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The short- and long-term effects of COVID-19 on CO_2 emissions & climate

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

ICOS Norway Annual Science Meeting (remote, 29/10/2020)

Emission Estimates 101

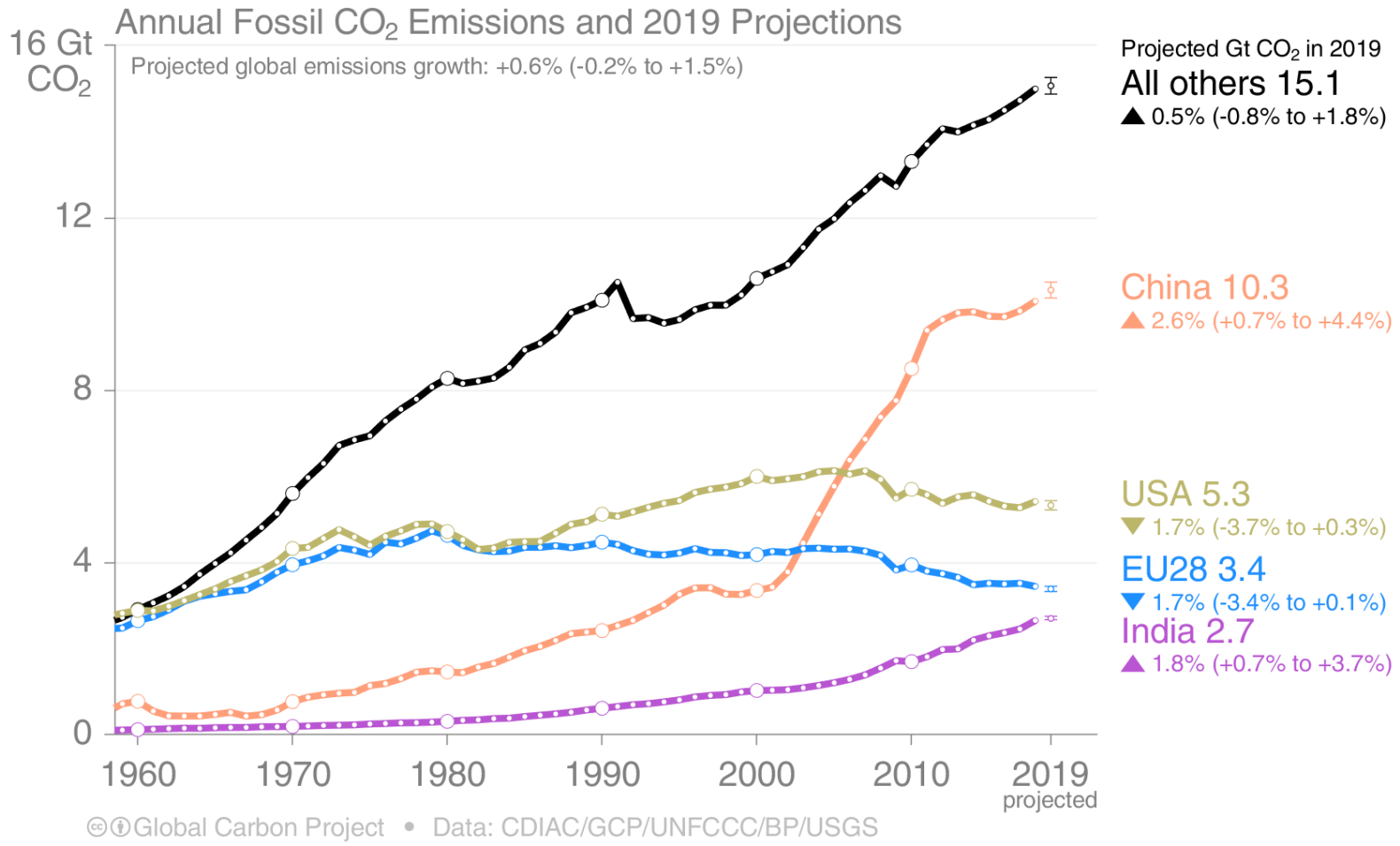
$$\text{Emissions} = \text{Activity} \times \text{Emission Factor}$$

Usually energy or fuel use

Emissions per unit fuel

Emissions reported with 1-2 year delay

Official emissions estimates are with a 1-2 year delay, in some cases longer. Global Carbon Budget changed this…
We make current-year projections in Nov/Dec using data for the first 6-9 months of the year: Big uncertainties…



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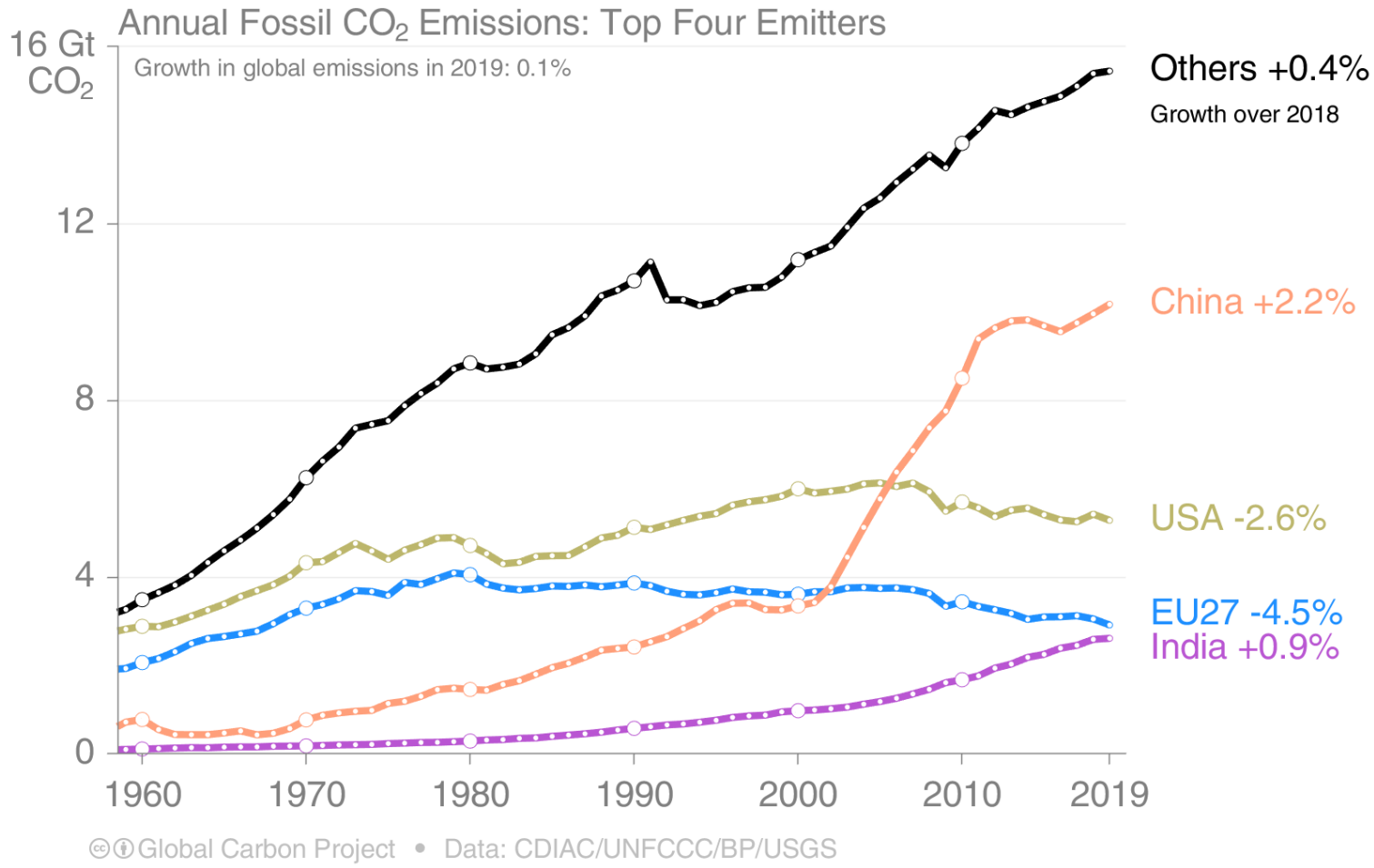
Source: Global Carbon Budget (2019)

Projections have uncertainty

Globally, we projected 0.6% and now expect 0.1% (still uncertain). Why differences?
Partial data (~6-9 months), monthly data is preliminary & often not revised, gap fill (~3-6 months), we are human!



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Source: Global Carbon Budget (2019), updated

Should we project in a COVID year?

