



Upscaling forest-atmosphere exchange from tower networks – some challenges and limitations

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Despite the recent advances in number and data quality of eddy flux towers in Europe, the upscaling of forest-atmosphere fluxes from local to continental scales is not trivial. Based on a review of several complementary studies it will be shown that additional efforts are necessary in order to interpret observations from flux towers correctly.

In many parts of Europe, the majority of the trees are located in "non-ideal" sites such as small patches of woodland or windbreaks. Controversial findings about the role of woodlands (as compared to grass) in catchment hydrology can often be related to woodland size and to edge effects in heterogeneous landscapes with small forest patches. Observations of higher sap flux density in "edge" compared to "inner" trees and higher basal area near the woodland edge correspond to a large spatial variability in annual forest transpiration per unit ground area depending on woodland geometry. It will be discussed whether such findings also have implications on the carbon balance of fragmented woodlands, and to what extent advection and plant physiology can affect vegetation-atmosphere exchange near the forest edge.

To explain the interannual variability in long-term eddy flux data, biological cycles must be observed and explained, too. It has often been reported that low frequency changes are significant but not consistent. For example, there is a close correlation between fruit production of European beech (*Fagus sylvatica*) and net carbon exchange, however it is still a matter of debate what the main triggers or driving factors of fruit production are. Another example is defoliation by insects that can be detected by satellite images but not yet predicted. For example, the German Meteorological Service can so far only predict the (hypothetical) seasonal starting time of infestations by bark beetle according to weather patterns, but neither the year nor the severity of the attack.

As a consequence of the reported uncertainties, more studies and more data integration are needed both on the carbon balance of fragmented forests that cannot be covered by flux towers and on biological drivers of the interannual variability in carbon and water fluxes such as, for example, the partitioning between vegetative and regenerative growth or the triggers of insect infestations.