Development of a Visualization System for Climate Data Analysis

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Abstract— **Now a days the concern about the climate studies is being increasing world over because of the natural disasters across the globe. In the present study an attempt is being made for developing a software system for Climate data Visualisation. The main aim is the development of an user friendly tool for the analysis as well as visualization representation of multi-source and multi-scale weather and climate data, which can be used for the efficient and real time analysis of weather and climate studies. On the growing importance of climate studies and High Performance Computing, different users starting from a farmer to a scientist to a policy maker needs to understand the various changes in the weather and climate parameters like Temperature, rainfall, humidity etc. Data discovery from multi-source like satellite, automatic weather station, reanalysis products and numerical weather prediction model outputs can be easily used and analysed.**

Keywords— **Visualisation, Weather and Climate Data, Analysis, Weather and Climate Parameters.**

I. INTRODUCTION

Weather is the state of the atmosphere, to the degree that it is hot or cold, wet or dry, calm or stormy, clear or cloudy. Most weather phenomena occur in the troposphere, just below the stratosphere. Weather generally refers to day-to-day temperature and precipitation activity, whereas climate is the term for the average atmospheric conditions over longer periods of time. When used without qualification, "weather" is understood to be the weather of Earth.

Weather forecasting is the application of science and technology to predict the state of the atmosphere for a future time and a given location. Human beings have attempted to predict the weather informally for millennia, and formally since at least the nineteenth century. Weather forecasts are made by collecting quantitative data about the current state of the atmosphere and using scientific understanding of atmospheric processes to project how the atmosphere will evolve.

Climate encompasses the statistics of temperature, humidity, atmospheric pressure, wind, precipitation, atmospheric particle count and other meteorological elemental measurements in a given region over long periods. Climate

can be contrasted to weather, which is the present condition of these elements and their variations over shorter periods. A region's climate is generated by the climate system, which has five components: atmosphere, hydrosphere, cryosphere, land surface, and biosphere.

With growth of computing power, virtualization techniques, satellite data and weather models now a days it can be possible to disseminate the information of weather and climate in a nice and user friendly way, which in turn can be easily used by various users like farmer, water manager, engineers to the policy maker.

The main objective of this study is to develop a GUI based platform for the visualization and analysis of multi-source and multi-format satellite and model derived climatological parameters like sea surface temperature, wind, temperature, cloud, humidity etc.

II. SOFTWARE AND TOOLS USED

A. GrADS

The Grid Analysis and Display System (GrADS) is an interactive desktop tool that is used for easy access, manipulation, and visualization of earth science data.

GrADS [1] uses a 5-Dimensional data environment: the four conventional dimensions (longitude, latitude, vertical level, and time) plus an optional 5th dimension for grids that is generally implemented but designed to be used for ensembles.

Data may be displayed using a variety of graphical techniques: line and bar graphs, scatter plots, smoothed contours, shaded contours, streamlines, wind vectors, grid boxes, shaded grid boxes, and station model plots.

B. Ferret

Ferret is a workstation-based visualization and analysis environment designed to meet the needs of physical scientists studying global ocean-climate interactions [2]. Ferret was developed as an adjunct to the numerical modelling studies of the Thermal Modelling and Analysis Project (NOAA/TMAP). Ferret was created in the belief that unifying data management,

analysis, and visualization and placing them directly in the hands of scientists would lead to new levels of productivity.

C. *Microsoft Visual Studio 2010*

Microsoft Visual Studio is an integrated development environment (IDE) from Microsoft. It is used to develop console and graphical user interface applications along with Windows Forms or WPF applications, web sites, web applications, and web services in both native code together with managed code for all platforms supported by Microsoft Windows, Windows Mobile, Windows CE, .NET Framework, .NET Compact Framework and Microsoft Silverlight.

Visual Studio includes a code editor supporting IntelliSense as well as code refactoring. The integrated debugger works both as a source-level debugger and a machine-level debugger. Other built-in tools include a forms designer for building GUI applications, designer, class designer, and database schema designer. It accepts plug-ins that enhance the functionality at almost every level—including adding support for source-control systems (like Subversion and Visual SourceSafe) and adding new toolsets like editors and visual designers for domain or toolsets for other aspects of the software development lifecycle

D. *C(Programming Language)*

C is an imperative (procedural) language. It was designed to be compiled using a relatively straightforward compiler, to provide low-level access to memory, to provide language constructs that map efficiently to machine instructions, and to require minimal run-time support. C was therefore useful for many applications that had formerly been coded in assembly language, such as in system programming.

C has facilities for structured programming and allows lexical variable scope and recursion, while a static type system prevents many unintended operations. In C, all executable code is contained within subroutines, which are called "functions". Function parameters are always passed by value. Pass-by-reference is simulated in C by explicitly passing pointer values. C program source text is free-format, using the semicolon as a statement terminator and curly braces for grouping blocks of statements.

E. *C#(Programming Language)*

C# is a multi-paradigm programming language encompassing strong typing, imperative, declarative, functional, procedural, generic, object (class-based) and component-oriented programming disciplines. It is intended to be a simple, modern, general-purpose, object-oriented programming language.

