

National Institute for Space Research – INPE Earth System Science Center – CCST

PROJECTIONS OF CLIMATE CHANGE FOR THE MEGACITIES OF SÃO PAULO AND RIO DE JANEIRO

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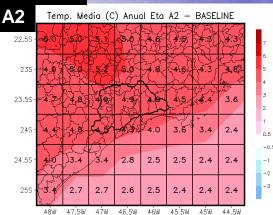
July 2009

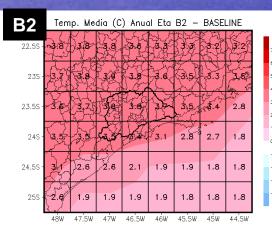
Ministério da Ciência e Tecnologia



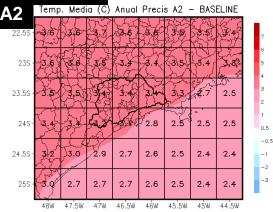
METROPOLITAN REGION OF SÃO PAULO Anomalies of Mean Annual Temperature (°C) 2071-2100 minus 1961-1990

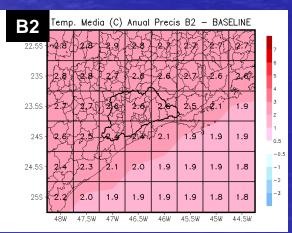
Eta Model





Precis Model



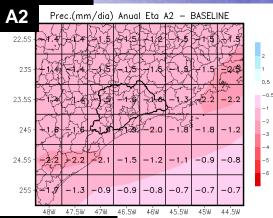


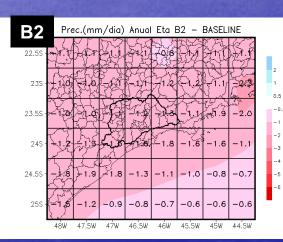
Regarding to the mean temperature, both models cope with an increase of temperature in the annual and seasonal scale, reaching up to ~ 3 °C in the optimistic scenario and ~ 4 °C in the pessimistic scenario. Among the seasons, the greatest increase is projected to happen in summer



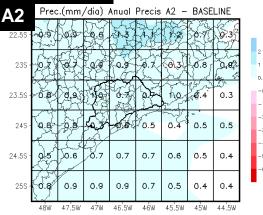
METROPOLITAN REGION OF SÃO PAULO Anomalies of Mean Annual Rainfall (mm/dia) 2071-2100 minus 1961-1990

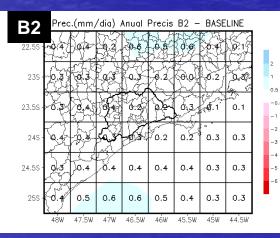
Eta Model





Precis Model





Analysing the projected changes in the mean annuam precipitation, the Eta model indicate a decrease in rainfall of about 2mm/day and the Precis Model a slight increase of aproximately 0.5 mm/day

METROPOLITAN REGION OF SÃO PAULO Anomalies of Mean Annual Relative Humidity (%) 2071-2100 minus 1961-1990

50 40

30

20

-5

-10

-20

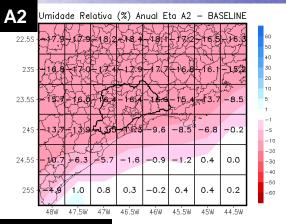
-30

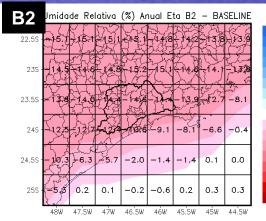
-40

-50

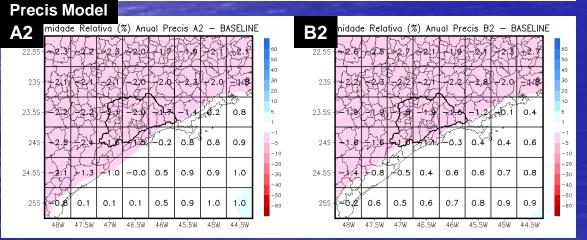
-60

Eta Model





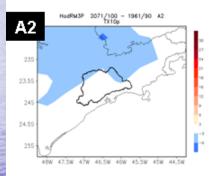
The regional climate models indicate with great deal a decrease in the relative humidity of about 5 to 15% by the end of this century

