System Users Guide

www.WaveForceTechnologies.com

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I. About Wavector

Wavector provides a modern set of ocean wave analysis tools in a convenient user-friendly software package for scientists, engineers, technicians and students. Based on the proven **XWaves** ocean wavefield analysis technology, Wavector provides a cost-effective solution for wave data analysis and visualization requirements.

Key features of Wavector include:

- Read in data from most popular instruments and models
- Download and process data from US national wave archives (NODC and NDBC)
- Versatile interactive exploration and plotting of results
- Powerful wave partitioning capability for wind sea and swell separation
- Wave system climatology analysis
- Convenient data editing and smoothing utilities
- Export data to user-defined tables (EXCEL, MATLAB, or Text)

Wavector is completely GUI-driven and packaged as a stand-alone application ready to go to work for you!

II. Program Installation

System Requirements

Wavector is designed to run as a stand-alone application in the MS Windows O/S environment on a personal computer.

Wavector Installation

To install from a CD follow these simple steps:

1. Decide where to install **Wavector** on your computer hard disk. The program will operate from any location that you have read/write access to.
2. Drag or copy the **Wavector** folder from the CD-ROM to the selected location on your PC hard disk
3. Initiate the installer by double-clicking on the wavector_install icon. Follow the on-screen instructions. A required Matlab Runtime Compiler (MCR) will be installed. The installation process can take several minutes.
4. Once installation is completed, double-click on the Wavector icon to launch the program. The first time you launch Wavector it takes a few extra minutes for the system to set up and initialize. When the Wavector splash screen appears, you are ready to go! Access the program user guide through the Help pull-down menu.

III. Quick-Start Guide

What follows is a typical **Wavector** data exploration and analysis session. Work through these steps to quickly become familiar with most **Wavector** capabilities and features.

1. Launch the **Wavector** application by double-clicking on the application icon.
2. Load a data set by either (a) loading the provided sample **Wavector** data file (*test_data.mat*) using either the *Open File* toolbar button or the *Open Wavector File* command in the *File* pull-down menu; or (b) importing data from your instrument or national data archive using the *Load Raw Data* command in the *File* pull-down menu. *Note: For first-time use we suggest experimenting with the provided test data!*
3. Explore your un-processed data using the *Data View* module. Use the *Data View* toolbar buttons and the *Layout* and *Options* pull-down menu commands to customize your displays. Right-click on any plot title to select a new plot type and further modify plot features.
4. Open the *Data Utilities* Module using either the *Data Utilities* toolbar button or the *Data Utilities* command in the *Options* pull-down menu. The *Data Utilities* Module allows you to remove records, smooth, interpolate, subset and sub-sample your data.
5. Explore your *Data Utilities* results using the *Data View* module

6. Process your data using either the *Process Data* toolbar button or the *Process Data* command on the *Options* pull-down menu. This performs a wave partitioning and swell tracking analysis on your data.
7. Explore your processed data using the *Data View* module. Note there are several new plot types and layout pages available with processed data. Save a set of plots in your favorite format using the *Export Image* command in the *File* pull-down menu.
8. Prepare and export a custom data file using the *Data Export Wizard* command in the *Tables* pull-down menu. You select which data fields to save and identify an output data format (Text, EXCEL or MATLAB).
9. Save your **Wavector** processed data file for future recall using either the *Save* toolbar button or the *Save* command in the *File* pull-down menu.
10. Exit **Wavector** using the *Exit Wavector* command in the *File* pull-down menu or by clicking on the close box in the upper right of the **Wavector** window.

