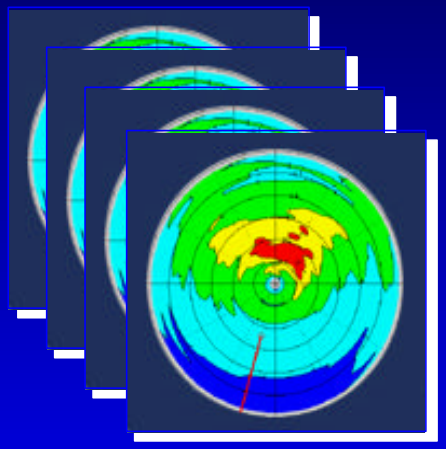
Wave System Diagnostics for Numerical Wave Models



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Robert Jensen
Waterways Experiment Station
Vicksburg, MS

8th International Workshop on Wave Hindcasting and Forecasting
Turtle Bay Resort
Oahu, Hawaii
November 14-19, 2004

Wave Model Validations

Bulk or integral statistics provide only a general verification of total model performance

Goal

Develop a robust capability to routinely quantify model performance at the wave system (wind-sea and swells) level and provide key diagnostics on model deficiencies and source term behavior

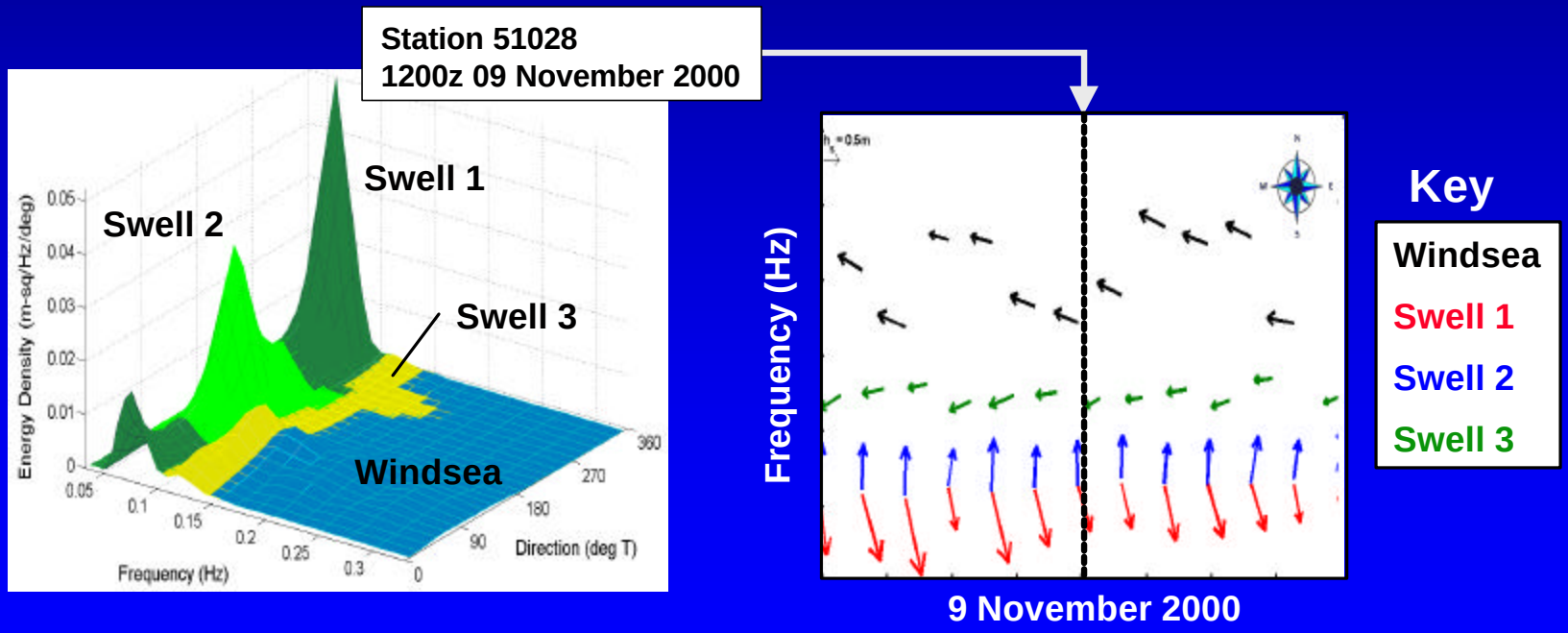
Definitions

Wave Component

A specific wind sea or swell that is attributed to a region of enhanced energy in a directional (2D) wave spectrum

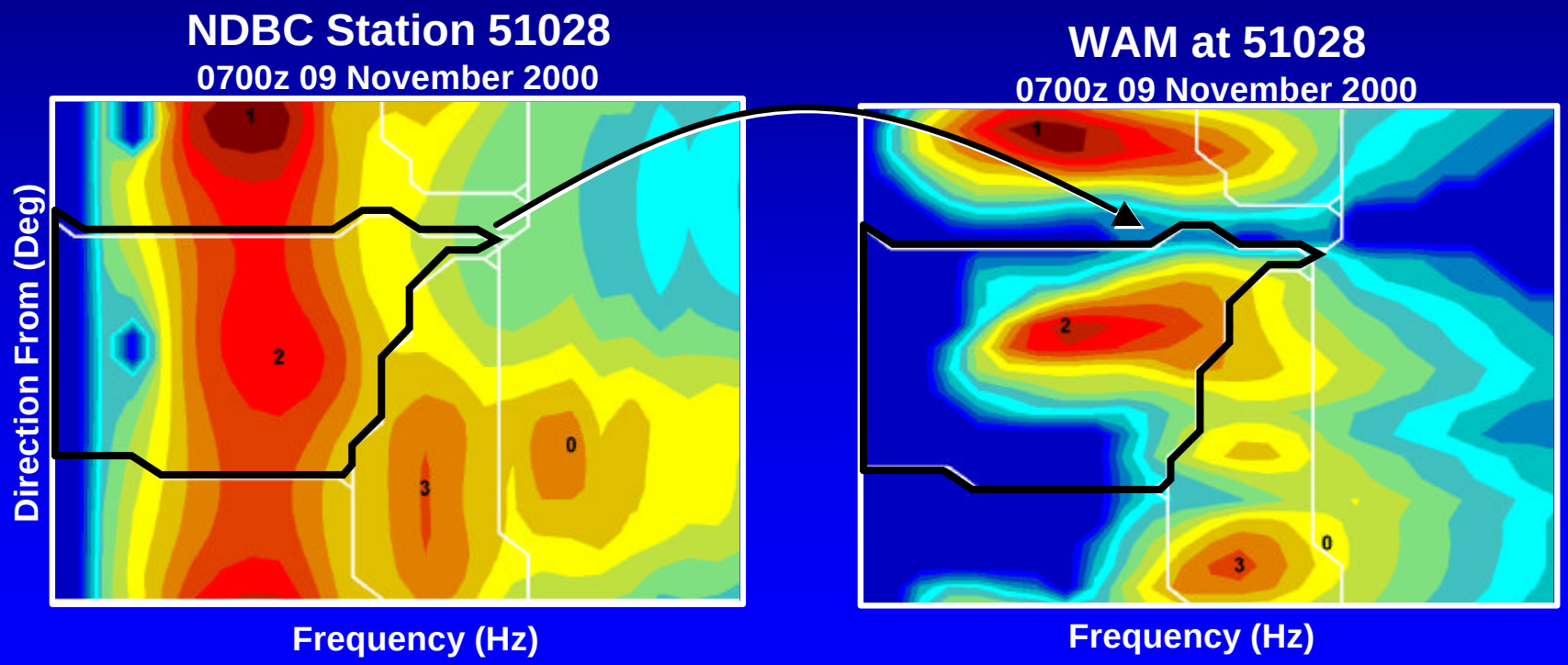
Wave System

An evolving series of wave components that can be traced to a specific wind generation event on the ocean surface



