



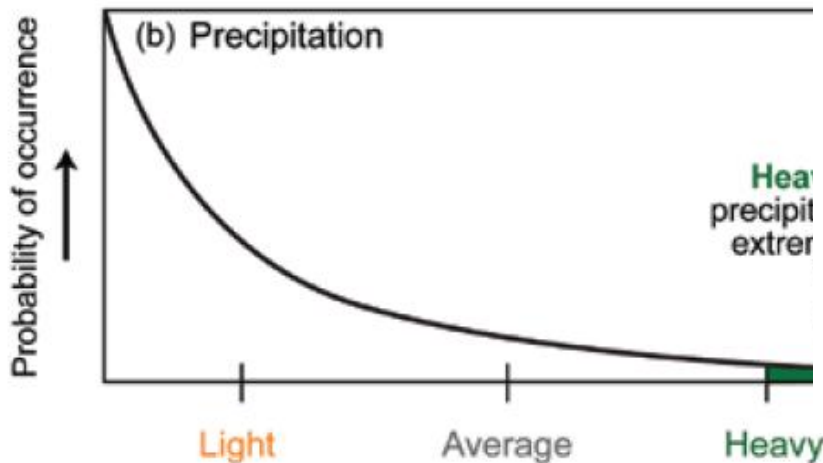
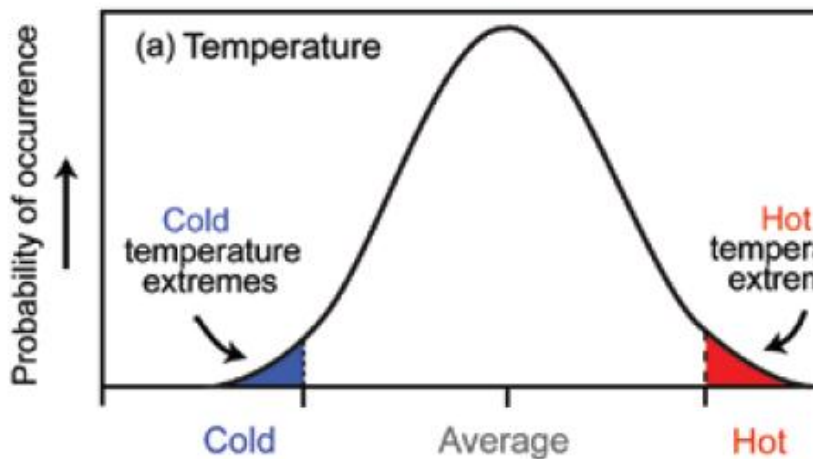
An increase in frequency of extreme events

“Economic Impacts of Extreme Events”

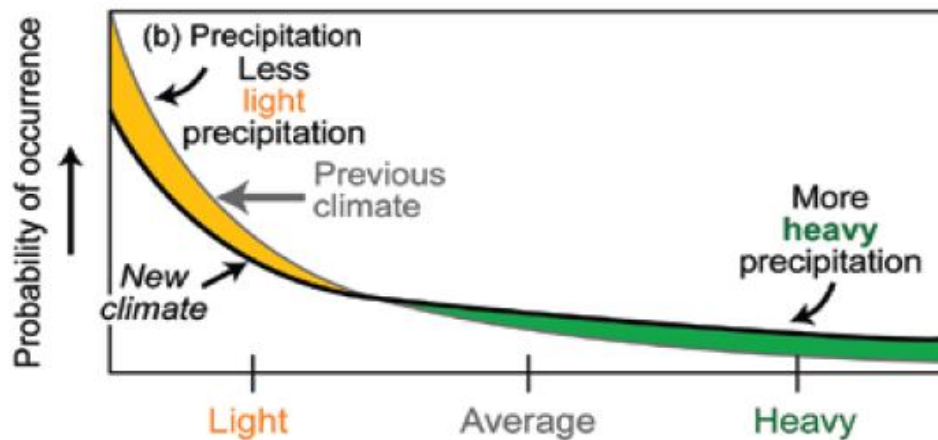
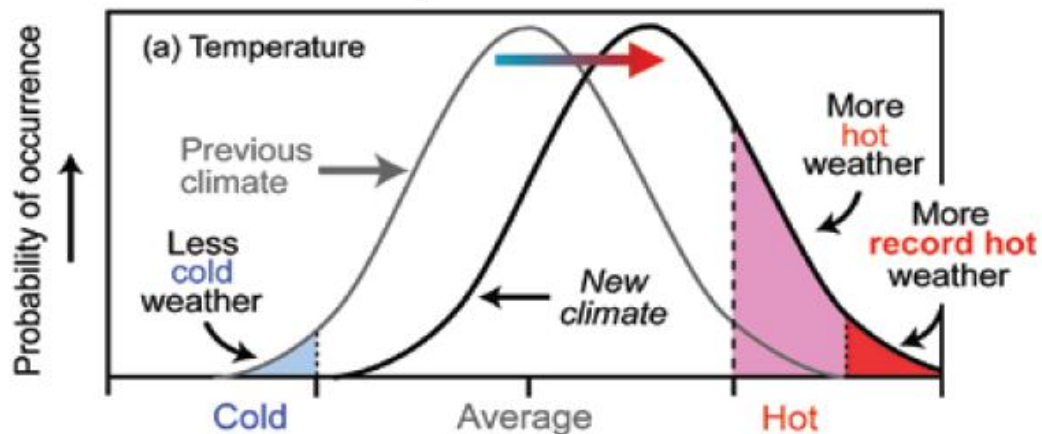
Maria Assunção Faus da Silva Dias
Departamento de Ciências Atmosféricas
Instituto de Astronomia, Geofísica e Ciências Atmosféricas
Universidade de São Paulo
23 March 2012

- What is extreme?
- A few examples
- Reinsurance companies looking at extremes
- Observed change is frequency of extremes
- Future trends
- Uncertainty of future climate scenarios

What Is an Extreme?



Increase in Probability of Extremes in a Warmer Climate

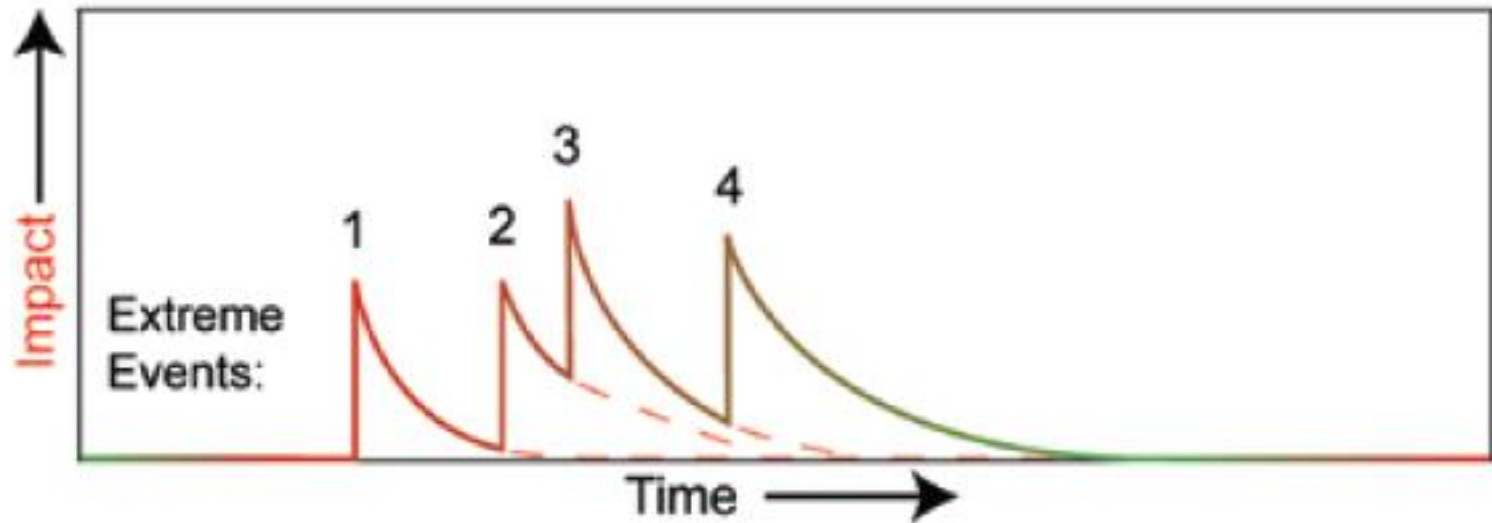
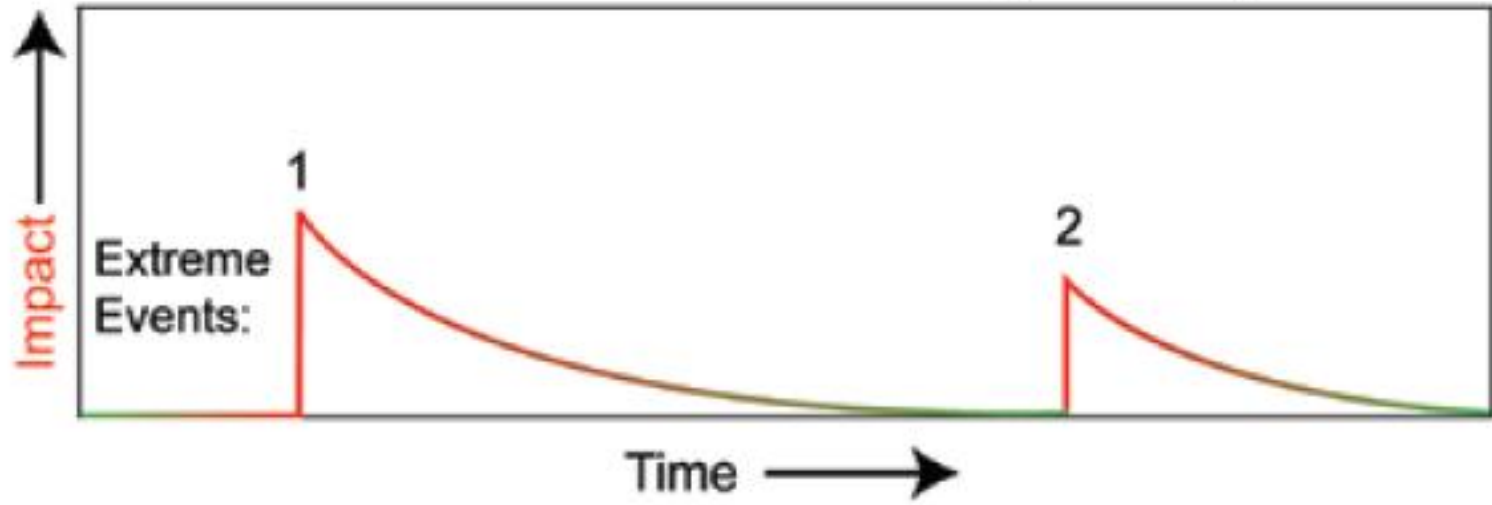


From a socio-economic perspective: IMPACTS

- Involve risk
 - Deaths, injured, damage to property
- Related to vulnerability and resilience

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Extreme Events and Recovery of a System



www.swissre.com

Swiss Reinsurance Company Ltd

Swiss Re



sigma

No 1/2011

Natural catastrophes and man-made disasters in 2010:
a year of devastating and costly events

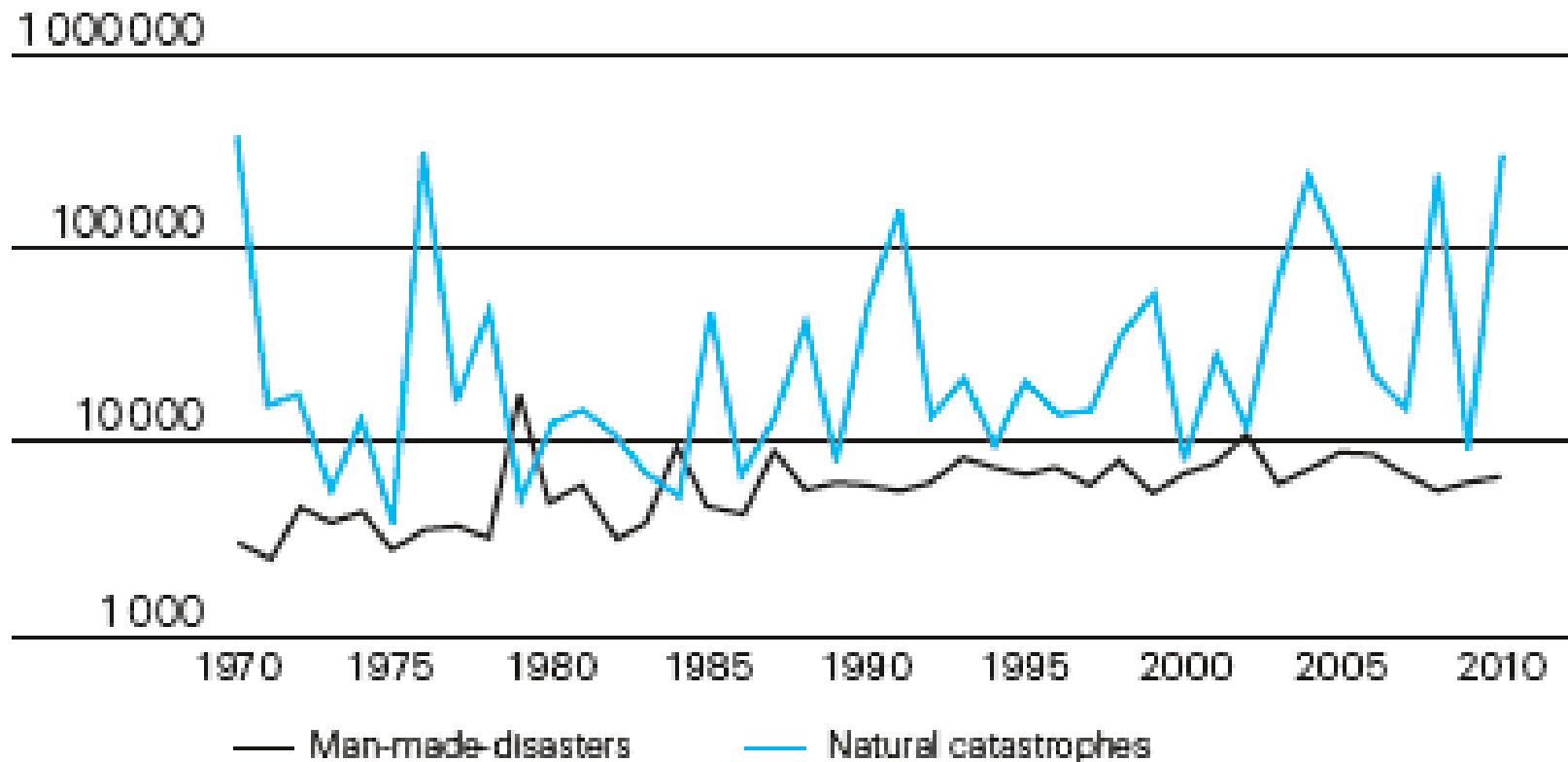
Natural catastrophes

The term "natural catastrophe" refers to an event caused by natural forces. Such an event generally results in a large number of individual losses involving many insurance policies. The scale of the losses resulting from a catastrophe depends not only on the severity of the natural forces concerned, but also on man-made factors, such as building design or the efficiency of disaster control in the afflicted region. In this *sigma* study, natural catastrophes are subdivided into the following categories: floods, storms, earthquakes, droughts/forest fires/heat waves, cold waves/frost, hail, tsunami and other natural catastrophes.

