Review of "Automatic Optical Depth Parametrization in Radiative Transfer Model RTTOV v13 via LASSO-Induced Sparsity for Satellite Data Assimilation" by Franklin Vargas Jiménez and Juan Carlos De los Reyes

This study applies the LASSO regression to reduce the number of predictors used to calculate optical depth. This makes the RTTOV model more computationally efficient for simulating top-of-atmosphere radiances observed by satellites. The authors demonstrate through experiments that their approach produces good estimates of transmittance and brightness temperatures when compared to the use of the full set of predictors in RTTOV v13. However, these experiments might not be enough to guarantee good performance in the application of satellite data assimilation.

General comments:

1. **Application to satellite data assimilation:** The authors suggest that their approach is intended for use in satellite data assimilation. However, they do not present any data assimilation experiments. Such experiments are important, as there may be problems when using this approach in such applications. In data assimilation, the difference between observed satellite radiances and those simulated from model state variables (via RTTOV) is used to update the relevant model state variables. If LASSO induces sparsity by zeroing out many regression parameters, it removes the sensitivity of radiances to certain model variables or layers. As a result, assimilating those radiances may influence fewer aspects of the model state in terms of both variable type and vertical level. This could be undesirable. Therefore, data assimilation experiments are necessary to assess how the induced sparsity affects the assimilation of radiances.
2. **Further explanation and interpretation of results**: In Sections 5.3 and 5.4, the authors provide a numerically detailed discussion of the approximation errors introduced by LASSO. However, it would be beneficial to provide a theoretical interpretation of these results. Specifically, is there a link between the approximation error and the number of non-zero parameters and the characteristics of individual channels? Do the authors believe that the observed variations in performance are largely due to random effects?
3. **Acronyms:** There are lots of acronyms used in the paper. While some might be familiar to many readers, it would be helpful if the authors could provide the full name where they first appear. This applies to both the abstract and the main text.
4. **Formatting issue with citations**: This issue appears in many places (e.g., lines 20-24, lines 32-35 and lines 54-57). For example, on line 54, it should be "… optical images (Hong and Kong, 2021) …"

Specific comments:

1. Line 1: This sentence is slightly misleading. In data assimilation, radiative transfer models map model state variables (e.g., temperature) onto the radiances measured by the satellite. It is the radiances that are assimilated, rather than the retrieved temperature.
2. Line 11: Move "(RT)" forward to be after "radiative transfer"
3. Line 11: Again, this sentence is a bit confusing. What the authors describe in the following two paragraphs is exactly what the reviewer expected!
4. Lines 39-40: Even for large centres where RTTOV is being used operationally, the proposed approach has benefits if it reduces computation costs while maintaining accuracy.
5. Line 64: Could the authors provide slightly more clarification at line 50, where it states that LASSO regression has been applied in the context of radiative transfer in Cardall et al. (2023).

6. Section 1.1: The reviewer recommend reformatting this subsection to the last paragraph of Section 1, as there is no Section 1.2.
7. Line 74: Reference for the monochromatic radiative transfer equation (Equation 1).
8. Line 134: Could the authors provide an example of the predictors for a given instrument and gas?
9. Equation (12): The second case is confusing because it states that $d_1 = \bar{d}_1$. How is d_1 on the right-hand calculated?
10. Line 232: Readers could benefit from some further discussion on the selection of the thresholds ϵ_1 and ϵ_2.
11. Line 245: Why is a factor of 2 used?
12. Line 261: The full name of VIIRS should be provided earlier in the text.
13. Line 267: What does "SRF" stand for? Does it stand for "Spectral Response Function"?

Technical corrections:

1. Line 135: "de number of predictor" -> "the number of predictors"
2. Caption of Table 9: "Maximun Relative Errors" -> "Maximum Relative Errors"
3. Line 172: "... predicted by the model (8)." -> "... predicted by the model (Equation 8)."
4. Line 207: "... considering M angles and N atmospheric profiles ..." -> "... considering N angles and M atmospheric profiles ..."
5. Line 264: "In this study, we use the VIIRS SRF J2 and can be downloaded from the following link: ..." -> "In this study, we use the VIIRS SRF J2, which can be downloaded from the following link: ..."