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Hydrology and Earth System Sciences Discussions

Interactive comment on "Characteristics of precipitation system accompanied with Changma front at Chujado, Korea, 5 to 6 July in 2007" *by* C.-H. You et al.

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Dear Editor,

We are grateful to the referees for their helpful comments, which would be carefully considered in preparing our next revised manuscript. The manuscript has been revised following the comments of the referees. The purpose of the paper has been made clearer, unreadable figures were changed and conclusion has been changed briefly. English grammar has been re-checked and mistakes have been corrected. The modifications made in the revised manuscript following the suggestions of the referees' are given below and supplement.

I hope you will find the paper acceptable for publication in the Hydrology and Earth System Sciences.

Best regards, Dong-In Lee

Response to the comments of Referee #1(C239-239)

General Comments

Referee's comment: A spatial/temporal average of radiosonde data would need to be done to filter out the fast modes in the atmosphere and retain the slowly-evolving balanced part of the flow.

Response: Thank you for your advice. We calculate the TVWS and DVWS using averaged data of radiosonde every 500m with height.

Referee's comment: I suggest using the re-analysis data to give more of a synoptic description of the frontal system. You can compute warm and cold air advection from this data set as well as frontogenesis parameters (shearing deformation) that may help characterize the kinematic structure. In addition, the authors could use the radar retrieved winds to compute some of these parameters and compare them to the re-analysis dataset.

Response: Referee's comment is reasonable. However, the NCEP/NCAR reanalysis data has low resolution of 2.5 degrees by 2.5 degree. It is difficult to represent small scale rainfall system. Our purpose is to find out the meso scale structure of rainfall system and analyze the three rainfall systems within precipitation system maintained for 22 hours. We used NCEP/NCAR reanalysis data for describing the synoptic condition. In the near future, we would like to analyze kinematic structure of the Changma front with fine resolution reanalysis data and numerical simulation.

Referee's comment: I think the authors are reading too much into the differences in the raindrop size distributions. Attributing these differences to warm/cold air advection may not be valid. Rainfall has much smallscale variability that is governed by many

processes (i.e. cloud microphysics including growth, phase changes and fallout). Response: We changed some of conclusions as referee's comment. However, we would like to point out that a possible relationship between temperature advection and rain drop distribution was found.

Referee's comment: It appears that the gamma raindrop size distribution approximates the disdrometer observations very well. I think this is an interesting and useful conclusion to make and maybe should be stated clearer.

Response: Thank you for your positive comments. We revised the conclusions following referee's comment.

Referee's comment: In my opinion, the real strength of this paper is the dual-Doppler analysis (I really liked what was done). Dual-Doppler is not an easy task and I think more focus on this part of the analysis would make the paper stronger.

Response: Thank you for encouraging dual-Doppler analyses. We focused into the relationship between rain drop size distribution and the strength of updraft/downdraft.

Specific Comments

Referee's comment: Fig. 1...Suggest showing the coverage for each radar so we can assess how much overlap exists for dual or tri Doppler analysis.

Response: Yes. We improved Figure 1 as referee's comment

Referee's comment: Was a power law relationship used for particle fall speed estimation? Gamma distributions are found to perform better than power law relationships (Ulbrich and Chilson 1994; Heymsfield et al. 1999).

Response: Regards of the average raindrop size distribution, gamma distribution is better fit than power law in this study. However, we did not retrieve the fall velocity from reflectivity as Heymsfield et al. and Ulbrich and Chilson did. We can get power spectrum and Doppler shift information from POSS(Sheppard and Joe, 1994 in Journal

of Atmospheric and Oceanic Technology, Vol. 11, No. 4).

Referee's comment: What were the boundary conditions chosen for the vertical velocity integrations? The answer you get is sensitive to these boundaries because the assumption propagates through the column.

Response: Yes. If we use upward integration, the errors will be increased by the beam blockage and ground clutter and so on. Therefore, we used downward integration for getting vertical wind.

Technical Comments

Referee's comment: pg. 1527 line 2. Should be "anelastic mass continuity equation".

Response: Yes. We corrected as follows; "And vertical velocity was computed from anelastic equations of continuity using downward integration"

Referee's comment: pg. 1528 line 7. This sentence doesn't make sense. First off, I'm fairly sure you are not calculating reflectivity from the radar. The radar "measures" reflectivity based on the returned power from hydrometeors. How is the data averaged? Do you average horizontally in space to get a vertical profile and then plot that over time? What elevation scan are you showing? Clearer explanation is needed here.

Response: We can get the vertical profile of reflectivity at certain range, since the weather radar which we used has 15 elevation angles per 10 minutes. The volume scan data were converted to rectangular coordinates system which has resolution of 100m in vertical and 1km in horizontal. We searched and found out the grid of Chujado from those data set. Then we could get the time series of radar reflectivity at all height.

Referee's comment: Figures 5 and 6 are hard to read. I suggest adding color shading to the plots in Fig. 5 (since the article is on-line there shouldn't be any extra charge). I suggest making all the panels in Fig. 6 MUCH larger and with better labeling. As it stands now, I can't tell much of anything from Fig. 6.

Response: We made Figures 5 and 6 clear.

Please also note the Supplement to this comment.

Interactive comment on Hydrol. Earth Syst. Sci. Discuss., 6, 1523, 2009.