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Improving Near-Surface Field Forecasts in NCEP Forecast Models

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Abstract

The accurate representation of land surface processes and their interactions with atmosphere in numerical models is regarded as the key for improving numerical weather and climate prediction and a challenging task owing to the multiplicity of the related physical processes and their complex interactions. It has been noticed that the Global Forecast System (GFS) and the North American Mesoscale Forecast System (NAM) at NCEP have large errors in surface temperature and surface humidity forecasts in some seasons. In particular, excessive cooling of 2-m temperature happens during sunset in GFS while a systematic wet bias in 2-meter dew point temperatures and cold bias in 2-meter temperature occur in NAM.

In this presentation, we identify GFS systematic errors in near-surface temperature forecast by investigating the Noah LSM and the land-atmosphere interactions, and find practical solutions. Our assessment reveals that the systematic deficiencies and substantial errors in GFS near-surface 2-m air temperature forecasts are considerably reduced, along with a notable reduction of bias and root-mean-square of air temperature throughout the lower atmosphere. Further updates include use of the high resolution land surface characteristic data (IGBP vegetation type and STATSGO soil type data) to replace the coarse data in the current operational GFS and use of the new MODIS-based maximum snow albedo data.

Three error sources in NAM have been identified through investigation. The first one is that NAM ignores the frozen soil water content effect on evapotranspiration. This causes not only evapotranspiration overestimates in winter seasons, but also an inconsistency of evapotranspiration between summer and winter. The second one is that an unrealistic constant LAI is used for all plant types and all seasons in NAM. The third one is that the LAI effect on canopy resistance is too weak. All together, the modifications to solve these three issues clearly improve NAM performance.