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Leaves, land-atmosphere interactions and extremes

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Leaves are the main interface between terrestrial ecosystems and the atmosphere. They govern the exchange of carbon, water and energy between vegetation and the atmospheric boundary layer. They are the surface designed to capture light and transform it to sugars via photosynthesis, but they also regulate how much water they transpire through their stomata. Their colour, density and orientation will affect their albedo, which determines how much energy is reflected back to the atmosphere, while their overall configuration within the canopy structure can affect the roughness length of the surface.

When we manage landscapes, be it by planting crops or cutting down forests, we are typically changing the quantity and type of leaves covering the surface of the land. By doing so, we can modify the land-atmosphere interactions and thereby have an effect on the climate. For instance, a substantial local cooling effect could be attained by using cover crops in winter, especially with highly reflective chlorophyll deficient mutants. Increasing forest cover appears to lead to more cloud cover, which itself could affect albedo at the top of the atmosphere. But the amount of leaves in the landscape can further affect extremes.

Here I will illustrate how leaves affect land-atmosphere interactions in the context of extreme events with two studies. The first study looks at the known biophysical effect of land use change on local surface temperature, but extends it to explore its sensitivity across the globe during the extremes observed in 20 years of satellite remote sensing records. The second study shows how much getting leaves right matters within the reanalysis records of ERA5 and ERA5-Land, where prescribed seasonal cycles of leaf area index (LAI) lead to biases in modelling land surface temperature (LST), thereby underestimating the intensity of heat waves over Europe.