Properties of Residual EM Bias Error

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Residual EM bias error

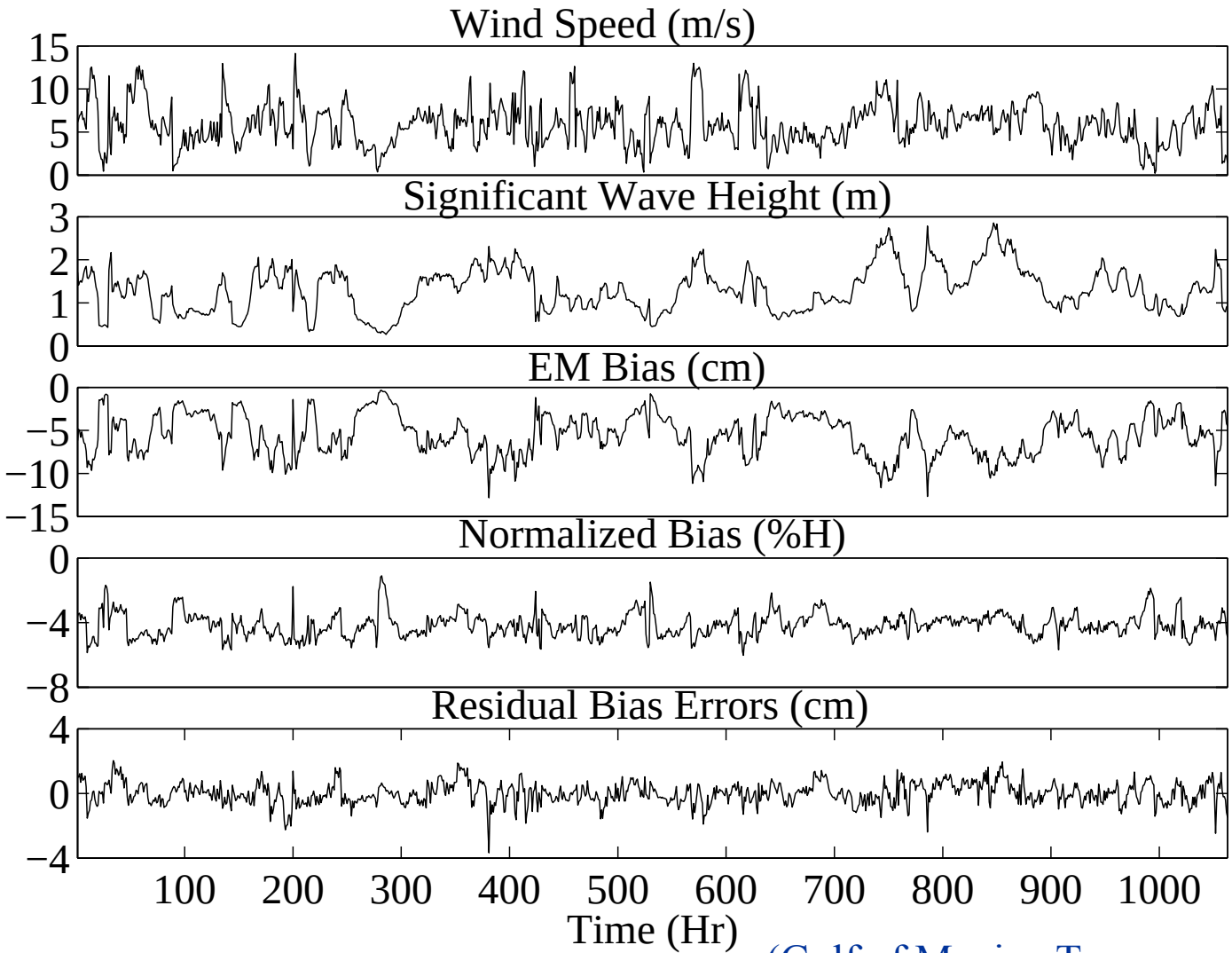
Residual error = remaining bias after correction by empirical parametric or nonparametric wind/wave model:

$$\text{Residual error} = \text{bias} - \text{meanbias}(U,H)$$

Due to finite fetch effects, multiple wave trains, etc., U,H pair does not uniquely specify sea state and hence residual EM bias variability remains.

Goal: Study correlation of residual error with U,H using *in situ* tower bias measurements.

