6. CMS-Wave Advanced Features

The most recent CMS-Wave code developed is Version 3.2. Several new capabilities and advanced features in this version include:

- Full-plane
- Automatic wave run-up calculation
- Infra-gravity wave
- Nonlinear wave-wave interaction
- Muddy bottom
- Binary file output
- Selection of multiple processors
- Permeable structure
- Spatially varied wind input
- Spatially varied spectral input
- Grid nesting

Users can use SMS11 or simply edit the existing model control file *.std to specify some of these advanced features.

The *.std has a maximum of 24 parameters - the first 15 parameters are more the basic ones as described in the CMS-Wave Technical Report (CHL-TR-08-13) while the remaining 9 parameters are relatively new for advanced CMS-Wave features.

1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th	11th	12th	13th	14th	15th
iprp	icur	ibk	irs	kout	ibnd	iwet	ibf	iark	iarkr	akap	bf	ark	arkr	iwvbk

16th	17th	18th	19th	20th	21st	22nd	23rd	24th
nonln	igrav	irunup	imud	iwnd	isolv	ixmdf	iproc	iview

Among these 24 parameters in *.std, the first 6 parameters are always required in CMS-Wave and the remaining ones starting any parameter after the 6th will be assigned to the default values if not provided in the *.std. The more specific use and options associated with each of these 1st to 24th parameters are given below.

iprp = 0 (wave propagation with wind input in *.eng)
1 (wave propagation only, neglect wind input in *.eng)
-1 (fast mode)
2 (forced grid internal rotation)
3 (without lateral energy flux)

icur = 0 (no current input)
1 (with current input *.cur)

2 (with *.cur, use only the 1st set current data)

ibk = 0 (no wave break info output)
1 (output breaking indices *.brk)
2 (output energy dissipation rate *.brk)

irs = 0 (no wave radiation stress calc)
1 (output radiation stress *.rad)
2 (calculate/output setup/max-water-level + *.rad)

kout = number of special wave output location, output spectrum in *.obs
and parameters in selhts.out

ibnd = 0 (no input a parent spectrum *.nst)
1 (read *.nst, averaging input spectrum)
2 (read *.nst, spatially variable spectrum input)

iwet = 0 (allow wet/dry, default)
1 (without wet/dry)
-1 (allow wet/dry, output swell and local sea files)
-2 (output combined steering wav files)
-3 (output swell, local sea, and combined wav files)

ibf = 0 (no bottom friction calc)
1 (constant Darcy-Weisbach coef, c_f)
2 (read variable c_f file, *.fric)
3 (constant Mannings n)
4 (read variable Mannings n file, *.fric)

iark = 0 (without forward reflection)
1 (with forward reflection)

iarkr = 0 (without backward reflection)
1 (with backward reflection)

akap = 0 to 4 (diffraction intensity, 0 for zero diffraction, 4 for strong diffraction)

bf = constant bottom friction coef c_f or n
(typical value is 0.005 for c_f and 0.025 for Mannings n)

ark = 0 to 1 (constant forward reflection coef, global specification,
0 for zero reflection, 1 for 100% or fully reflection)

arkr = 0 to 1 (constant backward reflection coef, global specification,
0 for zero reflection, 1 for 100% or fully reflection)

iwvbk = 0 to 3 (option for the primary wave breaking formula:
0 for Goda-extended, 1 for Miche-extended,
2 for Battjes and Janssen, 3 for Chawla and Kirby)

nonln = 0 (none, default) 1 (nonlinear wave-wave interaction)

igrav = 0 (none, default) 1 (infra-gravity wave enter inlets)

irunup = 0 (none, default) 1 (automatic, runup relative to absolute datum)
2 (automatic, runup relative to updated MWL)

imud = 0 (mud.dat, default) 1 (none) ---- useful to users who may not want to
include the mud effect when the mud.dat exists
(typical maximum kinematic viscosity in mud.dat
is 0.04 m^2/sec)

iwnd = 0 (wind.dat, default) 1 (none) ---- useful in steering if users decide not
to read the spatially varied wind field input wind.dat
when the wind.dat file exists

isolv = 0 (GSR solver, default) 1 (ADI)

ixmdf = 0 (output ascii, default) 1 (output xmdf) 2 (input & output xmdf)

iproc = 0 (same as 1, default) n (n processors for isolv = 0)
---- optimum n = (total row number) /300

iview = 0 (half-plane, default) 1 (full-plane) --- in the full plane, users can provide
additional input wave spectrum file wave.spc (same
format as the *.eng) along the opposite side boundary
(an imaginary origin for wave.spc at the opposite corner;
users can rotate the CMS-Wave grid by 180 deg in SMS
to generate this wave.spc)

Figure 6.1.1 shows the CMS-Wave interface window for *Model Control* in SMS11.

- Full-plane – In this mode, CMS-Wave performs two half-plane runs in the same grid. The first run is in the half-plane with the principle wave direction toward the shore. The second run is in the seaward half-plane. Upon the completion of the second run, two half-plane results are combined to one full-plane solution. Because the run time for the full-plane is approximately twice of the regular half-plane, users shall consider the full-plane mode only if the full-plane features like wave generation and propagation in a bay or around an island. An example is to run the Shark River wave case, 2009.sim, in the full plane (modify 2009.std).

