

Global Opportunities Fund – Climate Change and Energy Programme

Newsletter of the project

Using Regional Climate Change Scenarios for Studies on Vulnerability and Adaptation in Brazil and South America (GOF - UK)

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Editorial

The year of 2007 will be recognized as the year in which most of the world finally recognizes that climate change is a fact, and that we all are vulnerable to it. In the beginning of February 2007 the IPCC-WGI released in Paris the “Summary for Policy Makers - SPM” of the Working Group WGI “The Physical Science Basis” and one month later the SPM for the WGII “Climate Change Impacts, Adaptation and Vulnerability” and impacts was released in Brussels. In between, the National Institute for Space Research -INPE has released in a ceremony at the Ministry of the Environment in Brasilia the so called INPE’s Climate Report. This Climate Report can be considered as an IPCC-Brazil and includes analyses of observed trends of mean and extremes of climate and hydrology during the last 50 years, and also regional climate change projections (at resolution higher than the global IPCC AR4 models) for Brazil until 2100.

The INPE’s Climate Report represents a major contribution of the PROBIO and GOF-UK projects, and has already had an impact in Brazilian society and government. Recent polls suggest that almost 91% of the population in Brazil considers that climate change is a problem, and 87% consider that it may have negative impacts in Brazil. Perhaps the most important impact of this Climate Report is the fact that government is taking action, implementing a Congress Special Committee on Climate Change and also having public hearings about this subject in both the Senate and the House of Representatives. A National Network on Research on Climate Change is being implemented by the Ministry of Science and Technology, while the Ministry of Environment is hosting meetings to elaborate the agenda for the preparation of the National Plan on Climate Change.

Visit our web site (www.cptec.inpe.br/mudancas_climaticas) to get more information on the INPE’s Climate Report and other initiatives on climate change in Brazil and around the world.

José A. Marengo
CPTEC/INPE

Characterization of the current climate and definition of the climate changes for the Brazilian territory in the XXI Century

This Project was supported by PROBIO, through the National Coordination of the Climate Changes National Program of the MCT, and by Global Opportunity Fund GOF of the United Kingdom, through the project named “Using of regional climate Change Scenarios in Studies of Vulnerability and Adaptation in Brazil and south America”. Both projects aim a better understanding of the climate vulnerability of the current climate and of the future climate change scenarios due to the increase in concentration of greenhouse gases, as well as their possible impacts in Brazil.

The objective of the Project is to provide technical and scientific information about the possible climate changes over the Brazilian territory that have already happened and that are about to happen in the next hundred years. So, several different scenarios of the future climate and global models from the Intergovernmental Panel on Climate Changes (IPCC) were analyzed for different experiments with (SRES A2 e SRES B2) CO₂ concentrations. However, due to these models present a low resolution because they are global models, and because one should

need more detailed and specific results, some regionalization was made (dynamic downscaling) using as a base an ocean-atmosphere coupled model from the Hadley Centre for Climate Research of the United Kingdom (HadCM3) and three regional climate models: Eta, RegCM3 and HadRM3P. The regionalization was made to a scale of 0,5° latitude x 0,5° longitude. Climate and biological records, provided by institutions like INMET, CTA, and CPTEC / INPE, were used since the beginning of the XX Century. The simulations with the regional climate models were developed and ran at CPTEC / INPE and at IAG / USP in Brazil.

The research has ended last February and the results were reported in six Scientific Reports.

The conclusions of this research must be considered as a first approach to future climate characteristics in the national territory and have to stimulate the development of more detailed and amplified researches about the topic, considering also the evaluation aspects of impacts and of vulnerability from the different sectors of societies and environmental systems, according to the global and regional climate changes.

General description of the scientific reports

Report 1. “Characterization of the climate in the XX Century and Scenarios in Brazil and the South America for the XXI Century derived from IPCC Climate Global Models” (Marengo 2007).

It describes the recent results about the observational and modeling studies of the climate variability in Brazil, as well as climate trends observed since the beginning of the XX Century, and climate projections for the XXI Century, emphasizing the precipitation, temperature, fluvial discharge and climate extremes, using global models of IPCC TAR and AR4.

