WG I: The Physical Science Basis

Tércio Ambrizzi
Department of Atmospheric Sciences
University of São Paulo
Intergovernmental Panel on Climate Change
IPCC - Objective

- Created in 1988 by United Nations Environment Programme (UNEP) and World Meteorological Organization (WMO)

- Analyze the scientific, technical and socio-economic international climate change knowledge and synthesize in form of reports disseminated to all stakeholders

- Available to all UN and OMM members

=> Currently 194 countries
IPCC - Structure

The Physical Science Basis
Working Group I
TSU

Climate Change Impacts, Adaptation and Vulnerability
Working Group II
TSU

Mitigation of Climate Change
Working Group III
TSU

Task Force on National Greenhouse Gas Inventories

Authors, Contributors, Reviewers
IPCC - Structure

• Plenary
  – Bring together all members countries once a year
  – Highest organ of decision
  – Election of the President of the IPCC, IPCC Bureau
    an Bureau Task Force, structure and mandate, budget, scope of reporting

• Secretariat
  – Plan, coordinate and supervise all activities of the
    IPCC and Technical Support Units and WG's and TF.
IPCC - Structure

• 3 Working Groups and Task Force
  – GT 1: The Scientific Basis
  – GT 2: Climate Change Impacts, Adaptation and Vulnerability
  – GT 3: Mitigation
  – TF on National Greenhouse Gas Inventories

• The 3 Working Groups and Task Force are assisted by Technical Support Unit, which are hosted and funded by the government that offered to do it.
IPCC - Authors

Lead Authors – responsible for the production of certain sections using the best technical, scientific and socio-economic available information. Work in small groups and ensure that the information is high level and are assembled a edited according to established standard time.

Coordinating Lead Authors – coordinate the main sections of the report. Lead Authors are with the additional responsibility of ensuring that main sections of the report are completed to a high standard and delivered to the Working Groups on time and in accordance with the standards of style set for the document.

Contributing Authors – prepare technical information in the form of text, graphics or data by the 'lead authors' in the preparation step of the report ('draft section').

Expert Reviewers – should comment on the reports according to their knowledge and experience in relation to its completeness and accuracy regarding the information presented. Are nominated by governments, national and international organizations, the WG's/TF, 'lead authors' and 'contributing authors'.

Review Editors – should help the WG's/TF to identify experts for the review process to ensure appropriate consideration of comments received from governments and experts, advise 'lead authors' in dealing with controversial issues and to ensure that the controversy are represented in the text of the report.
• All the IPCC reports must be approved by their members; the WG’s and the Plenary. There are 3 levels of approval:

  – **Approved:** the text is discussed line by line. Used for the Summary for Policymakers;

  – **Adoption:** approval process section by section. Used for the Synthesis Report and overview of the Methodology Report;

  – **Acceptance:** it presents a comprehensive, balanced and objective of the subject.
Launched in 2007
CREAS - Regional Climate Change Scenarios for S. America - Strategy

Global IPCC models (HadCM3)

Models from IPCC: HadAM3P

Future scenarios IPCC A2, B2

Baseline 1961-90

Maps of climate change A2, B2 minus baseline, 2071-2100 and other time slices

Downscaling

Baseline regional models 1961-90

Maps of climate change A2, B2 for 2071-2100, and other time slices (South America, countries, and other regions)

RegCM3/USP 50 km

HadRM3/PRECIS 50 km

Eta/CPTEC 40 km
CREAS- Regional Climate Change Scenarios for S. America-Strategy

Regional climate change scenarios: A2, B2, 2071-2100 and other time slices, 3 regional models
  - Science
  - Training and capacity building

Users and decision makers
government and policy makers
society, NGO, academics

Socioeconomic development

Adaptation and mitigation measures

Impacts of climate change

Vulnerability Assessments

Development and Applications

Products: (Paper, digital and GIS)
- Maps of climate change projections for time slices, A2, B2 (and uncertainties)
- Reports, publications...
DJF Seasonal mean A2 – Rainfall anomalies (mm/day) – 

\[(2071-2085)-(1961-90)\]

HadRM3P

(Ambrizzi et al 2007)
DJF Seasonal mean A2 – Temperature anomalies (°C) – [(2071-2085)-(1961-90)]

(HadRM3P)

(Ambrizzi et al 2007)
South

(PRECIS)

