EC-DSBB: 35-Year Continuous Wind and Wave Hindcast in Baffin Bay

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Abstract

Oceanweather Inc. (OWI) has previously produced a wind and wave hindcast for the North Atlantic (MSC50) that includes a high resolution domain near the eastern Canadian coastal waters for Environment Canada (EC) as part of progression of study updates in the region intended to provide objective metocean data and the basis for design criteria in the harsh marine environment. While the Canadian coastline and maritime zones extend into Baffin Bay, the existing high resolution hindcast only extends as far north as 52° N. Using MSC50 to provide boundary conditions, the higher resolution grid hindcast was extended northward into Baffin Bay up to the permanent ice extent in the Davis Strait. Wind forcing was derived from the National Center for Environmental Prediction (NCEP) Climate Forecast System Reanalysis (CFSR) data product, with statistical corrections based on satellite altimetry applied by grid point. A blend of CFSR and Canadian Ice Service (CIS) gridded ice concentration data was incorporated by week into the continuous hindcast to impose the seasonal and annual changes in open water extent over the course of the 35-year hindcast period. Consistent with the MSC50, OWI's 3G wave model was applied to model the generation and propagation of ocean waves within the open water of Baffin Bay from 1979 through 2013.

Methodology

The MSC50 coarse grid was used to provide boundary wave spectra in the deep water along the Atlantic side of the Labrador Sea, which were applied with statistical corrections based on bulk wave parameter regressions of the spectral archives. The shape and location of the boundary between the MSC50 fine archive and the DSBB (Davis Strait/Baffin Bay) archive attempts to minimize differences due to changes in wind and bathymetry.

In contrast to the MSC50, the wind fields produced in this study are based on CFSR which tend to have better skill than the older NCEP/NCAR reanalysis, and have had per grid point statistical corrections applied based on satellite altimetry measurements of wind speeds for this study. No seperate kinematic analyses of the wind fields are performed for DSBB.

These inputs are combined to produce a wave hindcast using the same OWI-3G implementation as MSC50 (including the validated directional and frequency resolutions). Bathymetry was sourced from GEBCO2014 and the Canadian Hydrographic Service (CHS), and ice extents were derived from gridded concentration data sourced from CFSR and CIS.

Hindcast Products

- Wind, Bulk Wave, and Wave Partition Parameters archived at 1-hour steps over 1979-2013.
- Directional wave spectra with 26 frequency bins and 24 directional bins; at 1-hour timesteps on grid subset over 1979-2013.

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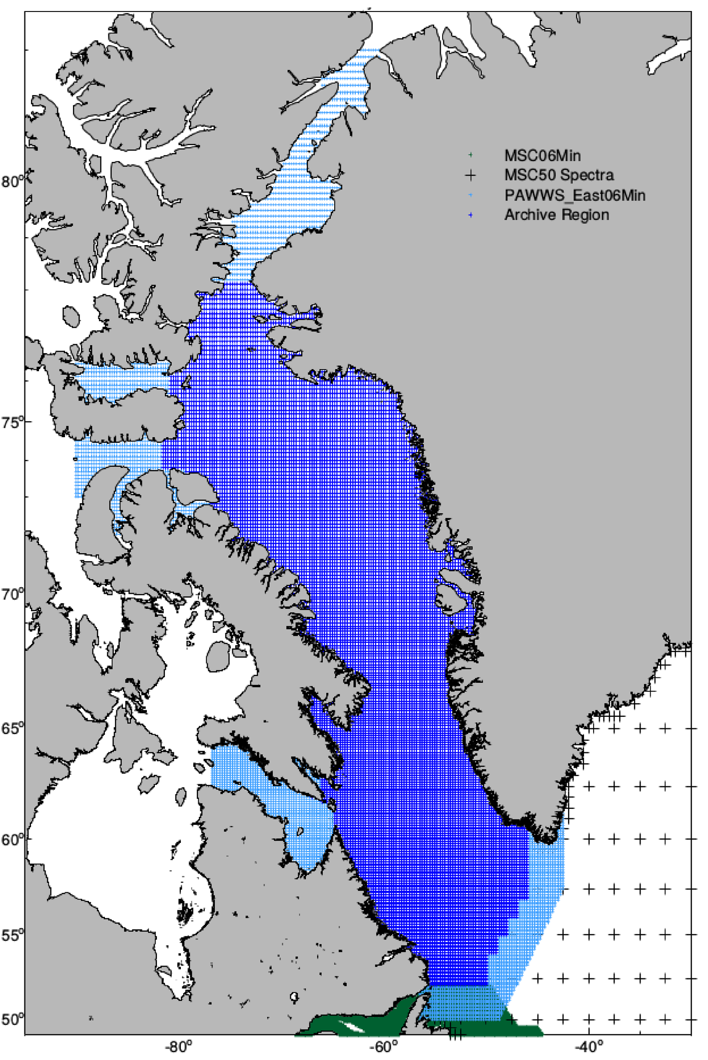
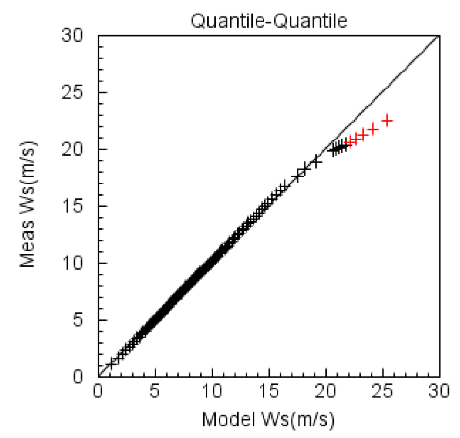
Domain



