The paper "Extreme Concentric Gravity Waves Observed in the Mesosphere and Thermosphere Regions over Southern Brazil Associated with Fast-Moving Severe Thunderstorms" by Li et al. is a thorough and convincing study of gravity wave events observed by airglow imaging over Brazil. It is demonstrated that the gravity waves were likely excited by thunderstorms in the region. Fortunate propagation conditions allowed to observe full ring structures of the convective gravity waves in OH airglow images.

Overall, this study is very interesting and of relevance for the readership of ACP. The paper is well written, and the figures are of good quality. The paper is therefore recommended for publication in ACP after minor revisions.

For specific and technical comments see below.

Thank you very much for your review of our paper "Extreme Concentric Gravity Waves Observed in the Mesosphere and Thermosphere Regions over Southern Brazil Associated with Fast-Moving Severe Thunderstorms". We are honored to receive such a positive evaluation from you, and we are particularly pleased that you consider this study to be comprehensive and convincing, and of significance to the readership of ACP. We also appreciate your comments on the good quality of the paper's writing and figures. We will carefully review every detail of the paper and make improvements to ensure the quality of the paper reaches a higher standard.

SPECIFIC COMMENTS:

(1) l.41: You should add some more general references for convective gravity waves. For example, Fovell et al. (1992), or Piani et al. (2000):

Fovell, R., Durran, D., and Holton, J. R.: Numerical simulations of convectively generated stratospheric gravity waves, J. Atmos. Sci., 49, 1427-1442, 1992.

Piani, C., Durran, D., Alexander, M. J., and Holton, J. R.: A Numerical Study of Three-Dimensional Gravity Waves Triggered by Deep Tropical Convection and Their Role in the Dynamics of the QBO, J. Atmos. Sci., 57, 3689-3702, https://doi.org/10.1175/1520-0469(2000)057%3C3689:ansotd%3E2.0.co;2, 2000.

Reply: Thank you for your suggestion. The recommended references have been incorporated into the text.

(2) l.42: For the jet/front source mechanisms please add the reference Plougonven and Zhang (2014):

Plougonven, R., and Zhang, F.: Internal gravity waves from atmospheric jets and fronts, Rev. Geophys., 52, 33-76, doi:10.1002/2012RG000419, 2014.

Reply: Thank you for your suggestion. The recommended reference has been incorporated into the text.

(3) l.58: You should mention that another method for determining the source location is backward ray tracing of gravity waves, which can also be performed for circular gravity wave patterns. An example is Ern et al. (2022):

Ern, M., Hoffmann, L., Rhode, S., and Preusse, P.: The mesoscale gravity wave response to the 2022 Tonga volcanic eruption: AIRS and MLS satellite observations and source backtracing, Geophysical Research Letters, 49, e2022GL098626, https://doi.org/10.1029/2022GL098626, 2022.

Reply: Thank you for your suggestion. The following description is incorporated into the main text.

“The backward ray tracing method, employed for source location determination, can also be applied to circular gravity wave patterns (Ern et al. 2022).”

(4) l.121: Please provide a reference for the ABI-GOES instrument. For example:

Schmit, T. J., Gunshor, M. M., Menzel, W. P., Gurka, J. J., Li, J., and Bachmeier, A. S.: Introducing the next-generation advanced baseline imager on GOES-R, Bull. Am. Met. Soc., 86, 1079-1096, doi:10.1175/BAMS-86-8-1079, 2005.

Reply: Thank you for your suggestion. The recommended references below has been incorporated into the text.

Schmit, T. J., Gunshor, M. M., Menzel, W. P., Gurka, J. J., Li, J., and Bachmeier, A. S.: Introducing the next-generation advanced baseline imager on GOES-R, Bull. Am. Met. Soc., 86, 1079-1096, doi:10.1175/BAMS-86-8-1079, 2005.

Schmit, T. J., Griffith, P., Gunshor, M. M., Daniels, J. M., Goodman, S. J., and Lebair, W. J.: A closer look at the ABI on the GOES-R series, Bull. Am. Met. Soc., 98(4), 681–698. https://doi.org/10.1175/BAMS-D-15-00230.1, 2017.

