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Arctic climate processes and European climate evolution on interannual to multidecadal time scales

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We present the results of climate simulations for the period 1500 to 2100 with a state-of-the-art coupled atmosphere-ocean general circulation model, which has been driven with all relevant forcings, both natural (solar variability, latitudinally dependent volcanic aerosol) and anthropogenic (greenhouse gases, sulphate aerosol, time-varying land-use changes). Simulations differ in the parameterization of temperature dependence of snow albedo and the inclusion of melt ponds on the sea ice in the Arctic, in better agreement with observations.

Even though there is no dynamical feedback, the model is able to simulate individual extreme events such as the "year without a summer" 1816. Simulated circulation anomalies resemble observed and reconstructed anomalies, and the model is able to reproduce some of the regional patterns. Cool conditions, e.g. during the Late Maunder Minimum, are accompanied by a decrease in pressure difference between low and high latitudes and a decrease of the North Atlantic Oscillation, favouring positive sea ice anomalies east of Greenland and around Iceland. Changes in Arctic albedo parameterization affect European climate on interannual to multidecadal time scales. In particular, we find an increase of blocking situations over Western Europe, especially in autumn, which contribute to the advection of cold air.

Strong warming, mainly over land, is simulated after 1850, along with an increase of the positive phase of the North Atlantic Oscillation. Temperature evolution in high latitudes depends strongly on the treatment of snow and ice albedo, leading to a much faster warming and a much stronger decrease of sea ice in the Arctic from 2030 on when these effects are taken into account.