(Ambrizzi et al 2007)
Precipitation Tendencies simulated by the regional model Precis (2071-2100) (Marengo et al 2007)

(Salati et al, 2007)
The Brazilian Network for Climate Change Research (Network CLIMA), supported by the Ministry of Science and Technology (MCT) was created at the end of 1997 and it aims to: provide scientific information in support of the international negotiations under the UN environmental conventions, to evaluate the natural and socio-economic systems to GHG emissions and to propose alternatives for mitigation beyond the promotion of technological developments to reduce these emissions, contributing in the strategies of adaptation of social, economic and natural systems to climate change.
In 2008, the MCT has announced the creation of the National Science and Technology Institutes (INCT), one of which was based on the Climate Change theme. The Global Change INCT has, as general goals, to detect environmental changes in Brazil and South America, to attribute possible causes to observed changes (global warming, changes in land use, urbanization, etc.), and develop a Brazilian model for the global climate system, to generate scenarios of future global and regional environmental change, especially high-resolution scenarios of climate change and land use and vegetation cover, studying the impacts and identifying the vulnerabilities of environmental systems and sectors to climate change (ecosystems and biodiversity, agriculture, water resources, human health, cities, coastal areas, renewable energy, economy), to develop techniques in order to help in the mitigation of these impacts, and provide scientific information to guide quality adaptation and mitigation policies.
Projections for the end of the 21st century indicate widespread increase of intense precipitation events and extreme droughts for some regions.

New future climate scenarios derived from the Eta-CPTEC/HadCM3 for South America under A1B emission scenario suggest that climate change and its related impacts have regional variability.

Changes in annual rainfall (%) in 2071-2100 relative to 1961-90.

- **northern areas of the continent** → rainfall deficiency
- **southeastern South America** → rainfall increase

Increase in frequency of heavy precipitation in 2071-2100 relative to 1961-90

Increase in consecutive dry days in 2071-2100 relative to 1961-90

Climate variability and change, and future climate scenarios.
Projected changes in extratropical cyclonic activity over the South Atlantic Ocean

Projections of changes in extratropical cyclones in global warming experiments for various high emission scenarios (a2-high, B2-low emissions) suggest that the cyclogenesis regions closer to the Brazilian southern coast will tend to move southward by 2071-2085. This would affect atmospheric blocking patterns over the subtropics and mid-latitudes, with potential consequences for droughts in Brazilian agricultural regions.

Mean annual cyclones density in the present climate (1975-1989) and A2 and B2 (2071-2085) scenarios simulated by the RegCM3 - Krüger (2009)

Reductions are more evident for initially intense cyclones
With respect to Brazil’s large urban areas, studies detected that in the city of São Paulo extreme rainfall events (greater than 30 and 50 mm/day) have become more frequent and intense since 1960, and this increase can probably be attributed to urbanization as well as to climate change caused by global warming.

Projections for 2080-90 show that the Metropolitan Region of São Paulo (MRSP) may experience increase in number of days with rainfall above 30 mm. The MRSP may be in the future more vulnerable to changes in extremes, with greater risk of floods, landslides and impacting the population (health, housing transportation).
Chuva causa transtornos em SP

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

São Paulo, 27 February 2011
### Tabela 1 – Lista de recordes registrados na Estação Meteorológica durante todo o período de funcionamento (1933-2010)

<table>
<thead>
<tr>
<th>Recorde</th>
<th>Valor</th>
<th>Data</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maior temperatura</td>
<td>35,6°C</td>
<td>7 de dezembro de 1940</td>
</tr>
<tr>
<td>Menor Temperatura</td>
<td>-1,2°C</td>
<td>6 de julho de 1942</td>
</tr>
<tr>
<td>Mês mais chuvoso</td>
<td>653,2mm</td>
<td>Janeiro de 2010</td>
</tr>
<tr>
<td>Mês menos chuvoso</td>
<td>0,4mm</td>
<td>Julho de 2008</td>
</tr>
<tr>
<td>Maior acumulação de precipitação em 24h</td>
<td>145,9mm</td>
<td>6 de março de 1966</td>
</tr>
<tr>
<td>Ano mais chuvoso</td>
<td>2236,0mm</td>
<td>1983</td>
</tr>
<tr>
<td>Menor Umidade Relativa</td>
<td>12%</td>
<td>23 de novembro 1968</td>
</tr>
<tr>
<td>Maior raiada registrada</td>
<td>101km/h</td>
<td>24 de novembro de 1973</td>
</tr>
<tr>
<td>Mês com mais dias com trovoadas</td>
<td>26 ocorrências</td>
<td>Janeiro/2010</td>
</tr>
<tr>
<td>Ano com mais dias com trovoadas</td>
<td>114 ocorrências</td>
<td>1976</td>
</tr>
</tbody>
</table>

