RAIN/NO RAIN CLASSIFICATION OVER TROPICAL REGIONS USING TRMM TMI

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ABSTRACT

This study focalizes on the comparative assessment of existing "rain" or "no rain" classification (RNC) methodologies over land surface. Using the data products from Tropical Rainfall Measuring Mission's Precipitation Radar (PR) and Microwave Imager (TMI), this work reveals the shortcomings of existing overland RNC methods hinged on scattering signatures from 85GHz high frequency channel with special reference to the Indian subcontinent. Overland RNC of microwave radiometer brightness temperatures (Tb) offers a myriad of complications as land surface presents itself as a radiometrically warm and highly variable background. Hence, sensitivity analysis of Tb captured at different microwave frequencies to near surface rain (NSR) rate is of supreme importance. Variability of Tb to NSR is investigated using exploratory data analysis (EDA), together with probability density functions (pdfs). Results indicate that the inclusion of 37 GHz vertical polarization channel for the computation of estimated 85GHz Tb is avoidable, due to its prominent correlation with NSR. Also relevant, were the contributions from 19 GHz channels (both horizontal and vertical). A novel attempt has been made to assess the performance of some powerful statistical descriptors to increase the accuracy of RNC. The comparative results are presented extensively in the form of contingency tables and kappa values. The descriptor giving best results from the analysis was used to formulate a regression relation with the rain rate (RR). Furthermore, this work also conducts a detailed examination on the use of Empirical Orthogonal Functions (EOF), to improve rain retrieval accuracy. Analysis reveals that, for TMI, the first two EOF's were deemed sufficient to fully explain the variability offered by the 9 channels. A regression based relationship was established between RR and EOF. A comparative analysis was conducted between the regression relation of RR with EOF and RR with "best RNC descriptor". Results reveal that the use of efficient methodologies for overland RNC does improve the classification accuracy (upto less than 10%). Even though the performance was not too high, it was proven to improve the retrieval accuracy.

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INTRODUCTION

- For almost over a decade, passive sensing of upwelling microwave radiation has been recognized as a promising source for the estimation of precipitation (Ferraro *et al*. 1996).
- Microwave instruments aboard Tropical Rainfall Measuring Mission (TRMM) namely, Microwave Imager (TMI) and Precipitation Radar (PR) offer excellent opportunity to study atmospheric phenomenon over tropics.
- Overland rain retrieval algorithms using passive radiometers, hinge mainly on the scattering signature from high microwave frequencies. Hence, problematic compared to ocean rainfall algorithms that utilize both emission and scattering signatures from observations at multiple frequencies (You *et al*. 2011).
- Studies dealing with physically based retrieval over land, are few and have not indicated better performance relative to purely statistical algorithms.
- A deterministic method known as rain /no rain classification (RNC), applied before actual rain retrieval is adopted to reduce computational burden as well as for quality checks (Seto *et al*. 2005).

DATA

- Orbital data (version 7) from TRMM Microwave Imager (TMI) and Precipitation Radar (PR) namely 1B11, 2A25 and 2A23 were used for study. (From *trmm.gsfc.nasa.gov* made available since September 2011)
- The effective field of view (EFOV) of the different data channels along the down track (DT) and cross track (CT) directions are shown in Figures 1 & 2.

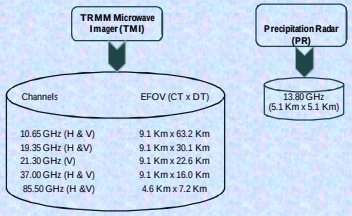

Figure 1: EFOV of TMI & PR channel frequencies.

RESULTS

- A total of 9635 collocated overland samples were extracted for analysis and subjected to Rain/No Rain classification (RNC) using scattering index (SI) as performance indicator. Methods proposed by 5 different authors were applied on the data.
- Overall accuracy & Kappa statistic, obtained after RNC are shown in Figure 3.
- Defying conventional views, a combination of lower channel frequencies were found to be more responsive to near surface rain rate (NSR) than ice scattering at 85 GHz (You *et al*, 2011). Spearman rank correlation coefficients for the top 20 data combinations are depicted in Figure 4.

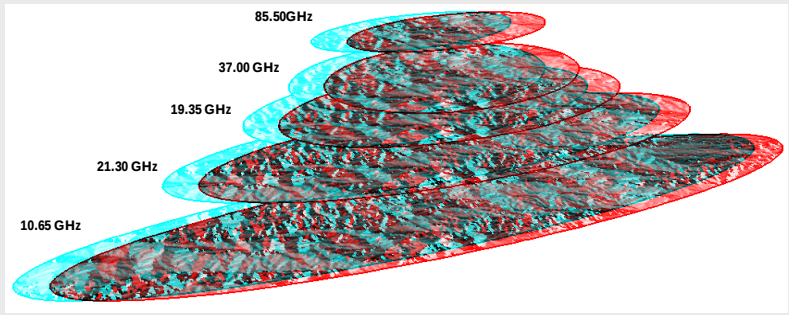

Figure 2: Anaglyph showing footprint size (not to scale) of various TMI channels
{*Best viewed with 3D glasses*}

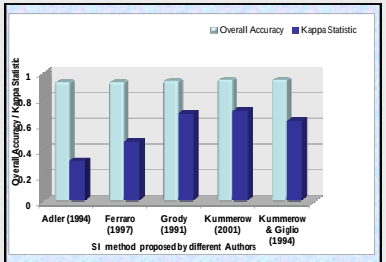

Figure 3: Results of RNC using SI

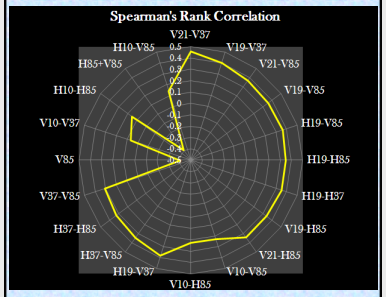

Figure 4 : Channel sensitivity with NSR

- Using the best results from RNC, non linear regression relations were developed between the highly correlated channel combination and NSR. The relation is shown in Figure 5.
- For TMI data, first two principal components were deemed sufficient to explain the variability of the data. Hence, polynomial regression based relation, linking first two principal components with NSR is shown in Figure 6.

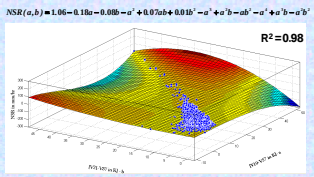

Figure 5 : Relation of NSR with highly correlated channel combination

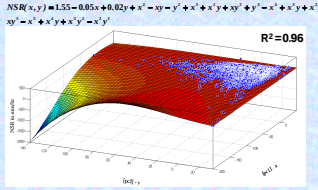

Figure 6 : Relation of NSR with 1st & 2nd principal components

CONCLUSIONS

- Scope exists to improve RNC over land regions by checking channel combinations for sensitivity to NSR.
- Use of sensitive channel combinations tend to improve the accuracy of relations developed between NSR and several predictor variables when compared with the use of Empirical orthogonal functions (EOFs).
- Need for relation over a region, for RNC to tackle issues in basin scale hydrology.

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