

Hurricane Imaging Radiometer (HIRAD) Observations in Hurricanes Patricia, Joaquin, and Marty (2015)

Daniel J. Cecil, NASA MSFC

Sayak Biswas, USRA

Acknowledgements:

Office of Naval Research

TCI science and forecasting teams

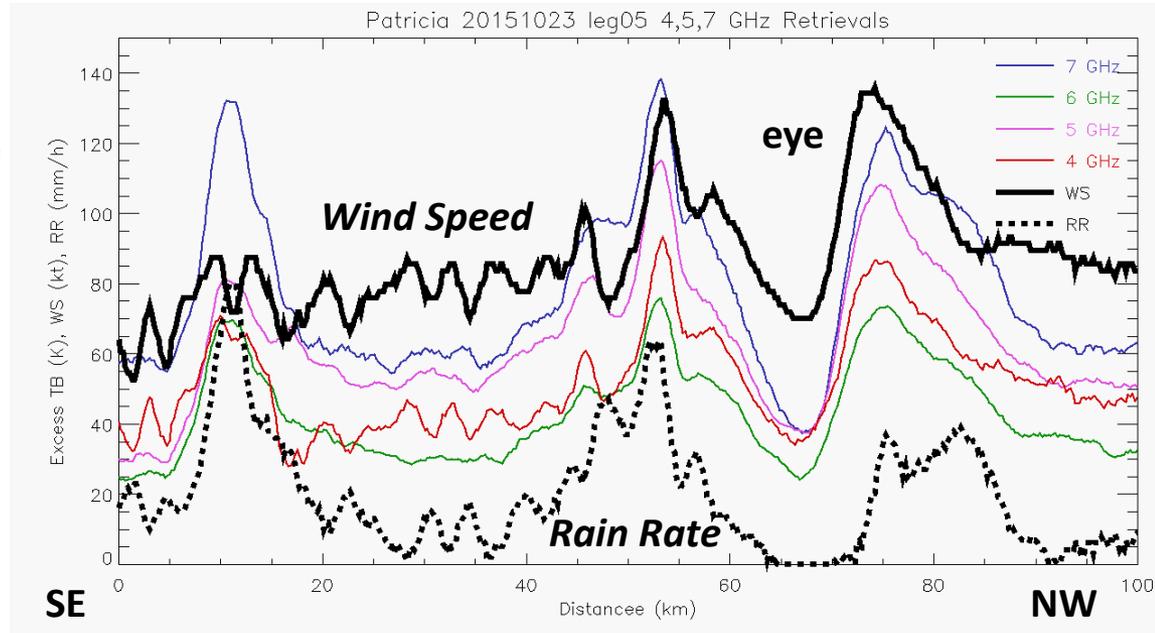
NASA WB-57 pilots and crew – *outstanding support to
make this field program a success!*

