MINISTÉRIO DA CIÊNCIA, TECNOLOGIA E INOVAÇÃO
INSTITUTO NACIONAL DE PESQUISAS ESPACIAIS

Current developments in the INPE/CPTEC modeling system

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Thanks for: Saulo Freitas, Carlos Bastarz, Paulo Kubota, Silvio N. Figueroa, João Gerd Z. De Mattos, Luiz F. Sapucci, Daniel Vila, Enver Ramirez

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Outline

- Introduction
- Some results - physics parametrization
  - Regional modeling
  - Global modeling
- Diagnostic/verification tool
- New dynamical core discussions

Introduction

- INPE/CPTEC: operational center, performs different models

- New employees (since March 2015)
  - 1 Global Ensemble (0)
  - 3 Data Assimilation (2)
  - 3 physics parameterization (2)
  - 1 Dynamics (1)
  - 2 ocean modeling (1)

- New Coordination – Dr. Antonio Manzi (since December 2015)

Physics parametrization

- Regional modeling

Scale-Aware Physics

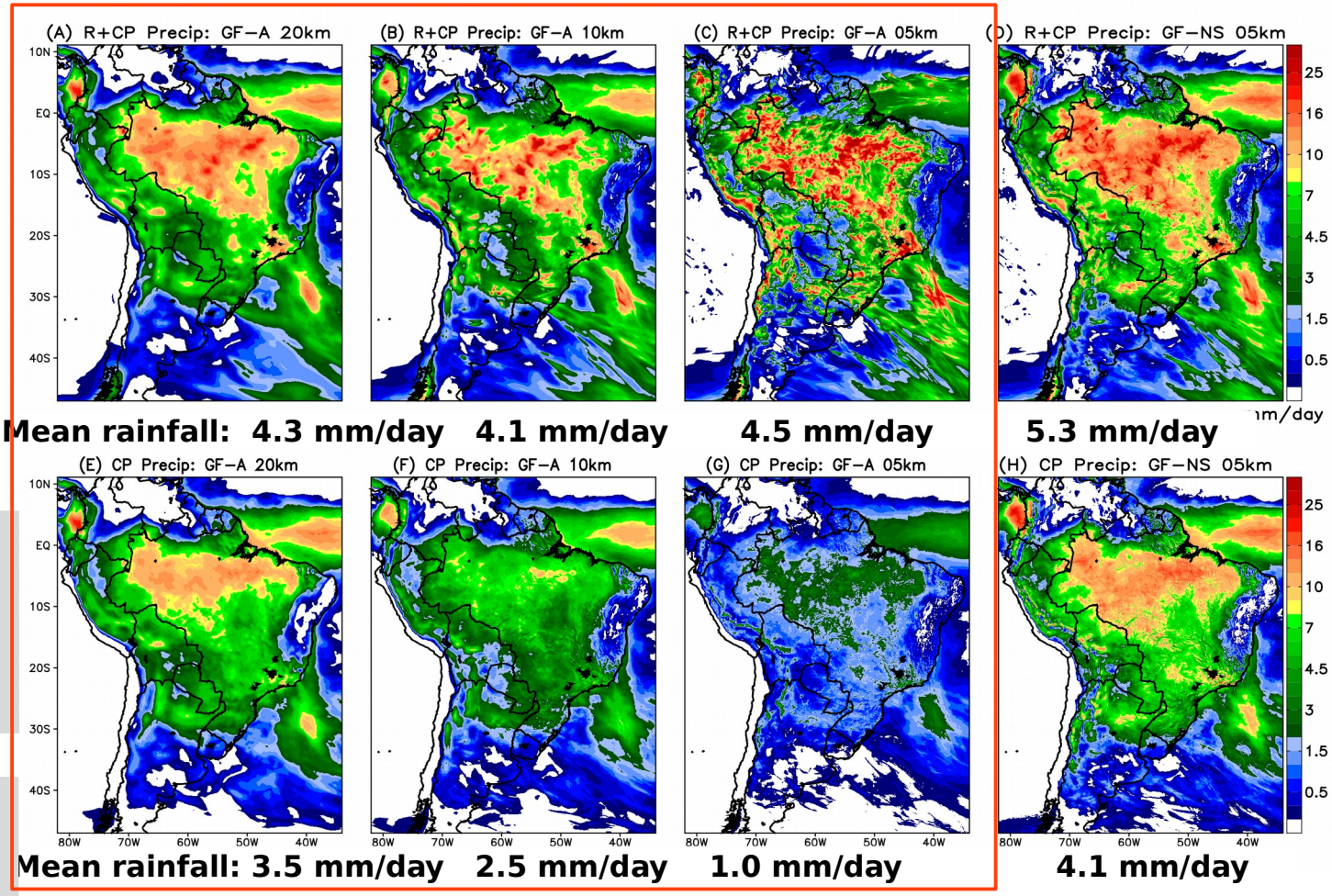
Addressing the grey-zone problem for deep convection

BRAMS Simulations on 20, 10 and 5 km grid spacing

Total 24h rainfall: resolved + from the convective param.

24 h Rainfall: only from the convective param.

Results are model average for Jan 2013 - 15 days 36h FCT



20km **10km** **05km** **05km**

with scale dependence **no scale dependence**

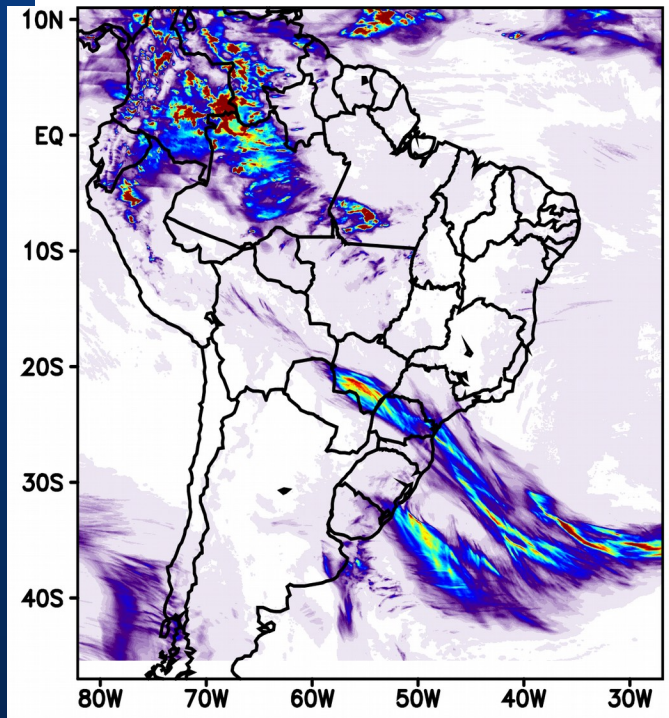
(Grell and Freitas, 2014, ACP)

