Multi-Source Observation and Modelling for Climate Studies

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***Abstract*--Climate change is a long period shift in the weather statistics for a given place and time. Climate change over a specific region is increasing day by day due to many reasons like increased population and human activities.**
Data regarding climate can be obtained from many sources from which we can analysis the weather data using different weather and climate model and do spatial and temporal analysis and find the trend of specific parameter over a specific region and time. Using these obtained results future climate can be predicted.
Index Terms-

I. INTRODUCTION

Climate change is one of the most major issue at both national and international level that has to be taken care. Climate change refers to a drastic change in the environment patterns observed over a time.

In recent days in Bengaluru due to the increased growth in population results in different kind of pollution, mainly air population and there is decrease in water evaporation and transpiration which leads for the formation of heat islands.

We get Climate data from different resource like Haiti data from which we get Haiti related geo-spatial information, Climate Analysis Indicators Tool(CAIT) provides us comprehensive and comparable database of greenhouse gas emission data and other climate related data. We also can get data image data and climate regarding data from satellites.

There are different types of climate data format namely GRIdded Binary (GRIB) edition 1 and edition 2, Network Common Data

Format(netCDF) version 3 and version 4, Hierarchical Data Format(HDF), Binary and ASCII etc.

There are different Climate models like GCMs (Global Climate Model), RCMs (Regional Climate Model) and WRF (Weather and Forecast Model) using which Climate and weather data can be analyzed and future climate can be predicted.

Climate Data Analysis:

Climate is commonly defined as the weather averaged over a long period. The standard averaging period is 30 years, but other periods may be used depending on the purpose. Climate also includes statistics other than the average, such as the magnitudes of day-to-day or year-to-year variations.

Climate is the long-term pattern of weather in a particular area. It is measured by assessing the patterns of variation in temperature, humidity, atmospheric pressure, wind, precipitation, atmospheric particle count and other meteorological variables in a given region over long periods of time.

Climate Change:

Climate change is the variation in global or regional climates over time. It reflects changes in the variability or average state of the atmosphere over time scales ranging from decades to millions of years. These changes can be caused by processes internal to the Earth, external forces (e.g. variations in sunlight intensity) or, more recently, human activities.

Climate models:

Climate models use quantitative methods to simulate the interactions of the atmosphere, oceans, land surface and ice. They are used for a variety of purposes; from the study of the dynamics of the weather and climate system, to projections of future climate. All climate models balance, or very nearly balance, incoming energy as short wave (including visible) electromagnetic radiation to the earth with outgoing energy as long wave (infrared) electromagnetic radiation from the earth.

Any imbalance results in a change in the average temperature of the earth. Climate models are mathematical models of past, present and future climates. Climate change may occur over long and short timescales from a variety of

factors; recent warming is discussed in global warming. Climate forecasting is a way by some scientists are using to predict climate change.

II. CLIMATE DATA FORMAT

NetCDF is a self-describing software library which is machine independent, portable and scalable data format.

NetCDF-3 library provide access to all necessary functionalities like opening old or new file, closing files, creating attributes, dimensions and variables, read and write fields and even inquire about what is in a file.

A. NetCDF Dataset

A NetCDF Dataset contains variable, dimensions and attributes. All NetCDF dataset contains a name and unique Id using which they can be identified. The CDL (network Common Data form Language) provides convenient way for describing netCDF datasets.

B. NetCDF File Structure

A NetCDF classic or 64-bit offset dataset stores as single file containing two parts: a header part and a data part. Header part contains information about dimensions variables and attributes expect variable data. Data part contains fixed size data and variable size data for variables. Fixed size data for variables don't have unlimited dimension and variable size data have unlimited dimensions.

C. NetCDF Utilities

NetCDF Utilities consists of ncdump, ncgen and nccopy. Ncdump used to read a netCDF dataset and prints its textual representation, ncgen reads data in textual representation and convert it into binary NetCDF, and nccopy reads a netCDF dataset using netCDF programming interface and copies into another netCDF dataset with chunking.

III. STUDY AREA AND DATA

A. Study area description

Bengaluru, the capital of Karnataka state is currently the fifth largest city and in India. This city is 920m above the sea level. Bengaluru Summer temperature is averagely 18-38˚C while in winter its between 12-15˚C.

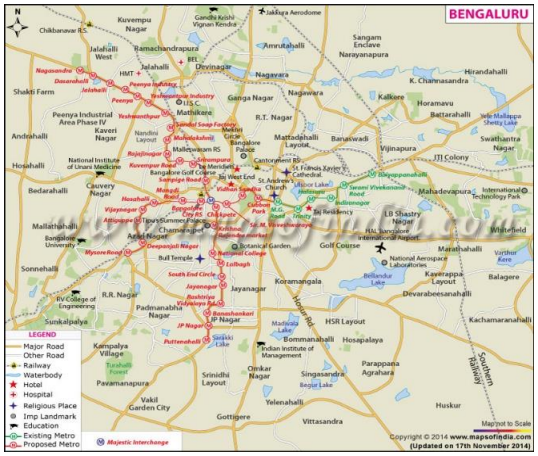

Fig. 1 Bengaluru Map

Rainy season in Bengaluru is from July to September and average rainfall is about 900mm each year.

B. Data

The research data consist to 20years of climate data and observations from 1995 to 2014. The observation data includes monthly mean temperature and monthly mean precipitation.

