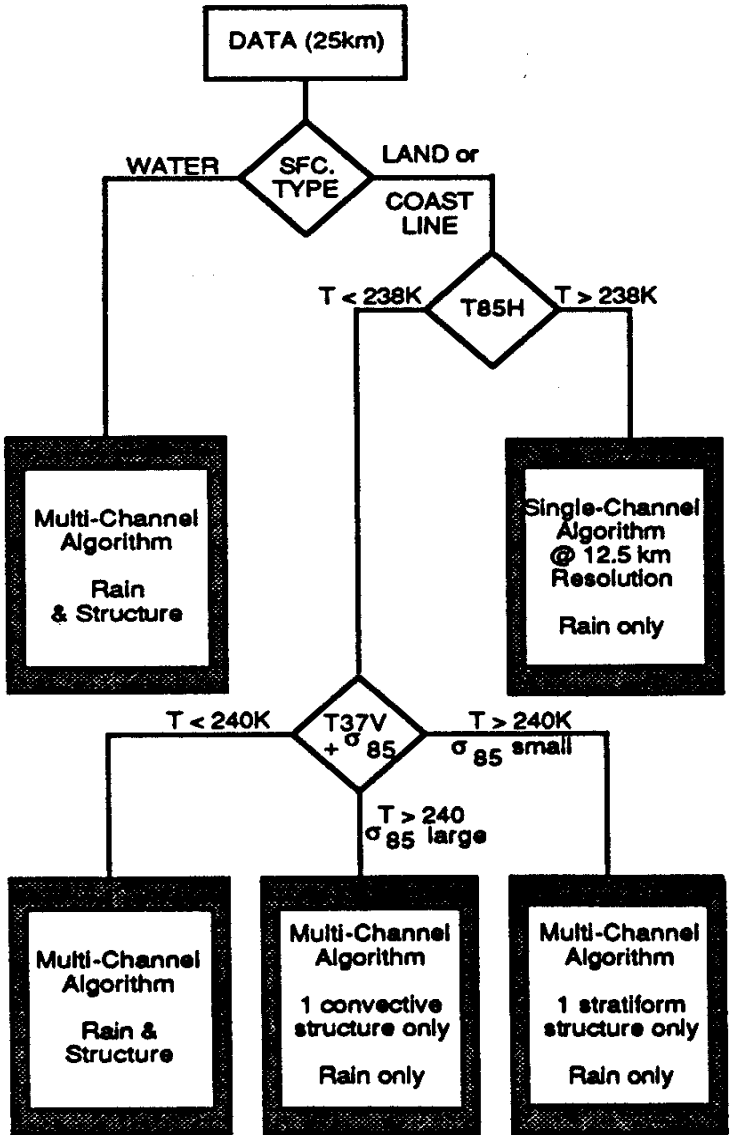
Outline

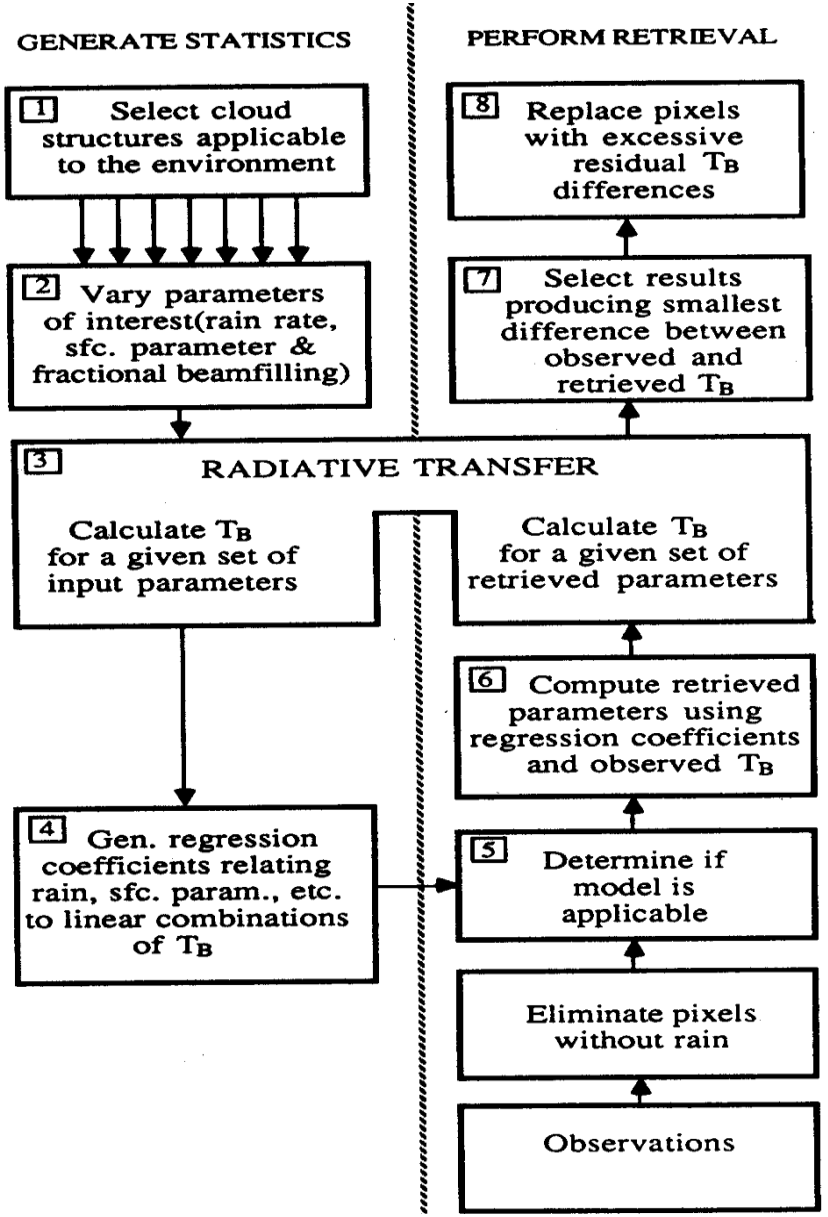
- Short description of the algorithms for rain rate retrievals from passive microwave radiometers on board low-orbiting satellites (i.e., SSMI/S)
- Case Study over Vale do Paraiba – 11 February 2012
- Comparison of different rain rate retrievals for heavy rain events during CHUVA-GLM period
- Future 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 the Global Precipitation Climatology Project (GPCP) merged rainfall product and TMPA.