An example of real-time performance of BRAMS 5.2

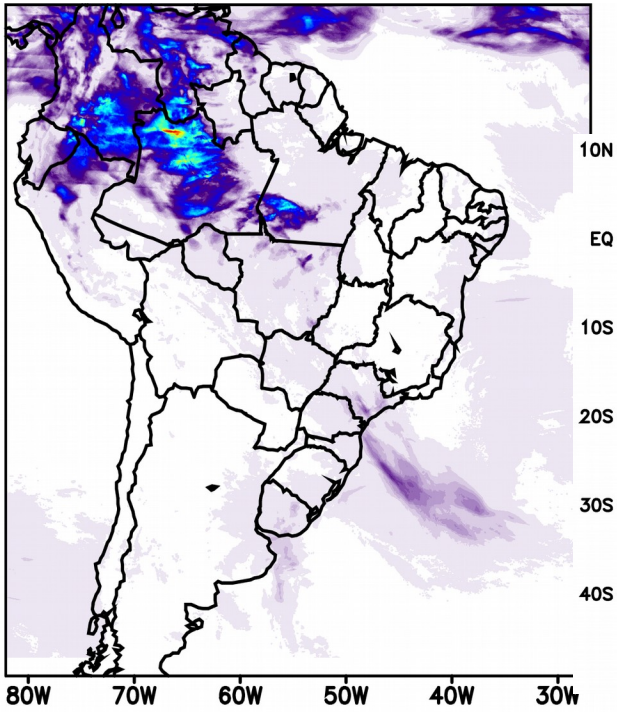
5 km grid spacing

24-hour accumulated rainfall for 12 October 2015

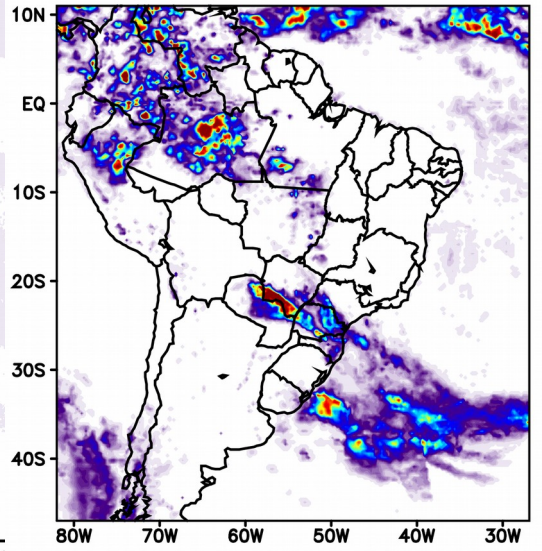
Total rainfall (mm)

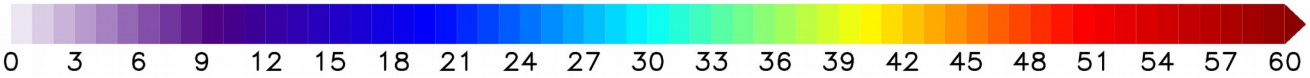


CUPAR rainfall (mm)



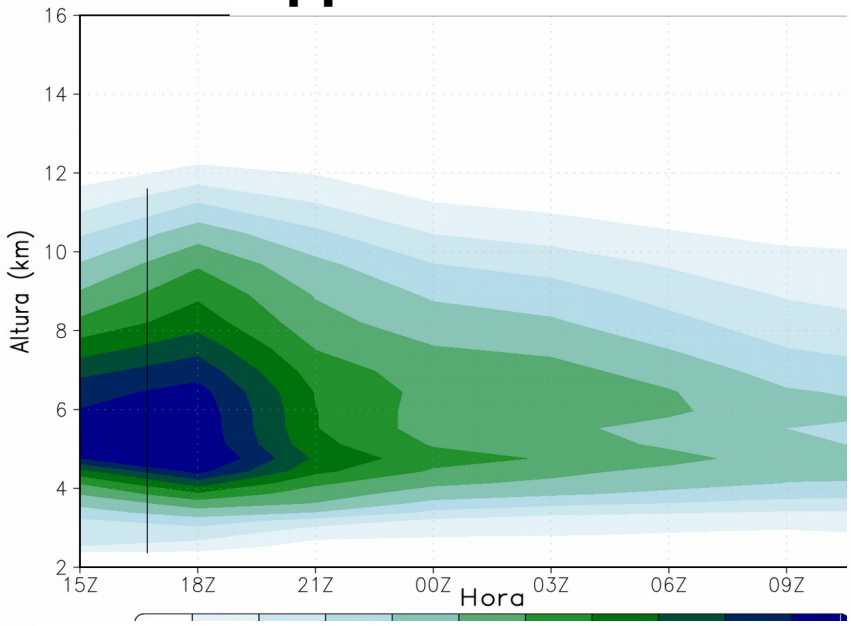
TRMM rainfall (mm)

