July 23, 2014

Global patterns of lightning properties derived by OTD and LIS by S. Beirle et al.

Reply to Colin Price

Green: Reviewer comment.
Black: Authors' reply.

We thank Colin Price for his constructive comments and suggestions. Below we reply to them one-by-one. Note that the review was obviously referring to the manuscript version which has been initally submitted; in the discussion paper, the technical corrections have already been applied.

Reviewer comment: title: "derived by OTD...."

Authors' reply: Done.

Reviewer comment: line 5: have been

Authors' reply: Done.

Reviewer comment: line 36: where is reference to Boccippio et al., 2000a? This should appear before 2000b.

Authors' reply: The inconsistencies in the references have been fixed.

Reviewer comment: line 38: I think the first measurements were from the DMSP satellite by Orville and Henderson.... They should be referenced

Authors' reply: We have added a reference to DMSP in the introduction.

Reviewer comment: line 112: a large impact

Authors' reply: Done.

Reviewer comment: Tables 2 and 3: How do you explain the large difference in multiplicity (groups per flash) between OTD and LIS? LIS has a mean multiplicity of 12?

Authors' reply: The number of groups per flash is related to, but not identical with flash multiplicity; flashes are clustered from groups both in space and time (see Mach et al., 2007, for details). The reason why LIS has more groups/flash than OTD is because LIS is a more sensitive instrument than OTD. So in effect, OTD misses some of the groups that LIS can see. For details see
Koshak, W. J., M. F. Stewart, H. J. Christian, J. W. Bergstrom, J. M. Hall, and R. J. Solakiewicz, Laboratory Calibration of the Optical Transient Detector and the Lightning Imaging Sensor, J. Atmos. Oceanic Technol., 17, 905-915, 2000.
Boccippio, D. J., W. J. Koshak, and R. J. Blakeslee, Performance Assessment of the Optical Transient Detector and Lightning Imaging Sensor. Part I: Predicted Diurnal Variability, J. Atmos. Ocean Technol., 19, 1318-1332, 2002.

Reviewer comment: Fig.3: The key for the LIS and OTD in 3f) is in black and white, and should be color.

Authors' reply: Color is used to discriminate ocean (blue) from land (red), while shading (dark/light) is used to discriminate between LIS and OTD. We have clarified the figure legend accordingly compared to the initial submission.

Reviewer comment: Fig.3: All plots show the mean of many measurements. What about the standard deviation or "error bars" around the mean. I know this may make the plots messy, but how do we know that the difference between the OTD and LIS, and the latitudinal differences are REAL? Maybe they all not significantly different from each other? This should be at least discussed in the text.

Authors' reply: Following the reviewers suggestion, we have computed standard deviations in addition to the means for all quantities. Standard deviations σ are generally of the same order of magnitude as the mean values for all quantities. Consequently, the standard error of the mean ($\frac{\sigma}{\sqrt{N}}$) is very low for all data points shown in Fig. 3 due to the high sample sizes (minimum 5000 for each 5° latitude bin). The differences between the different curves are thus all statistically significant. However, beyond statistical variability and respective uncertainties, there are systematic errors as well. One key source of uncertainty is the a-priori parameters used in the OTD and LIS clustering algorithms for groups and flashes. As investigated by Mach et al., 2007, the choice of a-priori affects the resulting number of flashes by less than 10%. We thus consider 10% as a realistic uncertainty of the means shown in Fig. 3 (if the number of flashes would be biased by 10%, the mean number of events per flash etc. would be biased by about 10% as well), and added error bars accordingly to Fig. 3. Consequently, the differences between the means from LIS and OTD (relative to the respective global mean value) are insignificant, while differences between land and sea are significant for both OTD and LIS.
We have extended the discussion of uncertainties of mean flash properties in the manuscript.

Reviewer comment: line 252: delete radiance (it appears twice)

Authors' reply: Done.

Reviewer comment: Section 4.5: Please note that Fullekrug et al (2002, Ann. Geophys.) also showed higher intensity flashes over the oceans than the land. They should be referenced as well.

Authors' reply: We thank the reviewer for this hint. We have added a new sub-section on the land-ocean contrast to the discussion, and refer to Füllekrug et al. as well as other studies reporting on intense oceanic lightning.