

Mudanças Climáticas e a Amazônia

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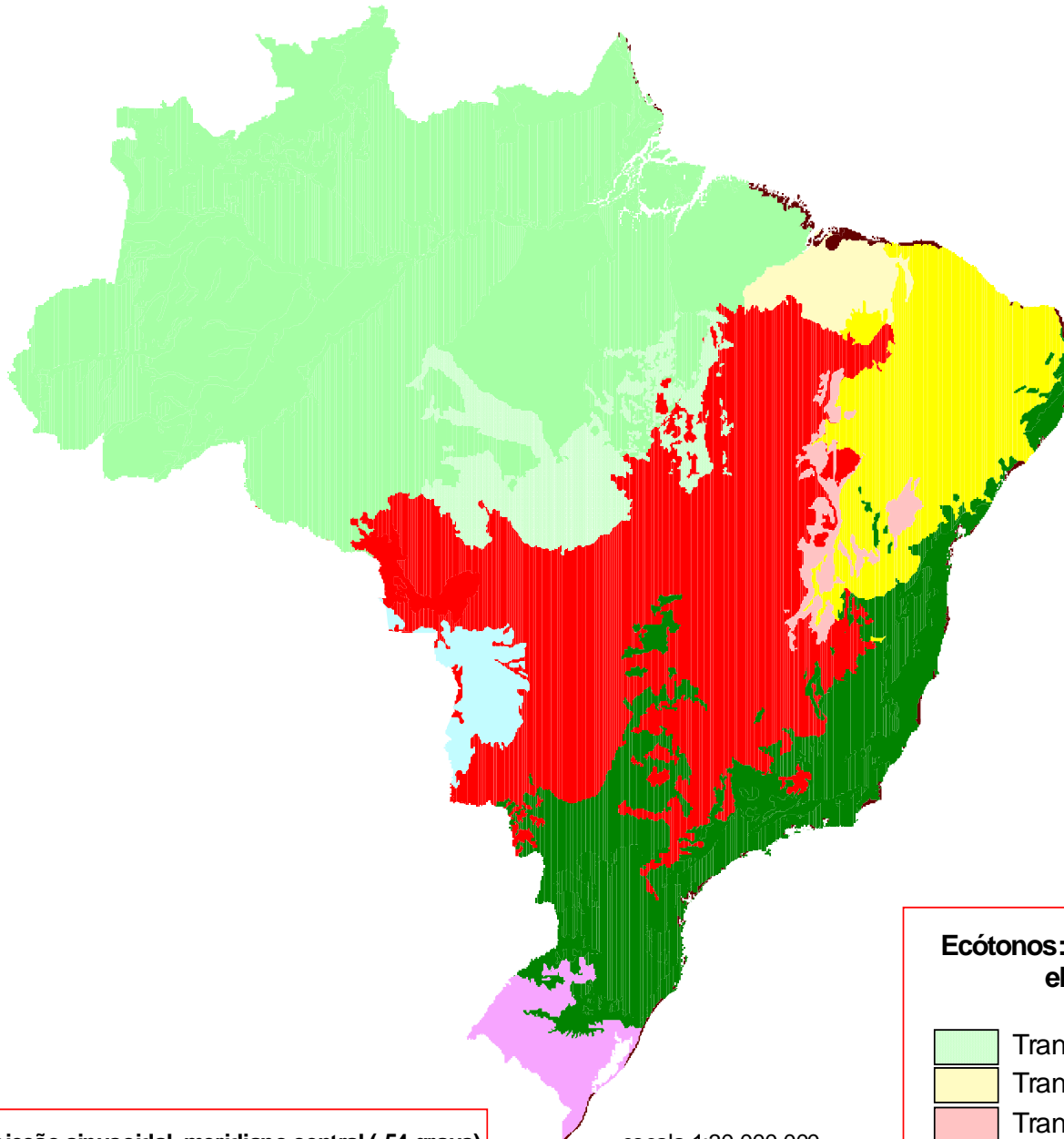
50ª Reunião Extraordinária do CONAMA

Mesa 3, Impactos nas Áreas Florestais: Amazônia,
Caatinga, Cerrado e Mata Atlântica.

Rio de Janeiro, 30 de maio de 2007

BIOMAS DO BRASIL




Complexidade



Biomas do Brasil

	Amazônia
	Caatinga
	Campos sulinos
	Cerrado
	Costeiro
	Mata Atlântica
	Pantanal

Ecótonos: Ecorregiões transicionais que contém elementos de mais de um bioma

	Transição (Amazônia-Cerrado)
	Transição (Amazônia-Cerrado-Caatinga)
	Transição (Mata Atlântica-Caatinga-Cerrado)

Projeção sinusoidal, meridiano central (-54 graus)
Nesta projeção a área das feições é preservada

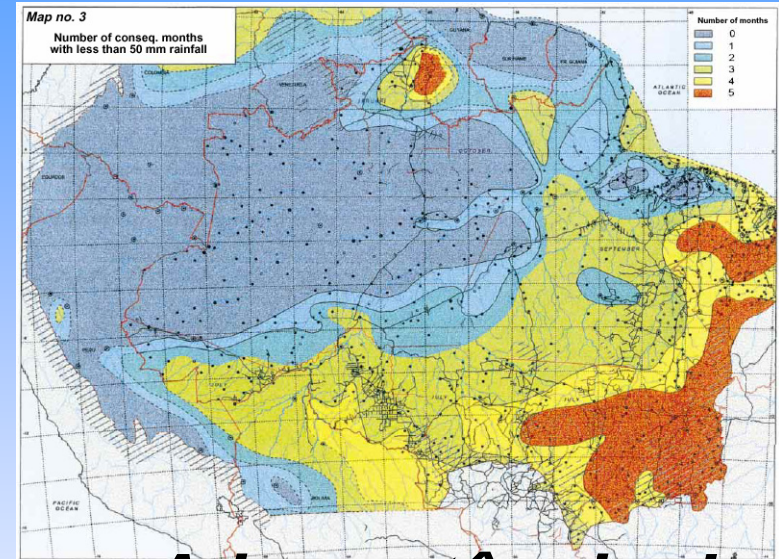
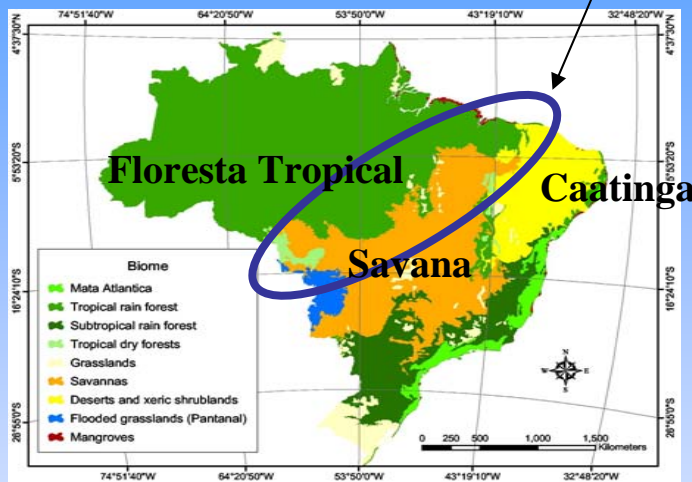
escala 1:30.000.000

Biomes of tropical south America and Sazonalidade da Precipitação

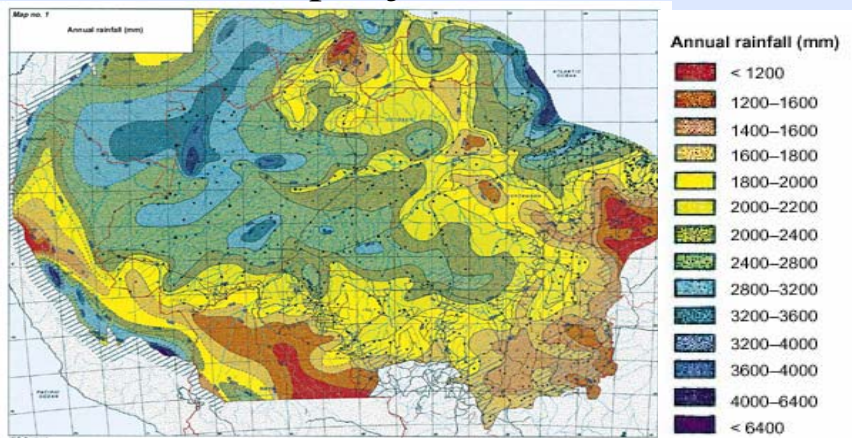
Fronteira Floresta Tropical-Savana

Número de meses consecutivos com chuva abaixo de 50 mm

Biomas do Brasil



Precipitação Anual



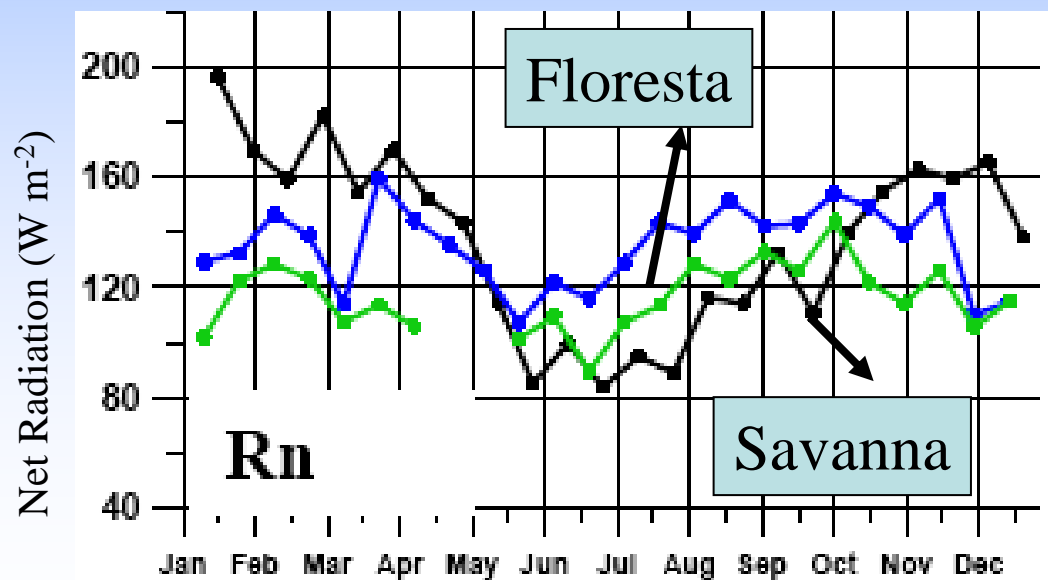
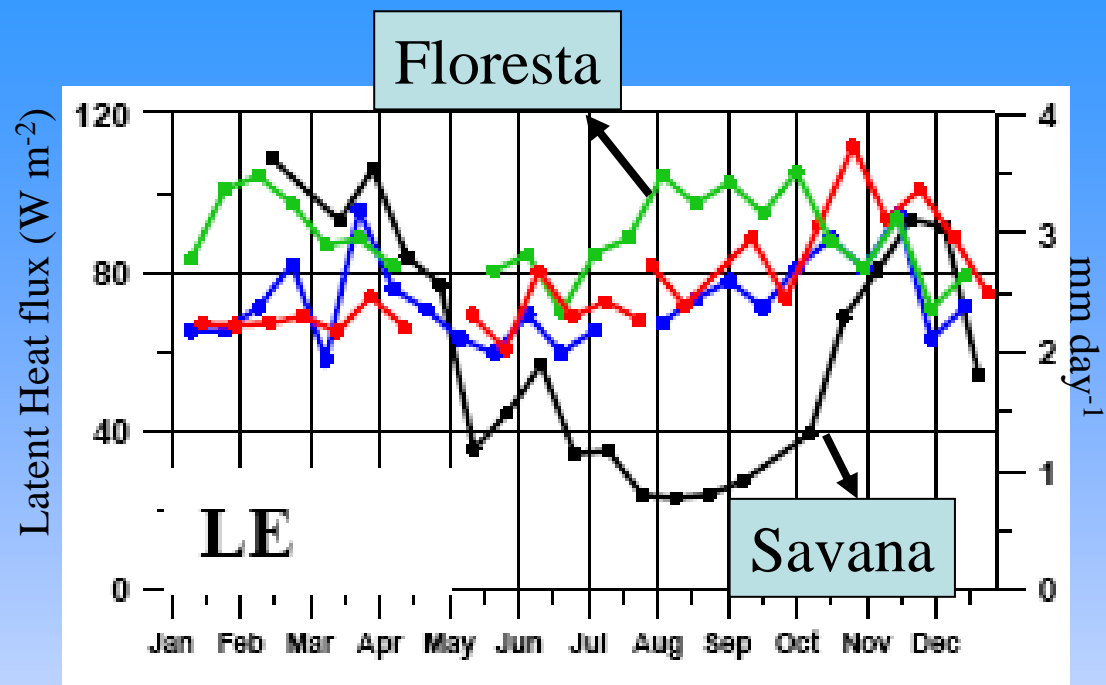
A importância da sazonalidade das chuvas (curtas estações secas) para manutenção da floresta tropical

Sombroek 2001, Ambio

Evapotranspiração: Sazonalidade na Floresta Amazônica e na Savana

Fonte: Rocha (2004)

