Mesonet Quality Control and Data Assimilation Challenges for the Real Time Mesoscale Analysis (RTMA) System

Steven Levine[a], Manuel Pondeca[b], Geoff DiMego[c]

[a]Systems Research Group (NOAA/NCEP/EMC), [b]IM Systems Group (NOAA/NCEP/EMC), [c]NOAA/NCEP/EMC

Abstract/Background

NCEP's Real-Time Mesoscale Analysis (RTMA) assimilates data from a variety of sources to create 2 dimensional surface analyses for wind, moisture and temperature. The use of mesonet data presents a unique challenge. Many mesonets are set up for specific uses, and are not necessarily representative of their surroundings. While some mesonet stations add value to the analysis, many do not, or only do so in certain situations.

NCEP has developed lists of usable and unusable mesonet stations based on O-B innovations compared to METAR sites. In this study, we attempt to test two versions of these lists against a control RTMA (without any improvements in QC).

The QC lists are based on O-B statistics. METAR sites are used as reference stations. The hypothesis behind the lists is that if a mesonet station has similar O-B innovations to METAR sites for a given variable, that station is probably well sited (at least for that variable) and therefore can be used in the analysis. Here, we test the impact of these lists on the RTMA. The lists are shows to have a slight impact on the analysis.

Fig 1. Example mesonet station, showing when wind observations from this site would be used (PASS) or not (FAIL) based on observed wind direction. The goal is to use wind observations when the flow is not obstructed, and to reject the observations when flow is obstructed.

Experiment Set-Up

Two sets of QC lists are tested here. In both cases, O-B innovations were taken for all stations in the RTMA's CONUS domain for a 3 month period (1 May —31 July 2013). If the mean innovation (O-B) for a given mesonet station and variable was within 1 standard deviation of the mean bias of a list of METAR stations for that same variable, then the station is marked as usable. Otherwise, the station is not used. Separate lists are computed for moisture, temperature, and wind speed. The lists are situational dependent; usable wind observations are partially dependent on wind direction (see fig 1), temperature and moisture lists change based on local sun angle. The difference between the two lists is the list of METAR sites used to compute reference stats. In the other (distance), only METAR stations within 150 km of a site are used. The use of these lists increases the number of wind obs used (see fig 2) and decreases the number of temperature and moisture obs used. For one set of lists (domain) all stations in the CONUS domain of RTMA are used to compute reference stats. In the control run, the RTMA's default QC was used: All moisture and temperature obs were used, except those failing a large gross error (O-B) check. Winds were only used from METAR sites and a list of mesonet providers with known, consistent siting standards (including RAWS, OK-Mesonet, WT-Mesonet, etc.)

Each parallel and the control were run every three hours for ten days (15-24 August, 2013). Each analysis was run at a 5 km resolution (note that the operational RTMA runs at 2.5 km resolution).

The RTMA uses a cross validation method to measure analysis accuracy. A subset of observation is withheld from the first two outer iterations in each analysis of the GSI. The obs are then re-inserted at the third iteration. The subset is selected using a Hilbert Curve method described in Pondeca (2011), this ensures that . O-A innovations are then computed against these obs are then used to compute root mean squared error averages.