IV. Loading Data

Wavector Start-Up Screen

Data Formats

Wavector is designed to read in and processes a temporal series of non-directional (1D) or directional (2D) wave spectra data from a specific observing station or numerical wave model output location. Wind speed and direction time series data are also read if included in the data file. When loading a data set for the first time, a variety of common data formats can be read, including

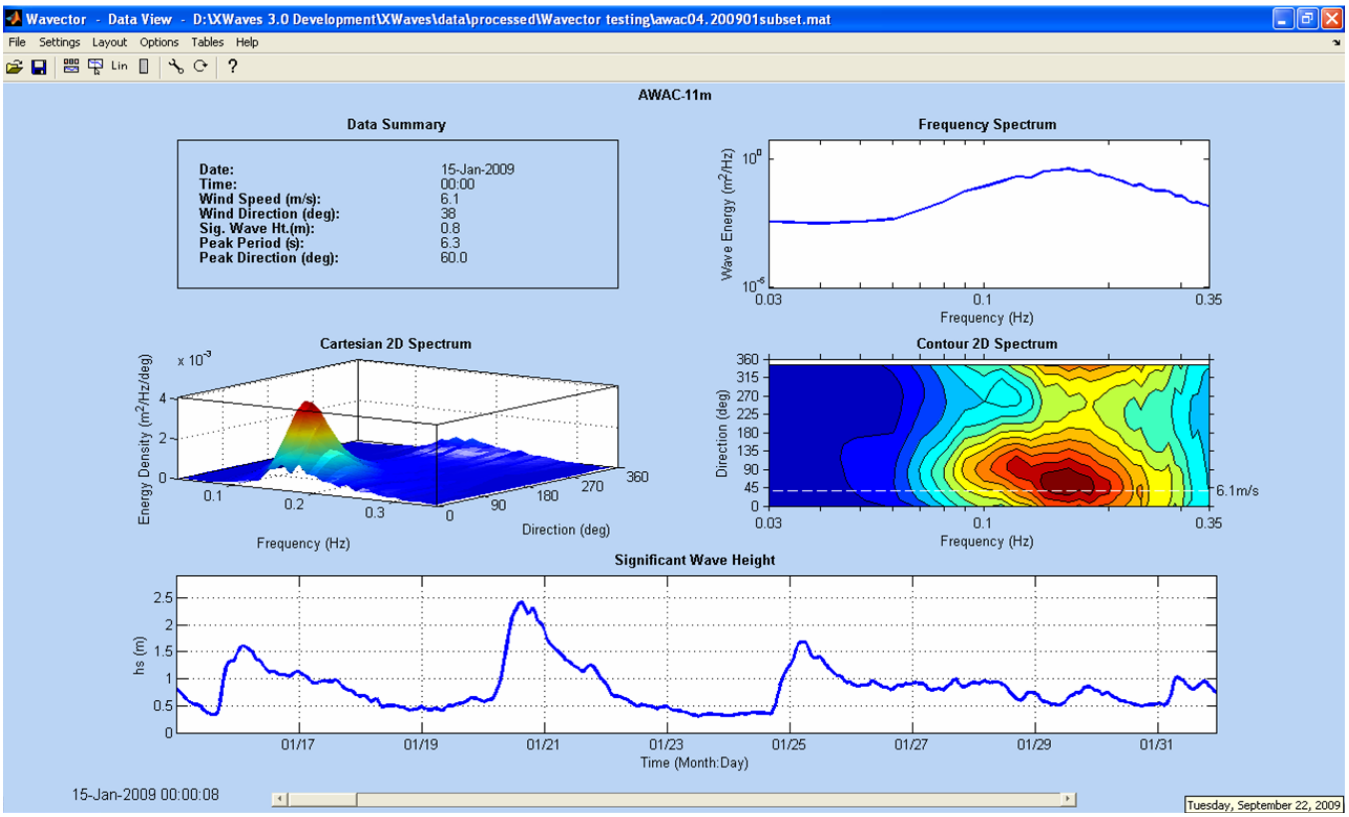
- NORTEK wave data files *.wft
- Datawell Waverider buoy files *.spt
- Triaxys buoy files *.dirspec
- Wavescan buoy data files
- WavescanTS files
- National Oceanographic Data Center (NODC) Type 291 Data Records
- National Data Buoy Center (NDBC) real-time (45-day) data files
- Coastal Data and Information Program (CDIP) spectra files
- Oceanweather, Inc wave model spectrum files
- WaveWatch III model station files
- SWAN model station files
- Esp2D files
- Generic ASCII data files *.csv

A unique feature is that **Wavector** will download and process NODC and NDBC monthly files directly over the World-Wide Web (WWW). This connects Wavector to the complete US National archive of real-time and historical wave observations.

