A Adaptação do Setor Saúde às Alterações Climáticas no Sul da Europa e em Portugal

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FCUL – Faculdade de Ciências da Universidade de Lisboa

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

Seminário "A Adaptação às Alterações Climáticas no Setor Saúde"

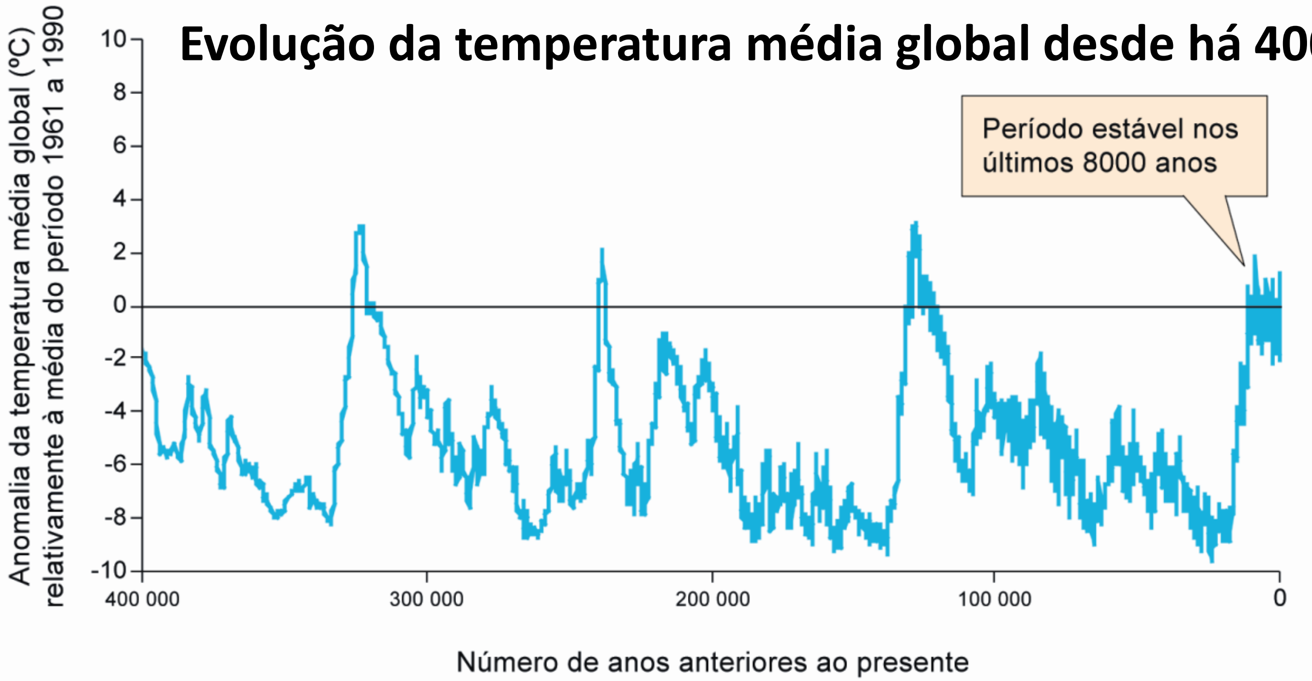
Serviço Nacional de Saúde

Direção-Geral de Saúde

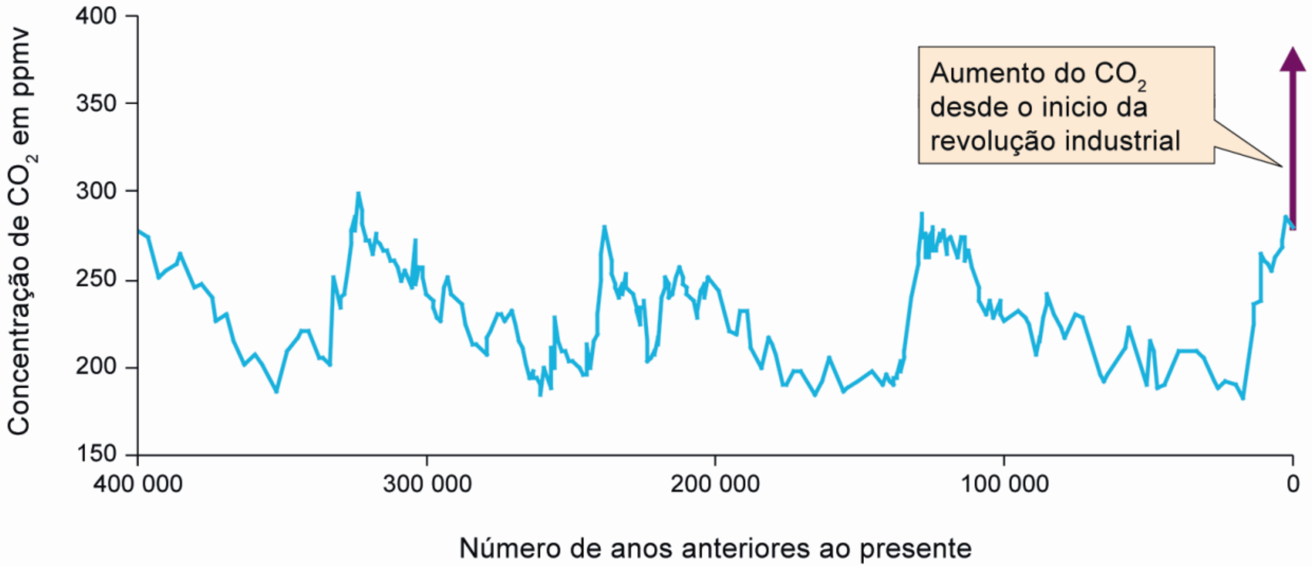
Fundação Calouste Gulbenkian

Lisboa, 20 de novembro, 2018

Evolução da temperatura média global desde há 400000 anos



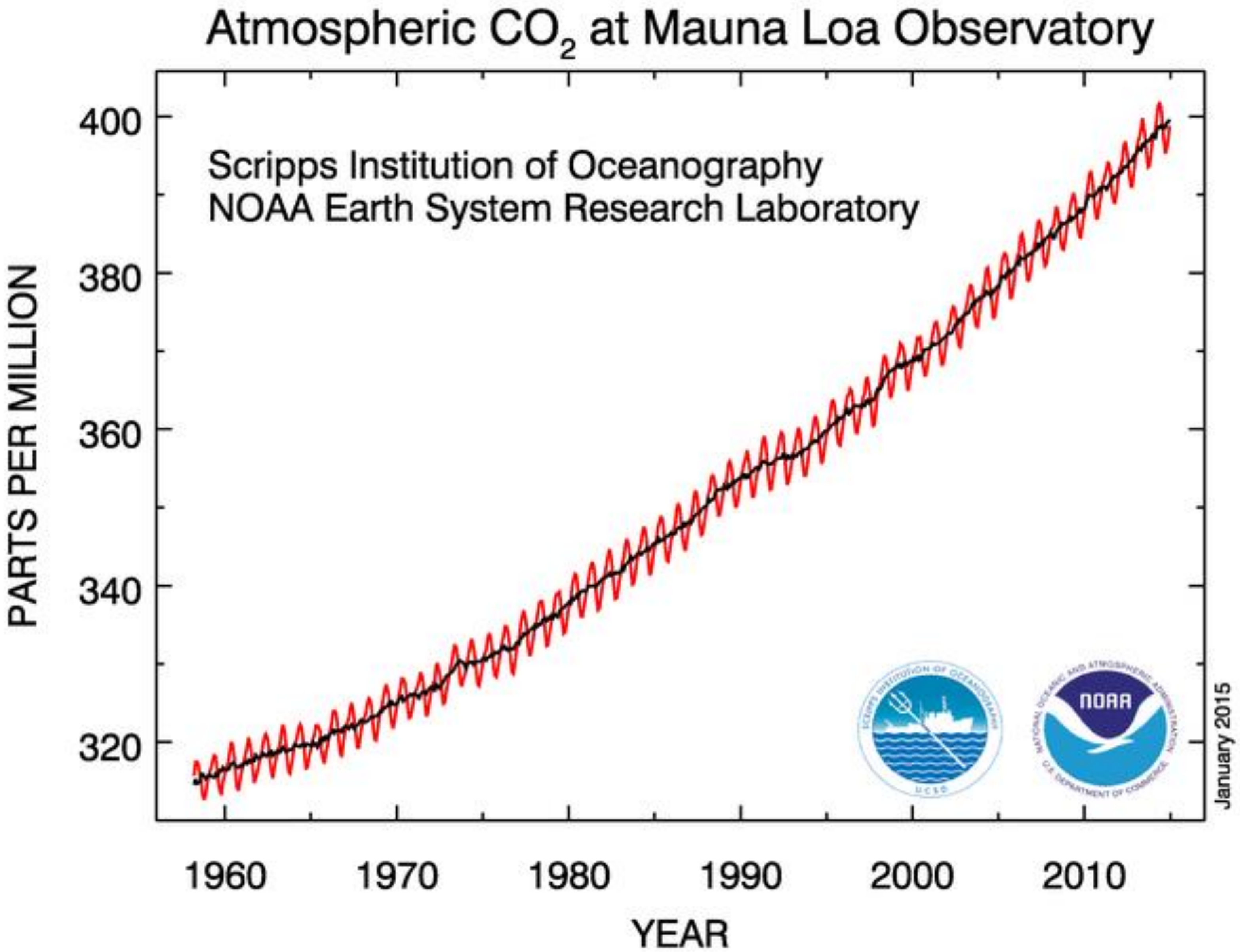
Evolução da concentação atmosférica de CO2



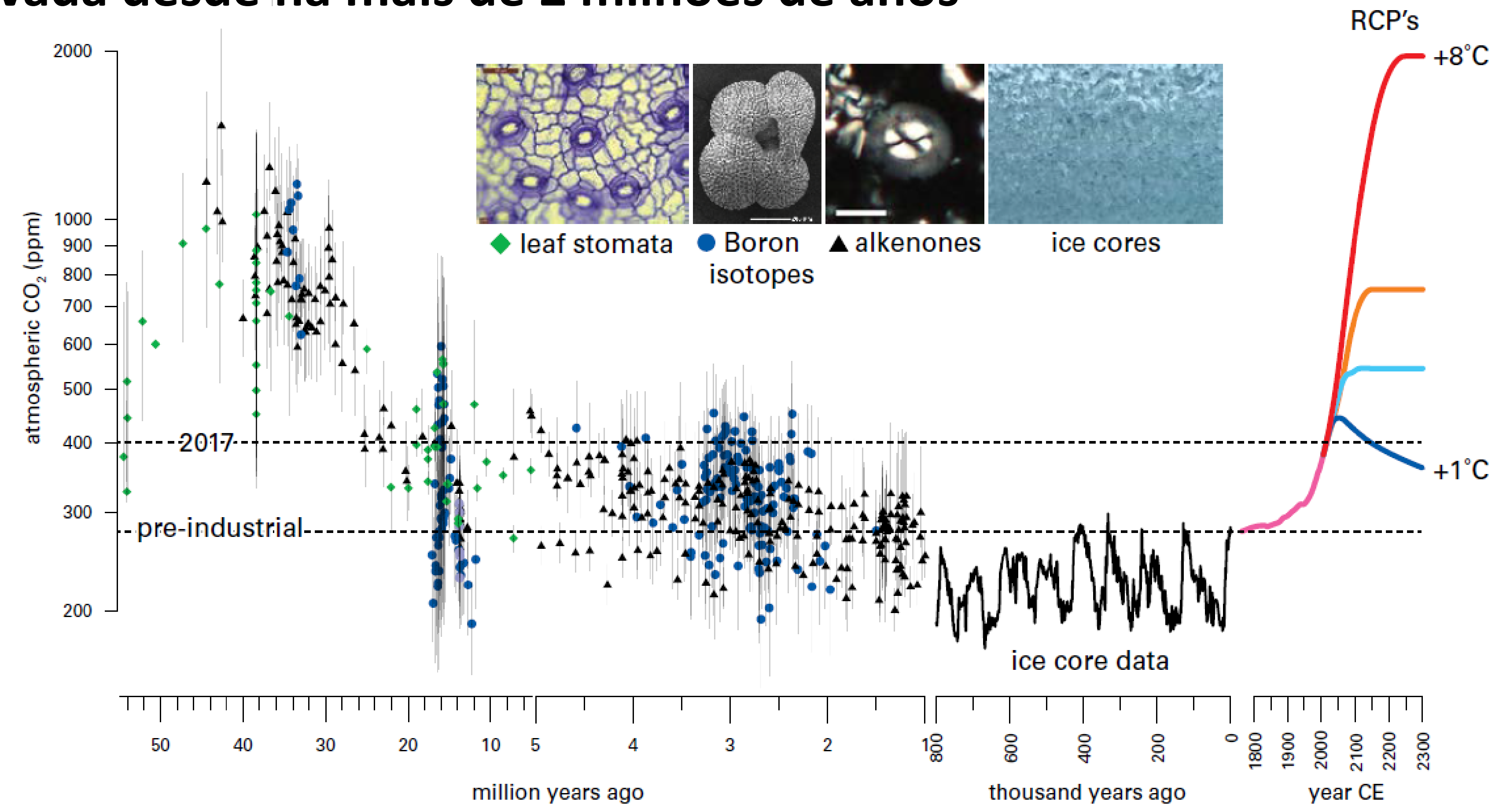
Reconstituição da evolução da temperatura média global da baixa atmosfera, representada por meio da anomalia relativamente à média do período de 1961 a 1990, e da concentração atmosférica do CO2 nos últimos 400 000 anos (Petit, 1999). Figura adaptada de EEA, 2004. Repare-se na correlação que se observa entre os dois registos. O aumento da concentração do CO2 a partir da revolução industrial e até ao presente está indicado por um vector aproximadamente vertical devido à escala de tempo utilizada na figura

Fonte, Petit et al., 1999

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

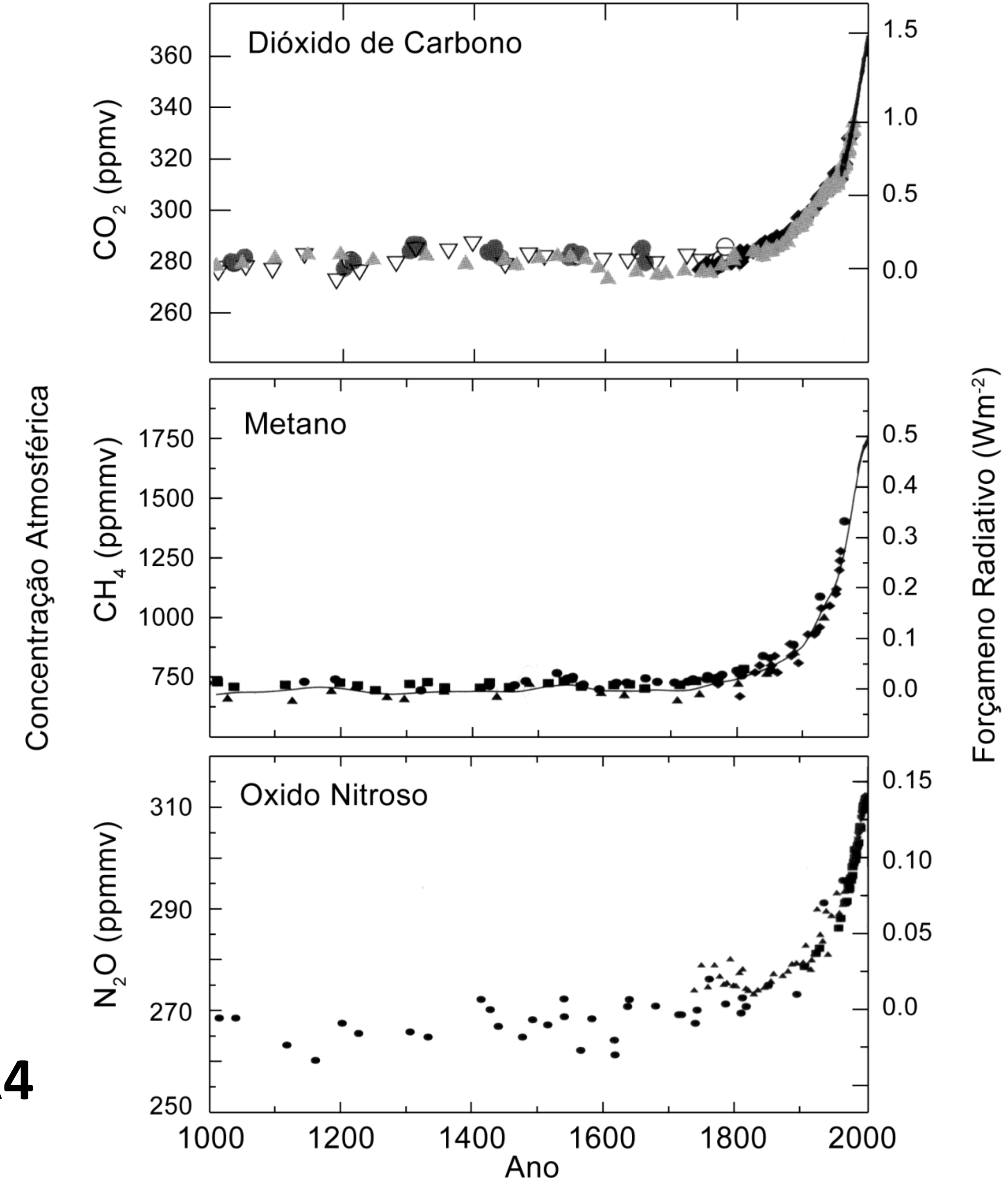


A concentração atmosférica atual (2017) de CO2 é a mais elevada desde há mais de 2 milhões de anos



