CPTEC
Centro de Previsão de Tempo e Estudos Climáticos

MINISTÉRIO DA CIÊNCIA E TECNOLOGIA
INSTITUTO NACIONAL DE PESQUISAS ESPACIAIS

The role of assimilating satellite data over South America using LETKF

José Antonio Aravéquia, Bruna Silveira , Maria das Dores da Silva Medeiros and CPTEC's DAS Group.

jose.aravequia@cptec.inpe.br

Affiliation: CPTEC/INPE
Rodovia Dutra, km 39, Cachoeira Paulista – SP, 12630-000
Brazil

WWW.CPTEC.INPE.BR

Acknowledgements

This presentation shows results of
the authors and contributions of all CPTEC's GDAD DA Group

LETKF have been used and developed at CPTEC within a collaboration with Dra. Eugenia Kalnay - UMD.

Outline

- Results of the assimilation of radiances from the AQUA AMSU-A sensor with LETKF – CPTEC’s AGCM system
  - this experiment was setup with 20 ensemble members, CPTEC’s AGCM in T126L28 resolution , for the period from 1-30 June 2008;
- Experiment to simulate GOES 10 channel 4 with atmosphere profile of CPTEC’s regional model and NCEP CFSR data.
- Next steps for DA team at CPTEC

Metodology

This experiment was performed with direct assimilation of radiances from the AMSU-A sensor by the LETKF/CPTEC AGCM system, following the Aravéquia et al (2011).

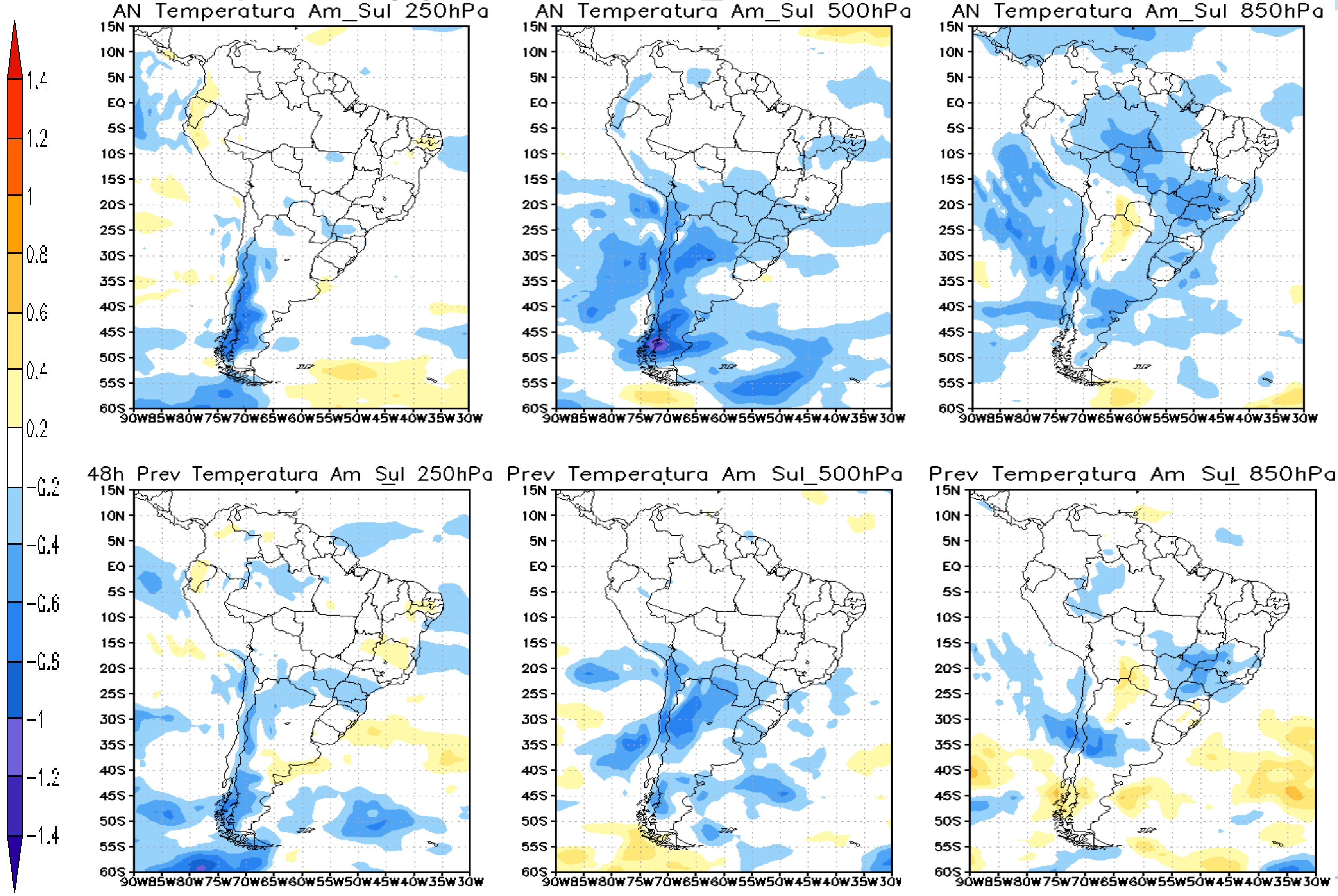
In this study, we examine the RMSE reduction by assimilating the radiances and then we verify the spread within the ensemble members in space of radiance over the study region.

