



Validation of the BRAMS high resolution simulations by satellite radiance comparison

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Objectives

Assess the BRAMS high resolution simulations skill to produce convection by the comparison with real satellite imagery and build a data base of simulated radiances of IR and MW satellite sensors.

The comparison is done by simulating the respective satellite imagery using a radiative transfer model (here, RTTOV version 9.3)

RTTOV simulations

The microphysical species of the NWP is used in the radiances simulations.

Uses the cloud scattering scheme (assumes clouds are not black body) – **IR only**

Need to determine the kind of clouds in each NWP level as well its concentration [kg/kg] and coverage (fraction)

Cloud types used:

- Cumulus (continental/maritime);
- Stratus (continental/maritime);
 - Cirrus.

Need to chose between 2 ice crystal shapes:

- Hexagonal;
- Aggregates.

2D vars	3D Vars
Temp. 2m [K]	Cloud [kg/kg]
land/sea mask [0 or 1] no height	Ice [kg/kg]
Sea Level Pressure [hPa]	Hail [kg/kg] *
Tveg2 [K]	Pristine [kg/kg] *
	Snow [kg/kg] *
	Graupel [kg/kg] *
	Aggregates [kg/kg] *
	Rain [kg/kg]***
	Total Condensated [kg/kg]
	Pressure [hPa]
	Relative Humidity [%]
	Specifc Humidity [ppmv]
	Temperature [K]
	Cloud Fraction [%] **

* Only used to choose ice shape and or cloud type;

** **Calculated by the cloud scheme**, not by Ramspost

*** Only for MW simulations



Working progress (simulated radiances database)

- IR radiances – **DONE (only Fortaleza and Vale)**
 - GOES/Imager (3.9, 6.7, 10.2)
 - MSG/SEVIRI (3.9, 6.2, 7.2, 8.7, 10.8, 12)
 - AVHRR (maybe is worth to simulate too?)
- MW radiances – **BEING DONE**
 - SSMIS/S
 - AMSU/A
 - AMSU/B
 - TRMM

Cloud scheme (CS) comparison

“all or nothing” vs Xu and Randall (1996)

- “All or nothing”:

Cloud fraction (cloud cover) = 100% if total condensate > 0.1 [g/kg]
0% otherwise

- Xu and Randall (1996):

$$C = RH^p \left[1 - e^{\frac{-\alpha_0 \bar{q}_l}{(q_s - q_v)^\gamma}} \right]$$

Where:

p, α and γ : method adjust constants;

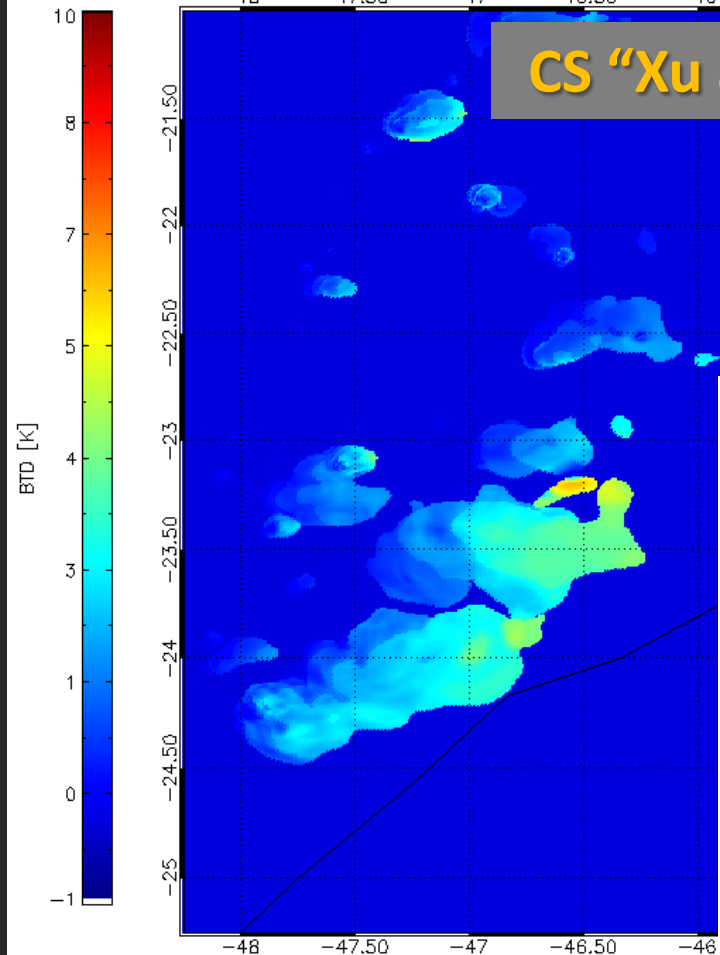
RH: relative humidity;

q: mixing ratio of saturation (s), vapor (v) and liquid water/ice (l).