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***

HIRAD Background



Rain especially affects
higher freq channels

Wind causes an
increase in all channels

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

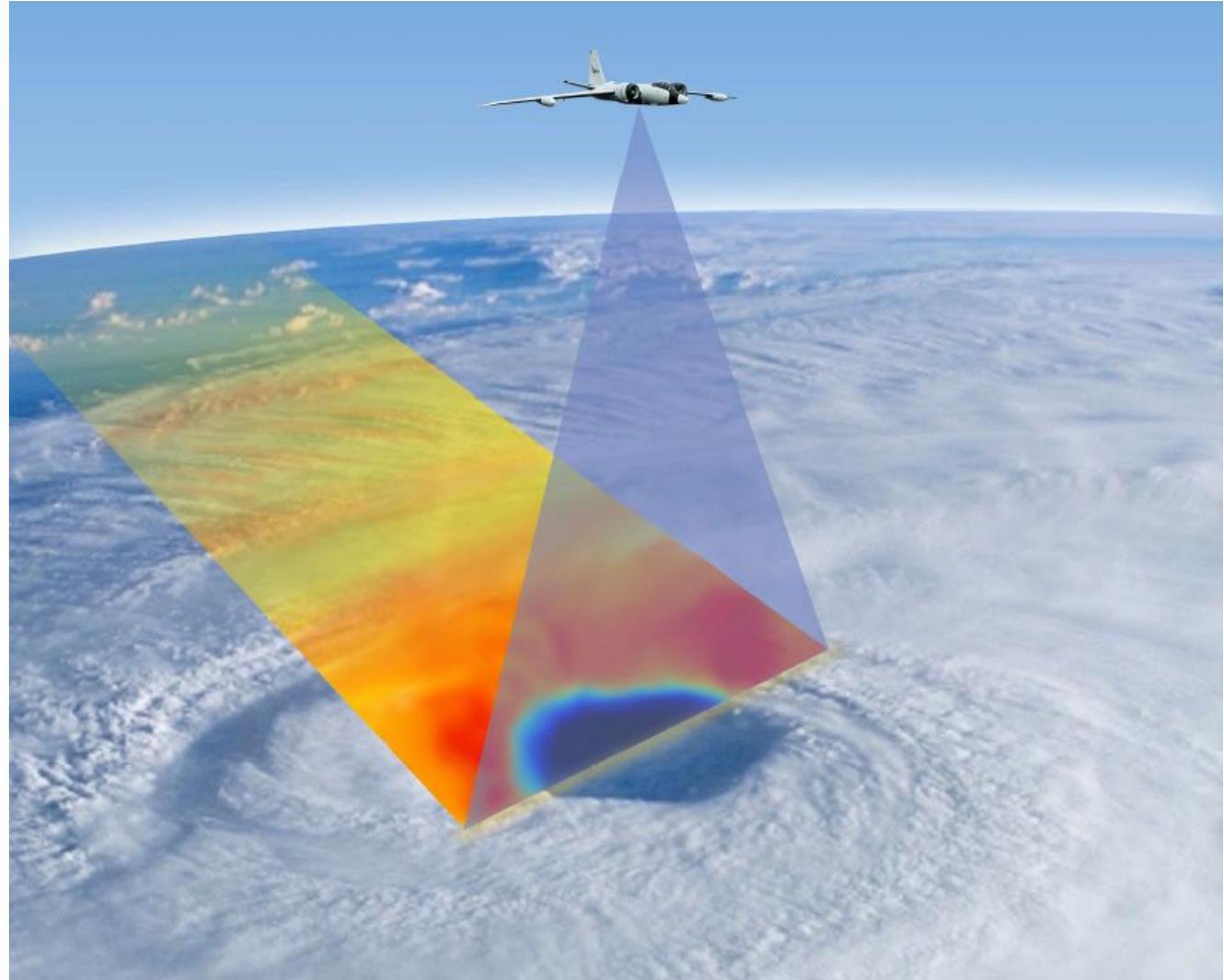
HIRAD on NASA WB-57

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

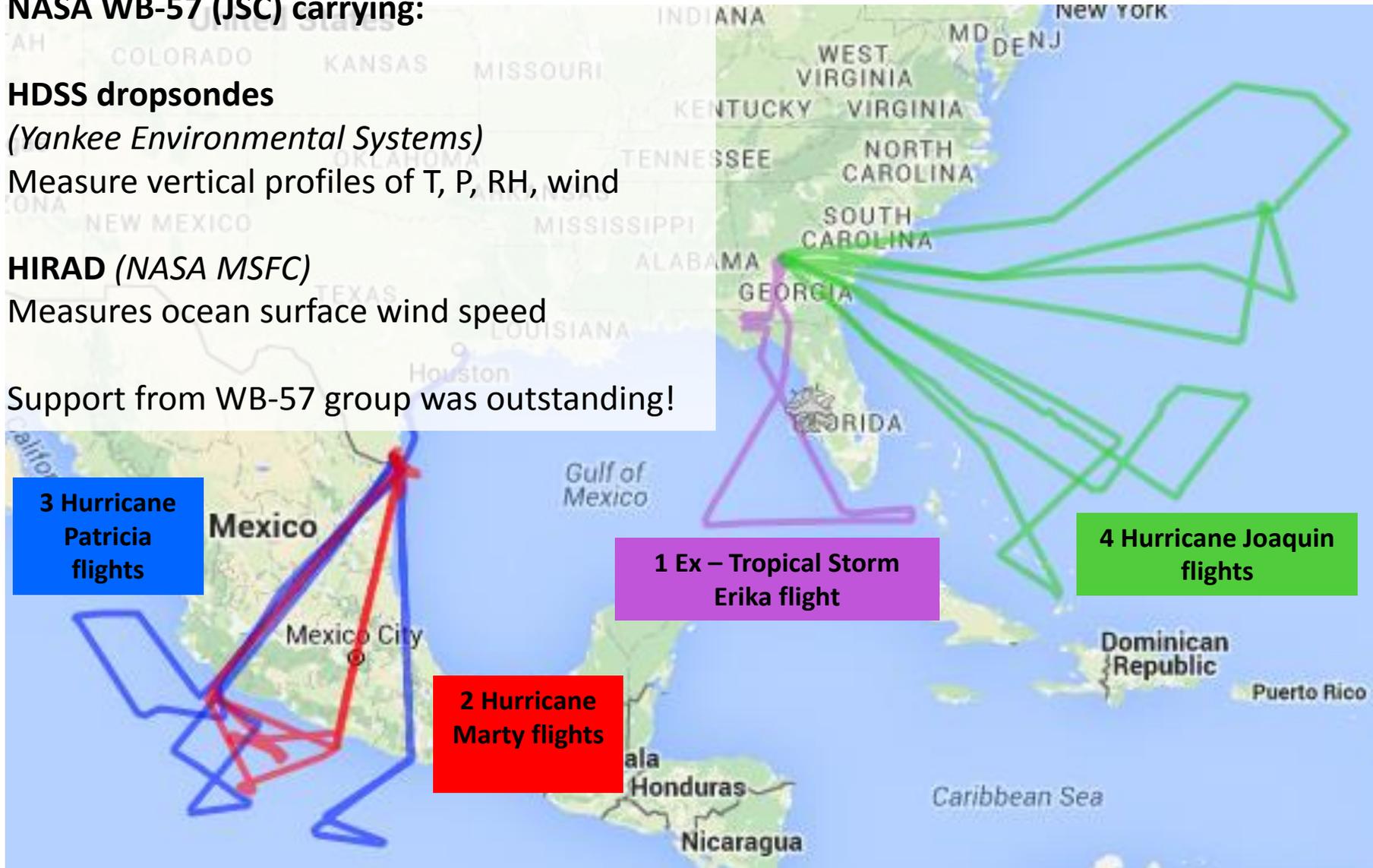
(Yankee Environmental Systems)

Measure vertical profiles of T, P, RH, wind

HIRAD (NASA MSFC)

