Simulation of the oceanic temperatures impact on the European weather conditions

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Significant changes of the weather conditions over Europe in the last three decades may be linked to warming trend of the sea surface temperatures (SSTs) of the world oceans. Several model studies suggested driving role of the SST warming in tropical oceans for the atmospheric circulation trends in Atlantic-European sector [Hurrell et al. 2004; Hoerling et al. 2004]. However, not all models simulate significant changes [e.g. Schneider et al. 2003], and if they do, the response is weaker then observed changes. Another region, which directly affects the northern extratropical climate and in particular European weather conditions, is the North Atlantic (NA). The recent studies demonstrated a major role of the NA SST for hemispheric climate variability [Zhang et al. 2007; Sutton and Hodson 2007]. Multidecadal SST variability in the North Atlantic may be linked to the variations of the meridional overturning circulation, MOC [Latif et al. 2004]. Long-term oscillations of the MOC provide predictability potential for the decadal SST changes and possible response of the European climate.

Here, we investigate the atmospheric response to prescribed SSTs and sea ice concentrations for two periods related of colder and warmer SSTs in the North Atlantic (Figure 1), which may represent low and high MOC circulation intensity [Latif et al. 2004]. Two simulations of 100 year duration with the ECHAM5 model at T42 resolution (~2.8°x2.8° lat/lon) were performed using climatological SST/sea ice boundary conditions (see Fig. 1). Simulated differences for surface air temperature (SAT) and sea level pressure (SLP) are presented in the Figure 2. The moderate warming is simulated over Europe with stronger changes over south-western part. The changes in summer season exceed those for the winter and reach 1.5 °C over Spain. Significance test has shown that summer changes are more detectable. This is in line with results by [Sutton and Hodson 2007] who found summer time response to be more robust than for the winter time. The SLP changes, however, are stronger in the winter season with statistically significant low pressure anomaly centered around 50E-50N. This anomaly is very similar to the observed feature as present in the NCEP/NCAR reanalysis data (not shown) and may be due to strong sea ice reduction in the Barents Sea, which accompanied the NA SST warming.

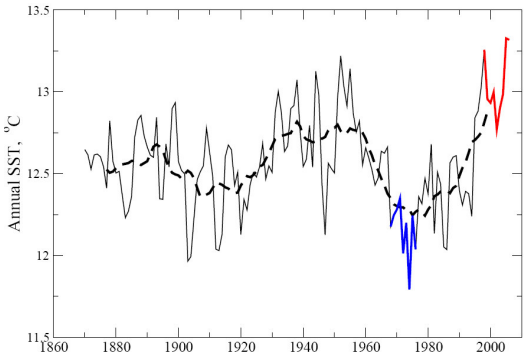

Figure 1: annual SST in the (50W-10W, 40N-60N) box in the NA (see Latif et al. 2004). Two climatologies of the SST and ice extent for the periods indicated by blue and red were used as boundary conditions for model simulations.

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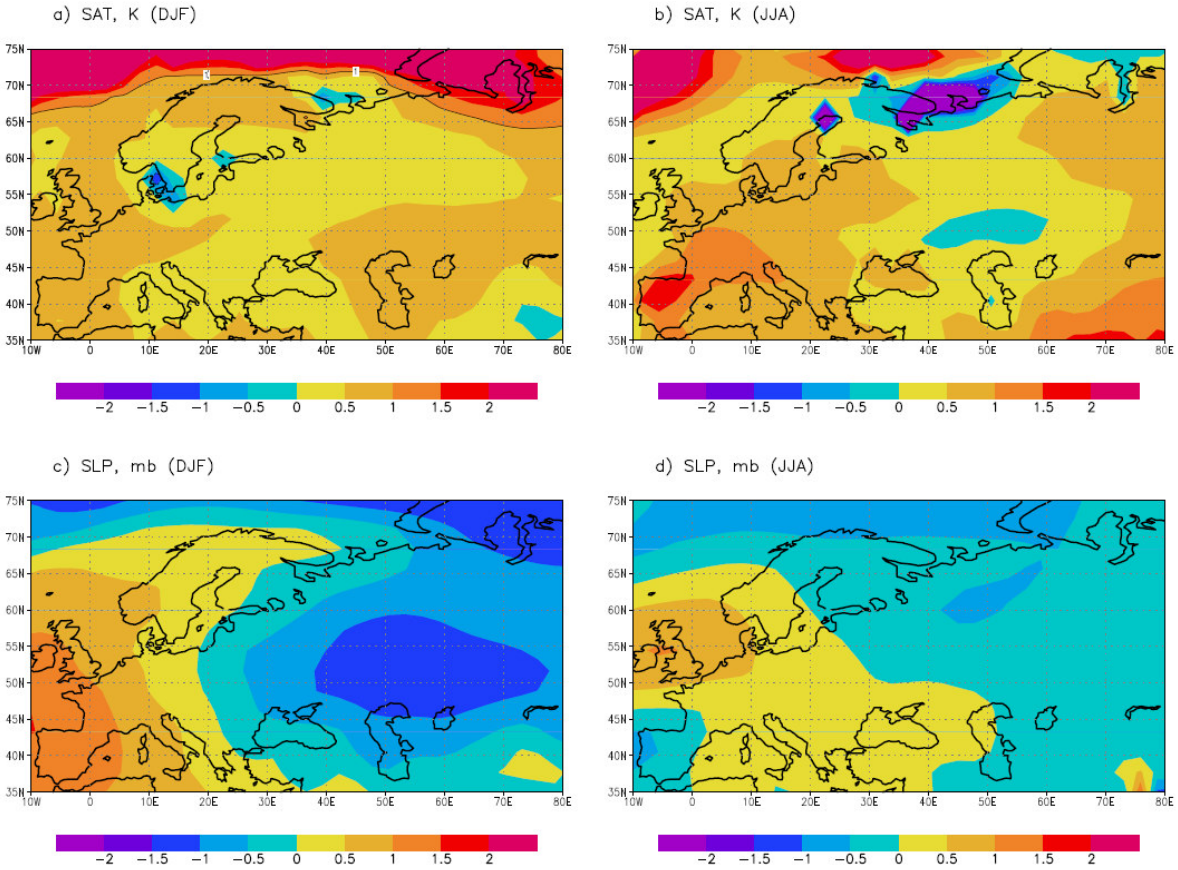

Figure 2: Simulated changes of the SAT and SLP for winter and summer between “warm” and “cold” North Atlantic numerical experiments.

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