Estimating the active and total whitecap coverage globally using satellite-derived winds

Aaron C. Paget [1,2] and Mark A. Bourassa [1,2,3]

Florida State University

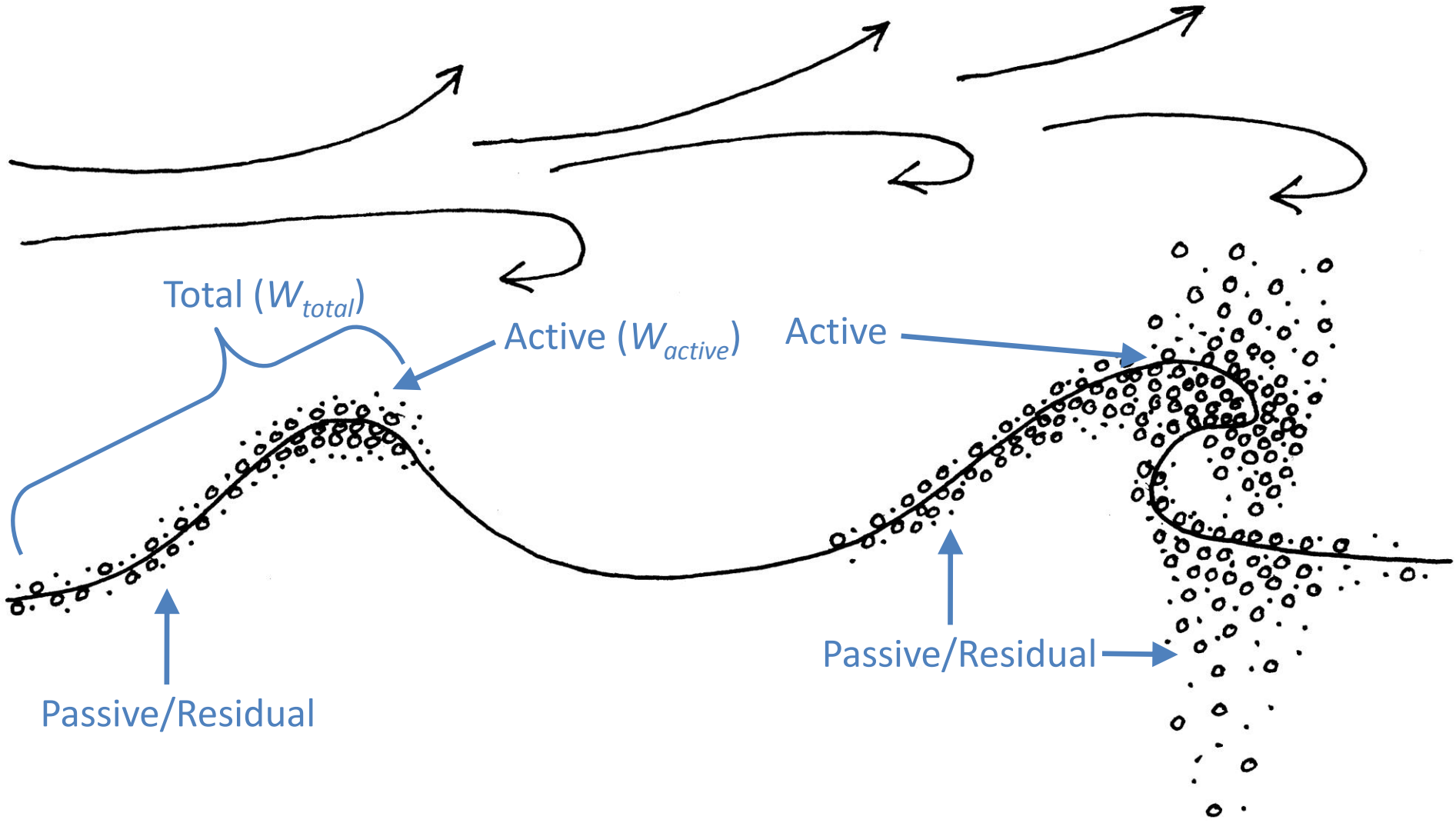
1) Geophysical Fluid Dynamics Institute (GFDI)

2) Center for Ocean-Atmospheric Prediction Studies (COAPS)

3) Department of Earth, Ocean, and Atmospheric Science (EOAS)

funding from NGI & NOAA

How Whitecaps Form



Whitecaps and Satellites

- Whitecaps influence visible, infrared, and microwave bands
- MODIS problems with whitecaps for $U_{10} > 8$ ms^{-1}
- Whitecap Database (WD) uses WindSat microwave emissivity to calculate whitecap coverage [*Anguelova and Webster*, 2006]
  - 0.5°x0.5° global grid, daily
  - Active (W_{active} - 10 GHz) and Total (W_{total} - 37 GHz)

Research Question

- Can local whitecap coverage be estimated using available satellite winds and a power law?

