Hydrol. Earth Syst. Sci. Discuss., 12, C2062–C2069, 2015
www.hydrol-earth-syst-sci-discuss.net/12/C2062/2015/

Hydrology and Earth System Sciences
Discussions

Interactive comment on "Climatological characteristics of raindrop size distributions within a topographically complex area" *by* S.-H. Suh et al.

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Received and published: 14 June 2015

Title: Since this is a paper dealing with the climate of a particular region, I think that the region (Busan, Korea) should be mentioned in the title. : Thank you for your comment. Actually, the first title name was same as you told. However, I thought that the results of present study is not limited to Busan area.

Abstract: not mentioning radar simulations, see above. : I will add the T-matrix simulation. Thank you.

Line 12: The variable D_m is not described. : I missed the description of the Dm. So,

I'll modify and add the definition of Dm in the abstract as you told. Thank you.

Page 4007: Lines 18-19: How is the microphysical structure more complicated in the high latitudes? Certainly deep convection, which might be regarded as "more complicated", is more common at lower latitudes. : Of course the convective rainfall system has more complicated microphysical structure compared to the stratiform rainfall type due to the strong upward wind. But, what I want to say here is that the microphysical structure of the same rainfall type (stratiform or convective) in the middle latitude region is more complicated compared to the low latitude region because of various atmospheric conditions like baroclinic atmospheric condition, crossing the warm and cold advection and seasonal variations.

Lines 28-29: This is true when the rain rate is held constant, however, convective rain tends to be more intense. Since rain rate correlates strongly with drop size, on average convective rain tends to have larger drop size. : Yes. I absolutely agree to your idea. I will modify and add the sentence more detail.

Page 4008: Line 8: The comment above is supported by this reference from Bringi et al., where large drop size is clearly one of the criteria for classifying rain as convective. : First of all, I'm so sorry for missing of your point. In this paper, I classified the rainfall types into stratiform and convective using the method proposed by Bringi et al. (2003). Of course the rain rate shows proportional relation to raindrop diameter. However, I did not consider the raindrop diameter to classify the rainfall types. Also, continental or maritime-like rainfall was classified only for the convective rainfall not stratiform rainfall type.

Line 15: Are not sea breezes generally associated with mornings rather than evenings? : This is considerable mistake. I will modify the word correctly as your comments. Thank you for your point.

Page 4009: Line 12: is D defined here as the volume-equivalent diameter? : Thank you for your comment. Yes, parameter D is the volume equivalent diameter or volume equivalent spherical diameter. I will modify the word more detail.

Page 4010: Eq. (9): The factor 3.6/10ËĘ3 is apparently here for a unit conversion, but you don't say which unit R is supposed to have. I would consider it preferable to make the equations independent of the units wherever possible and only give the units where needed (for example, for empirical relations such as Eq. (10)). : This is good point. Thank you for your opinion. I missed the detail explanation. I will add the explanation of unit conversion similar to the previous studies.

Page 4011: Line 7: What frequency was used? What are the channels? Please expand the explanation of the instrument. : First of all, channels means the detectable diameter range intervals of POSS. Detectable minimum and maximum diameter of POSS disdrometer is 0.34, 5.34 mm, respectively (Shappard and Joe, 1994). Also, frequency of POSS radar pulse is 10.525 GHz (Shappard, 1990). You could find the detail specification of POSS channels in attached table (Fig. 1).

Line 13: How were snow events detected? How about hail or graupel? : Thank you for your comment. The present study is focused on liquid raindrops. Therefore, we did not consider the snow, hail and graupel.

Lines 14-16: The sentence after (ii) is unclear. I don't understand what "DSD spectra was smaller than five consecutive channels" means. : I'm so sorry to make you confused. It means of that drop should be recorded at more then five channels for one minute.

Line 16: Criterion (iii) effectively introduces a minimum size for the DSD, what is this? : Thank you for your comment. It means that the total drop numbers should be larger than 10 m-3mm-1 at the entire POSS channels.

