Comissão de Meio Ambiente
Senado Federal, Brasília, 5 de junho de 2019

Aspectos científicos das mudanças climáticas globais

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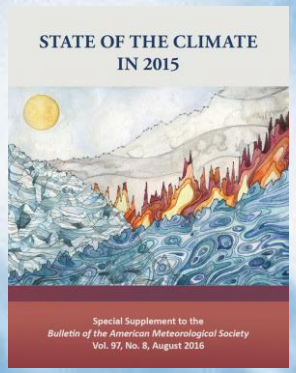
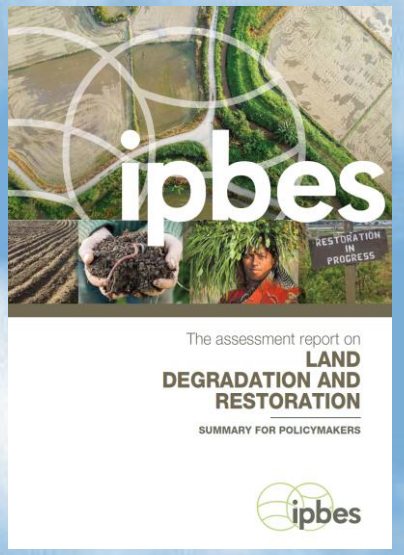
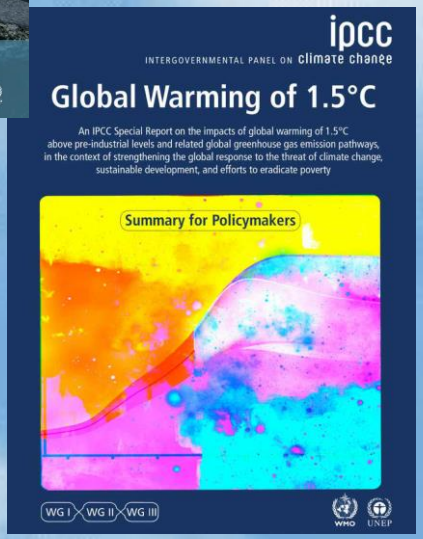
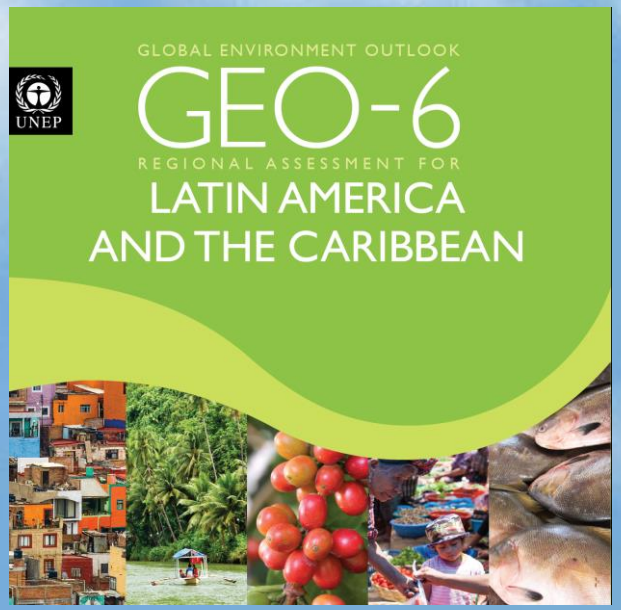
A Ciência é muito sólida nesta área, com centenas de relatórios de agências internacionais e milhares de artigos científicos

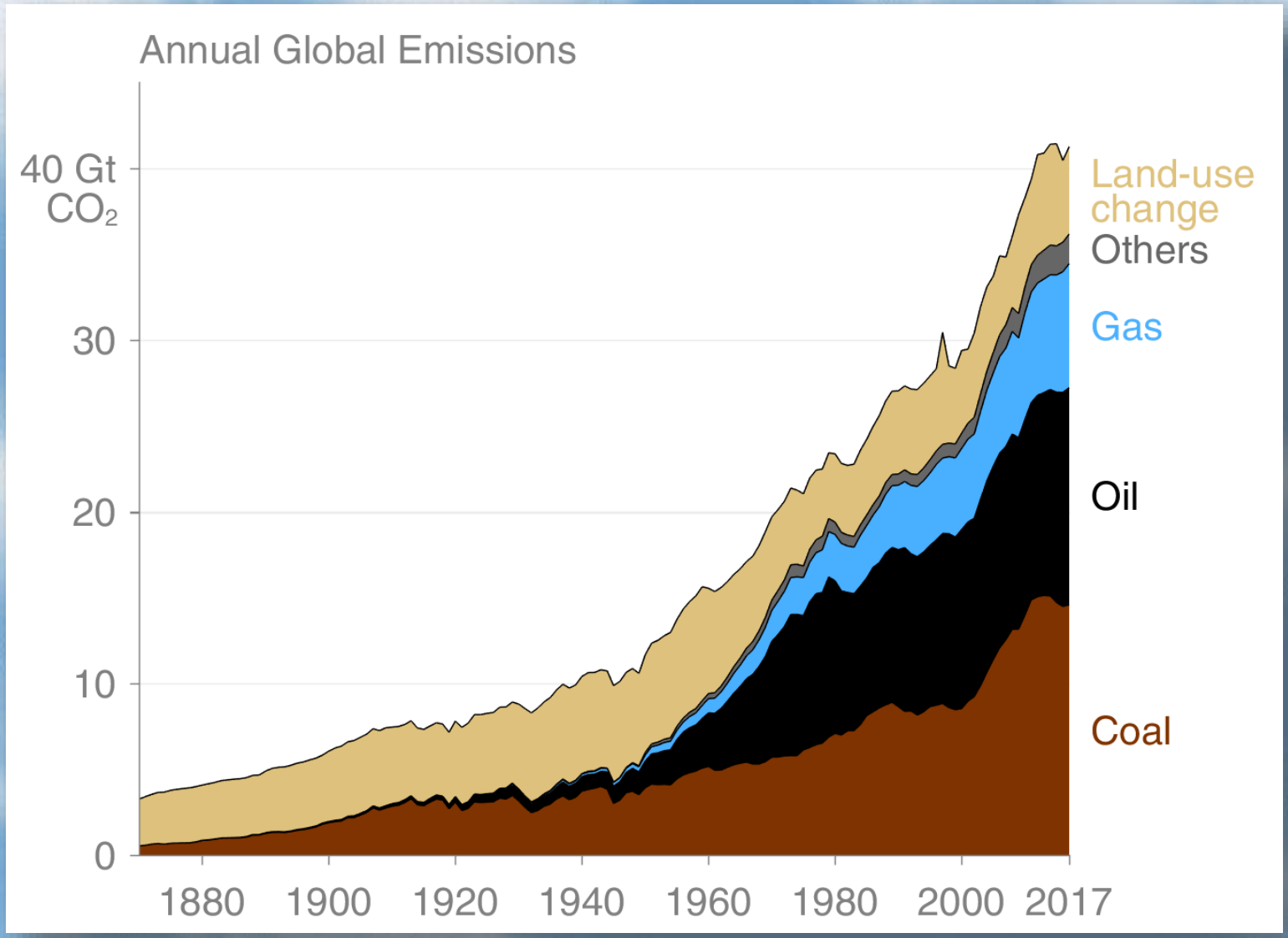






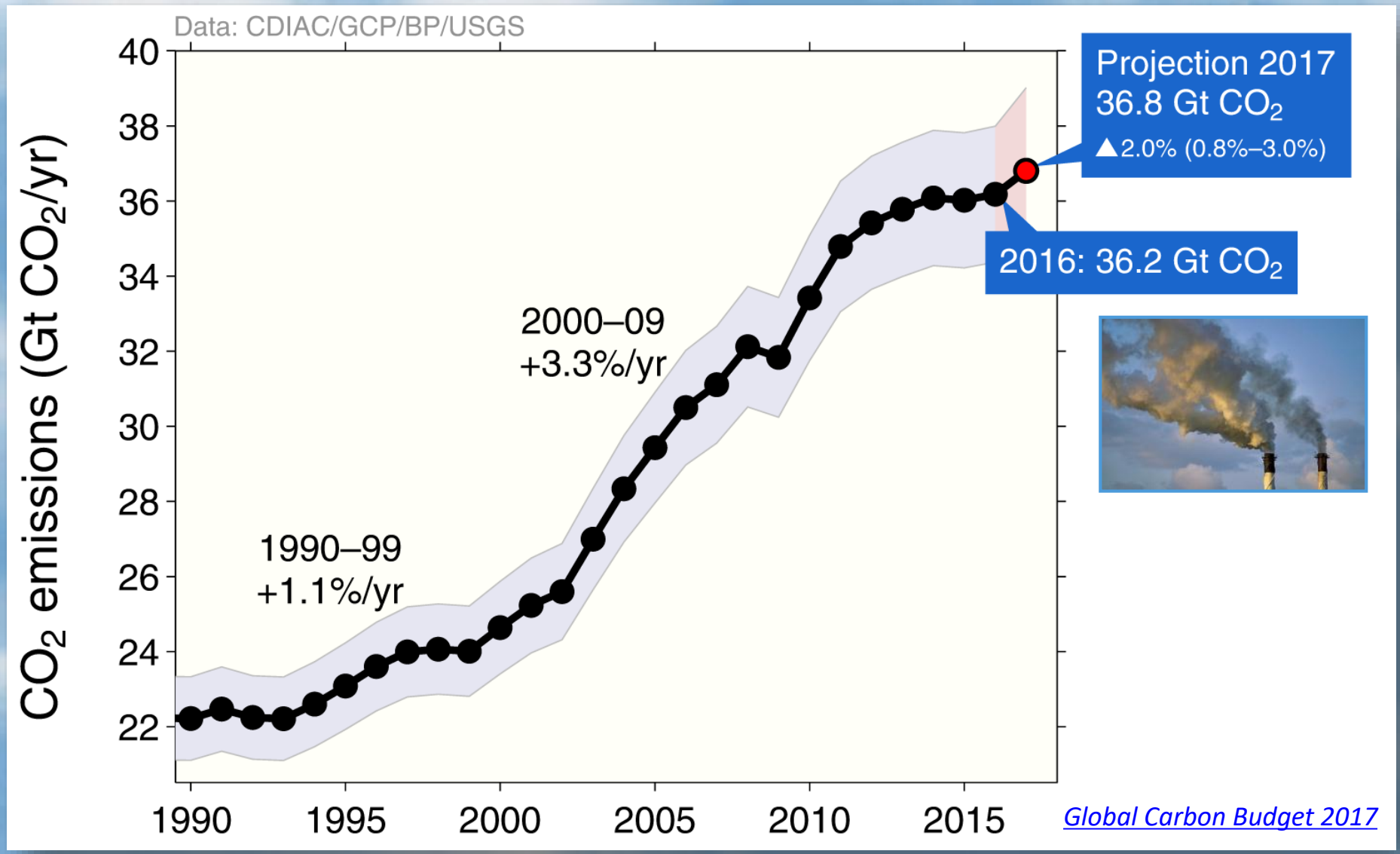


Emissões globais de carbono: Mudanças de uso do solo dominaram as emissões até 1940. Combustíveis fósseis dominam hoje (90%)



