O DESAFIO DAS ALTERAÇÕES CLIMÁTICAS NOS SÉCULOS XXI E SEGUINTES

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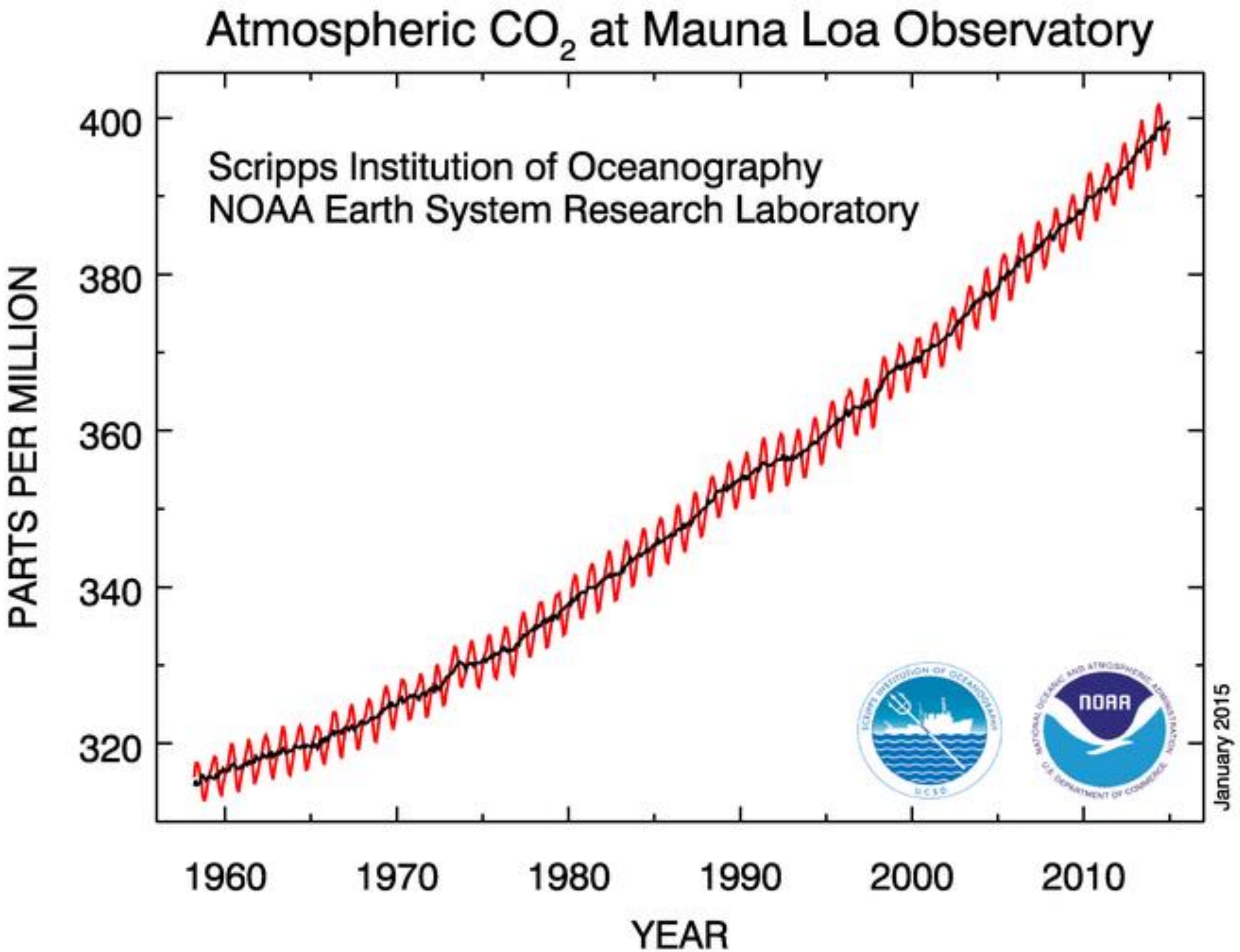
http://cciam.fc.ul.pt/

Sessão Comemorativa do Dia Mundial da Energia
Ordem dos Engenheiros e APREN

Lisboa, 29 de maio, 2018

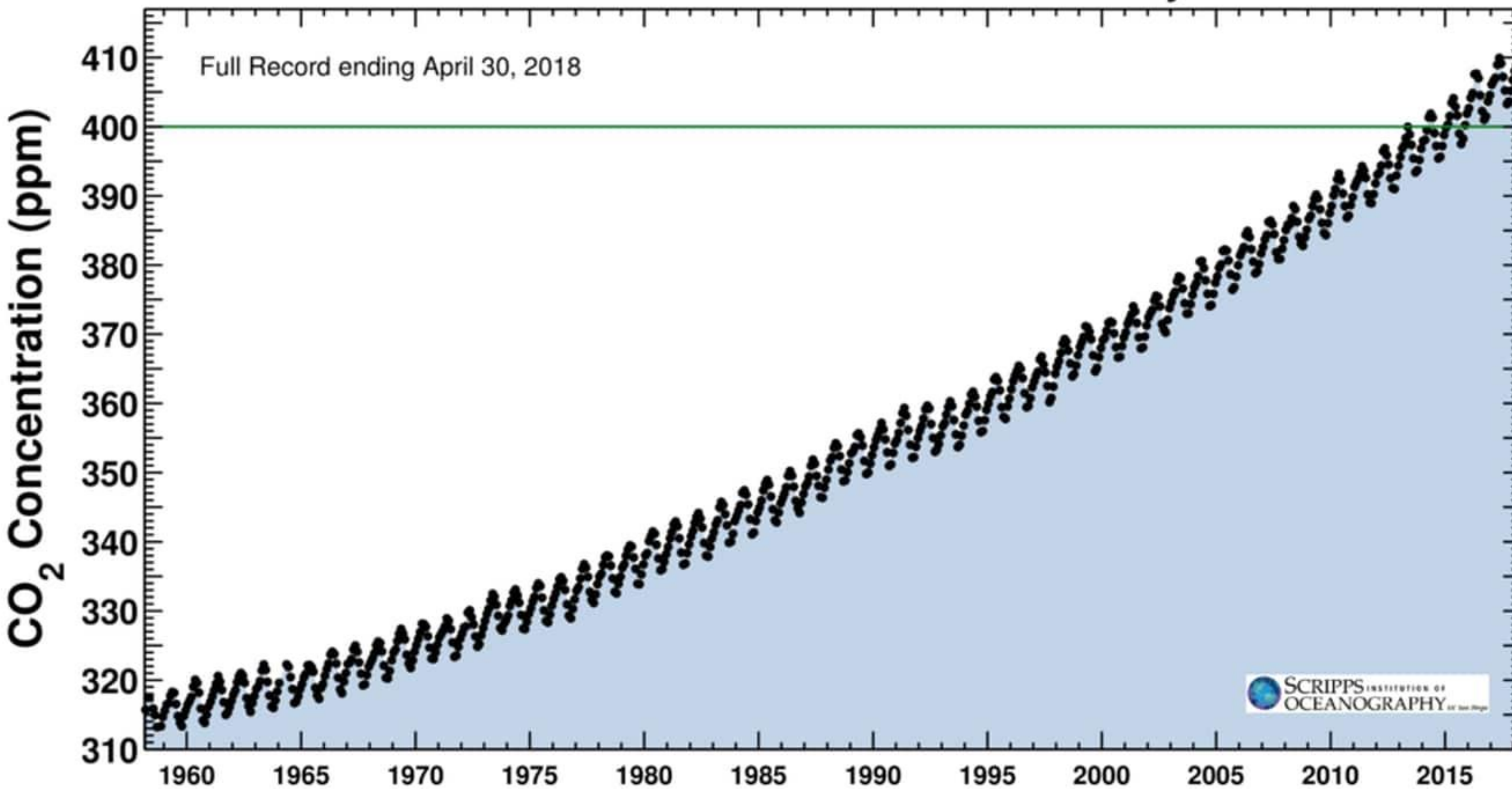
Concentração do dióxido de carbono aumentou de 42% desde o século XVIII



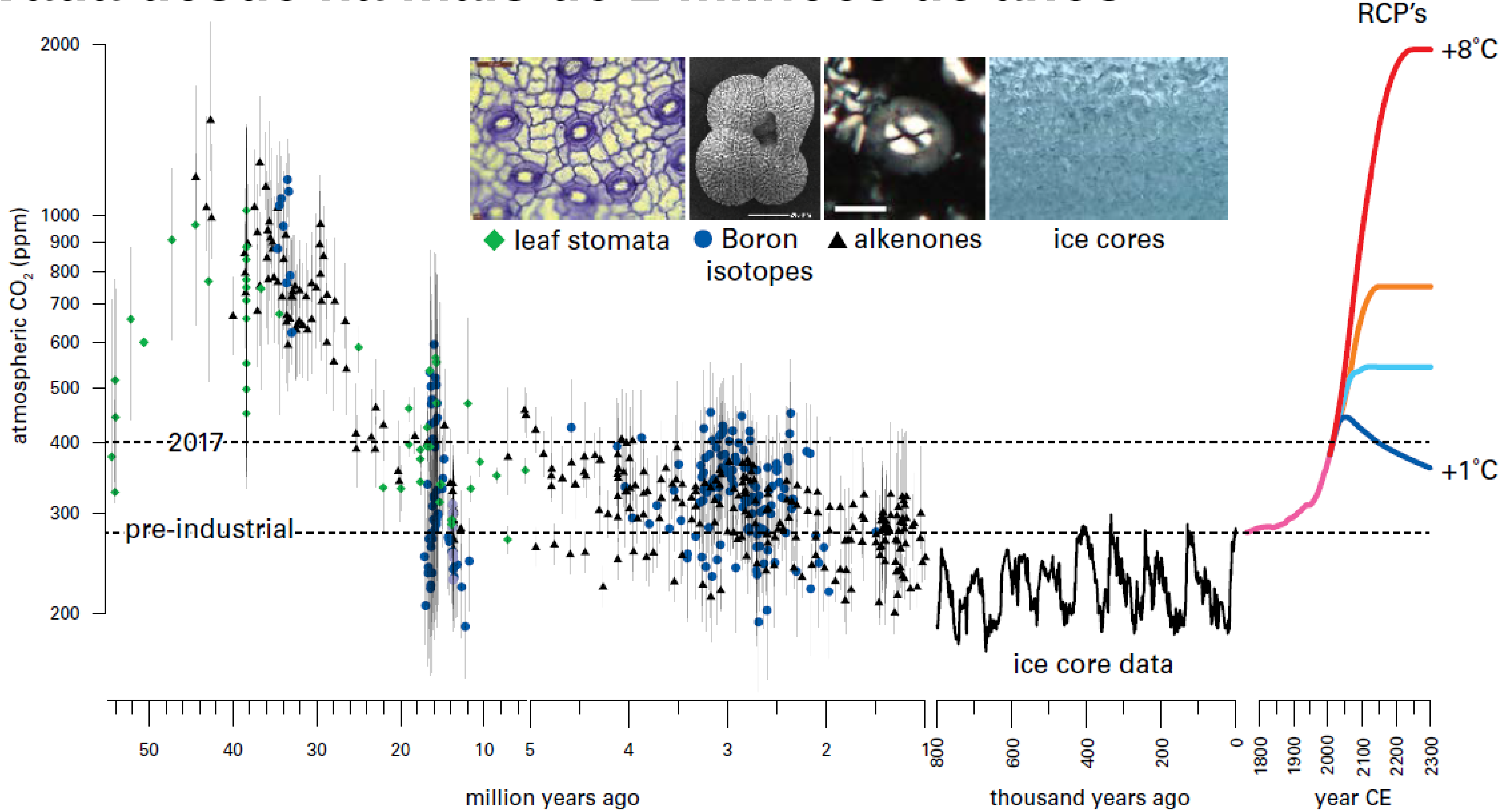
Latest CO_2 reading
April 29, 2018

411.24 ppm

Carbon dioxide concentration at Mauna Loa Observatory

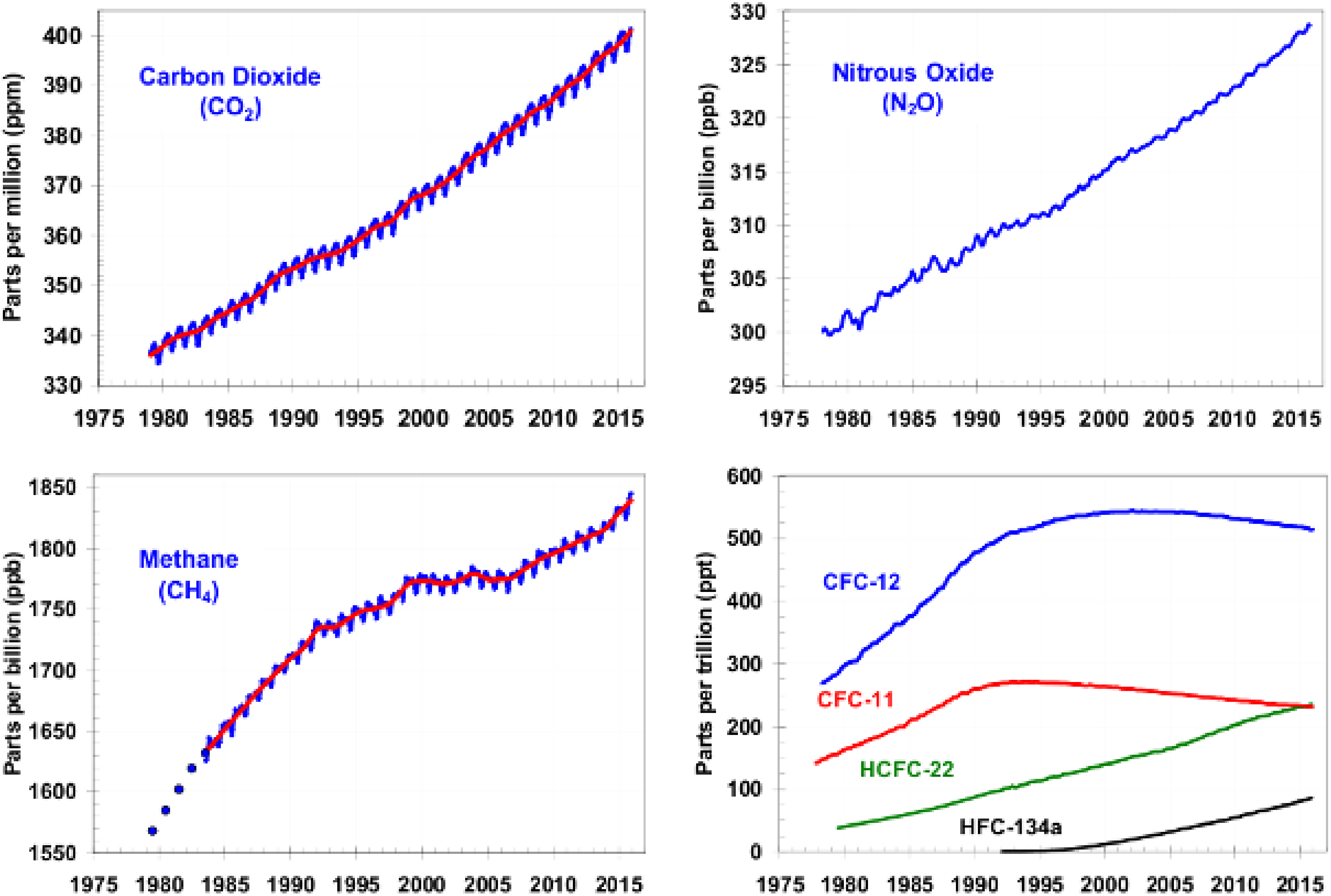


A concentração atmosférica atual (2017) de CO2 é a mais elevada desde há mais de 2 milhões de anos



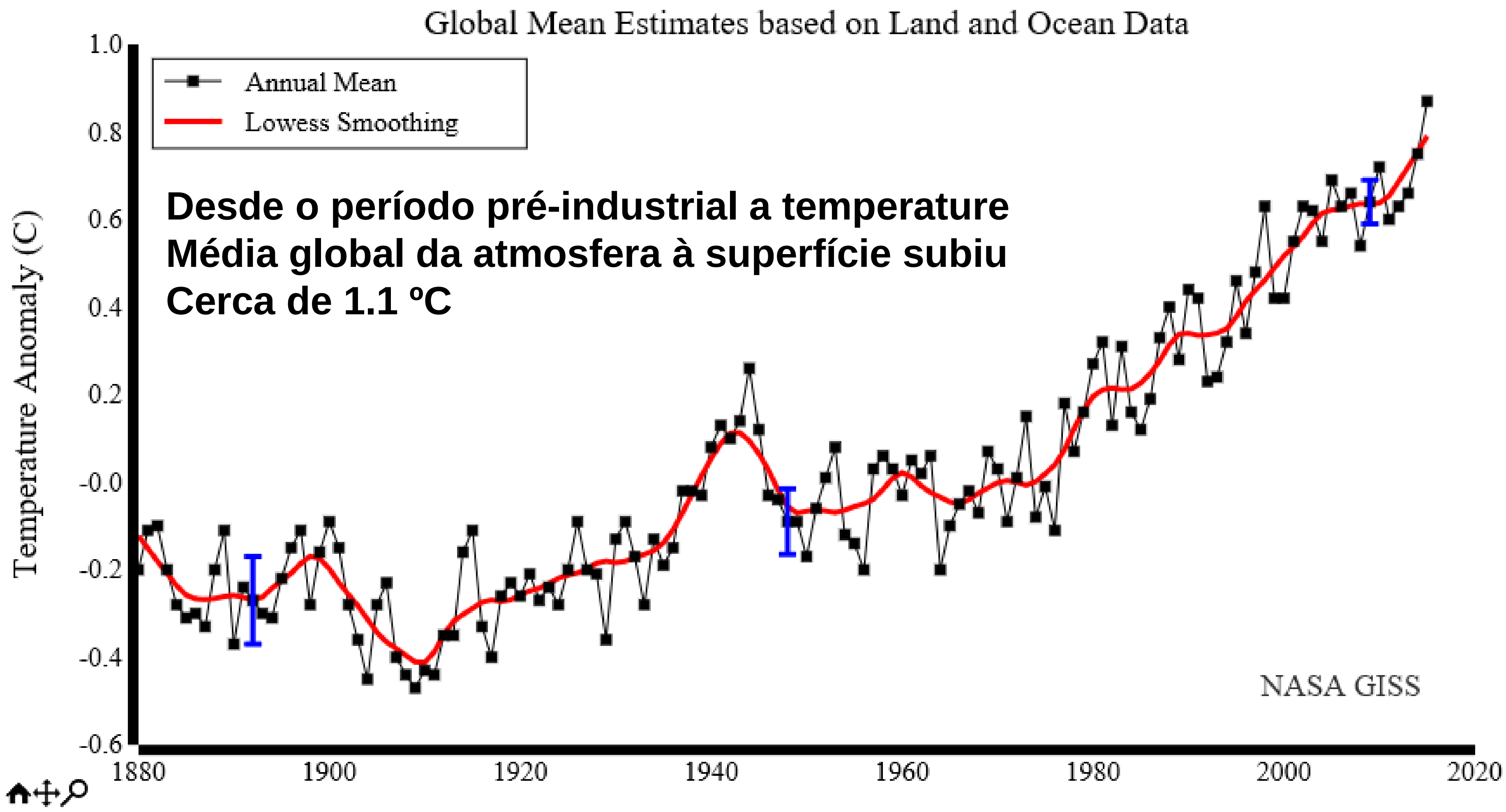
Reconstituição por meio de estudos de paleoclimatologia

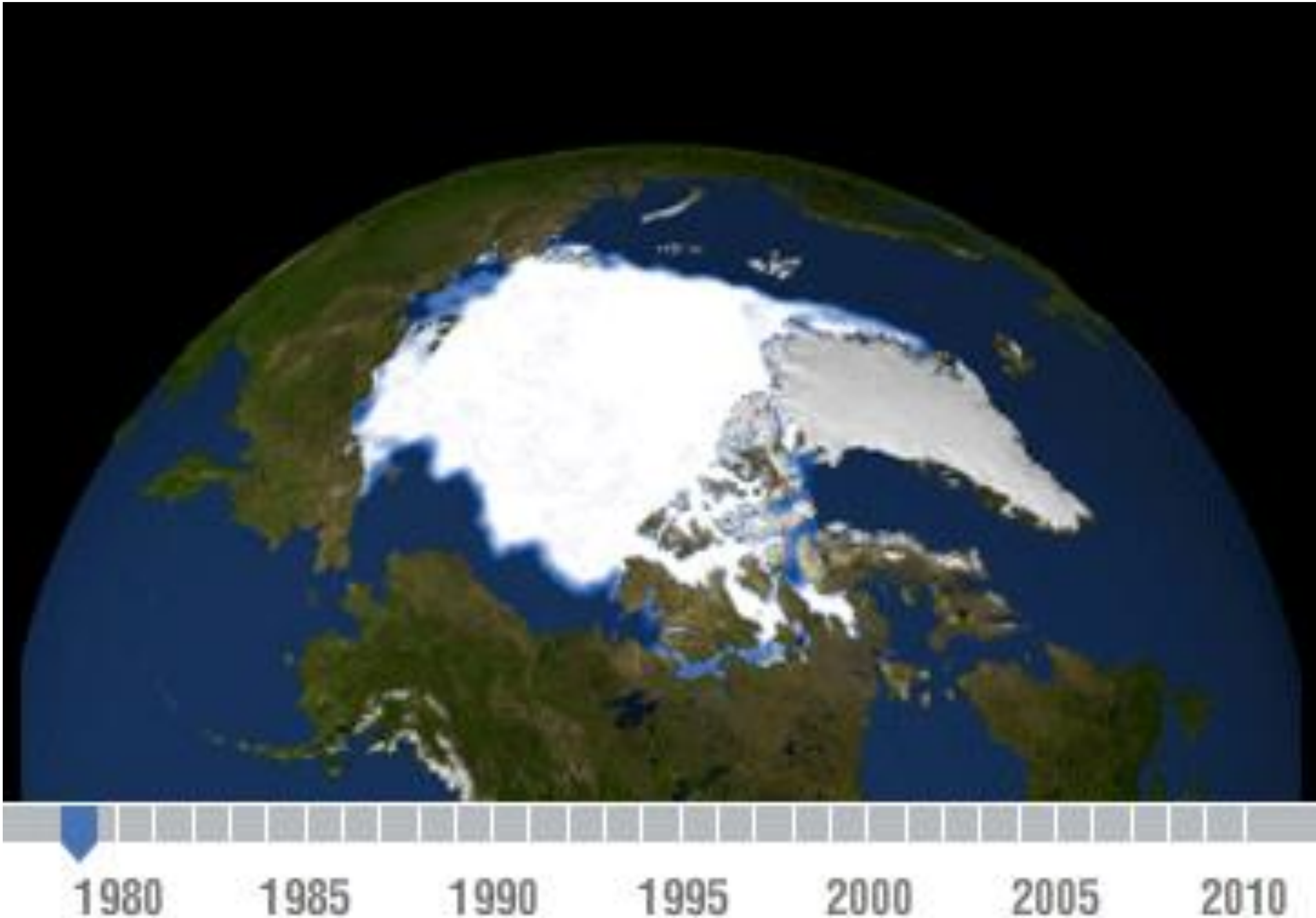
Reconstructions of atmospheric CO_2 over the past 55 million years are generated from proxy data that include boron isotopes (blue circles), alkenones (black triangles) and leaf stomata (green diamonds). Direct measurements from the past 800 000 years are acquired from Antarctic ice cores and modern instruments (pink). Future estimates include representative concentration pathways (RCPs) 8.5 (red), 6 (orange), 4.5 (light blue) and 2.6 (blue). References for all data shown in this plot are listed in the extended version online (http://www.wmo.int/pages/prog/arep/gaw/ghg/ghg-bulletin13.html). CE = Common Era.

