AMT-2021-267

Responses to the reviewer's comments

Reveiwer's comment:

This paper studies estimation methods of Doppler spectral parameters from clear-air and precipitation echoes by the Chung-Li VHF radar. Then radar observations of strong convective precipitation are compared with the data of dual-polarized microwave radiometer etc. when the typhoon Trami passed through Taiwan in August 2013. The proposed method shows a good performance, but this paper needs to be the revision.

Ans: We sincerely thank for the valuable comments from the reviewer. Point-by-point responses are given below. Paper title is revised, and moreover, the text and figures have been revised greatly according to the comments and suggestions from all reviewers. We add Figs. 3-5 to explain the processing steps in more detail, and remove the WRF results from the paper considering that the simulation results of WRF model are affected by many uncertain factors.

Because the text is revised greatly, we highlight some parts of the text in blue color which response the major concerns of the reviewers.

Comments: L78 Contour-based approach

I cannot understand the benefits of this method because extending to the orthogonal spectral dimension with a Gaussian function does not increase any information. Please explain the theoretical background that shows the goodness of this method.

Ans: Thank for the question. Contour-based approach was initially applied to our 2D range imaging for identifying multiple targets' locations. We think it is also usable for identification of multiple spectral peaks after some modification of the process. After modeling a 2D spectrum from the original 1D spectrum, mean contour centers are estimated for respective spectral humps. The mean contour centers are still located at the original spectral axis, but may be not at the same spectral lines of the spectral peaks. This is different from the peak-finding approach that is also used in our study. The peak-find approach yields the spectral peak locations. In general, the results of the two approaches are consistent with each other, but discrepancy still exists sometimes in the spectral parameters (Doppler velocity and spectral width) retrieved from the two approaches, especially in multi-peaked spectra. The contour-based approach may provide the spectral parameters that are discarded by the peak-finding approach, and vice versa. Examples have given in Figs. 3-5 and 7 in the revised

manuscript.

With the outcomes of the two approaches, we develop a tracing process for multiple Doppler profiles. In the future, we can also fuse the outcomes retrieved from the already existed methods to raise the reliability of spectral parameters and Doppler profiling, but not in this study. We focus on showing the usability of the two approaches as well as the grouping, sifting, and Gaussian fitting processes introduced in this paper. These consequences can be references to the community.

Comment: L155 multiple carrier-frequency mode ...
Only the data from the carrier frequency of 52 MHz are analyzed. But the data from all the five frequencies can be used for incoherent integrations of Doppler spectra, because the frequency difference is only within 1%.
Ans: Thank you for the suggestion. It is true that the five frequencies can be used for incoherent integrations of Doppler spectra. However, considering that VHF radar observations use single frequency most of the time, the single-frequency data are tested in this study. We expect the methods and processes examined here can be applied to most of the data. However, this is a good suggestion in case multiple-frequency mode is operated in observation.

Comment: L170 Figure 3
The horizontal axes of Figures (a) and (b) should be aligned.
Ans: Revised. Fig. 3 is renumbered Fig. 6.

Comment: L245 Figure 6(a)
The altitude variation of the mean profile of the spectral width seems to be too small. I think that the spectral width is mostly determined by the beam broadening effect. Was the altitude change of the horizontal wind small at this time?
Ans: Thank you for the question. We add the horizontal wind observation of rawindsonde for discussion of this issue, as shown in Fig 15 in the revised manuscript. The rewindsonde is launched routinely at the location of ~25 km east-northeast of the VHF radar. A further study of beam broadening effect is beyond the object of this study. However, we have provided a discussion on this issue because the broadening of spectral width indeed exists due to either horizontal wind or some processes such as running mean, incoherent integration of spectra, and so on. Moreover, the discussion is also necessary for the application study given in Sect. 5. Please find the discussion given in Sect. 5.

In fact, considering that the broadening of spectral width exists commonly, we have performed the Gaussian fitting for the spectral peaks and contour centers with various fitting points, and the Gaussian curve with the smallest standard deviation is selected to estimate the spectral width. It is expected that such collected spectral widths can represent the characteristics of turbulence or precipitation in a greater degree.

Comment: L344 Figure 9
The time intervals are different, how did you choose? In Section 5, although Figure 9 is referred to as radar data, it is better to add the time-height plots for the entire period.
Ans: Thank you for the question. There are 109 maps of Doppler spectra produced from the radar data shown in Fig. 6 (in the revised manuscript). Due to limited space, however, only 15 plots are selected for discussion. They are typical spectra in the time periods when clear air, precipitation, and concurrent echoes dominate the spectra, respectively. It is difficult in a spaced-limited article to display the 109 plots of time-height Doppler spectra along with the Doppler profiles on the maps. We provide the whole maps of one day for readers, please find them via the hyperlink attached with this paper:
https://drive.google.com/drive/folders/11vtU-Fh7s4YKcp2B-8d8XKF0hP4t8ICm?usp=sharing