

Crospec User's Guide

This program performs cross-spectral analysis on two time series. Key points are:

- Each input file (tab-delimited text) must be a single column at a constant Δt . Exclude the time column.
- The analysis may be applied to the entire series, or in an iterative fashion on portions of the data.
- Each cross-spectral analysis may include as many as 25,000 data values.
- If the time series has missing entries, replace the missing data values with -9999.
- There are 6 graphs available, including time series, cross-correlation, coherency and phase plots.
- The output file has 101 frequency values of coherency, coherency squared, phase, phase error and spectral density (both series). Amplitude and coherent amplitude are calculated in relation to the first series. The plot flag relates to the Coherency & Phase Show Significant option (explained below).
- The program will analyze additional input files, but only two data series are kept in memory at a time.

Explanation of the iterative feature:

- This feature examines coherency and phase changes over the course of the analysis length. For example, given two series of 10,000 values each, the user may wish to analyze 2000 samples at a time with an increment of 1000 samples. In this case, if the series starts at 0 and has a Δt of 2, 8 iterations are performed at time ranges of 0-4000, 2000-6000, 4000-8000, etc. The maximum is 75 iterations.
- The iterative output file contains coherency, phase and phase error for the three periods closest to the user-provided periods. The user is allowed to choose as many as 4 periods for this output file.

File Menu:

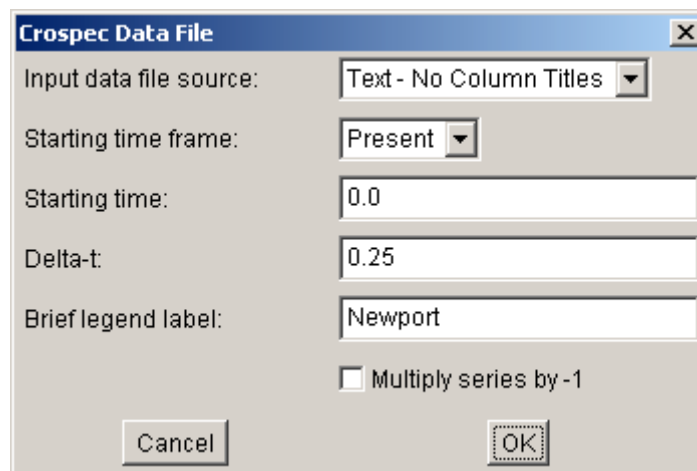
Open 1st File... Ctrl+X: This displays a dialog box to select the 1st input file, which must be a single data column. Once it is chosen, the *Crospec Data File* dialog box (explained below) is displayed.

Open 2nd File... Ctrl+Y: As with the 1st file above, this menu item displays a dialog box for the 2nd input file. Once the time series file is selected, the *Crospec Data File* dialog box (explained below) is displayed.

Input Parameters... Ctrl+I: This menu item opens the *Crospec Input Parameters* dialog box (explained below), which may be used to change cross-spectral analysis settings at any time, once both files are selected.

Output Crospec Data... Ctrl+O: Use this menu item to write the cross-spectral analysis output to a tab-delimited text file. A dialog box appears, allowing the user to name and save the file to disk.

Crospec Data File dialog box from Open 1st File and Open 2nd File menu items:



Crospec Data File

Input data file source: Text - No Column Titles

Starting time frame: Present

Starting time: 0.0

Delta-t: 0.25

Brief legend label: Newport

☐ Multiply series by -1

Cancel OK

Input data file source:

Text – Column Titles: The input file must be a tab-delimited text file with column titles on the first line.

Text – No Column Titles: The input file must be a tab-delimited text file without column titles.

Starting time frame: Choose Past, Present or Future as the time frame for the series.

Starting time: Enter the starting time for the input file.

Delta-t: Enter the sample interval (Δt) of the input file. The time series must have a constant Δt .

Brief legend label: Provide a brief legend to identify the series in the coherency plot.

Multiply series by -1: This is useful when two input series approach being 180 degrees out of phase.

If both input files have been selected when **OK** is clicked, then the *Crospec Input Parameters* dialog box (explained below) is displayed. Use it to provide parameter settings for the analysis.

Crospec Input Parameters dialog box from Input Parameters or the open file menu items:

Crospec Input Parameters

Confidence level: 80% ▾

Detrend option: Full Linear Detrend ▾

Starting time frame: Present ▾

Starting time: 0.0

Delta-t: 0.25

Final frequency: 0.2

Number of lags: 1000

Samples per analysis: 2900

Total samples: 2900

Sample increment: 100

Periods (four or fewer): 100.0 41.0
23.0 19.0

Phase (output file): -180 to 180 Range ▾

Cancel Run

Confidence level: Choose either 80% or 95% for the confidence interval level of the cross-spectral analysis.

Detrend option:

Subtract Mean Only: Subtract the mean from all input data values. The mean of the new series is zero.

Full Linear Detrend: Remove any linear trend in the data by calculating residuals from a linear regression. The mean is also subtracted, so the mean of the new series is zero.

Starting time frame: Choose Past, Present or Future as the time frame for the analysis.

Starting time: Enter the starting time for the cross-spectral analysis.

Delta-t: Enter the sample interval (Δt) for the cross-spectral analysis.

Final frequency: This is the last frequency to be calculated for the cross-spectral analysis. The highest frequency that can be resolved is the Nyquist frequency ($1/2\Delta t$).

Number of lags: Enter the number of lags for the analysis. Bandwidth is inversely related to the lag value. Lagging at a higher percent of the samples per analysis results in higher frequency resolution, but greater sampling error for spectral estimates. Lag around 1/3 the analysis length, then increase or decrease as needed.