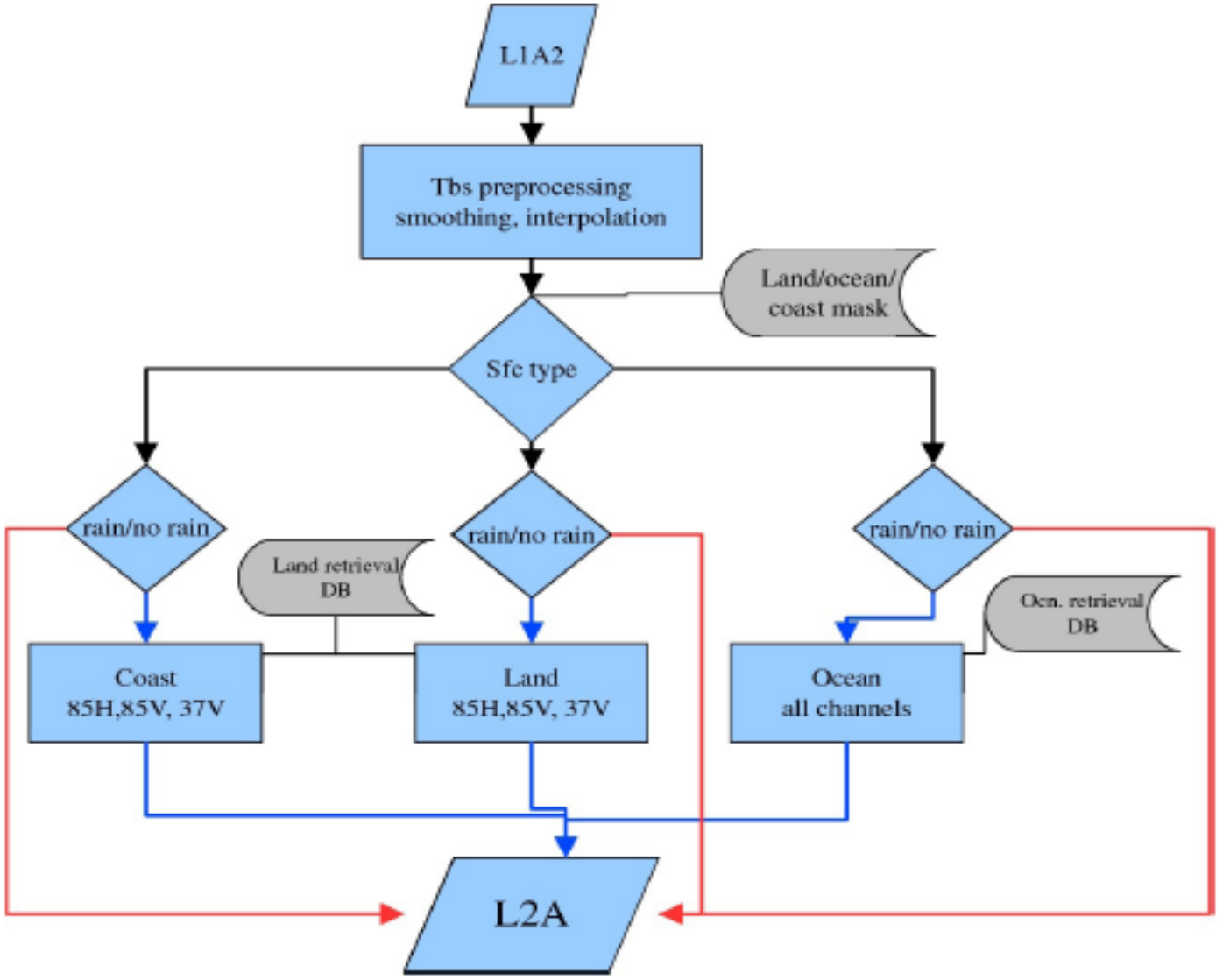
- GPROF retrieves both the instantaneous rainfall and the rainfall vertical structure by using a Bayesian approach to match the observed brightness temperatures to hydrometeor profiles derived from cloud resolving models (CRMs). A radiative transfer model based on a one-dimensional Eddington approximation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


DATA (25km)
SFC. TYPE
WATER
LAND or COAST LINE
T85H
T < 238K
T > 238K
Multi-Channel Algorithm
Rain & Structure
Single-Channel Algorithm @ 12.5 km Resolution
Rain only
T37V + σ85
T < 240K
T > 240K σ85 small
T > 240 σ85 large
Multi-Channel Algorithm
Rain & Structure
Multi-Channel Algorithm
1 convective structure only
Rain only
Multi-Channel Algorithm
1 stratiform structure only
Rain only


GENERATE STATISTICS
PERFORM RETRIEVAL
1 Select cloud structures applicable to the environment
2 Vary parameters of interest(rain rate, sfc. parameter & fractional beamfilling)
3 RADIATIVE TRANSFER
Calculate TB for a given set of input parameters
Calculate TB for a given set of retrieved parameters
4 Gen. regression coefficients relating rain, sfc. param., etc. to linear combinations of TB
5 Determine if model is applicable
6 Compute retrieved parameters using regression coefficients and observed TB
7 Select results producing smallest difference between observed and retrieved TB
8 Replace pixels with excessive residual TB differences
Eliminate pixels without rain
Observations

BRAIN general flow-chart diagram

Bayesian Rain retrieval Algorithm Including Neural network

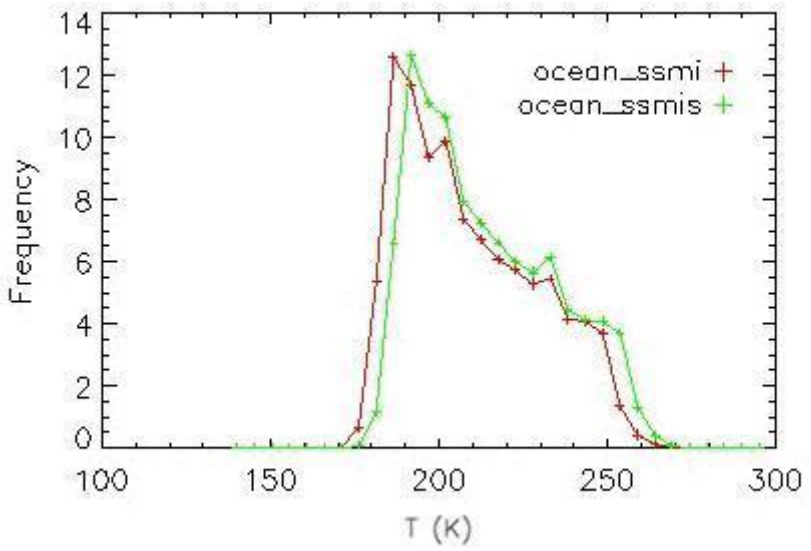


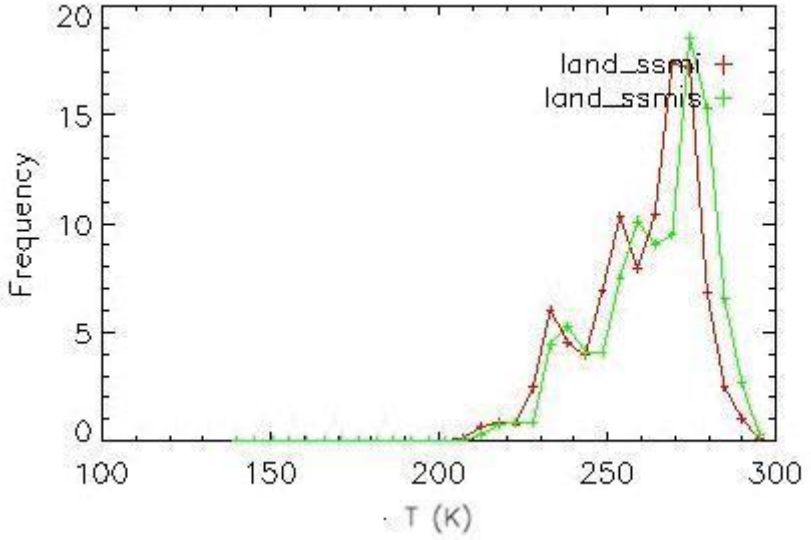
Emphasize on Bayesian-Based retrieval: BRAIN