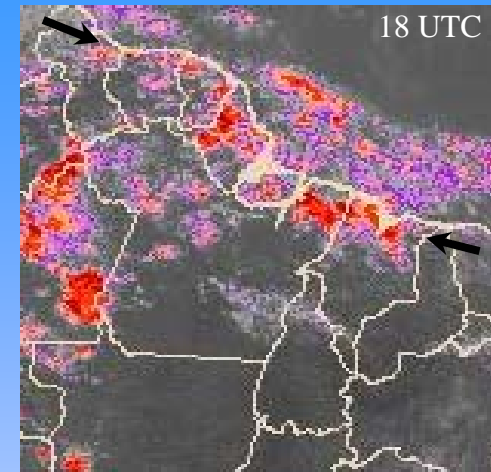
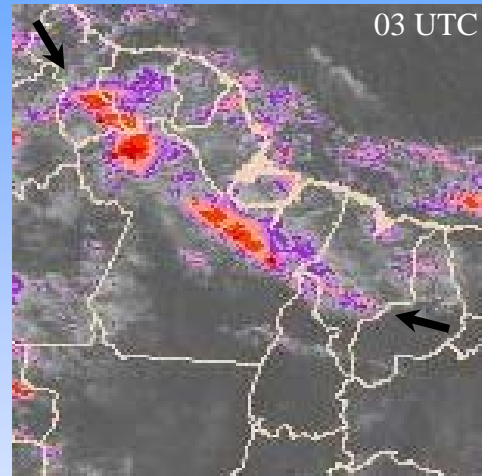
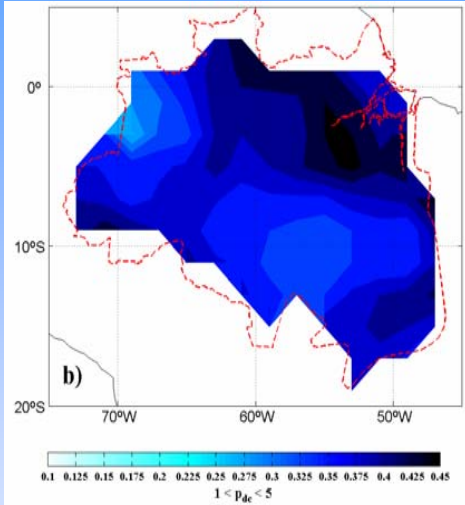
-  Cerrado s.s. SP
-  Floresta trop RO
-  Floresta trop Manaus
-  Floresta trop Santarém



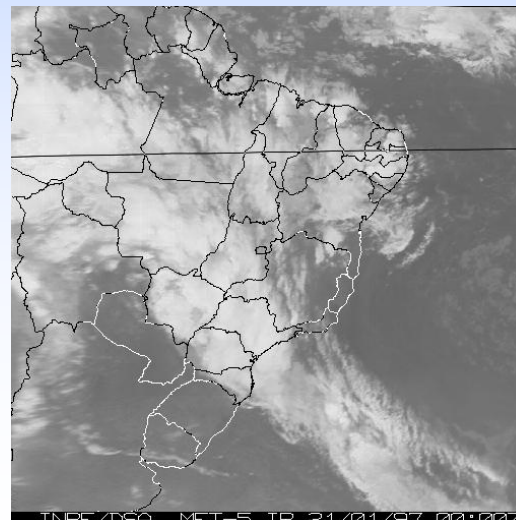
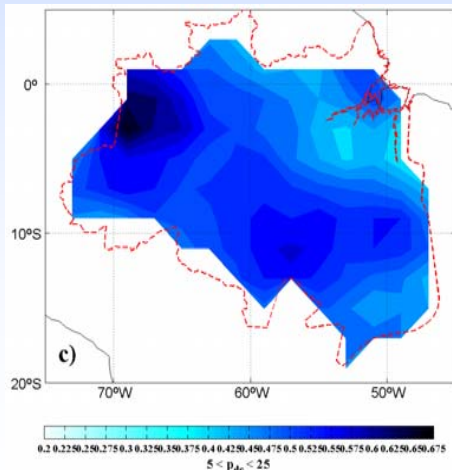
Mecanismos de Precipitação na Amazônia

Unconditional probability of a wet day.
The daily data spans 1979 to 1993

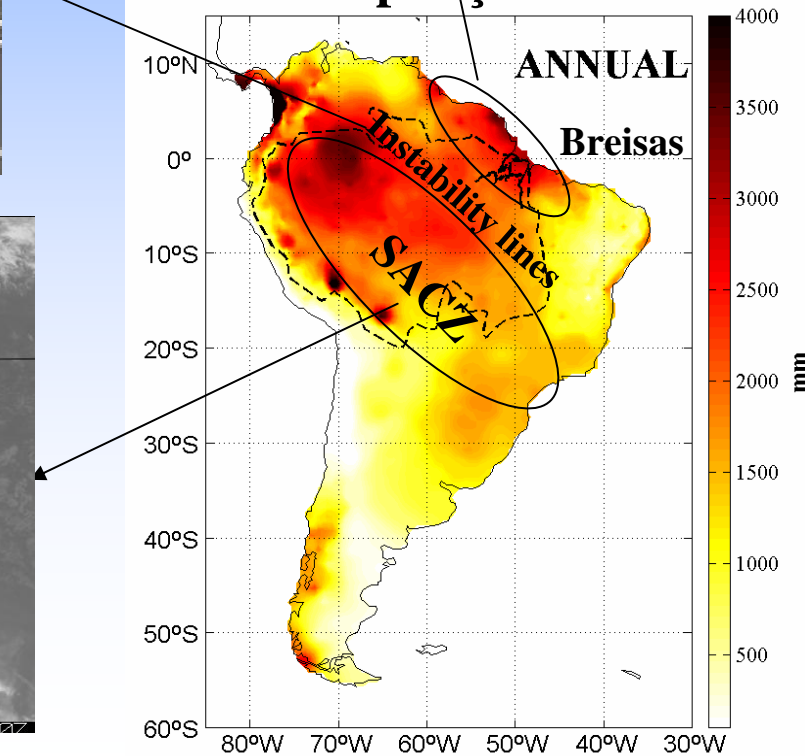
1 mm < P < 5 mm



5 mm < P < 25 mm

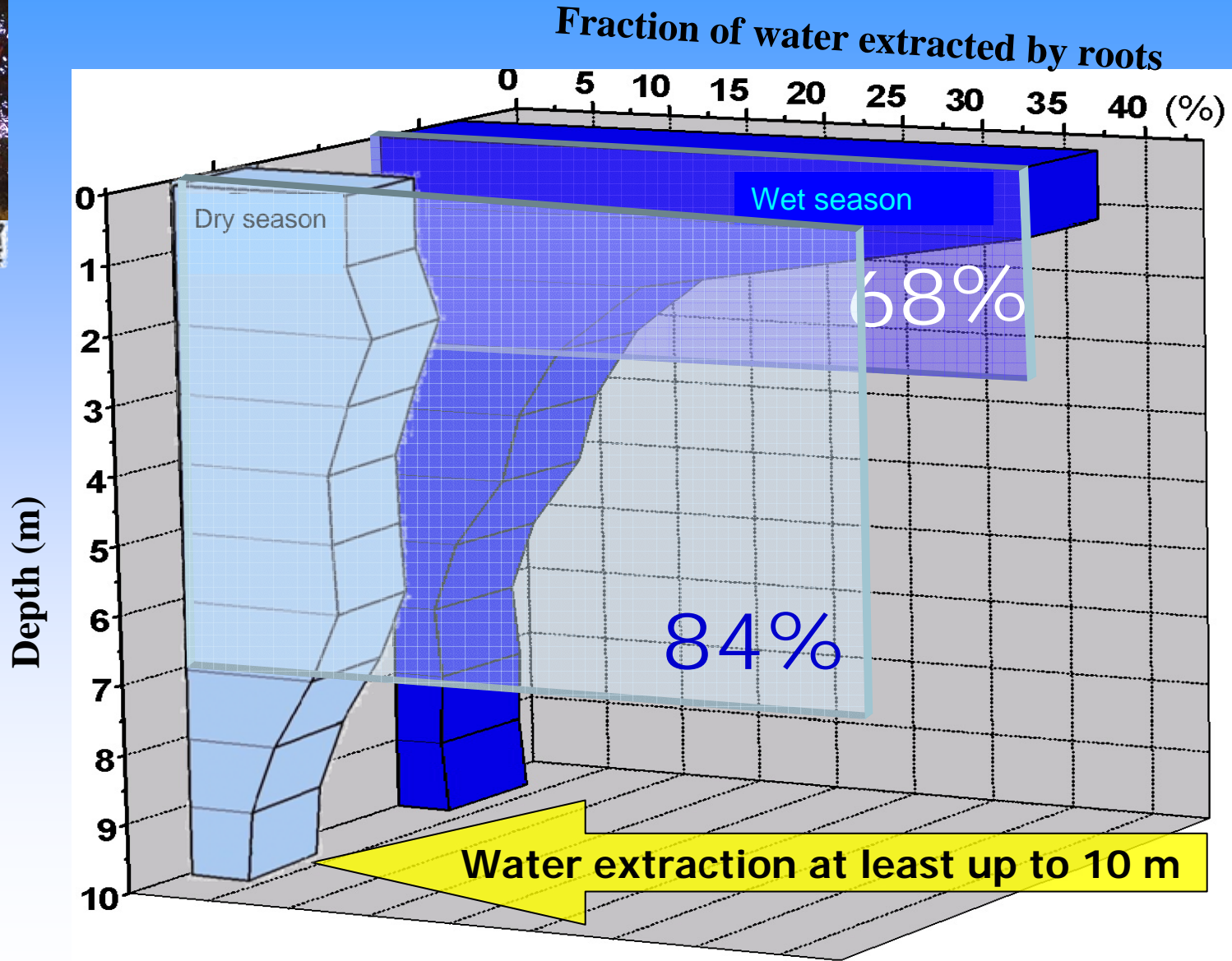
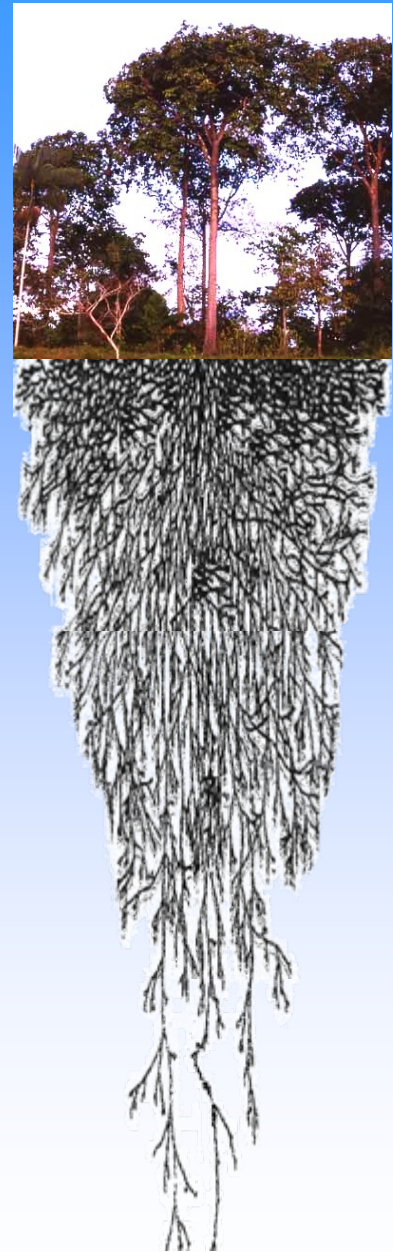


Precipitação Anual

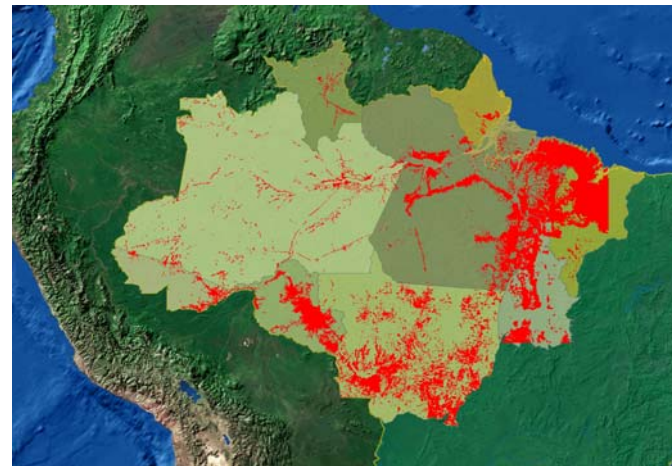
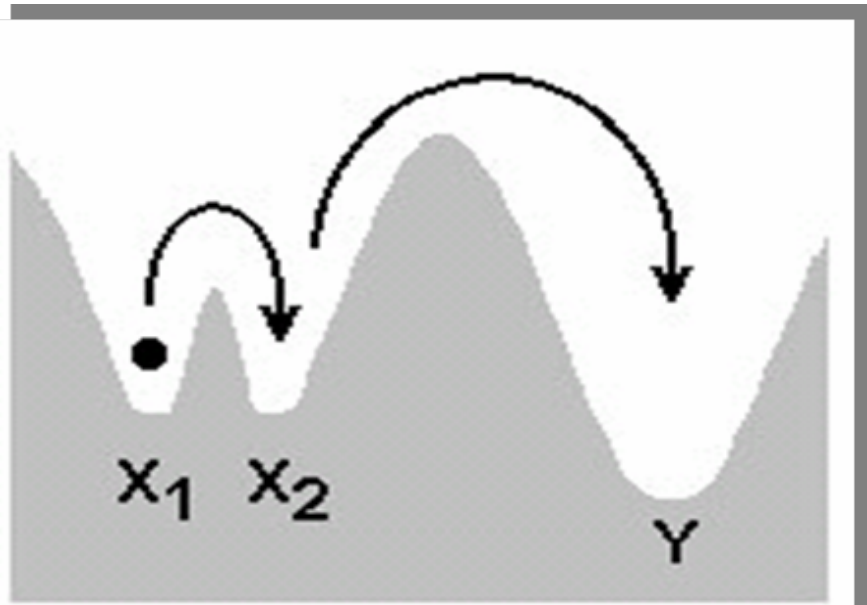


Source: Obregon, 2001

Exemplo de Adaptação Ecológica: Raízes Profundas



Source: Bruno et al., 2005 – Tropical forest data in Santarem km83



Até 2006, área desmatada total (corte raso) foi de 650,000 km² na Amazônia Brasileira (17%)

Resiliência Perturbações Estocásticas Perturbações Graduais
 afetam a Resiliência
 (e.g., desmatamento,
 fogo
 Fragmentação,
 aquecimento global,
 etc.)



Source: Greenpeace/Daniel Beltra

As *c*variabilidade climática (secas severas) desempenha um papel chave em ligar as mudanças climáticas, fatores edáficos e humanos?

I - DESMATAMENTOS



DEFORESTATION AND BURNING AROUND THE XINGU INDIGENOUS PARK, MATO GROSSO STATE, BRAZIL, 2004.

