Combined Active and Passive Remote Sensing of Ocean Surface Winds

Simon H. Yueh and Julian Chaubell

Jet Propulsion Laboratory

OVWST

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Outline

- Background
- Active and passive retrieval
- ASCAT C-band High Wind Sigma0
- Summary

Why should combined active and passive improve the accuracy?

- QuikSCAT multi-look geometries degenerated near nadir and far swath

$$\sigma_0 = A_0(w) + A_1(w)\cos(\phi_w - \phi_1) + A_2(w)\cos 2(\phi_w - \phi_1)$$

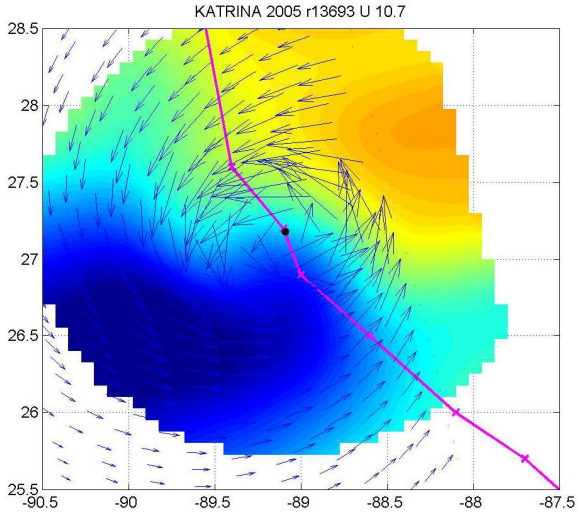
- 3rd Stokes parameter from radiometry will break symmetry and improve accuracy.

$$U = U_1(w)\sin(\phi_w - \phi_3)$$

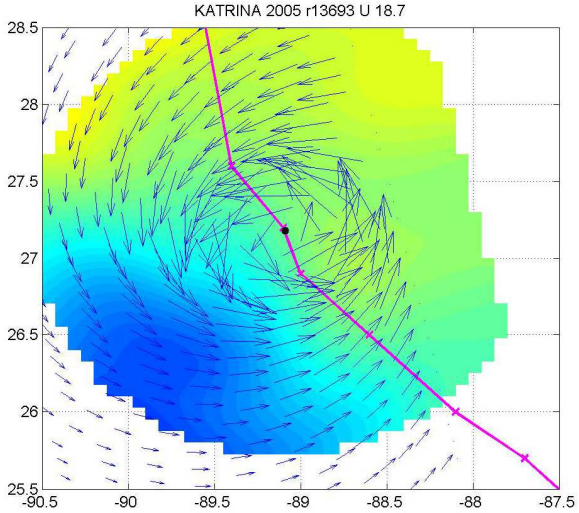
Can you identify the closed circulation from WindSAT Polarimetric Response Katrina 2005 (Rev 13693)?

- The WindSat third Stokes parameter at 10 GHz show the strongest response to wind direction for extreme high winds