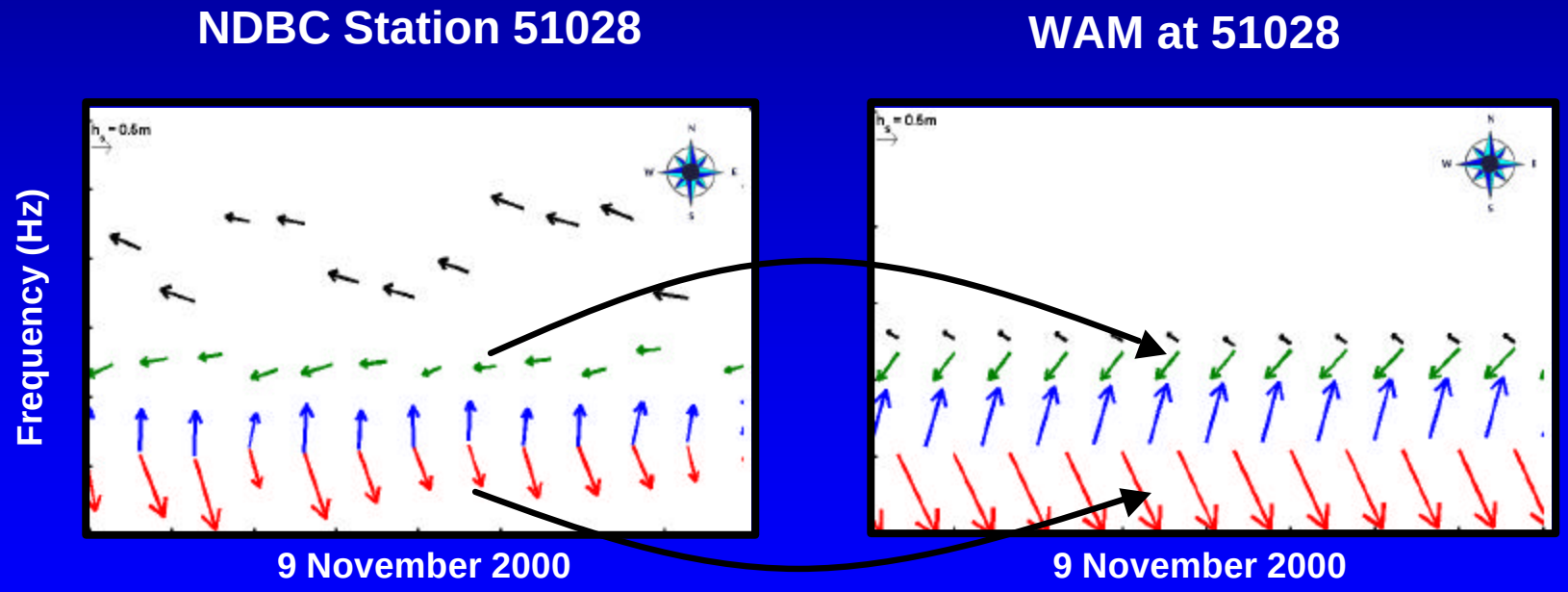
Wave Component Analysis

1. Partition Buoy Spectrum (Hanson and Phillips, 2001)
2. Overlay Buoy Partition Template on Hindcast Spectrum
3. Compute Integral Statistics in each Partition Domain: H_{m0}, T_p, q_m, Spread
4. Compute Monthly Hindcast Differences: RMS Error, Bias

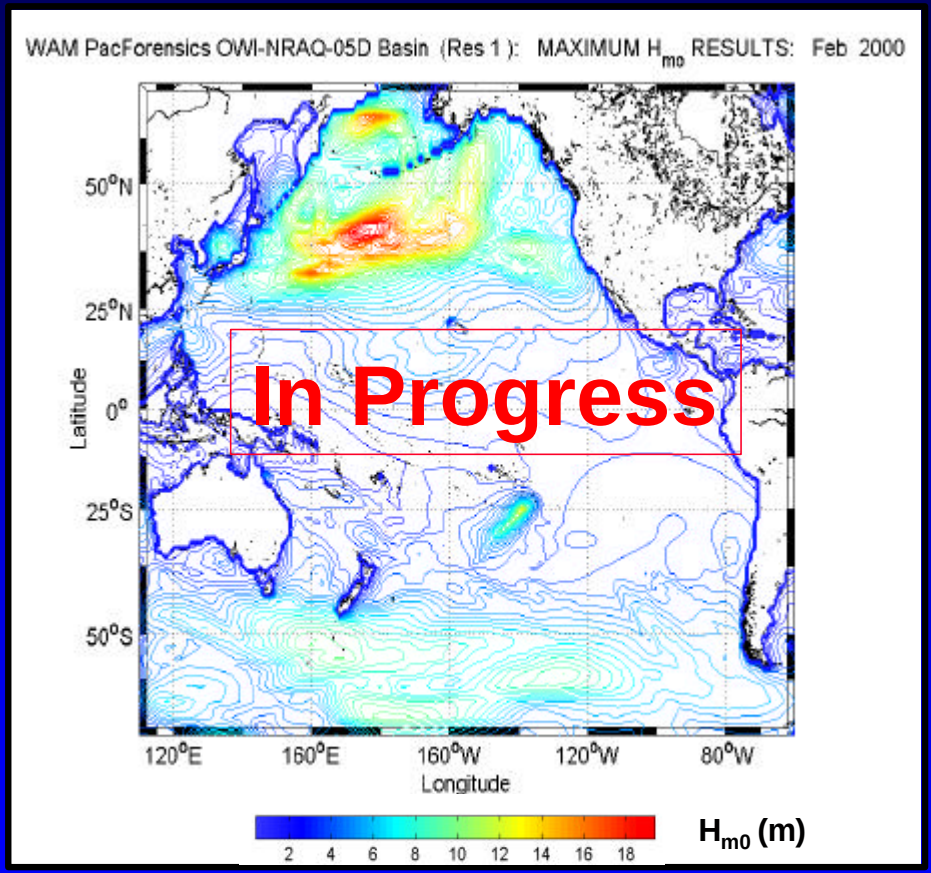


Wave System Analysis

- Wave System by Wave System Comparison
- Diagnose Model Deficiencies by Generation Area / Mechanism
- Insight into Specific Source Term Behaviors

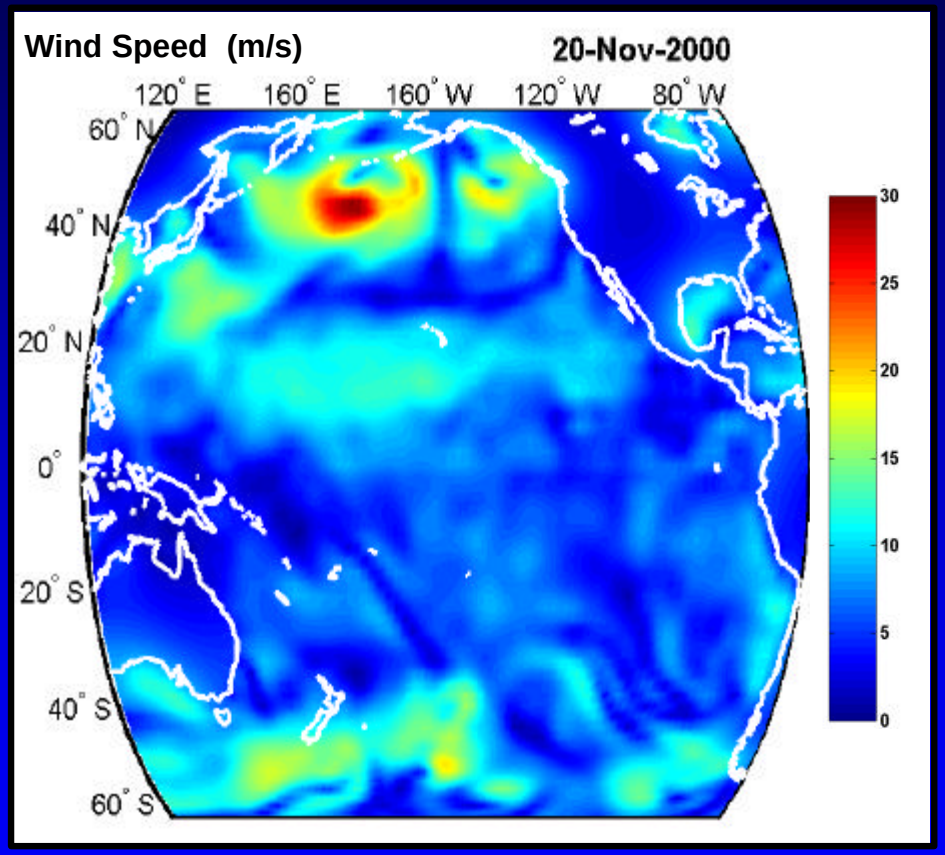


Wave Information Study (WIS)
Pacific 20-Year Hindcast



- 3G Wave Model WAM Cycle 4.5
- 1x1 deg Spatial Resolution
- 25 Frequencies
- 24 Directions
- Completed Year 2000 Test Run

