Sar Uncertainty Estimates and its Application to Tropical Cyclone Wind Retrieval

Silvia Falchetti[1, 2]
Jochen Horstmann[1]
Ralph Foster[3]
Jerome Patoux[4]

1) NATO Undersea Research Center, Italy
2) ITT Visual Information Solutions
3) Applied Physics Laboratory, University of Washington
4) University of Washington

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General Approach for Ocean SAR Wind Field Retrieval (WiSAR)

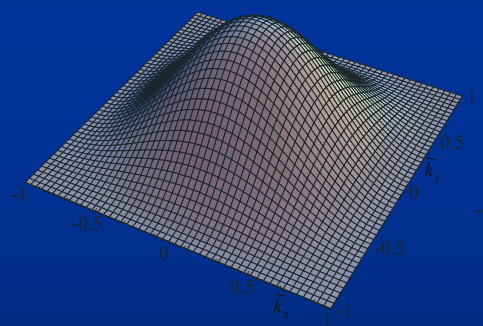
Local Gradient Method

1. Reduction of amplitude image to 100 200 and 400-m pixels by $R|_2$

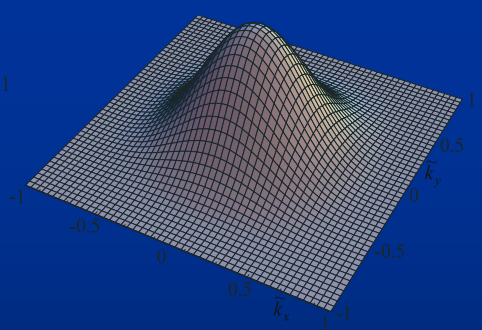
$$R|_2 = B^2 S|_2 B^4$$

where $S|_2$ is the reduction of the image at its half size

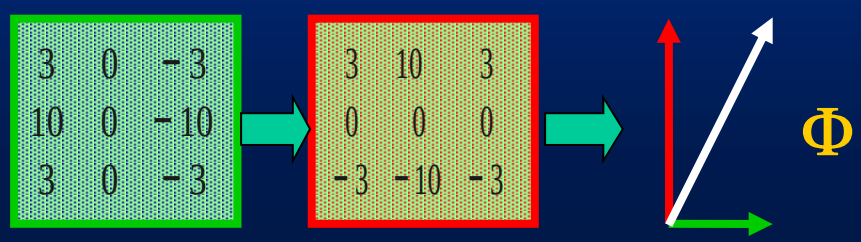
2 dim. B^2 Filter



2 dim. B^4 Filter

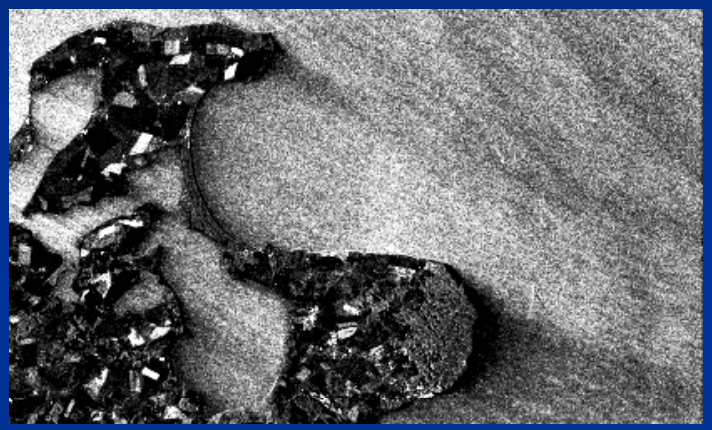


2. The component of gradients are computed with the optimized Sobel operators

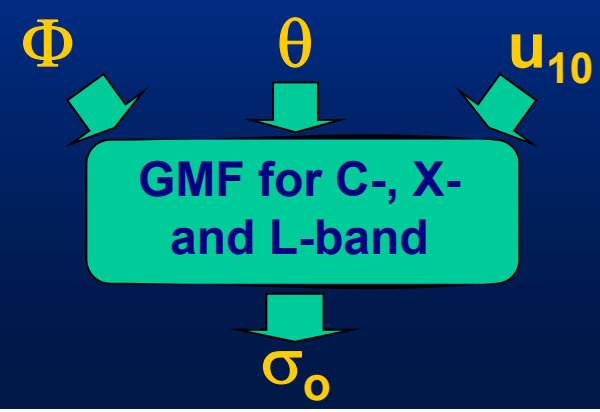


Geophysical Model Function

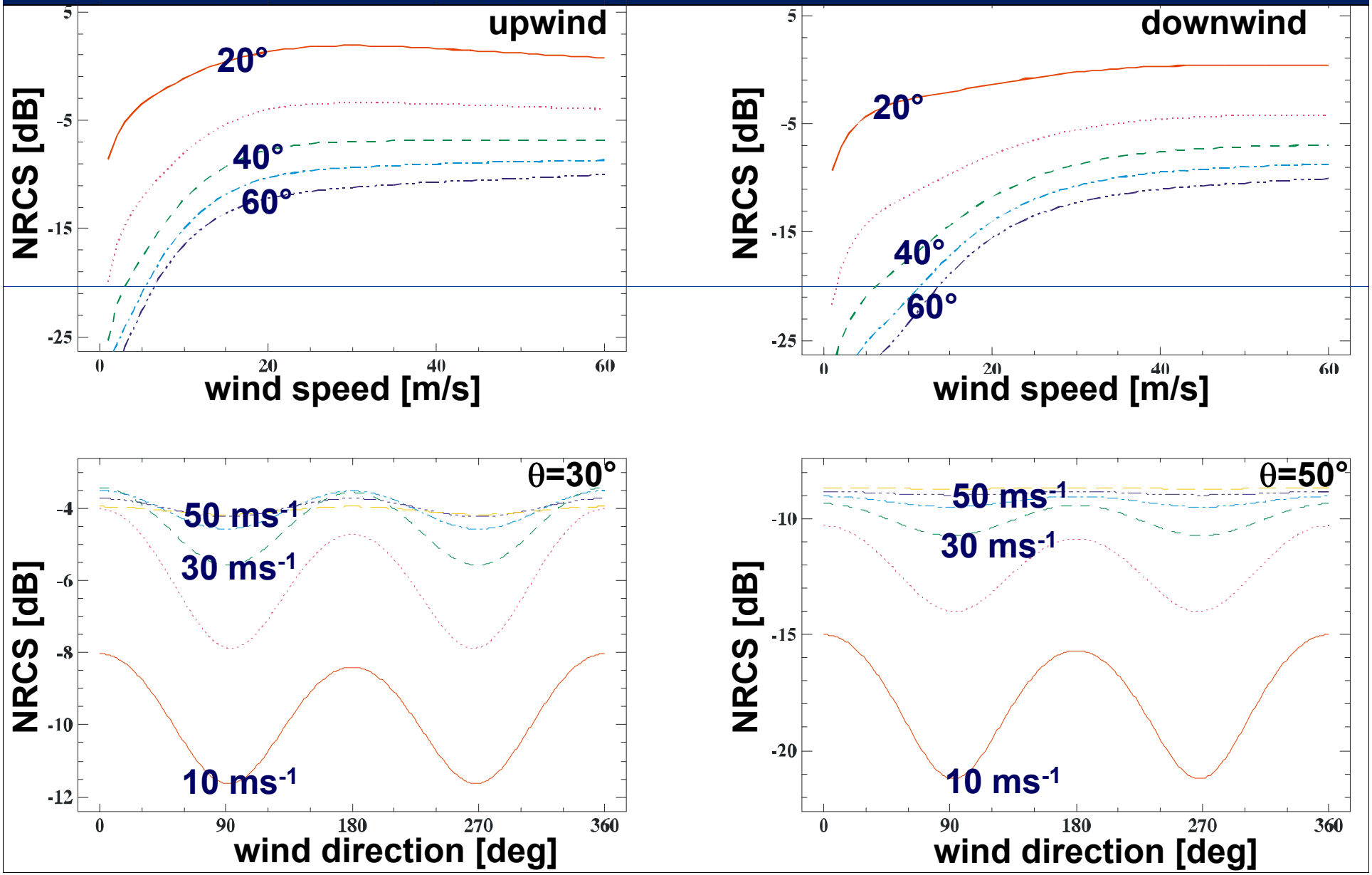
3. Wind speed retrieval



$$s_0^{pol} = a(q)u^{g(q)}\left[1 + b(q)\cos(f) + c(q)\cos(2f)\right]$$



Wind Speed Ambiguities in CMOD5



Relative error definition

$$\sigma = F(w, \phi, \theta)$$

$$w = F^{-1}(\sigma, \phi, \theta)$$

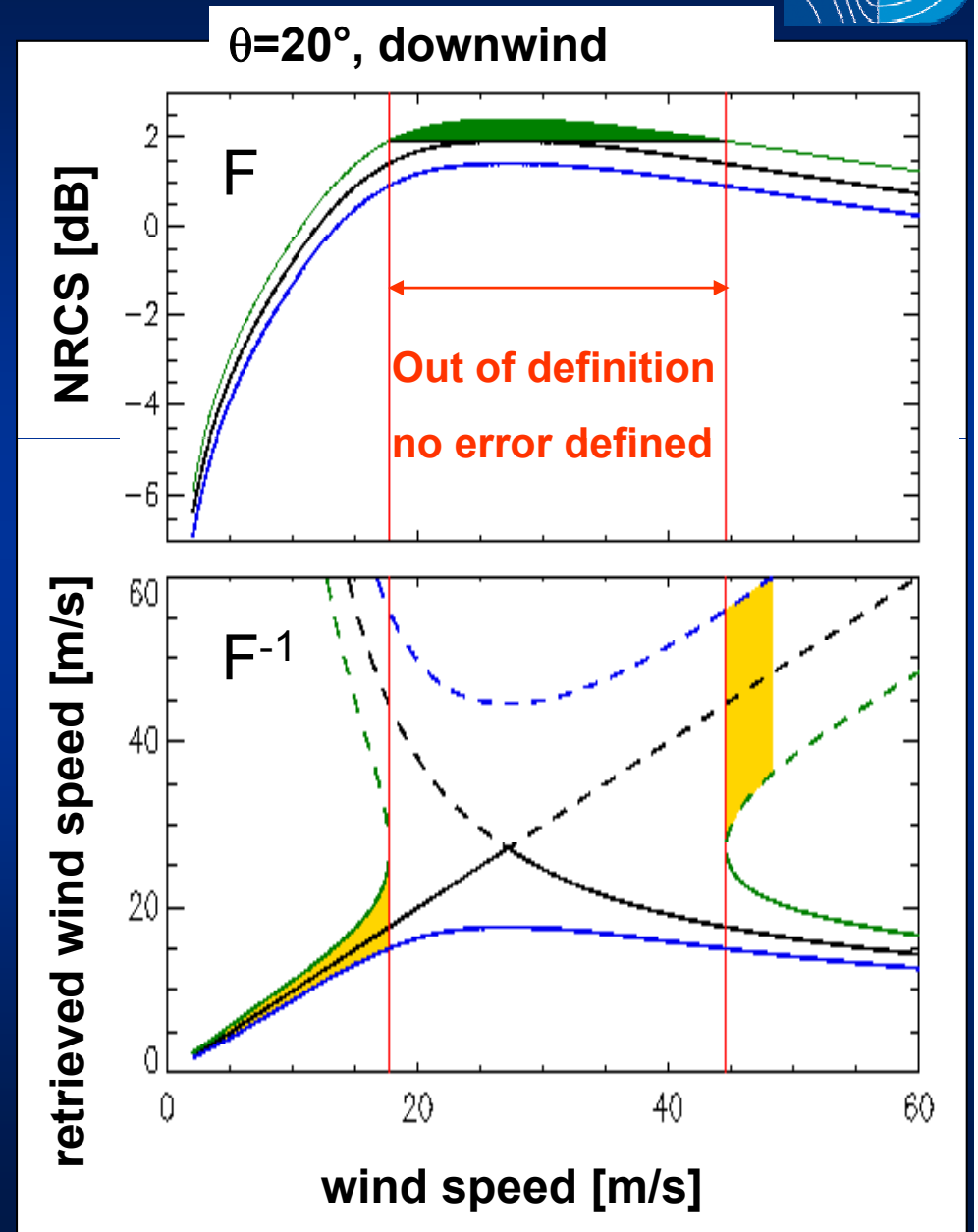
$$\tilde{w}^{\pm} = F^{-1}(\sigma \pm \Delta\sigma, \phi \pm \Delta\phi, \theta \pm \Delta\theta)$$