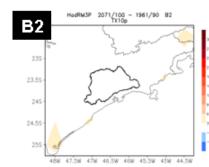


METROPOLITAN REGION OF SÃO PAULO

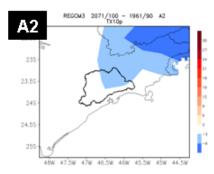
Cold Days – TX10p

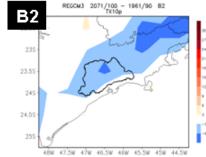
Modelo Precis



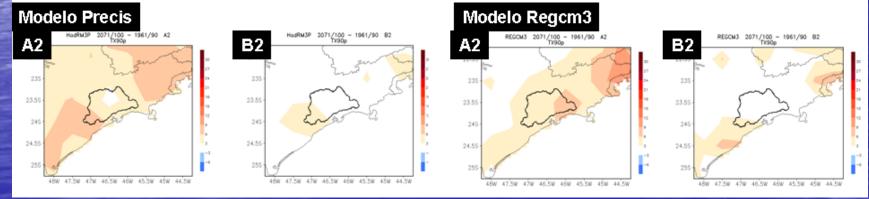


Modelo Regcm3





Hot Days – TX90p

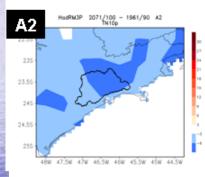


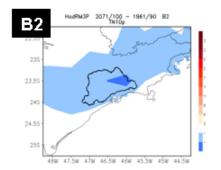
The climate models project a decrease in the number of cold days and an increase of hot days

METROPOLITAN REGION OF SÃO PAULO

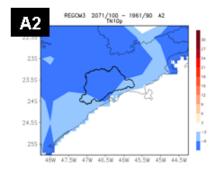
Cold Nights – TN10p

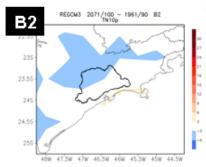
Modelo Precis



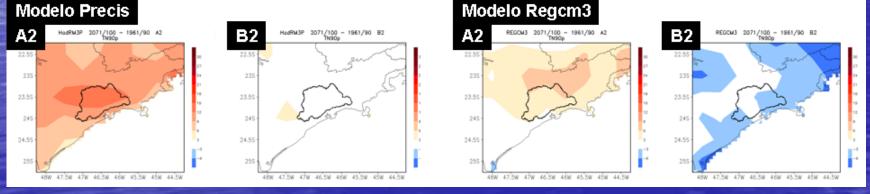


Modelo Regcm3





Hot Nights – TN90p



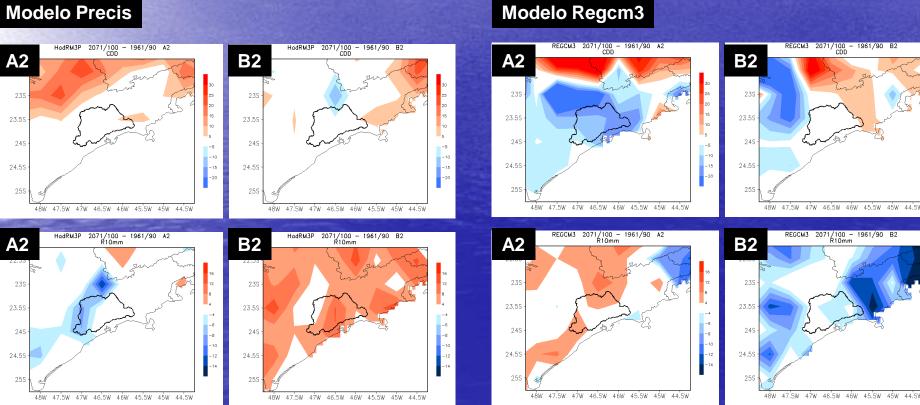
Regarding to the extreme temperature events, the models indicate a decrease in the number of cold nights and a possible increase in the hot nights