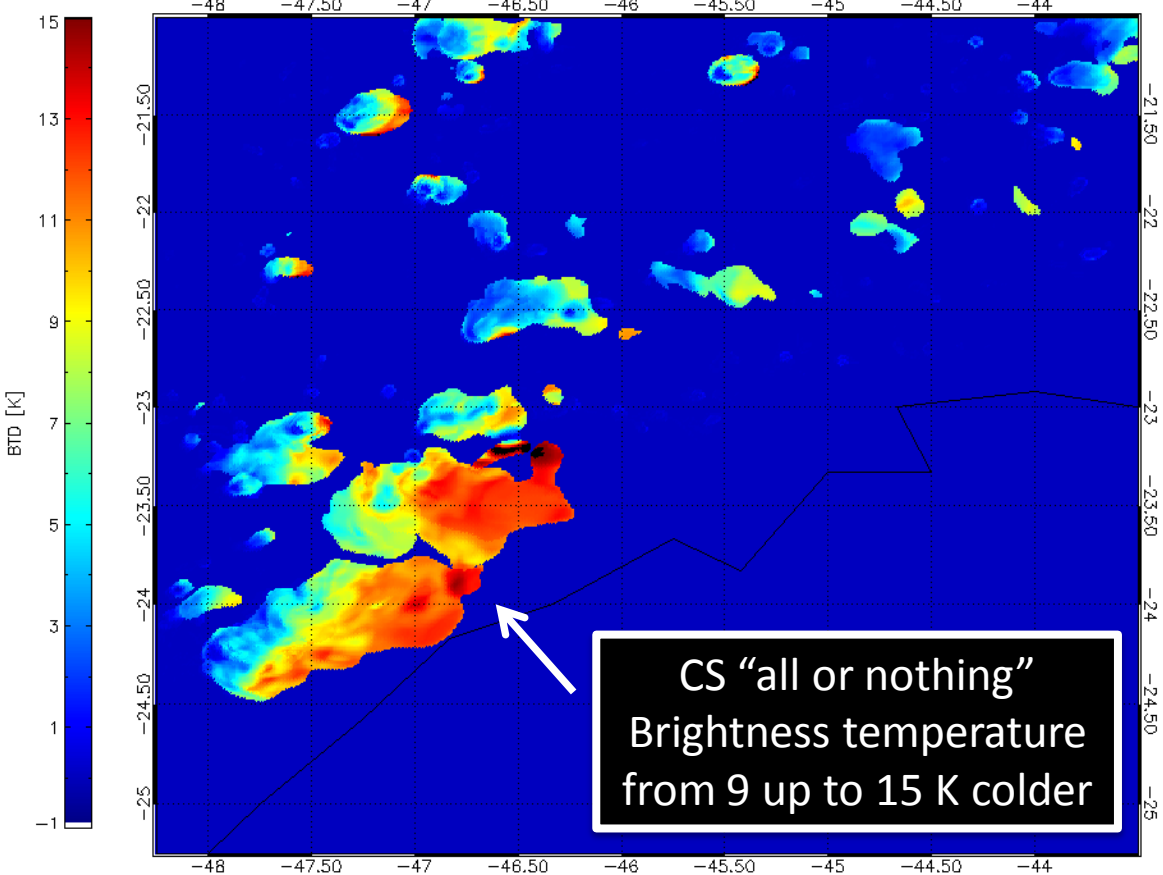
The Xu and Randall CS has been used for the BRAMS/RTTOV simulations.

6.7 microns CS "Xu Randall (1996)" - "all/nothing (totalCond)"

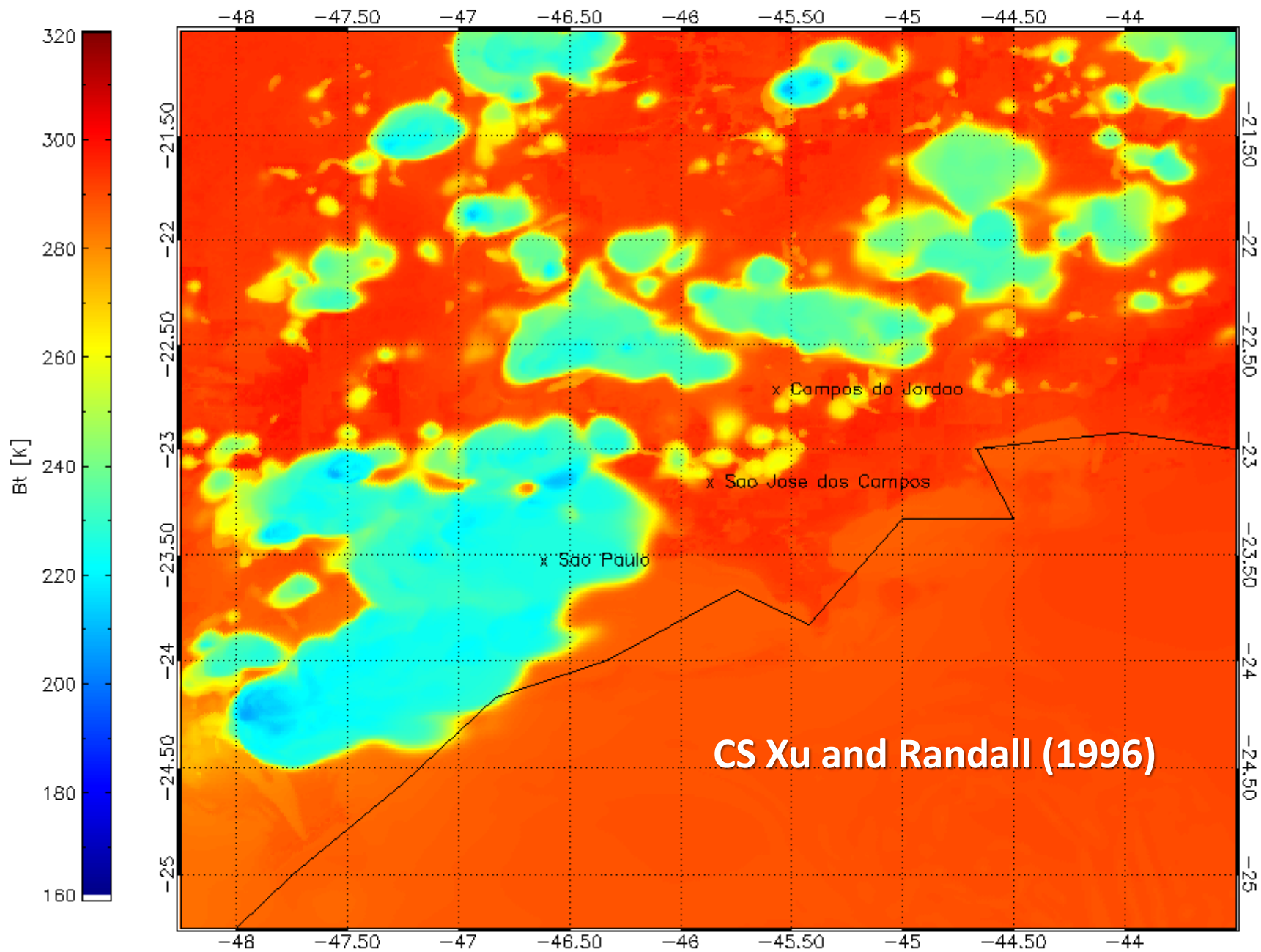
CS "Xu and Randall (1996)" minus "all or nothing"