Source: Tropical deforestation and climate change / edited by Paulo Moutinho and Stephan Schwartzman. -- IPAM - Instituto de Pesquisa Ambiental da Amazônia, 2005.

PROJEÇÕES DE DESMATAMENTOS

Control

20%

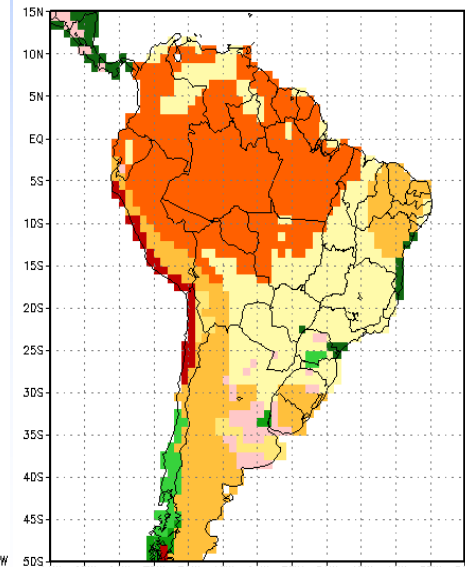
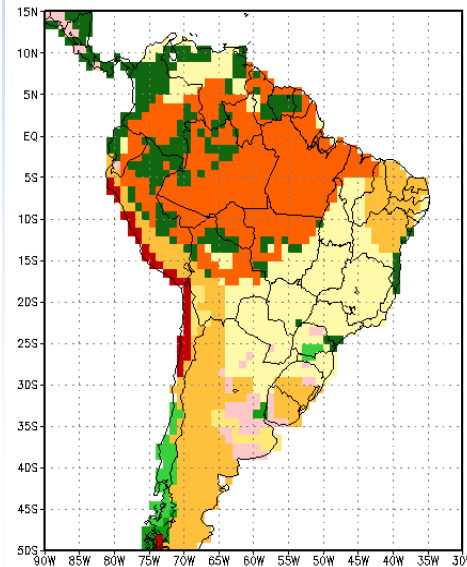
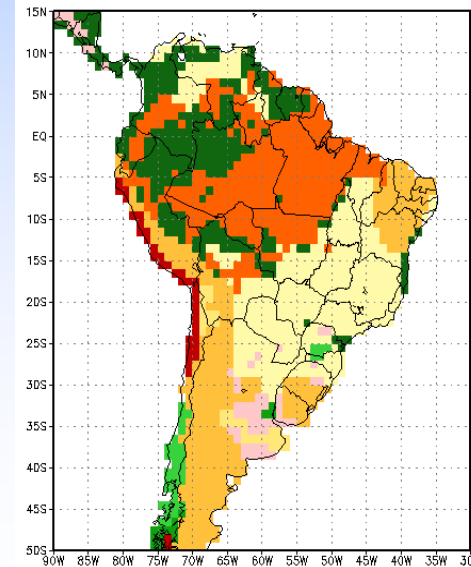
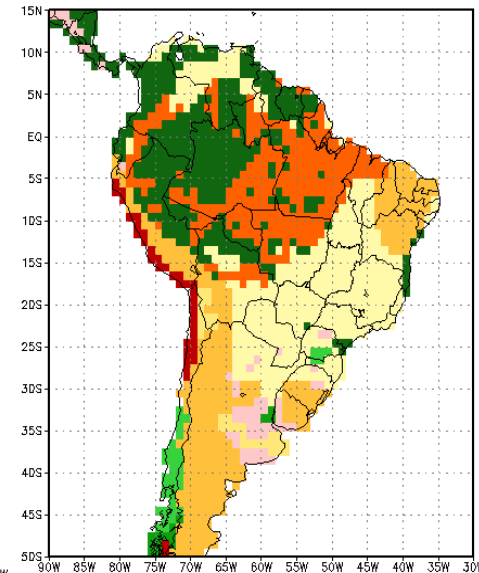
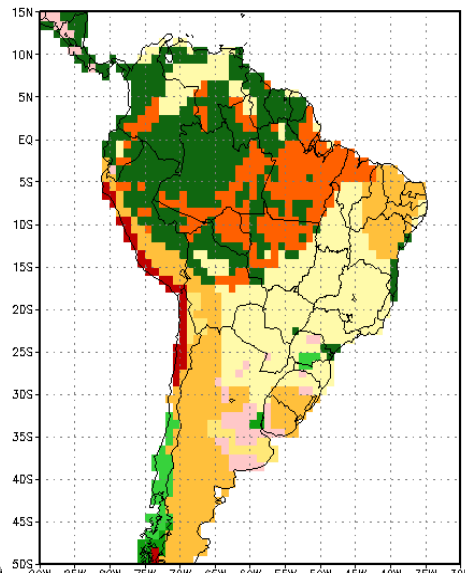
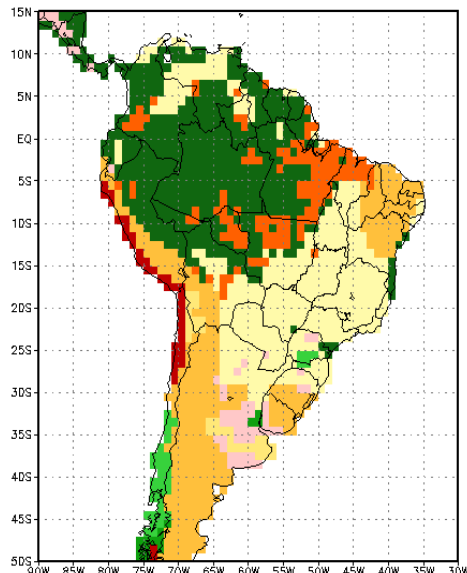
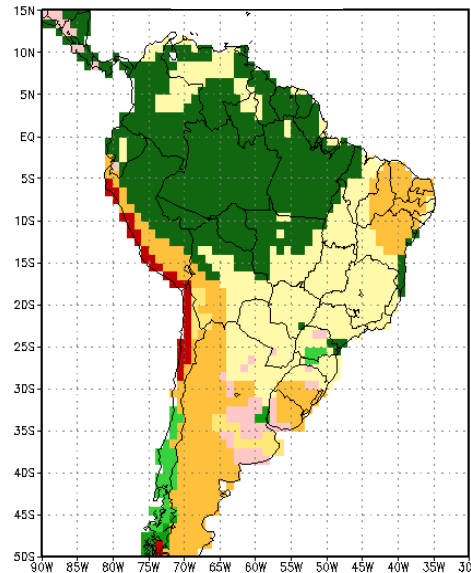
40%

50%

60%

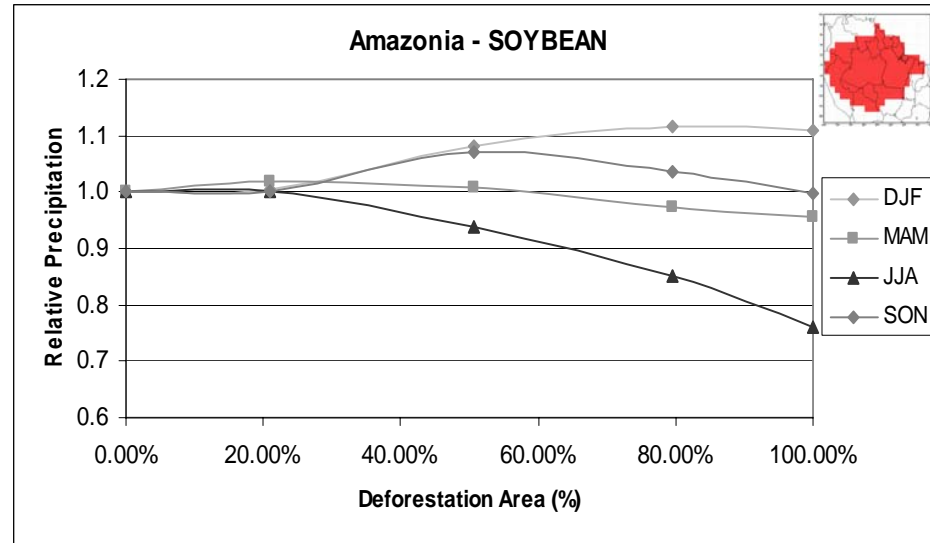
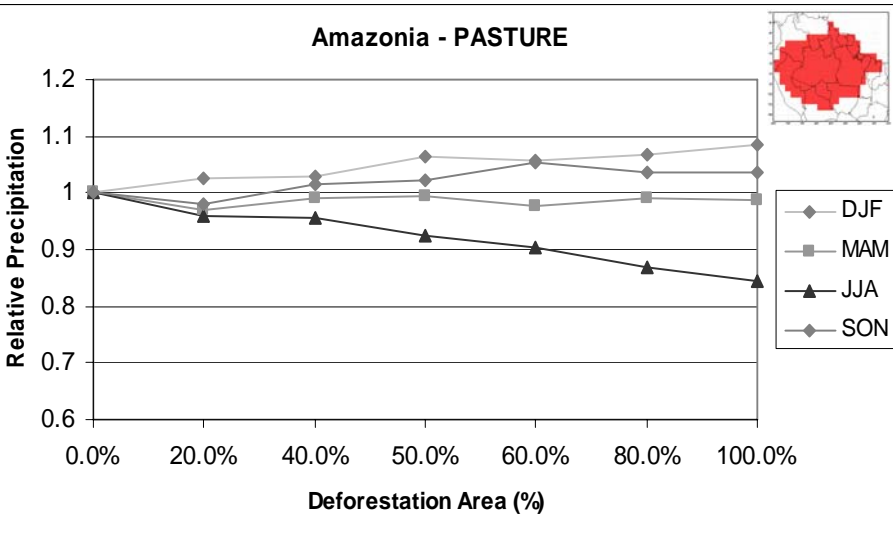
80%

100%



- Evergreen Broadleaf Trees
- Pasture or Soybean
- Broadleaf Deciduous Trees
- Deciduous and Evergreen Trees
- Evergreen Needleleaf Trees
- Deciduous Needleleaf Trees
- Ground Cover with Trees and Shrubs
- Groundcover Only
- Broadleaf Shrubs with Perennial Ground Cover
- Broadleaf Shrubs with Bare Soil
- Groundcover with Dwarf Trees and Shrubs
- Bare Soil
- Agriculture or C3 Grassland
- Perpetual Ice

Precipitação – Amazônia



Anomalia de Precipitação (%)

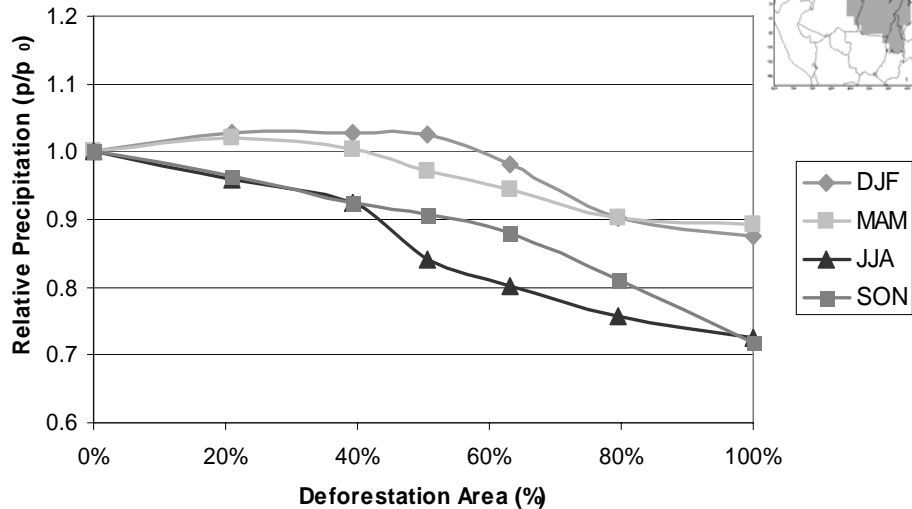
Estação do Ano	Pastagem	Soja
JJA	-15,7%	-24,0%
JJAS	-13,7%	-22,0%

Precipitação

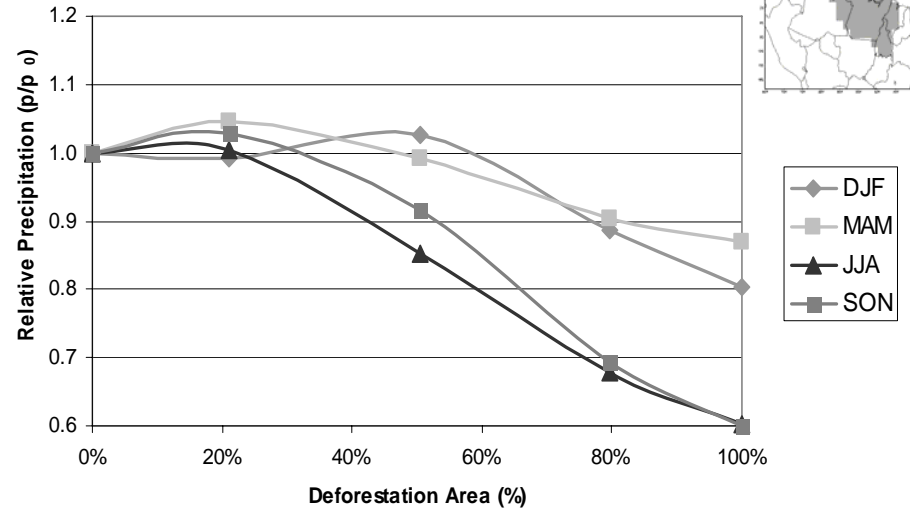
PASTAGEM

SOJA

Amazonia - PASTURE
Area: East/Northeast



Amazonia - SOYBEAN
Area: East/Northeast



Anomalias de Precipitação (%)

Estação do Ano	Pastagem	Soja
JJA	-27,5%	-3,8%
SON	-28,1%	-39,9%

The reduction in precipitation is larger during the **dry season**, and is more evident when the deforested area is larger than 40% !

