

Sensitivity of diurnal and seasonal precipitation to Land surface and prognostic SST scheme in RegCM4 over Central America

Motivation

Seasonal features

Diurnal Cycle

Summary

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Thanks to RegCM Team

—
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CORDEX workshop

Outline

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2 Seasonal features

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- There are two new schemes that are added in RegCM4, namely the Common Land Model (CLM) and prognostic Sea Surface skin temperature schemes.
- The question is
 - How does the the seasonal simulation would respond to the new land surface/prognostic SST scheme?
 - Do these schemes improve the timing and the magnitude of the amplitude of the diurnal cycle in precipitation?
- Central America is a good test bed for validation of the diurnal/seasonal variation of precipitation as the region is influenced by mesoscale features, such as **complex topography (isthmus, islands), different annual cycle regimes,(north american monsoon region, mid-summer drought over Caribbean and Mexico), mesoscale features like Caribbean low-level jet.**

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Model set up and design of Experiment

- Three integrations over central America CORDEX domain [140W - 20W, 20S -40N]
- RegCM-CTRL

Remark

- 50km (288x160 grid points) horizontal resolution and 18 level in the vertical
- ERA-Interim reanalysis and OI weekly SST for lateral and surface boundary condition
- Simulation period: January 1st 1997 to Jan 1st 2003
- Analysis is carried out between 1998 and 2002
- Convection scheme: Grell scheme with FC closure over land and Emanuel scheme over the ocean grid points
- Zeng over the ocean and BATS over land

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Model set up ...

- RegCM-DCSST
 - RegCM-CTRL + prognostic skin sea surface temperature scheme is switched on
- RegCM-CLM
 - RegCM-CTRL + CLM land surface model instead of BATS
 - in the CLM run (imask = 1 is used)

Remark

- => the same Land Mask as the RegCM-CTRL
- the same moisture initialization

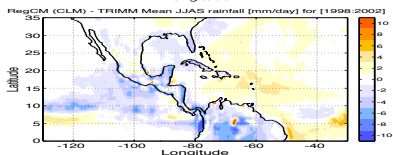
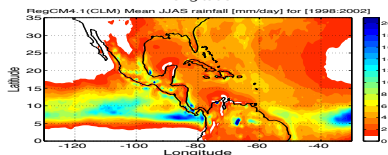
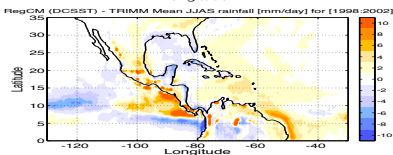
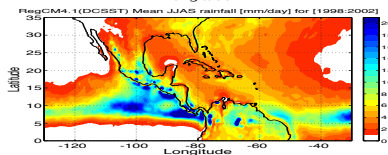
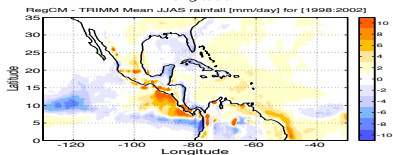
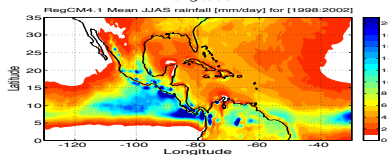
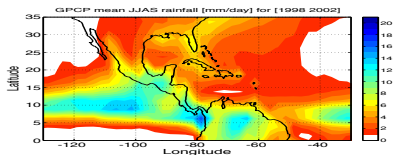
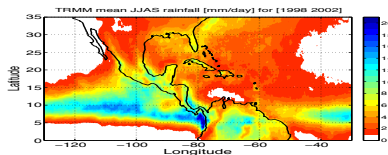
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Precipitation (JJAS)



