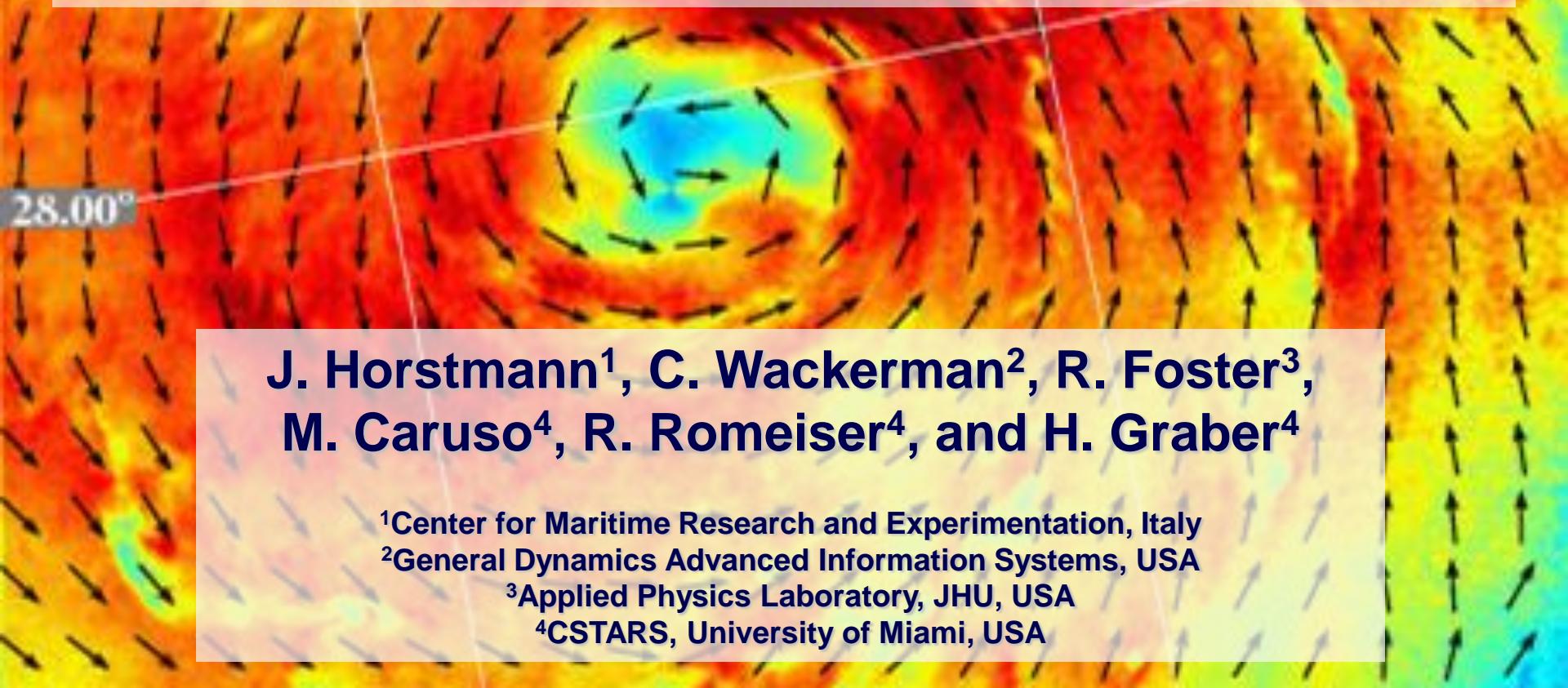


Estimating Winds from Synthetic Aperture Radar in Typhoon Conditions

funded by ONR DRI 32 ITOP,
Impacts of Typhoons on the Ocean in the Pacific



J. Horstmann¹, C. Wackerman², R. Foster³,
M. Caruso⁴, R. Romeiser⁴, and H. Graber⁴

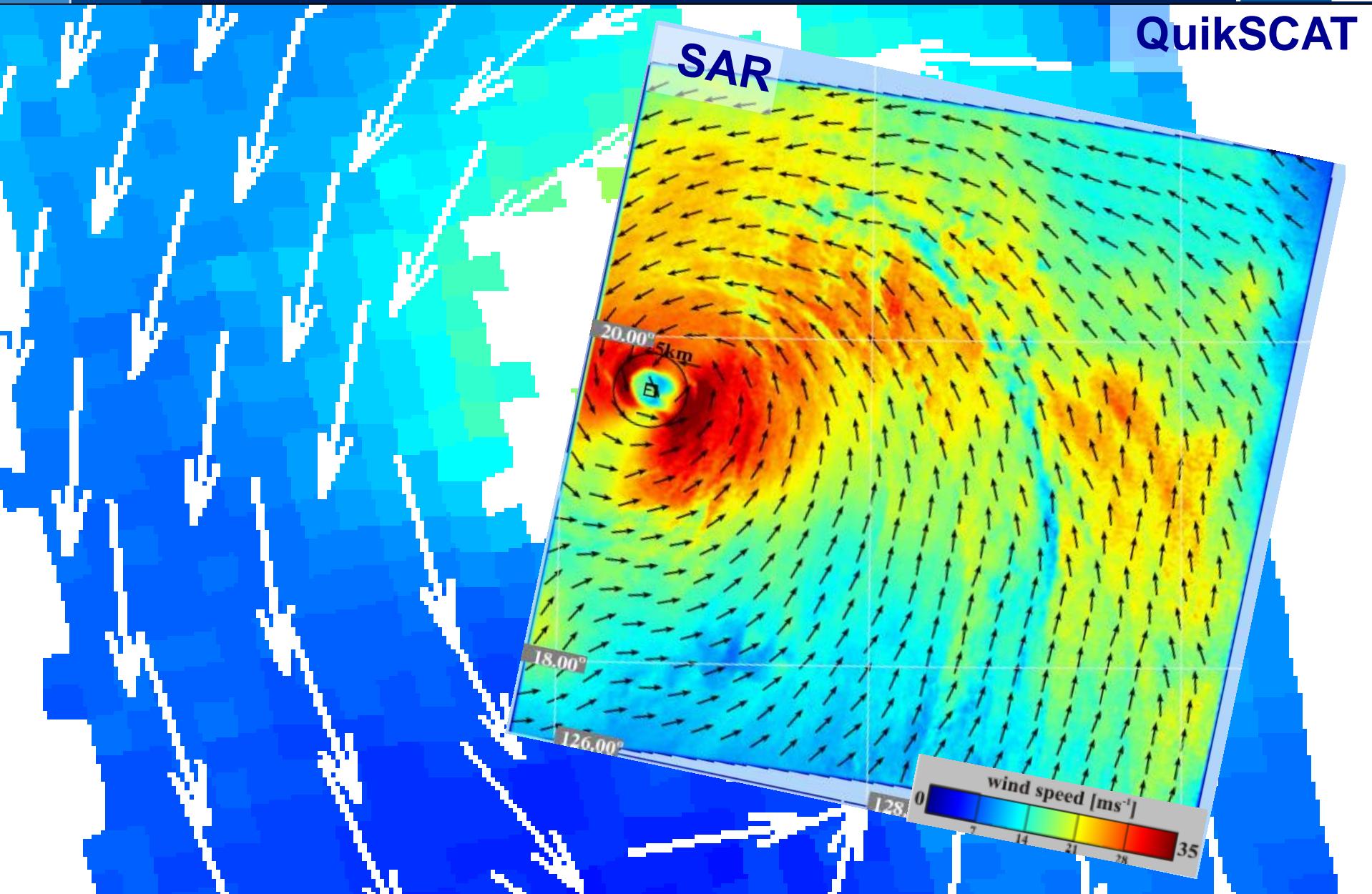
¹Center for Maritime Research and Experimentation, Italy

²General Dynamics Advanced Information Systems, USA

³Applied Physics Laboratory, JHU, USA

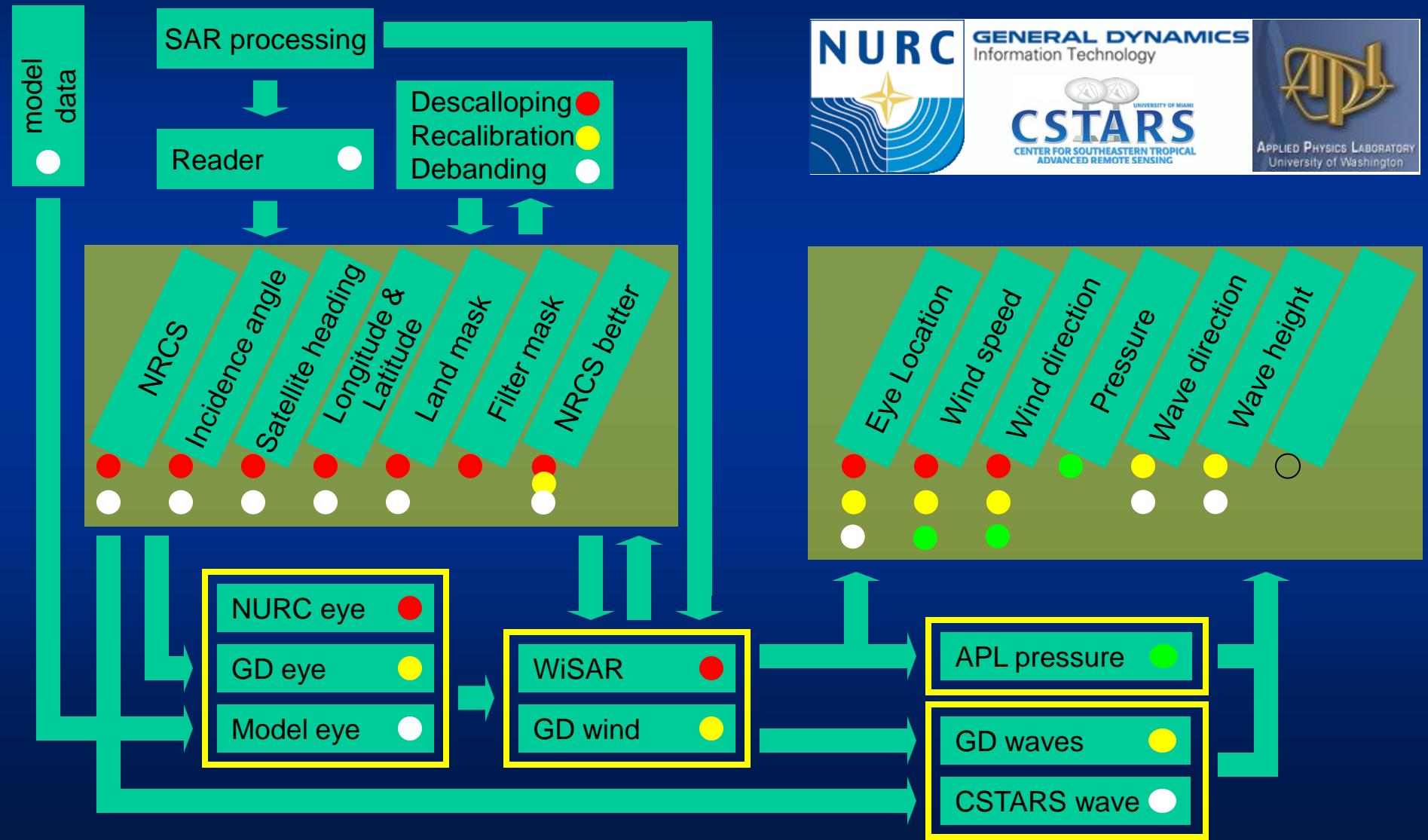
⁴CSTARS, University of Miami, USA

Why SAR for Tropical Cyclones





SAR Typhoon Processing System within the ITOP Project of ONR





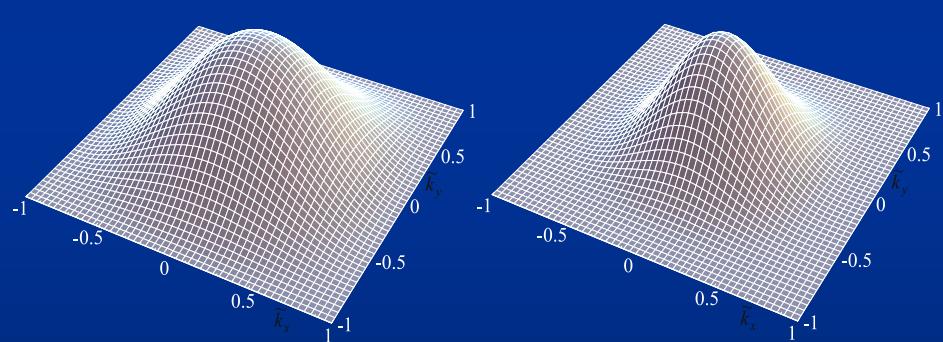
General Approach for Ocean SAR Wind Field Retrieval (WiSAR)

