Geophysical Research Abstracts
Vol. 18, EGU2016-18471, 2016
EGU General Assembly 2016

Stand age and climate drive forest carbon balance recovery

Simon Besnard (1,2), Nuno Carvalhais (1,3), Jan Clevers (3), Martin Herold (3), Martin Jung (1), and Markus Reichstein (1)

(1) Department for Biogeochemical Integration, Max-Planck-Institute for Biogeochemistry, Hans-Knoll-Str. 10, 07745 Jena, Germany, (2) Laboratory of Geo-Information Science and Remote Sensing, Wageningen University, P.O. Box 47, 6700 AAWageningen, the Netherlands, (3) Departamento de Ciências e Engenharia do Ambiente, Faculdade de Ciências e Tecnologia, Universidade NOVA de Lisboa, Caparica, Portugal

Forests play an essential role in the terrestrial carbon (C) cycle, especially in the C exchanges between the terrestrial biosphere and the atmosphere. Ecological disturbances and forest management are drivers of forest dynamics and strongly impact the forest C budget. However, there is a lack of knowledge on the exogenous and endogenous factors driving forest C recovery. Our analysis includes 68 forest sites in different climate zones to determine the relative influence of stand age and climate conditions on the forest carbon balance recovery. In this study, we only included forest regrowth after clear-cut stand replacement (e.g. harvest, fire), and afforestation/reforestation processes. We synthesized net ecosystem production (NEP), gross primary production (GPP), ecosystem respiration (Re), the photosynthetic respiratory ratio (GPP to Re ratio), the ecosystem carbon use efficiency (CUE), that is NEP to GPP ratio, and CUE_{climax}, where GPP is derived from the climate conditions. We implemented a non-linear regression analysis in order to identify the best model representing the C flux patterns with stand age. Furthermore, we showed that each C flux have a non-linear relationship with stand age, annual precipitation (P) and mean annual temperature (MAT), therefore, we proposed to use non-linear transformations of the covariates for C fluxes'estimates. Non-linear stand age and climate models were, therefore, used to establish multiple linear regressions for C flux predictions and for determining the contribution of stand age and climate in forest carbon recovery. Our findings depicted that a coupled stand age-climate model explained 33% (44%, average site), 62% (76%, average site), 56% (71%, average site), 41% (59%, average site), 50% (65%, average site) and 36% (50%, average site) of the variance of annual NEP, GPP, Re, photosynthetic respiratory ratio, CUE and CUE_{climax} across sites, respectively. In addition, we showed that gross fluxes (e.g. GPP and Re) are mainly climatically driven with 54.2% (68.4%, average site) and 54.1% (71.0%, average site) of GPP and Re variability, respectively, explained by the sum of MAT and P. However, annual NEP, GPP to Re ratio and CUE_{climax} are affected by both forest stand age and climate conditions, in particular MAT. The key result is that forest stand age plays a crucial role in determining CUE (36.4% and 48.2% for all years per site and average site, respectively), while climate conditions have less effect on CUE (13.6% and 15.4% for all years per site and average site, respectively). These findings are relevant for the implementation of Earth system models and imply that information both on forest stand age and climate conditions are critical to improve the accuracy of global terrestrial C models's estimates.