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WaveNet: A Web-Based Metocean Data Access, Processing and Analysis Tool

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PURPOSE: This Coastal and Hydraulics Engineering Technical Note (CHETN) describes the first module of the MetOcnDat (Meteorological and Oceanographic or Metocean) system, called WaveNet. Metocean data include winds, waves, tides (water levels and currents), and river discharges. WaveNet is a web-based Graphical-User-Interface (GUI) data management tool that allows users to access, process and analyze wave data from different data sources. This first release of WaveNet addresses only wave data required for coastal, ocean, and marine engineering applications, facilitates conversion of data used in input files for numerical wave models by Corps of Engineers, and provides tabular and graphical information for project planning and design reports.

BACKGROUND: WaveNet accesses user-selected wave data sources to check the availability of data types and durations. Once the user identifies the data needs for a time interval, WaveNet can perform on-the-fly data processing to check the quality and consistency of data, allowing the user to extract a selected portion of the data to download. WaveNet uses the extracted data to compute data metrics, generate data input files for numerical wave models, and create data graphics for engineering reports. The purpose of this web-based tool is to address a basic shared need of the Corps for coastal modeling and planning to acquire oceanographic data and metrics while minimizing complexity and uncertainty in the process. This first release is limited to wave data; later versions will expand to include other USACE data needs for winds, tides and river discharge data sources. Details of the WaveNet system are available from *http://dkbes.usace.army.mil/WaveNet/*. This CHETN introduces users to WaveNet and provides step-by-step instructions to demonstrate its components in an example application.

OVERVIEW: The WaveNet tool is a web-based GUI intended to provide users with a GIS mapping tool to query and select data sources according to the desired geographic region. It uses the Google Map interface to display data from different sources. Users can enable or disable the data sources for viewing, and select the available data parameters of interest. When the user selects the data source icon from the mapping interface, the utilities available at the data source are used to query the data source availability to plot, analyze, and extract data based on a user-specified date range (timeline selection). Once the users select the data range, tools are available to output data in desired format. Additional post-processing capabilities are available within WaveNet to produce tabular data or plots in a desired format, and write input files for numerical wave models.

There are two ways to use WaveNet: 1) fetch data from various sources including plots and tables provided by data sources, or 2) do the processing manually. WaveNet allows users to download the raw ASCII or zipped data files from the data sources for documentation in engineering reports or for use in data analysis. Plotting options include statistical wave data

parameters such as significant wave height for each day in the data plot range and wave roses for directional wave data. Users have the option of saving these files as image files (.png), portable document format (.pdf), or Matlab figures (.fig). The Matlab figure format allows users to view the plot in Matlab and modify axes, labels or text attributes for reports and other publications. The numerical model output functionality allows users to select a model such as CMS-Wave or STWAVE to write the *.eng input file in the required format for these models (Lin et al. 2008 and 2011). Features of WaveNet are next illustrated in an example application in a step-by-step manner and with comments and instructions to guide the users.

EXAMPLE: Wave Information for Eastern Shore of Alabama Project

This example is a demonstration of how the WaveNet Toolbox identifies oceanographic data for a user, calculates the wave data metrics, and produces the input data files for wave models.

Step 1. Click on *http://dkbes.usace.army.mil/WaveNet/* to start WaveNet from a remote server that resides on Corpsnet. WaveNet's main map page displays data sources available, including NOAA, WIS, CDIP, FRF, GROW (Global Reanalysis of Ocean Waves), WW3 (Wave Watch 3), and NWS data sources shown in the legend in Figure 1. Users can toggle the data sources visibility on the map using a toggle menu. For this tutorial, use the map tools to zoom in to the Gulf Coast as Figure 1 illustrates. Use the mouse to draw and create a box of interest where MetOcean data are desired, as shown in Figure 1. A selection box can be drawn for any part of the map displayed in Figure 1. In future releases, users will also be able to input the name of the site to zoom onto an area of interest.

