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Assessment of Temperature Scenarios for Chhattisgarh by using RegCM

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ABSTRACT

Computational modeling is playing significant role to simulate the climate scenario. RegCM is a popular climate modeling and it is adopted in various study. In this paper, RegCM 4.5 is used to assessment of temperature of last 25 years in context of Chhattisgarh. The simulated result was validated with the IMD dataset.

Keywords— RegCM, Climate Change, Computational Modelling

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I. INTRODUCTION

Climate change is a universal environmental challenge. The climate models are being used around the world using climate change scenarios in order to present the future scenario [1]. A climate model is an important tool to generate information regarding future changes in climate average and variability to better anticipate potential impacts of climate change. Climate models are used to understand the current climate, especially those processes that create a particular climate in each place. To become confident that a model correctly represents everything that shapes climate, scientists test models to see if they can accurately depict the current climate or recent historical climates on Earth. In this way, developers can improve the computer code that represents important physical processes that shape climate in any region [2][3].

In this study, the assessment for the temperature Chhattisgarh State of India is considered. The climate of Chhattisgarh is tropical. It is hot and humid because of its proximity to the Tropic of Cancer and its dependence on the monsoons for rains. Summer in Chhattisgarh is from April to June and temperatures can reach 48°C (100°F). The monsoon season is from late June to October and is a welcome respite from the heat. Chhattisgarh receives an average of 1,292 millimetres (50.9 in) of rain. Winter is from November to January and it is a good time to visit Chhattisgarh. Winters are pleasant with low temperatures and less humidity. The temperature varies between 30 and 47°C (86 and 117°F) in summer and between 5 and 25°C (41 and 77°F) during winter. However, extremes in temperature can be observed with scales falling to less than 0°C to 49°C. A study carried out in 2002 by the Institute for Human Development, New Delhi has identified several drought prone districts and blocks for priority attention [12]. The detailed studies/modelling on future climatic projections is not exist extensive with respect to Chhattisgarh.

II. RELATED WORK

Hu et al. [4] used BCC_RegCM 1.0 (RegCM for short) from Beijing Climate Center (BCC), China Meteorological Administration (CMA), the

Meiyu season characters over the Yangtze-Huaihe region during 1991–2005 are simulated. The major conclusions are as follows: (1) RegCM can reproduce the internal variation and the spatial distribution of the summertime precipitation and temperature in the Yangtze-Huaihe region. (2) By use of a generalized Meiyu criterion and in accordance with the model-calculated precipitation and temperature, the Meiyu onset and ending date have been determined. Compared with the observation, RegCM can simulate the interannual variation of the Yangtze-Huaihe Meiyu with preferable capability for most of the normal Meiyu year (such as 1995, 1997, 2000, 2001, 2002 and 2004), especially for the rich Meiyu years of 1996, 1998 and 1999. (3) In terms of the average simulation for the recent 15 years, the timings of onset and ending of Meiyu occur on June 1 and July 13, respectively, which are earlier than the climatological observation. For the duration, Meiyu persists for 32 d, 3 d shorter than the observation. The index of Meiyu intensity is 2.45, while the climatological one is 3.00. Therefore, RegCM is capable of simulating the climatological Meiyu duration and intensity, while the capability of simulating the onset and ending date of Meiyu still needs to be improved.

Almazroui [5] simulated of intense rainfall events over the Arabian Peninsula, this study examines its sensitivity to domain size, boundary location, forcing fields, and resolution. In the climatological results, RegCM3 performs well in reproducing the annual and the seasonal mean precipitation as well as the contrast between wet and dry years in terms of the amounts and locations of the rain bands. In addition, simulations are performed in two cases of intense rainfall events in the Jeddah area and surroundings using a combination of three domains and two boundaries forcing at 50 km. The results show that different combinations of these parameters provide different skills for the regional model. However, RegCM3 performs relatively better when ERA40 (NNRP2) is used at the boundaries in the smaller domain (larger domain), indicating the importance of the strong (relatively weaker) influence of the boundary forcing needed to capture these intense rainfall events around Jeddah. This may be explained by the fact that around that region, RegCM3 produces, in the smaller domain, higher relative humidity and stronger wind vectors closer to the analyse when nested within the ERA40, while it shows its best performance with the largest domain when driven by NNRP2. It is also shown that the use of high resolution does not systematically improve the simulation of such events, although some encouraging results were produced.

Ozturk et al. [6] experimented with the ICTP regional climate RegCM 4.0 model that was run for seasonal mean air temperature and precipitation total series were presented. The experiment consists of one simulation from 1989 to 2010 using ERA-Interim reanalysis data as the boundary condition, another simulation for the period 1970−2000 using the global climate model ECHAM5 A1B scenario data for forcing, and a simulation for the period 2070−2100 using the ECHAM5 A1B scenario projection data for forcing.