And, we examine if the magnitude of the spread model state is large enough to accommodate the observations of the radiances from AMSU-A.

Aravéquia, A. J., I. Szunyogh, E. J. Fertig, E. Kalnay, D. Kuhl, and E. J. Kostelich, 2011: Evaluation of a strategy for the assimilation of satellite radiance observations with the local ensemble transform Kalman filter. Mon. Wea. Rev. Vol. 138, Issue 10, pp. 1932–1951.

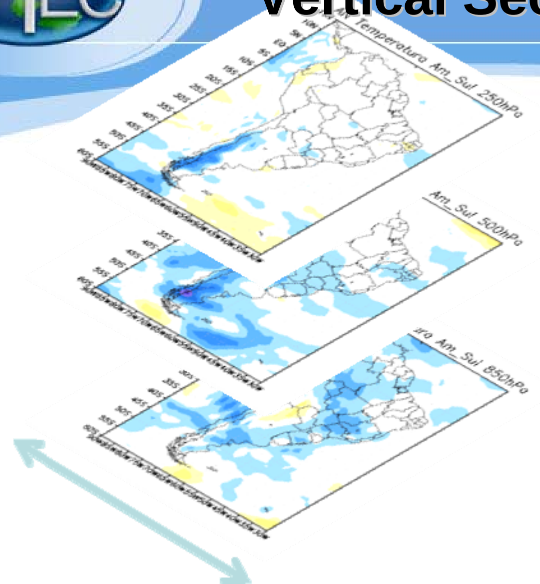
Impact of assimilating AMSU-A

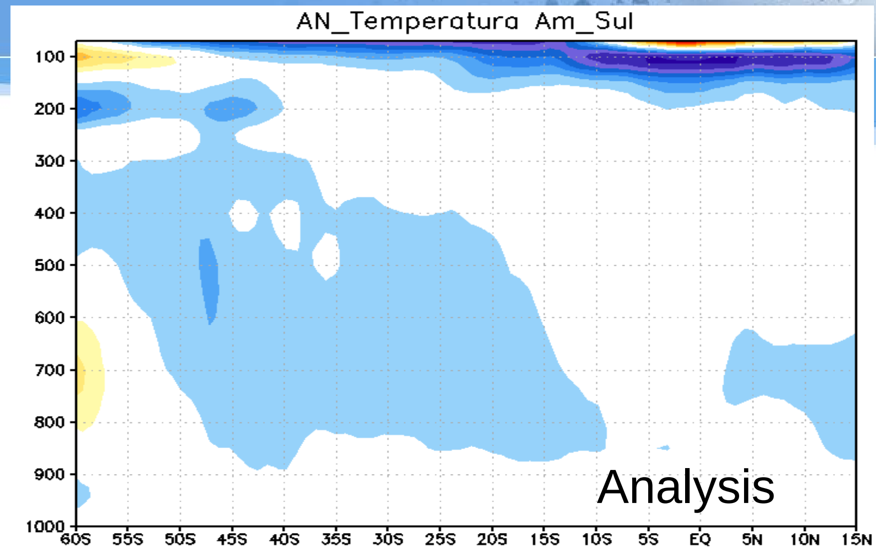
Air Temperature (K): RMSE LETKF_rad – REQM LETKF_conv