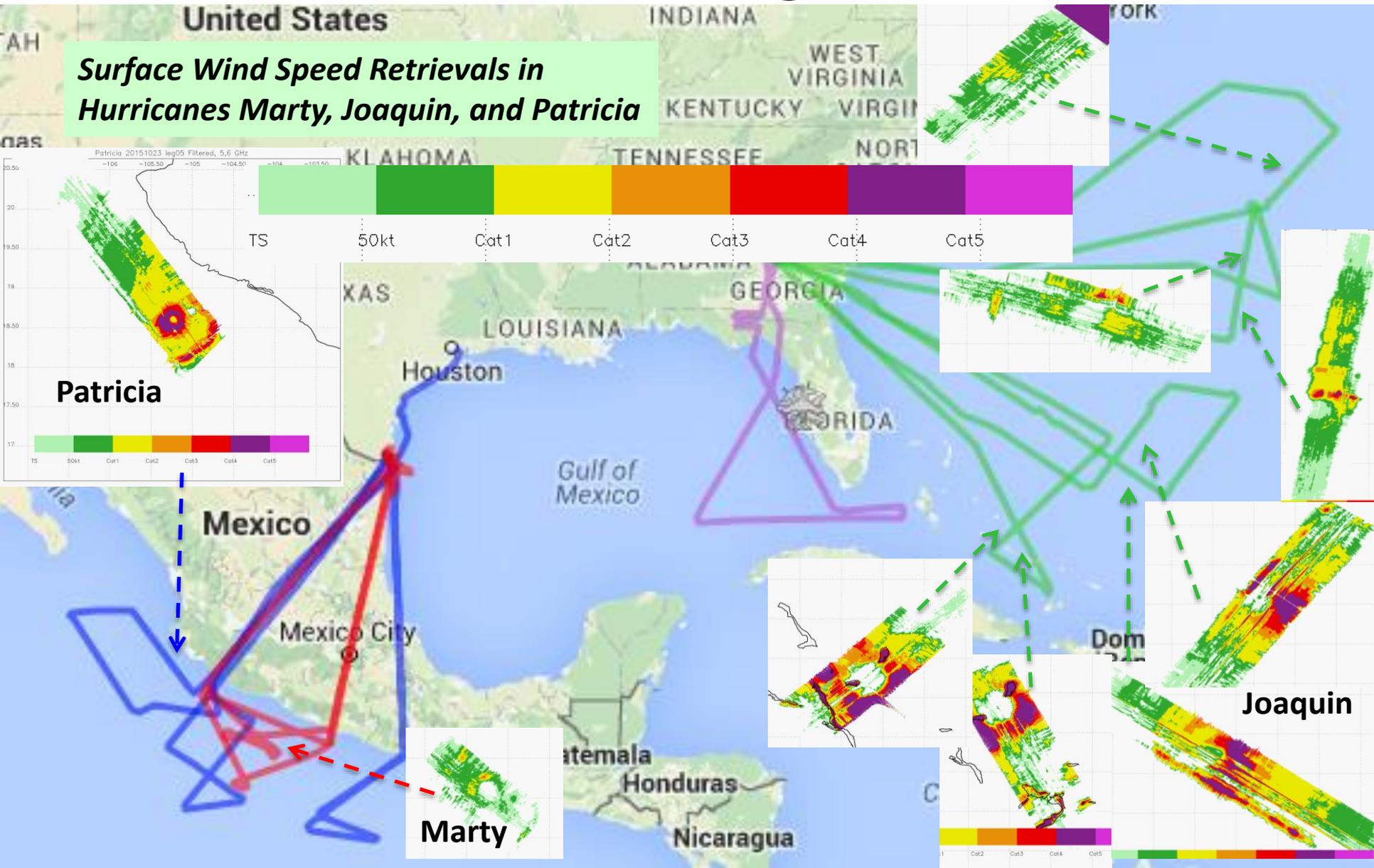
Measures ocean surface wind speed

Support from WB-57 group was outstanding!



