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# The MSC50 Wind and Wave Hindcast of the North Atlantic Ocean

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## Abstract

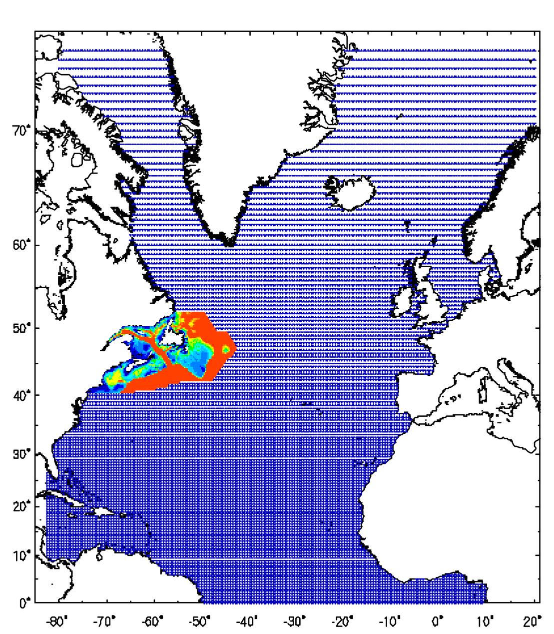
The AES40 wind and wave hindcast (Swail et al., 1998) has been shown to be a good description of the wave climatology of the North Atlantic Ocean (Caires et al., 2004). This hindcast has been widely used in wave climate and engineering studies for the North Atlantic, particularly for the areas offshore the east coast of Canada. It has recently been extended to 50 years in length (Cox et al., 2004). The present project, the MSC50 hindcast takes advantage of all of the high quality inputs to the AES40, and introduces some important enhancements, particularly for the Canadian east coast offshore regions. These include a finer grid, 0.5 degrees coarse over the entire North Atlantic, and 0.1 degrees fine over the northwest Atlantic, shallow water effects in the fine mesh area, better bathymetry and sea ice information, increased use of scatterometer wind data, and storm track information. The initial period of coverage for the MSC50 is July 1954 to June 2004.

## Project Methodology

MSC50 consists of two new wave model grids that define the North Atlantic basin. The coarse model is a ½ degree implementation of the UNIWAVE model over the same domain as the AES40 hindcast (0 to 75N, 82W to 20E). Total numbers of active grid points in this model are 18,637 (compared to 9023 for the AES40 model). This model will be run in deep-mode (no shallow water effects) and applied 3G-52 physics (same as AES40). The GROW global model provided spectral inputs along the equator. The goal of the coarse model is twofold: 1) to provide boundary spectra to the high-resolution nest and 2) to increase the resolution of the basin-scale hindcast from the original AES40's 0.625 by 0.833 degree implementation.