(5) l.132, 133: The expression "image acquisition time" is somewhat misleading! AIRS is scanning repeatedly in the across-track direction taking footprints one-by-one. The AIRS data are then arranged into granules of 6min, each.

Reply: Thank you for comments. We have made the following revisions:

"AIRS performs continuous across-track scanning, acquiring data footprints sequentially. The collected data are then organized into 6-minute granules."

(6) Please provide references for the AIRS instrument! For example:

Aumann, H. H., et al.: AIRS/AMSU/HSB on the Aqua mission: Design, science objective, data products, and processing systems, IEEE Trans. Geosci. Remote Sens., 41, 253-264, 2003.

Chahine, M. T., et al.: AIRS: Improving weather forecasting and providing new data on greenhouse gases, Bull. Am. Met. Soc., 87, 911-926, doi:10.1175/BAMS-87-7-911, 2006.

Reply: Thank you for your suggestion. The recommended references have been incorporated into the text.

(7) p.8: Please provide in Sect.2 also some information about the SABER instrument because also SABER data are used later in the manuscript.

Reply: Thank you for your suggestion. We added the following description to section 2.2 of the main text.

"Sounding of the Atmosphere using Broadband Emission Radiometry (SABER) is one of four instruments on NASA's Thermosphere Ionosphere Mesosphere Energetics Dynamics (TIMED) satellite (Russell et al., 1999), launched on December 7, 2001. TIMED focuses on exploring the energy properties and redistribution in the MLT region, providing data to define the basic states and thermal balance of this area. SABER is a 10-channel broadband limb-scanning infrared radiometer (1.27-17 µm). It measures kinetic temperature through CO_2 emissions (15 µm Local Thermodynamic Equilibrium (LTE) below 90 km; 4.3 µm non-LTE above 90 km) with ±2-5 K accuracy. Simultaneously observing O_3 (9.6 µm), OH (1.6-2.0 µm), and O_2 (1.27 µm) emissions, it quantifies radiative cooling (up to 150 K/day) and chemical heating (~8 K/day) in the MLT region with 2-4 km vertical resolution."

(8) l.217: In Fig.4, upper row, there are also indications of 630nm wave structures that are superimposed on the OH signature that is highlighted by the yellow square. These wave fronts are perpendicular to the OH wave fronts. Similar findings in Fig.5. You should comment on this. Do you think these patterns are from a different wave?

Reply: Thank you very much for your careful review. Yes, you are right. They are from a different wave. Their phase fronts are incoherent, and there are differences in the directions of propagation. We have marked these in Figs. 4 and 5 respectively.

The following comments have been incorporated into the main text.

“There are also observed curved wave structures (thermospheric CGW no. 2) (indicated by green arrows) whose wave fronts are perpendicular to those of the contaminating OH wave fronts.”

