The CHUVA Project: First results and implications to satellite precipitation Estimation.

L. Machado, D. Vila, C. Morales, M. Silva Dias, G. Fisch and all CHUVA participants.

Luiz.Machado@cptec.inpe.br

CHUVA Project: Main Goals

WORKING GROUP–1: CHARACTERISTICS OF THE PRECIPITATING SYSTEMS AS FUNCTION OF THE REGION AND LIFE STAGE (Luiz Machado)

WORKING GROUP–2: PRECIPITATION ESTIMATION – DEVELOPMENT AND VALIDATION ALGORITHM (Daniel Vila)

WORKING GROUP–3: ELETRIFICATION PROCESS: MOVING FROM CLOUDS TO THUNDERSTORMS (Carlos Morales)

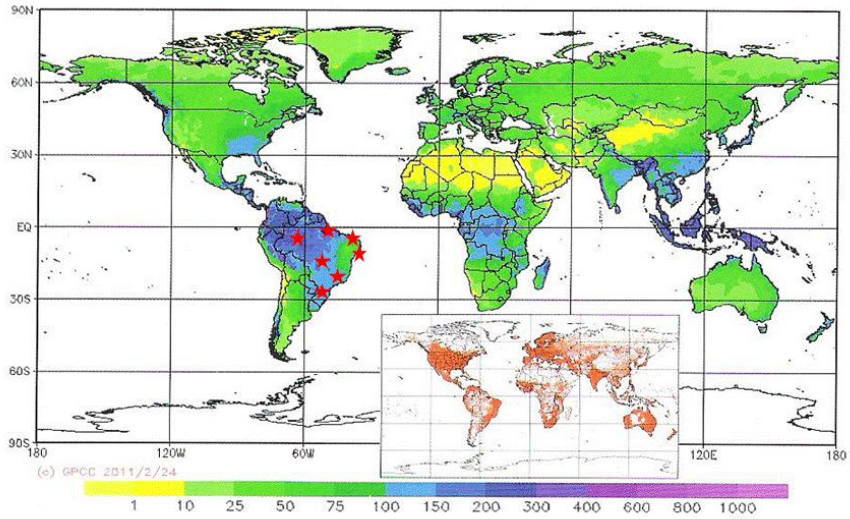
WORKING GROUP–4: CHARACTERISTICS OF THE BOUNDARY LAYER FOR DIFFERENT CLOUD PROCESSES AND PRECIPITATION REGIMES (Gilberto Fisch)

WORKING GROUP–5: MODEL IMPROVEMENTS AND VALIDATION, WITH FOCUS IN CLOUD MICROPHYSICS AND AEROSOL INTERACTIONS, FOR SATELLITE PRECIPITATION ESTIMATES IN BRAZIL (Maria Assunção Dias)

- Contributes to Improve Rainfall Estimation Using Satellites and/or Radar
- Contributes to Improve Skill of Cloud Resolving Models
- Develop a Cloud Process Climatology of the Main Precipitation Systems in Brazil.
- Develop Tools for Nowcasting.

CHUVA Field Campaign Schedule

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEZ
2010			ALCANTARA									
2011			FORTALEZA	FORTALEZA		BELÉM	BELEM				Vale do Paraiba	Vale do Paraiba
2012	Vale do Paraiba	Vale do Paraiba	Vale do Paraiba								Santa Maria	Santa Maria
2013		BRASÍLIA	BRASÍLIA									
2014		MANAUS	MANAUS	MANAUS	MANAUS	MANAUS	MANAUS	MANAUS	MANAUS	MANAUS	MANAUS	MANAUS



Plot of the annual precipitation in mm/month derived from the 12 monthly gridded GPCC climatologies. Underlying station locations are shown in the inset map.

CHUVA PROJECT

CPTEC

Experimentos

THE PRE - CHUVA - GPM 2010
CAMPANHA - 01/03/2010 à 25/03/2010

29/03/2011 à 29/04/2011

30/06/2011 à 02/07/2011

Vale do Paraiba

Short Campaign - several over the year – The way to improve rainfall records by selecting rainfall season of each region.

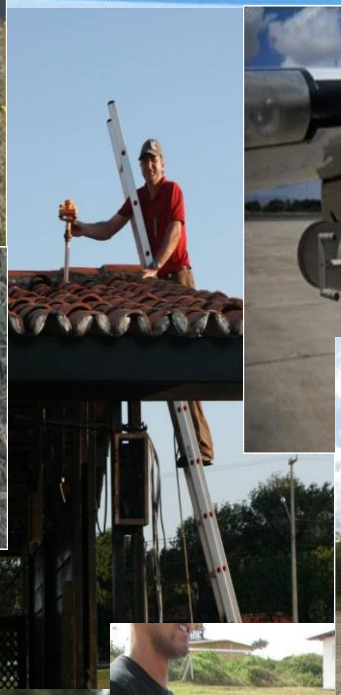
CHUVA Portal: http://chuvaproject.cptec.inpe.br/portal/en/

Field Campaign and SOS System

CHUVA - Alcântara







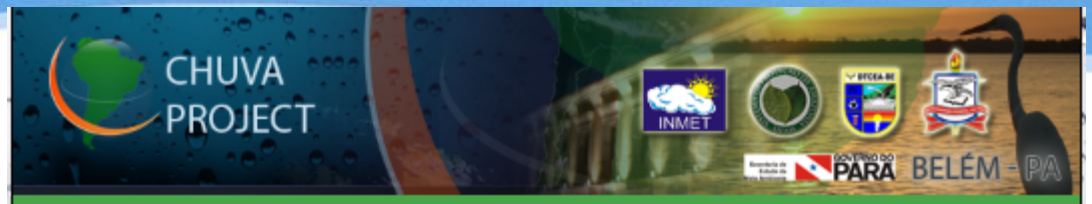




CHUVA -Fortaleza

Precipitação (mm/h)
0.1 1 3 8 25 50 >100
5 10 15 20 25 30 35 40 45 50 55 60 65 70 75
Refletividade (dBZ)

CHUVA - Belém



Boa Tarde! Sexta-feira, 28 de outubro de 2011

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- Portal Chuva Project
- Relatório de Dados
- Fotos
- Instrumentos
- Localização
- Estratégias de Medidas
- Participantes
- Previsão Numérica
- Boletim Meteorológico
- Curso
- SOS Belém
- Quicklook
- Balões Lagrangianos

CAMPANHA DE BELÉM

O projeto inicia em junho segundo experimento de campo para estudar e melhorar modelos de previsão e estimativa de chuvas.

Um mês após o encerramento da campanha científica de Fortaleza, começa em junho o segundo experimento de campo do Projeto Chuva, que até o final de 2012 cobrirá seis cidades. Desta vez, Belém (PA) será a sede da campanha, que terá o mesmo formato da de Fortaleza. Além dos trabalhos de coleta de dados, envolvendo diversas instituições e equipamentos, será montado o Sistema de Observação de Tempo Severo, como em Fortaleza, para a emissão de alertas e avisos meteorológicos, e o mini-curso - Processos Físicos das Nuvens -, voltado a alunos de graduação e pós-graduação, reeditado para ser realizado na Universidade Federal do Pará (UFPA).

O Projeto Chuva está sob a coordenação geral do Centro de Previsão do Tempo e Estudos Climáticos (CPTEC), do Instituto Nacional de Pesquisas Espaciais (INPE) e conta com financiamento da Fundação de Amparo à Pesquisa do Estado de São Paulo (FAPESP).

O foco principal da pesquisa será as linhas de instabilidades que se formam na região costeira do continente, dando origem a grandes aglomerados de nuvens Cúmulo Nimbos. Nesta época do ano, estes aglomerados penetram o interior da Amazônia, provocando chuvas intensas. Estas chuvas são fundamentais ao clima da Floresta Amazônica. Por outro lado, elas também provocam enchentes e prejuízos às cidades e metrópoles da região.

Para acompanhar os sistemas convectivos, o pesquisador Frederico Angelis, do CPTEC/INPE, e um dos coordenadores científicos do projeto, conta que será utilizado durante a campanha um dos mais avançados radares meteorológicos do mundo, com capacidade de discriminar diferentes tipos de precipitação e partículas no interior das nuvens. "O resultado é semelhante a uma tomografia, só que das nuvens", destaca.

A expectativa é de que as medidas tragam dados e informações que ajudem a conhecer melhor a estrutura das linhas de instabilidades. Os dados também poderão ser aplicados em áreas de pesquisa de mudanças climáticas e em análises dos efeitos dos aerossóis (partículas suspensas na atmosfera) na formação de nuvens de chuva.

Os processos de eletrificação das nuvens também serão estudados nesta campanha. O pesquisador da USP, Carlos Augusto Morales, coordena as atividades na área e a coleta de dados.

Outro resultado esperado com grande expectativa é a obtenção de dados que permitirão às novas gerações de satélites meteorológicos estimar as chuvas da região. As medidas de campo serão úteis na especificação de sensores a bordo de um satélite brasileiro, que fará parte do programa Global Precipitation Measurement (GPM ou Medidas Globais de Precipitação), sob a liderança das agências espaciais dos Estados Unidos (NASA) e do Japão (JAXA).

Melhoria das previsões – O pesquisador Luiz Augusto Machado afirma que os processos físicos associados às nuvens de tempestade, que evoluem em escala de alguns quilômetros, ainda não são totalmente conhecidos e há pouca precisão na sua descrição pelos modelos numéricos de previsão de tempo e clima.

