The Pandemic & Air Quality - An opportunity to observe how changes in human activity affect Earth's atmosphere

Background

The COVID-19 pandemic has changed almost every aspect of our lives, especially in the early days. In March 2020, a new coronavirus had spread around the world, and millions of people were urged to stay home to curb the spread. The majority of the Earth's population was no longer going about many of their daily tasks.

With such a disruption to our lives and the global economy, we wondered what changes did we see in the atmosphere? We took a deep dive into the data and visualizations from the first six months of 2020 to examine the environmental impacts from so many people staying home. The following is what we found.

1. COVID Cases -

- This animation shows the total number of COVID-19 cases from January - June 2020. Although the pandemic has lasted much longer, this is the time period in which "normal" life came to an abrupt stop for many of us, and when the bulk of the observations in this story take place.

- An important date to keep in mind was March 11, 2020, when the World Health Organization declared COVID-19 a global pandemic.
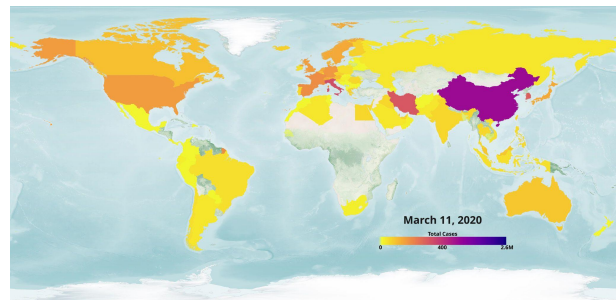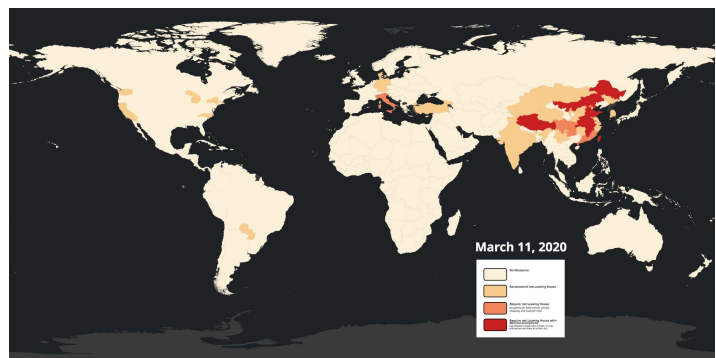
Engaging Questions

1. Do you remember when you first heard about the virus? Who told you?
2. What do you remember about the beginning of the pandemic? How did you respond?

2. Lockdown Restrictions-

- Many government officials shut down their country's international borders and restricted local travel; meaning, people were asked, and sometimes forced by law, to stay home.

- This animation shows where, when, and at what level lockdown restrictions were being enforced in countries (and states in the U.S.) from the middle of January through June of 2020.

- For the first time in known history, [most communities on the planet were in lockdown by the end of April 2020](#).

Engaging Questions

1. How did *your* life change?
2. What do you think happened with the environment while people stayed at home?
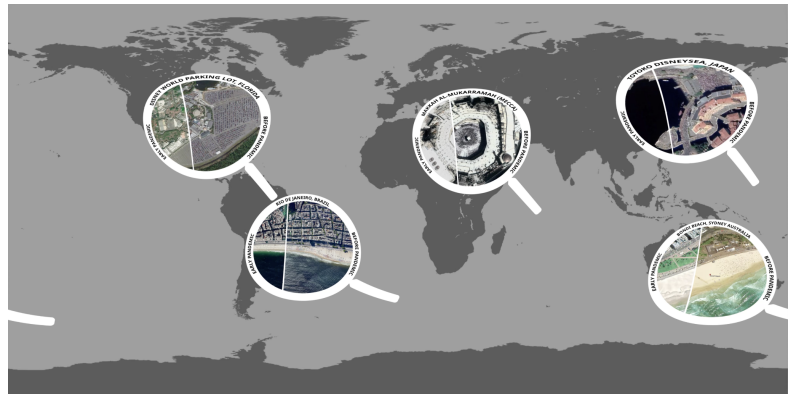3. Were you and your family able to stay home? If not, why not?