Giorgi et al. [7] compared RegCM4 with previous versions, includes new land surface, planetary boundary layer, and air–sea flux schemes, a mixed convection and tropical band configuration, modifications to the pre-existing radiative transfer and boundary layer schemes, and a full upgrade of the model code towards improved flexibility, portability, and user friendliness. The model can be interactively coupled to a 1D lake model, a simplified aerosol scheme (including organic carbon, black carbon, SO4, dust, and sea spray), and a gas phase chemistry module (CBM-Z). After a general description of the model, a series of test experiments are presented over 4 domains prescribed under the CORDEX framework (Africa, South America, East Asia, and Europe) to provide illustrative examples of the model behaviour and sensitivities under different climatic regimes. These experiments indicate that, overall, RegCM4shows an improved performance in several respects compared to previous versions, although further testing by the user community is needed to fully explore its sensitivities and range of applications.

Rajalakshmi et al. [1] analysised performance of the RegCM Model in simulating climate change projection over the Cauvery delta zone. The exit positive significant difference in rainfall and relative humidity, whereas negative significance for all other parameters, between RegCM3 and RegCM4 for yearly and decadal comparisons were identified. Further, considering

seasonal and monthly comparisons significant variations across weather variables were recorded.

Jaczewski et al. [8] performed the comparative study on teprature indices for three IPCC SRES scenario by utilizing the RegCM for the Poland. The period of 2011-2030 was used for the simulation and result shows that a mean yearly rise in the number of summer and hot days and a fall in the number of frost and ice days.

III. Data and Methodology

A. Study Area

According to the Köppen system, Indian states and districts are classified under six climatic zones, namely Montance, Humid subtropical, Tropical wet and dry, Tropical wet, Semiarid and Arid. Figure 1 depicts Köppen climate zone classification of India. In this study, in order to account the climate change effect and future scenario estimation, the study will focus on the existing climate zones of Chhattisgarh (Humid subtropical and Tropical wet and dry).

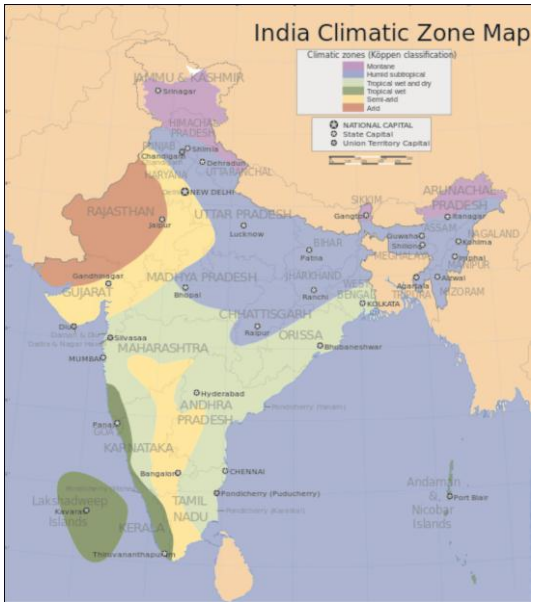

Figure 1. Köppen Climate Zone Classification of India (Source: www.wikimedia.org)

B. Data Access

The metrological data of Chhattisgarh was obtained from Indian Metrological Department (IMD), Pune. The following data sets to simulate the RegCM model were obtained from the The Abdus Salam International Centre for Theoretical Physics, Trieste, Italy[9]. These data were obtained in the netCDF file format.

Static Surface Dataset: The model needs topography and land type to localize on a particular domain. These data are global archives at 30 second horizontal resolution on a global latitude-longitude grid of the data. It is a global digital elevation model (DEM) with a horizontal grid spacing of 30 arc seconds (approximately 1 Kilometre) [10].

CLM Dataset: Community Land Model (CLM) data includes global land surface characteristics[10].

Sea Surface Temperature :Sea Surface Temperature (SST) data set includes ocean temperature[10].

Atmosphere and Land temperature Global Dataset: The model needs to build initial and boundary conditions for the regional scale, interpolating on the RegCM grid the data from a Global Climatic Model output [10]. EIN15 dataset for the year 1991 Jan 01 00:00:00 UTC to 2016 Dec 31 24:00:00 UTC were obtained and used in the simulation task.

C. Model Description

In this study, REGional Climate Model (RegCM) version 4.5 is used. RegCM was originally developed at the National Center for Atmospheric Research (NCAR). Terrain, ICBC, RegCM, and Postprocessor the four major components were used for the model simulation with respect to Chhattisgarh. Terrestrial variables (including elevation, land use and sea surface temperature) and three-dimensional isobaric meteorological data are horizontally interpolated from a latitude longitude mesh to a high-resolution domain on either a Rotated (and Normal) Mercator, Lambert Conformal, or Polar Stereographic projection [9][10]. The modelling system is shown in the Figure 2.