### Mean Temperature

### Monthly precipitation IAG/USP
Daily Precipitation PDF at IAG station for a window of 20 years

Running window of 20 years

(maria Assunção Silva Dias 2010)
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

(Maria Assunção Silva Dias 2010)
Extreme Events

Precipitation intensity

Dry days

Year

Map of global precipitation intensity and dry days changes over time for different scenarios.
In 2008, it was launched the FAPESP Research Program on Global Climate Change (PFMCG) that aims to improve the scientific knowledge on the subject, and to study the necessary strategies for mitigation and adaptation to a climate change scenario. As a benefit, it is expected that the results arising from the research program will assist in developing scientific based decisions, considering the risk assessments and mitigation and adaptation strategies. The PFMCG funds projects of scientific research on atmospheric, oceanic, change of land use, accelerated urbanization, ecological response to climate change for the main Brazilian biomes, among other topics. The PFMCG also funds the development of the Brazilian Model of Global Climate, and the new Tupã supercomputer, which is in operation at INPE, and should be used by researchers from the São Paulo State.
Panel History

- The establishment of the Brazilian Panel on Climate Change is one of the actions foreseen in the axis of research and development of the National Plan on Climate Change;

- Established by Ministerial Ordinance MCT/MMA nº 356 of 28.09.2009;

- The Chairmen of the Director and Scientific Committees were appointed by the Ministerial Ordinance MCT/MMA nº 369 of 15.10.2009;

- In 24.11.2009, Carlos Minc (MMA) and Sergio Rezende (MCT) ministers officially launched the BPCC;

- Ministerial Ordinance MCT/MMA nº 53 of 18.03.2010 appointed the Scientific Committee of BPCC.
Panel's objective

To provide a Policymakers and society in general, the latest scientific, technical and socio-economic information relevant for the understanding of climate change, its potential impacts and options for adaptation and mitigation.
Core activities

- Undertake integrated and objective assessment about the technical and scientific knowledge produced in Brazil and/or abroad, over causes, effects and projections related to climate change that focus or have relevance to Brazil.

- Prepare and publish periodic reports of national assessment, technical reports (TR's), summaries to policymakers and special reports on specific topics.
Composition

- Plenary;
- Board;
- Scientific Committee;
- Executive Secretary;
- Working Groups and Task Force;
- Technical Support Unit.
BPCC ACTIVITIES DISTRIBUTION

CONSELHO DIRETOR - CD

PLENÁRIA DO PBMC
Presidida por Presidente do CD e do CC

COMITÊ CIENTÍFICO - CC

SECRETARIA EXECUTIVA (COPPE)

UNIDADE DE APOIO TÉCNICO aos GTS

GT1
Base Científica

GT2
Impacto,
Vulnerabilidade e
Adaptação

GT3
Mitigação

FT
Metodologias de
Inventário

UNIDADE DE APOIO TÉCNICO
Secretário Executivo Adjunto; 4 Coordenadores de GT (1 para cada GT); 4 Vice-Coordenador de GT (1 para cada GT); Apoio Técnico IT; Financeiro; Arquivista; Administrativo; Apoio Técnico substantivo.
(Estes seriam os profissionais remunerados pelo Painel)
Plenary

• Composition

- One representative from each of the Ministries
- Director Board
- Scientific Committee
- One representative from each State and Federal District

• Competences

I. approval of the scopes of the National Assessment Reports - NAR;

II. approval of Summary to Policymakers;

III. consideration of others matters suggested by the Board and/or Scientific Committee; and

IV. approval of the proposed continuation of BPCC and the rules and procedures for electing their members to a second mandate, presented by the Board and the Scientific Committee.
Board

Competences

I – approve scopes of the documents (National Assessment Reports – NAR, Technical Reports and Summaries for Policymakers on Climate Change and special reports on specific topics);