- 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

THE HISTOGRAM MATCHING APPROACH

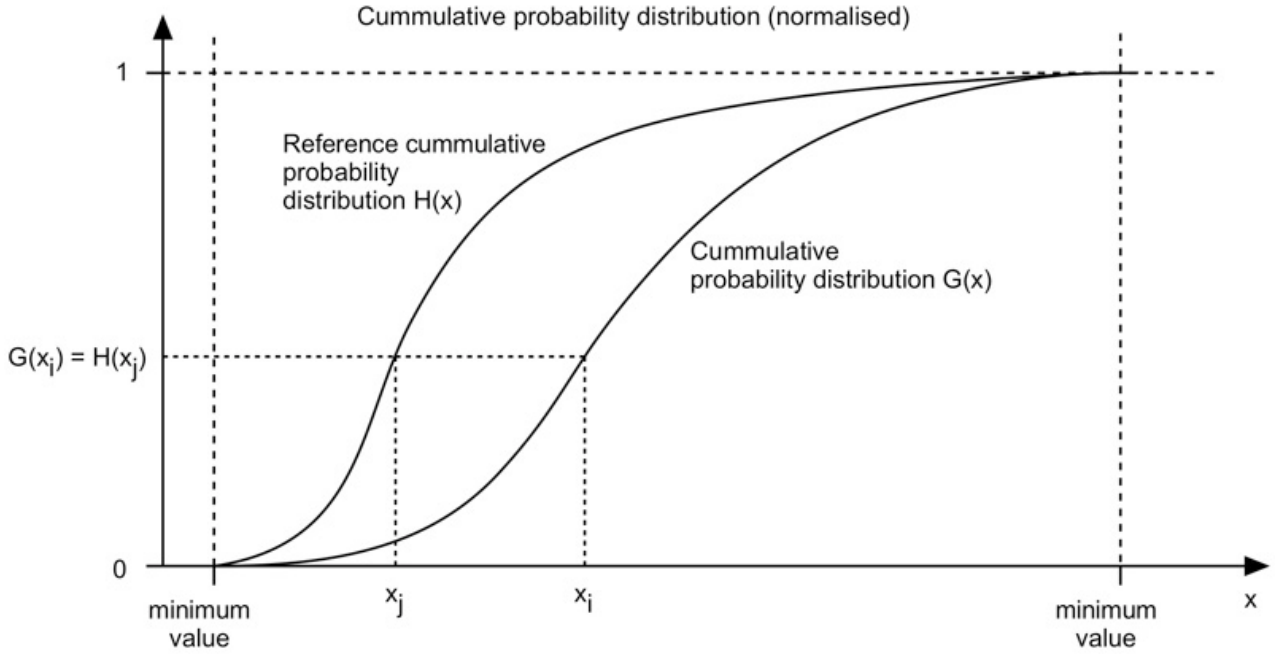
- Because one of the objectives of this study is the use of the existing algorithms for hydrological parameters available for SSM/I, the histogram matching approach appears as a suitable scheme to modify SSMI/S temperatures to match with the SSM/I reference.
- To achieve this purpose, seven months between 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.



