

General comments:

The manuscript entitled, *“The Adaptable 4A Inversion (5AI): Description and first XCO₂ retrievals from OCO-2 observations”* presents a description of the 5AI retrieval, designed for use with OCO-2 but adaptable to other current and future GHG satellites. They show that, although there is a small offset of a few ppm, 5AI agrees in many ways with the B8/B9 ACOS XCO₂ retrieval. The manuscript is very well-written and I recommend publication in AMT after the authors address comments below.

The primary weakness I see is that this is a non-scattering retrieval, which isn't mentioned until page 8 of the manuscript. This is important to discuss and likely contributes to the especially large differences seen between 5AI and ACOS in Africa, South America, India, etc. (Fig. 7) and the general lack of data in typically aerosol- or cloud-laden areas (Fig. 2). All other major near-infrared XCO₂ retrieval algorithms include a scattering component because no scene is truly “clear sky” and you'll end up with unacceptably high biases unless you heavily filter the data. Annoyingly, the places we care about most regarding the carbon cycle are also cloudy and full of aerosols, so a retrieval needs to be able to at least get quality XCO₂ for slightly contaminated scenes.

Specific comments:

- Maybe too many details in the introduction. E.g. listing all the HITRAN/ABSCO versions. Suggest moving elsewhere.
- P2 L64: S5P doesn't measure XCO₂, so maybe not relevant here.
- P4 L121: which version of ACOS? B10 is the current version.
- *“In this work we assume a slow variation of the Jacobian matrix along the 200 iterations and therefore choose not to update it in order to save computational time... We performed a sensitivity test and assessed that this approximation does not significantly change the retrieval results (not shown).”*

Is this because not solving for a scattering component makes the retrieval much more linear?

- *“(O'Dell et al., 2018) explains that this uncertainty is 0.0005 /cm-1 but B8r data release uses 1.0 /cm-1 in the 'apriori_covariance_matrix', in 'RetrievalResults', in Diagnostics files.”*

Appears to be a typo in O'Dell 2018. 1.0 is correct for B8r.

- *“its most recent version is distributed within the B8 retrospective (B8r) ACOS data release”*

B10 is the latest version, as of a few months ago. But B8/B9 is fine for an analysis like this.

- *“we apply a simplistic empirical correction on 5AI”*

Have you thought about what you’ll do for a more complex bias correction in the future?

- *“0.05 ppm difference between 5AI and ACOS”*

Are you comparing 5AI lat bias corr to ACOS lat bias corr? Don’t you want to compare 5AI lat bias corr to ACOS official bias corr (so, $1.17 - 0.98$, not $1.17 - 1.12$)?

- *“and account for cirrus clouds or aerosols in the retrievals.”*

This is critical. Figure 7 clearly shows the disadvantages of a non-scattering retrieval. Your algorithm differs substantially from ACOS where there are high levels of dust (e.g. Sahara), pollution (e.g. India), etc. And probably is suffering from an inability to do anything about unscreened thin clouds in general.

Technical comments:

P4 L120: “target mode” instead of “target session”

P6 L169: “many projects” instead of “many work”. The sentence is a bit clunky.

P6 L188: Would recommend something like: “Moreover, as the forward model for this retrieval is highly non-linear...”