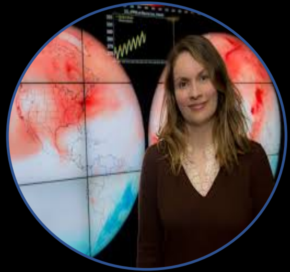
National Aeronautics and Space Administration

NASA Carbon Monitoring System

NASA Carbon Monitoring System (CMS) Policy Speaker Series | Special Virtual Panel Edition

Covid-19 and Its Impact on Global Carbon Emissions

Thursday, May 28, 2020 | 11AM-12PM Eastern Time, Via Adobe Connect (see details below)

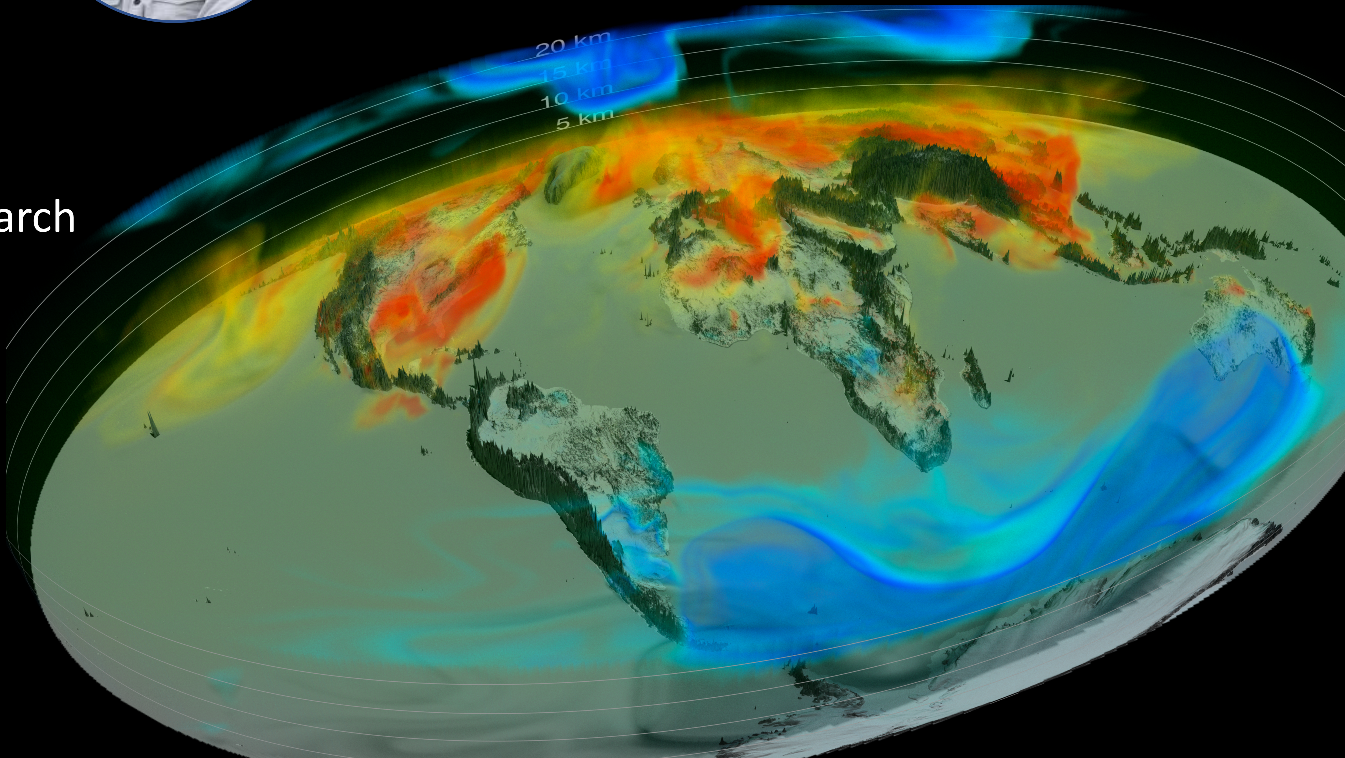


Dr. Lesley Ott, Research Meteorologist,
Global Modeling and Assimilation Office,
NASA Goddard Space Flight Center

Moderator: Dr. Ben Poulter
NASA Goddard Space Flight Center

Dr. Glen Peters, Research Director
CICERO Center for International Climate Research

Alden Meyer, Director of Strategy & Policy
Union of Concerned Scientists (UCS)



You may access the seminar remotely: To register for live stream:
https://gsfc610.adobeconnect.com/cmsmay2020/event/registration.html
For audio, please call: USA Toll free: 1-844-467-4685, Access code: 9907511380

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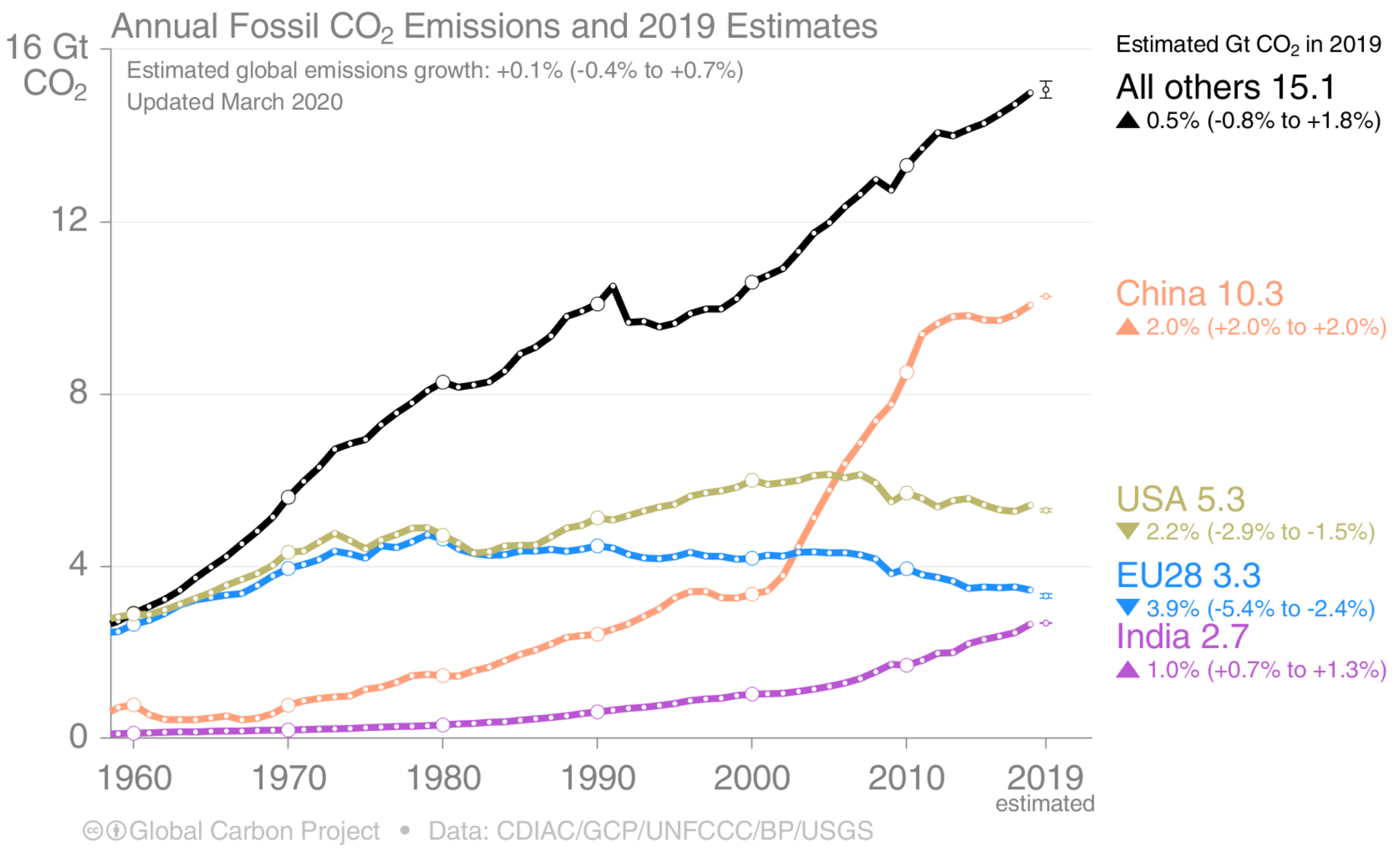
Temporary reduction in daily global CO_2 emissions during the COVID-19 forced confinement

Glen Peters (CICERO Center for International Climate Research, Norway)

NASA Carbon Monitoring System (CMS) (remote, 28/05/2020)

Project or not to project?

We make current-year projections in Nov/Dec using data for the first 6-9 months of the year: Big uncertainties…
Should we make projections in April/May for 2020? What if the monthly data only goes to January?



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Source: Global Carbon Budget (2019), updated Carbon Brief (2020)

nature climate change

ARTICLES

https://doi.org/10.1038/s41558-020-0797-x

Temporary reduction in daily global CO_2 emissions during the COVID-19 forced confinement

Corinne Le Quéré[1,2] ✉, Robert B. Jackson[3,4,5], Matthew W. Jones[1,2], Adam J. P. Smith[1,2], Sam Abernethy[3,6], Robbie M. Andrew[7], Anthony J. De-Gol[1,2], David R. Willis[1,2], Yuli Shan[8], Josep G. Canadell[9], Pierre Friedlingstein[10,11], Felix Creutzig[12,13] and Glen P. Peters[7]

Government policies during the COVID-19 pandemic have drastically altered patterns of energy demand around the world. Many international borders were closed and populations were confined to their homes, which reduced transport and changed consumption patterns. Here we compile government policies and activity data to estimate the decrease in CO_2 emissions during forced confinements. Daily global CO_2 emissions decreased by –17% (–11 to –25% for $\pm 1\sigma$) by early April 2020 compared with the mean 2019 levels, just under half from changes in surface transport. At their peak, emissions in individual countries decreased by –26% on average. The impact on 2020 annual emissions depends on the duration of the confinement, with a low estimate of –4% (–2 to –7%) if prepandemic conditions return by mid-June, and a high estimate of –7% (–3 to –13%) if some restrictions remain worldwide until the end of 2020. Government actions and economic incentives postcrisis will likely influence the global CO_2 emissions path for decades.

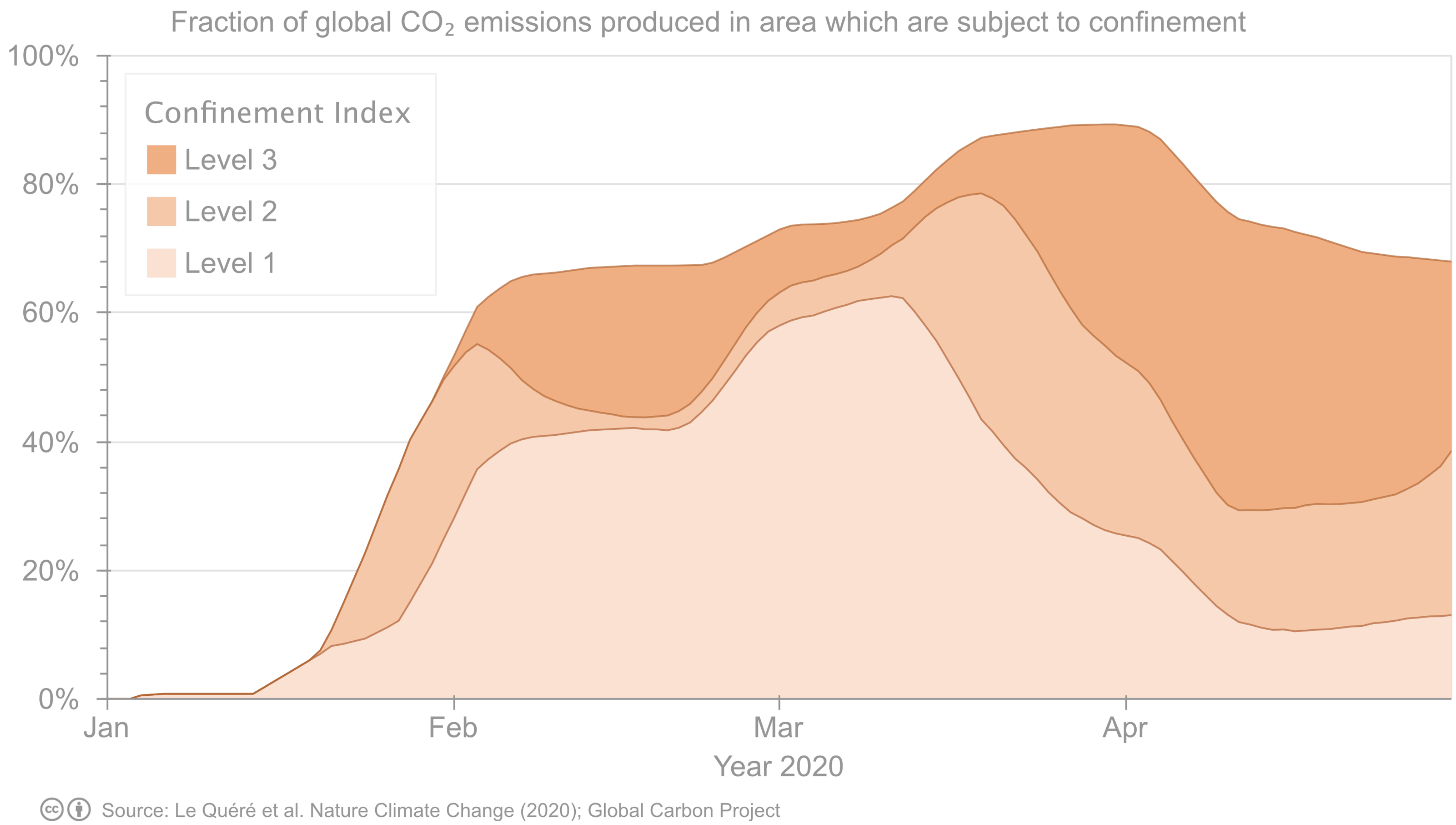
A daily approach

Method and Data

- No daily approaches in use (& often not needed)
- Method: Geared towards COVID & confinement
- Data: Daily electricity, Apple mobility, TomTom, industry organizations, government, smart meters, etc, etc
- Step 1: What happened from January to ‘now’
  – Calibrate a confinement index (3 levels)
- Step 2: Scenarios on how confinement changes from ‘now’
  – This step has some influence on the method

Daily confinement

The method is built around a confinement index. At its peak in April, regions responsible for ~90% of global fossil CO_2 emissions were under some level of confinement. This approach makes scenarios for 2020 easier to implement.



