Effects of forest cover changes on regional weather conditions - results of a modeling study

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The study intends to estimate the influence of forest cover change on regional weather conditions using the non-hydrostatic model COSMO. The main attention is paid on changes of spatial temperature and precipitation patterns as well as of the frequency of severe weather events, such as frosts, fogs, heavy rains, wind gusts, etc. For the numerical experiments a modeling domain located between 50˚-70˚N and 15˚-55˚E, and covering almost the entire area of the East European plain was selected. The output of the numerical experiments was provided at a 6 km grid spacing. The ERA-Interim global atmospheric reanalysis was used to quantify the initial and boundary conditions.
The central part of the East European Plain was selected as the model region for the study. It is situated in the central part of the model domain and is bounded by coordinates 55˚ and 59˚N and 28˚ and 37˚E. The forests cover about 50% of the area and consist mainly of coniferous tree species in the north and broad-leaved species - in the south. Within the model region the three main scenarios of forest cover change were simulated. The first modeling scenario assumed the total deforestation of the model region. The second experiment was a scenario of its total afforestation. It assumed the suspension of logging and active forest regeneration and growth in agricultural and abandoned lands. In the third ‘control’ experiment the weather conditions were simulated under the present land-use and vegetation patterns of the 'model region'.
For our modeling experiments, the period from May to September of 2010 was used. It was characterized by various and very contrasting weather conditions. A unique feature of the selected period was extremely hot and dry weather in the middle of summer (July - August).
The results of numerical experiments showed that the modern forest cover and land-use changes can significantly influence the atmospheric parameters, not only within the selected model region, but also in the areas situated within the modeling domain far away from the actual model region (Figure 1). The spatial patterns of the temperature and precipitation changes under deforestation and afforestation scenarios show their very strong spatial heterogeneity. Whereas the significant changes of the air temperature can be seen in internal areas of the model region only, the changes of precipitation amount can be traced within the entire modeling domain (Kuzmina et al 2017).
Under the scenario imitating deforestation processes the mean air temperature within the model region was higher than that was obtained in the control experiment. Under the afforestation scenario the mean air temperature, on the contrary, was lower than under the control conditions. The maximum temperature differences between both scenarios imitating the forest cover changes and the control experiment were obtained for the summer months (July): +0.6˚C –for the deforestation scenario and -0.1˚C –for the scenario with afforestation, respectively.
The influence of forest cover change within the model region on precipitation is manifested in an increase of its total amount under the afforestation scenario, and in its decrease under the scenario imitating total deforestation. The maximum increase of precipitation (+4.8%) for the model region under the afforestation scenario was predicted for June-July, and its maximum decrease (-8.8%) under deforestation scenario for July - August, i.e. in the hottest months of 2010.
Results of modeling experiments showed also a strong effect of forest cover changes on the frequency of

severe weather events. Deforestation can lead to more frequent severe weather phenomena that are unfavorable for agriculture and any other economic activity (e.g. frosts, wind gusts) in the region. Influence of forest cover changes on fogs was ambiguous and dependent on time of days and regional synoptic processes.

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Keywords: forest cover change, regional weather conditions, numerical experiments with the COSMO model, air temperature and precipitation pattern, severe weather events

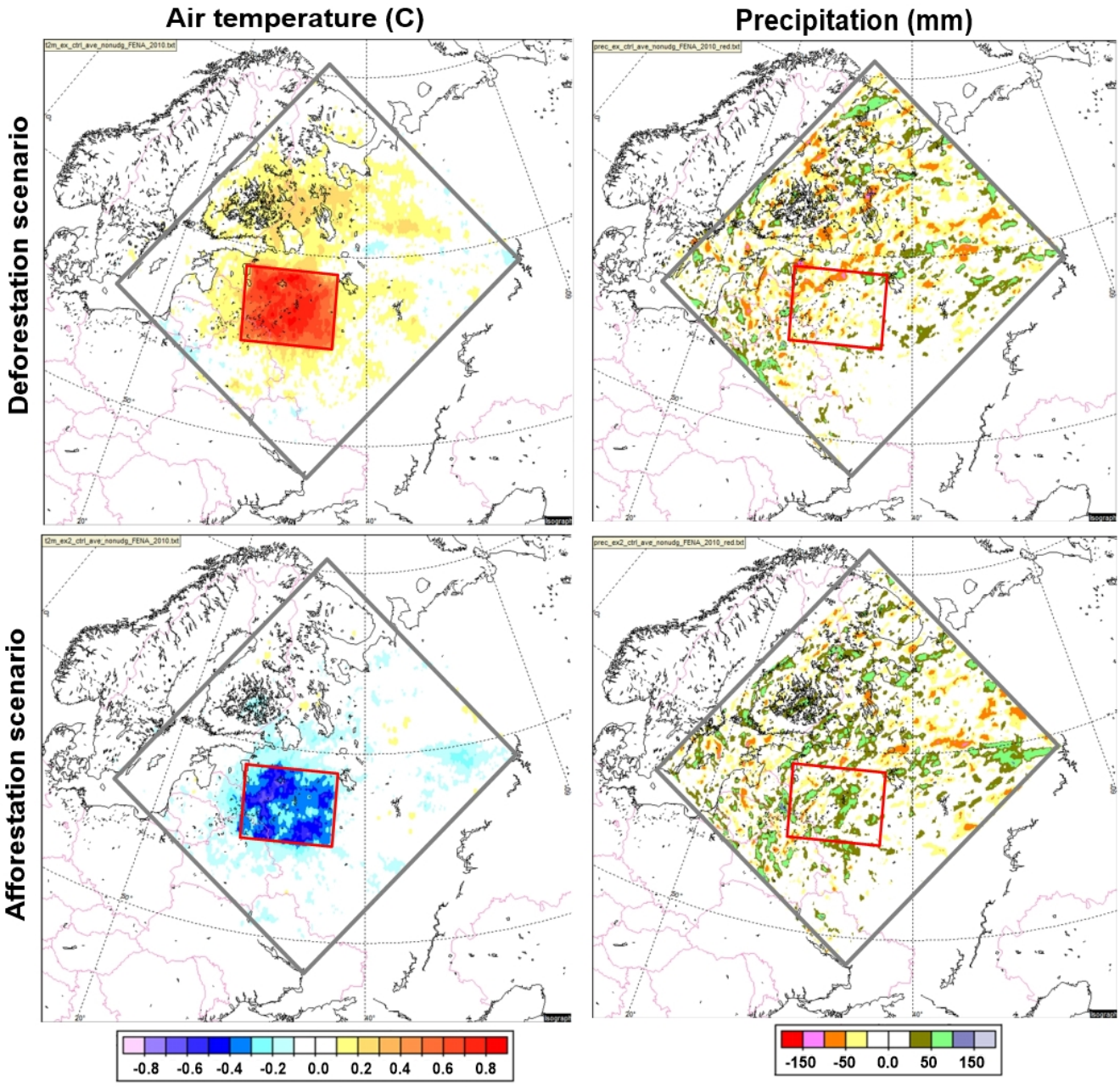

Figure 1. Simulated differences in the air temperature (°C) and precipitation rate (mm) for the selected model domain between the deforestation and afforestation scenarios of the model region and the control experiment, assuming present land-use structure