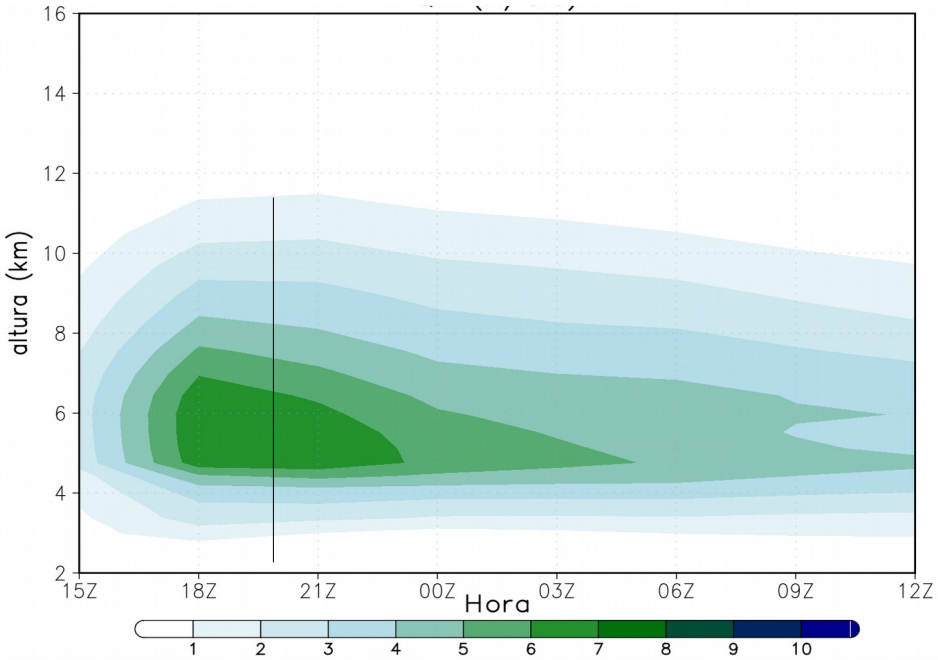


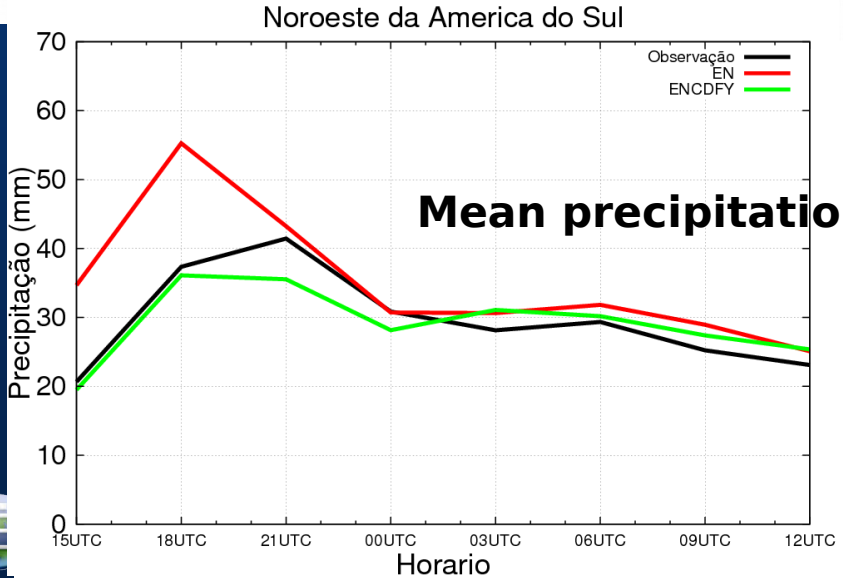


GD ensemble with weights optimized

Apparent heat source (K/day) Jan 2008 NW AS ul







Mean precipitation diurnal cycle - Northwest SA

Results from Thesis (2014)

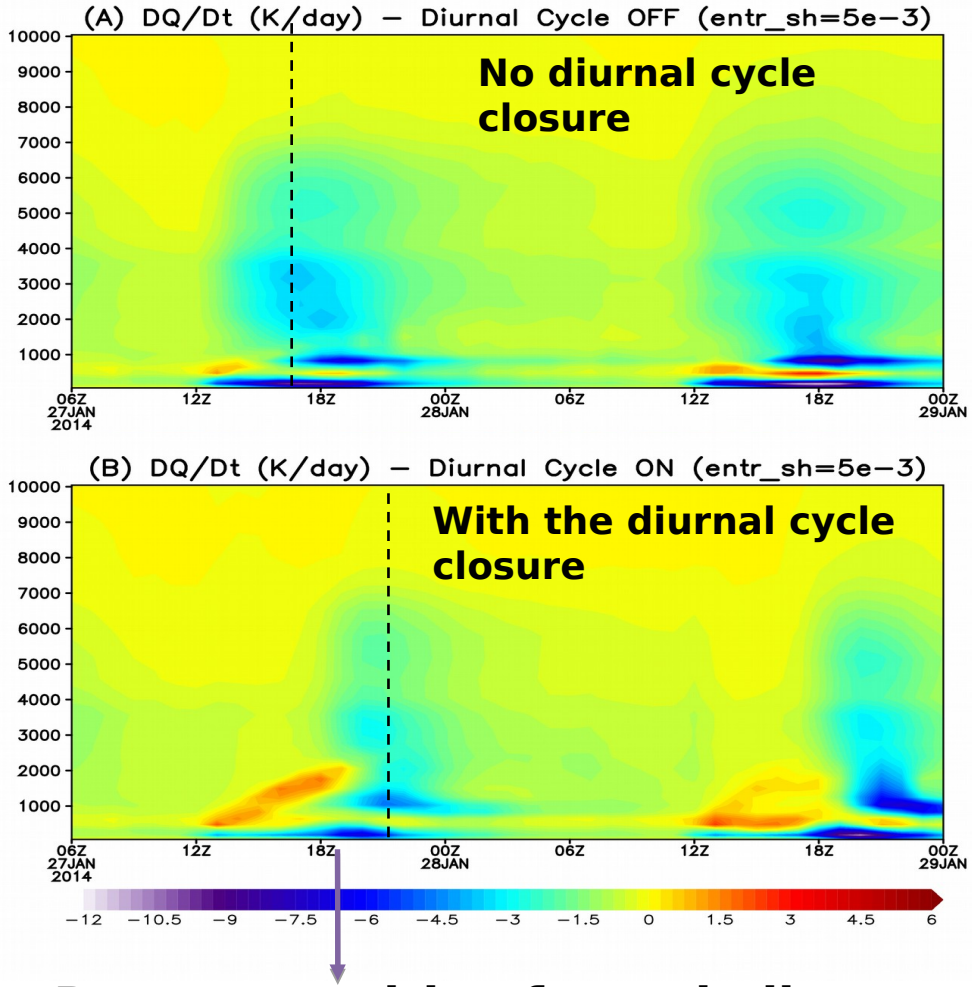
Improved diurnal cycle of deep convection over the Amazonia: Applying the new closure from P. Bechtold for non-equilibrium convection

BRAMS
RELEASE
BRAMS + CCATT + JULES

Convective Precipitation (mm/h)

- 5 days forecast of CUPAR precipitation
- Model grid spacing: 27 km
- Area average over Amazon Basin
- BLUE = diurnal cycle closure OFF
- RED = diurnal cycle closure ON
- GREEN= surface solar radiation

water vapor tendency (K/day)



Better transition from shallow to deep convection regimes

Bechtold et al., 2014; Freitas and Grell, in prep.