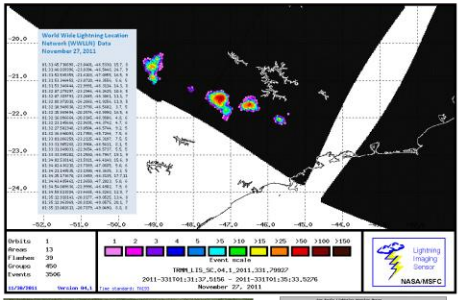
Com o aumento da resolução espacial dos atuais modelos, devido ao maior poder computacional do novo supercomputador do INPE (batizado de Tupã), os processos que envolvem as partículas de chuva e gelo nas nuvens terão que ser descritos com maior detalhamento. O pesquisador Saulo Freitas, também do CPTEC, irá radar, durante a campanha, um modelo de alta resolução, com o intuito de testar e validar a previsão imediata para a região.

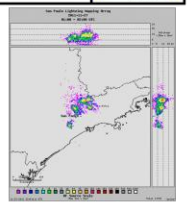
CHUVA – GLM - Vale do Paraíba


X-Band- Pol - UNIVAP
SP-035
SP-056
SP-070
SP-077
SP-103
SP-121
SP-125
iacit
ieav
sitio
cesp
pousada
BR 381
SP-019
SP-088
SP-093
SP-131
45 km
Data SIO, NOAA, U.S. Navy, NGA,
© 2011 MapLink/TeleAtlas
© 2011 Google
10 km
20 km
30 km
40 km
50 km
60 km
70 km
80 km

GLM – CHUVA Resources

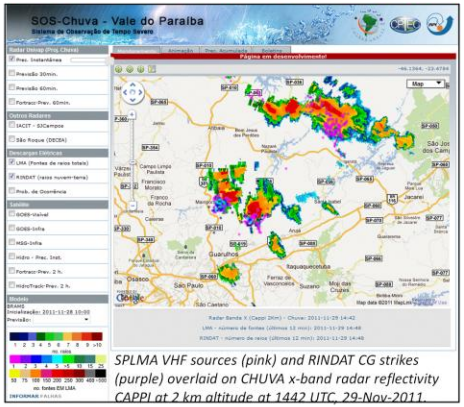
Coincident LIS, WWLLN, & LMA Observations





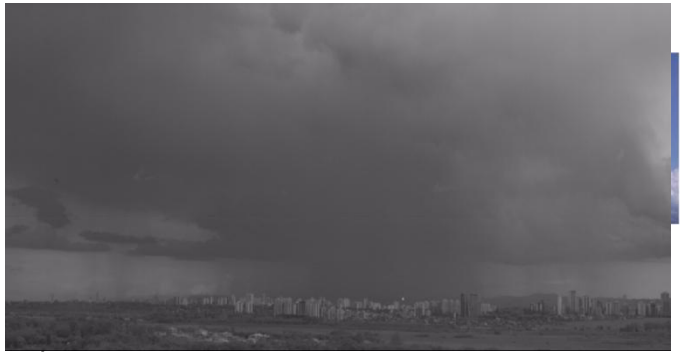
São Paulo Lightning Mapping Array (SPLMA) station showing the VHF (Channel 8, 162 MHz) ground plane antenna, sensor electronics and computer package (left). Plot with horizontal and vertical projections of 1-hour source density for 0100-0200 UTC on 27-Nov-2011 encompassing the LIS overpass 0131-0135 UTC and WWLLN observations (above).

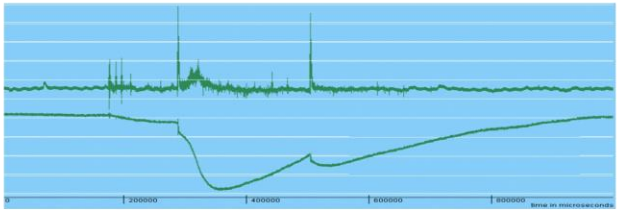
Coincident Radar, LMA, RINDAT (CG)



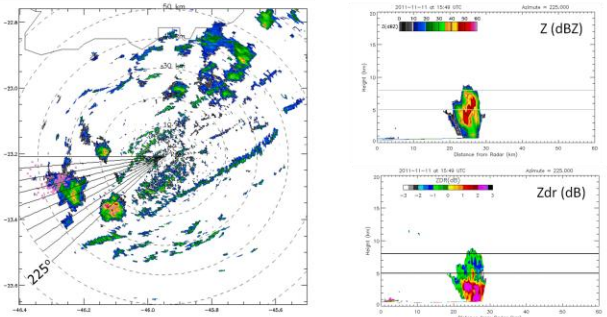
SPLMA VHF sources (pink) and RINDAT CG strikes (purple) overlaid on CHUVA x-band radar reflectivity CAPPI at 2 km altitude at 1442 UTC, 29-Nov-2011.

High Speed Video, Electric Field and Radar

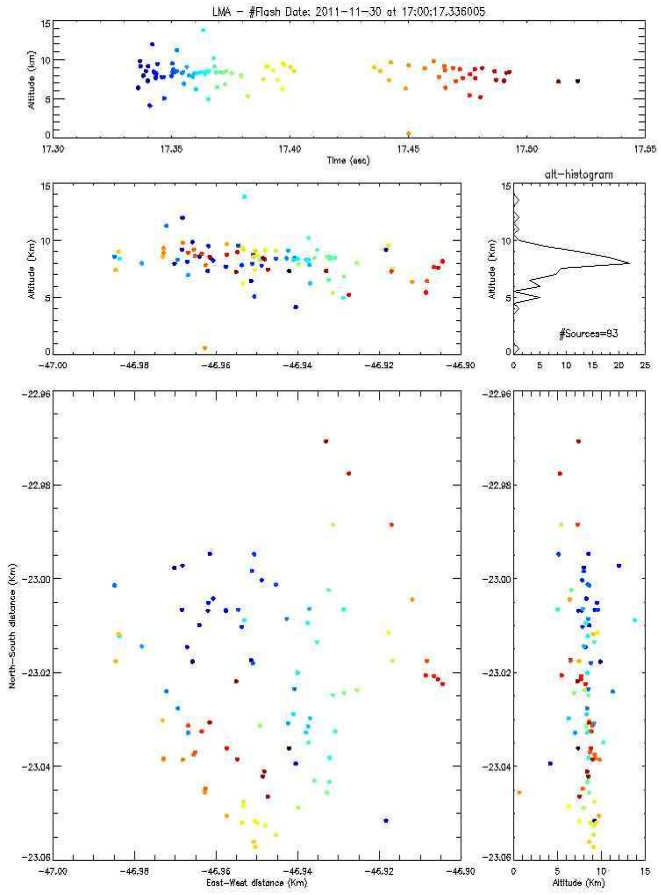




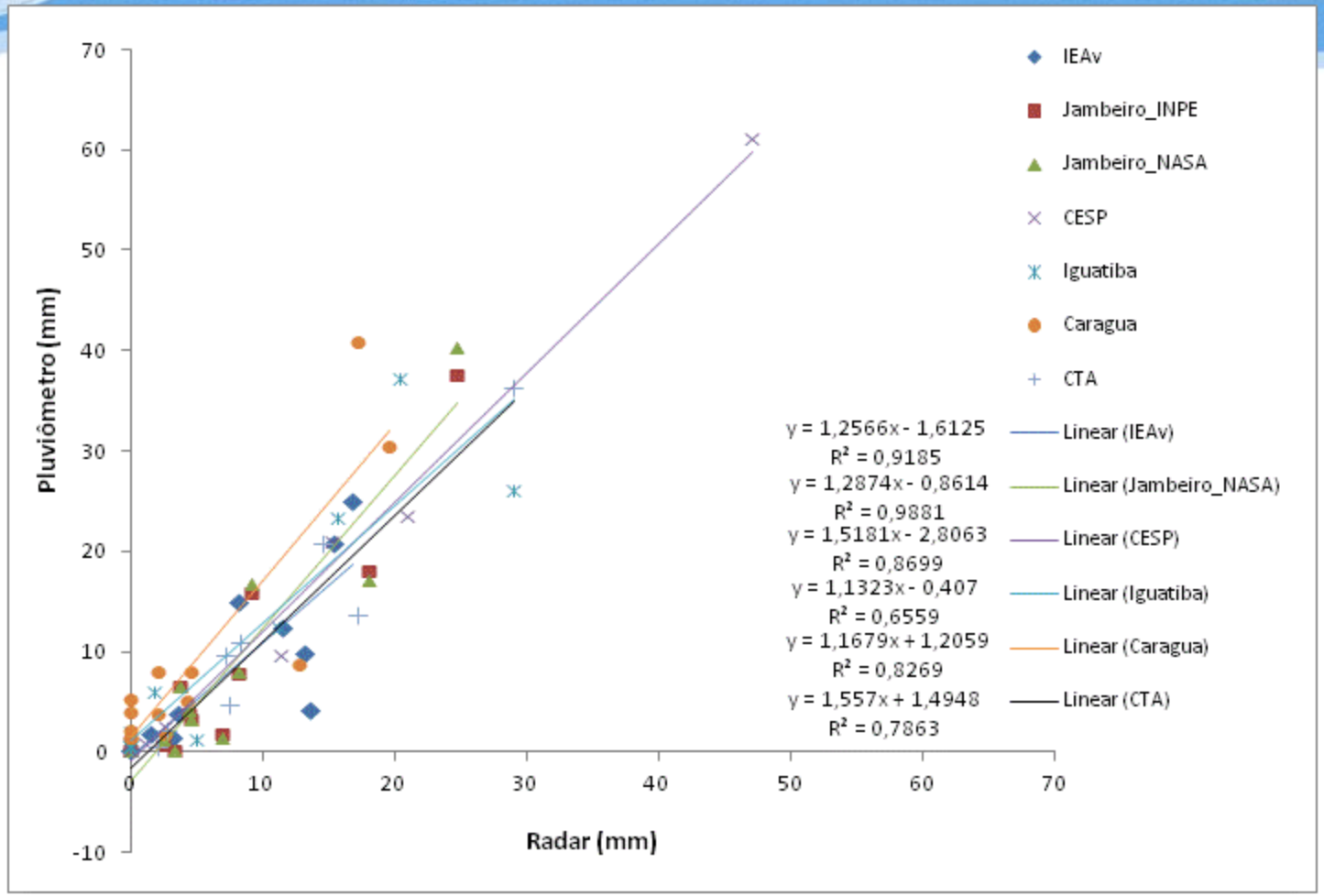
Slow-E and fast-E field for a positive CG flash



X-band dual-pol radar reflectivity CAPPI (dBZ) with overlay of SPLMA VHF sources in pink (above left) on 11-Nov-2011. Cross-section of reflectivity (dBZ, upper right) and Zdr (dB, lower right) along 225 degree azimuth. Region of frozen hydrometeors indicated by the high reflectivity and negative Zdr above the melting level at ~4 km.



