

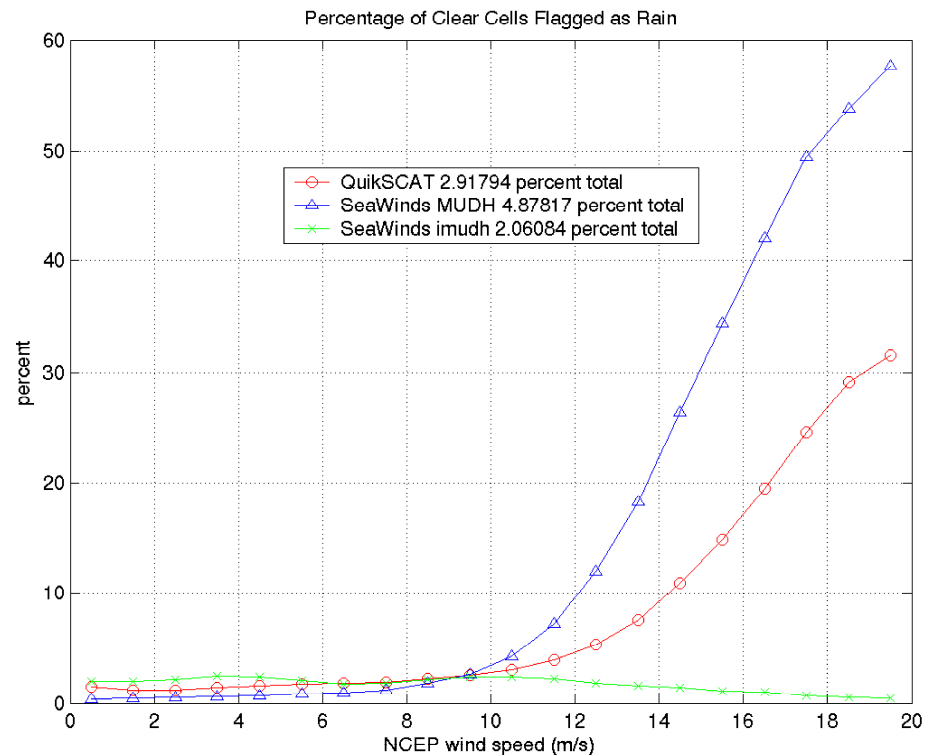
IMUDH Rain Impact Flagging Algorithm

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Background

- Old MUDH rain flag over-flags high winds
 - Sensitivity to rain decreases with wind speed.
 - Overflagging adversely impacts:
 - Global circulation models
 - Tropical and Extra-tropical cyclone studies
 - Forecasting of high wind events
- Instead of flagging for rain we now flag *rain-impacted* winds.



