Surface Classification For Improved PIA Estimation Over Land

Stephen L. Durden[1], Simone Tanelli[1], and Robert Meneghini[2]

[1]Jet Propulsion Laboratory, California Institute of Technology

[2]NASA Goddard Space Flight Center

Email: sdurden@jpl.nasa.gov

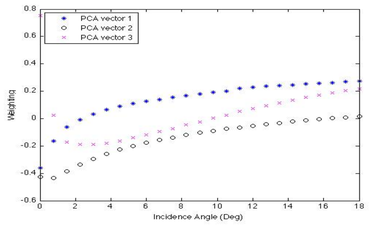
Introduction

1

- Surface Reference Technique (SRT) is the primary technique for estimating the path integrated attenuation (PIA) in moderate and heavy rainfall: PIA = σ0(no_rain) – σ0(rain)
- σ0(no_rain) is estimated by measuring a different location at nearly the same time (spatial, along-track) or by measuring the same location at a different time (temporal)
- It will take many months after GPM launch to build a global, dual-frequency surface backscatter database that can be used for the temporal reference (similar to the TRMM database)
- Since the standard along-track method does not perform well over land, we are investigating either improving the along-track SRT or estimating PIA via non-SRT methods
- To improve the SRT we implemented a class-based approach
  - Use global classification to identify various landtypes with differing radar backscatter
  - Save reference σ0 for each class
  - PIA is difference of σ0 between raining pixel and closest non-raining of the same class

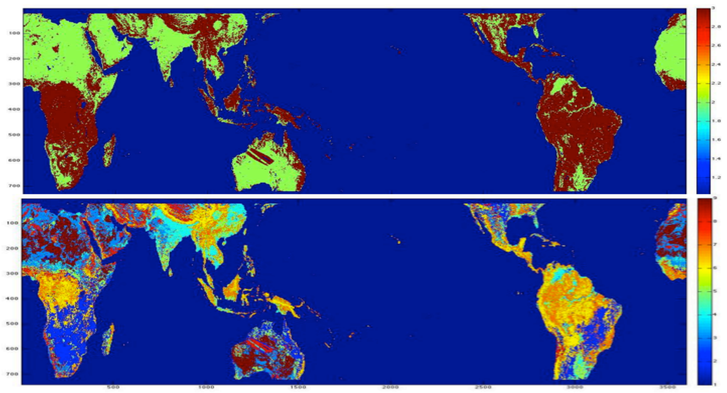
2

- Best way to classify land surfaces is with TRMM data
- Initial feature vector is TRMM PR σ0 for each incidence angle using data from July in temporal database
- Feature vector with only three components found from principal component analysis (PCA) of original feature vector



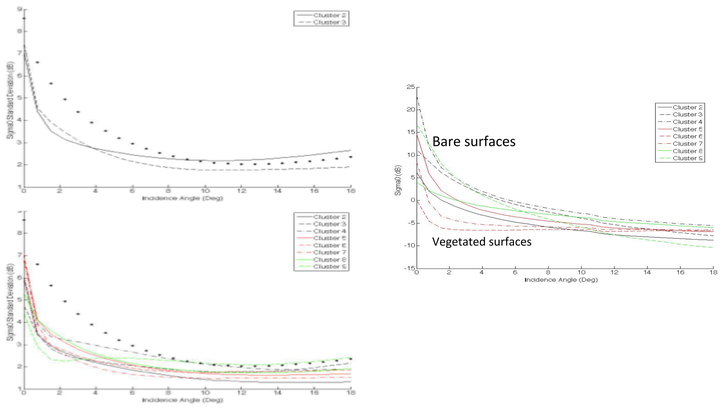
- Above - first three PCA vectors. The corresponding principal component is found as the dot product of the 25-element data vector with the PCA vector. Hence, the principal component is the sum of the 25 elements, weighted by the PCA vectors.
- First three principal components explains 97% of the total variance

3



Classification maps for 2 and 8 land clusters (plus ocean) using TRMM temporal database for July, based on years 1998-2009.

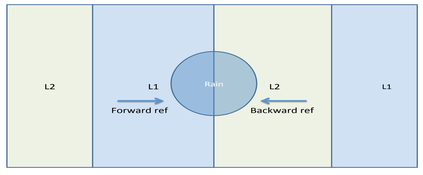
4

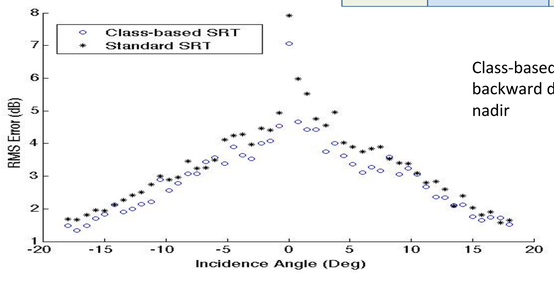


Standard deviation of s0 in each land cluster (shown as lines) and for all data combined (shown as asterisks). Upper: two clusters, lower: eight clusters.
Right:. Mean s0 for each of the eight land clusters (lower left) found from the July TRMM land surface backscatter database (1998-2009).

5

- We developed a new code that maintains a 49-element reference vector for each of the kmeans clusters
- Upper figure is illustration of SRT with two classes of land surface (L1 and L2) and a raining area. For class-based SRT there will be references for both classes L1 and L2, so when crossing the boundary in either direction, the appropriate reference is used
- Lower: Root mean square forward/backward difference (error) for new, class-based SRT and current, standard SRT, over land.

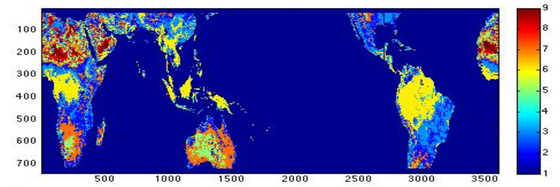




Class-based SRT has smaller forward/ backward difference, especially near nadir

6

- For application to GPM, we need to extend the TRMM land classification to higher latitudes.
- Most global datasets do not seem to have the same information as the TRMM PR surface return (e.g., AVHRR classification maps, DEMs, etc.)
- Most promising is data from Ku-band scatterometer (46 degree incidence) and land surface emissivity; cluster map below is a combination of scatterometer and 10.6 GHz emissivity



Unsupervised classification using SeaWinds and AMSR 10.6 GHz data

Acknowledgment

The authors gratefully acknowledge support by the Precipitation Measurement Missions Program. The research described here was carried out at the Jet Propulsion Laboratory, California Institute of Technology, under contract with the National Aeronautics and Space Administration, and at NASA GSFC.

Bibliography

Durden, S.L., S. Tanelli, and R. Meneghini, 2012: Using surface classification to improve surface reference technique performance over land. *Indian Journal of Radio & Space Physics*, 41, 403-410.

Meneghini, R., T. Iguchi, T. Kozu, L. Liao, K. Okamoto, J. A. Jones, and J. Kwiatkowski, 2000: Use of the surface reference technique for path attenuation estimates from the TRMM Precipitation Radar. *J. Appl. Meteor.*, **39**, 2053–2070.

Meneghini, R., L. Liao, S. Tanelli, and S. L. Durden, 2012: Assessment of the performance of a dual-frequency surface reference technique over ocean. *IEEE Geosci. Remote Sensing*, 50, 2968-2977.

J. Izenman, *Modern Multivariate Statistical Techniques – Regression, Classification, and Manifold Learning*. Springer, 2008, 731 pp.