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

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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], M
Sam Abernethy[3,6], Robbie M. Andrew[7], Anthon
Josep G. Canadell[9], Pierre Friedlingstein[10,11], Fel

**Government policies during the COVID-19 pandemic have dra
Many international borders were closed and populations were
consumption patterns. Here we compile government policies
during forced confinements. Daily global CO_2 emissions decreas
with the mean 2019 levels, just under half from changes in sur
decreased by −26% on average. The impact on 2020 annual
low estimate of −4% (−2 to −7%) if prepandemic conditions r
some restrictions remain worldwide until the end of 2020. Go
influence the global CO_2 emissions path for decades.**

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https://doi.org/10.1038/s41558-020-0883-0

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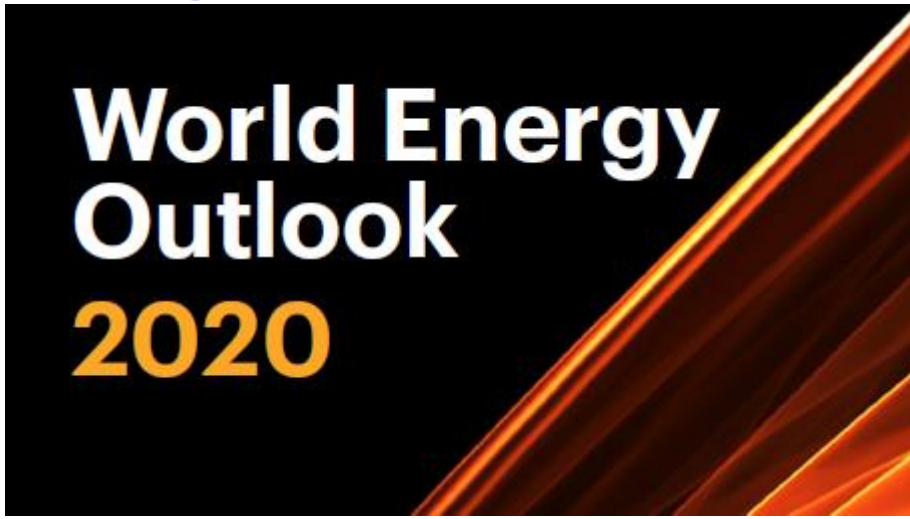
Current and future global climate impacts resulting from COVID-19

Piers M. Forster[1]✉, Harriet I. Forster[2], Mat J. Evans
Christoph A. Keller[8,9], Robin D. Lamboll[10], Corinne Le
Carl-Friedrich Schleussner[5,13], Thomas B. Richardson
Steven T. Turnock[1,7]

**The global response to the COVID-19 pandemic has led to a sudden r
using national mobility data, we estimate global emission reductions
We estimate that global NO_x emissions declined by as much as 30% i
the year. This cooling trend is offset by ~20% reduction in global SO_2
short-term warming. As a result, we estimate that the direct effect
cooling of around 0.01 ± 0.005 °C by 2030 compared to a baseline s
with an economic recovery tilted towards green stimulus and reducti
warming of 0.3 °C by 2050.**



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https://doi.org/10.1038/s41467-020-18922-7 OPEN

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Near-real-time monitoring of global CO_2 emissions reveals the effects of the COVID-19 pandemic

Zhu Liu et al.#

The COVID-19 pandemic is impacting human activities, and in turn energy use and carbon dioxide (CO_2) emissions. Here we present daily estimates of country-level CO_2 emissions for different sectors based on near-real-time activity data. The key result is an abrupt 8.8% decrease in global CO_2 emissions (−1551 Mt CO_2) in the first half of 2020 compared to the same period in 2019. The magnitude of this decrease is larger than during previous economic downturns or World War II. The timing of emissions decreases corresponds to lockdown measures in each country. By July 1st, the pandemic's effects on global emissions diminished as lockdown restrictions relaxed and some economic activities restarted, especially in China

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A daily approach (1)

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Check for updates

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]

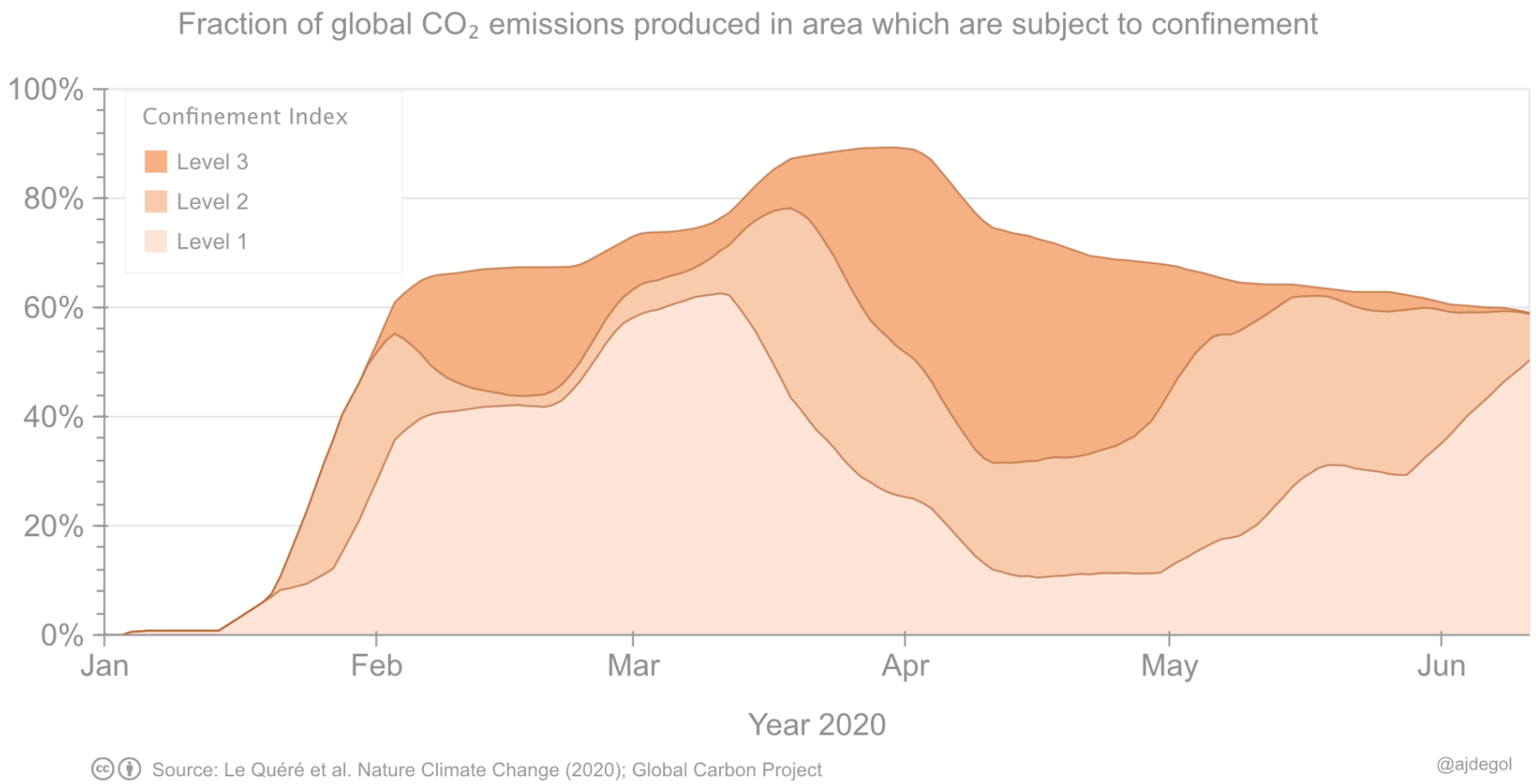
Government policies during the COVID-19 pandemic have drastically altered patterns of energy demand around the world. Many international borders were closed and populations were confined to their homes, which reduced transport and changed consumption patterns. Here we compile government policies and 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.

