MINISTÉRIO DA CIÊNCIA E TECNOLOGIA
INSTITUTO NACIONAL DE PESQUISAS ESPACIAIS

Use of Regional Climate Models in Impact Assessments and Adaptations Studies from Continental to Regional and Local Scales

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PROBIO

GEF

CNPq

UNDP

Facts from PCC AR4

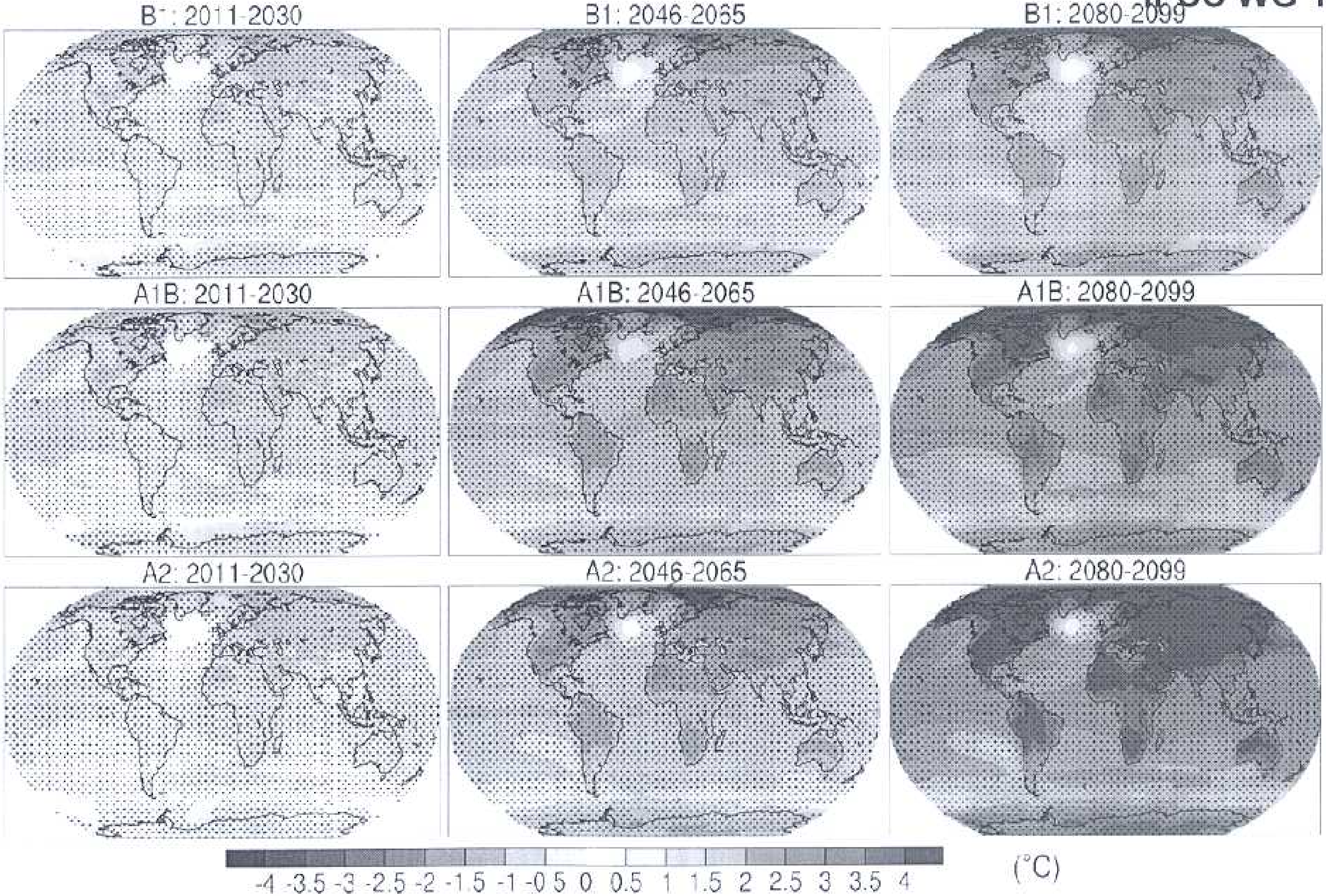
Most of the observed increase in globally averaged temperatures since the mid-20th century is *very likely* due to the observed increase in anthropogenic greenhouse gas concentrations12. This is na advance since the TAR's conclusion that "most of the observed warming over the last 50 years is *likely* to have been due to the increase in greenhouse gas concentrations". Discernible human influences now extend to other aspects of climate, including ocean warming, continental-average temperatures, temperature extremes and wind patterns

There is now higher confidence in projected patterns of warming and other regional-scale features, including changes in wind patterns, precipitation, and some aspects of extremes and of ice.

Anthropogenic warming and sea level rise would continue for centuries due to the timescales associated with climate processes and feedbacks, even if greenhouse gas concentrations were to be stabilized.

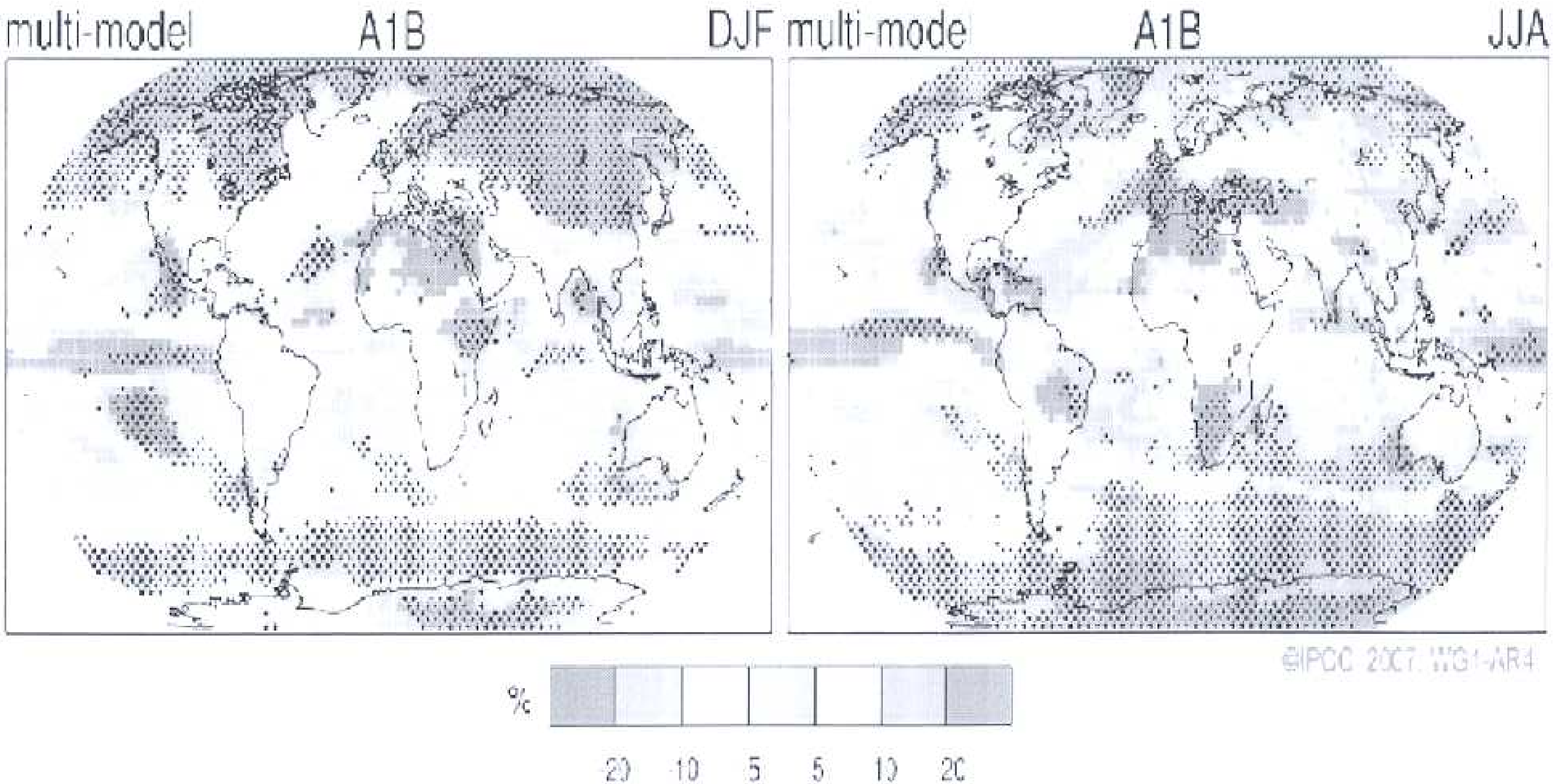
Projeções aumento na temperatura do ar ate 2100 em relação a 1980-99.

