PSI(T) Hackathon

Atmospheric and Climate Science

You've all probably heard the phrase "Climate change is happening!", "Sea levels are rising!", "Global warming is coming!", "Glaciers are melting" etc. Now it's time to really quantify and justify such statements.

1) CO2 Dataset

Therefore, you are given the task of predicting the Carbon Dioxide levels in the atmosphere. You can start by downloading the data and importing it on the programming platform of your preference.

Link for the Dataset: Trends in Global Atmospheric Carbon Dioxide

The above dataset can be downloaded in the commonly used CSV format. Have a good look at the dataset and what each column represents. Did you figure out how the decimal date is calculated?

A good start will be to plot the average carbon dioxide levels. Can you find how the CO2 levels vary each year? Obtain a profile of the net monthly deviation from the yearly trend and give possible causes for the same.

Predict what the value of Carbon Dioxide levels in the atmosphere would be for each month in 2022. Make sure to include the seasonal variations!!!

(3 hints are available)

2) Reanalysis Data

Reanalysis data provides the most complete picture currently possible of past weather and climate. They are a blend of observations with past short-range weather forecasts rerun with modern weather forecasting models. They are globally complete and consistent in time and are sometimes referred to as 'maps without gaps. In this question, we will use this data to find correlations between different parameters, specifically the Surface Solar Radiation Downwards, Temperature at 2m from the surface and the Total cloud cover.

You will be using two datasets.
Dataset 1: Hourly average for two months for a small location (9°N, 76.5°W, 8°S, 77.5°E)
Dataset 2: Monthly average for 21 years for the Indian subcontinent, sampled over 12 hour period (40°N, 65°W, 5°S, 100°E)
You can find the datasets here: Reanalysis Data.
(The folder has both .grib and .nc files. We suggest using the netCDF format due to better speed and ease in understanding the structure. Check next page for a short guide to read netCDF files.)

The first task is to form a hypothesis of how these parameters would be related. Then, justify/reject your hypothesis by validating the same from the datasets.

Appropriate plotting methods can be used to visualise the correlations qualitatively. Don't forget to quantify the correlations in the end!

Can you logically explain the presence or absence of correlations in each dataset?

Bonus: Can you produce animations of how different parameters change with time across the spatial region? An animation of the total cloud cover can show you the monsoons clearly.

(2 hints are available)

A guide for opening netCDF files in Python and MATLAB

For Python:

```
from netCDF4 import Dataset #importing necessary modules

#name of the file
f = "filename.nc"

file = Dataset(f) #reading the file

#you can get the list of other parameters and their description by
file.variables.keys()

#you can view the details as
file.variables['latitude']

#to get an array of latitude
lat = numpy.asarray(file.variables['latitude'])
```

For MATLAB:

```
longitude = ncread('dataname.nc','longitude'); #will give you an array of “longitude”
```

3) Satellite Data - Clouds and Ocean Temperature

The data collected from the satellites play a significant role as inputs for various climate models. Your goal now is to obtain the ocean's temperature from a very commonly used satellite dataset.
Link for the dataset: LAADS DAAC
A Guide for downloading and reading the data: Reading Satellite Data.pptx

Download the data for the following parameters: 10th-11th December 2021 09:00:00, W: 66°, N: 40°, E: 100°, S: 5°
(Please share your downloaded filename with the moderators and confirm before proceeding)

Make sure to re-scale and offset the data before you proceed further. The next step would be to plot these datasets along with the longitude and latitude.

The Reflective Solar Bands represent how much solar radiation is reflected. The Emissive band represents the radiation emitted by the surface, which includes clouds, ocean and land. Assuming that all surfaces are ideal black bodies, compute the Temperature of each point on the surface from an appropriate band and represent them using suitable plots.

One of the critical parameters in climate modelling is the ocean's average temperature in a given area. So, you know the drill. Calculate the average surface temperature of *just* the ocean. What do you expect it to be?

(2 hints are available)

Submissions

Documenting results is as essential as obtaining them. Make sure you periodically document the steps and the reasoning behind them.

- You will have to upload a document containing the outline of the steps you undertook to solve the problem. You need not elaborate much; a concise description will be enough. You may attach plots wherever you find them necessary.
- Make sure your plots are readable and understandable for the third person.
- Your codes should be annotated wherever required with what the particular part will achieve.
- Plagiarism will be penalized. However, making use of online resources is allowed.
- Even if you don't solve the problem entirely, you will be awarded marks for steps if you submit them on time.

You can submit your solutions below.

Carbon Dioxide Dataset

Satellite Data - Clouds and Ocean Temperature

Reanalysis Data