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The Extreme Flooding of July 2012 in Krymsk, Russia, from a Climate Perspective

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One of the most devastating meteorological extremes during recent years has been the extreme precipitation event along Russia's Black Sea coast, near the town of Krymsk, during the 6th and 7th of July 2012. The town was inundated by the ensuing downslope deluge; torrents of water caused widespread destruction and lead to over 170 deaths. The extreme precipitation was caused by a low pressure system that advected warm and moist air north-eastwards from the Black Sea. Whether global warming contributed to the unprecedented magnitude of this event remains unclear.

Sea surface temperatures in the Black Sea have exhibited a strong and continuous upward trend over the last decades, with warming exceeding 2K in some regions. As the Black Sea served as the principal moisture source for the observed extreme precipitation, we investigate the impact of the increased SSTs on the properties of the cyclone and the resultant magnitude of the precipitation.

This is done by employing ensemble sensitivity simulations with the WRF regional model, in both nudged and unnudged mode. The model is run for an eastern Black Sea domain using multiply nested sub-domains increasing up to very high, convection resolving, resolution to simulate the observed event. The model's ability to reproduce the extreme event is first verified. The simulations are then repeated with reduced SST, characteristic of the last decades of the 20th century.

Our results suggest that such an extreme event would not have been possible without the current warmed SSTs. We find that the increased SSTs played an important role in amplifying the precipitation experienced near Krymsk, facilitating enhanced moisture fluxes and increasing instability within the planetary boundary layer (PBL). While the location of the heaviest precipitation remains broadly similar, the magnitude of the simulated precipitation caused by the same cyclone passing over the cooler SSTs was reduced, on average, by a factor of three or more in most places. Likewise, surface evaporation from the Black Sea is decreased by a factor of three to four over much of the eastern Black Sea, giving reduced moisture advection towards the coastal hills surrounding Krymsk. An analogous decrease in surface latent heat fluxes adds stability to the PBL through reduced moisture and heat, the latter indicated by a more than twofold decrease in PBL heights.