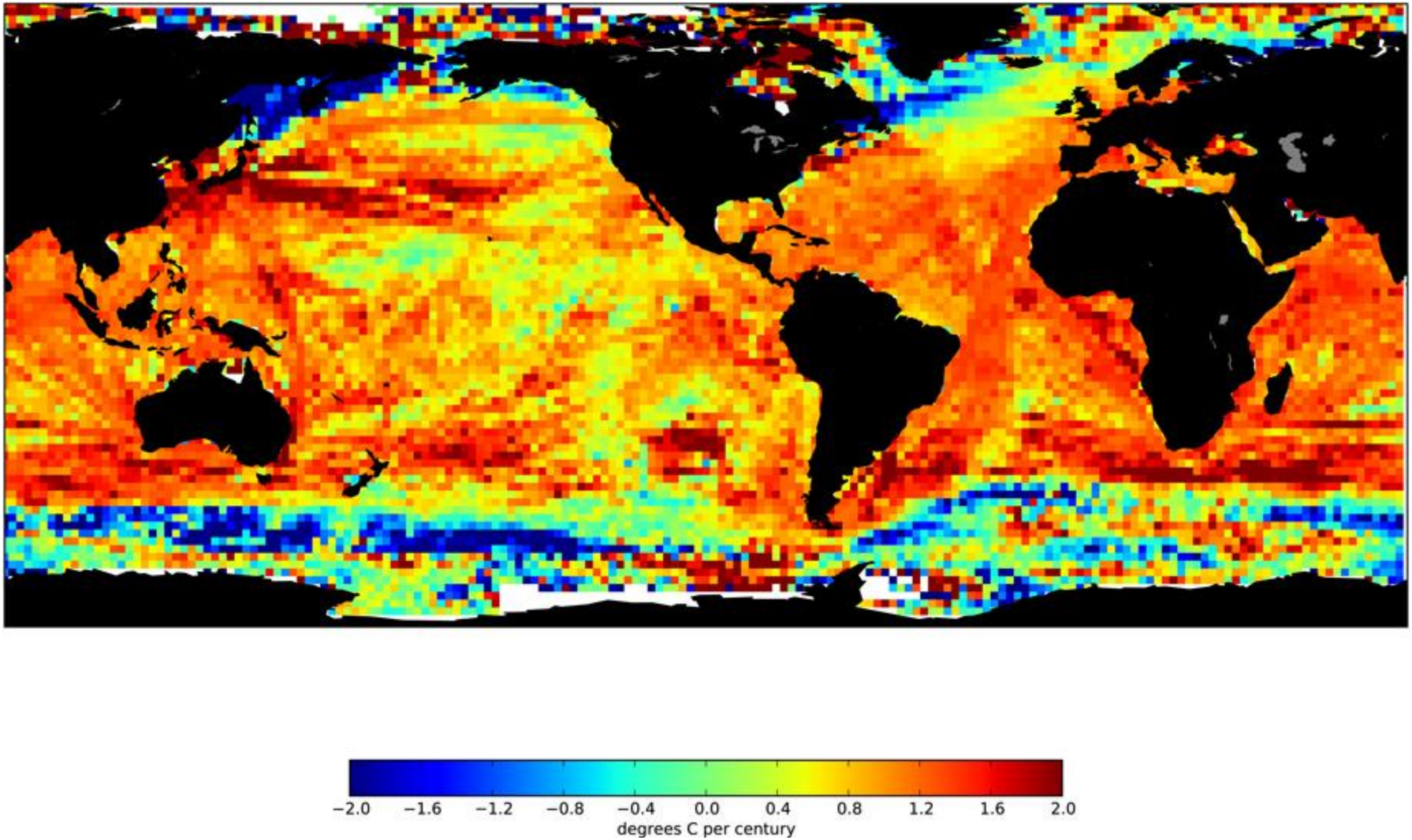

Carbon Dioxide
(CO_2)
Parts per million (ppm)
330
340
350
360
370
380
390
400
1975
1980
1985
1990
1995
2000
2005
2010
2015
Nitrous Oxide
(N_2O)
Parts per billion (ppb)
295
300
305
310
315
320
325
330
Methane
(CH_4)
Parts per billion (ppb)
1550
1600
1650
1700
1750
1800
1850
CFC-12
CFC-11
HCFC-22
HFC-134a
Parts per trillion (ppt)
0
100
200
300
400
500
600

Fonte NOAA

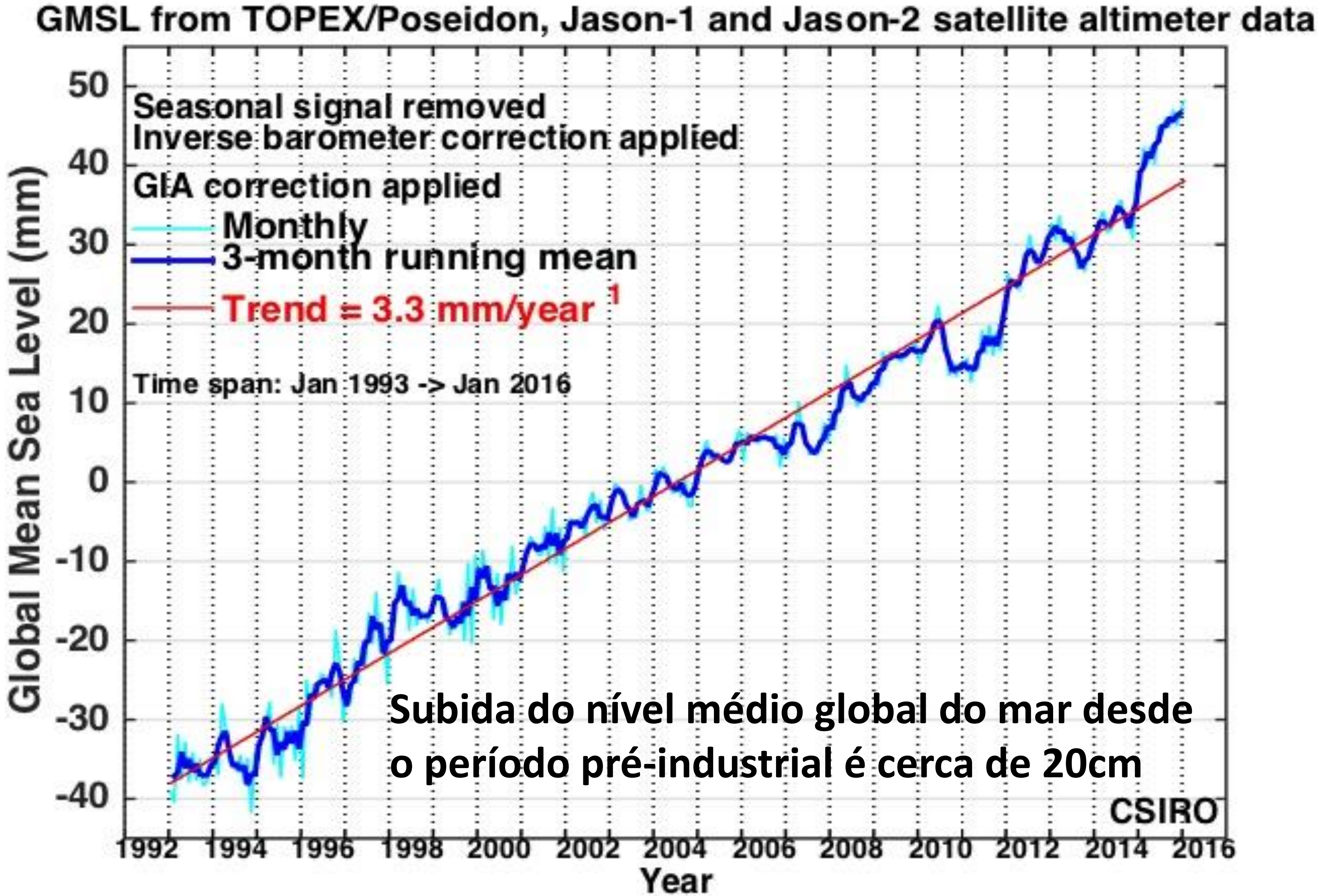
Variação da temperatura média global da atmosfera à superfície desde 1880




1980
1985
1990
1995
2000
2005
2010

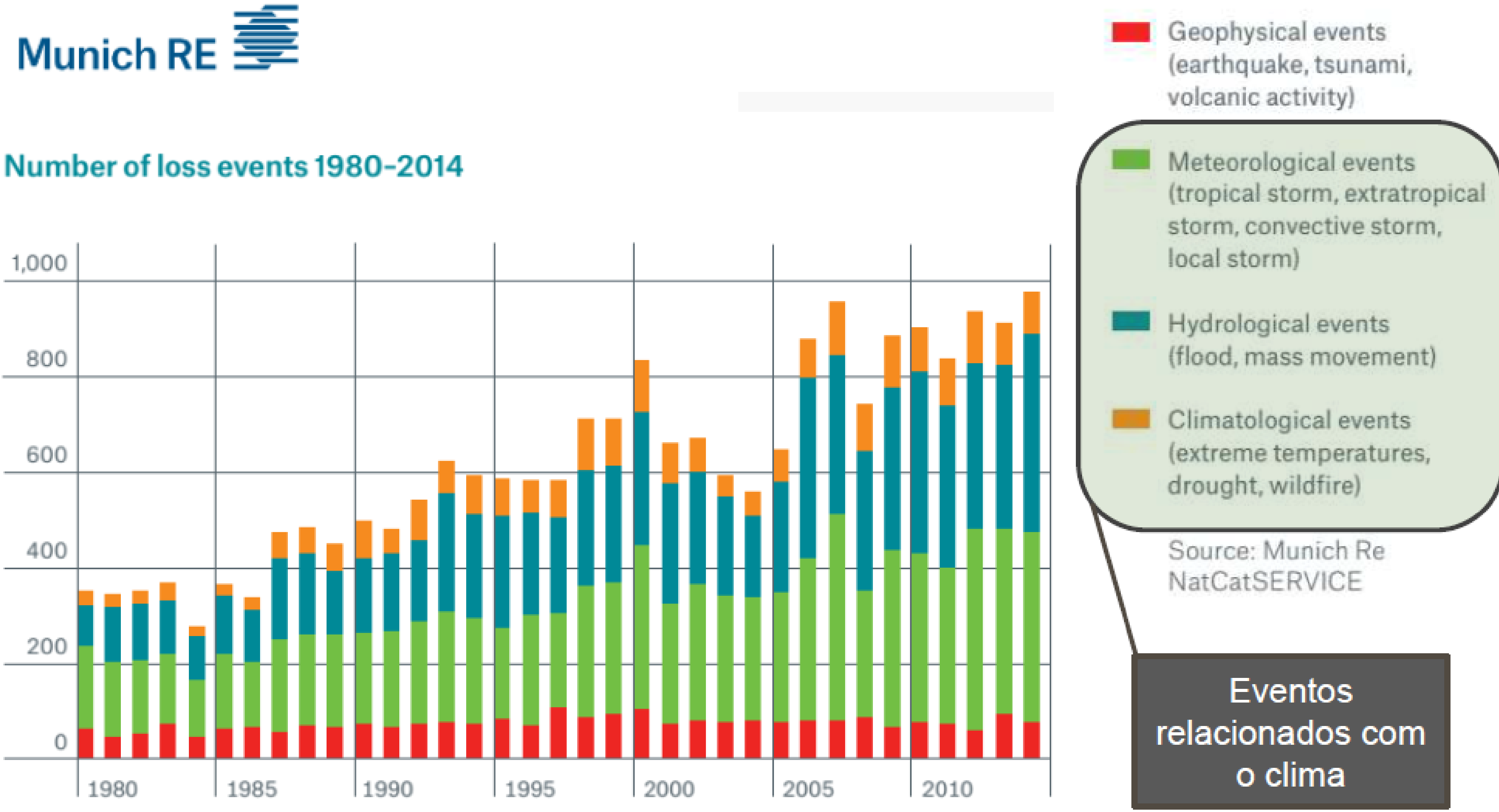


Changes in Sea-Surface Temperature Since 1900



Subida do nível médio global do mar desde o período pré-industrial é cerca de 20cm

Número de eventos extremos em que houve perdas reportadas à escala mundial



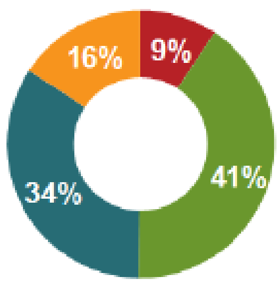
NatCatSERVICE

Natural catastrophes in Europe 1980 – 2010

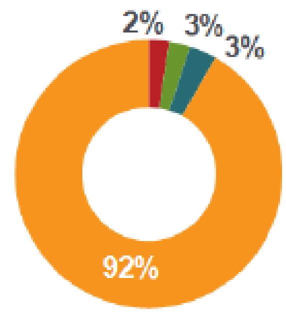
Percentage distribution

Munich RE

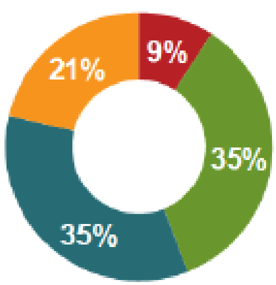
4,100 Loss events



150,000 Fatalities

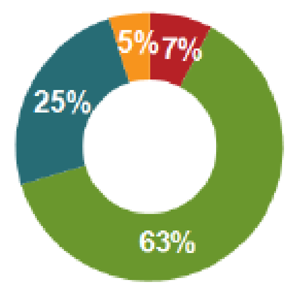


Overall losses* EUR 415bn



*in 2010 values

Insured losses* EUR 130bn



*in 2010 values

Geophysical events (Earthquake, tsunami, volcanic eruption)

Meteorological events (Storm)

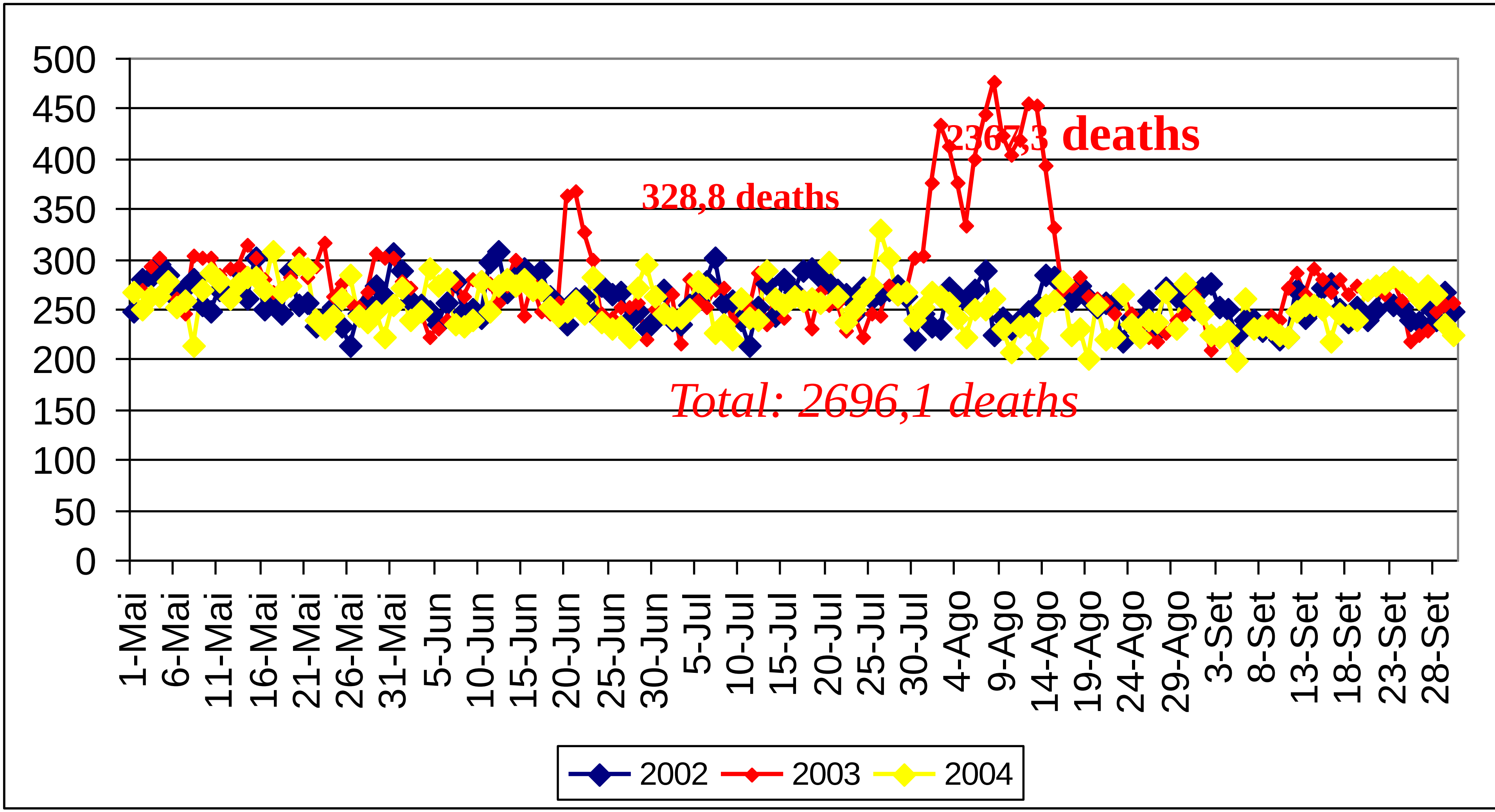
Hydrological events (Flood, mass movement)

Climatological events (Extreme temperature, drought, forest fire)