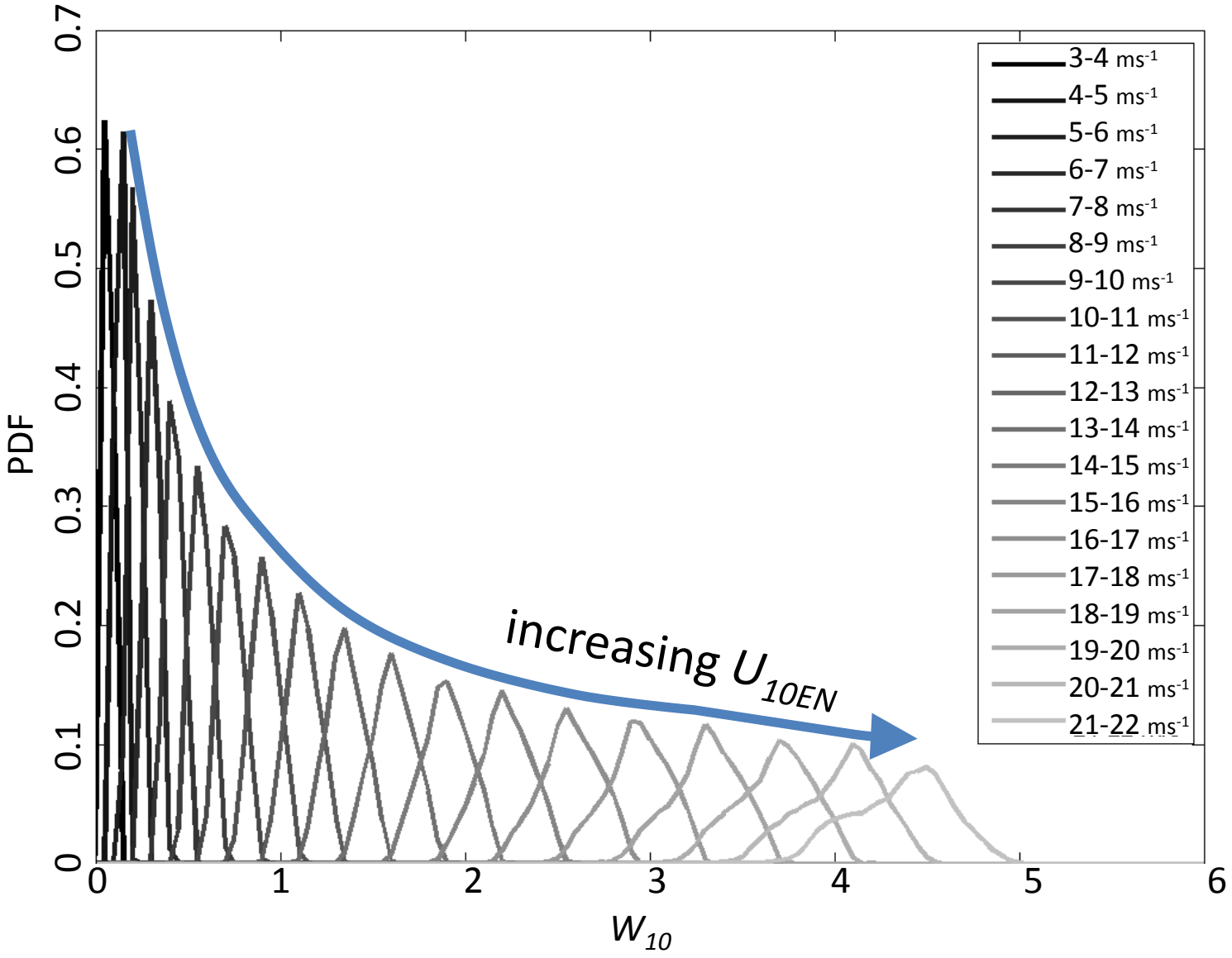
$$W = aU_{10EN}^{\ b}$$

- Whitecap observations
  - Whitecap Database (W_{active} and W_{total})
- Winds
  - QuikSCAT Level 2b Version 3 Winds (U_{10EN})
  - $3 < U_{10EN} < 22$ ms^{-1}