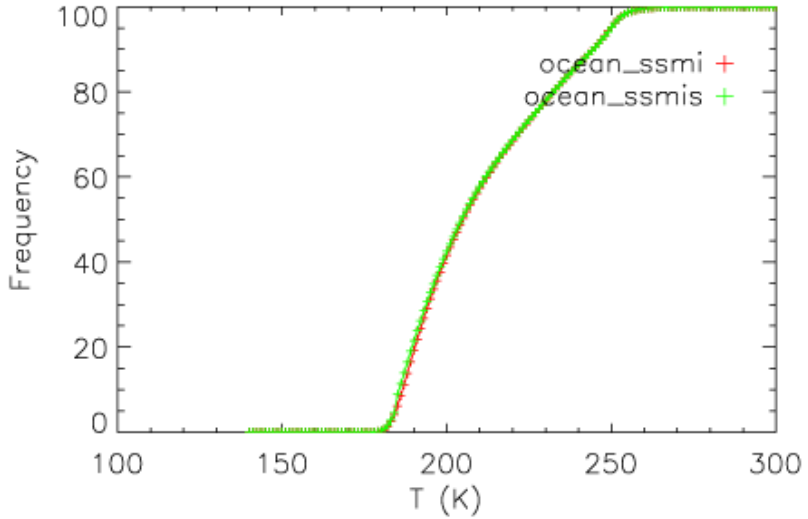


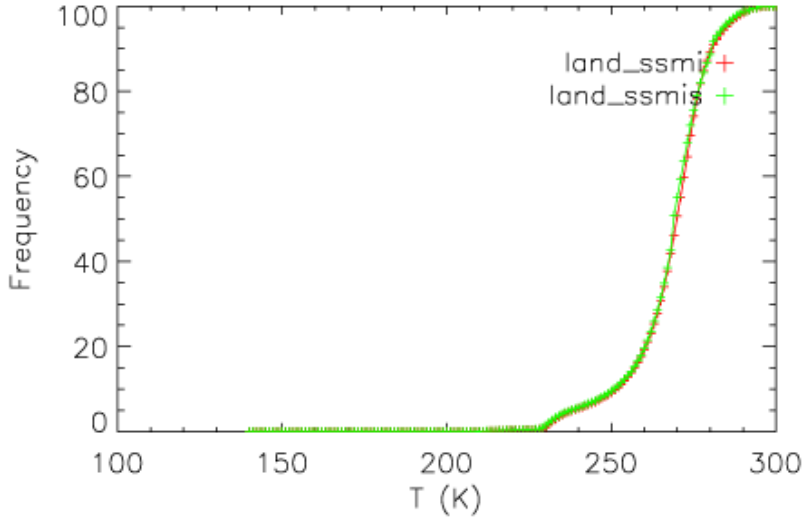
THE HISTOGRAM MATCHING APPROACH

- 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

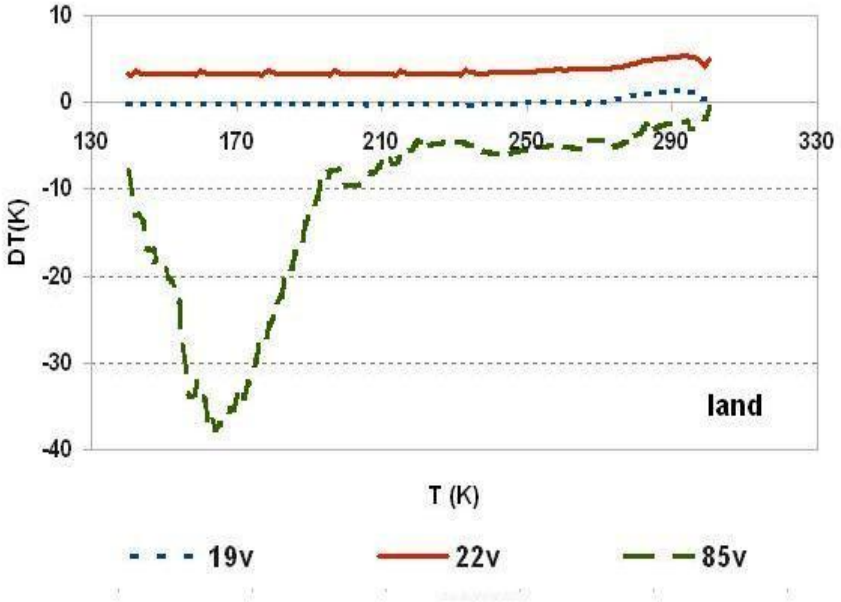


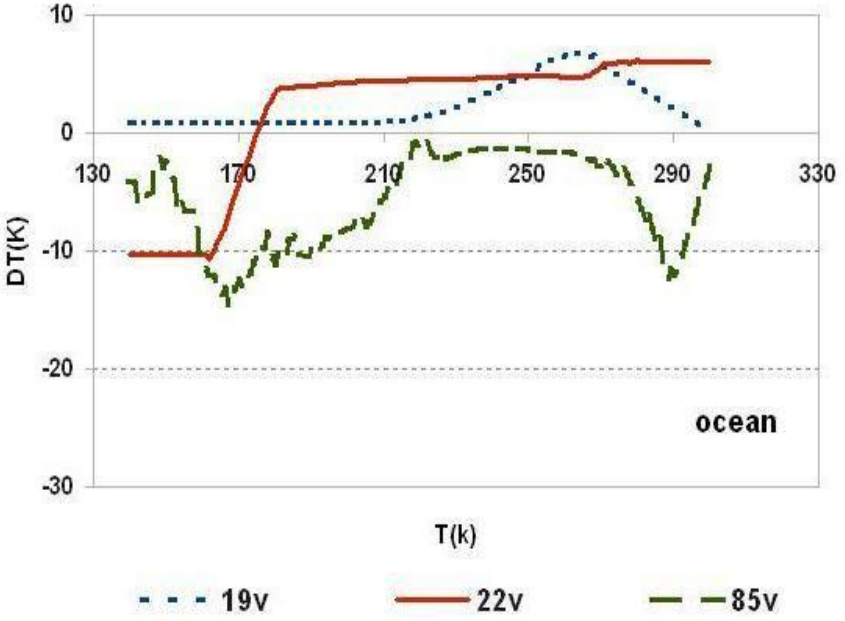


- Look-up tables (LUTs) for every channel (19 GHz H, 19 GHz V, 22 GHz V, 37 GHz V, 37 GHz H, 91/85 GHz V and 91/85 GHz H) stratified for surface type (land & ocean) were created using global 1/3 degree global daily grids for January - July 2009. Those LUTs were applied to SSMI/S channels .

- 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.

