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Spatial variation in tree mortality

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Climate change, consisting of rising atmospheric carbon dioxide (CO_2) concentrations and an increase in global average temperatures, has currently been accepted as one of the most pressing societal challenges of the 21^{st} century. The increase in atmospheric CO_2 concentrations is a result of carbonsources (mainly fossil fuel) emissions being greater than the uptake by carbon sinks (the oceans and the land). At present the global terrestrial vegetation is a substantial carbon sink, but it is highly variable and its responses to a changing climate are uncertain. An increased atmospheric CO_2 concentration could be beneficial to plant growth. Increased temperatures and more frequent occurrences of drought could lead to plants becoming stressed though, which could make them more vulnerable to for example insect plagues. Whether the global terrestrial vegetation will continue to function as a carbon sink or whether it might turn into a carbon source, will thus depend on the response of the vegetation to the changing climate.

To understand how the global terrestrial vegetation will respond to climate changes, Dynamic Global Vegetation Models (DGVMs) are created within the models used to predict global climate change (Earth System Models, ESMs). These DGVMs contain a growth component (carbon assimilation) and a mortality component. Compared to the growth component, the mortality component is generally modelled in a relatively simple fashion. Most DGVMs assume that carbon loss through mortality occurs at a constant rate or only incorporate some stochastic disturbances to account for e.g. the occurrence of fires. Thus potential variations in mortality due to tree size, age, species or location are generally not taken into account. The objective of this study is thus to identify what determines the variation in tree mortality across vegetation types and environmental gradients in order to improve DGVM predictions.

Large-scale variations in mortality are derived from tree censuses as recorded for the permanent sample plots of the Forest Plots Database[1] (pan-tropical) and the USDA FIA Database[2] (United States; temperate). Mortality rates have been determined in two manners; based on the number of stems and as the amount of biomass lost per unit of area. Both have been compared amongst the world's different biological biomes and tree-dominated realms. Using statistical models, the relations between spatial variations in mortality rates and tree characteristics (e.g. wood density, diameter at breast height and relative growth rate) and environmental characteristics (e.g. temperature and cumulative water deficit) have been quantified. These empirical mortality estimates and the identified mechanistic understanding will be used to improve present DGVM predictions. Through simulating possible future climatic changes, the impacts on mortality and carbon storage implications will be explored.

[1] Lopez-Gonzalez, G., Lewis, S.L., Phillips, O.L., Burkitt, M. Forest Plots Database. http://www.forestplots.net/ Date of extraction [15-04-2010]

[2] USDA-Forest Service. Forest Inventory and Analysis Database. http://fia.fs.fed.us/ Date of extraction [28-09-2010]