



Cross-Polarized C-band Scatterometer Measurements of the Sea Surface in Extreme Winds

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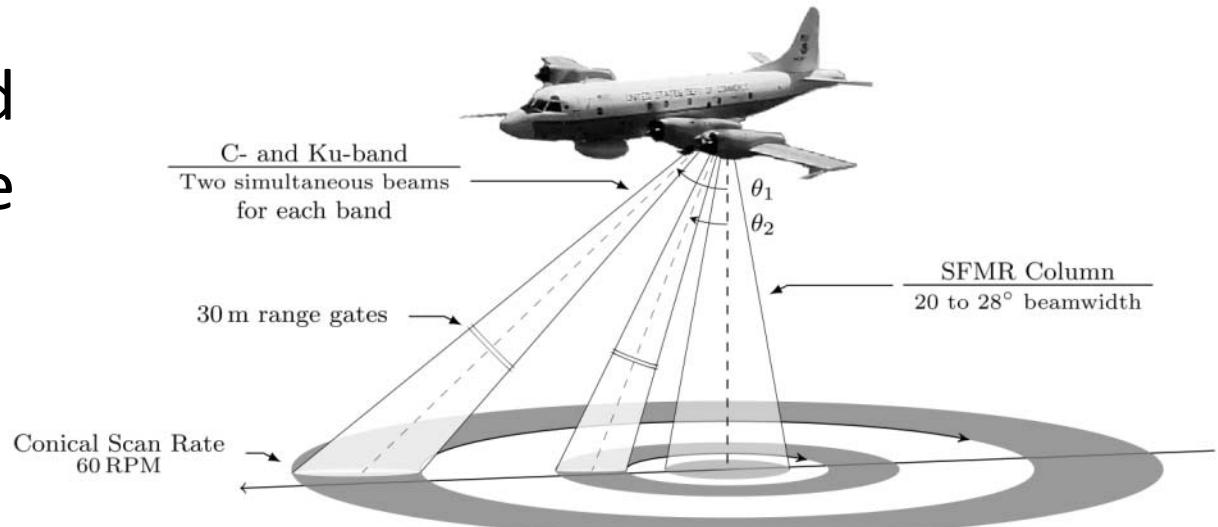


Experiment Overview



IWRAP Airborne Scatterometer Overview

The Imaging Wind and Rain Airborne Profiler (IWRAP)



- Operated from a NOAA WP-3D “Hurricane Hunter” aircraft
- Developed and maintained by the University of Massachusetts Amherst’s (UMass) Microwave Remote Sensing Laboratory (MIRSL)
- Capable of measuring the sea-surface NRCS at all polarization combinations
- Samples each polarization in consecutive blocks



Hurricane 2016 Experiment Description

- ESA/RUAG antenna was mounted in a **fixed position** with bore sight at 25° off nadir (pointing to the right of the aircraft)
 - Allowed for observations at approximately 10° – 45° in level flight
 - Maximum gain is at ~45°
- IWRAP configured to sample HH, VV, and VH in alternating blocks



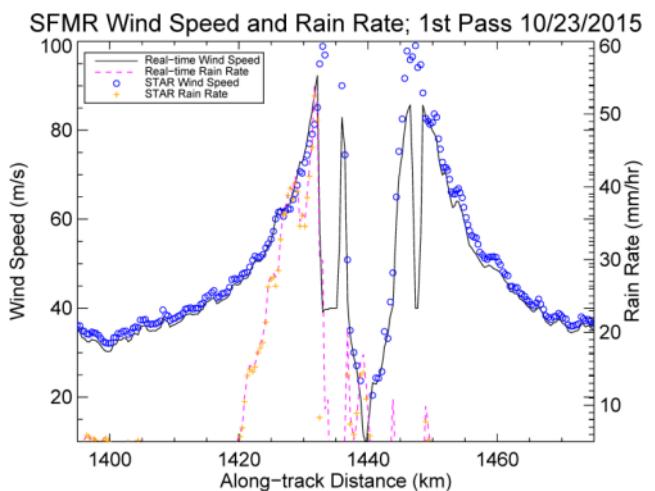
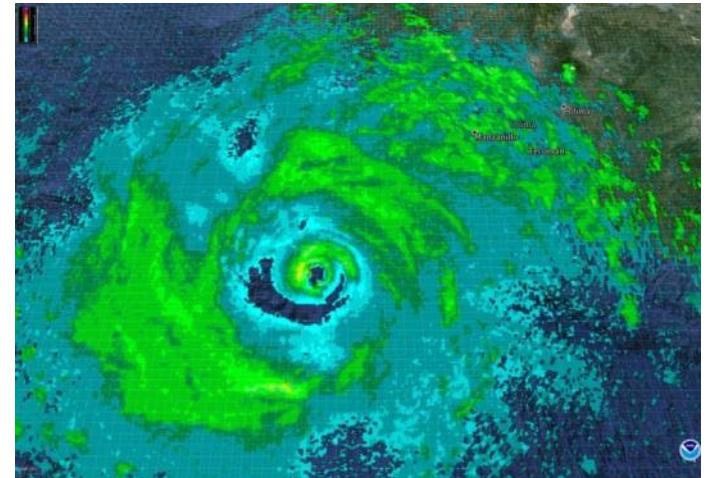
Aft-looking picture of the C-band antenna.

Ku-band fairing visible at bottom of picture.