II - FOGO



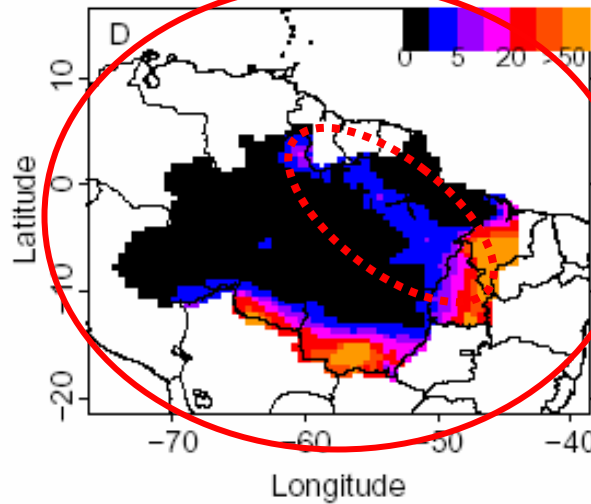
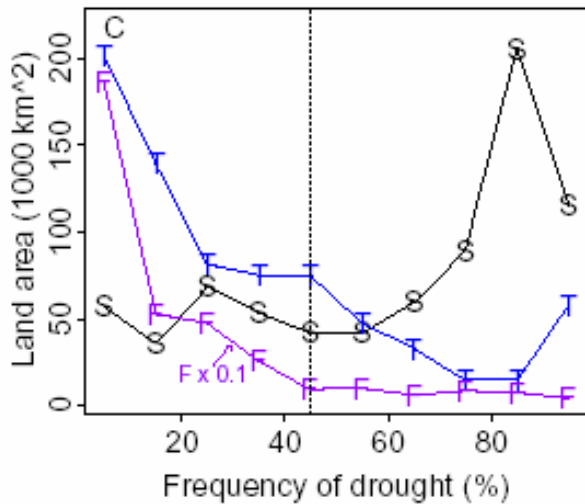
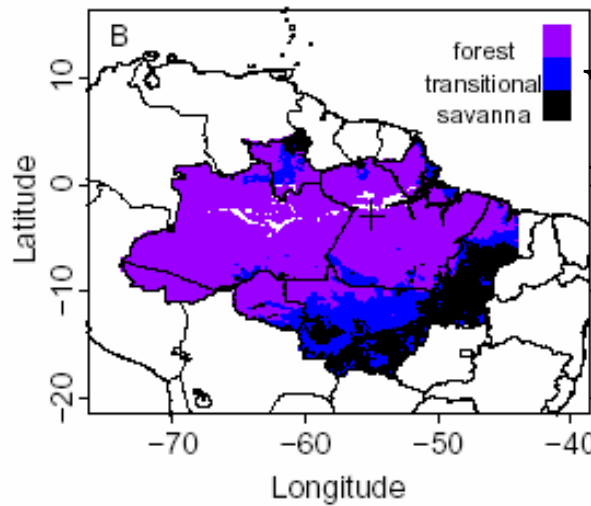
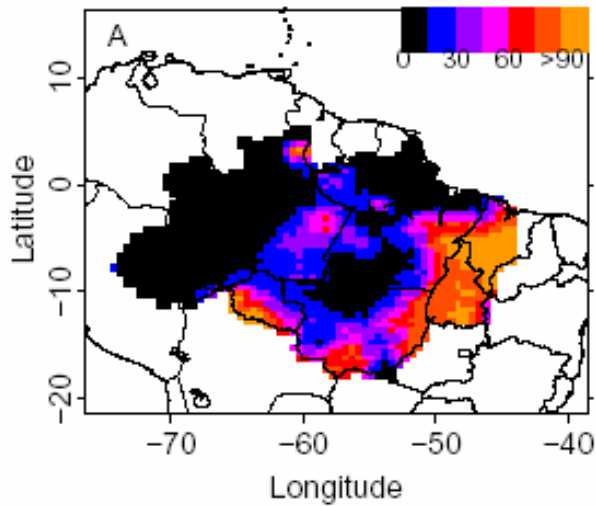
III – EXTREMOS CLIMÁTICOS



O impacto de secas



Vulnerabilidade da Vegetação às Secas



Percent attainment of the Nix criteria [1983] for savanna in the last 100 years

Climate conditions for tropical savannas (Nix 1983)

$$T_{\text{mean}} > 24 \text{ C}$$

$$13 \text{ C} < T_{\text{coldest month}} < 18 \text{ C}$$

$$P(3 \text{ driest months}) < 50 \text{ mm}$$

$$P(6 \text{ wettest months}) > 600 \text{ mm}$$

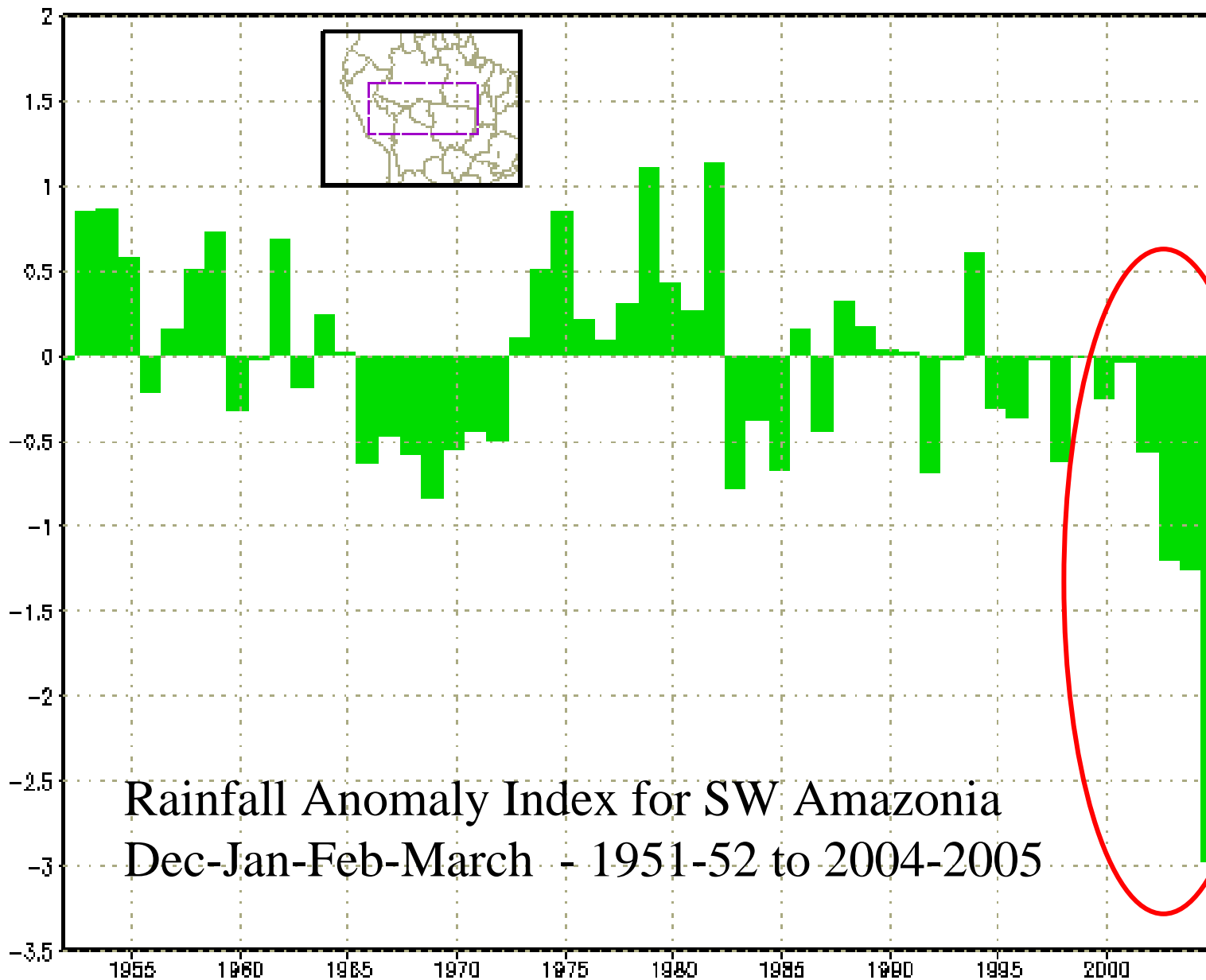
$$1000 \text{ mm} < P_{\text{annual}} < 1500 \text{ mm}$$

(A) Observed drought frequency (% years); (B) distribution of savanna, transitional vegetation, and forest across the legal Brazilian Amazon; (C) Land area (1000 km²) of vegetation types for pixels with given drought frequency (%), forest land area is multiplied by 0.1 for scaling; (D) percent attainment of the Nix [1983] criteria for savanna vegetation in the last 100 years.

Source: Hutylara et al, 2005

Anomalia de Precipitação

Dez-Jan-Fev-Mar de 1951/52 a 2004/05



Rainfall Anomaly Index for SW Amazonia
Dec-Jan-Feb-March - 1951-52 to 2004-2005



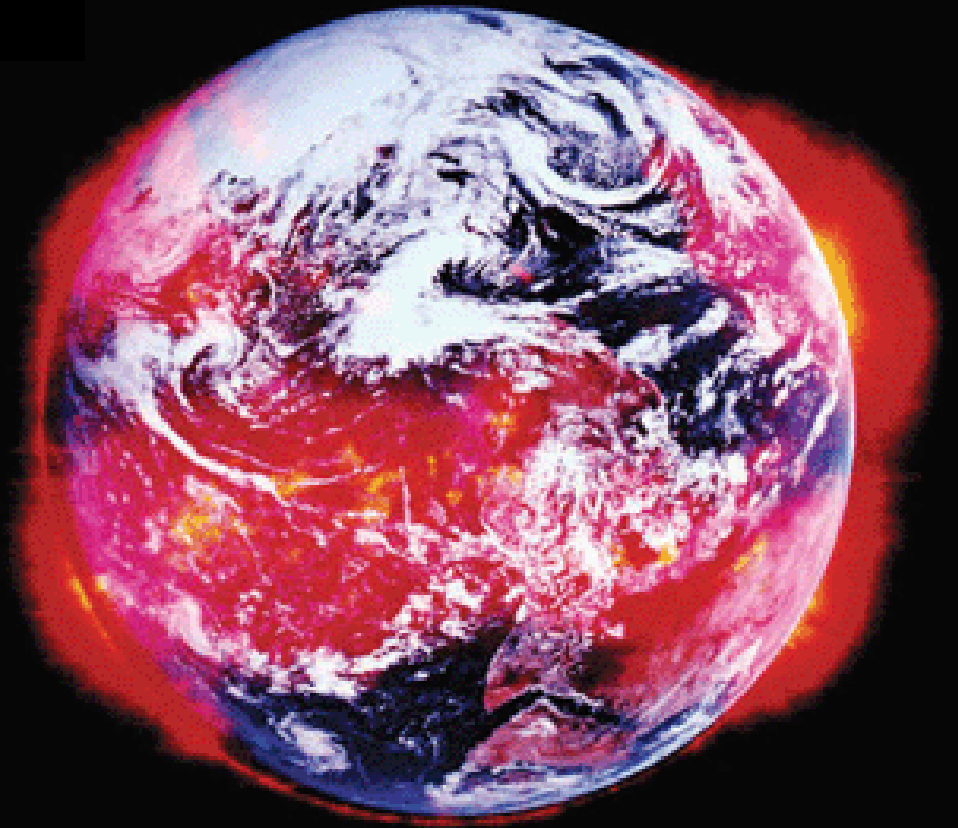
Foto 16 : Barco encalhado na areia a leste de Barreirinha, perto da fronteira do Pará.

Estamos assistindo a mais extremos hidrológicos?

**“A Seca da Amazônia em 2005 considerada uma das mais severas em
100 anos”**



IV – AQUECIMENTO GLOBAL



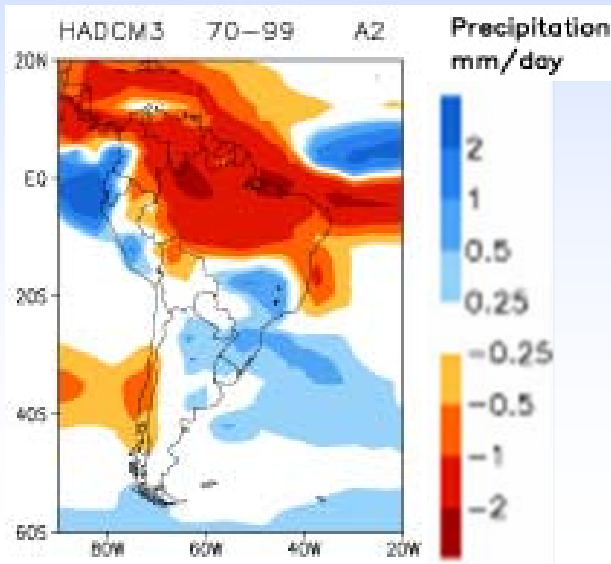
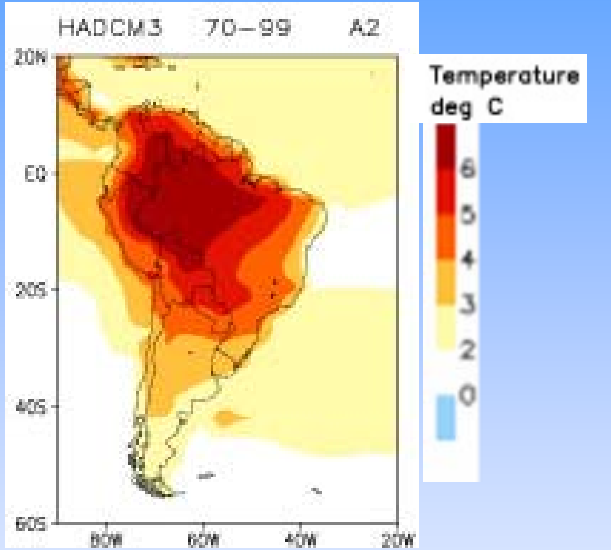
O que ocorrerá com as florestas tropicais da América do Sul em decorrência do Aquecimento Global?

