METR 5433 - Advanced Statistical Meteorology
Spring 2020 – Homework #5
Due: 30 April 2020

(#1) Download the following time series from the website: **HW#5TimeSeries1.txt**. Calculate and plot the power spectrum for the time series using the analysis constraints outlined below. Again, assume $\Delta t = 1$ month. In all plots, include (a) the power spectrum, (b) the experimental red-noise power spectrum, and (c) the 95% significance curve as done in class. You may plot the power versus frequency or period - your choice. However, use the same axis for all cases.

Case (a): Lowest resolved frequency: 2π per N. No window tapering and no smoothing.

Case (b): Lowest resolved frequency: 2π per N. No window tapering. Smooth the spectra using a 5-point running mean. (e.g., the value of $\Phi(\omega_3)$ is the average of all the values of the spectrum between $\Phi(\omega_1)$ and $\Phi(\omega_5)$).

Case (c): Lowest resolved frequency: 2π per $N/5$. Hanning window. No smoothing. Use an overlap corresponding to half the length of each subset of the data (i.e., 1:200, 101:300,...). Note that since there is an overlap between successive subsets, you will actually be calculating spectra for 9 subsets of the data.

Discuss the results for each case, and then all cases as a whole. What are the dominant frequencies in this time series? How did each of the cases above help you reach that conclusion? Be specific, including any assumptions made and the value of your significance testing.

(#2) Go back to HW#4, Problem 1 –> i.e., the problem in which you reconstructed the figure from You and Furtado (2017). Take the PC-1 time series you computed in that problem, and call it the *South Pacific Oscillation (SPO) Index*, a measure of the phase and strength of the meridional SLP dipole shown in the EOF image you made. Assuming *a priori* statistics and using whatever constraints you deem necessary (smoothing, windows, etc.), determine the dominant timescale(s) of variability in the SPO index. Be sure to explain your methodology and how you reached your conclusions.

(#3) Download the Jupyter notebook file "HW5Prob3.ipynb" and two files: **HW#5TimeSeries2.txt** and **HW#5TimeSeries3.txt**. This notebook contains a template for completing both cross-spectral analysis and a filtering exercise with these time series. Following the directions within the notebook, complete the template. For your writeup, provide the following:

- The figure containing the power spectra of your two time series and the coherence squared, including significance (see the template for more information).
- The common period(s) between the two time series, including their phase relationship.

- The lag correlation plot of the low-pass filtered time series with the lag between relationships indicated on the plot.
- A discussion of the major findings of the exercise, including the advantages and disadvantages of using the cross-spectral analysis vs. filtering/lag-correlation method to find out the common periods and lagged relationships between the two time series.