Atmos. Chem. Phys. Discuss.,
https://doi.org/10.5194/acp-2018-383-RC2, 2018

Atmospheric Chemistry and Physics Discussions

Interactive comment on "Undulating wave front of mesospheric bore; Space-borne observations by ISS-IMAP/VISI" *by* Yuta Hozumi et al.

Anonymous Referee #2

Received and published: 18 June 2018

This paper reports two unusual mesospheric bores from an onboard camera on the ISS. While mesospheric bores in the past decades have been described in the literature, this paper is novel in several ways: 1) the reported bores are occurring in southern mid-latitudes (rare), 2) one bore demonstrated a counter clockwise rotation in comparison to clockwise rotation of NH bores (first report), and 3) a large front exhibiting horizontal undulation (first report). Due to these new observations, this paper is worthy of consideration for publication after major revisions. Below are my comments.

Major 1) How is the Brunt-Vaisaila frequency derived from the SABER temperature data? This derivation must depend on an estimation of the derivative. The author should identify which numerical scheme is used and the applied step size to allow proper interpretation of the data. 2) Regarding event 1: In figure 2, it is determined

that there are reflection points separated by ∼5 km in altitude. However, the reflection point (or unstable region) at 95 km appear very narrow and may have a limited impact on the bore. It may be more likely that the lower reflection point is at 90 km. While this should not have much impact on the result stated in the paper, I believe it does deserve a proper discussion. In fact, I recommend the authors perform a calculation of the vertical wavenumber squared, assuming a simple dispersion relation. With that result, the damping impact from the reflection point at 95 km can be estimated. 3) Regarding event 2: Similar to the comment above for event 1. In this case, the narrowly ducted region (3 km) would imply a maximum vertical wavelength of a ducted wave train of ∼6 km. This is less than the anticipated thickness of the airglow layer and one would expect cancellation effects within the emitted airglow. How does that play into the clear observed signature? Again, a simple analysis of the vertical wavenumber may give some indications to whether the statements are within reasonable agreement to the stated conclusions. 4) Line 7.15-16: This sentence needs to be substantiated with an analysis of the vertical wave number.

Minor Recommendations Page 1 Line 1: "...observed by the Visible..." Line 4: "One event was observed over the African..." Line 5-7: Flipping between past and present tense. This should be fixed throughout the paper. Line 7: Change m/sec into m/s. This should be done throughout the paper. Line 7: "...3.5 waves/hour." Line 11: "...undulated with a wavelength of 1000 km" Line 12: FOV is a new acronym. Line 14: "...(SABER) onboard the Thermosphere..." Line 18: "A mesospheric bore is characterized by a propagating, and sharp, front in the upper mesosphere." Line 18-19: "The front is often followed by undulations (undular bore) or turbulence (turbulent bore)." Line 19: "Mesospheric bores have been ..."

Line 2.1: "...explanation of a mesospheric bore as a..." Line 2.6: "...Picard (2001) provided a possible explanation of mesospheric bores through critical layer interaction of gravity waves with the mean flow." I just think that "tried" makes it sound as if Dewan and Picard were not successful in their postulation. Line 2.8: "...demonstrated, by

using a numerical simulation, that. . .” Line 2.9: “. . .a mesospheric bore from..”. This should be fixed throughout the paper. Line 2.10: “. . .(2010) utilizing ground-based observations.” Line 2.10: “generation mechanism” and “origin” are the same, right? Line 2.13: “. . .than the imagers (FOV).” Line 2.13: FOV was used earlier (Line 1.12) and the acronym definition should be moved to Line 1.12 Line 2.15: replace “wide” with “wider”. The ground-based cameras are considered to have a wide FOV, so it would be better to make “wide” as a comparative. Line 2.19: The paper is lacking a clear, strong objective/reasoning to study these waves. I feel that this is a great place where the authors can place their objective. It is pointed out that there are still lot of works to be done. List some of those and then state how your paper addresses these outstanding questions regarding mesospheric bores. Line 2.22: Remove the word “simply”. Miller et al. (2015) presented a great work. Instead, try something like “While the focus of the work by Miller et al. (2015) was limited to illustrate the DNB’s potential. . .” Line 2.28: “After the variation,. . .” I do not know the meaning of this part of the sentence. Line 2.30: The authors should sell the horizontal undulation stronger. While Dewan and Picard discussed undulations, it was vertical undulations and not horizontal. This is, as far as I know, completely new observation and should be highlighted. This has the potential to be a stand out paper for this exact reason. Figure 1: I recommend a full-page figure with the two figures stacked vertically. It will help the reader some of the undulations. Also, Rayleigh is the unit, not label. I suggest writing “Intensity (R)”. The last line in the figure caption does not make sense and needs a rewrite. Line 3.6-7: “The spatial resolutions are 13 km along and 12-15 km across the ISS orbit track.” Line 3.7: “. . .ISS is 7.4 km/s, which is significantly higher than. . .” Line 3.8: Provide some references for the reported bore phase speeds. At a minimum show the references of the papers documenting the lowest and highest bore speed. Line 3.10: “Temperature profiles. . .” Line 3.11: “. . .satellite are employed as. . .” Line 4.8: Missing space between the degree sign and “E”. This should be fixed throughout the paper. Line 4.8: “. . .exactly the same. . .” Line 4.10: “. . .front, with an estimated wavelength of 30 km”. Line 4.10: How is the horizontal wavelength determined? Line