ECOSSISTEMAS NATURAIS

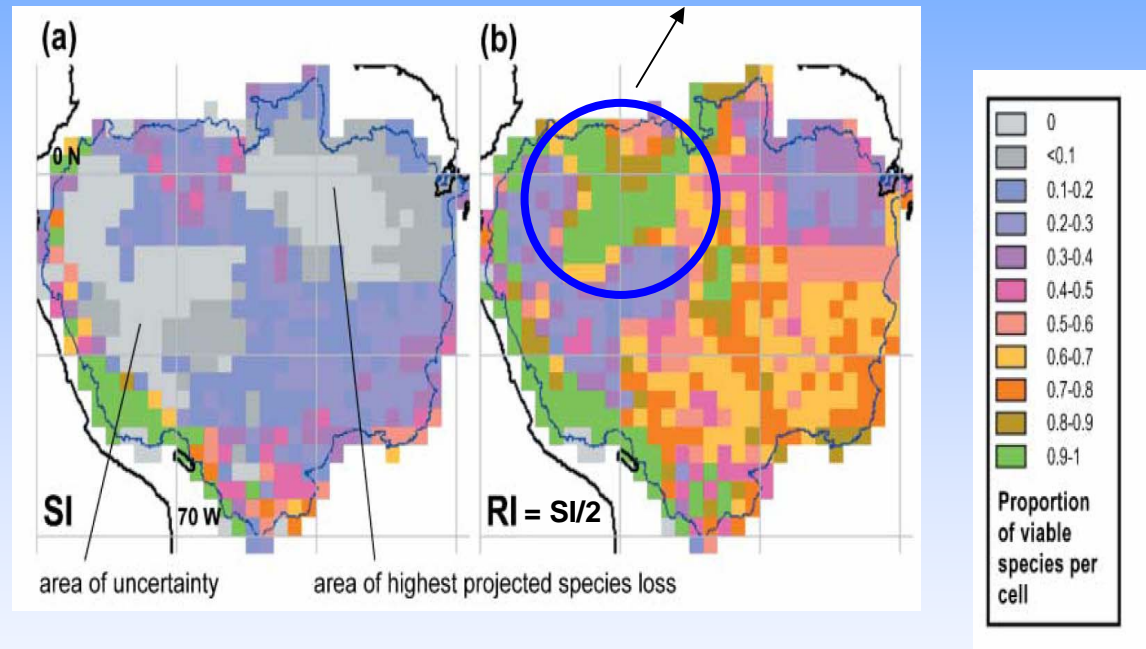
- Em meados do século, projeta-se que aumentos de temperatura e conseqüentes diminuições da água do solo irão levar a uma **gradual substituição da floresta tropical por savana na Amazônia Oriental.**
- A **vegetação semi-árida tenderá a ser substituída por vegetação de zonas áridas.**
- Há um risco de **perda significativa de biodiversidade** através da extinção de espécies em muitas áreas tropicais da América Latina. ** D [13.4]

O impacto das mudanças climáticas globais na biodiversidade da Amazônia

Climate Model: HADCM2GSa1
1% CO₂ increase/yr



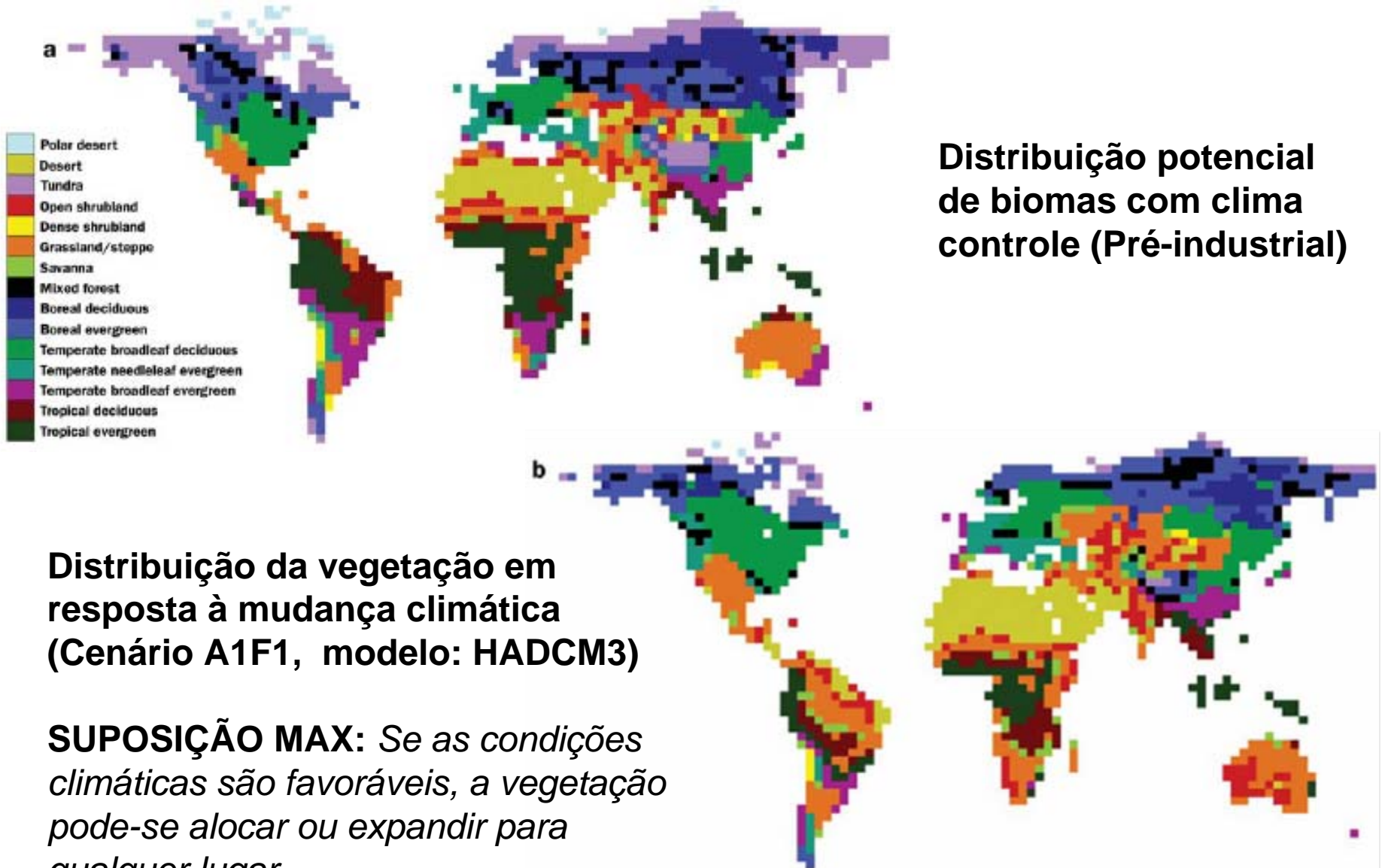
Bacia do Rio Negro: 90% a 100% de manutenção da biodiversidade!



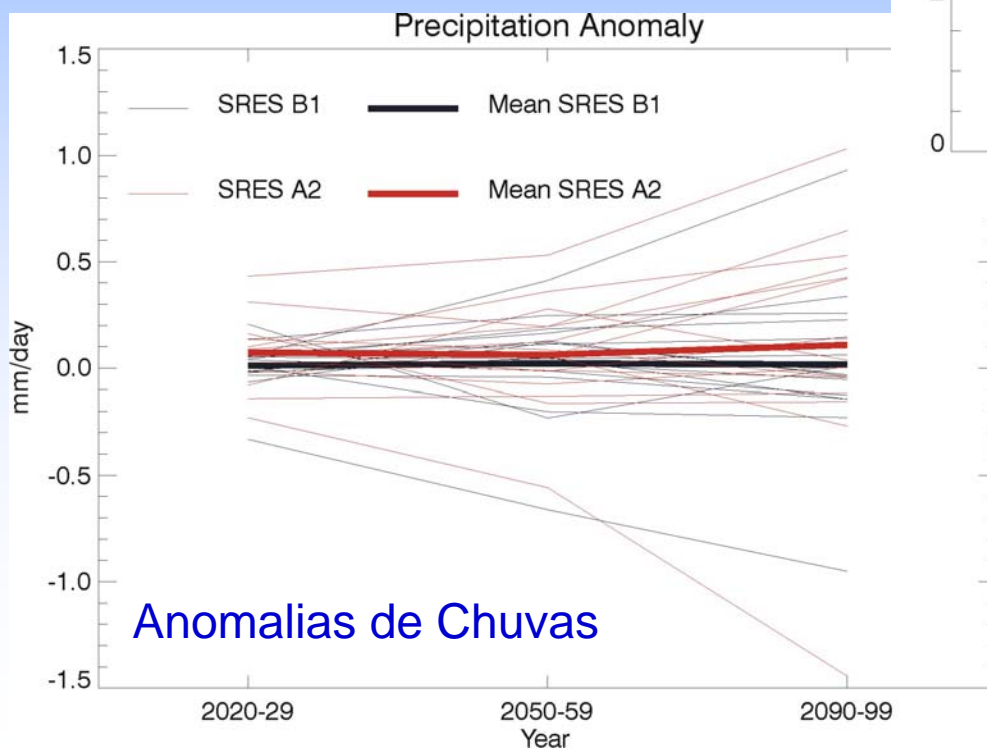
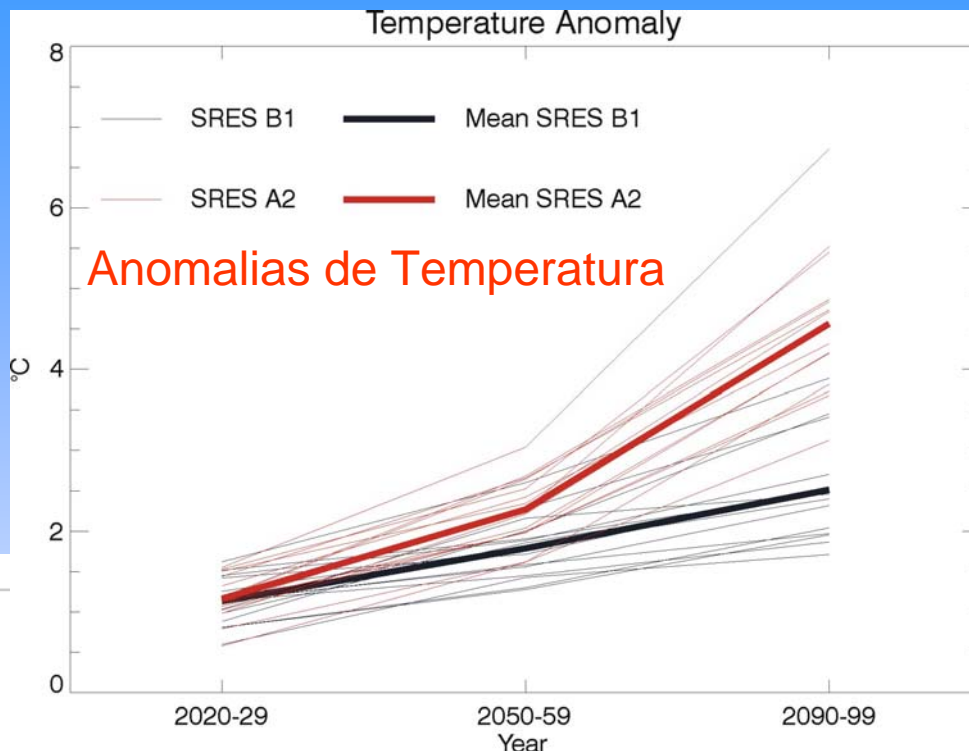
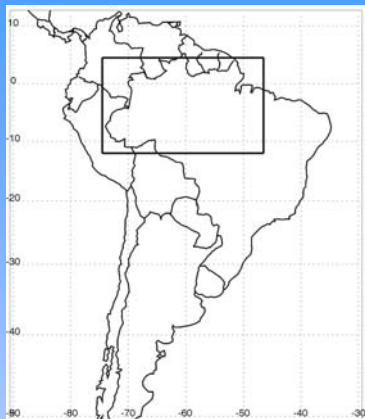
43% of 69 species of *Angiosperms* become non-viable by 2095!

Source: Miles et al. 2004.