Transportation & Traffic

3. Travel Impacts -

Take a look at these travel destination image swipes before the pandemic (on the left) and during lockdown (on the right).
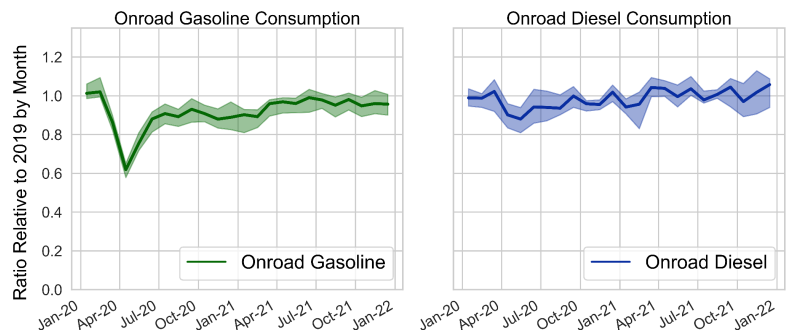

Engaging Question

Did your family travel less during the early days of the pandemic?

4. Gasoline vs. Diesel -

- In these gasoline and diesel consumption graphs created by scientists at NOAA, there is a sudden drop in gasoline consumption from March through July 2020. Gasoline is used mostly in passenger vehicles.

- We don't see the same drop in diesel consumption. In the United States, diesel is predominantly used in trucks that ship goods across the country.
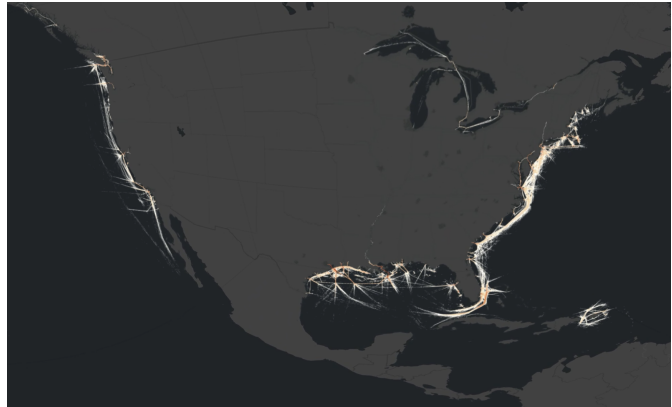
Engaging Question

Why do you think there was less change in diesel consumption than gasoline consumption over the same time period?

Answer/Transition

Even if you traveled less or canceled trips in response to the pandemic, chances are you still needed supplies like food, toilet paper, and a comfortable office chair while staying home. Those supplies were either shipped or trucked, or both.

5. Ship Traffic

- In this map of commercial ship track density around the United States, the darker the color, the more ships traveled through that area. You can see that there is heavy ship traffic near busy ports and much less in the open ocean.
- The magnifiers highlight major ports and swipe between March 2019 - before the pandemic (on the left) and March 2020 - during lockdown (on the right).

What do you notice about ship density near the U.S. before and during lockdown?

Overall, we don't see major changes in ship track density between March 2019 and March 2020. However, you can see some differences when you zoom in to the port level. You might also notice decreased traffic in certain areas where the ships were headed for international ports, like Montreal or Miami. Unlike vacation or car travel, shipping traffic was more constant during the early days of the pandemic.

6. Air Traffic

Air Traffic Before and After Global Pandemic Declaration

March 7, 2020

April 7, 2020

- If an airplane was the last place you wanted to be during the early days of the pandemic, you weren't alone.
- The World Health Organization declared COVID-19 a global pandemic on March 11, 2020, in between the two dates shown in the image swipe.
- The swipe compares March 7, 2020 (on the left), with 15,017 flights in the air to April 7, 2020 (on the right), with one third of the flights.
- Air Traffic in the world diminished by 41% in the last two weeks of March 2020 compared to March 2019.
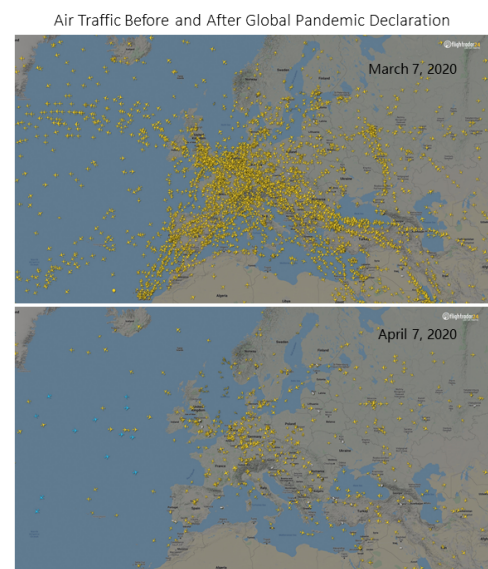
We've seen some evidence that *most* people traveled a lot less. How do you think that affected Earth's atmosphere?

