2009 NASA Ocean Vector Wind Science Team Meeting, Boulder, Colorado

Hurricane OVW Retrieval Performance for the Dual Frequency Scatterometer (DFS)

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Abstract

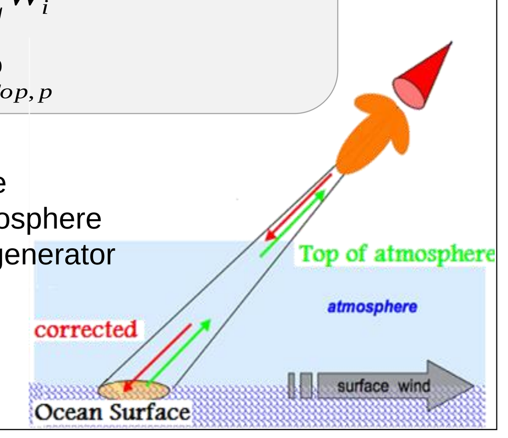
- DFS is a candidate design of the next generation NASA/NOAA scatterometer
  - Ku & C-band conical scanning dual beam system
  - Proposed to fly on the future GCOM-W2 JAXA mission
  - Operates with the JAXA Advanced Scanning Microwave Radiometer (AMSR)
- This poster paper presents simulation results for DFS/AMSR Ocean Vector Wind Retrievals
  - Nature run provided by WRF numerical weather model simulations for Hurricane Katrina

Slice Sigma-0 at Top of Atmosphere

$$\sigma^0_{Top,p} = \frac{\sum_{i=1}^{n}\left[W_i \times \left(\left(\sigma^0_{Surface,p,i} \times T_{p,i}\right) + \sigma^0_{Rain,p,i}\right)\right]}{\sum_{i=1}^{n} W_i}$$

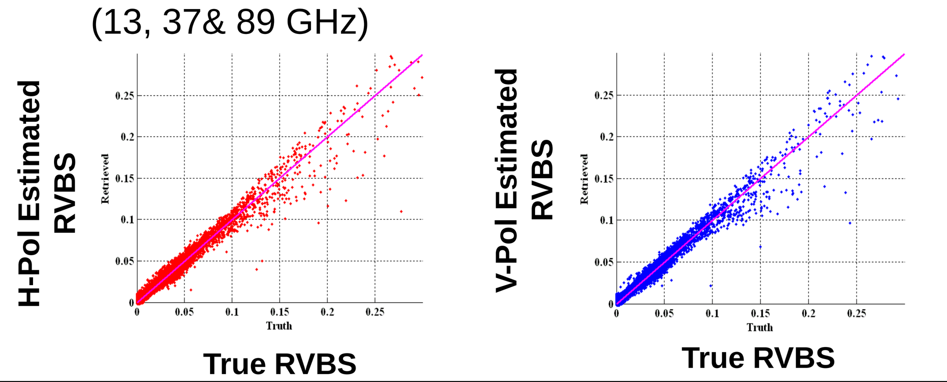
$$\sigma^0_{Noisy,p} = \left(1 + K_p\right) \times \eta \times \sigma^0_{Top,p}$$

- $\sigma^0_{Surface}$ = Sub-slice Sig-0 @ ocean surface
- σ^0_{Top} = Sub-slice Sig-0 @ top of atmosphere
- σ^0_{Noisy} = Noisy sub-slice Sig-0 @ top of atmosphere
- η= Unit normal Gaussian random number generator
- W = Gaussian antenna gain weighting
- Subscript "$_p$" denotes polarization
- Subscript "$_i$" denotes the i[th] sub-slice