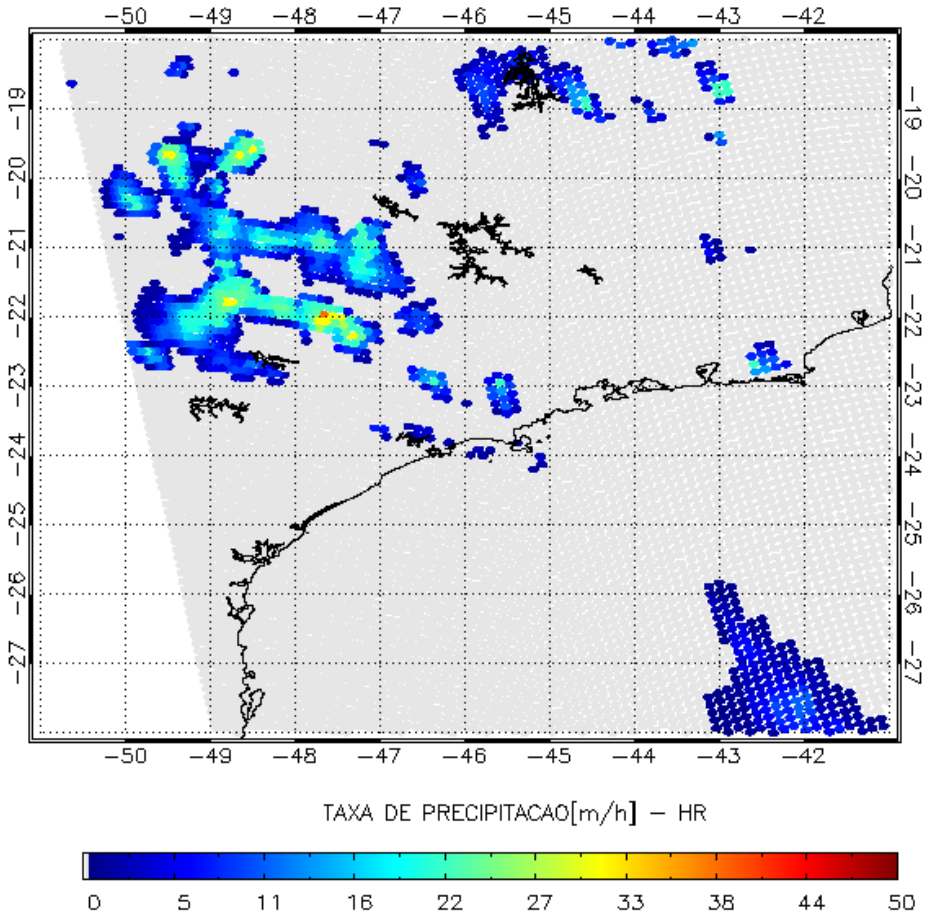
THE HISTOGRAM MATCHING APPROACH



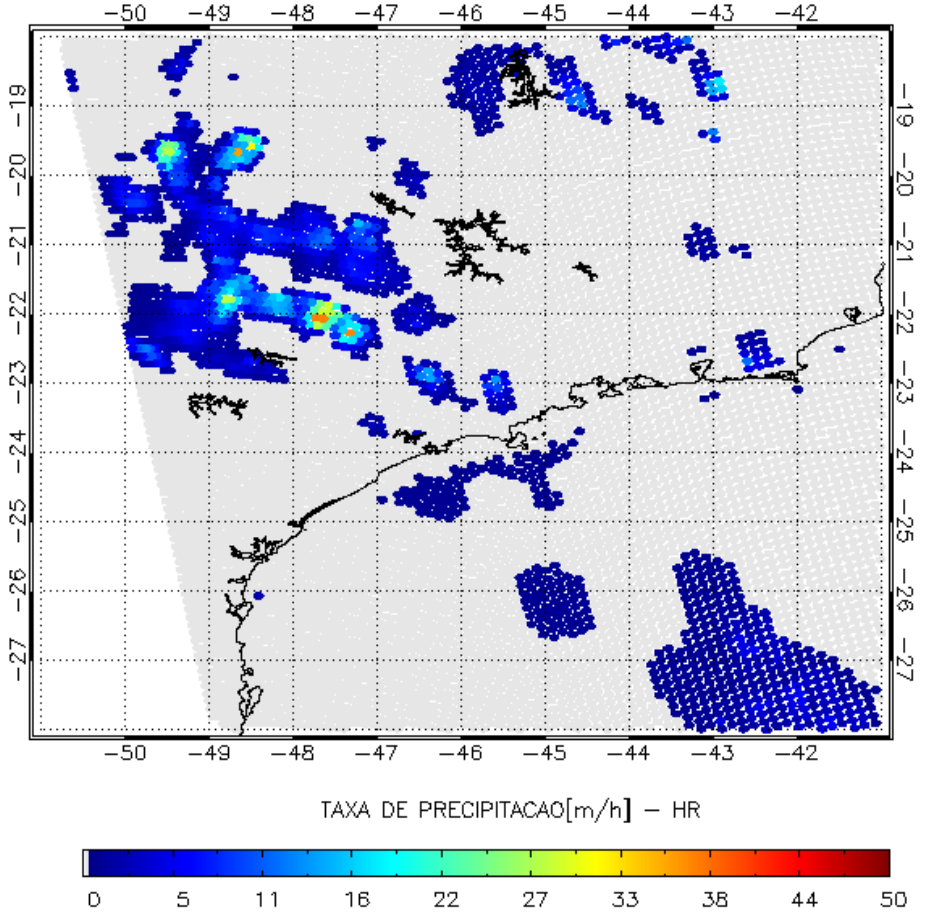


- For low frequency channels, the bias is positive (SSMI/S values are larger than SSM/I values) while for high frequency channels is the opposite and this bias is larger for lower temperatures (especially over land).

Case Study: 11 February 2012 – 19:30 UTC



BRAIN



GPROF

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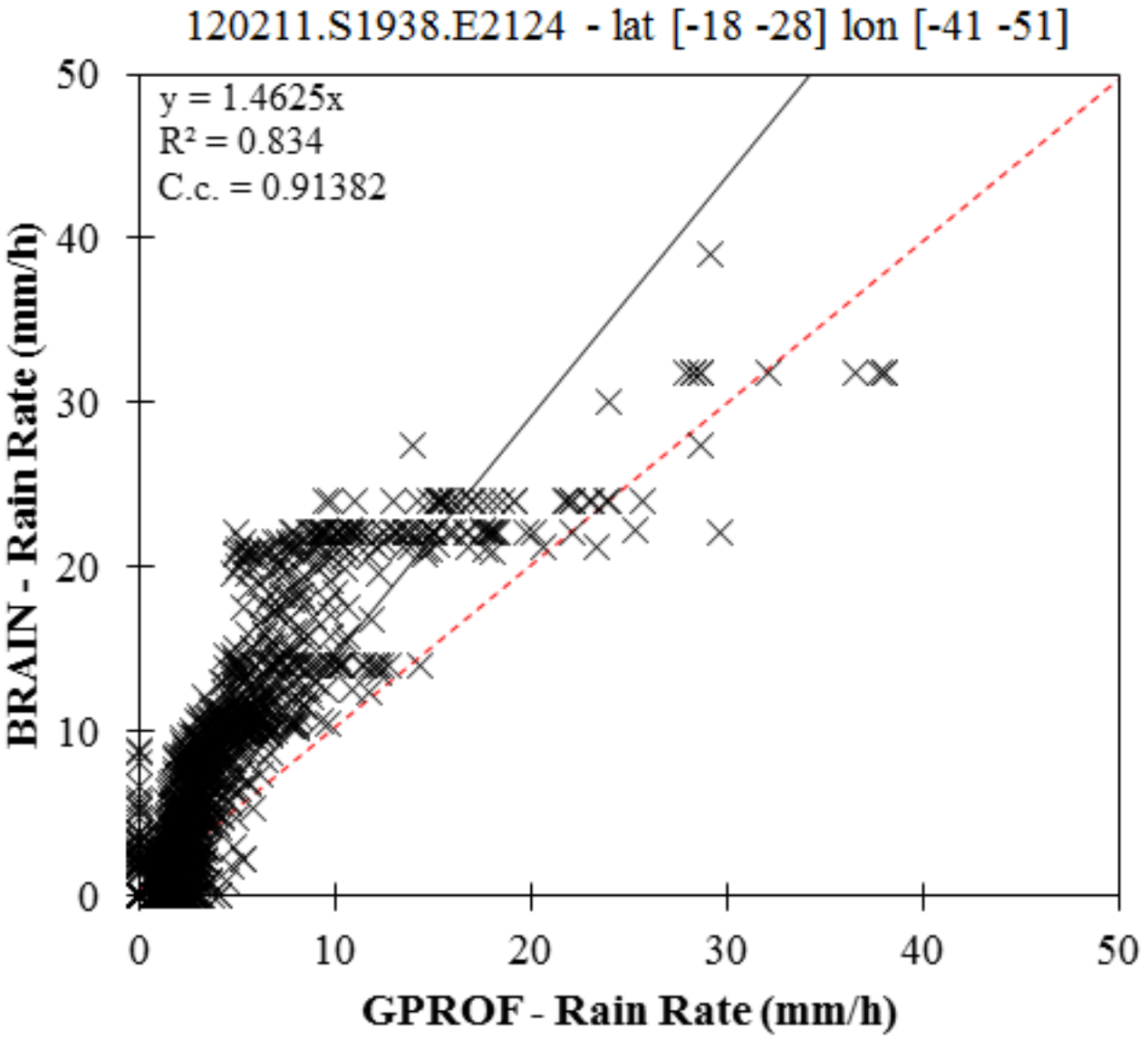

