New Advancements in Boundary Layer Observation Technology

Alana Dachtler

International Met Systems

PRESENTED AT:

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2011, A WXUAS ODYSSEY

InterMet Systems was manufacturing and installing Upper Air Systems decades before drones entered the weather observation scene. In 2011, InterMet partnered with another company to strip a radiosonde down to it's most vital components; a circuit board and a sensor boom, and installed it inside the body of a fixed-wing aircraft. The Raytheon Coyote is a later (and much more expensive) version of the first prototypes.

The success of this project proved that high quality weather observations could be performed using Unmanned Aircraft Systems, now known as WxUAS.

ENTER THE IMET-XQ

Introduced in 2015, the iMet-XQ was a self-contained sensor package that was lightweight and small enough to be delpoyed on virtually any UAS. It was designed to be a reuseable radiosonde that measured:

- Pressure
- Temperature
- Humidity
- GPS Altitude
- GPS Location (lat., long.)

The XQ was also integrated onto the 3DR SOLO drone package that allowed for real-time data to be streamed through the drone's telemetry. The concept was ahead of it's time and an unconventional method of measuring weather data. Just a few years after partnering with 3DR, the SOLO model was discontinued and the extensive development work required to implement the compatibility between the XQ and the drone was lost.

Another lesson quickly learned during the testing phase was that the GPS antenna ground-plane turned out to be a little too small and GPS reception was poor. A new design was introduced later that year and our most popular WxUAS product, the iMet-XQ2 was born!

BRING ON THE DATA!

With improved GPS performance and reliable weather data, the iMet-XQ2 has been featured in numerous campaigns all over the world and on every continent. Hundreds of units have been sold and it has become the industry standard for DYI drone-based weather observation efforts.

The sensor package is an easy introduction to WxUAS observations because of its simplicity, from operation to deployment.

The XQ2 publishes data at a rate of 1 Hz and each line of data is GPS timestamped allowing users to spend less time parsing data and more time analyzing the flight environment.

The sensors used on the XQ2 are the same ones used on InterMet radiosondes. They are tried and tested to be of the highest quality under rigorous flight conditions. [1]

[VIDEO] https://res.cloudinary.com/amuze-interactive/video/upload/q_auto/v1701464763/agu23/EC-1E-69-A9-19-85-5A-7A-8A-4E-77-AA-71-F1-E3-C4/Video/iMet_XQ2_V2_1210_Lower_Res_uhpmyo.mp4

But a few vital things were still missing: real-time data being transmitted to the ground during a flight and wind measurements.

InterMet has introduced two new products to address these needs; the iMet-X4 and the CopterSonde 3.

THE IMET-X4 MEANS MORE

With an ever-burning desire to innovate and advance the science of observation, the iMet-X4 has been in development for nearly four years. Now, it's ready to hit the market and is quickly gaining momentum.

Featuring dual temperature and humidity ports, the X4 Hub allows users to duplicate their measurments for added data fidelity, providing a "sanity check" that their sensors are operating within specifications. The X4 Hub also has two additional ports that will offer support to additional third-party sensors. This introduces a new option for air-pollution measurements.

A radio kit is also availble for the user to stream real-time data to their computer on the ground during a flight. The user can now perform flights that target specific areas of the boundarly layer like never before.

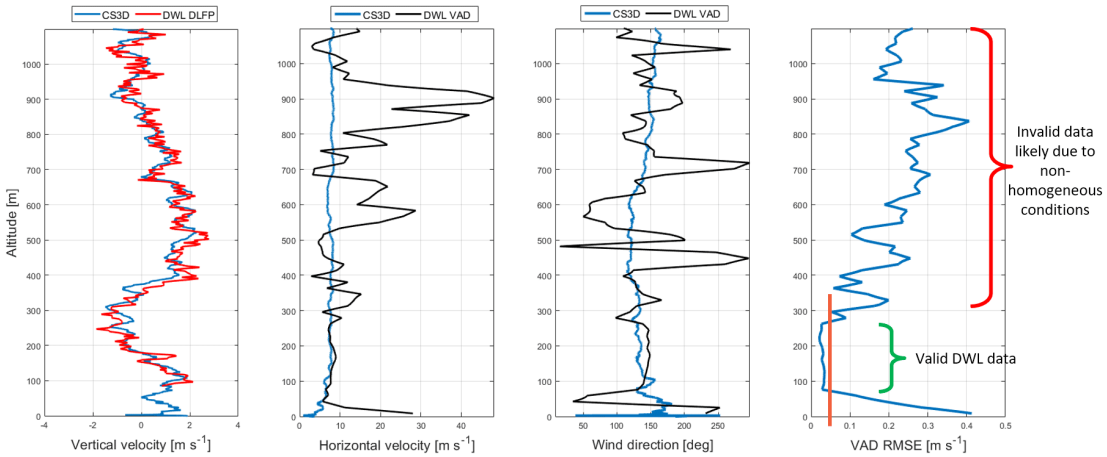
COPTERSONDE 3: THE ULTIMATE WXUAS MACHINE