Man-made disasters

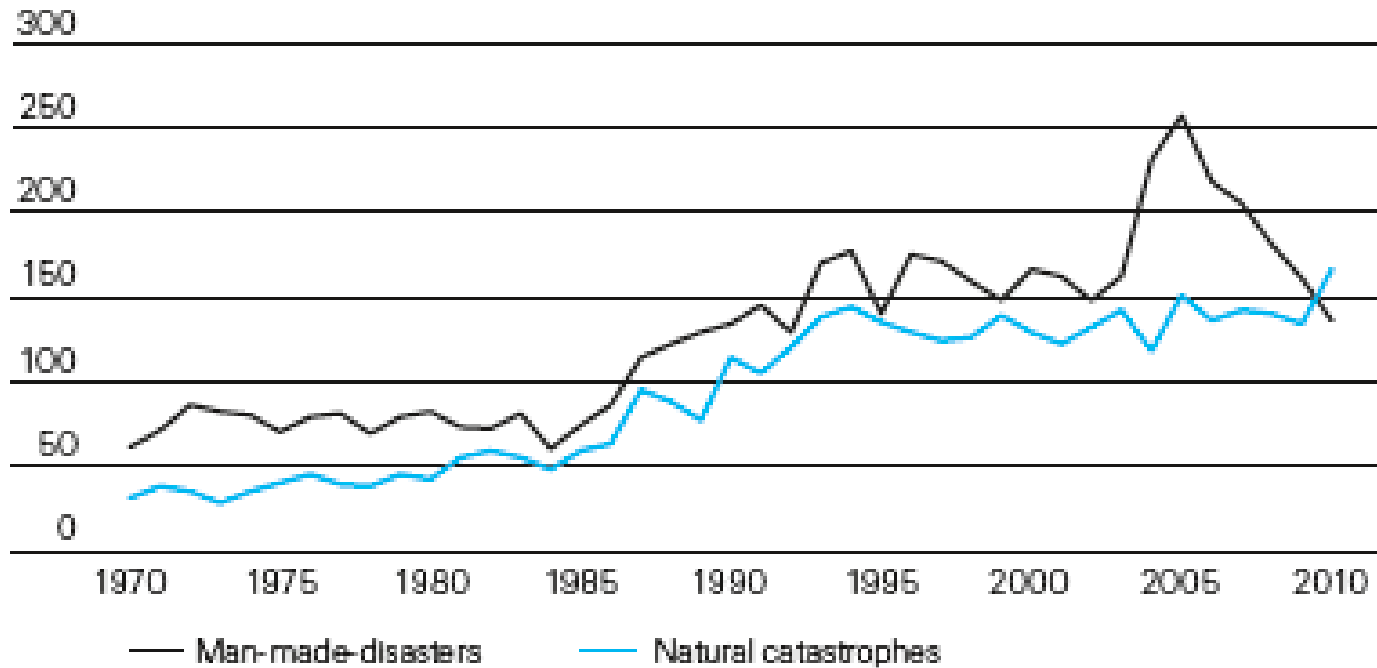
This study categorises as "man-made" or "technical" disasters major events associated with human activities. Generally, a large object in a very limited space is affected, which is covered by a small number of insurance policies. War, civil war and war-like events are excluded. *sigma* subdivides man-made disasters into the following categories: major fires and explosions, aviation and space disasters, shipping disasters, rail disasters, mining accidents, collapse of buildings/bridges and miscellaneous (including terrorism).

Number of victims



Source: Swiss Re Economic Research & Consulting

Number of events



Source: Swiss Re Economic Research & Consulting

Tables for reporting year 2010

Table 3
List of major losses in 2010 according to loss category

	Number	in %	Victims ¹	in %	Insured loss ² (in USD m)	in %
Natural catastrophes	167	54.9%	297 127	97.9%	39 869	91.7%
Floods	69		11 027		6 393	
Storms	63		1 702		20 126	
Earthquakes	13		227 050		12 943	
Droughts, bush fires, heat waves	9		56 276		10	
Cold, frost	10		1 024		397	
Hail	1		28			
Other natural catastrophes	2		20			
Man-made disasters	137	45.1%	6 446	2.1%	3 606	8.3%

Table 6

Chronological list of all natural catastrophes 2010**Floods**

Date	Country Place	Event	No. of victims/amount of damage in original currency and (USD)
1.1.–4.1.	Brazil Rio de Janeiro, Angra dos Reis, Sao Paulo, Minas Gerais	Floods and mudslides caused by heavy rain; collapse of hillside buries bungalows at luxury beach resort	85 dead USD 145m total damage
1.1.–15.1.	Kenya North Rift, South Rift, Nyanza	Floods caused by heavy rains; 6 664 houses, croplands, infrastructure destroyed	40 dead 8 270 homeless
18.1.–22.1.	United States CA (La Conchita), AZ	Floods and mudslides caused by heavy rain, snow	USD 100–300m insured loss*
1.4.–6.4.	Peru Huánuco, Chinchao, Ambo, Trujillo, Porvenir	Floods and mudslides caused by heavy rain	68 dead 50 injured
4.4.–12.4.	Brazil Rio de Janeiro, Niteroi	Floods and landslides caused by heavy rain; mudslides bury houses in slums of hill areas	256 dead 403 injured 74 535 homeless USD 200m total damage
30.4.–3.5.	United States TN (Nashville), KY, GA, AR	Floods caused by heavy rain, storms; Country Music Hall of Fame, Grand Ole Opry House flooded	33 dead USD 600m–1bn insured loss* USD 1.5bn total damage
			12 000 homeless
15.6.–16.6.	France Var, Arcs, Draguignan, Luc, Muy, Roquebrune sur Argens, Cote d'Azur	Floods caused by heavy rain; damage to cars, homes, businesses and infrastructure	23 dead, 2 missing EUR 610m (USD 818m) insured loss EUR 1.05bn (USD 1.41bn) total damage
19.6.–21.6.	Brazil Alagoas, Quebrangulo, Pernambuco	Floods and mudslides caused by heavy rain; bridges, highways washed away	at least 54 dead, 53 missing 40 000 homeless BRL 1bn (USD 602m) total damage
19.6.–23.6.	Bosnia and Herzegovina Sava River, Brčko, Banja Luka, Tuzla	Floods causes by heavy rains. 4 000 houses flooded. Damage to roads and infrastructure	2 229 homeless BAM 128m (USD 87m) total damage

Sigma Table of Catastrophic events for 2008

21.11.–2.12.	Brazil Santa Catarina, Ilhota	Floods and landslides in Itajai Valley caused by heavy rain; damage to Port of Itajai	118 dead 15 injured 23 000 homeless BRL 600m (USD 257m) insured loss BRL 935m (USD 401m) total damage
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THE CASE OF THE SÃO PAULO METROPOLITAN AREA

Inundações em São Paulo

Isto é - São Paulo, 10 de fevereiro de 2004



A avenida Aricanduva virou rio. O resgate de pessoas chegou a ser feito de helicópteros.

Em todo o País, os números são assustadores. Já são 98 mortos, 120 feridos, mais de 120 mil desabrigados em 405 cidades, 14 grandes barragens e 4.500 casas totalmente destruídas, além de 28 mil



São Paulo, 27 de fevereiro de 2011



Ponto de alagamento intransitável na esquina da rua Cardeal Arcoverde, em Pinheiros. 27/02/2011

Chuva causa transtornos em SP

Mercado da Ceagesp, na Lapa, Zona Oeste, alagou.
Bombeiros dizem ter enviado equipes com bote nos bairros da região.

Do G1 SP

imprimir

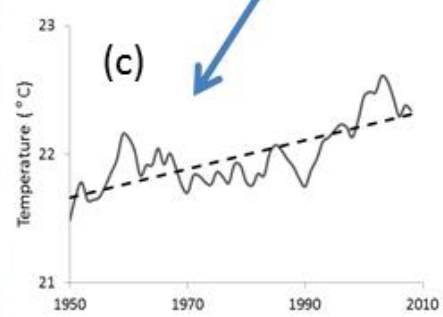
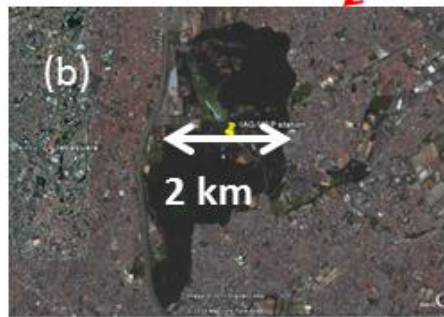
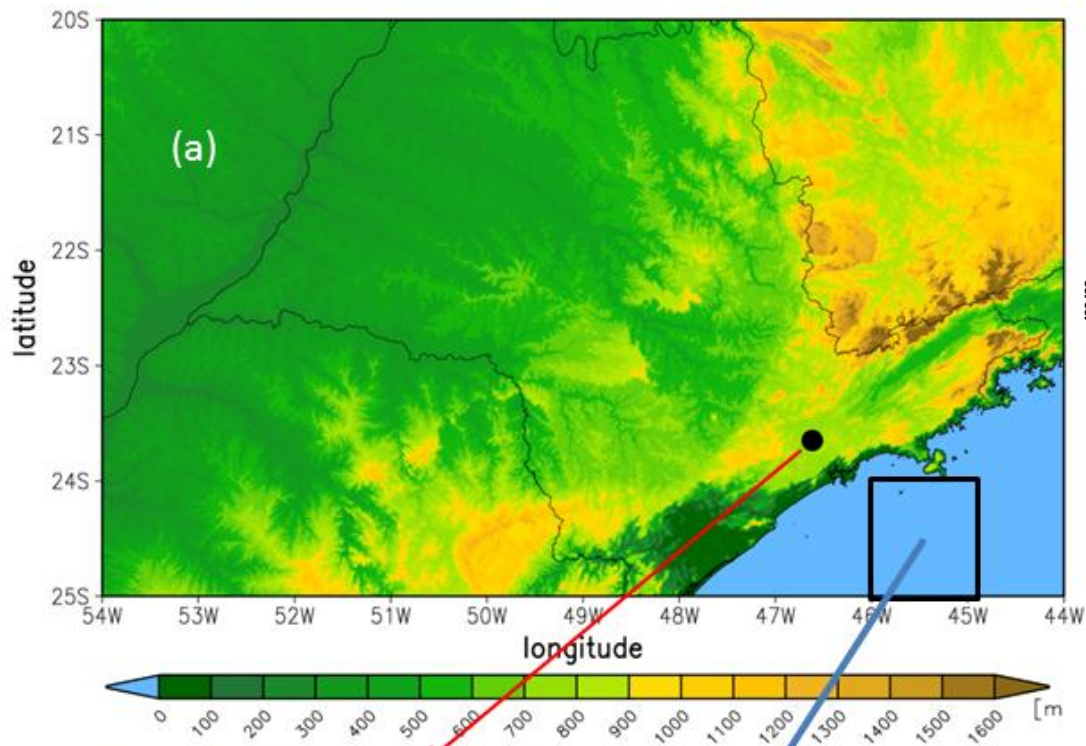


Homens empurram carro na Avenida Dumont Villares, na Zona Norte. (Foto: Mario Ângelo/ AE)

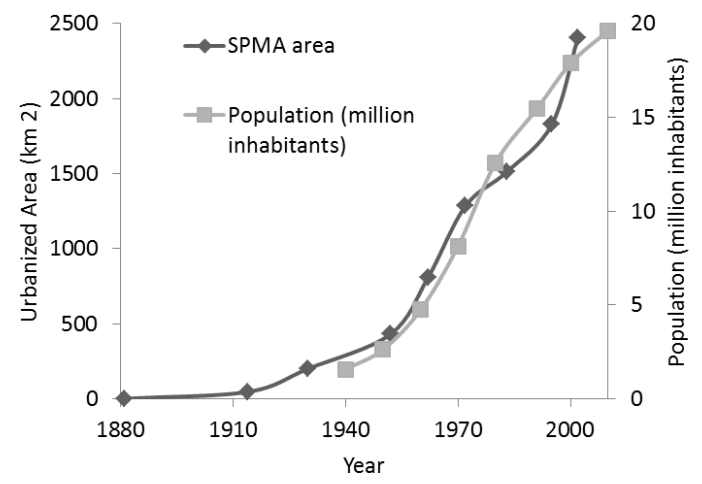
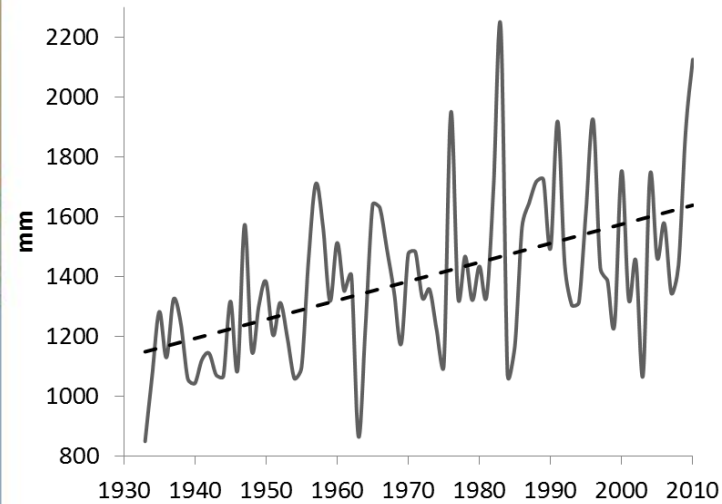


Moacyr Lopes Junior/Folhapress

ARENA MULTIUSO: Torcedor nada em área alagada na arquibancada do Morumbi; São Paulo e Palmeiras empataram (1 a 1) pelo Paulista



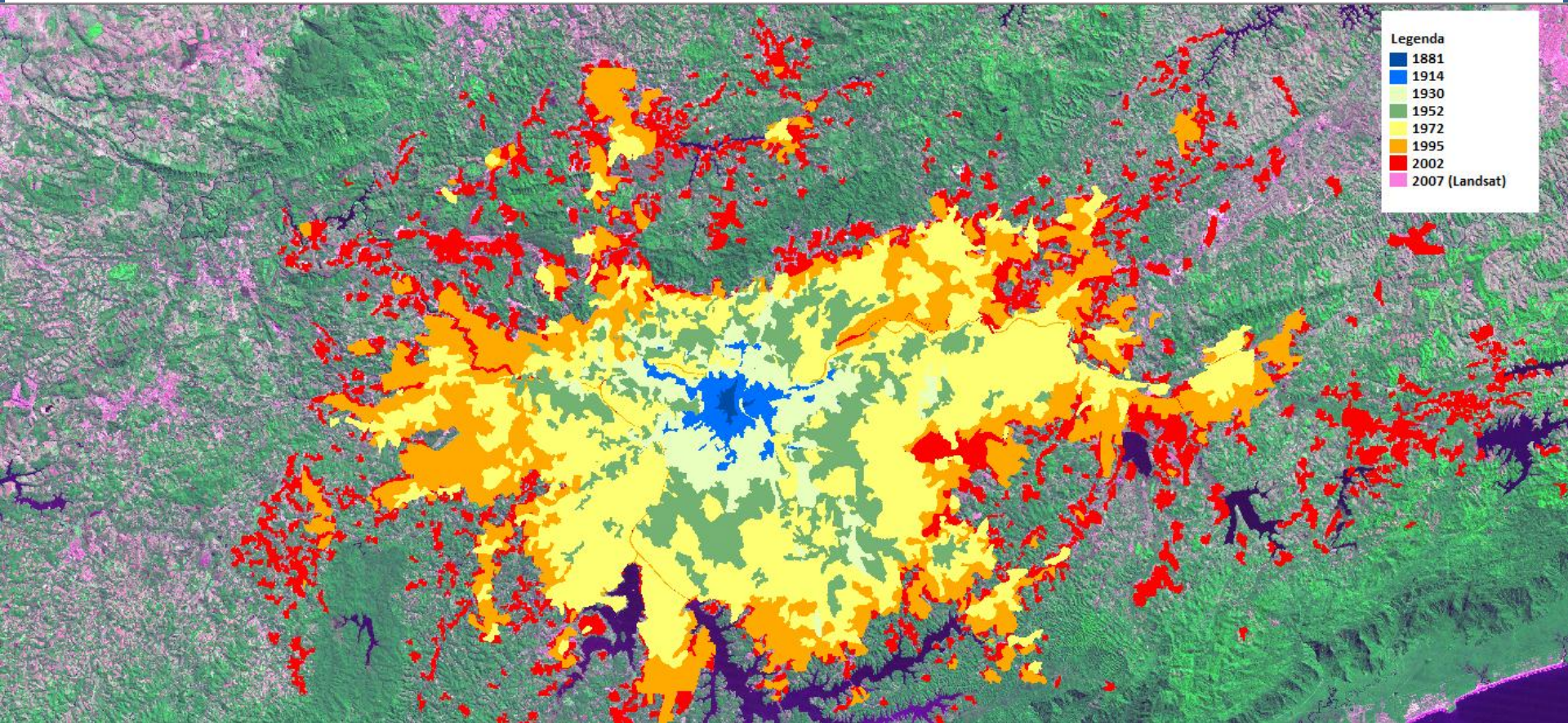
Year averaged rainfall (mm)