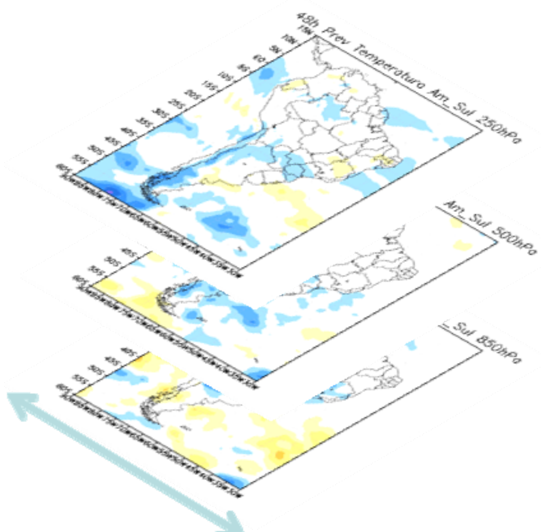


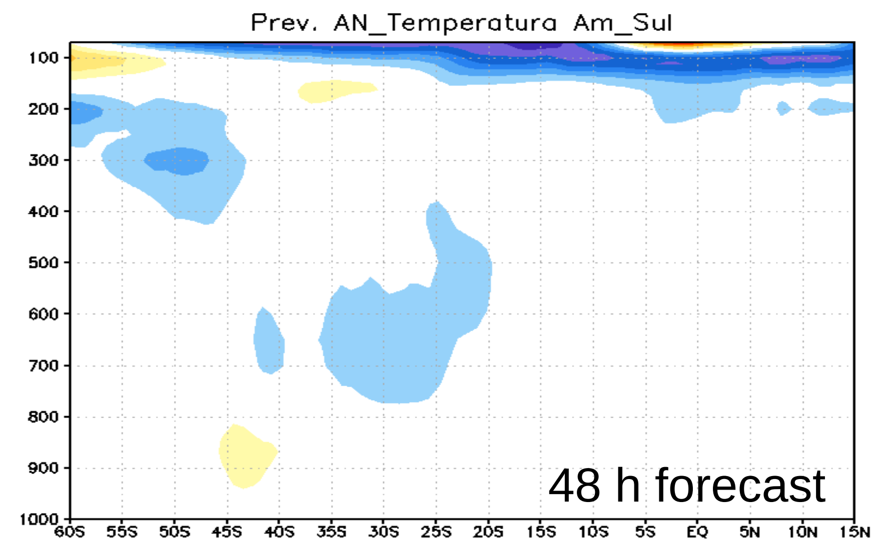
Air Temperature (K): RMSE LETKF_rad – REQM LETKF_conv

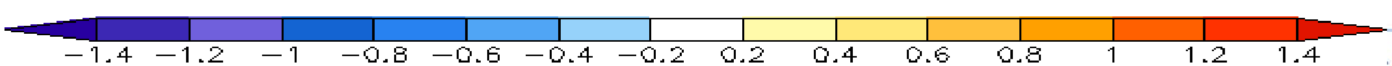
Vertical Section





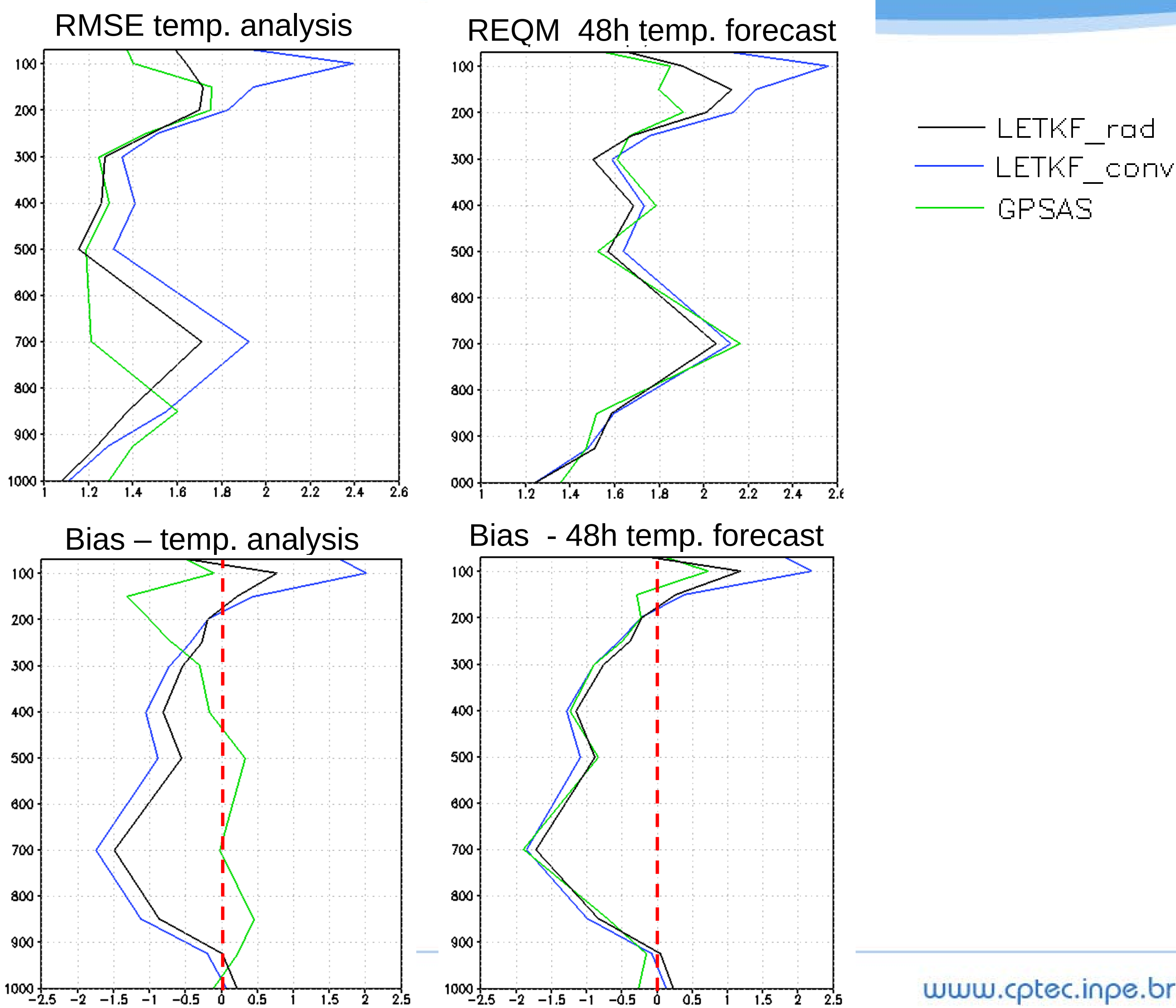






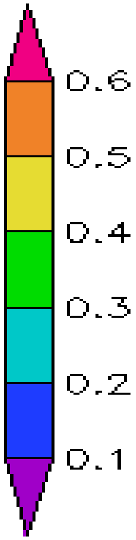
RMSE

Air Temperature (K)



Analysis Spread of ensemble members

Analysis: Temperature Spread at 800hPa 2008061818



Spread magnitude suggests that assimilation is not keeping the uncertainty given by the model errors.

