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A Regional Perspective of Storyline Simulations of the Recent European Summer Heatwaves

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Heatwaves are a major natural hazard affecting Europe, and their maximum temperatures are projected to increase strongly with climate change. In recent years, the event-based storyline approach has proven its applicability for climate change attribution studies. Constraining the large-scale dynamics to that of the recent past serves to separate the thermodynamic effects of increasing greenhouse gas concentrations from the largely uncertain dynamic changes. Within the SCENIC project, the storylines are produced with the spectrally nudged global coupled AWI-CM1 model (90 km horizontal resolution). They are downscaled with ICON-CLM to the Euro-Cordex (12 km) and subsequently to the central European domain (3 km). Using this model chain, we captured the series of European summer heat waves and droughts of 2018-2022. We placed them into the pre-industrial climate and three environments corresponding to +2, +3, and +4 K warmer worlds. We quantified the warming rate per degree of global warming (which sometimes exceeds 2.5 over larger areas) and assessed the role of soil-atmosphere feedback in contributing to these rates. More specifically, for several European heatwaves, we explored the connection of the evaporative regime of a region affected by a heatwave to the region's response to global warming during this event. Taking advantage of the high signal-to-noise ratio of event-based storylines, we add one more dimension - the global warming level - to the scope of land-atmosphere feedback studies.