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

Steve Levine (NOAA/NCEP/EMC/IMSG, Camp Springs, MD), Steven Lazarus, Michael Splitt (Florida Institute of Technology, Melbourne, FL) and
Manuel S.F.V Pondeca (NOAA/NCEP/EMC/IMSG, Camp Springs, MD)

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 a pre-determined 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.

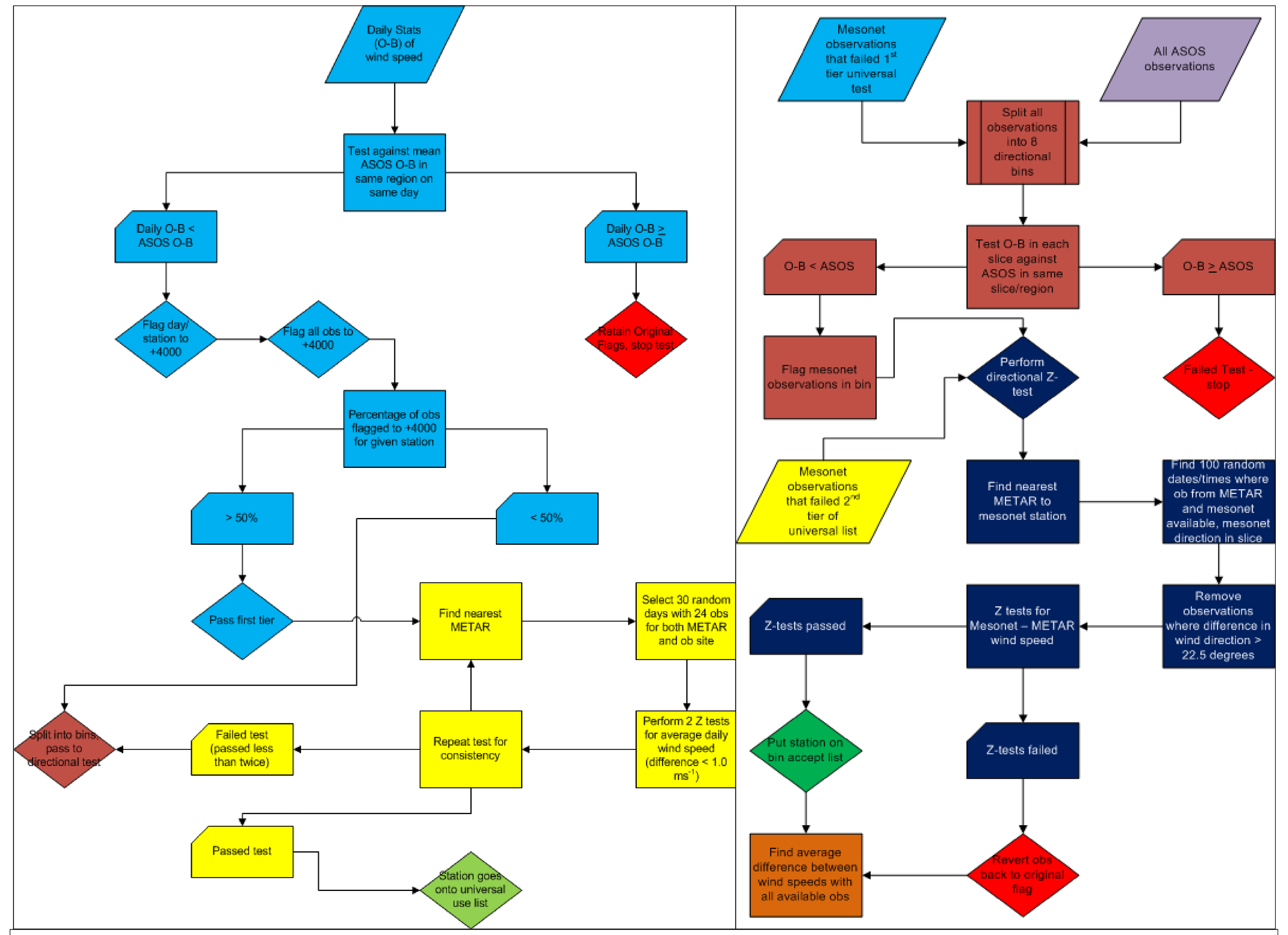

Fig. 1. Decision trees illustrating the QC procedure for an expanded universal accept list (a) and a new directionally dependent accept list (b).