Furthermore, Generic MATLAB file formats allow the MATLAB user to convert wave spectrum data from any source into a useable form. Custom data formatters are available upon request.

Once a series of wave spectra records has been read into **Wavector**, it can be saved as a **Wavector** data file for repeated easy loading at any time. All processed results are saved along with original data in the **Wavector** data file.

V. Data View



Data View' 2D Spectra' Plot Layout

Data View is a versatile data plotting and exploration tool for visualizing **Wavector** imported and processed data. Features include 10 different page layout options with 1 to 6 plots per page and several different plot libraries to select from. As your data analysis proceeds, the number of display options in *Data View* increases. Image and movie-file export capability is included.

As described below, *Data View* features are accessible through a variety of interactive plot features, toolbar commands, and pull-down menu commands.

Data View Interactive Plot Features

Plot Menu – Right-Click on a plot to access the menu for that axes. All the available plots for the current data are available here as well as a variety of display options (described below).

Note: As data processing proceeds, additional plot options will become available.

Record Scrolling – The scroll bar at the bottom of the *Data View* window allows the user to scroll forward and back through the data records. A dashed vertical red line will appear in all time-series plot to identify the time of the currently active record.

Record List – Right clicking anywhere in *Data View* will bring up a menu of plot commands that includes "View Record List". This opens a *Record List* window that provides additional user controls for exploring data. Specific controls for the Record List include:

Up Arrow: View Next Record
Right Arrow: Same as Up Arrow
Down Arrow: View Previous Record
Left Arrow: Same as Down Arrow
Page Up: View Next Record Section if Time Axis is Zoomed in
Page Down: View Previous Section if Time Axis is Zoomed in
Home: View First Record
End: View Last Record

View button – Time series plots zoom into display only selected records.

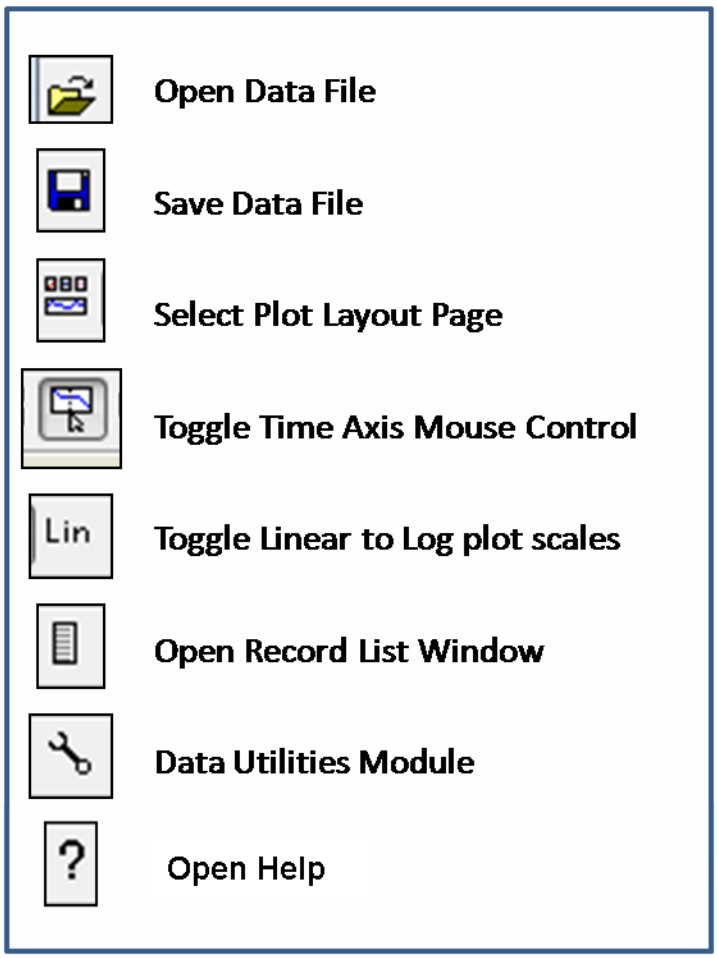
View All button – Time series plots display all records

Select Record Using Time Series Plot – See *Time Axis Mouse Control* in the Options pull-down menu below.