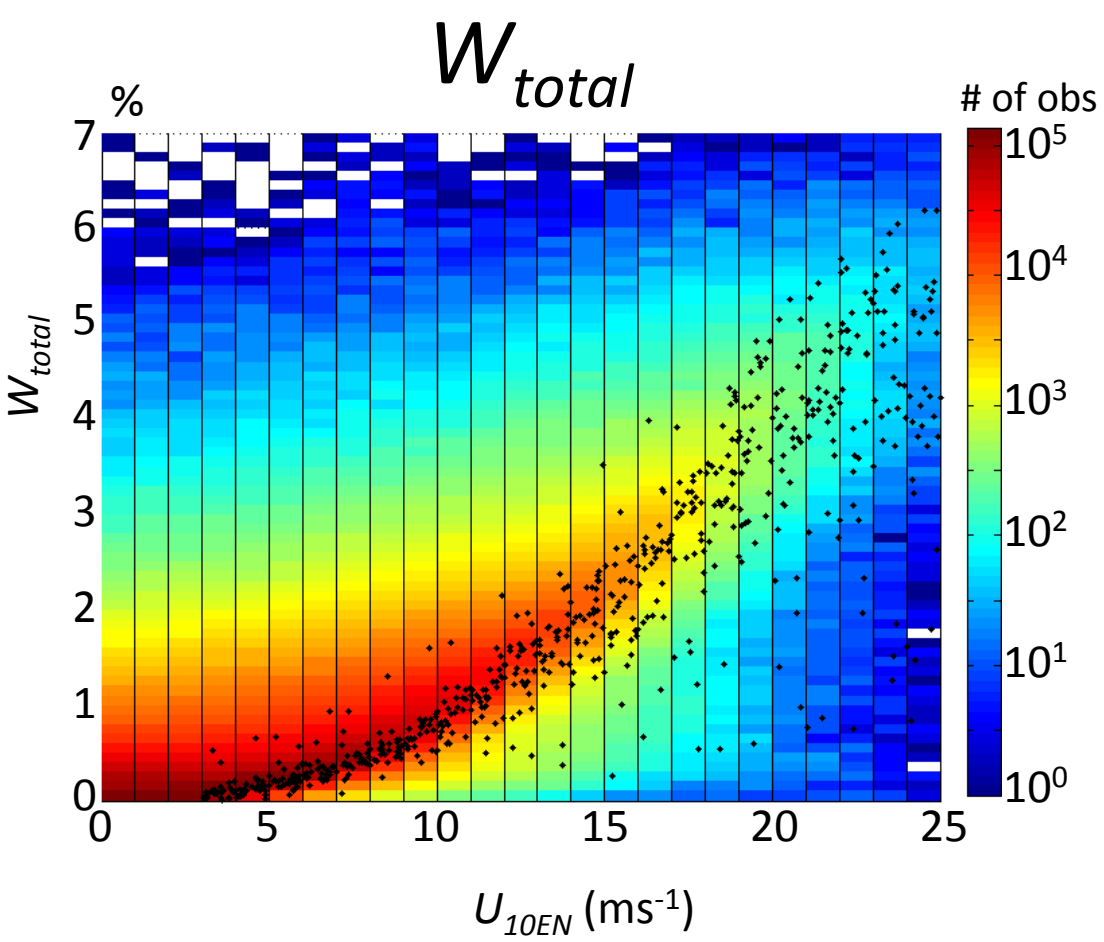
Research Question

- Can local whitecap coverage be estimated using available satellite winds and a power law?
- PDF evaluations
- Binning, Sampling, and Fitting to power law