Local Gradient Method

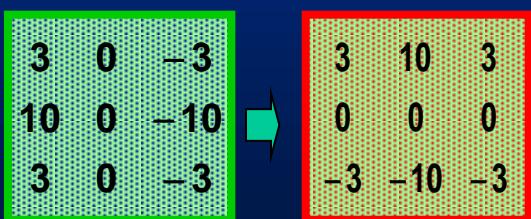


Binomial filter

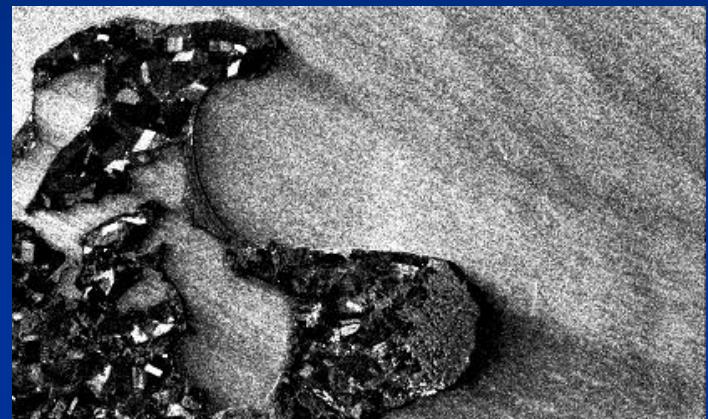
2 dim. B^2 Filter



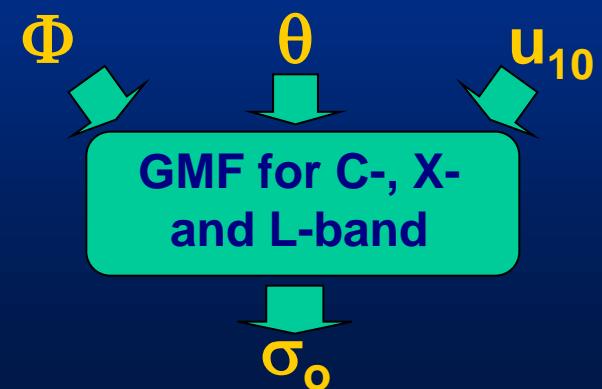
Optimized Sobel-Filter



Geophysical Model Function



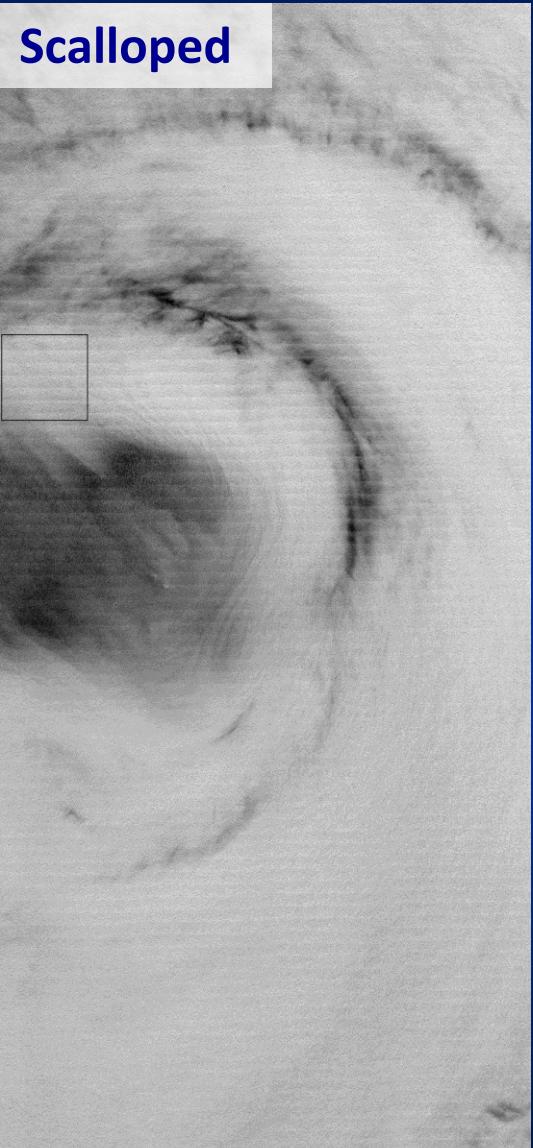
$$\sigma_0^{pol} = a(\theta)u^{\gamma(\theta)}[1 + b(\theta)\cos\phi + c(\theta)\cos(2\phi)]$$



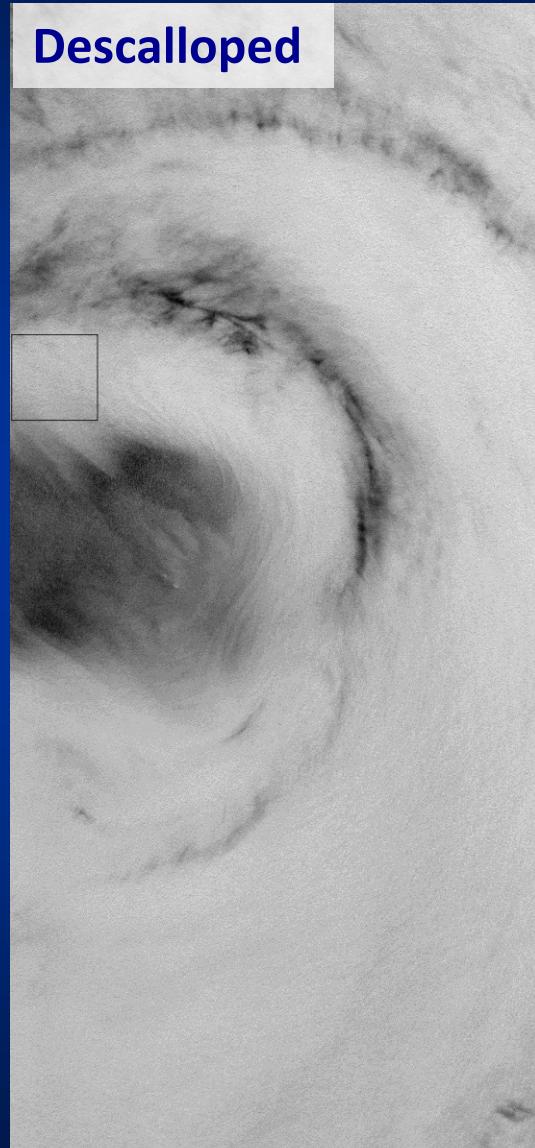


Removal of Scalloping

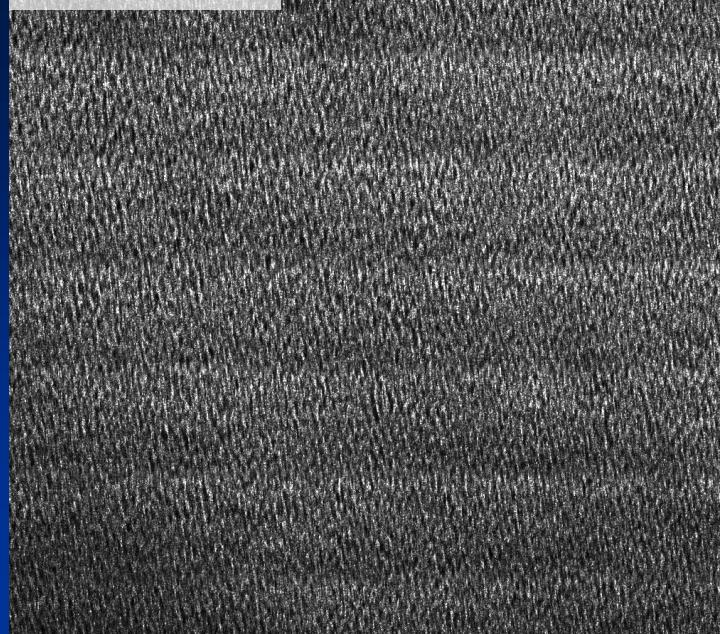
Scalloped



Descalloped



Scalloped

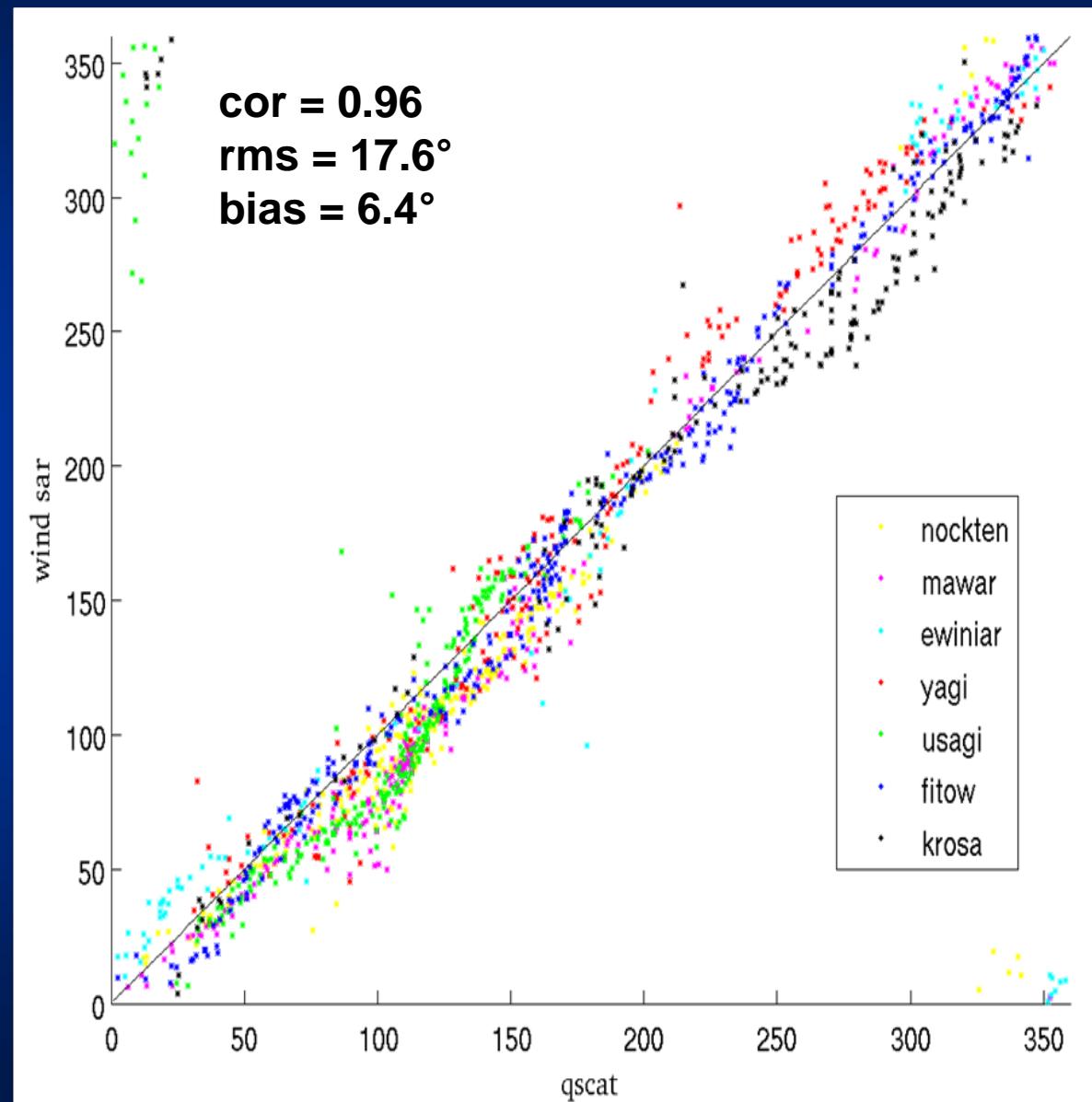
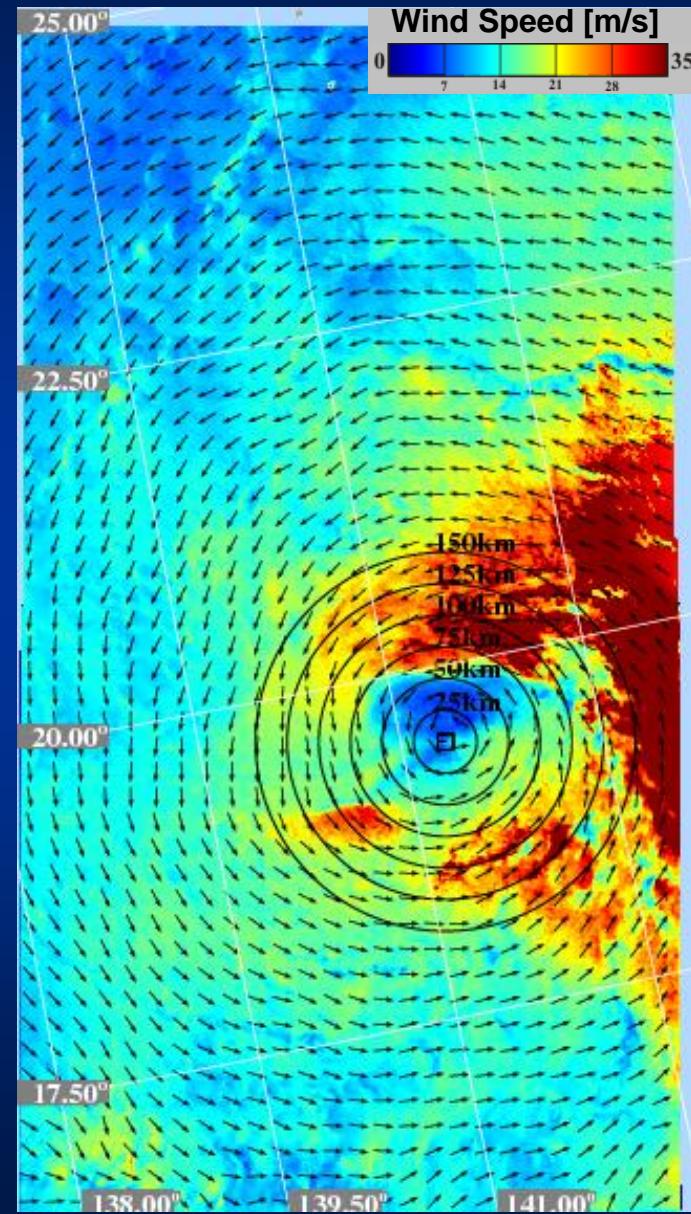


