Wave Information Studies Online Visualization and Validation of 30+ Year Hindcast

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U.S. Army Engineer Research and Development Center

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What progress has the Wave Information Studies made?

- Hindcast Updates
- New validation tools
- New file format and storage
- New online validation and visualization tools for customers

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What is the Wave Information Studies?

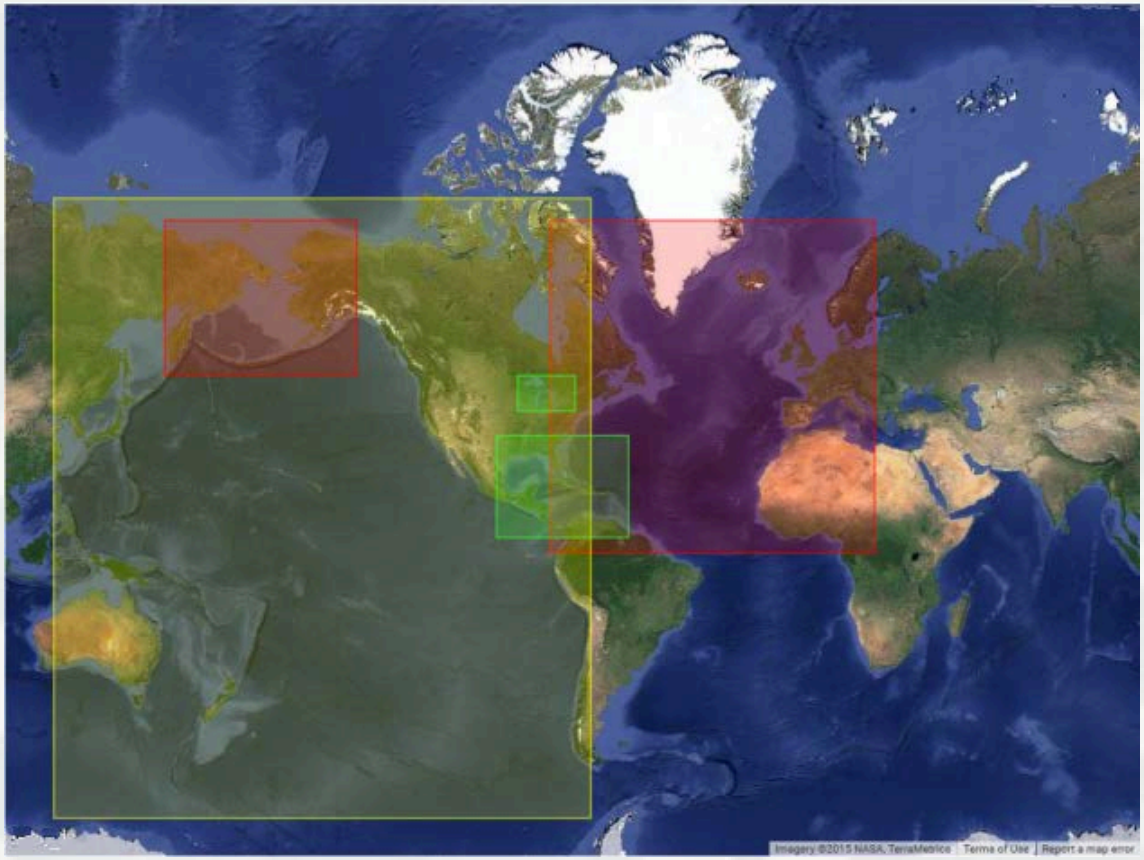
Mission

The Wave Information Studies (WIS) is a US Army Corps of Engineers (USACE) sponsored project that generates consistent, hourly, long-term (30+ years) wave climatologies along all US coastlines, including the Great Lakes and US island territories.

History

The Wave Information Studies has been providing wave information for US coastlines since 1976. Through the years, WIS has continued to develop hindcasts while evaluating model results and modeling technology.

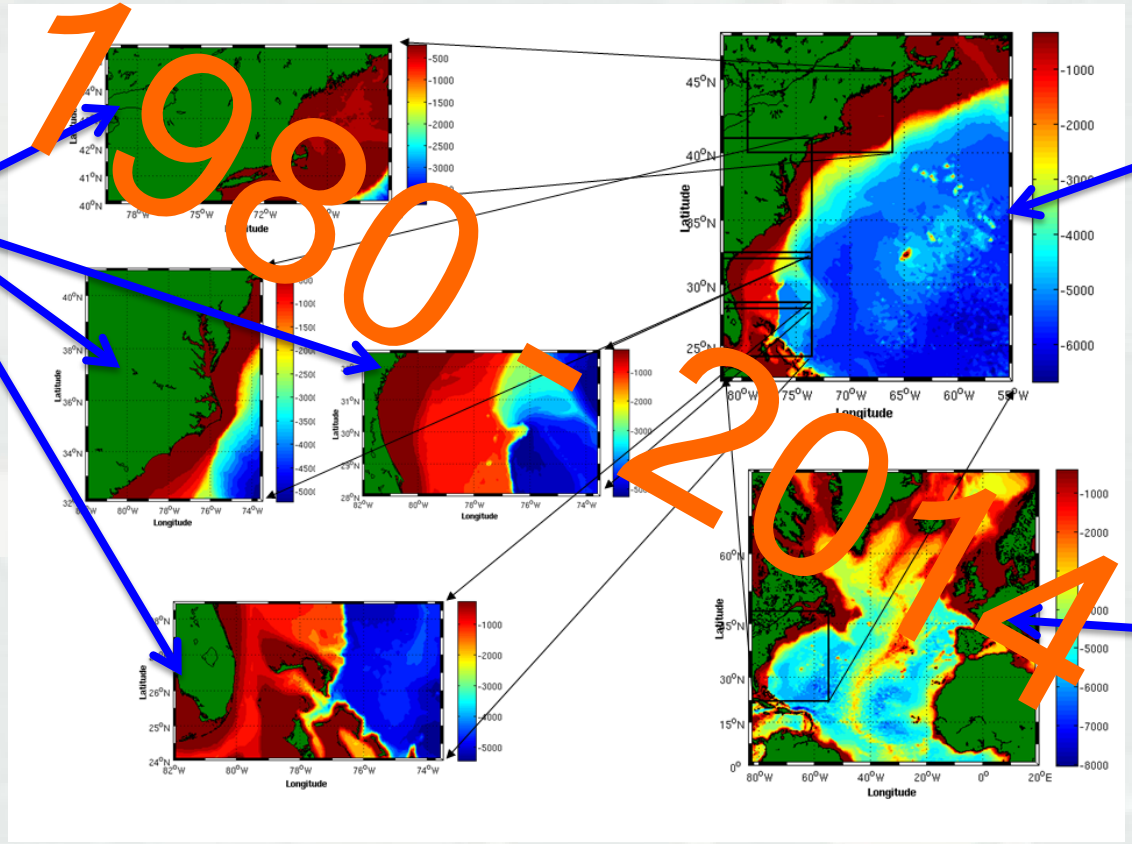
Where does WIS focus efforts?



