MET 359 Assignment

Climate Science Assignment: Exploring Climate Variability and Trends Using CRU TS Data

Submission Deadline: 7th May 2025
Format: Individual Assignment

General Instructions

- Each student will be assigned a **different country** for assessment.
- Students must define a **bounding box** (latitude-longitude rectangle) that adequately covers their assigned country.
- All analyses and visualizations must focus **only within the bounding box** selected.
- Use the **CRU TS4.07** dataset, available in NetCDF format, from:
  - https://crudata.uea.ac.uk/cru/data/hrg/
- Variable of interest: **Monthly Precipitation (pre)**.
- Tools: Python (xarray, matplotlib, numpy).

Specific Tasks

Part 1: Data Acquisition and Exploration

1.1 Dataset Download

- Download the **monthly precipitation** data (NetCDF format) from CRU TS4.07 for the period **1990–2020**.

1.2 Bounding Box Definition

- Define a **bounding grid** that covers your assigned country.
  - Specify the **minimum and maximum latitude and longitude** values clearly.
  - Document the bounding box in your report.

1.3 Data Loading and Initial Inspection

- Load the data using xarray.
- Briefly describe:
    - Dataset dimensions and coordinate system.
    - Main variables and units.

1.4 Mean Precipitation Mapping

- Calculate the **mean precipitation** over the full period (1990–2020) for the bounding box.
- Generate a **spatial map** showing the distribution of mean precipitation across the country.

Part 2: Temporal Analysis

2.1 Annual Mean Precipitation Time Series

- Aggregate monthly precipitation to compute **annual mean precipitation** over the bounding box.
- Generate and plot the **annual mean precipitation time series** for the period 1990–2020.

2.2 Trend Analysis

- Fit a **linear trend line** to the annual time series.
- Interpret whether precipitation is increasing, decreasing, or showing no clear trend.

2.3 Variability Analysis

- Calculate:
    - The **standard deviation** of the annual mean precipitation.
    - Briefly discuss the magnitude of interannual variability.

Part 3: Spatial Patterns over Time

3.1 Decadal Averages

- Calculate and plot mean precipitation for two separate periods:
    - **1990–1999** (first decade),
    - **2010–2020** (recent decade).
- Generate a **difference map** (2010–2020 minus 1990–1999) to illustrate spatial changes over time.

3.2 Hotspot Identification

- Identify and report:
    - The **top 5 grid points** with the largest **increase** in precipitation.
    - The **top 5 grid points** with the largest **decrease** in precipitation.
- Include a table listing:
    - Latitude,
    - Longitude,
    - Magnitude of change (in mm/year).

Part 4: Extreme Event Analysis

4.1 Wet Year Frequency

- Define a **"wet year"** as a year in which the annual mean precipitation exceeds the **90th percentile** across the period 1990–2020.
- For each grid cell:
    - Count the number of "wet years."
- Produce a spatial map showing the **frequency of wet years** across the bounding box.

Deliverables

Each student must submit:

- A **well-organized report** (maximum 8 pages) including:
    - Description of the bounding box,
    - Plots and maps (with labeled axes, colorbars, and legends),
    - Tables of hotspot results,
    - Short interpretations under each figure or table,
    - A concluding summary of key findings.
- The **Python code** (.ipynb or .py script), with:
    - Clear code comments,
    - Logical sectioning following the assignment structure.

Grading Rubric

Task	Marks
Part 1: Data Handling and Mean Map	15
Part 2: Time Series, Trend and Variability	25
Part 3: Decadal Change and Hotspot Identification	30
Part 4: Extreme Event (Wet Year) Analysis	20
Report Structure, Code Quality, and Interpretation	10

Total: 100 Marks

Important Notes

- You must **cite** the CRU dataset in your report:
  Harris, I. C., & Jones, P. D. (2022). CRU TS4.07: Climatic Research Unit (CRU) Time-Series (TS) Version 4.07 of High-Resolution Gridded Data of Month-by-month Variation in Climate (January 1901-December 2022). Centre for Environmental Data Analysis. https://crudata.uea.ac.uk/cru/data/hrg/
- Make sure all figures are of high quality, properly labeled, and easy to interpret.

- Ensure consistency between your plots, tables, and descriptions.
- Plagiarism will result in zero marks for the assignment.