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Impact of sea surface temperatures on convective activity in the tropics in a CCM

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Change of location, strength and frequency of precipitation acts as a main indicator that reveals a change of climate. While observations of precipitation show an increase of total precipitation north of 30° over land in the recent century, however the tropics are dominated by a general decrease of precipitation since the 1970s (IPCC, 2007). It is also known that the amount of tropical precipitation dominates the global mean total precipitation and that convectively driven precipitation dominates the precipitation in the tropics.

This study focuses on investigating processes that lead to changes of tropical precipitation. The temporal evolution of tropical convective activity in the chemistry-climate model (CCM) E39C-A is used to explore the impact of changes in sea surface temperatures (SSTs) on convective activity. Results derived from a transient model simulation spanning from 1960 to 2049 of E39C-A show that SSTs have a strong impact on tropical convection and its future evolution. Moreover, the transient simulation generally indicates that a global increase of SSTs with time leads to a general decrease of the frequency of occurrence of deep convective events and additionally to an increase of the strength of the mean convective event. The regions affected most are located in the tropics. The results derived for the future (up to 2049) show a further intensification of the long-term trends found for the past (1970 to 1999) with a displacement of areas of major change of convective activity from the Atlantic to the Pacific region.

To specify the role of tropical SST-anomalies and -changes on convective activity, precipitation patterns and strength of convection, two sensitivity studies were performed with E39C-A. These experiments offer the advantage, that the background noise is low, so that the pattern of changes becomes more evident. The sensitivity experiments are designed to be comparable with the long-term trends from 1970 to 1999 of the transient simulation as the SST-anomaly of the sensitivity experiments resembles the SST-trend in the transient simulation. This allows to quantify the role of tropical SST-change on convective activity.
The investigations of the two sensitivity simulations indicate that an interaction exists between tropical SST-change and extratropical change of convective activity. The tropical SST-change affects significantly not only convective activity in the tropics, but also in the extratropical northern hemisphere in terms of an amplified convective activity in the northern storm track region. Thus monitoring SSTs is of main importance to reveal changes of circulation patterns and hence changes of precipitation patterns.