Geophysical Research Abstracts
Vol. 21, EGU2019-17838-5, 2019
EGU General Assembly 2019

Magnitude and geographical distribution of memory, vegetation, and climate variations' effects on CO_2 flux dynamics

Simon Besnard (1,2), Nuno Carvalhais (1,3), Jan G.P.W Clevers (2), Fabian Gans (1), Martin Herold (2), Martin Jung (1), Ulrich Weber (1), and Markus Reichstein (1)

(1) Max Planck Institute, Biogeochemistry, Germany (sbesnard@bgc-jena.mpg.de), (2) Laboratory of Geo-Information Science and Remote Sensing, Wageningen University, Wageningen, the Netherlands, (3) CENSE, Departamento de Ciências e Engenharia do Ambiente, Faculdade de Ciências e Tecnologia, Universidade NOVA de Lisboa, Caparica, Portugal

Climate extremes and disturbances impact the functioning of terrestrial ecosystems, thereby can alter the carbon (C) balances regionally and globally. Yet, either the memory or the interannual variability (IAV) effects of climate and vegetation on carbon dioxide (CO_2) flux dynamics, including their magnitude and geographic distribution, are poorly understood. Here we present advances in understanding both the memory and IAV effects of vegetation and climate on net ecosystem exchange (NEE), gross primary productivity (GPP) and ecosystem respiration (ER) globally. This analysis relies on a dynamic statistical approach - a type of recurrent neural network (RNN) called Long Short-Term Memory model (LSTM) - that captures temporal dependencies of vegetation and climate fluctuations. LSTM models were used to translate gridded datasets of climate and vegetation variables into time-varying 0.05° grids of NEE, GPP, and ER for the 2001-2017 period. By comparing several spatio-temporal grids of CO_2 fluxes, which vary in the model training procedures (i.e. model trained with either original or randomly permuted order of the predictor-target pairs) or in the presence of IAV in the input variables, we find different magnitude of the effects of memory and interannual vegetation and climate fluctuations on CO_2 fluxes across ecosystems. Around 35% of the global land surface area exhibit substantial memory effects for NEE, while GPP (areal fraction of <5%) and ER (areal fraction of <1%) show limited memory effects across space. But there are widespread and substantial IAV effects of vegetation and climate on NEE, GPP and ER with global land area's fractions of 42%, 40% and 13%, respectively. We find that the spatial patterns of memory effects on CO_2 fluxes are mainly driven by the atmospheric conditions, while both terrestrial biosphere and atmosphere variables have comparable controls on IAV effects. These findings emphasize the importance of capturing memory and IAV effects on CO_2 fluxes to understand the implications of climate extreme events and disturbances on the C cycle.