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Interactive comment

Interactive comment on "A new method to separate precipitation phases" *by* Yulian Liu et al.

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Reviewer #1

The authors analyzed the range and distribution of the threshold temperature of rain and snow based on the CMA daily data, and developed a statistical model to discriminate rain and snow based on the relationship between threshold temperature and latitude, elevation, and annual precipitation. This study provides a practical method to separate precipitation types. However, the introduction needs to be adjusted, and the relationship between threshold temperature and other variables needs more consideration and discussion. R: Thanks for the comments. Section Introduction has been rewritten according to the suggestion and why this work does not consider other variables has been discussed.

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Major Revisions:

1. The title of the paper is too broad. It is suggested to be more specific. R: The title has been changed already to: "A new method for determining the single threshold temperature of precipitation phase separation".

2. The number of key words is too many. Please revise it according to the requirement of the journal (usually not more than 5-6 key words). R: Done. Thanks.

3. L120-L185: (a) These five paragraphs are all about the precipitation type discrimination schemes. The L120-l134 part introduces some precipitation type discrimination methods based on surface variables (air temperature, pressure, dewpoint, relative humidity, and wet-bulb temperature), the following L135-155 part presents the methods based on surface air temperature and upper air temperature, the L156-L162 part introduces the methods based on vertical structure of atmosphere, and the L163-L180 part presents the surface variable based methods again (single threshold temperature and double threshold temperature), and finally analyzes the difficulty of humidity based method (which is also surface variable based method). These parts of content are about various kinds of method and mixed together. The structure of these paragraphs needs to be adjusted. R: Thanks a lot for the constructive suggestions. We have almost rewritten the paragraphs, and we hope that the revised introduction reads much better than before.

(b) L120-L185: This part has reviewed the various methods of separating different precipitation types. It is surprising that the recent work about precipitation type discrimination (Ding et al., 2014) has not been cited in the paper, which finds out that the precipitation type is dependent on the temperature, elevation, and relative humidity (i.e., the threshold temperature for rain and snow increases with the increasing of elevation, and the probability of sleet increases when relative humidity increases), and develops a dynamic threshold scheme to discriminate rain, sleet, and snow. Ding, B., K. Yang, J. Qin, L. Wang, Y. Chen, and X. He, 2014: The dependence of precipitation types on surface elevation and meteorological conditions and its parameterization, J. Hydrol., 513, 154-163, doi:10.1016/j.jhydrol.2014.03.038. R: This paper has been cited in the revised version of the manuscript. This is indeed an important publication, and we have also made a citation of it in section Discussion of the new manuscript.

(c) L153-155: This sentence is a little abrupt here. It seems not closely related to the last sentence or paragraph, and also does not have any reference cited for the sentence. R: This sentence has been deleted.

4. Section 2 “Data and methods” could be divided into two sub-sections like “2.1 Data” and “2.2 Methods (or data processing)”. Further, the flow diagram of the analysis needs to be explained more clearly. R: The section has been divided into two parts according to the suggestion. Another change in the section is the remove of the flow chart.

5. L335, L338, and L339: Actually, these three values are 90 percent instead of “95 percent”, since the authors gave the percentages of snowfall, rainfall, and sleet between the 5 percent and 95 percent of the event profile, respectively. R: The three values are 95%. They are consistent with the contents of the related figures and tables. Thanks for the comments.

6. (a) In L349, the minimum daily mean temperature of rainfall at Zhaozhou station was 3.4âŮęC; however, it was -3.4âŮęC in Table 2. (b) The maximum daily mean temperature of snowfall at Balikun station was -5.1âŮęC in L352, but 5.1âŮęC in Table 2. (c) The minimum daily mean temperature of sleet at Shiquanhe station was -3.3âŮęC in L357, but -5.3âŮęC in Table 2. Please correct them, and also check the other numbers in the paper carefully. R: Many thanks for the careful reading of the manuscript. These problems should not escape from our eyes. We have corrected the errors, and checked again through the text.

7. Fig. 4d, if reversing the positive and negative, the spatial distribution of (Trn-Tsn) would be also similar to those of maximum daily mean temperature of snowfall (Fig. 4a), minimum daily mean temperature of rainfall (Fig. 4b), and the average daily mean

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temperature of sleet (Fig. 4c). R: It seems similar to one another. Thanks for pointing this out.

8. Fig.5, about the positive deviation of the snowfall amount by the threshold temperature (Tt-d), is there any possible that because there is occasionally snowfall occurred at high temperature in these areas, which may pull up the threshold temperature by the few snowfall events? If the temperature range to settle the threshold is enlarged (larger than Tsn âĹij Trn), for example, ranking from (Trn-2)âŮęC to (Tsn+2)âŮęC, and settling the threshold temperature from this ranking profile, maybe this deviation could be reduced. R: It is possible that the occasionally occurred events in higher temperature environment cause uncertainty in some extent. However, to enlarge the temperature range will leads to other problems. Anyway this is a good question, and we would make some experiments in future.

9. (a) L452: the authors stated that "and it decreased from east to west in areas west of 90âŮęE", however, from Fig. 6, it seems the threshold temperature decreased from south to north in the areas west of 90âŮęE. (b) Actually, the L451-L452 sentence has the totally same meaning with the L453-L456 sentence, only with the different demarcations of longitude values (i.e., 90âŮęE and 105âŮęE, respectively). R: Yes, you are right. Actually it decreased from southeast to northwest. We have revised the description of the paragraph in the new version of the manuscript.

