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NASA WB-57 pilots and crew – outstanding support to make this field program a success!
C-band (4, 5, 6, 6.6 GHz) radiometer

Retrieval concept similar to the operational Stepped Frequency Microwave Radiometer (SFMR)

Retrieve Wind Speed and Rain Rate over ocean, **but over a wide swath**

C-band frequencies have varying sensitivity to rain but ~equal sensitivity to wind speed (emission from foam on wind-roughened ocean surface)
HIRAD on NASA WB-57

HIRAD flew on WB-57 for NASA HS3 in 2014 and ONR TCI in 2015.

~20 km altitude, looking down on storm

~50-70 km swath width

WB57 also had High Density Dropsonde System (HDSS) in 2015, typically dropping ~70-80 sondes in a flight.
Tropical Cyclone Intensity Experiment (TCI 2015)

_funded by Office of Naval Research_

NASA WB-57 (JSC) carrying:

**HDSS dropsondes**  
(Yanke Environmental Systems)  
Measure vertical profiles of T, P, RH, wind

**HIRAD (NASA MSFC)**  
Measures ocean surface wind speed

Support from WB-57 group was outstanding!

- 3 Hurricane Patricia flights
- 1 Ex – Tropical Storm Erika flight
- 2 Hurricane Marty flights
- 4 Hurricane Joaquin flights
2015 Tropical Cyclone Intensity (TCI)
Science Flights

Surface Wind Speed Retrievals in
Hurricanes Marty, Joaquin, and Patricia
Hurricane Patricia
21 Oct 2015

Winds mostly 40 kt and less from dropsondes – not much for HIRAD to see
Hurricane Patricia
22 Oct 2015

Wind speed retrieval (work in progress; biased low) compared with HDSS dropsonde near surface winds
Hurricane Patricia
23 Oct 2015
20:00 UTC

Wind speed retrieval (work in progress) compared with HDSS dropsonde near surface winds
Hurricane Patricia
23 Oct 2015 20:00 UTC

Peak in this retrieval is 165 kt, but we’re not confident in some aspects of these retrievals yet.

For reference, SFMR:
180 kt 1733 UTC
131 kt 2033 UTC
Hurricane Marty
28 Sep 2015
19:25 UTC

Wind speed retrieval (work in progress) compared with HDSS dropsonde near surface winds
Hurricane Joaquin 02 Oct 2015

Preliminary HIRAD 6.6 GHz Excess TB, rough calibration.

WB-57 dropsondes support 942 mb pressure, 105 kt surface wind, likely missed max wind.

Wind Barbs are surface wind speed estimates from WB-57 dropsondes.

White barbs are estimates from sondes that failed higher than 150 m above surface.
Hurricane Joaquin
03 Oct 2015

Preliminary HIRAD 6.6 GHz Excess TB, rough calibration.

100 kt surface winds from dropsondes, but HIRAD shows those sondes missed the region of strongest winds

NHC estimate was 130 kt during this flight, end of RI period

Wind Barbs are surface wind speed estimates from WB-57 dropsondes
Summary

• Initial retrievals realistically depict the horizontal structure of the hurricanes (Marty 15, Joaquin 15, Patricia 15)
• But quantitative aspects of the calibration and retrievals need more work
• Depicts remarkable development of Hurricane Patricia from 50-kt TS on Oct 21, ~100 kt Hurr on Oct 22, rapidly weakening cat 5 on Oct 23 (~20:00 UTC)
• Patricia small core size fits within a single HIRAD swath
• Joaquin was larger, have to piece together multiple passes
• Lots of dropsonde data available for comparisons, we’ve only qualitatively looked at that so far
Future / Ongoing Work

• Filtering the scan-position-dependent biases (promising, but imperfect)
• Improve relative calibrations between the channels, in order to improve the retrievals
• Long term, hope to add wind *direction* in a future instrument with greater sensitivity, full polarization