- Every US coastline is covered
- Each basin is modeling independently to provide the best results
- Multiple models and winds are evaluated prior to running each hindcast

WIS Atlantic transitioned to 3G wave model with 5-min near shore resolution

5-min coastal grids

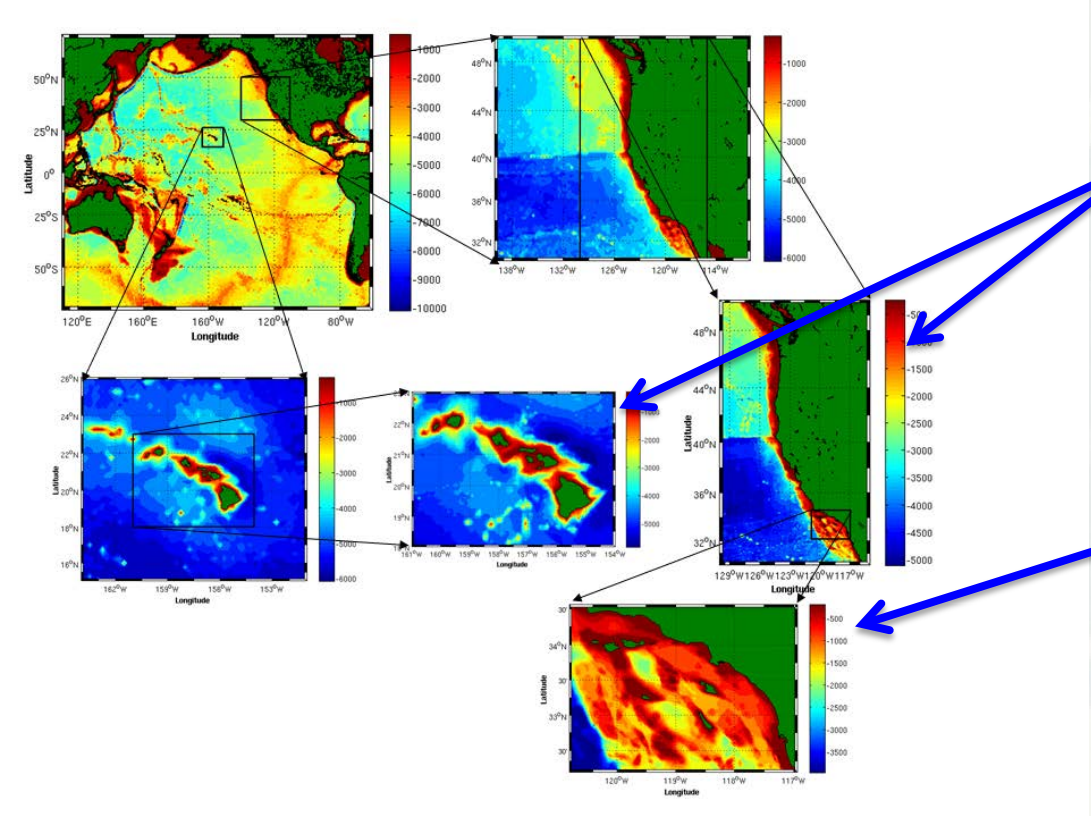


0.25-deg East Coast grid

0.5-deg North Atlantic Basin

**Found little improvement in results for tests with 3-min grid

WIS Pacific increased near shore grid resolution for Southern California and Hawaii.



5-min Hawaii and West Coast grids

90-sec Southern California grid

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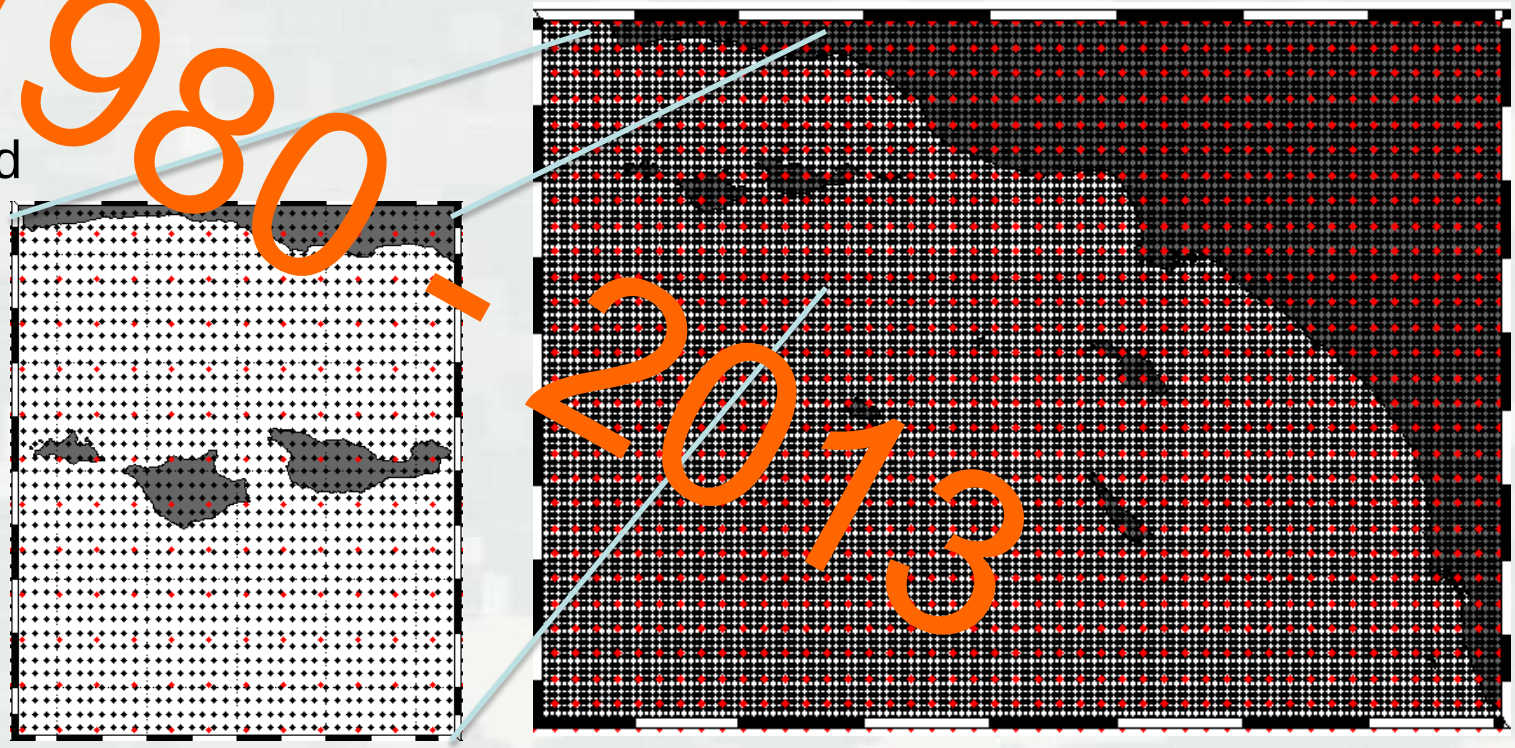
The wave model grid for Southern California increased in resolution from 5-min to 90-sec

