Title: NSSL Oklahoma Mobile Mesonet Meteorological Data

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1.0 Data Set Overview:

This dataset contains NSSL Oklahoma Mobile Mesonet (MM) Meteorological data obtained during the Deep Convective Clouds and Chemistry Project (DC3) from 19 May 2012 to 21 June 2012. Data were obtained from two platforms (each equipped with mobile mesonet instrumentation): the NSSL3 in-storm sounding vehicle (denoted "probe 3" or "P3") and the NSSL4 mobile environmental sounding vehicle denoted "probe 4" or "P4"). The mobile mesonet observations were obtained during joint mobile missions conducted along with mobile ground-based radars and specially-equipped mobile in-storm ballooning vehicles within the bounds of the Oklahoma-Texas DC3 venue. Missions were conducted on 13 irregularly-spaced mission days (IOPs) spanning the period of observation. Observations were obtained from one of the MMs on all IOP days, while the other MM obtained measurements on most but not all days.

2.0 Instrument Description:

Each NSSL mobile mesonet vehicle during DC3 consisted of a 2008 Dodge Grand Caravan equipped with a roof-mounted meteorological instrumentation rack (including data-logger) combined with interior-mounted computing and communications hardware. Measured MM variables are described in sections 3.0, 4.0, and 5.0 below.

3.0 Data Collection and Processing:

These mobile mesonet datasets combine periods of ferrying from the base at the National Weather Center
(NWC) in Norman, OK to the initial mobile sounding location, followed by stationary observing periods as individual soundings are obtained; this pattern repeats with ferry to each subsequent sounding site, followed by return to base to complete an IOP. These NSSL mobile mesonet data records are obtained at a nominal spacing of 1 Hz. There may be rather infrequent missing 1 Hz records or small groups of consecutive records, due to QC removal of those few records that were corrupted in either the GPS location group, the time group, the raw observation, or the derived variable groups (see section 4 below). These occasional corrupted values were in turn caused by the different system clocks occasionally getting out of synchronization. The QC process has objectively detected and removed the infrequent corrupted records from the archived datasets.

The temperature and relative humidity sensors on the NSSL mobile mesonet systems were pre-calibrated by the Oklahoma Climate Survey (OCS) instrumentation laboratory prior to the DC3 field phase.

Users of these data are advised to add checks into their processing or plotting software, etc, to gracefully detect and handle occasional missing records. As some missions extended into the night of the next (UTC) day, had a short break, and then resumed (but did not continue past ~ 10 UTC the following morning), it is recommended to add a check to guarantee that time is computed in UTC hours relative to 0000 UTC on the day of initial deployment. (I.e., decimal time during Night #1 will be greater than 24.00 UTC.) Users are cautioned against relying on wind speed/direction data in low vehicle ground-speeds (~ 2-3 m/s) while the MM is either rapidly accelerating from or rapidly decelerating to stationary position. Users are cautioned to employ specific "derived" variables and avoid using the so-called "slow-response" temperature and relative humidity observations (as elaborated in sections 4.0 and 5.0).

4.0 Data Format:

Each NSSL mobile mesonet file contains the mobile mesonet data for a specific vehicle for one mission day or IOP. In each file, the file header includes a list of variable names in each data record.

The data are in regular, space-delimited ASCII format. The filename prefix ends in either P3 (e.g. C18095P3) for data files associated with Probe 3, or else P4 (e.g. C18096P4) for data files associated with Probe 4.ÊThese data files are provided by IOP relative to UTC time and date of departure for the IOP. The IOP departure date and time are indicated in the filenames.

Each NSSL mobile mesonet data set includes a 6-record header followed by a time series of 1-Hz mobile mesonet data records. The NSSL mobile mesonets in DC3 correspond to vehicle ID's P3 and P4 as previously noted.

Useful mobile mesonet variables include the following basic quantities:

pressure (mb);
fast-response temperature (C) or "Tfast" - see discussion below;
derived dewpoint temperature (C) - see discussion below;
derived ground-relative wind direction (wind from indicated direction, deg clockwise from north);
derived ground-relative wind speed (m/s);
GPS deployment year;
GPS deployment month;
GPS deployment day;
GPS hour (UTC relative to 0000 UTC on day of initial deployment);
GPS minute;
GPS second;
latitude (decimal deg);
longitude (decimal deg west of Greenwich Meridian).

