Methodology:

We investigated Co2 emission from January 1 2019 - December 30 2020 through the daily Co2 emission data in the world and 13 countries specifically. The countries include Brazil, China, EU27 & U.K, France, Germany, India, Italy, Japan, ROW, Russia, Spain, UK and the U.S. We acquired the data through Carbon Monitor, which updates daily Co2 regularly.

The dataset is 5.6 MB, containing 92064 rows and 5 columns, including country name, measure date, emission sector, emission value and measure timestamp. The data is measured from a diverse range of activity, including electrical power generation, industrial production, ground transportation, residential activity, domestic aviation, and international aviation, and the sector column shows the source activity that the emission is measured from.

We also downloaded historical yearly Co2 emission data from 1990 to 2018 through Climate Watch, a website that provides open climate data to show countries' climate progress. In this dataset, we focus on 10 countries to compare the historical emission with the one within 2019 to 2020. Those countries are China, the U.S, India, Japan, Russia, Brazil, Germany, U.K, Italy, France and Spain. This dataset is 37KB, containing 195 rows, and the columns are the emission values from 1990 to 2018, respectively.

Combining the historical yearly Co2 from 1990 to 2018 and the daily Co2 from 2019 to 2020, we analyzed the trend of yearly Co2 emission within six years, from 2014 to 2020 and plotted a line chart for each country in the joined dataset. As 2019 and 2020 are considered as an important period for COVID-19, we then focused our research on the daily Co2 emission in this period by classifying the daily emission data into four groups: pre-COVID-19 period and COVID-19 period in 2019 and 2020 respectively. The COVID-19 period spans March 1 - June 1 (exclusively), with March 1st being when most countries started to report cases and suggested social distancing. The pre-COVID-19 period is January 1st - March 1st, exclusively. Emissions from 2020 are considered 'current' data and emissions in 2019 are considered 'previous'. Statistics are calculated during the COVID-19 period and pre-COVID periods. We report both absolute differences in CO2 and percentage change in Co2 from previous to current year.

Results:

In Table 1, we illustrate Co2 emission differences in 2019 compared to 2020, both before and during the COVID-19 lockdown period. Compared to 2019, the average Co2 emission during pre-COVID-19 period in 2020 is 7% lower in Brazil, 30% lower in China, 7% lower in India, 2% lower in Germany, 4% lower in Italy, 4% lower in Japan, 5% lower in ROW, 3% lower in Russia, and 3% lower in the U.S.

However, during the COVID-19 lockdown period, we observed more significant reductions in the average Co2 emission value. Co2 emission in Brazil was reduced 23%, Germany 7%, India 30%, Italy 24%, Japan 12%, ROW 28%, Russia 11%, U.S 17%. Some countries that did not lower Co2 emission in the pre-COVID-19 period reduced Co2 emission in the COVID-19 lockdown period. Co2 emission in EU 27 & UK was reduced 17%, France 25%, Spain 30% and U.K 19%.

To point out, China is an outlier in these countries. It showed 30% reduction in pre-COVID period and 15% reduction in COVID lockdown period. It is the only country that did not have a lower Co2 emission value during COVID lockdown period.

Fig.1 provides a visualization of the trend of Co2 emissions from 2014 to 2020 in 10 countries: including China, U.S, India, Japan, Russia, Germany, Brazil, U.K, Italy and France. We categorized the countries into 4 groups, according to their total emission value. China, the one with the most Co2 emission, still increased its emission of Co2 but increased slower during 2019 - 2020, compared to previous years. In 2019 - 2020, Co2 emission in Brazil reduced less significantly than the previous year but still decreased. For all the other countries, we observed a significant drop of Co2 emission during 2019 - 2020.

	Country	2019 Jan-Feb Mean	2020 Jan-Feb Mean	Difference in Previous and Current Mean (percentage change)
0	Brazil	0.46	0.43	–0.03(–7%)
1	China	2.53	1.76	–0.77(–30%)
2	EU27 & UK	2.38	2.39	0.01(0%)
3	France	0.31	0.31	0.0(0%)
4	Germany	0.40	0.41	0.01(2%)
5	India	0.84	0.78	–0.06(–7%)
6	Italy	0.25	0.24	–0.01(–4%)
7	Japan	0.49	0.47	–0.02(–4%)
8	ROW	6.07	5.75	–0.32(–5%)
9	Russia	0.64	0.62	–0.02(–3%)
10	Spain	0.23	0.23	0.0(0%)
11	UK	0.31	0.31	0.0(0%)
12	US	4.41	4.26	–0.15(–3%)

Table 1. Co2 emission during Jan 1 - March 1 (exclusively) in 2019 and 2020 from 13 countries.

	Country	2019 Mar-May Mean	2020 Mar-May Mean	Difference in Previous and Current Mean (percentage change)
0	Brazil	0.47	0.36	-0.11(-23%)
1	China	2.53	2.16	-0.37(-15%)
2	EU27 & UK	2.40	2.00	-0.4(-17%)
3	France	0.32	0.24	-0.08(-25%)
4	Germany	0.41	0.38	-0.03(-7%)
5	India	0.82	0.57	-0.25(-30%)
6	Italy	0.25	0.19	-0.06(-24%)
7	Japan	0.49	0.43	-0.06(-12%)
8	ROW	6.11	4.37	-1.74(-28%)
9	Russia	0.64	0.57	-0.07(-11%)
10	Spain	0.23	0.16	-0.07(-30%)
11	UK	0.31	0.25	-0.06(-19%)
12	US	4.52	3.75	-0.77(-17%)

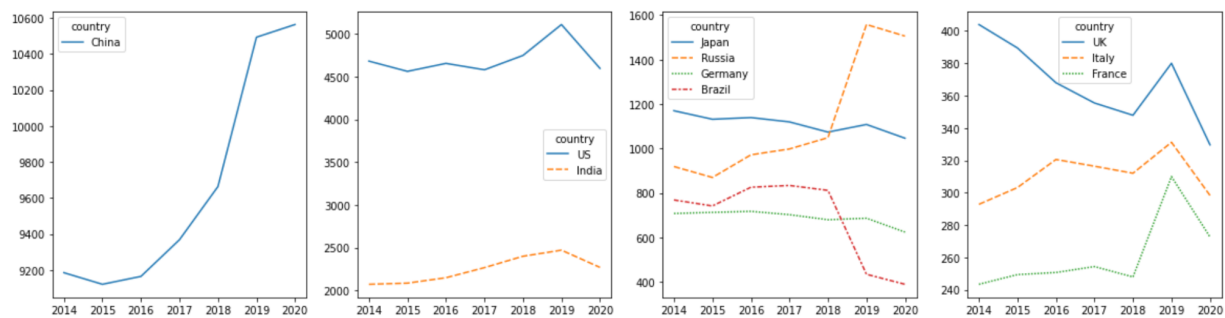Table 2. Co2 emission during March 1 - May 30 in 2019 and 2020 from 13 countries.

Fig 1. Yearly Co2 emission from 2014 - 2020 in 10 countries