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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Inter-annual variability of surface ozone at coastal (Dumont d'Urville, 2004–2014) and inland (Concordia, 2007–2014) sites in East Antarctica" *by* M. Legrand et al.

M. Legrand et al.

Michel.LEGRAND@lgge.obs.ujf-grenoble.fr

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REV2: General: This is a reasonably constructed paper largely focused on comparison of ozone measurements over the high plateau versus those in coastal areas over a period of less than a decade. A significant amount of text addressed ozone production versus loss terms in the context of several case studies from balloon profiling. Section 5, describing observations at other sites on the coasts, could be in Supplemental material so that the paper stays focused on high plateau (DC and SP) and provides a comparison with a coastal site (DDU).

AUT: Well, as stated in the introduction, the paper aims to fill the lack of ozone data in East Antarctica (both central and coastal). Also, the OPALE project addressed the

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Discussion paper

topics of oxidants at the central and coastal sites in East Antarctica. The comparison of the different coastal sites is also of great interest and thus we think that this coastal aspect is not at all marginal in the paper.

REV2: In a number of cases, it was hard to identify the “bottom line” or how robust the conclusions were. In terms of trends, in the face of decadal variability in the circulation around Antarctica, it would be useful to show some composite synoptic maps (e.g. high and low ozone at DDU) and assess if the patterns have changed. In some of the discussion, it was easy to get lost in the details. It would also be nice to have some plots from ERA-I showing synoptic patterns rather than abstract statements of trajectories originating from x, y, or z (I looked at vector wind plots and maps of GPH for some of the examples.).

AUT: OK in the revised version we report backward trajectories in summer (high and low ozone values) both for DDU and Concordia to better highlight the role of the transport on ozone levels (in addition to fig. 5 and 10).

REV2: Specific areas for improvement: P4, L9 and L12: “Adjustment” or “change” are probably better words than “correction.”

AUT: We think that correction is correct in this context.

REV2: P6, L7-20: The trajectory length analysis should be supported by a cluster plot showing the actual trajectories (or trajectory origins) overlain on the Antarctic region. This might help identify preferred source areas, if any. For example, do the trajectories follow terrain isopleths to DC or do they originate over the high terrain around Dome A? This could be a supplemental figure.

AUT: As above mentioned we introduced a figure showing traces of backward trajectories from which region air masses reaching Concordia are coming from.

REV2: P6, L21-23: This deserves some discussion of the high NOx fluxes in early December reported by Frey et al and the high surface nitrate at that time vis-à-vis the

NOx-to-O3 conversion process. It is also unfortunate that the Gallee et al. modeling work for OPALE did not include O3 calculations.

AUT: We agree

REV2: P6, L26+: Table I displays total column ozone with no discussion of its importance. Also there needs to be a few words explaining the red highlighted O3 values (the highest values in each time period.

AUT: This Table (including the SAOZ values now not discussed in section 6, see below) was removed. Instead we report backward trajectories for the month of December (2007 to 2014) (a new figure, Fig. 6 has been introduced) to generalize the role of the transport on ozone values as shown for the Figure 4 and 5.

REV2: P6: Was there any evidence of stratospheric intrusions. Although rare, Crawford et al 2001 showed one case in early December with an increase in 7Be while Traversi et al 2014 (Tellus Series B-Chemical and Physical Meteorology) argued for such a signature in nitrate measurements at Concordia.

AUT: At least for summer, vertical ozone soundings from either the South Pole or Concordia do not reveal an importance of stratospheric intrusion for the surface ozone budget. We think that arguments developed by Traversi on nitrate are not directly helpful for the ozone concern (ozone is gaseous species, nitrate coming from the stratospheric reservoir would partly be due to PSCs sedimentation, Be is stuck on sub-micronic sulphate, ...).

REV2: P7, L10: Fig. 5a only shows length of trajectory not its origin. The claim of origin on the "high plateau" needs to be supported, especially where on the high plateau.

AUT: Right and in the new version we removed Table 1 that was not very useful and instead we plotted all backward trajectories for December (over the 7-8 years of the record) as a function of the corresponding ozone range. This figure far better illustrates the importance of the transport.

REV2: Section 3.1.2: The discussion of cases examining the competing effects of ozone production versus dilution in a growing convective boundary took a bit to follow before a final conclusion that dilution dominated the afternoon drop of ozone. The amount of data does not justify any robust conclusions. This should be emphasized.

AUT: We agree and reworded the text as follows: Though further investigations with diurnal vertical profiling over the course of the day are clearly needed, this example suggests that the decrease of ozone mixing ratio often detected near the surface in the afternoon (Fig. 8) may be related to dilution from the increase in the boundary layer depth which counteracts the local ozone photochemical production."

REV2: The authors should also look at the changing meteorology 1-4 January 2010 as a strong ridge developed over DC by 3 January (I looked at ERA-I results). The associated subsidence might account for the shallow mixing layer on 3 January compared to 31 December.

AUT: We agree but it should be at the border of the scope of this paper to describe synoptic conditions associated with day to day change of the vertical profiles.

REV2: P11, L9: ". . .difference in the dynamic of the lower atmosphere. . ." is vague.

AUT: Right, we added in parenthesis (more stratified lower atmospheric layers at the South Pole than at Concordia).

REV2: P13, L4-5: This is confusing: "The time contact of air with sea-ice shown by backward trajectory was twice of 10 hours, twice of 20 hours, and once of 60 hours"

AUT: Right the wording was corrected as "The contact time of air with sea-ice shown by backward trajectory was twice 10 hours, twice 20 hours, and once 60 hours.

REV2: Section 5: This section should discuss the differences in the area of the topographic features that channel air from the interior to the coastal areas. Each of the stations may have distinctly difference source regions associated with local topography.

AUT: We agree and we introduce a new figure to discuss this point (second part of Figure 1). We also added the following: “These differences suggest that ozone rich air masses present over the inland Antarctic plateau are more efficiently transported to DDU than to NM and HA. Fig. 1 shows that the near-surface airflow between the Antarctic plateau and the coastal regions is largely controlled by the topography of the underlying ice sheets and the vicinity of low pressure systems at the coast of the Antarctic continent (Parish and Bromwich, 2007). Consequently, the airflow coming from inland Antarctica is important at DDU and to a lesser extent at SY, but not at NM and HA. Âż

REV2: P12, L12,L20: “downslope” is more general. Low pressure systems on the coast can produce similar downslope conditions. It would be interesting to do a composite synoptic map for high and low ozone conditions at DDU etc.

AUT: Right we now report backward trajectories traces at DDU and discuss the role of topography and surface wind with the help of the second part of Figure 1.

REV2: Section 6. This section is rather speculative and could be tightened up considerably.

AUT: We discarded the discussion of Concordia data with respect to stratospheric change (SAOZ data initially reported in Table 1). Nevertheless since we found an opposite trend to the previous one published by Helmig, the difference has to be discussed a bit. At the end, this section was shortened as far as possible.

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