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Multivariate Analysis Rejects the Theory of Human-caused Atmospheric Carbon Dioxide Increase: The Sea Surface Temperature Rules

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Abstract

The impact of certain factors on the changes in atmospheric carbon dioxide (CO_2) concentrations has yet to be elucidated. In particular, the impacts of sea surface temperature (SST) on the balance of CO_2 emissions and absorption in the atmosphere and the human use of fossil fuels have not been rigorously compared. In this study, the impact of each factor was examined using multivariate analysis. Publicly available data from prominent climate research and energy-related organizations were used. Multiple linear regression analysis was performed using the annual changes in atmospheric CO_2 levels for each year as the objective variable. The SST and human emissions for each year were the explanatory factors. After 1959, the model using the SST derived from NASA best represented the annual CO_2 increase (regression coefficient $B = 2.406$, $P < 0.0002$, model $R^2 = 0.663$, $P <$ 7e-15). However, human emissions were not a determining factor in any of the regression models. Furthermore, the atmospheric CO_2 concentration predicted, using the regression equation obtained for the SST derived from UK-HADLEY centre after 1960, showed an extremely high correlation with the actual CO_2 concentration (Pearson correlation coefficient $r = 0.9995$, $P <$ 3e-92). The difference was 1.45 ppm in 2022. In conclusion, this study is the first to use multiple regression analysis to demonstrate that the independent determinant of the annual increase in atmospheric CO_2 concentration was SST, which showed strong predictive ability. However, human CO_2 emissions were irrelevant. This result indicates that atmospheric CO_2 has fluctuated as natural phenomenon, regardless of human activity.

Keywords: human emission; global warming; climate change; ice core; Jaworowski; CLINTEL

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1. Introduction

Since the establishment of the Intergovernmental Panel on Climate Change (IPCC), endorsed by Margaret Thatcher (Thatcher, [1]), the “so-called” global consensus that human emissions of carbon dioxide (CO_2) are the primary cause of global warming, has been said to be growing. Nowadays, the term "global warming" has been replaced by the term "climate change.” Beginning in 1990, the IPCC has published reports every few years. The latest version of the sixth report (IPCC, [2]) stated that humanity's impact on climate change is certain.

This argument has been also refuted by skeptics. In recent years, starting with the Global Warming Petition Project [3,4], the Nongovernmental International Panel on Climate Change (NIPCC) was established in 2007 (later the International Conference of Climate Change, Singer, [5]).

Furthermore, the Global Climate Intelligence Group (CLINTEL, [6]) and more than 90 Italian scientists [7] have denied the impact of humans on climate change. They share the belief that being pessimistic about the impact of increased anthropogenic CO_2 emissions is unnecessary. Among these beliefs, the rejection of the anthropogenic theory by John Clauser, Nobel laureate in Physics in 2022, is significant (Clauser, [8]).

The main indicators used in the climate change debate include atmospheric CO_2, human emissions, and land and sea surface temperatures. The accuracy of these temperature measurements has been debated since the early 1990s because of the differences between the data from meteorological satellites, observation balloons and the values of surface measurements [4,5,9]. For measurements recorded at the ground surface, issues have arisen related to the objectivity of the error correction, especially those caused by the heat island effect [4,5,9]. Thus, no realistic consensus exists on the extent of global warming.

Regarding the other main indicator, CO_2, the assumptions that its atmospheric levels have risen consistently since the post-industrial revolution and that this is due to human emissions are also controversial. High-precision measurements began at Mauna Loa, Hawaii, in 1959. However, a discrepancy exists between the ice core reproduction and the chemical method used for measuring atmospheric CO_2 concentrations before that time. Jaworowski noted that the historical figures of atmospheric CO_2 were underestimated by 30%–50% owing to various limitations of the ice core reconstruction method (Jaworowski, [10,11]). Jaworowski also strongly criticized the link between data from Hawaii since 1959 and the data reconstructed from the ice core [10,11,12]. The results of the analysis of radioisotopes have indicated defects in shifting the age of atmospheric constituents [10,11,13]. Jaworowski further noted [10] that the time required to release gas from the ice core could cause a huge discrepancy, by referring to a study of Stauffer et al. [14]. Furthermore, Beck [15] compiled and published data from many papers on CO_2 measurements using direct chemical methods. Recently, Yndestad [16] argued that atmospheric CO_2 concentrations are governed by the lunar node cycle.

The ocean is a huge reservoir of CO_2 and a major contributor to the global CO_2 cycle because of solubility changes with temperature. Therefore, depending on the temperature, CO_2 release into the atmosphere or CO_2 absorption occurs during both the day and the seasonal cycle. According to the National Aeronautics and Space Administration (NASA) Earth Observatory, annual emissions and absorption are approximately 330 gigatons for oceanic sources. The terrestrial biological origin of CO_2 is considered to be 440 gigatons absorbed by photosynthesis and 440 gigatons emitted by respiration [17]. However, precisely evaluating annual fluctuations is difficult because the amount of CO_2 fixed by organisms involves an increase in the total amount of organisms themselves. Volcanic emissions are considered stable. Human CO_2 emissions reached approximately 37 gigatons by 2021 (International Energy Agency (IEA), [18]). This should be considered much less than the amount released and absorbed by oceans and organisms. Based on this information, whether the increased atmospheric CO_2 values in recent years are attributable, at least partially, to human activity, and to what extent remain unclear. Therefore, the impact of human emissions on atmospheric CO_2 concentrations was statistically analyzed using multiple regression analysis. And if the human activity is responsible, it must be reflected in the analysis.