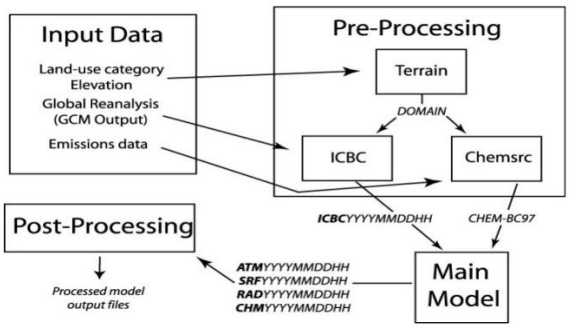

Figure 2. Different steps of modelling system [7][10].

IV. Simulation and Result

The model is localized with respect to Chhattisgarh and set up the centre longitude 81.82,

the centre latitude 21.29. The domain file was created. The Sea Surface Temperature were created by using sst program. Initial Condition, Boundary Conditions (ICBC) was created using the icbc program. The map of domain is depicted on figure 3 and the SST map is shown in the figure 4. The ICBC value of year 2011 is shown in the Figure 5 and Figure 6.

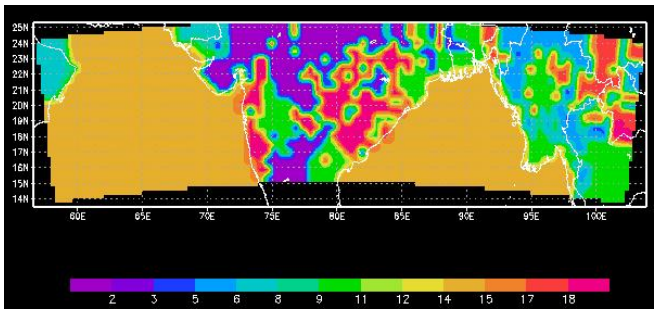

Figure 3. Domain

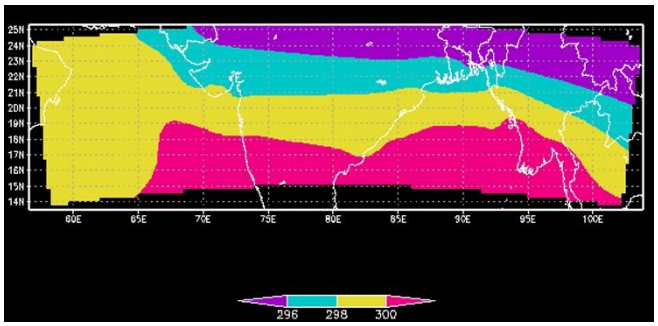

Figure 4. SST

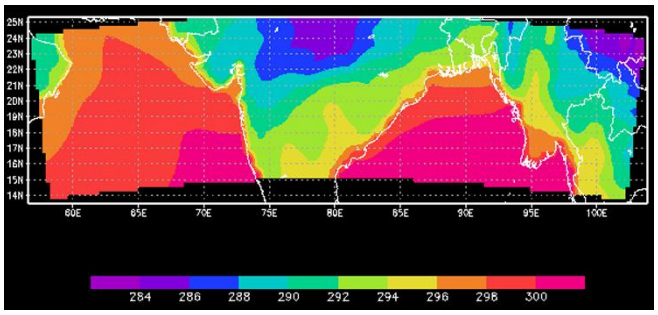

Figure 5. ICBC

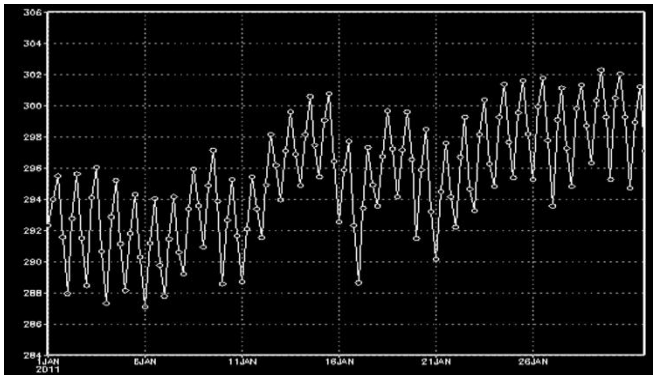

Figure 6.

The model were simulated by using Message Passing Interface feature regcmMPI. The atmosphere status from the model, surface diagnostic variable and the radiation fluxes information were generated after the end of simulation. Further, the mean and maximum temperature data were validated with the temperature data obtained from IMD.

V. Conclusion

The climate change study is become important in the present era. RegCM was utilized to simulated the temperature and radiation to taking the centre of Chhattisgarh. The result were validated with IMD data. The result shown that RegCM can be adopted as research tool for this area for further simulation such as hydro and chemical.

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