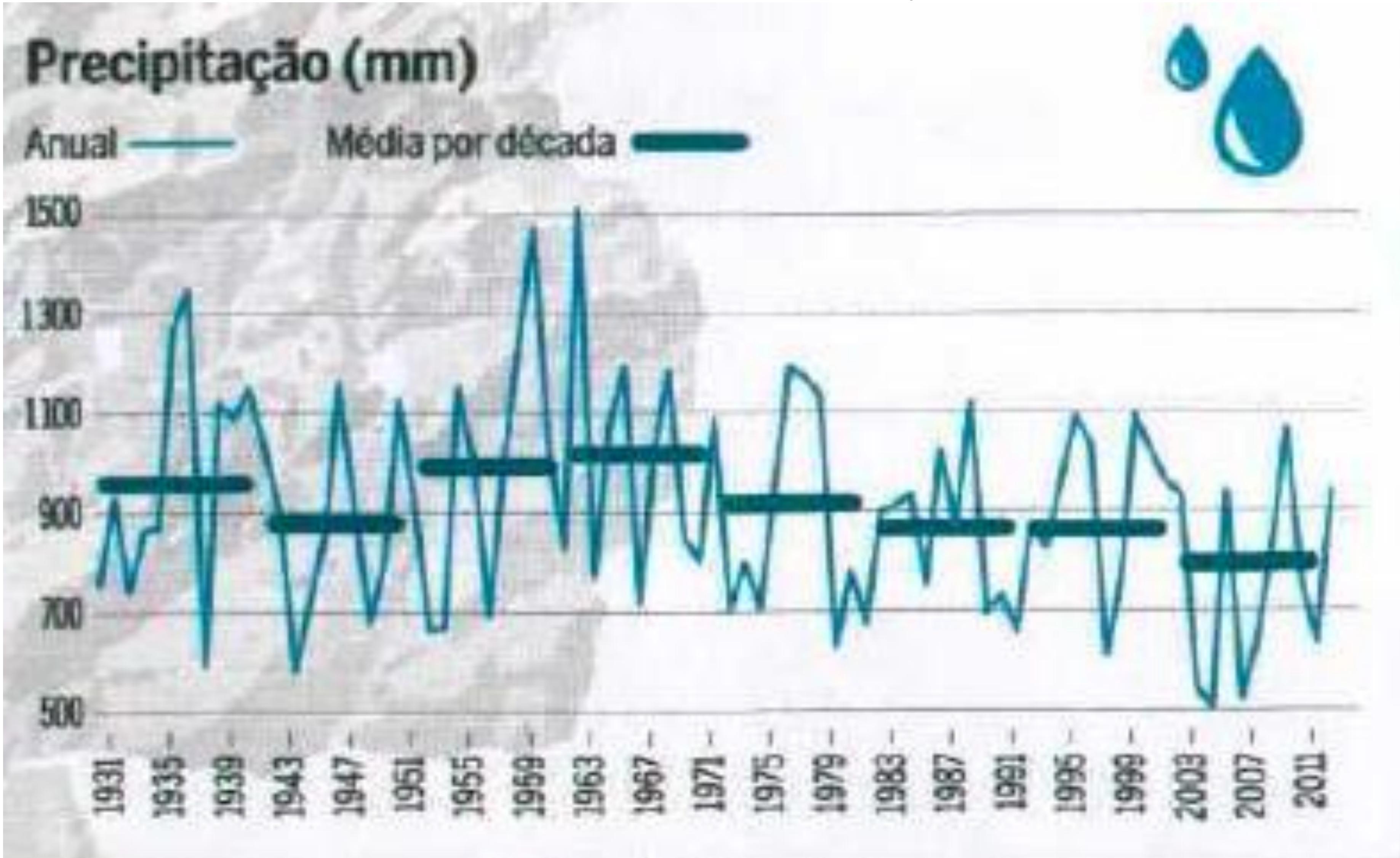
Source: Instituto Nacional de Saúde

Onda de Calor de Julho-Agosto 2003

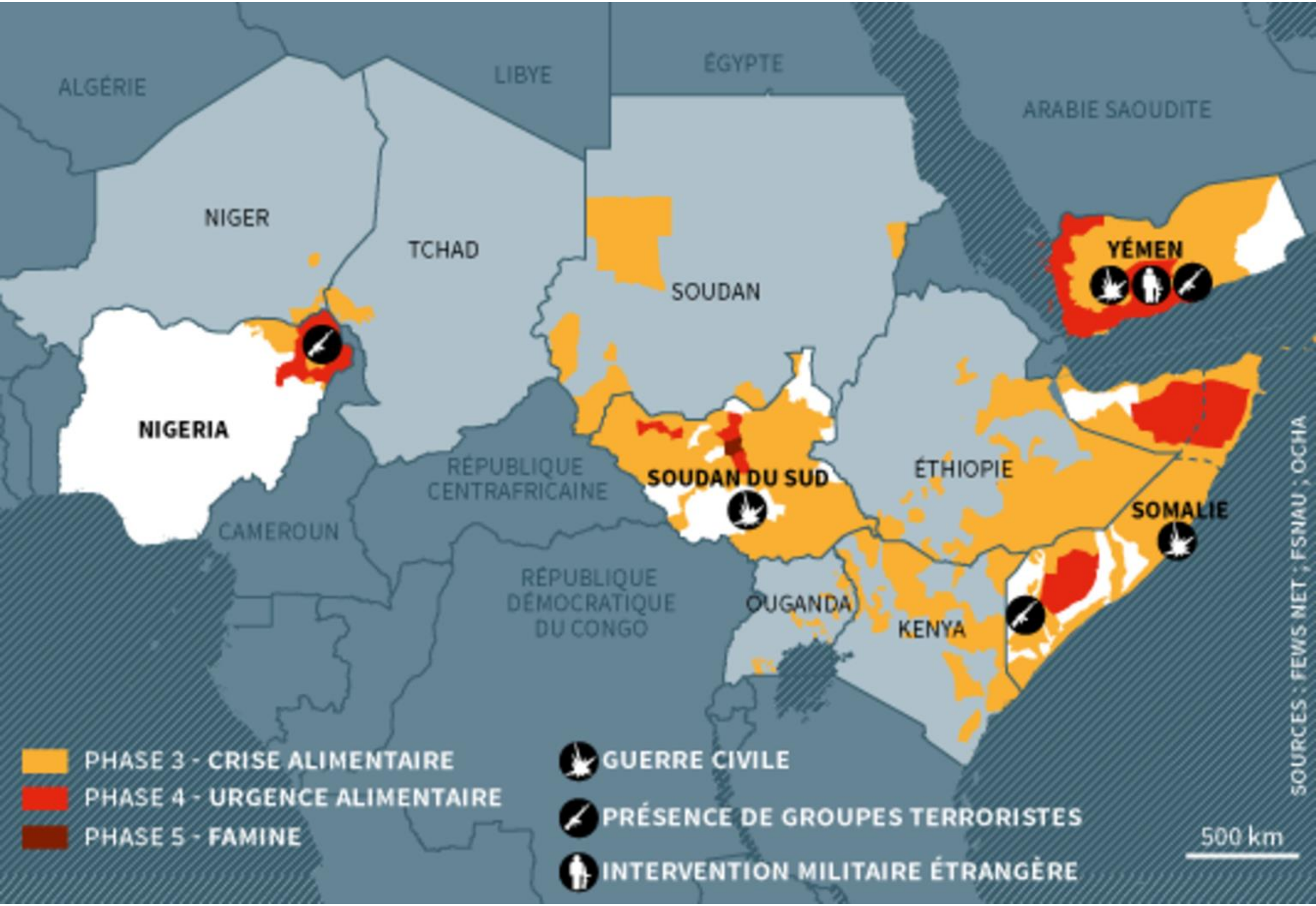
Comparação da mortalidade em anos adjacentes

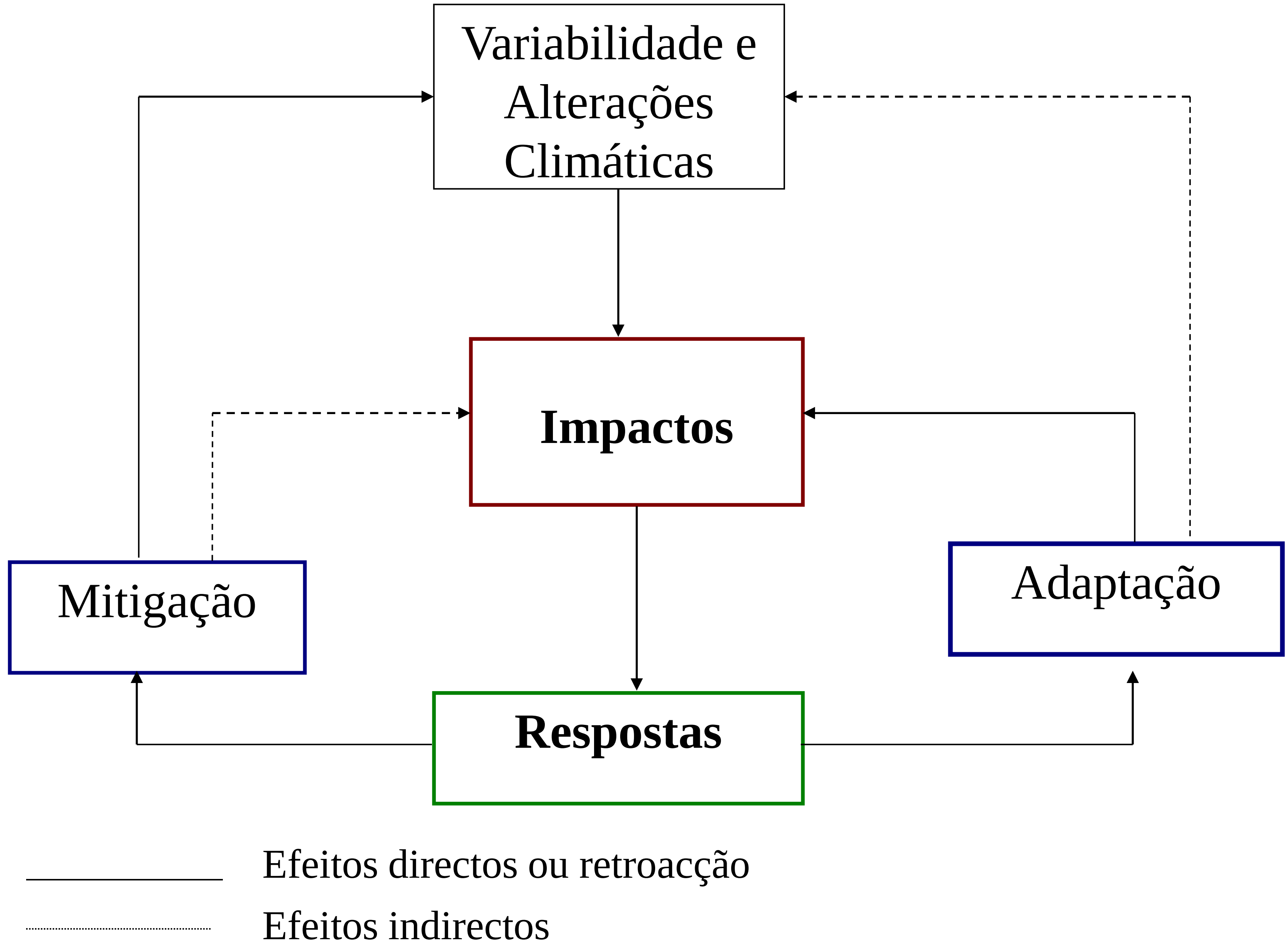


Fonte, IPMA



Variação decadal da precipitação em Portugal Continental


ALGÉRIE
LIBYE
ÉGYPTE
ARABIE SAOUDITE
NIGER
TCHAD
SOUDAN
YÉMEN
NIGERIA
RÉPUBLIQUE CENTRAFRICAINE
SOUDAN DU SUD
ÉTHIOPIE
SOMALIE
CAMEROUN
RÉPUBLIQUE DÉMOCRATIQUE DU CONGO
OUGANDA
KENYA
SOURCES : FEWS NET ; FSNAU ; OCHA
PHASE 3 - CRISE ALIMENTAIRE
PHASE 4 - URGENCE ALIMENTAIRE
PHASE 5 - FAMINE
GUERRE CIVILE
PRÉSENCE DE GROUPES TERRORISTES
INTERVENTION MILITAIRE ÉTRANGÈRE
500 km


Variabilidade e Alterações Climáticas
Impactos
Mitigação
Adaptação
Respostas
Efeitos directos ou retroacção
Efeitos indirectos

Sources of emissions

Energy production remains the primary driver of GHG emissions

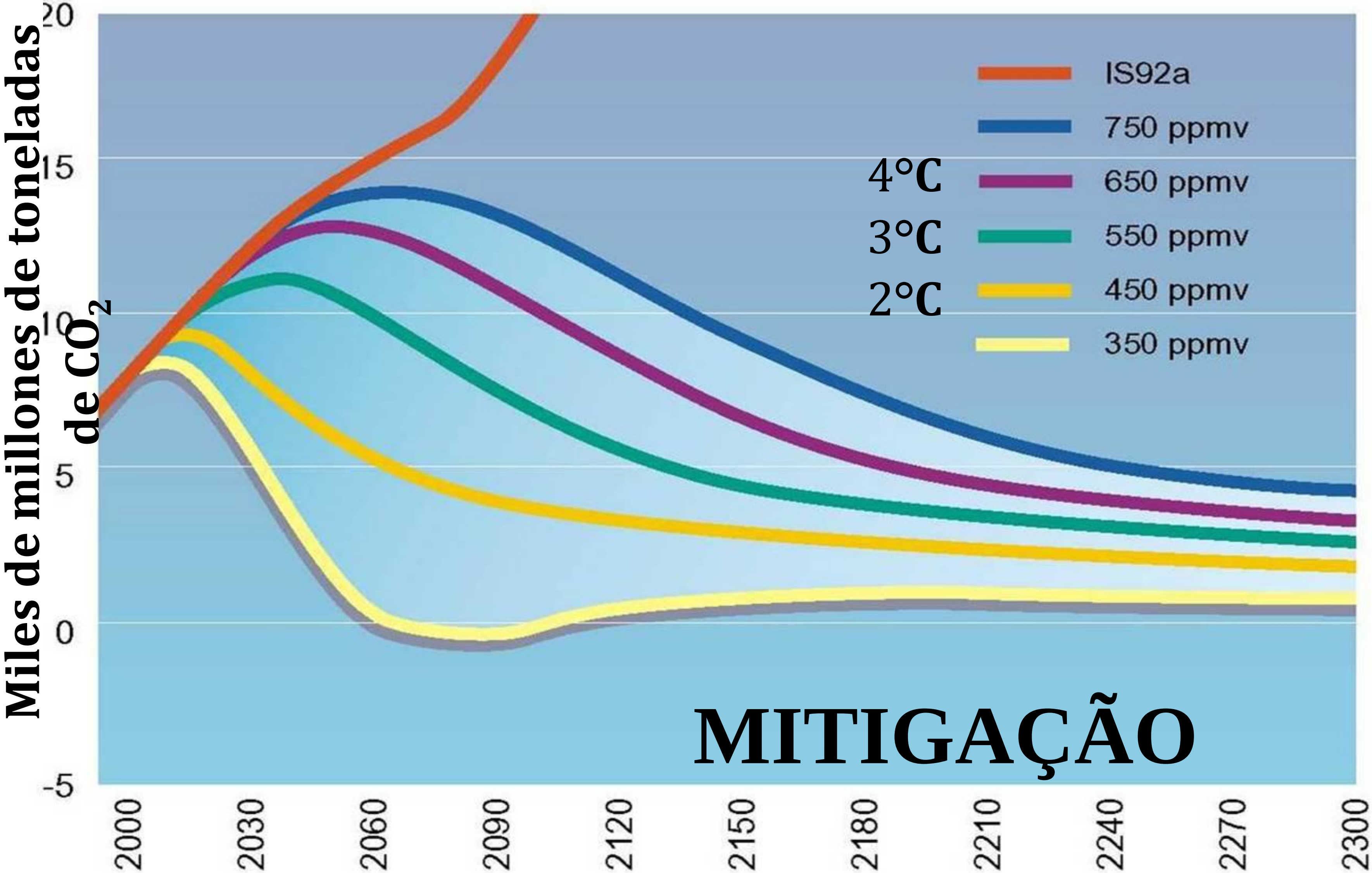
- **35%** Energy Sector
- **24%** Agriculture, forests and other land uses
- **21%** Industry
- **14%** Transport
- **6.4%** Building Sector

2010 GHG emissions

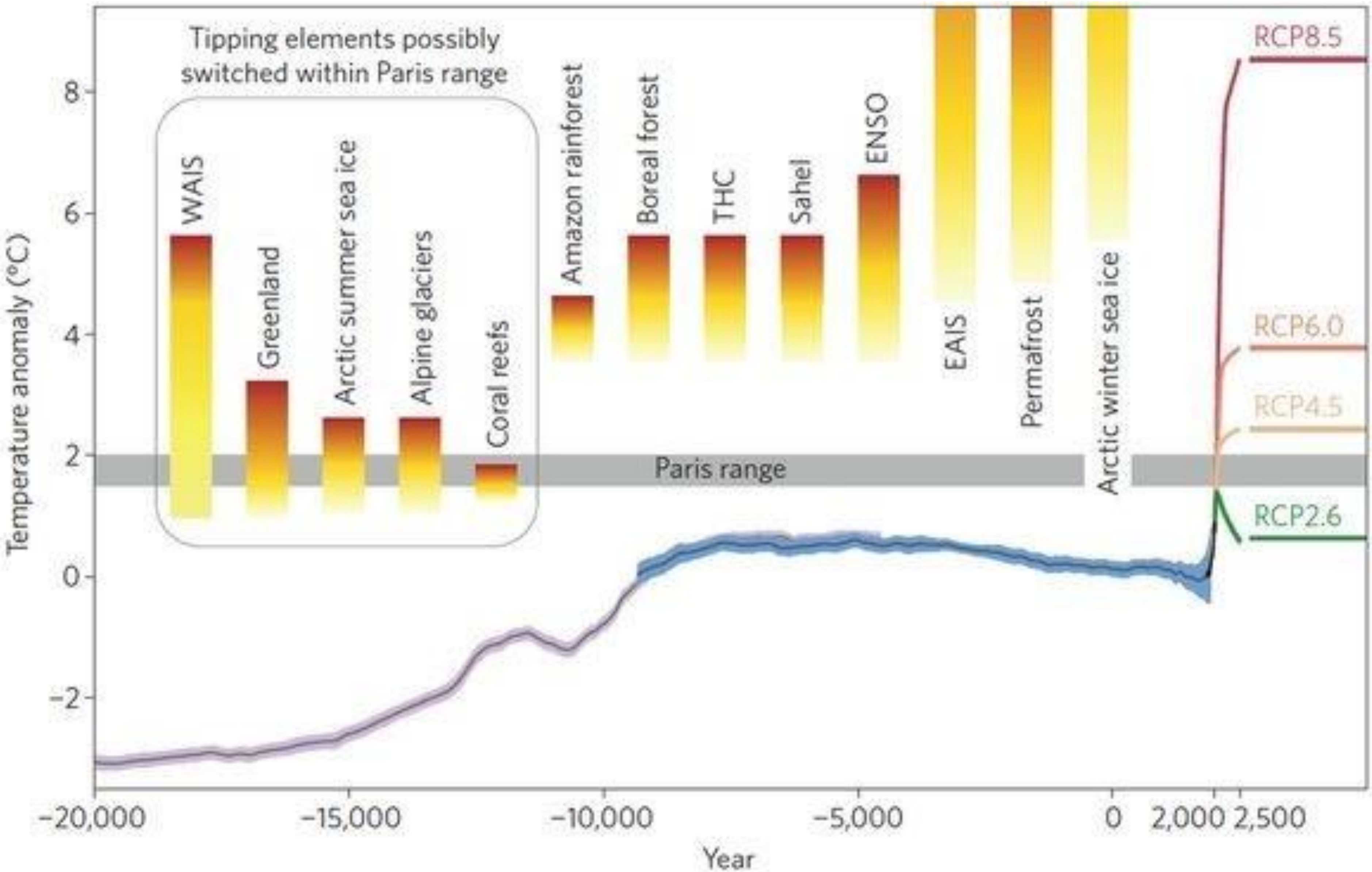
AR5 WGIII SPM

Trajectórias das emissões de CO_2e

(2005 = 380 ppmv)



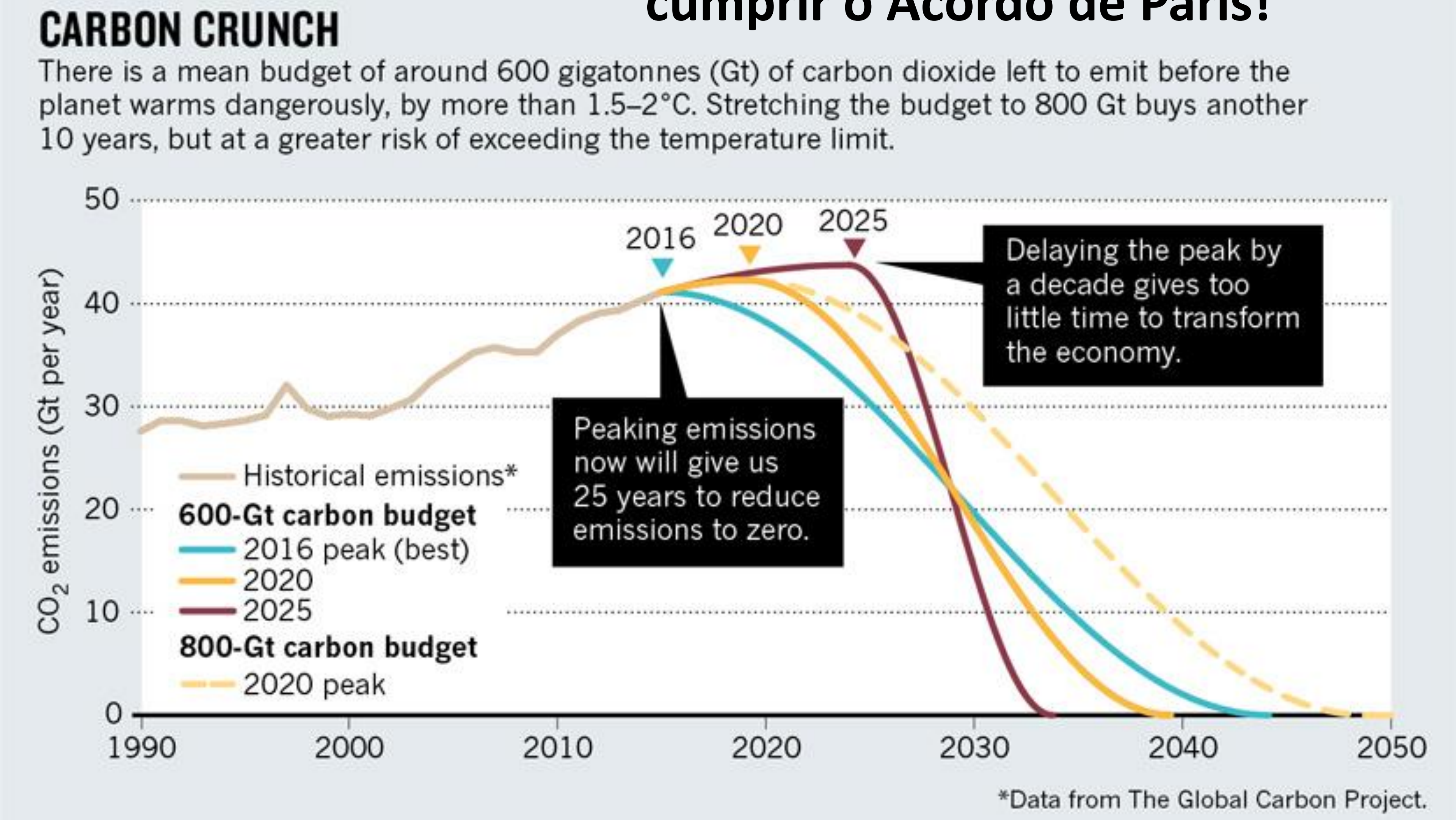
Fuente: Stern Review; World Resources Institute



Source: Schellnhuber et al., 2015

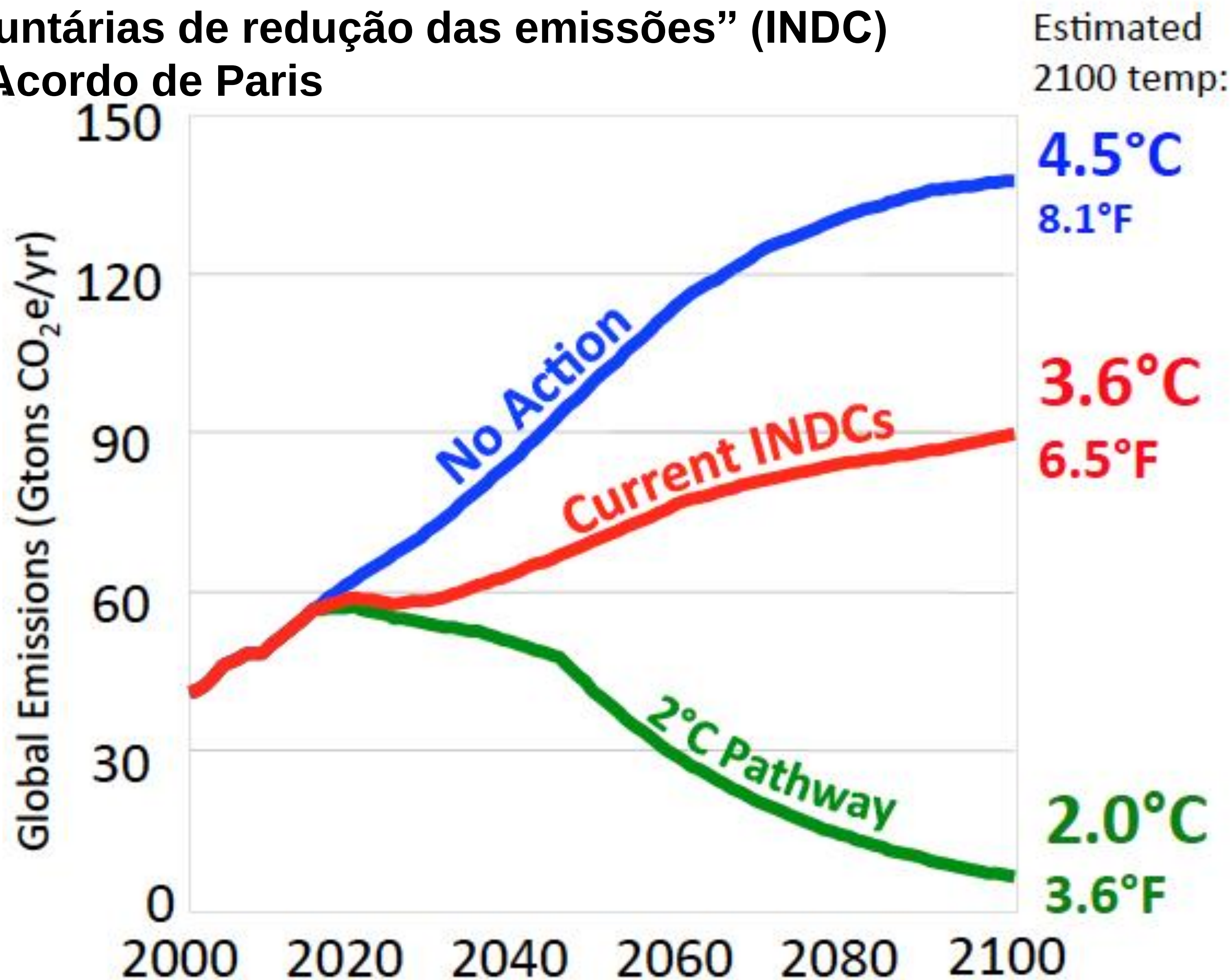
Orçamento de Carbono

Temos pouco tempo para cumprir o Acordo de Paris!