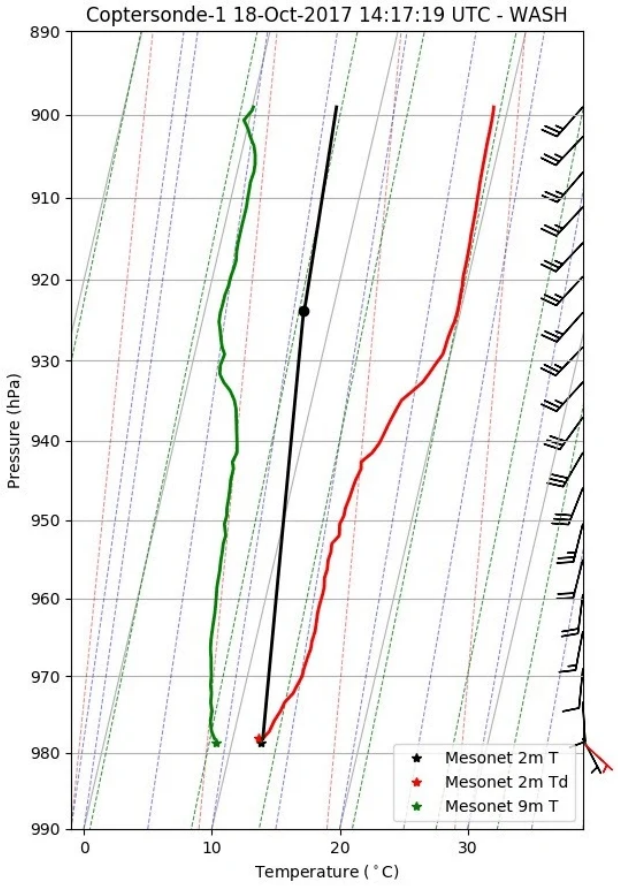
The number one request from WxUAS users was always, "Can it measure winds?". The CopterSonde 3 answers with a resounding, "YES"!

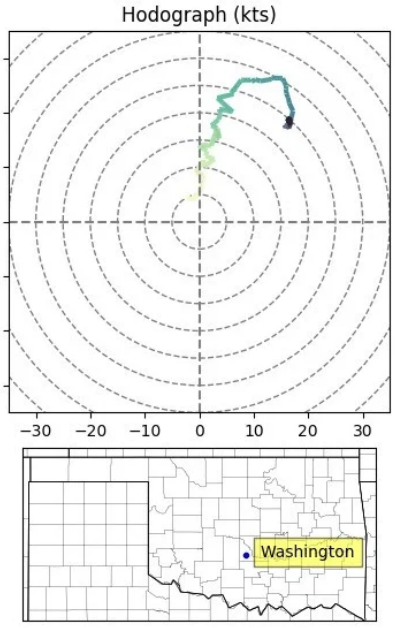
Developed by researchers at the University of Oklahoma, this Boundary Layer Vertical Profiler is a turn-key solution for measuring all standard atmospheric variables including wind speed and wind direction.

Dozens of previous CopterSonde versions have been deployed in several campaigns made possible by funds from NOAA and NSF. The CS3 is the culmination of a significant body of research. [2] [3]

[VIDEO] https://res.cloudinary.com/amuze-interactive/video/upload/q_auto/v1701802322/agu23/EC-1E-69-A9-19-85-5A-7A-8A-4E-77-AA-71-F1-E3-C4/Video/DJI_0007_s2klte.mp4







