# The Year Earth Changed

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# Introduction

- People were required to **stay at home** during COVID-19 lockdown period.
- **The Year Earth Changed documentary** reveals that **air quality** and **global emission of greenhouse gas** have **fallen** due to COVID-19 lockdown. The moment we paused, the earth was able to breath again.


Fig. 1 The Himalayas before and after lockdown in Jalandhar, India(source: https://www.heraldscotland.com/news/19283486.lorraine-kelly-show-probed-photoshopping-himalayas-row-involving-david-attenborough-bbc-documentary/)

# Introduction

- Our study has two parts: firstly we analyzed **air quality in India and California**, secondly we studied **carbon dioxide emissions in China, United States and India**.
- Preliminary evaluations: we found **drops** of both the air pollution and carbon dioxide emission during the COVID-19 lockdown period.
- Importance of our study:  provide insights regarding health and control of air pollution and greenhouse gas emissions.

# Methodology

## ---Air Quality Analysis

India:

- 2015 to 2022
- PM2.5, PM10, NO, NO2, NOx, NH3, CO, SO2, O3, Benzene, Toluene, Xylene, AQI and AQI_Bucket
- Lockdown period: 2020.03.25 - 2020.06.06
- Data wrangling: missing data

# Methodology

## ---Air Quality Analysis

| | Missing Values | % of Total Values |
|---|---|---|
| Xylene | 18109 | 61.300000 |
| PM10 | 11140 | 37.700000 |
| NH3 | 10328 | 35.000000 |
| Toluene | 8041 | 27.200000 |
| Benzene | 5623 | 19.000000 |
| AQI | 4681 | 15.900000 |
| AQI_Bucket | 4681 | 15.900000 |
| PM2.5 | 4598 | 15.600000 |
| NOx | 4185 | 14.200000 |
| O3 | 4022 | 13.600000 |
| SO2 | 3854 | 13.100000 |
| NO2 | 3585 | 12.100000 |
| NO | 3582 | 12.100000 |
| CO | 2059 | 7.000000 |