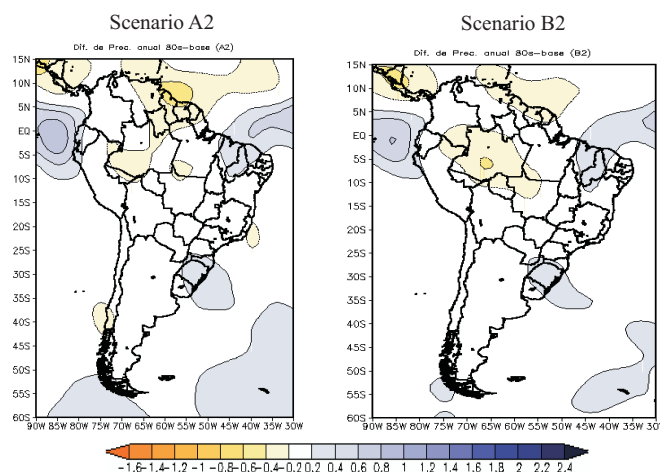


Figure 1. Annual average precipitation anomalies of 5 AGCMs (CCCMA, NIES/CCSR, CSIRO, GFDL and HadCM3) of the scenarios A2 and B2, period 2071-2100. (Units are in mm/day).

Report 2. “Characterization of the climate in the XX Century in Brazil: Trends in precipitation and Mean and Extreme Temperatures” (Obregón and Marengo, 2007).

It also makes a climate characterization of the XX Century in Brazil, however with more details and more complexity than in Report 1. Climate series were analyzed with a more than 50-year register, were submitted to the quality control, and used to elaborate and reevaluate the annual and seasonal climatology of precipitation, temperature

Scenario A2

Scenario B2

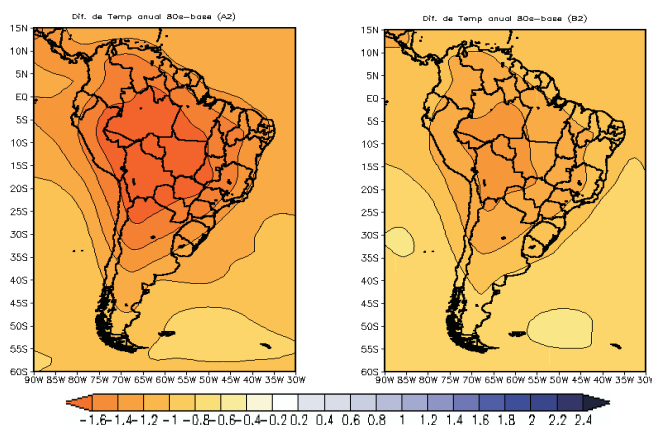


Figure 2. Annual average air temperature anomalies of the 5 AGCMs (CCCMA, NIES/CCSR, CSIRO, GFDL and HadCM3) of the scenarios A2 and B2, for the period between 2071-2100. (Units are in $^{\circ}\text{C}$).

for the 1951-2002 period. The presented studies show also probability maps of extreme precipitation above a threshold value, annual and seasonal maps of mean and extreme temperatures, as well as the daily thermal amplitude, which allows the establishment of observed temperature trends through seasons in Brazil. Linear trends were analyzed for mean and extreme precipitation and temperature in Brazil, with statistical significance evaluations. The results showed in the Reports 1 and 2 have helped the evaluation and interpretation of the climate scenarios generated by the regional models presented in the Report 3.

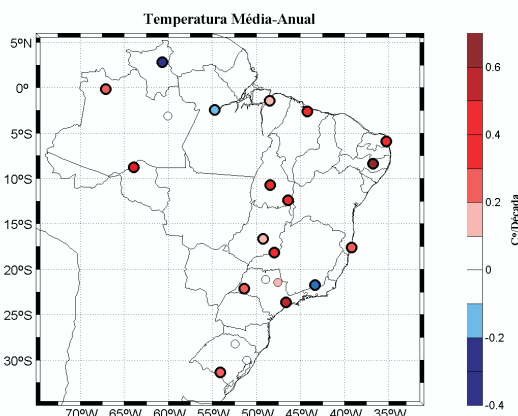


Figure 3. Annual average temperature trend (1961-2000) in $^{\circ}\text{C}/\text{decade}$. Circles with thick contours indicate significance statistics of the Mann-Kendal Test for significance level of 0.05.