• More inflation is needed,

•To explore the thinning the observation .

Verification of model state

It is reasonable to expect that the model state represents basic aspects observed in satellite images (IR , near Vis.)

So, we studied how model state feeds CRTM to simulate that images in case studies with Mesoscale Convective Systems (MCS) over South America.

We examine how the MCS are in the satellite images and how are the images simulated by the radiative transfer model CRTM.

GOES 10 – Channel 4 experiment

For these experiments we use model analysis and 12 hours forecast .

- ETA (20x20 Km - 19 levels)
- ETA/RPSAS (40x40 Km, 19 levels)

Model variables and levels used to identify the MCS:

Variables: air temperature.; specific humidity; zonal and meridional wind (u and v); vertical velocity (omega); CAPE
Levels: surface, 850hPa; 500hPa; 250 hPa

Model variables and levels used in the CRTM to simulate the MCS:

Variables: pressure levels.; air temperature; specific humidity ; wind *u* e *v* (10 m); topo ; soil temperature; pressure at base and top of cloud .
Levels: from 1000hPa – 100hPa (model pos-processed levels)

GOES 10 – Channel 4 experiment … data

and we used NCEP CFSR reanalysis data

50x50 Km , 37 levels

Reanalysis variables and levels used to identify the MCS:

Variables: air temperature.; specific humidity; zonal and meridional wind (at 10m); pressure at cloud base and at cloud top.
Levels: 1000hPa – 1hPa (model top)

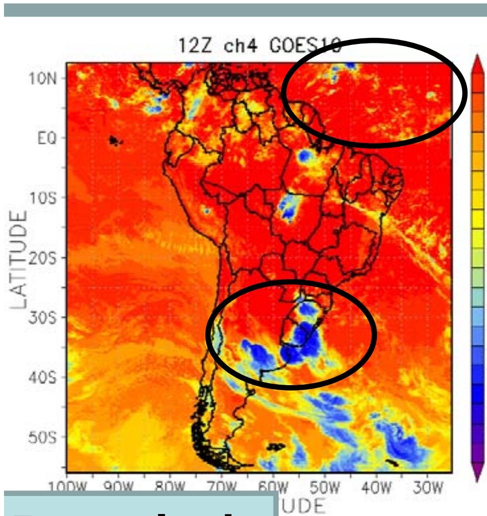
Some input values for CRTM

CRTM	Assigned Value
Surface pressure	1000hPa
Cloud water content	5Kg/m^2
Cloud top	Max(100 hPa, model cloud top)
Cloud (yes/no)	Cloud deep larger than 300hPa
Droplet effective radius	20 microns
Number of clouds	1 (cloud / atm. profile)
Number of absorbers	2 (H_2O e O_3)
Number of aerossols	0
Surface type	GRASS_SOIL – CRTM default
Soil temperature	Temperature at 0.1 m deep (K)
Soil water amout	0.05 g/m^3, CRTM default
Water surface type	SEA_WATER
Wind direction	0, CRMT default
Salinity	33 ppmv, CRTM default

