Adaption and Resilience of Hydropower – Discussion of Indicators

Energy Indicators

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Room for more Hydropower Development in Climate Change

Eletrobras Cepel
45 anos
A Pesquisa que constrói o futuro

Background

There has been a growing concern about global warming, i.e., climate change issues

- this led to the Paris Agreement during the UN COP 21 (2015)

The energy sector has been a major player in global climate change

- contributing at least 2/3 of its greenhouse gas emissions
- the Paris Agreement on Climate Change is, in essence, an agreement on energy

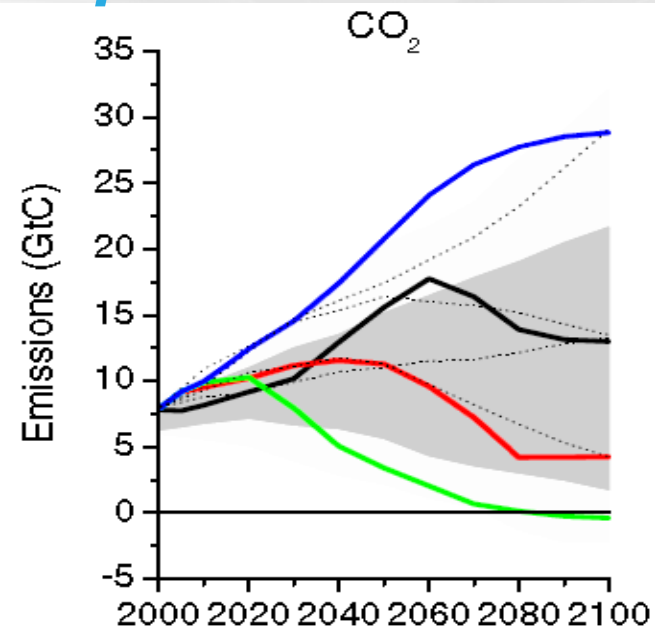
The Paris Agreement calls for transformative change in the world energy system

- implying the need to accelerate the decarbonization of the world economy
- and to implement, on a large scale, clean, eminently renewable technologies, whether existing or new ➡ *room for hydropower*

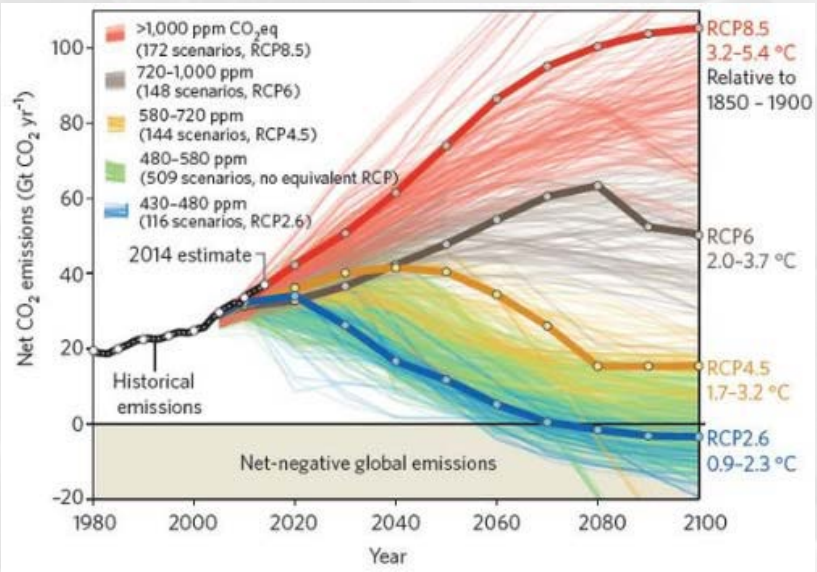
How to identify, assess and manage climate changes?

Climate Change Context

Representative Concentration Pathways – RCPs (AR5/IPCC)



- **In all RCPs, atmospheric CO2 concentrations are higher by 2100 than in the present day**
- **Wide variation in projected scenarios**



- **Uncertainties to be faced when establishing public policies**

Climate Change Context

Nexus Energy & Water

- the water sector needs the energy sector and the energy sector needs the water sector
- **IEA estimates that 15% of fresh water withdrawn worldwide is used for the energy sector**
- About 4% of the world's electricity consumed is used to collect, distribute and treat drinking water, apart from the energy used in irrigation pumps and desalination plants
- **in line with economic and population growth, global demand for energy and water will increase, and in some scenarios may double by 2030**
- in addition, climate change may exacerbate water stress in several region

The nexus water and energy becomes a critical component of both mitigation and adaptation strategies

- especially in Brazil, due to the predominance of hydroelectric generation

Climate Change Context

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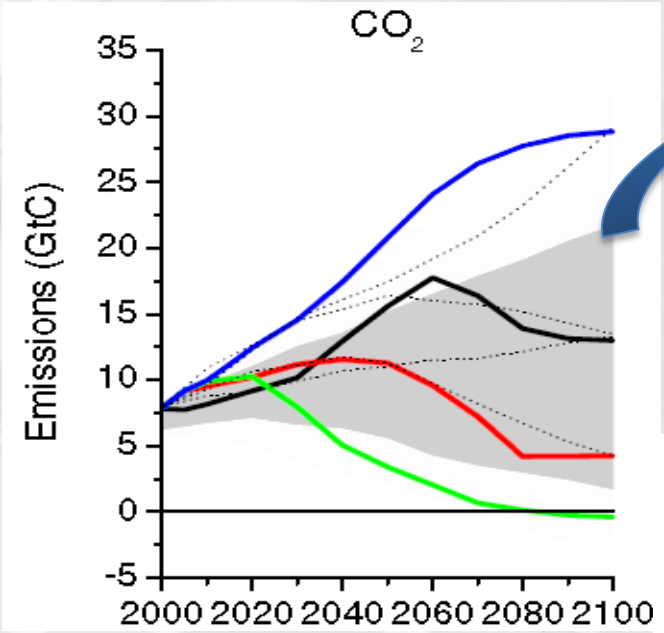
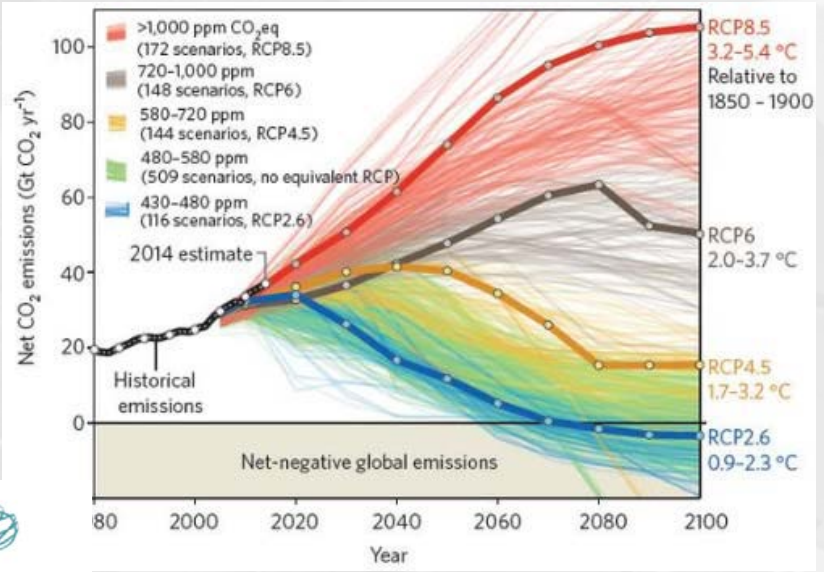
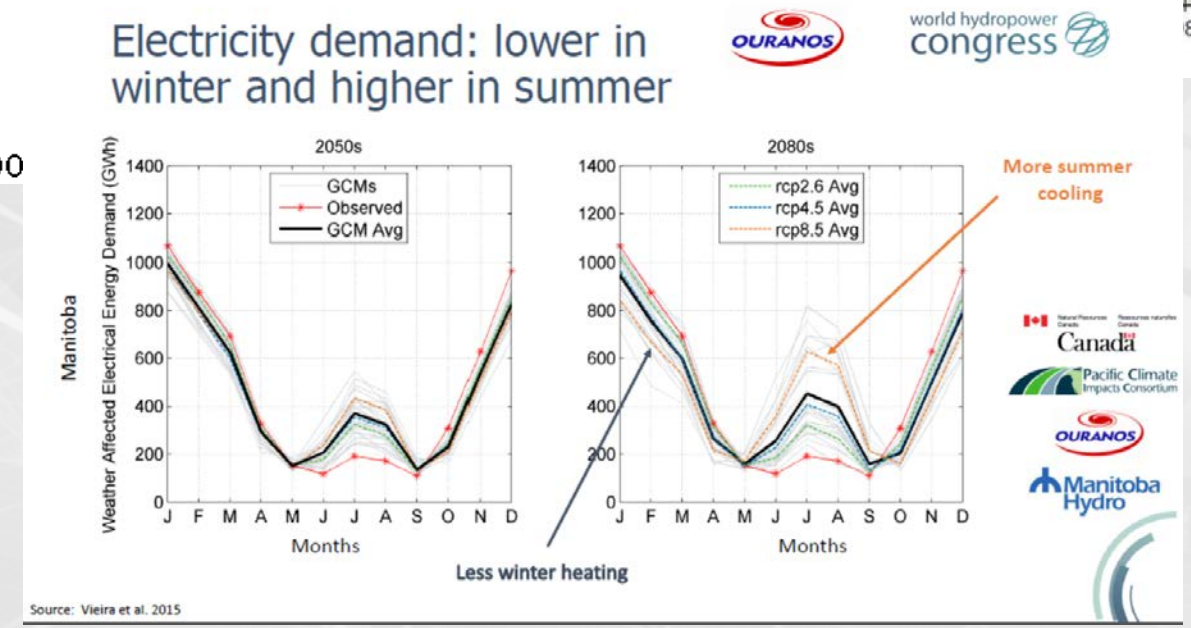


