



CARBON  
MONITOR

# Carbon Monitor, daily global CO<sub>2</sub> emissions from fossil fuel and cement production

Z. Liu, P. Ciais, S. Davis et al.

## Near-real-time data captured record decline in global CO<sub>2</sub> emissions due to COVID-19

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<https://arxiv.org/abs/2004.13614> Liu et al., Nature Communications, in review

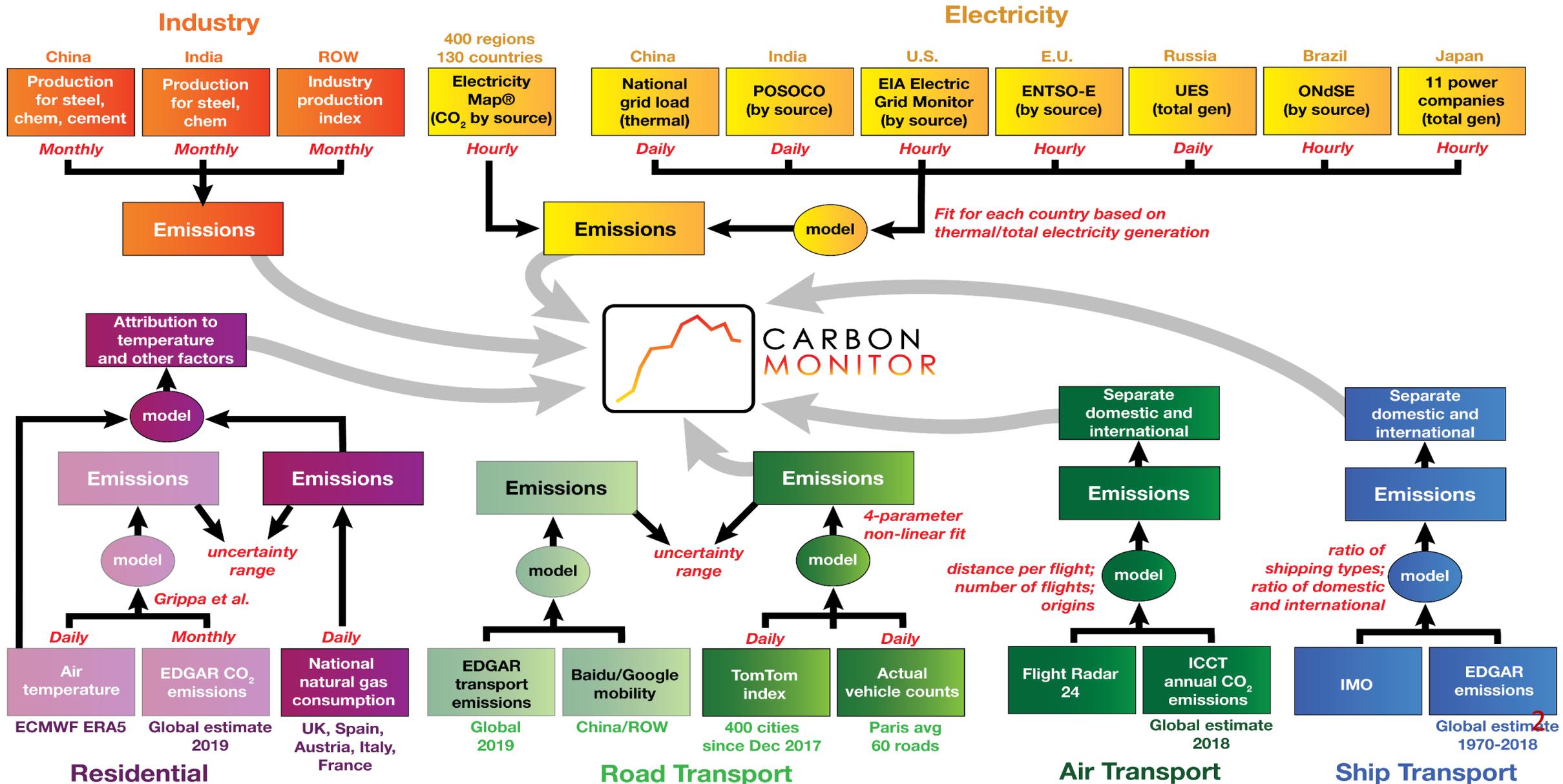
<https://arxiv.org/abs/2006.07690> Liu et al., Nature Scientific data, in review

