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Evaluation of Potential Influence of Lacking the Consideration of Aerosol Perturbations on NCEP GFS Precipitation Forecast

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Cloud-Aerosol-Precipitation-Interactions have been widely recognized as affecting precipitation very much in the water and energy cycles, however, are not considered in the operational NCEP GFS model. We evaluated the NCEP operational precipitation forecast from the aspect of lacking consideration of aerosol effects, using multiple datasets from ground-based and satellite observations and model reanalysis. CPC unified gauge-based precipitation analysis, and MERRA-2 aerosol reanalysis were used to evaluate the forecast in three countries in the year 2015. The phenomena of overestimation of light rain (47.84%) and underestimation of heavier rain (31.83%, 52.94%, and 65.74% for moderate rain, heavy rain, and very heavy rain, respectively) of the model are consistent with the scenario that no aerosol effects are considered. The standard deviation of forecast bias are significantly positive correlated with AOD with coefficient of 0.5602, 0.6522, and 0.5182 for Australia, US, and China, respectively. The ETS score in the U.S. decreases with AOD increasing. In addition, long-term forecast with a focus in Fujian, China were evaluated and analyzed using gauge-based observations of precipitation, visibility, water vapor, and convective available, and satellite datasets. The results show that model overestimates light rain and underestimates heavy rain. Long-term analysis indicated that there is a trend in heavy rain increase in summer, while a light rain decrease in other seasons. A decreasing trend of visibility is found while no obvious trend is found of water vapor or a little increase trend in summer CAPE. The results also show that more aerosols decrease cloud effective radii for liquid water path greater than 80 g/m2 situation. The increase of cloud top temperature with AOD for liquid clouds, and the decrease of that for warm mixed phase clouds, suggest that aerosols inhibit the development of shallow liquid clouds, and invigorate warm base mixed-phase clouds (especially in summertime), which may further influence precipitation.