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Storylines of plausible past and future climates for the July 2019 European heatwave

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Under the current global warming trend, heatwaves are becoming more intense, frequent, and longer-lasting; and this trend will continue in the future. In this context, the recent 2019 summer was exceptionally hot in large areas of the Northern Hemisphere, with embedded heatwaves, as for example the June and July 2019 European events, redrawing the temperature record map in western Europe. Large-scale dynamics (associated with blockings or subtropical ridges) play a key role in explaining these-large scale events.

Conceptually, global warming can be split into two different contributions: Dynamic and thermodynamic changes. Whereas dynamic changes remain highly uncertain, some thermodynamic changes can be quantified with higher confidence. We exploit this concept by studying how these recent European heatwaves would have developed in a pre-industrial climate and how it would develop in the future for 1.5, 2 and 4 ºC warmer climates (storyline scenarios). To do so, we employ the spectral nudging technique with AWI-CM (CMIP6 model, a combination of ECHAM6 AGCM + FESOM Sea Ice-Ocean Model). Large-scale dynamics are prescribed by reanalysis data (ERA5). Meanwhile, the model is run for different boundary conditions corresponding to preindustrial and future climates along the SSP370 forcing scenario. This approach can be useful to help understand and communicate what climate change will mean to people’s life and hence facilitate effective decision-making regarding adaptation to climate change, as we are quantifying how recent outstanding events would be modified by our climate action.

Temperatures during the heatwaves often increase twice as much as global mean temperatures, especially in a future 4 ºC warmer climate. In this future climate, maximum temperatures can locally reach 50ºC in many western Europe countries. Nighttime temperatures would be similar to the daytime temperatures in a preindustrial world. The global warming amplification can be partly explained by a robust soil drying in the future 4 ºC warmer climate (exacerbated due to the June 2019 heatwave) which is transmitted to a robust increase in Bowen ratio. Importantly, by design of our study, this response occurs without any changes in atmospheric circulation.