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The extreme 2013/2014 winter in a future climate

Lucinda Rasmijn (1), Gerard van der Schrier (1), Jan Barkmeijer (1), Andreas Sterl (1), Wilco Hazeleger (1,2)
(1) Royal Netherlands Meteorological Institute, De Bilt, Netherlands (schrier@knmi.nl), (2) Wageningen University, Wageningen, The Netherlands

How would the spell of extreme weather observed over North America and western Europe during the 2013/2014 winter manifest itself in a warmer climate? Here a Forced Sensitivity method is used to calculate optimal model tendency perturbations which result in a simulation which has its atmospheric circulation shifted in the direction of the anomalous January 2014 pattern.

We apply this novel technique to a simulation run under present-day conditions which reproduces the main features of the observations of this event, such as the position and strength of the mid-latitude North Atlantic storm track, the temperature pattern over North America and the excessive precipitation in parts of Europe. When this method is applied to the future climate, we find that the mid-latitude North Atlantic storm track changes to a more zonal orientation, similar to the present-day simulations, but with less vigour compared to the present-day simulations.

Despite southward advection of polar air into Northeastern America, which has occurred during the 2013/2014 winter, the associated drop in temperature is less in the future climate than in the present day climate because of the strong warming at high latitudes in a future climate. The less steep drop in temperatures over Northeastern America leads to a smaller land-sea temperature contrast, less baroclinic instability and a decrease of mid-latitude storminess for this event, despite the increased atmospheric moisture content in the warmer climate. The increase in precipitation related to the equivalent of the 2013/2014 winter in a warmer climate is comparable to the one observed in the present-day climate.