IPCC WG 1



Chapter 10

Projected Patterns of Precipitation Changes

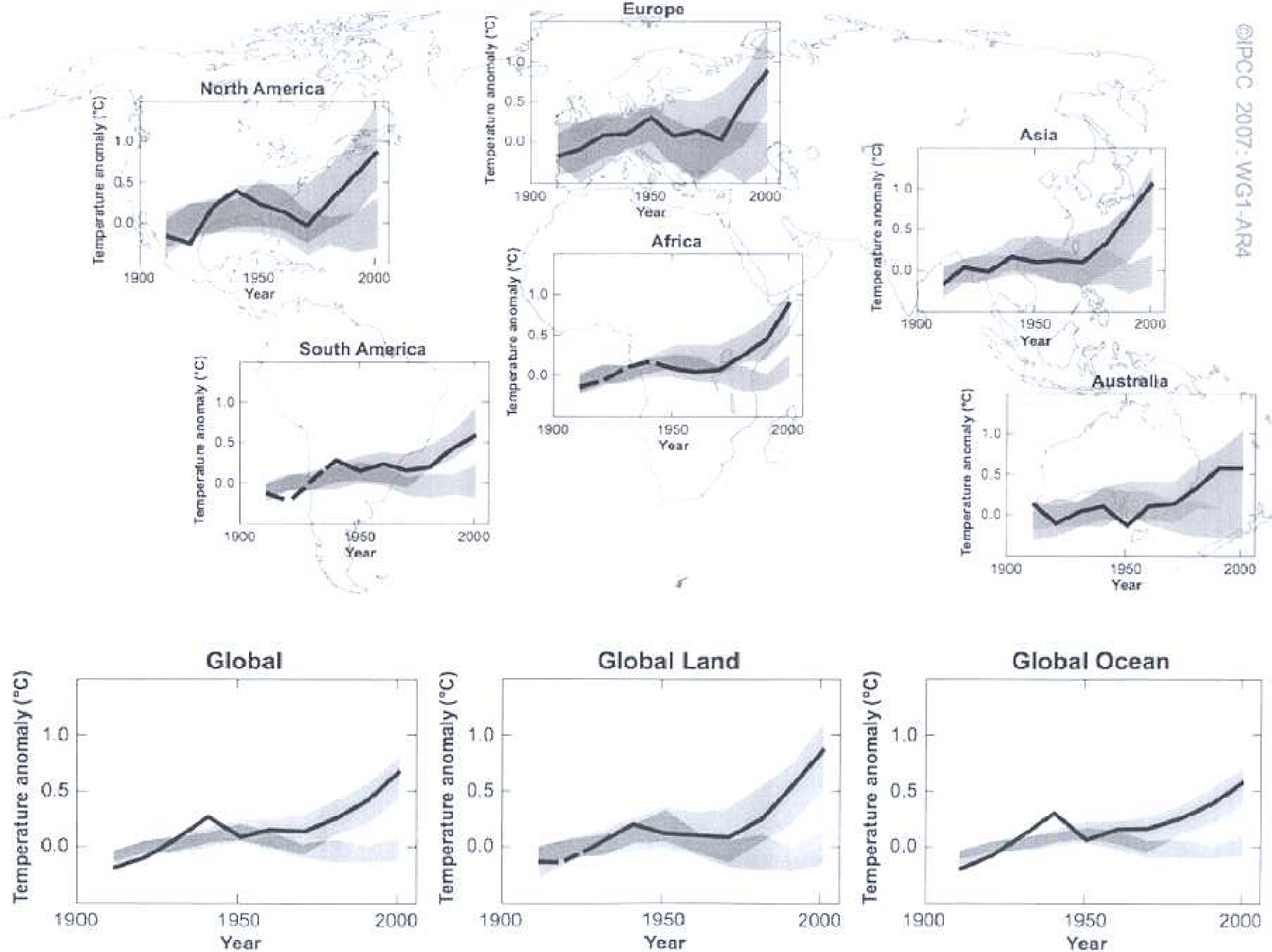


Mudanças da precipitação (%) para o período de 2090–2099, relativo a 1980–1999. Media de vários modelos e IPCC AR4.

Chapter 10

Global and Continental Temperature Change

IPCC WG 1



Limitations of climate projections from AOGCM

Coupled Atmosphere-Ocean Global Climate Models (AOGCMs) are the modeling tools traditionally used for generating climate change projections and scenarios.

The horizontal atmospheric resolution of present day AOGCMs is still relatively coarse, order of 300 km, and regional climate is often affected by forcings and circulations that occur at smaller scales. As a result, AOGCMs cannot explicitly capture the fine scale structure that characterizes climatic variables in many regions of the world and that is needed for many impact assessment studies.

Regional Climate Models (RCMs) are useful tools for generating high resolution climate change scenarios for use in climate impacts and adaptation studies.

Why regional models?

The issue of the spatial resolution in scenarios must be put in the context of other uncertainties of climate change. Studies and analyses of climate change impact and adaptation assessments recognize that there are a number of sources of uncertainty in such studies which contribute to uncertainty in the final assessment.

The importance of high resolution climate scenarios for impacts and adaptation studies remains to be thoroughly explored in Brazil and South America.

Most of these activities have been linked to implementation of scenarios for the UNFCC National Communications on Climate Change at the country level. In studies so far, mainly concerning agriculture and water resources, significant differences in the estimated impacts based on spatial resolution are found.

So far it has been explicitly demonstrated that the necessary adaptation measures varies with the spatial resolution. And of course, this point could be deduced from the fact that the level of impacts varies.

Downscaling of climate change scenarios in Brazil

An initiative from Brazil has been the implementation of CREAS (Regional Climate Change Scenarios for South America). CREAS is being established as consequence of a GEF-Ministry of Environment/PROBIO project lead by CPTEC in Brazil for studies on impacts of climate change in natural ecosystems in Brazil (PROBIO).

Additional funding for CREAS comes from the GOF-UK CLIMATE CHANGE & ENERGY PROGRAMME: Using Regional Climate Change Scenarios for Studies on Vulnerability and Adaptation in Brazil and South America, and the National Climate Change Program from the Ministry of Science and Technology.

The projects aim to provide high resolution climate change scenarios in the three most populated basins in South America for raising awareness among government and policy makers in assessing climate change impact, vulnerability and in designing adaptation measures.

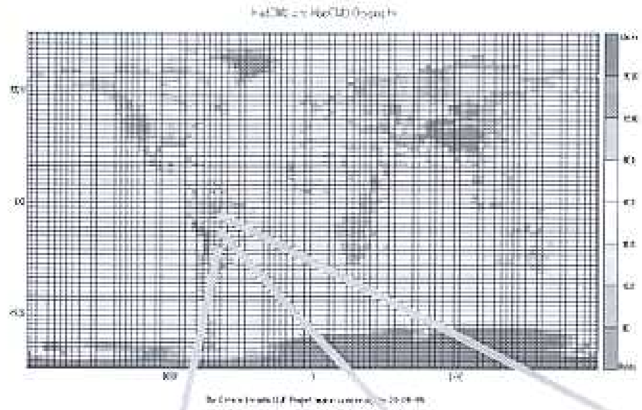
Project strategy summary

To provide high resolution future climate change scenarios in South America for development of studies that should lead to raising awareness among government and policy makers in assessing climate change impact, vulnerability and in designing adaptation measures.

PROBIO-IPCC Global models ised: IPCC TAR (HadCM3)-Version 1

Downscaling

Modelos do IPCC: HadCM3



Climatology 1961-90

IPCC Scenarios A2, B2

Climate anomalies (future-present), from regional mulimodel ensemble Time slices 2071-2100, A2, B2

