

Interactive comment on “Long-range transport of ozone and related pollutants over the North Atlantic in spring and summer” by S. A. Penkett et al.

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This paper reports on an extensive set of atmospheric trace gas and aerosol (CN) measurements made over the northern Atlantic during the spring and summer of 1997. It shows a strongly layered nature of pollutant transport, limited mostly to altitudes above 3 km, up to the ceiling of the aircraft around 8 km. In particular, it brings out a number of interesting points, such as a strong anti-correlation between O₃ and H₂O even in airmasses which are not strongly influenced by the stratosphere, which is attributed to being due to the role of H₂O in O₃ loss in polluted airmasses. On the whole, this is an important contribution to the growing literature on transatlantic pollution transport and should be published in ACP, after a number of straightforward revisions as follows.

One of my key concerns is the conclusions which are drawn based on the comparison between the spring and summer observations. Only a few flights were made in each season (very few in spring, a bit more in summer). How large is the day-to-day variability in this region? If it is comparable or larger than the differences in the average measurements for each season, then I don't think the seasonal differences can be seen as statistically significant. The authors should try to characterize the day-to-day variability to the extent possible, and place the seasonal differences in this perspective; I suspect for several gases they may find the seasonal differences to be significant after all, but this needs to be examined first to make the discussion more soundly based. For O₃, the day-to-day variability was examined in Lawrence (Tellus, 53B, 22-39, 2001) based on O₃ soundings from the Azores during NARE, and shown to be considerable, though strongly dependent on altitude. Perhaps published measurements from the Pico, Azores station (Honrath and colleagues) could provide insight into the variability for other compounds at a few km altitude, at the lower end of the altitude range of interest.

Following up on this, a figure with mean profiles (with boxes and whiskers showing the variability) for spring and summer separately would be helpful for the overall analysis.

The finding of a highly layered structure is important but of course not entirely new; it would be helpful to have it put in perspective of some of the major studies done on this, especially those using the MOZIAC data (Newell and others).

It is interesting that the authors find evidence of sufficient NO_x in the Asian plume to suggest significant ozone formation during transport. This is different than the findings of Scheeren et al. (ACP, 2003) for MINOS observations; the authors should comment on what they think might be the reasons for the difference.

The second paragraph of section 2 would be much more useful as a table listing the flight numbers, dates, approximate geographical coverage, working (key) instrumenta-

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tion (abbreviated), and notes. Also, it would be easier for me to follow the section if the objectives of the campaign (the 3rd paragraph) were stated first, then the way in which the flights fulfilled these objectives were outlined (easy to do if in a table).

The last part of section 2, starting "The main theme of this paper" would be much more appropriate to me in the introduction to avoid jumping back in topics from the Azores detachment to the overall priorities.

Abstract: "whether chemical production and destruction processes are occurring" - they are of course occurring everywhere, the question to ask is the degree to which (gross and net magnitudes) they are occurring.

p. 4420-4421, the paragraph describing the flights would fit better into section 2

p. 4422 The CN profile is not plotted; which profiles are meant (#3 or #4)? I find the paragraph discussing this hard to follow without a figure.

p. 4422 "source of ozone..." add "and precursors"

Fig 4 and others - I would find "a/b" labelling easier to follow than "left hand / right hand panel"

p. 4423, the discussion of Fig 4 is hard to follow, it would be more solid if the differences were quantified, e.g., in terms of r^2 for vertical sub-regimes in a table (e.g., from 0-4 km, from 4-8 km, etc.).

p. 4425, although the trajectories do not go below 5 km, the northward sweep over the mid-US is indicative of a cyclonic front and rapid resolved lifting, which implies that there was also likely unresolved deep convection in this region that would have resulted in lifting in reality. In general, it would be very helpful to look at satellite pictures (IR cloud top temperatures) along the trajectories.

p. 4426 "...origin west of the USA...", specify, does this imply the Pacific or Asia?

p. 4426 "significantly less than in the summer flights", this applies except for the

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PCASP vs CN observations, although it isn't clear to me exactly how well these can be compared; this should be commented on, and perhaps it would be helpful to use a different color for PCASP.

p. 4429 "only rarely is any trace", I think "any" would be more precisely stated "a clear"

p. 4430, I think it would be easier to follow if most of the discussion in the paragraph starting "Whereas..." were moved to the instrument description (and shortened to the critical details); the discussion on the next 2 pages (4431-2) would also be a target for shortening, unless it is felt that all the detail is really necessary for specialty audiences.

p. 4434, "Much of the ozone...may suggest a greater role...time of year"; the line of argumentation isn't clear to me here; if there is more NO_x in summer than in spring, then wouldn't one expect even more production of O₃ during transport than during spring? Or is the comparison to the amount that already comes from the continental boundary layer?

p. 4448, fig. 6, it is a bit confusing that the scale switches from NO_y/10 in fig. 4 to NO_y and CO*10 and O₃*10 here, better to choose one and use it for all figs.

p. 4452, Fig. 10; I find the spline smoothing harder to read/compare than simply connecting the points, which gives a better indication of the vertical resolution into which the measurements have been binned (which could be indicated in the caption, along with a legend or at least an indication that the line colours are the same as in the previous figures).

Citations

On p. 4410, along with Wenig et al. (2003), the authors should also cite the study of Kunhikrishnan et al. (GRL, 2004, v. 31, L08110, doi 10.1029/2003GL019269), which shows that these types of plumes are recurrent phenomena originating from both Africa and Indonesia during the monsoon transition periods.

The citation of Lawrence et al. (2003) on p. 4411 really belongs one paragraph earlier, together with the reference to Stohl et al., with an extra specification like "and tagged tracers in an Eulerian model" (after "through backward particle modelling"); for ICARTT, it would be better to give the ICARTT website than referencing my paper.

p. 4420, along with Clarke et al. (1999), the work of de Reus et al. (JGR, 106, 28629–2001) is also an important observation of enhanced new particle formation that should be cited.

p. 4423, it would be helpful if 1-2 studies which make this (over-)simple assumption of a negative correlation between H₂O and O₃ implying stratospheric air could be cited.

p. 4424, wasn't there some MINATROC work (in the ACP special issue) on heterogeneous loss of O₃ on dust which should be cited here?

Is there a website reference for the US Forest Board in Idaho (p. 4409-10)?

Only a few minor grammar corrections:

p. 4409: "twice as much...than in the summer flights"; "than" should be "as"

"USA." should be "USA" without the period (multiple occasions)

p. 4414: no close parentheses ")" after "nitrate"

p. 4415: after "converter", the "-" should be a comma ","

p. 4417 "at 0 K", I suspect this is a typo (0 C or 273 K?)

p. 4417 "Methven (Methven, 1997)" remove the second "Methven"

p. 4419 "and others as where CN..." remove "as"

p. 4426, "Iberian/African, origin" remove the comma

Commas are missing in the following places:

p. 4418, between "Atlantic, particularly"

p. 4422, between "surface, no"

p. 4442, Table 1, second line, between "text, 1s"

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