EVALUATION OF DATA ASSIMILATION ON NUMERICAL WEATHER PREDICTION FOR EGYPT

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Egypt as a developing country has special needs for integrating Numerical Weather Prediction, NWP, to several of its national projects. Examples are the ambitious renewable energy plan to 2020 and beyond, the treatment of air pollution in Egypt's mega cities, the efforts of health sector to manage trans-boundary diseases and infections, the management of the agriculture and irrigation activities, including crop health, and the needed optimal utilization of resources. Use of techniques like Data Assimilation and Ensemble Forecasting in NWP practices in developed countries usually results in better weather simulations/predictions. Accuracy of the computations is expected to increase with the density of the observations but may be countered by the distribution of the observation sites and the grid size used. The application of such techniques in Egypt may not always produce the expected better accuracy. The main reason for this is the scarcity of observational data and the non-uniformity of the sparse observation sites. Moreover, the simulations/predictions may have different qualities at different locations of the same region depending on whether the location is in the vicinity of an observation site, between observations sites, far from observations sites, or at a site with complex terrain.

The objective of this work is to investigate the effects of Data Assimilation via different nudging options on the qualities of simulation/prediction at locations with different observation site density inside Egypt, stressing the effects on accuracy at the observational-data-void areas and at the locations with complex terrain. The MM5 Model was used with three nested domains for samples of three days simulations in two seasons, one in summer and the other in winter. Data was obtained from the Objective Analysis, of NCEP Final Analysis, FNL, and/or coarser-grid solution with the conventional data (surface reports and upper-air radiosondes from ground stations of the World Meteorological Organization). The remotelysensed data received at the NARSS Weather and Climate Station was planned for updating the boundary conditions and for model evaluation. This includes temperature and water vapor retrievals from NOAA/ATOVS data and Albedo, NDVI and SST/LST from NOAA/AVHRR data. The observational data was assimilated using Four-Dimensional Data Assimilation, FDDA, (nudging of temperature, humidity, and wind fields). Inside the Planetary Boundary Layer, PBL, nudging of temperature and humidity is turned off for all simulations.

Five sets of simulations were performed. First, a reference case, “Ref”, no FDDA was utilized for all domains. Second, “No D3”, FDDA with Multi-quadric nudging scheme, MQ, was utilized for the coarser domains only. Third, “No PBL”, FDDA with MQ was utilized for all domains but not in the PBL. Fourth, “DA MQ”, FDDA with MQ was utilized for all domains. Finally, “DA CM”, FDDA with Cressman nudging scheme was utilized for all domains. Four sets were selected for data sampling locations. First, a “principal set”, is the set of stations used in data assimilation. Second, “interpolation set”, is the set of stations located in-between the principal stations. Third, “extrapolation set”, is the set of stations located far from the principal stations. A final, “special set”, is the set of stations located at complex terrain. The stations near coast lines were included in different sets according to their locations. Figure 1 shows the distribution and locations of the different observation sets.

The differences between the simulation sets were not always as expected. Figure 2 shows the near-surface temperature difference between “Ref” and “DA MQ” simulations in two different situations. The locations of large differences were sometimes found around the extrapolation set (left figure) and appear occasionally around the special set and near the coast lines (right figure). Figure 3 shows sample results of the principal set while Figure 4 shows sample results of the special set. The results at the principal stations are better and more correlated to the observations than those at the special set.

The paper will present details of the model configurations, the results of the carried out simulations, and the behavior of the model with/without different FDDA nudging options for the selected observation sets. The analysis of the results will also show where and why large differences may occur and how to get better solutions. Accuracy at the observational-data-void areas and at the locations of difficult terrain/land-use will be assessed. Locations with best/worst results will be identified and the other conclusions drawn from this work will be presented.

