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Using GIS Methods to Predict NCAR Climate Change Data

Swapna Narla,

USA

Abstract: This research is an effort to investigate the use of Geographic Information System (GIS) methods for forecasting climate change data from the National Centers for Advanced Research (NCAR). Climate datasets used in this study were created using the Community Climate System Model (CCSM) and were made available through the National Center for Atmospheric Research (NCAR) GIS Initiative Climate Change Scenarios portal. These datasets were originally created for the IPCC 4th Assessment Report. This research validates the use of geographic information systems (GIS) as a powerful tool for assessing large-scale climatic data and pinpointing potential hotspots for climate change.

Keywords: CCSM, GIS, and data on climate change from the National Center for Atmospheric Research (NCAR)

1. Introduction

2. When the statistical distribution of weather patterns changes significantly and persistently throughout time scales from decades to millions of years, we say that the climate is changing. We think a geographic solution is necessary since this is a geographical issue. Users of geographic information systems (GIS) are a treasure trove of information when it comes to understanding the effects of climate change on both natural and human systems, as well as how to employ GIS as a foundational tool in this field.
   A monumental task lies in mitigating the dangers posed by climate change. Experts in several fields have used geographic information system (GIS) technology to get a deeper understanding of a complicated issue and provide concrete answers. We can learn more about Earth's processes on a really global scale with the use of a GIS-based framework, which also allows us to make better, more educated decisions. In this study, we show how to use a GIS to examine projected weather conditions derived from a Global Climate Model (GCM). Climate datasets distributed in a GIS format through the NCAR GIS Initiative Climate Change Scenarios portal were utilized in this study. The datasets were produced by the Community Climate System Model (CCSM) for the IPCC 4th Assessment Report. Here we compare the results of current-day climate models with those of future-day climate models.

3. Objectives

1. To demonstrate GIS-based analysis of the Northern hemisphere summer months (June, July and August) temperature anomaly in 2040 with respect to the averagesummer temperatures of present-day climate.
2. To compare the most current climatic data availablefrom the CCSM runs with an ensemble average, the 20thCentury (1980-1999) Experiment to the SRES A2 scenario ensemble average for 2040.
3. To create anomaly map to highlight areas around the globe that will experience either air temperature increaseor decrease in 2040 relative to 1980.

Database Software Used: ESRI ArcGIS 9.3
Region: Global
Data: NCAR GIS climate change portal.
Data set -1
CCSM Model Run: 20th Century Experiment, EnsembleAverage
Dates of Interest:

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June: Start Year: 1980, End Year: 1999 July: Start Year: 1980, End Year: 1999 August: Start Year: 1980, End Year: 1999**Dataset:** Atmospheric
Atmospheric Variable: Air Temperature (Degree Kelvin)
Download: Download shapes file Region

Data set-2
Global CCSM Model Run: Scenario A2, EnsembleAverage
Dates of Interest:
June: Start Year: 2021, End Year: 2040 July: Start Year: 2021, End Year: 2040 August: Start Year: 2021, End Year: 2040**Dataset:** Atmospheric
Data Atmospheric Variable: Air Temperature (DegreeKelvin)
Download: Download shapes file Region

3. Methodology

In the present study predicting NCAR Climate Change Data Using GIS techniques has been carried out using datais distributed through the National Center for Atmospheric Research (NCAR) GIS Initiative Climate ChangeScenarios portal in a GIS format. The methodology adopted in the present study is shown in the figure number 01.

20th Century Ensemble Average, JJA, 1980 – 1999								
ID	JJA1980Avg*	JJA1981Avg*	JJA1982Avg*	…	…	JJA1999Avg*	JJA20YearAvg	Std

Scenario A2 Ensemble Average, JJA, 2021 – 2040								
ID	JJA2021Avg*	JJA2022Avg*	JJA2023Avg*	…	…	JJA2040Avg*	JJA20YearAvg	Std

* Values are weighted averages

$$2021\text{Avg JJA} = \frac{((30*202106)+(31*202107)+(31*20210))}{92}$$

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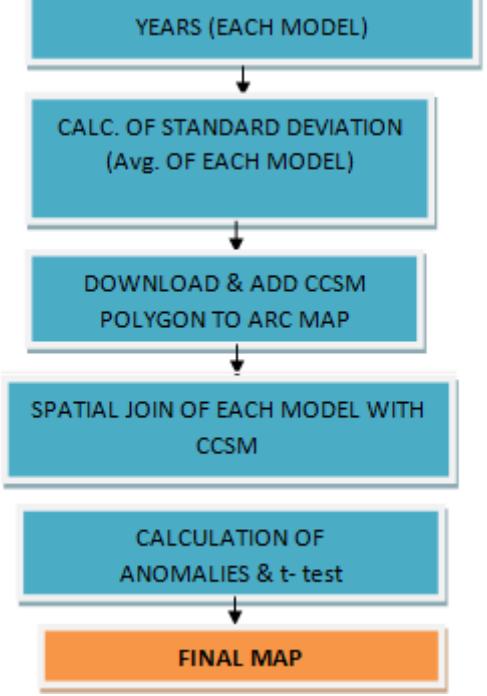

Figure 1

4. Methodology Adopted

Part 1 – **Download Data**
Download data from NCAR Climate Change Portal.