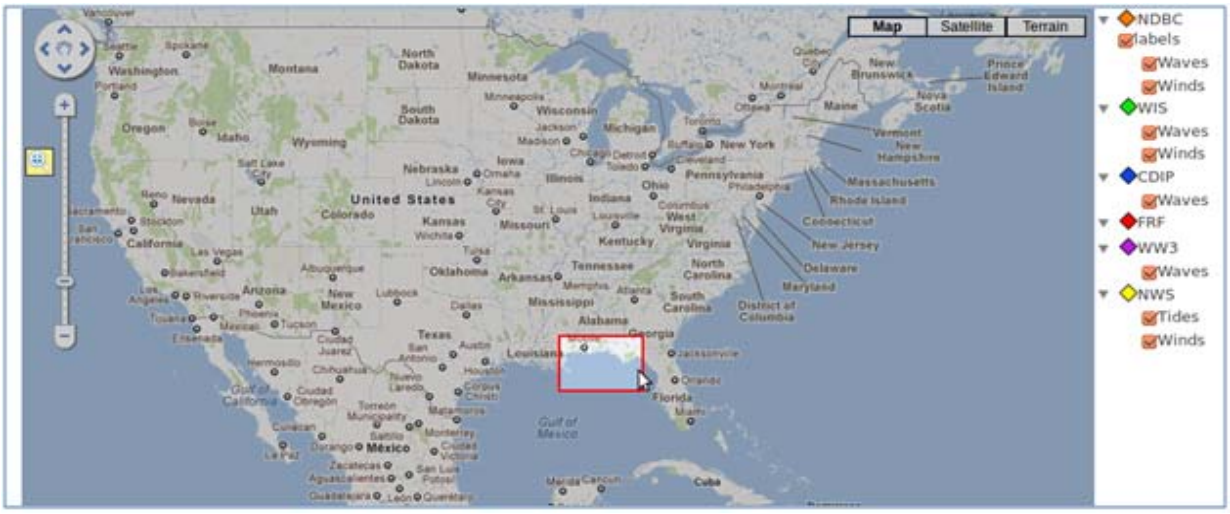

Figure 1. WaveNet main page with user-defined “box” of interest.

Step 2. Users can toggle the label visibility as well as data sources according to data availability such as wind and waves. In this example, NDBC is selected as the data source (see Figure 2). Click on NDBC Buoy 42012 to bring up the data source information as Figure 2 illustrates. Summary information about Buoy 42012 appears in a white pop-up window in Figure 2. Users can access the station's home page either by clicking the “View Station Home” link or the buoy number in the “Access 42012 Data” window, query and view the years of historical data available. These links will display the data availability list shown at the bottom of the WaveNet map page (Figure 2).