$$err = \frac{\left|\tilde{w}^{+} - \tilde{w}^{-}\right|}{w}$$

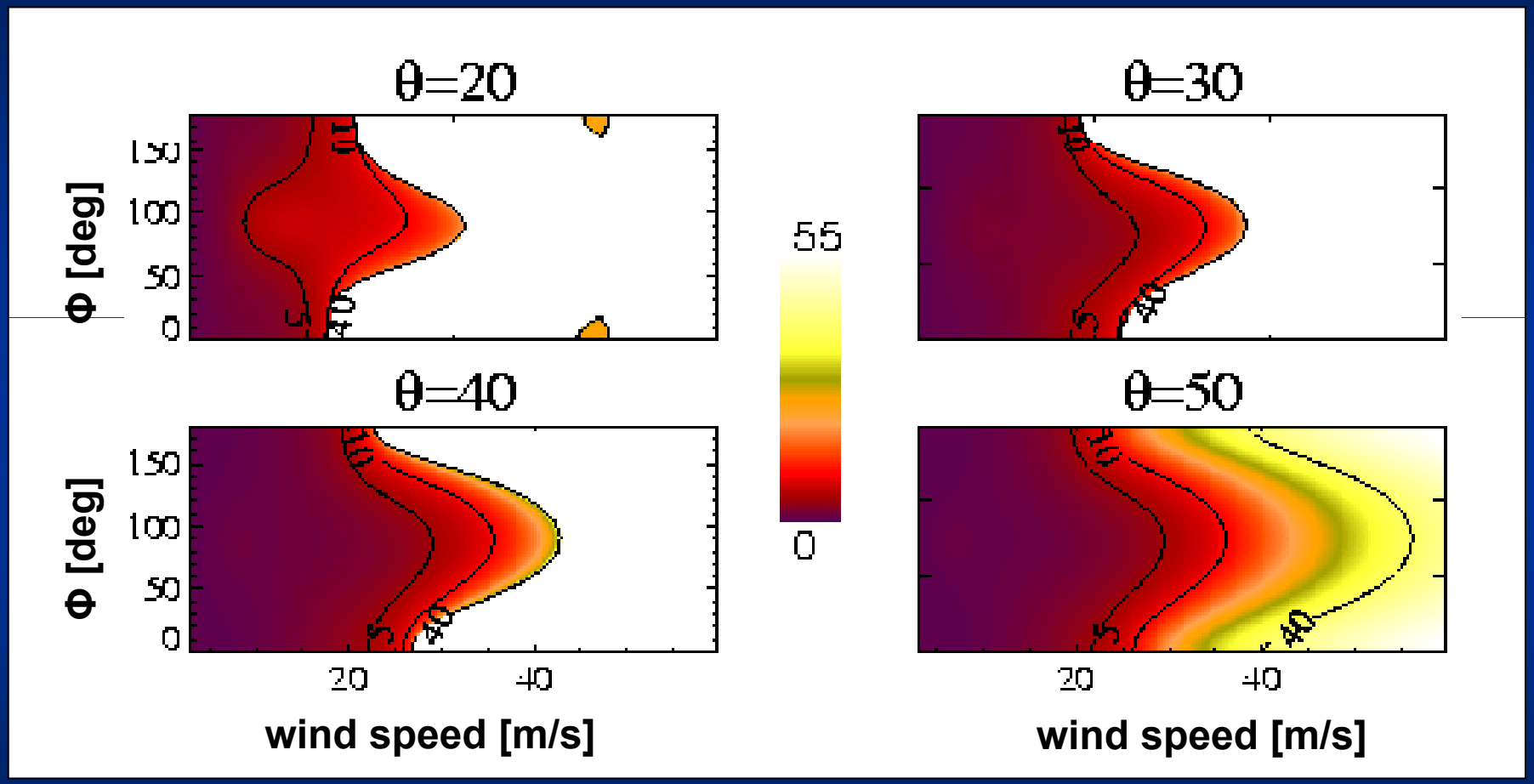
1st - 2nd sol. for σ-0.5db

1st - 2nd sol. for σ

1st - 2nd sol. for σ+0.5db



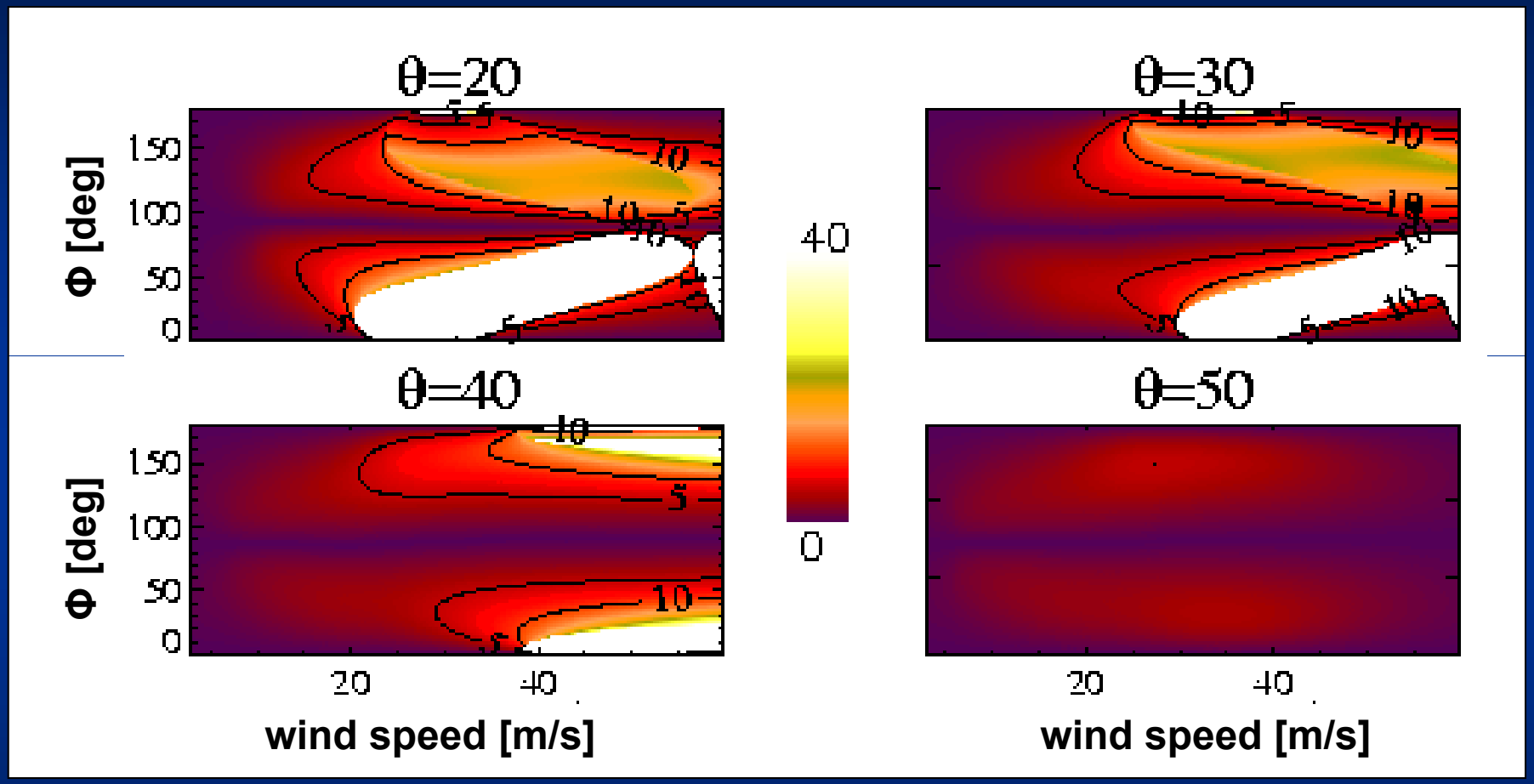
Absolute error for an uncertainty in NRCS of 0.5dB



1. The error is largest at crosswind and decreases with increasing incidence angle

2. The error is significant for wind speeds above 10m/s and low incidence angle.

Uncertainties in Φ of 10deg

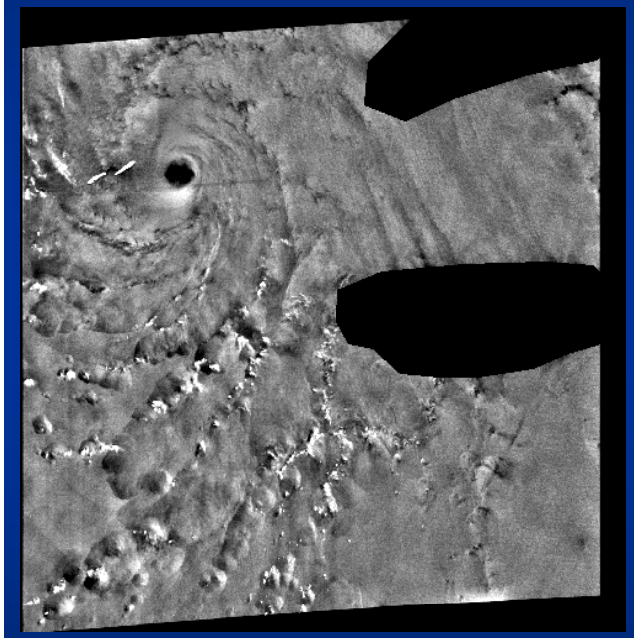


1. The error increases with wind speed and decreases with increasing incidence angles.

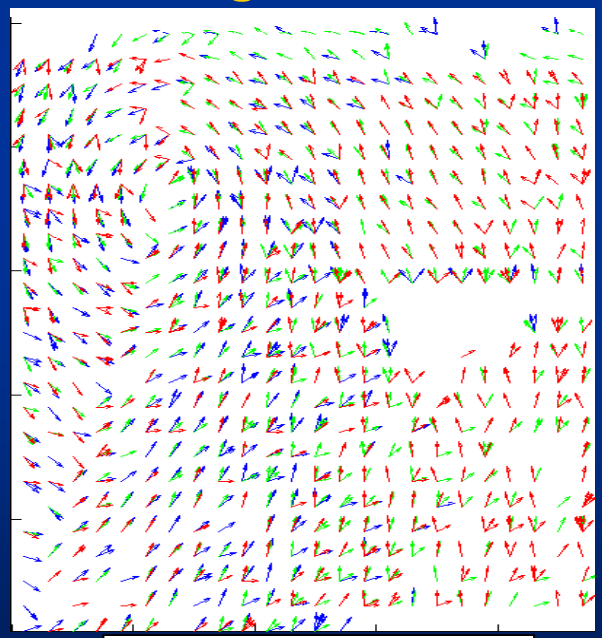
2. For wind speeds above 15m/s and low incidence angle the error is significant.

