A GRAPES-based mesoscale EPS for TC forecasting: configuration and performance

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To improve short-range tropical cyclone (TC) forecasting in China from both deterministic and probabilistic standpoints, a mesoscale ensemble prediction system (TREPS) based on the Global/Regional Assimilation and Prediction System (GRAPES) is constructed as a planned operational system. TREPS comprises one unperturbed and 30 perturbed forecasts ranging up to 60 h at horizontal resolution of 9 km. Downscaling perturbations from the ECMWF ensemble prediction system (ENS) are used to generate initial perturbations by blending them with balanced random perturbations implemented around the TC and to generate perturbations for lateral boundary conditions. The surface temperature around the TC is also perturbed, with a combination of multi-physics and stochastically perturbed parametrization tendencies considered to represent uncertainties in the model physics. These perturbation methods contribute a full-area, multi-scale and multi-variable mutual complement to increasing forecast perturbations. TREPS is evaluated for 19 TCs making landfall in China during 2014–2016. For deterministic guidance, TREPS significantly improves TC forecasting for intensity, rainfall and wind compared to ECMWF deterministic and ensemble forecasts. TREPS demonstrates significant advantages over its deterministic forecasts in predicting track, intensity, (extremely) heavy rainfall and wind. Furthermore, TREPS effectively reduces the degree of underdispersion in intensity forecasting compared to ENS. For probabilistic forecasting, TREPS outperforms ENS in accurately predicting extremely heavy rainfall and (extremely) strong wind owing to its better discriminating ability, but performs worse in predicting modest wind, light and heavy rainfall. Two post-processing techniques –optimal member and optimal probability –to improve, respectively, deterministic and probabilistic guidance of TREPS in rainfall and wind forecasting are proposed. The former is shown to be effective only for light rainfall, while the latter demonstrates consistent (partial) improvements in rainfall (wind). The superiorities and inferiorities of TREPS, as well as possible reasons for these, are intuitively illustrated in a case-study for Rammasun.

Keywords: ensemble prediction system, mesoscale, tropical cyclone