

Geosci. Model Dev. Discuss., referee comment RC1  
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## Comment on gmd-2021-350

Gijs van den Oord (Referee)

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Referee comment on "Earth System Model Aerosol-Cloud Diagnostics (ESMAC Diags) package, version 1: assessing E3SM aerosol predictions using aircraft, ship, and surface measurements" by Shuaiqi Tang et al., Geosci. Model Dev. Discuss., <https://doi.org/10.5194/gmd-2021-350-RC1>, 2022

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### General Comments

The overall quality of the manuscript is in my opinion very good, and a perfect match for this journal. The writing is concise yet detailed, the displayed graphs are of high quality and informative, and the structure is easy to follow. The topic is highly relevant for the audience of GMD and the authors seem to have a great expertise in it. The proposed model evaluation software is a valuable contribution to the field of atmospheric science, deepening the impact of the incorporated measurement campaigns in the modelling community. This package could become an indispensable tool to improve aerosol-cloud interactions, particle formation and other parametrizations in the E3SM – and potentially other GCM's as well. Investments in well-documented, open-source model validation software should be encouraged because they allow the community to get the most out of the available observation data.

### Specific Comments

- Figure 1 caption: I wouldn't call this a workflow but a directory structure. I personally think a workflow – boxes representing functions and arrows representing data flows – is more informative to understand the processing steps, so I would recommend to make such a graph, and perhaps move the current directory structure of Fig. 1 to an appendix
- Line 158: Here I believe it is appropriate to actually mention the applied thresholds in the text.
- Line 186: This information to me seems crucial for applicability of ESMAC Diags beyond

E3SM, and I would therefore clearly state what the package exactly needs from E3SM, on which resolution and which frequency, maybe even in a small table. Also it would be great to have a remark on the applicability of this software to CMIP6 data. On line 490 we again encounter a short statement about generalization beyond E3SM, and also there I believe the paper would benefit from elaborations on the necessary model output for this.

- Line 312: I see a discrepancy between organic aerosol composition during IOP1 at 300 m height (from Fig. 6) and the surface measurements (Fig. 7); where the simulations agree with the former, the difference with the latter is striking when one looks at Fig. 7. The authors have a similar observation for the ACE-ENA campaign and address this on line 349, could that explanation cover the HI-SCALE case too?
- Figure 10: The clipping of the heat map at (I believe) 700 nm due to the range of the (nano)SMPS is somewhat confusing in a comparison graph: maybe the model graph could be cut off there too? Or just limit both y-axes to that threshold?
- Line 390-407: This is an interesting section showcasing the ability to focus upon single events and assess the representation of aerosol-cloud interactions on shorter time scales. Is this event automatically chosen by the package, or does the user need to select this particular day by hand? Are there other interesting events the authors could mention (possibly involving precipitation)?
- Figure 14+15: It is somewhat confusing to me the authors chose to display the aerosol number concentrations for the ship measurements on a log scale and for the aircraft measurements on a linear scale.
- Line 433+446: This section contains a digression into cloud scheme assessment. I understand from the summary that the authors intend to expand this capability of the package, but I would consider dropping this paragraph or moving it elsewhere because it may distract from the main topic.
- Summary section: The authors present an outlook into future development of the package, including more cloud-related diagnostics and supporting high-resolution versions of the model. Here I would expect a few sentences about which other measurement campaigns the authors wish to include in a future version of ESMAC Diags (or if none: why current observation datasets provide a complete assessment of aerosol processes).

## Technical Corrections

- Line 98: SOA and MOA should be spelled out, they are mentioned first here
- Line 154: CPC should be spelled out, it is mentioned first here