Session: C34 Poster: W191B

C20C - Climate of the 20th Century: Skill of simulating Indian monsoon rainfall on interannual to decadal timescales and role of east-west heating contrast

Fred Kucharski[†]; Jim Kinter; Chris Folland
[†] Abdus Salam ICTP, Italy
Leading author: kucharsk@ictp.it

The ability of atmospheric general circulation models (AGCMs), that are forced with observed sea surface temperatures (SSTs), to simulate the Indian monsoon rainfall (IMR) variability on interannual to decadal timescales is analyzed in a multimodel intercomparison. The multimodel ensemble has been performed within the CLIVAR International "Climate of the 20th Century" (C20C) Project. This paper is part of a C20C intercomparison of key climate time series. Whereas on the interannual timescale there is modest skill in reproducing the observed IMR variability, on decadal timescale the skill is much larger. It is shown that the decadal IMR variability is largely forced, most likely by tropical sea surface temperatures (SSTs), but as well by extratropical and especially Atlantic Multidecadal Oscillation (AMO) related SSTs. In particular there has been a decrease from the late 1950s to the 1990s that corresponds to a general warming of tropical SSTs. Using a selection of control integrations from the World Climate Research Programme's (WCRP's) Coupled Model Intercomparison Project phase 3 (CMIP3), it is shown that the increase of greenhouse gases (GHG) in the 20th century has not significantly contributed to the observed decadal variability. The relative role of the north-south and east-west contrasts in atmospheric heating for the maintenance of the South Asian summer monsoon climatology is also assessed. The juxtaposition of the Eurasian land mass and the Indian Ocean is responsible for the north-south contrast, while the greater diabatic heating above the western Pacific compared to the one over the African and the tropical South Atlantic Ocean region introduces the east-west gradient. With a series of idealized atmospheric general circulation model experiments, it is found that both contrasts contribute to the maintenance of the South Asian monsoon climatology, but their impact varies at regional scales. The surface atmospheric cyclone and precipitation over northern India are mainly due to the north-south contrast. On the other hand, when the Indian Ocean sea surface temperatures are close to their climatological mean values, the low-level cyclone and consequent rainfall activity in the Bay of Bengal and southern India result from the east-west gradient. The physical mechanism relays on the southern part of the upper-level South Asian monsoon high being forced by the east-west diabatic heating contrast via Sverdrup balance. The east-west heating difference controls also the strength of the Tropical Easterly Jet. Finally, the contribution of the El Ni\~no Southern Oscillation to the interannual variability of the Indian monsoon is interpreted as the result of a longitudinal shift of one of the centers of diabatic heating contributing to the east-west contrast.