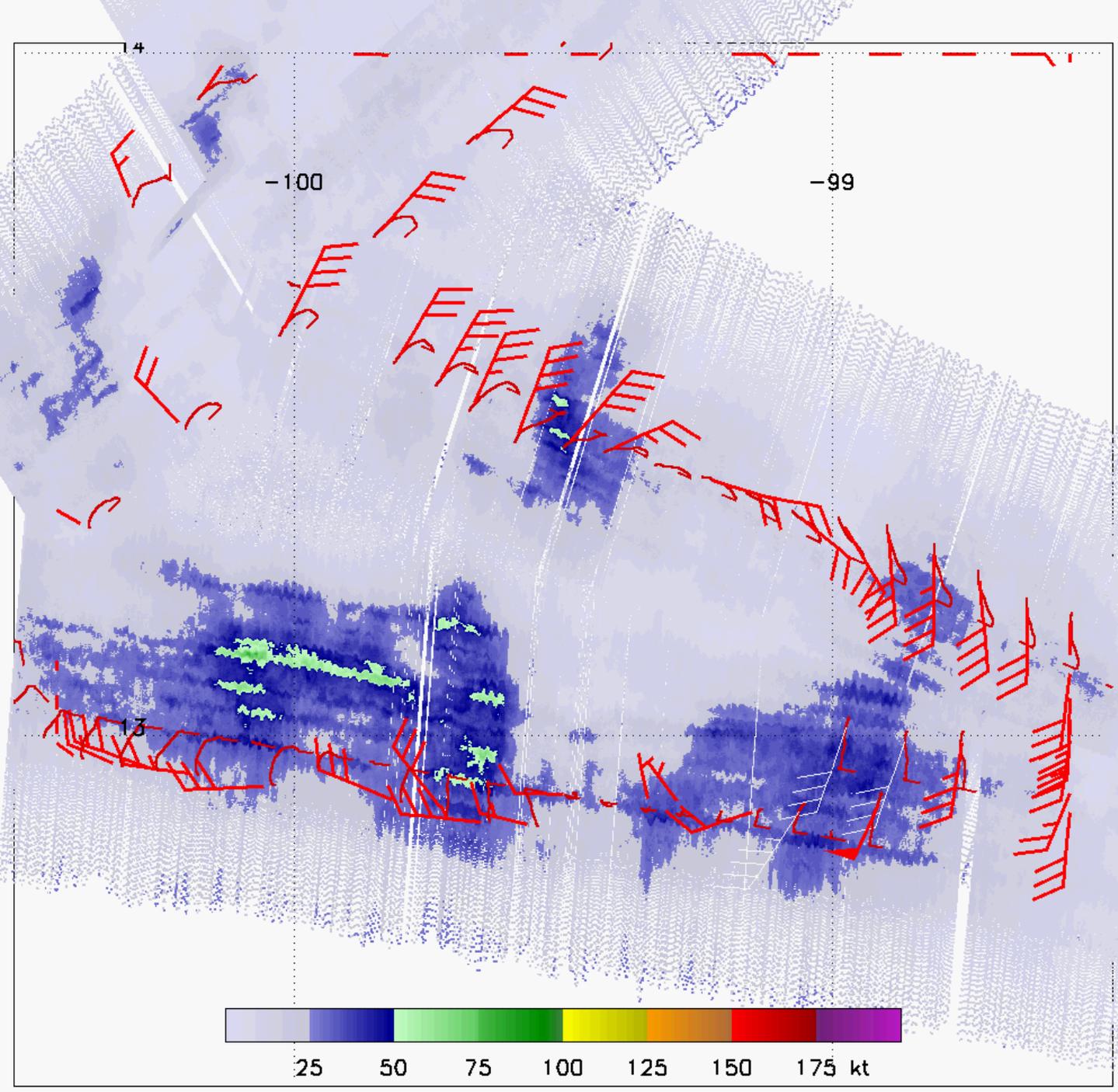
2015 Tropical Cyclone Intensity (TCI) Science Flights

