2024 GLOBE International Virtual Scienc Symposium

Exploration of changes in carbon dioxide concentration at the school entrance

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Abstract

During the study, we recorded changes in carbon dioxide concentration at the school gate for about a month. After observing the data, we discuss the following three questions:

1. The impact of pedestrian and vehicle density on carbon dioxide concentration at the school gate.
2. The impact of weather factors on carbon dioxide concentration
3. The impact of students' transportation methods to and from school on carbon dioxide concentration at the school gate.

After analyzing the data and references, we found that vehicles are the cause of high carbon dioxide concentration during school hours, and whether the vehicle stalls or not will also affect the carbon dioxide concentration. In addition, it was also observed that the carbon dioxide concentration on cloudy days was higher than that on sunny days, which is speculated to be related to the photosynthesis of plants. Besides, through the survey on students' transportation methods when going home after school, it was found that half of the students still rely on their parents' car for transportation. Therefore, we will continue to observe and provide data for students' reference, promote the use of public transportation, engage in various carbon reduction activities, and advise students to wear masks when entering and leaving the school gate to protect their health.

Research motivation and purposes

In recent years, there has been an increased focus on air quality, and students spend one-third of their day on campus. Therefore, we focus on the campus. This study continues the title of the previous essays, focusing on the influence of vehicles and meteorological factors. Find out the correlation between air quality, vehicles and climate, and find solutions

Main discussion content

1. The instrument "Air Pollution Nose" is used to measure whether the concentration of carbon dioxide in the air will increase when the number of people and cars at the school gate increases during school hours. And explore the relationship between the two and the reasons behind it, or other

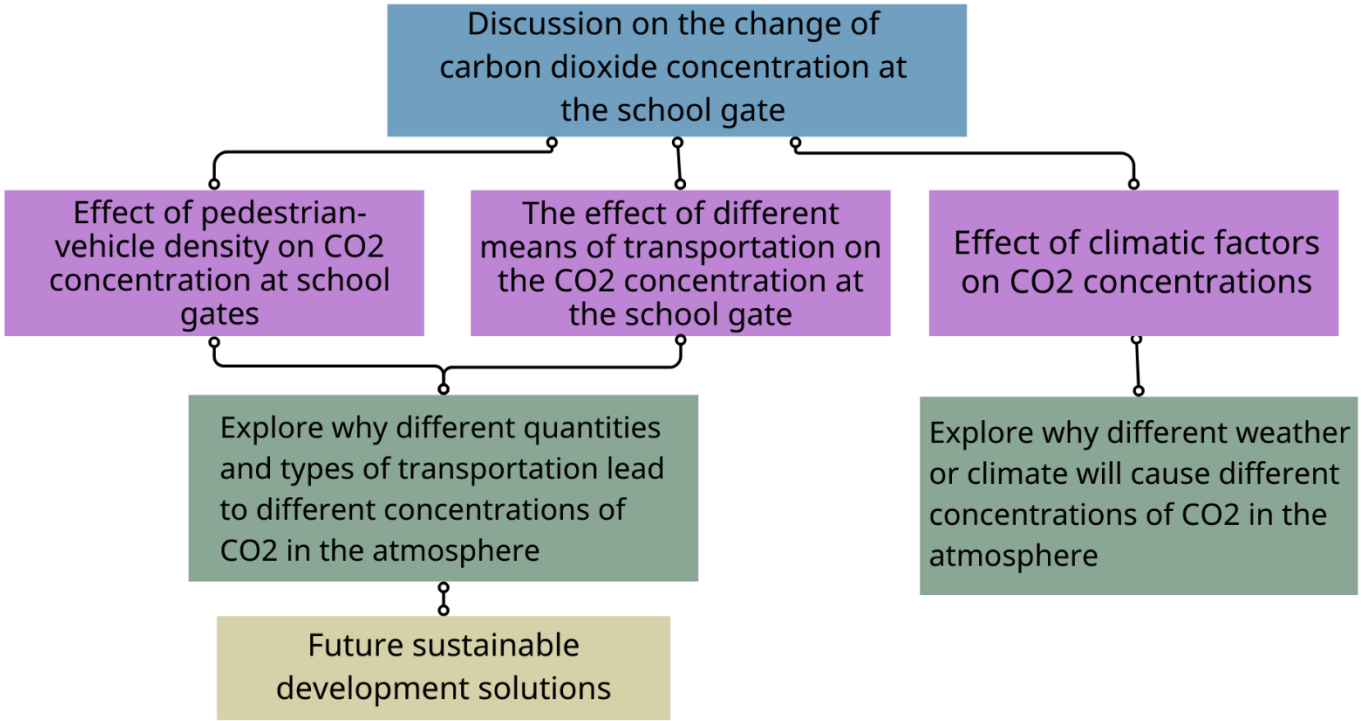
more related phenomena. and then allow actions to improve the problem.

