Review of Observation of the Lunar Tide in the Middle Atmosphere by the Aura Microwave Limb Sounder

Summary of the paper

This paper presents the first identification of the lunar tide in the geopotential height observations of the middle atmosphere from Aura/MLS. The lunar tide is identified as a clear semi-monthly variation in Aura/MLS observations between 2004 and 2021. A comparison with model results from Geller (1970) as well as temperature observations from TIMED/SABER have been discussed. The paper further examines the vertical, seasonal and latitudinal structure of the lunar tide. The results show that lunar tide signal is stronger in January than in July and peaks near the equator.

Summary of the review and major comments

The main question addressed in this paper is whether the semidiurnal lunar M2 tide can be reliably identified in Aura/MLS through its semi-monthly signature, and whether the vertical, seasonal and latitudinal structure of the retrieved lunar tide signal is consistent with previous modeling and observational work. The paper contains a significant new result, i.e. the lunar tide can be identified clearly in satellite geopotential height observations. The comparison with model results and TIMED/SABER observations aids in interpreting the Aura/MLS results. However, some issues require clarification before the manuscript can be recommended for publication.

- Line 43–48 – The manuscript refers to the (2,2) and (2,4) modes of the lunar tide, but these are not really defined for the reader. Since the later interpretation of the phase profiles also relies on this terminology, a brief explanation of what these mode labels mean and why they are relevant here would help the reader follow the later discussion.
- Line 90 – The most important issue in the paper is the explanation of how the semidiurnal lunar M2 tide appears as a semi-monthly signature in Aura/MLS because of the sun-synchronous sampling. This is central to the interpretation of the entire analysis but is currently explained mostly qualitatively. Since the analysis relies on the 14.7653-day signal as the observational signature of M2, it would improve the paper if the authors could include a clearer explanation, or a short mathematical derivation, of this sampling/aliasing framework.
- Line 104-105 - The text states “the arithmetic mean of all observed atmospheric profiles is computed” each day, but Aura samples each latitude twice per orbit at two fixed local solar times (~01:45 and ~13:45 LST at the equator). This daily mean combines sampled from both Aura local-time branches. Since the two overpasses are separated by about 12 hours, this works for the semidiurnal tide because the two samples are nearly in phase for a ~12.42-hour oscillation. Could the authors state this explicitly in the methodology, since this seems important for justifying the daily averaging procedure used to construct the time series?

- Line 137 – 148 - Line 137 - 148 The manuscript does show January-versus-July variability for Aura/MLS at ~82 km in Figure 7. However, the vertical-profile comparison with Geller (1970) in Figures 4 and 5 seems to be compared with the full-record Aura/MLS amplitudes, whereas the values from Geller are for January and July. Since the Aura/MLS data also show a pronounced January-July difference in Figure 7, it would help if the authors could clarify how the full-record Aura/MLS amplitudes in Figures 4 and 5 should be compared with the January and July values from Geller (1970).
- Line 172–179 and 206–215 – Figures 8 and 9 show enhanced amplitudes at high latitudes in winter, and the discussion relates this to radar observations and possible SSW-related amplification. At the same time, the manuscript also states that contamination by planetary wave-like oscillations cannot be excluded. Could the authors comment on how much contamination from other variability is expected at high latitudes in winter, and whether the signal seen at high latitudes in Figure 9 can still be confidently interpreted as a lunar tide signature?

Minor comments

- Line 74 - The authors mention the vertical range of the atmospheric profiles between 15 to 95 km and then note on line 86 that 'The temperature and geopotential height values beyond 90 km altitude are less reliable'. However, it is not explicitly whether the analysis will be limited below 90 km. The vertical profiles in Figures 4 and 6 appear to slightly extend over 90 km, and the text describes the upper limit for these figures at 90.4 km. A simple line stating the altitude or pressure range used in the analysis will improve the clarity for the reader.
- Line 77 - Could the authors briefly explain how the interpolation errors would affect the analysis or results? i.e. would the method used here affect the retrieved amplitudes and phases?

Typographical and stylistic comments/suggestions

- Line 93 – 'The bulge toward to the moon' > 'the bulge toward the moon'
- Line 150 – 'obsevations' > 'observations'
- Line 177 – Please provide citations for the 'numerous reports'
- Line 187 – 'geopotent' > 'geopotential'
- Line 189 – 'geopotantial' > 'geopotential'
- Line 204 – 'geopotantial' > 'geopotential'