CPTEC
Centro de Previsão de Tempo e Estudos Climáticos

MINISTÉRIO DA CIÊNCIA E TECNOLOGIA
INSTITUTO NACIONAL DE PESQUISAS ESPACIAIS

Simulation of the Diurnal Cycle of Precipitation over Western Amazon by CPTEC Climate AGCM

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Outline

- Motivation
- Development a Simplified Shallow Scheme (SSH) using Cloud Resolving Model (CRM) and Testing this new model (1D) for the BOMEX case
- 3D Simulation for transition period (SEP-NOV-2002) in AGCM with different cumulus shallow and deep schemes
- Preliminary Conclusions
- Future plans

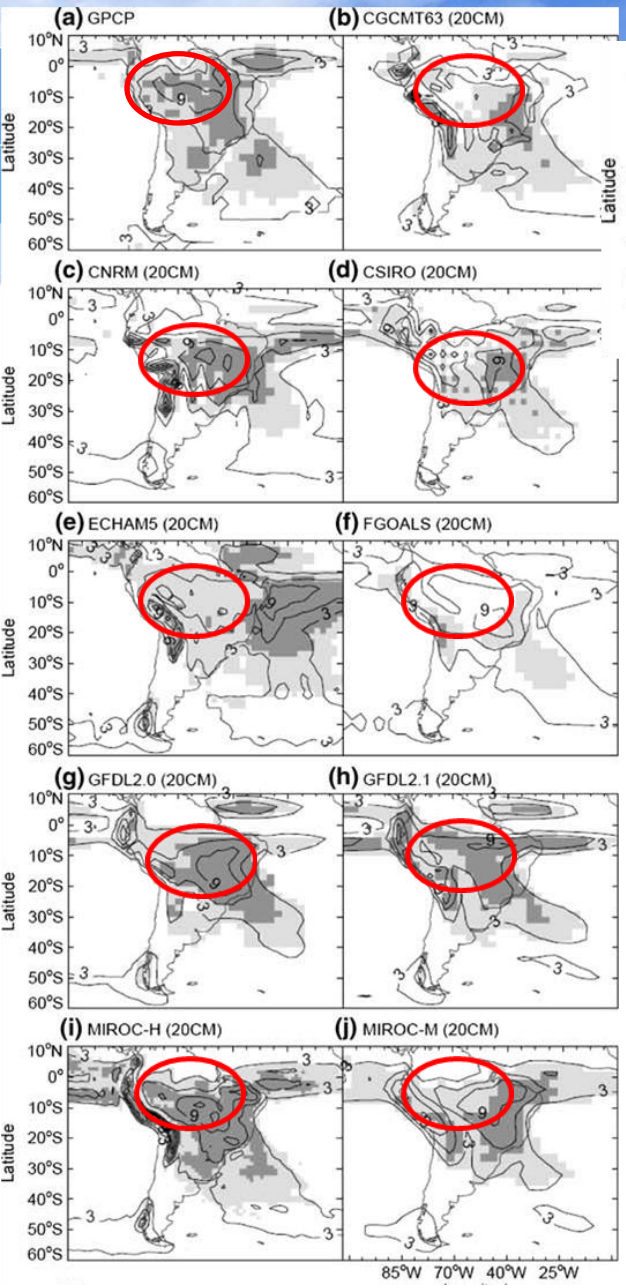
MOTIVATION

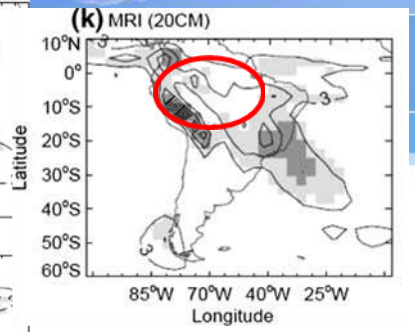
WHY AMAZON CONVECTION IS POORLY SIMULATED BY CLMATE AGCMs?

1-This poor simulation of major center of convection and heat latent source over tropical land is one of the serious limitations not only for future climate prediction, but also for simulations to understand the present and past climate over South America.

2.The model must simulate the current climate state for confidence the future climate predictions. Maybe is not sufficient but it must be the necessary condition. The ability of the models to reproduce the current climate builds confidence in their physical validity.