WIS Wind Fields

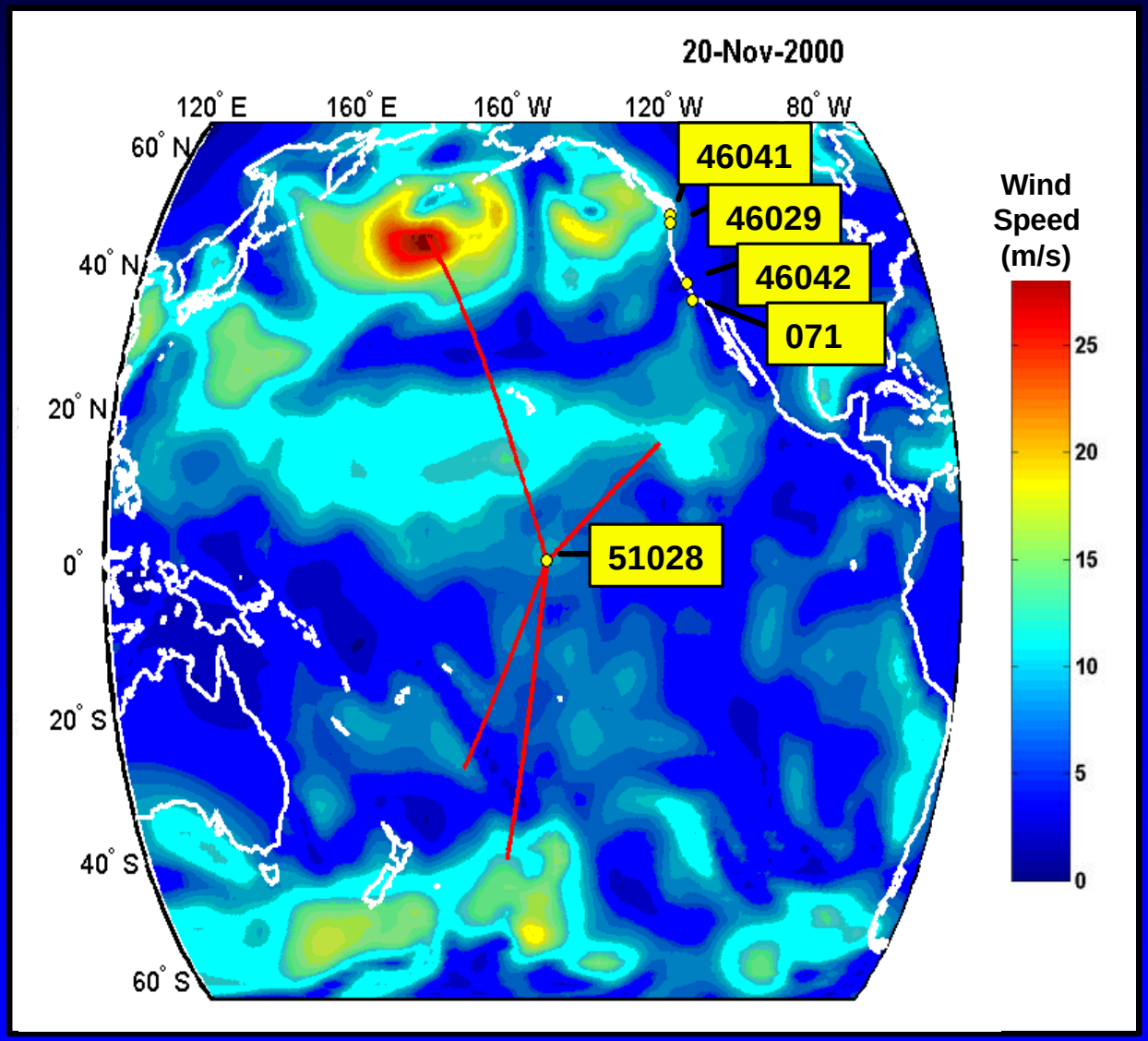


Oceanweather, Inc.
3-Level Wind Analysis

1. **NCEP-NCAR Global Reanalysis 6-h 10-m Base Winds**
2. **QuickSCATT Scatterometer Adjustments in Northern Hemisphere**
3. **Manual Kinematic Adjustment of Top-Ranked Storms**

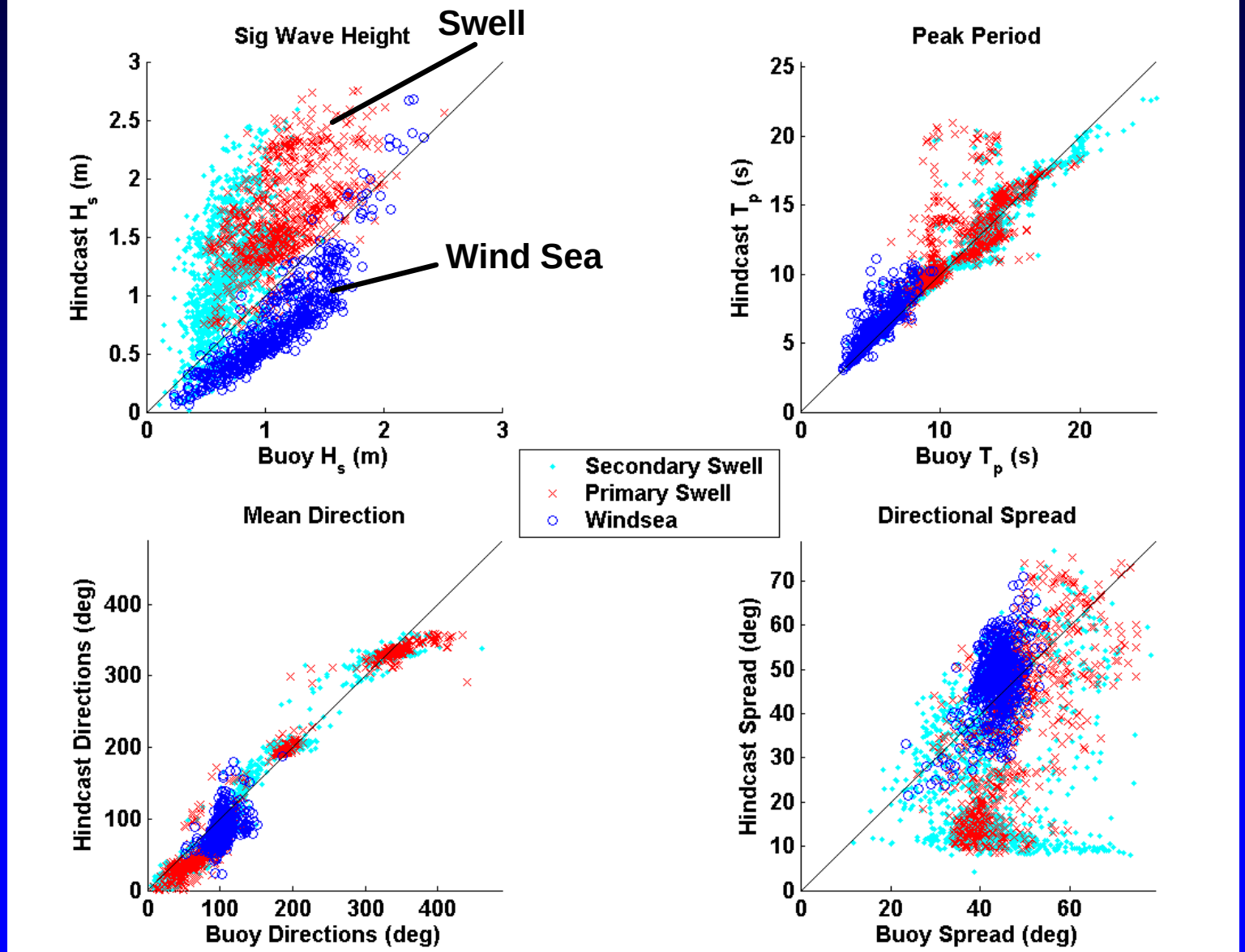
2D Ground Truth Stations

NDBC and CDIP



Wave Component Scatter

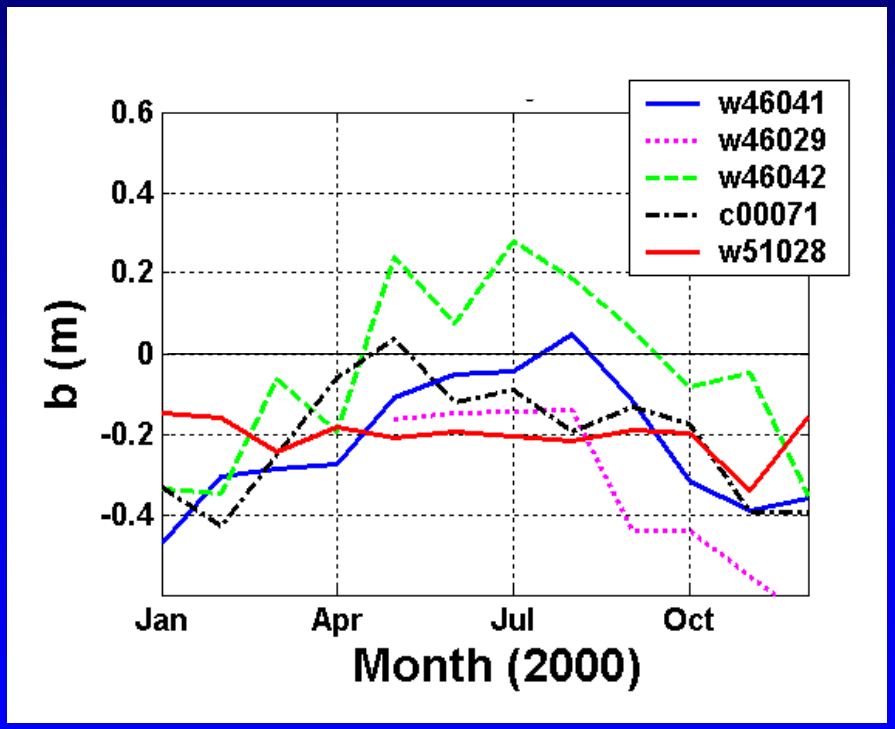
November 2000 at NDBC Station 51028 (Christmas Island)



