Atmos. Meas. Tech. Discuss., 6, C4015–C4025, 2014
www.atmos-meas-tech-discuss.net/6/C4015/2014/

Atmospheric Measurement Techniques
Discussions
Open Access

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.

vincent.noel@lmd.polytechnique.fr

Received and published: 17 January 2014

Common reply to both Reviewers

1 Major changes

Following the remarks from both Reviewers, the following important structural changes have been made to the paper:

- We raised the noise threshold to 500 to limit the pollution of our SAA results by sunlight scattering, in order to lower the influence of instrumental changes on noise measurements (a problem raised by both Reviewers). Fig. 1 now includes two maps, showing how the choice of noise threshold influences how noisy profile are geographically distributed. This addresses several issues raised by both Reviewers (see Sect. 4 below).

- The period under study has been extended to the end of 2013.
- F10.7 index data has been used as a proxy of solar activity (request from Reviewer 1)
- two figures have been added to describe more precisely the main geographic properties of the SAA (request from Reviewer 2)
- The second panel of the previous Fig. 4 (now Fig. 6) has been removed, following the combined suggestions of both Reviewers regarding the origin of the noise yearly cycle in clear areas and the increase in noise threshold.

2 About the scientific value of the article

Both reviewers voice the concern that the scientific results presented in the paper are not new. Reviewer 1 points out that the size of the SAA has already been measured by several other means. Reviewer 2 shares this concern, noting that the only new aspect seems to be the seasonal cycle of the noise outside the SAA. To correct this, Reviewer 1 suggests to expand on our results in regions outside the SAA, while Reviewer 2 suggests to expand on our results inside the SAA. The observation from Reviewer 2 that the yearly cycle outside the SAA bears a striking resemblance to changes in the CALIPSO PMT temperature, which are driven by sun-earth distance (an explanation also mentioned by Reviewer 1), seems to us the most likely explanation for the yearly cycle (see specific comment 6 from Reviewer 2). Therefore, we decided to focus on expanding the description of the SAA, as suggested by Reviewer 2. We hope the new results we have included provide scientific value. In this section we argue why we think the scientific value of our submission is not primarily in the results.

We agree that our results did not necessarily bring new scientific discoveries to light. We did not hide this in the submitted article, as we referenced several prior works that present similar results, often with more precision and larger in scope. However, one of our objectives in this article was to show that these results could be duplicated using noise levels from an instrument that is not primarily concerned with this phenomenon (as noted by Reviewer 2). This is now explained more clearly in the text, as Reviewer 1 suggested. We think exploring novel uses for existing spaceborne data is an important avenue of research by itself, even if it does not necessarily bring out new discoveries at the same time. Papers discussing novel uses of existing measurements are not rare (some examples discussing novel uses of downward-looking lidar measurements alone: Flamant et al. 1998, Hu et al. 2008, Josset et al. 2010, Rodier et al. 2013, Lu and Hu 2013).

Moreover, it seems important to us to communicate that CALIPSO data can be used to retrieve the spatial properties of the SAA. This information could be useful to researchers in high-energy space radiation, who could potentially use it to complete other datasets or devise new approaches to unsolved problems in their field (of which we are admittedly no experts). We think our work is also relevant for future spaceborne lidar missions, as the SAA strongly impacts the usefulness of spaceborne lidar profiles in the atmosphere above, and up to this point very little article space has been devoted to this issue.

Finally, we think that exploring novel uses for existing remote sensing datasets fits very well the purpose of Atmospheric Measurement Techniques, which focuses on “the advances in remote sensing, in-situ and laboratory measurement techniques for the constituents and properties of the Earth’s atmosphere”. AMT guidelines state that contributions should “concentrate on new results or techniques”, and we think the sub-

Full Screen / Esc
Printer-friendly Version
Interactive Discussion
Discussion Paper

mitted article respects the technique part.

