Simulation of Monsoon Rainfall Variability in the Tropical Atlantic region

J. Bader and R. Schnur
Max-Planck-Institut Fuer Meteorologie, Hamburg, Germany
bader@dkrz.de

The impact of sea surface temperature (SST) - especially the role of the tropical Atlantic meridional SST gradient and the El Nino-Southern Oscillation - on precipitation is investigated with the atmospheric general circulation model ECHAM4/T42. Ensemble experiments - driven with observed SST - show that Atlantic SST has a significant influence on precipitation over West Africa and northeast Brazil.

SST sensitivity experiments were performed in which the climatological SST was enhanced or decreased by one Kelvin in certain Atlantic ocean areas. Changing SST in the eastern tropical Atlantic caused significant changes only along the Guinea Coast, with a positive anomaly (SSTA) increasing rainfall and a negative SSTA reducing it. The response was nearly linear. Changing SST in other ocean areas caused significant changes over West Africa, especially in the Sahel area. The response is found to be non linear, with only negative SSTA leading to significant reduction in Sahel rainfall. Also, the impact of the SSTAs from the different ocean regions was not additive with respect to the rainfall.

Additionally, experiments were performed to investigate the impact of SSTAs from the different ocean basins on the decadal rainfall change in the Sahel. Our study indicates that it is not the Interhemispheric Atlantic SST gradient, which is responsible for the decadal reduction in Sahel JJAS rainfall between the 1950's and 1980's:

Simulations driven with a typical Atlantic SST gradient from the 1950s, superimposed on the climatological amip2-SST (1979-1995), cannot reproduce the wet mode of the Sahel that was prevalent during this time. On the other hand, simulations forced by reduced SSTs in the Indian ocean (amip2-SST elsewhere) lead to a significant enhancement in Sahel rainfall.

The influence of SST on precipitation over northeast Brazil was also investigated. We performed 3 experiments. In the 1st the climatological SST in the North Atlantic was increased by 1 Kelvin and in the South Atlantic reduced by 1 Kelvin. The second experiment was vice versa. In the third experiment we increased the SST in the Nino3 ocean area by two Kelvin. All experiments caused significant changes over northeast Brazil, with an enhanced/reduced SST gradient in the Atlantic increasing/reducing rainfall. The response was nearly linear. The main effect of the Atlantic SST gradient was a shift of the ITCZ, caused by trade wind changes. The El Nino event generates a significant reduction in northeast Brazil rainfall. A significant positive SLP anomaly occurs in northeast Brazil which may be associated with the descending branch of the Walker circulation. Also a significant positive SLP over the Atlantic from 30S to 10N occurs. This results in a reduced SLP gradient from the subtropical highs to the equator and a weakening of the trade winds.

The impact of anthropogenic forcings on the West African monsoon is analysed by using existing climate change scenario experiments, including ensemble simulations with the new ECHAM5/MPI-OM1 coupled model. Preliminary results from a climate change detection analysis are presented.

Monday III (Talk)