

Controles regionais nas mudanças climáticas

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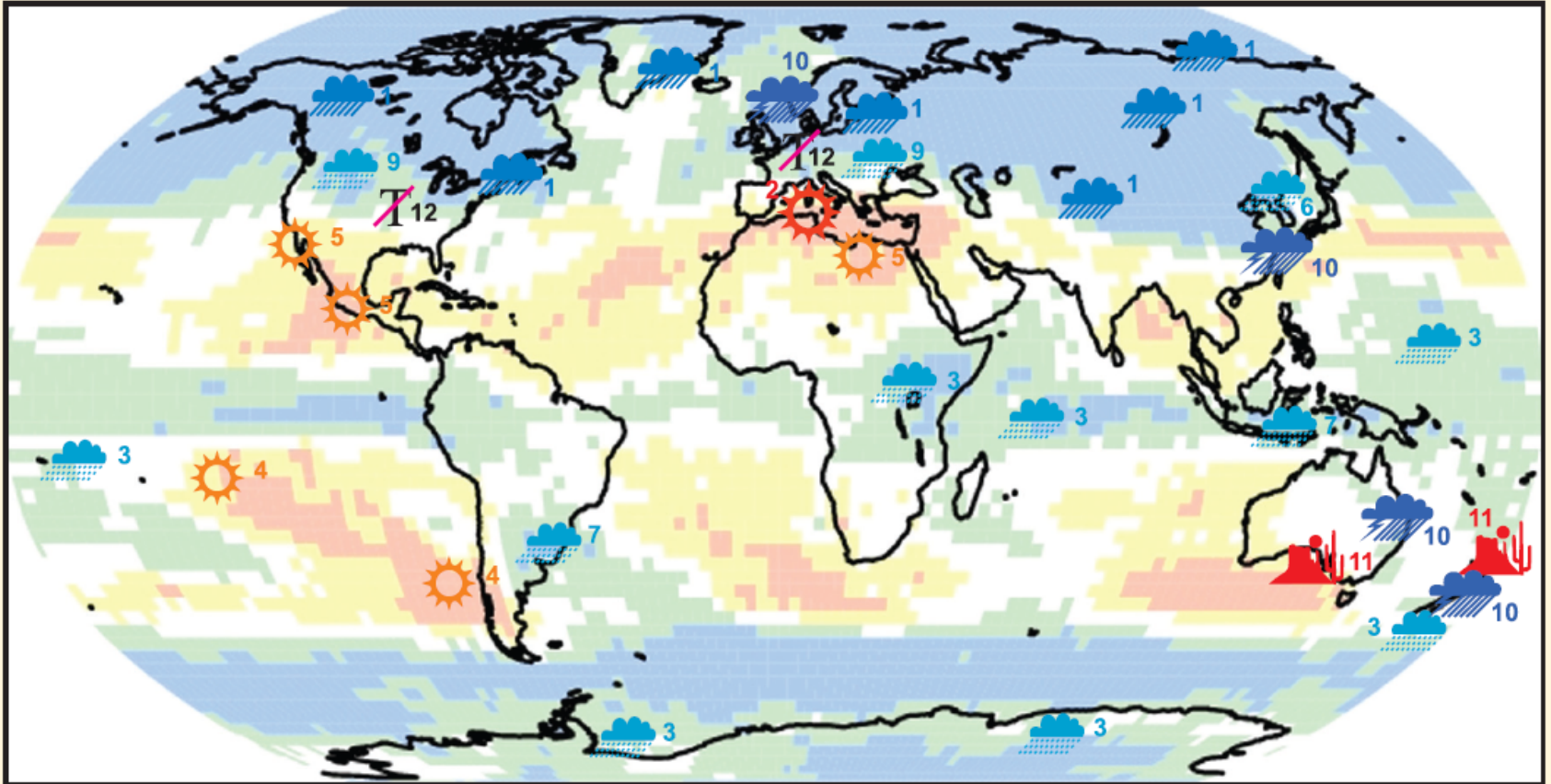


- Percepção das projeções
de precipitação no Brasil
- Controle da evaporação e aquecimento local
- Variação da temperatura no estado de SP












Regional Climate Projections

- **Precipitation projections:** Overall patterns of change are comparable to those of TAR, with greater confidence in the projections for some regions. Model agreement is seen over more and larger regions. For some regions, there are grounds for stating that the projected precipitation changes are *likely* or *very likely*. For other regions, confidence in the projected change remains weak.
- **Extremes:** There has been a large increase in the available analyses of changes in extremes. This allows for a more comprehensive assessment for most regions. The general findings are in line with the assessment made in TAR and now have a higher level of confidence derived from multiple sources of information. The most notable improvements in confidence relate to the regional statements concerning heat waves, heavy precipitation and droughts. Despite these advances, specific analyses of models are not available for some regions, which is reflected in the robust statements on extremes. In particular, projections concerning extreme events in the tropics remain uncertain. The difficulty in projecting the distribution of tropical cyclones adds to this uncertainty. Changes in extra-tropical cyclones are dependent on details of regional atmospheric circulation response, some of which remain uncertain.

December–January–February (DJF)



Based on regional studies assessed in chapter 11:

- | | | |
|--|--|---|
|  Precipitation increase in $\geq 90\%$ of simulations |  Precipitation decrease – very likely |  Precipitation extreme increase – likely |
|  Precipitation increase in $\geq 66\%$ of simulations |  Precipitation decrease – likely |  Increased drought – likely |
|  Precipitation decrease in $\geq 66\%$ of simulations |  Precipitation increase – very likely |  Less snow – very likely |
|  Precipitation decrease in $\geq 90\%$ of simulations |  Precipitation increase – likely | |

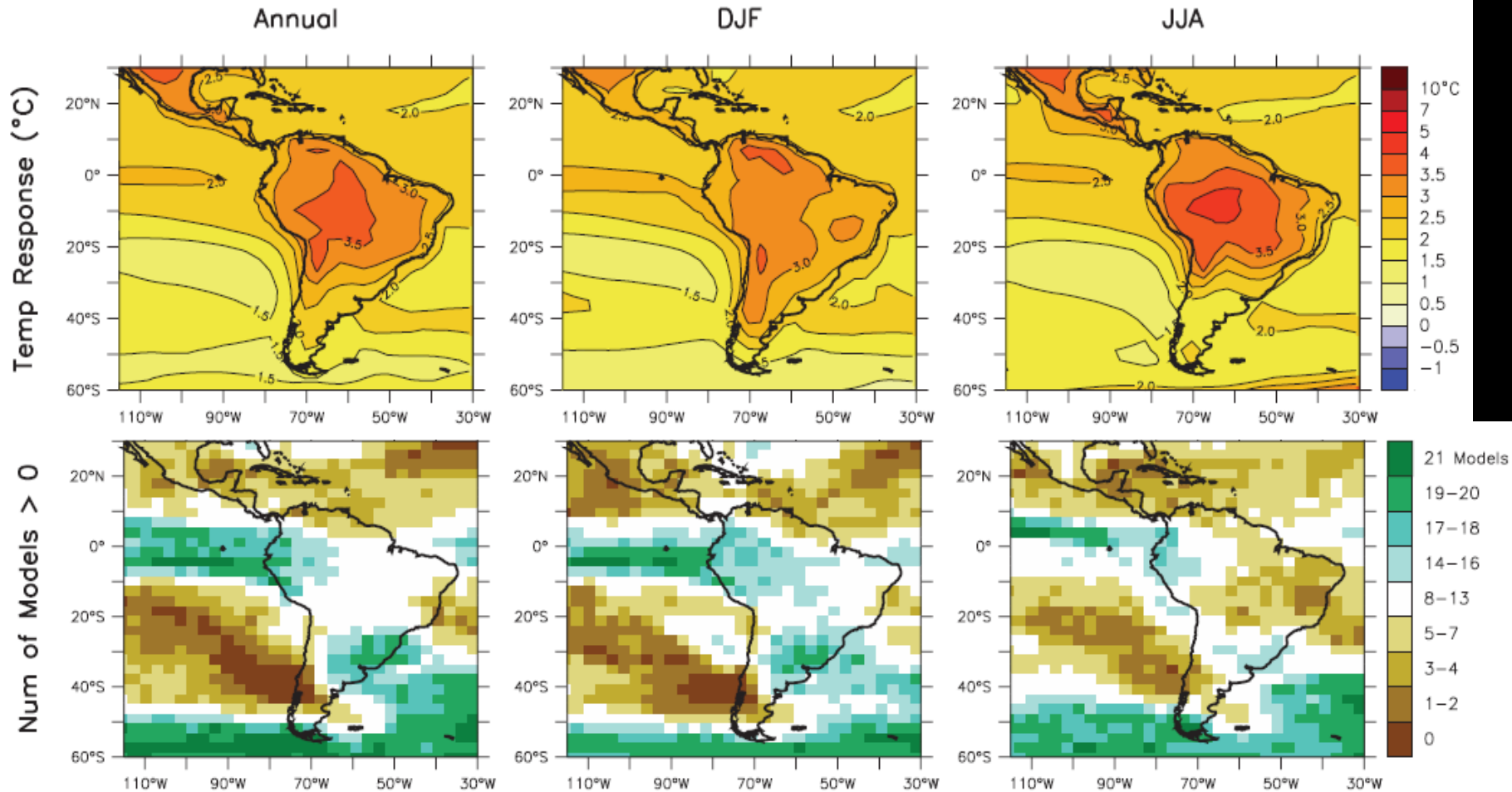
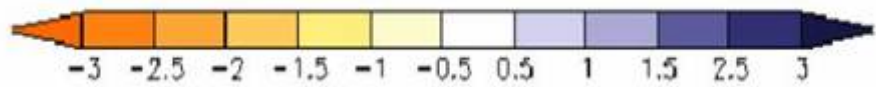


