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Spatio-temporal variability of Arctic summer temperatures over the past two millennia

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We present the first spatially resolved and millennium-length summer (June - August) temperature reconstruction over the Arctic and Subarctic domain (north of 60°N). The reconstruction is based on a set of 44 annually dated temperature sensitive proxy archives of various types, mainly from the updated and revised PAGES2k database supplemented with 6 new recently updated proxy records. The technique applied is a recent extension of the Bayesian BARCAST which explicitly treats climate archives with dating uncertainties which previously would be used on their “best guess” chronologies. In total BARCAST generated over 600 independent possible realisations of the past Arctic summer temperatures, enabling further analyses to be carried out in a probabilistic framework.
The new seasonal CF reconstruction for the Arctic region is skilful for the majority of the terrestrial nodes. The decrease in the proxy data density back in time however limits the analyses in the spatial domain to the period after 750 CE, while the spatially averaged reconstruction covers the entire time interval of 1 - 2002 CE. The analysis is focused on major climate tendencies of the CE including a regional expression of past major climate anomalies.
The long-term, centennial to millennial, evolution of the reconstructed temperature is in good agreement with a general pattern that was inferred in recent studies for the Arctic and its sub-regions. The reconstruction shows a pronounced Medieval Climate Anomaly (MCA, here, ca. ∼920 - 1060 CE), which was characterised by a sequence of extremely warm decades over the whole domain. The medieval warming was followed by a gradual cooling into the Little Ice Age (LIA), with 1766 - 1865 CE as the longest centennial-scale cold period, culminating around 1811 - 1820 CE for most of the target region.
While our analysis shows that the peak MCA summer temperatures were as high as in the late 20th and early 21st century, the spatial coherence of extreme years over the last decades of the reconstruction (1980s onwards) seems unprecedented at least back until 750 CE. However, statistical testing could not provide conclusive support of the contemporary warming to exceed the peak of the MCA in terms of the pan-Arctic mean summer temperatures: neither can the reconstruction be extended reliably past 2000 CE due to lack of proxy data and thus the most recent warming is not captured, nor is it (from a statistical viewpoint) advisable to directly compare the reconstruction and instrumental data.