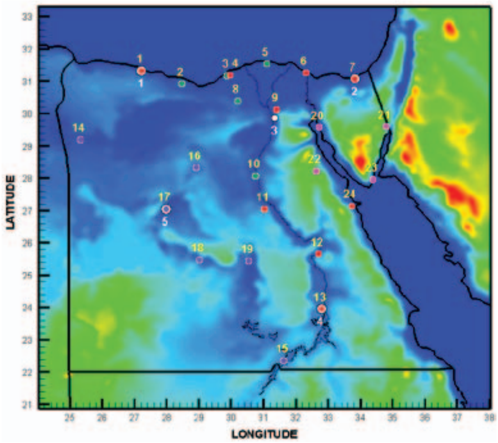

Figure 1 The locations of WMO stations used for the evaluation

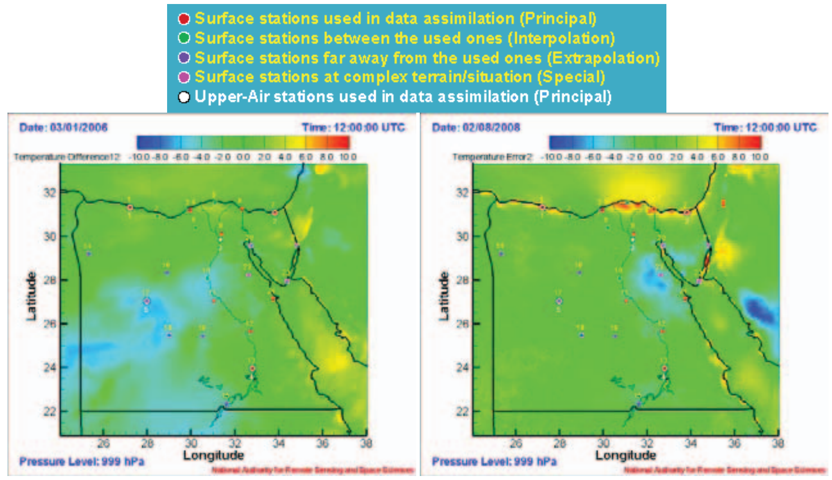

Figure 2 The near-surface temperature difference between “Ref” and “DA MQ” simulations in two different situations

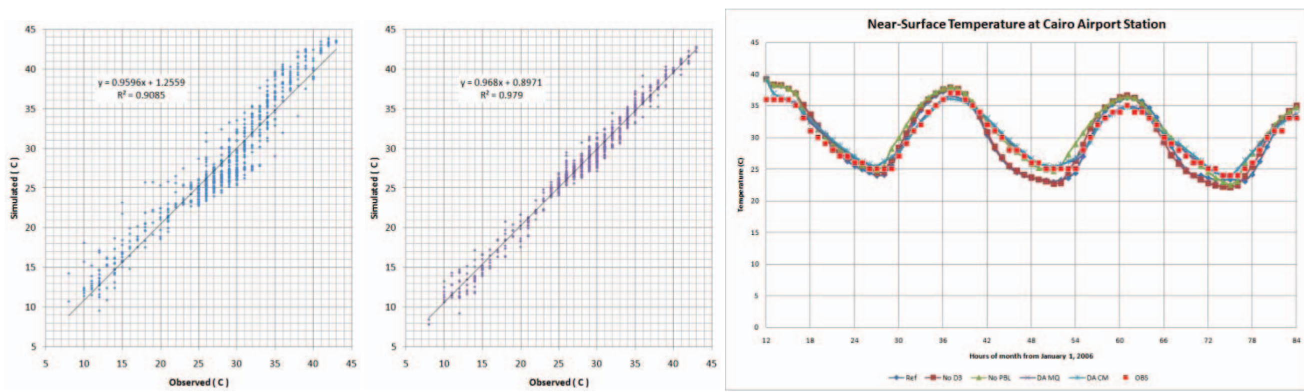

Figure 3 Sample results for the principal set: “Ref” simulations vs. “DA MQ” simulations scatter plots and near surface temperature at Cairo Airport Station

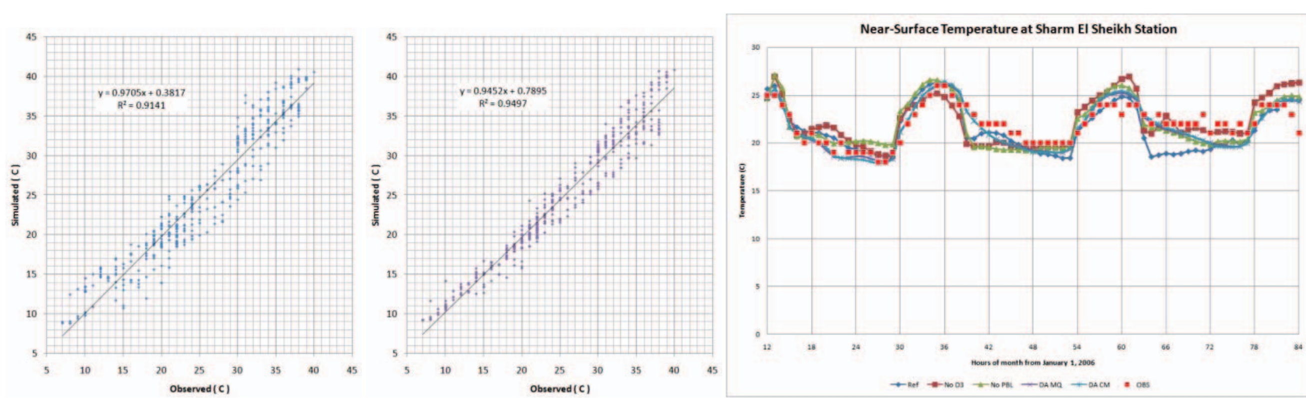

Figure 4 Sample results for the special set: “Ref” simulations vs. “DA MQ” simulations scatter plots and near surface temperature at Sharm El Sheikh Station

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