

## ***Interactive comment on “Ultra-clean and smoky marine boundary layers frequently occur in the same season over the southeast Atlantic” by Sam Pennypacker et al.***

### **Anonymous Referee #2**

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Review of “Ultra-clean and smoky marine boundary layers frequently occur in the same season over the southeast Atlantic” by Sam Pennypacker et al.

This manuscript presents a really interesting observation using data from a recent field campaign (LASIC) in the southeast Atlantic, such that both the highest and lowest accumulation mode aerosol particle concentrations have been observed in the same season, i.e. the biomass burning season, highlighting the high daily variability of MBL aerosol loading and the level of complexity between aerosol-cloud interactions in the region. In the study, comparisons between the ultra-clean days and the background non-burning days are made, in terms of CO and BC concentrations, LWP, and pre-

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precipitation intensity and frequency, to highlight the role of coalescence scavenging in creating these ultra-clean days in between highly polluted days.

I find the manuscript well-written and easy to follow, with well-organized sections and clear questions to address.

Major comments:

1. Medians with inter-quartiles are used throughout the manuscript, favored over means with standard deviations. I wonder if there is a reason for such preference, and suggest specifying why medians better represent the characteristics of these variables at the daily time scale?

2. The polluted days used for the back-trajectory comparison raised a concern. As most of the ultra-clean days are from the biomass burning season, would it make more sense to compare directly to the polluted days within the BB season, i.e. excluding the non-burning season? Besides, even the upper 5 percentile of daily median Na from December to April aren't really "polluted," are they?

Minor comments:

P2-13, only one set of parentheses is needed here.

P3-9, Is there a reason or any reference suggesting 50 as the threshold for ultra-clean condition? What is the instrument sensitivity of the UHSAS measurements?

P3-14, I suggest including the sampling frequency as well as the instrument sensitivity for CO and rBC measurements.

P3-28, the full name of HYSPLIT should be introduced here, and details on the HYSPLIT runs should be given as well, e.g. what meteorological dataset is used, at what spatial resolution.

Section 2.3, sampling frequency of the laser disdrometer and the microwave radiometer should be given here, and I assume the 2-channel MWR is the one at the AMF1

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site, not the one at the airport, correct?

P4-24, “available LASIC data,” I am curious to know how many available days there are in total, i.e. 41 out of how many days?

P5-5~7, could you label the  $r^2$  values on Fig. 1 c and d?

P5-10, could you provide  $r^2$  values for the hourly correlations in Fig. S1 (on the figure as well)?

P5-16, this sentence is unclear to me, are you saying  $r^2 > 0.65$  is for the early biomass burning season, which is a subset of your data? Please define the early biomass burning season, i.e. which month?

P5-17, “day-to-day the correlation” → “the day-to-day correlation”, and you are talking about CO to Na correlation here, right?

P5-18, “rBC generally follows . . .” suggest adding  $r^2$  values here.

P5-22, agreed, for future work, maybe check with the SP2 instrument mentor, as SP2 is an optical device, and things that are not smoke can still trigger it.

P5-26, “median hourly median”, how about “median of hourly median”?

P5-27, I suggest putting these statistics on the figure as well, maybe in the same color as the ultra-clean days, but in dashed lines, this will help me a lot to visualize the shift.

P6-9~10, see the second comment in Major comments, and how many polluted days are there, based on your criteria?

P6-25, I agree with you on the use of CDF, but I find PDFs are useful to see as well, have you considered showing both of them on the same plot? Well, this could make a really busy plot, I will leave the decision up to you.

P6-29, Why the mean is shown here instead of median, what are the median values of these?

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Figure 4 a, suggest adding those vertical dashed lines in the background when log scale is used, just like you did in figure 5 a.

Section 4, In the discussion, you proposed reasons for the fact that these ultra-clean days are prone to appear during the BB season. Besides the fact that the seasonal peaks in LWP and CF coincide with this time period, I think of the buffering system introduced by Stevens and Feingold, Nature, 2009, i.e. high loading of Na -> strong indirect effect -> higher LWP -> strong scavenging -> remove Na. As you mentioned a two-way aerosol-cloud interactions in the abstract, have you considered this as another possibility?

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