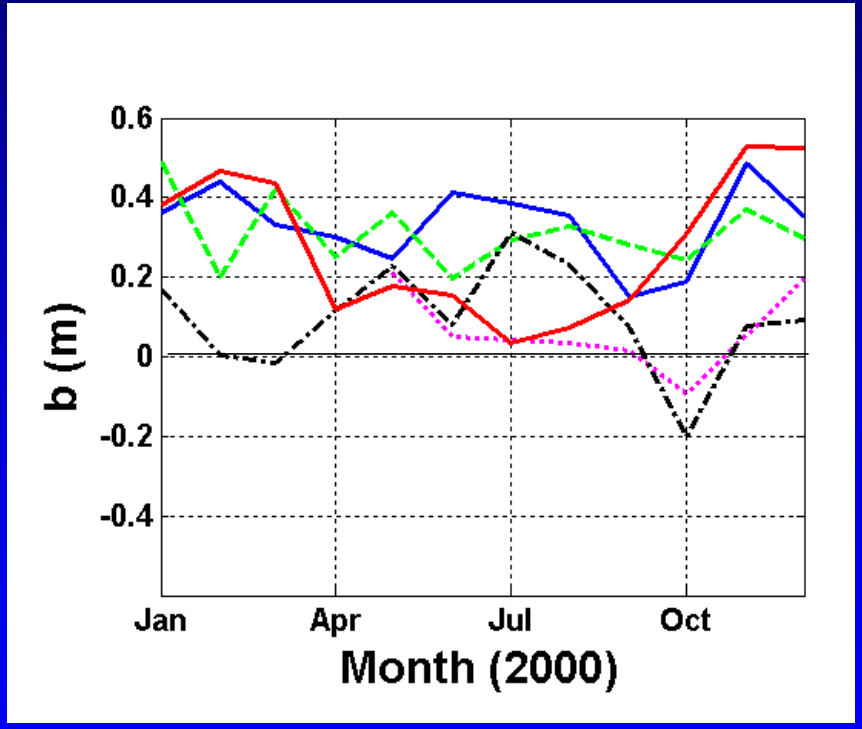
Monthly Hindcast Wave Height Bias

All Stations

Wind Sea

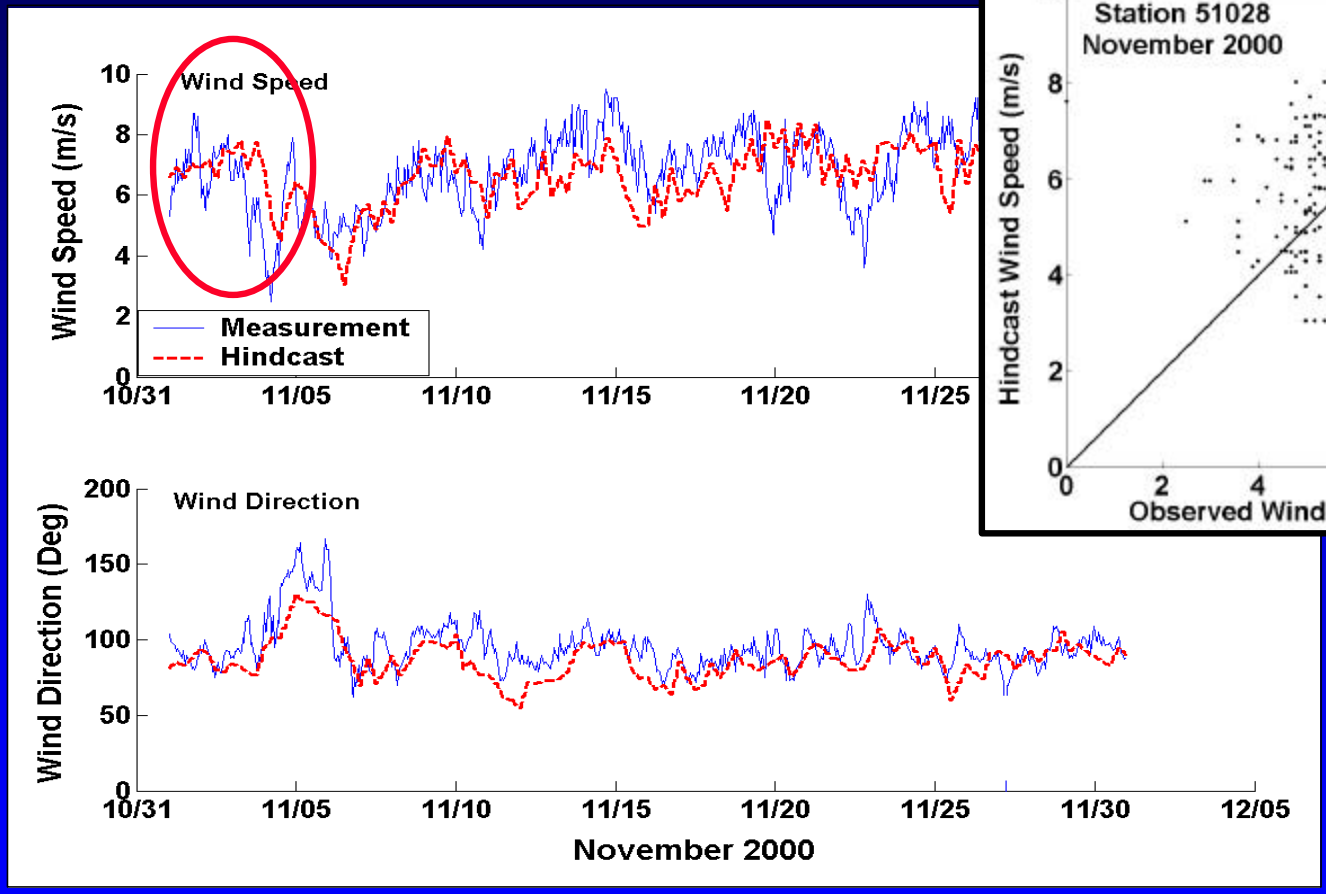


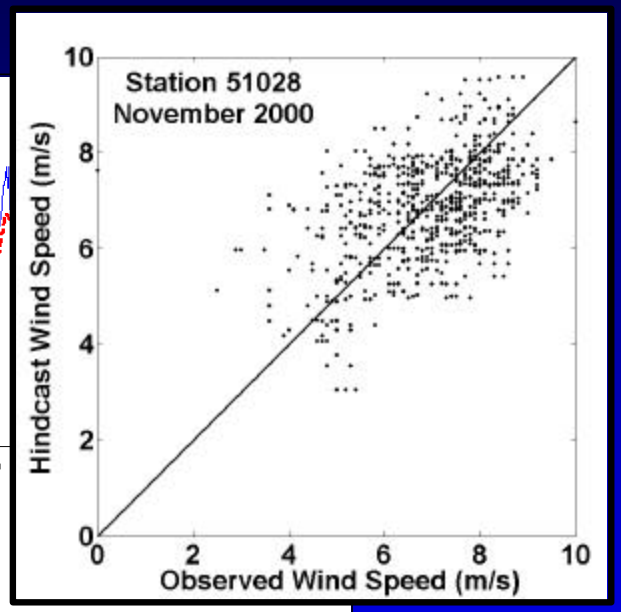
Primary Swell



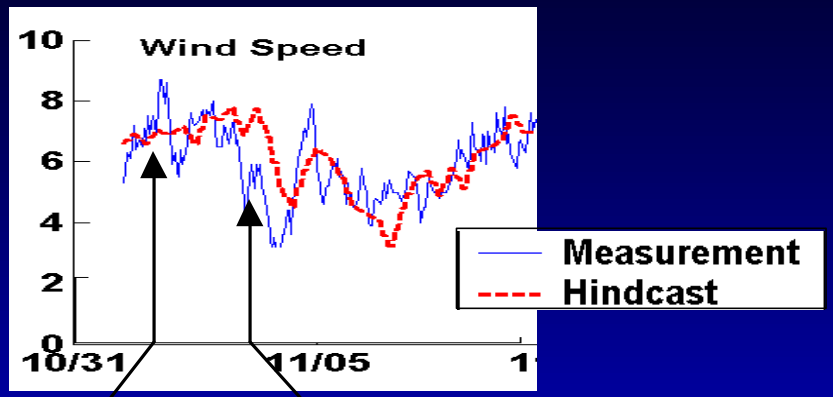
No Consistent Wind Bias