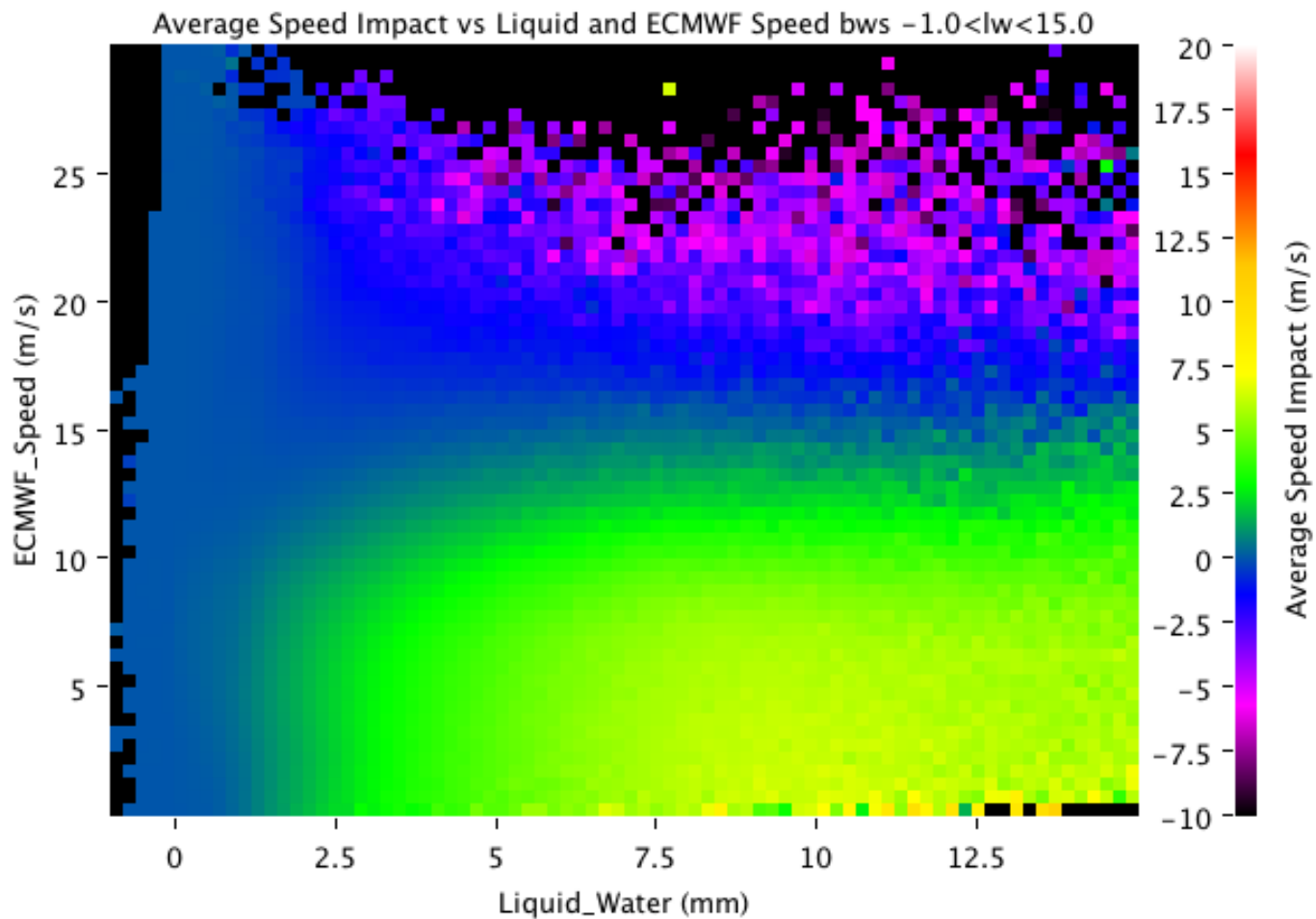
IMUDH Overview

- 1) Estimate rain correction coefficients for SeaWinds/AMSR.
- 2) Use coefficients to estimate AMSR-derived speed and direction impact
- 3) Train autonomous rain flag (IMUDH table) using AMSR-derived impact
- 4) Justify using SeaWinds IMUDH table on QuikSCAT.

Computing Impact from AMSR

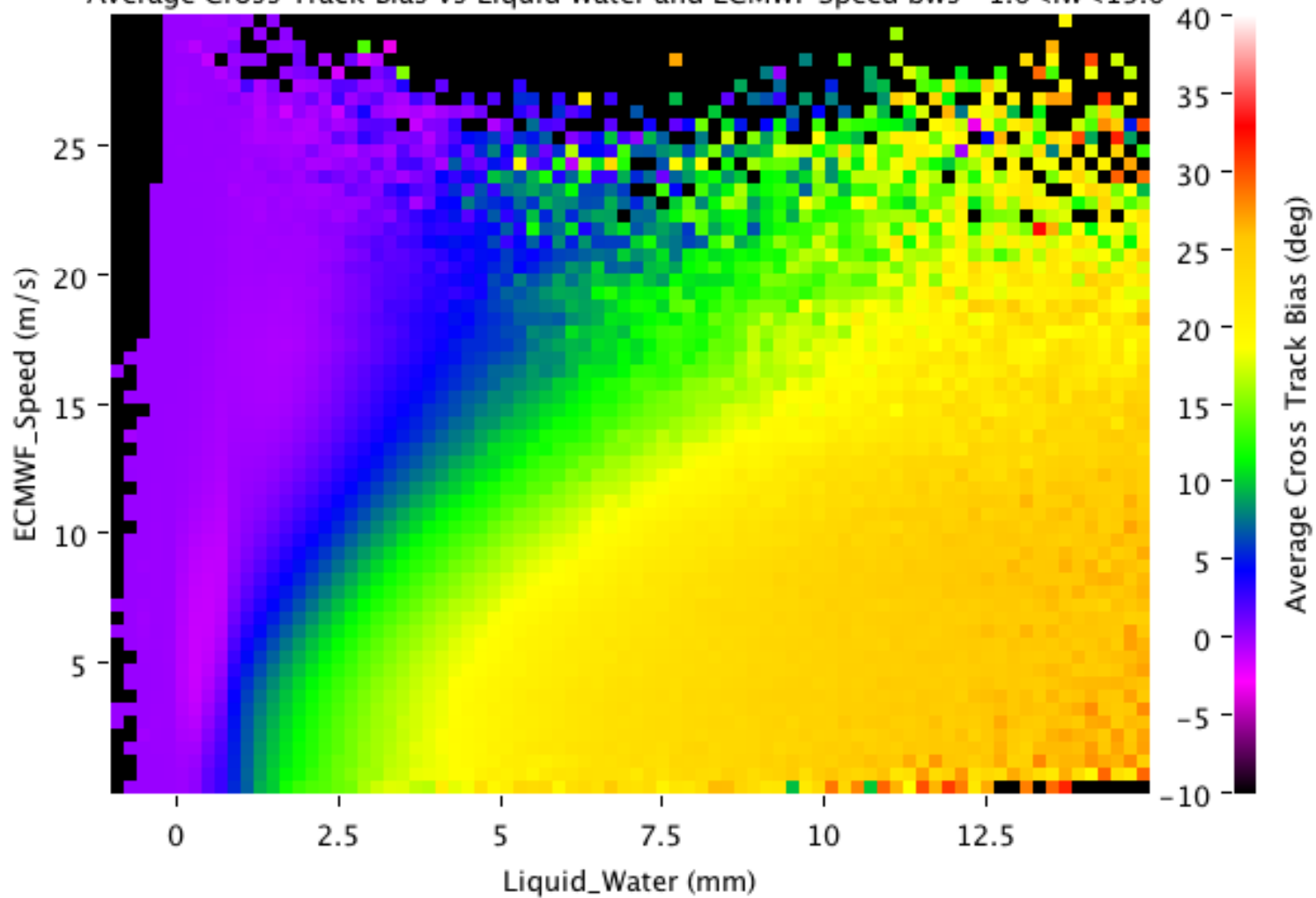
- We used AMSR to correct SeaWinds wind vectors.
- We also used it to determine how badly the rain impacted the SeaWinds vectors.
- To estimate Directional Impact and Speed Impact we computed a table.
- Table used to estimate both impacts for each wind vector cell.
- Speed Bias and Cross Track Directional Bias are tabularized by:
 - Attenuation
 - Backscatter ratio B/σ_0
 - Cross Track Distance (Incorporates measurement geometry)
 - Average outer beam measured σ_0 (incorporates wind speed)