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 h 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.

In the second QC application, wind observations are stratified based on direction and are divided into eight 45 degree bins. Error statistics are computed separately for each directional bin, again using the background field 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 versus 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 nearest METAR site is less than 1.0 ms^{-1}. This is accomplished through dual z-tests (90% confidence interval) as well as an average difference test (see Fig. 2).

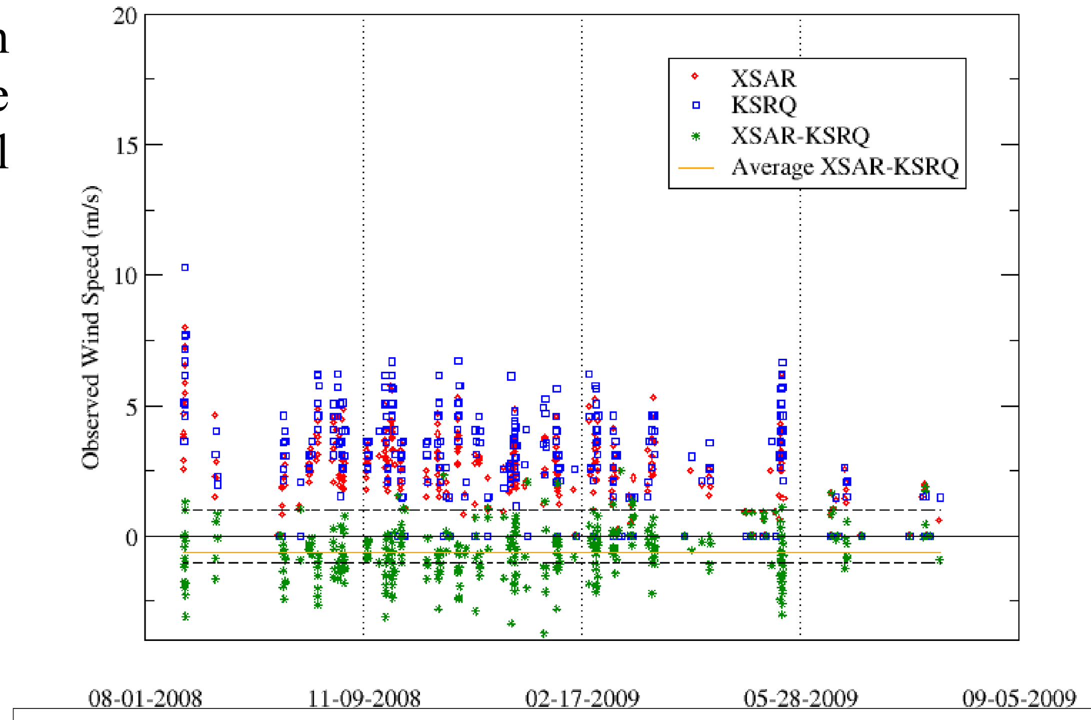

Fig. 2. Example graph showing observed wind speed at mesonet site (red), METAR site (blue), difference (meso—METAR, green)), and average difference (yellow line) for all observations in one directional bin. Black dashed lines represent +/- 1.0 ms^{-1}, the threshold used to determine if a given station/bin was suitable for use. This bin was found suitable for use