Regular, space-delimited observations in each record are formatted according in the following sequence (with above useful observations defined after the given variable):

DL.HHMM;
DL.Sec;
UTFas_YSI - fast-response temperature (C) or "Tfast";
UTSloT_H45;
UTRH_H45;
DL.RMYASP_YSI;
DL.AirSpd_mps;
DL.NoseRelWd;
DL.SolarRad;
DL.Box_Temp;
DL.Ref_Volts;
DL.Batt_Volts;
DL.InvalidRecord;
Pressure.Value - pressure (mb);
Pressure.InvalidRecord;
Fluxgate.Heading;
Fluxgate.Overload;
Fluxgate.InvalidRecord;
GPS.Year - GPS deployment year;
GPS.Month - GPS deployment month;
GPS.Day - GPS deployment day;
GPS.Hour - GPS hour (UTC relative to 0000 UTC on day of initial deployment);
GPS.Minute - GPS minute;
GPS.Second - GPS second;
GPS.Latitude - latitude (decimal deg);
GPS.Longitude - longitude (decimal deg west of Greenwich Meridian);
GPS.AltEllipsoid;
GPS.AltMSL;
GPS.Heading;
GPS.Velocity;
GPS.SatellitesVisible;
GPS.SatelliteLock;
GPS.InvalidRecord;
Derived.AmbWndDir - derived ground-relative wind direction (wind from indicated direction; deg clockwise from north);
Derived.AmbWndSpd - derived ground-relative wind speed (m/s);
Derived.Dewpoint - derived dewpoint temperature (C);
Derived.ThetaE;
Derived.VehDir;
Derived.VehSpd;
Derived.Timecode.

Other variables of note (with comments on Tslow and RHslow expanded in section 5.0):

Derived.ThetaE - derived theta-e (K);
Derived.VehDir - derived vehicle direction of motion (deg);
Derived.VehSpd - derived vehicle speed (m/s);

UTSloT_H45 = slow-response temperature (C) or "Tslow" (sensor behind membrane, AVOID USING);
UTRH_H45 = slow-response relative humidity RH or "RHslow" (sensor behind membrane, AVOID USING);

Formulas/algorithms for computing additional useful derived quantities:

- GPS hours (decimal UTC) = GPS_Hour + (GPS_Minute/60.) + (GPS_Second/3600.)

- Ambient derived RH (%):
(1) compute Tfast (K) from Tfast (C);
(2) compute saturation vapor pressure (mb) at Tfast (K) using Bolton (1980, eq. 10);
(3) compute saturation vapor mixing ratio qvsat = 1000.0 * ep * se / (p - se), where ep = 0.622, se is saturation vapor pressure (#2), and p = pressure (mb);
(4) compute derived dewpoint (K) from derived dewpoint (C);
(5) compute actual derived vapor pressure (mb) from derived dewpoint (K) using Bolton (1980, eq. 10);
(6) compute vapor mixing ratio qv = 1000.0 * ep * ae / (p - ae), where ep = 0.622, ae is vapor pressure (5), and p = pressure (mb);
(7) compute derived ambient RH = 100.0 * (qv / qvsat) from #3 and #6.

5.0 Data Remarks:

For more information, contact Conrad Ziegler (conrad.ziegler@noaa.gov).

Note on Tfast: The Tfast sensor is well-sheltered from weather and solar radiation and well-aspirated (exposed) via ambient air drawn across the protected Tfast sensor within a "U-tube" enclosure designed by NSSL (Waugh 2012). The new U-tube enclosure design proceeds from and improves on the earlier successful "J-tube" enclosure (Straka et al. 1996). Users should employ Tfast for all temperature or temperature-related quantities. Tfast measurements have been determined to be reliable even when vehicles are stationary (Waugh 2012).

Note on Tslow and RHslow: The Tslow and RHslow sensor responses are slowed because the sensors are located inside a trapped volume enclosed by a microporous membrane that keeps the RH probe from being contaminated by pollutants (Waugh 2012). Although the membrane is porous to water vapor molecules (thus vapor pressure is equilibrated across the membrane), users should note that the RHslow measurement is not representative of the RH in the ambient environment. Users should also note that derived variables involving moisture and temperature are similarly unrepresentative of the ambient environment, because neither RHslow nor Tslow are representative. Instead, the pressure, Tfast, and RHslow have been combined following Richardson et al. (1998) to obtain the derived ambient RH value. Users should always employ the derived ambient RH value for all moisture or moisture-related quantities (also using Tfast for all moisture-temperature related quantities).

6.0 References:

Richardson, S.J., S.E. Fredrickson, F.V. Brock and J.A. Brotzge, 1998: Combination Temperature and Relative Humidity Probes: Avoiding Large Air Temperature Errors and Associated Relative Humidity Errors. Preprints, 10th Symposium on Meteorological Observations and Instrumentation; American Meteorological Society, Phoenix, Arizona, January 11-16.

Straka, J.M., E.N. Rasmussen, and S.E. Fredrickson, 1996: A mobile mesonet for finescale meteorological observations. Journal of Atmospheric and Oceanic Technology, 13, 921-936.

Waugh, S., 2012: The "U-Tube": An improved aspirated temperature system for mobile meteorological observations, especially in severe weather. M.S. Thesis, University of Oklahoma, 76 pp.