Problems Week 5

Due Tuesday, November 2, 2021

This problem set is to be completed independently, without collaborating with your classmates. At the top of your problem set, please write and sign the following statement: "I certify that this represents my own work and that I have not worked with classmates or other individuals to complete this assignment."

For thie problem set we will use three wind data records from the Tropical Atmosphere Ocean Project:
https://dods.ndbc.noaa.gov/thredds/dodsC/oceansites-tao/T8S110W/OS_T8S110W_DM134A-20150425_D_WIND_10min.nc
https://dods.ndbc.noaa.gov/thredds/dodsC/oceansites-tao/T8S110W/OS_T8S110W_DM183A-20160321_D_WIND_10min.nc
https://dods.ndbc.noaa.gov/thredds/dodsC/oceansites-tao/T8S110W/OS_T8S110W_DM231A-20170606_D_WIND_10min.nc

1. **Make a preliminary assessment of the data.** First, plot time series of the total wind speed ("WSPD"), zonal wind ("UWND"), and meridional wind ("VWND"). What is the time interval between data points? What is the time gap between the data files? How are gaps in the data handled?

   Since there are some gaps in the data, for the rest of this problem set, you will need to fill the gaps. Fill the gaps in each record by linear interpolation. (You can do this with the Matlab function interp1 or xarray.interpolate_na in python.) Do not try to interpolate across the gaps between the 3 records, since the gaps are several hours long.

2. **Segment the data** into 60-day segments with 50% overlap. How many segments do you have for each of the data files? How many points are in each segment? Determine the frequencies (in cycles per day) that you will be able to analyze when you Fourier transform the data.

3. **Compute and plot spectra using 3 different approaches, for the 2015 wind speed record only.** Compute the spectrum from the raw data, from the detrended data, and from the detrended data with a Hanning window applied. How does detrending and windowing alter the spectrum in this case?

4. **Add uncertainty estimates to the 2015 wind speed spectra.** Indicate whether you think the uncertainty should differ for the 3 cases.

5. **Compute the wind speed spectrum using data from all three data files.** Do this just using the detrended and Hanning-windowed records. Be sure to compute the uncertainty estimate. Overlay the multi-year spectrum over the 2015 spectrum you computed earlier. How do they differ? Why? Can the differences be explained by differences in the uncertainties?

6. **Compare the spectra for wind speed, zonal wind, and meridional wind.** Use all 3 data files, and be sure to detrend and Hanning window. Examine the peaks at the diurnal and semi-diurnal frequencies. How do they differ? Are the differences statistically significant? What do you hypothesize might account for differences?