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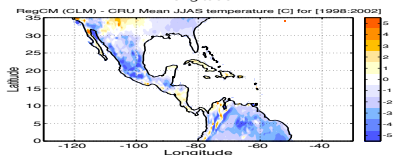
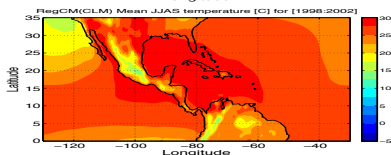
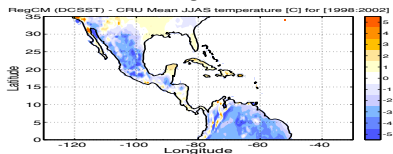
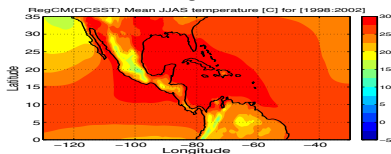
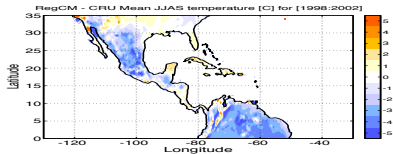
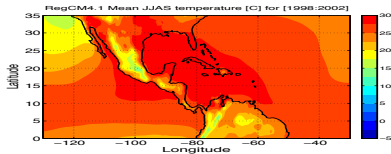
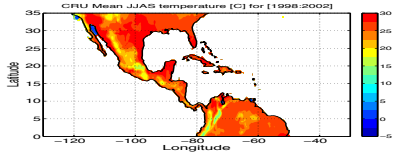
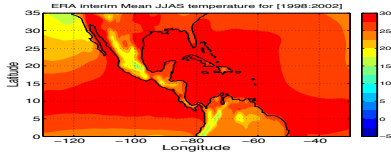
OBS

CTRL

DCSST

CLM

Temperature (JJAS)



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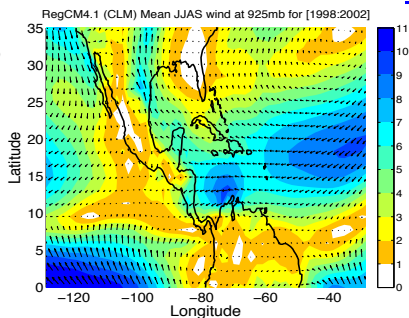
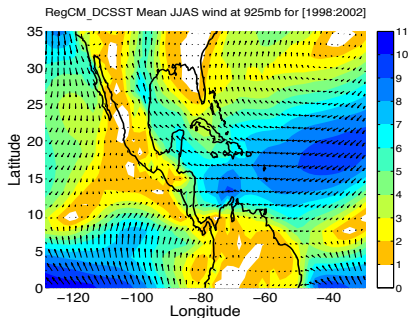
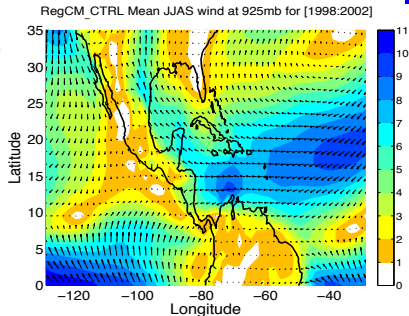
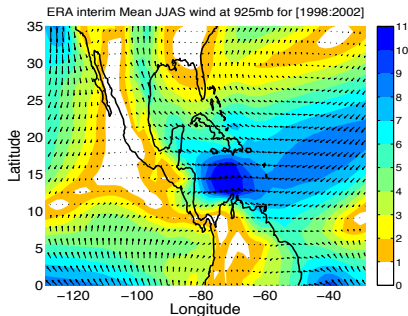
OBS

CTRL

DCSST

CLM

Low Level wind (JJAS)



Motivation

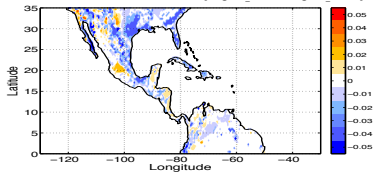
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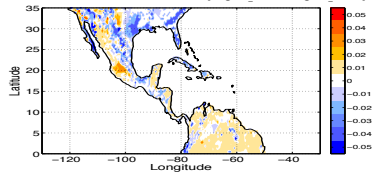
Summary

Surface energy (RegCM-CLM vs RegCM-CTRL)

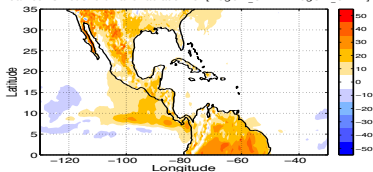
Mean JJAS albedo to direct radiation for [RegCM_CLM - RegCM_CTRL]



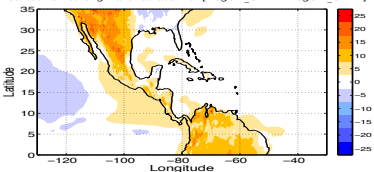
Mean JJAS albedo to diffuse radiation for [RegCM_CLM - RegCM_CTRL]



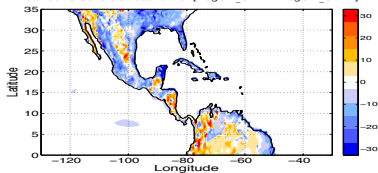
Mean JJAS net short wave radiation for [RegCM_CLM - RegCM_CTRL]