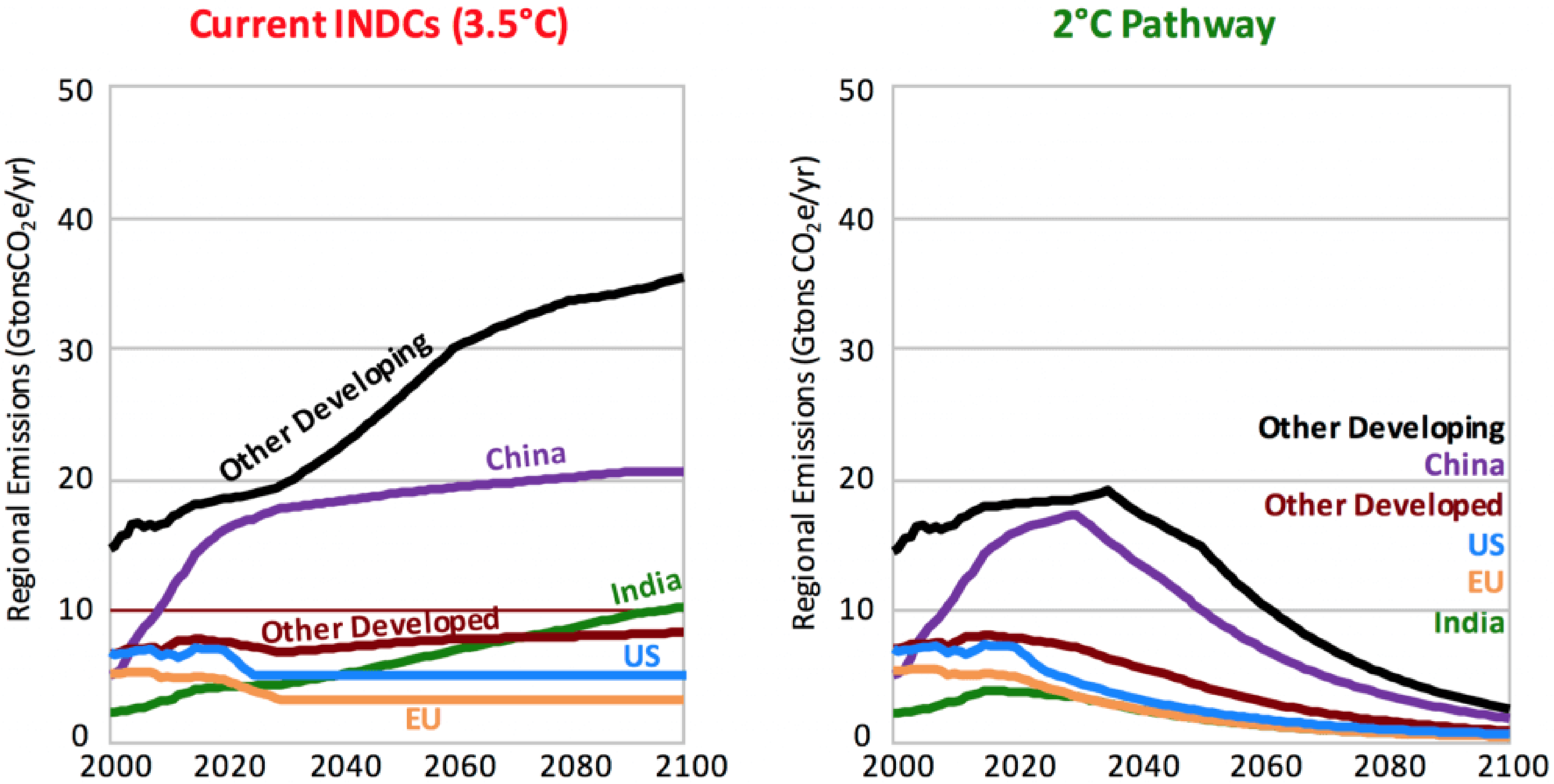


Three years to safeguard our climate **Christiana Figueres and colleagues set out a six-point plan for turning the tide of the world's carbon dioxide by 2020, Nature, 29 June 2017**

Projeção das emissões globais com base nas “Contribuições nacionais voluntárias de redução das emissões” (INDC) feitas para o Acordo de Paris



Impact of national climate pledges (aka INDCs) on world’s greenhouse gas emissions measured in CO2 equivalents (CO2e).



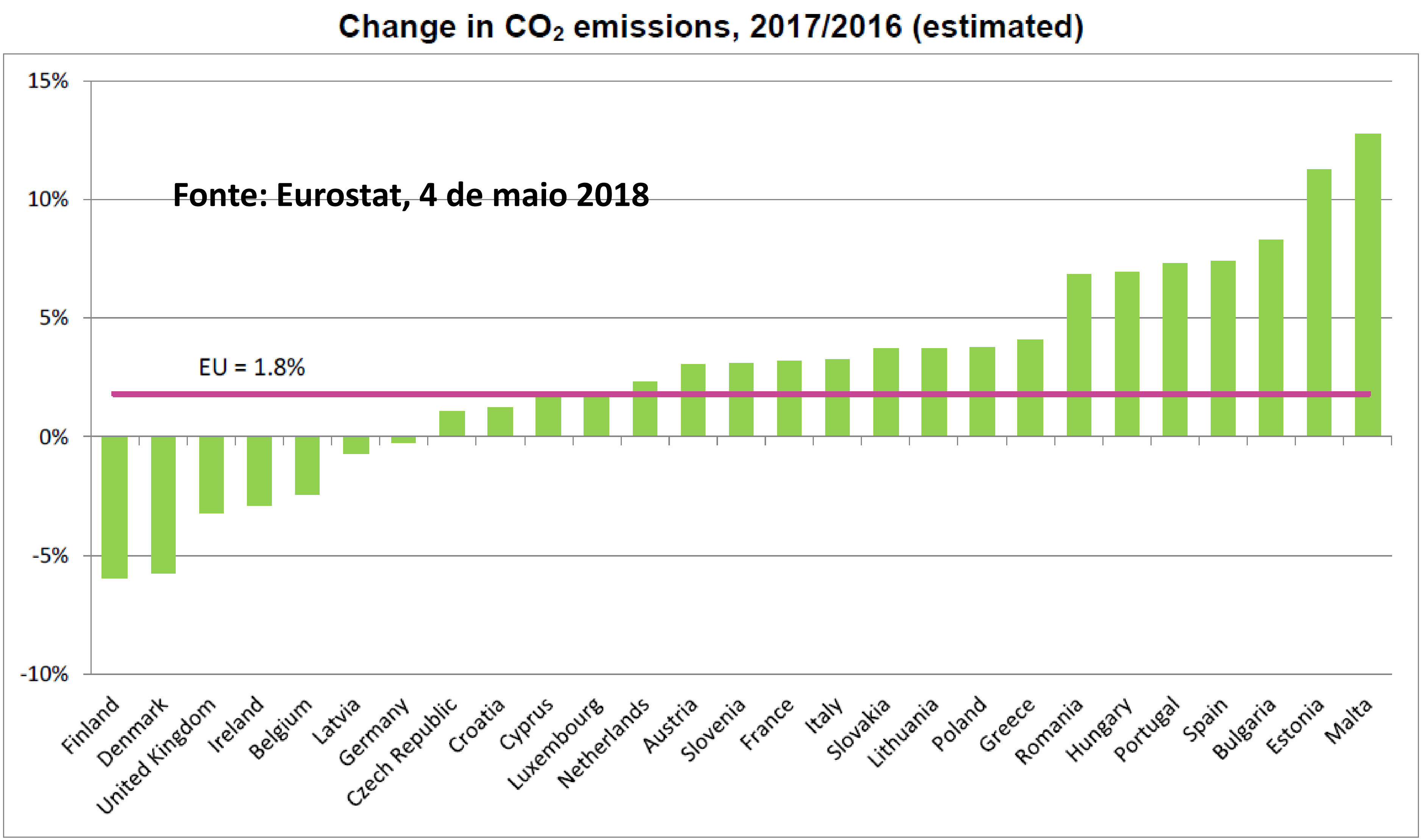
Source: Climate interactive

1990, Portugal: 62,1 MtCO2e

1990, UE28: 5735,1 MtCO2e

PT - 1,08% da UE

Fonte: Eurostat



Change in CO_2 emissions, 2017/2016 (estimated)
Fonte: Eurostat, 4 de maio 2018
EU = 1.8%
15%
10%
5%
0%
-5%
-10%
Finland
Denmark
United Kingdom
Ireland
Belgium
Latvia
Germany
Czech Republic
Croatia
Cyprus
Luxembourg
Netherlands
Austria
Slovenia
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Hungary
Portugal
Spain
Bulgaria
Estonia
Malta

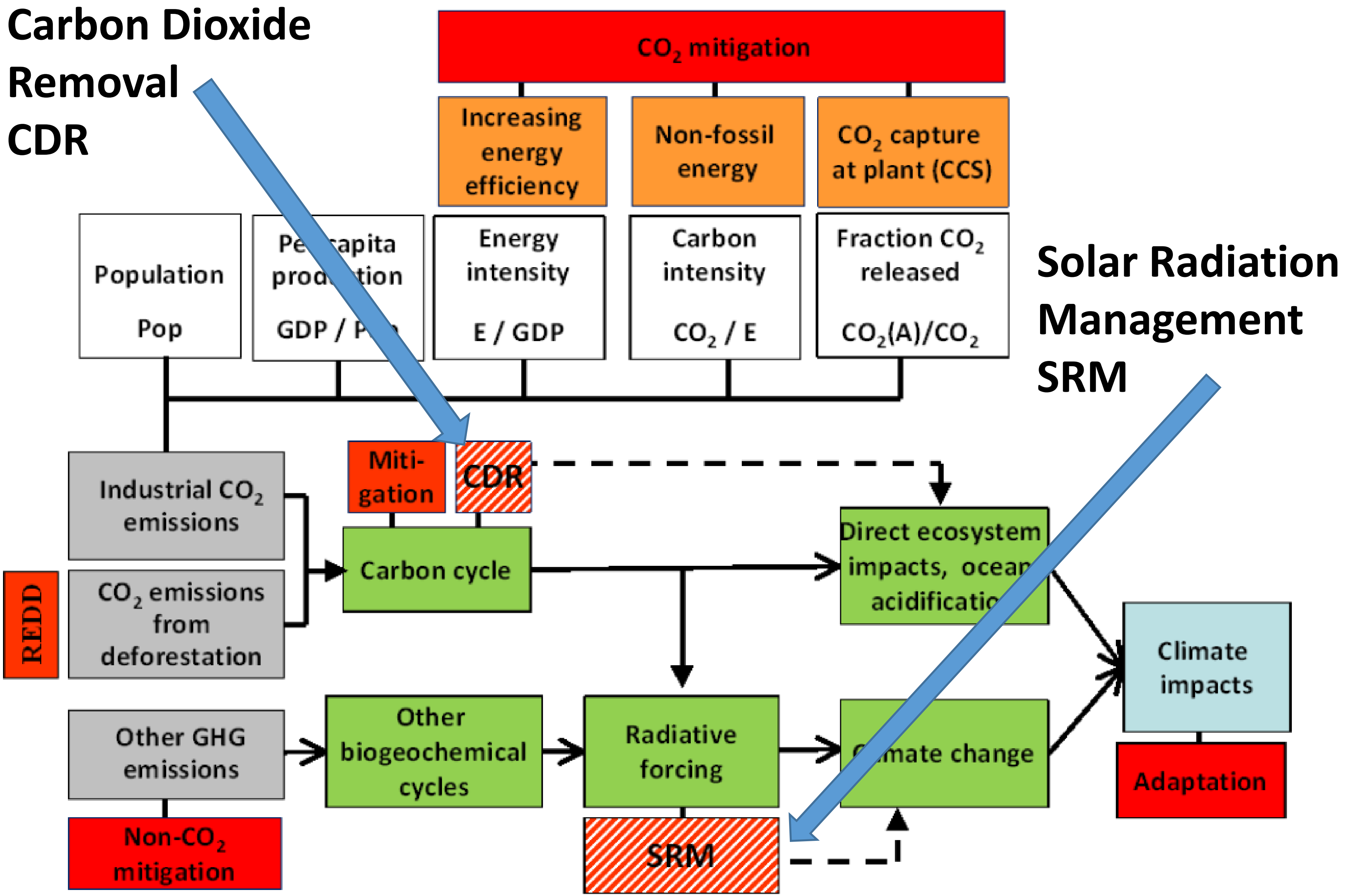
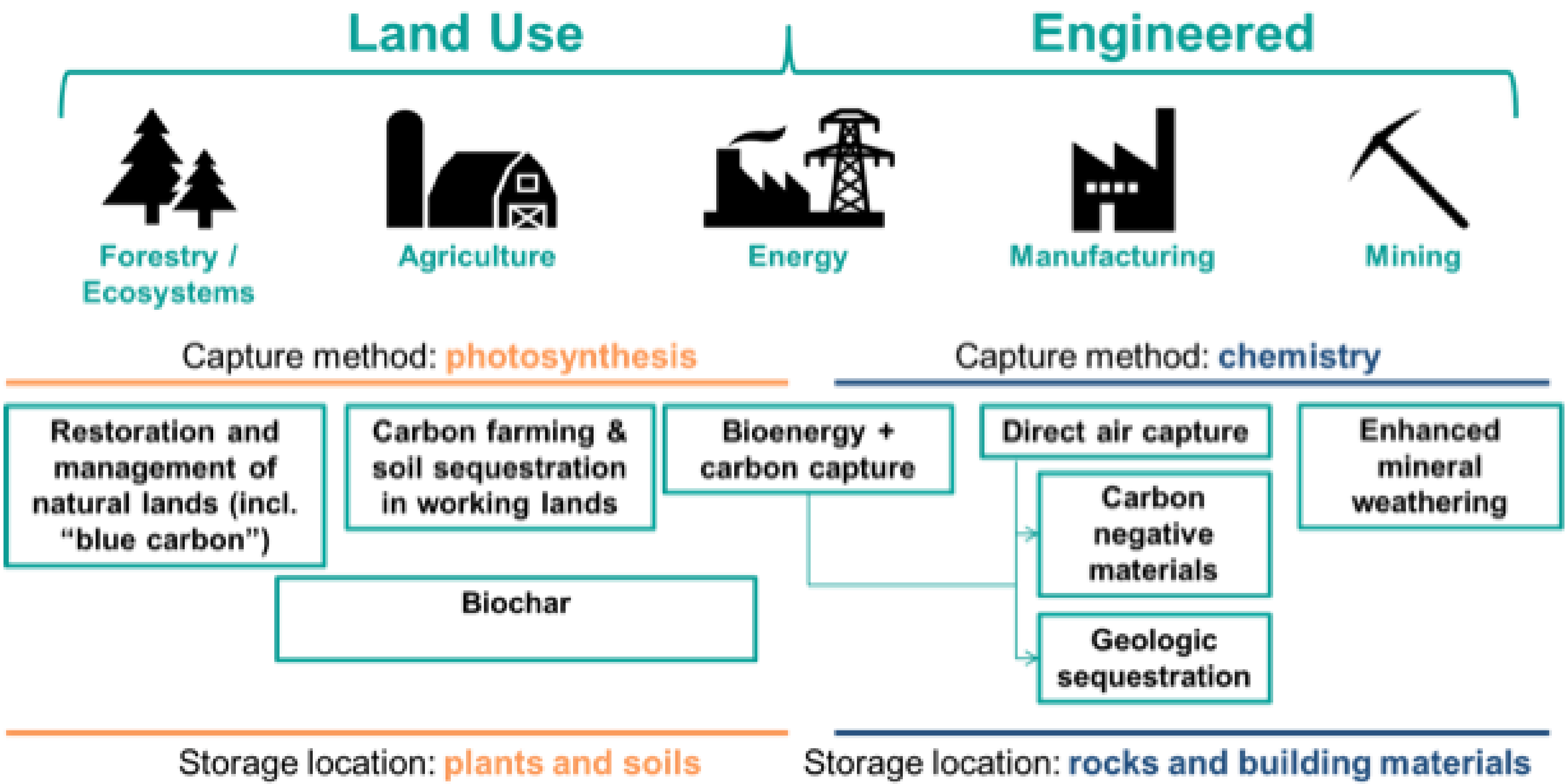


Figure 1.1: *Illustration of mitigation, adaptation, Solar Radiation Management (SRM) and Carbon Dioxide Removal (CDR) methods in relation to the interconnected human, socio-economic and climatic systems and with respect to mitigation and adaptation. The top part of the figure represents the Kaya identity. REDD stands for Reduced Emissions from Deforestation and forest Degradation. The Figure has been revised after the meeting.*

