The influence of non-wind based parameters on estimating the active and total whitecap coverage globally

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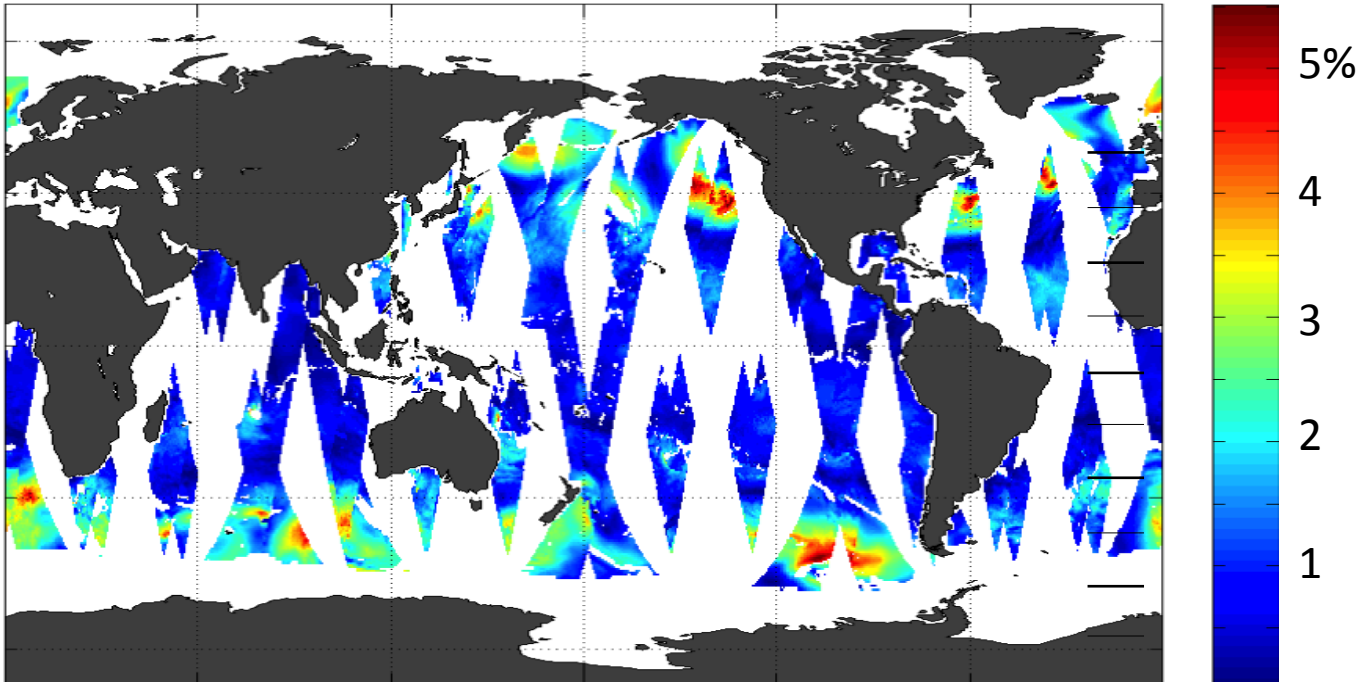
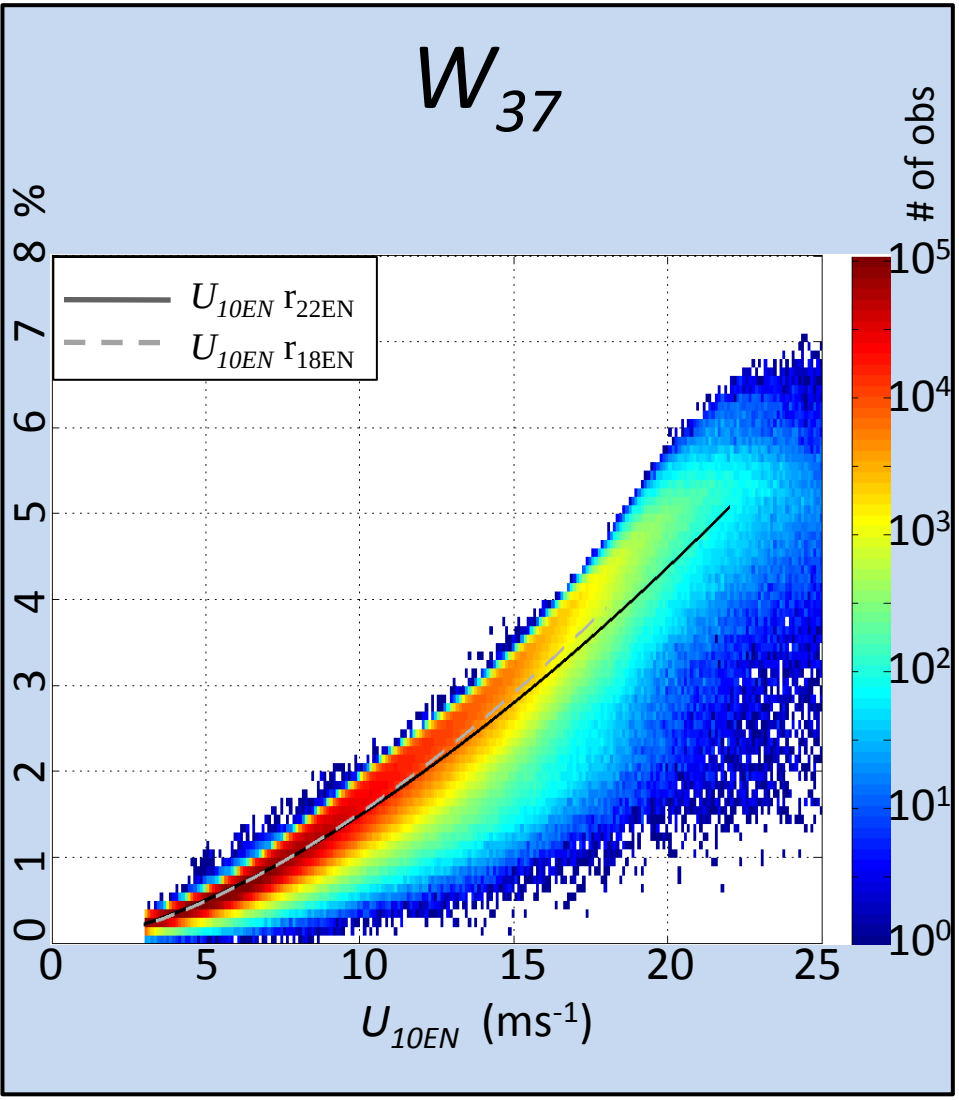
The Great Wave – 1830-1833 Katsushika Hokusai

