Summary Sheet

Since the beginning of Industrial Revolution, the concentration of CO2 in the atmosphere, together with global temperature, has been on the rise. Past researches have proved that global warming will lead to irreversible damages to earth’s ecosystems, posing threat on human civilization. To take stronger control of economic fluctuations and to implement effective conservational policies, we are in urgent need for accurate predictions of CO2 levels and its relationship with global temperature.

In this paper, we built two sets of models in an effort to demonstrate our own perspectives and suggest proper responses. In Problem one, we first selected 10 factors that directly influence or reflect the changes in CO2 emission, including urban population, global GDP, industry added value and forest area. Then, we developed three parallel models to predict the CO2 concentration, which are applying successively Principal Components Analysis and Multivariate Regression (Model 1), extended STIRPAT projection (Model 2) and predictions based on Differential Equation, respectively. In Model 1, we first reduced the dimensions of original data to utilize Multivariate Regression and figured the relationship between CO2 and all ten factors. To simplify the database and stabilize the output, we designed our second algorithm based on the STIRPAT model. We applied Stepwise Regression to simplify factors and arrived at three factors of most importance to build a regression model, which produced the second projection. As for the third approach, we employed differential equation to express artificial feedbacks to the changes, in which two hand-picked factors featured the CO2 concentration’s function of time.

Thus, we received three interpretations of the relationship between economy, energy consumption and urbanization and atmospheric CO2 levels. Accordingly, the CO2 concentration will not reach 685 ppm by 2050. The figures projected that in 2100, CO2 levels will hit 650 ppm, 445 ppm or 460 ppm, respectively.

Upon answering Problem 2, to optimize the illustration of land-ocean temperature over the predicted future, we implemented Lowess smoothing to smoothen the historical curve and simulate the periodically increasing temperature with a specially designed function. The average land-ocean temperature is predicted to complete the 1.25C change in 2028, the 1.50C change in 2037 and the eventual 2C change in 2056 compared to the base period 1951-1980. We then divide the factors influencing land-ocean temperature into two categories: natural factors --- specifically, sunspots, solar shortwave radiation and earth longwave radiation --- and artificial factors: greenhouse gases emitted artificially, including CO2, CH4 and N2O. The Grey Relational Analysis is then applied to calculate the relative proportional influence of each factor upon changes in temperature, where CO2 scored 0.8, the highest among all factors listed. Finally, we quantify the extent to which CO2 is connected to temperature with Spearman’s coefficient. We took a partial-estimating strategy to figure out the trend of temperature-CO2 correlation. Eventually, we computed the coefficients as three functions, respectively yielded from three CO2-predicting models. The functions overlapped each other before 2060, when they seize to synchronize and go separate ways.