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Analyzing the management and disturbance in European forest based on self-thinning theory

Y. Yan (1), B. Gielen (1), M. Schelhaas (2), F. Mohren (3), S. Luyssaert (4), and IA. Janssens (1)

(1) Department of Biology, University of Antwerp, Universiteitsplein 1, 2610, wilrijk, Belgium(yuan.yan@ua.ac.be), (2) ALTERRA, Wageningen University and Research Centre, P.O. Box 47, 6700AA Wageningen, The Netherlands, (3) Forest Ecology and Forest Management Group (FEM), Wageningen University, P.O. Box 47, NL-6700 AA Wageningen, The Netherlands, (4) Laboratoire des Sciences du Climat et de l'Environnement, IPSL-LSCE, CEA-CNRS-UVSQ, 91191 Gif sur Yvette Cedex, France

There is increasing awareness that natural and anthropogenic disturbance in forests affects exchange of CO_2, H_2O and energy between the ecosystem and the atmosphere. Consequently quantification of land use and disturbance intensity is one of the next steps needed to improve our understanding of the carbon cycle, its interactions with the atmosphere and its main drivers at local as well as at global level. The conventional NPP-based approaches to quantify the intensity of land management are limited because they lack a sound ecological basis. Here we apply a new way of characterising the degree of management and disturbance in forests using the self- thinning theory and observations of diameter at breast height and stand density. We used plot level information on dominant tree species, diameter at breast height, stand density and soil type from the French national forest inventory from 2005 to 2010. Stand density and diameter at breast height were used to parameterize the intercept of the self-thinning relationship and combined with theoretical slope to obtain an upper boundary for stand productivity given its density. Subsequently, we tested the sensitivity of the self-thinning relationship for tree species, soil type, climate and other environmental characteristics. We could find statistical differences in the self-thinning relationship between species and soil types, mainly due to the large uncertainty of the parameter estimates. Deviation from the theoretical self-thinning line defined as DBH=$\alpha N^{-3/4}$, was used as a proxy for disturbances, allowing to make spatially explicit maps of forest disturbance over France. The same framework was used to quantify the density-DBH trajectory of even-aged stand management of beech and oak over France. These trajectories will be used as a driver of forest management in the land surface model ORCHIDEE.