Surface Wind Speed Retrievals in Hurricanes Marty, Joaquin, and Patricia



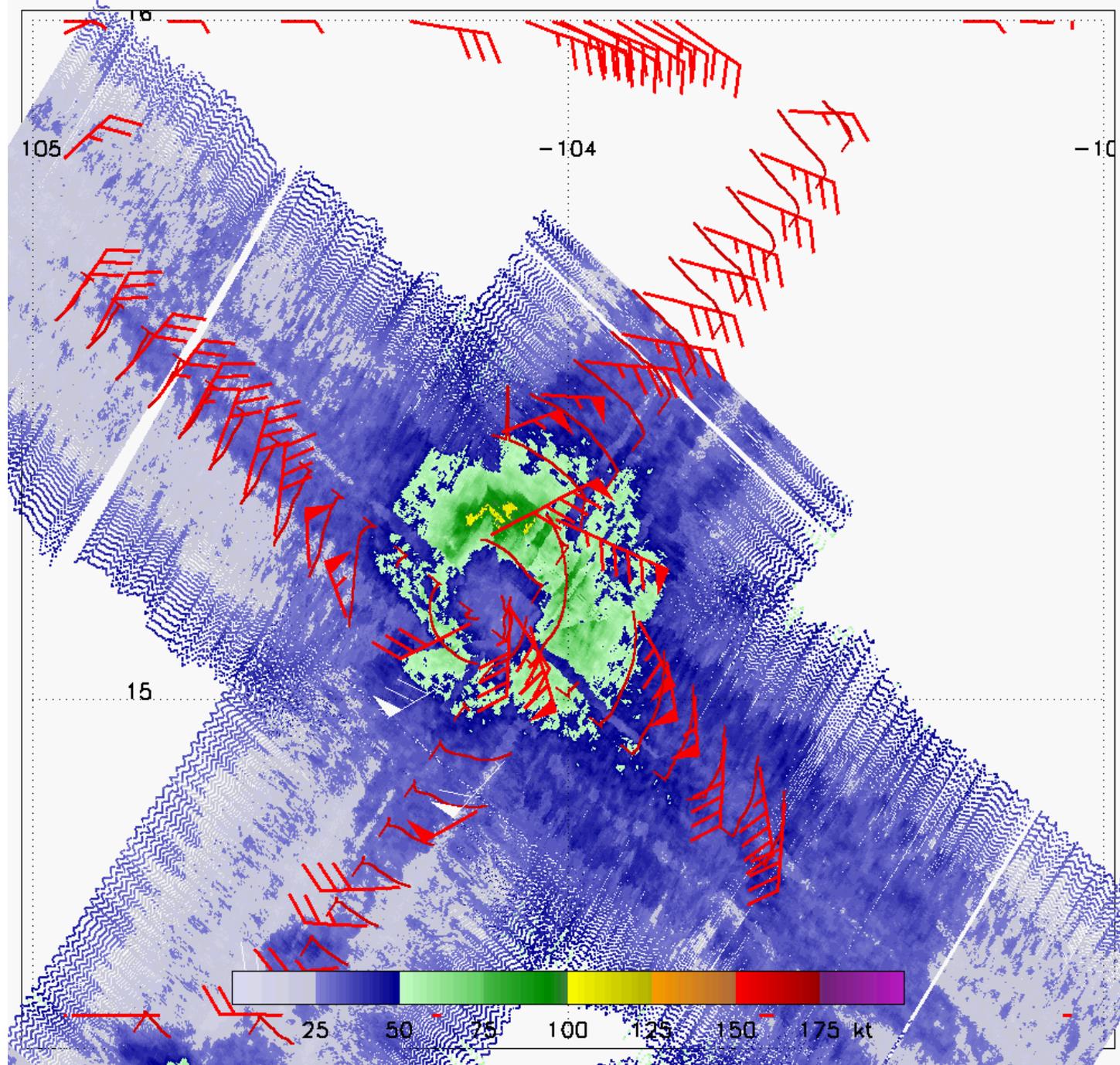
Hurricane Patricia 21 Oct 2015

Winds mostly 40 kt and less from dropsondes – not much for HIRAD to see



Hurricane Patricia 22 Oct 2015

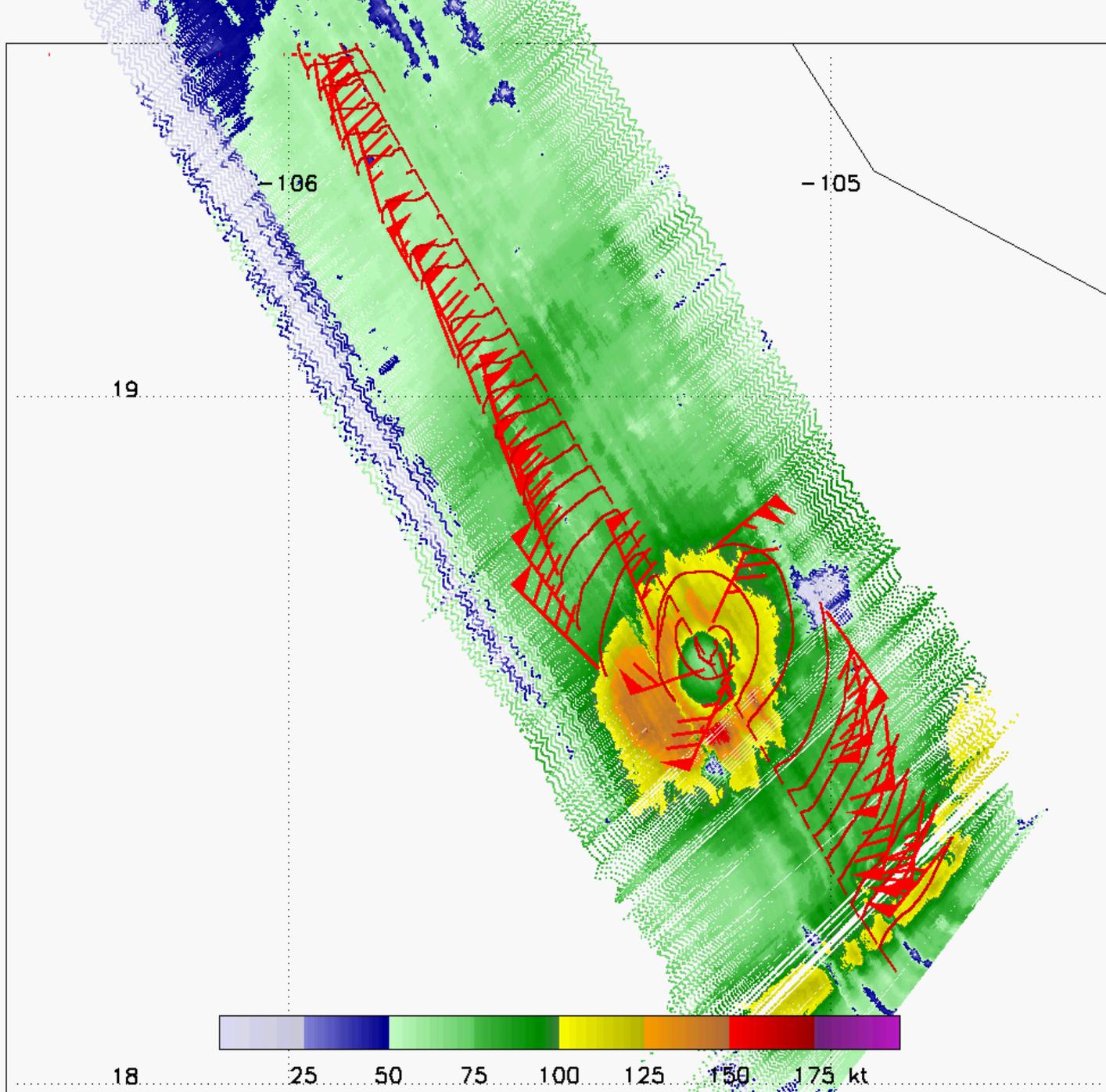
Wind speed retrieval
(work in progress;
biased low)
compared
with HDSS
dropsonde
near surface
winds