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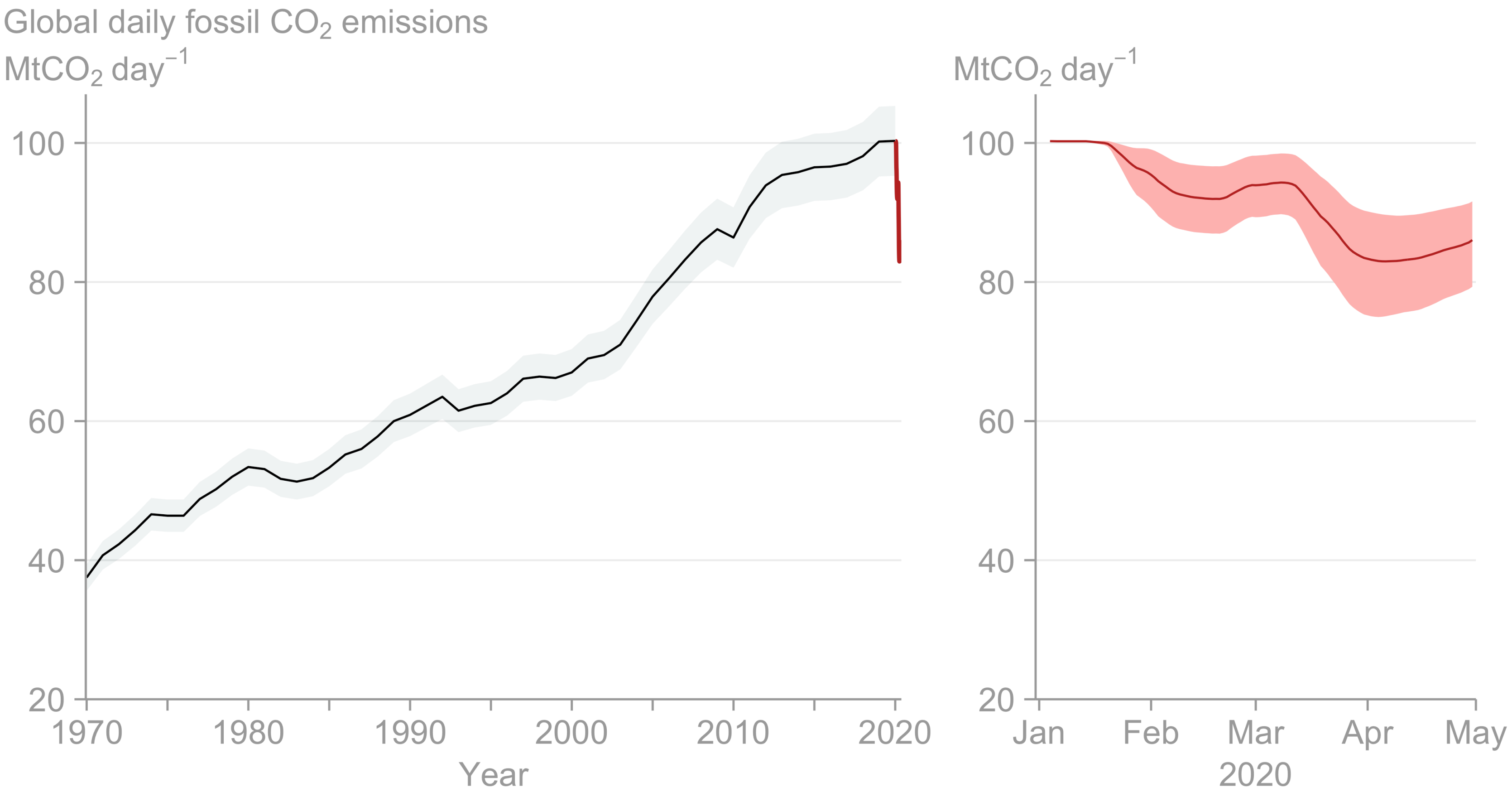
Source: [Le Quéré et al (2020)], Figure 1

Daily CO_2 emissions (until May)

Daily global fossil CO_2 emissions decreased by –17% (–11% to –25%) by early April 2020 compared to 2019
The change in emissions until the end of April was –8.6% decrease over January–April 2019 or –2.9% for all 2019



Source: Le Quéré et al. Nature Climate Change (2020); Global Carbon Project

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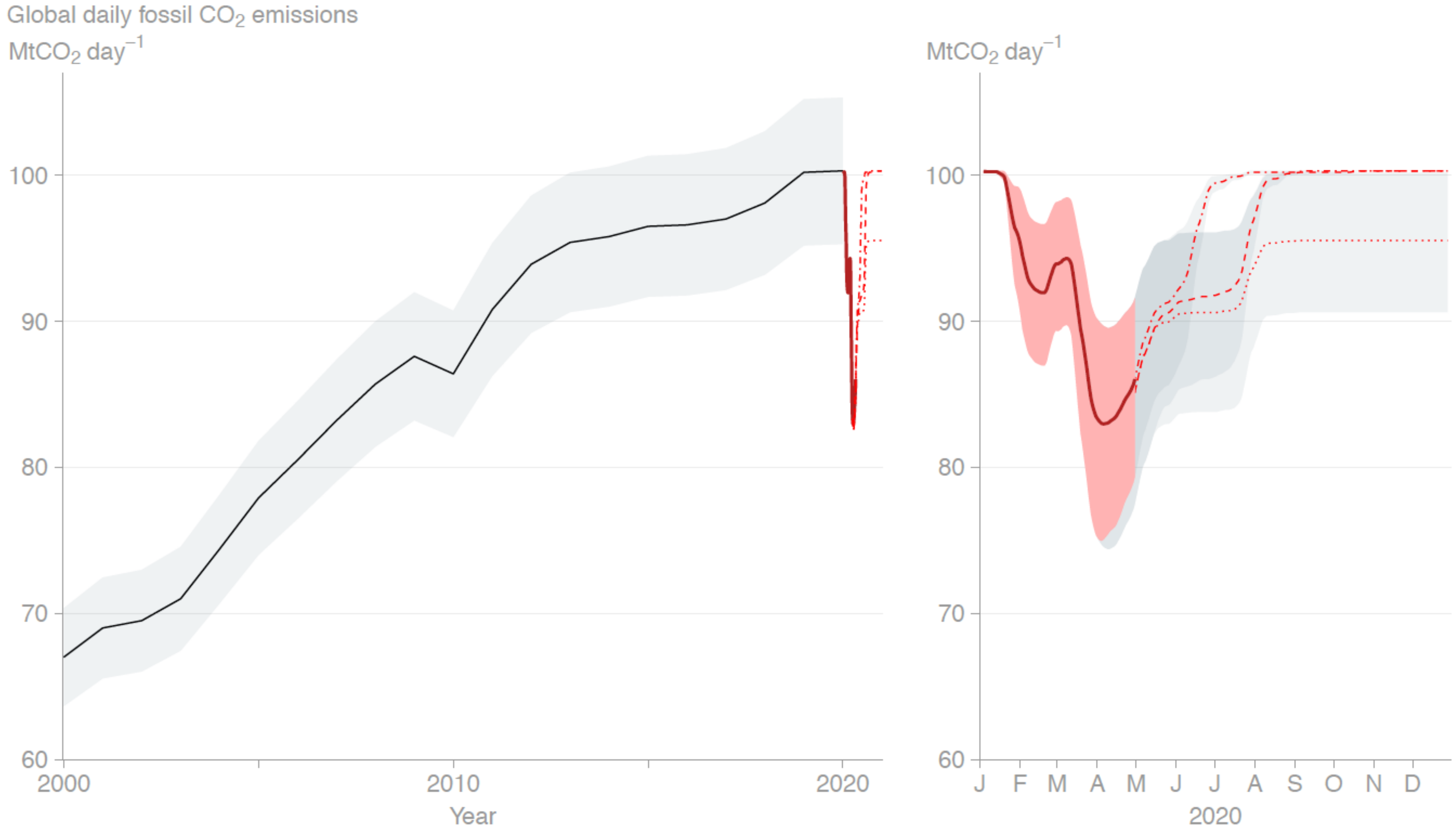
Source: Le Quéré et al (2020)

Fossil CO_2 emissions in 2020

2020 emissions depend on confinement duration: low estimate of –4% (–2% to –7%) if pre-pandemic conditions return by mid-June & a high estimate of –7% (–3% to –13%) if some restrictions remain worldwide.



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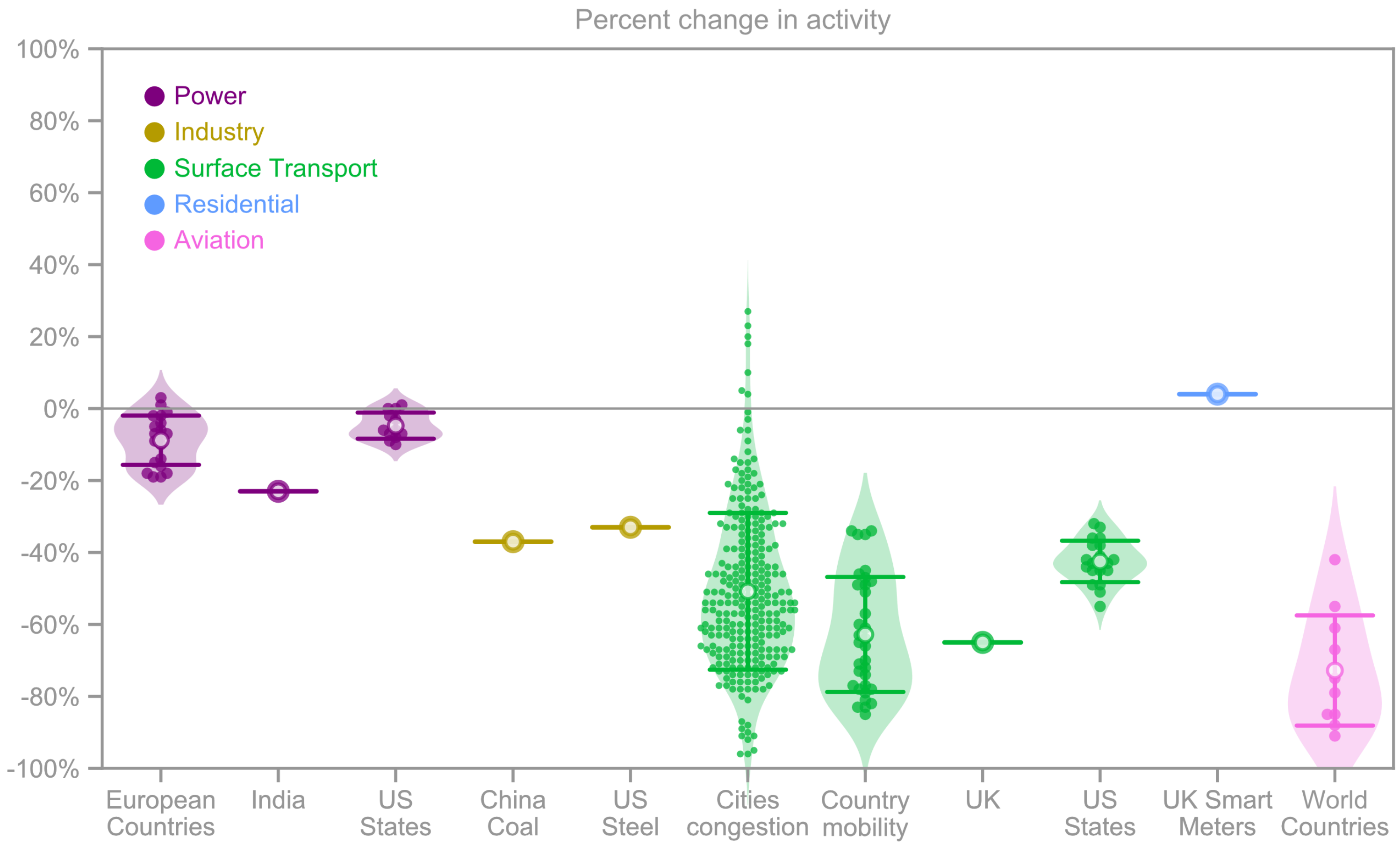
Source: Le Quéré et al (2020)

Change in *activity* levels

On average across different levels of lockdown at the peak in April: aviation decreased by 60%, surface transport by 36%, industry 19%, power generation 7%, with a small increase in residential buildings of 3%



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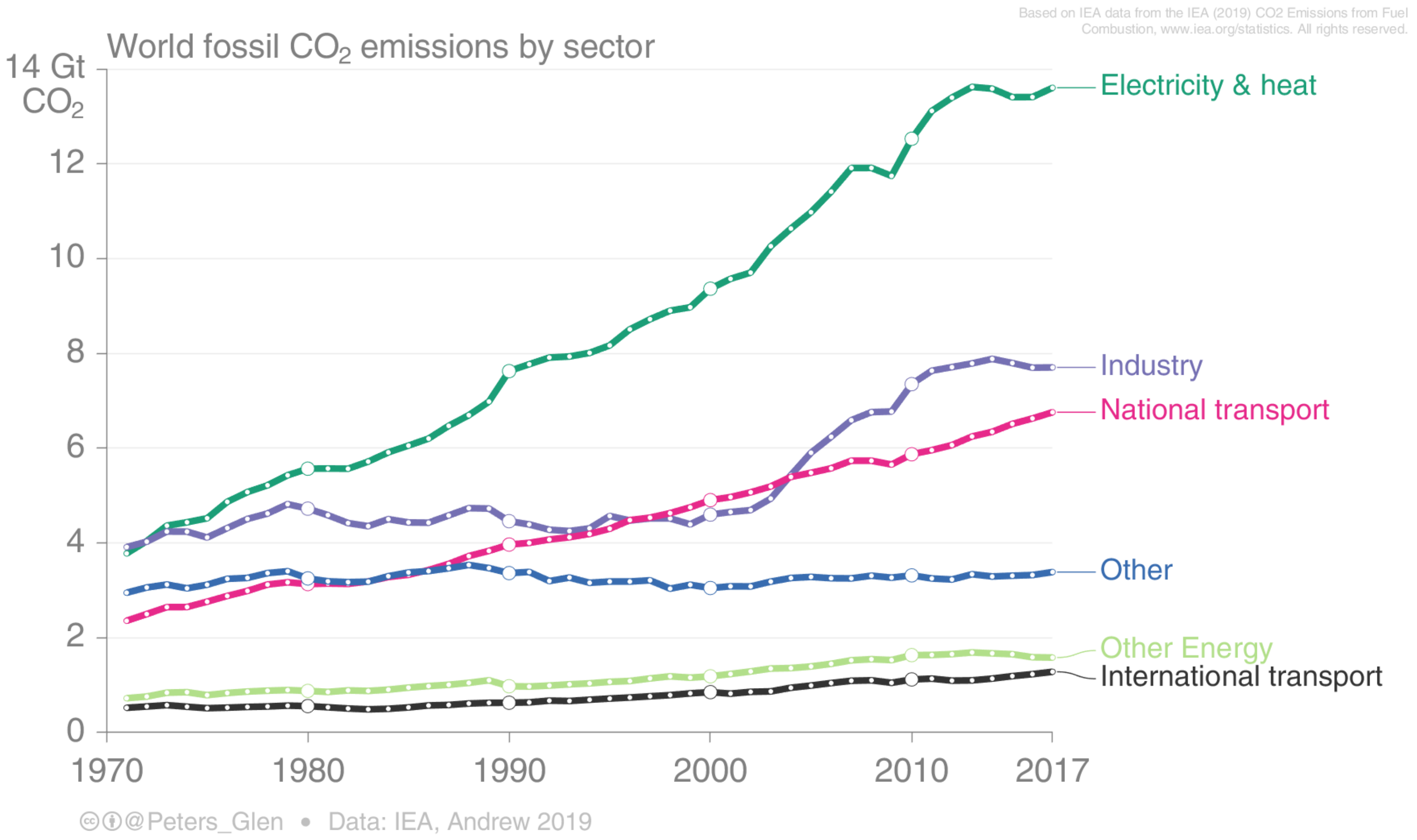
Source: Le Quéré et al (2020), Figure 2

Emissions by sector

Electricity, heat, energy 45%, industry 23%, national transport 19%, international transport 3%, other 10%
Individual countries vary from the global averages, driving the differences between emission changes by country