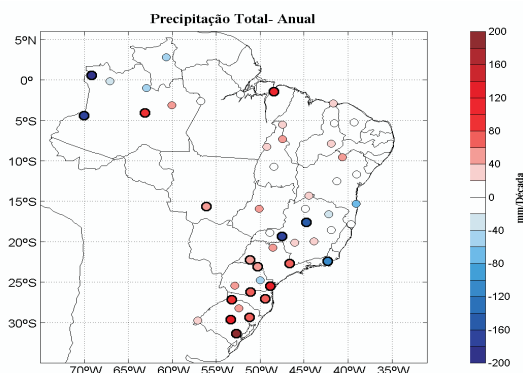


Figure 4. Annual total precipitation trend (1951-2000) in mm/decade . Circles with thick contours indicate significance statistics of the Mann-Kendal Test for significance level of 0.05.

Report 3. “Regionalized scenarios of climate in Brazil and South America for the XXI Century: Projections of future climate using three regional models” (Ambrizzi et al., 2007).

Elaborated by The Group of Climate Studies (GrEC) of the Department of Atmospheric Sciences from IAG/USP together with CPTEC/INPE, this report presents the future climate scenarios generated by the three regional climate models that have been numerically integrated using initial data obtained from the Hadley Centre’s climate global model. Through analyzes of two 30-year climate scenario simulations for the periods 1961-1990 (current climate) and 2070-2100 (future climate, second half of the XXI Century), considering the high emissions scenarios of greenhouse gases A2 and of low emissions B2 of SRES / IPCC. Seasonal and Monthly Averages of the temperature and precipitation for South America generated by each regional model, and by the “ensemble” of them are discussed in this report for South America and Brazil, as well as in a sub-regional level.

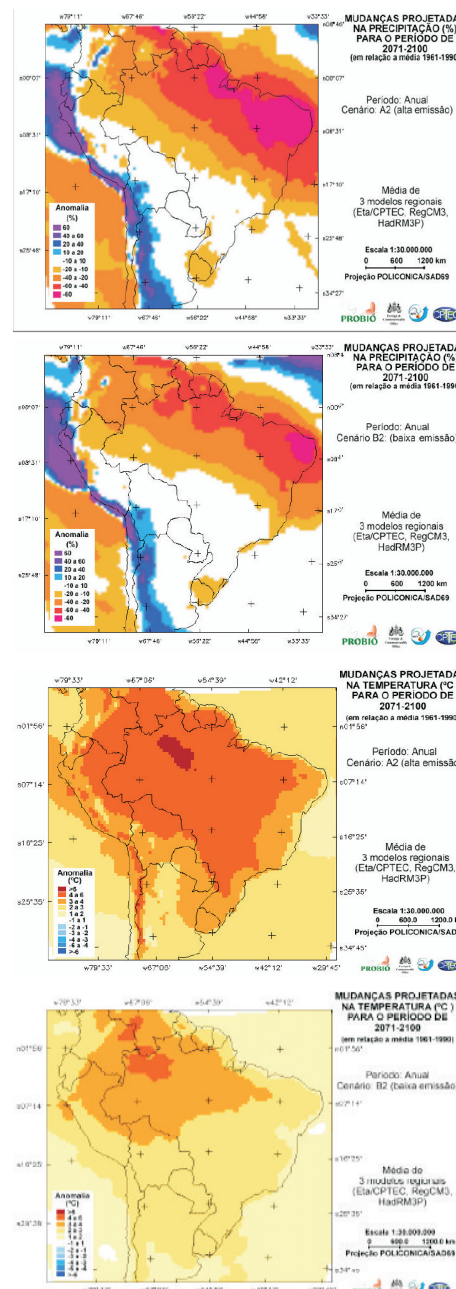


Figure 5. Average of precipitation and temperature of three regional models Eta, RegCM3 and HadRM3P for A2 and B2 scenarios, for the period between 2071-2100.

Report 4. “Trends in Climate Variations for Brazil in the XX Century and Water Balance for Climate Scenarios for the XXI Century” (Salati et al., 2007).