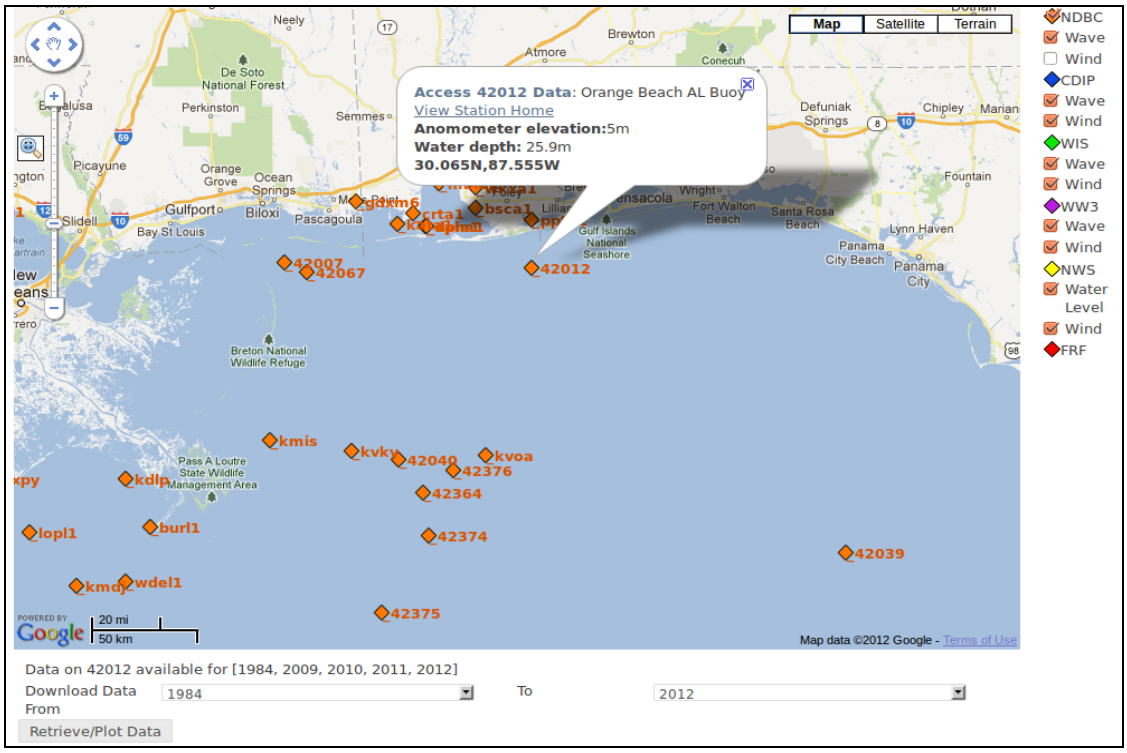

Figure 2. NDBC Buoy 42012 off the Eastern Shore of Alabama.

Step 3. Users can now view the available data parameters by selecting the years of interest (a time window) and clicking on "Retrieve/Plot Data." Users can preview and download these data from the selected buoy's/station's home page and/or plot the data parameters directly on the WaveNet page, as Figure 3 illustrates. Each data source provides its own data management tools for access, display, view, animate and download. Users should take advantage of these data management tools to avoid unnecessary data operations. Note that WaveNet will retain the previous session information for each user to reduce downloading times. Figure 3 shows the selection of a time window from 2009 to 2011 using the "slider bar" at the bottom of Figure 3.

Step 4. The user can now narrow the time window of interest to specific days or months by using the slider bar at the bottom of the plot or by clicking the box. Users can type dates in the Start and End Date boxes, as illustrated in Figure 3, or use the calendar in Figure 4. The timeline plot will show data availability for wave height and wind speed as well as identify any data gaps.

Step 5. If the user wants to perform additional analyses of data on desktop, s/he can now download the selected date range of data source (in this example, Buoy 42012) by clicking on "Download to CSV." The csv is an ASCII spreadsheet text format. Figure 5 illustrates the tabulated csv data saved that can be used with Matlab or Fortran codes, if desired.

Step 6. Other WaveNet data processing options (may not be available for all data sources) include a plotting capability for wave roses. Users can view/download a rose plot of the selected wave data by clicking on "Rose Plot" below the timeline plot. Figure 6 illustrates a wave rose, with each concentric circle representing a 0.5 m increment of wave height. Future capabilities will include more advanced and extensive plotting capabilities for coastal modelers, and data tables and plots geared for project planners and engineers.