Rotate 3D Plots Using Mouse – Left Click the left or right side of a 3D plot to rotate clockwise or counter clockwise, Shift + Left Click (or Right + Left Click) the top or bottom of a 3D plot to rotate up or down.

Data View Toolbar Commands

A toolbar across the top of the plot page has the following click-tools. Simply click on each toolbar icon to activate the command. A listing of the toolbar commands appears in the figure below.



Data View Toolbar Icons. Not shown: Process Data icon (circular arrow).

Data View Pull-Down Menu Commands

File Menu – for loading and saving data, plots and movies

- *Load Raw Data* – Select available data source to read and format unprocessed wave spectra files.
- *Open Wavector File* – Select and load processed data files from previous **Wavector** sessions.
- *Save As* – Save **Wavector** data file with a new filename
- *Save* – Save **Wavector** data with existing filename
- *Copy* – Copy an image of the current window to the clipboard
- *Export* – Save an image file, MATLAB figure file or movie file to disk
- *Page Setup, Print Preview, Print* – Standard printing dialogue boxes
- *Clear All Data* – Clear all data currently stored in **Wavector** and return to the Start-Up screen.

- *Exit Wavector* – Quit the **Wavector** program and close all windows.

Settings

- *Color Scheme* – Set background and text colors for all windows and plots

Layout

- *Templates* – Display *Plot Layout Templates*
- *Default Plots – Pre-defined plot layouts, including the following options:*
  - *Spectra Plots* – Default layout for unprocessed data
  - *Wave System Plots* – Default layout for processed data
  - *Climatology Spectra Plots* – Default Climatology layout for unprocessed data
  - *Climatology Wave System Plots* – Default Climatology layout for processed data
- *Saved Layouts*- User-defined page layouts. Save custom page layouts by name and recall them through this menu command.

Options

- *Data Utilities* – Open the *Data Utilities Module*
- *Process Data* – Initiate wave spectra partitioning and swell tracking analysis
- *Time Axis Mouse Control* – Toggles the ability to select records to display using the mouse on time series plots. A vertical reference bar is displayed.
- *Plot Axis Scaling* – Set 1D and 2D spectrum plots to logarithmic or linear Scale, this option also appears in the Plot Menu
- *Enable Pierson-Moskowitz* – Toggles the display of a Pierson-Moskowitz (PM) model spectrum with the *Frequency Spectrum* (1D) plot. The PM spectrum is computed from the wind speed for each record.
- *Enable 2D Contour Plot Legend* – Toggle a colorbar plot scale for the 2D Contour Plot

Tables

The *Tables* pull-down menu provides the following option for displaying and exporting tables generated by Wavector*:*

- *Export Wizard – Custom export of Wavector data. See Data Export Wizard.*

Help

- *Help Contents* – Display **Wavector** Help Table of Contents

VI. Data Utilities

The *Utilities Module* in **Wavector** provides a variety of database manipulation tools for user wave data. These tools allow the user to add or remove data records, apply record smoothing or sub-sampling, change the frequency and angular resolution of wave spectrum records, and change the data set name.

Launching the Utilities Module

Once data has been loaded into **Wavector** (see *Loading Data*), the *Data Utility Module* can be launched by either activating the *Data Utilities* toolbar command or by selecting the *Data Utilities* command in the *Option* pull-down menu. Since the data utilities tools make changes to the data in memory, a *Save Data* window appears and provides the opportunity to save user data before proceeding. If the user has already processed these data, the *Save Data* window will warn the user that wave system information will be lost. This is because the data utilities only operate on the wave spectrum records, not processed wave system data. However if only using the *Rename* utility then no data will be lost. When finished with the *Data Utilities*, **Wavector** will automatically re-process the data to generate new wave system information.