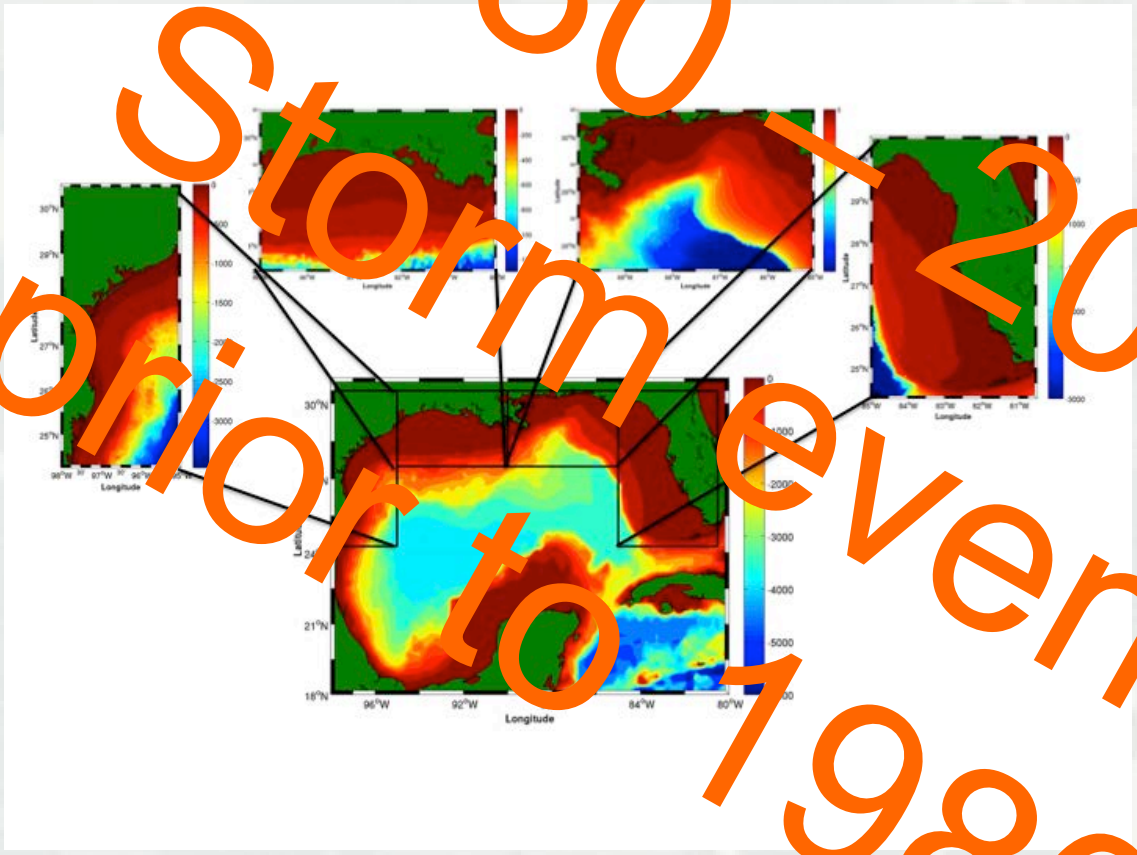
NEW 90-sec Southern California Grid

1980-2013

5-min West Coast Grid



Gulf of Mexico near shore grid increased resolution to 3-min



Near shore grid resolution at 3-min

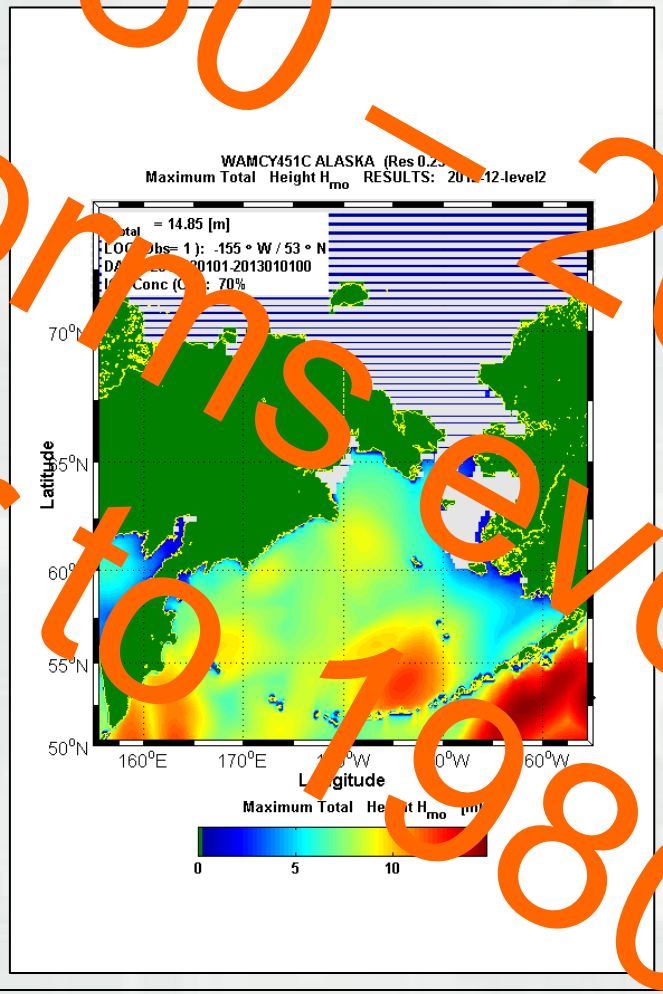
Winds generated from NCEP/NCAR R1 with QuickSCAT adjustment and IOKA for top ten storms

1980 – 2014
Storm events
prior to 1980

Alaska region was run with mean monthly ice fields and higher resolution.

70% ice threshold turns water into land

Focus of WIS Alaska was on region north of Aleutian Islands



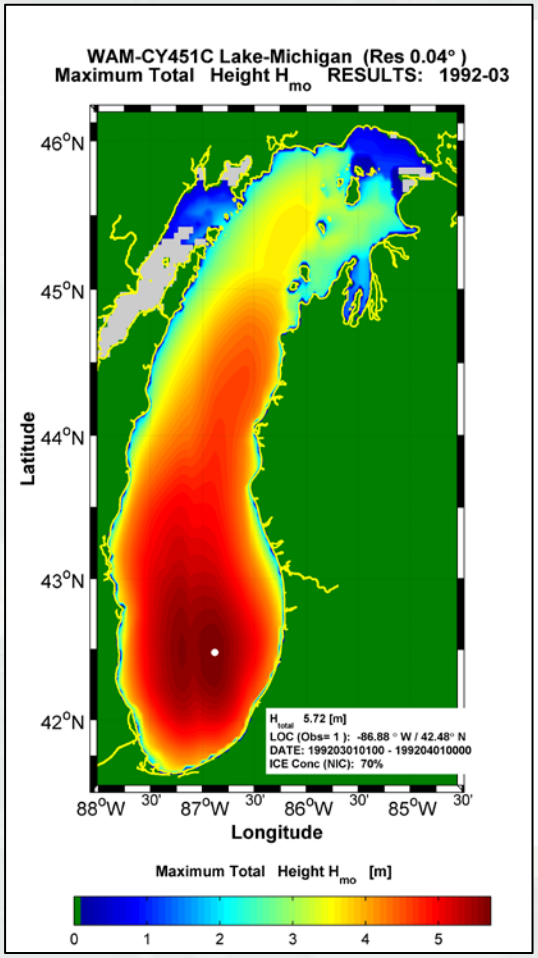
0.25-deg grid resolution, plan to upgrade to 5-min

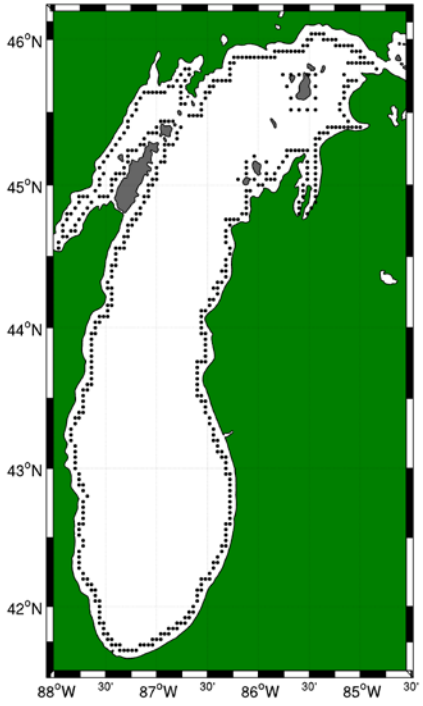
Plan to extend eastern boundary to US/Canadian boarder