Hurricane Patricia

- The only storm data from the 2015 hurricane season for IWRAP came from Patricia (EPAC)
- Co- and cross-polarized NRCS measurements made with IWRAP
- Strongest recorded “hurricane” (western hemisphere)
- Cat 5 at landfall (23 Oct 2015)
- SFMR retrieved wind speeds above 80 m/s
 - In both NOAA Hurricane Hunter and USAF reconnaissance aircraft
 - NOAA dropsondes don't show higher than 80 m/s







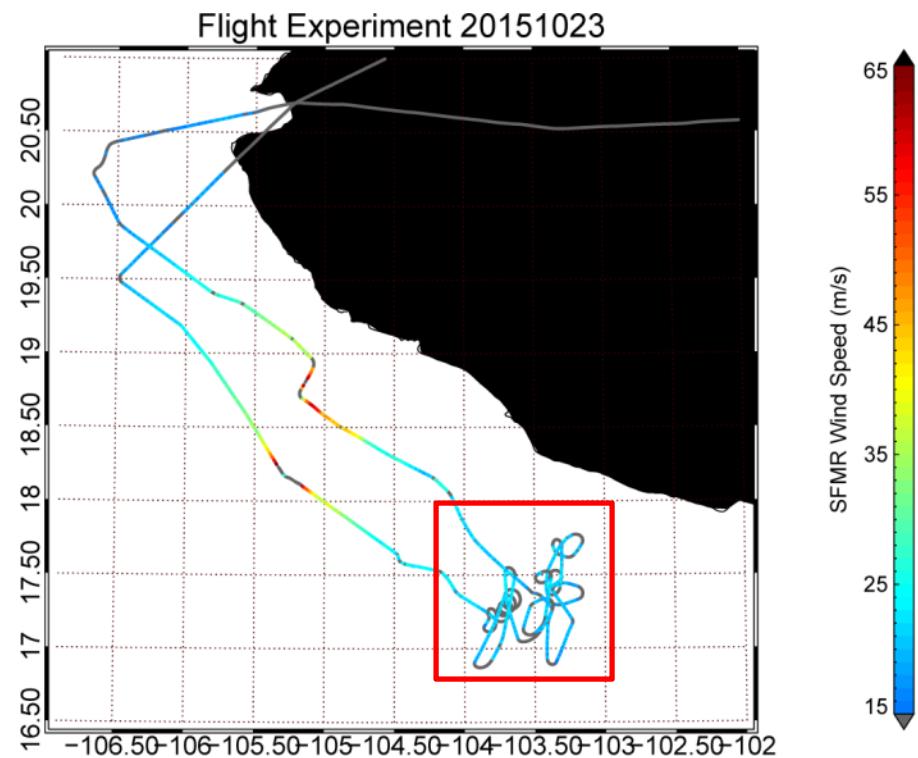


Cross-Polarized Sea-Surface NRCS Measurements at High Winds



Initial Results – Calibration

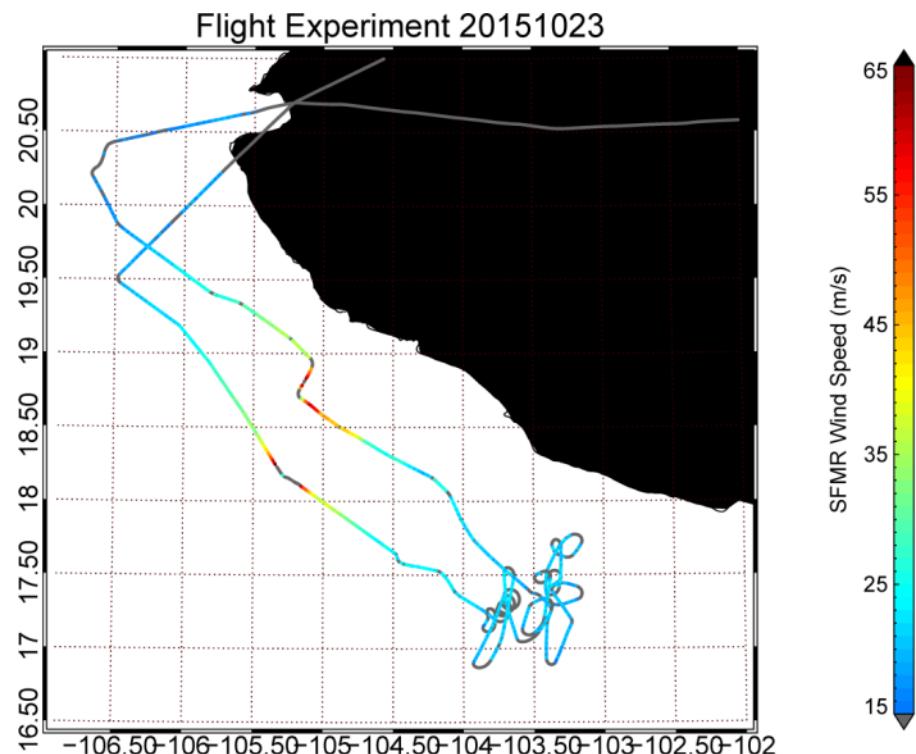
- C-band data calibrated during orbits after first penetration
- Uniform area of wind speed
- Use mean NRCS (A_0)
- Surface wind speed is from SFMR
- Determine offset between VV NRCS and CMOD5.h
- Apply offset to all NRCS at all polarizations