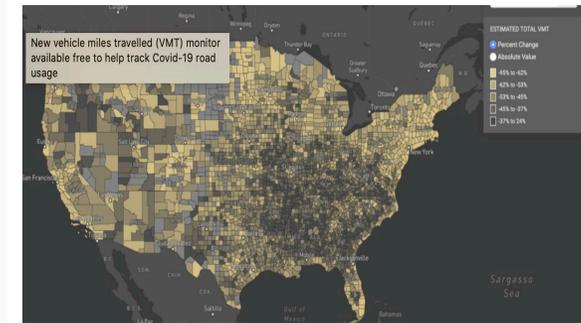
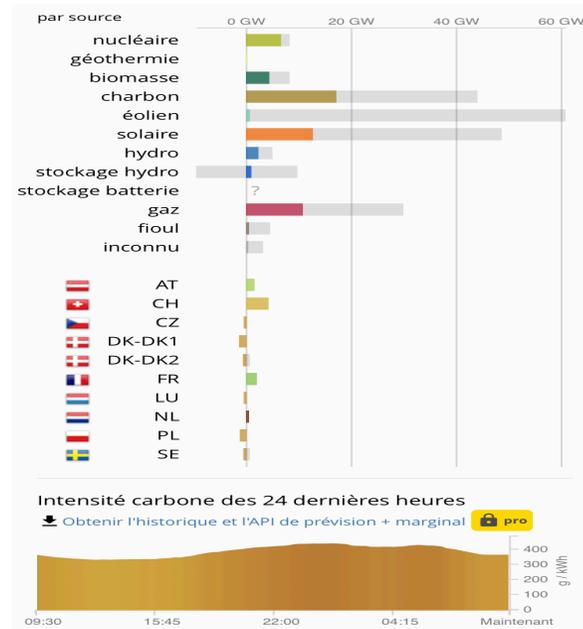
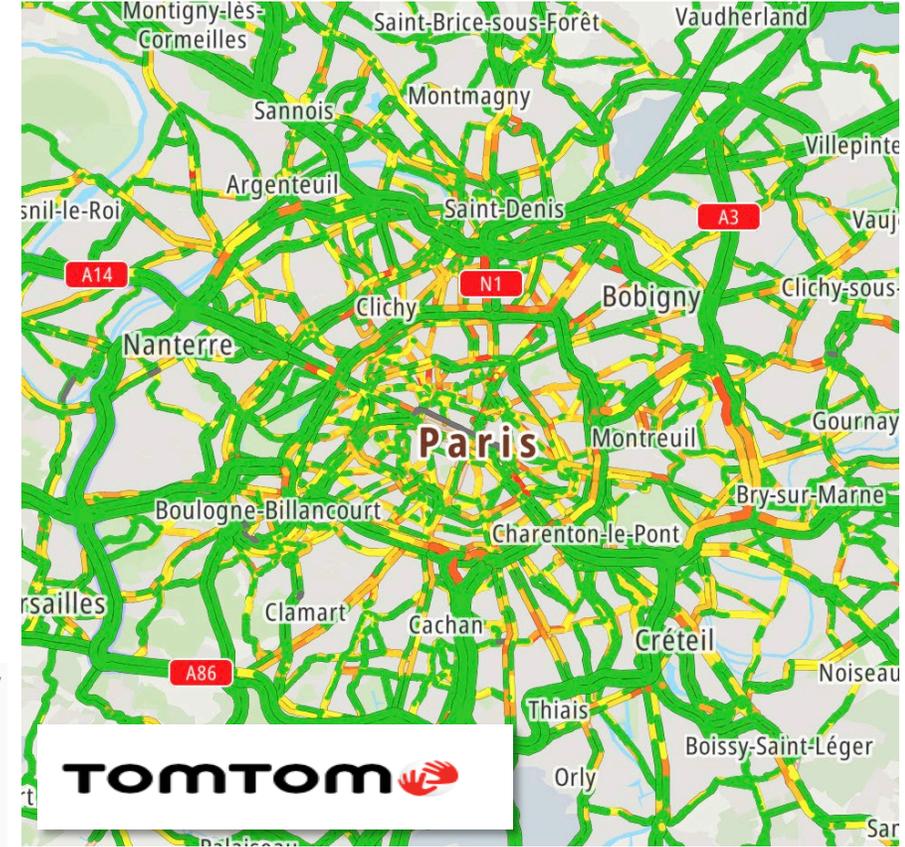
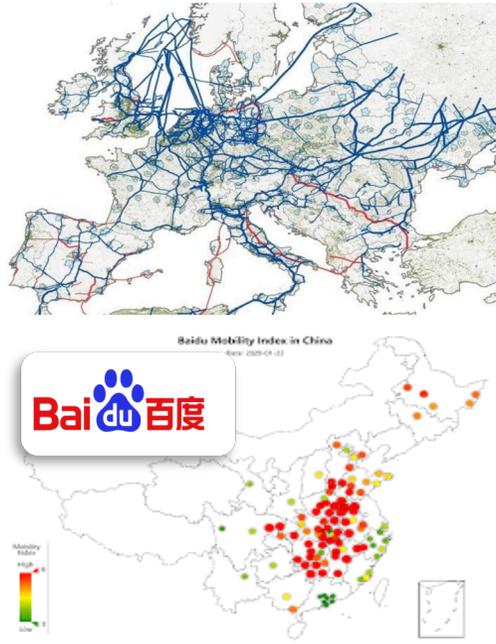
Daily data, graphics, methods freely available

<https://carbonmonitor.org>

<https://carbonmonitor.org.cn>

# CO<sub>2</sub> emissions from real daily activity data across six sectors



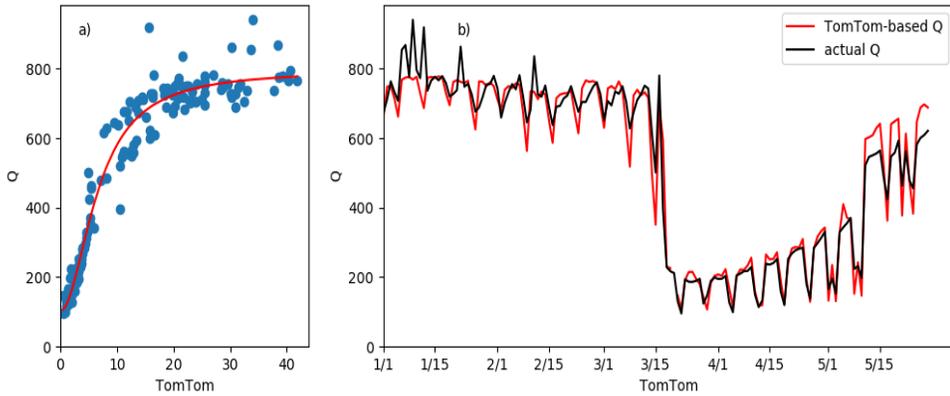


# Examples of real daily emissions calculation

Per city traffic emission modeling from congestion & mobility

Congestion index is **NOT** proportional to emissions

~~$$\Delta CO_2^{c,s,d} = CO_2^c \times \delta S^c \times \Delta A^{s,d}(CI,c)$$~~