1980 – 2014 Storms events prior to 1980

Resolution in the Great Lakes was increased allowing for more save points

Grid resolution for all Great Lakes at 0.04-deg



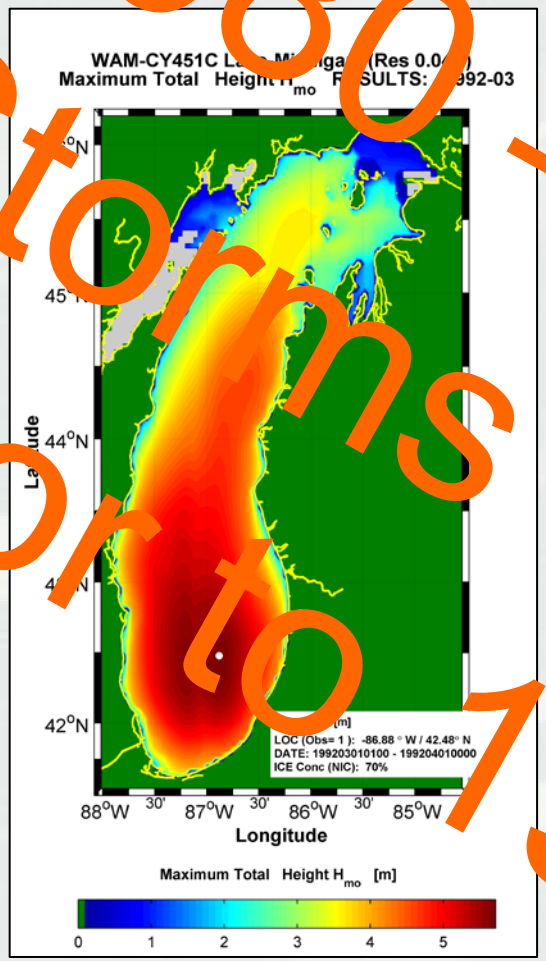


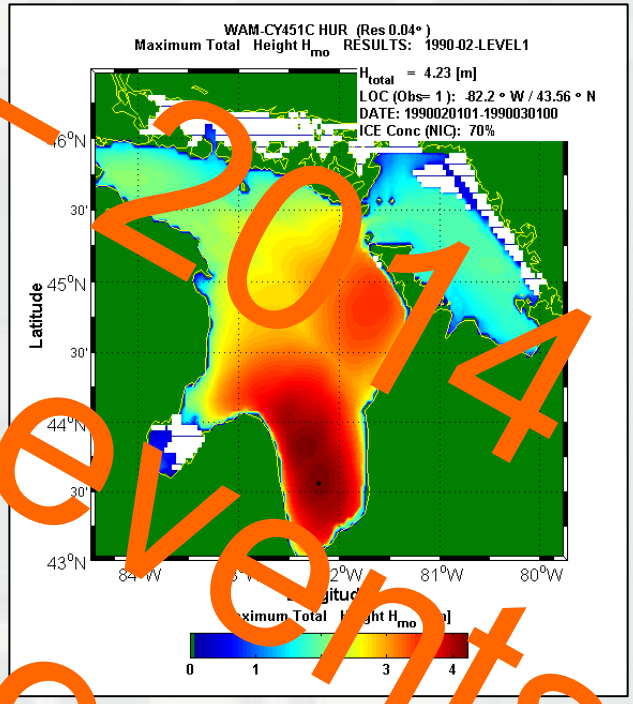
1,950 save points for Great Lakes

Mean daily ice concentrations were used in the Great Lakes

Mean daily ice fields provide temporal and spatial changes

Working on including recent research for ice into future hindcasts





70% ice threshold turns water into land

1980 – 2014 Storms events prior to 1980

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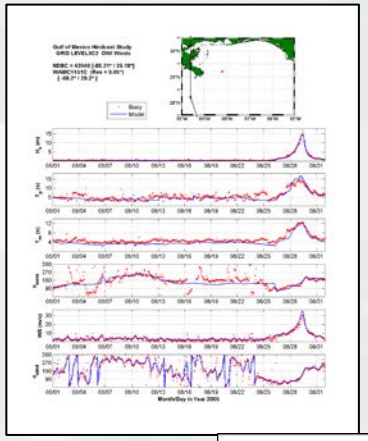
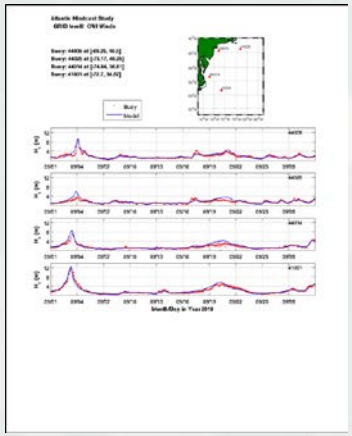
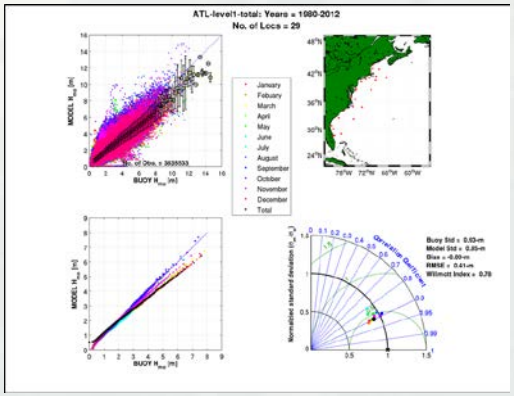
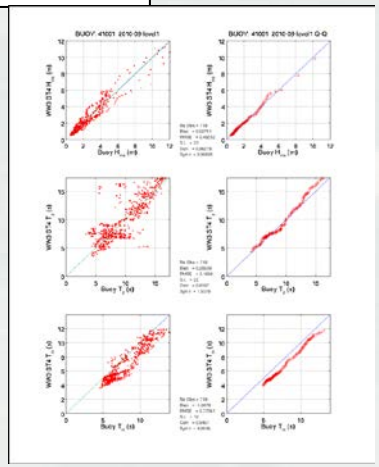
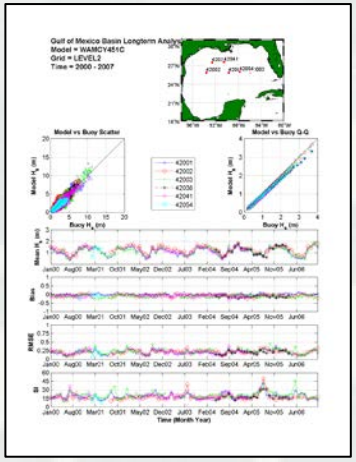
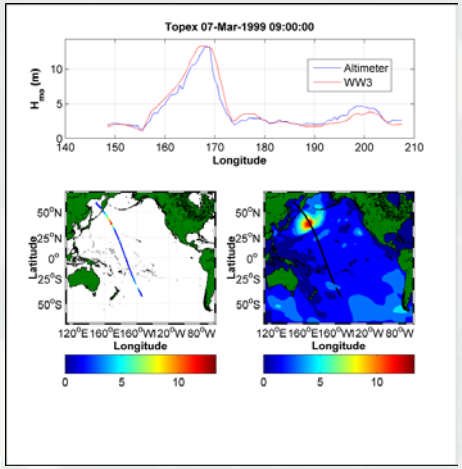






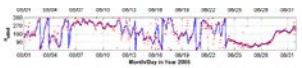


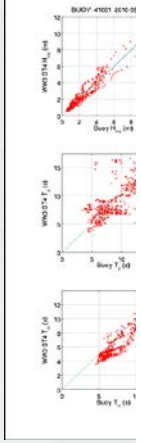




How does WIS evaluate hindcast results?