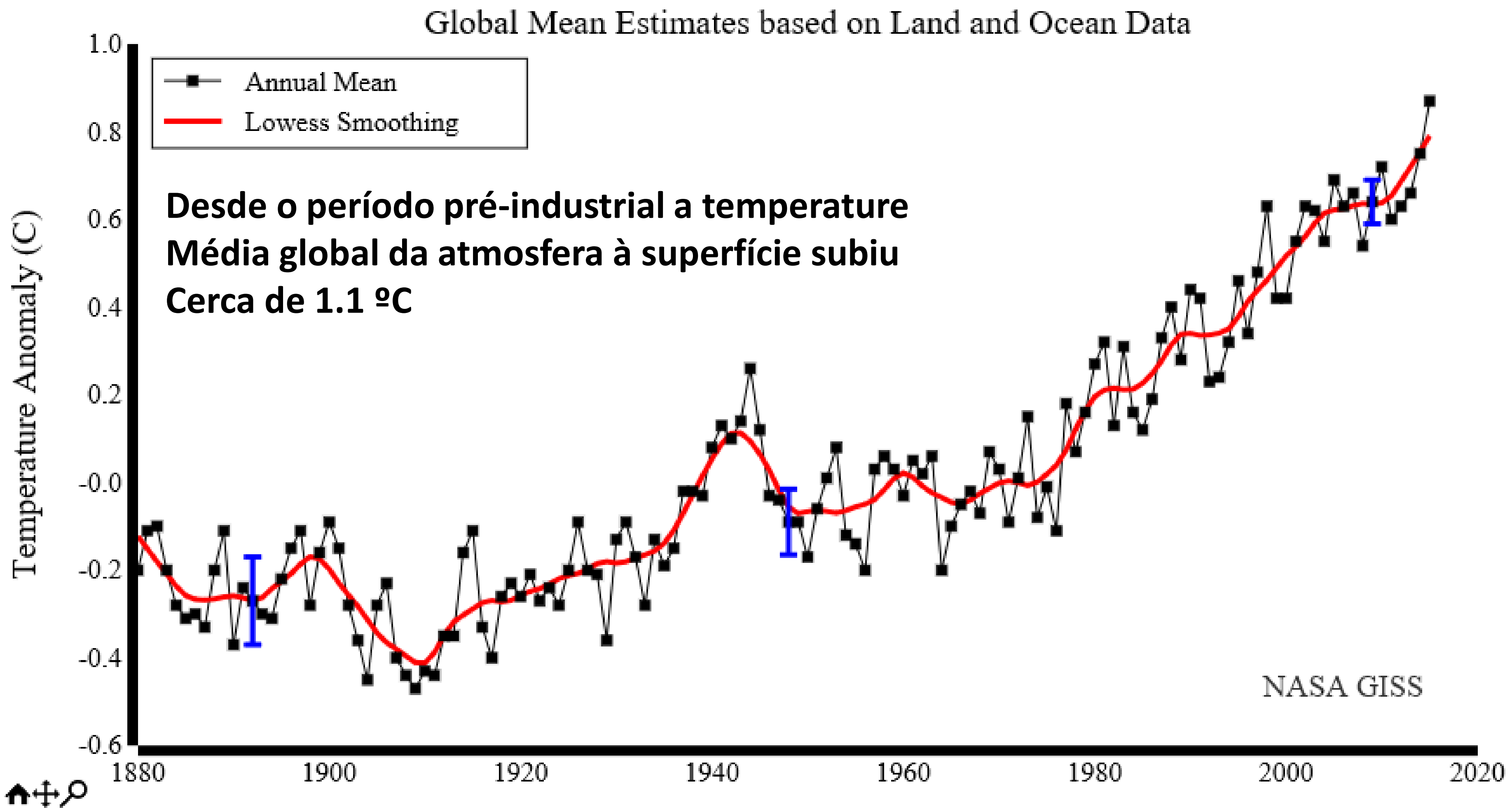
Reconstituição por meio de estudos de paleoclimatologia

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.



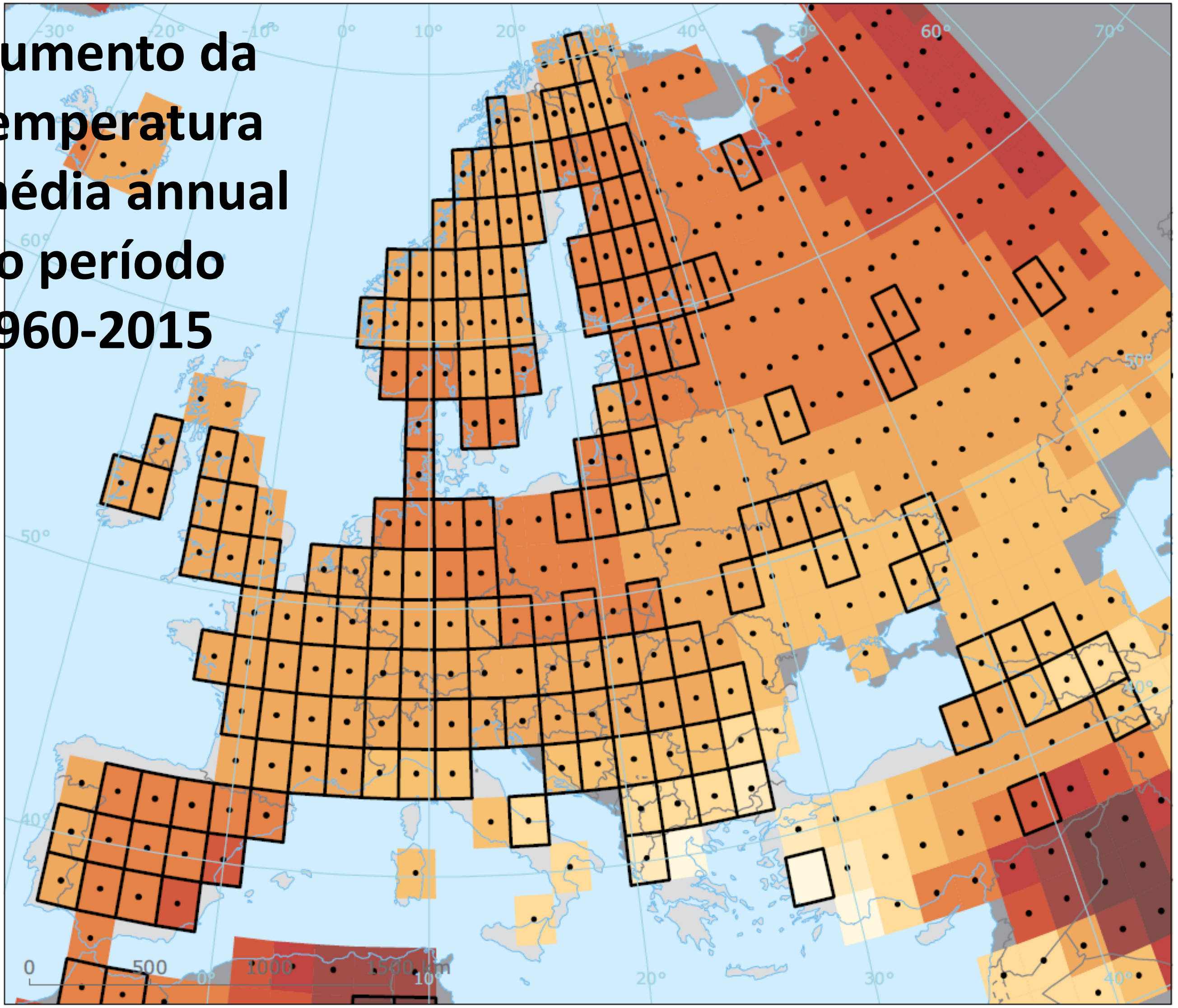
Fonte IPCC AR4

Variação da temperatura média global da atmosfera à superfície desde 1880



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

Aumento da temperatura média annual no período 1960-2015



Trends in annual temperature across Europe between 1960 and 2015

°C/decade

- 0–0.05
- 0.05–0.1
- 0.1–0.15
- 0.15–0.2
- 0.2–0.25
- 0.25–0.3
- 0.3–0.35
- 0.35–0.4
- 0.4– 0.45
- 0.45–0.5
- > 0.5
- No data
- Outside coverage

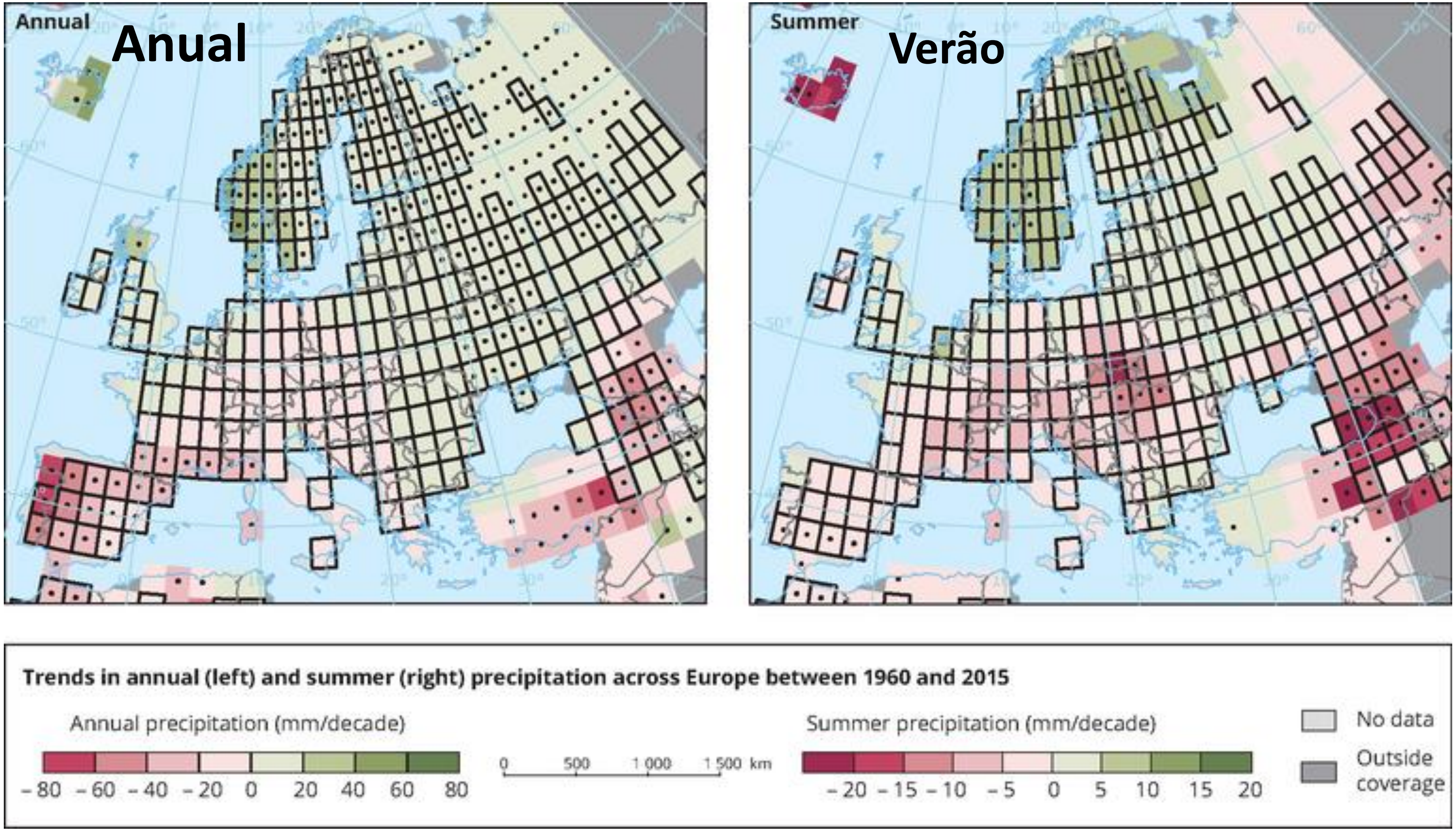
Note: Grid boxes outlined with solid black lines contain at least three stations and so are likely to be more representative of the grid box than those that are not outlined. Significance (at the 5 % level) of the long-term trend is shown by a black dot (which is the case for almost all grid boxes in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

