Comparison of CO emission reduction estimates during lockdown periods

Benjamin Gaubert

Simone Tilmes, Louisa Emmons, Forrest Lacey, Helen Worden, Wenfu Tang, Rebecca Buchholz, Idir Bouarar, Thierno Doumbia, Yiming Liu, Trissevgeni Stavrakou, Adrien Deroubaix, Sabine Darras, Nellie Elguindi, Claire Granier, Jean-François Müller, Xiaoqin Shi, Tao Wang, Guy P. Brasseur

NCAR

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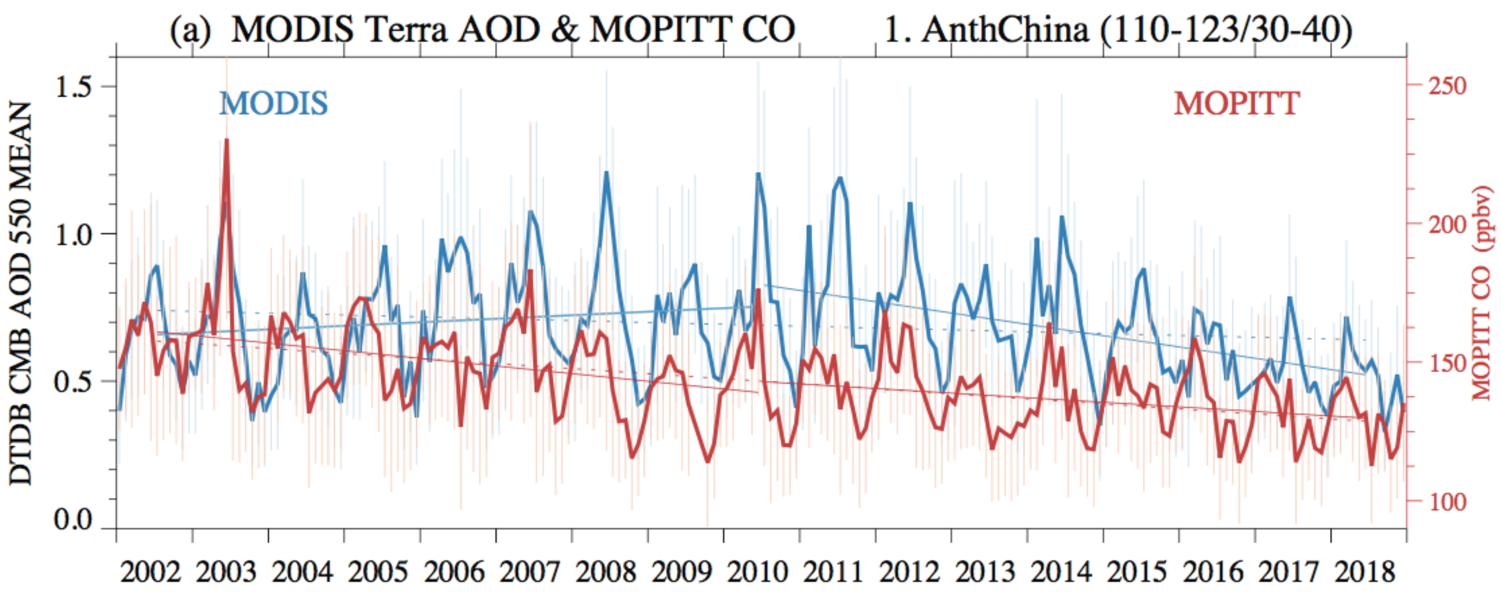
The satellite perspective



