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Atmospheric Circulation Variability During the Past 120 Years

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In order to better understand climate variability, it is important to relate climate at the Earth's surface, as it is measured, documented or reconstructed from proxy data, not only to possible drivers of its variability, but also to the large-scale atmospheric circulation that links the two. The focus on circulation variability provides an important perspective that allows process-oriented assessment of models and provides diagnostics for assessing changes in the climate system, both in the past and present. Up to now, analysis of the global atmospheric circulation was either limited to the reanalysis period, i.e., after 1948 (a relatively short period that includes strong trends) or are restricted to the Earth's surface (which does not allow analyzing important features of the large-scale circulation). In particular, with respect to interpreting past climate variations documented with proxies, a sufficiently long overlap between proxies and observation-based circulation data is often not found.

Here we present new approaches of reconstructing global 3-dimensional atmospheric circulation variability back into the 19th century. The approaches are based on newly digitised and compiled historical observations and numerical techniques such as statistical reconstructions, historical reanalyses and climate modelling and are linked to the ACRE (Atmospheric Circulation Reconstruction over the Earth) initiative (http://www.met-acre.org/).

Using examples of strong circulation variations on different time scales (storms in Europe, global effects of the 1939-1942 El Niño, and the 1910s to 1940s Arctic warming) we demonstrate the usefulness of the new data sets, discuss the underlying physical processes and specifically show the imprint of these particular events in natural archives such as ice cores and other proxies. We also illustrate the representation of these events in state-of-the-art climate models.

The presentation aims at stimulating the discussion on how we can use, in a quantitative way, current knowledge on circulation variability together with new numerical techniques for better interpreting past climate variability as it is recorded in natural archives.