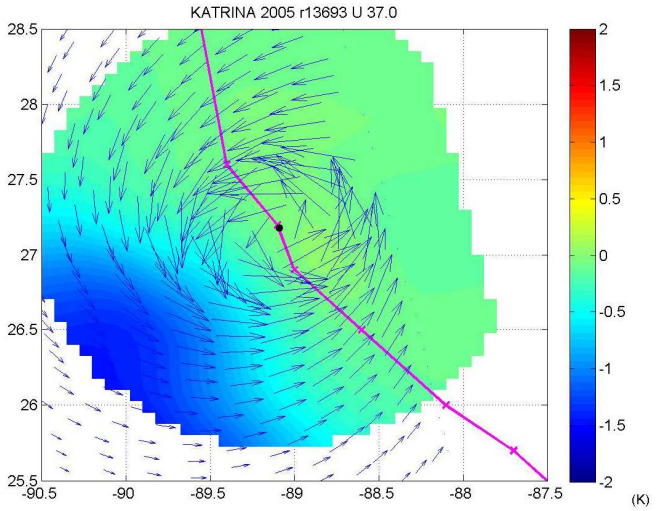
10 GHz U



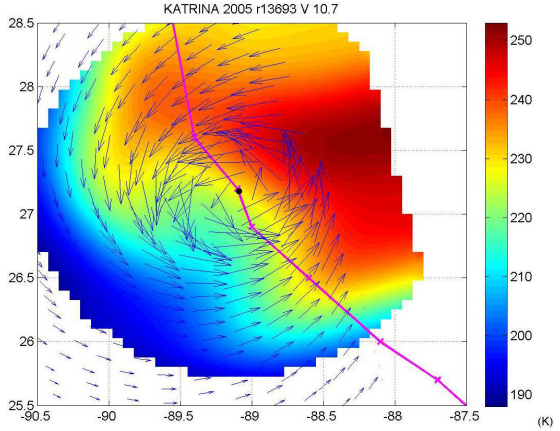
18 GHz U



37 GHz U

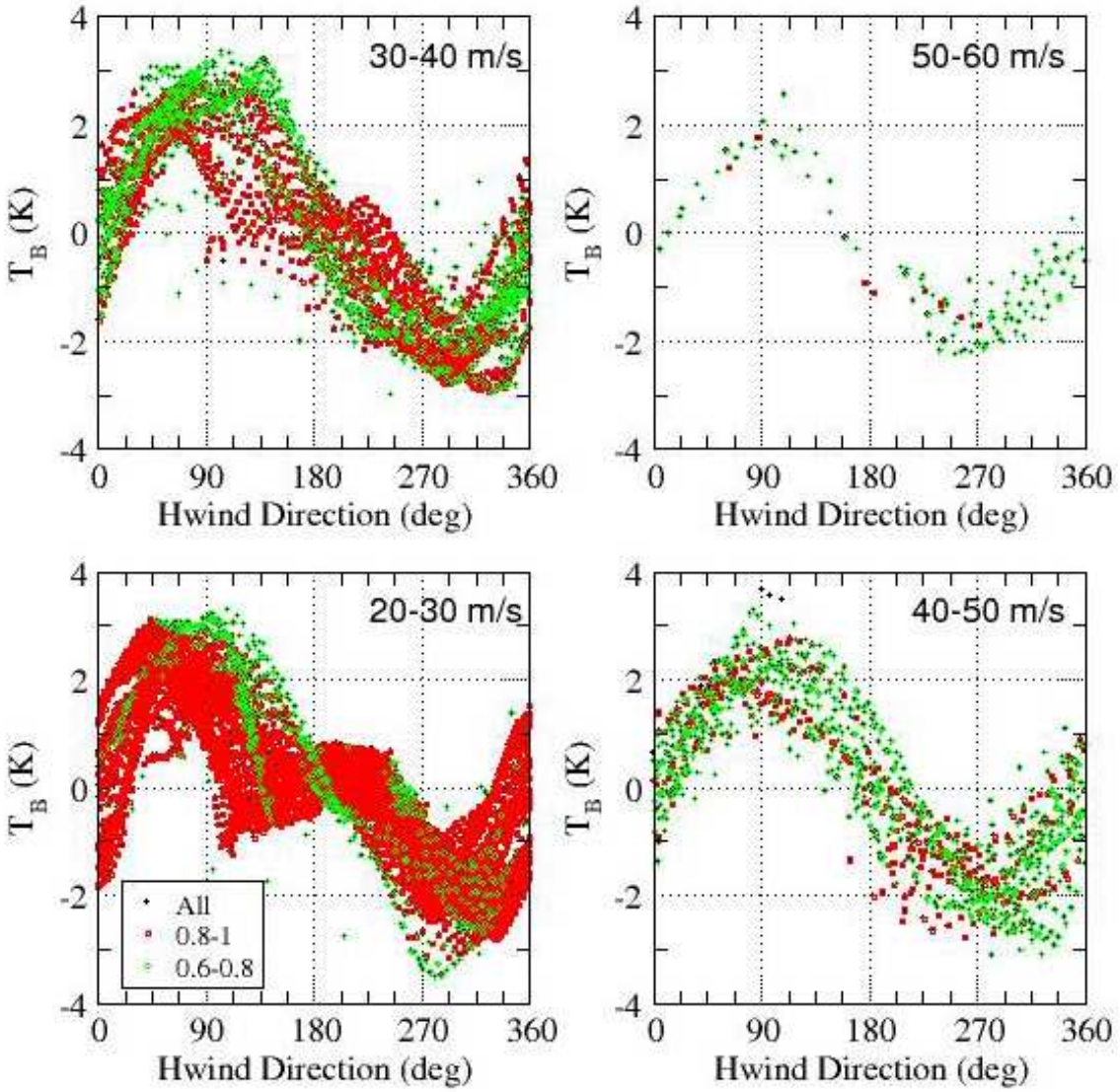


- NOAA HRD HWind Vectors are collocated.



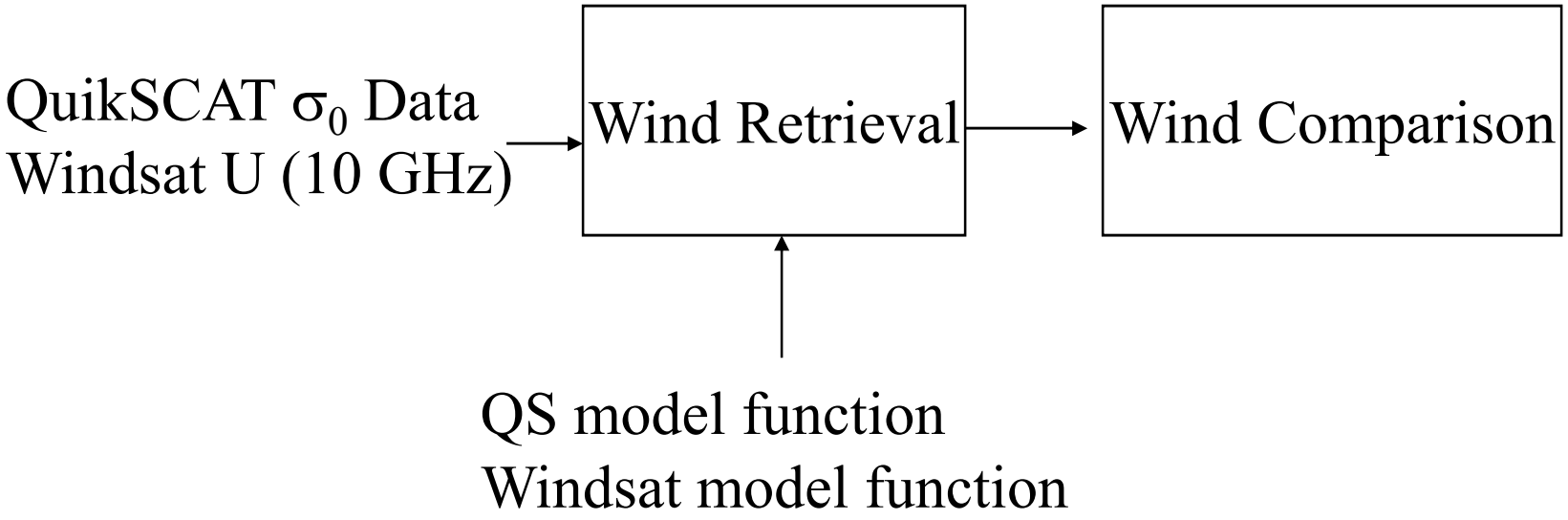
Windsat 10 GHz TV and TH data showed heavy precipitation to the right of track on August 28, 2005

WindSAT 10 GHz U Data For Atlantic Hurricanes 2003-2005

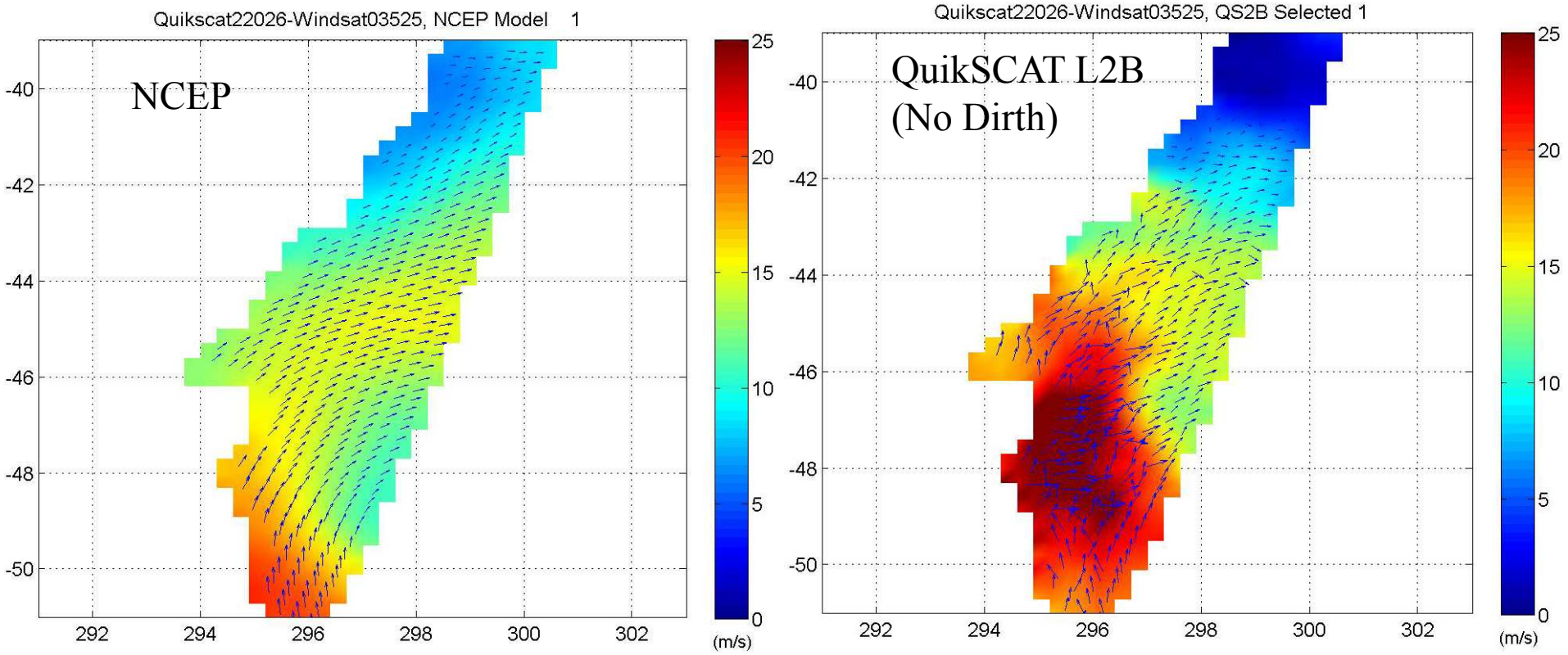


- After corrected for attenuation, WindSAT 10 GHz U had 3-4 K peak to peak sinusoidal signals at 50-60 m/s wind speeds.