METROPOLITAN REGION OF SÃO PAULO

Consecutive Dry Days - CDD

47W

46.5W 46W 45.5W 45W 44.5V



Number of Days with Precipitation Greater then10mm - R10mm

Modelo Precis

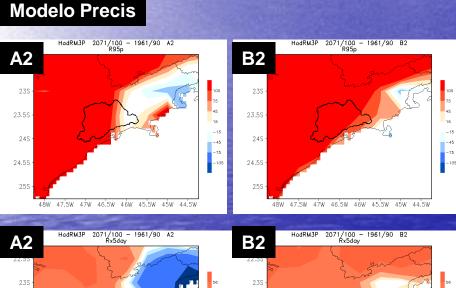
24S

24.5S

48W 47.5W 47W 46.5W 46W 45.5W 45W 44.5W

METROPOLITAN REGION OF SÃO PAULO

Heavy Precipitation - R95p



24S

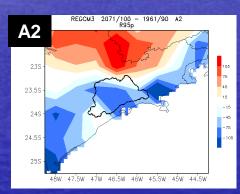
24.5S

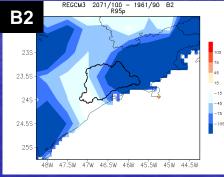
48W 47.5W 47W 46.5W 46W 45.5W 45W 44.5W

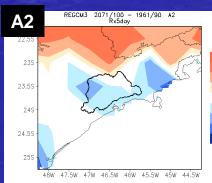
-28

-56

Modelo Regcm3

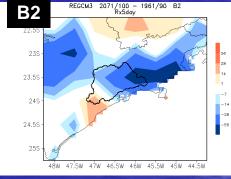






-28

-56



Precipitation Acumulated in 5 days - RX5day

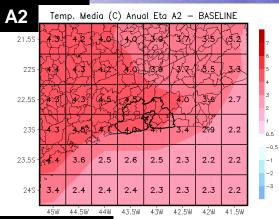
-28

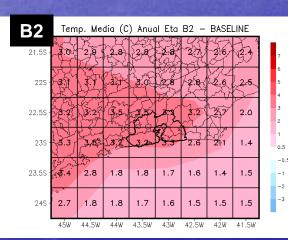
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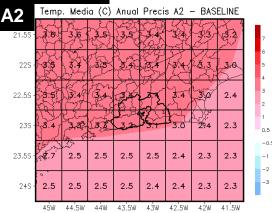
METROPOLITAN REGION OF RIO DE JANEIRO Anomalies of Mean Annual Temperature 2071-2100 minus 1961-1990

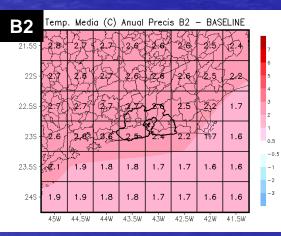
Eta Model





Precis Model





Regarding to the mean temperature, both models show a temperature increase in the annual and seasonal scale, reaching aproximately 3 °C in the pessimistic scenario and about 4 °C in the optimistic scenario. Among the seasons, the greatest increase is projected to happen during summer



METROPOLITAN REGION OF RIO DE JANEIRO Anomalies of Mean Annual Rainfall (mm/dia)

