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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Year-round record of near-surface ozone and "O_3 enhancement events" (OEEs) at Dome A, East Antarctica" *by* Minghu Ding et al.

Anonymous Referee #2

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Reviewer's comments on the paper by Ding et al. entitled "Year-round record of near-surface ozone and "O3 enhancement events" (OEEs) at Dome A, East Antarctica" submitted to Atmospheric Chemistry and Physics

The manuscript is within the scope of ACP. It presents scientifically significant material based on surface ozone measurements at three Antarctic stations. Of especial importance are data of measurements at Dome Argus, the highest Antarctic plateau (∼4000 m above sea level). However I have a lot of comments to the manuscript, which are listed below. The manuscript needs major revision.

General comments

1. One significant disadvantage of the manuscript is that some explanations of analysis results look like mere assertions. They are specified in more detail in the specific comments section.

2. The authors repeatedly expressed about importance of photochemical source of near-surface ozone in the Antarctic without providing evidence of it. Presumably they do not have clear idea of photochemical production of tropospheric ozone. See especially page 10.

3. Inconsistent scientific language is often used in the manuscript. English should be generally improved.

4. The potential source contribution function (PSCF) is corrected by multiplying it by some weights suggested earlier by other authors. However these weights are arbitrary and do not have any physical or mathematical reason. They modify arbitrary the distribution of the PSCF but do not allow estimating its statistical significance. I suppose that analysis of the PSCF distribution has to be done with accounting for statistical significance. Estimating statistical significance should take into account the fact that close-in-time trajectories are not independent. Without knowing whether the PSCF distribution is statistically significant one cannot rely on Fig. 6. Perhaps the following paper will help: Shikurov and Shukurova, Source regions of ammonium nitrate, ammonium sulfate, and natural silicates in the surface aerosols of Moscow oblast, Izvestiya, Atmos. Oceanic Phys. 2017, v. 53, p. 316-325, doi: 10.1134/S0001433817030136.

5. Potential vorticity (PV) in the southern hemisphere polar stratosphere is generally negative. However values of PV in Fig. 7 are of inverse sign. This contradicts also to PV distribution in Fig. 10.

6. Values of ozone concentration are given with excessive accuracy. One decimal place is enough.

7. There are no references to Fig. 4 and Fig. 7e in the text.

8. Some works that are referenced to in the text are absent in the reference list.

Specific comments

L45-46. Add reference(s) to confirm this.

L61-62. Add reference(s) regarding the depth of the mixing layer.

L73-76. The downward transport of ozone is important not only on high-altitude terrains. Note also that stratospheric ozone in the polar regions can be transported to the troposphere not only during intrusion events but also as a result of slow but prolonged subsidence. In this sentence, references would be more appropriate to papers concerning polar regions (e.g., Gruzdev and Sitnov 1993; Roscoe 2004, Possible descent across the “Tropopause” in Antarctic winter, Adv. Space Res., v. 33, p. 1048-1052; Greenslade et al. 2017, Stratospheric ozone intrusion events and their impacts on tropospheric ozone in the Southern Hemisphere, Atmos. Chem. Phys. V. 17, p. 10269–10290).

L91-92. Unclear. Why does it lead to overestimation?

L125-126. Specify address.

L154. What is PM?

L180-184. This paragraph is somewhat misleading. It reduces the ozone annual variation to change between polar day and polar night. However Fig. 2 shows that large values of ozone concentration peculiar to polar night are also observed for long time intervals before or/and after the polar night period. Similarly, low ozone concentration values peculiar to polar day are observed after the polar day period.

L185. Wrong statement. According to Fig. 2, Ozone concentration at the SP during polar night is generally less than at the Kunlun station.

L191-192. Gruzdev et al. –> Gruzdev and Sitnov. Oltmans et al. 1976 and Ghude et al. 2010 are absent in the reference list. Probably you mean Oltmans and Komhyr

1976, Surface ozone in Antarctica, JGR, v. 81, p. 5359-5364.

L193-196. Unfounded statements. Please confirm these by references or give clear arguments.

L198-199. Unreasonable explanation. Why weaker variability is due to short polar night?

L200-201. This explanation is not sufficiently reasoned since it refers to literature sources one of which is absent in the reference list and the other is an abstract.