Radar Rainfall and Raingauge - Daily



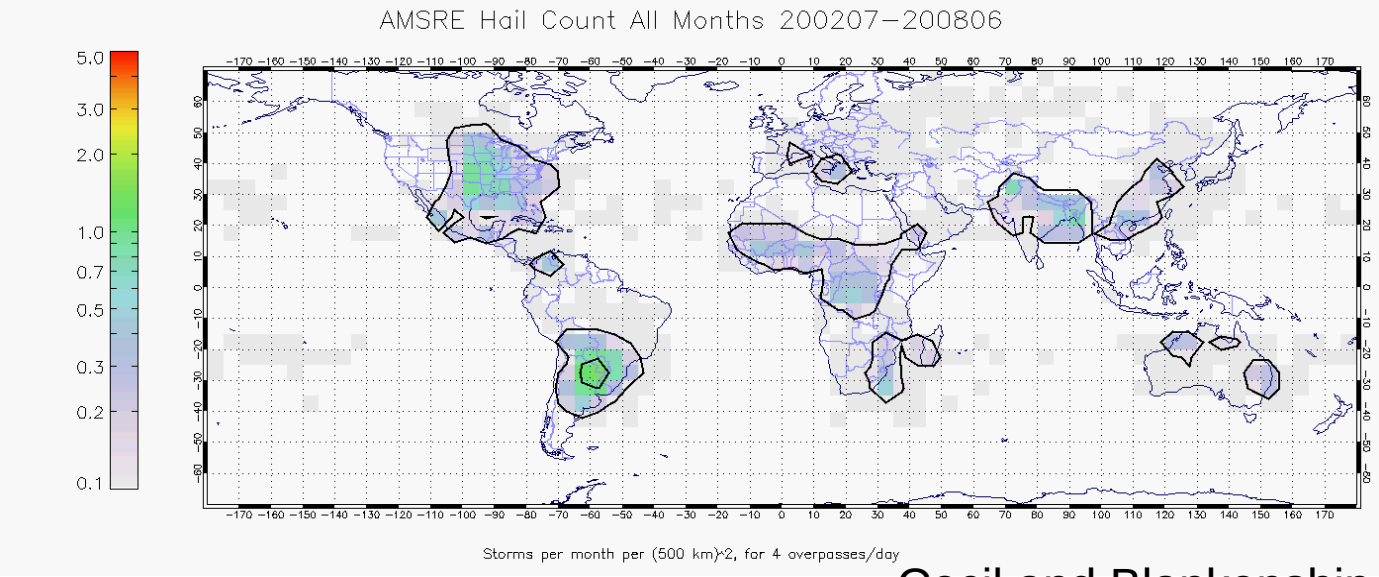
$IF - Z > 35 dBZ - and - KDP > 0.3 \deg/km$

$R = 19.63 |KDP|^{0.823}$

Otherwise

$R = 200 Z^{1.6}$

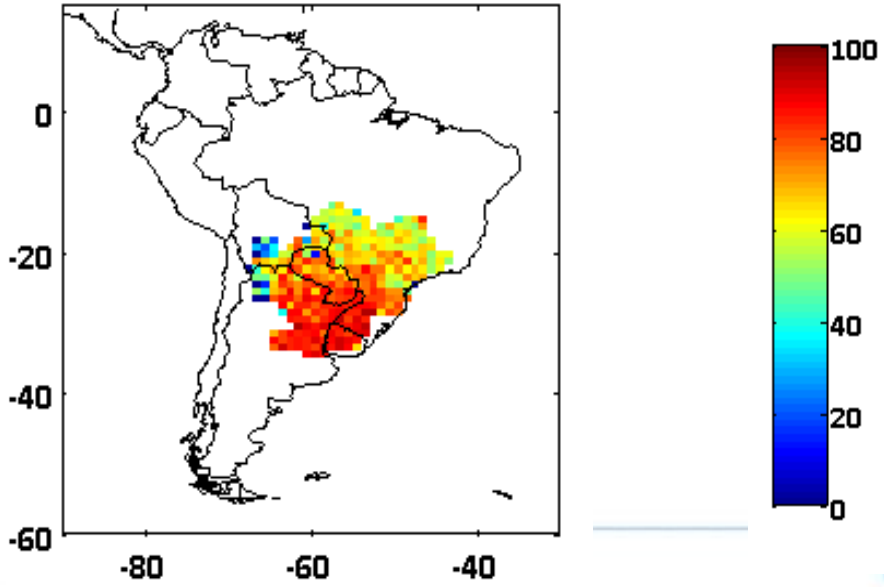
Next Campaing – Santa Maria – Nov-Dec 2012



Cecil and Blankenship, 2011, J. Clim.

