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Exacerbation of South Asian monsoon biases in GCMs using when using coupled ocean models

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Cold biases during spring in the northern Arabian Sea of coupled ocean-atmosphere GCMs have previously been shown to limit monsoon rainfall over South Asia during the subsequent summer, by limiting the availability of moisture being advected. The cold biases develop following advection of cold dry air on anomalous northerly low level flow, suggestive of a too-strong winter monsoon in the coupled GCMs. As the same time, these cold biases and the anomalous advection have been related to larger scales by interaction with progression of the midlatitude westerly upper level flow.

In this study we compare monsoon characteristics in 20th century historical and AMIP integrations of the CMIP5 multi-model database. We use a period of 1979-2005, common to both the AMIP and historical integrations. While all available observed boundary conditions, including sea-surface temperature (SST), are prescribed in the AMIP integrations, the historical integrations feature ocean-atmosphere models that generate SSTs via air-sea coupled processes.

In AMIP experiments, the seasonal mean monsoon rainfall is shown to be systematically larger than in the coupled versions, with an earlier onset date also shown using a variety of circulation and precipitation metrics. In addition, examination of the springtime jet structure suggests that it sits too far south in the coupled models, leading to a delayed formation of the South Asia High over the Tibetan Plateau in summer. Further, we show that anomalous low entropy air is being advected near the surface from the north over the Arabian Sea in spring in the coupled models.