Source: Le Quéré et al 2018; Global Carbon Budget 2018

Emissões globais de CO2: 36.8 $GtCO_2$ em 2017, 62% acima de 1990

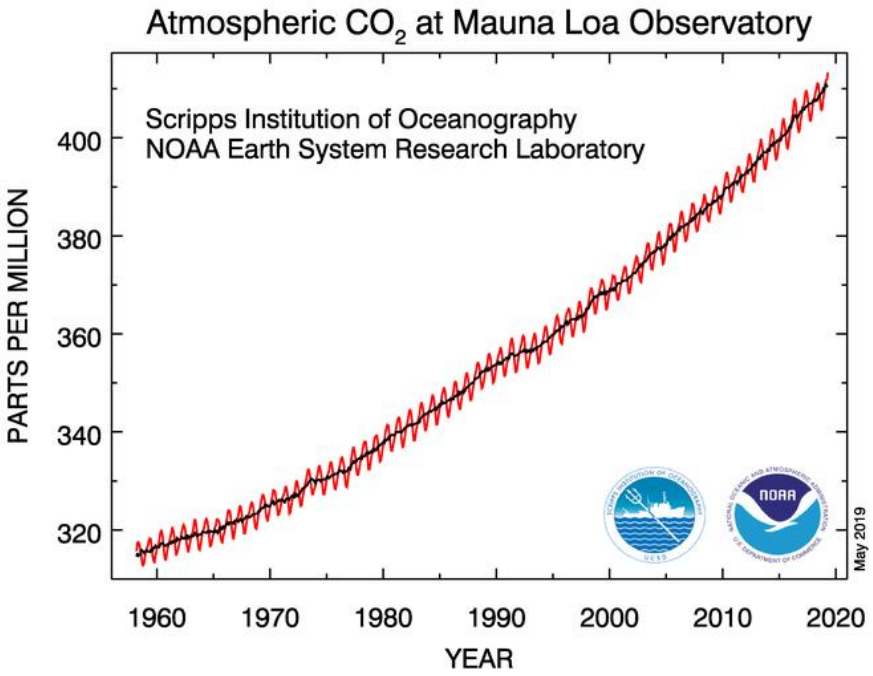


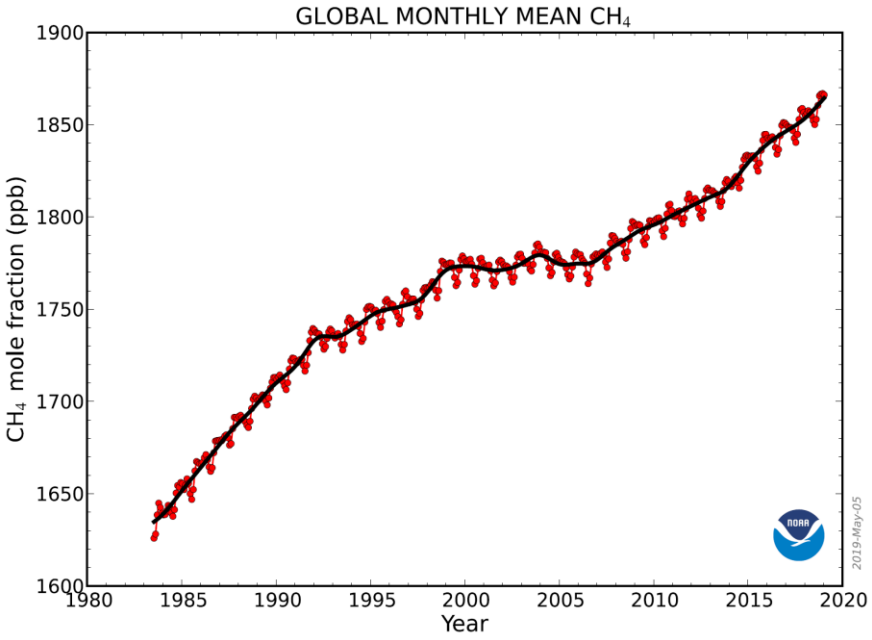
Global Carbon Budget 2017

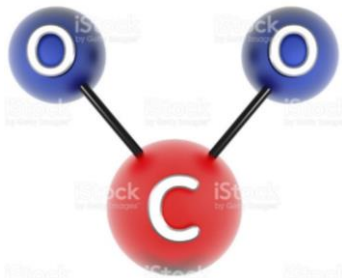
Aumento na concentração de dióxido de carbono (CO_2) e metano (CH_4)

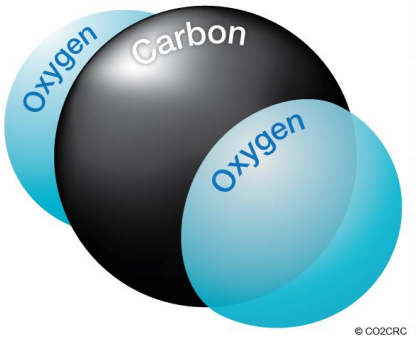
CO2: Aumento de 44% desde 1850

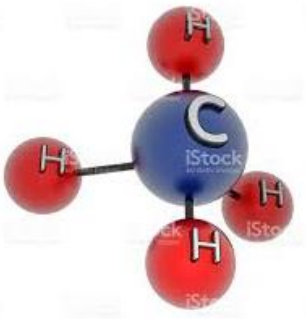
CH4: Aumento de 175% desde 1850

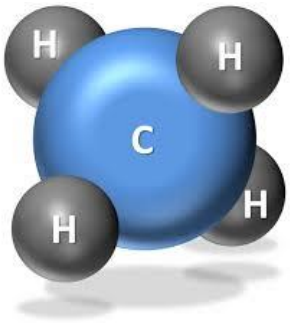




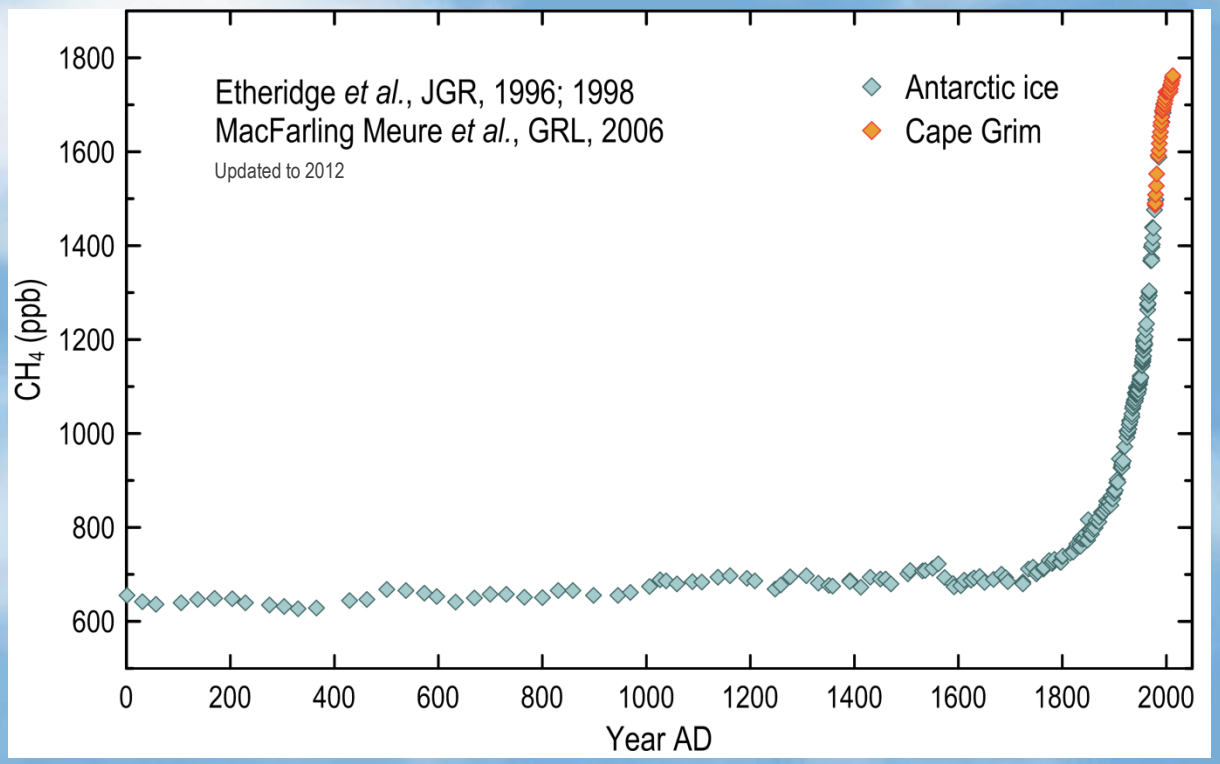


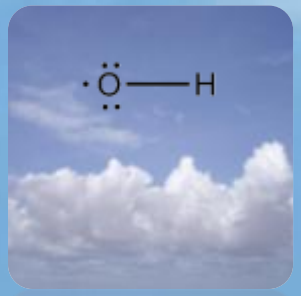




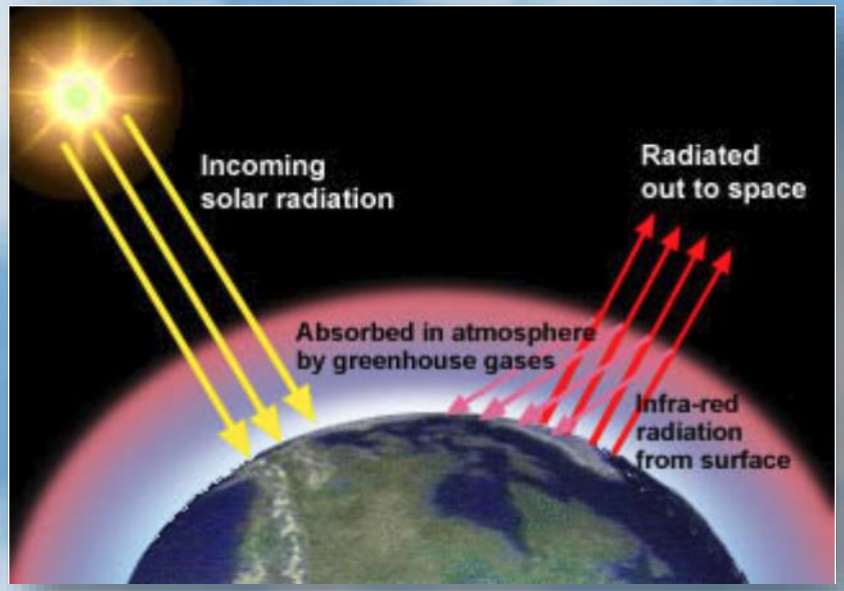


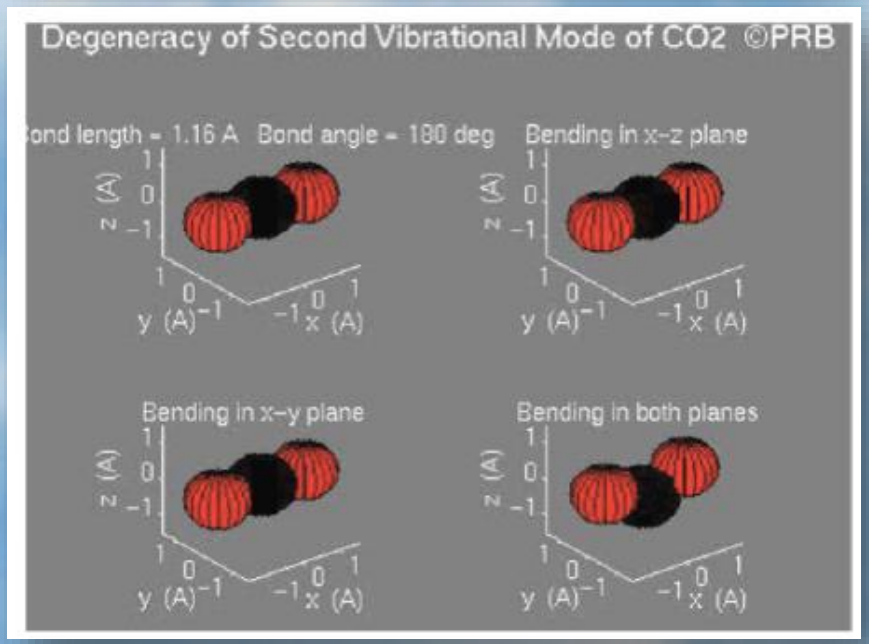
Metano: Gás de efeito estufa 28 vezes mais forte que o CO_2 e de meia vida de 11 anos.