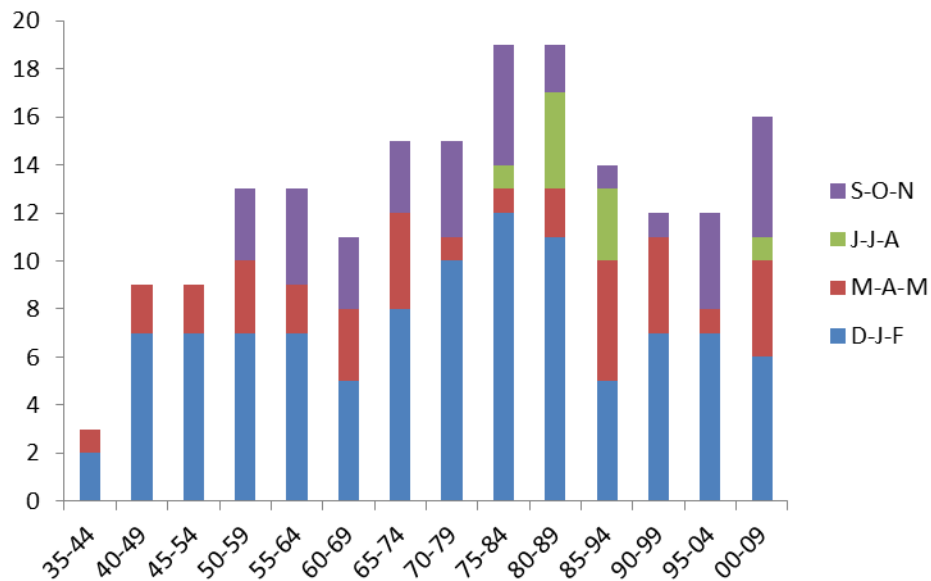
Parque do Estado
Água Funda

Sea surface Temperature (°C

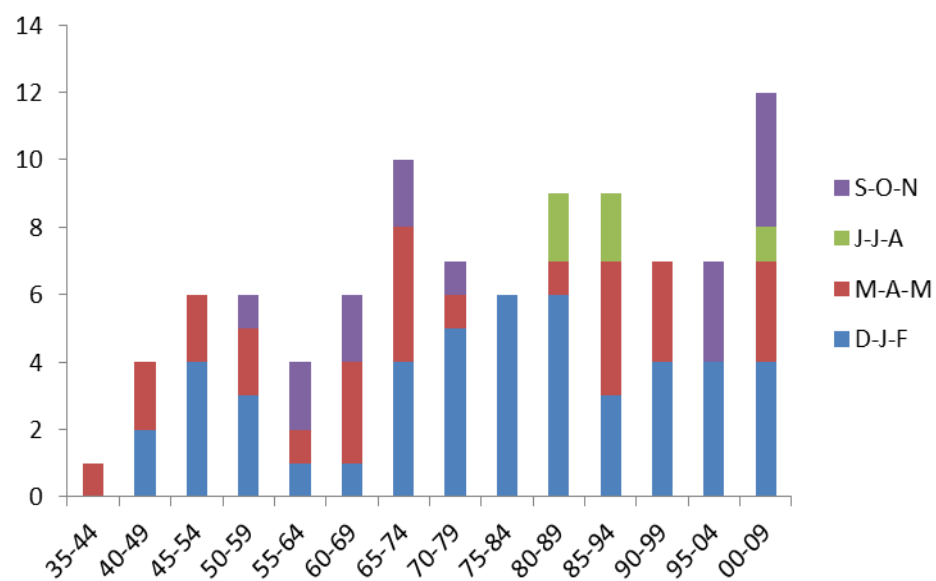
Evolution of the urban area of SPMA from 1891 to 2007



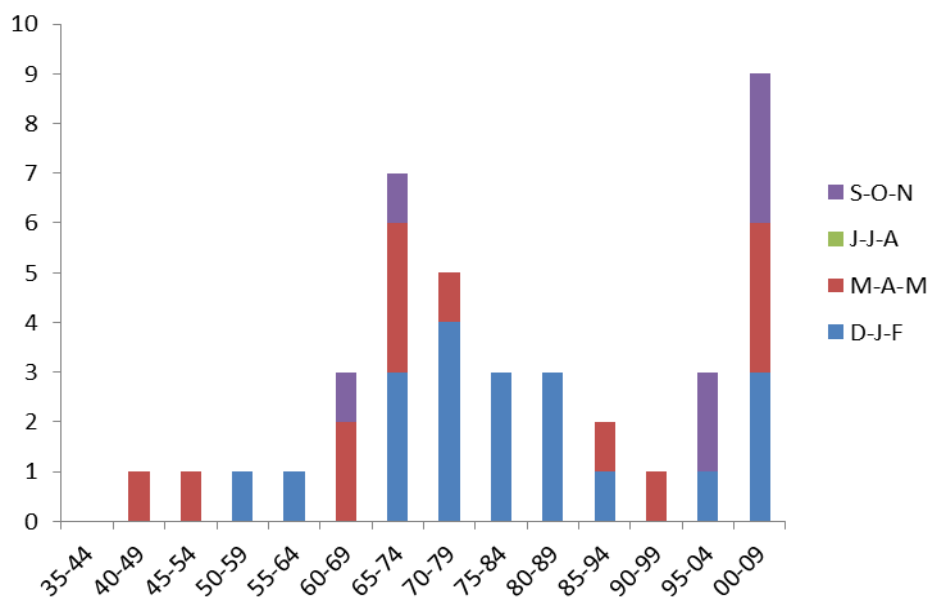
Número de dias em que a chuva excedeu 60mm



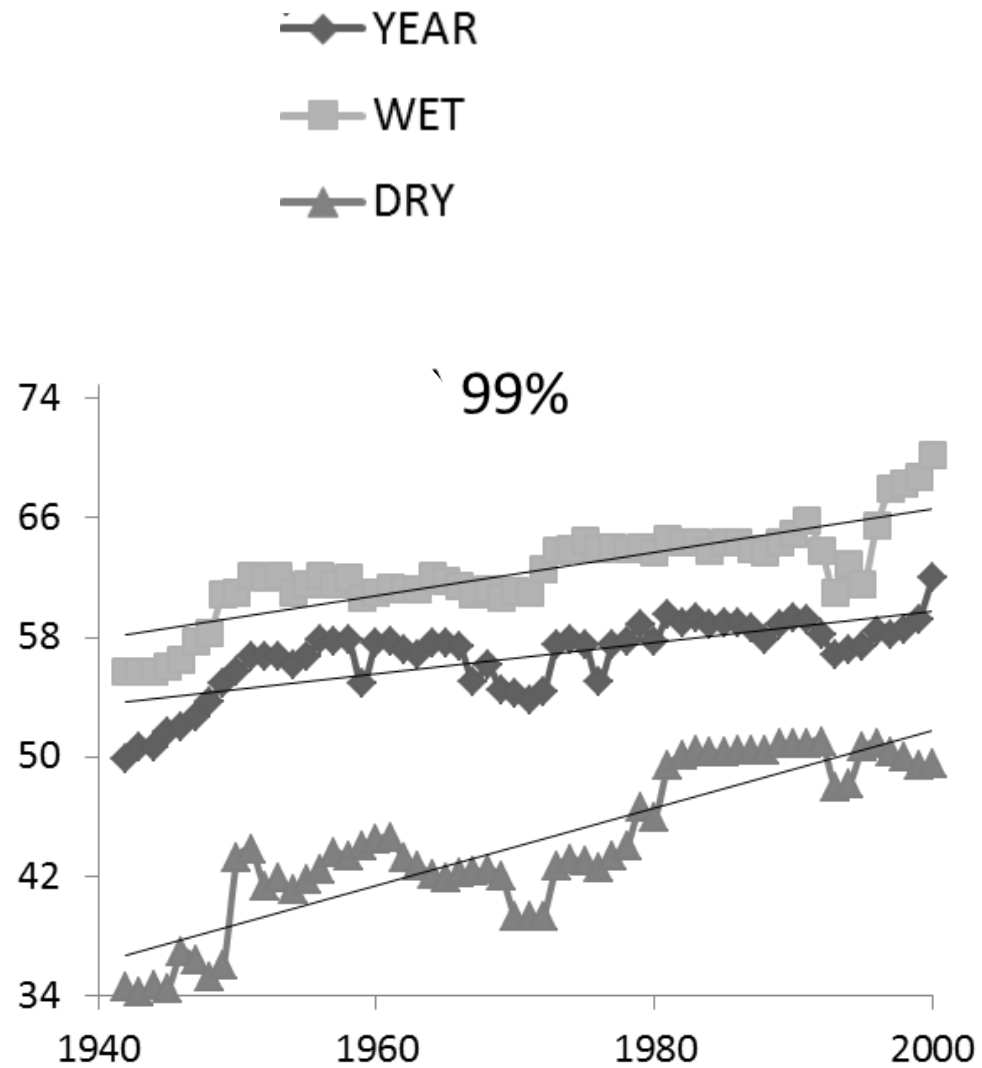
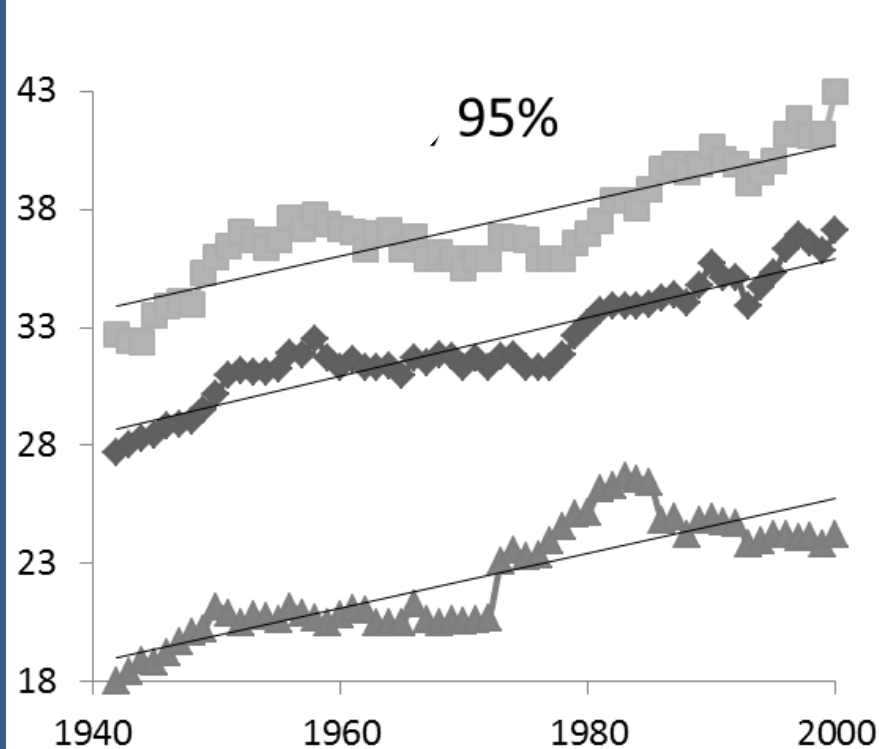
Número de dias em que a chuva excedeu 70mm



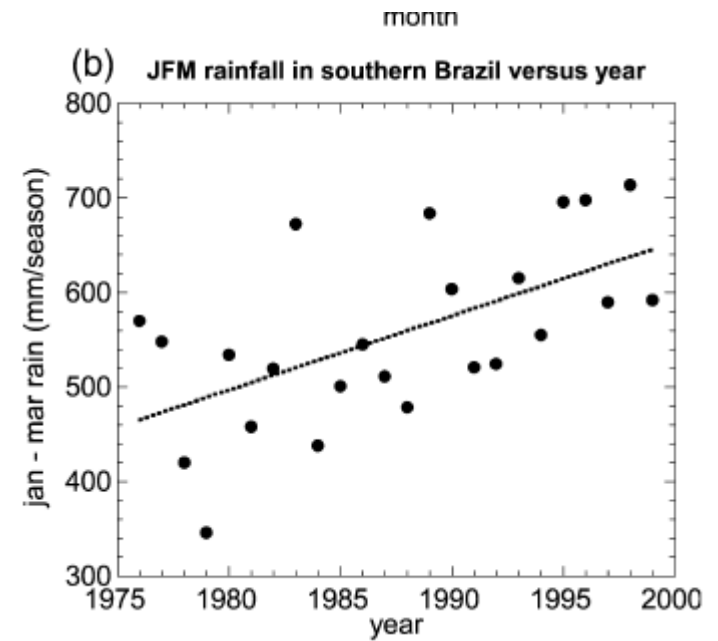
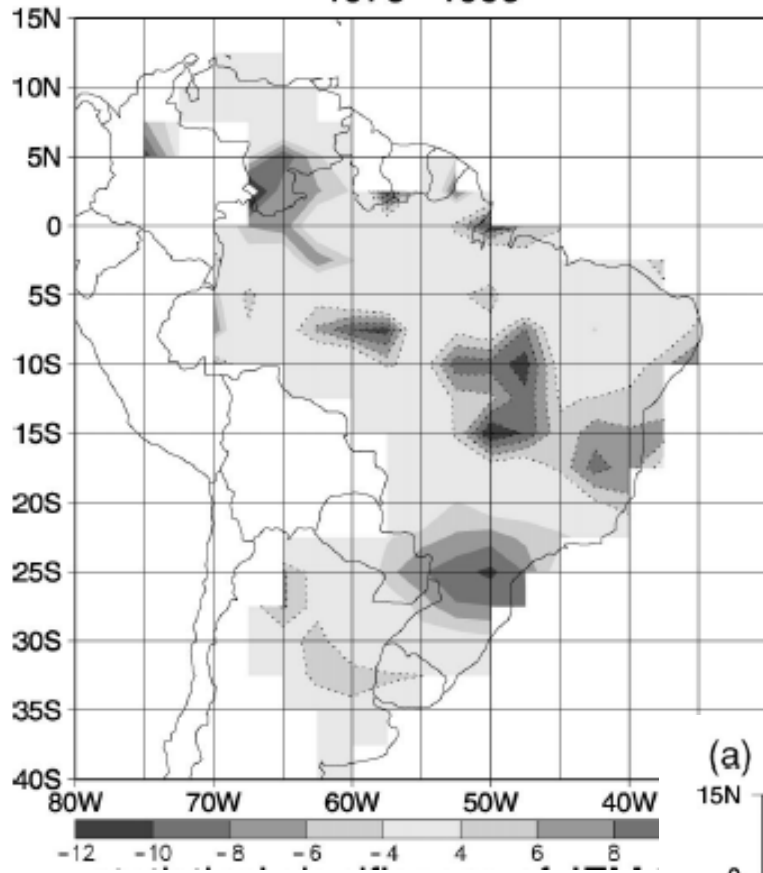
Número de dias em que a chuva excedeu 80mm



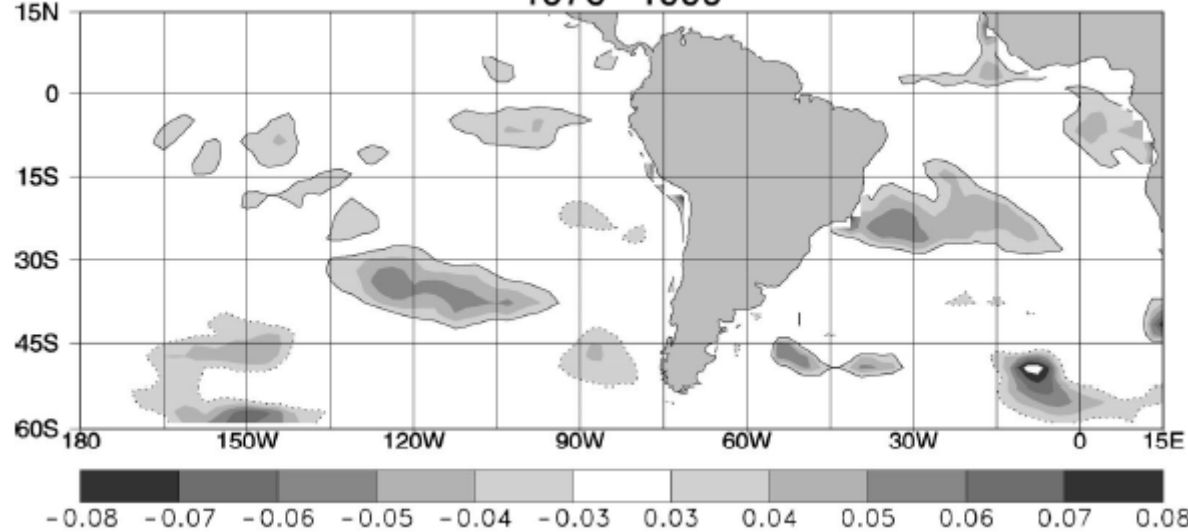
Evolution of the 95% and 99% percentiles of daily rainfall from a 20 year PDF determined every successive year