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

Fonte, EEA, 2016

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

Fonte, EEA, 2016

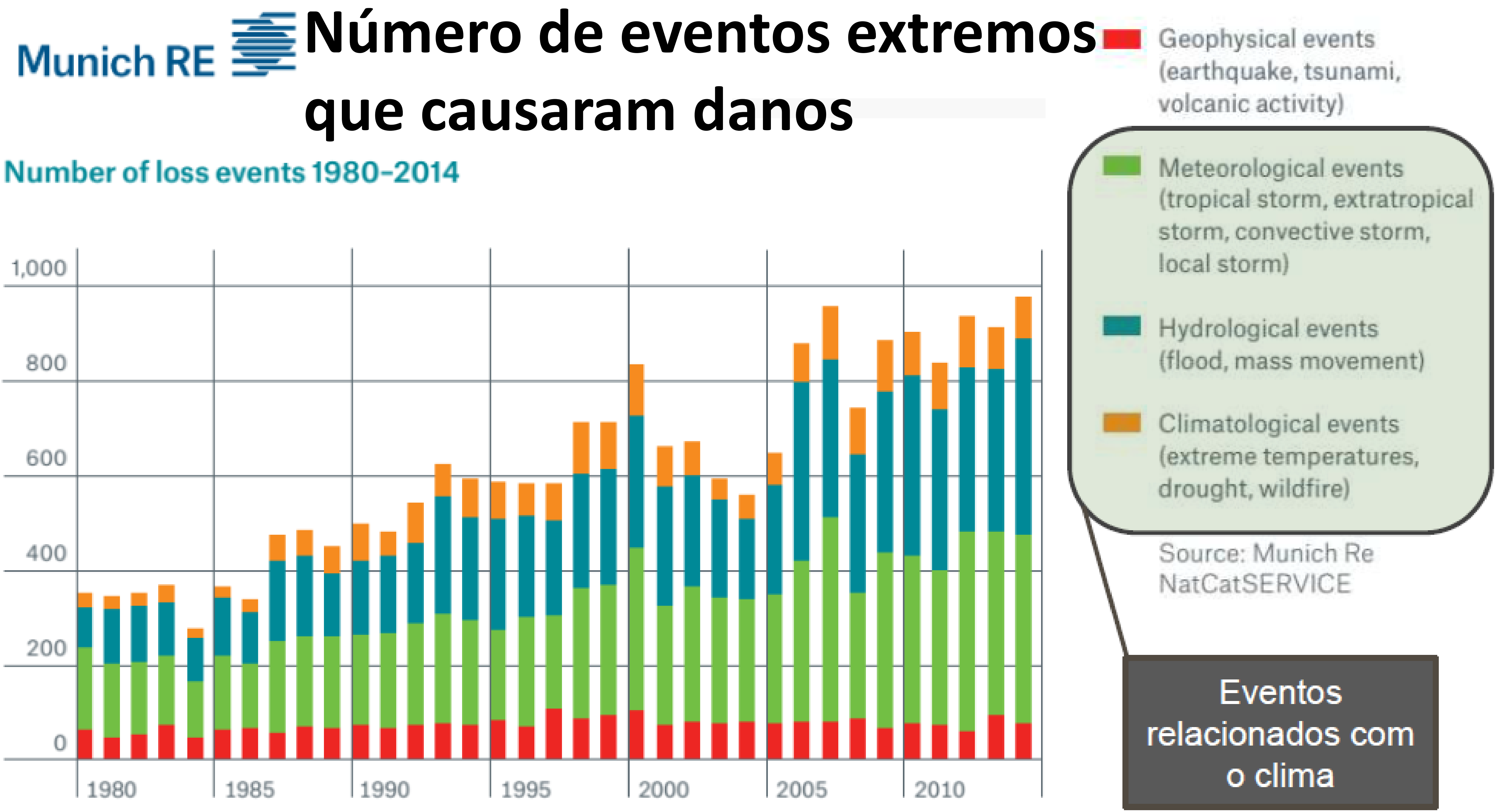


Em Portugal, redução media de 40mm por década

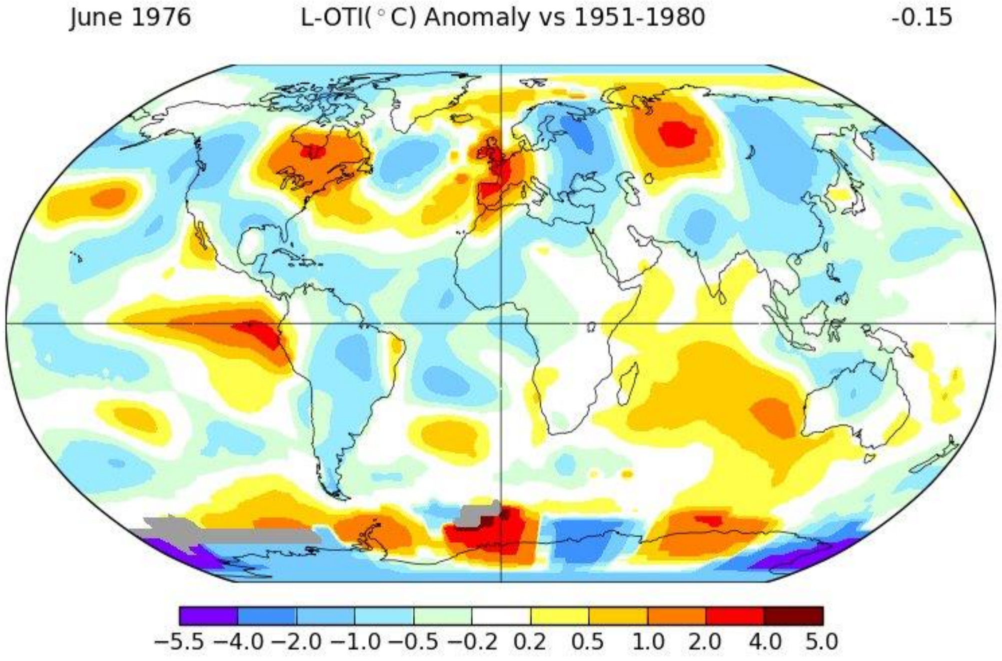
Fonte, IPMA

Variação decadal da precipitação em Portugal Continental

Número de eventos extremos que causaram danos

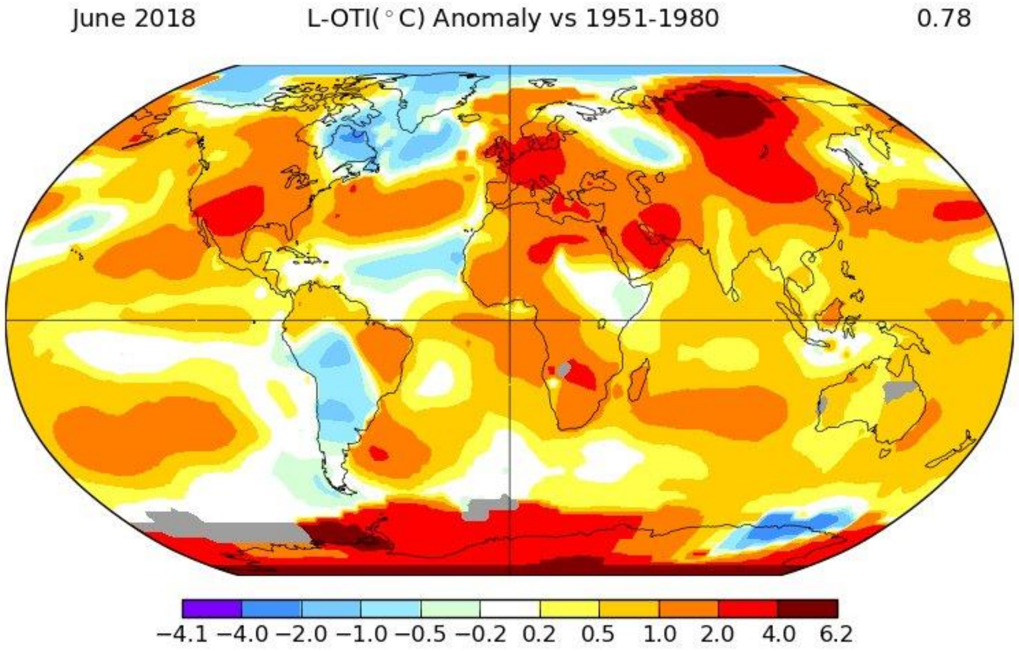


More intense heat waves



June 1976

June 2018



Source: NASA GISS

Onda de calor na Europa em 2003

Observações

Cenário para o passado

Cenário para o futuro

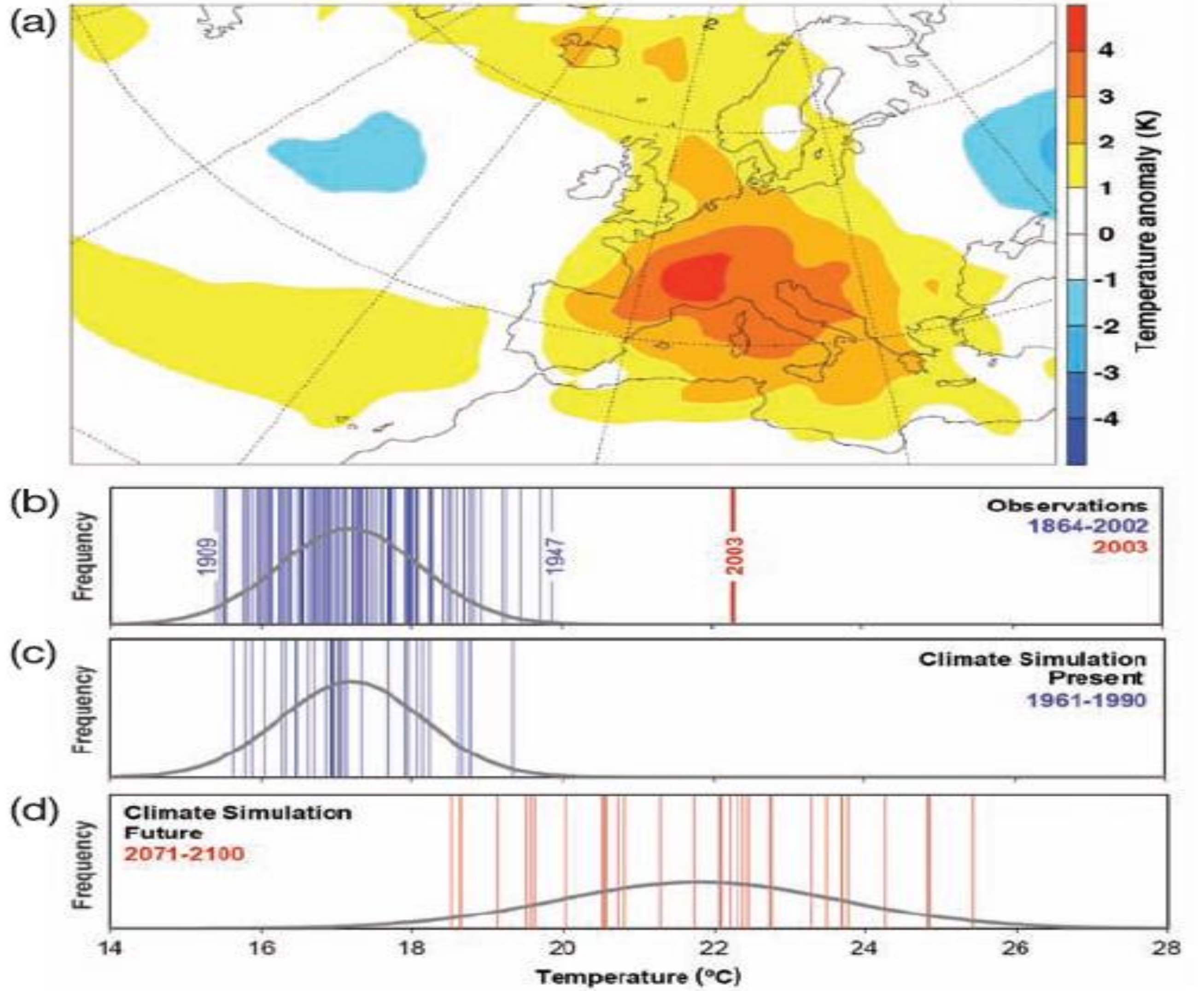


Figure TS.13. *Characteristics of the summer 2003 heatwave: (a) JJA temperature anomaly with respect to 1961-1990; (b-d) June, July, August temperatures for Switzerland; (b) observed during 1864-2003; (c) simulated using a regional climate model for the period 1961-1990; (d) simulated for 2071-2100 under the SRES A2 scenario. The vertical bars in panels (b-d) represent mean summer surface temperature for each year of the time period considered; the fitted Gaussian distribution is indicated in black. Reprinted by permission from Macmillan Publishers Ltd. [Nature] (Schär et al., 2004), copyright 2004, [F12.4].*

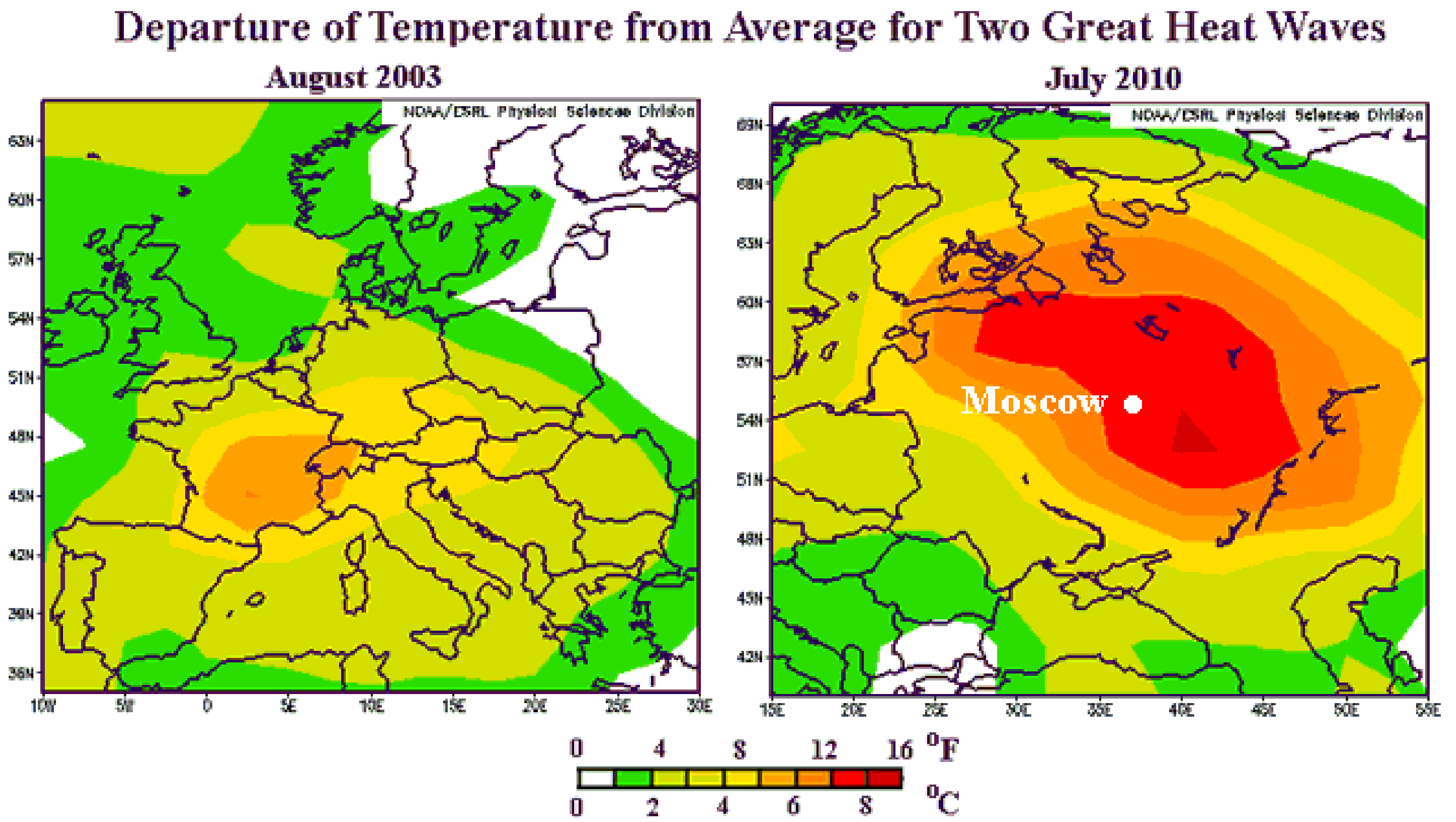
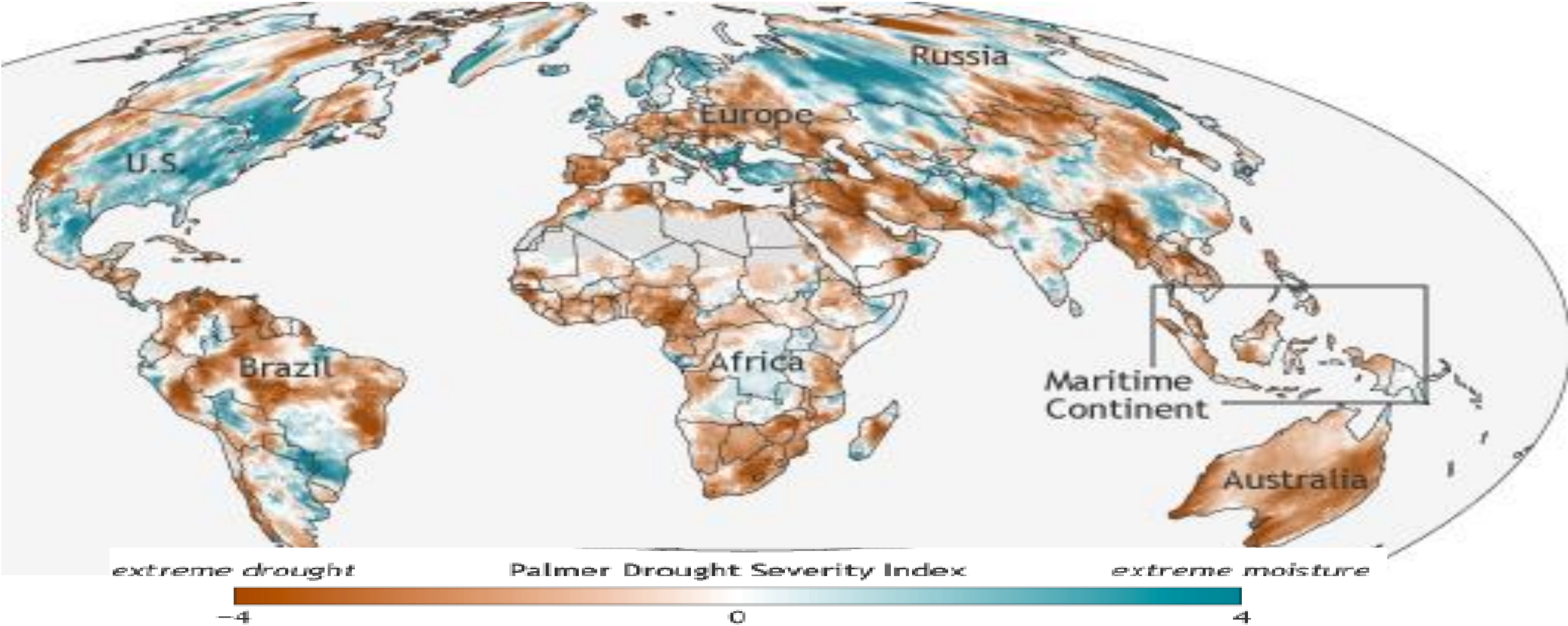


Figure 1. A comparison of August temperatures, the peak of the great European heat wave of 2003 (left) with July temperatures from the Great Russian Heat Wave of 2010 (right) reveals that this year's heat wave is more intense and covers a wider area of Europe.