To sum up, while we agree that our paper does not bring to light much new information about our planet, we argue that 1) it describes a novel way to retrieve spatial properties of the SAA from spaceborne observations, 2) it present new information about how the interaction between the space lidar CALIPSO and the SAA evolve with time, and 3) its results might be useful to researchers using CALIPSO data and/or studying high-energy radiation within the SAA. We think these achievements are scientifically relevant, and fit in the frame of AMT.

3 About the noise outside the SAA

Both reviewers point out the section about noise outside the SAA is weak. Reviewer 2 points out the very low noise levels there make it very hard to distinguish between changes in the radiative environment and changes in the instrumental characteristics, which are affected by the same yearly cycle. In the submitted article, we proposed an explanation for this cycle based on changes in the radiative environment (i.e. the geomagnetic field). Reviewer 1 points out that this explanation is not well justified and that others are possible, including the more simple effect of varying sun-earth distance. This explanation echoes the suggestion from Reviewer 2 that noise variations outside the SAA could be due to changes in how the sun warms up the detectors, i.e. a change in instrumental characteristics instead of natural radiative environment. Following these remarks, we removed the proposition that noise levels in these clear areas are somehow affected by changes in geomagnetic field through a unspecified process, and instead mentioned the at once more mundane and more convincing explanation involving changes in the PMT temperature (Sect. 4). We thank both Reviewers for clearing up our view of the issue.

4 About the noise inside the SAA

Reviewer 2 (W. Hunt) noted that the 200 threshold selected to identify "noisy" profiles is not high enough to totally remove scattered sunlight, as shown by the increase in noisy profiles at high latitudes in Fig. 1. This was noted in the submitted paper. M. Hunt also points out (specific comment 1) this means that sunlight scattering noise originates with photoelectron, which is different from the radiation-induced pulses that generate noise above the SAA. Photoelectron noise will be affected by the receiver gain, which is susceptible to drift. This makes it harder to interpret the observed changes as purely due to changes in the radiative environment of the instrument. Reviewer 1 also raises this issue (comment 3), noting that the impact the chosen 200 threshold has on the results should be discussed. Specific comments 6 from Reviewer 1, and 2 from Reviewer 2, also mention that the southern boundary of the area defined as the SAA in Fig. 1 in fact does not include the entire noisy region. This was initially to avoid increased noise from sunlight scattering in DJF.

Following these comments we attempted to correct these issues by finding a better procedure to chose the cutoff noise threshold, and in the process lessen the influence of sunlight scattering on our results. We extracted from one month of CALIPSO data (January 2007) the profile noise (Parallel RMS Baseline variable) in the four regions shown in Fig. 1, plus a new region in the South Pacific unaffected by the auroras or the SAA (lat 55°S-35°S, lon 150°E-100°E), but strongly affected by sunlight scattering in January CALIPSO observations. The map below shows the percentage of profiles with noise above the 200 threshold in nighttime CALIPSO observations for January 2007, the effect of sunlight scattering is obvious in the South Pacific region (black box).

In each of these regions, we built histograms of noise from individual profiles. Table R1 below shows the fraction of noisy profiles in several ranges for these zones. These numbers show that imposing a 200 noise threshold leaves at least 2% of profiles affected by noise outside the SAA, up to 8% in regions affected by sunlight scattering.

Full Screen / Esc

Printer-friendly Version

Interactive Discussion

Discussion Paper

Raising this threshold to 500 leaves at most 1% of profiles affected by noise in all areas outside the SAA, even in regions strongly affected by sunlight scattering. Unfortunately, it is not possible to use a very large threshold that completely eliminates noisy profiles outside the SAA while retaining noisy profiles within the SAA: the maximum values of Parallel RMS Baseline are very similar within and outside the SAA and both distributions trail off to very high values. Following this study, we choose 500 as the new noise cutoff threshold to identify noisy profiles. We hope that by using this threshold, the noise originating from sunlight scatter has become low enough to at least remove gain changes as a source of possible change in the noise contribution.