When the *Utilities Module* is launched an interactive *Data Utilities* window appears. Record listing boxes show the years, months, days, and records represented in the user data. All utility functions are activated from this window. A list of the available commands, and instructions for their operation, appear below.

Utility Commands

Smooth Records

The *Smooth Records* utility performs a weighted running average over the wave spectra loaded into Wavector. This utility is activated by clicking on the *Smooth Records* button in the *Data Utilities Window*. A message box will request the user to type in the desired wave spectrum smoothing interval in hours. Over this specified duration, **Wavector** will perform a weighted running average of the input directional wave spectra. For example, a 4-h smoothing window will smooth all spectra occurring up to 2-h prior and 2-h after each observation time. This feature is quite helpful for measured spectra, and will help reduce data processing time by eliminating spurious peaks.

SubSample File

The *SubSample* utility reduces user data file sizes by saving only those records that occur at a specified time interval. This utility is activated by clicking on the *SubSample File* button in the *Data Utilities Window*. A message box will request the user to type in the desired interval in hours for record sub-sampling. **Wavector** will

remove records that fall in-between this interval. For example, if a 3-h data subsample interval is selected for data that is provided hourly, every third record will be saved. This feature is helpful for decreasing the size of large files, and will reduce data processing time by providing fewer records to process.

Spectral Resolution

The *Spectral Resolution* utility is used to change the frequency range, frequency resolution, and directional resolution of the directional wave spectra. This utility is activated by clicking on the *Spectral Resolution* button in the *Data Utilities Window*. A Spectral Resolution GUI will open that allows the user to specify the frequency and angle bins in the output directional spectra. Input spectra are linearly interpolated to the requested resolution.

The use of this feature can greatly reduce output file sizes and save on data processing times for large data sets. Measured data are often saved at a very high directional resolution. Try setting your angular resolution at 10 or 15 degrees, corresponding to 36 or 24 angle bins.

Append File

The *Append File* utility is used to add another data set to the current user data loaded in **Wavector**. This utility is activated by clicking on the *Append File* button in the *Data Utilities Window*. A browser window will open to allow the user to select a data file to append. Selected files must have observation times that either precede or follow the observation times of the user data in memory. Once a file to append is selected, click on *Open* to execute the utility. Once the utility is complete, the window display of available data records is updated.

Subset File

The *Subset File* utility allows the user to create a new data file from a subset of the user data in memory. The user should first interactively select the range of data to be subset. Data can be selected by year, month, day, or record attributes by clicking and dragging the cursor over the desired range, shift-clicking a range, or double-clicking on a particular attribute. Control-clicks can be used to select different data segments to subset. Once the desired range is selected, clicking on the *Subset File* button activates the utility. Once the utility is complete, the window display of available data records is updated.

Remove Records

The *Remove Records* utility allows the user to extract and discard records from the user data in memory. The user should first interactively select the range of data to be removed. Data can be selected by year, month, day, or record attributes by clicking and dragging the cursor over the desired range, shift-clicking a range, or double-clicking on a particular attribute. Control-clicks can be used to select different data segments to subset. Once the desired range is selected, clicking on the *Remove Records* button activates the utility. Once the utility is complete, the window display of available data records is updated.

Rename

The *Rename* utility allows the user to change the name of the user data in memory. Clicking on *Rename* opens up an input dialog box with the current name. The user can either change the name and click *OK* to save or click *Cancel* to keep the existing name. Selecting rename will not cause any processed data to be lost.

VII. Data Export Wizard

The *Export Wizard* is a data export utility for **Wavector** that allows the user to develop and save custom output data table files. Features include selection of desired output fields and specification of the desired output format (ASCII, EXCEL or mat-file). Furthermore the *Export Wizard* will allow these custom table formats to be named and saved for future recall.