Impactos na saúde das inundações e cheias

- **Immediate deaths and injuries**
- **Low income countries --Infectious diseases** - leptospirosis, cholera and diarrhoeal diseases, hepatitis, respiratory diseases, vector-borne diseases e.g. Rift Valley fever, malaria.
- **Secondary to economic losses**
- **Long term mental health effects** Depression, suicide

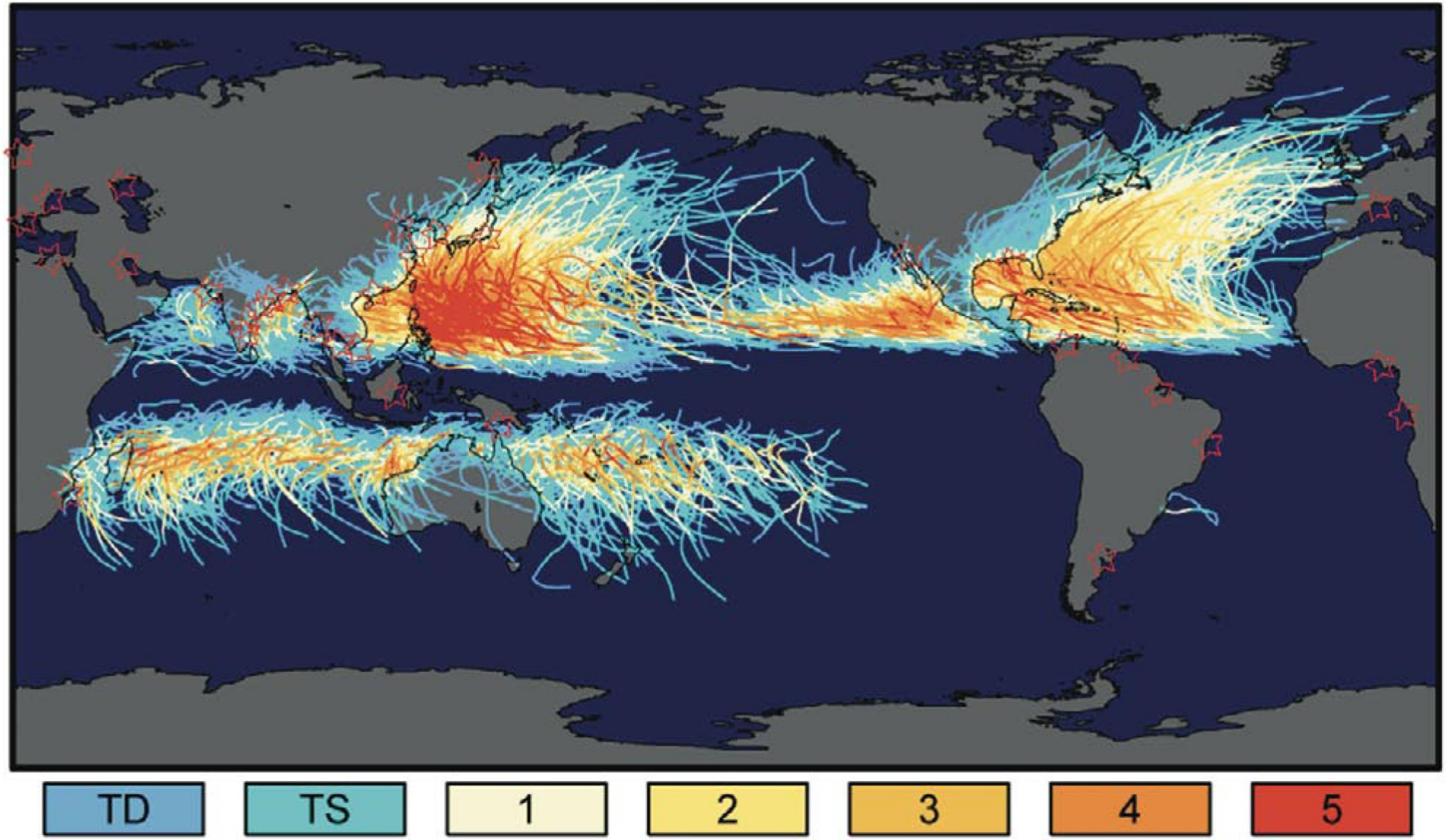


Secas em 2015 à escala global

14% da área terrestre estiveram nesse ano em seca severa ou extrema, a percentagem mais elevada de área desde que começaram os registos deste indicador em 1950

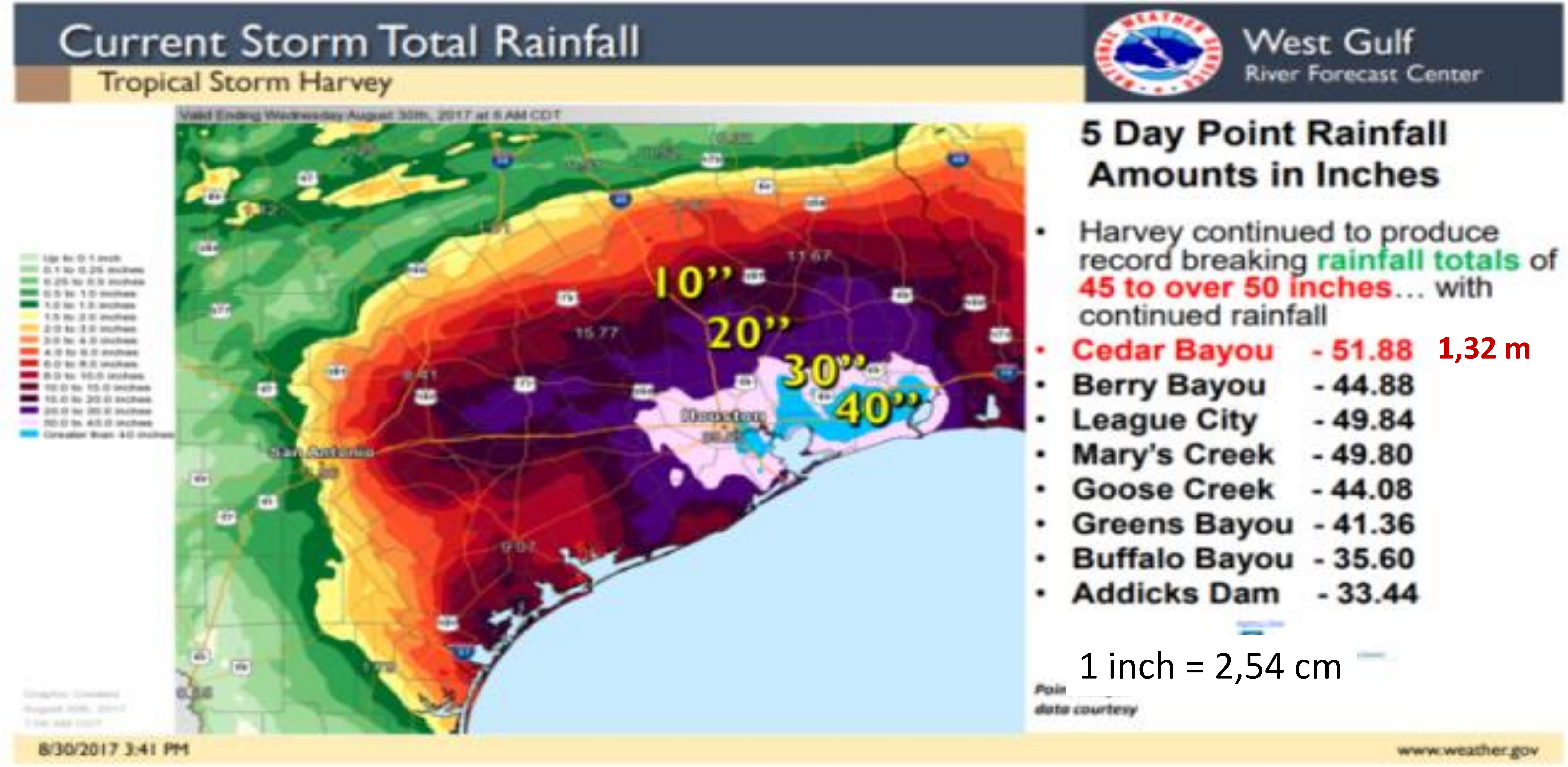
FONTE: https**climate.gov/print/816791**

Tracks and Intensity of All Tropical Storms



Saffir-Simpson Hurricane Intensity Scale

Record breaking rainfall from Hurricane Harvey



1,32 m

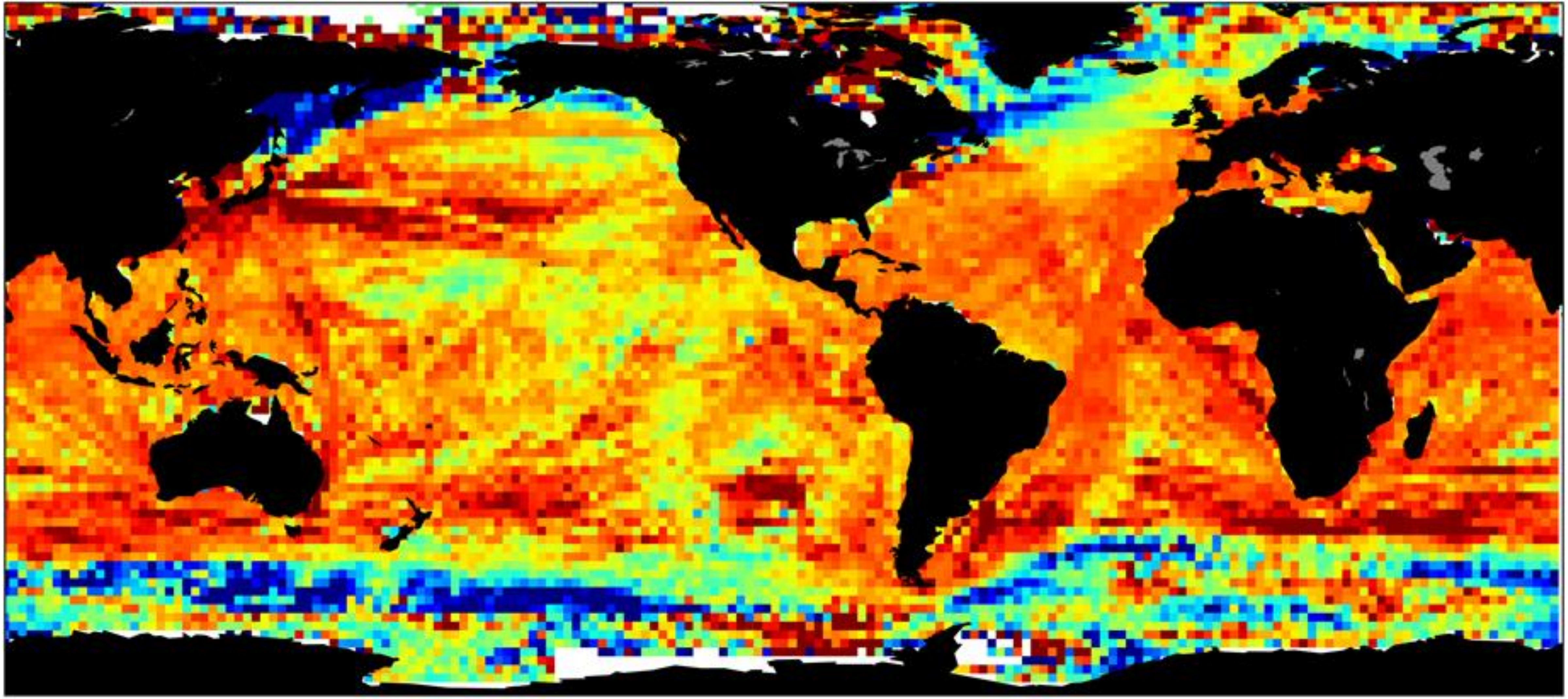
1 inch = 2,54 cm

Hurricane Sandy, Queens, New York City, 22 - 31 October 2012

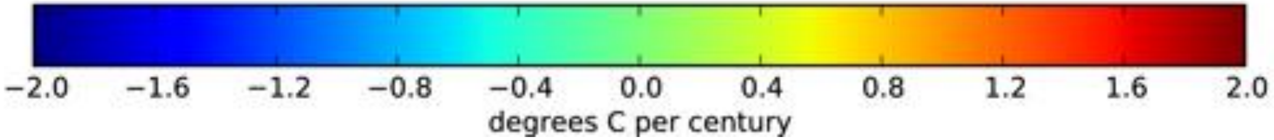
http://darkroom.baltimoresun.com/2012/11/aerial-images-of-sandys-destruction/

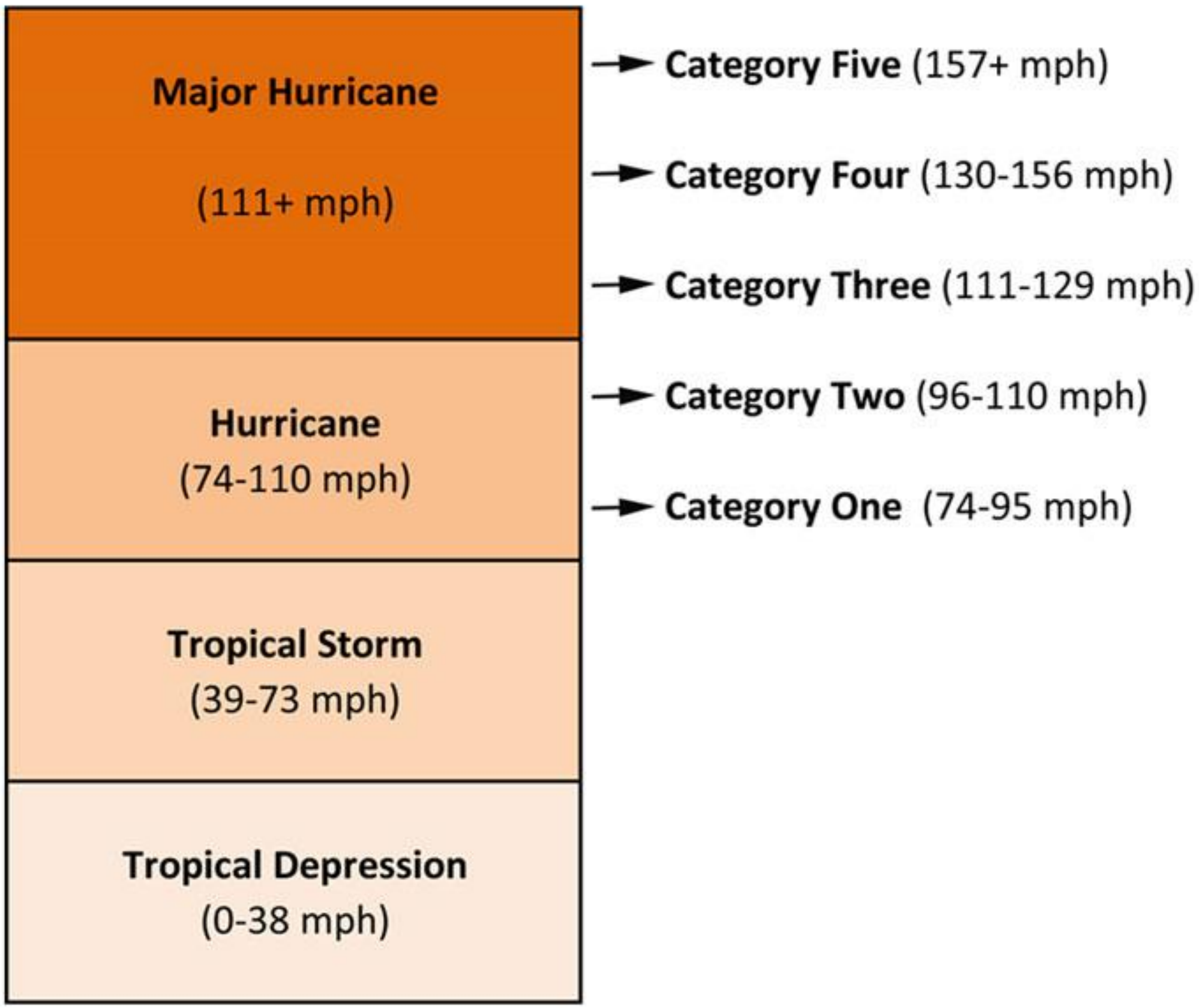
Tufão Yolanda, Filipinas, 3-11 novembro 2013