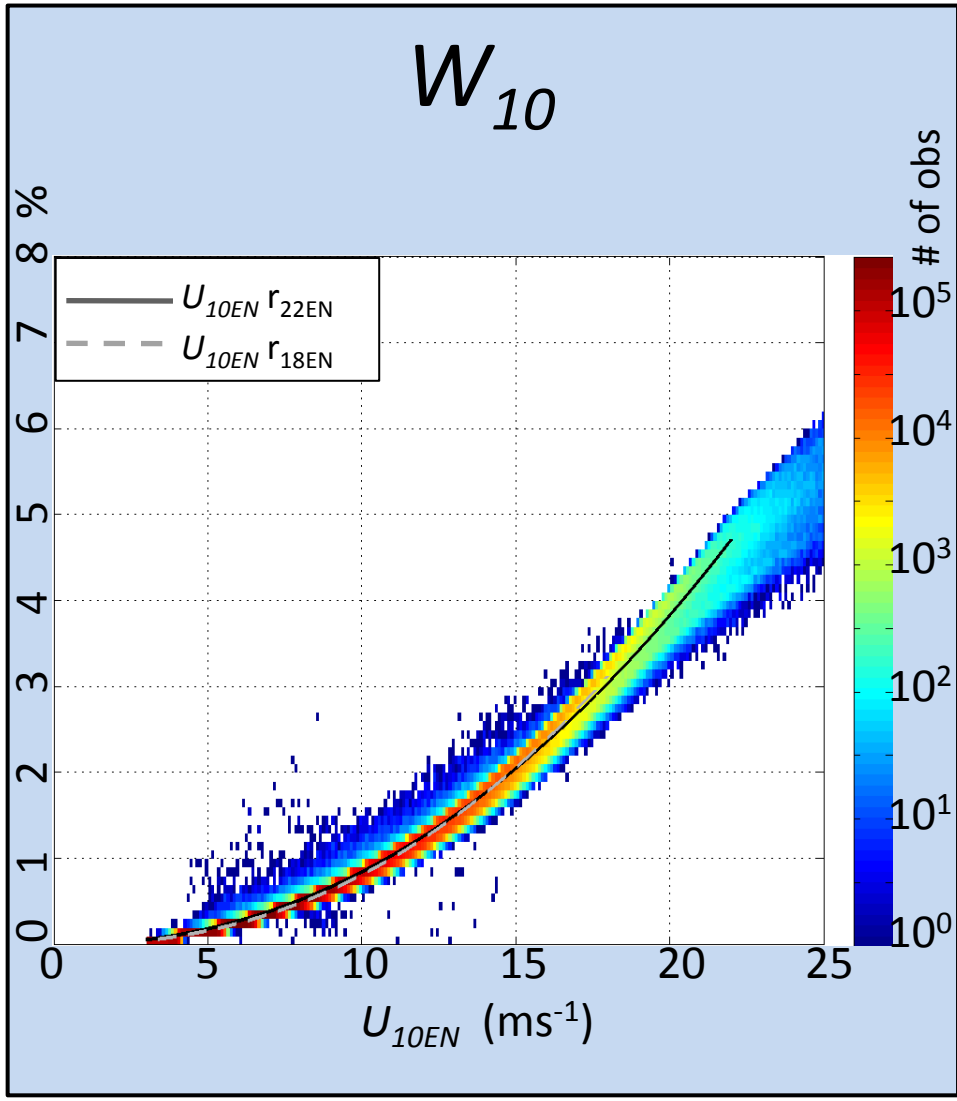
WindSat Whitecap Database

- WindSat Whitecap Database (WWD)
  - WindSat microwave emissivity to calculate whitecap coverage [*Anguelova and Webster*, 2006]
  - 0.5°x0.5° global grid, daily
  - Active (W_{10}) and Total (W_{37}) matched to U_{10EN}



WWD with $W = a\ U_{10EN}^{b}$





What are the important parameters that influence whitecap formation and duration?

What are the important parameters that influence whitecap formation and duration?

- PDF Evaluations
- Exploit the codependence of the power law coefficients with a modified power law

$$W = \alpha(\gamma) U_{10EN}^{\beta(\gamma)}$$

List of Investigated Parameters

SST	Sea Surface Temperature
T_{air}	Air Temperature
Lon	Longitude
Bath	Bathymetry
dT	Air-Sea Temperature Difference
Wave	Non-Dimensional Wave Height
Date	Day of the Year
Season	Seasonally Adjusted Date
Fetch	Fetch
U_{orb}	Orbital Velocity (magnitude)
$dSST_x$	Longitudinal *SST* Gradient
$dSST_y$	Latitudinal *SST* Gradient
$dSST_{xy}$	*SST* Gradient (magnitude)
$U_{10EN}dSST$	Along *SST* Gradient Wind
NH	Northern Hemisphere
SH	Southern Hemisphere
Slope	Slope of Wave

