Outline

- Short description of the algorithms for rain rate retrievals from passive microwave radiometers on board low-orbiting satellites (i.e., SSMI/S)

- Case Study over Vale do Paraiba – 11 February 2012

- Comparison of different rain rate retrievals for heavy rain events during CHUVA-GLM period

- Future Work
GPROF Algorithm Description

- The Goddard profiling algorithm (GPROF) is the current operational rainfall algorithm for both TRMM TMI and AMSR-E. In addition, GPROF rainfall estimates from SSM/I and SSMI/S are used in the Global Precipitation Climatology Project (GPCP) merged rainfall product and TMPA.

- GPROF retrieves both the instantaneous rainfall and the rainfall vertical structure by using a Bayesian approach to match the observed brightness temperatures to hydrometeor profiles derived from cloud resolving models (CRMs). A radiative transfer model based on a one-dimensional Eddington approximation [Kummerow, 1993] is used to compute brightness temperatures from the CRM hydrometeor profiles at the observed satellite frequencies.
BRAIN general flow-chart diagram

Bayesian Rain retrieval Algorithm Including Neural network

L1A2

Tbs preprocessing smoothing, interpolation

Sfc type

Land/ocean/coast mask

rain/no rain

Coast 85H, 85V, 37V

Land retrieval DB

85H, 85V, 37V

rain/no rain

Ocn. retrieval DB

Ocean all channels

L2A
Emphasize on Bayesian-Based retrieval: BRAIN

- Brain is very close to Gprof (2A12) developed at GSFC for TRMM
- The general principle of the algorithm is the same
  - Database-based
  - Bayesian approach (probabilistic)
- Retrieve profiles and surface rain at 12 km resolution
- The databases differ in their principle
  - Gprof is pure model (both cloud and RTM)
  - BRAIN is mixed observation and model
• Because one of the objectives of this study is the use of the existing algorithms for hydrological parameters available for SSM/I, the histogram matching approach appears as a suitable scheme to modify SSMI/S temperatures to match with the SSM/I reference.

• To achieve this purpose, seven months between January and July 2009 of 1/3 degrees daily grids for SSM/I F-13 and SSMI/S F-17 were chosen to perform this technique. During that period both satellites were flying together with time shift of approximately 1.5 hours.
THE HISTOGRAM MATCHING APPROACH

- Histogram matching is a process where a time series, image, or higher dimension scalar data (SSMI/S antenna temperature, in this case) is modified such that its histogram matches that of another reference dataset (SSM/I antenna temperature).
- In this particular application, seven channels of the SSM/I sensor were “matched” with the correspondent channels in the SSMI/S array.
THE HISTOGRAM MATCHING APPROACH

- Look-up tables (LUTs) for every channel (19 GHz H, 19 GHz V, 22 GHz V, 37 GHz V, 37 GHz H, 91/85 GHz V and 91/85 GHz H) stratified for surface type (land & ocean) were created using global 1/3 degree global daily grids for January - July 2009. Those LUTs were applied to SSMI/S channels.

- Cumulative probability distribution normalized (CPF) for 22 GHz V for August 2009. In this case the red line is SSMI and the green line is the adjusted SSMI/S value. It is important to notice that August 2009 was not used to create the LUTs, so it can be considered as an independent dataset.
• For low frequency channels, the bias is positive (SSMI/S values are larger than SSM/I values) while for high frequency channels is the opposite and this bias is larger for lower temperatures (especially over land).
Case Study: 11 February 2012 – 19:30 UTC

BRAIN

GPROF

CHUVA International Workshop, IAG- USP, São Paulo, 8-10 May 2013
Case Study: 11 February 2012 – 19:30 UTC


\[ y = 1.4625x \]

\[ R^2 = 0.834 \]

\[ C.c. = 0.91382 \]
Case Study: 11 February 2012 – 19:30 UTC

CHUVA – SJC

GPROF_ocean +
GPROF_land +

BRAIN_ocean +
BRAIN_land +

Frequency

Frequency

0 10 20 30
0 10 20 30

rain rate (mm/h)
Case Study: 11 February 2012 – 19:30 UTC

CHUVA International Workshop, IAG- USP, São Paulo, 8-10 May 2013
Case Study: 11 February 2012 – 19:30 UTC

BRAIN

TMI (-1 hrs)
Heavy rain rate cases – statistical comparison BRAIN vs. GPROF (12.5 km resolution) – 35 cases

\[ f(x) = 1.55x + 0.27 \]
\[ R^2 = 0.65 \]
Heavy rain rate cases – statistical comparison BRAIN vs. GPROF (12.5 km resolution) – 35 cases