Residual bias error - time series

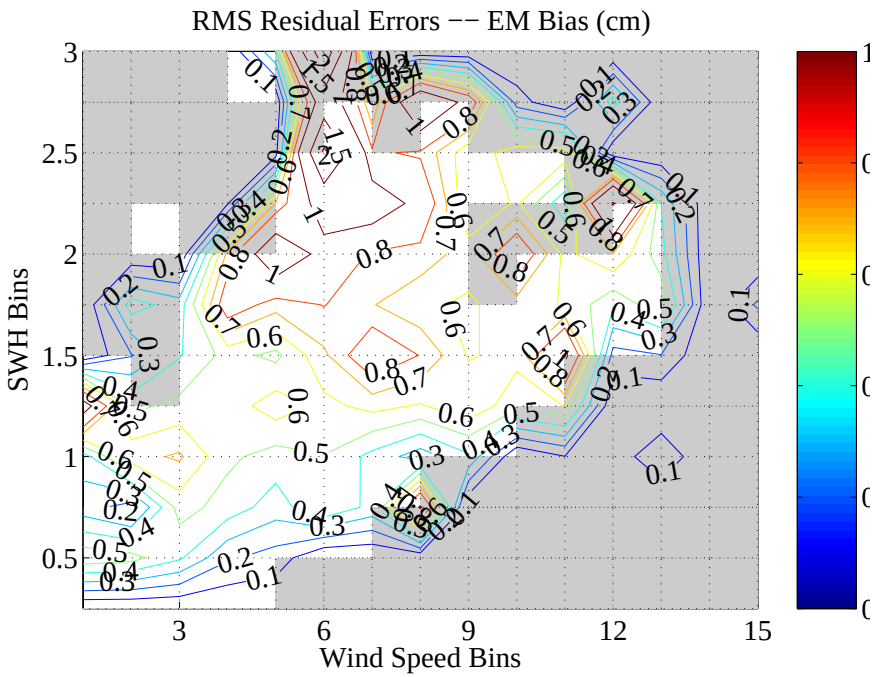


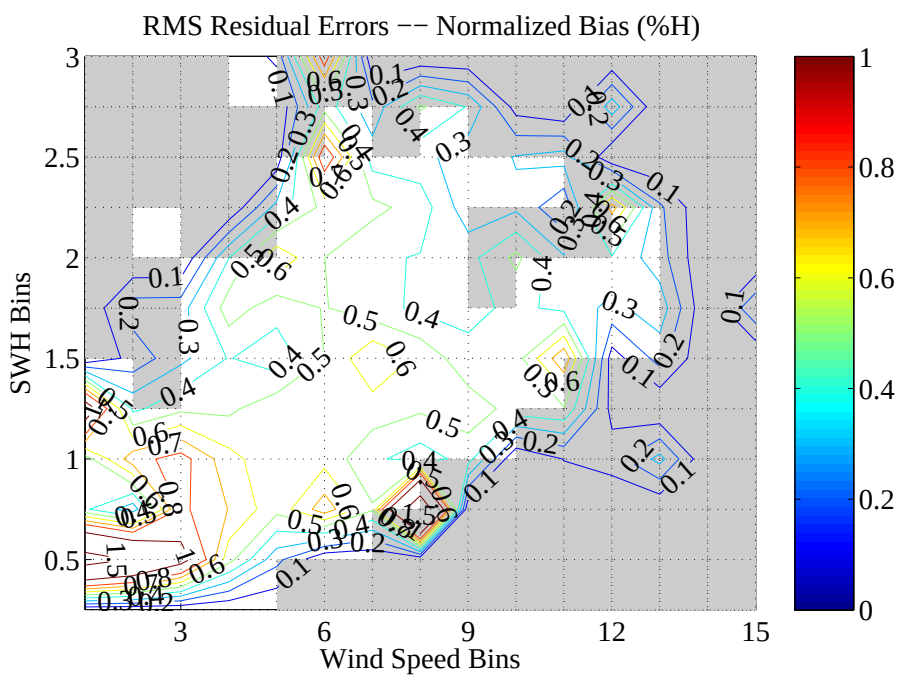
(Gulf of Mexico Tower experiment)

RMS residual bias error

Residual error in wind speed/SWH bins after correction by nonparametric model fit to tower data

Shaded areas indicate low data density





Physics-based EM bias model

Use physics-based model with an additional sea state parameter (RMS long wave slope) to study residual error.