RCPs Uncertainties



Electricity Demand



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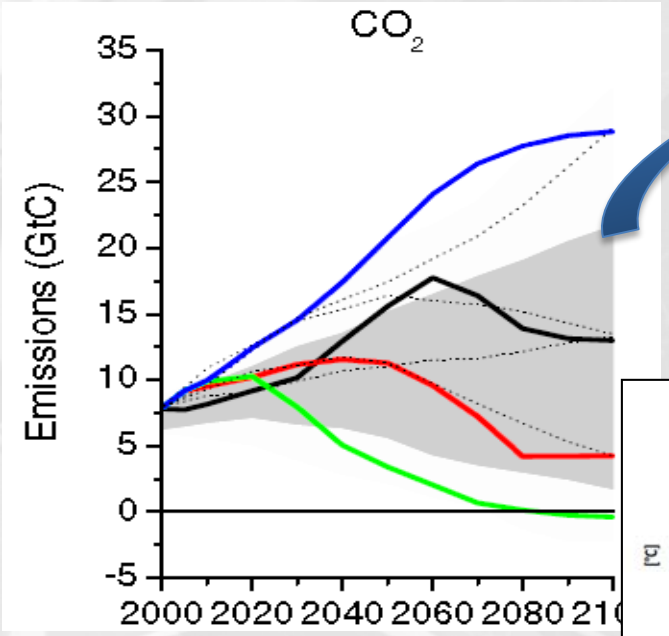

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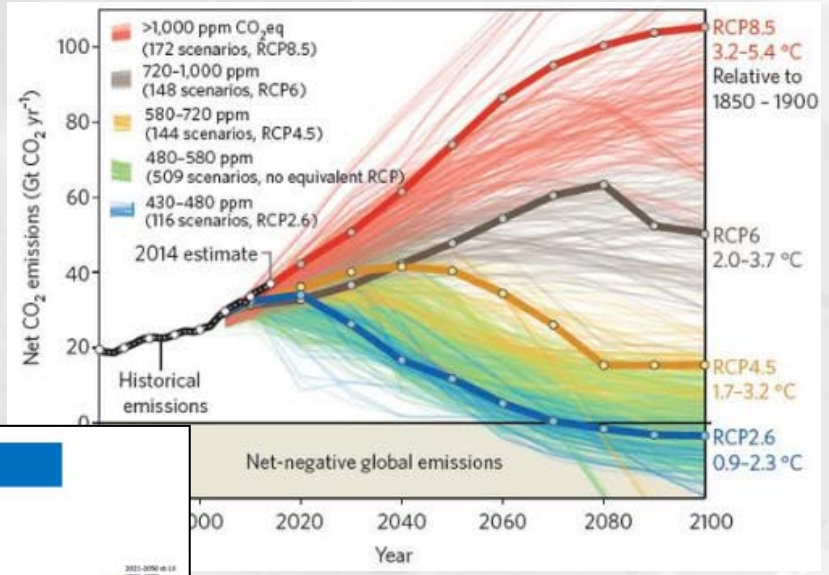

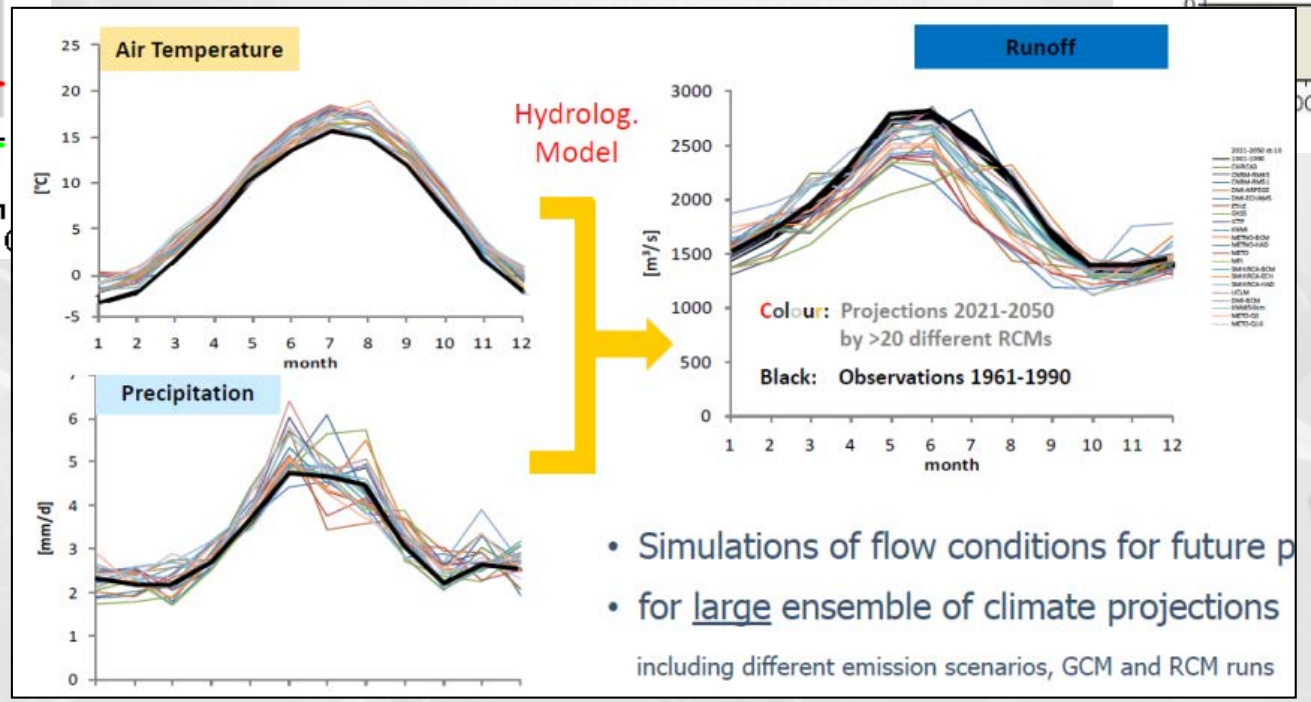

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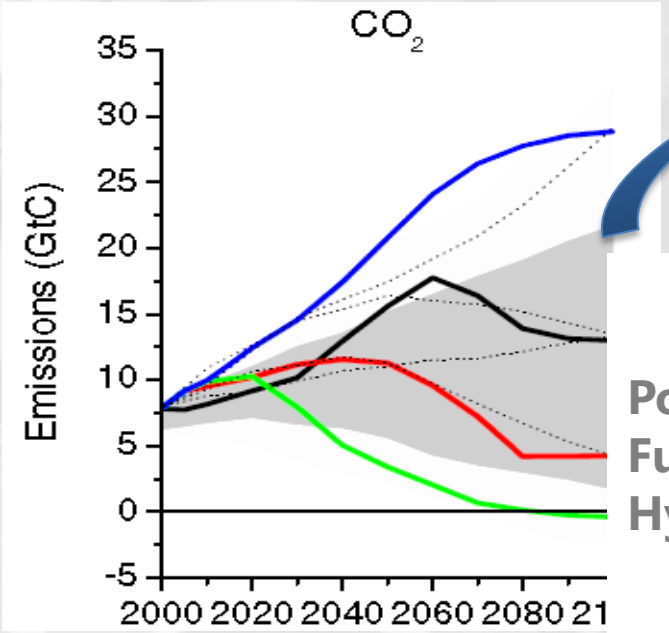
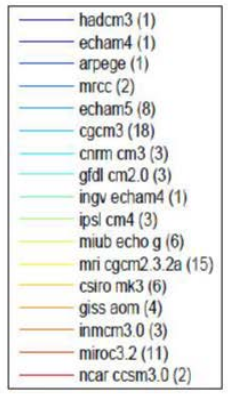
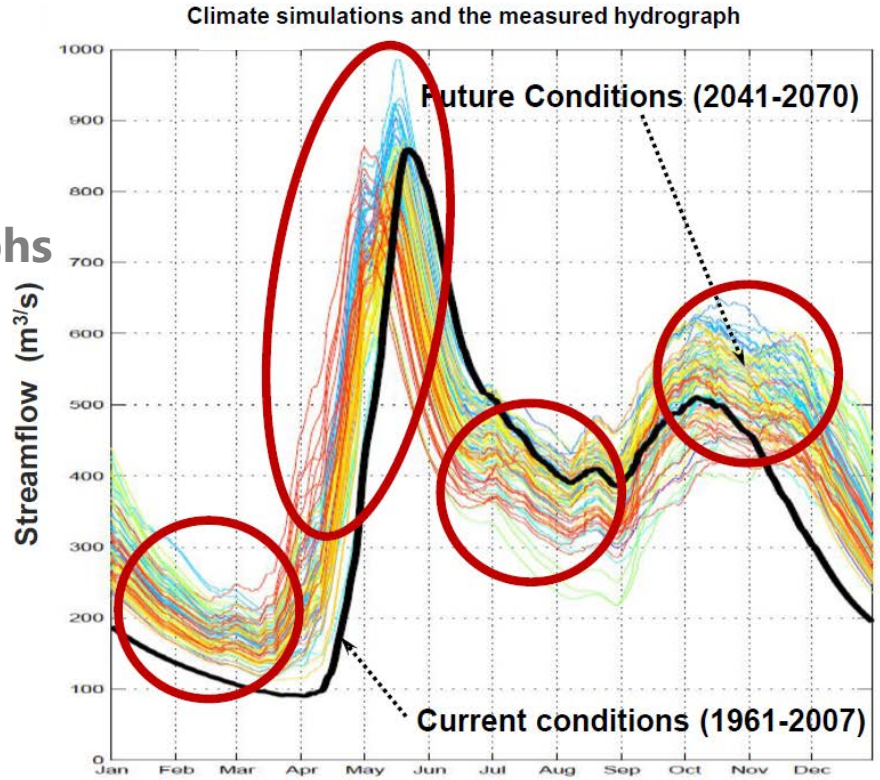


