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Impact of deforestation on surface radiative properties and temperature characteristics in Ukraine based on LUMIP CMIP6 datasets

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The impact of temperate forests on climate still has open questions about their quantitative effect on radiative and thermal properties of the territory. The study addresses some of these questions and the analysis is based on the data from the Land-Use Model Intercomparison Project (LUMIP), which is the part of Coupled Model Intercomparison Project Phase 6 (CMIP6). The main aim of CMIP is to study climate on different periods of time from the past to the future with help of observations and Earth System Models (ESM).

LUMIP belongs to historical experiments and implies gradual deforestation with linear trend up to 1% all over the world during 50 years in pre-industrial period (1850-1899) and next 30 years with no change in forest cover. The goal of this experiment is to reveal the contribution of forest cover reduction on climate characteristics under quasi-constant anthropogenic forcing. This experiment was based on ESM simulations and the dataset of 8 ESM was retrieved for calculations of different climatic characteristics for the territory of Ukraine. These models have different spatial resolution, the initial and the final forest cover in grid cells respectively. Therefore, we analysed ESMs one-by-one and summarised the results over latitudinal zones. To analyse radiative regime we used monthly data of downwelling and upwelling shortwave radiation, which affect thermal regime estimated via surface and 2-m air temperature changes as well as mean daily and annual ranges. Anomalies of each characteristics were obtained over the base averages of the first 20 years of deforestation (1850-1869), which were further smoothed using the 5-year running mean.

It is known that the forest cover influences the ratio of surface downwelling and upwelling shortwave radiation, particularly, via albedo. We found the highest changes in albedo in winter season, most probably due to the presence of snow cover. Increase of albedo is well correlated with deforestation and the maximal rate of 18%/50 years was found in the Carpathians in winter. There were much less changes in warm season with rates up to 2%/50 years due to small difference between values of forest (~3-10%) with grass (~10-30%) than snow albedo (~40-90%).

These changes in radiative properties cause shifts in temperature regime with moderate and strong negative correlations between albedo and both surface and air temperatures. Higher albedo in winter season caused the decrease of mean monthly surface temperature up to -0.4□/10 years in winter and -0.3□/10 years in warm season. Values of changes of mean monthly air

temperature corresponded to surface temperature changes and they were -0.4□/10 years in winter and -0.2□/10 years in warm season. Based on mean maximum and minimum monthly temperatures we found that deforestation also affected mean daily air temperature range only in winter with tendency up to 0.1–0.3□/ 10 years. Meanwhile the models showed controversial results for annual air temperature range. One of the essential research outcomes we found that the impact of gradual deforestation on the thermal regime was shifted on approximately 20 years and diminished after stopping land cover change.