Theoretical form of EM bias:

$$\text{Bias} = -\gamma(U, H)SH$$

S = RMS long wave slope (cutoff = 2.4 m)
H = Significant wave height (SWH)

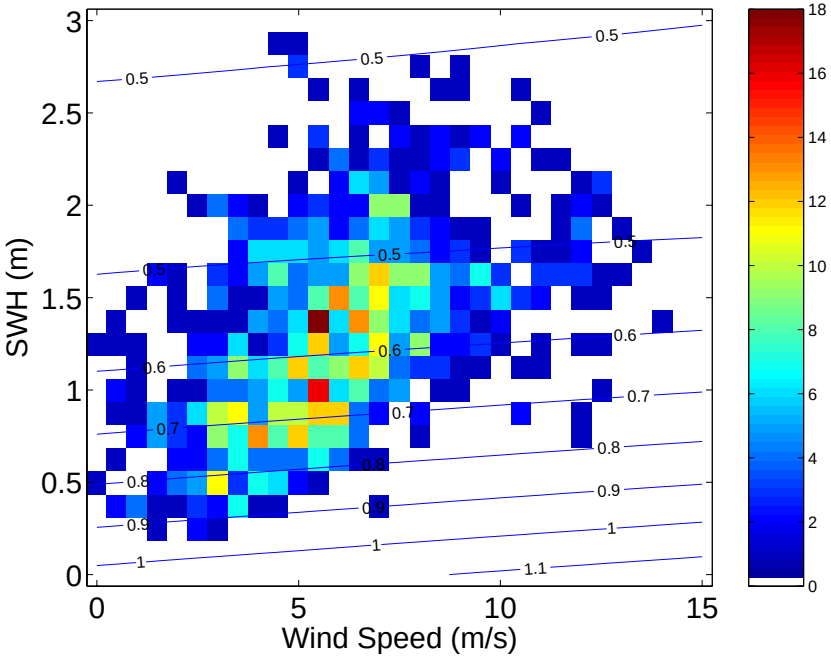
Theory: $\gamma \approx$ constant (0.6), determined by small wave spectrum

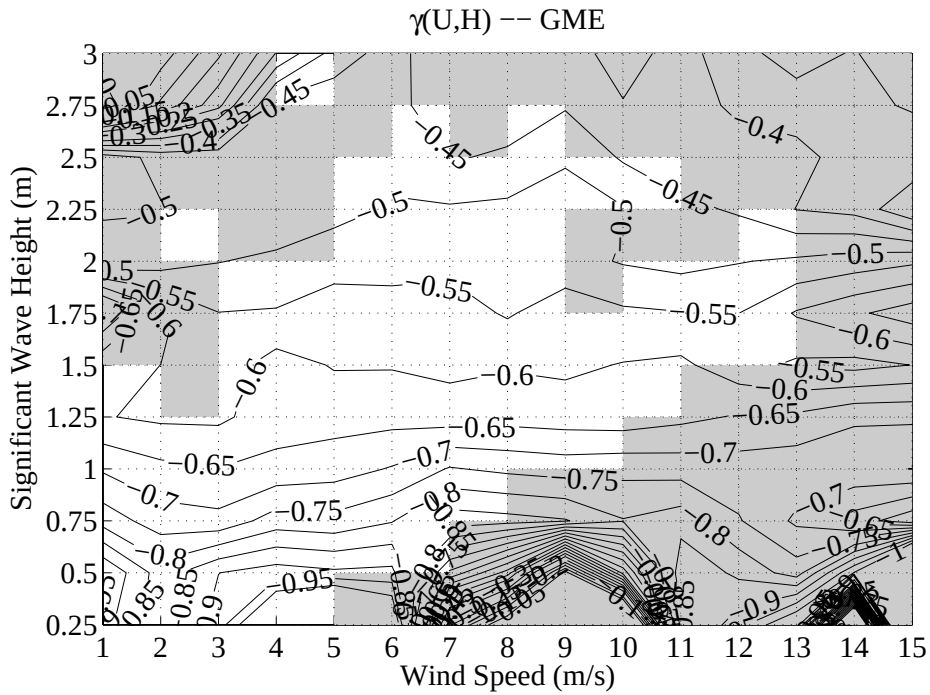
Empirical: fit $\gamma(U,H)$ to tower data set using *low order* polynomial model

