MICROPHYSICAL RETRIEVAL FROM DUAL FREQUENCY PRECIPITATION RADAR ON BOARD GPM

Minda Le, V. Chandrasekar and S.Lim

Colorado State University
1373, campus Delivery
Fort Collins, CO 80523-1373, USA

1. ABSTRACT

Global Precipitation Measurement (GPM) is poised to be the next generation observations from space after TRMM mission. The GPM mission concept is centered on the deployment of a core observatory satellite with an active dual-frequency precipitation radar (DPR), operating at Ku and Ka bands. The DPR is expected to improve our knowledge of precipitation processes relative to singe-frequency radar on microphysics, and better accuracies in rainfall and liquid water content retrievals. This paper presents an algorithm to retrieve parameters of drop size distribution for GPM-DPR. This paper will also compare the algorithm result with other existing DPR algorithms. In addition a classification procedure is also described with further study focused on ice and melting ice particles detection.

2. INTRODUCTION

GPM is a science mission with integrated application goals for advancing the knowledge of the global water/energy cycle variability as well as improving weather, climate and hydrological prediction capabilities through more accurate and frequent precipitation measurements around the global. GPM mission concept is centered on the deployment of a core observatory satellite with an active dual-frequency (Ku and Ka band) precipitation radar (DPR) which is expected to improve our knowledge of precipitation processes.. Generally, there are two types of dual-frequency algorithms for a down-looking space radar: 1) the forward method, where the DSDs are calculated at each bin starting from the top bin and move downward to bottom; 2) the backward method, where the algorithm begins at bottom and move upward to the top; Forward method has limited application because of a tendency to diverge in regions of moderate-to-heavy attenuation [1]. Backward method can be further divided into three groups: 1) Standard dual-wavelength (or DAD); 2) Surface reference technique (SRT); and 3) Iterative non-SRT. DAD method requires one of two assumptions: first the rain rate must be uniform over the measured interval; or second, Rayleigh scattering is true at both frequencies [2][3]. The SRT method uses a backward calculation method which is more stable than forward method but requires a prior knowledge of the total two-way path-integrated attenuation (PIA) for each ray which is hard to accurately estimated especially over land [4][5]. The non-SRT method is a self-consistent algorithm wherein the total PIA for each frequency channel is first estimated using initial guess then optimized it through an iteration process [6]. However, both forward and backward method suffered from bi-valued solution when retrieving median volume diameter D_0 for rain described in detail by [7]. Rose and Chandrasekar [8] proposed an alternate method using linear assumption of vertical profiles for D_0 and N_w (in log scale) in rain region to avoid the bi-valued problem. Minda et al [9], later, proposed an algorithm using a hybrid approach combining the advantage of forward method and linear assumption in an iterative way and tested the algorithm for the full vertical profiles. The diagram of the algorithm is shown in figure 1. Meneghini and Liao [10] used the backward recursion method and with a weak constraint on PIA.

This paper will focus on cross comparison between the algorithm developed from Minda et al [9] (refered as the Hybrid algorithm) and from Meneghini and Liao [10], referred as SRWC (surface reference with weak constraints) . Some preliminary comparison results are shown from figure 2 to figure 4. Figure 2 shows an overpass of NAMMA (NASA African Monsoon Multidisciplinary Analysis) experiment data and marker A, B, C are vertical profiles of interest. Figure 4 is an example of the comparison result using profile B which is shown in figure 3.

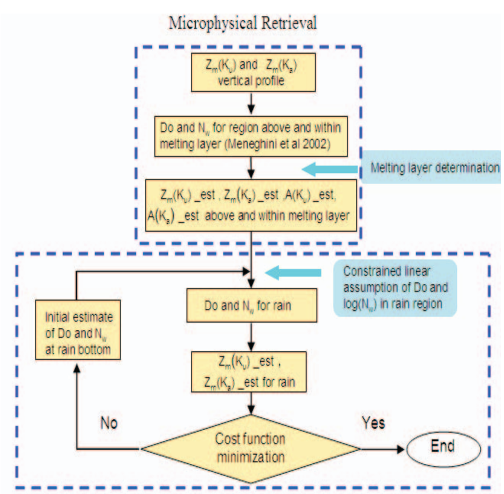


Figure 1, Diagram of the DPR algorithm.

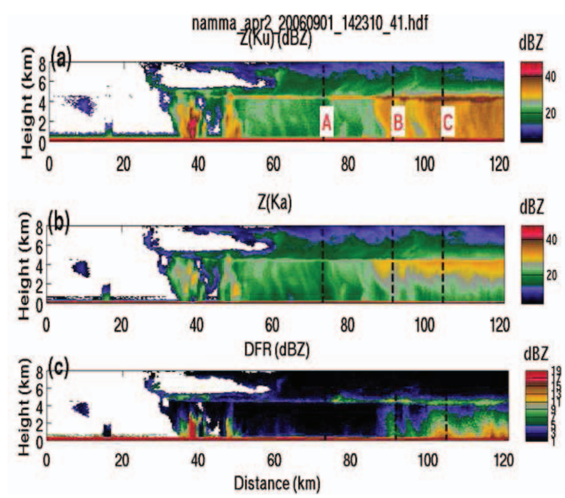
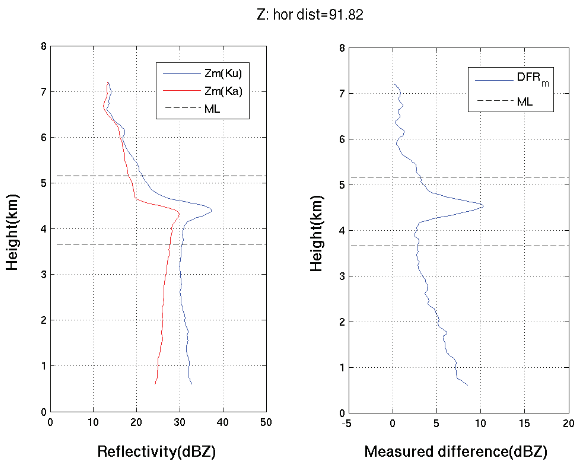


