Geophysical Research Abstracts
Vol. 15, EGU2013-10243, 2013
EGU General Assembly 2013

Current net ecosystem exchange of CO_2 in a young mixed forest: any heritage from the previous ecosystem?

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For 15 years, networks of flux towers have been developed to determine accurate carbon balance with the eddy-covariance method and determine if forests are sink or source of carbon. However, for prediction of the evolution of carbon cycle and climate, major uncertainties remain on the ecosystem respiration (Reco, which includes the respiration of above ground part of trees, roots respiration and mineralization of the soil organic matter), the gross primary productivity (GPP) and their difference, the net ecosystem exchange (NEE) of forests. These uncertainties are consequences of spatial and inter-annual variability, driven by previous and current climatic conditions, as well as by the particular history of the site (management, diseases, etc.).
In this study we focus on the carbon cycle in two mixed forests in the Belgian Ardennes. The first site, Vielsalm, is a mature stand mostly composed of beeches (Fagus sylvatica) and douglas fir (Pseudotsuga menziesii) from 80 to 100 years old. The second site, La Robinette, was covered before 1995 with spruces. After an important windfall and a clear cutting, the site was replanted, between 1995 and 2000, with spruces (Piceas abies) and deciduous species (mostly Betula pendula, Aulnus glutinosa and Salix aurita).
The challenge here is to highlight how initial conditions can influence the current behavior of the carbon cycle in a growing stand compared to a mature one, where initial conditions are supposed to be forgotten. A modeling approach suits particularly well for sensitivity tests and estimation of the temporal lag between an event and the ecosystem response. We use the forest ecosystem model ASPECTS (Rasse et al., Ecological Modelling 141, 35-52, 2001). This model predicts long-term forest growth by calculating, over time, hourly NEE. It was developed and already validated on the Vielsalm forest. Modelling results are confronted to eddy-covariance data on both sites from 2006 to 2011. The main difference between both sites seems to rely on soil respiration, which is probably partly a heritage of the previous ecosystem at the young forest site.