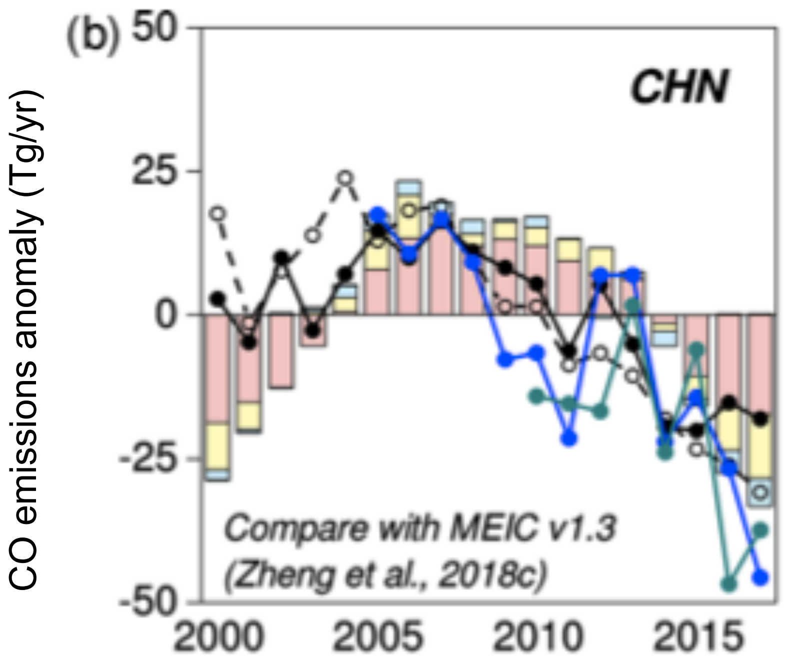
Buchholz et al., Air pollution trends measured from Terra: CO and AOD over industrial, fire-prone, and background regions

- Observed decrease in CO in the NH with consistent trends between satellite instruments
- Reduction of 1 %.yr^{-1} for Northern China

The satellite perspective & Emission trends

- Decreasing trend in CO emissions
  - Northern hemisphere and in China
  - Agreements and recent convergence between top down and bottom-up estimates
- Improvements in

1. combustion efficiency following economic development
2. industrial processes, recycling of industrial coal gases
3. vehicle emission standards



Tang et al. (2019); Satellite data reveal a common combustion emission pathway for major cities in China
Li et al., (2017); Anthropogenic emission inventories in China: a review
Zheng et al. (2019) Global atmospheric carbon monoxide budget 2000–2017 inferred from multi-species atmospheric inversions
Elguindi et al. 2020: Intercomparison of Magnitudes and Trends in Anthropogenic Surface Emissions From Bottom-Up Inventories, Top-Down Estimates, and Emission Scenarios

The satellite perspective

- Filonchyk et al., Aerosol and Air Quality Research, 20: 1530–1540, 2020.
  - Found a lower CO in than 2020 than 2019 using the NASA Atmospheric Infrared Sounder (AIRS) CO at 400 hPa
  - Higher CO found in the southern China

- Fan et al., *Remote Sens*, *12*, 1613; doi:10.3390/rs12101613 , 2020.
  - Use TROPOMI CO and found small differences between 2020 and 2019, within +/- 20 %
  - From the comparison of surface observations across cities, they found little variation "no substantial decrease in 2020".

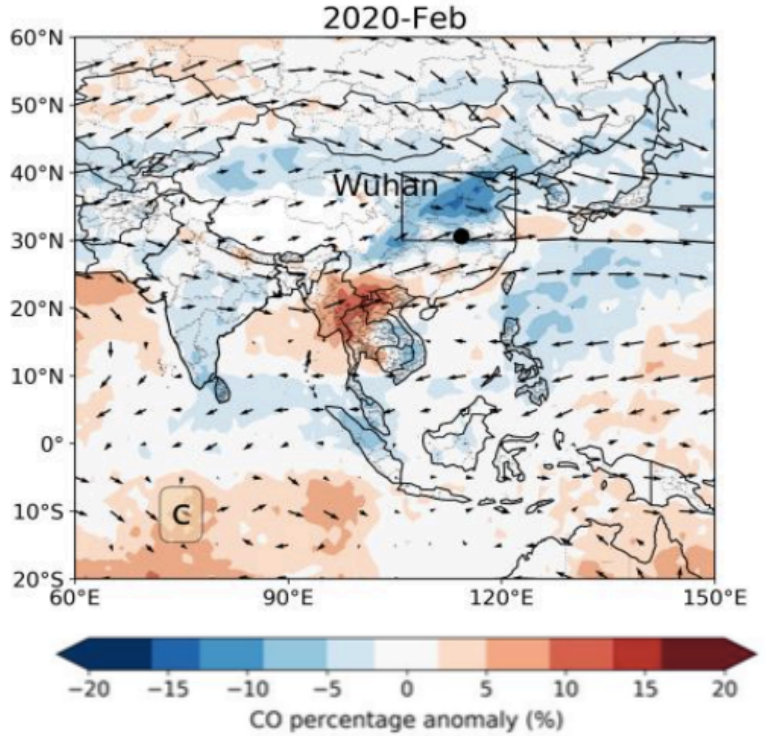
- Field et al., Atmos. Chem. Phys. Discuss., 10.5194/acp-2020-567, 2020.
  - Looked at AIRS at 500 hPa and found that CO in 2020 was 12% lower than the 2005-2019 mean, but **<u>only 2% lower than what would be expected given the decreasing CO trend over that period.</u>**