2. To measure whether the concentration of carbon dioxide in the air rises when transportation is different between school and school.
3. To measure whether the concentration of carbon dioxide in the air will increase when the means of transportation are different during the school day and after school.

Research methods

1. Observe the distribution of vehicles and pedestrians at the school gate during school hours.
2. On-site instruments were used to measure the change characteristics of suspended particulate concentration and carbon dioxide concentration at the school gate during the school entrance period.
3. Understand the correlation between weather and dicarbon concentration through literature data.
4. Draw and analyze various observation data.

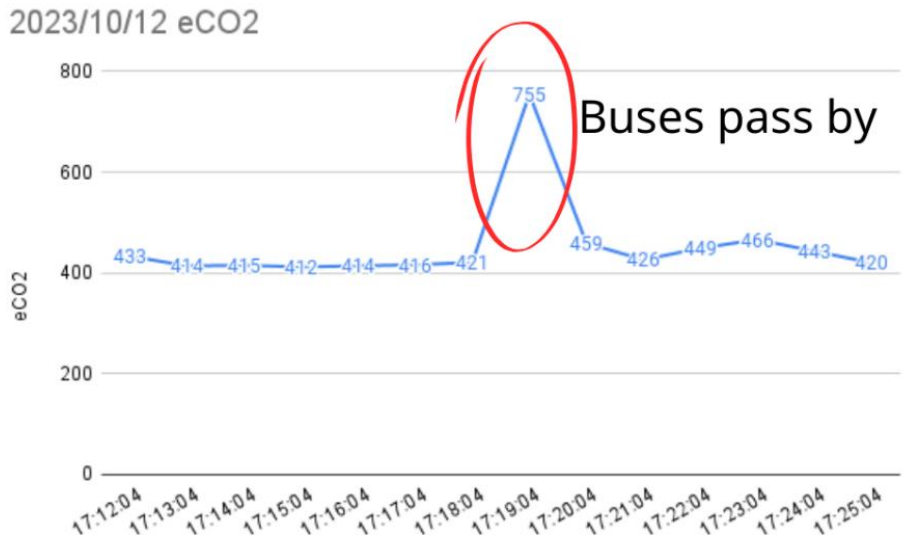
Research Process



(Figure1. Research flowcharts)

Research Data, Results, and Discussion

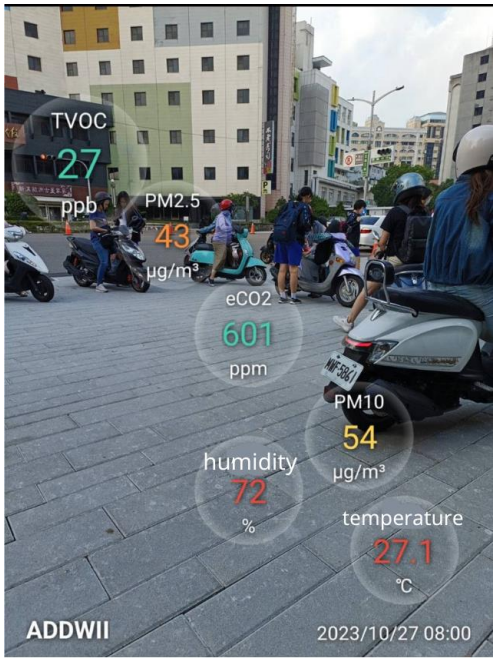
1. Observe and analyze the changes in carbon dioxide when vehicles pass by the school gate.



