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Air flow over a small clear-cutting area in a spruce forest: results of modelling study

A. Sogachev (1), T. Vesala (1), A. Olchev (2), K. Radler (3), O. Panferov (3)

(1) Department of Physical Sciences, University of Helsinki, Finland, (2) A. N. Severtsov Institute of Ecology and Evolution of RAS, Moscow, Russia, (3) Institute of Bioclimatology, University of Goettingen, Germany (Andrei.sogachev@helsinki.fi / Phone: ++358-9-191 50573)

There is a surprising lack of experimental studies of the airflow structure within transition zones at a forest edge considering that small and medium forested patches are common for European landscapes. Comparing to the expenses of field experiments required to examine the in-depth spatial variation of physical processes at these transitions needed for many practical applications, the modeling is cost-efficient and flexible and, therefore, frequently used as a complementary investigation tool. The two-equation closure approach does not require a predefined mixing length and seems to be naturally suited to modeling of atmospheric flows over heterogeneous surfaces. We applied a three-dimensional atmospheric boundary-layer E–ω closure model SCADIS which accounts for the flow dynamics within a plant canopy (Sogachev et al. 2002, 2005; Sogachev and Panferov, 2006) to describe air flow over a small clear-cutting area within an experimental forest in Solling mountains, Central Germany. The objectives of this study were (1) to describe the spatial heterogeneity of wind field and turbulent kinetic energy over the forest clearing as a function of both speed and direction of upstream flow, (2) to quantify changes in the flow regime and (3) to evaluate the risk of windthrows at forest edges exposed by the clear- cutting. The importance of the last objectives was amplified by the strong windthrow events at the north-eastern boundary of the study site in spring of 2004 and 2007. Modelling effort was supported by results of continuous measurements of wind speed and direction (at 2 m above ground) by means of 7 automatic meteorological stations located within and around the clear-cutting area. Comparative analysis revealed an adequate agreement

between modelled and measured parameters. Modelling results showed a very strong spatial heterogeneity of turbulent parameters within the studied clear-cut. The risk of windthrow is maximal at the windward forest boundary. It can, however, be reduced by optimising the form and dimensions of clear-cutting area and of its orientation in relation to dominating wind direction. This study was supported by the Nordic Centre of Excellence (NECC) and the DFG (Grant Gr 738/16-1).