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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Investigation of aerosol indirect effects on monsoon clouds using ground-based measurements over a high-altitude site in Western Ghats" *by* V. Anil Kumar et al.

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Response to the Anonymous referee #1

We would like to thank the Anonymous referee#1 for his valuable suggestions which helped in improving the quality of this paper. Suggested corrections and additions were incorporated in the revised manuscript.

Q1: Page 2, Line 3: Authors should define the parameter (herein, ε) or acronyms when it firstly appeared in the article.

Reply: Thanks for the suggestion and accordingly the parameter ÉŻ is defined on its first occurrence (Pg #2 Line #3) in the revised manuscript.

Q2: Page 2, Line 5: 'They also noticed that this small difference can be noticed'. This sentence should be modified.

Reply: Corrected. (Page #2, Line #6) The above sentence is rewritten as follows: "They also observed that this small σ difference can be noticed if cloud parcels with droplets of same mean diameter were considered".

Q3: Page2, Line 8: 'shows' should be changed to 'show'

Reply: Corrected. (Page #2, Line #9)

Q4: Page2, Line 9: 'slight' should be changed to 'slightly'. There are English editorial issues throughout the paper. Authors should pay more attention on it.

Reply: Corrected. (Page #2, Line #10)

Q5: Page 2, Line 30: The unit of average rainfall should be 'cm/yr'.

Reply: Corrected. (Page #3, Line #9)

Q6: Authors should give a brief introduction about sources and types of aerosols in this site. And the size range of aerosol instrument, ranging from 5nm to 30 um, is very broad. Details about quality of surface instruments and calibration should be added.

Reply: The site is a small village in Western Ghats and tourists come during summer. Also, site is surrounded by thick vegetation with very high rainfall during summer monsoon season. Recent analysis with a chemical speciation monitor shows that sub-micron aerosols mainly consist of organics (77%), sulfates (14%), chlorides (4%). (Page #3, Line #15) Aerosol concentration and size distribution were measured using a Wide-Range Aerosol Spectrometer (WRAS) manufactured by GRIMM, Germany which is a combination of SMPS (Scanning Mobility Particle Sizer), measures particles in the size range 5 nm to 350 nm and APS (Aerosol Particle Sizer), measures particles in the size range from 350 nm to 32 μm. Combining SMPS and APS, the WRAS is capable of measuring the particle concentration covering full size range (5 nm –

32 μm) of atmospheric particles in 72 channels with a minimum scan time of 5 minutes. This is a stand-alone system with an automatic sample air dehumidification and condensate removal system in the condensation particle counter (CPC). SMPS was factory calibrated and APS calibration was done periodically with Polystyrene Latex (PSL) spheres of 300nm and measured by atomizing the hydrosol using a nebulizer; the resulting aerosol is dried and measured the size distribution of the aerosol particles. (The above detailed information is included in the revised manuscript Page #3, Line #25)

Q7: Define of ðİŻijðİŻ¡ in equation 6

Reply: ðİŻ¡ is a dimensionless parameter depends on the spectral shape of the cloud droplet size distribution. In the equation 6, ðİŻijðİŻ¡ is the intercept of the power law fit between ðİŻ¡ and L/N and the exponent bðİŻ¡ gives the dispersion effect. (Page #6, Line #8)

Q8: For Figure 1 and 2, the LWC is fixed about 0.15g/m3, while in Figure 3 the LWC is fixed from 0.20g/m3 to 0.22g/m3. Why don't use the consistent LWC bin?

Reply: As reviewer suggested we have changed the figure 1a and 1b, with consistent LWC bins (0.20 – 0.23) as given in figure 3. (Page #14)

Q9: Page 8, Line 9: explain the calculation step from 0.07 to 21

Reply: According to Liu et.al, 2008, 3$\times$bðİŻ¡ in percentage is the dispersion offset ie, (3 $\times$ 0.07). (Page #9, Line #4)

Q10: Cloud effective radius going down with aerosol concentration increasing might be due to the aerosol indirect effect as the author discussed in this article. It might also be due to the aerosol semi-direct effect (Huang et al., 2006a, 2006b, 2008 and 2010, 2014), which is very popular over the Asia region. Author should clarify this problem in the article.

Reply: Authors agree that semi-direct effect is dominant in Asia region during dry

season where in biomass burning and anthropogenic aerosols are dominant. As this study focuses only during monsoon (wet) season, we can see percentage/fraction of absorbing aerosol is very less compared to other aerosols. Organics and chlorides are dominant during this season and the semi-direct effect due to absorbing aerosol (eg., BC) is comparatively very less as compared to aerosol indirect effect. So the aerosol semi-direct effect is not addressed in this study. (Page #2, Line #23)

Please also note the supplement to this comment:
http://www.atmos-chem-phys-discuss.net/acp-2015-1057/acp-2015-1057-AC1-supplement.pdf

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