Towards Global Wave Climate Trend and Variability

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Summary

- Introduce the GROW 31-year global wave hindcast
- Highlight the inclusion of tropical cyclones in the wind fields
- Present (brief) overall validation
- Highlight performance in VESS (Very Extreme Sea States)
- Show (very) preliminary assessment of step changes found in the CFSR

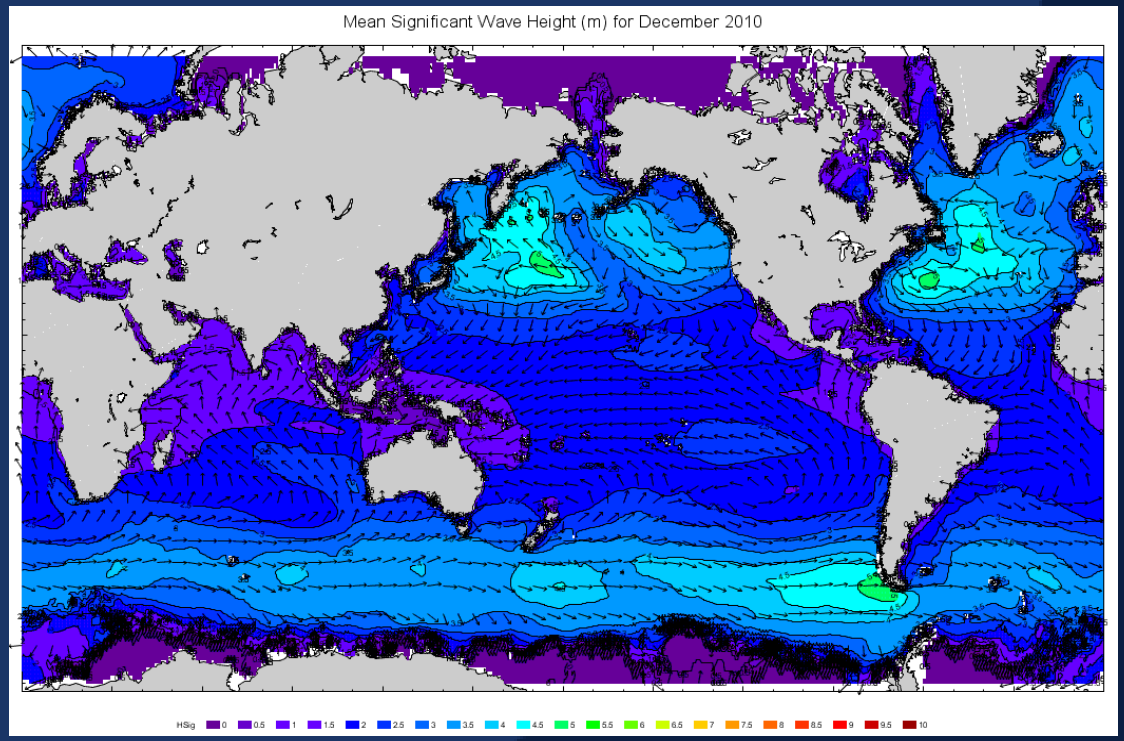
No maps of global trend or variability will be shown!

GROW: Global Reanalysis of Ocean Waves

GROW2012: Latest iteration of the GROW hindcast (original GROW released 1997)

OWI3G on 0.5 degree global grid

CFSR/CFS2 Wind Forcing (1979-Present)



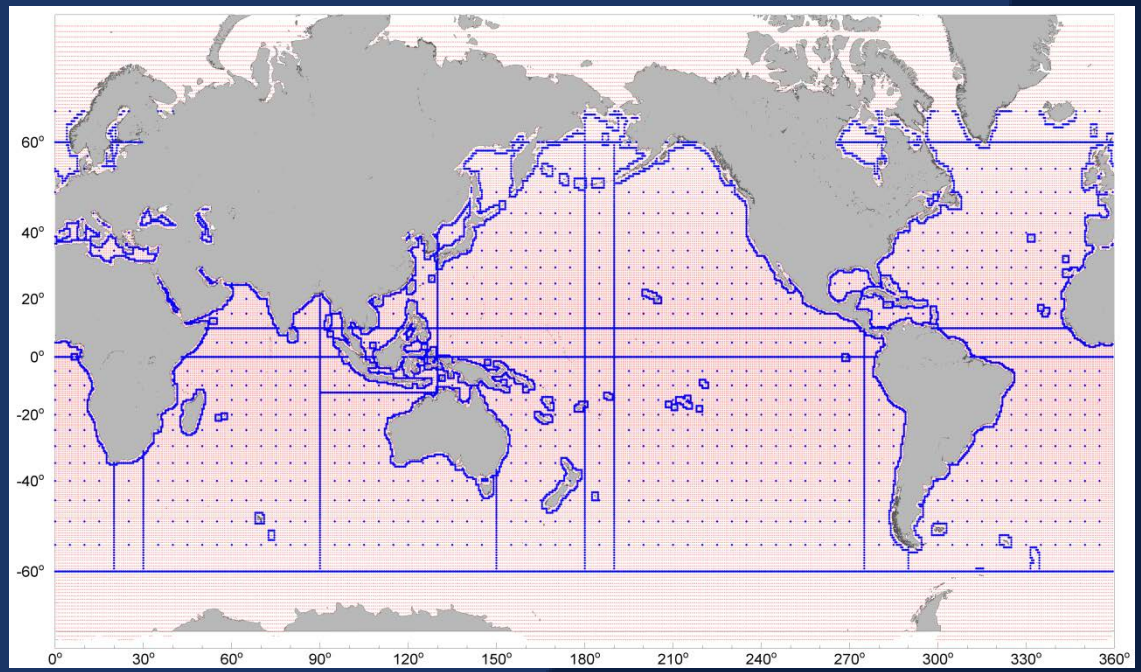
Goals of GROW2012

Operability Assessment Applications

Database for tow simulation (TOWSIM)

Update global trend/variability first depicted in JGR 2001 GROW paper

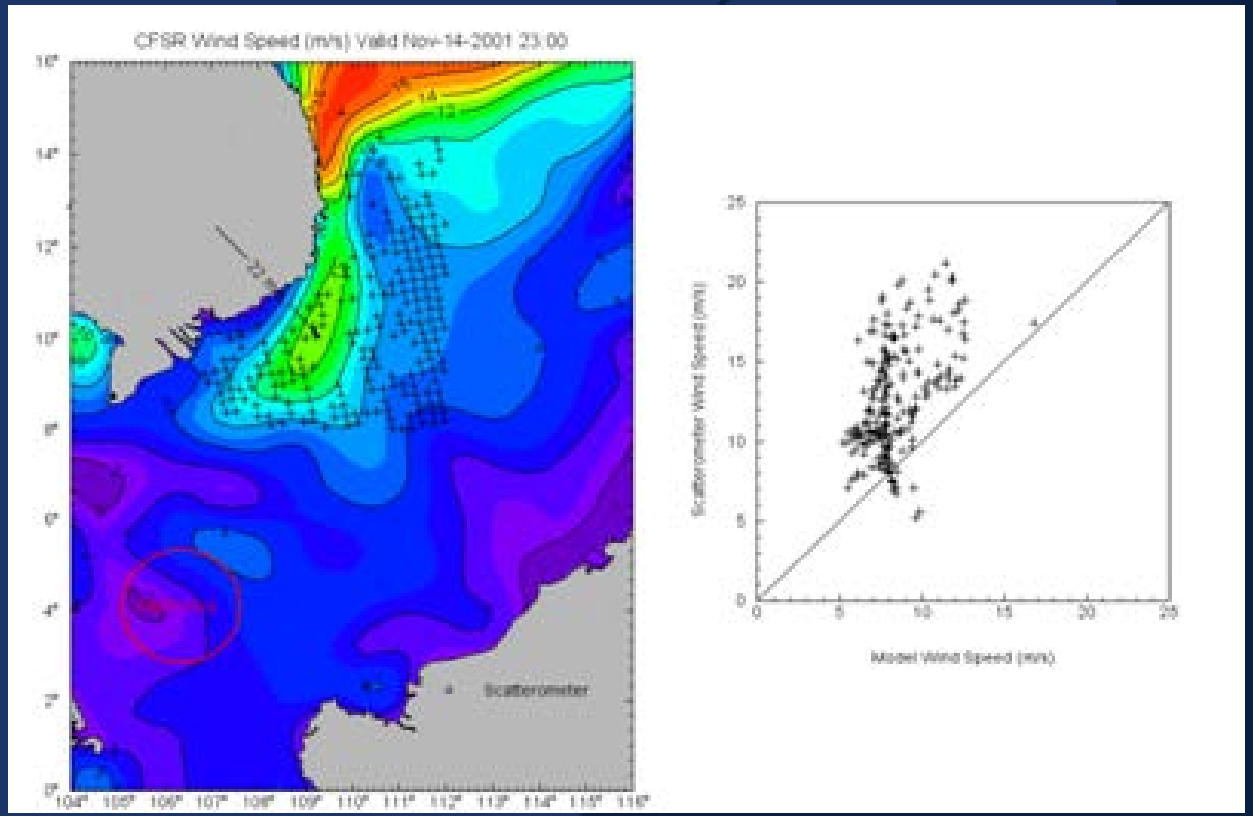
Generation of boundary conditions and initial assessment of forcing/response for more targeted basin/local response modeling



Why targeted basin/local follow-on modeling?