Geoengenharia

Figure: Umbrella of leading carbon removal solution options

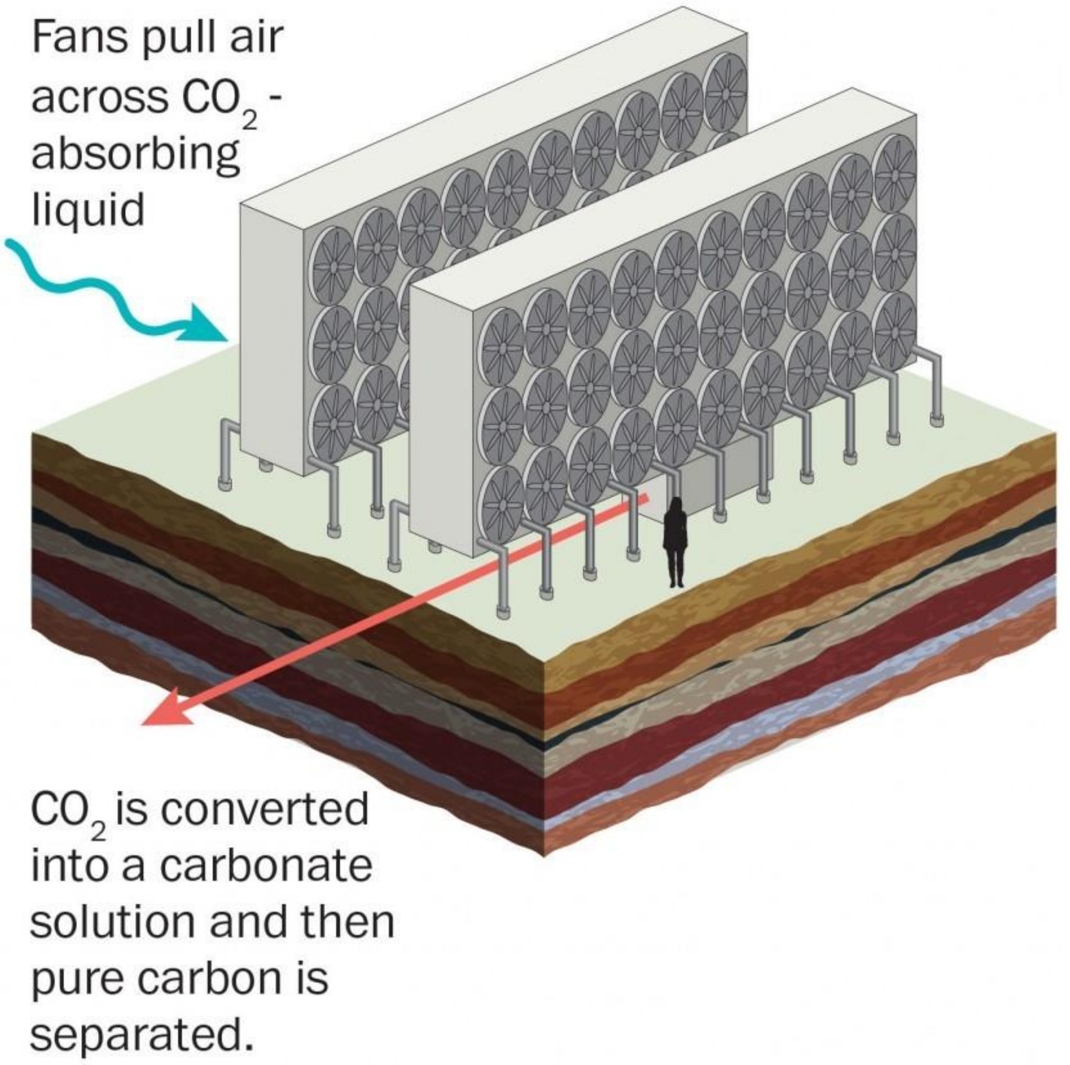


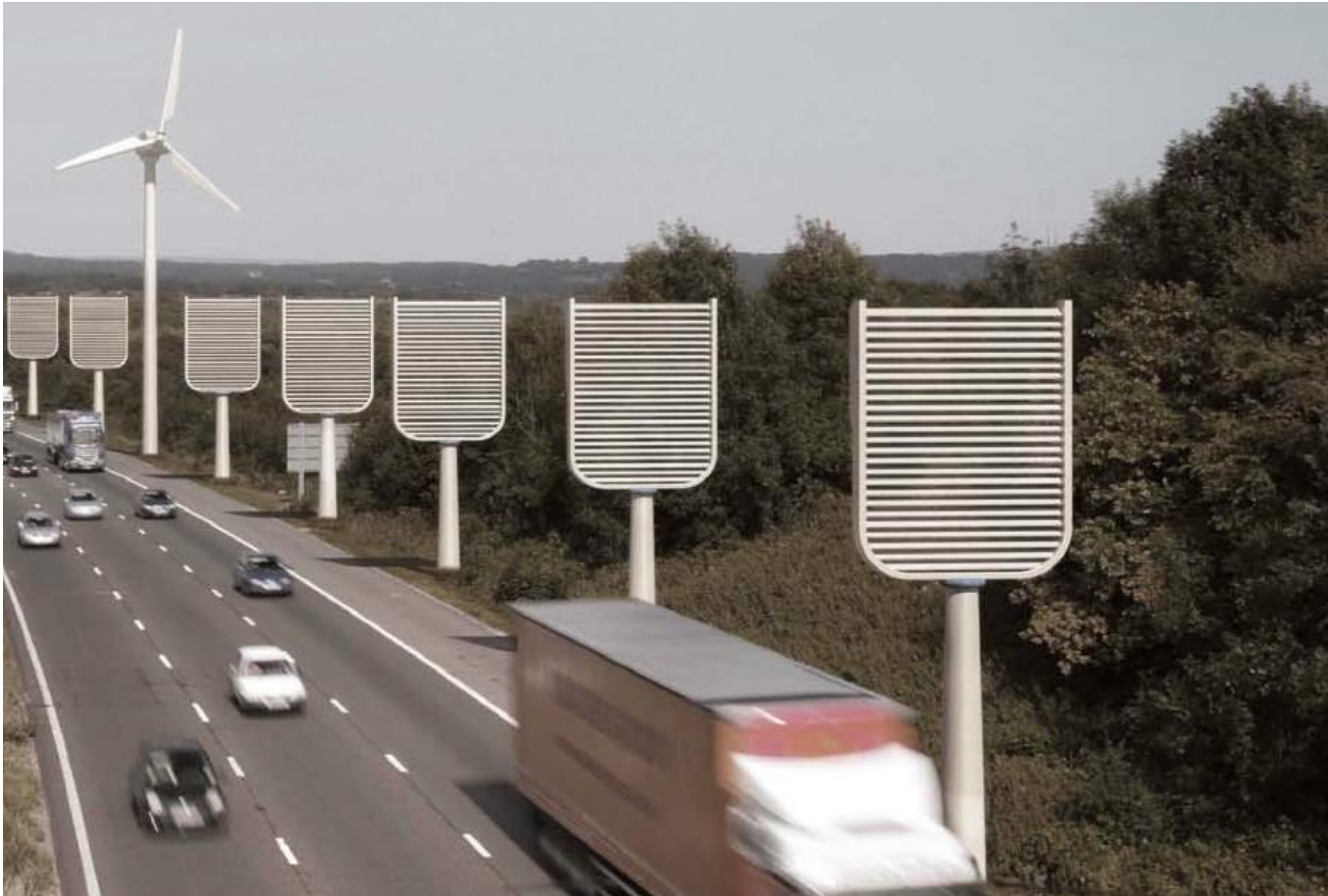
Direct air capture

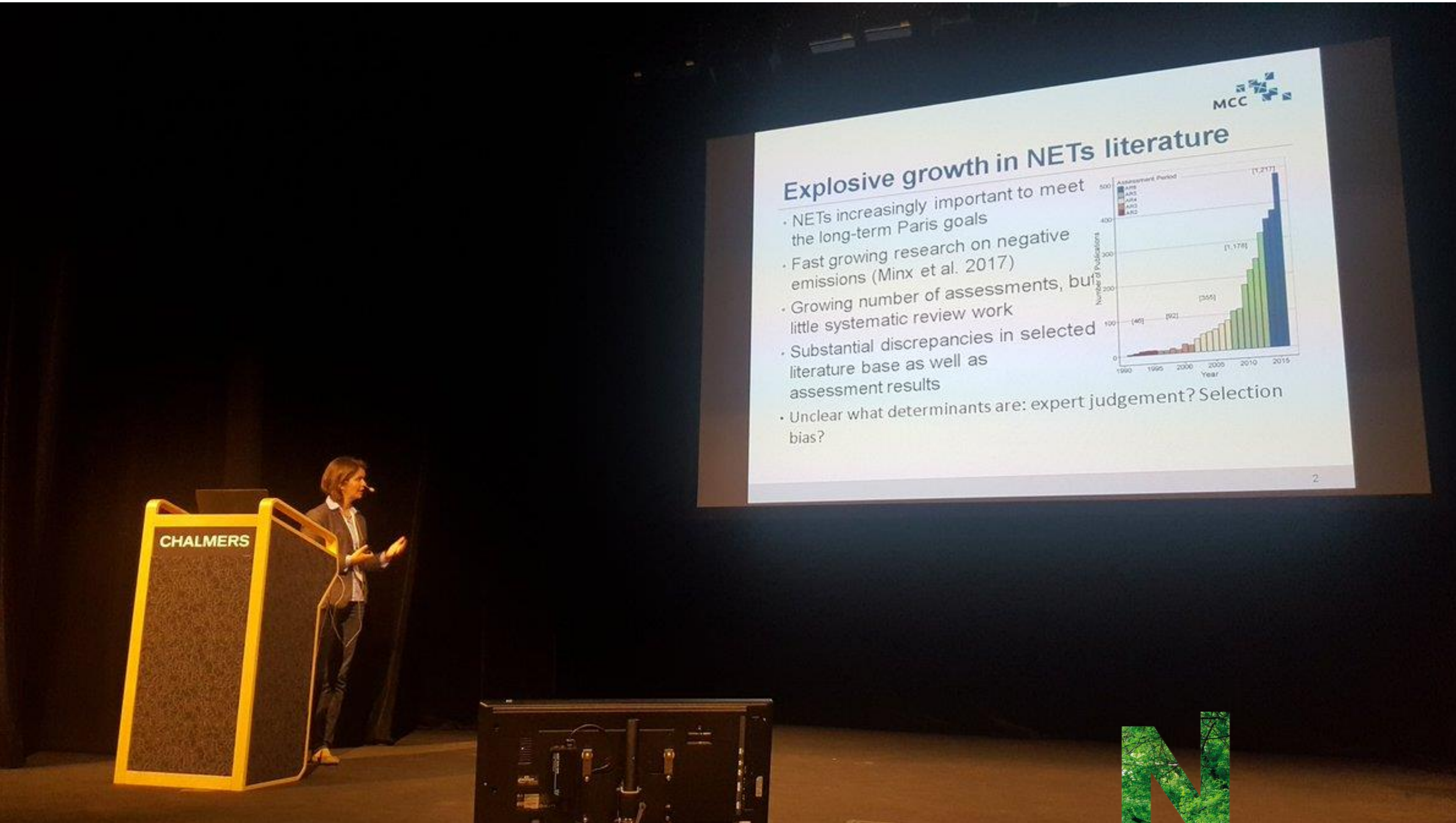
Carbon dioxide is pulled out of ambient air using absorptive substances that selectively bind to CO_2. A company called Carbon Engineering uses fans to pull air across an absorbant membrane. There, CO_2 is converted into a carbonate solution, which can be processed to trap the carbon.

- ⊕ Pulls CO_2 from all sources, not just power plants with smoke-stack-collection systems.
- ⊕ Low land use and can be scaled up to fit local demand.

- ⊖ Technology is still being developed.
- ⊖ Not available on a commercial scale yet.

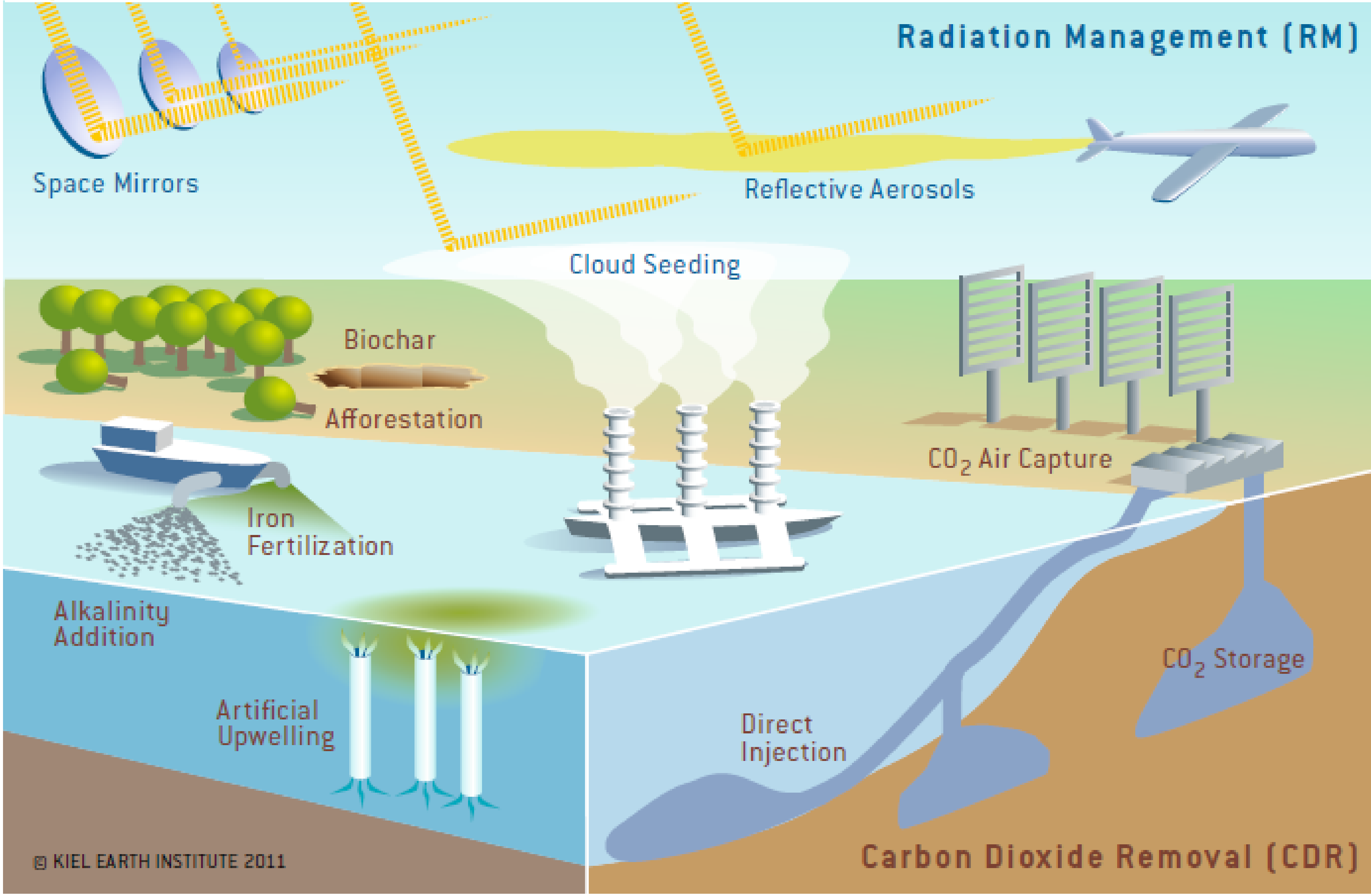






Day 2 of #negCO2 has started with keynote by Sabine Fuss from @MCC_Berlin highlighting the huge growth in literature on negative emissions. Big task for @IPCC_CH AR6 to assess them all…

INTERNATIONAL CONFERENCE ON
NEGATIVE CO_2 EMISSIONS
MAY 22-24, 2018


Radiation Management (RM)
Space Mirrors
Reflective Aerosols
Cloud Seeding
Biochar
Afforestation
CO_2 Air Capture
Iron Fertilization
Alkalinity Addition
Artificial Upwelling
Direct Injection
CO_2 Storage
© KIEL EARTH INSTITUTE 2011
Carbon Dioxide Removal (CDR)

David Keith
Gordon McKay Professor of Applied Physics and Professor of Public Policy (HKS) at Harvard University

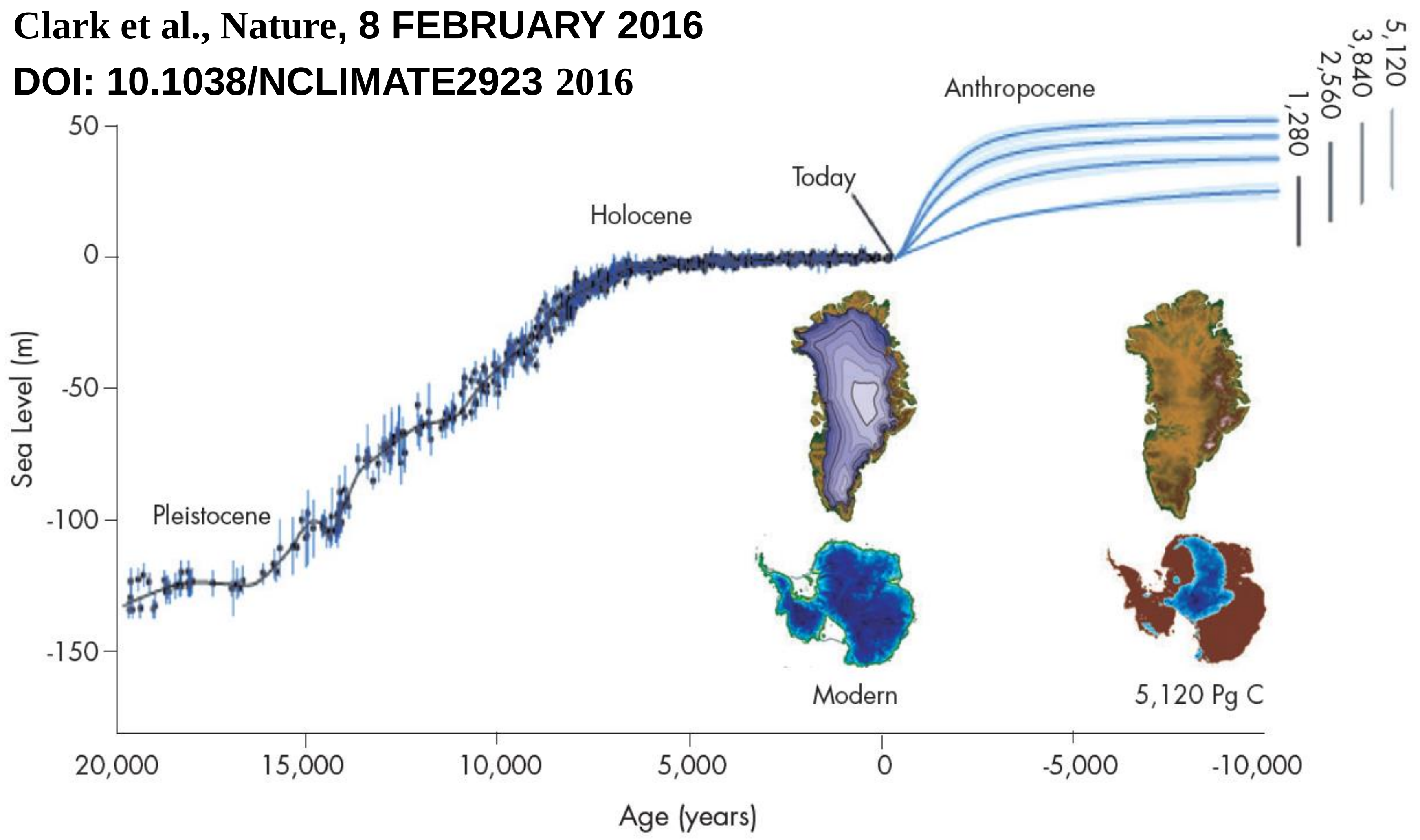
David Keith's own work at Harvard has progressed. This month, he is helping to start Harvard's Solar Geoengineering Research Program, a broad endeavor that begins with $7 million in funding and intends to reach $20 million over seven years. One backer is the Hewlett Foundation; another is Bill Gates, whom Keith regularly advises on climate change**. Keith is planning to conduct a field experiment early next year by putting particles into the stratosphere over Tucson** (NYT, 18/4/2017).

Asked about solutions to climate change at an ExxonMobil shareholder meeting in 2015, Rex Tillerson said that a "plan B has always been grounded in our beliefs around the continued evolution of technology and engineered solutions."

Past and future changes in global mean sea level

Clark et al., Nature, 8 FEBRUARY 2016

DOI: 10.1038/NCLIMATE2923 2016



Long-term global mean sea-level change for the past 20,000 years (black line) based on palaeo sea level records (black dots with depth uncertainties shown by blue vertical lines) and projections for the next 10,000 years for four emissions scenarios (1,280, 2,560, 3,840, and 5,120 Pg C). Vertical grey bars show range of long-term sea-level rise for each emission scenario. Images show reconstructions of the Greenland (top) and Antarctic (bottom) ice sheets for today (left) and for the 5,120 Pg C emission scenario (right). (Figure adapted from Clark *et al,* 2016).

Over the next 10,000 years, the global mean sea-level rise that will inevitably result from even a modest emissions scenario will reach 25 m, causing inundation of many of the world's most densely populated coastal cities and regions, directly affecting 1.3 billion people or 19% of the global population (based on 2010 population figures). A higher, business-as-usual scenario will result in a global mean sea-level rise of 52 m, with even more devastating effects.

Clark et al., 2016

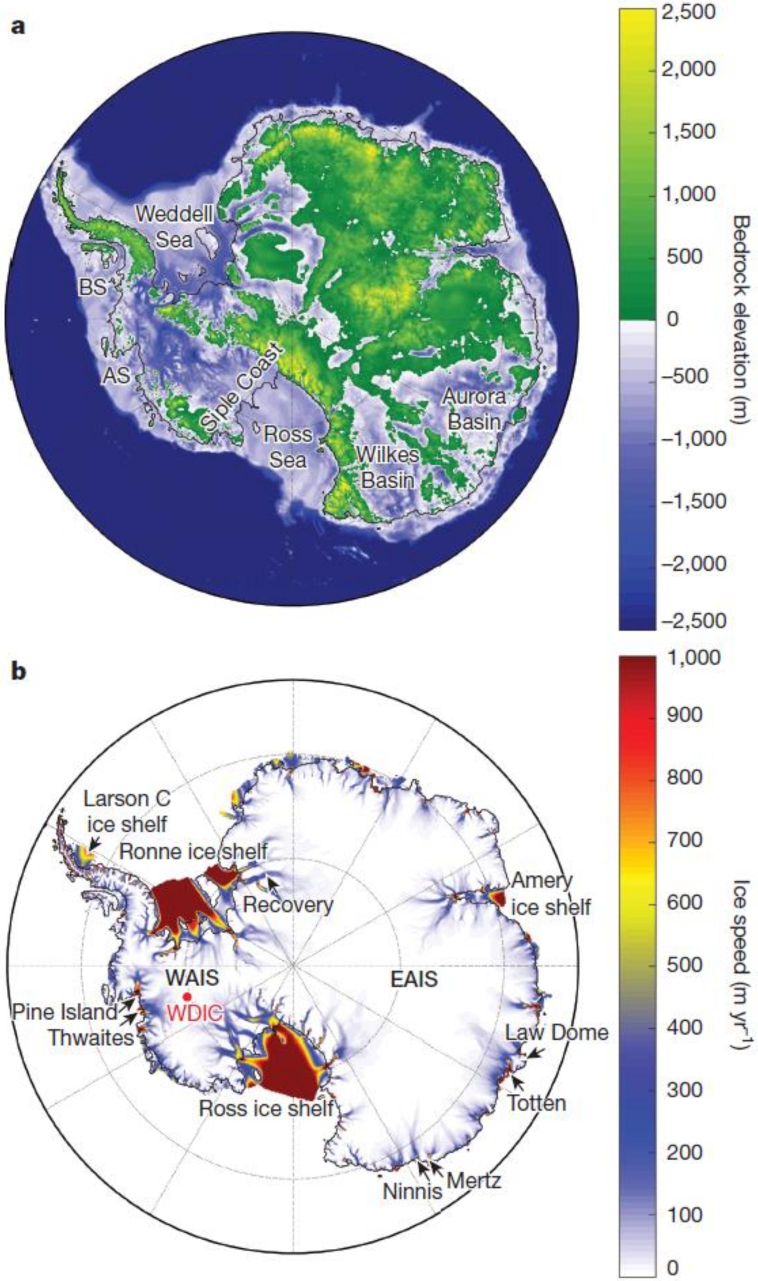


Figure 1 | Antarctic sub-glacial topography and ice sheet features. **a**, Bedrock elevations[13] interpolated onto the 10-km polar stereographic ice-sheet model grid and used in Pliocene, LIG, and future ice-sheet simulations. **b**, Model surface ice speeds and grounding lines (black lines) show the location of major ice streams, outlet glaciers, and buttressing ice shelves (seaward of grounding lines) relative to the underlying topography in **a**. Features and place names mentioned in the text are also shown. AS, Amundsen Sea; BS, Bellingshausen Sea; WDIC, WAIS Divide Ice Core. The locations of the Pine Island, Thwaites, Ninnis, Mertz, Totten, and Recovery glaciers are shown. Model ice speeds (**b**) are shown after equilibration with a modern atmospheric and ocean climatology (see Methods).

Antarctica has the potential to contribute more than a meter of sea-level rise by 2100 and more than 15 metres by 2500, if emissions continue unabated.

ARTICLE

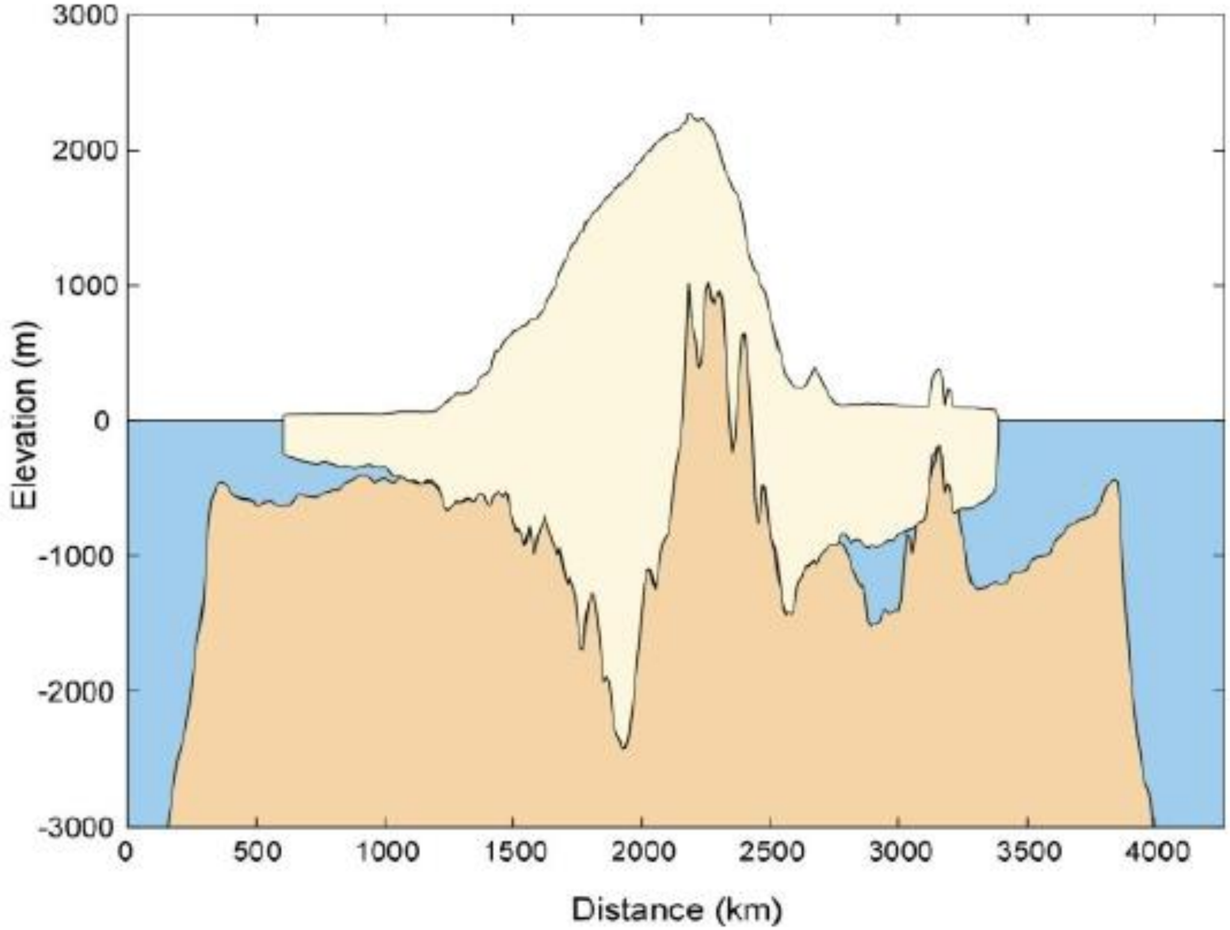
doi:10.1038/nature17145

Contribution of Antarctica to past and future sea-level rise

Robert M. DeConto[1] & David Pollard[2]

DeConto, Nature, 2016

FIGURE 1-1. **Cross-section of West Antarctica**



Much of West Antarctica is below sea-level, allowing water to flow in and potentially, rapidly destabilize the ice sheets above.