# Methodology

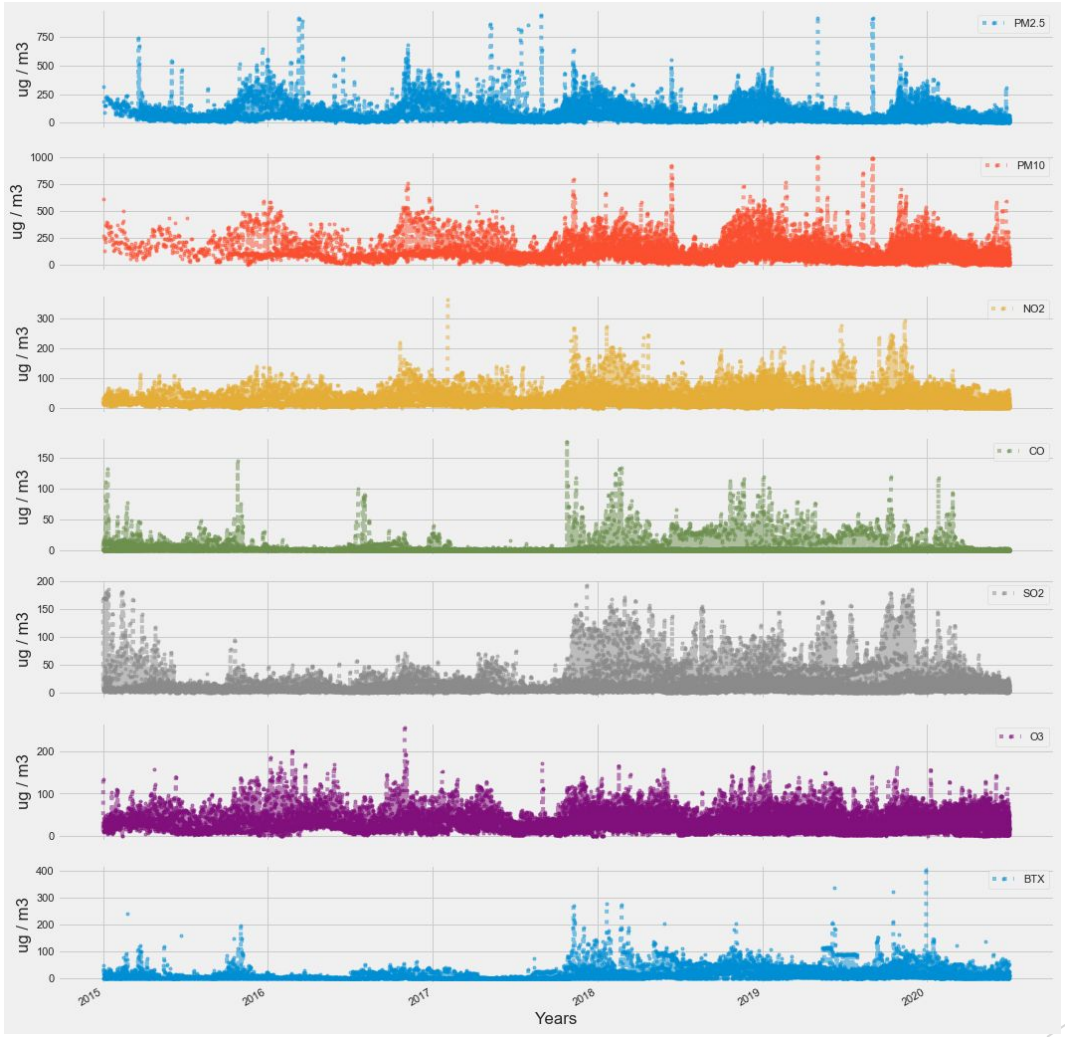
## ---Air Quality Analysis

India:

- City select: Ahmedabad, Bengaluru, Chennai, Delhi, Hyderabad and Mumbai
- Factors that might affect the air quality of India.