Method and Data

- No daily approaches in use (& often not needed)
- Method:
  - Le Quéré et al: Geared towards COVID & confinement
  - Zhu et al: Geared towards real-time emission estimates
- Data: Daily electricity, Apple mobility, TomTom, industry organizations, government, smart meters, etc, etc

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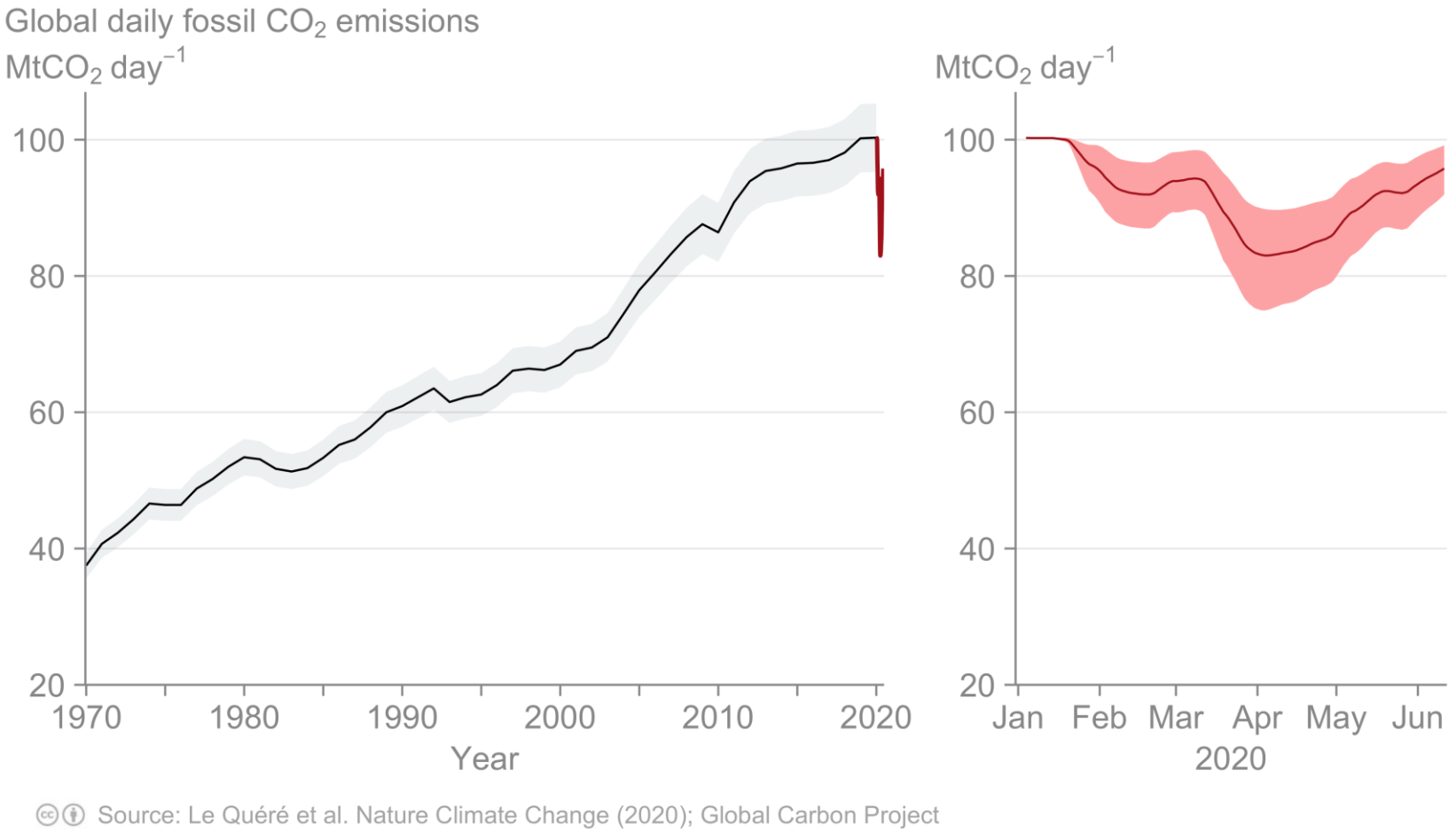
Source: Le Quéré et al (2020), Figure 1

Daily CO_2 emissions (until 11 June)

Daily global fossil CO_2 emissions decreased by –17% (–11% to –25%) by early April 2020 compared to 2019
The change in emissions until 11 June was –8.6% decrease over January–June 2019



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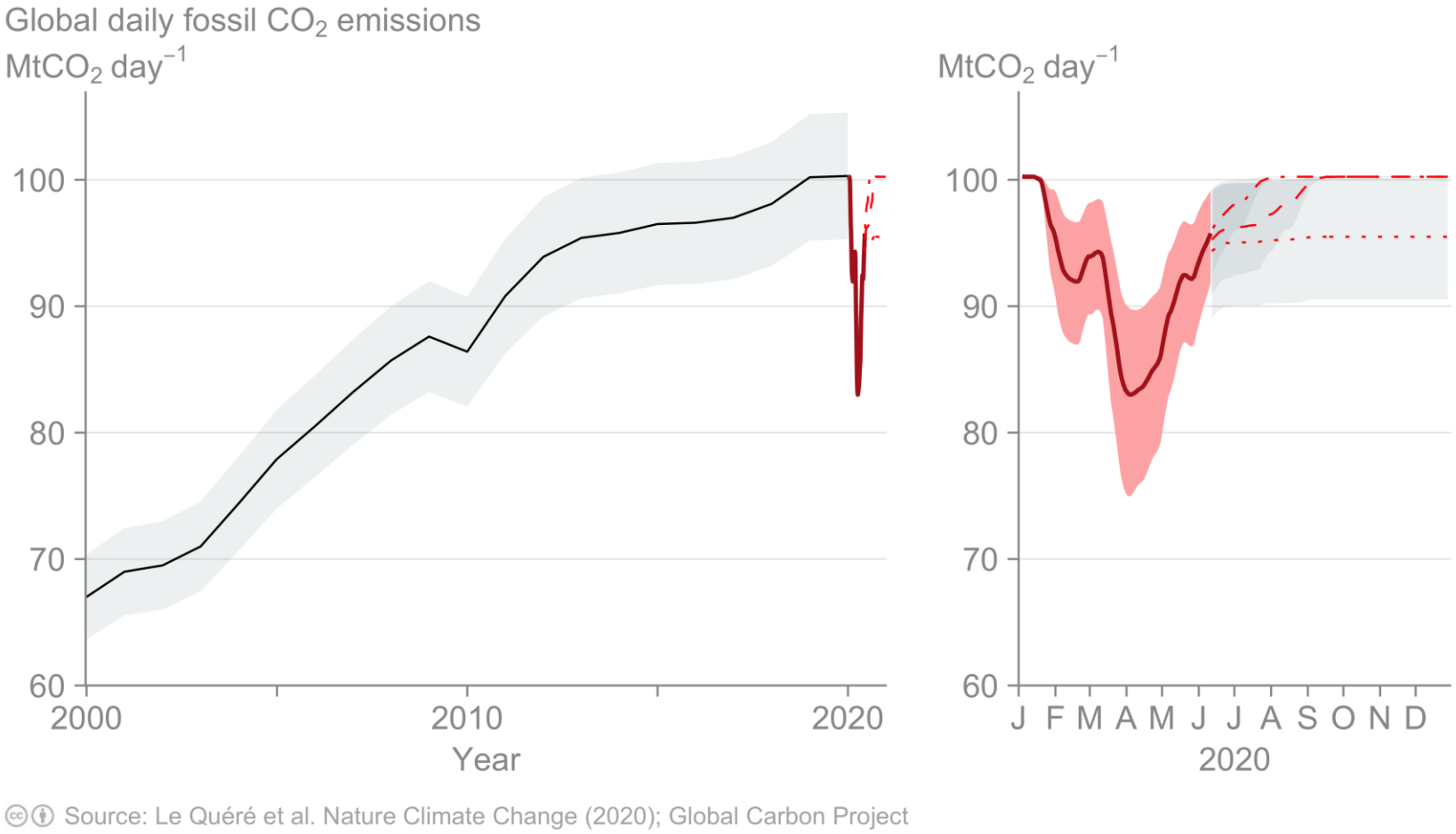
Source: Le Quéré et al (2020)

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 –12%) if some restrictions remain worldwide.