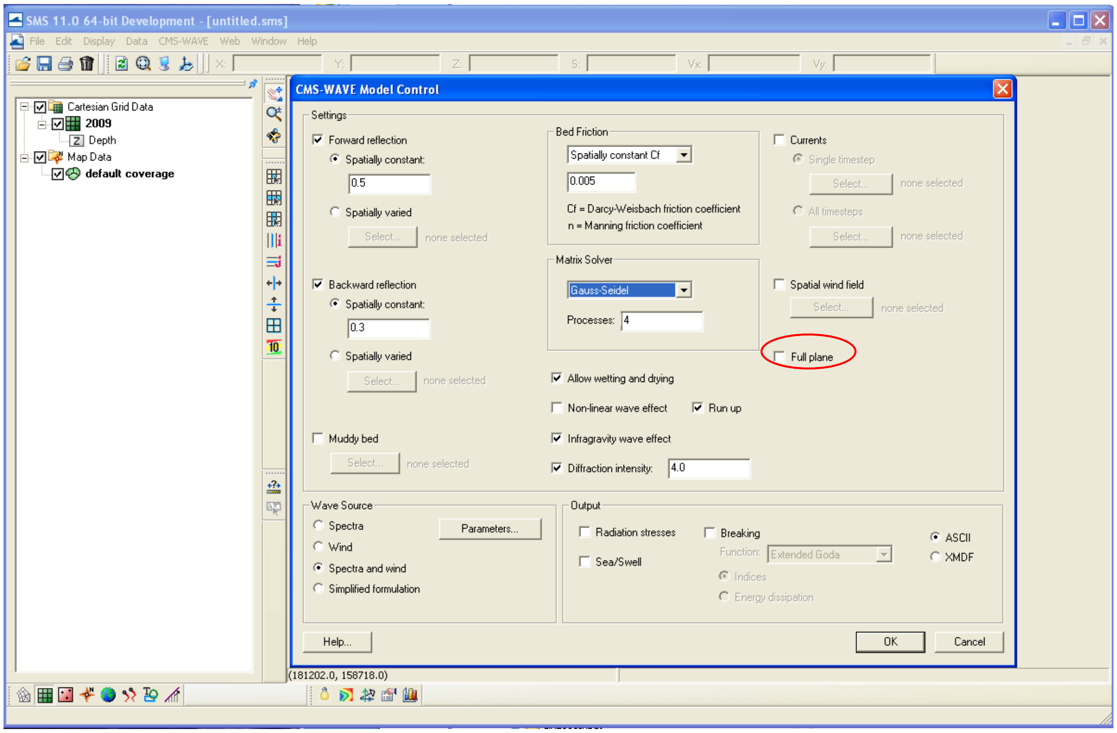


Figure 6.1.1 CMS-Wave *Model Control* in SMS11.

6.1 Wave Run-up, Infra-gravity Wave, Nonlinear Wave-Wave Interaction, Muddy Bed, Spatial Wind Input

- To include (trigger) either of wave run-up, infra-gravity wave, nonlinear wave-wave interaction, binary (xmdf) output, multiple processors, muddy bed, and spatial wind field input is just a one-click step in the SMS11 interface (Fig 6.1.1). Additional files are required for the muddy bed and spatial wind field input.

- If the muddy bed calculation is required, users shall prepare a mud.dat file or *.mud (in the same format as *.dep) to list the spatial maximum kinematic viscosity for the entire grid (recommended maximum kinematic viscosity for mud is 0.04 m^2/sec)

- If the spatial wind field input is required, users shall prepare a wind.dat file or *.wind (in the same format as *.cur) to provide the x- and y-component wind speed data corresponding to the incident wave conditions in the model grid.

6.2 Permeable Structure

- Permeable structure – users will need to select and specify permeable structure cells through SMS11 CMS-Wave *Assign Cell Attributes* and select *Permeable Breakwater* (see Fig 6.2.1). Because this permeable structure cell feature is not yet available (functional) in the present SMS11 Beta, users need to modify the *.struct to manually assign the permeable structure cells of interest. Recall that each feature cell is described by four parameters, istruc, jstruc, kstruc, and cstruc in a line format in *.struct (CMS-Wave Technical Report CHL-TR-08-13).

  istruc = i-th column in the grid

  jstruc = j-th row in the grid

  kstruc = feature cell identity

  = 1, for adding alternative feature or structure (immersed or exposed) without modifying the input depth

  = 2, for calculation of wave runup and overwash on beach face or structure, and adjacent land

  = 3, for calculation of transmitted waves of a floating breakwater

  = 4, for vertical wall breakwater

  = 5, for composite or rubble-mound breakwater

  = 6, for a highly permeable structure like the pier or bridge

  =7, for a low-permeable structure, like the rubble-mound breakwater

  cstruc =feature structure characteristic length

  = feature structure depth, for kstruc = 1 (assume a land cell if not provided)

  = beach/structure elevation above mean water level, for kstruc = 2 (use the input depth if not provided; no effect for cstruc < 0)

  = floating breakwater draft, for kstruc =3 (skip if not provided or cstruc < 0.05 m)

= breakwater/structure elevation, for kstruc = 4 or 5 (use the input depth if not provided; immersed if cstruc < 0)

= the permeable portion (>0, the section below the mean water depth) of a high-crest structure for kstruc = 6 or 7

In the Figure 6.2.1 example, users can modify 2009.struct to assign South Jetty 6 seaward end breakwater cells as permeable ones. The top 10 lines of the modified 2009.struct is shown below (the number 191 in the first row is the total structure cells in *.struct)

191			
76	110	7	1.5
77	110	7	1.5
78	110	7	1.5
79	110	7	1.5
76	111	7	1.5
77	111	7	1.5
91	10	5	
92	10	5	
93	10	5	

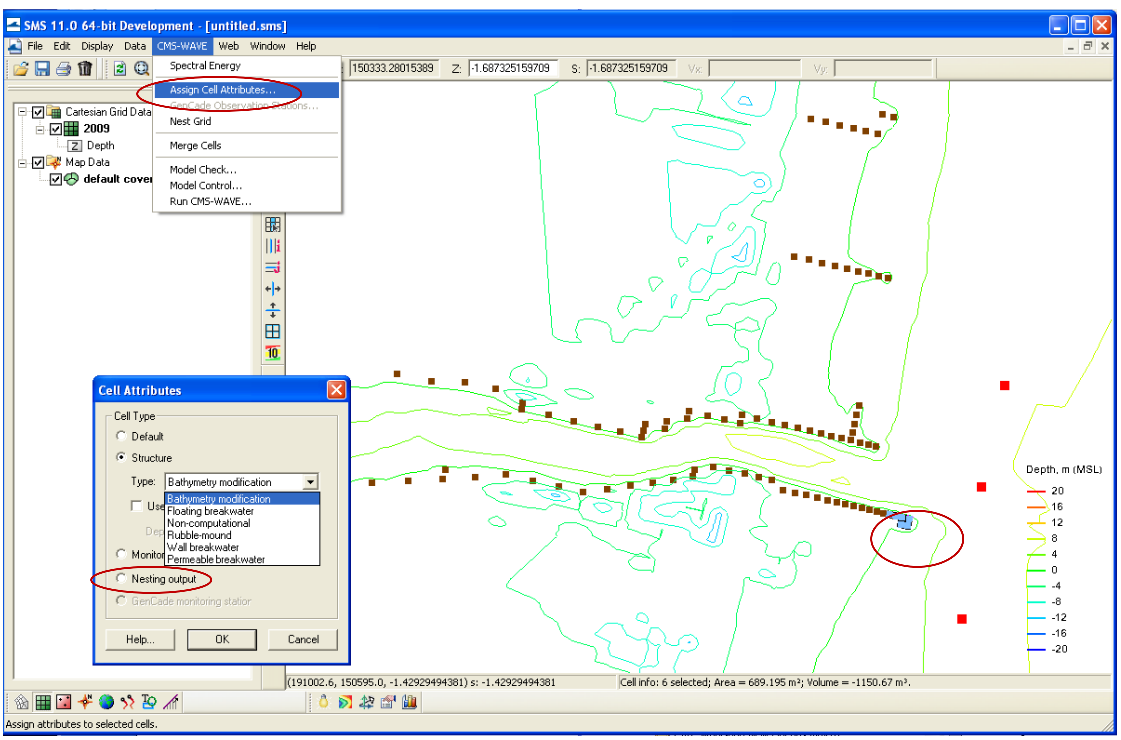


Figure 6.2.1 CMS-Wave *Assign Cell Attributes* in SMS11.