Elaborated by Brazilian Foundation of the Sustainable Development FBDS together with CPTEC/INPE, this report presents evaluations of some climate trends in Brazilian regions to get basis for comparisons with future climate scenarios which complete the results of Reports 1 and 2. An interesting aspect developed in this report is the result about the water balance obtained from temperature and precipitation variations for several regions of Brazil. The water balance is a determining factor for farmer potential and hydroelectric energy production. Any variation in the water availability will have social-economic effects and will have to be considered in future planning of country development. A comparison was made between the water balance obtained with data from future climate models and the ones obtained with real data observed from current climate, using observed data in the period 1961-1990. Evaluations of water balance component sensibility were also made for increases in the temperature and precipitation, typical of the IPCC scenarios of warmer future climates. That was made to evaluate if the soil moisture content in Brazil and periods of soil water storage, important for farmer activities, could be compromised for increases in temperature varying from 1 to 6 °C all over Brazil.

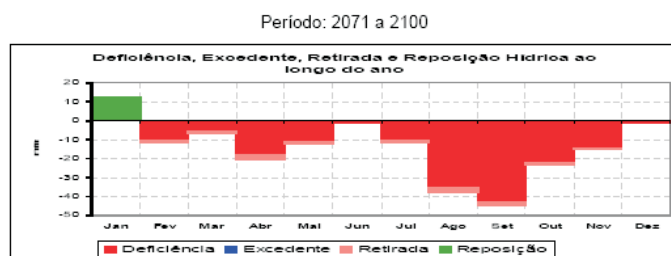


Figure 6. Water balance obtained from the temperature and precipitation values in the XXI Century for the Plata Basin, using average values of the HadCM3, GFDL, CCCma, SCIRO and NIES models for the A2 scenario and the data of the period of 1961 to 1990 (data CRU).

Report 5. “Extreme events in regionalized scenarios of climate in Brazil and South America for the XXI Century: Projections of future climate using three regional models” (Marengo et al., 2007).

It deepens the analysis of extreme events of weather and climate, using index of climate extremes defined by the World Meteorological Organization WMO. The calculations were made for meteorological stations in Brazil for current climate, and for the scenarios generated by IPCC AR4 global models and by the three regional climate models for the scenarios A2 and B2 during the second half of the XXI Century. This Report 5 considers the analysis of extremes defined in Report 1 with observational bases and from the IPCC AR4 global models, and from future climate scenarios and regional climate models derived from Report 3. Special emphasis is given to recent events in the seasonal scale, as the Catarina Hurricane in 2004 and the Amazon drought in 2005, where analysis of climate projections and observations of the future are considered to define if such extreme events are really a sample of what could happen if the global warming is maintained in the future.

Report 6. “Climate Changes and possible modifications in South America Biomes” (Nobre et al., 2007).

It mentions the projections of potential modifications in South America Biomes due to the future climate changes. Scenarios of monthly precipitation and temperature derived from sixteen IPCC AR4 global climate models were used as input data for the CPTEC/INPE Potential Vegetation Model (PVM) for the period of 2070-2099 for three emission scenarios A2, A1B and B1. The results indicate high probabilities of important changes in the biomes in different South America regions, especially in the tropical area.

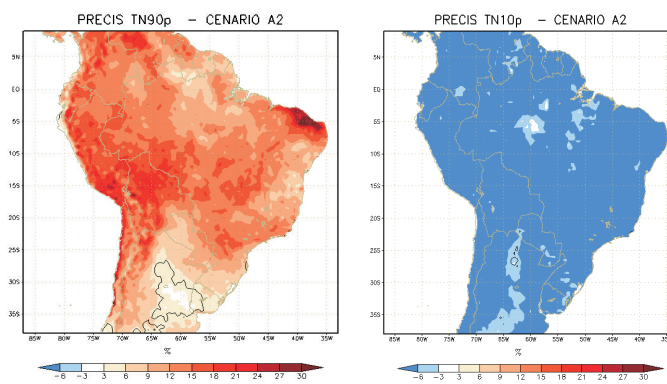


Figure 7. Projected trends for regional model HadRM3, A2 scenario, period 2071-2100 of hot nights TN90P and cold nights TN10P in South America.