Hurricane wind fields estimated with Cmod5 lower wind solution

1) Find the dark blob in flattened SAR image which corresponds to the eye

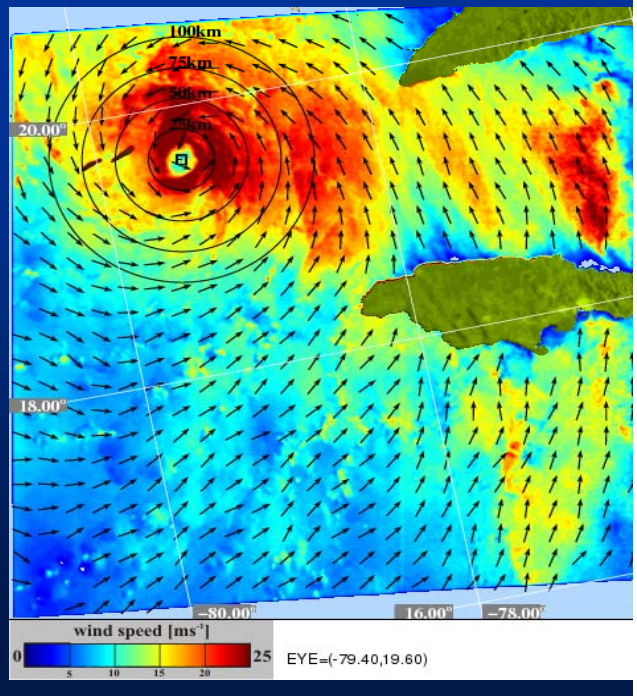


2. Selection of the nearest wind direction that is radially aligned around the eye including a 10 ° inflow

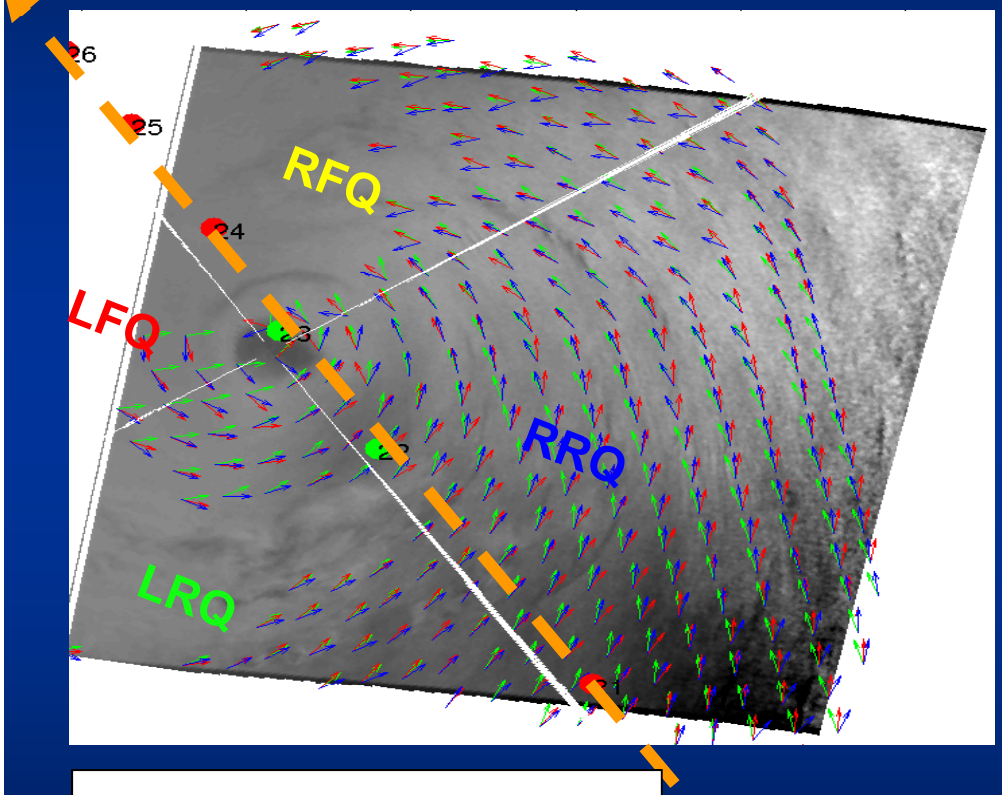


100m scale
200m scale
400m scale

3. Final wind field

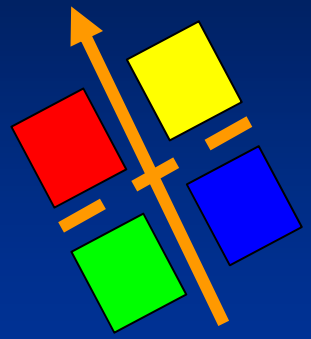


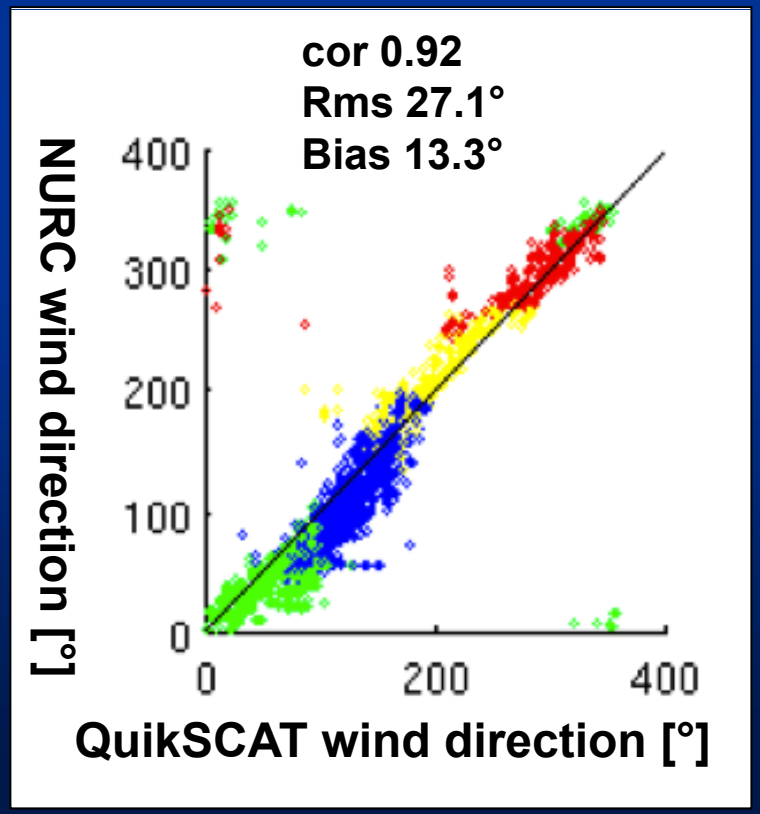
Comparison of SAR Retrieved Winds with CMOD5 to QuikSCAT



