**Research Methods for Climate Science (2020)**

**Tentative Tasks**

**Task 1: Cluster Analysis (CA)**

The aim of this task is to study the characteristics of three CA algorithms. As discussed, use the climate dataset (CRU) over the city of your interest for this task. Using “R” or “Python” or “Statistical” software, cluster the data matrix to explore the groping of (i) the climate variable and (ii) years (1960 -2010) over the city, for each of the three algorithms (single linkage, average linkage, and Ward’s algorithm). Write a scientific report to summarise your findings. If possible (for bonus marks), give physical interpretations of your results.

**Task 2: Principal Component Analysis (PCA)**

The aim of this task is to study the characteristics of PCA and compare them with that of CA. As discussed, use the climate dataset (CRU) over the city of your interest for this task. Using “R” or “Python” or “Statistical” software, perform PCA on the data using (i) rotated and (ii) non-rotated methods to reduces dimension of the dataset and identify the leading principal factors (PFs; i.e. processes). Write a scientific report (with appropriate diagrams) to discuss influence on the climate variables and the temporal variation of the PFs over the study period. If possible (for bonus marks), give physical interpretations of your results. Compare the results with those obtained with Ward’s method in Task 1

**Task 3: Time-series Analysis Part I (Auto-correlation and Correlation)**

The aim of this task is to explore the time series patterns in precipitation (PRE) and temperature (TMP) data and the relationships between the two variables.

1) Plot PRE and TMP time series and find a best linear line fit. Conclude on whether the time series shows trend and what this means physically

2) De-trend the data – compare original and de-trended data

3) Obtain a correlogram for PRE and TMP and make physical interpretations.

4) Perform a cross-correlation analysis of PRE and TMP

Write a scientific report to discuss your results. If possible (for bonus marks), give physical interpretations of the results.

**Task 4: Time-series Analysis Part II (Spectral Analysis and Wavelet Analysis)**

The aim of this task is to explore and compare spectral analysis and wavelet analysis using the precipitation data.

1. Remove the trend in PRE time series (if there is any). Perform spectral analysis on the de-trended PRE and study the periodogram. How sensitive is the periodogram to 6-month moving average?
2. Load the dataset de-trended PRE time series into the online wavelet software. Using Morlet option, obtain the power wavelet figures and study the differences and similarities to the spectral analysis. Study the sensitivity of the power wavelet figures to different wavelet options (e.g. Paul and Gaussian)

Write a scientific report to discuss your results; if possible (for bonus marks), give physical interpretations of the results.