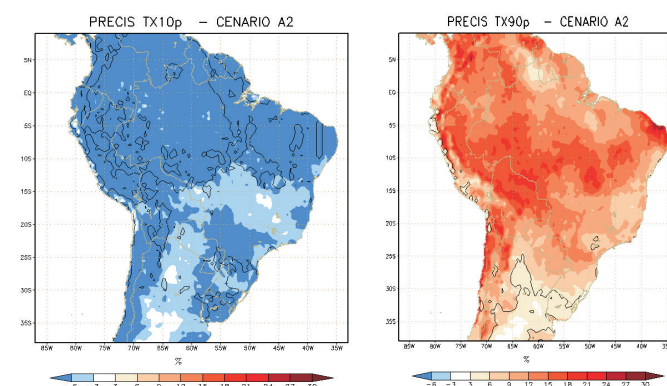


Figure 8. Projected trends for regional model HadRM3, A2 scenario, period 2071-2100 of cold days TX10P and hot days TX90P in South America.

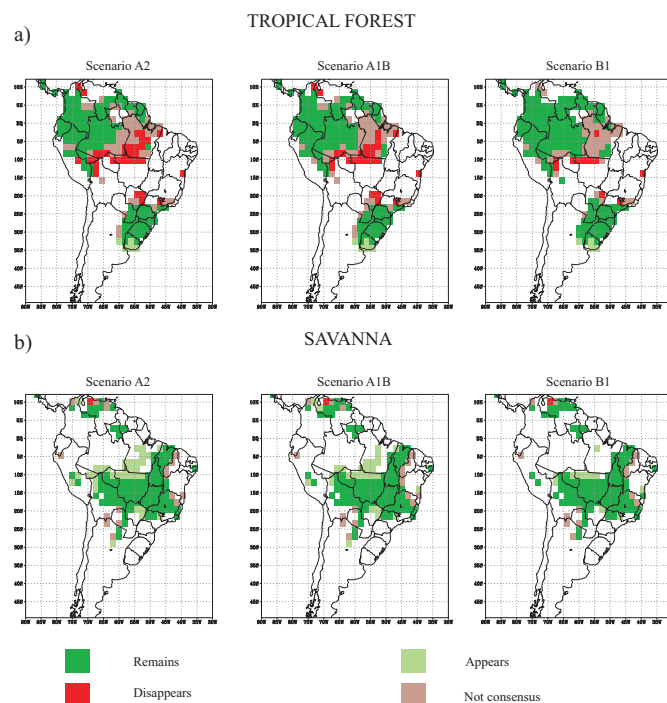


Figure 9. Condition of (a) tropical forest and (b) savanna for the period of 2070-2099 for 75% of the models, compared with current natural potential vegetation, in the A2, A1B and B1 scenarios.

Main results related to current climate

✳ Analysis of the observational integrated evidencies for the Brazilian territory points to an increase of mean and extreme temperatures in Brazil, for both annual and seasonal values.

✳ Looking to the precipitation, the observational analysis in the current climate does not point to a reduction trend in the Amazon (due to the deforestation). What has been observed, is the interdecadal variations including periods relatively drier or rainier in Brazil, in the Amazon and Northeast. Regionally, it has been observed an precipitation increase in South and portions of South of Brazil, in the Paraná-Plata Basin, since 1950, consistent with similar tendencies in other countries of the Southeast of South America. In the southeast, the total annual precipitation does not seems to have suffered any visible modification in the last 50 years.

✳ About the river streamflows, the observed trends reflect well the trends in the precipitation, with a clear tendency of increase in the Paraná River and other river streamflows in the Southeast of South America. In Amazon, Pantanal and Northeast, has not been observed long-term systematic trends towards drier or rainier conditions, with more relevance to the interannual and interdecadal variations, associated with the climate natural variability in the same temporal scale variability of Pacific and tropical Atlantic Ocean interdecadal phenomena.

✳ About extreme events, positive trends in the frequency of warm nights and days and negative trends in the frequency of cold nights and days have been observed, consistent with a global warming scenario. For the Southeast of South America, it has been observed an increase in the intensity of the episodes and frequency of days with intense rain in the period of 1961-2000, that is, the rains are becoming more violent. Despite the fact that the total annual precipitation have not suffered visible modification, some studies have shown relation between precipitation extremes in Southeast and South of Brazil and frequency/intensity of patterns of circulation as the South Atlantic Convergence Zone (ZCAS) or the South America Low Level Jets (SALLJ). The highest availability of the data allows analysis for the Southeast of South America, while the absence of long-term daily data in the tropical region does not allow a wider analysis of the extremes.