Per flight aircraft emissions per country  
( domestic and international separated)

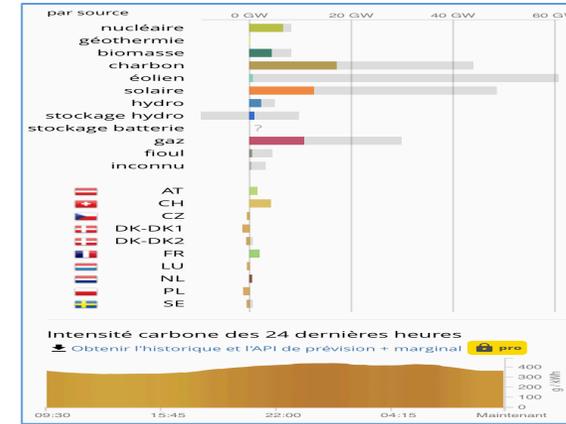
Aircraft type included in dataset



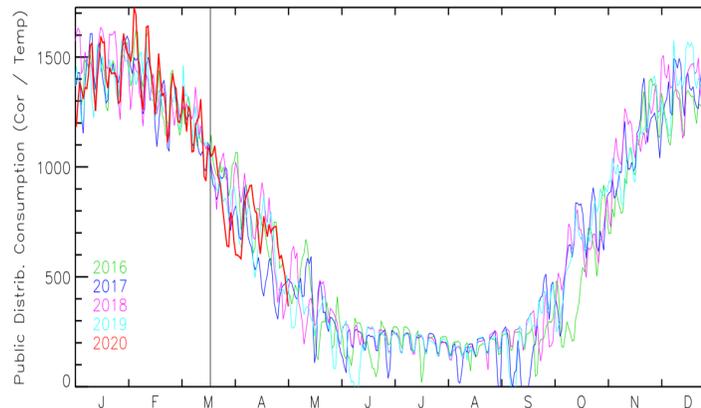
Hourly electricity mix and fuel types covarying with production to

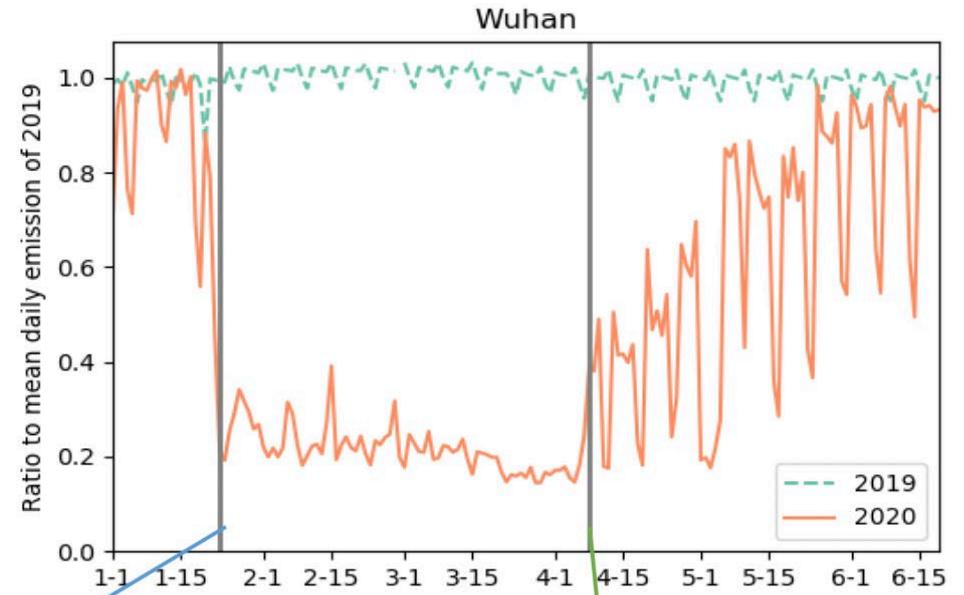
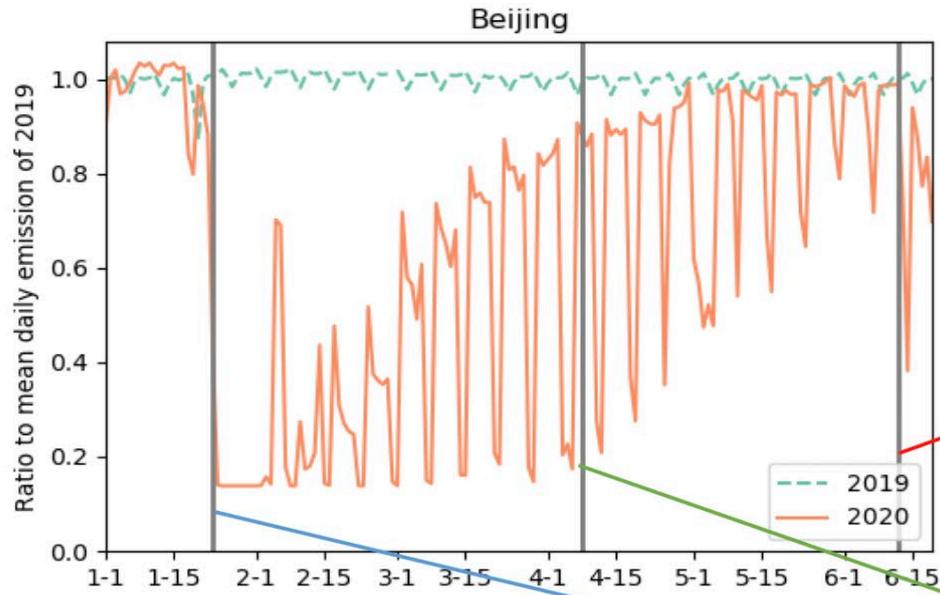
**capture daily fuel mix changes affecting emissions**