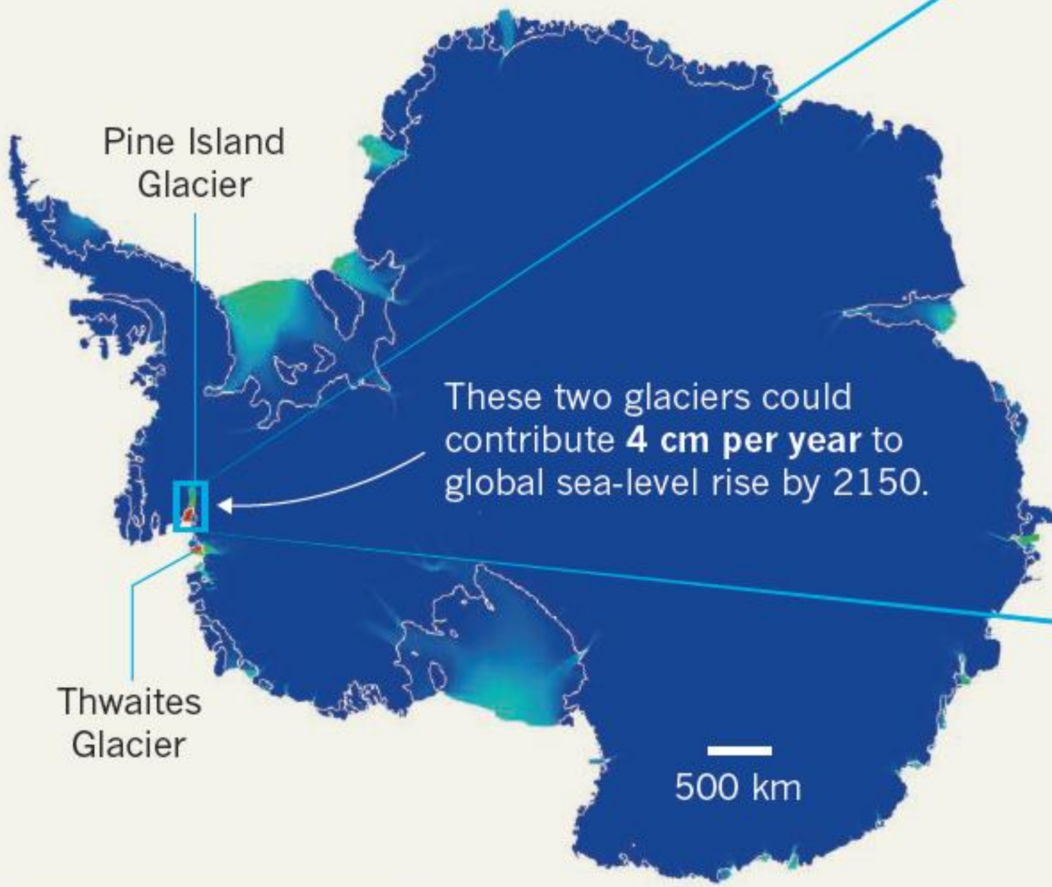
SOURCE: ILLUSTRATION BY JONATHAN BAMBER

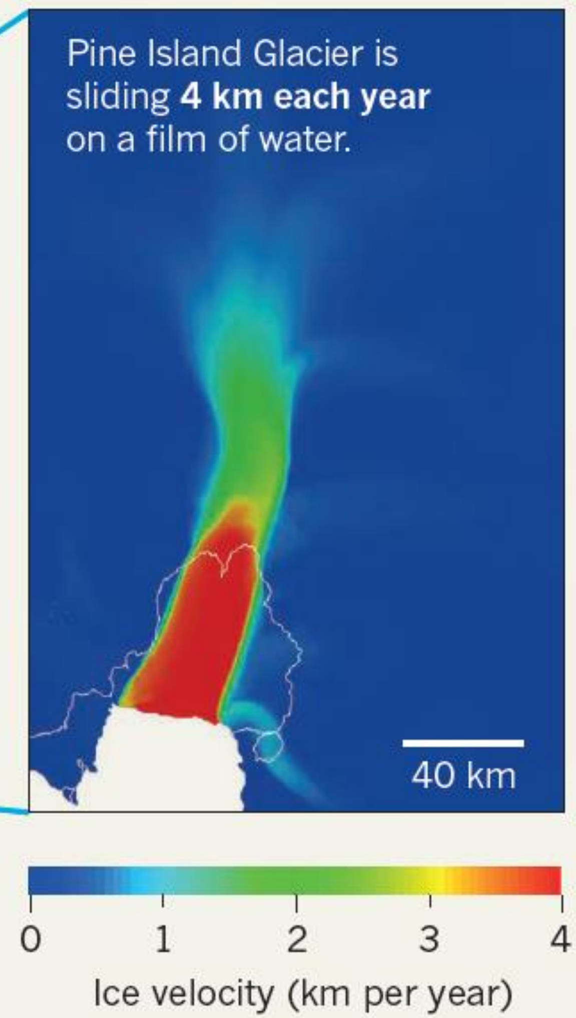
GLACIAL GEOENGINEERING

Two fast-moving glaciers in West Antarctica — Pine Island and Thwaites — are shedding most of the ice lost from the continent into the sea. Slowing them down could delay global sea-level rise by centuries.

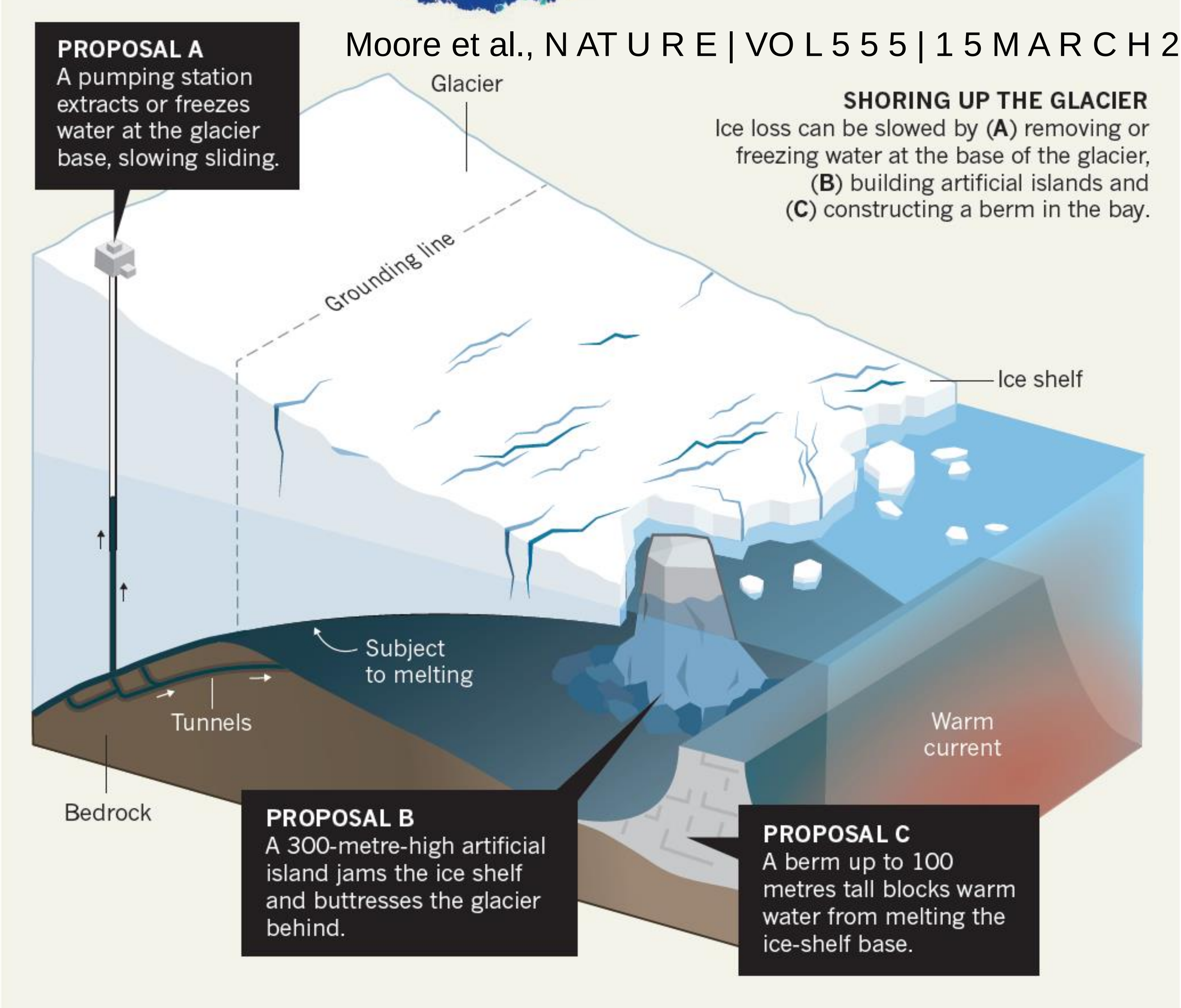
ICE FLOW

When the glaciers reach the coast, the ice forms a floating shelf in the bay that breaks up, thins and melts.





Moore et al., N AT U R E | VO L 5 5 5 | 1 5 M A R C H 2 0 1 8



A portion of the Rhône Glacier in Switzerland is covered in blankets to help prevent it from melting, 2018

This Rhône glacier is covered with sheets to protect the ice from melting. (Photo: Michal Stipek/Shutterstock), 2018

Time to Speed Up Coral Evolution? Cosmos 6 April 2018
Global warming threatens our reefs. Some marine scientists have a controversial plan to save them. Elizabeth Finkel explains.

The Australian Institute of Marine Science in Townsville, Australia, is a glorious place.
Something quite wild is happening inside the buildings too. Here, marine biologist Madeleine van Oppen and colleagues are pursuing a bold, and controversial, goal – to speed up the evolution of corals to ensure the survival of the world's reefs, particularly the one on the institute's doorstep, the 2,300 km-long Great Barrier Reef.
Their research, once considered fringe, has gone mainstream.
In January the Australian government committed $6 million to a study on the feasibility of helping the reef adapt to climate change.

How much is it worth spending to save the reef? Its ecological value is immeasurable, but its economic value can be calculated. According to an analysis by Deloitte Access Economics, reef tourism contributes more than $6 billion a year to the Australian economy. Add in the services to fisheries and coastal protection, and it is an asset valued at $56 billion. Surely, worth a sizeable chunk of research dollars to save it.

EL PAÍS__LAB Pablo Léon, El País,16 de Maio 2018

Una encina tarda 40 años en florecer; este hongo la puede secar en días

El calentamiento global fomenta el crecimiento de fitóftora, patógeno que ataca las raíces de los árboles de cuyas bellotas se alimenta el cerdo ibérico

"…que en Andalucía en los últimos diez años hayan desaparecido casi medio millón de encinas"."La seca se ve agravada por el cambio climático", explica Raúl Tapias, ingeniero agroforestal que lleva décadas investigando esta enfermedad en la Universidad de Huelva. "El patógeno se hace más virulento en situaciones de temperaturas elevadas del suelo. Como los escenarios de futuro del cambio climático predicen un incremento de la temperatura, el área afectada por fitóftora tenderá a incrementarse", agrega. "Además, se mantiene en el suelo durante largos períodos de tiempo por lo que su erradicación es casi imposible", continúa el experto. "Intentamos aislar el código genético de los árboles que aguantan el envite de la enfermedad", explica el ingeniero Tapia, que escribió sobre este tema su tesis doctoral (*Selección de progenies de encina y alcornoque tolerantes al patógeno Phytophthora cinnamomi*). La finalidad es plantar ejemplares resistentes para repoblar la dehesa. La idea funciona, pero el tiempo acecha: una encina necesita unos 40 años desde que se planta para producir su primera bellota. En ese tiempo, la temperatura seguirá subiendo y la seca aumentando su área de influencia

Obrigado pela vossa atenção

Washington Post, 18 March 2018

By Peter Jamison and Valerie Strauss

D.C. Politics

D.C. lawmaker says recent snowfall caused by 'Rothschilds controlling the climate'

"Man, it just started snowing out of nowhere this morning, man. Y'all better pay attention to this climate control, man, this climate manipulation," he says. "And D.C. keep talking about, 'We a resilient city.' And that's a model based off the Rothschilds controlling the climate to create natural disasters they can pay for to own the cities, man. Be careful."

The Rothschilds are a famous European business dynasty descended from Mayer Amschel Rothschild, an 18th-century Jewish banker who lived in what is today Frankfurt, Germany. The family has repeatedly been subject over the years to anti-Semitic conspiracy theories alleging that they and other Jews clandestinely manipulate world events for their advantage.

Pablo Canto, 2 mar 2018, EL PAIS

Ni te fumigan ni quieren provocar sequía: vuelve la conspiración de los 'chemtrails‘

El bulo es tan popular que un eurodiputado español llegó a preguntar por él en el Parlamento Europeo

La teoría de la conspiración de los *chemtrails* (rastros químicos) defiende que, a través de productos químicos rociados desde aviones, el gobierno intenta controlar el clima para favorecer el turismo, aunque esto provoque sequías y gotas frías. La élite mundial de científicos atmosféricos desmintió en 2016 la existencia de esta práctica, pero eso no ha logrado acabar con el mito. Este febrero ha resucitado una de las cadenas más populares del bulo, que afirma que trabajadores del Instituto de Meteorología han reconocido que España entera está siendo fumigada.

Um estudo do consórcio, Eni e Galp para a exploração da costa vicentina, estima um volume potencial recuperável de petróleo que varia entre os 1.000 e os 1.500 milhões de barris, um valor equivalente a 17 anos de importação de petróleo.

As duas empresas não quiseram contudo comentar estes valores, mas num comunicado conjunto adiantam: "Se for provada a presença de hidrocarbonetos, a sua exploração, numa localização que não visível da costa, representará uma oportunidade para o desenvolvimento económico de Portugal e para reduzir o défice da balança comercial e energética do país"

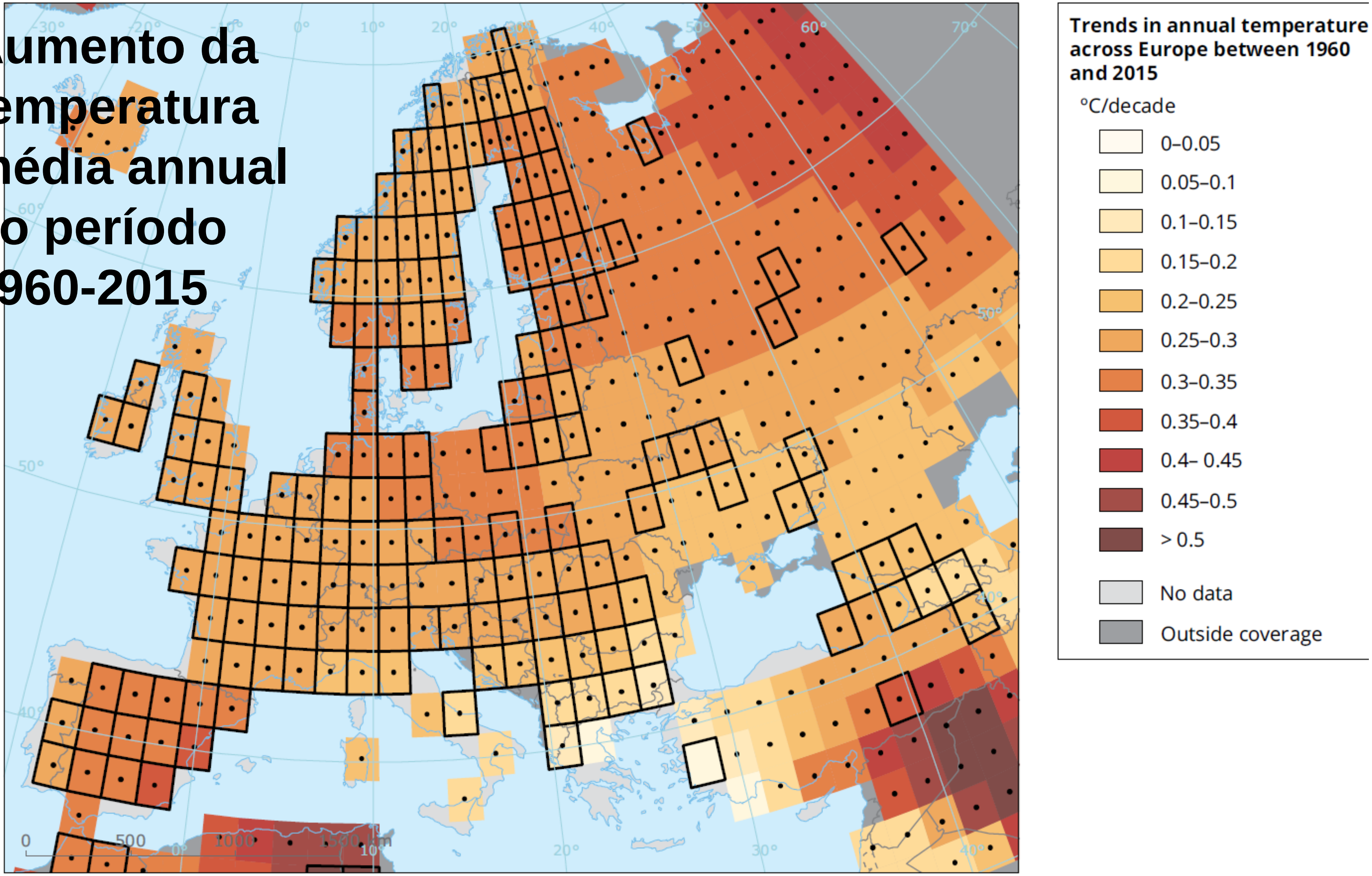
Caso as estimativas do consórcio se confirmem, e atendendo à atual cotação do crude, as receitas potenciais são de 57 mil milhões de euros. Nos 30 anos de concessão o Estado poderá receber 4 mil milhões de royalties.

O primeiro furo, a 46 quilómetros de Aljezur, será feito no final do ano. O teste deverá ter a duração de 46 dias, estimando-se um custo de pelo menos 37 milhões de euros.

David Simon ✔ @AoDespair
In the pantheon of visual metaphors for America today, this is the money shot. 12:49 PM - Sep 7, 2017

Map 3.3 **Trends in annual temperature across Europe between 1960 and 2015**

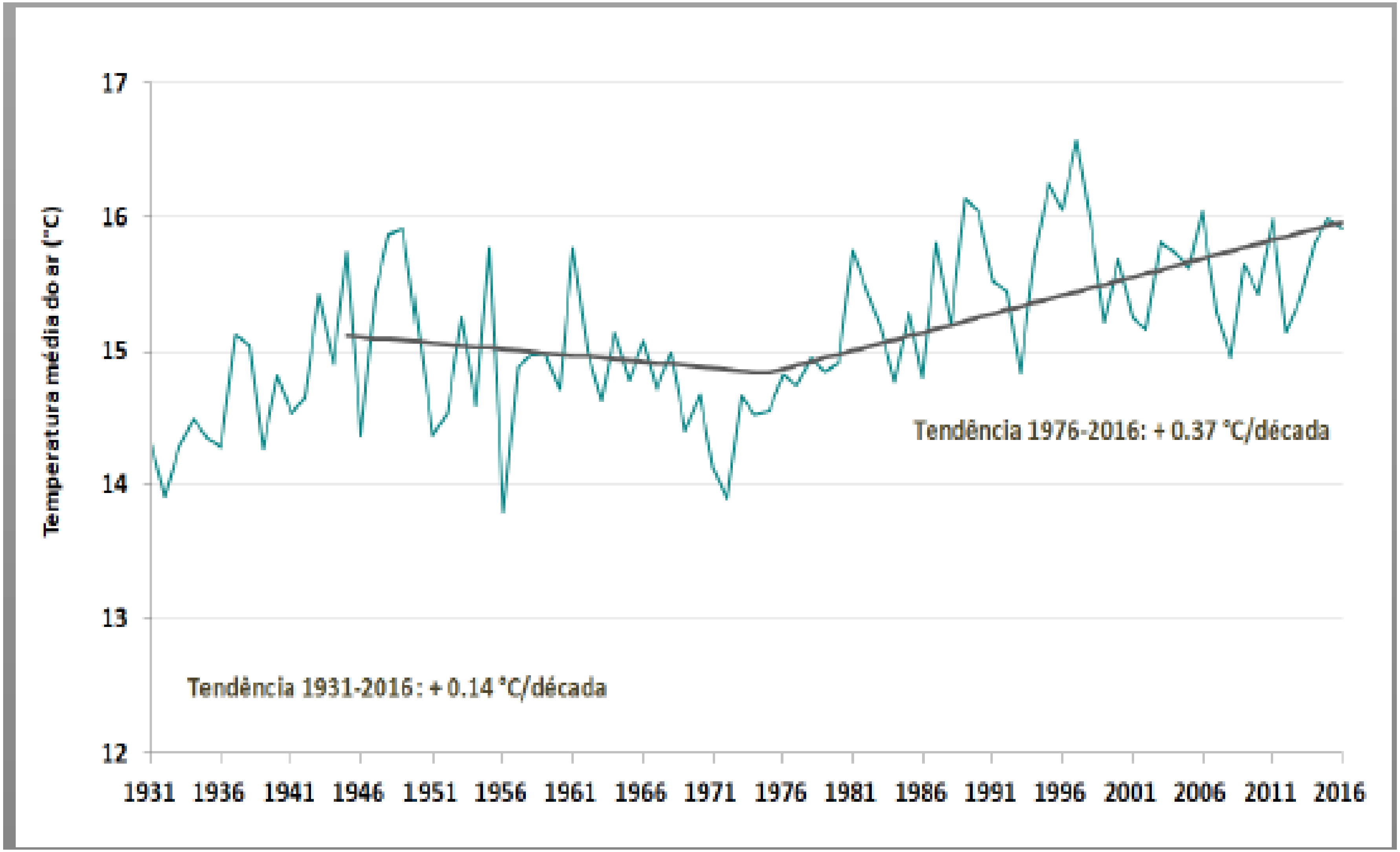
Aumento da temperatura média annual no período 1960-2015



Note: Grid boxes outlined with solid black lines contain at least three stations and so are likely to be more representative of the grid box than those that are not outlined. Significance (at the 5 % level) of the long-term trend is shown by a black dot (which is the case for almost all grid boxes in this map).

