Assignment 5 (50 pts)

You may complete the assignment using your programming language of choice. Feel free to use built-in functions but make sure you have read the documentation about these functions and are confident they are indeed conducting the calculations you intend. Please submit your assignment and the code used to generate any results by uploading the files to Canvas by the assignment due date. I should be able to re-create all of your results given the scripts you have provided me, this includes any data import commands. For your data loading, please ensure that your path is a relative path in the form '../../data/filename.ncl'. Your code should be well commented so that others can easily understand what has been done and marks may be removed from your assignment if this is not the case.

In this assignment, we are going explore the use of empirical orthogonal function for two simple test datasets. The data can be found in the class box folder: `sine_wave_data1.nc` and `2D_bulls_eyes.nc` for the first and second question respectively.

1. (30 pt) The first dataset `sine_wave_data1.nc` consists of a simple sine wave that propagates to the right over time.

a) (8pt) Compute the EOF of the data to obtain the eigenvectors, eigenvalues, and variance explained by each EOF. Sort the eigenvectors based on the size of the eigenvalues. Compute the principal components for these eigenvectors. Note: You are welcome to use built-in functions for this question.

b) (2pt) Identify the number of EOFs/PCs that you would like to plot. To do so, use the criteria of retaining the number of EOFs/PCs required to explain 90% of the total variance.

c) (5pt) Plot the standardized principal component time series for each of the selected principal components. Include their fraction of variance explained in a legend or title.

d) (5pt) Compute and plot the standardized principal component time series regressed onto the original data for each of the selected principal components. This provides one visualization of the pattern of variability associated with the EOFs. Include their fraction of variance explained in a legend or title. Note: Instead of regressing onto the original data, one could also choose to regress the PC onto additional fields to identify relationships to the mode of variability.

e) (5pt) Compute and plot the selected EOFs scaled by the square root of their eigenvalues for each of the selected principal components. This provides a second visualization of the EOF patterns that is scaled such that it equals the regression of the PC onto the data shown above. Include their fraction of variance explained in a legend or title.

f) (5pt) Include all of these figures in your final report and summarize your findings. This should include a description of the selected EOF patterns you have produced, the associated principal component time series, and the percent of explained variance. Describe how these EOFs correspond to the actual data. What do these results tell you

about how well the EOF method is able to capture what you know about the behavior of each of the toy data?

2. In this question, you be using the 2D bulls eye patterns. This data set consists of four patterns as shown in the figure below. They are repeated in the order shown, with the first figure occurring for 10 time steps, followed by the 2nd, 3rd, and 4th. The process is repeated over the course of 400 time steps.

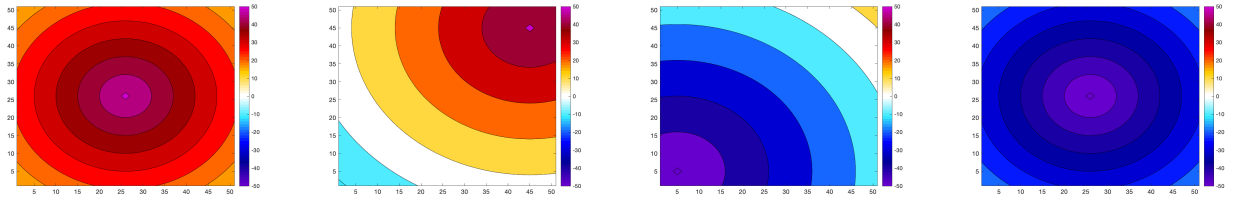

Figure 1: Four patterns found in 2-D bulls eye data

a) (2pt) This dataset is 3-dimensional with dimensions (x,y,t). Reshape the data to be 2-dimensional with dimensions of space x time.

b) (5pt) Repeat steps a) through c) from question 1. Be sure to plot each PC in it's own separate figure for clarity.

c) (8pt) Repeat step d) and e) from question 1. Unlike in question 1 you will need to be plotting a 2-D array in this step. Be sure to include a colorbar with ranges identical to the sample figure provided.

d) (5pt) Include all of these figures in your final report and summarize your findings. This should include a description of the selected EOF patterns you have produced, the associated principal component time series, and the percent of explained variance. Describe how these EOFs correspond to the actual data. What do these results tell you about how well the EOF method is able to capture what you know about the behavior of each of the toy data?