Wind forcing issues are still the major source of error in ocean modeling of the events which drive design (ITWS)

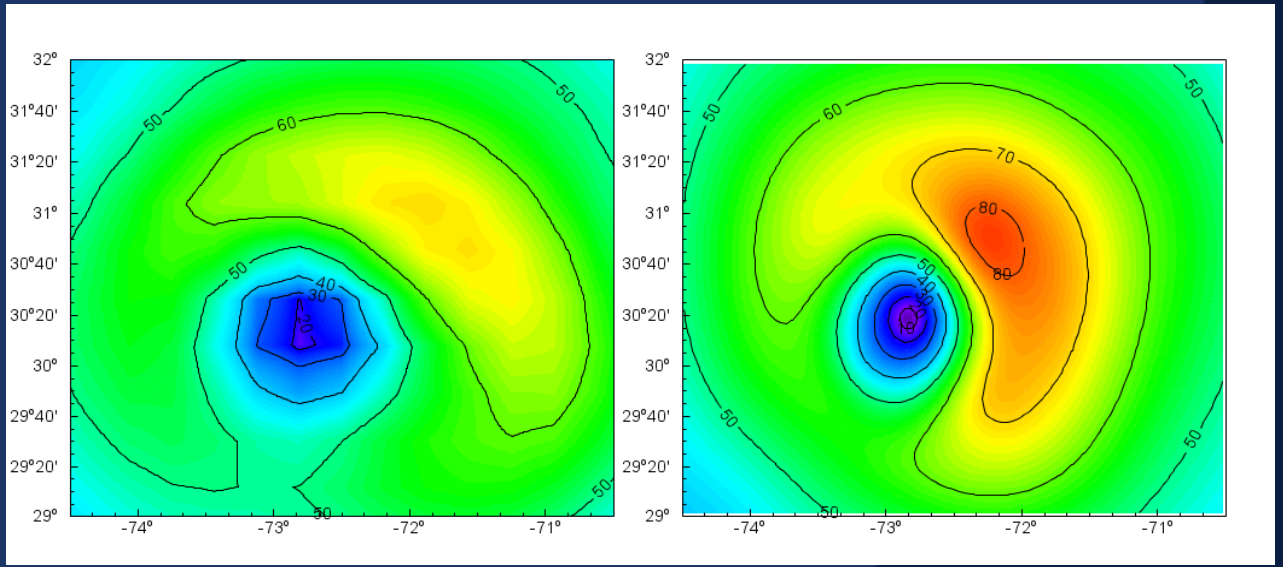
Assessment and correction (through statistical, dynamic, and manual reanalysis methods) is best performed on a local basis



CFSR wind estimates in Nov 2001 monsoonal flow vs. scatterometer wind measurements

Tropical Systems in GROW

CFSR includes a vortex track repositioning scheme, but still does not faithfully represent the peak wind speed or radius of maximum winds of tropical systems



Comparison of CFSR (left) and HWind (right) wind speeds (knots, 30-min)
Valid 17-Sep-2003 16:30 UTC during Isabel – RMW ~ 95km

Tropical Systems in GROW

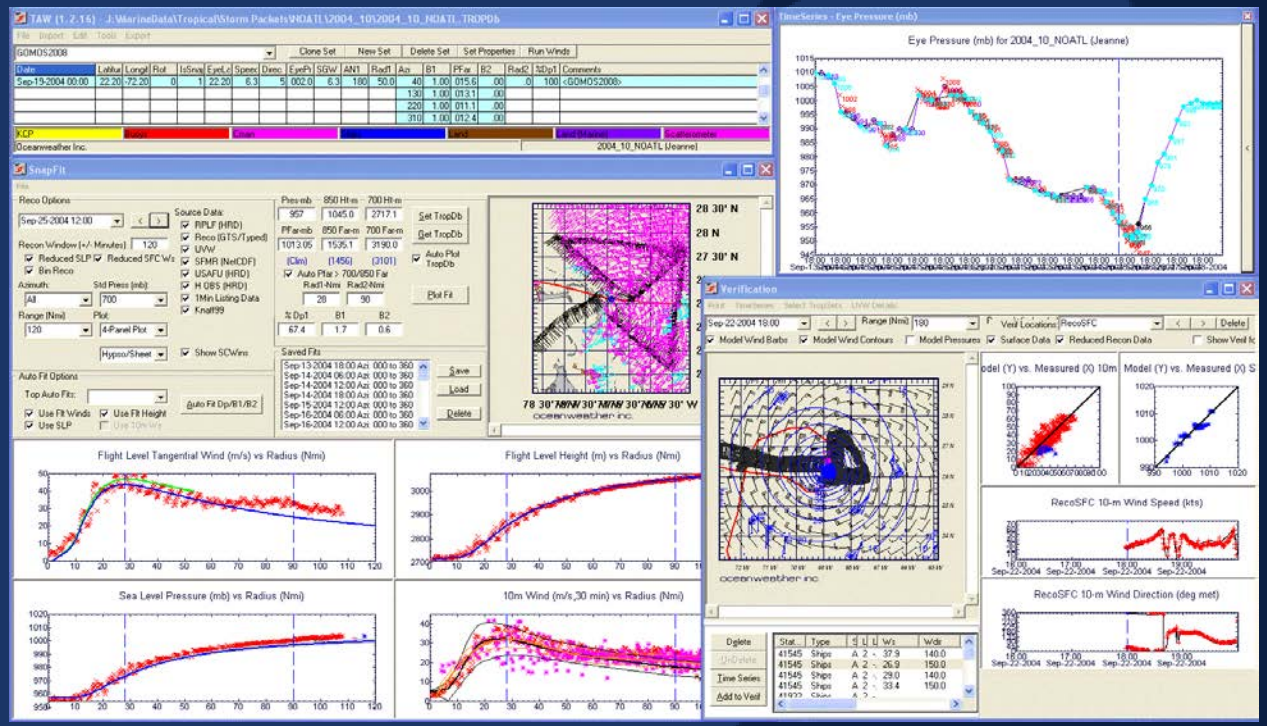
Original GROW Solution:

- Apply PBL model with official track/intensity using climatology for wind profile

Study/Follow on Solution:

- Complete storm analysis using a tropical PBL model ~2-4 hours/per storm

Over 3,000 tropical systems to include!



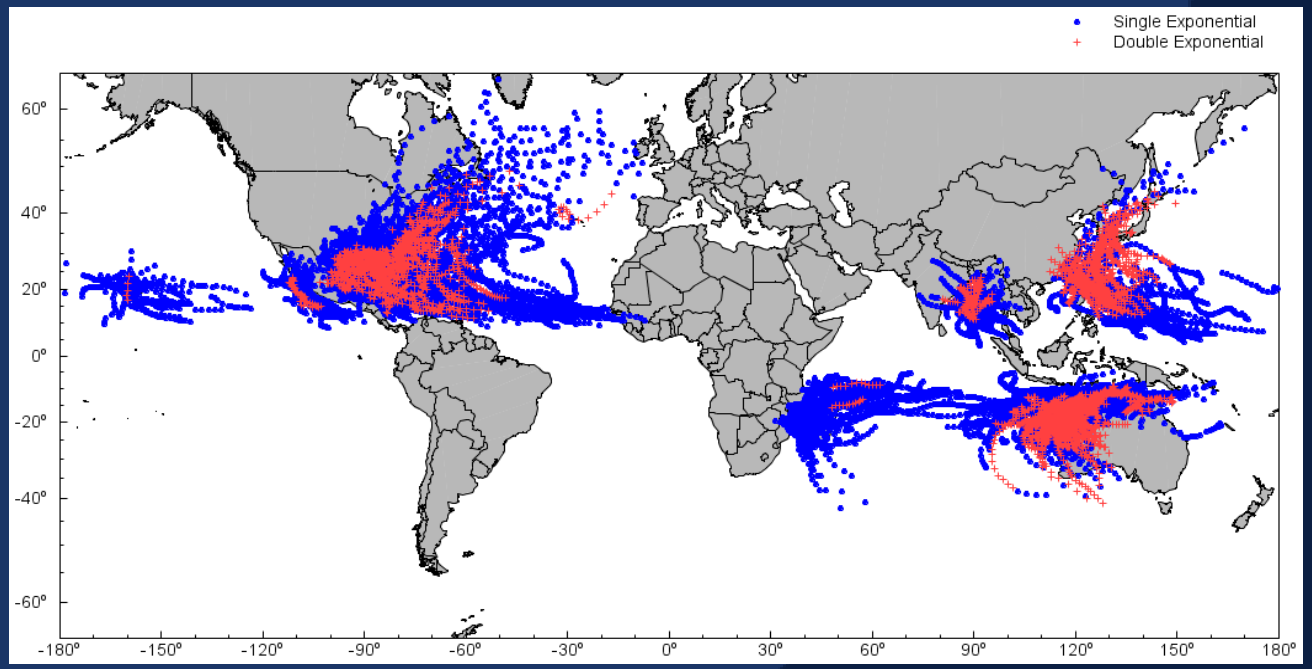
Tropical Analysis Workstation

Tropical Systems in GROW

GROW2012 Solution:

