

Anonymous Referee#2:

I am very grateful that the referee gave me a lot of valuable advice, the following is the comment and response.

Comment: This study quantifies how utilizing cloud base and cloud thickness estimates from MWCR and radiosonde data is beneficial for improving temperature and humidity retrievals derived from MWR measurements. In general, the methodology is unclear.

There is decent discussion of the retrievals and the various measurements but it is unclear how the BT and cloud information derived from the radiosonde data is used in the retrieval process. A reader should be able to read a clear, consolidated description of the methodology stating how the retrievals were developed.

Response: The retrieval method based on the neural network algorithm. Ensure that the other conditions unchanged, and the cloud base height and cloud thickness were set into the input layers as the independent elements. And the retrieval results are compared with the retrieval results without the cloud base height and cloud thickness data.

The description may be not clear, I have revised it, please review.

Comment: One of the key findings is that adding cloud macrophysical measurements improves the retrieved temperature and humidity profile accuracy. While it is useful to quantify this truth, the paper needs to put the current study in context with previous findings. How this approach is different or better than previous retrievals (more references are needed to put this paper in context) will help make clear the purpose of the paper.

Response: I realized the reported literature is really poor, I have modified this part. In the revised manuscript, the source and development of the neural network algorithm were described. The overview of the different instrument joint detect atmospheric profiles have been shown, and the part of link of this study with previous studies is added, please review it.

Comment: In addition, adding the location of the study will clarify in what environment these measurements were taken and suggest how applicable they are to other locations.

Response: The location of the study is nanjiao, Beijing. In the current study, I don't think this method could be suitable at the place which is high humidity on the ground, because the estimated cloud by radiosonde may be large error. I think this method should be applicable at the other environment.

Comment: These changes require major revisions.

Specific Comments:

Section 2 should include more detail regarding the measurements. Was the MWR calibrated via a tip-curve technique, LN2 calibrations, or a combination of both? What

is the threshold of the MWCR reflectivity (in dBz) to detect cloud base height and cloud thickness? How does changing this threshold affect the comparison in Fig 2?

**Response:** In the revised manuscript, I add the detail about the RPG-HATPRO. The MWR calibrated via a combination of tip-curve technique and LN2 calibrations. The threshold of the MWCR reflectivity is -30dBz, the setting of threshold is fixed value, I'm sorry that I have not change it.

**Comment:** Section 2.2 discusses the “pre-treatment of sounding data”. Why is the simulated BT not included in this section? It would make sense to discuss all the measurements and radiosonde-derived parameters together before introducing the retrieval methodology.

In table 1 what is the average bias of the 60 samples of each MWR channel compared to the radiosonde-derived BT value? Bias of the MWR BT will affect the accuracy of the temperature retrievals.

**Response:** I have revised. The simulated BT is included in “pre-treatment of sounding data”. In the table 1, I added the average bias of the MWR and radiosonde-derived BT.

**Comment:** Section 3 is titled “Retrieval methodology” and is where I expect to find clear explanation of the retrieval processes. Yet, prior to this section (pg 3, line 14-19) a training dataset is introduced, which is based on the sounding data. It seems that the description of the training data set should be included in the methodology section and the description of the data sources should be introduced prior to this section. I do not know what is meant by: “Initially, the pre-treatment of the radiosonde data focused on the removal of rainy or uncertain weather conditions” (pg 3, 15-16). There needs to be a clear, consolidated explanation of the retrieval and the training dataset used in the retrieval.

**Response:** I have revised that “simulated BT based on MonoRTM” is included in “pre-treatment of sounding data” now. And “Retrieval methodology” should be only the description of neural network. I added the explanation of the way to adding cloud information. please review.

**Comment:** Page 5 line 16: “The linear regression method and neural networks are probably the most popular in current research.” The most popular what? Provide references. What about optimal estimation techniques?