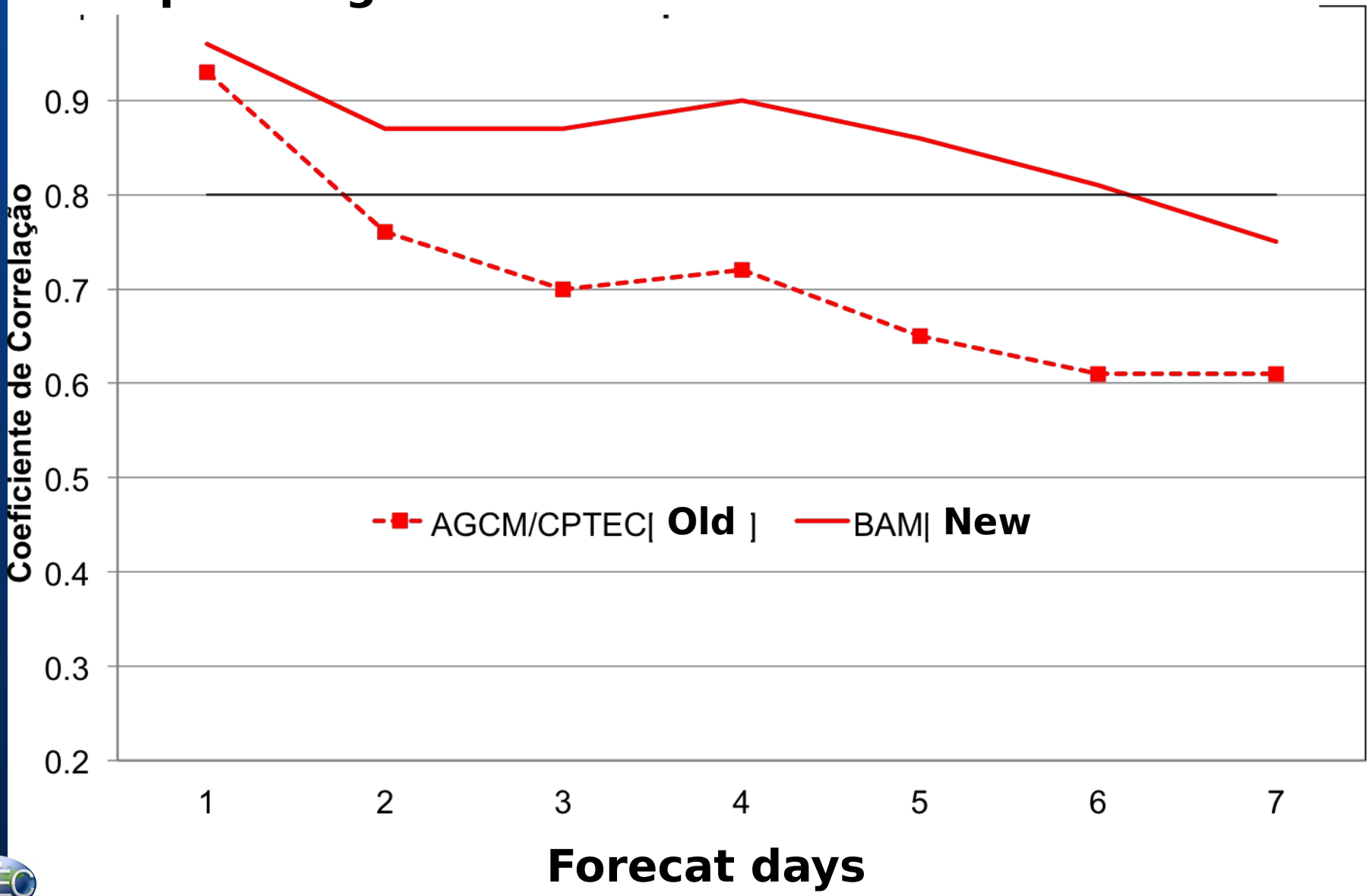
Parametrization developments

- Global modeling

Summary of the physics and dynamics of AGCM/CPTEC

Dynamics and Physics	AGCM3 (old)	BAM - Brazilian Global Atmospheric Model (new)
Dynamics	Spectral Eulerian or semi-Lagrangian	Spectral Eulerian or semi-Lagrangian implicit model, full or reduced gaussian grids, semi-Lagrangian monotonic transport scheme of moisture
Land surface process	SSiB (Xue et al., 1991)	IBIS model (Foley et al, 1996), adapted by Kubota (2012)
Land surface process	The bulk transfer coefficiets determined by analytical functions (Sato et al., 1989)	Monin-Obukhov theory (Zeng et al., 1998)
PBL	Mellor-Yamada (1982)	Modified the Mellor-Yamada (1982) scheme
Gravity-wave Drag	Alpert et al. (1988) scheme without low-level blocking	Webster et al. (2003) scheme with low-level blocking
Cloud microphysics	Single-moment scheme (Rasch and Kristjansson, 1998)	Double-moment scheme (Morrison et al., 2009)
Radiation	CLIRAD, Chou and Suarez (1999)	RRTMG, Iacomo et al. (2008)
Shallow convection	Tiedke (1983) diffusion scheme	University of Washington Shallow convection (Park and Bretherton, 2009)
Deep convection	Grell and Dévényi (2002) ensemble	GD with CAPE based closure (Zhang 2002) Simplified Arakawa-Schubert (Pan & Wu, 1995)

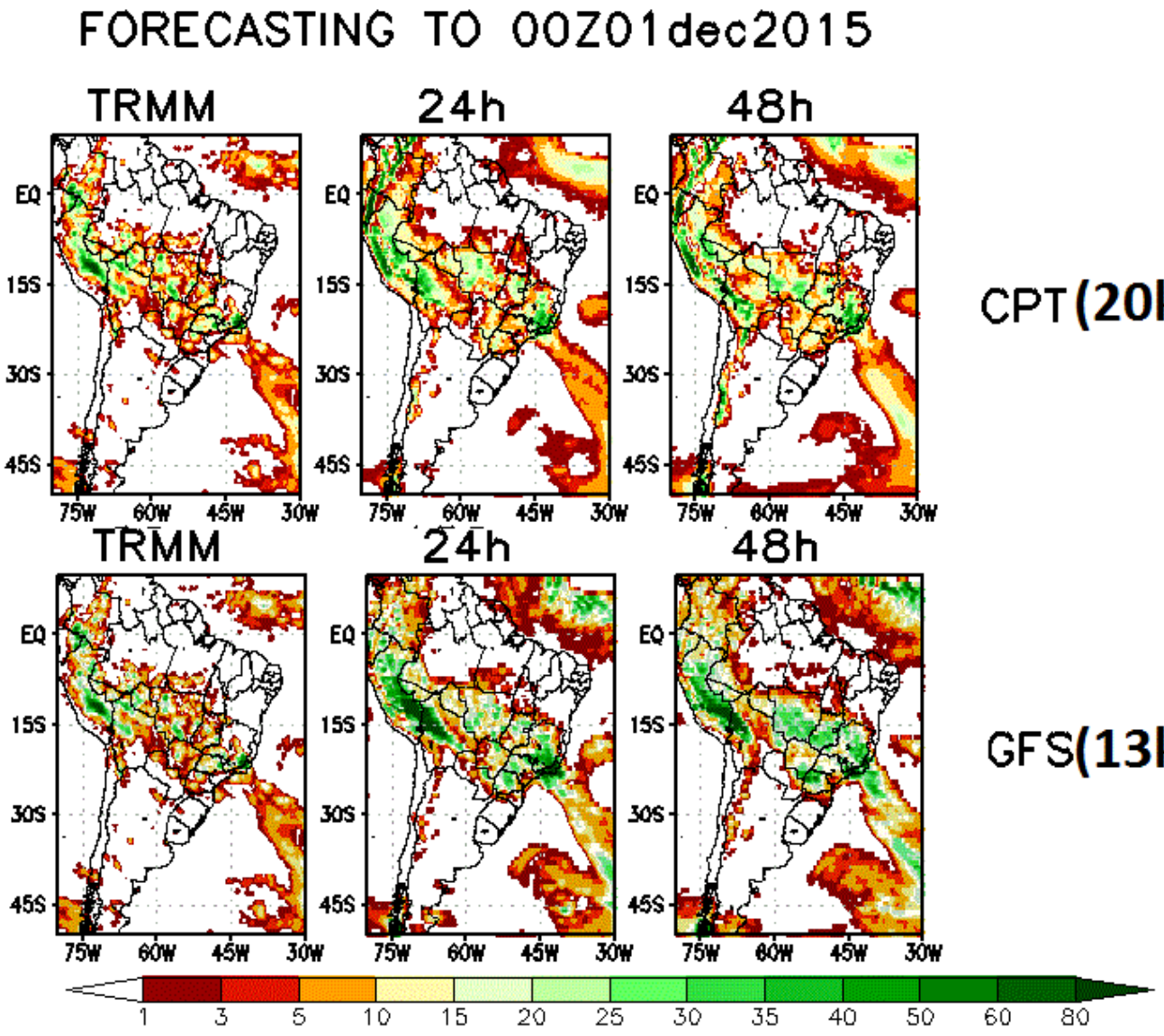
Anomaly correlation – geopotential height 500 hPa
Tropical region