2. Methods

2.1 Data and evaluation periods

The indicators for each year were atmospheric CO_2, CO_2 emissions, and sea surface temperature (SST). Publicly available data from prominent climate research and energy-related organizations worldwide were used. Data from the National Oceanic and Atmospheric Administration (NOAA) were used to determine atmospheric CO_2 values [19]. The latest global SST data were derived from the University of Alabama in Huntsville (version 6.0, UAH-SST) (lower troposphere globe ocean data as a surrogate) (Spencer et al, [20,21]), HADLEY Centre (version HAD-SST4, HAD-

SST) [22,23], and NASA-Goddard Institute for Space Studies (GISS, version GISTEMP v4, GISS-SST) [24,25]. UAH-SST data were derived only from meteorological satellites. Because the UAH-SST data are provided monthly, the annual averages of the global sea temperature were calculated. The reason to use UAH data as SST surrogate is that meteorological satellite provides unbiased data all over the world and the temperature in the atmosphere above the ocean strongly reflects the SST. In fact, UAH-SST shows similar temperature trends and results of the analysis like the other SSTs, as described in the Results section. Each SST data until 2022 was available.

Based on the availability of data, the statistical analysis was divided into two periods, after 1979 and after 1959, depending on the starting year for each measurement. The UAH-SST was limited to the period after 1979.

Highly accurate measurements of CO_2 concentrations started being recorded on Hawaii in 1959 [19]. This data until 2022 is available. Data from the International Energy Agency (IEA, [18]) and Our World in Data (OWID, [26]) were used to determine human emissions. These data until 2021 were available. The IEA data were analyzed only from 1979 to 2021, whereas the OWID data were analyzed from 1959 to 2021 and from 1979 to 2021. The reason for this division is that publicly available CO_2 emission data from the IEA are only available for the period after 1971. Data before 1970 required registration and the payment of a fee (US$ 610 as of October 2023). Hopefully, all people worldwide will facilitate the viewing of the same results using publicly available data using inexpensive and widely used spreadsheet applications such as Microsoft® Excel. Therefore, OWID data were used in the analysis after 1959. The consistency of the IEA and OWID data is discussed in the Statistics and Results sections.

Thus, the combinations of data used were as follows:

- After 1979: IEA and OWID for human emissions; UAH, HADLEY, and GISS for SST.
- After 1959: OWID for human emissions; HADLEY and GISS for SST.

2.2 Statistical analysis

EZR Version 1.61 (Kanda (2013) [27]) and Microsoft® Excel were used for analysis. The Pearson correlation test was used to analyze the correlations for each indicator.

The steps of the analysis were as follows:

1. For the period between 1979 and 2021, we assessed the Pearson correlation of UAH-SST and emissions data obtained by the IEA against the annual CO_2 concentration increase.
2. For the period between 1979 and 2021, a multiple linear regression analysis was performed with the annual atmospheric CO_2 concentration increase as the objective variable and UAH-SST and IEA emissions as explanatory variables. Based on these results, which are discussed in more detail in the Results section, an analysis using more data and years was performed.
3. Correlations and differences between the SSTs of each agency (UAH, HADLEY, and GISS) were assessed with data up to 2021 using linear regression.
4. The correlations and differences between the IEA and OWID CO_2 emissions data were assessed.
5. For the period between 1979 and 2021, multiple linear regression analysis was performed with the annual atmospheric CO_2 concentration increase as the objective variable, and SST and CO_2 emissions as explanatory variables.
   As discussed in more detail in the Results section, similar multiple linear regression analysis results were obtained for UAH, HADLEY, and GISS for SSTs; IEA and OWID for CO_2 emissions; and for any combination. Subsequently, the following analyses were conducted.
6. For the period between 1959 and 2021, multiple linear regression analysis was similarly conducted using the annual atmospheric CO_2 concentration increase as the objective variable.

HADLEY or GISS for SST and OWID CO_2 emissions were used as the explanatory variables. The results of the multiple regression analyses were similar for each SST. However, each emission was strongly correlated to the HAD-SST and GISS-SST. The possibility of multicollinearity due to this phenomenon and the interpretation of the results are discussed in the APPENDIX.

7. Based on the results of the multiple linear regression analysis, the atmospheric CO_2 concentrations after 1979 and 1959 were predicted from the SST and compared with the actual NOAA data.

The calculation was performed as follows:

$$[\Delta CO_2]_i = B \times T_i + Co\,, \tag{1}$$

where $[\Delta CO_2]_i$ is the annual CO_2 concentration increase in the atmosphere, B is the regression coefficient for the SST, T_i is the SST of each year and Co is the constant of the regression model. As described in the Results section, the only statistically significant factor for the objective variable was SST and not human emissions. Therefore, the annual increase in atmospheric CO_2 concentration can be estimated using the above equation. Subsequently, the CO_2 concentrations were predicted as:

$$[CO_2]_n = \sum_{i=x}^{n} [\Delta CO_2]_i + C_{st}\,, \tag{2}$$

where $[CO_2]_n$ is the predicted atmospheric CO_2 concentration, and C_{st} is the actual value of the atmospheric CO_2 concentration in the starting year. For example, the predicted atmospheric CO_2 concentration in 2022 is the sum of the estimated annual increase during 1979–2022 and the actual atmospheric CO_2 concentration in 1978.

A P value of ≤ 0.05 was considered statistically significant (two-sided).