Percentage of surface rain from 2A25 explained by MCSs over La Plata Basin

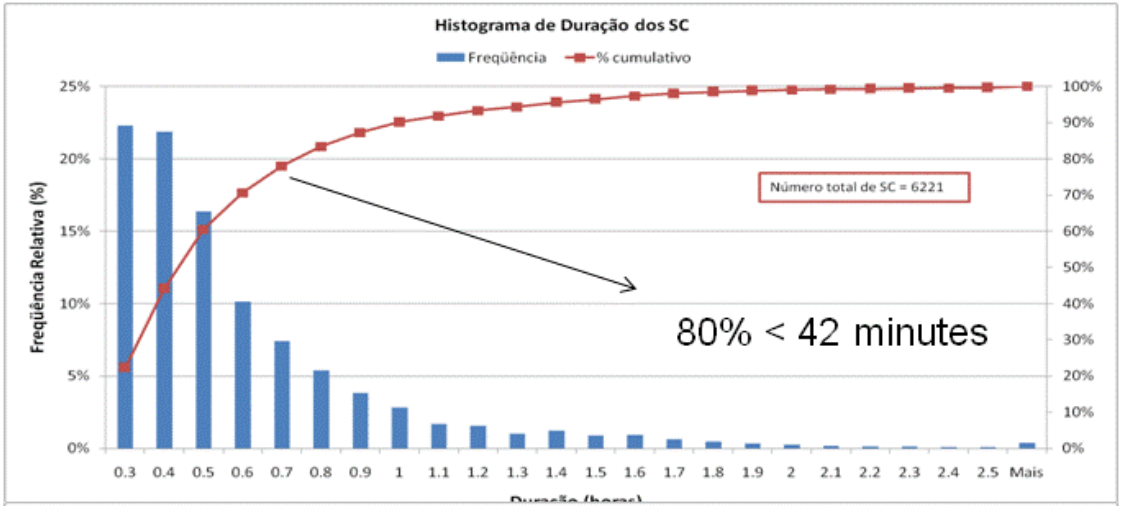
Results from Paola Salio

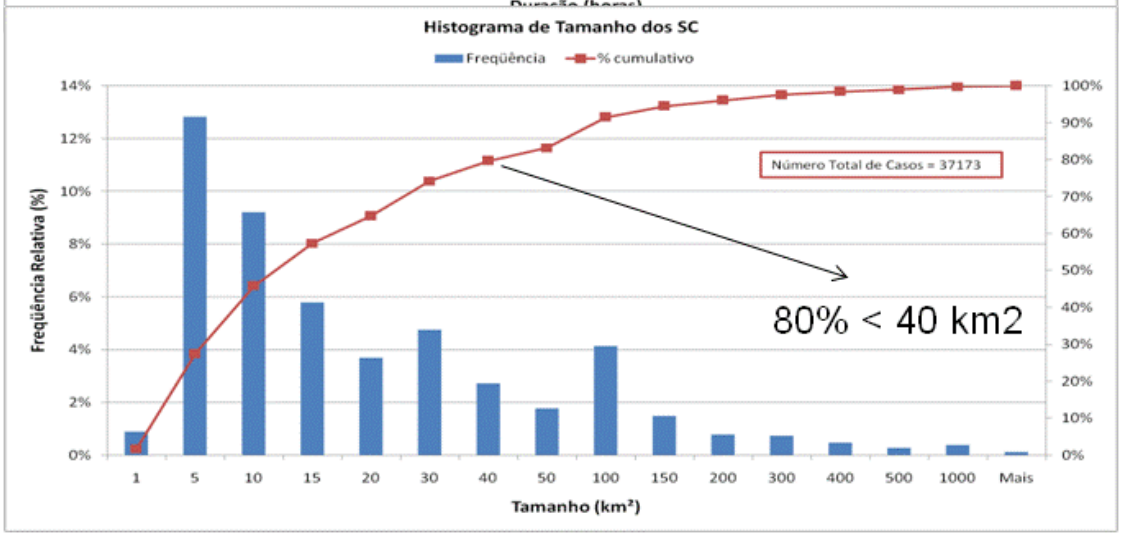


Preliminary Results and studies been done in CHUVA Project

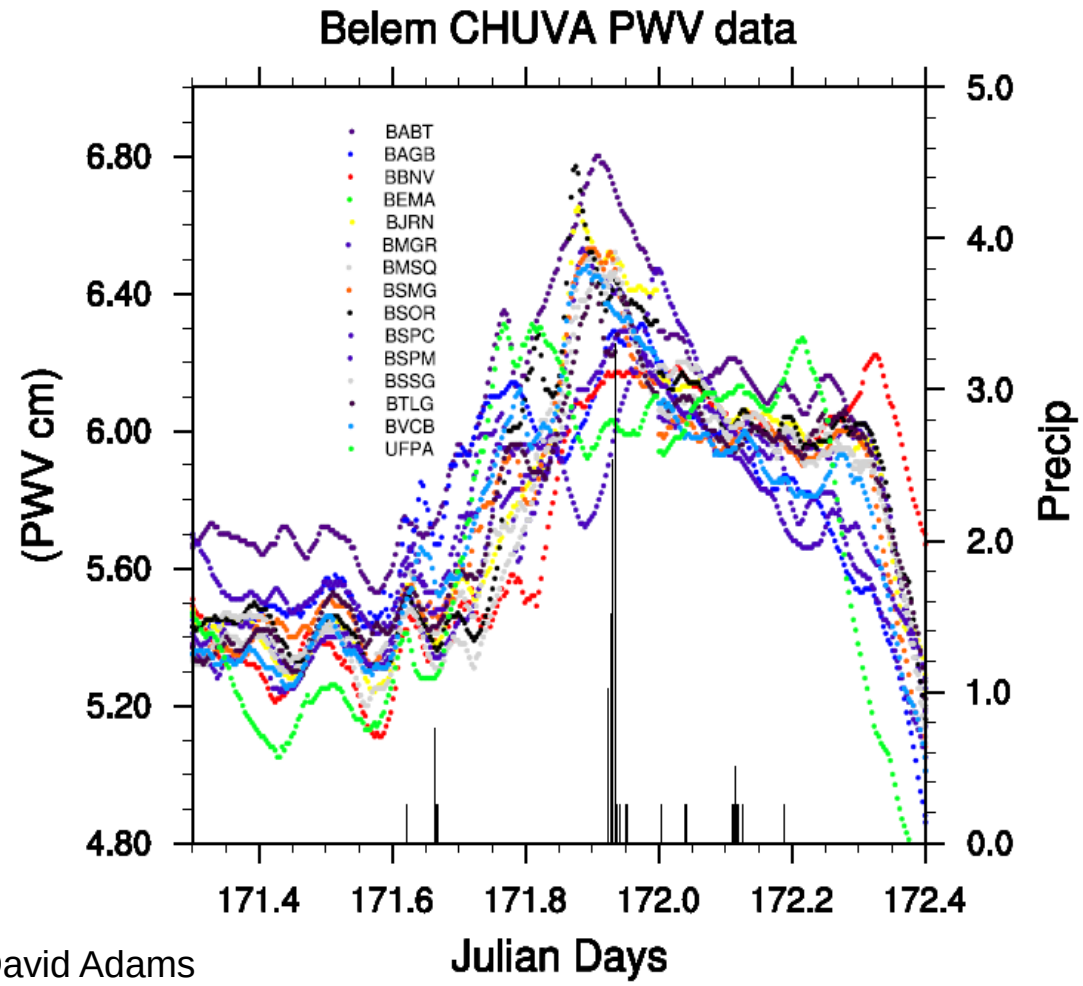
Rain Cells Life Cycle and Size - Fortaleza

Life Cycle of Cloud type organizations and the relationships:
Scattering – rainfall
Hydrometeor population, IWL, IIC and microwave brightness temperature





Water Vapor variation and conversion to liquid water



David Adams

Pranab Karmakar

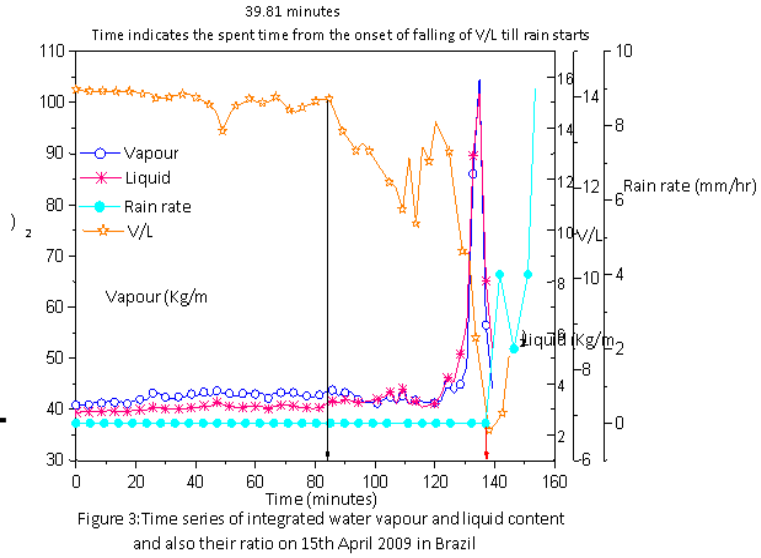
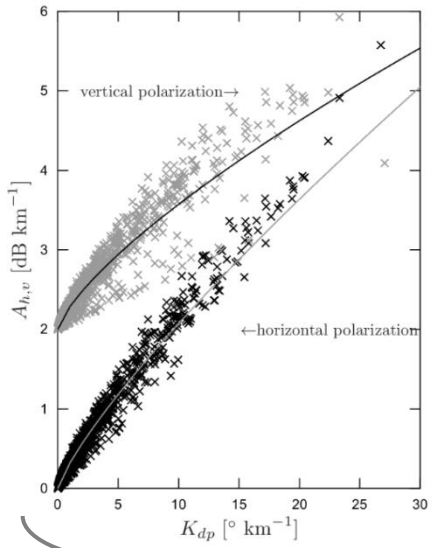
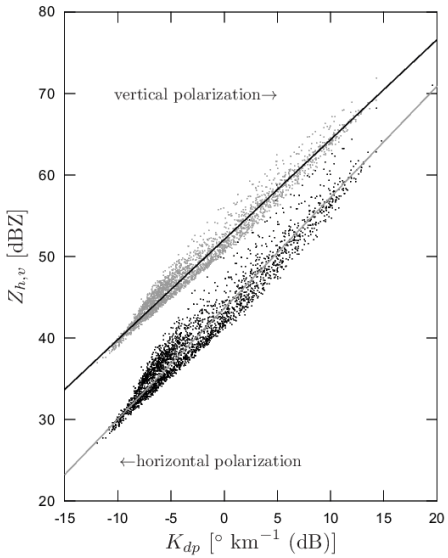


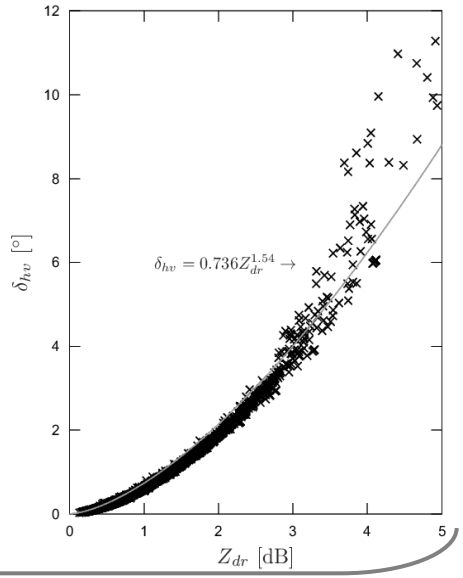
Figure 3:Time series of integrated water vapour and liquid content and also their ratio on 15th April 2009 in Brazil

Evolution of PWV and correlation and time lag with rainfall
Conversion Water Vapor to Liquid Water and the description by Brightness Temperature.

Radar data processing with Kalman filtering





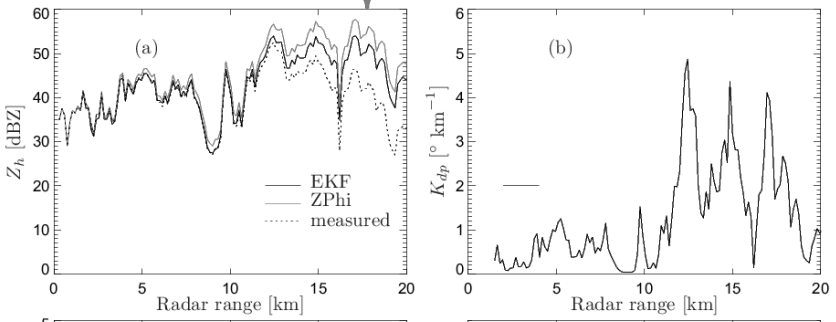


T-matrix modeling of relations between polarimetric radar variables based on drop size distributions from Parsivel measurements

Observations of tropical rain with a polarimetric X-band radar: first results from the CHUVA campaign
M. Schneebeli, J Sakuragi, T. Biscaro, C. F. Angelis, I. Carvalho da Costa C. Morales, L. Baldini, and L. A. T. Machado

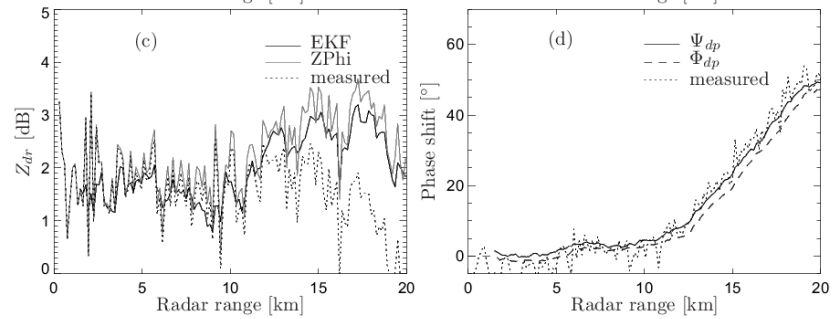
Atmospheric Measurement Techniques Discussions