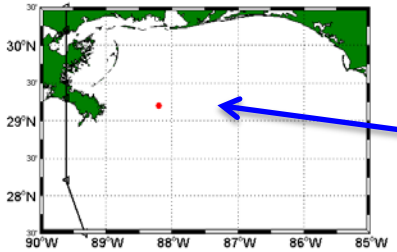
Time Series of Buoy and Model Wave Parameters

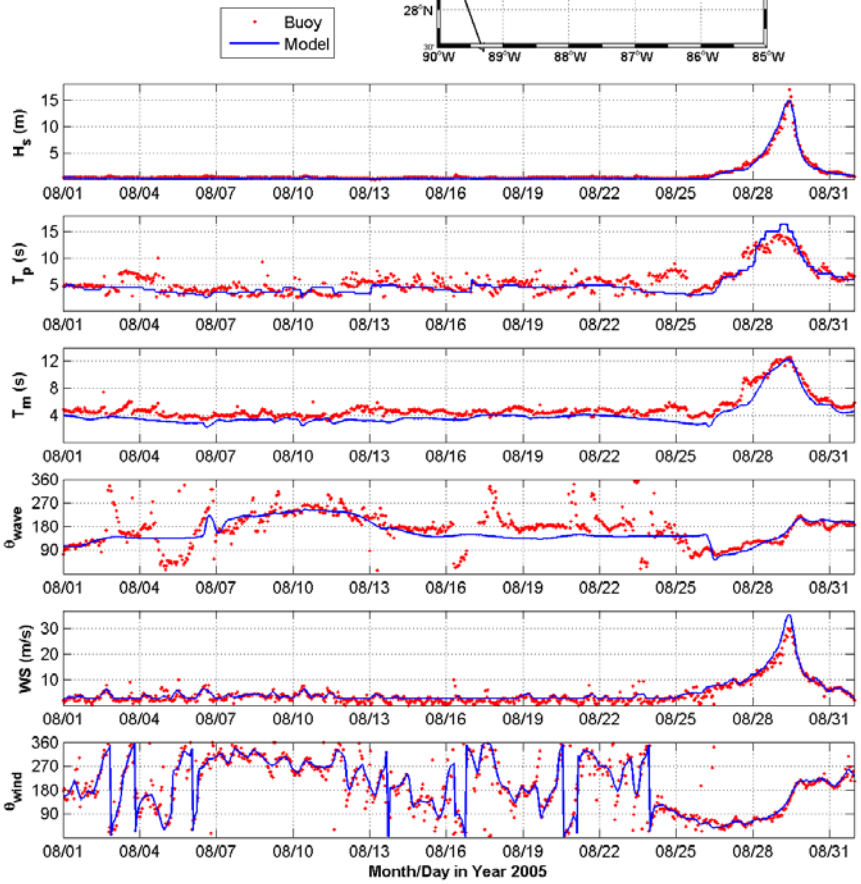




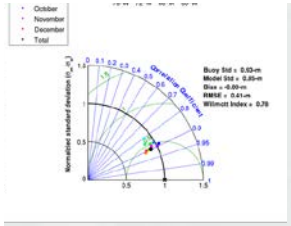
Gulf of Mexico Hindcast Study
GRID LEVEL3C2 OWI Winds

NDBC = 42040 [-88.21° / 29.18°]
WAMCY451C (Res = 0.05°)
[-88.2° / 29.2°]

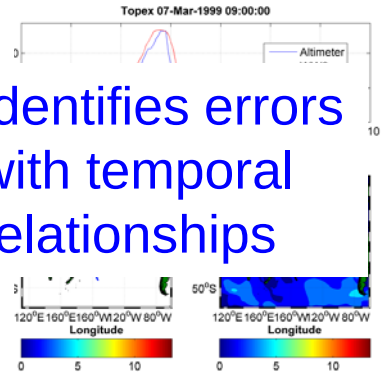




Relative spatial location for validation point



Identifies errors with temporal relationships



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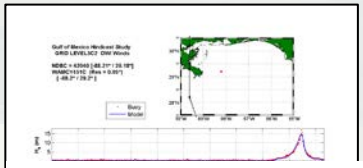
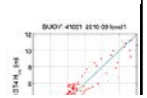
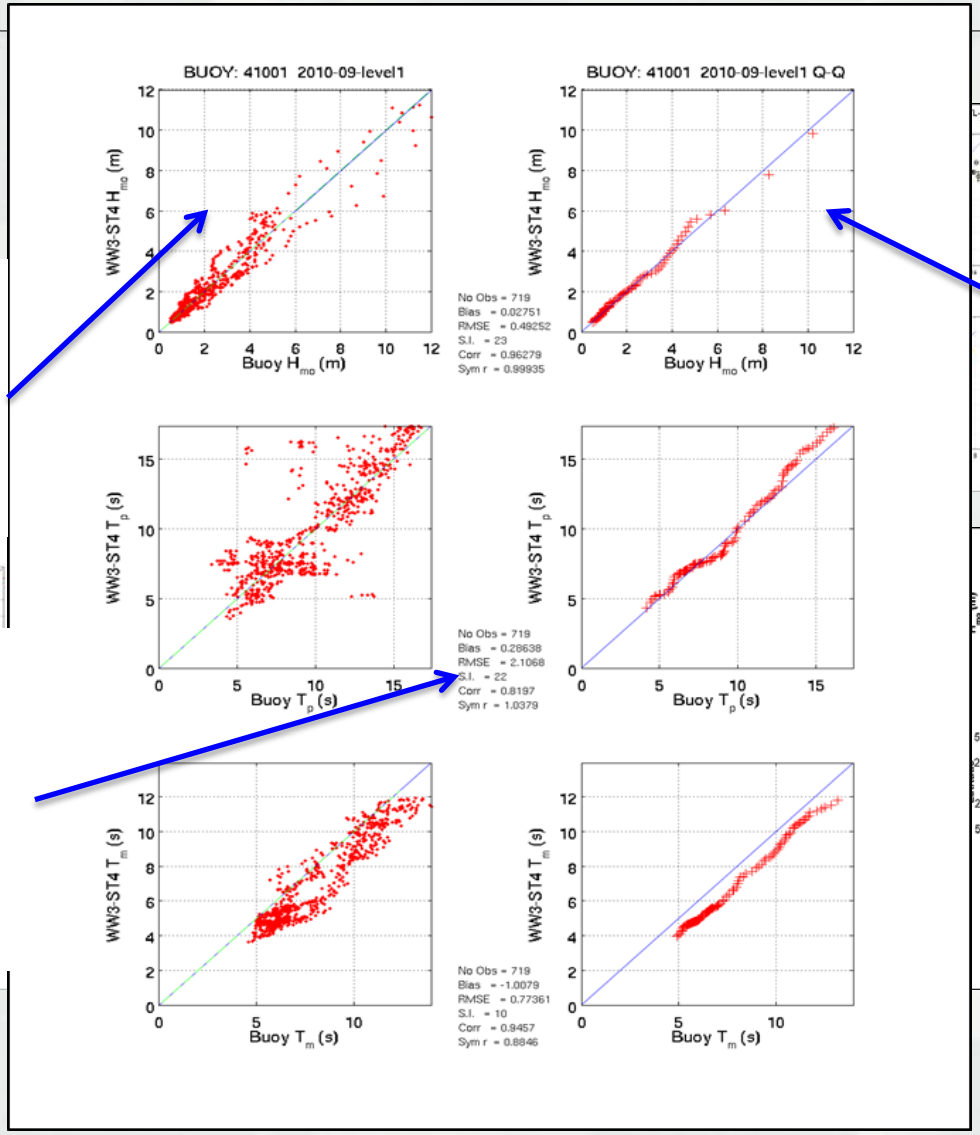
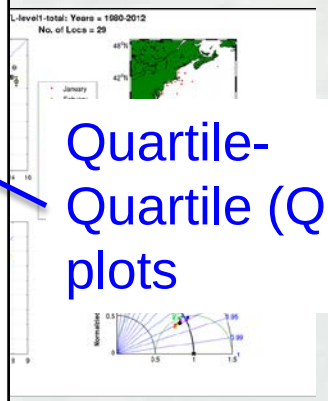