# Methodology

## ---Air Quality Analysis



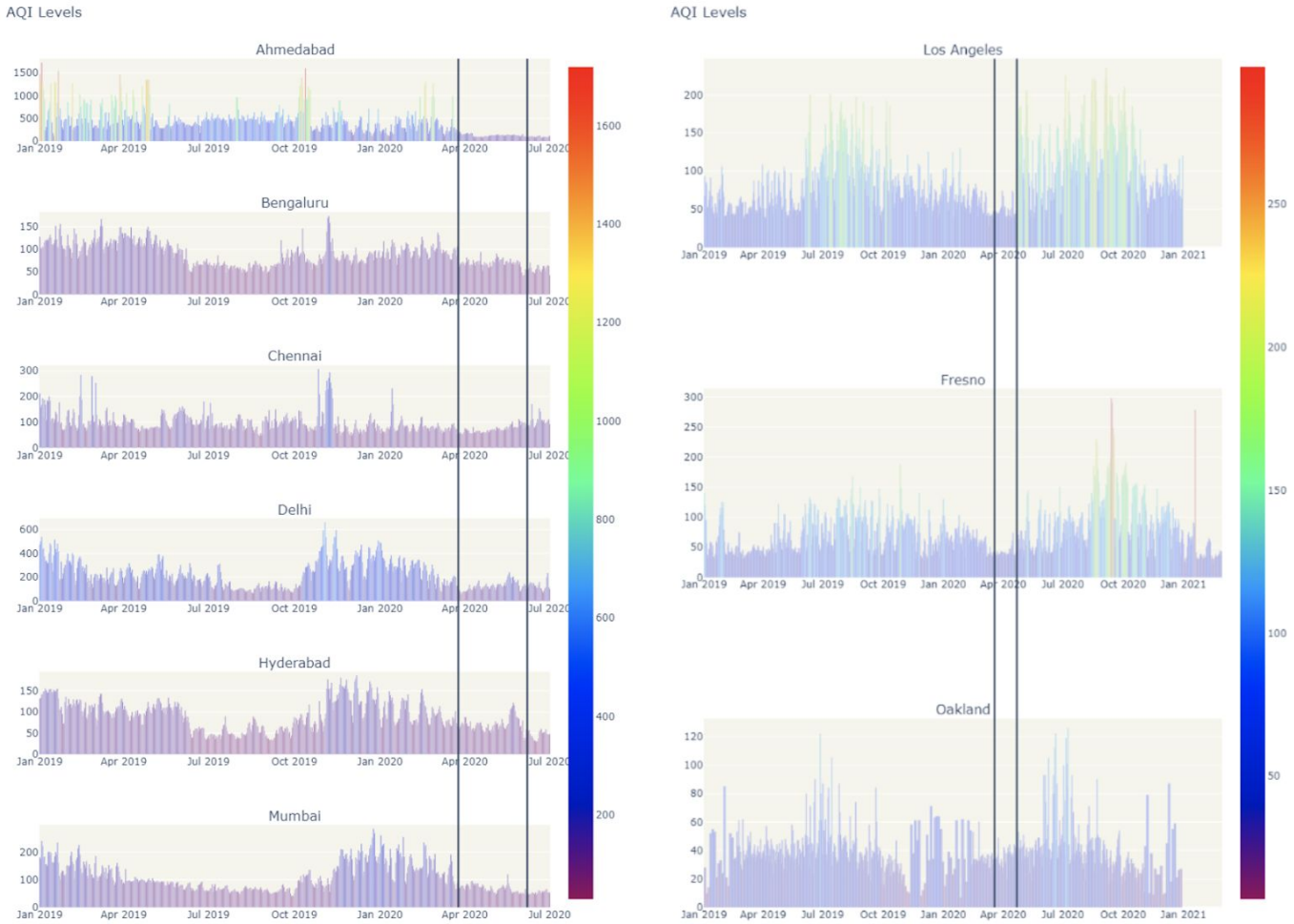
# Methodology

## ---Air Quality Analysis

- Compare the level of AQI before and after the lockdown period
- Compare the impact of lockdown period between India and California

# Methodology

## ---Air Quality Analysis



# Result

## ---Air Quality Analysis

- As AQI levels have a significant drop after the lockdown policy was posted, we concluded that the lockdown policy has a very positive impact on air pollution in both India and California.
- Except for all those experiments, we also calculate the average AQL value of all those cities before and after the lockdown policy. The AQI value dropped 66.8% in Ahmedabad, 29.2% in Bengaluru, 22.5% in Chennai, 52.8% in Delhi, 29.8% in Hyderabad, and 50.3% in Mumbai. In California, the AQI value dropped 39.1% in Fresno, 50.3% in Los Angeles, and 7.7% in Oakland.

# Methodology & Results
## Carbon Dioxide Emission Analysis

- Representative countries: **China**, the **U.S** and **India**

- Dataset: acquired from Carbon Monitor [1]; contains emissions data from **Jan 1 2019** to **Dec 30 2020**; measured from electrical power generation, industrial production, **ground transportation**, residential activity, and domestic and international **aviation**.

# Methodology & Results
## Carbon Dioxide Emission Analysis

- lockdown period of each country:

| Country | Lockdown Period |
|---|---|
| India | Mar 25 2020 - May 31 2020 |
| United States (New York State) | Mar 19 2020 - June 18 2020 |
| China (Wuhan) | Jan 23 2020 - Mar 25 2020 |

(Investigated from [2][3][4][5])

# Methodology & Results
## Carbon Dioxide Emission Analysis

- Fig 2. CO2 during **pre-lockdown** period in 2019 and 2020

| Country (before lockdown) | Mean in 2019 | Mean in 2020 | Difference in Means of 2019 and 2020 |
|---|---|---|---|
| China (Jan.1 - Jan.23) | 0.92 | 0.83 | -0.09 (**-10%**) |
| India (Jan.1 - Mar.25) | 0.29 | 0.26 | -0.03 (**-10%**) |
| U.S (Jan.1 - Mar.19) | 1.70 | 1.61 | -0.09 (**-5%**) |

# Methodology & Results
## Carbon Dioxide Emission Analysis

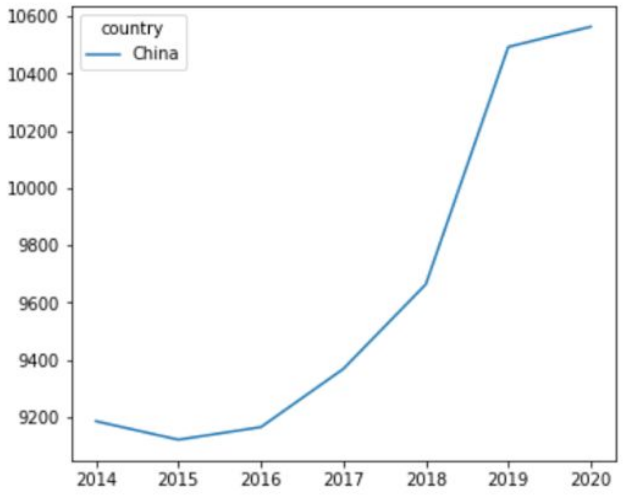
- Fig 3. CO2 during **lockdown** period in 2019 and 2020

| Country (during lockdown) | Mean in 2019 | Mean in 2020 | Difference in Means of 2019 and 2020 |
|---|---|---|---|
| China (Jan.23 - Mar.25) | 0.93 | 0.61 | -0.32 (**-34%**) |
| India (Mar.25 - May.31) | 0.29 | 0.18 | -0.11 (**-38%**) |
| U.S (Mar.19 - June.18) | 1.75 | 1.36 | -0.39 (**-22%**) |

