We would like to thank the reviewer for their thoughtful and constructive comments and suggestions to improve the clarity of the manuscript. We have made changes to address these comments and suggestions.

Point-by-point responses to the comments are provided below. The reviewer comments are in blue, our responses are in red (line numbers refer to those in the revised manuscript), and modifications to the original manuscript are highlighted in yellow.

Sincerely,

Vijay Natraj

On behalf of all co-authors

RC1: 'Comment on amt-2021-290', Anonymous Referee #1, 18 Nov 2021

The authors present a detailed computation of DOFs for atmospheric retrievals for a notional multispectral sounder. The paper is well presented and high-quality a-priori data that has been used for other instruments is used for their DOF estimates. I don't think their are any surprises here, but the paper does give decisions makers and proposers a feel for the benefits of their notional sounder (most likely a very expensive one indeed).

However, I think the discussion on OSSEs near the end is uneeded and gives the reader the wrong impression. No OSSEs are done here and I don't think it is warranted to talk about what you are going to do in the future. A sentence will do.

We thank the reviewer for this useful feedback. We agree that the section on OSSEs looks redundant because such experiments were not performed in this work. However, we do feel that the utility of the retrievals for OSSEs is an important issue that deserves discussion in the manuscript. Therefore, we have renamed Section 6 and shortened the discussion as follows (lines 360–386):

6 Discussion: Use of GEO-IR Information in Data Assimilation and Observation System Simulation Experiments

We have focused in this paper on the characteristics of the measurements and retrievals that we expect to obtain from the GEO-IR observing platform. While this paper does not deal directly with the use of this information in a data assimilation system, the results we have presented lay the necessary groundwork for future work in this area. In particular, the detailed characterization of uncertainties in the TATM and H_2O retrievals provided by this study can be directly incorporated into a set of weather forecast OSSEs. We have begun this research, and will report on the results in a subsequent paper. Note that, for a weather forecast OSSE to be credible, it is crucial to represent the synthetic measurements as accurately as possible. TATM and H_2O precision and total error are reported in Table 8; it can be seen that the errors for the MWIR-only configuration are on the order of the errors in CrIS and AIRS retrievals, while the full-spectrum JPL GEO-IR Sounder configuration yields total errors that are smaller than those from either CrIS or AIRS. As

such, assimilation of information from JPL GEO-IR Sounder measurements is expected a priori to have as much or greater impact on weather forecasts compared with existing hyperspectral sounders. Note that the total error in the full-spectral-range TATM and H_2O retrievals is equivalent to, or less than, the uncertainty reported for radiosonde measurements of these quantities (Rienecker et al., 2008; Table 3.5.2).

We also note that there will be particular advantages and challenges in assimilating the high temporal resolution data that will be available from the JPL GEO-IR Sounder. The clear advantage is the ability to observe rapidly evolving processes (e.g., the environment around thunderstorms and hurricanes). This information is not available from the current LEO constellation. However, many modern data assimilation systems are configured for assimilation of intermittent data (at best hourly in operational data assimilation systems). While four-dimensional variational data assimilation (4D-Var) is capable of ingesting data at non-synoptic times, assimilation of sub-hourly data remains challenging. It is likely that all but the most rapid-update data assimilation systems will require modification to make best use of the high time frequency geostationary soundings provided by the JPL GEO-IR Sounder.