3. Although both GCMs coupled atmosphere-ocean and Atmospheric GCMs (AGCMs) with sea temperature (SST) prescript reproduce the large scale features, but most of them, including CPTEC-AGCM fail to simulate clouds and precipitation over Tropical South America realistically. Look at the next Figure.





1-Amazon Convection is poorly simulated in all AGCMs

2- Intense precipitation over Northeast in all cases.

3. Atlantic ITCZ is poorly simulated

4. SCAZ is also poorly simulated in most of models.

5. In the CPTEC-AGCM there are similar problems.

WHY?.

Dynamics, Physics?.

Radiation, PBL, Clouds, Surface, Convection, .. ?

We have tested different options...but continue the problem.

How good the diurnal cycle of precipitation is simulated in global models?

An accurate representation of the amplitude and phase of the diurnal cycle provides a key test of many aspects of the physical parameterizations in an atmospheric model.

Bombardi and Carvalho (2009)

The transition from shallow to deep convection in the diurnal cycle over land is a complex process.

- Over the continents where the diurnal forcing is dominant (eg Amazon), deep precipitation typically occurs at late afternoons.

- However, in most global models the convective triggering somehow delays by another few hours, because the models are not able to simulate the transition from shallow to deep convection.

- Shallow cumulus convection plays an important role in tropical climate dynamics, in which convective mixing between the atmospheric boundary layer and the free troposphere initiates a chain of large-scale feedbacks.

The prognostic equation for conserved variable

A SIMPLIFIED SHALLOW CONVECTION SCHEME (SSH) HAS BEEN DEVELOPED.

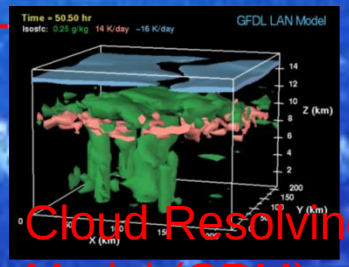
It is based on a mass-flux parameterization approach, using Cloud Resolving Model (CRM). The problem of closure in cumulus parameterization requires an understanding of the sensitivities of convectivecloud systems to their large-scale setting (Mapes,2004).

$$\varrho \frac{\partial a\chi_c}{\partial t} = -\frac{\partial (M_c \chi_c)}{\partial z} + E\chi_e - D\chi_c - \frac{\partial a\varrho(z)\overline{w'\chi'}^{c}}{\partial z}$$

$$-\varrho \frac{\partial (1-a)\chi_e}{\partial t} = -\frac{\partial (M_c \chi_e)}{\partial z} - E\chi_e + D\chi_c - \frac{\partial (1-a)\varrho(z)\overline{w'\chi'}^{e}}{\partial z}$$

$$\varrho \frac{\partial a}{\partial t} = -\frac{\partial M_c}{\partial z} + E - D$$