Regional models

RegCM3

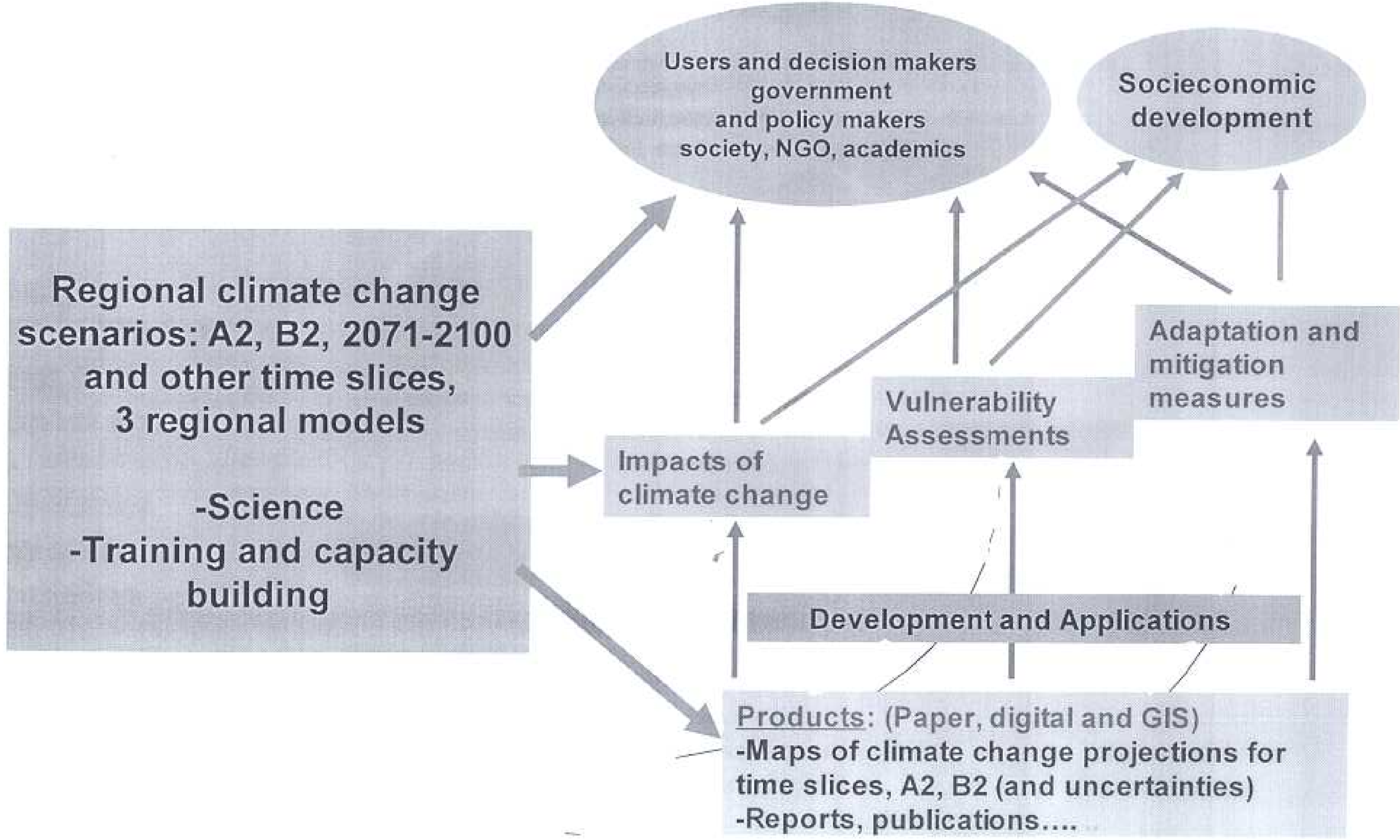
HadRM3

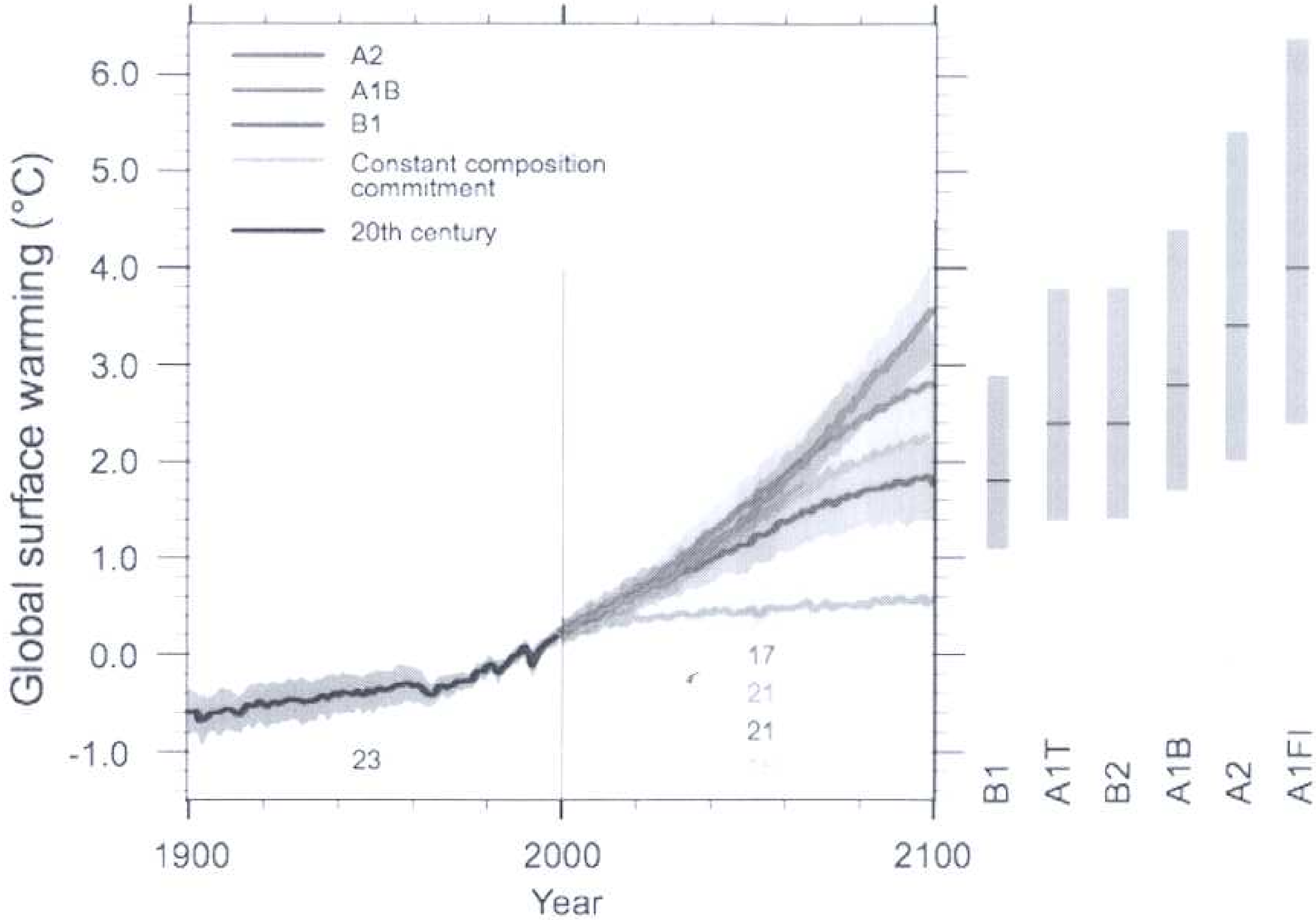
Eta CCS

Climatology regional model 1961-90

Maps of climate anomalies, and indices of extremes (Regional multimodel ensemble) 2071-2100, A2, B2

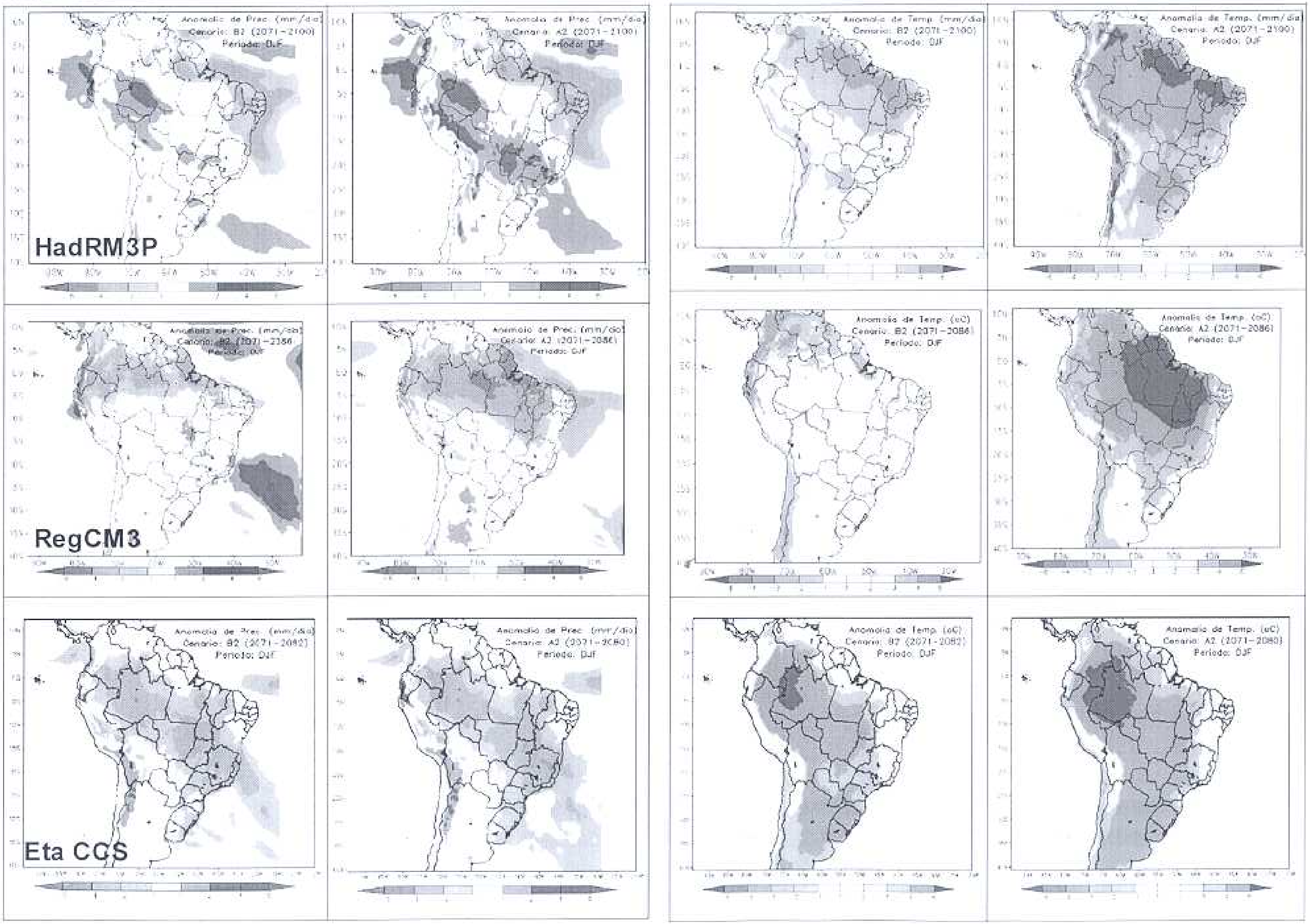
Applications for impacts and vulnerability studies



