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The fate of the NAO in a very long climate change simulation

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Since the Danish colonization of Greenland in the early 18th century, a “see-saw“ in winter temperatures between western Greenland and the Canadian Arctic on one side and northern Europe on the other is well-known. It is associated with pressure anomalies (the North Atlantic Oscillation, NAO) not only near the region of interest, but over large parts of the Northern Hemisphere. Recent research has pointed out the role of sea ice in maintaining circulation anomalies, thus leaving the NAO and consequently the see-saw in either its positive or its negative phase over extended periods, which strongly affects winter temperatures over large parts of the Northern Hemisphere.
However, what would happen if Arctic sea ice were to disappear completely? In the framework of the FP7-funded project ice2ice, we try to answer this and related questions. We have conducted a very long global simulation with a global climate model interactively coupled to a Greenland ice sheet component, covering the period 1850-3250 at a horizontal resolution of approximately 125 km. Up to 2005, the forcing is from observed greenhouse gas concentrations, and from 2006 onward it follows the extended RCP8.5 scenario, in which greenhouse gas concentrations continue to increase and eventually level out around 2250. With such a strong forcing, all Arctic sea ice has completely disappeared by roughly the same time, and the mass balance of the Greenland Ice Sheet becomes strongly negative.
We investigate how the atmospheric circulation changes in such an ice-free world by means of self-organizing maps, SOMs. SOMs are a powerful tool used to extract diagnostic information from large datasets without any a priori assumptions about the signal to be identified. We have conducted such a SOM analysis on daily 500 hPa fields for the entire 1400 year period and compared present-day climate with a seasonally and later a totally ice-free Arctic. These changes in sea ice have a profound effect on the atmospheric circulation over large parts of the Northern Hemisphere.