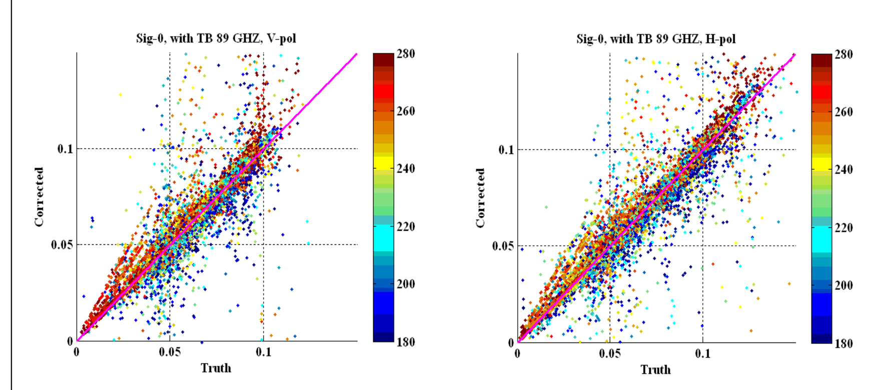
Estimated Rain Volume Backscatter

- Slice estimated rain-volume backscatter (RVBS)
  - Multivariate regression
  - Function of multi-bands Tb's (V- & H-pol)
  - Regression uses Tb's @ 1.3 km resolution (13, 37& 89 GHz)

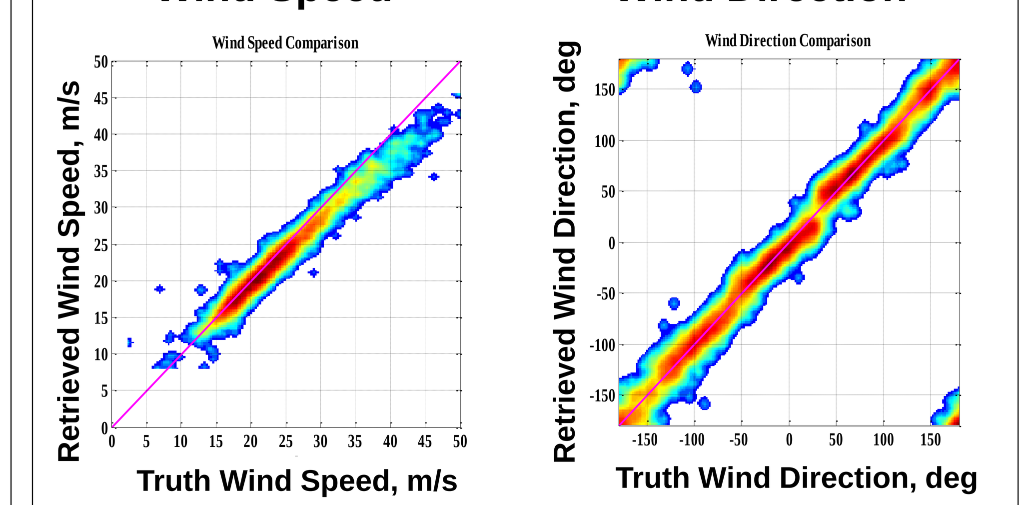


Tb Flagging

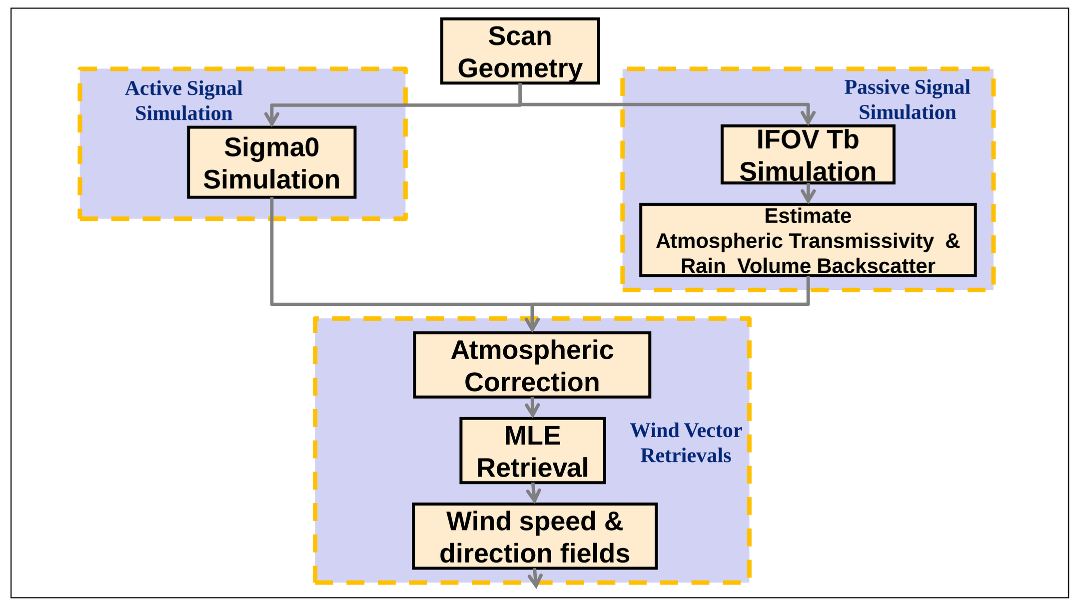
H & V-pol Tb's at 89 GHz were used to remove rain contaminated pixels before MLE OVW retrieval