January - March precipitation trend
1976 - 1999



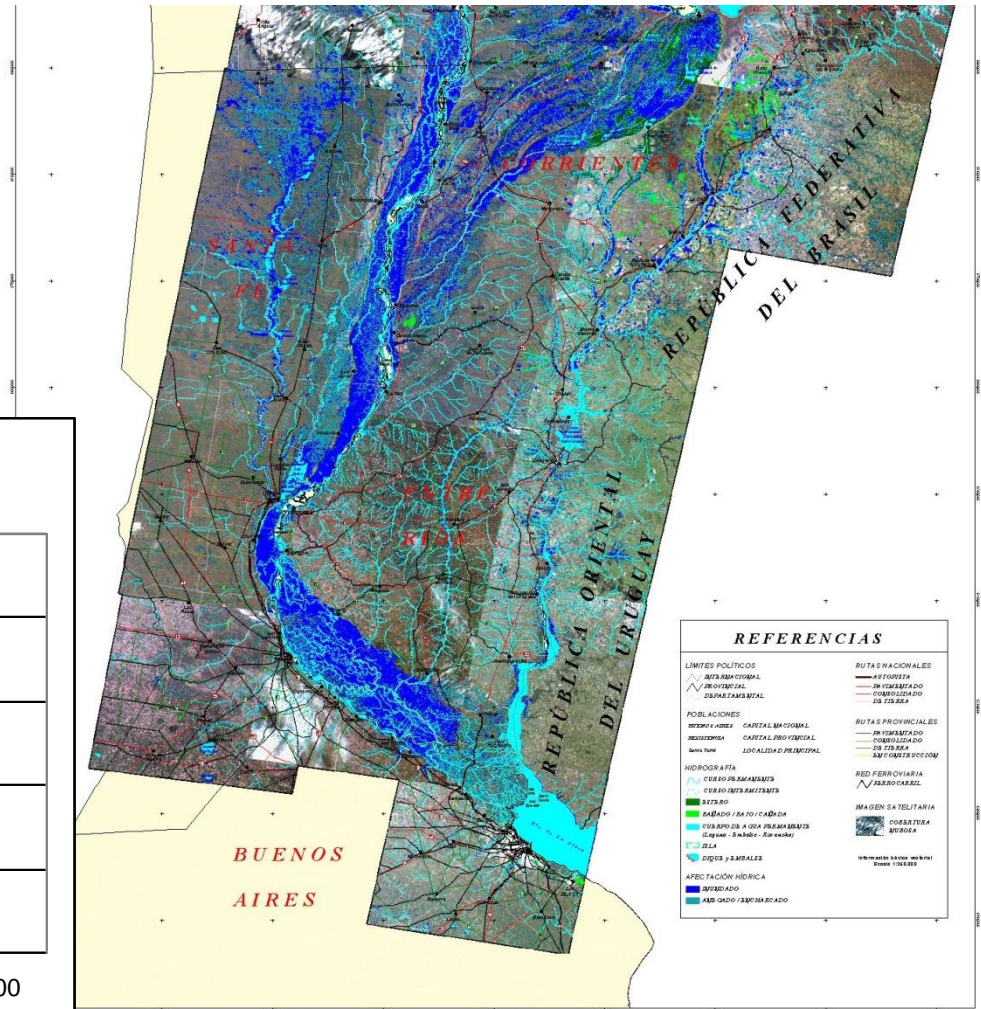
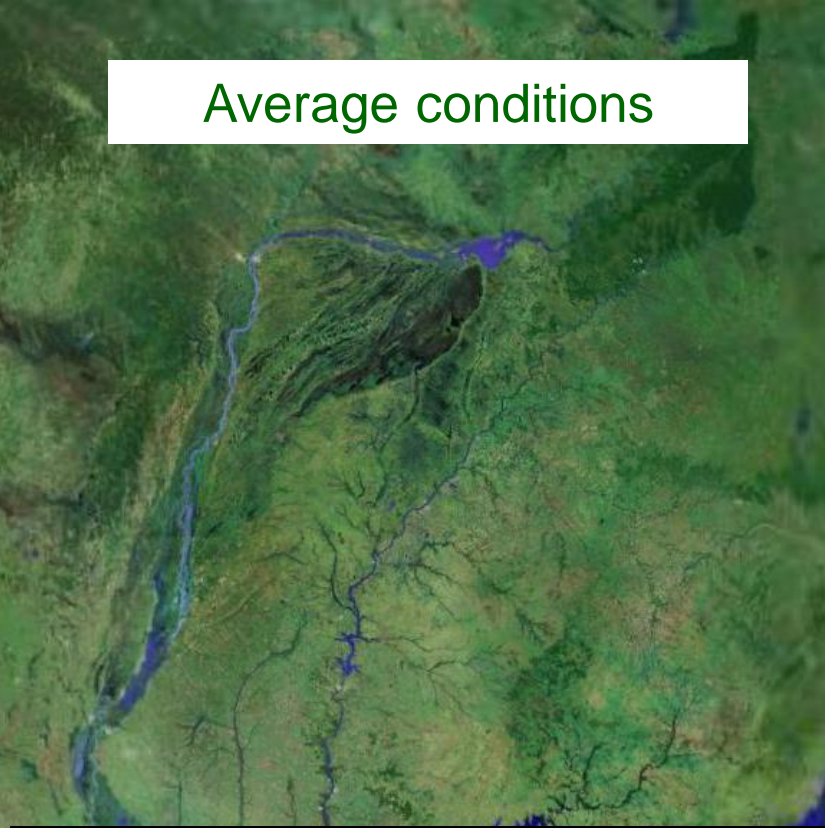
(a) January - March SST trend
1976 - 1999



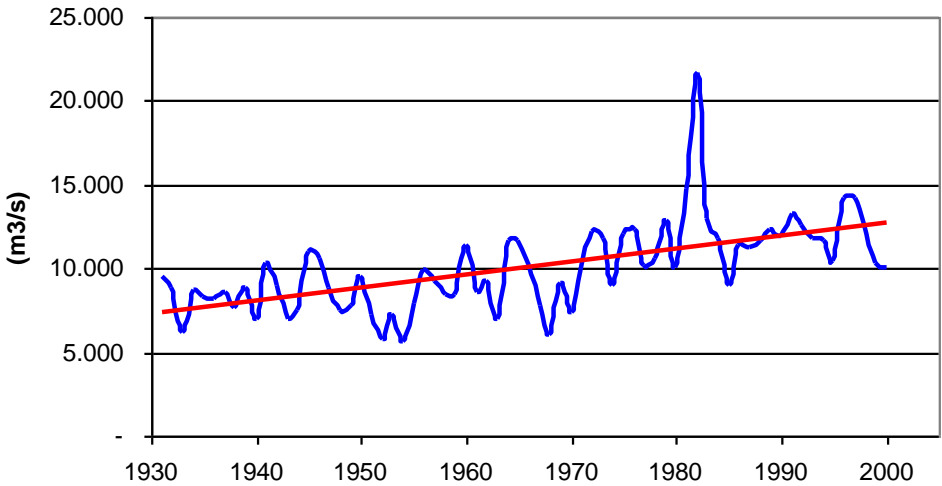
LA PLATA BASIN

Average conditions

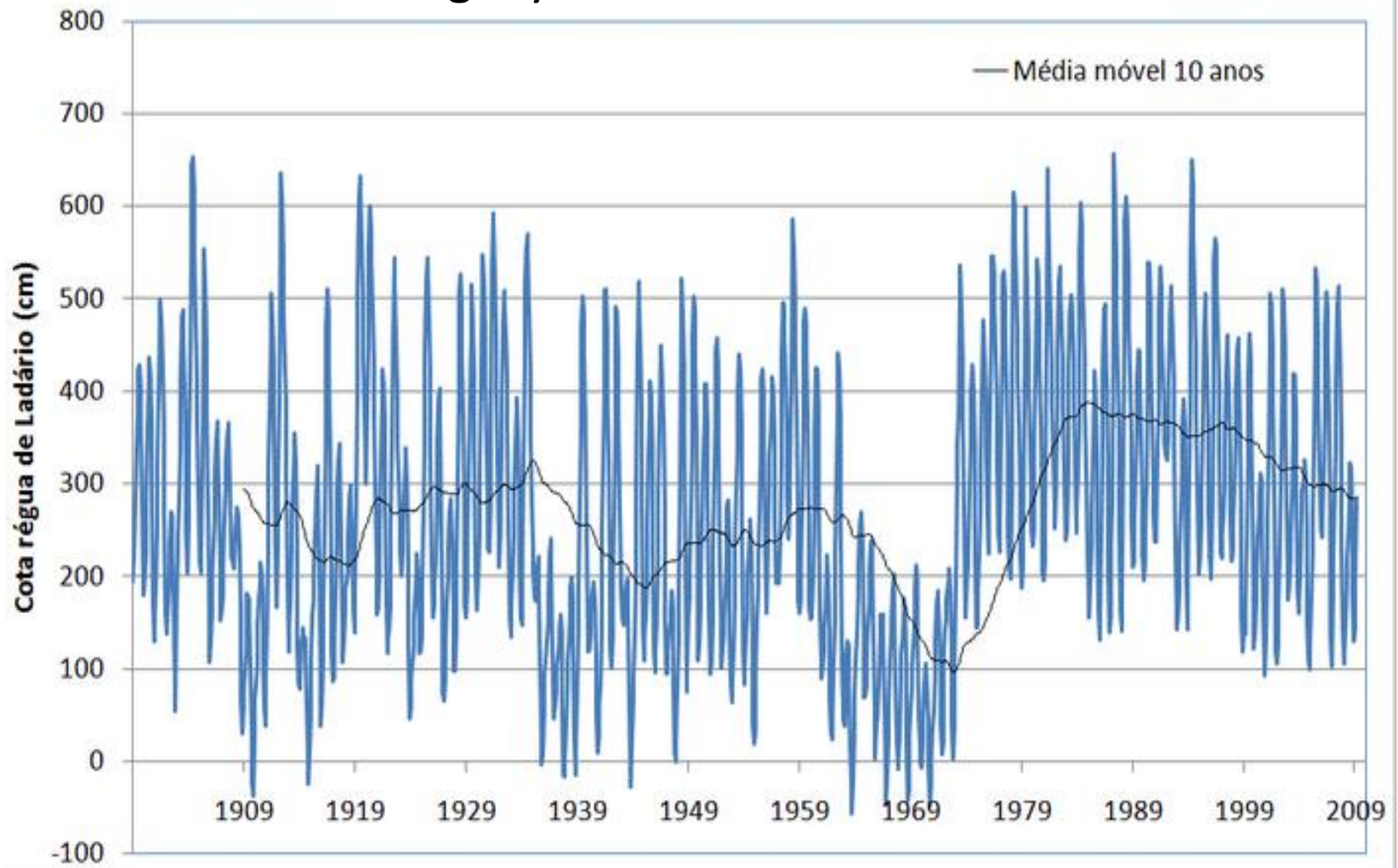
1997/98 Flooding Paraná River



Rio Paraná em Itaipu
Vazões Naturais Médias Anuais

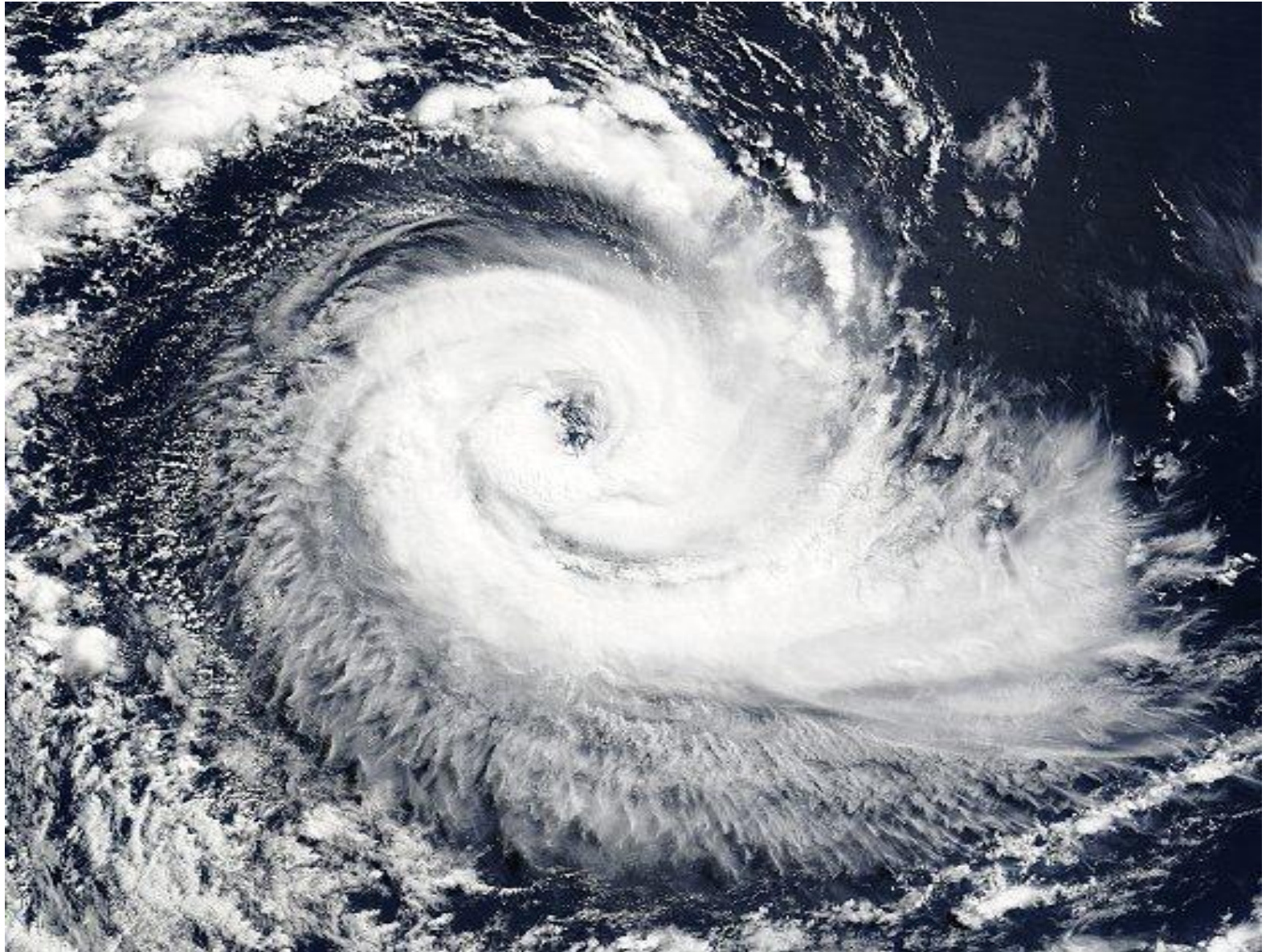


Paraguay river at Ladário



Walter Collichonn et al

Hurricane Catarina 26 March 2004

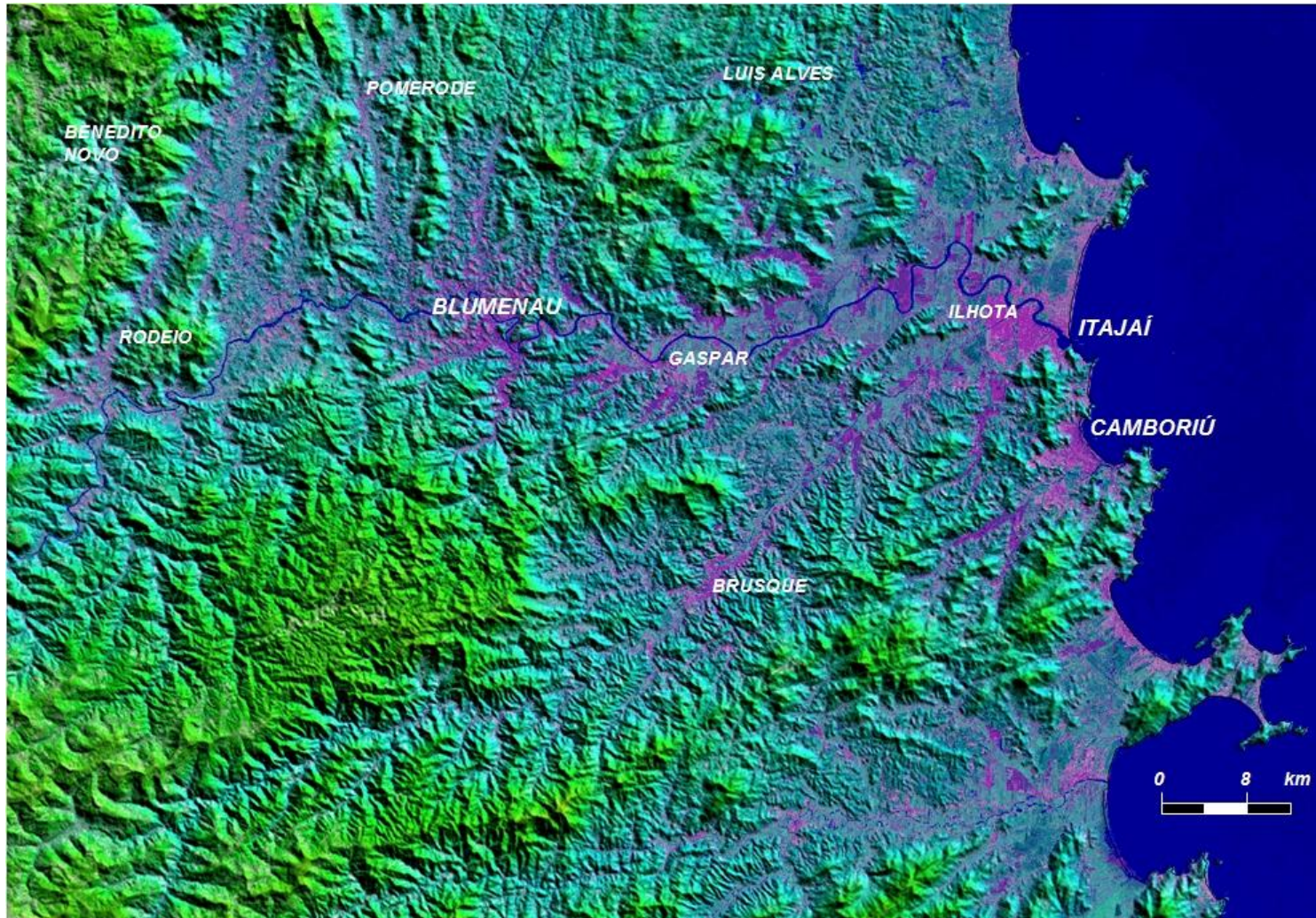




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Landslides in Santa Catarina November 2008



