

## ***Interactive comment on “Establishment of AIRS Climate-Level Radiometric Stability using Radiance Anomaly Retrievals of Minor Gases and SST” by L. Larrabee Strow and Sergio DeSouza-Machado***

**Anonymous Referee #3**

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The authors present a novel approach with which to characterize decadal trends using AIRS radiance data. They apply this method to test instrument stability as well as temporal accuracy of retrieved geophysical variables over 16 years of AIRS measurements, limiting their scope to clear daytime scenes over ocean. With this work, the authors make a unique and valuable contribution to the science and application of satellite soundings.

This is a dense paper, and the authors expect the reader to hold on to an ever-increasing number of abstract concepts as the paper progresses. I suspect some of

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the meaning and impact of their work may be lost as a result.

SCIENTIFIC ISSUES:

(1) Could the authors explain how they determine a scene to be over ocean? From Figure 1 it looks like coastlines are included.

(2) Determining clear scenes (Lines 91-93): The authors mention that the BT of each scene is subtracted from the BT of each of its 8 neighbors. Do the authors mean that they do this calculation for each 3 x 3 cluster of fields-of-view (i.e., within a field-of-regard), or do they treat each AIRS footprint (BT spectrum) independently and find 8 neighbors from adjacent fields-of-regard?

- What do the authors mean by “scene”? A field-of-view, or field-of-regard?

- My understanding here is that the authors select clear scenes based on two criteria, (i) scene uniformity, and (ii) accuracy of BT residuals, using ERA-I in simulation. This means that the authors select scenes for subsequent analyses only where ERA-I agrees well with the measured radiance. I feel one should keep this in mind when interpreting results. Could the authors clarify how many scenes are removed from each step?

- After applying these clear-sky filters, the authors then select ~20k scenes randomly. Given the total available, what percentage is this?

(3) Lines 106-107: This is the first time the authors introduce the AIRS Level 1c radiance product.

- Could the authors provide a reference here?

- What is the significance of using the L1c product?

- Do the authors use L1b radiances at all? If not, are the recommendations about radiometric stability and channel selection for the L1c product exclusively or does it also apply to L1b?

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(4) Attributing results to sampling issues, Line 132 “the non-uniform spatial sampling”, Line 162 “Some of this is likely due to changes in sampling from day to day”, Line 166 “weather and sampling”. I’m wondering how their sampling strategy could contribute large systematic effects in the results. If ~20,000 scenes are randomly selected every day, then sampling variation from day to day will average out by design. The sampling bias should be a minimum. Could the authors elaborate on their reasoning here? I am wondering if some of the systematic effects visible in Figures 4 and 5 cannot not partly be explained by spectral interference from state variables used in simulation, especially those not present in ERA-I, like the minor gases.

(5) Line 168: “Note that since the ERA-I tracks the atmospheric state quite accurately most of the time-series “noise” is removed” Could the authors provide a reference here? How accurate is ERA-I compared to other models? Here, one should also remember that the authors specifically selected those scenes where ERA-I simulated BT spectral yielded a low residual. I feel that this simply demonstrates that their sampling strategy produced the desired results, not that ERA-I is accurate per se.

(6) Line 202: “These a-priori covariance uncertainty terms improved simulated retrievals and profile trends generated from these retrievals by 3-10%.” Could the authors elaborate on this result? It appears like a large range and I’m wondering if improvements were limited to specific latitudinal zones or regions.

(7) Section 4.3 (Lines 250-259): This section is confusing to me. Could the authors better explain Figure 7? Is the panel on the left, “-55 deg latitude CO2 retrieval” for a single scene?

(8) Figure 9: How is it that the AIRS-ERA SST trend is a perfectly straight line across all wavenumbers?

(9) Lines 567-568: “This work emphasizes that users of AIRS data for climate applications must pay careful attention to channel selection since certain detector arrays and channels are presently not suitable for climate trending, including all of the AIRS short

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wave channels”

- By “AIRS data”, do the authors mean L1c?

- The authors demonstrated that they could calculate the shortwave spectral drift after the fact and, when subtracting it from the retrieved trend in Susskind et al. (2019), they could correct the trend sufficiently. Would such an approach not be a suitable alternative to channel selection? I imagine that the range of geophysical retrievals possible from bias-free channels must be reduced. This gives rise to the question whether climate-quality retrievals could be made from a reduction in spectral channels.

- How do the authors envisage the practical implementation of their recommendation here? The method the authors present here appears nuanced and expensive, not easy to implement by users of AIRS data.

- Do the authors consider publishing a list of AIRS channels suitable for climate applications?

TECHNICAL ISSUES:

- Discussion of spectral features: It will help the reader a great deal if the authors specify the wavenumber range they refer to with each mention of specific features, e.g., “CO2 region” in Line 160, or “upper-tropospheric water vapor” in Line 162, or “window region...water bands” in Line 207, etc.

- Line 28: “sea surface temperatures.” Define the acronym “SST” upon first use.

- Line 59: “After a summarizing”

- Line 89: “Radiance (BT) anomalies” this is confusing since “BT” is an acronym or Brightness temperature, not Radiance.

- Line 106: “are matched to each clear scene are also saved”

- Figure 1 caption: “Density of AIRS clear ocean scene for calendar years 2012” should

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be “Density of AIRS clear ocean scenes for calendar year 2012”

- Figure 2:

Caption: Should it not be “long-wave” instead of “short-wave”? Since the authors make specific reference to a CO<sub>2</sub> feature, would they consider expanding the x-axis and adding more detailed tick marks to help the reader identify this feature specifically? As reader, I have the same issue with Figure 3 and its subsequent discussion.

Y-axis label: Reference to B(T) instead of BT. (Same in Fig. 4, Fig. 9)

- Line 161: “by by”

- Line 203: “each observations”

- Lines 202-203: Awkward sentence. Meaning unclear.

- Line 225: Add a comma to ease reading: “As discussed in Section 2, only”

- Lines 238, 264, 516: “(Aumann)” reference needs a date.

- Line 254: “to to”

- Figure 6 (page 11): legend should probably be “All channels used” for the blue profile?

- Line 267: “every so slightly”

- Line 294: “channels in located below 1615 cm<sup>-1</sup>”

- Line 300: Could the authors provide a reference for the L2c product here, so that the reader could follow up and better understand how “channels that do not exist . . . are filled during L1c creation”.

- Line 312: “discussed in Sect. {sec:sst}”

- Line 316: “results presented here use avoid the short wave”

- Line 418: “just two two small”

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- Line 546: “improvements to the AIRS products can be improved”

- Line 564: “jumps are observed in the all retrieved”

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Interactive comment on Atmos. Meas. Tech. Discuss., doi:10.5194/amt-2019-504, 2020.

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