e.g. low gas price effects -> reduced coal electricity in the U.S. in 2020

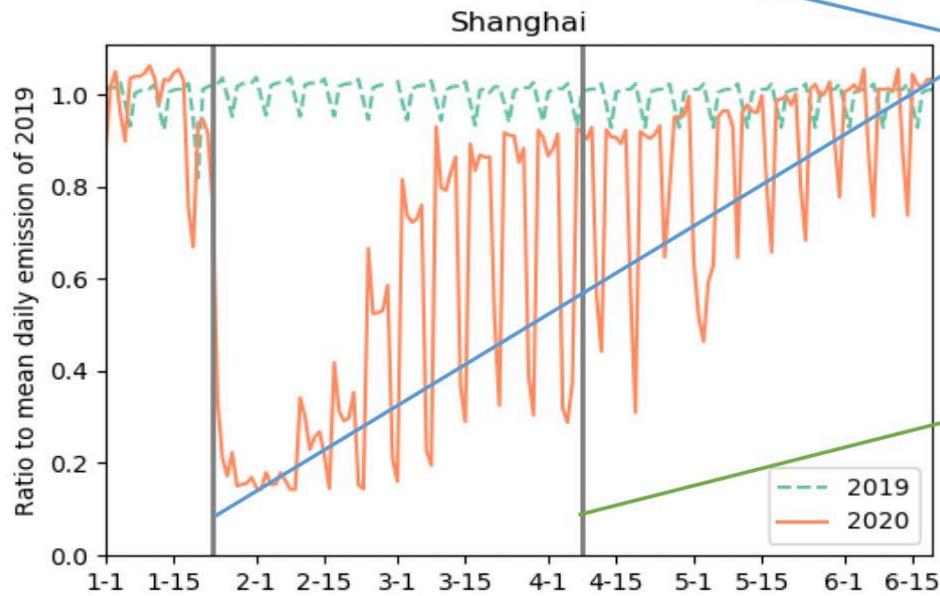


Real hourly natural gas residential consumption for heating and cooking



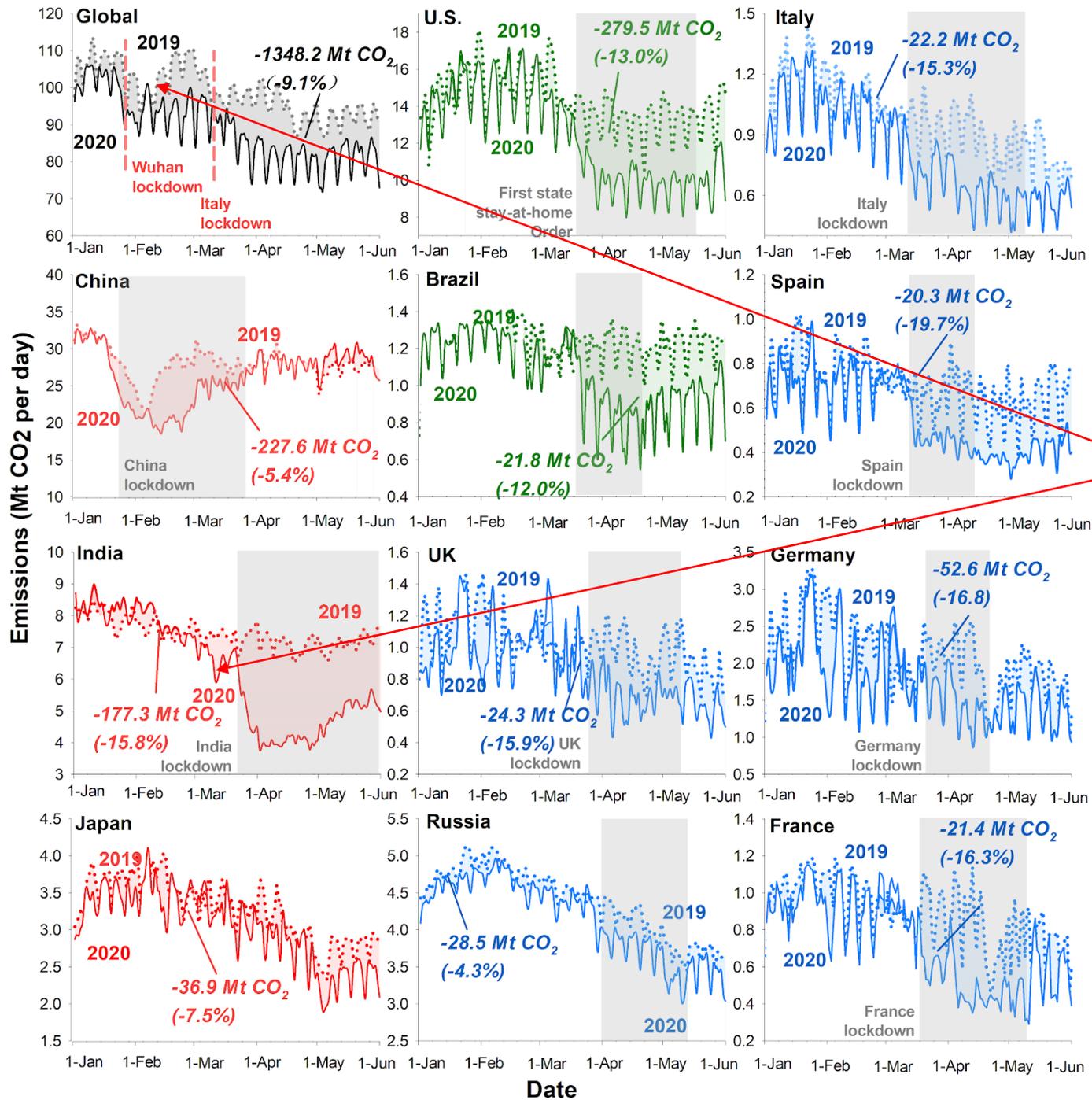


Report of new cases



