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Improved Forecasting of Near Surface Fields in the NCEP Operational Global Forecast System

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It has long been known that the NOAA National Centers for Environmental Prediction (NCEP) Global Forecast System suffers from biases in the forecast of near-surface fields such as surface temperature, humidity and wind speed over land. This presentation summarizes recently identified systematic errors of near-surface-fields forecasting in the current spectral-model-based operational NCEP GFS (GFSv14) and the first version of the Finite Volume Cubed Sphere (FV3) dynamic core based GFS (GFSv15), including severe cold or warm biases of 2-m surface air temperature forecasts which are closely associated with the land surface model, surface layer parameterization, and planetary boundary layer parameterization and the interactions between these parameterizations. Several practical approaches have been tested to reduce the errors. Introduction of a constraint on the stability parameter in the Monin–Obukov similarity theory prevents the land–atmosphere system from fully decoupling and is demonstrated very effective in elimination of precipitous 2-m temperature drops that have occurred in GFS forecasts in very weak winds under very stable lapse rates. The background diffusivity in the planetary boundary scheme is found to modulate 2-m temperatures strongly. Optimization of this parameter has a significant positive impact in tests of cases involving large winter warm biases. The changes of land data parameters and incorporation with green vegetation fraction lead to reduce the unreasonably hot daytime 2-m temperatures that have been predicted in urban regions in summer. Furthermore, a comprehensive set of daily 7-day forecast experiments spanning more than one month in various seasons demonstrate that using the proposed approaches can considerably reduce systematic deficiencies and substantial errors in 2-m temperature forecasts, along with a notable reduction of temperature errors throughout the lower atmosphere and improvement of forecast skill scores for light and medium precipitation amounts.