

Review of “Direct Observations of NO_x emissions over the San Joaquin Valley using airborne flux measurements during RECAP-CA 2021 field campaign,” Zhu et al., ACP, 2023.

This paper presents measurements of NO_x emissions made from an aircraft using the eddy covariance technique, over various land uses in the San Joaquin Valley, California in summer 2021. It presents comparisons of NO_x emissions from highway, urban and soil with estimates from bottom up inventories. It is a generally excellent paper, well written and within the subject matter for ACP. I do have some concerns that should be addressed before publication:

General comments:

Section 2:

There is very little description of the instrument performance in this section. The authors have reference previous papers for the same instrument, but they are all relatively old. Some comment should be made of sensitivity and, in particular time, resolution of the instrument, with evidence needed that it is truly providing a 5Hz measurement. This is particularly important for the NO measurement, that is a result of the chemical transformation of NO to NO₂ on addition of ozone. Is the chemistry fast enough to result in a 5Hz measurement?

Section 3.4:

The vertical divergence section needs expanding. The authors take a subset of all flux data measured over croplands to provide a homogeneous emission set of to use for vertical divergence assessment. There are a few questions about this methodology that need expanding upon. Do the croplands subset cover all different conditions experienced during the campaign and hence give a full picture of the flux divergence? How can the authors be sure that there are no other emission sources in the subset? For example, what about farm machinery that could produce a large perturbation to the data?

In figure 2, the linear regression is fit through medians of the z/z_i data subsets. However, the spread on this data is quite large, as shown by the standard deviations. (also, would a median absolute deviation be more appropriate here?) The linear regression does not take into account this spread, so some more discussion is needed as to how this linear divergence feeds into the overall error calculation in the next section. With corrections up to 30% of the measured flux, it is important that this paid more attention.

Section 3.5

The authors note that they expect limited high-frequency loss due to the 5 Hz time resolution of the instrument. However, no quantification of this is presented – especially with the aforementioned concerns regarding the NO → NO₂ conversion rate, the authors should include estimates of the losses for each species.

Line 172 Here several papers that do not include an estimate of the uncertainty due to vertical flux divergence are listed. The wording is unclear a first reading as to whether they do not address the uncertainty, or do not address vertical flux divergence as a whole.

Section 5:

The first paragraph of this section would benefit from some discussion on how the measured emissions here compare to other similar studies. For instance, on line 243 it is stated that there are 'high' NO_x emissions in the cities. Could the actual numbers be stated and maybe compared to other measurements from the literature?

Section 6:

The conclusions section needs further expanding to put the results in context. For instance, how important is the discrepancy between the measured and inventory NO_x emissions in the area for regional air pollution models in the context of ozone formation. Clearly an order of magnitude underestimation of NO_x emissions from soils is likely to be globally important so some comment should be made on this. Also, the authors should comment on the limitations of the study, especially with respect to whether their measured emissions are truly only coming from soil.

Figures:

The figures could be improved so that they all have similar formatting. Figures 1-4 look very different to 5-8 (font type, size, label size etc). There are also thick black borders around 5-8 which are not around 1-4. Figure 6 could also benefit from being shown as a scatter plot rather than box / whiskers.

Specific:

Section 3.3: It is not clear what the grid cell resolution is – please state it here.

Figure 1 (d): The map is very unclear. The labels are too small to read properly and the grey lines showing the percentiles of the footprint are too light. Also, I assume the caption is meant to say 90th percentile rather than 9th?

Line 214: What does k denote in the equation and why is it 1, 2 or 3. Presumably these are the land mass types but this should be stated.

Line 226: I'm not sure of the meaning of the phrase 'spatial resolution of the landscape'. Please expand as to what this means.

Line 287: What do the authors mean by a 'wide spread'? Please state explicitly what the spread of data is.

Line 238: What do the authors mean by 'significantly lower'? Please state the statistics used to come up with this statement.

Line 277: Capital B needed on biogenic.