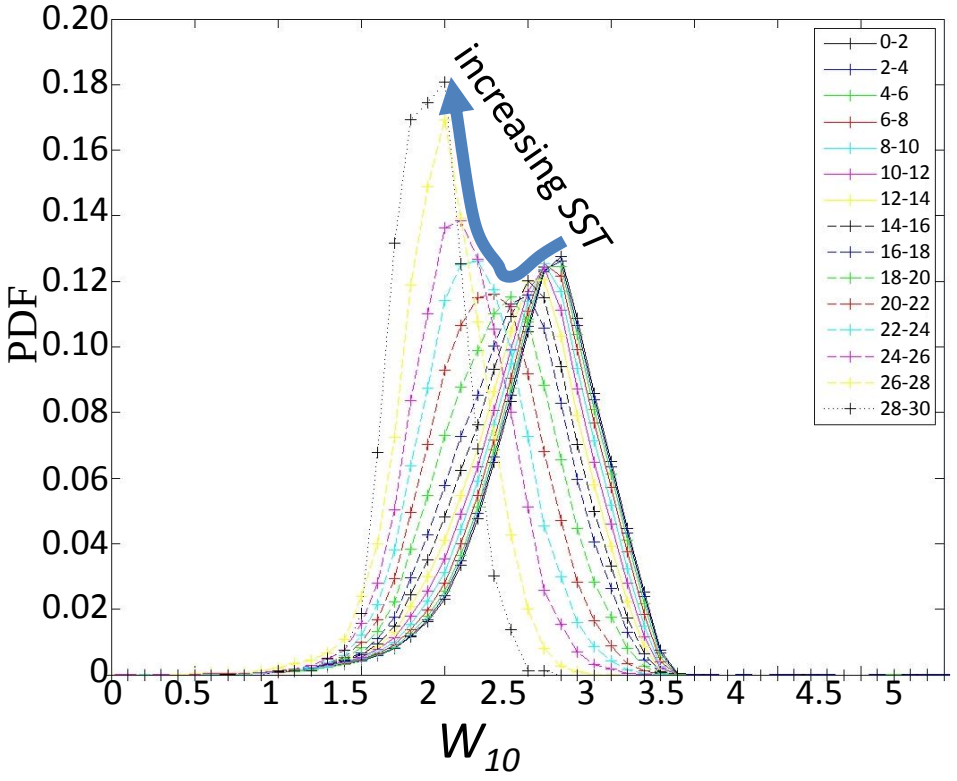
Temperature/Stability Related

Location/Date Related

Wave Dynamics Related

PDF Comparisons

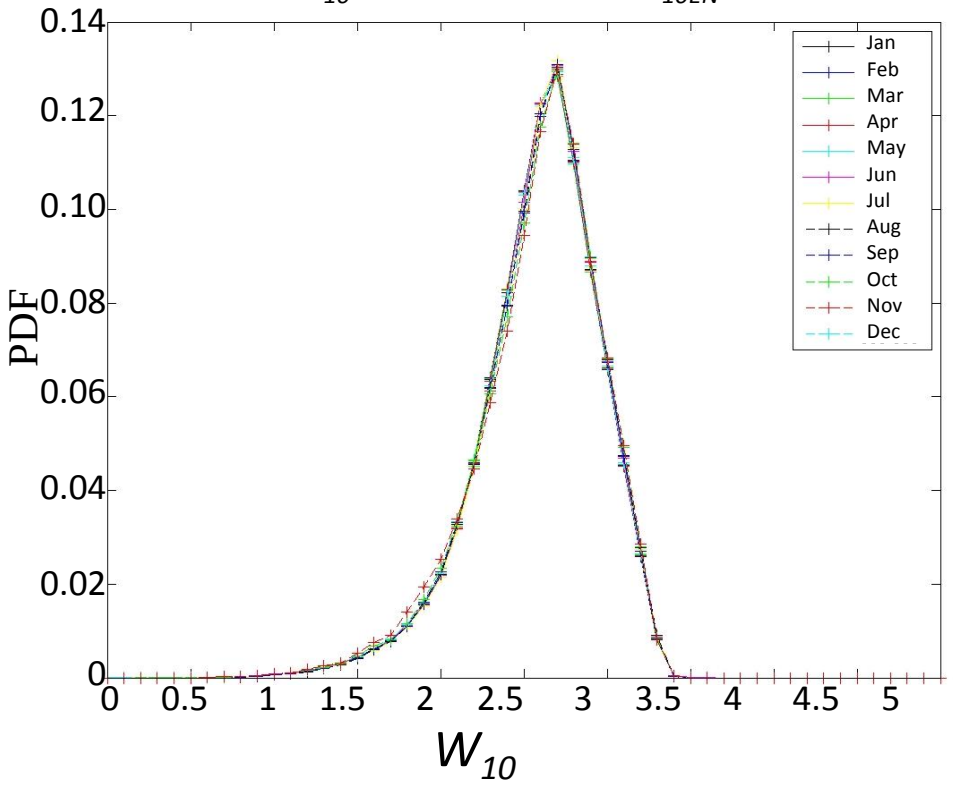
PDF of W_{10} for *SST* (0°C – 30°C) for $13 < U_{10EN} < 15$ ms^{-1}