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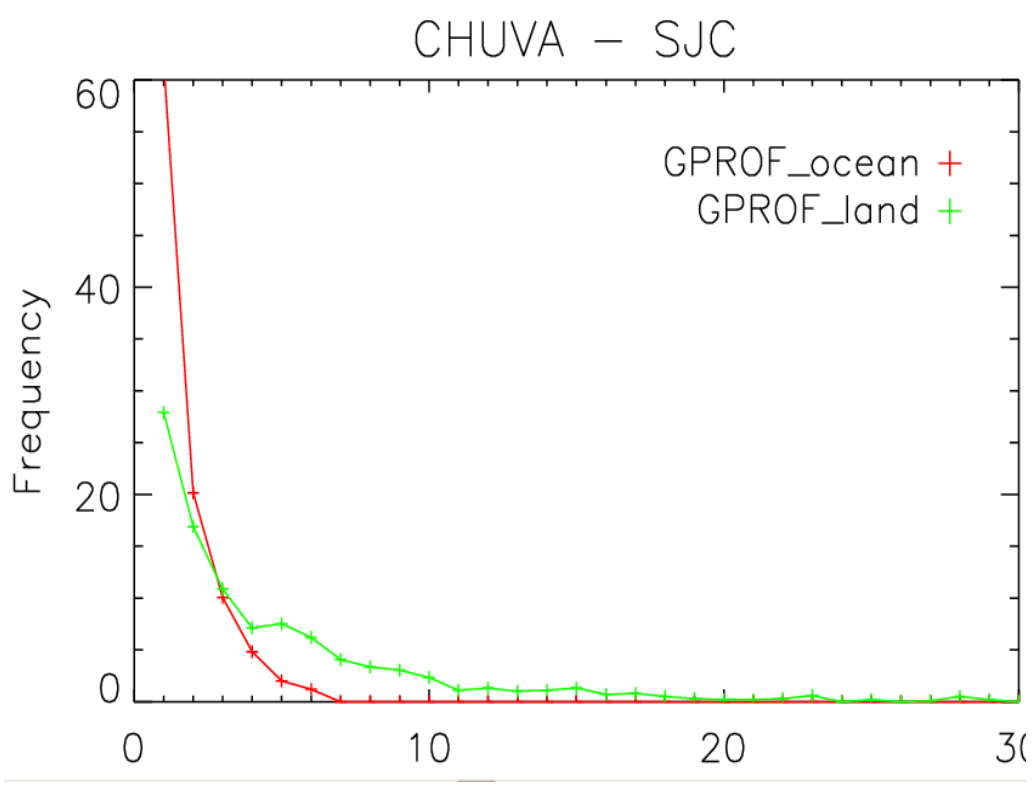