The modeling domain overlaps the fine MSC50 grid on its southern boundary and extends north to the permanent ice boundary in Davis Strait, encompassing both the Labrador Sea and Baffin Bay. The resolution of the grid is 0.25° x 0.1° in Longitude and Latitude respectively. The permanent ice extent was determined from a statistical analysis of the CFSR ice concentrations in the Davis Strait region. The model output is archived at 14473 grid points over the interior extent of the computational grid, with directional wave spectra archived at a subset of 107 points. Depths for the wave modeling grid were derived from the GEBCO2014 bathymetric archive and CHS 500m resolution gridded surveys. Resulting depths were verified with navigational charts.

Wind Corrections

Wind corrections were applied to the CFSR wind fields after being downscaled to the DSBB grid based on statistics derived from Globwave wind speed observations from a relatively modern continuous period with good coverage in the northern latitudes (2000-2012), in order to reduce bias by month. The corrections are small given the overall skill of CFSR over the study domain.



	Number of Pts	Mean Meas	Mean Hind	Diff (H-M)	RMS Error	Stnd Dev	Scat Index	Ratio	Corr Coeff
Uncorr. Wind Spd. (m/s)	3484100	9.01	9.02	0.00	1.92	1.92	0.21	0.52	0.90

Select Resources

Canadian Hydrographic Service Digital Data: 500m Bathymetry, http://www.chs.gc.ca/data-gestion/bathy/500-lic-eng.asp, Accessed August 2015.

The Canadian Ice Service Digital Charts Database: History of Data and Procedures Used in the Preparation if Regional Ice Charts, Report by Ballicater Consulting Ltd., March 2000.

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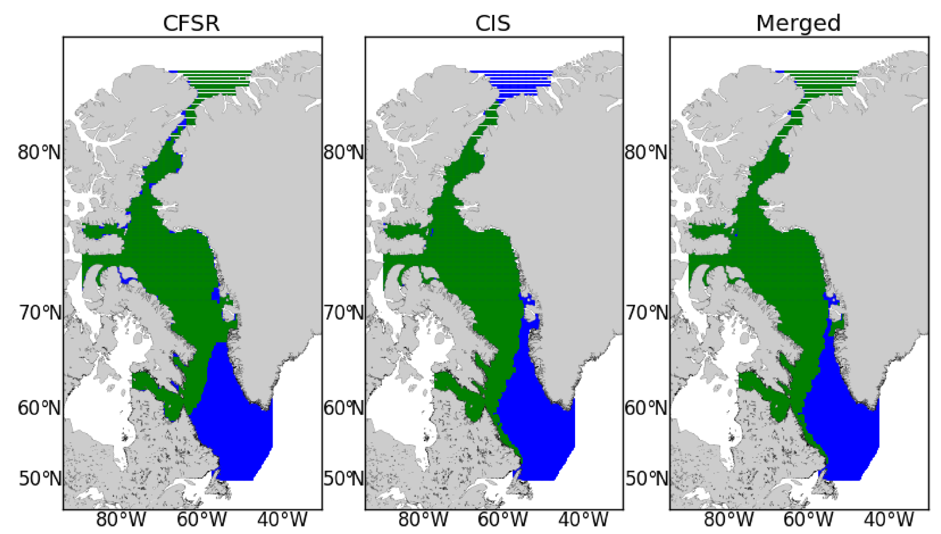
Swail, V.R., X.L. Wang and A.T. Cox, 2002. The Wave Climate of the North Atlantic - Past, Present and Future . Proceedings 7th International Workshop on Wave Hindcasting and Forecasting, 21-25 October 2002, Banff, Alberta.

The GEBCO_2014 Grid, version 20150318, http://www.gebco.net.

Ice Coverage

The sea ice extents were based on ice concentration data from two sources. The CFSR ice data is based on the available CFSR product, and corresponds to the ice used as part of the reanalysis modeling. Data from the Canadian Ice Service is assumed in this study to be a higher quality product than the CFSR data in this region due to scale and mission of the organization, despite also being an assimilation of multiple forms of ice concentration observations (including direct observation, overflight, and satellite). The resulting data is a more cohesive and finely scaled representation of the sea ice concentrations despite variations in geographic extent available week to week.



Both datasets were merged to produce weekly sea ice coverage over the course of the DSBB hindcast period by supplementing the CFSR data with CIS where and when available. A quality control process ensured continuity in space and time of the final ice coverage dataset used in the DSBB hindcast.

Validation

Observations for validation in this region were limited to satellite measurements of wave height from Globwave. A statistical analysis of the time- and spatially-matched H_s shows an overall bias of -2 cm. Because the wind fields were corrected based on Globwave measurements, they are expected to have high skill overall when compared to the Globwave observed winds, thus a H_s comparison is a reasonable approach to validation of the resulting hindcast overall.