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Role of the frequency of coupling in the simulation of the monsoon-ENSO relationship in a global coupled model

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The impact of diurnal air-sea coupling and ocean vertical resolution on the coupled simulation of the Indian Summer Monsoon (ISM) and its relationship with El Niño-Southern Oscillation (ENSO) are studied through the analysis of four long integrations of the same high resolution Coupled General Circulation Model (CGCM), but with different configurations. The only differences between the four integrations are the frequency of coupling between the ocean and atmosphere for the Sea Surface Temperature (SST) parameter (2 vs 24 hours coupling) and/or the vertical resolution (31 vs 301 levels) in the ocean component of the coupled model.

Although the summer mean tropical climate is reasonably well captured with all the configurations of the coupled model and is not significantly modified by changing the frequency of coupling from once to twelve per day for SST, the monsoon-ENSO teleconnection is rather poorly simulated in the two simulations in which SST is exchanged only once per day, independently of the ocean vertical resolution in the coupled model. This systematic error is also apparent in nearly all the state-of-the-art CGCMs that have contributed to the fourth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC AR4), which use for most of them a 1-day air-sea coupling frequency.

Surprisingly, when 2 hours coupling for SST is implemented in the coupled model, the monsoon-ENSO teleconnection is better represented. Particularly, the complex lead-lag relationships between the two phenomena is closely resembling the observed one. Evidence will be presented to show that these improvements are related to changes in the characteristics of the model's El Niño which has a more realistic evolution in its developing and decaying phases, a stronger amplitude and a shift to lower frequencies when a 2 hours coupling strategy is implemented, without any significant changes in the basic state of the coupled model. As a consequence of these improvements in ENSO variability, the lead relationships between Indo-Pacific SSTs and ISM rainfall resemble the observed patterns more closely and the monsoon-ENSO teleconnection is strengthened during boreal summer in better agreement with the observations.

The results presented here highlight the need of a proper assessment of both temporal scale interactions and coupling strategies in order to improve current CGCMs. These results, which must be confirmed with other CGCMs, have also important implications for dynamical seasonal prediction systems of the monsoon.