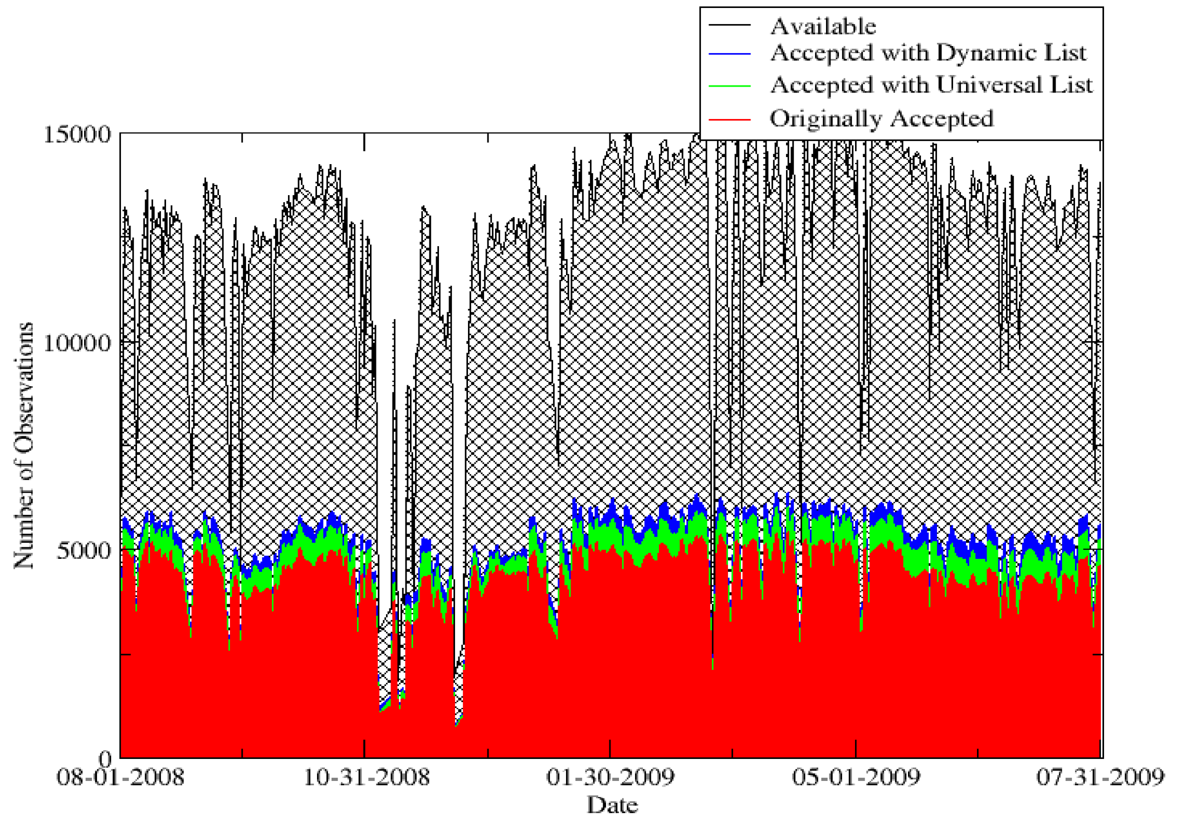

Fig. 3. Number of observations flagged as acceptable before use of system (red), using only universal accept list (green), and using both universal and directionally dependent accept lists (blue), along with number of observations available for use in RTMA by date (black/white checkerboard).

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 unidirectional 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 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, non-standard anemometer height, or interference from foreign objects not visible in aerial imagery may also affect data quality.

Each station was examined individually, but trends among different mesonet providers were evident. Mesonets set up by government entities or academic/research institutions (e.g., South Florida Water Management District, National Ocean Service, Florida Mesonet) generally showed low wind speed biases is most directions. Networks consisting of stations set up by individuals (e.g., APRSWXNET, AWS Weatherbug network), generally demonstrated a low bias. This may be due to consistent siting criteria (or lack thereof) used in a particular network.