Wuhan lockdown

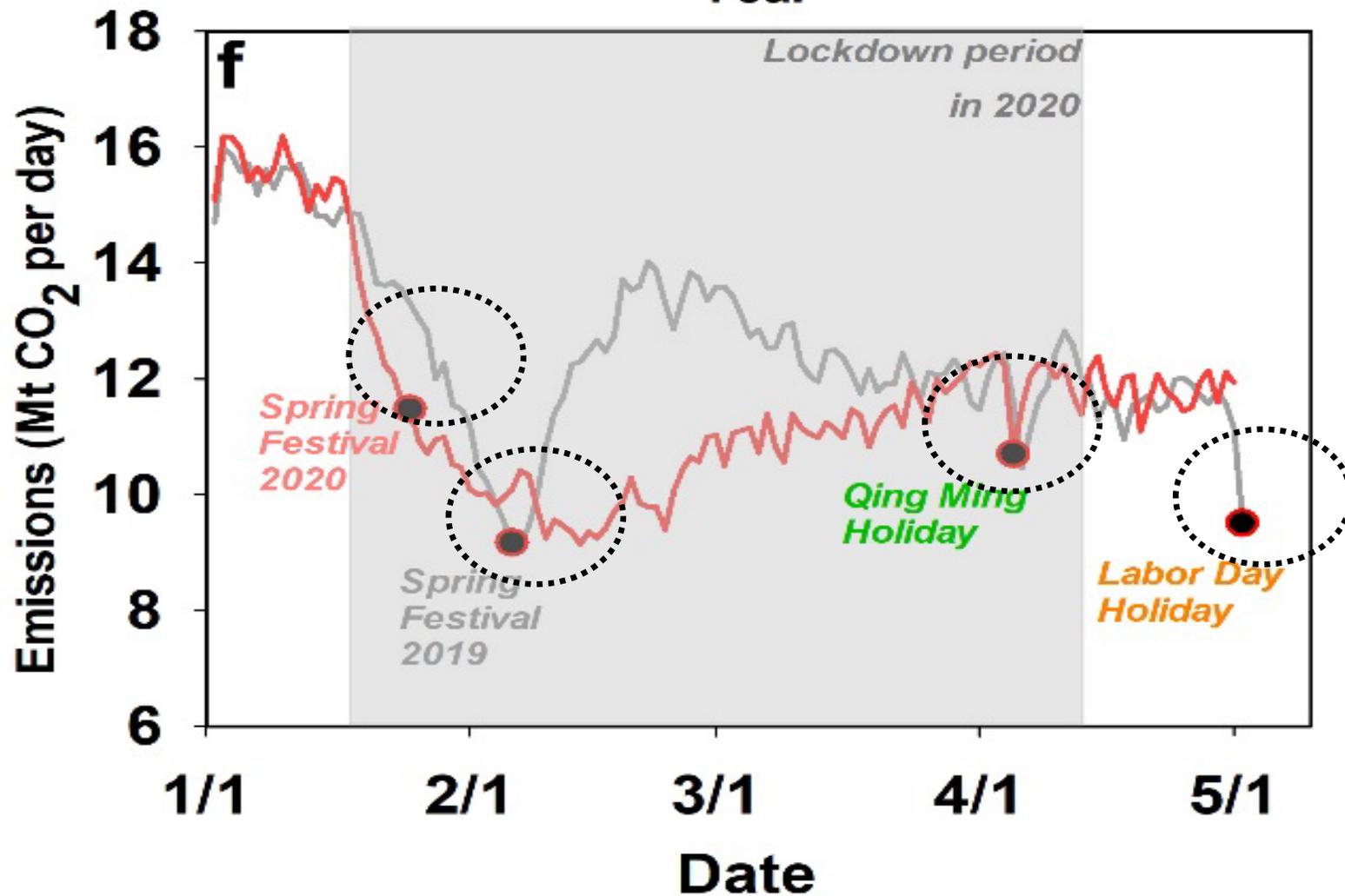
End of Wuhan lockdown



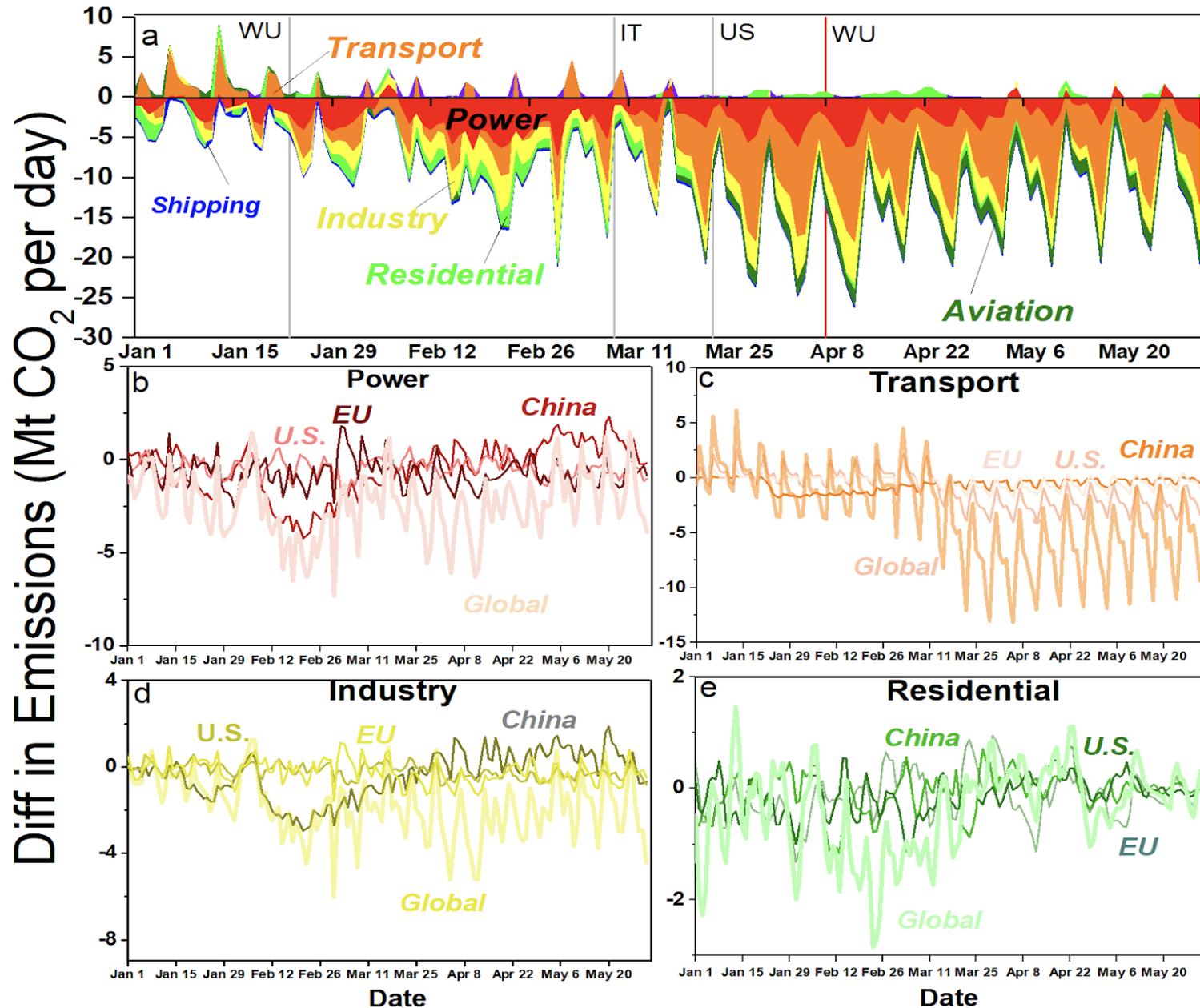
Daily emission estimates show daily, weekly and seasonal variations caused by weather, climate, strikes, vacations & COVID-19