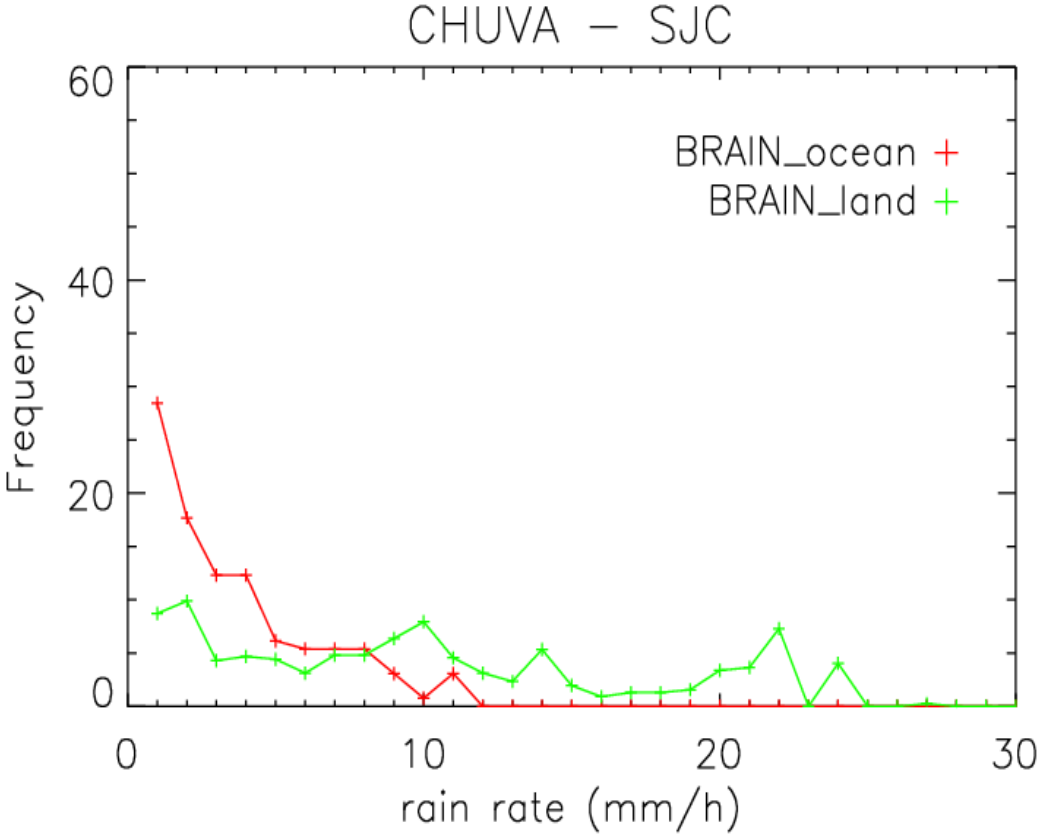

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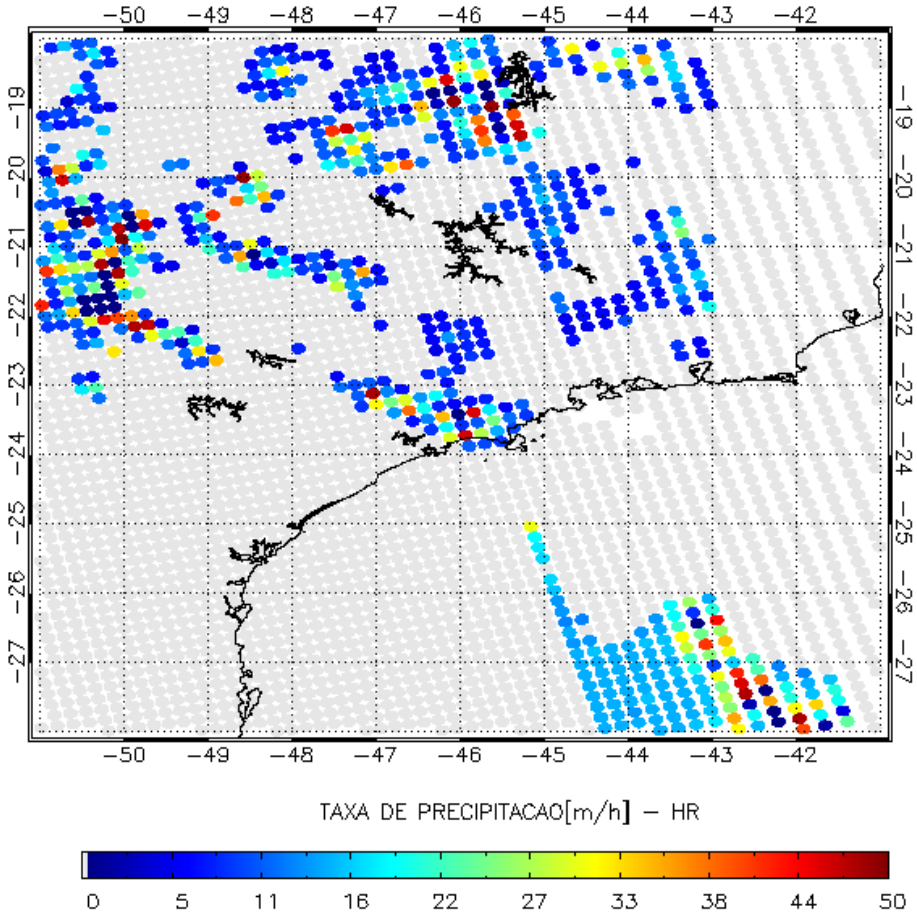
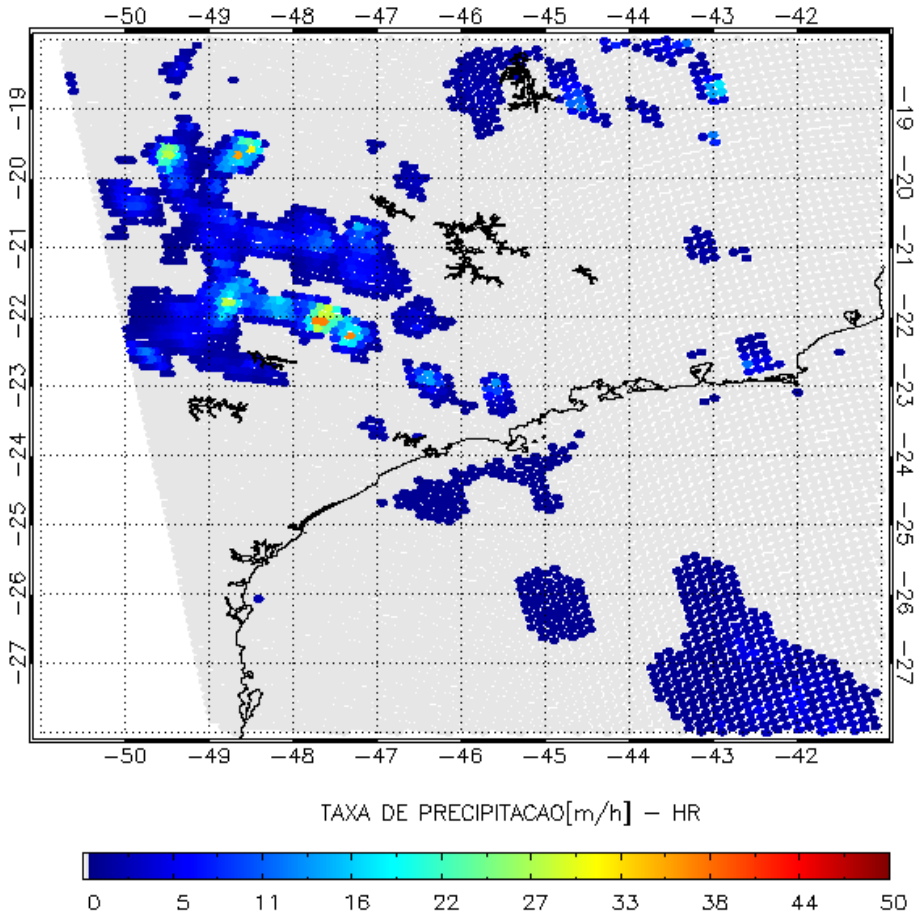
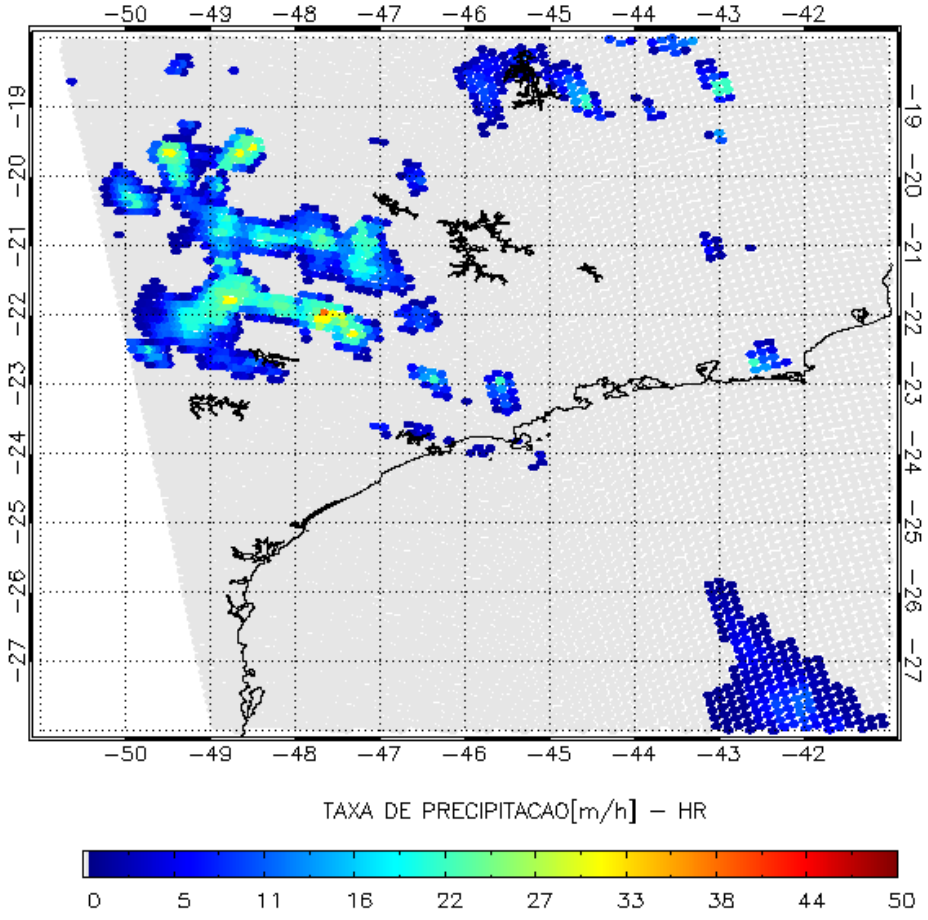


MSPPS/MHS (-1.5 hrs)