PDF Evaluation of W_{active}



Binning, Sampling, and Fitting



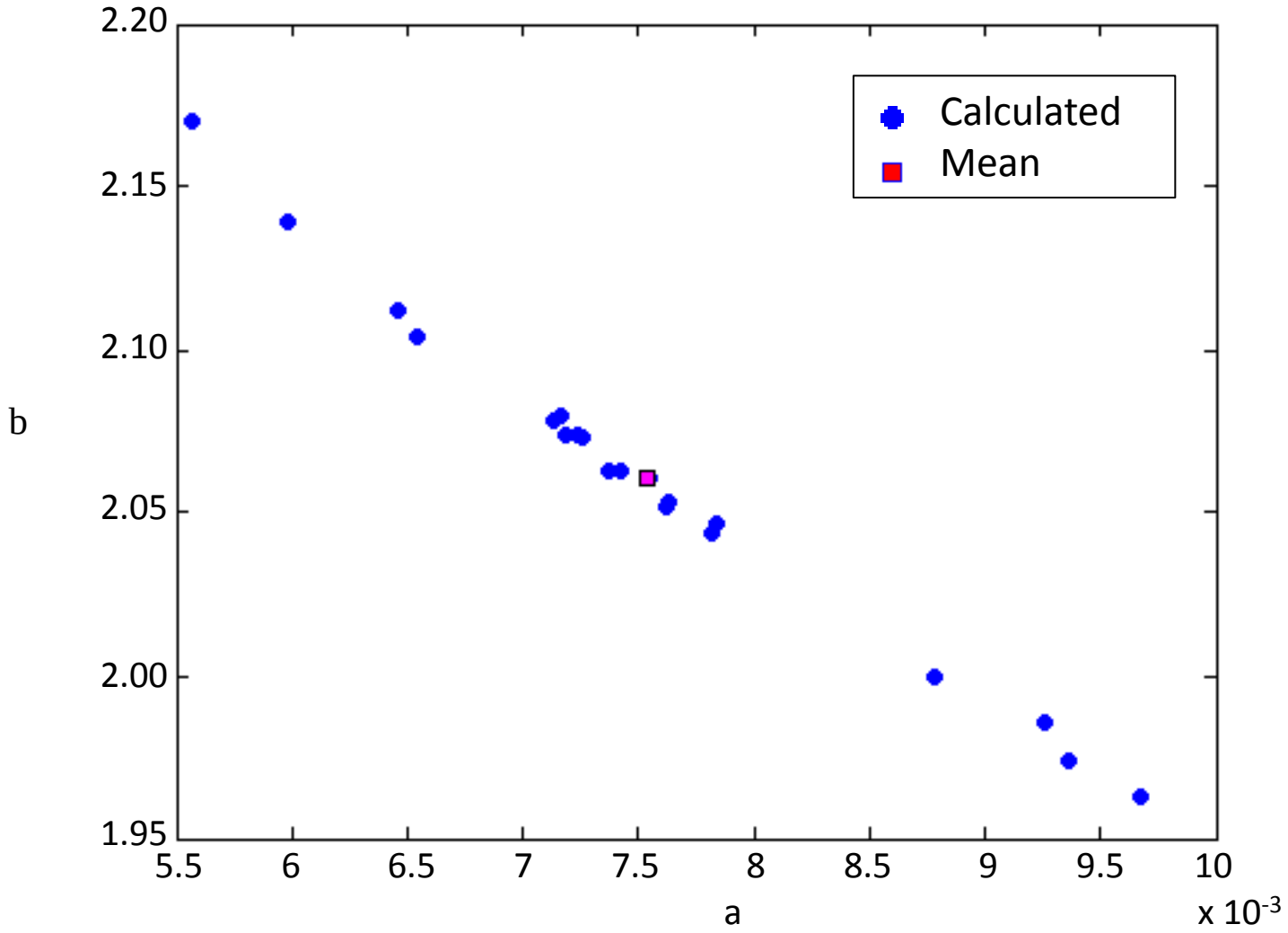
Binning and Sampling
- Maintain mean and variance
- Reduces bias
- Reduces computational resources
- Repeatable

Fit to Function
- Power law equation
- Fit minimizes least squares error
- Coefficients represent best fit