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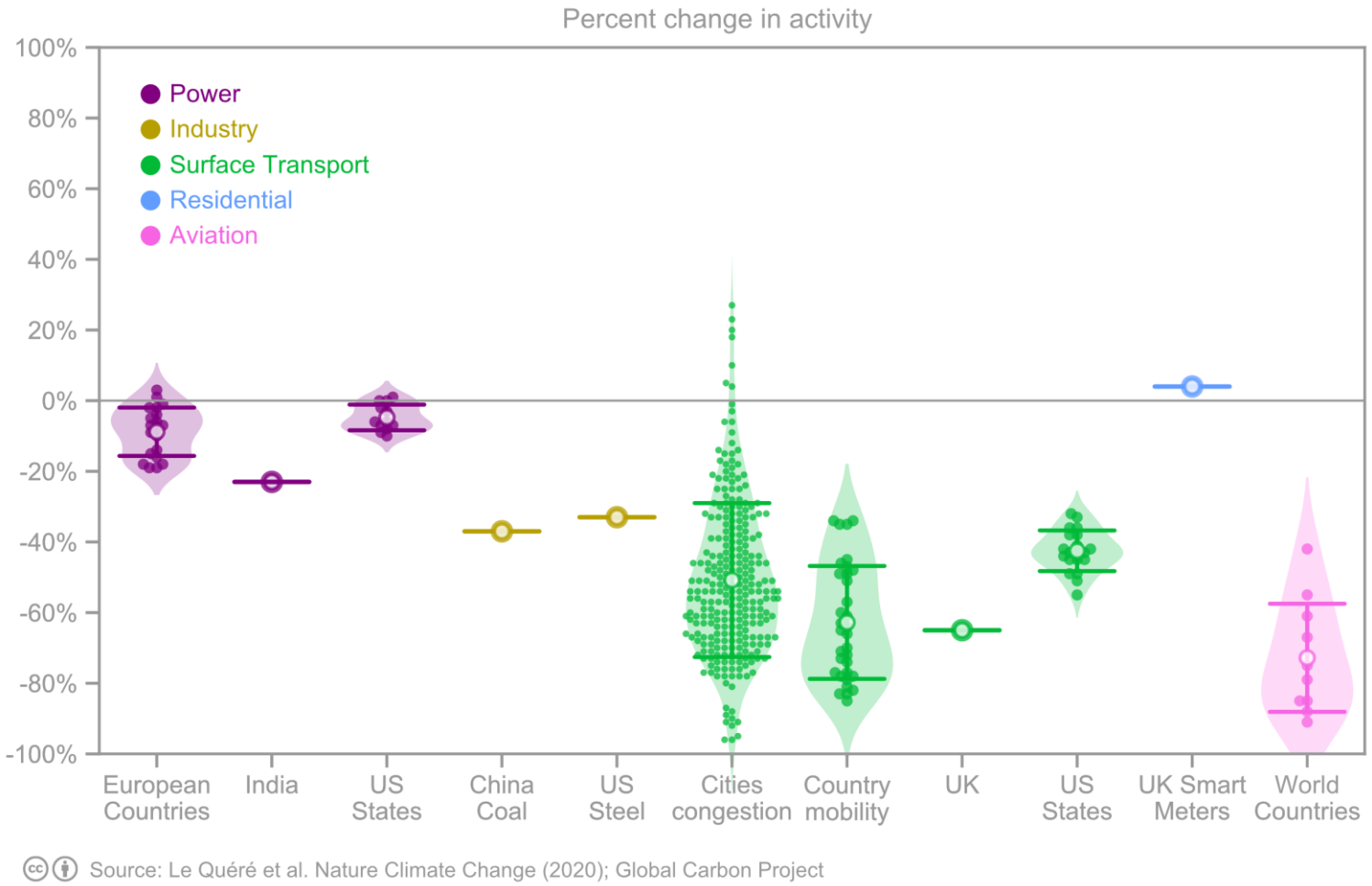
Source: Le Quéré et al (2020)

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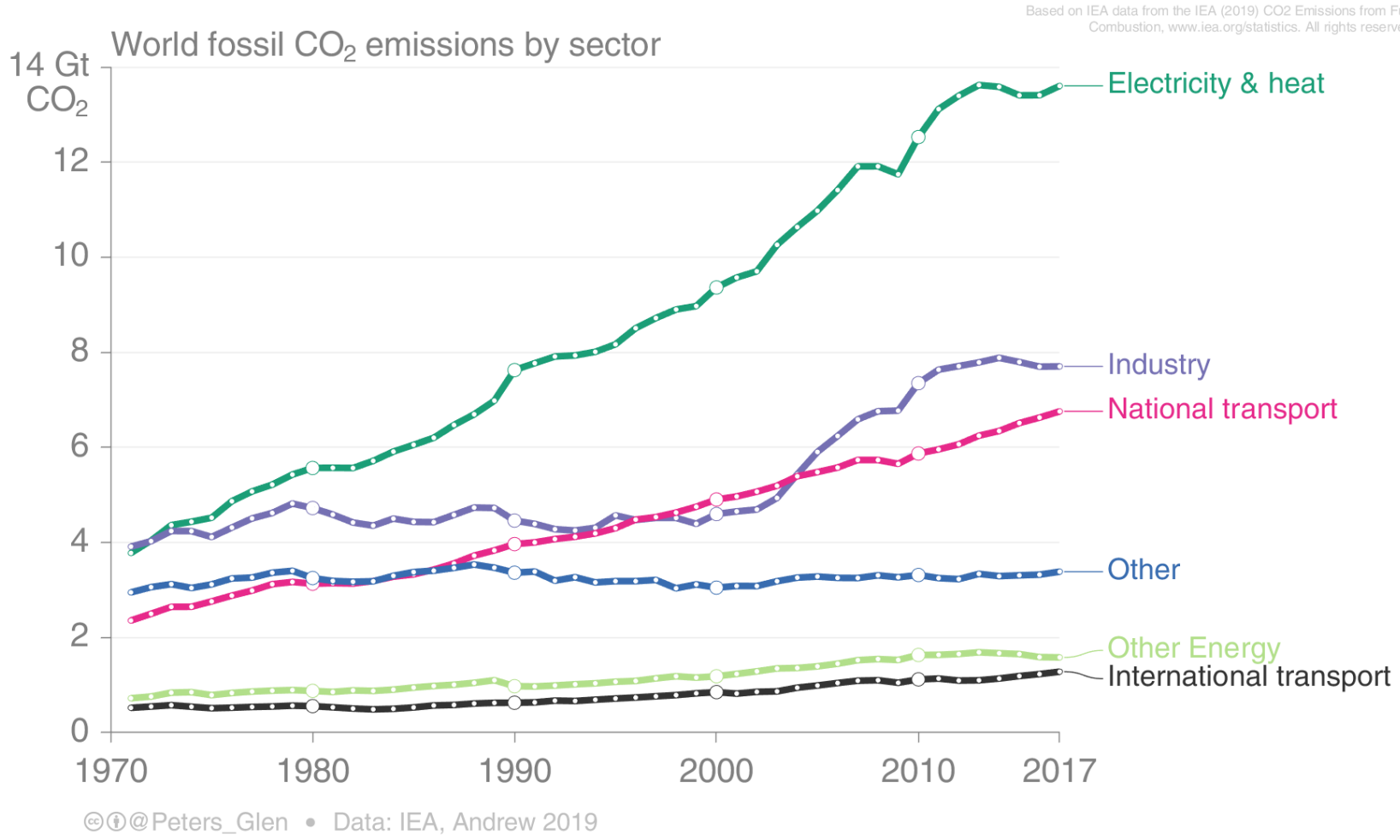
Source: [Le Quéré et al (2020)](), Figure 2

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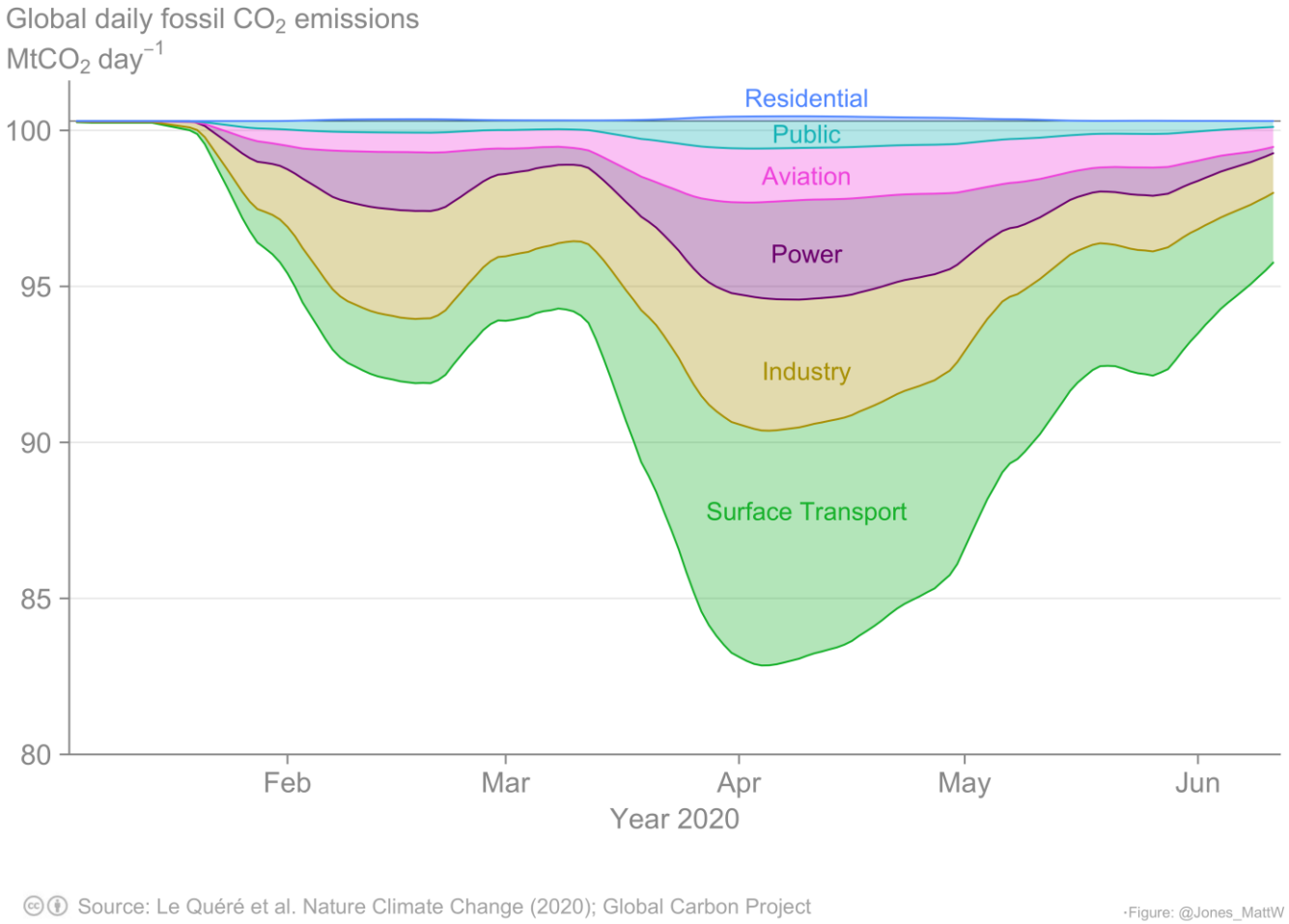
Source: Peters et al (2020); Global Carbon Budget (2019)