Source: EEA and UK Met Office, based on the E-OBS dataset (updated from Haylock et al., 2008).

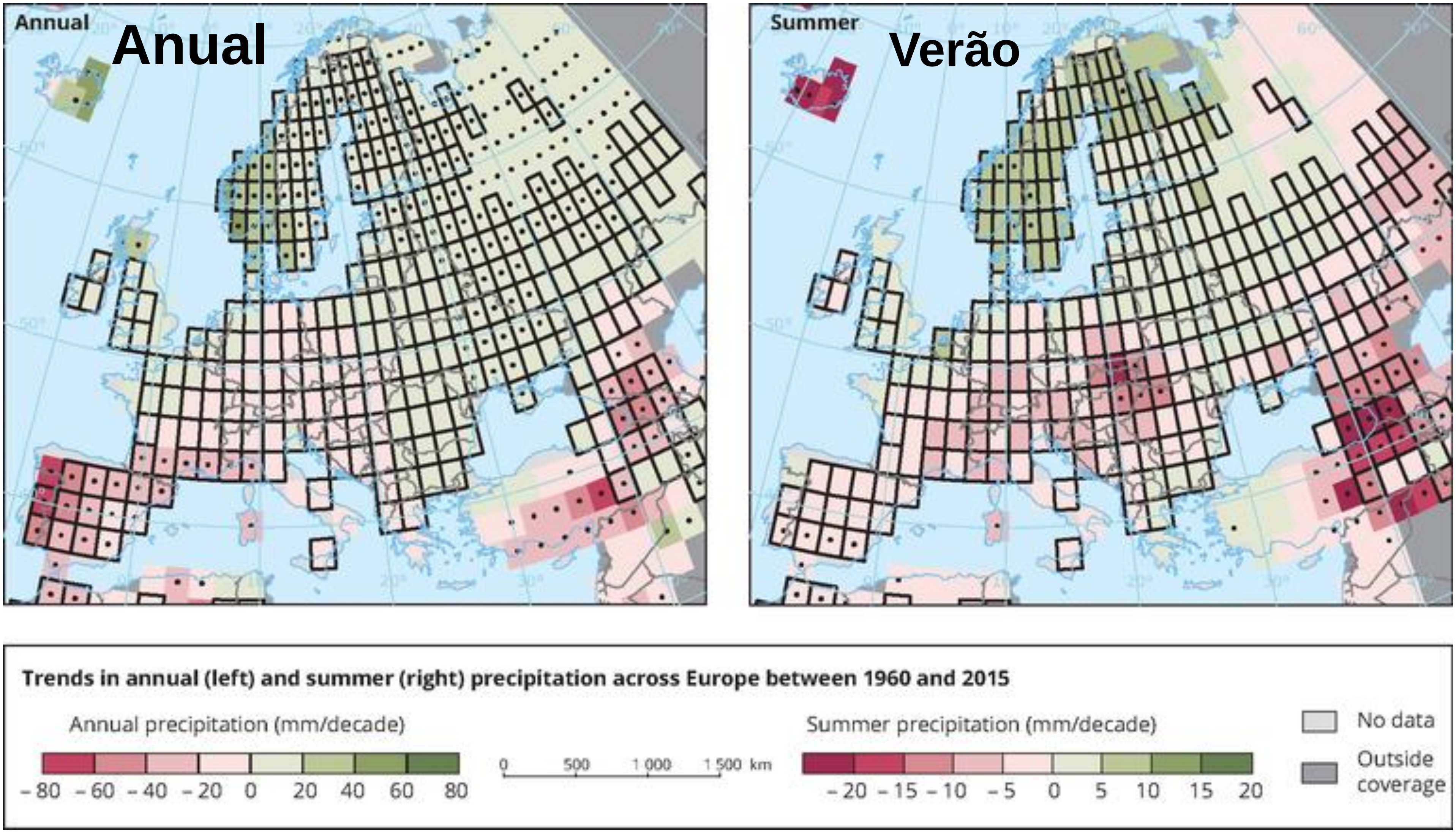
Fonte, EEA, 2016



Aumento da temperatura media de 0,14ºC por década no período de 1931-2016, e de 0,4 ºC por década desde meados da década de 1970

Fonte: IPMA

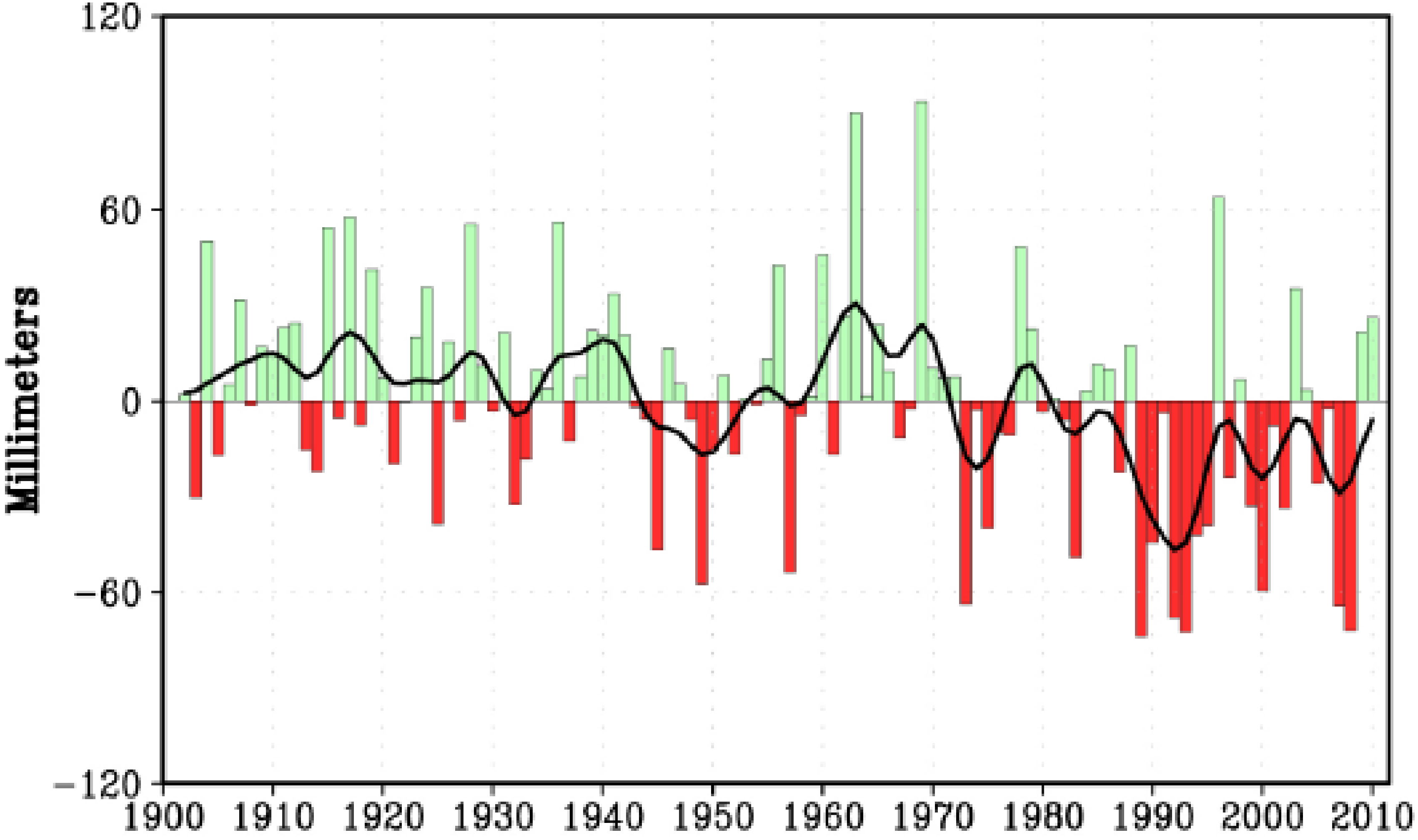
Variação da precipitação média por década no período de 1960 a 2015



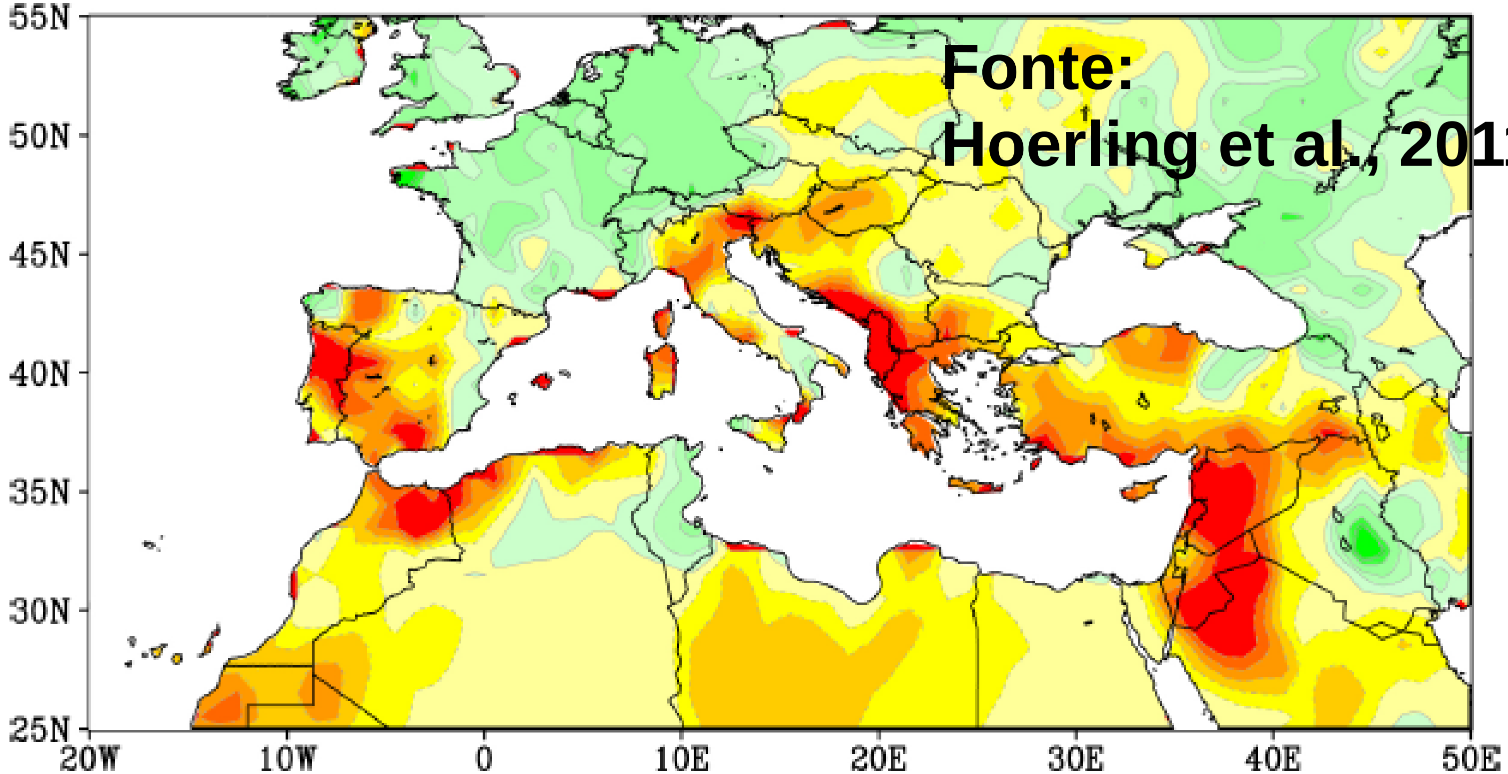
Fonte, EEA, 2016

Em Portugal, redução media de 40mm por década

Precipitação no Mediterrâneo nos meses de Novembro a Abril de 1902 a 2010



Hoerling et al., 2011



Precipitação de 1971 a 2010 menos a de 1902 a 1970

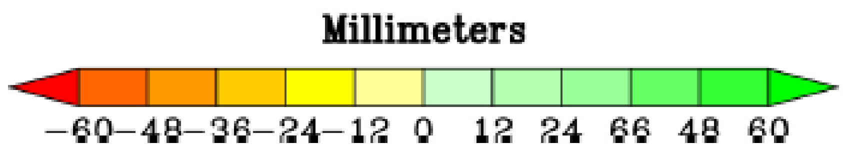
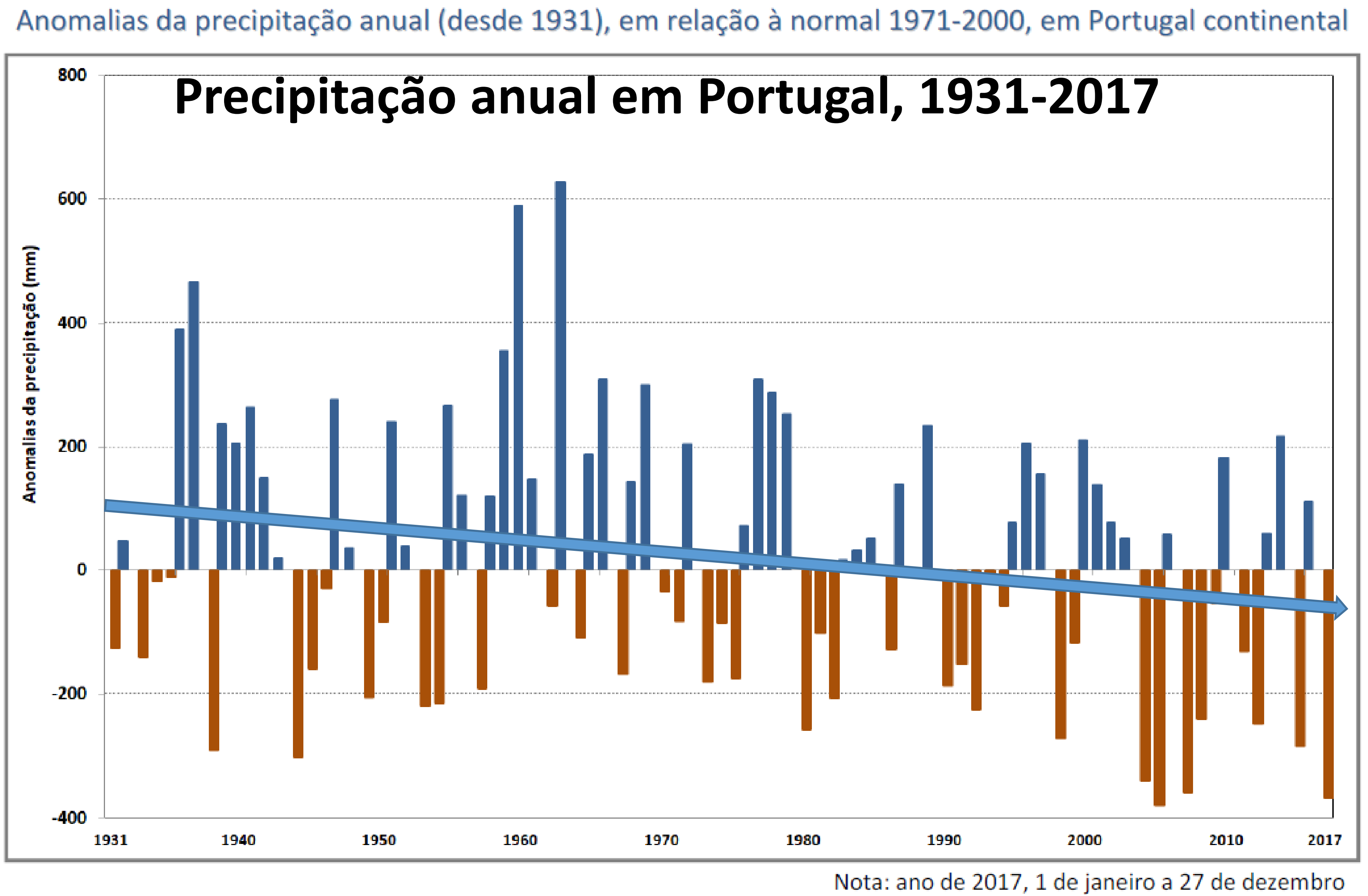


Figure 1. *Observed time series of Mediterranean (30N-45N; 10W-40E) cold season (Nov-Apr) precipitation for the period 1902-2010 (top) and the observed change in cold season precipitation for the period 1971-2010 minus 1902-1970 (bottom). Anomalies (mm) are relative to the 1902-2010 period. Solid curve is the smoothed precipitation time series using a 9-pt Gaussian filter. Data is from the Global Precipitation Climatology Center (GPCC).*

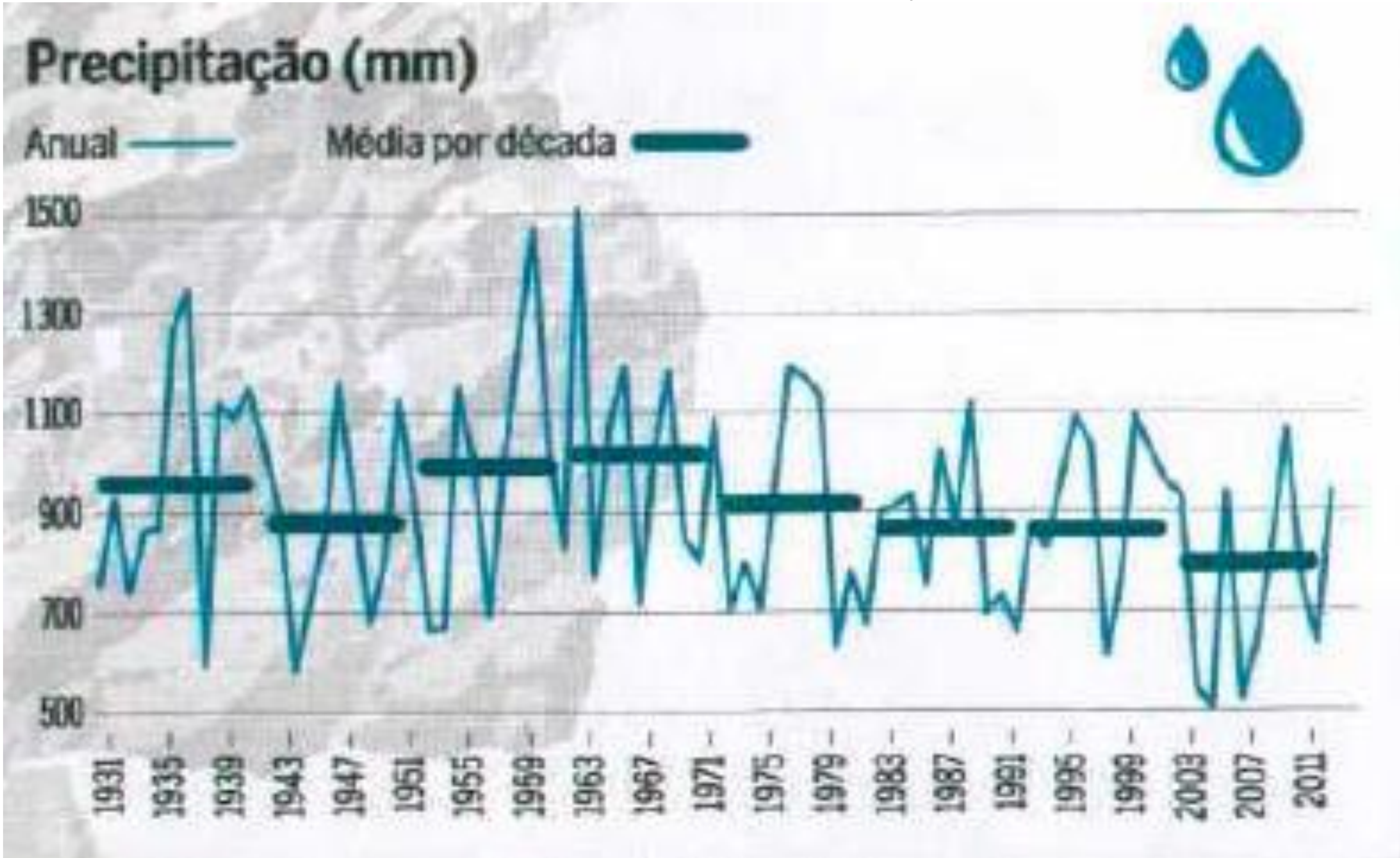
Fonte: Hoerling et al., 2011



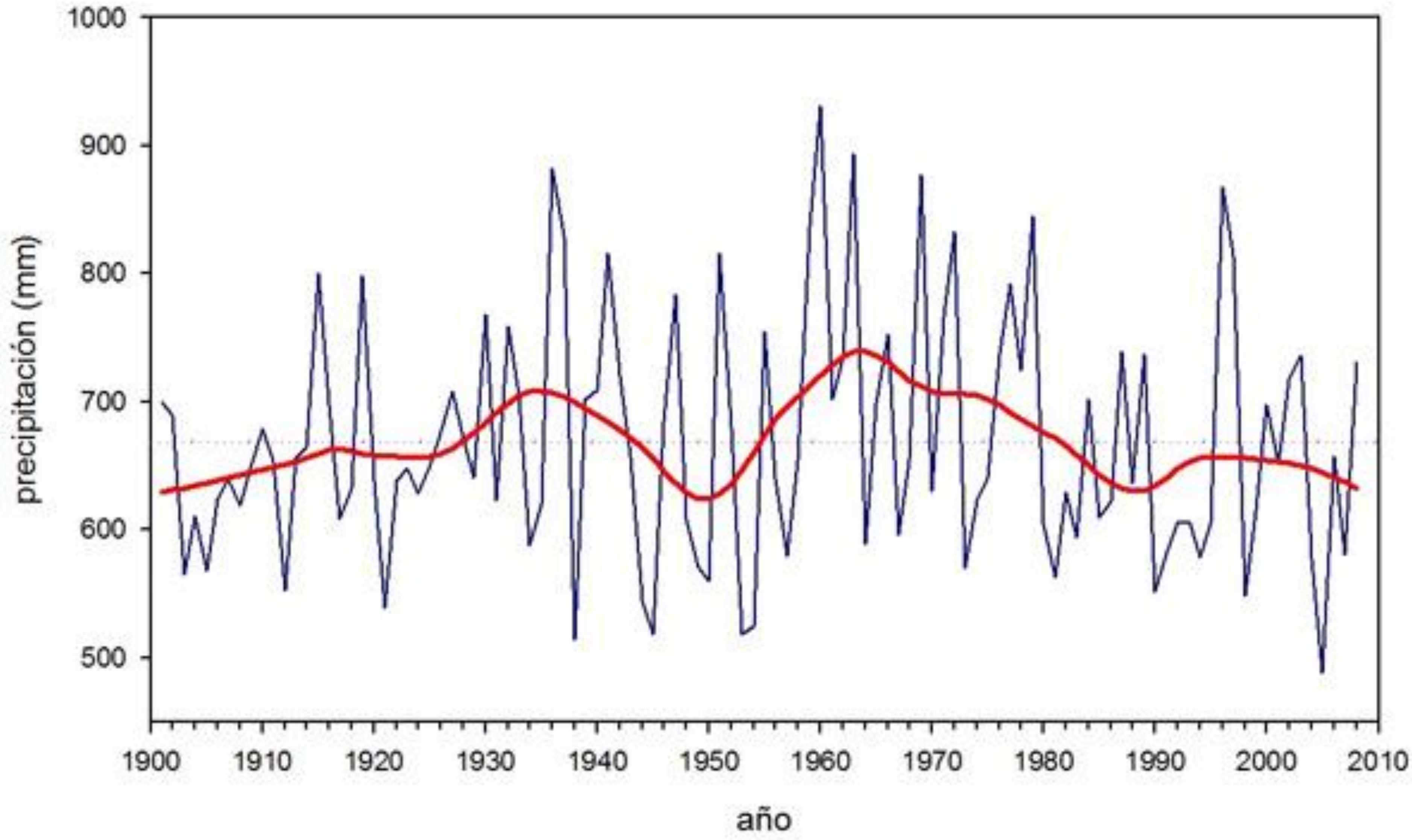
Anomalias da precipitação anual (desde 1931), em relação à normal 1971-2000, em Portugal continental
Precipitação anual em Portugal, 1931-2017
Anomalias da precipitação (mm)
800
600
400
200
0
-200
-400
1931
1940
1950
1960
1970
1980
1990
2000
2010
2017
Nota: ano de 2017, 1 de janeiro a 27 de dezembro