Descalloped



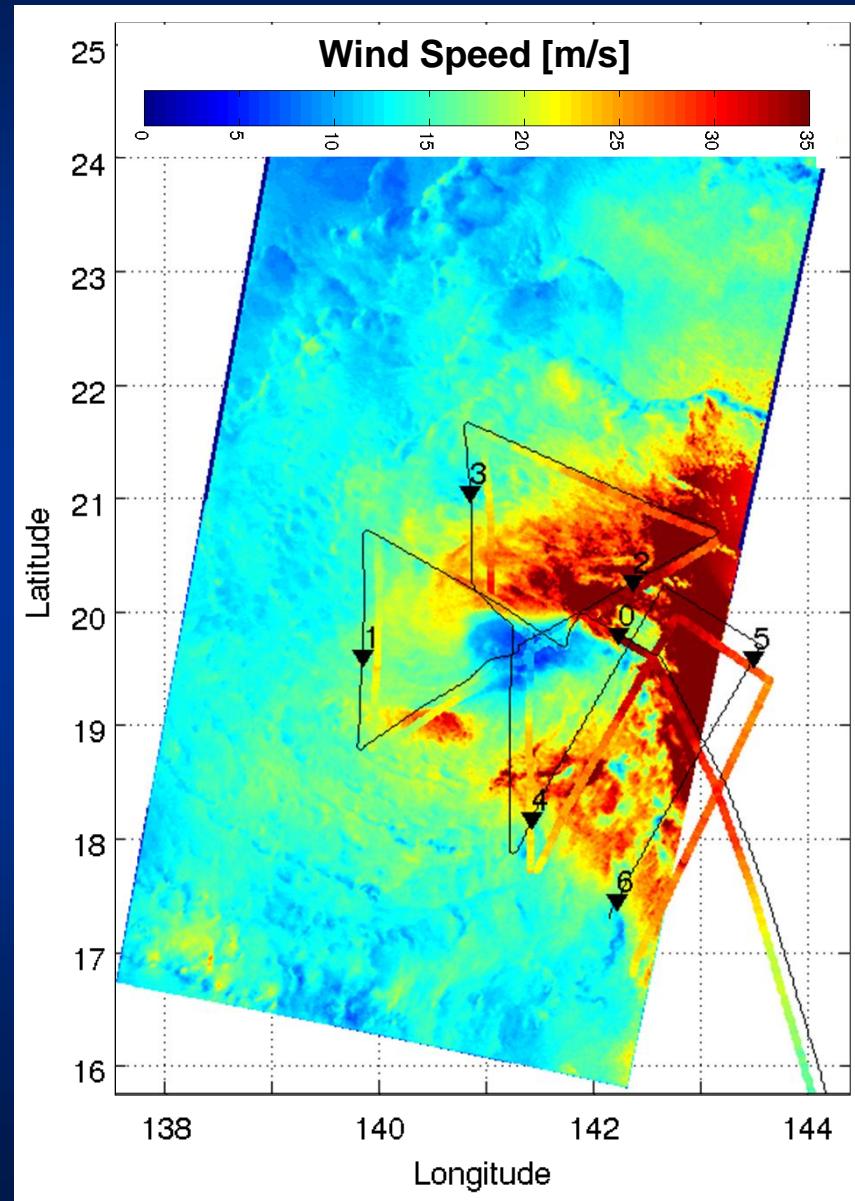
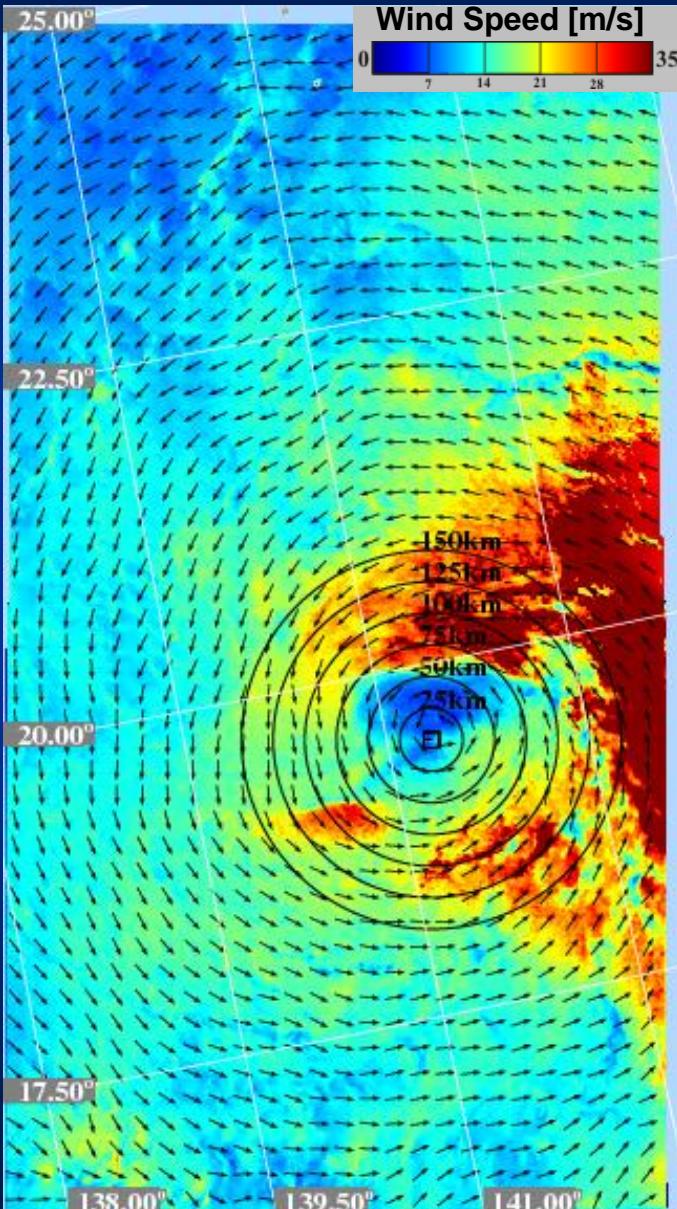