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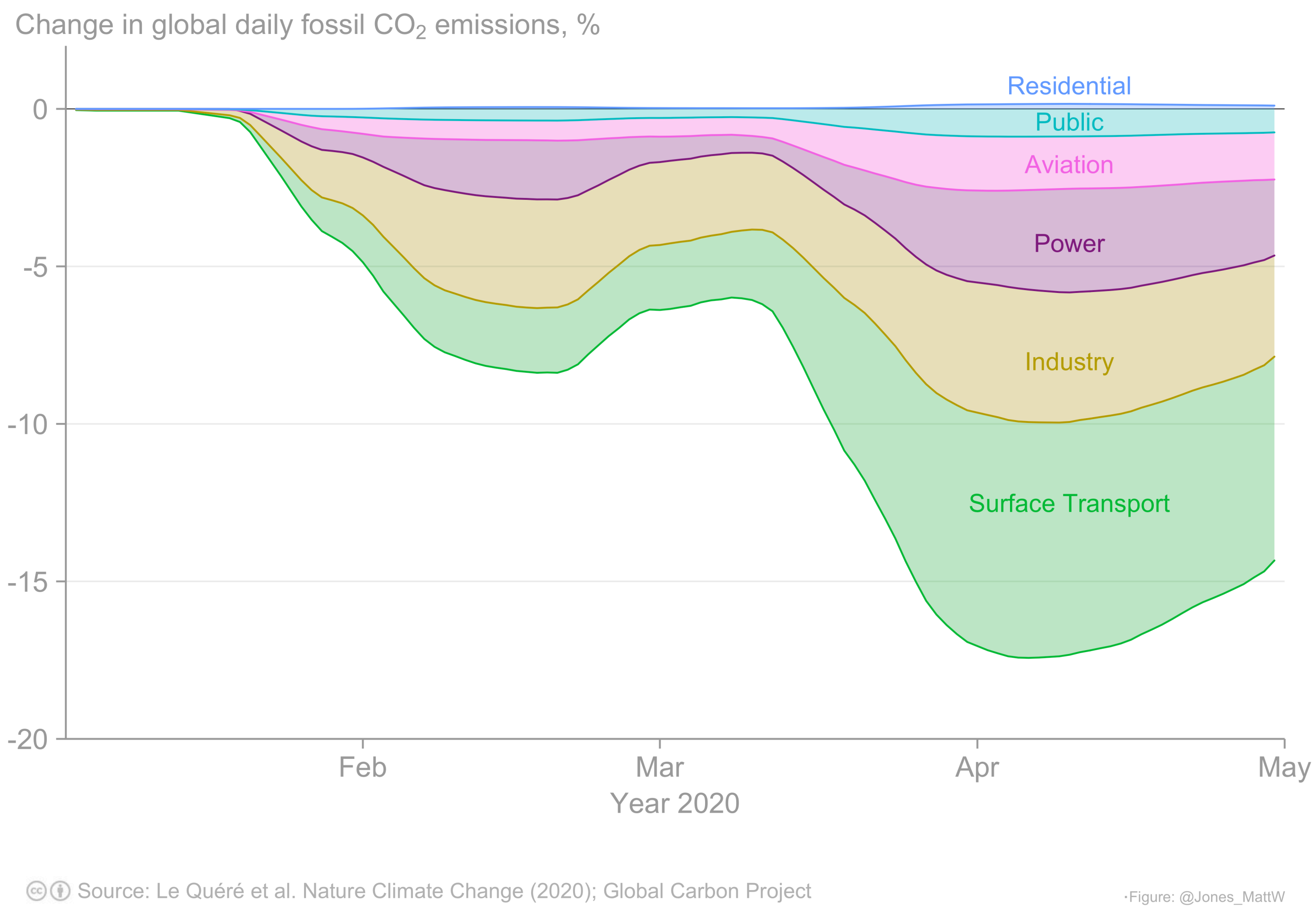
Source: Peters et al (2020); Global Carbon Budget (2019)

Daily CO_2 emissions (until May)

Emissions from surface transport accounted for almost half (43%) of the decrease in emissions, industry & power together accounted for 43%, & aviation 10%. Residential led to a slight increase



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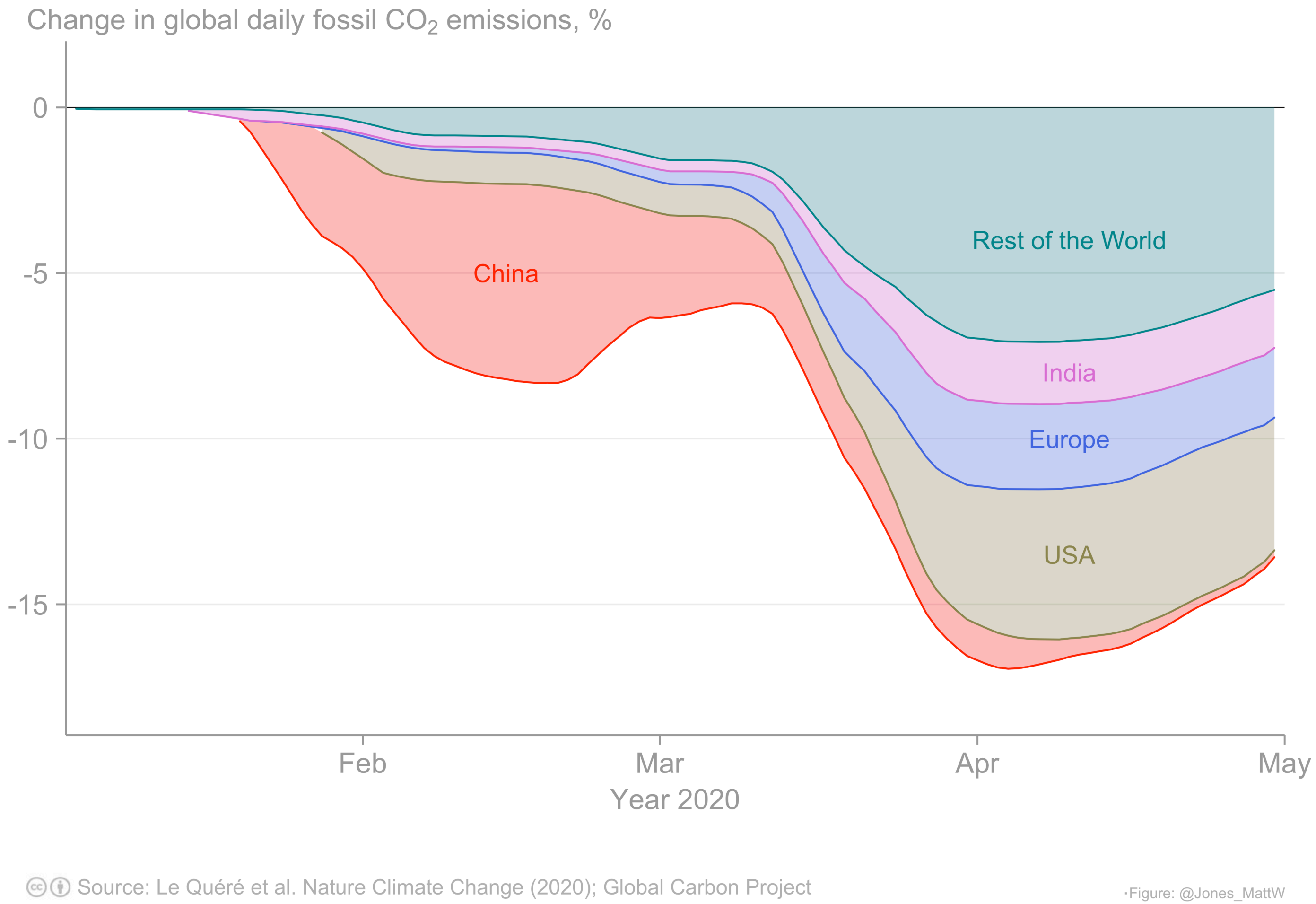
Source: [Le Quéré et al (2020)]

Daily CO_2 emissions (until May)

The total change in emissions until the end of April was –1048 (–543 to –1638) $MtCO_2$.
China: –242 $MtCO_2$ (23% of total change), US: –207 $MtCO_2$ (20%), Europe: –123 $MtCO_2$ (12%), India: –98 $MtCO_2$ (9%)



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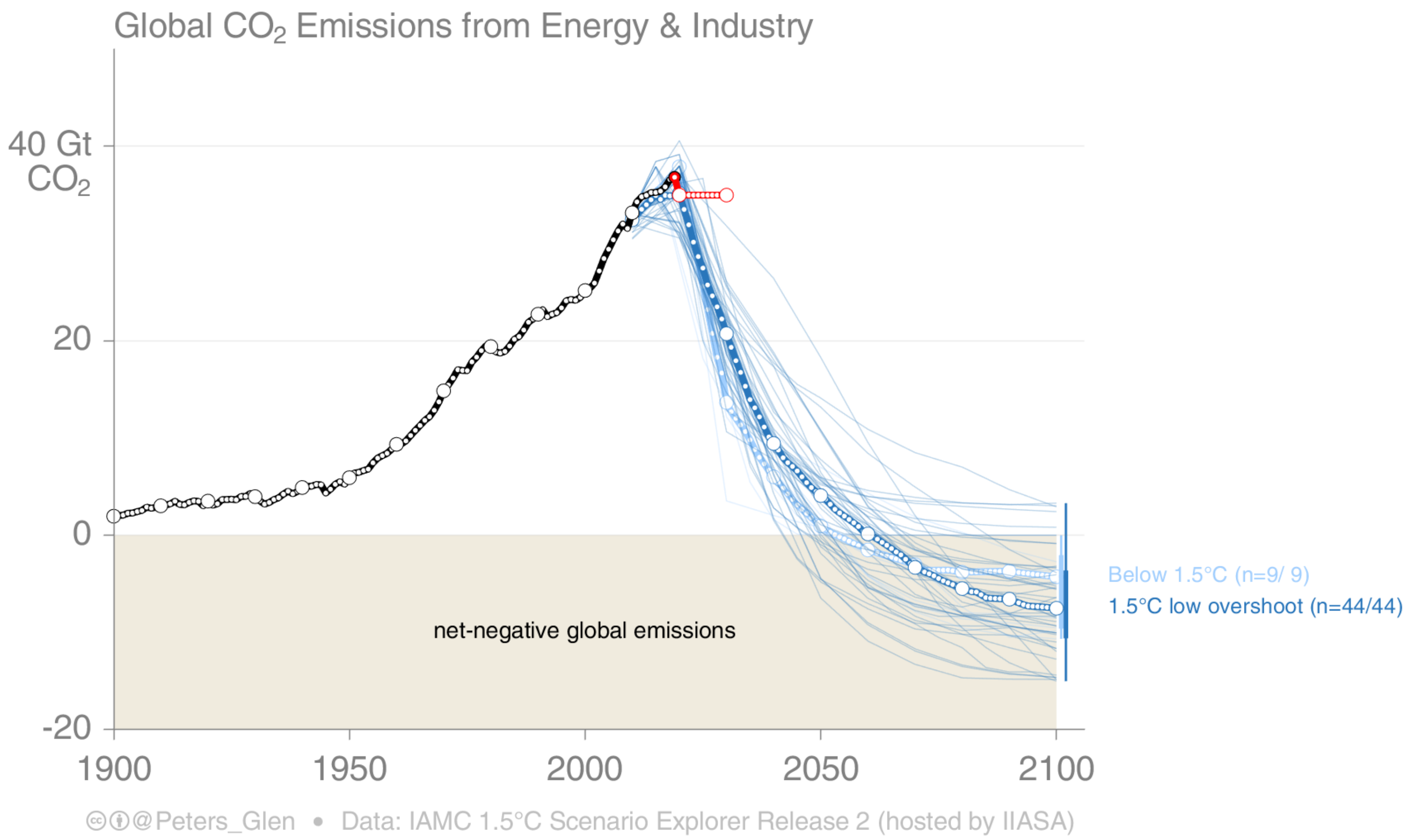
Source: [Le Quéré et al (2020)]

Implications

Climate implications

The reduction is CO_2 emissions is broadly consistent with what is required for 1.5°C or 2.0°C, but it is a one-off
To reduce emissions 5% per year requires continuous changes in technology, behaviour, infrastructure, …



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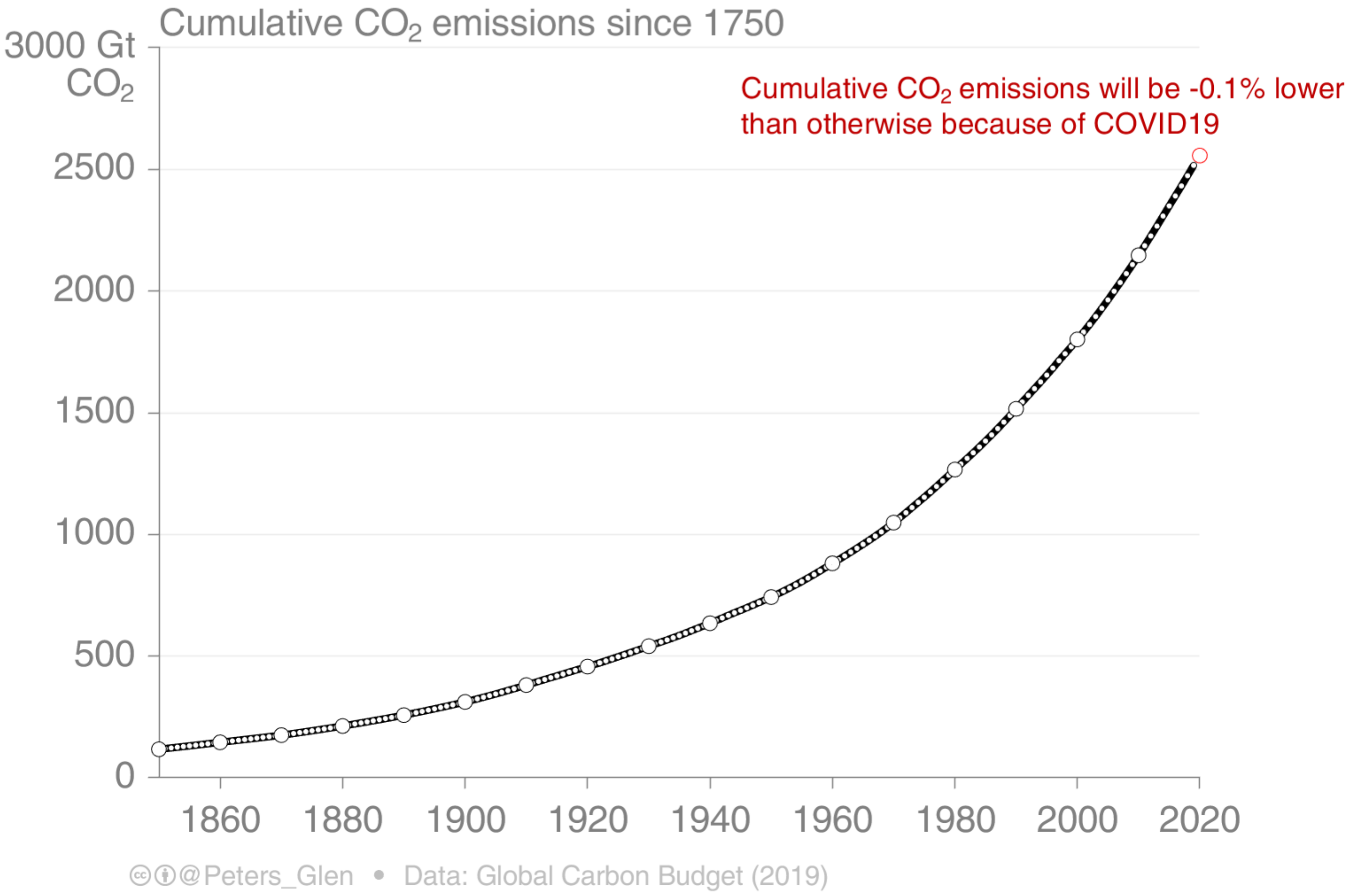
Source: Le Quéré et al (2020)

Climate implications

Climate change is a consequence of cumulative CO_2 emissions, and a reduction of global emissions by 5% in one year will have an undetectable effect on temperature (~0.001°C)…



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Source: Le Quéré et al (2020)

Implications

- “Real-time” estimates of CO_2 emissions (new methods)
- “Real-time” feedback on effects of policy interventions
- There will be a rebound post-COVID, but highly uncertain

