Comments by X.Ma

This manuscript quantified the contribution of one stratospheric ozone intrusion event in tropospheric ozone pollution in Hong Kong. They pointed out the importance of the non-local SI ozone transport through tropopause folding from midlatitude. In general, the manuscript is well-written and analyzed. However, there are still some parts related to the use of the dataset and STE-flux calculation can be further improved. The detailed comments are listed below,

L64-66: “**At low to middle northern hemisphere latitudes**, the subtropical jet stream (STJ)…”, changes to “At low to middle latitudes in Northern Hemisphere”?

L88-92: “**They** demonstrated that the trajectory model captured SI and contributed 3–6 ppbv to surface O3. The tagging stratospheric air mass method is a more direct method for quantifying the impact of SI on tropospheric O3. **They** estimated that the average contribution of SI was in the range of 1.5–10 ppb, which is closely related to altitude”. Who are they? Could you be more specific about the reference?

L93-96: “To the best of our knowledge, studies on the quantification of the contribution of SI **have primarily focused on the Northeastern and mid-latitude regions in China**, whereas the contributions of SI in Southeastern China have been less investigated.” The author did not mention any related research in Northeastern and mid-latitude regions in China in this paragraph.

L120-122: “The objectives of this study were to **1) calculate the STE O3 flux, (2) quantify the contribution of SI to tropospheric O3,** and (3) investigate an enhanced emission reduction pathway while considering the constraints imposed by the SI impact” The first and the second object seems to be the same.

L174: There is a mistake in the subtitle, no 2.3 in the Method part.

L176: “by Appenzeller et al. **(1996** was used in…” Lack of the second half of the parenthesis.

L179-181: “where 𝐹𝑖𝑛 represents the downward O3 flux across the tropopause, calculated as the area-weighted integral of the hourly mean O3 concentration multiplied by the negative hourly mean vertical velocity over Hong Kong” Why the vertical velocity is negative? Which direction (up/down) is positive in the equations? Could you add a more specific definition of Fout?

L204-208: “As highlighted by the white arrow in the WRF-Chem simulation, O3-enriched air descends to 700 hPa but is then blocked and does not further intrude the surface layer. Conversely, the ERA5 and WACCM simulations revealed that the O3-enriched air from the stratosphere further penetrated the boundary layer and persistently mixed with the surface layer over the following days.” It is not convincing enough to conclude the ozone in the near-surface is transported by the stratosphere just based on the ozone distribution here. There are possibilities that high tropospheric ozone below 750 hPa is coming from the regional transport or near-surface ozone photochemical production. A more detailed explanation related to the PV might be useful.

L211-223: Which dataset is analyzed here? ERA5 or WAR-Chem?

L219-220: “One day later, the SI event concluded with a strong downward air movement, transitioning to a weak upward motion.” Again, which dataset is analyzed here? ERA5 in Figure 1a or WAF-Chem in Figure 1c?

L223-224: “Previous studies have demonstrated that SI intensity is closely related to variations in **large-scale circulation**” Could you be more specific here?

L227: In Figure 1, what is the scale for the wind arrow in Figure 1 a and 1c? The transport pathway indicated in the white arrow in Figure 1 seems subjective and arbitrary. In the title of Figure 1, “The black contour line indicates the dynamical tropopause of 1 PVU.” There are not just 1 PUV line in the figure.

L231: “Deep SI episodes are generally associated with **favorable synoptic systems** (Chang et

al., 2023; Zhao et al., 2021a).” Could you be more specific here?

L256: Could you mark the HK in Figure 3? It’s hard to distinguish without the latitude and longitude in the figure.

L266: Why did the author use ERA5 reanalysis to calculate STE flux instead of the WRF-Chem model? Which is the data source for the tropopause height? Which domain is considered for the calculation of the STE flux, and tropopause height?

L286: Which one is the data source for the O3s? WACCM?

L291: “A pool of high O3S concentrations of up to 60 ppbv” At which altitude?

L312: “This O3S pool contributed to an increase in surface O3 concentrations through **fumigation** and vertical mixing in the morning” It sounds strange to use “Fumigation” here.

L319: “Owing to unfavorable meteorological conditions,” Could you be more elaborate here?

L330: “Our results highlight that stratospheric O3 can still modulate the surface O3 budget even though no SI was detected over Hong Kong and underscore the significance of characterizing the behaviors of SI in middle latitudes to gain insight into natural sources leading to O3 pollution over subtropical regions.” Have you compared the relative contribution from biomass burning with stratospheric intrusion for a long period before drawing such conclude? It’s not convincing enough to just infer the conclusion based on one case. And also, could you list the reference that claims the natural sources contribute more? “Subtropical regions” are also a broad region, that could have a different mechanism that varies with regions.

L341: I assume that the integrated process rate (IPR) results here are based on WRF-chem simulation. However, the author just mentioned that the WRF-chem could not reproduce the further intrusion of stratospheric ozone into the surface layer in L204-208. How can we trust the results here?

L360: In Figure 8, which is the data source of O3s? WACCM? And which level of O3s is used to analyze here?

L387: what is the unit for the “Extra emission reduction”? What is the definition of it? Why does it change over time?

L401-403: “During the deep SI event, the effective emission reduction path was re-ordered as the “AVOC only,” “NOx only,” “AVOC/NOx = 1:2,” “AVOC/NOx = 2:1,” and “AVOC/NOx = 1:1” paths.” This conclusion seems not correct. According to Figure 9, the order should be “AVOC/NOx = 1:1”, “AVOC/NOx = 2:1,”, “AVOC/NOx = 1:2,” , “AVOC only,” and “NOx only,”

L435-436: There are three datasets the author used in this paper. More discussion about the limit of WRF-Chem results and the reason for using the ERA5 and WACCM are needed for clarity and reliability of the conclusion.