Possible Future Hydrographs





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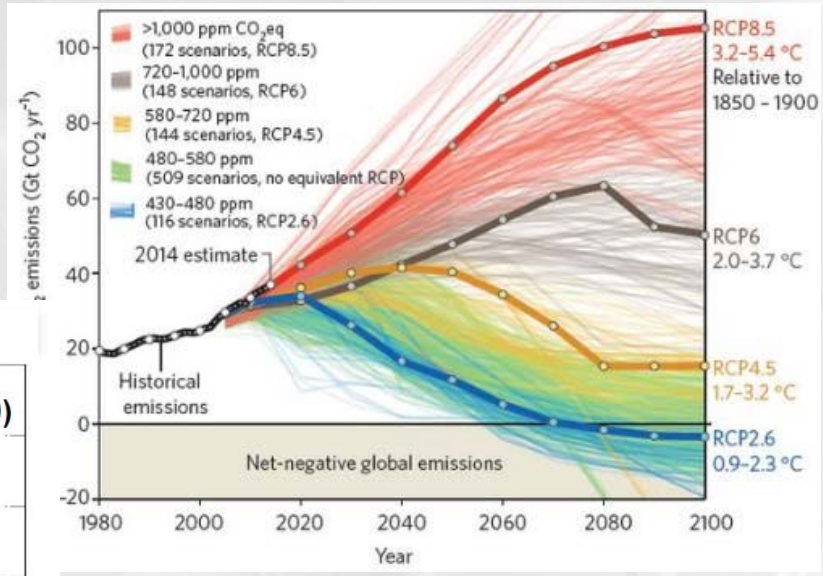


Resilience to Climate Change

Resilience

- The capacity of social, economic and environmental systems to cope with a hazardous event or trend or disturbance, responding or reorganizing in ways that maintain their essential function, identity and structure, while also maintaining the capacity for adaptation, learning and transformation – IPCC AR5, 2014

Climate Resilience

- It is a capacity of a hydropower project or system to absorb the stresses imposed by climate change, and in the process to evolve to into greater robustness - K. Macpherson et allii, 2017

Robustness

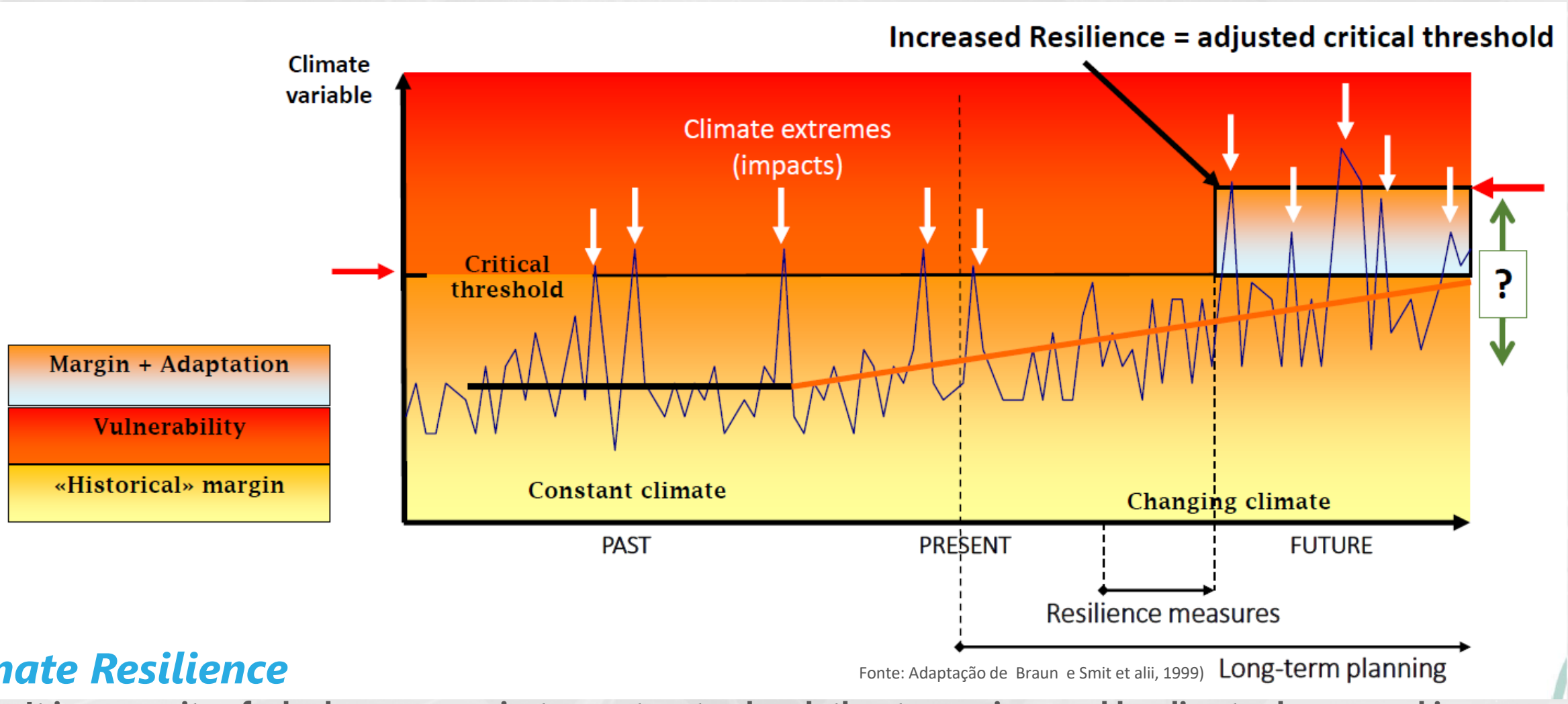
- performing reasonably well in comparison to the alternatives in a wide range of plausible futures - R. J. Lempert et allii, 2006

Why focus on hydroelectric resilience?

- To identify, assess and manage climate changes to mitigate the risks of new and existing hydropower projects

  This implies in thinking about the default use of historical data, the assumption that hydrological variability will remain the same over the lifetime of a project and the limited knowledge of how best to access, use and interpret climate change modelling and observed climate data

Resilience to Climate Change



Fonte: Adaptação de Braun e Smit et alii, 1999)

Climate Resilience

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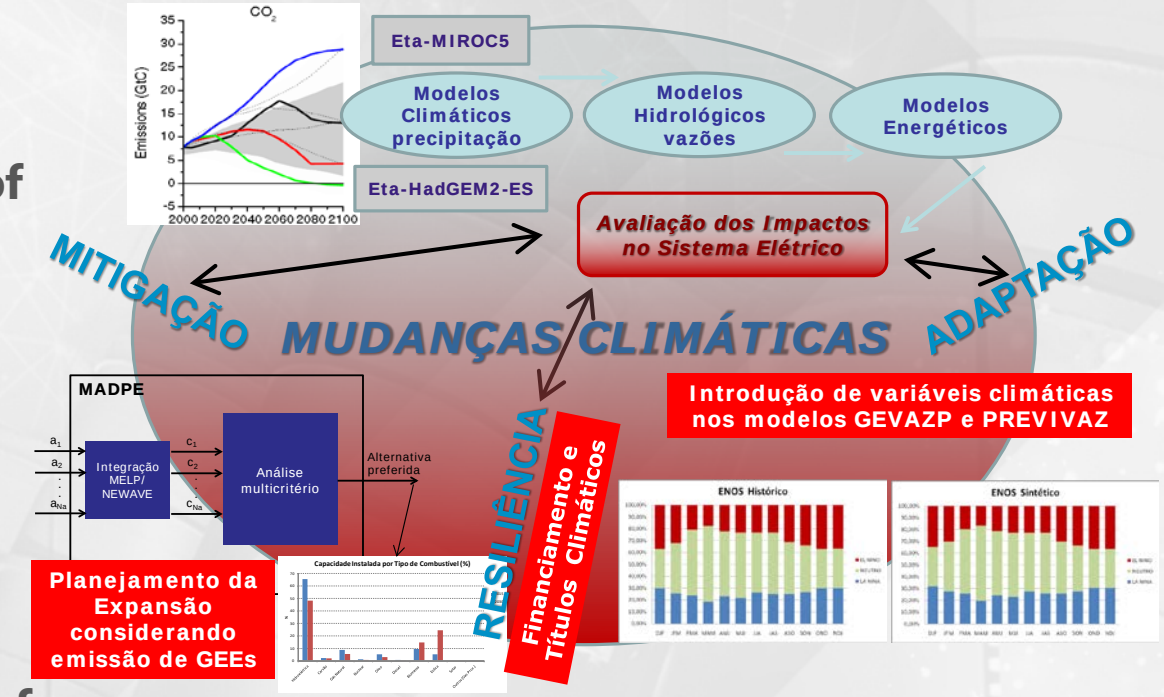
Climate Change CEPEL's Project (MudClima)

Research aspects

- preparation and analysis, from IPCC's Representative Concentration Pathways (RCP), of inflow scenarios to hydropower plants by 2100, including extreme events (wind, solar, ...)
- identification and evaluation of the influence of climate variables on scenario generation and inflow forecast (wind, solar, ...)
- development of methodologies for the consideration of their impacts in the energy expansion planning and operation, in terms of economics, reliability and greenhouse gas emissions, with impacts on mitigation and adaptation policies;
- development of strategies and actions to adapt to the effects of climate change in the social, ecosystem and corporate areas;
- development of methodologies for the establishment of indicators related to adaptation and resilience for the eligibility of hydropower projects to climatic bonds.