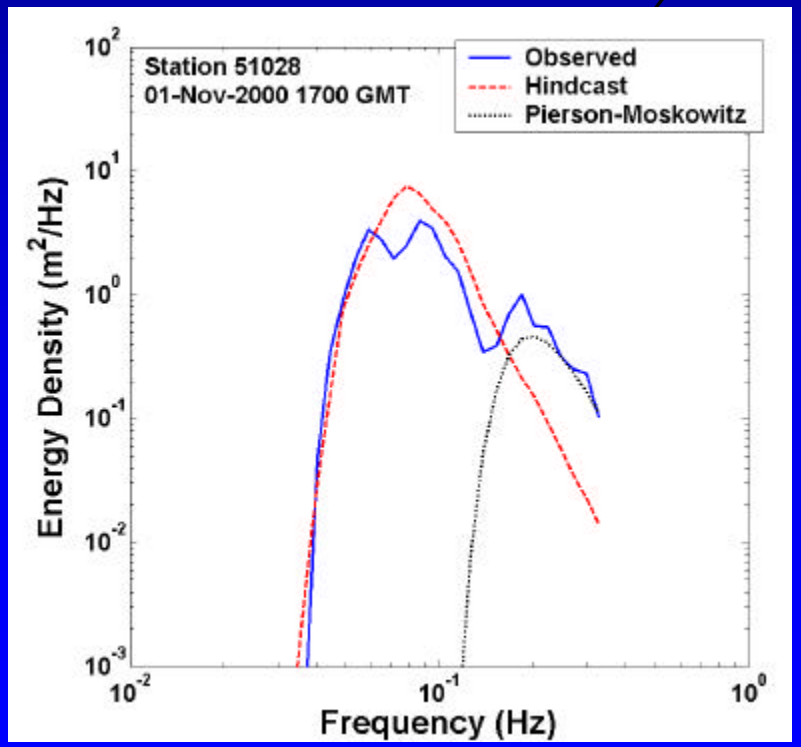
November 2000 Station 51028

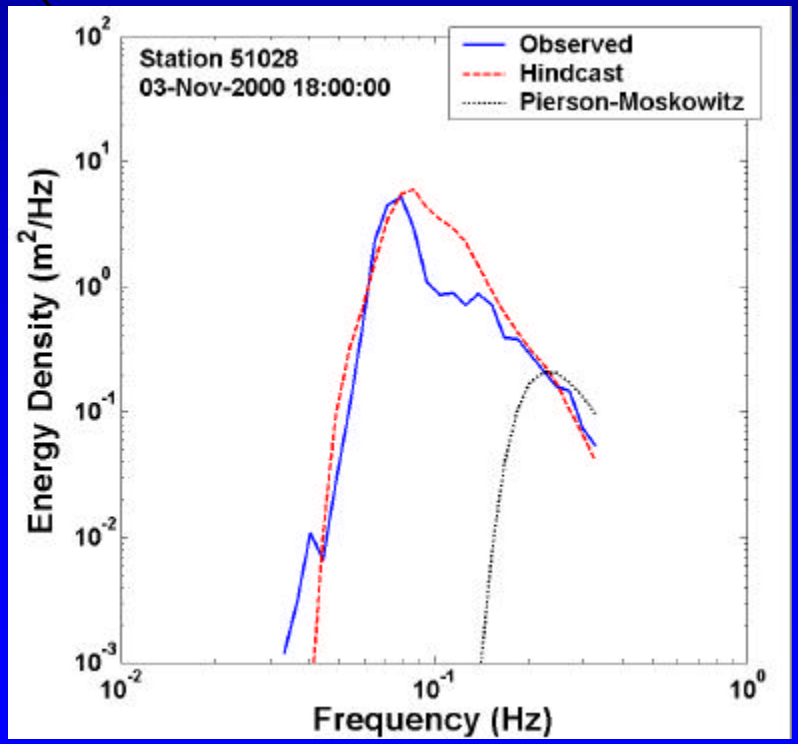




Delayed Growth of Young Wind Seas

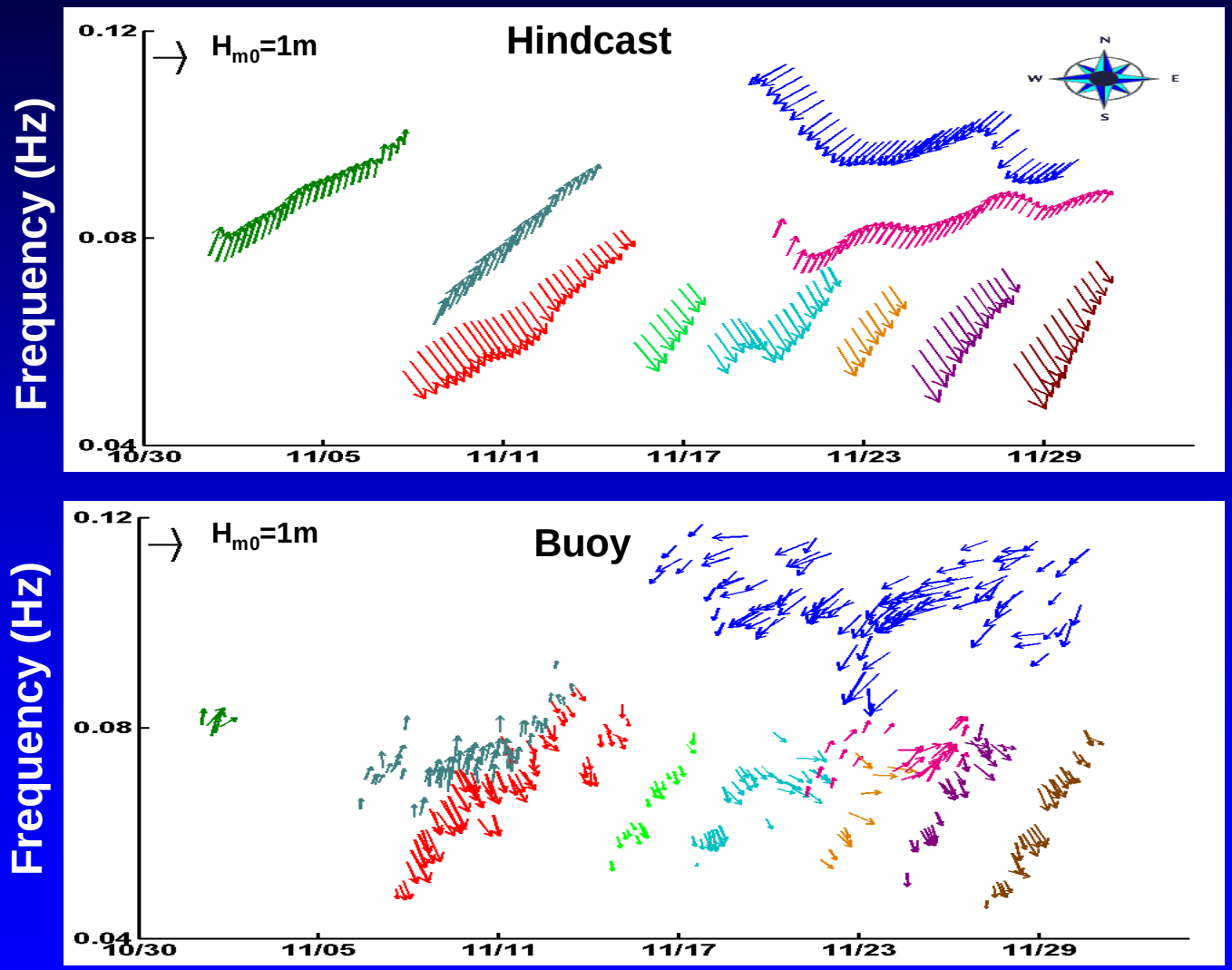






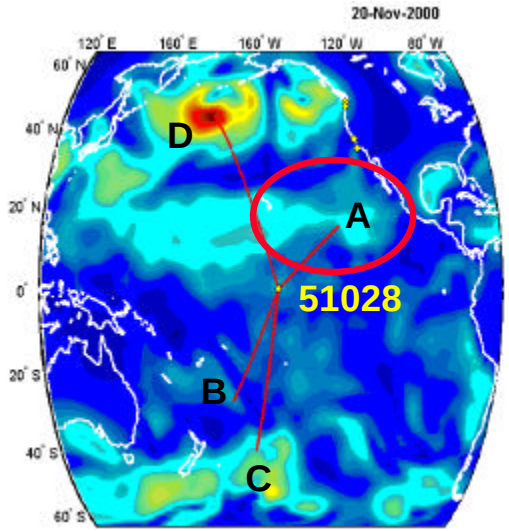
10 Most Energetic Swell Systems

