

Atmos. Chem. Phys. Discuss., referee comment RC2
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Comment on acp-2021-866

Anonymous Referee #2

Referee comment on "Measurement report: Variations in surface SO₂ and NO_x mixing ratios from 2004 to 2016 at a background site in the North China Plain" by Xueli Liu et al., Atmos. Chem. Phys. Discuss., <https://doi.org/10.5194/acp-2021-866-RC2>, 2022

The study by Liu et al. reports long term measurements of surface SO₂ and NO_x from a background measurement site in North China. I consider the data suited for publication in ACP, the manuscript is well organized and well written. However, concerning the data analysis, presentation and interpretation I have a few concerns detailed in the specific comments below that should be accounted in the revised version. Please consider making your data publicly available.

Specific comments:

l8-9: Are the differences in diurnal cycle of SO₂ and NO_x due to sources or chemistry?

l32-34: Please explicitly state the difference between regional and local/suburban pollution.

l36: What are "typical regional characteristics"? Please provide this information.

l43: Please provide examples for the few studies (references).

l98 & l100-104: Does "heating season" mean winter? Please disentangle the season = winter and the cause for the high NO_x values = heating. What is mainly used for heating in China? Coal, wood, oil, gas, electricity? Are your conclusion that the high NO_x and SO₂ concentrations are caused by higher emissions in combination with the meteorological conditions that slow down the reduction by less transport and slower chemical reactions?

I106-113: What causes the diurnal cycles? Please explain.

I141-145: Could the significant peak of SO₂ concentrations in 2008 be correlated with the (preparations for) the Olympic summer games 2008?

I146-152: Please explain the cause for the changes in NO_x.

Fig 6: Which months are shown for November-March? Jan, Feb, Mar, Nov, Dec of e.g 2008, or Nov 2007 - Mar 2008, or Nov 2008 - Mar 2009?

Fig 6b: The splitted fits should be consistently covering the same time periods: 2005-2010 and 2010-2017. What caused the change in NO_x trends 2010/2011?

6b April-May: Why is the fit put through the lowest values and does not seem to account for the high values in 2006, 2008, 2010, 2012, 2014, 2017?
I'm not fully convinced by the increasing and then decreasing trend. Do the median values support these trends?

I169: Which day or month did the emission control measures for the Olympic games came into effect? Shouldn't this be visible in the seasonal data in Fig. 6?

Fig 5 right column: Please add data for the median. Maybe the NO_x median fluctuates less than the NO_x mean? Does the median also show a trend over time? Please add a description of the left and right y-axis to the figure caption. I assume that the 95 percentile refers to the left axis and the 5 percentile to the right axis. Is this correct?

Fig5c: What caused the steep increase in NO_x in 2010?

I201: Please provide information on the details of the pollution prevention plans, especially with respect to SO₂ and NO_x, so that the reader can see how strict the measures were and how they changed over time.

I207-208: Please add what caused the shift in time of the maximum and what are the implications?

l217-220: Please show in how far the changes in NO_x correlate with the emission control measures in Beijing and/or NCP. I think this is speculative and giving details on the pollution prevention plans could support your conclusion.

Fig7.: Do you have an explanation for the small peak at 2 am? Are the differences in SO₂ and NO_x between the years significant? Please provide uncertainty range, e.g. 1-sigma-range for SO₂ and NO_x.

Fig. 8: Again, what are the uncertainty ranges? I assume, that the decreasing trend for SO₂ is robust. However, I'm not convinced that the differences in NO_x between the different periods are outside the 1-sigma range.

l238: Please detail what you mean with "relatively more difficult in emission control". Are there less regulations with respect to traffic emission control? Are the traffic emission control regulation less strictly adhered to?

l246-278: When discussing the differences in the diurnal cycle of SO₂ and NO_x their different lifetimes also should be considered. With SO₂ lifetimes of ~13-10h in summer and 48-58h in winter [e.g. 1] transport from the NCP to the measurement site certainly has an impact. However, NO_x lifetimes are shorter and significantly differ between summer (~6h) and winter (~24h) [e.g. 2] and day (29h) and nighttime (6h) [e.g. 3]. Here transport not always may have an impact and the observed NO_x levels might be more local. Please discuss.
Moreover, is there a diurnal cycle in the local emissions of SO₂ and NO_x?

Technical corrections:

l8: and other instances: valley -> minimum

l16: What is SDZ? Please introduce abbreviations before first usage.

l91: high value -> high concentrations

l115,123,132,: showed -> shows

l205: were -> are

I221: "is" -> "shows" or "are"

I232: has -> has been

I237: should -> could

I243: were not be -> have not been

I247: high -> high concentrations
low -> low concentrations

I272: Please specify what "YRD" is.

I277: was -> were

I285: exhibited greatly different for all -> exhibited large differences in all

I299-300: "... had weaker influence than SO₂ by the emission reduction..." -> had a weaker response to the emission reduction in ... than SO₂

References

- [1] Lee, C., Martin, R. V., van Donkelaar, A., Lee, H., Dickerson, R. R., Hains, J. C., Krotkov, N., Richter, A., Vinnikov, K., and Schwab, J. J. (2011), SO₂ emissions and lifetimes: Estimates from inverse modeling using in situ and global, space-based (SCIAMACHY and OMI) observations, *J. Geophys. Res.*, 116, D06304, doi:10.1029/2010JD014758.
- [2] Shah, V., Jacob, D. J., Li, K., Silvern, R. F., Zhai, S., Liu, M., Lin, J., and Zhang, Q.: Effect of changing NO_x lifetime on the seasonality and long-term trends of satellite-observed tropospheric NO₂ columns over China, *Atmos. Chem. Phys.*, 20, 1483–1495, <https://doi.org/10.5194/acp-20-1483-2020>, 2020.
- [3] Kenagy, H. S., Sparks, T. L., Ebben, C. J., Wooldrige, P. J., Lopez-Hilfiker, F. D., Lee, B. H., et al. (2018). NO_x lifetime and NO_y partitioning during WINTER. *Journal of Geophysical Research: Atmospheres*, 123, 9813– 9827.

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