Approach for To Test Combined Active/Passive Wind Retrieval

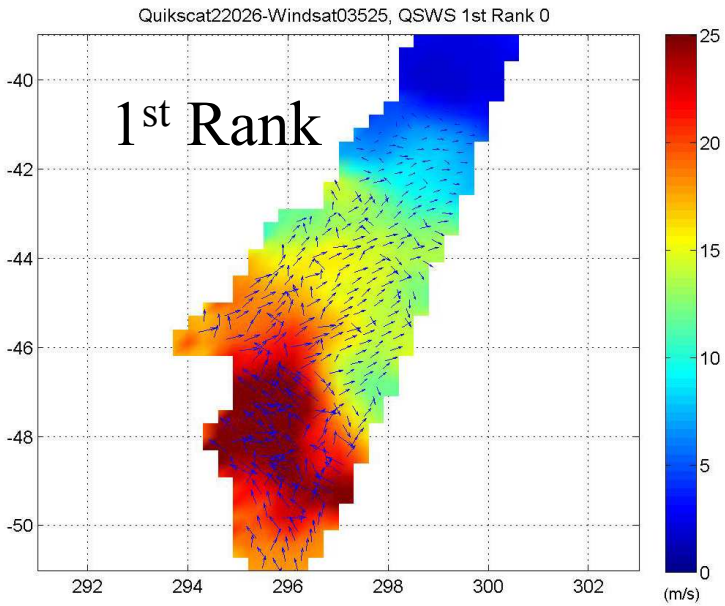


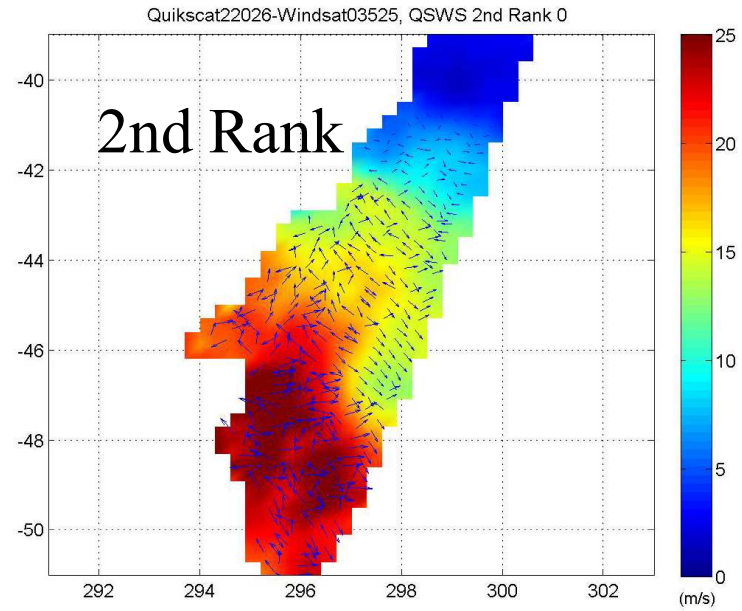
QuikSCAT and NCEP Model Fields for Collocated QS Rev 22026 and Windsat Rev 3525 off Argentina

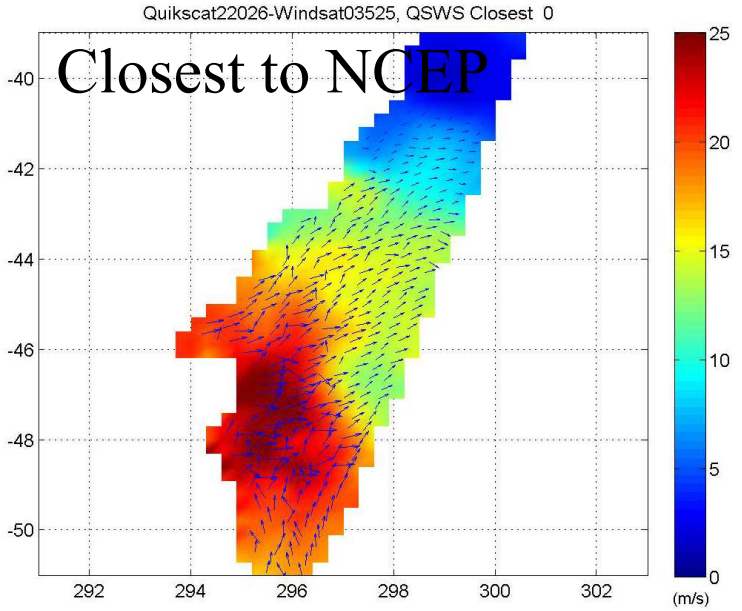


- Quikscat (closest to NCEP) winds are noisy near nadir (+/-200 km).
- There are stronger winds in the retrievals.