A RESPOSTA BIOFÍSICA À MUDANÇA CLIMÁTICA DEPENDE DA DISPERSÃO E MIGRAÇÃO



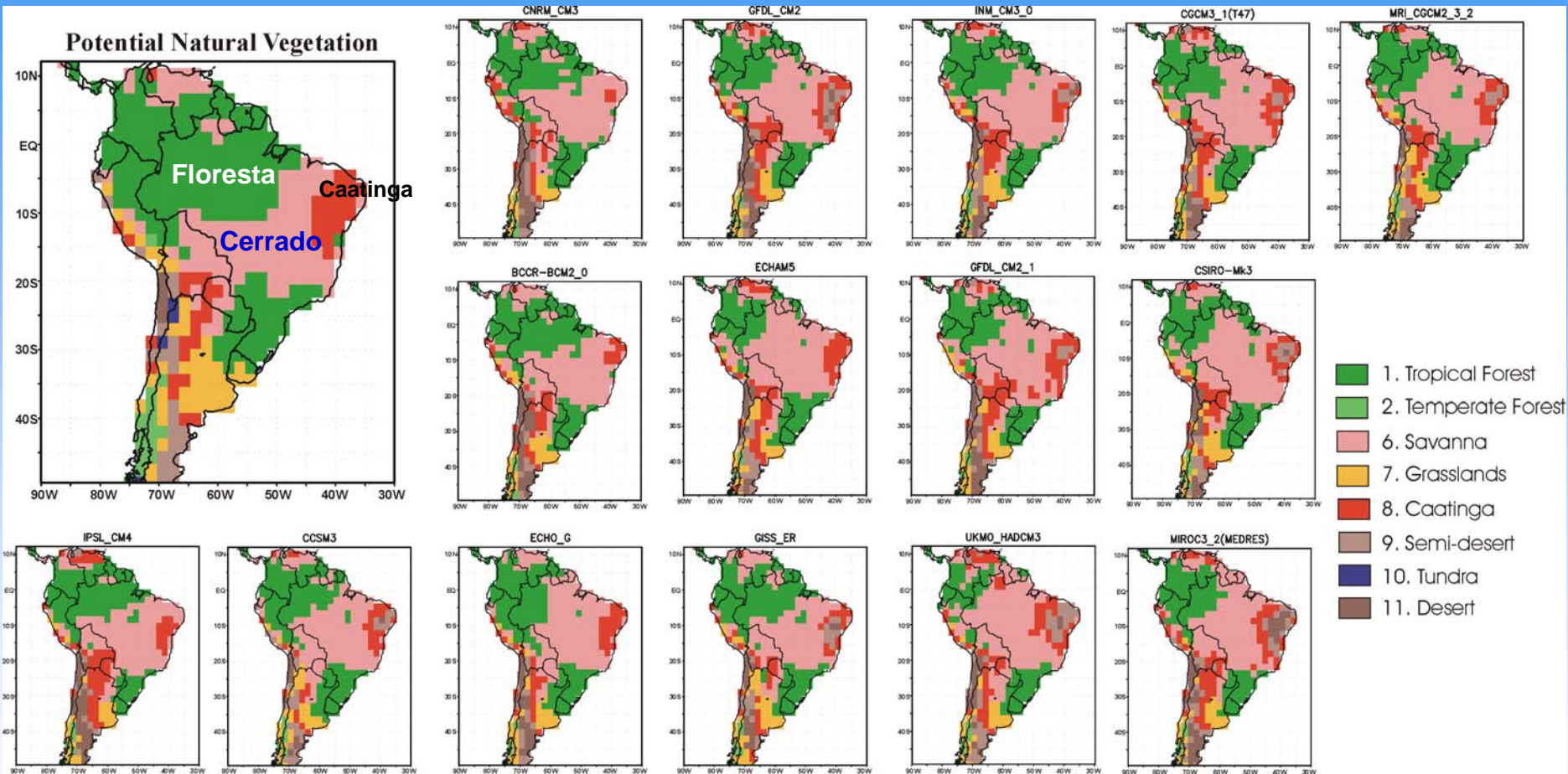
Cenários de Mudanças Climáticas para a Amazônia



Resultados de 15 Modelos Acoplados Oceano-Atmosfera para os cenários SRES A2 e B1 de emissões de gases de efeito estufa, preparados para o IPCC/AR4.

Models: BCCR-BCM2.0, CCSM3, CGCM3.1(T47), CNRM-CM3, CSIRO-MK3, ECHAM5, GFDL-CM2, GFDL-CM2.1, GISS-ER, INM-CM3, IPSL-CM4, MIROC3.2 (MEDRES), MRI-CGCM2.3.2, UKMO-HADCM3, ECHO-G

Consequência das Mudanças Climáticas na Redistribuição de Vegetação na América do Sul



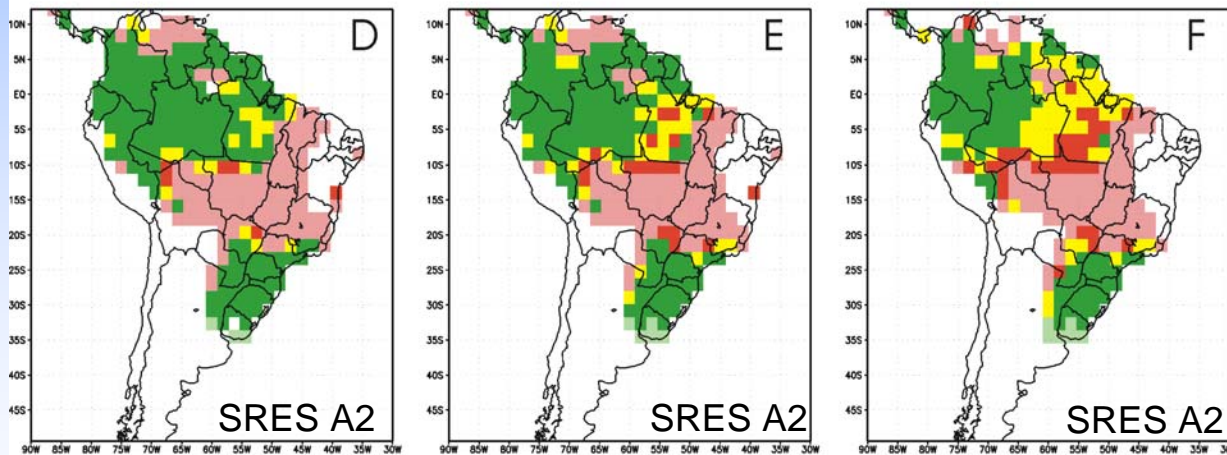
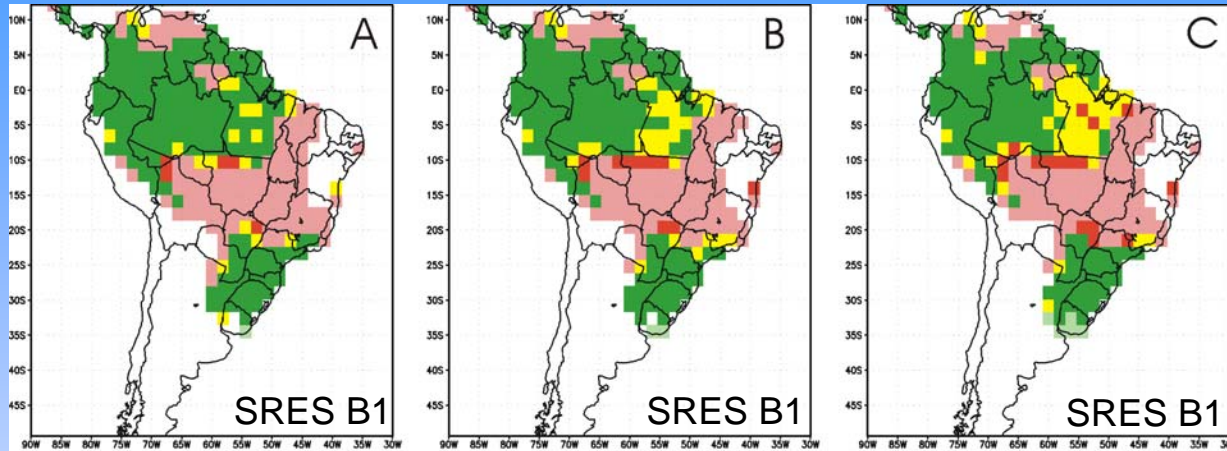
Projected distribution of natural biomes in South America for 2090-2099 from 15 AOGCMs for the A2 emissions scenarios, calculated by using CPTEC-INPE PVM.

Consequência das Mudanças Climáticas na Redistribuição de Vegetação na América do Sul

2020-2029

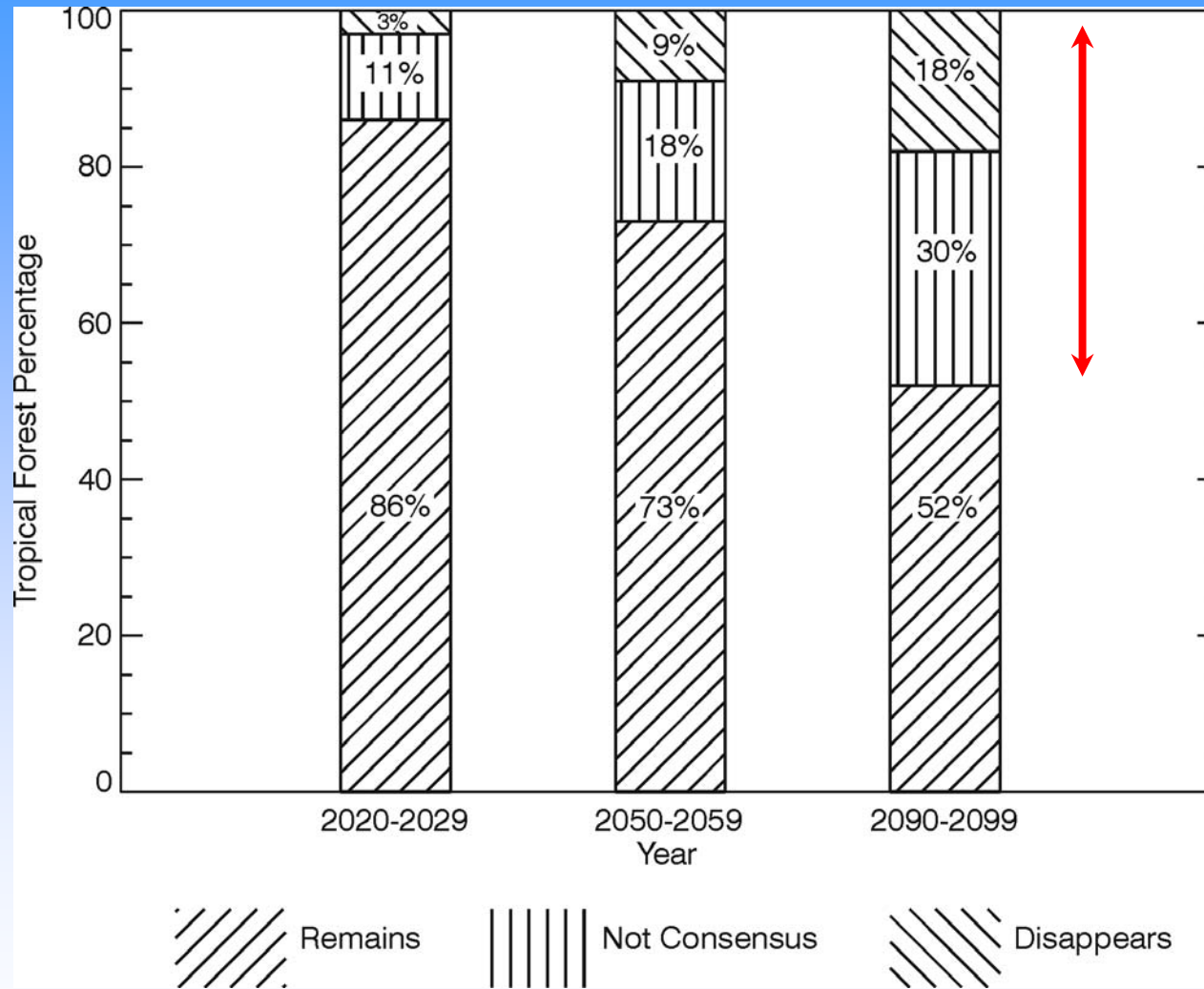
2050-2059

2090-2099



Grid points where more than 75% of the models used (> 11 models) coincide as projecting the future condition of the tropical forest and the savanna in relation with the current potential vegetation. The figure also shows the grid points where a consensus amongst the models of the future condition of the tropical forest was not found. for the periods (a) 2020-2029, (b) 2050-2059 and (c) 2090-2099 for B1 GHG emissions scenario and (d), (e) and (f) similarly for A2 GHG emissions scenario.

Consequência das Mudanças Climáticas na Redistribuição de Vegetação na América do Sul



Entre 18% até um máximo de 48% (18% + 30%) podem ser convertidos em savana empobrecida até o final do Século!

Percentage of the area where more than 75% of the experiments for the A2 GHG scenarios, coincide as projecting the permanence or disappearance of the current potential tropical forest, and where there is not a conclusive consensus amongst models

Conclusões

O futuro da vegetação da Amazônia em resposta ao desmatamento e às mudanças climáticas

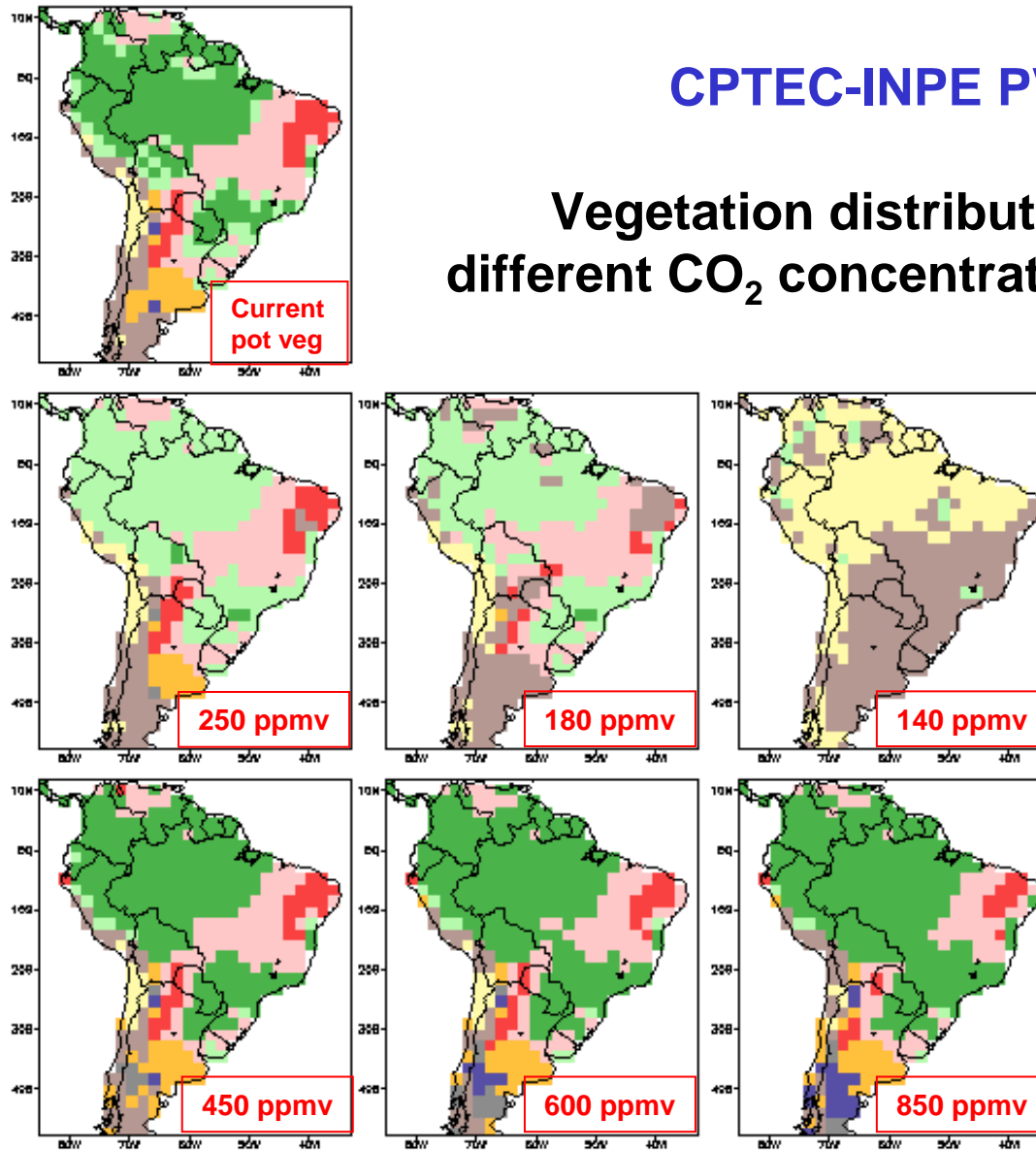
- Os ecossistemas na Amazônia vem sofrendo por pressão dos desmatamentos por mais de 40 anos.
- O desmatamento, o aquecimento global, o aumento da incidência de incêndios florestais e secas mais intensas ou mais frequentes irão reduzir a resiliência da floresta tropical.
- O efeito sinérgico de todos estes fatores poderá desencadear um acelerado processo de “savanização” do centro-leste da Amazônia.
- O impacto deste efeito não será homogêneo na vasta Bacia Amazônica. No oeste e noroeste, as mudanças climáticas exercerão menor influência e a biodiversidade estará menos ameaçada.
- A política de conservação deve levar em conta as mudanças climáticas sob risco de se tornar inefetiva no futuro.

