

Robert E. Barbré, Jr.
Jacobs ESSSA Group, Huntsville, AL

Ryan K. Decker, Frank B. Leahy
NASA Marshall Space Flight Center, Huntsville, AL

Lisa Huddleston
NASA Kennedy Space Center, Cape Canaveral, FL

Background

- NASA's 50-MHz Doppler Radar Wind Profiler (DRWP) at Kennedy Space Center (KSC).
 - Vertically-pointing radar that collects wind profiles every five minutes from near 2-18 km.
 - Identifies short-term wind changes.
 - Situational awareness asset for launch operations.
 - NASA replaced the original instrument in autumn 2014.
- Full certification required prior to acceptance.
 - Evaluates DRWP over multiple seasons.
 - Time-consuming process.
 - Vehicle programs desire to use the DRWP conditionally prior to certification.
- Operational Acceptance Test (OAT)
 - Short-term test to assess the new DRWP's data quality against the previous DRWP.
 - Verify DRWP data quality for Eastern Range launch support.



Figure 1: View of the new DRWP during installation.

OAT Criteria

Table 1: OAT parameters and criteria.

OAT Test Plan Specifications	
Required Data	Wind Speed and Direction, Altitude, Shear, Radial Velocities, Signal Power, Noise Power, Spectral Width.
Time Interval	5 min
Vertical Data Interval	150 m
Altitude	2-18.6 km
Wind Accuracy	1.5 m/s RMS component difference
Effective Vertical Resolution	500 m

- OAT Test Plan [1] specifies parameters' acceptance criteria.
- Wind accuracy and effective vertical resolution (EVR) criteria are based on [2] and [3].
- Analysis methodology:
 - Required data, time interval, vertical data interval, and altitude: Data examination
 - Wind accuracy: Examine root mean square (RMS) wind component differences between DRWP and balloon data.
 - EVR: Spectral analysis of DRWP wind profiles.

Data

- Automated Meteorological Profiling System (AMPS) balloons.
 - Low-Resolution (LR) and High-Resolution (HR) Flight Element (FE).
 - 30.5-m (100.0 ft) wind component profiles.
- DRWP
 - Winds and radar parameters reported every 150 m (492 ft) from 1798-19465 m (5899-63862 ft) at ~5 minute intervals.
 - Meets the OAT's criteria for required data, time interval, altitude, and vertical data interval.
- Data collected from 6 Jan 2015 to 19 Feb 2015.
- Quality control
 - Removed convective periods from DRWP archive.
 - Removed vector shears exceeding 0.15 s^{-1} .
- A total of 5426 concurrent winds from 49 profiles exist.

DRWP and Balloon Comparison

Preprocessing

- Extracted balloon data at each DRWP altitude.
- Extracted DRWP data at the timestamp corresponding to the balloon's altitude.
- Computed the wind component difference at each altitude.
- Scrutinized cases where vector differences exceeded 15 m/s.

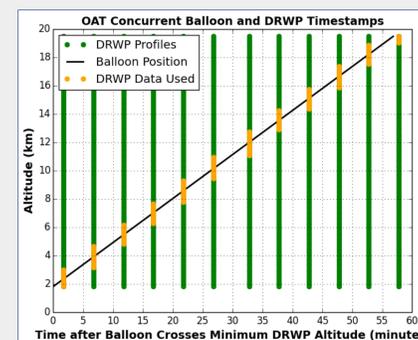
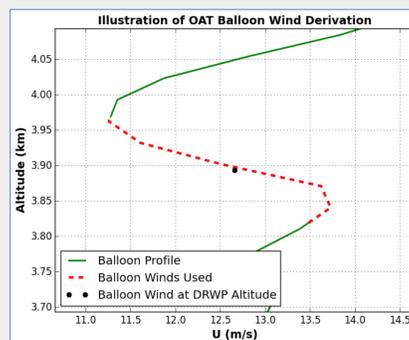


Figure 2: Illustration of OAT balloon (left) and DRWP (right) wind profile derivation.

Results

- RMS $\Delta U = 2.02 \text{ m/s}$ and RMS $\Delta V = 2.14 \text{ m/s}$ exceed criteria.
- Adjustments for system noise changed results by less than 0.03 m/s .
- Balloon drift has significant effect on results.
 - RMS $\Delta U, \Delta V$ below 1.6 m/s , which is near the LRFE error.
 - Sample size artifact at close ranges.

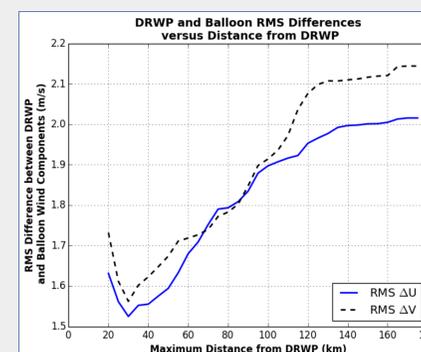


Figure 3: RMS ΔU and ΔV versus balloon's distance from the DRWP.

DRWP EVR Assessment

- Magnitude Coherence Squared (Coh^2) [3].
 - Quantifies correlation versus wavelength.
 - EVR defined at wavelength where Coh^2 equals 0.25.
- Computed daily mean power and cross spectral density and Coh^2 .
- Sample-weighted mean Coh^2 exceeds 0.25 at all wavelengths.

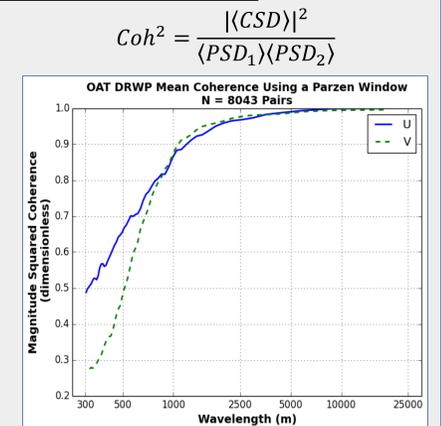


Figure 4: U and V Coh^2 versus wavelength.

Vertical Data Coverage Analysis

- DRWP reports a wind at all altitudes.
 - Median Filter First Guess algorithm [4].
 - Implements a first-guess propagation (FGP) if the signal to noise ratio is less than -30 dB .
- Examined FGPs versus altitude for awareness.

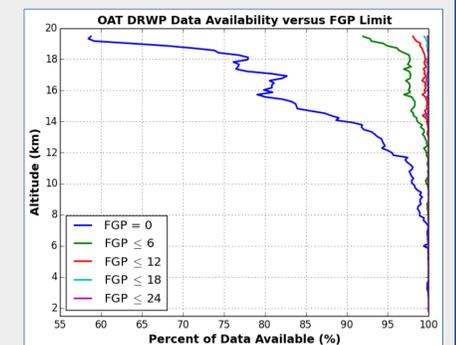


Figure 5: FGP limit versus altitude.

Conclusion

- Results pass all criteria except wind accuracy. However, data is good enough to use for its short-term purpose based on the OAT's intent and through experience.
- Individual vehicle programs decide if and how to use the DRWP.
- Intend to use the OAT methodology for DRWP full certification.

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