Fonte: IPMA

Fonte, IPMA

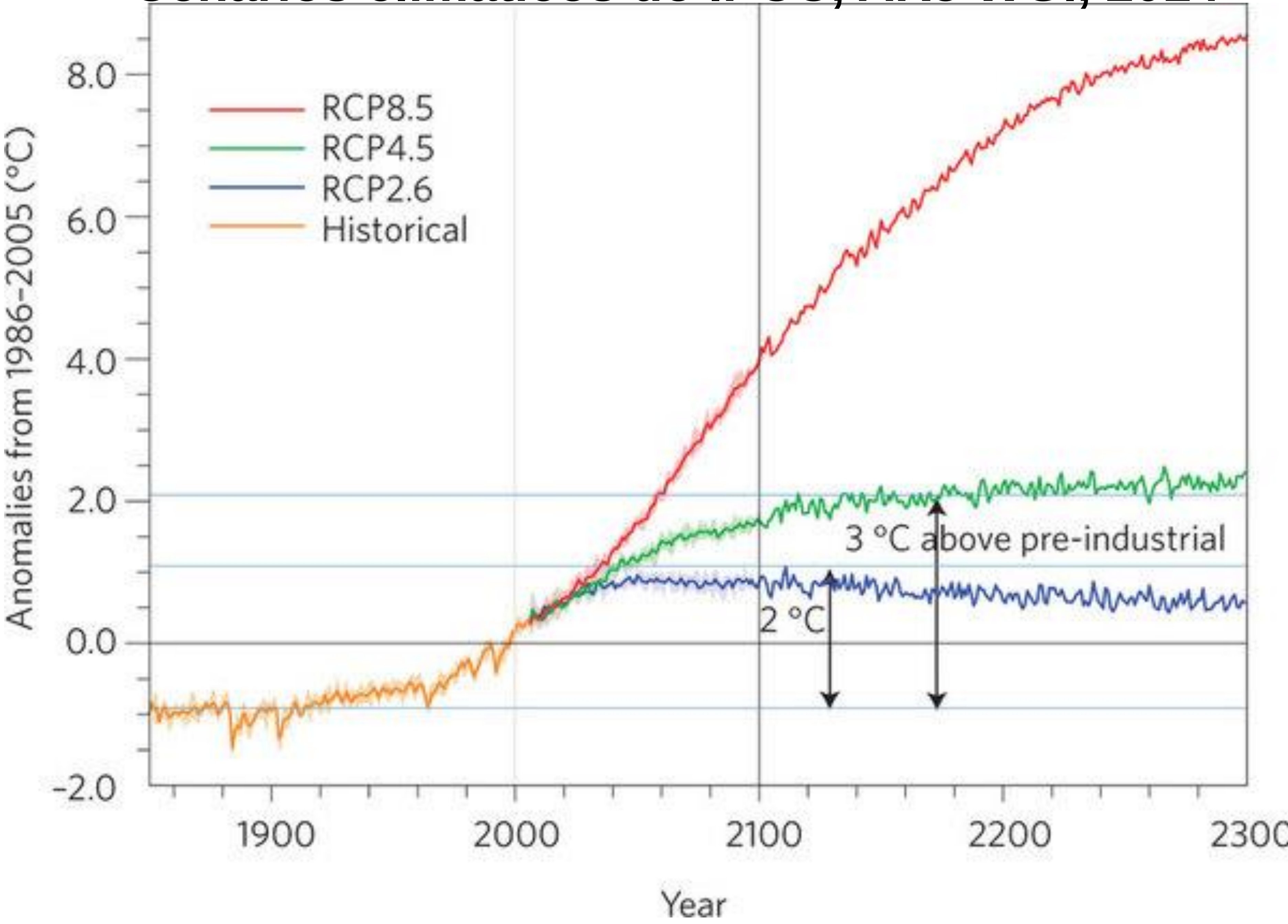


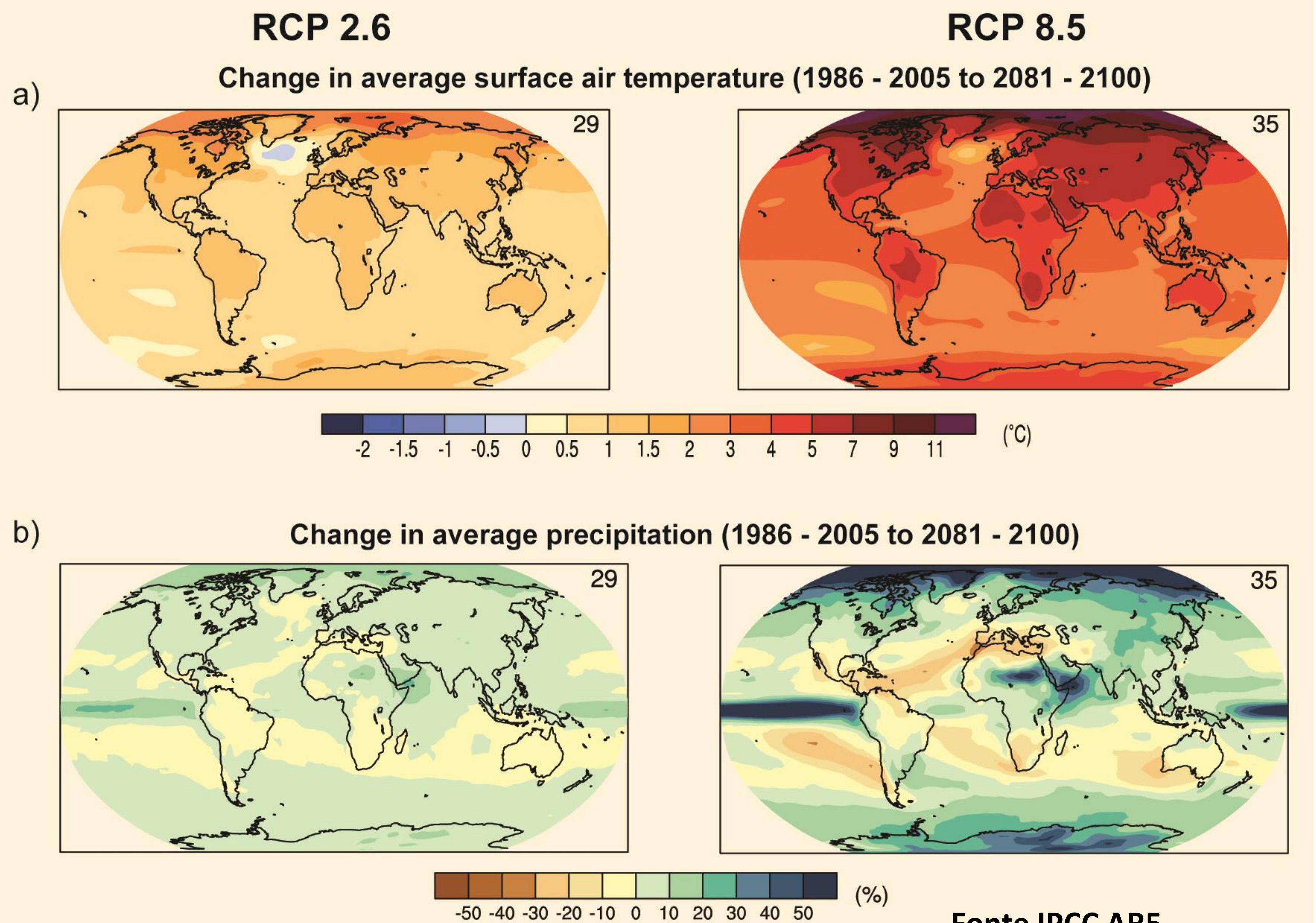
Variação decadal da precipitação em Portugal Continental



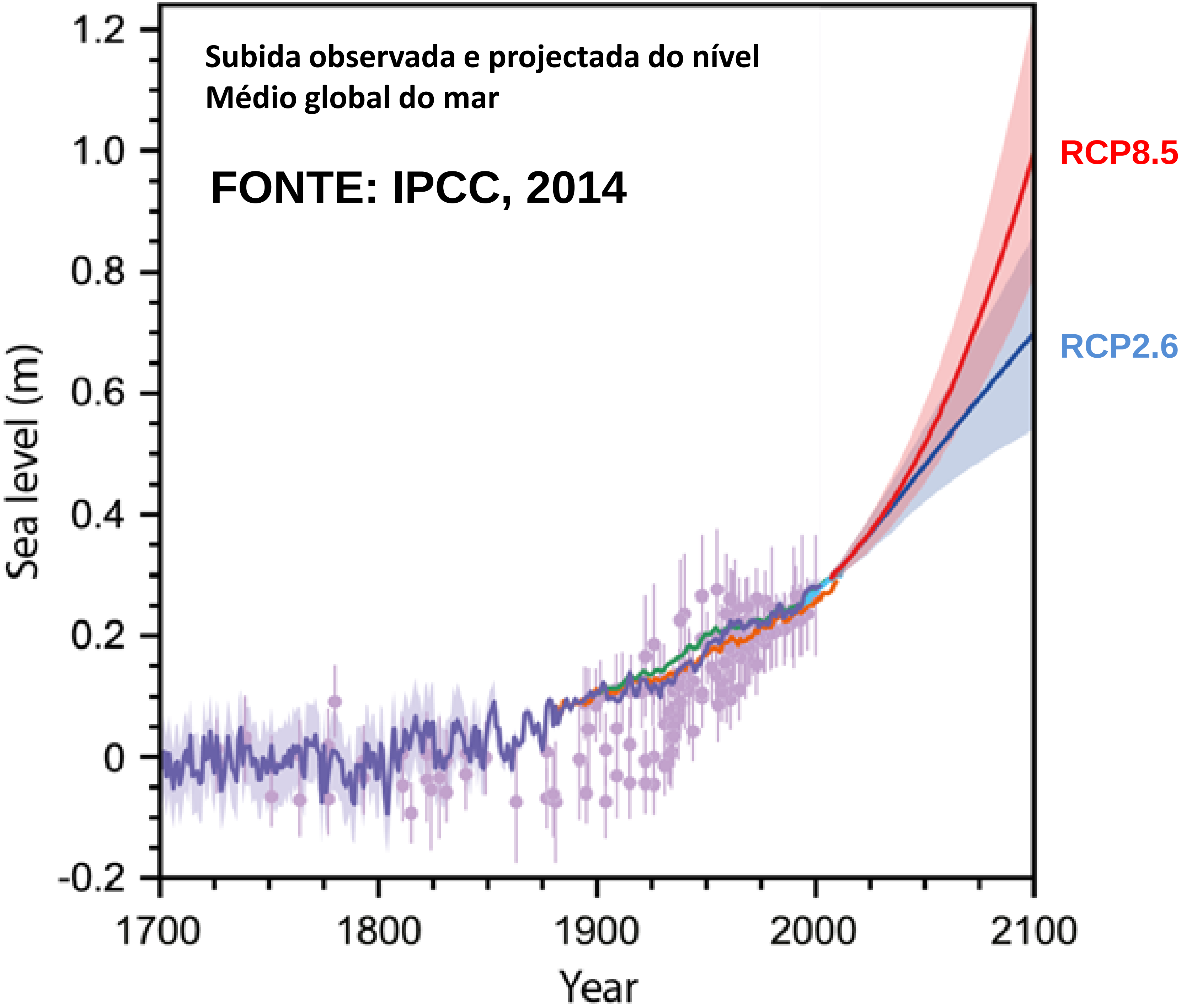
Evolução da precipitação na Espanha Peninsular 1900-2010
Evolución de la precipitación acumulada anual a partir de las series reconstruidas Fonte: AEMET, Espanha

Cenários climáticos do IPCC, AR5 WGI, 2014

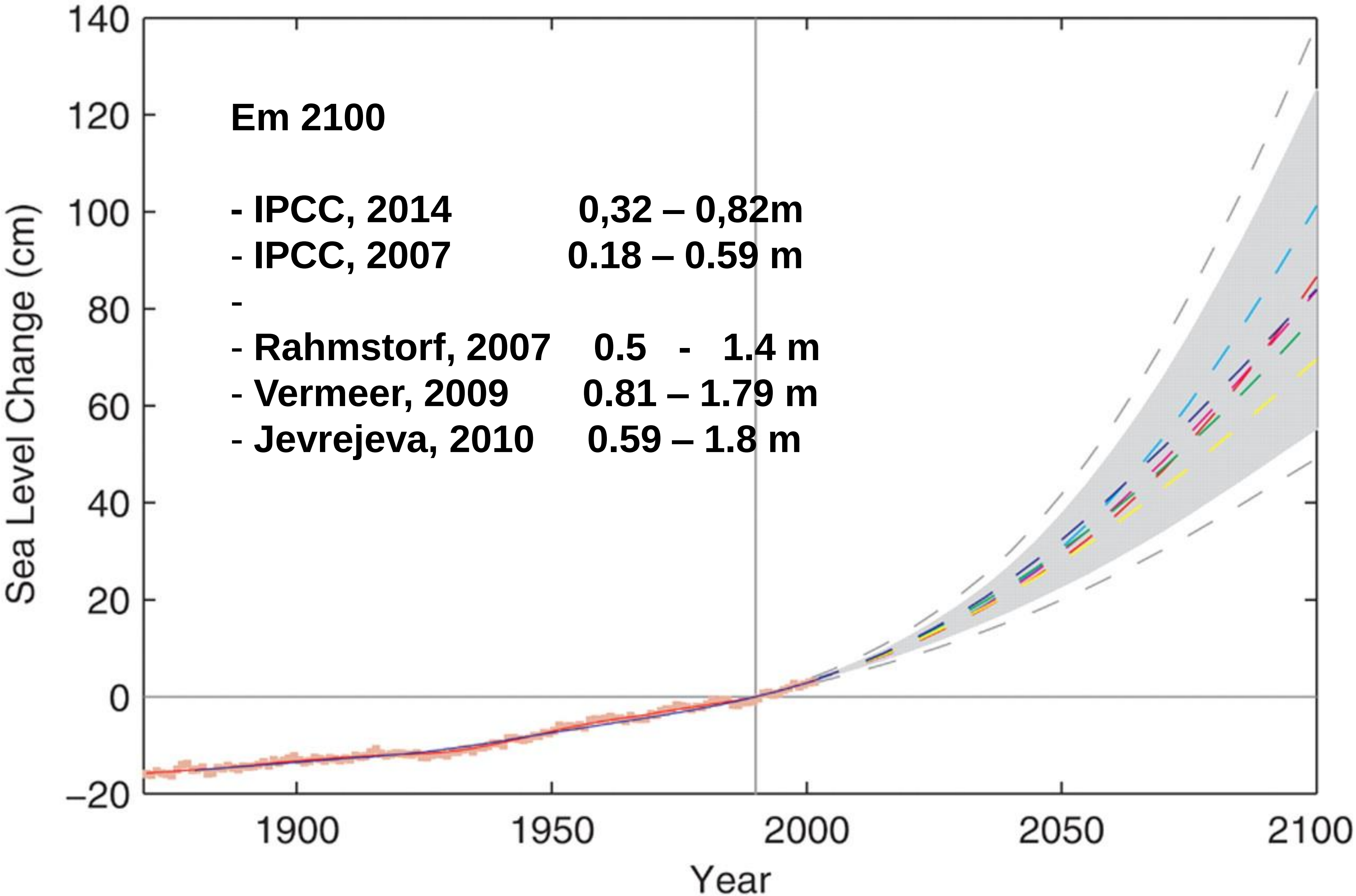




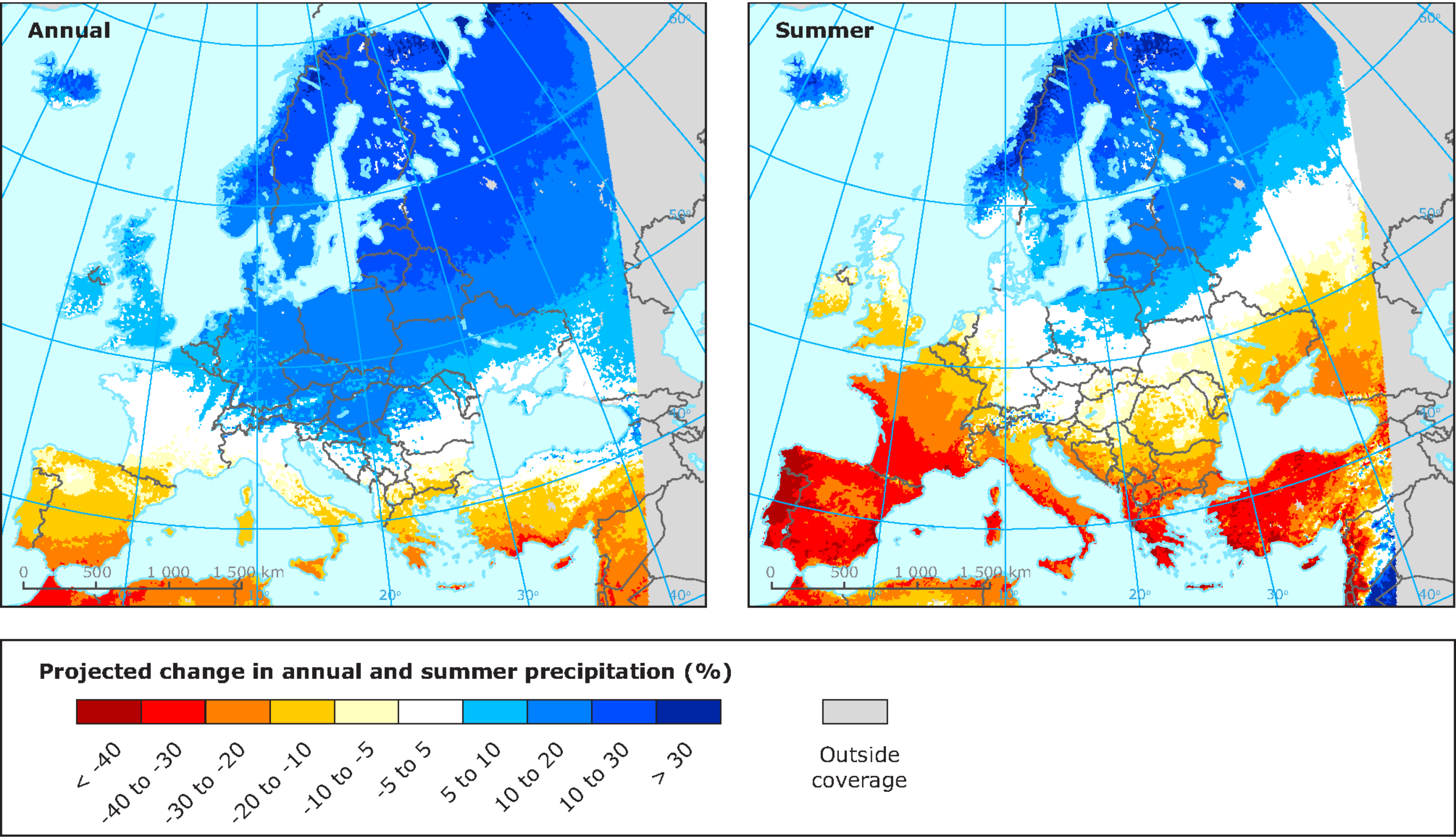
Fonte IPCC AR5



Subida observada e projectada do nível
Médio global do mar
FONTE: IPCC, 2014
RCP8.5
RCP2.6
Sea level (m)
1.2
1.0
0.8
0.6
0.4
0.2
0
-0.2
1700
1800
1900
2000
2100
Year



Rahmstorf, 2007



Projected changes in annual (left) and summer (right) precipitation (%) in the period 2071-2100 compared to the baseline period 1971-2000 for the forcing scenario RCP 8.5. Model simulations are based on the multi-model ensemble average of RCM simulations from the EURO-CORDEX initiative.