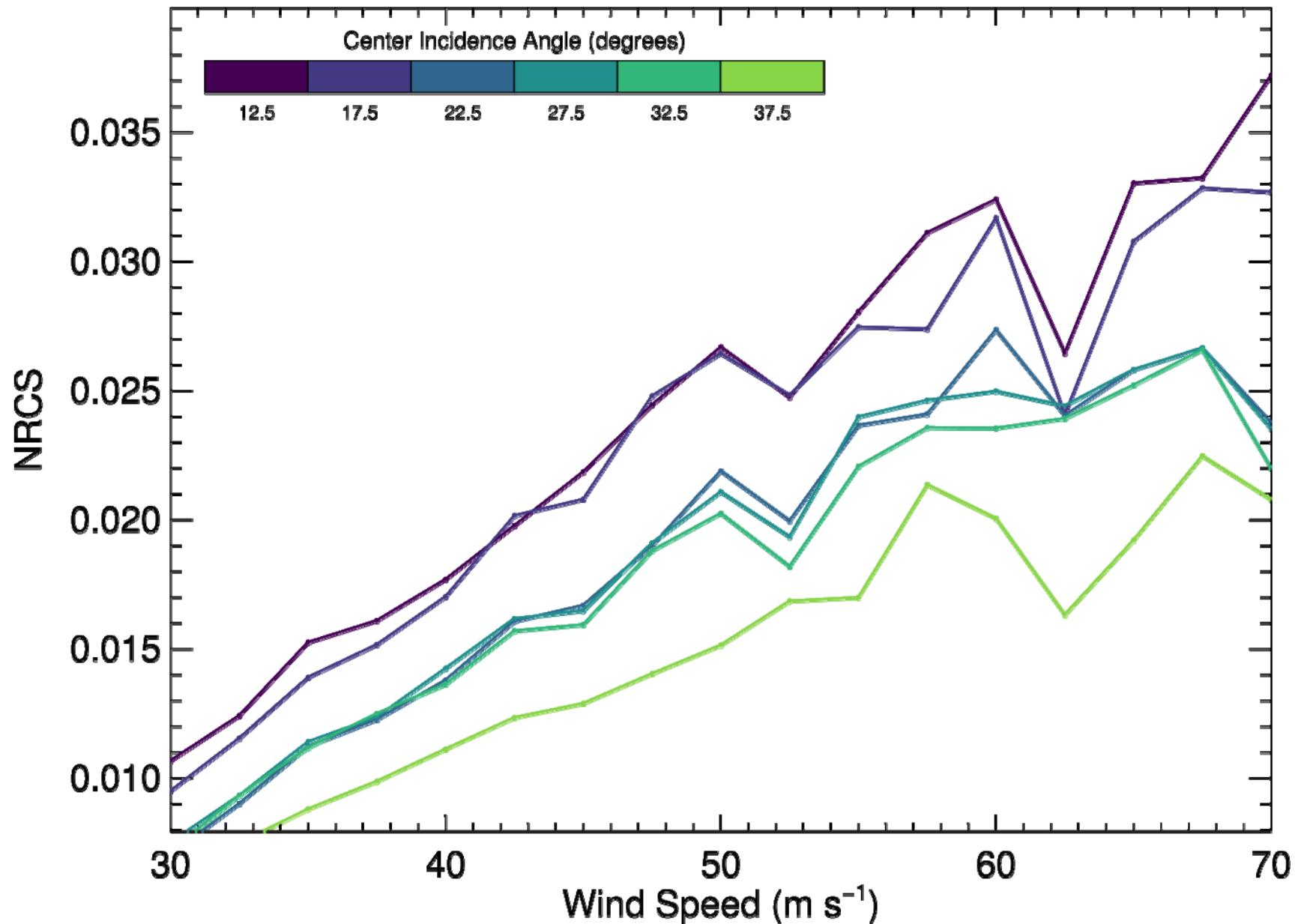
Initial Results

- Data from two eyewall penetrations on 2015 Oct 23
- SFMR wind speeds and rain rates used as ground truth
- IWRAP fan-beam was separated into 5° bins and located absolutely on surface
- Aircraft heading was offset from flight track, so SFMR data collocated with IWRAP measurements based on distance from nearest center fix
- Any surface measurements with SFMR rain rate greater than 5 mm/hr excluded
- NRCS assumed to be independent of azimuth at these wind speeds