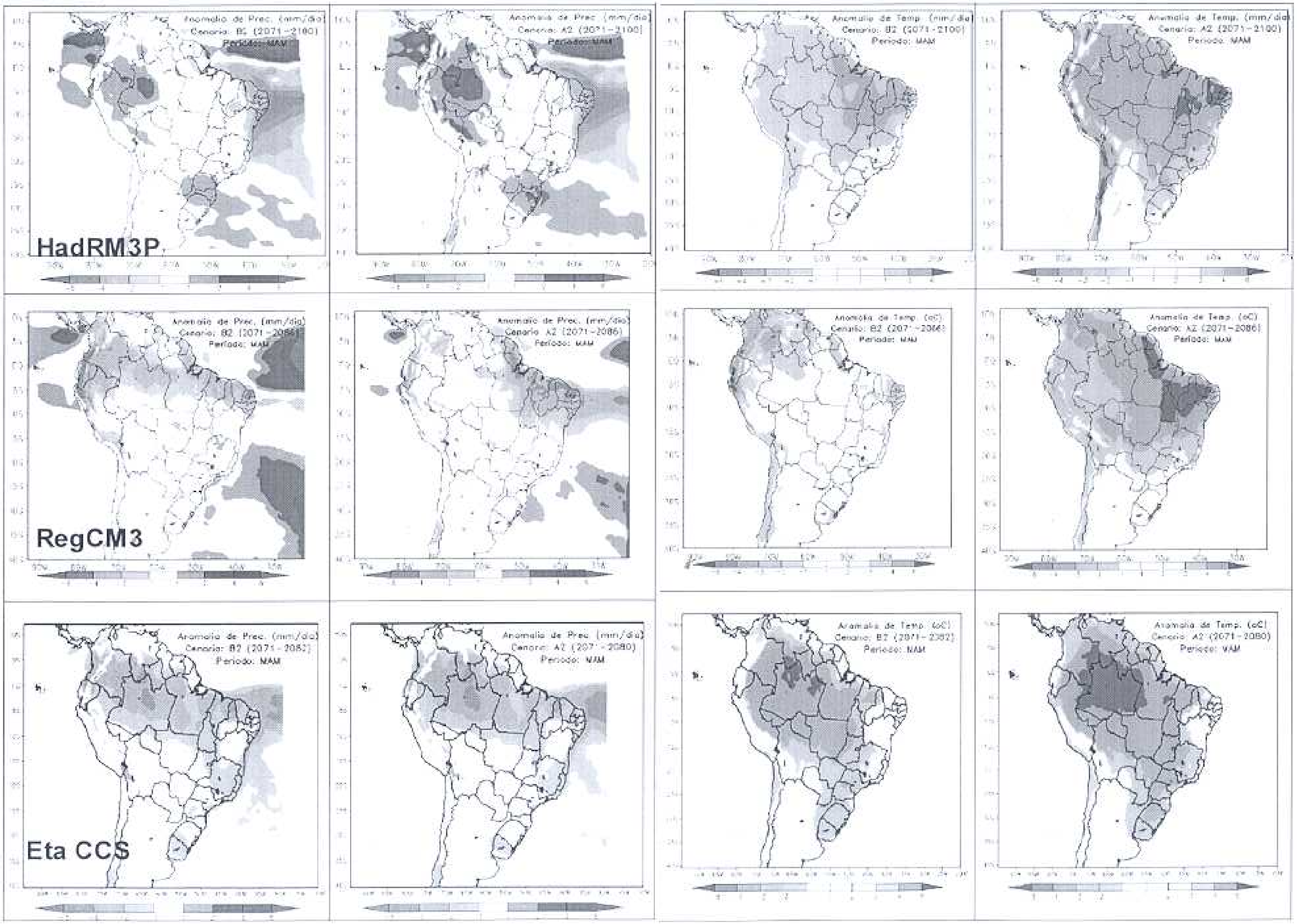


Solid lines are multi-model global averages of surface warming (relative to 1980-99) for the scenarios A2, A1B and B1, shown as continuations of the 20th century simulations. Shading denotes the plus/minus
one standard deviation range of individual model annual means. The number of AOGCMs run for a given

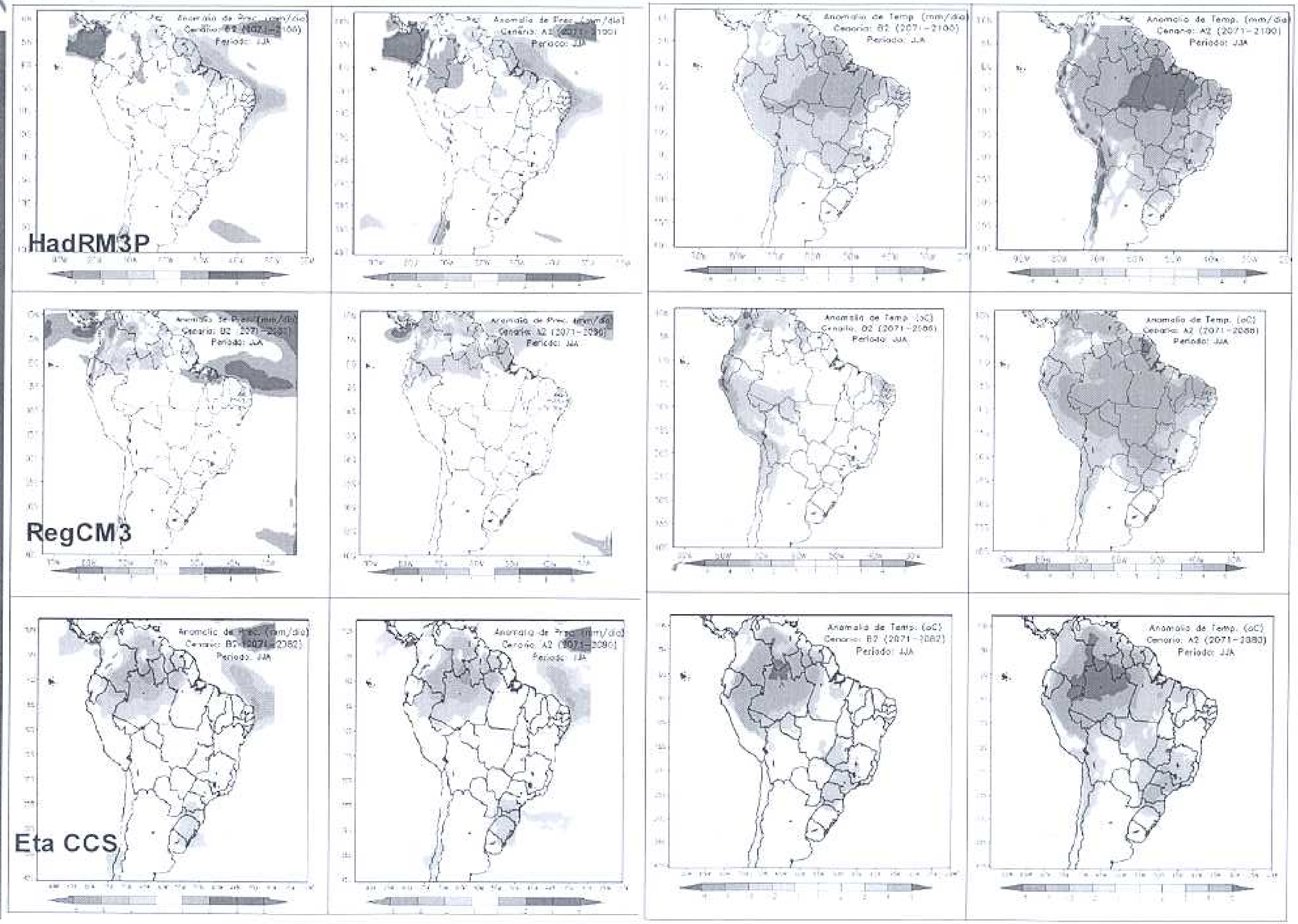
Regional climate change projections (summer DJF): Rainfall and temperature



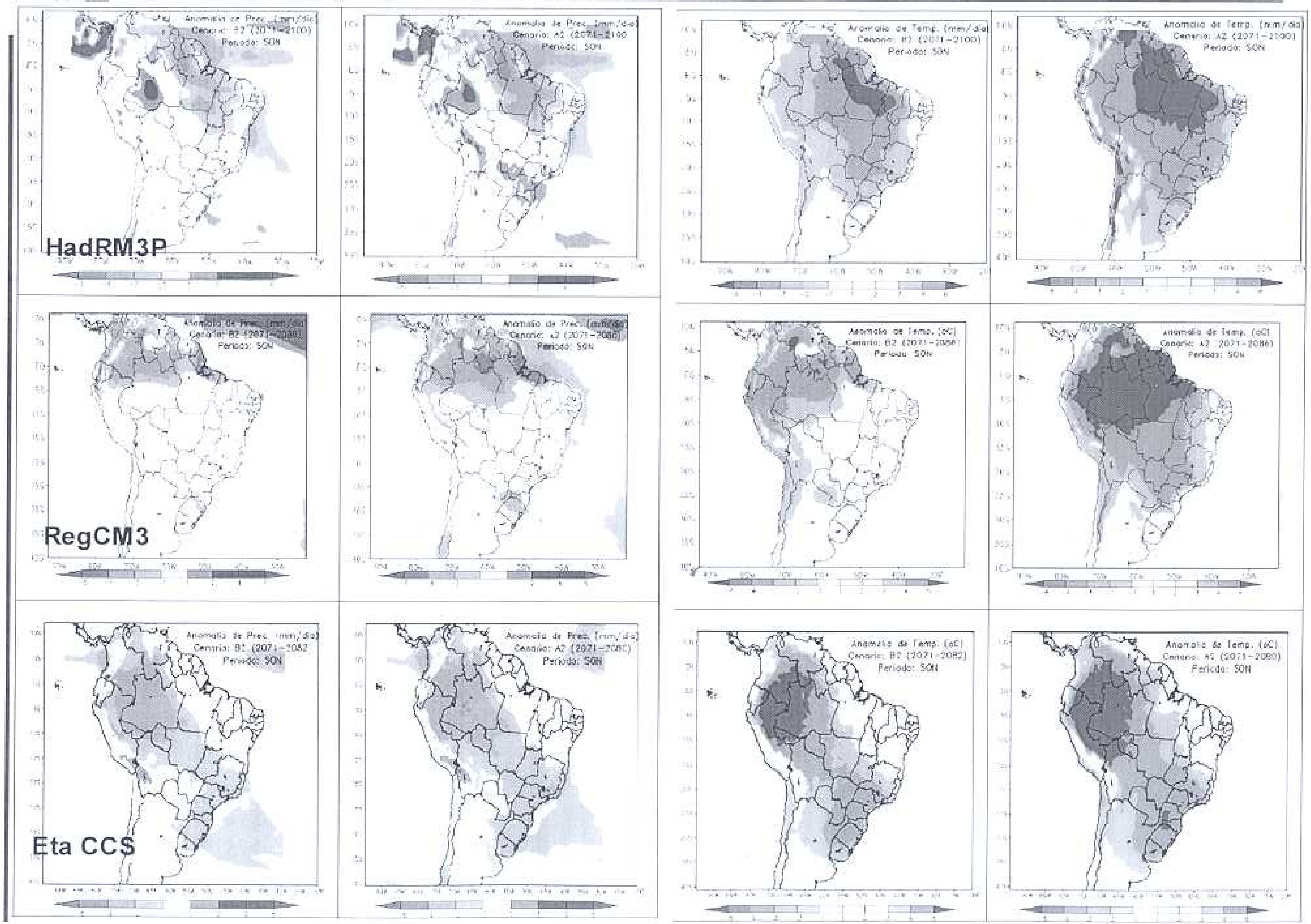
Regional climate change projections (Fall MAM): Rainfall and temperature



