Pacific Hindcast Performance Evaluation Of Three Numerical Wave Models

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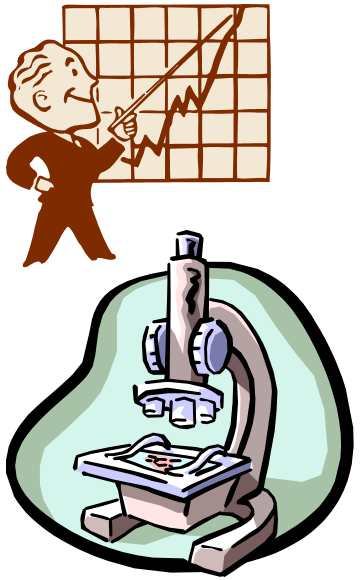
Coastal and Hydraulics Laboratory

Wave Information Studies (WIS)

Hindcast Wave Data for U.S. Coasts

OBJECTIVE: Produce a 30-Year Pacific Wave Hindcast

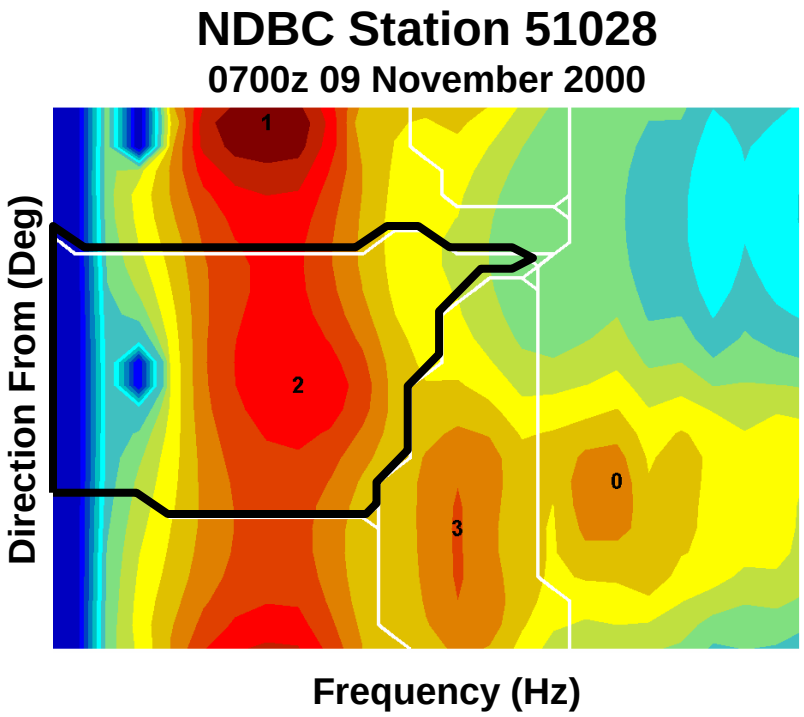


- **Quantify Model Performance**
- **Diagnose Model Deficiencies**

- **Oceanweather year 2000 NRAQ Winds (NCEP/NCAR + QUICKSCAT)**
- **Model Candidates: WAM, WAVEWATCH III (WW3), WAVAD**
- **Groundtruth Data from 7 NDBC and CDIP deep-ocean buoys**

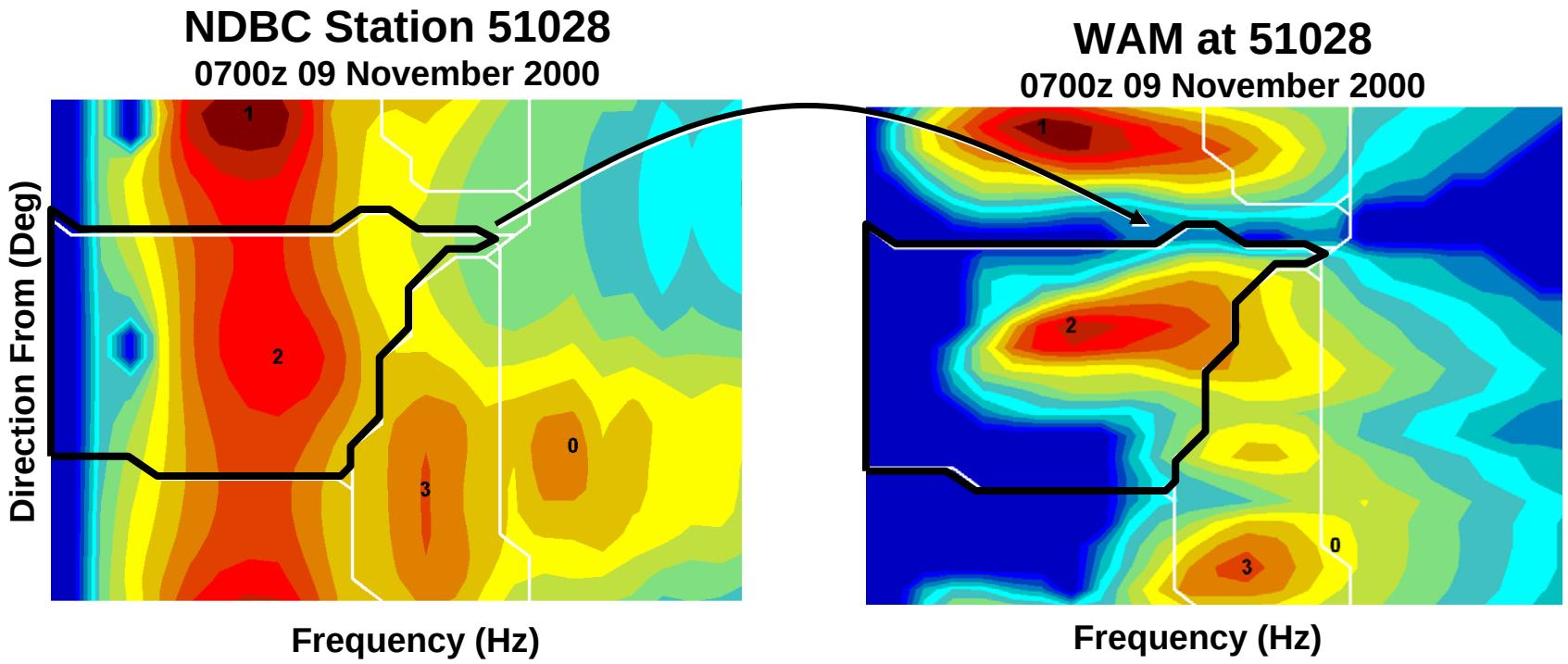
Wave Model Evaluation and Diagnostics System (WaveMEDS)

1. Partition Buoy Spectrum



Wave Model Evaluation and Diagnostics System (WaveMEDS)

