Review reports on a manuscript entitled “Optimising ozone control strategies for Chinese megacity clusters under the influence of stratospheric intrusion” submitted by Zhao et al.

General Comments

The manuscript explores the critical role of stratospheric intrusion (SI) in tropospheric ozone (O₃) pollution in China, providing a detailed assessment of its seasonal, spatial, and policy-related implications. The data and methods that are used to support their findings sound reasonable, but there are areas where the alignment, clarity, and depth of discussion could be improved. The major and comments are attached below. I would recommend a major revision

Major comments:

1. In the abstract, the authors stated that “*We found that SI contributions vary seasonally, peaking in spring and* ***reaching a minimum in summer****”.* However, in Lines 179–181, the authors described, “O*₃ enhancement (approximately 80–90 ppbv) can be seen above 500 hPa in April and May in YRD, PRD, and CY. Comparatively, the O₃ pool, exceeding 110 ppbv, appears progressively later at higher latitudes,* ***peaking in BTH and FWP in June***”, and Lines 265-267 state that “*Temporally, contributions from SI exhibited strong seasonality, with the largest impact in spring, followed by winter and summer, and* ***the smallest in autumn***”. These results do not seem to support the conclusion presented in the abstract. Please clarify.
2. What model outputs were used to determine the relative contributions of stratospheric intrusion (SI) to surface O₃ levels and O₃ exceedance events? This question arises because the authors reference statements related to WACCM in the paragraph beginning at Line 116, and similar statements regarding WRF/Chem work in the paragraph starting at Line 134.
3. Please confirm how many criteria were used to determine SI occurrence. Are these three criteria presented in Lines 186–188, along with the PV values, used to define SI occurrence? Additionally, what data was used for the determination of SI occurrences presented in Table 1? Are you using hourly ERA5 data files? What are the intervals for those data? Please clarify.
4. Lines 99–104: Would moving the paragraph evaluating WACCM simulations using AIRS, O3 soundings, and ERA5 data from Section 2 (Materials and Methods) to Section 3 (Results) improve the paper's structure? Similarly, should the evaluation of WRF/Chem simulations in Lines 131–133 also be moved to the Results section?
5. What emission inventory data was used in the WRF simulations? WACCM outputs utilized to generate chemical initial and lateral boundary conditions for WRF/Chem simulations. What data was used to generate meteorological or physical initial and lateral boundary conditions for the WRF/Chem simulations?
6. The authors stated in Section 2 that '39 emission reduction scenarios with anthropogenic VOCs (AVOCs) and NOx emission reductions were used to identify the OPS.' Could you provide a detailed description of these 39 emission reduction scenarios? Additionally, how were these scenarios designed, and what was the specific purpose behind their design?
7. Lines 149–153: Would moving the background information from the Results section to the Introduction improve the readability of the manuscript?
8. Table 1. Please provide more details in the caption of table on how the SI events were identified and which datasets were used.
9. The authors mention on Lines 254-255 that the stratospheric ozone tagging approach is used to quantify the contribution of stratospheric intrusion to tropospheric O3. Is this ozone tagging approach implemented in WRF/Chem or WACCM?
10. Figure 4: The authors state that "The contributions of SI to surface O₃ followed an increasing trend over BTH, YRD, and FWP during spring from 2020 to 2023, with annual increases of 0.45, 0.25, 0.39, and 0.39 ppb/yr, respectively” (Lines 292-294). It would be helpful if the authors could add regression lines in Figure 4 to demonstrate this trend. If needed, additional figures can be included in the Supplementary Material.
11. Figure 5: The legends in Figure 5 are unclear. Please improve the figure's quality for better clarity.
12. Lines 360–363: The authors state, 'Therefore, for the BTH and PRD regions, when SI contributions exceed the local control capacity, policymakers need to dynamically adjust priorities to reduce O₃ precursors in specific industries, thereby offsetting the additional contribution from SI.' However, in the discussion, the authors mention that the impact of SI on surface O₃ in PRD is not significant. These statements appear inconsistent; please review for clarity.
13. In the conclusion (starting at line 400), the authors discuss the impact of climate change on stratospheric intrusion and mitigation policies for ozone control. However, I did not find any mention of climate change in the Introduction, Method Section, and Abstract. Is it appropriate to include this topic in the conclusion?

Specific comments:

1. L11: Please add “tropospheric” before ozone.
2. Please ensure all abbreviations are spelled out upon their first appearance, as many are not defined when initially mentioned. For example, abbreviations such as BTH, PRD, YRD, FWP, CY, and VOC are not defined in the abstract. Additionally, ensure that abbreviation definitions comply with JGR requirements. For instance, use 'HAO (High Altitude Observatory)' or 'High Altitude Observatory (HAO)' as appropriate. WACCM should be defined on Line 94 rather than Line 129.
3. L61: The website link does not exist. Please have a double check.
4. Line 141: What is the time frequency for AIRS satellite retrieval O3 vertical profiles?
5. Should the information in the paragraph beginning at Line 149 be moved to the Introduction section instead of the Results section?
6. Line 146: Is this the correct format for citing the data used? Please review the JGR manuscript preparation guidelines to ensure compliance with their data citation requirements.
7. Lines 183–184: Should the sentence 'However, the annual variation in SI occurrence has not been thoroughly investigated' be deleted from this section?
8. Lines 194–196: The sentence is somewhat unclear. Please consider rewriting it for better clarity.
9. Line 226: Please add two references after typhoon: (1) [**https://doi.org/10.1029/2004JD004914**](https://doi.org/10.1029/2004JD004914) and (b) [**https://doi.org/10.1029/2005JD007012**](https://doi.org/10.1029/2005JD007012)
10. Figure S2: What observational data has been utilized to verify the WRF/Chem simulations? What time period of the WRF/Chem simulations and verification is presented in the figure?
11. Figure S3: Panel (a) should be presented earlier, as the locations it depicts are mentioned earlier in the text
12. Lines 235–236: Is the threshold value of 100 $μg/m^{3}$ or 50 ppb used to determine O3 exceedance event? I do not think that this is the right threshold values to define ozone exceedance events. Please have a double check.
13. Lines 288-290: In the caption of Figure 4, the authors state, 'The bars in green, yellow, and purple represent spring, summer, and autumn, respectively.' However, the colors in Figure 4 do not match those described in the figure caption.