Interactive comment on “A Singular Value Decomposition framework for retrievals with vertical distribution information from greenhouse gas column absorption spectroscopy measurements” by Anand K. Ramanathan et al.

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Response to Anonymous Referee 1

• P 4 line 22: “better representing” I don’t know what is meant here, please restate.
   Changed the sentence for more clarity from  
   “Such simple methods have the advantage of better representing the instrument measurement, and enabling more feedback on instrument performance.”
   to
   “Such simple methods have the advantage of enabling more feedback on instrument performance by virtue of forcing the retrieval to derive certain information strictly from the measurement even when non-optimal.”

• P 7: forward model definition. I find this section confusing. The measurement vector \( y \) is described as the deviation in the absorption from that corresponding to \( x_u \), but that is not a measurable quantity and the statement is contradicted by Eq. (4). Near the bottom of page 8 it is claimed a valid choice for the reference profile is \( x_u = 0 \), so that \( y \) is a ‘deviation’ from zero. I believe this is correct in the end, and exploits the assumed linearity of the problem, but it is still not entirely clear to me, and I think the concepts should be better explained.
   We agree with the reviewer. We have modified Eqn. 4 to include the noise term epsilon
   The point of the equations at the bottom of page 8 were to use the offset and scale choices that we have at our disposal in setting how \( x \) relates to the CO\(_2\) profile (in units of ppm). Our specific choice was made based on making the SVD equations least complicated. In the revised version, we will include an additional equation to explicitly show that relationship and include a sample calculation for clarity.
   In the examples we show, we set the uninformative prior to be a 400 ppm uniform column. With \( x_u \) being zero, \( \hat{x} \) having all elements 0 corresponds to a uniform column of 400 ppm. An element of \( \hat{x} \) having a value of 0.02 corresponds to that layer in the atmosphere having a mixing ratio of \( (1 + 0.02) \times 400 = 408 \) ppm. Similarly, an element of \( \hat{x} \) having a value of -0.02 corresponds to that layer in the atmosphere having a mixing ratio of 392 ppm.
The element in \( x_u \) corresponding to the surface reflectance or signal level (\( x_0 \)) also has degrees of freedom for the offset and scale. Thus, one can set \( x_u \) to be zero with no loss in generality.

We have revised the text at the bottom of page 8 to

“...confirms the notion that the retrieval of a column mean using least-squares line fitting of an absorption spectrum yields a bias-free estimate of the \( X_{GHG} \), regardless of the shape of the profile used in the prior (which turns out to be uninformative)”

to

“...confirms the notion that the retrieval of a column mean using least-squares line fitting of an absorption spectrum yields an estimate of the \( X_{GHG} \) without incurring bias from the regularization or retrieval, regardless of the shape of the profile used in the prior (which turns out to be uninformative)”