Part 2 – Calculate Summer Air Temperature Averages 1980-1999
Calculate summer average temperatures during the growing season (June, July, and August) using simulated, present day climate modeled output (1980 to 1999).

Part 3 – Calculate Summer Air Temperature Averages 2021-2040
Calculate summer average temperatures during the growing season (June, July, and August) using projected, future climate modeled output (2021 to 2040).Calculation of the JJA 20 year average for each modelrun year (1980-1999 & 2021-2040)

```
([tas_JJA_2021_2040_SRESA2.JJA2021avg]      +
[tas_JJA_2021_2040_SRESA2.JJA2022avg]       +
[tas_JJA_2021_2040_SRESA2.JJA2023avg]       +
[tas_JJA_2021_2040_SRESA2.JJA2024avg]       +
[tas_JJA_2021_2040_SRESA2.JJA2025avg]       +
[tas_JJA_2021_2040_SRESA2.JJA2026avg]       +
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[tas_JJA_2021_2040_SRESA2.JJA2028avg]       +
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[tas_JJA_2021_2040_SRESA2.JJA2037avg]       +
[tas_JJA_2021_2040_SRESA2.JJA2038avg]       +
[tas_JJA_2021_2040_SRESA2.JJA2039avg]       +
[tas_JJA_2021_2040_SRESA2.JJA2040avg]) / 20
```

Calculation of standard deviation using field calculator

$$\sigma_{N-1} = \sqrt{\frac{1}{N-1}\sum_{i=1}^{N}\left(x_i - \overline{x}\right)^2}$$

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Part 4 – Compare Average JJA Temperatures for bothModel Runs
Visually compare the temperature differences for the (1980 to 1999) and the (2021 to 2040) model runs.

Part 5 – Create a Temperature Anomaly Map
Create a temperature anomaly map to highlight areas around the globe that will experience either air temperature increases or decreases in 2040 relative to 1990.

Part-6- Student's t-test calculations were derived from the general formula

$$t = \frac{\overline{X_1} - \overline{X_2}}{\sqrt{\frac{\sigma_1^2 + \sigma_2^2}{N}}}$$

5. Analysis and Result

We analyzed and compared CCSM model runs, available through the GIS Climate Change Scenarios portal, in a GIS environment. We used one variable, air temperature, and compared simulations of a present-day climate to a projected climate of 2040. Same method can be applied to other, scenarios, variables and time periods that are available from the CCSM and the GIS portal. In addition, within a GIS framework, additional spatial informationsuch as land use/land cover change detection, population projections, or any other environmental and social spatial data of interest can be used for climate change impacts studies.

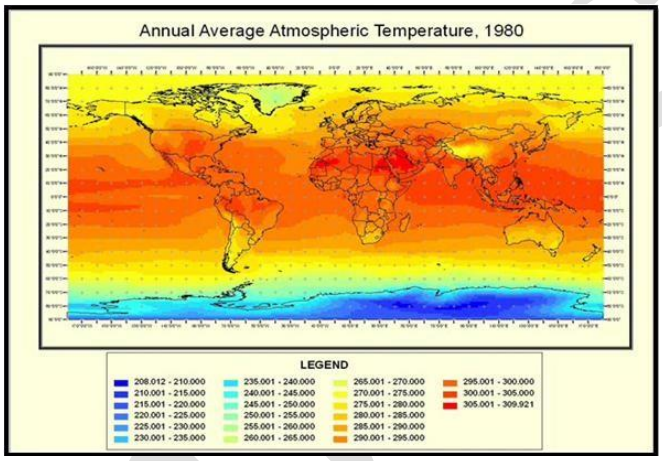

Figure No.02

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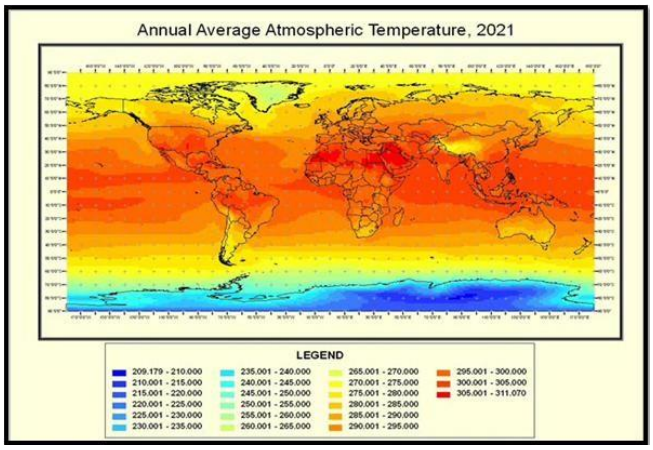

