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Constraining climate analysis and climate change projections over Europe using land heat flux observations

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In the coming decades more frequent and more severe heatwaves are expected to occur over Europe, with consequences for amongst others human health and ecosystems. To reduce negative impacts, an early warning system would be useful. Hot summer years are known to be preceded by Southern Europe rainfall deficit, and such a signal might also be present for other climate variables. Because land-atmosphere feedbacks are expected to become more important in large parts over Europe, it is useful to consider variables that are relevant to these feedbacks.

In this study we analyze latent (LH) and sensible heat (H) flux in observation based data and regional climate models (RCMs) from the ENSEMBLES project with the aim 1) to study the evolution of the fluxes with in particular the difference between warm and cold summer years, and the possibility to use land fluxes as early indicator for heatwaves; 2) to evaluate the ability of RCMs to capture both the seasonal cycle and interannual variability of the fluxes; and 3) to investigate whether heat fluxes can be used to constrain temperature projections, because strong feedbacks in the current climate might lead to more climate warming in future scenarios.

We find that warm summers are preceded by a positive springtime LH anomaly. During these summers both fluxes increase over the largest part of Europe, but there is a LH deficit of the Iberian Peninsula, indicating a soil moisture limited regime in this area. In general the RCMs overestimate LH and underestimate H in the seasonal cycle as compared to observation based data. In the difference between warm and cold summer years H tend to increase too much in late spring, probably leading to too strong drying, a LH deficit, and the establishment of a soil moisture limited regime over Europe in summer. Land heat flux observations suggest that temperature projections may regionally be slightly underestimated in Central-Western Europe to Northern Europe, but overestimated over the Mediterranean and the Balkan in the RCM ensemble mean. With the use of H observations we were able to reduce uncertainty in temperature change predictions up to regionally 40%.