Absorção Infravermelha de radiação por gases de efeito estufa





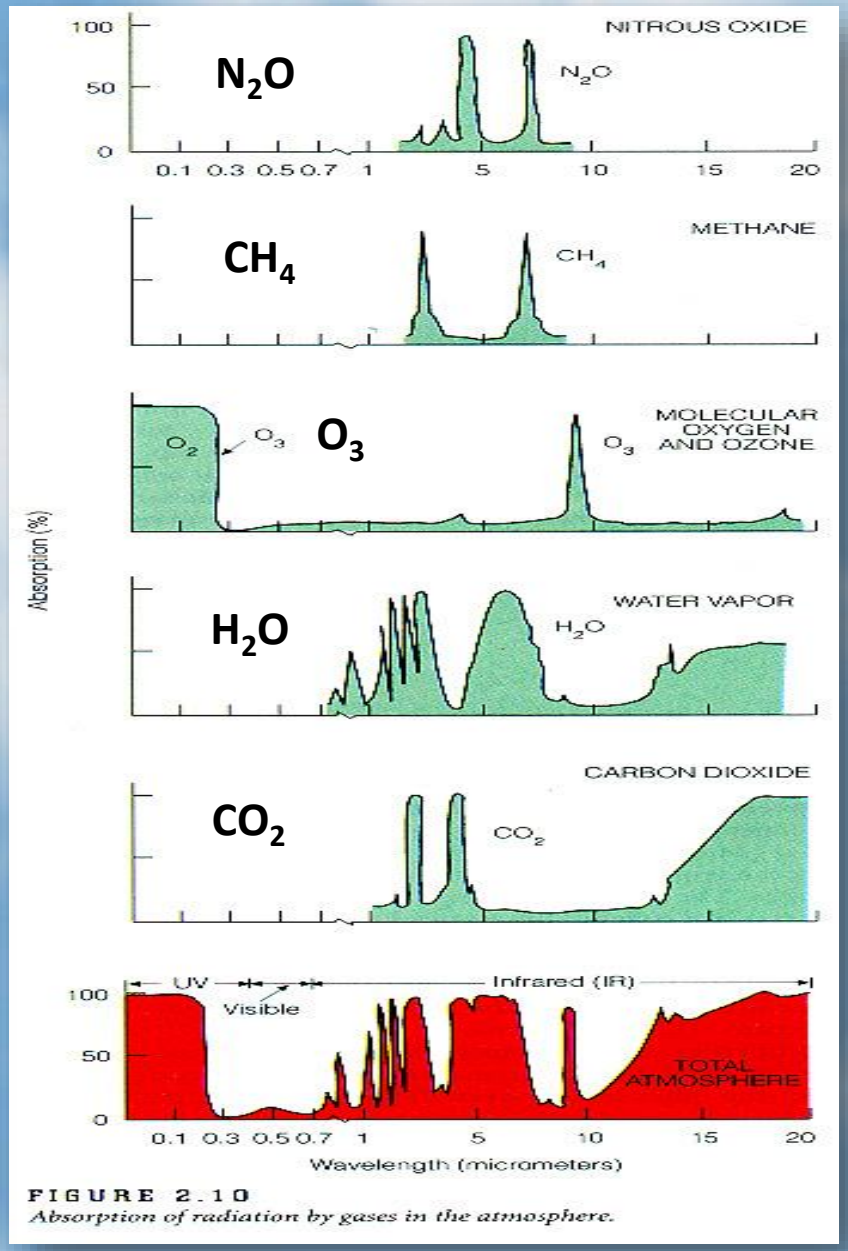


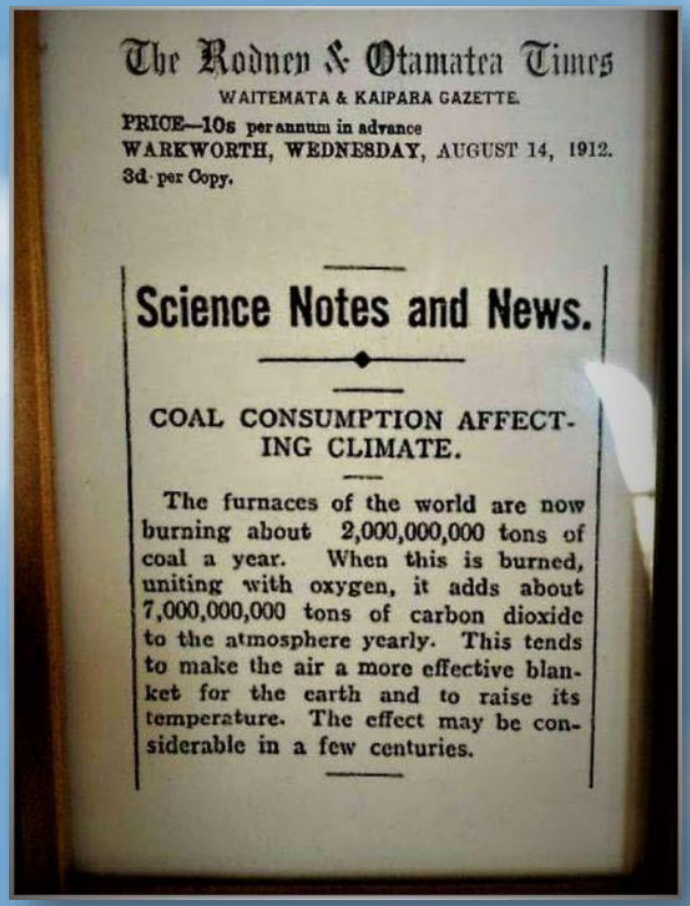
FIGURE 2.10
Absorption of radiation by gases in the atmosphere.

Em 1896, a primeira previsão climática: Svante Arrhenius

Arrhenius

Arrhenius quantificou em 1896 as mudanças na temperatura da superfície (aprox. 5 C) que deveriam ocorrer se dobrássemos a concentração de CO_2, baseado nos conceito do efeito "glass bowl" introduzido em 1824 por Joseph Fourier.

Matéria de jornal de 1912!!!



The Rodney & Otamatea Times

WAITEMATA & KAIPARA GAZETTE.

PRICE—10s per annum in advance

WARKWORTH, WEDNESDAY, AUGUST 14, 1912.

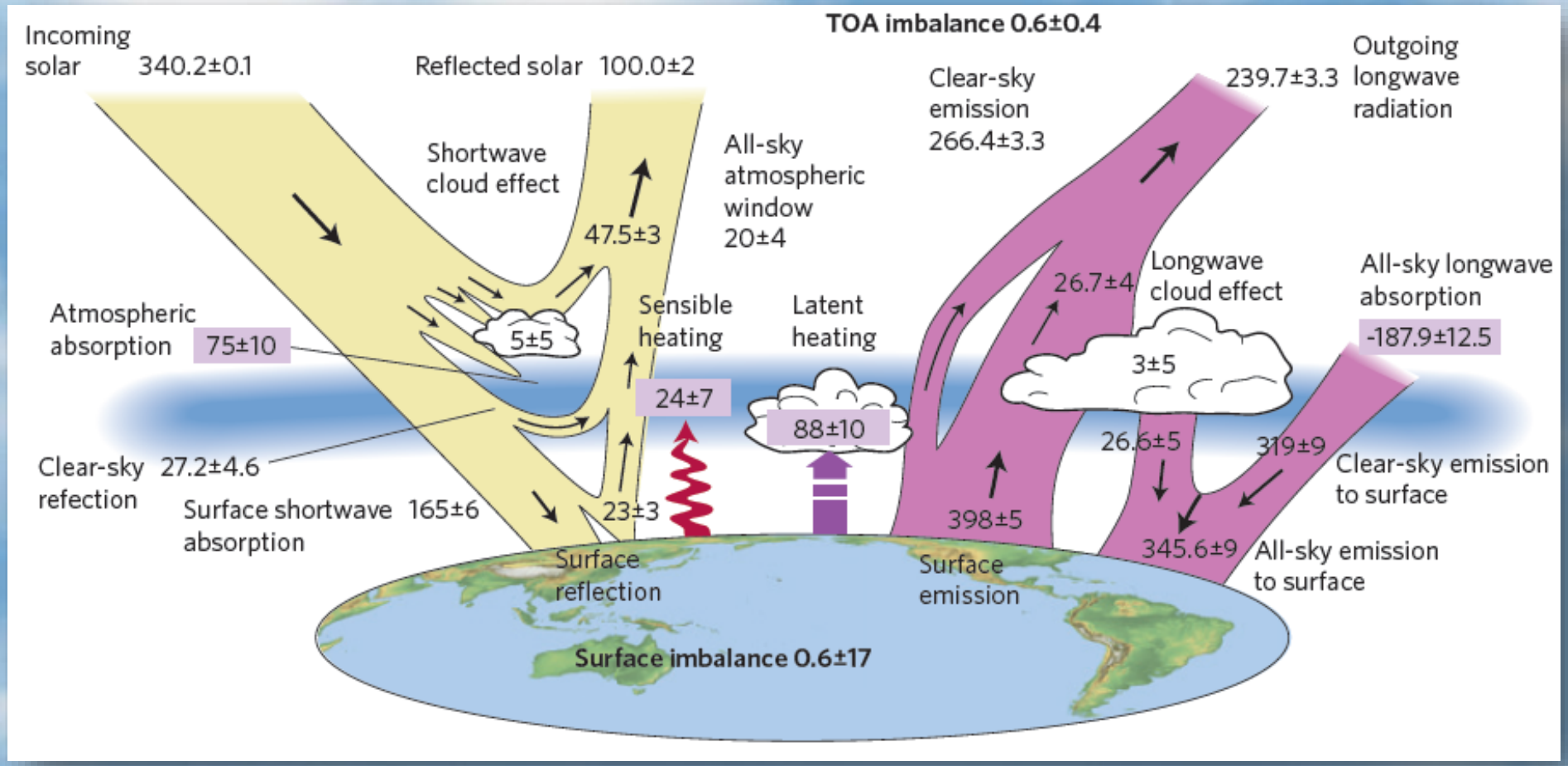
3d. per Copy.

Science Notes and News.

COAL CONSUMPTION AFFECTING CLIMATE.

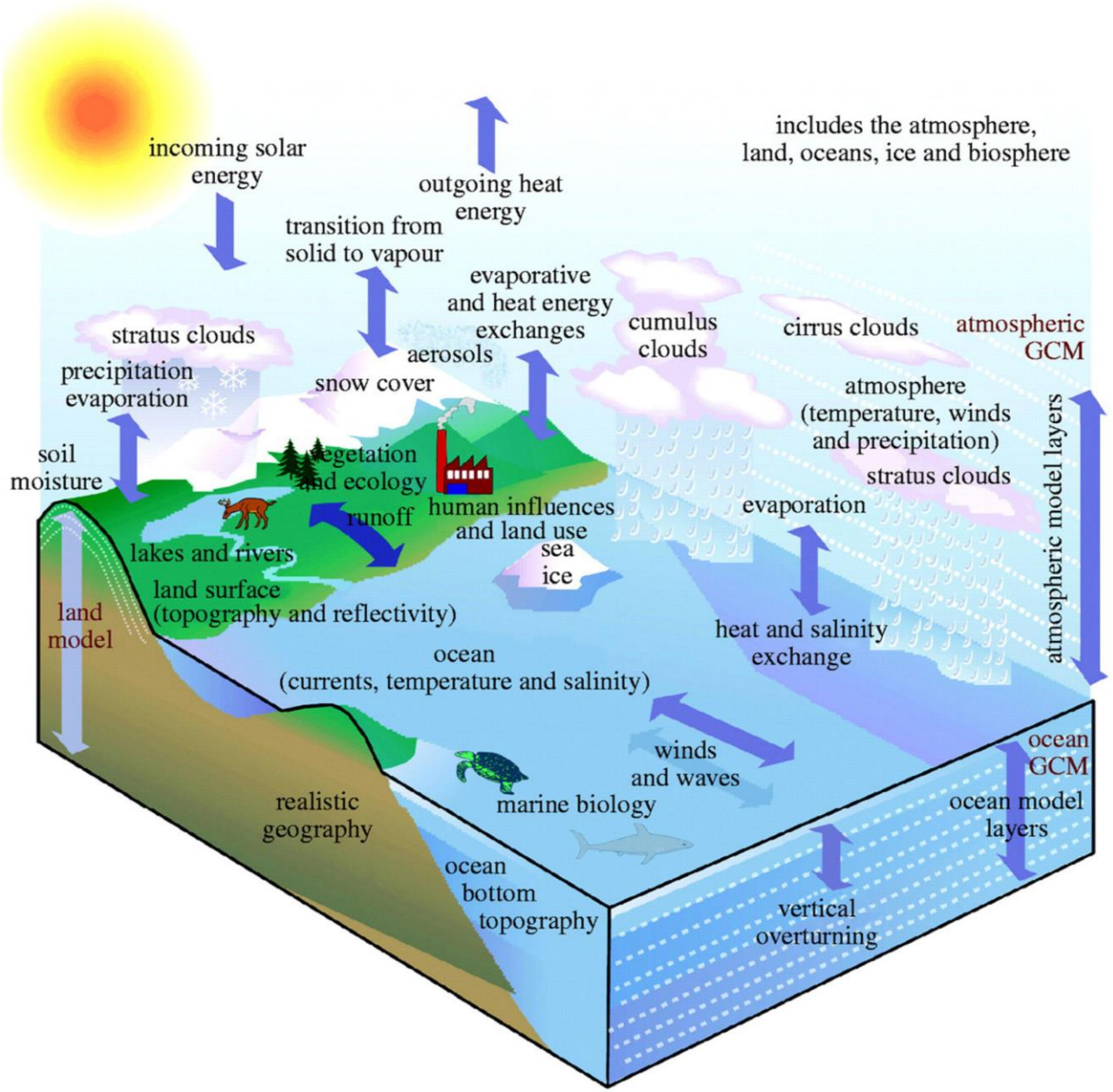
The furnaces of the world are now burning about 2,000,000,000 tons of coal a year. When this is burned, uniting with oxygen, it adds about 7,000,000,000 tons of carbon dioxide to the atmosphere yearly. This tends to make the air a more effective blanket for the earth and to raise its temperature. The effect may be considerable in a few centuries.