Lower emission during holidays

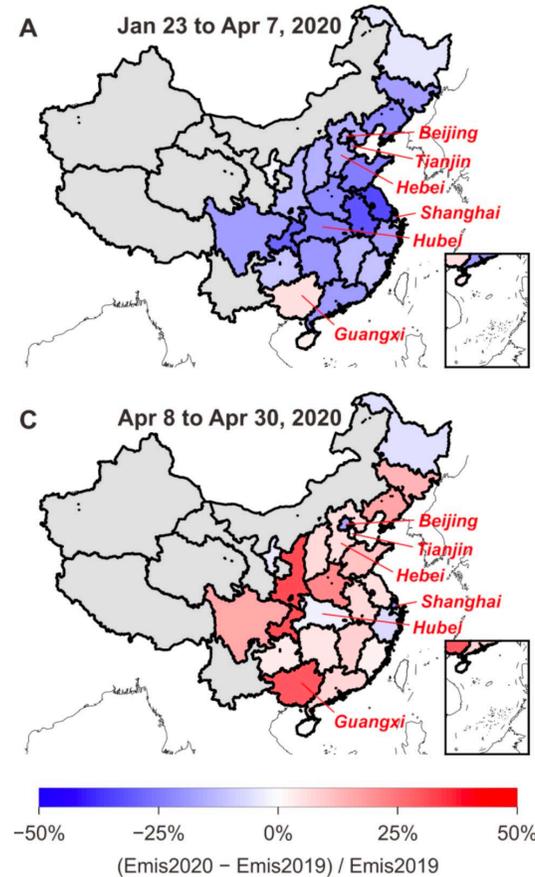
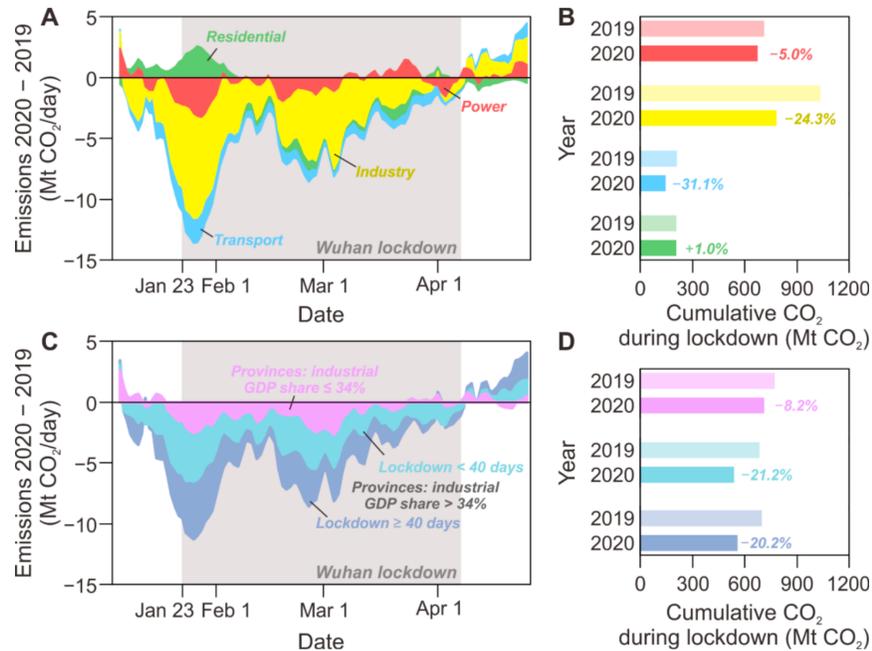
Impacts on emission decline in China for Feb. 2020 was moderate as COVID lockdown happened  $\approx$  at time of Spring Festival previous reduction in 2019



