

# *A Thirty Year Wave Hindcast using the latest NCEP Climate Forecast System Reanalysis (CFSR) Winds*

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Partners:

NOPP participants

USACE

FNMOCC

NRL

DOE

UCSD

*12<sup>th</sup> International Workshop on Wave  
Hindcasting and Forecasting and 3<sup>rd</sup> Coastal  
Hazards Consortium  
30<sup>th</sup> Oct – 4<sup>th</sup> Nov, 2011  
Kona, Hawaii*

# Motivation

- Development of a high resolution Climate Forecast System Reanalysis (CFSR) winds global database (1979 – 2010)
- Wind resolution high enough to resolve significant storms
- Develop a thirty year wave hindcast run to
  - For detailed seasonal and inter – annual validation studies
  - Develop wave climatology
  - Provide boundary conditions for smaller domain modeling studies

# Database Plan

- Development of this database is part of the NOPP initiative for improving physics packages in Operational Wind Wave Models
- Database is being developed in three stages using the WAVEWATCH III model
  - Stage 1: Develop the database using current NCEP operational wave model physics
  - Stage 2: Develop the database using new physics from NOPP project in its second year (current plan to use Ardhuin et al 2010 physics)
  - Stage 3: Develop a final database using the final physics packages from the end of the NOPP program
- Stage 1 is complete and is reported here

# Conclusions

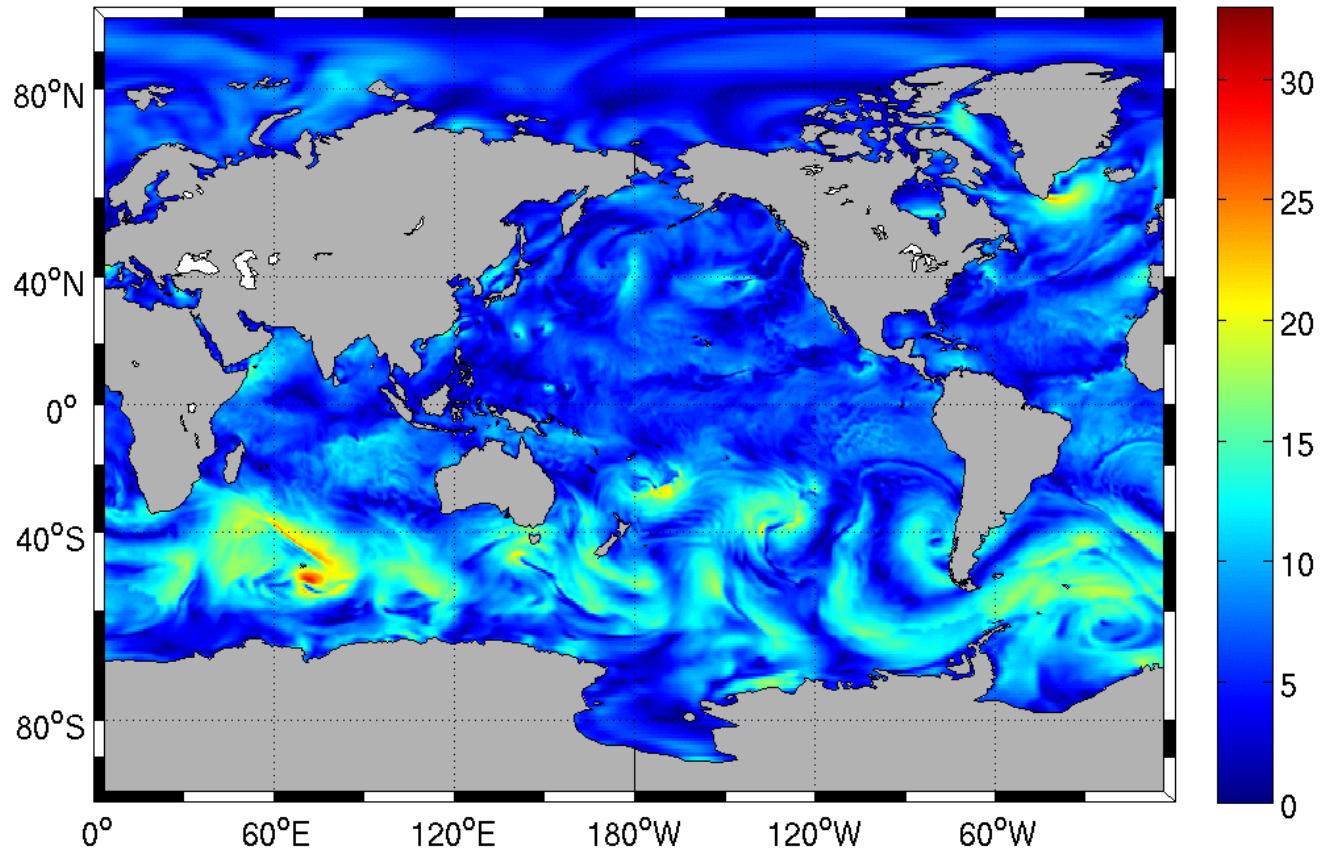
- A thirty year hindcast run has been completed using NCEP CFSR reanalysis winds
- CFSR winds in the Southern Hemisphere show distinct changes at the higher wind speeds
- Validation studies with altimeter data show
  - Reduction in Scatter Indices globally (and consequent increase in Goodness-of-fit) with time
  - Wave height biases in the Northern Hemisphere show a seasonal bias that corresponds to swell dissipation issues
  - Wave height biases in the Southern Hemisphere have an inter-annual signature on top of the seasonal signature

# CFSR Winds

- A coupled re-analysis of atmosphere, ocean, sea ice and land data (Saha et al, 2010)
- Reanalysis extends from 1979 to 2010, and a Reforecast from 2010 to present.
- Much higher resolution than the previous Global and North American Reanalysis.
- See Andrew Cox talks on skill of CFSR
- Forcings used in database
  - Hourly 10 m winds with  $\frac{1}{2}$  deg spatial resolution.
  - Hourly Air – sea temperature difference with  $\frac{1}{2}$  deg spatial resolution.
  - Daily Sea ice with 1 deg spatial resolution.
- Global domain (90S – 90N ; 0 – 360 )