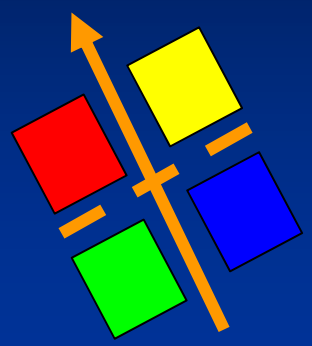
Wisar direction

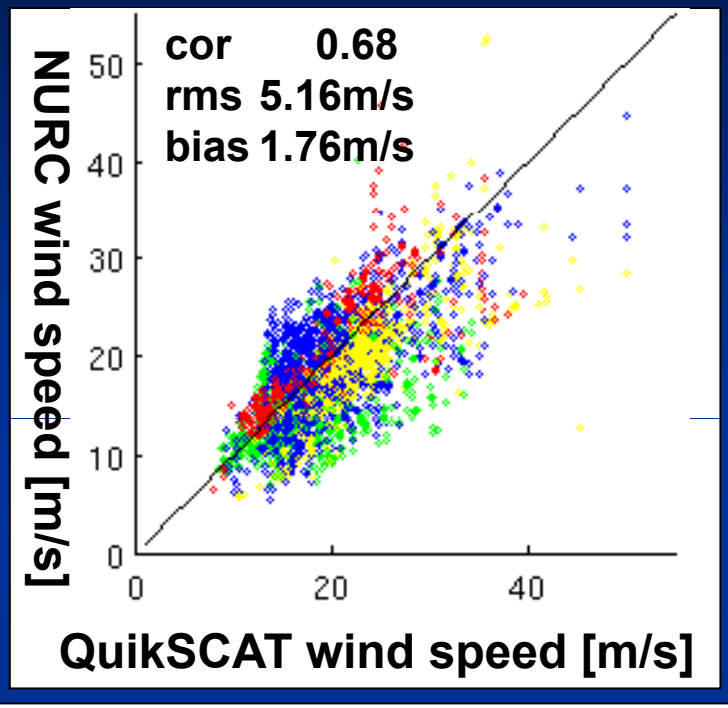
Quikscat direction

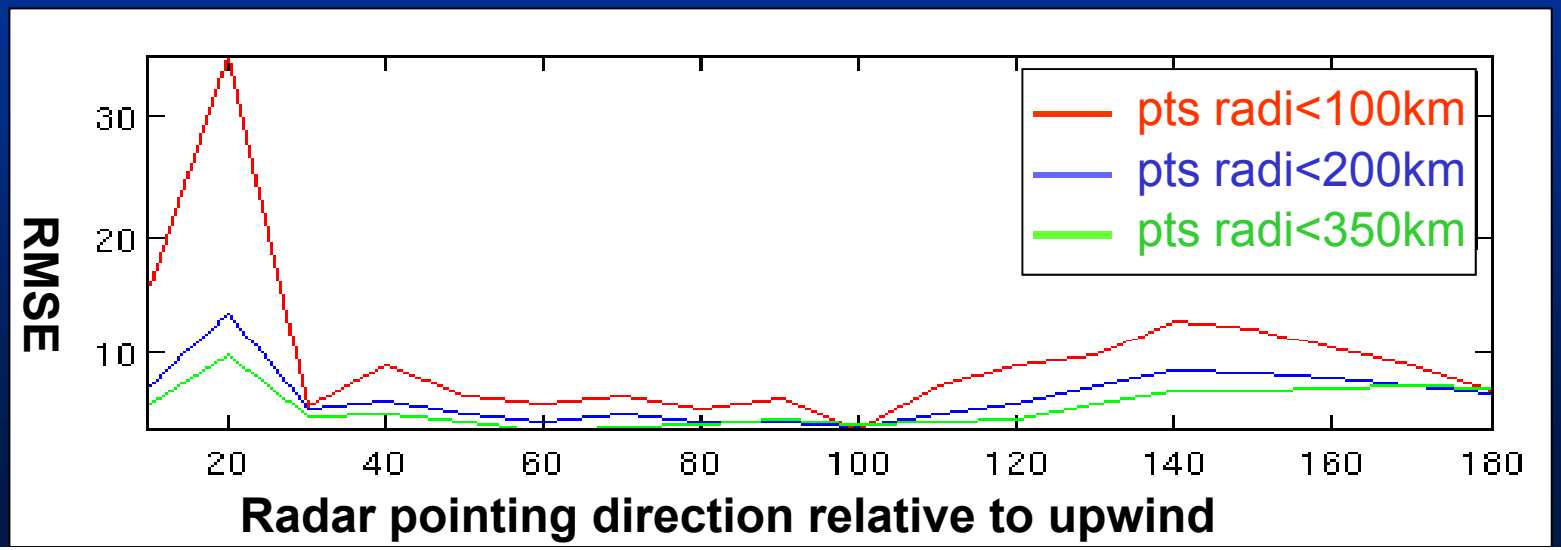




Comparison of SAR Retrieved Winds with CMOD5 to QuikSCAT

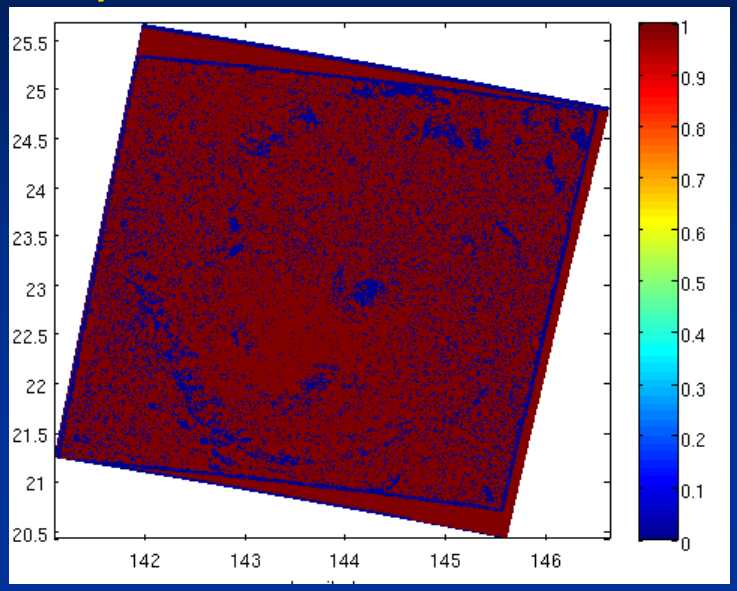