Fonte: M.E.P. Maceira et alii

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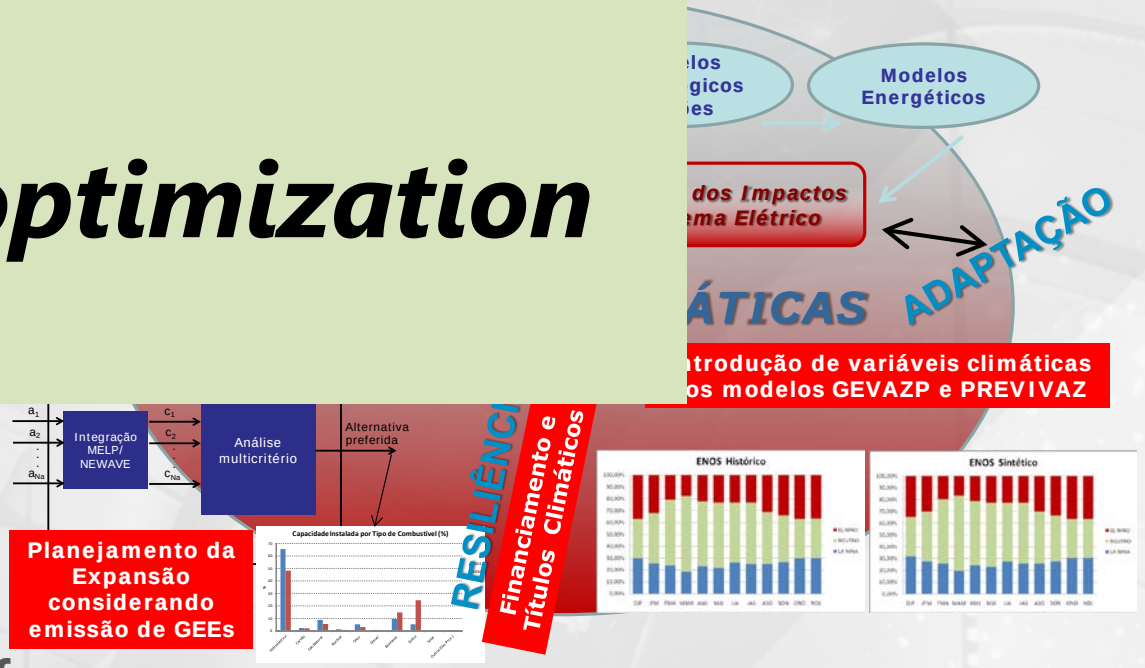
Narrowing the gap between the climate models and simulation/energy optimization models of CEPEL



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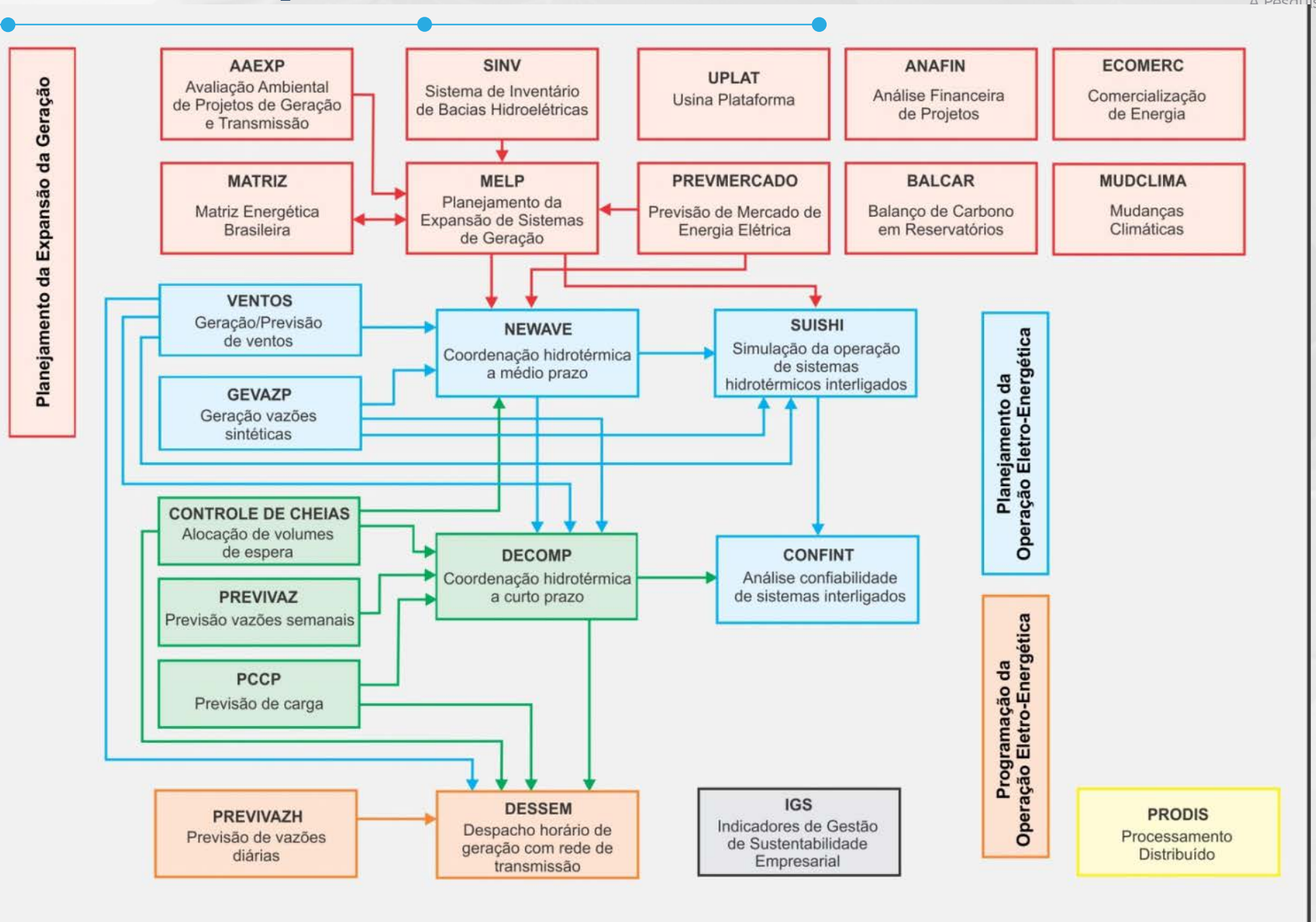
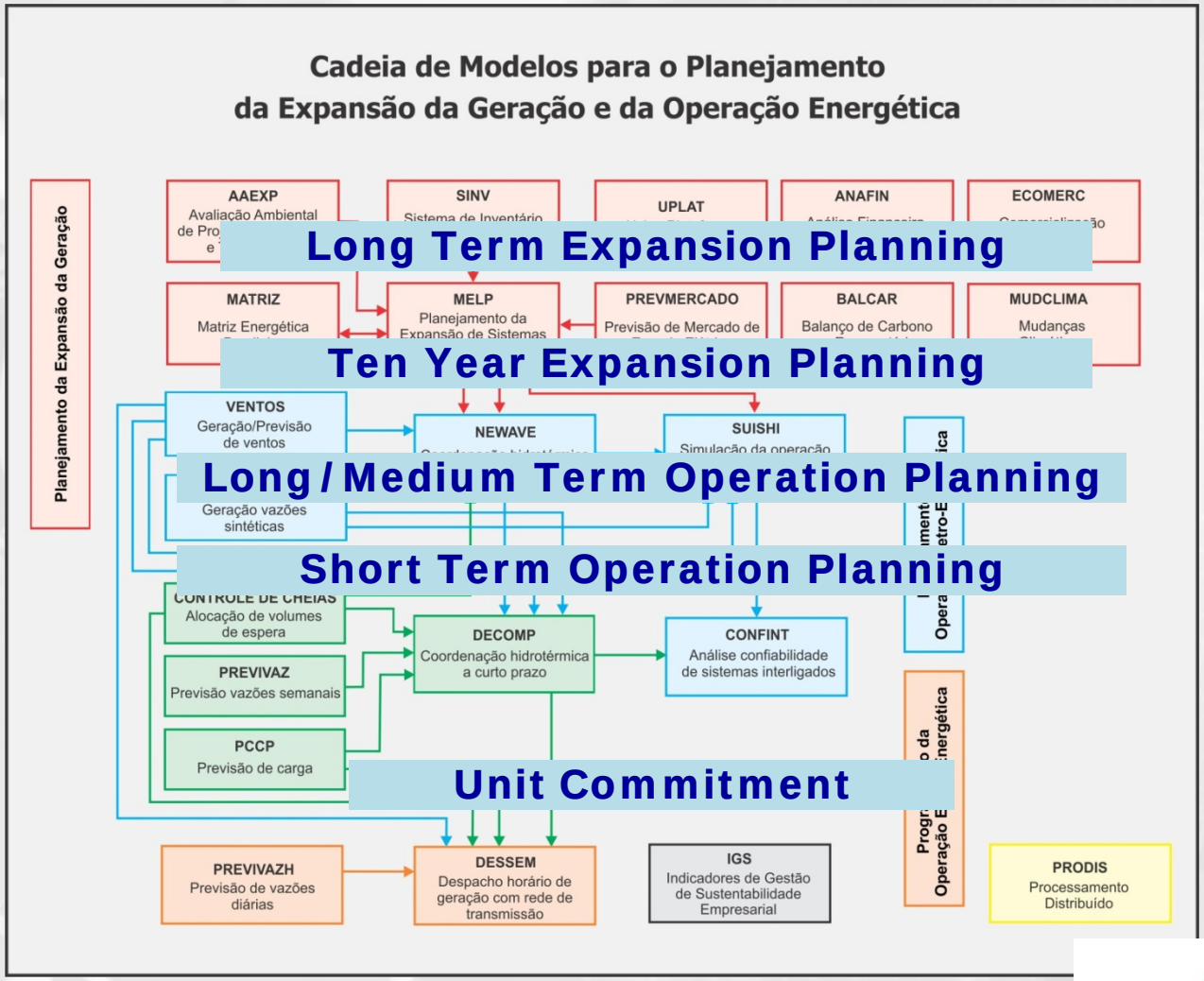
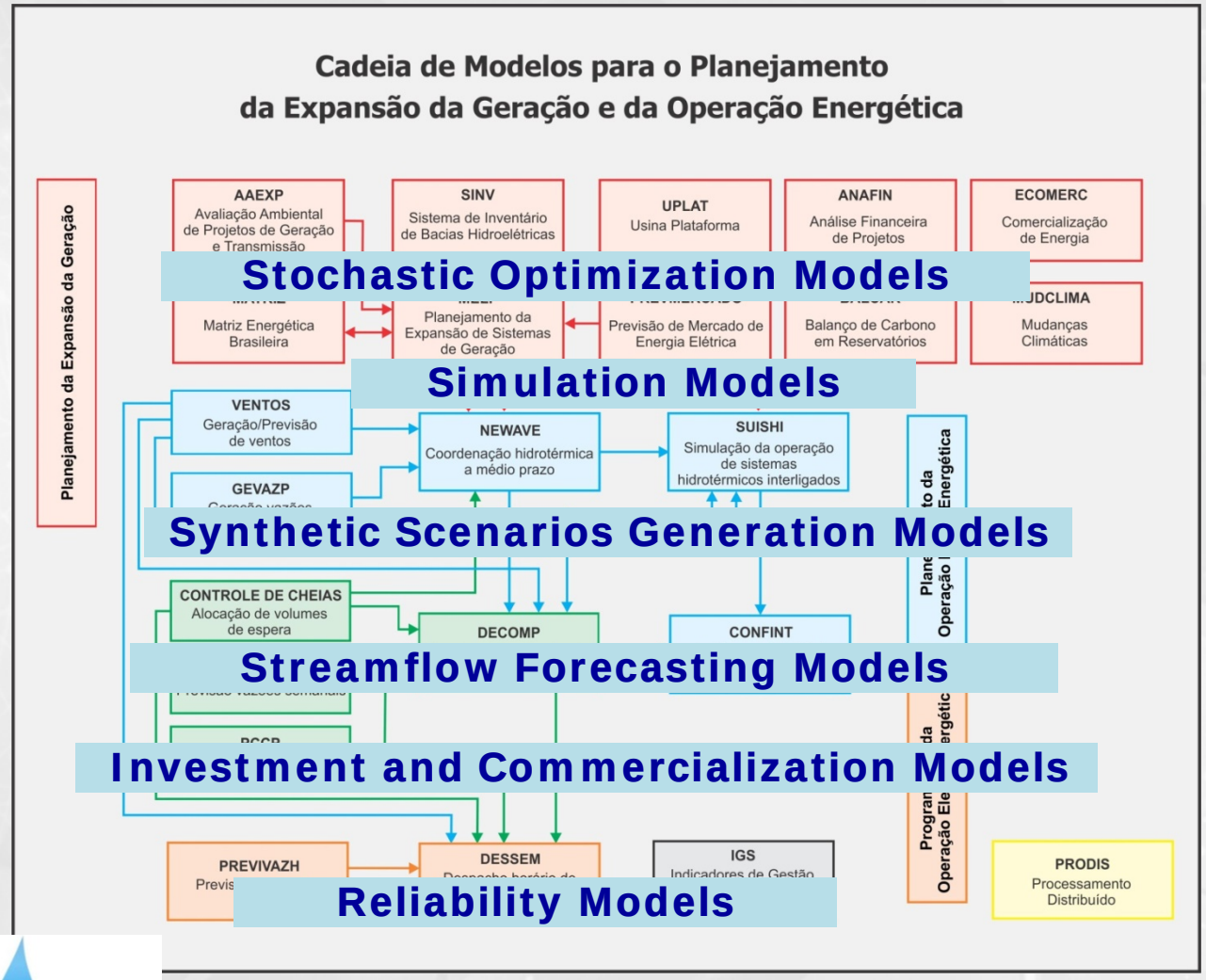
CEPEL's Chain of Optimization and Simulation Models



