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One-year lead-time predictability of Indian summer monsoon due to delayed ENSO impact

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The possibility of long-term prediction of the Indian Summer Monsoon Rainfall (ISMR) intensity can lead to enormous socio-economical advantages over the South Asian region. Even small variations of ISMR from its normal conditions can lead to floods or droughts with important consequences for the agriculture. The enhanced predictability of the ISMR allows the implementation of mitigation measures in advance. The El Niño Southern Oscillation (ENSO) has a main role in modulating climate, in particular over the tropical belt. Its effects are transferred from the Pacific to the Atlantic and the Indian Ocean, mainly through atmospheric teleconnections. ENSO modifies the Walker circulation and thus directly influences the South Asian climate inducing a weaker/stronger monsoon during a positive/negative phase of ENSO. Over the Indian Ocean (IO) basin the ENSO effects can last for more than a season, and this persistence is in part linked to air-sea coupled mechanisms that involve the IO and the North Western Pacific Ocean and is also related to the Western Arabian Sea Upwelling. The resulting IO warming/cooling leads in turn to an increase/decrease of ISMR in the summer following a positive/negative phase of ENSO. Here we present an analysis of observational and regional coupled model data of the lead-lag relationship between ENSO and ISMR and its multi-decadal changes.

To evaluate the performance of the regional Earth System Model RegCM-ES in reproducing the ENSO-ISMR relationship, two twins simulations, one using the regional coupled model RegCM-ES (ESMexp) and the other the related standalone regional climate model (RCMexp), have been performed over the South Asia CORDEX domain. The RegCM model is coupled online with the MITgcm ocean model in the ESMexp while in the RCMexp sea surface temperatures are prescribed.

We find that the well known decrease of instantaneous negative correlation between the ISMR and ENSO after the 60's is concurrently associated to an increase of positive correlation between the one year leading ENSO and ISMR, thus providing potential predictability of ISMR with several months lead time. This observed signal, is also present in the ESMexp whereas is totally missing in the RCMexp. This confirm the coupled nature of the phenomenon and the need of using coupled models to correctly simulate all the features of the Indian Summer Monsoon, and in particular interannual and interdecadal variability.