Geophysical Research Abstracts
Vol. 17, EGU2015-12711, 2015
EGU General Assembly 2015

Effectiveness of statistical method for estimation of water use efficiency in temperate and boreal forests of North America exclusively using MODIS data

Mengjie Wang, Yunhao Chen, and Jinling Quan

College of Resources Science and Technology, Beijing Normal University, Beijing, China (mjwang@mail.bnu.edu.cn, cyh@bnu.edu.cn, jlquan0123@gmail.com)

Water use efficiency (WUE) is an important biophysical variable reflecting the couple of water and carbon cycle in the ecosystem. The canopy level WUE including ecosystem WUE (eWUE) and inherent WUE (iWUE) can be estimated at flux towers, where eWUE is derived from the ratio of gross primary product (GPP) to evapotranspiration (ET) and iWUE is the product of eWUE and vapor pressure deficit (VPD). Upscaling methods are necessary to obtain spatially continuous WUE. Previous methods require field measurement which cannot be easily acquired by remote sensing. Moreover, the effectiveness of statistical method for estimation WUE across different forest types and climates, exclusively using remote sensing, remains unknown. In this study, we calculate 16-day forest WUE at temperate and boreal forests (including deciduous and evergreen forests) of North America using flux tower data and conduct a linear regression between WUE and related variables derived from Moderate Resolution Imaging Spectroradiometer (MODIS), including enhanced vegetation index (EVI), daytime land surface temperature (dLST), leaf area index (LAI), fraction of absorbed photosynthetically active radiation (fPAR) and normalized difference water index (NDWI). Results show that the correlation varies among different sites and variables. EVI, LAI and fPAR result in higher correlation coefficients (R^2) of 0.34-0.75, 0.39-0.68, and 0.35-0.76, respectively, at five deciduous forest sites without much disturbance (e.g. drought). For all of the deciduous forest sites, EVI has the closest relation with eWUE (R^2=0.35, $p<0.001$). The regression coefficient ('slope') could be further calibrated by the minimum EVI of each site (R^2=0.84, p=0.027). However, at all eighteen evergreen forest sites, the correlation between WUE and MODIS variables is not significant. The reason might be that the greenness of evergreen forests varies little within a year and MODIS optical data might not be a proper surrogate for WUE variations. We also compared different responses to the variables between eWUE and iWUE and found that iWUE is more tolerant with climate disturbance. Especially at some water-limited sites suffering from drought, iWUE is much more closely correlated with EVI (R^2=0.55, $p<0.001$) compared to eWUE ($R^2<0.1$, p=0.36). In conclusion, MODIS optical and thermal observations are able to capture the variations of WUE at most deciduous forests and iWUE is much more effective to reflect the inherence of the forest ecosystem especially under environmental disturbance (e.g. drought). This study will be useful for future development of WUE models using remote sensing across different land cover types and climates.