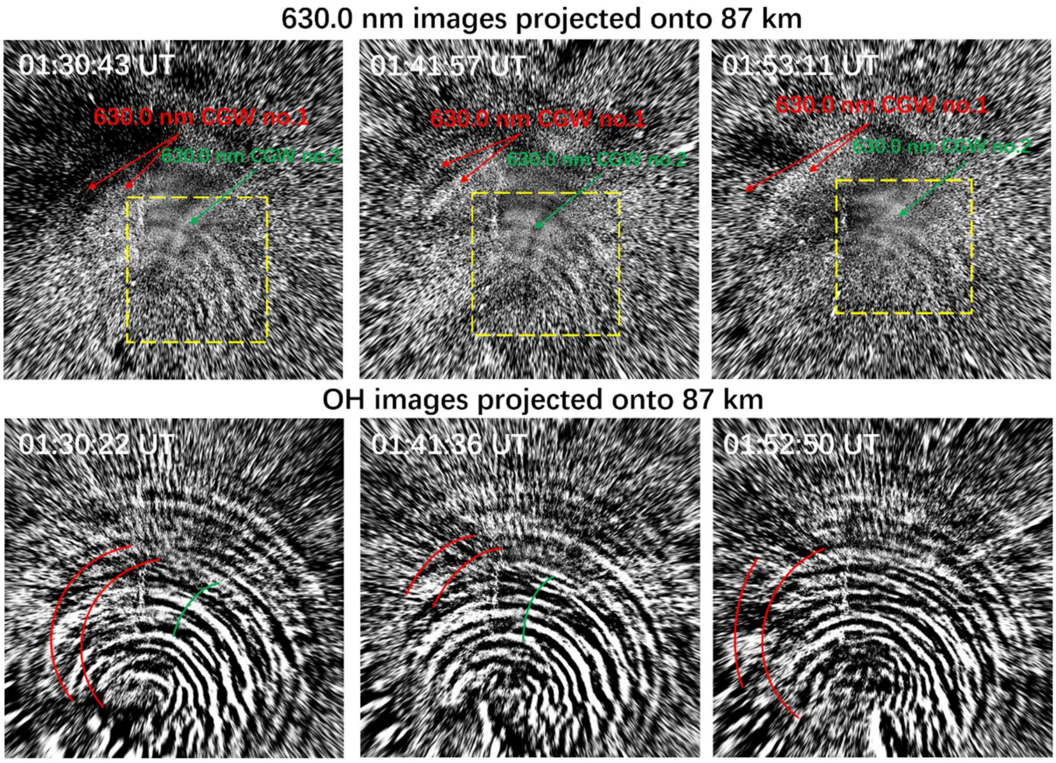

Figure 4. All-sky 630.0 nm images (top panel) and OH images (bottom panel) were both projected onto an altitude of 87 km with an area of 1000 km × 1000 km. The northeastward-propagating CGW (marked with a yellow dashed box) shows contamination from OH airglow emission. Thermospheric CGWs propagating northwestward confirmed in 630.0 nm images (top panel). The phase fronts of the thermospheric CGW nos.1 (red lines) and 2 (green lines) are superimposed onto the OH images (bottom panel).