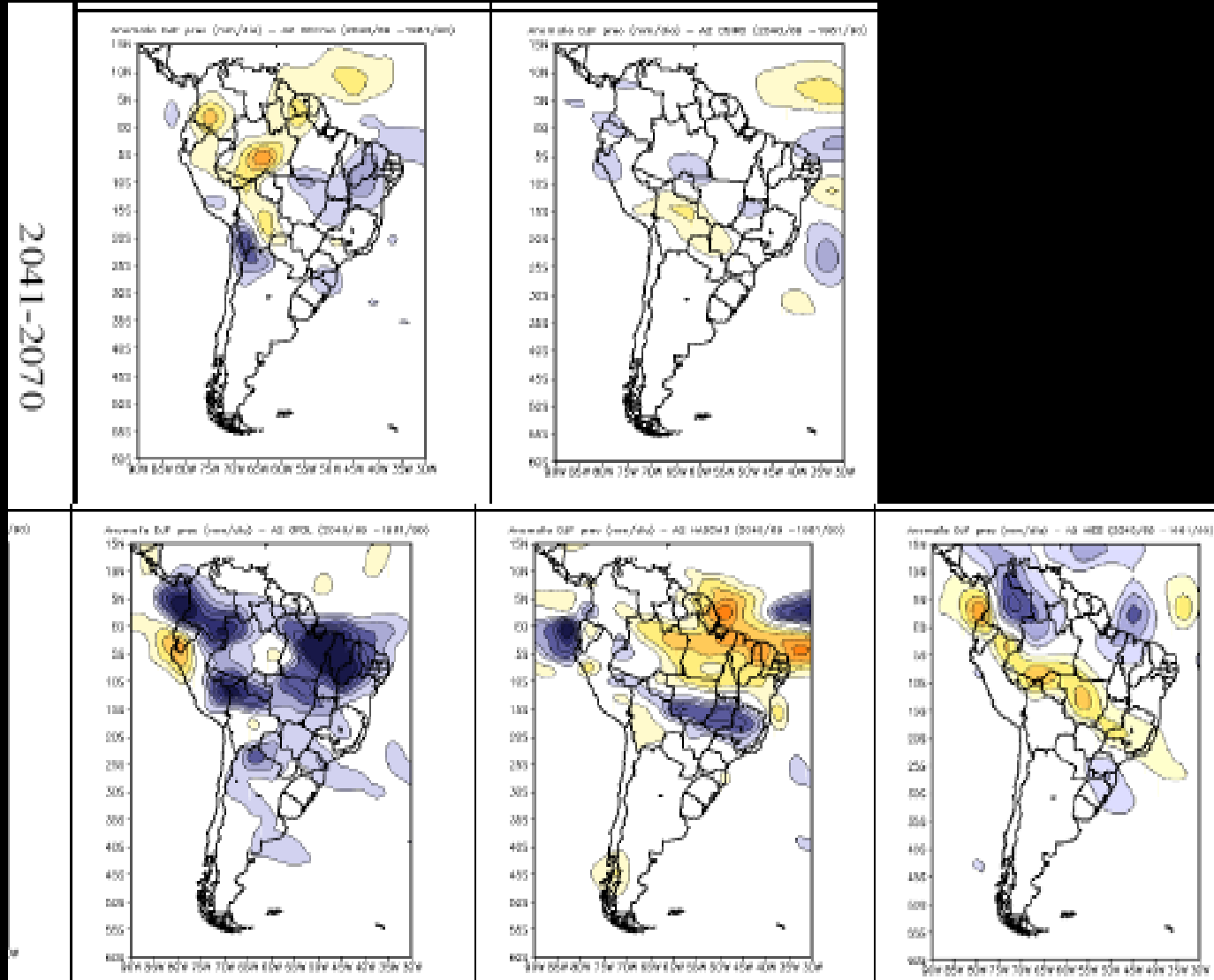
Figure 11.15. Temperature and precipitation changes over Central and South America from the MMD-A1B simulations. Top row: Annual mean, DJF and JJA temperature change between 1980 to 1999 and 2080 to 2099, averaged over 21 models. Middle row: same as top, but for fractional change in precipitation. Bottom row: number of models out of 21 that project increases in precipitation.

Projeção de mudança da chuva no Verão

(Marengo et al. 2007)



seco (mm/dia) **úmido**



11.6.4 Extremes

Little research is available on extremes of temperature and precipitation for this region. Table 11.1 provides estimates on how frequently the seasonal temperature and precipitation extremes as simulated in 1980 to 1999 are exceeded in model projections using the A1B scenario. Essentially all seasons and regions are extremely warm by this criterion by the end



Region ^a	Season	Temperature Response (°C)						Precipitation Response (%)						Extreme Seasons (%)		
		Min	25	50	75	Max	T yrs	Min	25	50	75	Max	T yrs	Warm	Wet	Dry
 AMZ	DJF	1.7	2.4	3.0	3.7	4.6	10	-13	0	4	11	17	>100	93	27	4
	MAM	1.7	2.5	3.0	3.7	4.6	10	-13	-1	1	4	14		100	18	
	JJA	2.0	2.7	3.5	3.9	5.6	10	-38	-10	-3	2	13		100		
	SON	1.8	2.8	3.5	4.1	5.4	10	-35	-12	-2	8	21		100		
	Annual	1.8	2.6	3.3	3.7	5.1	10	-21	-3	0	6	14		100		
 SSA	DJF	1.5	2.5	2.7	3.3	4.3	10	-16	-2	1	7	10		100		
	MAM	1.8	2.3	2.6	3.0	4.2	15	-11	-2	1	5	7		98	8	
	JJA	1.7	2.1	2.4	2.8	3.6	15	-20	-7	0	3	17		95		
	SON	1.8	2.2	2.7	3.2	4.0	15	-20	-12	1	6	11		99		
	Annual	1.7	2.3	2.5	3.1	3.9	10	-12	-1	3	5	7		100		

Table 11.1. Regional averages of temperature and precipitation projections from a set of 21 global models in the MMD for the A1B scenario.

Extremos de precipitação nos trópicos

1. longos períodos de chuva

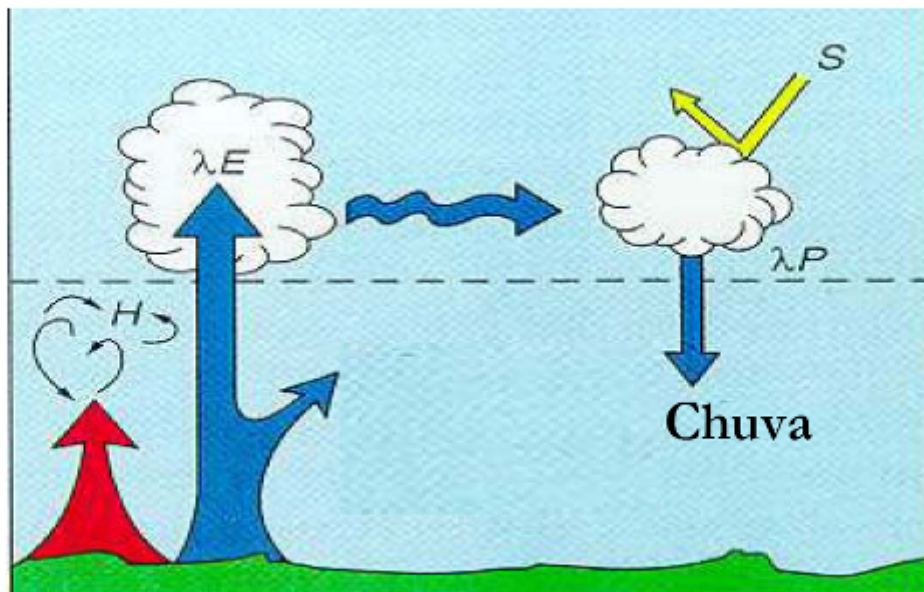
& seca em regiões vizinhas (ondas de calor)

2. Eventos de chuva intensiva

- ... outros

- Percepção das projeções
de precipitação no Brasil
- Controle da evaporação e aquecimento local
- Variação da temperatura no estado de SP

Proporções específicas de (+) evapotranspiração
e (-) calor sensível (temperatura)
favorecem a chuva convectiva

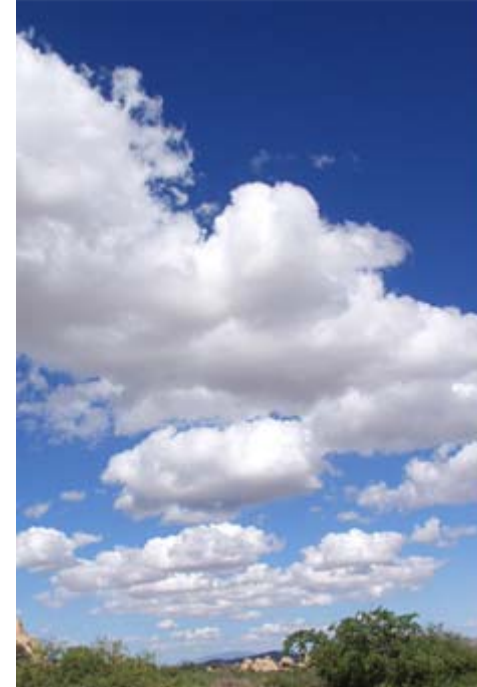


Calor sensível

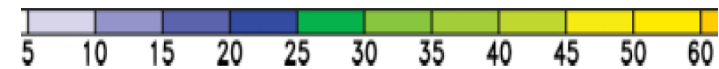
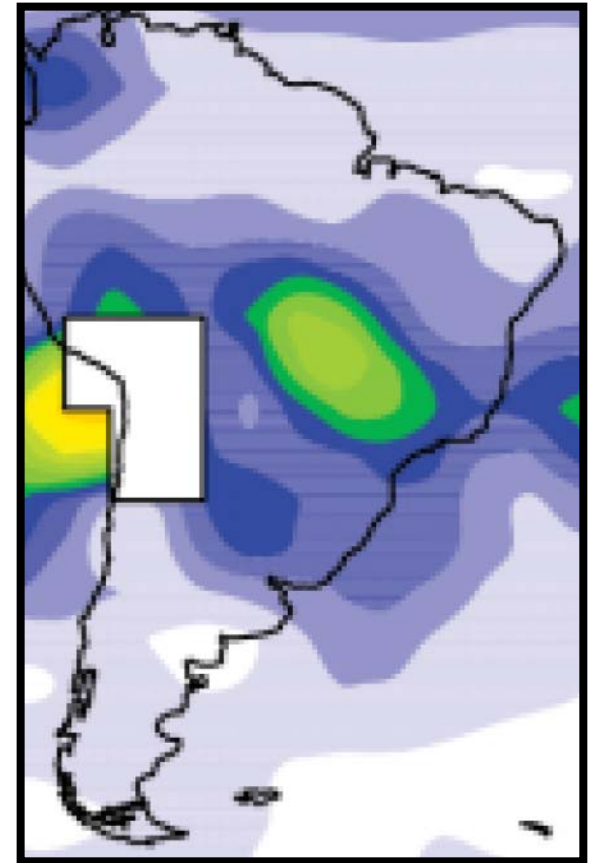
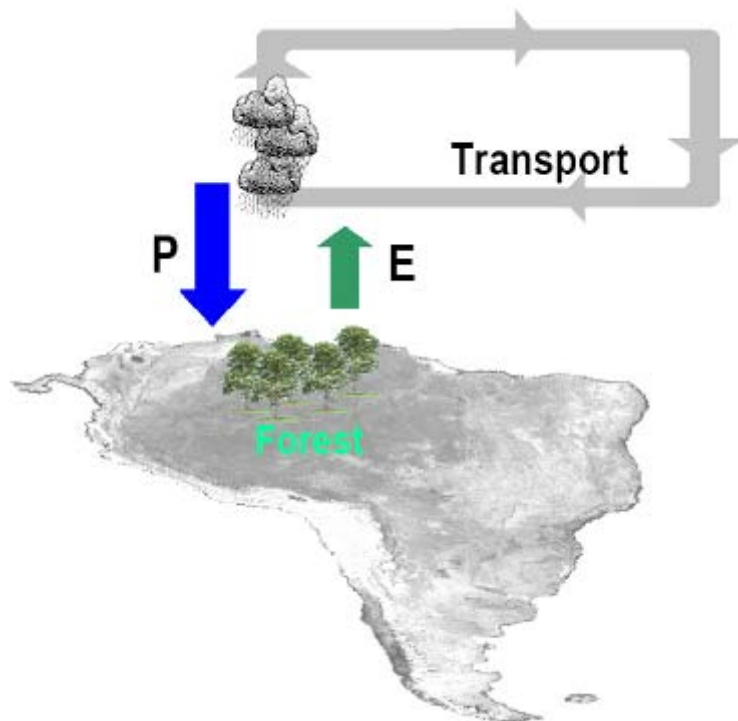
Evapotranspiração