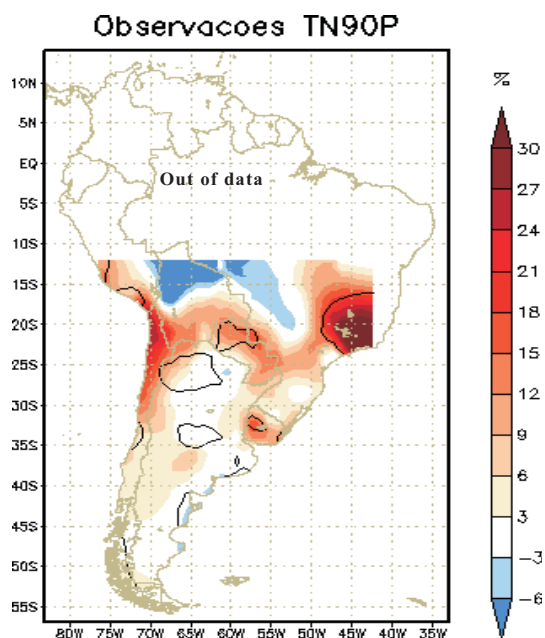


Figure 10. Tn90-Indicator index of hot nights considering minimum temperatures. (Report 5. Marengo et al., 2007).

✳ It has been observed some interannual variability impact associated to El Niño in the coral reef of Brazilian coast, however there are no evidences that the global warming has already affected the corals. It is all about the marine ecosystem of highest biodiversity, of great importance for fishing, coastal protection, control of erosion and tourism.

✳ In the last 50 years a relative tendency of increase in the sea level, around 40cm/century, or 4mm/year has been observed in the Brazilian coast.

Main results related to the future climate

✳ The projections of an increase of the mean Brazilian surface air temperature indicates that the values can reach 4 °C above the climatological average (1961-90) for 2100, depending on the emission scenario of greenhouse gases and IPCC TAR global climate models. The increases of the temperature projected present considerable regional variation. For example, in Amazon the warming can reach 8 °C in the most pessimist scenario.

✳ The projections of changing in precipitation regimes and distribution, derived from the IPCC TAR and AR4 global models, for warmer climates in the future are not conclusive, and the uncertainties are still high, because such features depend on the models and the considered regions. In Amazon and Northeast, although some global climate models present drastic reductions of precipitation, other models present increase. The average of all models, on the other hand, indicates a higher probability of precipitation reduction in these regions as a consequence of the global warming. South, Southeast and Central-West do not show visible changes or a kind of increase until the end of the XX century; however the rains could be more intense.

✳ There are uncertainties in the tendencies observed from the variability of climate extremes in Brazil, excepting perhaps the South region, due fundamentally to the lack of reliable long term information or to the restrict access to this kind of information for large regions, as Amazon and Pantanal. The projections of extremes for the second half of the XXI Century show, in general, increases in the temperature extremes, as hotter nights, heat waves, and indicators of extreme events of rain.

✳ Climate projections for the second half of the XXI Century, using IPCC A2 and B2 extreme scenarios of emissions provide more details about temperature and precipitation changes in the distribution and intensity in Brazil and South America. The uncertainties are still high, because the difference between the analysis of the IPCC TAR and AR4 global models, shows that only one global model has been used as well as three regional models for the downscaling of the future climate scenarios.

✳ Related to the El Niño - South Oscillation phenomenon (ENOS), the climate projections show few evidences of changes for the next 100 years. However, there are extreme intensification possibilities of droughts and inundations that happen during warm events of El Niño.

✳ Studies using simulations of water balance for Brazilian regions, considering the projections of precipitation and temperature future climate scenarios generated by the project, suggest for the scenario of higher emissions, a tendency of water deficiency extension for practically the whole year for Northeast, which, nowadays, only happens during the dry season, that is, a tendency of dryness of the half-barren region until the end the XXI Century. For Amazon, the period of water exceeding observed in the current climate, during the rainy season, can be reduced significantly in warmer future climates, associated to the increase of the temperature and evaporation and a precipitation reduction.

