Second review round for manuscript 'Improving solution availability and temporal consistency of an optimal estimation physical retrieval for ground-based thermodynamic boundary layer profiling'

Response to Reviewer 2

We appreciate the reviewer's comment which made us think again on how we can better explain the noise inflation approach and hope that our response is satisfying for the reviewer. The reviewer's comment is printed in italic and our response in roman font type.

I am largely satisfied with the changes that have been made to the manuscript. I do feel that a little more discussion on the noise is appropriate: specifically, why are you filtering noise out with the PCA noise filter only to increase it back again? Perhaps I am not understanding it the way it is written. This is a one-to-two sentence change, and so I am satisfied with a minor revision of this point.

We modified the text in the introduction trying to better explain how and why we need to inflate the uncertainty:

"Ideally, uncertainties in the observations, prior, and forward model are propagated and characterized by the posterior covariance matrix which is part of the TROPoe output. Because including the uncertainty of the forward model would increase the computational costs of the retrieval substantially, the uncertainty of the forward model is assumed to be zero in the current framework of TROPoe. Instead, the missing uncertainty of the forward model is assumed to be included in the uncertainty of the infrared radiances in the error covariance matrix of the observations. The uncertainty of the infrared radiances is instrument specific and is determined during the IRS calibration process (see Revercomb et al. (1988) and Knuteson et al. (2004b) for details). A common approach is to greatly reduce the random noise of the infrared radiances using a principal component-based noise filter before the radiances are used within TROPoe (Turner et al., 2006). At the same time, the original radiance uncertainty is included in the error covariance matrix of the observations of the retrieval. The intention is that the larger original radiance uncertainty captures the sum of the lower uncertainty of the noise-filtered radiances and the forward model uncertainty. For details on this approach see Turner and Blumberg (2019). However, depending on the radiance noise level of a specific IRS, the original radiance uncertainty might not be sufficient to compensate for the missing uncertainty of the forward model for some instruments, which may still lead to overfitting of the data and unrealistic profiles (Adler et al., 2023). We propose a minimum noise level for infrared radiances which should be used for the IRS radiance uncertainty in TROPoe as an intermediate solution before a computationally efficient implementation of the IRS forward model error can be included in the TROPoe framework. Because the signal to noise ratio in the MWR brightness temperature observations is lower than for the IRS radiances, overfitting is less of an issue for MWR-based retrievals."