Review of the paper entitled: "Ozone recovery effects on mesospheric dynamics in the southern hemisphere" by Ales Kuchar et al. [MS No.: egusphere-2025-2827].

The paper investigates the impact of ozone recovery on the mesosphere and lower thermosphere (MLT) zonal and meridional wind trends using the meteor radar (MR) and SABER observations over mid-, and high-latitude locations in the southern hemisphere. It further compares the observational results with that from the whole atmosphere models to highlight the discrepancies of the models especially SD-WACCM-X. The authors claim that the ozone recovery impacts the gravity waves (GWs) that propagate and affect the mesospheric winds in spring and early summer. They further use the MERRA2 and ERA5 datasets to compare the winds below 80 km.

Although the paper presents results at 20-100 km, combining MERRA2, ERA5 an MR datasets, the results presented are limited and they do not fundamentally support the given information to evaluate the merits that it claims to report. Significant concerns are due to methodology which does not present complete details of analysis of various datasets including how the trends GW momentum flux and potential energies are estimated from the observations and models. I wonder about using the ozone hole area how it is helpful to correlate with the mesospheric winds? The authors define the ozone hole area as the region of ozone values below 220 DU, however, is this the same for all the months? Moreover it is not specified at which the ozone hole area was estimated. The ozone concentration (in terms of column ozone or the mixing ratios) is more helpful here instead of 'area' as the waves should propagate vertically to reach the mesosphere to affect the winds there. In addition, the tides especially the semidiurnal tide, which is sensitive to the ozone changes, is more effective in modulating the MLT winds. However the role of tides and their interaction with GWs was not discussed in this paper. Further PWs, which have more impact on the polar vortex, have been neglected. The paper focussed more on zonal component but not the meridional winds for the pole-to-pole circulation.

The description of figures is too short, and their detailed scientific merits are not presented. Moreover, the paper does not attempt to address the physical processes to interpret the significant results. The paper is not recommended for publication in the present form.

The specific (major & minor) comments/concerns are listed below.

Title: Include 'mid-high latitude' in the title as this study focuses mainly over these regions.

In the title: mesospheric dynamics, but why the figures represent from 20 km? In the title ozone recovery but no ozone variabities (not area) were shown.

Abstract:
L1-2 - How was the recovery of Antarctic ozone 'altered' the stratospheric circulation as the number of recent studies explored this particular topic?
Expand GAIA, MERRA2, ERA5, SD-WACCM-X.

L3-Specify the period/duration of the observations/simulations used in this study.
L44- 'They'….who?
L43-45 – decrease in meridional and zonal winds….specify north/south & east/west. Include 'radar' after MF.
L42-46 – Were the trends for all the seasons?
L47-48 – Why not the trends in MLT winds can't be compared before and after 1990? Specify why this particular year.
L51- Include lat. & long. coordinates for Syowa station.
L53-54 – Does winter over Syowa station refer to December-March?
L56- Expand WACCM.
L65 – Replace 'stations' with 'observations'.
L71-72- What is the specific reason for selecting these locations with same latitude/longitudes?
L75-76 – What does the 'methodology' refer here and how did these values obtain?
L79 – Expand SABER. 'vector' or 'magnitude'?
L82- What is meant by 'true'?
L96 – What is 'JRA-25/55'?
L132 – Expand 'MLS'.
L135-137- The 12^{o}x30^{o} (lat. x long.) could be a significant concern of analyzing the MLT winds for individual stations as the dynamics particularly the tidal (atleast non-migrating) forcing could have greater impact on driving the winds in this region.
L142- per 'unit' volume?
L142-143- What is the purpose of GW PE to estimate here and how the 'noisy' and the 'fraction of the data' is helpful here to estimate from the SABER?
L147-148- What causes the seasonal variations of the atmospheric density in MLT and how does it impact the GW activity and background wind….need to explain.
L151- Need brief explanation of ASF2D.
L158- Insert references.
L161- Need brief explanation.
L163-164-What is 'corrupted' here?
L170- Include climatological means of winds for zonal and meridional components prior to the trends.
L172-173- How did these winds retrieve as the 'methodology' didn't reflect it? Further with respect to which year the trends were calculated?
L175 – Specify the height region as the colours are indistinguishable.
L176-177- What could be the physical mechanism for negative trend and how do the ozone recovery linked to the wind reversal? Any explanation for positive trends during May-September?
L177-182- Why the zonal winds are compared with ozone hole area instead ozone concentrations? The ozone concentrations must be presented. Not sure how could the ozone hole area (at which height region) affect the zonal winds at various altitudes of the atmosphere. Further it is confusing 'anti-correated' and 'positive correlations' when comparing with Venkateswara Rao et al. (2015).
L182- What is 'opposite' relation here?
L180-181- Figure A3 showing negative correlations, however Figure A2 displays positive correlations. What is the possible mechanisms behind the two opposite correlations at two height regions?

