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The temporal and spatial response of the Nordic Seas surface conditions to external and internal forcings during the Holocene – A Data-Model comparison

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The transition from the last glaciation to a relatively warmer early Holocene, offers an opportunity to look at the mechanisms and feedbacks of the climate system. Modelling experiments provide an opportunity to enhance our understanding of these processes. Of special interest is the Holocene thermal maximum (HTM), a period of relatively warm climate. In the Northern Hemisphere, the HTM is associated with an orbitally forced summer insolation maximum approximately 10,000 years B.P.. Orbital forcing is the dominant long-term forcing over the Holocene when considering the temperature response on the scale of the Arctic. By contrast the effect of variations in atmospheric greenhouse gases is minor. Although the HTM is orbitally forced, the spatial and temporal response of the climate system, as well as its positive and negative feedback mechanisms, is nonuniform.

We present here simulations highlighting the expression of the spatial and temporal variability of the HTM in surface temperatures (SSTs) in the Nordic Seas. Previous modelling studies focusing on the HTM have looked mainly at atmospheric temperature, whereas proxy studies have also shown a strong response in Nordic Seas SSTs. We compare our simulated SSTs with proxy data from the Nordic Seas. Proxy-based SST reconstructions from this region suggest an east-west gradient in response, with the clearest expression of the HTM in the east near the Norwegian Coast. This response can be attributed to orbital forcing, whereas the weaker HTM near the Greenland shelf, the response is not as easily attributable to any forcing. In the early Holocene a major influence on climate is the deglaciation of the Laurentide ice sheet (LIS) and its freshwater flux as well as the cooling effect of the remnant LIS. In a similar way the Greenland ice sheet (GIS) influences the Nordic Seas region considerably. To investigate all these factors, we have performed simulations with an Earth Model of Intermediate Complexity (LOVECLIM) with different forcings. The main focus is to determine the sensitivity of processes to varying freshwater flux and sea ice extent.