7A.5 USE OF POLARIMETRIC RADAR OBSERVATIONS IN THE EVALUATION OF A TRMM COMBINED RADAR-RADIOMETER ALGORITHM FOR ESTIMATION OF PRECIPITATION PROFILES

Mircea Grecu[1,2] and William S. Olson[1,2]
[1]University of Maryland, Baltimore County
and
[2]NASA Goddard Space Flight Center,Greenbelt, MD

1. INTRODUCTION

A major challenge in precipitation estimation from satellite active microwave observations arises from the fact that precipitation particle size distributions (PSDs) vary considerably in space and time, which makes the determination of one-to-one relationships between radar observations and precipitation amounts difficult. To mitigate these difficulties, various approaches have been developed to independently estimate the total path-integrated attenuation (PIA), and use it as additional information that allows for a better determination of PSD. Independent PIA estimates may be derived from the Surface Return Technique (SRT, Meneghini et al., 2000) and radiometer observations (Weinman et al. 1990). However, the use of independent PIA estimates in precipitation estimation from space-borne radar observations is not always optimal. This is because the SRT estimates are unreliable for low PIA values, while the radiometer estimates depend on the vertical distribution of precipitation. A better use of SRT and radiometer information can be achieved through combined radar-radiometer retrievals requiring that the precipitation estimates simultaneously satisfy the radar, radiometer, and SRT observations within the measurement error. Such an approach was developed by Grecu and Anagnostou (2002) for airborne observations and extended to Tropical Rainfall Measuring Mission (TRMM) observations.

The purpose of this study is to present a comparison between combined TRMM precipitation estimates and precipitation estimates derived from polarimetric radar observations. Various parameters, including the rain rate, the intercept in a normalized gamma distribution and the mass weighted mean diameter are considered in the comparison.

2. METHODOLOGY

The combined retrieval from passive and active observation requires the minimization of a functional that evaluates the differences between the TRMM Microwave Imager (TMI) radiometer observed and model predicted normalized polarizations, NP, the precipitation radar (PR) predicted and SRT derived PIA, and the similarity between the covariance of retrieved PSD intercept, N_0^*, and PSD intercept covariance derived from polarimetric radar observations. The functional minimization is performed using a gradient based technique.

The precipitation estimates from polarimetric radar observations are derived using the formulae of Bringi et al. (2003). The combined retrieval technique is applied to TRMM observations collected during the Kwajalein Experiment (KWAJEX). Coincident ground radar observations are used to derive independent precipitation estimates that are compared to the combined TRMM estimates. This is described next.

3. RESULTS

The application of the technique to the TRMM KWAJEX data reveals differences between PR-only retrievals and combined retrievals. This may be noted from the analysis of the NPs derived from PR-only and combined precipitation estimates, respectively. The NPs derived from the PR-only retrievals are higher than the TMI observed NPs (Fig. 1). When the radiometer information is used in the retrieval, significantly better agreement between the calculated and observed NPs is achieved, indicating precipitation estimates larger than those derived from PR-only observations. Ground-based precipitation estimates, derived from ground polarimetric radar data consistent with rain gauge observations, are in better agreement with the combined estimates than with the TRMM PR-only estimates, which suggests that information useful for improving the radar-only estimates is contained in the brightness temperature data. Although the random differences between ground and combined TRMM estimates are similar to the random differences between ground and PR-2A25 estimates, the systematic differences decrease when the radiometer observations are included in the retrieval (Fig 2).

4. SUMMARY

A method for estimating precipitation profiles from multifrequency, multiresolution, active and passive microwave observations is examined in this paper. The method is applied to three months of TRMM TMI and PR data in the domain and period of the KWAJEX field campaign. Results show that estimates consistent with both TMI and PR observations can be obtained with the method. Based upon the KWAJEX data, precipitation estimates less biased relative to ground radar estimates can be obtained by including radiometer information in PR retrievals.