Empirical fit of model coefficient

Fit of $\gamma(U,H)$ to tower data set

- Dependence is simple - nearly linear in SWH





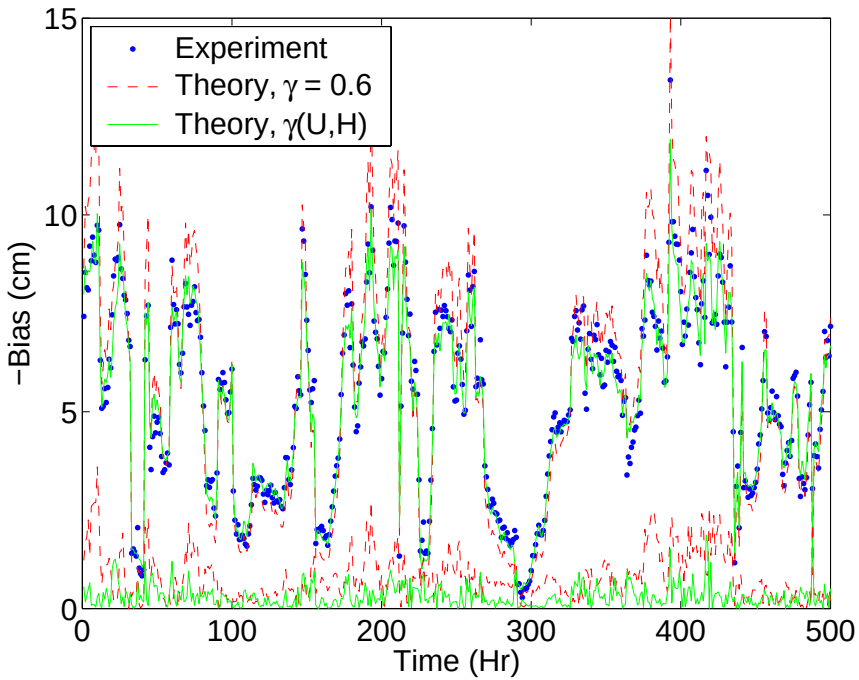
Parametric fit

(second order polynomial)
Overlaid on histogram of wind speed/SWH measurements

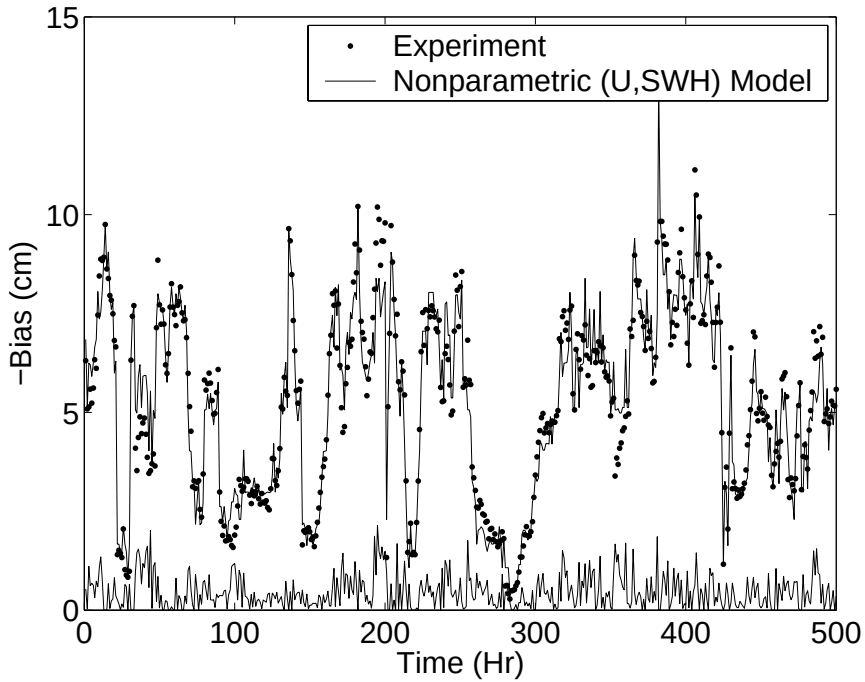
Nonparametric fit

Shaded areas indicate low data density

Physics-based model - results



Predicted and measured EM bias