3. Results

Step 1: Figure 1 shows the correlation of UAH-SST (a) and IEA emissions (b) with the annual atmospheric increase in CO_2 concentration. A linear correlation is shown, with correlation coefficients of $r = 0.749$, $P < 8e\text{-}9$ for UAH-SST and $r = 0.581$, $P < 5e\text{-}5$ for emissions.

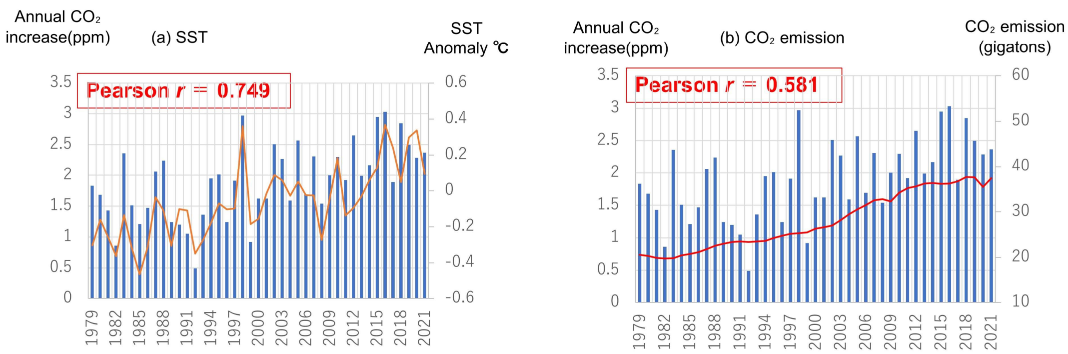

Figure 1. Comparison between annual increase in atmospheric CO_2 concentration and (a) SST, (b) anthropogenic CO_2 emissions:
(a) SST: sea surface temperature (orange line, right vertical axis) derived from the University of Alabama in Huntsville, Blue bar (left vertical axis): annual CO_2 increase derived from National Oceanic and Atmospheric Administration, SST anomaly "0" is the average through 1991 – 2020, horizontal axis: year
(b) anthropogenic CO_2 emission derived from International Energy Agency (red line, right vertical axis), Blue bar (left vertical axis): annual CO_2 increase derived from National Oceanic and Atmospheric Administration, horizontal axis: year

Step 2: Table 1 shows the results of the multiple linear regression analysis with the annual CO_2 change in concentration as the objective variable. Only UAH-SST was a significant explanatory factor (regression coefficient $B = 1.964$, $P < 4e-5$, model $R^2 = 0.571$, $P < 5e-8$). IEA CO_2 emission was not ($B = 0.013$, $P = 0.35$).

Table 1. Results of multiple linear regression analysis for annual increase in atmospheric CO_2 concentrations as objective variable.

Model R^2 = 0.571	*B*	*t*	*P*
Constant	1.660 (ppm)	4.068	< 0.0003
SST	1.964 (ppm/°C)	4.661	< 4e-05
CO_2 emission	0.013 (ppm/Gt)	0.949	0.348

B: regression coefficient (value of B in the equation (1)), t: result of t-test, SST: sea surface temperature derived from the University of Alabama in Huntsville, CO_2 emission derived from International Energy Agency

Step 3: Figure 2 (a, b) shows plots of three types of SST. From 1979 to 2022 (a), each SST was strongly correlated, and the slopes of the linear regression equation were similar. The results were similar from 1959 to 2022 (b).

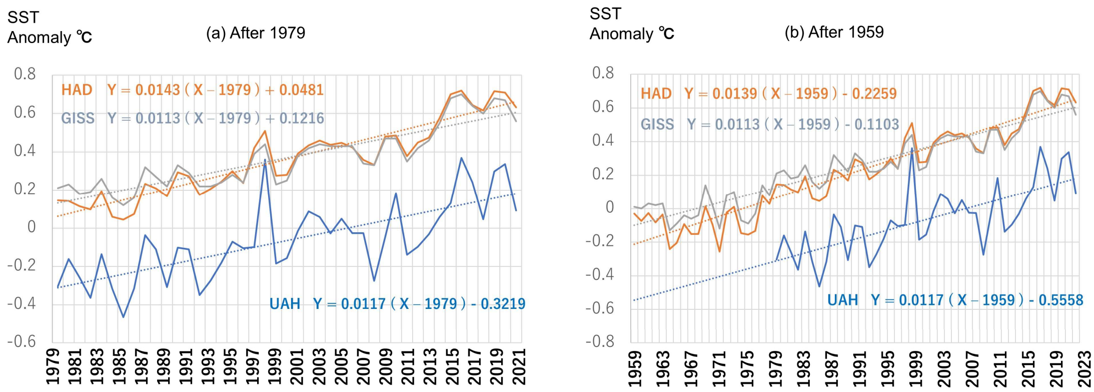

Figure 2. Comparison between SSTs: UAH - University of Alabama in Huntsville (blue line); HAD - Hadley centre (orange line): GISS - Goddard Institute for Space Studies (gray line). All SSTs are the difference from the average (UAH: 1991 – 2020, HAD: 1961-1990, GISS: 1951-1980). Horizontal axis: year, note that Y in the linear regression equation means SST anomaly, X means year. (a) after 1979, Pearson correlation coefficient, UAH vs HAD $r = 0.892$, $P < 5e-16$; UAH vs GISS $r = 0.888$, $P <$ e-15, (b) after 1959, Pearson correlation coefficient, HAD vs GISS $r = 0.993$, $P < 8e-59$.