# Ongoing changes and differences across sectors



# Combining Carbon Monitor with daily atmospheric inversion of TROPOMI Sentinel-5P spaceborne NO<sub>2</sub> observations : industry emissions snapping back



See Bo Zheng's presentation

**Satellite-based estimates of decline and rebound in China's CO<sub>2</sub> emissions during COVID-19 pandemic**  
 Bo Zheng<sup>1,2,†</sup>, Guannan Geng<sup>3,†</sup>, Philippe Ciais<sup>1</sup>, Steven J. Davis<sup>4</sup>, Randall V. Martin<sup>5,6,7</sup>, Jun Meng<sup>6,5</sup>, Nana Wu<sup>2</sup>, Frederic Chevallier<sup>1</sup>, Gregoire Broquet<sup>1</sup>, Folkert Boersma<sup>8,9</sup>, Ronald van der A<sup>8</sup>, Jintai Lin<sup>10</sup>, Dabo Guan<sup>2</sup>, Yu Lei<sup>11</sup>, Kebin He<sup>3</sup>, Qiang Zhang<sup>2,4</sup>

**Fig. 3. Decomposition of the difference in the ten-day moving average of CO<sub>2</sub> emissions between 2019 and 2020 by source sector and by source region.** The emissions difference is split into power, industry, residential, and transport sectors in (A), and split into three regional categories in (C), including 1) the provinces with the share of industrial GDP in provincial total GDP lower than 34%, 2) the provinces with a share of industrial GDP higher than 34% and a lockdown shorter than 40 days, and 3) the provinces with the industrial GDP share higher than 34% and a lockdown longer than 40 days. The cumulative CO<sub>2</sub> emissions during Wuhan lockdown (grey shades in (A) and (C)) are presented by source sector in (B) and by source region in (D).

Next release : daily industrial emissions in each country aggregated from facility level data

## Arcelormittal - Aciérie de Grande-Synthe

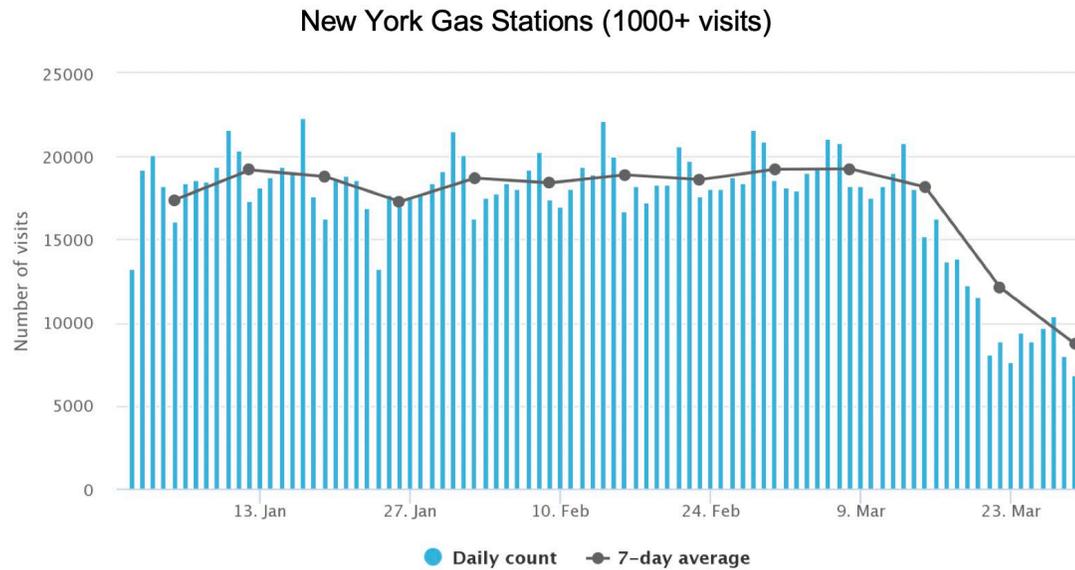


Industrial facilities and sub-facilities level daily activity using high-resolution satellite imagery (Sentinel-2 thermal bands and VHR imagery)