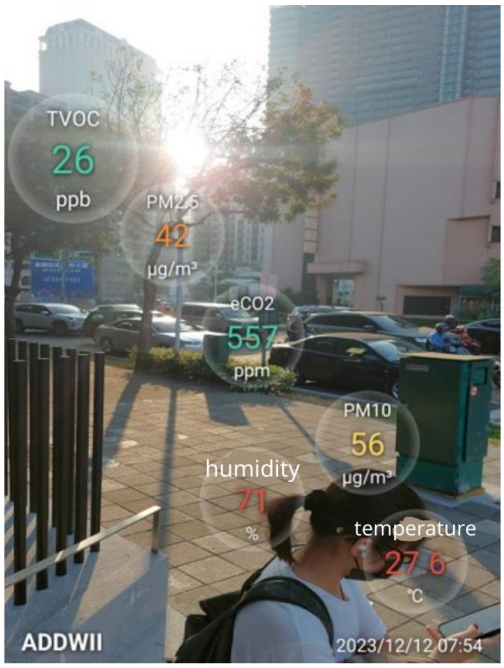
(Figure2. Changes in carbon dioxide concentration when a bus passes by)

(Figure3. Changes in carbon dioxide concentration when a car passes by)

Through the line chart, you can see that the normal carbon dioxide concentration is about 400ppm. When a car passes by, the carbon dioxide concentration increases by about 100ppm. When a bus passes by, the carbon dioxide concentration increases by about 250ppm. It can be seen that the number of vehicles during school hours is directly proportional to the concentration of carbon dioxide, and vehicles are one of the reasons for poor air quality during this period.



(Figure4. 6 motorcycles parked at the school gate)



(Figure5. 8 cars waiting at a traffic light)

(Figure6. 2 buses passing by)

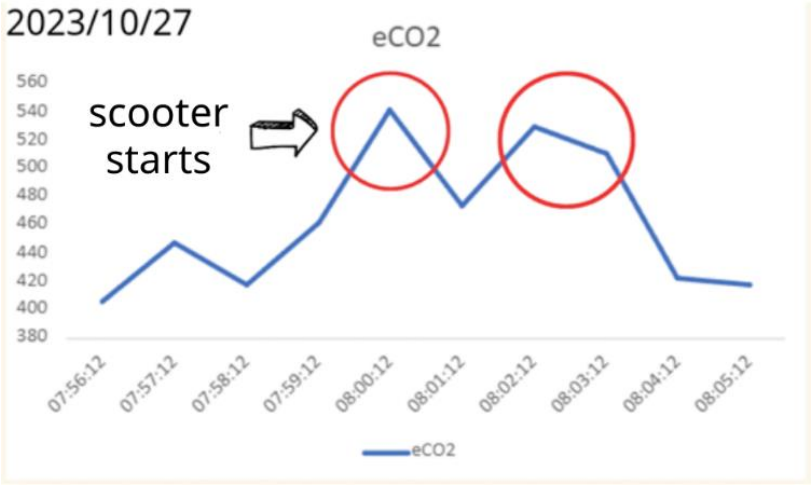
The three pictures above show 6 motorcycles parked at the school gate, with a carbon dioxide concentration of 601ppm (Figure4) 8 cars waiting at a traffic light, with a carbon dioxide concentration of 557ppm (Figure5) Two buses passing by, with a carbon dioxide concentration of 1064ppm (Figure6).

Although buses contribute more to the increase in carbon dioxide concentration compared to cars, they can carry nearly 8 times more passengers. When considering individual carbon emissions, taking the bus is still more environmentally friendly.

Upon reviewing the references, we found several discrepancies in our data. For example, it was observed that the increase in eCO2 caused by cars was lower compared to motorcycles. In our subsequent analysis, we discovered that this difference was due to the measurement setup. Due to safety concerns, the observers were unable to get too close to the road, resulting in spatial variations that introduced errors. However, there is another viewpoint that can be considered as supporting evidence. Even though the carbon dioxide concentration does not increase as much when cars are in motion compared to motorcycles, the average CO2 concentration in the atmosphere surrounding cars is higher than that around motorcycles during red

lights.