Step 4: Figure 3 shows the strong correlation between the IEA and OWID emissions ($r = 0.9996$, $P < 2e-75$). The slopes of the linear regression were almost identical (0.446 for IEA and 0.454 (Gt / year) for OWID).

Step 5: Table 2 shows the results of the multiple linear regression analysis of the data after 1979. All data combinations yielded similar results. SST was consistently a strong independent determinant of annual CO_2 concentration increases but not human emissions. Moreover, no significant difference was found in the explanatory power of each SST using either emission type. In this step of the analysis, the combination of the IEA and UAH-SST data provided the most accurate predictions of the annual increases in CO_2 levels, and the explanatory power of the regression model was model $R^2 = 0.571$ ($P < 5e-8$), as described in Step 2. The analysis using the OWID instead of the IEA CO_2 emission data produced similar results in each regression model. The results of Steps 4 and 5 showed that the use of only OWID CO_2 emissions was appropriate after 1959.

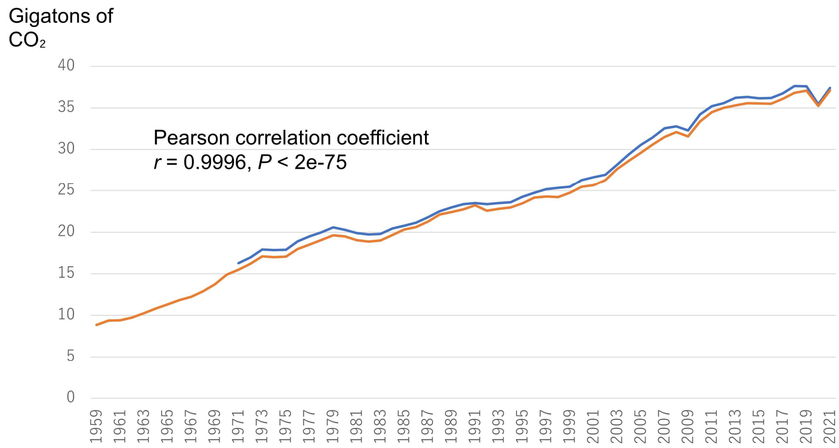

Figure 3. CO_2 emissions data of IEA and OWID. IEA - International Energy Agency (blue line), OWID - Our World In Data (orange line), horizontal axis: year.

Table 2. Results of multiple linear regression analysis for annual increase in atmospheric CO_2 concentrations as objective variable after 1979

	IEA emission			OWID emission		
	R^2=0.5711	***B***	***P***	***R^2=0.5702***	***B***	***P***
UAH	*Constant*	1.660	<0.0003	*Constant*	1.688	<0.0002
	UAH-SST	1.964	<4e-5	*UAH-SST*	1.977	<4e-5
	IEA emission	0.013	0.348	*OWID emission*	0.012	0.372
	R^2=0.5038	***B***	***P***	***R^2=0.5058***	***B***	***P***
HAD	*Constant*	1.505	<0.002	*Constant*	1.522	<0.002
	HAD-SST	2.834	<0.0008	*HAD-SST*	2.894	<0.0006
	IEA emission	-0.023	0.356	*OWID emission*	-0.025	0.314
	R^2=0.506	***B***	***P***	***R^2=0.5076***	***B***	***P***
GISS	*Constant*	1.136	<0.005	*Constant*	1.156	<0.004
	GISS-SST	3.155	<0.0007	*GISS-SST*	3.230	<0.0006
	IEA emission	-0.014	0.517	*OWID emission*	-0.017	0.458

B - regression coefficient (value of B in equation (1)), IEA - International Energy Agency, OWID - Our World In Data, SST - Sea surface temperature, UAH - University of Alabama in Huntsville, HAD - Hadley centre, GISS - Goddard Institute for Space Studies. Unit for constant is ppm, unit for SST is ℃, unit for emission is gigatons, note that the units for each B is the same as Table 1.

Step 6: Table 3 shows the results of the multiple linear regression analysis of the data from 1959. Similar to the above results, both SST data sources were independent determinants of the annual increase in CO_2 levels, but CO_2 emissions were not. Furthermore, the explanatory power of the regression models exceeded that of the models derived from the UAH-SST and IEA data after 1979. Both SST data sources produced similar results, including the explanatory power of the models. However, in terms of R^2, GISS-SST slightly outperformed HAD-SST (model R^2=0.663, P<7e-15).

Table 3. Multiple linear regression analysis for annual CO_2 increase as objective variable after 1959. Meaning of symbols and units of *B*, see Table 1 and 2.

R^2 = 0.6559	***B***	***P***
Constant	1.143	<0.0002
HAD-SST	2.006	<0.0003
OWID emission	0.0017	0.918

R^2 = 0.6628	***B***	***P***
Constant	0.953	<0.0002
GISS-SST	2.406	<0.0002
OWID emission	0.0027	0.863

Step 7: Thus, the annual increase in atmospheric CO_2 concentrations can be explained using the SST as follows:

$$\textit{Annual } CO_2 \textit{ increase} = 1.964 \times \textit{UAH-SST} + 1.660 \text{ (after 1979)}$$

$$\textit{Annual } CO_2 \textit{ increase} = 2.006 \times \textit{HAD-SST} + 1.143 \text{ (after 1959)}$$

$$\textit{Annual } CO_2 \textit{ increase} = 2.406 \times \textit{GISS-SST} + 0.953 \text{ (after 1959)}$$

Based on these equations, the atmospheric CO_2 concentration was predicted using the UAH-SST data after 1979 (values of the model using IEA data were selected according to the higher R^2), starting from the NOAA data in 1978. For HAD-SST and GISS-SST, CO_2 concentrations after 1960 were predicted using the 1959 NOAA data as the starting point. The results are shown in Figure 4(a, b, c).