$$\chi \epsilon \{s_l, q_t\}$$

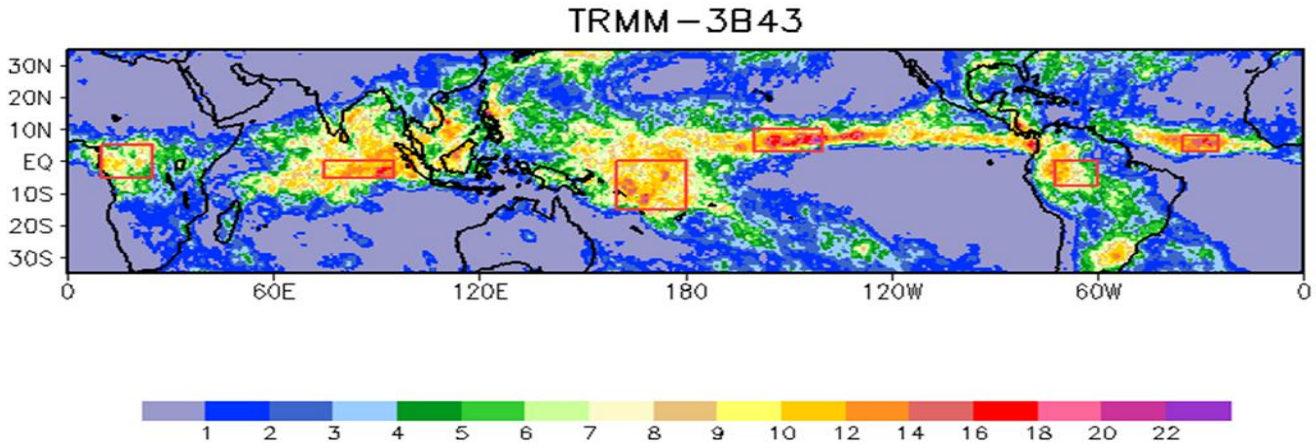


Cloud Resolving Model (CRM)

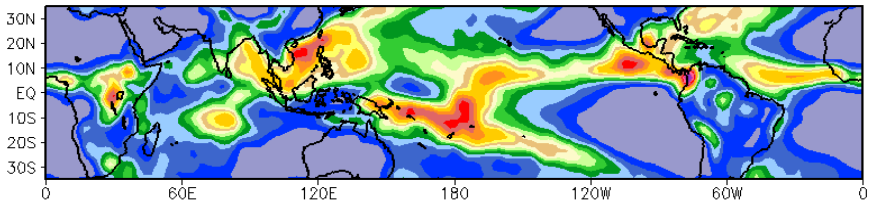
Simulation for transition period Nov-Dec-2002 with different cumulus schemes

The model with triangular truncation T63 and 28 levels and for 5 different initial conditions has been run for three months from 2002/09/01 to 2002/11/30 in order to evaluate the impact of different cumulus schemes in simulating the diurnal cycle of precipitation over Tropical Region.

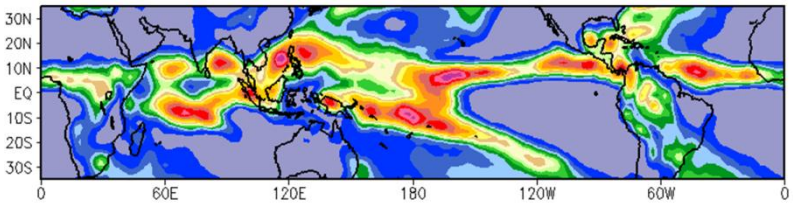
Output date each 1 hour, using the observed SST as boundary condition.