Global Atmospheric Modeling

Operacional model: TQ666L64 ~20km

Up to 168 forecast hours



CPT (20km)

GFS (13km)

Global Atmospheric Modeling

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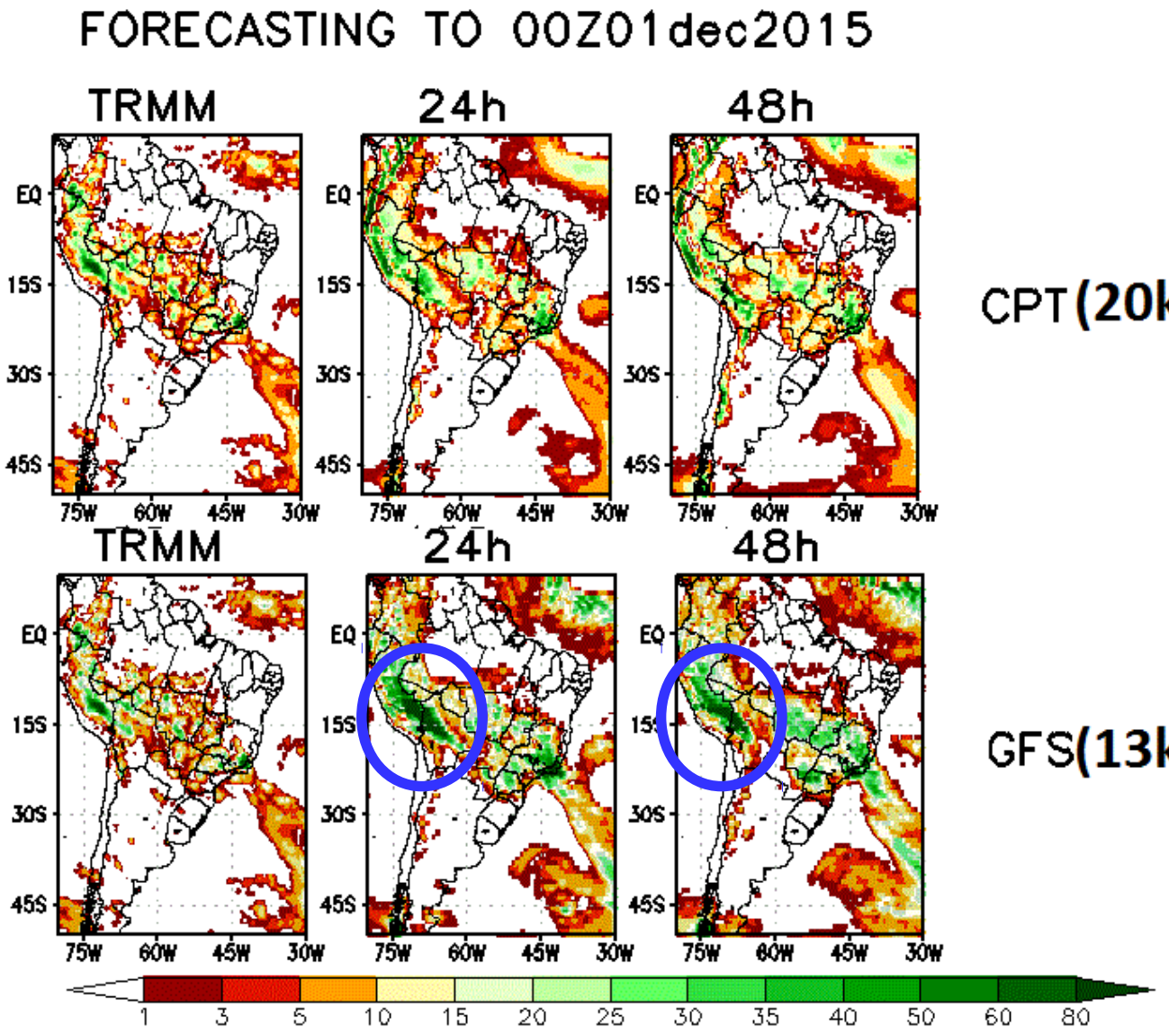
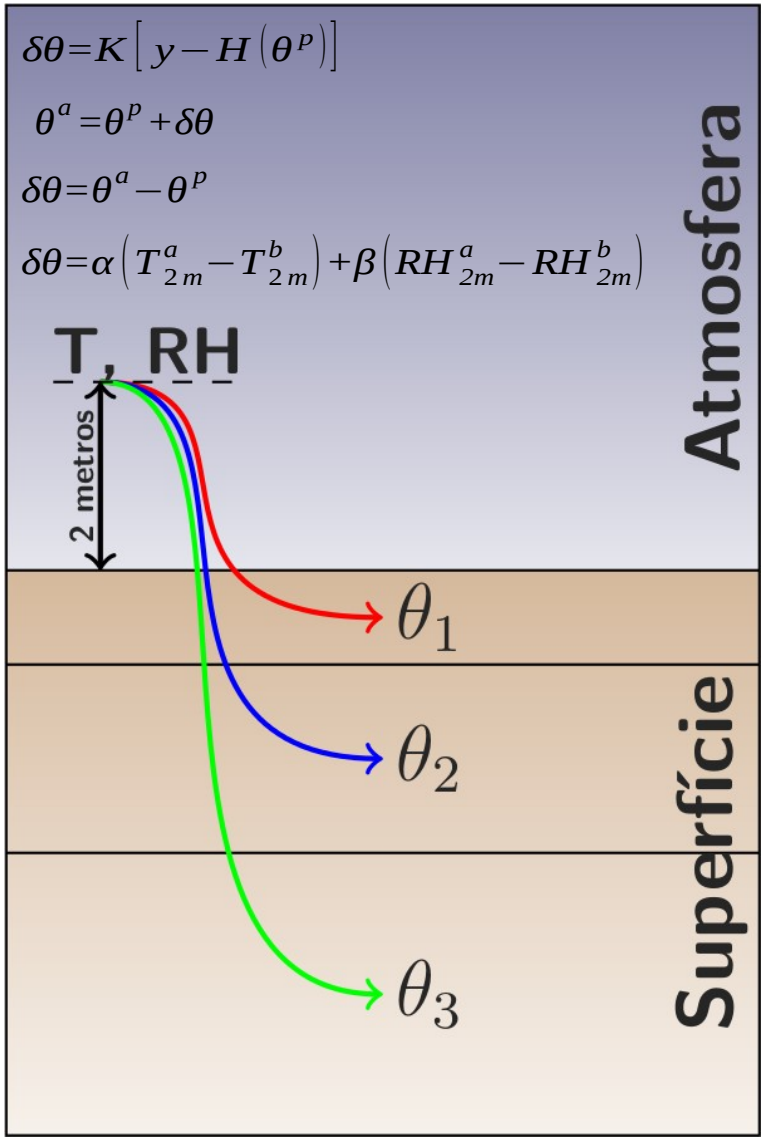