SAR-Retrieved Wind Field and Comparison to QuikScat data



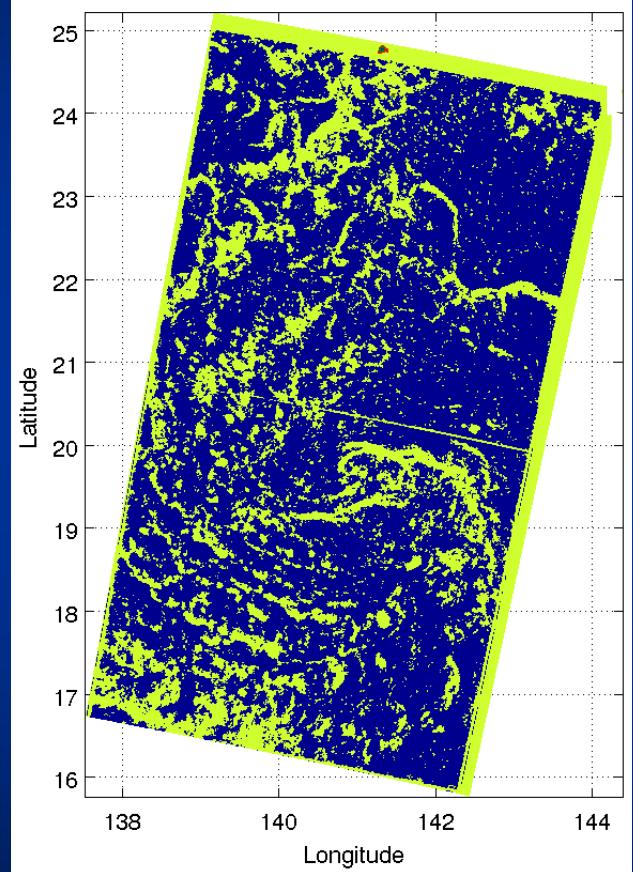


SAR-Retrieved Wind Field and Comparison to SFMR data

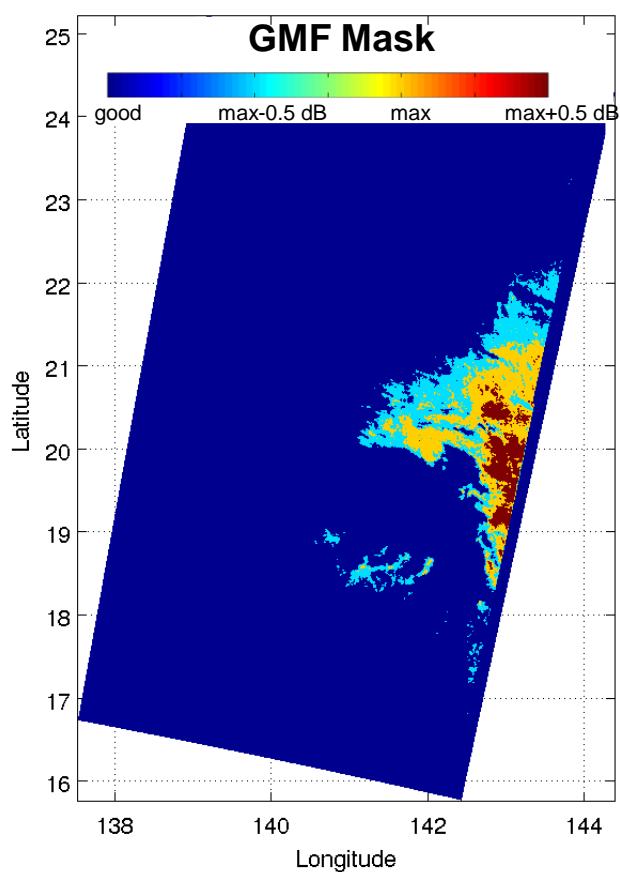




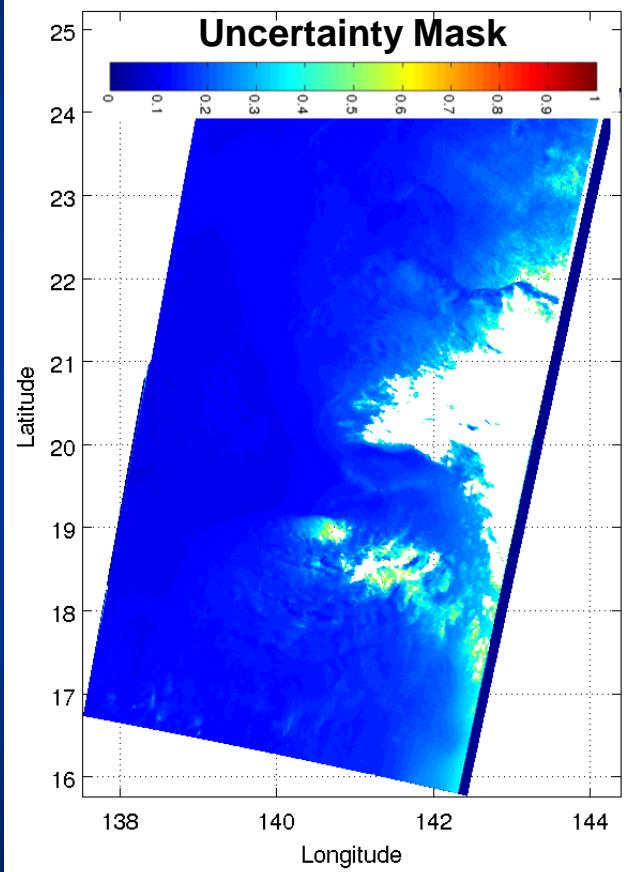
Estimation of Wind Field Uncertainties and GMF Limitations



SAR wind field



Limitation of GMF
definition



Wind speed
uncertainty



Noise Correction of Radarsat-2 Cross Pol NRCS

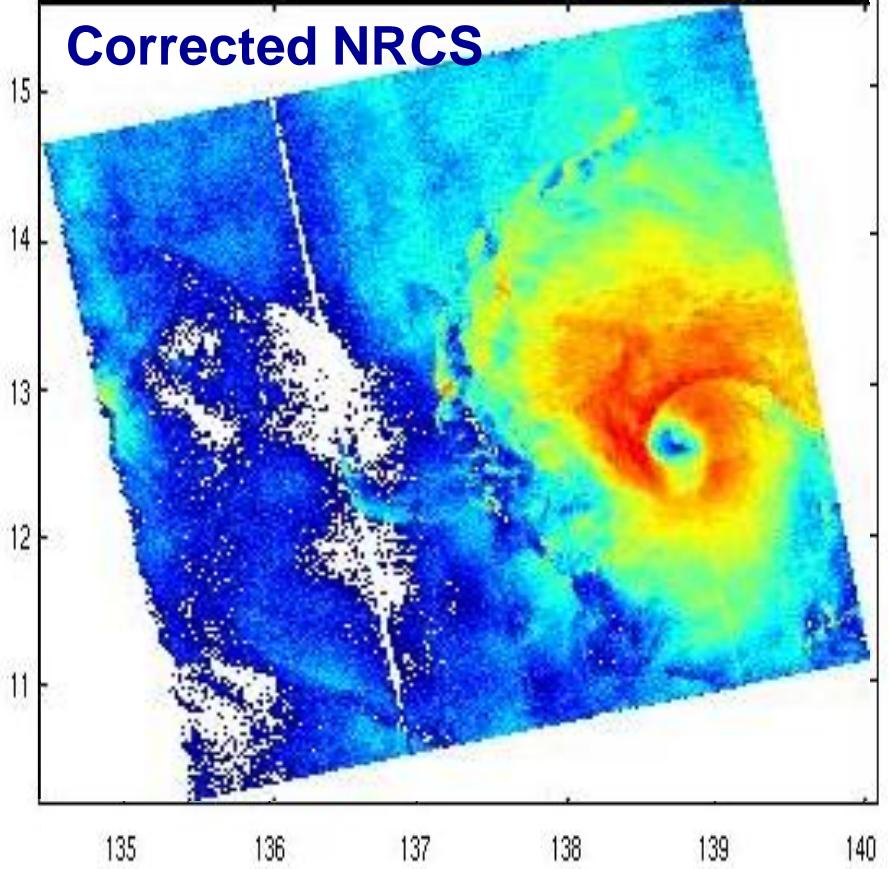
S&T
organization
CMRE

NRCS [dB]