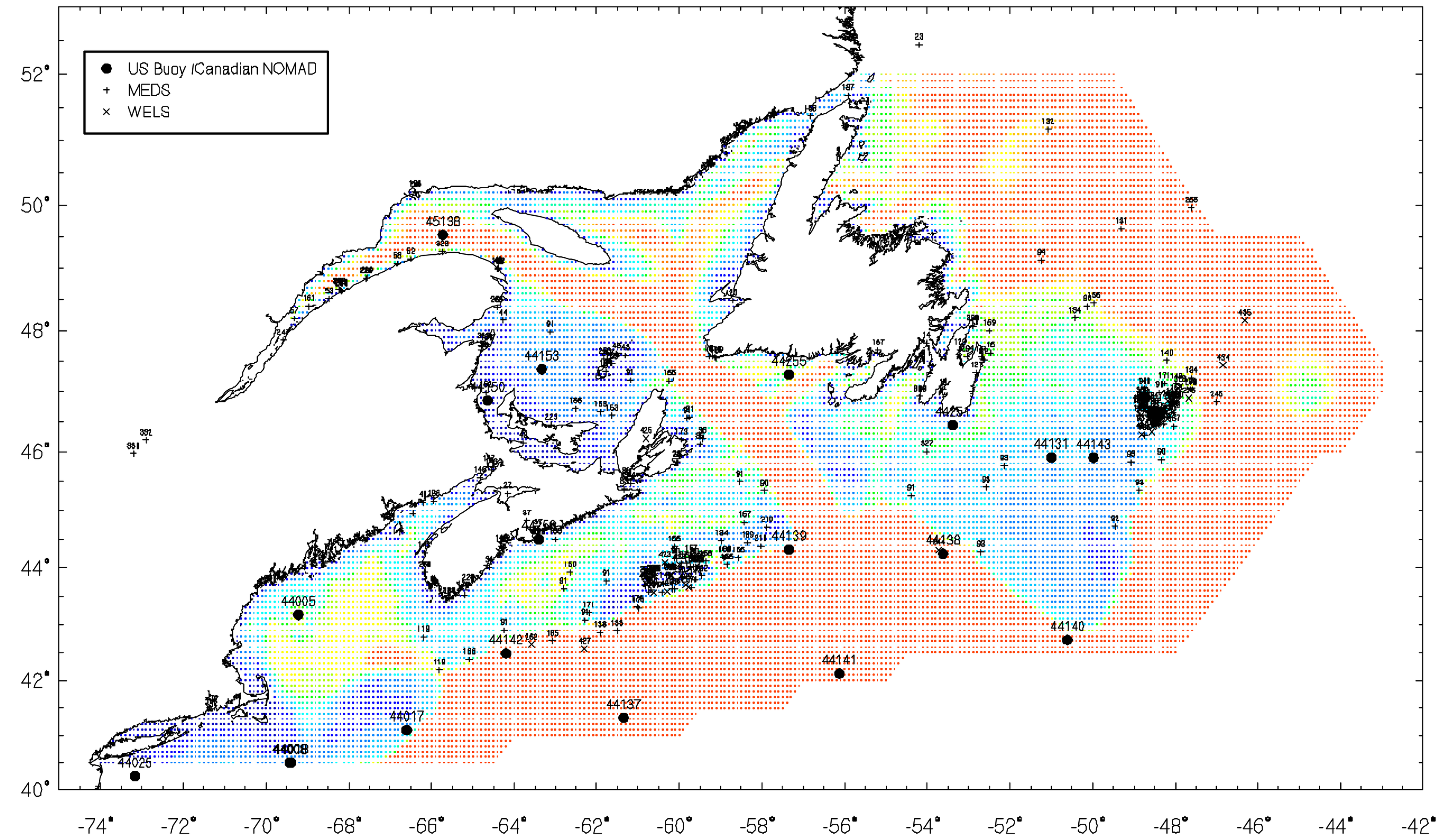
The second wave model applied in this hindcast is the fine 0.1-degree implementation of the UNIWAVE model. The domain of this model was developed in keeping with the operational requirements of MSC and selecting spectral boundaries between the coarse and fine models in deep-water. This model was run in shallow mode and applies 3G-52 physics. The total number of active points in this model is 18,541. Bathymetry for this model was provided from the GEBCO 1-arc second digital database.

Improvements to the AES40 also include additional reanalysis of the winds on the fine grid domain. These improvements apply QUIKSCAT data to reduce systematic bias in the source NCEP/NCAR reanalysis fields and will make better use of off-hour insitu data used in the analysis. Ice fields will be dynamically updated in the wave model daily using 5-day running median ice concentration data derived from DMSP satellite data (in the later periods).



MSC50 Coarse Domain Water Model

| AES40 | MSC50 |
|---|---|
| 0.625 x 0.833 | 0.5 x 0.5 Coarse<br>0.1 x 0.1 Fine |
| 9023 Grid Points | 18637 Coarse Grid Points<br>18541 Fine Grid Points |
| OWI 3G52 Deep | OWI 3G52 Shallow |
| Monthly Ice Fields | Dynamically Updated Daily Ice Fields |
| Kinematic Reanalysis of Wind Fields | Enhanced Kinematic Analysis of Winds |




MSC50 Fine Domain Water Model with Water Depths (m)