# CFSR winds

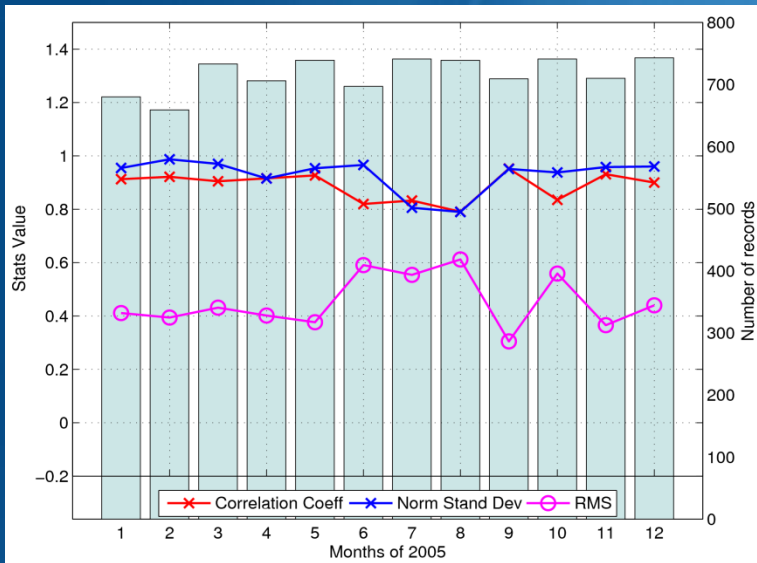
Windspeed (m/s) for 20050821 0



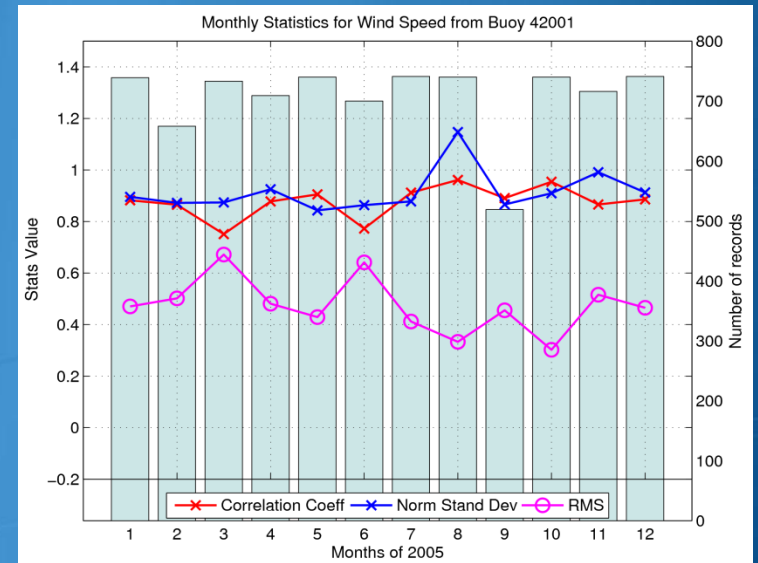


# CFSR Winds – Statistics

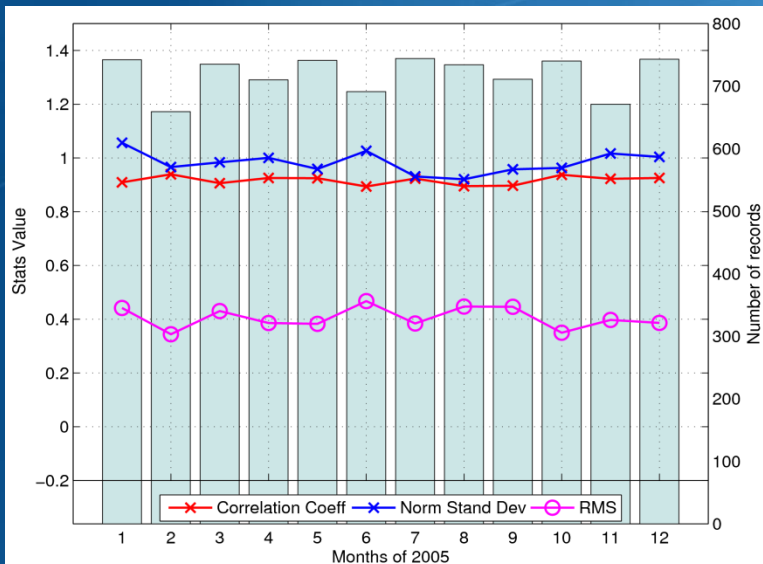
Buoy 41002



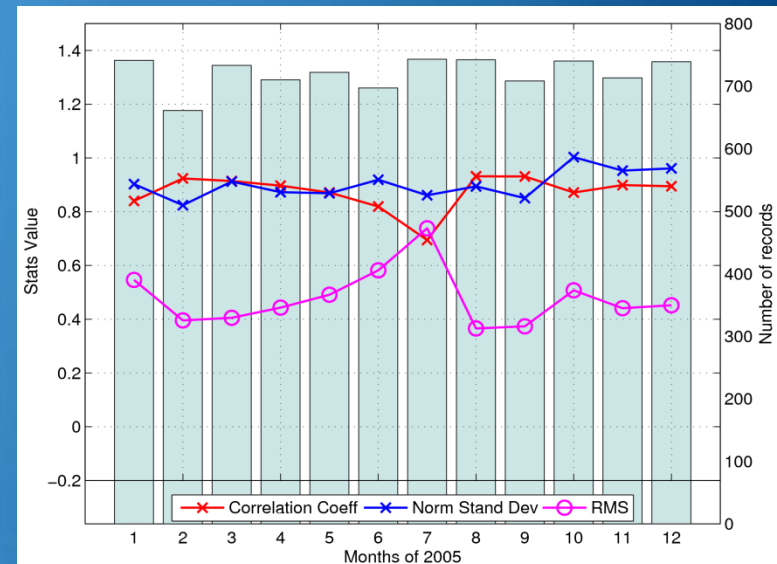
Buoy 42001



Buoy 46002

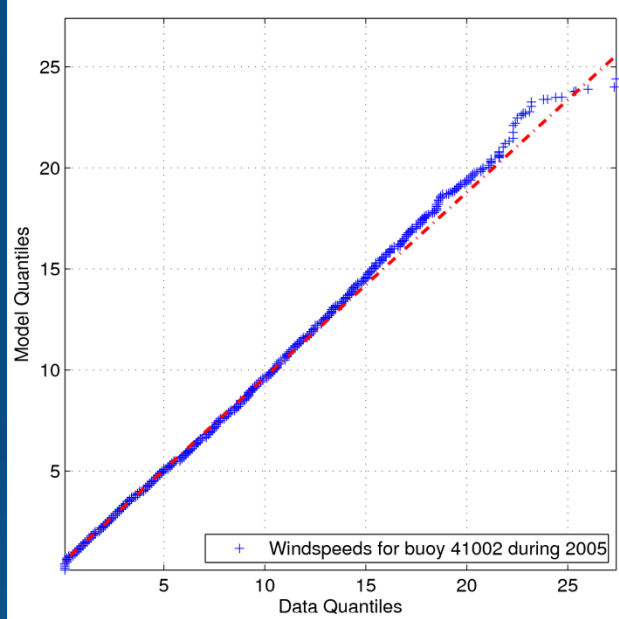


Buoy 51001

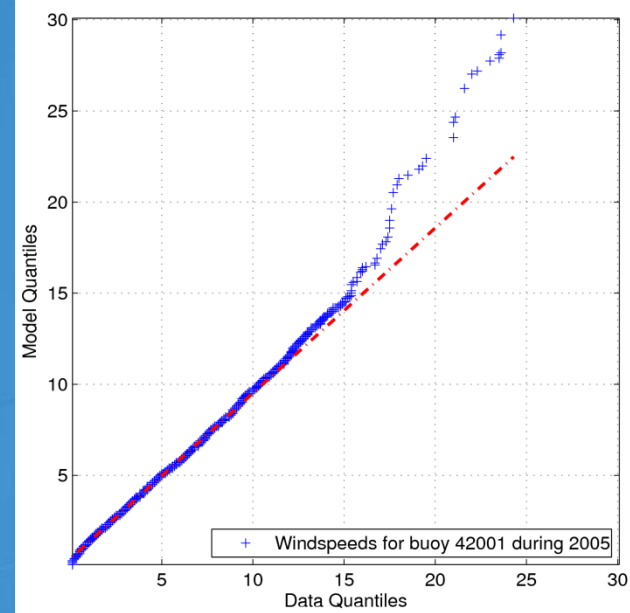


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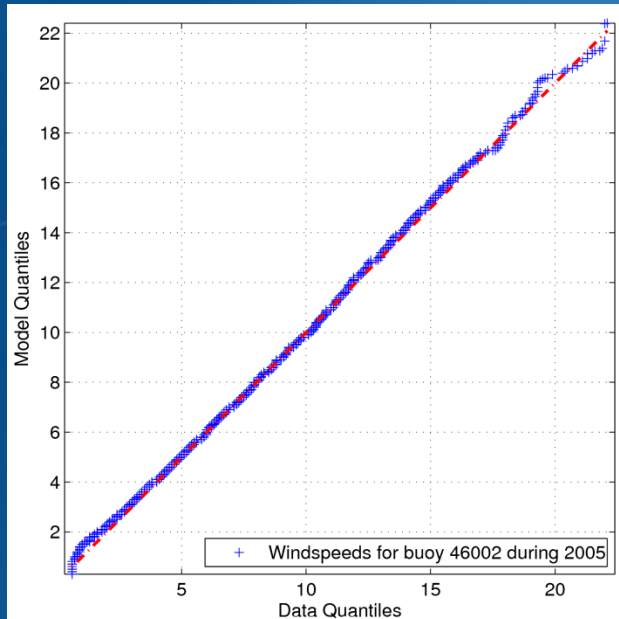