Retrievals from QuikScat Only

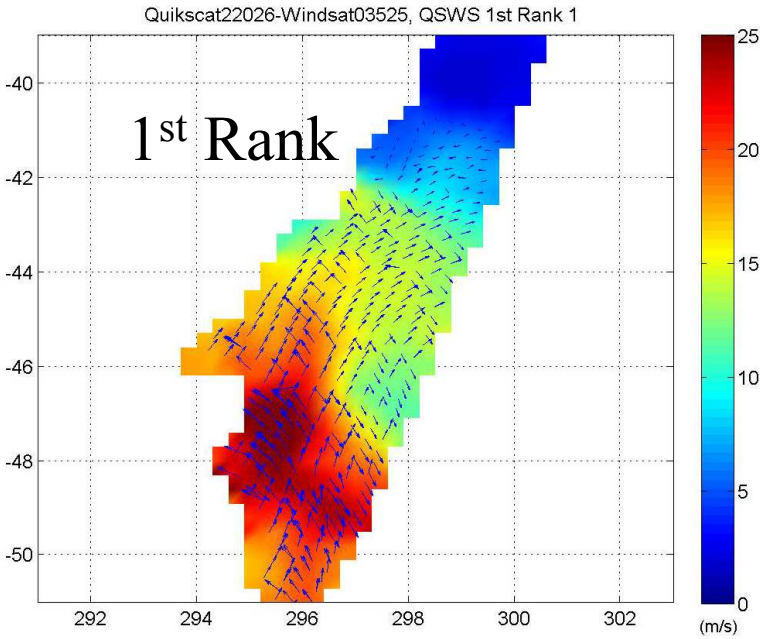


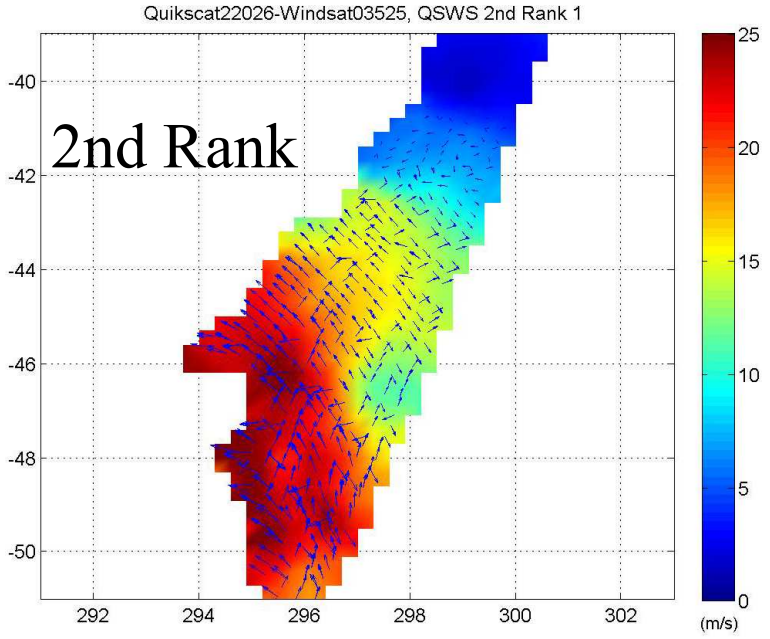


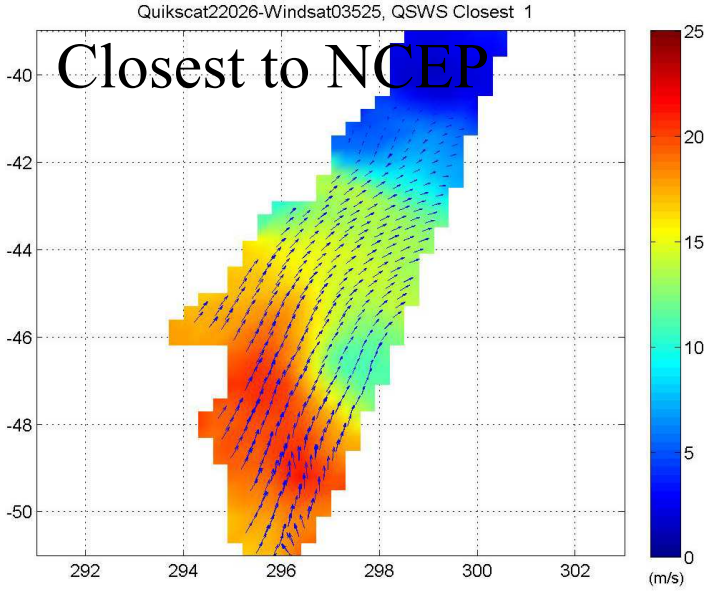


- Quikscat closest wind vectors were still noisy near nadir (+/-200 km).

Retrievals from Quikscat and Windsat U10

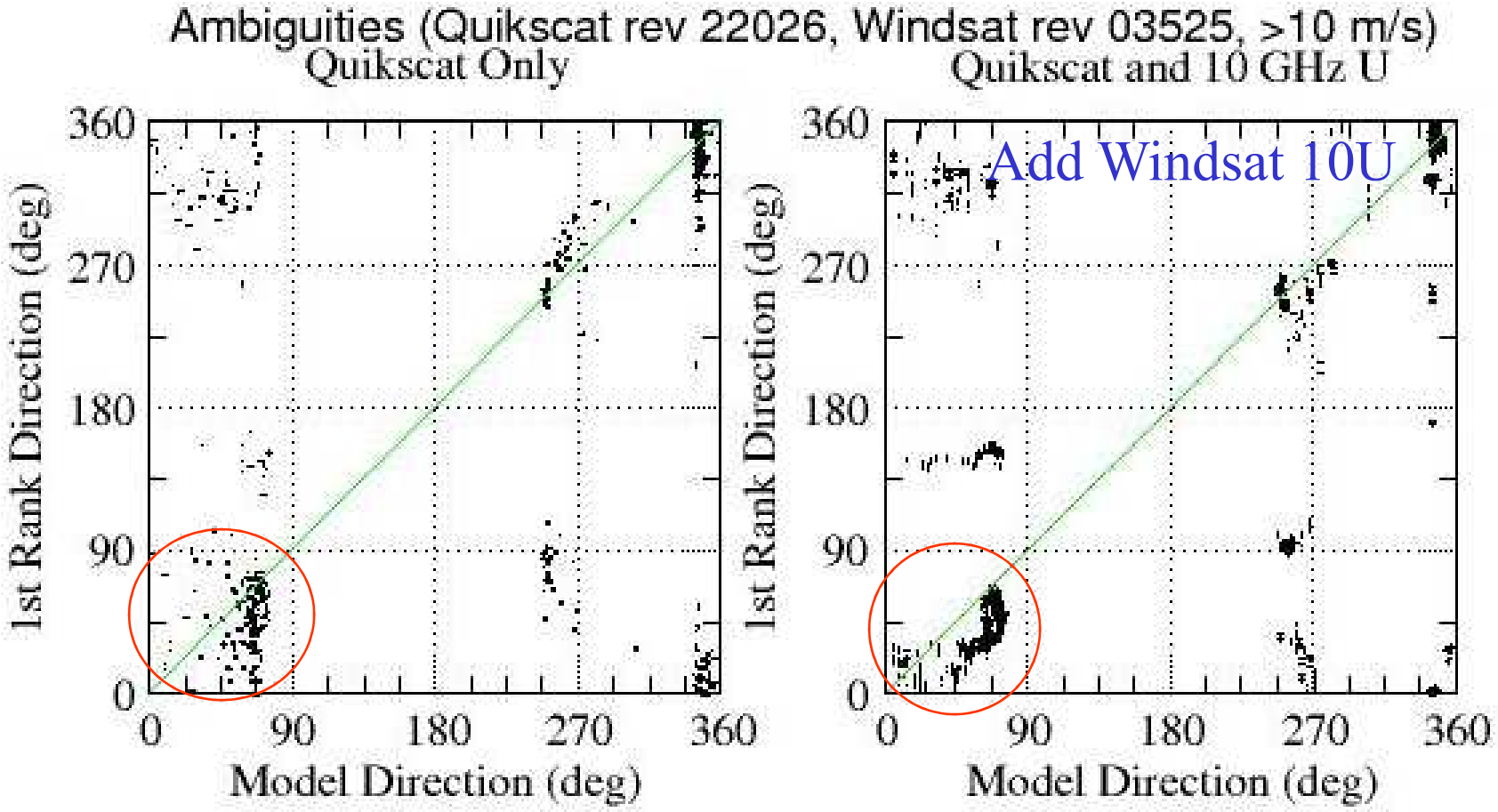






- Smooth fields from the addition of Windsat U10 near nadir (+/-200 km).
- 1st rank has higher skill.