FORTUNE

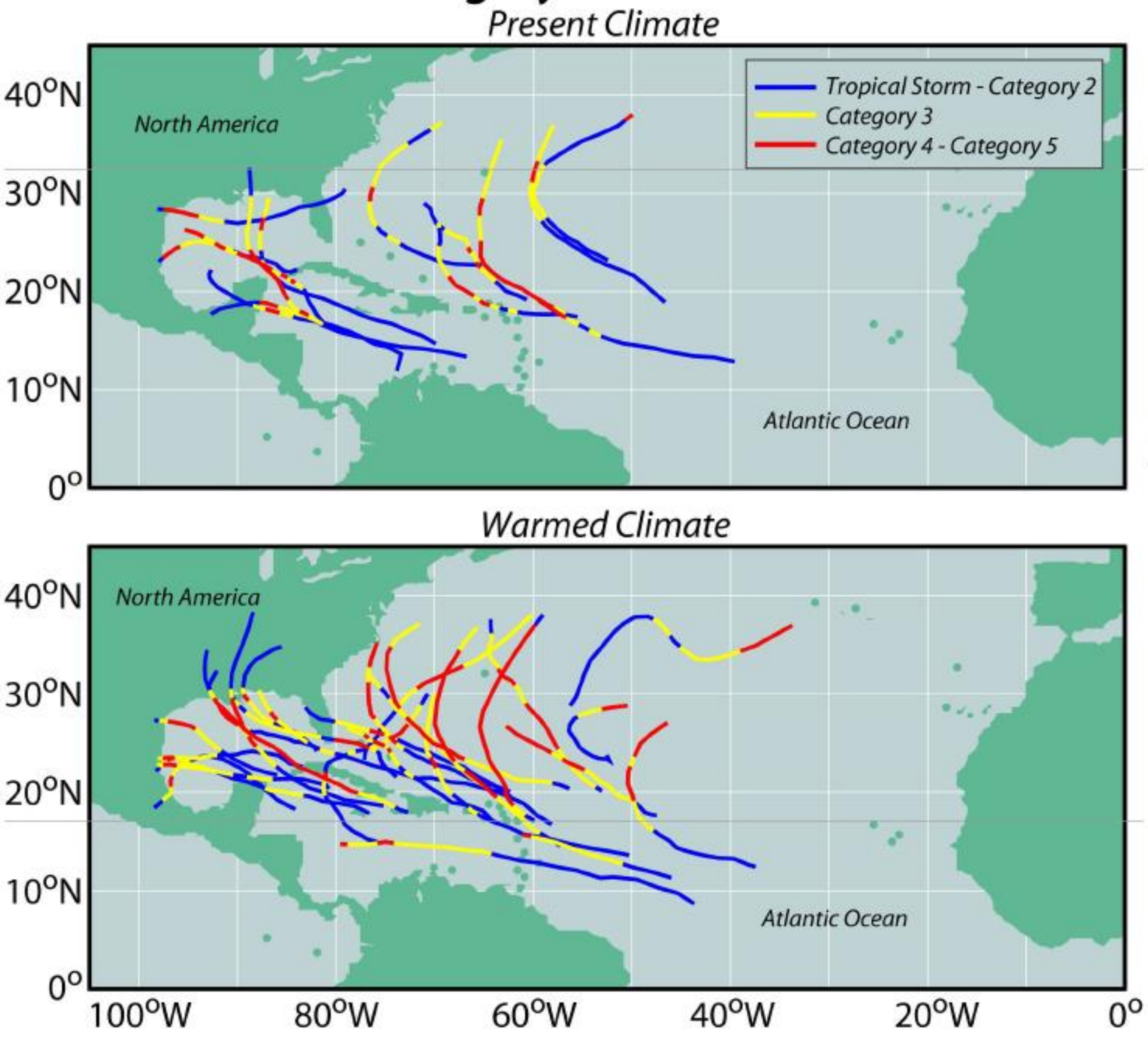


Changes in Sea-Surface Temperature Since 1900




Major Hurricane
(111+ mph)
Hurricane
(74-110 mph)
Tropical Storm
(39-73 mph)
Tropical Depression
(0-38 mph)
Category Five (157+ mph)
Category Four (130-156 mph)
Category Three (111-129 mph)
Category Two (96-110 mph)
Category One (74-95 mph)

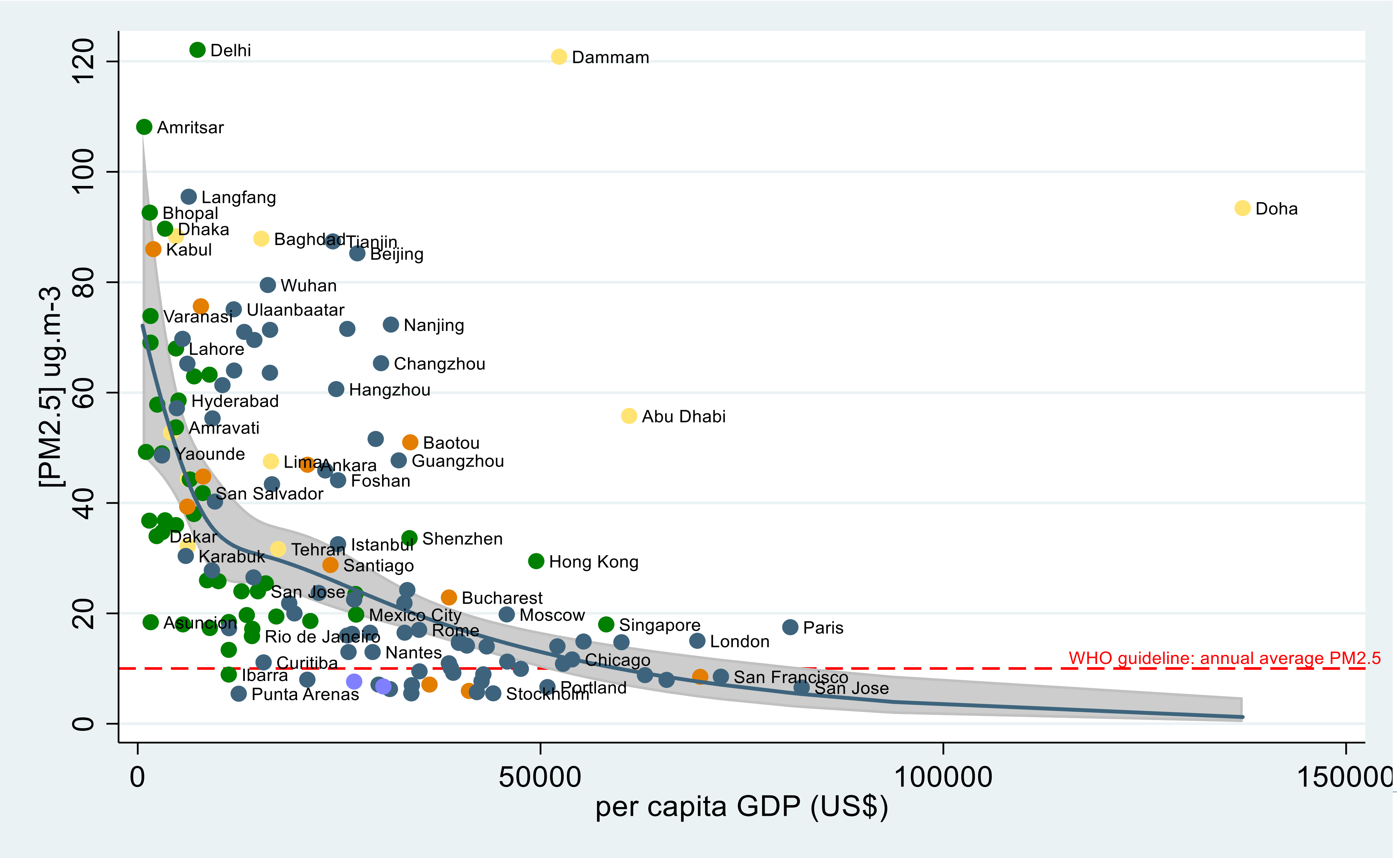
Modeled Category 4 & 5 Hurricane Tracks



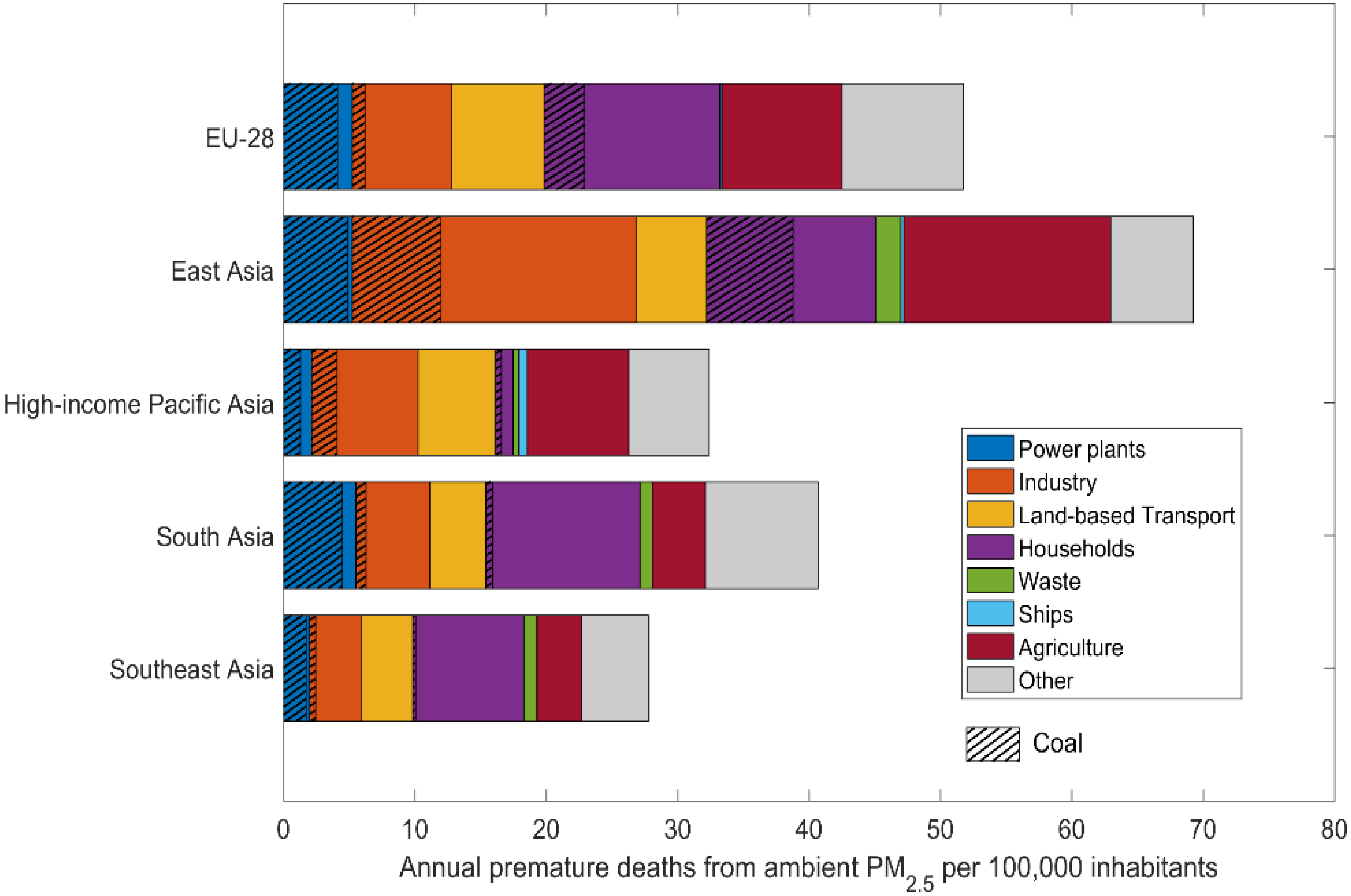
Source: Bender et al., Science, 2010

Pinhal de Leiria, Estrada perto de São Pedro de Moel após o ciclone pós-tropical Leslie, foto de 23-10-2018

Air pollution: annual average $PM_{2.5}$, SHUE database cities



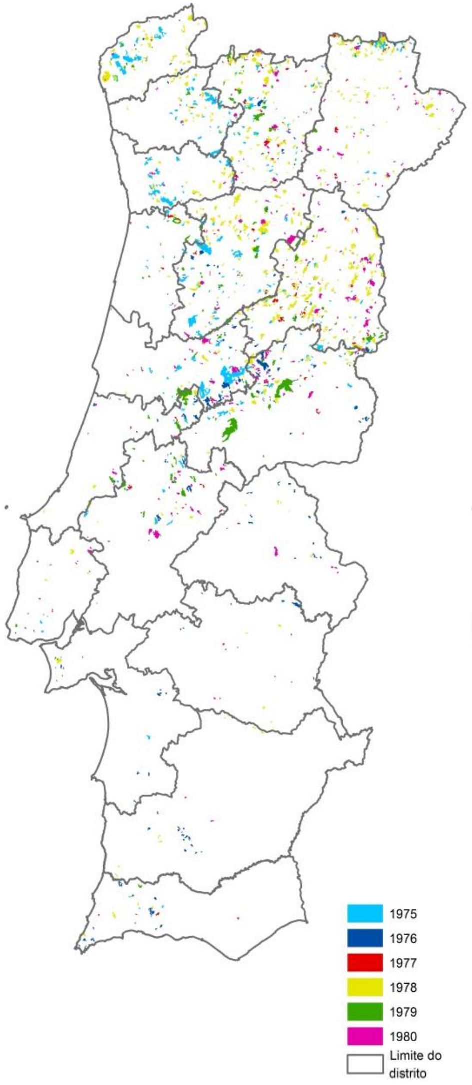
Premature mortality from ambient $PM_{2.5}$ in 2015 by pollution source



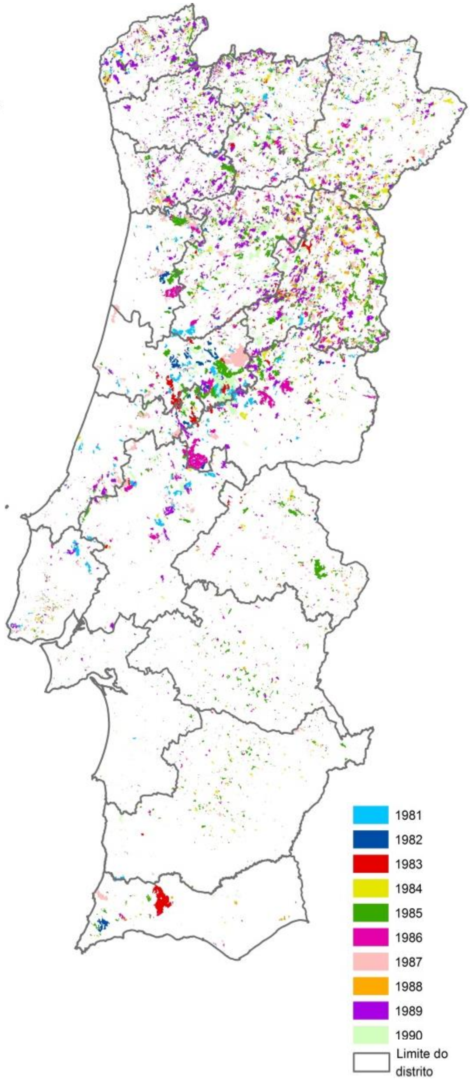
Coal as a fuel is highlighted by hatching

Source: The 2018 Report of The Lancet Countdown on Health and Climate Change, *Lancet* in press