Balanço de energia do sistema terrestre (w/m²)

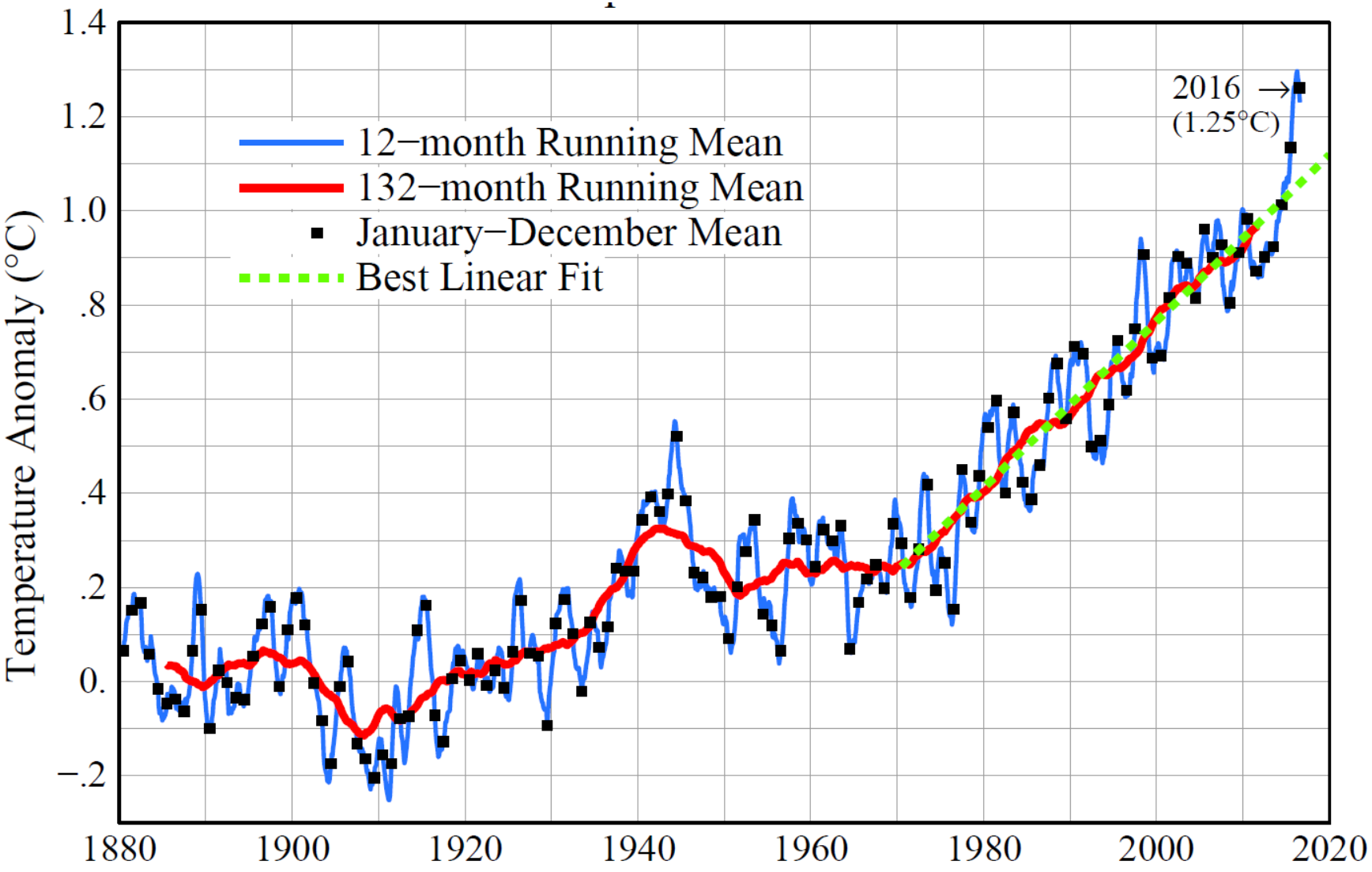


Stephens, Nature 2012

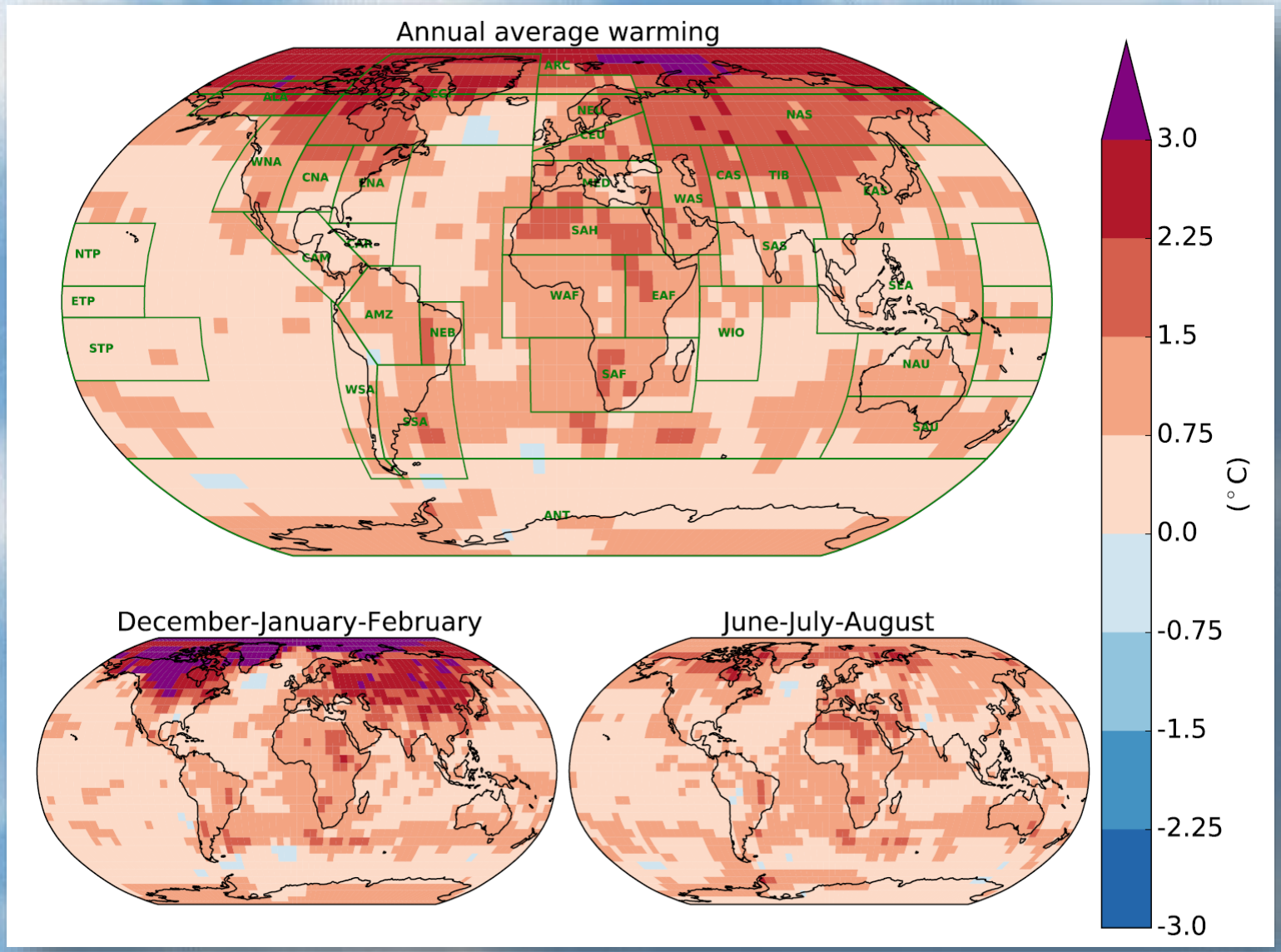
Estamos alterando o complexo sistema climático terrestre