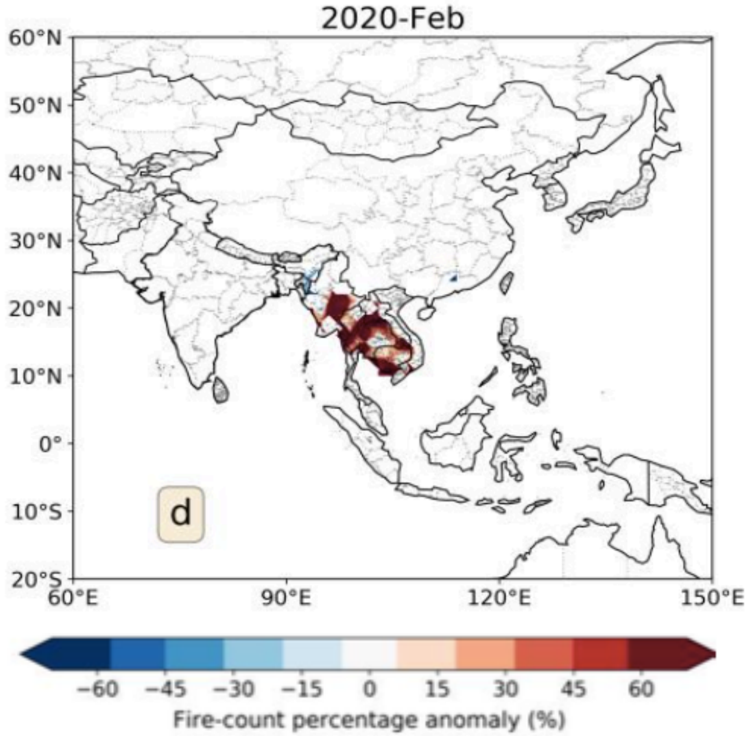
The satellite perspective

- Metya et al., Aerosol and Air Quality Research, 20: 1772–1782, 2020
- Used AIRS CO at 700, and detrend the CO using a climatology (2010–2020) for each month (January– February–March)

- Positive anomalies are associated with fire activities that mask the actual lockdown in Vietnam.

- Small (~5 %) but significant decrease CO in northern China





Changes observed from Air Quality network

- Overall reduction of CO in Chinese cities.
- Lian et al. (2020) suggest than the reduction for CO in Wuhan was mainly driven by the transportation sector.

	Reference period	2020 change (%)	References
Wuhan	Jan. 23–Feb. 23	-22.7	Lian et al.; Shi and Brasseur (2020)
Anqing, Hefei, and Suzhou	Jan. 2017-2019	-16.7	Xu et al., Aerosol Air Qual. Res. (2020)
	Feb. 2017-2019	-36.2	
	Mar. 2017-2019	-24.2	
Shanghai and YRD	10 January-23 January	0 (2017); +2.3 (2018); -7.6 (2019)	Filonchyk and Peterson, J geovis spat anal. (2020)
	24 January–6 February	-16.8 (2017); -24.8 (2018); -3.0 (2019)	
	7 February-20 February	-36.5 (2017); -14.1 (2018); +4.7 (2019)	
	21 February–6 March	-38.1 (2017); +4.8 (2018); -45.1 (2019)	
	24 Jan - 25 Feb 2019	-7.8	Li et al., Science of the Total Environment, 2020
	26 Feb.- 31 Mar. 2019	-25.9	

Adapted from Anil and Alagha (2020)