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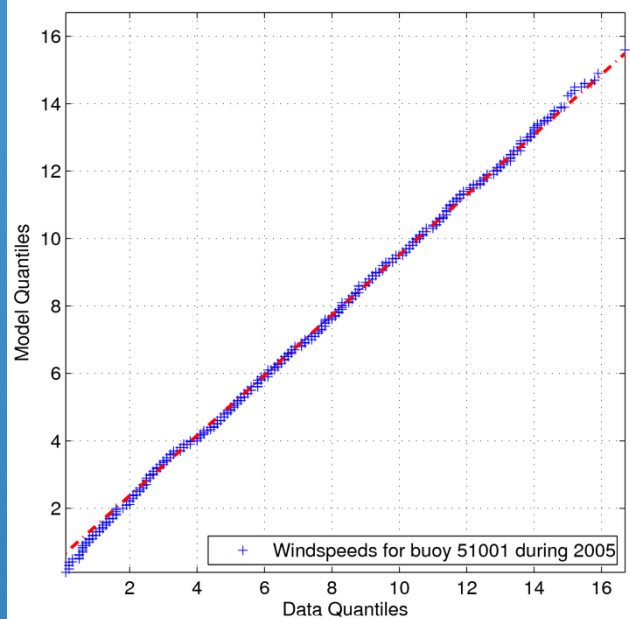
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Buoy 46002



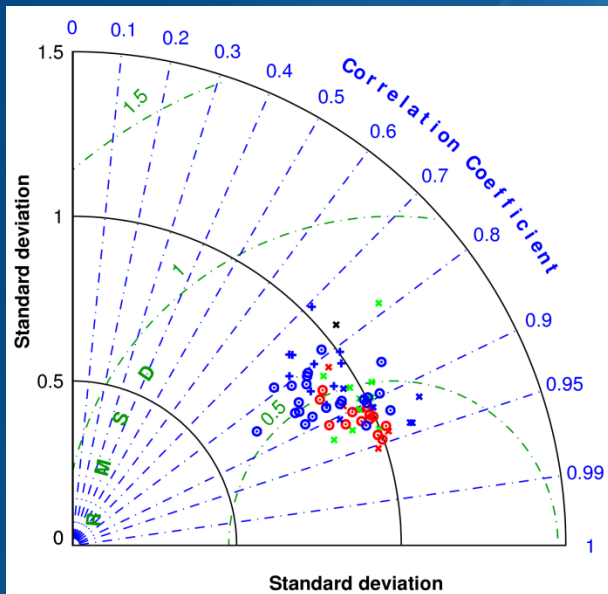
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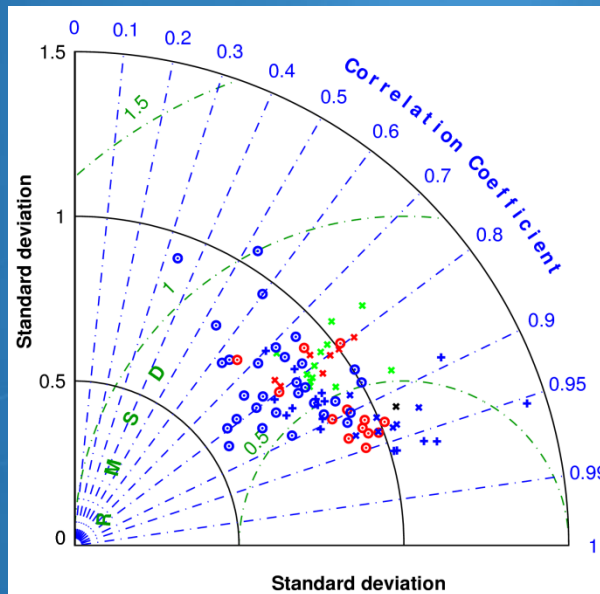


# CFSR Winds – Taylor diagrams

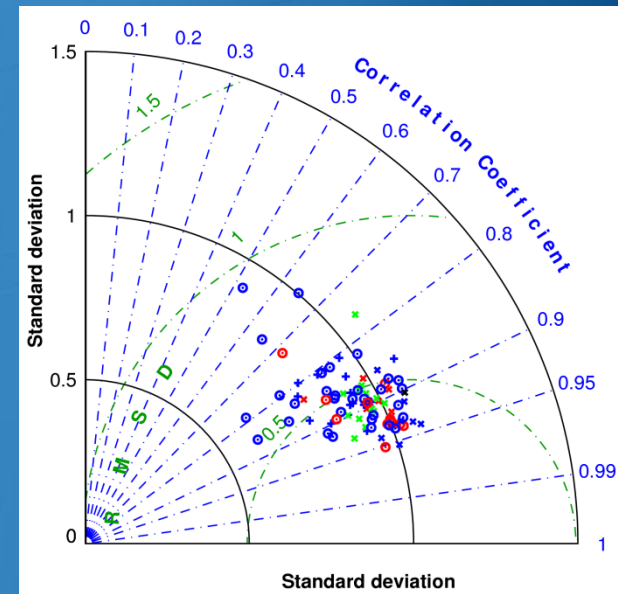
*Wind comparisons at NDBC Buoys for select months*