- Bonus Extra: Fossil industries hit harder than renewables, could mean 2019 was peak emissions even after a recovery

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Interpreting atmospheric CO_2 observations during COVID-19: why it's complicated

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Dave Schimel, *JPL*
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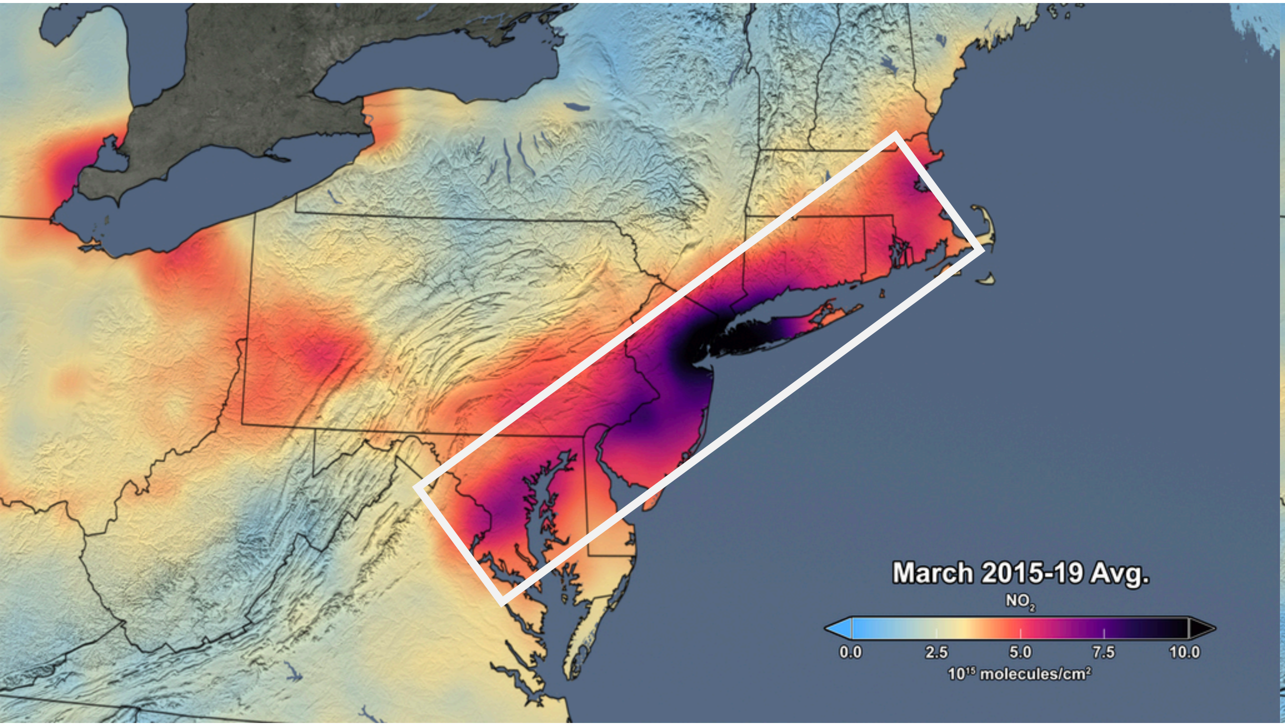
Ben Poulter, *NASA GSFC*
Junjie Liu, *JPL*
Kevin Bowman, *JPL*
Dave Crisp, *JPL*
NASA Center for Climate Simulation

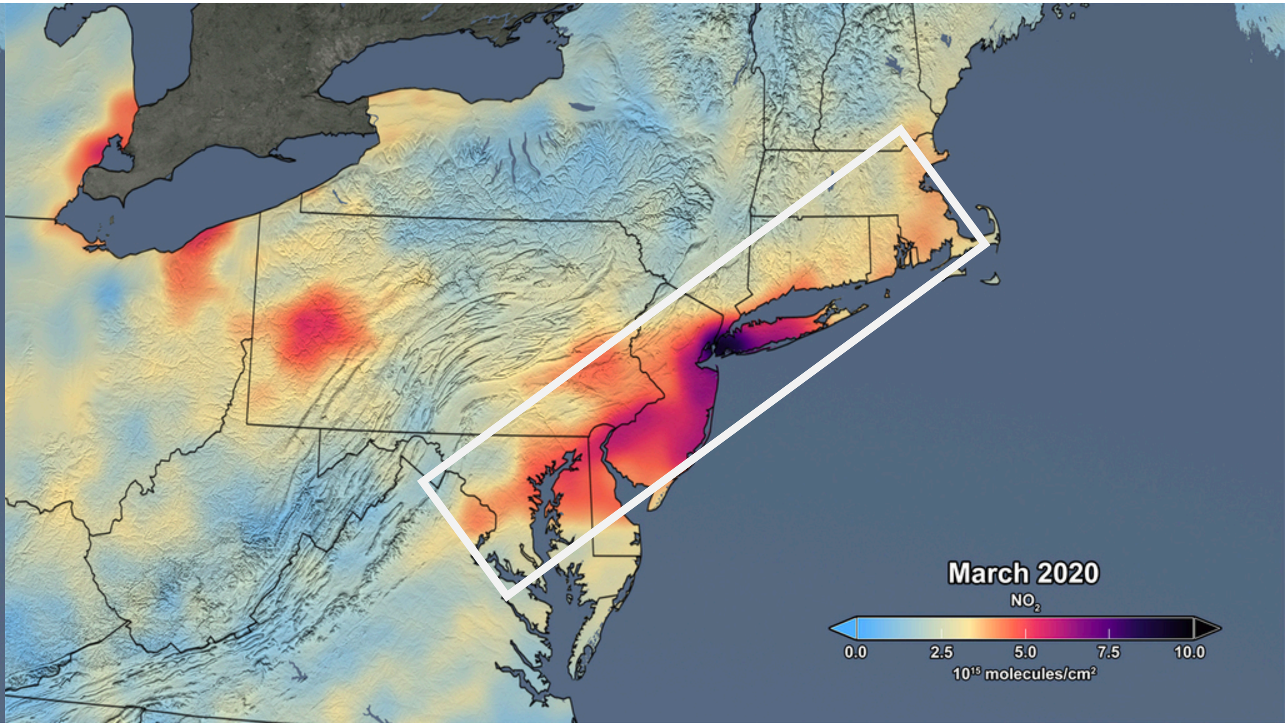
What kind of information are satellites giving us about COVID-19?

OMI NO_2 – March 2015-2019 Average



Total NO_2 in NE corridor: *496 kt*

OMI NO_2 – March 2020

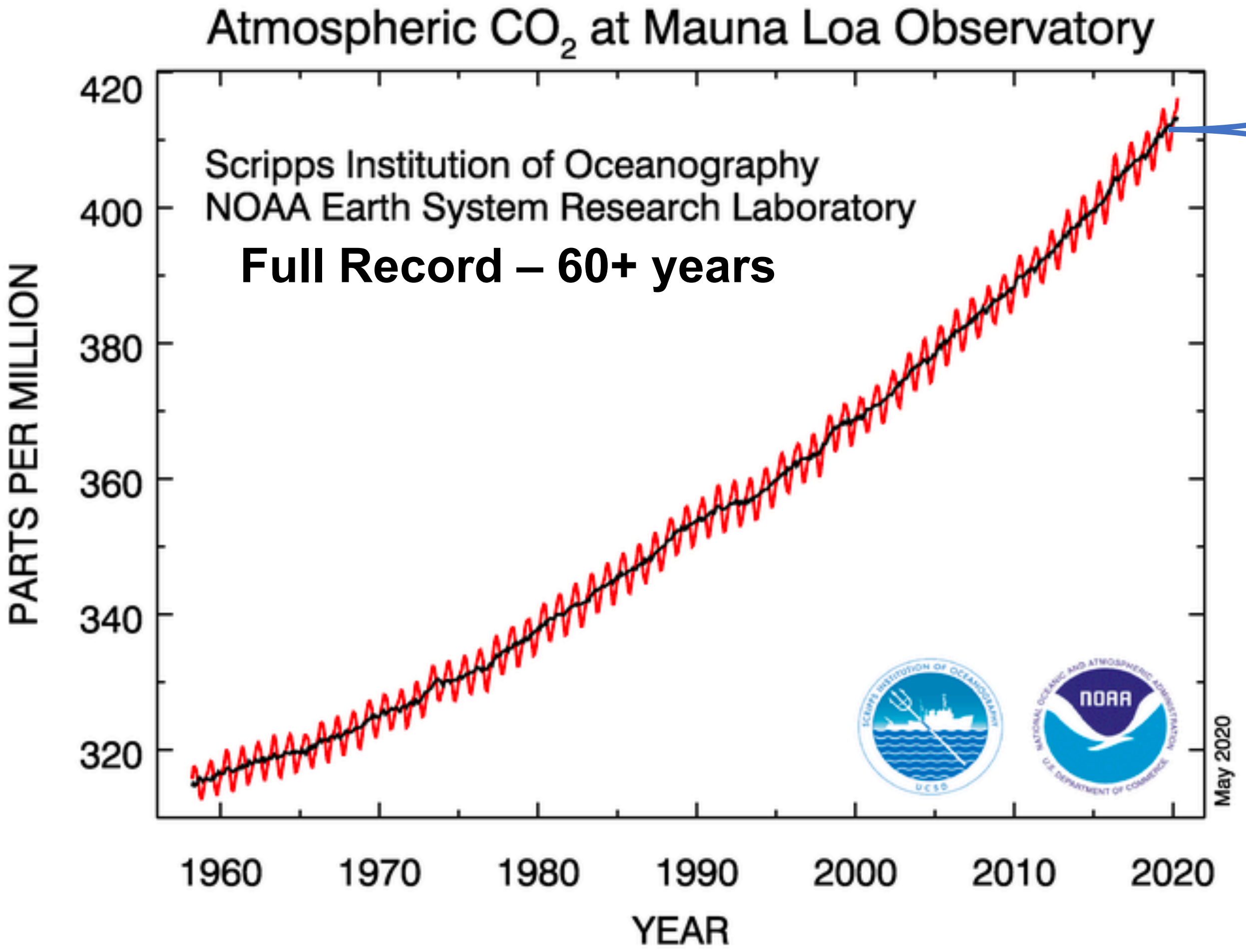


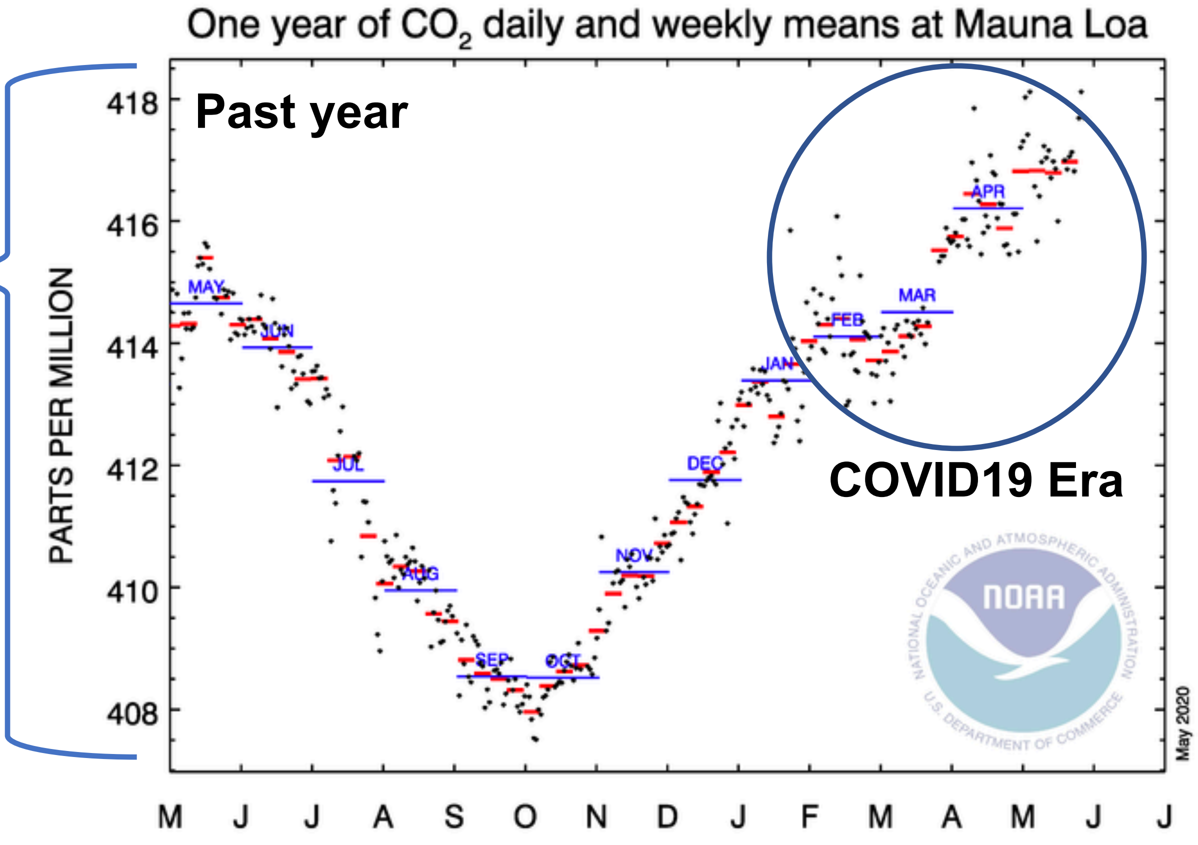
Total NO_2 in NE corridor: *347 kt*

More images and updates: https://airquality.gsfc.nasa.gov/
Analysis of world cities: https://so2.gsfc.nasa.gov/no2/no2_index.html

Observing CO_2 concentration changes: a look at Mauna Loa

Because CO_2 is long-lived, the surface signal is very small relative to the background

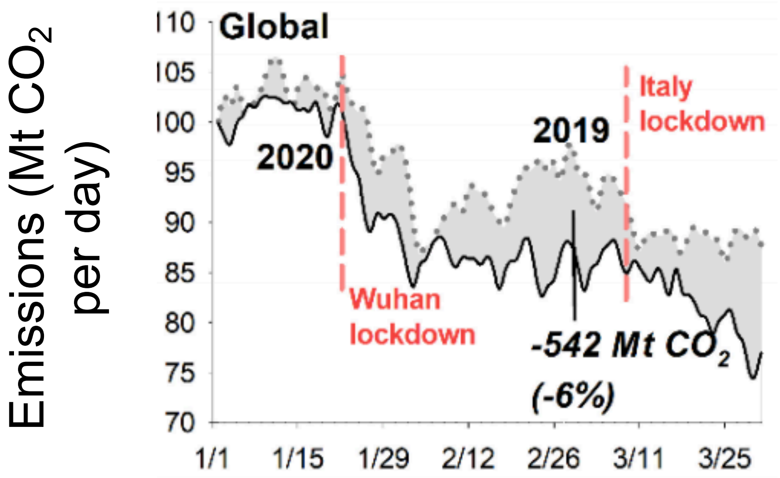




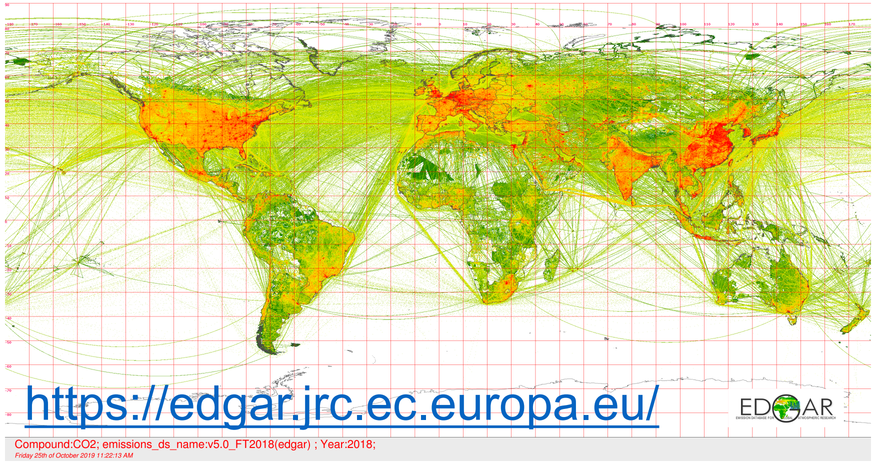
Images and more information available at: https://www.esrl.noaa.gov/gmd/ccgg/trends/

