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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Influence of corona discharge on the ozone budget in the tropical free troposphere: a case study of deep convection during GABRIEL" *by* H. Bozem et al.

Anonymous Referee #1

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Review of Bozem et al. "Influence of cold corona discharge on the ozone budget in the tropical free troposphere: A case study of deep convection during GABREIL"

General Comments:

Bozem et al., present a case study of deep convection as measured during the GABREIL campaign in 2005. They use both in situ measurements and photochemical box modeling analyses in an attempt to partition measured ozone in convective ouflow between that which is: 1) lofted from the surface, 2) entrained from the FT, 3) produced photochemically, and 4) produced by lightning. The conclusions of Bozem et

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al are that cold corona discharge has a large effect of ozone concentrations in the outflow of deep convection. The paper is well written and the observations are described in sufficient detail. However, there is limited discussion of the implications of high lightning O3 production rates on other detailed deep convection studies. Below are a few comments that need to be addressed in the revised manuscript:

1)The selection of data for the lower troposphere, 0.4-2.8 km appears somewhat arbitrary. What was the justification for this altitude range and what are the implications for narrowing this or expanding it to the surface. Expanding the references in this section would be helpful, specifically with respect to the altitude range for which air is entrained into a developing Cb cloud. Further, it was not clear what spatial regions were used. The entire flight? Just the immediate region surrounding the cell?

2)The authors should address if their method for calculating the O3 production rate per flash is consistent with other field observations. There are many observations of [NO] »> 100ppt in convective outflow, some observations well above 1ppb. Much of this has been attributed to LNOx. If the same methodology as argued here was applied in these studies, the O3 concentrations in the outflow would be very large. Specifically, is there room for this much lightning generated O3 in the DeCaria analysis of STERAO-A? Or other modeling studies focused on O3 and NOx production that have been constrained by field observations?

REF: DeCaria et al., JGR 2000, A cloud-scale model study of lightning-generated NOx in an individual thunderstorm during STERAO-A

3)Some discussion of the near zero isoprene concentrations in the convective outflow is warranted. What does this imply about the vertical velocity within the storm or other sources of entrainment/detrainment that are not considered in this analysis.

Specific Comments:

1) Page 5236 lines 10-15: It would be reasonable to think that mechanistically, the per

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flash NO production rate would be related to the per flash O3 production rates as both involve the formation of atomic oxygen. If O+N2 and O+O2 are the production channels for O3 and NO formation, wouldn't we expect there to be a limit imposed by N2/O2 and the kinetics of these processes? Is this consistent with LO3 / LNO » 1? More extensive references in this section would be helpful

REF: Navarro-Gonzalez et al., GRL 2001 The physical mechanism of nitric oxide formation in simulated lightning.

2) Page 5241 lines 16-18: What is the enhancement in NO that is attributed to lightning? From Figure 2, it looks like 50 ppt? Yet the ozone enhancement that will be attributed to lightning in is ∼20 ppb (page 5242, line 4)? This would imply a LO3 / LNO is ca. 400? Is this reasonable?

3) Section 2.3 Observations of the convectively influenced layer are made during an ascent. As such, the background air, from which the enhancement is derived, is not from the same altitude, but above or below the detrainment region. Given the strong vertical heterogeneity in ozone even in the absence of deep convection, what is the expected impact that this may have on the derived "enhanced O3"?

4) Page 5247: This section needs a more complete error analysis. At the end of the section we have a statement that there is "∼" 35% ozone missing from the budget. This needs to be a number x ± y ppb based on a proper representation of the uncertainty in this analysis. Then, section 5 can discuss the potential mechanisms that this is met.

5) Section 5: This section should then piece apart the unaccounted for ozone. For example, upwards of x ± y ppb could be attributed to missing chemistry; x ± y ppb could be attributed to missing dynamics. At the end of this analysis, a missing ozone number could be evaluated and perhaps assigned to lightning production.

6) Page 5249, line 29: Please remove "∼". This should be a number with an associated uncertainty. The subsequent discussion of the calculation of the limits for the O3

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lightning flash rate should carry the uncertainty that is derived from section 3 and 4.

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