Answer to 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 #2

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We thank Referee #2 for all the helpful comments. The suggestions are included in the revised manuscript and specific comments are answered below.

This manuscript presents aircraft observations of trace gases taken in the inflow and outflow of a deep convective cloud over Suriname, South America. Enhanced ozone was noted in the outflow. The authors have done a comprehensive job in showing that neither photochemistry nor transport can account for this enhancement. They suggest that coronal discharge could explain the additional ozone that was observed in the outflow, and perform calculations to estimate the ozone production per flash. The paper is very well written, and I recommend publication after some minor revisions outlined below.

p. 5241, line 5: change to "....was only ~12% less than the value in the..."
Answer:
Manuscript modified

p. 5241, lines 9-10" "....convective transport to the upper troposphere with only little dilution."
Answer:
Manuscript modified

p. 5247, line 2: "....and entrained air from outside the cloud at the same altitude as the outflow...."
Answer:
Manuscript modified

p. 5247, line 8: "....was entrained from the upper troposphere."
Answer:
Manuscript modified

Conclusions Section: Many deep convective clouds have been penetrated by research aircraft over the last nearly 30 years, and ozone enhancements have very rarely been found in fresh anvil outflow. Why is the ozone production from coronal discharge very rarely detected in field measurements? The authors should at least speculate on why this is the case.

Answer:
In many field studies the convective outflow is probed and analyzed. But additional measurements in the boundary layer at the same time are often missing, which is in general the main inflow region. Also measurements of radicals as for example HO_x, which is crucial for calculating ozone production rates are missing. Therefore, budget analysis similar to the calculations in this study, are difficult. It is then hard to distinguish between different processes to separate contributions from convective transport, entrainment and photochemical production to the observed ozone values. High amounts of ozone in convectively active regions are often attributed to post convective production (*De Caria et al. (2000)*) or downward transport from the stratosphere (*Poulida et al. (1996)*, *Stenchikov et al. (1996)*, *Skamarock et al. (2000)*). Additionally, these studies are mostly for mid-latitude regions where the outflow region is close to the tropopause. The dynamic features associated with deep convection lead to the intrusion of stratospheric air with high ozone mixing ratios into the outflow region. It might be possible that also in these cases, a contribution of lightning and

especially corona discharge was present, but was not addressed by these studies since no gap in the budget analysis might have been present.

Short term ozone enhancements have also been observed from aircraft flights within thunderstorms by Clarke and *Griffing (1985)*, *Zahn et al. (2002)*, and *Ridley et al. (2006)*. *Zahn et al. (2002)* and *Ridley et al. (2006)* both point out the possibility for artificial production of ozone from corona on metal inlet tubes of aircraft instruments. On the other hand, *Zahn et al. (2002)* attributed an observation of a broad plume of elevated ozone to corona discharge by cloud particles.

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