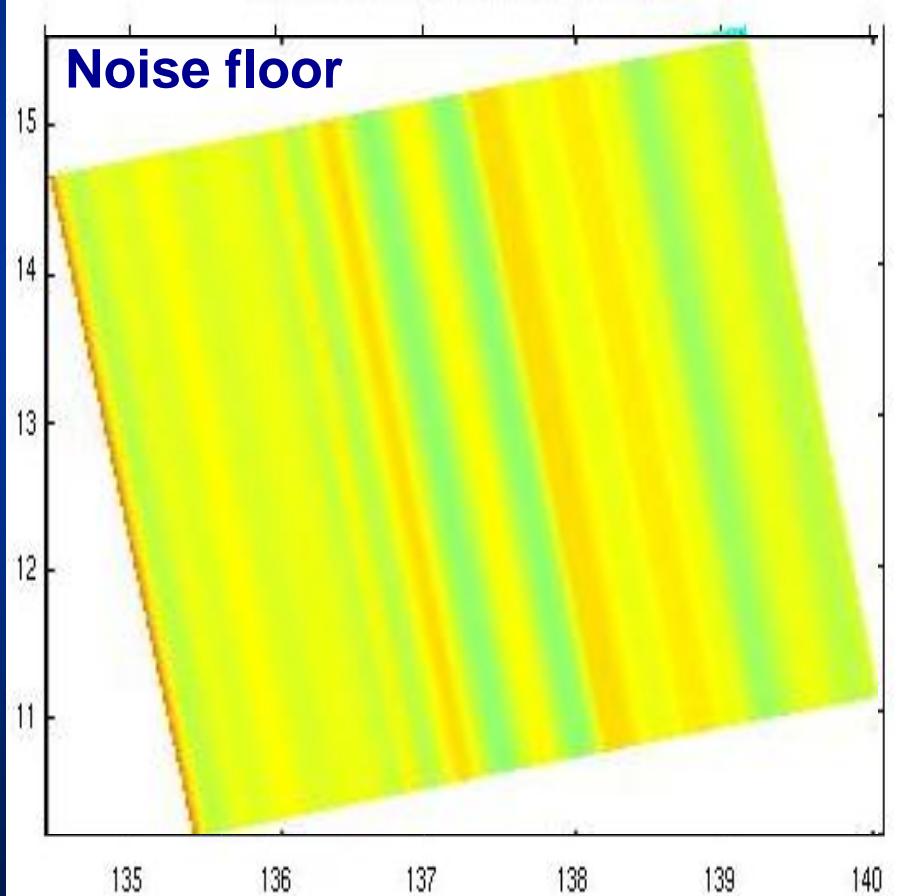
-40 -20

Radarsat-2 HV image of
Typhoon Megi 17. Sep 2010

Corrected NRCS

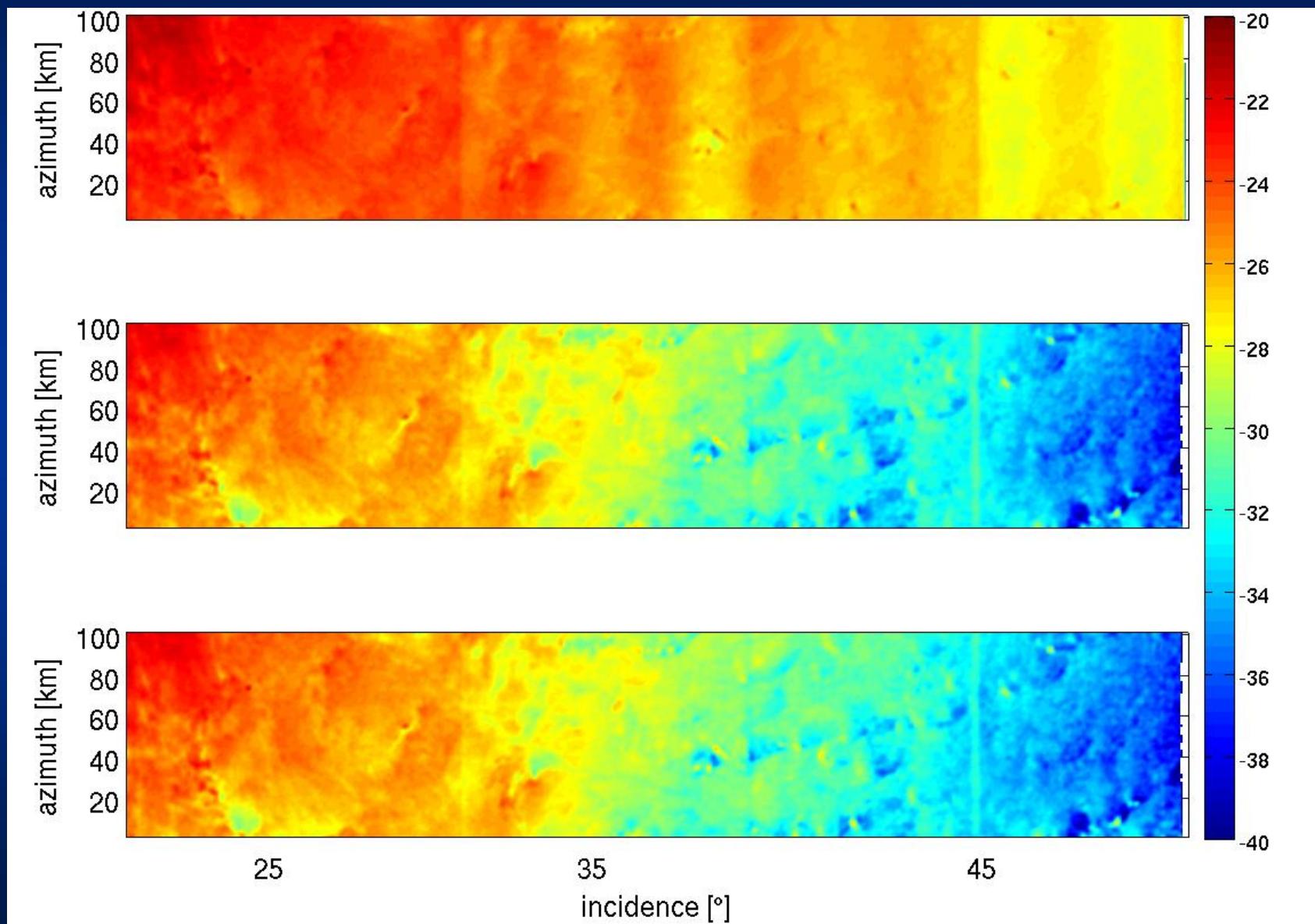


Noise floor



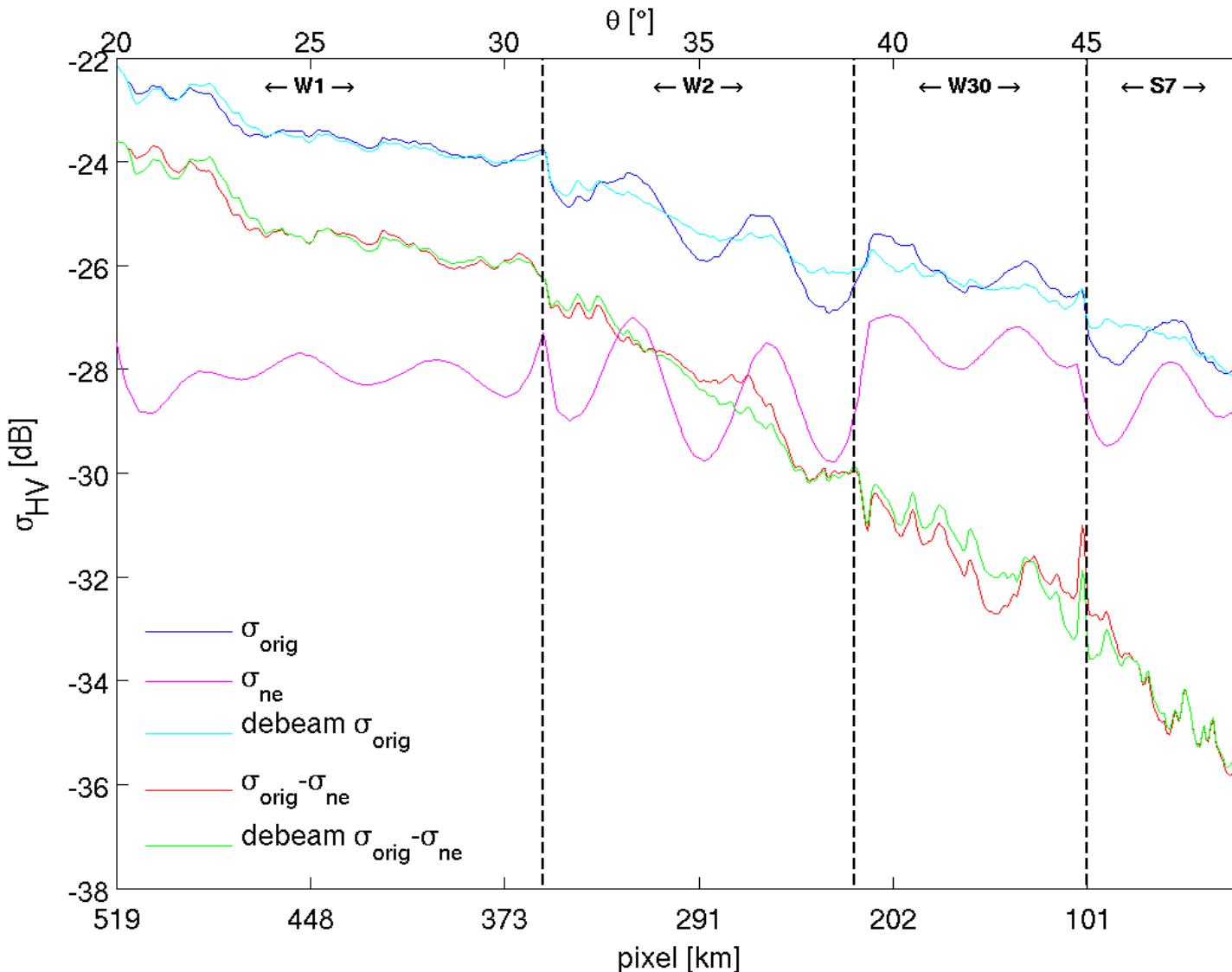


Noise Correction of Radarsat-2 Cross Pol NRCS



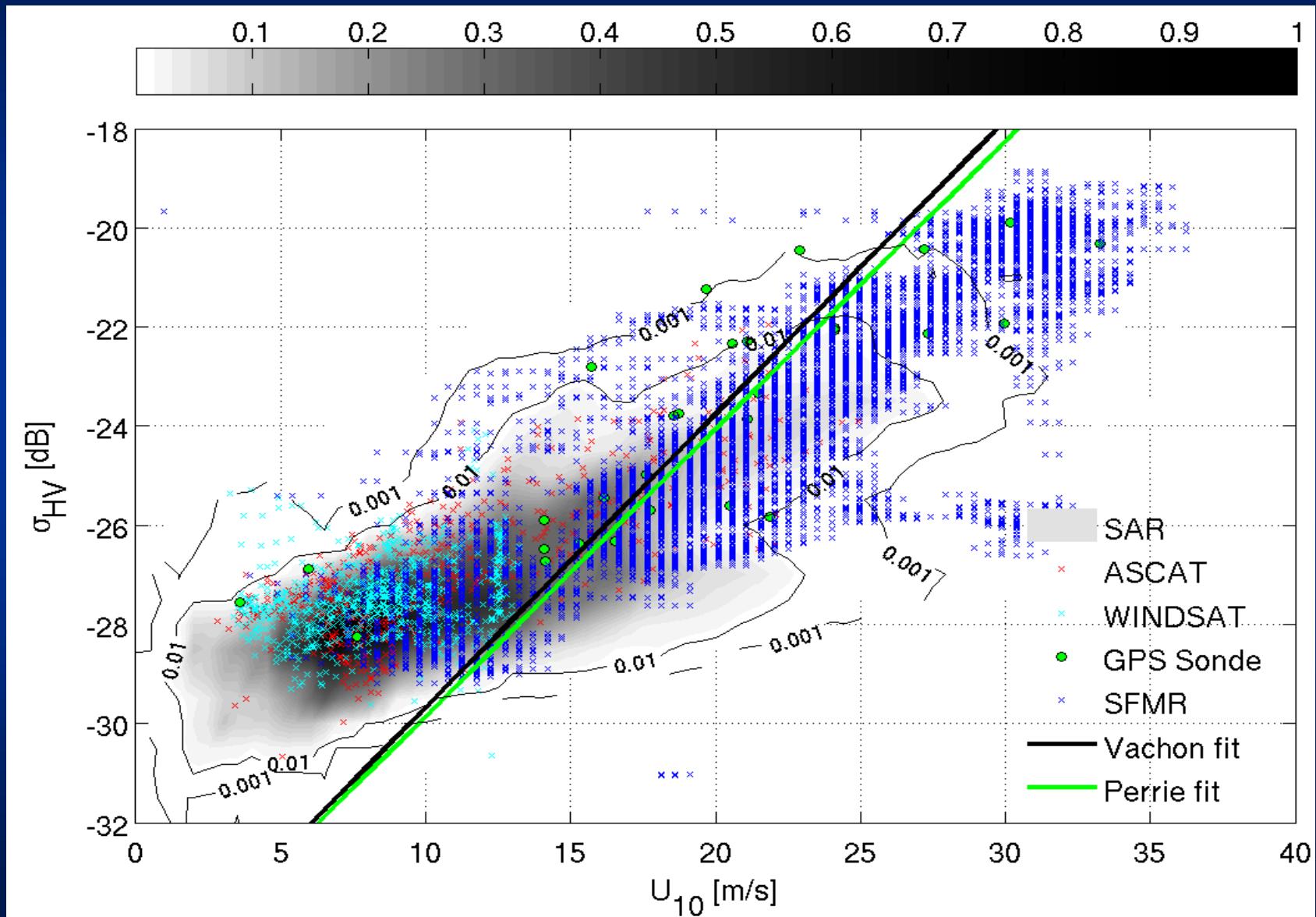


Noise Correction of Radarsat-2 Cross Pol NRCS



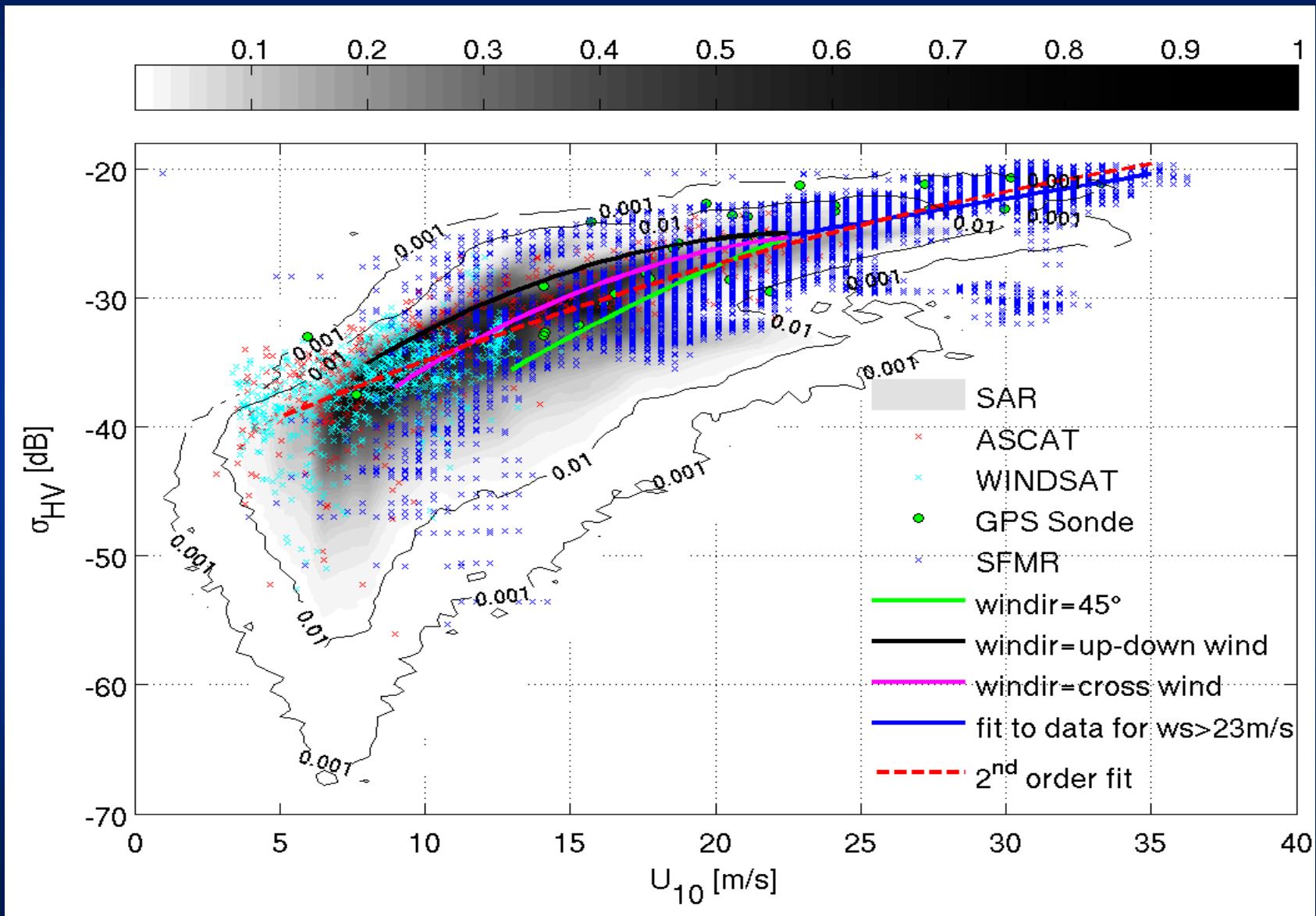


Dependence of NRCS on Wind Speed (Including Noise Floor)