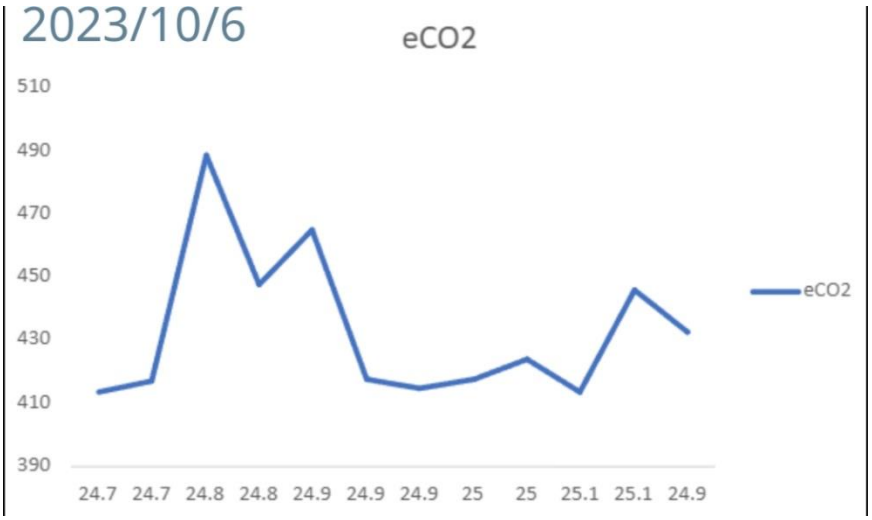
2. The impact of whether the vehicle is stalled on carbon dioxide concentration



(Figure7. Changes in carbon dioxide when the scooter is started)

It can be seen from the figure that when the motorcycle starts, the carbon dioxide concentration increases significantly by about 100ppm, and when the scooter stalls, the carbon dioxide concentration also decreases significantly. It can be inferred that scooter stalling can reduce the concentration of carbon dioxide. Some literature also mentioned that vehicle stalling can indeed reduce pollution. Therefore, it can be concluded that vehicle stalling is beneficial to reducing environmental pollution.

3. Correlation between weather and atmospheric carbon dioxide concentration.



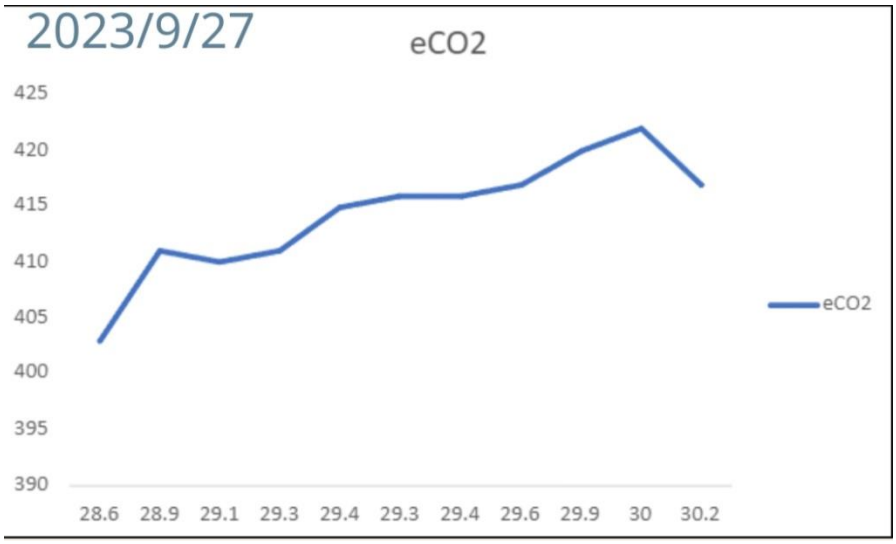
(Figure8. Changes in carbon dioxide concentration from 12:30 to 12:40 noon when the typhoon passes through.)

Vertical axis: eCO2 Unit: ppm

Horizontal axis: Temperature Unit: ℃

Average eCO2 concentration: 433ppm

Measurement location: Lawn



(Figure9. Changes in carbon dioxide concentration from 12:30 to 12:40 noon on a sunny day.)

