Geophysical Research Abstracts
Vol. 15, EGU2013-7908-1, 2013
EGU General Assembly 2013

Biophysical impact of forestation on European climate, as simulated by the RCM COSMO-CLM2

Sam Vanden Broucke (1), Nicole Van Lipzig (1), Sebastiaan Luyssaert (2), and Ivan Janssens (2)
(1) University of Leuven, (2) University of Antwerp

In recent years, afforestation has been proposed as a promising strategy for climate change mitigation. However, when discussing the potential place of forestry in climate change mitigation policy, the biophysical impact of forestation, which could potentially offset or enhance biochemical cooling at the regional scale, is often overlooked. Several studies have therefore tried to quantify the biophysical effects of forestation for Europe, often resulting in conflicting conclusions. For example, while simulations with a GCM show that forestation leads to a mean temperature warming in all mid-latitude climates, some regional simulations for Europe indicate the opposite, and suggest that increased forestation cools the surface by increasing evapotranspiration and precipitation.
The goal of this study is to contribute to the understanding of the biophysical impact of forestation in Europe. As a tool, we use the regional climate model COSMO-CLM2, a version of the non-hydrostatic atmospheric COSMO-CLM model coupled to the Community Land Model. Two one-year simulations were performed: a reference run with default vegetation and a sensitivity run replacing all forest with grassland/tundra. In addition to these model runs, observations for model validation were acquired through FLUXNET, a database of long term ground based ecosystem monitoring using the eddy covariance technique.
Results show strong seasonal and regional differences in the sensitivity of local climate to forestation. The presence of temperate forests on the European mainland leads to a small to moderate biophysical warming of the lower boundary layer (0 to 0.5 K), compared to grassland. The effect is mostly limited to daytime temperatures, and can be attributed to a decrease in reflectivity, which leads to higher sunlight absorption and a relatively small increase in the sensible heat flux coming from the soil vegetation complex (+10%, on average), as well as an increase in latent heat (+2.5%, on average). Moreover, the extent to which the surplus energy associated with forestation is translated into latent rather than sensible heat flux increases as we go south. This is especially true for summer, when, for example, forestation in the southern half of the Italian peninsula leads to a 20% increase in latent heat flux compared to grassland, nullifying the effect of forestation on sensible heat observed farther north.
Boreal European forests (Scandinavia, the Alps), on the other hand, respond differently to the energy surplus associated with a darker land surface. In contrast to the temperate forests elsewhere in Europe, boreal forests decrease total evapotranspiration compared to grassland. As a result, these forests are characterized by a low evaporative fraction and high sensible heat exchange, and their presence leads to a relatively high biophysical warming of the lower boundary layer during daytime (0 to 1.5 K). This is especially true in late winter and spring, when seasonal snow cover greatly increases reflectivity over grassland but only moderately increases reflectivity for forested areas. As a result, the mitigating effect of afforestation on climate change in these regions is uncertain.