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Atmospheric Chemistry and Physics Discussions

Interactive comment on "The lofting of Western Pacific regional aerosol by island thermodynamics as observed around Borneo" *by* N. H. Robinson et al.

Anonymous Referee #2

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This paper with title "The lofting of Western Pacific regional aerosol by island thermodynamics as observed around Borneo" by Robinson et al presents results of airborne aerosol measurements in upwind and downwind of the Borneo island. It is based on approximately 30 vertical profiles and observations include aerosol microphysics using PCASP for accumulation mode aerosol and CNC for total aerosol number. Aerosol chemistry is based on airborne AMS measurements. It is a nice observational process oriented study combining atmospheric dynamics and transport in lower troposphere together with aerosol microphysical and chemical properties. The main focus is on role of tropical island induced changes in aerosol composition and mesoscale changes in atmospheric dynamics. The data presentation and result part is of high quality, com-

prehensive and descriptive. The discussion and analysis part, however does not on my opinion fully exploit the potential of dataset. Text is clear and well structured. Only some typos should be corrected.

This manuscript deserves publication in ACP, but prior that I would like to ask authors to have a look on following issues.

1) Starting from the end when circulation over the island of Borneo is combined with aerosol data (Fig. 14). I think there is a certain misinterpretation. Mixed layer (ML) in tropics is cloud free and the fact that it is well mixed is due to dry convection up to cloud base, which is often on top or slightly above top of the ML. The cloud convective layer (CCL) above connects ML with lower troposphere. Not like authors state on page 1235, line 5: "Layer One represents a boundary layer well mixed by turbulence and and shallow convection". There is a clear difference in tropics between marine boundary layer (MBL) depth and diurnal cycle compared the ML depth and diurnal cycle over land. MBL height does not change a lot during day and night, however over the land ML varies from couple of hundred meters during night up to one km or more during midday and afternoon. Over the ocean shallow convection seldom shows similar activity compared to the shallow convection over land (thanks to extra latent heat from evapotranspiration and in this case also Borneo orography). Shallow convection over land usually reaches altitudes similar to authors Layer Two and Layer Three border. The peaks in aerosol number concentrations on several figures very likely indicate typical cloud top in the region of profiles and it will be nice if authors can add to the vertical profiles also water vapour mixing ratio or humidity. Where I am heading with this long paragraph is following:

During daytime or when shallow convection is active, ML and CCL (up to top of Level Two) are very closely coupled through clouds. This is nicely shown in this study using changes in aerosol composition. Presented data are as far as I understand from cloud free environment, so it is biased to observations in region of in-between cloud subsidence. It will be nice if authors will use this very nice opportunity and include in discussion paragraph or two on concept of layers using meteorology and thermodynamics compared to layers defined by chemical properties. In the other words, can one say that chemically boundary layer in tropics extends to the top of the shallow convection?

Book by Garstang & Fitzjaralד " Observations of surface to atmosphere interactions in tropics, Oxford University Press is a good material to have a look at. Then also papers by Garstang (Garstang et al., 1988), Betts (Betts et al., 2002) or Martin (Martin et al., 1988) can be useful.

2) At several occasions authors discuss new particle formation, but with the instrumental set up, which covers total aerosol concentration > 3 nm (CPC) and then aerosol size distribution from 0.1 to 3 μm (PCASP) they cannot show, where new particle formation happened. The difference between both instruments can also involve Aitken mode aerosol, which can be many hours or even days old. I do think that authors are correct with their interpretation, but it should be clearly stated that the interpretation is likely right guess based on previous experiments and published work.

3) In experimental part of the manuscript is mentioned that SLR runs were performed. What is the variability on horizontal scale and how does it compare to vertical variability in different layers? Is there a difference between measurements upwind over the ocean and over the Borneo?

4) Discussing changes in aerosol composition, authors often argue with influence of cloud processing and wet removal. There is very likely extensive observational log for each flight maybe including also if there have been in vicinity precipitating and non-precipitating clouds. Can this be used in the analysis?

Minor comments:

Page 1222, Data handling part: With respect to available data, why potential and/or equivalent potential temperature was not used to define atmospheric layers prior in-

volving aerosol in their definition? Both are very good tools to do it and easy to include them in vertical profiles figures. Using aerosols as one of the key parameters to define layers and then discuss role of meteorology using these layers involves a danger of circular reasoning and bias thanks to assumptions how the profile and layers should look like based on aerosol.

Page 1227, line 6: instead of "sub-degree" should be "sub-grid"?

Page 1229, "upwind" and Fig. 6: Several thousand pp*cm-3 is very high aerosol number concentration for MBL. Typically remote tropical MBL contains around 300 – 600 pp*cm-3. Where the air came from? Is sulphate really resulting from DMS oxidation as discussed later in the paper or it can be long range transport of polluted air?

Page 1234, lines 17-18: Cumulonimbus or cumulus formation? Data shown extend up to approximately 5 km altitude. Typical height of Cb clouds in tropics is 10+ km. Then the question is of the described effects on aerosol profiles is due to lateral ventilation of the CB clouds or due to more intensive shallow convection in vicinity of Cb clouds, which is often the case.

Page 1241, lines 15-16: Can Doppler lidar data can be used to show that during MCS-regime the shallow convection, which is likely controlling the exchange between ML and CCL is less active compared to ITC-regime?

References

Betts, A. K., Fuentes, J. D., Garstang, M., and Ball, J. H.: Surface diurnal cycle and boundary layer structure over Rondonia during the rainy season, J. Geophys. Res.-Atmos., 107, Art. No. 8065, 8010.1029/2001JD000356, 2002. Garstang, M., Scala, J., Greco, S., Harriss, R., Beck, S., Browell, E., Sachse, G., Gregory, G., Hill, G., Simpson, J., Tao, W. K., and Torres, A.: Trace gas exchanges and convective transports over the Amazonian rain forest, J. Geophys. Res., 93, 1528-1550, 1988. Martin, C. L., Fitzjarrald, D., Garstang, M., Oliveira, A. P., Greco, S., and Browell, E.: Structure and growth of the mixing layer over the Amazonian rain forest, J. Geophys. Res., 93, 1361-1375, 1988.

Interactive comment on Atmos. Chem. Phys. Discuss., 12, 1215, 2012.