EGU 2022 abstract

Title:
How getting the leaves right matters to represent heatwaves across Europe: case study of ERA5 and ERA5-Land

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Text:

Heatwaves are expected to increase in frequency over Europe as a consequence of climate change. It is thus imperative to ensure they are correctly represented in some of our best tools to describe the atmosphere and the land, such as the ERA5 reanalysis and its downscaled land component ERA5-Land. While these meteorological reanalyses ingest a large number of observations into a land-atmosphere modelling framework through data assimilation, they do not always represent that status of the land surface in a highly detailed manner. Yet, the state of the land surface, and more specifically that of vegetation, is known to affect heatwaves, potentially amplifying them. In this respect leaves play a prominent role, as they represent the main interface between vegetation and the atmosphere and modulate the exchanges in carbon, water and energy fluxes. The biophysical variable known as leaf area index (LAI), defined as half the total green leaf area per unit horizontal ground surface area, can be used to summarise the status of vegetation incorporating not only changes in leaf phenology but also those caused by land cover change. Moreover, LAI can conveniently be estimated from satellite remote sensing observations across space and time. The objective of this study is to analyse how the misrepresentation of LAI in ERA5 and ERA5-Land can have a consequence on the characterization of European heatwaves. In ERA5 (and by extension also in ERA5-Land), LAI is prescribed. That means that the seasonal cycle of LAI is fixed for every pixel based on a climatological mean. As a consequence, if the season was advanced or delayed, or if the LAI is lower than normal (as could be expected in a heatwave), a discrepancy occurs with what is simulated, with possible consequences on the surface energy balance and the resulting land surface temperature (LST). While previous analyses have reported that LAI biases in ERA5 can lead to biases in LST, none have considered the dynamic nature of these biases. Here we first do an overall evaluation of how these biases co-vary following particular hysteretic patterns. We then focus on how these affect three specific heatwaves in Europe during the summers of 2003, 2010 and 2018. We show that in years of heatwaves, the overestimation of LAI by the prescribed seasonal cycle within ERA5 coincides with an amplification of the LST bias with respect to satellite observations. As a result, the magnitude of heatwaves appears to be larger than what is represented in ERA5. These results call for a renewed effort in ingesting LAI

dynamically into reanalysis schemes in order to better characterize the land-atmosphere interactions for climate extremes.

Target session:
Land–atmosphere interactions and climate extremes

Land–atmosphere interactions often play a decisive role in shaping climate extremes. As climate change continues to exacerbate the occurrence of extreme events, a key challenge is to unravel how land states regulate the occurrence of droughts, heatwaves, intense precipitation and other extreme events. This session focuses on how natural and managed land surface conditions (e.g., soil moisture, soil temperature, vegetation state, surface albedo, snow or frozen soil) interact with other components of the climate system – via water, heat and carbon exchanges – and how these interactions affect the state and evolution of the atmospheric boundary layer. Moreover, emphasis is placed on the role of these interactions in alleviating or aggravating the occurrence and impacts of extreme events. We welcome studies using field measurements, remote sensing observations, theory and modelling to analyse this interplay under past, present and/or future climates and at scales ranging from local to global but with emphasis on larger scales.