Changes in emissions

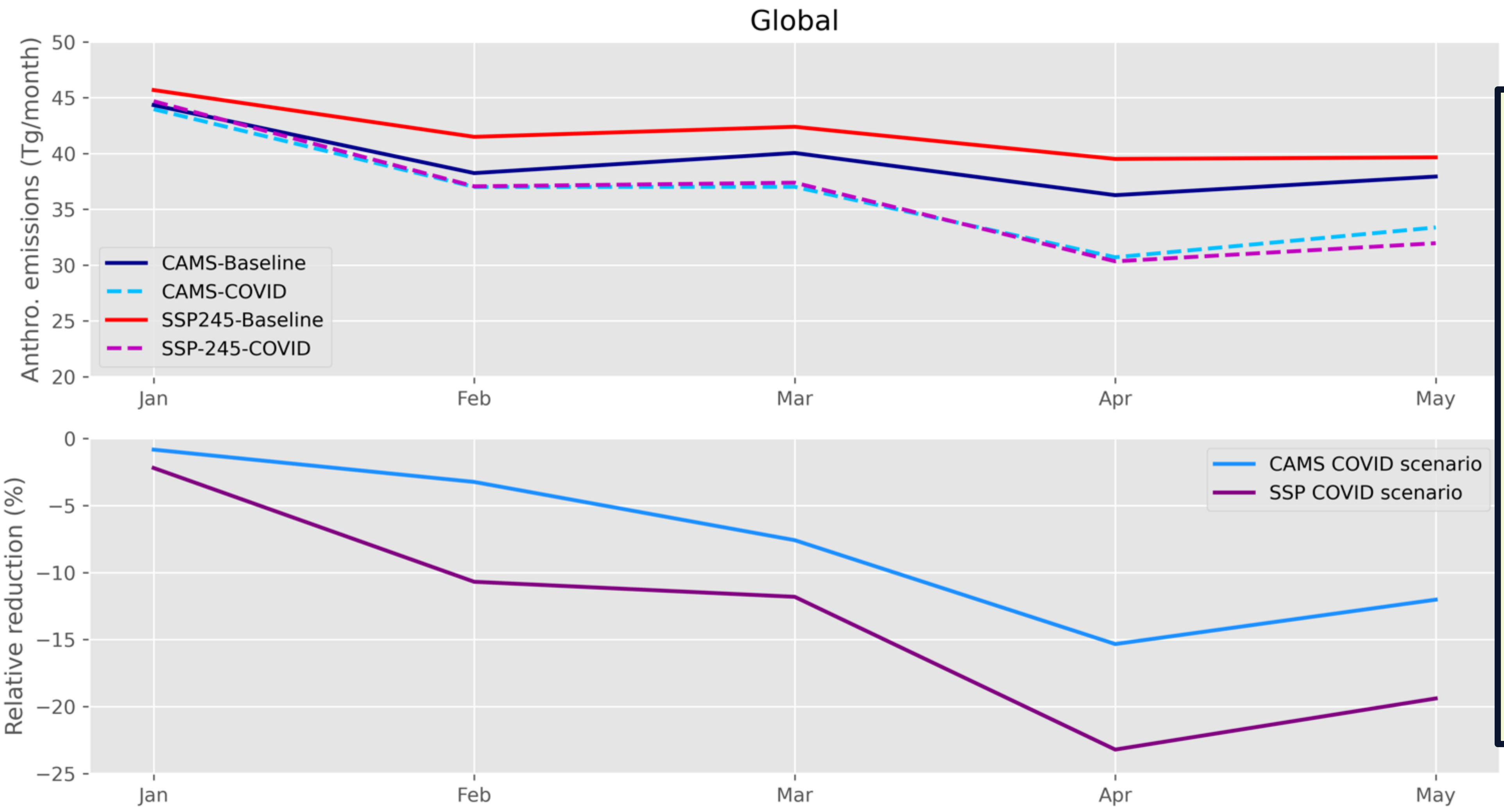
Current and future global climate impacts resulting from COVID-19

Piers M. Forster[1✉], Harriet I. Forster[2], Mat J. Evans[3,4], Matthew J. Gidden[5,6], Chris D. Jones[7], Christoph A. Keller[8,9], Robin D. Lamboll[10], Corinne Le Quéré[11,12], Joeri Rogelj[6,10], Deborah Rosen[1], Carl-Friedrich Schleussner[5,13], Thomas B. Richardson[1], Christopher J. Smith[1,6] and Steven T. Turnock[1,7]

- Baseline defined as a a central estimate of emissions pathways
- Chemicals based on the 2015 emissions in the EDGAR database
- Apply COVID related emissions reduction by sector and on a daily basis based on ancillary data (e.g. Google mobility data)

- Doumbia et al. (to be submitted to ESSD), another estimate of lockdown induced change in emissions.
- Approach is similar to Forster et al., 0.1x0.1 latitude/longitude degree grid
- Applied to CAMS (Version v4.2-R1.1), includes the MEIC v1.3 emissions in China
- Baseline emissions are calculated for the year 2020.
- daily emissions interpolated from monthly means

