BACS Drone Profile Meteorological Data

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1.0 Data Set Description

This dataset contains meteorological measurements collected by an InterMet iMet-XQ2 sensor mounted on a DJI M600 Pro uncrewed aerial vehicle (UAV/drone) flying “profile” flights during the BioAerosols and Convective Storms (BACS) field campaign. Flights occurred before, during, and after cold pool passages to examine changes in near-surface vertical profiles of temperature, moisture, and pressure.

Data version 1.1, 11/14/2025

Data Status: Final

Time Period: During the BACS-I and BACS-II campaigns in May and June of 2022 and 2023.

Physical Location: Within the Central Plains Experimental Range. The sensors were mounted on drones flying above the surface meteorological station located near the Semi-Arid Grasslands Research Center (40.8095 N, 104.7778 W) at varying altitudes. Ground level was approximately 1661.4m above mean sea level (msl).

Data Frequency: 1 second

Data Source: BACS PI field measurements

Project information: https://www.eol.ucar.edu/field_projects/bacs

Dataset restrictions: none

2.0 Instrument Description

1 Hz meteorological data were collected using InterMet iMet-XQ2 sensors mounted on a DJI M600 Pro drone. The drone was deployed in a "profile" making repeated ascents/descents at a constant rate to repeatedly sample the vertical structure of the atmosphere.

The relevant specifications of the iMet-XQ2 sensors are listed below. A full description of the instrument can be found here: https://www.intermetsystems.com/wp-content/uploads/2023/03/252013-13-iMet-XQ2-User-Guide-and-Manual.pdf

Quantity	Accuracy	Range	Resolution	Sensor(s) Used
Pressure	±1.5 hPa	1200 – 10 hPa	0.02 hPa	Digital piezoelectric (MS5607)
Temperature	±0.3ºC	-95 – 50ºC	0.01°C	NTC thermistor (PB5-41E)
Relative humidity	±5% RH	0 – 100%	0.1%	Digital capacitive (HYT 271)
GPS	±8m (horizontal), ±12m (vertical)	40km	0.01M	UBlox M8 Engine (CAM-M8Q)

3.0 Data Collection and Processing

The iMet-XQ2 sensors automatically collected data during the entire duration they were on, which was typically throughout the IOP except when drones were brought inside to avoid precipitation/extreme heat. At the end of each IOP, data were downloaded from the sensors. The final dataset here includes only the “profile” period when drones were ascending/descending in formation (i.e., excludes data collected while drones were on the ground or in transit).

The data processing involves two steps: (1) identifying the “profile” period, and (2) quality control of meteorological data.

First, we identified the period of time when drones were “profiling”. To determine if a drone was profiling, we checked that the XQ2 GPS sensor reported periods of relatively consistent ascent/descent rate >0.5m/s. We checked that the standard deviation in the ascent/descent rate was <1.5m/s. We allowed for small deviations from these criteria if the deviations were less than 15s long (which allows for e.g., temporary drift in the drone position to correct for wind gusts). Finally, we checked that each ascending/descending profile was at least 30s long and spanned an altitude of at least 60m. In these data files, we have included two flags (“ascending_flag” and “descending_flag”) which describe whether a measurement was taken during an ascending or descending profile.

Second, we quality controlled the meteorological data measured by the XQ2 sensor. We corrected the relative humidity measurement according to the procedure suggested in the iMet-XQ2 manual:

$$RH_{corrected} = RH_{raw} \times \frac{e_s(T_{RH\ sensor})}{e_s(T_{temperature\ sensor})}$$

We also screened out sudden fluctuations in the pressure, RH, and temperature when the values deviate from the 5-minute rolling median value by 10 times the stated sensor accuracy or by more than 10 times the 5-minute rolling standard deviation. We then visually inspected the resulting data and further identify three flights with problematic pressure/humidity data (Flight 3, Flight 4, and Flight 15), which are manually indicted in

our quality flags. These outliers in the pressure, RH, and temperature were replaced with NaNs and are indicated by the associated quality flags.

4.0 Data Format

The data are uploaded with one file per drone flight. Each flight consists of one drone flying one or more ascending/descending profiles. Each drone can have up to two sensors, one aspirated and one unaspirated ("sensor_type"). The naming convection for the files is "BACS-drone-met-profile_**YYYYMMDD**_IOP**XX**_F**NN**.nc". The date is written such that **YYYY** is the year, **MM** is the month, **DD** is the day of the flight in local time (MDT). **XX** is the two-digit number of the IOP and **NN** is the two-digit number of the flight (both numbered continuously from the beginning of BACS-I to the end of BACS-II). Data is in NetCDF format.

The variables are listed in the following table.

Name	Dimension	Units	Description
datetime_local	datetime_utc	Seconds since date given in the attribute "units"	Time in MDT
datetime_utc	datetime_utc	Seconds since date given in the attribute "units"	Time in UTC
datetime_utc_str	Datetime_utc	N/A	String giving date in format "YYYY-mm-dd-HHMMSS"
temperature	sensor_type, datetime_utc	°C	Temperature
temperature_qcflag	sensor_type, datetime_utc	Unitless	Temperature quality flag: 1 if data is good, 0 if data was bad and has been removed.
rh	sensor_type, datetime_utc	%	Relative Humidity
rh_qcflag	sensor_type, datetime_utc	Unitless	Relative humidity quality flag: 1 if data is good, 0 if data was bad and has been removed.
pressure	sensor_type, datetime_utc	hPa	Pressure

pressure_qcflag	sensor_type, datetime_utc	Unitless	Pressure quality flag: 1 if data is good, 0 if data was bad and has been removed.
altitude_msl	sensor_type, datetime_utc	Meters above sea level	Altitude from iMet-XQ2 GPS
latitude	sensor_type, datetime_utc	Degrees N-S	Latitude from iMet-XQ2 GPS
longitude	sensor_type, datetime_utc	Degrees E-W	Longitude from iMet-XQ2 GPS
satellite_count	sensor_type, datetime_utc	Number	Number of satellites detected by iMet-XQ2 GPS
ascent_flag	sensor_type, datetime_utc	Unitless	Ascent flag: 1 if ascending, 0 if not ascending
descent_flag	sensor_type, datetime_utc	Unitless	Descent flag: 1 if descending, 0 if not descending

5.0 Remarks

Code used to produce these data files can be found at:

https://doi.org/10.5281/zenodo.17594202.

6.0 References

7.0 Appendix

GCMD science keywords:

Air Temperature

Relative Humidity

Surface Pressure