Scatter plot for all integral wave parameters

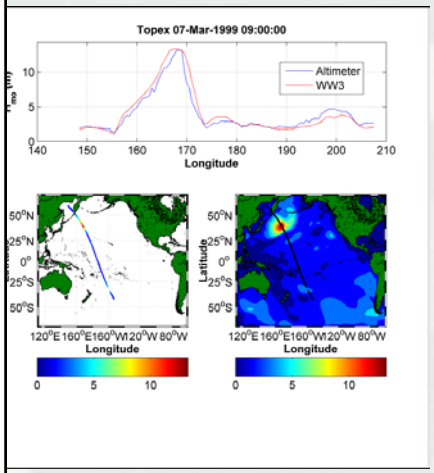


Statistics including RMSE, Bias, Scatter Index, Symmetric r





Quartile-Quartile (Q-Q) plots



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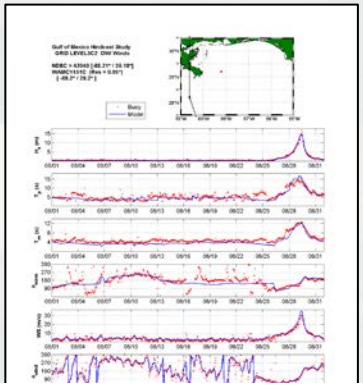
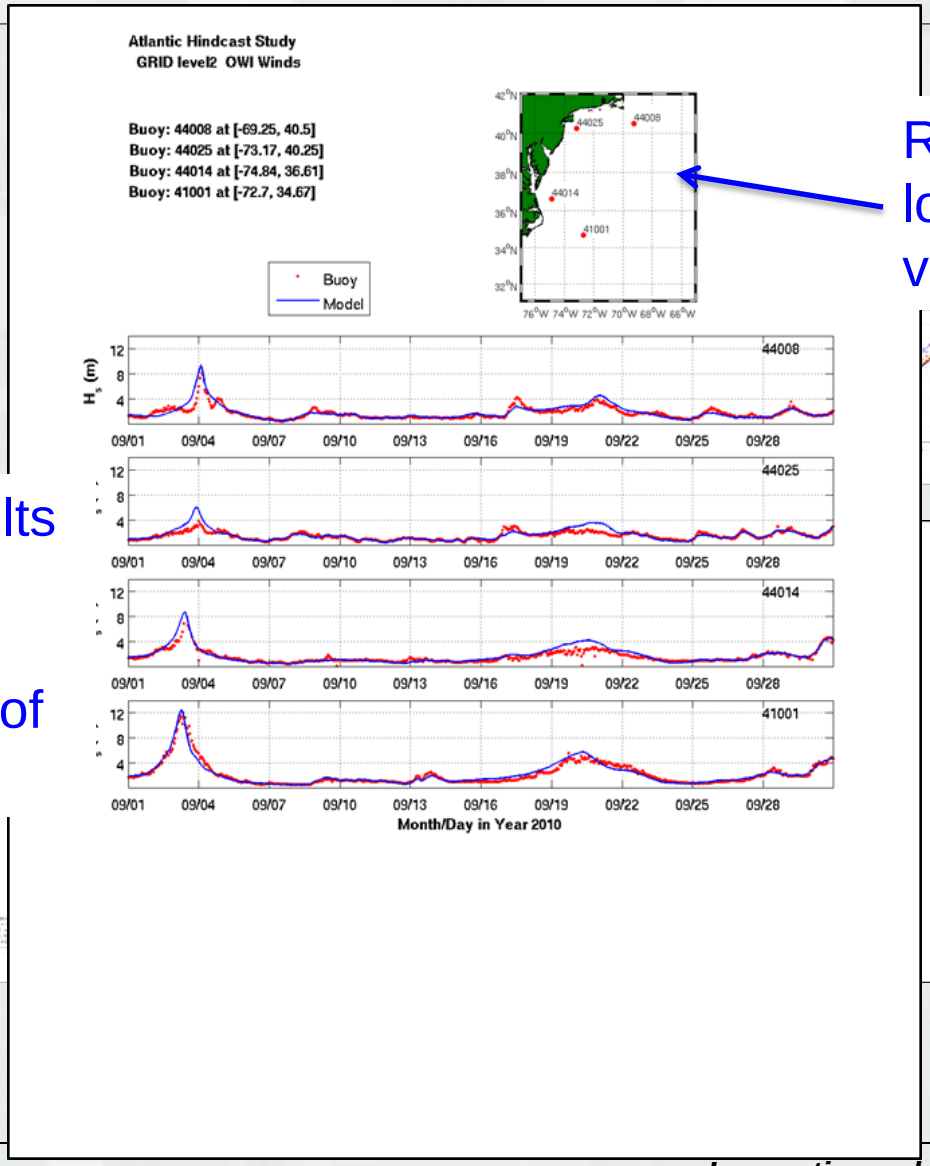
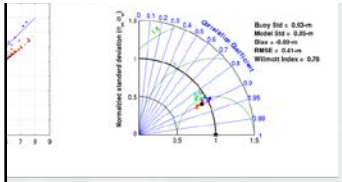
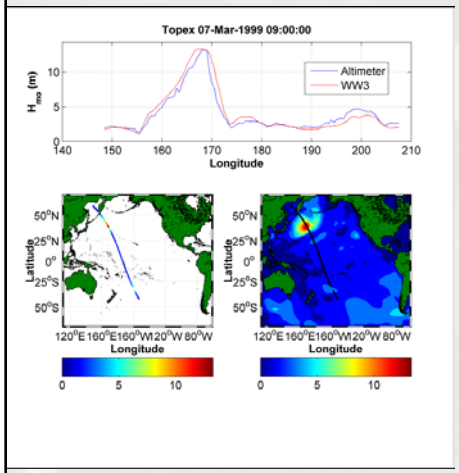


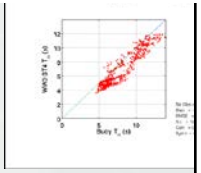
Wave height results from multiple stations shows spatial validation of events.