6.3 Grid Nesting

- Grid Nesting – Users can use the CMS-Wave *Assign Cell Attributes* and *Nesting Output* (Fig 6.2.1) to specify the wave information output cells for saving spectrum data file (to serve as wave input to a child grid run). Figure 6.3.1 shows 6 nesting output locations (blue triangle) using the Shark River 2009.sim case. The nesting output file is *.nst (in the case of running CMS steering, an additional file nst.dat is automatically generated that merge all individual cycle *.nst files).

  Figure 6.3.2 shows a child grid domain (c2009.sim) within the parent grid (the child grid was generated based on scatter points converted from the parent grid). The child grid wave input file (2009.nst, as generated from the parent grid) shall be assigned in the child *.std. This can be done by manually editing the child *.std or using the SMS *CMS-Wave* and *Nest Grid* menu (Fig 6.3.3).

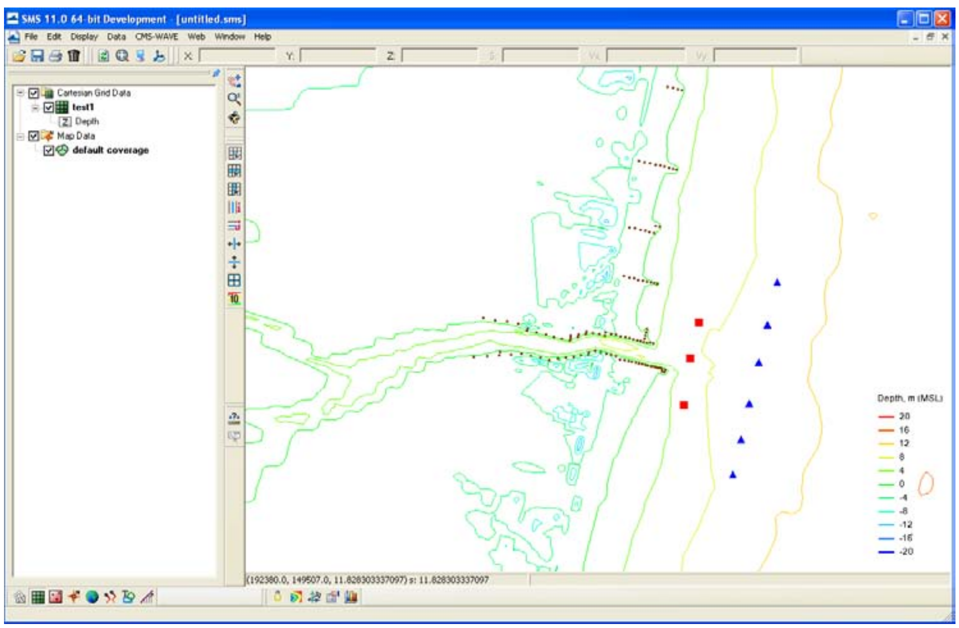


Figure 6.3.1 Nesting output 6 locations (blue triangle) and monitoring output 3 stations (red square).

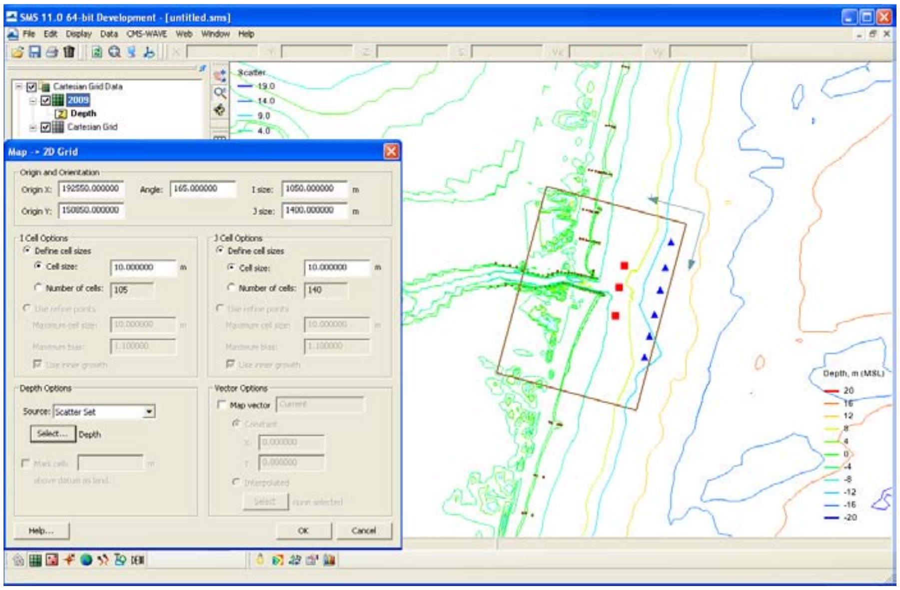


Figure 6.3.2 The child grid domain and spectral input stations (blue triangle).

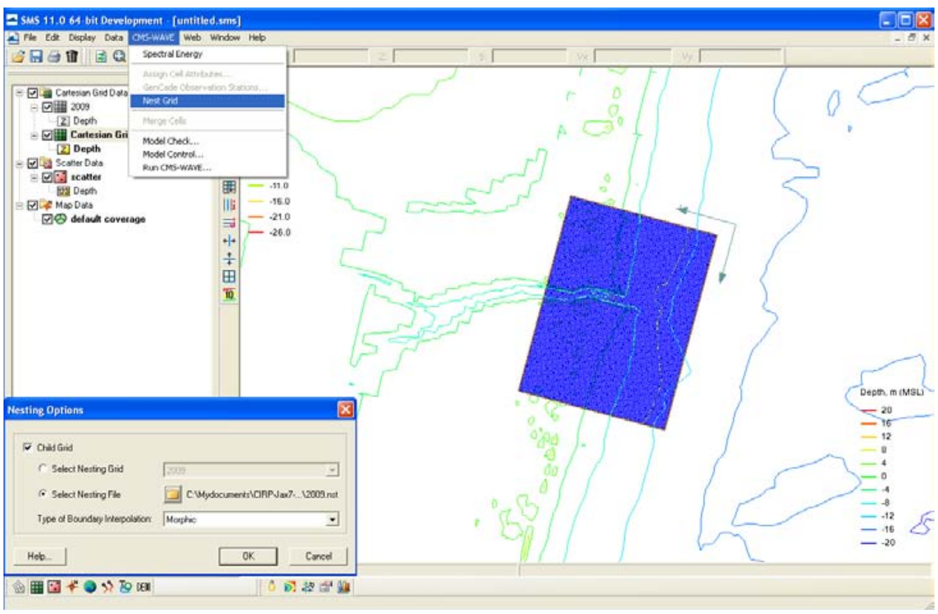


Figure 6.3.3 CMS-Wave *Nest Grid* and *Nesting Options* menu in SMS11.