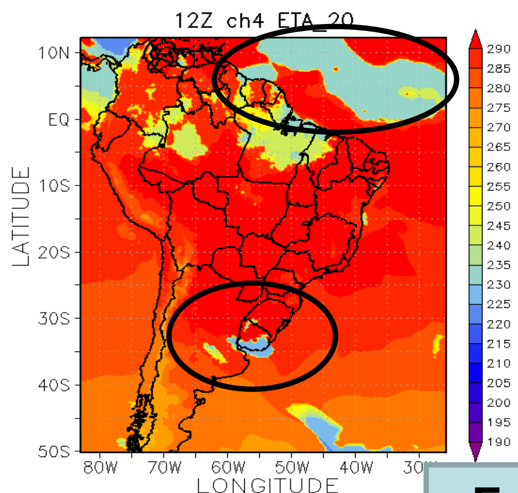
CRTM results for MCS 05/oct/2007-12Z

Simulated GOES 10 - channel 4

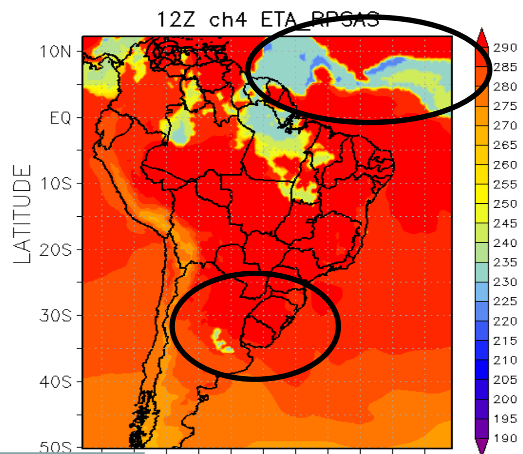
Observed

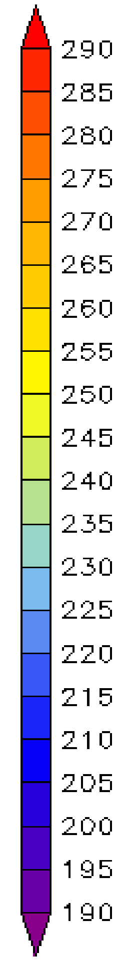


Eta Analysis

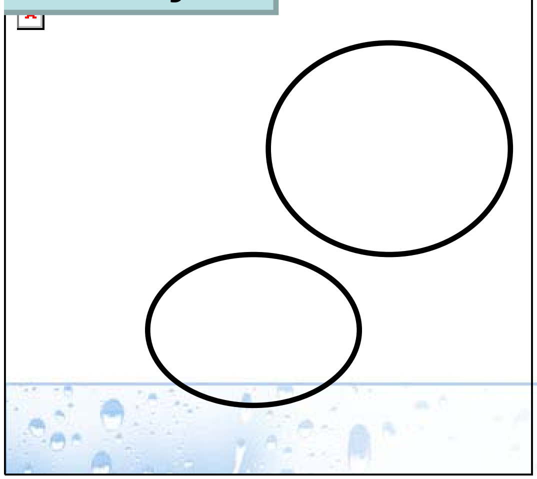


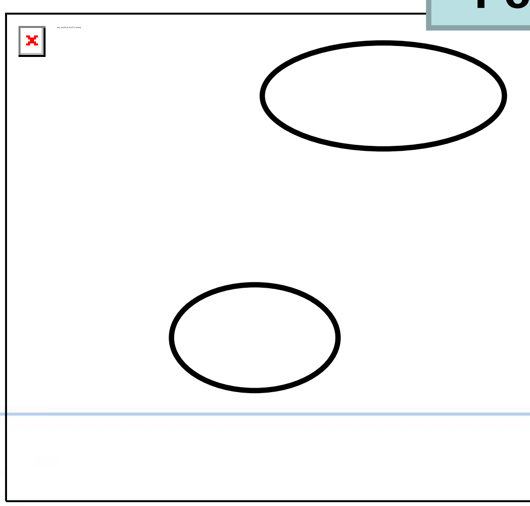
ETA/RPSAS Analysis





Reanalysis





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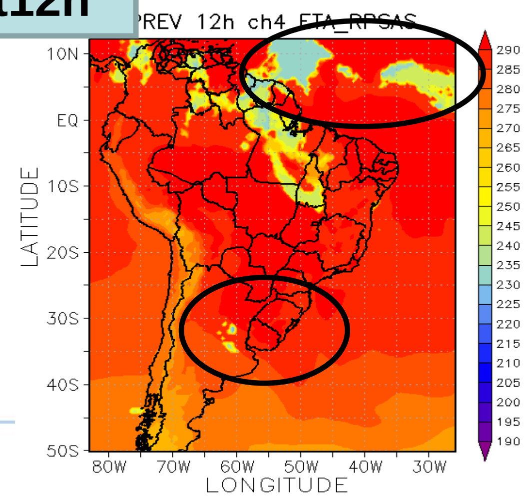
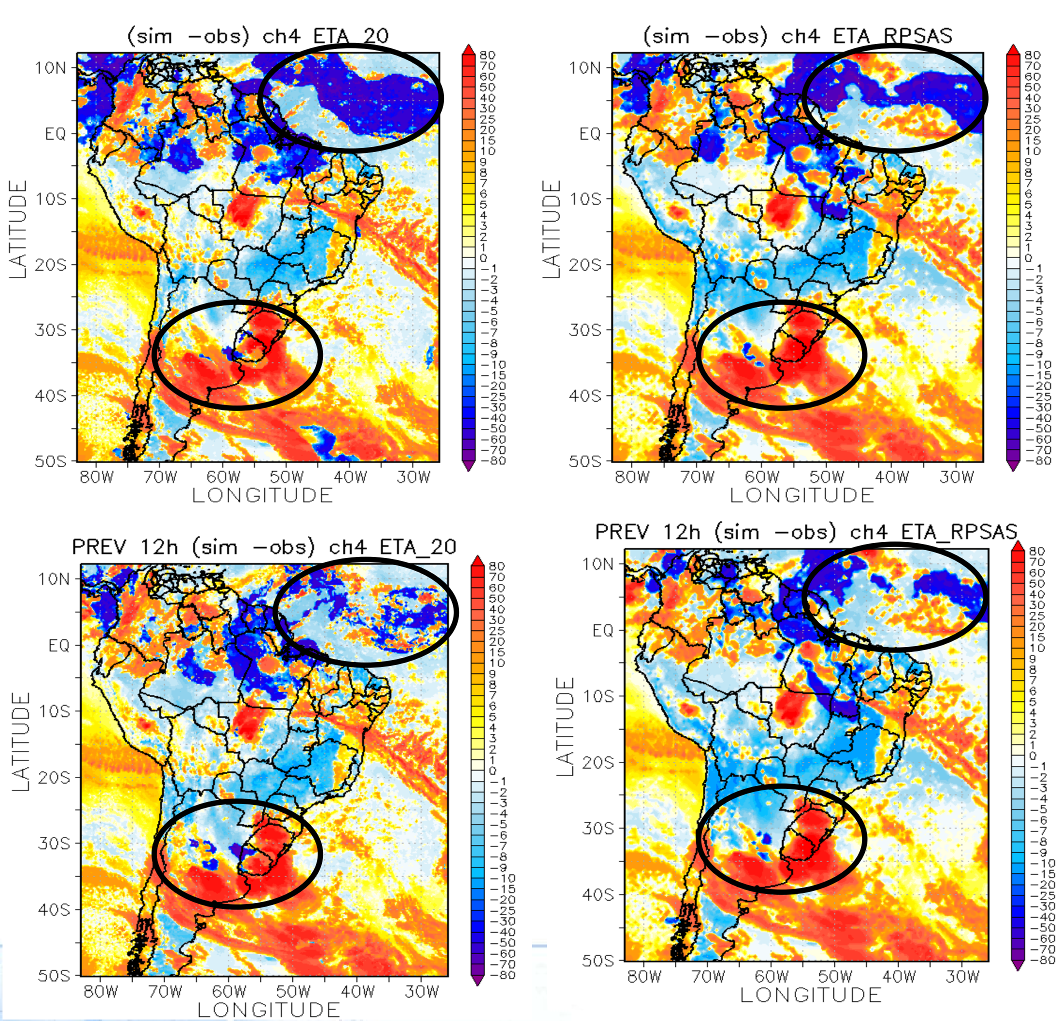