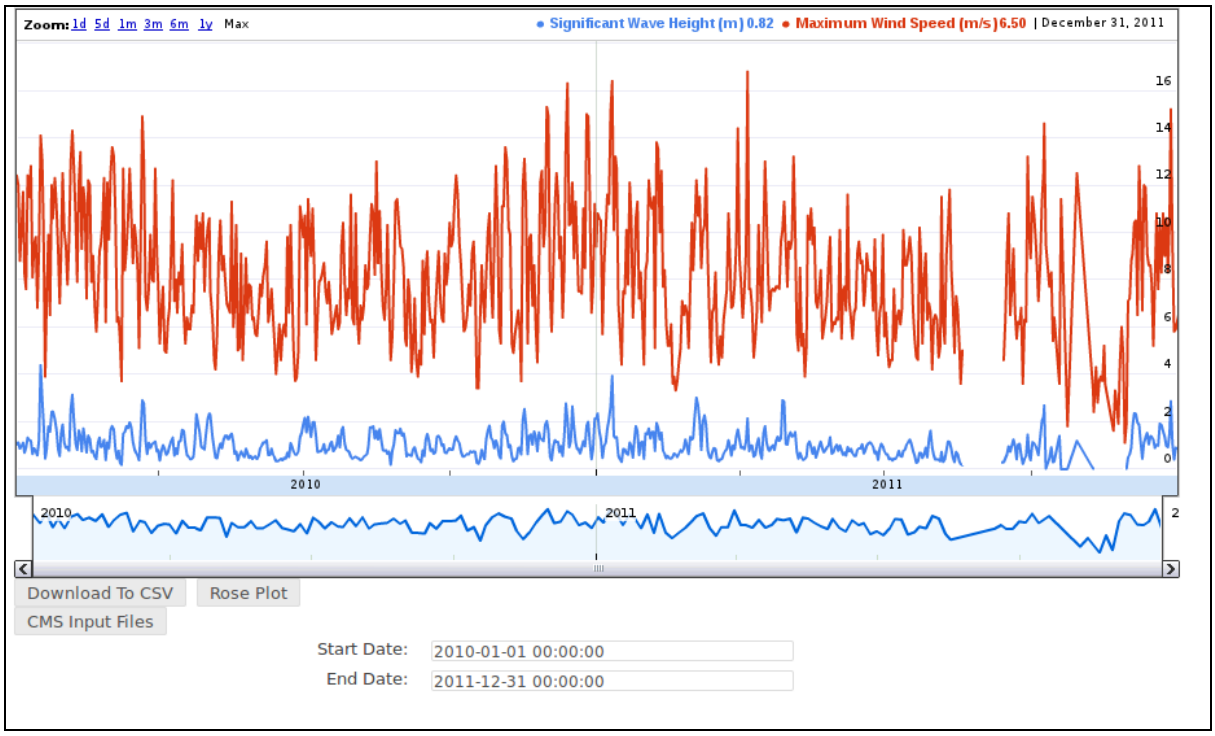

Figure 3. Availability of data range for NDBC Buoy 42102.

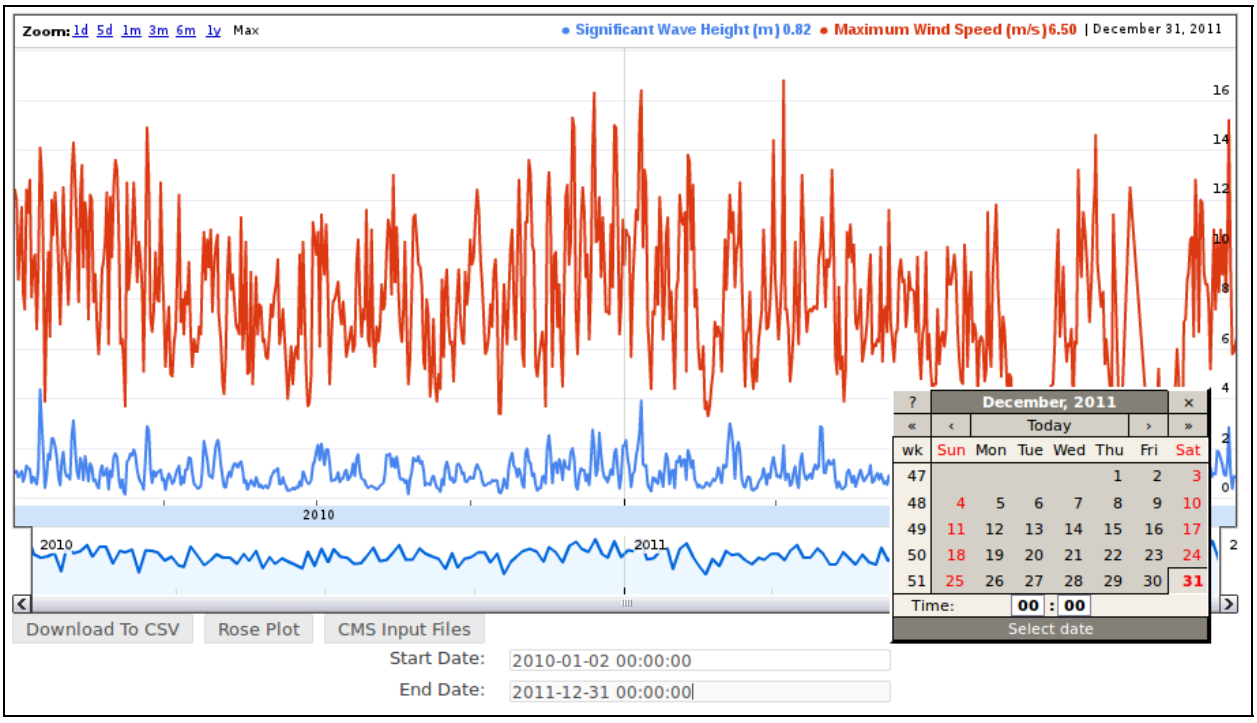

Figure 4. Plot zooming features for NDBC Buoy 42102.