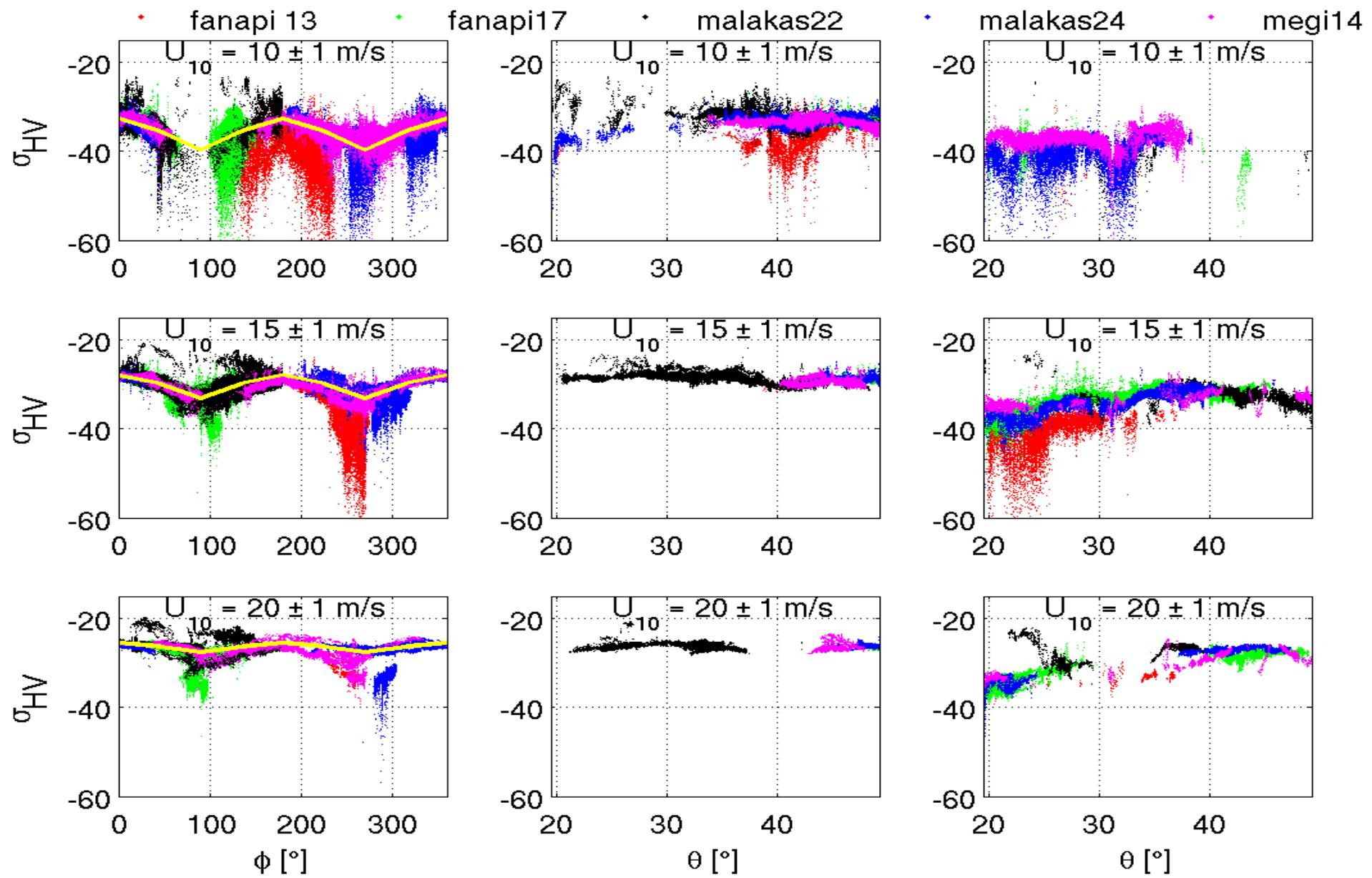


Dependence of NRCS on Wind Speed (Noise Floor removed)

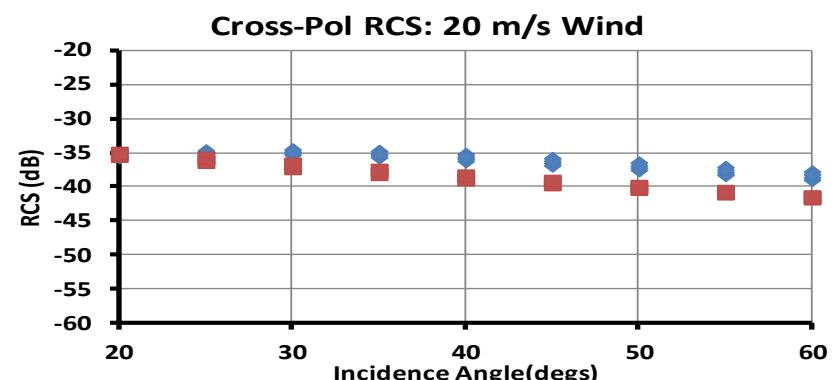
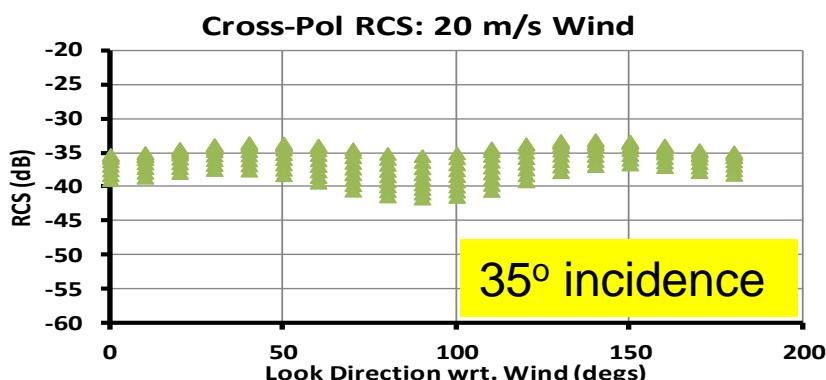
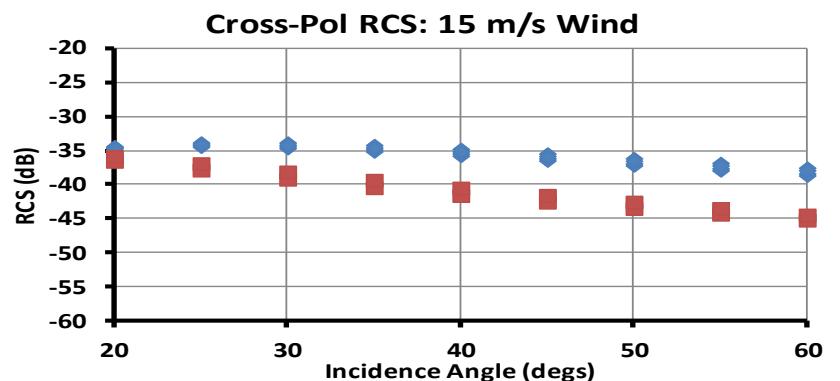
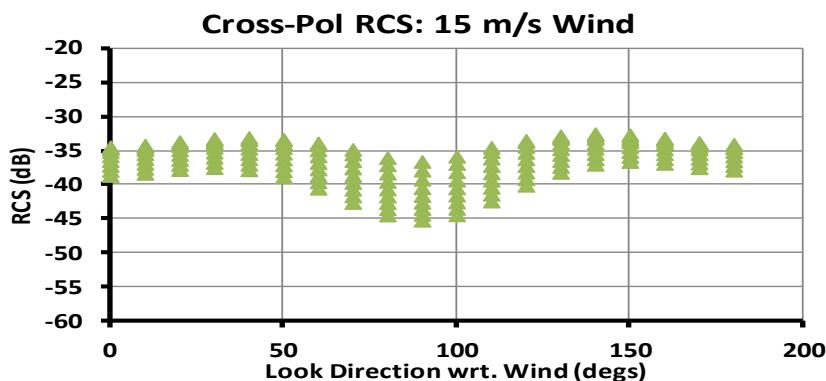
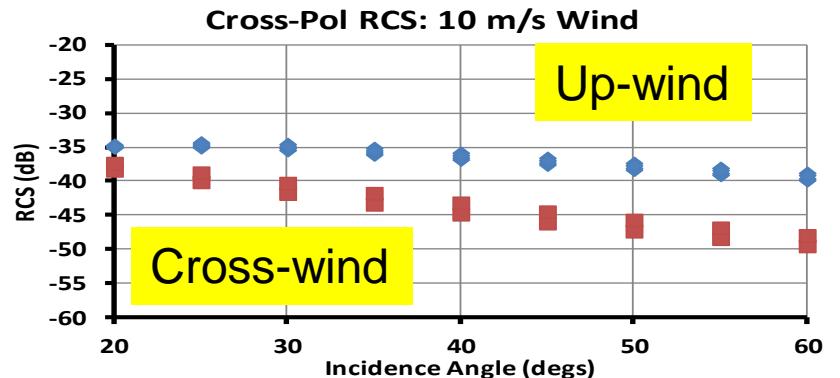
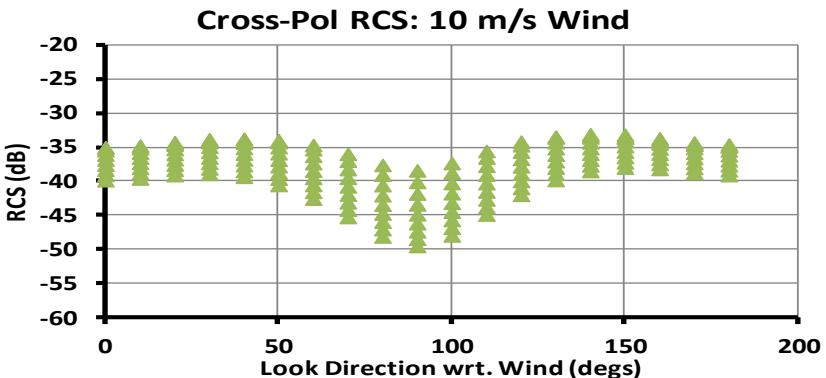




Additional Dependencies of Cross-pol NRCS

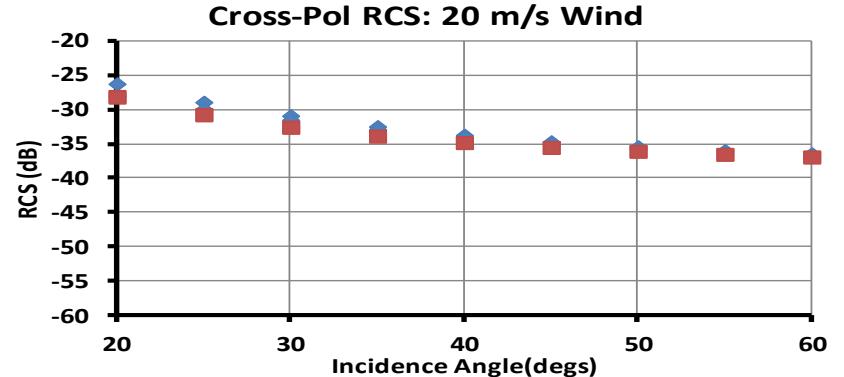
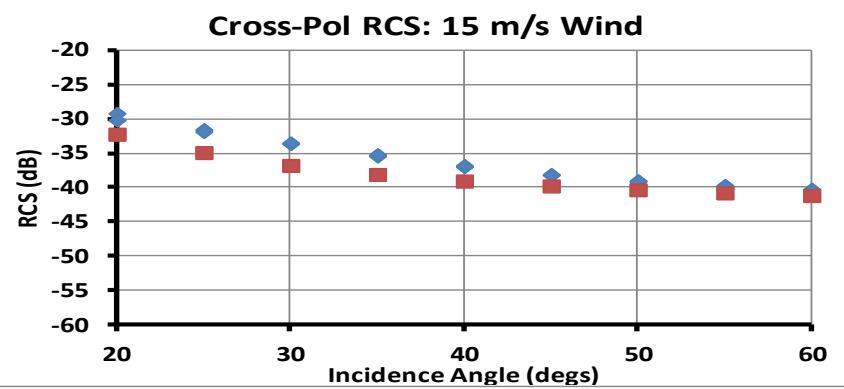
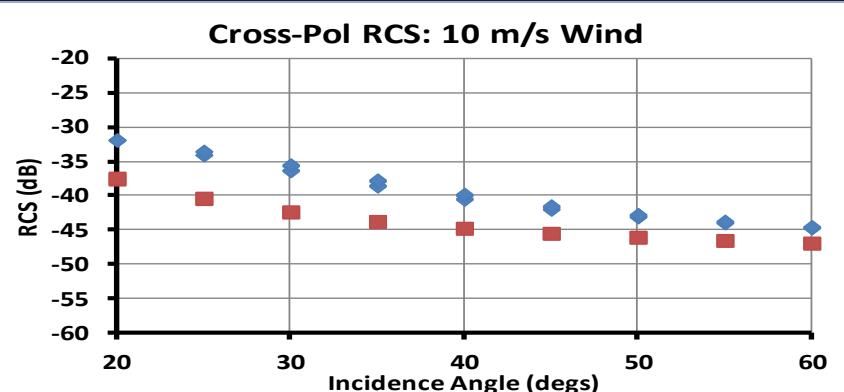
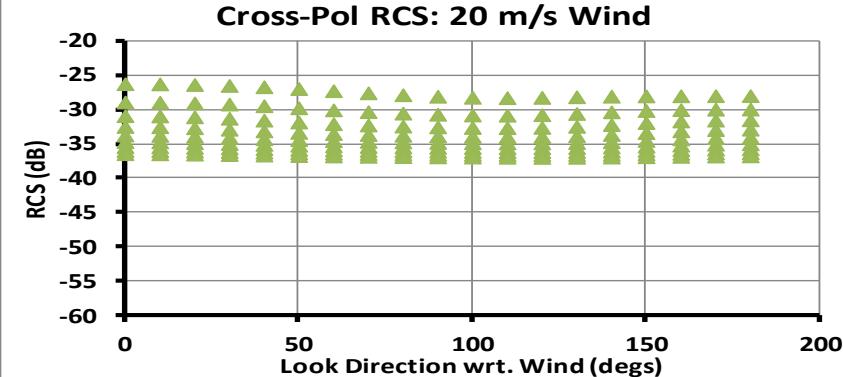
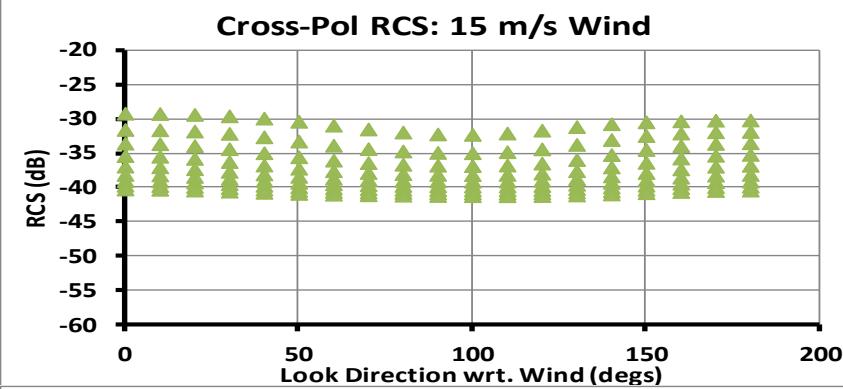
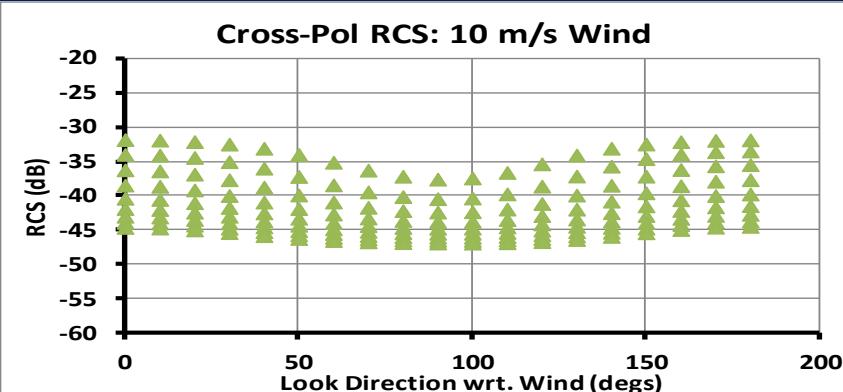