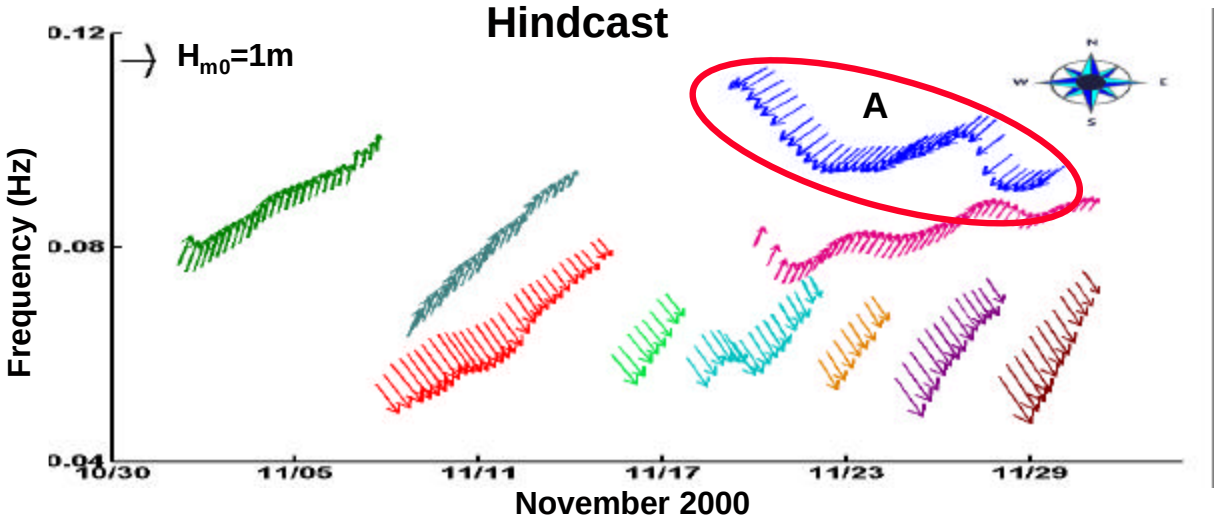
Station 51028 November 2000

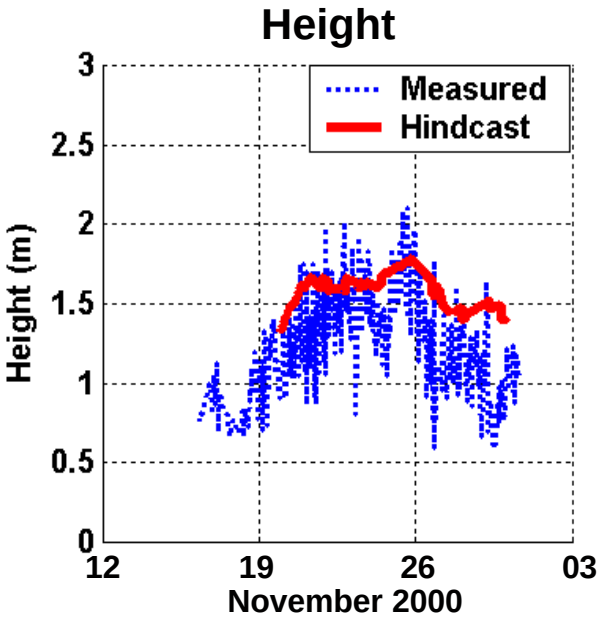


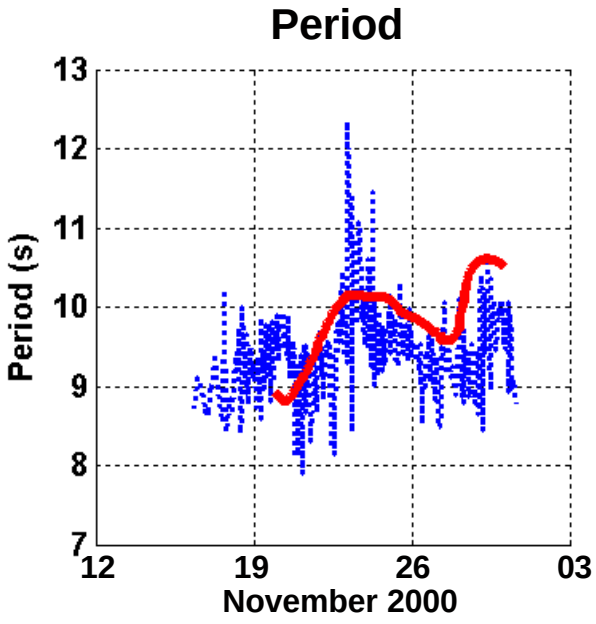
November 2000

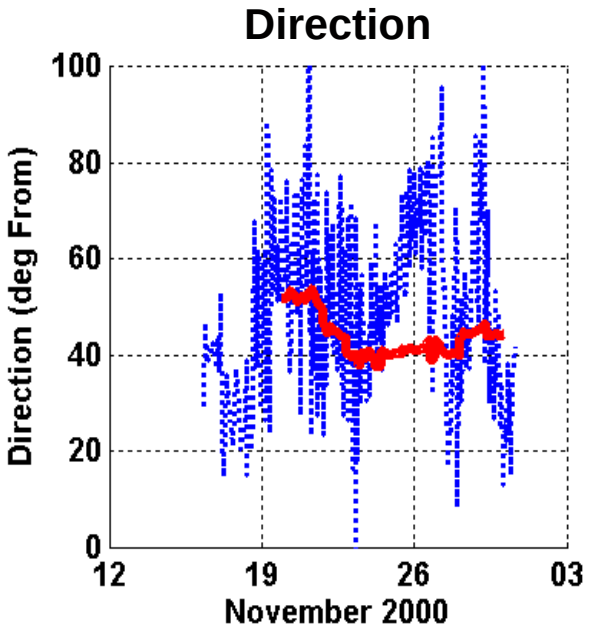
Wave System Comparison: Generation Area A