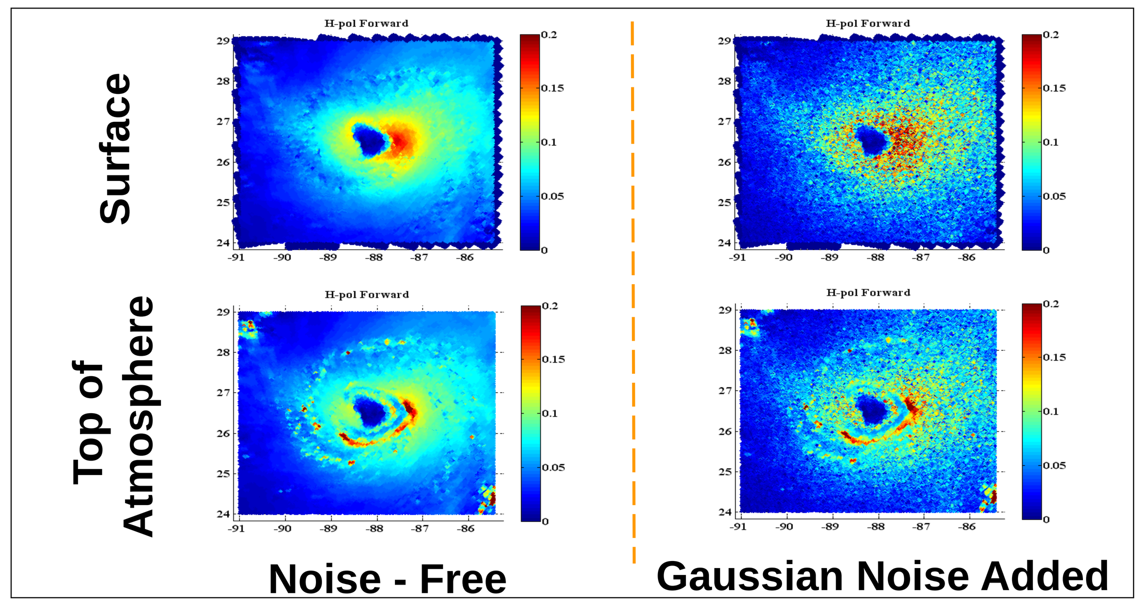
C-band Noisy Retrievals



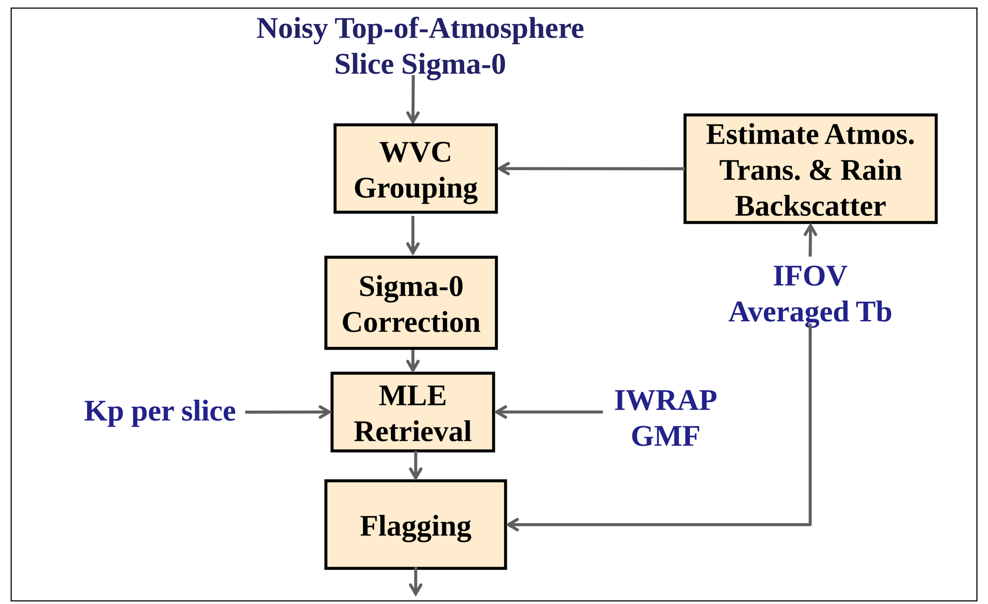
DFS End-to-End Simulation



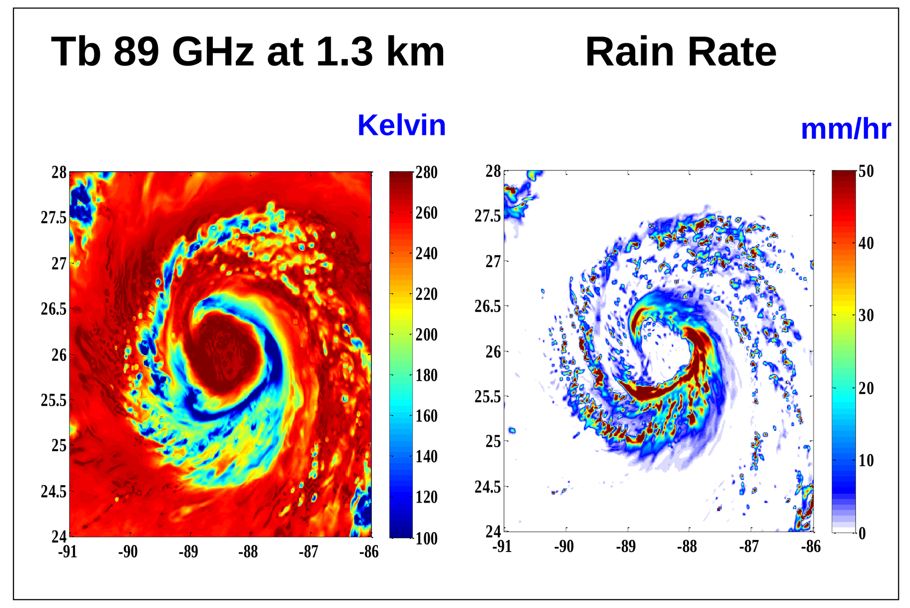
Sigma-0 Field Simulation



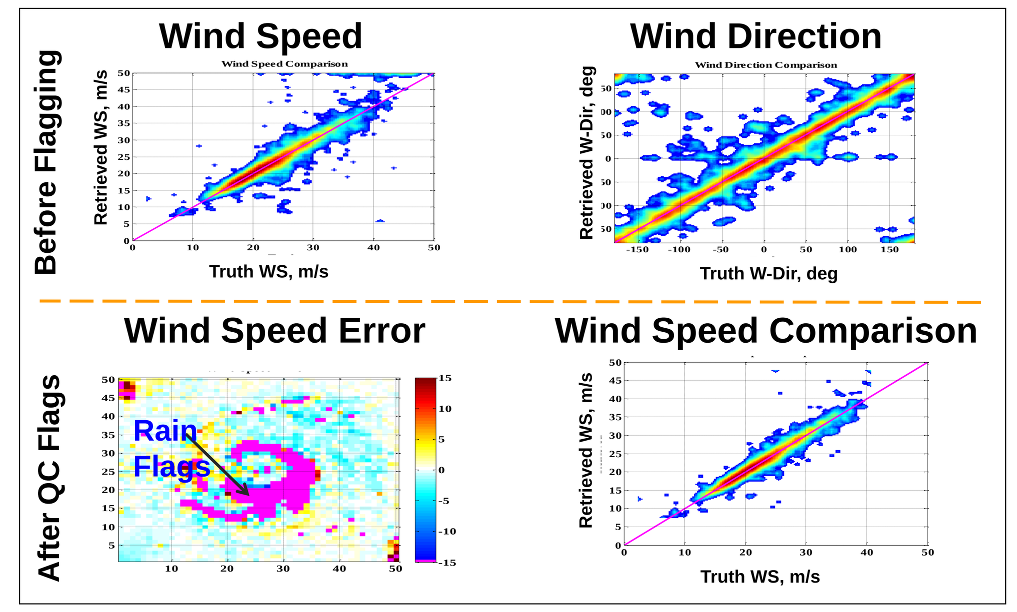
Wind Vector Retrieval



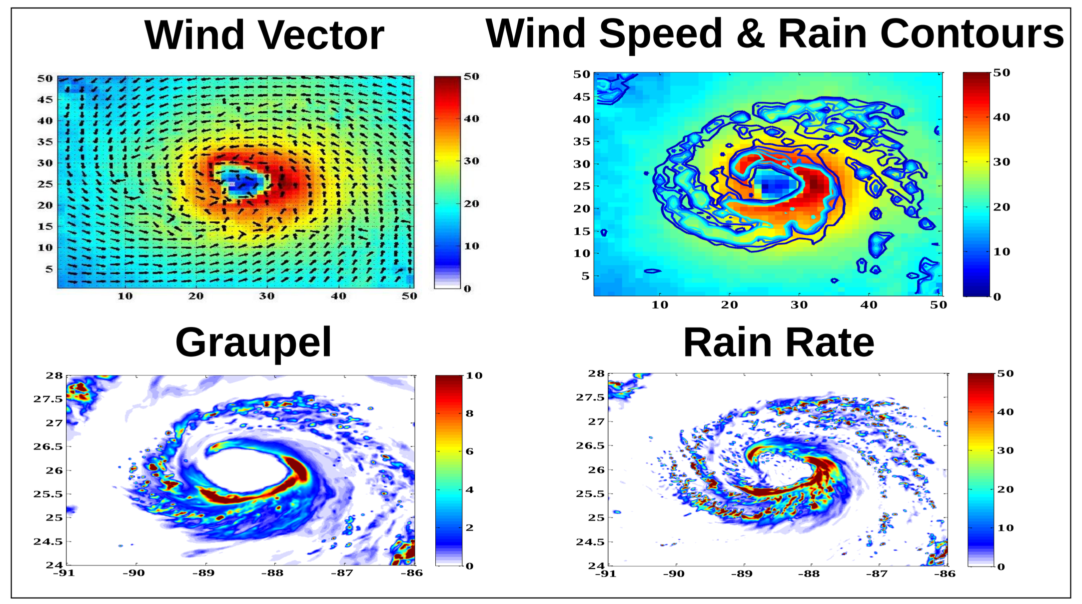
89 GHz H-Pol Tb



Ku-band Noisy Retrieval

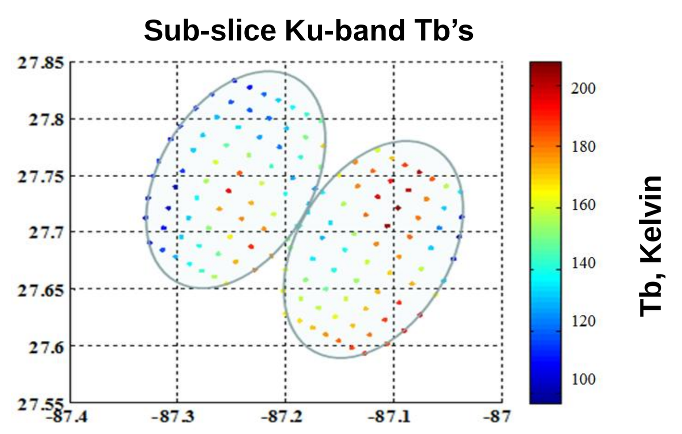


Katrina Wind & Precipitation WRF Simulation