10. In Section 3.3, the authors stated that the threshold temperature (Tt-d) is related to longitude, latitude, altitude, annual precipitation, annual mean air temperature, and annual relative humidity. However, from R2 in Figure 7, altitude is most closely related to the threshold temperature (Tt-d), and then the relative humidity is. Although latitude and longitude showed some negative relationship with the threshold temperature, actually, from Fig. 6 "the distribution of the threshold temperature", the relationship between the threshold temperature with longitude and latitude is also related to that with altitude. Since in China, the mean altitude decreases from west to east and from south to north, as well as the decreasing trend of threshold temperature with decrease of altitude, that

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is why threshold temperature decreases with the increase of the longitude and the increase of the latitude. R: We agree to the comments. It is possible that the relationship of the threshold temperature with longitude and latitude is also related to the variations of altitude and relative humidity in the study region. The altitude and relative humidity generally also decrease from west to east and from south to north, and the altitude and relative humidity have better correlations with the threshold temperature. These may be the reason why threshold temperature decreases with the increase of the longitude and latitude. If so, altitude and relative humidity may be the more important factors in determining the threshold temperature. We have added a paragraph to discuss about this. Thanks a lot.

11. Also in Section 3.3, I think another explanation is more reasonable for the negative relationship of threshold temperature with the relative humidity. In the arid area, where the relative humidity is lower, when the snow particle is falling from the same condensation height, since the relative humidity of atmosphere is lower, the difference of specific humidity between the particle surface and the air is larger, and therefore the heat absorbed by the snow particle is easier to be released in the form of latent heat flux. In that case, it needs more energy, i.e., higher surface air temperature, to melt the snow particles. That is why the threshold temperature is relative higher in the arid region (i.e., lower relative humidity region). R: This is an interesting alternative explanation. However, the further examination of the mechanism could be done in future studies. We added a sentence in the end of the paragraph to embody this possibility.

12. From the above Question 10, the threshold temperature has close relationship with altitude, but not latitude or longitude. Beside, from R2 in Fig. 7c, the relationship between the threshold temperature and the annual precipitation is also relative low. Therefore, the statistical model of threshold temperature derived from latitude, altitude, and annual precipitation (Equation 1) needs more consideration. Actually, from Equation 1, the impact from R (annual precipitation) on Tt-p (threshold) is relative low comparing with N (latitude) and H (altitude). And the impact of N could be also com-

bined to H. R: We agree with you at this point. It should be good to directly use altitude and relative humidity as predictors. However, as we discussed above, in a larger scale, the relative humidity data are unavailable for use in studies, and we have to apply precipitation data instead if the method developed in this study is to be applicable for following works.

13. L575: What is MSRE short for? Do you mean RMSE? R: Yes. It is for RMSE. Corrected already.

14. L584-L585: from Figure 9, it seems the deviation is generally positive, no matter the low threshold temperature area or the high threshold temperature area. R: Yes. More areas have positive deviation. However, the deviation is generally larger in the low threshold temperature area, and smaller in high threshold temperature area.

Minor Revisions:

1. Please check the references. The reference “Stefan et al. (2008)” (L123) has not been included in the reference list. R: This was wrongly cited for Kienzle er al. (2008). Corrected in the revised manuscript.

2. L146: phrases => phases R: Corrected.

3. L193: was = > were R: changed already.

4. L211-L214: daily data of 839 national stations’ air pressure, surface air temperature (daily mean, daily maximum and daily minimum), precipitation, evaporation, relative humidity, wind speed, sunshine hours, and 0-cm ground temperature => daily data of air pressure, surface air temperature (daily mean, daily maximum and daily minimum), precipitation, evaporation, relative humidity, wind speed, sunshine hours, and 0-cm ground temperature from 839 stations R: Thanks. Changed.

5. L228-L229: greater than or equal to 1 mm => no less than 1 mm R: Corrected already.

6. L233: sleet, snow => sleet, and snow R: Done.

7. L234: registered => recorded R: Corrected.

8. L247: isotherm of in 3âŮęC => isotherm of 3âŮęC R: Corrected.

9. L336: less => lower R: Corrected.

10. L361: than instantaneous air temperature => than the instantaneous air temperature R: Corrected.

11. Fig 4: (a) the symbol "Tsm" and "Trn" is suggested to be added in the figure caption and in the figures to be more clearer; R: We have added it to the caption and in the figures, according to the suggestion.

(b) the caption for Figure 4d could be revised as "difference between the maximum daily mean temperature on snowfall day and the minimum daily mean temperature on rainfall day" or "difference between Tsm and Trn"; R: Changed already.

(c) L397: occur => occurs R: Corrected.

12. L384: Trm-Trn => Tsm-Trn R: corrected.

13. There are several different spellings as "Qinghai-Xizang Plateau" (L557), "QinghaiTibet Plateau" (L557-L558), and "Qinghai-Tibetan Plateau" (L539). They need to be unified. R: These have been checked, and changed to "Qinghai-Tibetan Plateau".

14. L660 (two places): phrases => phases R: Corrected.

Please also note the supplement to this comment:
https://www.hydrol-earth-syst-sci-discuss.net/hess-2018-307/hess-2018-307-AC1-supplement.pdf

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