

## ***Interactive comment on “Marine boundary layer aerosol in Eastern North Atlantic: seasonal variations and key controlling processes” by G. Zheng et al.***

### **Anonymous Referee #1**

Received and published: 26 July 2018

The paper provides a thorough analysis of the processes controlling the number concentration of the Aitken, accumulation, and sea spray aerosol modes in the eastern North Atlantic based on a several year data record from a site in the Azores. The conclusions that the free troposphere is a significant source of the Aitken and accumulation modes in the MBL and that sea spray aerosol makes up a small fraction of the total particle number at this site are significant and consistent with recently published papers. One intriguing result, if I am interpreting the analysis correctly, is that a significant impact of biogenic sulfur on the CCN population requires the flux of continental Aitken mode particles from the FT to the MBL.

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Page 2, line 40: add the qualifier "...long term observation IN THE ENA."

Page 4, line 3: change to "...the parameters of which ARE DERIVED from fitting"?

Page 4, line 35: The red trajectories in Fig.1 a, c, and d are all very similar, i.e., originating over the Arctic and passing over northern Canada. Why are they described as "air masses influenced by anthropogenic emissions from North America for fall and winter" and "contribution from Arctic" for Spring. Also – I don't see the "northern Europe air masses" in the trajectories for spring.

Figure 3.b2. and throughout: Figure 3.b2. clearly shows that what is termed here to be "Large Accumulation" mode is actually the sea spray aerosol coarse mode. To be in line with what it actually is and with published literature, it would be more appropriate to call it the SSA, PMA (primary marine aerosol), or primary aerosol mode.

Page 6, lines 23 – 24: The Ac mode  $D_p$  is 161 +/- 25 in summer and 155 +/- 31 in winter. Does the Ac mode really have a larger  $D_p$  in summer than winter given the fairly large standard deviations of the mean  $D_p$ ?

Table 1: There is no instrument listed for MBL height or precipitation rate – unless they are included in the "Vertically pointing K-band..." list of instruments.

Table 2: Why aren't modal volumes included in the table – especially since they are referred to in the text (e.g., page 6, line 25).

Page 11, Line 9: should be Figure 6c.

Page 11, Lines 10 – 12: Has a volume mode with a diameter of 0.6 to 0.8  $\mu\text{m}$  ever been observed in the remote marine boundary layer? It is not clear why it is discussed here as a possibility and why the "LA" mode is not simply called the "SSA" mode.

Page 11, Lines 15 – 16: There are many, many published papers that establish that MBL supermicron particles are dominated by SSA. Why is it being debated/emphasized here?

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Page 12, Lines 7 – 8: There is no need to invoke a lack of correlation of Nat or Nac with wind speed to conclude that SSA is a minor contribution to those two modes. Figure 3 is evidence enough.

Figure 8: Should make it clear in the caption that “(0.1%)” refers to supersaturation level.

Page 12, Line 33: should be “. . .fraction is consistent”, not “in consistent”.

Page 13, Line 2: “The SSA number concentration. . .” What number concentration is being referred to here? The present paper or Quinn et al., 2017? Page 13, Lines 3 – 7: Please clarify what the “above estimation” is. Numbering the equations and referring to them by number would help. Also, please define the  $f_{ac,SSA}$  and  $f_{at,SSA}$  terms. Are these the flux of SSA in the accumulation and Aitken modes, respectively?

Page 14, Lines 13 - 14: Please provide previously published fluxes of DMS in the ENA compared to the remote Southern Ocean. Also – this sentence is incomplete.

Figure 9: What is meant by secondary processing rate? Isn't the SSA flux a primary process, i.e., direct mechanical production?

Figure 9b: This half of Figure 9 does not appear to be explained in the main text.

Figure S5: Please provide  $r^2$  values for these correlations to support the conclusion given on page 15, lines 20 – 21.

Page 16, Lines 11 – 19: Is the correct interpretation here that Aitken mode particles measured at ENA are continentally derived, while the growth of those particles to CCN size in the MBL is due to biogenic H<sub>2</sub>SO<sub>4</sub>? This implies that for ocean ecosystems (at least in the ENA) to have a substantial influence on the MBL CCN population, there must be Aitken mode continental aerosol for the required condensation and growth to occur.

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Interactive comment on Atmos. Chem. Phys. Discuss., <https://doi.org/10.5194/acp-2018-574>,

2018.

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