Daily CO_2 emissions (until 11 June)

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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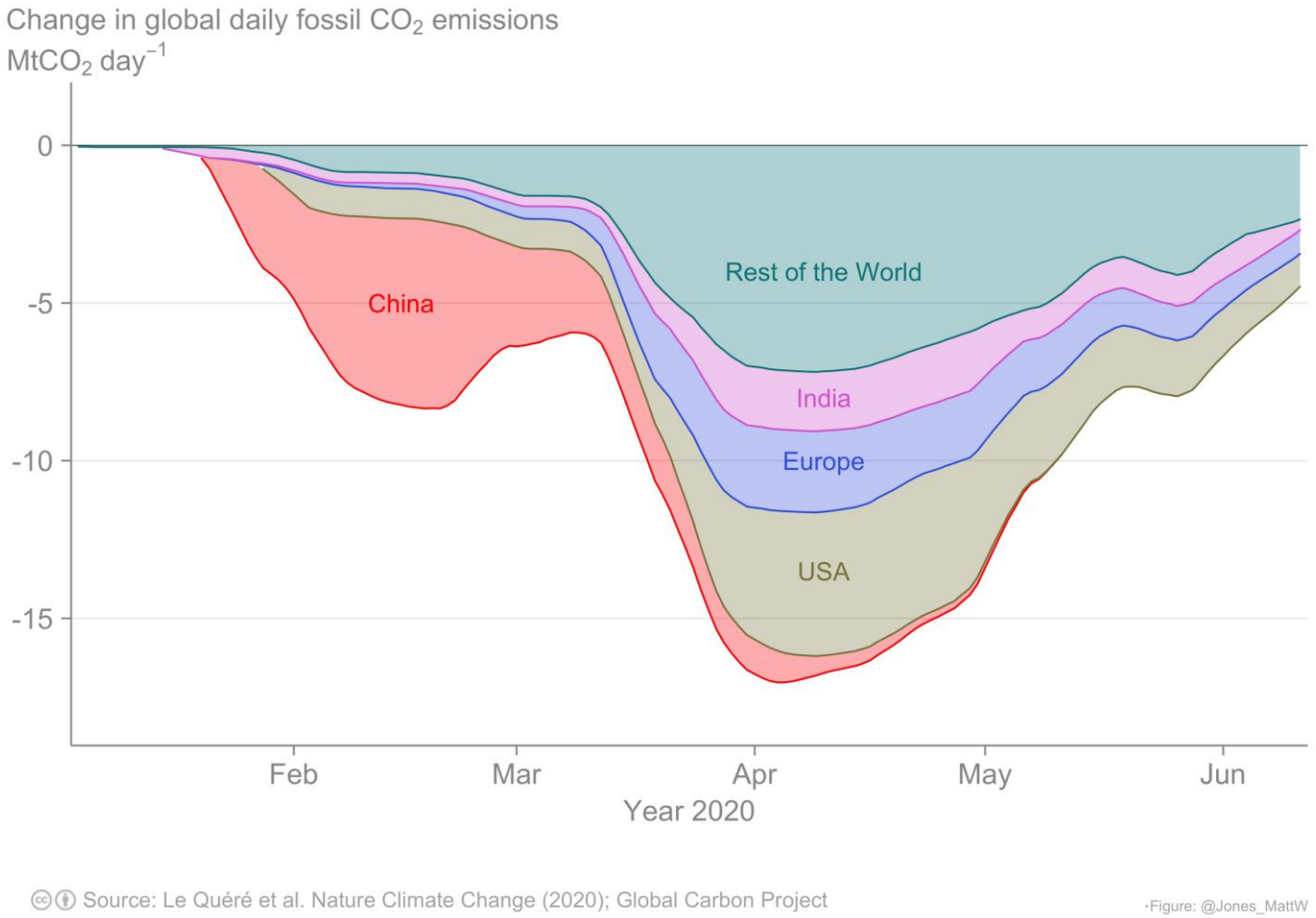
Source: Le Quéré et al (2020)

Daily CO_2 emissions (until 11 June)

China was the main country pushing emissions down in February, but this shifted to Europe, USA, etc, by April



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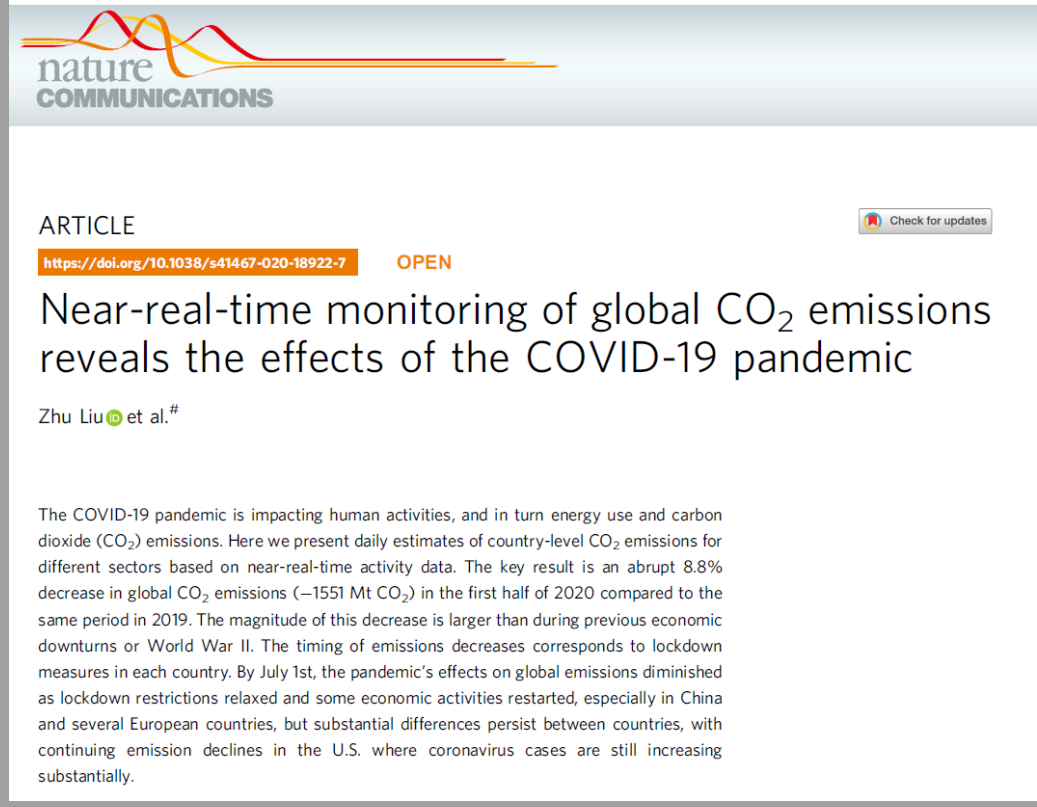
Source: Le Quéré et al (2020)