- Track/Intensity obtained from IBTracs (composite of national centers)
- Model inputs related to wind profile (Holland's B, Scale Pressure Radius, etc.) sourced from climatological fits to previously analyzed storms

Climatological wind profiles will give the "average" wind profile solution, but what about cases where storms are stronger/weaker or tighter/broader?

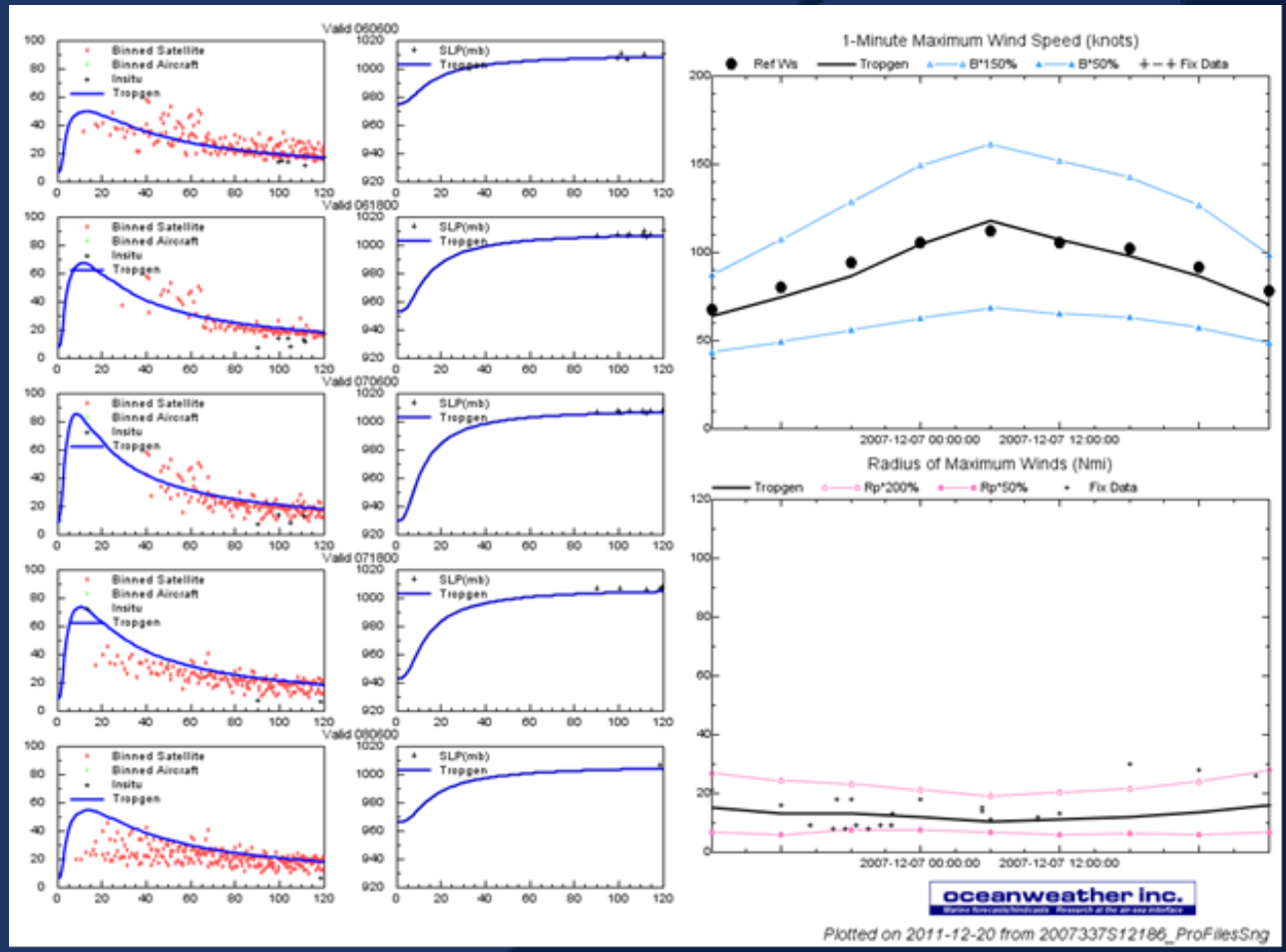


Tropical Systems in GROW

Composite wind profile and pressure plots of the 48 hours of storm maximum intensity

Comparison data includes aircraft, insitu, satellite observations

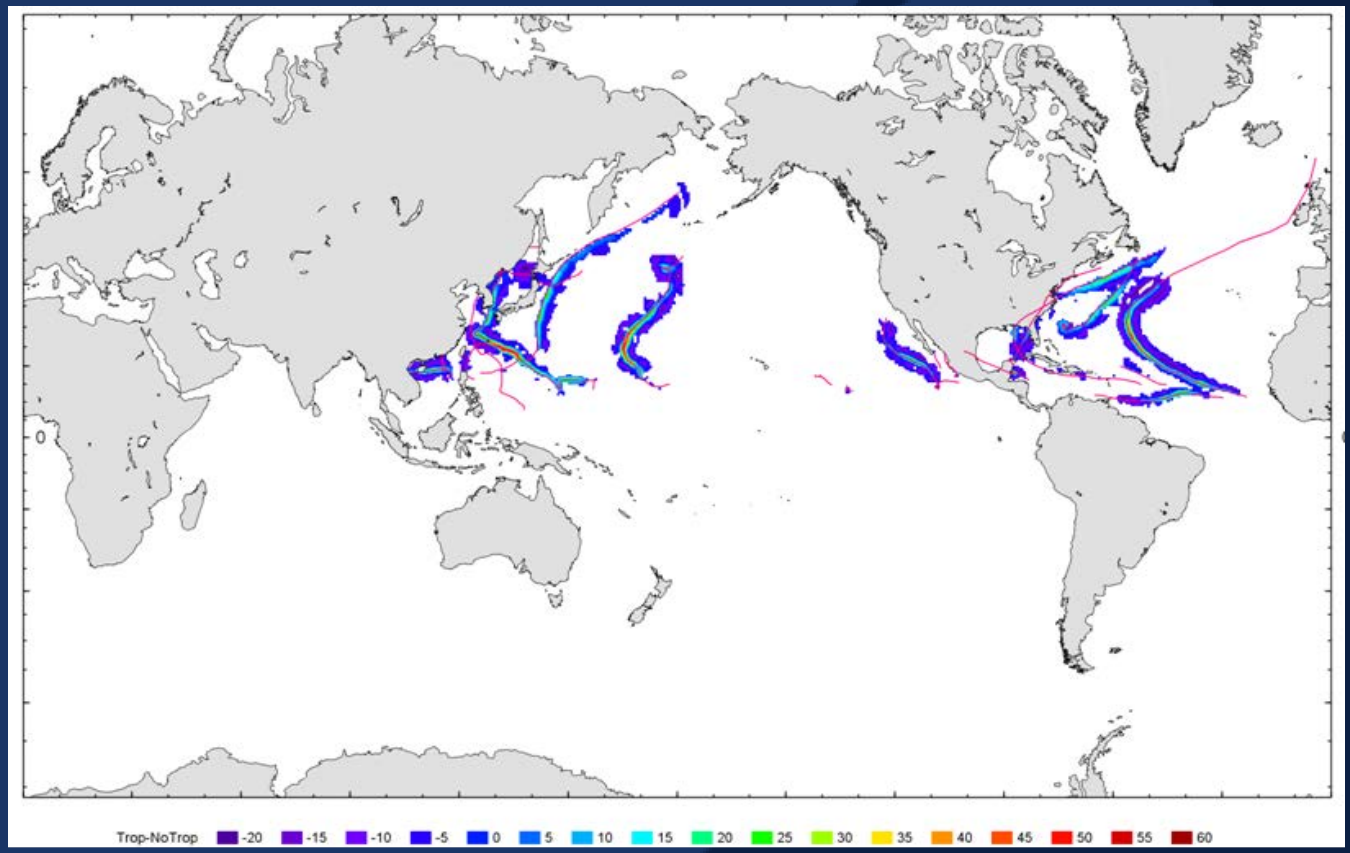
Climatological tropical model inputs are scaled up/down to result in storm solution which retains the IBTracs intensity and produces best estimate of wind profile shape based on available observations



Tropical Systems in GROW

All tropical systems were run, evaluated, and rerun with nudging based on review.