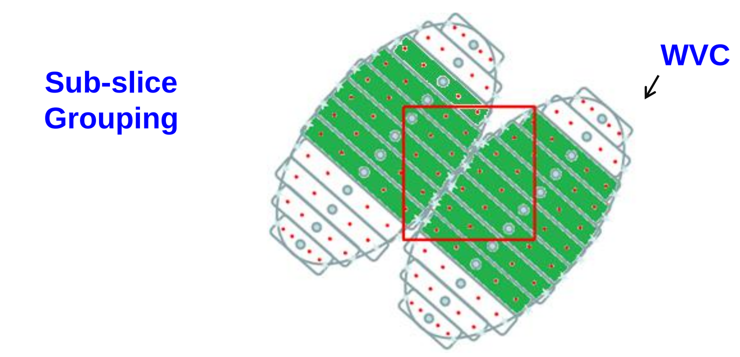
Tb Simulation

- Tb's are calculated at sub-slice locations (~ 1.3 km)
- Simulated T_b - weighted average over pulse IFOV



Grouping Sigma-0 Slices into WVC's

- Sigma-0 slices are grouped based upon intersection of sub-slices with WVC
  - Sig-0 slices are included when any sub-slice points falls within one WVC



Maximum Likelihood Estimation

- Wind vector retrieval using maximum likelihood estimation (MLE) of objective function (ζ)