Regional climate change projections (winter JJA): Rainfall and temperature



Regional climate change projections (spring SON): Rainfall and temperature



Amazonia

Precipitation

Temperature

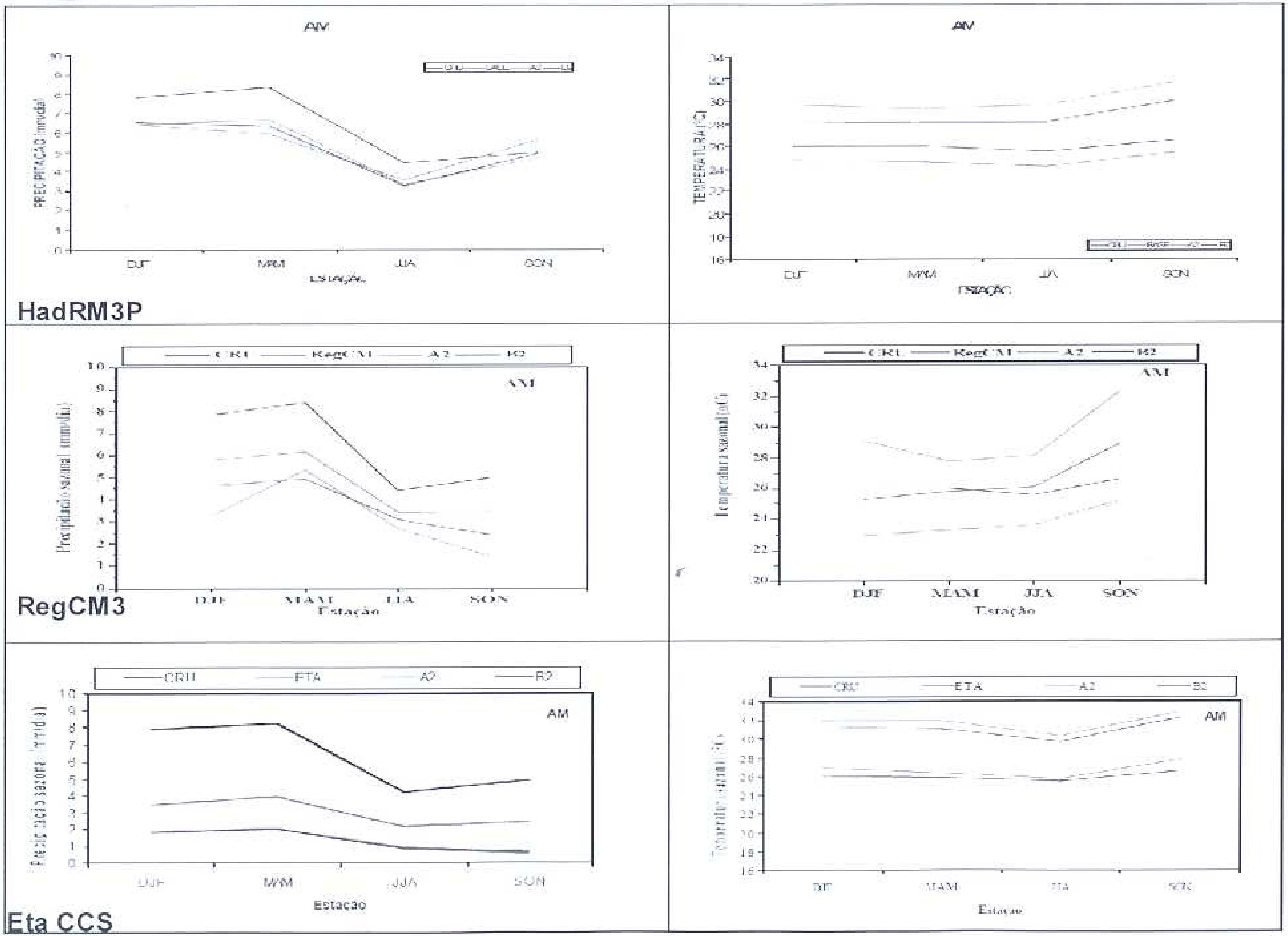
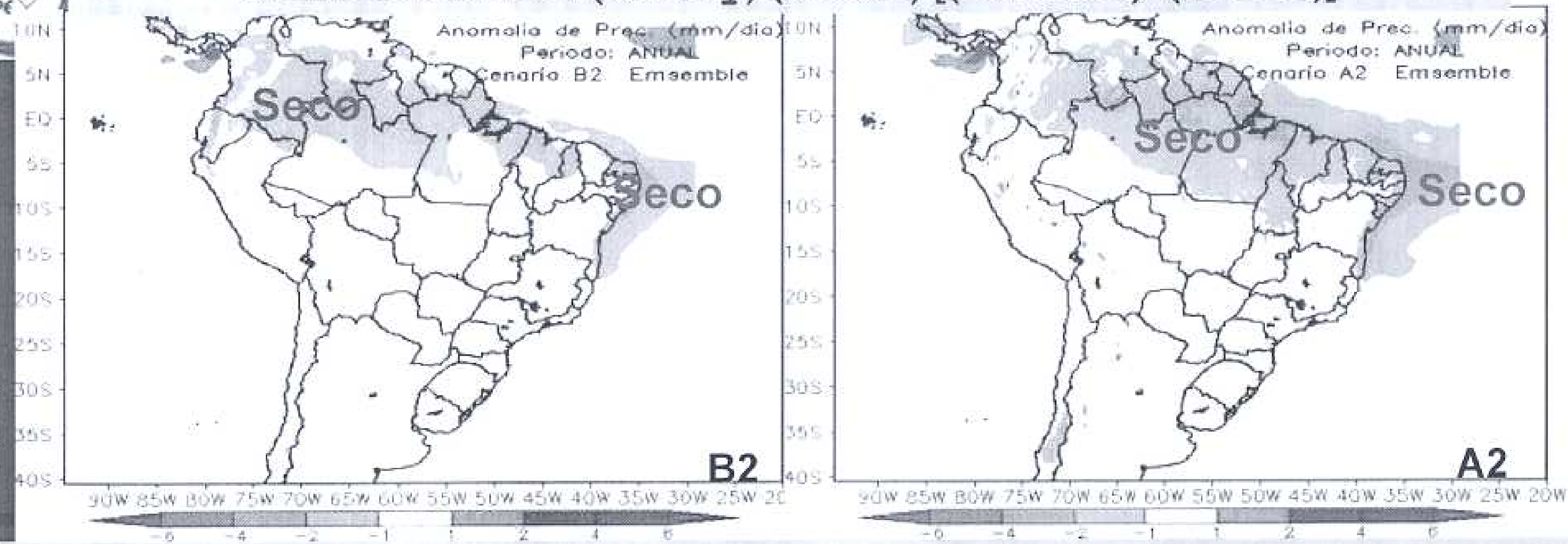


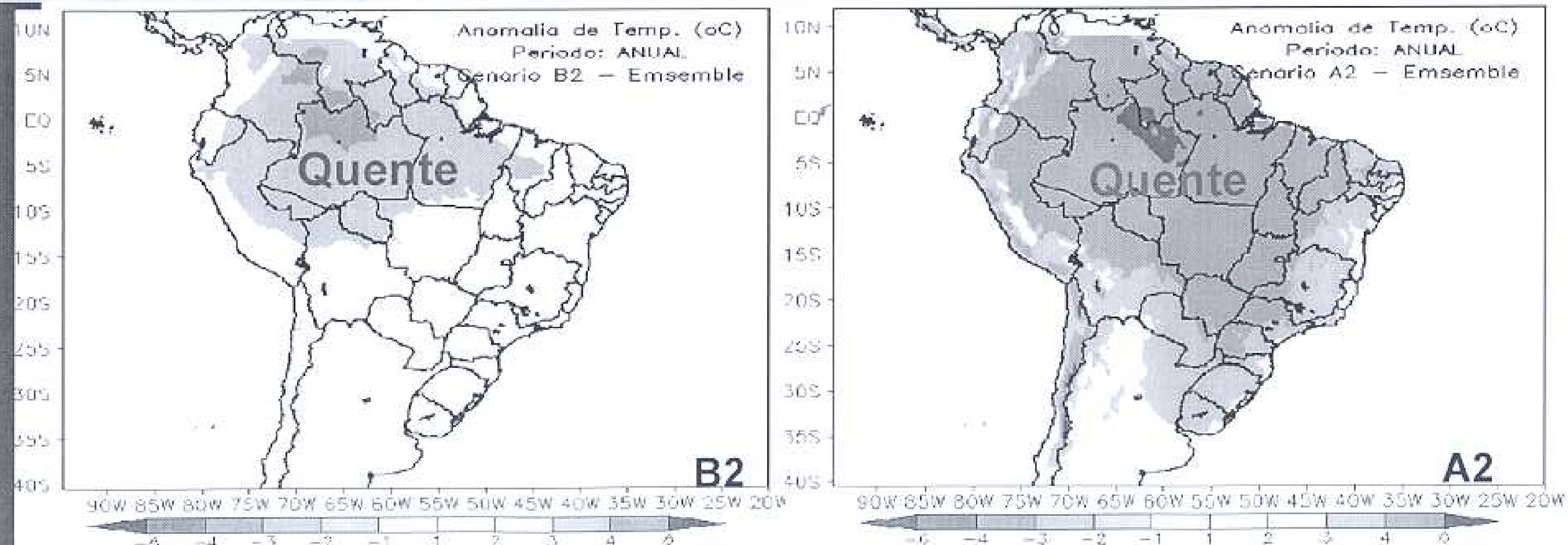
TABELA 3. Índices estatísticos mensais da precipitação calculados nos subdomínios definidos na Fig.6. São mostrados o viés, o desvio padrão (dp), o erro da raiz quadrática média (RMSE) e o coeficiente de correlação (CC) em relação aos dados climatológicos do CRU.