Final PBL model winds were then blended into GROW wind fields

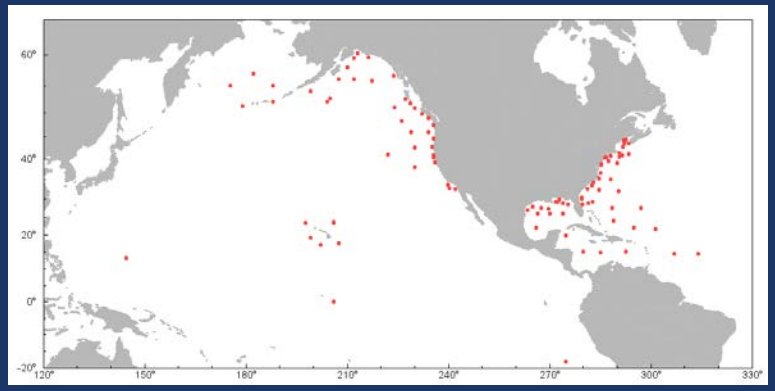


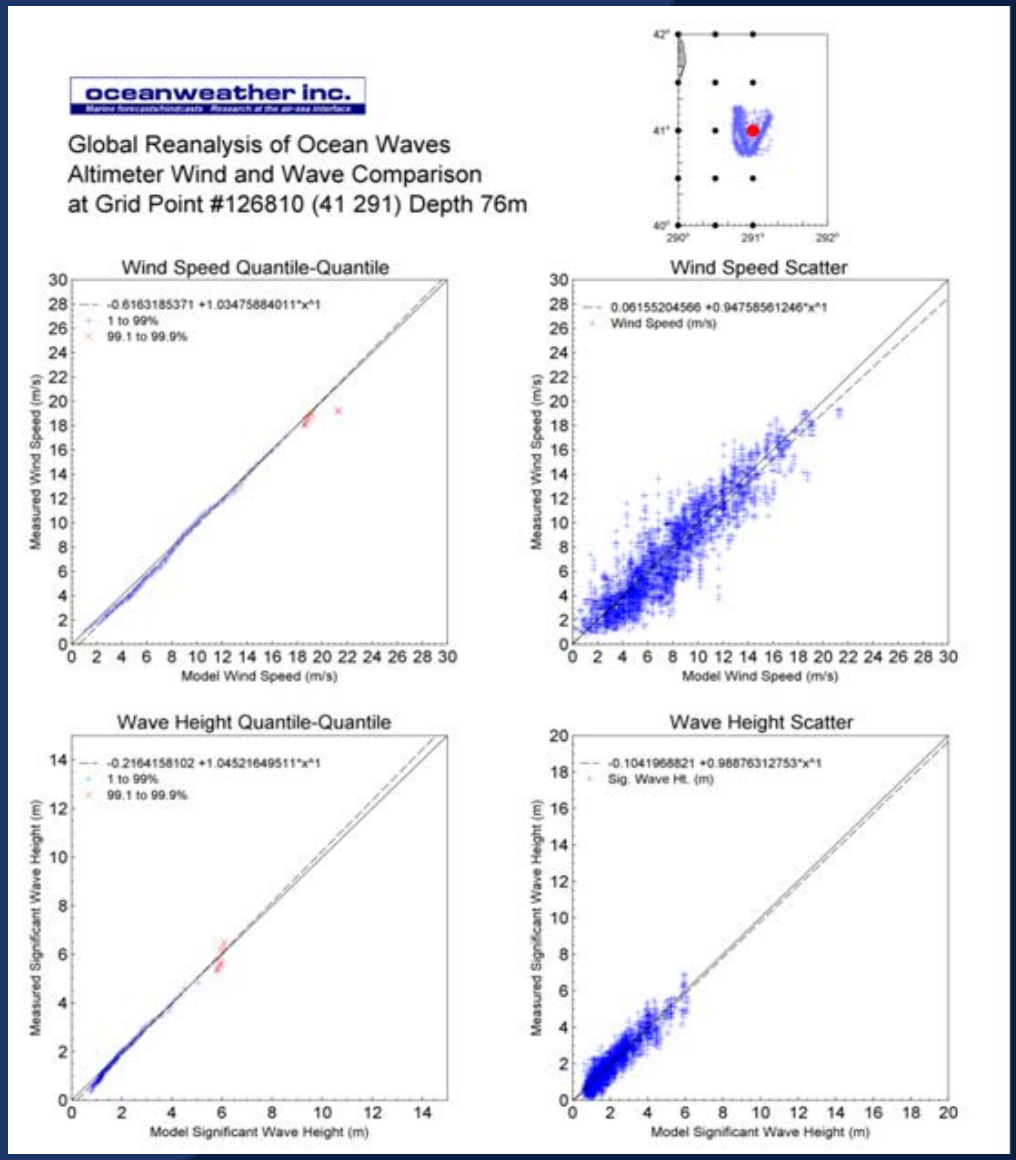
Wind speed (knots) difference between baseline CFSR and tropical overlay during Sept 2000