Line 19: How common were cases with R > 200 mm/h? : Do not understand this question. I'm so sorry for that. For my understanding, when rain rate (R) exceed 200 mm h-1, disdrometer has a tendency to reduce of detection capacity of small raindrops.

Therefore, we did not consider R > 200 mm h-1 to eliminate the noisy data.

Line 21: The threshold below which the DSD is overestimated depends on the disdrometer. Leinonen et al. (2012) used a different type of disdrometer. : Thank you for your opinion. As far as I know, the tendency of overestimating DSD in D0 < 0.5 mm would be caused by characteristics of disdrometer type. And it is also by intrinsic feature of gamma DSD model (Leinonen et al., 2012). Therefore, I think it is possible to use this thresholdin present study.

Line 29: Please describe the results of the POSS-AWS comparison here. : Thank you for your opinion. Figure 3 shows the comparison of between POSS and AWS for entire period of the present study. The correlation is good and RMSE is small about 0.162).

Page 4012: Line 3: What T-matrix implementation was used? Eq (11): This equation holds for the Rayleigh scattering regime; since you have omitted the radar wavelength, I cannot evaluate if it is applicable to your calculations. : I'm so sorry, i missed that. The radar frequency in the T-matrix simulation is considered as S-band (2.85 GHz). We will add the specification of this in the present study detail.

Page 4013: Line 11: Please give the units (mm hËĘ{-1}) for the SD as well. : This is my mistake. Thank you for your guidance. I will add the unit (mm h-1).

Lines 20-24: Here, you seem to acknowledge that the sunrise/sunset times vary considerably and then say that you used fixed times regardless. Since analysis of the diurnal cycle is among the key points of your paper, surely you could use the actual sunset/sunrise times instead, in order to eliminate a known source of error? : The purpose of present study is to find the dominant characteristics of DSD between day and night. Also, main research strategy of present study is statistical analysis using long-term DSD data (four years). Therefore, we used the fixed daytime and nighttime for the entire period. Of course, classification method of daytime and nighttime applied each sunrise and sunset time is more logic and analytic. Consequently, the entire data was divided four seasons which has different sunrise and sunset times (you could find the time in Table 1 and 4) to find more detail characteristics of DSD according to the wind effects. You could find the results of seasonal variations between summer and winter season.

Page 4014: Lines 6-8: The description of Changma should be moved somewhere before first mention of it on the previous page. I suggest moving it to the introduction and expanding it to a paragraph giving a short introduction to the local climate and geography to readers who are not familiar with those aspects of the Korean peninsula. : Thank you for your comment. Changma is local rainfall phenomenon on the Korea region during early summer season (from mid June to mid July) which is similar to the Meiyu (China) or Baiu (Japan). However, in this study, there is major results from Changma data. Therefore, i'll consider your comment.

Page 4015: Line 24: This occurs in many places in the paper but I will just remark on it here: you cannot use a logarithm like this! If you take log(R), the result will be unitless but will depend on the unit of R. Therefore you cannot say that log(R) = 2 mm hËĘ{-1}. All the occurrences of this should be fixed. : Thank you for your comment. Your opinion is absolutely right. I did not consider unit of log parameters. I will eliminate unit of each log parameters.

Page 4016: Line 7: "frequencies" should be "reflectivities"? : Thank you for your comment. 'Frequencies' means the value of PDF not 'reflectivities'. Anyway, I will modify the word more correctly.

Page 4017: Line 24: Eq. (15) is not linear. : Thank you for your comment. Strictly speaking, your comment is right. I'm so sorry to make you confused. However, what I want to say is the relationship between log(Nw) and Dm shows linear relation. I will revise the sentence more correctly.

Page 4018: Line 15: In which direction is the coastline? : The coastline is located to eastern side of the observation site.

Lines 19-21: I am not sure that any conclusions can be drawn about peaks in mu, the data in Fig. 8 mostly looks like noise. : Thank you for your comment. As your comment, I did not find the diurnal characteristics of shape parameter. Therefore, I just explain its maximum and minimum values.