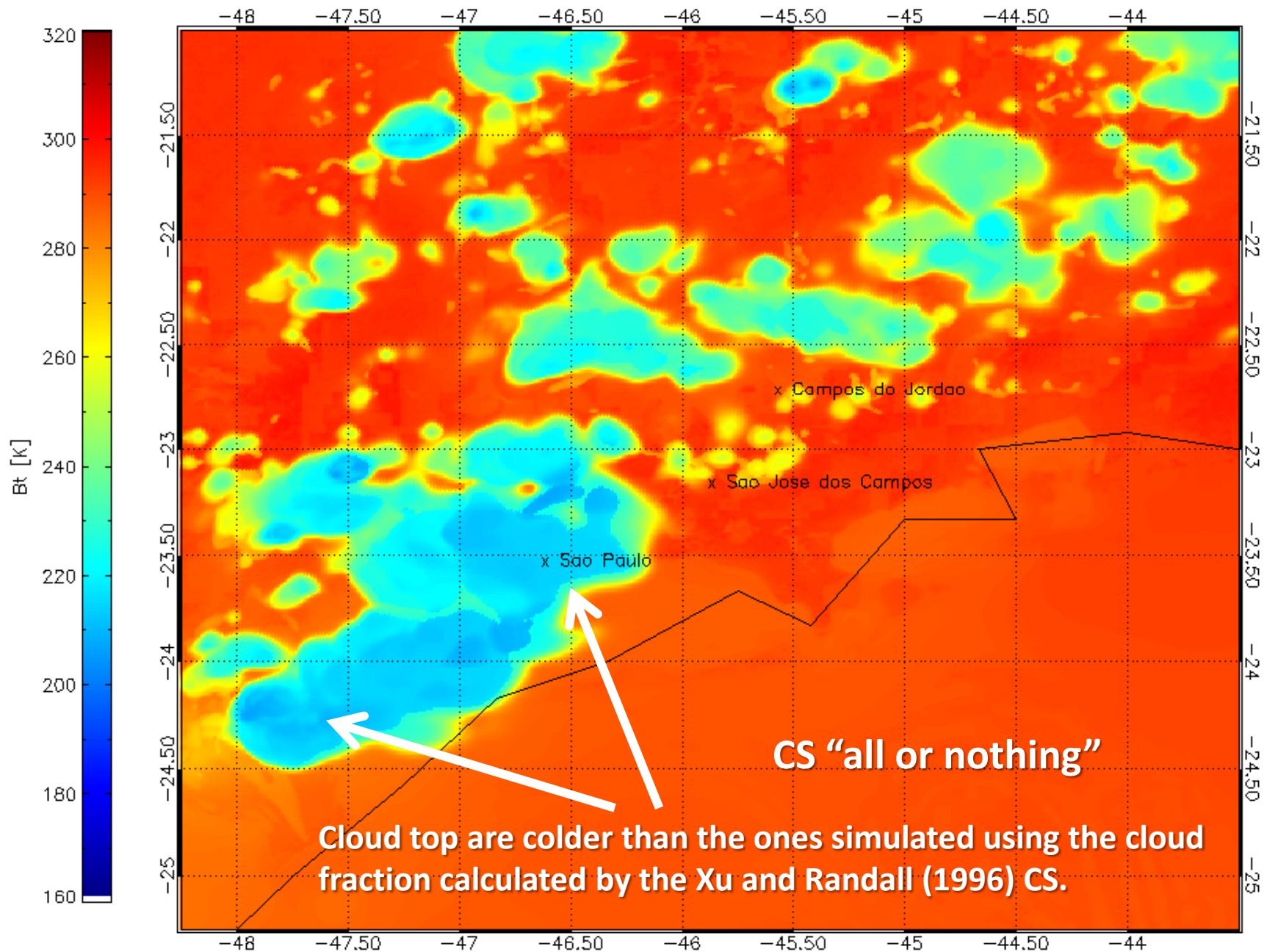


10.2 microns CS "Xu Randall (1996)" - "all/nothing (totalCond)"



CS "all or nothing"
Brightness temperature
from 9 up to 15 K colder





First analysis

- Verify some general aspects of the convection produced by the BRAMS, the GOES-12 6.7 and 10.2 μm radiances, for all golden days:
 - Convection start, is it in phase with the reality?
 - Cloud position (not expecting the exactly position);
 - Cloud amount, (number of cells, its sizes);
 - High level humidity distribution (Water vapor absorption channel 6 μm).
- The analysis was done by:
 - Visual inspection of the simulation/satelite plots;
 - Brightness temperature histograms analysis.
- An table in next slide shows a brief description of each golden day of **Vale do Paraíba** experiment.
- For the **Fortaleza** experiment, the representation of the observed convection is poor, for almost all golden days, if compared with the **Vale do Paraíba** ones.
- Until now, the runs for **Belém** and **Alcântara** experiments are not available, but will be soon.

