2022 Asia and Pacific Mathematical Contest in Modeling

Problem C

Global Warming OR Not?

Canada's 49.6 °C has set a new temperature record for regions above 50 °N of the earth, and hundreds of people died of heat within a week; Death Valley, California, USA, is 54.4 °C, which is the highest temperature ever recorded on the earth; Kuwait 53.5 °C, even more than 70 °C under direct sunlight, and more than 50 °C in many countries in the Middle East.

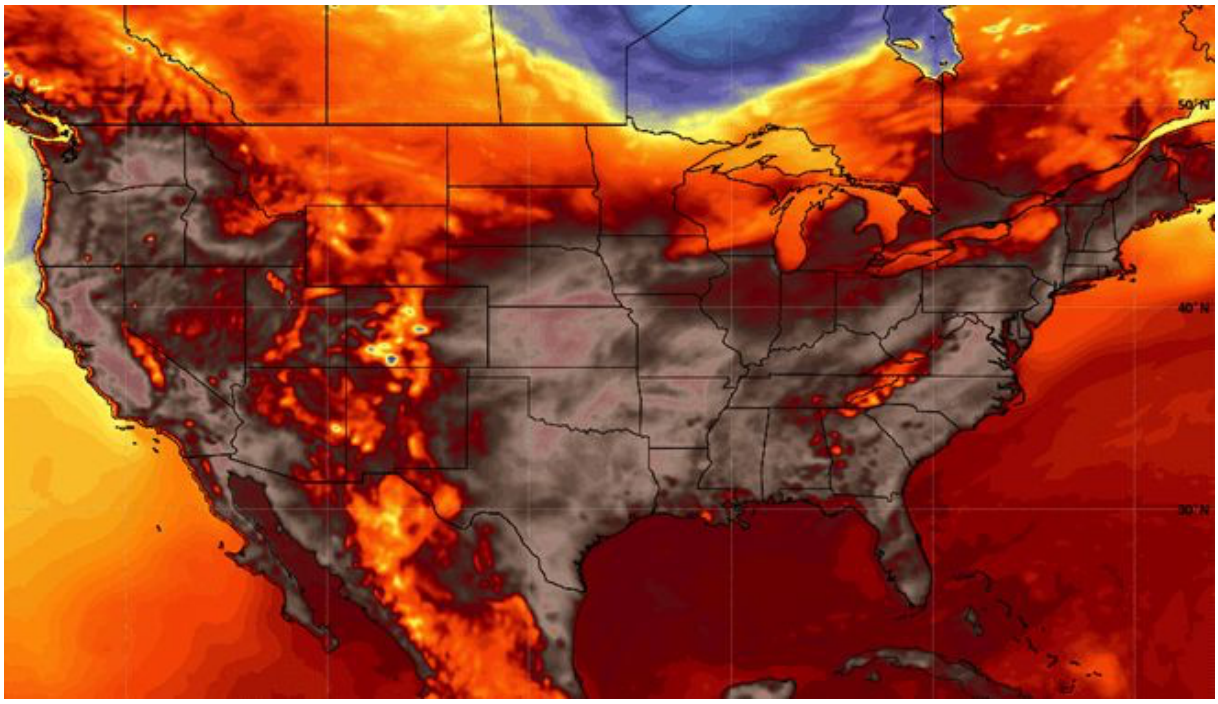

Figure 1. The high temperature in North American.

Since this year, we have seen a large amount of amazing temperature reports. The reality that the earth is burning is beyond doubt. Following the terrible high temperature in these regions from the end of June to the beginning of July, Italy once again set a European temperature record, reaching an astonishing 48.8 °C, and many countries declared a state of emergency.

Global climate warming is a phenomenon related to nature. It is due to the continuous accumulation of greenhouse effect, which leads to the imbalance of energy absorbed and emitted by the earth atmosphere system, and the continuous accumulation of energy in the earth atmosphere system, leading to temperature rise and global climate warming.

Prior to the Industrial Revolution, carbon dioxide (CO_2) in the atmosphere was consistently around 280 parts per million (ppm). The concentration of CO_2 in the atmosphere reached 377.7 ppm in March of 2004, resulting in the largest 10-year average increase up to that time.[1] According to scientists from National Oceanographic and Atmospheric Administration (NOAA) and Scripps Institution of Oceanography (SIO) the monthly mean CO_2 concentration level peaked at 421 ppm in May 2022.[2] An Organisation for Economic Co-Operations and Development (OECD) report predicts a CO_2 level of 685 ppm by 2050.[3]

The APMCM organizing committee has asked your team to address these claims of the current reported and future predictions of global temperature levels. They provided data set 2022_APMCM_C_Data.csv which contains 239177 records to assist in your research.

Requirements

1. Do you agree with the claims of global temperature? Use 2022_APMCM_C_Data.csv in the attachment and other datasets your team collects to analyze global temperature changes.

a) Do you agree that the increase of global temperature in March 2022 resulted in a larger increase than observed over any previous 10-year period? Why or why not?

b) Based on the historical data, please build two or more mathematical models to describe the past and predict the future global temperature level.

c) Use each of your models in 1(b) to predict global temperatures in 2050 and 2100, respectively. Do any of your models agree with the prediction that the average global temperature of observation points in 2050 or 2100 will reach 20.00 °C? If not in 2050 or 2100, when will the average temperature of observation points in your prediction models reach 20.00 °C?

d) Which model you built in 1(b) do you consider most accurate? Why?

2. What are the reasons that affect the temperature change?

a) Use the results of question 1 and the data in the attachment 2022_ APMCM_C_ Data.csv and other datasets collected by your team, build a mathematical model to analyze the relationship (if any) between global temperature, time and location, and explain the relationship or prove that there is no relationship between them.

b) Please collect relevant data and analyze the factors of natural disasters (such as volcanic eruptions, forest fires and the COVID-19). Is there any impact on global temperature?

c) What do you think is the main reason that affects the global temperature change?

d) Do you think there are some measures to curb or slow down global warming?

3. Prepare a non-technical article (1 page maximum) Please write a non-technical article (1 page at most) to the APMCM organizing committee, explaining your team's findings and suggestions for the future.

Your PDF solution of no more than 25 total pages should include:

- One-page Summary Sheet.
- Table of Contents.
- Your complete solution.
- One-page non-technical Article.

Note: The APMCM Contest has a 25-page limit. All aspects of your submission count toward the 25-page limit (Summary Sheet, Table of Contents, Article). However, the pages of Reference List and Appendices are not limited.

Attachment:

2022_APMCM_C_Data.csv

Data Source: Berkeley Earth data page http://berkeleyearth.org/data/

References:

[1] National Oceanographic and Atmospheric Administration. NOAA Earth System Research Laboratory. (2022, October). Trends in atmospheric carbon dioxide [Internet]. https://gml.noaa.gov/ccgg/trends/data.html

[2] National Oceanographic and Atmospheric Administration. NOAA Research News & Features. (2022, June 3). Carbon dioxide now mare than 50% higher than pre-industrial levels [Internet].https://www.noaa.gov/news-release/carbon-dioxide-now-more-than-50-higher-than-pre-industrial-levels.

[3] Organisation for Economic Co-Operations and Development. (2012). The OECD environmental outlook to 2050 [Internet]. https://www.oecd.org/env/cc/Outlook%20to%202050_Climate%20Change%20Chapter_HIGLIGHTS-FINA-8pager-UPDATED%20NOV2012.pdf.