Balneário Camboriu

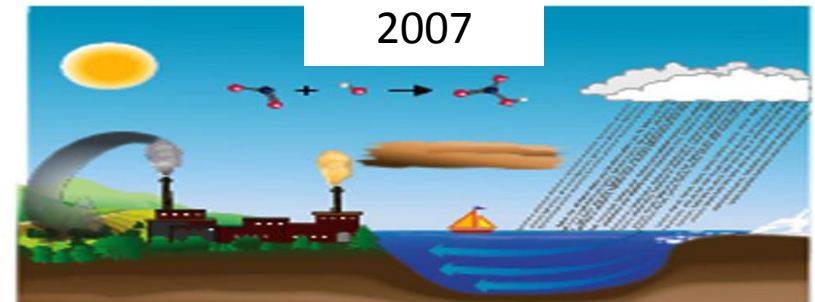
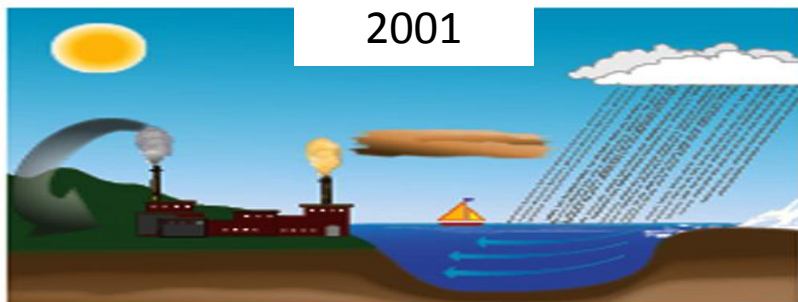
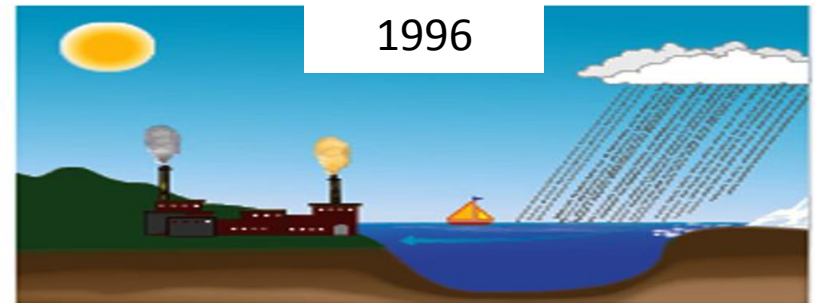
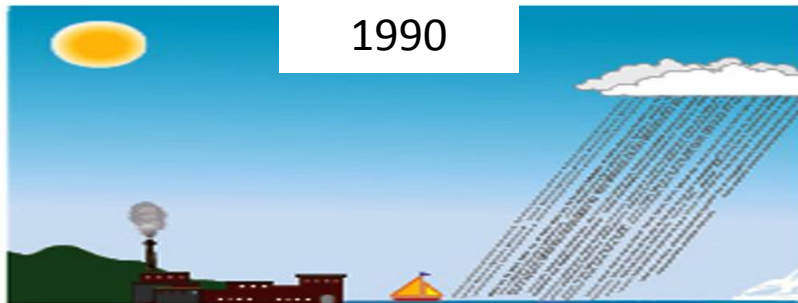


Blumenau

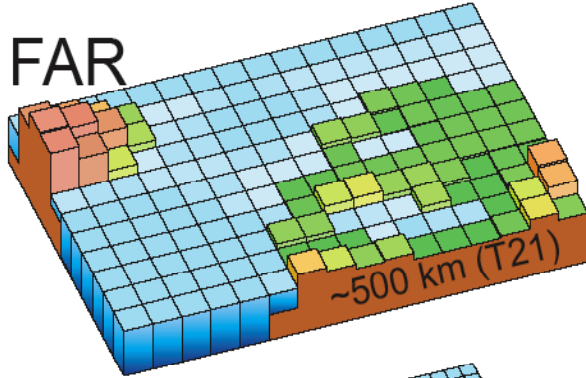


CAUSE ATRIBUTION OF THE OBSERVED CHANGES

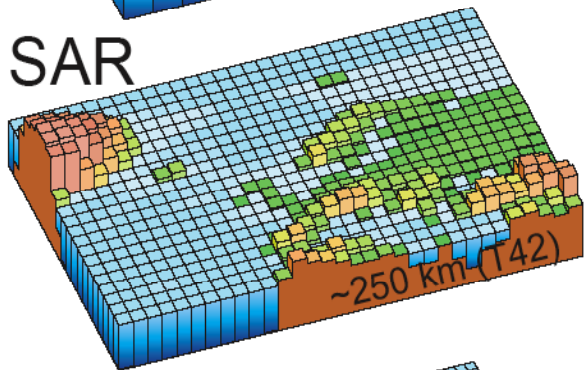
The world according to climate models



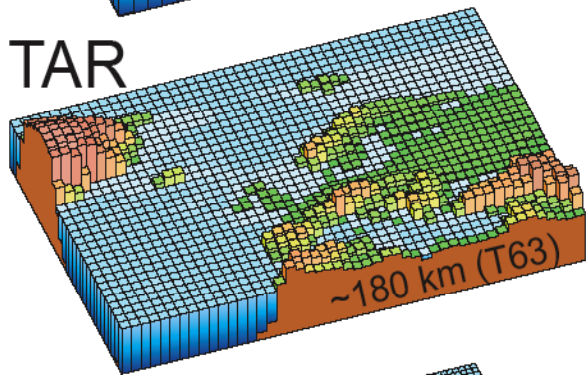
FAR



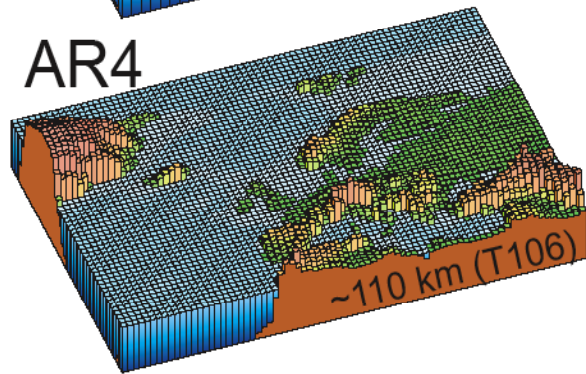
SAR



TAR



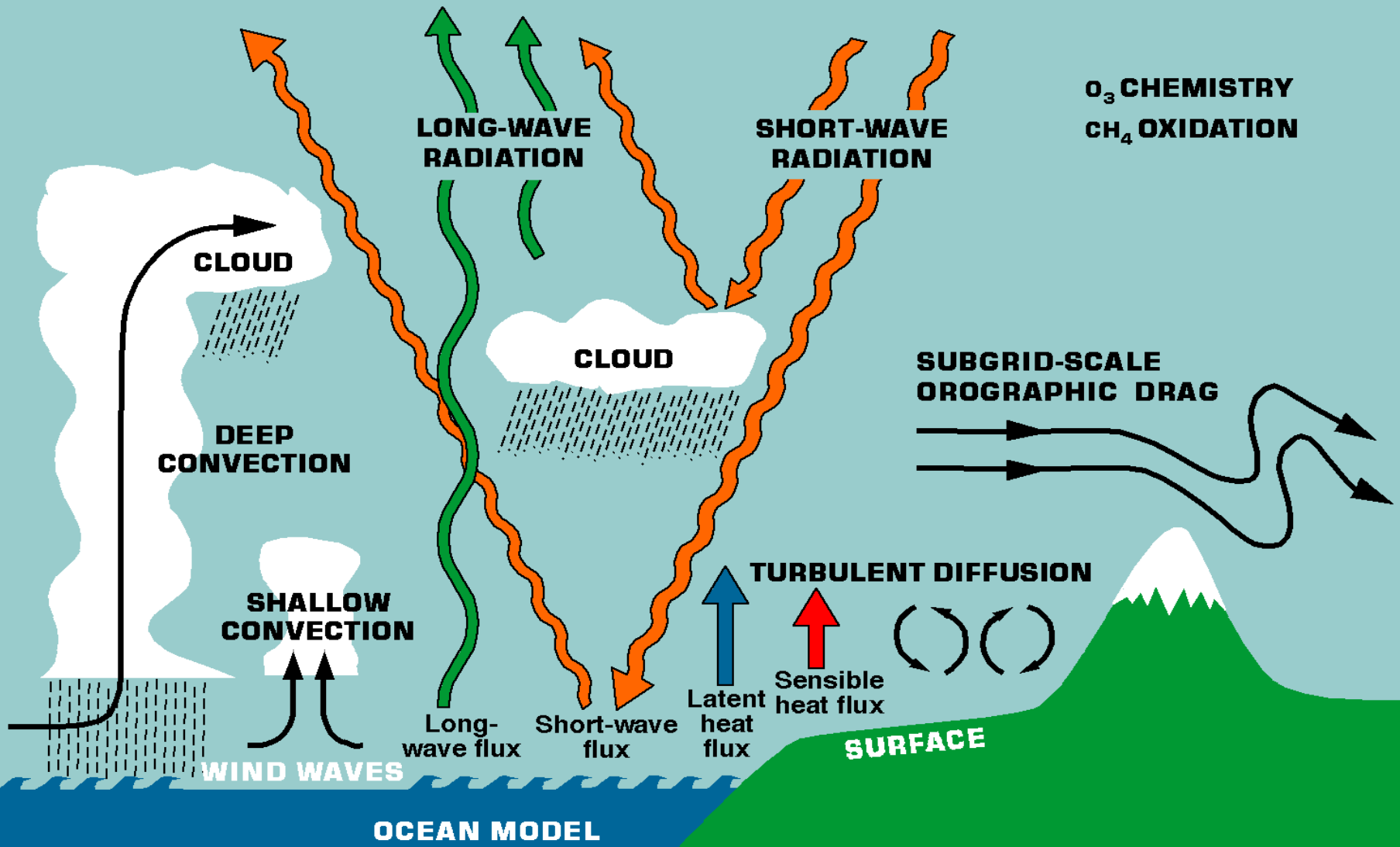
AR4



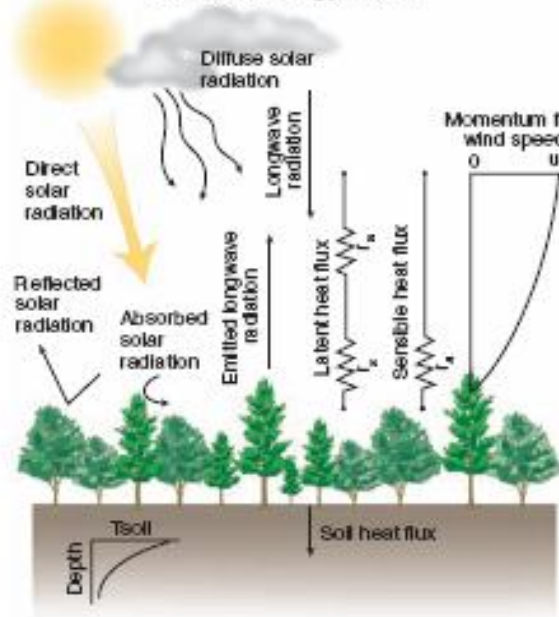
*FAR (1990),
SAR (1996),
TAR (2001) e
AR4 (2007).*

***Grid evolution tied to computer
power evolution***

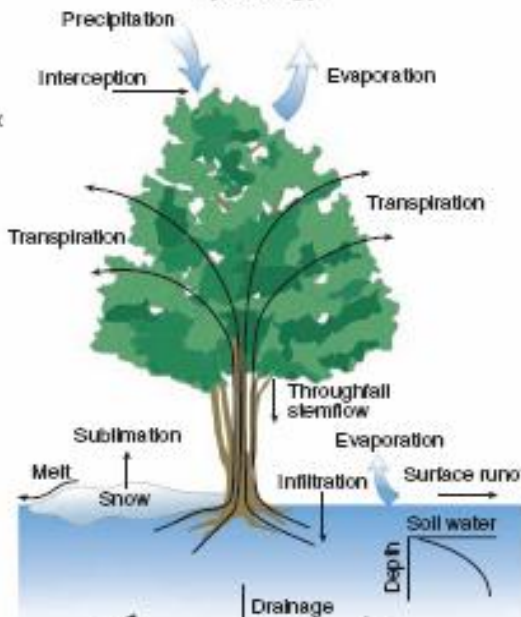
Modeling Physical Processes



A Surface energy fluxes



B Hydrology



C Carbon Cycle

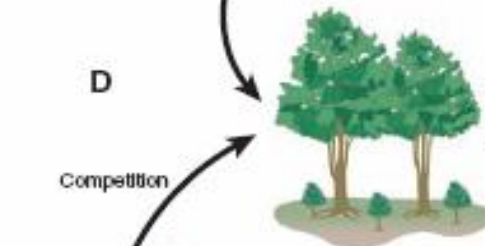


F



Urbanization

D



Vegetation dynamics

Competition

Growth

E



Deforestation

Land use

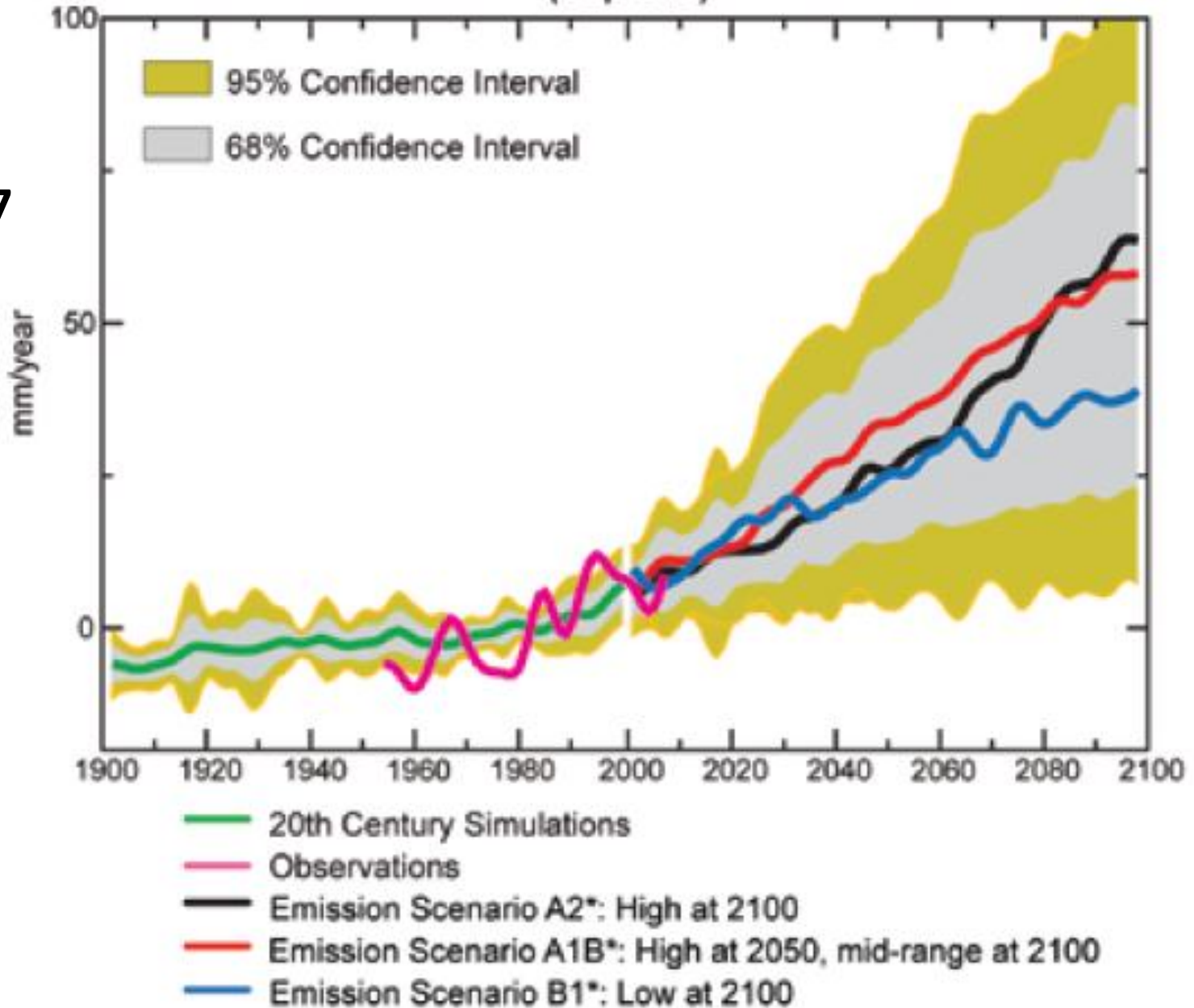
Farm abandonment

Establishment

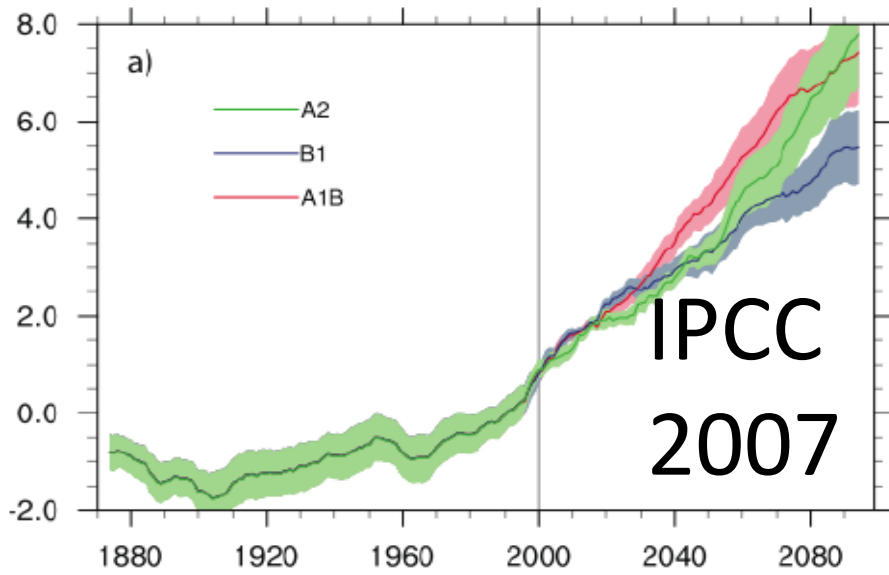
IPCC 2007

Increase in Heavy Daily Precipitation (Top 5%)

