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Interactive comment on "Contribution of air-mass transport via the South Asia High to the deep stratosphere in summer" *by* Yu Liu

Yu Liu

yuliu@cma.gov.cn

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Thank Dr. Diallo for his comments, questions, guidance and suggestions. The replies to his major and minor questions are as follows:

Replies for the major questions

1. Equation (5) ignores the time tendency term. If the time tendency term remains, it can be treated as a source or sink term. When the tendency is positive, it is a sink; when the tendency is negative, it is a source. Its relative influence is

$-1/(a+b) \; 1/c \; (\partial c)/\partial t$

According to Figure 3 of Rendel et al. (2010), the HCN difference between June and

September is less than 0.02 ppbv, and the HCN average concentration of HCN is more than 0.2 ppbv in the tropical. The air-mass from mid latitude of northern hemisphere can be transported to the tropical within one month, $1 / (a + b)$ is less than $1 / a$, and $1 / a$ is taken as 1 month; the average duration is 4 months (June to September), so the influence of time tendency term is about less than 2.5 percent.

The chemical process of HCN is depletion role, which is a sink. Its chemical lifetime is about 4 years (Park et al., 2013). The CAM5 model results show that the chemical lifetime of HCN is 2.91 years (about 35 months) at 90 hPa in the tropical. The model top is 1.8 hPa, and vertical levels are 56 layers, the model including troposphere and stratosphere chemistry. Its influence is

$1/(a+b) \ Q/c$

which is about 2.9 percent. Compared with the roles of the transportation from meridional and vertical directions, the influences of the time tendency time and sink term are smaller. So, both are ignored.

2. The contribution of the vertical transport to the local is 1 (=100 percent), and takes as reference. G is total transportation that includes the contribution to local and meridional transport, and is equal to $e / (e-d)$ (> 1). The contribution of the vertical transport to meridional transport is $d / (e-d)$, that is equal to G-1. So, G is closed. The mass is conserved.

3-4. There are several ways to define the scope of ASM. Because of the coarse resolution of data, it is difficult to define the range of ASM accurately. However, the upward transportation of the ASM is the key of the ASM, so it is OK to determine the main area of AMS, which includes the upward transport area of the ASM. Therefore, based on wind fields and HCN distributions in the UTLS I identified the 20-40°N region, which includes the ascending region of the AMS. And it can avoid overestimating the impact of the AMS. The observation error of satellite data is less than 10

Above 18.5 km, the tropical rising area becomes narrower from 20°S-20°N to 10°S-10°N. First, it can be seen from Figure 1. Second, if 20°S-20°N was taken as the rising region, the distribution of HCN does not satisfy the equations (10) and (12). In addition, plodger et al. (2017) selected 10°S-10°N as the tropical rising region. Therefore, the tropical rising region becomes 10°S-10°N above 18.5 km. The ASM area is still 20-40°N. The case of region 10-20°N needs to be considered. Since the rising speed of this region is 0, the meridional variation is 0 in 10- 20°N ($(\partial c)/\partial y=0$). Therefore, HCN in this region is equal to HCN from 20-40°N. The two areas are put together to treat for easy.

5. According the suggestions, the paper is revised.

Replies for the minor questions

1. According to the suggestion, The title is revised.

2. According to the suggestion, The "deep stratosphere" is revised.

3. According to the suggestion, the relative contents are revised.

4. I think that there are differences between modeled and observed HCN in the southern hemisphere and tropical middle stratosphere in summer (Park et al., 2013; Ploeger et al., 2017).

5. According the suggestions, the "ratio" and "portion" are revised.

6. According the suggestion, low cases of the "c" are revised.

7. According the suggestion, the contents are revised.

8. According the suggestion, the data description is supplied.

9. HCN vertical resolution is supplied in the data description, same as question 8.

10. Because my result is in summer, that of previous works are in spring next of year, they are not suited to be compare numerical values.

11. This is the cumulative result of the meridional transport.

12. HCN percent is 6

13. According to the suggestion, Figure 1 caption is revised.

14. This is same with Major question 3-4.

15. This is same with Major question 2.

16. According to the suggestion, the horizontal outflow is added.

17. The budget analysis show this result. Because the meridional transport keeps to dilute the role from the tropical troposphere, the role from the mid-latitude of northern hemisphere gradually enhances.

Please also note the supplement to this comment:
https://acp.copernicus.org/preprints/acp-2020-990/acp-2020-990-AC2-supplement.pdf

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