Responses to review comments:

We sincerely appreciate the reviewer's careful review and constructive comments. Our response to each comment is listed in the following in red. For convenience of reading, we repeat each comment in front of our response. Note that only future revision plans are mentioned because we are yet to be invited to revise the manuscript by the editor.

Review of "In-flight receiver calibration of the Ganymede Laser Altimeter (GALA) by passive Earth observations" by Nishiyama et al."

Overall Assessment

This is an important paper that presents a novel approach to calibrating the GALA instrument using passive Earth observations during the JUICE mission's Earth-farewell campaign. The methodology is scientifically sound and has significant implications for the accuracy of future GALA measurements at Jupiter's moons. The paper is generally well-structured and addresses a critical calibration need for the mission. There are however, some shortcommings that need to be addressed. The first thing is the insufficient description of the observation campaign. The second issue is the rather qualitative approach to error handling. I recommend **major revisions** before acceptance.

Major Strengths

- The paper clearly articulates the scientific question and presents a well-designed methodology to address it
- The approach of using Earth observations for boresight vector calibration is innovative and valuable for the mission

Response: We are grateful for the reviewer's concise summary and thoughtful comments. See our detailed responses below.

Major Concerns Requiring Revision

1. Spacecraft Attitude Uncertainties

The most significant concern is that the authors assume spacecraft attitude is accurately known at 1-minute intervals without adequately addressing potential uncertainties in these measurements. The paper states: "during the Earth-farewell campaign, the Juice attitude data were acquired only at one-minute intervals" (line 117), but does not quantify the expected error in these attitude measurements.

The manuscript mentions that "discrepancies between simulations and observations remain (Fig. 4), perhaps due to uncertainties in spacecraft attitude knowledge" (line 280), but this needs to be quantified rather than merely acknowledged.

The authors need to:

- Explicitly state the expected accuracy of the spacecraft attitude determination system
- Incorporate these uncertainties into their error analysis
- Demonstrate how attitude uncertainties propagate through their interpolation methods and affect the boresight vector determination
- Address whether the observed discrepancies between simulations and observations could be explained by attitude uncertainties rather than a boresight offset

Response: The accuracy of JUICE attitude data is expected to be 15 microrad level (1-sigma; personal communication with Nicolas Altobelli) and, therefore, is too small to explain the boresight offset shown in this study. The error of the boresight vector estimation rather comes from area of the high correlation coefficients in Figure 5. We also note that this accuracy level is high enough to use temporal variation in incoming flux as the source of noise modeling. In Figure 4 of the revised manuscript, we will include several cases of noise variation by adding random noise to the attitude data.

2. Clarification of the Earth-farewell Campaign

The paper refers repeatedly to the "Earth-farewell campaign" without adequately defining it.

Readers need to know:

- What specific dates and times this campaign encompassed
- The spacecraft's distance from Earth during observations
- The spacecraft's velocity relative to Earth (dV)
- Whether the spacecraft was rotating to keep Earth in the field of view
- Why is it called "farewell" when JUICE will return for additional Earth gravity assists in 2026 and 2029?

This information is critical for understanding the observational context and should be added to Section 2.

Response: Thank you so much for your suggestions. We will add more information accordingly to Section 2.

3. Inconsistent Terminology

The paper uses "Juice" throughout the text. As JUICE is an acronym (JUpiter ICy moons Explorer), it should consistently appear in all capital letters.

Response: Officially, the acronym for this mission is “Juice”, not “JUICE”, as seen in the title of this special issue. Therefore, the current terminology will be kept in the revised manuscript.

The manuscript refers to the GALA background observations as "noise". Although this term makes sense for laser observations, it is inappropriate in this context, where the GALA background represents the signal to be measured.

Response: As the observed data contains only "background noise", we basically keep this terminology. However, to emphasize that the noise can be signal for radiance measurement, we carefully define the term in the revised manuscript.

Minor Issues Requiring Revision

1. Grammatical and Typographical Errors

- Line 110: "5 degree" should be "5 degrees"
- Line 317: "may be also performed" should be "may also be performed"
- Line 331: "unknown uncertainty in the analyzes" should be "unknown uncertainties in the analysis"
- Line 340: "GEochemistry,and" should be "GEochemistry, and"
- Line 351: "instrument teams proprietary period" should be "instrument teams' proprietary period"
- Line 355: "aquirement" should be "acquisition"

Response: Thank you for pointing out our typos. We will correct them in the revised manuscript.

2. Figure Interpretation

Figure 2 shows an asymmetric response with the GALA noise increasing slowly (~20s) after the first limb crossing but dropping rapidly (~5s) during the second limb crossing. The authors should explain this asymmetry, which may relate to the spacecraft's motion relative to Earth or instrument characteristics.

Response: Thank you for your suggestion. This feature is related to difference in spacecraft motion relative to Earth. The attitude movement is faster at the end of the overlap. We will explain this point in the revised manuscript.

3. Methodology Clarification

The paper would benefit from additional details about:

- The specific SPICE kernels used for attitude reconstruction

Response: We will document the name of CK kernel used in this study.

- The exact interpolation routines applied to the quaternion data

Response: We used interpolation routines from scipy.interpolate. We will document all function names in the revised manuscript.

- How were the criteria in Figure 5 combined (line 268). Were they weighted equally?
    - I gather it should be something like this:
    Where max(corr(sim(t),obs(t))) at boresight timing residuals RMS < 15s AND |Mean noise difference| < 0.25mV
    - That does not fit with Fig.5. The point of highest correlation does not coincide with marked "most

likely point" within bounds given above

Response: The criterion mentioned in the reviewer comments is the same as the one we implemented. All criteria were used equally, but all simulations that does not mean either of the criteria are excluded from the final results. Note that the point of the highest correlation is actually located at the marked location in Figure 5. The point of highest correlation is chosen where the absolute mean noise difference < 0.25 mV. This condition eliminates parameter areas with higher correlations. We will emphasize this point in the revised manuscript.

4. On Discussion and Conclusion

The authors state that their method can be applied to other laser altimeter instruments used in different missions. In particular, they mention BELA. This made me wonder, as BELA could not perform any observations during the Earth fly-bys as it was pointing towards the transport module. At Mercury, timing limb crossings could help to narrow down any boresight offsets; however, the much lower albedo range of Mercury's surface compared to Earth would likely present an obstacle to the correlation part of the authors' algorithm.

Response: BELA cannot observe the Earth but can observe the noise increase at Mercury. Although Mercury has albedo lower than the Earth, solar flux incident on Mercury is much higher than the Earth due to the closer distance to the sun. This makes that noise increase due to reflected sunlight from Mercury is observable at dayside, being sufficiently high for future BELA calibrations. Because estimation for BELA is out of focus of this paper and will be documented in another paper that will be submitted soon, we will not mention quantitatively in this manuscript.

Conclusion

This paper presents an important calibration technique for the GALA instrument that will improve the scientific results of the JUICE mission. While the methodology is fundamentally sound, the manuscript requires revisions to adequately address uncertainties in spacecraft attitude and provide clearer context for the Earth farewell campaign. Once these revisions have been made, the paper will make a valuable contribution to the field of planetary laser altimetry. I recommend acceptance following revisions to address the above concerns.