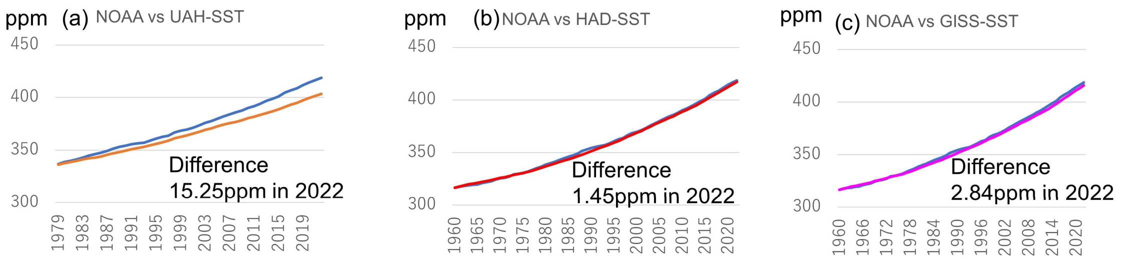

Figure 4. Measured and predicted CO_2 concentrations: (a) NOAA (all blue lines) vs UAH-SST (orange), (b) NOAA vs HAD-SST (red), (c) NOAA vs GISS-SST (purple), horizontal axes: year

The Pearson correlations between the predicted CO_2 concentrations and the NOAA measurements for each SST were as follows:

UAH-SST (1979～2022) $r = 0.9995$, $P <$ 4e-64

HAD-SST (1960～2022) $r = 0.9995$, $P <$ 3e-92

GISS-SST (1960～2022) $r = 0.9997$, $P <$ 7e-99

Each showed a very strong correlation.

The smallest error in 2022 was 1.45 ppm, which was predicted by HAD-SST, based on the analysis of data from the period starting in 1959.

4. Discussion

To the best of our knowledge, this is the first use of multiple regression analysis to demonstrate that SST has been the determinant of the annual changes in atmospheric CO_2 concentrations and that anthropogenic emissions have been irrelevant in this process, by head-to-head comparison. Furthermore, this study supports existing studies on the strong correlation between preceding global temperature changes and changes in atmospheric CO_2 concentrations (Harde, [28], Koutsoyiannis et al, [29], Salby et al, [30], Stallinga et al. [31]). Those results of this study are reasonable considering the total amount of CO_2 cycling on Earth. The annual CO_2 cycle includes 330 gigatons from oceanic sources, 440 gigatons from terrestrial sources, and 37 gigatons from human emissions, including recent years (NASA, [17], IEA, [18]). The CO_2 emitted by all the sources is used in photosynthesis and by the animals, both terrestrial and marine, that benefit from it. Furthermore, there has been a recent research reporting particularly of thermally induced CO_2 emissions from soil respiration in the tropical areas [Salby et al, [30]]. If the increase in atmospheric CO_2 were entirely caused by mankind, it would have been reflected in the multiple regression analysis, by cancelling the effect of SST (e.g. $B =$ 0.0613, $P < 0.05$ for OWID emissions; non-significant for HAD-SST, note that these values are obtained by univariate analysis.).

If the analysis in this study is incorrect, that is, if the results are artifacts, then all the data for each SST are fatally wrong, the CO_2 measurements since 1959 are fatally wrong, or both. Moreover, these data would be coincidentally incorrect. The emissions data being grossly erroneous is unlikely.

In this study, the data published by organizations with international reputations were used. The CO_2 concentrations on Hawaii were measured using trusted methods and are consistent with worldwide data (Figure 5) (NOAA, [32]). As such, the assumption that the most objective measure of air and ocean temperatures results from meteorological satellites, which can assess a wide range of areas, is reasonable. Among the UAH-SST, HAD-SST, and GISS-SST datasets used in this study, UAH-SST data are more sensitive and show a wider range of fluctuation (Figure 2). However, all datasets exhibit similar upward slopes. Furthermore, the Pearson correlation between HAD-SST and GISS-SST or UAH-SST was also high, at approximately 0.9. For the data from 1979 and later, the results of multiple linear regression analysis were similar for all three SST datasets, regardless which was used. The slopes of the HAD-SST and GISS-SST increases were similar when considering the analysis from 1959 onward. The explanatory power of the multiple regression analysis was stronger for HAD-SST and GISS-SST after 1959 than for UAH-SST after 1979. Therefore, as SST has been the main determinant of the CO_2 cycle between the ocean and the atmosphere, this indicates a causal relationship and its extent.

