A high-resolution merged wind dataset for DYNAMO: Progress and future p

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1. Introduction

One of the most distinctive signals of the Madden-Julian Oscillation (MJO) is the upscale development and organization of convection in the Indian Ocean. Dynamics of the MJO (DYNAMO) campaign occurred in late 2011 – early 2012 to investigate this genesis stage. One of the best non-satellite wind datasets ever obtained over the ocean.

The Cyclone Global Navigation Satellite System (CYGNSS) mission can exploit this dataset to better understand the performance of the satellite constellation in regions of deep convection, in particular for characterizing the MJO.

Main Scientific Objectives

1. Produce a high-resolution surface wind dataset for multiple MJO onsets using WRF-assimilated winds and other data from DYNAMO.
2. Use the DYNAMO datasets, along with available scatterometer observations, to study the causes and impacts of wind variability at spatial and temporal scales finer than those planned to be provided by CYGNSS, and the implications of these processes for CYGNSS observations.
3. These wind maps will be ingested into the CYGNSS End-to-End Simulator (E2ES) to produce simulated CYGNSS observations for DYNAMO. This will provide an excellent core dataset for understanding how CYGNSS can improve our understanding of convective inflow/outflow structures, wind/precipitation feedbacks, and the initiation and development of the MJO.

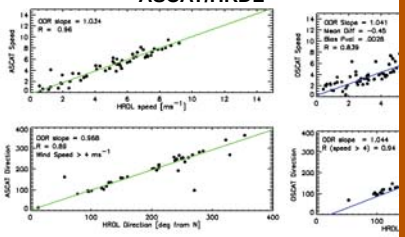
3. HRDL/Scatterometer Comparison

NOAA High-Resolution Doppler Lidar (HRDL)

- On Revelle for Cruises 1-3 (1 September - 6 December 2011)
- HRDL scanning ability provided 20-min averaged vertical profiles of wind speed and direction from 12.5 m to ~2000 m
- 12.5-m gate used to compare HRDL to scatterometers (OSCAT and ASCAT)
- Examine relationship between winds and mean square slope as Richardson number varies

$$Ri = \frac{g(T_a - T_w)z}{T_w U_z^2},$$

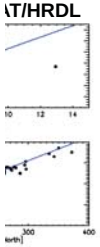
ASCAT/HRDL



Preliminary Results

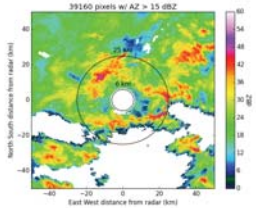
- Richardson number always negative for DY
- ASCAT matches HRDL better than OSCAT

T/HRDL



unstable)

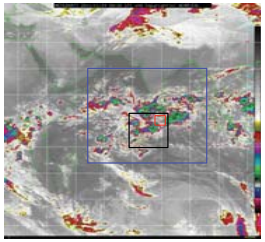
- TOGA radar suggests precipitation a factor in many poor HRDL/OSCAT matches
- Example (11/27, ~1800 UTC): OSCAT = 13.2 m/s, HRDL = 8.7 m/s

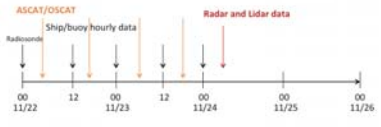


4. WRF Model Assimilation

WRF Model Setup

- Advanced Research WRF
- A: 9-km resolution Indian Ocean domain
- B: 3-km DYNAMO quadrilateral domain
- C: 1-km high-resolution domain focused on Revelle
- 40 sigma levels (more levels in lower troposphere)
- Nested 9-3-1 km runs, plus separate 3- and 1-km runs
- Background runs successfully resolve mesoscale features for MJO events
- Focus on late October, late November, late December 2011 MJO onsets





WRF 3DVAR Progress

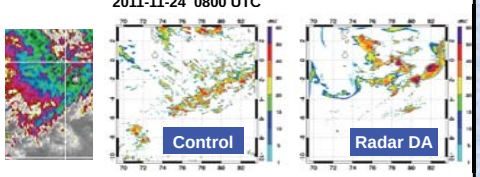
- Finalizing WRF runs for B/R matrices generation
- Assimilation tests underway

Assimilation Datasets

- Radars - TOGA, Mirai, S-PolKa
- Soundings
- Surface, Ship, and Buoy observations
- ASCAT/OSCAT

eliminary Radar Data Assimilation Results

2011-11-24 0800 UTC



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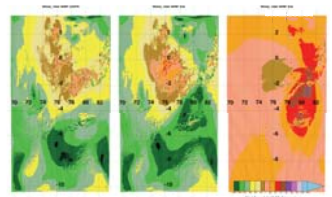
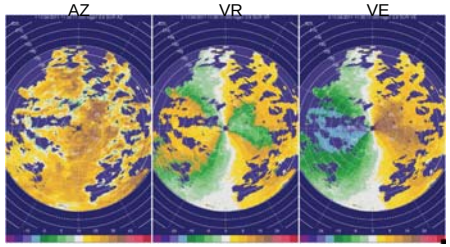
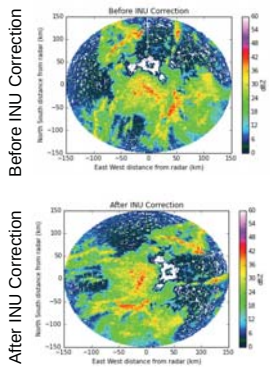


2. TOGA Radar Data Quality Control

DYNAMO Radars
NASA TOGA (Revelle)
Mirai C-band
NCAR S-PolKa (Gan)

Worked with CSU to de-alias the TOGA velocities, and also fix occasional azimuthal errors. Used Py-ART software package for both, with hand editing of velocities as needed.





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5. Summary

- DYNAMO dataset prepped for assimilatio into WRF.
- HRDL/scatterometer comparison suggest good overall performance, with ASCAT (C band) better than OSCAT (Ku-band).
- WRF domains established and preparato 3DVAR assimilation matrices nearly finalized.
- Initial assimilation testing suggests realist background runs receive large impacts fr radar data.

6. Next Steps

Finalize assimilation plans through more testing.

Produce merged wind maps during each DYNAMO-observed MJO onset, at ~0.5-1 h time steps, and provide to MJO community. Wind maps will be produced for a few days per onset at first, then we will add more days as needed.

Ingest wind maps into CYGNSS E2ES. Study potential impact of CYGNSS for studying MJO processes at multiple scales.

More detailed analysis of HRDL/scatterometer dataset. Examine wind speed-MSS relationship for positive Richardson number scenarios.