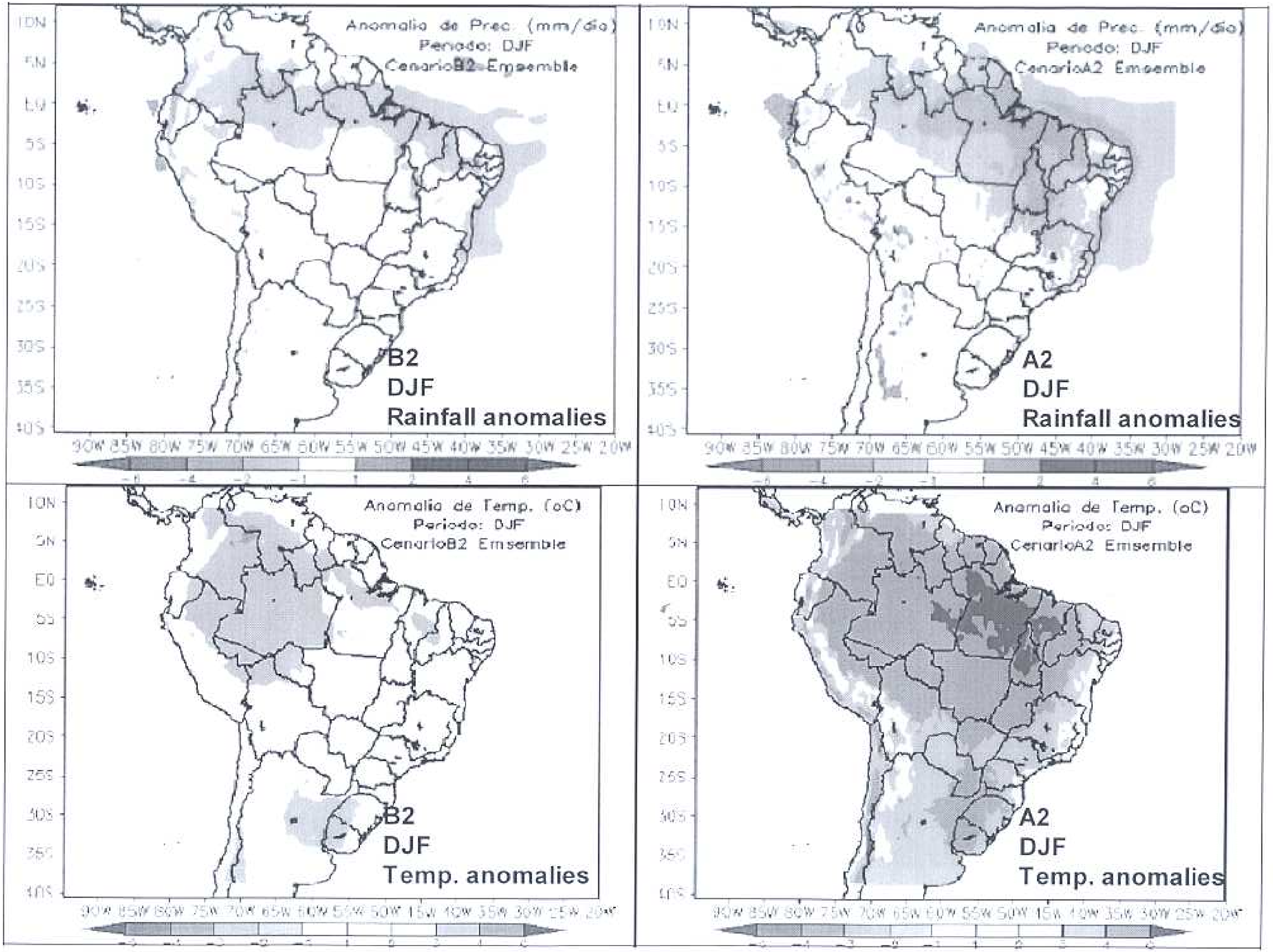
	HadRM3P	RegCM3	ETA/CPTEC
Amazonia			
Bias	-1.0	-1.70	-3.31
dp	1.82	1.40	0.78
Rmse	1.78	2.04	3.51
COR	0.77	0.91	0.97
Nordeste			
Bias	0.5	-0.67	-1.19
dp	1.98	2.20	0.67
Rmse	1.50	1.00	1.82
COR	0.92	0.91	0.49
Sul			
Bias	-0.4	-0.60	-1.21
Dp	1.85	1.07	1.27
Rmse	1.51	1.08	1.34
COR	0.95	0.79	0.96
Pantanal			
Bias	0.0	-0.62	-1.38
Dp	1.85	0.41	1.62
Rmse	1.51	1.01	1.49
COR	0.96	0.70	0.97

Rainfall anomalies (mm/day) (Annual) [(2071-2100)-(1961-90)]