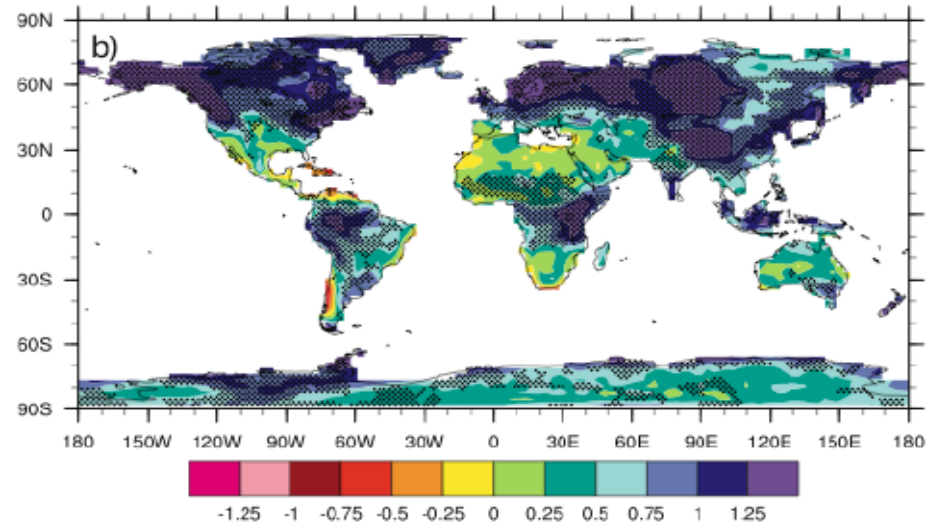
IPCC
2007



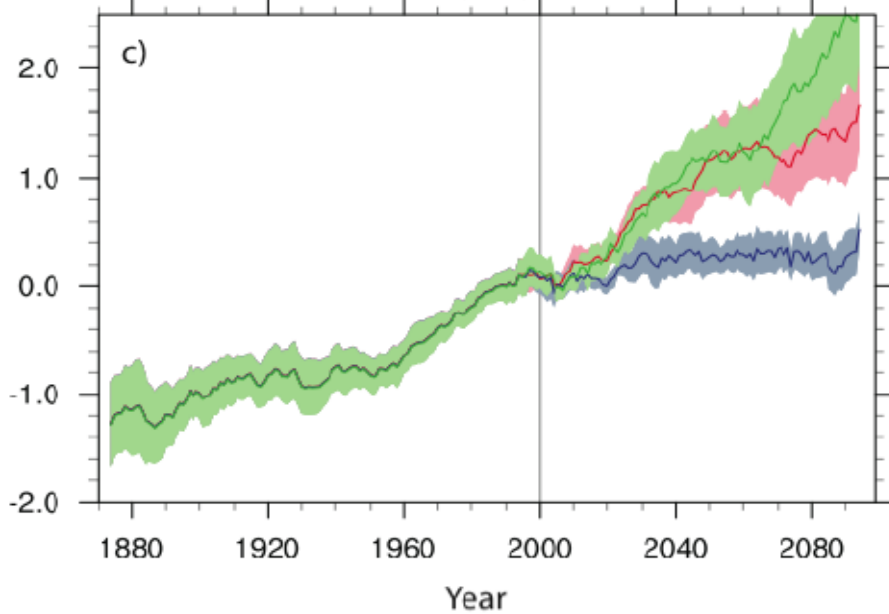
Precipitation intensity



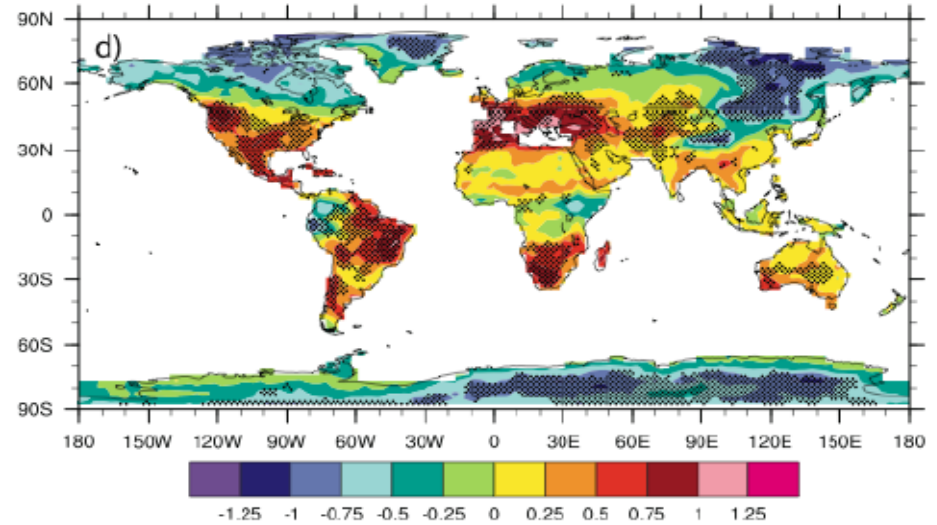
Precipitation intensity



Dry days

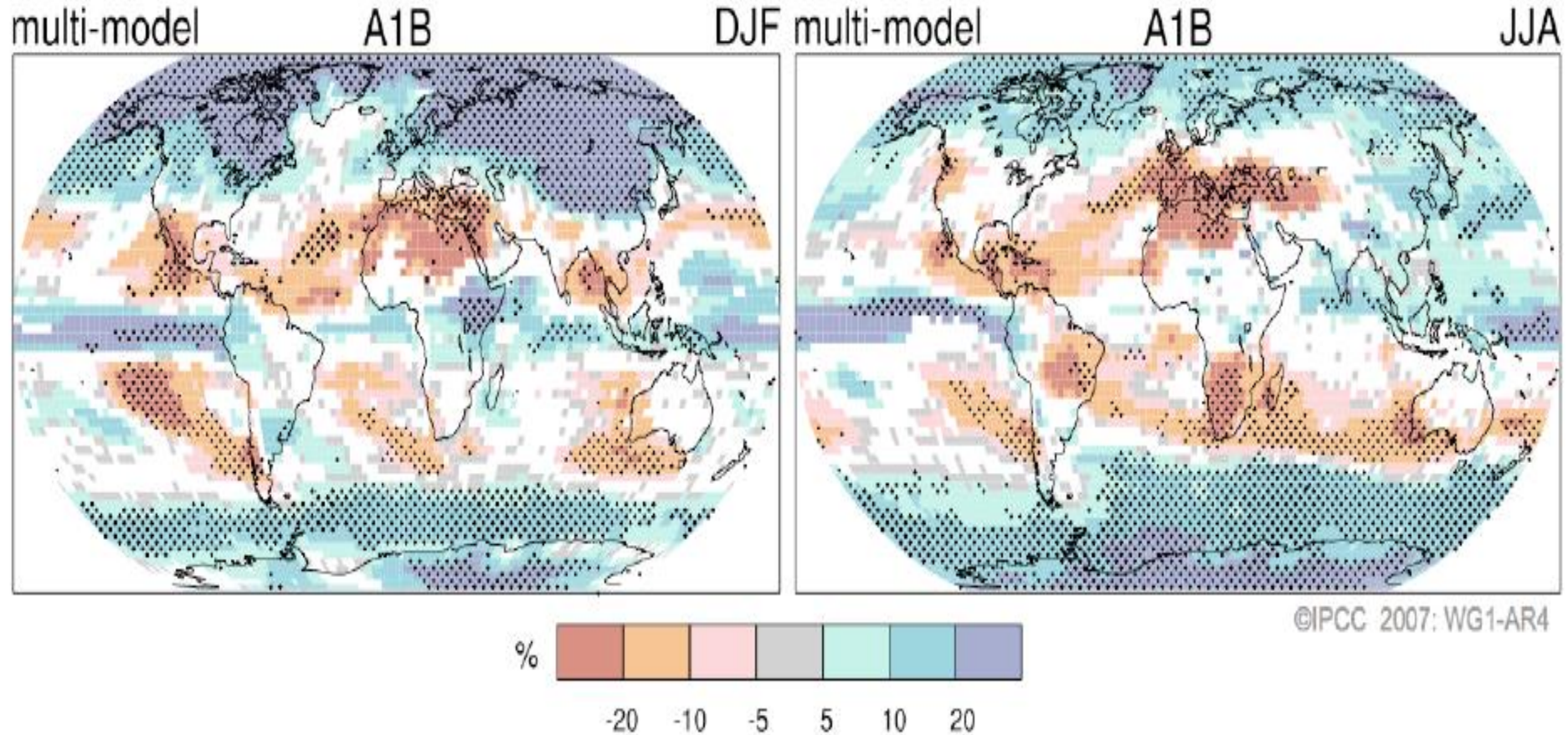


Dry days



Eventos Extremos

Projected Patterns of Precipitation Changes

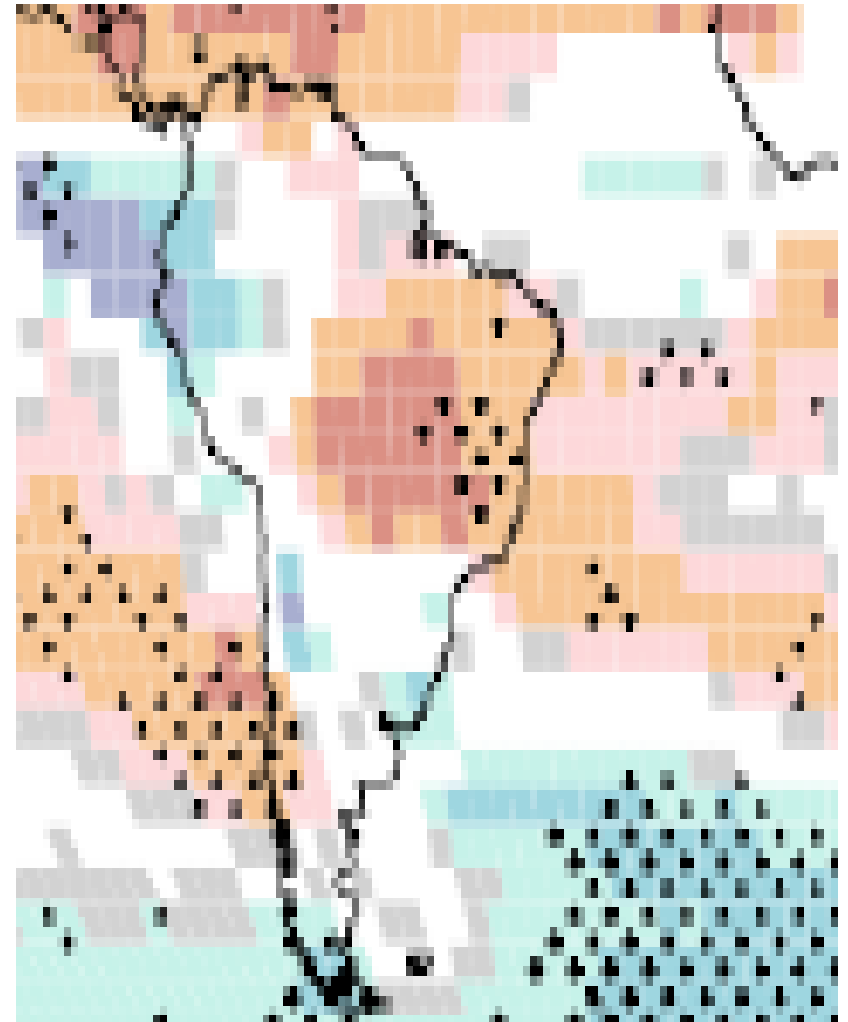
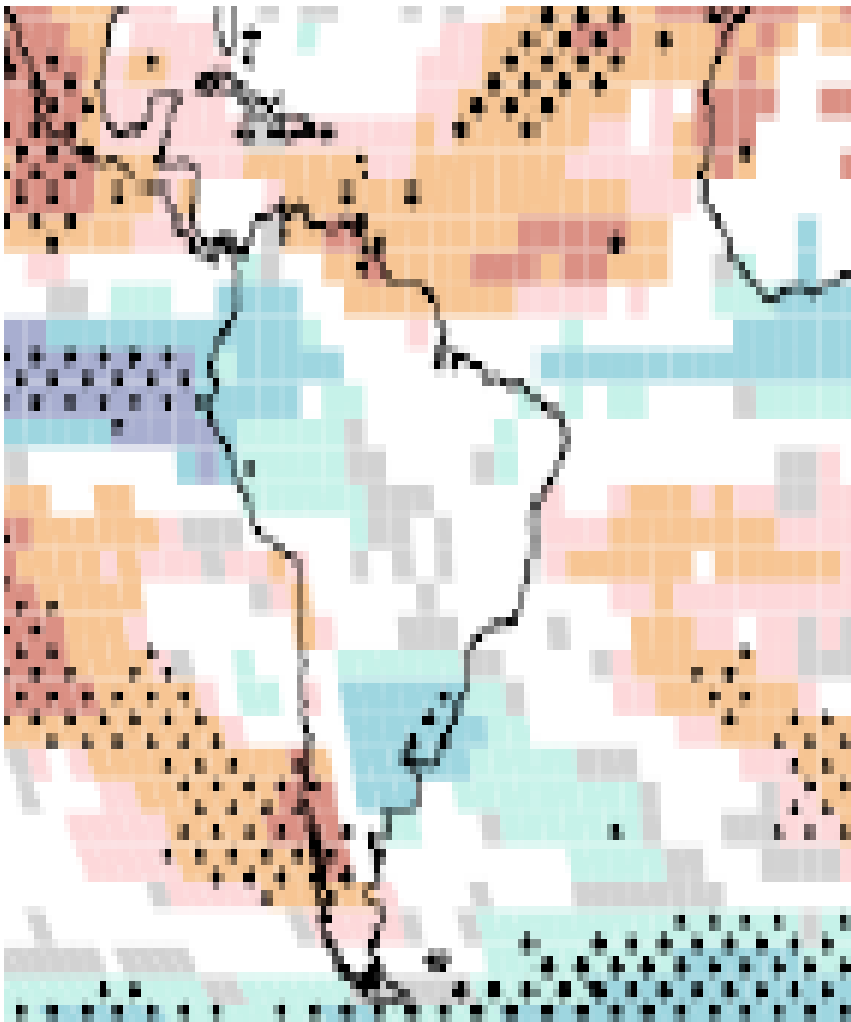


Relative changes in precipitation (in percent) for the period 2090–2099, relative to 1980–1999. Values are multi-model averages based on the SRES A1B scenario for December to February (left) and June to August (right). White areas are where less than 66% of the models agree in the sign of the change and stippled areas are where more than 90% of the models agree in the sign of the change.