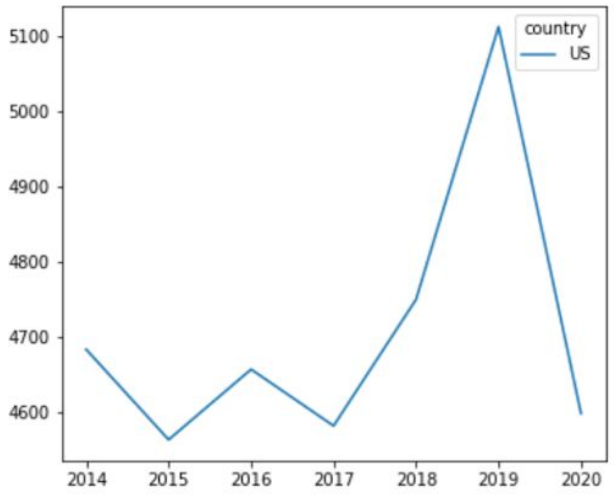
# Methodology & Results
## Carbon Dioxide Emission Analysis

- Yearly Co2 from 2014 - 2020
  - Obtained 2014-2018 data from Climate Watch [6]
  - Computed the sum of daily emissions in 2019-20
  - Fig 5. In 2020, growth in **China** is much **slower** than previous years and **significant drops** in **India** and **U.S**

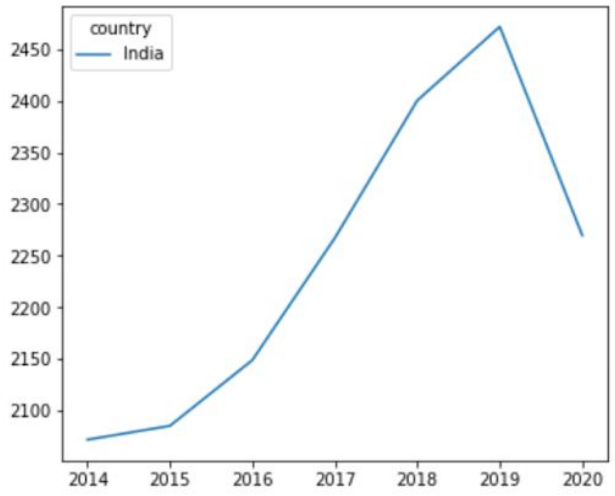
yearly co2 in China




yearly co2 in U.S




yearly co2 in India



# Discussion

- Our findings present evidence that, during the COVID-19 pandemic, air pollution has declined across India and California in the U.S and $CO_2$ emission has declined in U.S, and India. Growth of $CO_2$ in China was slower in 2020.
- Improvement of pollution are likely associated with reduced ground transportation and aviation as people working remotely and travels were limited.
- **Pro**:
  - Real-time $CO_2$ emission measurements provide ground based quantification of pollution change
  - Our research is also geographically broad, including 3 countries across the world
- **Con**:
  - Only studied correlation rather than causation of pollution and COVID-19
  - Lacks the consideration of weather and large-scale events that could potentially impact the pollution level.

# Conclusion

- Studied the impact of **COVID-19 lockdown** on **environmental changes**
- Analyzed the **air pollution** in India and California and showed a decrease of AQI level in both areas during COVID-19 lockdown period
- Analyzed the **CO2** emissions in China, the U.S and India and found a decrease in average emission during COVID-19 lockdown period and reductions of yearly emissions in the U.S and India. The increase of yearly emission in China was slower.
- Protect the public health and the planet earth
- Future Work: study the causation of COVID-19 lockdown and environmental changes and the impact of weather and large-scale events

# Reference


- [1]“Carbon monitor.” [Online]. Available: https://carbonmonitor.org/
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- [6]. [Online]. Available: https://www.climatewatchdata.org/

Thank you!