Response to review by anonymous referee #2

Opening remarks

We warmly thank the four anonymous referees and Tim Hewison for taking the time to review our manuscript and to provide valuable feedback. As there are commonalities between several of the reviews, we start with some general remarks.
To begin, we emphasise that our goal is not to encompass the entire AWS mission. First of all, this would be very challenging to cover within a standard manuscript length and would approximately double the number of co-authors. For example, the primary objective of AWS is numerical weather prediction (NWP), and addressing the aspects and applications of AWS within this area could be a manuscript in itself. The manuscript's aim is instead to provide the necessary information to understand the design of the AWS radiometer and to utilise the L1b data from this instrument. In the revision, we focus on improving the text around these aspects based on the provided feedback, as well as adding some new information.
A related question is how much in-orbit characterisation to include. Here, we hope to have an understanding of the difficulty of compiling the manuscript at the same time as the team is preoccupied with the satellite's commissioning phase. The initial aim was to submit the manuscript in 2024. In particular, the sudden deviating behaviour of the 174 GHz receiver (Sec. 6.3) caused significant concern and resulted in a substantial delay in the manuscript. Nevertheless, our approach is to include some initial basic results, primarily to indicate that the findings from the on-ground tests appear to be valid. We have added a sentence to exemplify this further and on the same time indicate the range of aspects that has to be considered. We avoid going further to leave room for one or several upcoming articles that are entirely focused on in-orbit testing. In addition, to fully cover the in-orbit testing would again require a considerable extension of the list of authors. This work is ongoing and far from complete. At least one update of the L1b processing algorithm is foreseen.
In summary, we find it reasonable to focus on the development of the instrument up to the launch. On this side, we think the manuscript is already more information-rich than usual. This brings us to an unstated objective. It is already difficult to find in the open literature the relevant background information about the satellite instruments we use for research. The trend towards new space and more substantial commercialisation risks making the situation worse; with this manuscript, we aim to demonstrate that this need not be the case.

The replies below refer to the revised version of the manuscript we have prepared.

Replies on referee's comments

General comments:

- "I found the order of the sections to be awkward, and suggest following the order closer to the ESA SMOS paper ..."
    - We have decided to not follow this suggestion. The proposed rearrangement builds on, at least partly, that the full mission is treated, which is not the case as described above. Section 6.1 is included only to exemplify the AWS data, in particular to give a first glimpse from the novel 325 GHz channels. We also refer to that this subject has not been brought up by the other four reviewers.

Specific comments:

- "The paper's title should include the word Mission to go with Radiometer"
    - See Opening remarks above.
- "Merge radiometer background (Sect. 2.1) with intro section (Sect. 1.0). It wasn't until 2.1 that I learned why Artic is in the name."
    - Thanks for this suggestion, we agree that having the background and "history" behind AWS in the Introduction is better. We have moved Section 2.1 to the introduction with minor adaptations to make it flow with the rest of the introduction, at the same time as text has been incorporated in response to a comment from another referee.
- "I see a statement on Line 368 of radiometric accuracy, but no target in Table 1."
    - Table 1 is not meant to give a complete coverage of the long list of all requirements.
- "Per the ATBD, L1b is brightness temp., but the paper seems to consistently call it antenna temperature (traditionally ant. temp. is L1a, but AWS doesn't seem to offer it)."
    - An observant remark! We avoid going into a discussion of the correct term for calibrated data, and approach the question from a pragmatic standpoint. Since the submission we have noticed that this question has generated confusion even inside the broader AWS team (i.e. including data end users), and we have adopted the nomenclature to the one of ATBD and L1b data. That is, antenna temperature is now replaced with brightness temperature.
- "Sect. 4.0 Pre-launch Characterization: I didn't see any discussion on non-linearity. The only thing I could find in the ATBD was a detector nonlinearity correction without mention on how it was derived. Also, it doesn't look like AWS radiometer went through TVac calibration where an instrument-level non-linearity correct is derived? While I'm an advocate of the New Space approach, the non-linearity is very hard to derive on-orbit ..."