4.11: “. . .2,500-3,000 R. . .”. This should be fixed throughout the paper Line 4.15: “. . .in the western (bright) side as compared to 1,300 R in the eastern (dark) side.” Line 4.15: Change westward to eastward. It is stated (correctly) in line 4.13 that the front is moving eastward. Line 4.17: On previous page, it was mentioned that the typical bore speeds are 20 m/s – 100 m/s. I think, the 20 m/s – 100 m/s may be the more extreme limits, whereas 60 m/s -80 m/s are more typical. This should be reflected in the two sentences. Line 4.18: “. . .increased to seven, implying a wave generation estimated to be 3.5 waves/hour. Line 4.19: “. . .waves/hour (XXX, XXX, XXX). There are not that many papers detailing wave generation from the leading front, so make references to them here. Line 4.21: It was not expected, it was observed. “. . .front was observed. . .” Line 4.26: “. . .atmospheric tides”. There are several tidal modes present. Line 4.26: “. . .tides make clockwise variations in the northern hemisphere and counter clockwise variations in the southern hemisphere due to the Coriolis acceleration.” Line 4.29: “. . .with the expected background tidal wind variations.” The authors should present what these expected tidal wind variations are and provide references. Line 4:29-31: This paragraph could use a rewrite. “Only few reports exist on mesospheric bores in the southern hemispheric midlatitude region (reference(s)) due to the sparse ground-based observation sites. VISI provide the opportunity to study this region and provide more insight into hemispheric differences.” Since it is pointed out that only a few studies exist, then provide the list of references. Line 4.32: “TIMED/SABER” made a near-coincident observation. . .” Line 5.2: “A mesospheric bore is. . .” Line 5.6: “This mesospheric bore event is likely. . .” Line 5.12: “A front, characterized by a sharp increase in brightness, elongated W to NW and E to SE was captured. . .” Line 5.12: I am confused. It was previously stated that a swath was captured every $\sim$3 seconds. In this sentence is seems like to different regions of a swath is captured at different times. Is the swath then comprised of multiple images, and each image is recorded every 3 seconds? If that is the case, then Lines 2.4-5 should be re-written. If not, then this sentence needs more clarification. Line 5.15: “. . .is the horizontally undulating wave front.” This is a key observation of the paper and it should be specific. This is a great observation!

Line 7.2: Since the spatial extend is large, is it possible the evolution of the duct over these scales could be assessed by the previous/following SABER passes? I would be curious to see the N2 analysis for the previous and following SABER passes. Line 7.9: "...bore has never been reported." I agree with this, and I think the authors should consider a new title that captures this. Suggestion: Space-borne mesospheric bore observations by ISS-IMAP/VISI; A first report of an undulating wave front" Line 7.20: "A point-like tropospheric source location of an atmospheric gravity wave can be found by estimating the curvature of the observed wave front from in airglow imagery with the assumption..." Line 8.4: "These results validates the use of VISI for bore studies." Line 8.8: "...tidal backward tidal wind...". I am sure this is a typo. Line 8.12-13. Remove the last sentence.

Interactive comment on Atmos. Chem. Phys. Discuss., https://doi.org/10.5194/acp-2018-383, 2018.