# WHAT IS THE INFORMATION CONTENT OF TRMM PRECIPITATION RADAR FOR DETERMINING RADIOMETER OBSERVATIONS AND VICE VERSA?

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## Abstract

Both the space borne radar and the radiometer suite on the TRMM satellite observe the same column of precipitation and derive rain rates, however at different spatial resolutions. The observations from TRMM PR and TMI are fundamentally different measurements. While the radar provides a backscatter measurement resolved in vertical profile, the radiometer is a passive instrument obtaining integrated observations over the full depth of the cloud. In addition, they respond to different physical mechanisms. Nevertheless, they are observing the same precipitation medium and retrieve the same output products. Therefore it begs the question, what type of information about radiometric observations can be directly retrieved from radar observations? This question can be further focused and stated as, can one predict the radiometric observations from radar observations?
This question can be answered in several ways, and one of them is an informational theoretic approach using neural networks which is described in this paper.

*Problem formulation*

The TRMM- Precipitation Radar (PR) measures reflectivity up to a height of 15 km from the ground, with a vertical resolution of 250 m. The TRMM's Microwave Imager (TMI), which is on the same space platform, estimates the rainfall rate by observing the upwelling radiances at 5 frequencies and 2 polarizations (10.65, 19.35, 21.3, 37.0, and 85.5 GHz ) sans the horizontal polarization of 21.3 GHz

(Kummerow 1997). In the present study, a neural network based on back propagation is trained with PR reflectivity profiles as inputs and TMI brightness temperatures as the targets.

For the analysis, rainfall events that occurred during the period 2000 to 2004 in the North Indian Ocean bounded by the 0 N and 25 N latitude and 60 E and 100 E longitude are considered. The attenuation corrected reflectivity profiles from the 2A25 data set of TRMM (TRMM Data Products) and the Normalized Radar Cross Section (NRCS) are used as inputs to the neural network, while the brightness temperature data from 1B11 of TRMM are used as target values. In order to have a homogeneous background, data from ocean surface alone is considered. The convective / stratiform characteristics from 2A23 are used to eliminate mixed scenes from the data set.

*Method of solution*

The collocated database consisting of 40 radar reflectivities up to 10 km height and NRCS taken from 2A25 data set, and corresponding 9 brightness temperatures from 5 frequencies and 2 polarizations of TMI collected from 5 rain events are used to train the network. Thus the input and output layer of the neural network consists of 41 and 9 neurons respectively. The trained network is then tested against known brightness temperatures from 3 different events that are not part of the training data set.

*Practical considerations*

Though the radar and radiometer are used to obtain same rain products, the fundamental physics governing the two sensors are different. While the TRMM PR can sense only the precipitating quantities, the radiometer is sensitive to non raining parameters too such as cloud liquid water and cloud ice. The ground resolution and the geometry of scan of the active and passive sensors are not the same. Furthermore, at low resolutions the inhomogeneity of the rainfall rate is more pronounced which leads to further errors in the comparisons. Hence, these issues have to be critically addressed while trying to predict the brightness temperatures from radar reflectivity.

*Results*

Independent collocated data set from 3 different events during the period 2000 to 2004 is used for testing the network performance. The analysis presented here is focused on evaluating the brightness temperatures for the 21.3 GHz channel. The evaluation shows that the neural network derived brightness temperatures from TRMM PR agree fairly well with the TMI measured brightness temperatures with a correlation coefficient of 0.77 and an RMSE of 4.6 K. The paper provides detailed evaluation of all the TMI channels and the details will be presented.

*References:*


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