Problems Week 7

Due Wednesday, November 20, 2019

For this set of problems, we'll consider atmospheric and ocean temperatures from the Stratus XIV mooring at 19°49'S, 84°44.4'W in the Pacific Ocean. This deployment extended from April 2015 through June 2016. You can download the high resolution surface meteorological from here:

http://uop.whoi.edu/currentprojects/Stratus/stratusarchive.html

And the specific NetCDF file that you need is here:

http://uop.whoi.edu/currentprojects/Stratus/data/OS_Stratus_2015_D_M.nc

or I'll put a copy in TritonEd (in the Lecture 13 folder). The goals of this exercise are to show that you can compute spectra of real data and carry out some basic interpretation.

1. **Inspect the data.** Retrieve the data, plot time series of sea water temperature (T_o, identified as 'TEMP') and surface air temperature (T_a, identified as 'AIRT'), with appropriately labeled axes. Be sure to check for values that might be flagged as bad data and treat them as NaN. Are there gaps in the data? (If so, replace missing values (NaN) with the mean of nonmissing values (nanmean(data)).) What do you notice about the data?

2. **Compute the spectra for T_o and T_a.** Use the segmenting approach that we discussed in class to compute the spectra. Please follow the "best" practices that we have discussed and explain your approach. Be sure to do the following:

   a Verify Parseval's theorem.
   b Be attentive in labeling your x axis.
   c Be attentive in labeling your y axis.
   d Provide an uncertainty estimate.
   e Compute the Nyquist frequency.
   f Identify the frequency resolution.
   g Identify and discuss the spectral peaks.
   h Ignoring spectral peaks, roughly what is the spectral slope for each variable?

   What are the differences between the two spectra?

3. **Compute spectra for the two data sets using the autocovariance approach.**

   a Compute the autocovariances of the data. You might want to remove the annual cycle (or choose an analysis approach that suppresses the annual cycle), as it will dominate the autocovariance. (But you can obtain spectra even if you don't think about the annual cycle.) You can segment the data before computing the autocovariance, or work from the full record. (In what ways does it make a difference?)
   b Choose a window width over which to compute the spectra. Decide if you will apply a window to the data, and explain your decision.

c Fourier transform the windowed auto-covariances and plot the resulting spectra.

d Estimate the degrees of freedom. Add error bars to your spectra.

e Comment on differences and similarities between the spectra computed using overlapping segments and spectra computed using the autocovariance approach.