2071-2100 minus 1961-1990

0.5

-0.5

-2

-3

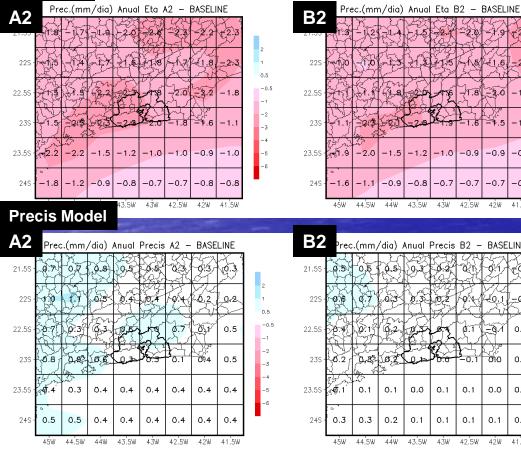
-5

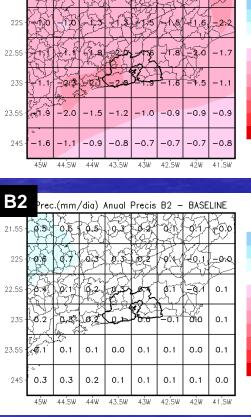
0.5

-2

-3 -4

Eta Model



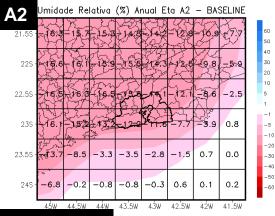


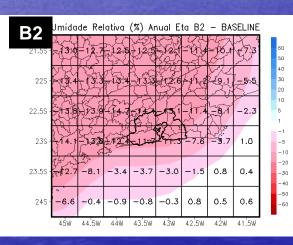
Analysing the projected changes in the mean annual precipitation, the Eta model indicate a decrease of about 2 mm/day and the Precis Model a little increase of about 0,5 mm/day by the end of the XXI century



METROPOLITAN REGION OF RIO DE JANEIRO Anomalies of Mean Annual Relative Humidity (%) 2071-2100 minus 1961-1990

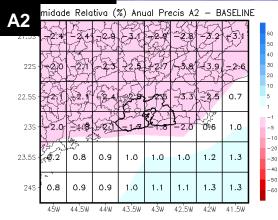
Eta Model

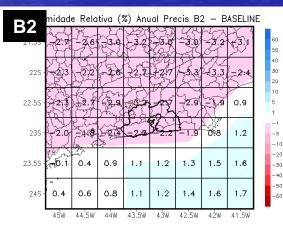




Models project a decrease in the mean annual relative humidity of 5 to 15% by the end of the XXI century

Precis Model





METROPOLITAN REGION OF RIO DE JANEIRO

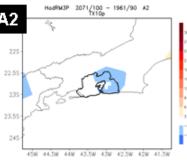
HadRM3P 2071/100 - 1961/90 82 4edRM3P 2071/100 - 1961/90 A2 REGCM3 2071/100 - 1961/90 B2 TX10p - 1961/90 A2 **B**2 **B**2 A2 23.4 245 245 45W 44.5W 44W 43.5W 43W 42.5W 42W 41.5W Hot Days – TX90p **Modelo Precis** Modelo Regcm3 HodRM3P 2071/100 - 1961/90 82 TX90p 1961/90 A2 EGCM3 2071/100 - 1961/90 A3 TX90p REGCM3 2071/100 - 1961/90 B2 TX90p A2 **B**2 A2 **B**2 22.55 245 245 245

Models indicate a decrease in the number of cold days and an increase of hot days

45W 44.5W 44W 43.5W 43W 42.5W 42W 41.5W

Cold Days – TX10p

Modelo Precis



45W 44.5W 44W 43.5W 43W 42.5W 42W 41.5W

Modelo Regcm3

45W 44.5W 44N 43.5W 43W 42.5W 42W 41.5W

45W 44.5W 44W 43.5W 43W 42.5W 42W 41.5W

Modelo Precis

METROPOLITAN REGION OF RIO DE JANEIRO

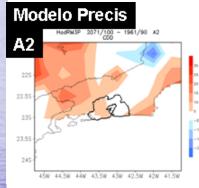
Modelo Regcm3

HodRM3P 2071/100 - 1961/90 A2 2071/100 - 1961/90 B2 REGCM3 2071/100 - 1961/90 A2 TN10p REGCM3 2071/100 - 1961/90 B: TN10p A2 **B2** A2 **B**2 245 241 243 45w 44.5w 44w 43.5w 43w 42.5w 42w 41.5v 458 44.58 448 43.58 438 42.58 428 41.5 45W 445W 44W 435W 43W 425W 42W 415 4510 44500 4400 43500 4300 4550 4500 450 Hot Nights <u>– TN90p</u> **Modelo Precis** Modelo Regcm3 2071/100 - 1961/90 82 TX90p REGCM3 2071/100 - 1961/90 B2 TX900 1961/90 EGCM3 2071/100 -A2 **B**2 A2 **B**2 243 245 245 243 44.5W 44W 43.5W 43W 42.5W 42W 41.5V 44.50 440 43.50 430 42.50 420 41.51 45w 44.5w 44w 43.5w 43w 42.5w 42w 41.5v 45W 44.5W 44W 43.5W 43W 42.5W 42W 41.5