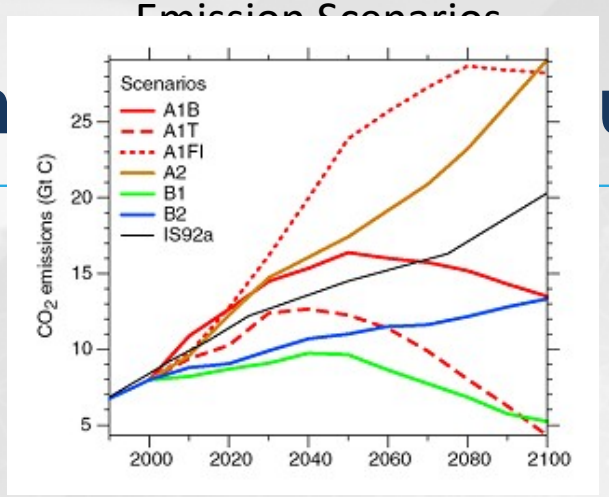
CEPEL's Chain of Models





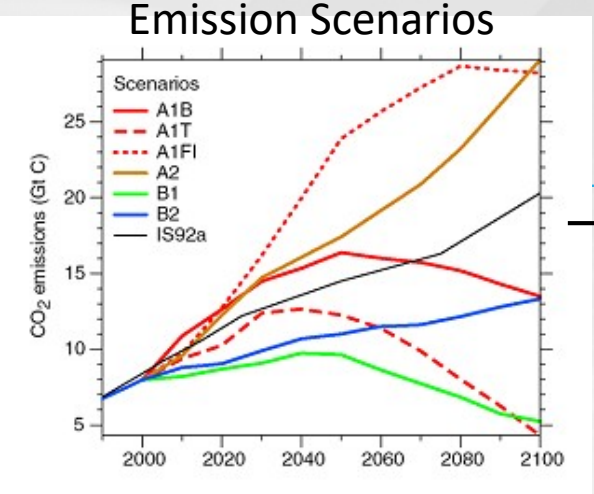
Climate Chan uation on Power Systems

IPCC's Representative Concentration Pathways (RCPs)

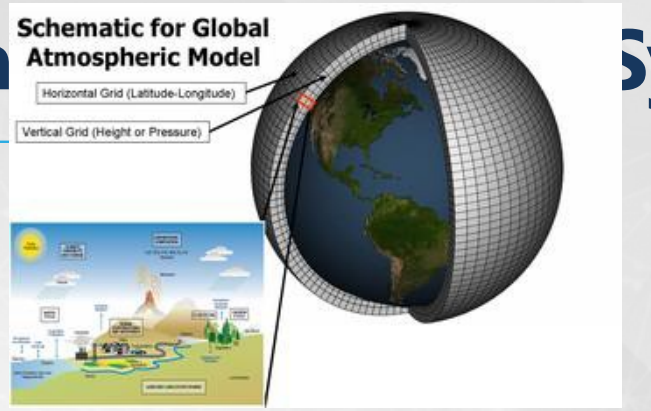


Climate Chan ua Systems

Emission Scenarios



General Circulation Models (GCMs)



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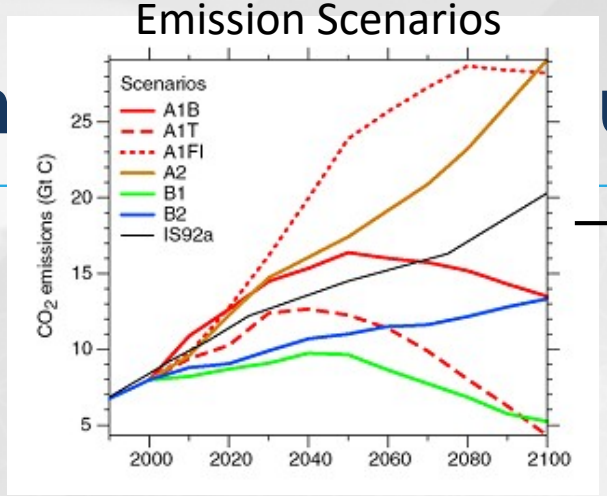

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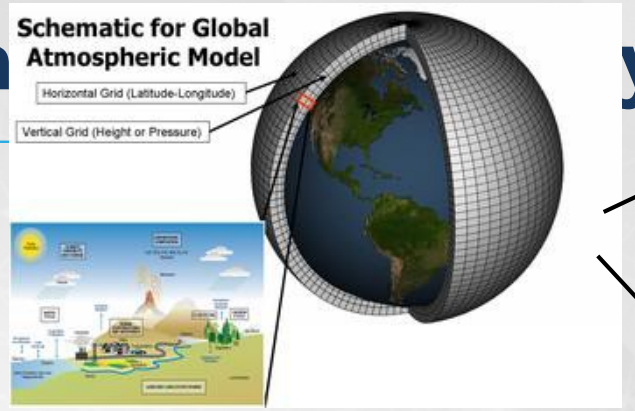
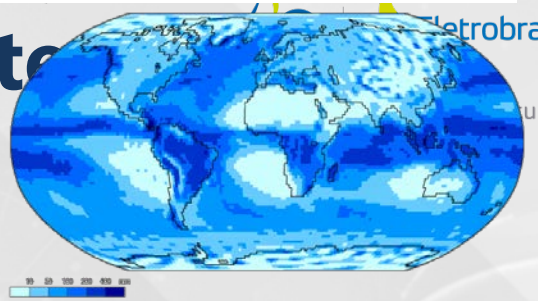
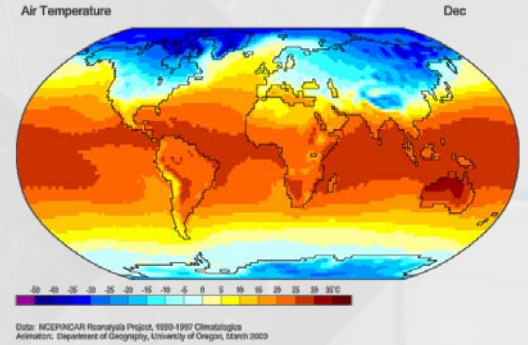


Geography Department, U. Oregon





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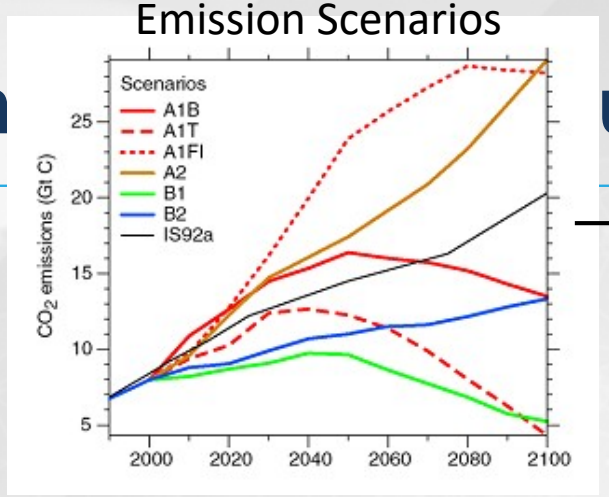

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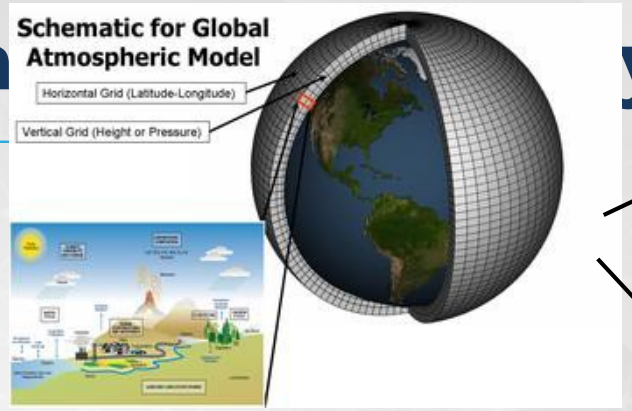