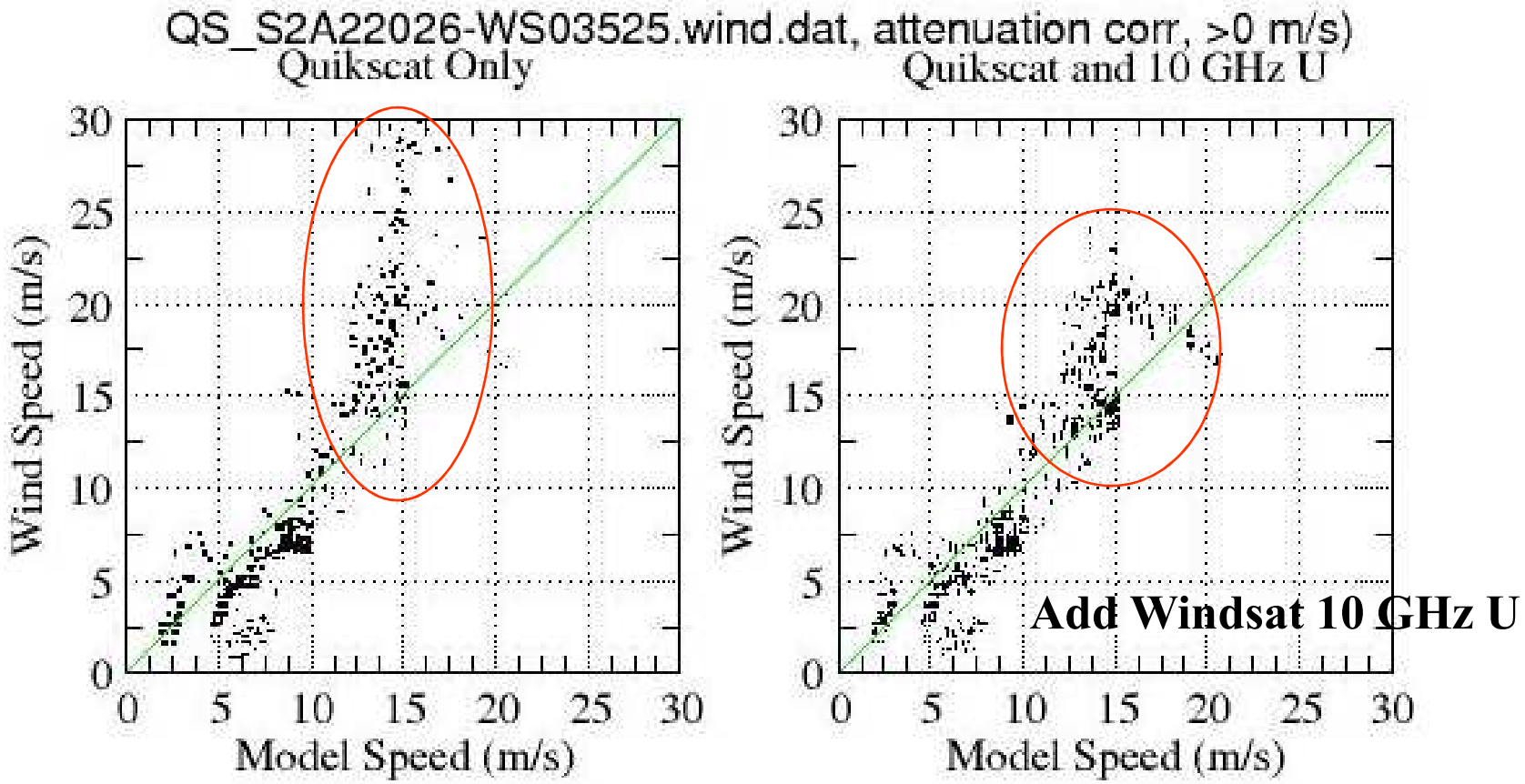
Comparison of QuikSCAT and QuikSCAT+WS Wind Direction Versus NCEP Model Fields



- The addition of Windsat U10 near nadir (+/-200 km) has tightened up the wind direction distribution.

$$\sigma_0 = A_0(w) + A_1(w)\cos(\phi_w - \phi_1) + A_2(w)\cos 2(\phi_w - \phi_1)$$

Comparison of QuikSCAT and QuikSCAT+WS Wind Speeds



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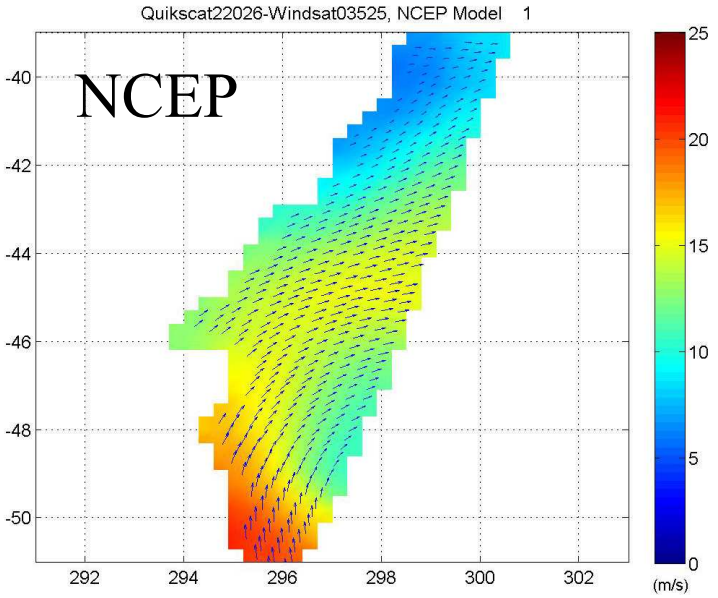
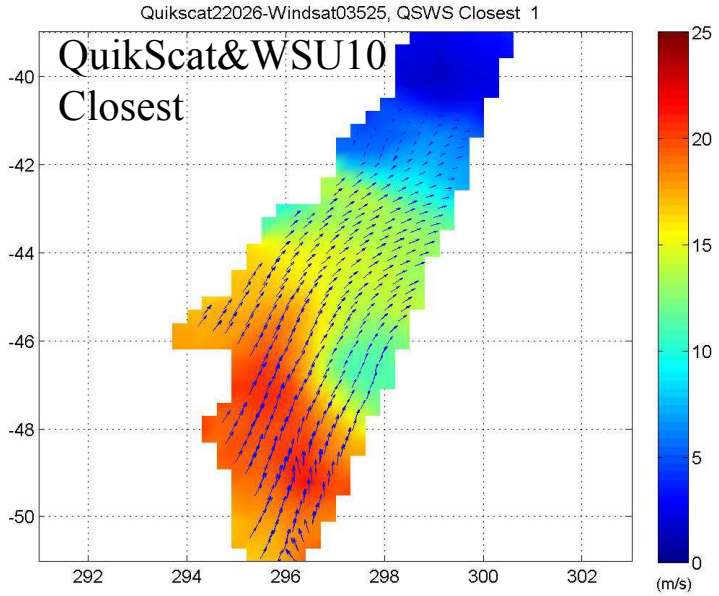
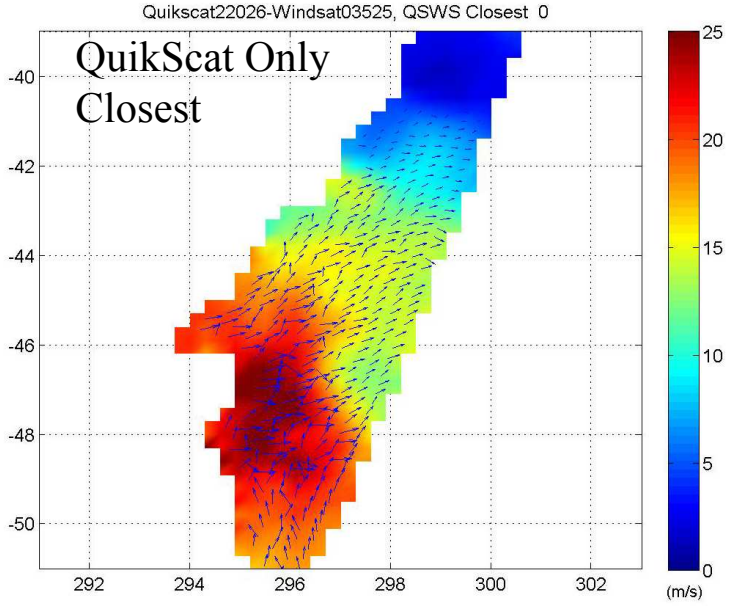
Wind Comparison for Collocated QS Rev 22026 and Windsat Rev 3525 off Argentina





