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

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We present results of experiments with a state-of-the-art coupled atmosphere-ocean general circulation model, covering the period 1500 to 2100. The model has been driven with all relevant natural (solar variability, latitudinally dependent volcanic aerosol) and anthropogenic forcings (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 Arctic sea ice, in better agreement with observations.

Even minor changes in the parameterization of Arctic processes can exert strong influences on mid-latitude climate on interannual to multidecadal time scales via changes in the ice-albedo feedback. This modifies strength and position of the storm tracks and thus changes tropospheric energy fluxes. Cool conditions, e.g. during the Late Maunder Minimum, are accompanied by a decrease in geopotential gradient between low and high latitudes and a decrease of the North Atlantic Oscillation, favouring positive sea-ice anomalies east of Greenland and around Iceland. With the changed parameterization of sea ice and snow, we find an increase of blocking situations over Western Europe, especially in autumn, which contribute to the advection of cold air.

With all parameterizations, the model simulates strong warming, particularly over land, and an increase of the positive phase of the North Atlantic Oscillation from 1850 on. However, high latitude temperature evolution is strongly dependent 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.

Based on daily data, an investigation of the low-frequency variability will be presented.