A new GMF for estimating whitecap coverage from Ku-band scatterometers

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Scatterometers Uses

- Ocean vector winds
- Monitoring hurricanes
- Precipitation
- Vegetation
- Soil moisture
- Polar ice sheets
- Glaciers
- Iceberg tracking
- Winds over sand and snow dunes
- Urban infrastructure changes

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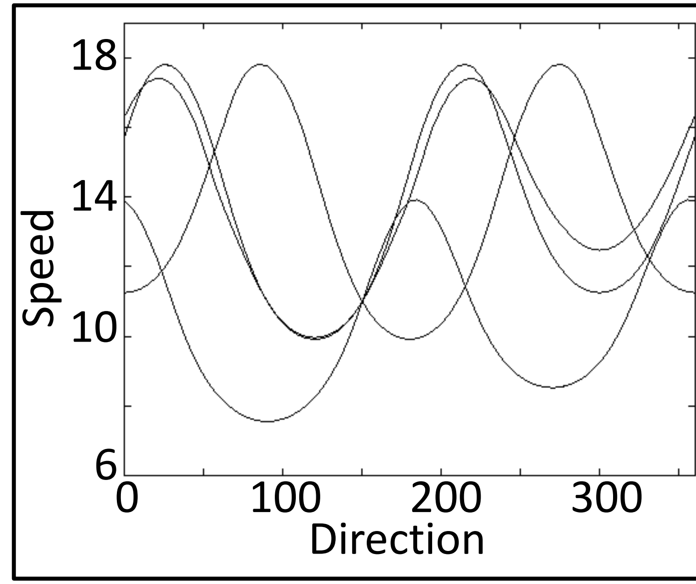
- Direct whitecap fraction estimates

Traditional Whitecap Estimation Approach

1. σ^0 observations from scatterometers



2. Wind GMF

3. Wind Speed + Direction

4. Whitecap Parameterization

$$W = aU^b$$

5. Whitecap Estimate

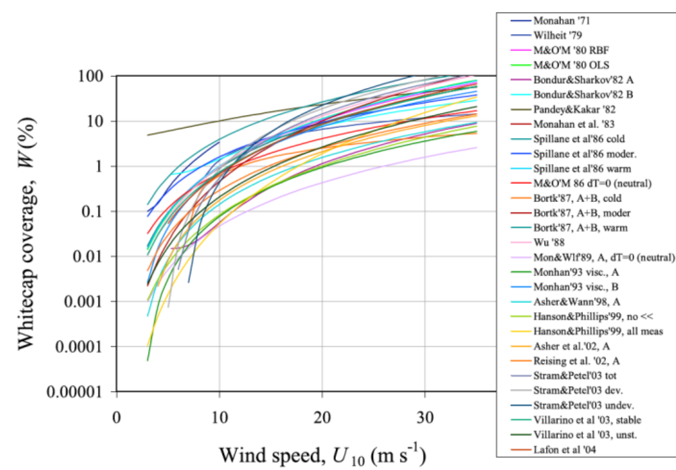


Figure 1. Various parameterizations for $W(U_{10})$ relation.

Proposed Whitecap Estimation Approach

Measure whitecap fraction directly from σ^0

1. σ^0 observations from scatterometers

2. Whitecap GMF

3. Whitecap fraction

Proposed Whitecap Estimation Approach

Potential advantages

1. Reduced uncertainty to whitecap estimates

2. Explain whitecap contributions to wind signal

3. A new 10-year whitecap fraction dataset

4. Potential to determine wave directionality

The Theory

- Scatterometers measure the surface backscatter
- Surface backscatter increases with surface bubbles
- Capillary waves and whitecaps are bright in Ku-band
- The backscatter signal includes the whitecap response