Speed Impact vs ECMWF wind and AMSR Liquid



Direction Impact vs ECMWF wind and AMSR Liquid

Average Cross Track Bias vs Liquid Water and ECMWF Speed bws $-1.0 < lw < 15.0$



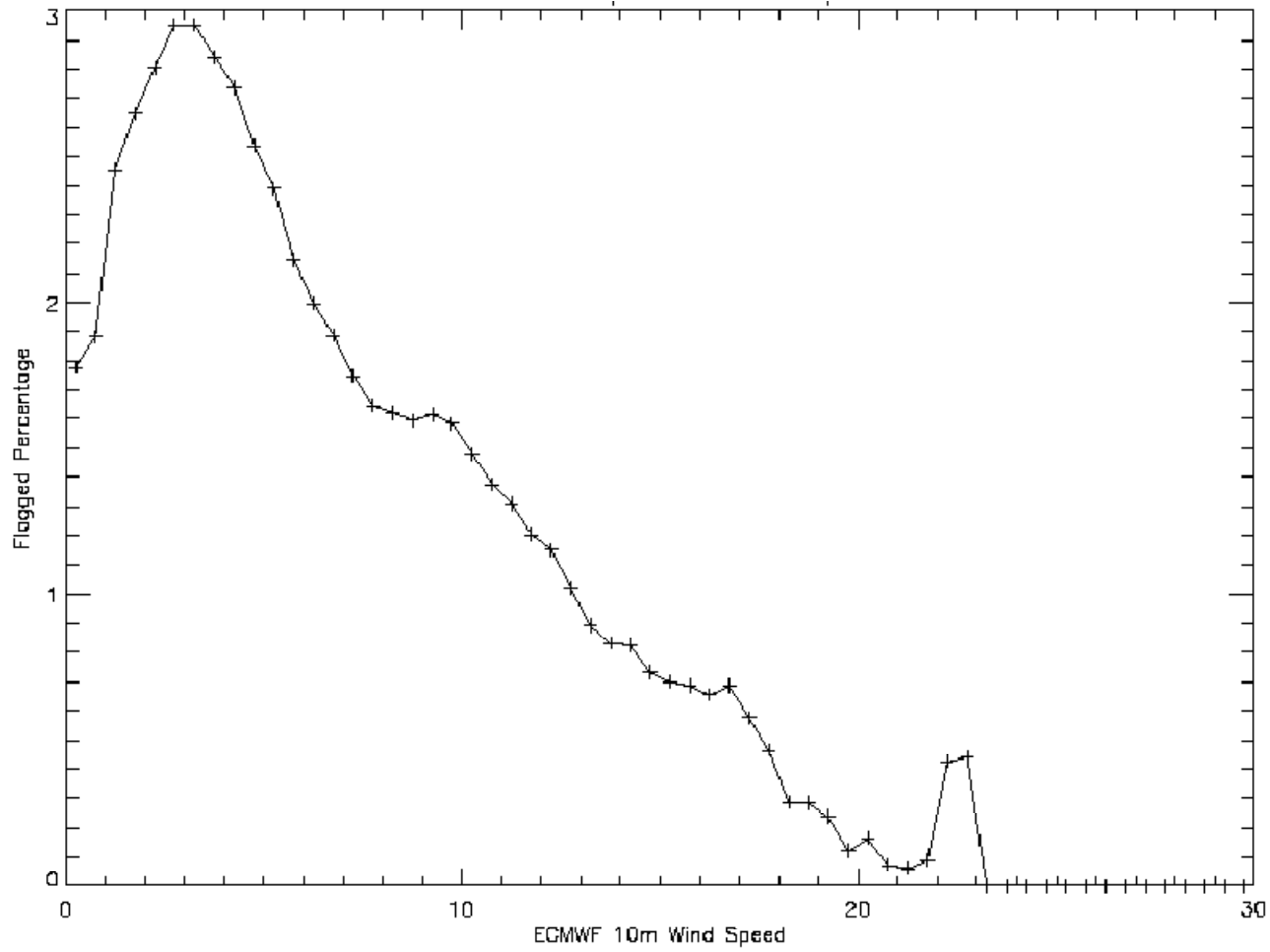
Autonomous Rain Flagging

- Two 4-D probability of rain tables are estimated.
 - One for dual beam swath binned by the following rain dependent parameters.
 - First Rank Speed
 - First Rank MLE
 - Normalized Beam Difference
 - H pol QRAD (or SRAD) Brightness temperature
 - One for single beam swath binned by
 - First Rank Speed
 - First Rank MLE
 - First Rank Direction w.r.t cross swath
 - V pol QRAD/SRAD Brightness temperature

Autonomous Rain Flagging

- Values in the table are the fraction of wind vector cells that are:
 - “rainy”(old MUDH) =SSMI rain rate > 2 km mm/hr
 - “impacted” (IMUDH) =
 - Estimated speed bias > 2 m/s OR
 - Estimated cross track directional bias > 15 degrees
- Table is used in flagging for each WVC by:
 - 1) read probability from table
 - 2) initially flag if greater than threshold T_{low}
 - 3) remove flag if fewer than K initially flagged neighbors in an N by N window
 - 4) flag if probability greater than T_{high}

IMUDH Fixes Over-Flagging of High Winds

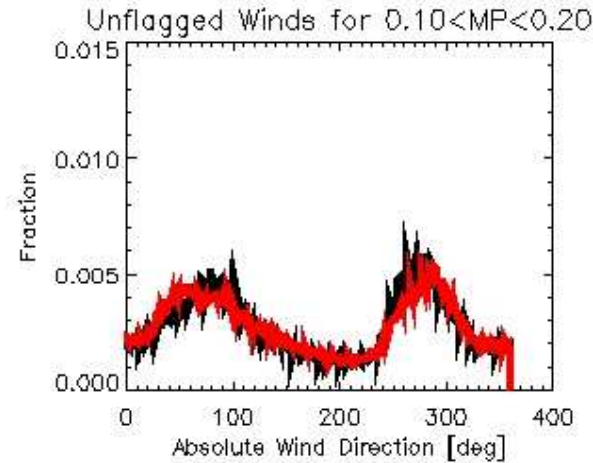
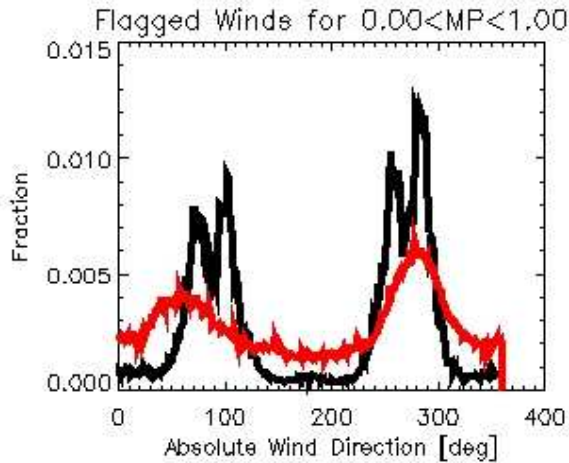