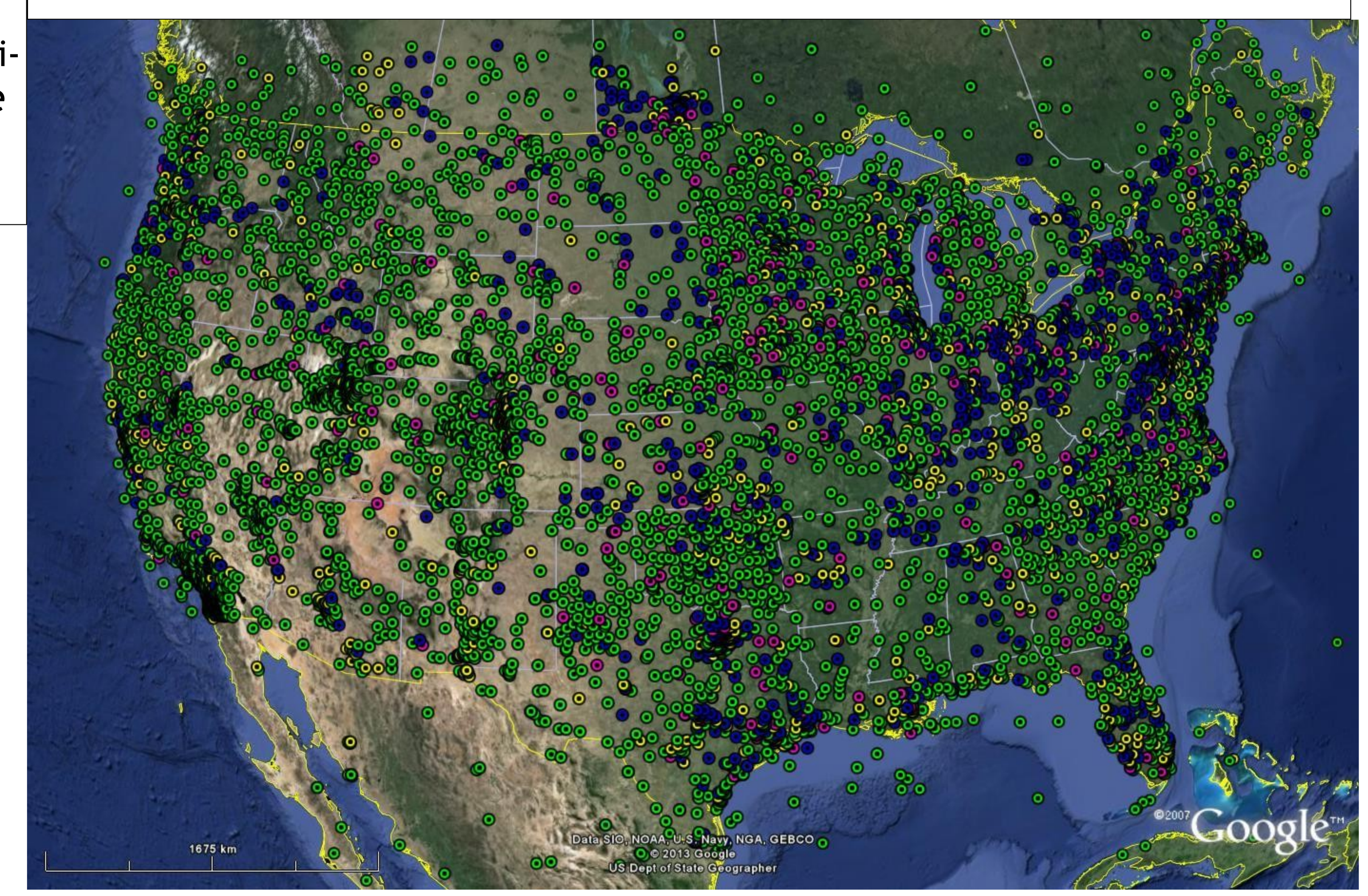

Fig 2. Color coded map showing how stations were used in one analysis (21 August 09Z). Green stations were used in the control and both experiments, yellow stations were used in the domain-wide lists, purple stations were used in the distance-based lists, blue stations were used in both experimental runs

Results/Conclusions

Average RMSE stats for the control run and two parallels are shown in figure 1. The new QC lists appear to have increased error for temperature and dew point, and only slightly decreased for wind. Time of day average RMSE's for the domain based and distance based lists for temperature are shown in figure 3 and 4. The diurnal based lists for temperature do not appear to have had a meaningful impact on the analysis. Similar results occurred in the distance based-lists and control run. While a larger dataset would be necessary to further evaluate this quality control method, these results seem to show that other methods should be used to improve quality control in the RTMA.

