

Review of the manuscript “Satellite observations of gravity wave momentum flux in the mesosphere / lower thermosphere (MLT): feasibility and requirements” by Chen et al. submitted for a possible publication in AMT [Manuscript ID: #amt-2022-224]

General comment

The manuscript investigates requirements for satellite limb optical measurements using O₂ A-band emissions to retrieve characteristics of gravity waves (GWs) and GW momentum flux that strongly influences global circulation in the middle and upper atmosphere. The manuscript is mainly based on modelling results. The present study is very useful and worth publication. However, the text is rather demanding to read, partly due to the complexity of the problem. Nevertheless, I believe that some formulations could be simplified, some points better explained and specified or located in more convenient places in the text. I provide several examples in the specific comments below, but I encourage the authors not to limit themselves to them only. I recommend a moderate revision.

Specific comments:

-Introduction (for example in Key Quantities), the authors only speak about zonal GW momentum flux and direction distribution of the flux. Does the direction only mean the sign of zonal flux, or also the meridional component. Please explain and reformulate. Why is the meridional component not mentioned in the Introduction section when it is shown in some Figures of the following Sections?

-It is difficult to understand, namely in the Introduction, why “by separately inverting left-hand and right-hand part of the interferogram”, independent observation tracks are obtained. Please reformulate or explain better here.

-line 190, u' , v' , w' , define the coordinate system.

Section 2.2. Last sentence. It is partly explained in the Discussion, but here, the meaning of this sentence is quite unclear. Please reformulate/explain or remove.

-line 210, S3D, it should be defined here at the first usage.

-Section 3.1, around line 241, “...moist convection...” The moist convection at such high altitudes deserves some explanation.

-Section 3.3. A comparison of usable height ranges for day- and night-time observation should be discussed in more detail.

In addition, HAMMONIA model should be briefly introduced and/or referenced.

-Section 3.5. It should be better explained how two independent temperatures are obtained along the horizontal axis using O₂ A-band emissions only.

-last line on page 15, “...retrieved temperatures, which are about 17 km apart...”. That doesn't make sense to me. Please reformulate.

-Section 3.6. Specify the time interval over which the snapshots used for the tomography are taken. Discuss this time interval with respect to the GW period/wavelength and propagation velocity. Discuss also the assumed angle difference between different positions marked by different colors in Figure 8.

-Section 3.6 or 3.7 (Table 2). Note that the definition of spectral wavenumbers (in cm^{-1}) is $1/\lambda$ here, where λ is the wavelength, and not $2\pi/\lambda$ which is often used.

-line 393, define FWHM

-Section 3.7, last but one paragraph. The text is difficult to read. Please reformulate/simplify.

-Section 4.2.1, second paragraph “*From the model set-up we expect shortest horizontal wavelengths of 0(200km)...*” It should be discussed here that a number of radio and optical observations show shorter wavelengths than 200 km (Nishioka et al., 2013; Chum et al., 2021; Shiokawa et al., 2009; among others)

The authors partly discuss this wavelength limit in the Discussion section and in Appendix E, but this information should be briefly given already here. Moreover, the Discussion section mainly relies on modelling. The already available observations should also be mentioned.

Chum, J., Podolská, K., Rusz, J., Baše, J., Tedoradze, N. (2021), Statistical investigation of gravity wave characteristics in the ionosphere. *Earth Planets Space* **73**, 60, <https://doi.org/10.1186/s40623-021-01379-3>

Nishioka M, Tsugawa T, Kubota M, Ishii M (2013) Concentric waves and short-period oscillations observed in the ionosphere after the 2013 Moore EF5 tornado. *Geophys Res Lett*. <https://doi.org/10.1002/2013GL057963>

Shiokawa K, Otsuka Y, Ogawa T (2009) Propagation characteristics of nighttime mesospheric and thermospheric waves observed by optical mesosphere thermosphere imagers at middle and low latitudes. *Earth Planets Space* **61**:479–491. <https://doi.org/10.1186/BF03353165>

- Figure 13. Specify the time interval (season) for which the Figure was constructed.

-line 622, “*tides cause changes of the large scale winds at similar time scales as the periods of the GWs propagating through these winds*”. Specify the periods of tides and GWs considered here.