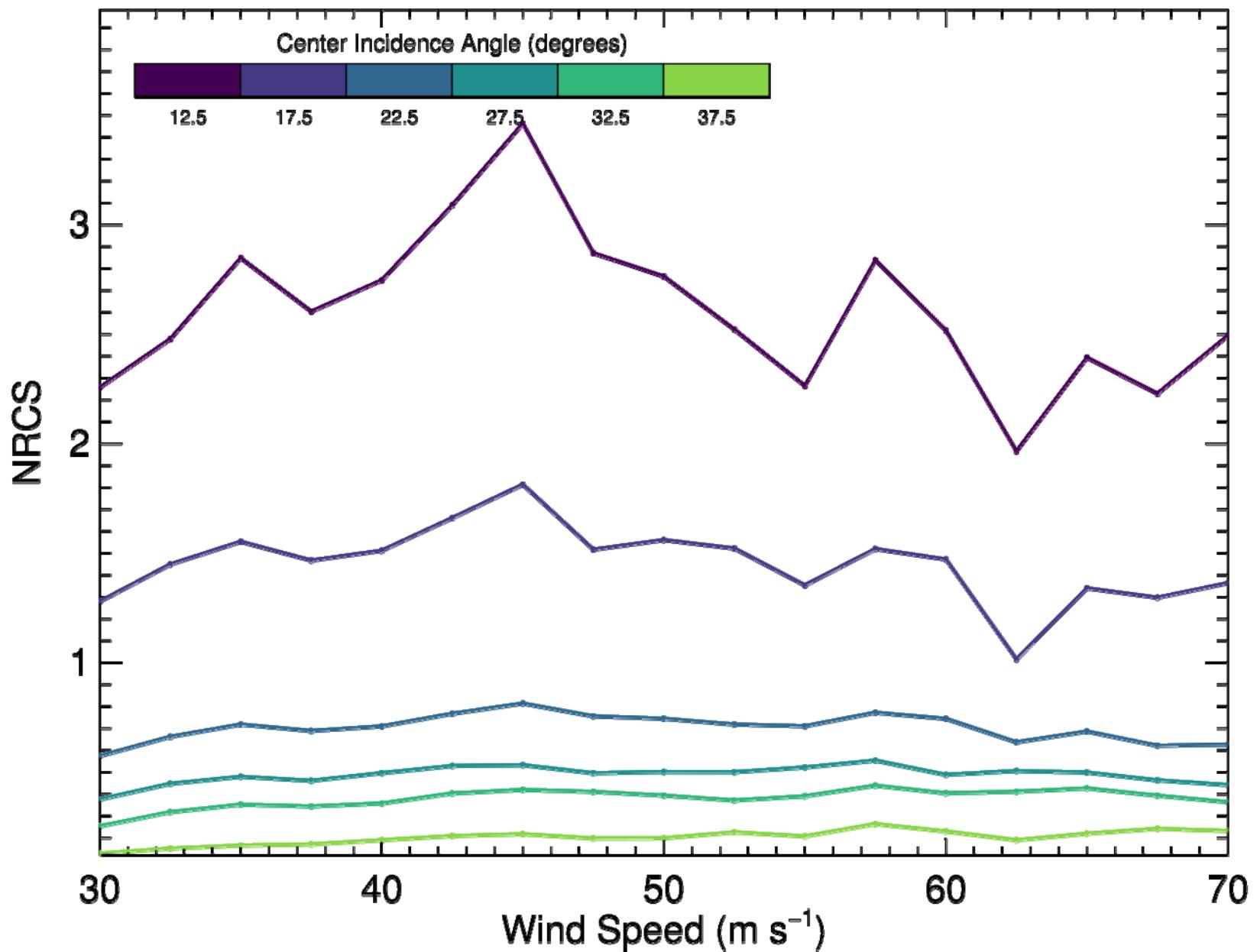


Cross-Pol NRCS (VH) (rain-free) vs. Wind Speed



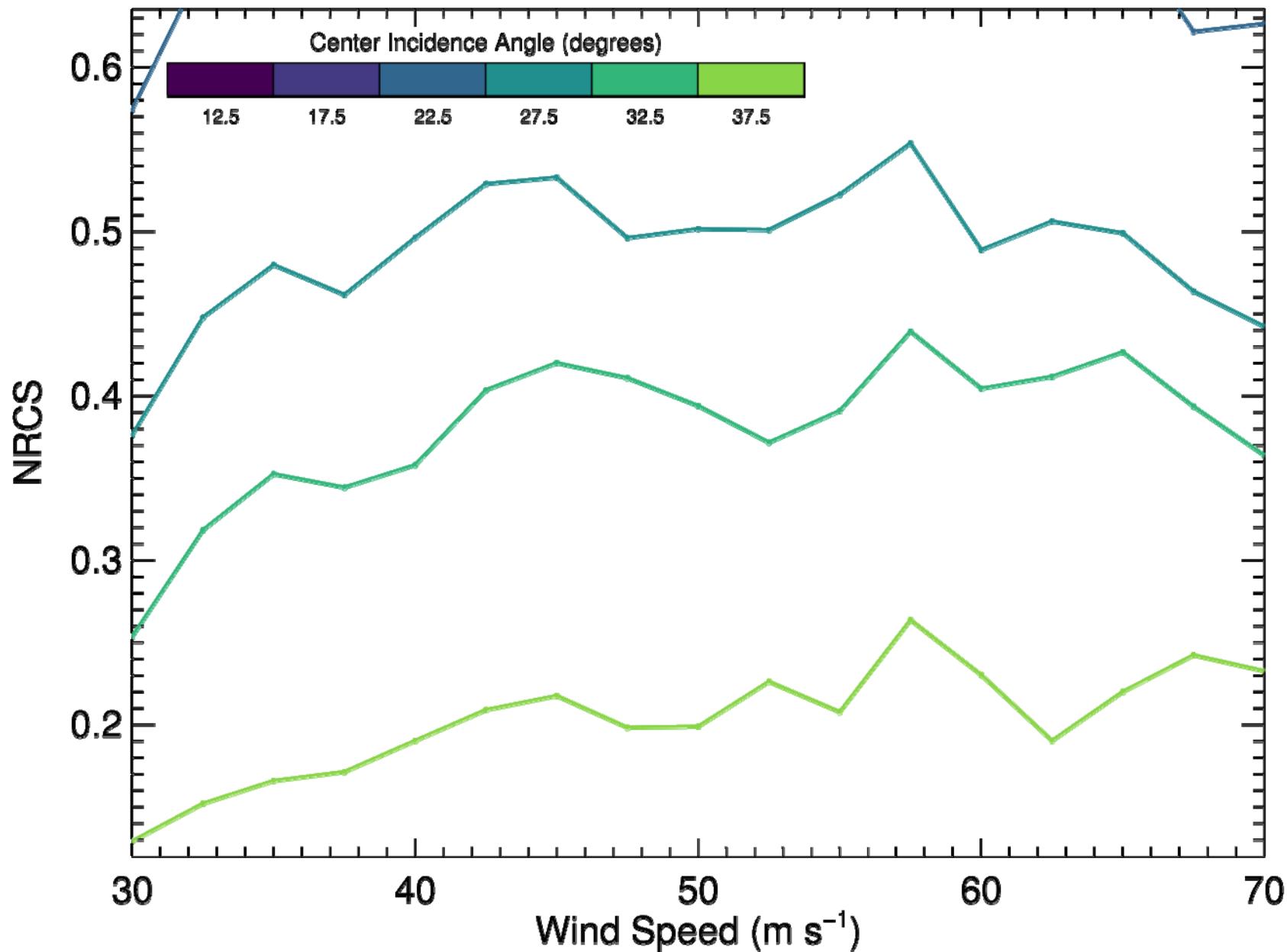


VV NRCS (rain-free) vs. Wind Speed



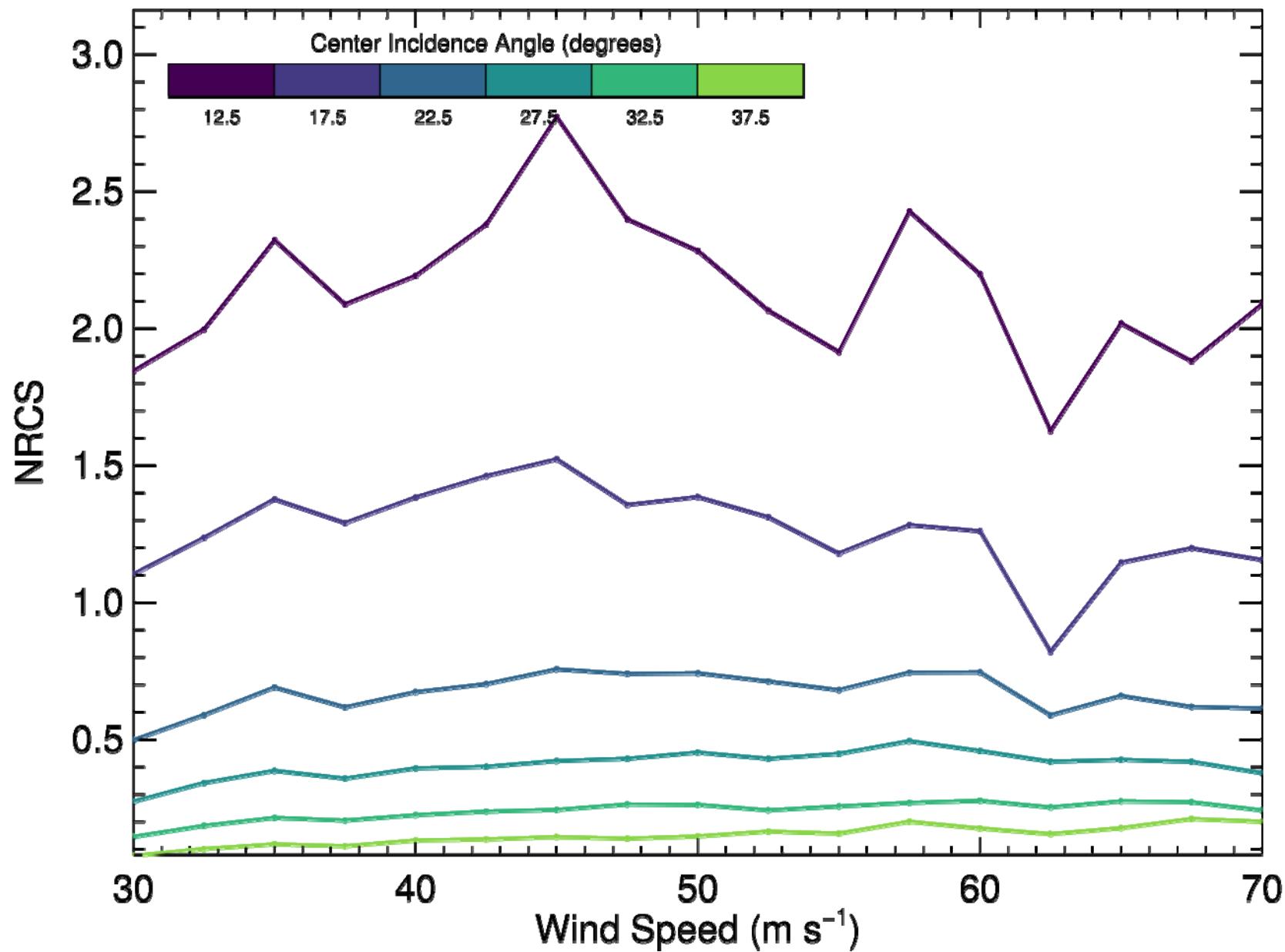


VV NRCS (rain-free) vs. Wind Speed Higher Incidence Angles