Aumento
temperatura

Fonte de umidade do ar

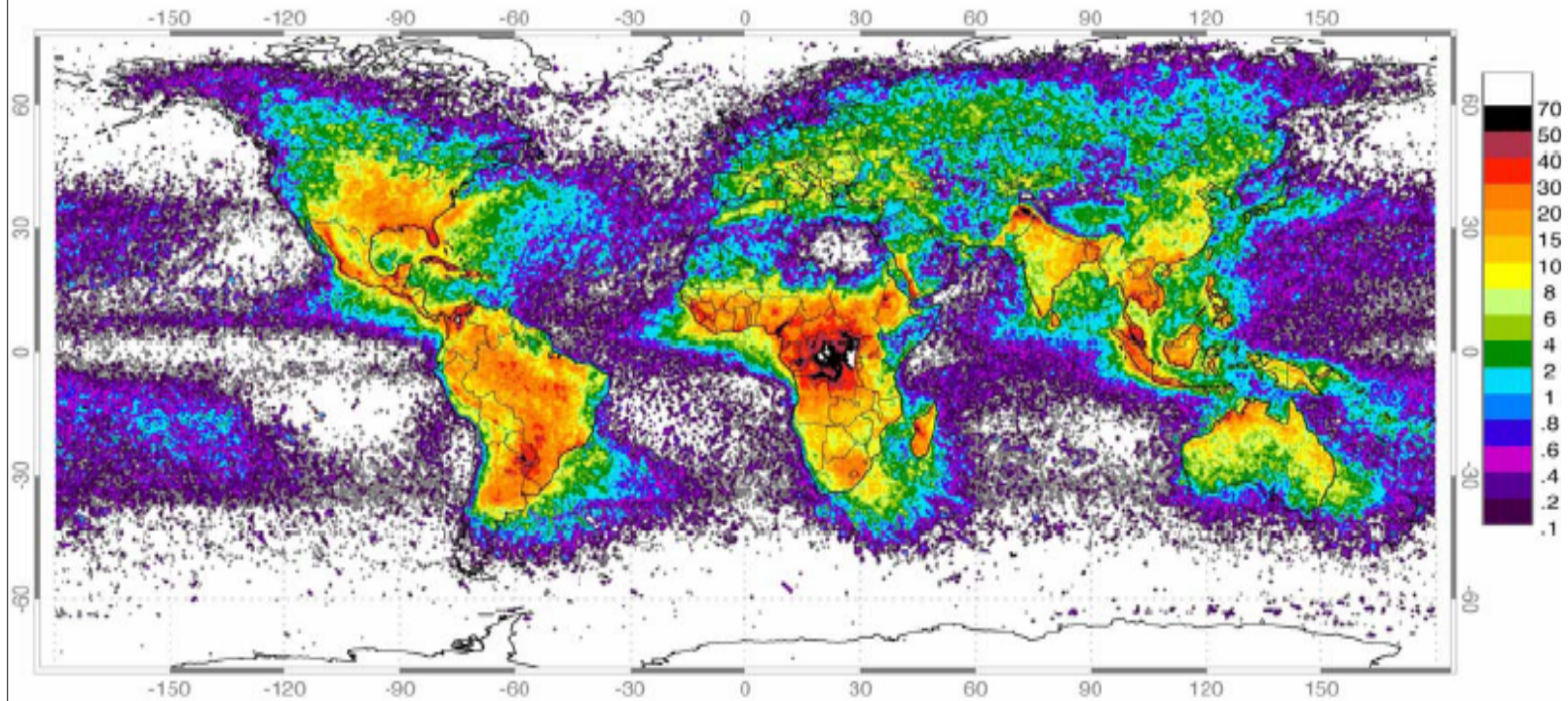


Por quê a evaporação e o aquecimento da superfície influenciam os extremos de chuva ?



Taxa de reciclagem da precipitação anual (%)

Trenberth (1999)



High Resolution Full Climatology Annual Flash Rate

Global distribution of lightning April 1995-February 2003 from the combined

Por quê a evaporação e o aquecimento da superfície influenciam os extremos de chuva ?

Tempestades elétricas (grandes cúmulos) estão nos continentes
Slide : Dr. Roger Pielke

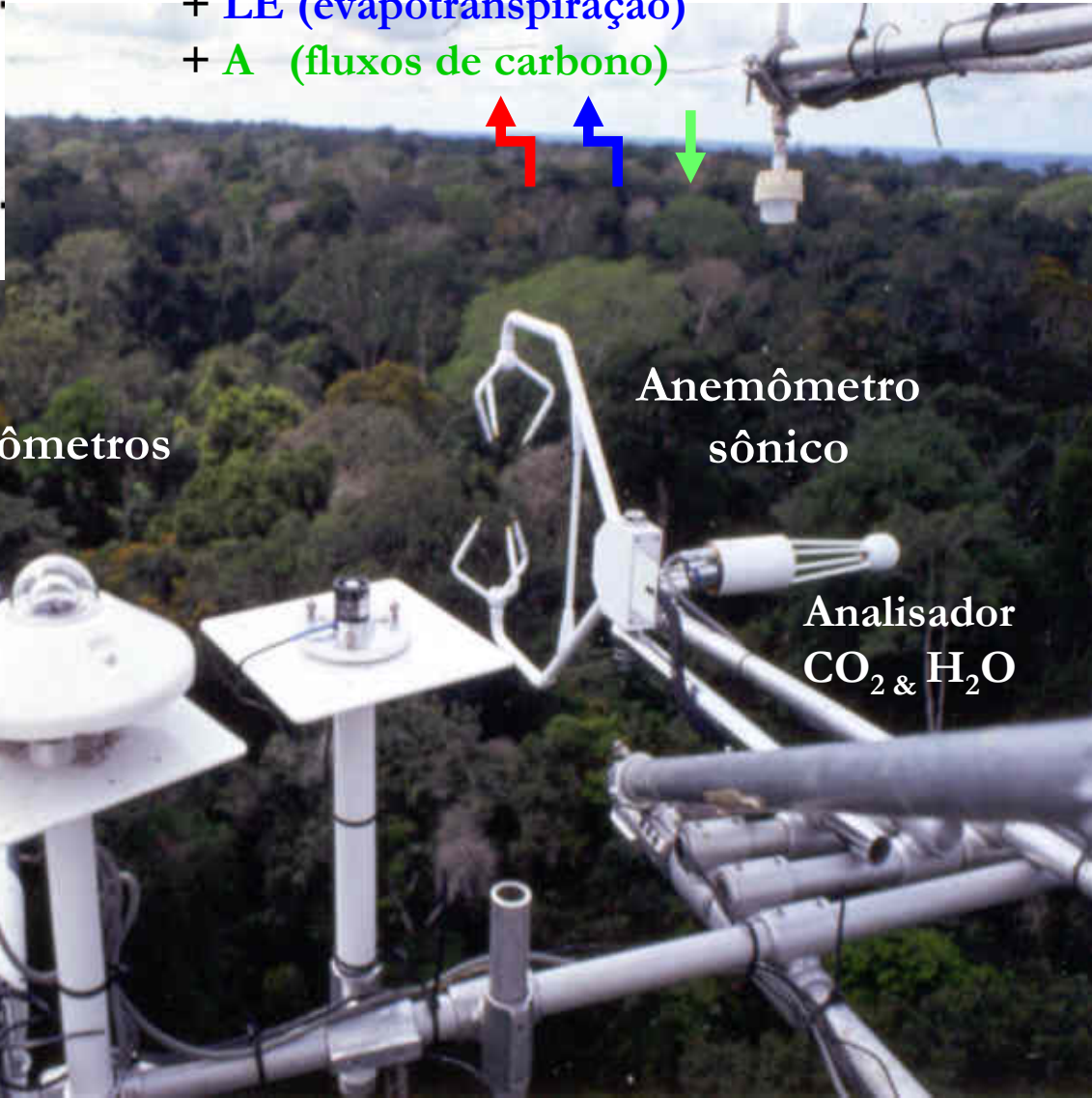
Rede de torres de fluxo

= Energia utilizada

= + **H** (fluxo calor sensível)

+ **LE** (evapotranspiração)

+ **A** (fluxos de carbono)

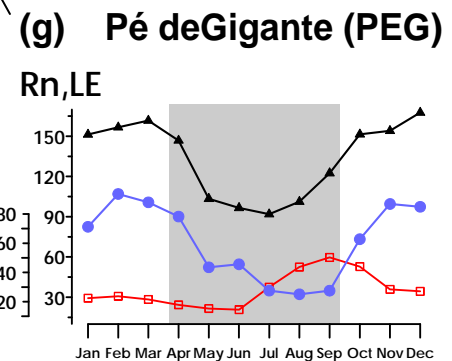
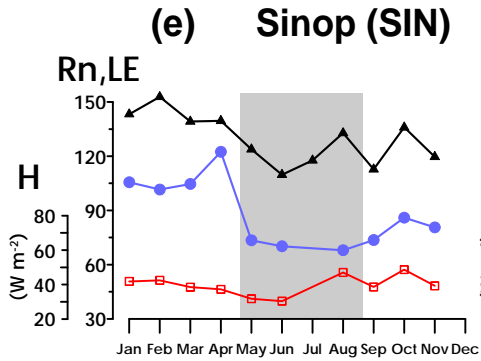
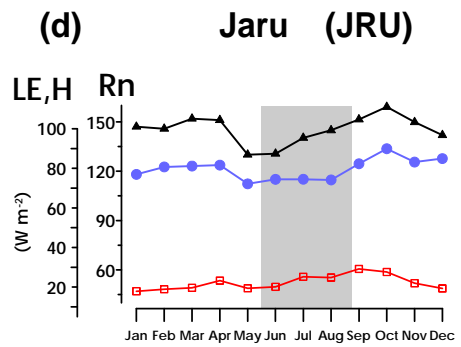
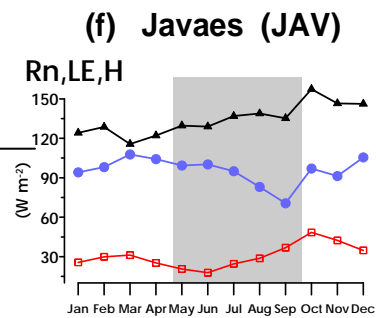
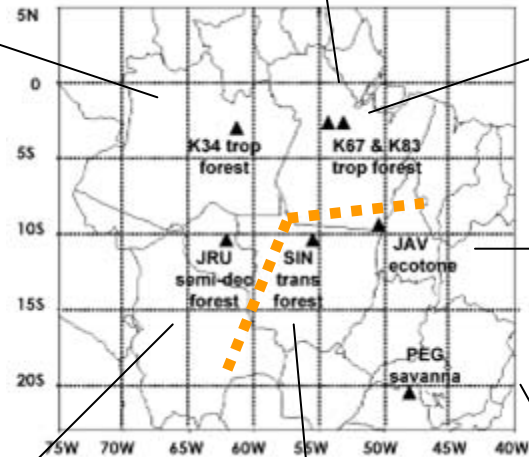
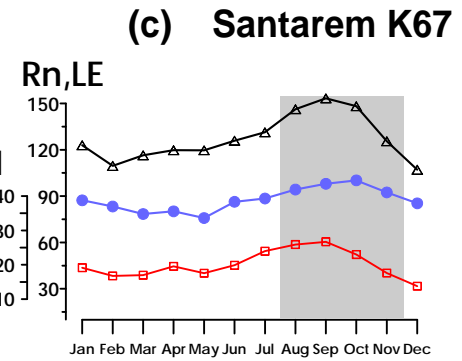
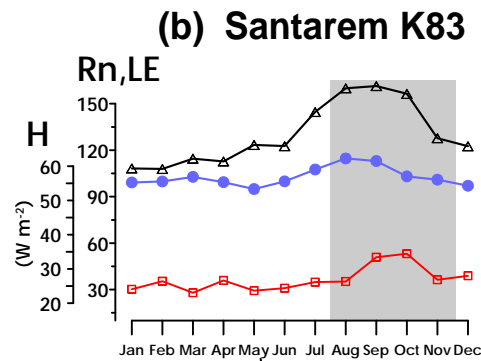
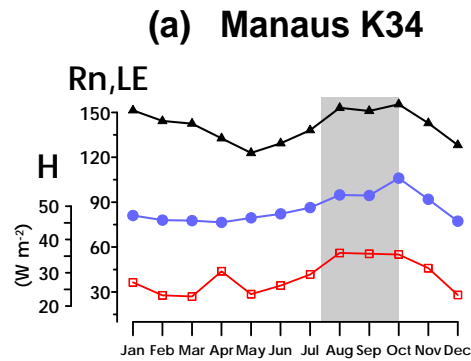