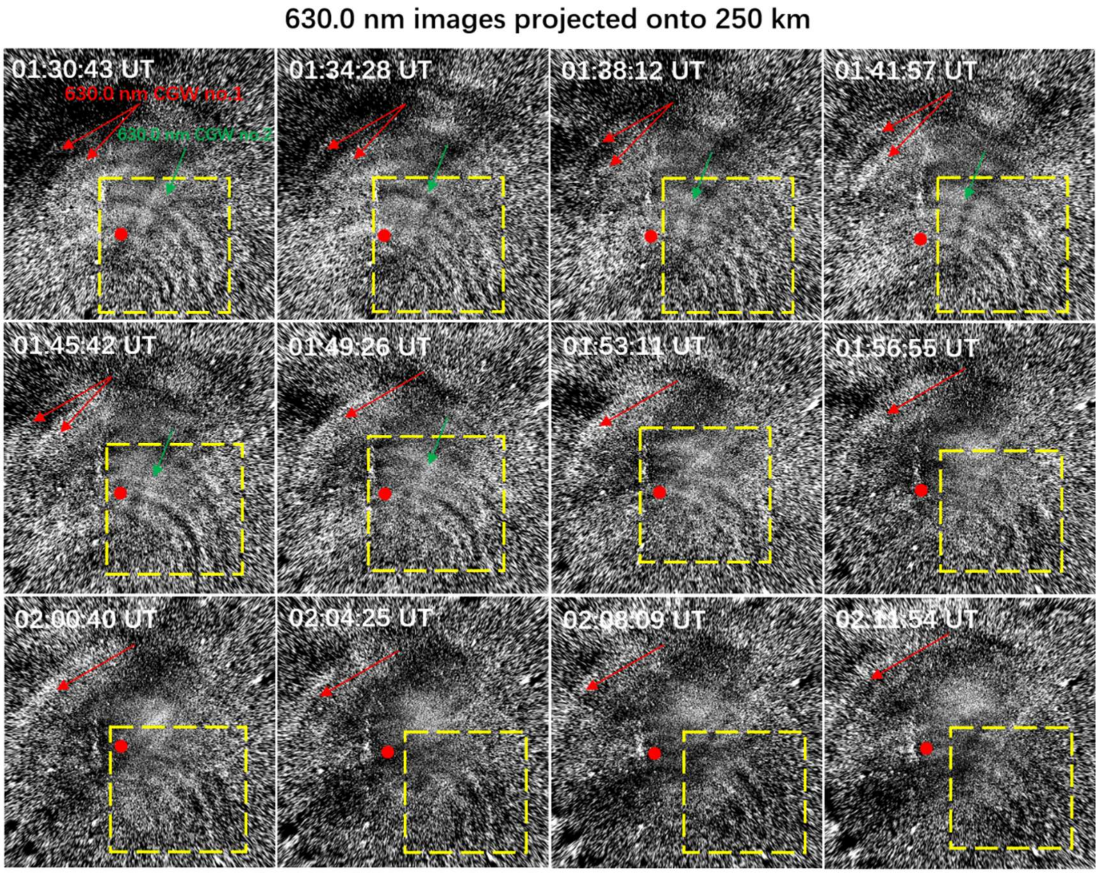

Figure 5. All-sky 630.0 nm images projected onto an area of 2000 km × 2000 km showing the thermospheric CGW nos.1 (indicated by red arrows) and 2 (indicated by green arrows) at approximately 4 min intervals in the SMS station on 18 September 2023. The red dots mark the estimated centers of the thermospheric CGW. The northeastward-propagating CGW (marked with a yellow dashed box) exhibits artifacts influenced by OH airglow emission.

(9) About Fig.4: The OH images and OI images were taken at almost the same time for demonstrating the contamination effect. Later in the manuscript you determine the time that the CGW takes to propagate from the OH altitude to the OI altitude to be around 1 hour. Therefore you should mention that some of the mismatches in the wave patterns shown in Fig.4 might be related to this.

Reply: Thank you for your good suggestion. The following description has been added to the main text.

"As discussed above, the OH images and OI images were captured nearly simultaneously to illustrate the contamination effect in Fig. 4. Some of the wave pattern mismatches in Fig. 4 are due to the propagation time required for CGWs to travel from the OH altitude to the OI altitude."

(10) Fig.7: Suggest to replace the red text "large scale CGW" in the figure with just "large scale GW" because it is difficult to tell whether this would be part of a concentric GW pattern. Even in the text you do not use the expression "CGW" for this wave pattern.

Reply: Thank you for your suggestion. Fig. 7 has been modified as shown below:

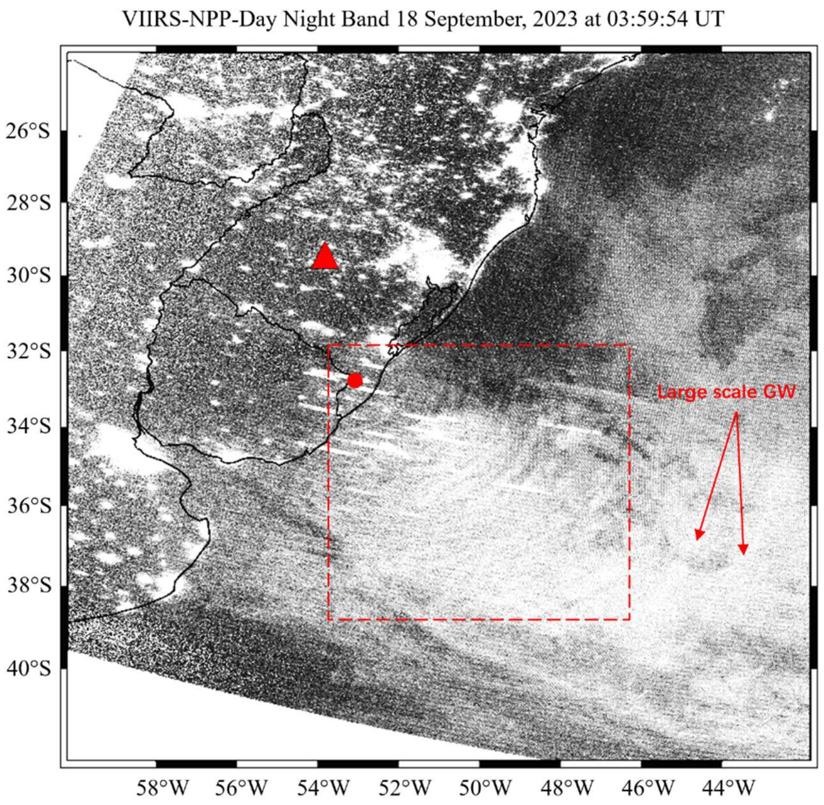

Figure 7. Suomi-NPP satellite Day Night Band radiance observations of CGWs at 03:59:54 UT on 18 September 2023. Red triangle represents the SMS station, and the red dot represents the position of the fitted center of the CGW.

In the text, the corresponding "CGW" has been revised to "GW".

(11) Caption of Fig.11: Please state whether these images are from OH, or from OI.

Reply: We have made the following modifications to the caption of Fig. 11.

"Figure 11. Simultaneous observations of mesopause CGWs using OH channel ground-based all-sky airglow imager and TIMED/SABER satellite measurements. The red triangle marks the location of the SMS station. The instantaneous field of view of TIMED/SABER is 0.7 mrad by 10 mrad."

(12) l.342: Please check! The double-peak structure is seen mainly during the second overpass in the 07:18:23 UT profile, but not so much during the first overpass.

Reply: Thank you for your comment. The following discussion has been added to the text.

"There are weak double-peak structures during the first overpass at 00:24:10 UT and 00:28:15 UT. In contrast, the double-peak structure is more prominent during the second overpass in the 07:18:23 UT profile."

(13) l.368, 369: Please state that the flux is calculated for the altitude of the OH layer.

Reply: Thank you for your suggestion. We have made the following revisions:

"Figure 13 shows the calculated vertical flux of the horizontal momentum flux of mesopause CGWs in the altitude of the OH layer from 22:00 to 09:00 UT on 17-18 September 2023."

(14) l.374: How does this momentum flux compare to average values determined from SABER satellite data? A climatology is given, for example, in Ern et al. (2018).

Ern, M., Trinh, Q. T., Preusse, P., Gille, J. C., Mlynczak, M. G., Russell III, J. M., and Riese, M.: GRACILE: a comprehensive climatology of atmospheric gravity wave parameters based on satellite limb soundings, Earth Syst. Sci. Data, 10, 857-892, https://doi.org/10.5194/essd-10-857-2018, 2018.

Reply: Thank you for your suggestion. We compared our results with the gravity wave flux observations from satellite limb soundings by Ern et al. (2018), as described below.

"Ern et al. (2018) studied the climatology momentum flux determined from SABER satellite limb sounding data. They find that the GW absolute momentum flux is approximately 1–4 m^2s^{-2} in the mesopause region."

(15) l.387: The parameter alpha does not occur in Eq. (6), but only later in Eq. (7). Therefore the introduction of alpha should be moved there.

Reply: Thank you. The introduction of α has been moved after Eq. (7).

TECHNICAL COMMENTS:

l.18: CGWs -> concentric gravity waves (CGWs)

Reply: It has been revised.

l.81: its role -> their role

Reply: It has been revised.

l.250: Sumi -> Suomi

Reply: It has been revised.

l.301-307: Same sentence appears twice. Delete one of them.

Reply: It has been revised.

l.332: saber -> SABER

Reply: It has been revised.

l.356: are expressed -> is expressed

Reply: It has been revised.

l.358: is cancellation factor -> is a cancellation factor

Reply: It has been revised.

l.417: can be -> and can be

Reply: It has been revised.

l.475: for downloaded -> for download

Reply: It has been revised.

l.479: delete "radiances data" (double occurence).

Reply: It has been revised.

l.584: publication year of Heale et al. is 2022, not 2021.

Reply: It has been revised.