Modelling of the NRCS Excluding Cross Talk



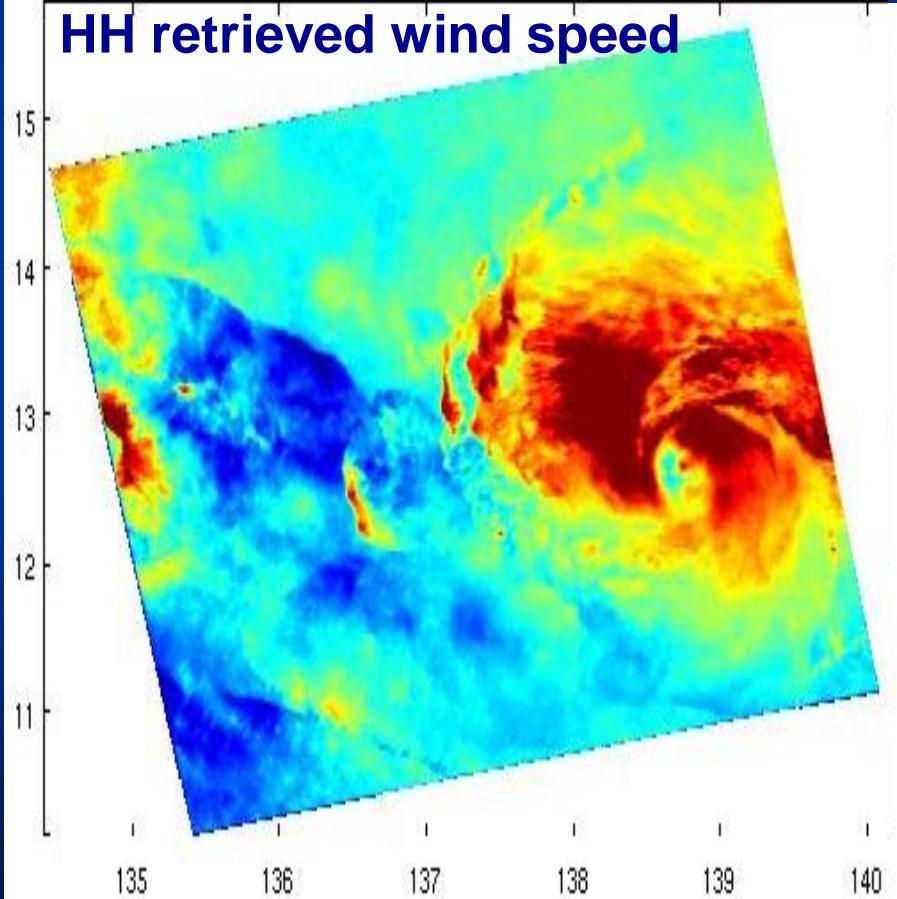
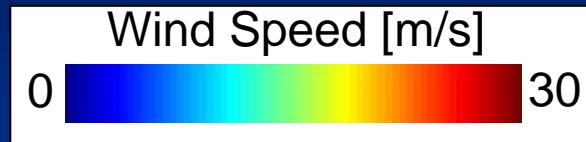


Modelling of the NRCS Including Cross Talk (-32 dB Isolation)

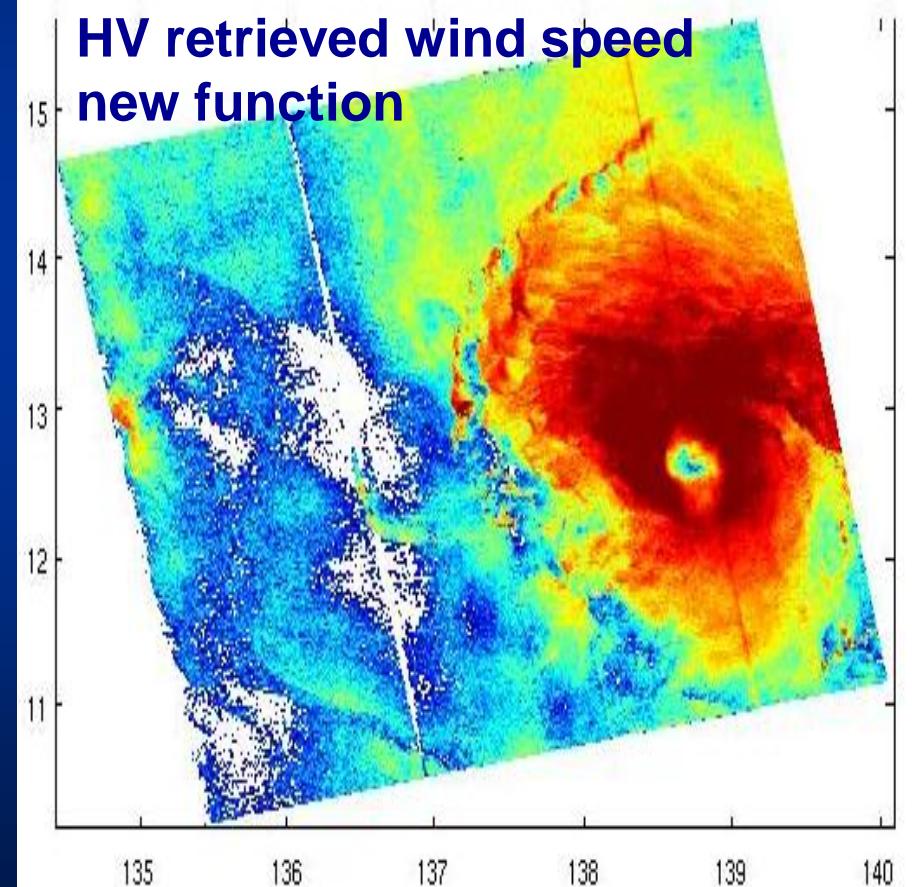




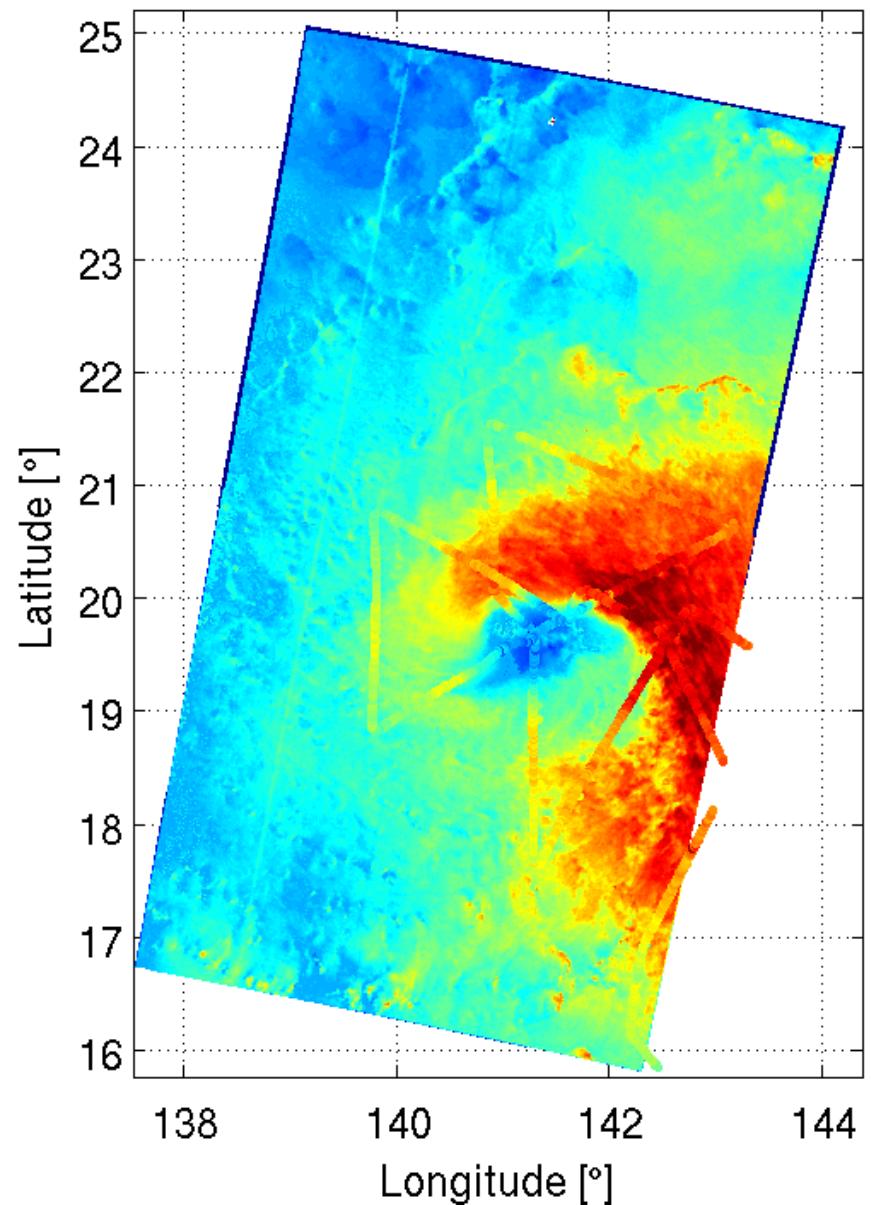
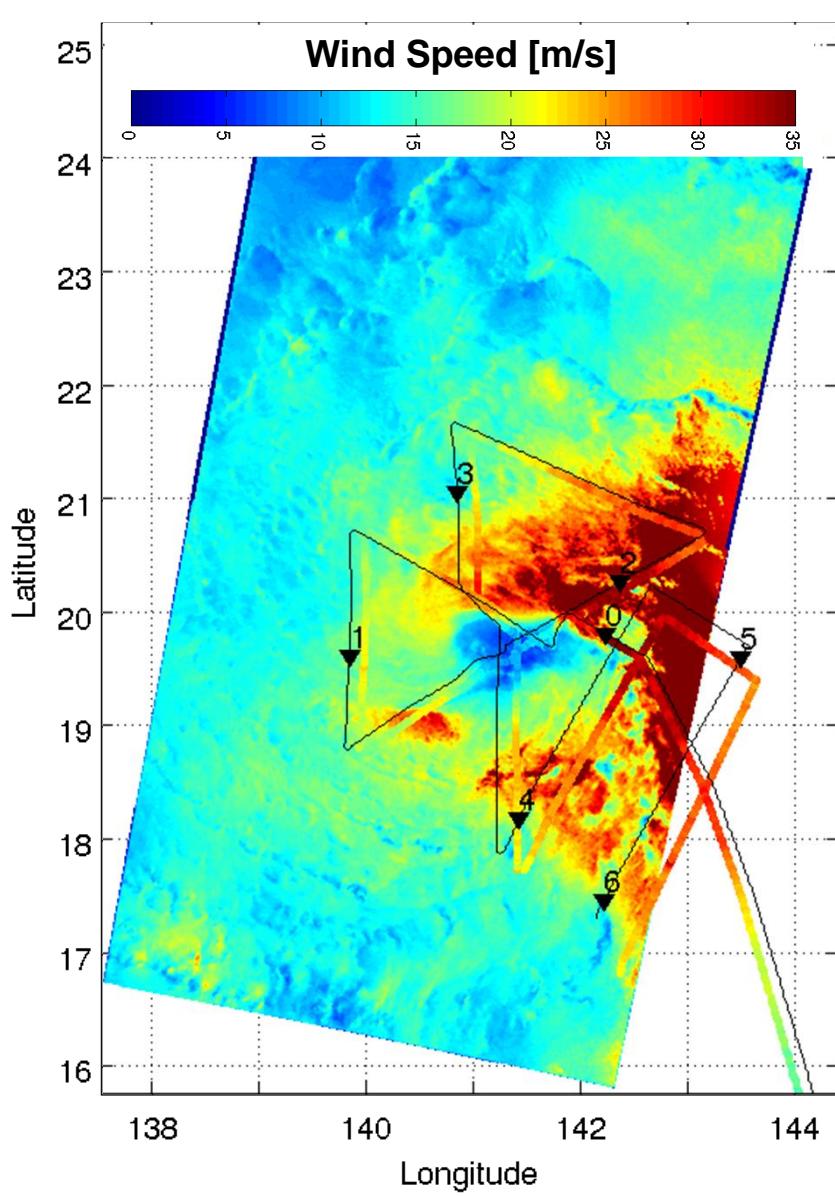
Radarsat-2 Crosspol (HV) Retrieved Wind Speeds