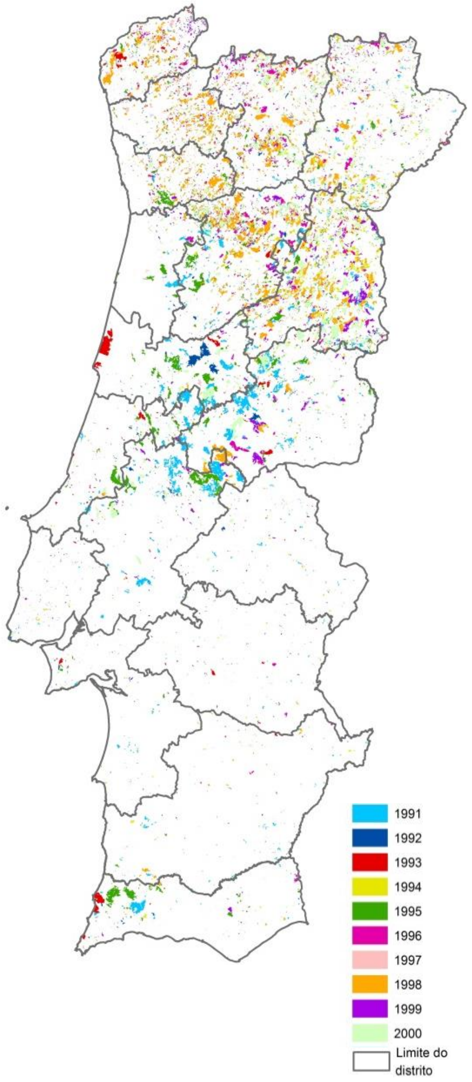
Perímetros das áreas queimadas em Portugal Continental (satélite Landsat)



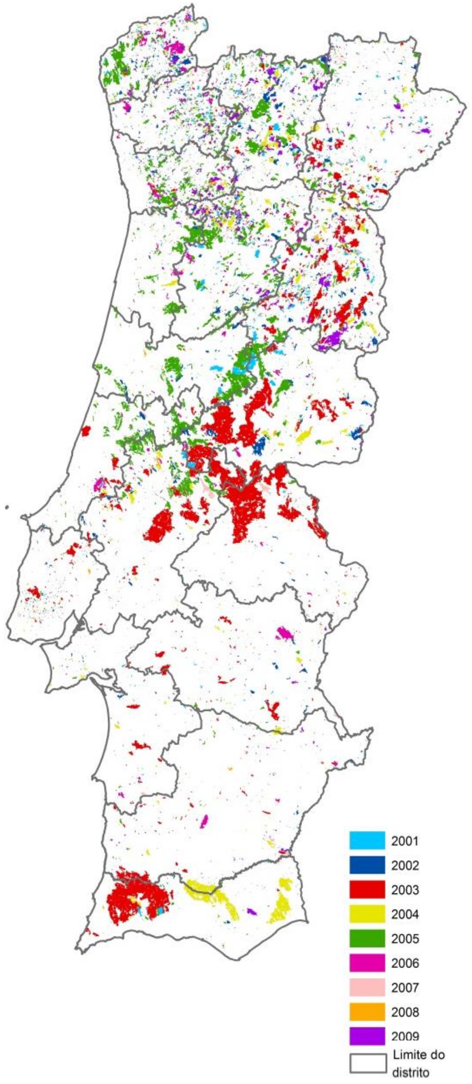
1975-1980



1981-1990



1991-2000



2001-2009

Fonte: João Silva et al., 2015

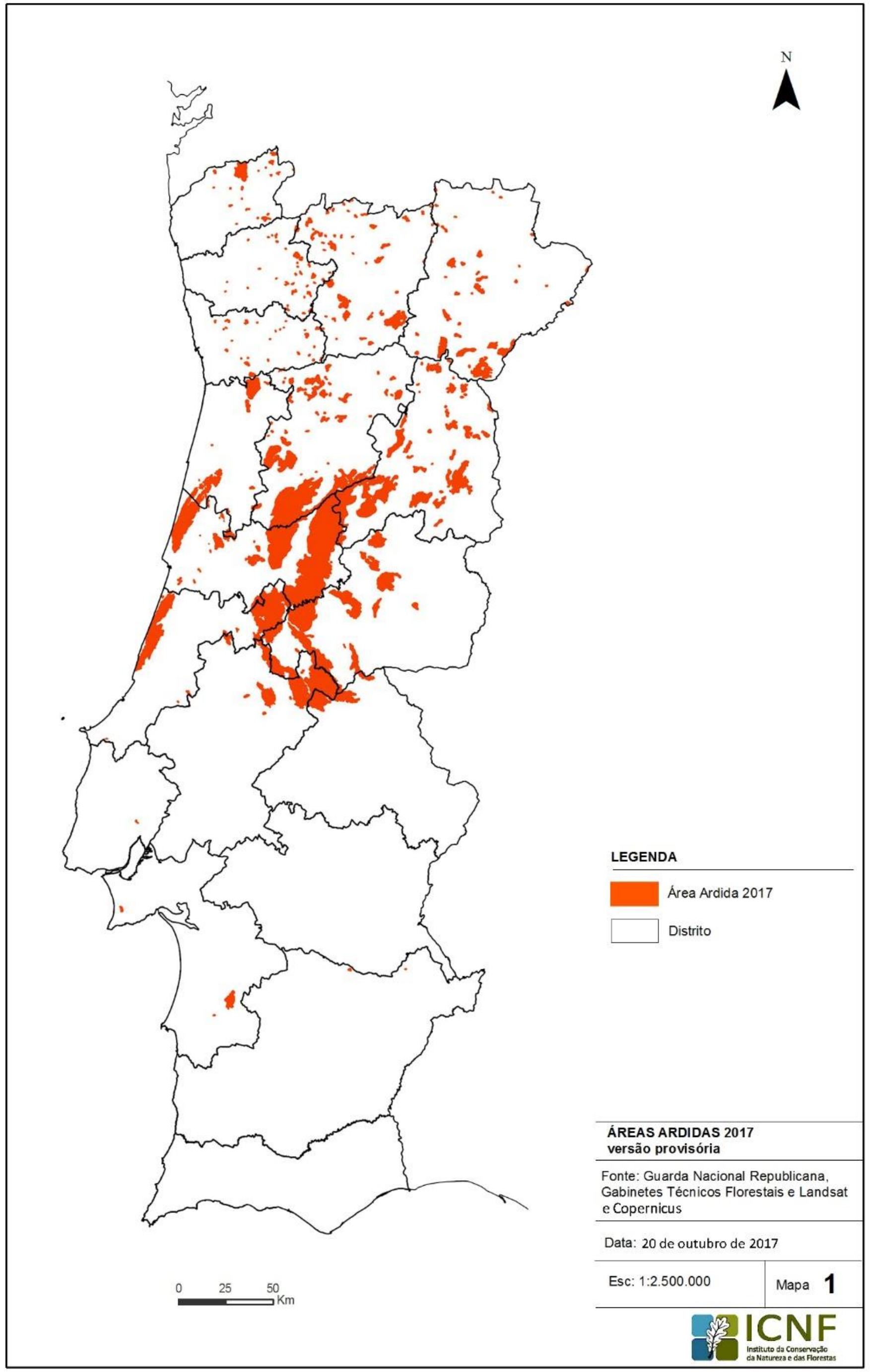
Área ardida em 2017

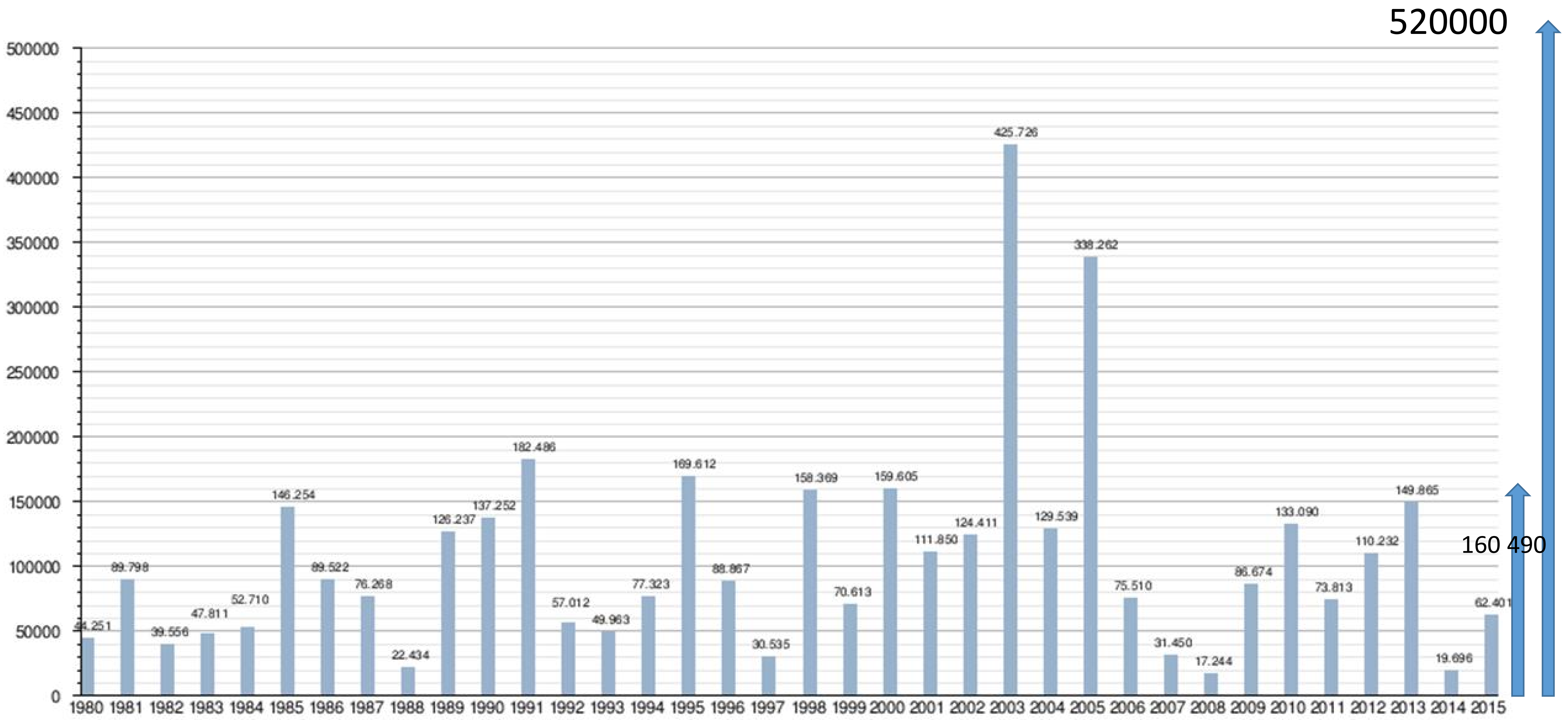
A floresta
está a tornar-se
insustentável
em várias regiões do
país, especialmente
a monocultura de
pinheiros e eucaliptos

Fonte: ICNF

2017: Portugal
442 418 ha

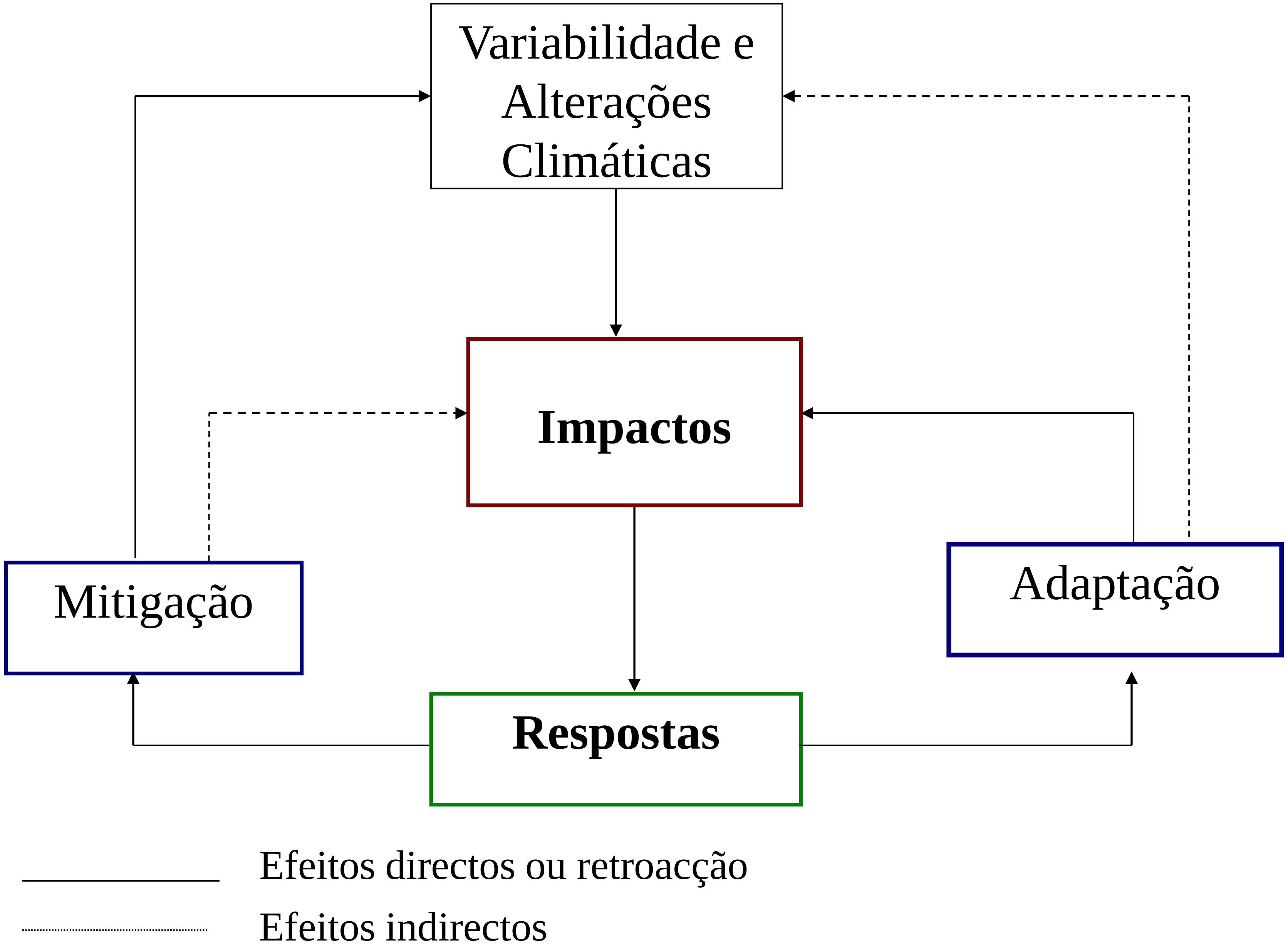
EUA 2300000 ha





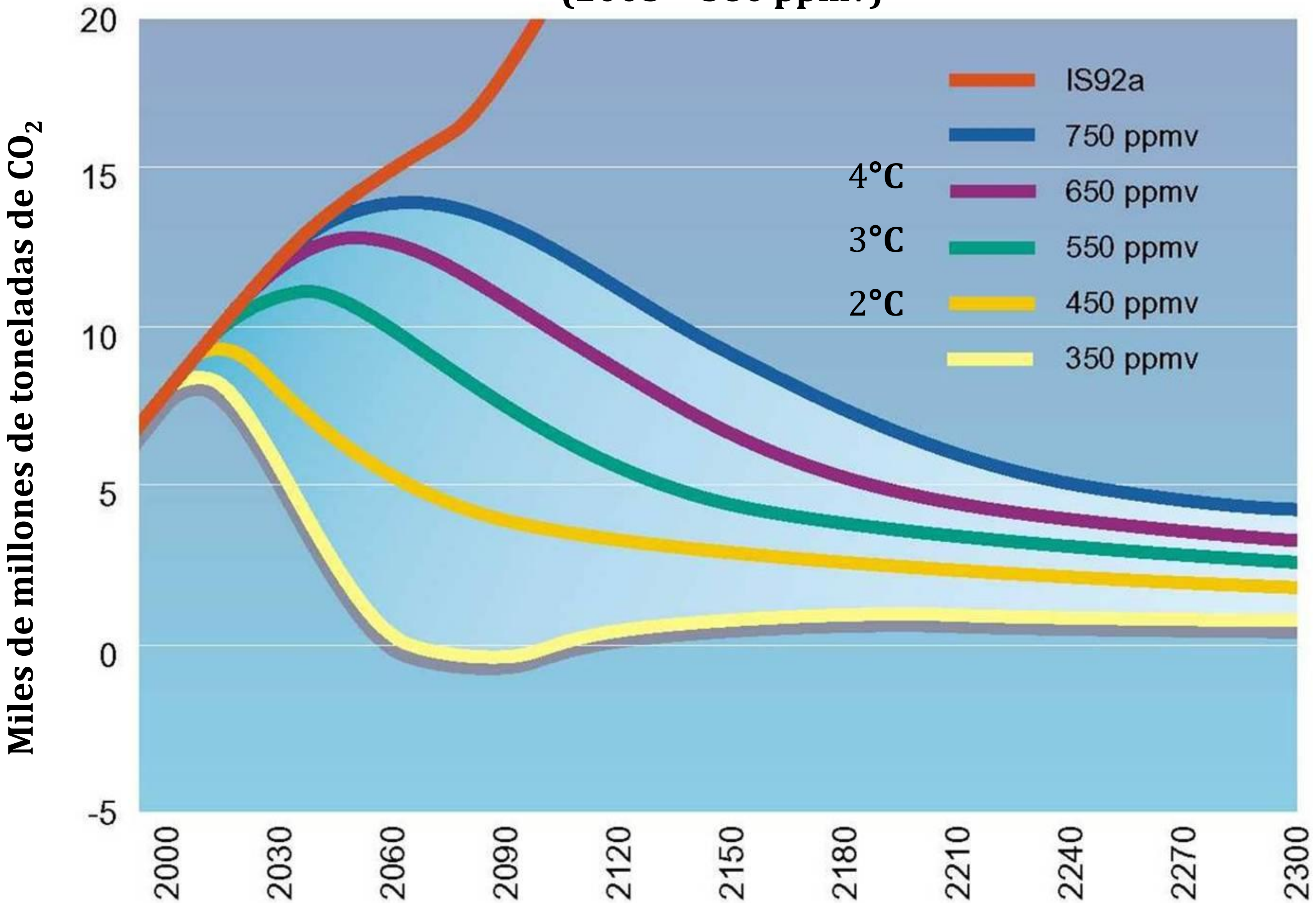
Os dados foram recolhidos dos RELATÓRIOS ANUAIS DE ÁREAS ARDIDAS E OCORRÊNCIAS relativos a cada ano e editados pela Autoridade Florestal Nacional - http://www.afn.min-agricultura.pt