SeaWinds Wind Histograms

Flagged, the “Bad”

Unflagged, Worst of the “Good”

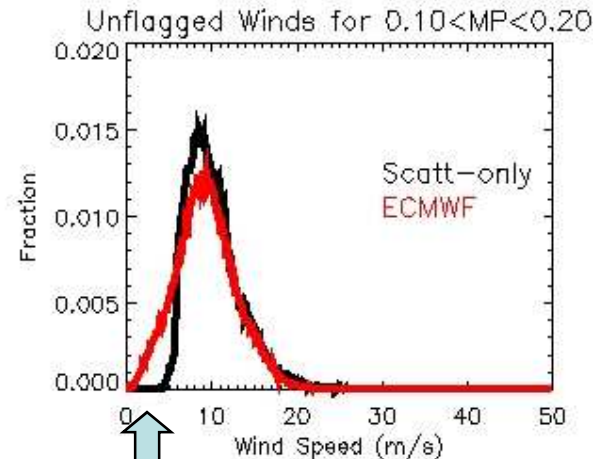
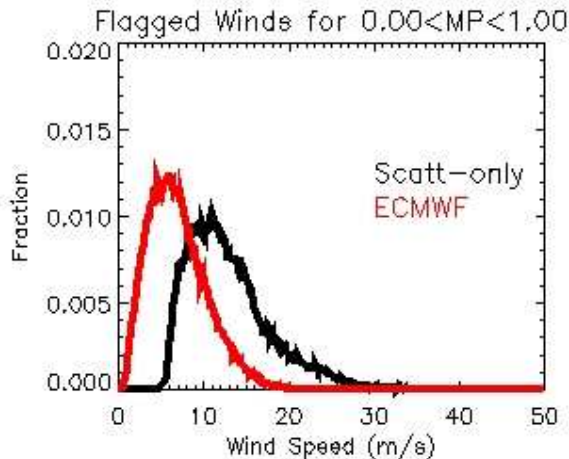
Direction



Scat Winds

ECMWF

Speed



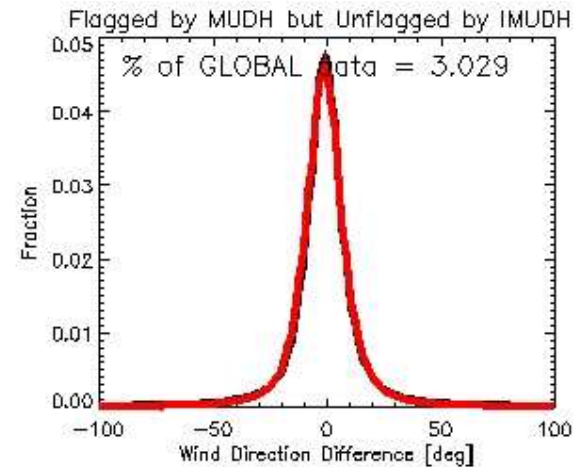
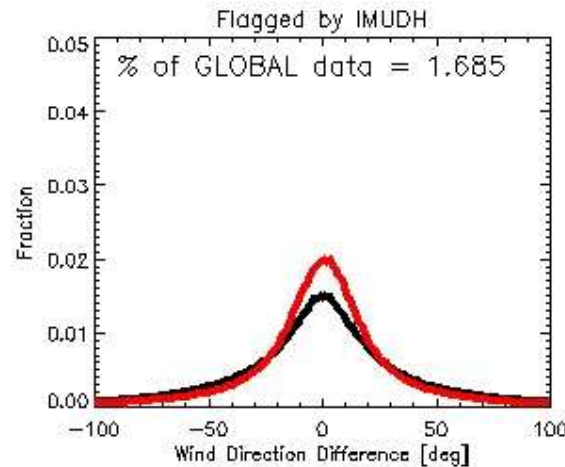
Very low *retrieved* winds have rain probability $MP < 0.1$

