

Atmos. Chem. Phys. Discuss., referee comment RC2  
<https://doi.org/10.5194/acp-2022-558-RC2>, 2022  
© Author(s) 2022. This work is distributed under  
the Creative Commons Attribution 4.0 License.

## Comment on acp-2022-558

Anonymous Referee #2

---

Referee comment on "Hemispheric-wide climate response to regional COVID-19-related aerosol emission reductions: the prominent role of atmospheric circulation adjustments" by Nora L. S. Fahrenbach and Massimo A. Bollasina, Atmos. Chem. Phys. Discuss., <https://doi.org/10.5194/acp-2022-558-RC2>, 2022

---

This study aims to investigate seasonal atmospheric circulation and climate responses to regional aerosol emission reductions related to COVID-19 pandemic by analyzing multi-model ensembles from the CovidMIP. It's focused on January-February (JF) and March-May (MAM) in 2020 when the decrease in aerosol emissions was the largest over eastern China and India, respectively. The results show a precipitation increase over the Maritime Continent driven by regional sea-level pressure and atmospheric circulation adjustments. I find it very interesting that the anomalous climate patterns reverse polarity between JF and MAM, attributed to the shift of dominant source region of SO<sub>2</sub> emission reduction from eastern China in JF to India in MAM. The study highlights the important global climate impact of abrupt regional emission changes. The paper is well written, and the main conclusions are mostly supported by the analyses. I have the following specific comments for the authors to consider to better put this study in the context of literature.

- It's still unclear how exactly the aerosol reductions caused the atmospheric circulation adjustments. Is it mostly from the aerosol-radiation interaction or aerosol-cloud interaction? Ming et al. (2021) found that the large change in shortwave radiative fluxes in March over East Asia was due to aerosol-radiation interaction and, to a large extent, weather variability. It appears that this study attributes the circulation response merely to anomalous surface warming owing to the reduction of sulphate aerosol. How about the role of internal variability in 2020?
- Yang et al. (2022) found that the atmospheric convection over eastern China was enhanced by COVID emission reductions and there was a positive feedback of moisture convergence from a sea-level pressure anomaly over northwestern Pacific, which together contributed largely to the record summer rainfall in eastern China. They identified a key role of the intensified western Pacific subtropical high (WPSH). In the section 3.2 of this study (starting from Line 235), the weakening and eastward shift of WPSH are also mentioned. Are the mechanisms consistent with each other? Please provide a discussion on this.
- Two low-resolution CovidMIP models were excluded from the analysis. Jones et al. (2021) didn't mention potential issues associated with model resolution. I am curious

whether the resolution was key to resolving the atmospheric circulation adjustments in response to the abrupt aerosol changes. Is there evidence supporting this?

- I understand that this study focuses on the fast atmospheric responses at the monthly timescale. However, the CovidMIP short simulations were conducted with coupled atmosphere-ocean models. I wonder whether the authors assessed any oceanic responses that cause SST changes and sea-level pressure anomalies.

#### References:

Jones, C. D., Hickman, J. E., Rumbold, S. T., Walton, J., Lamboll, R. D., Skeie, R. B., et al. (2021). The climate response to emissions reductions due to COVID-19: Initial results from CovidMIP. *Geophysical Research Letters*, 48, e2020GL091883. <https://doi.org/10.1029/2020GL091883>

Ming, Y., Loeb, N. G., Lin, P., Shen, Z., Naik, V., Singer, C. E., et al. (2021). Assessing the influence of COVID-19 on the shortwave radiative fluxes over the east asian marginal seas. *Geophysical Research Letters*, 48, e2020GL091699. <https://doi.org/10.1029/2020GL091699>

Yang, Y., Ren, L., Wu, M. *et al.* Abrupt emissions reductions during COVID-19 contributed to record summer rainfall in China. *Nat Commun* **13**, 959 (2022). <https://doi.org/10.1038/s41467-022-28537-9>