Nonparametric model for comparison

Residual errors in cm units on same scale

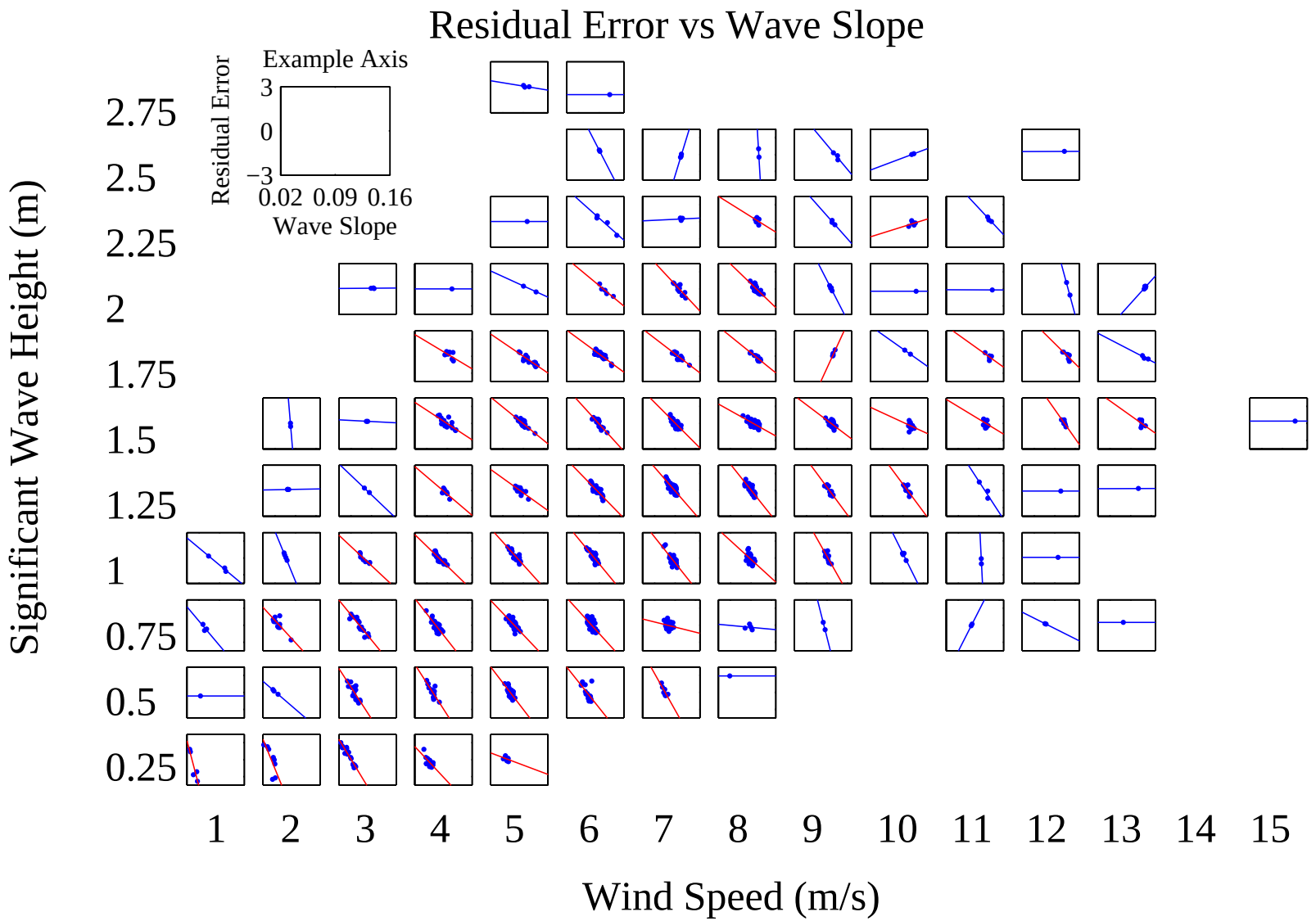
Errors (mean±1std): -0.52 ± 1.1cm (-0.14 ± 0.78%H) for bias = 0.6*SH*

0.01 ± 0.51cm (0.01 ± 0.41%H), parametric model, bias = γ(*U,H*) *SH*

0 ± 0.4cm (0 ± 0.30%H), nonparametric model, bias = *f*(*U,H*)

- *Parametric physics-based model is nearly as good as nonparametric model, with the benefit of more smoothing and less noise sensitivity*