Reflectivity corrected for rain and radome attenuation



Very accurate K_{DP} estimate

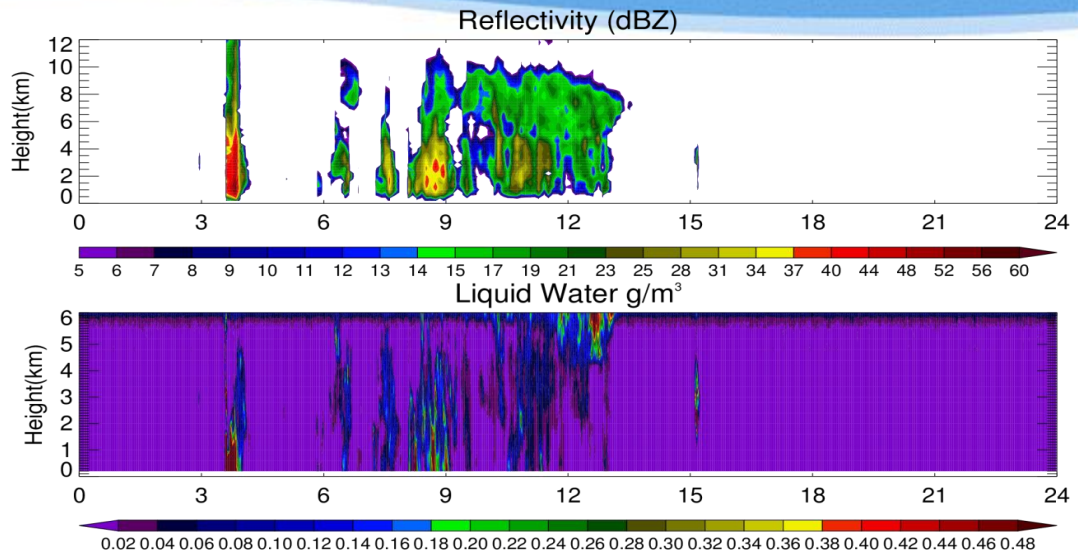
Differential reflectivity corrected for rain attenuation and measurement noise

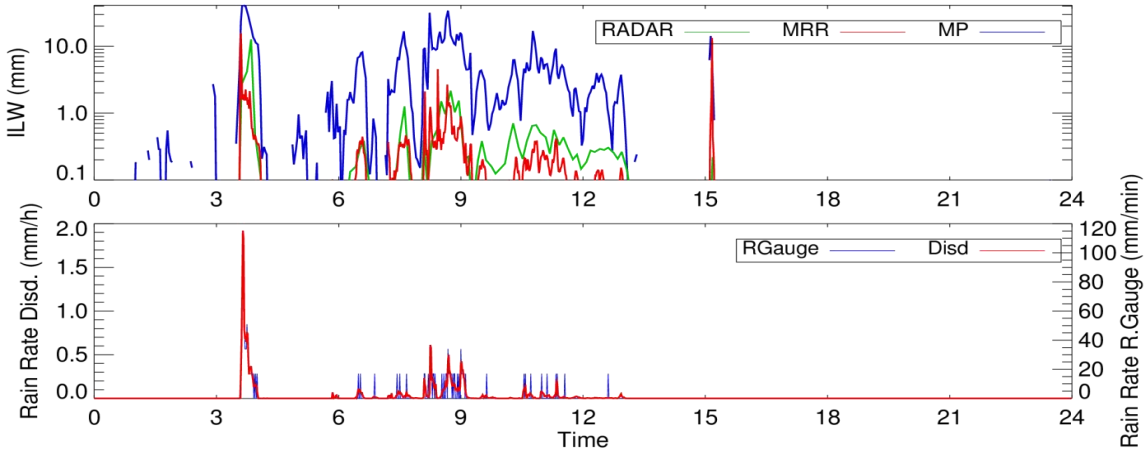


Estimate of the differential phase shift on propagation and on backscatter

Cloud and rain Liquid Water

- XPOL Radar
- MRR
- ILW from MP3000A, MRR, and XPOL
- Rain Rate from Disdrometer and Raingauge

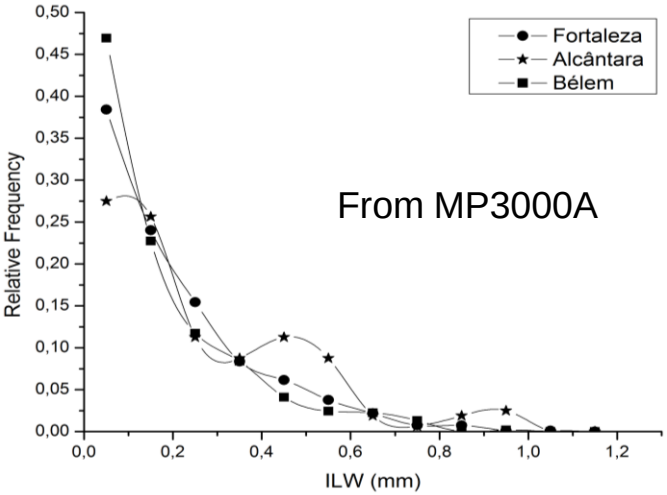




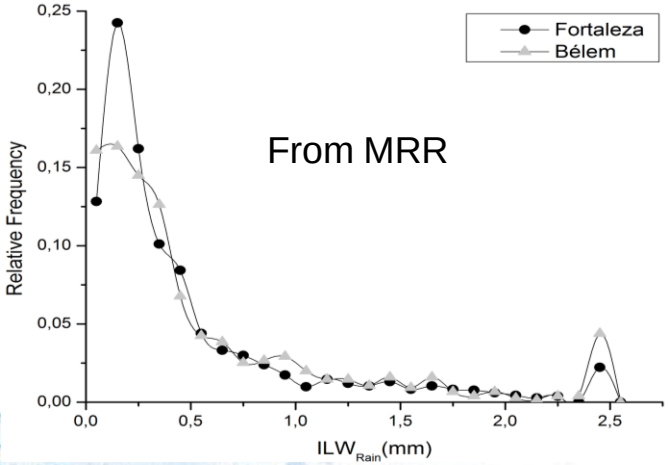
Integrated Liquid Water (ILW)