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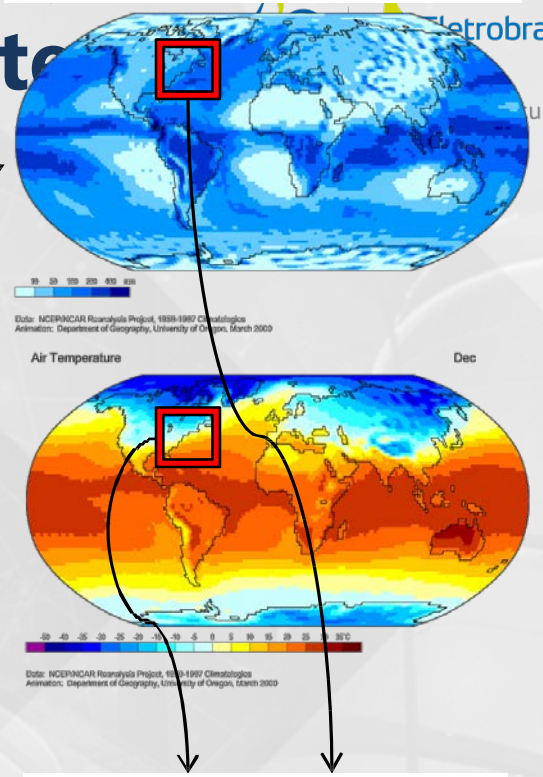
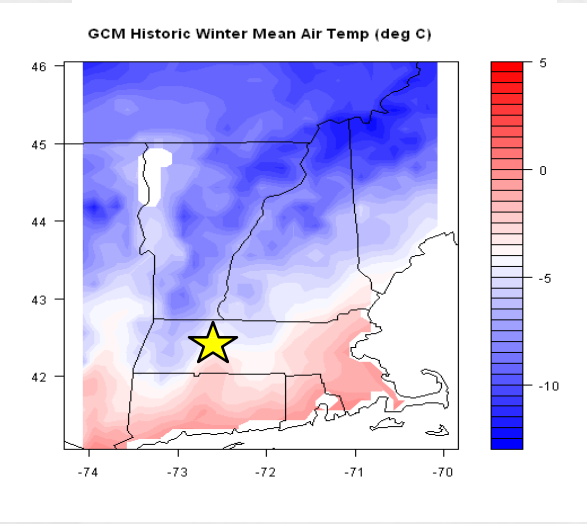


Downscaling



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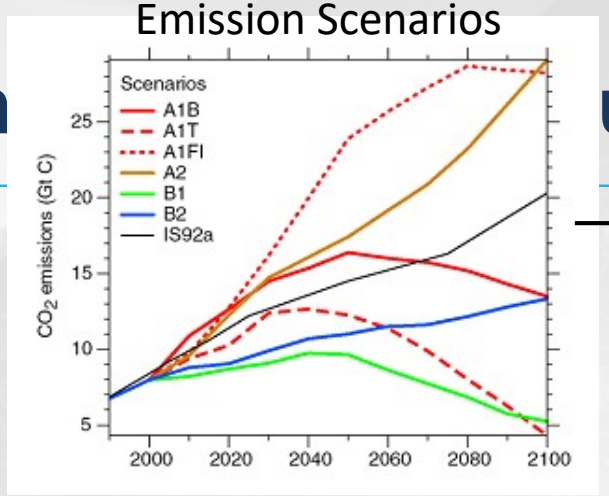

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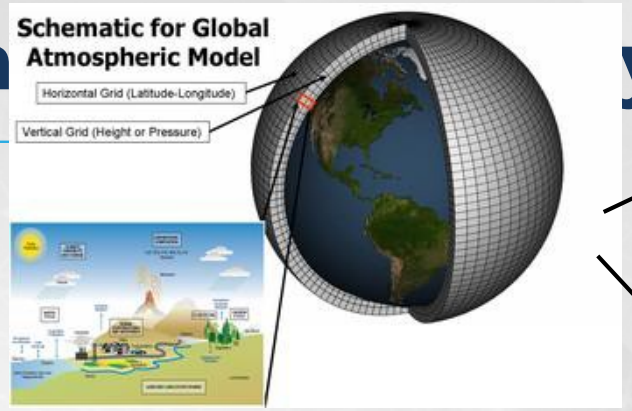

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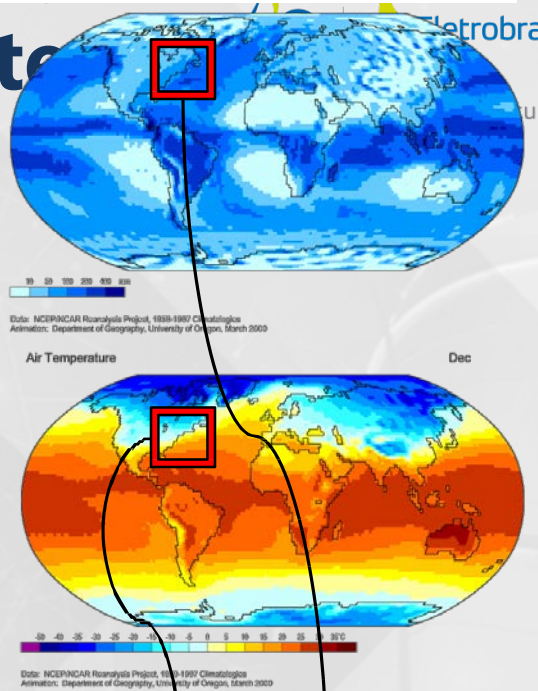
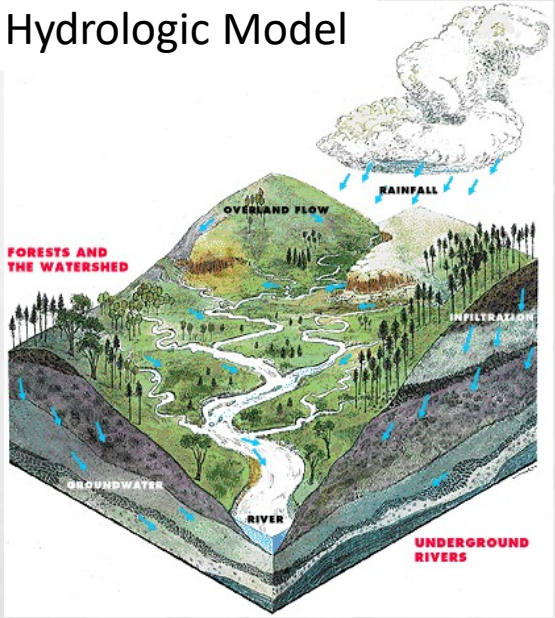


Hydrologic Model



Greene County, PA Department of Econ. Development

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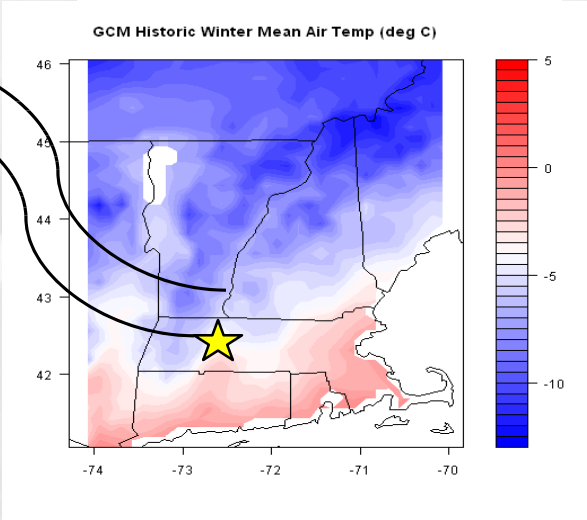
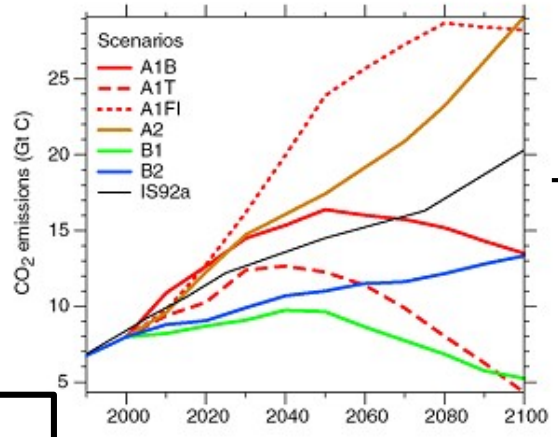


Climate Chan ua Syst

IPCC's Representative Concentration Pathways (RCPs)

Emission Scenarios



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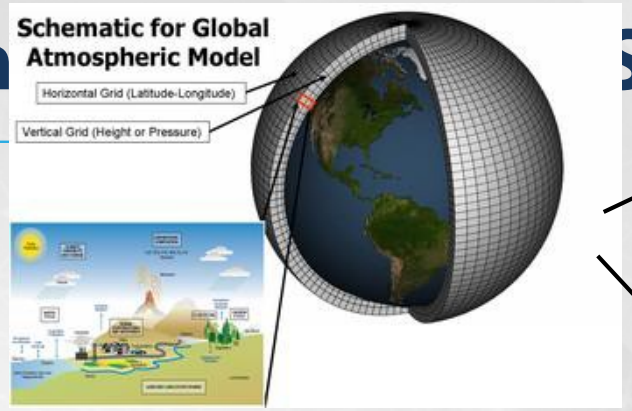