$$\zeta = \sum_{pol=V,H} \frac{W_j * \left(\sigma_{sur} - GMF(wspd,\chi)_{pol}\right)^2}{(Kp^2)}$$

where W_j is the Sig-0 slice weight applied in the WVC grouping

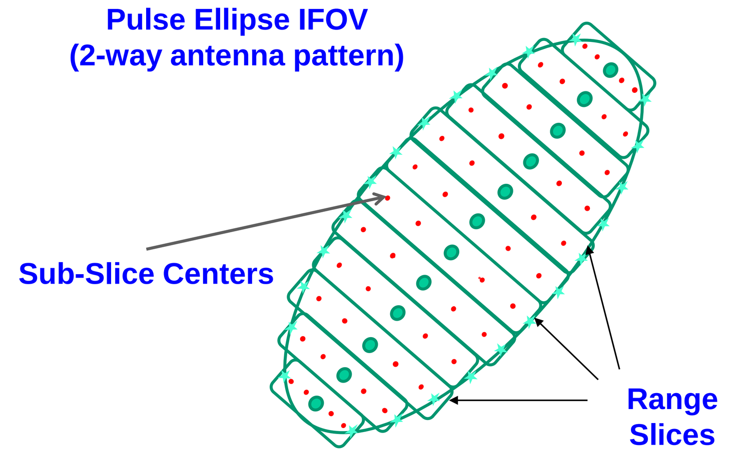
- Wind vector solutions (ambiguities) ranked according to cumulative residue of objective function
- Nearest neighbor ambiguity selection (compared to wind direction truth)

Summary & Conclusion

- Ku-band OWV retrievals for active/passive technique are significantly improved over active alone
  - Simple Tb threshold setting can effectively provide realistic QC rain flags for active/passive retrievals
    - Removes majority of severely contaminated WVC's
  - Rain attenuation correction improves wind speed retrievals where rain sig-0's are << ocean surface sig-0's
    - Active/passive retrievals have significant reduction of wind speed negative bias compared to active alone