Temperatura média global 1880-2017

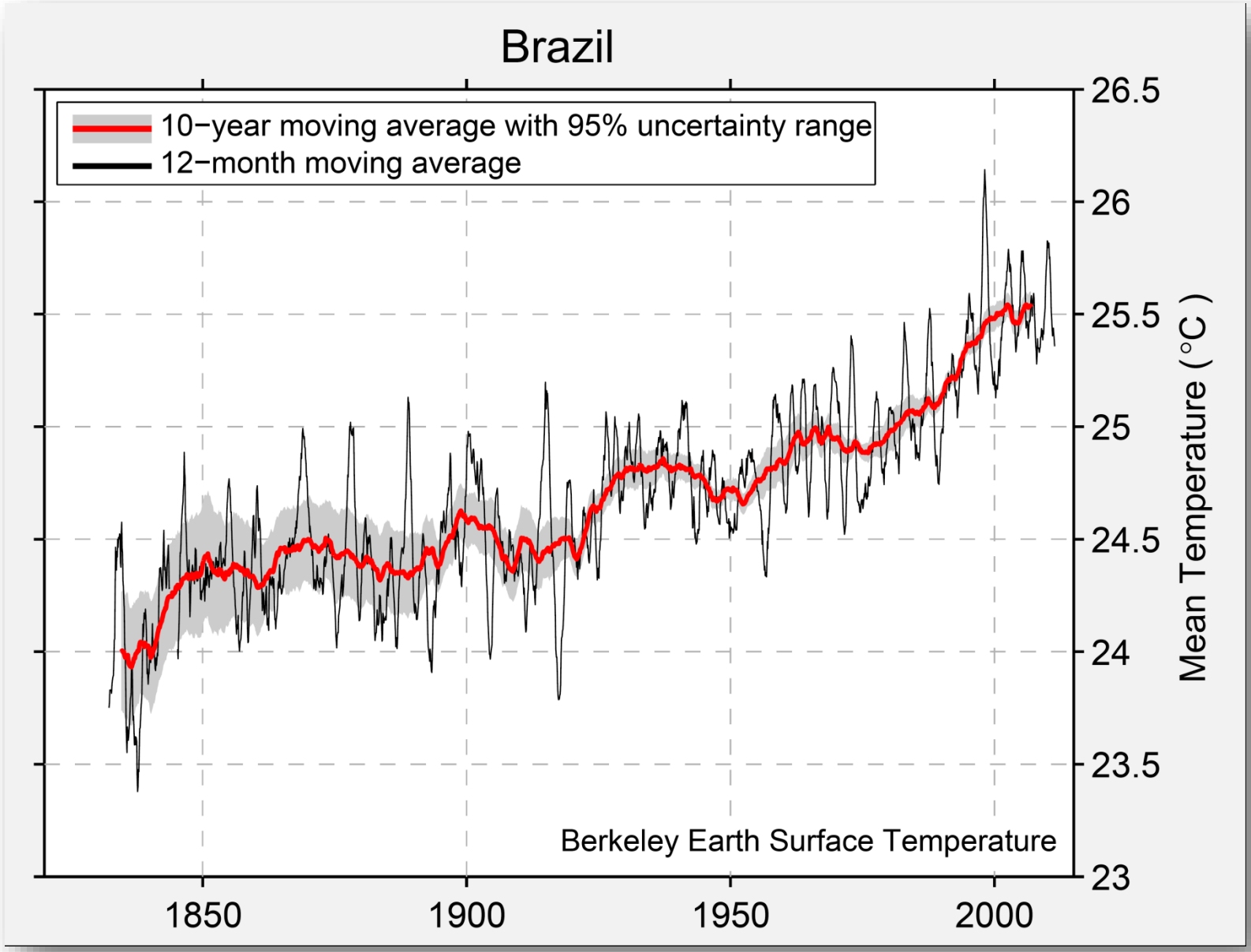


Aumento observado da temperatura 1901 a 2012



Source: IPCC 2018 Special Report on Global Warming of 1.5°C

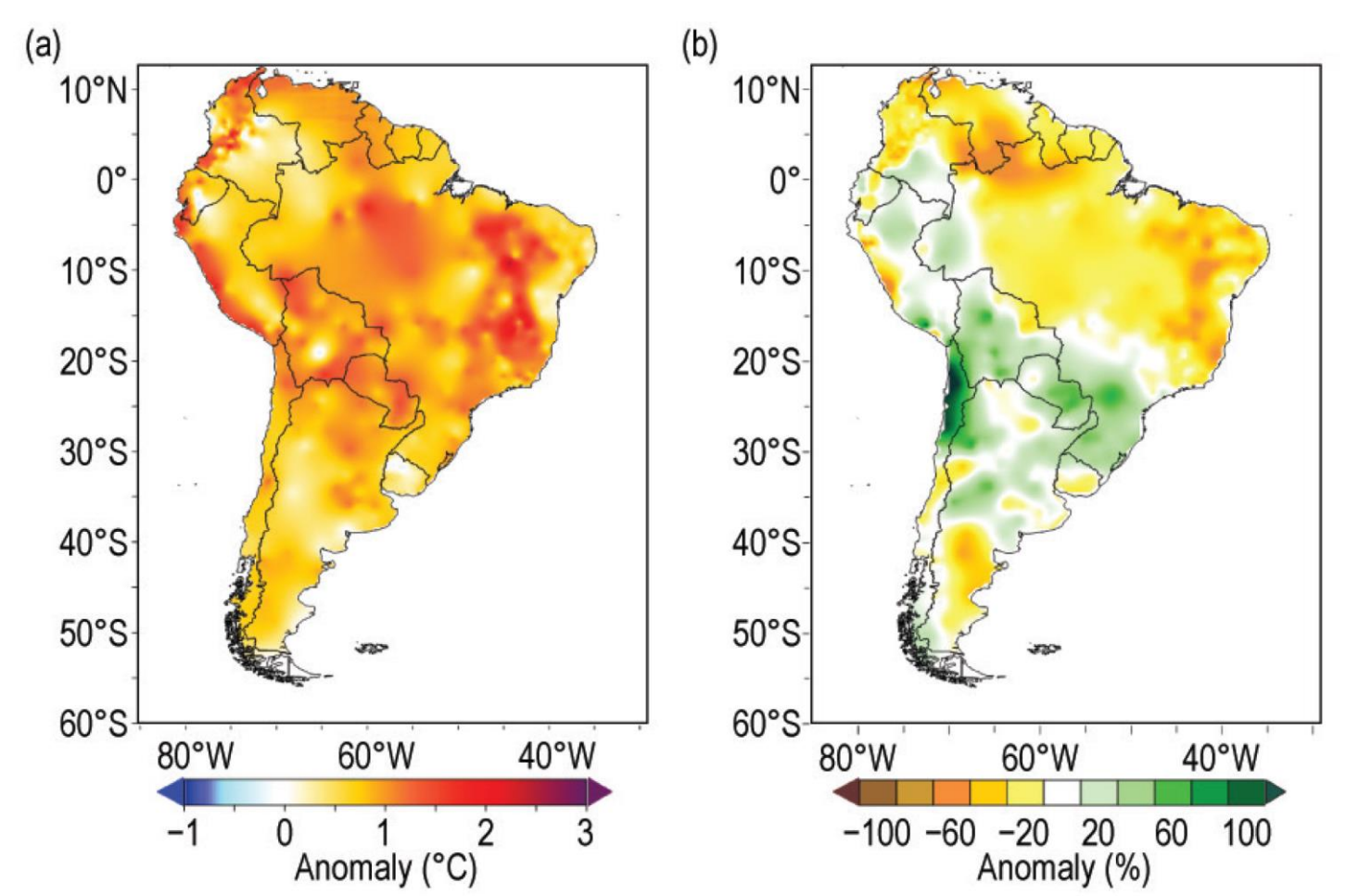
Aumento da temperatura média no Brasil



1.5 C

http://berkeleyearth.org/

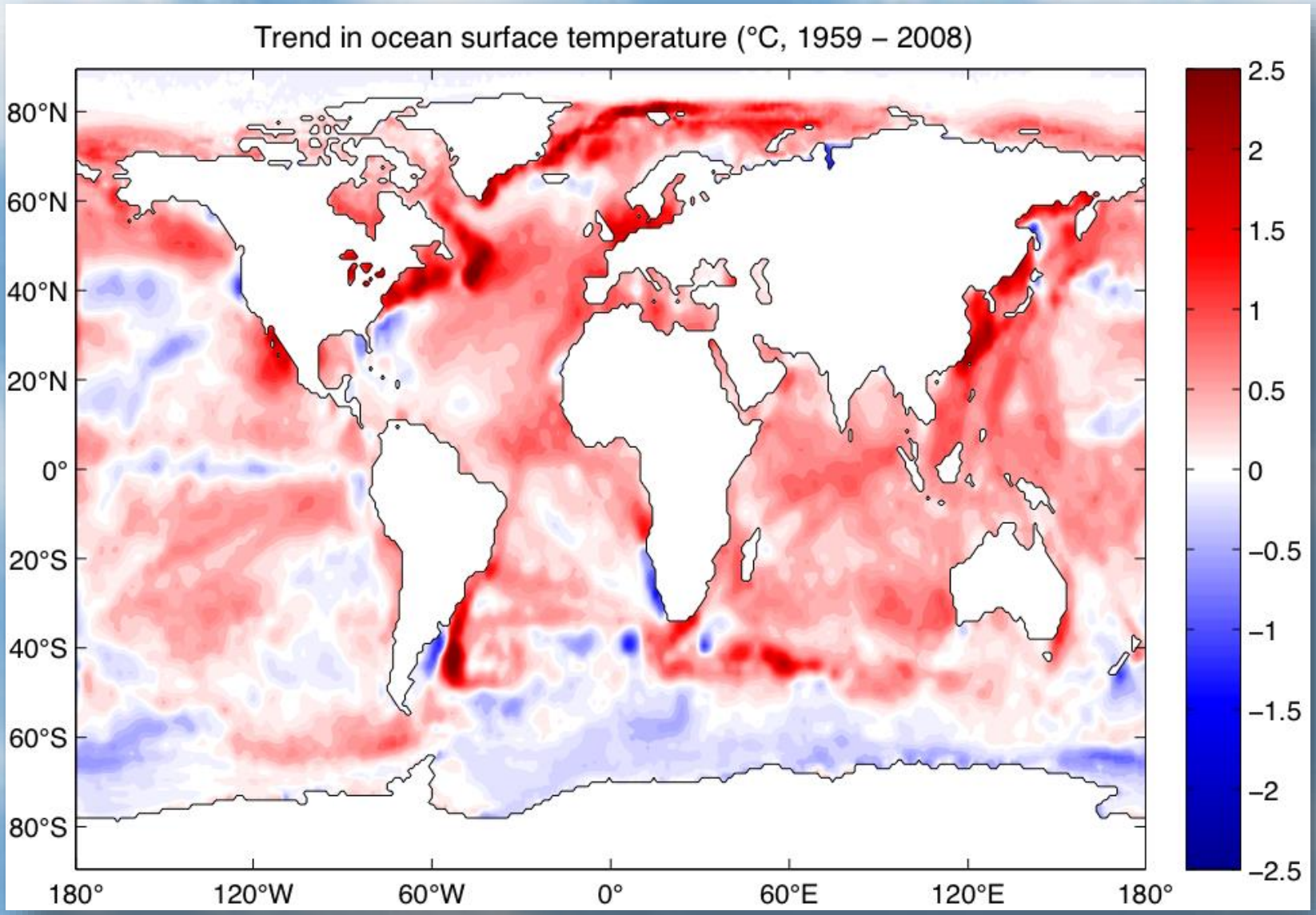
América do Sul: (a) anomalias de temperaturas (°C) e (b) anomalias de chuva (%)



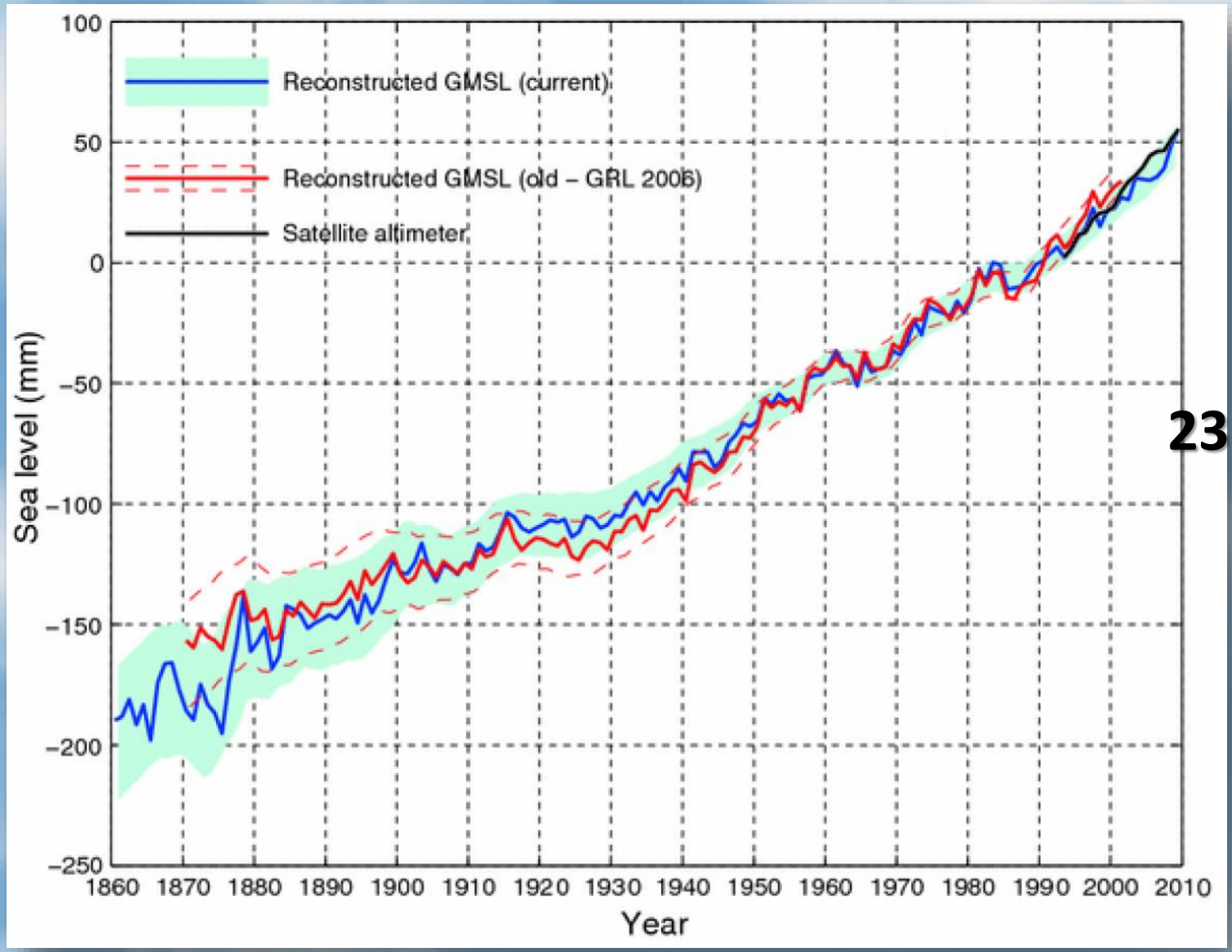
Período de base: 1981–2010.

Fonte: State of the Climate in 2015, Bull. Amer. Meteor. Soc., 97 (8), 2016.

Temperatura dos oceanos, também aumentando - 1959 - 2008



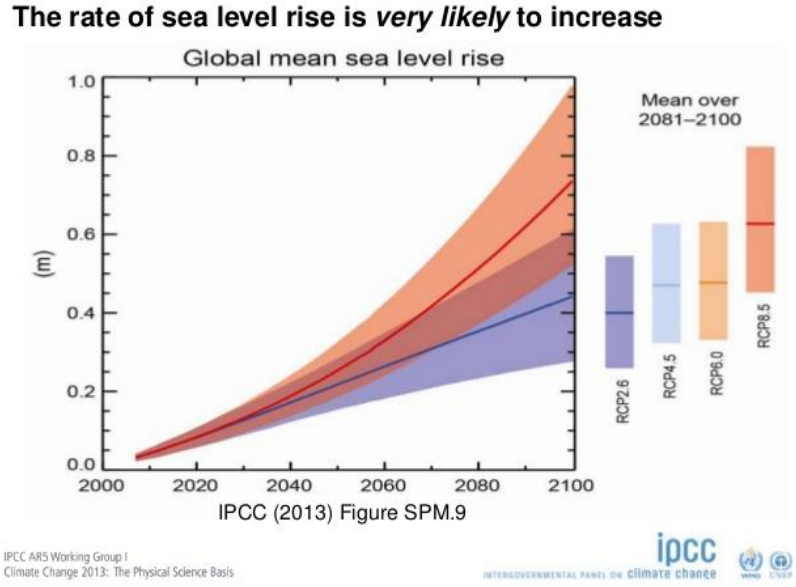
Nível médio dos oceanos subindo - 1860 a 2010



Global mean sea level (GMSL) reconstructed from tide gauge data (blue, red) and measured from satellite altimetry (black).

Source: Church and White (2011).

