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Seasonal Prediction of Indian Summer Monsoon: Influence of Well-resolved Stratosphere

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The performance of sub-seasonal to seasonal prediction models, particularly outlining the role of the stratosphere in representing the surface climate viz. precipitation and temperature associated with the Indian Summer Monsoon (ISM), has been examined in this study. The hindcast data from two configurations of a fully coupled model part of the UK Met Office seasonal prediction system that differ only in vertical resolution namely Glosea4 L38 (GL38, Low Top) and Glosea4 L85 (GL85, High Top) have been used. In addition to this, the hindcast data from the updated version of the model i.e. Glosea5 (GL5) is also analyzed, which resembles the GL85 in case of vertical resolution thereby including an exclusively well-resolved stratosphere (unlike GL38) but with finer horizontal resolution than the later. It has been found that the GL85 is performing much better by eliminating the dry bias, particularly over the central Indian region as compared to the GL38 and GL5. The same implications are seen in the inter-annual variabilities produced by the models as GL85 is showing better results and closer to the observation in reproducing interannual variability of both precipitation and temperature. A large part of the inter-annual variations can be explained by the internal variability of the models but other important modes of inter-annual variability are also needed to explain the noted year-to-year fluctuations in these models. The impact of resolving the stratosphere on the temperature is not significant, as both GL38 and GL85 are producing similar biases over the ISM domain, and overall GL5 is showing better results. Furthermore, the influence of resolving stratosphere in representing surface climate by two versions of a CMIP5 model, CMCC-CM (Low Top) and CMCC-CMS (High Top) is also examined, and the improvement has been observed in the case of the high top model. Moreover, the circulation associated with the ISM for the models has also been analyzed to relate the model performance in reproducing the precipitation. The Somali jet is stronger in the high-top models leading to more moisture transport and convergence over the Indian land. In contrast, the Somali jet is shifted southwards and weaker in low-top version leading to more rainfall over the equatorial Indian Ocean and relatively less over India. The increase in vertical resolution (from GL38 to GL85) yields good results in representing precipitation, however, the increase in horizontal resolution (from GL85 to GL5) keeping the vertical resolution same has not been useful as it leads to the drier bias over the region.

Keyword: sub-seasonal prediction to seasonal, hindcast, High Top/Low Top, Indian Summer Monsoon