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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Building a cloud in the Southeast Atlantic: Understanding low-cloud controls based on satellite observations with machine learning" *by* Julia Fuchs et al.

Anonymous Referee #2

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This manuscript disentagles aerosol effects on the southeast Atlantic stratocumuls deck from meteorological effects through the use of a machine learning approach labeled Gradient Boosting Regression Trees (GBRTs). It is welcome to see a recognition of both impacts, and the use of an innovate approach to discriminate them. The use of lat_src and lon_src is nice. The results are sensible. I do however feel the study suffers from over-interpretation. One concern is the focus on only the cloud fraction and the cloud effective radius (REF) as the cloud properties. While the REF is influenced by aerosol, it is also a function of the liquid water path. A more straightforward physical relationship is that between AOD (CCN) and the cloud droplet number concentration (Nd), which can be estimated as a function of REF and the cloud optical depth. Cloud

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Discussion paper

deepening is likewise better interpreted through the use of LWP than of REF. Another concern is the lumping of July-August-September. It is by now well appreciated that the biomass-burning aerosol is more likely to be present within the boundary layer in July, moving up in altitude through September, when it is more likely to be above the cloudy boundary layer. Different cloud responses would be anticipated as a function of the month. A useful additional analysis is to examine the GBRT results as a function of month, and interpret them as a function of the varying cloud-aerosol vertical structure.

Other comments follow:

1. I am not completely comfortable with the use of the 8-day MODIS L3 product used as opposed to shorter time scale, as the 8-day time scale will average over the synoptic time scale and is far longer than the cloud adjustment time scale of 1-2 days. The authors mention that an 8-day time scale "allows for the large-scale and thermodynamic forcings of cloud properties to be combined", but I remain unclear what this means exactly. In several places in the manuscript the authors refer to processes that occur at much smaller time scales, such as the cloud microphysical response to aerosol. Instead it seems to me the 8-day time scale is primarily capturing a portion of the monthly evolution in the aerosol-cloud vertical structure and seasonal meteorological cycle. Also, the 8-day time scale should be explicitly mentioned in the abstract. 2. an issue with using the relative humidity at 950 hPa is that changes in RH are more likely to reflect co-variations with other factors such as the cold-temperature advection (I suspect this explains the stronger relationship between RH_950hpa and REF in the SE sub-region) and cloud-top inversion strength. Have the authors examined the cross-correlations between their predictors? 3. how is it that the machine learning approach is able to grasp non-linear relationships? The description of the technique presented on p. 4 still seems to present it as a basically linear technique. 4. It is worth mentioning that the larger region encompassing the 4 subregions has been previously examined in Klein and Hartmann 1993.

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