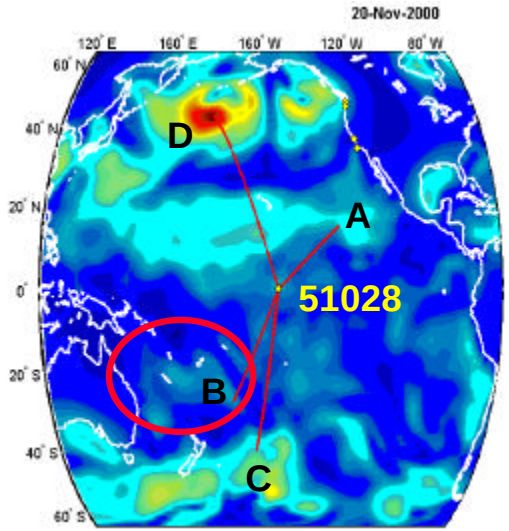


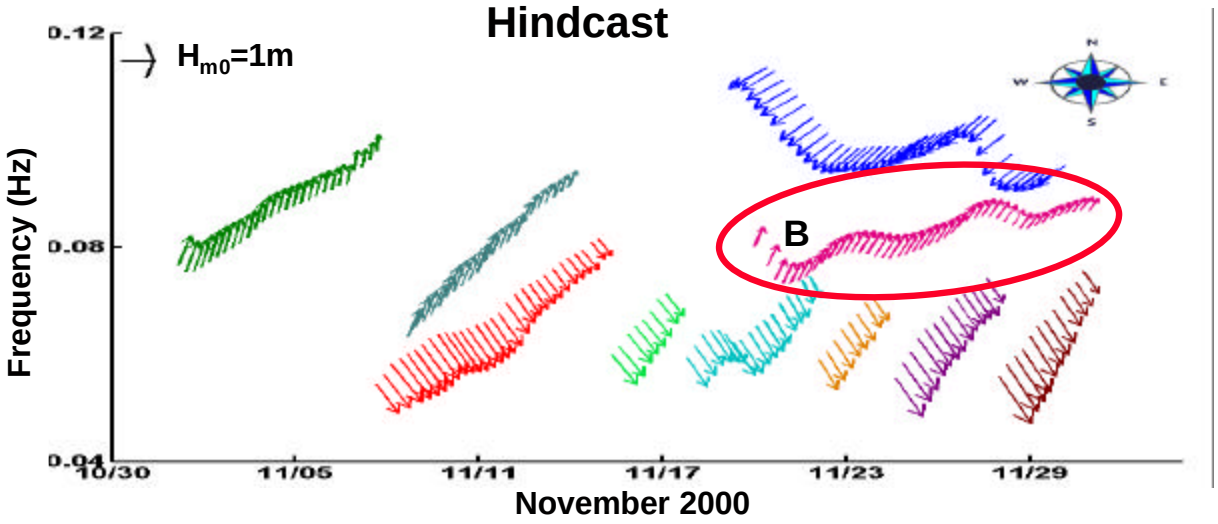


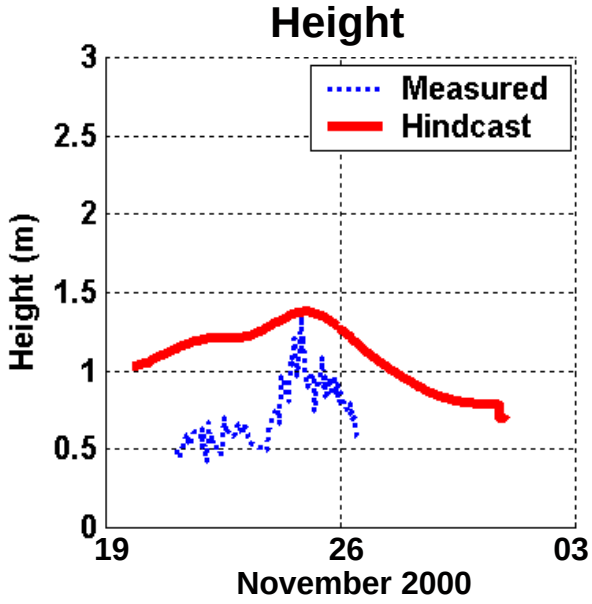


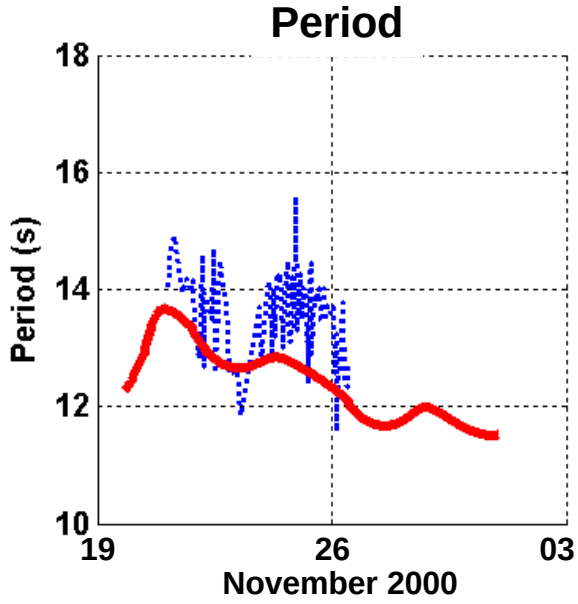


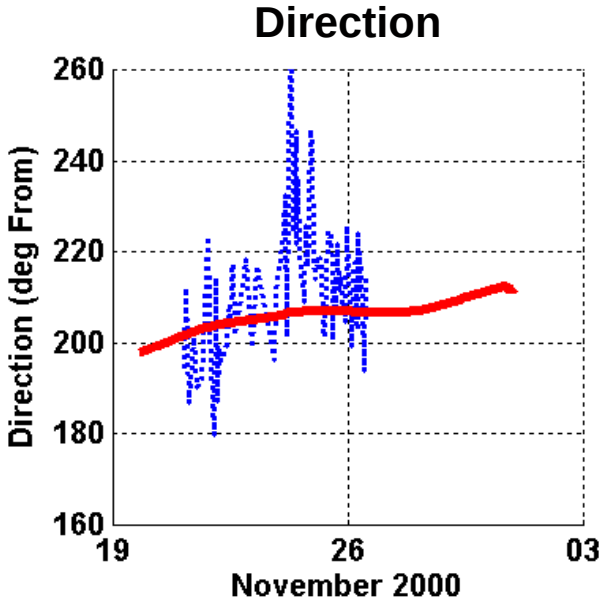
Wave System Comparison: Generation Area B



