Geophysical Research Abstracts
Vol. 18, EGU2016-10092-1, 2016
EGU General Assembly 2016

The impact of European forests on cloud cover: an observation-based study

Ryan Teuling (1), Lieke Melsen (1), Jordi Vila-Guerau de Arellano (2), Chiel van Heerwaarden (2), Diego Miralles (3,4), Chris Taylor (5), Annemiek Stegehuis (6), Jan Fokke Meirink (7), and Gert-Jan Nabuurs (8)

(1) Wageningen University, Hydrology and Quantitative Water Management Group, Wageningen, Netherlands (ryan.teuling@wur.nl), (2) Wageningen University, Meteorology and Air Quality Group, Wageningen, Netherlands, (3) Ghent University Ghent Belgium, (4) VU Amsterdam, Netherlands, (5) Centre for Ecology and Hydrology Wallingford United Kingdom, (6) LSCE Laboratoire des Sciences du Climat et de l'Environnement Gif-Sur-Yvette Cedex France, (7) Royal Netherlands Meteorological Institute De Bilt Netherlands, (8) Alterra, Wageningen, Netherlands

The impact of temperate forests on their environment is still uncertain [1]. While forests generally have a lower albedo, the flux partitioning over forests and its relation to weather conditions is still poorly understood [2,3], complicating attempts to study impacts of forest cover on atmospheric conditions through modeling. Effects of land surface conditions on boundary-layer humidity and cloud formation can also be very non-linear [4]. Furthermore, the study of hydrological and climate impacts of temperate European forests is complicated because forests are strongly fragmented and often can be found on hilly terrain, making it impossible to attribute differences in for instance cloud cover or runoff directly to forest cover. Only few regions exist where forests can be found in absence of strong topography of a size large enough to result in near-equilibrium between the atmospheric boundary layer and local surface conditions.

In this study, we analyse 10 years (2004-2013) of cloud cover observations from the Meteosat Second Generation satellite platform at a 15-minute temporal resolution. These observations come from a physically-based cloud product at the 6 km resolution [5], and a statistical cloud product based on the high-resolution visible imagery (1 km resolution). We focus on two regions in France where large forests are found which satisfy the following criteria: a) absence of strong topography, and b) presence of sharp contrast between forest and non-forest regions. Cloud occurrence is expressed by the fraction of the daytime that clouds are detected within a pixel. We find that in particular in summer and late summer, clouds are much more likely to occur over forest than over the surrounding non-forest land (difference in the order of 0.2). An opposite signal, but of much weaker magnitude, is found during springtime, when clouds are less likely to develop over forest. Difference in cloud occurrence is consistent with MODIS-derived differences in EVI, which reflects a more pronounced soil moisture reduction in the non-forested areas.

In addition to investigating seasonal and diurnal patterns, we also investigate the effects of windthrow on cloud occurrence. In 2009, storm Klaus caused extensive damage in southern France, resulting in a large-scale disturbance of the forest cover conditions. This disturbance lead to a significantly lower cloud cover over the forest region in the period after the storm in comparison to the period before the storm, suggesting that storm damage to forests can have unexpected long-term climate impacts through a reduced cloud cover.

[1] Bonan, G. B. Forests and climate change: Forcings, feedbacks, and the climate benefits of forests. Science 320, 1444-1449 (2008).
[2] Teuling, A. J., et al. Contrasting response of European forest and grassland energy exchange to heatwaves. Nature Geosci. 3(10), 722-727 (2010).
[3] Van Heerwaarden, C. C. & A. J. Teuling (2014), Disentangling the response of forest and grassland energy exchange to heatwaves under idealized land-atmosphere coupling. Biogeosci., 11, 6159-6171 (2014).
[4] Ek, M. B. and Holtslag, A. A. M.: Influence of Soil Moisture on Boundary Layer Cloud Development, J. Hydrometeorol., 5, 86–99 (2004).
[5] Roebeling & van Meijgaard, J. Climate, 22 (2009).