Hurricane Patricia

23 Oct 2015
20:00 UTC

Wind speed
retrieval
(work in
progress)
compared
with HDSS
dropsonde
near surface
winds

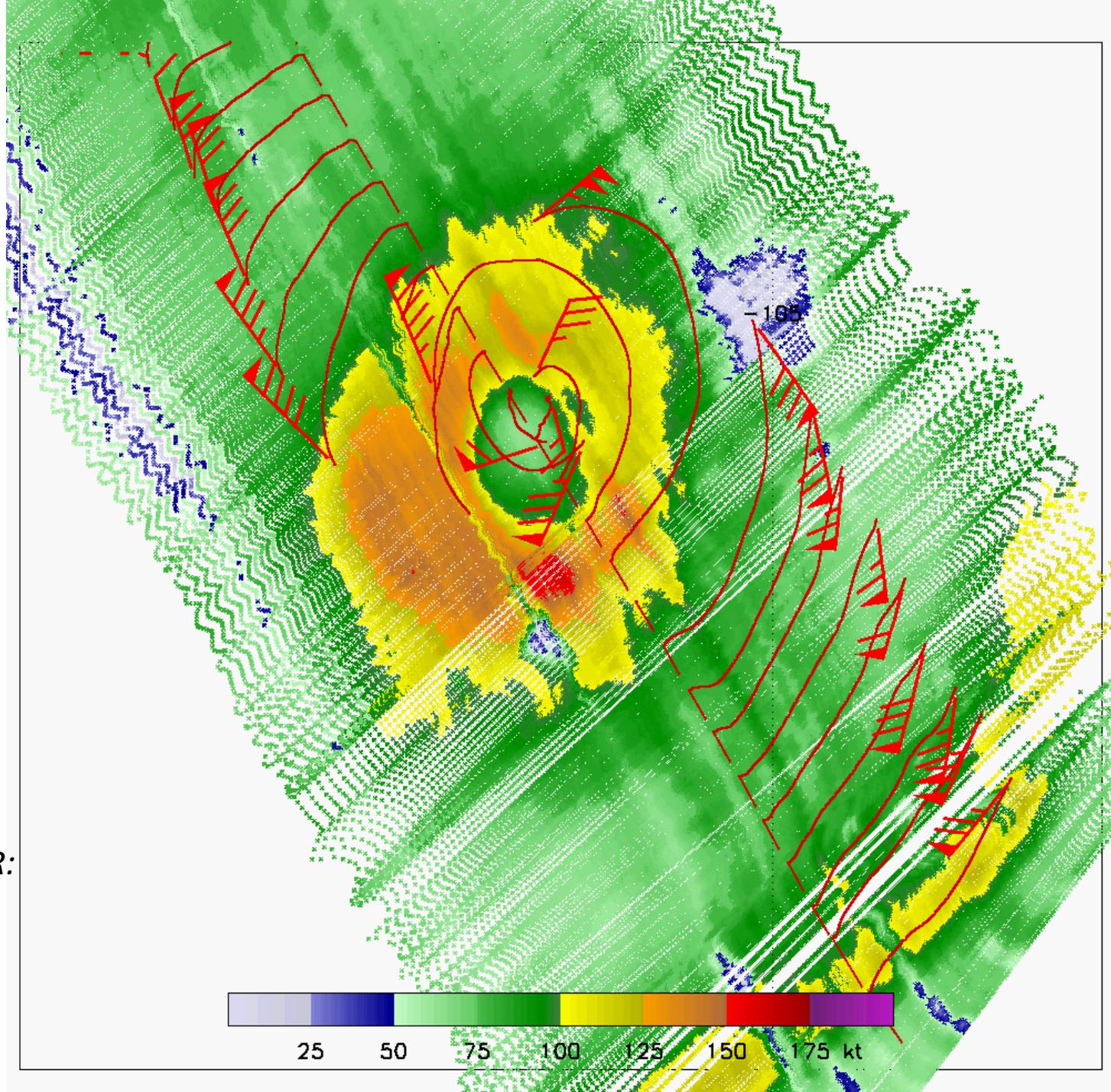


Hurricane Patricia