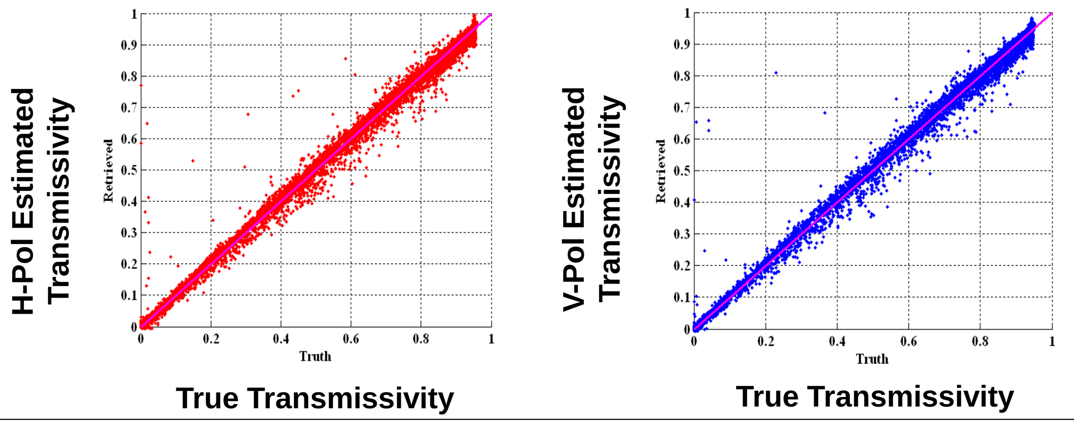
Sigma-0 Geometry Simulation

- Radar backscatter simulated at sub-slice level (~ 1.3 km)
- Radar slice sigma-0 produces by summing sub-slices



Estimated Rain Transmissivity

- Slice atmos. (rain) transmissivity multivariate regression
  - Function of Ku-band Tb's (V- & H-pol)
  - Regression uses Tb's @ 1.3 km resolution (10, 13 GHz)



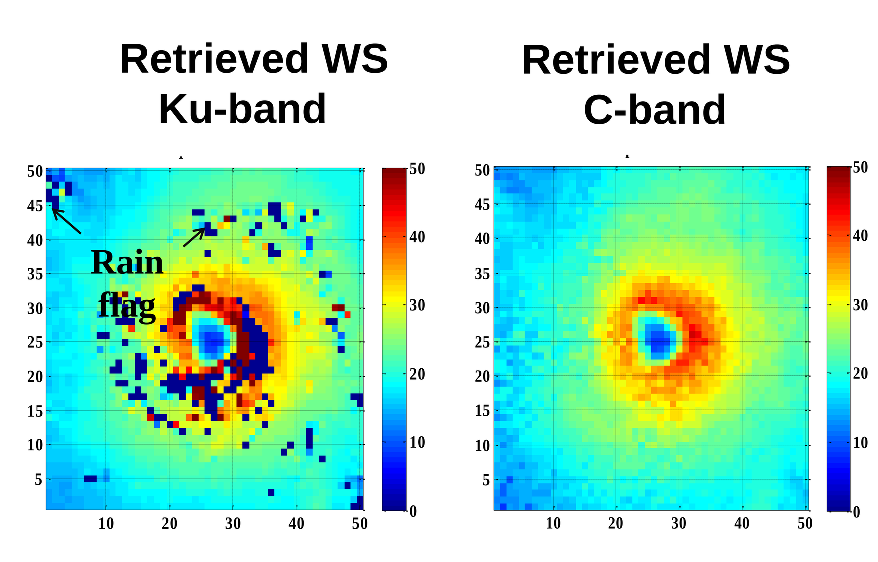
Sigma-0 Correction

- Sigma-0 slices are corrected for rain effects

$$\hat{\sigma}^0_{Surface,p} = \frac{\left(\sigma^0_{Top,p} - \hat{\sigma}^0_{Rain,p}\right)}{\hat{T}_p}$$

- $\sigma^0_{Surface}$ = Estimated slice sigma-0 at ocean surface
- σ^0_{Top} = Slice sigma-0 at top of atmosphere
- σ^0_{rain} = Slice rain-volume backscatter
- T = Slice atmospheric (rain) transmissivity
- Superscript "^" is estimated parameter from Ku-band Tb regression
- Subscript "$_p$" denotes polarization

Wind Speed Retrievals



Summary & Conclusion

- C-band retrievals have significant spatial smoothing of high wind gradients because of the larger IFOV
- C-band OVW retrievals for active passive techniques are more stable than Ku-band because of the lack of significant rain volume backscatter
  - At high rain rates, C-band suffers small but significant atmos attenuation
  - Use of Ku-band Tb's to provide C-band attenuation correction results in small but significant reductions of negative (too low) wind speed biases and slight improvements in error standard deviations