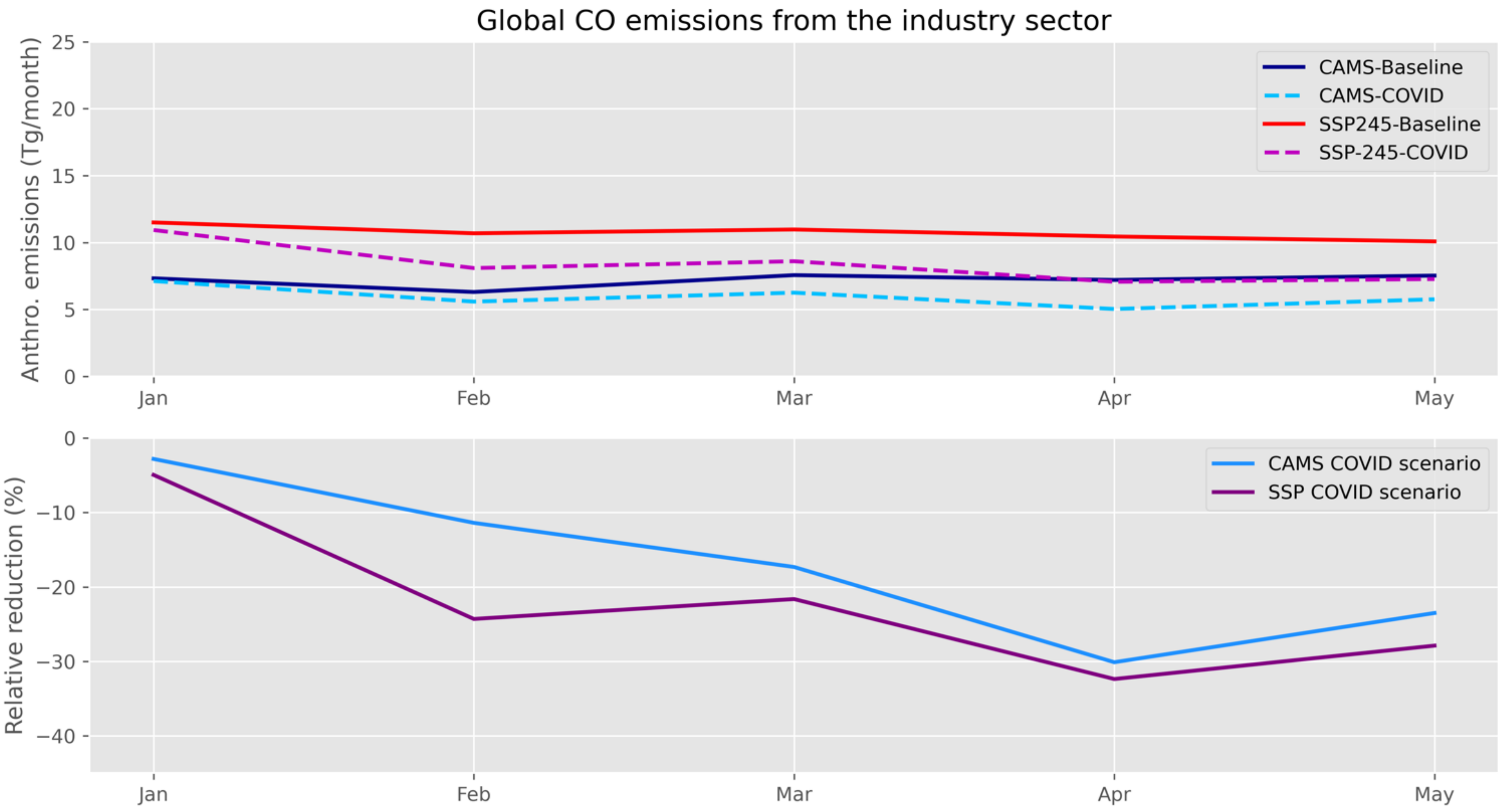
Comparison of anthropogenic CO emission inventories



- ❖ **Baseline CO higher in the SSP245**
- ❖ **Larger reduction in SSP**
- ❖ **CAMS peaks at -15 %**
- ❖ **SSP peaks at ~-25 %**