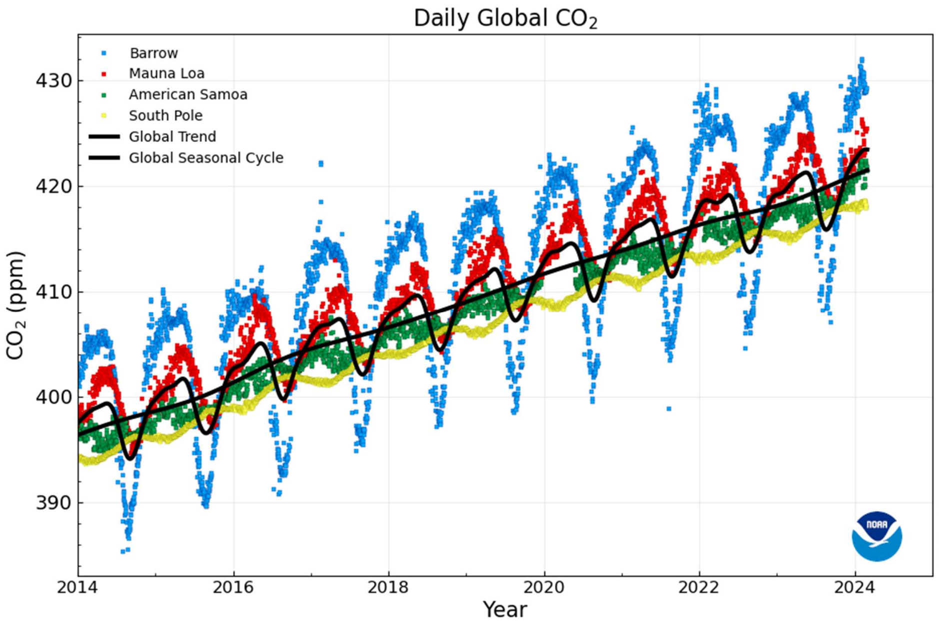

Figure 5. Recent Global CO_2 Trend: Image from National Oceanic and Atmospheric Administration.

Figure 1(a) illustrates this phenomenon. In 1992, the year of the global cold snap caused by the Pinatubo eruption, the atmospheric CO_2 concentration increased 0.49 ppm. If all the human emissions of the year had stayed in the atmosphere, they would have risen by approximately 3 ppm. In contrast, in 1998 and 2016, when El Niño warmed the world, the CO_2 concentration increased 2.97 and 3.05 ppm, respectively, showing a six-fold difference (3 divided by 0.5=6). Additionally, the emissions in these years were 23.4, 25.3, and 36.2 gigatons (IEA, [18]), respectively. Human emissions in 1992 and 1998 differed by only 8%. Moreover, the emissions in 2016 were only 1.56 times higher (36.2 divided by 23.4). These data suggest that the main factor governing the annual increase in atmospheric CO_2 concentration is the SST rather than human emissions, as confirmed by the results of the multiple linear regression analysis in this study. The results of this study are also consistent from a perspective of carbon isotope that the increase in the atmospheric CO_2 is originated from the ocean. As Spencer [33] pointed out in 2009, the ^{13}C concentration in the ocean is lower than in the atmosphere.

The atmospheric CO_2 concentration predicted using the UAH-SST dataset using the regression equation deviated the most from the NOAA-measured data as of 2022 (Figure 4a, b, c). In contrast, the HAD-SST and GISS-SST data from 1959 onward produced an accurate approximation. This result is reasonable because of the increased accuracy of the model in the regression analysis. HADLEY and GISS contain approximately 20 years more of data with good fit with the increase in atmospheric CO_2, which will consequently increase the explanatory power of the multiple regression analysis model. For HAD-SST and GISS-SST, the CO_2 values predicted using the model obtained with data only since 1979 were 30.8 and 21.1 ppm in 2022, respectively, which are overestimations compared with the measured CO_2 concentrations.

The results of this study also indicate that recent concentrations and increases in atmospheric CO_2 are not abnormally high as they are natural phenomena. The reasons why modern CO_2 concentrations have been said to be abnormally high (or the highest in one million years) are as follows: The atmospheric CO_2 concentration reconstructed using ice cores was approximately 280 ppm at the time of the Industrial Revolution, and the subsequent rise in CO_2 levels chronologically coincided with an increase in human activity. However, this theory has some fundamental limitations. As mentioned in the Introduction, reasonable arguments exist against the theory that modern CO_2 concentrations are abnormally high. Jaworowski pointed out [10,11] that ice core reconstructions of CO_2 concentrations were underestimated by 30–50%. Phenomena that support the argument by Jaworowski on the ice core method have been observed in the atmosphere, even in recent years. Although humanity is releasing vast amounts of methane, atmospheric methane concentrations have declined twice since the 21st century (Figure 6) (NOAA, [34]). If all human emissions of methane remain in the atmosphere, they would have to rise by more than 115 ppb per year in the 21st century and beyond (human emissions more than 0.3 gigatons (NASA, [35]), 1ppb ≅ 0.0026 gigatons). This indicates that natural fluctuations are far more powerful than human emissions in terms of the influence on atmospheric methane levels.