L204-205. This explanation is not sufficiently reasoned since it does not follow from the references given.

L205-206. Misconception. Enhanced variability does not require a special ozone source.

L207-209. The explanation is unfounded.

L231-232. Papers by Oltmans et al. 1976 are absent in the reference list (see comment to L191-192). Gruzdev et al. is also absent in the reference list. However it is relevant and can be added: Gruzdev, Elokhov, Makarov and Mokhov, 1993, Some recent results of Russian measurements of surface ozone in Antarctica. A meteorological interpretation, Tellus, v. 45B, p. 99-105.

L219-234. It would be relevant to refer to Fig. 4 here. One interesting feature in Fig. 4 is the presence of a specific and very regular diurnal variation at the DA station during the polar day period. You could try to associate it with the slope katabatic winds which have diurnal cycle in summer (see aforementioned reference to Gruzdev et al. 1993). Although these winds are most prominent off the plateau they, due to their large horizontal scale, can induce slow subsidence of the air in the boundary layer over plateau and therefore influence the surface ozone concentration because of vertical ozone gradient.

L241-249. This part should be revised or removed.

L241-242. Are hydrocarbons really produced in surface snow?

L243. Wrong reaction.

L245. What do you mean by a chain reaction?

L245-246. Inconsistency: production occurs when loss (destruction) occurs.

L248-249. Why the cold is the reason of the variation?

L259. What is meant by a well-mixed state? Does it have to do with atmospheric mixing?

L258-265. This procedure is not completely clear and internally contradictory. First, it is hypothesized that data falling out of the Gaussian distribution are “abnormal”. But then the Gaussian fit is applied to these data.

L267 and further. Two significant digits are enough.

L285. Do you mean the time or spatial scale?

L296. Air mass circulation? What is it? In meteorology, air mass is a volume of air which covers many hundreds or thousands kilometers in horizontal direction and hundreds meters or a few kilometers in vertical direction.

L297-309. See general comment 4. It is very probable that at least part of the PSCF is statistically insignificant. From my point of view, the main conclusion from the back trajectory analysis is that all the 5-day trajectories depicted in Figs 6a, b are located around the plateau and do not have their origin out of the continent.

L310. Simulated? Did you do your own simulations or use HYSPLIT?

L315. Jones et al. 1999 is absent in the reference list.

L317-318. A very probable reason is that the DA station is higher and therefore closer

to the tropopause.

L319. Do you mean the stratospheric polar vortex? Why do you mention it here? How is it related to ground level ozone?

L354-355. This explanation is unclear.

L359-369. This analysis is vague due to many reasons, see below.

L362-364. Bad language.

L263. September is not presented in Fig. 7.

L363-364. On what basis do you conclude about “extensive turbulence”. The only source of turbulence in polar night is dynamical instability. But according to your data mentioned on page 15 the wind velocity was small during OEE events.

L363-365. I do not agree with this conclusion. Analysis of Figs 7a and c shows that there is no good correspondence between ozone maxima at Fig. 7a and subsidence of potential vorticity in Fig. 7c.

L365-366. The 50-200 hPa layer is not presented in Fig. 7.

L367. On what basis do you conclude that turbulence near the tropopause affects directly ozone? Do you really believe that there is intensive turbulence near the tropopause which is defined as a most statically stable layer?

L374. Which two events? The corresponding number is absent in the table.

L376-377. It is obvious, by definition of OEE, that increase during OEE is larger.

L380. What is PBLs? And what do lower PBLs mean?

Section4.3.3. Do not confuse vorticity with vortex.

L402-403. Negative value cannot be larger than positive value.

Technical corrections

L16. from –> at

L16. Specify that the Zhongshan Station is coastal.

L28. “account for” is probably wrong word.

L100. monitored –> measured

L104. spatial temporal –> spatial and temporal

L115. Give here the full name of the station.

L118. transported –> transferred

L123. related coefficients –> appropriate correlation coefficients

L178. experienced –> is characterized by

L192. stable –> less changeable

L193. variable –> more changeable

L309. pressure altitude?

L332. What is SI?

L336. stratosphere intrusion –> stratospheric intrusion

L337. stratospheric-affected –> stratosphere-affected

L340. define –> determine

L357. transmission –> transport

Figure 6c. The color scale used does not allow distinguishing peculiarities of the PSCF distribution.

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