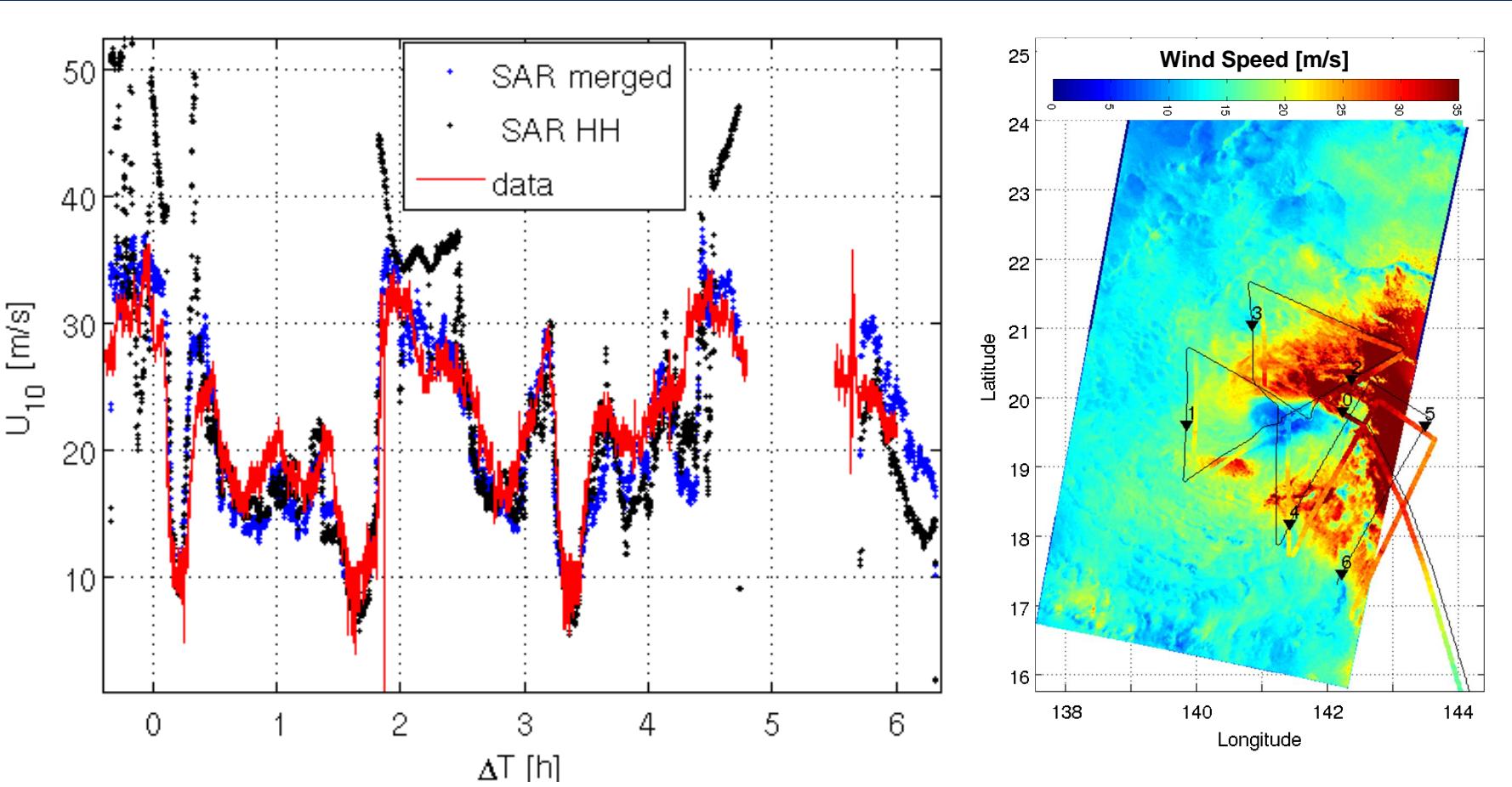
Radarsat-2 HV image of
Typhoon Megi 17. Sep 2010



Comparison of Co-pol and Cross-pol Retrieved Wind Speeds to SFMR data

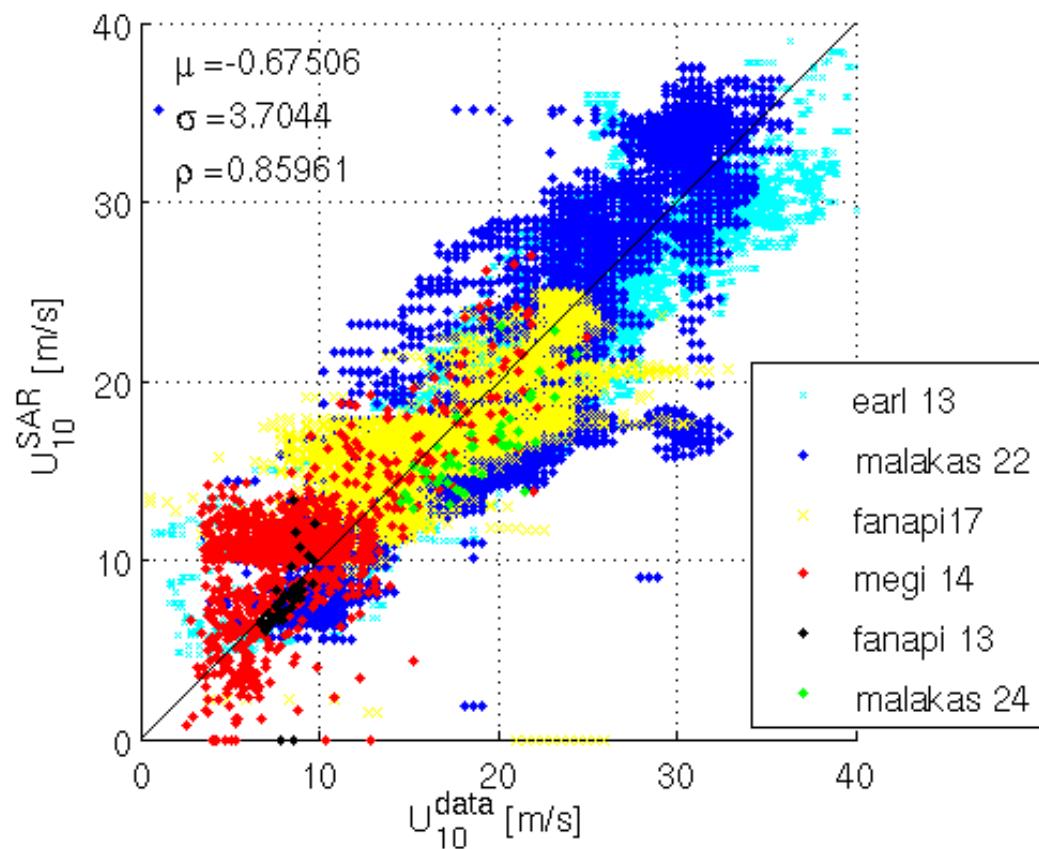


Comparison of Co-pol and Cross-pol Retrieved Wind Speeds to SFMR data



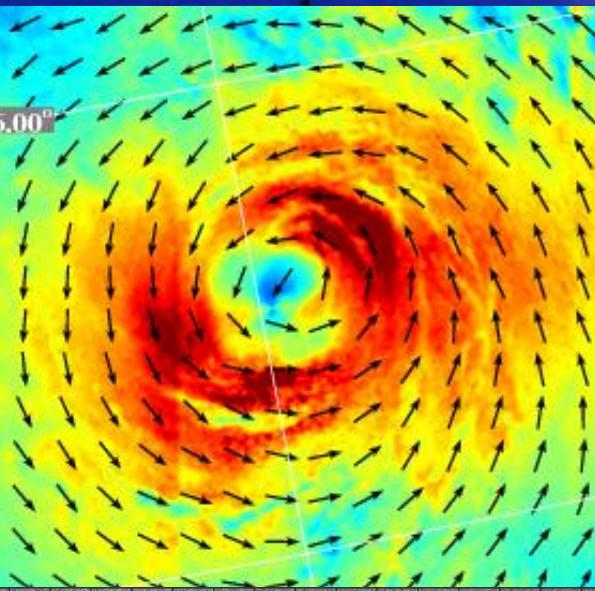


Comparison of Co-pol and Cross-pol Retrieved Wind Speeds to SFMR data

GMF	Bias [m]	Standard Deviation [m]	Correlation
Co pol GMF	0.4	6.42	0.75
HV GMF	0.11	3.75	0.83
HV GMF wind direction dependent	-0.69	3.79	0.85
VH GMF	-1.48	3.22	0.8

Summary & Outlook



SAR wind directions from orientation of linear features (rms of 18°, lack of inflow)

Filters have been developed to flag:

- non wind induced areas
- areas with uncertain wind speeds

C-band cross pol GMF developed (better for high wind speeds)

Investigation of cross pol with respect to wind direction and incidence angle

Merging of co-pol and cros pol retrieved winds