1. Partition Buoy Spectrum
2. Overlay Buoy Partition Template on Hindcast Spectrum



Wave Model Evaluation and Diagnostics System (WaveMEDS)

1. Partition Buoy Spectrum
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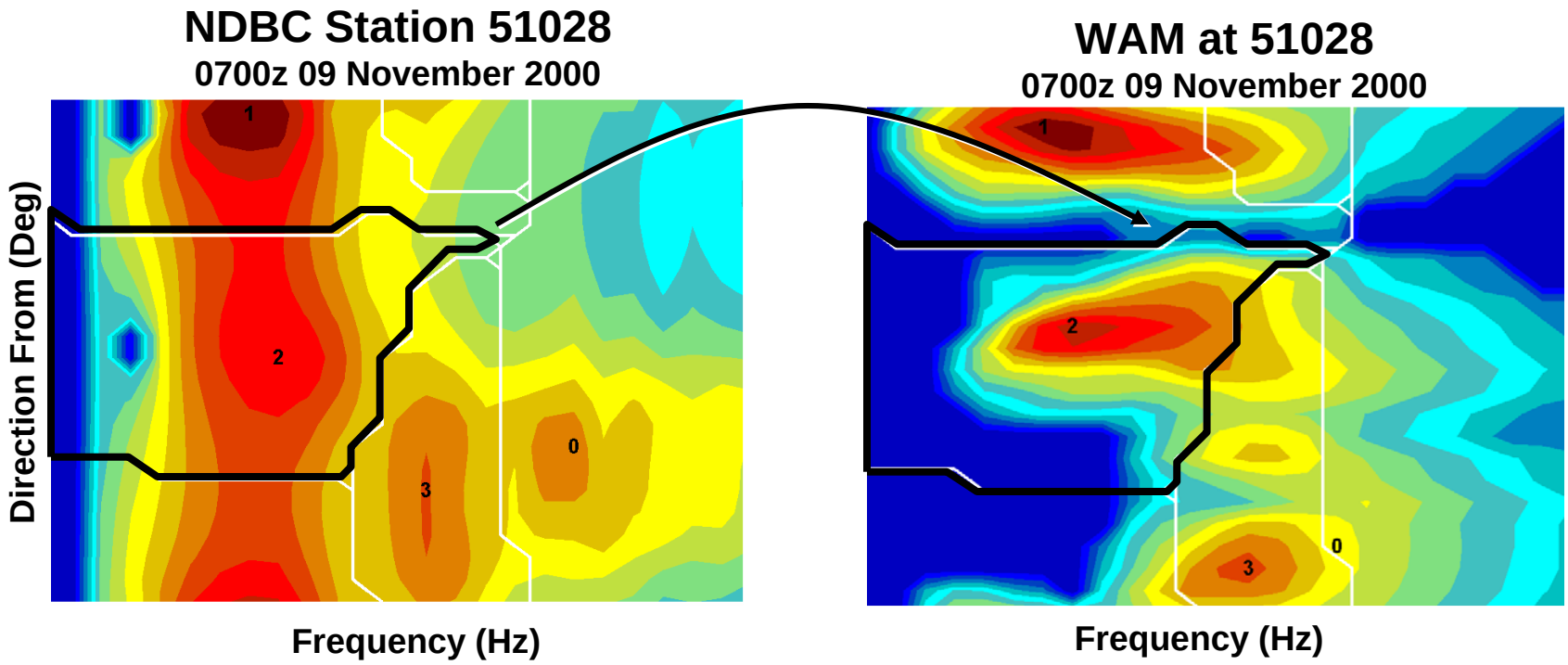
3. Compute Integral Parameters in each Partition Domain: H_{m0}, T_p, θ_m



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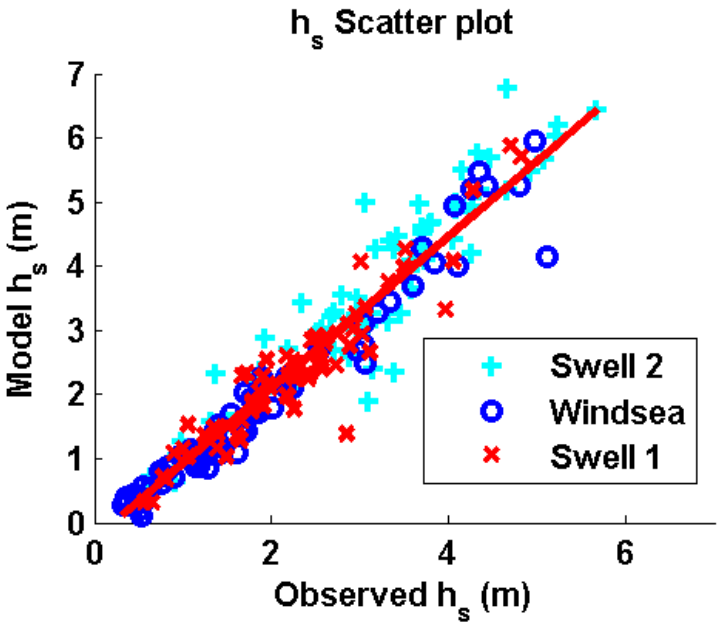
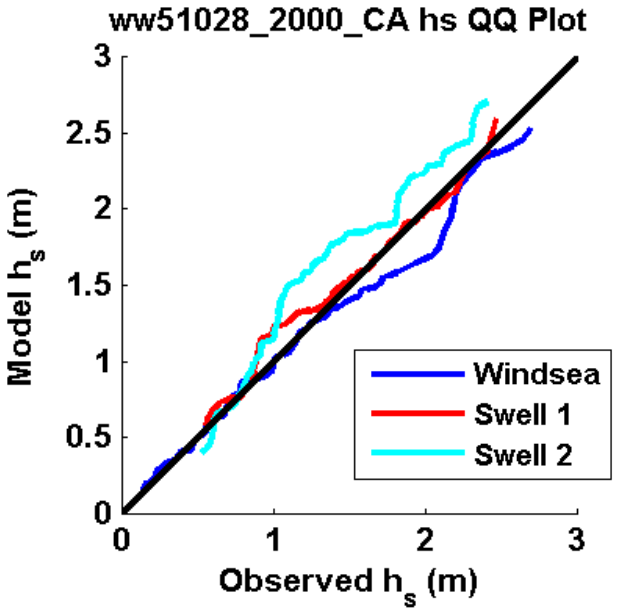
1. Partition Buoy Spectrum
2. Overlay Buoy Partition Template on Hindcast Spectrum
3. Compute Integral Parameters in each Partition Domain: H_{m0}, T_p, θ_m
4. Perform Statistical Analyses: RMS Error, Bias, Scatter Index, etc…