An aerial photograph of a vast, dense tropical rainforest. The forest canopy is a rich, textured green, with some taller trees standing out. The sky above is filled with dramatic, dark, and heavy clouds, with some light breaking through near the horizon. The overall mood is one of natural grandeur and mystery.

OBRIGADO!

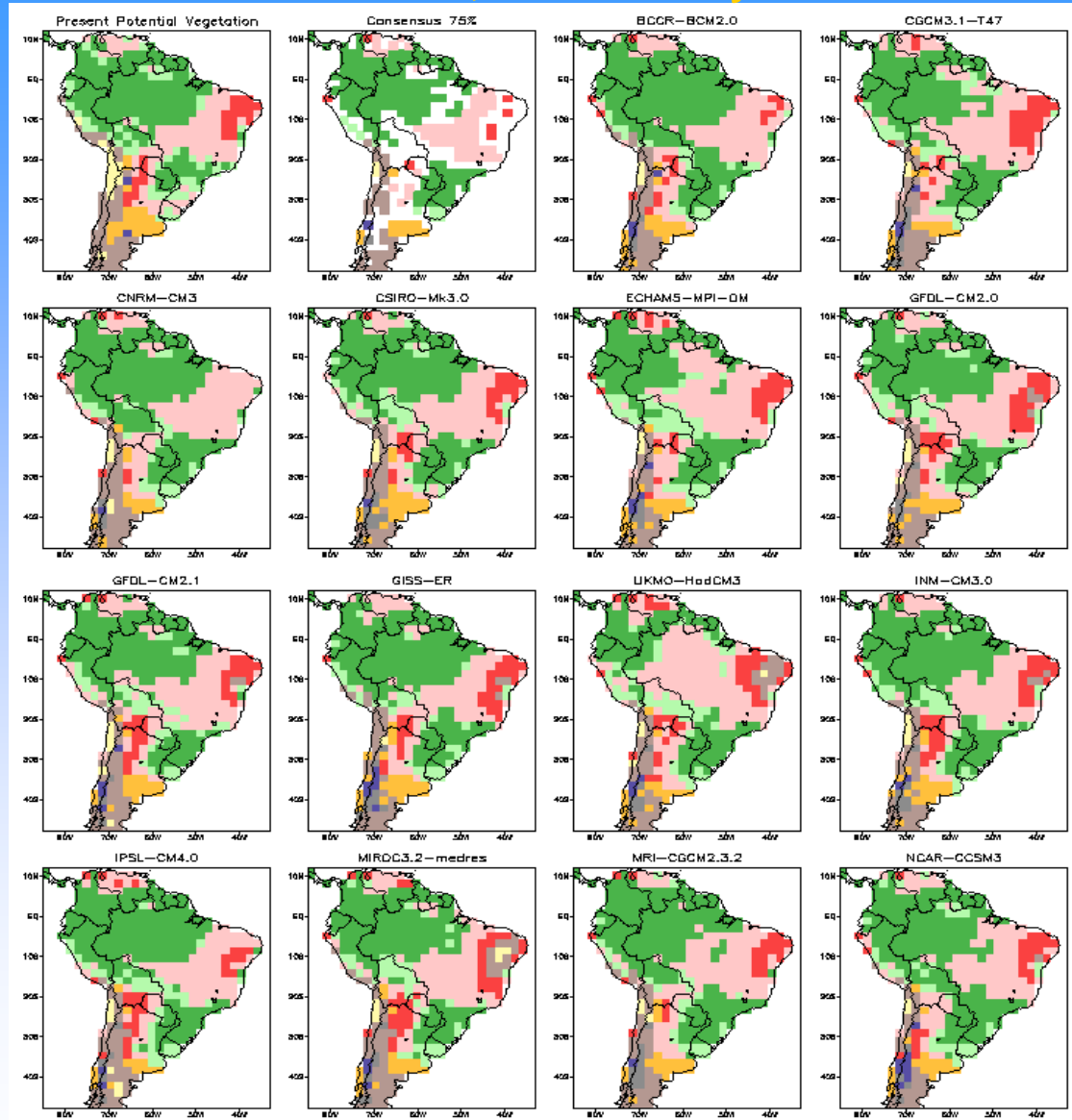
CPTEC-INPE PVM 2

Vegetation distribution under different CO₂ concentration scenarios



- | | | | |
|-----------------------------------|-------------------|-----------------|-------------------------------|
| ■ 1 Tropical Ombróphyllous Forest | ■ 4 Boreal Forest | ■ 8 Coatingo | ■ 13 Tropical Seasonal Forest |
| ■ 2 Temperate Forest | ■ 5 Larch | ■ 9 Semi-desert | ■ 20 Ice |
| ■ 3 Mixed Forest | ■ 6 Savanna | ■ 10 Tundra | |
| ■ 7 Grassland | ■ 11 Desert | | |

Projected distribution of natural biomes in South America for 2090-2099 from 14 AOGCMs for the A2 emissions scenarios, calculated by the CPTEC-INPE PVM with Carbon Cycle



The ethical dimensions of Global Environmental Change

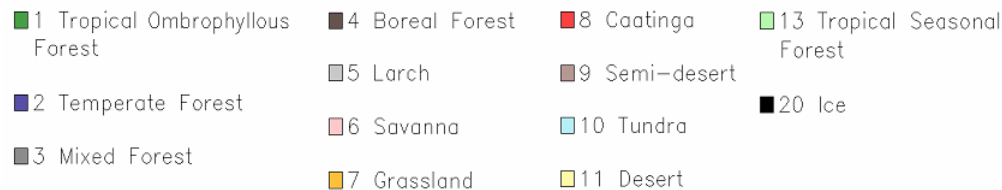
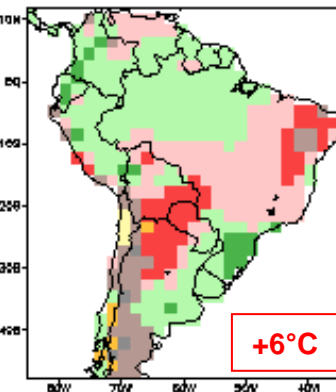
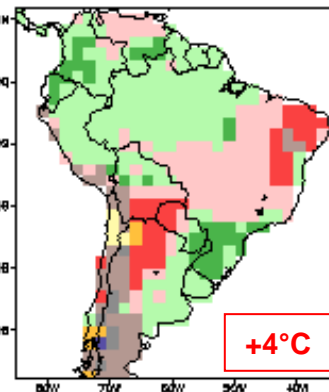
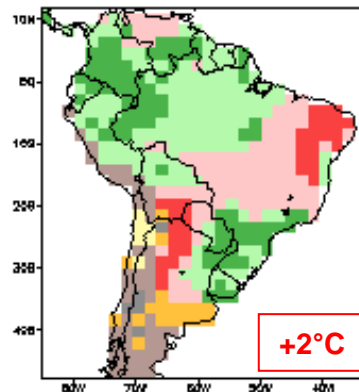
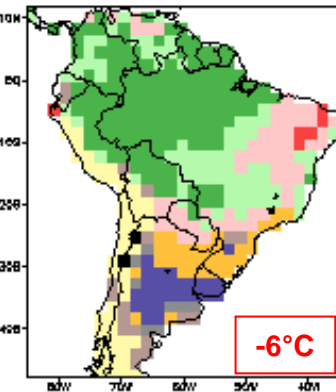
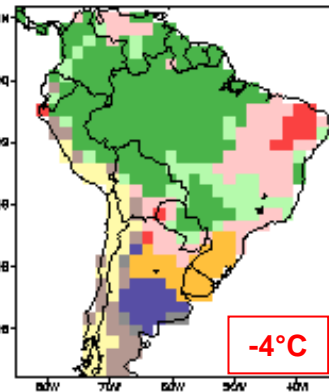
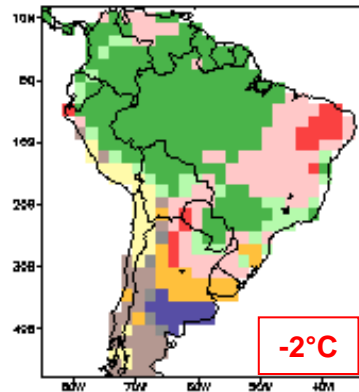
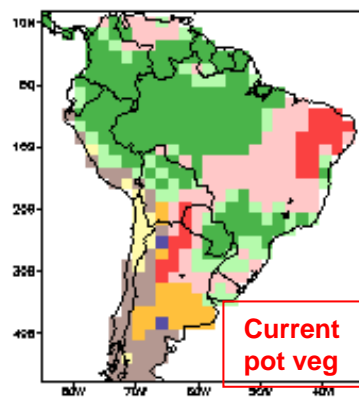
There is an issue of ethics and justice: the people [and other forms of life] most likely to bear the brunt of Global Environmental Change are those who have contributed least to it

Historical contributions to CO₂ emissions:

Europe	30%
USA	28%
China	8%
Amazonia	1% - 1.5%

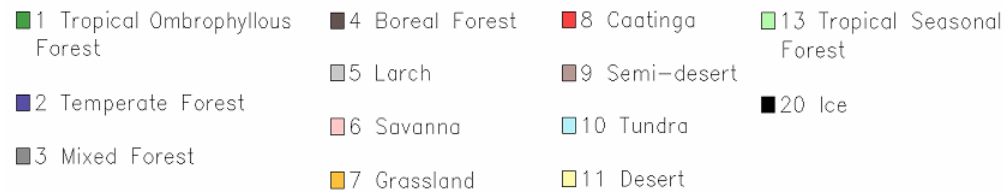
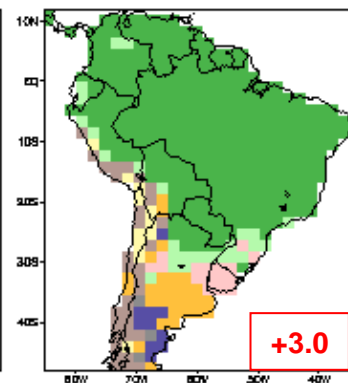
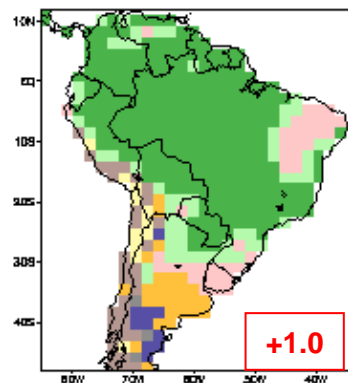
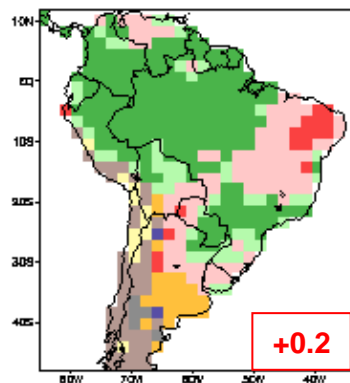
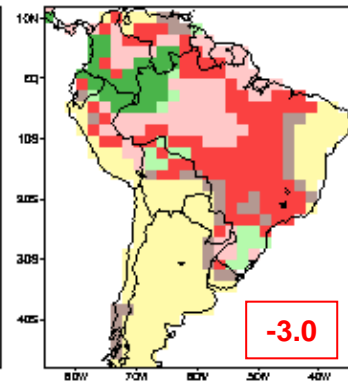
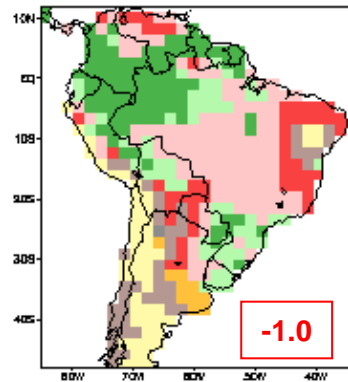
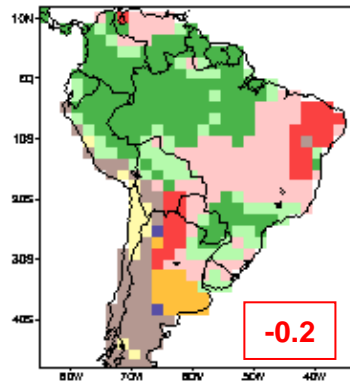
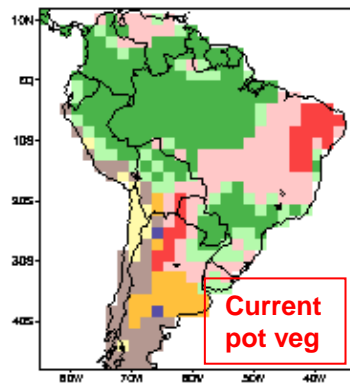
CPTEC PVM 2

