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Land-atmosphere coupling in operational NCUM forecasts during the 2020 monsoon season

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The onset, persistence and variability of summer monsoon rainfall impacts over a billion people. Advance knowledge is critical for agricultural planning and hazard mitigation, yet forecasting remains a challenge. Sources of error that have been identified in forecast models include the representation of the land surface and subsequent coupling with the boundary layer and convection. This study presents an analysis of land-atmosphere coupling in the operational Indian 4km convective scale regional model configuration of the Unified Model (NCUM-R), used by NCMRWF to provide daily forecasts. An earlier study (Barton et al, QJRMS 2019) analysed the coupling in this model for a single forecast when research aircraft observations were available. It revealed rapidly evolving biases in the monsoon trough linked to errors in the representation of soil moisture. Our current work aims to understand whether this behavior is typical of the monsoon season. This matters because the trough is an important dynamical feature and a key driver of regional rainfall. Here we provide a more comprehensive analysis by assessing the impact of initial soil moisture state on a full season of operational three day forecasts. NCUM-R output is evaluated by comparison to ERA5 reanalysis (atmospheric temperature and pressure) and satellite observations from AMSR2 (land surface temperature) and SMAP (soil moisture). Correlations between surface and atmospheric variables in the model are computed using linear regression. Our results suggest that systematic biases in the evolution of atmospheric temperature and pressure over three days are indeed linked to errors in the initial soil moisture state. These biases likely impact rainfall predictions derived from the forecasts throughout the monsoon season. This work highlights the importance for realistic soil moisture initialisation in high resolution operational forecasts.