Temporal Correlations



Quantile-Quantile Analysis



Performance Calculation

Performance of Hindcasts *h* Relative to Measurements *m*

RMS Error

$$\hat{E}_{rms} = (1 - \frac{E_{rms}}{rms\ (m)})$$

Bias

$$\hat{b} = (1 - \frac{b}{rms\ (m)})$$

Scatter Index

$$\hat{S}I = (1 - SI)$$

Angular Bias

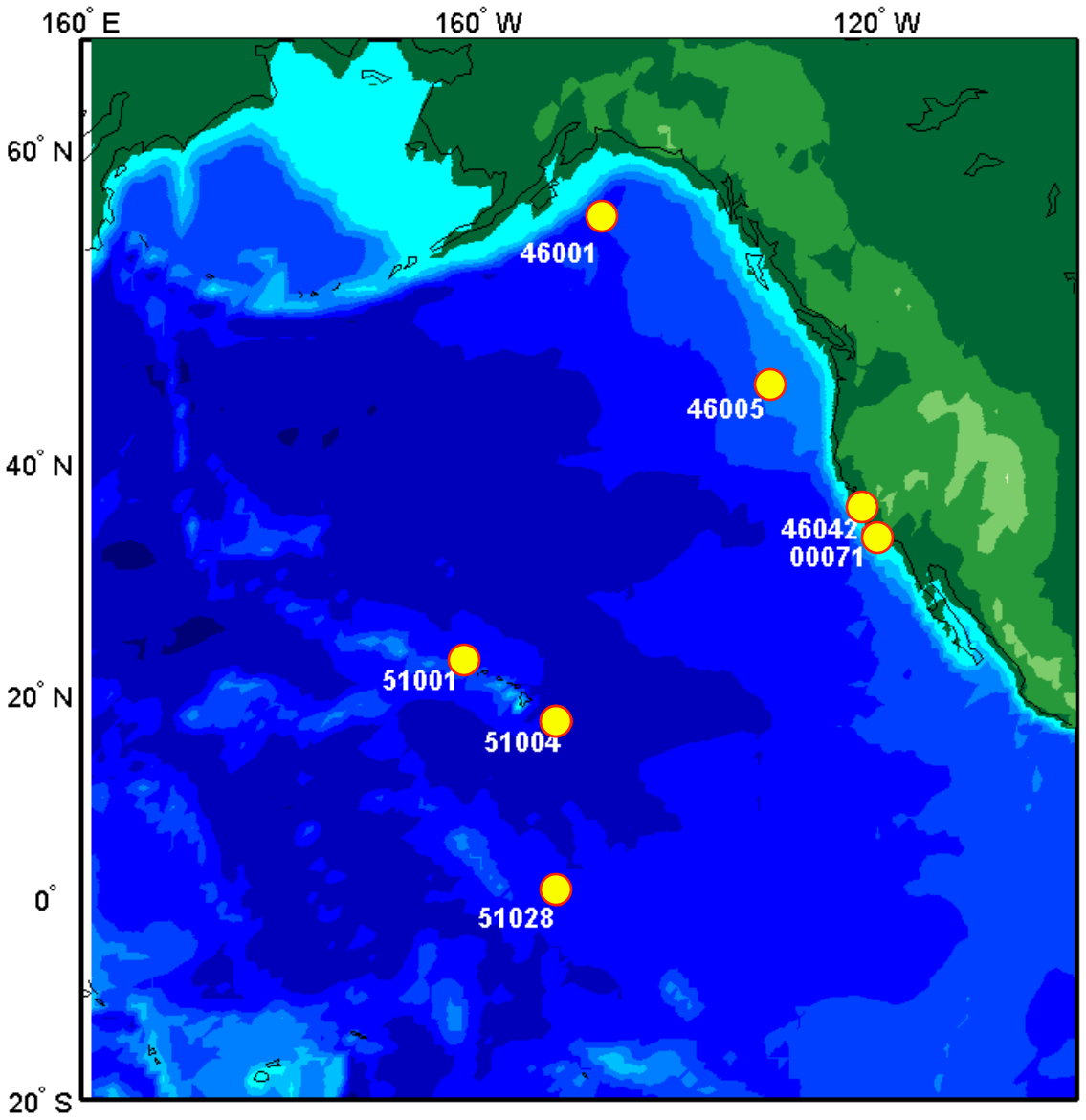
$$\hat{b}_a = (1 - \frac{b_a}{180})$$

Circular Correlation

$$C\hat{o}rr\ (\%) = Corr$$

Performance Scores are Averaged using Sample Size Weighting Factors

Pacific Hindcast Validation Stations



Significant Wave Height

Model Performance Summary

	Temporal Correlations			Quantile-Quantile		
Component	WAVAD	WAM	WW3	WAVAD	WAM	WW3
Windsea	0.83	0.79	0.88	0.88	0.82	0.92
Young Swell	0.79	0.84	0.85	0.86	0.90	0.89
Mature Swell	0.73	0.72	0.78	0.81	0.78	0.83
Combined	0.78	0.79	0.84	0.85	0.83	0.88

