# Referee comment on "Long-term trends in aerosol properties derived from AERONET measurements" by Zhang et al.

Anonymous Referee

This article makes use of level 2 AOD AERONET data from 165 stations located worldwide to conduct a comprehensive and consistent study on trends in aerosol load (including different aerosol types) and possible changes due to the impact of emission reduction policies in developed countries, or possible increases in emissions in developing countries. This is a necessary study for the scientific community as it considerably expands the databases used in previous studies, both spatially and temporally, and includes the latest data from Version 3 of the AERONET algorithm. This information is complemented by the use of level 1.5 AERONET observations of key variables for identifying the radiative effect of aerosols, such as AAOD and SSA, taken from 74 stations located around the world. Therefore, this is a paper that provides necessary and useful information for the scientific community, is well-written, and is supported by high-quality data, perfectly aligning with the scientific objective of this journal. I thus recommend its publication in ACP with some minor and technical comments.

## Minor comments:

General question about the stations selected in this study: I'm curious to know why polar stations are not included in the analysis, despite some of them, such as Opal or Andenes, having long-term observations. It is also evident from Figure 1 that there is a clear bias towards Europe and the United States.

Figure 2 and the stations selected for discussion: The rationale for selecting the stations displayed in this figure is not clear.

General comment about general-global trends results: Given that this paper aims to study general trends on a global scale, I wonder if it would be more appropriate to quantify the results in terms of regions. Currently, the quantification of the observed trends is done only in terms of the different stations defined (in a way that is not clear to me) in Figure 2.

A more general question: Do the authors have any ideas about the general lack of statistical significance of the results found over the African continent? While AOD and AE trends are significant over the Arabian Peninsula, suggesting a possible increase in dust activity in this region, there is no statistical significance over Africa. Some recent studies show declining DOD trends across the Sahara and the Eastern Mediterranean. Do the authors have any insights on this?

**Technical comments:**

Figure 1: Why is panel (a) labeled as "Solar" Level 2.0? I recommend using the terminology "Direct Sun," consistent with AERONET products.

Line 96: I don't understand the relevance of mentioning the "unique data logging" system used in Australia. Was there a problem with the acquisition time of the photometer?

Line 97: In line with the previous comment, the authors mention an unnatural increase in AOD in Birdsville. Are the authors referring to a diurnal cycle or to the Kciclo, as explained by Cachorro et al. (2009) and subsequent papers?

Line 120: Sea salt is not included in the aerosol typing, even though it is one of the most abundant aerosol species in Earth's atmosphere, and its hygroscopicity is an important parameter for quantifying its interaction with solar radiation.

Figure 3: I find this figure (and the following figures that use the same criterion) difficult to understand due to the exclusive use of dots. I suggest that the authors improve the figure by using different symbols to indicate varying levels of statistical significance.

Figure 4: Are the stations used in this figure selected for a specific reason? Are they chosen based on their geographical location, or do they represent significant trends? Additionally, why does Figure 4c contain two different stations in the same panel? It is difficult to distinguish between the two lines. Another suggestion is to include the country name in each subfigure label to help focus the reader's attention on the specific region discussed in the text. This suggestion could also be applied to other similar figures.

Line 135: The authors discuss the different rates of AOD reduction found in Western Europe compared to the values reported by Li et al. (2014). It would be very helpful if they could include the specific numbers found in that paper and also reference Figures 4h and 4g.

Lines 141-144: The authors state that, according to previous studies, a substantial reduction in AOD has occurred in the last decade. However, looking at Figure 4a, for instance, I see a reduction in AOD over the entire period, starting from 2002. Did the authors analyse the presence of any breakpoints in these datasets?

Lines 150 and 162: The authors mention results for "several oceanic island stations" in these two lines, while they also state that sea salt aerosols, the dominant species at these sites, are not included in the analysis. Do they expect a bias in these sites because of this omission?

Line 155: Is the AOD trend 0.066 per decade according to Figure 4e?

Line 158: Is the AOD trend 0.166 per decade according to Figure 4f?

Line 161: In line 96, the authors attribute the problems in Birdsville to the logging system, but now they attribute it to a data screening anomaly. I don't understand either of these terms. I suspect there is a calibration problem (diurnal cycle or Kciclo); can the authors confirm?

Line 194: The discussion introduced here about significant positive trends in some places in Asia is interesting. Why not include one of these stations in Figure 6?

Section 3.2: The two paragraphs starting at lines 241 and 256 are meant to provide the results related to AAOD and SSA, respectively. However, these two variables are mixed throughout both paragraphs, making it difficult for the reader to follow the discussion. I wonder if the authors could present these two pieces of information in a clearer manner.

Line 271: The authors mention a positive SSA trend in Solar Village. However, in Figure 12d, there is a negative SSA trend of -0.034 per decade. Can the authors clarify this discrepancy?

Section 3.3: I recommend using italics or quotation marks when referring to the different types of aerosols, such as "Mixture," "Dust," or "Non-absorbing," for example. I also suggest including the abbreviations SA, MA, and HA in the figure captions or somewhere in the text, since they were introduced in Table 1 (page 6).

Section 4: This section is quite long and difficult to read. Rather than focusing on highlighting the most relevant results of this study, it seems to center on the differences observed with the paper published by Li et al. (2014). I recommend summarizing and streamlining this section to emphasize the important findings of the authors.