Review of "Source attribution of cloud condensation nuclei and their impact on stratocumulus clouds and radiation in the south-eastern Atlantic" by H. Che et al.

This study examines the contribution of various emission sources and atmospheric processes to cloud condensation nuclei over the southeast Atlantic stratocumulus region and their impact on cloud properties, including droplet number concentration and liquid water path, and shortwave radiation using a large-scale modeling approach by turning off contributing components in the model one at a time. The manuscript is clearly written and easy to follow. I like the first part of the manuscript very much, i.e. source attribution of CCN, as it demonstrates nicely how does each source contributes to the overall CCN budget over the region, seasonally and annually, especially that these contributions are also examined as a function of the vertical structure of the emission sources and atmospheric processes. However, in the assessment of cloud adjustments and radiative impacts, this vertical structure aspect seems to be overlooked (or not included in the manuscript). Therefore, my main concern lies in the second half of the manuscript, and I suggest mostly minor revisions before being considered for publication.

Overall, I think this is a nicely designed and conducted study, which can make valuable contribution to the field. Here I provided some specific comments and suggested changes regarding my concerns of the manuscript.

Major concerns/questions:

1. The southeast Atlantic (at least the remote part) has a dynamic aerosol/smoke environment during the biomass burning season (*Zhang & Zuidema 2021 ACP*), such that early in the season (June-August), significant amount of biomass burning smoke is present in the marine boundary layer (*e.g. Zuidema et al. 2018 GRL, Zhang & Zuidema 2019 ACP*), whereas late in the season (September-October), as the southern African easterly jet builds up in the free-troposphere (*Adebiyi & Zuidema 2016 QJRMS*), smoke tends to be preferably located in the free-troposphere. This seasonal evolution in aerosol vertical structure can lead to different, even opposite, responses in cloud properties and SW radiation from month to month (*e.g. Zhang & Zuidema 2021 ACP*). In your 2021 ACP paper, you also pointed out the opposite signs of the semi-direct effect between remote and coastal SEA regions, in response to the different smoke vertical distributions.

   Although this study looked at annual and seasonal mean contributions/adjustments, I think it's worthwhile to look at contributions to cloud adjustments and radiative impacts from emission sources and atmospheric processes in different atmospheric layers, e.g. MBL, cloud layer, and FT, as you did for the CCN budget analyses.

   A question rather than a concern:
   Are you expecting (or not) to obtain heterogeneous attributions/adjustments/impacts on monthly scale (for BB at least) if you break your analyses into monthly means (as BB smoke vertical structure shifts from June to October), compared to the BB seasonal mean currently shown in the manuscript?

2. In the Method section, when I read the methodology part, i.e. how contributions from various emission sources and atmospheric processes are calculated, I assume they are calculated by simply taking the difference between baseline simulation and the runs with emissions/components turned off? I think this can be made clearer in the revised manuscript.

   Moreover, how well does this approach (emission/process turn-off) represent contributions from individual sources? For instance, as you pointed out, turning off anthropogenic emissions (or pre-industrial run) will also reduce nucleation processes (due to reduction in H2SO4 precursor), I wonder if there is way to quantify these entangled contributions and perhaps show that such entangled contributions are minimal/negligible compared to the individual ones.

3. Besides LWP and CDNC adjustments, do you also see cloud fraction changes attributed to these emission sources and nucleation processes. I think changes in cloud cover can also contribute to the CRE results you shown towards the end, as you also pointed out (P16, line 13). I tend to think it's worth showing cloud fraction changes in this study.

Minor comments:

P1, line 19, please make sure BB is defined when first used.

P2, line 24-26, I would argue that the radiative effect of BB aerosol can also act to reduce cloud fraction and LWP when smoke is present in the MBL (the cloud "burn-off" effect, e.g. *Zhang & Zuidema 2019 ACP, Ackerman et al. 2000 Science, Che et al. 2021 ACP*).

P11, line 23-24, please check this sentence, I see BB and anthropogenic contributions increase with altitude.

P13, line 19, 'through' → 'throughout'?

P14, line 6-7, is this not shown? I think this type of plot showing contributions from different atmospheric layers, i.e. vertical structure, is worth including.

P15, line 14-15, a rather minor point, just want to point out that an increase in CDNC does not always lead to an increase in LWP, as the sedimentation-entrainment and evaporation-entrainment feedbacks can decrease the LWP for non-precipitating stratocumulus (*e.g. Glassmeier et al. 2021 Science, Gryspeerdt et al. 2019 ACP*).

Figures 3, 5-7, these figures are nice; just a suggestion for the figure titles: perhaps adding the word 'contribution' to the end could help readers digest them faster. For me, I thought they represent absolute concentrations/SS/CDNC/LWP at first when I read the title, then I saw negative values on the color bars (seemed odd), then I realized that the values show differences between additional runs and the baseline run, which are representing contributions from individual sources.