Reply for Anonymous Referee #1

The manuscript is within the scope of ESSD. It presents scientifically significant material based on surface ozone measurements at three Antarctic stations. Of especial importance are data of measurements at Dome A, the highest Antarctic plateau (4000 m above sea level), which is one of the remotest areas on earth. The analysis of the data is reasonable and reliable, the data is unique. The authors should consider the following comments prior to publication.

General comments

1. I would appreciate it if the authors could please introduce more about the details of instruments and the measurements.

Reply： The detailed information of these instrument and observation introduction has been added in Section 2.1. Please find it in the Tracking version of the manuscript.

2. Because the results of trajectory clustering analysis are important in the discussion, there should be more description of trajectory clustering method.

Reply： The introduction of the trajectory cluster was added in Section 2.3, as bellow.

"The air mass trajectories were assigned to distinct clusters according to their moving speed and direction using a k-means clustering algorithm (Wong, 1979). Concerning with this study focused on transport pathway of O_3, the clustering result with the smallest number was selected as done by Wang et al., (2014). It was found three clusters performance best to represented the meteorological characteristics of the transport pathways at DA. This number was then selected as the expected number of air mass trajectory clusters. A more detailed clustering procedure using the k-means algorithm can be found in Wang et al. (2014)."

3. L64-70. The specific chemical reaction process of nitrate aerosol photodegradation on snow pack should be increased. It is necessary to clarify the effect of NOx released by photodegradation on O_3 emission from snow pack if it is possible.

Reply： According to your suggestion, the photochemical reaction process of snow surface is supplemented in Section 1. These explanation and correction have been added in the context (line 67-69).

L67-L69: "As the solar irradiance and the nitrate aerosol concentration increase, the emission of NO_X will increase through the photodenitrification process of the summer snowpack (e.g. $NO^{3-}+hv \rightarrow NO^{2}+O^{-}$; $O^{-}+H^{+} \rightarrow OH$; Honrath et al., 2000; Warneck et al., 1989)."

4. In Section 3.3, the author's statement is too simple and arbitrary. The standard deviation of the average daily concentration in Zhongshan station was significantly higher than that in the other two inland stations. L259-L264 completely said that every solar chemical reaction had little effect on the concentration variation characteristics of the three stations, which was not rigorous. This paper focuses on the influence of daily photochemical reaction on the concentration variation characteristics of Dome A, and the difference of average daily concentration fluctuation between coastal stations and inland stations also needs to be

discussed briefly. For example, coastal stations are easily affected by halogen gas mass in summer, and ODE (Ozone Depletion Event) is triggered (A.E. Jones et al., 2009), which has obvious impact on the fluctuation of average daily concentration in summer. Section 3.3 needs to add relevant references to support the author's statement.

Reply: Thanks for your suggestion. As a coastal station, the average daily concentration fluctuation in Zhongshan station was obviously different with the two inland stations, which can be attributed into their background climates. In Spring, ODEs occur frequently at Zhongshan Station. And this phenomenon always accompanies with abrupt weather transit from continental dominant to oceanic dominant, in other words, the BrO brought by northerly wind from sea ice area could leaded to serious ozone depletion (Wang et al., 2011; Ye et al., 2018). Whereas at inland stations like DA and SP, there were rarely ODEs.

These explanation and correction have been added in the context.

5. In Section 4, the influence of STT on OEE is discussed by STEFLUX. It is also mentioned that STT can be judged by atmospheric chemical model (such as GFDL-AM3 and CAM-CHEM). Can author try to use CAM-CHEM Model to analyze the STT events in Dome A and compare the results with the OEE. At the same time, results of the two methods may be compared if it is possible.

Reply： Thank you for your suggestion. Starting to analyze the results of CAM-CHEM model after receiving this reply. But the results reflect an interesting phenomenon.

During the whole polar night, the results of CAM-CHEM model show that STT occur frequently over DA (Figure 1). However, the frequency of OEEs is lower than that of STT events. During the whole polar night, much times of STT promoted the increase of near surface ozone concentration of DA. However, on the one hand, the occurrence of OEE during the polar night is affected by STT. On the other hand, it may be related to the specific meteorological conditions. Based on the statistics of the meteorological elements of OEE and NOEE during the polar night (Table 1), the average wind speed was low and the average height of the planet boundary layer (PBL) was 66.46m. Moreover, the lower mean potential vorticity at 550 Hpa implies a stronger vertical downward transport process. The lower wind speed makes the high concentration ozone grow rapidly near the ground.

Compared with the analysis results of STEFLUX tool and CAM-CHEM model, the STEFLUX tool has a good selection for “deep” STT process. But the results show that “deep” STT process has little effect on OEE. However, the model results better reflect the frequent occurrence of STT over DA during the polar night, which is an important reason for the continuous accumulation of near surface ozone concentration during the polar night. However, the low frequency of OEE makes it difficult to establish a direct relationship with the model results. Under the frequent STT, the stable boundary layer condition with low wind speed near the ground is helpful to the occurrence of OEE.

Interestingly, on May 31, both the pattern results and STEFLUX results showed a strong STT, and OEE occurred on that day. The combination of the two methods makes us have more interesting findings. We hope to analyze such events in the future based on the meteorological data of DA and relevant model methods.

These findings is not the main purpose of the paper, we want to conduct a new detailed study on the comparison of the two methods in the future. However, if you insist to add this part, it can be done in the next modification.