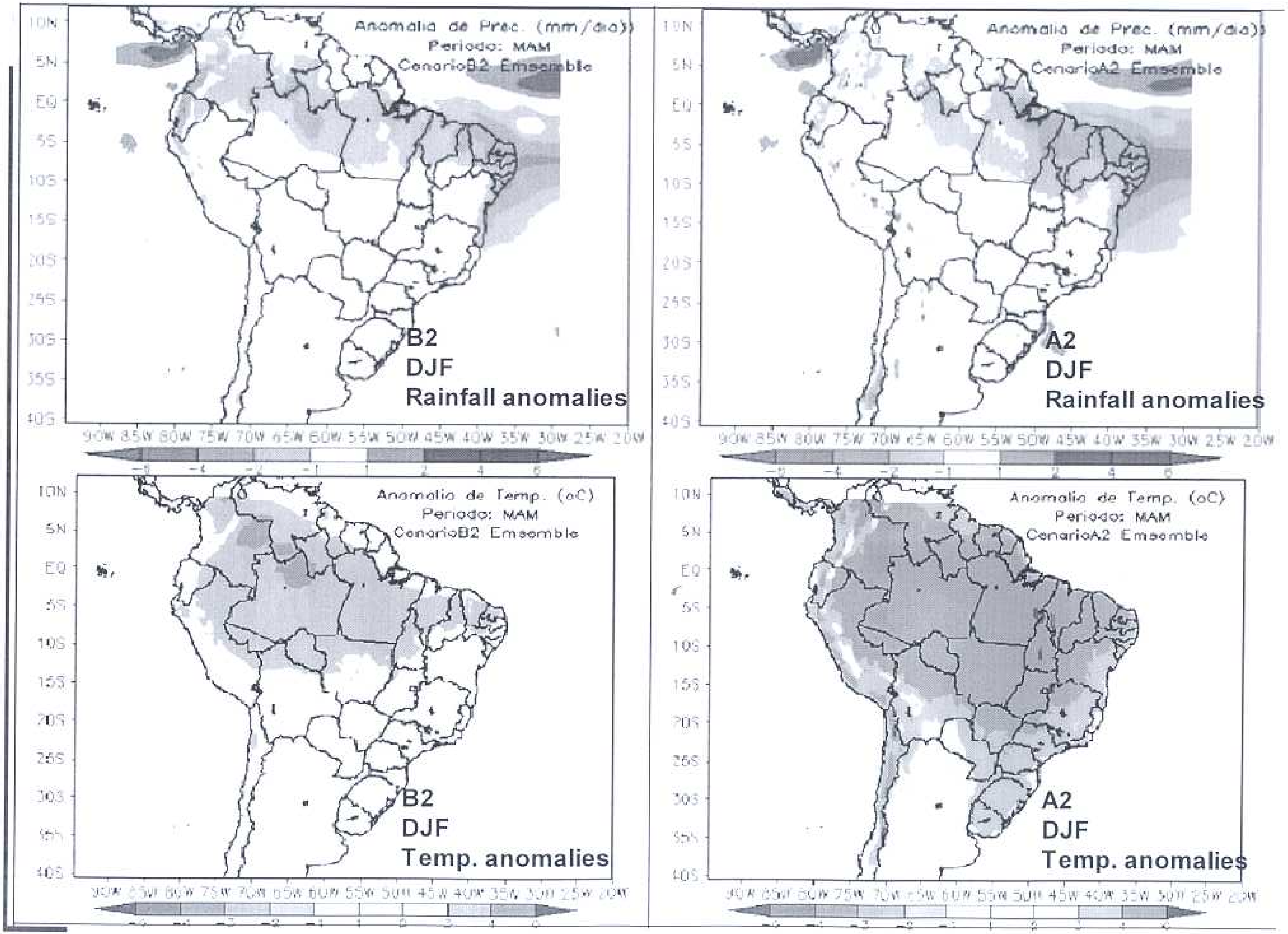


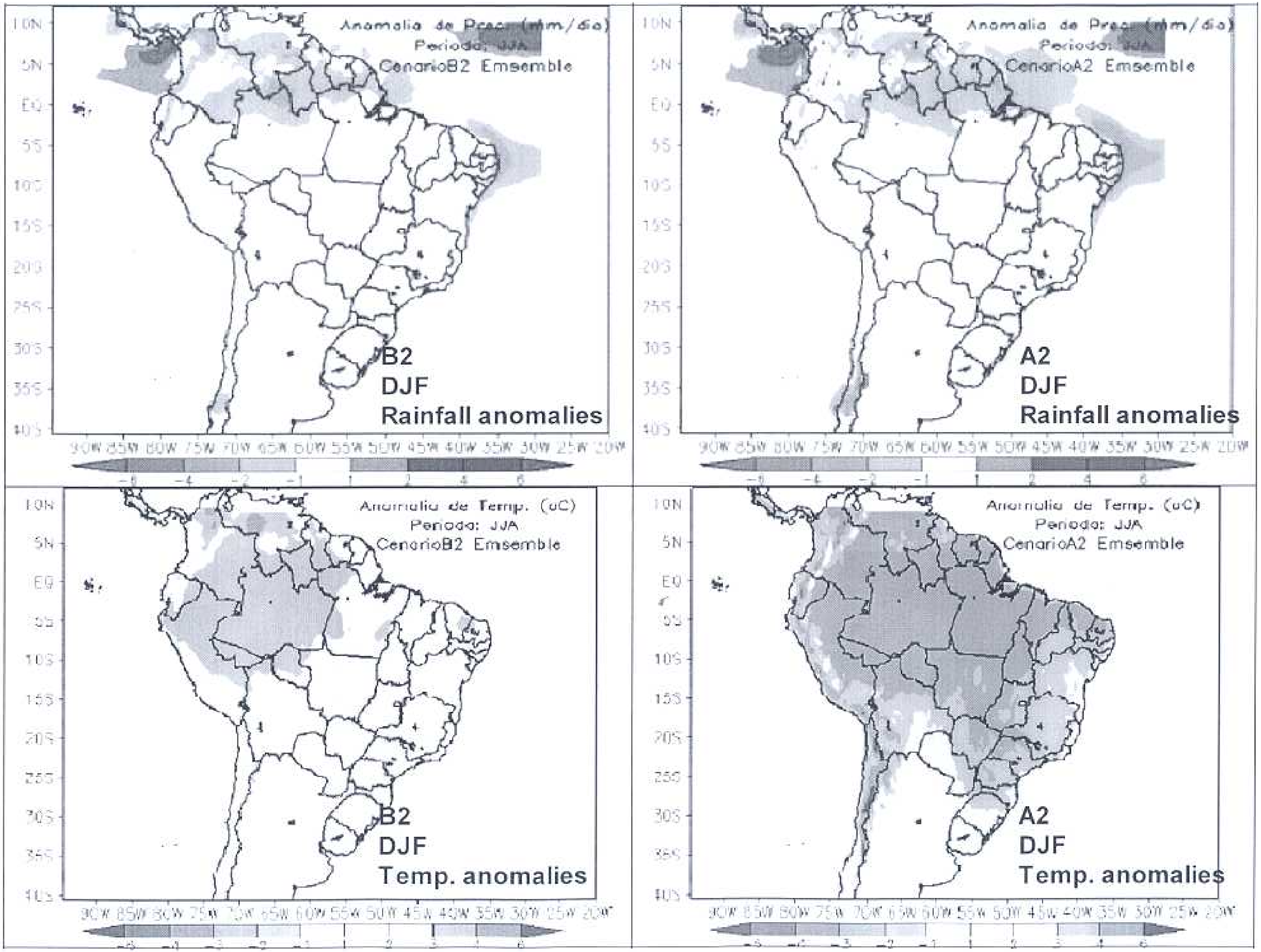
Temperature anomalies (C) Annual [(2071-2100)-(1961-90)]

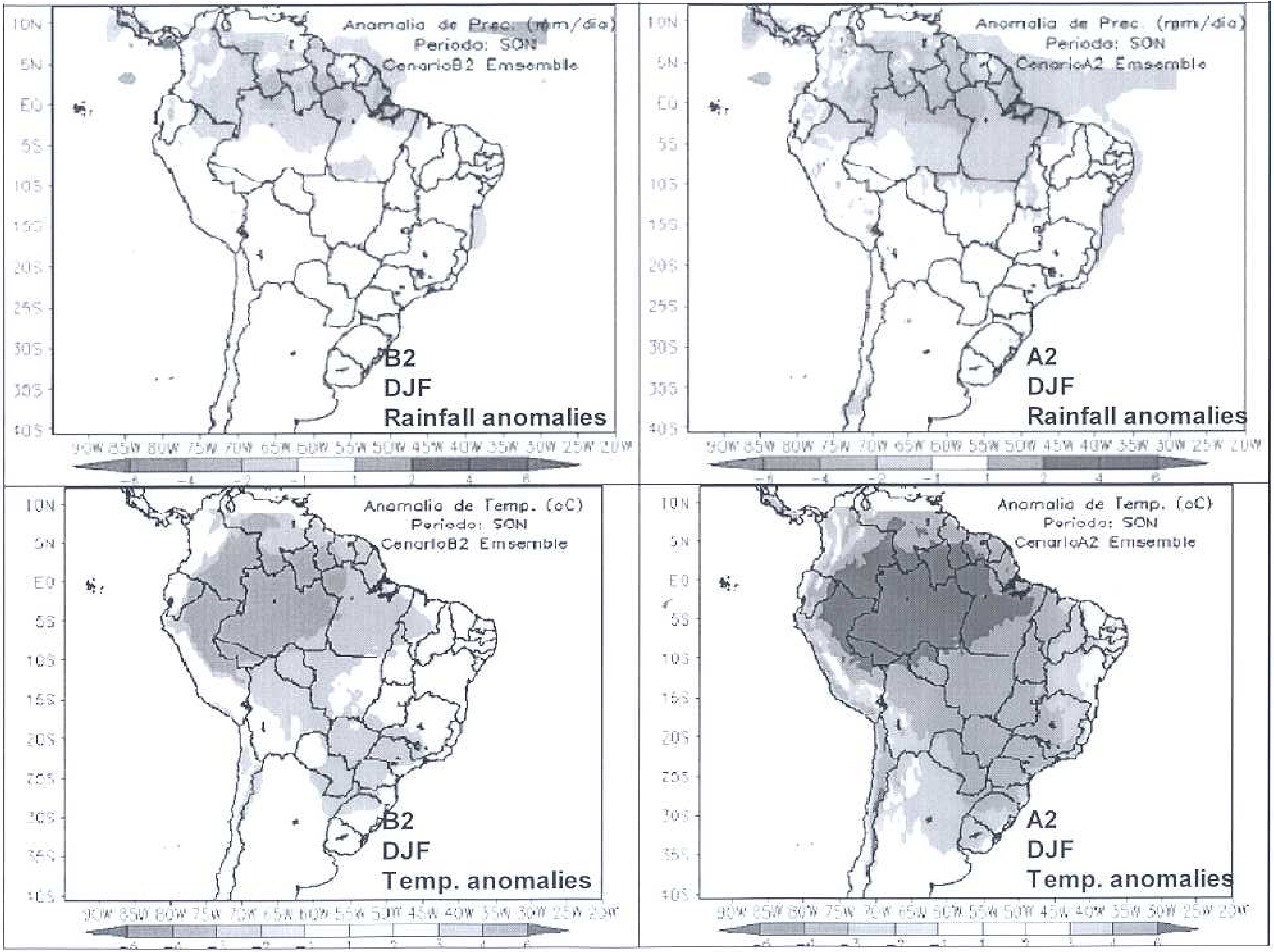




Anomalia de Prec. (mm/dia)
Periodo: DJF
CenarioB2 Ensemble
B2
DJF
Rainfall anomalies
Anomalia de Prec. (mm/dia)
Periodo: DJF
CenarioA2 Ensemble
A2
DJF
Rainfall anomalies
Anomalia de Temp. (oC)
Periodo: DJF
CenarioB2 Ensemble
B2
DJF
Temp. anomalies
Anomalia de Temp. (oC)
Periodo: DJF
CenarioA2 Ensemble
A2
DJF
Temp. anomalies