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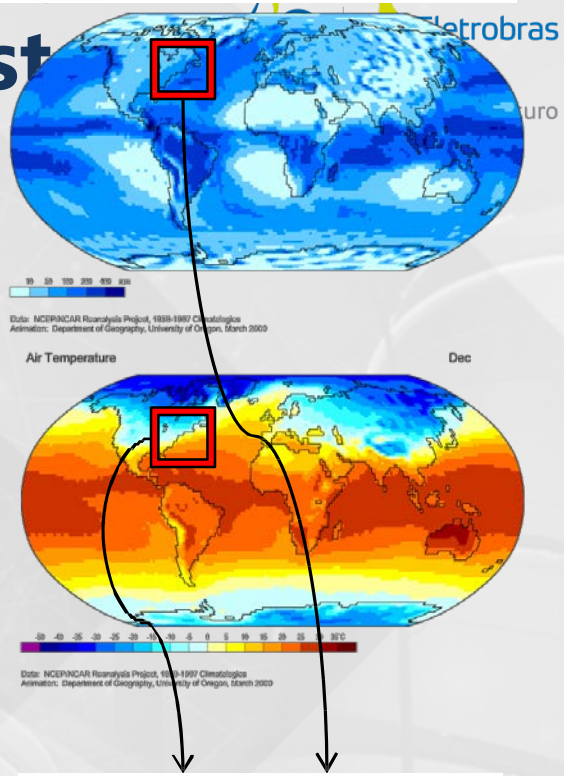
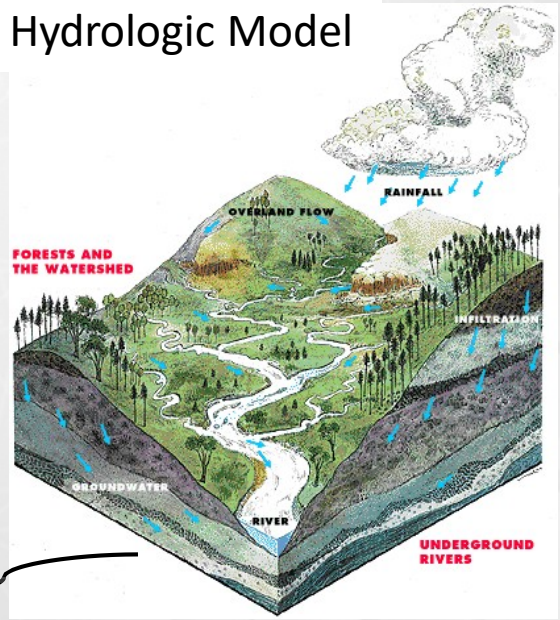


Synthetic Scenarios Generation
inflows, wind, solar

Hydrologic Model



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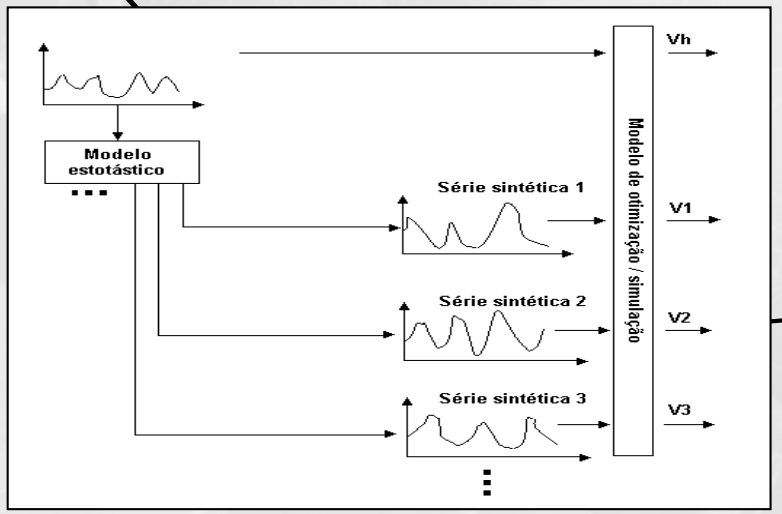
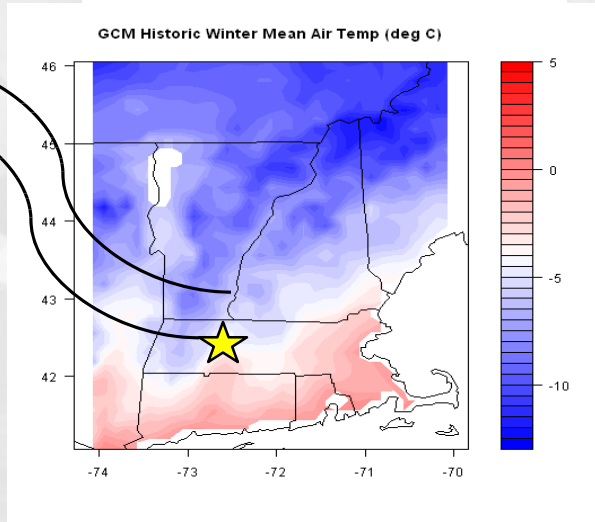


Inflow scenarios to hydropower (wind, solar, ...)

CEPEL's Chain of Models



Source: Adaptation on S. Steinschneider,

Climate Chan ua Syst

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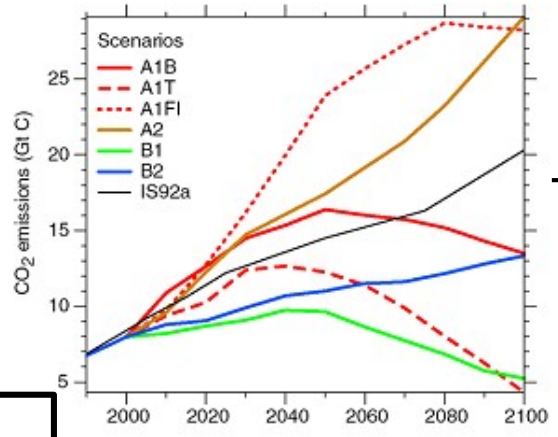

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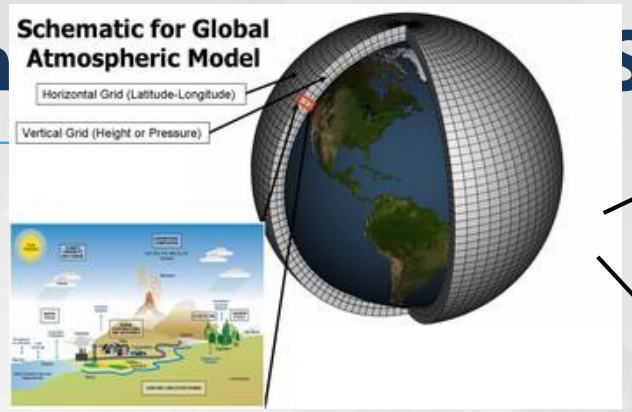

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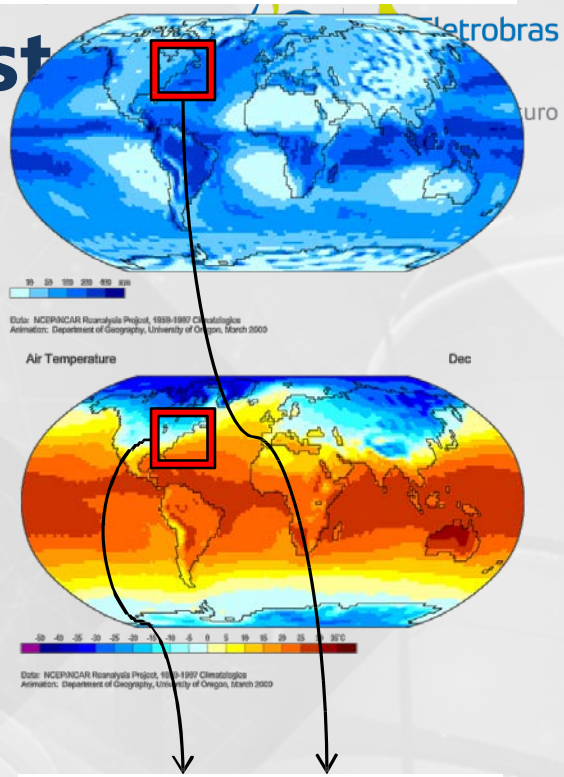
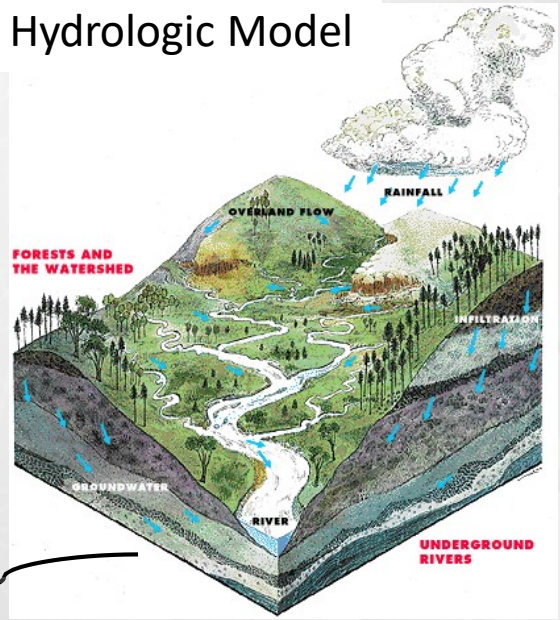