Soil moisture data assimilation

Used Optimal Interpolation (OI) => computationally cheap

Performed multiple linear regression => errors relate atmospheric variables with soil moisture corrections



Mean precipitation in different areas of the globe

Simulation: Jan 1998 - Dec 2014

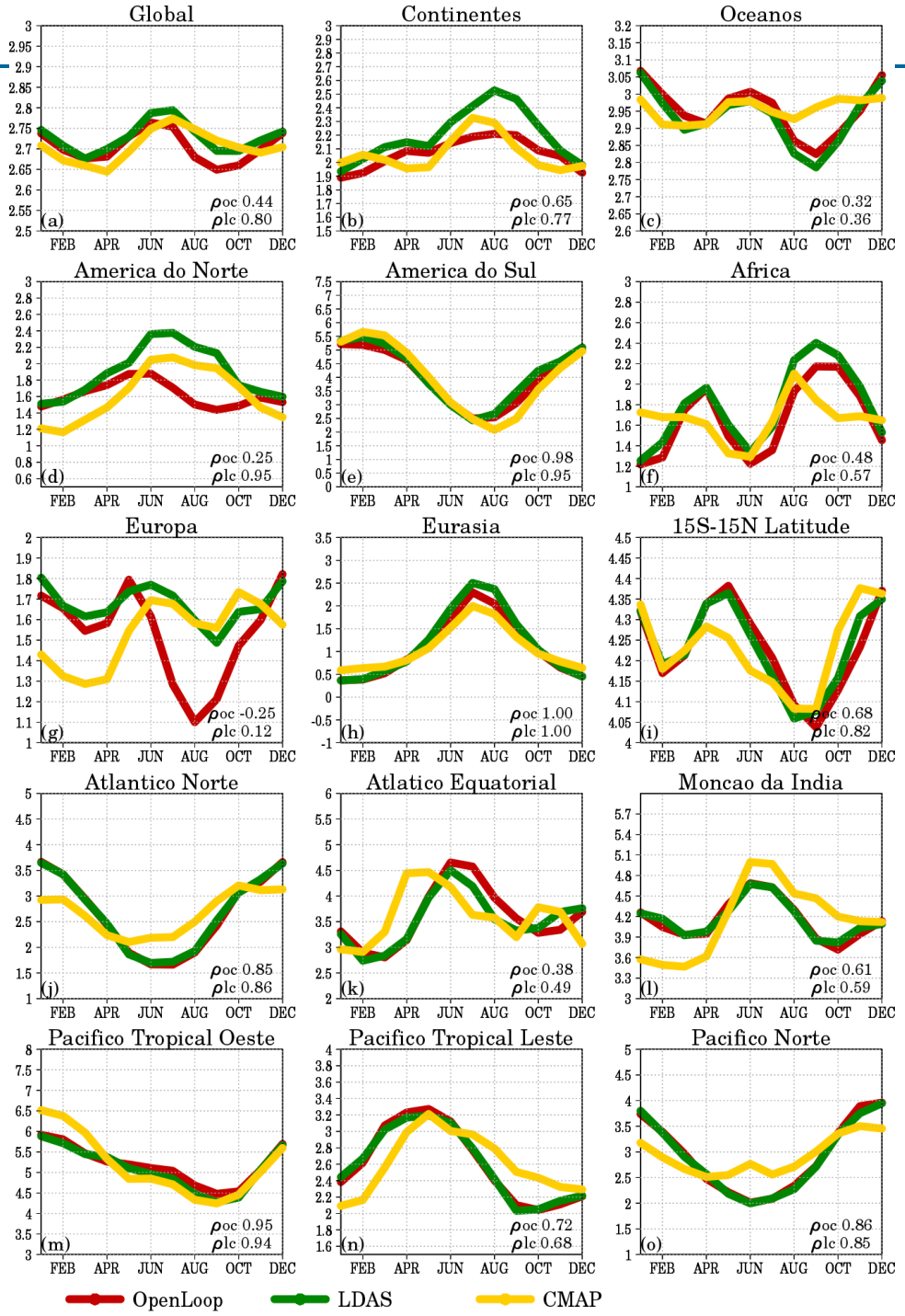
