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An objective weather-regime-based verification of WRF-RTFDDA forecasts over the eastern Mediterranean

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Numerical weather prediction in the eastern Mediterranean is very challenging because of the region's unique geography, which includes strong land-sea contrast, complex topography, highly varied vegetation, and mosaic of urban and desert areas. This geographic heterogeneity often results in complex and dramatically different mesoscale and microscale flows underdifferent synoptic situations.

WRF-RTFDDA (Weather Research and Forecasting – Realtime four-dimensional data assimilation and forecasting system) is a WRF-based multi-scale 4-dimensional weather analysis and prediction system. It effectively assimilates diverse types of direct, retrieved and non-direct observations available at irregular time and locations using a hybrid Newtonian relaxation and 3DVar data assimilation procedure to initiate regional weather forecast. The hybrid data assimilation and forecasting system has been implemented in a triple-nested WRF configuration with 30, 10, and 3.3 km horizontal grid spacing over the eastern Mediterranean. Analysis and forecasts have been run for a one-year long period, covering four seasons that include a wide variety of synoptic weather regimes. Objective verification is conducted to study the model performance under different weather regime. The Alpert et al. (2001) weather-regime classification method is adopted to classify the synoptic weather into 19 classes according to daily surface synoptic flows that include cyclones, highs and troughs. The aim of this paper is to investigate the model skill under different synoptic weather regimes. Objective verification statistics including Bias, RMSE and MAE of main weather variables are calculated by comparing the model data with soundings and surface observations for each weather regime. Preliminary examination of the verification scores shows significant differences of model forecast accuracy under different weather situations. The RMSE of 24h forecasts of 2-m temperatures varies from 1.6 C to 2.3C among different weather regimes, and RMSE of 24h forecast of 10m wind speed spans from 1.2 to nearly 5 m/s. Strikingly, it is found that the diurnal variation of the forecast accuracy of surface variables are comparable to the variation among the different weather regimes. Thus, to further improve the model system for this region, both refining the local and regional underlying dynamical and physical forcing the model (i.e. land-surface parameterizations) and improving the synoptic weather modeling (mostly through data assimilation) are equally important.