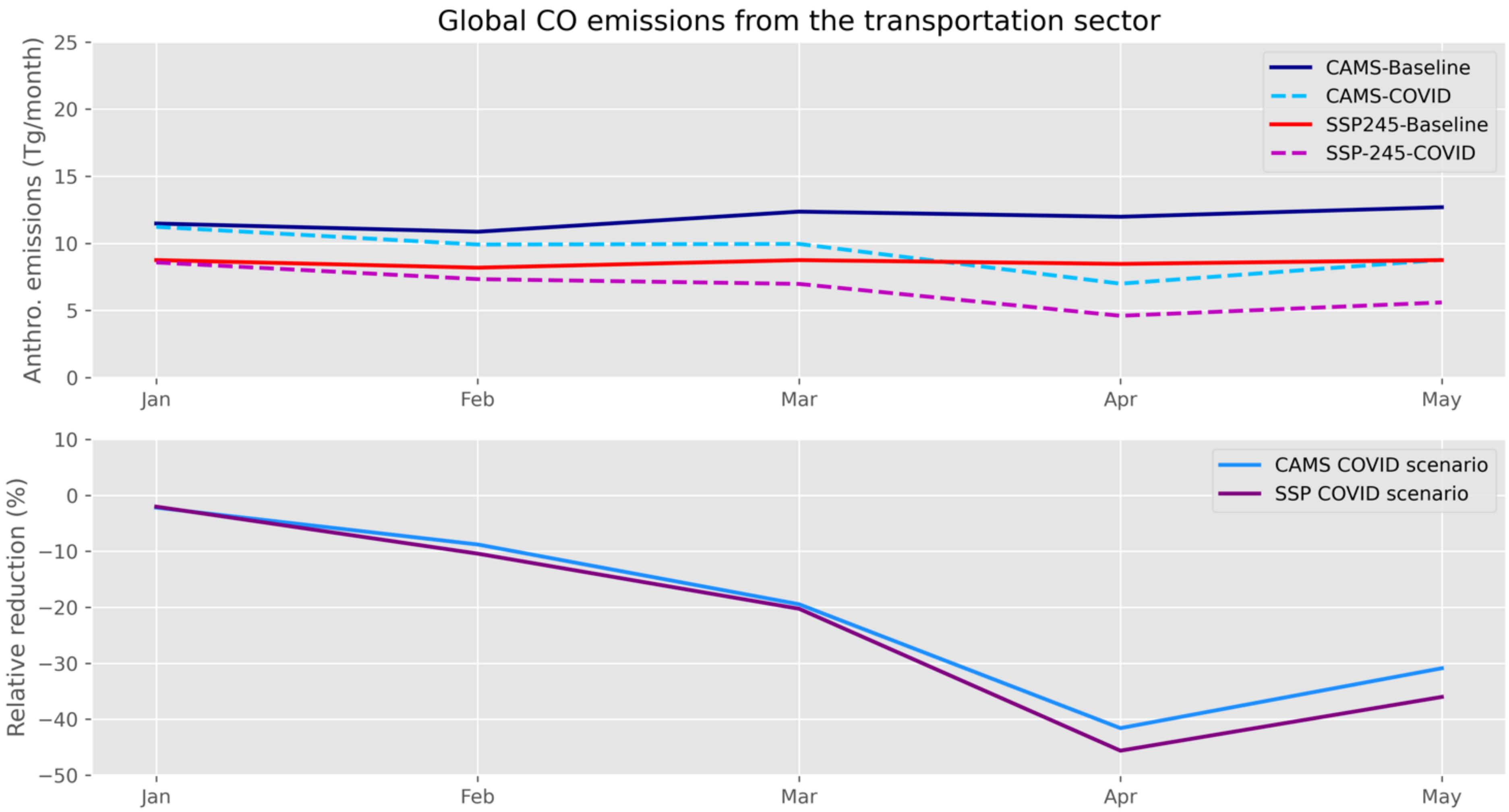
Note that daily variability can be larger

