A Closer Look at CODAR HF Radar Spectra


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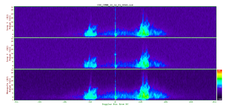
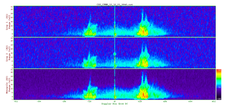
A Method for Tracking Spectral Features in MATLAB

Imaging Processing tools are used to look at spectra characteristics or unique site-specific features over time. The results could be used to recommend temporal changes for first order settings or investigate times of a specific type of interference.

Adjust color settings in the SpectraPlotterMap (SPM) software and decide which settings to place in the SpectraPlotterMap.plist file for use with image output.

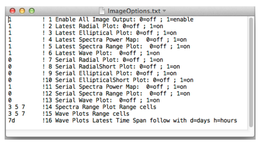


SpectraPlotterMap display using default settings for color bar minimum, threshold and maximum values.

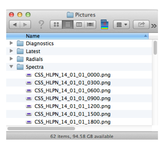


The same SpectraPlotterMap display using lower threshold and maximum values.

Allow recording of images.



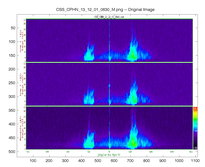
Edit the ImageOptions.txt file in the RadialConfigs folder. Lines 1 and 11 must be set to 1.



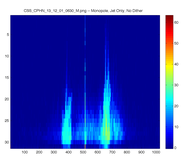
PNG image files will be saved to the Data/Pictures/Spectra folder during processing.

Create images by processing CSS spectra files of interest with RunSpectraAnalysis. For images only, turn off all other processing output and use any set of CSS files (any order, any time step).

Load image output into MATLAB.



The MATLAB rendition of the Doppler spectra after importation by the imread function and plotting with the image function.



A result of further processing of the imported image. The monopole channel section was isolated and then remapped by the rbg2ind command specifying the 'jet' colormap. This reduced the number of unique colors to 64 and set another color index related to signal strength.

TEST CASE: Investigate saturation of spectra at CPHN.

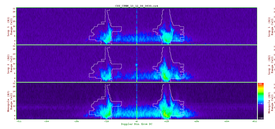


Figure A: December 9 2013 06:30 UTC

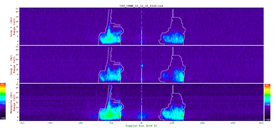
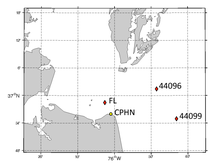


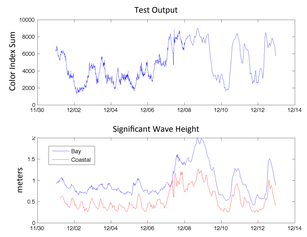
Figure B: December 10 2013 02:20 UTC

A test was developed to detect the presence of saturation or "clouds" of signal that can interfere with the processing of first order sea echo, as seen in Figure A above but not in Figure B. The test focused on a central region in the monopole spectra that covered range cells 2 to 10 and Doppler cells associated with velocities between 150 cm/s and 280 cm/s. A sum of the color index values in this region is an indicator of the level of signal and the amount of saturation.

Since these clouds should be associated with second order echo or wave activity, the test output was compared with wave data from three nearby wave buoys.



A map of the Chesapeake Bay mouth showing locations of wave buoys (red diamonds) near the CPHN 25MHz radar site (yellow).



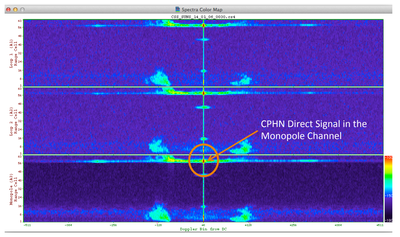
The test output is a reasonable indicator of echo clouds (compare with December 9 & 10 images above) and compares well with wave data.

Direction Finding Test for Sites with Baselines

The Spectra Point Extractor (SPE) software tool extracts information, such as peak signal or a sum of signals, from an operator defined "window" within the Doppler spectra. Standard processing algorithms are applied to the signal including direction finding with ideal and measured patterns and the results are given in a diagnostic output (.SDT) file.

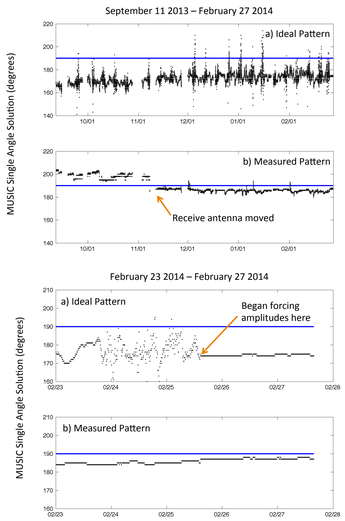
Baselines between radar sites in the Chesapeake Bay. The bearing of CPHN from SUNS is 190 degrees and the bearing of VIEW from SUNS is 229.

The November 7 2013 pattern currently installed at SUNS.



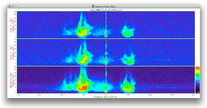
SUNS and CPHN sites are set to the same frequency and timing adjusted so that echo returns from the CPHN transmit signal appear in the far ranges of received spectra at SUNS. SPE is set to pick out the strong signal at 0 Doppler that is the direct signal from the transmitter at CPHN.

The figures to the right show results of SUNS direction finding on the direct signal from CPHN. The correct bearing to the site is shown by the horizontal blue lines. On November 7 2013, the receive antenna was moved inland approximately 6 feet and results improved although the exact reason is not clear. Pattern distortion helps explain why the measured results are better than ideal. The variable ideal results are a consequence of fluctuating sea echo amplitudes and this is steadied by setting forced amplitudes in the configuration files.



Isolating First Order Sea Echo

- Use CSA average spectra files to set first order lines.
- Copy a select set of files (files from different hours and days throughout the month) to a new folder and work with that set in SpectraPlotterMap.
- Focus on the monopole channel.
- Set lines to define an area slightly larger than the first order region unless noise or second order is often close to first order.
- Use the blackout feature in SPM to check the settings.
- Re-check the lines after processing. SPM-determined (purple) lines are approximate. The processed (white) lines for individual CSS spectra files may show differences from those anticipated by the purple lines in some cases.



Sites like CPHN may benefit from using different first order settings for different ranges.

A First Order Evaluation Chart is used to check first order line settings with a select set of CSA or CSS spectra collected at different hours and days throughout the month.

Date	Hour 0	Hour 3	Hour 6	Hour 9	Hour 12	Hour 15	Hour 18	Hour 21
1	T	0	N	T	N, T	0	0	T
5	0	0	0	0	0	0	T	T
10	T	T	T	T	T	T	0	0
15	T	0	T	N	T	N	T	T
20	T	0	T	T	0	T	T	T
25	T	T	0	T	T	T	T	T
30	N	N	T	T	T	T	0	0

0	Good
NI	Noise - Ionosphere
N2	Second order
NS	Ship echoes
N	Noise Other
T	Too tight, missing some first order

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IOOS INTEGRATED OCEAN OBSERVING SYSTEM
MACOORA Mid-Atlantic Coastal Ocean Observing Regional Association
NOAA
CIT CENTER FOR INNOVATIVE TECHNOLOGY