A daily approach (2)



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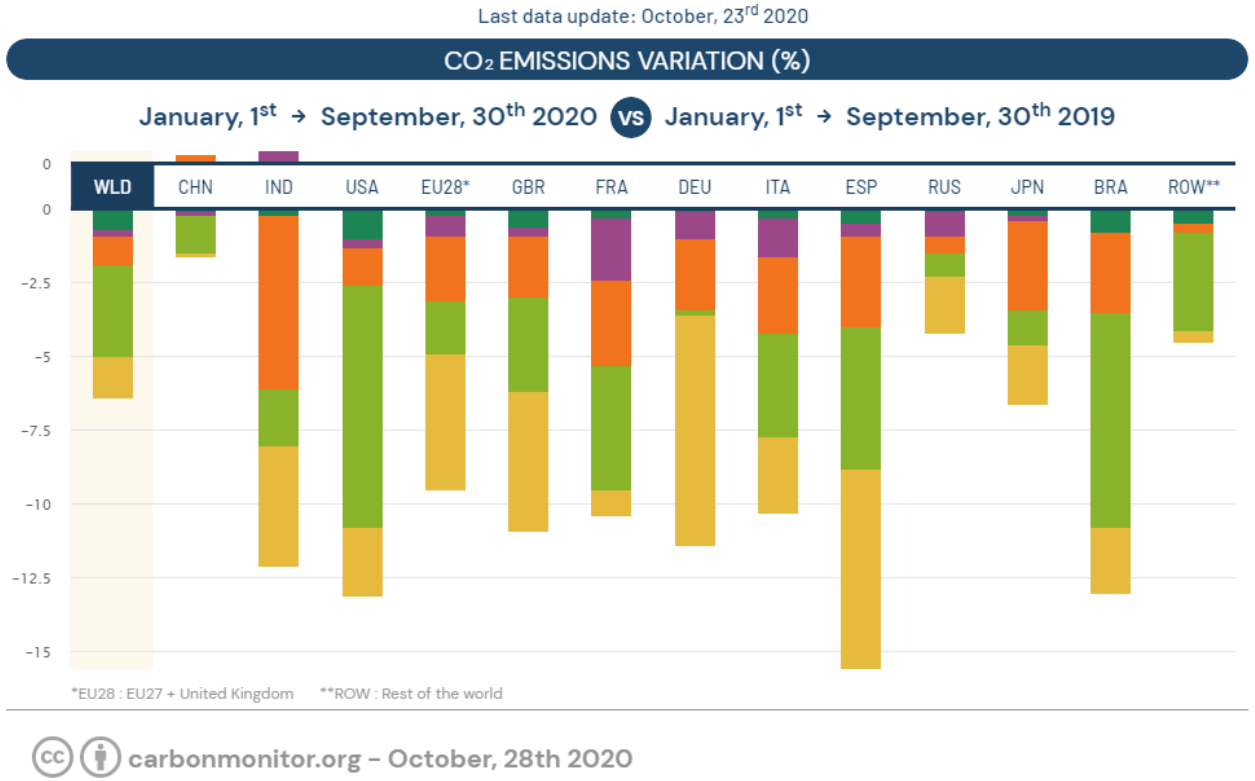
Carbon Monitor has regular updates

The approach uses similar data, but tries to estimate daily emissions in 2019 and 2020.
No projections provided for 2020.



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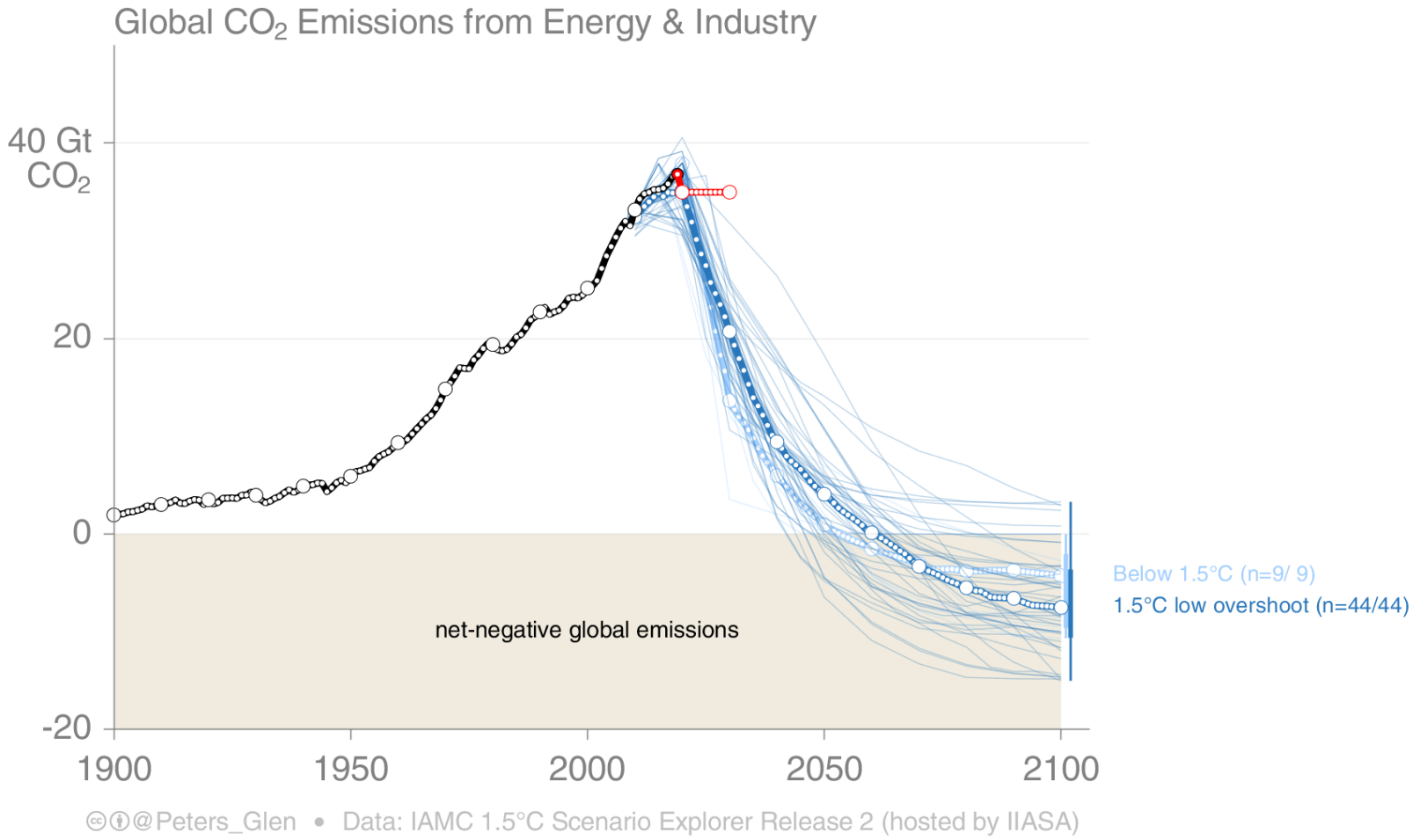
https://carbonmonitor.org/