SeaWinds Wind Difference Histograms

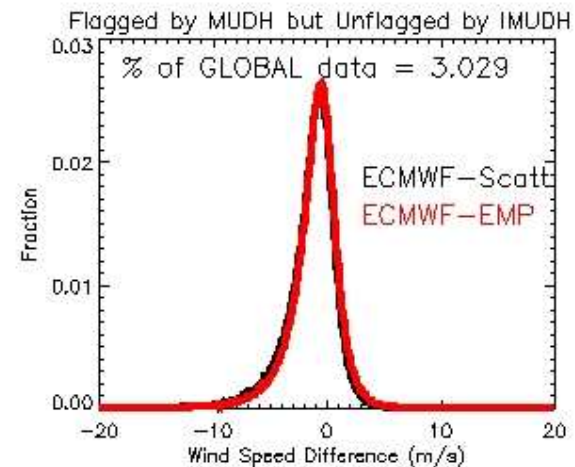
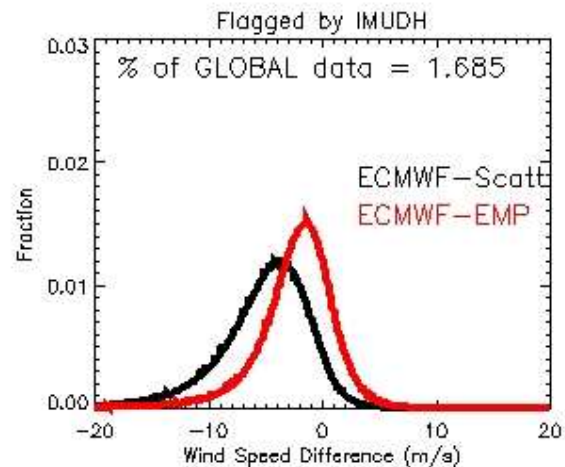
IMUDH Flagged= impacted