March, 2005

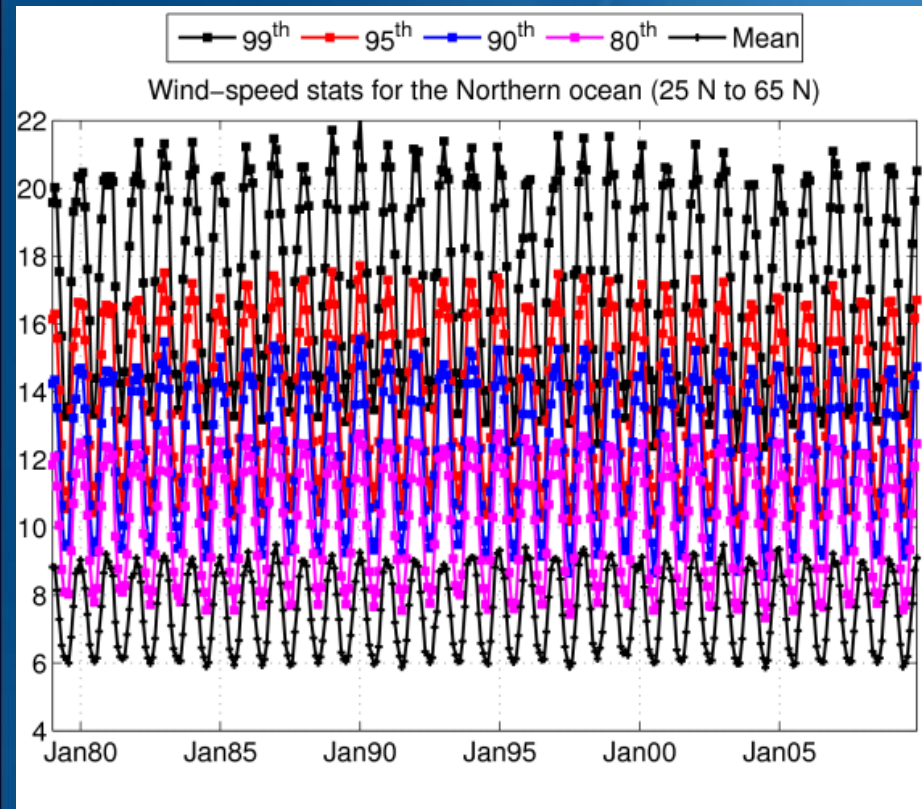


August, 2005

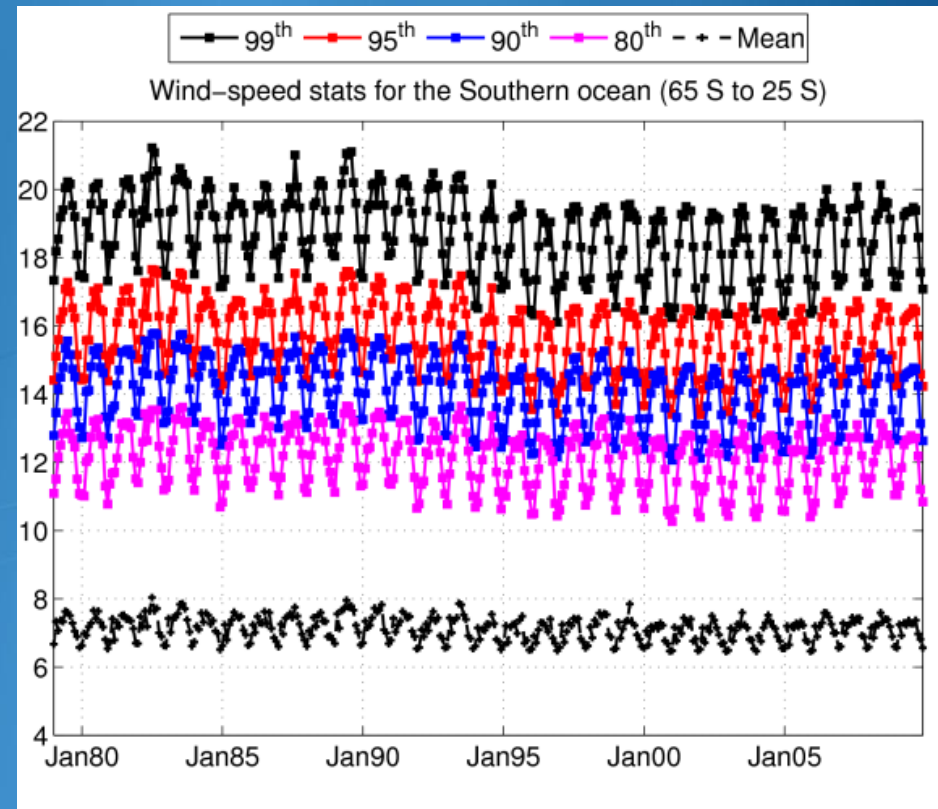


December, 2005

# CFSR Winds – Percentile distribution



N Hemisphere wind  
distribution  
(25 N to 65 N)

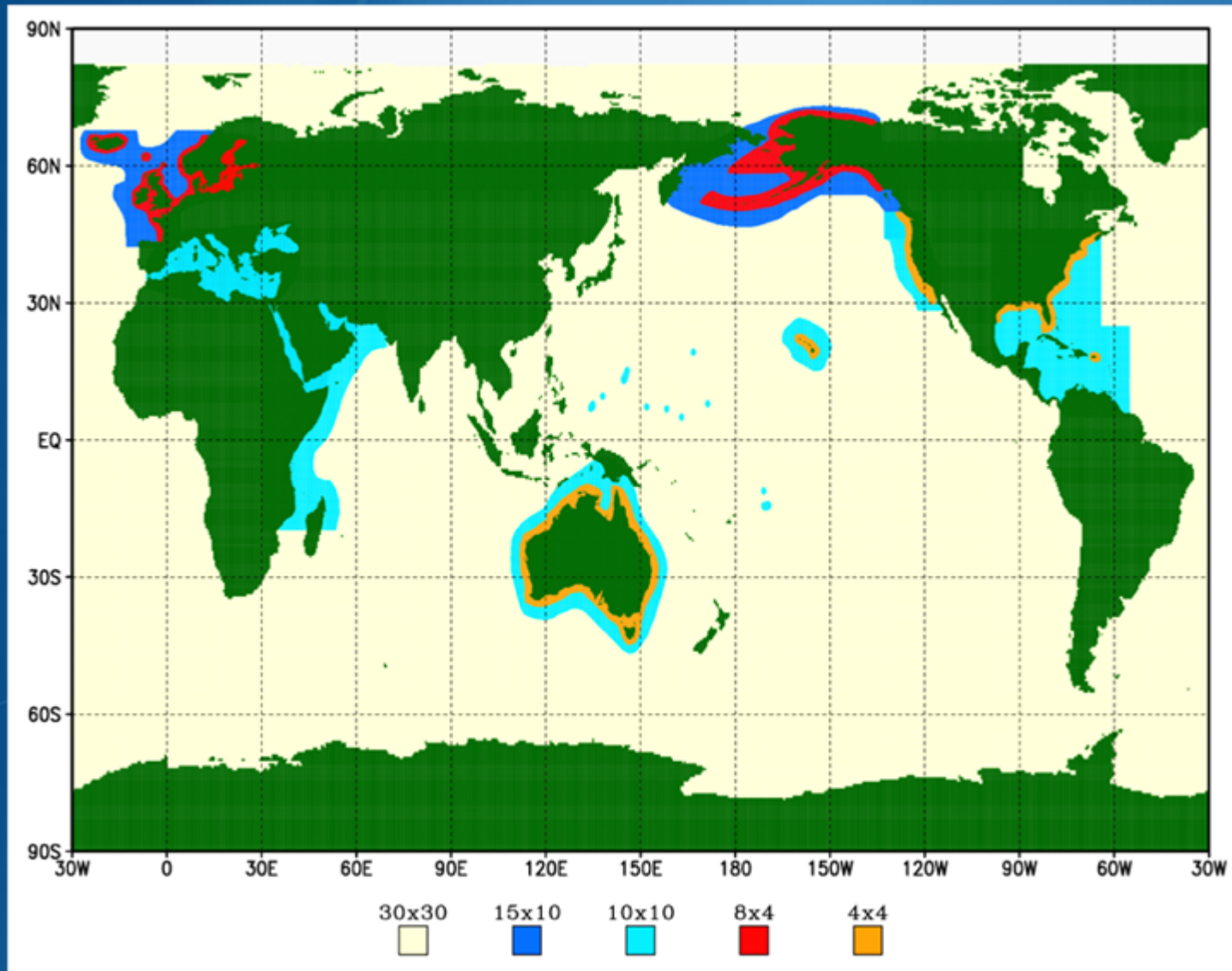


S Hemisphere wind distribution  
(25 S to 65 S)