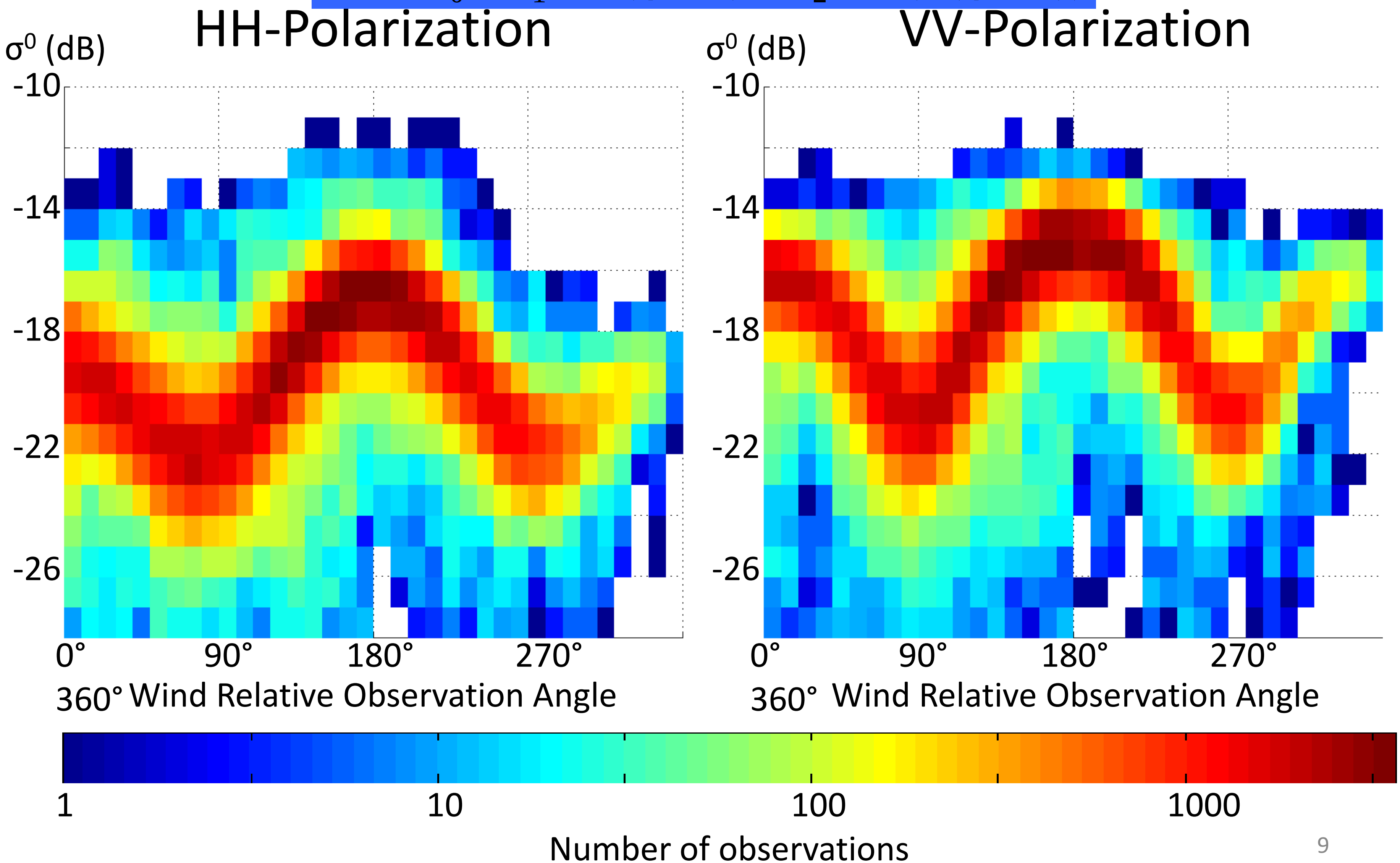
Goal: Develop a whitecap GMF for QuikSCAT

- Matchups between QuikSCAT σ^0 and the WindSat Whitecap Database (WWD)
  - 10 GHz WWD (Active whitecap fraction)
  - 0.5° spatial grid
  - 90-minute temporal window
  - January – December 2006
  - Approximately 40 QuikSCAT observations per WWD observation
  - 3.5 million matchups
- Determine directional response and strength
- Develop a GMF to determine whitecap fraction
  - To run only with values and parameters available in L1B files
- Reduce overall estimation error