The child wave input file format is almost identical to the parent *.eng. The only difference is that the child wave input has additional 3 parameters (the local x and y coordinates, and local significant wave height at the spectral wave input location) in the individual spectral header along with the regular 5 parameters (spectral id, wind speed, wind direction, spectral peak frequency, water level adjustment) in the parent *.eng. The top 10 lines of 2009.nst is shown below (notice the 8th line is a spectral header for the 1st individual wave input spectrum):

30	35	6	167.00	
0.04	0.05	0.06	0.07	0.08
0.09	0.10	0.11	0.12	0.13

	0.14	0.15	0.16	0.17	0.18											
	0.19	0.20	0.21	0.22	0.23											
	0.24	0.25	0.26	0.27	0.28											
	0.29	0.30	0.31	0.32	0.33											
9120103		9.80	-221.0	0.1200	0.00	192440.33	150712.28	0.563								
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

To run the child grid in the steering mode, the spectral wave input file needs to be renamed to a default “nest.dat” (overwrite the wave input filename in the child *.std). It is noted that this “nest.dat” is only required for the child steering run. The parent grid run must be conducted and completed first to start a child grid run irrespective of whether CMS-Wave is or is not coupled with CMS-Flow (see more information in ERDC/CHL CHETN-IV-76).

6.4 Spatially Varied Spectral Wave Input

- Spatially varied spectral input – This is simply the case as in a child grid that spatially varied wave spectra are permitted to assign at user specified locations along or near the seaward boundary of the child grid. To apply spatially varied spectra for wave input without a parent grid, users will need to prepare the wave input file with the format as described in the child grid run.

  A FORTRAN program **merge-eng-to-nst.exe** is provided to combine all wave spectra files (*.eng) from individual locations into a single wave input file in the format for spatially varied spectral input to CMS-Wave. Figure 6.4.1 shows the map of two locations that each location has a wave input files available, 2009-ndbc.eng at Pt 1 (coordinates are 192,602 m and 151,037 m) and 2009-sp154.eng at Pt 2 (coordinates are 192,315 m and 149,579 m) – recall that 2009-ndbc.eng and 2009-sp154.eng were originally generated for the parent grid. Figure 6.4.2 shows running **merge-eng-to-nst.exe** in DOS to combine two wave input files into one single wave input file (spatially varied spectral wave input to the child grid). Because 2009-ndbc.eng and 2009-sp154.eng were generated respect to the shore-normal direction at 167 deg and the local child grid orientation is 165 deg, a -2 deg direction adjustment is needed in running **merge-eng-to-nst.exe** here.

  It is required that all individual wave input files must cover the same period and timestamps (users must edit the files to fill the missing data). In the example, wave spectra at time stamps 09122000, 0912003, and 0912006 are missing in 2009-ndbc.eng, and wave spectra at timestamps 09120400 and 09121000 are missing in 2009-sp154.eng. Two revised files, 2009-ndbc-edit.eng and 2009-sp154-edit.eng (cover the time period from 09120103 to 09123121 in 3-hr interval) are actually used in **merge-eng-to-nst.exe** to generate c2009.nst.

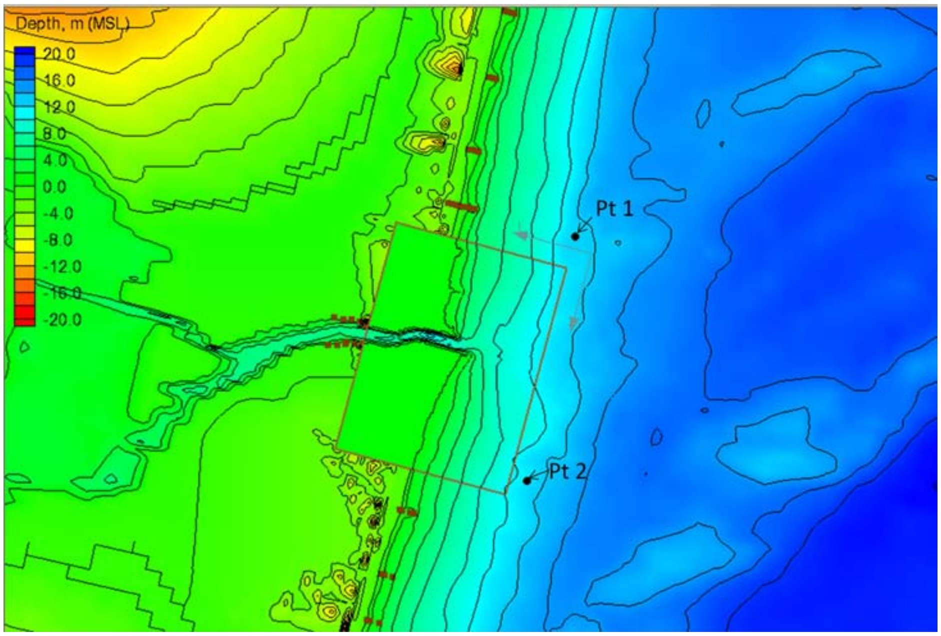


Figure 6.4.1 Child grid domain and two wave input locations Pt1 and Pt2.

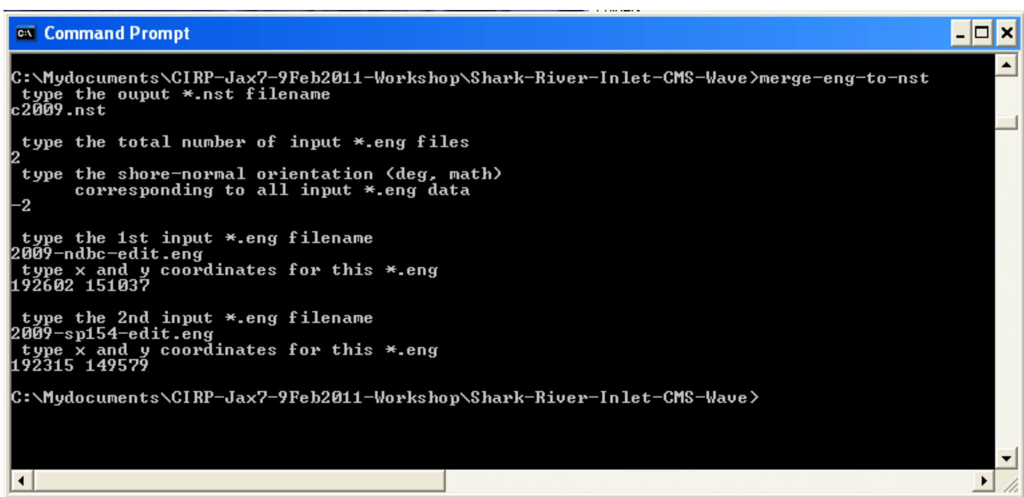


Figure 6.4.2 Example of running merge-eng-to-nst.exe in DOS.