# Future updates : daily mobility data combined with SAR

## Gas station visits in New York State

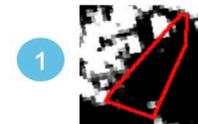


20

## Car density in major malls in France via SAR imagery



SAR



2019-03-20



2019-06-24



2019-07-06

CCTV

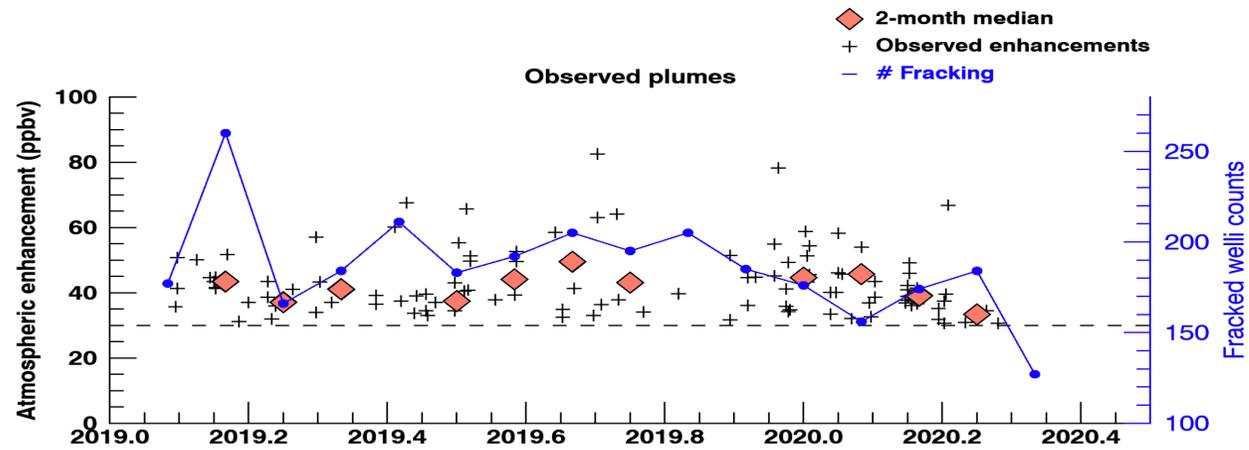
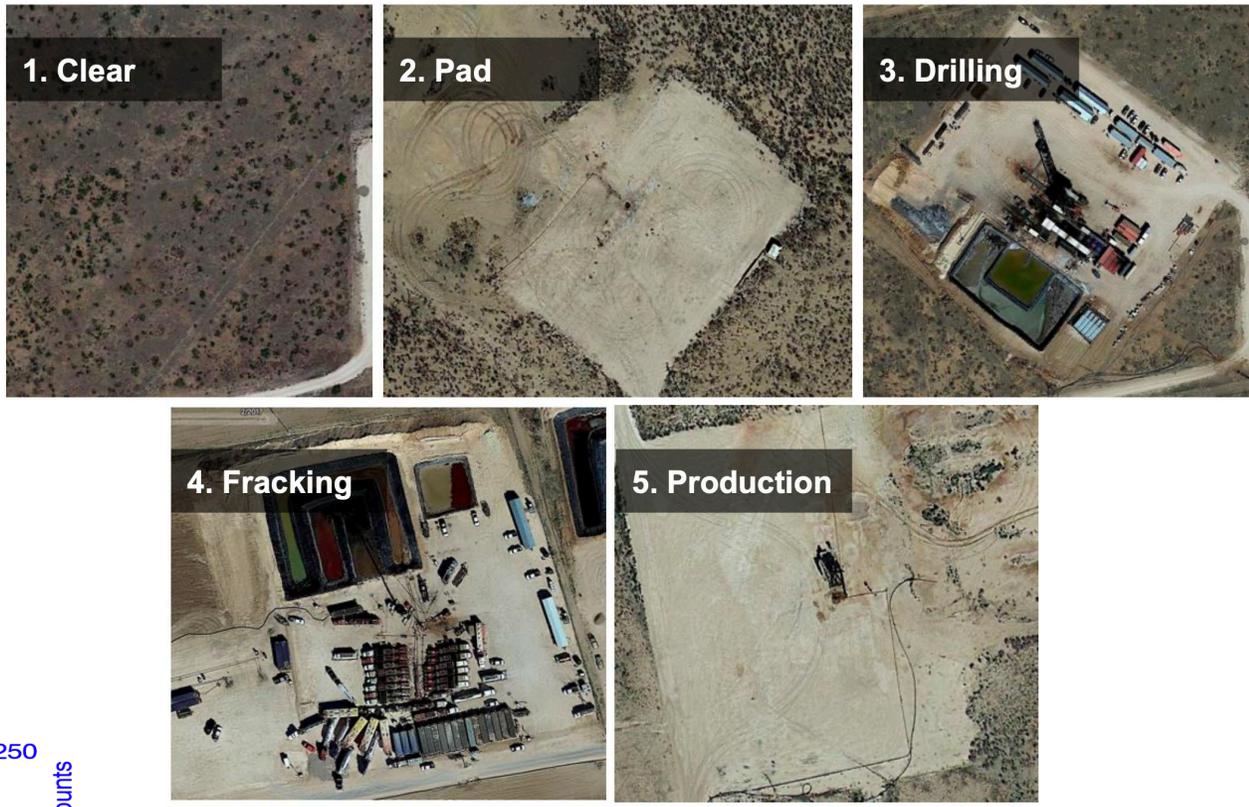
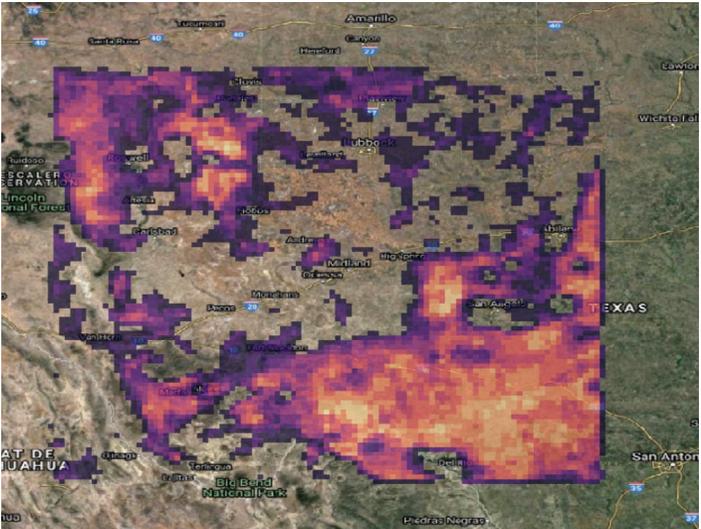


17

# Future updates : regional and global CH<sub>4</sub> emissions from Oil & Gas



TROPOMI CH<sub>4</sub> data combined with very high resolution activity imagery ( Permian area)



Sources: Kayrros, Google Earth





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