Climate Change Impact Evaluation on Power Systems

Hydrologic Model



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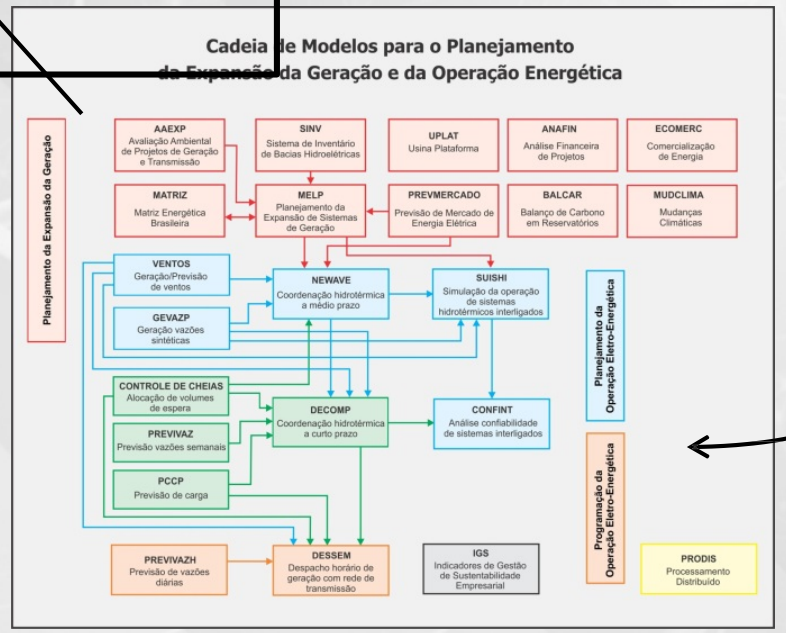
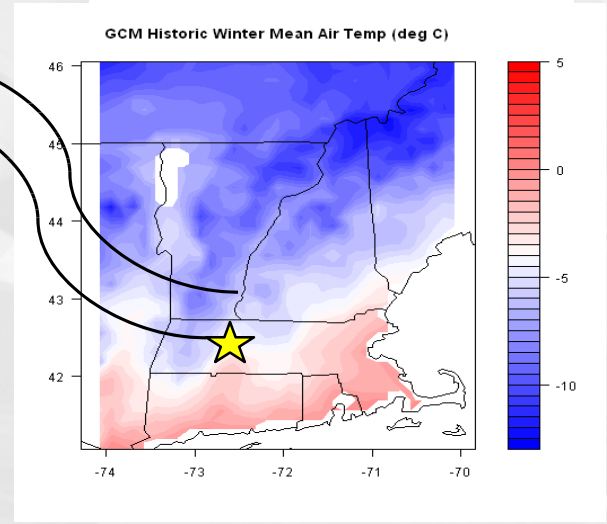


CEPEL's Chain of Models



Source: Adaptation on S. Steinschneider,

Climate Change Impact Evaluation on Power Systems

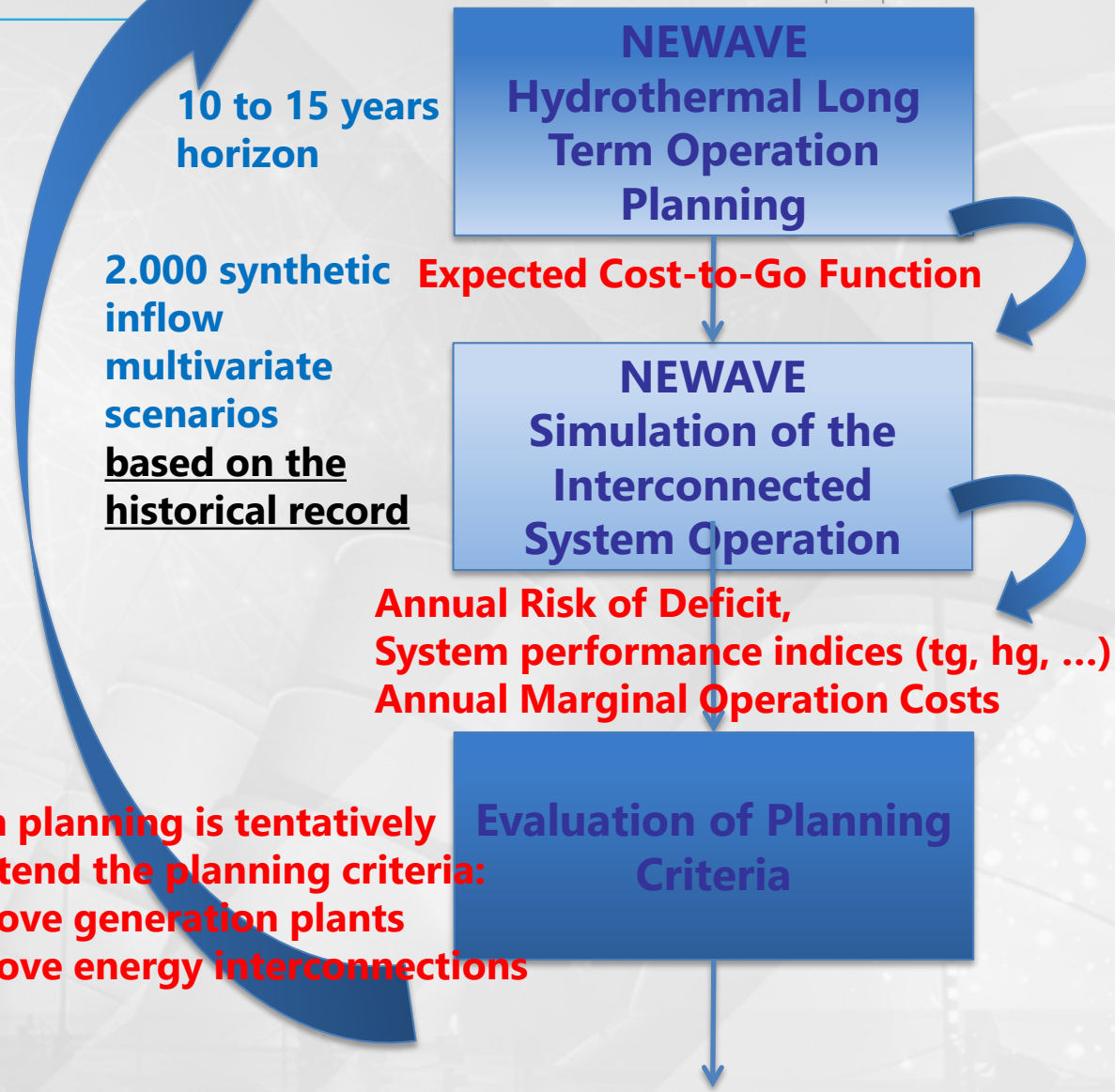
Brazilian Case

Ten (Fifteen) Year Expansion Plan

Hydro, wind, solar, interconnections are energetically and economically evaluated

Evaluation of Brazilian Planning Criteria

- The expected annual marginal costs should equal the expansion marginal cost at each year of the planning horizon
- Risk of Deficit below 5%



Climate Change Impact Evaluation on Power Systems

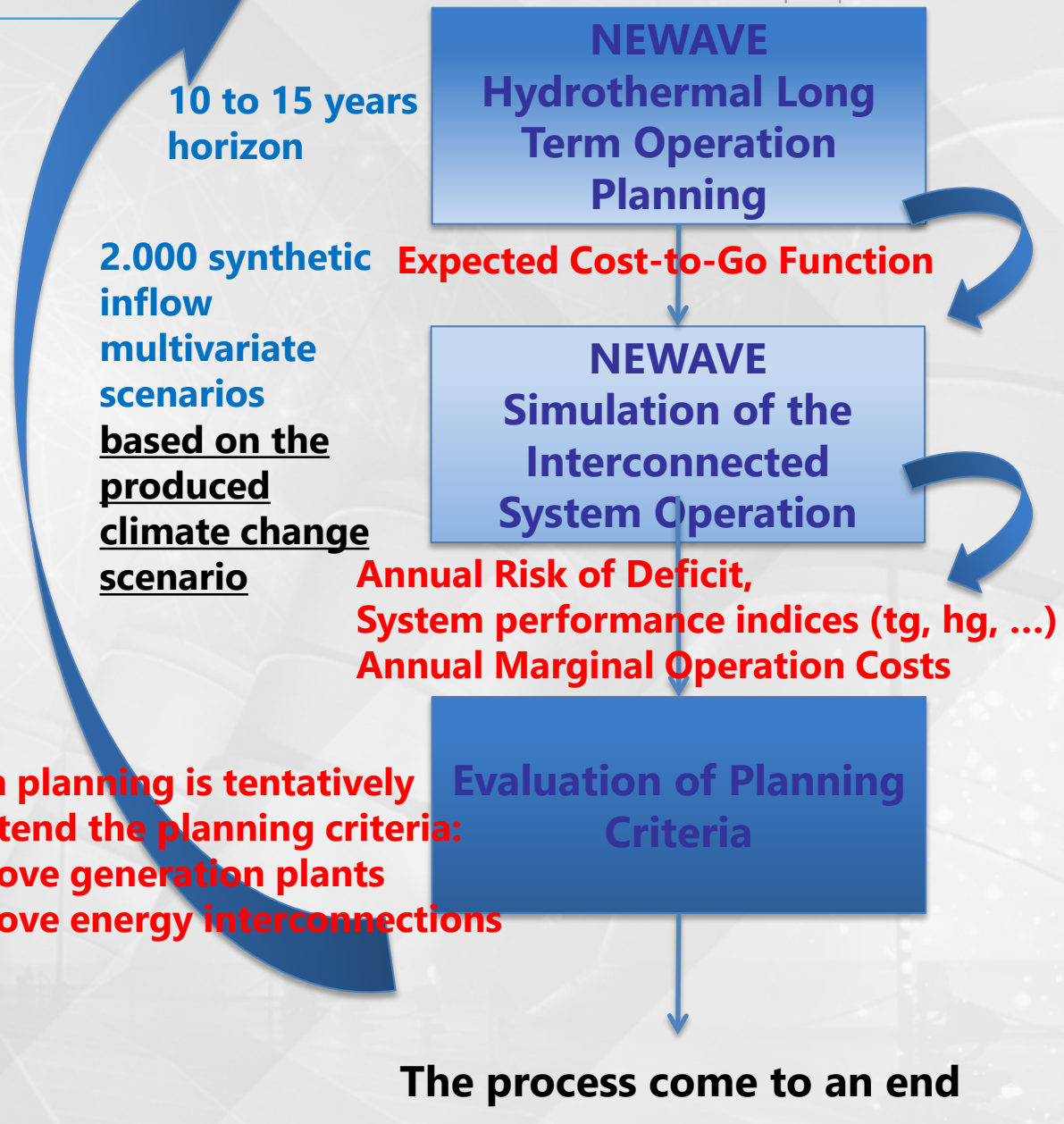
Brazilian Case

For each Climate Change Scenario (nCCS)

With all these results probabilistic indices could be constructed to evaluate the resilience of the generation plant and the electrical system as a whole

At the end, it will be provided:

- for the country electrical system, a map of expansion strategies
- for a generation plant, a frequency distribution of its generation , ...



CEPEL – Electric Energy Research Center

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OBRIGADA
Thank you

45 anos
Eletrobras
Cepel
A Pesquisa que constrói o futuro

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