Shifts & Broadens

Investigate further

PDF of W_{10} for *Date* for $13 < U_{10EN} < 15$ ms^{-1}



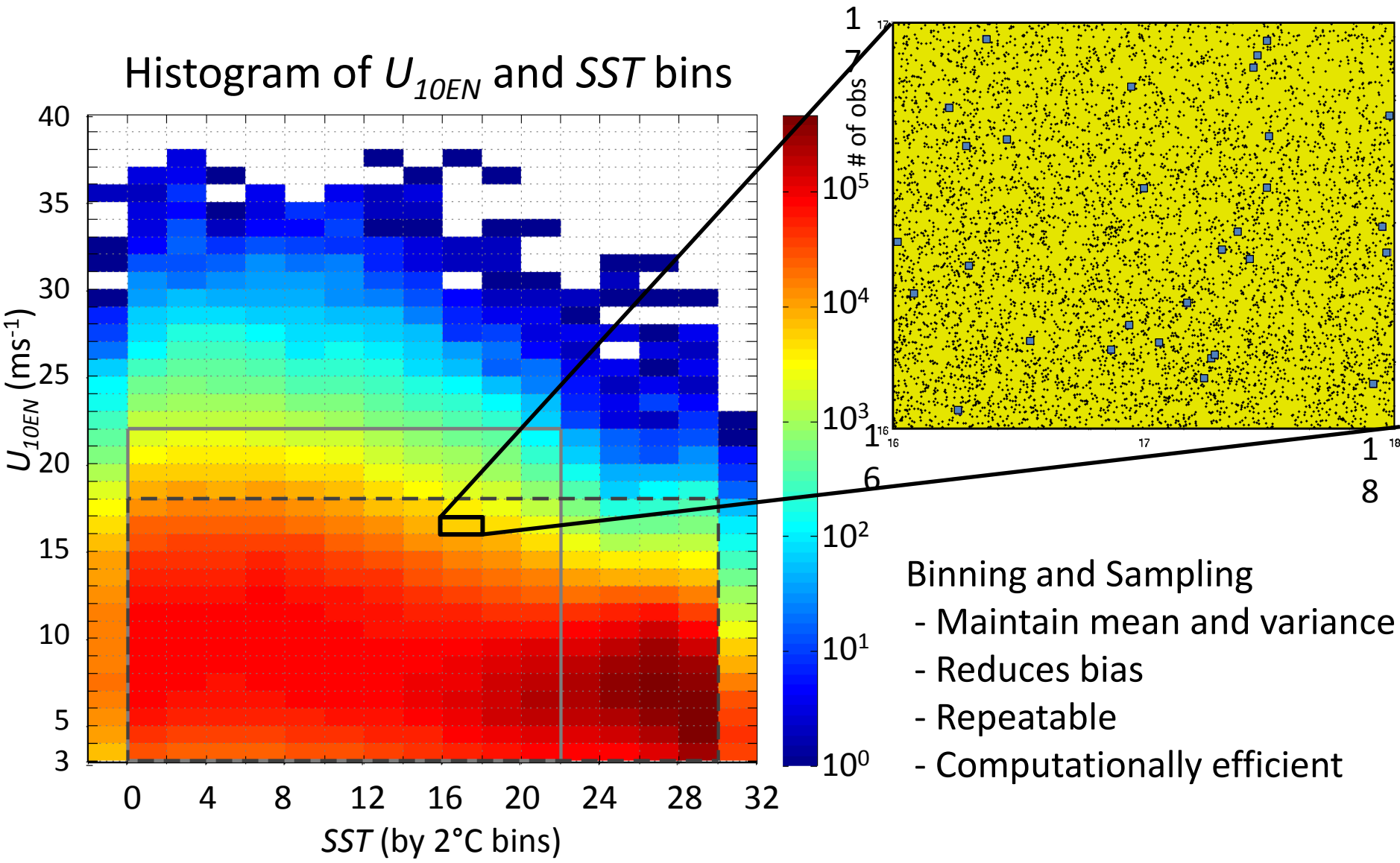
No Shift & No Broaden

No Investigation

Short List

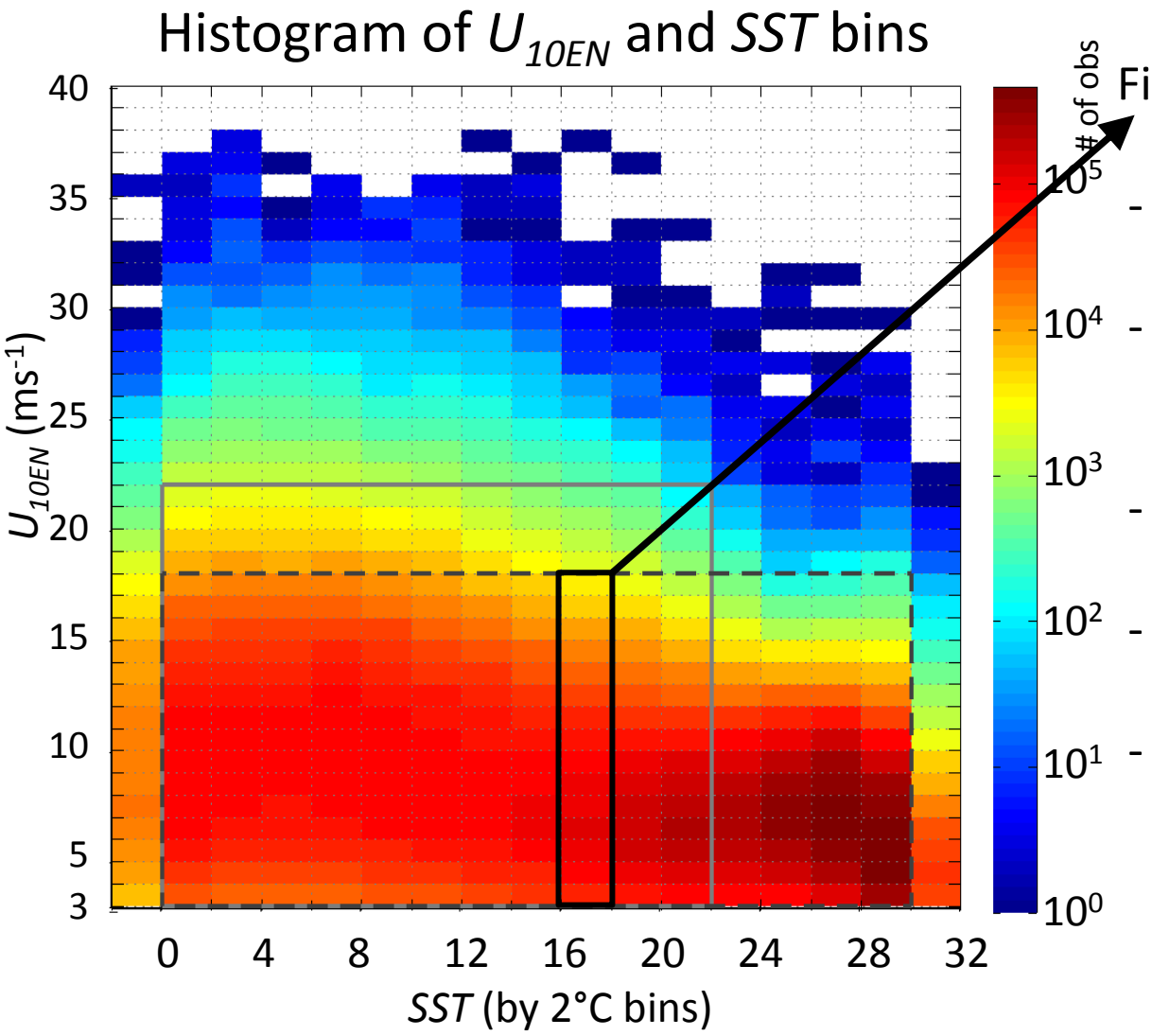
	W_{10}		W_{37}	
Variable Name	r_{18EN}	r_{22EN}	r_{18EN}	r_{22EN}
SST	X	X	X	X
T_{air}	X	X	X	X
Lon				
Bath				
dT	X	X	X	X
Wave	X	X	X	X
Date				
Season				
Fetch	X		X	
U_{orb}	X	X	X	X
$dSST_x$				
$dSST_y$	X	X	X	X
$dSST_{xy}$				
U_{10EN}dSST	X	X	X	X
NH	X	X	X	X
SH	X	X	X	X
Slope	X	X	X	X