CRTM results for MCS 05/oct/2007-12Z

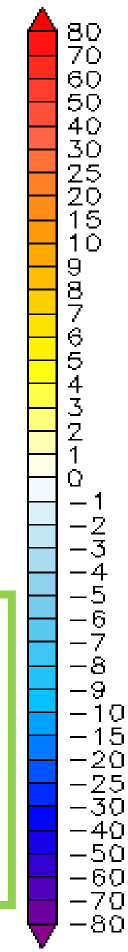
(Simulation – Observation)



CRTM Sim. BT **Model**

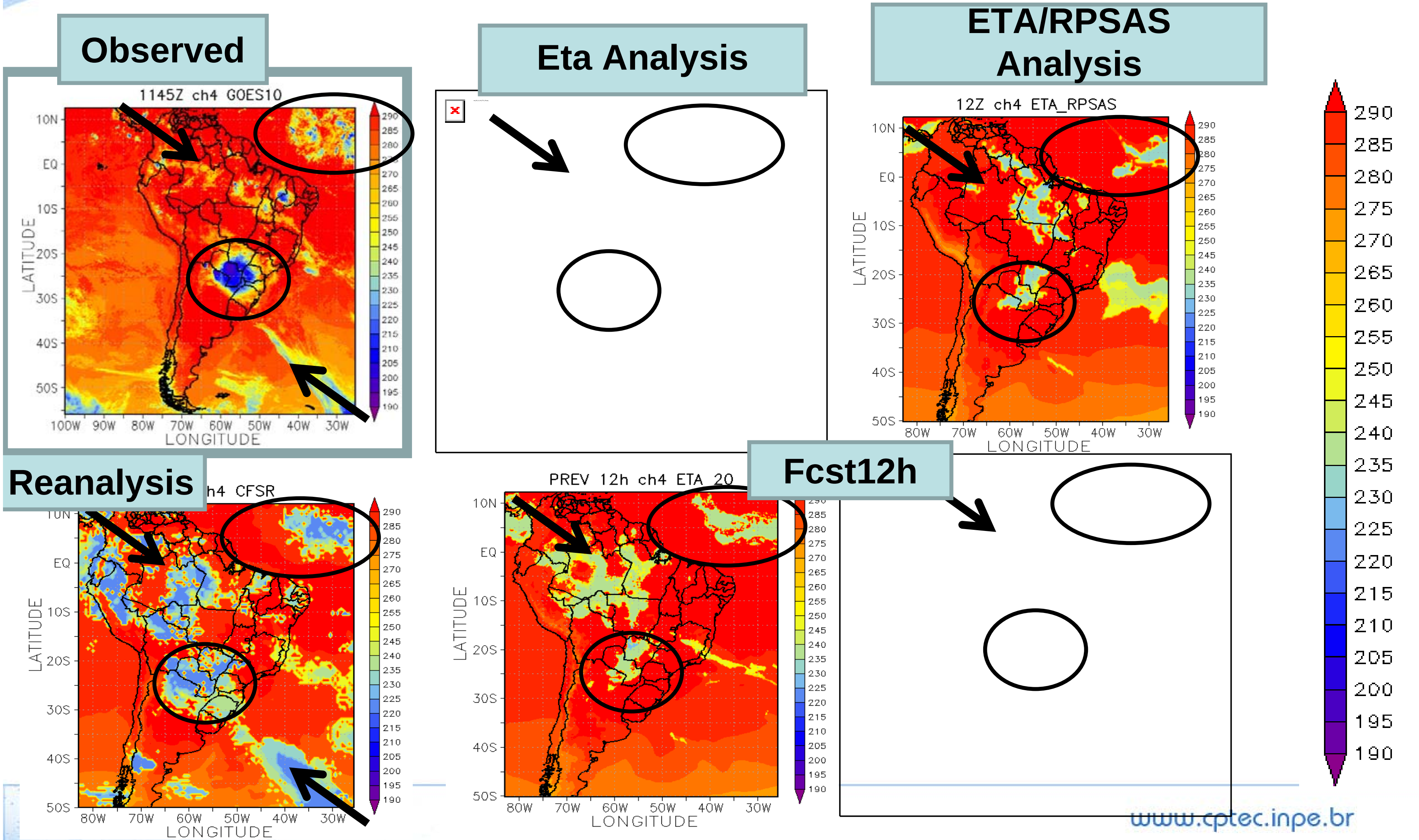
Overestimate ⇨ less cloud

Underestimate ⇨ more cloud