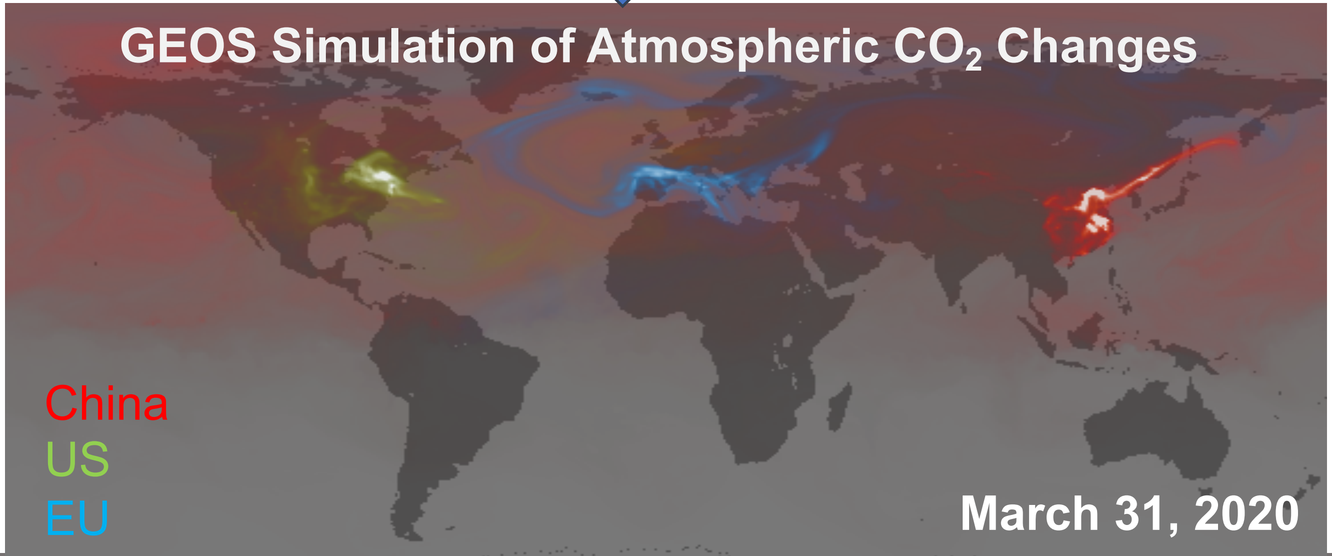
Targeted model simulations show us what to expect

Liu et al. estimate of Emission Changes



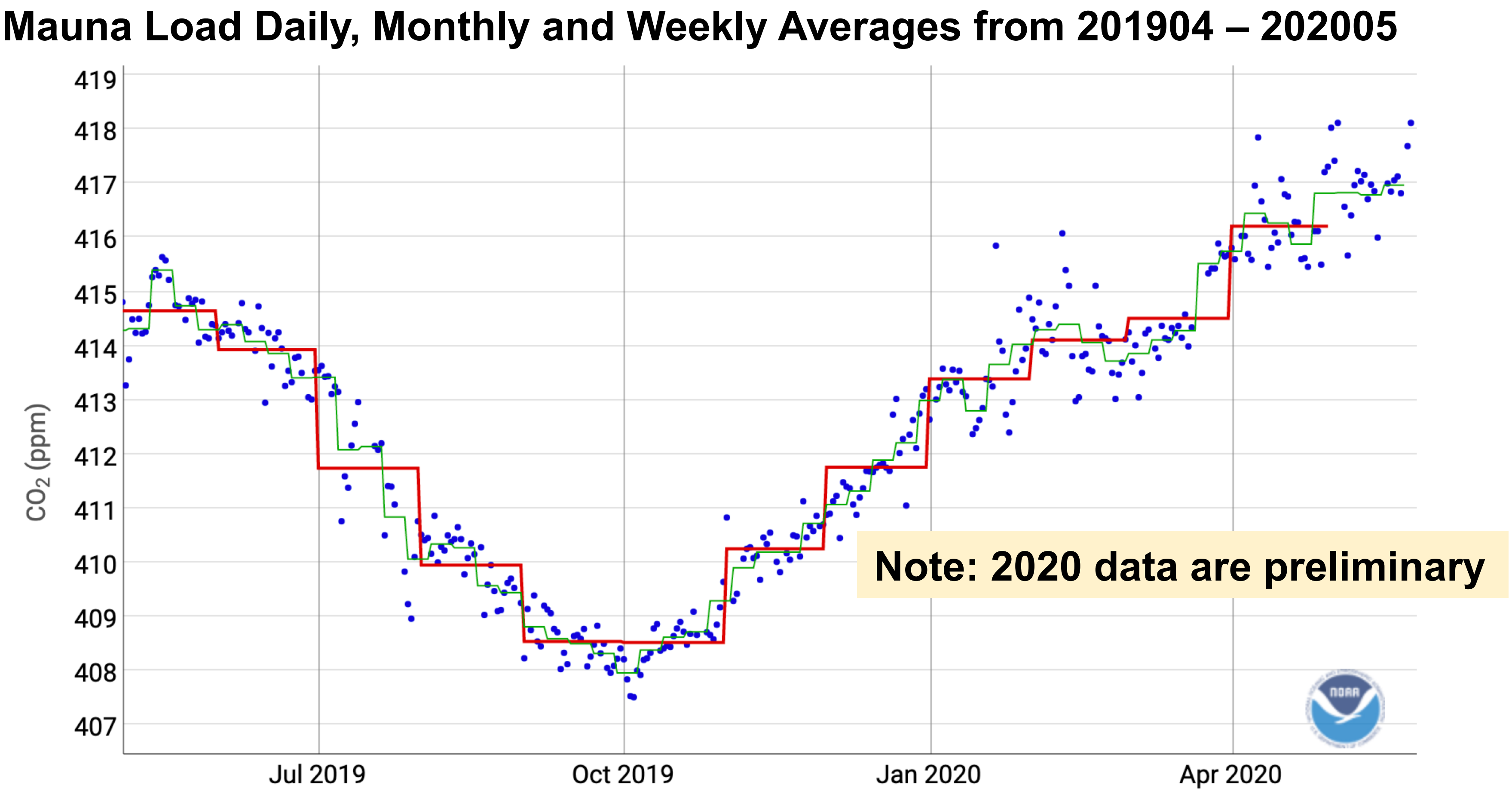
EDGAR gridded emissions estimate





Liu paper: https://arxiv.org/pdf/2004.13614.pdf

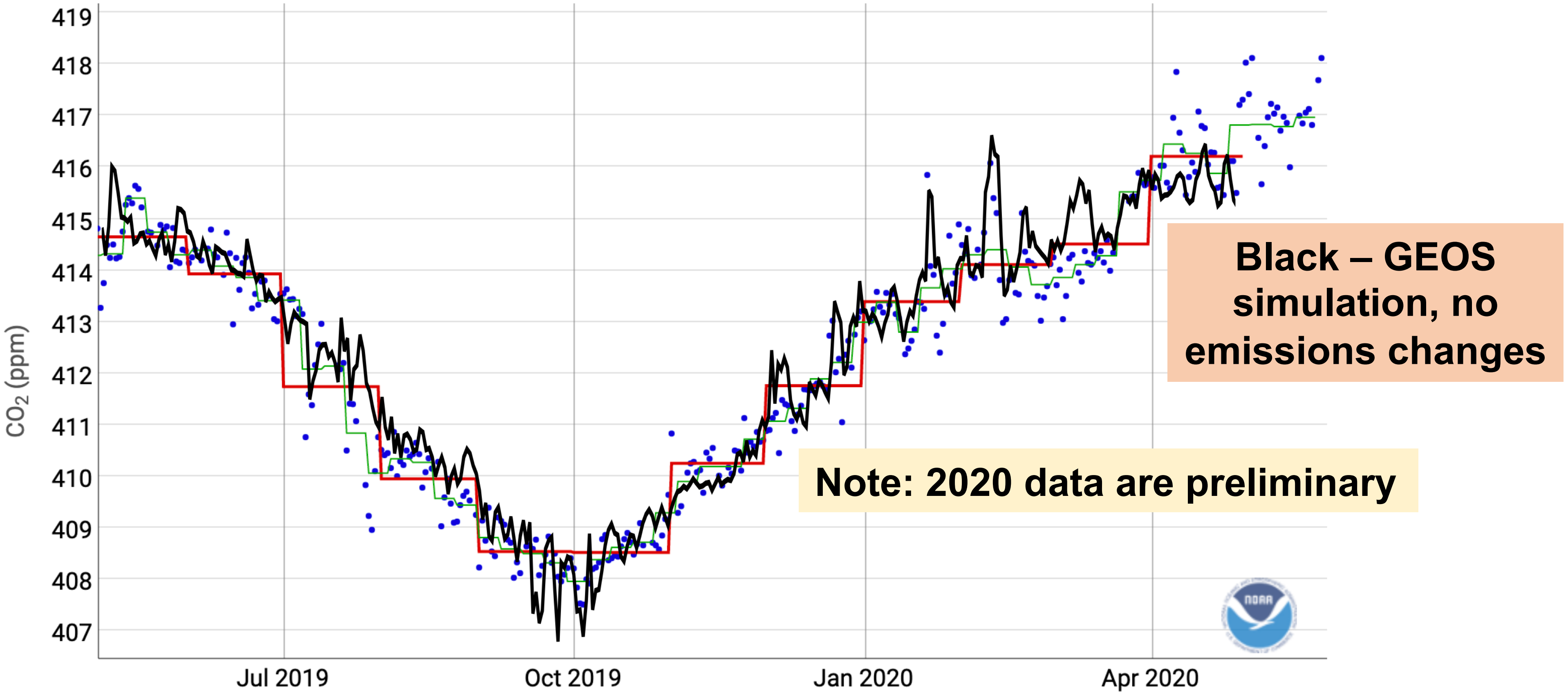
A closer look at Mauna Loa



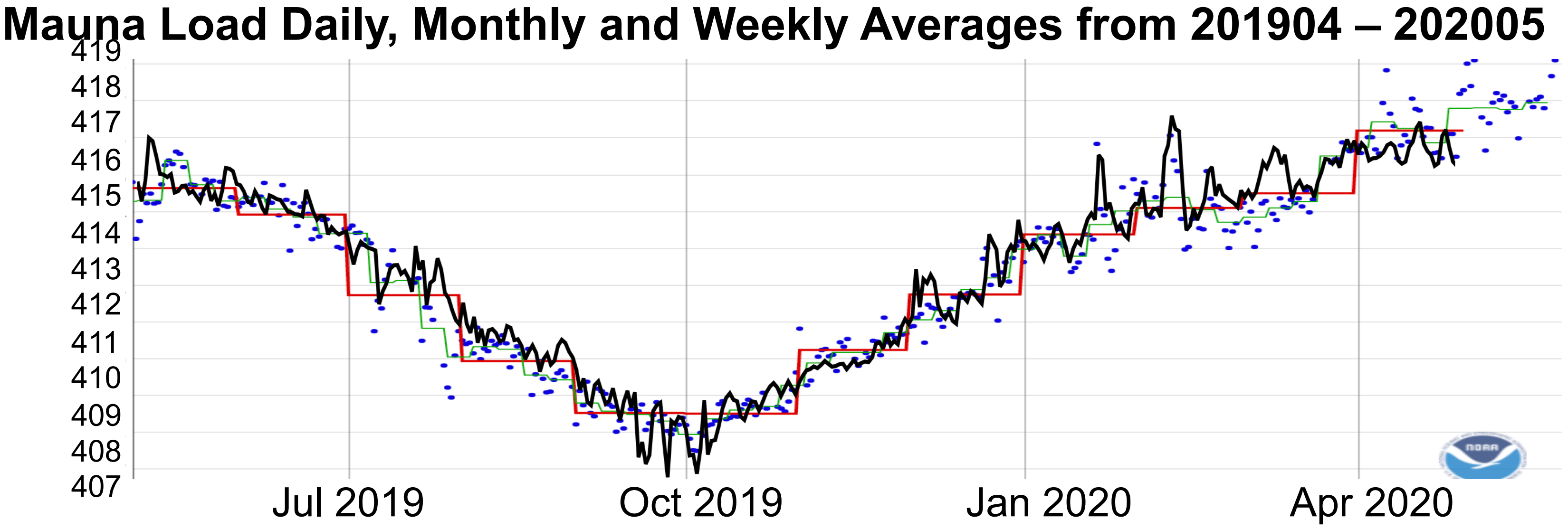
https://www.esrl.noaa.gov/gmd/ccgg/trends/

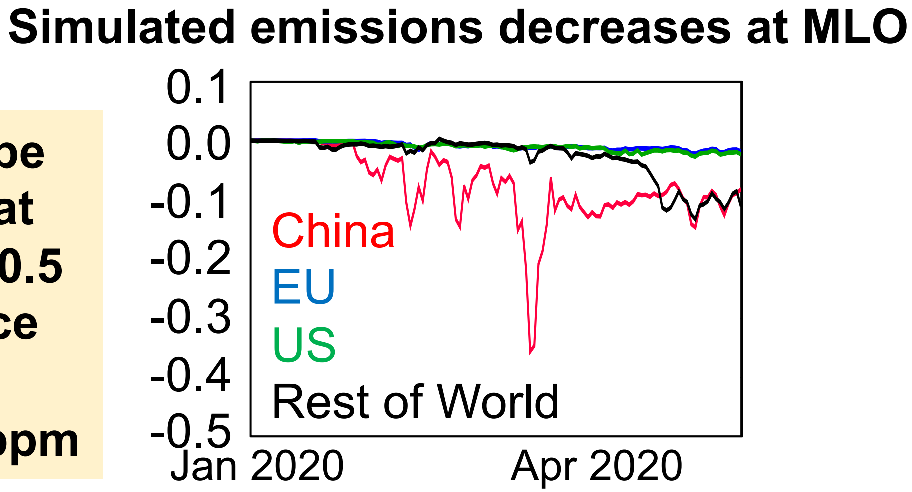
Models can realistically simulate recent Mauna Loa data, even without including emissions changes

Mauna Load Daily, Monthly and Weekly Averages from 201904 – 202005



What are we seeing at Mauna Loa?