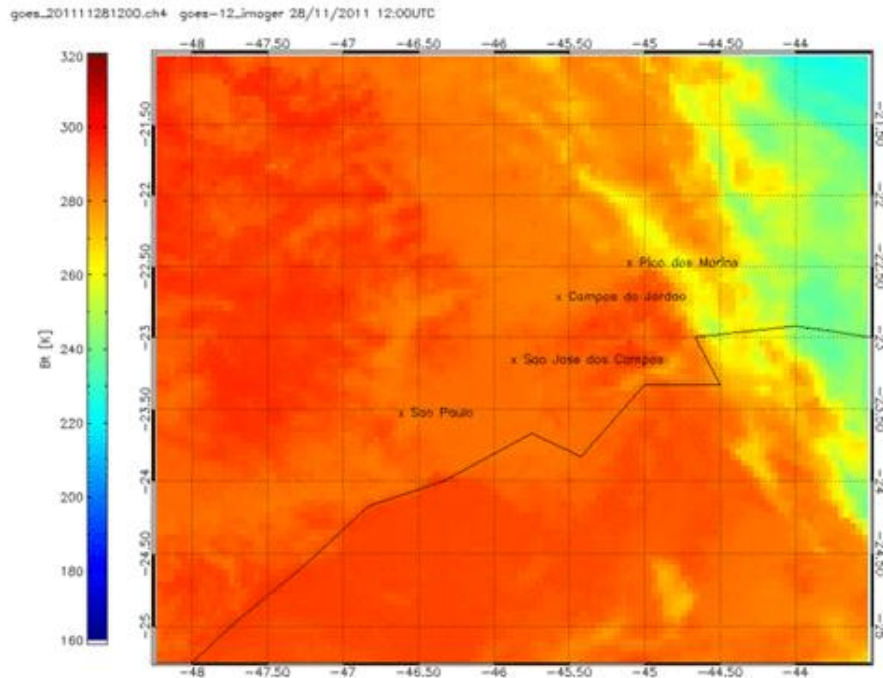
First analysis

Experiment: Vale do Paraíba

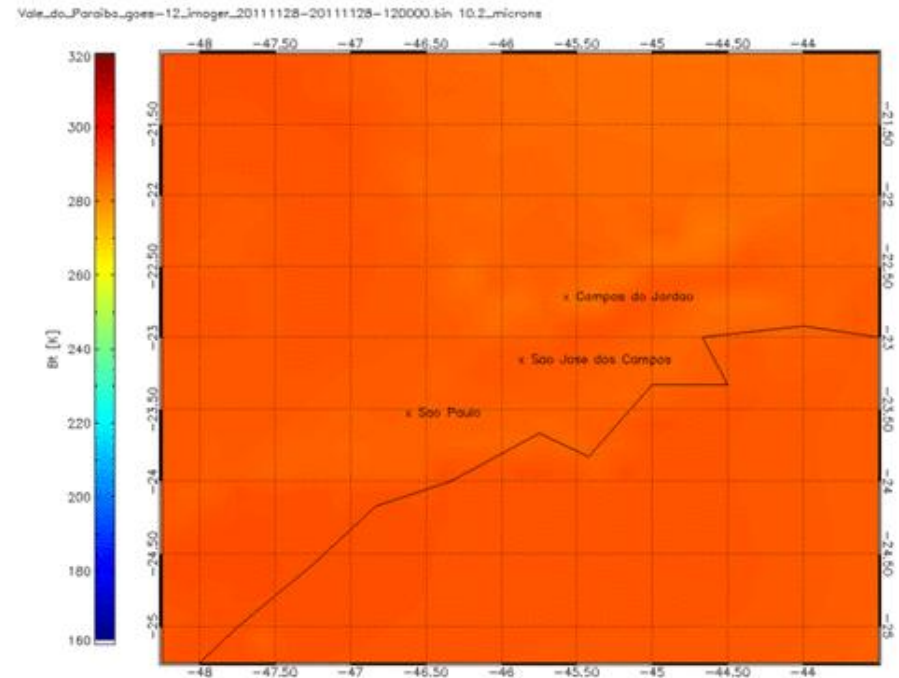
Golden Days		
11/11/11	good	med level clouds are overestimated
12/11/11	good	very homogeneous cloud field after 2nd third
13/11/11	good	same as previous golden day
14/11/11	bad	very different than reality
15/11/11	bad	very different than reality
22/11/11	good	reproduce nebulosity (right half) after 21UTC
23/11/11	bad	mostly clear sky
28/11/11	very good	convection underestimated (area), convection start/pos. match
29/11/11	bad	convection underestimated (heavily) and mismatch
30/11/11	good	convection underestimated
01/12/11	very good	one of the best cases
02/12/11	bad	mostly clear sky
14/12/11	very good	capture the main features, overestimate nebulosity
15/12/11	very good	like previous, last 3 hours are usefull
18/12/11	very good	match well, overestimate long life clouds
19/12/11	good	match well the last hours, mostly clear sky
20/12/11	very good	but have only 7 hours, last 3 are useful

28 Nov 2011 – Vale do Paraíba
BRAMS's convection started allmost at same time
Almost no longer life clouds
Few middle level clouds

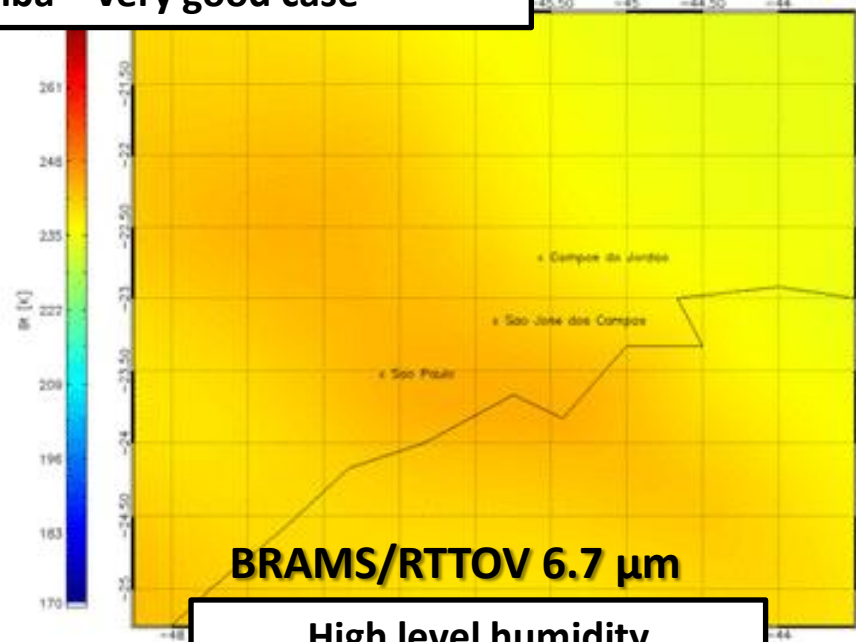
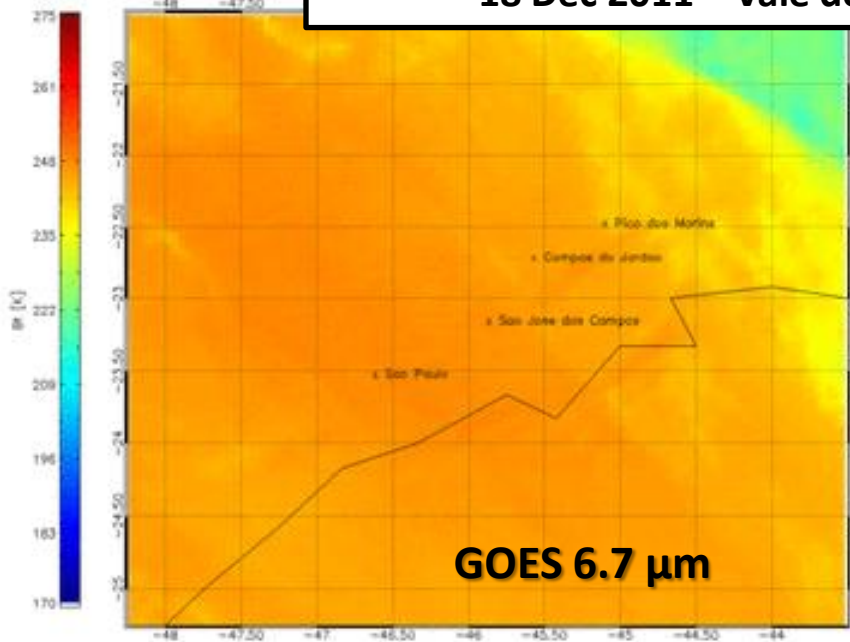
GOES 10.2 μm



