Title: CoMeT-2: UNL Mobile Mesonet Data

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1.0 Data Set Overview

This data set contains observations from the second Combined Mesonet and Tracker (CoMeT-2) collected during the Targeted Observation by Radars and UAS of Supercells (TORUS) 2019 field campaign. Deployments occurred between 13 May - 15 June 2019. CoMeT-2 was principally operated in the Right-Flank Mission. CoMeT-2 is a 2017 Ford Explorer with a forward-mounted suite of meteorological sensors and a dual moonroof, combining the capability of a mobile mesonet to collect near-surface observations with the capability of an unmanned aircraft systems (UAS) tracker vehicle, which enables an observer in the second row of seats to see the aircraft and maintain compliance with Federal Aviation Administration policies on UAS operation.

CoMeT-2 was funded through an equipment allocation included in the NSF Research Infrastructure Improvement Program: Track-2 Focused EPSCoR Collaborations award (OIA-1539070).

2.0 Instrument Description

The CoMeT collects observations of slow temperature and humidity at ~2 m above ground level (AGL) using a Vaisala HMP155E, fast temperature at ~2 m AGL using a Campbell Scientific 109SS-L thermistor, pressure at ~2.5 m AGL using a Vaisala PTB210, wind speed and direction at ~3.25 m AGL using an R.M. Young 05103 propellor anemometer, and vehicle heading using a KVH Industries C-100 fluxgate compass. The HMP155E and 109SS-L thermistor are shielded and aspirated within a U-tube (Waugh and Frederickson 2010; Houston et al. 2016). This list of sensors is also included in the CoMeT data file metadata. Fast temperature and corrected RH measurements (using sensors housed within the U-tube) have a time constant of 10-12 s based on data collected across a temperature and RH shock during the CLOUD-MAP 2017 calibration/validation tests on June 26, 2017. Vehicle speed was < 10 kts for this test.

Sensor Specifications:

Relative Humidity (RH) and slow temperature

Model: Vaisala HMP155E
Output Temp: -80°C to +60°C
Output RH: 0%-100%
Accuracy Temp: ±(0.226-0.0028 X temperature)°C
Accuracy RH: ±(1.0 + 0.008 X reading)% RH
Response Time: 20 s

Fast temperature

Model: Campbell Scientific 109SS-L12-PW
Output: -40°C to +70°C
Accuracy: ±0.1°C
Response time: 7.5 s (air at 3 ms^{-1})

Pressure

Model: Vaisala PTB210
Output: 500-1100 hPa
Accuracy: ± 0.25 hPa

Wind

Model: RM Young 01053-L20-PW Propeller-vane Anemometer
Output wind speed: 0-100 ms^{-1}
Output wind direction: 0°-360°
Accuracy wind speed: ±0.3 ms^{-1} or 1% of reading
Accuracy wind direction: ±3°

Vehicle Heading

Model: KVH C100 Fluxgate
Accuracy: ±0.5°
Resolution: 0.1°

3.0 Data Collection and Processing

The reported measured quantities are summarized in the table below.

Quantity	Units	Source
Epoch time	Seconds	GPS

Latitude and longitude	Degrees	GPS
Altitude	m	GPS
Pressure	hPa	PTB210
Temperature (fast)	deg C	109SS-L
Temperature (slow)	deg C	HMP155E
RH (slow)	%	HMP155E
Vehicle speed	m/s	GPS
Vehicle heading	deg	C-100

In addition to the measured variables, the CoMeT-2 logger uses the observations to calculate dewpoint temperature (T_d in degrees C), mixing ratio (q_v in g/kg), potential temperature (θ in Kelvin), equivalent potential temperature (θ_e in Kelvin), virtual potential temperature (θ_v in Kelvin), and wind speed (in m/s) and direction (in degrees). The equations used to calculate these quantities are included here:

$$\theta = T\left(\frac{10^5}{p}\right)^{R_d/C_{pd}}$$

$$\theta_e = \left[\theta\left(\frac{T}{\theta}\right)^{\frac{R_d q_v}{C_{pd}}}\right]^{\left(\frac{3376}{T_{LCL}}-2.54\right)\left(q_v+0.81q_v^2\right)}$$

$$\theta_v = \theta\left(1+0.61q_v\right)$$

$$q_v = 62.2\frac{e}{p}$$

$$T_d = \frac{-5420}{\ln\left(\frac{p \cdot q_v}{62.2 \cdot 2.53\times10^9}\right)}$$

where, for these calculations, T is fast temperature in K, p is pressure in Pa, e is the vapor pressure in Pa based on $e = 0.01 \cdot RH \cdot e_s$, e_s is the saturation vapor pressure in Pa based on $e_s = 6.112^{\left[17.67(T-273.15)/243.5+(T-273.15)\right]}$, T_{LCL} is the temperature at the LCL in K based on

$$T_{LCL} = 55 + \frac{2840}{3.5\ln(T) - \ln(e) - 4.805}$$

, R_d is the gas constant of dry air, C_{pd} is the specific heat of dry air at constant pressure, and RH is relative humidity in percent adjusted to the fast temperature following Richardson et al. (1998) and Houston et al. (2016).

Regular intercomparisons between all three CoMeTs were performed during TORUS 2019. In these intercomparisons, the vehicles were parked adjacent to each other aligned perpendicular to (and facing into) the wind. To minimize engine heating effects, intercomparisons were only conducted when the wind speed was >10 kts.

4.0 Data Format

Original data files for each deployment are saved as text files and then converted to NETCDF. Included in this data set are the NETCDF versions only with units that are CF compliant and may not match the original units measured by the sensor. Each deployment day corresponds with its own file that uses the naming convention:

UNL.CoMeT2.{deployment date YYYYMMDD}.{start time of observation collection in UTC HHMM}.L2.{post-processing codes}.cdf

example: UNL.CoMeT2.20190615.1812.L2.g1.cdf

Post-processing codes are included to track modifications to the raw data. These codes are closely connected to error flags associated with each record. Each letter corresponds to a particular instrument:

g: GPS
p: Barometer
tf: Fast temperature
ts: Slow temperature
rh: Relative humidity
f: Compass
w: Wind monitor
a: All instruments

For the CoMeT-2 data collected during TORUS-2019, post-processing codes that could appear in the file name are as follows:

g1: No error but GPS position and time reprocessed from raw because of initial error

Measured and derived variables are included in the following table.

Variable Heading	Standard Name	Units
time	Time	seconds since 00:00:00, 01-01-1970
alt	Altitude	meters
lat	Latitude	degrees north
lon	Longitude	degrees east
fast_temp	Air Temperature	kelvin
slow_temp	Air Temperature	kelvin
pressure	Air Pressure	pascals
logger_RH	Relative Humidity	percent
calc_corr_RH	Relative Humidity	percent
wind_speed	Wind Speed	meters per second
wind_dir	Wind From Direction	degrees
vehicle_dir	Vehicle Direction	degrees
dewpoint	Dew Point Temperature	kelvin
mixing_ratio	Humidity Mixing Ratio	g/g
theta	Air Potential Temperature	kelvin
theta_v	Virtual Potential Temperature	kelvin
theta_e	Equivalent Potential Temperature	kelvin
error_flag		

The error_flag variable is a string that matches the post-processing codes listed above. All instruments will have an associated code, but will have a "0" if the datum is unchanged from the initial processed value.

5.0 References

Richardson, S. J., S. E. Frederickson, 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 Symp. On Meteorological Observations and Instrumentation, Phoenix, AZ, Amer. Meteor. Soc., 278–283.

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