Here are the consequences of this choice:

- solar scattering is not noticeable anymore when mapping noisy profiles (Fig. 1b)
- the entire SAA region can now be selected to create the time series of Fig. 2 (relevant to comment 6 from Reviewer 1). We tried to refine the region box to include the entire region where > 50% of profiles are noisy according to the new threshold.
- the point of maximum SAA influence is now easier to identify, since the area of 100% noisy profiles is now a lot smaller (cf. Fig. 1).
- We have included a shorter version of this discussion in the updated paper (Sect. 2), showing first the map of noisy profiles using a threshold of 150 (instead of 200 above) as it appears to be the most commonly used threshold to identify large noise levels.

Within the SAA region defined as in Fig. 1 in our initial submission, the percentage of noisy profiles decreases from the old 200 threshold (57% avg) to the new 500 threshold (38% avg, top row in Fig. R2 below). However, the deviation from the mean is not affected as much (bottom row in Fig. R2). Our results within the SAA appear therefore to be only slightly dependent on the choice of threshold value.

Fig. R2 uses the same SAA region defined as in Fig. 1 in the initial submission, to make clear how much of an impact the threshold change has on the results. The new Fig. 2 in the updated article is slightly different, as it uses the new SAA region made possible by the elimination of the sunlight scattering.

5 References

- Flamant C., V. Trouillet, P. Chazette, et J. Pelon, Wind speed dependence of the atmospheric boundary layer optical properties and ocean surface reflectance as observed by airborne backscatter lidar, J. Geophys. Res., 103, 25137-25158, 1998.
- Hu, Y., Stamnes, K., Vaughan, M., Pelon, J., Weimer, C., Wu, D., Cisewski, M., Sun, W., Yang, P., Lin, B., Omar, A., Flittner, D., Hostetler, C., Trepte, C., Winker, D., Gibson, G., and Santa-Maria, M.: Sea surface wind speed estimation from space-based lidar measurements, Atmos. Chem. Phys., 8, 3593-3601, doi:10.5194/acp-8-3593-2008, 2008.
- Damien Josset, Peng-Wang Zhai, Yongxiang Hu, Jacques Pelon, and Patricia L. Lucker, "Lidar equation for ocean surface and subsurface," Opt. Express 18, 20862-20875 (2010)
- Xiaomei Lu and Yongxiang Hu: Ice sheet surface elevation retrieval from CALIPSO lidar measurements. Proc. SPIE 8731, Laser Radar Technology and Applications XVIII, 87310Z (May 20, 2013); doi:10.1117/12.2026617.

- Rodier, S., Hu, Y., and Vaughan, M.: Sea ice detection with space-based LIDAR, The Cryosphere Discuss., 7, 4681-4701, doi:10.5194/tcd-7-4681-2013, 2013.