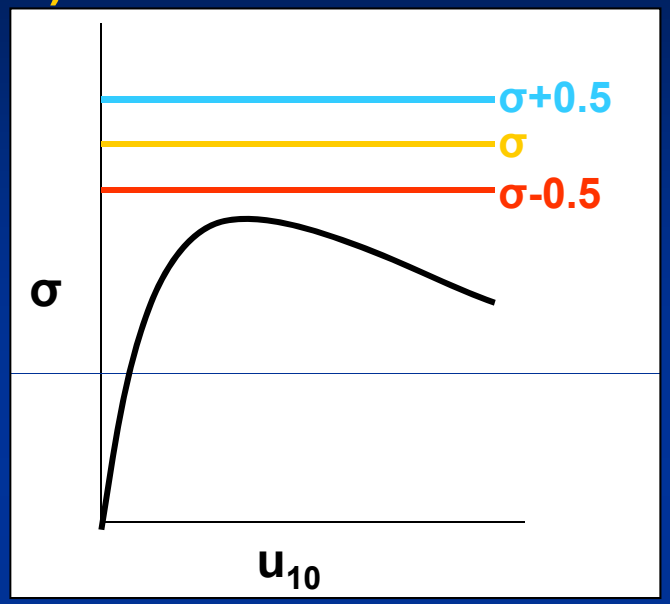


Estimation of uncertainties

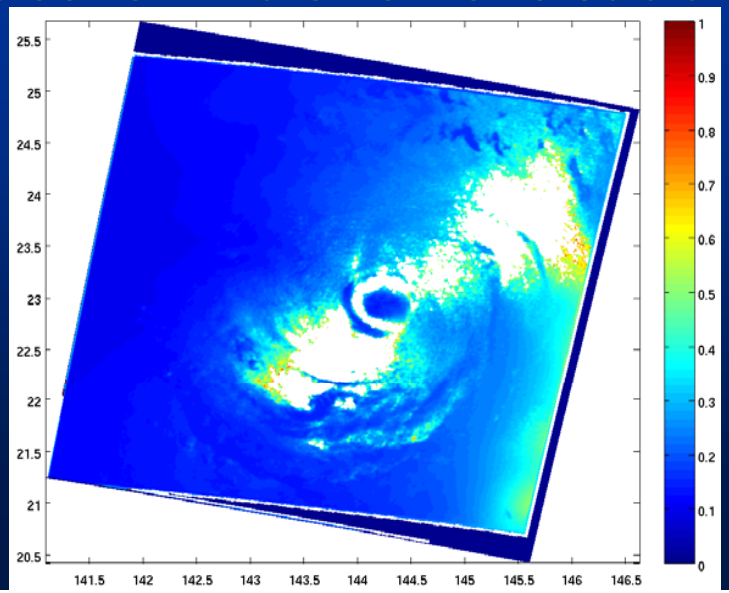
1) Non-wind induced mask

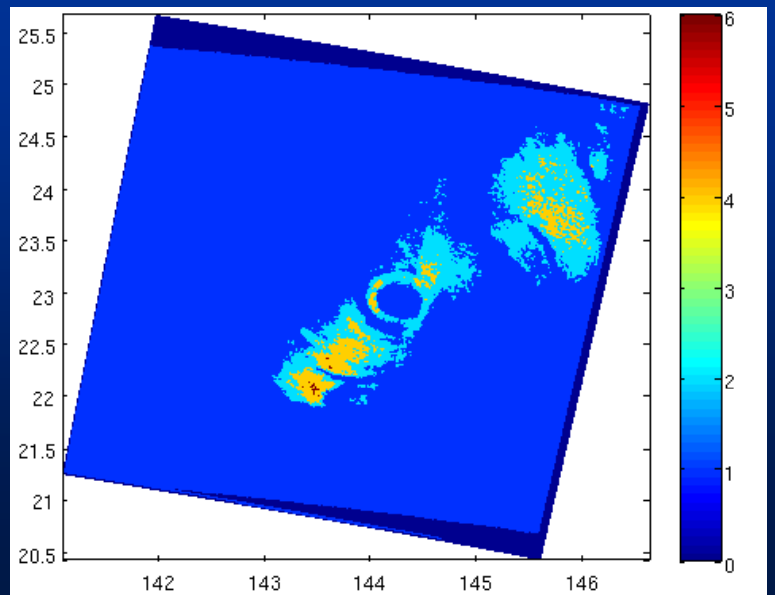


3) Out of definition mask

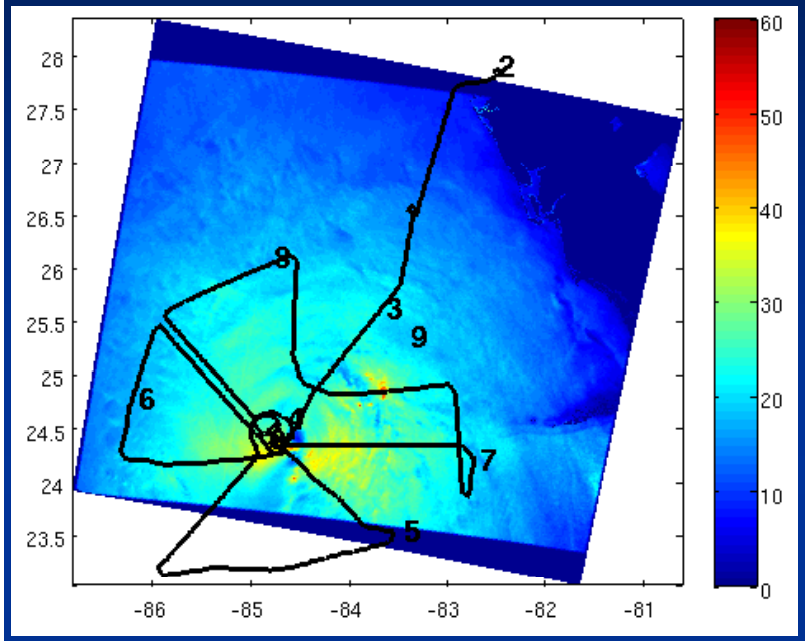


2) Relative wind error for 0.5db uncertainty