Variable	Distance-based lists	Domain-based lists	Control
2 m Air Temperature (K)	1.644	1.631	1.608
2m Dew Point Temperature (K)	2.005	2.019	1.870
10 m Wind Speed (m/s)	1.640	1.645	1.676

Table 1. Average RMSE for air temperature, dew point and wind speed averaged over the experiment period. Stats computed with RTMA's internal cross-validation system

Conclusions and Further Work

In addition to testing these lists on a larger dataset, the addition of further quality control tests. Metadata gathering through the National Mesonet project could prove invaluable in examining the representativeness of certain mesonet stations. We are also interested in computing lists based on an improved RTMA background field; the current field is downscaled from 13 km (RAP) to 5 (or 2.5 operationally) km, and has been known to produce unrealistic background fields. Future RTMA upgrades will include background from the CONUS NAM nest (4 km), and possibly the High Resolution Rapid Refresh (3 km). We also plan to explore the use of variational quality control.

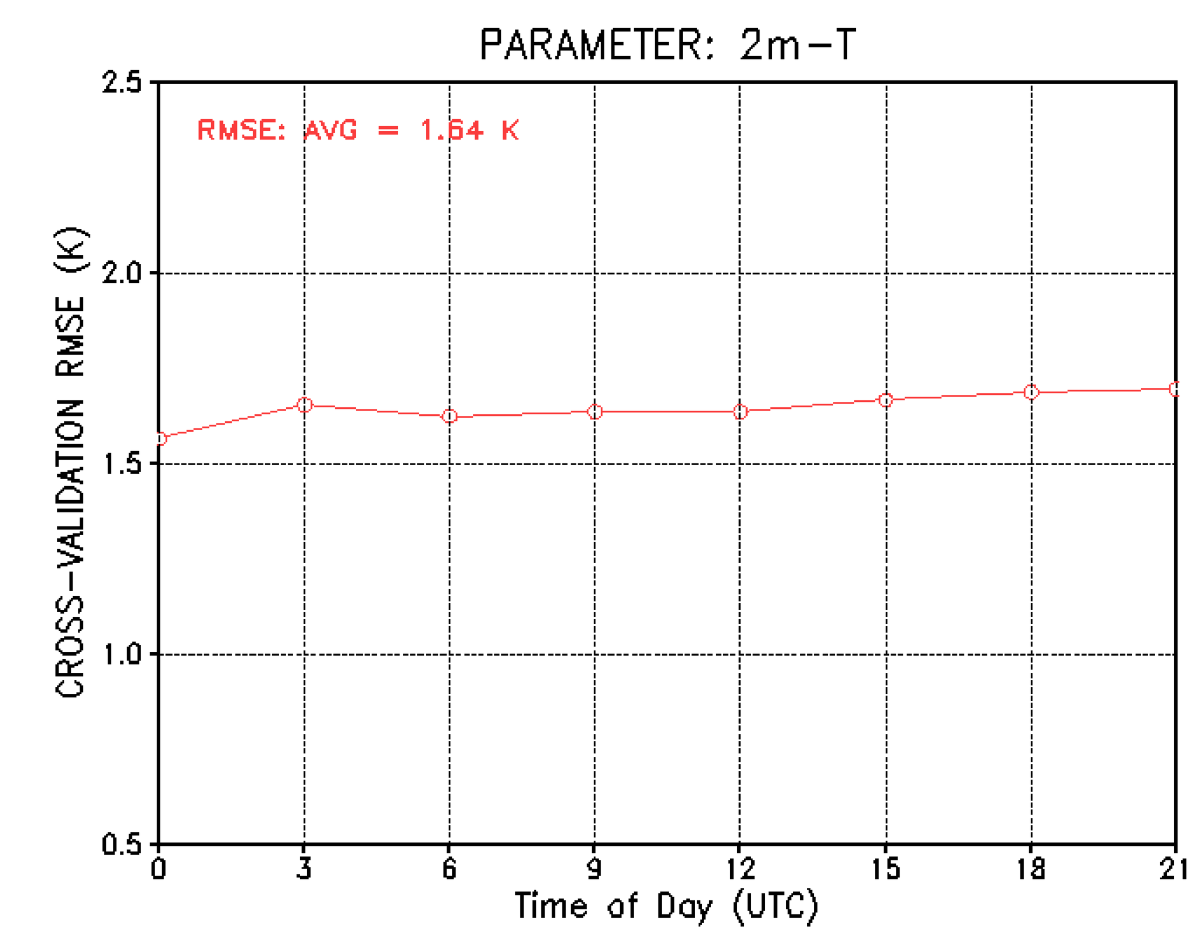

Fig 3. Time-average RMSE of temperature throughout the 10 day experiment

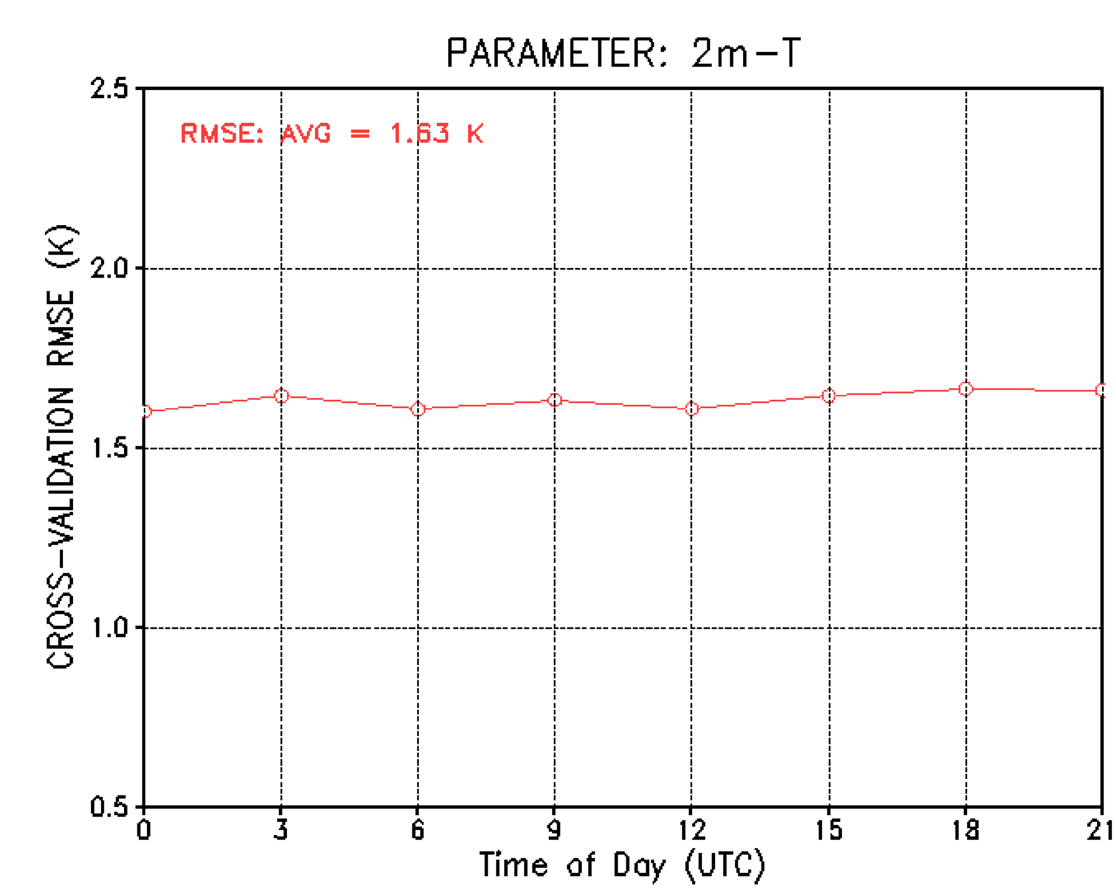

Fig 4. Same as figure 3, but for the distance based domain lists