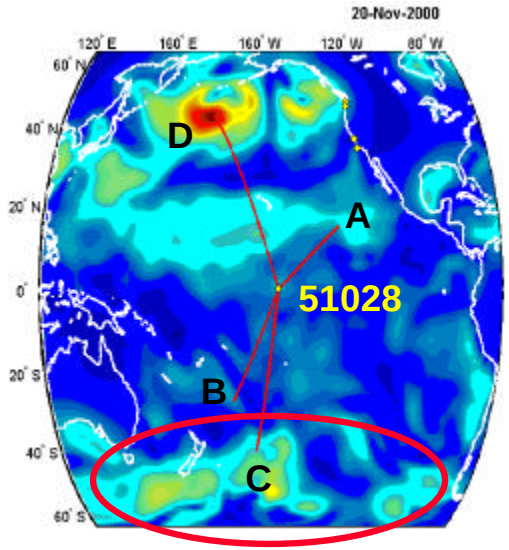


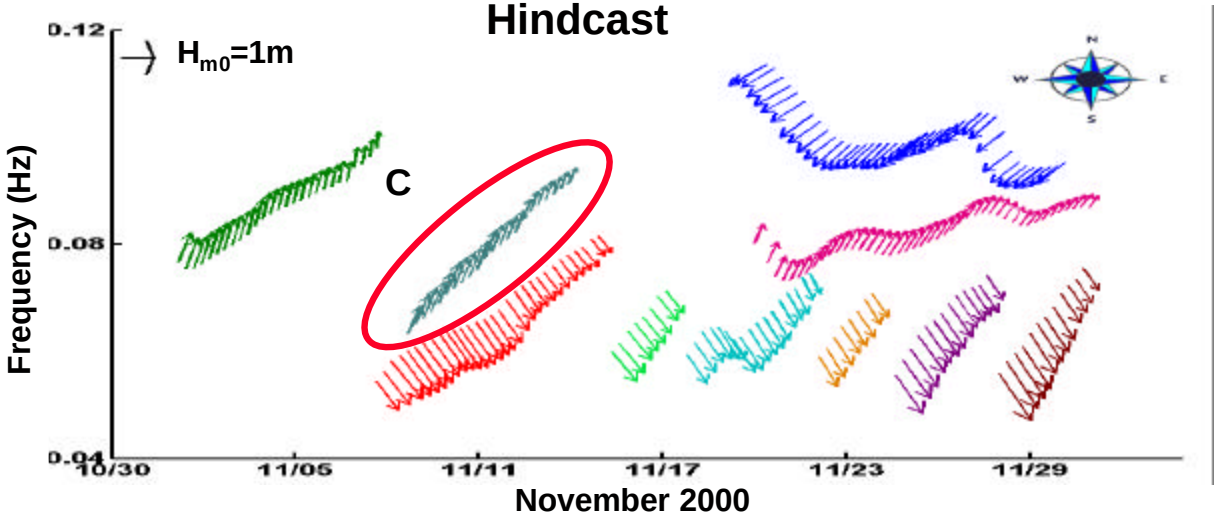


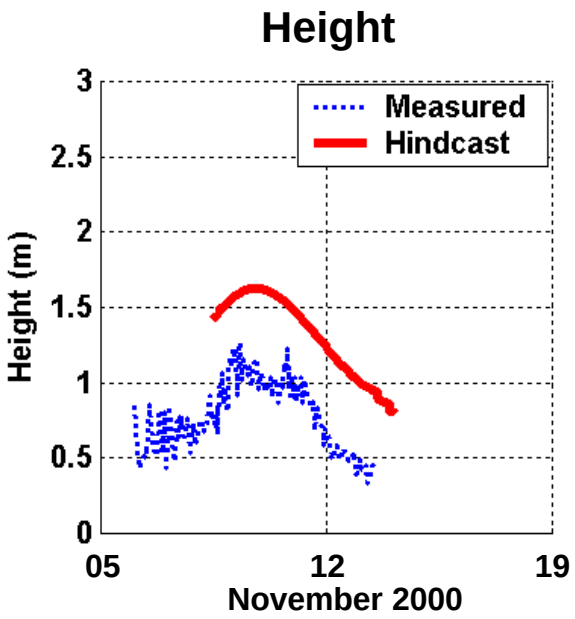


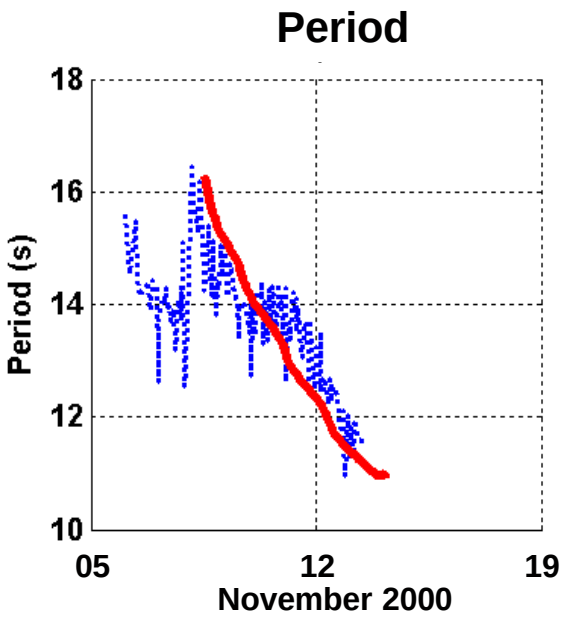


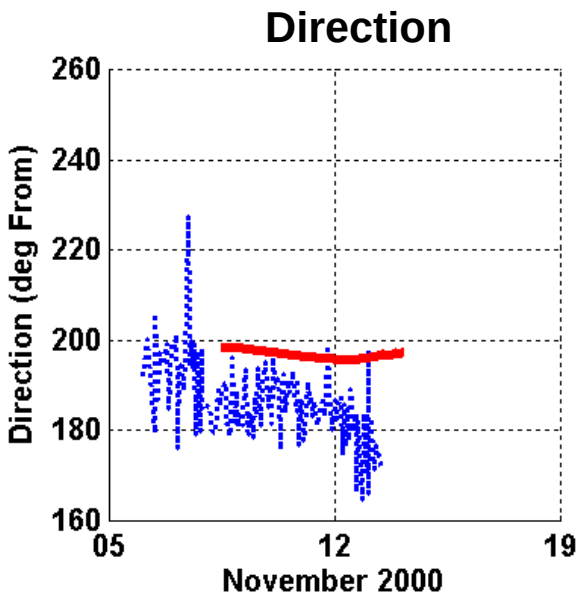
Wave System Comparison: Generation Area C



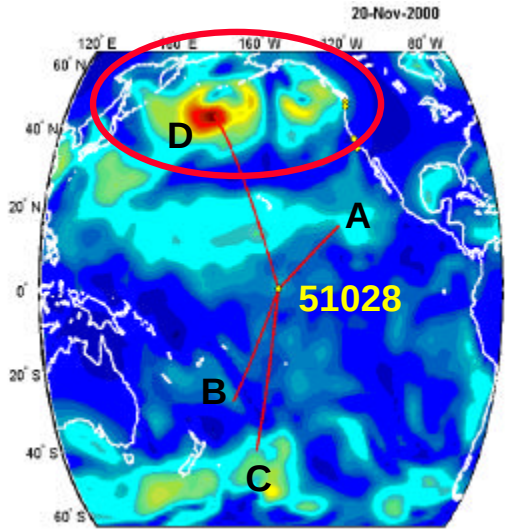


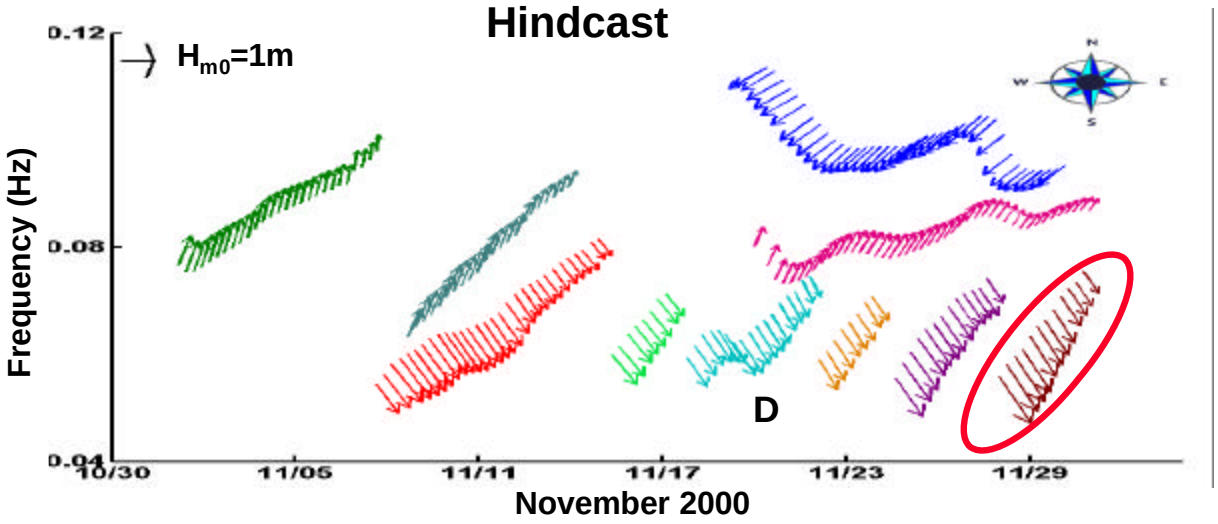


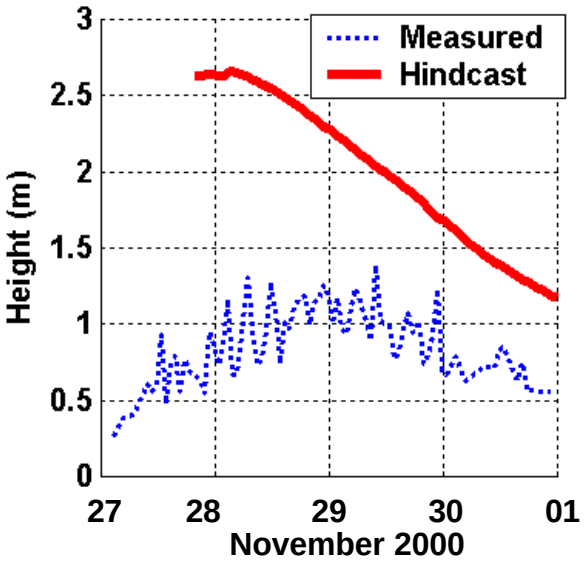


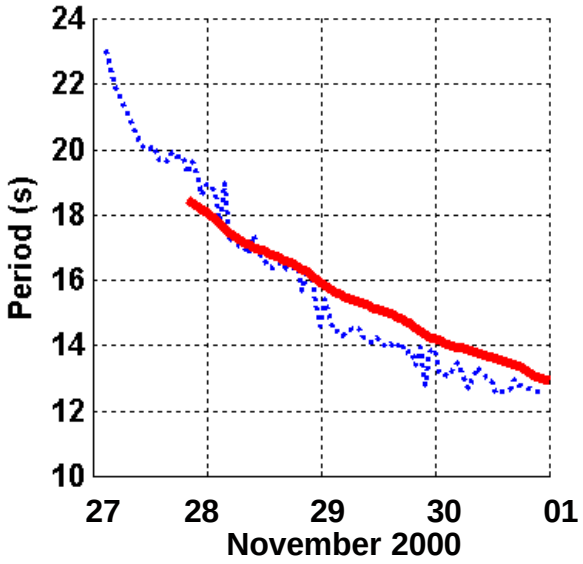


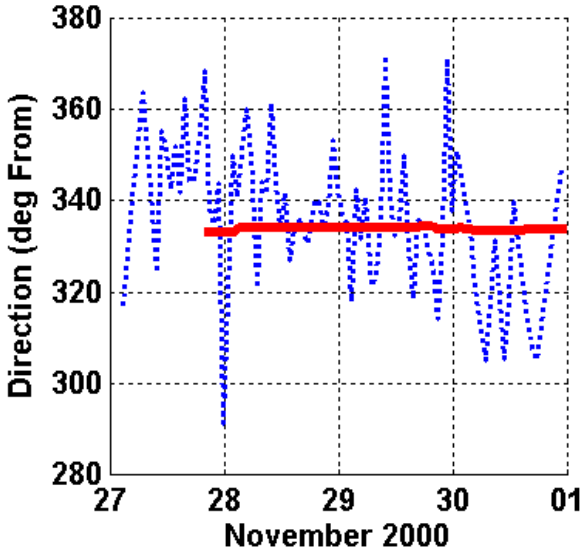
Wave System Comparison: Generation Area D











Summary

- Wave system method provides a unique forensics capability to identify hindcast deficiencies
- Young wind seas are biased low
- Swell period and direction are quite reasonable
- Swell height bias increases with distance traveled
- Results will accelerate model formulation and source term improvements
- These methods are being developed for incorporation into a robust hindcast verification and diagnostics capability

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