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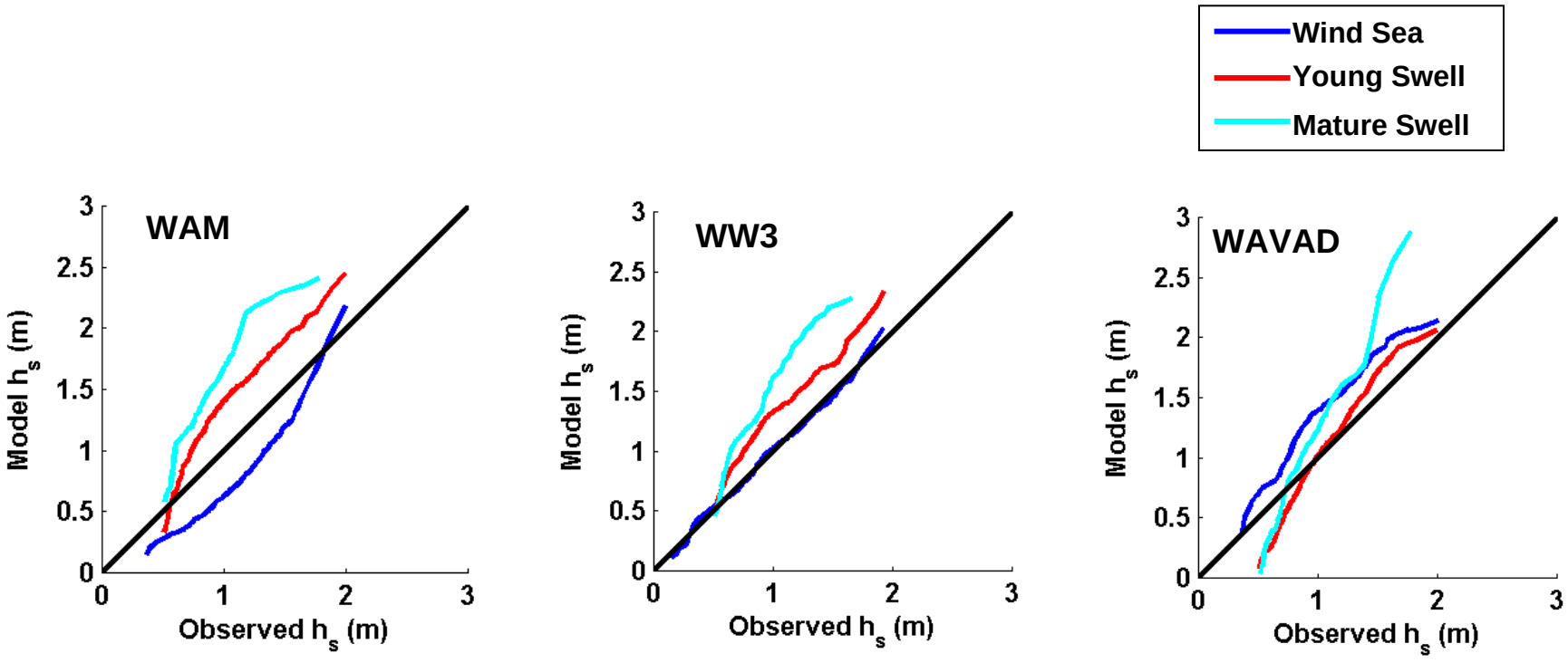
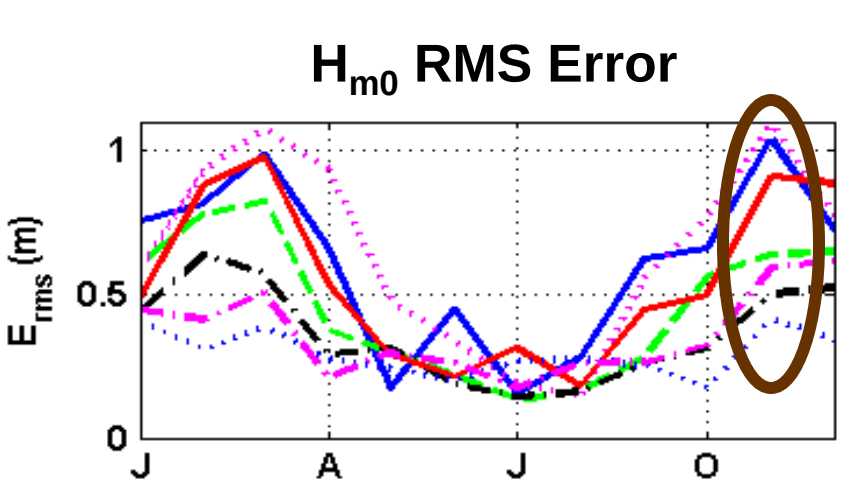
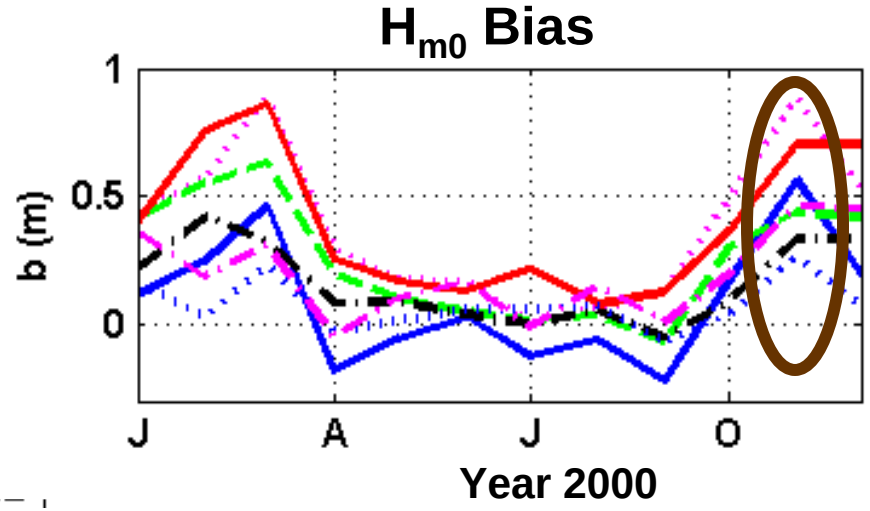
Typical Wave Height QQ Results

