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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Low cloud reduction within the smoky marine boundary layer and the diurnal cycle" *by* J. Zhang and P. Zuidema

Anonymous Referee #2

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Zhang and Zuidema present a very detailed and insightful analysis of clouds and boundary layer structure in the Southeast Atlantic ocean for situations with low and large smoke concentrations. A lot of different observations are compiled and analysed in order to describe the differences between the two situations. The study is very useful and very well conducted, and the text and figures are very well prepared.

However, I have two larger concerns, and a number of minor concerns, that the authors should address before publication.

1. Causality. At several instances the text suggests a causal link from smoke to clouds and precipitation that is not obvious. The general solution is to describe what is seen and not to assert causality where it is not evident. The most important aspect here is the finding that there is less precipitation when there is more smoke. I am convinced

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Discussion paper

that here the causality is that when it rains, smoke is washed out. The authors propose the opposite causality, i.e. that rain is suppressed due to the smoke. Unless one applies models, it is impossible to prove either causal pathway. So my suggestion is to just use a different language to describe what the observational result is.

2. Aerosol forcing. In my opinion, the difference in the two lines in Fig. 17 is mostly attributable to differences in LWP, so what the authors infer is not a radiative perturbation due to the aerosol-radiation interactions. There are means to infer the radiative forcing. It seems the authors mostly want to assess the clear-sky scattering effect, which is easy to do using the AOD that should be available e.g. from MODIS (or from Aeronet). The authors could use an albedo scaling with AOD perturbation of 0.07 AOD-1 (Myhre et al. ACP 2013, 10.5194/acp-13-1853-2013). If one was to include the effect of aerosol absorption above clouds, the calculation becomes more difficult (e.g Peters et al. ACP 2011 10.5194/acp-11-1393-2011).

p1 l15 “direct aerosol radiation” is probably better as “increase in reflected solar radiation in clear sky attributable to aerosol” or so?

p2 l3 “decks”

p2 l17 “prior”

p3 l17 The authors should define what they mean by “meteorology” here.

p4 l8 In fact the airport is shown in plain

p5 l3 Here and later, “meter” should be abbreviated as “m”. Same later for “seconds” → “s”

p5 l22-23 This sentence I do not understand. One radiometer failed in 2016, and another one was used in 2017? Where is the problem?

p6 l3 The definition “liquid-only water+suspected water” requires slightly more explanation. Is “water” = “liquid cloud”? Or rather open ocean surface?

p6 l10 The difference in the two MODIS retrievals (the one included in the CERES product and the other one used) should be explained, ideally by providing the references for the two retrieval algorithms.

p6 l12 Is the difference between MODIS and SEVIRI due to the fact that SEVIRI resolves the diurnal cycle? i.e. is SEVIRI = MODIS if SEVIRI is sampled at the (four? or more?) MODIS overpass times?

p6 l16 What is the CO concentration background value?

p6 l22 Another obvious explanation is the opposite causality: smoke is low when it is washed out by rain, and larger when there is no rain

p6 l28 What motivates the current choice of thresholds, rather than the actual terciles?

p7 l6 “is clear” - there is no proof for causality here. Why not a more cautious language just stating the co-variation?

p7 l11 “more to a measure of cloud thickness than cloud fraction” - is this in fact all-sky LWP? Because else the sentence is mis-leading: it only is cloud thickness, and not cloud fraction (even if of course ancillary knowledge is that the two are usually correlated).

p7 l21 The causality presumably is the inverse: there is less smoke when it rains

p11 l26 Also LWP differences play a – presumably dominant – role.

p12 l2 So far I would have understood the topic is cloud adjustments to aerosol-radiation interactions (“semi-direct effect”), not so much aerosol-cloud interactions (what was called “microphysical” earlier in this manuscript).

p14 l21 Diabatic warming, not necessarily radiative: precipitation can play a role (and presumably usually does, since mostly radiation acts to cool the layer)

p24 Fig. 3: The median obviously is also shown. (same p25 Fig 4)

p28 Fig. 7: presumably the grey shading indicates sun below horizon?

p35 Fig. 14: slightly more explanation is necessary on how the detrending is done, and on what exactly is the “Delta” value on the y-axis. Why not a deviation from the mean?

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