II – approve the documents listed above in the Plenary session together with the case summaries for Policymakers;

III – approve the members of the Scientific Committee;

IV – approve recommendations made by the Scientific Committee coming from the Lead Authors, Contributing Authors and Reviewers Authors;

V – approve the headquarter and composition of the Technical Support Units indicated by the Coordinators of each WG, in conjunction with the Scientific Committee;
VI – send request to the Scientific Committee, duly justified, for the preparation of Special Reports as necessary;

VII – supervise the activities of the Executive Secretariat and Technical Support Units;

VIII – assess the need and, if appropriate, approval of the application of resources for the budget subsequent period to the current; and

IX – approve the proposed continuation of the BPCC presented by the Scientific Committee, by defining procedures for electing their members to a second mandate, subject to approval by the Plenary.
Board

**Composition:**

<table>
<thead>
<tr>
<th>INSTITUIÇÃO</th>
<th>REPRESENTANTE(S)</th>
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<tbody>
<tr>
<td>Instituto de Pesquisas Espaciais - INPE</td>
<td>Presidente: Carlos Afonso Nobre</td>
</tr>
<tr>
<td>Ministério da Ciência e Tecnologia</td>
<td>Titular: Carlos Afonso Nobre</td>
</tr>
<tr>
<td>Suplente: Marcos Buckeridge</td>
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<tr>
<td>Ministério do Meio Ambiente</td>
<td>Titular: Suzana Kahn Ribeiro</td>
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<tr>
<td>Suplente: Branca Bastos Americano</td>
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<tr>
<td>Ministério das Relações Exteriores</td>
<td>Titular: Luiz Alberto Figueiredo Machado</td>
</tr>
<tr>
<td>Suplente: André Odenbreit Carvalho</td>
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<tr>
<td>Academia Brasileira de Ciências – ABC</td>
<td>Titular: Jailson Bittencourt de Andrade</td>
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<tr>
<td>Suplente: Prof. Luiz Drude de Lacerda</td>
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<tr>
<td>Sociedade Brasileira para o Progresso da Ciência – SBPC</td>
<td>Titular: Paulo Artaxo Neto</td>
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<tr>
<td>Suplente: Jefferson Cardia Simões</td>
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<tr>
<td>Rede Brasileira de Pesquisas sobre Mudanças Climáticas – Rede CLIMA</td>
<td>Titular: Jose Antonio Marengo</td>
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<tr>
<td>Suplente: Carlos Alberto Eiras Garcia</td>
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<tr>
<td>Coordenação de Aperfeiçoamento de Nível Superior – CAPES</td>
<td>Titular: Arlindo Phillipi Júnior</td>
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<tr>
<td>Suplente: João Lima Sant’Anna Neto</td>
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<tr>
<td>Conselho Nacional de Desenvolvimento Científico e Tecnológico – CNPq</td>
<td>Titular: José Oswaldo Siqueira</td>
</tr>
<tr>
<td>Suplente: Eliana Maria Gouveia Fontes</td>
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<tr>
<td>Fórum Brasileiro de Mudanças Climáticas</td>
<td>Titular: Luiz Pinguelli Rosa</td>
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<td>Suplente: Marcos Aurelio Vasconcelos Freitas</td>
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</table>
Competences

I – develop the proposed scopes of the documents (National Assessment Reports, Technical Reports – RT's and Summaries to Policymakers on Climate Change and Special Reports on specific topics) to be submitted to the Board;

II – appoint and submit to the Board, the Lead Authors, Contributing Authors and Reviewers Authors, responsible for preparing the documents listed above;

III - approve the headquarters and composition of the Technical Support Units as suggested by the Coordinators of each WG and TF, in conjunction with the Board;
Scientific Committee

IV – ensure the scientific integrity of National Assessment Reports and other documents associated;

V – representation of BPCC in technical meetings of Working Groups; and

VI – submission of proposal for continuation of BPCC to the Board, by defining procedures for electing their members to a second mandate, subject to approval by the Plenary.
## Scientific Committee