**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*



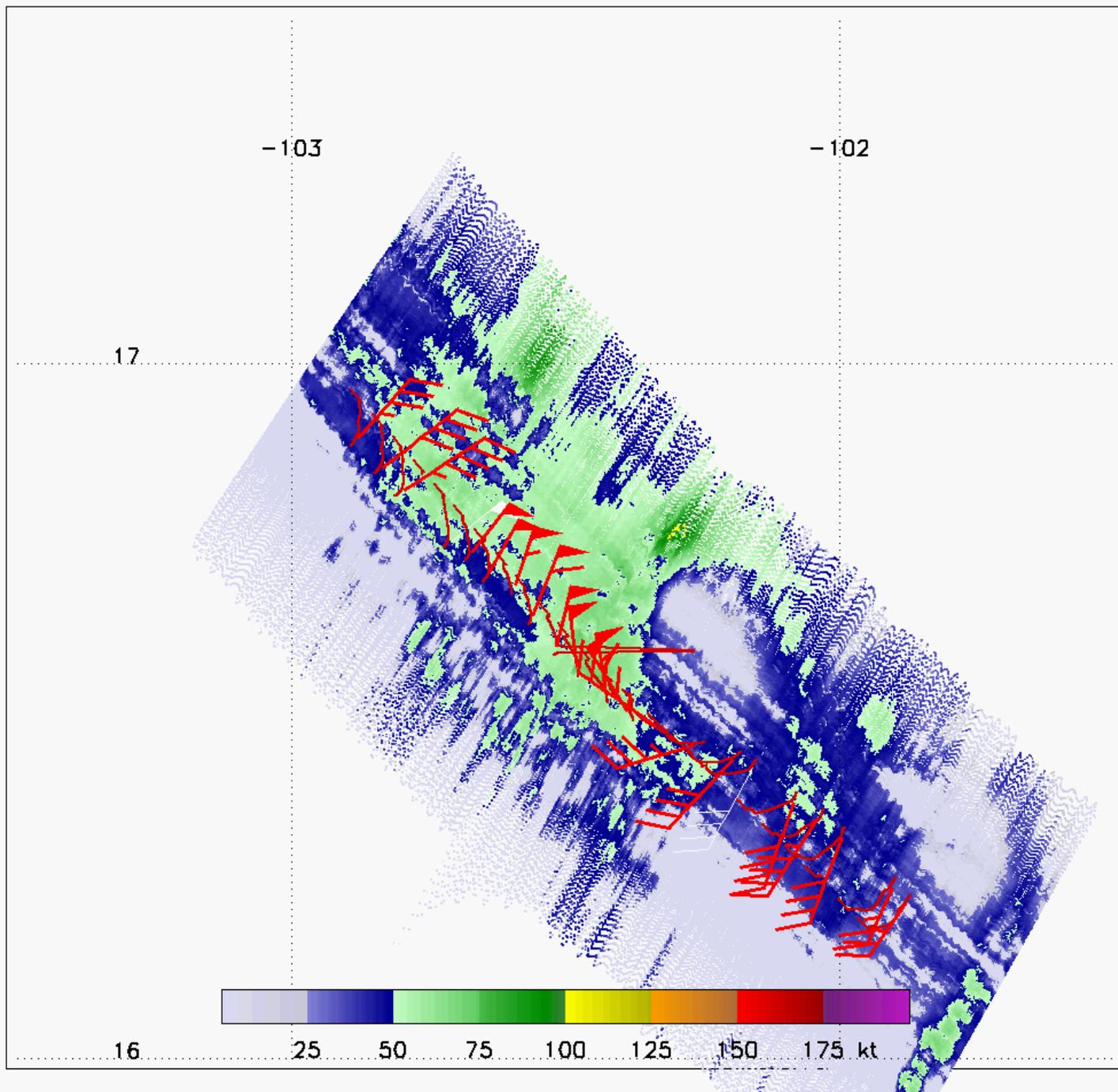
Hurricane

Marty

28 Sep 2015

19:25 UTC

Wind speed
retrieval
(work in
progress)
compared
with HDSS
dropsonde
near surface
winds