# Model Set-up

- WAVEWATCH III model
- Multi – grid domain consisting of 16 grids ranging from  $\frac{1}{2}$  deg to  $1/15$  deg
- Spectral domain – 50 frequency by 36 directional bins
- Physics Package
  - Tolman – Chalikov source term package (with a cap for drag coefficient)
  - DIA for non – linear interaction
  - Battjes – Janssen shallow water depth limited wave breaking
- Model includes a partitioning algorithm (see Hanson et al, 2009) that is used for generating products

# Multi – grid domain



*(all resolutions in arc-minutes)*

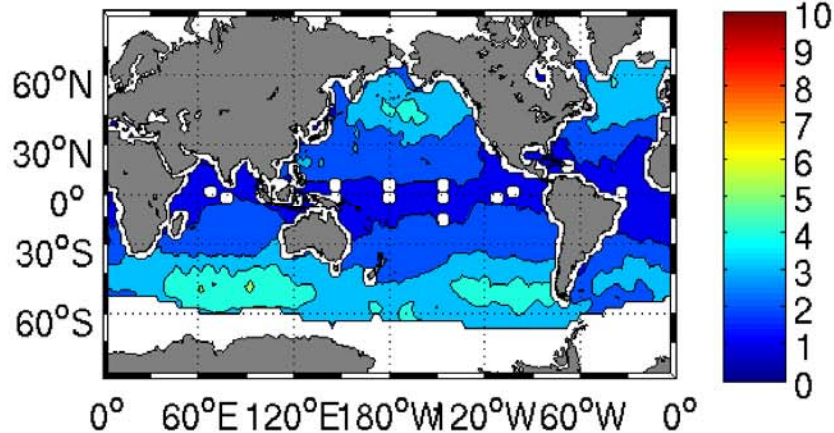
# Products

- Field Output in GRIB2 format (every 3 hours)
  - Wind speed and direction
  - Bulk spectral parameters (significant wave height, peak period and average wave direction at peak period)
- Partition output
  - Available hourly, for each individual grid
  - Ascii files that provide bulk spectral estimates for each wave system (identified from a local partitioning of the spectrum)
- Point output
  - Over 2000 point outputs (buoy locations + additional output points requested by collaborators)
  - Hourly spectra, bulk parameters and partition data saved at the output points
- Altimeter collocations
  - Wind speed and wave height saved along altimeter tracks (interpolated in space and time from hourly field output files)
  - Quality controlled altimeter data archived at IFREMER used for identifying tracks

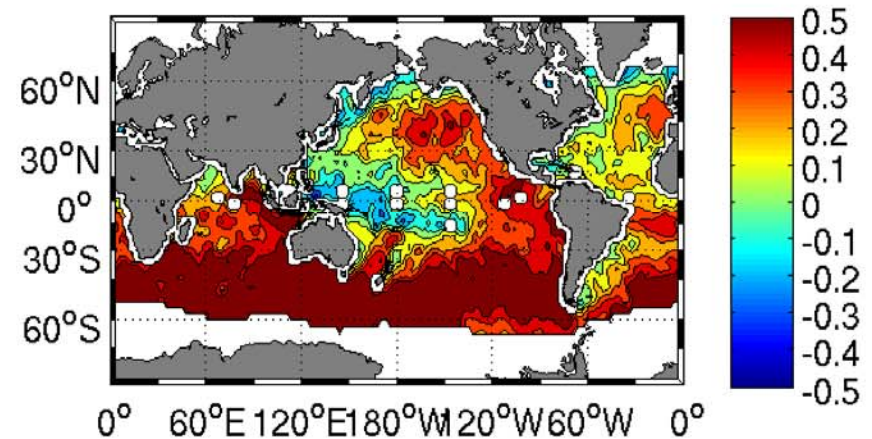


# Model Validation – Altimeters

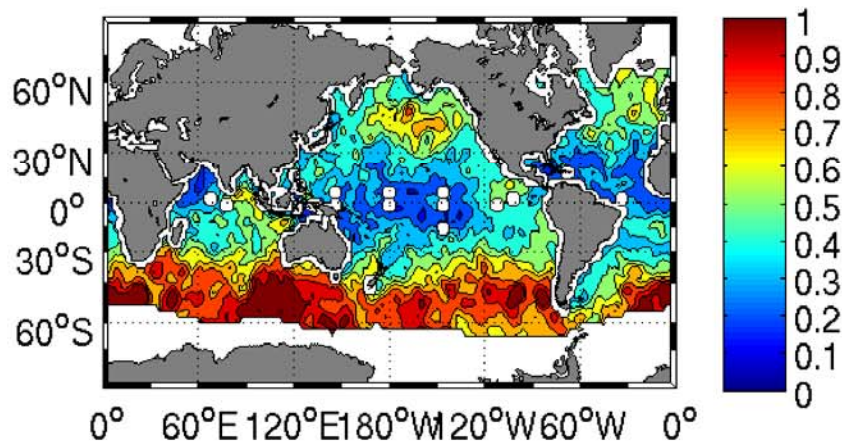
Hs -- tpx (199210)