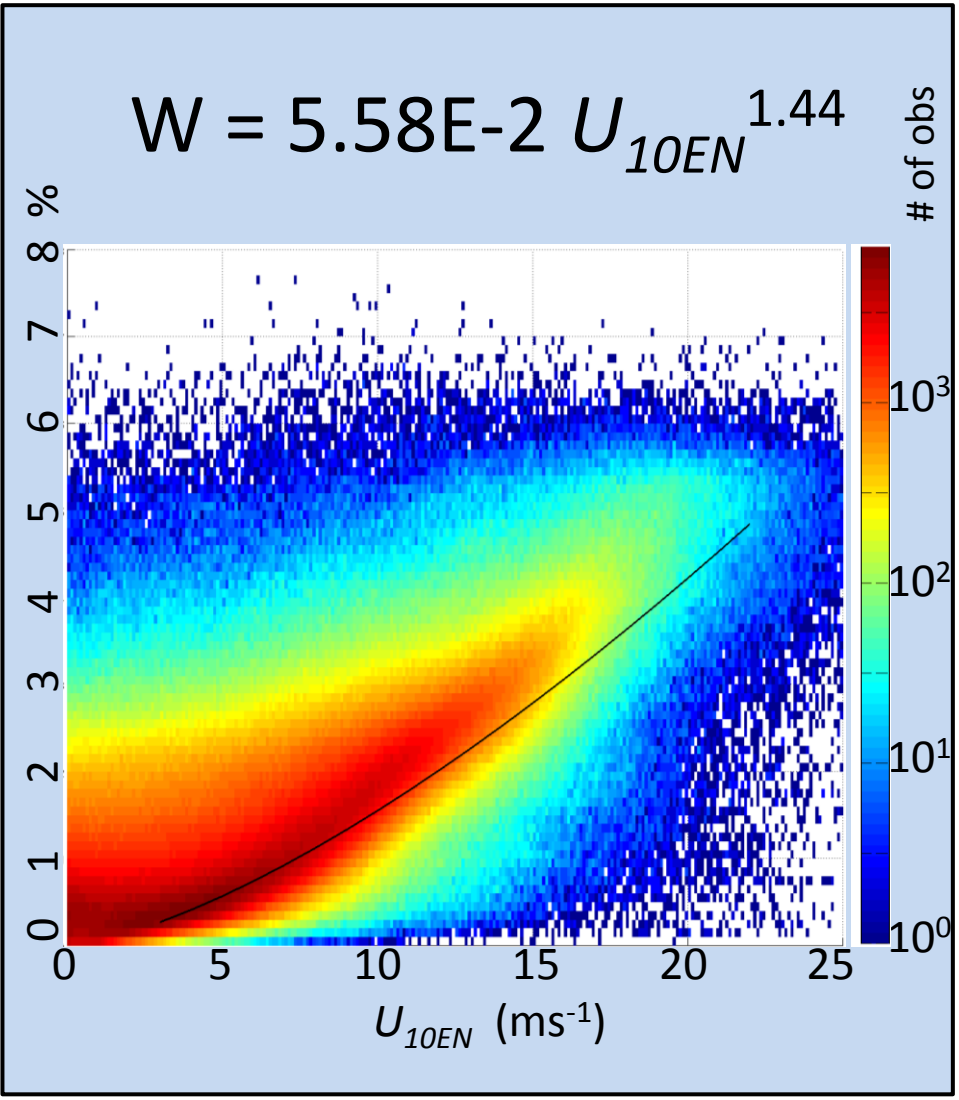
$$W = aU_{10EN}^{\ b}$$

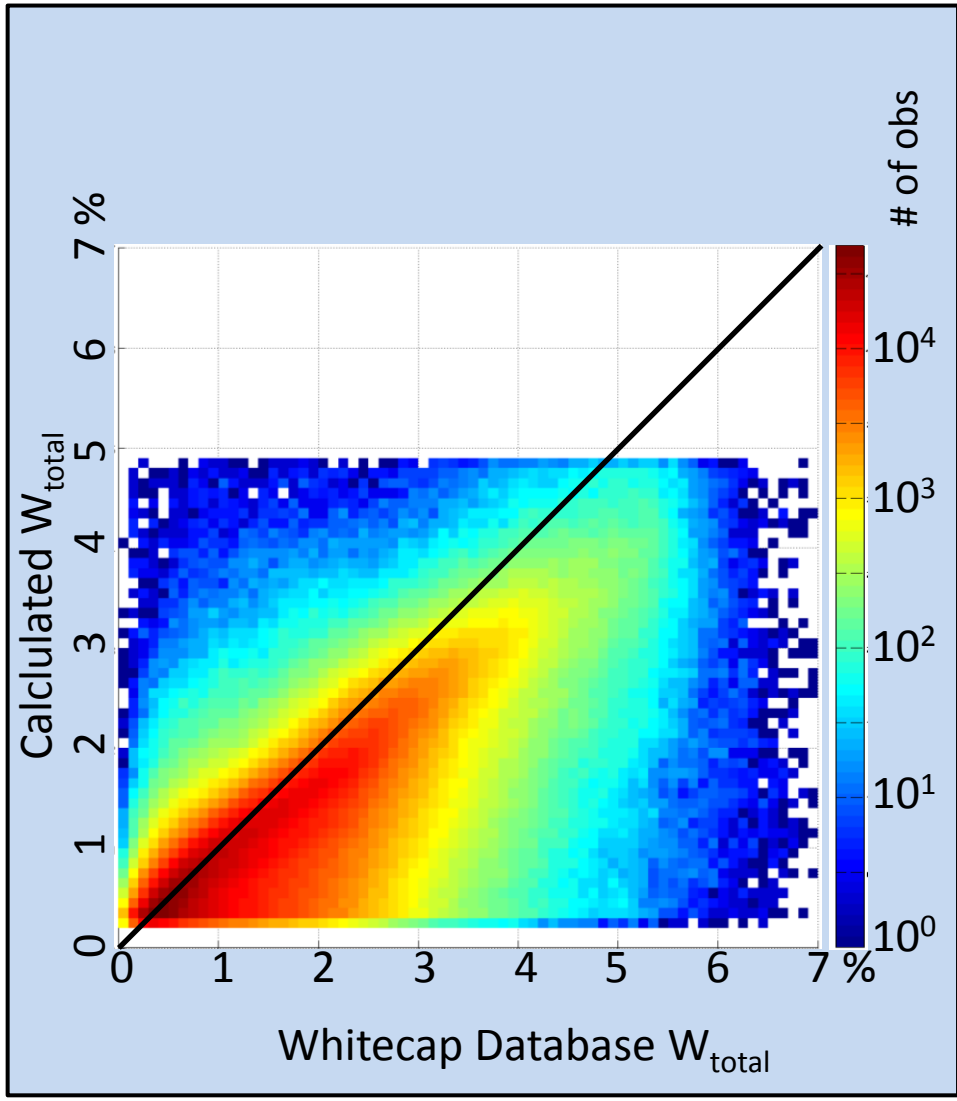
Coefficient Codependence

W_{active} $3 < U_{10EN} < 22$ ms^{-1} $W = aU_{10EN}^{\ b}$

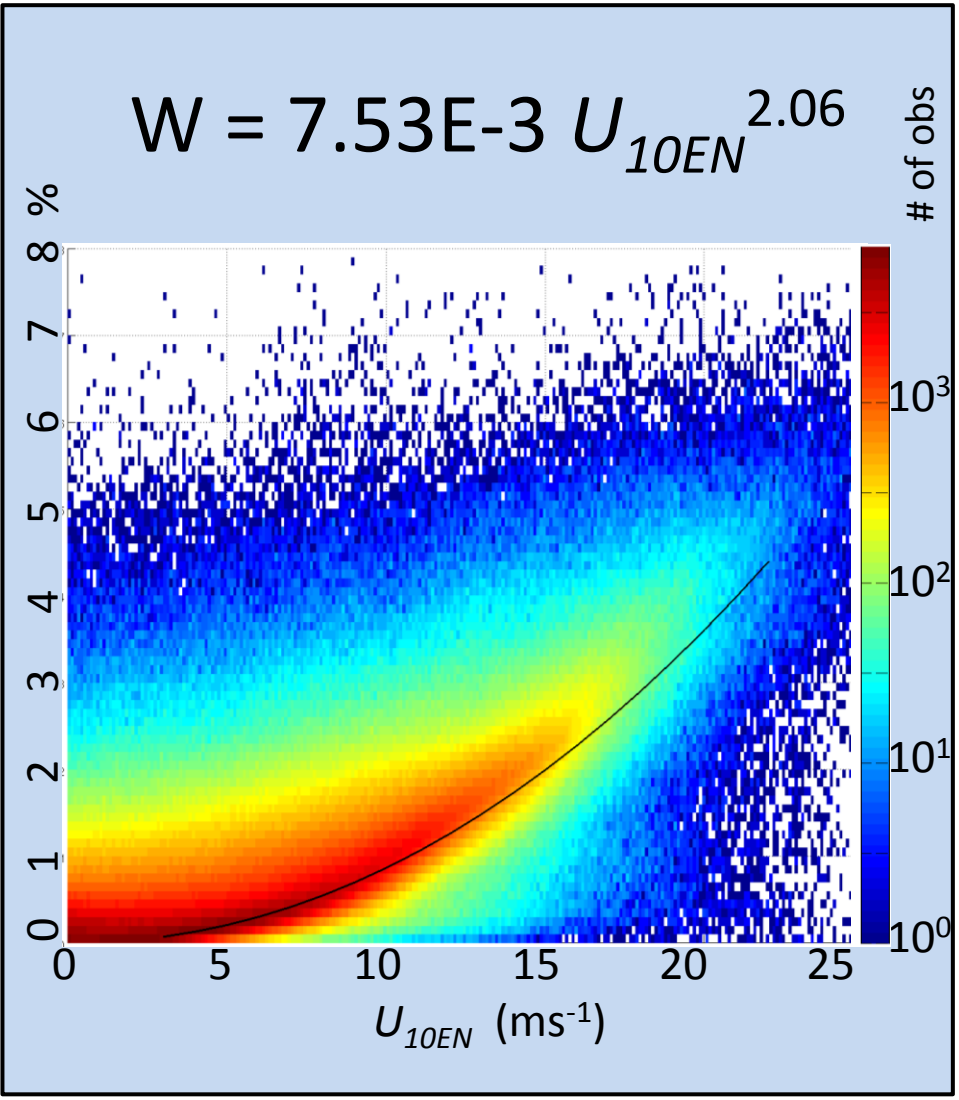


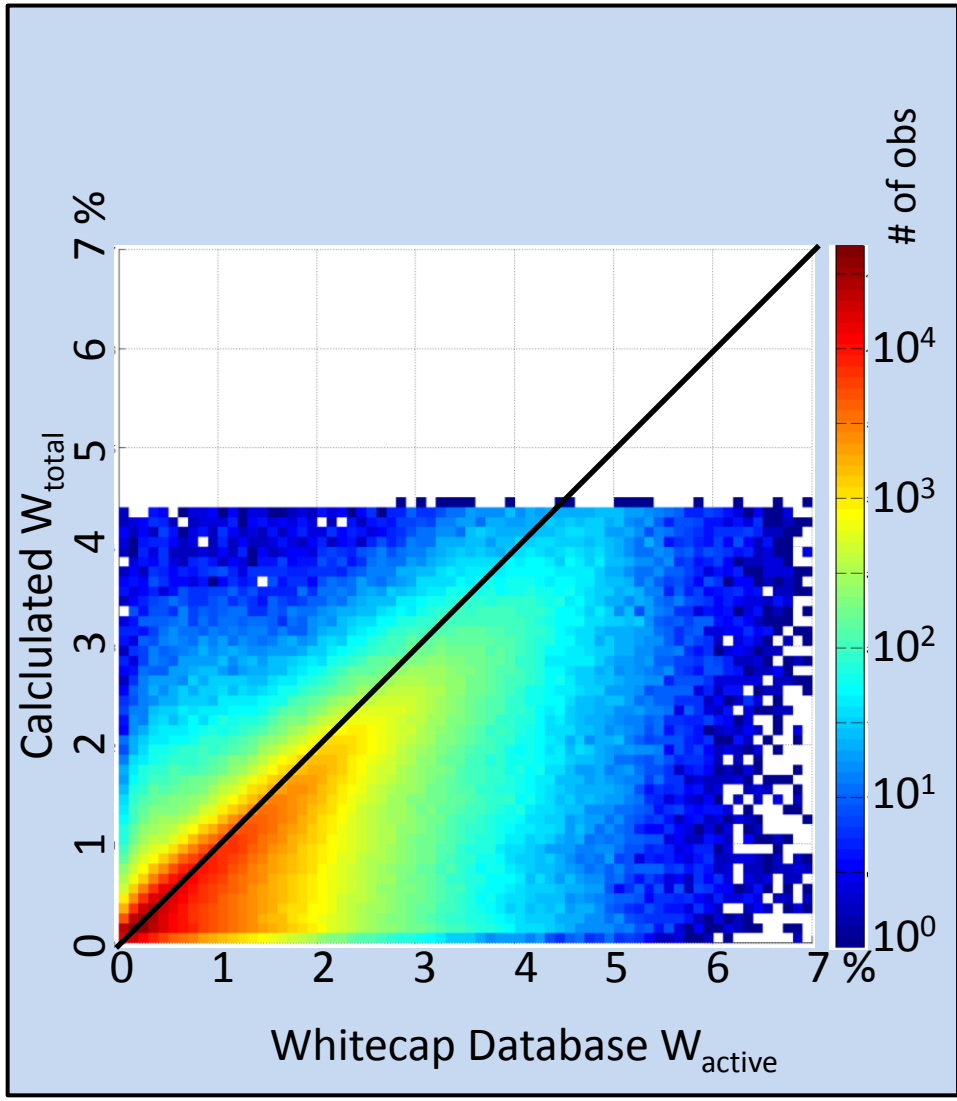
W_{total}


W = 5.58E-2 $U_{10EN}^{1.44}$
