Atmos. Meas. Tech. Discuss.,
doi:10.5194/amt-2017-424-RC1, 2018

Atmospheric Measurement Techniques Discussions

Interactive comment on "3-D tomographic reconstruction of atmospheric gravity waves in the mesosphere and lower thermosphere (MLT)" *by* Rui Song et al.

Anonymous Referee #1

Received and published: 6 February 2018

This paper outlines simulations of retrieving 3D gravity wave structure in the MLT from a satellite platform measuring O2 A-band airglow. It is an interesting topic and approach and is well suited for publication in AMT. Also, it is well written with only a few minor technical issues that need to be addressed (listed below). Some other minor issues (listed below) need to be addressed, mostly for completeness and better clarity. After these issues are properly addressed I would recommend publication.

P2 Lines 16-30 – SABER on TIMED has also been used for a large number of studies on gravity waves. Please include/describe some example references. (e.g. doi:10.1002/2017JD026604, doi:10.1029/2008GL037054, doi: 10.1007/s00382-012-

1329-9, etc.)

P3 Figure 1 –I find the represented geometry in this figure confusing, I think mainly because the instrument LOS is in the middle of the temperature structure (so, we don't know if this is ascending or descending), and it's not clear where the orbital track is. Please include a clearer figure, or perhaps not include this figure as it's not entirely necessary given Fig 2.

P4 Lines 20-21 – Technically, the separate R and P branches follow a Boltzmann distribution (not the entire A-band spectrum), and only when in local thermodynamic equilibrium (and even then not a strict Boltzmann distribution).

P5 Figure 2 – For further clarity, please add black arrows to panel (b), and caption should explain the significance of the purple box. Also, both of these panels seem to be inconsistent with the simulation explanation in Section 4. Please add a panel with the simulation geometry going from 0 to 45°.

P6 Line 8 – airglow is misspelt P7 Eqn 1 – just after the eqn it should be mentioned that O2(1Σ) in the v=1 state is quickly quenched into the v=0 state, which is why it is necessary to model absorption in the B-band and the subsequent quenching to O2(1Σ, v=0).

Line 14 – "more than 12 sec" should be "approximately 12 sec".

Line 14 – at higher altitudes (lower pressures), the LTE assumption is going to break down. Have you done any calculations to determine at what altitude LTE can't be assumed? I know the OSIRIS team believes this to be around 110 km, but I can't find any reference to that.

Lines 17-18 – The emission spectrum doesn't simply follow a Boltzmann distribution, and the Mies 1974 reference details how to calculate OH Mienel band transition intensities, which is not the same as the O2 A-band emission spectrum. More discussion/detail is needed here on how you're calculating the A-band emission intensities,

and a better reference would be Babcock and Herzberg 1948 (doi:10.1086/145062)

Line 19 – “aiming to the derivation of” should be “aiming to derive”

Line 21 – please indicate that this is HITRAN 2012

Line 23 – “rotational structure” should be “rotational line emission intensity”

P8 Table 1 – please include references for where the constants were obtained

P9 Line 2 – Need to indicate that you’re ignoring other sources of light (i.e. stray light, scattered sunlight) and you’re ignoring pressure broadening. Or you could use a more general term in the eqn for the line shape, and then later explain that you can simplify the line shape to be D (which is essentially what you do later anyway).

Eqn 5 – should the “-s” in the second integral be “s”?

Lines 21-22 – please quantify what degree of accuracy you are deeming to be sufficient

Line 23 – “very” is unnecessary

Lines 24-25 – This sentence is very misleading. It seems like you’re saying that the only factor determining the airglow emission rate is temperature, and the only factor determining the amount of absorption is O2 density. The emission rate, as detailed in section 3 is dependent on many factors, including both O2 density and temperature; and, as shown in eqns 5, 6, and 7, the self-absorption is dependent on both O2 density and temperature. Please confirm that all relevant processes are being accounted for in your calculations of ΔI/I (i.e. ΔT is considered in self-absorption, and ΔO2 is considered in emission rate).

P10 Line 2 – Two or three sentences are needed here giving the basic details of the retrieval algorithm. E.g. Is it global-fitting least squares? MAP? Levenberg-Marquardt? Any a posteriori regularization? Etc.

Lines 7-8 – why are approximate values for the orbit height and tangent altitudes given?

Do they change throughout the simulation? If so, please mention that in the text.

P11 Figure 6 – As previously mentioned, it would be helpful if this figure was consistent with Fig 2. It would also be helpful to have Figs 6 and 7 as two panels in one figure.

Line 7 – “This viewing angle keeps increasing until the predeïňĄned turning angle has been reached.” was just said in previous sentence

P12 Line 15 – Should “calculating” be “calculation”?

P13 Figure 8 – Unit labels for b-d and f-h should be ΔTemperature (same in Figs 12, 13, and 14). In the first line of the caption, “retrieval results” should be “retrieval a priori, simulated true state, and results”

P14 Figure 9 – Please show results for full altitude range. Or at least explain in the text why only this altitude range is being shown.

Line 4 – What does this profile represent? Is it a single profile at one location, an across-track average, along-track average, total average?

Line 5 – Please explain how gridding error is determined.

Lines 11-12 – Please provide details of how Sa and Se are determined.

P17 Line 19 – “It is obvious” is unnecessary

Line 20 – It would be clearer to discuss “the 90° case” rather than “Fig. 13(b)”. Similarly, please specify what it is closer than.

Line 22 – better than what?

P18 Line 9 – What is the minimum wavelength achievable (across-track at 90)?

P20 Line 27 – “whereas it decreases”

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