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

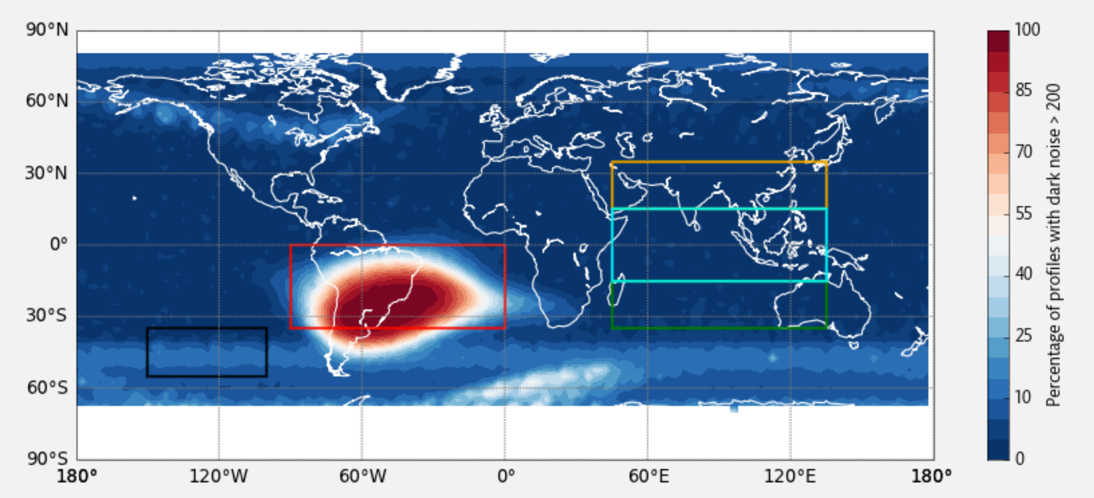
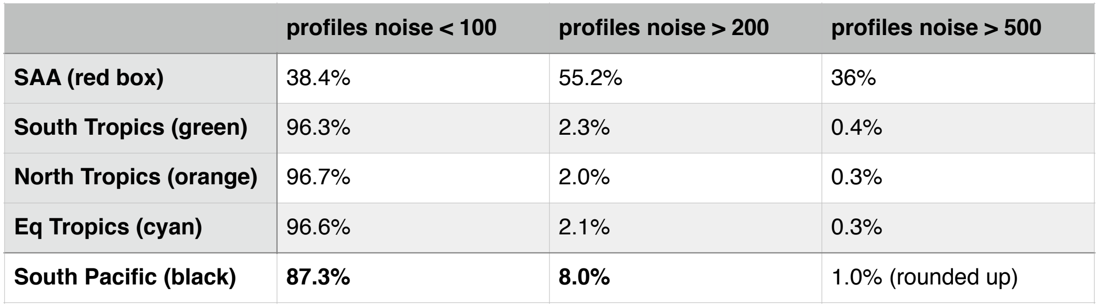


Fig. 1. Fig. R1: percentage of profiles with dark noise above 200 in CALIPSO nighttime observations for January 2007.



	profiles noise < 100	profiles noise > 200	profiles noise > 500
SAA (red box)	38.4%	55.2%	36%
South Tropics (green)	96.3%	2.3%	0.4%
North Tropics (orange)	96.7%	2.0%	0.3%
Eq Tropics (cyan)	96.6%	2.1%	0.3%
South Pacific (black)	**87.3%**	**8.0%**	1.0% (rounded up)

Fig. 2. Table R1: Percentage of profiles with noise in several ranges over the regions from Fig. R1

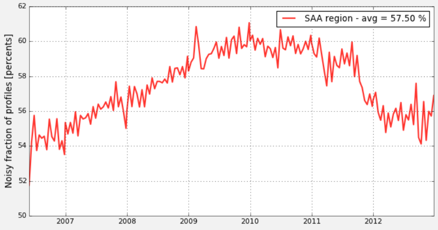
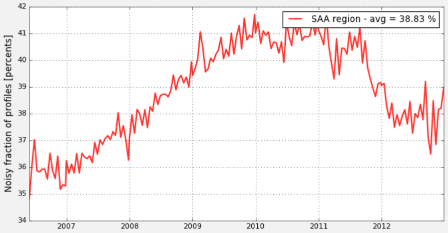
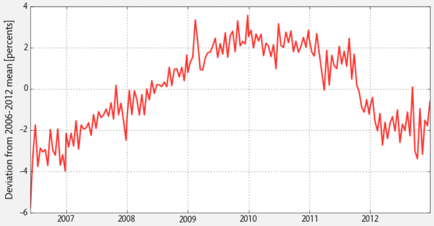
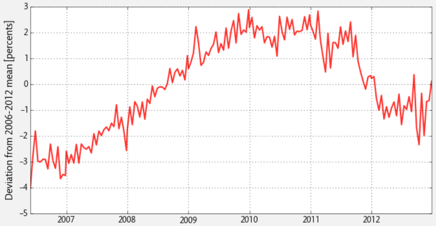
	threshold = 200 (old)	threshold = 500 (new)
fraction of noisy profiles in the SAA (%)		
deviation from 2006-2012 mean (percents)		

Fig. 3. Fig. R2: Fraction of noisy profiles (top) and deviation from 2006-2012 mean (bottom) within the SAA using a noise threshold of 200 (left) and 500 (right).

Full Screen / Esc

Printer-friendly Version

Interactive Discussion

Discussion Paper