Radiômetros

Anemômetro
sônico

Analizador
CO₂ & H₂O





 Rn saldo de radiação (W m⁻²)
 LE evaporação (W m⁻²)
 H fluxo calor sensível (W m⁻²)
 climatological dry season



- Percepção das projeções
de precipitação no Brasil
- Controle da evaporação e aquecimento local
- **Variação da temperatura no estado de SP**

Variação de temperatura no estado de SP

Quais as causas ?

(ΔT) Variabilidade natural

+

(ΔT) Mudanças de uso da terra

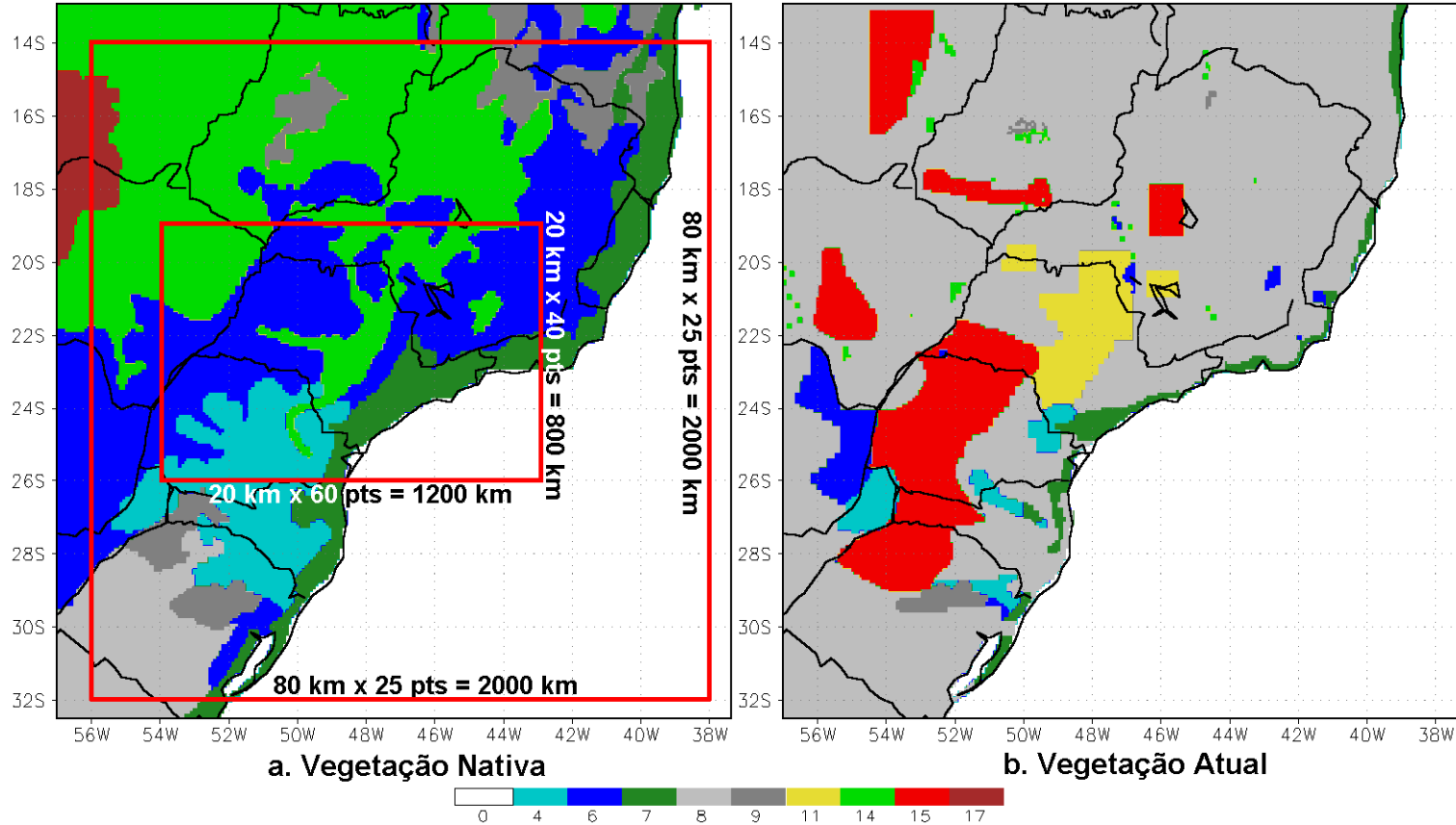
(ΔT) Urbanização

(ΔT) Aquecimento Global

-

ε (erros sistematicos e/ou aleatorios de aquisição)

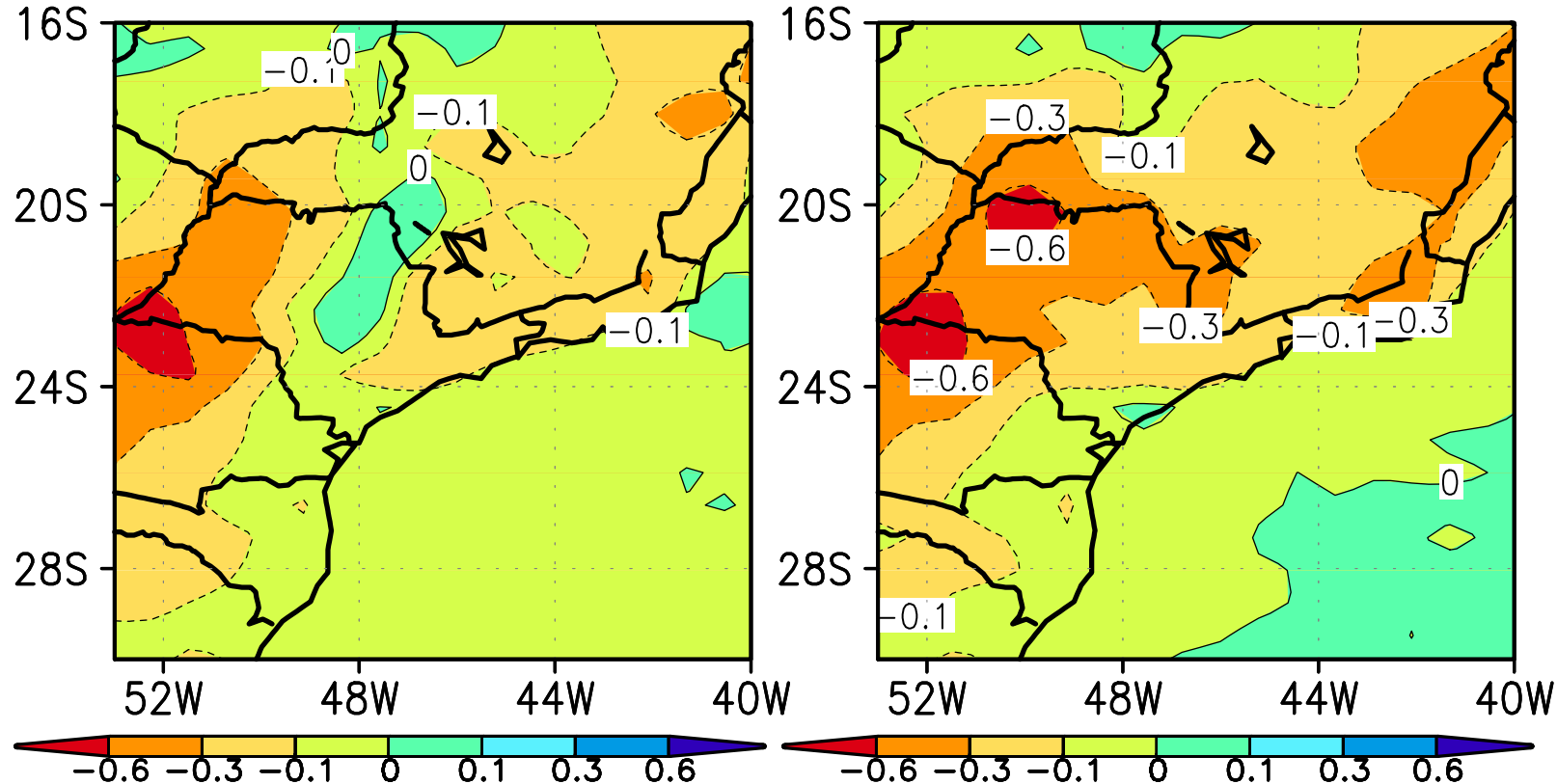
ΔT observado



Vegetação nativa x atual

Modelagem do clima regional no Sudeste com modelo BRAMS : sensibilidade ao uso da terra.