GROW Evaluation

Comparisons made against buoys and global altimeter set

Hs +13 cm Bias, SI ~19%
Tp +0.36 s Bias, SI ~25%
VMD -1.02 deg Bias, SI ~10%



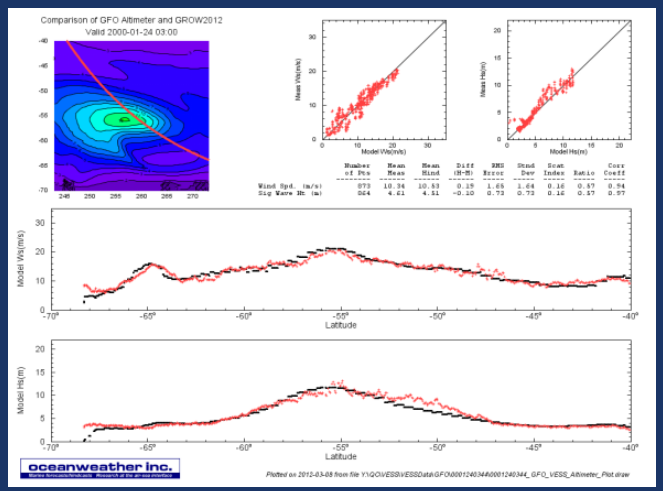


GROW Evaluation – Very Extreme Sea States

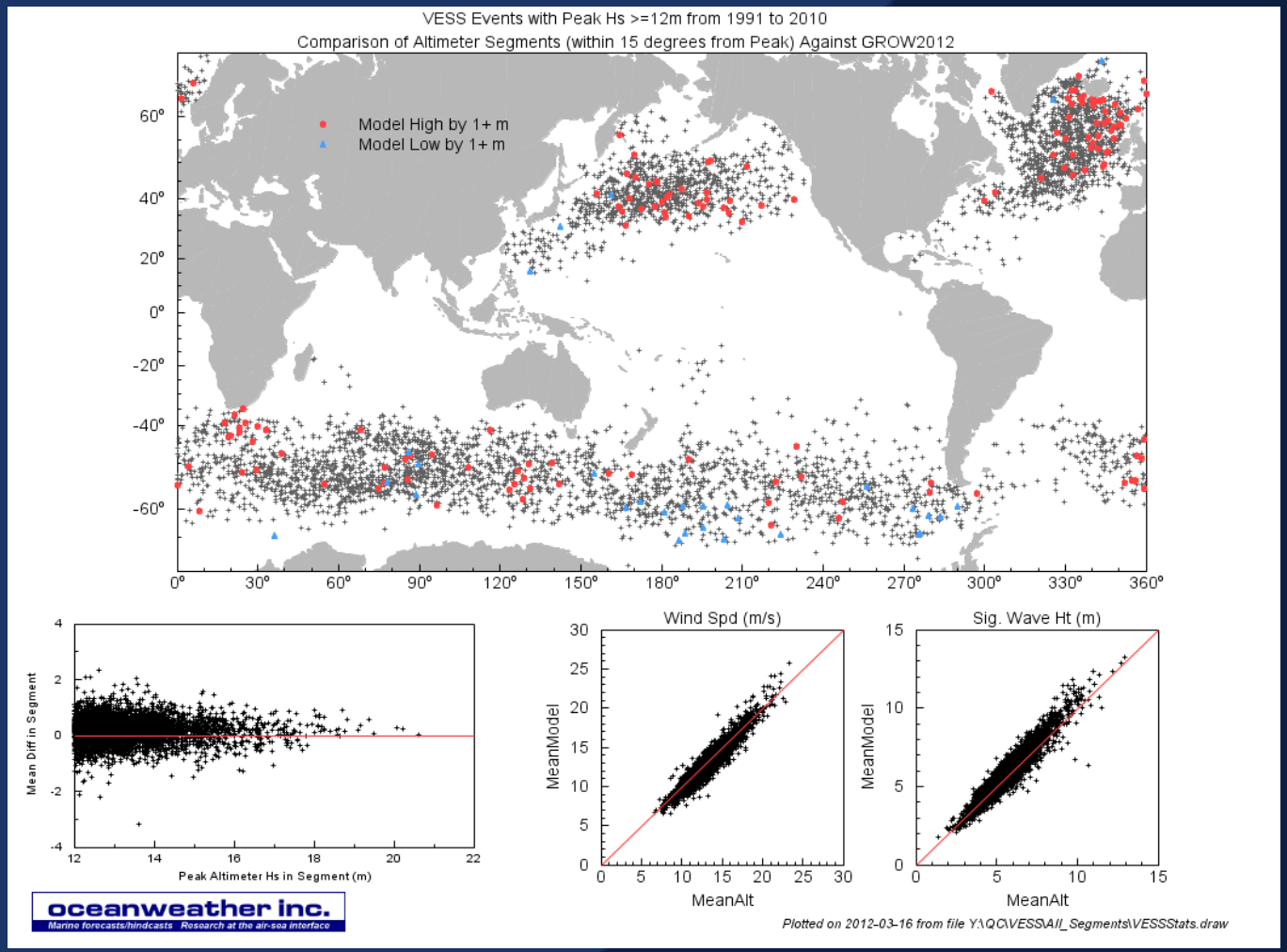
Comparisons made against altimeter measurements in storms where altimeter measurements exceeded 12 m

Summary of Storm Segments:

3293 Storms Segments
Ave Meas 13.68 m
Ave Hindcast 13.39 m
Mean Difference -0.28 m
Scatter Index: 7%

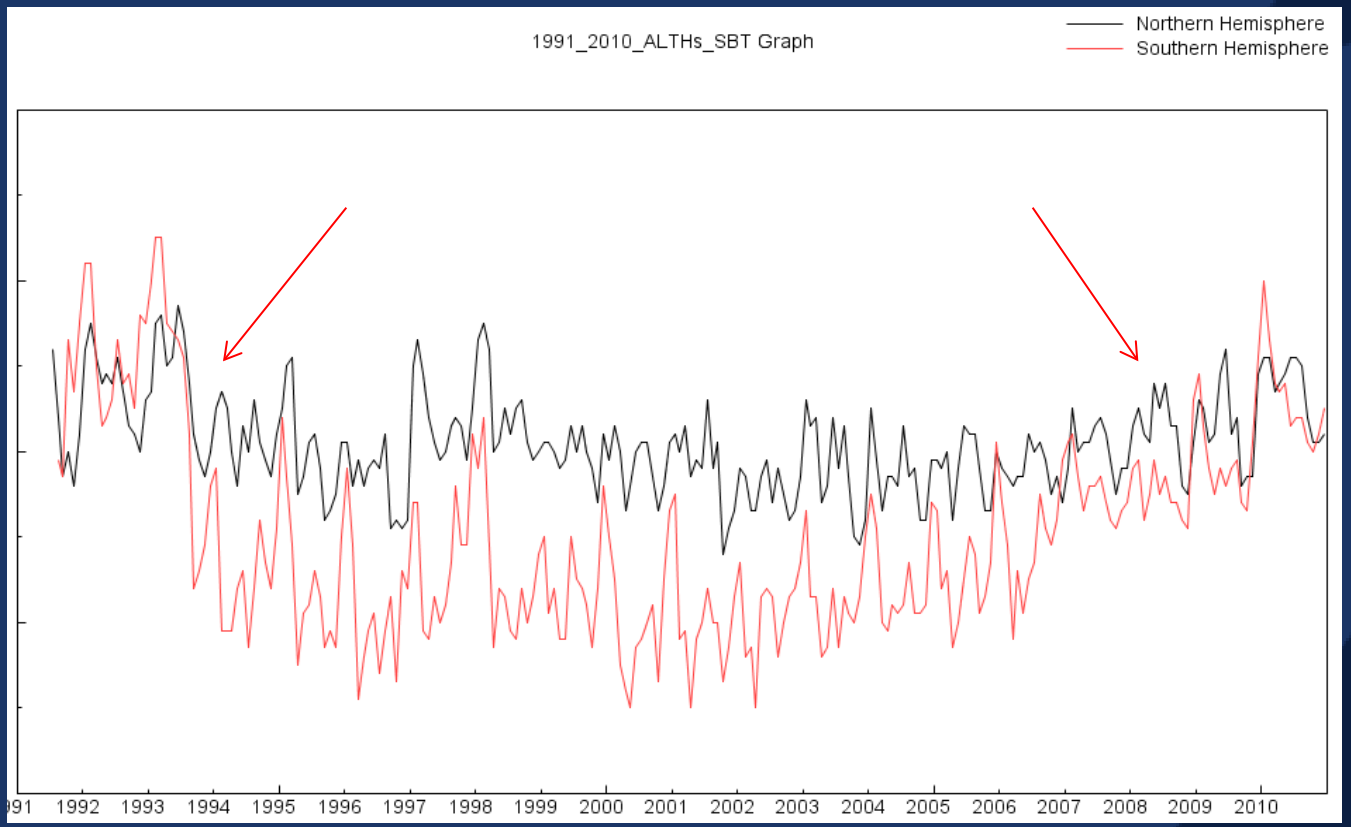


Example Storm Segment



Summary of all VESS storm segments

GROW Evaluation – Altimeter Bias Over Time

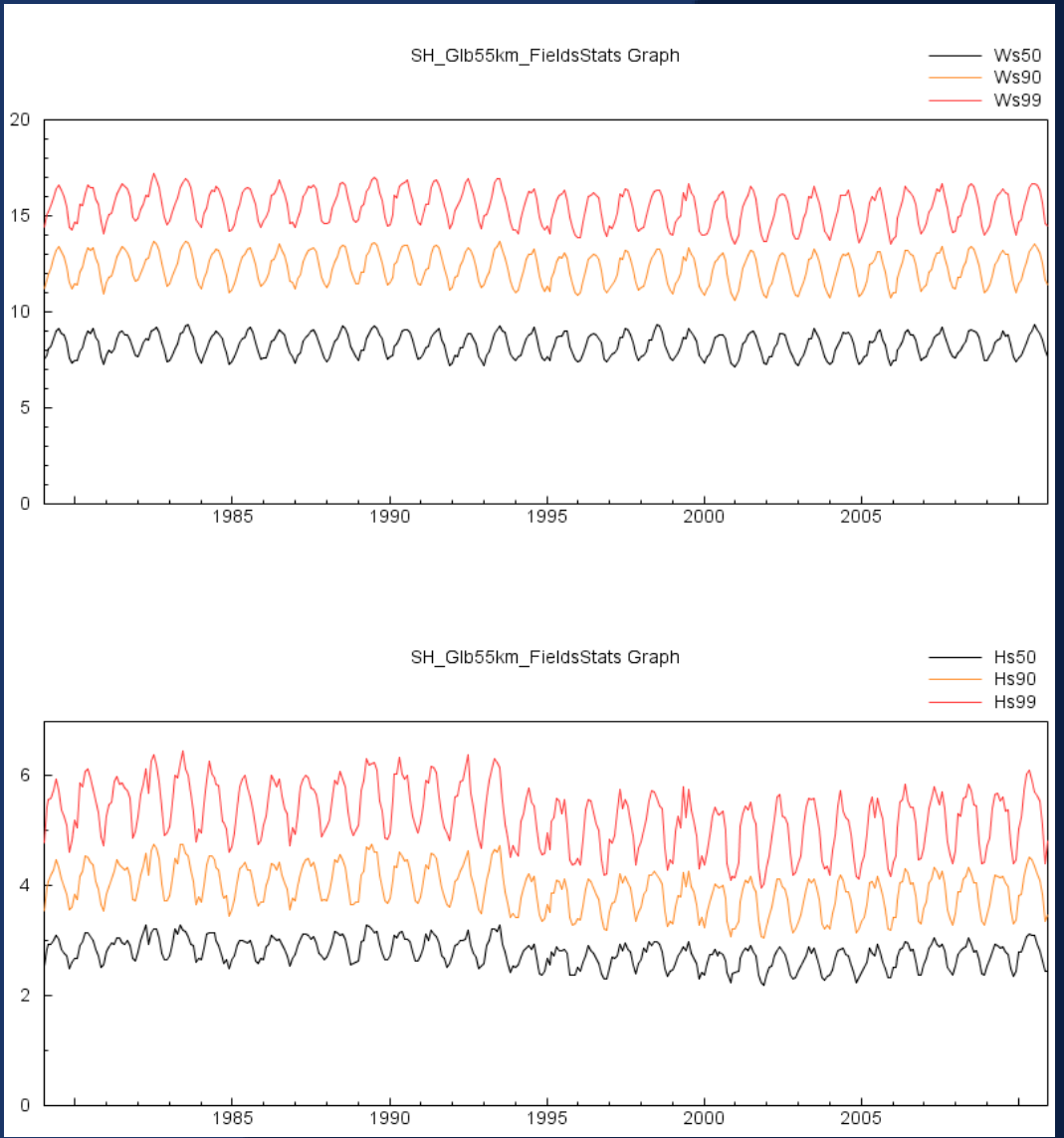


A comparison of bias in altimeter-hindcast waves over time shows a step-change in the Southern Hemisphere bias in 1993 and a more gradual change post 2007 relative to the Northern Hemisphere bias

GROW Trend and Variability

Until apparent changes in the hindcast brought to light by the altimeter comparisons can be explained/corrected for, any expression of climate trends would be suspect…

Monthly median, 90th and 99th percentile wind speed and wave height all show the step change around 1993 in the Southern Hemisphere

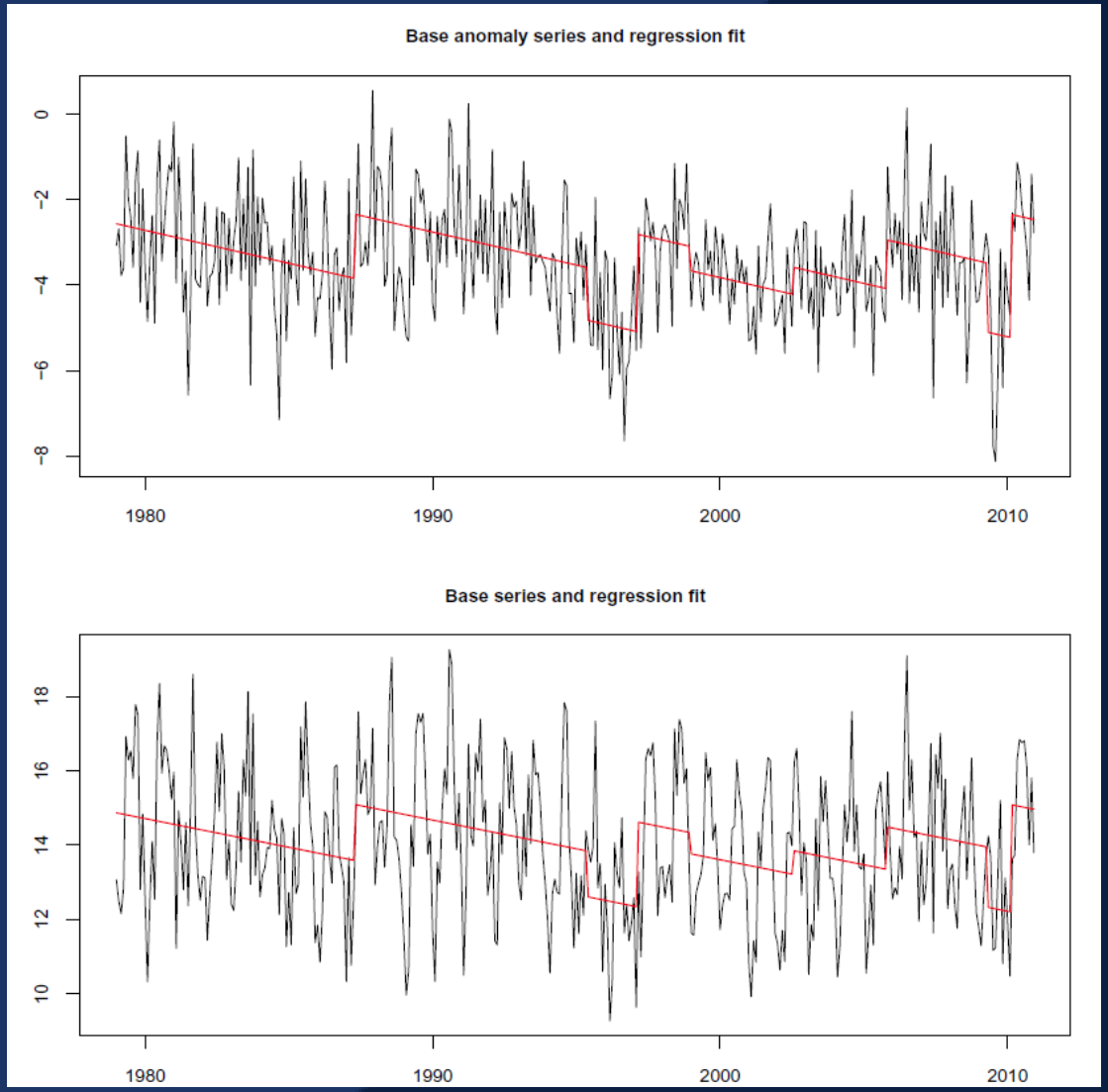


Mean Monthly Wind Speed (m/s, top) and Wave Height (m, bottom) in Southern Hemisphere 1979-2011

RHTests

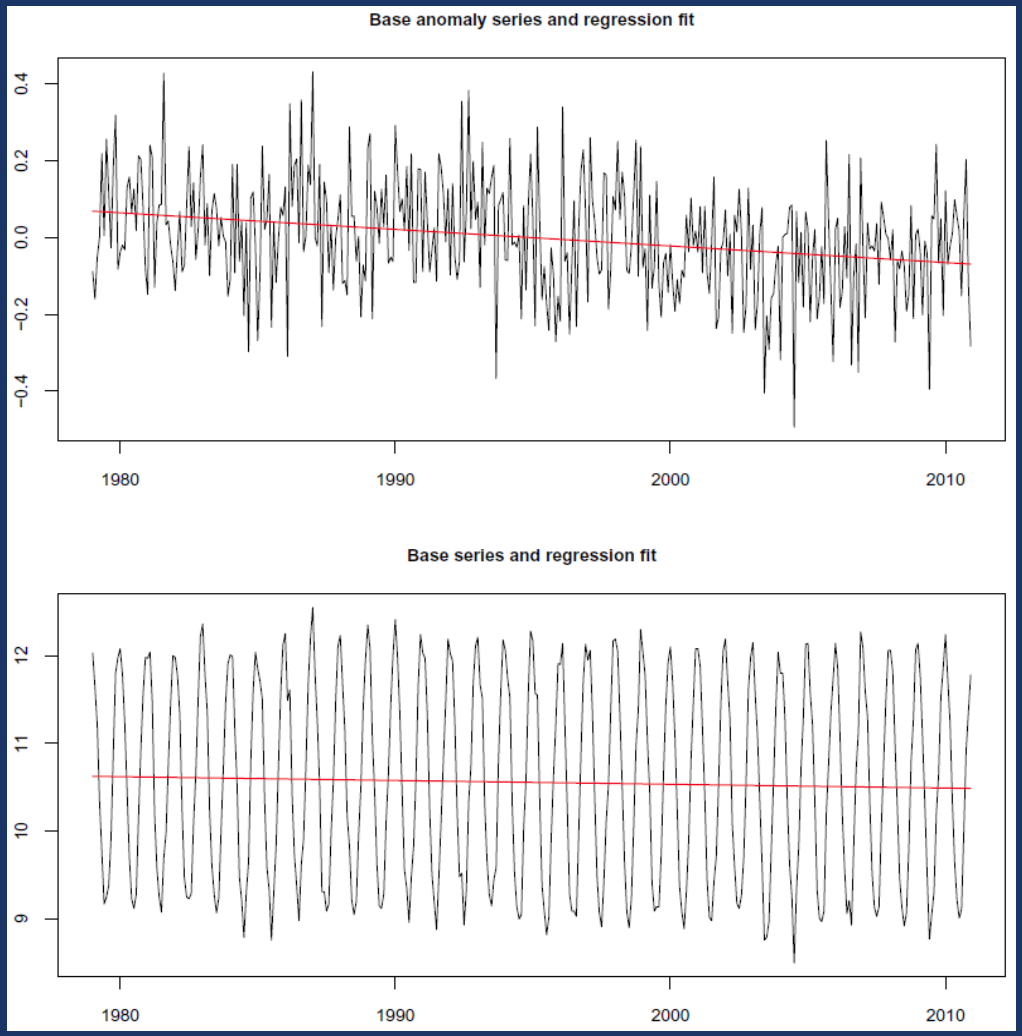
A tool to detect and adjust for multiple change points (shifts) that can occur in a data series.