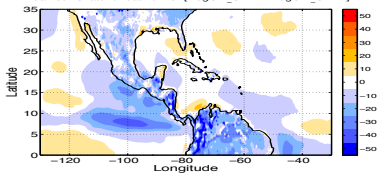
Mean JJAS net long wave radiation for [RegCM_CLM - RegCM_CTRL]



Mean JJAS Sensible heat flux for [RegCM_CLM - RegCM_CTRL]



Mean JJAS latent heat flux for [RegCM_CLM - RegCM_CTRL]



- ↓ albedo (DR) → ↑ net SW and Temp → ↑ net LW
- ↓ Latent Heat flux, and hence evaporation and rainfall

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Surface energy (RegCM-DCSST vs RegCM-CTRL)

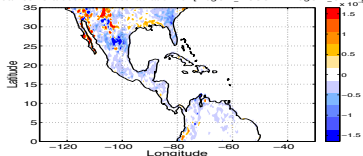
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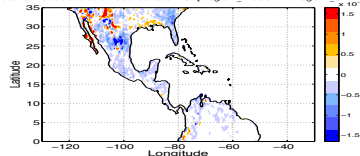
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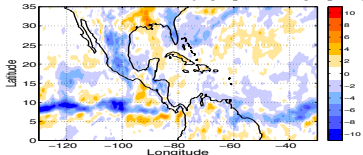
Mean JJAS albedo to direct radiation for [RegCM_DCSST - RegCM_CTRL] $\times 10^3$



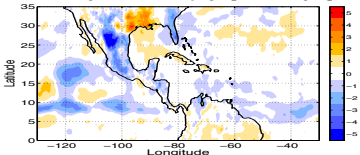
Mean JJAS albedo to diffuse radiation for [RegCM_DCSST - RegCM_CTRL] $\times 10^3$



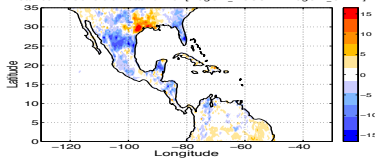
Mean JJAS net short wave radiation for [RegCM_DCSST - RegCM_CTRL]



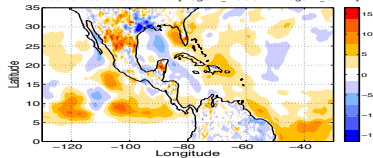
Mean JJAS net long wave radiation for [RegCM_DCSST - RegCM_CTRL]



Mean JJAS Sensible heat flux for [RegCM_DCSST - RegCM_CTRL]



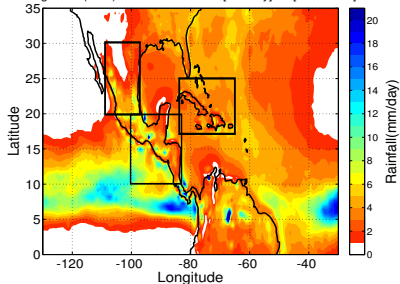
Mean JJAS latent heat flux for [RegCM_DCSST - RegCM_CTRL]



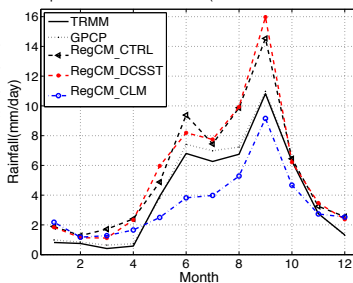
- ↓ albedo, net SW and LW but ↑ Latent heat flux over the ITCZ region

Annual cycle

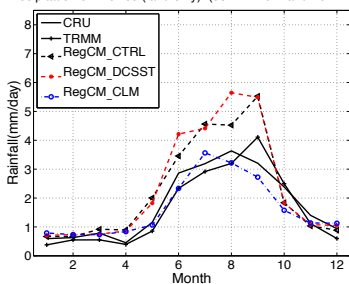
RegCM4.1(CLM) Mean JJAS rainfall (mm/day) for [1998:2002]



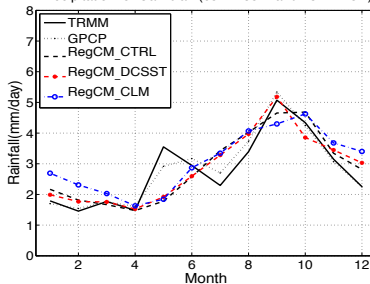
Precipitation for Central America (85W –100W and 10N – 20N)



Precipitation on Mexico (land only) (95W –110W and 20N – 30N)



Precipitation for Caribbean (65W –85W and 18N – 25N)



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Diurnal cycle

- Harmonic analysis is used to study the characteristic of the diurnal cycle i.e.

$$R(t_k) = \hat{R} + \sum_{i=1}^{N/2} A_i \cos(i(2\pi t_k/24) - \phi_i) \quad (1)$$

where,

- $t_k = (00,03,06,09,12,15,18,21)$ is the time,
- A_i and ϕ_i represent the amplitude and the phase of the i^{th} harmonic respectively.
- A_i and ϕ_i are computed from the coefficients of Fourier components
- $R(t_k)$ is the estimated precipitation for each three hour interval.
- $\hat{R}$ is the average of the eight 3 hourly samples.