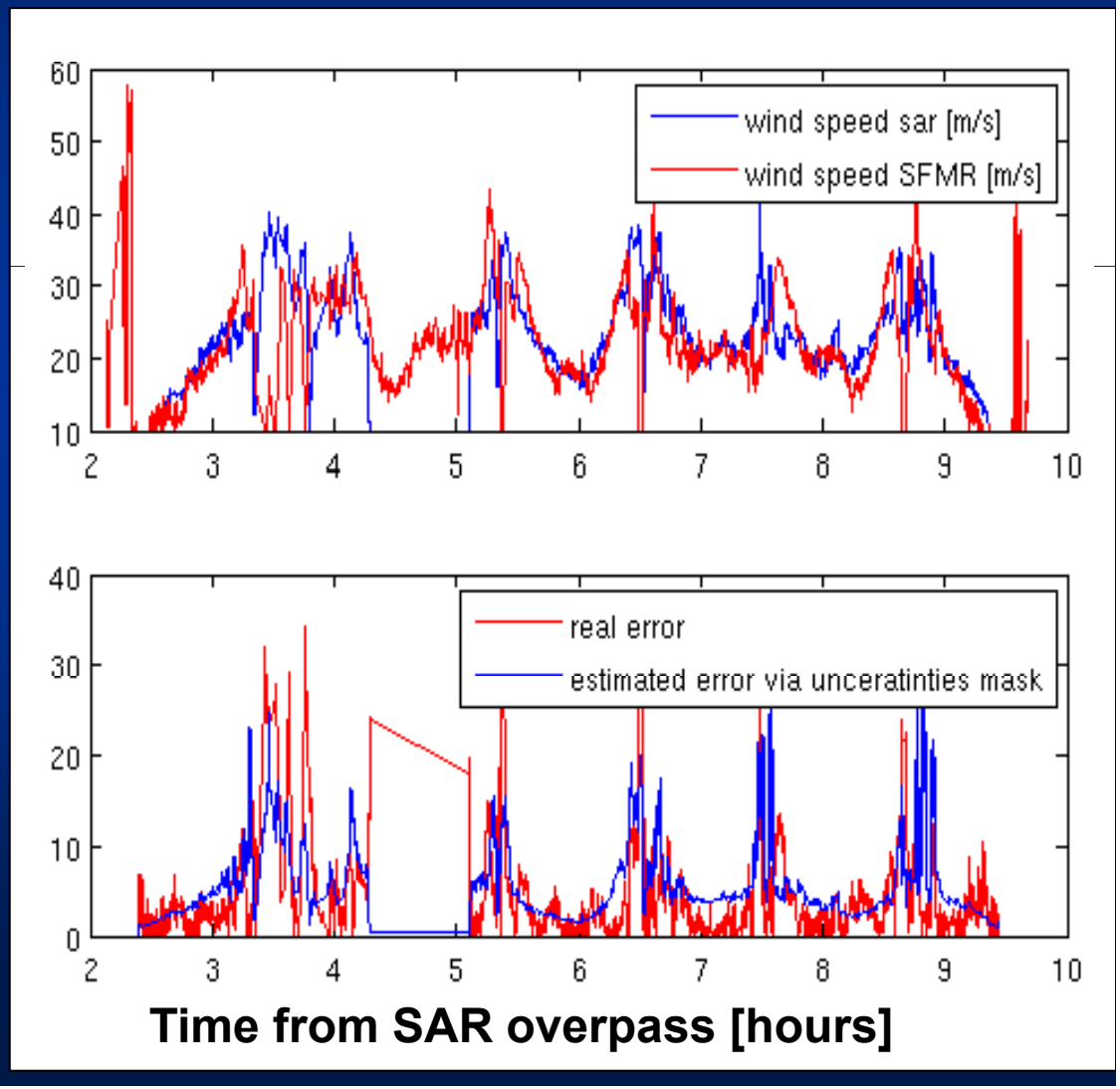


Uncertainty mask in NRCS

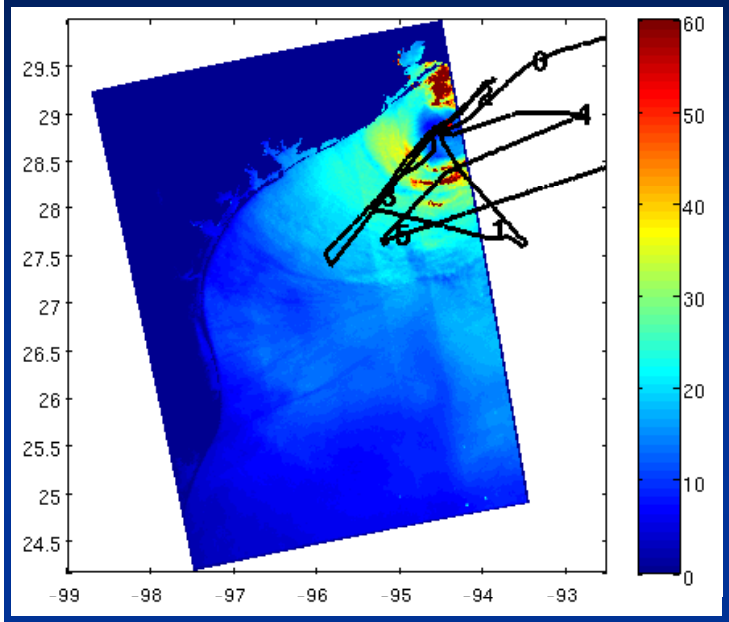


KATRINA 27 August 2005
11:28 GMT

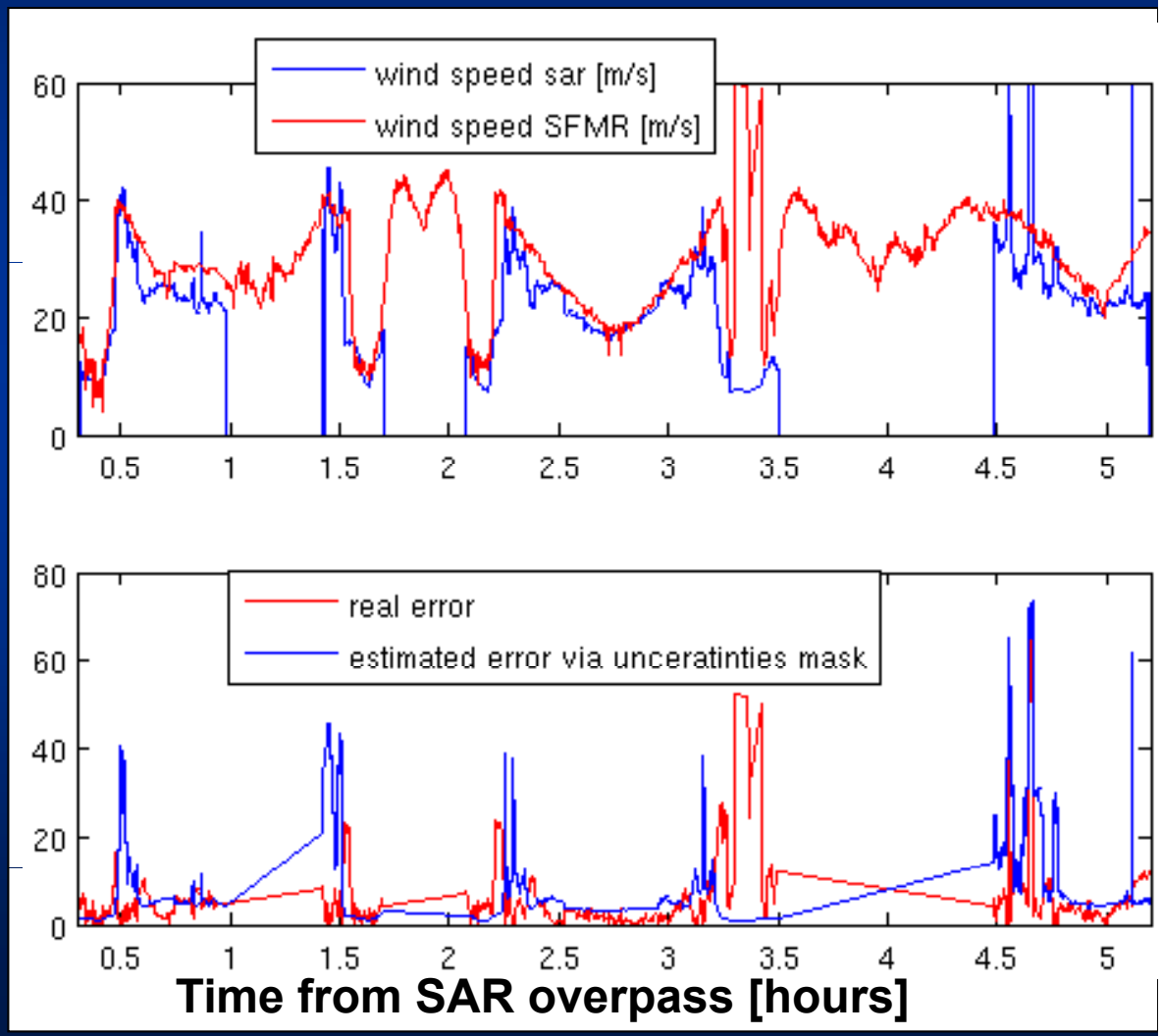
72% wind estimates within "error bar"
estimated / observed rmse 6.75 / 6.06 m/s



