Response to Reviewer

19 December 2024

Overview:

This paper is an evaluation of precipitation type diagnosis algorithms in a region of complex terrain and coastal influences in South Korea. In general, the paper is well written, and the results are clearly explained. I think that the paper is ready for publication after the authors address some minor issues.

Dear Referee,

We greatly appreciate your positive feedback and the time and effort you devoted to reviewing our manuscript and dataset. We have carefully reviewed your comments and actively reflected them. Thank you again for your help in improving our manuscript.

Best regards,

Wonbae Bang (on behalf of the author team)

Specific Comments:

1. Line 34: Does vaporization = evaporation? I would recommend using evaporation here (as already used elsewhere in the paper), as it is more commonly used in meteorology and will be more familiar to readers.

➔ thank you for confirming. I modify it.

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There is a complex variety of winter precipitation types (WPTs) such as rain (RA), snow (SN), rain and snow (RASN), ice pellets (IPs), freezing rain (FZRA), and a mixture of ice pellets and freezing rain (IPFZRA). Various thermodynamical and microphysical processes can determine surface WPTs in nature. Some microphysical processes, such as melting, freezing, evaporation, and sublimation, change the phase and/or mass of precipitation particles and are diabatic thermodynamic

2. Lines 41-77: I think it would be worthwhile to mention precipitation type diagnosis algorithms that work in conjunction with microphysical parameterizations within numerical weather prediction models. For example, the algorithm described in this paper:

https://doi.org/10.1175/WAF-D-15-0136.1

If you briefly described those algorithms, you could distinguish them from the types of algorithms you are evaluating herein (which are based purely on observations).

➔ Thank you for recommending this good paper. I describe algorithm of Benjamin et al. (2016) at Introduction.

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account situations where the melting of ice particles begins while they are falling, which is especially important for conditions that include low-level temperature inversions. However, because this scheme was developed using global data without regional and/or synoptic weather dependence, it is only valid when used in a globally averaged manner. The validity for the regions of this study has not been investigated in Sims and Liu (2015). In addition to those described here, many other WPT diagnostic methods based on the environment or numerical model data have been proposed (e.g., Ramer, 1993; Baldwin et al., 1994; Bourgouin, 2000; Schuur et al., 2012; Benjamin et al., 2016). As an example, Benjamin et al. (2016) suggested diagnostic logic for WPT using output of the Rapid Refresh (RAP) and High-Resolution Rapid Refresh (HRRR) models such as 2-m *T*, total precipitation, precipitation except graupel, snow-only precipitation, snow fraction, precipitation rate, and so on. The diagnostic logic classifies four WPTs (RA, SN, FZRA, IP) based on a decision tree method.

3. Lines 309-321: Can you explicitly describe h. Is it the overall hit rate? Whereas h' is averaged across three p types? So if one p-type does particularly badly, but only has a few cases, h' will be much lower than h. Is that right? I think the distinction between h and h' could be more clearly described, which would help the reader interpret results.

➔ Yes, your understanding is correct. I also feels description of h, h' in manuscript is insufficient, I modifies more specifically the sentence.

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where O is the number of observed cases, and E is the number of correctly diagnosed cases from among the observed cases for each method. We calculate the h, h_{SN}, h_{RASN}, h_{RA}, and h' for each of the diagnosis methods. Here, h without a subscript is the overall hit rate. h with a subscript (SN, RASN, RA) represents the accuracy for each WPT type, while h' is the average accuracy across all three WPTs. The skill scores are also compared between the mountain sites (DGW and MOO) and coastal sites (GWU, SCW, and BKC), and the effect of vertical T_w profiles on the accuracy of each diagnosis method is investigated to assess the strengths and weaknesses of each diagnosis method.

4. Lines 525-527: It seems like collision-coalescence is an important factor to include in SBM. Can you provide some more detail on its effects and reasons for exclusion?

➔ Yes, Collision-coalescence (C-C) process is also an important factor because C-C process change drop size distribution. However, considering collision-coalescence in SBM is area not yet developed. I add a sentence about importance of C-C process and a sentence about including C-C process in the development direction of SBM.

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optimized SBM simulation significantly increases the amount of melting. However, the maximum diameter with complete melting (~ 1.35 mm) in the simulation is still slightly smaller than the observed D_{max} (~ 1.62 mm). This difference could be the result of three sources of error: northward advection of the rawinsonde due to low-level southerly winds, hardware

calibration issues for the GWU PARSIVEL, and/or the growth of raindrops via a collision–coalescence process. Collision-coalescence is also an important factor for the classification of WPT because the process increases the average raindrop size and decreases the number concentration of small drops. However, this process is not currently included in the SBM owing to algorithm efficiency demands but it is a major area for future improvement.