Updates on Profile Classification Algorithm

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Abstract

As part of the DPR algorithm development group, this poster is focused on maintenance, validation and enhancement for the profile classification module with algorithms developed for precipitation type classification and hydrometeor identification for DPR.

These studies are done, using space-borne observations from the GPM platform as well as ground dual polarization radar. The performance of the algorithms with the scan pattern change is discussed. Additional updates such as modification on melting layer detection, and graupel/hail identification are also presented.

Modification on melting layer detection of dual-frequency classification model

One function of the dual-frequency classification module is to detect melting layer on a profile basis. Currently, the detection of melting layer top and bottom is done simultaneously. If either the top or bottom is not detected, both melting layer top and bottom are not available. In order to increase the detectability, we modify the current version of algorithm to separate the melting layer top and bottom detection to make it independent.

Figure 1 illustrates the modified flow chart of the melting layer detection algorithm in the dual-frequency classification module.

Figure 2 shows a section (Scan range: 3032~3070) of the GPM DPR orbit #24981, where precipitation was captured over Buffalo, New York on 07/22/2018. (a) is Zmk at 2km, (b) is Zmk at 2 km. Sample vertical cut at angle bin # 18 & nadir is shown in (c) and (d). Black dashed lines are melting layer top and bottom before modification. Pink dashed lines are melting layer top and bottom after modification.

Figure 3 illustrates the count of rain types and melting layer top detection for one day of GPM orbits on 08/01/2018. Column of “V6” indicates the results before modification and column of “new” is for after modification. Changes of stratiform / convective counts occur in the inner swath only. Those small differences between V6 and updated codes occur due to the change of threshold. However, melting layer top detection counts increase largely for both MS and HS condition. For MS, during one-day orbits, the count increases from 24,262 to 35,918, with increase percentage of 46%. For the HS condition, the increase percentage is around 63%. This is a big improvement on the melting layer detection part of the dual-frequency classification module. More extensive analysis will be performed in the near future.

Extension of current dual-frequency classification algorithms from inner swath to full swath

The current dual-frequency classification algorithms including rain type classification, hydrometeor profile characterization, and surface snowfall identification are for GPM DPR matched inner swath. The performances of the current algorithms are summarized in Lu et al. 2017, Awaka et al. 2016, and Chandrasekar, 2016. However, after scan pattern change, the dual-frequency profiles are available for outer swath also. There are some technical challenges merging the inner and outer swath, the most obvious being the resolution and sensitivity. It is essential that these dual-frequency algorithms are tested and validated on outer swath and makes any corresponding adjustments.

For the testing purposes, we have acquired 32 orbits data. These data are reformatted using beam-matching strategy in order to study the outer swath dual-frequency data. Interpretation on vertical resolution is also performed. Total of 59,059 vertical profiles are used for a preliminary study. The following shows initial results.

(a) Precipitation type classification

After the scan pattern change, V3 index is re-evaluated based on the test data of outer swath dual-frequency profiles. While we do not expect big changes in the threshold of V3 for inner versus outer swath, still extensive study needs to be done to make sure this is correct. Figures below illustrate the histogram of V3 for stratiform and convective rain based on matched outer swath profiles. Thresholds for stratiform rain is changed based on 70% CDF curve. Similarly, threshold for convective rain also is changed. Preliminary analysis of the 32-test orbit data sets show that there is less than 10% change in the thresholds of the algorithms for convective/stratiform separation in V3 index.

(b) Melting layer detection

The algorithm for melting layer bottom and top detection is applicable to both DPR inner and outer swath melting layer detection. However, for DPR outer swath, the radar scan angle is larger, which will affect (increase) the range bin number of melting layer top and bottom. The slant range is larger than the vertical range following a cosine relation. Total of 45,000 vertical profiles are used for the outer swath testing. The data was used to calculate the cosines correction of all the profiles between inner swath and outer swath and the details are skipped for brevity.

(c) Surface snowfall identification

A surface snowfall index is another product that is part of the suite of DPR algorithms (Le et al. 2017). It provides a “snow flag” at surface using dual-frequency profile information. The snow index is a somewhat sensitive parameter and it was developed originally for best inner swath performance. For DPR outer swath, the snow index needs to be evaluated and fine-tuned with the outer swath data. However, in the test data there are not many profiles for snow case to be evaluated, we still collected total of 860 snow profiles and 79042 rain profiles within 46 GPM orbits for an initial evaluation. Snow profiles are chosen using 0 degree information and reflectivity values for this test purpose. Threshold of snow index for rain / snow separation is calculated for outer swath data as shown in the figure below.

Figure 7. Histogram of snow index for snow and rain using constructed DPR outer swath data.

Summary

The algorithm to perform melting layer detection has been updated. Melting layer top detection is largely improved. Algorithms currently implemented in the dual-frequency classification module are adjusted for full DPR swath. Parameter tuning and testing are undergoing. Preliminary results show that algorithms are affected less than 10%.

Reference


M. Le and V. Chandrasekar, Graupel and Hail Detection using GPM Dual-frequency Precipitation Radar Observation, AGU Fall meeting, 2019, Washington DC.