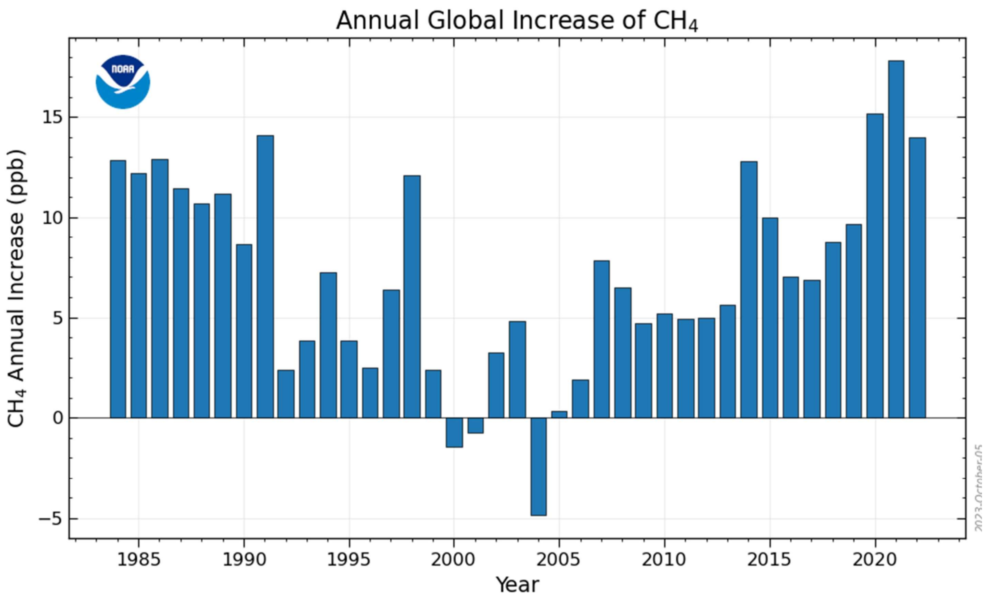

Figure 6. Recent atmospheric concentration of methane. Iimage taken from NOAA.

Furthermore, this contradicts the estimates that atmospheric methane concentrations have increased by approximately 1000 ppb since the Industrial Revolution (Figure 7) (IPCC, [36]). This fact supports the point made by Jaworowski [10,11] regarding the deficiencies in the reproduction method using ice cores, particularly with respect to the reproduced concentrations of the atmospheric components. Beck [15] compiled chemical measurements and reported that the pre-1958 values of atmospheric CO_2 concentration were several tens ppm higher than those reproduced in ice cores. The results of this study are consistent with those of these reports.

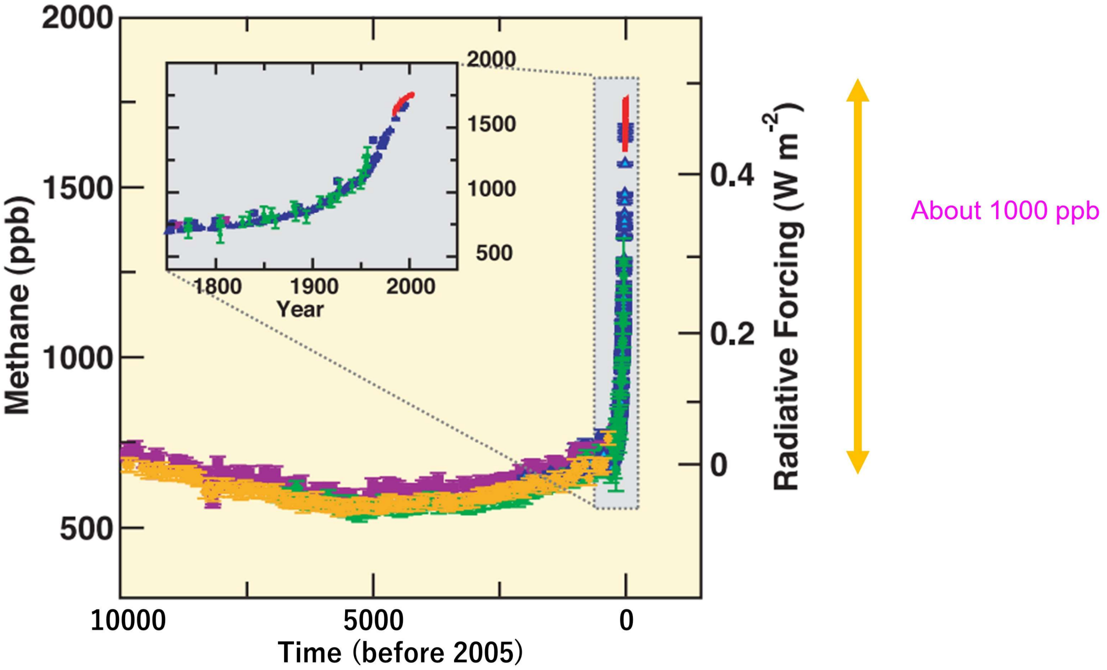

Figure 7. Reconstruction of atmospheric methane concentration. Image taken from the IPCC Fourth Assessment Report, Summary for Policymakers.

There are strengths and limitations in this study. This study involved a correlational analysis, which cannot identify direct causality. In addition, the effects of terrestrial organisms and volcanoes were not evaluated. These two indicators are difficult to precisely assess from year to year, unlike the CO_2 concentration measurements in Hawaii or human emissions.

However, as SST is a strong determinant of the CO_2 cycle between the ocean and the atmosphere, the assumption is reasonable that this is some proof of causality and its degree of influence. The results of the post-1959 analysis suggest that terrestrial organisms and volcanic activity may have been responsible for approximately 35% of the residual power in the regression model, which could not be explained by SST. Nevertheless, the accuracy of the CO_2 concentration predicted using each SST dataset (including the constants in the regression models) suggests that little improvement in the explanatory power can be expected.

All the results of the multiple linear regression analysis in this study could only be wrong if all the data in each SST dataset, if all the CO_2 measurements from Hawaii, or all of them are coincidentally similarly fatally wrong.

5. Conclusions

The global SST has been the main determinant of annual increases in atmospheric CO_2 concentrations since 1959. No human impact was observed. This result indicates that human efforts to curb CO_2 emissions have been, at least in the past, meaningless. Moreover, the theory that modern global warming and climate change are caused by human-emitted CO_2 is also wrong, irrelevantly to the credibility of the story that modern warming and climate change are occurring more dramatically than those in the past.

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Declaration of competing interest

The author declares no conflict of interest. Dai Ato, an autonomous and private researcher, authored this article as an academic activity based on the guaranteed right of freedom in an academy for the Japanese (Article 23) and the Supreme Law provided in Article 98 of the Constitution of Japan.

