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Effects of deforestation on extratropical cyclones and precipitation over Europe

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Deforestation affects land-atmosphere interactions in a number of ways, including changes in evapotranspiration, albedo and surface roughness. Effects of deforestation on climate can be dominated by one or more of these factors, depending on the latitude, available moisture and large-scale circulation patterns. In the midlatitudes, extratropical cyclones have a considerable influence on weather and climate, including extremes. Here we study the effects of changing forest cover over Europe on extratropical cyclones and consequently climate. The effects of four different forest covers over Europe on climate are simulated using the regional climate model RCA4: the current (control) forest cover, complete potential afforestation, complete deforestation, and complete deforestation but with afforestation roughness lengths.

We find that the effects of deforestation on mean climate can have opposite signs for different regions, mostly depending on the latitude. Using a cyclone-tracking algorithm, we study the spatial distribution of the number and intensity of cyclones, as well as their effects on precipitation. The number of cyclones over Europe is about 40% larger in the deforestation case compared to afforestation. The increase is mostly due to the decreased surface roughness in the deforestation case, as corroborated by the simulation with changed roughness lengths. While this mechanism itself is not surprising, this is the first time that its effect on the climatology of cyclones has been quantified. We further find that the cyclone-related precipitation can be larger by up to 80% compared to the afforestation case.

The effects on total mean precipitation are different for different regions of Europe. Since northern Europe is more frequently affected by cyclones, the mean precipitation there is also increased in the deforestation case. On the other hand, some regions in central and southern Europe experience a decrease of mean precipitation, which is caused by reduced evapotranspiration without forest cover.