satellite derived parameters. The high quality ground truth data were obtained by careful field observations. Availability of long-term field data, ground truth, and RS-data and their synthesis are important.

We hope the field data archived in this study are used for wide range of science and social (public) interests. The studies were supported by multi-funding resources of IJIS (IARC-JAXA-Information System), JSPS (Kakenhi) , NSF, and others.

Keywords: ground truth, long-term observation, regional estimation, terrestrial carbon budget, satellite remote sensing