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Indian monsoon onset and progression in nested suite simulations of the UK Met Office Unified Model

Arathy Menon (1,2), Andrew Turner (1,2), Ambrogio Volonte (1,2), Stuart Webster (3), and Gill Martin (3)

(1) Department of Meteorology, University of Reading, Reading, UK (arathy.menon@reading.ac.uk), (2) NCAS-Climate, University of Reading, Reading, UK, (3) Met Office, FitzroyRoad, Exeter, UK

The Indian monsoon has strong socio-economic implications as a significant percentage of the country's GDP depends on rain-fed agriculture. Hence a skillful prediction of the timing and strength of the monsoon ahead of the season is vital. However, forecasting the Indian monsoon onset and progression is limited by model errors due to inadequate representation of sub-grid scale processes and lack of adequate observations to understand those processes.

In this study, we try to understand the dynamic and thermodynamic features associated with the onset and progression of the 2016 India monsoon in comparison to climatology with the help of a convection permitting regional simulation using the UK Met Office Unified model at 4.5 km resolution nested within a global model that includes convective parameterization. The simulations were run as a part of the Interaction of Convective Organisation with Monsoon Precipitation, Atmosphere, Surface and Sea (INCOMPASS) project that aims to improve the Indian monsoon forecasting capabilities by field measurements and high resolution modelling. The progression of the monsoon in a north-westward direction, perpendicular to the direction of the mean flow could be aided by moistening of the free troposphere or by land-atmosphere interactions. We find that the mid-tropospheric moistening that erodes the dry intrusions from southeast, along with the increase in soil moisture associated with the pre-monsoon showers help in the progression of the monsoon in the north-westward direction. The model also captures the dynamic and thermodynamic features of a monsoon depression that formed during July 2016. Further, we compare these simulations with a parameterised convection model at 17 km resolution to isolate the effect of convective parameterisation and model resolution on the monsoon dynamics. The 4.5 km model is also tested with two different land ancillaries to explore its sensitivity to land surface processes.