Geophysical Research Abstracts
Vol. 19, EGU2017-5618, 2017
EGU General Assembly 2017

Reanalysis of the 1893 heat wave in France through offline data assimilation in a downscaled ensemble meteorological reconstruction

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The knowledge of historical French weather has recently been improved through the development of the SCOPE (Spatially COherent Probabilistic Extended) Climate reconstruction, a probabilistic high-resolution daily reconstruction of precipitation and temperature covering the period 1871–2012 and based on the statistical downscaling of the Twentieth Century Reanalysis (Caillouet et al., 2016). However, historical surface observations – even though rather scarce and sparse – do exist from at least the beginning of the period considered, and this information does not currently feed SCOPE Climate reconstructions. The goal of this study is therefore to assimilate these historical observations into SCOPE Climate reconstructions in order to build a 150-year meteorological reanalysis over France.

This study considers "offline" data assimilation methods – Kalman filtering methods like the Ensemble Square Root Filter – that have successfully been used in recent paleoclimate studies, i.e. at much larger temporal and spatial scales (see e.g. Bhend et al., 2012). These methods are here applied for reconstructing the 8-24 August 1893 heat wave in France, using all available daily temperature observations from that period. Temperatures reached that summer were indeed compared at the time to those of Senegal (Garnier, 2012). Results show a spatially coherent view of the heat wave at the national scale as well as a reduced uncertainty compared to initial meteorological reconstructions, thus demonstrating the added value of data assimilation.

In order to assess the performance of assimilation methods in a more recent context, these methods are also used to reconstruct the well-known 3-14 August 2003 heat wave by using (1) all available stations, and (2) the same station density as in August 1893, the rest of the observations being saved for validation. This analysis allows comparing two heat waves having occurred 100 years apart in France with different associated uncertainties, in terms of dynamics and intensity.

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