GMF Development

for *W* between 1% and 1.1%

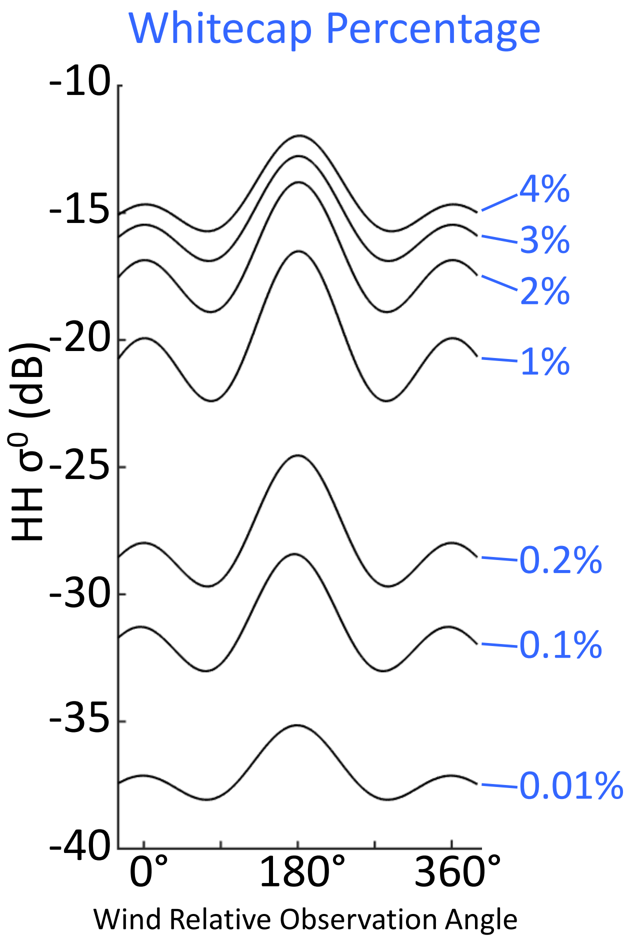
$$s^0 = a_0 + a_1 \cos(q + f) + a_2 \cos(2(q + f))$$