Cidades brasileiras em risco pelo aumento do nivel do mar



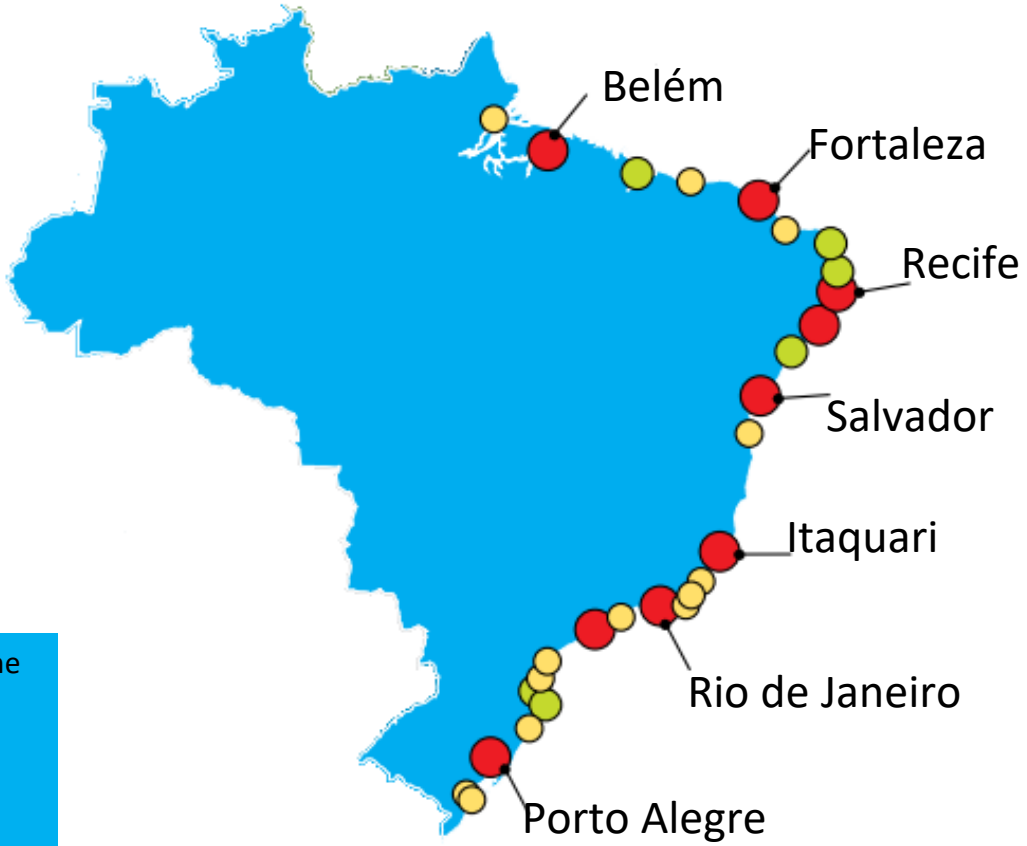
In the 20th century, sea levels rose by an estimated 23 cm, and the conservative global mean projections for sea-level rise between 1990 and 2080 range from 22 cm to 100 cm.

Oceans, which have been absorbing 80% of the temperature increase attributable to global warming, are expanding as ice sheets in the North and South poles melt.

These events have led to a rise in sea levels and increased flooding in coastal cities.

The projected rise in sea levels could result in catastrophic flooding of coastal cities.

Thirteen of the world's 20 megacities are situated along coastlines.



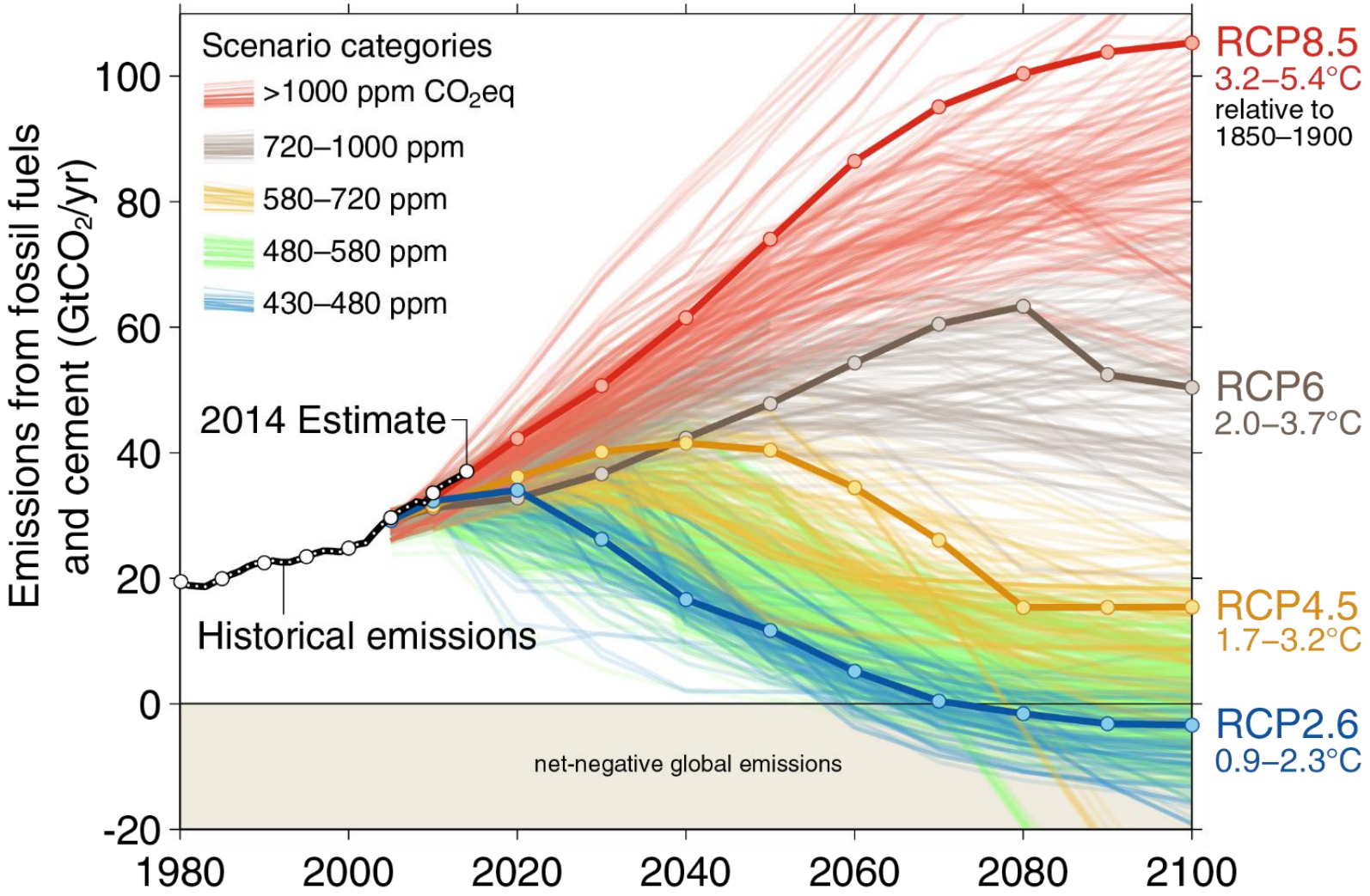
Source: *UN-HABITAT* Global Urban Observatory 2008 (adapted)

Emissões observadas e cenários futuros

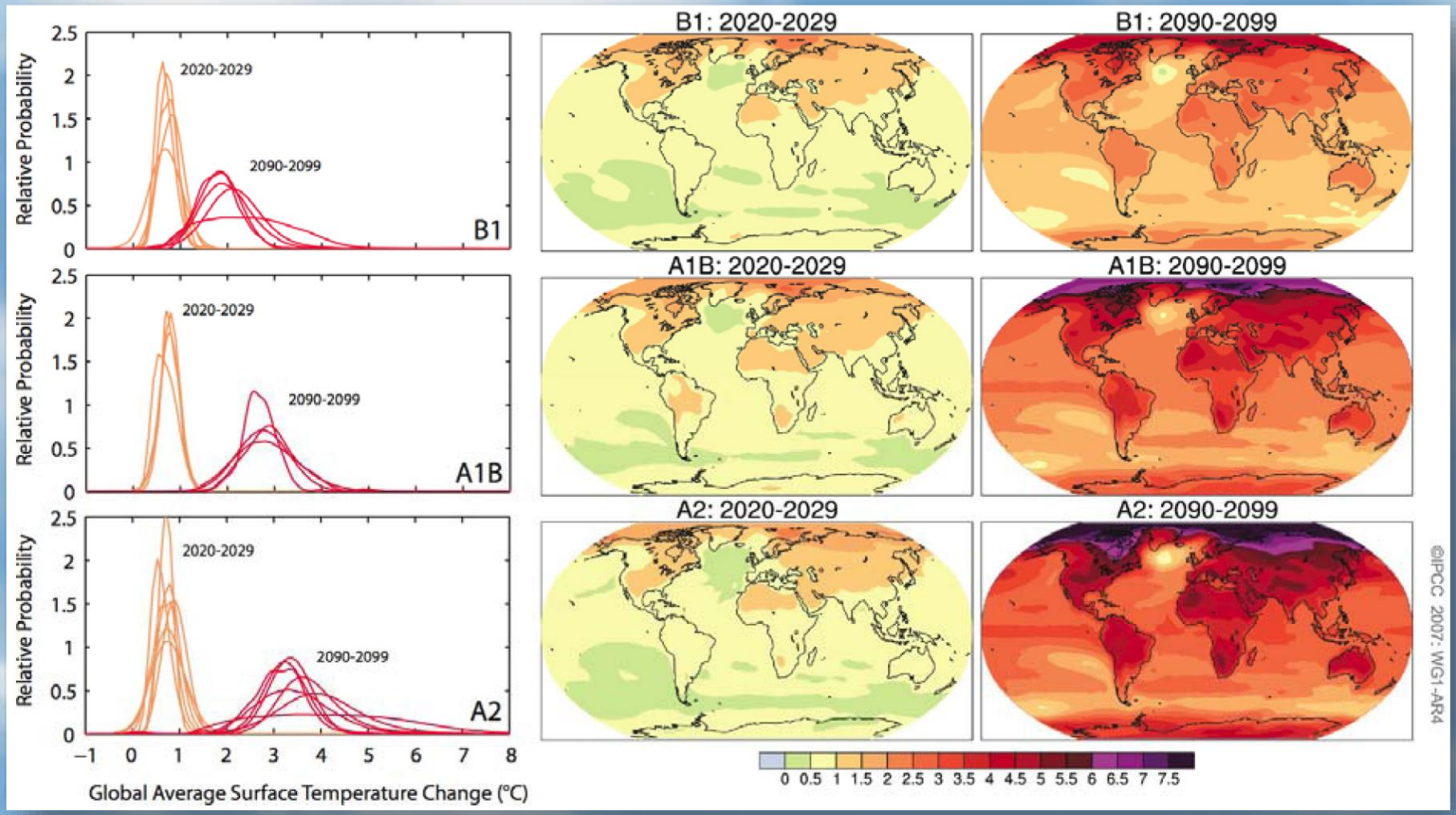
As emissões estão a caminho de um aumento de 3.2–5.4ºC acima de valores pré-industriais

Forte e contínua mitigação são necessários para a meta de 2ºC

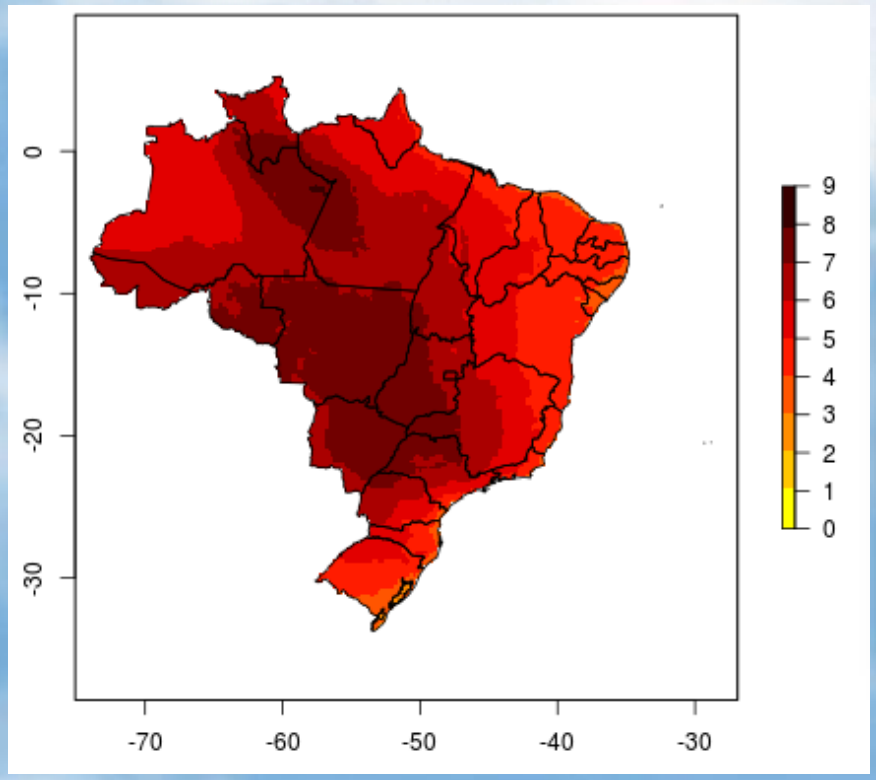
Source: Fuss et al 2014



Estimativas do aumento da temperatura para 2029 e 2099 de acordo com 3 cenários de emissões

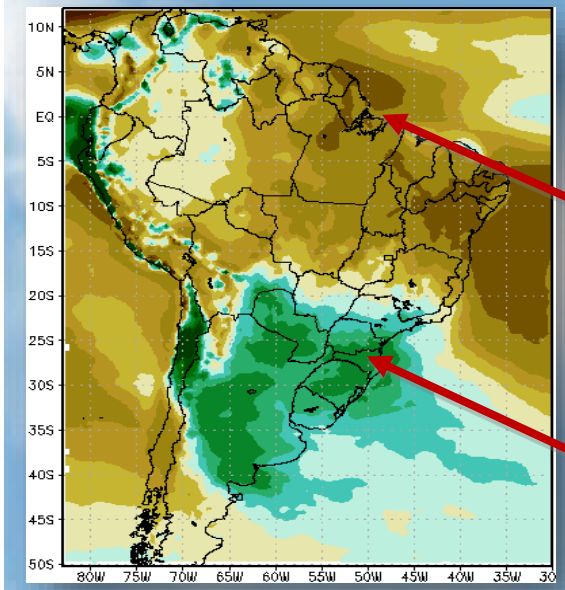


Aumento médio de temperatura esperado para o Brasil 2071-2099



Áreas continentais se aquecem mais que áreas oceânicas

Mudança na precipitação esperada para o Brasil 2071-2100



Mudanças na chuva (%) em 2071-2100 relativo a 1961-90.