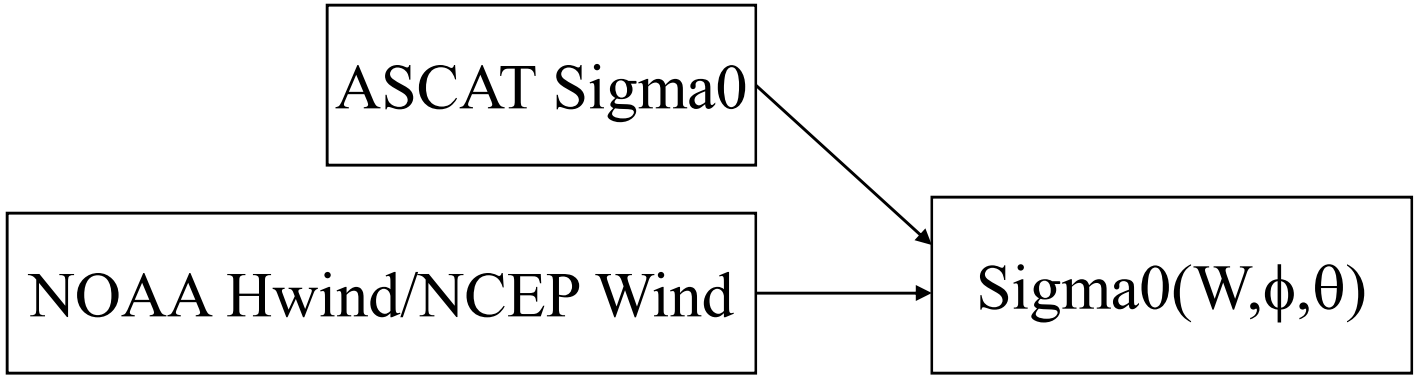
- The addition of Windsat 10 GHz U data results in less noisy fields and smaller sd wrt NCEP for > 10 m/s



	QS (Closest)	QS (DIRTH)	QS+WS
Sd speed (m/s)	5.2	4.4	3.3
Sd direction (deg)	24	10	16

High Wind Geophysical Model Function for C-Band Scatterometer

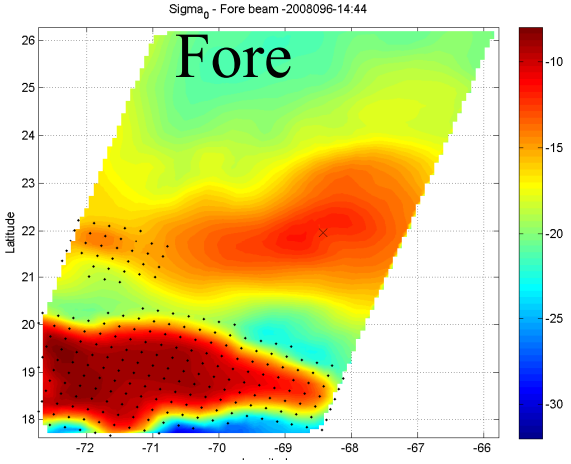
- ASCAT data are paired with the NOAA HDR HWind analyses
- Collocated data are binned as a function of wind speed and direction

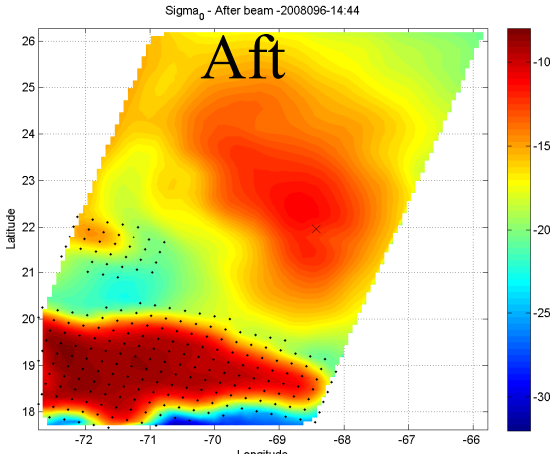


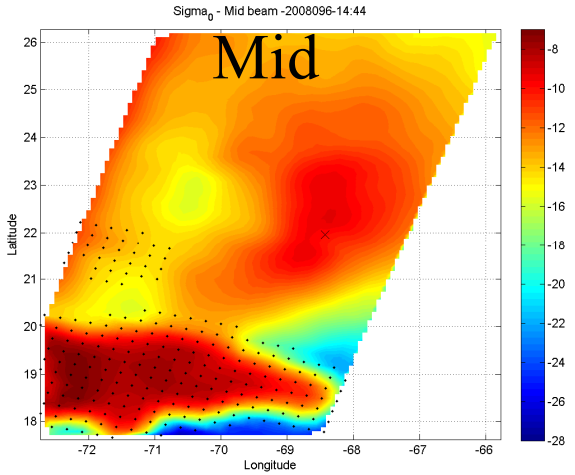
Storms for Collocated Analysis of ASCAT sigma0s and NOAA HWind

Name	Date	Max Wind
NOEL	Oct 2007	27 m/s
OLGA	Dec 2007	29 m/s
CRISTOBAL	July 2008	23 m/s
DOLLY	July 2008	26 m/s
EDOUARD	August 2008	23 m/s
FAY	August 2008	29 m/s
GUSTAV	Aug-Sept 2008	50 m/s
HANNA	Aug-Sept 2008	28 m/s
IKE	Sept 2008	51 m/s
KYLE	Sept 2008	29 m/s
OMAR	Oct 2008	46 m/s
PALOMA	Nov 2008	53 m/s