Residual vs. RMS slope



Residual error - correlation

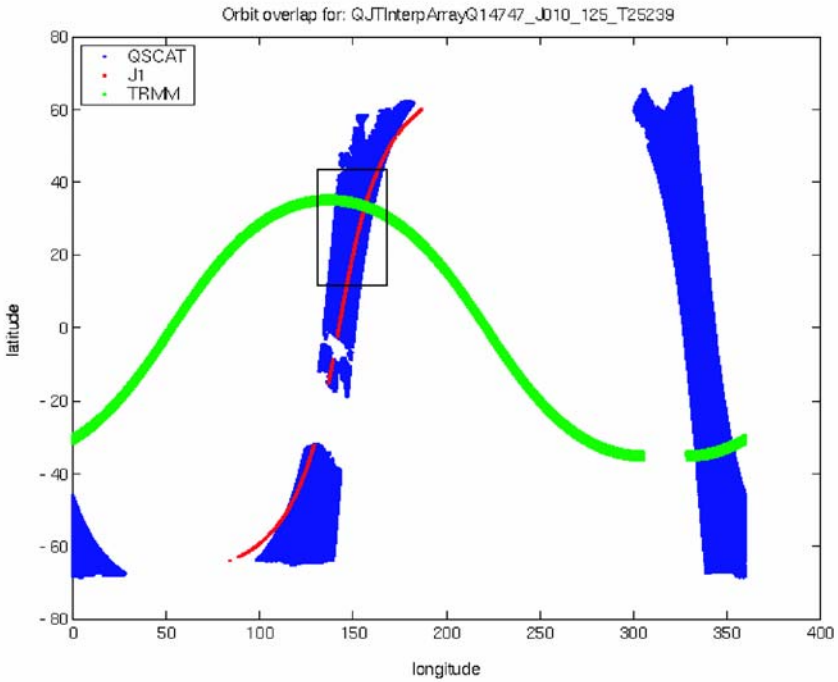
- RMS slope explains much of residual variability
- Vertical spread gives magnitude of residual error in each wind/wave bin
- Horizontal spread is variability of RMS slope
- Slope of line fit gives sensitivity of bias to RMS slope

Instrument cross-comparison

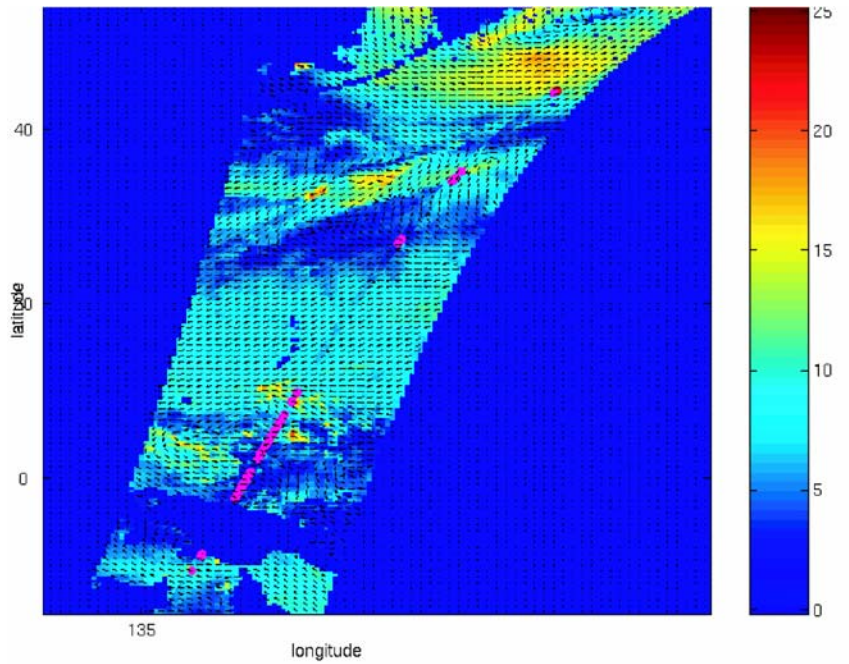
Goal: Study correlation of environmental state with wind speed, SWH, bias

Co-located SeaWinds-on-Quikscat wind speed measurements

- Temporal collocation within 30 minutes



Sample orbit passes of
Jason-1 (red), SeaWinds, and TRMM



Jason-1 wind speeds overlaid on SeaWinds
Pink shows differences greater than 2m/s

- Discrepancies are correlated with mesoscale wind field/rain features

Conclusions

- cm-order residual bias variability remains after correction by mean bias at a given wind speed/SWH
- RMS long wave slope explains much of this residual variability
- Variability and sensitivity to RMS slope is correlated with sea state
- Variability may also be correlated with mesoscale environmental features