IPCC
2007

DJF

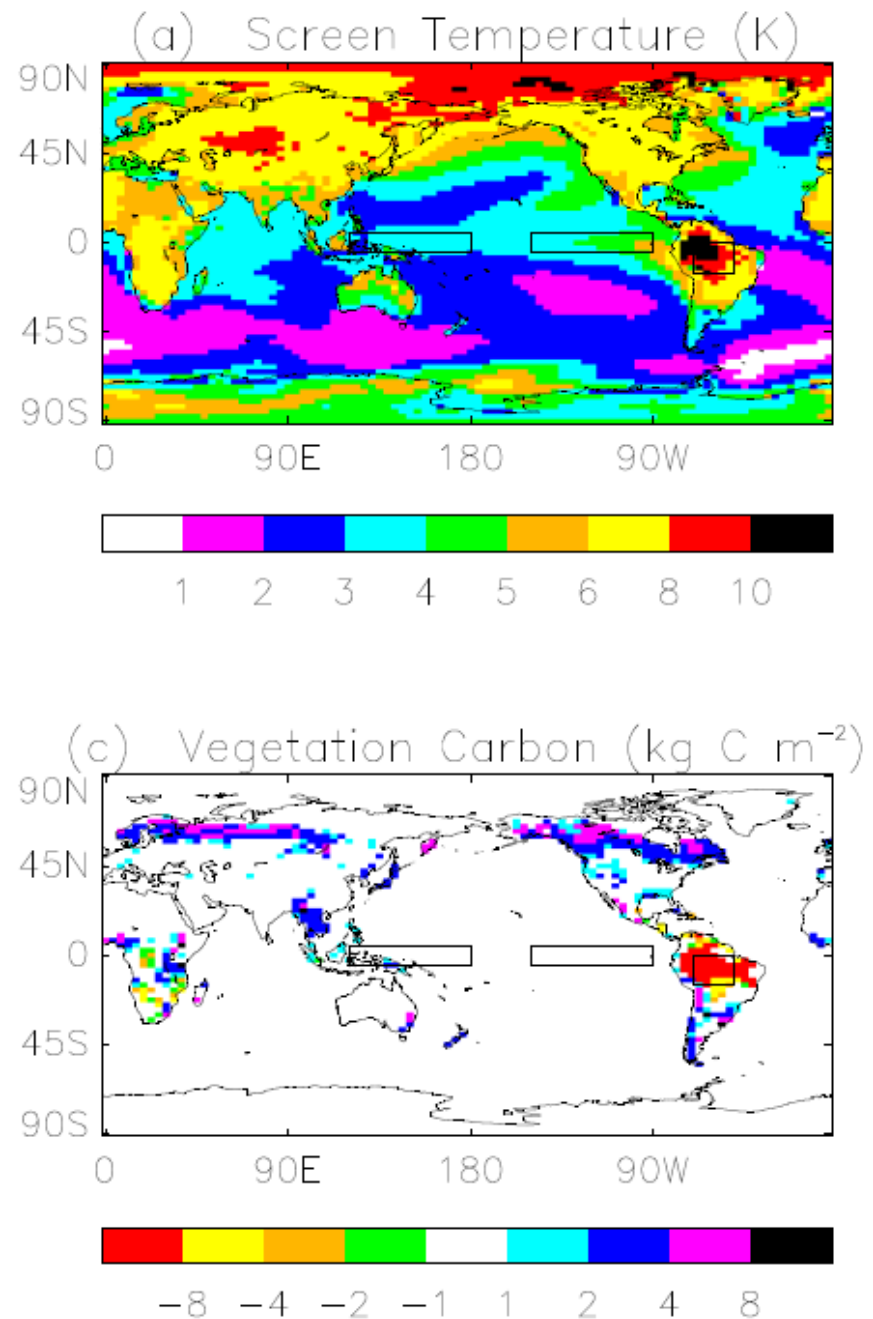
JJA



Cox PM, Betts RA, Collins M, Harris PP, Huntingford C, Jones C. **2004**.

Amazonian forest dieback under climate-carbon cycle projections for the 21st century.

Theoretical and Applied Climatol. 78: 137–156.





ECONOMIA DAS MUDANÇAS CLIMÁTICAS NO BRASIL

Estimativas da Oferta de Recursos Hídricos no Brasil em Cenários Futuros de Clima (2015 – 2100)

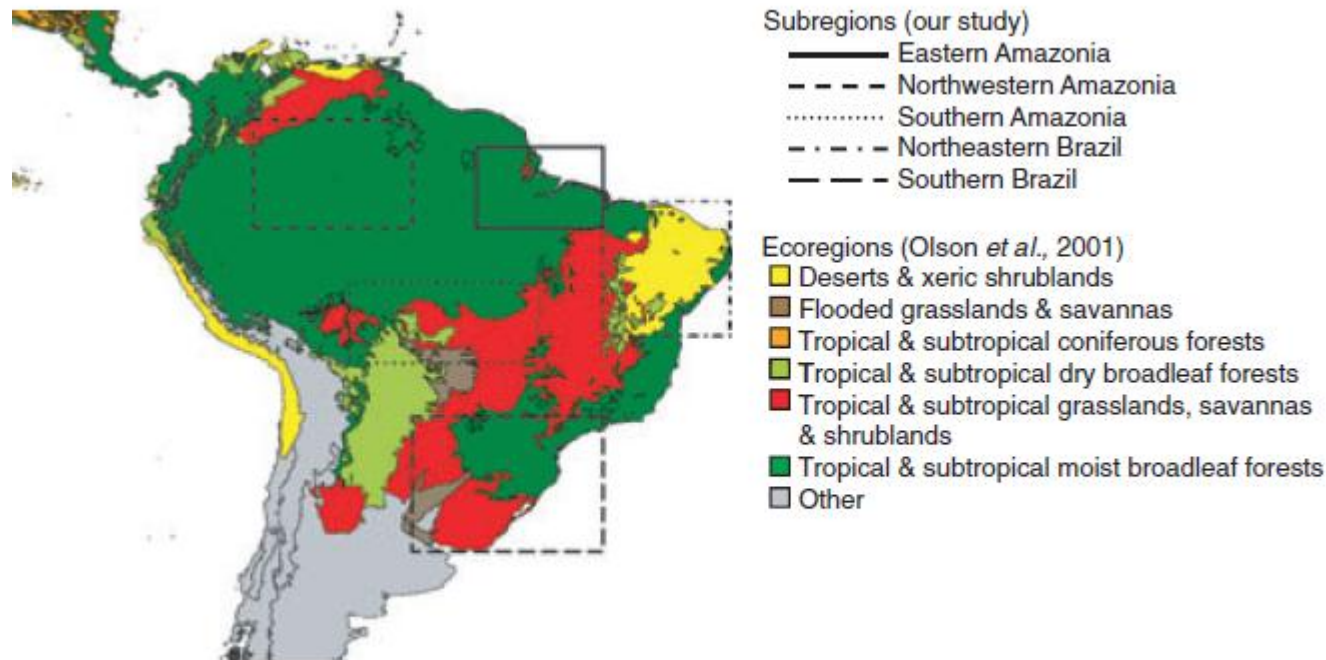
Sub-Projeto: Efeitos das Mudanças Climáticas Globais na Disponibilidade de Recursos Hídricos no Brasil

Balço Hídrico no Brasil e Determinação e Verificação dos Métodos para os Cálculos de Balço Hídrico do Futuro

Estimating the risk of Amazonian forest dieback

Anja Rammig¹, Tim Jupp², Kirsten Thonicke¹, Britta Tietjen¹, Jens Heinke¹, Sebastian Ostberg¹, Wolfgang Lucht¹, Wolfgang Cramer¹ and Peter Cox²

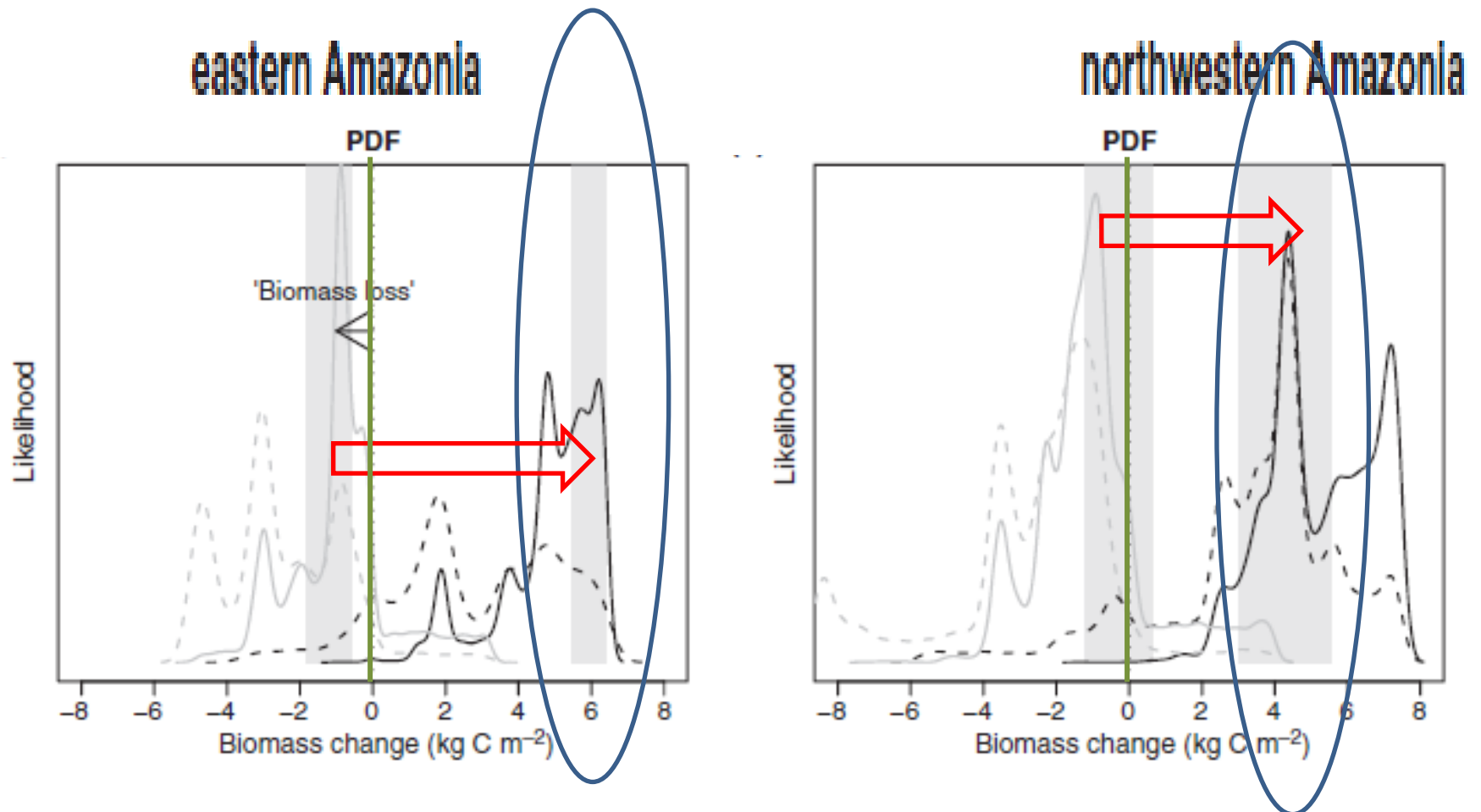
2010



Three steps

- ❑ Define *index* based on how well a climate simulation reproduces the present climate
- ❑ Perform weighed average of RAINFALL from all climate projections using *index* as weighting factor
- ❑ Feed a dynamic vegetation model with resulting rainfall