### Composition:

<table>
<thead>
<tr>
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<th>REPRESENTANTE(S)</th>
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<tbody>
<tr>
<td>Presidente</td>
<td>Suzana Kahn Ribeiro</td>
<td>Universidade Federal do Rio de Janeiro - UFRJ/COPPE</td>
</tr>
<tr>
<td>Vice-Presidente</td>
<td>Carlos Afonso Nobre</td>
<td>Instituto de Pesquisas Espaciais - INPE</td>
</tr>
<tr>
<td>GT 1 - Base científica</td>
<td>Coordenador 1: Tércio Ambrizzi</td>
<td>Universidade de São Paulo USP</td>
</tr>
<tr>
<td></td>
<td>Coordenador 2: Moacyr Cunha de Araújo Filho</td>
<td>Universidade Federal de Pernambuco - UFPE</td>
</tr>
<tr>
<td>GT 2 - Impacto, vulnerabilidade e adaptação</td>
<td>Coordenador 1: Eduardo Delgado Assad</td>
<td>Embrapa Informática Agropecuária</td>
</tr>
<tr>
<td></td>
<td>Coordenador 2: Antônio Rocha Magalhães</td>
<td>Centro de Gestão e Estudos Estratégicos - CGEE</td>
</tr>
<tr>
<td>GT 3 - Mitigação</td>
<td>Coordenador 1: Emilio Lèbre La Rovere</td>
<td>Universidade Federal do Rio de Janeiro - UFRJ/COPPE</td>
</tr>
<tr>
<td></td>
<td>Coordenador 2: Mercedes Maria da Cunha Bustamante</td>
<td>Universidade de Brasília - UnB</td>
</tr>
<tr>
<td>Força-tarefa em metodologias de Inventários de GEE</td>
<td>Coordenador 1: Thelma Krug</td>
<td>Instituto Nacional de Pesquisas Espaciais - INPE</td>
</tr>
<tr>
<td></td>
<td>Coordenador 2: Laerte Guimaraes Ferreira Júnior</td>
<td>Universidade Federal de Goiás - UFG</td>
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Executive Secretary

- Competences

I – administrative and financial management of BPCC;

II – supporting the work of the Board, the Scientific Committee, the Technical Support Units and the Working Groups;

III – accompanying schedules;

IV – providing suitable environment for information and technology for the Plenary, Board, Scientific Committee and Working Groups;

V – support in organizing Plenary and Scientific Committee meetings;

VI – logistical support and secretariat to the Chairmen of the Board and Scientific Committee; and

VII – publication of final National Assessment Reports and Summaries for Policymakers, after approval of the WG's.
Working Groups

- Competences

I – implementation of comprehensive assessment, periodic review and critical evaluation of scientific literature produced in Brazil and abroad, on all aspects of Climate Change that have relevance to Brazil;

II – provision of technical and scientific support to the Scientific Committee for drafting the scope of the documents;

III – the Task Force will review periodically the scientific literature, aiming at improvement of the implementation of the guidelines of BPCC to the compilation of national inventories of anthropogenic emissions by sources and removals by sinks of GEE's not controlled by the Montreal Protocol, with respect to determination and selection of methodologies and emission factors relevant to national circumstances;
Working Groups

IV – preparation of Summaries for Policymakers and Technical Reports to be submitted to the Board for approval;

V – assistance in providing support to the government's review of the IPCC Assessment Reports;

VI – incorporating the suggestions and criticisms on each report, made by members of the federation, by the scientific community and civil society as well as justification for any non-consideration, with the logistical support of the Technical Support Unit.

- Members
  - Coordinators
  - Lead Authors
  - Contributing Authors
  - Reviewers Authors
Technical Support Units

I – offering administrative and technical support to the Working Groups and Task Force;

II – helping with the Terms of Reference, Technical Studies and others inputs required by the Working Groups and Task Force;

III – organizing and monitoring work plan of BPCC and WG's;

IV – offering support for technical meetings of the WG's;

V – preparation of schedules, reports, consultations, rounds of negotiation and integration of texts and maintenance of documents and proceedings;

VI – organize and maintain platform on the World Wide Web;

VII – control of budget and financial execution of the Working Groups and Task Force;
## WG-1 Scope and Lead Authors