Vertical axis: eCO2 Unit: ppm

Horizontal axis: Temperature Unit: ℃

Average eCO2 concentration: 414ppm

Measurement location: Lawn

October 6, 2023 is the moment when Typhoon Koinu passes through. From

Figure 5, we can see that the average concentration of carbon dioxide on October 6 is about 433 ppm, and the highest reached 490 ppm. Figure 6 is the data observed at noon on a clear day. The average concentration is about 414ppm, and the highest concentration is 420ppm.The average carbon dioxide concentration difference between these two days is about 20ppm. From the above two figures we make the following two inferences

(1)Sunny/Cloudy

Plant photosynthesis contributes a lot to the metabolism of carbon dioxide in the atmosphere, and some literature says it is related to season and temperature. However, we believe that in terms of influence, there is a bigger difference between sunny days and cloudy days. When it is cloudy, the photosynthesis rate of plants It is slower and the carbon dioxide in the atmosphere is more difficult to absorb. Therefore, the cloudy weather caused by the typhoon on 10/6 led to the higher average carbon dioxide concentration on 10/6.

(2) Typhoon

There is currently no substantial literature showing that the carbon dioxide concentration in areas where typhoons pass will be higher, but there is another theory that the sea breeze and ocean surface carbon dioxide concentration will be higher when the typhoon passes by, and the observation location is closer to Sizihwan Bay (Taiwan Strait). And the eye of the typhoon was in the Taiwan Strait that day, so we speculate that this may be the reason for the higher average carbon dioxide concentration in 10/6.

4. The correlation between students' transportation methods to and from school and

carbon dioxide concentration

Class	Take bus or MRT	Parents drive	Parents riding scooter	walk or bike	other
312	11	15	1	2	1
(29people)	36.8%	50%	3.3%	6.6%	3.3%
314	14	6	6	4	0
(30people)	46.7%	20%	20%	13.3%	0%
106	20	6	5	5	0
(36people)	55.5 %	16.7%	13.9%	13.9%	0%

(Figure6. the statistics of the means of transportation used by Kaohsiung Girls' Senior High School students to and from school.)

Based on observations, it was found that the duration of people staying at the school gate is not long, so the crowd density has little impact on the concentration of carbon dioxide. We believe that vehicles are the main factor causing changes in carbon dioxide concentration at the school gate. Therefore, an additional survey was conducted on the types of transportation used by students from three classes when going to and from school. From the table above, it can be seen that in some classes, the number of students taking public transportation has exceeded half of the class size, and about one-tenth of the students walk or ride bicycles. However, there are still more than one-third of the students who commute to and from school by car or motorcycle. Interviews with some classmates revealed that the distance between their homes and the school is not too far, and they could choose to use public transportation or ride bicycles. Therefore, we have decided to continue promoting these carbon reduction behaviors to the students.

Conclusion

By analyzing the data on changes in carbon dioxide concentration at the school gate, we found that the main reason for the high carbon dioxide concentration during the rush hour is crowded traffic. The more vehicles there are, the higher the carbon dioxide concentration. Secondly, turning off the vehicle is beneficial to reducing carbon dioxide concentration. We will educate students to turn off the vehicle when parking at the door. Third, carbon dioxide concentration will be affected by climate and weather, including sunny days, rainy days, and typhoons, which are closely related to photosynthesis. Finally, from the transportation methods of students to and from school, we can see that we still have a long way to go to reduce carbon dioxide emissions. In addition to publicity to students,we will recommend to the school the implementation of more routes for school buses to reduce the number of vehicles congregating at the school gate. We also remind students to wear masks in crowded areas when entering or leaving the school gate.

Future Work

We will continue to conduct observations and provide observation data to students for reference, so that students can better understand the air quality at the school gate and raise students' awareness, stimulate their interest in reducing carbon dioxide emissions, and improve carbon dioxide emissions through practical actions.

Review of Literature

Greenhouse Effect - Discussion on Changes in Carbon Dioxide Concentration in Taiwan
https://school.cy.edu.tw/uploads/1580718133747Hd2b9UOY.pdf
Effects of Typhoons on Surface Seawater pCO2 and Air- Sea CO2 Fluxes in the Northern South China Sea
https://agupubs.onlinelibrary.wiley.com/doi/full/10.1029/2020JC016258
Why should transportation carbon emissions be calculated in 2023? What can it improve?
https://esg-cfv.com/transportation-carbon-emission-calculation/