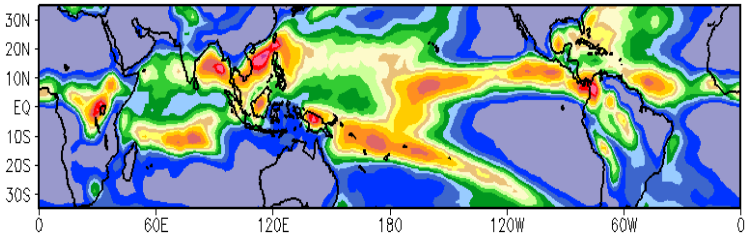
Kuo&Tied



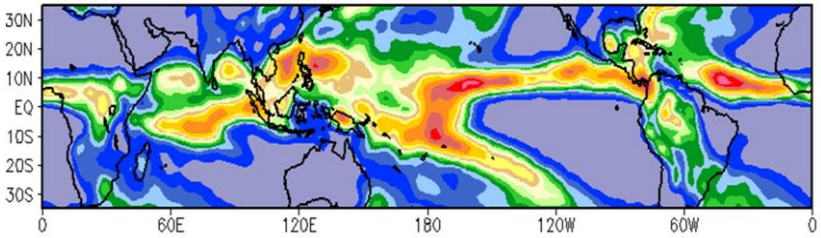
Gre&Shall1

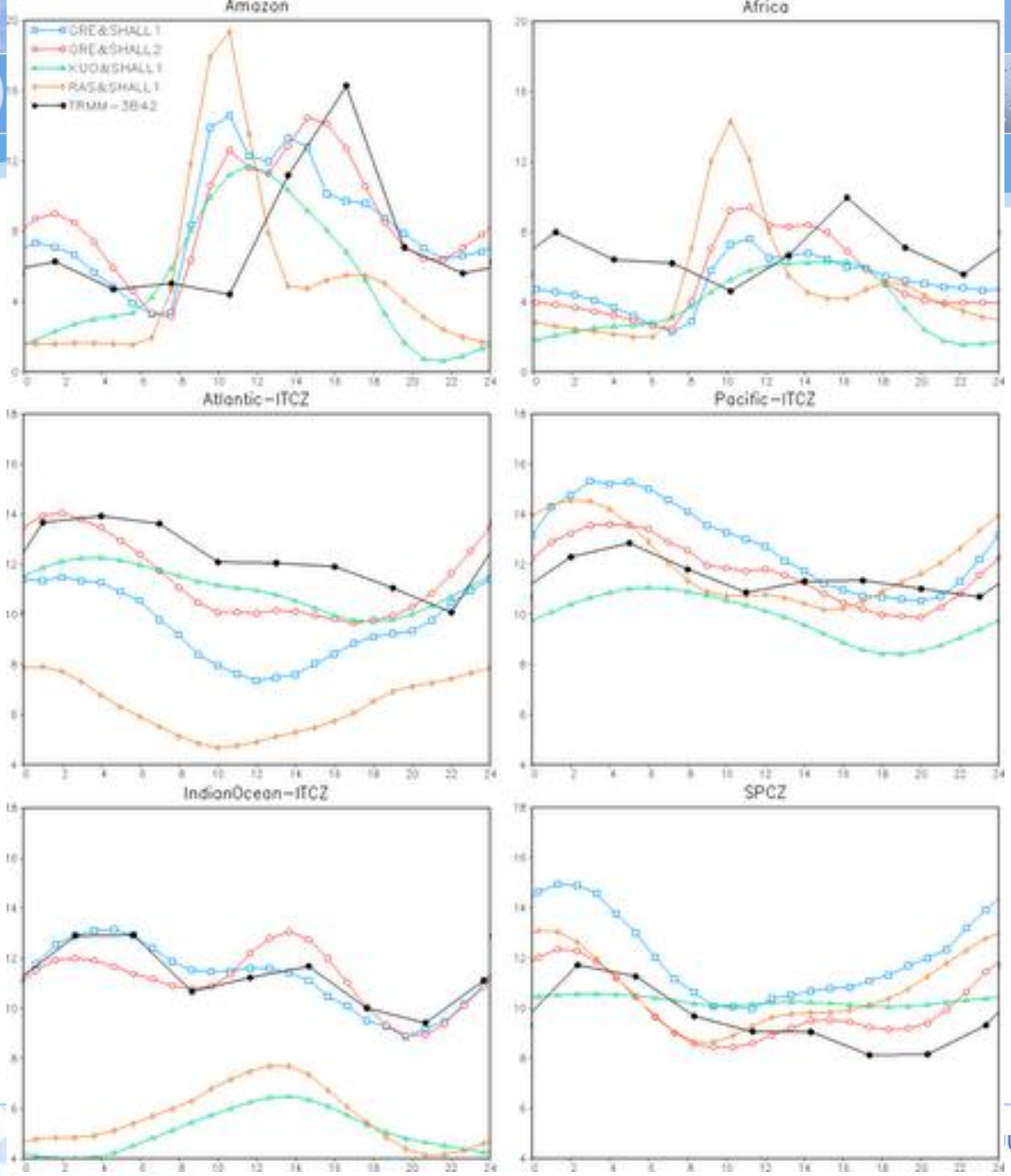


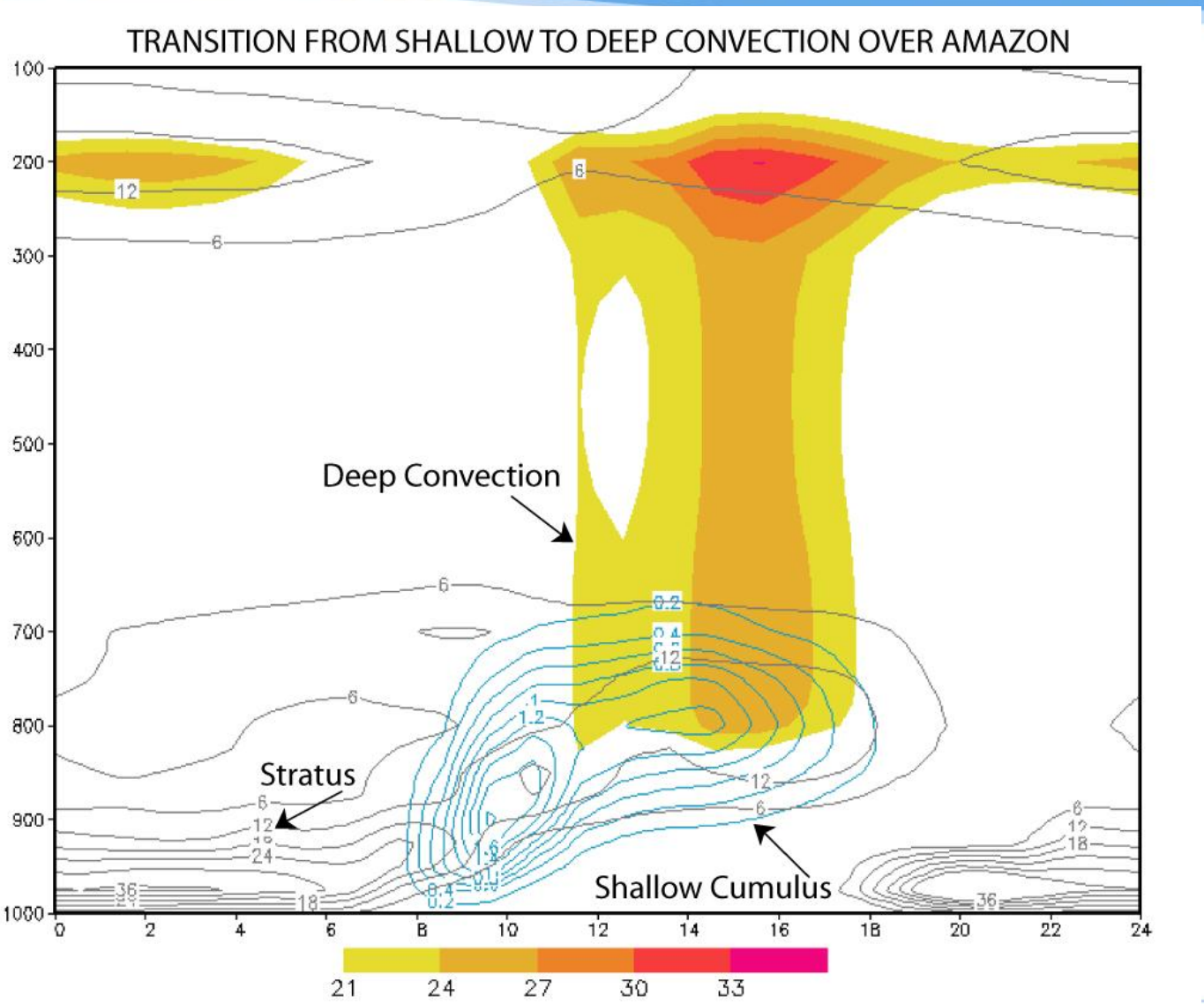
RAS&Tied



Gre&Shall2




Amazon
CRE&SHALL1
CRE&SHALL2
KUO&SHALL1
RAS&SHALL1
TRMM-3B42
Africa
Atlantic-ITCZ
Pacific-ITCZ
IndianOcean-ITCZ
SPCZ


TRANSITION FROM SHALLOW TO DEEP CONVECTION OVER AMAZON
Deep Convection
Stratus
Shallow Cumulus
100
200
300
400
500
600
700
800
900
1000
0
2
4
6
8
10
12
14
16
18
20
22
24
21
24
27
30
33

Preliminary conclusions

- The diurnal cycle of precipitation over land and ocean Tropical Region has been improved using the new shallow cumulus
- The new shallow scheme also is able to reproduce the transition from shallow to deep convection.
- The transition from shallow to deep convection is very complex process, however it seems to be the most important process on the land to simulate the diurnal cycle of precipitation.
- What is the impact of the new shallow scheme on the climate over Amazon in short and long integrations?. .

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