Atmospheric Effects

7. Air Pollution

- Five major pollutants affecting air quality are ground-level ozone, particulate matter, carbon monoxide, sulfur dioxide, and nitrogen dioxide.
- Air pollution and poor air quality are a serious global health concern. The World Health Organization (WHO) estimates that 4.2 million people die each year as a result of ambient outdoor air pollution.


carbon monoxide (CO) nitrogen dioxide (NO$_2$)
sulfur dioxide (SO$_2$) ozone (O$_3$)
particulate matter

Air Pollution
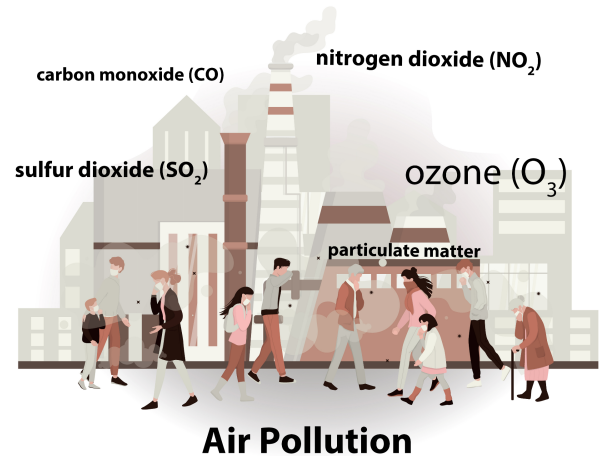
8. Nitrogen Dioxide

- Nitrogen dioxide (NO$_2$) is one of the dangerous pollutants that is emitted by cars and factories. In the video, you can see a comparison of NO$_2$ for 2019 and 2020. Specifically, the comparisons show February in East Asia and Europe, as well as March in the continental United States.

Engaging Question

What do you notice about NO$_2$ levels when you compare 2019 (pre-lockdown) to 2020 (post-lockdown)?
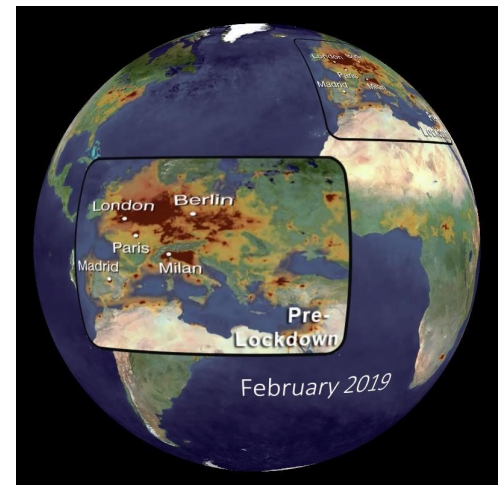

Answer/Transition

Nitrogen dioxide has a short lifetime in the atmosphere. After it's emitted, it only lasts a few hours before it disappears. Once people's mobility was restricted by lockdowns or by their own attempts to avoid exposure to the virus, the reduction in nitrogen dioxide concentrations was like flipping a switch. That is not the case with all air pollutants.

9. Air Quality Index

- Nitrogen dioxide is only one component of air quality. Sulfur dioxide (SO$_2$), ground-level ozone (O$_3$), carbon monoxide (CO), and other atmospheric constituents like particulate matter also influence the quality of the air we breathe.
- The air quality index is a measure of those pollutants and is the best signal for whether the air you breathe is healthy or hazardous.
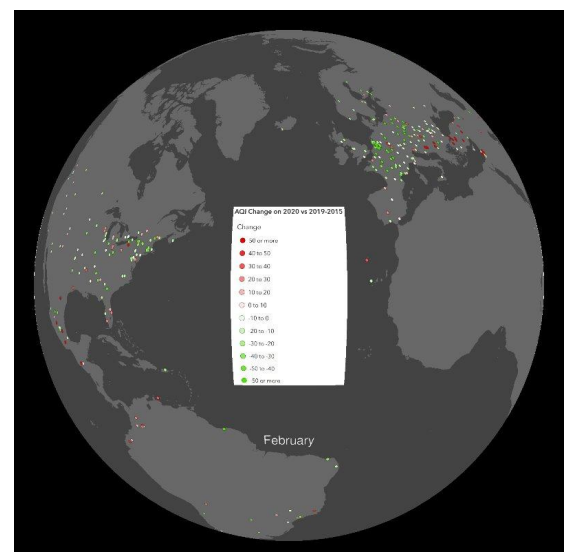
- The air quality index (AQI) runs from 0 to 500. The higher the value, the greater the level of air pollution and health risk. You want your city to have low AQI values.
- There are four anomaly maps here: January, February, March, and April, which compare 2020 to the average of the same months from 2015-2019.
- If you see green, air quality improved during the start of the pandemic. If you see red, it got worse during that time.

Engaging Questions

How would you describe what you see? Which month shows the most improvement in air quality in Asia? What about Europe and North America?

