



EGUsphere, referee comment RC1
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Comment on egusphere-2022-656

Anonymous Referee #1

Referee comment on "Nitrogen oxides in the free troposphere: Implications for tropospheric oxidants and the interpretation of satellite NO₂ measurements" by Viral Shah et al., EGU sphere, <https://doi.org/10.5194/egusphere-2022-656-RC1>, 2022

This manuscript contains important analyses with regard to observations and model calculations of NO_x in the free troposphere. The paper convincingly proves that NO₂ from both laser-induced fluorescence and photolysis/chemiluminescence instruments have significant high biases due to interferences from other NO_y species. NO₂ calculated from photostationary state (PSS) assumptions likely yield a better estimate. However, the GEOS-Chem model overestimates the PSS-NO₂ in the free troposphere in the southeast US during the SEAC4RS and DC3 experiments. In the remote free troposphere the model underestimates NO during ATom, but inclusion of photolysis of particulate nitrate greatly improves the simulations. The implications of these findings for NO₂ satellite retrievals are discussed. As found in previous studies, lightning is noted as the primary NO_x source to the free troposphere over the tropics and southern midlatitudes in all seasons and over the US in summer. The free tropospheric component of the NO₂ column over the US in summer (65%) is sufficiently large to make surface emissions estimates in this season difficult. This is an important conclusion of the manuscript. The paper is very well written and should be published with just a few minor revisions as noted below:

line 131:column retrievals, if the airborne measurements are assumed to be correct.

line 167: NO_y/NO > 3 seems like this would be aged emissions, not fresh. Maybe this should be < 3 ?

line 563: "...errors in modeled tropospheric NO₂ columns over clean areas in relatively small." This doesn't seem correct based on the model results shown in Figure 6. The difference between models is $\sim 1 \times 10^{14}$ and the PSS-based NO₂ column is $\sim 1.9 \times 10^{14}$. Wouldn't this imply an uncertainty greater than 50%?