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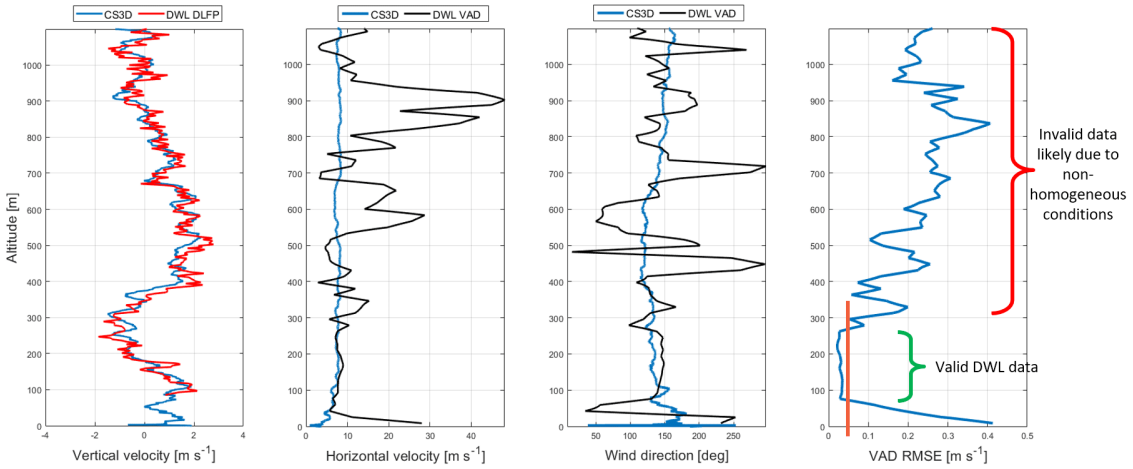
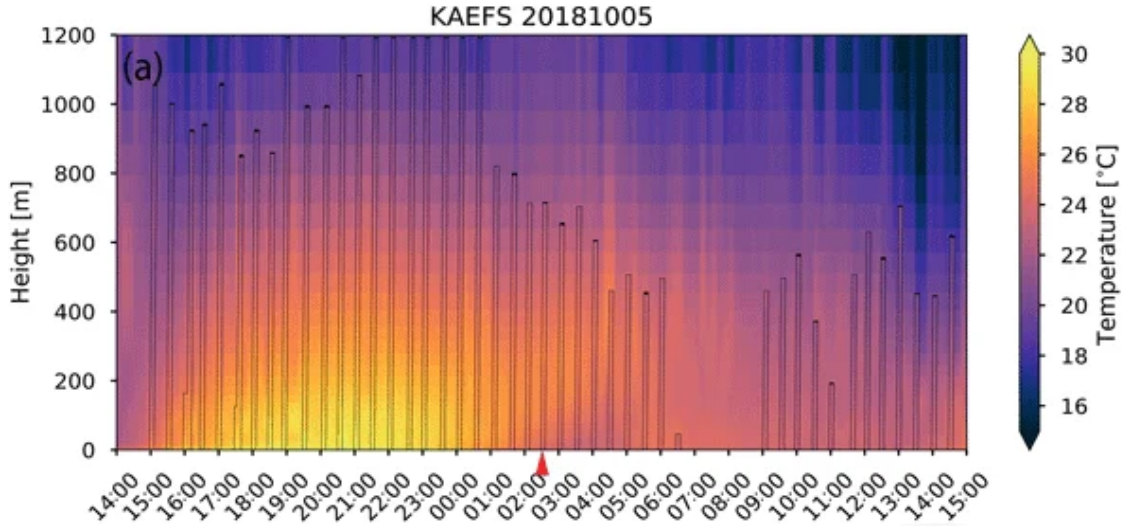
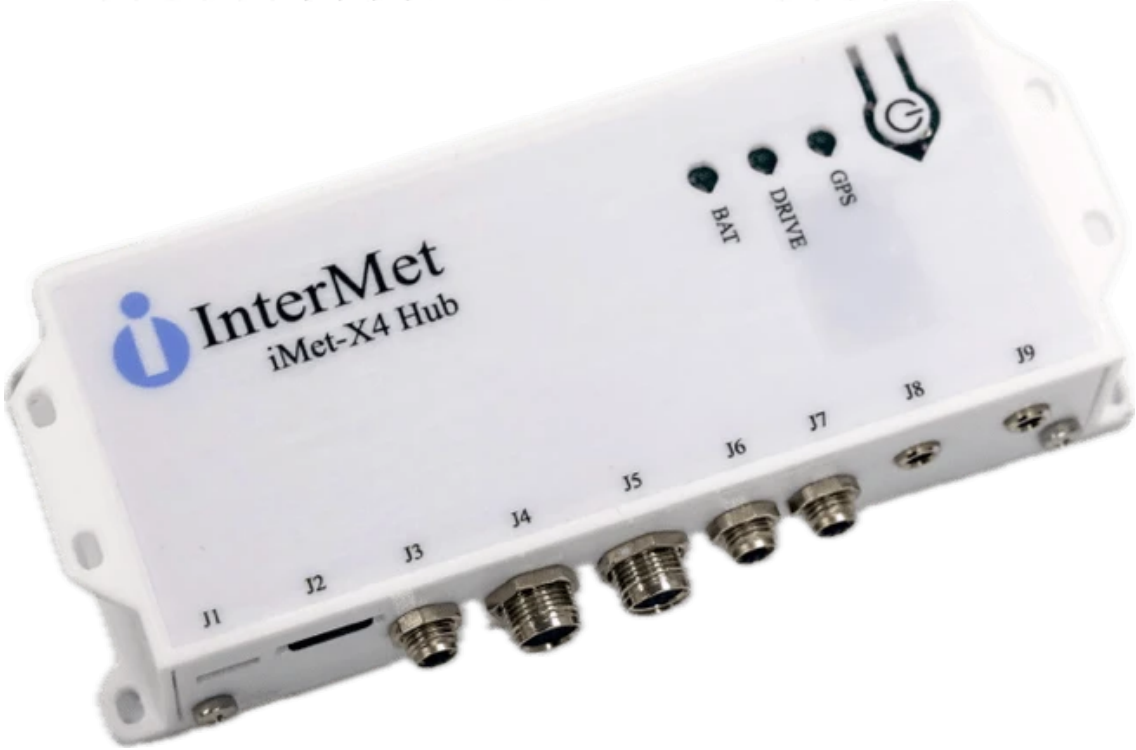
SBCAPE = -182 J kg^{-1}
0-720 m bulk shear
= 20 kts


