

Review of “A significant mechanism of stratospheric O<sub>3</sub> intrusion to atmospheric environment: a case study of North China Plain” by Luo et al.

#### General comments

Stratospheric intrusion (SI) is an important process that brings ozone-rich air mass from the stratosphere to the troposphere. Among all SI events, only a limited portion can reach the surface and impact air quality. It is important, as well as challenging, to identify a SI event that reaches the surface, and to explore the associated mechanisms and impacts. Therefore, this paper is of scientific importance. The authors investigated a SI event occurring in May 2019 in North China Plain (NCP), using some of the best data and methods available. They proposed a mechanism of “upper westerly trough-middle the Northeast Cold Vortex-lower extratropical cyclone” in the troposphere to explain this SI event. The analysis showed their deep understanding of atmospheric dynamic and chemistry. The expression is logic and clear.

I am convinced of this SI event and the associated meteorological and chemistry evolution. My main concern is that surface observations (Figure 5) seem not to strongly support the claim that this SI reached the surface. The diurnal cycles of ozone and temperature seem not to be disturbed by the SI event, but the ones of carbon monoxide and humidity seem indicative. This can be due to that the average over NCP was considered. The authors are encouraged to examine the observations at individual sites for stronger indications of the SI to the surface.

Quantitatively, the authors conducted sensitivity simulations using a regional chemical transport model, WRF-Chem. They concluded that “this SI event made the absolute contributions of 9.61 ppbv to the near surface O<sub>3</sub>, accounting for 26.77% in the relative contribution”. However, this assessment of the SI impact seems higher than the observations showed in Figure 5 if the claim refers to the entire NCP area.

#### Minor comment

L22, please provide the information on latitudes, longitudes of the North China Plain, and the time the SI event occurred.

L23, remove “and”.

L45, remove “the” before “stratospheric O<sub>3</sub>”

L60-61, “In the mid-latitudes of the northern hemisphere, approximately 20–30% of the O<sub>3</sub> reserve in the troposphere is sourced from the stratosphere”? The number looks high.

L115, the supplement should be cited, instead of the references.

L117, leave a space between a number and its unit.

L190, at “the” before “western plateau”. It is better to make the sentence clearer: western of what?

L214, “Wang, H. et al. 2020” are not found in References.

L226-227, No much change in temperature is observed in Figure 5a. Temperature seems to follow a normal diurnal cycle.

L227, change to “Precipitation”.

L138-139, “Therefore, our simulation results are available and convincing.” ?

L241 and L242, what kind of disturbance? Where did the disturbance come from?

L339, “significant” is used a few times in the text, also in the title and abstract. I suggest removing the word throughout. Otherwise, the authors may explain “significant” in what sense? How does this proposed mechanism compare with others? Is this a dominant or not dominant mechanism?

L339, replace “atmospheric environment” with “tropospheric”.

L355, 9.61 ppbv? on average over the NCP? How large is the affected area?

Figure 4, the quality is poor, too small, not supporting the points in the text.

Figure S4, the blue lines are difficult to see.

References are not fully listed alphabetically.

It is better to indicate data sources for each figure.

Please pay attention to recent literature on the topic.

MERRA2 O<sub>3</sub> data were used substantially. However, a discussion on the data performance, especially for variable O<sub>3</sub>S, is lacking.