Coluna de fumo junto a Vieira de Leiria, Portugal 15 outubro 2017


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

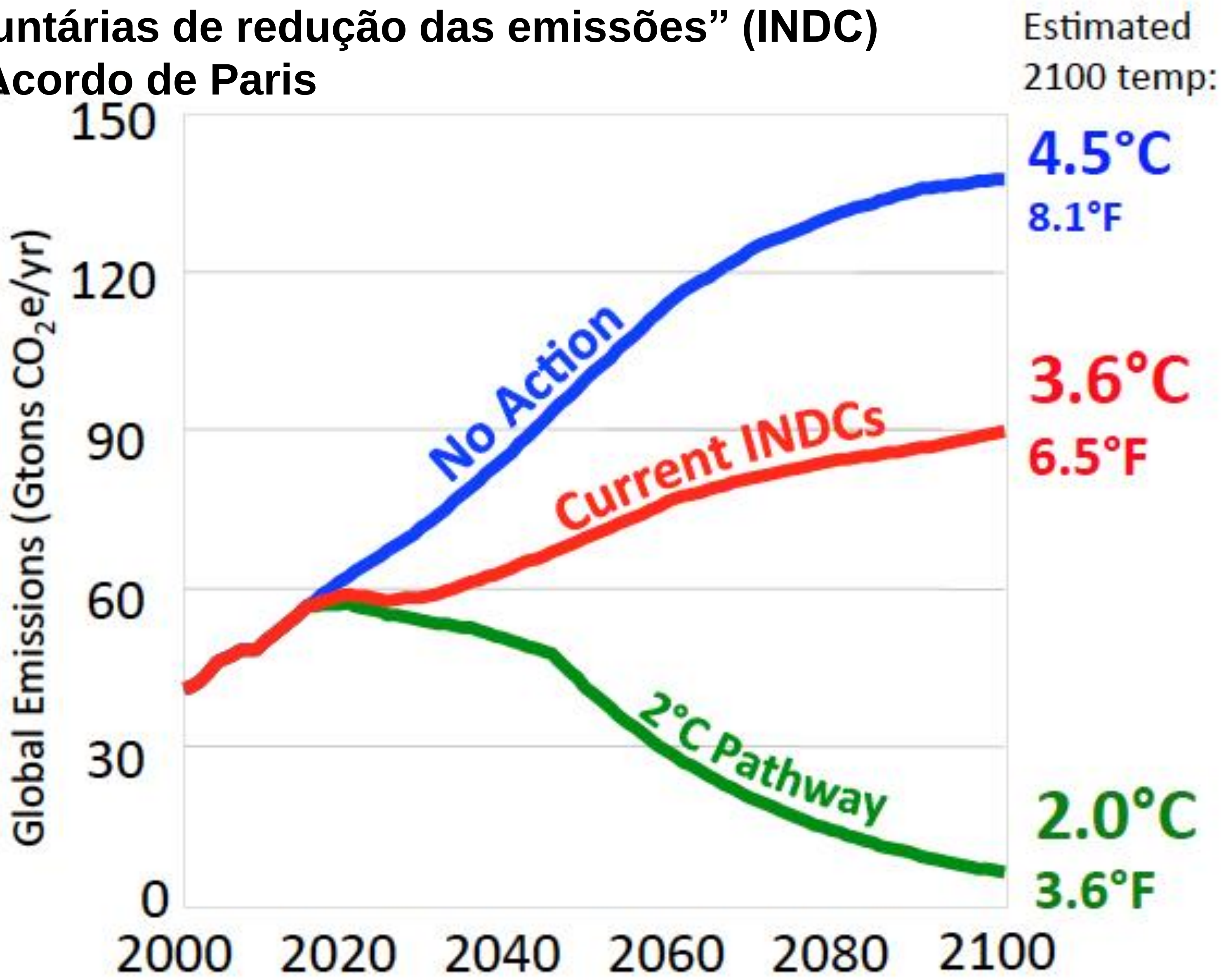
Trajectórias das emissões de CO_2e

(2005 = 380 ppmv)



Fuente: Stern Review; World Resources Institute

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

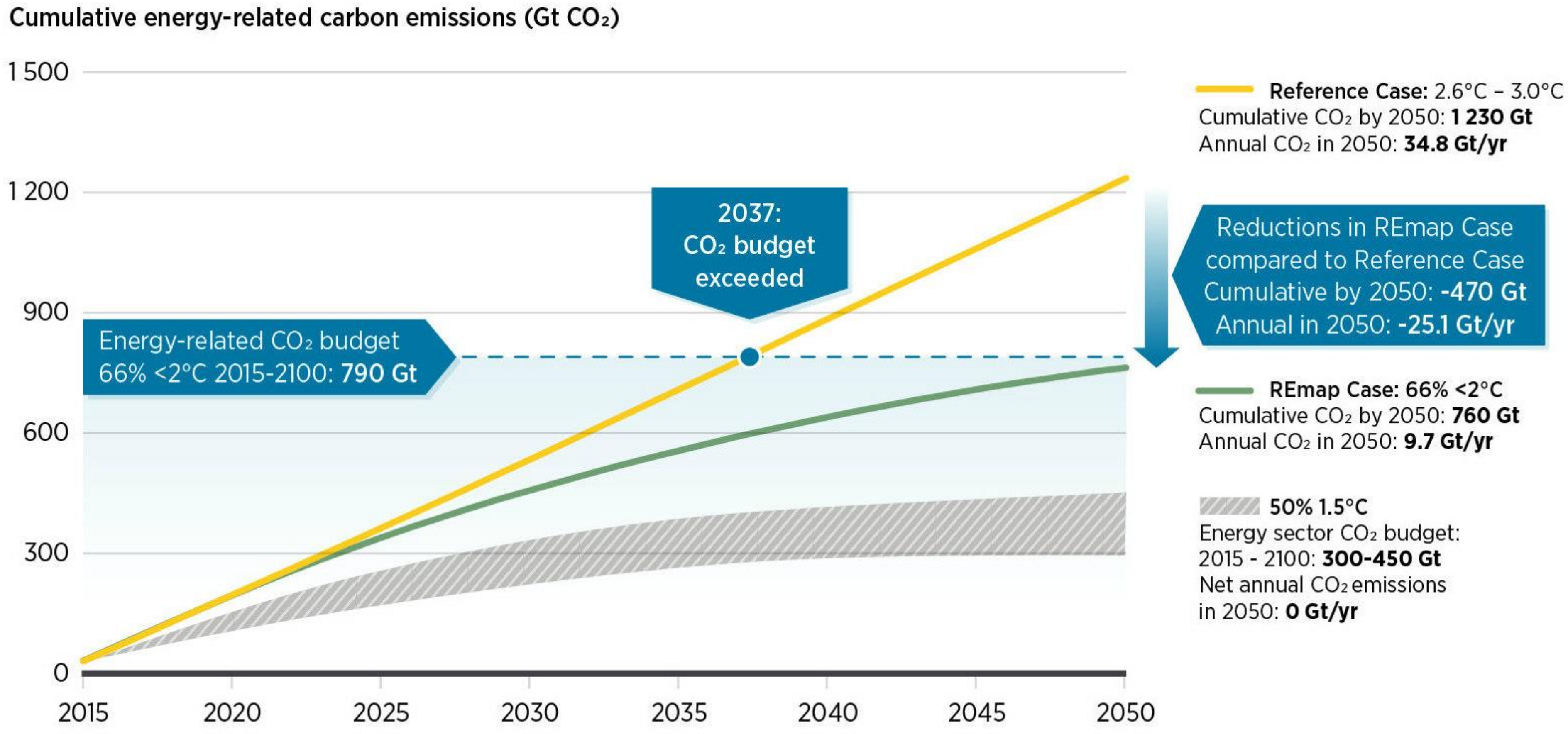


Impact of national climate pledges (aka INDCs) on world's greenhouse gas emissions measured in CO2 equivalents (CO2e).

In under 20 years, the global energy-related CO2 emissions budget to keep warming below 2°C would be exhausted. Source:
IRENA, 2018, Global Energy Transformation: A roadmap to 2050, International Renewable Energy Agency, Abu Dhabi

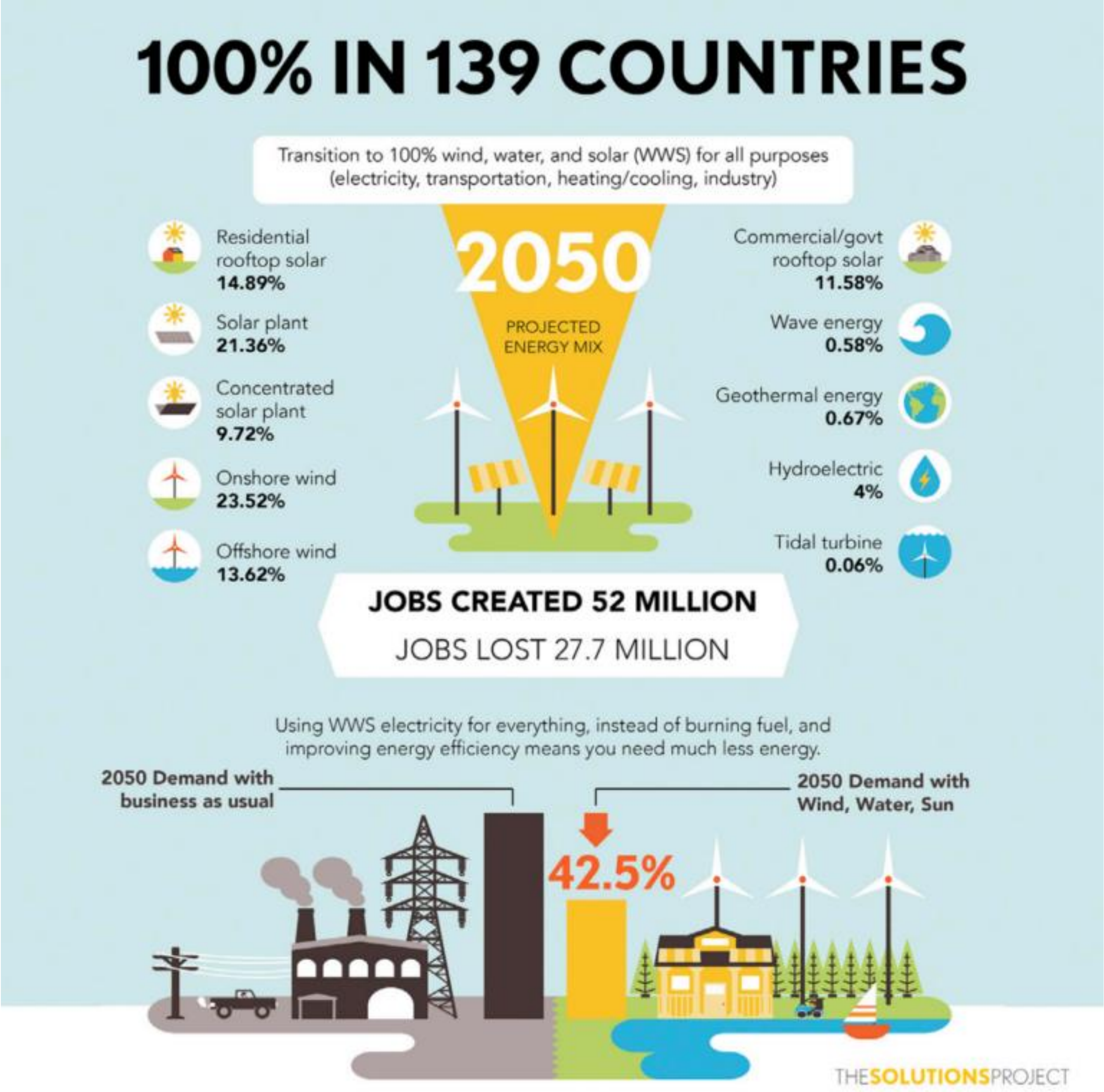
Annual CO2 emissions from fóssil fuel uses and industry in 2014: 35,7 GtCO2

Emissions and the emissions gap, 2015-2050



IPCC AR5 established in 2014 that the CO2 emissions budget is 870 a 1240 GtCO2

É possível descarbonizar a economia mundial até 2050 com aumento do número de empregos no setor da energia e diminuição da procura de energia



Fonte: Jacobson, 2018

PNAS

Low-cost solution to the grid reliability problem with 100% penetration of intermittent wind, water, and solar for all purposes

Mark Z. Jacobson[a,1], Mark A. Delucchi[b], Mary A. Cameron[a], and Bethany A. Frew[a]

[a]Department of Civil and Environmental Engineering, Stanford University, Stanford, CA 94305; and [b]Institute of Transportation Studies, University of California, Berkeley, CA 94720