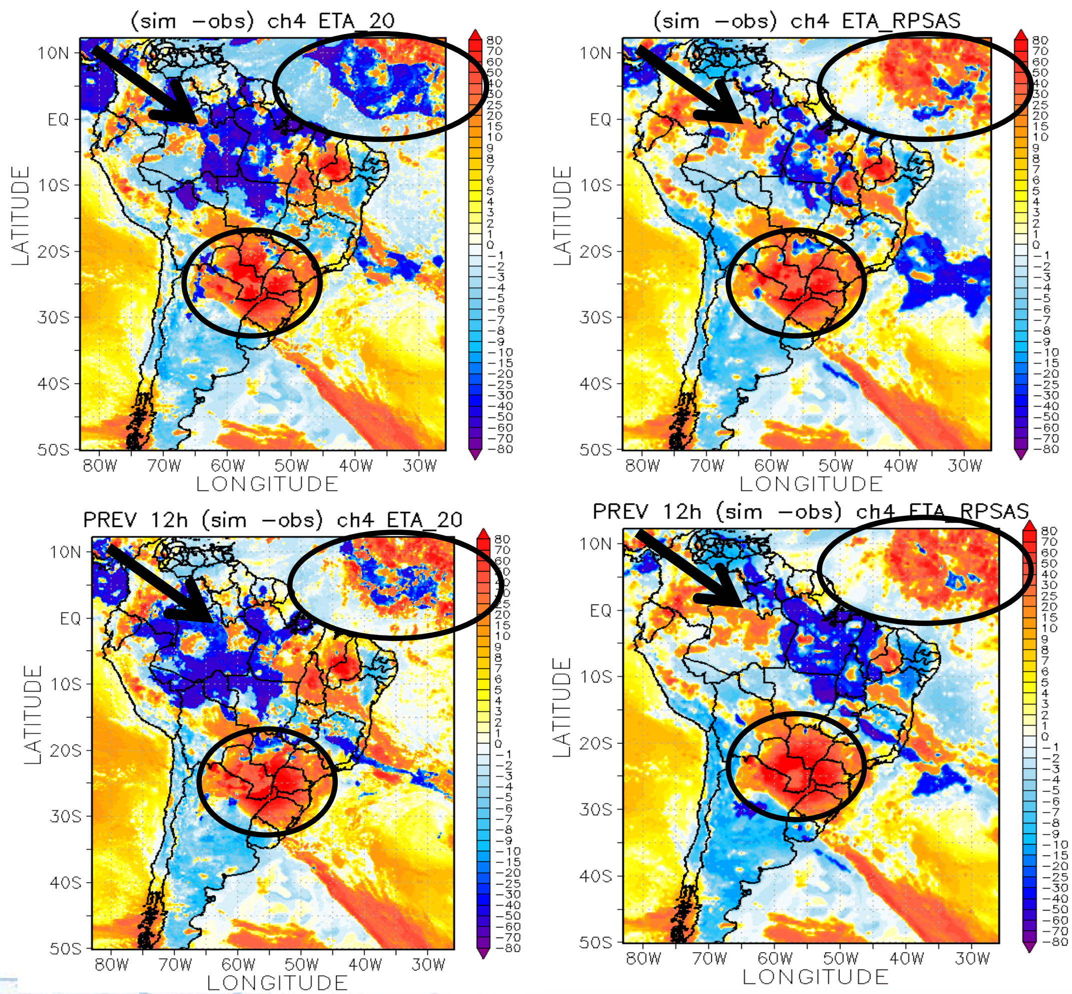
CRTM Results for MCS 09/nov/2008-12Z

Simulated GOES 10 - channel 4

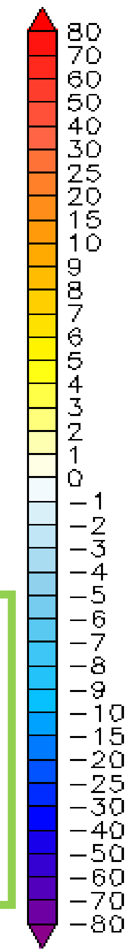


CRTM Results for MCS 09/nov/2008-12Z

(Simulation – Observation)