Figure No.03

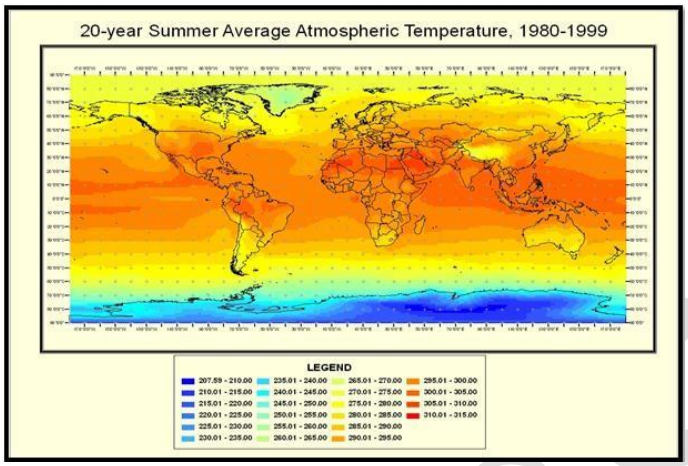

Figure No.04

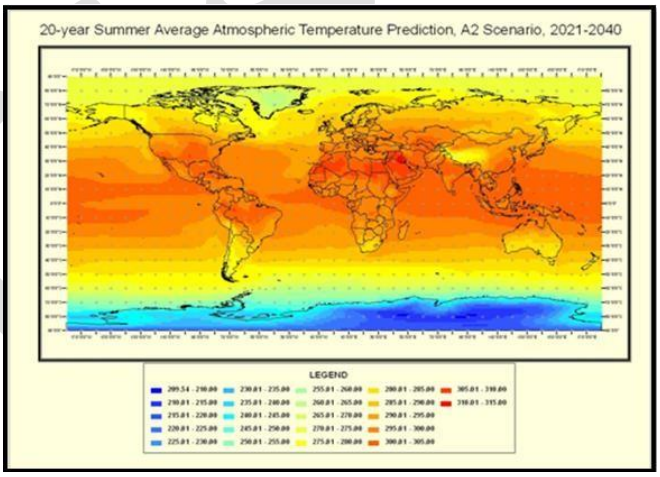

Figure No.05

Finally we understand the meaning and uncertainties of climate model projections. The data available through the NCAR Climate Change Portal are from one of many GCMs, (i.e., the Community Climate System Model), that contributed to the current understanding of the global Climate System. IPCC climate change projections were based on multi-model results from a world-wide climate modeling effort. As indicated in the final map the areas that are warming most dramatically are over land they are colored in red. The areas that are colored in blue show the temperature decreases (Figure no.06).

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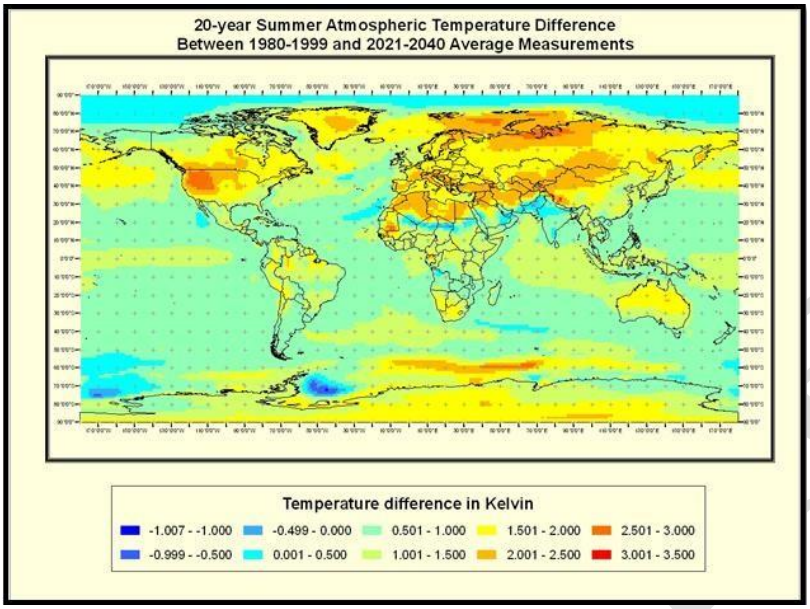
Figure No.06

6. Conclusion

Finally, our work lends credence to the idea that GIS is a valuable tool for qualitatively tracking global



climate change over the long haul. Moreover, GIS is a time-saving tool for studying climate data on a wide scale, and it can rapidly pinpoint the areas that will be most affected by climate change in the future. The final temperature anomaly map produced by a GIS allows one to formulate an appropriate policy strategy to lessen the impact of climate change on a worldwide scale.

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[2]The 2003 French Chaleur Wave and Its Health Effects (INVS, 2003). Perspectives and Bilan [The Effects of the 2003 French Heat Wave on Public Health] Holy Spirit Health Institute, Saint-Maurice, 120 pages.

Climate Change 2007: Impacts, Adaptation, and Vulnerability was published by the IPCC in 2007. Publication by Cambridge University Press, Cambridge, UK, 976 pages, edited by M.L. Parry, O.F. Canziani, J.P. Palutikof, P.J. van der Linden, and C.E. Hanson, as part of Working Group II's contribution to the IPCC's Fourth Assessment Report.

According to [4], you may get this information at: http://serc.carleton.edu/eet/ncardatagis/index.html.

The Global Impacts of Climate Change [5] website