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Simulated response to inter-annual SST variations in the Gulf Stream region

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The regions of western boundary currents are characterized by strong meridional SST gradients. Recent studies show that the sharp SST fronts over the Gulf Stream and Kuroshio-Oyashio have a significant impact on the climatological state of the overlying atmosphere. For the Kuroshio-Oyashio Extension it has further be shown, that also SST variability influences the atmospheric circulation. However, the impact of SST variations on the atmosphere has been less studied for the Gulf Stream region. Since on the long-term timescales ocean dynamics start to control SST, a better understanding of the coupling processes could help to improve atmospheric predictability in the North Atlantic sector.

The work we present here involves analysis of a set of experiments with ECHAM5, a state-of-the-art Atmospheric General Circulation Model (AGCM). We used the model in a relatively high resolution (T106L31, according to $\sim 1^{\circ}$ horizontal resolution). Our aim was, to investigate the mechanisms linking observed 5-year low-pass filtered SST variability in the Gulf Stream region and atmospheric variability, with our focus on precipitation. First, we analysed a 5-member ensemble forced by observed, monthly varying SST from the HadISST dataset. An Analysis of variance (ANOVA) shows that up to 70% of the local convective precipitation variability on these timescales can be explained by Gulf Stream SST variations. In the region of our focus, SST and convective precipitation are strongly correlated in both, summer (r=0.73) and winter (r=0.55). The results from the transient run motivated a sensitivity experiment with a prescribed local warm SST anomaly in the Gulf Stream region. The sensitivity experiment confirms that local SST drives most of the convective precipitation variability over the Gulf Stream. Increased evaporation connected to the anomalous warm SST plays a crucial role in both, summer and winter. In summer our model responds with an enhanced local SLP minimum, a concentrated band of low level convergence, deep upward motion and enhanced precipitation. In winter, we also get enhanced precipitation, but the direct connection to deep vertical upward motion is lacking. Nearly all of the anomalous precipitation in winter is connected to passing atmospheric fronts. In summer the connection between precipitation and atmospheric fronts is weaker, but still present.