Climate effect

Similar reductions needed for 1.5°C…

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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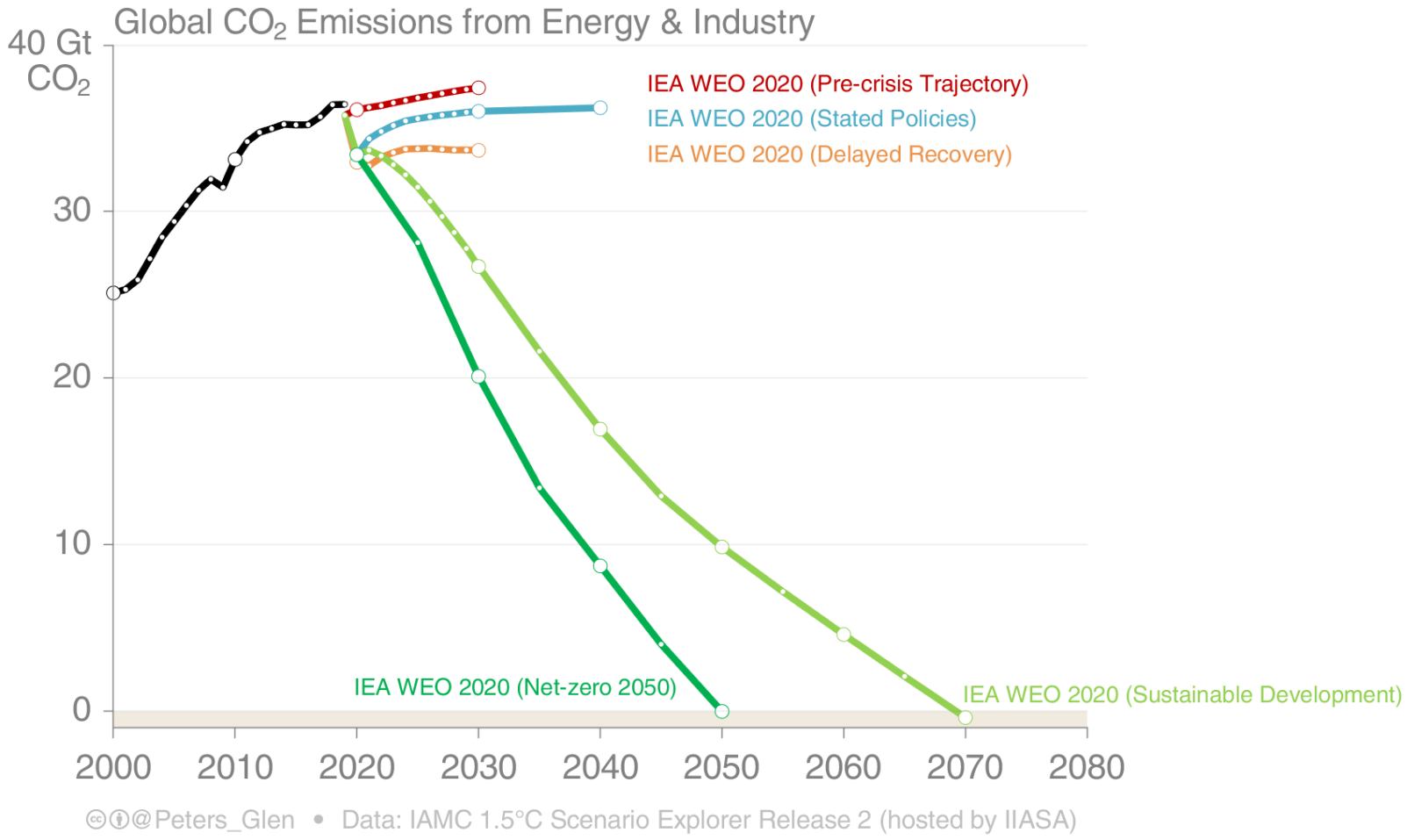
Source: Own calculations

Are we at global peak emissions?

The expectation is for a big drop in emissions in 2020, then a rebound that is not sufficient to return to pre-COVID19
Even with no new policies, it is possible that emissions will have now peaked in 2019!



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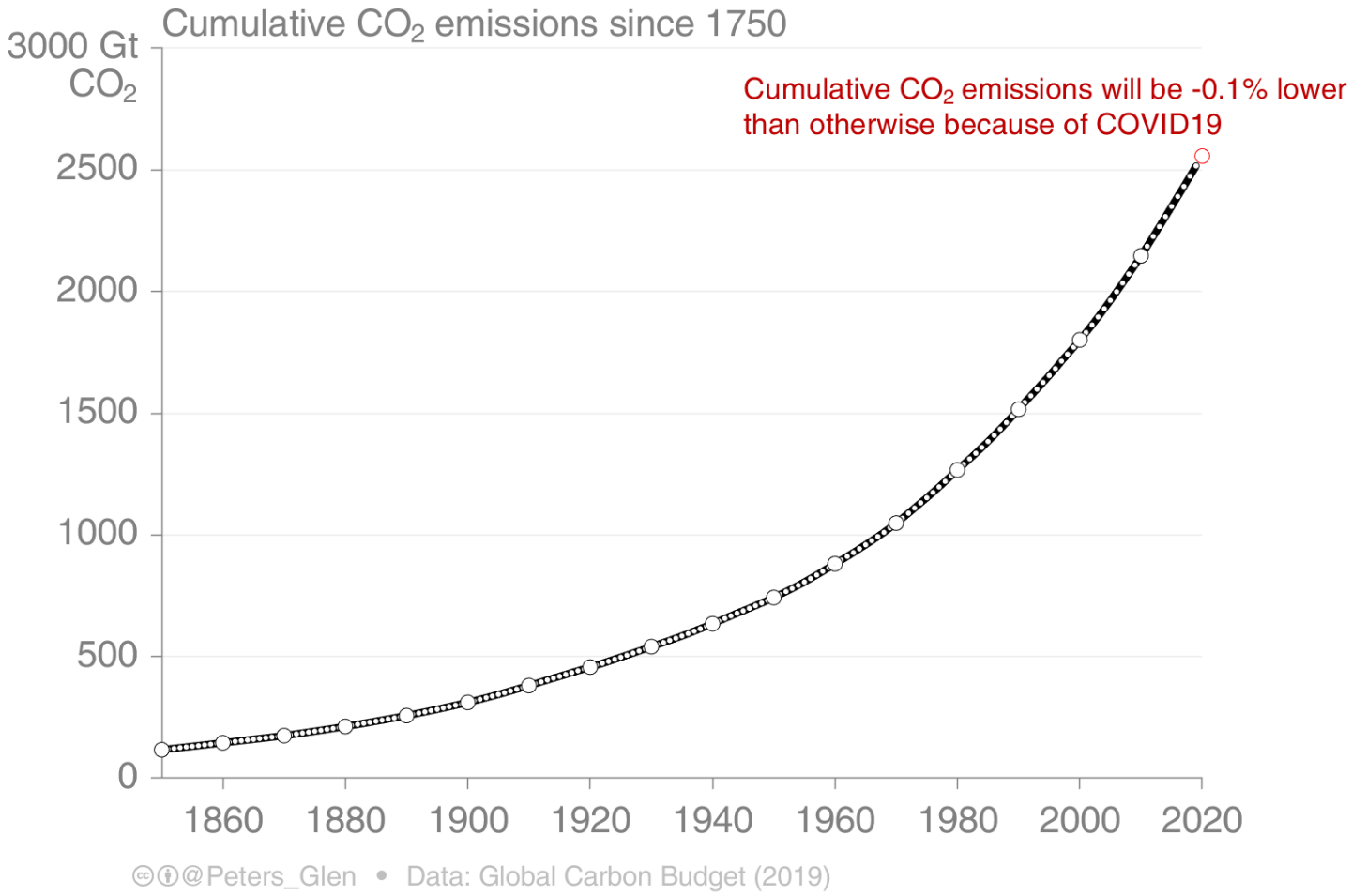
Source: IEA World Energy Outlook (2020)

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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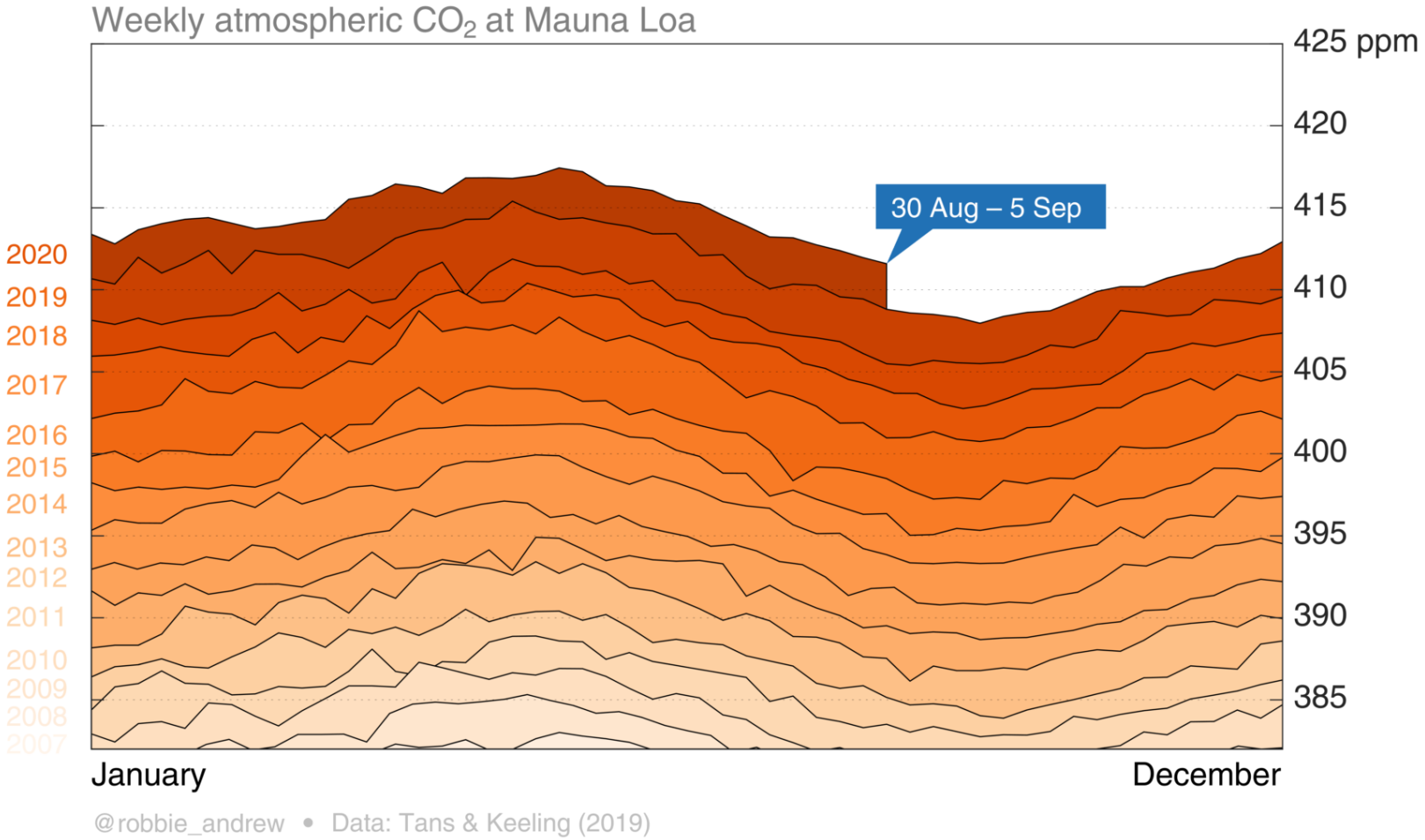
Source: Own calculations