Sampling U_{10EN} and *SST*



Binning and Sampling
- Maintain mean and variance
- Reduces bias
- Repeatable
- Computationally efficient

Sampling U_{10EN} and *SST*



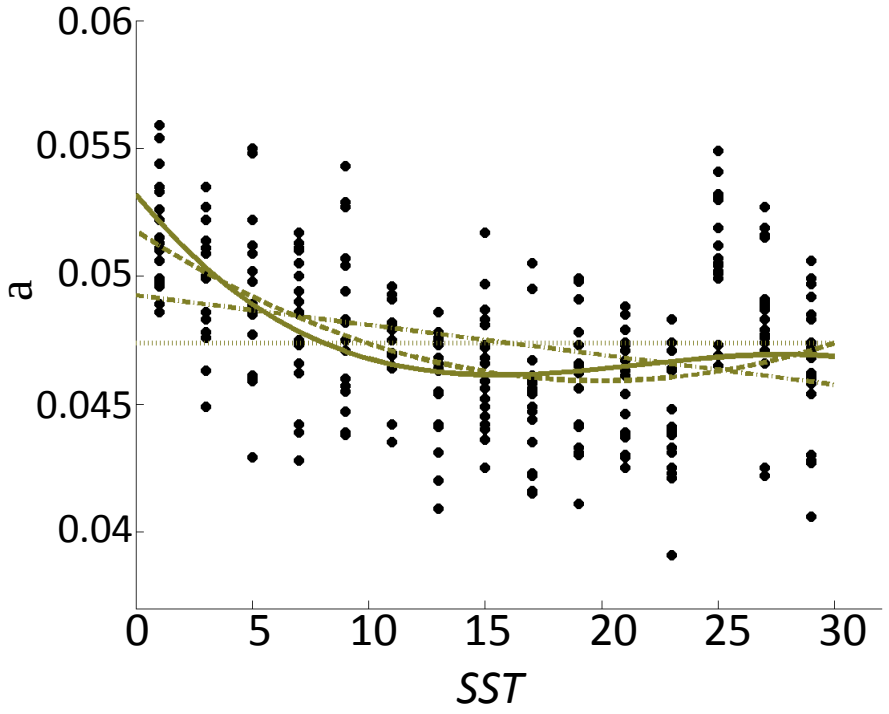
Fit to Power law equation

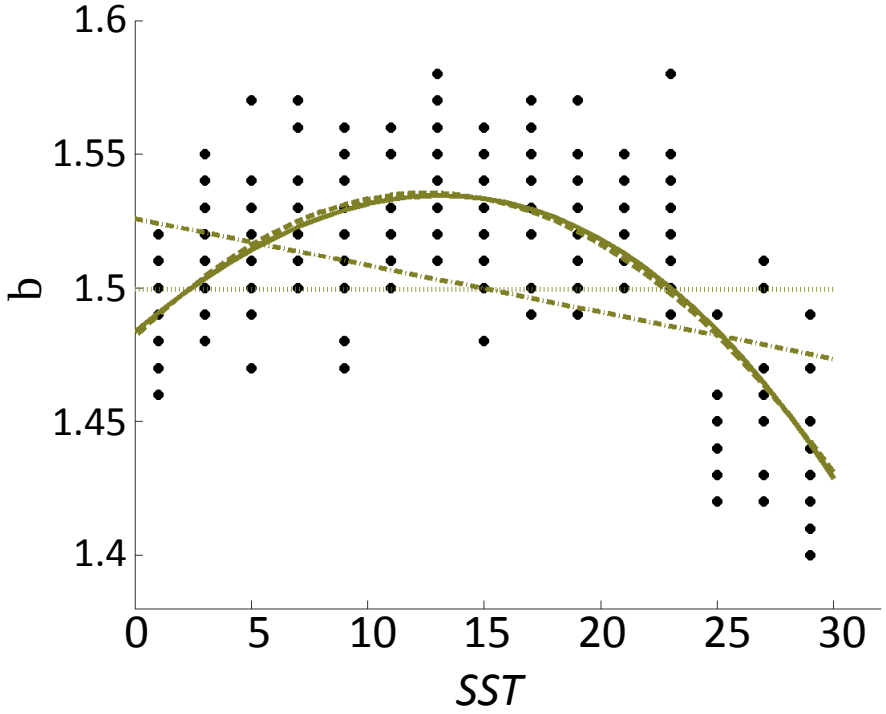
- Sampled values
- Fit minimizes least squares error
- Repeat 20 times
- Repeat for each *SST* range
- Coefficients represent best fit