Alan Calheiros

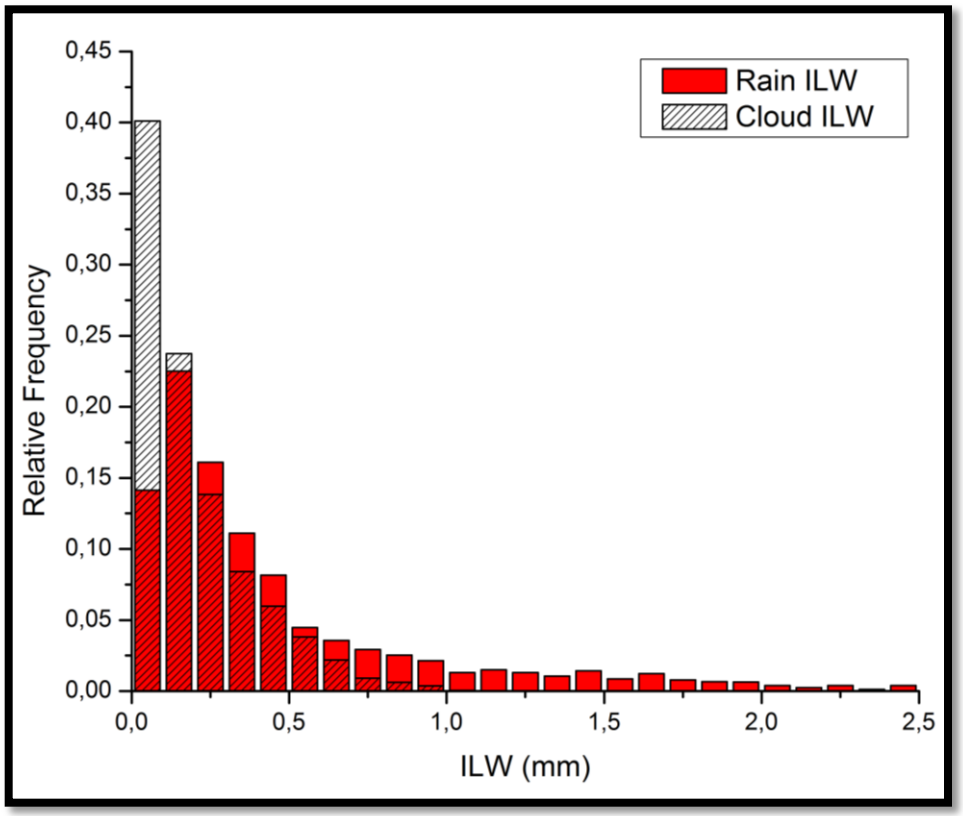
Cloud ILW for Different Sites



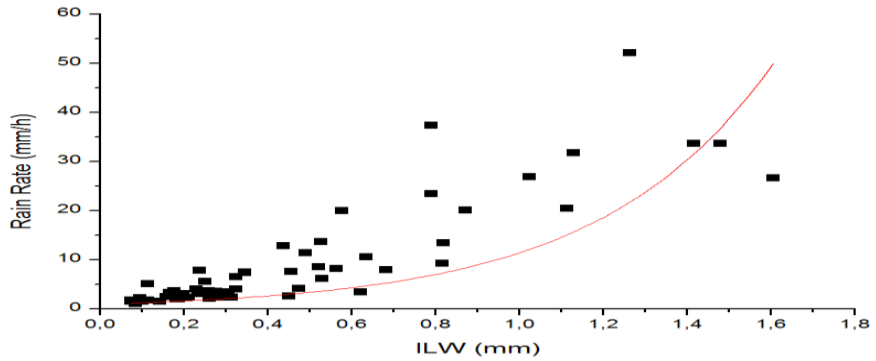
Rain ILW for Different Sites



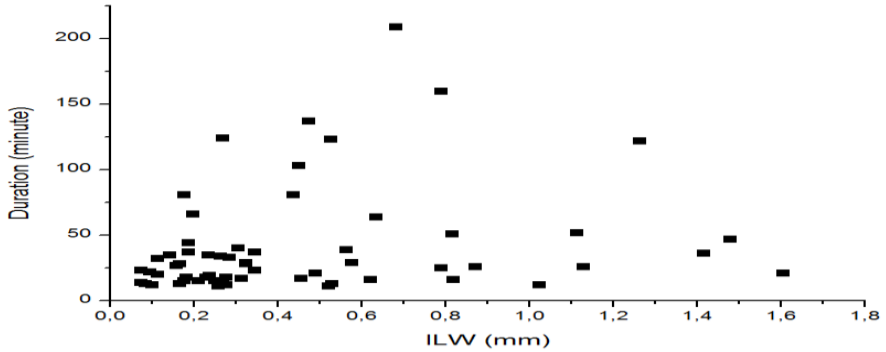
TOTAL RAIN AND CLOUD ILW (ALL SITES)



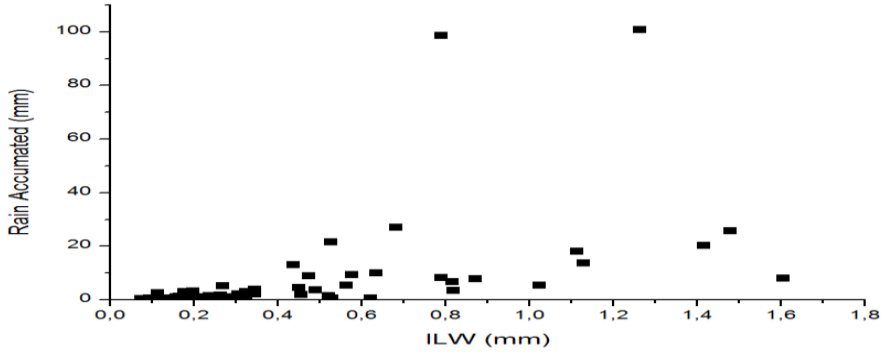
Integrated Liquid Water (ILW)



Mean ILW and
Mean Rain Rate



Mean ILW and
Rain Duration



Mean ILW and
Rain Accumulation

ILW for Different Types of Rain Systems

- Regional Cloud Type Properties

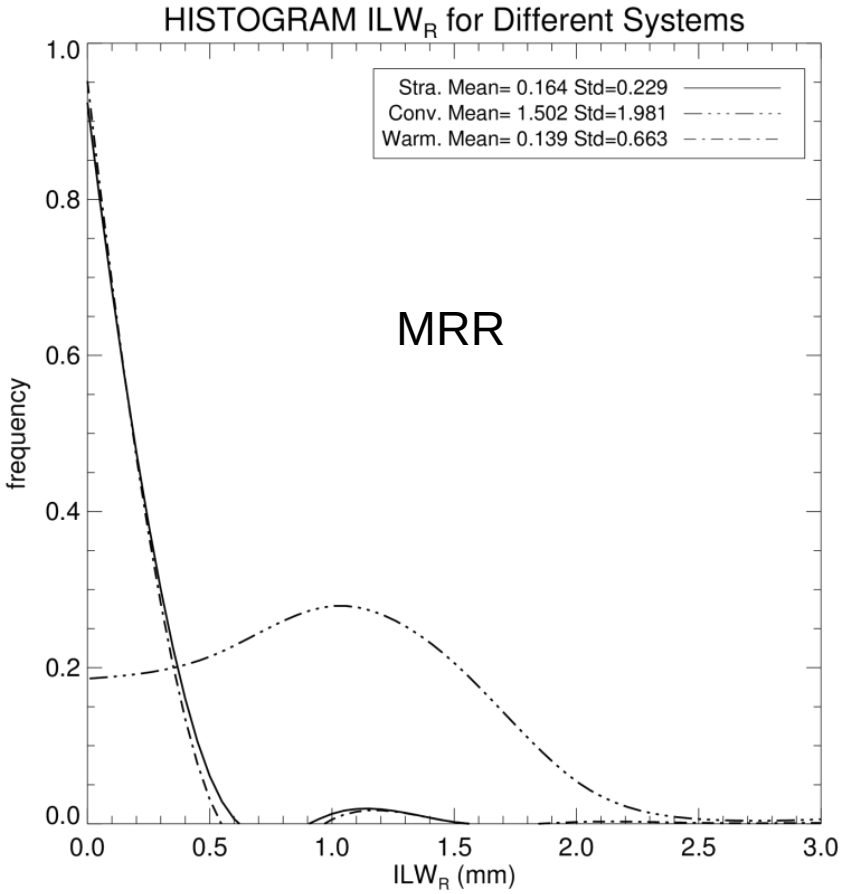
DSD, cloud ILW, rain ILW, top and base

Radiative transfer Models and observation by Satellite to analyze

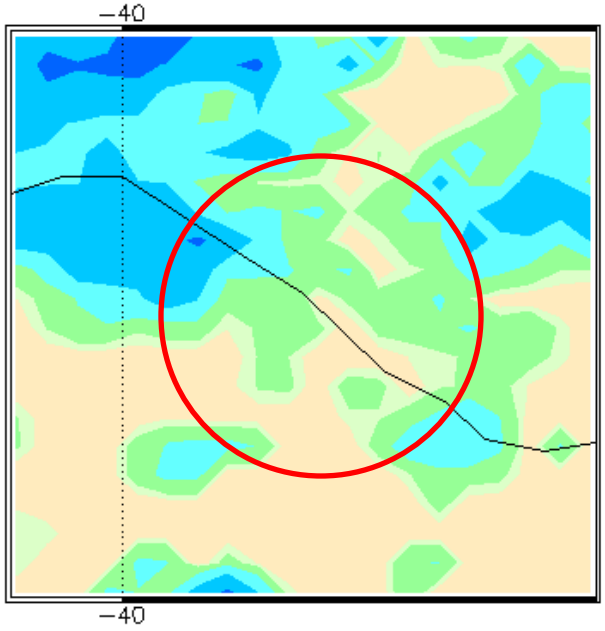
For clear, cloud and Warm rain cases

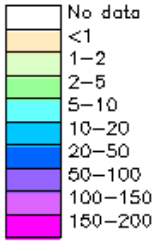
Different characteristics

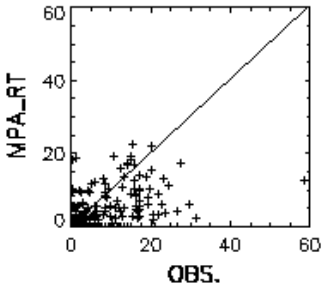
$$\Phi(Freq) => \Delta Tb$$

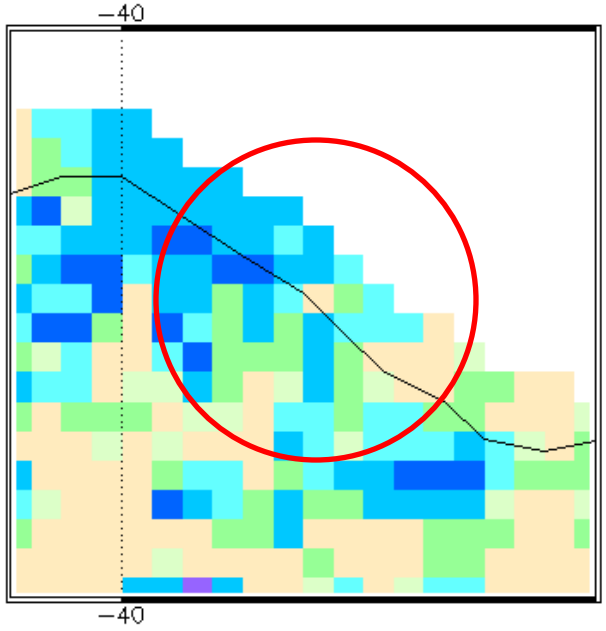


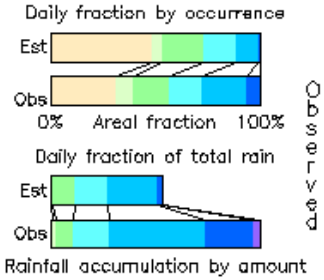
FORTALEZA – 3B42RT











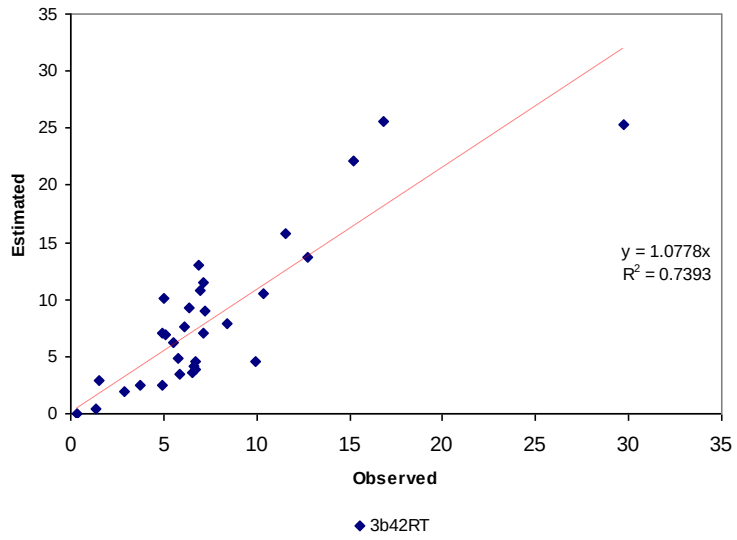
Observed \ MPA_RT	<1	≥1
<1	55	26
≥1	69	105