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<tr>
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<th>Title</th>
<th>Lead Authors</th>
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<td>Chapter 1</td>
<td>Introduction and Structure of the main issues to be addressed</td>
<td>Tércio Ambrizzi and Moacyr Araujo</td>
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<tr>
<td>Chapter 2</td>
<td>Environmental Observations of Atmospheric and Surface Properties</td>
<td>Alice Marlene Grimm and Gylvan Sampaio de Oliveira</td>
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<td>Chapter 3</td>
<td>Coastal and Oceanic Observations</td>
<td>Edmo José Dias Campos and Dieter Muehe</td>
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<tr>
<td>Chapter 4</td>
<td>Observations on the Polar and Andean Cryosphere</td>
<td>Ulisses F. Bremer and Jefferson Cardia Simões</td>
</tr>
<tr>
<td>Chapter 5</td>
<td>Brazilian Paleoclimatic Informations</td>
<td>Abdelfettah Sifeddine, Cristiano Chessi and Francisco Willian da Cruz Filho</td>
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<tr>
<td>Chapter 6</td>
<td>Cycling of Carbon and Nitrogen</td>
<td>Luiz Antonio Martinelli and Humberto Rocha</td>
</tr>
<tr>
<td>Chapter 7</td>
<td>Atmospheric Aerosols and Clouds</td>
<td>Alexandre Araujo Costa and Theotonio Pauliquevis Júnior</td>
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<tr>
<td>Chapter 8</td>
<td>Natural and Anthropogenic Radiative Forcing</td>
<td>Marcia Akemi Yamasoe and Alexandre Correia</td>
</tr>
<tr>
<td>Chapter 9</td>
<td>Assessment of Global and Regional Models: Climate and Sea Level Rise</td>
<td>Paulo Nobre and Chou Sin Chan</td>
</tr>
<tr>
<td>Chapter 10</td>
<td>Environmental Changes in Short and Long Term: Projections, Reversibility and Assignment</td>
<td>Antonio Ocimar Manzi and Everaldo Barreiros de Souza</td>
</tr>
<tr>
<td>Chapter 11</td>
<td>Climatic Phenomena and their relevance to Regional Climate Change</td>
<td>Tércio Ambrizzi and Iracema Cavalcanti</td>
</tr>
</tbody>
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Time Line – NAR1 WG1

2010

- Dez: Entrega do Draft zero
  
- 13 Dez: 5ª Reunião do Comitê Científico: - Procedimentos e prazo para Draft zero; Definição de estratégias.
  
- 05 Out: 4ª Reunião do Comitê Científico: - Escopo e Lista de Autores; Definição de estratégias.
  
- 21 e 22 Junho: 3ª Reunião CC e 1ª Reunião de Autores Convidados: • Proposição de escopo por GT e indicação de autores para suprir lacunas identificadas
  
- 10 Maio: 2ª Reunião CC: • Aprovação dos autores, definição de revisores, Autor Líder; Definição do Escopo
  
Abril: Prazo Final para Chamada de Autores - RAN 1

2011

- 28-29 Set: 2ª Reunião de Autores Principais do GT1
  
- Ago/Set: Elaboração do DRAFT II: • Definição de Estratégia para o Sumário Executivo;
  • Incorporação de contribuições dos revisores.
  • 12 de setembro – Prazo final para APs encaminharem o Draft II aos Coord. GT1
  
- Julho: PRAZO Retorno do Draft I aos APs.
  
- Junho: Envio do DRAFT I aos Revisores.
  
- 18-19 abril: 1ª Reunião de Autores Principais do GT1
  
Março: Entrega do Draft I – 1ª minuta

2012

- Dez: Entrega do Draft II
  
- May: General Plenary: Final approve of the Draft
CENTER FOR SUPPORT TO CLIMATE CHANGE RESEARCH
NapMC
The Center for Support to Climate Change Research (NapMC)

As a general goal, the NapMC will contribute to a better understanding of the complex interactions between Earth systems/Environment/Man, by the design and implementation of a project of an interdisciplinary nature, combining specialists from various fields and making the necessary connections with policymakers, public policies and private initiative, fulfilling its role on contributing to solutions and viable alternatives to emissions reduction, mitigation of current faced problems, and pointing new directions and models for sustainable growth.
CENTER FOR SUPPORT TO CLIMATE CHANGE RESEARCH
NapMC

- MEGA-CITIES
- HYDROLOGY
- AGRICULTURE BIO-ENERGY
- HEALTH
- ENERGY
- OCEAN - ATMOSPHERE
- EXTREME EVENTS
- ECONOMY
- AMAZON FOREST
- PALEOCLIMATE
THANK YOU FOR YOUR ATTENTION AND FAPESP FOR THE INVITATION