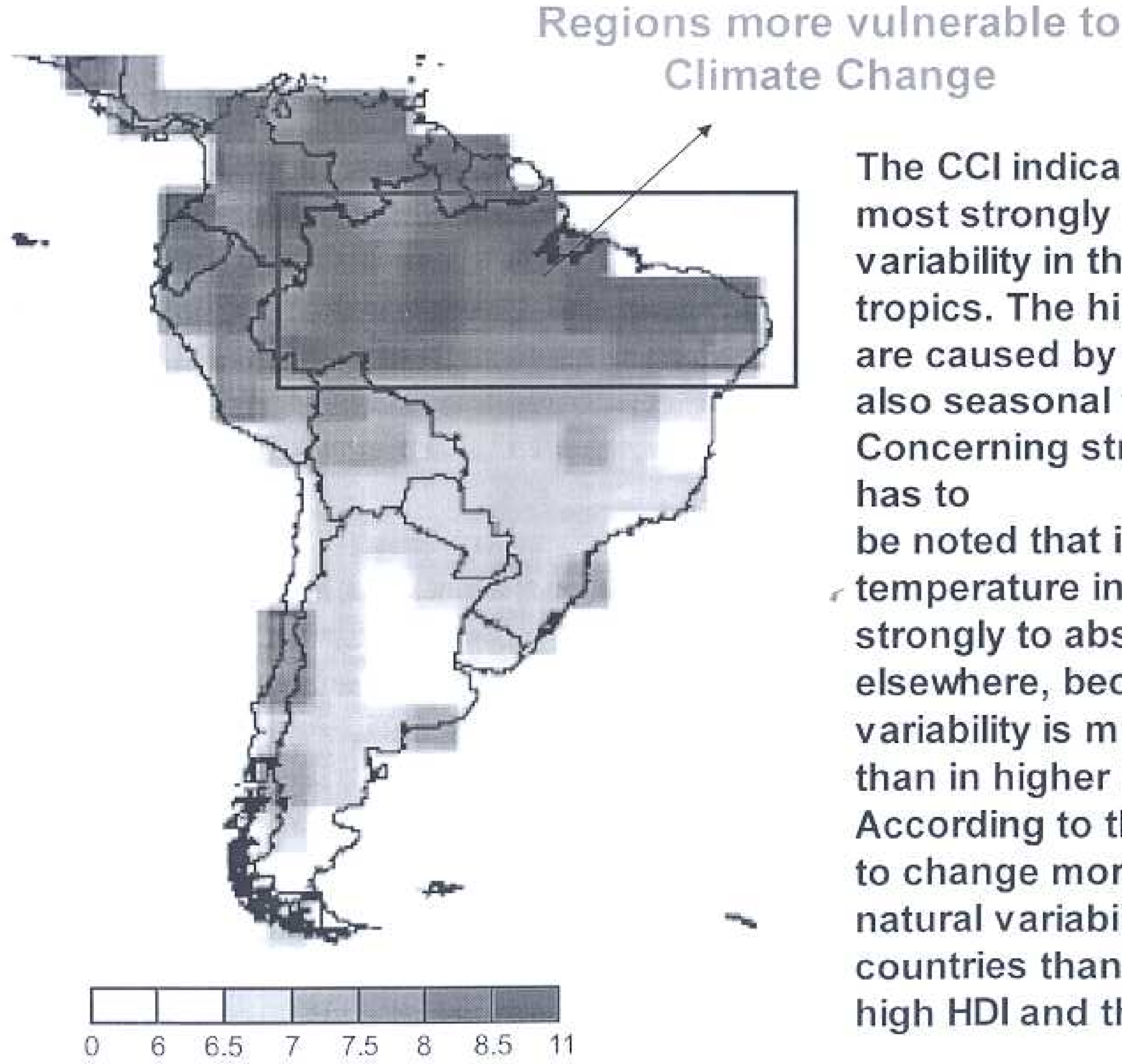

Anomalia de Prec. (mm/dia)
Periodo: MAM
CenarioB2 Ensemble
B2
DJF
Rainfall anomalies
Anomalia de Prec. (mm/dia)
Periodo: MAM
CenarioA2 Ensemble
A2
DJF
Rainfall anomalies
Anomalia de Temp. (oC)
Periodo: MAM
CenarioB2 Ensemble
B2
DJF
Temp. anomalies
Anomalia de Temp. (oC)
Periodo: MAM
CenarioA2 Ensemble
A2
DJF
Temp. anomalies


Periodo: JJA
CenarioB2 Emsemble
B2
DJF
Rainfall anomalies
CenarioA2 Emsemble
A2
DJF
Rainfall anomalies
Anomalia de Temp. (oC)
Periodo: JJA
CenarioB2 Emsemble
B2
DJF
Temp. anomalies
Anomalia de Temp. (oC)
Periodo: JJA
CenarioA2 Emsemble
A2
DJF
Temp. anomalies



Anomalia de Prec. (mm/dia)
Periodo: SON
CenarioB2 Ensemble
B2
DJF
Rainfall anomalies
Anomalia de Prec. (mm/dia)
Periodo: SON
CenarioA2 Ensemble
A2
DJF
Rainfall anomalies
Anomalia de Temp. (oC)
Periodo: SON
CenarioB2 Ensemble
B2
DJF
Temp. anomalies
Anomalia de Temp. (oC)
Periodo: SON
CenarioA2 Ensemble
A2
DJF
Temp. anomalies
10N 5N EQ 5S 10S 15S 20S 25S 30S 35S 40S
90W 85W 80W 75W 70W 65W 60W 55W 50W 45W 40W 35W 30W 25W 20W

The aggregated CCI (Climate Change index) on a grid basis for South America, for the 2071-2100 period in relation to 1961-90. (Baettig et al. 2007).



The CCI indicates that climate will change most strongly relative to today's natural variability in the tropics. The high CCI-values in the tropics are caused by precipitation changes but also seasonal temperature events.

Concerning strong temperature changes, it has to be noted that in the tropics the hot temperature indicator responds more strongly to absolute changes in mean than elsewhere, because natural temperature variability is much smaller in the tropics than in higher latitudes.

According to the CCI, climate is expected to change more strongly relative to today's natural variability in these more vulnerable countries than in many countries with a high HDI and thus lower vulnerability.

Summary of future climate change scenarios for the end of the XXI Century and possible impacts in Brazil

AMAZON REGION
A2: 4-8 C warmer, 15-20% less rainfall
B2: 3-5 C warmer, 5-15 % less rainfall
Possible impacts: High frequency of dry spells in eastern Amazonia and intense rainfall events in western Amazonia, losses in natural ecosystems, rain forest and biodiversity. Low river levels affecting transportation and commerce. Possible impacts on moisture transport and rainfall in Southeastern South America. Impacts on hydroelectric generation. More favorable conditions for spread of forest fires. Impacts on health and commerce due to smoke.

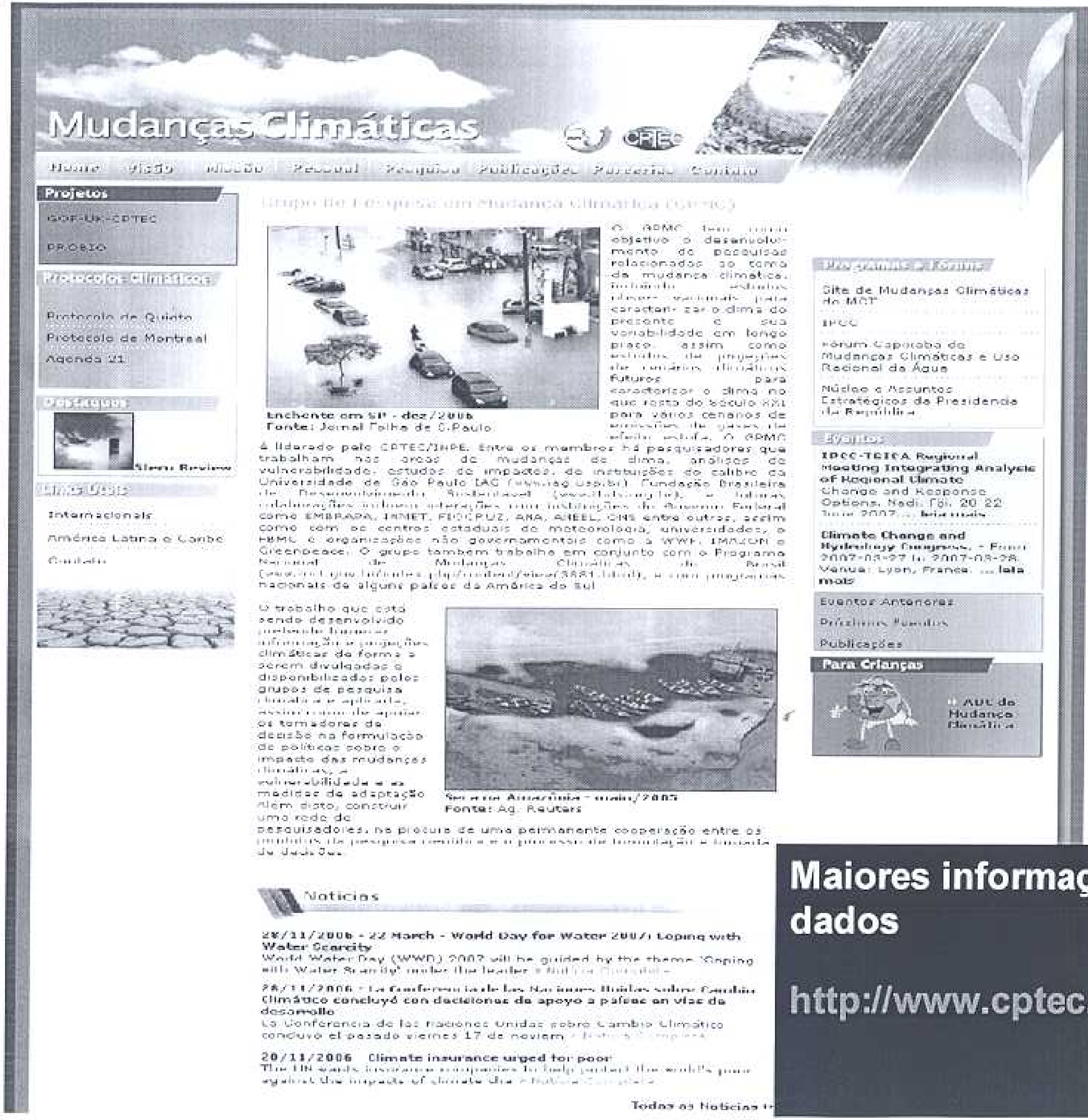
NORTHEAST BRAZIL
A2: 2-4 C warmer, 15-20% less rainfall
B2: 1-3 C warmer, 10-15 % less rainfall
Possible impacts: High frequency of dry spells and evaporation rates and low soil moisture levels affecting levels of channels and reservoirs. Losses in natural ecosystems caatinga.Tendency towards aridization and desertification in the semiarid region. Water scarsity. Waves of climate refugees migrating towards large cities agravating social problems. Impacts on human health

WEST CENTRAL BRAZIL
A2: 3-6 C warmer,
B2: 2-4 C warmer,
Possible impacts: High frequency of intense rainfall events and dry spells. High evaporation rates and lower soil moisture can affect agriculture (coffee) and hydroelectric generation. Soil erosion due to high temperatures and intense dry spells can affect agriculture and natural ecosystems Pantanal and cerrado.

SOUTHERN BRAZIL
A2: 2-4 C warmer, 5-10% more rainfall
B2: 1-3 C warmer, 0-5 % more rainfall
Possible impacts: High frequency of intense rainfall events, increase in warm nights frequency (reduction of cold nights). Intense rainfall and high evaporation due to dry spells can affect agriculture (weath and soybean). Losses in natural ecosystems. High temperatures and intense rainfall can affect human health

SOUTHEASTERN BRAZIL
A2: 3-6 C warmer,
B2: 2-3 C warmer,
Possible impacts: High frequency of intense rainfall events. High evaporation rates and lower soil moisture can affect agriculture (coffee) and hydroelectric generation. High temperatures and intense rainfall can affect human health. Possible sea level rise.

Sources: INPE, MMA-PROBIO, EMBRAPA, CEPAGRI



Maiores informações a acesso aos dados

http://www.cptec.inpe.br/mudancas_cli