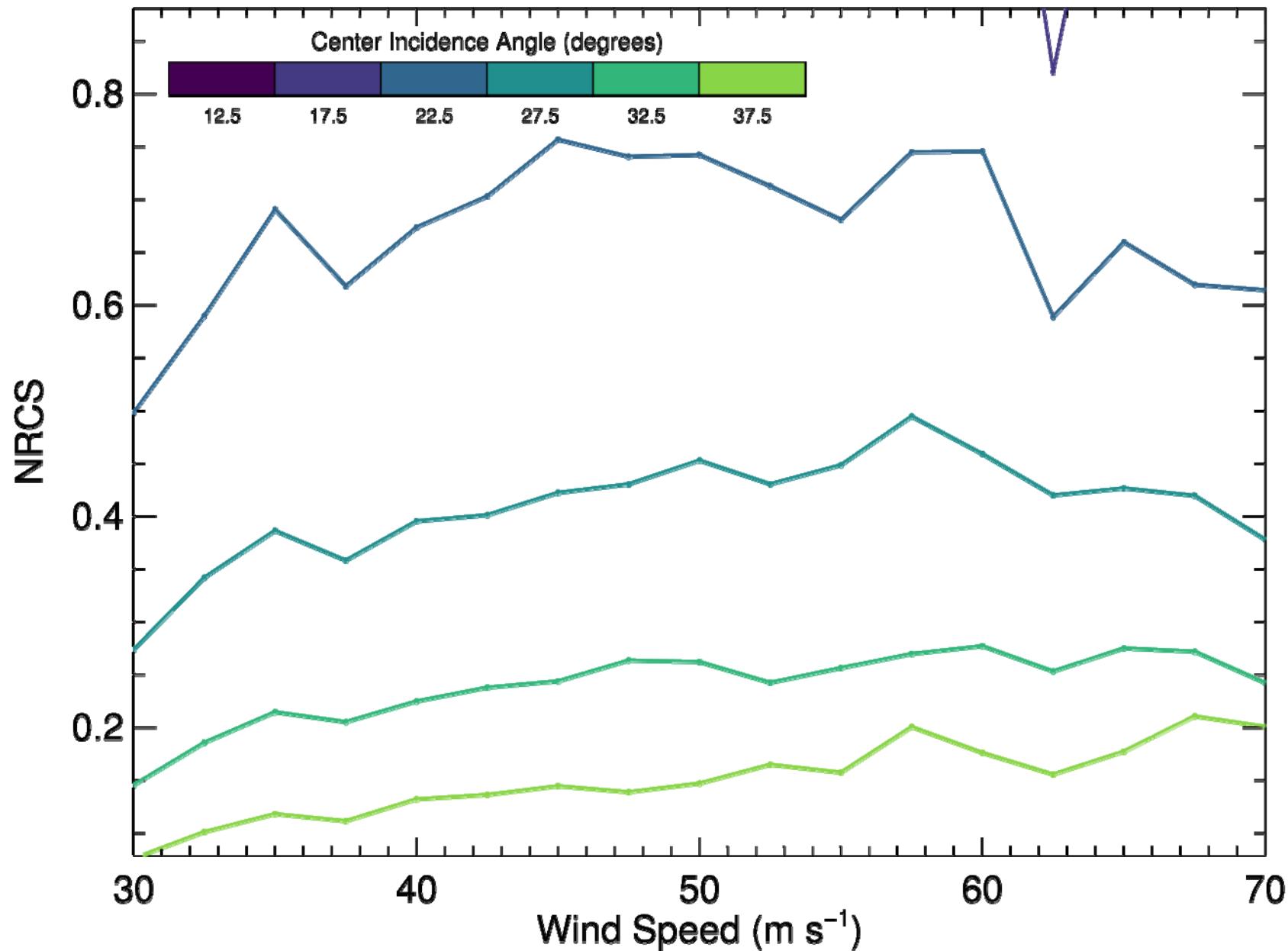


HH NRCS (rain-free) vs. Wind Speed



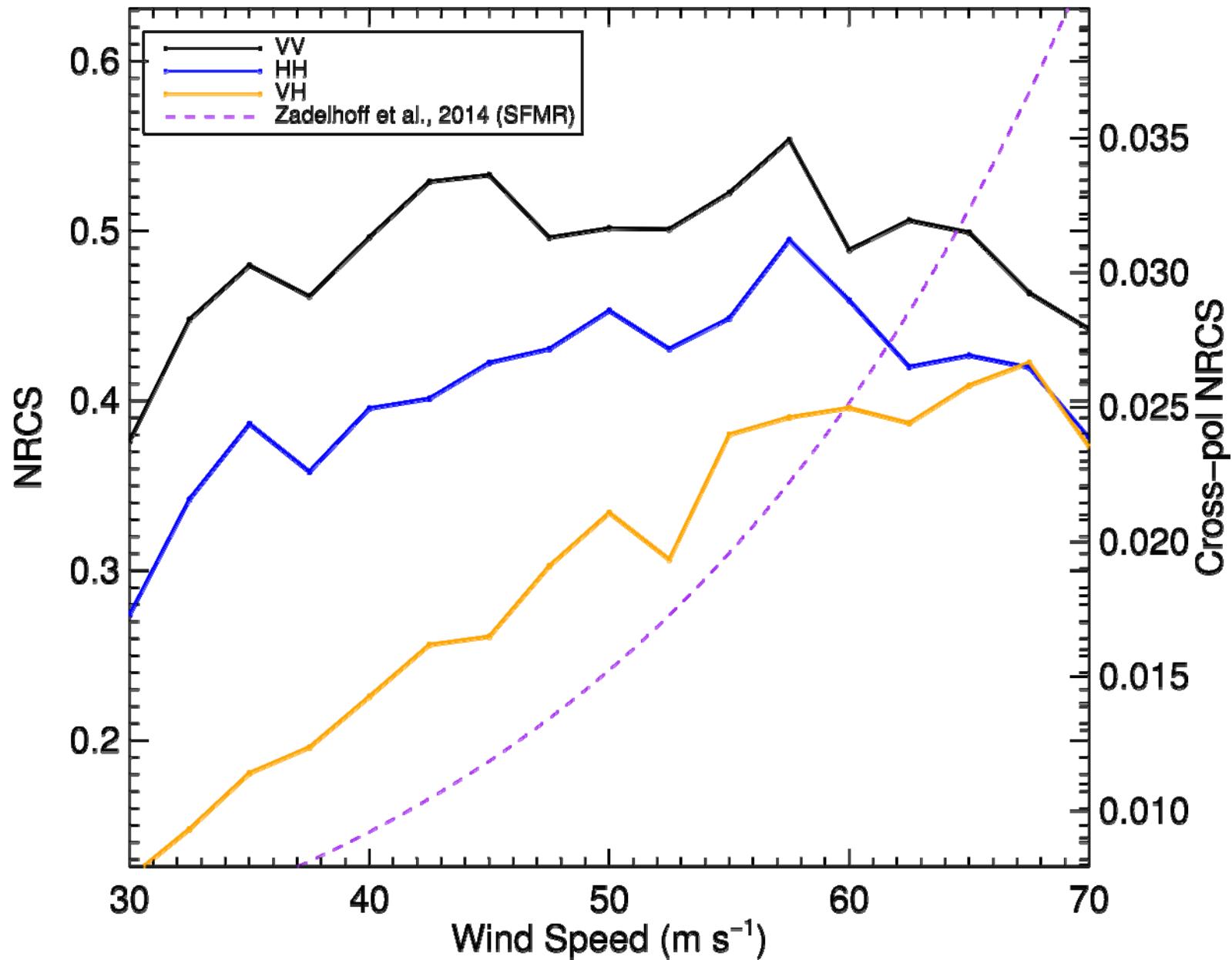


HH NRCS (rain-free) vs. Wind Speed Higher Incidence Angles





All Data from 25 – 30° Incidence





Summary