Relative spatial location for multiple validation stations







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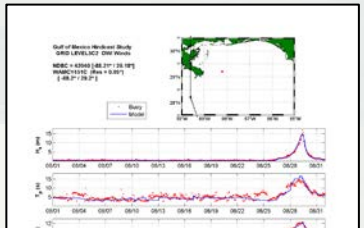
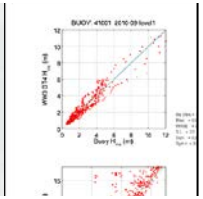
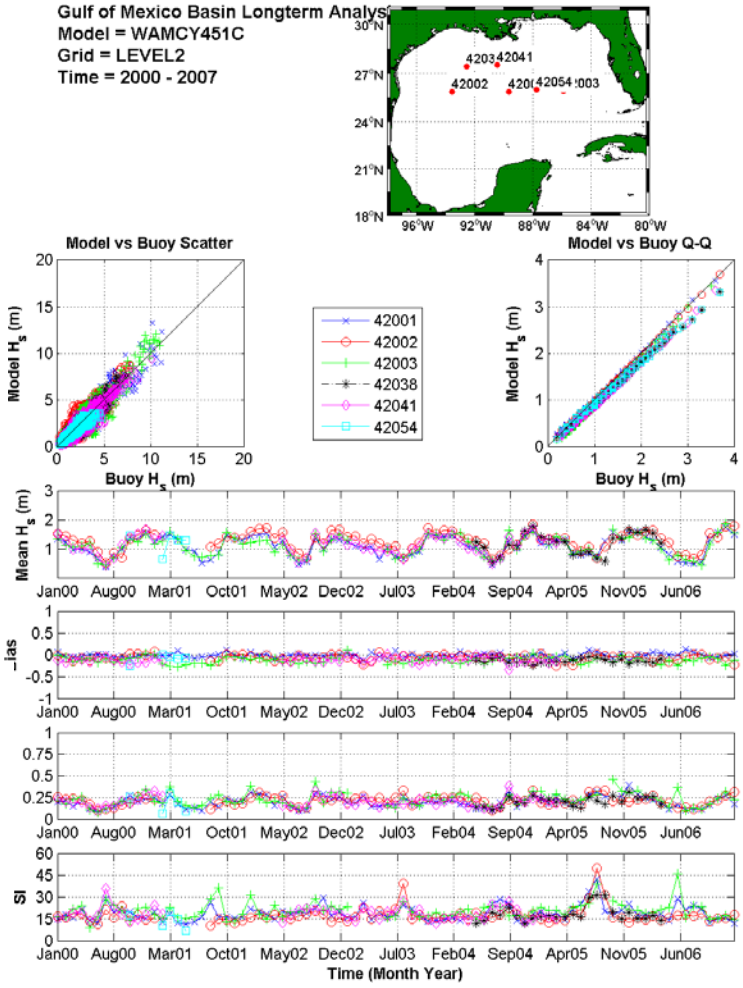


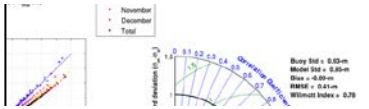
Scatter plot for the entire time series at each station



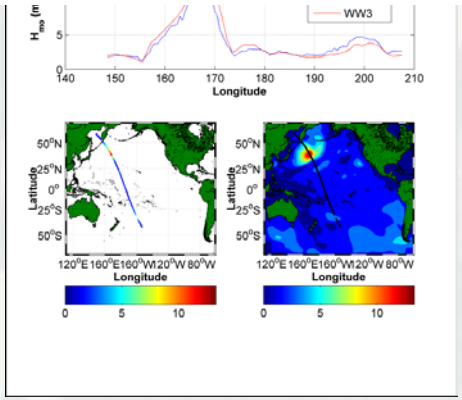
Time series of statistics including bias, RMSE, Scatter Index



Relative spatial location for multiple validation stations



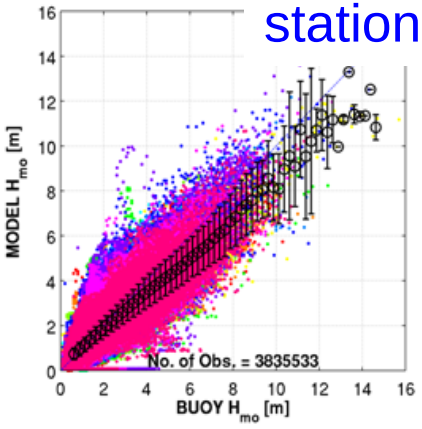
Q-Q for entire time series at each validation point

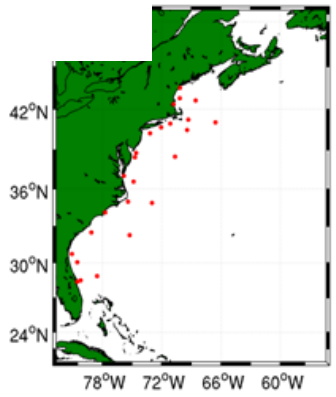


How does WIS e…st results?

Validation results divided into months instead of individual stations

Scatter plot including mean and standard deviation





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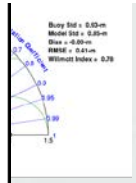
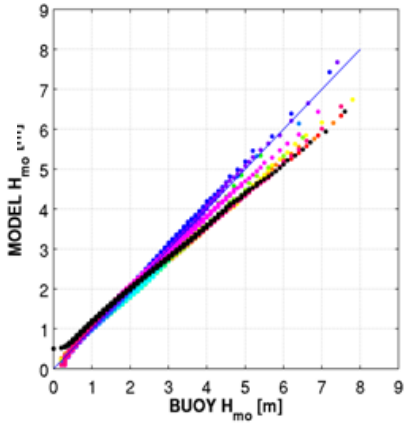
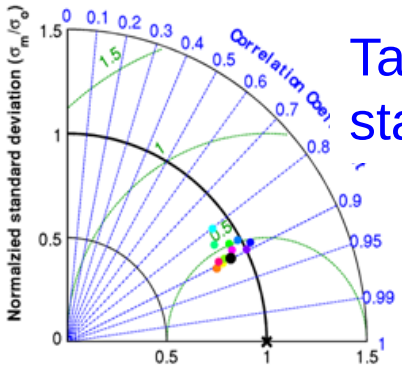
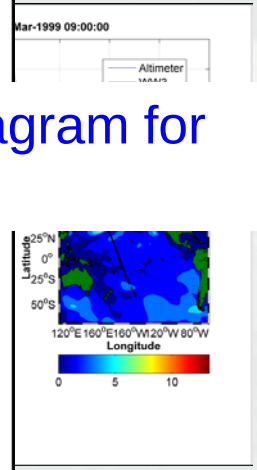


Q-Q diagram

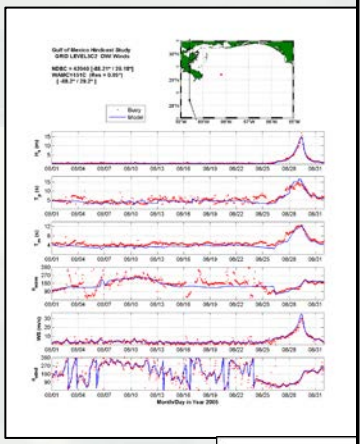


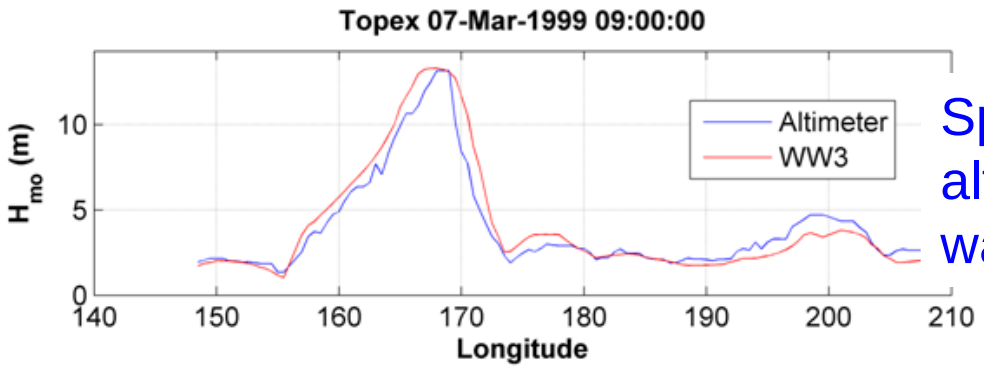
Taylor diagram for statistics



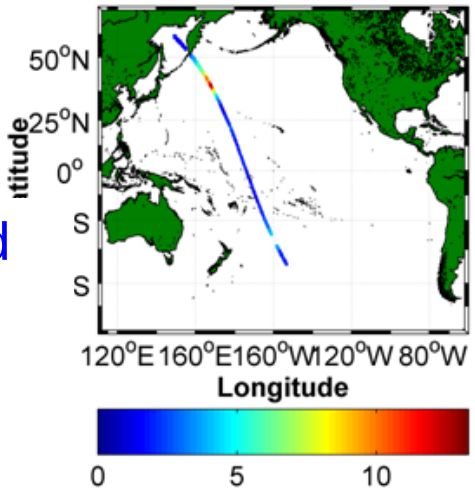


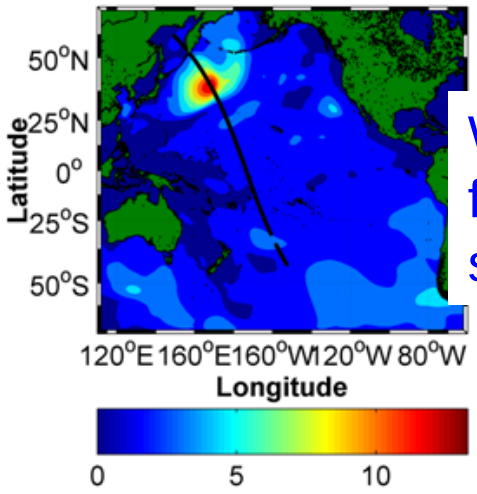
How does WIS evaluate hindcast results?