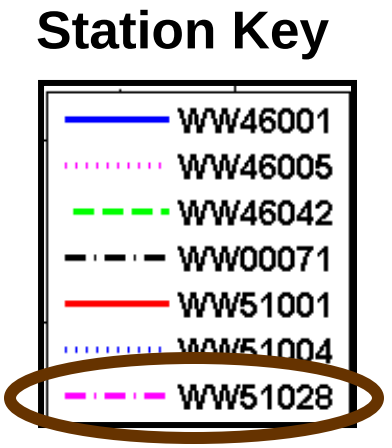
Station 51028 November

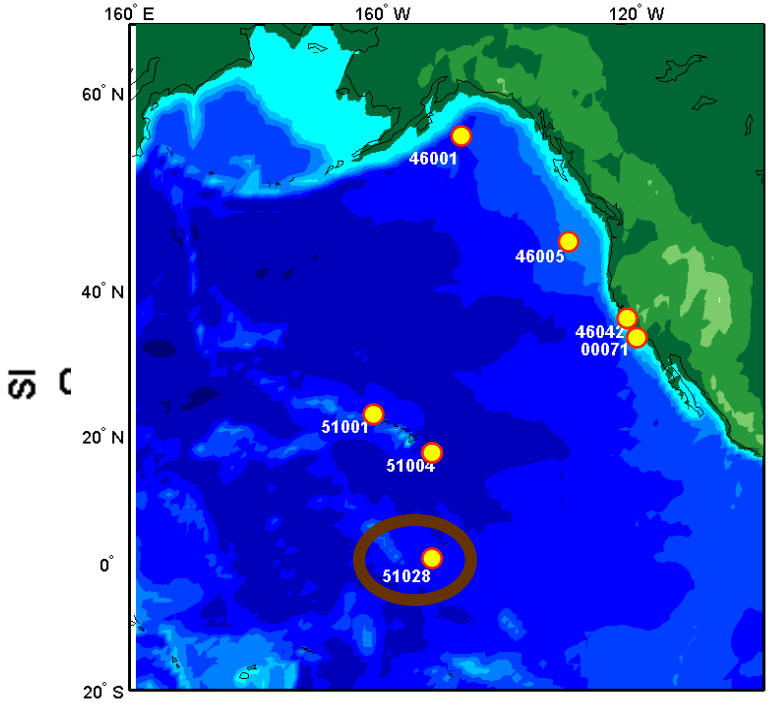


WW3 Monthly Mature Swell Height Metrics

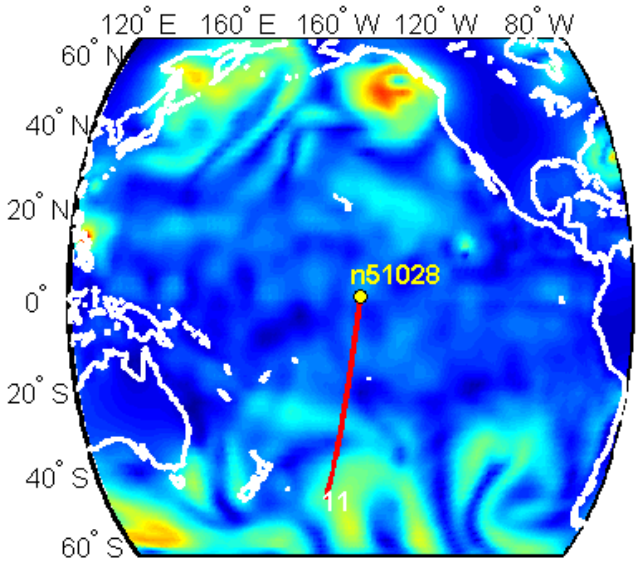


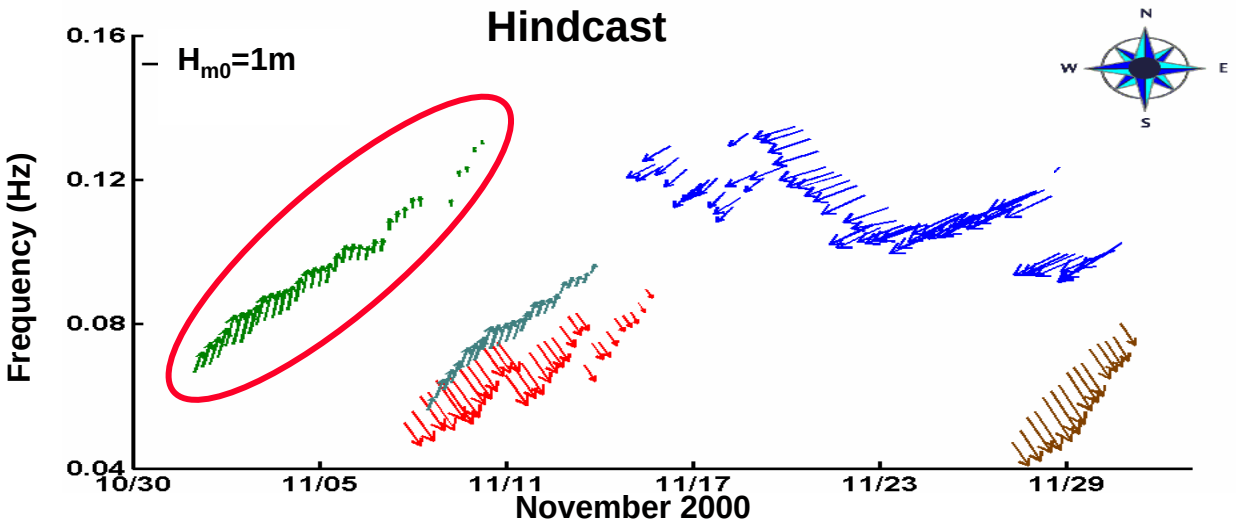


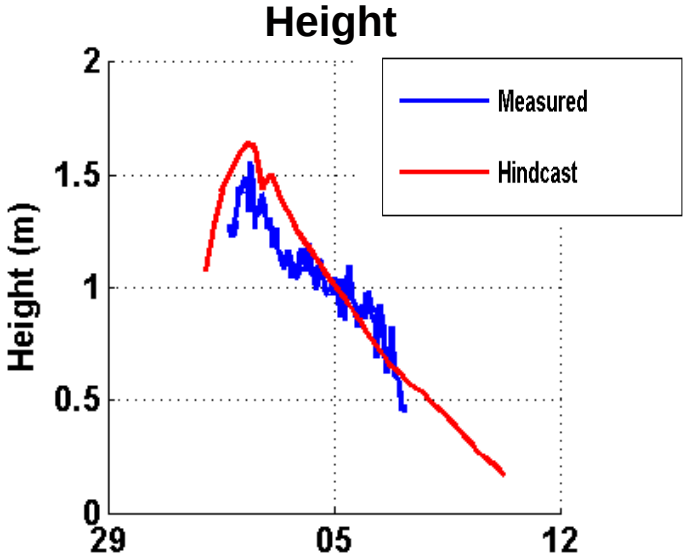


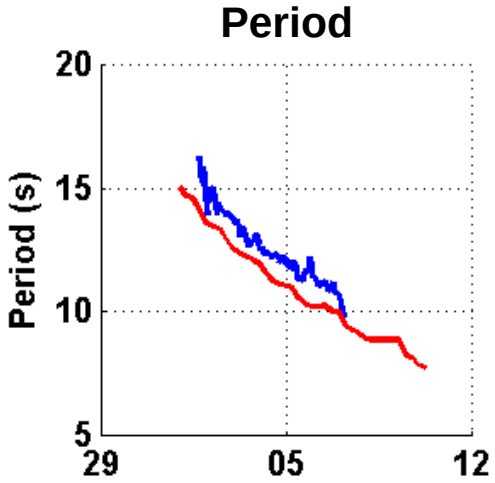


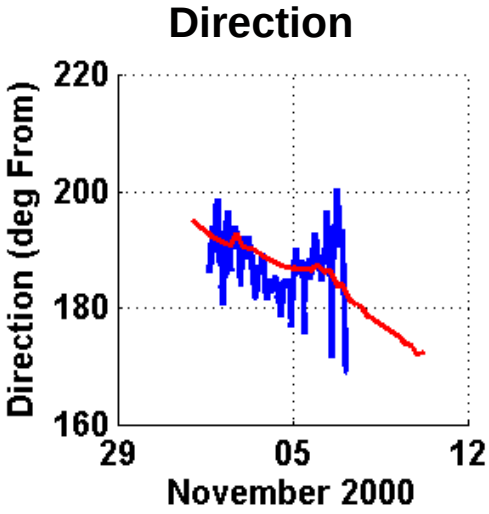
WW3 Wave System Comparison: Southern Swell