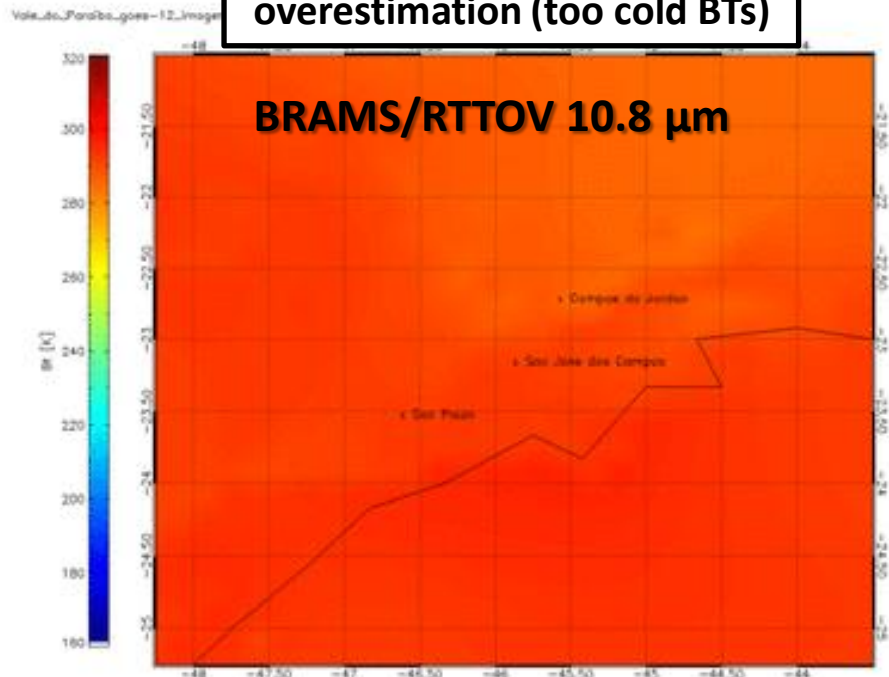
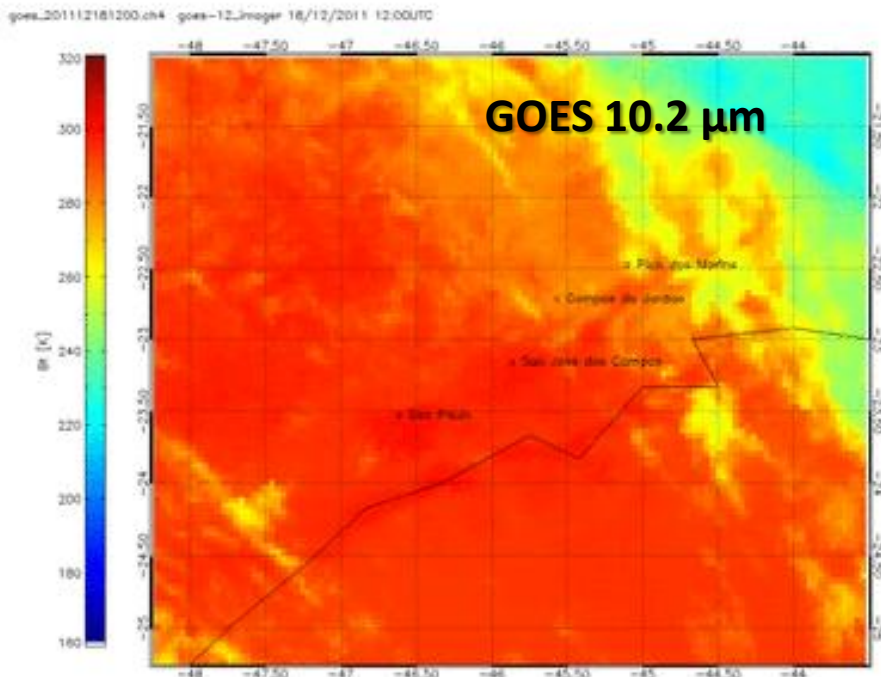
BRAMS/RTTOV



18 Dec 2011 – Vale do Paraiba - very good case

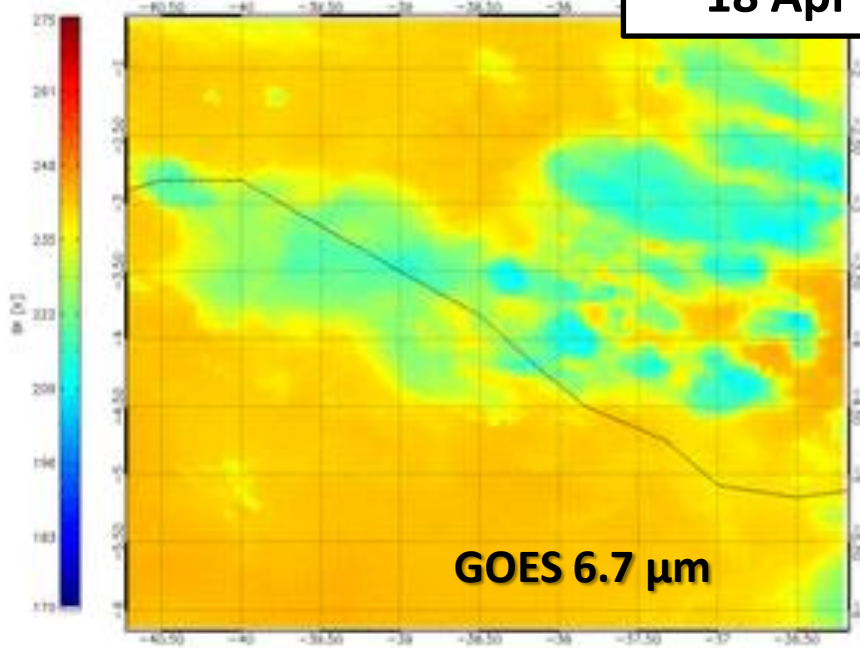


High level humidity overestimation (too cold BTs)