- Users can visit the CIRP Wiki site http://cirp.usace.army.mil/wiki/CMS-Wave for CMS-Wave validation cases or use the link below to access and download more CMS-Wave examples

  ftp://chlguest:3bit5map@134.164.34.99/Lin/CMS-Wave/CMS-Wave-Package

6.5 Providing Sea Buoy Data to CMS-Wave

Directional spectral data collected by NDBC or CDIP buoys can be processed as alternative source for wave input to CMS-Wave. Two examples are given below using CDIP 154 and NDBC 44025 standard spectral files for December 2009.

- NDBC buoy data – run **ndbc-spectra.exe** (FORTRAN) to read the NDBC standard directional wave file and generate the CMS-Wave input spectral *.eng.

  1. Download the NDBC standard monthly directional wave spectral file from http://www.nodc.noaa.gov/BUOY/buoy.html (e.g., 44025_200912) - see Figs 6.5.1 to 6.5.4 for accessing NDBC spectral data from the Web.

  2. In the DOS window, run **ndbc-spectra.exe**

  3. Responding to the on-screen input, type the NDBC spectral filename

  4. Type the starting timestamp (default value is 0) for saving output files

  5. Type ending timestamp (default is 99999999) for saving output files

  6. Type the time interval (hr) for saving output data

  7. Type 2 to save the CMS-Wave *.eng and *.txt files

  8. Type the CMS-Wave input spectrum filename (*.eng)

  9. Type the local shoreline orientation (the CMS-Wave grid y axis) in clockwise polar coordinates (deg, positive from North covering the sea, e.g., 180 deg for St Mary's Entrance, FL/GA, or 360 deg - the wave grid orientation angle in *.sim)

  10. Type the NDBC buoy location water depth (m) and then the CMS-Wave seaward boundary mean water depth (m), e.g. Buoy 44025 has a nominal depth of 36.3 m relative to Mean Sea Level

  11. Type 1 to include wind or 0 to skip the wind input information

  12. Type 1 or 2 or 3 for different choice of calculated frequency bins to complete the run – see Fig 6.5.5 for running **ndbc-spectra.exe** in DOS.

  13. The output files include *.txt, *.eng, *.out (time series of wave parameters at the buoy), and *.dat (time series of shoreward wave parameters at the CMS-Wave offshore boundary).

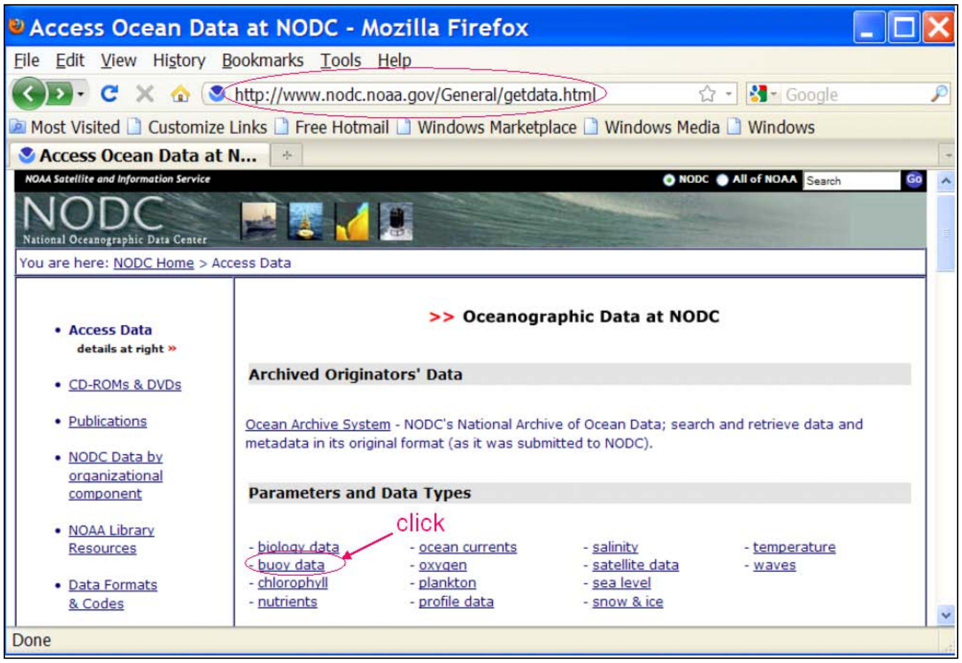


Figure 6.5.1 NODC buoy data access website.

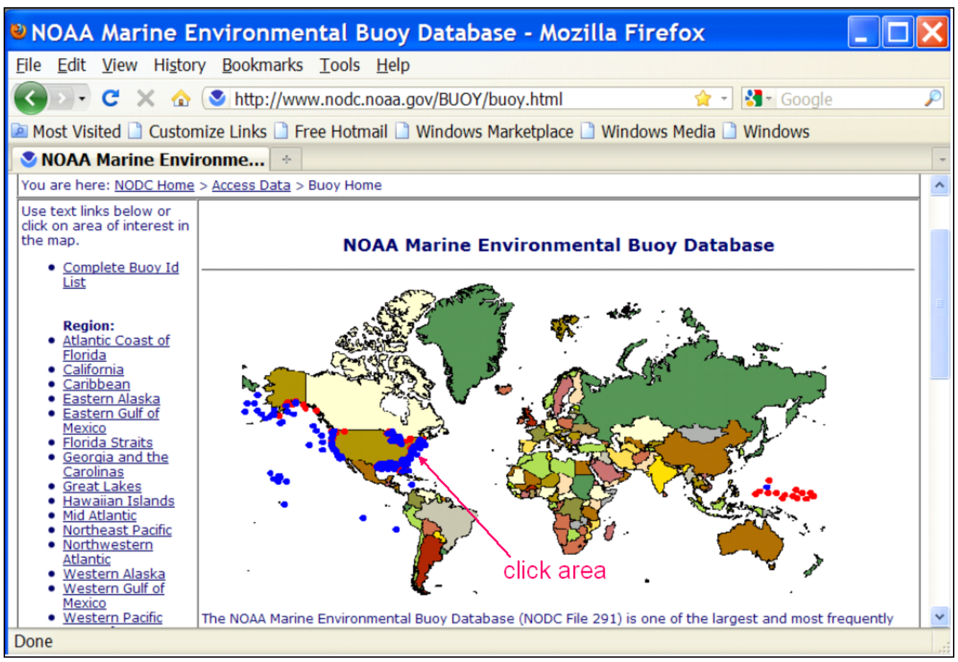


Figure 6.5.2 NODC buoy data access world map.

