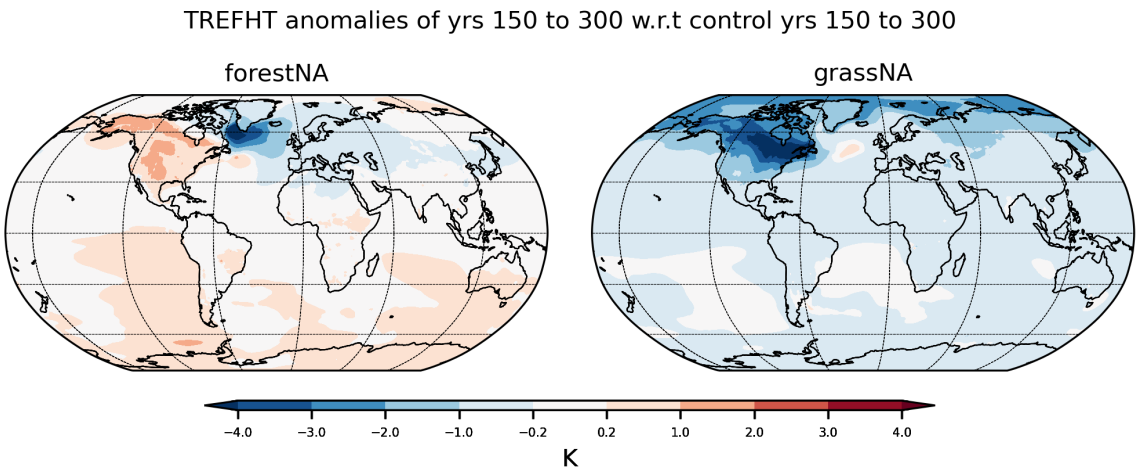
Effects of forestation and deforestation over North America on remote weather and climate

Large scale increase of forest cover has been proposed as an effective climate change mitigation option. Apart from reducing carbon dioxide levels, however, a change of surface vegetation also impacts weather and climate in other ways. In comparison to grasslands, forested areas have a lower albedo, lower surface roughness, but enhanced evapotranspiration, which all affect the atmospheric circulation locally and remotely through teleconnections. Previous model results have shown that afforestation and reforestation over the North American continent lead to a global temperature increase. Simultaneously, North Atlantic sea surface temperatures decrease which is a phenomenon termed as "North Atlantic warming hole". Interestingly, the temperature response to deforestation is of opposite sign up to regional variations.

Using global Earth System models, we found that global-scale forestation as well as forestation over North America leads (locally and remotely) to warmer near-surface temperatures and affects wind patterns by changes in surface roughness. Consequently, following forestation over North America, air transported towards the North Atlantic is warmer, which reduces air-sea heat fluxes in the Labrador Sea and Gulf Stream (and vice versa for deforestation). This drives changes in the ocean circulation resulting in reduced overturning and local cooling of sea surface temperatures. In modeling experiments with global-scale forestation and deforestation we also found considerable remote effects on the tropical circulation (Hadley cell) and the jet streams. However, the remote atmospheric circulation response over Europe or expected changes to the Hadley cell have not yet been investigated in the simulations with forestation and deforestation over North America. Addressing these questions will shed further light on how extratropical changes in forest cover affect remote weather and climate.



Aims of thesis:

- Investigating downstream effects of forestation and deforestation over North America on European weather and climate.
- Analysing the remote effects of forestation and deforestation over North America on Hadley cell circulation and tropical precipitation patterns.
- Studying changes in heat transport on the global scale.

The data basis for this thesis are 6-hourly data of 5x300 years of CESM2 simulations, including cyclone tracks and Lagrangian trajectories

Requirements: Interest in combining mid-latitude atmospheric dynamics with land/ocean-atmosphere interactions, and processes on the climate time scale. Interest to analyse large climate model datasets.
Basic knowledge or interest in programming, ideally python.

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