PS4

Assignment 04 Report

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1. Global Earthquakes

Method

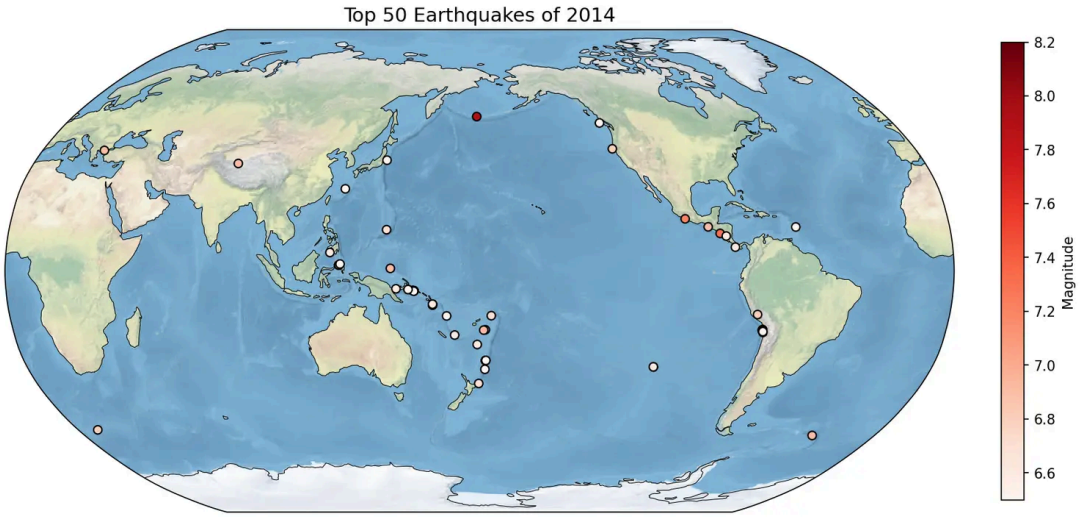
I loaded the dataset **usgs_earthquakes.csv**, which contains longitude, latitude, and magnitude information for the top 50 earthquakes data in 2014.

Following the assignment description, I completed the following steps:

1. Read the CSV file into a pandas DataFrame.
2. Extract the fields needed for mapping (longitude, latitude, magnitude).
3. Construct a global map using **Cartopy** with the *PlateCarree* projection.
4. Overlay earthquake locations using circles whose size and color reflect the earthquake magnitude.
5. Add coastlines, borders, gridlines, title, and a colorbar for magnitude to match the example figure structure.

Result

The resulting map successfully reproduces the global distribution of the top earthquakes in 2014 as same as the figure from problem. Strong events (M > 7.5) mainly occur along major subduction zones around the Pacific Rim, consistent with global seismicity patterns.The overall spatial pattern agrees with the expected tectonic boundary activities.



2. Explore a netCDF Dataset (MERRA-2 BCCMASS)

For this problem I explored the NASA GES DISC reanalysis product MERRA-2 aerosol diagnostics `https://disc.gsfc.nasa.gov/datasets/M2TMNXAER_5.12.4/summary?keywords=month`, using monthly mean two-dimensional fields (tavgM_2d_aer_Nx) from 1980-01 to 2024-01, consistent with Assignment 03. The variable of interest is BCCMASS, the black carbon column mass density (kg m^{-2}).

2.1 Global Map of BC Column Mass

Method

I opened all monthly files using `xr.open_mfdataset( )` and selected the variable `BCCMASS`. Then:

1. I compute the temporal mean over 1980–2024.
2. Generate global 2D fields using `pcolormesh()`.
3. Use a global projection (PlateCarree, 0° central longitude).
4. Add all required elements:
    - x/y labels and ticks
    - coastlines and borders
    - gridlines
    - colorbar
    - legend identifying the maximum BC point
    - annotation (arrow + marker)
    - text box summarizing the dataset & period