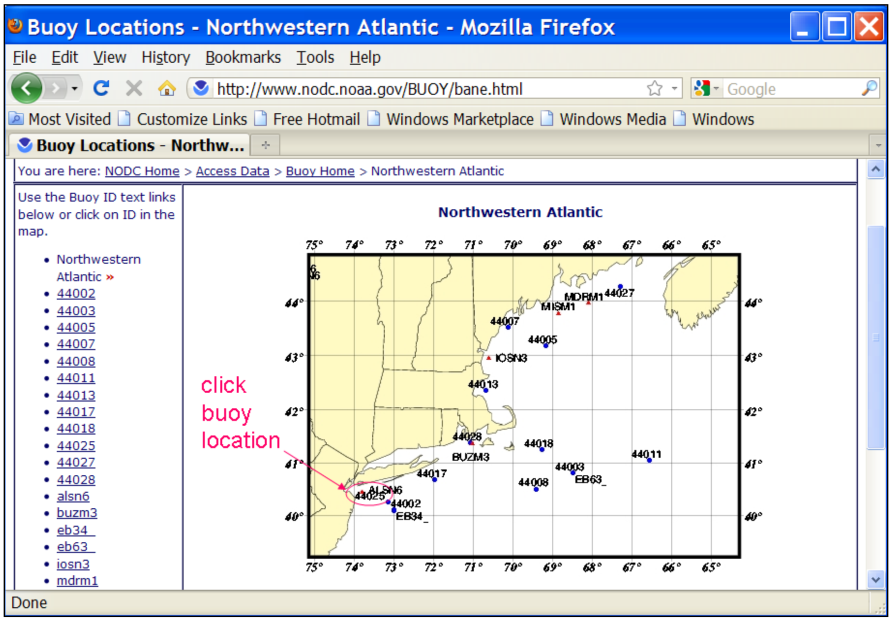
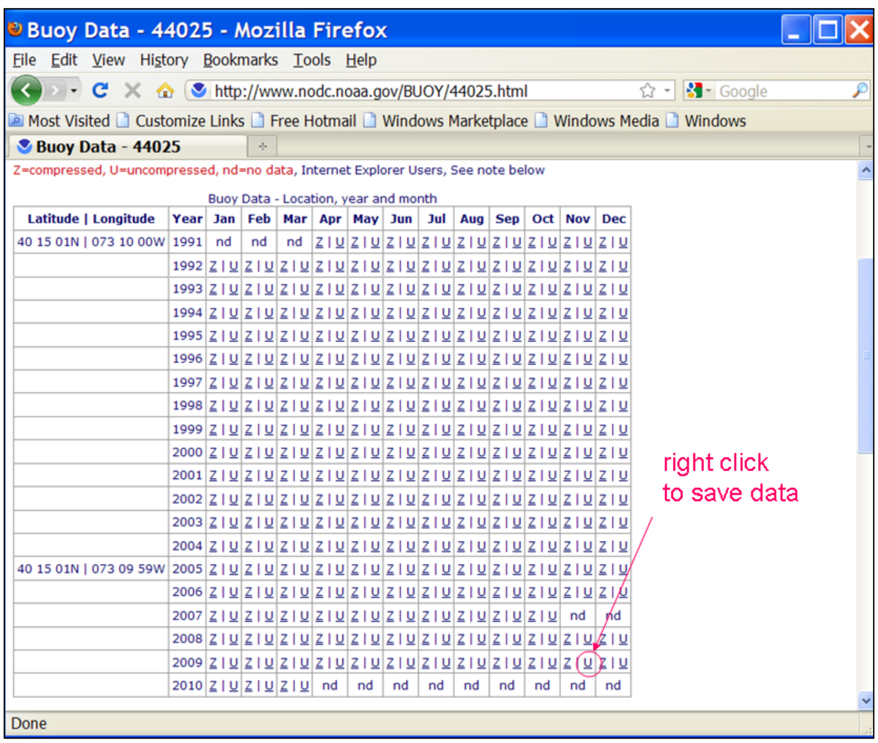


Figure 6.5.3 NODC buoy data access regional map.



Latitude | Longitude	Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
40 15 01N | 073 10 00W	1991	nd	nd	nd	Z | U	Z | U	Z | U	Z | U	Z | U	Z | U	Z | U	Z | U	Z | U
	1992	Z | U	Z | U	Z | U	Z | U	Z | U	Z | U	Z | U	Z | U	Z | U	Z | U	Z | U	Z | U
	1993	Z | U	Z | U	Z | U	Z | U	Z | U	Z | U	Z | U	Z | U	Z | U	Z | U	Z | U	Z | U
	1994	Z | U	Z | U	Z | U	Z | U	Z | U	Z | U	Z | U	Z | U	Z | U	Z | U	Z | U	Z | U
	1995	Z | U	Z | U	Z | U	Z | U	Z | U	Z | U	Z | U	Z | U	Z | U	Z | U	Z | U	Z | U
	1996	Z | U	Z | U	Z | U	Z | U	Z | U	Z | U	Z | U	Z | U	Z | U	Z | U	Z | U	Z | U
	1997	Z | U	Z | U	Z | U	Z | U	Z | U	Z | U	Z | U	Z | U	Z | U	Z | U	Z | U	Z | U
	1998	Z | U	Z | U	Z | U	Z | U	Z | U	Z | U	Z | U	Z | U	Z | U	Z | U	Z | U	Z | U
	1999	Z | U	Z | U	Z | U	Z | U	Z | U	Z | U	Z | U	Z | U	Z | U	Z | U	Z | U	Z | U
	2000	Z | U	Z | U	Z | U	Z | U	Z | U	Z | U	Z | U	Z | U	Z | U	Z | U	Z | U	Z | U
	2001	Z | U	Z | U	Z | U	Z | U	Z | U	Z | U	Z | U	Z | U	Z | U	Z | U	Z | U	Z | U
	2002	Z | U	Z | U	Z | U	Z | U	Z | U	Z | U	Z | U	Z | U	Z | U	Z | U	Z | U	Z | U
	2003	Z | U	Z | U	Z | U	Z | U	Z | U	Z | U	Z | U	Z | U	Z | U	Z | U	Z | U	Z | U
	2004	Z | U	Z | U	Z | U	Z | U	Z | U	Z | U	Z | U	Z | U	Z | U	Z | U	Z | U	Z | U
40 15 01N | 073 09 59W	2005	Z | U	Z | U	Z | U	Z | U	Z | U	Z | U	Z | U	Z | U	Z | U	Z | U	Z | U	Z | U
	2006	Z | U	Z | U	Z | U	Z | U	Z | U	Z | U	Z | U	Z | U	Z | U	Z | U	Z | U	Z | U
	2007	Z | U	Z | U	Z | U	Z | U	Z | U	Z | U	Z | U	Z | U	Z | U	Z | U	nd	nd
	2008	Z | U	Z | U	Z | U	Z | U	Z | U	Z | U	Z | U	Z | U	Z | U	Z | U	Z | U	Z | U
	2009	Z | U	Z | U	Z | U	Z | U	Z | U	Z | U	Z | U	Z | U	Z | U	Z | U	Z | U	Z | U
	2010	Z | U	Z | U	Z | U	nd	nd	nd	nd	nd	nd	nd	nd	nd