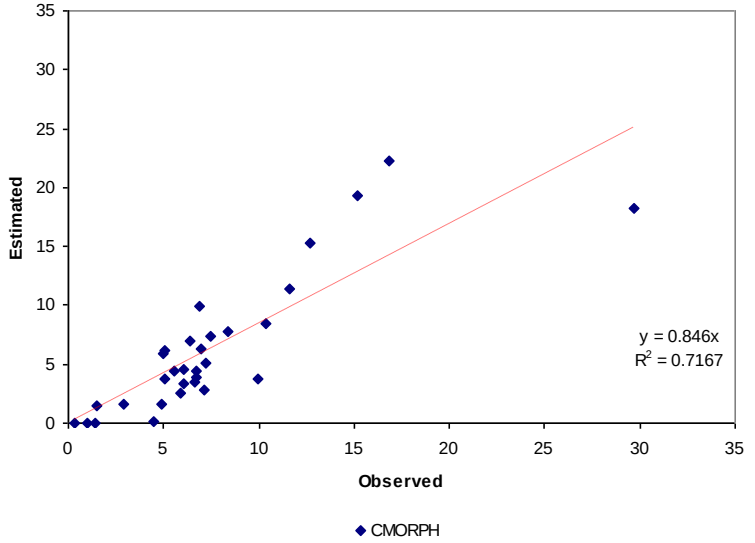
Verification statistics for 20110406 n=255 Verif. grid=0.25° Units=mm/d

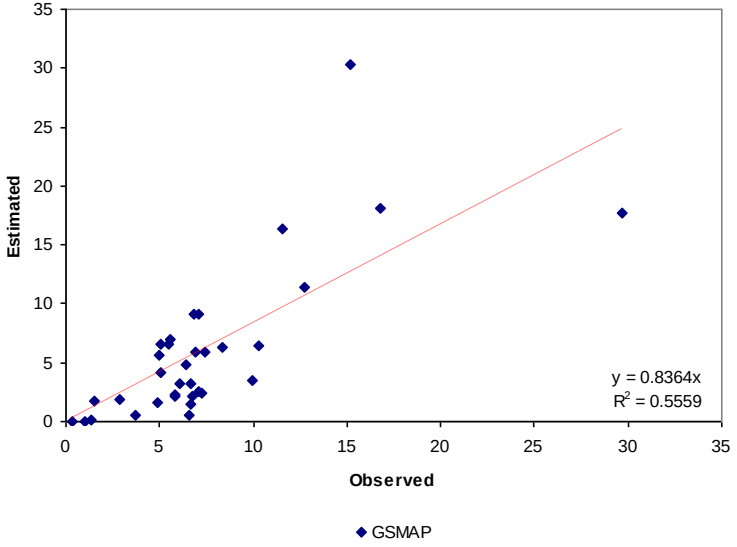
	Observed	MPA_RT
# gridpoints raining	174	131
Average rain	6.6	3.5
Conditional rain	9.6	6.9
Rain volume (mm*km²x10⁸)	1.3	0.7
Maximum rain	58.5	22.4

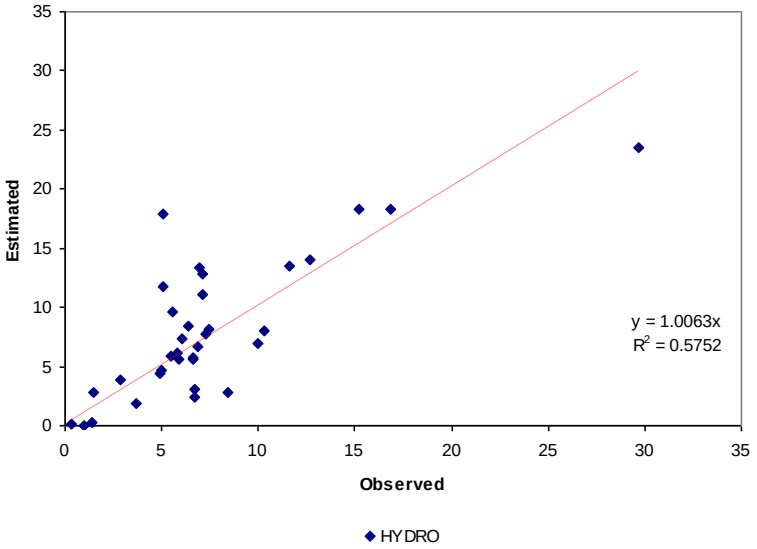
Mean abs error = 5.0
RMS error = 7.8
Correlation coeff = 0.454
Frequency bias = 0.753
Probability of detection = 0.603
False alarm ratio = 0.198
Hanssen & Kuipers score = 0.282
Equitable threat score= 0.141