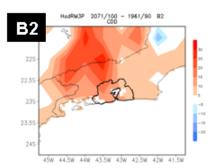
Regarding to the temperature extremes, model indicate a decrease in the number of cold nights and an increase of hot nights

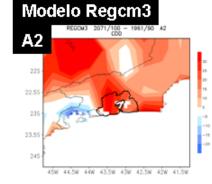
Cold Nights – TN10p

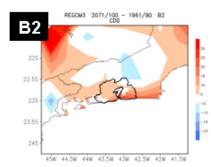
METROPOLITAN REGION OF RIO DE JANEIRO



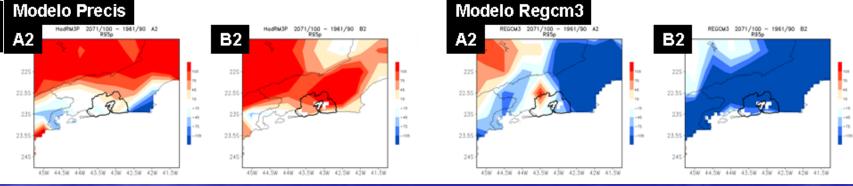
Consecutive Dry Days - CDD







Number of Heavy Rainfall



By the end of this century models show a great deal in project an increase in the number of consecutive dry days and a possible increase in the number of days with heavy or extreme rainfall

SUMARY AND CONCLUSIONS

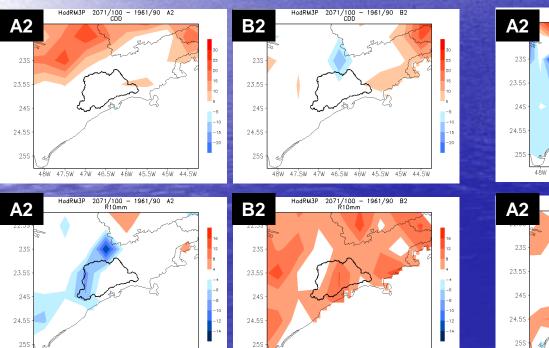
- Regarding to the mean temperature, both models indicate with great confidence an increase of temperature in both annual and seasonal scale, reaching up to 3 °C in the optimistic scenario and ~ 4 °C in the pessimistic scenario. Among seasons, the greatest increase is projected to happen during summer;
- Analysing the projected changes in precipitation for the Metropolitan Regions of Rio de Janeiro and São Paulo, in the seasonal scale, the regional climate models in general agree with a little decrease in rainfall of about -0.5 mm/day in the optimistic scenario B2 and ~0.8 mm/day in the pessimistic scenario A2, mainly during winter. In the mean annual precipitation, the Eta Model show a decrease of aproximately 2 mm/day and the Precis Model indicate a slight increase of ~0.5 mm/day;
- The temperature extreme indexes show an increase in the number of hot days and nights and a reduction in the number of cold days and nights;
- Models indicate an increase in the number of heavy precipitation events concentrated in short periods for the Metropolitan Region of Rio de Janeiro.



Dias Secos Consecutivos - CDD

Modelo Precis

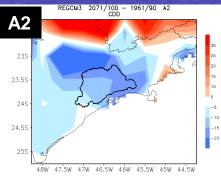
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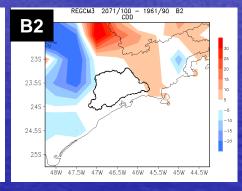


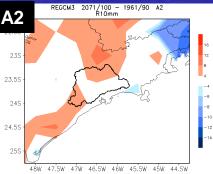
48W

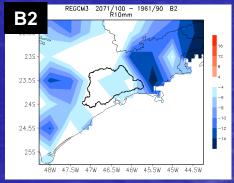
47.5W 47W 46.5W 46W 45.5W 45W 44.5W

Modelo Regcm3









N⁰ de dias com precip. maior a 10mm - R10mm