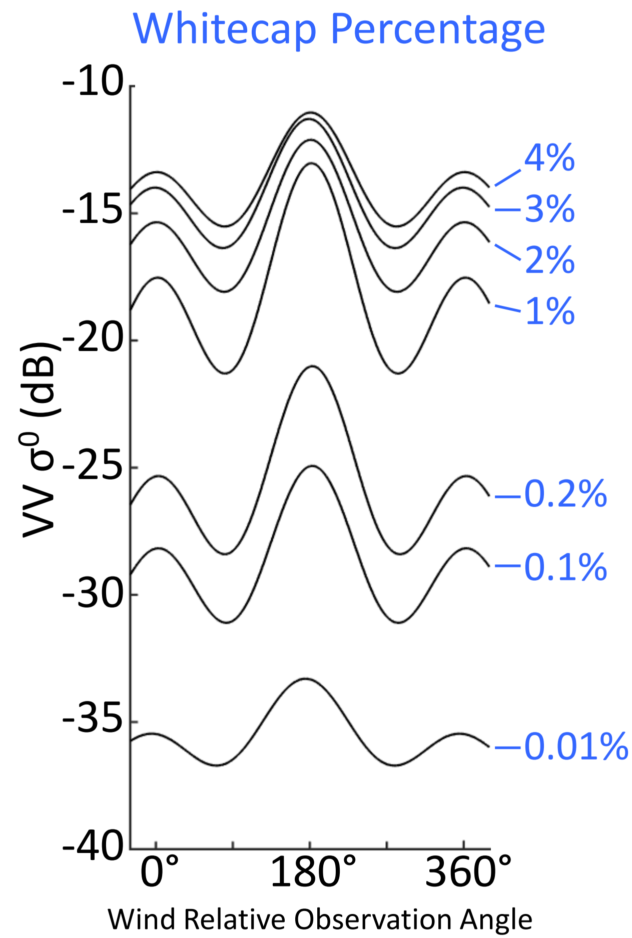
Preliminary Results

$$s^0 = a_0 + a_1 \cos(q + f) + a_2 \cos(2(q + f))$$

HH-polarization



VV-polarization

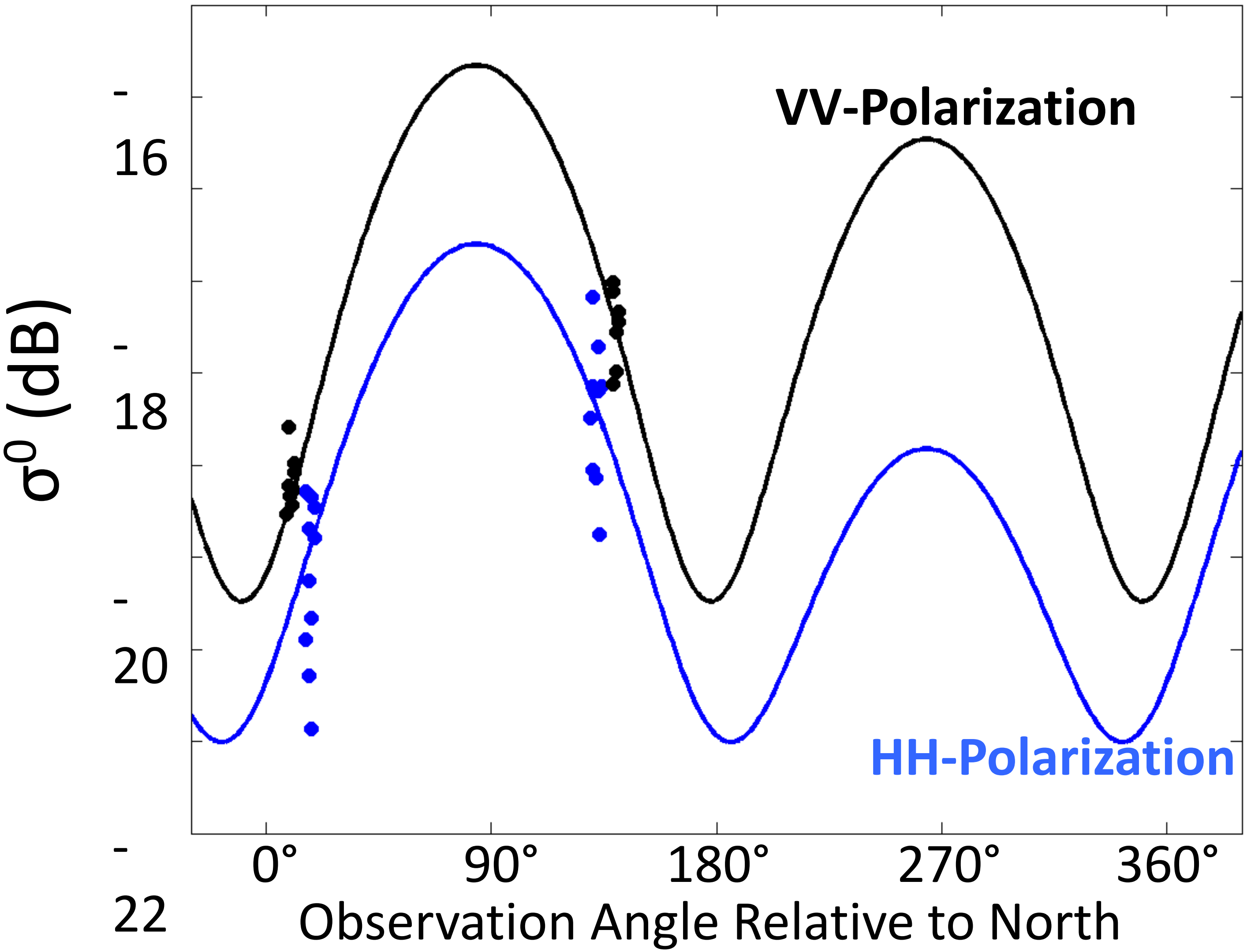


Wind speeds up to 20 m s^{-1}

Preliminary Results

$$s^0 = a_0 + a_1\cos(q+f) + a_2\cos(2(q+f))$$

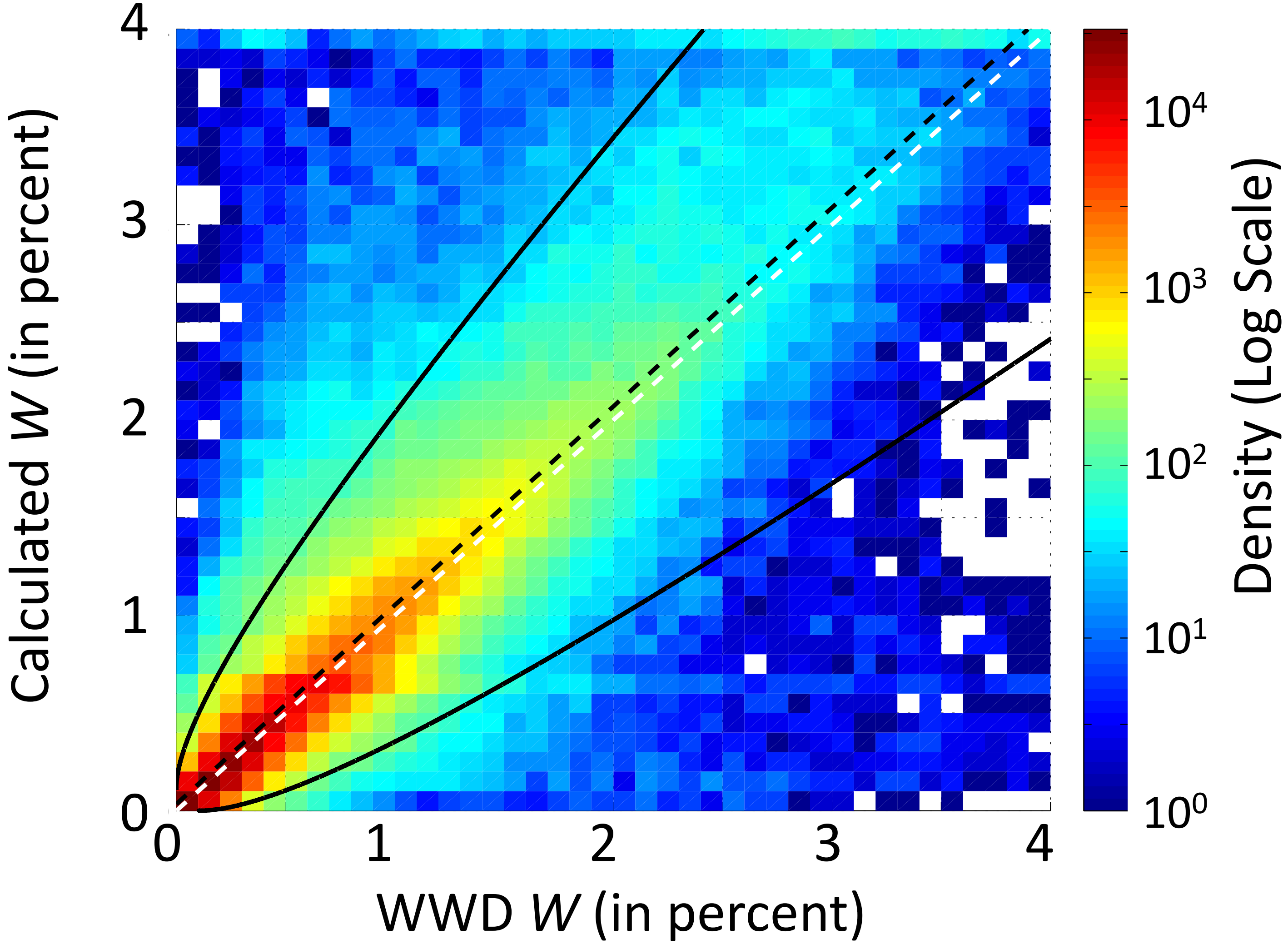
$W = 1\%$



Preliminary Results

WWD vs whitecap GMF *W* estimates (σ^0 – only)

Bias = +0.034



Conclusions

- Preliminary results are encouraging
  - Whitecaps are directionally responsive in σ^0
  - The whitecap GMF estimates *W*
  - Whitecap GMF error is less than possible satellite wind *W* parameterization error for over 95% of cases
- More refinement of the whitecap GMF is required
  - Tuning for smaller spatial regions
  - Inclusion of other parameters
  - Reduce estimation errors
- Differences in passive 10 GHz (WindSat) and active Ku-band (QuikSCAT) surface observations need to be determined

Thoughts?

(THE END)

How Whitecaps Form