FORTALEZA: Daily Rainfall

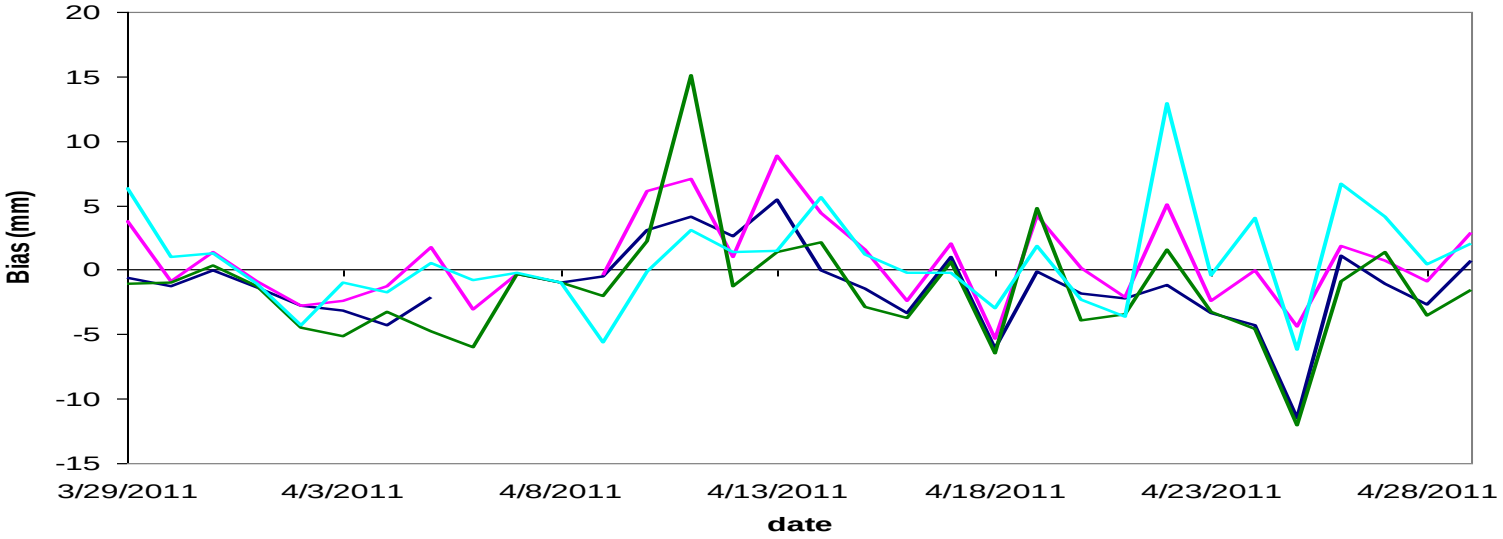


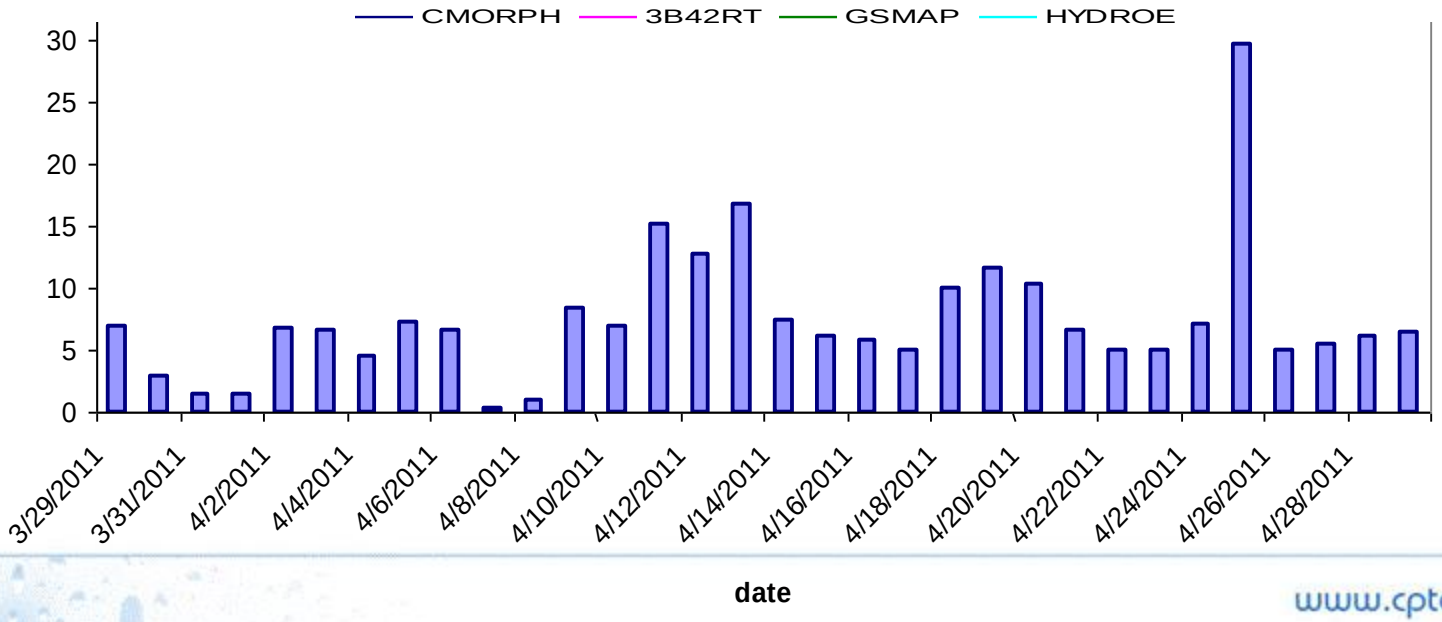




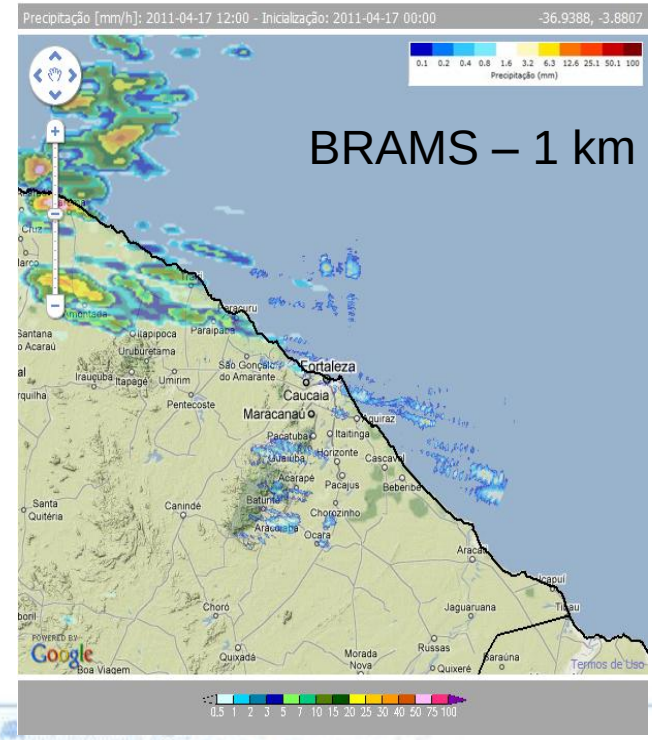


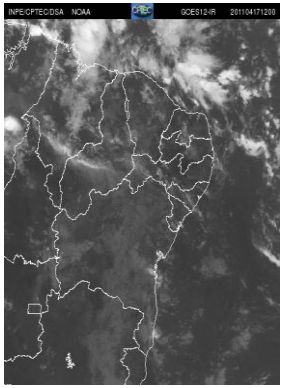
FORTALEZA – Bias





- Data Base – cloud process and microphysics using high resolution model





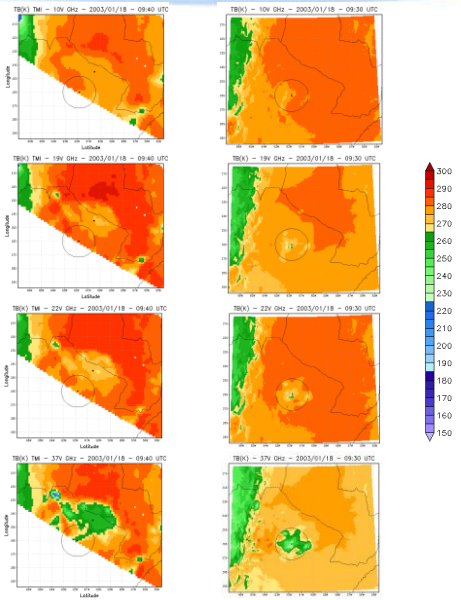
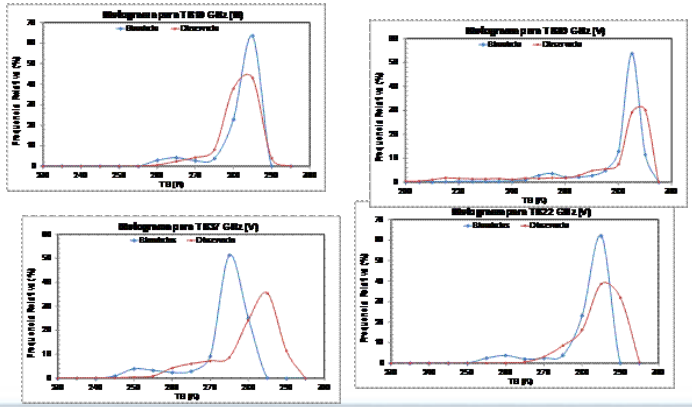


Figura 5.1 – Campos de temperatura de brilho observada e simulada para os canais de emissão sobre o CMM. Coluna esquerda: TB observadas pelo sensor TMI às 09:40 UTC. Coluna direita: TB simuladas pelo RTTOV às 09:30 UTC de 18/01/2003.



Cloud top multichannel characteristics and cloud reflectivity Profile

Wagner Lima

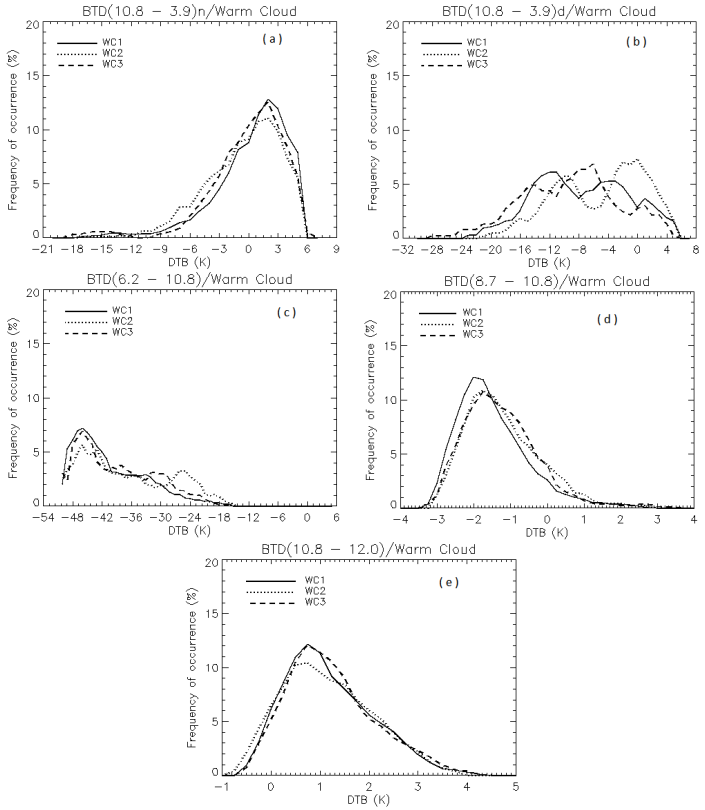


Figure 4. Histogramas das diferenças a) $BTD_{10.8\text{-}3.9n}$, b) $BTD_{10.8\text{-}3.9d}$, c) $BTD_{6.2\text{-}10.8}$, d) $BTD_{8.7\text{-}10.8}$, e e) $BTD_{10.8\text{-}12}$ para os três centróides de nuvens quentes .

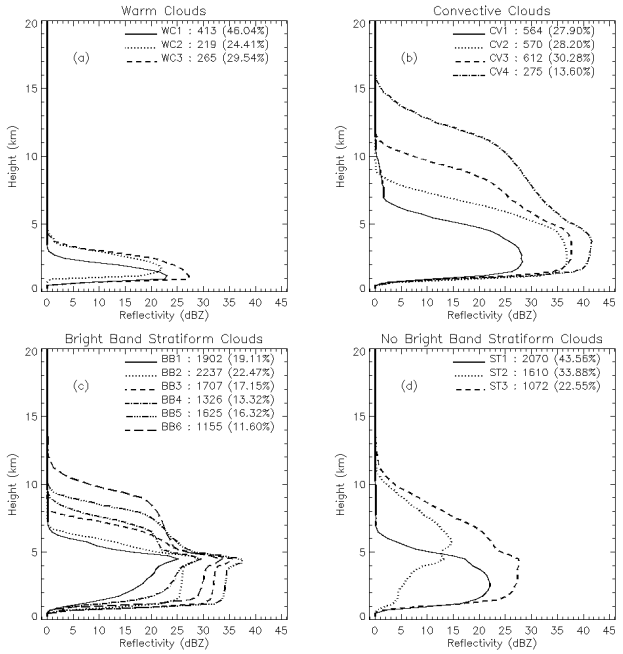


Figure 1. Centróides para os perfis a) Warm Clouds (WC), b) Convective Clouds (CV), c) Bright Band Stratiform clouds (BB) e d) No Bright Band Stratiform clouds (ST). Os valores nos gráficos representam a frequência absoluta para cada centroide, e entre parentes a frequência relativa.

Conclusions

- Warm Clouds have a short lifetime and size 80% are smaller than 40 km2 and lifetime duration smaller than 40 minutes
- Cloud liquid water and rain liquid water are very close form region to region, however is very different among cloud types
- Precipitation estimation in Fortaleza clear shows underestimation for warm rain events
- News techniques using multichannel cloud top signature can improve precipitation estimation