Samples per analysis: Enter the number of samples for the cross-spectral analysis. (This is effectively samples per iteration when in iterative mode.) The maximum number of samples is 25000.

The following four dialog box choices are only available when the using the iterative mode:

Total samples: Enter the total number of samples for the iterative mode. For the example given in the explanation of the iterative feature above, this value would be 10000.

Sample increment: Each iterative analysis increments further into the data by the number of samples entered for this value. In the iterative feature explanation above, the value used in the example was 1000.

Periods (four or fewer): Enter as many as 4 periods in descending order. Enter 0 to skip one or more periods. The iterative output file will contain coherency, phase and phase error for the three periods closest to these user-provided periods. If 0 is entered for all 4 periods, then an iterative output file will not be available.

Phase (output file): Choose either -180 to 180 or -360 to 0 for the phase range used in the iterative output file.

Clicking the **Run** button performs the cross-spectral analysis. It activates all the **Graphs** menu choices, as well as **Output Crospec Data** in the **File** menu (except when all 4 periods are 0 in the iterative mode).

Graphs Menu:

Plot 1st Time Series... Ctrl+1, Plot 2nd Time Series... Ctrl+2 and Plot Both Time Series... Ctrl+3 respectively plot the 1st, 2nd or both series together. Each is plotted after detrending. The x-axis is in time units.

Plot Cross-correlation... Ctrl+4: This option plots the cross-correlation curve. The *Shift Value* dialog box (explained below) is displayed.

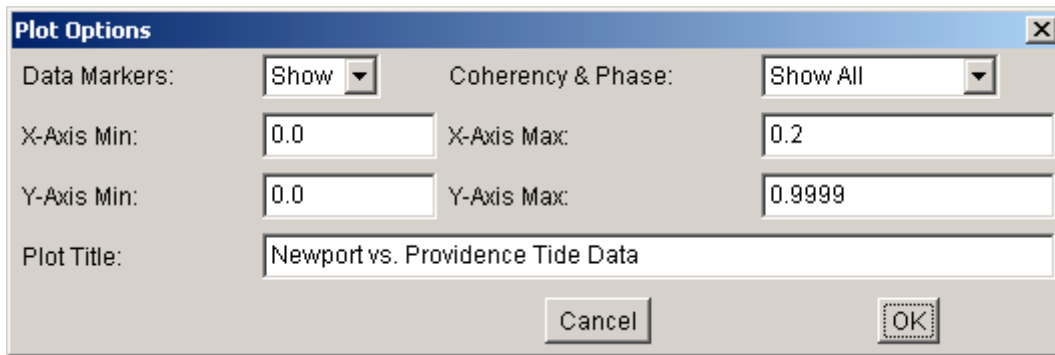
Plot Coherency... Ctrl+5: Plot frequency versus coherency, along with the spectra of both series. Coherency is on a hyperbolic arctangent scale, but spectral density is scaled to the maximum of its respective series.

Plot Phase... Ctrl+6: Plot frequency versus phase angle. Error bars are plotted on every fourth value.

Save Graph/Printer Options... Ctrl+S: This option offers a full print dialog box, giving the user the ability to save the plot as a PDF, switch printers and change other properties. To save the graph as a PDF, choose a PDF writer from the dropdown list in the *Print* dialog box and proceed as if printing. At that point, the next dialog box allows the user to save the PDF to disk. Refer to section 6 in ReadMe.pdf for more information on obtaining a PDF writer.

Print Graph Ctrl+P: Send the plot (in landscape mode) to the default printer. No dialog box is displayed.

Plot Options dialog box from any of the six plot menu items above:



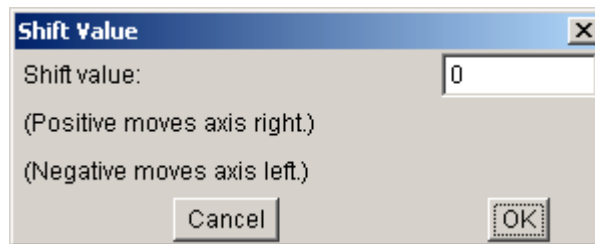
Data Markers: Either show a plus sign (+) marking each data point on the plot, or hide the sign so that no data points are marked and a smooth curve is plotted.

Coherency & Phase: The Show All option plots all 101 frequencies for the coherency and phase plots. The Show Significant option only plots the frequency values for coherency and phase that are deemed significant, i.e., when both spectral density values are greater than 1% of their respective maximum.

X-Axis and Y-Axis Min and Max: Change the defaults to view different axis ranges.

Plot Title: Enter a title to describe the plot.

Shift Value dialog box from the Plot Cross-correlation menu item above:



Shift value: Realign the cross-correlation plot by shifting it a given number of points in either direction. Coherency, phase and related values are recalculated after a shift. Entering 0 leaves things unchanged.

Note that **OK** and **Cancel** are interchangeable for a zero shift value, as no new calculations are necessary. For non-zero shift entries, click **OK** to recalculate values and plot a new cross-correlation graph.

Iterative Menu:

Iterative Mode Ctrl+M: Check this item to activate the iterative mode. This feature allows examination of changes over time by performing a series of analyses on subsets of the input data. The default mode, a standard single cross-spectral analysis, is performed when this item is not checked.

Plot Next Iteration Ctrl+N: Use this menu item to plot the next analysis when the program is in the iterative mode. This option only becomes available after one of the six plots is chosen in the **Graphs** menu.

Plot Previous Iteration Ctrl+B: Use this item to view the previous analysis when in the iterative mode.