Data Availability

The data set used in this study is available as a supplemental file (Ato, 2024 [37]).

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Appendix

Discussion of the results about the high correlation between SSTs and human emissions

As shown in Appendix Table 1, HAD-SST or GISS-SST and emissions were highly correlated at the coefficient of approximately 0.9. On the other hand, it is slightly lower than 0.7 for UAH-SST and each emission.

Appendix Table 1. Pearson correlation coefficient between each indicator.
All abbreviations refer to the main text.

1979~2021	UAH-SST	HAD-SST	GISS-SST	IEA	OWID
Annual CO_2 Increase	r = 0.749, P = 7.46e-9	r = 0.702, P = 1.55e-7	r = 0.708, P = 1.12e-7	r = 0.581, P = 4.33e-5	r = 0.578, P = 4.98e-5
UAH-SST	---	r = 0.892, P = 1.03e-15	r = 0.886, P = 2.73e-15	r = 0.680, P = 5.33e-7	r = 0.679, P = 5.45e-7
HAD-SST	---	---	r = 0.984, P = 2.76e-32	r = 0.894, P = 6.52e-16	r = 0.895, P = 5.98e-16
GISS-SST	---	---	---	r = 0.872, P = 2.69e-14	r = 0.874, P = 2.1e-14
IEA	---	---	---	---	r = 0.999, P = 1.17e-62
1959~2021	**UAH-SST**	**HAD-SST**	**GISS-SST**	**IEA**	**OWID**
Annual CO_2 Increase	---	r = 0.810, P = 9.29e-16	r = 0.814, P = 5.03e-16	---	r = 0.753, P = 1.1e-12
HAD-SST	---	---	r = 0.993, P = 1.87e-57	---	r = 0.926, P = 1.64e-27
GISS-SST	---	---	---	---	r = 0.919, P = 2.73e-26

Furthermore, the correlation coefficient for CO_2 increase is consistently higher with SST than with emissions.

And in the analysis of Step 2 (after 1979), only UAH-SST was the explanatory factor in the multiple regression analysis. The Variance Inflation Factor (VIF) in this case is 1.86 in both IEA and OWID (Appendix Table 2).

Appendix Table 2. Variance inflation factors in the multiple regression analysis Annual CO_2 increase is the objective factor. All abbreviations refer to the main text.

	OWID	IEA
UAH-SST	<1979~2021> 1.86	<1979~2021> 1.86
HAD-SST	<1979~2021> 5.02 <1959~2021> 7.03	<1979~2021> 5.00
GISS-SST	<1979~2021> 4.22 <1959~2021> 6.41	<1979~2021> 4.17

The same analysis was performed (Step 5) using HAD-SST and GISS-SST in the post-1979 analysis, and the results of the multiple regression analysis were also similar. And the VIF was about 4 to 5 (Appendix Table 2).

Thus, at least as an interpretation of the results from the post-1979 analysis, the human emissions were not significant factor because of the high explanatory power of each SST.

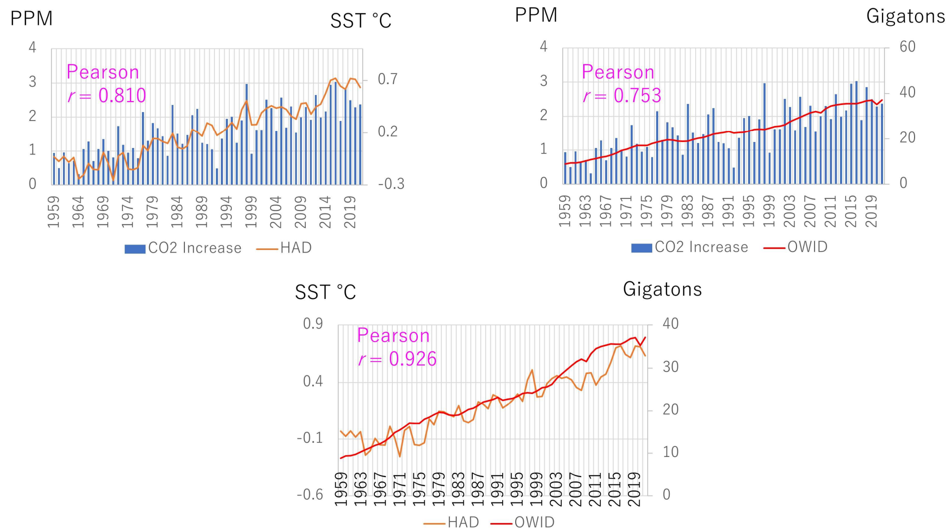
Furthermore, the results were essentially the same in the post-1959 analysis (Step 6).

Again, even in the post-1979 analysis, when emissions have clearly increased than before, only SSTs independently explained the annual increase of CO_2. Even during this period, human emissions did not predict the annual CO_2 increase. Therefore, it is inevitable that the same result was obtained including the period of much smaller emissions from 1959 to 1978 (27.30 ± 6.25 gigatons for after 1979, and 13.70 ± 3.43 gigatons between 1959 and 1978, OWID data).

And because the VIF is 6.4~7 in the entire period (Appendix Table 2), the results of the multiple regression analysis are considered reasonable and valid.

The predictive power of CO_2 concentrations by SST after 1959 (Step 7) also supports this interpretation and the results of this study.

For reference, correlation diagrams of each indicator since 1959 are shown below.



Appendix Figure. HAD-SST, human emissions, CO_2 increase between 1959 and 2021

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