III. SYSTEM DESIGN

A. *Data Flow Diagram*

The data flow diagram of the project work is described in the figure 1 below. In the 1st step multi-source data are taken, then through the algorithm the spatio-temporal analysis are being computed and finally the output is post processed by using GrADS and in C#. Finally the output in image format is presented. The GUI is also developed in C#. Here the data from IMD [3],TRMM [4] and NCEP [5] are used.
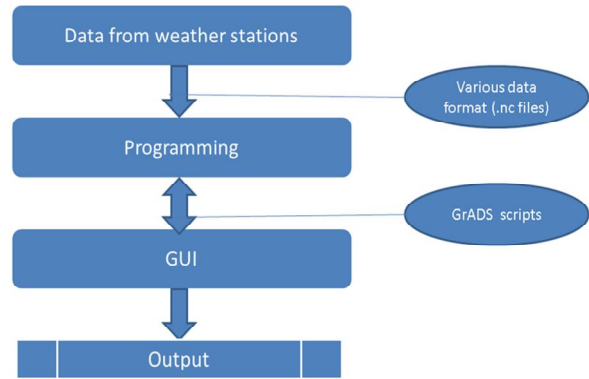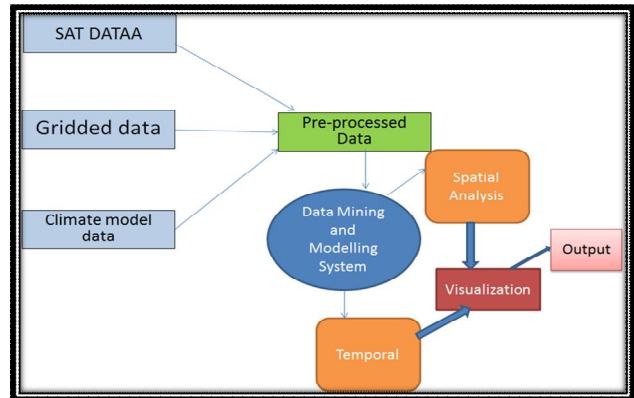

Fig. 1 Data Flow Diagram

Fig 2 Schematic of system analysis.

In the present system analysis basically three work steps are considered, firstly collect the multi-source satellite data, check the quality control like missing data etc. Then analysis the data as well as run the prediction model using the real time data as the initial condition, finally the post processing using the visualization software like GrADS for the easy dissemination of the results to the users. The schematic of the proposed system analysis is presented in figure 2.

IV. RESULTS AND DISCUSSIONS

The GUI and the visualization are well implemented and tested the user input like the parameters to be extracted from database and analysis is presented in the figure 3. Which basically allows the users to select the parameters like temperature, rainfall, wind, humidity etc.

Fig. 3 User input to select the parameters to be plotted

After selection of the data the corresponding global data breing fetched by the algorithm then the domain selection and time selection options should be provided by the user depending upon the area of interest. The drop down menu is in the left side of the GUI presented in figure 4.
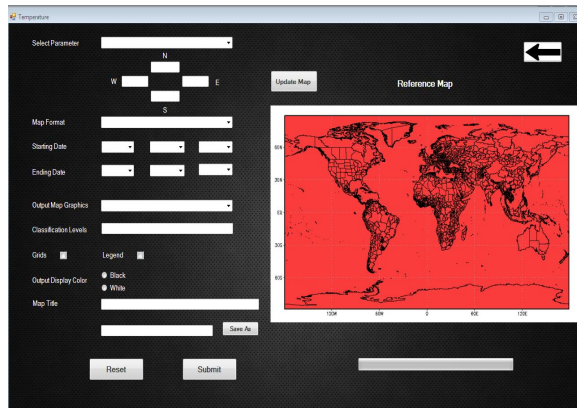

Fig. 4 Screenshot of developed GUI for Visualizations of global map to select the domain of interest

After getting the spatial and temporal extent the system uses the spatio-temporal data analysis algorithm and also the statistical analysis like the area averaging, time averaging, generation of climatology over an area as well as the time average at a single position etc. and the final spatial results are generated and visualised with GrADS background analysis. Fig 5 and 6 represents respectively the contour and shaded map of the rainfall over Indian land mass as well as over the adjoining seas like Bay of Bengal in east and Arabian sea in the west.
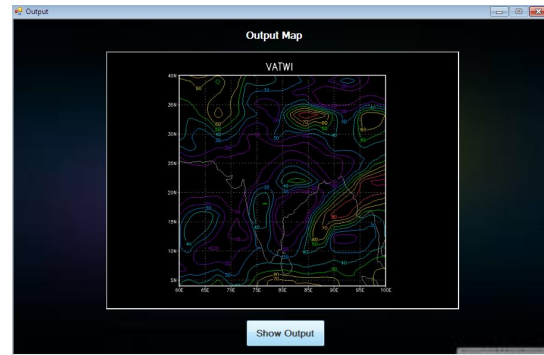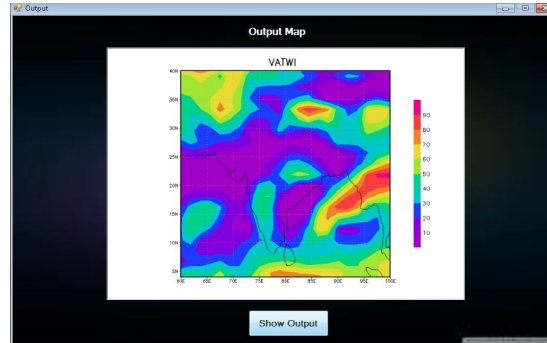

Fig 5 Final output in contour map

Fig 6 Screenshot of Visualizations (shaded) of regional map over India

V. CONCLUSIONS

In this work a GUI based platform is developed which is a user friendly tool for the analysis as well as visualization representation of multi-source and multi-scale weather and climate data. This can be used for the efficient and real time analysis of weather and climate studies, model derived climatological parameters such as sea surface temperature, wind, atmospheric temperature, cloud, humidity etc.

It can be used as a very robust tool for the visualization of multi-scale weather data with metadata. It can also be used for the weather informatics for users like farmers, water managers, disaster managers etc. It ensures well representation of spatial (map) and temporal data. It could also be used in statistical analysis over regions of interest also can be interfaced with web for the web visualization.

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