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Atmospheric Measurement Techniques Discussions



# *Interactive comment on* "Effects of solar activity and geomagnetic field on noise in CALIOP profiles above the South Atlantic Anomaly" *by* V. Noel et al.

**V. Noel et al.**

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## 1 Major comments

The main comment of Reviewer 1 is that most of the conclusions of the manuscript seem to be not new. He suggests that if the aim of the paper is to confirm known results using a different data set, we should state this more clearly. Following this comment, we have amended the text of the article throughout to make it clearer that our objective was to show how it is possible to retrieve known properties of the SAA using documented noise levels in CALIOP measurements. The scientific value of our paper is not in providing new discoveries about our planet, but in exploring a new use

for an existing spaceborne dataset. We argue in our common reply (Sect. 2) that such exploration is a valuable scientific endeavour in itself.

The Reviewer suggests that a possible way to include new results in our paper would be to include additional details on the cyclical nature of noise levels in clear areas, which we suggested was driven by changes in the Earth's geomagnetic activity. However, Reviewer 2 suggests a more convincing explanation for this cycle: the change in PMT temperature with the distance to the sun, a possible influence also suggested by Reviewer 1. Following those comments, we have adopted Reviewer 2's explanation for the yearly cycle (based on his extensive knowledge of the issue) and not pursued further the exploration of noise in clear areas. On the other hand, we have followed another suggestion from Reviewer 2 and documented with more precision how the geographic characteristics of the SAA evolve with time. We hope the new results are of scientific value, even though we argue above that value in the article comes mostly from the technique itself.

The Reviewer was also interested by a discussion of how the noise variability affect the day-to-day analysis of CALIOP observations in clear areas. This is an important concern that we share. However, the present paper deals mainly with the retrieval of the properties of the SAA based on high noise levels. As detailed in our response, this imposes the definition of a relatively high noise threshold to keep only profiles that are significantly affected by high-energy radiation. This is different from trying to define a threshold aimed at the exclusion of profiles that are not usable for the retrieval of atmospheric properties. In fact, our objective is opposite, and Sect. 2 now mentions this point. The amount of profiles affected by such large noise levels is very small in clear areas (below 0.2



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## 2 Specific comments

1. The Reviewer points out that CALIPSO provides two channels at 532nm, one parallel and perpendicular, and requests that we explain which one we used and why. We used noise reports from the 532nm parallel channel, an information which was present in the submitted article (p. 8592, l.3 and 6). The initial report by Hunt et al. (2009) showing the effects of the SAA used measurements in the parallel channel. Noise reports from the perpendicular channels have received much less attention. In particular, it is very unclear at this point how noise levels in the perpendicular channel will be affected by the depolarizing properties of the atmosphere or surface below the lidar. This effect could decrease the usability of perpendicular noise to correctly describe the SAA. It therefore seems a much safer choice to use noise levels from the parallel channel. This is now mentioned in the text.

2. 333m is the horizontal resolution of CALIPSO level 1 data, i.e. the horizontal distance between two vertical profiles documented by the lidar. This is now mentioned in the text and in the caption of Fig. 1. The information has been removed from the caption of Fig. 3 as it was redundant.

3. The Reviewer asks how dependent are the results on the choice of a noise threshold of 200. Following this comment and specific comment 1 from Reviewer 2, we have devised a procedure to make a more informed choice for the noise threshold. See section 1 in our common reply. One of the conclusions of this procedure is that our results within the SAA are not significantly dependent on the choice of the noise threshold. Using a higher threshold however allowed us to reach a finer description of the fraction of noisy profiles close to the SAA center.

4. The switch in level 1 data from version 3.01 to version 3.02 describes the move of the CALIPSO processing code to a new cluster computing system.



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There is no expected or known change to the data, barring unidentified side-effects from changes in compilers and architecture. To extend our study until the end of 2013, we used Level 1 data version 3.30, which included an update to meteorological data but no change to the variables used here (cf https://eosweb.larc.nasa.gov/news/calipso-lidar-version-33-realease).

5. The Reviewer requests a clarification of the description of Fig. 4 (bottom pane). This echoes comment 7 from Reviewer 2. We agree with both Reviewers that the description was confusing. Following the change in noise threshold (see common response), noise fluctuations in clear areas are now very small and the initial detrending brings less value to the analysis. Since it now brings little value and adds confusion to the description, we have elected to only show the noise fluctuation. The confusing section has been removed.

6. The red box in the original Fig. 1 did not cover the whole SAA region because CALIPSO nighttime observations in the southern border of the SAA region were affected by sunlight scattering during the south hemisphere summer (i.e. DJF, see the new Fig. 1A). The SAA box was therefore cropped to avoid strong noise spikes showing up in time series such as the one shown in Fig. 2. Following the change in threshold (see common reply), the effect of solar scattering has been strongly reduced and eliminated in most cases. We were therefore able to delimit an updated region for time series extraction that covers the entire SAA region (cf. Fig. 1A and 1B). The change in threshold also means a better spatial definition of the area affected by noise (see Fig. 1B). We were therefore able to refine the limits of the region to roughly enclose the area with > 50

7. The Reviewer suggests to plot a proxy for solar activity on top of Fig. 2. He suggests using F10.7. Following this suggestion, we have plotted the anomaly in Radio Flux at 10.7cm (obtained from https://celestrak.com/SpaceData/SpaceWx-format.asp and relative to the mean for the 2006-2013 period) on top of Fig. 2



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(and 6), delayed by a year.

## 3 Technical corrections

1. The Reviewer points out a mistake in the spelling of a cited author's name. We have corrected the mistake.

2. The Reviewer points out that units in both panels of Fig. 4 are incoherent. We have removed the bottom panel of Fig. 4 (now Fig. 6), which included the detrended percentages. The confusion noted by the Reviewer has been removed.

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Interactive comment on Atmos. Meas. Tech. Discuss., 6, 8589, 2013.