Amazonia e Nordeste do Brasil → redução de chuvas

Sudeste da America do Sul → aumento nas chuvas

INPE, (RCP 8.5)

Forum Econômico Mundial: Relatório Riscos Globais 2019

5 Maiores riscos em **termos de probabilidade**

2017	2018	2019
Extreme weather events	Extreme weather events	Extreme weather events
Large-scale involuntary migration	Natural disasters	Failure of climate-change mitigation and adaptation
Major natural disasters	Cyber-attacks	Natural disasters
Large-scale terrorist attacks	Data fraud or theft	Data fraud or theft
Massive incident of data fraud/theft	Failure of climate-change mitigation and adaptation	Cyber-attacks

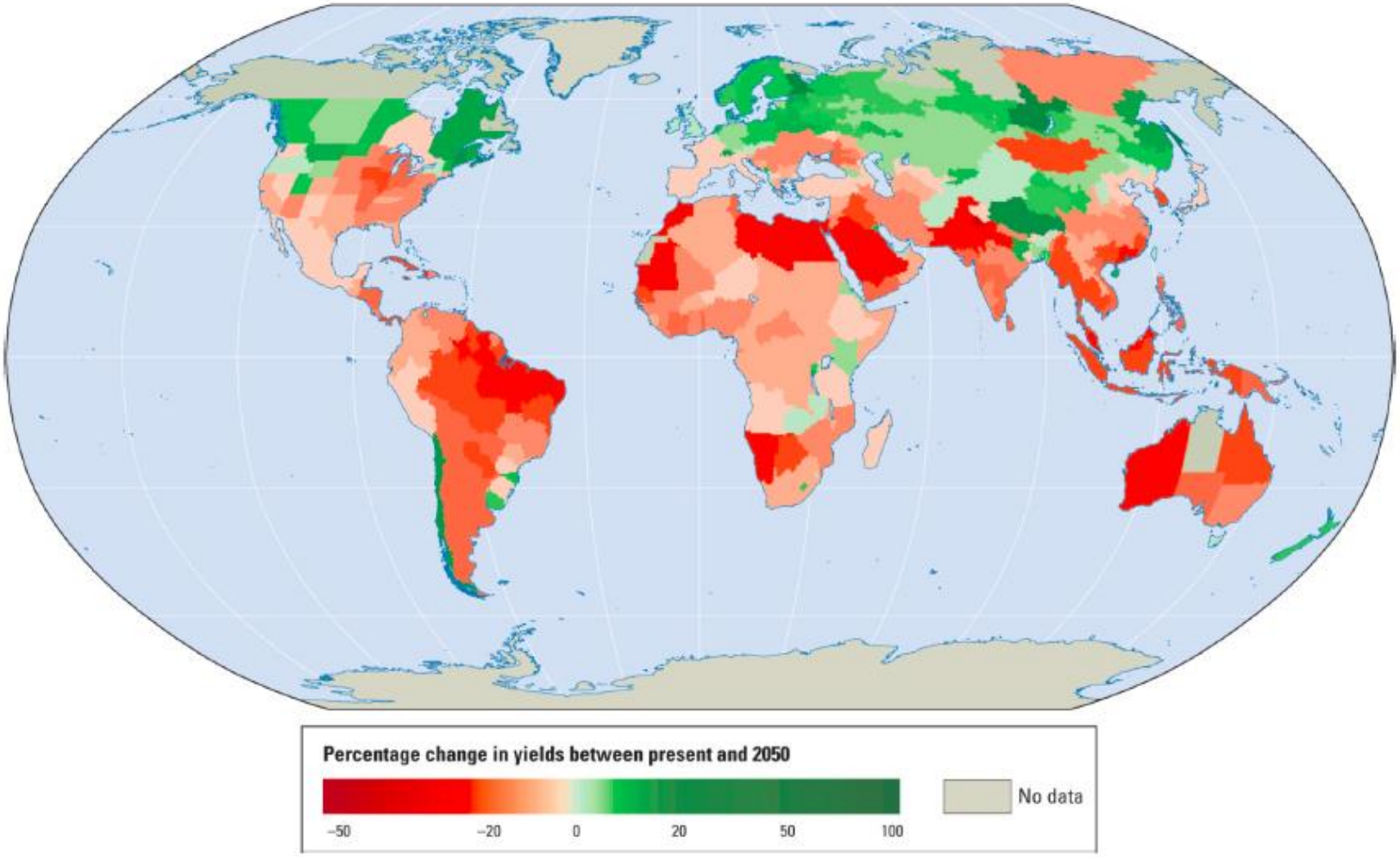
5 maiores riscos globais em **termos de impactos**

2017	2018	2019
Weapons of mass destruction	Weapons of mass destruction	Weapons of mass destruction
Extreme weather events	Extreme weather events	Failure of climate-change mitigation and adaptation
Water crises	Natural disasters	Extreme weather events
Major natural disasters	Failure of climate-change mitigation and adaptation	Water crises
Failure of climate-change mitigation and adaptation	Water crises	Natural disasters

Economic Environmental Geopolitical Societal Technological

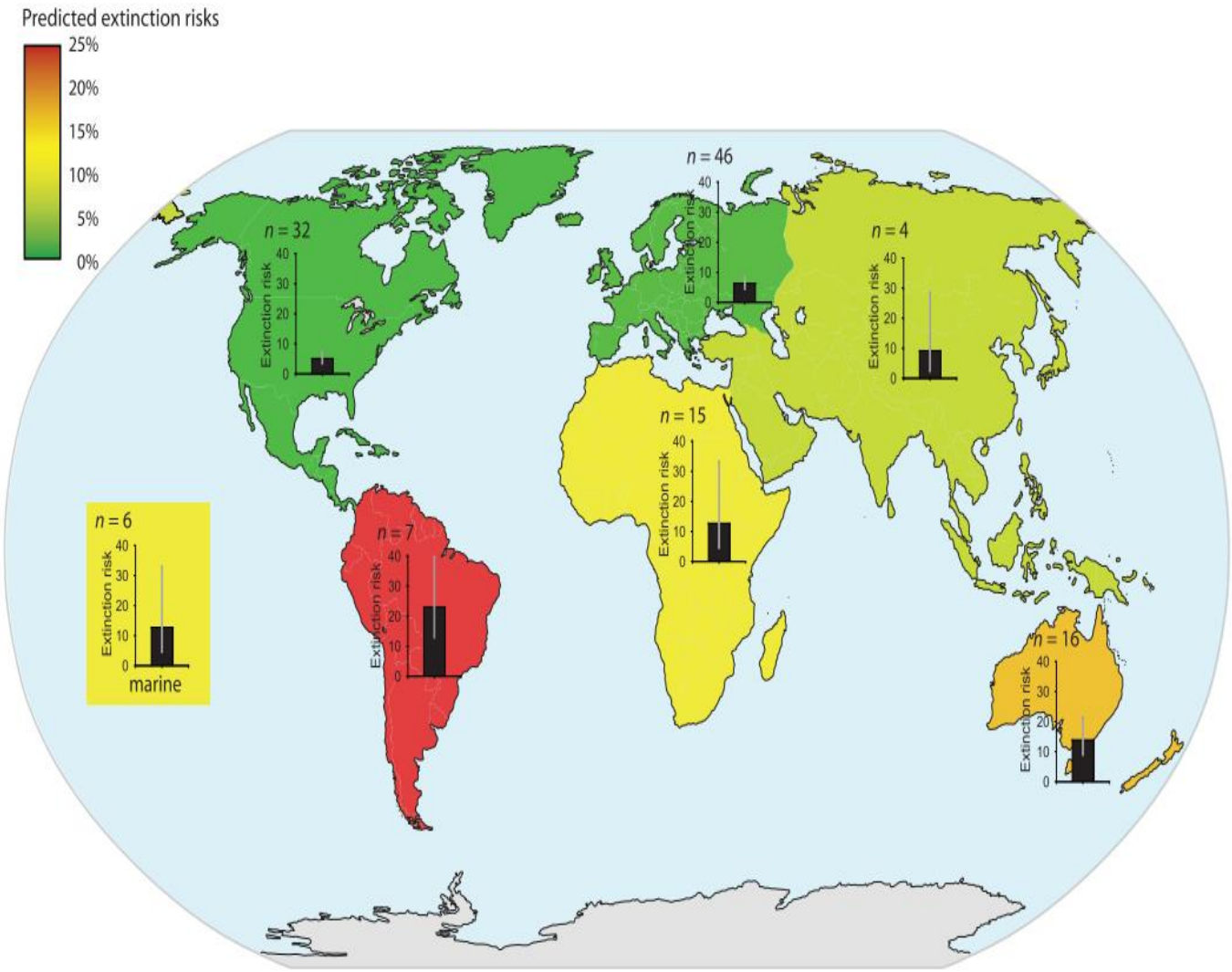
Importante: São questões levantadas por economistas. Não são cientistas ou de ONGs.

Impactos na produção de alimentos em um planeta 3°C mais quente



World Economic Forum: Global Risks 2016

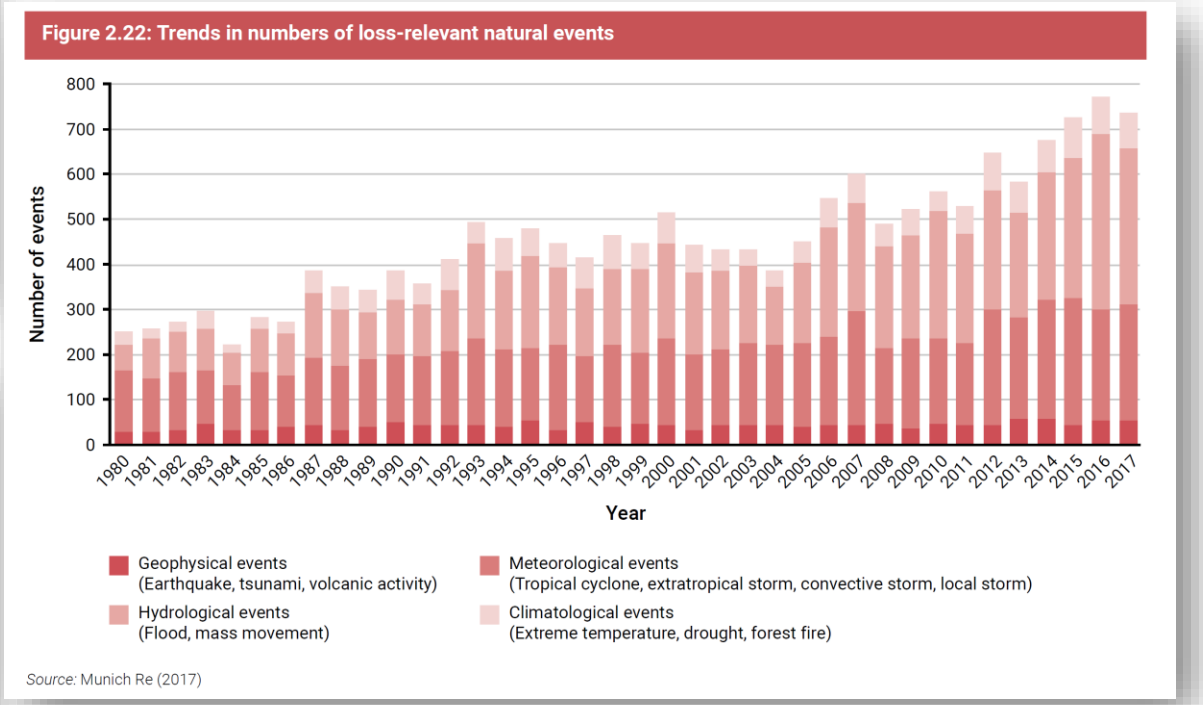
Risco de perdas de espécies biológicas



Os maiores riscos: América do Sul, Austrália (14 a 23%)

