Air-Sea Interaction during active and suppressed phases of the MJO

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Research funded by ONR
UCI Instruments for DYNAMO

Starboard View
- Fast H2O Krypton

Aft View
- OXTS RT3003 GPS/INS
- Wave Scanning Lidar
- IR SST
- 858 Probes Side Slip (Top) Angle of Attack (Side)

5-Hole Radome Wind System

Static Pressure Ports Aft Left and Right (Manifolded)

LI-COR 7200 Fast H2O/CO2

Fast Temperature Probes

NOAA WP-3D N43RF DYNAMO 2011
New radome plumbing, effectively traps clouds (or rain) liquid water preventing it from obstructing the pressure xducers lines. Zero water-related failure in DYNAMO.
<table>
<thead>
<tr>
<th>Instrument</th>
<th>Flight</th>
<th>November 11 - December 13 2011</th>
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<tbody>
<tr>
<td></td>
<td></td>
<td>11/11</td>
<td>RF 01</td>
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<tr>
<td>Total Temperature Thermistor</td>
<td></td>
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<td>Rosemount Temperature</td>
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<td>RF 03</td>
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<td>RF 04</td>
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<td>RF 05</td>
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<td>RF 07 *</td>
<td>RF 08</td>
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<td>RF 10</td>
</tr>
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**Legend**

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<td>Boundary Layer Mission</td>
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**Convection Flights**

**Boundary Layer Flights**
High (Multi-rate) Data from NOAA/AOC New Data System
Not QCed and Not Processed by AOC

Nov 28, 2012

Dec 13, 2012
\[ V = V_a + V_p \]

Wind: \( V \)

\[
\begin{align*}
    u &= U_p - U_a D \\
    &\times \left[ \sin \psi \cos \theta + \tan \beta (\cos \psi \cos \phi + \sin \psi \sin \theta \sin \phi) \\
    &+ \tan \alpha (\sin \psi \sin \theta \cos \phi - \cos \psi \sin \phi) \right] \\
    -&L (\dot{\theta} \sin \theta \sin \psi - \dot{\psi} \cos \theta) \\
    v &= v_p - U_a D \\
    &\times \left[ \cos \psi \cos \theta - \tan \beta (\sin \psi \cos \phi - \cos \psi \sin \theta \sin \phi) \\
    &+ \tan \alpha (\cos \psi \sin \theta \cos \phi + \sin \psi \sin \phi) \right] \\
    -&L (\dot{\psi} \sin \psi \sin \theta + \dot{\theta} \cos \theta) \\
    w &= w_p - U_a D [\sin \theta - \tan \beta \cos \theta \sin \phi - \tan \alpha \cos \phi \cos \theta] \\
    &+ L \dot{\theta} \cos \theta
\end{align*}
\]

where \( u_p \) and \( v_p \) are the east and north aircraft velocity components, respectively; \( U_a \) is the true airspeed; \( \alpha, \beta, \theta, \phi, \) and \( \psi \) are the aircraft attack, sideslip, pitch, roll, and true heading angles, respectively; \( L \) is the distance separating the INS and gust probe along the aircraft’s center line; \( D = (1 + \tan^2 \alpha + \tan^2 \beta)^{-1/2} \); and \( \dot{\psi} = d\psi/dt \) and \( \dot{\theta} = d\theta/dt \); \( w_p \) is the aircraft vertical velocity.

Figure adapted from D.H. Lenschow and P. Spyers-Duran, NCAR/RAF Bulletin 23

Serial data from INS/GPS C-MIGITS III unit.
Analog data (5-port radome gust system, \( P_s \) and \( T_r \))
Analog-Serial Synchronization

![Graph showing pitching rate over time for Analog sensor and Serial C-MIGITS](image-url)
Ground Speed AOC vs. UCI
UCI Winds

1111119

WS, m s⁻¹

WD, °

WZ, m s⁻¹
Vertical Wind Critical Test

Rule of thumb: $\sigma_w/\sigma_{Vz} < 10\%$ is acceptable

WSZ(DPJ): 18% ; UWZ(AOC): 11% ; WZR(UCI): 4% ; WZF(UCI): 3% ;
Air-Sea Fluxes

\[ \tau = -\rho (\overline{u\omega i} + \overline{v\omega j}) = \rho C_{d10} U_{10}^2 \]

\[ H_s = \rho C_p \overline{w\theta} = \rho C_p C_H U_{10} (\Theta_s - \Theta_{10}) \]

\[ E = \overline{w\rho_v} = C_E U_{10} (\rho_{vs} - \rho_{v10}) \]

\[ H_l = h_{fg} E \]
# High-Rate Data Status

## High-Rate Data:
- **P**: Processed
- **PF**: Processed and fluxes estimated

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Means ($z \sim 60 \text{ m}, \Delta t = 180 \text{ s}$)
Turbulent Fluxes ($z \sim 60$ m, $\Delta t=180$ s)
Airborne Scanning LiDAR for wave mapping
Post-Experiment Riegl Boresighting and Wind Cals Flight 13 Jan 2012, Tampa, FL
Wave field example on 111204
Along North East Track
Wave Spectra

![Wave Spectra Graph]

- PSD, m$^2$/Hz
- Freq, Hz

Lines:
- Blue: scan1
- Green: scan1
- Red: scan3
- Black Dashed: Freq$^3$
Summary

- Turbulence instrumentation we installed on the NOAA P3 performed reasonably well as evidenced by the flux measurements capturing the suppressed to active MJO transition.
- Our vertical wind passes the pitching maneuver tests and is an improvement from the standard AOC’s 1-Hz data.
- High-rate data from AOC had dropouts and occasional data gaps due to new data system hickups.
- Wave measurements from the new lidar system yielded promising results though its point density is limited by the high speed of the P3.
- Finalize the data set especially the 3 flights with gaps to proceed with more in-depth analysis.