Modified Power Law

$$W = \alpha(\gamma) U_{10EN}^{\beta(\gamma)}$$

	α(γ)	β(γ)
Constant	$\alpha=\alpha_1$	$\beta=\beta_1$
Linear	$\alpha=\alpha_1*\gamma+\alpha_2$	$\beta=\beta_1*\gamma+\beta_2$
Quadratic	$\alpha=\alpha_1*\gamma^2+\alpha_2*\gamma+\alpha_3$	$\beta=\beta_1*\gamma^2+\beta_2*\gamma+\beta_3$
Cubic	$\alpha=\alpha_1*\gamma^3+\alpha_2*\gamma^2+\alpha_3*\gamma+\alpha_4$	$\beta=\beta_1*\gamma^3+\beta_2*\gamma^2+\beta_3*\gamma+\beta_4$





Ranking

- 4-α(γ) x 4-β(γ) equations give 16 pairs
- Equations Ranked
  - Least Sum of Absolute Error
- Best α – β pair retained for later use

Short List of Parameters

	W_{10}				W_{37}			
	r_{18EN}		r_{22EN}		r_{18EN}		r_{22EN}	
Variable Name	α	β	α	β	α	β	α	β
SST	1	1	0	1	3	2	1	1
T_{air}	1	1	3	3	1	2	2	2
dT	0	3	0	1	3	3	2	2
Wave	0	1	2	3	0	0	2	3
Fetch	2	2	-	-	2	2	-	-
U_{orb}	3	3	3	3	2	2	2	3
$dSST_y$	2	3	3	3	3	2	3	3
$U_{10EN}dSST$	0	1	3	2	1	3	2	2
Slope	0	3	0	2	2	2	2	2

0	Constant
1	Linear
2	Quadratic
3	Cubic

Ranked

	W_{10}		W_{37}	
Rank	r_{18EN}	r_{22EN}	r_{18EN}	r_{22EN}
1	T_{air}	U_{orb}	T_{air}	$U_{10EN}dSST$
2	$U_{10EN}dSST$	$dSST_y$	SST	dT
3	SST	SST	dT	$Wave$
4	U_{orb}	$Wave$	$U_{10EN}dSST$	$Slope$
5	$Fetch$	$U_{10EN}dSST$	$Slope$	SST
6	$Wave$	T_{air}	$Fetch$	U_{10EN}
7	$dSST_y$	U_{10EN}	U_{10EN}	U_{orb}
8	U_{10EN}	$Slope$	$Wave$	T_{air}
9	dT	dT	U_{orb}	$dSST_y$
10	$Slope$	-	$dSST_y$	-

- W_{10} - U_{orb}, SST, and $U_{10EN}dSST$. T_{air} and $Fetch$ for $U_{10EN} < 18$ ms^{-1}
- W_{37} - SST, $U_{10EN}dSST$, and dT. T_{air} for $U_{10EN} < 18$ ms^{-1}
- W_{10} and W_{37} - SST and $U_{10EN}dSST$. T_{air} for $U_{10EN} < 18$ ms^{-1}

Conclusions

What are the important parameters that influence whitecap formation and duration?

U_{orb}, *SST*, U_{10EN}*dSST*, T_{air}, *Fetch*, and *dT*

- W_{10} - U_{orb}, *SST*, and U_{10EN}*dSST*. T_{air} and *Fetch* for $U_{10EN} < 18$ ms^{-1}
- W_{37} - *SST*, U_{10EN}*dSST*, and *dT*. T_{air} for $U_{10EN} < 18$ ms^{-1}
- W_{10} and W_{37} - *SST* and U_{10EN}*dSST*. T_{air} for $U_{10EN} < 18$ ms^{-1}