**Response:** This is my neglect, I'm sorry for this expression and I will delete it, please review it.

**Comment:** Section 3.2.2 is where the input elements are defined for “no-cloud” and

“cloud”, yet the retrieval nomenclature is introduced on page 8 lines 14-15. Section 3.2.2, called “Methodology on the comparison of the addition of cloud”, actually introduces both the “no-cloud” and “cloud” retrievals but fails to label them leaving the reader to decipher that these two methods are what will be later and be dubbed BBPN(cloud) and BPNN(no-cloud).

**Response:** This is my neglect, BPNN(cloud) and BPNN(no-cloud) should be defined in the “Methodology on the comparison of the addition of cloud”, I have revised, please review.

**Comment:** Generally, the methodology should explicitly describe the training data set, the two BPNN retrievals, and the HATPRO retrieval so it is clear what is being compared in figures 5-9.

Why aren't the same soundings to train the RPG-HATPRO retrieval (page7 lines 6-7) and were used to train the BBPN retrievals? The differences in the results section could be due to differences in the training set and not the retrieval methods.

**Response:**

The description of the two BPNN retrievals, and the RPG retrieval have been added . It is no doubt that the same soundings to train the RPG retrieval could be more meaning. But we can not modify the RPG retrieval, The manufacturer have finished the process of retrieval when we get the instrument, and we only get the matrix of retrieval. But I still think it is necessary to add RPG retrieval to compare, because if the RPG retrieval have good performance, the work which I study is meaningless.

**Comment:** What is meant by “In the whole 75 group samples, the number of correlation coefficients generated increased to 49 after the addition of cloud information.”? (page9, lines 29-30)

**Response:** I want to show that 49 group samples have been better when adding cloud information, while the number of whole samples is 75. I have deleted and revised this expression in the revised manuscript.

**Comment:** Section 4.1 “Theory” This section seems out of place as well. The information on page 7 could be condensed and used to motivate why you did the retrievals. By the time the reader gets to page 8, lines 2-4, you have already described the retrievals, thus you are motivating why you are doing the new retrieval after you have already described it in a fragmented way.

**Response:** In this section, I want to explain the theory of the adding cloud information, so the description of the retrieval will be deleted in this section, and the theory need to be condensed, please review.

Page 7 lines 24-25. Cite the research that has shown this statement.

Page 10 line 28: reword the last paragraph of section 5 (page 10 lines 22-31). The use

of “can” makes it difficult to discern what was actually done and what will be done in future. On line 28 “judged” should be reworded because the sounding data is not used to judge the cloud-base height and thickness. Perhaps use “performed”?

**Response: I have reworded the use of “can”, and The “judged” is substituted by “estimated”, please review.**

Comment: Stay consistent in referring to the MWR retrieval. The Figures are labeled “RPG” and the text talks of MWR retrievals, but it is unclear if the MWR retrievals are RPG derived or the BPNN technique. For example: page 11, line 12 says “3. The precision of the retrieval without cloud and the MWR product reduced significantly in the cloud layers, but the precision significantly improved after addition of accurate information from the cloud radar.” This sentence seems to be the main message of the paper yet it is still unclear which retrievals are being referred to.

**Response: The description may be not clear, “MWR product” is same as “RPG retrieval”, but In the manuscript, I should stay consistent in referring to retrieval, I will revise it at once.**

Overall the language needs to be more precise. Avoid statements such as those used in the conclusion: “basically showed”, “. . . tackle the problem of increased bias . . .”, or “. . . a more complete vertical profile.

**Response: I’m sorry for the language, I will check the whole manuscript and avoid statements like this.**

Comment: Technical corrections:

Page1, line 4: Should be “Key Laboratory for Cloud Physics,”

**Response: I have revised it, please review.**

Comment: Reword: pg 4 line 16-17.” . . . the cloud information must be more accurate and richer than before.” This is unclear. “Clean-sky” should be “clear-sky” throughout the manuscript.

**Response: I’m very sorry for this error, I have revised it, please review.**

Comment: Fig 10: The axis labels are too small. Perhaps make it a 4 panel figure (a-d) with infrared radiometer components overlaid the cloud radar reflectivities.