Negrón-Juarez (2004). Tese de doutorado Depto Ciências Atmosféricas IAG/UsP

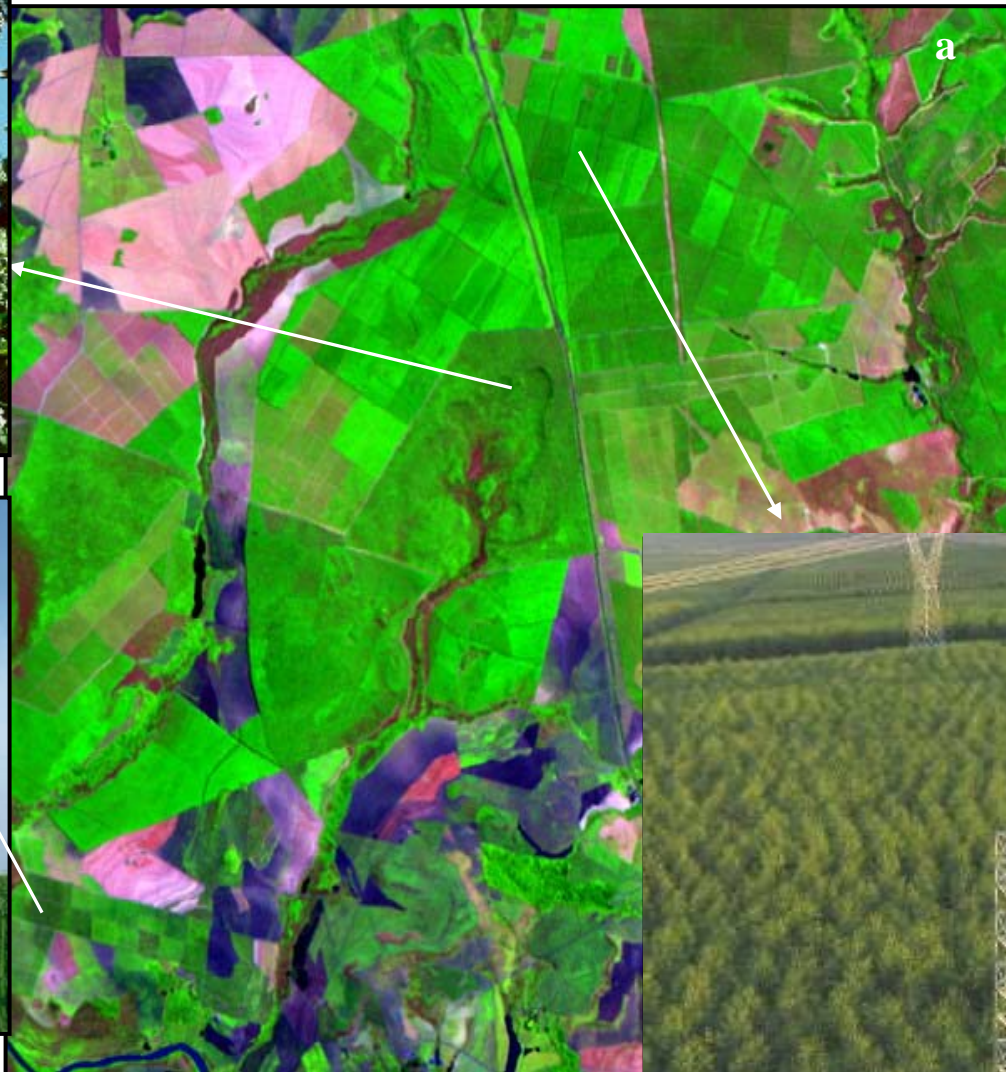


$T_{VNativa} - T_{VAtual}$ ($^{\circ}\text{C}$)
 (estação úmida e seca)

aquecimento na Veg atual de até $\sim 0,6$ $^{\circ}\text{C}$



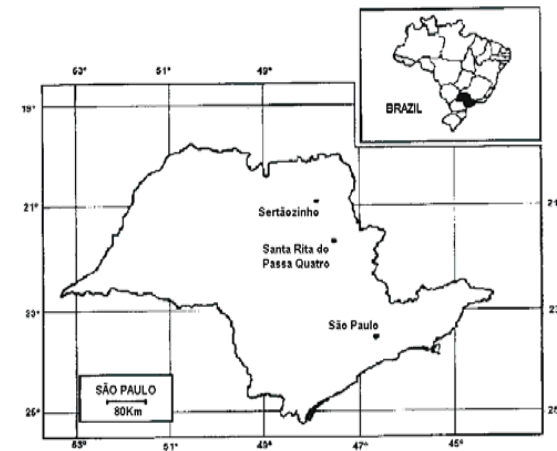
b



a



c



**Experimento de
microbacias
pareadas**

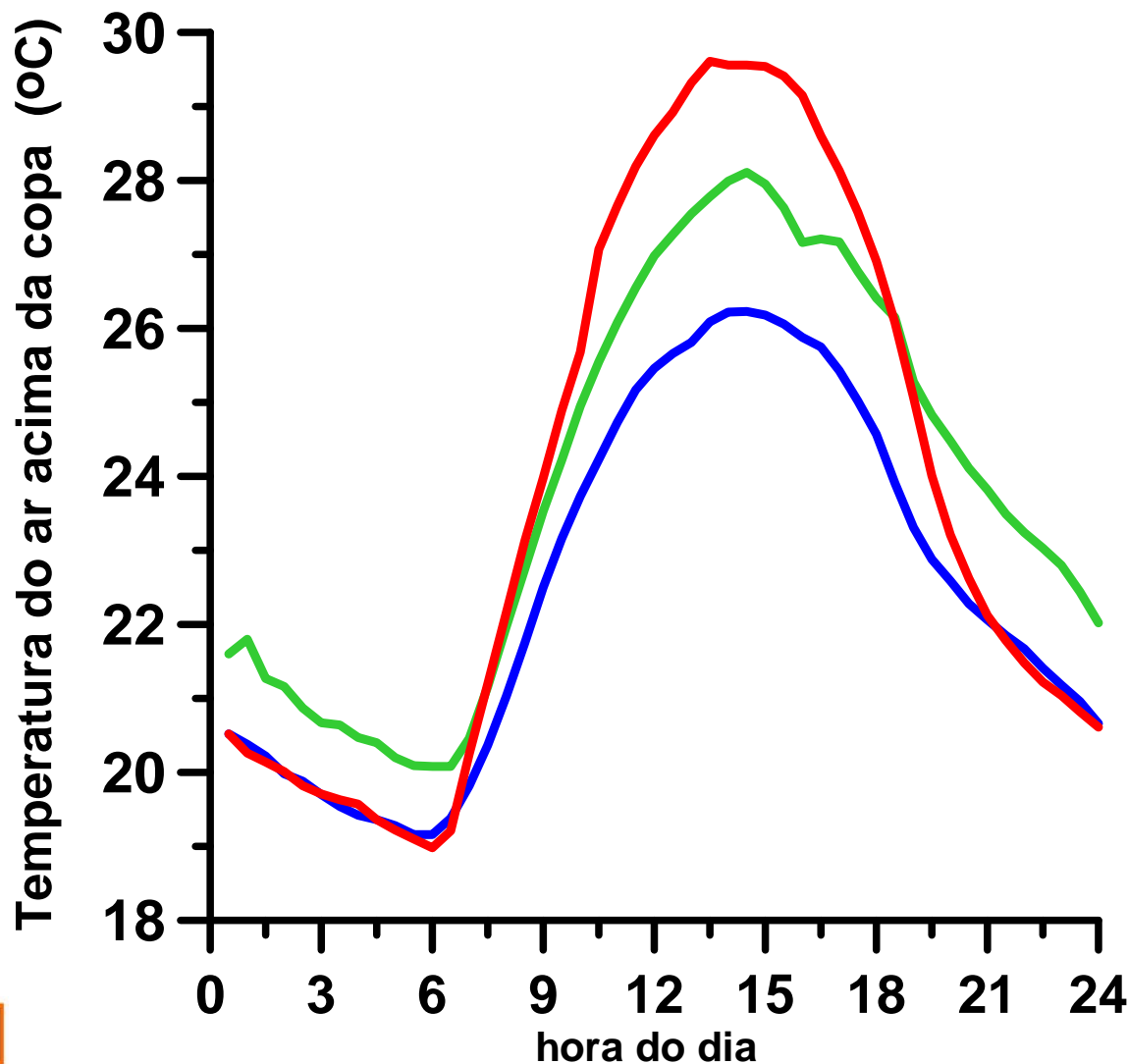
**Cerrado
Cana-de-açúcar
Eucalipto**

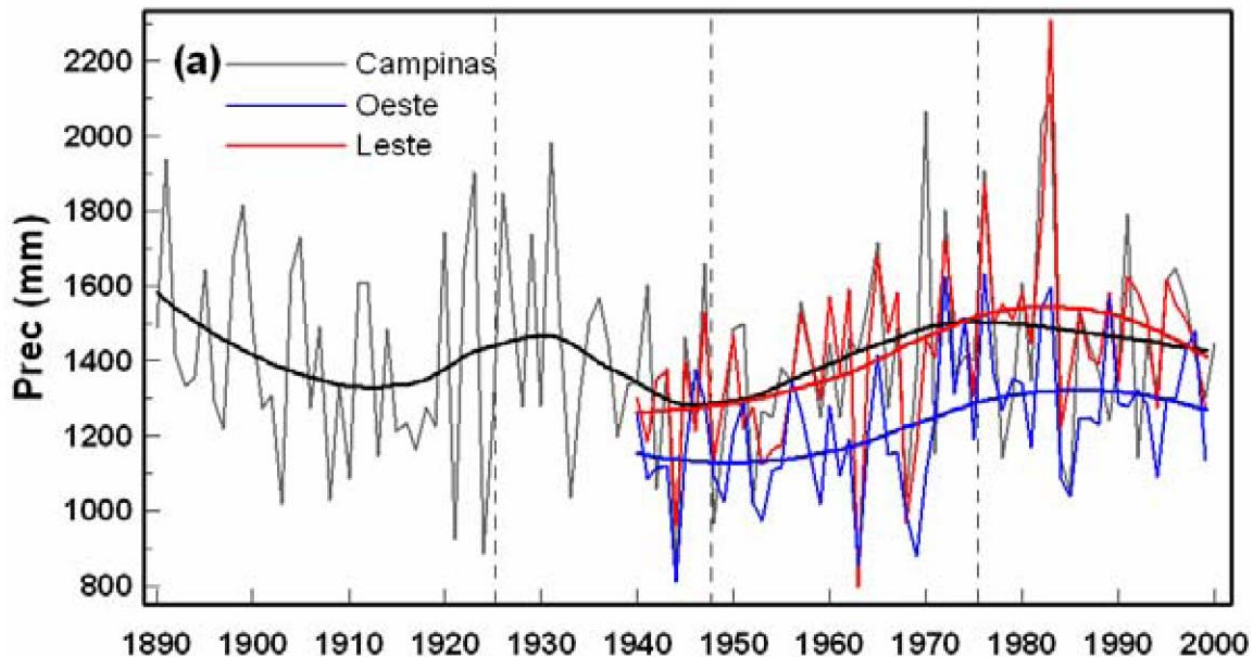
**Projeto Temático
Fapesp**

Fonte :
Projeto Temático Fapesp
USP
Embrapa Meio Ambiente
Instituto de Botânica
Iag/Usp
DAEE/SP