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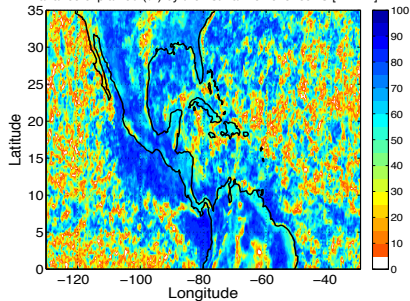
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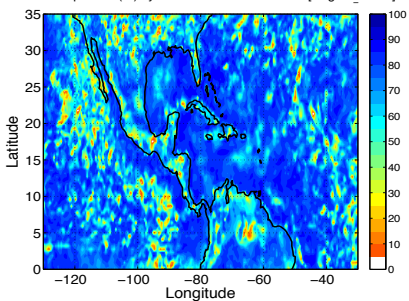
Summary

Percentage of variance

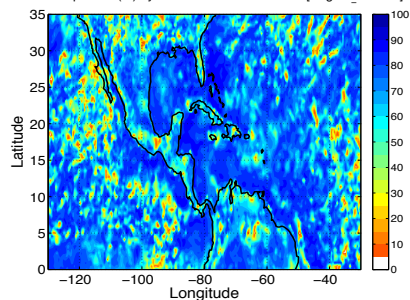
Variance explained (%) by the 1st harmonic for JJAS [TRMM]



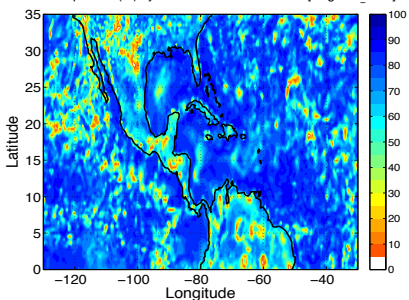
Variance explained (%) by the 1st harmonic for JJAS [RegCM_CTRL]



Variance explained (%) by the 1st harmonic for JJAS [RegCM_DCSST]



Variance explained (%) by the 1st harmonic for JJAS [RegCM4_CLM]



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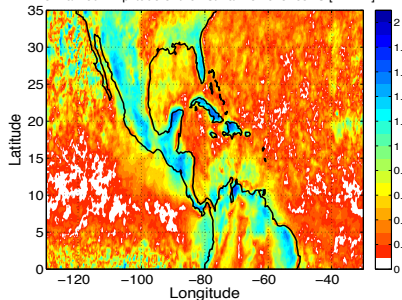
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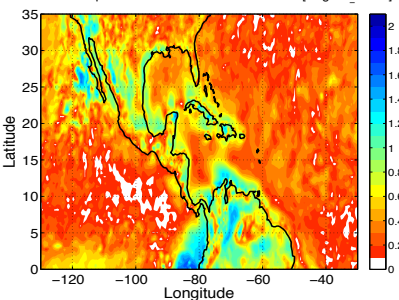
Summary

Amplitude

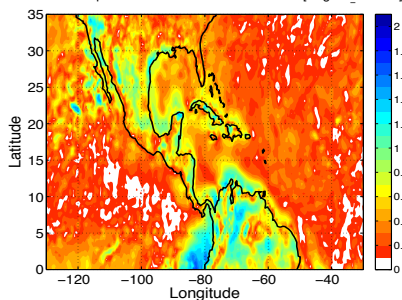
Normalized Amplitude of the 1st harmonic for JJAS [TRMM]



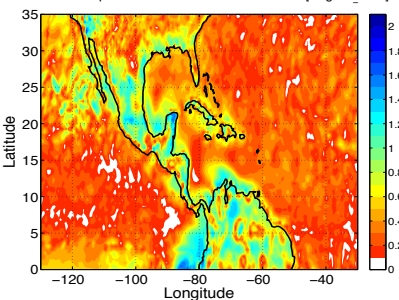
Normalized Amplitude of the 1st harmonic for JJAS [RegCM_CTRL]



