1 Introduction

1.1 Problem Background

From around 800,000 years ago, CO2 concentration in the atmosphere has stayed relatively stable around 280 parts per million until the Industrial Revolution[[1]](#endnote-1). From the prevalence of steam engines in the early 19th century and following dazzling evolvement of coal-consuming industries, together with multiple chain effects in economy, has led to rapid increase in CO2 levels in the atmosphere. The growth rate has kept rocketing with progresses in productivity throughout major industrial renovations. With an annual increase of 2.66 ppm in 2021---the tenth consecutive year of an increase over 2 ppm[[2]](#endnote-2), we are currently facing the highest speed of CO2 concentrating around the globe since the very beginning of human kind. Yet, not until the last century did modern observations of climate change and global warming remind researchers of the impacts of CO2 levels worldwide. We are urged to analyze the relevance between CO2 concentration and temperature to predict future trends for references in environmental conservation, policy making and more sustainable development approaches.

Factors leading to CO2 emissions are far beyond estimation, and they are still expanding with new industries emerging from traditional ones. Direct emissions from industrial production and transportation block indirect agricultural factors responsible for increases in CO2 levels. Apart from the first and the second industry, following economic effects spread across the third industry. In underdeveloped regions, urban populations are booming and taking over more naturally vegetated fields and farmlands, decreasing the CO2 recycled through photosynthesis. Yet in contrast, the governments in developed regions are proposing carbon neutralization that has already been mentioned in legal reforms and policy making, limiting the rise of CO2 emissions to various extents.

These phenomena partially explain the controversy stirred up by predictions about the levels of CO2 in the atmosphere. In order to stress the urgent need, apart from seeking determining factors for prediction, observations on major variations that close resemble the changes are highly expected. Among these factors, temperature is widely endowed with the most importance, as excessive CO2 form barriers that block the exit of solar heat that accumulates to arouse greenhouse effects.

1.2 Restatement of Questions

Problem 1: In order to reassess current claims about CO2 levels, we will take various factors into account as materials for further modeling. For the creditability of the factors, we should research in advance and filtrate the wide range of emission sources according to relevance, comprehensiveness and reliability. We should then build mathematical models to each of these variations and produce multiple algorithms developed through separated methods. They are expected to describes the historical levels of CO2 in the atmosphere as early as recorded, so as to predict future changes in CO2 concentration. It is necessary to mention that despite the general trend of increase in CO2 emission, efforts made to neutralize the emission across the previous three stages ought not to be forgotten. According to the results, we will come to an opinion for or against the CO2 level claims and point out exactly when CO2 concentration reaches 685 ppm.

Problem 2: To find out the relationship between temperature CO2 concentration in the atmosphere, we will first need to combine different functions to build a fitting curve for the history of land-ocean temperatures. Upon finishing this section, we will then broaden our scope of analysis to list preselected possible factors influencing global temperature, including CO2 concentration that we have figured out. Through mathematical processes that inputs historical and predicted concentration, each factor’s proportional relative correlation with temperature will then be output to determine if CO2 is responsible for the majority of rise in temperature. Yet, this process only compares different factors. To acquire the relationship between solely CO2 and temperature, we need to process previous data outputs of the two variables through a quantifying approach. Results from the comparison, enhanced by a specifically quantified relationship, will support us to answer the problem.

1.3 Assumptions and Justifications

To simplify the problem, several assumptions and justifications are listed below.

Assumption 1: Solar Cycle Length maintains stable before 2100 when the prediction ends.

Justification: As the sun directly radiates a daily 340 watts in forms of heat to each square meter on earth[[3]](#endnote-3), global temperature is directly connected to the sun’s status over long periods of time. Yet its influence on modern changes in global temperature is calculated to be of little importance, and the 11-year length of a single cycle stays basically unchanged over the past century. Yet, the cycle is still viable, occasionally extending the peak or the trough of a cycle. Considering the disparate scale of the heat emitted by the sun and that received by earth, any vibration in the cycle will lead to sudden and drastic changes to temperature. We ought to keep this factor as irrelevant to lower unpredictability.

Assumption 2: Catastrophes with global influences, including alien invasion, world wars and large-scale natural disasters, are excluded from determining factors.

Justification: Upon reflecting on history, it is obvious that sudden turning points are generally out of expectation. Hardly are sudden changes dealt with well or in time, which leads to unpredictable chaos. Moreover, major nuclear-armed countries are to be trusted not to start world wars before 2100. Not only is the assumption realistic, but it also contributes to the simplification of models.

Assumption 3: CO2 concentration is in direct proportion to the influence on heat radiation from earth.

Justifications: The major approach in which CO2 concentration affects the changes in temperature is blocking the radiation of heat from earth into space. Because mathematical methods are limited to multiplying the CO2 curve to get the level that radiation is blocked, when CO2 changes equally twice in concentration, the depending blockade to radiation should theoretically change in equal amounts. Otherwise, any model that projects the relationship between CO2 and temperature will doubted as unrealistic.

Assumption 4:

1. https://gml.noaa.gov/ccgg/trends/history.html [↑](#endnote-ref-1)
2. https://www.noaa.gov/news-release/increase-in-atmospheric-methane-set-another-record-during-2021#:~:text=Meanwhile%2C%20levels%20of%20carbon%20dioxide%20also%20continue%20to,increase%20in%20the%2063%20years%20since%20monitoring%20began. [↑](#endnote-ref-2)
3. [↑](#endnote-ref-3)