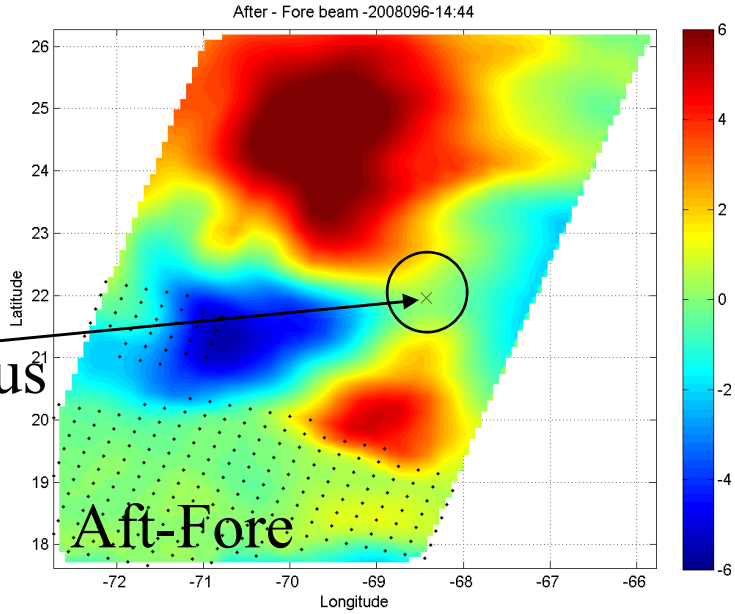
ASCAT Sigma0 Images for Ike

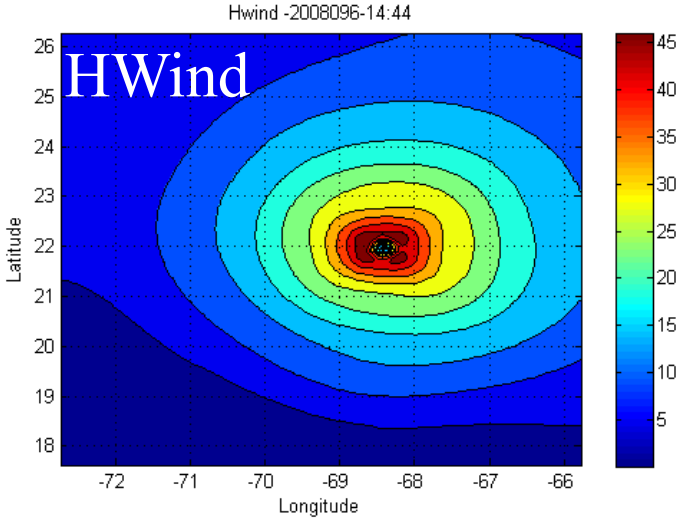






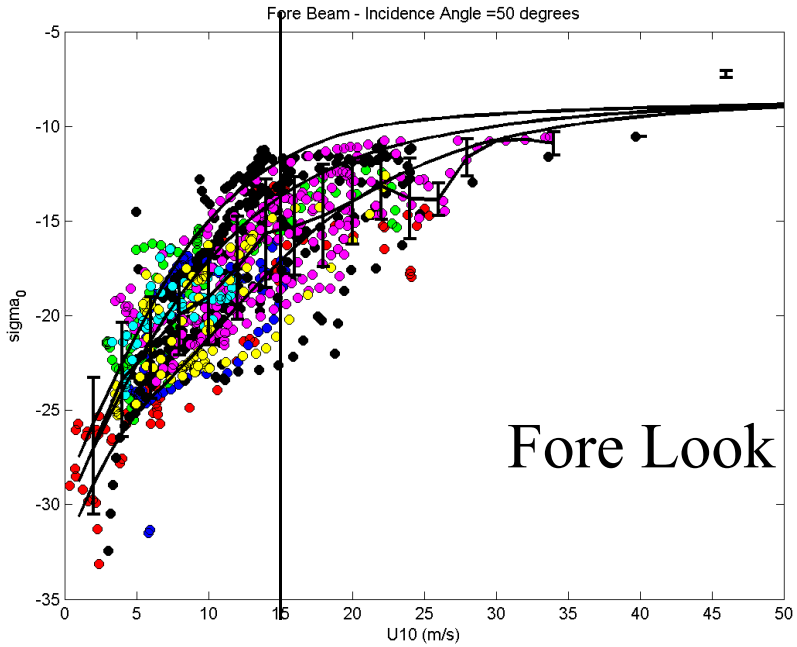
Eye and
1deg radius

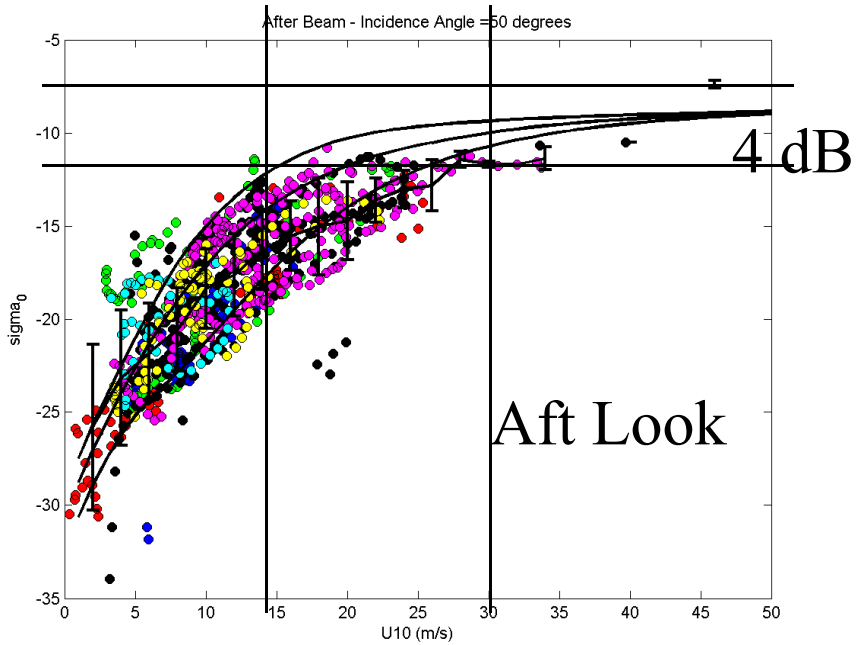




- ASCAT data showed response to wind speed and direction near storm.

ASCAT Sigma0 vs Wind Speed at 50 deg Incidence Angle

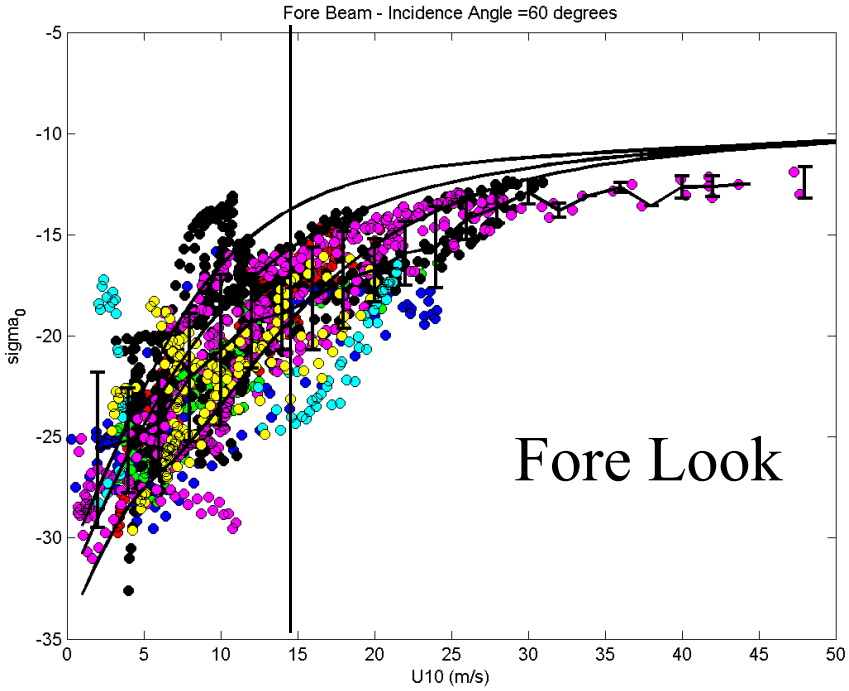


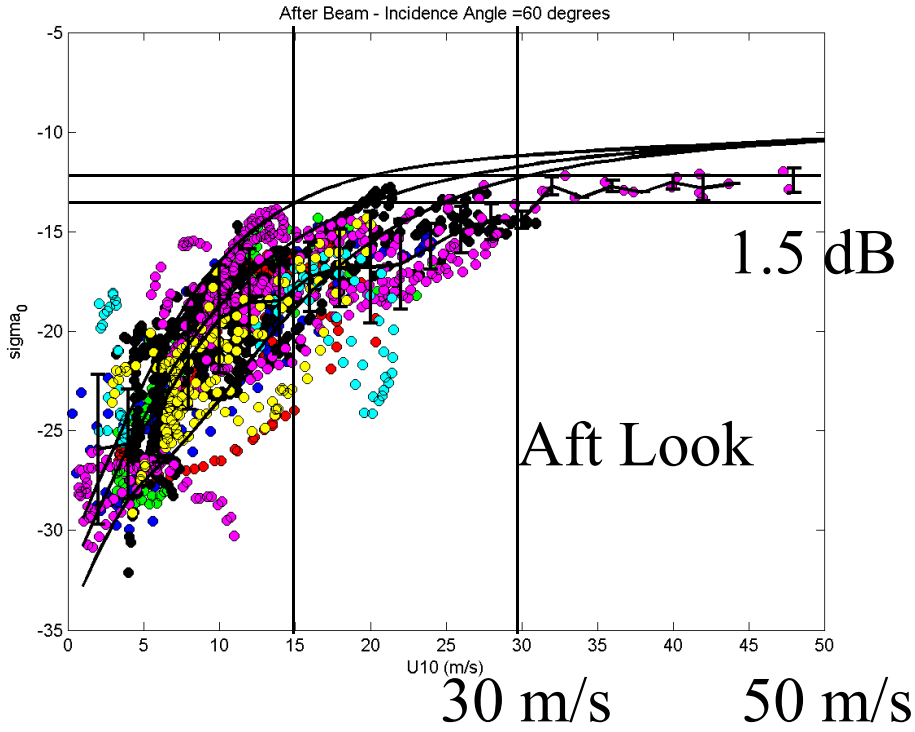


30 m/s 50 m/s

- The vertical distribution of sigma0 essentially corresponds to the wind direction dependence.
- ASCAT C-band sigma0s generally appear to be lower than the CMOD5 at above 15 m/s.
- There was a significant oulier at about 45 m/s.