Normalized Amplitude of the 1st harmonic for JJAS [RegCM_DCSST]



Normalized Amplitude of the 1st harmonic for JJAS [RegCM_CLM]



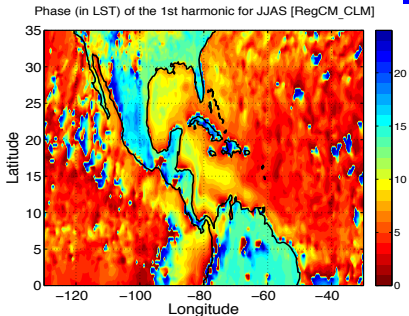
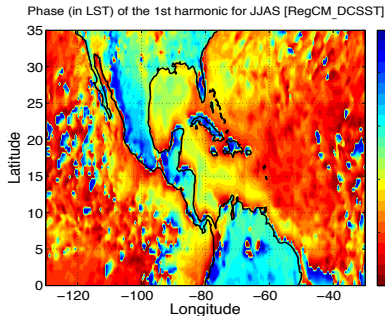
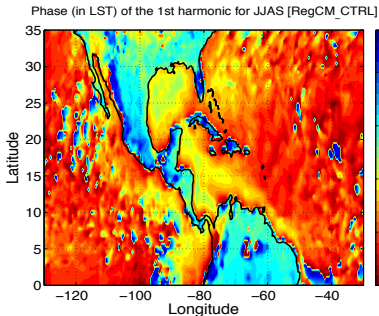
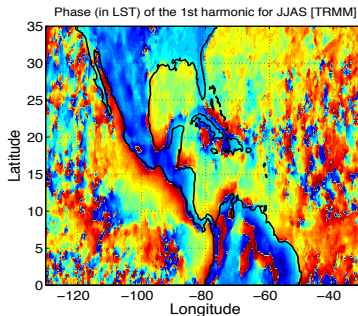
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Time of Maxima



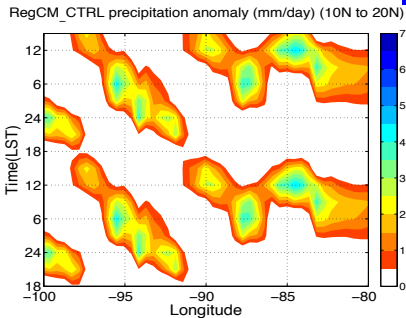
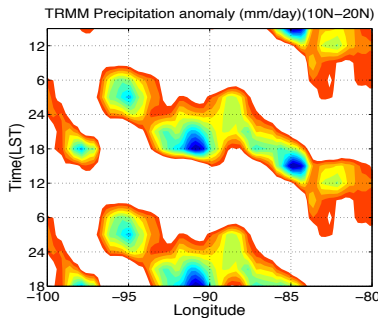
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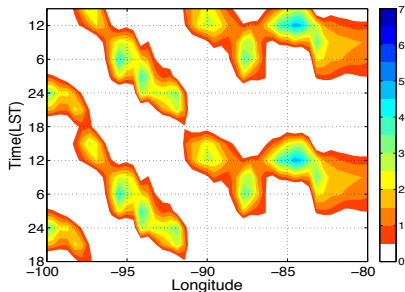
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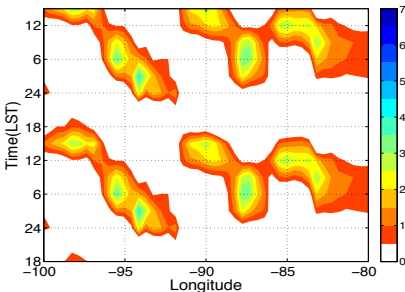
Westward Propagation of Rainfall anomaly



RegCM_DCSST precipitation anomaly (mm/day) (10N to 20N)



RegCM_CLM precipitation anomaly (mm/day) (10N to 20N)



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Propagation of 3 hourly rainfall anomaly: animation

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- RegCM captures the annual cycle fairly well although the best configuration depends on the region under consideration
- In RegCM-CLM simulation, the diurnal precipitation peaks earlier than TRMM and the other two simulations
- RegCM-CLM shows higher surface temperature, lower precipitation at the seasonal time scale because of the feedback i.e. lower evaporation, Latent heat and higher net short wave radiation
- the impact of RegCM-DCSST is generally small at the seasonal time but has an effect of decreasing the net short and long wave radiation and increasing the latent heat flux and hence reducing the dry bias over the central Pacific
- RegCM-CLM gives the amplitude of the diurnal cycle better over Central America whereas RegCM-DCSST slightly better captured the propagation

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