Média no período chuvoso

cana-de-açúcar
Cerrado
eucalipto

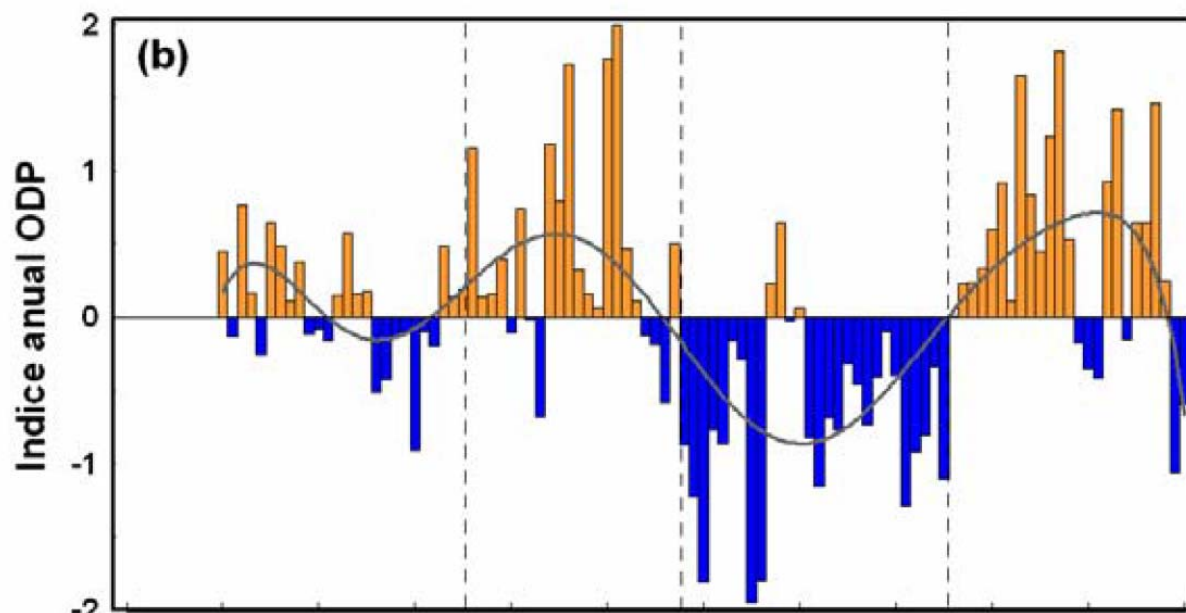




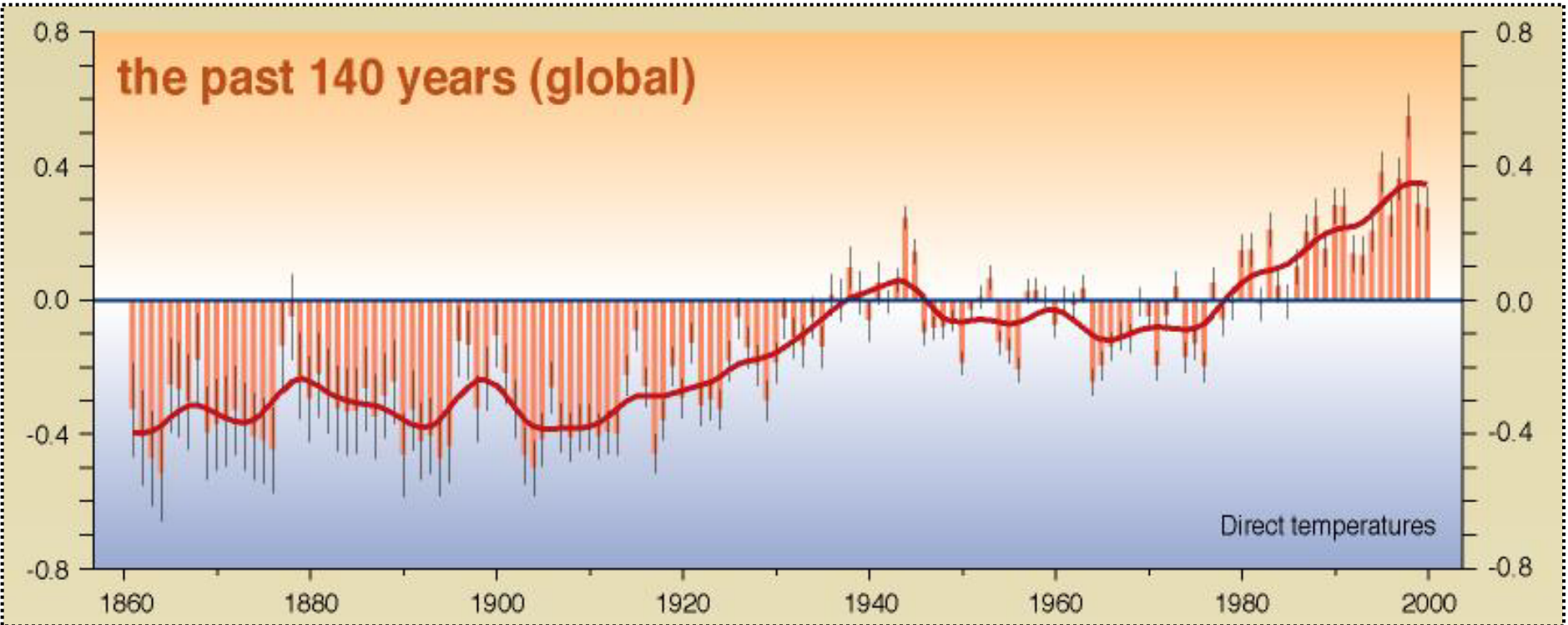
Séries históricas do clima

Chuva

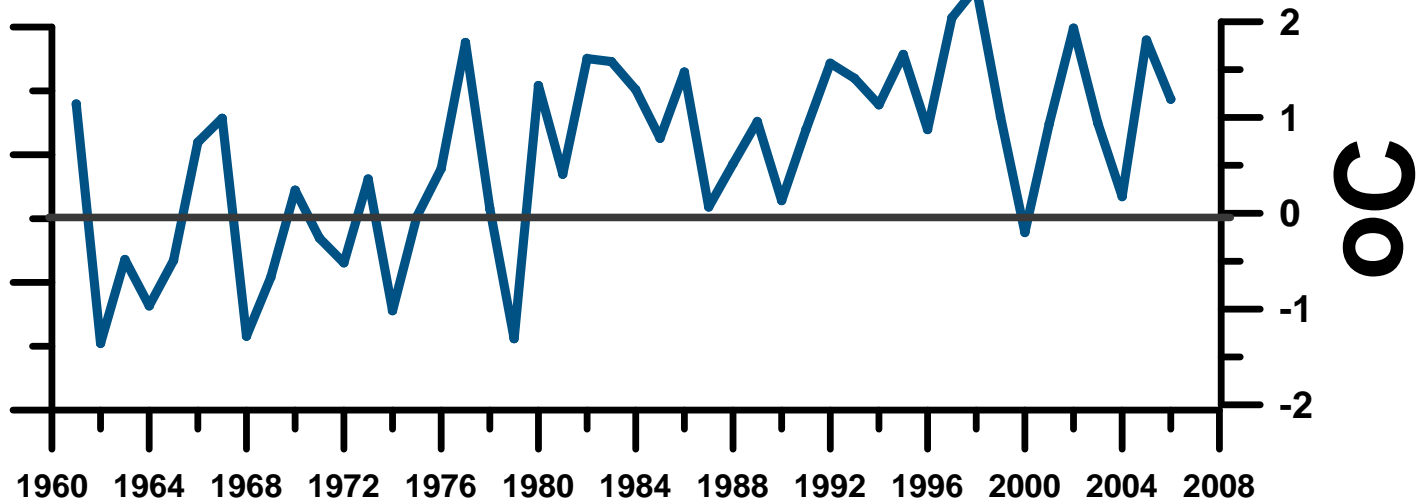
- Campinas
- Média ~100 estações nos setores Leste/Oeste do estado de SP



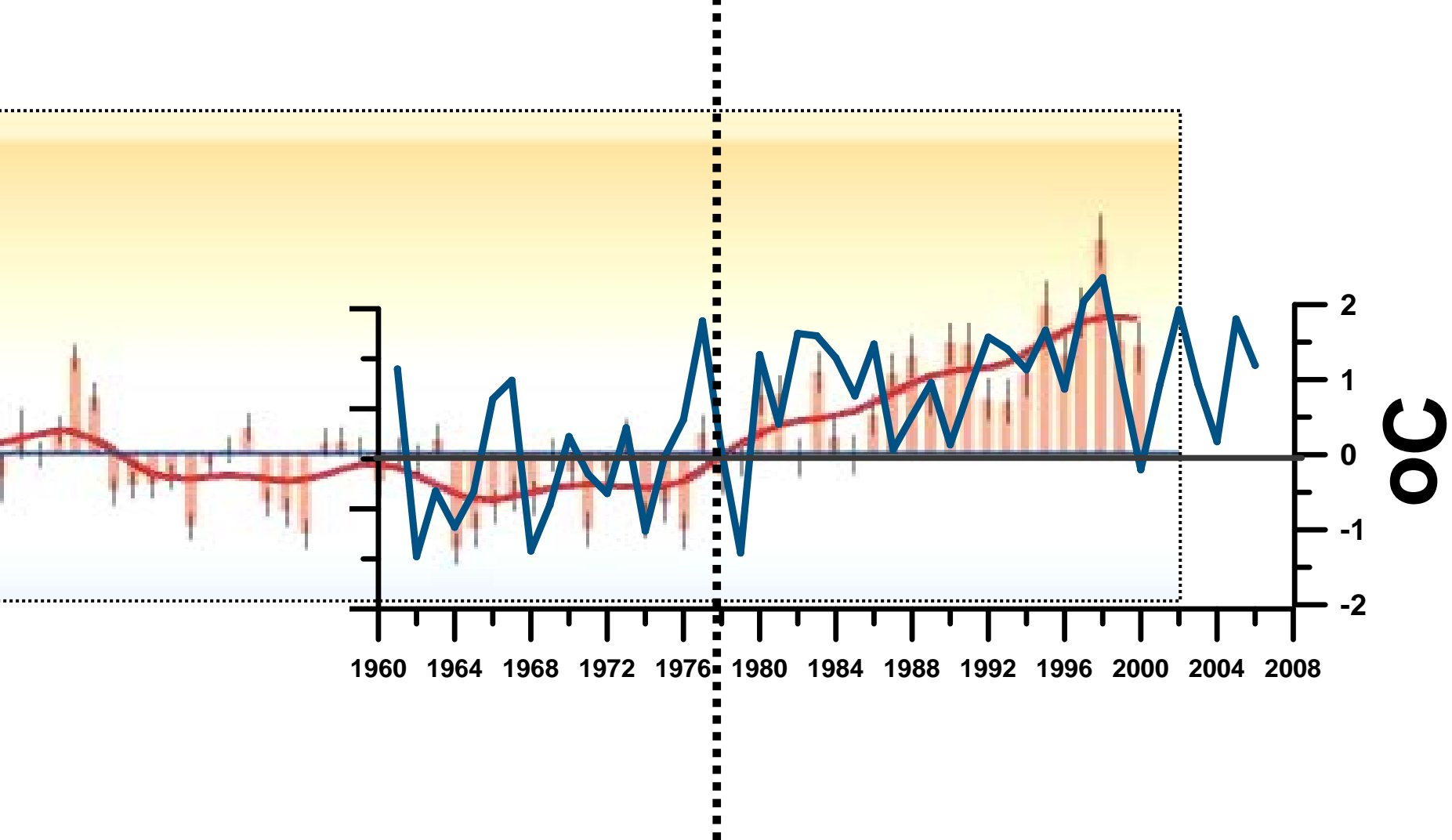
Sugere em fase com variação da Oscilação decadal do Pacífico (ODP)