Vegetation distribution under different annual mean temperature scenarios



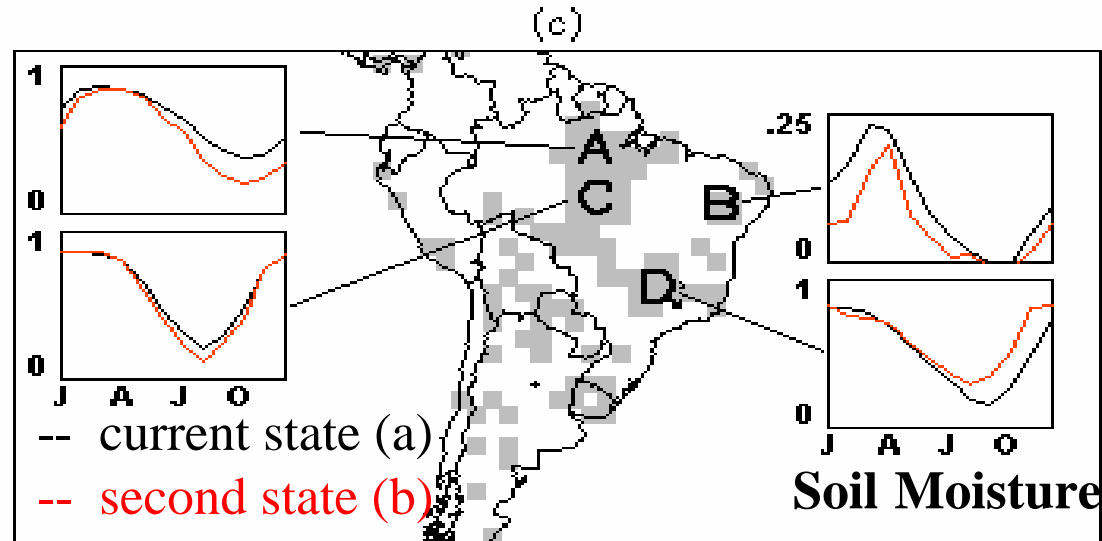
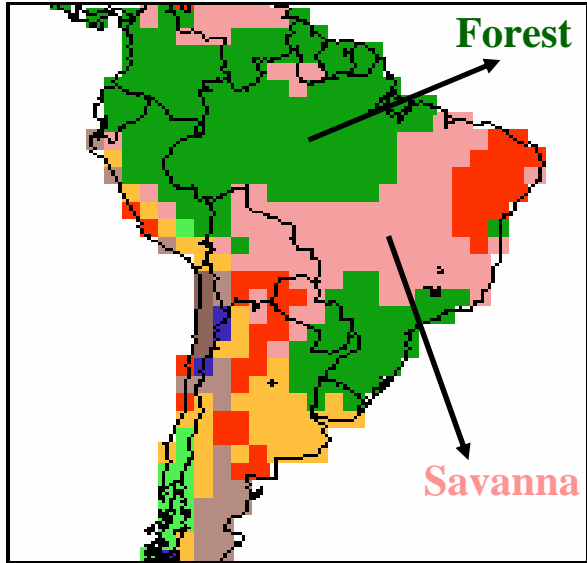
CPTEC PVM 2

Vegetation distribution under different annual mean precipitation scenarios (mm/day)



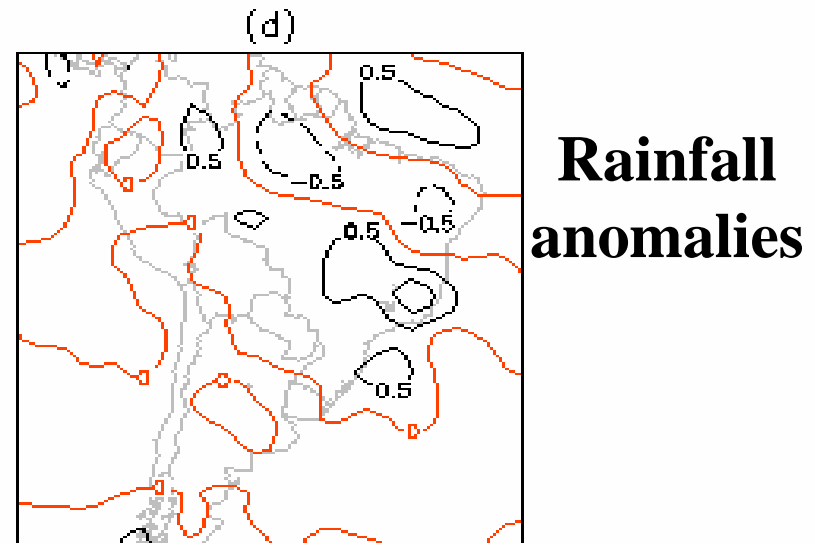
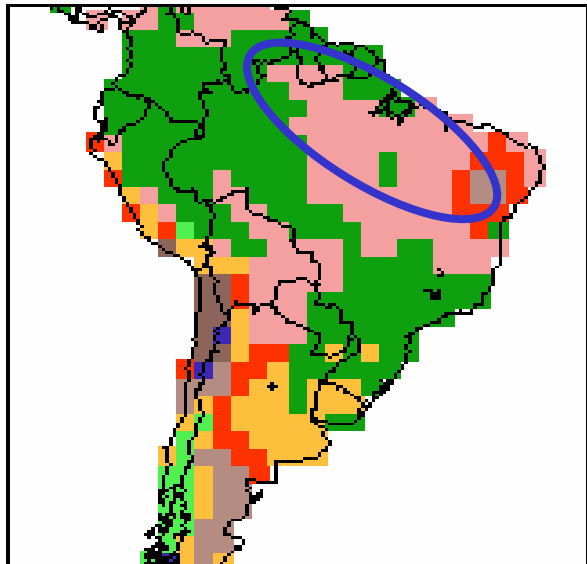
Two Biome-Climate Equilibrium States found for South America

Current potential vegetation

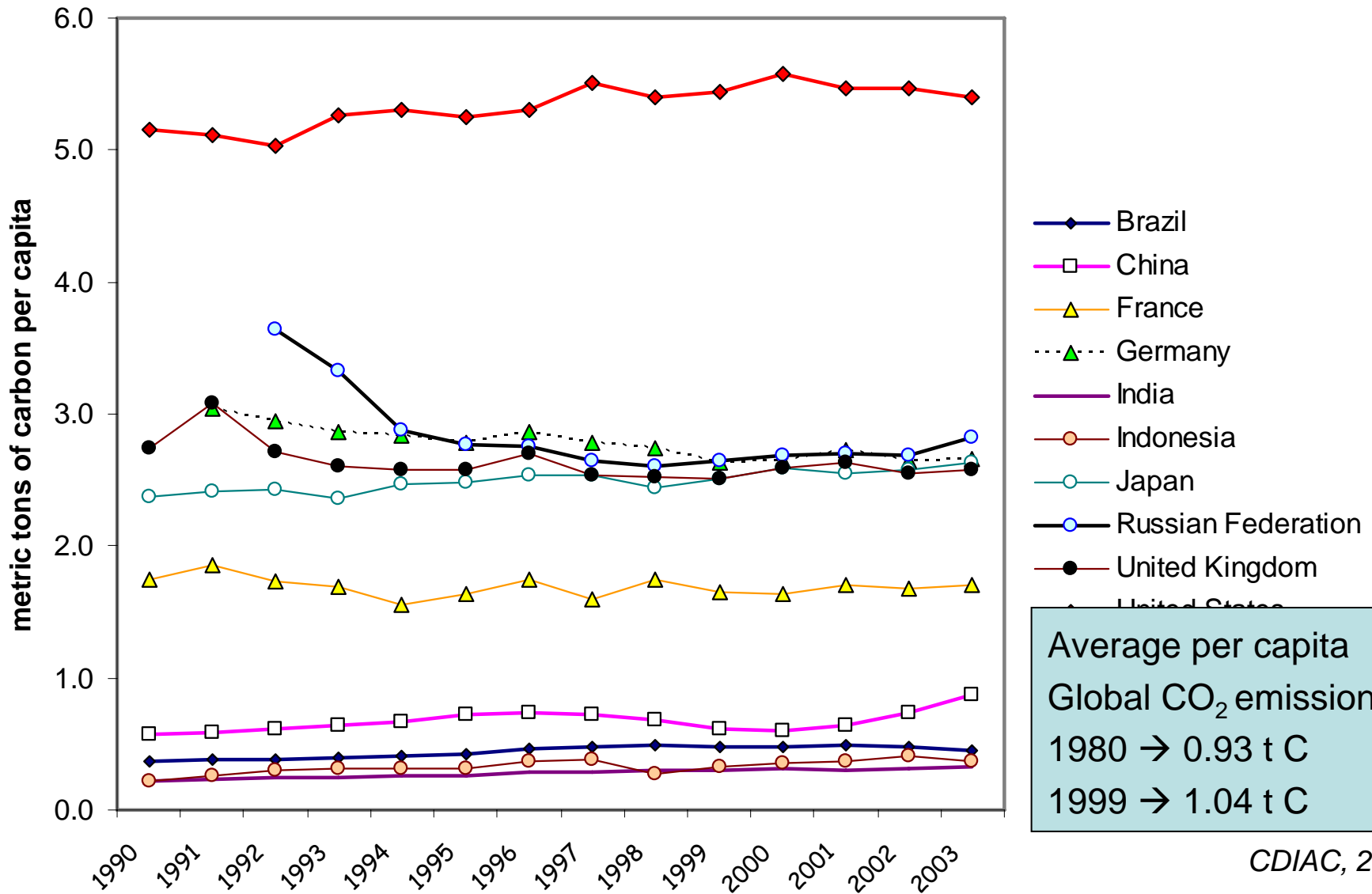


Second State

Results of CPTEC-DBM Initial Conditions : desert



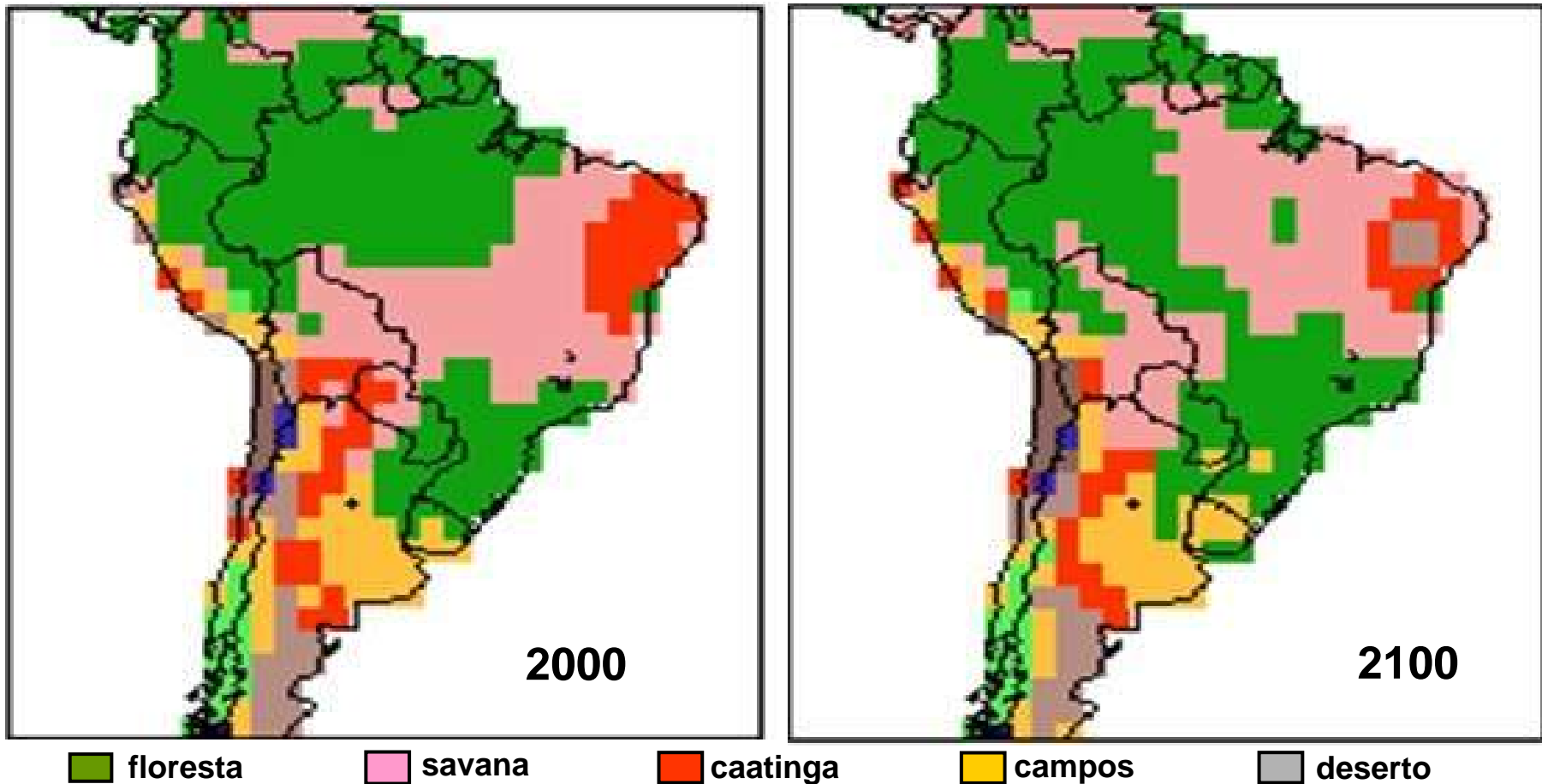
Is an equitable and sustainable 'ecological footprint' achievable?



CDIAC, 2006

Per Capita Carbon Dioxide Emissions (1990-2003)

Futuro dos Biomas Amazônicos?



“Savanização” da Amazônia: um estado de equilíbrio na relação bioma-clima?