Impact of the North Atlantic thermohaline circulation on the European and Northern Atlantic weather in a coupled GCM simulation

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Impact of the North Atlantic thermohaline circulation (THC) on the European weather characteristics has been analyzed using a 500-years control simulation with the global coupled atmosphere-ocean general circulation model ECHAM5/MPI-OM (Marsland et al., 2003; Roeckner et al., 2003) of spatial resolution T42 (Jungclaus et al., 2004; 2007; Pohlmann et al., 2006). Index of North Atlantic THC was defined as a maximum strength of ocean meridional overturning at 30N.

Correlations between annual mean North Atlantic THC index and precipitation, sea level pressure (SLP), and surface air temperature (SAT) has been computed for different seasons. The strongest correlations are found for boreal winter season, whilst summer season in general does not show significant correlations. The winter correlations are shown in the Figure 1.

As can be seen, the positive phase of the THC is related to increase of precipitation (decrease of SLP) over Norwegian-Barents Seas and northern Eurasia and warming over North Atlantic, Europe and northern Asia. These changes are due to increased sea surface temperatures (SST) in the Northern Atlantic related to the positive THC phase (Latif et al., 2004). These induce intensified advection from the ocean to the western part of Eurasia. Another mechanism is an increase of the oceanic inflow to the marginal Arctic seas with corresponding sea ice retreat. This causes particular strong correlations in the Norwegian and Barents Sea areas.

Changes in the SST can affect large-scale atmospheric circulation in the Northern Atlantic. Figure 2 shows 20-years running mean time series of annual North Atlantic THC index and anomalies of wintertime Icelandic Low intensity index in the control run.

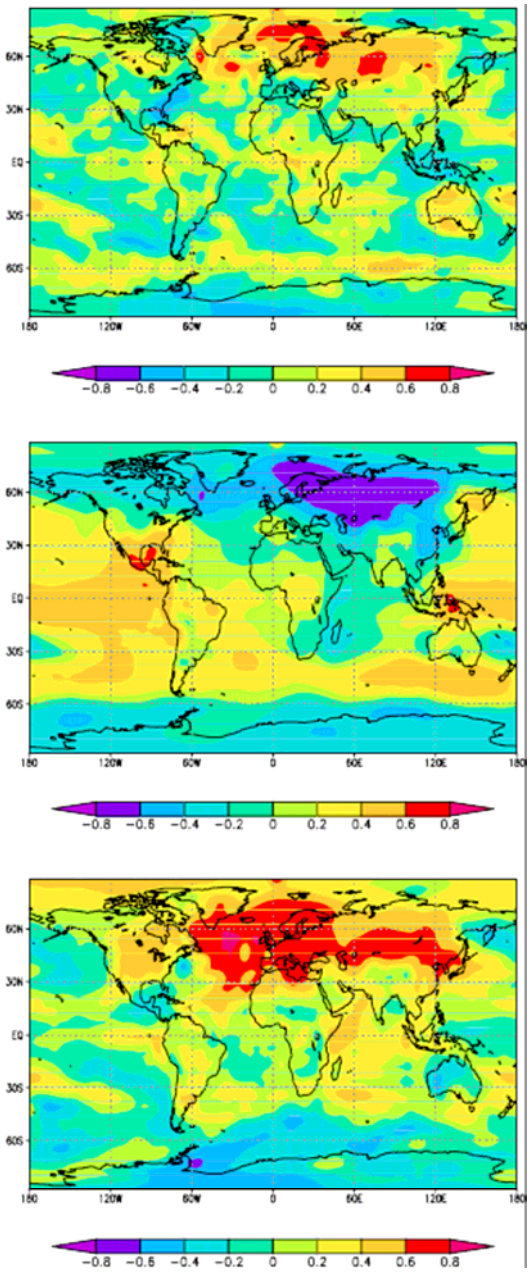

Figure 1. Correlations between low-passed (20-year running means) annual mean THC index and precipitation (top), sea level pressure (middle), surface air temperature (bottom) for the winter according to model simulations. 95% significance level is +- 0.45.

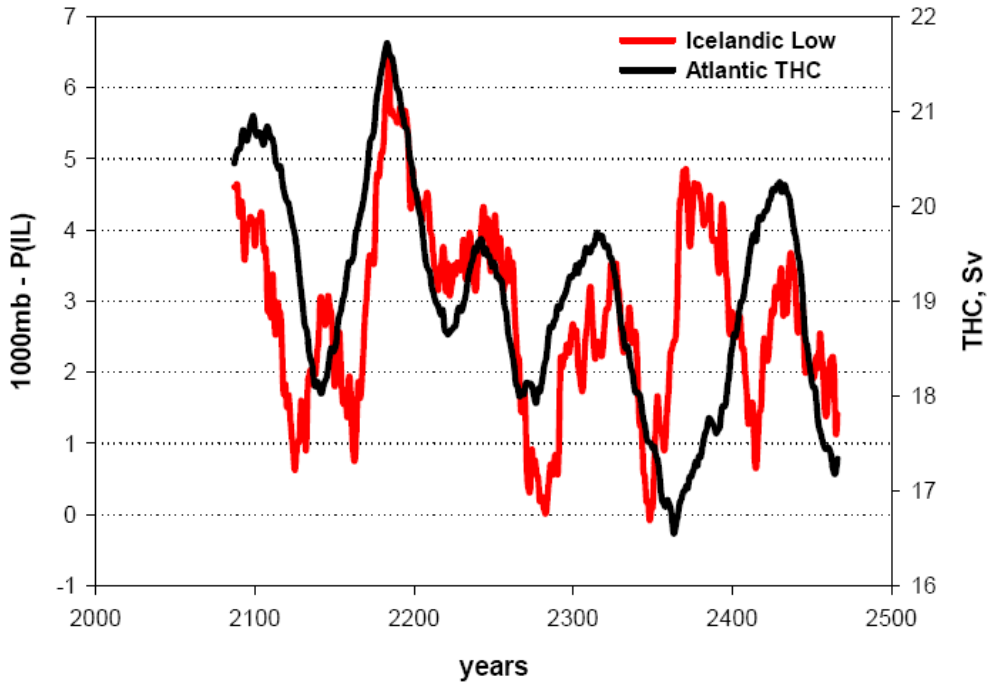

Figure 2 Time series of annual mean North Atlantic THC index and wintertime Icelandic Low (IL) intensity index (1000mb minus SLP in the center of IL) in the control run (20-years running means).

According to the model simulation (Figure 2), there is significant modulation of the Iceland Low intensity by the North Atlantic THC on the multidecadal timescale. Intensification of the Iceland Low (and increase of atmospheric zonal circulation, respectively) can produce large-scale positive anomalies in the surface air temperature over the Eurasian continent (Figure 1, bottom).

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