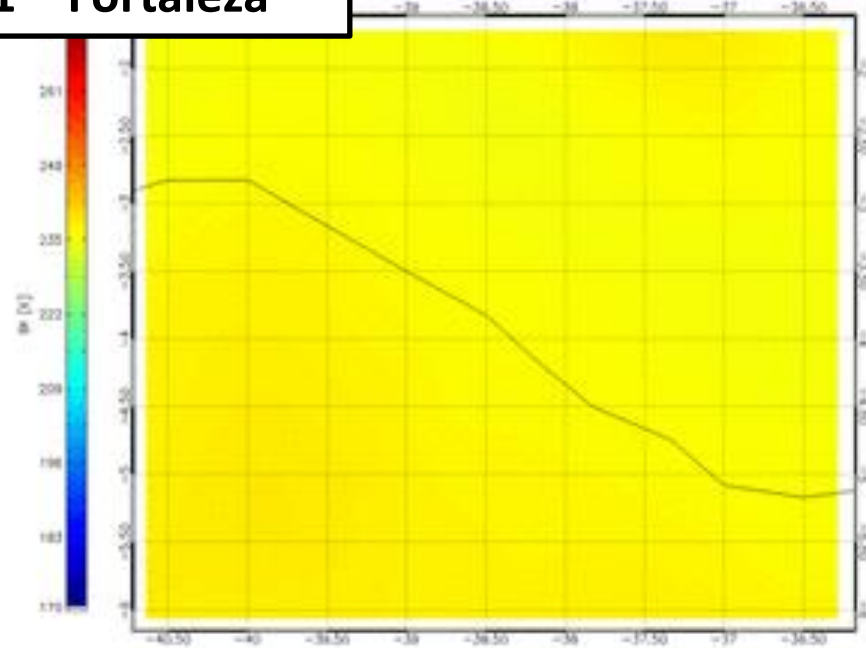


18 Apr 2011 – Fortaleza

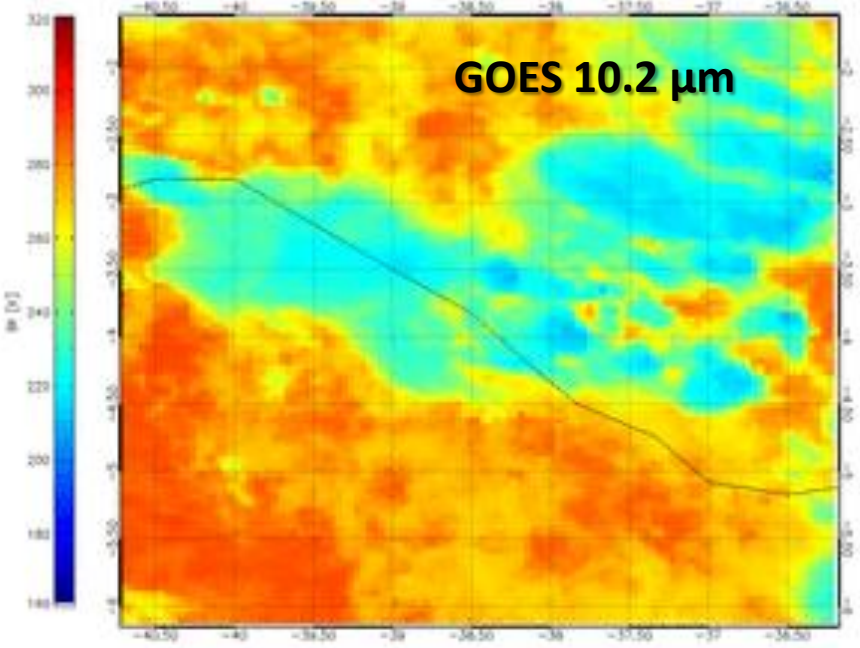
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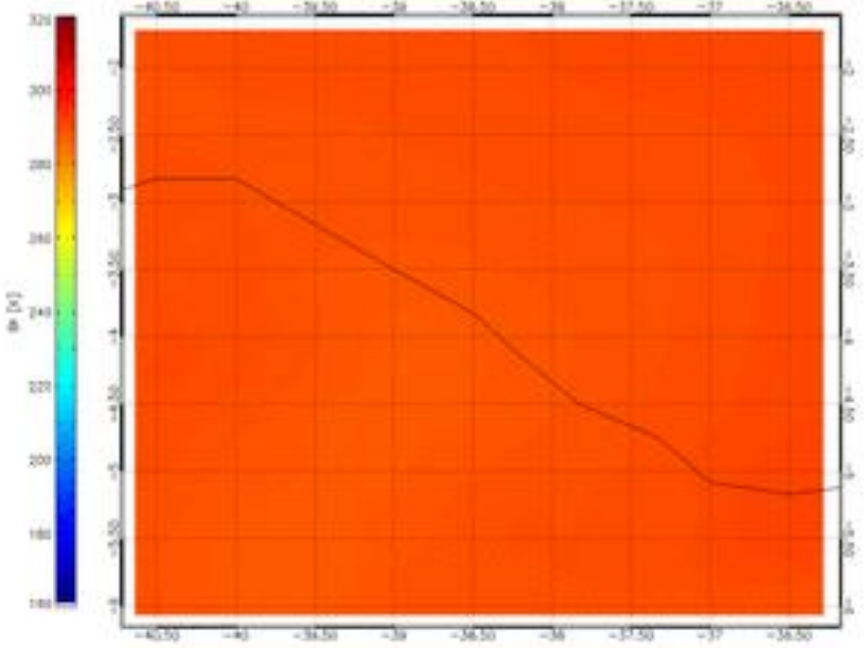
Fortaleza_gres-12_image