CS3D
DWL DLFP
CS3D
DWL VAD
CS3D
DWL VAD
Altitude [m]
Vertical velocity [m s-1]
Horizontal velocity [m s-1]
Wind direction [deg]
VAD RMSE [m s-1]
Invalid data likely due to non-homogeneous conditions
Valid DWL data


KAEFS 20181005
(a)
Height [m]
Temperature [°C]


InterMet
iMet-X4 Hub
BAT
DRIVE
GPS
J1
J2
J3
J4
J5
J6
J7
J8
J9


InterMet
iMet-XQ2

AUTHOR INFORMATION

Alana Dachtler

Vice President of Sales and Marketing

International Met Systems

Email: alana@intermetsystems.com

LinkedIn: https://www.linkedin.com/in/alanadachtler/ (https://www.linkedin.com/in/alanadachtler/)

Website: https://www.intermetsystems.com/ (https://www.intermetsystems.com/)

ABSTRACT

InterMet Systems designed its first UAS-deployed sensor in 2011 by hacking up a radiosonde and stuffing it into the nose of a fixed-wing aircraft. Since then, the goal has been to provide researchers with better tools to efficiently sample the Boundary Layer with radiosonde-equivalent performance.

After failed efforts to partner with UAS manufacturers, InterMet focused on aircraft-agnostic sensor systems that were fully independent (iMet-XQ and XQ2) or designed for integration into fixed-wing aircraft (iMet-XF). In 2024 InterMet is introducing the iMet-X4 as its next-generation sensor package for fixed or rotary-wing deployment. The X4 includes six ports for atmospheric sensors, including two each for redundant air temperature and humidity. Remaining ports are for third-party sensors measuring ozone, PM 2.5, solar radiation, and additional criteria pollutants. The X4 includes removable data storage, as well as options for real-time radio transmission or integration with the aircraft's data stream.

Missing from the independent sensor systems has been the key measurement of ambient winds. The nature of rotary-wing aircraft makes this a particular challenge that was not adequately met by adding miniature anemometers. To address this final challenge, InterMet is teaming with the University of Oklahoma to commercialize their patented CopterSonde and make it available to the research community.

The CopterSonde 3 is a turn-key design measuring all standard atmospheric variables. Real-time pressure, temperature, humidity, wind speed and wind direction are represented in familiar formats such as Skew-T Log-P diagrams, hodographs and time vs. height temperature / humidity evolution and contour plots. All necessary algorithms are contained on the aircraft, with no cloud-based post-processing required.

REFERENCES

[1] Inoue, Jun & Sato, Kazutoshi. (2021). Toward sustainable meteorological profiling in polar regions: Case studies using an inexpensive UAS on measuring lower boundary layers with quality of radiosondes. Environmental Research. 205. 112468. 10.1016/j.envres.2021.112468.

[2] Segales, A. R., Greene, B. R., Bell, T. M., Doyle, W., Martin, J. J., Pillar-Little, E. A., and Chilson, P. B.: The CopterSonde: an insight into the development of a smart unmanned aircraft system for atmospheric boundary layer research, Atmos. Meas. Tech., 13, 2833–2848, https://doi.org/10.5194/amt-13-2833-2020, 2020

[3] Bell, T. M., Greene, B. R., Klein, P. M., Carney, M., and Chilson, P. B.: Confronting the boundary layer data gap: evaluating new and existing methodologies of probing the lower atmosphere, Atmos. Meas. Tech., 13, 3855–3872, https://doi.org/10.5194/amt-13-3855-2020, 2020