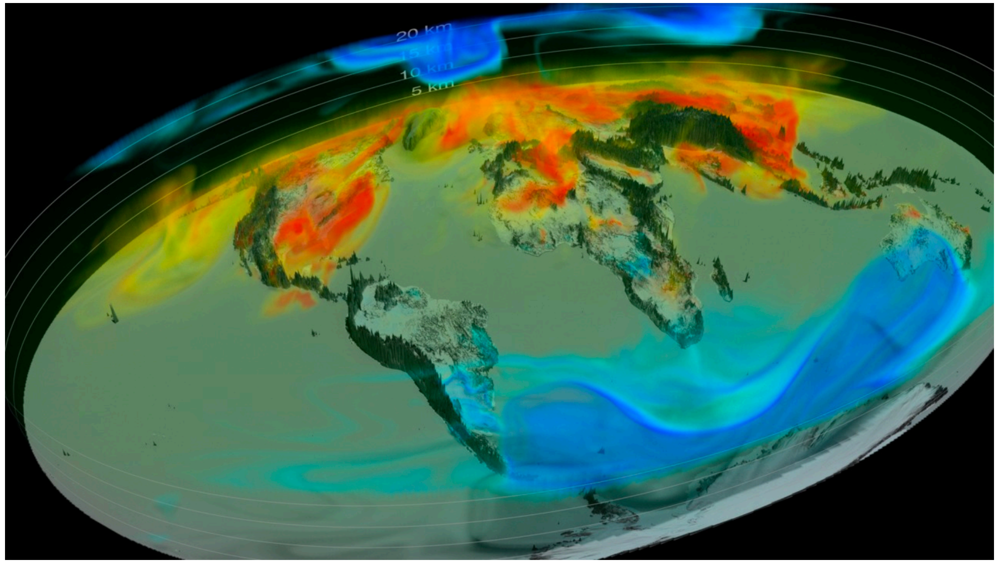
Preliminary model analysis suggests that we may be starting to see the signal of emissions decreases at Mauna Loa, but changes are very small – less than 0.5 ppm, consistent with forecasts by the UK Met Office

Note: the accuracy of NOAA measurements is ~0.2 ppm

https://www.esrl.noaa.gov/gmd/ccgg/trends/

A space-based perspective on CO_2 changes

Anthropogenic signals are even smaller when mixed through the entire depth of the atmosphere



https://svs.gsfc.nasa.gov/12478

A space-based perspective on CO_2 changes

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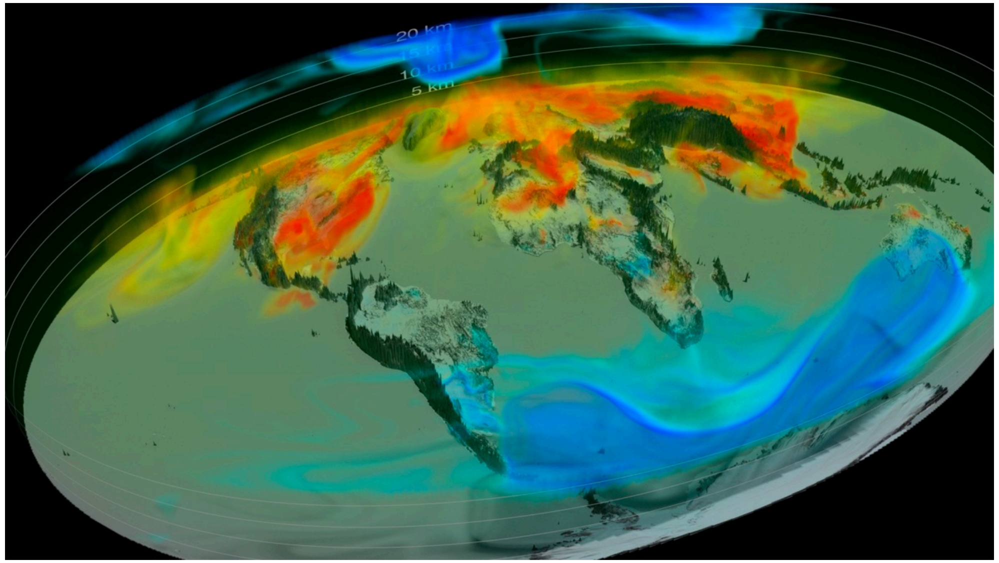
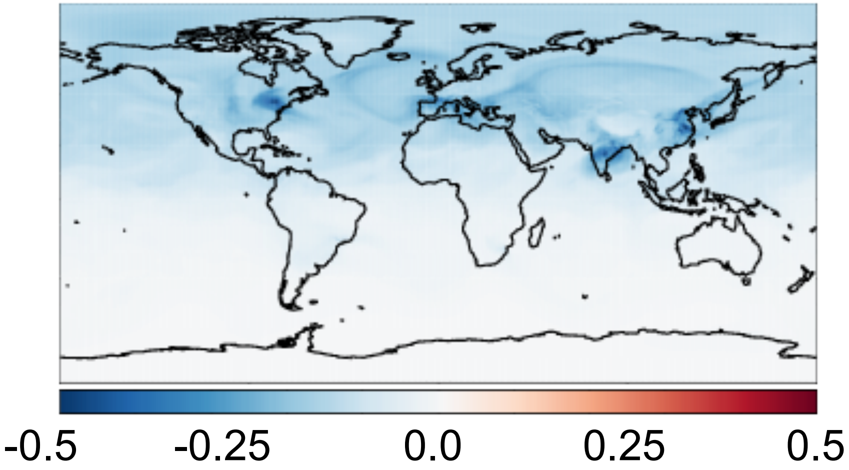
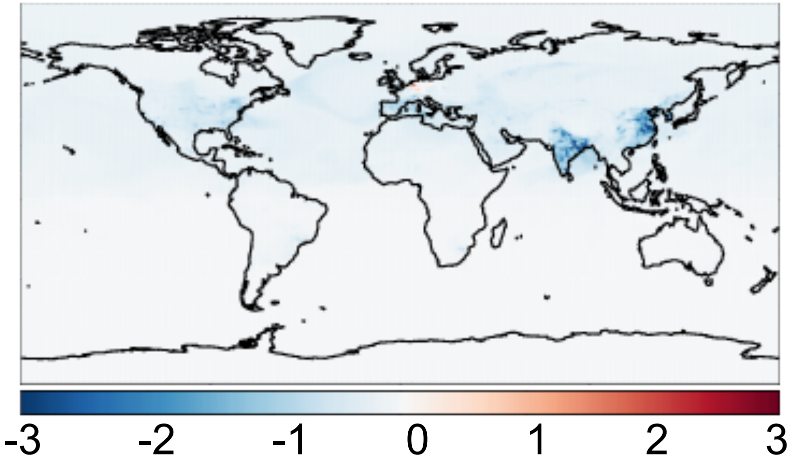


https://svs.gsfc.nasa.gov/12478

GEOS simulated Change in column-averaged CO_2 due to decreased emissions - Mar. 31



Change in surface CO_2



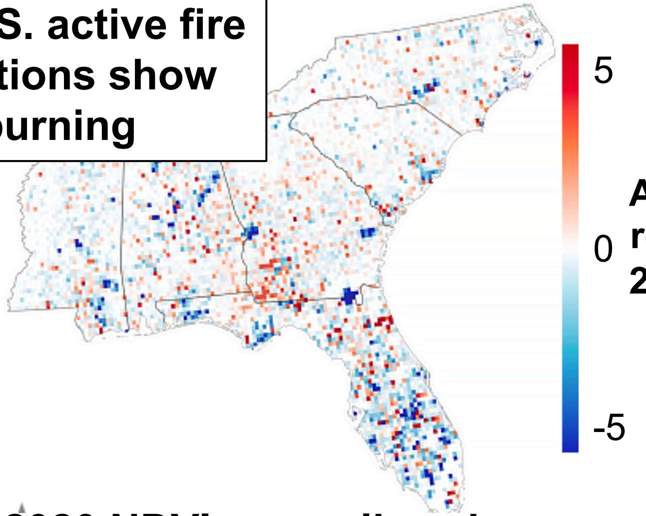
Changes in column CO_2 measured by satellites are smaller than at the surface, strongly influenced by weather patterns, and may contain information from many different regions

Urban observing networks are starting to see localized surface changes which provide a valuable complement to broader-scale measurements

Many of the changes that we see aren't related to human emissions

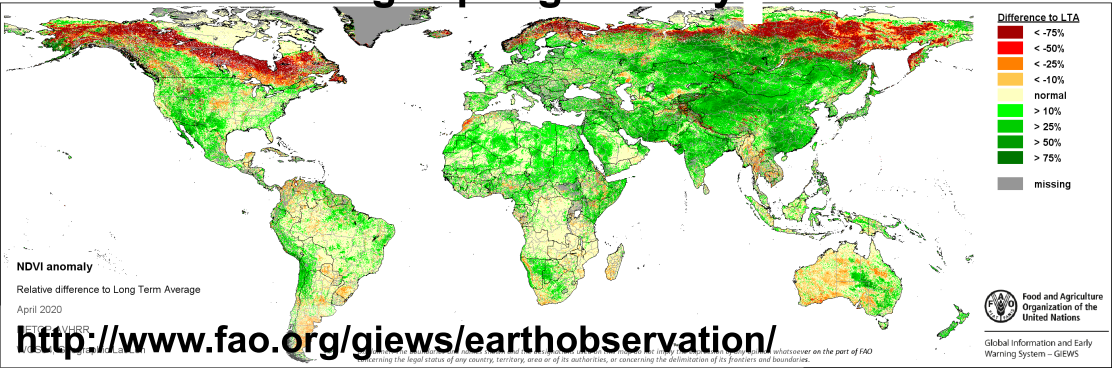
There's more going on than just fossil fuel emissions changes in 2020

SE U.S. active fire detections show less burning



April 2020 relative to 2012-2019

April 2020 NDVI anomalies show a greener than average spring in many areas



http://www.fao.org/giews/earthobservation/

Fire story available at: https://earthobservatory.nasa.gov/images/146714/

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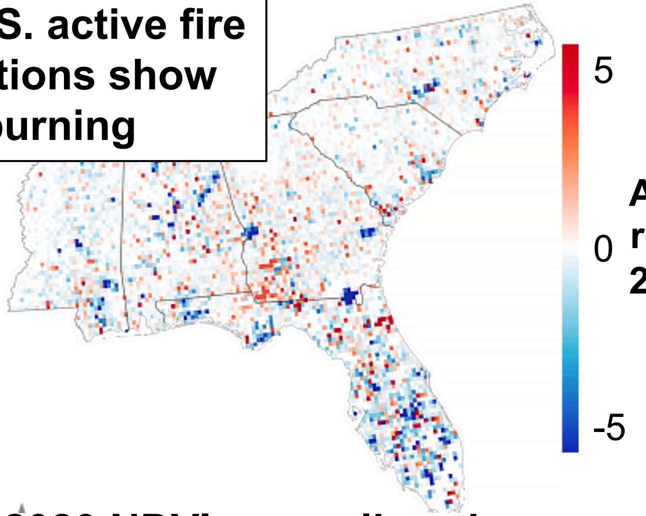

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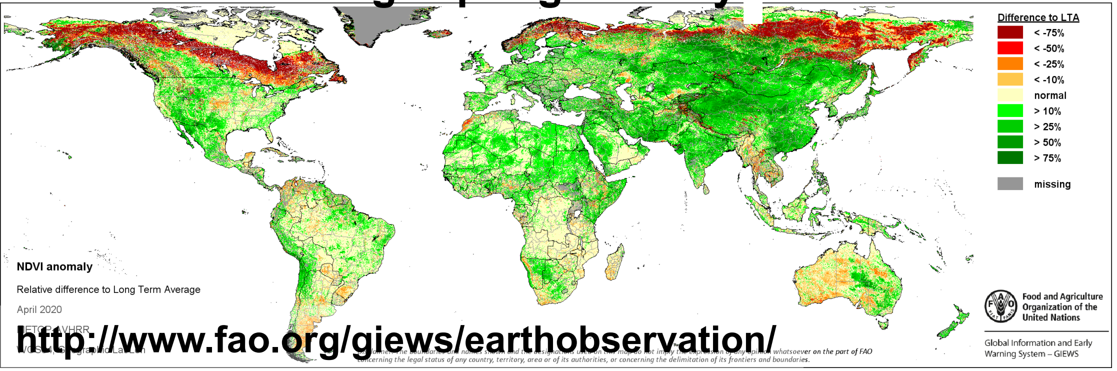

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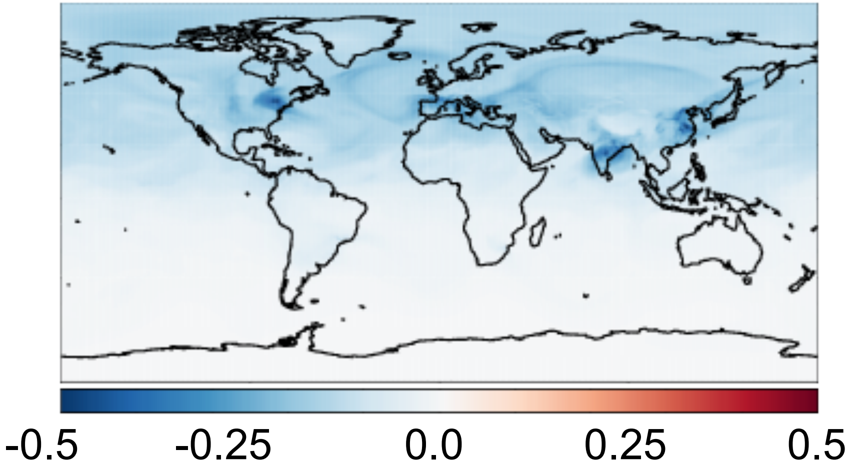
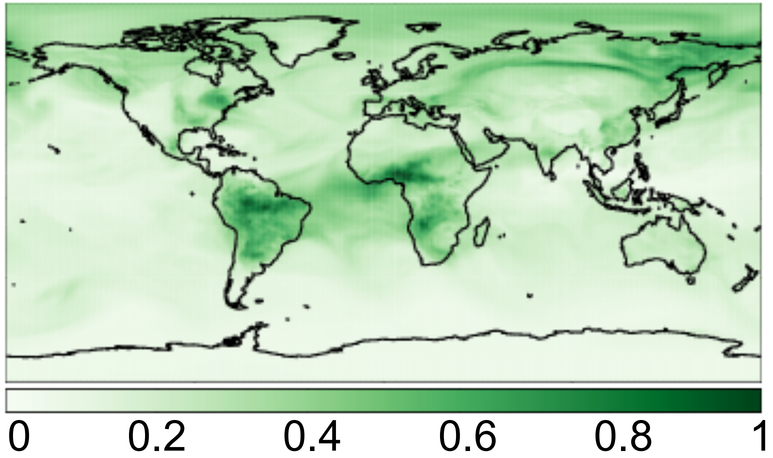


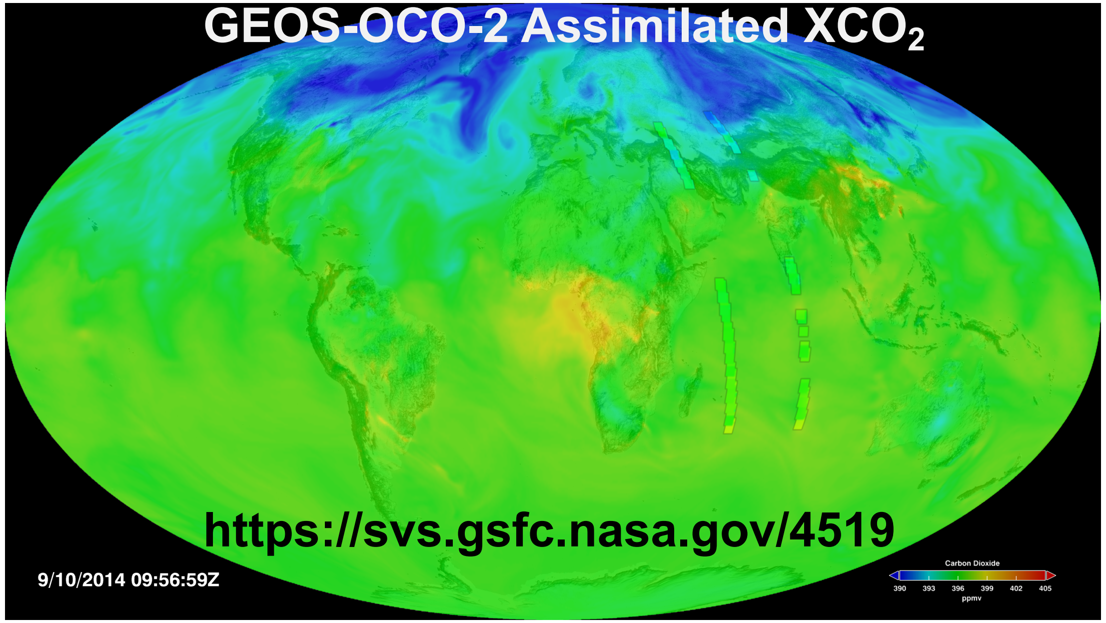
The biospheric signal is often as large as the fossil fuel decreases we're looking for