5. Highlight the global maximum BC column mass location using a circular marker.

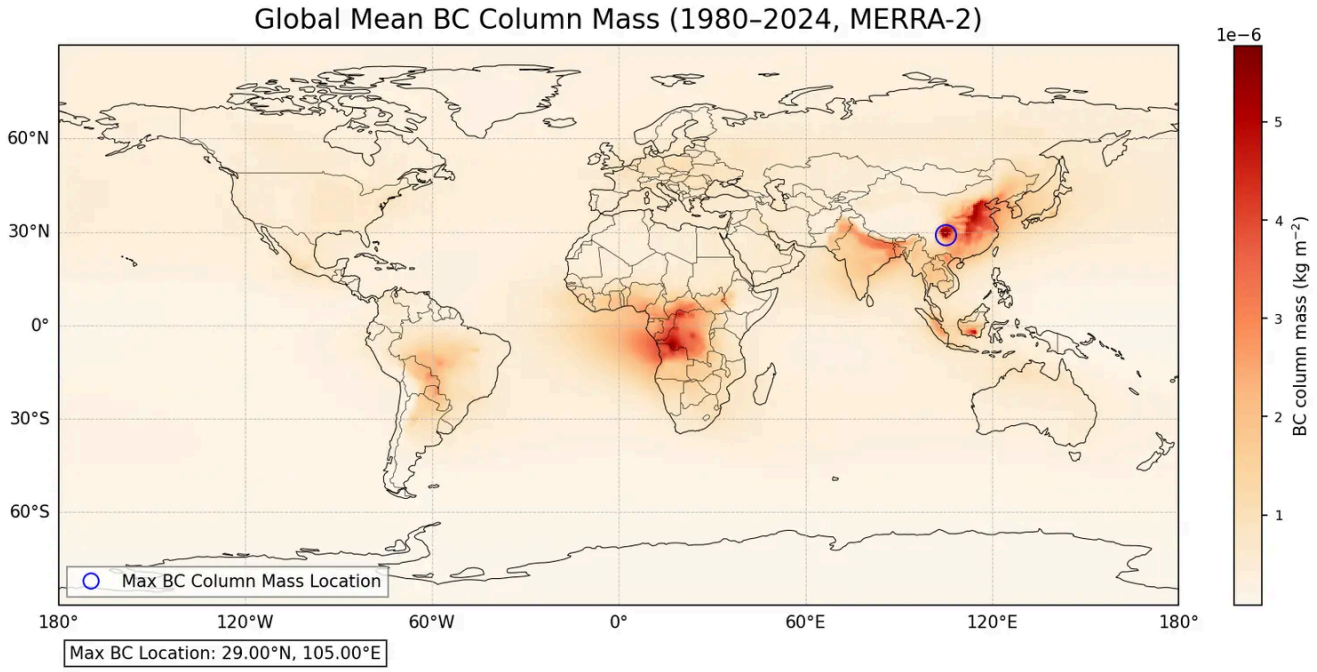
Result

The global mean BC field shows clear hotspots over East Asia, India, and Central Africa.The strongest hotspot appears over East China, where dense population, industrial emissions, and frequent stagnation events lead to the highest BC loading. The global maximum, identified at 29.00°N, 105.00°E, lies in the Sichuan Basin, a region known for persistent anthropogenic emissions and limited ventilation.

Additional elevated BC regions are found over Northern India due to industrial activity and seasonal biomass burning, and over Central Africa, where year-round savanna fires contribute significantly to BC levels. Moderate enhancements also appear across Southeast Asia and parts of South America.

In contrast, remote areas such as oceans, polar regions, and high-latitude land show very low BC values, consistent with minimal emissions and efficient atmospheric removal.

Overall, the long-term global mean field highlights the strong influence of anthropogenic activity and biomass burning on BC spatial distribution.



2.2 Regional Map: East Asia

Method

I extracted a regional subset (60–150°E, 0–60°N) from the BC field. Then I used a different projection(Mercator).