	A	B	C	D	E	F
1	BuoyNum	timedate	WindDir	WindSpeed	WindGust	WaveHeight
2	42012	2009-12-31 23:50:00	261	1.7	2.4	0.81
3	42012	2010-01-01 00:50:00	277	1.4	1.8	0.75
4	42012	2010-01-01 01:50:00	268	0.7	1.2	0.79
5	42012	2010-01-01 02:50:00	236	0.7	1.1	0.65
6	42012	2010-01-01 03:50:00	328	2.2	3	0.67
7	42012	2010-01-01 04:50:00	355	2.4	2.9	0.68
8	42012	2010-01-01 05:50:00	30	2.4	3	0.63
9	42012	2010-01-01 06:50:00	39	5.1	6.2	0.62
10	42012	2010-01-01 07:50:00	50	5.8	6.6	0.6
11	42012	2010-01-01 08:50:00	40	6.8	7.9	0.69
12	42012	2010-01-01 09:50:00	354	12.4	15.1	0.8
13	42012	2010-01-01 10:50:00	16	10.2	11.8	1.03
14	42012	2010-01-01 11:50:00	18	9.1	10.5	0.94
15	42012	2010-01-01 12:50:00	356	9.1	11.1	0.8

Figure 5. Downloaded tabulated data for NDBC Buoy 42102.

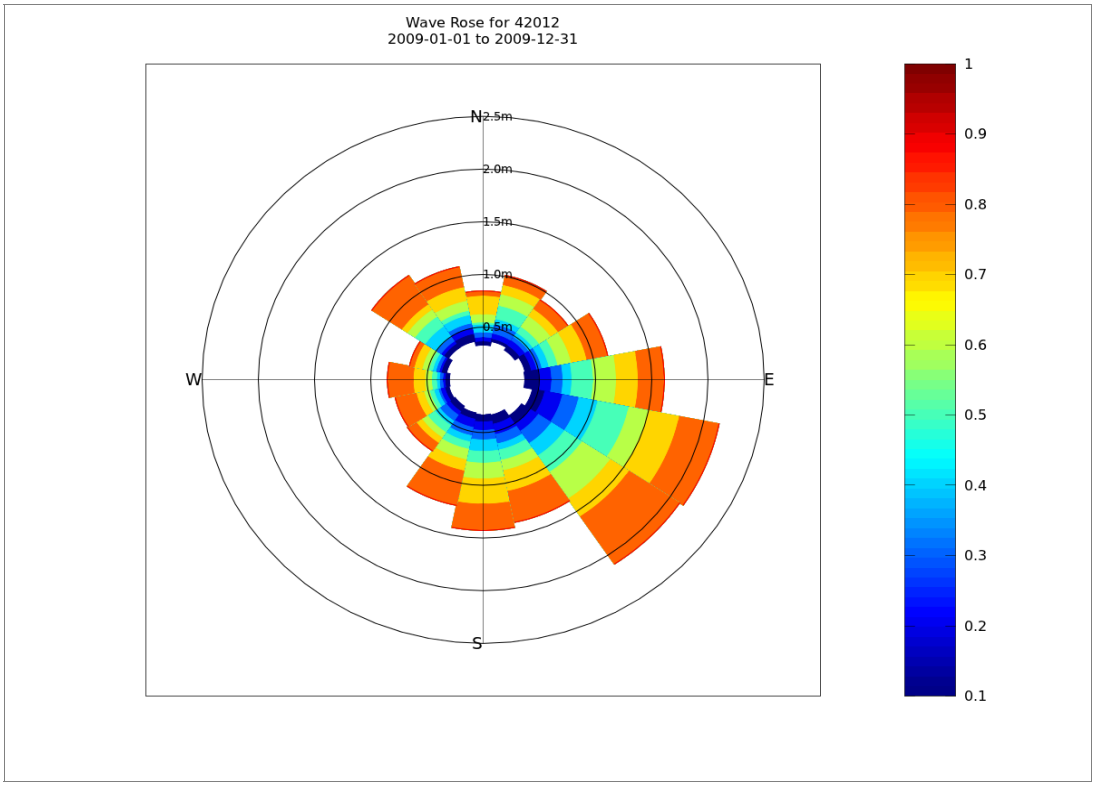

Figure 6. Wave rose plot for NDBC Buoy 42102.