Line 22: While I agree that there is clearly a drop in D_m, 0.1 mm is hardly "dramatic". : Thank you for your comment. Actually, 0.1 mm of Dm is not large in case study. However, in long-term statistical analysis, 0.1 mm is not small different to be ignored the long-term DSD data. Furthermore, in relatively short time scale (diurnal variation), the small difference of Dm (e.g., about 0.1 mm) could be consider as significant difference.

Line 24: Fig. 5a clearly seems to show an inverse relationship. Between D_m and mu. : Yes. However, this explanation in the paper is just limited to PDF analysis (Fig. 8) not for the dominant relationship between Dm and Nw (Fig. 5). Of course, it is common truth is that the Dm and Nw has inverse relationship. However, in Fig. 8(b) and (c), it is hard to find the inverse relationship of time series between Dm and Nw.

Page 4019: Line 8: "A larger number of smaller and larger raindrops": this sentence makes no sense. : I'm so sorry for make you confuesed. it means that the number concentration (N(D)) of relatively small (D < 1 mm) and large (D > 3 mm) raindrop was increased.

Lines 9-11: Since you are already separating stratiform and convective precipitation, it would be interesting to see if there are larger differences between day and night if you also differentiate between convective and stratiform. (In particular: is the daytime convective DSD different from that at nighttime?) : Thank you for your comment. Acturally, in my opinion, data of convective rainfall is considerably small (about 5.68%) compared to stratiform rainfall type (about 90.60 %, you could find the result in Table. 3). Therefore, it is incorrect method to compare between stratiform and convective rainfall type.

Line 24: KST for non-Korean regions? : Thank you so much. Gadanki is located in

India. I'll modify the time from KST to LST.

Page 4020: Lines 2-4: What does Fig. 9f say about the relationship between Z and R? All it seems to do is report the distribution of Z. : Thank you for your comment. Actually, reflectivity (Z) has the proportional to rain rate (R) and LWC. Because of this, we describe the PDF analysis of reflectivity with those of rain rate and LWC. Also, think that there is no worth noticing the PDF of reflectivity.

Page 4012: Line 8: The inverse behavior of Dm in summer vs. winter is an interesting result. This might be a topic for another study, but do you have any guesses as to why this is happening? : Thank you for your interest. In our opinion, considerable difference of DSDs between daytime and nighttime might be come from the wind effects blowing from land or ocean which is already described in conclusion part.

Figure 8: are these the 1-hour averages of these parameters? : Thank you for your comment. The time series of DSD parameters is 2 hr average which is described in main sentence, page 4020 line 19.

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TABLE 3. POSS channel parameters.

Channel	Diameter (mm)	Diameter interval (mm)	Measurement volume ($cm^3 s^{-1}$)
1	0.34	0.05	0.32E+06
2	0.38	0.05	0.44E+06
3	0.44	0.05	0.71E+06
4	0.49	0.05	0.78E+06
5	0.54	0.06	0.10E+07
6	0.60	0.06	0.13E+07
7	0.66	0.06	0.19E+07
8	0.72	0.06	0.24E+07
9	0.78	0.06	0.29E+07
10	0.84	0.06	0.37E+07
11	0.91	0.07	0.43E+07
12	0.97	0.07	0.52E+07
13	1.05	0.07	0.58E+07
14	1.12	0.08	0.69E+07
15	1.20	0.08	0.79E+07
16	1.28	0.08	0.86E+07
17	1.37	0.09	0.10E+08
18	1.46	0.09	0.11E+08
19	1.55	0.10	0.13E+08
20	1.65	0.10	0.15E+08
21	1.76	0.11	0.18E+08
22	1.87	0.12	0.21E+08
23	2.00	0.12	0.26E+08
24	2.12	0.13	0.30E+08
25	2.26	0.14	0.36E+08
26	2.40	0.15	0.41E+08
27	2.56	0.17	0.49E+08
28	2.73	0.18	0.58E+08
29	2.92	0.20	0.73E+08
30	3.14	0.23	0.92E+08
31	3.40	0.28	0.11E+09
32	3.70	0.36	0.13E+09
33	4.15	0.56	0.15E+09
34	5.34	1.84	0.19E+09

Fig. 1. Channels of POSS disdrometer