L192-193- ‘twice less’ – does it mean half? Why the trends in meridional winds (MWs) are half that of zonal winds (ZWs) as no climatological means are presented here? Further how do the trends in ZWs and MWs are comparable to extract the common trend structure?
L194- ‘southward’…do you mean further poleward? Clarify.
L194-195- What could be the reason for negative trend at two different heights at two different stations?
L200-What are these ‘constraints’ – elaborate.
L202-203- I could not see any positive trends over Davis below 90 km in the summer from Figure 2.
L204- What is the reason for increased upwelling?
Figure 2 – What are A-F labels represent in the figure?
L207- I could not find the positive trends (statistically significant) of ZW at 80 km over any station in September.
L208- Does the figure A3 signifies the trends in ZW or simply ZW variation at 82 km for November?
L207-211 – How significant the ZW trends at 80 km estimated by MRs as the meteor counts are minimum at this height?
L209- How was the zonal momentum flux calculated and then the trends in the same?
L211-215- I could see the eastward momentum flux is not statistically significant over Rothera especially after September below ~90 km; however it is significant over Davis and what could be the reason despite the two stations being on the same latitude band.
L217- The main concern is that no result was showed for the link/coupling between GWs and the ozone recovery. What is the direct impact of ozone (depletion/recovery)on the GWs as well as the MLT winds? Must be specified.
L216-217 and Figures 2 & 3 – I could see the westward trend of GW momentum flux during May-Sept. over Davis from Fig. 3A, however, the trend in ZWs are eastward during this period above 80 km. Same for Rothera above 90 km. Why? Comparing to Figs. 2B and 3B, what could be the reason for negative and positive trends of ZWs below and above 90 km during Nov.-Feb. over RioGrande? Is there any link between GW MF and ZW trends? What is the ‘slope’ in Fig. 3B?
L219-222 – I could see transition of westward trends to eastward around at 90 km over all the stations during Nov.-Feb.
L219-222- I wonder what is the transition refer here with Jan.-Feb. being the summer in SH? Further what are ‘weaker’ and ‘stronger’ refer to as the eastward MF is more significant over Davis than that over Rothera during Jan. – Feb.? Also why the westward MF above 90 km is more persistent all the year over Rothera than Davis being both the stations located at the same latitude band?
L223-229- Explain how these values are calculated and include appropriate references. Further is this valid over other two stations as no results are presented?
Figure 5 – This figure needs more explanation with additional details to understand the importance of these comparisons.
L230-236 – Since the period 2005-2021 is longer than a 11-year solar cycle, this time series is enough to derive the trends. If that is the case, what is the need of Fig. 6 and not enough details are explained to understand this figure and its relevance to Fig. 4. Further fewer years i.e. 8 years are inadequate to retrieve the trends.

L239-240 & L241-242- Which correct…above 200 km or 500 km? Further what are the GW parameters like vertical wavelength and periods as both ground based and space borne measurements have different horizontal and vertical resolutions and periods.
L243-What is the data source and how was the GW potential energy (PE) calculated and trends in it? Should be explained. Why it was limited upto 90 km only?
L243-245- Did you omit the time series of MR GW PE as same as shown in Fig. 7 for better comparisons?
L245-246- I could see the negative trends instead positive.
L247- What does weakening winds mean…eastward or westward?
L249- Why does the negative trends stronger at Davis than at Rothera despite at the same latitude?
L251- What are net momentum fluxes? Explain.
L255 - E_{pot} and not Epot.
L261-262- Here and wherever applicable – Do MR observations have continuous measurements or any data gaps exist? No where this was mentioned. Further data gaps could be serious concern when compare with other datasets like WACCM.
Figure 8 – It is well known that the WACCM doesn't reproduce the winter westerlies (eastward winds) over mid-high latitudes in the upper MLT. I am wondering how did the authors obtain positive trends above ~85 km in the model. Further as trend means changes on a time scale longer than a solar cycle (11-year), the data shown here are inadequate. How were the trends in winds from the models calculated?
Figures 8A & D were already shown and repeated from Figure 2. Same for Figures 9 and 10.
Figure 8F – As the WACCM reproduces winter southward and northwards winds below and above ~90 km, why the trends shown in this figure are insignificant and do not agree with the observations in the upper MLT?
L274- If the focus of this study was the mesosphere, why the trends shown for all layers from 20 km? This applies to all figures and lines.
L275- Specify here what is meant by beginning and end of summer as I could not find negative trends in the beginning and positive trends in the end of the summer?
L279- Remove '.' I wonder why most of the trends are statistically insignificant? Further why the trends are positive in Nov./Dec. as it contradicts with the westward zonal flow below ~90 km in winter including Oct. – Mar.?
L281-282- I could not see the WACCM reproduction of the long-term changes in zonal winds.
L283-285- I trust the focus of this study is of the mesosphere and not the below layers, and I could not see any negative and positive trends in the meridional winds during the said period at the heights of meteor radar observations.
L289- I wonder how the trends are positive if the zonal flow is westward during Nov. – Feb. below 90 km?
290- I could see the opposite trends during these months below 80 km.
L291 – Again I still believe the focus of this study is mesosphere and not stratosphere.
L296- I wonder no result has been presented on the ozone recovery in terms of concentration/vmr and this led to misinterpretation on the wave dynamics and in turn the MLT winds over Antarctic.
L296-297- Is this 'evident' from any result shown here?

L301 – In this case, no results on PWs and tides were shown. It is very important to focus on these wave phenomena especially over the polar latitudes in the context of ozone variability.
L305 – Which ‘analysis’?
Figure A2 – What is the significance of this figure at 30 km? Why the blue lines (ozone hole area) are different from those in Figure A3?