06/10/2024

We would like to express our gratitude for the valuable feedback from the referee. We appreciate your tireless efforts in reviewing our manuscript, which has allowed us to improve the quality of our article.

1) Adjust the text started in Line 328 to correctly describe the kind of filter that you have used in Figure 2. There is incompatibility between the manuscript and Caption of Figure 11. Please, see the report of Referee #3.

   Response: Thank you. Since the line you mentioned, all the text and the caption of Figure 11 have been corrected as shown from the lines 321-356:

   "Gravity waves form when air parcels oscillate due to the restoring force of gravity after being transported vertically. Several factors contribute to these waves, including airflow over mountains, convection, and wind shear. Propagating vertically, the waves break and dissipate, releasing energy and momentum into the surrounding atmosphere. This process, frequently responsible for the formation of inversion layers, is further investigated by identifying gravity wave potential energy (Ep) and its impact on inversion layers at selected MLT regions. This approach assumes that gravity wave activity is represented by potential energy, as described by numerous authors (Tsuda et al., 2000; Wang and Geller, 2003; Liu et al., 2014; Thurairajah et al., 2014). The gravity wave contribution is quantified by calculating the potential energy and evaluating instability through the Brunt-Väisälä frequency (N^2), derived from perturbed temperature (Tp') data spanning 2005–2020. The analysis focused on altitudes of 90, 85, 75, and 70 km by applying a high-pass filter with a one-hour interval to the Tp' data (see Figure 10 a-d). In the upper mesosphere (90 and 85 km), the filter reduces the amplitude of wave oscillations from approximately ±20 K to ±10 K, as shown by the blue curve in Figure 10a and b, compared to the red curve. Similarly, in the lower mesosphere (75 and 70 km) at (Figure 10 c & d), the amplitude decreases from ~(-20 to 20 K) to ~(-8 to 8 K) by filtering out higher amplitudes. By removing the impact of long-period wave oscillations, such as tidal and planetary wave contributions, the filter effectively isolates the gravity waves (Gw) on the MLT inversions.

In the MLT atmospheric region, gravity wave breaking typically dissipates their potential and kinetic energy, leading to increased turbulence and mixing. This energy transfer can alter thermal patterns and impact the overall dynamics of the upper atmosphere. As illustrated, gravity wave propagation and dissipation are major forces in the MLT region (Lindzen, 1981; Holton, 1983), influencing middle and upper atmospheric inversions. This has a substantial impact on the MLT's thermal structure, particularly the increase in temperature variability with elevation, known as inversion. Holton et al. (2003) and Holton and Hakim (2013) has demonstrated an interaction between the potential energy of gravity waves and inversions. Interestingly, in this investigation, the dissipation of gravity waves can lead to the mesospheric inversion layers (MILs). The study we conducted has clearly shown that the occurrence of an inversion is maximum at the upper MLT region relative to the lower MLT region from Figure 4. In a comparable manner, Figure 11 depicts the highest potential energy of gravity waves in the upper MLT regions, demonstrating the interactions between inversion and gravity wave potential energy."

2) Item 11) from Referee #2, you have not addressed this point properly. Please provide an example as suggested by the Referee. If you prefer, you can include the example and explanation in a supplementary section.

Response: Thank you. We have given the connection between the invers and gravity wave potential energy in a supplementary section specifically from line 343-356:

"In the MLT atmospheric region, gravity wave breaking typically dissipates their potential and kinetic energy, leading to increased turbulence and mixing. This energy transfer can alter thermal patterns and impact the overall dynamics of the upper atmosphere. As illustrated, gravity wave propagation and dissipation are major forces in the MLT region (Lindzen, 1981; Holton, 1983), influencing middle and upper atmospheric inversions. This has a substantial impact on the MLT's thermal structure, particularly the increase in temperature variability with elevation, known as inversion. Holton et al. (2003) and Holton and Hakim (2013) has demonstrated an interaction between the potential energy of gravity waves and inversions. Interestingly, in this investigation, the dissipation of gravity waves can lead to the mesospheric inversion layers (MILs). The study we conducted has clearly shown that the occurrence of an inversion is maximum at the upper MLT region relative to the lower MLT region from Figure 4. In a comparable manner, Figure 11 depicts the highest potential energy of gravity waves in the upper MLT regions, demonstrating the interactions between inversion and gravity wave potential energy."