gres_201104181200_uK4 gres-12_image 18/04/2011 12:00UTC



Fortaleza_gres-12_image_201104181200_uK4

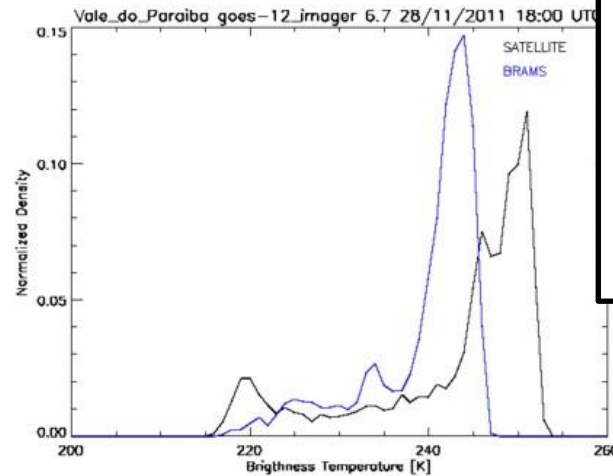
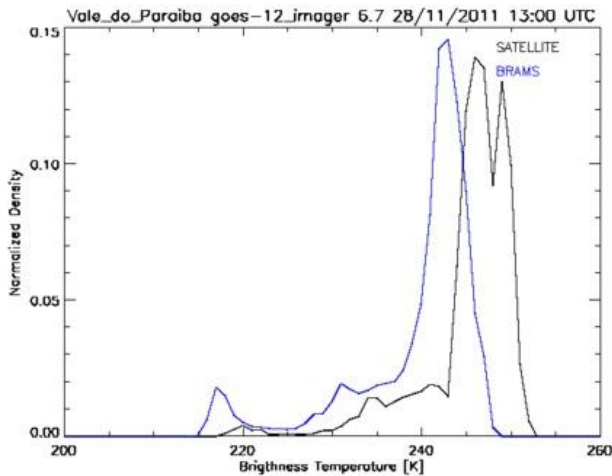


28 Nov 2011 GOES-12 6.7 μm

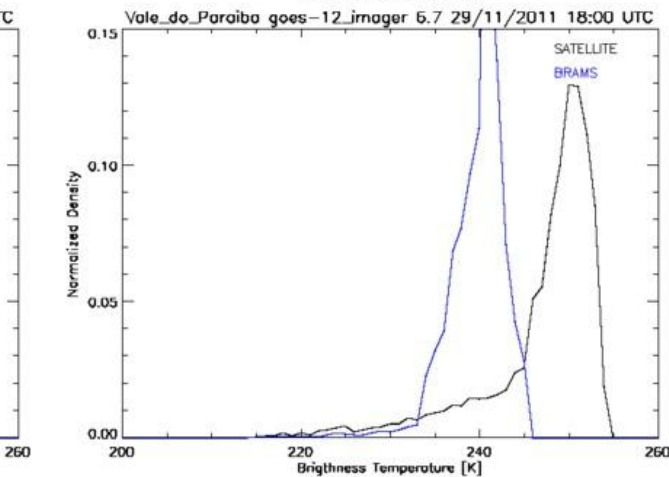
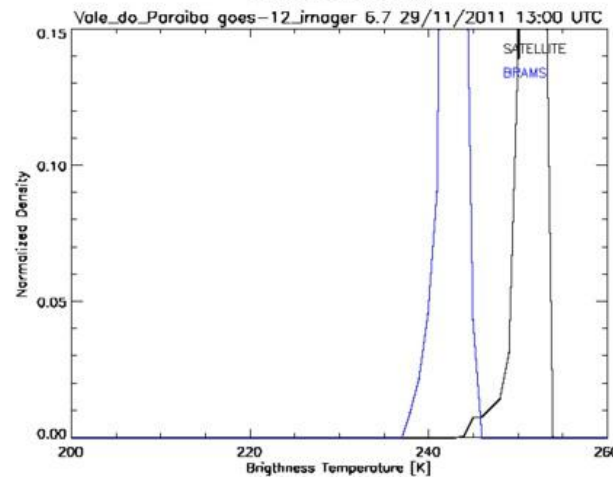
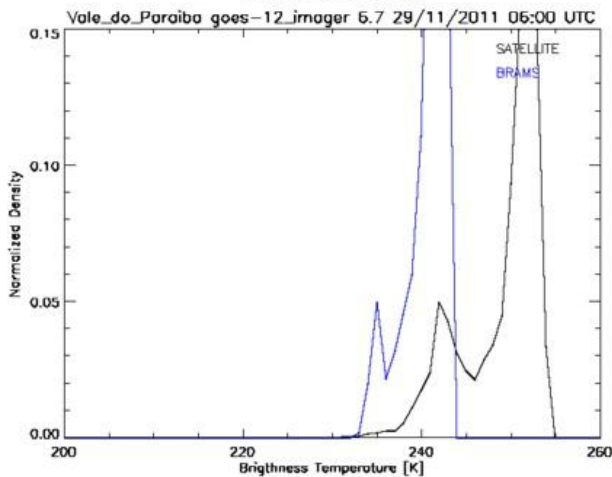
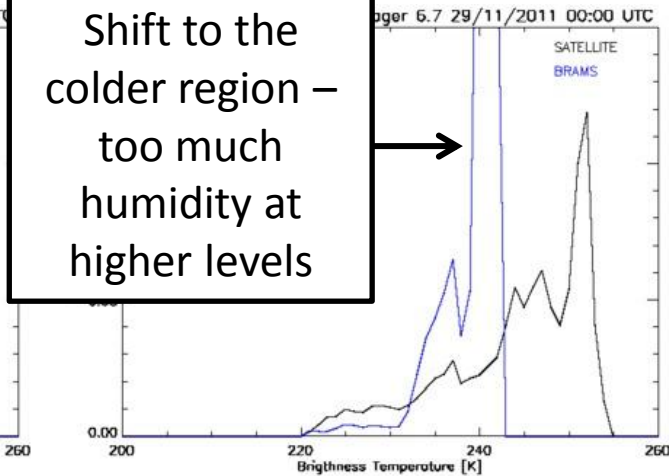
13:00 UTC

