Geophysical Research Abstracts
Vol. 15, EGU2013-8637, 2013
EGU General Assembly 2013

Amplification of European Little Ice Age by sea ice-ocean-atmosphere feedbacks

Flavio Lehner (1,2), Andreas Born (1,2), Christoph C. Raible (1,2), Thomas F. Stocker (1,2)

(1) Climate and Environmental Physics, University of Bern, Switzerland, (2) Oeschger Centre for Climate Change Research, University of Bern, Switzerland

The transition from the Medieval Climate Anomaly (∼950-1250 AD) to the Little Ice Age (∼1400-1700 AD) is believed to have been driven by an interplay of external forcing and climate system-internal variability. While the hemispheric signal seems to have been dominated by solar irradiance and volcanic eruptions, the understanding of mechanisms shaping the climate on continental scale is less robust. Examining an ensemble of transient model simulations as well as a new type of sensitivity experiments with artificial sea ice growth, we identify a sea ice-ocean-atmosphere feedback mechanism that amplifies the Little Ice Age cooling in the North Atlantic-European region and produces the temperature pattern expected from reconstructions. Initiated by increasing negative forcing, the Arctic sea ice substantially expands at the beginning of the Little Ice Age. The excess of sea ice is exported to the subpolar North Atlantic, where it melts, thereby weakening convection of the ocean. As a consequence, northward ocean heat transport is reduced, reinforcing the expansion of the sea ice and the cooling of the Northern Hemisphere. In the Nordic Seas, sea surface height anomalies cause the oceanic recirculation to strengthen at the expense of the warm Barents Sea inflow, thereby further reinforcing sea ice growth in the Barents Sea. The absent ocean-atmosphere heat flux in the Barents Sea results in an amplified cooling over Northern Europe. The positive nature of this feedback mechanism enables sea ice to remain in an expanded state for decades to centuries and explain sustained cold periods over Europe such as the Little Ice Age. Support for the feedback mechanism comes from recent proxy reconstructions around the Nordic Seas.