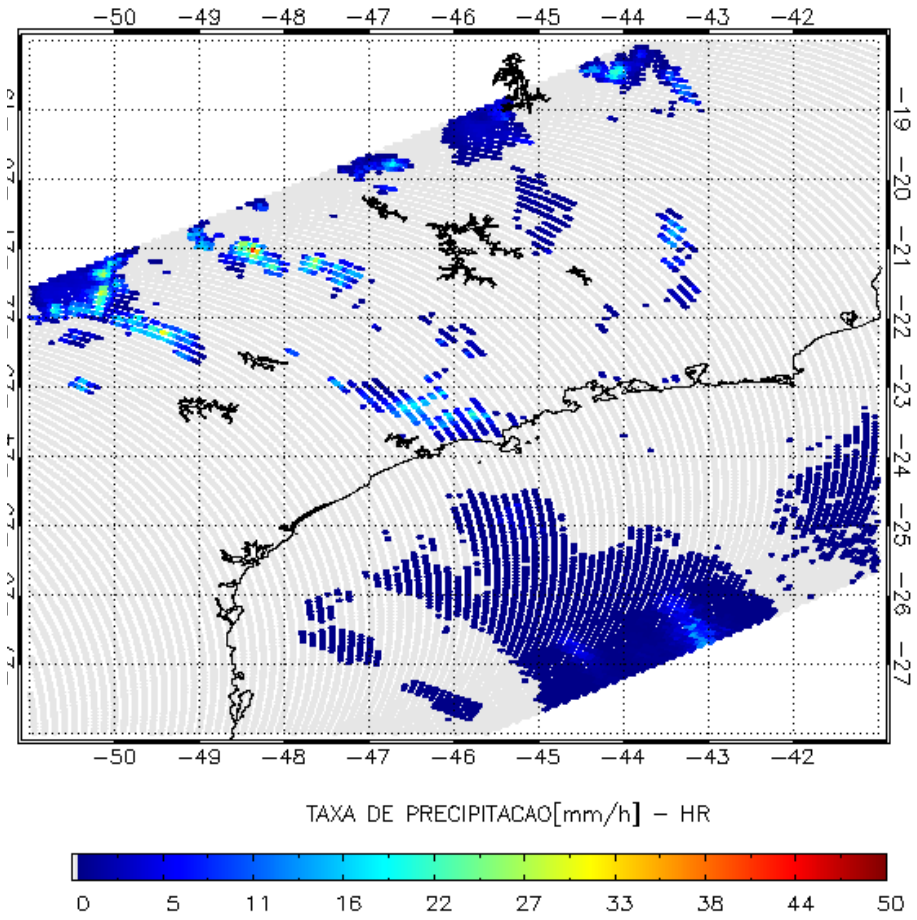


GPROF

Case Study: 11 February 2012 – 19:30 UTC

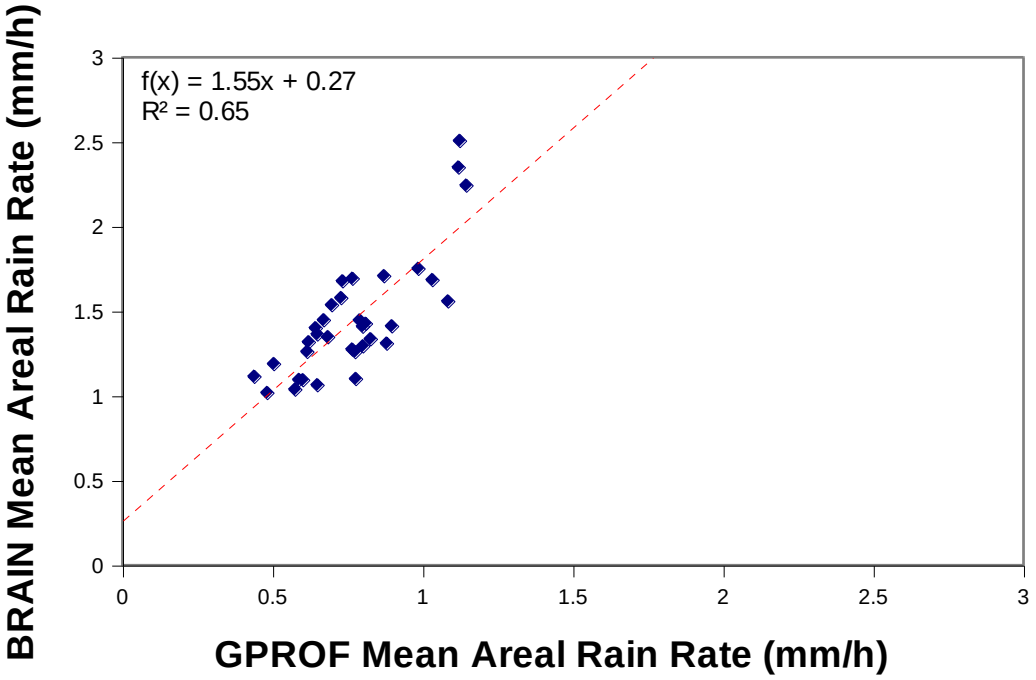


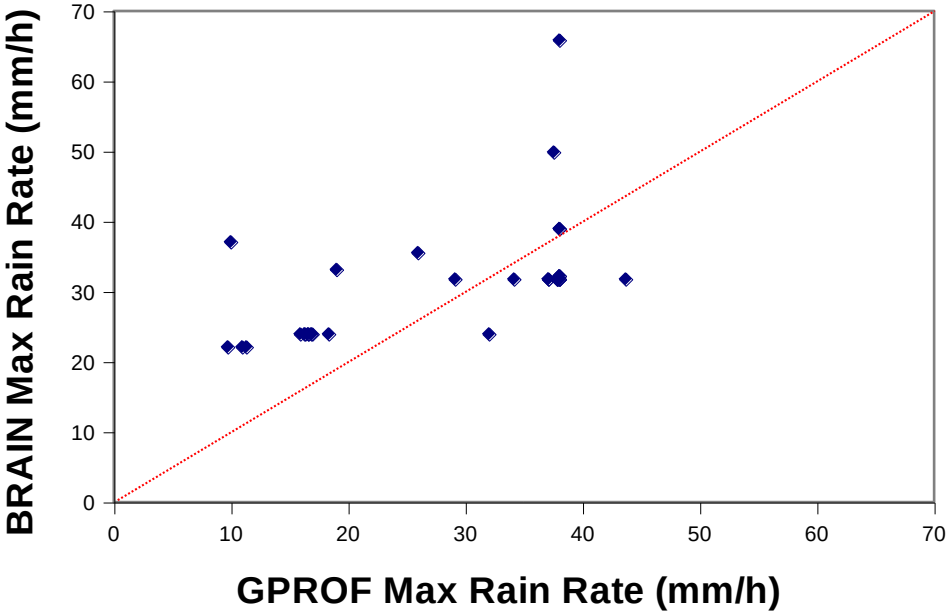
BRAIN



TMI (-1 hrs)

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





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