18:00 UTC

00:00 UTC



Shift to the colder region – too much humidity at higher levels



06:00 UTC

13:00 UTC

18:00 UTC

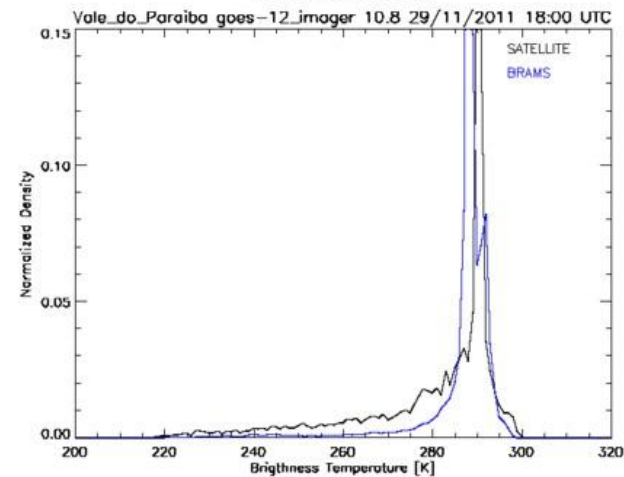
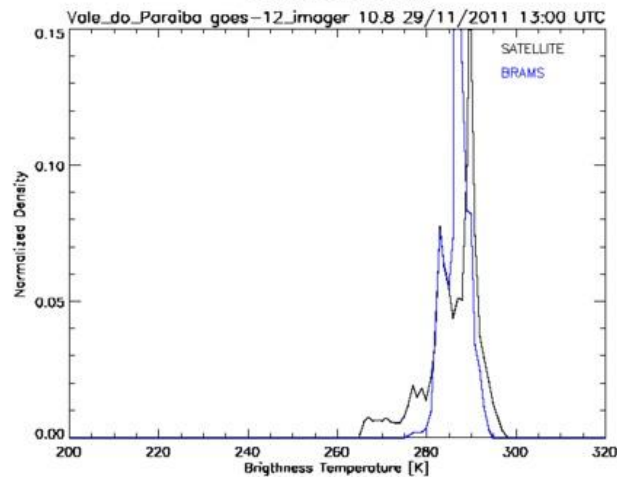
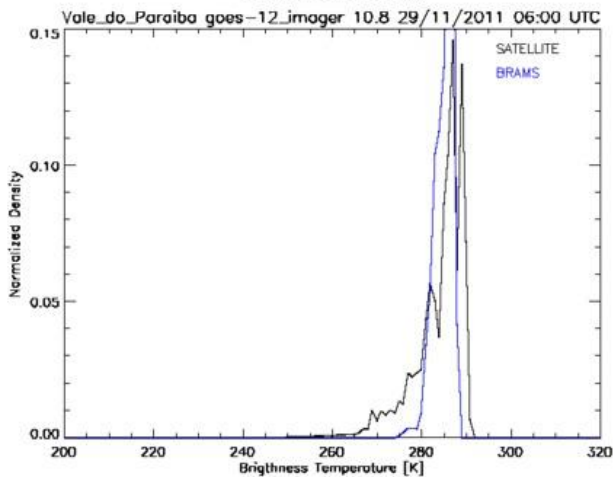
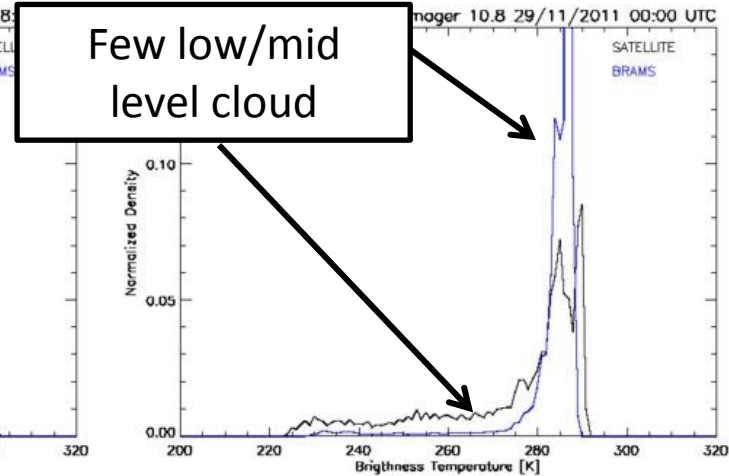
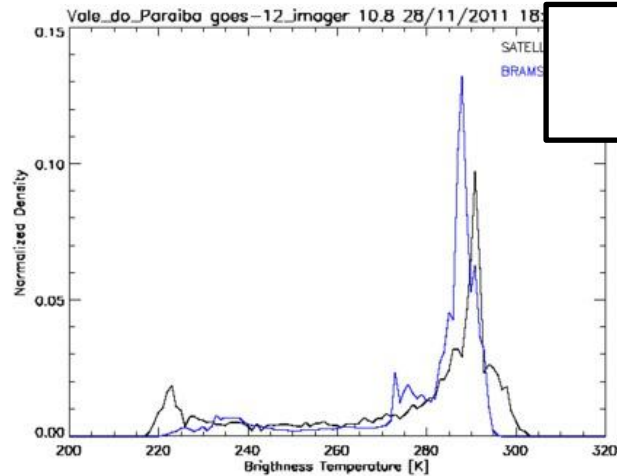
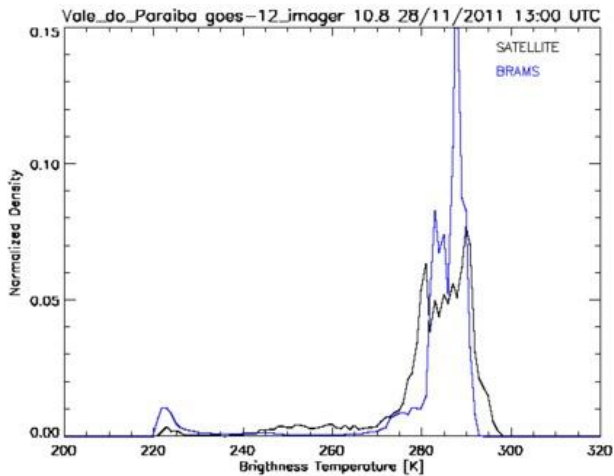
Satellite (black lines) RTTOV/BRAMS (blue)

28 Nov 2011 GOES-12 10.2 μm

13:00 UTC

18:00 UTC

00:00 UTC



06:00 UTC

13:00 UTC

18:00 UTC

Satellite (black lines) RTTOV/BRAMS (blue)



Conclusions

- For the golden days of Vale do Paraiba experiment:
 - The BRAMS high resolution simulations have few middle level clouds.
 - An delay of 1 to 3h was observed for the convection start in the BRAMS.
 - The high level humidity (400 hPa) gradients show a tendency to became weaker since the begin of the simulations.
 - The convective cells and the nebulosity are, in many golden days, located near to the observed convection, however, the horizontal area are generally small.
- The Xu and Randall (1996) cloud scheme work well (the high level cloud tops are not too cold as when using the “all or nothing” CS).



Next Steps

- Finish the MW simulations for Vale do Paraíba experiment and analyze the whole dataset.
- Verify with the CPTEC/BRAMS modeling group why the Fortaleza simulations are poor.
- Apply a different Cloud Scheme for a more concise comparison.