Anthropogenic CO emission inventories, by sectors, *Industry*



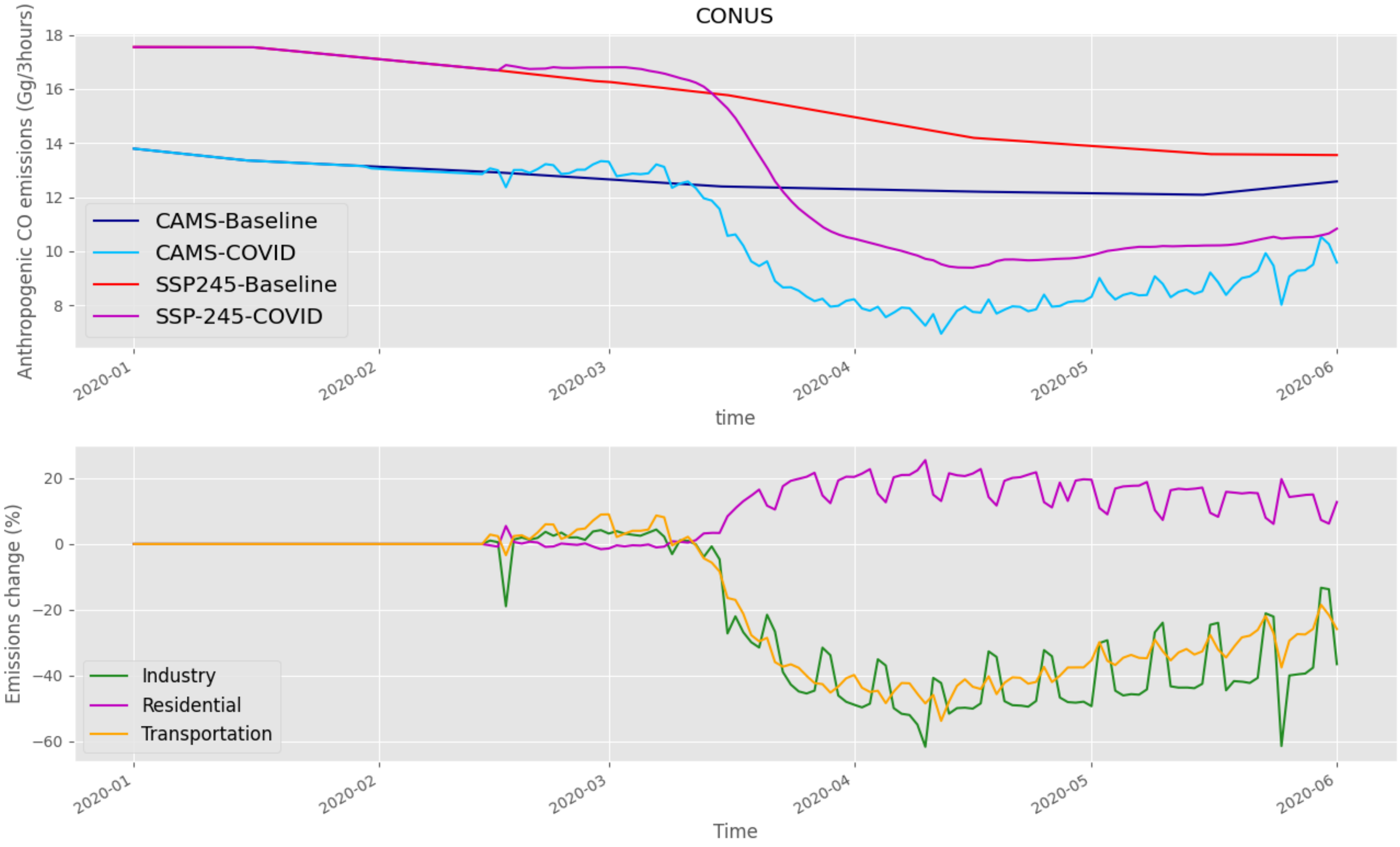
- Larger changes in China (Feb) in SSP
- Both agree very well for April (30 %)
- Reference emission values larger than scenarios

Anthropogenic CO emission inventories, by sectors, *Transportation*



- Larger CO emissions from transportation in CAMS
- Good agreement in lockdown induced change
- ~40 % in monthly totals for April 2020