Figure 2, Overpass of NAMMA 20060901-142310 overpass.



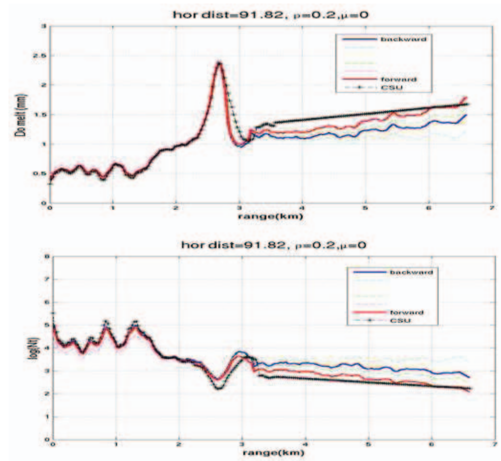


Figure 3, Vertical profile at marker B in figure 2. Figure 4, Retrieved Do and log (Nw) from different algorithms.

Any DSD retrieval algorithm for DPR relies on a classification method. Minda et al [9] provided a hydrometeor classification method including two models: 1) the model to classify stratiform, convective or other type vertical profile; 2) the model to detect the melting layer region. The two models, basically, are developed based on a statistical study of the measured DFR (dual-frequency ratio) and reflectivity profiles. The classification method works well for stratiform case while it is not clear enough for some convective cases especially on ice and melting ice region classification. Liao [11] presented a method to do hydrometeor detection on a pixel basis which showed good result especially on snow detection.

REFERENCES

[1] Liao, L., and R. Meneghini,: On study of air/space-borne dual-wavelength radar for estimates of rain profiles. *Third Int. Ocean-Atmosphere Conf., Beijing, China, Institute of Atmospheric Physics of Academic Sinica*, CD-ROM, 2004.

[2] Iguchi, T,:Possible algorithm for the dual-polarization precipitation radar (DPR) on the GPM core satellite. *32nd Conf. on Radar Meteorology, Amer. Meteor. Soc., Albuquerque, NM,* CD-ROM, 2005.

[3] Chandrasekar, V. and Direk Khajonrat,: Simulation of space-borne radar observations of precipitation at Ku and Ka band. . *34^nd Conf on Radar Meteorology. Amer. Meteor. Soc.,Williamsburg, VA,* Oct, 2009.

[4] Meneghini, R, H. Kumagai, J. R. Wang, T. Iguchi and T. Kozu,: Microphysical retrievals over stratiform rain using measurements from an airborne dual-wavelength radar radiometer. *IEEE Trans. Geosci. Remote Sens.*, 35, 487-506,1997.

[5] Meneghini, R, L. Liao and T. Iguchi,: Integral equations for a dual-wavelength radar. Proc. *Geoscience and Remote Sensing Symp., IGARSS'02,* Toronto, ON, Canada, IEEE, 272-274,2002.

[6] Mardiana, R., T. Iguchi and N. Takahashi, : A dual-frequency rain profiling method without the use of a surface reference technique. *IEEE Trans. Geosci. Remote Sens.,* 42, 2214-2225, 2004.

[7] Liao, L., R. Meneghini, T. Iguchi, and A. Detwiler,: Validation of snow parameters as derived from dual-wavelength airborne radar. *Preprints, 31th Int. Conf. on Radar Meteorology, Seattle, WA, Amer. Meteor. Soc*., CD-ROM, P3A.4,2003.

[8] Rose, C. R. and V. Chandrasekar, : A GPM dual-frequency retrieval algorithm: DSD profile optimization method. *J. Atmos. Oceanic Technol,* 23, 1372-1383,2006.

[9] Le, Minda, V. Chandrasekar, and S. Lim, : Microphysical retrieval from dual-frequency GPM observations. *34nd Conf on Radar Meteorology. Amer. Meteor. Soc.,Williamsburg, VA,* Oct, 2009.

[10] Meneghini, R. and L. Liao,: An integral equation method for dual-wavelength radar data using a weak constraint. . *34nd Conf on Radar Meteorology. Amer. Meteor. Soc.,Williamsburg, VA*, Oct, 2009.

[11] Liao, Liang, Snow detection and estimation from Ku- and Ka- band dual-wavelength radar. *34nd Conf on Radar Meteorology. Amer. Meteor. Soc.,Williamsburg, VA,* Oct, 2009.