TAR / IPCC 2001

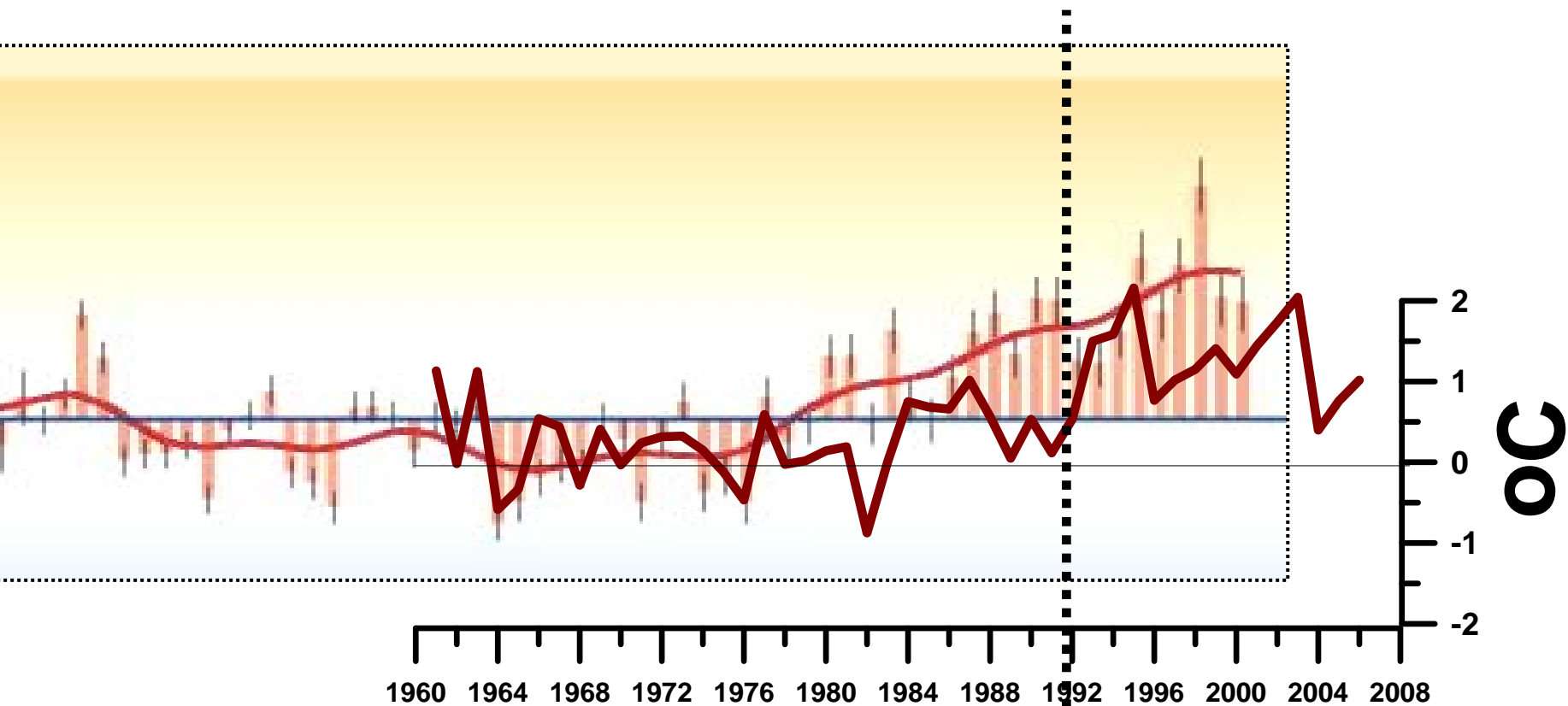


Tmin São Paulo



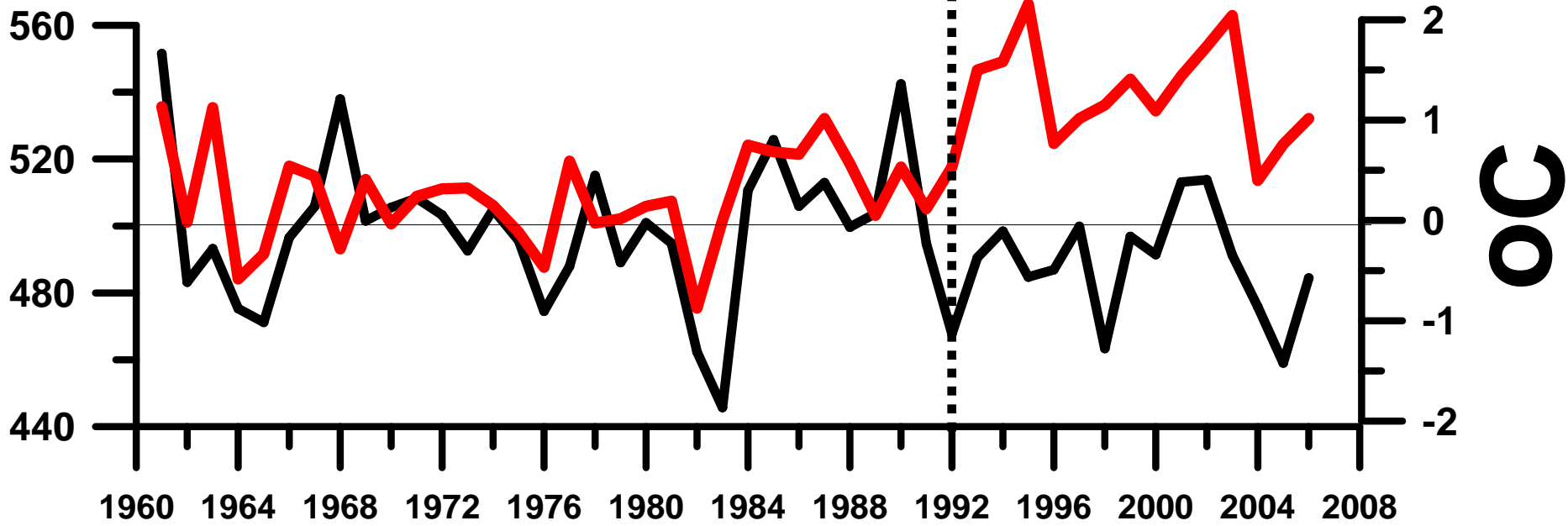
Tmin São Paulo

Aquecimento global, urbanização ?



Tmax São Paulo

Aquecimento global, urbanização ?

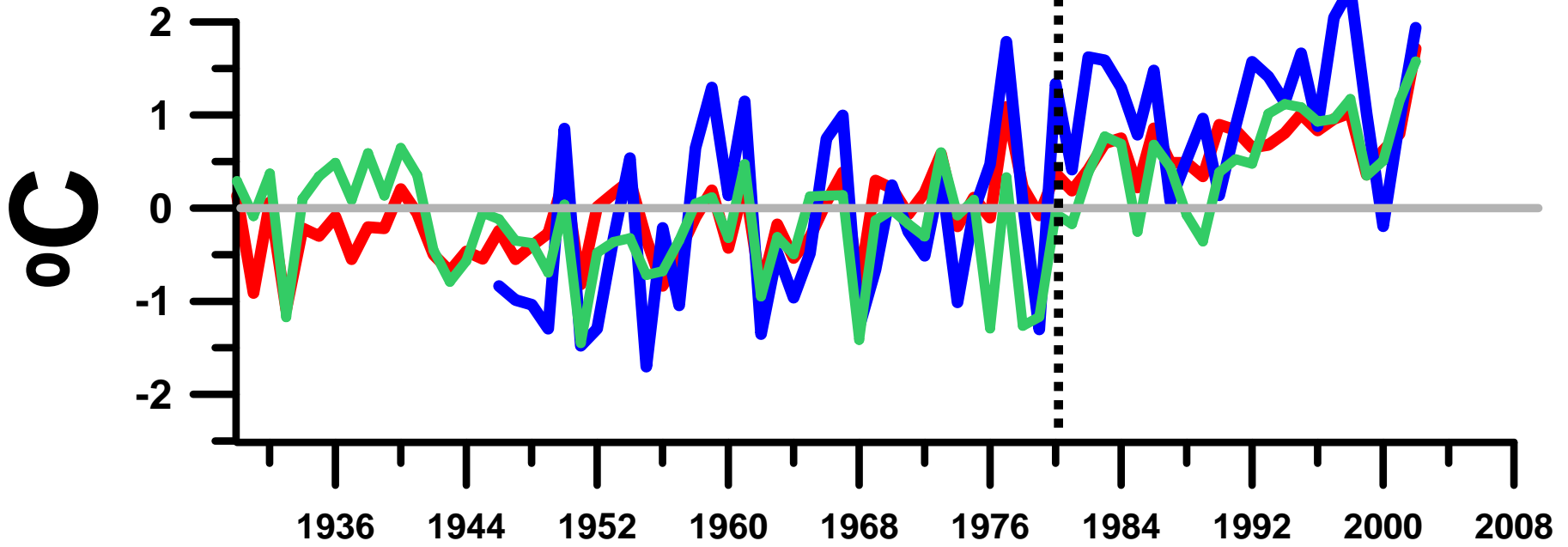


Aquecimento global,

urbanização, amostragem ?



72 a
62 a
72 a



Aquecimento global +++

urbanização + muds uso terra +?

