Assignment: Regional Climate Normals Analysis Using Data Science

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1 Introduction

This assignment focuses on the analysis of regional climate normals using real-world precipitation data. Students will investigate the typical monthly precipitation patterns over Europe by computing climatological means for a defined reference period. The goal is to understand what constitutes "normal" climate conditions and how these can serve as a baseline for future anomaly detection and climate trend analysis.

The core objective is to compute monthly climate normals for the period **January 1979 to December 2008**, and to visualize these normals **over Europe**. Additionally, students will compare these normals with observed precipitation for a specific month—**June 2022**—to illustrate how deviations from the norm can be identified.

This project provides hands-on experience with climate data formats such as NetCDF and reinforces essential data science skills including data wrangling, spatial analysis, and scientific visualization.

2 Objectives

- Explore and understand the structure of climate data in NetCDF format.
- Understand the concept of climate normals and their scientific relevance.
- Calculate monthly climate normals for a defined baseline period.
- Visualize climate normals using spatial maps.
- Compare climate normals with observed data to identify deviations.
- Develop and communicate insights using data science tools and techniques.

3 Dataset Description

- **Source**:Global Precipitation Climatology Project (GPCP) Monthly Analysis Product.
- **URL**: https://psl.noaa.gov/data/gridded/data.gpcp.html
- **Variable**: Monthly mean precipitation (`precip`)
- **Units**: mm/day (to be converted to mm/month)
- **Temporal coverage**: 1979–present
- **Spatial resolution**: 2.5° x 2.5°
- **Format**: NetCDF

4 Study Region and Period

- **Geographic focus**: Europe
- **Baseline period for climate normals**: January 1979 – December 2008
- **Comparison month and year**: June 2022

5 Workflow

1. Load and explore the provided NetCDF dataset.
2. Convert precipitation units from mm/day to mm/month.
3. Extract data for the baseline period (1979–2008).
4. Compute monthly climate normals (mean for each calendar month).
5. Extract observed data for June 2022.
6. Visualize:
    - A map of the climate normal for June.
    - A map of observed precipitation for June 2022.
7. Optionally, compute and visualize the anomaly (difference between 2022 and the normal).

6 Suggested Tools

- Python libraries: `xarray`, `numpy`, `matplotlib`, `cartopy`
- Optional: Climate Data Operators (CDO) for command-line processing of NetCDF files

7 Deliverables

- Python script(s) used for data processing and visualization.
- Two maps:
    - Climate normal for June (1979–2008)
    - Observed precipitation for June 2022
- A brief report summarizing the methodology and key insights.

8 Optional Extensions

- Compute and visualize the anomaly (difference between 2022 and the normal).
- Compare climate normals across different baseline periods (e.g., 1991–2020).

9 Evaluation Criteria

- **Correctness and completeness of analysis (40%)**.

- **Code quality and reproducibility (20%)**: Well-structured and documented scripts.
- **Clarity of visualizations (20%)**: Effective use of maps and plots.
- **Quality of written report (20%)**: Clear explanation of methods and results.