Variability in column CO_2 due to biosphere



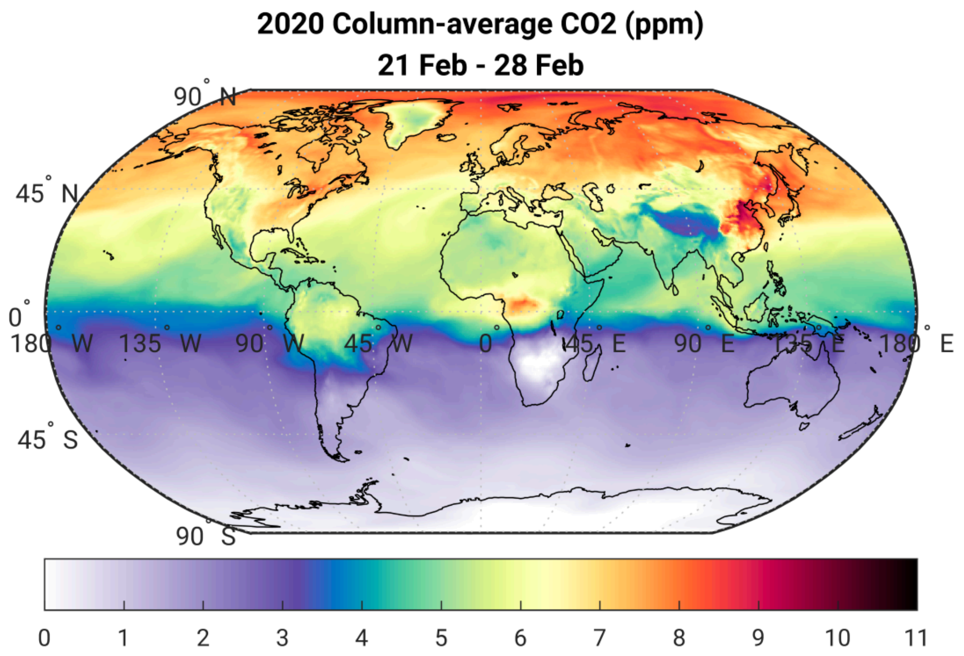
Fire story available at: https://earthobservatory.nasa.gov/images/146714/

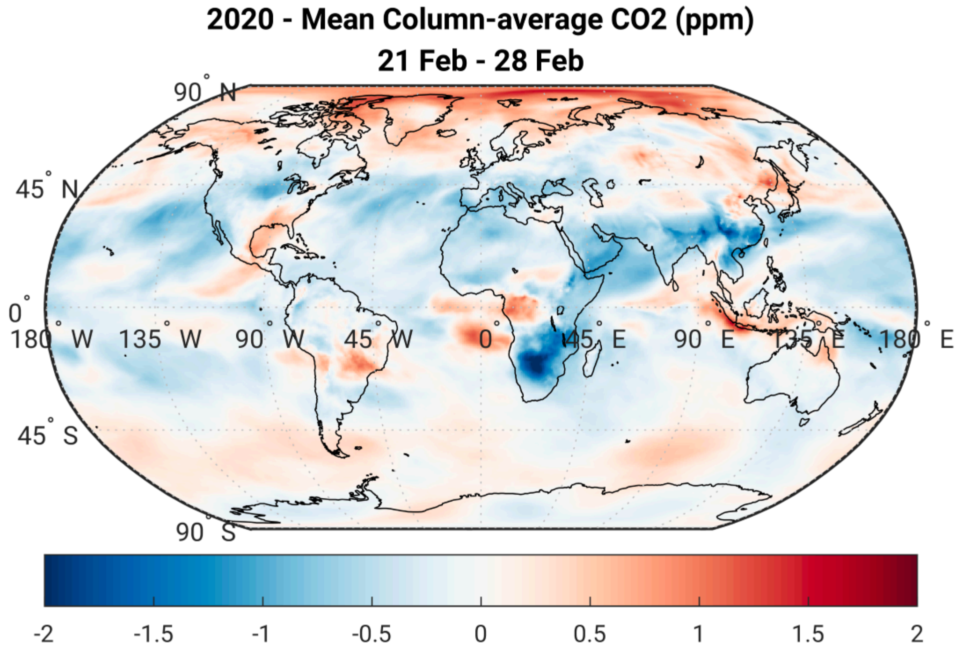
A first look at atmospheric CO_2 anomalies using a combination of OCO-2 data and NASA's GEOS Data Assimilation System – much more to come!



Merging model products with satellite observations:

- Fills gaps when observations are not available
- Integrates surface, satellite, and aircraft observations
- Accelerates the process of detecting anomalies





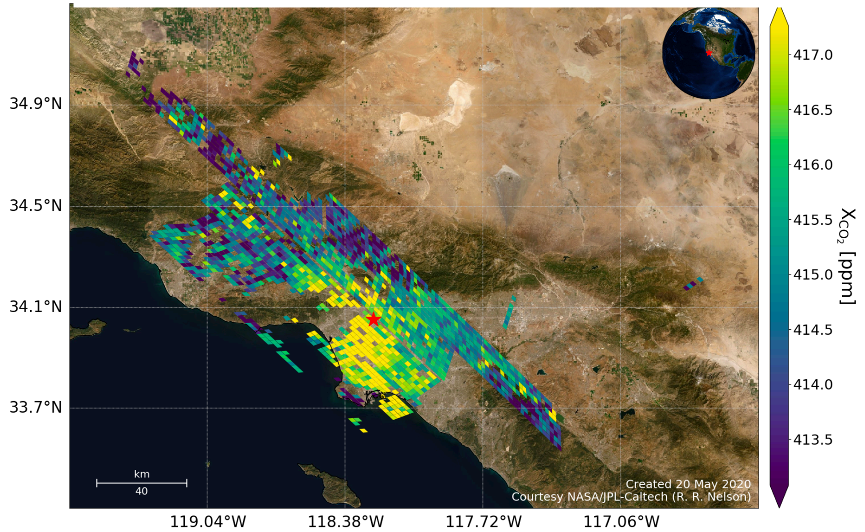
Warning: data very preliminary!

Where we are right now in interpreting space-based CO_2 observations

- Bottom-up analysis of activity data is providing valuable information about emission reductions related to COVID-19
- Integrating this information with atmospheric models tells us that (for now) we should expect these signals to be very small, often just larger than the accuracy of our measurements
- Major challenges ahead in interpreting the changes we are starting to see in satellite CO_2 observations and separating changes in emissions from shifts in weather and biospheric flux
- For the first time, we have many of the observations and models that we need to interpret these changes shortly after they happen, largely thanks to support from CMS

- In addition to OCO-2 data, newly released OCO-3 data may provide additional insights on urban changes using a unique capability to zoom in on cities (https://ocov3.jpl.nasa.gov/)

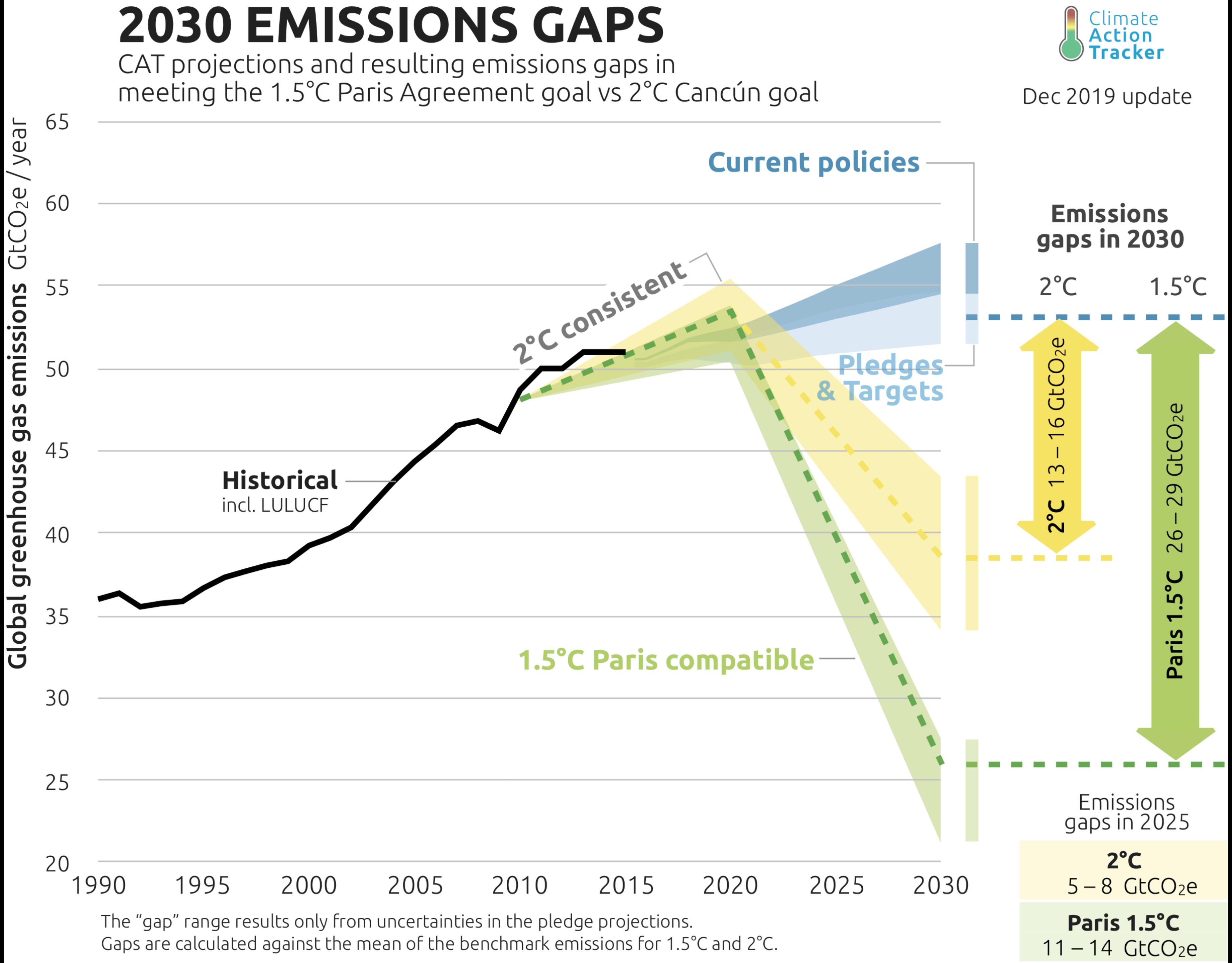
OCO-3 observations over Los Angeles, Feb. 24, 2020

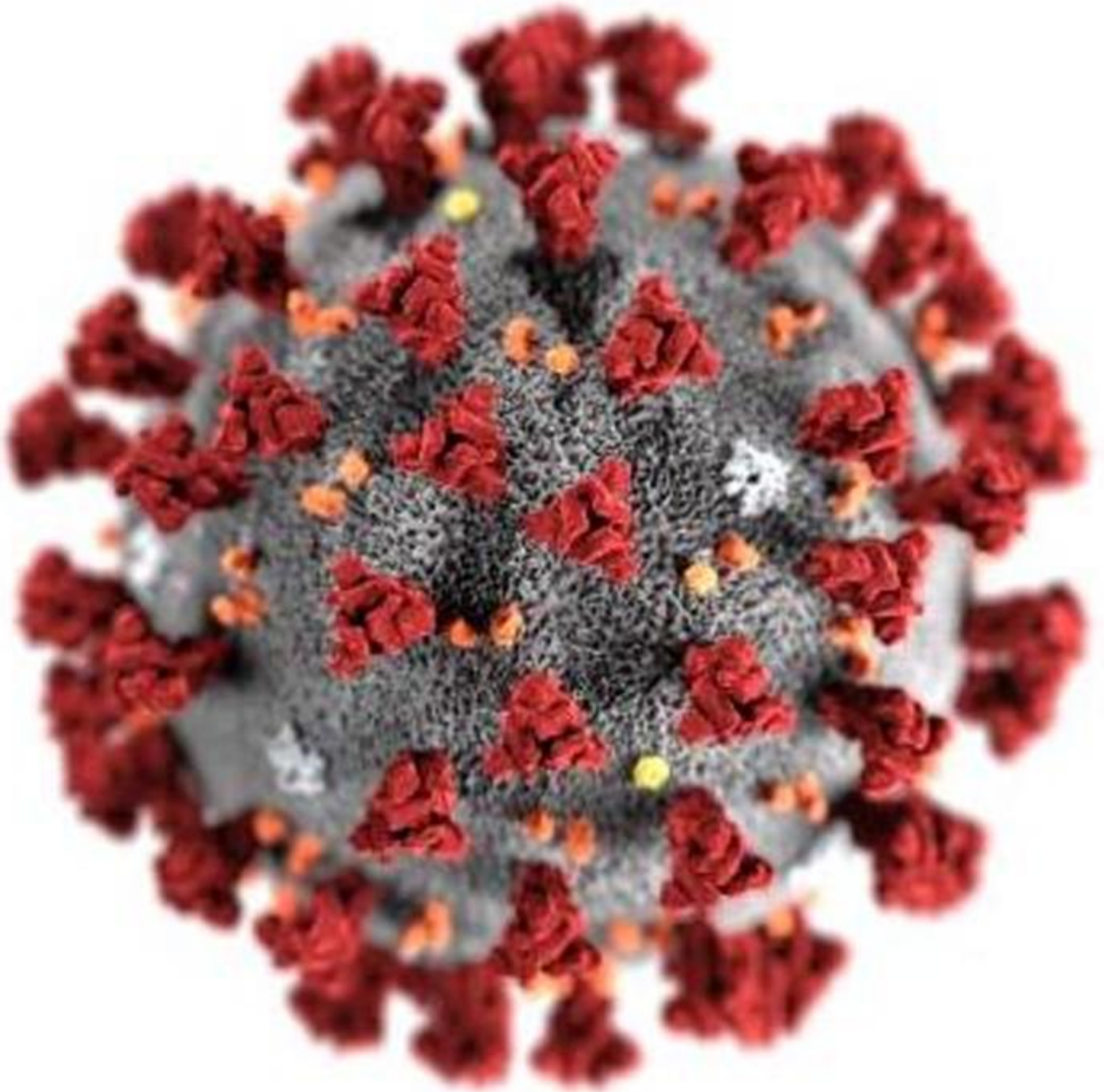



COVID-19 and the Climate Crisis:
The Long and Winding Road

Paris Ambition Mechanism

- Ambition gap acknowledged in 2015
- 5-year revision cycle for Paris pledges
- Invitation to “update” initial pledges by 2020
- UK climate summit postponed to 2021
- Need for much greater ambition remains


2030 EMISSIONS GAPS
CAT projections and resulting emissions gaps in meeting the 1.5°C Paris Agreement goal vs 2°C Cancún goal
Climate Action Tracker
Dec 2019 update
Global greenhouse gas emissions GtCO2e / year
65
60
55
50
45
40
35
30
25
20
1990
1995
2000
2005
2010
2015
2020
2025
2030
Current policies
2°C consistent
Pledges & Targets
Historical
incl. LULUCF
1.5°C Paris compatible
Emissions gaps in 2030
2°C
1.5°C
2°C 13 – 16 GtCO2e
Paris 1.5°C 26 – 29 GtCO2e
Emissions gaps in 2025
2°C
5 – 8 GtCO2e
Paris 1.5°C
11 – 14 GtCO2e
The "gap" range results only from uncertainties in the pledge projections.
Gaps are calculated against the mean of the benchmark emissions for 1.5°C and 2°C.