✳ There are uncertainties in the possibility of having more hurricanes as Catarina in the South Atlantic due to the global warming.

Possible impacts of the climate changes in Brazil

✱ With the global warming, some regions of Brazil and South América will have their temperature and precipitation levels increased, while others, will have them decreased. With or without changes in precipitation annual patterns, even where there is not an increase or decrease in the total annual of precipitation, the isolated rains will be more violent and rainstorms more frequent. The consensus is higher related to extremes of temperature, where the tendency of increase in the diurnal and nocturnal temperatures are more intense in winter.

✱ Concerning to the population, those with less resources and which have less adaptation ability are the most vulnerable. The study developed by the Nucleus of Strategic Subjects of the Presidency of Republic in 2005 (NAE 2005 a, b) suggests that the Northeast is the most vulnerable region to the climate changes. The half-barren northeastern which presents short, however, crucially important rainy season in the current climate, could, in a warmer climate in the future, become in a barren region. This could affect the regional subsistence of farmer, the availability of the water and health of the population, causing the migration of them, and generating groups of "climate refugees" into the close or far bigger cities, increasing social problems already existent in the great cities.

✱ Besides, it fears that thousands of people die every year as a consequence of the heat waves, especially the most vulnerable ones, like children and elder people. The agrarian productivity fall will also aggravate the lack of nutrition that today already affects 800 million people globally.

✱ In all the great cities, the warming must also exacerbate the problem of the heat islands, in which buildings and asphalt retain much more thermal radiation than in a non-urban area.

✱ The coral reefs are especially vulnerable to changes in the temperature of the water an increase about 3 and 4 degrees would cause their death.

✱ The climate change will be able to modify the structure and working of the ecosystems, and consequently biodiversity losses and natural resources, especially when adding simultaneously to the climate changes, the effects of vegetation cover, mainly the deforestation. Modifications of migration roots and changes in the reproductive patterns are some of these effects. It scares that the capacity of carbon absorption of tropical forests, which are very sensitive to climate change, decreases as the time passes by, and that they stop working as carbon sinks and become sources of such gas. In the worst scenario, Amazon could become a savannah until the end of the XXI Century, due to an increase of greenhouse gases concentration.

✱ The climate change can cause a risk increase of disease appearing such as malaria, dengue, yellow fever and encephalitis that would have approvable conditions to expand in a warmer planet, in part because the insects which carry them (like malaria and dengue) would easily have conditions to reproduce. This will also increase the risk of getting salmonellas, cholera and other diseases, which must be transmitted through the water. Breathing diseases could also be more common as a consequence of a possible fire increase in forest and vegetation of Amazon and savannah, due to a reduction of precipitation in a warmer and drier atmosphere.

✱ Climate changes in Brazil threaten to intensify the difficulties in accessing water. The combination of climate modifications, with a lack of rain as well as less rain coupled to high temperatures and evaporation rates and to competition for water resources, can lead to a potentially catastrophic crisis, whit the most vulnerable as the poor farmers, for example, the subsistence farmers in the half barren areas of Northeast ("drought polygon"), a half barren region of 940 thousand km², which embraces nine States of Northeast, and faces a lack of water chronic problem.

The researches have worked with two scenarios for climate changes in Brazil, in the second half of the century. The first one was called A2 and is the most pessimistic. It previews higher emissions and a global temperature elevation of 5,8°Celsius (this value can change according to the regions of the world). The other scenario is called B2 and is more optimistic, with smaller emissions and an elevation of 1,4°.

North

A2 Increasing of 4,8° Celsius, with a reduction of 15% to 20% of the rain volume and delays in the rainy season. A change like that would affect the biodiversity and the river level would become lower. Changes in Amazon influence the humidity transport towards South and Southeast regions, with consequences in health and generation of hydroelectric energy.

B2 Elevation is from 3 to 5°Celsius, and precipitation reduction from 5% to 15%. The impact is not very different from the one predicted by the A2 scenario.

Central West

A2 From 3 to 6° Celsius warmer. Reduction of Pantanal and Cerrado biodiversities and impact on the agriculture.

B2 From 2 to 4° warmer. Reduction of Pantanal and Cerrado biodiversities and impact on the agriculture.