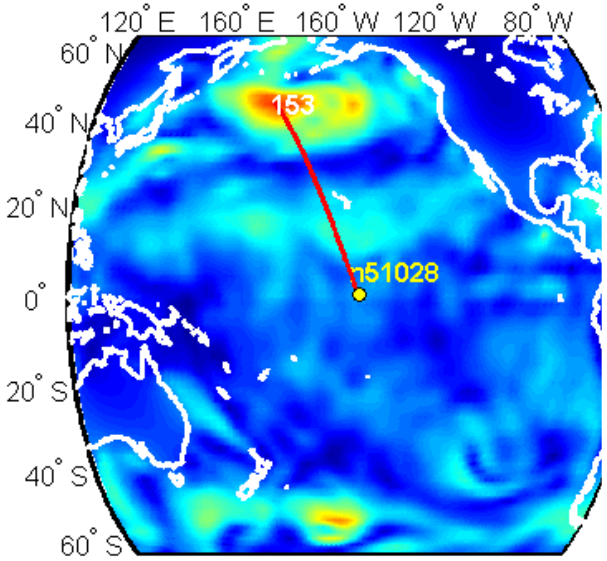


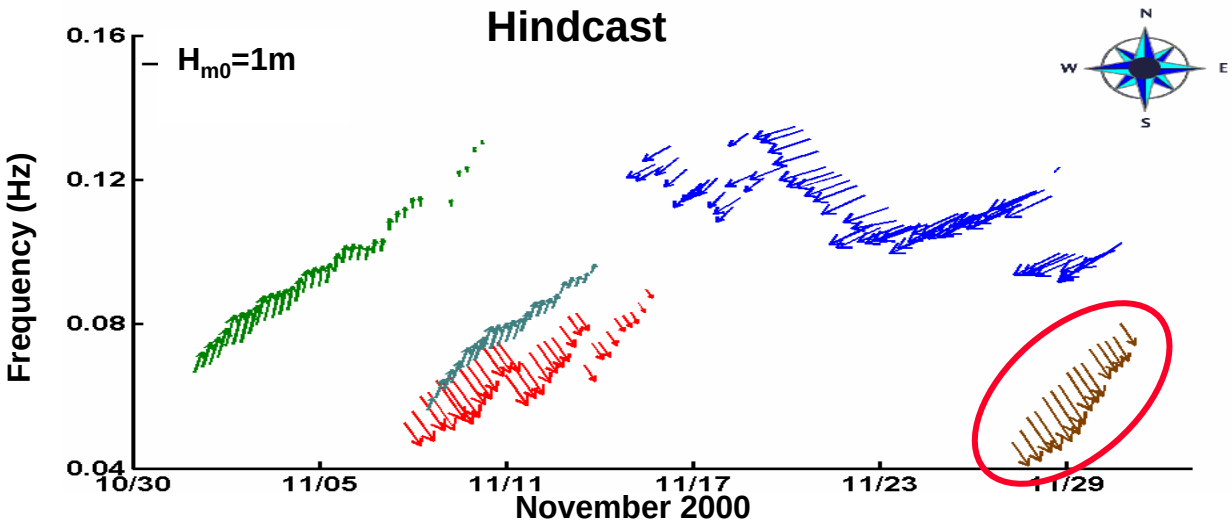


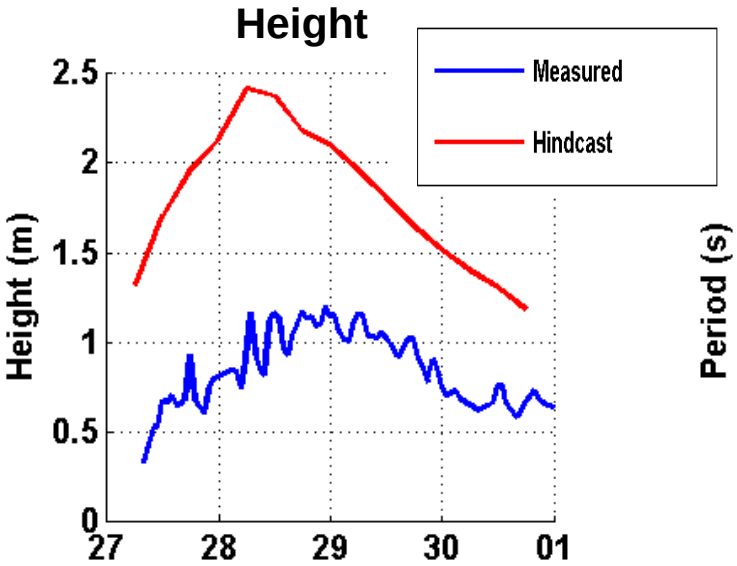


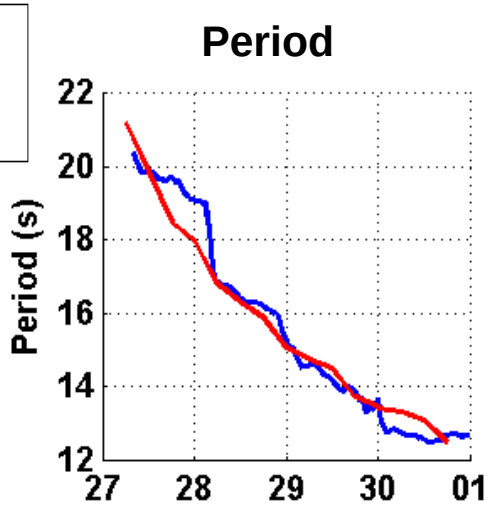


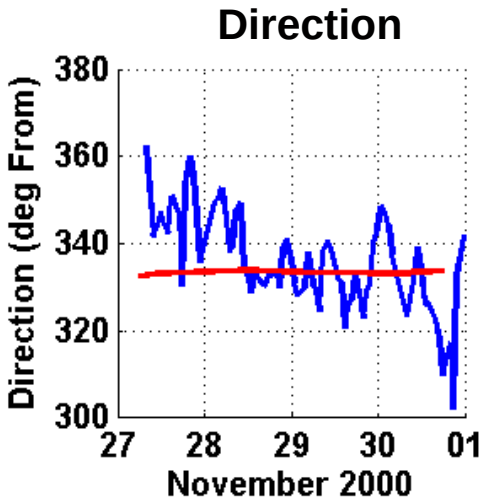
WW3 Wave System Comparison: Northern Swell