Figure 6.5.4 NDBC buoy spectral data download website.

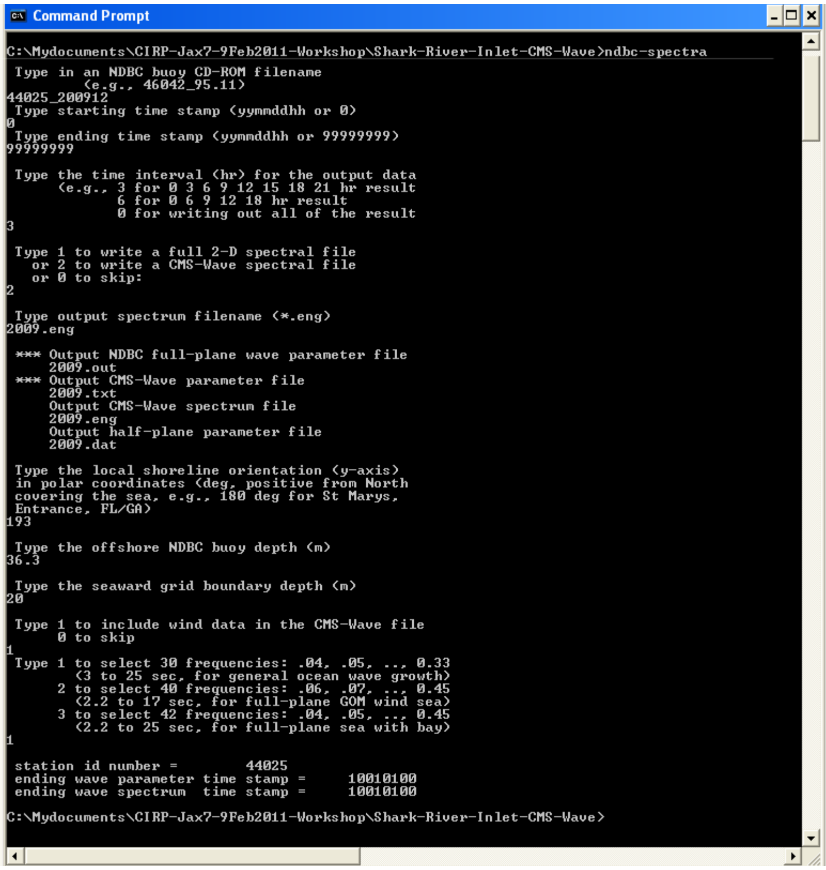


Figure 6.5.5 Run ndbc-spectra.exe in DOS.

- CDIP buoy data - run **cdip-spectra.exe** (also FORTRAN code) to read the CDIP standard directional wave file and generate the CMS-Wave input *.eng file. Download the CDIP wave file from http://cdip.ucsd.edu/?nav=historic&sub=data (e.g., sp154-200912) – see Figs 6.5.6 to 6.5.8.

  Run **cdip-spectra.exe** in the DOS window similar to **ndbc-spectra.exe** – see Fig 6.5.9. Because CDIP spectral file already contains the buoy location depth information, **cdip-spectra.exe** will not prompt for this depth input. For processing either NDBC or CDIP data, users shall check and manually fill any data gaps in *.eng and *.txt files (using the first available spectral data from the neighboring time interval).

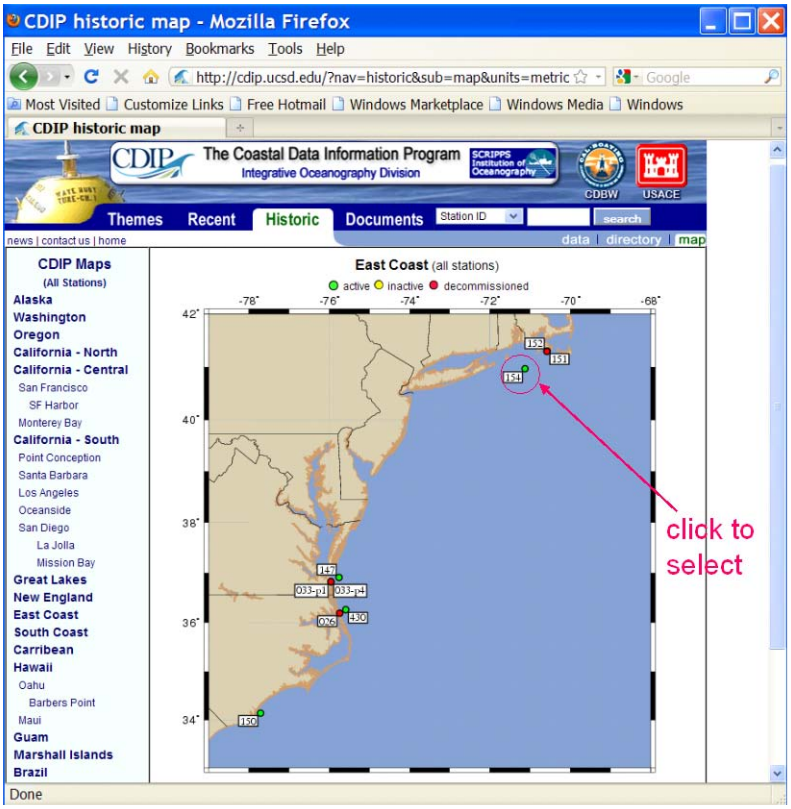


Figure 6.5.6 CDIP buoy data access website.