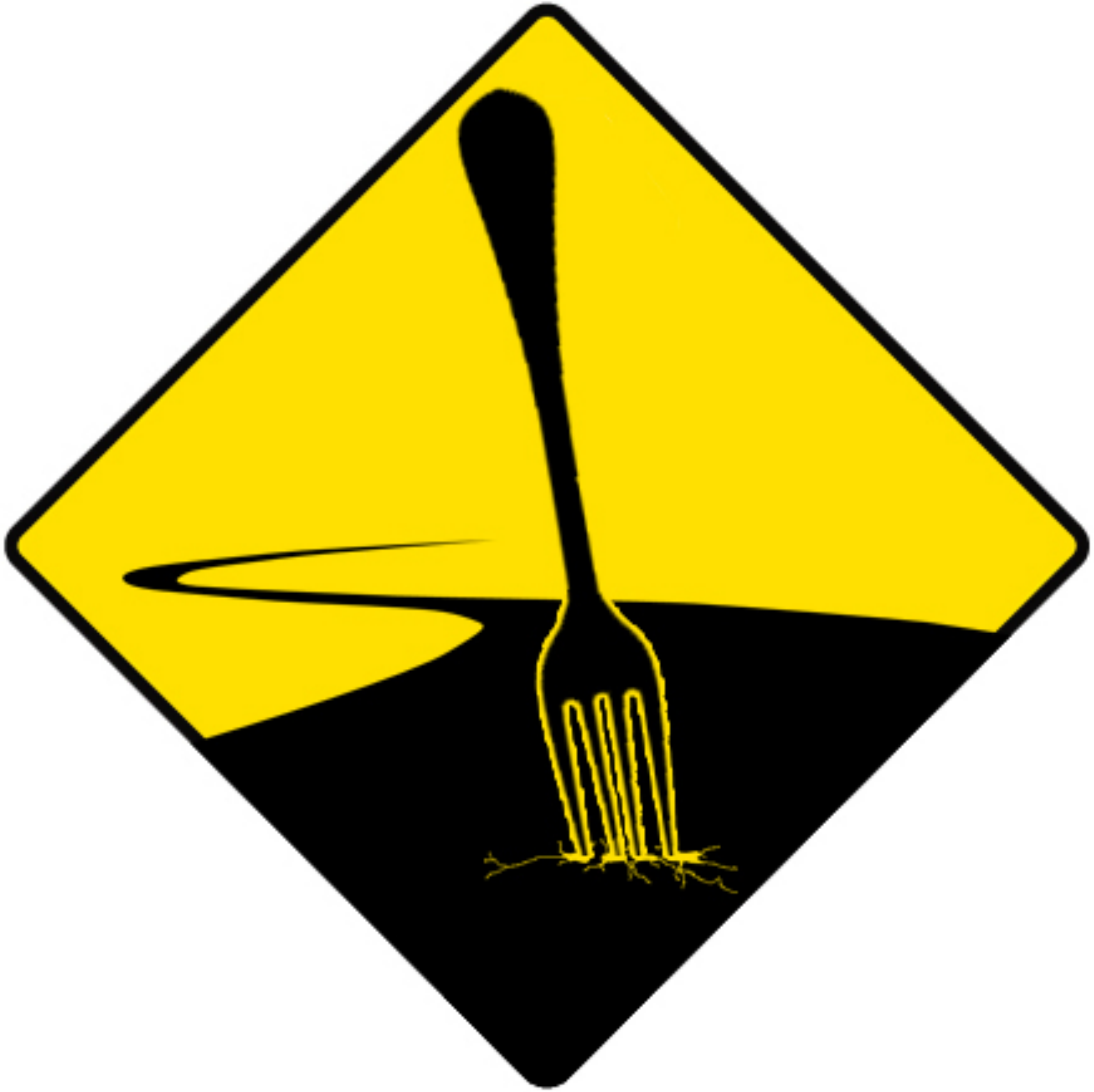
Health impacts

Economic shock

Fiscal instability

Policymaker and Public Focus

Geopolitical tensions



"Back to normal" (which was never sustainable)

OR

"Build Back Better"

THE DO'S AND DON'TS OF GREEN ECONOMIC RECOVERY

Green stimulus interventions and harmful actions to avoid

Climate Action Tracker

Energy and electricity supply

✔ Do:

- Direct support for zero-emissions technologies and infrastructure
- Fiscal reform on fossil fuel subsidies

✘ Don't:

- Revive plans for 'shovel-ready' fossil fuel power plants
- Waive oil and gas industry environmental regulations
- Bail out fossil fuel companies without conditions for zero-emission transition

Land-based transport and mobility

✔ Do:

- Financial incentives for zero-emission vehicles
- Direct investments in low-carbon public transport

✘ Don't:

- Roll back emission standards for cars
- Support to automobile companies without conditions for zero-emissions transition

Industry

✔ Do:

- Support uptake of efficient appliances, lighting, and digital devices
- Low-carbon technology R&D and pilot projects (e.g. steel and cement)

✘ Don't:

- Roll back climate measures and regulation (e.g. industry levy for supporting renewable energy)
- Support for industry without conditions for zero-emission transition

Aviation

✔ Do:

- Conditional sector support for aviation industry (e.g. bailout) and accelerated R&D efforts

✘ Don't:

- Roll back regulations and taxes (e.g. ticket taxes)
- Recalibrate CORSIA baseline without substantially improving entire scheme

Buildings

✔ Do:

- Support for energy efficient retrofits of existing buildings
- Support for accelerated construction of low and zero-energy buildings

✘ Don't:

- Stimulus programmes for new buildings without energy efficiency criteria

Land-use and environmental protection

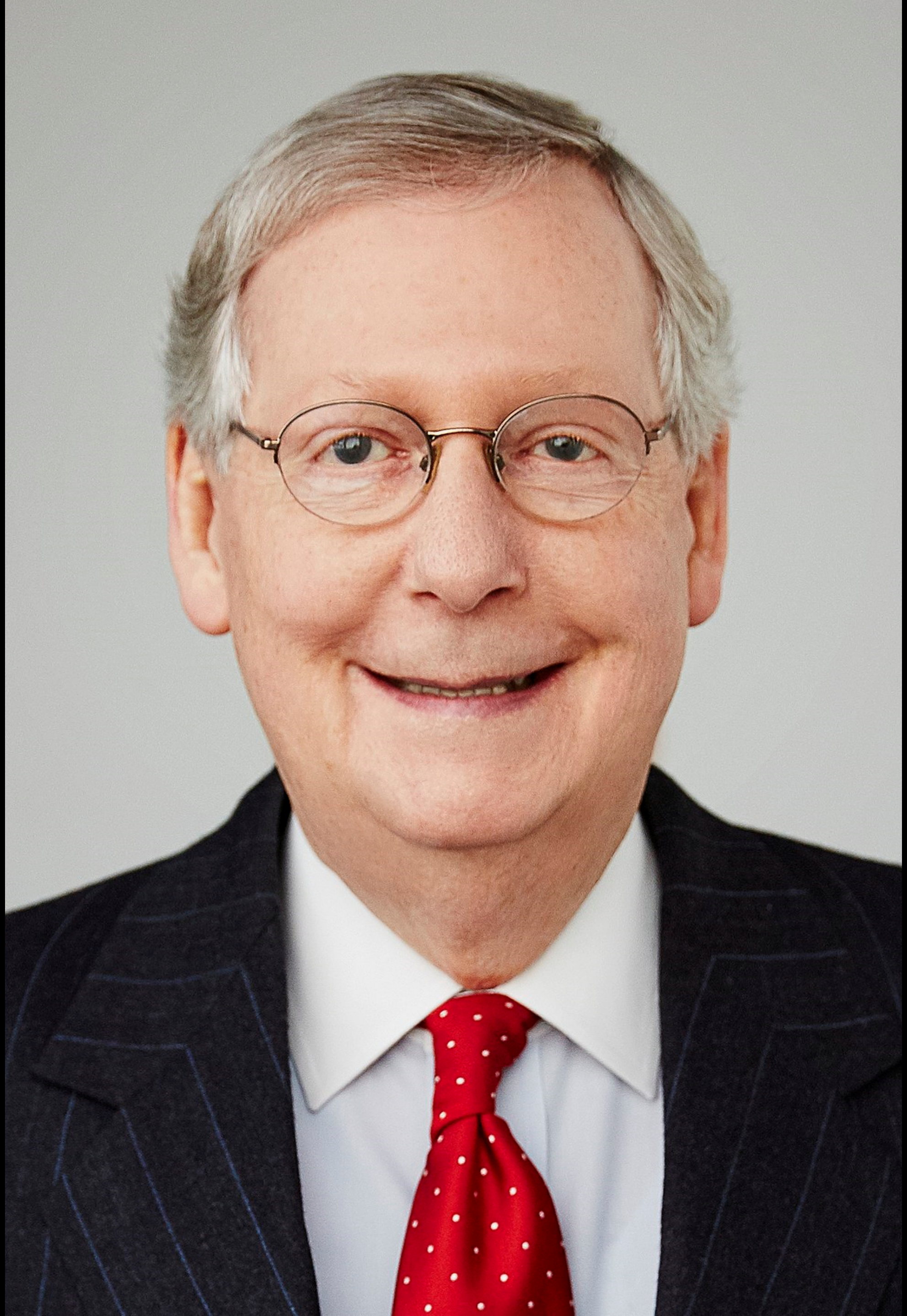
✔ Do:

- Large-scale landscape restoration and reforestation efforts

✘ Don't:

- Roll back environmental regulations
- Dismantling enforcement of state protection for natural habitats


#CORONAVIRUS
© Reuters/F. Lenoir




U.S. governors, mayors, businesses, investors, colleges and universities say:

WE ARE STILL IN

and will work together to ensure the U.S. remains a global leader in reducing carbon emissions.

“You can always count on the Americans to do the right thing, after they have exhausted all the other possibilities.”


G20 OSAKA SUMMIT
2019
G20
2019
JAPAN

Principles for a Sustainable Recovery

Health professionals

https://healthyrecovery.net/

Investors:

http://theinvestoragenda.org

States and Regions:

https://www.under2coalition.org

Cities:

https://www.c40.org/other/covid-task-force

Labor:

https://www.bluegreenalliance.org/work-issue/solidarity-for-climate-action/

- Depth/duration of economic shock
- Fiscal crises, potential debt defaults
- Nationalism/Isolationism
- US-China tensions
- Leadership deficit
- Power of the fossil fuel industry

"Yes, the planet got destroyed. But for a beautiful moment in time we created a lot of value for shareholders."

- Sharp drop in cost of solutions
- Business/investor/subnational commitments & action
- Perception of financial risk
- Public awareness and concern


TAXIS
YOU ARE NEVER TOO SMALL TO MAKE A DIFFERENCE


NO PLANET B
SAVE EARTH


STOP Dirtying my/your OUR HOME


CLIMATE ACTION NOW
SAVE OUR FUTURE


SYSTEM CHANGE NOT CLIMATE CHANGE
Opa was ist ein Schneemann


"Earth Rise" – Apollo 8, Christmas Eve, 1968


Questions?
Union of Concerned Scientists

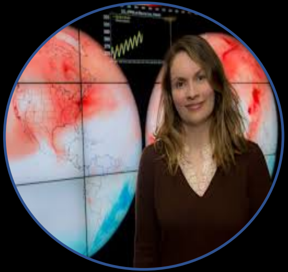
National Aeronautics and Space Administration

NASA Carbon Monitoring System

NASA Carbon Monitoring System (CMS) Policy Speaker Series | Special Virtual Panel Edition

Covid-19 and Its Impact on Global Carbon Emissions

Thursday, May 28, 2020 | 11AM-12PM Eastern Time, Via Adobe Connect (see details below)

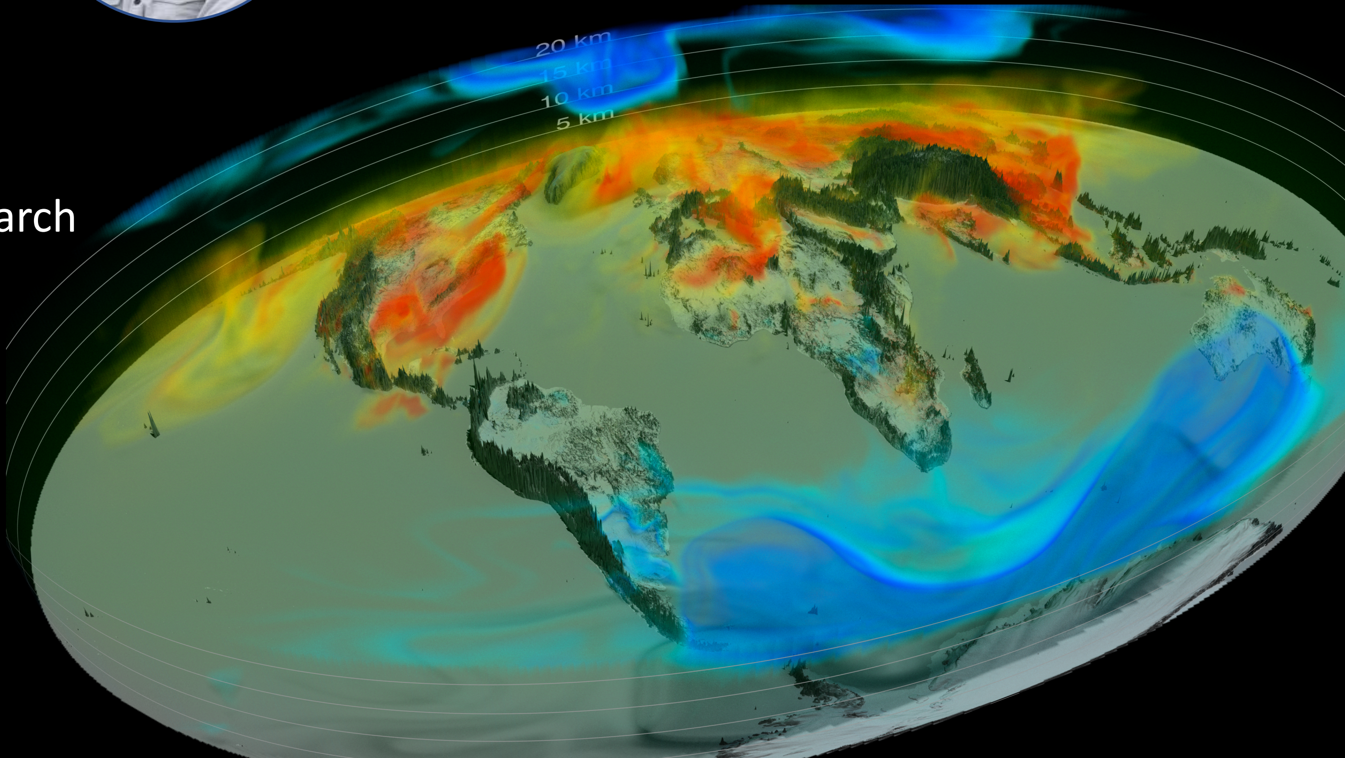


Dr. Lesley Ott, Research Meteorologist,
Global Modeling and Assimilation Office,
NASA Goddard Space Flight Center

Moderator: Dr. Ben Poulter
NASA Goddard Space Flight Center

Dr. Glen Peters, Research Director
CICERO Center for International Climate Research

Alden Meyer, Director of Strategy & Policy
Union of Concerned Scientists (UCS)



You may access the seminar remotely: To register for live stream:
https://gsfc610.adobeconnect.com/cmsmay2020/event/registration.html
For audio, please call: USA Toll free: 1-844-467-4685, Access code: 9907511380