MUDH but NOT IMUDH flagged=
Some rain likely but not impacted

Direction



Speed



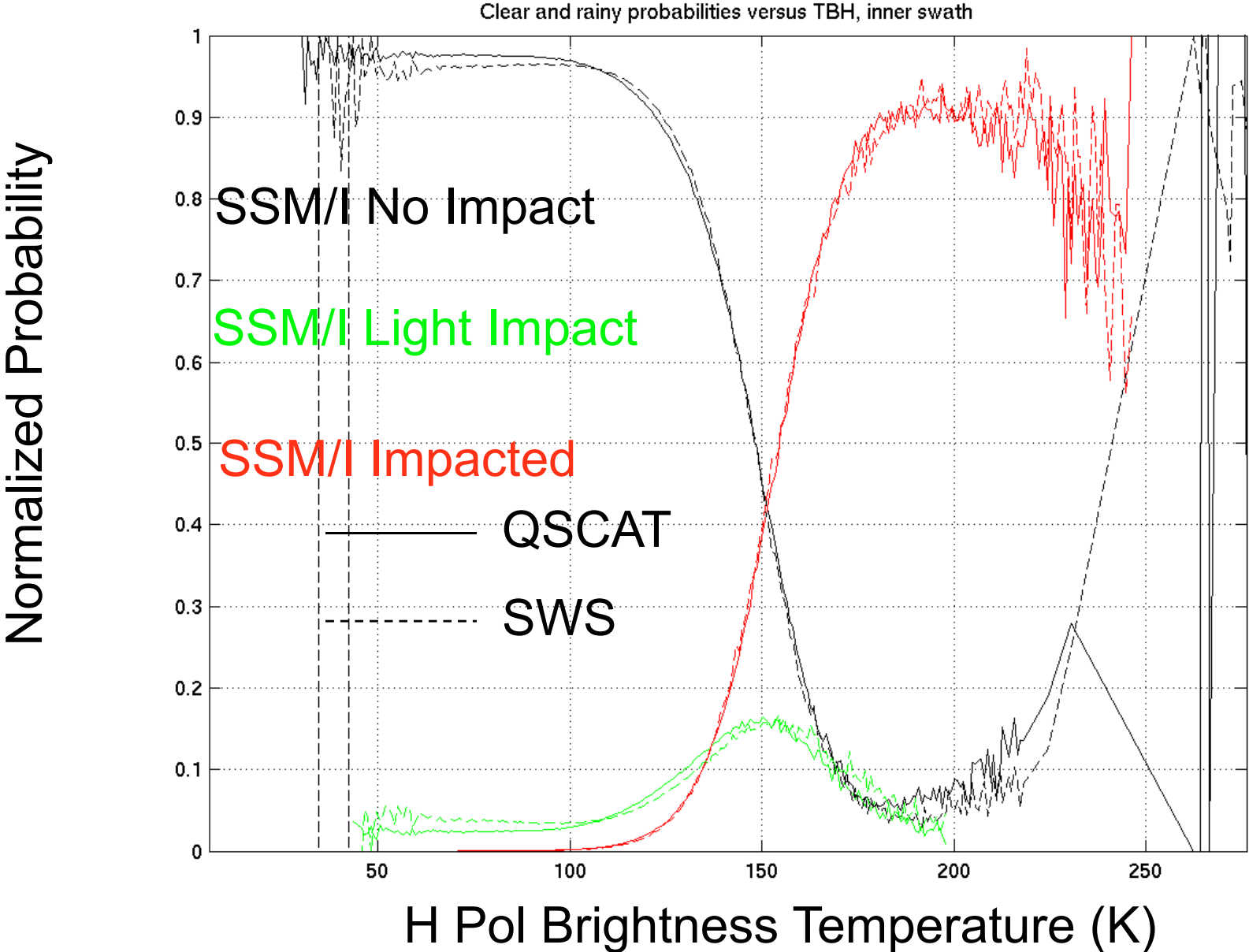
ECMWF-Scat Winds

ECMWF -Corrected Winds

SeaWinds To QuikSCAT

- Used same IMUDH table and thresholds for both.
- To justify this decision we:
 - Compared histograms of input parameters for QuikSCAT and SeaWinds for different SSM/I rain categories
 - Compares speed and direction histograms of flagged and unflagged SeaWinds and QuikSCAT data.

Similarity of QuikSCAT and SeaWinds Parameter Distributions

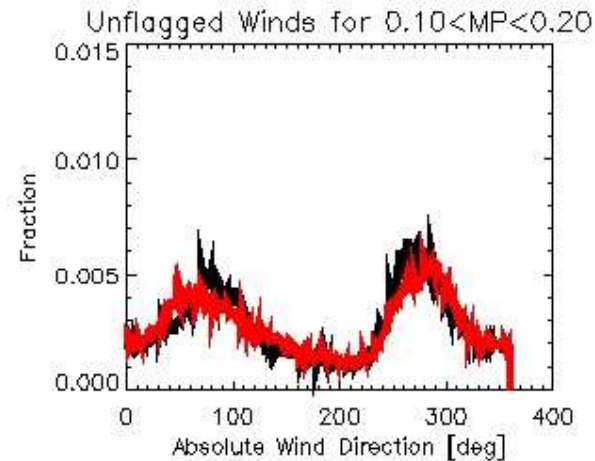
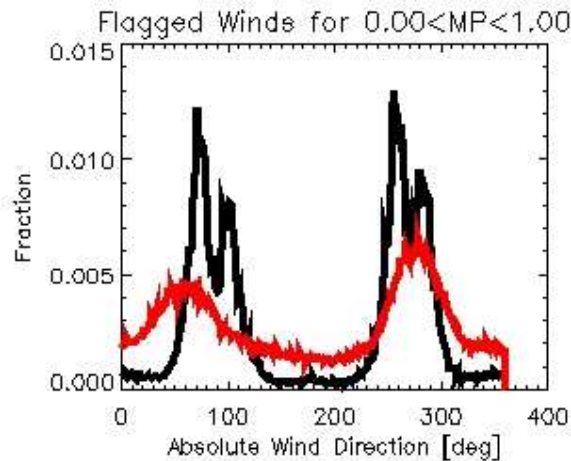


QuikSCAT Wind Histograms

Flagged, the “Bad”

Unflagged, Worst of the “Good”

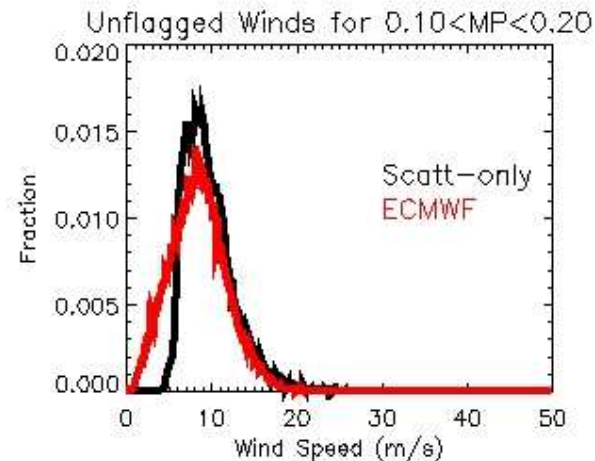
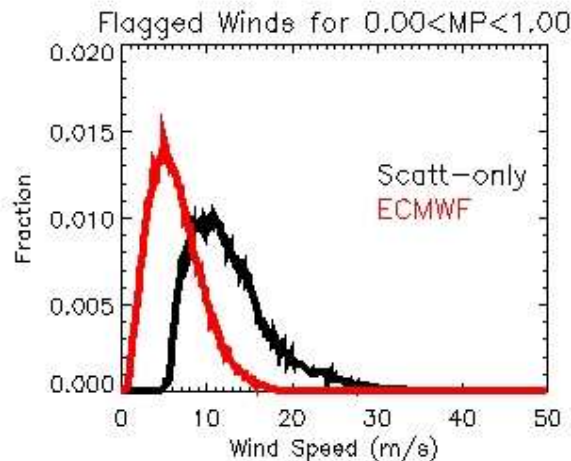
Direction