Uncertainty mask in NRCS

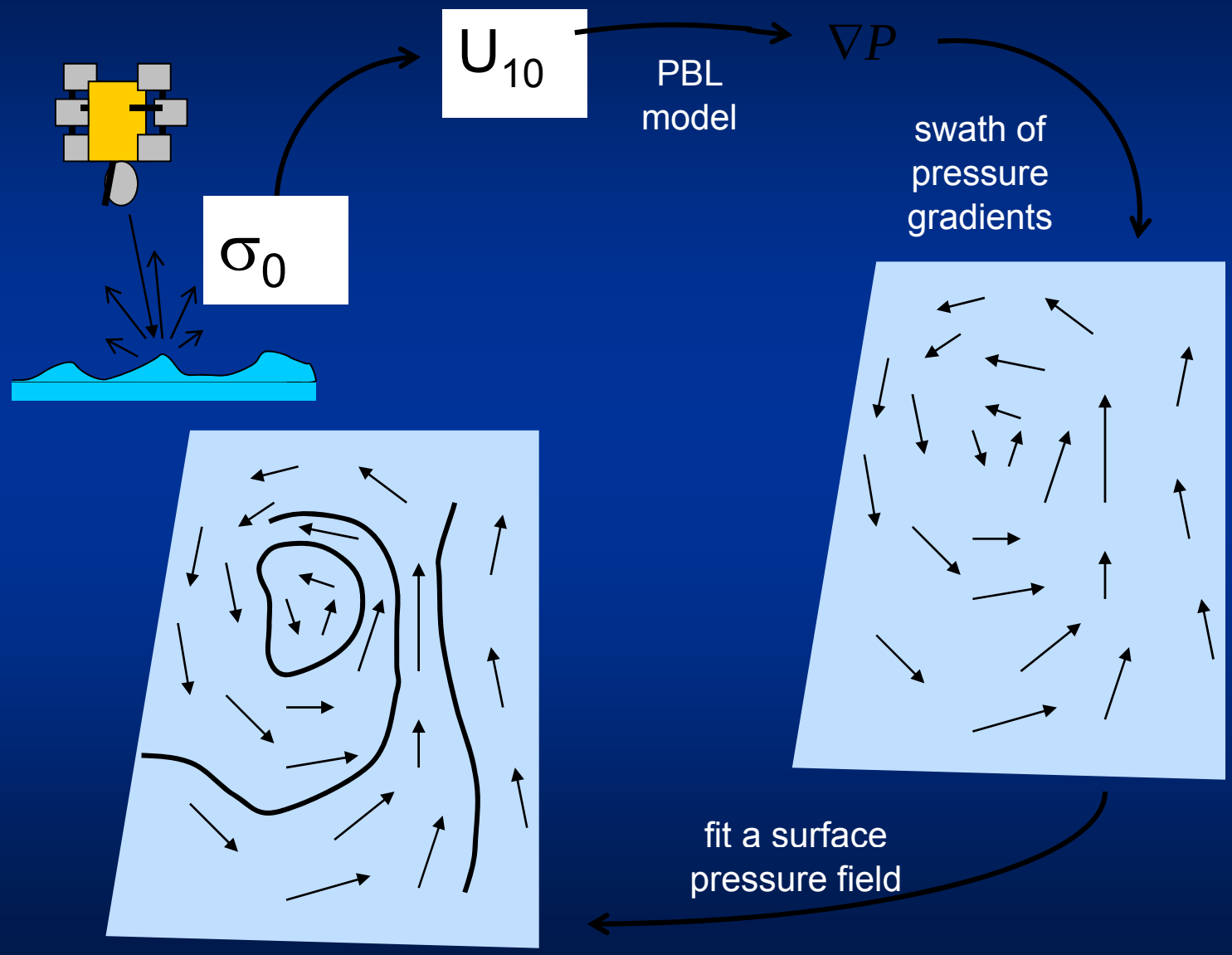


61% wind estimates within "error bar"
estimated / observed rmse 13.31 / 8.54 m/s



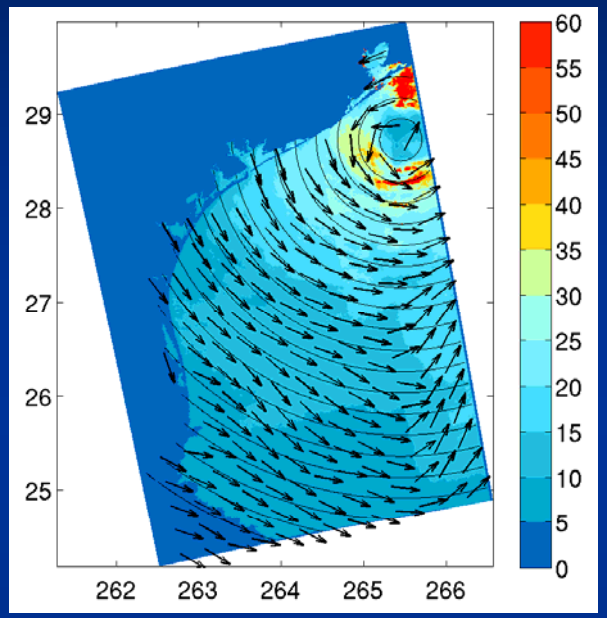
IKE 13 September 2008
04:23 GMT

Methodology on BL model of R. Foster and J. Patoux

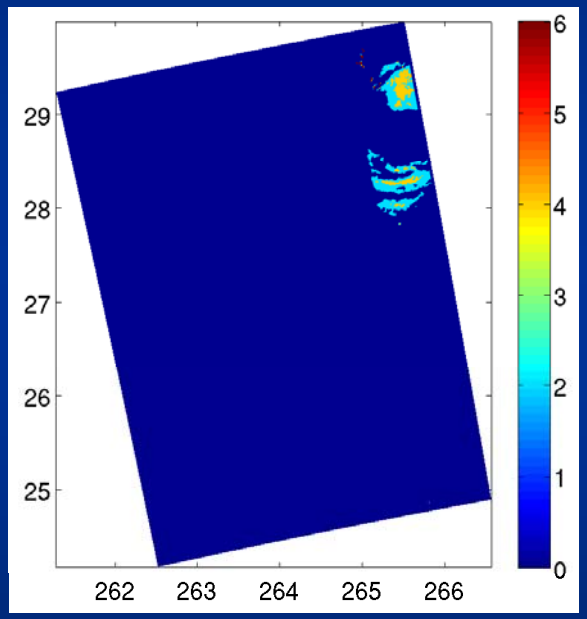


Chain of BL model for Hurricane IKE

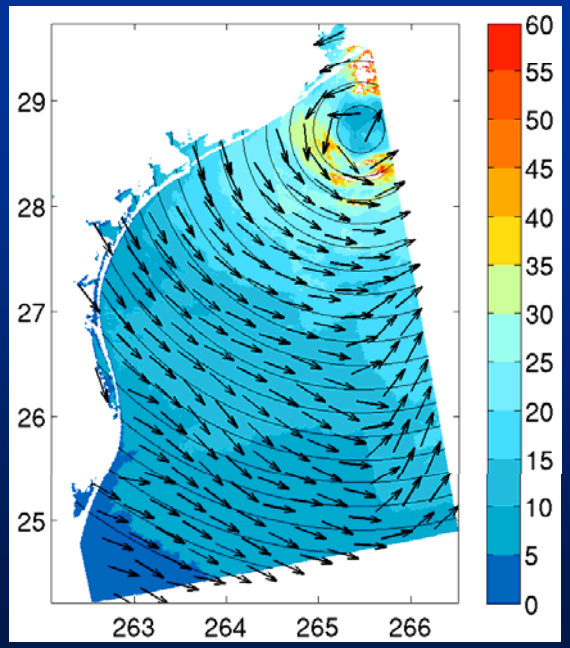
1) SAR wind speed



2) OUT of definition mask

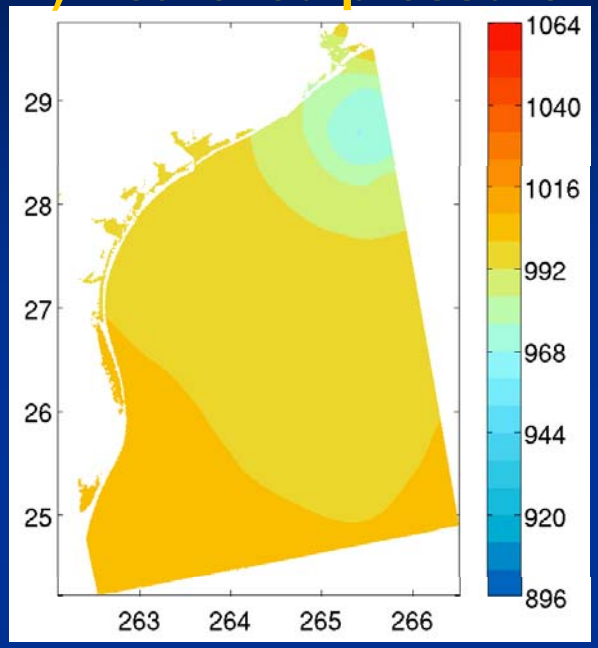


3) SAR input to BL model

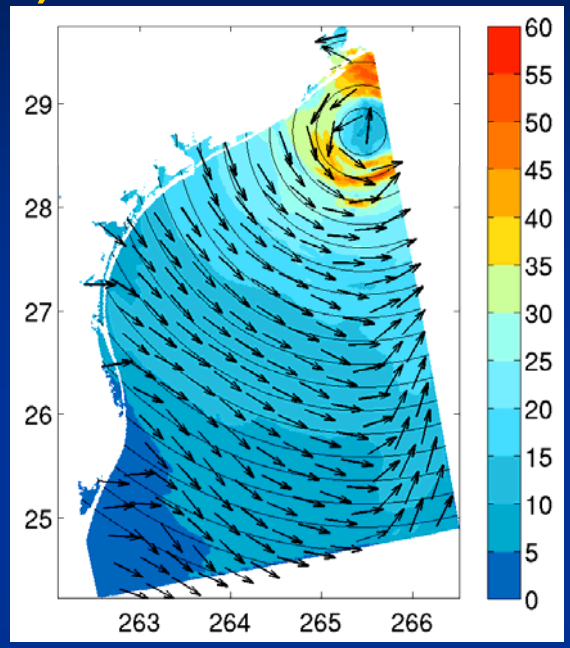


Results of BL model for Hurricane IKE

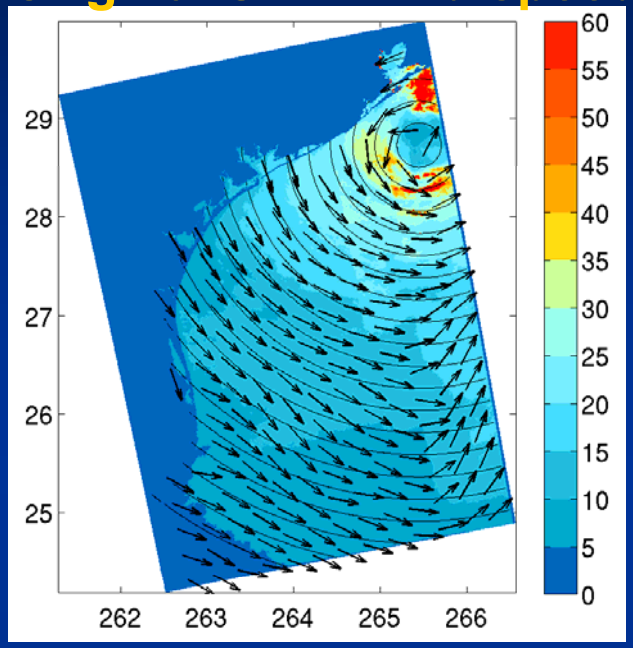
1) Retrieved pressure