Step 7. Finally, once the segments of data are retrieved, reviewed and downloaded using the WaveNet, users can now perform certain data analyses on the wave data files downloaded to the user's local machine. For example, the CMS-Wave model requires an *.eng file for directional

wave input. As was noted earlier, if directional wave data (1-D or 2-D wave spectra and associated Fourier coefficients used to generate wave spectra) are available from the data source site, users can download these files to his/her local machine and apply any post-processing analyses as desired. Alternatively, the user can perform these operations using the WaveNet by clicking on "CMS Input Files" below the timeline plot. In future releases, additional numerical models will be added to the list, and this menu will change. At the bottom of Figure 7, *.eng files are listed according to the timeline selected. Figure 8 displays a partial content of these *.eng files for illustration, for details see Lin et al. (2008 and 2011). Future capabilities of WaveNet will include input files for other models such as CGWAVE and Bouss-2D, each of which require their own data input format and data processing programs to produce these input files.

CONCLUSIONS: This CHETN describes WaveNet, the first component of the MetOcnDat system. WaveNet provides access to a number of Web-based wave data sources, and enables extraction and analysis of data relevant to USACE coastal navigation as well as storm damage reduction projects. This tool is intended to provide planners and engineers with information required for project planning, design and evaluation study reports, as well as input files required for numerical wave models used in support of these activities. Data sources vary in content, complexity and accuracy of information. Use of such data may require help from experts and can often contain data gaps that may affect the utility of data in USACE studies. Presently, knowledgeable users are required to modify data files manually to fill in (pad or remove) the missing data gaps. Future releases of the WaveNet will include additional capabilities (e.g., identify gaps and provide users with options to handle data gaps, including interpolation options between the endpoints of the gap in the data timeline, fetching missing data from the geographically nearest wave data source, and mission-specific analysis capabilities). We seek user feedback to augment the capabilities of WaveNet to better serve the USACE. We welcome users to report problems they encounter and to inform us of additional needs that are desired for all engineering applications.

