The development and utility of a database of mesonet observations for use in the Real Time Mesoscale Analysis (RTMA) system

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Purpose and Goals
Greater than 60% of mesonet wind observations available for use in the RTMA are excluded from the analysis due to a perceived low bias. This low bias, when compared to nearby 'gold standard' (i.e. METAR) wind observations, suggests that many of these mesonet stations are located in less than 'ideal' settings that exhibit relatively significant surface roughness and/or sheltering effects. Quality control (QC) for RTMA wind observations is nonexistent for many stations and stations not on an unconfirmed accept list are excluded from the analysis by default. In addition, a lack of site metadata remains problematic from a data assimilation perspective as it can have an impact on observation error, data rejection, etc. The primary goal of this work is to assess the quality of the heretofore unexamined wind observations in an effort to update the RTMA accept/reject lists. The quality control process used herein is unique in that we incorporate a flow-dependent approach in which the station data are not necessarily accepted or rejected outright but, rather, are examined and flagged based on the observed wind direction and then evaluated with respect to nearby obstructions. The results presented illustrate how a database system (MySQL) can be used to stratify/organize mesonet observation data for quality control and can be extended for other purposes.

In the second QC application, wind observations are stratified based on direction and are divided into eight 45-degree bins. Error statistics (RMSE and bias) that are computed using a first guess field (downscaled Rapid Update Cycle 1 forecast) as 'truth.' In lieu of the background, stations are then compared directly to nearby METAR sites. Those with similar wind speeds (i.e., low bias) and RMSE for a particular wind speed bin are placed on an accept list for that directional bin. Decision trees illustrating the two QC procedures involved in the assignment of flags (i.e., accept vs. reject) are presented in Fig. 1. Here, we arbitrarily assign a given station and/or a particular directional bin to the accept list if the average difference in wind speed between the mesonet site and the METAR site is less than 1.0 m/s. This is accomplished through dual z-tests (90% confidence interval) as well as an average difference test (see Fig. 2).

Results/Discussion
Following application of the QC procedures shown in Figs. 1a and b (for a 1-year period), the number of hourly wind observations flagged as acceptable for use in the RTMA increased by 18%, from 1,373,131 to 1,621,249 (out of 4,044,142 possible observations). This increase (red-to-blue, Fig. 3) includes observations that passed either the directionally dependent or nondirectional tests. A large number of observations continue to be rejected — most of which are likely due to poor siting.

Stations placed on either a directional or universal accept list were also inspected via aerial/Google Earth imagery. Four of these images are presented in Fig. 4. In most (but not all) cases, stations placed on the universal accept list were in open, obstruction-free areas consistent with the standard siting criteria. Stations placed on a directionally dependent accept list were generally in partially open areas in which the wind flow was obstructed in some directions by nearby trees, buildings, etc. Directional bins that passed the directionally dependent test were generally (though not always) free of these obstructions, while bins which failed the test generally (though not always) contained numerous obstacles (e.g., trees, buildings, etc.). In some cases, malfunctioning instruments, imprecise or inaccurate location data, nonstandard anemometer height, or interference from foreign objects not visible in aerial imagery may also affect data quality.

Future Work
The methods used in this study will be expanded to the entire CONUS domain, and possibly Alaska to further increase the number of stations assimilated by the RTMA. A joint method will also be used to incorporate mesonet wind observations in upgraded versions of the NAM and other high-resolution NWP products at NCEP. These methods are also being used in combination with the National Mesonet project to infer metadata for various mesonet sites where site visits are not feasible. These metadata will be further utilized in future mesonet QC/QA methods.

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Methodology
Regional (Florida, southern Georgia and Alabama) wind observations are examined for one year (1 August 2008–31 July 2009). The procedure consists of two basic components: the first involves statistics (RMSE and bias) that are computed using a first guess field (downscaled Rapid Update Cycle 1 forecast) as ‘truth.’ Mesonet sites with similar RMSE and wind speeds (i.e., low bias) to that of nearby ‘gold standard’ METAR sites are placed in an updated accept list.

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