

Geosci. Model Dev. Discuss., referee comment RC2  
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## Comment on gmd-2022-45

Christian Frankenberg (Referee)

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Referee comment on "Integrated Methane Inversion (IMI 1.0): a user-friendly, cloud-based facility for inferring high-resolution methane emissions from TROPOMI satellite observations" by Daniel J. Varon et al., Geosci. Model Dev. Discuss., <https://doi.org/10.5194/gmd-2022-45-RC2>, 2022

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Varon et al present a user-friendly cloud based inversion system that enables (almost) everyone to perform the complex task of atmospheric inversions. As such, this is a highly commendable effort, which should benefit the scientific community overall but also achieves greater transparency in the scientific process. The manuscript is well written, the code is archived and documented and the paper well suited for GMD. Thus, I recommend publishing this article after consideration of some minor points outlined below:

Line 2: "resolution by inversion of satellite observations from the TROPOspheric" it reads is if observations are inverted (but fluxes are inverted so that the forward model matches observations). Maybe rephrase a bit.

Line 110: I am sure you meant to say albedo  $>0.05$ ?

Line 149: While reading the manuscript, I was always waiting for the "time-dimension" of your state vector. Afterwards, I realized the setup uses one fixed time-period in which the emissions are supposed to be constant, right? This could be a week (with a low DOFs), a month (in your example) or a year or more I guess. Maybe it would be good to discuss the temporal aspect of the inversions up front somewhere, so that the general reader knows about it early on (or maybe it escaped me).

Line 240: Is there an option to add co-variances to  $S_a$ ? It seems an uncorrelated error per grid cell of 50% actually results in a rather low total prior error covariance for a regional aggregate. In fact, I am curious what the regional total prior uncertainty for your Permian run would be (you could add these prior uncertainties to the plots as well, e.g. Figure 6). Given that more naive users will use this inversion system, it could be very important to inform the user what the prior uncertainty of the target of interest total emissions are.

People might otherwise naively assume it would also be 50% (which it would be with perfectly correlated errors). In your example inversion in Figure 3, your posterior is 30% higher than your prior. My guess is that the prior total uncertainty is quite a bit lower than 30%, given the amount of grid cells within the domain (I just wildly guesstimate it might be around 10% or lower).

Apart from that, well done, a good contribution to science, transparency, and a more "democratic" access to complex tools.