# of obs
10^3
10^2
10^1
10^0
0 1 2 3 4 5 6 7 8 %
0 5 10 15 20 25
U_{10EN} (ms^{-1})


# of obs
10^4
10^3
10^2
10^1
10^0
Calculated W_{total}
0 1 2 3 4 5 6 7 %
0 1 2 3 4 5 6 7 %
Whitecap Database W_{total}

W_{active}


W = 7.53E-3 $U_{10EN}^{2.06}$
# of obs
10^3
10^2
10^1
10^0
0 1 2 3 4 5 6 7 8 %
0 5 10 15 20 25
U_{10EN} (ms^{-1})


# of obs
10^4
10^3
10^2
10^1
10^0
Calculated W_{total}
0 1 2 3 4 5 6 7 %
0 1 2 3 4 5 6 7 %
Whitecap Database W_{active}

Conclusions

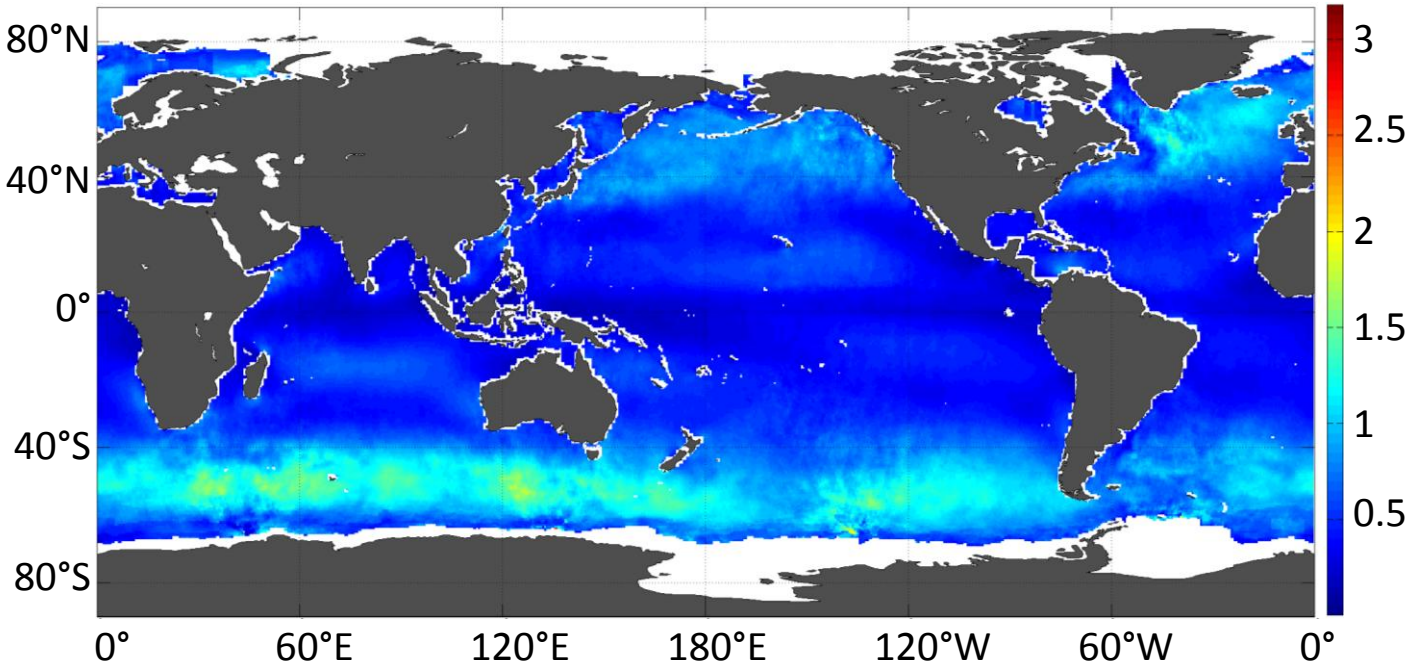
- Power law can be used to estimate W_{total} and W_{active}
- Variance not explained
- Valid for $3 < U_{10EN} < 22$ ms^{-1}