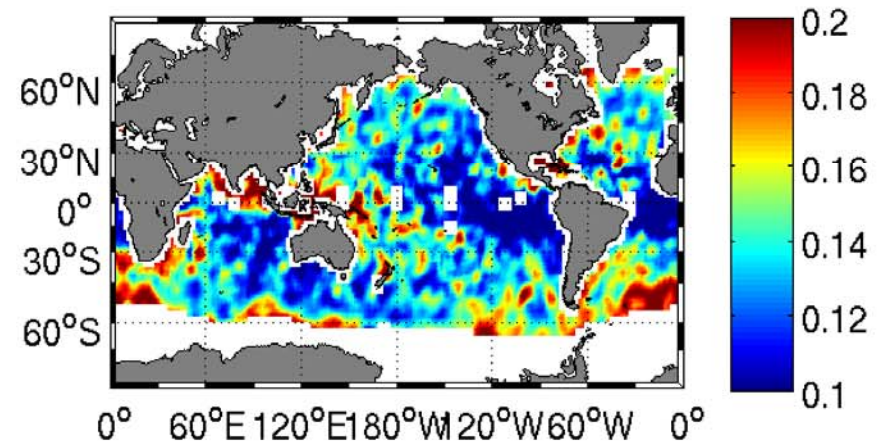
Bias



RMS Err

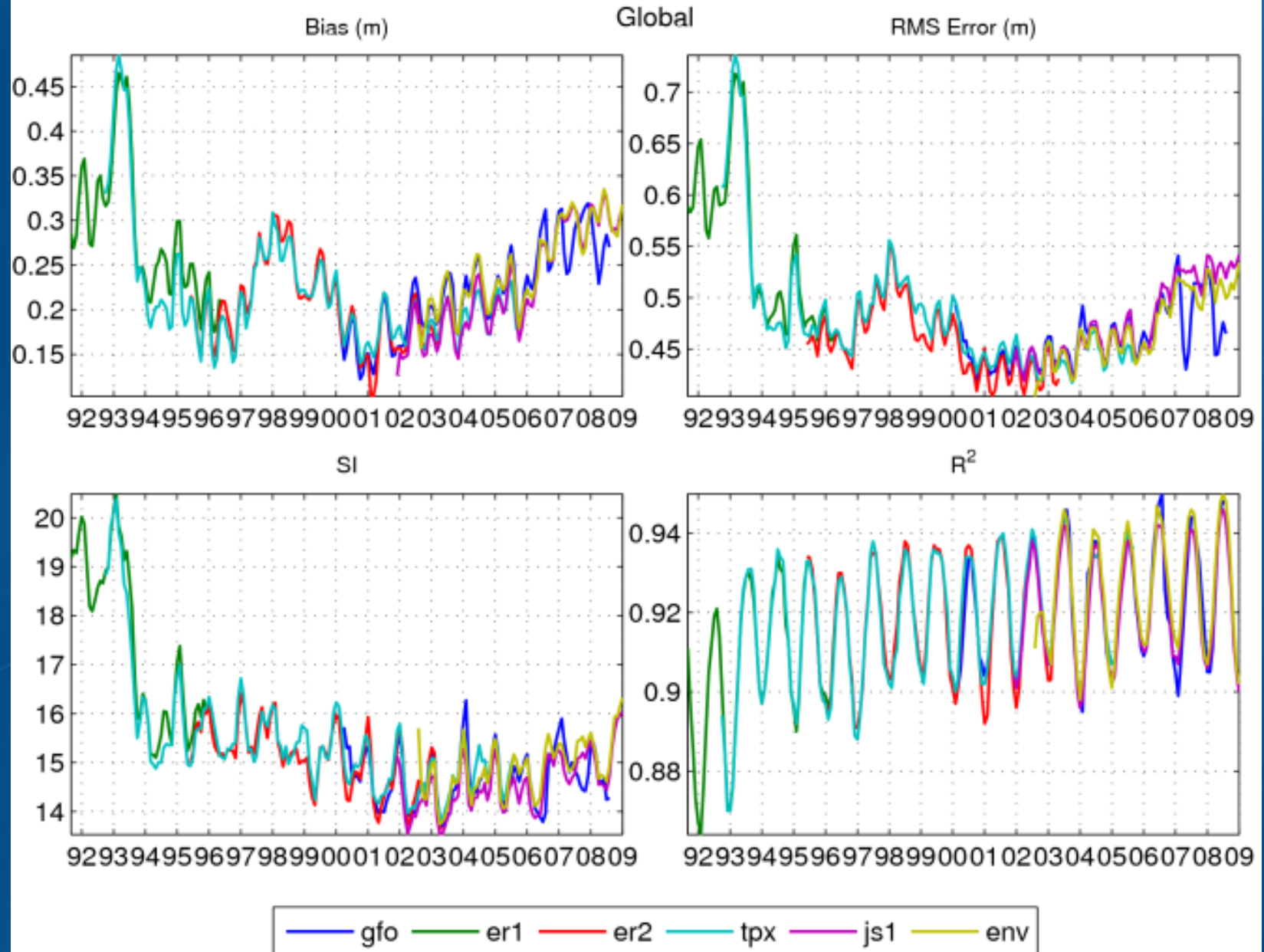


SI



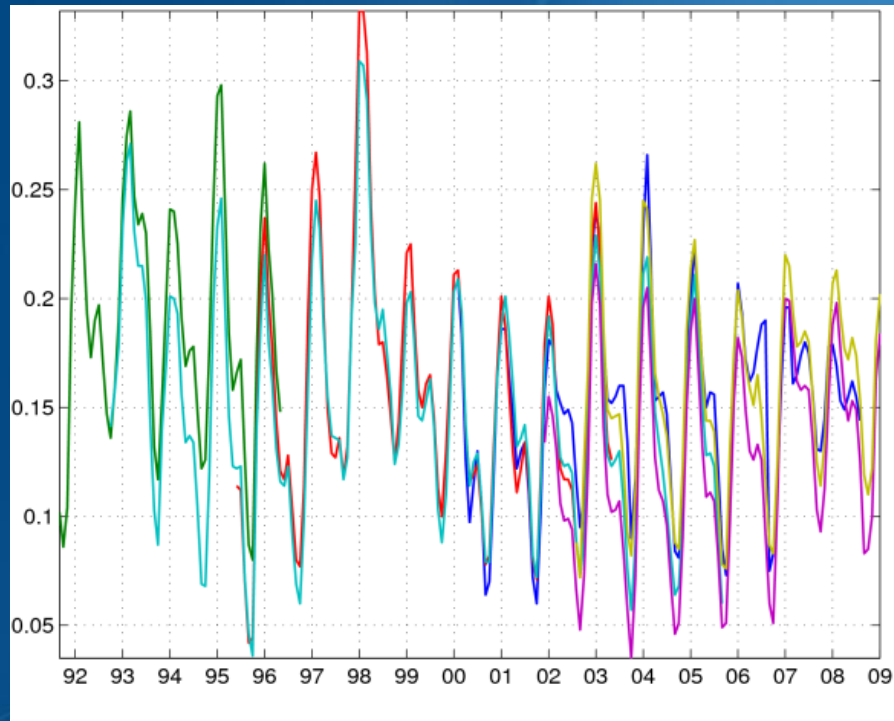


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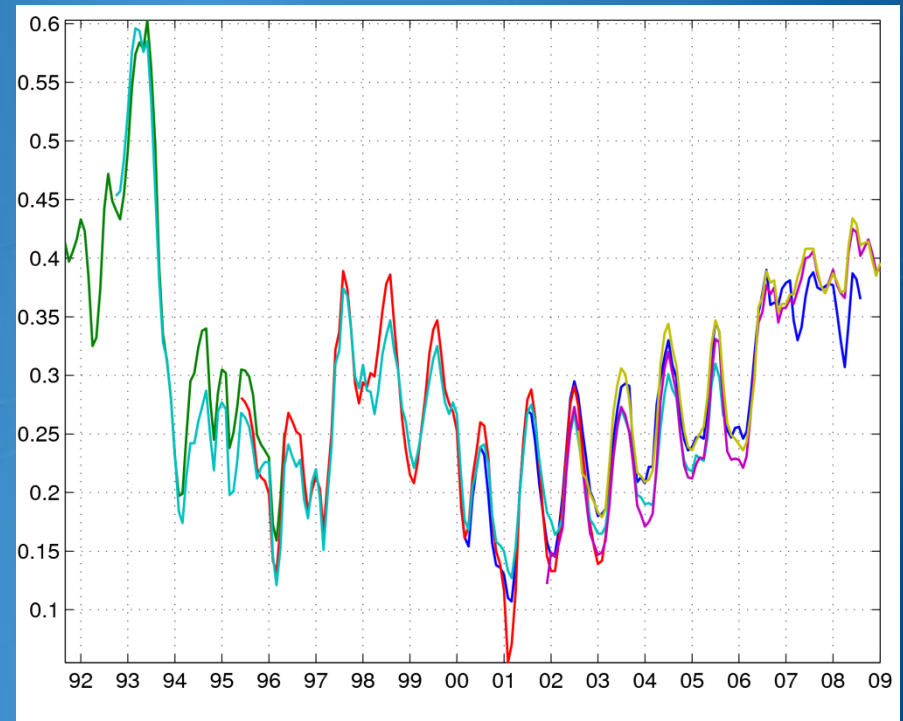