Using the Export Wizard

The program is launched from the *Export Wizard* command in the **Wavector** *Tables* pull-down menu. This opens up the *Export Wizard* GUI. The various command options are listed in the table below.

***Export Wizard* GUI Command Options**

Command	**Function**	**Description**
Named Settings	Pull-Down List	Names of user-provided settings
Update	Push Button	Update current named setting
Save New	Push Button	Save a new named setting
Reset	Push Button	Revert to original settings
Delete	Push Button	Delete named setting
Run	Push Button	Run the export data function
Cancel	Push Button	Cancel operation and return to previous Module
View Fields	Push Button	Opens a listing of available field names and their descriptions
Select Fields	Push Button	Opens the Select Export Data Fields GUI (see below)
Export Format	Pull-Down List	Select format of export data file (ASCII, EXCEL or mat file)
Number of Wave Systems	Pull-Down List	Select from 1-5 output wave systems. Option only available for Wave Systems and Spectral Fit data.
Data Header Options	Selection Boxes	Select desired header information for export files (see below)
?	Push Button	Open Export Wizard Help page

The *Data Header Options* selection boxes allow the user to select the desired data header information to be written along with the data to the export data file. The following options are available.

Header Options	**Description**
Data Set Name	Name given to this data set (can be changed in *Utilities Module*)
Metadata	Misc. Information on Dataset: 1D or 2D, water depth, latitude, longitude, number of records
Processing_History	Lists the data processing history as recorded by Wavector
Field_Descriptions	List of field names and descriptions
Field_Names	Field names across top of data columns

The *Export Wizard* GUI will allow the user to select from lists of available field names. The available fields are described in the following tables.

Standard Data Export Fields

Field	**Description**
Date	Format: YYYYMMDD HHMM
WS	Wind speed (m/s)
WD	Wind Direction (deg from true north)
Hs	Significant wave height (m) of total spectrum
Tp	Peak period (s) of total spectrum
T01	Mean (zero-crossing) period (s) of total spectrum
L01	Wave length (m) of total spectrum calculated from T01
Cp	Phase speed (m/s) of total spectrum calculated from Tp
Dp	Peak direction (deg from true north) of total spectrum
Dm	Mean direction (deg from true north) of total spectrum
Sp	Spectral spread (deg) of total spectrum

Processed Data Export Fields

Field	**Description**
par	Partition identifier (0= windsea, 1-n = swells)
sys	System group identifier (0= windsea, 1-n = swells groups)
Hsi	Significant wave height (m) of system
Tpi	Peak period (s) of system
T01i	Mean (zero-crossing) period (s) of system
L01i	Wave length (m) of system calculated from T01i
Cpi	Phase speed (m/s) of system calculated from Tpi

Dpi	Peak direction (deg from true north) of system
Dmi	Mean direction (deg from true north) of system
Spi	Spectral spread (deg) of system

Notes: Wind data are only included if available in wavedat
Directional and spread fields are not included for type 1D data.
Key: i = 0 for windsea, i>0 for swells, in order of highest energy to lowest

Export Data Formats

ASCII (text) and EXCEL data tables are exported as column-oriented time series lists. Each wave record has a single row in the table. The order of the data columns is identical to the sequential order of the fields in the above tables. For Wave System data, multiple wave systems as specified by the user will appear as repeating sets of columns on a given row:

Date/Time; full spectrum fields; system 1 fields; system 2 fields; system 3 fields; etc.

The Export Wizard allows an additional export option for a MATLAB mat-file data structure (xdat). The data structure is organized as column-oriented vectors and has header and field names identical to those listed in the above tables:

xdat.Date
xdat.Hs
xdat.Tp
etc…

For multiple wave systems the 'i' in the field names will be replaced with the sequential wave parition number (for example, hs1, hs2, and hs3 for dominant, secondary and teriary wave systems). This occurs in both the table header field names (if selected for output) and the mat-file structure field names.

VIII. Additional Help

Wavector help and product support is available through our web site at www.WaveForceTechnologies.com

Licensed users are entitled to email support at help@WaveForceTechnologies.com

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