Geophysical Research Abstracts
Vol. 19, EGU2017-14191, 2017
EGU General Assembly 2017

Global variation of carbon use efficiency in terrestrial ecosystems

Xiaolu Tang, Nuno Carvalhais, Catarina Moura, and Markus Reichstein
Germany (xtang@bgc-jena.mpg.de)

Carbon use efficiency (CUE), defined as the ratio between net primary production (NPP) and gross primary production (GPP), is an emergent property of vegetation that describes its effectiveness in storing carbon (C) and is of significance for understanding C biosphere-atmosphere exchange dynamics. A constant CUE value of 0.5 has been widely used in terrestrial C-cycle models, such as the Carnegie-Ames-Stanford-Approach model, or the Marine Biological Laboratory/Soil Plant-Atmosphere Canopy Model, for regional or global modeling purposes. However, increasing evidence argues that CUE is not constant, but varies with ecosystem types, site fertility, climate, site management and forest age. Hence, the assumption of a constant CUE of 0.5 can produce great uncertainty in estimating global carbon dynamics between terrestrial ecosystems and the atmosphere. Here, in order to analyze the global variations in CUE and understand how CUE varies with environmental variables, a global database was constructed based on published data for crops, forests, grasslands, wetlands and tundra ecosystems. In addition to CUE data, were also collected: GPP and NPP; site variables (e.g. climate zone, site management and plant function type); climate variables (e.g. temperature and precipitation); additional carbon fluxes (e.g. soil respiration, autotrophic respiration and heterotrophic respiration); and carbon pools (e.g. stem, leaf and root biomass). Different climate metrics were derived to diagnose seasonal temperature (mean annual temperature, MAT, and maximum temperature, Tmax) and water availability proxies (mean annual precipitation, MAP, and Palmer Drought Severity Index), in order to improve the local representation of environmental variables. Additionally were also included vegetation phenology dynamics as observed by different vegetation indices from the MODIS satellite.
The mean CUE of all terrestrial ecosystems was 0.45, 10% lower than the previous assumed constant CUE of 0.50. CUE varied significantly between sites – from 0.13 to 0.93 – and between ecosystem types, ranging between 0.41 and 0.60, decreasing from wetlands, to tundra, to croplands, to grasslands until the lower CUE found on average for forested ecosystems. Our analysis shows that ecosystem type was the most important predictor of CUE in terrestrial ecosystems, immediately followed by Tmax; MAT and management practices. For crop, forest and wetland ecosystems CUE varied with climate zones and a strong linear negative correlation was found between CUE and MAT and MAP for grassland ecosystems. Overall, the interaction between different environmental variables showed significant effects on CUE for all ecosystem types. Our results challenge the consideration of a constant value of 0.5 for modeling global purposes, and argue for a deeper understanding of environmental controls on CUE for different ecosystem types.