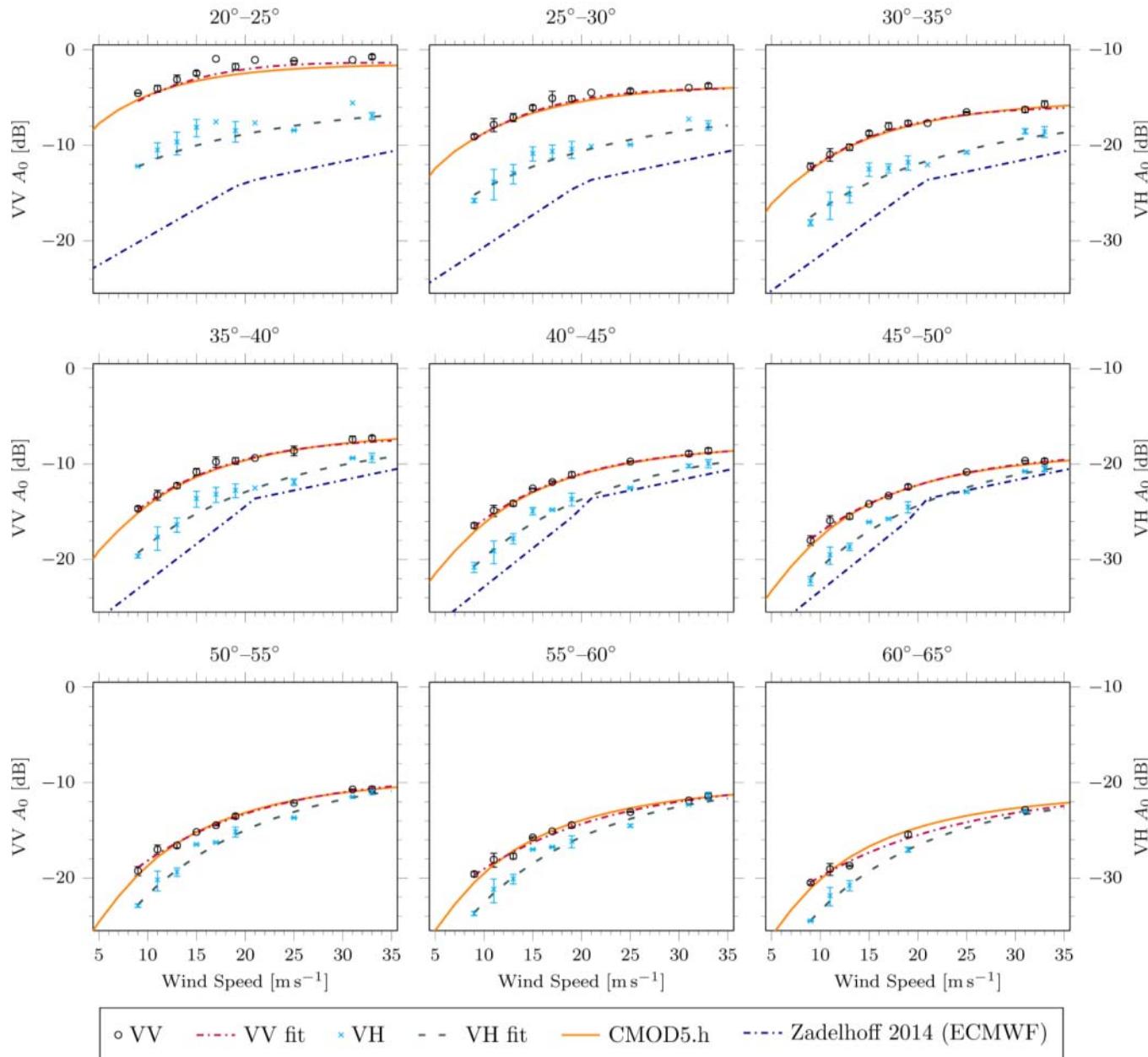
- Co-polarized NRCS wind speed sensitivity clearly saturates at all incidence angles measured
 - Downward slope at lowest incidence angles, as expected
- VH sensitivity to wind speed:
 - Is incidence-angle dependent
 - Does not appear to be strongly dependent on azimuth above 30 m/s
 - Is lower at higher incidence angles
 - Does not appear to saturate below 60 m/s
- VH measurement requires a system 10 – 25 dB more sensitive than equivalent at co-pol, depending on incidence angles and wind speeds required