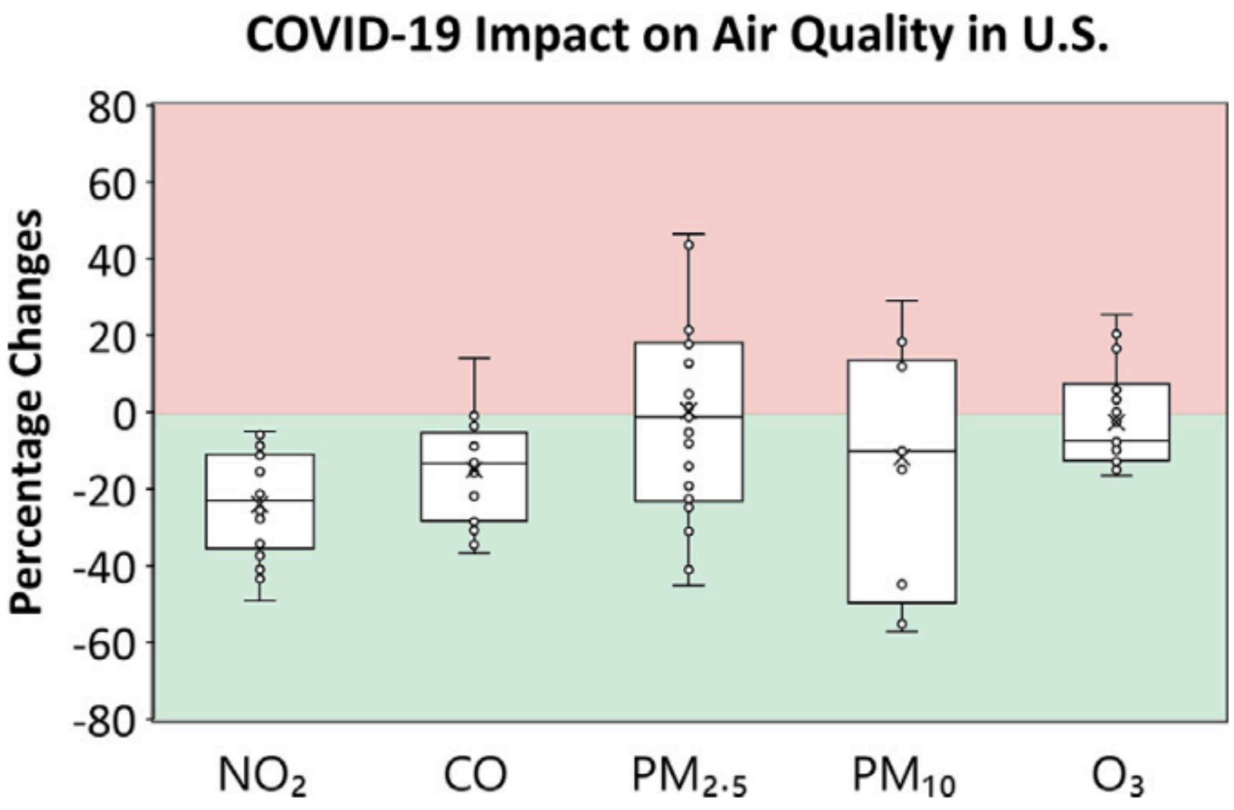
Anthropogenic CO emission inventories, CONUS



- Offset in baseline emissions can be as large as the reduction
- Disentangle the sector contributions

Global lockdown

❖ Chen et al. (2020): Consistent NO2 and CO declines corroborate with low transportation/utility demands.



An assessment of the impact of a nation-wide lockdown on air pollution – a remote sensing perspective over India

Review status
A revised version of this preprint is currently under review for the journal ACP.

Mahesh Pathakoti[1], Aarathi Muppalla[2], Sayan Hazra[3], Mahalakshmi Dangeti[1], Raja Shekhar[2], Srinivasulu Jella[1], Sesha Sai Mullapudi[1], Prasad Andugulapati[2], and Uma Vijayasundaram[3]
[1]Analytics and Modelling Division; Land and Atmospheric Physics Division; Earth and Climate Sciences Area, National Remote Sensing Centre (NRSC), Indian Space Research Organization (ISRO), Hyderabad-500037, India
[2]Bhuvan Project Management and Software Evaluation Division, Bhuvan Geoportal and Data Dissemination Area, NRSC, ISRO, Hyderabad-500037, India
[3]Department of Computer Science, School of Engineering & Technology, Pondicherry University, Chinna Kalapet, Kalapet, Puducherry-605014, India

❖ Pathakoti et al. (2020): An increase in CO levels was noticeable, probably due to its longer life-time as compared to NO_2 and aerosols. This study also reports the rate of change of NO_2, CO and AOD, indicating increase/decrease in pollutant emissions over the different states of India.

Conclusions

- Surface Air Quality networks are more sensitive to emission changes than satellite observations
- Disentangle effects from secondary CO, natural sources from biogenic and biomass burning
- Response to emissions perturbations is non linear and chemical feedback should be investigated

Perspectives:

- Different prior emission dataset and lockdown scenarios should be considered for inversion studies
- Correlative measurements (CO, AOD…) in multi-species inversion framework
- Comparison of top-down and bottom-up inversions