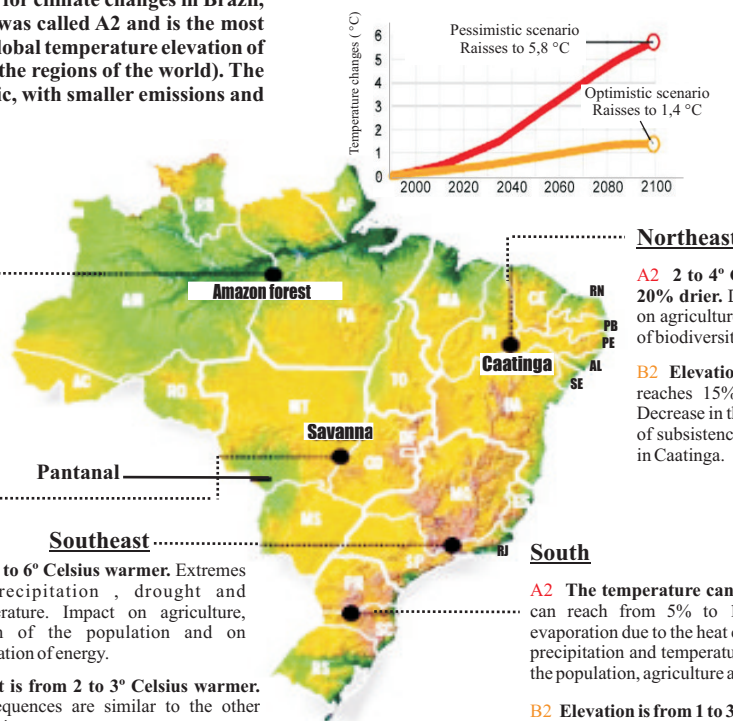


Figure 11. Possible impacts of temperature changes in Brazil, scenarios A2 (pessimistic) and B2 (optimistic).



New Website about climate change

Mudanças Climáticas

The National Institute of Spatial Researches INPE - and the Weather Prediction and Climate Studies Center CPTEC - enable all the community, scientists, non scientists, students, police makers and decision makers a new website that gives all the research results from the Research Group in Climate Change GPMC. The results include observational studies to characterize the present climate and its variability in long term, as well as studies of projections of future climate scenarios to characterize the climate in the rest of XXI Century, for several emission scenarios of greenhouse gases, analyzing the vulnerability and the implementation of adaptation measures.

The website design was made by Ana Paula Tavares, from the visualization group of CPTEC/INPE. The idea of the visual project is to show, through the use of contrasting warm (red and yellow) and cold (green and blue) colors, even in a subjective way, the extremes caused by the climate variations. It was also created a logo mark for the website, inspired in the symbol of the harmony, "Yin Yang", however, placed in a way which generates a conflict between the red and blue tones that could be seen as the variations of temperature of the planet.



The link "publications" are available to publish the research articles from Research Group in Climate Change and the community in general related to the climate change subject. We have the texts of the main climate protocols, Protocol of Kyoto, Protocol of Montreal and Agenda 21. On the section "Highlights", will be available the most relevant and current documents. And to know more about the climate change, the user is able to surf through the section "Programs and Forums" and on the links of international institutions, Latin America and Caribbean, related to the climate change.

The website is on its first step of settle. Nowadays it is available the INPE Report of the climate (**Relatório de Clima do INPE**), which is a result of the project "Characterization of the current climate and definition of the climate changes for the Brazilian territory through the XXI Century" ("Caracterização do clima atual e definição das alterações climáticas para o território brasileiro ao longo do Século XXI"), and soon we will enable all data of the regional future scenarios of climate change produced by the Research Group in climate Change.

Project "Using Regional Climate Change Scenarios for Studies on Vulnerability and Adaptation in Brazil and South America (GOF-UK)"

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Our objective with the website is to interact with the community which is interested in learning more about the climate change subject and its impacts. Besides the scientific material, we have didactic material for kids with the ABC of the climate change, in the interactive brochure called "The Little Planet and His Troup" ("Planetinha e Sua Turma"). We also have information about the academic events and news from Brazil and from the world about climate change, as well as some reports of previous events realized by CPTEC/INPE.