Fonte: Urban M.C-Nature, 2015

Riscos: Aumento na intensidade e frequencia de eventos climáticos extremos



Já está ocorrendo desde a década de 80

Soluções

More efficient use of energy

Greater use of low-carbon and no-carbon energy

- Many of these technologies exist today
- Nearly a quadrupling of zero- and low-carbon energy supply from renewable energy by 2050

Improved carbon sinks

- Reduced deforestation and improved forest management and planting of new forests
- Bio-energy with carbon capture and storage

Lifestyle and behavioural changes

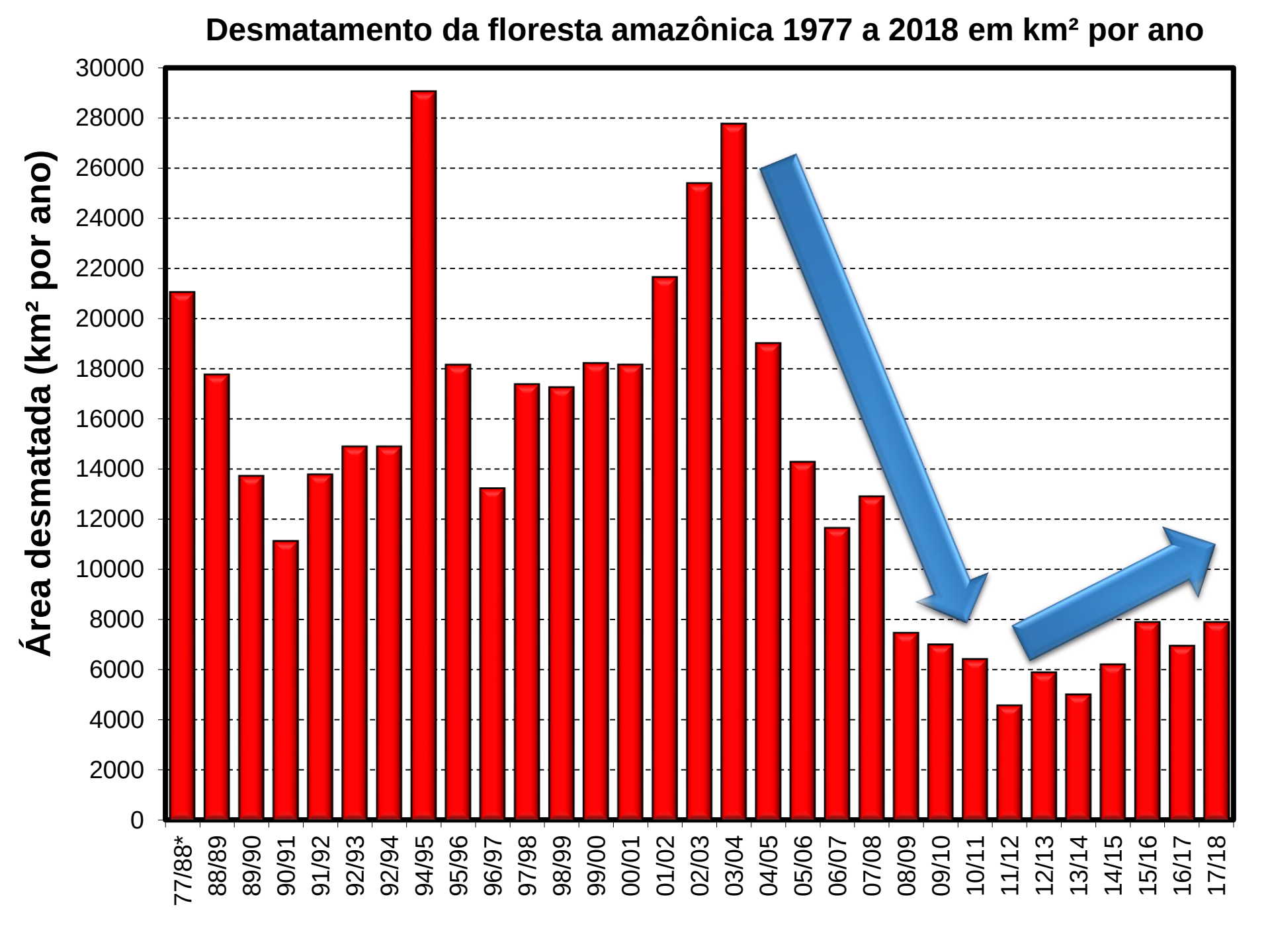
AR5

Produção de energia

Transporte

Agricultura

Biocombustíveis


Desmatamento da floresta amazônica 1977 a 2018 em km² por ano
Área desmatada (km² por ano)
30000
28000
26000
24000
22000
20000
18000
16000
14000
12000
10000
8000
6000
4000
2000
0
77/88*
88/89
89/90
90/91
91/92
92/93
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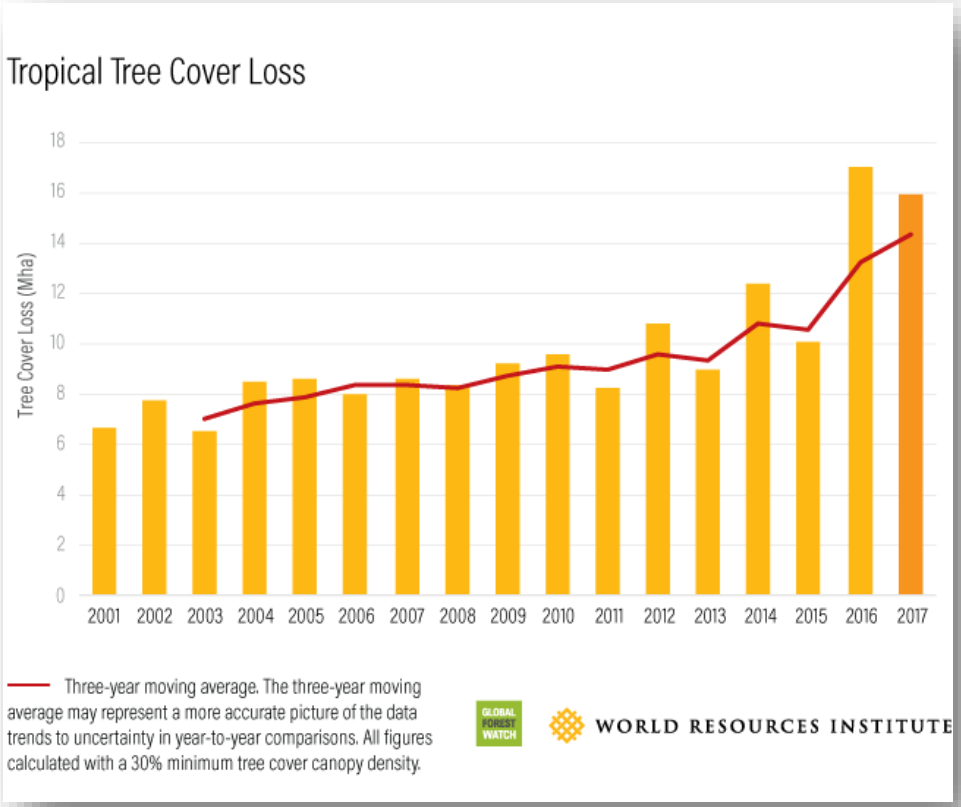
Desflorestamento tropical no planeta



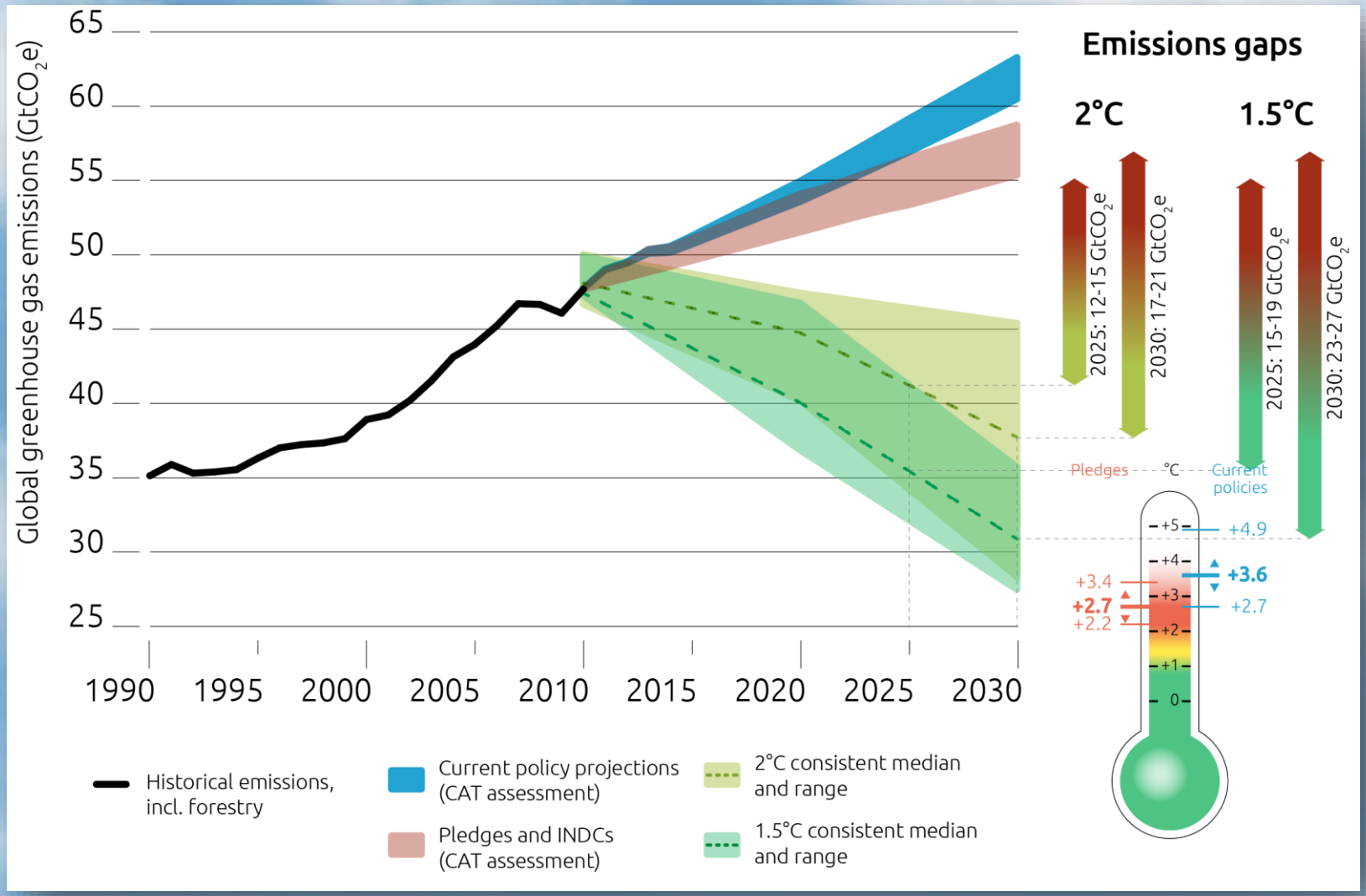
Os 10 países que mais desmataram em 2017

Os 17 objetivos do desenvolvimento sustentável adotados pela ONU

O desenvolvimento sustentável é definido como o desenvolvimento que procura satisfazer as necessidades da geração atual, sem comprometer a capacidade das futuras gerações de satisfazerem as suas próprias necessidades.

OBJETIVOS DE DESENVOLVIMENTO SUSTENTÁVEL
17 OBJETIVOS PARA TRANSFORMAR NOSSO MUNDO

Acordo de Paris: Compromisso de mais de 190 países da ONU



Que nível de emissão nos levam as políticas atuais (azul), as INDCs (rosa) e o que é preciso para ficar nos 2 graus (amarelo) e no 1,5 grau C (verde)

http://climateactiontracker.org/

Questões éticas

Encyclical Letter *LAUDATO SI' of Pope Francis (2015)*

I urgently appeal for a new dialogue about how we are shaping the future of our planet. We need a conversation which includes everyone, since the environmental challenge we are undergoing, and its human roots, concern and affect us all.

Depois da Rio-92, 24 reuniões das COPs, mais de 190 países endossaram o Acordo de Paris, com milhares de cientistas defendendo as reduções de emissões em seus países. Endosso também do Fórum Econômico Mundial, do Papa e das associações científicas do mundo todo.

Obrigado pela atenção!!!

Slides Extras