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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Lightning-produced NO_x during the Northern Australian monsoon; results from the ACTIVE campaign" *by* L. Labrador et al.

L. Labrador et al.

lorenzo.labrador@manchester.ac.uk

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Interactive comment on "Lightning-produced NOx during the Northern Australian monsoon; results from the ACTIVE campaign". Response to referee #2

We thank the referee for his/her useful comments.

1. The ACTIVE campaign lasted over several months. Measurements of CO (Fig. 1), as well as flash counts (Table 3), are presented for the whole campaign; but for NOx, only one measurement day is presented in this study. What is the reason for this restriction? Table 3 reports on high flash counts for Nov. 2005 and Feb. 2006, but the respective NOx levels are not discussed. Are they comparably high? Also a figure like Fig. 1 could be presented for NOx.

R: Unfortunately, during the second part of the campaign, only one flight was made with the NOx instrument as a payload onboard the Egrett to sample active convection during the monsoon season (Another flight with the NOx instrument as a payload was long-range survey flight). Two NOx flight were carried out during the first phase of the campaign, in November/December 2005 and further NOx flight on 10 February during the monsoon break regime, to sample Hector convection over the Tiwi Islands. A paragraph was added in the "Campaign description section to clarify this fact. The Hector storms NOx flights will be discussed in a manuscript currently in preparation. As for the NOx levels sampled during each regime, higher NOx mixing ratios were measured during the pre-monsoon regime flights sampling Hector storms (peak values of the order of 4000 ppt), the average out-of-cloud values a full one order of magnitude lower than those peak values. In contrast, during the monsoon flight, while the in-cloud peak NOx mixing were significantly lower (maximum of 2000 ppt), the difference between average in-cloud and out-of-cloud mixing ratios was of the order of 27%, indicating a much more mixed troposphere, consistent with the more organized and widespread convection present during the monsoon regime along with the possible closed circulation pattern suggested by some of the back-trajectories. A figure showing the average vertical NOx profiles of the two pre-monsoon NOx flights and the vertical profile of the flight discussed in the manuscript, along with a discussion, has been added to the "Discussion" section.

2. The origin of the high mixing ratios of NOx is discussed and cannot be explained by local NOx production. However, the discussion is rather speculative and does not fully exploit additional information that is publically available: a) ATSR measurements show fires in Eastern Australia for January 2006 and up to 15° S and 144° E, i.e quite close to the backward trajectories! A potential interference of NOx from biomass burning, lifted up by convection, has to be discussed.

R: Good point. After searching the January 2006 ATSR file for fires in north-western Australia, we found that indeed there were some fire episodes during that month, how-

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ever, those occurred either or too far south (south of -21 degrees south) or too early in the month (mainly around 4 January) to have significantly affected the measurements on 22 January, if we are to assume the lifetime of NOx in the upper troposphere to be of the order of one week.. On the other hand the CO values measured onboard the Egrett during the flight discussed in the manuscript are in the 45-75-80 ppb range, significantly lower than the 80-100 ppb sampled during the 16 Nov flight, indicating no biomass burning signal in the measurements. A paragraph discussing the possible interference of biomass burning to the NOx signal has been added.

b) The hypothesized accumulation of LNOx along the backward trajectories sounds plausible, but could easily be verified (and partly quantified) by using additional lightning information. In particular, WWLLN data could b used to estimate the number of flashes along the trajectory, and might be related to the observed NOx mixing ratios. I am aware that WWLLN data is with costs, but I assume that at least one of the institutes involved has access. It would spare some speculations!

R: We considered using WWLLN to back the data from the LINET, however, the WWLLDN's detection accuracy is rather low, ranging from $\sim$2-20 km, with a global median of $\sim$3km. Furthermore the network's detection efficiency depends on peak current, being approximately only 30% for flashes with currents of 30kA globally. This, along with the fact that detection accuracy of the LINET is best with 300 km of the station and that the distances travelled by the airmasses sampled, of over 1000 km as suggested by the back-trajectories, precludes in our view the use either WWLLDN or LINET data to derive quantitative results in our study. However, in order to lend support to the idea that airmasses travelled along a convectively-active area and were exposed to lightning during the five days previous to sampling, we have added a 5-panel figure of the back-trajectories on a day-by-day basis with the LINET strokes overlaid on the image IR image for each day. The images suggest that the airmasses sampled on transects 1-5, which originated due east of Darwin, on the north end of the Cape York peninsula, travelled over areas of intensive convection and lightning activity particu-

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larly on 21 and 22 January, as they approached the sampling points, where those on transects 6-9, which originated south of the sampling point, were exposed to intense lightning activity on those as well as on 17 January. This discussion has also been added to the manuscript.

Detailed comments:

p. 10648, 14-15: Close to the backward trajectories, biomass burning was observed!
R: See above

p. 10649, 17: repetition of 10; 9-19 could be perhaps smoothed.

R:The paragraph has been re-worded

p. 10650, 18: TTL

Done

p. 10651, 5: What is the BLC?

R:Blue Light Converter. Spelled out in the text now.

p. 10659, 11: Jaegl'e

Done

Figures: Should generally be larger and of higher resolution (dpi) with lossless compression.

R:All figures are in .pdf format now.

Fig. 5: It is hard to recognize the NOx measurements. What is the use of the additional colorscale (from green to violet), if the measurements are all red?

R: This segment of the flight, overlaid on a satellite image close to the time of the flight, was isolated in order to highlight the high out-of –cloud values during this transect. The new version of the figure, in .pdf format made the transect portion appear much more

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clear.

Fig. 6: In a) and b) there is only one back trajectory visible, not a group of trajectories at different altitudes as discussed in the manuscript.

R: The two figures show the two main types of trajectories that all the point sampled transects resulted in. In the text: "The two back-trajectories shown are characteristic of all the transects where NOx was sampled: airmasses sampled in transects 1-5, between 5000 and 12600 m altitude followed easterly trajectories from the Gulf of Carpentaria whereas those in transects 6-8, sampled above 12600 and 13800 m, followed curved paths starting south of the sampling point"

Please also note the Supplement to this comment.

Interactive comment on Atmos. Chem. Phys. Discuss., 9, 10647, 2009.

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Interactive Comment