## Validation and Preliminary Results

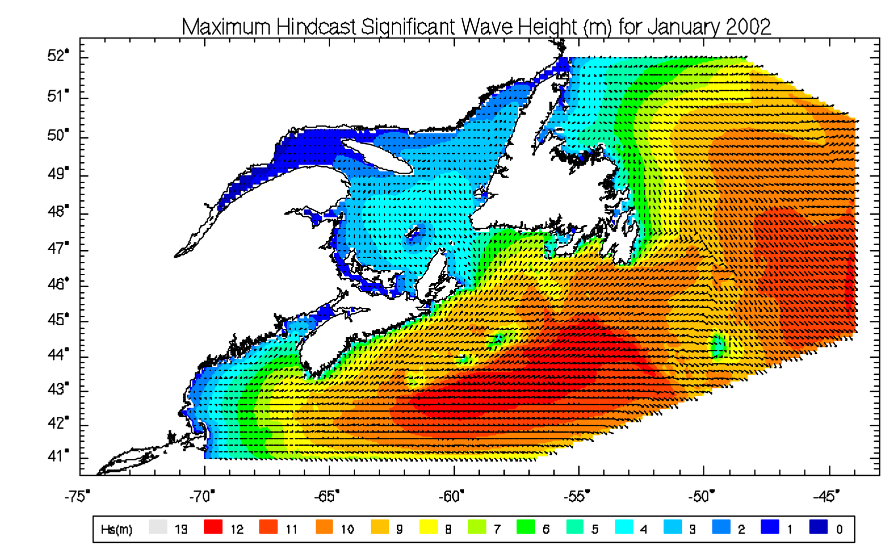
Validation of the MSC50 models for the period January-December 2002 was performed using adjusted TOPEX altimeter measurements and buoy data collected by NOAA and MEDS. This buoy list incorporates locations previous ignored in the AES40 hindcast due to either their water depth or proximity to the shoreline. Overall the hindcast are very similar, the MSC06 does have a smaller overall bias and lower scatter index for wave height. Overall bias for the MSC50 hindcast vs. TOPEX measurements is just 1 cm. A time series comparison at 44251 (Figure 3.3) shows several events over-estimated by the AES40 hindcast that are better predicted in the MSC50. Similar differences are seen at buoys 44255 and 44258. A comparison of TOPEX wave bias over the basin shows the MSC50 hindcast generally in better agreement. However, it should be noted that the validation set of TOPEX observations have been box-averaged to a ½ degree grid that is closer to the resolution of the AES40 model.

| | Number of Pts | Mean Meas | Mean Hind | Diff (H-M) | RMS Error | Stnd Dev | Scat Index | Corr Coeff |
|---|---|---|---|---|---|---|---|---|
| MSC50 vs. Buoys | | | | | | | | |
| Wind Spd. (m/s) | 85882 | 7.45 | 7.70 | 0.25 | 1.85 | 1.83 | 0.25 | 0.91 |
| Wind Dir. (deg) | 85880 | 252.85 | 252.02 | 0.38 | N/A | 23.32 | 0.06 | N/A |
| Sig Wave Ht (m) | 85421 | 1.91 | 2.09 | ***0.18*** | 0.43 | 0.39 | ***0.20*** | 0.96 |
| Wave Period (s) | 85421 | 7.89 | 7.08 | -0.81 | 1.79 | 1.60 | 0.20 | 0.80 |
| AES40 vs. Buoys | | | | | | | | |
| Wind Spd. (m/s) | 85882 | 7.45 | 7.67 | 0.22 | 1.85 | 1.84 | 0.25 | 0.91 |
| Wind Dir. (deg) | 85880 | 252.85 | 251.95 | 0.41 | N/A | 23.63 | 0.07 | N/A |
| Sig Wave Ht (m) | 85421 | 1.91 | 2.20 | ***0.29*** | 0.52 | 0.43 | ***0.23*** | 0.95 |
| Wave Period (s) | 85421 | 7.89 | 7.24 | -0.65 | 1.70 | 1.57 | 0.20 | 0.81 |