# Model Validation - Altimeters

## *Wave Height Biases*



N Hemisphere

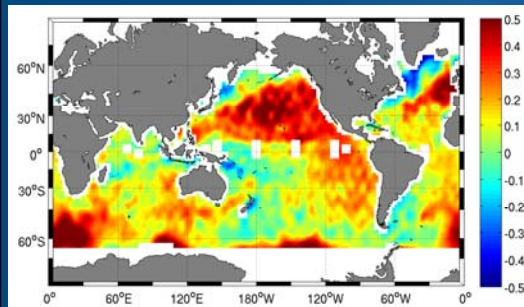


S Hemisphere

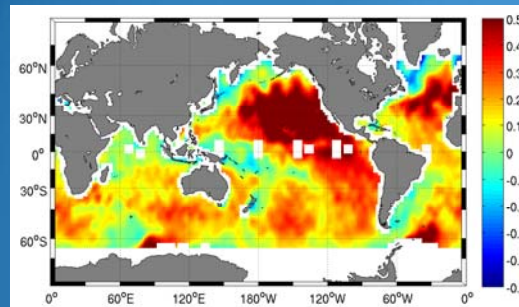
# Model Validation – Altimeters

## *Snapshots of wave height biases (Jason-1)*

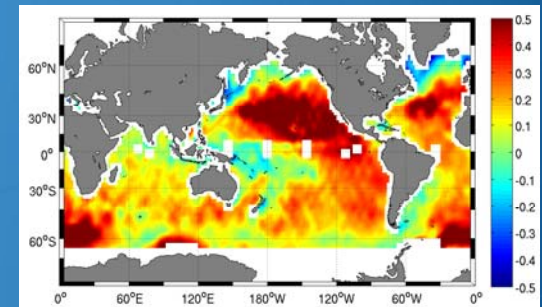
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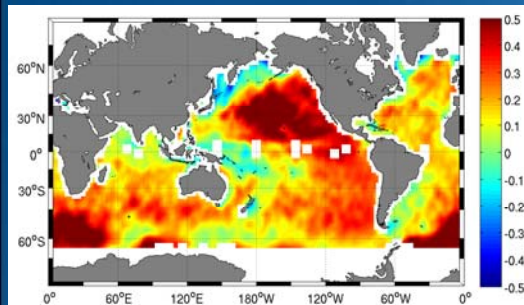
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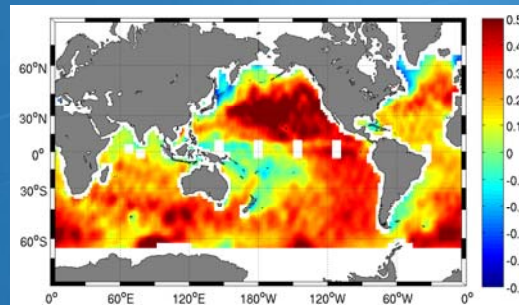
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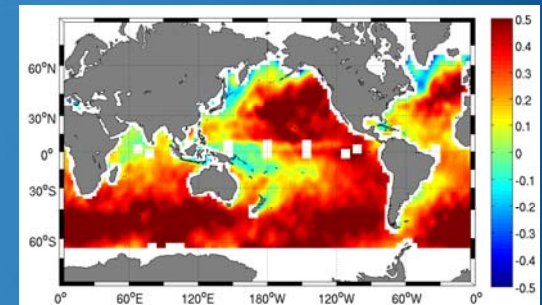
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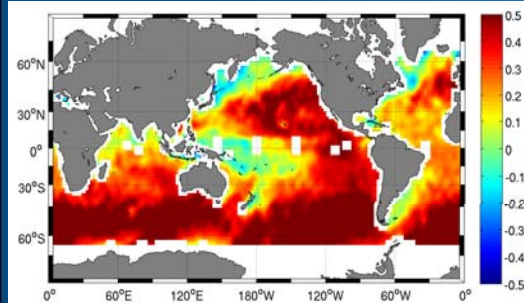
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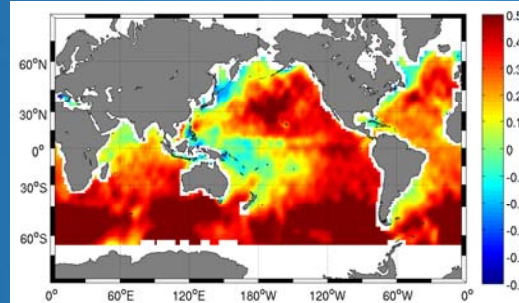
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Jan 2008

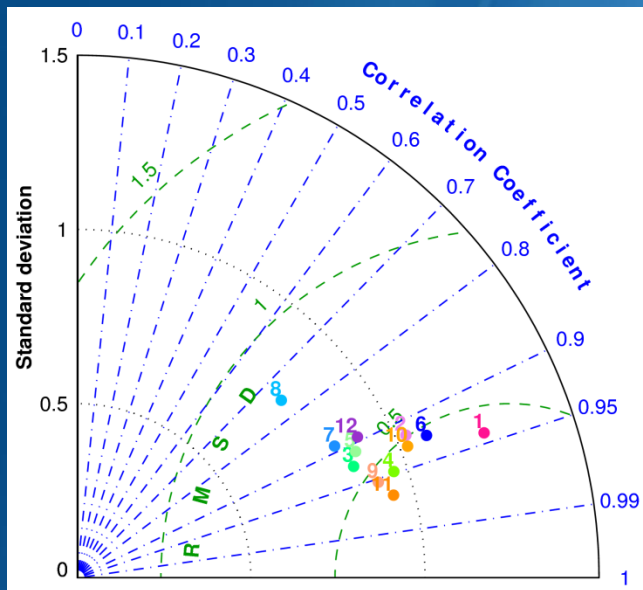


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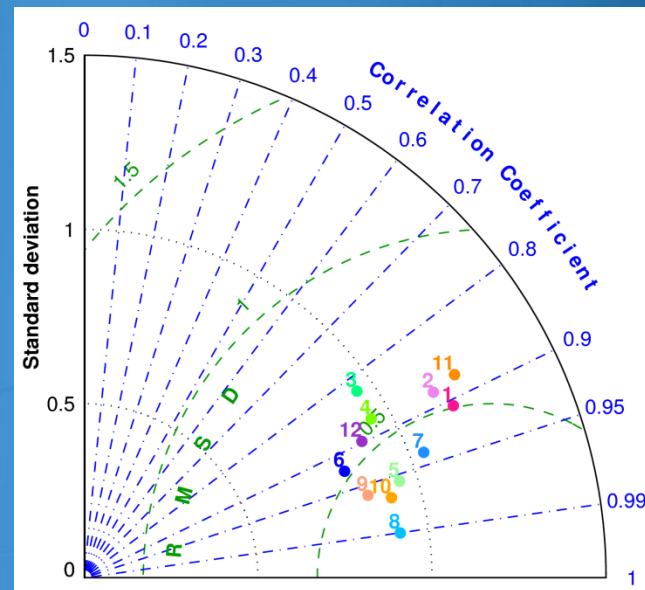