Kuo – SSiB

Initialized from *restart* of an AMIP simulation type

DA cycle: 6 h

Modification of the land *restart* file

de Mattos 2016 Thesis



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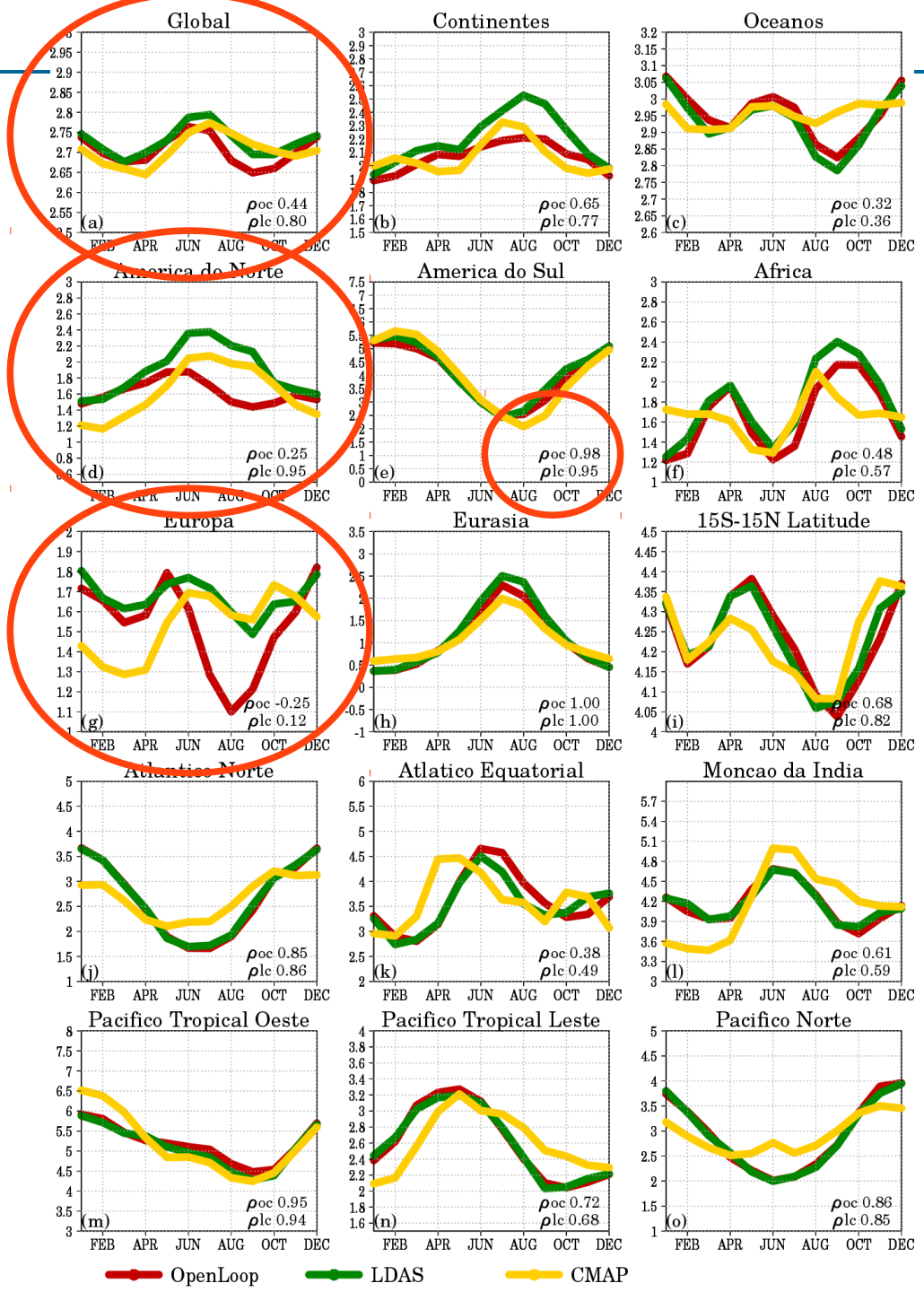
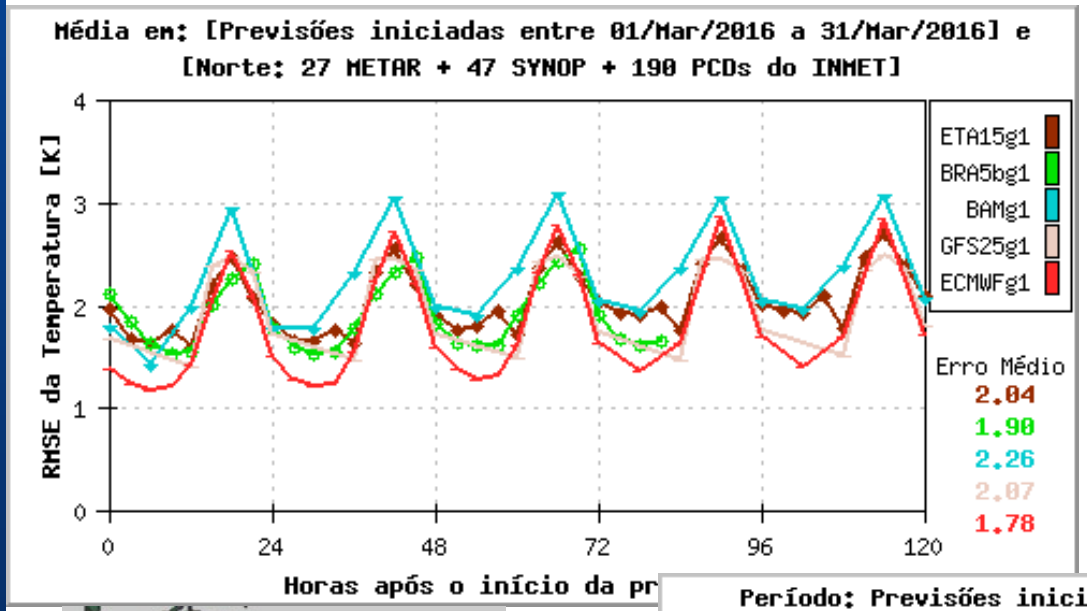
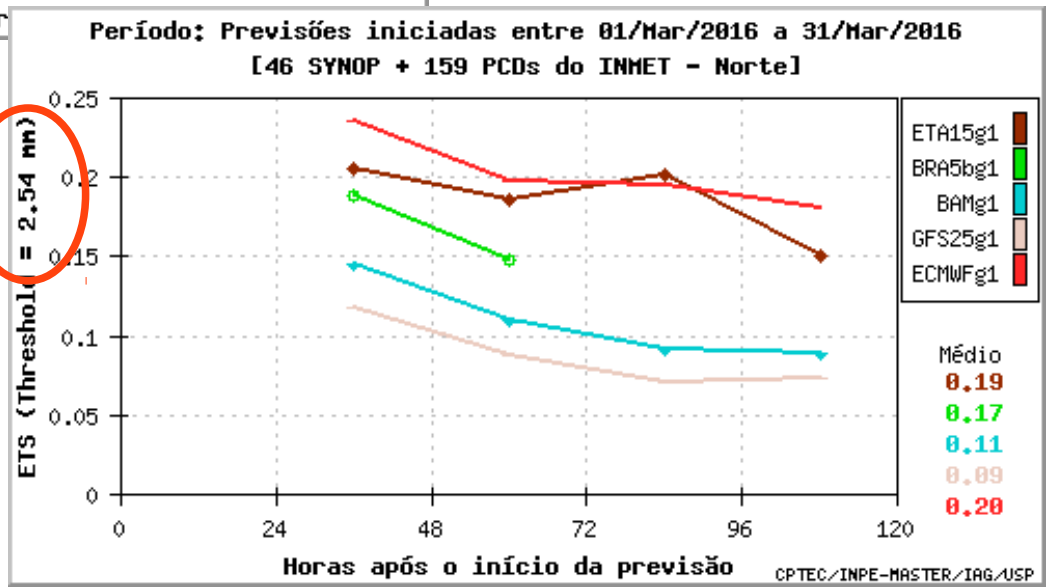