$$W = aU_{10EN}^{\ b}$$

Whitecap	a	b
Active	7.54E-03	2.06
Total	5.58E-02	1.44

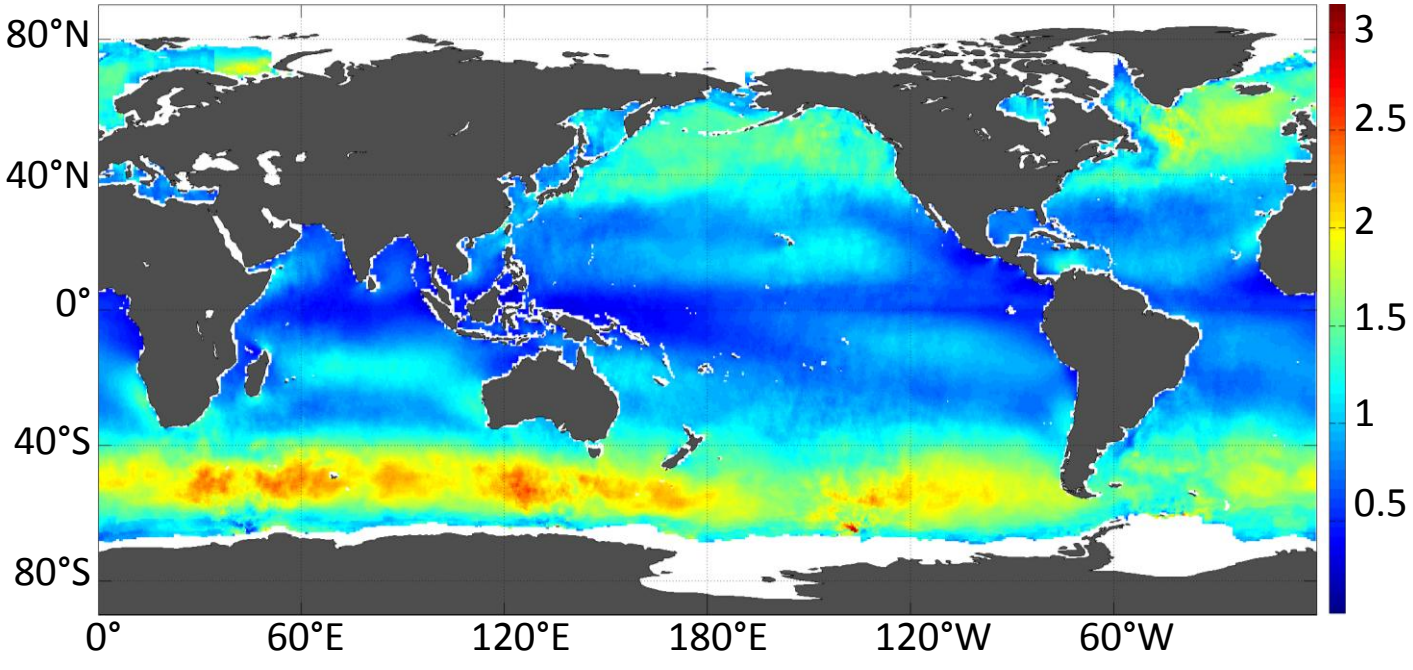
Future applications

- Calibration and validation
- Satellite retrievals of sea surface
- Ocean color – reduce retrieval error
- Turbulent flux parameterizations
- Wave energy dissipation from breaking waves



W_{active} (%)

0.62% global coverage



W_{total} (%)

1.13% global coverage