Not possible to detect in atmosphere

The increase in CO_2 concentrations is driven by emissions (past and current) and the one-off change by COVID19 will be well within natural variability. May be possible to detect signals in atmospheric transport at certain times.



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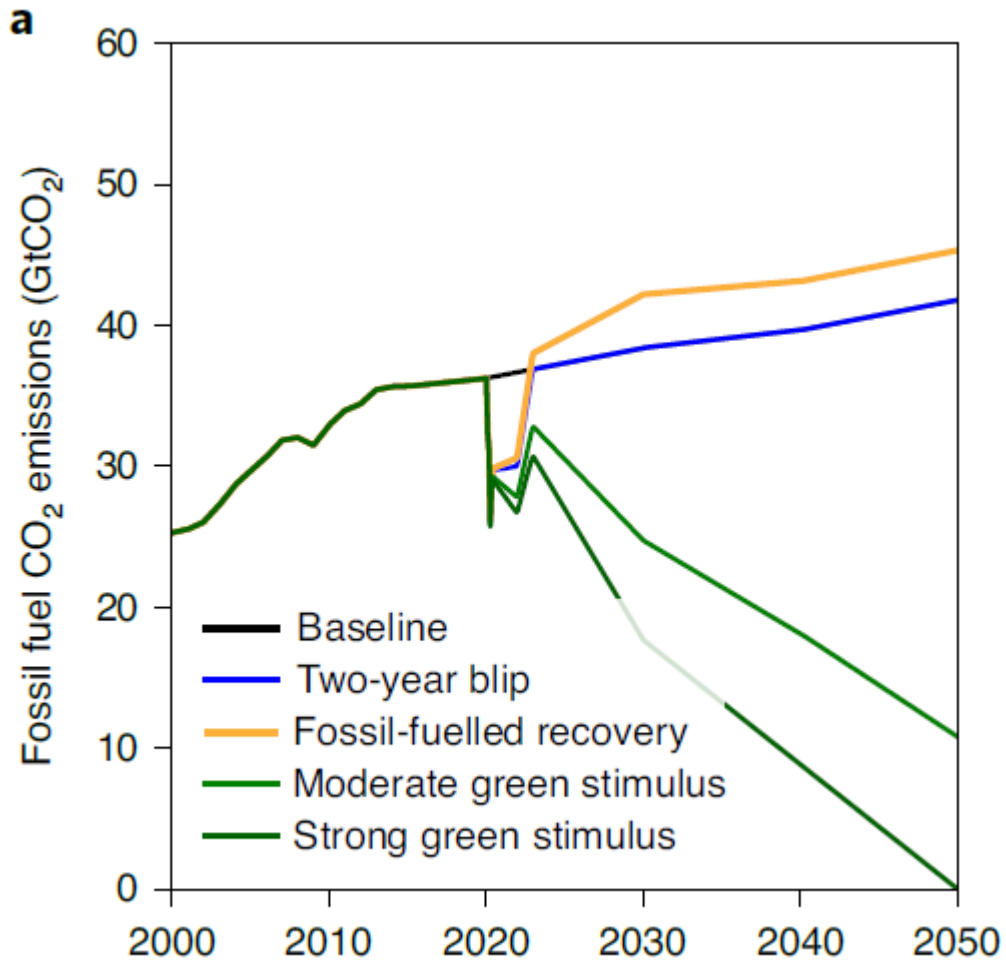
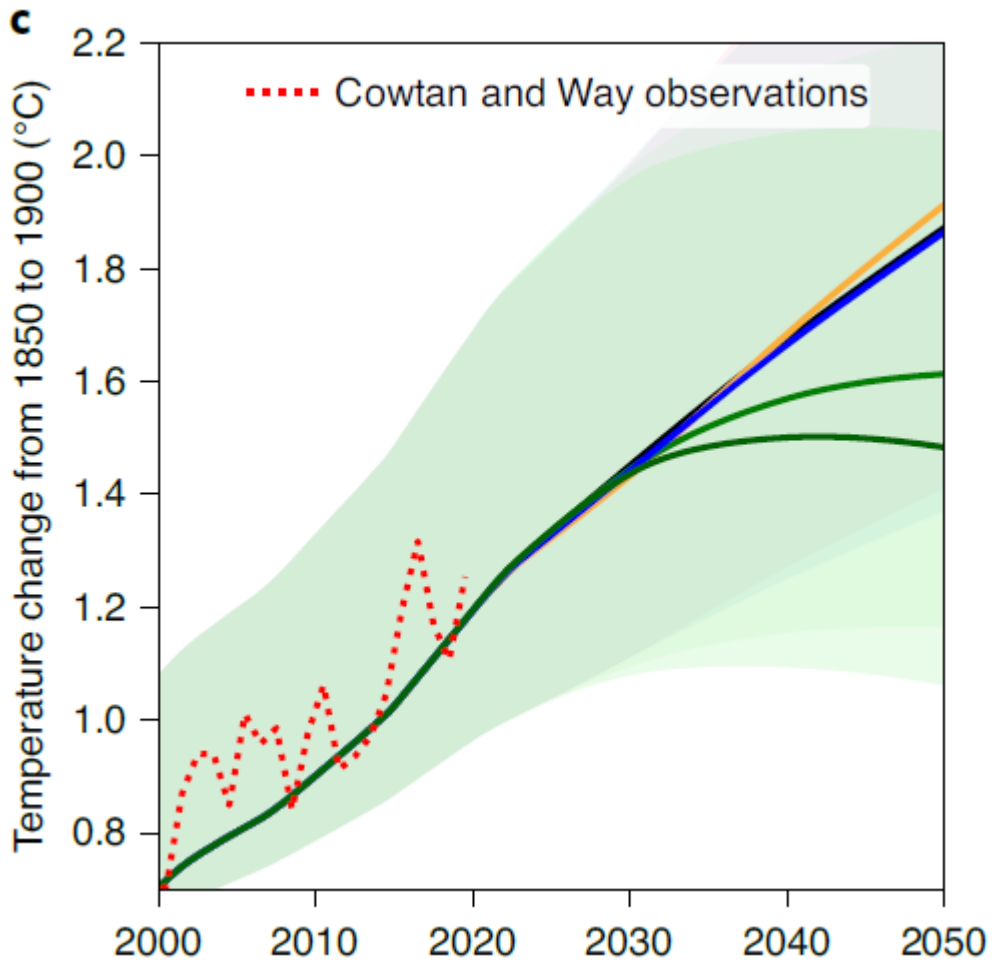
Source: Andrew (2020)

Climate implications

Considering all components of the climate system, the temperature response is negligible
A “green recovery” will bring bigger gains, however defined (“green recovery” here is a 1.5°C scenario)





Source: Forster et al (2020)

Implications

Implications

- “Real-time” estimates of CO_2 emissions (new methods)
- “Real-time” feedback on effects of policy interventions
- Expectations & observations are for minimal climate impact
- There will be a rebound post-COVID, but highly uncertain
  - 2019 could be peak emissions…
- Bonus Extra: Fossil industries hit harder than renewables, could mean 2019 was peak emissions even after a recovery

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