ASCAT Sigma0 vs Wind Speed at 60 deg Incidence Angle



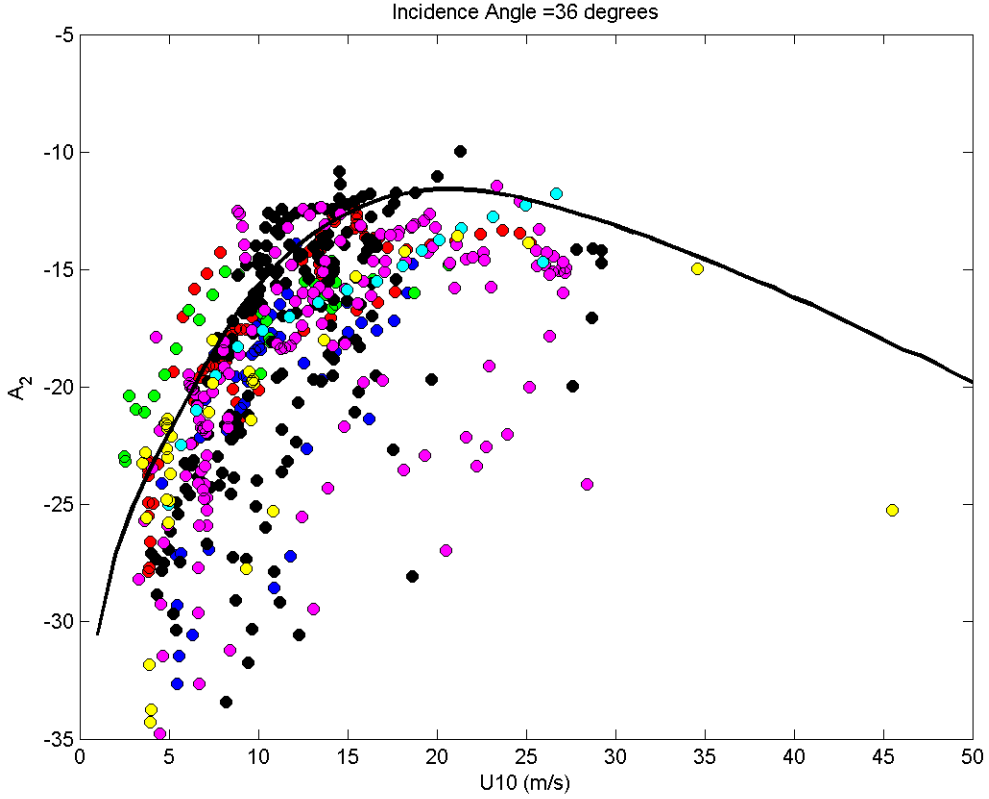


30 m/s 50 m/s

- The vertical distribution of sigma0 essentially corresponds to the wind direction dependence.
- ASCAT C-band sigma0s appear to be lower than the CMOD5 at above 15 m/s.

ASCAT A2 vs Wind Speed at 36 deg Incidence Angle

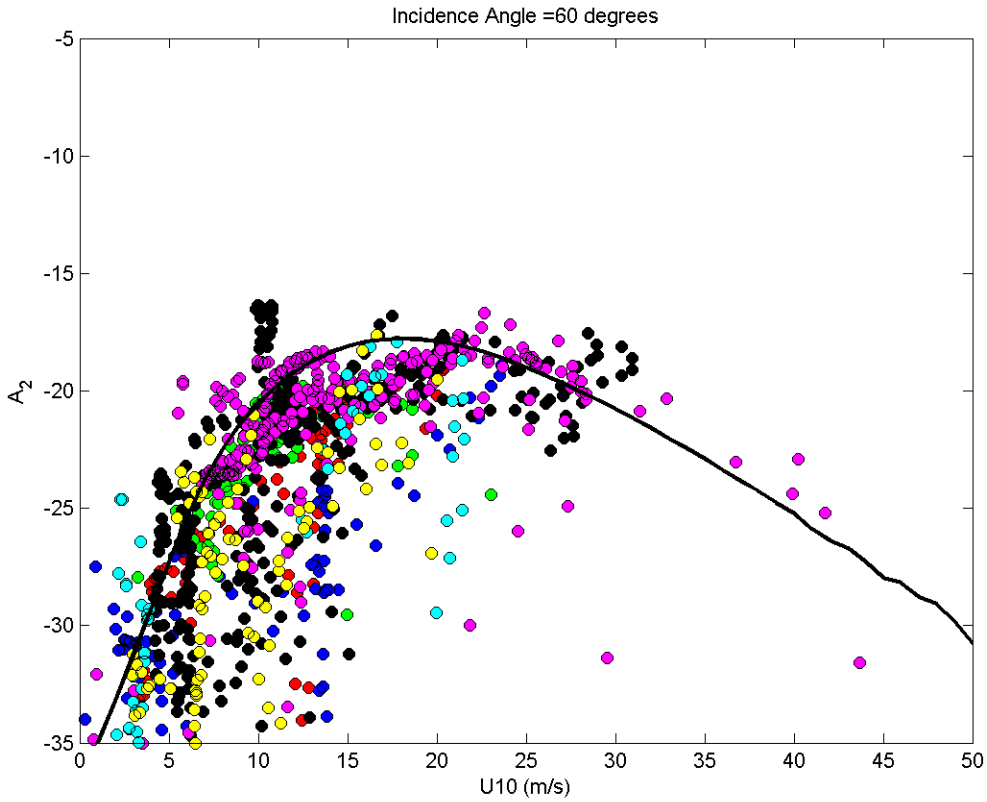
$$\sigma_0 = A_0(w) + A_1(w)\cos(\phi_w - \phi_1) + A_2(w)\cos 2(\phi_w - \phi_1)$$



- The A2 coefficients appear to saturate and reduce at about 20 m/s.
- The noise should be primarily due to the inaccuracies of Hwind direction and time separation.

ASCAT A2 vs Wind Speed at 60 deg Incidence Angle

$$\sigma_0 = A_0(w) + A_1(w)\cos(\phi_w - \phi_1) + A_2(w)\cos 2(\phi_w - \phi_1)$$



- The A2 coefficients appear to saturate and reduce at about 20 m/s.
- The noise should be primarily due to the inaccuracies of Hwind direction and time separation.

Summary

- The addition of WindSat 10 GHz U data to QuikSCAT data provides more coherent fields, better 1st rank skill and likely more accurate wind vectors near nadir track.
  - Supports the XOVWM active/passive concept
- ASCAT C-band V-pol sigma0 show response to wind speed and direction for several tropical storms
  - Small increase of about 1.5 dB from 30 m/s to 50 m/s at 60 deg incidence angle
  - Small directional signals (~0.5 to 1 dB) at 30 m/s wind speed
  - No obvious wind direction response at above 40 m/s wind speed
    - Probably need to augment DFS with X-band polarimetric radiometer to assist wind direction retrieval
  - ASCAT Sigma0s generally lower than CMOD5 at above15 m/s wind speed.
    - What causes the discrepancy: Model function, HWind and/or rain?
    - What is the significance the outliers at 45 and 50 deg incidence angles

Aquarius Instrument for Ocean Surface Salinity

- Aquarius instrument: L-band high precision radiometer and radar has been fully integrated.