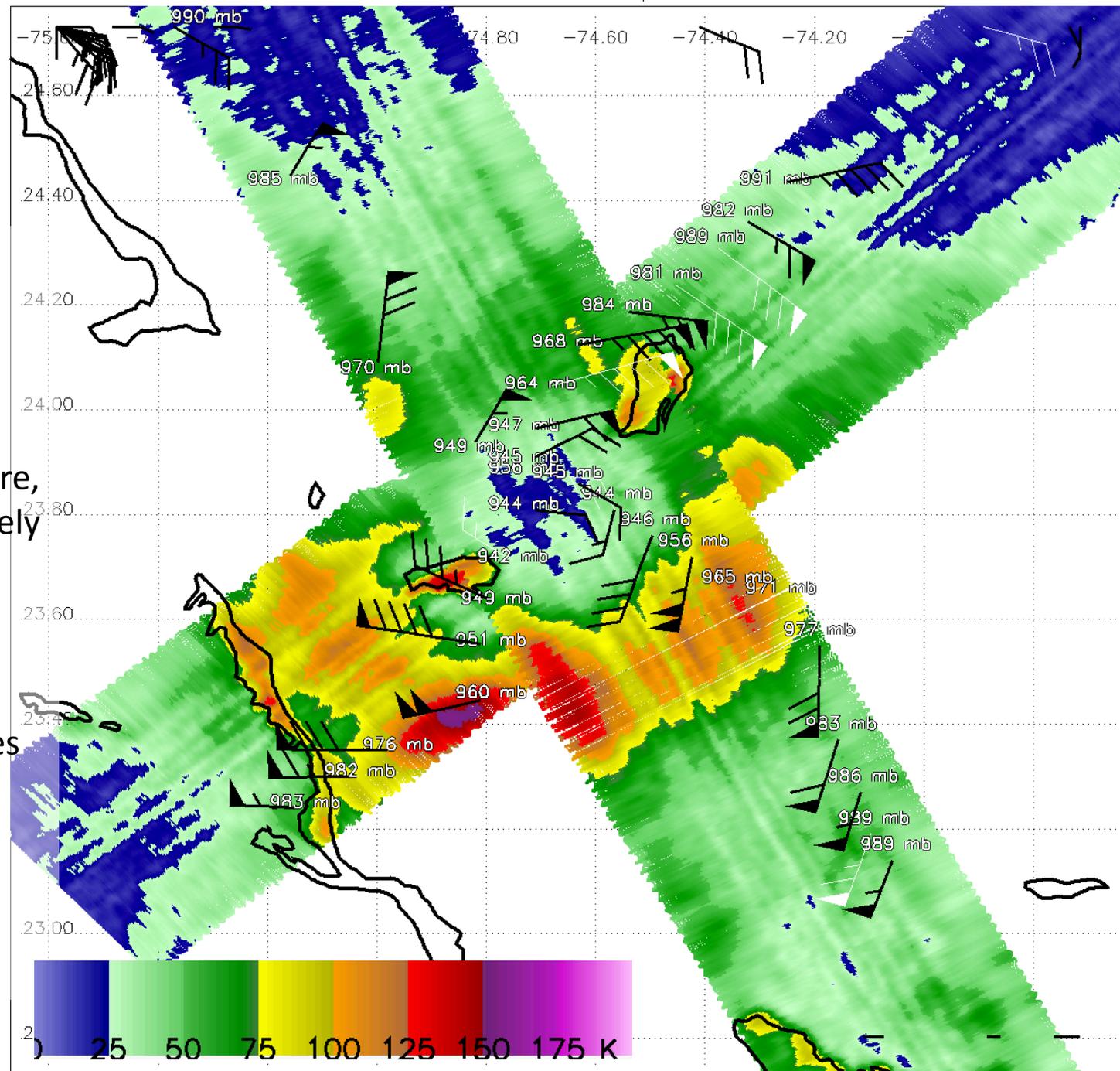
Hurricane Joaquin 02 Oct 2015

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



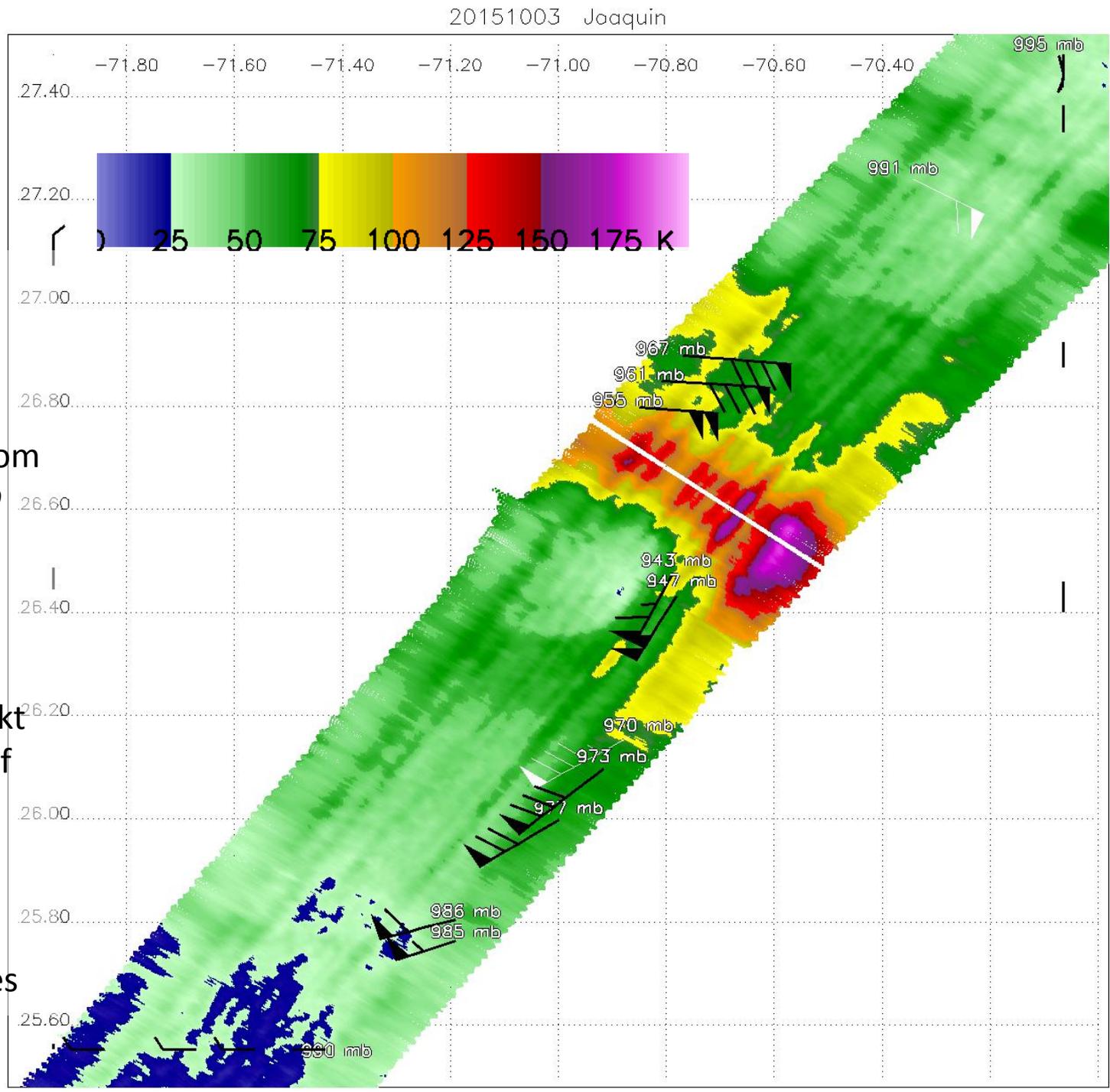
Hurricane Joaquin 03 Oct 2015

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