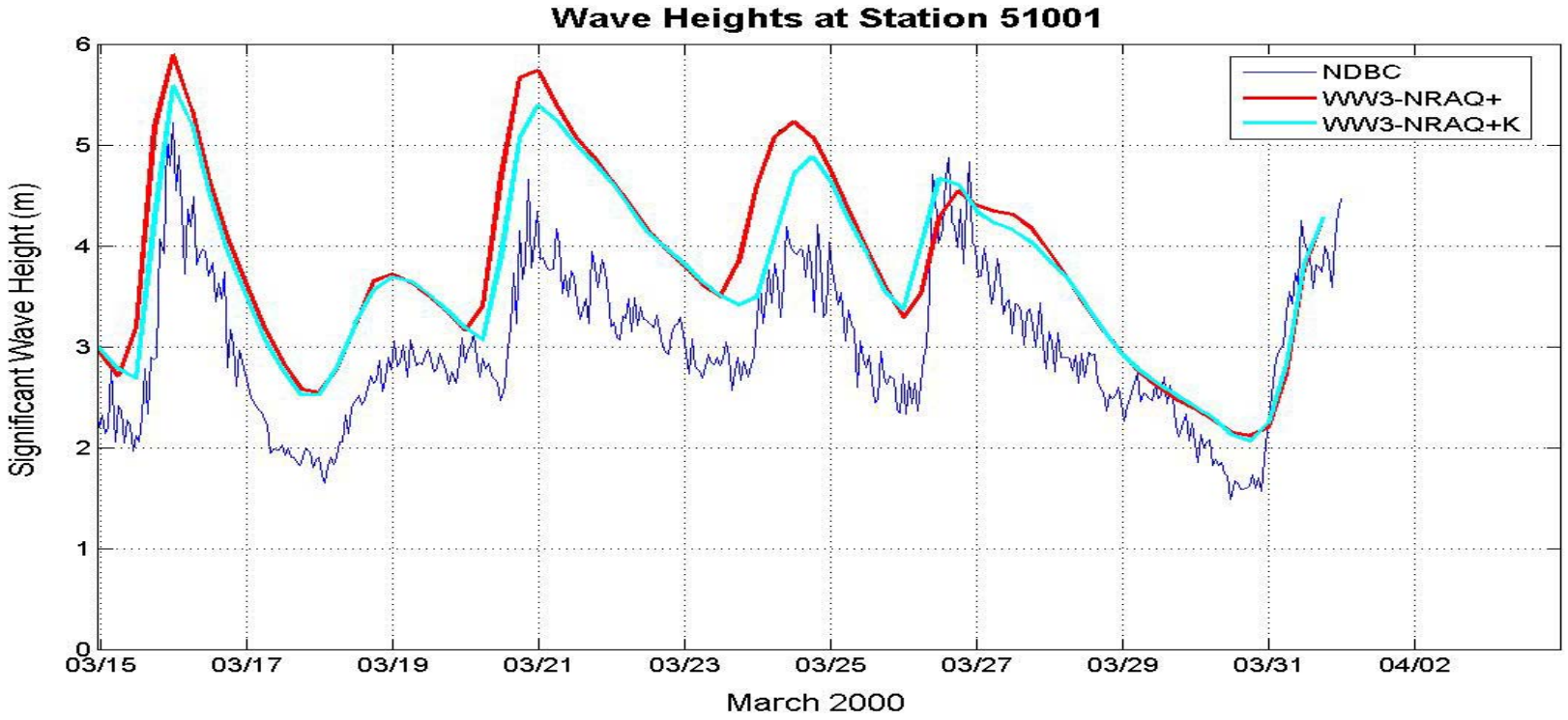






Source Winds too High?

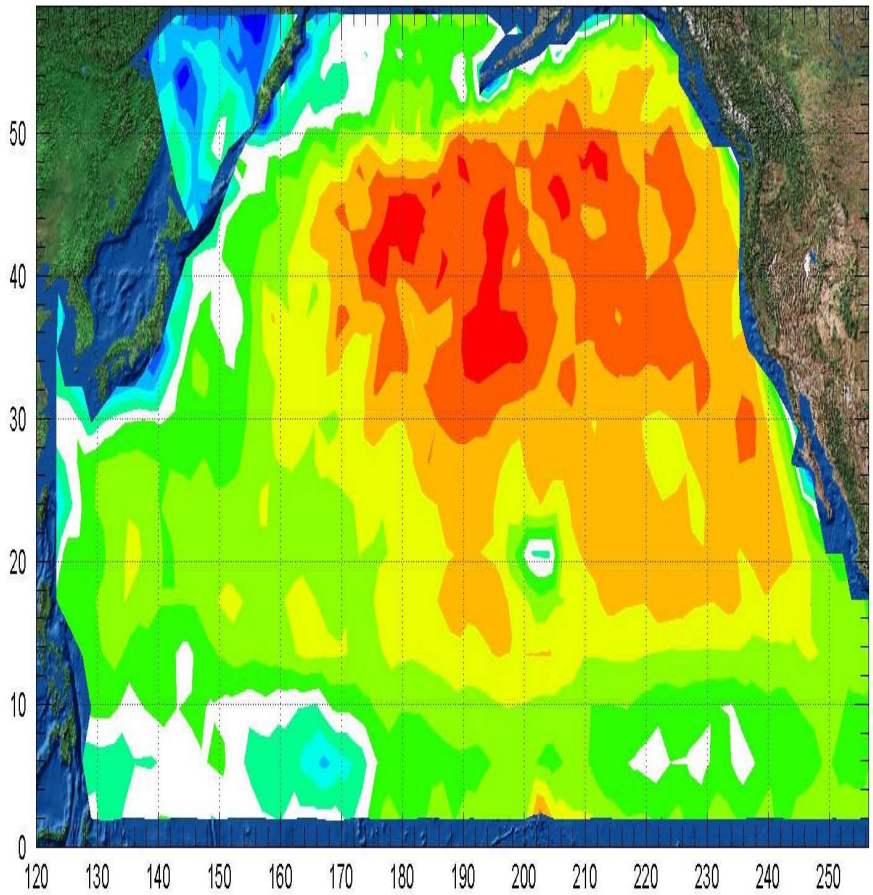
Enhanced kinematic analysis of March 2000 storms reduced bias by 20-30%