IV. ANALYSIS ON CLIMATE CHANGE

Bengaluru Climate doesn't fluctuates to a greater extend. As it is 900m above the sea level the climate of Bengaluru region is very pleasant.

Here in the analysis we have considered data from 1995 to 2014. Mean(R) of all considered parameter are determined using the formula:

$$(R) = \frac{Sum\ of\ Annual}{Number\ of\ years}$$

The deviation from the determined mean that is Mean Deviation Anamoly (Ra(i)) is determined using the formula:

$$Ra\ (i) = R_i - R$$

Here R_i is the considered parameters like annual, spring, monsoon, pre-monsoon and post-monsoon.

Once the Mean Deviation Anamoly is determined Deviation expression in percentage of mean(Ran(i)) is calculated using the formula:

$$Ran(i) = \frac{Ra(i)}{R} * 100$$

Trend lines gives the direction to where the given set of points are heading to. Trend line determines the behavior of given set of data.

Trend line $y = \alpha x + \beta$

$$Slope\ \alpha = \frac{n\sum(xy) - x\sum y}{n\sum x2 - (\sum x)2}$$

$$Offset\ \beta = \frac{\sum y - \alpha\sum x}{n}$$

Here x refers to x axis set of data and y refers to y axis set of data.

The below figure gives the details about the annual temperature of each year from 1995 to 2014. The yearly temperature is calculated from every month monthly average.

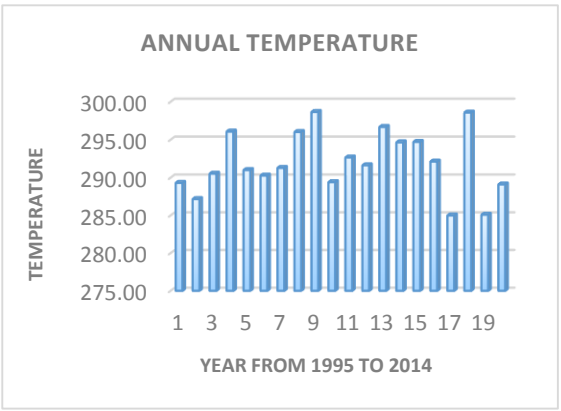

Fig 2: Annual Temperature

Similarly the precipitation is taken as second parameter and its annual precipitation is calculated for 20years. Here also each month's monthly average is considered and that corresponding year's annual precipitation is calculated.

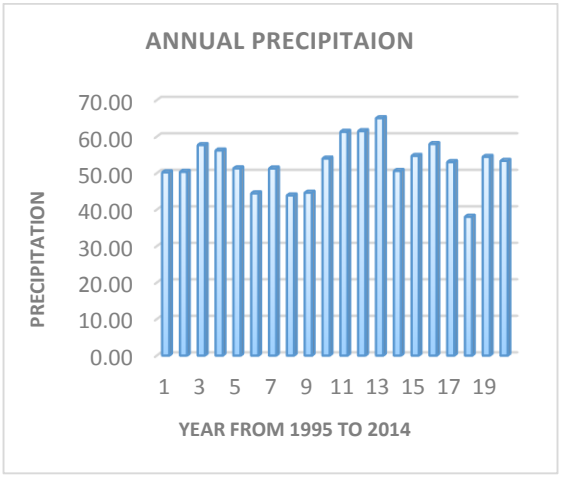

Fig 3: Annual Precipitation

Once the considered parameters are analyzed for annual that is for 12 months duration, then it continues for all seasons like spring, Monsoon, Pre-Monsoon, Post-Monsoon.

The Mean(R), Mean Deviation Anamoly (Ra(i)) and Deviation Expression (Ran(i)) are calculated for both considered parameters and for all above mentioned seasons. The results are calculated and graphs are plotted for each season.

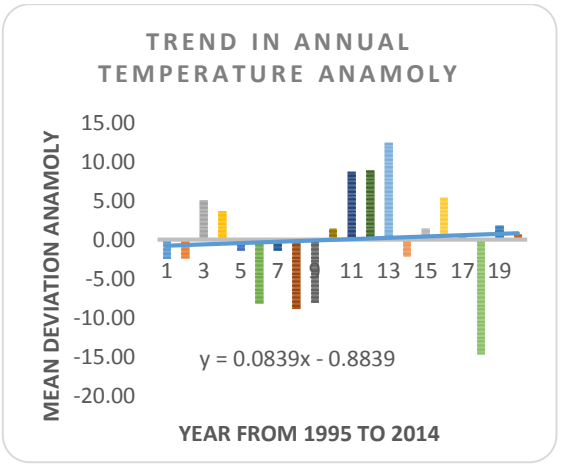

Fig 4: Trend in Anamoly

After plotting the graph, its trend line and trend equation are also calculated as shown in figure 4.

Trend lines gives the direction to where the given set of points are heading to. It determines the behavior of given set of data.

V. CONCLUSION

Here in the survey we have considered Bengaluru region for our research. For this region the temperature and precipitation parameters are considered because these are the two parameters mostly fluctuating these days.

For these two parameters the data are calculated from satellite source and data are analyzed and data for Bengaluru region is segregated. Later the annual, spring, monsoon, post-monsoon, pre-monsoon seasons data and obtained.

Using these data the Mean(R), Mean Deviation Anamoly (Ra(i)) and Deviation Expression (Ran(i)) are calculated for both considered parameters and for all above mentioned seasons.

The trend line and trend equation have been calculated. These trend line and trend equation gives to where the data are heading to.

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