**BACS Drone Stack 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 “stack” of DJI M600 Pro uncrewed aerial vehicles (UAVs/drones) 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 1.0, MM/DD/YYY

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.

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 three DJI M600 Pro drones. Drones were deployed in a “stack” at different measurement altitudes (typically 120, 235, and 350m above the ground) for simultaneous measurements over a vertical profile.

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 “in-stack” period when drones were stationary and 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 “in-stack” period, and (2) quality control of meteorological data.

First, we identified the period of time when drones were “in-stack”. To determine if a drone was in stack, we checked that the XQ2 GPS sensor reported altitudes within 36m of the nominal flight altitude (thrice the stated accuracy). We also checked that the drone was no longer moving by taking the standard deviation of altitude, latitude, and longitude over a rolling 120s window, and checked that this standard deviation was less than the stated GPS accuracy. We allowed for small deviations from these criteria if the deviations were less than 30s long (which allows for e.g., temporary drift in the drone position to correct for wind gusts). We did this process separately for each sensor, since each drone may reach its place within the formation at a different time.

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:

We also screened out sudden fluctuations in the pressure, RH, and temperature when the values deviate from the 5-minute rolling median value by 5 times the stated sensor accuracy or by more than 5 times the 5-minute rolling standard deviation. For flights where there were large discontinuities in pressure (pressure changes > 5hPa within the duration of the stack segment), we remove the pressure for the entire flight. 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. Typical flights had three stacked drones (i.e., three files for one “stack”). The naming convection for the files is “BACS-drone-met-stack\_**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 |
| time | Time | Datetime | Time in MDT |
| time\_utc | Time | Datetime | Time in UTC |
| temperature | Time, Nominal\_Altitude | °C | Temperature |
| temperature\_quality | Time, Nominal\_Altitude | Unitless | Temperature quality flag: 1 if data is good, 0 if data was bad and has been removed. |
| rh | Time, Nominal\_Altitude | % | Relative Humidity |
| rh\_quality | Time, Nominal\_Altitude | Unitless | Relative humidity quality flag: 1 if data is good, 0 if data was bad and has been removed. |
| pressure | Time, Nominal\_Altitude | hPa | Pressure |
| pressure\_quality | Time, Nominal\_Altitude | Unitless | Pressure quality flag: 1 if data is good, 0 if data was bad and has been removed. |
| altitude | Time, Nominal\_Altitude | Meters above sea level | Altitude from iMet-XQ2 GPS |
| latitude | Time, Nominal\_Altitude | Degrees N-S | Latitude from iMet-XQ2 GPS |
| longitude | Time, Nominal\_Altitude | Degrees E-W | Longitude from iMet-XQ2 GPS |
| satellite\_count | Time, Nominal\_Altitude | Number | Number of satellites detected by iMet-XQ2 GPS |

**5.0 Remarks**

**6.0 References**

**7.0 Appendix**

GCMD science keywords:

Air Temperature

Relative Humidity

Surface Pressure