Sincere apologies for a slower than hoped response with this review.

This is a nicely done study, with a set of results that show a clear sensitivity of gravity waves and drag to vertical resolution in the IFS for SSW events. The results also clearly show:

(1) That the higher vertical resolution leads to more stratospheric drag by resolved gravity waves in the weakened wind conditions during and following SSW events.
(2) That higher vertical resolution becomes more important in IFS with finer horizontal resolution.
(3) That the increased vertical resolution resolves more short vertical wavelength gravity waves in the stratosphere.

This is a fine and useful study utilizing state-of-the-art and computationally intensive high-resolution simulations that are not widely available or analyzed in this way. It will certainly make a fine addition to the literature and makes clear some important new points.

There is one smaller but I think important issue with one specific conclusion drawn that is not supported by the presented results. To go one step further, the results may be explained without this unsupported conclusion. Please see major comment (1). I suggest here a few changes and a suggested alternate for this minor conclusion as a way for the authors to proceed without any new calculations, but alternatively if a bit more work is done to support the current conclusion, that could be another approach.

Major comment (2) itemizes a few places where the current text wording communicates some misunderstanding about gravity wave breaking and critical levels that could be corrected with only minor rephrasing. These few sentences are also relevant to the misstated conclusion in (1).

Major comments:

(1) L263: "To make full use of the critical layer as a predictor and to benefit from the aforementioned positive feedback, increased vertical resolution is necessary for an enhanced vertical gravity wave momentum flux. Specifically, it is found that a significant part of the gravity wave potential energy corresponds to waves with small vertical wavelengths that are not resolved in the model configuration with only 91 vertical levels."

While the second sentence is supported by Figure 7, nowhere is it shown that there is "an enhanced vertical gravity wave momentum flux." Figure 5 shows enhanced drag at higher vertical resolution. Figure 7 clearly shows enhanced potential energy at shorter vertical wavelengths, and it appears that the enhancement appears at longer vertical wavelengths at higher altitudes, possibly in concert with the changes in resolution with height (Fig. 1). At face value, this Fig. 7 seems to show that improving vertical resolution prevents artificial dissipation at too-coarse vertical scales, and that the improved resolution allows waves to propagate a bit closer to critical levels, delaying dissipation until higher altitude. This delayed dissipation effect alone can increase drag without any increase in momentum flux. The 1/density factor in the drag equation will give larger drag if the same wave momentum flux is dissipated at a higher altitude. (See for example Vincent and Alexander (2020) and text surrounding their equation (2) in the context of the QBO shear zones.) To claim instead that the momentum flux in the stratosphere is higher at higher vertical resolution, the flux profiles would need to be computed and compared. A simpler approach would be to discuss the enhanced waves in the high vertical resolution simulation in terms of this delay in artificial dissipation at too-short vertical scales. Perhaps this was what is intended, and if so please find several suggested changes to the text to clarify things below in (2), which I hope may improve the paper for readers.

(2) Please find here several suggested changes (by line number) to improve the descriptions related to gravity wave breaking/dissipation and critical levels. Wave dissipation/breaking in a model like

this will always occur somewhere significantly below a critical level. Using the word “layer” instead of “level” doesn’t really solve the problem.

L29-31: “These waves propagate via the stratosphere into the mesosphere, where their amplitudes grow until they break. However, depending on their phase speed and the background wind, gravity waves can encounter a critical layer, where vertical length scale shrinks to zero, and deposit their momentum already at lower altitudes in the stratosphere.”

It would be best to begin L29 with “*Commonly*, these waves propagate…” While it is a general tendency for gravity waves in models like IFS to have their biggest impacts in the mesosphere, real atmospheric gravity waves have a wide distribution of amplitudes, and many dissipate/break in the stratosphere (e.g. de la Camara and Lott, 2014; 2015). Suggested change is to add the word “Commonly,” at the beginning of this sentence. The second sentence might be better phrased as e.g., “…depending on their amplitude, phase speed, and the background wind, gravity waves would encounter a critical level (where vertical wavelength shrinks to zero), and break somewhere below that level, depositing more momentum at lower altitudes in the stratosphere.”

L190-195: Wind changes and associated changes in wave critical levels were discussed by these earlier references more generally than implied here. Wind contours can show limits where any gravity waves with phase speeds within certain wind speed ranges will certainly not be able to propagate through that level, but the phase speed range of breaking waves will not be equal to the wind speed range because wave breaking/dissipation will generally occur somewhere below the wave critical level (particularly for models, including IFS, which has good but still limited vertical resolution). Suggested small wording changes:

L190 change “zero or negative phase speed” to “low negative phase speeds”
L193 change “critical layer” to “breaking layer” or “dissipation layer”
L195 change “is indicative” to “may be indicative”

L206-207: “With 91 vertical level, there is zero wave drag on pressure surfaces around 100 hPa indicating that, with low vertical resolution, gravity waves do not reach that altitude. This becomes clearer in the discussion of Figure 7.” Zero drag at 100hPa indicates no dissipation/breaking at that level, but waves with large momentum flux could pass through without dissipation and no drag. To instead say some waves are missing at 100hPa, would require comparison of the momentum fluxes. So it would only be accurate if you change “do not reach” to “do not break at”. I might suggest deleting both sentences since the first statement does not become clearer after Fig.7. (See above.)

L266: Suggest some additional clarification after L266 to mention that the enhanced scales get longer at higher altitudes and may be related to the profile of vertical resolution shown in Fig.1, as mentioned above. e.g. enhanced vertical wavelengths ~4–10Δz? Again, restating an earlier comment, I do not see any clear evidence in Fig. 7 that there are enhancements in wave fluxes crossing the tropopause.

Minor comments:

L77: Typo, e.g missing word “mitigated by” or “mitigated in”
L115: “normal mode”. These aren’t normal modes. Perhaps change to “wave mode” or “mode”?
Figure 5 caption, add word “parameterized” after (b) and (c) for clarity.