Biomass change for weighted vs non weighted average rainfall: from loss to gain

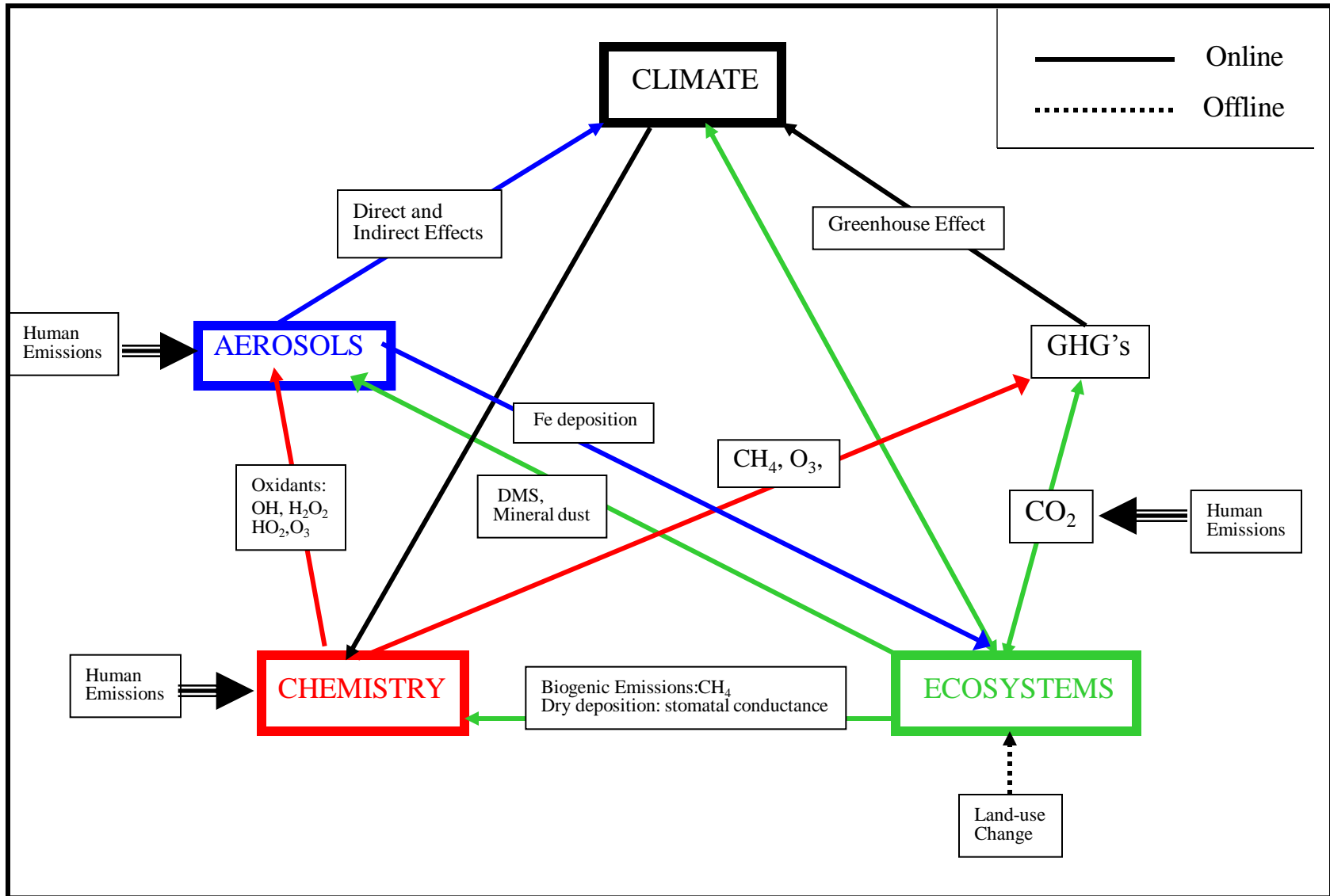


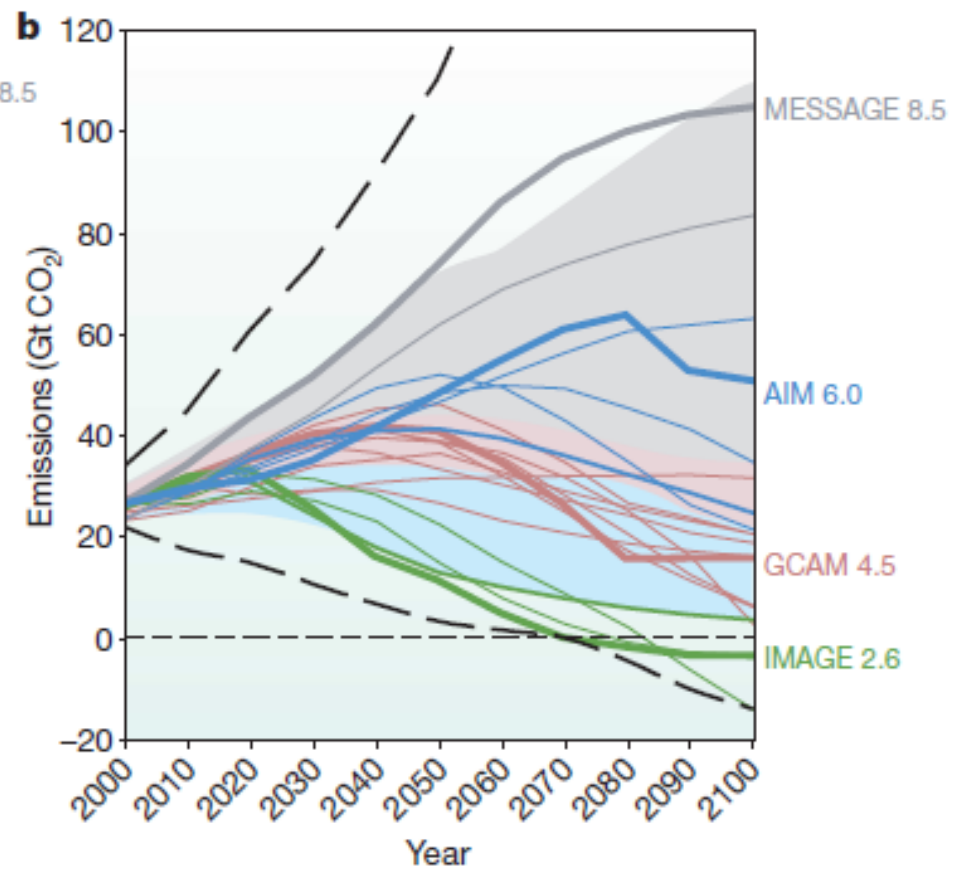
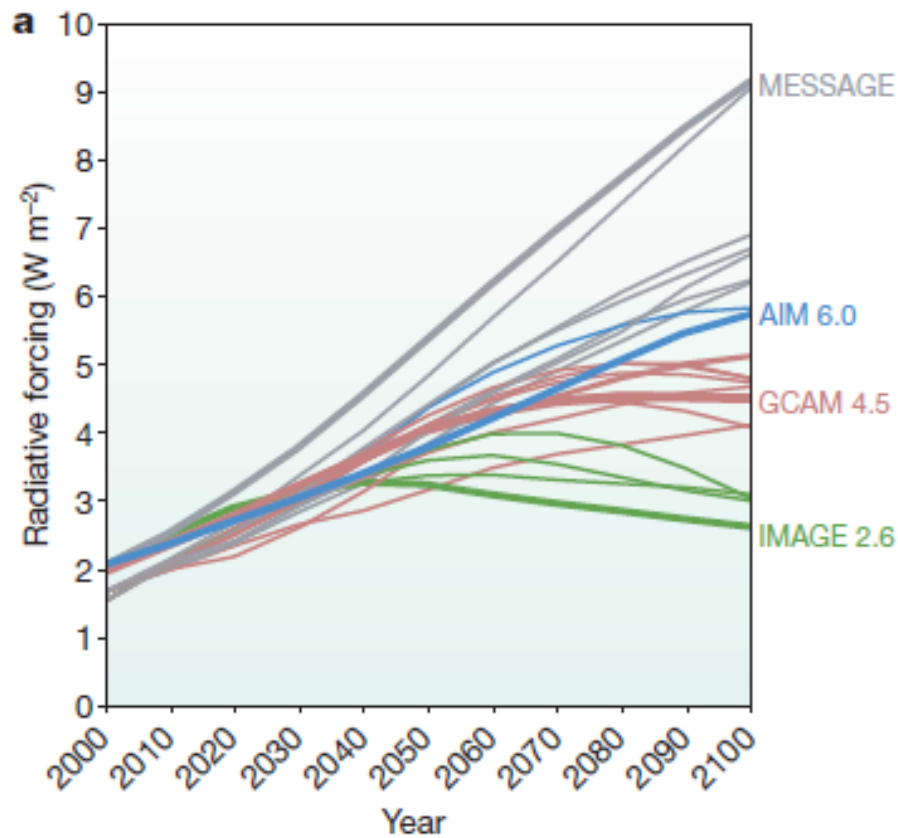
2011

The Hadley Centre Earth System Model (HadGEM2-ES) for Climate Impacts

Jemma Gornall, Richard Betts, Ron
Kahana, Nicola Golding, Paul Halloran
and Andy Wiltshire

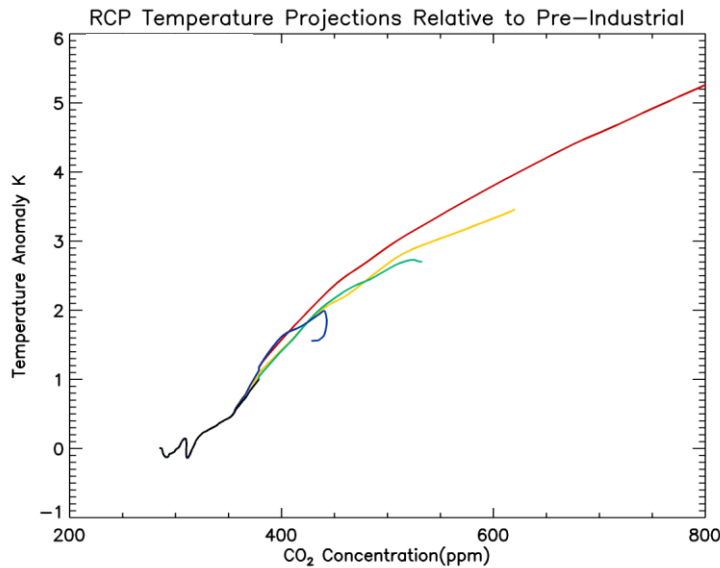
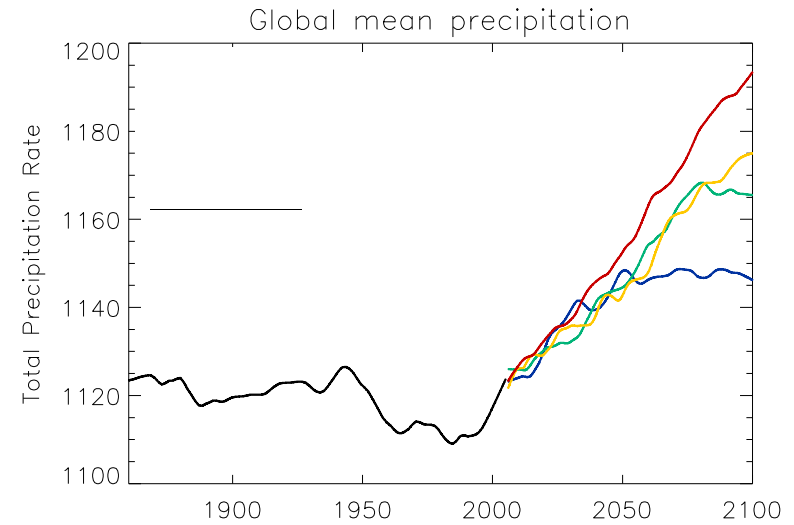
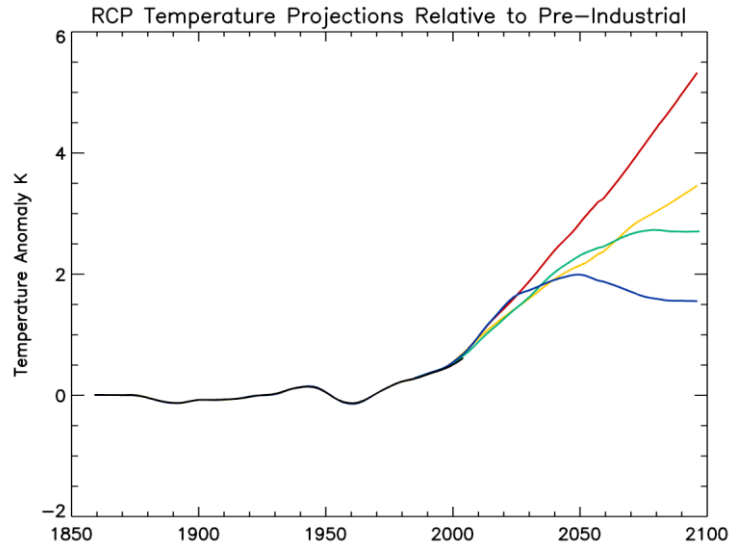
The climate system – HadGEM2





Name	Radiative forcing	Concentration (p.p.m.)	Pathway	Model providing RCP*	Reference
RCP8.5	>8.5 W m ⁻² in 2100	>1,370 CO ₂ -equiv. in 2100	Rising	MESSAGE	55,56
RCP6.0	~6 W m ⁻² at stabilization after 2100	~850 CO ₂ -equiv. (at stabilization after 2100)	Stabilization without overshoot	AIM	57,58
RCP4.5	~4.5 W m ⁻² at stabilization after 2100	~650 CO ₂ -equiv. (at stabilization after 2100)	Stabilization without overshoot	GCAM	48,59
RCP2.6	Peak at ~3 W m ⁻² before 2100 and then declines	Peak at ~490 CO ₂ -equiv. before 2100 and then declines	Peak and decline	IMAGE	60,61

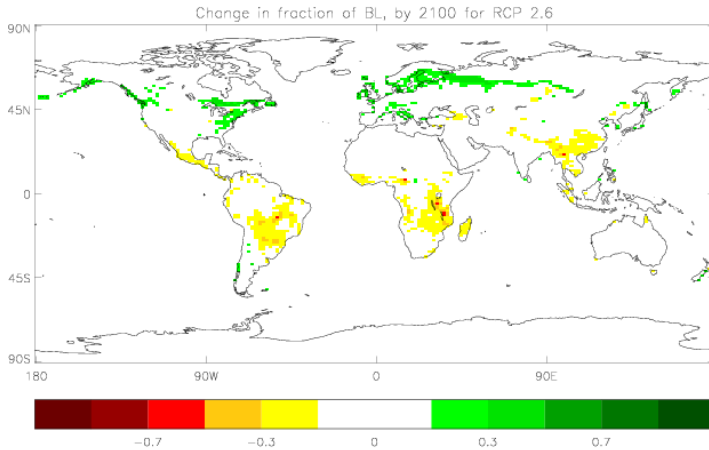
Global climate



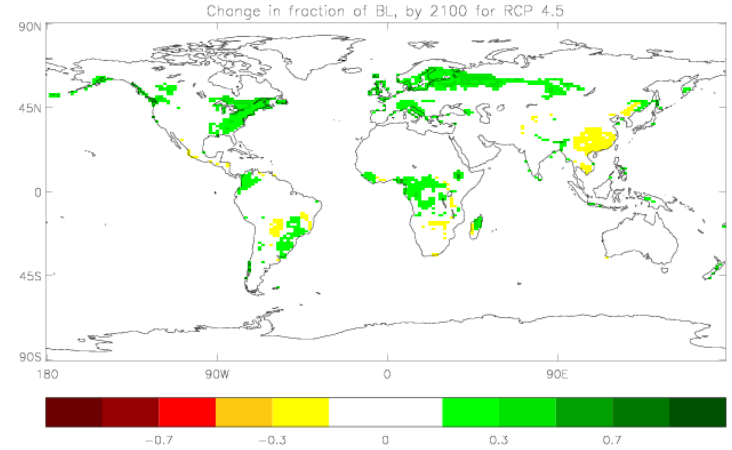
- Historic
- 2.6
- 4.5
- 6.0
- 8.5

Broad-leaf Tree Fraction

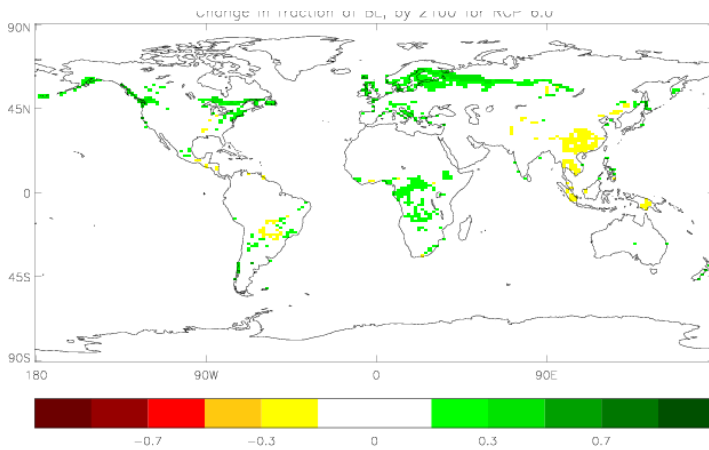
2.6



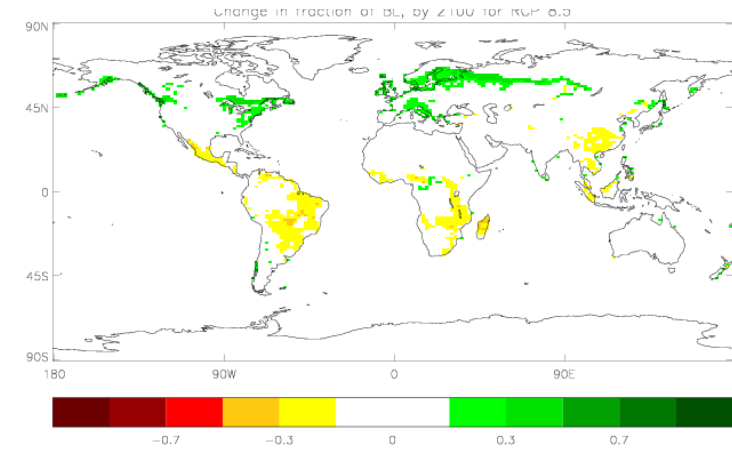
4.5



6.0



8.5



Critical points

- Uncertainty is due to
 - Rainfall simulation in climate models
 - Biomass behavior in dynamic vegetation models
 - changes in rainfall
 - high CO₂ concentration

Uncertainty reduction in future climate projections

- Use models that reproduce main features of past and present climate
- Use model differences as a measure of uncertainty



Thank you!







ECONOMIA DAS MUDANÇAS CLIMÁTICAS NO BRASIL

Estimativas da Oferta de Recursos Hídricos no Brasil em Cenários Futuros de Clima (2015 – 2100)

Sub-Projeto: Efeitos das Mudanças Climáticas Globais na Disponibilidade de Recursos Hídricos no Brasil

Balço Hídrico no Brasil e Determinação e Verificação dos Métodos para os Cálculos de Balço Hídrico do Futuro

5.3 Conclusões relativas aos dados provenientes das análises dos climas futuros para o modelo HadRM3P na escala de 50 km X 50 km

Pelos resultados obtidos, observa-se que as vazões das bacias hidrográficas do Tocantins, Atlântico NE Ocidental, Parnaíba e Amazônica, terão uma considerável diminuição até 2100 para os dois cenários de emissão analisados.

Observa-se uma diminuição dos valores das vazões da bacia do Paraná no período de 2011 a 2070 para os dois cenários de emissão analisados e um aumento da vazão no período de 2071 a 2100, sendo que para o cenário A2-BR a vazão fica acima à observada no período de 1961 a 1900. Nesta bacia, observa-se um aumento da precipitação ao longo do tempo que nem sempre reflete num aumento das vazões em decorrência das perdas por evapotranspiração.

Para a bacia do Paraguai observa-se uma pequena diminuição nos valores da vazão para o cenário de emissão B2-BR no período de 2011 a 2040 e um pequeno aumento no período de 2041 a 2100, mantendo-se constante neste período. Para o cenário de emissão A2-BR observa-se uma pequena diminuição dos valores da vazão no período de

2011 a 2070 e um grande aumento no período de 2071 a 2100 com valores muito acima aos observados no período de 1961 a 1990.

Para as bacias do Atlântico Sul e Uruguai observa-se uma pequena tendência de aumento das vazões até 2100 nos dois cenários.

A vazão da bacia do Atlântico SE apresenta uma tendência de uma pequena diminuição até o ano 2100 para o cenário B2-BR e praticamente não se altera no cenário A2-BR.

Para as bacias do NE Oriental e Atlântico E observa-se uma redução brusca das vazões até o período de 2100 para os dois cenários de emissão, chegando a valores praticamente nulos.

Para a bacia do São Francisco observa-se que haverá uma diminuição da vazão até o período de 2011 a 2040 com tendência de pequeno aumento nos períodos de 2041 a 2100 para os dois cenários de emissão analisados.

[http://www.ipea.gov.br/mudancaclimatica/imag
es/stories/PDFs/Economia_das_Mudancas_Clim
aticas_estudos_e_pesquisas.pdf](http://www.ipea.gov.br/mudancaclimatica/imag
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Economia das Mudanças Climáticas

José Aroudo Mota
Jeferson Gazoni
Geraldo Sandoval Góes

Região	Impacto previsto	Fontes
Norte	Grande parte do bioma Amazônico, no leste da região, deverá ser sobreposto por Savana	Cramer <i>et al.</i> (2004) Nobre <i>et al.</i> (2007)
	Secas durante os períodos mais quentes do ano	Marengo (2007a) Wara; Ravelo; Delaney (2005)
	Aumento da incidência de incêndios florestais	Nepstad <i>et al.</i> (2001)
	Perda de florestas no norte da Amazônia	Jones <i>et al.</i> (2003) Cox <i>et al.</i> (2004)
	Inundações e erosões nas áreas mais baixas e próximas ao litoral	IPCC (2001)
	Aumento na incidência de doenças como malária e dengue	Moreira (1986) Lieshout <i>et al.</i> (2004)
	Sazonalidade das precipitações deverá afetar a quantia e variabilidade de fluxo de água na bacia do Amazonas e alterações na distribuição de espécie aquáticas	Carpenter <i>et al.</i> (1992) Lake <i>et al.</i> (2000)
	Perda de biodiversidade	Higgins (2007) Miles; Grainger; Phillips (2004)