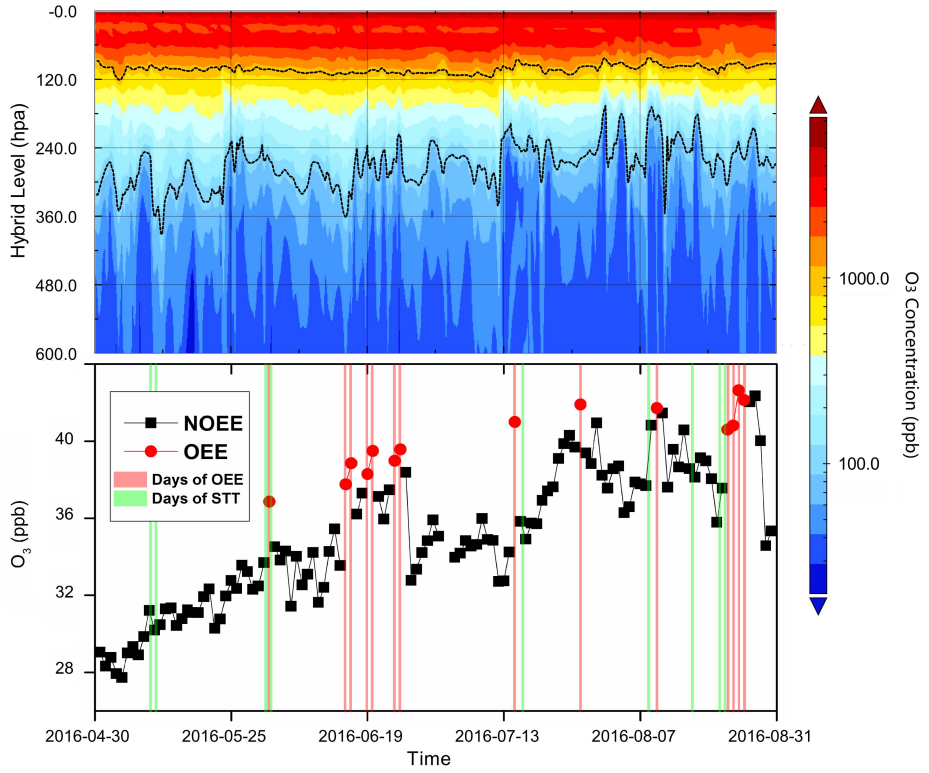


Figure 1 The vertical distribution of ozone concentration over DA was calculated by CAM-CHEM model. During the polar night, the fluctuation of ozone concentration, the distribution of OEE and "deep" STT.

Table 1 The mean wind speed, air temperature, PBL and 550Hpa potential vorticity of OEEs and NOEEs during the polar night.

Days	Wind Speed (m/s)	Temperature (℃)	PBL (m)	550Hpa PV
OEEs	2.77	-33.07	66.46	-3.47
NOEEs	3.13	-35.66	32.29	-2.55

6. Table 1 is not necessary, I suggest to delete it or move it to supplementary.

Reply： According to your suggestion, the original Table 1 was deleted. The comparison of instrument parameters of the three stations is supplemented to replace the contents in Table 1.

7. Fig. or Figure, please use the unified one in the whole paper.

Reply： It has been done.

Specific comments

1. Line 22, what is DA.

Reply： It has been modified.

2. Line 232, only “in this part"? Sept—Sep?

Reply： It has been modified.

3. Line 217-220, “concentration, molar ratio, mixting ratio", please be consistent with each others.

Reply： The three words were unified as **concentration** in the full text.

4. Line 282, from the results above, “it can be seen that" SP was characterized....

Reply： It has been modified.

5. Line 301, the wind of DA were “predominantly" from north and west. Prevalent may be better.

Reply： It has been modified.

6. Line 317, have — has.

Reply： It has been modified.

7. Line 361, As the station name has been abbraviatted, such as Amundsen-Scott —SP, all station names should be checked and properly used.

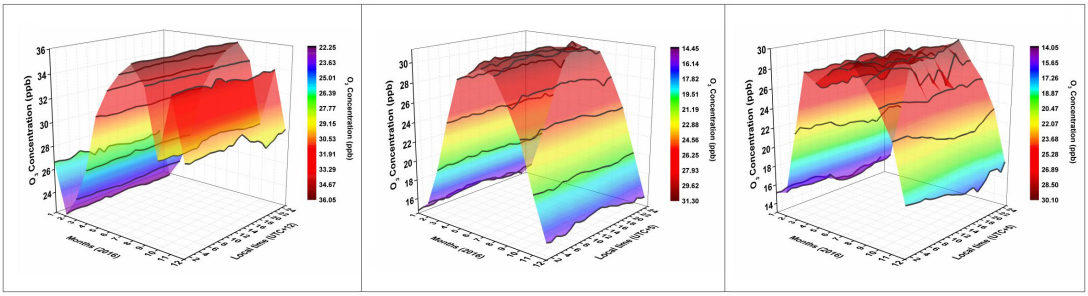
Reply： It has been modified and the station names has been checked.

8. Line 375-376, the last sentence should be rewrite or removed.

Reply： The sentence has been removed.

9. I would suggest improving the readability of the label in Figure 4 if it is possible. It seems to not clear on my copy.

Reply： The figure in the PDF file were compressed, and the clear and non-destructive image was replaced.



10. Figure 5, Standard deviations of mean diurnal variation in near-surface....

Reply： It has been modified.

11. Figure 8, what are the error bars.

Reply： Error bars are the standard deviation of the same cluster. The explanation has been added in the caption.

12. Figure 11, δ should be △?

Reply： It has been modified.