    - Comments on these points are now found in Secs. 2.2 and 4.5.
- "Sect. 4.5: Can you include references or more details on this section? There seems to be all results with no information on how it was calculated."
    - Sec 4.5 has been rewritten and hopefully better clarifies the approach and ambition of the tests.
- "NEDT consistency (Sect. 2.3, 4.4, & 6.2): It doesn't seem that the comparison of the various stated NEDTs are consistent. Just looking for more details and not re-analysis. 6 is the intrinsic NEDT equation, but there are other sources of NEDT contribution: ..."
    - A rigorous assessment of NEDT is surprisingly difficult. The contribution of gain variations (striping) is especially challenging. The AWS team is fully aware of these issues, and it is acknowledged that the NEDT values presented in this manuscript are approximative. However, there seems also be some misunderstanding and we have done some changes around Eq 6 for better clarity.
    - On request from several of the referees, the way NEDTs have been derived is now described (in Sec 4.4). The same calculation approach was used for on-ground and in-orbit data, clarified in Sec 6.2.
- "Sect. 2.6 Scan Sequence: The ATBD mentioned two potential cold sky sectors (ATBD Sect. 3.6.1) and that "the cold sky measurement depends on the orbit and occur before or after the earth scene." What was the final result?"
    - The two different cold sky views are mainly of interest for Sterna, with satellites in different orbits. For AWS only a single view can be used. As this is taken from ATBD, no change in the manuscript.
- Sect. 3.1: "What, if any, thermal control of the radiometer is there?"
    - Sec 2.1 has been extended with a sentence addressing the question.
- Sect. 3.1: "Can you add something on geolocation target accuracy and/or point to your sensitivity study in Table 2 of AWS-OMN-RP-0002 Issue C? This report seems to have more info. than the referenced AWS-SMHI-RP-0002 Issue A?"
    - In lack of values on the possible errors of the angles of concern, including the table seems not motivated at this point. In addition, the geolocation does not only depend on those angles, also e.g. timing issues are of concern. See further the next answer.
- Sect. 3.1: "What on-orbit verification (e.g., Coastline Inflection Point technique) will be used to tune the geolocation parameters?"
    - In line with the Opening remarks, we don't go into details of the geolocation accuracy. There will be a dedicated journal article on the subject.

- Sect. 3.1: "What pre-launch measurements were made to confirm pointing knowledge? The antenna pattern is a start, but doesn't include the alignment/transform between the instrument and the spacecraft LVLH control. Is it just the close placement of the star trackers to the payload and use a post-launch empirical correction based on CIP?"
    - The efforts made are now outlined in Sec. 4.5.
- Sect. 3.4: "Consider adding a less detailed version of the ATBD Fig. 6 "Overview of the AWS instr. signal proc. chain" be included that allows the activities in the Pre-launch section be tied to the calibration algorithm?"
    - We understand the interest in the actual calibration algorithm, but still think simply referring to Kempe (2025) is the best solution for the manuscript. Including a simplified figure can cause confusion of the actual algorithm, and would still require a significant extension of the manuscript to explain the figure.
- Sect. 3.4: "Regarding Line 260 starting with "The final L1b…": Is this 2.5 times the channel's FWHM projection on the surface?"
    - Yes. Text changed.
- Sect 4.1: "line 307: "should be minimal" Is there any reference for this statement? …"
    - Yes, an unclear statement. The text has been changed to be more informative then just saying minimal. New information has also been added to clarify that front- and back-end combinations were also measured, but over a lower dynamic range.
- Sect. 5.3: "Please add more info. on the "five distinct atmospheres" or a reference."
    - We now explicitly mentioned the five scenarios and a reference to the data at the start of section 5.3.
- Sect. 5.3: "Regarding AWS14 passband crossing over the absorption line, what spectral sampling did you use?"
    - Thanks for this keen observation. The frequency sampling in our simulations was not dense enough to properly resolve the O2 transition covered by AWS14. Thanks to this comment, the sampling is substantially increased to properly resolve this line, including a sample point right on the transition. Figure 14 (Temperature Jacobian of AMSU-A and AWS14) and Table 4 (simulated channel performances) have been updated accordingly. We see no discernible difference in Figure 14, and very small differences for AWS14 in Table 4:
        - Max difference measured boxcar is changed from 0.06K to 0.05K

        - After addressing comments by CC1 on how bandwidths are measured, the final value in Table 4 is 0.03K
          These changes do not change any conclusions in the text.
- Sect. 5.3: "How do RTTOV-folks handle it?"
    - How AWS is handled inside RTTOV is not inside the manuscript's scope.
- Sect. 5.3: "I'm not clear on the take away or point of the last paragraph. [...] I think you should emphasize that you're saying that any residual SRF uncertainties are marginal. Using the ATMS has an example isn't the same in my opinion because they had the strict requirements in place, so the SRF was fairly close to the boxcar."
    - As the reviewer helpfully points out, the ATMS comparison in the section's concluding paragraph adds confusion to the message and is therefore removed. We focus on saying that 1) deviations from target specifications are small and 2) that measured SRF gives even smaller differences over the adjusted boxcar SRF.
- Sect. 5.4: "Is the impact in Table 4 the difference between zeroing out the 03 or using the climatology mean O3 profile? That is, are the numbers in Table 4 the residual error of using the mean O3 profile?"
    - Table 4 reports the difference having O3 and zeroing it out, across the same five atmospheres as used for the SRF analysis. We have clarified this in Section 5.4.