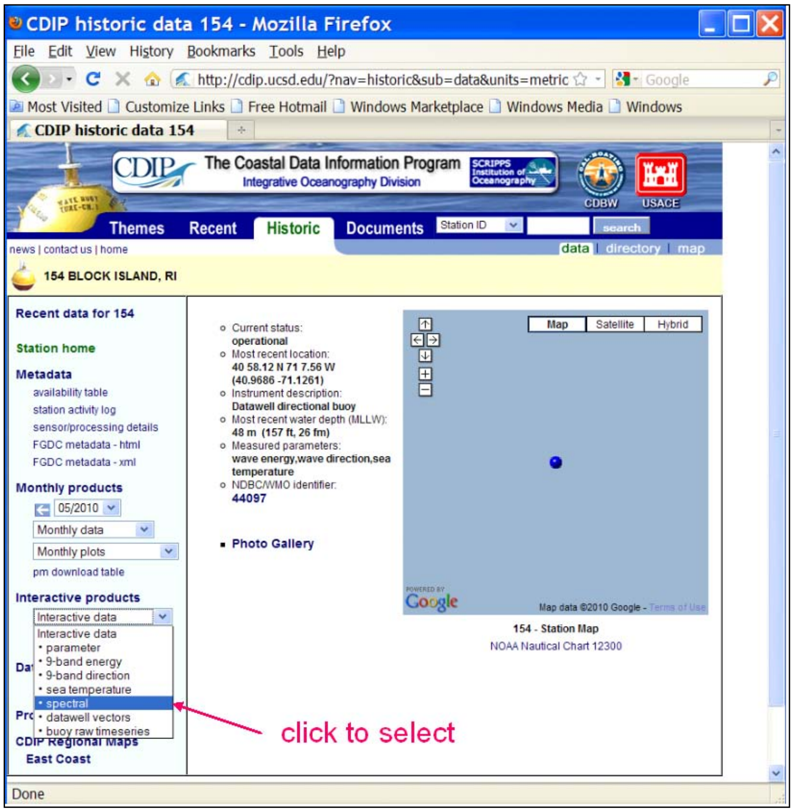


Figure 6.5.7 CDIP buoy data access website.

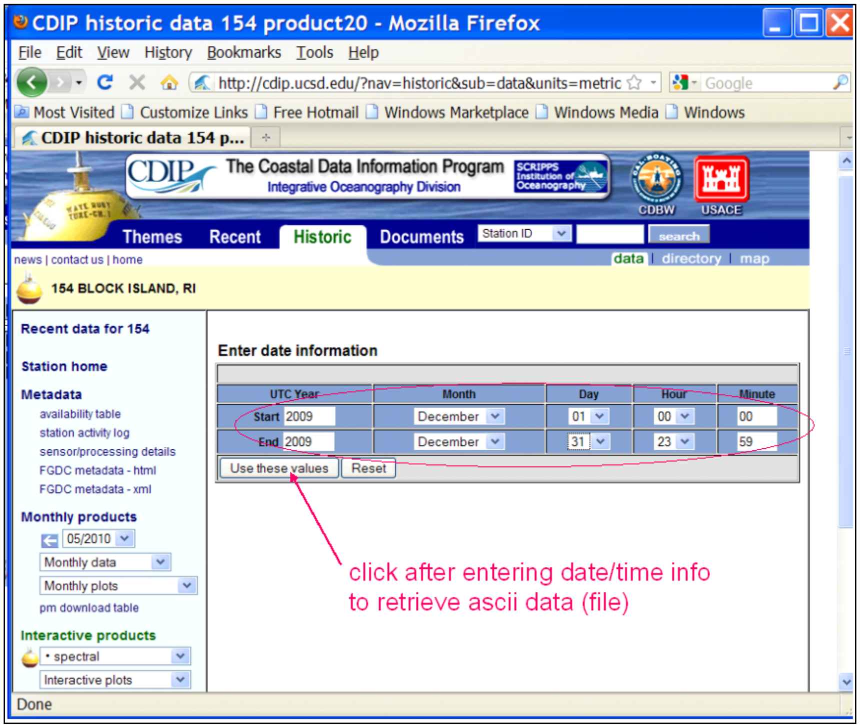


Figure 6.5.8 CDIP buoy spectral data download website.

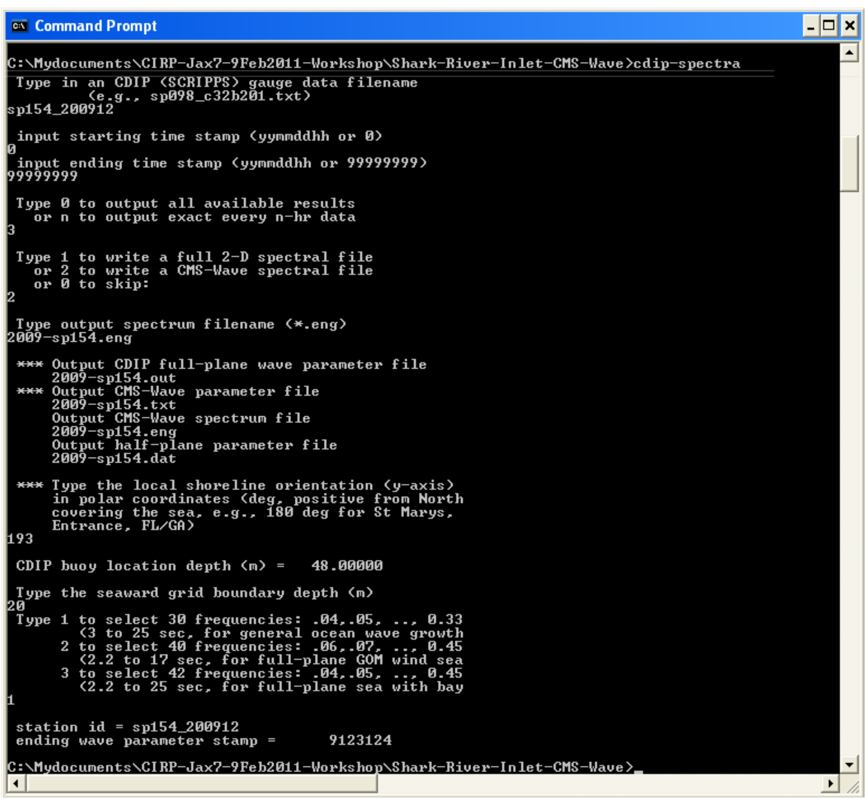


Figure 6.5.9 Run cdip-spectra.exe in DOS.