Steps:

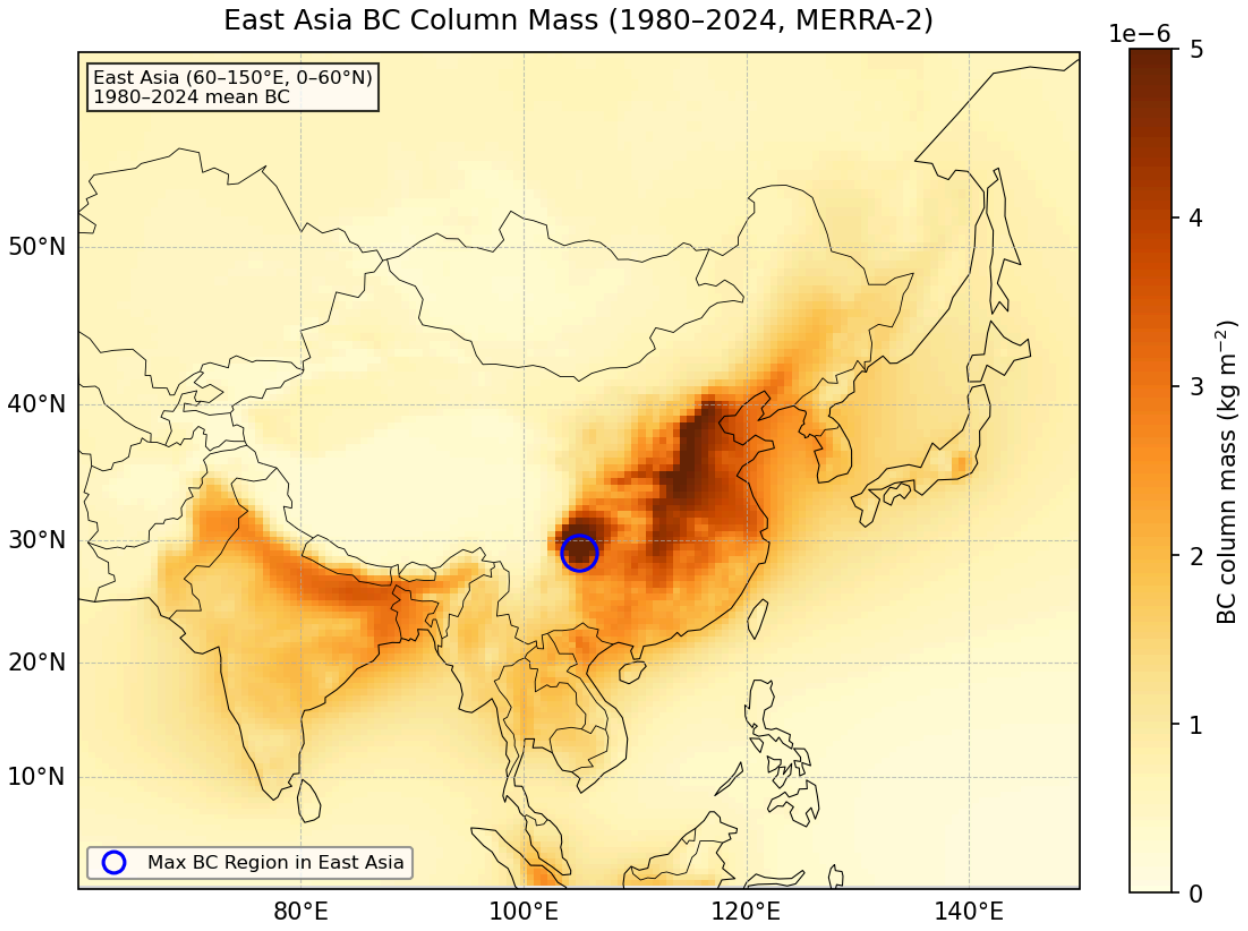
1. Subset the MERRA-2 BC dataset spatially.
2. Apply `pcolormesh()` to render the regional distribution.
3. Add all required elements labels (ticks, gridlines, borders, colorbar, and legend similar to Section 2.1).
4. Annotate the regional maximum point and include a text box describing the region.

Result

The regional map over East Asia highlights strong BC enhancements in eastern China, where dense population and industrial activities dominate emissions. The regional maximum occurs at 29.0°N, 105.0°E in the Sichuan Basin, a location known for pollutant accumulation due to enclosed terrain.

Additional high BC levels appear over northern India, influenced by household fuel use and seasonal biomass burning. BC concentrations decrease rapidly over oceans and sparsely populated regions.

Overall, the map shows clear spatial gradients controlled by emission strength and regional topography.



Collaboration

- I used ChatGPT to help me translate this report from Chinese to English.