CAMPINAS



limite da área urbana de Campinas

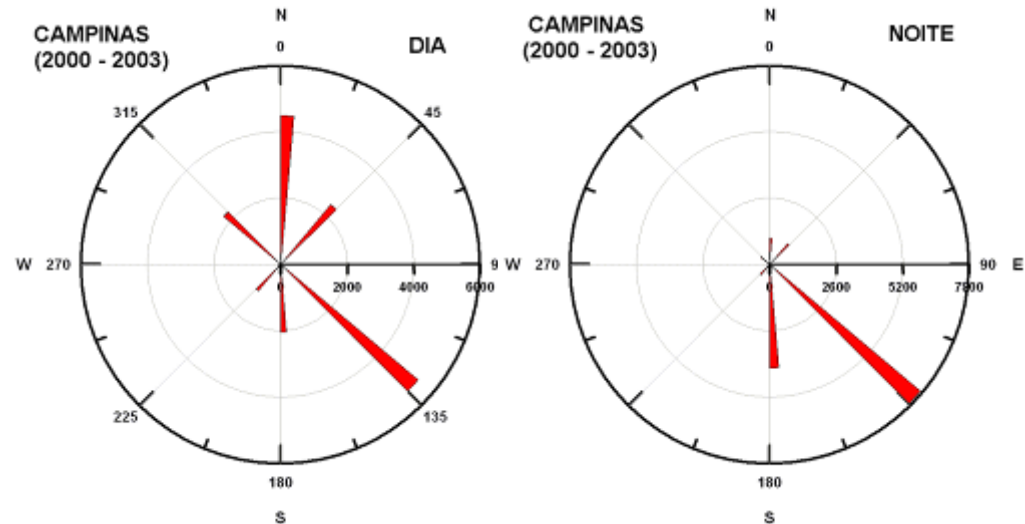
azul: *estação meteorológica do IAC*

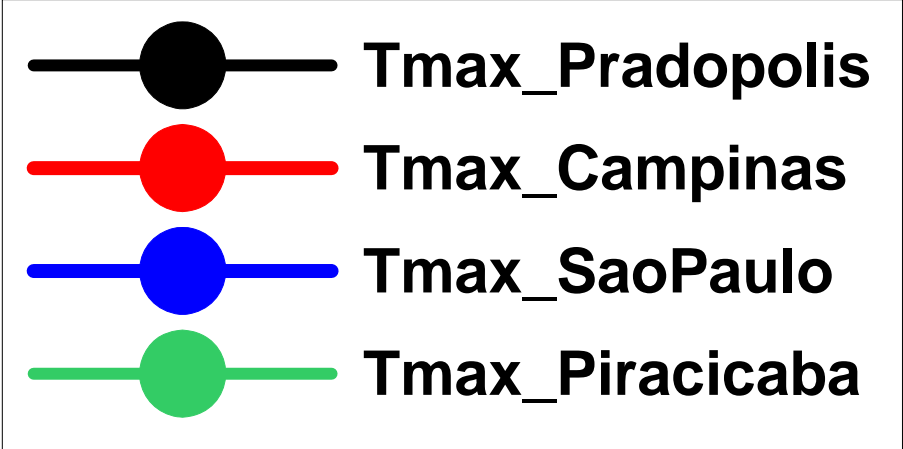
CAMPINAS



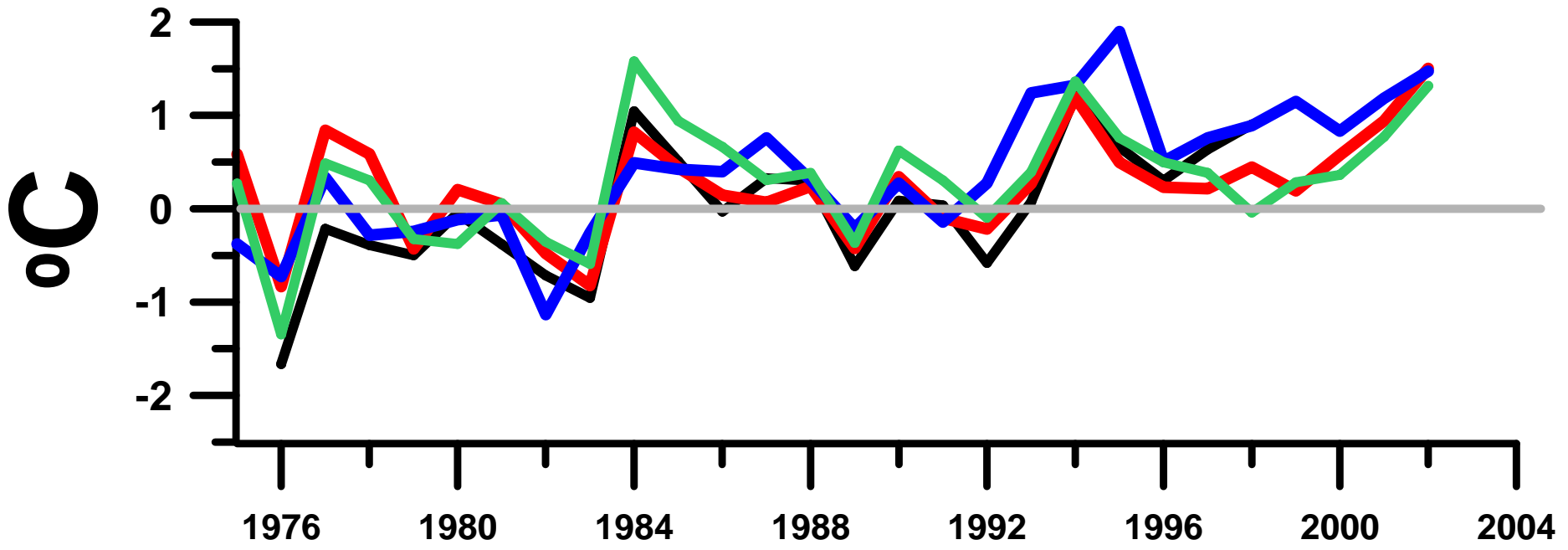
limite da área urbana de Campinas

azul: *estação meteorológica do IAC*



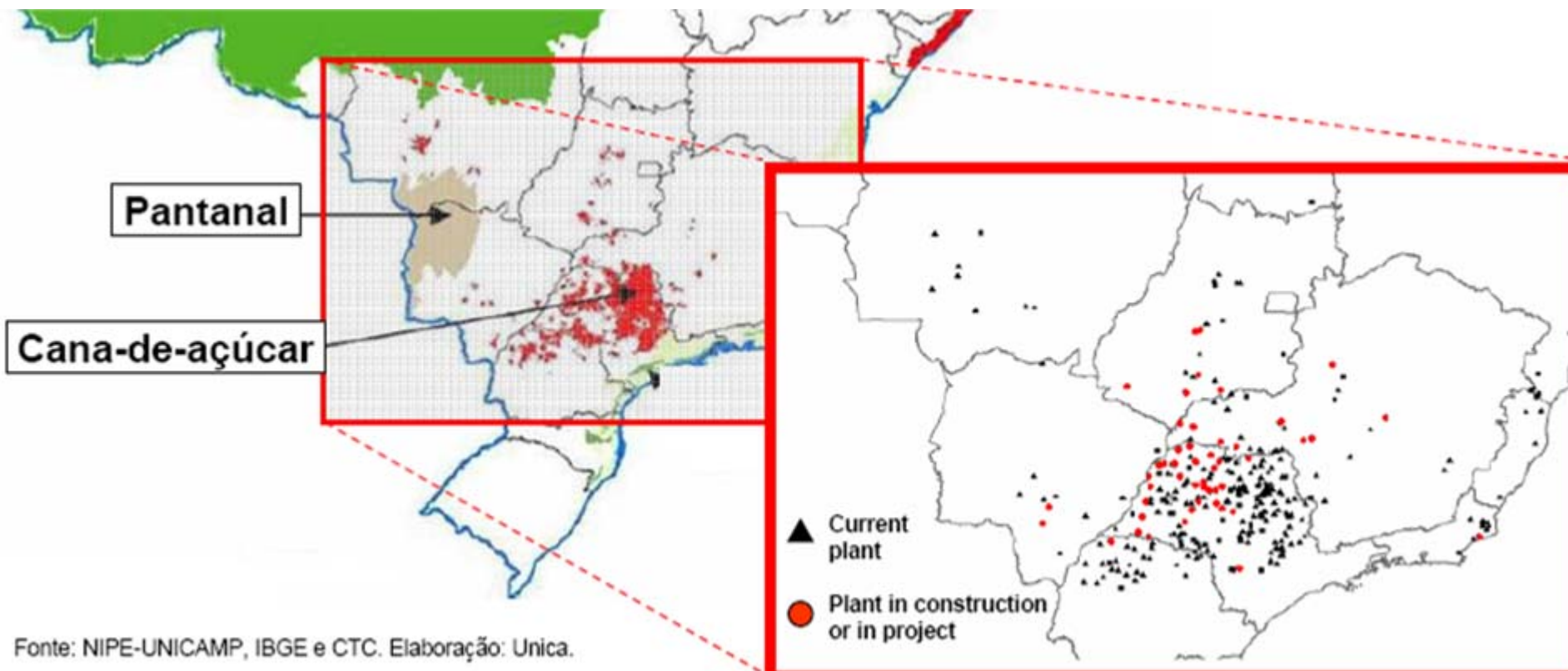


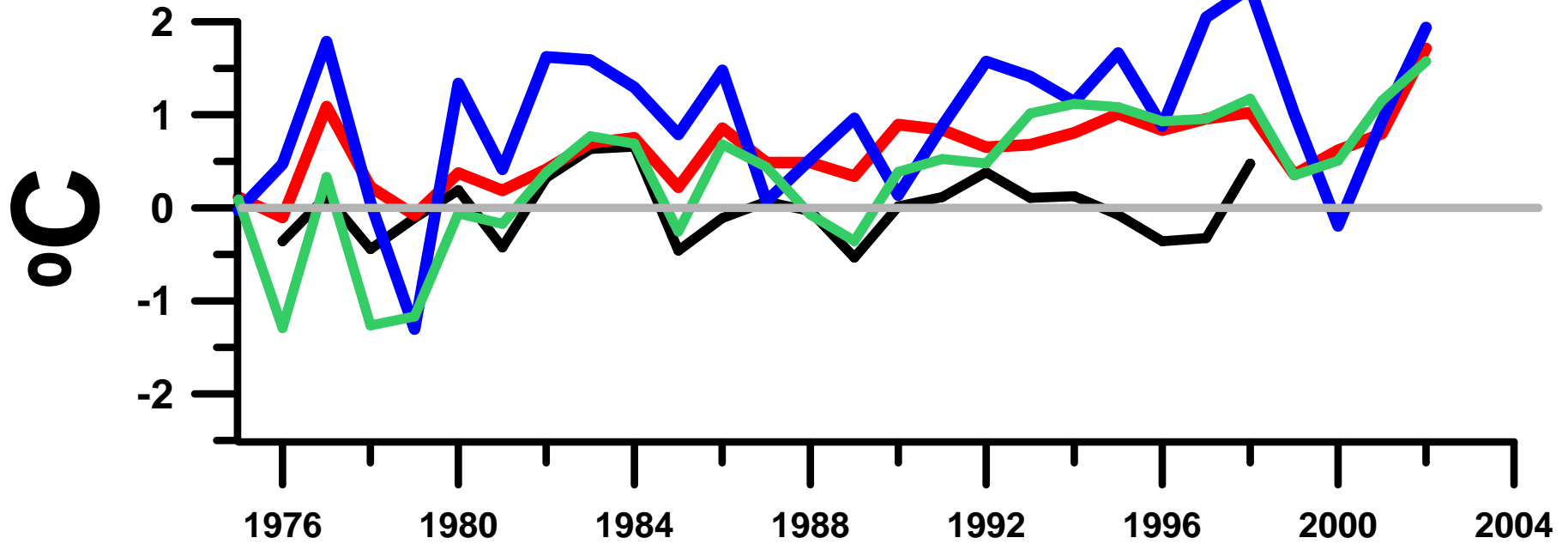
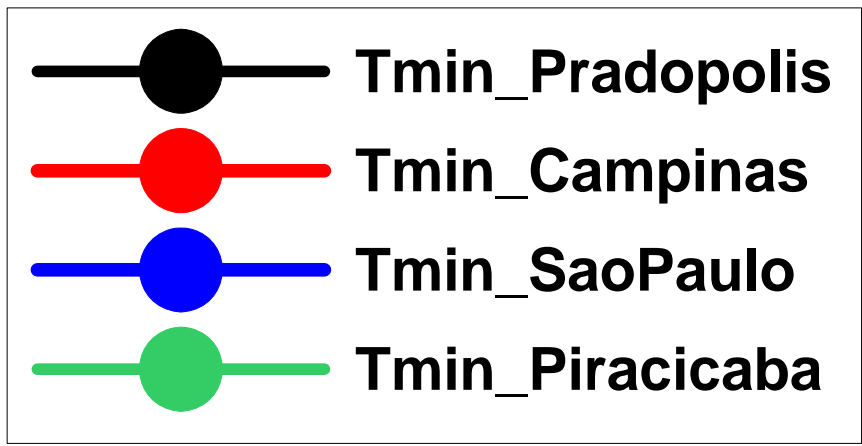
8000 hab, 4km², estação rural
dados 1976 - 2002



Aquecimento global ?

Cana-de-açúcar ?





Pradopolis : Cana-de-açúcar +

Conclusões

1. As projeções de chuva em grande parte do Brasil nas próximas décadas
 - podem ser substanciais, mas há ainda desconhecimento
 - extremos precisam ser investigados com métodos e escala regionais
2. Há indícios de que, além do aquecimento global, a urbanização, mudanças de uso da terra e variações naturais (decadais) compõem a variação do clima multi-decadal no estado de SP

