



## Impacts of Indian Ocean SST biases on the Indo-Pacific climate as simulated in a global coupled model

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Sea Surface Temperature (SST) variations over the tropical Indian Ocean play an important role in monsoon circulation and have significant impacts, especially on boreal summer precipitation over the heavily populated surrounding regions. Furthermore, many previous studies have demonstrated the crucial role of the ocean-atmosphere coupling in order to better capture the observed monsoon intraseasonal to interannual variability in these regions. However, a major limiting factor for current Coupled General Circulation Models (CGCMs) comes from model deficiencies in capturing the rainfall and SST seasonal cycles over the Indian Ocean area. As an illustration, many current CGCMs present strong SST biases over the tropical Indian Ocean, which drastically limit our understanding of the physical processes involved in the climate fluctuations over these areas, especially those associated with the Indian Ocean Dipole (IOD) and the Indian Summer Monsoon (ISM). These results warrant the need for improved monsoon simulations with current CGCMs.

In this work, we therefore examine the impacts of SST biases on the monsoon rainfall and the Indo-Pacific mean state, in a state-of-the-art CGCM, the SINTEX-F2 model, with the help of a comparison of forced and coupled control simulations and two sensitivity coupled experiments. In the coupled control simulation, strong SST biases of opposite sign are observed over the western and eastern tropical Indian Ocean and the rainfall amounts over the ocean (land) are systematically higher (lower) during ISM. Furthermore, the CGCM fails to simulate the heavy rainfall band over the south equatorial Indian Ocean, which is one of the important sources for ISM rainfall variability. The comparison of the forced and coupled simulations demonstrates that most of the rainfall biases observed during boreal summer are related to coupled processes. Therefore, in order to highlight the role of the Indian Ocean SST biases on the rainfall errors in the Indian region, two coupled sensitivity experiments have been designed, in which the SST biases in the seasonal cycle (maximal during boreal summer and autumn), of approximately  $2^\circ$ , are corrected either in the western (warm bias) or eastern (cold bias) Indian Ocean.

We observe in both sensitivity experiments a strong decrease of the summer rainfall biases over the ocean, of about half of the over-estimated precipitation bias over the Arabian sea and south of Indian Peninsula. In the western Indian Ocean experiment, which removes the warm bias in the west, we observe a strong decrease of the monsoon flux over the north Arabian Sea and the local precipitation bias. The eastern Indian Ocean experiment (removing the cold bias in the east) leads to a southward displacement of the convection as observed (precipitations around India decrease and increase in the south eastern Indian Ocean) and the associated cross equatorial wind bias is also half corrected. Surprisingly, in these two experiments, no improvements are observed in the summer rainfall distribution over the Indo-Gangetic plains. Finally, the possible role of the Indian Ocean SST biases on errors in the Pacific mean state are also discussed.