Based on the penalized maximal *PMT, PMF, regular t, and regular F* tests (Wang 2008b)

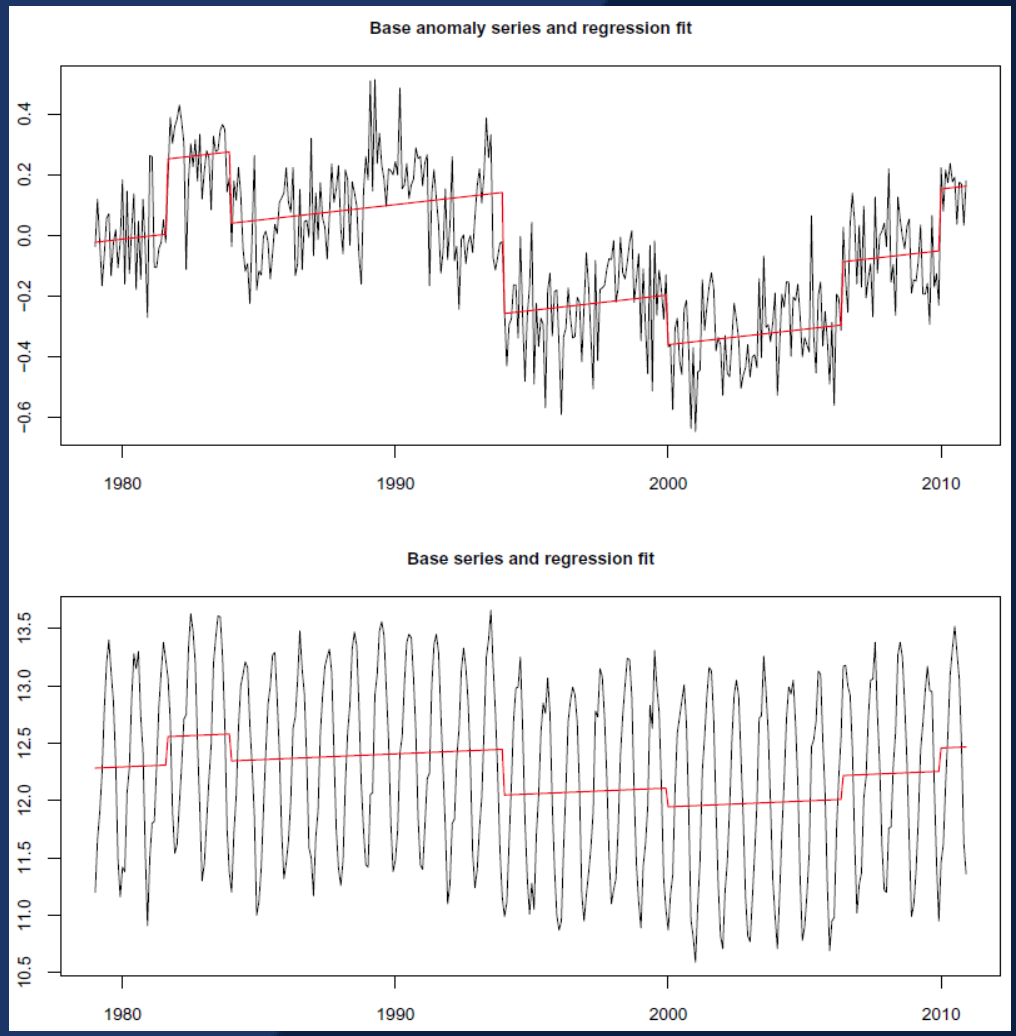


Analysis of Wind Speed at Kerguelen Island

90th Percentile Wind Speed RHTests with Type-1 Change Points



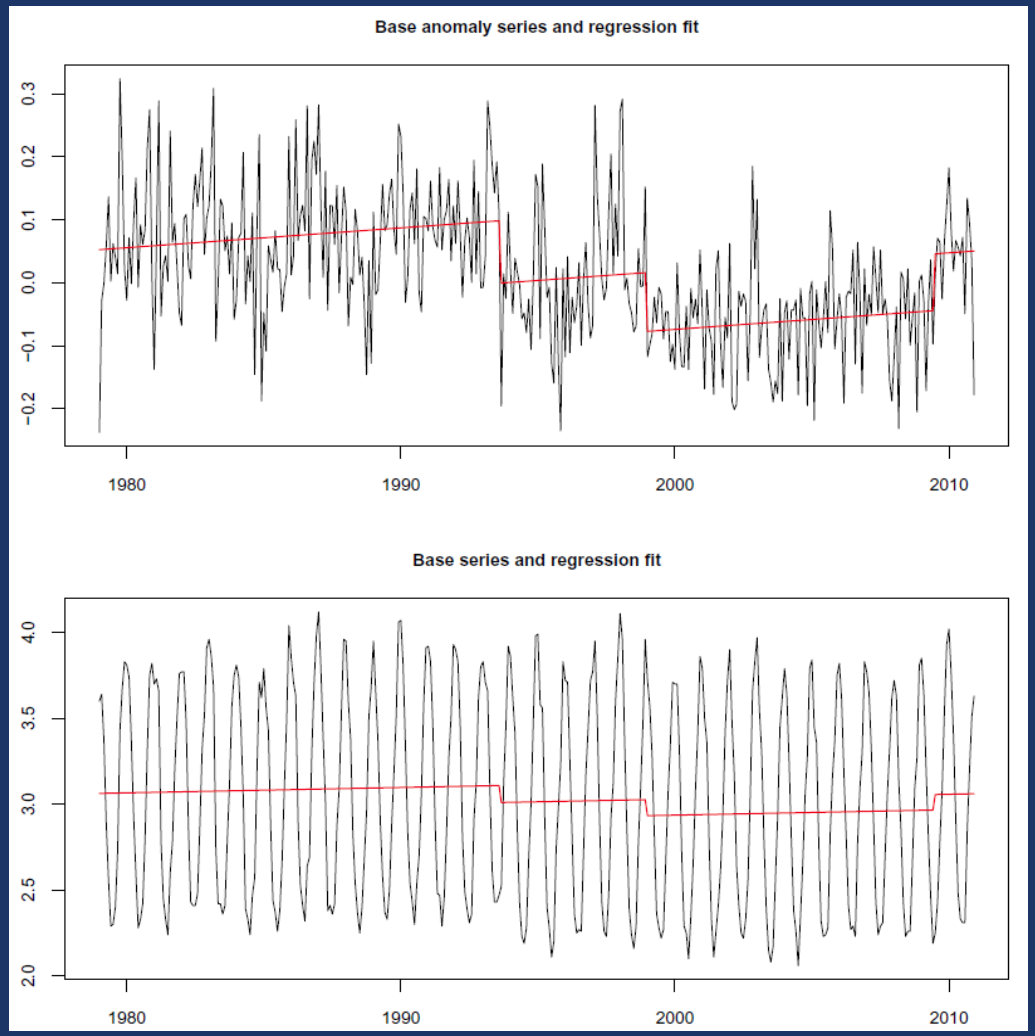
Northern Hemisphere



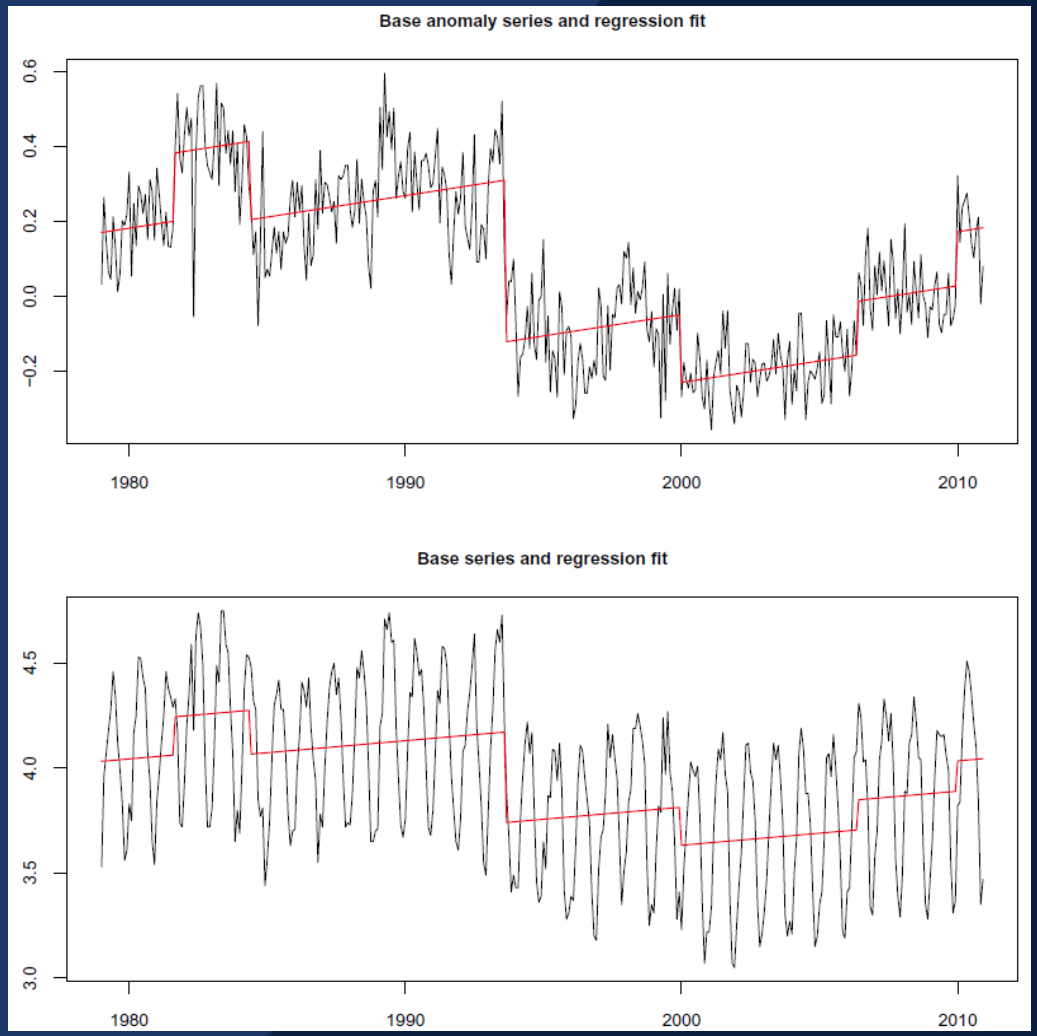
Southern Hemisphere

Preliminary Results

90th Percentile Wave Height RHTests with Type-1 Change Points



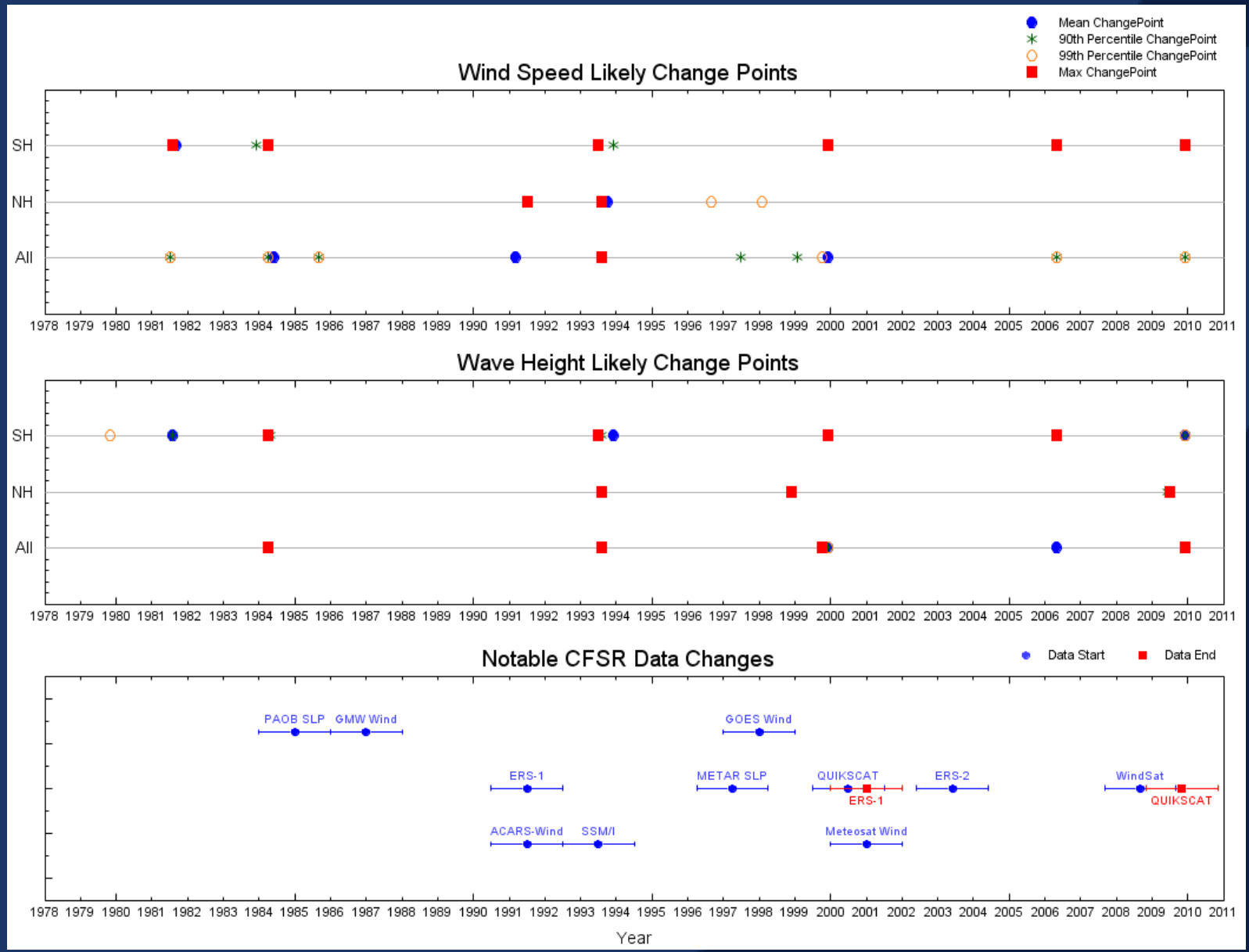
Northern Hemisphere