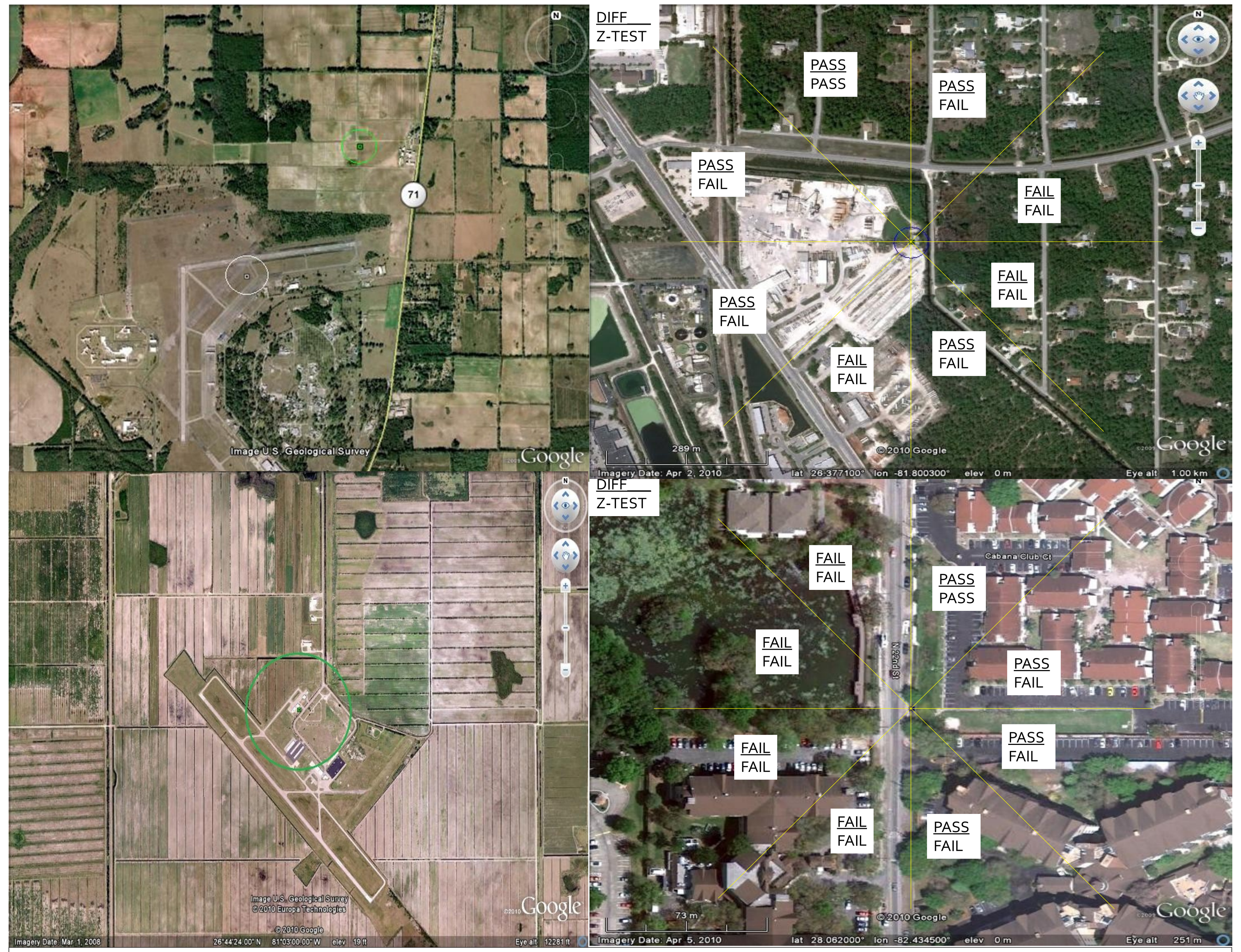

Fig. 4. Google Earth images showing location of 4 mesonet sites placed on one of the accept lists. The two on the left were placed on the universal list, the two on the right were placed on one (or more) of the directionally dependent accept lists as shown.

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 similar 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 site where site visits are not feasible. These metadata will be further utilized in future mesonet QC/QA methods.

This work was funded by COMET Partners Project S09-81065. The authors wish to thank Geoff DiMego (NCEP/EMC), Pable Santos (NWS/Miami) and Dave Sharp (NWS/MLB) for their help and coordination with this study.