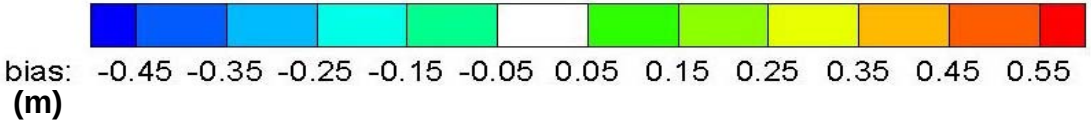


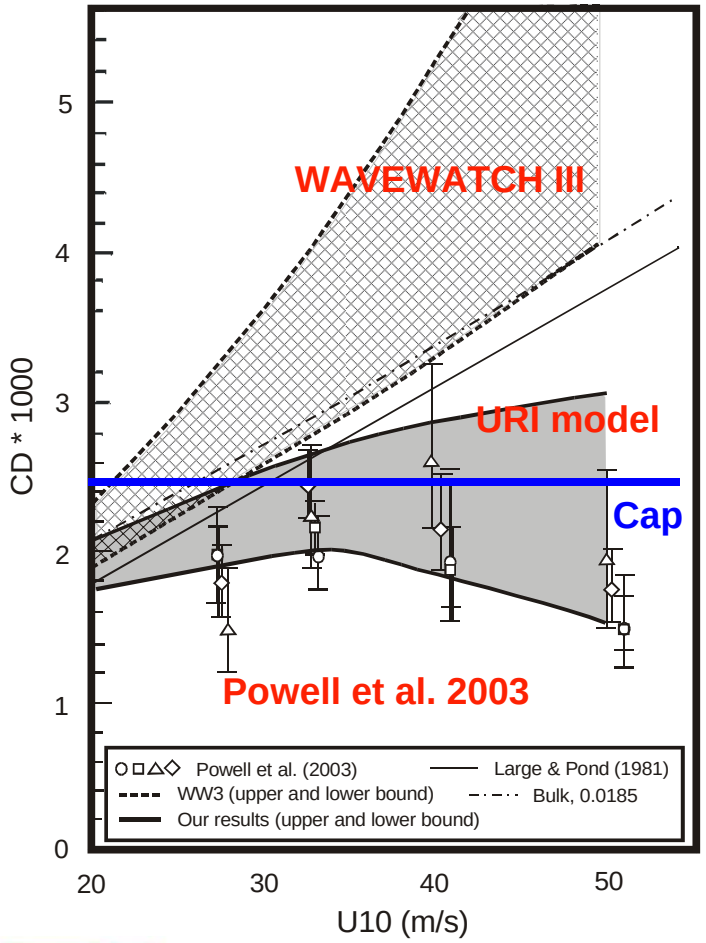
Need to Cap Atmospheric Drag C_D?

Wave Height Bias from Year 2000 Topex/Poseidon Altimetry

WW3 Un-Capped C_D







Courtesy of URI

Need to Cap Atmospheric Drag C_D?

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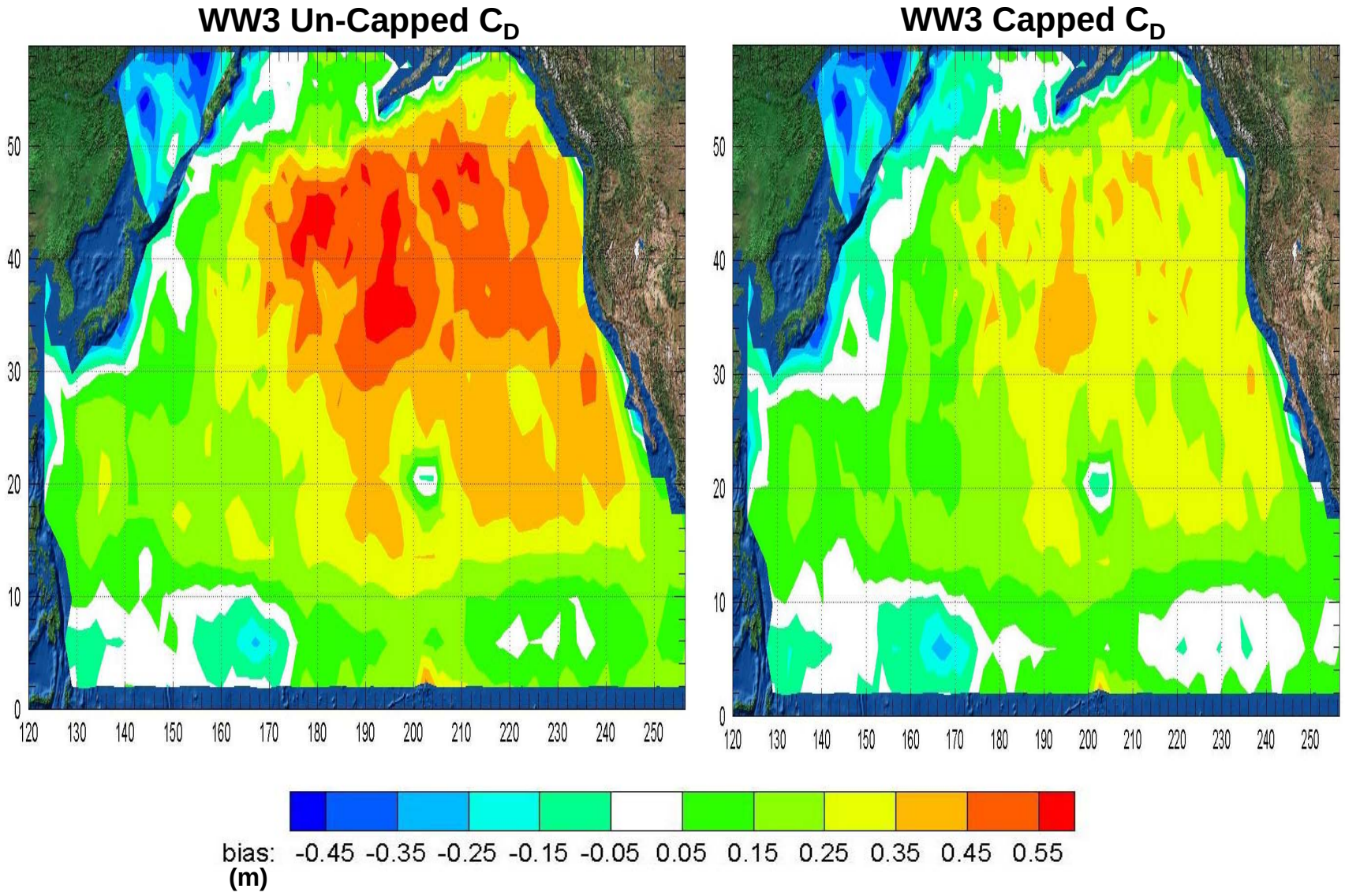

Summary Points

1. **Unique Wave system validation method applied to 3 numerical models**

2. **All 3 models performed well; WAVEWATCH III consistently out-performed others**

3. **Mature swell height bias (+) a problem with 3G hindcasts in Northern Hemisphere winter**

4. **20-30% of bias attributed to hindcast wind field errors**

5. **30-40% of bias attributed to un-capped drag coefficient**

Additional gains will likely require source term improvements!


Thank You!
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