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Atmospheric Measurement Techniques Discussions

Interactive comment on "Recovering Long-term Aerosol Optical Depth Series (1976–2012) from an Astronomical Potassium-based Resonance Scattering Spectrometer" *by* A. Barreto et al.

Anonymous Referee #1

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Review for Atmospheric Measurement Techniques

Title: Recovering Long-term Aerosol Optical Depth Series (1976–2012) from an Astronomical Potassium-based Resonance Scattering Spectrometer

Authors: A. Barreto, E. Cuevas, P. Pallé, P. M. Romero, F. Almansa, and C. Wehrli

General Comments:

This paper presents a new long-term data set of AOD at a high altitude observatory (Izana in the Canary Islands), based on astronomical spectrometer measurements. Accurate long-term data sets of AOD are relatively rare and very valuable to the sci-

entific community. The authors suggest that the AOD data set (at one wavelength = 769.9 nm) they have created from these measurements do indeed have high accuracy. However, there are some important aspects of the calibration and data presented that suggest to me that there are significant issues with the data accuracy. First, the calibration of this instrument exhibits very large and rapid changes, on the order of >50% in one year at times (see 2010-2011 in Fig. 3) that are of concern and also large changes in a few months (2008: see green points in the first few months). These large and rapid changes imply larger uncertainty than suggested in the paper, and more detail needs to be provided to make a convincing argument for accuracy (scatter plot validation graphs of Mark-I AOD versus sunphotometers would be useful). Second, the authors have analyzed the data for temporal trends and have found that for 1984 trough 1993 the trend was -0.047 per decade (page 4109 lines 18-20; also repeated in the Conclusions). However this decadal trend is the same magnitude as the average AOD ($\sim$0.05) and it seems highly unlikely for an actual trend in AOD to be equal to the magnitude of the average AOD for the site. Further explanation is warranted regarding this trend. Third, your analysis of the reported AOD data record at Izana suggested only a 0.02 enhancement in AOD due to the Mt. Pinatubo injection of sulfur dioxide into the stratosphere and subsequent sulfate aerosol production. This is a much smaller increase in AOD due to Mt. Pinatubo generated aerosols than has been measured by all other methods as reported in the refereed literature. This apparent lack of sensitivity to the increase in AOD associated with the Pinatubo eruption needs to be explained.

Additionally there is a need for discussion of the cloud screening methodology applied to this AOD data set. If the Langley plot analysis method is the de facto means of cloud screening then this should be mentioned in the paper. If that is the case then all temporally variable aerosols events will be screened from the data record and may lead to sampling biases and differences with other methods. It would also be valuable to plot monthly mean AOD as measured by sunphotometer versus the Mark-I monthly mean AOD, using all cloud-screened observations from each data set separately, not just the data that are coincidently cloud screened in both.

I recommend that this paper be reconsidered for publication after substantial revisions to address the issues I have raised.

Specific Comments:

Page 4094, line 17: The assumption of constant AOD for the Langley technique is most likely met under low AOD conditions and much less probable as the AOD level increases. This needs to be mentioned in the paper.

Page 4097, line 19: The Holben et al. (1998) paper is not an appropriate reference to cite for the GAW network, as this sentence currently reads. Please replace with a GAW network paper.

Page 4097, line 23: Suggest that "...the most adequate..." should be replaced with something like "...important..."

Page 4098, line 10: Suggest that "...ad-hoc..." should be replaced with something like "...various..."

Page 4101, line 6: You say the ratio r is filtered for clouds. Please provide details on the cloud screening methodology and the physical basis for the cloud filtering technique.

Page 4102, line 3: The Holben et al. (1998) paper is not an appropriate reference for the Langley technique. A much better choice would be Shaw (1983; Bull. Am. Met. Soc.).

Page 4102, line 16-18: It is confusing as to why you mention the same AOD threshold (0.3) for both scattering and extinction. More discussion is desired for clarification.

Page 4103, line 1: Please add some discussion on how you separate the fictitious diurnal cycle of AOD from real diurnal cycles that may occur.

Page 4103, line 4-6: Note that an AOD diurnal amplitude of >0.3 is extremely large and if it is due to Vo uncertainty then the uncertainty in Vo is $\sim$30%, which is enormous. Please explain how you can have such large errors as 30% error in your calibration

analysis.

Page 4103, line 13: When referring to the range in Vo you say: "It ranges from 3332 to 2.54 x 10^5." This is somewhat unclear, and more discussion is desirable. Also discuss the fact that there is very large scatter in Vo (blue and green points) about the cubic spline fit in Figure 3, and the reasons for this large scatter.

Page 4103, line 21-24: Should use a 2nd order fit of ln AOD versus ln WL using multiple wavelengths from sunphotometer data to interpolate to the Mark-1 wavelength of 770 nm. This is a more accurate way to interpolate AOD data in wavelength (Eck et al., 1999). Also using multiple wavelengths, say from the interval of 400 to 870 nm is better than using only 2 wavelengths as implied in equation (1) since it minimizes an error in any single wavelength.

Page 4104, line 19: An RMSE of 0.3 is extremely large, suggesting very poor data quality. Is this a typo (0.03)?

Page 4104, line 23-28: It would be useful to add scatter plots here of the Mark-I AOD versus sunphotometer values.

Page 4105, line 7-9: Please note that Nyeki et al. (2012) showed much smaller differences between PFR and AERONET measurements of AOD. From Nyeki et al. (2012): "A comparison of the instantaneous AOD difference between AERONET and GAW-PFR (WL = 500 nm) in 2007– 2010 at DAV resulted in a mean AOD difference of -0.0024 and a root-mean square error of 0.0071."

Page 4106, line 3-5: Please state here whether each point in Figure 4 is a monthly mean.

Page 4107, line 16-18: The peak impact of the Mt. Pintubo eruption on your measured AOD from Mark-I data is only a 0.020 anomaly. Please compare this with other published results on Pinatubo AOD and explain the large discrepancy, as your AOD data from Mark-I suggests much less stratospheric AOD from the eruption than all other

data that has published in the literature (see Russell et al., 1996 and Bauman et al., 2003 (Part 2) for example, plus numerous other published papers).

Page 4109, line 5-8: The sunphotometer precision of AOD measurement is much better than 0.02. You seem to be confusing precision with accuracy (see below). Even then the accuracy of sunphotometer measured AOD is 0.01 or better, so this sentence is quite misleading.

From Wikipedia: In the fields of science, engineering, industry, and statistics, the accuracy of a measurement system is the degree of closeness of measurements of a quantity to that quantity's actual (true) value.[1] The precision of a measurement system, related to reproducibility and repeatability, is the degree to which repeated measurements under unchanged conditions show the same results.[1][2] Although the two words precision and accuracy can be synonymous in colloquial use, they are deliberately contrasted in the context of the scientific method.

Interactive comment on Atmos. Meas. Tech. Discuss., 7, 4093, 2014.