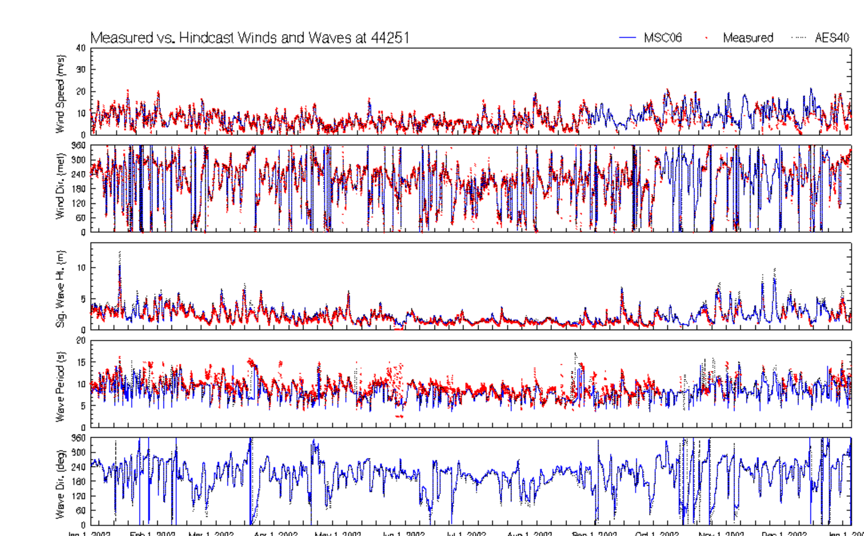
| | Number of Pts | Mean Meas | Mean Hind | Diff (H-M) | RMS Error | Stnd Dev | Scat Index | Corr Coeff |
|---|---|---|---|---|---|---|---|---|
| MSC50 vs. Altimeter | | | | | | | | |
| Wind Spd. (m/s) | 8840 | 8.20 | 8.63 | 0.43 | 1.68 | 1.62 | 0.20 | 0.90 |
| Sig Wave Ht (m) | 8999 | 2.74 | 2.74 | -0.01 | 0.54 | 0.54 | 0.20 | 0.94 |
| AES40 vs. Altimeter | | | | | | | | |
| Wind Spd. (m/s) | 273119 | 7.82 | 7.95 | 0.12 | 1.60 | 1.59 | 0.20 | 0.89 |
| Sig Wave Ht (m) | 277054 | 2.74 | 2.78 | 0.04 | 0.52 | 0.52 | 0.19 | 0.95 |