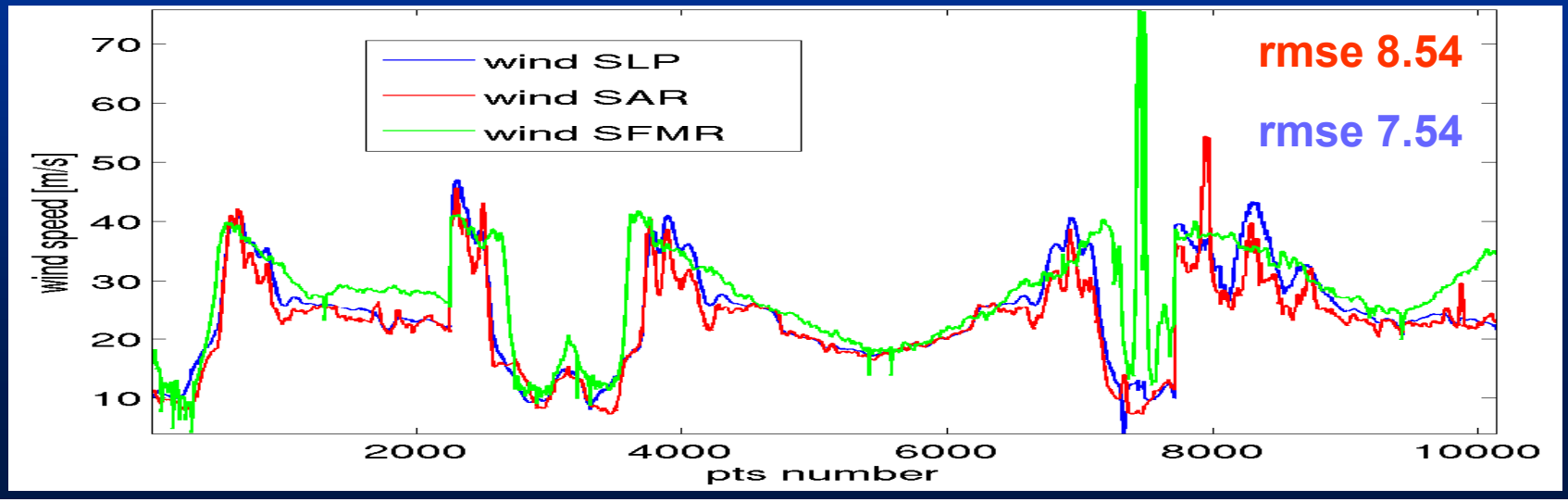


2) Retrieved wind field



Original SAR wind speed





Conclusions

- Error due to wind direction uncertainties is to be considered at low incidence angles and wind speed above 10m/s

- The typical radiometric accuracy of 0.5db leads to significant error for high wind speeds and low incidence angles (<30deg)

- The uncertainties nrcs mask may be used as an estimate of rmse

- Winds is underestimated at upwind and downwind for hurricanes scenarios

- The BL model approach provides to be a promising methodology for extrapolating wind fields where model function are not defined and SAR uncertainties are significant

Thanks for your attention