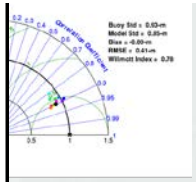
Spatial pair of altimeter and model wave heights

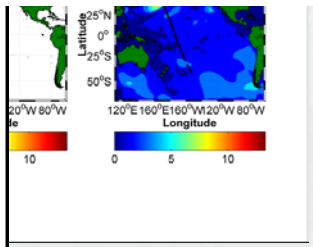




Wave height field from model at a single output time

Track of measured wave height from altimeter around model output time





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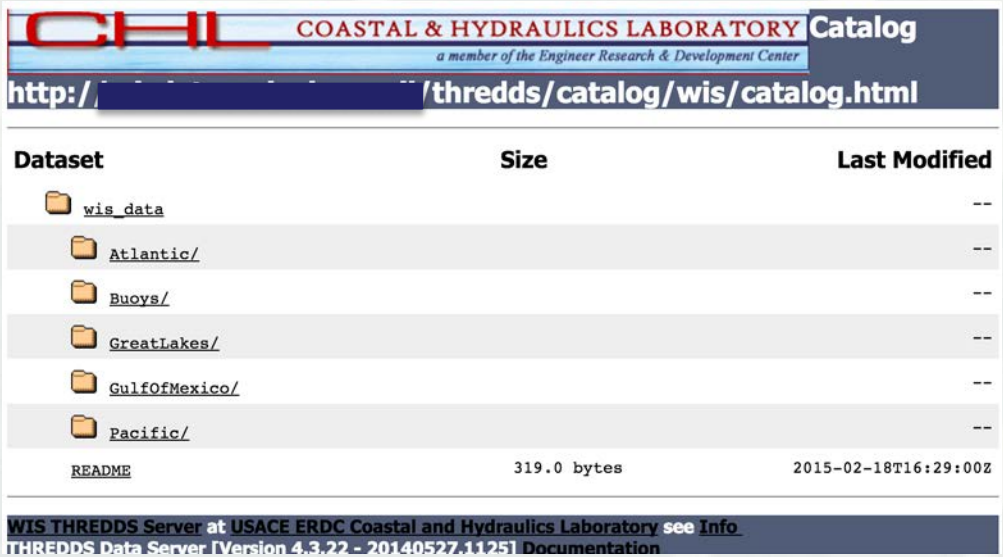
WIS is using a THREDDS server with netCDF file formats to make the wave parameters and 2D spectra available



netCDF file allows us to serve up both wave parameters and 2D spectra

All metadata follows requirements by outside organizations

Thredds server provides access to data through web interface and Matlab/Python protocols.

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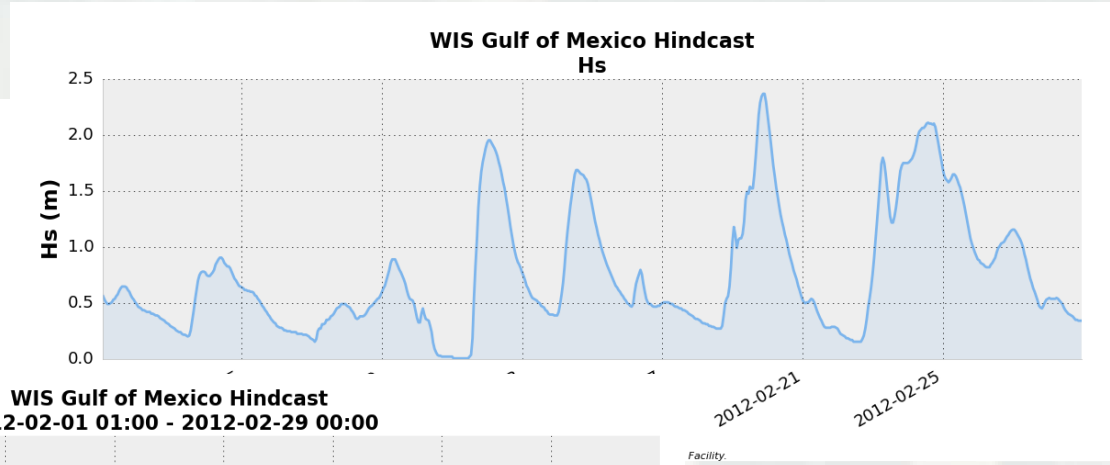
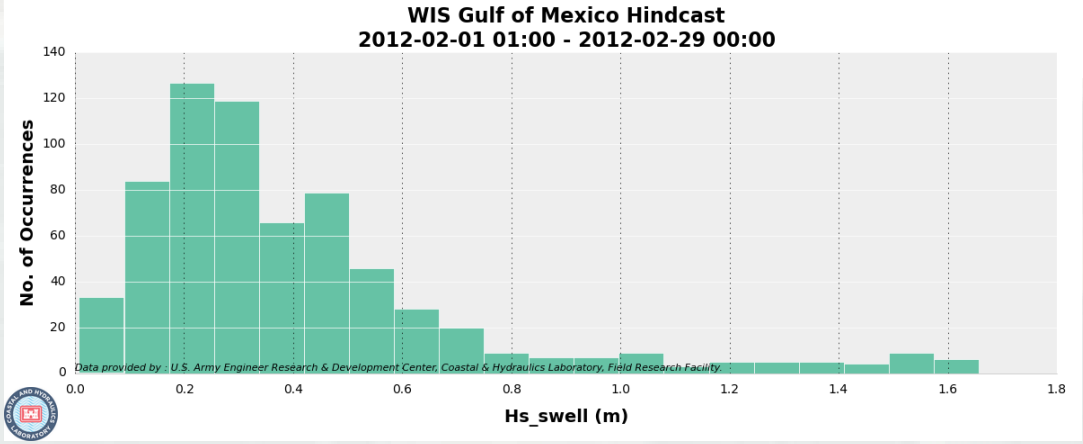
Python webtools are running on the THREDDS server for interactive tools. (soon to be released)

http://wisdomain/plotting/getplot/?provider=wis&datacat=GulfOfMexico&datatype=waves&id=ST42005&startdate=2012-02-01T00:00:00Z&enddate=2012-02-28T23:00:00Z&variables=waveHs&plottype=stats

Plotting and validation available as user defined functions through a url or website





Summary

- WIS Updates
  - Atlantic, Pacific, and Gulf of Mexcio 1980-2014
  - Great Lakes and Alaska 1979-2014 plus extreme events to 1954
- WIS Validation Tools
  - Continuing to develop new tools to identify problem areas during a hindcast for time periods ranging form extreme events to full hindcasts
- WIS has developed netCDF file format with complient metadata to be served on a THREDDS server
- WIS has developed python web tools to provide interactive access to plotting and validation functions through the web