RMSE and ETS for North Brazil – comparison with local met. stations





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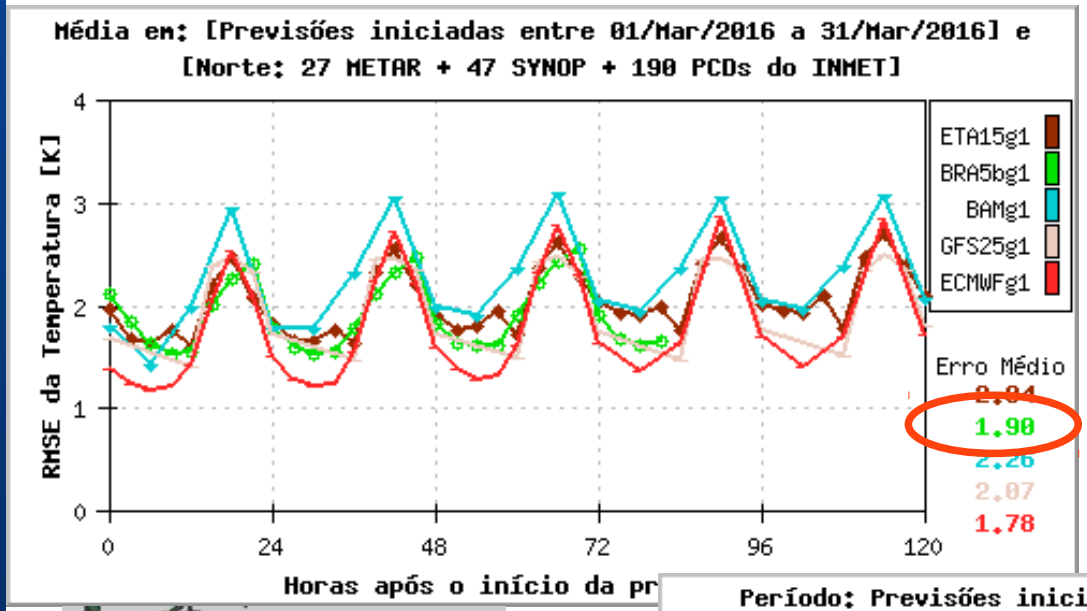
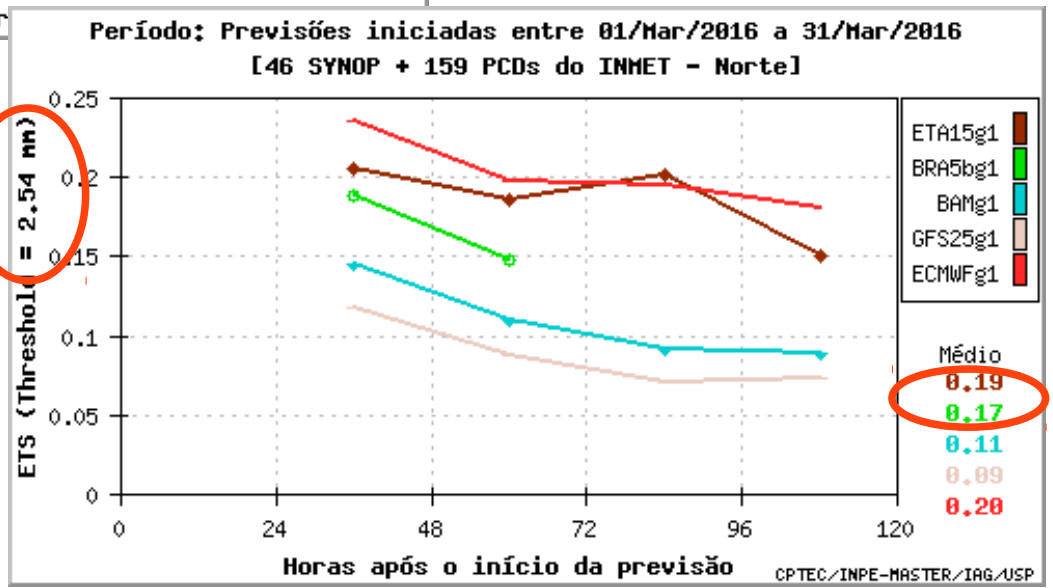




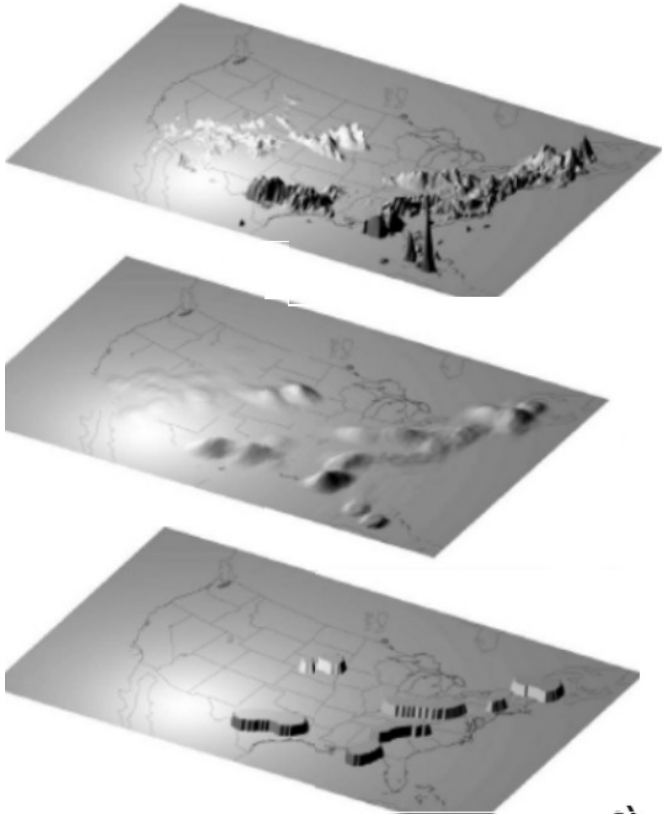
Diagnostic/verification tool

Moving for a standard and more complete Verification System

SCANTEC acronym for
Sistema Comunitário de Avaliação de modelos Numéricos de TEmpo e Clima

Communitary Evaluation System for Numerical Models of Weather and Climate

- Free software
- Developed in Fortran
- Structured programming
- Object-oriented (polymorphism)
- Flexibility with data files formats and models (analysis and forecasts)
- Easily adding new metrics
- ***Follow the recommendations of verification methods for WGNE/WMO***



New dynamical core

Which dynamical core to use between those currently evaluated?

- MPAS
- FV3
- NUMA
- ...
- Global Eta (developed at CPTEC)

Is it feasible to test Eta vertical coordinate, that better represents deep terrain in South America?

Suggestions:

- verification of Andes precipitation
- Verification of Amazon convection

Thanks for your attention!

Questions?