Southern Hemisphere

Preliminary Results

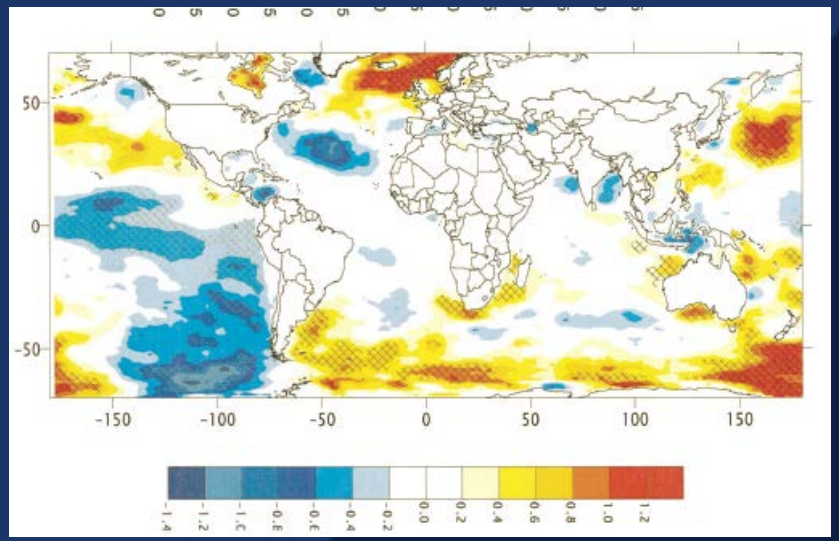
Comparison of RHTests Change Points with CFSR Data Changes



Preliminary Results

Future Work

- Complete Inventory of CFSR Data Changes to Test Significance of Type-0 Change Points
- Finalize Analysis of Hemispheric Time Series
- Move on to Regional Analysis of Change Points
- Apply Changes on Regional Basis to Entire Time History of Winds/Waves
- On to Trend Analysis!



Inferred change in 99th Percentile Wave Height from original GROW (2001)