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Corresponding author address: Mircea Grecu, NASA Goddard Space Flight Center, Greenbelt, MD 20771.
E-mail: mgrecu@umbc.edu

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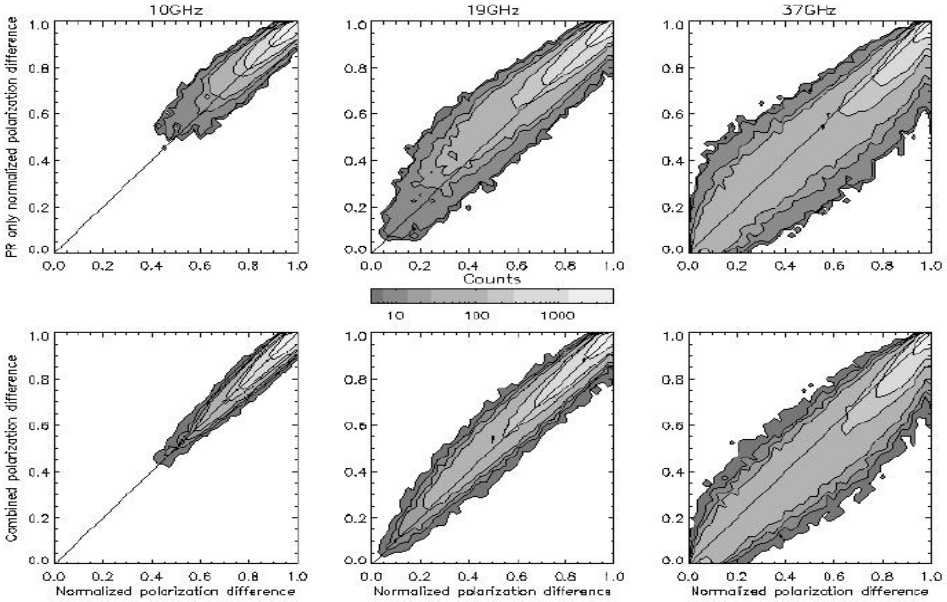

Fig.1. Observed and model derived normalized polarizations from PR-only (top panels) and combined retrievals (bottom panels)

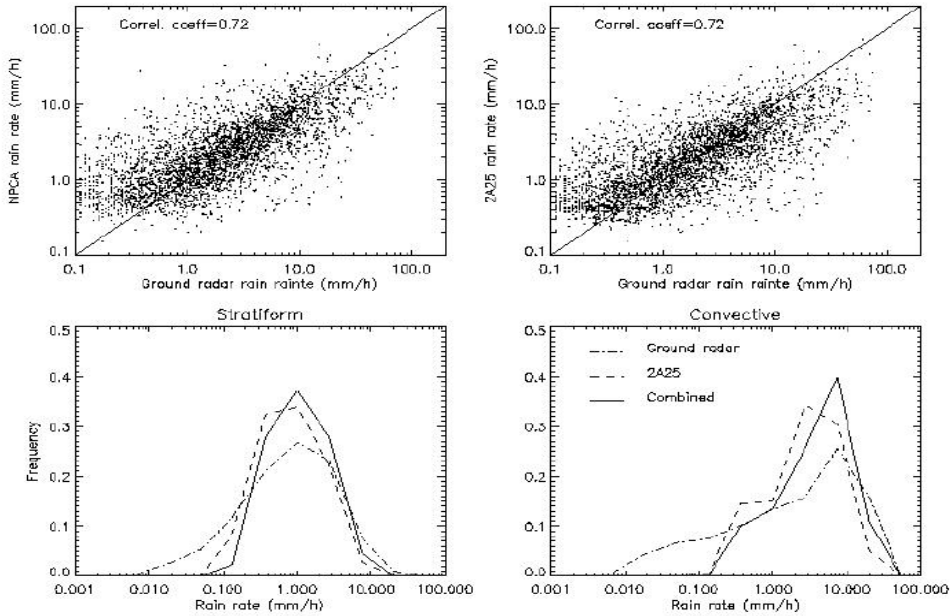

Fig. 2. Top panels: NPCA (combined) and 2A25 rainrates estimates vs. ground radar for convective and stratiform rain. Bottom panels: Histograms of ground radar, NPCA and 2A25 rain rates for convective and stratiform rain.