## Hindcast Products

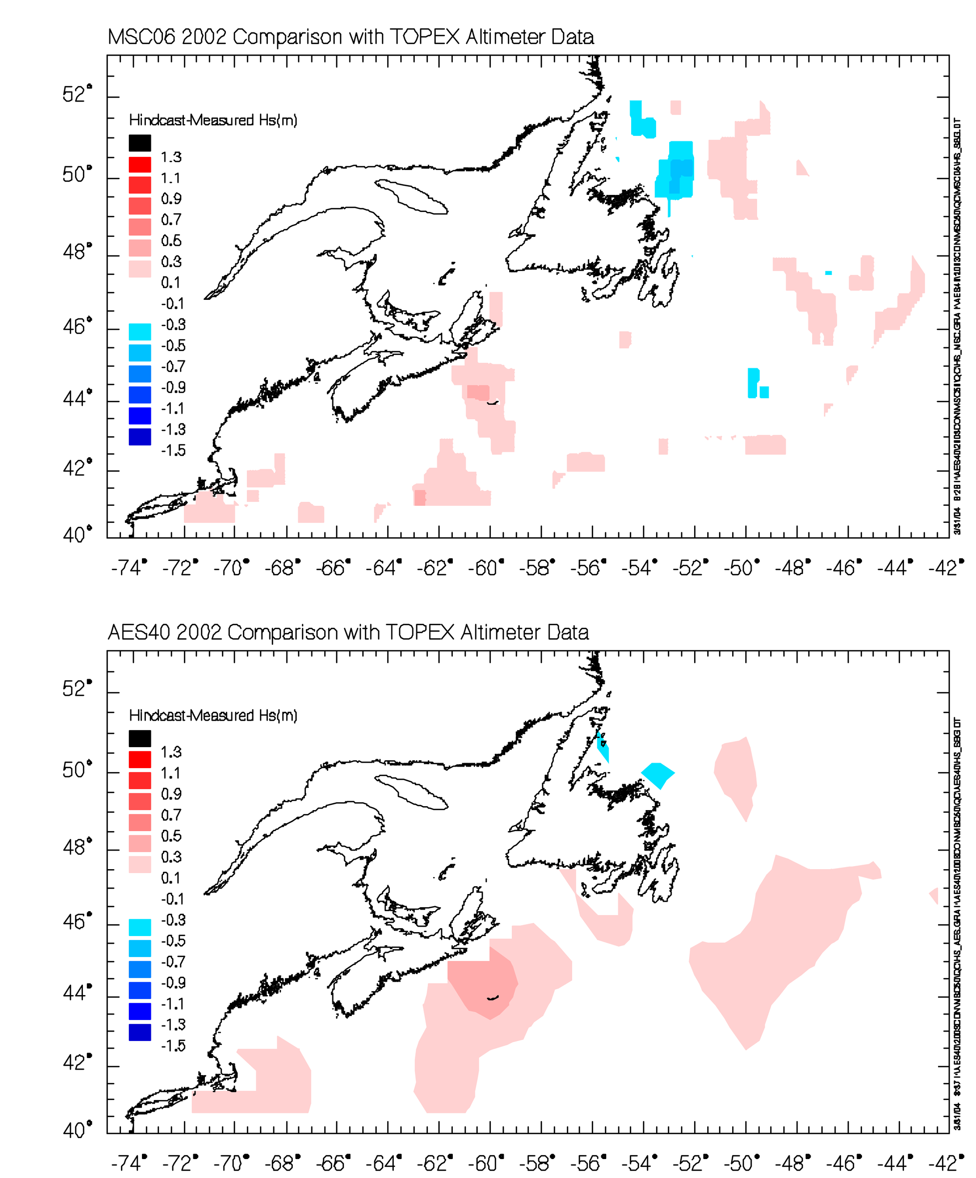
- •17 wind and wave parameters archived at all model locations (includes sea/swell partitions), 3-hourly time step
- •Full 23 frequency by 24 direction band wave spectra at select locations
- •Pre-computed extremes of wind speed and wave height
- •Graphical representations of annual mean and maximum wind speed and wave height
- •Canadian-waters archive with analysis tool for offshore operators




Maximum significant wave height (m)for January 2002




Comparison of wind and wave hindcasts AES40 and MSC50 at Buoy 44251




Mean differences between MSC06 (top) and AES40 (bottom) when compared to TOPEX altimeter data

## Selected Publications

Cardone, V.J., A.T. Cox and V.R. Swail, 2003. ***Evaluation of NCEP reanalysis surface marine wind fields for ocean wave hindcasts***. JCOMM Technical Report No. 13, WMO/TD-No. 108, pp. 68-85.
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Caires, S., Sterl, A., Bidlot, J.-R., Graham, N. and Swail, V., 2004: ***Intercomparison of different wind wave reanalyses***. J. Climate, **17** (10), 1893-1913
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Swail, V.R., A.T. Cox and V.J. Cardone, 1999. ***Trends and potential biases in NCEP-driven ocean wave hindcasts***. Proc. 2nd International Conference on Reanalyses. 23-27 August 1999, Reading, UK, WMO/TD-NO. 985, WCRP-109, p.129-132.
Swail, V.R., V.J. Cardone and A.T. Cox, 1998. ***A Long Term North Atlantic Wave Hindcast.*** 5th International Workshop on Wave Hindcasting and Forecasting. January 26-30, 1998. Melbourne, Florida.
Swail, V. R., A. T. Cox and V. J. Cardone, 2003. ***Analysis of wave climate trends and variability***. JCOMM Technical Report No. 13, WMO/TD-No. 108, pp. 217-226.
Swail, V.R., Xiaolan L. Wang and Andrew Cox, 2002. ***The Wave Climate of the North Atlantic - Past, Present and Future .*** Proceedings 7th International Workshop on Wave Hindcasting and Forecasting, 21-25 October 2002, Banff, Alberta