Transition

What does this mean for human health? In a study published by the [U.S. National Library of Medicine National Institutes of Health](#), there was a nationwide decrease of almost half of the hospitalizations for asthma and chronic obstructive pulmonary disease from February to July 2020 compared to the average of the 4 previous years.

10. Aerosols

- Particulate matter in the air we breathe is measured by satellites as aerosol optical depth (AOD). The higher the AOD, the more particulate matter is in the air. Here, the difference measured by NOAA satellites between 2019 and 2020 is shown in many countries around the world.

Aerosol Optical Depth Difference 2020 - 2019 (unit less)

- Blue indicates a drop in AOD whereas red indicates an increase. In many populated places, the amount of particulate matter in the air decreased during lockdown.
- The [EPA defines particle pollution](#), also known as particulate matter or PM, as a general term for a mixture of solid and liquid droplets suspended in the air. $PM_{2.5}$ and PM_{10} represent two size ranges of particles, which are called aerosols, that are measured by satellites are two of the particles, which are called aerosols.
- According to the [American Lung Association](#), particle pollution can increase the risk of heart disease, lung cancer and asthma attacks and can interfere with the growth and work of the lungs.
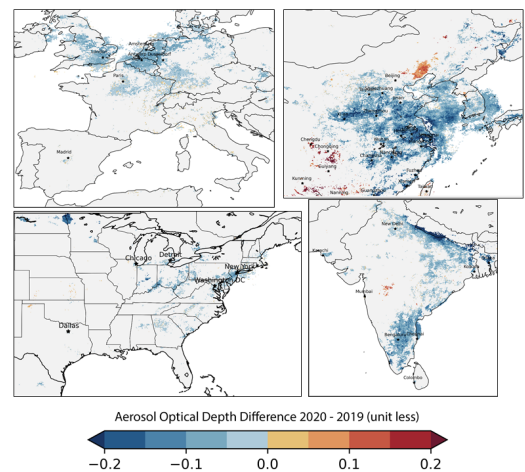
11. Carbon Dioxide

- [Carbon dioxide](#) in the atmosphere is the leading cause of global warming and our planet's climate change crisis. You may be wondering, did we make a dent in the climate crisis with all the reduced emissions from vehicles? The answer, unfortunately, is no.

- Despite changes in air quality as a result of decreased emissions from vehicles, there was no [discernible difference](#) in the carbon dioxide record as a result of pandemic lockdowns. In fact, uptake of CO_2 by plants during the [northern hemisphere summer](#) results in a greater reduction of atmospheric carbon dioxide than the brief drop we saw during the pandemic. It would take a more [sustained change](#) to affect the long-term record.
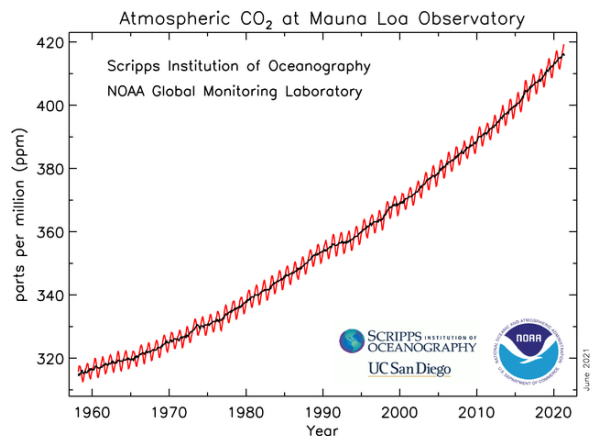
Summary (with Blue Marble)

- Early in the global COVID-19 pandemic, from January to June 2020, the virus quickly spread around the world, and most countries went into lockdown restrictions. By decreasing transportation and other human activities, we briefly decreased air pollution and emissions from cars and planes.
- Ship traffic and diesel fuel used by trucks, on the other hand, didn't appear to decrease dramatically because the demand for food and goods didn't change significantly.
- Decreasing air pollution improved air quality in the short-term. In the short term, these changes reduced the risk of asthma, lung disease, and heart disease.
- Now, more than two years into the pandemic, most global lockdowns have ceased, and car and air traffic are returning to pre-pandemic levels. Accordingly, pollution levels related to these activities have risen but not quite reached the level they were prior to the pandemic. While no one would look to a global health crisis as a playbook for environmental action, there are things we can learn from observations taken during this time. These datasets give us important windows into which aspects of our global economy and society we can change quickly – driving cars, flying on airplanes – and which – like shipping and manufacturing – are much harder to change. In a world where we are facing increasing challenges related to our changing climate, these datasets also show how the environment responds to changes in human activities.