Scat Winds

ECMWF

Speed

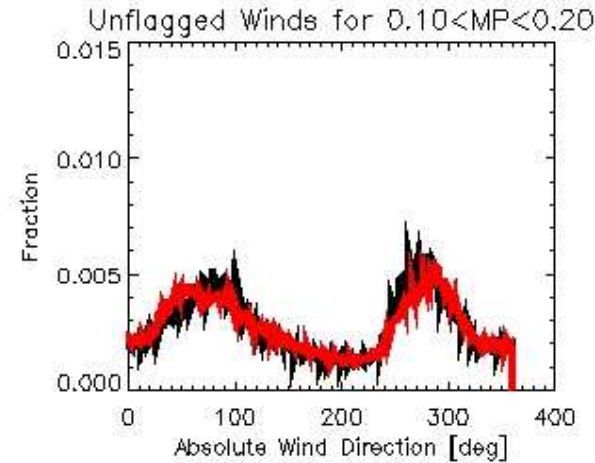
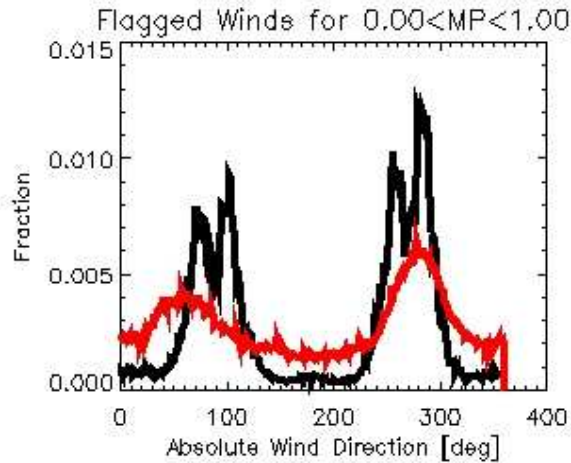


SeaWinds Wind Histograms

Flagged, the “Bad”

Unflagged, Worst of the “Good”

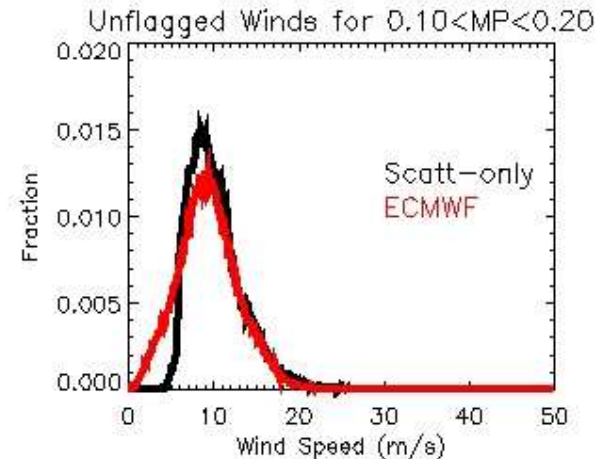
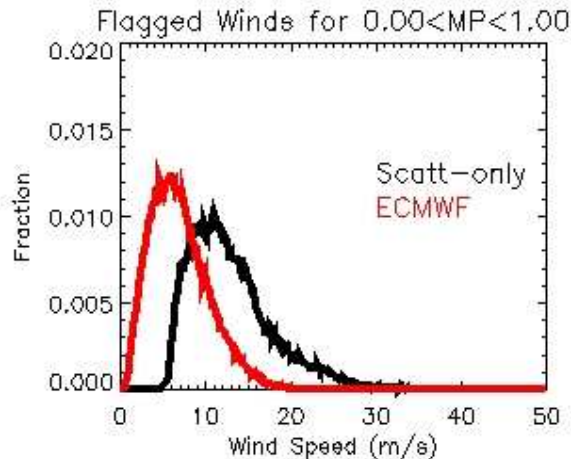
Direction



Scat Winds

ECMWF

Speed



Summary

- The old rain flagging algorithm
 - Overflagged high winds
 - Detected rain
- The new algorithm
 - Flags less high winds and less overall.
 - Detects rain contamination of wind data.
- Preliminary validation supports the flag changes:
 - Data previously flagged but no longer looks good when compared with ECMWF.
- Up Next: More validation