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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Effect of changing NO_x lifetime on the seasonality and long-term trends of satellite-observed tropospheric NO_2 columns over China" *by* Viral Shah et al.

Anonymous Referee #2

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General Comments: Shaw et al present a combined model, satellite, and ground-based approach to disentangle the effects of changing NOx emissions and NOx lifetime on observed column NO2. The results of this study, and studies like this, are of great importance to the community seeking to utilize remote sensing approaches to infer trends in emissions. It has been well established that NOx lifetime is dependent on NOx concentration (due to the feedback on HOx) especially in the extremes of high and low [NOx] leading to strong spatial variability in NOx lifetime. There has been less focus on variability in tau(NOx) at a fixed location can impact calculated NOx emissions and the impact of NOx on tau(NOx) beyond its control on HOx.

The manuscript is well written and within the scope of ACP. I recommend that it be published following the authors attention to the following comments.

Specific Comments:

1. Model resolution: To what extent does model spatial resolution impact the results? If I am not mistaken, the model resolution is approximately 50 x 50 km in the study region. I would expect that O3 titration would display significant variability on this scale and that the mean modeled P(NO3) = k[NO2][O3], which is driving the nocturnal NOx lifetime, may not correspond to that calculated at smaller spatial scales? It would be helpful for the authors to comment on the extent to which model resolution is important and what direction the effects of resolution may have on calculations in NOx lifetime.

2. N2O5 to NO3 ratio: The N2O5 / NO3 ratio also scales with [NOx]. With decreasing NOx, this ratio decreases and L(NO3) becomes more important than L(N2O5). To what extent is this important here, or is the nocturnal NOx lifetimes essentially all limited by P(NO3) and L(N2O5 + NO3) »> P(NO3)? While this may not impact the retrieval of NOx emissions trends, it could have a sizeable effect on nitrate aerosol formation rates.

3. ClNO2 branching fraction: What is the mechanism for ClNO2 in the model? What is the distribution of ClNO2 branching fractions? Does this change in time? If 30-50% of NOx is lost to N2O5, ClNO2 has the potential to return half of this. A short section on the parameterization used and the uncertainty in this (most measurements show that parameterizations of ClNO2 branching fractions are much larger than observations) should be included. I appreciate that NOx lifetime may not be that dependent on aerosol surface area, but the net NOx removal is certainly dependent on the ClNO2 branching fraction.

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