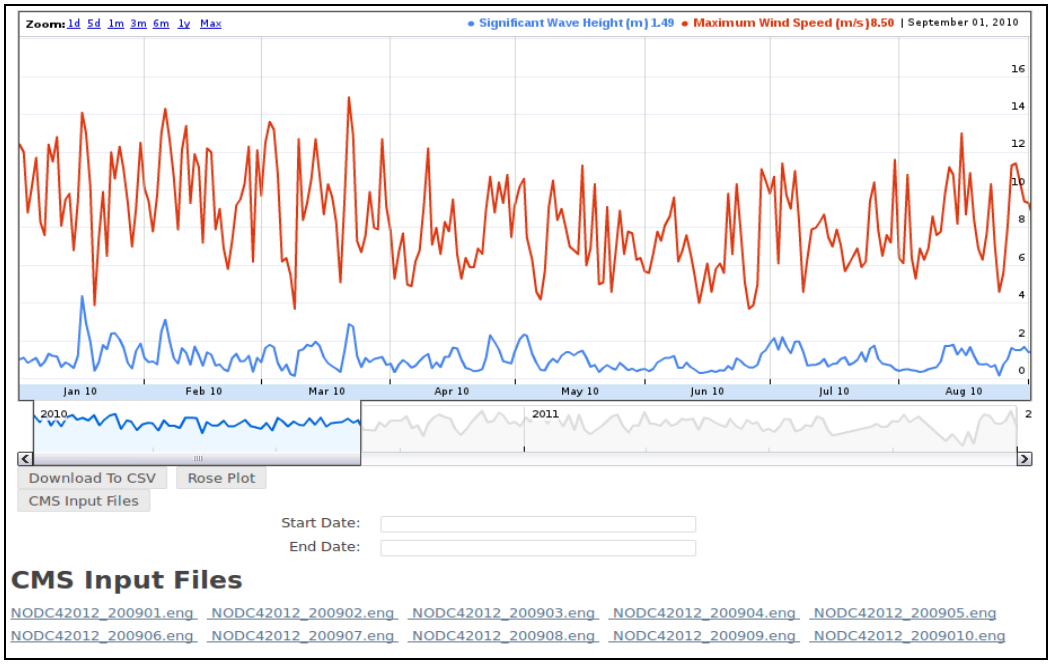

Figure 7. CMS-Wave files for NDBC Buoy 42102.

```
30 35
0.04000 0.05000 0.06000 0.07000 0.08000 0.09000 0.10000 0.11000 0.12000 0.13000
0.14000 0.15000 0.16000 0.17000 0.18000 0.19000 0.20000 0.21000 0.22000 0.23000
0.24000 0.25000 0.26000 0.27000 0.28000 0.29000 0.30000 0.31000 0.32000 0.33000
9040821     9.1       -42.    0.30000    0.00
   0.00032    0.00033    0.00034    0.00034    0.00034    0.00033    0.00032
   0.00030    0.00029    0.00026    0.00024    0.00021    0.00018    0.00015
   0.00013    0.00010    0.00007    0.00005    0.00003    0.00001    0.00000
   0.00001    0.00005    0.00010    0.00017    0.00025    0.00033    0.00043
   0.00052    0.00062    0.00071    0.00081    0.00089    0.00097    0.00103
   0.00108    0.00112    0.00114    0.00115    0.00114    0.00112    0.00108
   0.00103    0.00097    0.00089    0.00081    0.00071    0.00062    0.00052
   0.00043    0.00033    0.00025    0.00017    0.00010    0.00005    0.00001
   0.00005    0.00017    0.00034    0.00056    0.00082    0.00111    0.00142
   0.00174    0.00206    0.00238    0.00268    0.00296    0.00322    0.00343
   0.00360    0.00373    0.00381    0.00384    0.00381    0.00373    0.00360
   0.00343    0.00322    0.00296    0.00268    0.00238    0.00206    0.00174
   0.00142    0.00111    0.00082    0.00056    0.00034    0.00017    0.00005
   0.00005    0.00017    0.00035    0.00057    0.00084    0.00113    0.00144
   0.00177    0.00210    0.00242    0.00273    0.00302    0.00328    0.00350
   0.00367    0.00380    0.00388    0.00391    0.00388    0.00380    0.00367
   0.00350    0.00328    0.00302    0.00273    0.00242    0.00210    0.00177
   0.00144    0.00113    0.00084    0.00057    0.00035    0.00017    0.00005
   0.00009    0.00031    0.00063    0.00103    0.00151    0.00204    0.00261
   0.00320    0.00380    0.00439    0.00495    0.00546    0.00593    0.00632
   0.00664    0.00688    0.00702    0.00707    0.00702    0.00688    0.00664
   0.00632    0.00593    0.00546    0.00495    0.00439    0.00380    0.00320
   0.00261    0.00204    0.00151    0.00103    0.00063    0.00031    0.00009
   0.00007    0.00025    0.00052    0.00086    0.00125    0.00169    0.00216
   0.00265    0.00315    0.00363    0.00409    0.00452    0.00491    0.00524
   0.00550    0.00570    0.00581    0.00585    0.00581    0.00570    0.00550
   0.00524    0.00491    0.00452    0.00409    0.00363    0.00315    0.00265
   0.00216    0.00169    0.00125    0.00086    0.00052    0.00025    0.00007
   0.00007    0.00026    0.00053    0.00087    0.00127    0.00171    0.00219
   0.00268    0.00318    0.00367    0.00414    0.00458    0.00497    0.00530
   0.00557    0.00576    0.00588    0.00592    0.00588    0.00576    0.00557
   0.00530    0.00497    0.00458    0.00414    0.00367    0.00318    0.00268
```

Figure 8. CMS-Wave *.eng wave input files generated by WaveNet.

POINTS OF CONTACT: This CHETN was prepared as part of the Coastal Inlets Research Program (CIRP) and was written by a team. The POC for technical inquiries is Dr. Zeki Demirbilek (*Zeki.Demirbilek@usace.army.mil*). For information about CIRP, please contact the CIRP Program Manager, Dr. Julie Dean Rosati (tel: 251-694-3719) or by email (*Julie.D.Rosati@usace.army.mil*). This technical note should be referenced as follows:

> Wilson, D., Rosati, J., Demirbilek, Z., and Lin, L. 2012. WaveNet: A Web Based Metocean Data Access, Processing and Analysis Tool. Coastal and Hydraulics Engineering Technical Note ERDC/CHL CHETN-IV-83, U.S. Army Engineer Research and Development Center, Vicksburg, MS. An electronic copy of this CHETN is available from: *http://chl.erdc.usace.army.mil/chetn*.

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