# Model Validation – Buoys

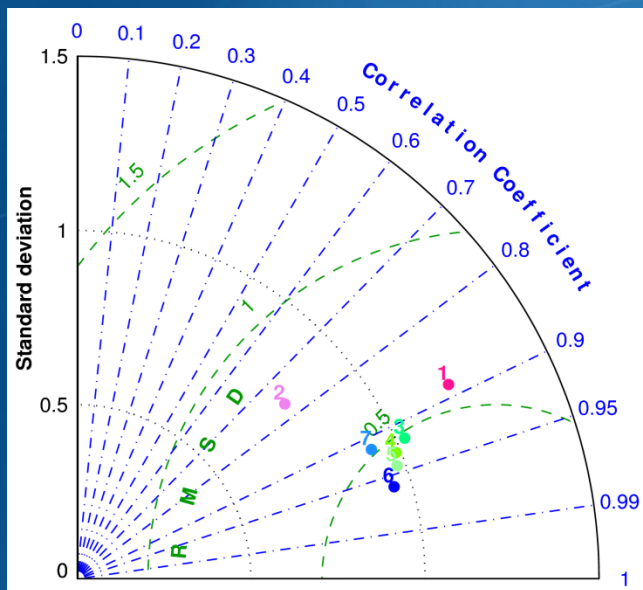
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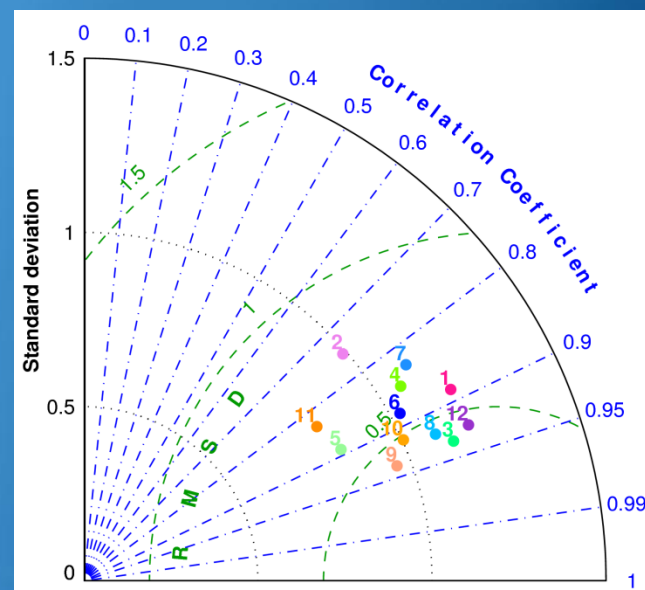
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Buoy 46002



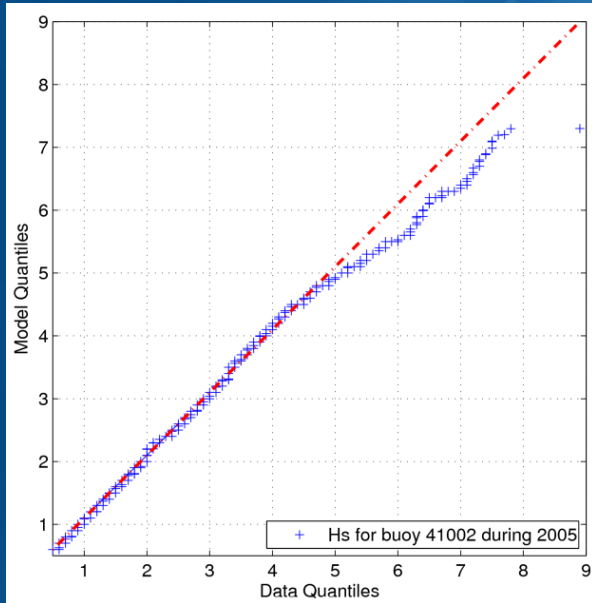
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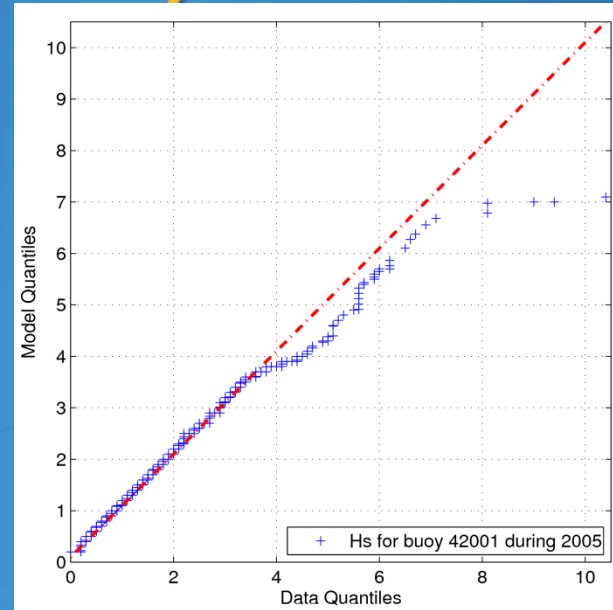


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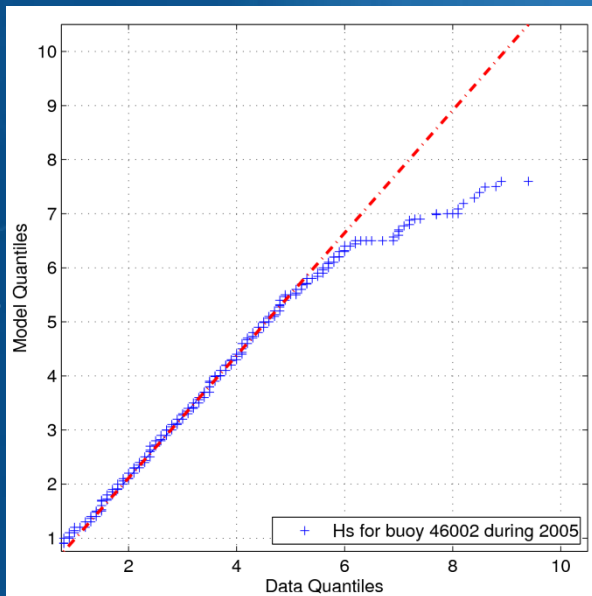
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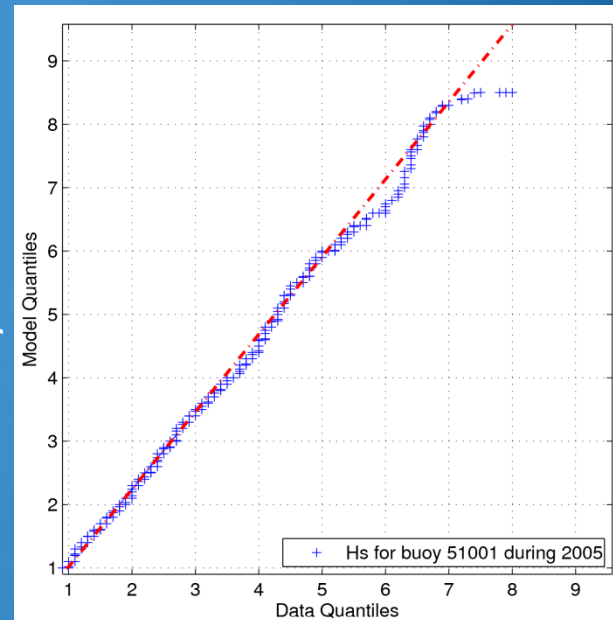
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