Modelling the moistening of the free troposphere during the northwestward progression of Indian monsoon onset

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Prediction of the Indian monsoon onset is of critical importance for agricultural planning that affects food production and the economy of the country. The Indian monsoon onset progresses in a northwestward direction, perpendicular to the mean wind flow. A recent study suggests that this occurs due to the moistening of the free troposphere by pre-monsoon showers and wetting of the land surface. As the onset progresses, the mid-tropospheric dry layer is thought to be constantly moistened from below by detrainment from shallow cumulus and congestus clouds from the southeast. The dry layer becomes much shallower towards southeast India, making the profile closer to moist adiabatic, providing favourable conditions for deep cumulus convection. Increased moistening of the free troposphere thereby pushes the northern limit of moist convection to move north-westwards. Here we examine the representation of this process in hindcast simulations from the fully coupled atmosphere-ocean seasonal forecast system of the UK Met Office, GloSea5. The model effectively captures the mid-level dry air intrusion from the northwest which suppresses convection over the northwestern parts of India. We also show that detrainment from shallow convection, measured by moisture tendencies around the freezing level, acts to saturate the free troposphere ahead of the monsoon onset, eroding the dry-layer from the southeast. This work suggests that initialized coupled models are capable of simulating dynamic and thermodynamic processes inherent in monsoon progression during the onset.