Appendix

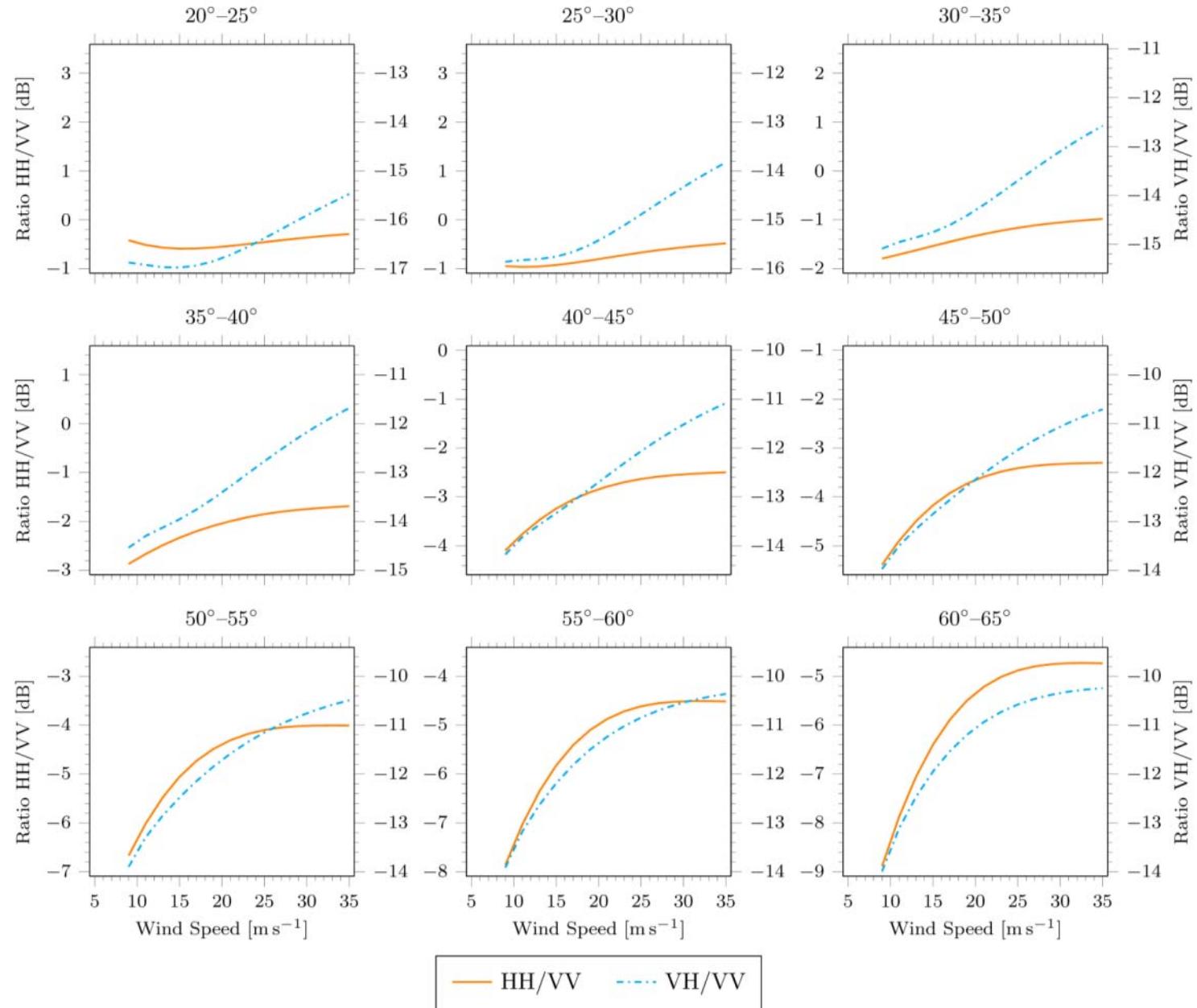


A_0 vs. Wind Speed Below 35 m/s



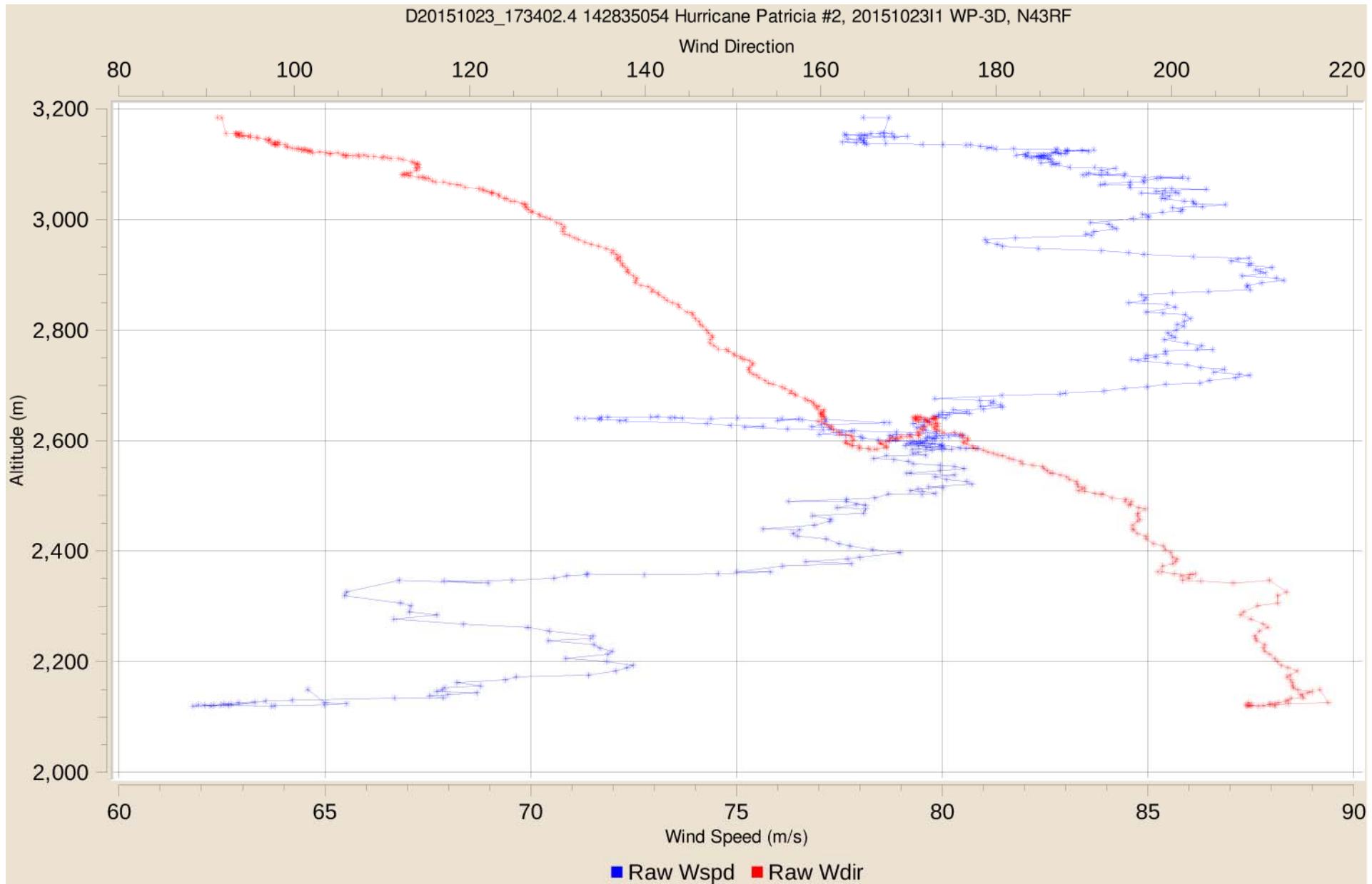


A_0 Polarization Ratios Below 35 m/s





Failed Dropsonde





Failed Dropsonde

D20151023_173402.4 142835054 Hurricane Patricia #2, 20151023I1 WP-3D, N43RF