CRTM Sim. BT		Model
Overestimate	⇨	less cloud
Underestimate	⇨	more cloud



GOES 10 Simulations remarks

- The simulated results from the regional model does not get the main system position and its intensity.
- The simulation with CFSR presents better agreement with the observed MCS's T_B .
- A better representation of the vertical and horizontal distribution of the humidity is needed beside others improvements.
- We need to use updated measured information (instead of climatology or standard values) to provide CRTM input values.

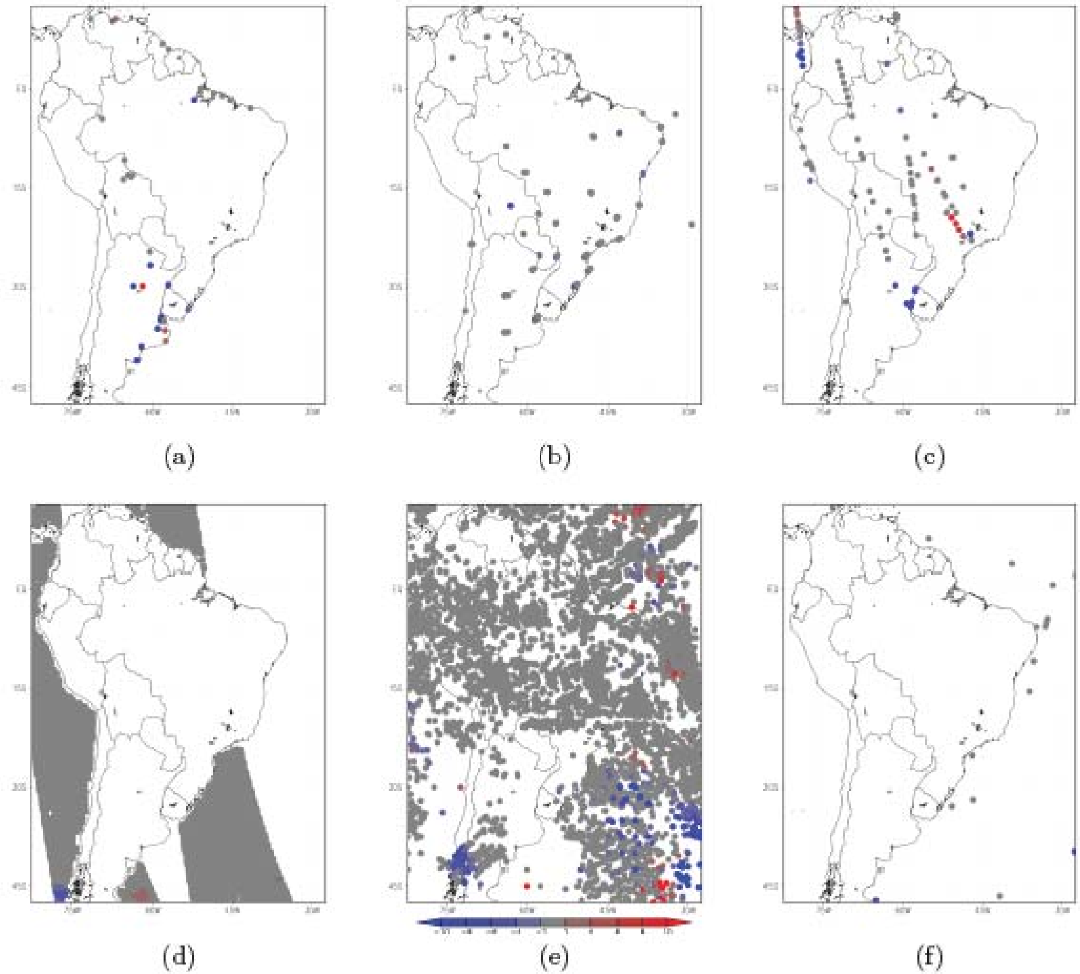
Next steps

At this point we know that AMSU-A has been able to bring positive improvement to the analysis and forecast in the LETKF – CPTEC AGCM system.

CPTEC D.A. team is working with:

- implementing an objective method to evaluate the impact of observations (next slide);
- Implementing GPS-RO assimilation (short range plan);
- Implementing LETKF DA with the regional forecast models (medium range plan);
- Developing a hybrid system 3D-Var – LETKF (long range plan);

IMPACT – Using Liu and Kalnay (2008)



Diniz, F. L. R. dissertation

Figure 2: Observation impact of various message types on the 24-h forecasts at 1200 UTC February 07, 2004: (a) ADPSFC, (b) ADPUPA, (c) AIRCAR, (d) QKSWND, (e) SATWND and (f) SFCSHP. The scale factor is 10^{-5}.

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Thank you !

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