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Comment on acp-2021-604

Anonymous Referee #1

Referee comment on "COVID-19 lockdown emission reductions have the potential to explain over half of the coincident increase in global atmospheric methane" by David S. Stevenson et al., Atmos. Chem. Phys. Discuss., https://doi.org/10.5194/acp-2021-604-RC1, 2021

Stevenson et al. explained the extraordinarily high methane growth rate in 2020 with anomalously low methane sink (less OH) in response to reduced anthropogenic NO_x emissions due to COVID-19 lockdown. They referred to previous modeling results to quantify the sensitivity (CH_4 mixing to NO_x emissions) and argued that the observed additional methane growth can be almost fully explained by reduced NO_x emissions. While their hypothesis is an interesting and potentially important one, it still lacks concrete and convincing proof of the hypothesis as usually found in a research paper.

Specific comments are as follows.

First, the authors did not assess the impact of other species whose emissions may also have reduced together with NO_x during COVID-19, for example, CO and NMVOC. Reduced emissions of these species have an opposite effect to that of NOx, that is, to increase OH and reduce CH_4 lifetime. According to Fig 3 of Lamboll et al. (2021), emissions of CO and NMVOC were also substantially reduced though with slightly smaller fractions compared to NO_x. Fry et al. (2012) showed with their model that the net effect on OH is close to 0 with compensating effects from a combined 20% reduction of NOx, CO, and NMVOC. So, the author's argument can be much stronger if they can estimate the net chemical effect of the COVID-19 emission perturbation.

Second, the calculation of the authors relies on the sensitivity of CH_4 mixing to NO_x emissions, taken from previous studies. Most of the studies cited are from the 2000s. The "baseline" emissions of NO_x as well as other chemicals may have changed a lot from the early 2000s to 2020. I wonder if the sensitivity of global OH and CH_4 to NO_x emissions will also change, and if so change by how much, with the "baseline" emissions. This chemical system is known to be nonlinear.

Third, independent observation evidence on reduced global OH, if there is, can be really powerful. The 5 ppb additional increase in methane mixing ratio translates roughly to a 3% decrease in global OH concentration if they were attributed entirely to reduced NO_x emissions. This magnitude of decrease in global OH can have detectable signals on burden or distribution on many species besides CH_4 , such as CH_3CCl_3. If these analyses are consistent with the author's hypothesis of NO_x chemical feedback, it can really increase the confidence, though it may be a lot of work.