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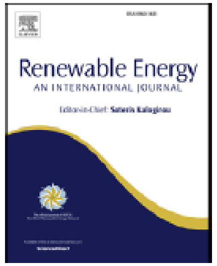
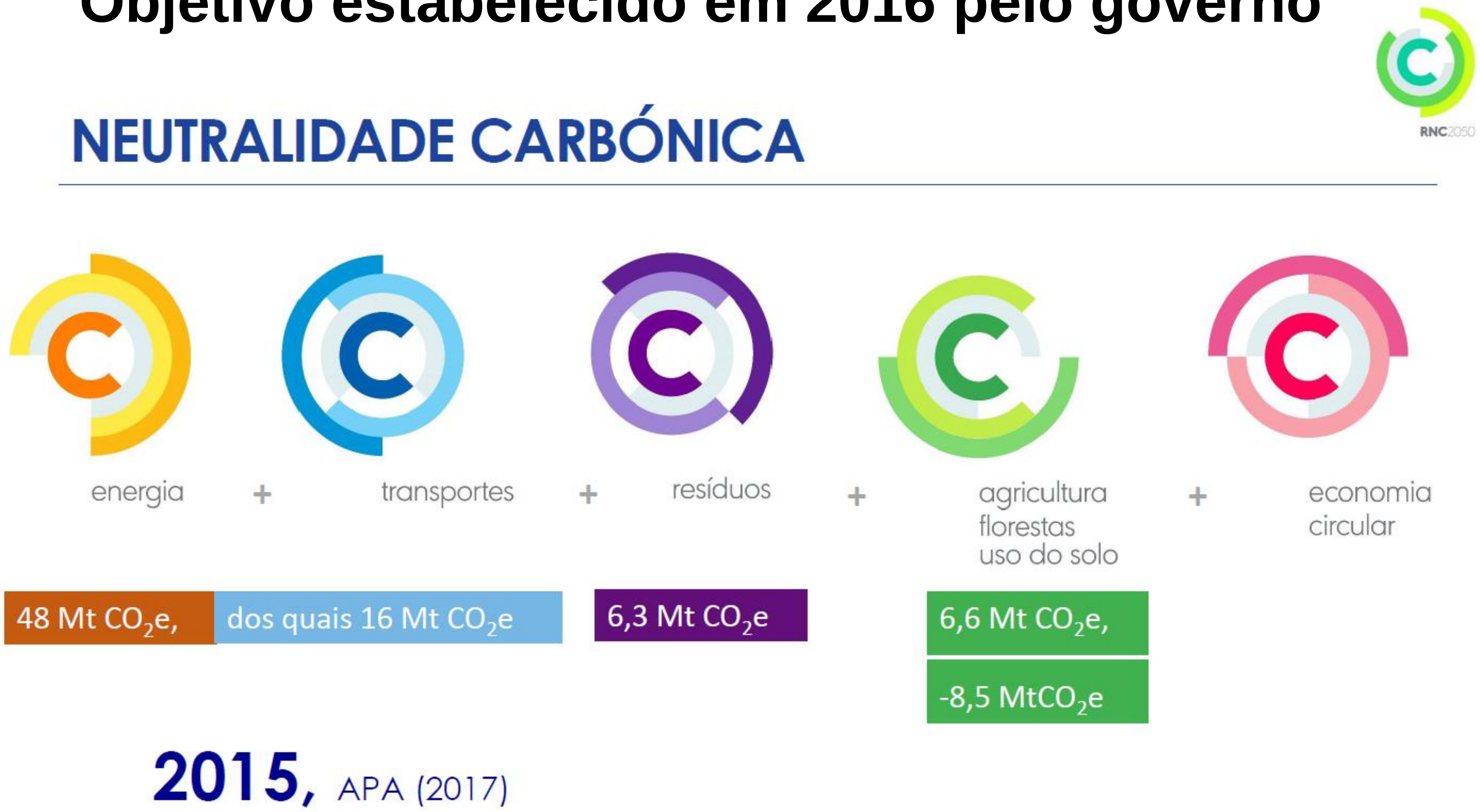
journal homepage: www.elsevier.com/locate/renene



Matching demand with supply at low cost in 139 countries among 20 world regions with 100% intermittent wind, water, and sunlight (WWS) for all purposes

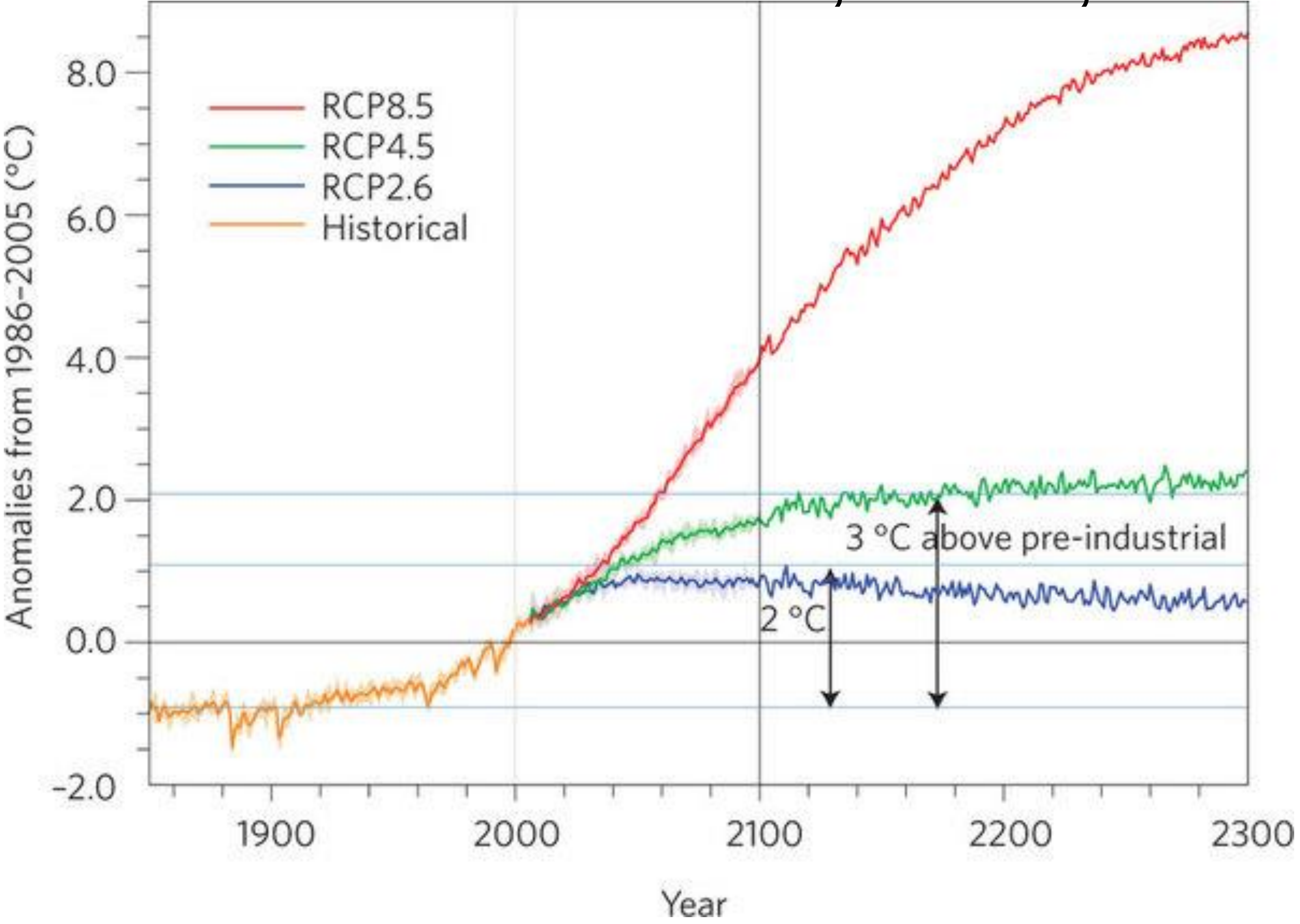
Mark Z. Jacobson [a,*], Mark A. Delucchi [b], Mary A. Cameron [a], Brian V. Mathiesen [c]

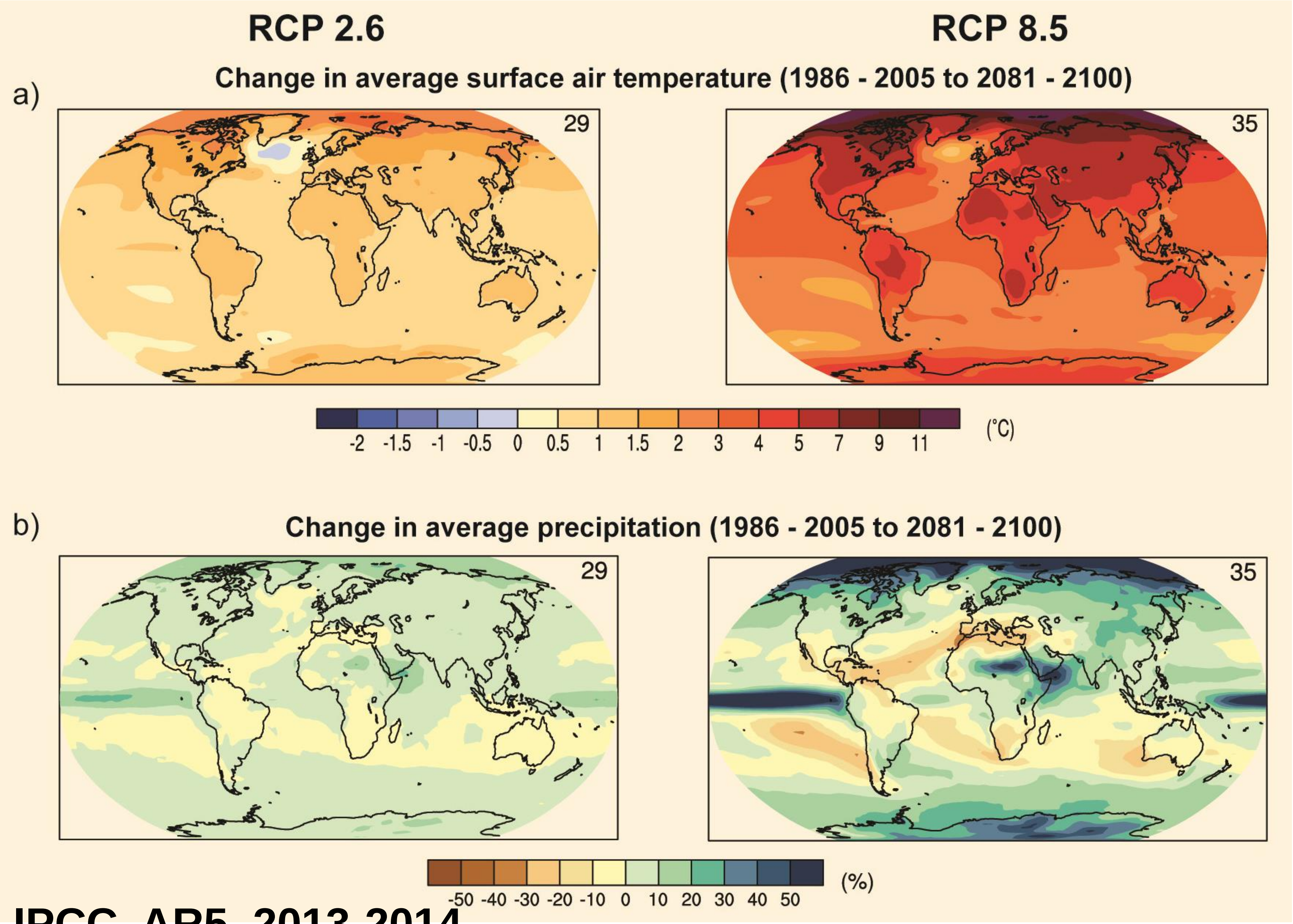
Neutralidade carbónica de Portugal em 2050
Objetivo estabelecido em 2016 pelo governo



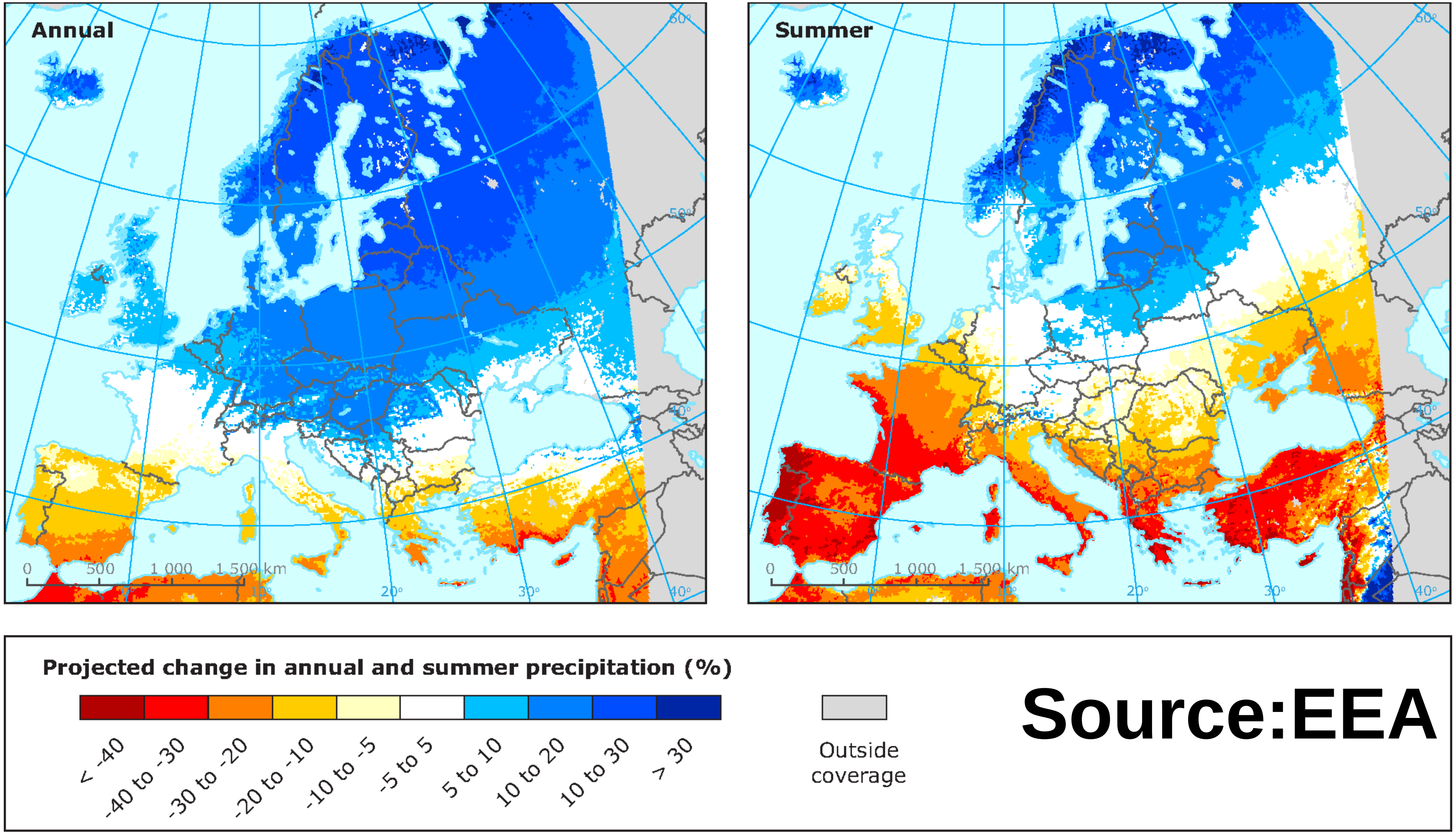
Passar de cerca de 70 MtCO2 para cerca de 10MtCO2 em 2050

Cenários climáticos do IPCC, AR5 WGI, 2014



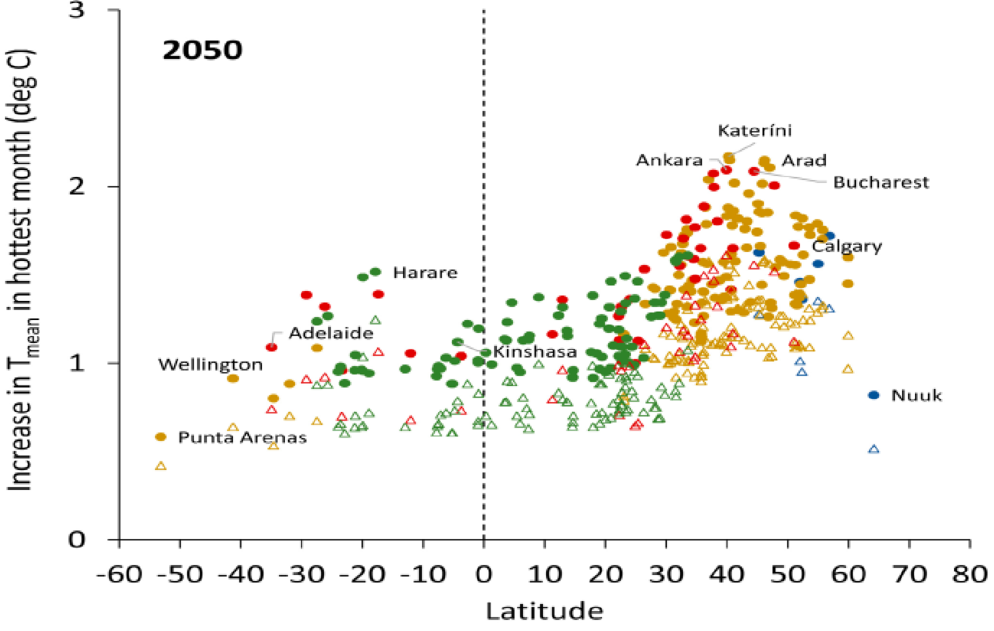


IPCC, AR5, 2013-2014

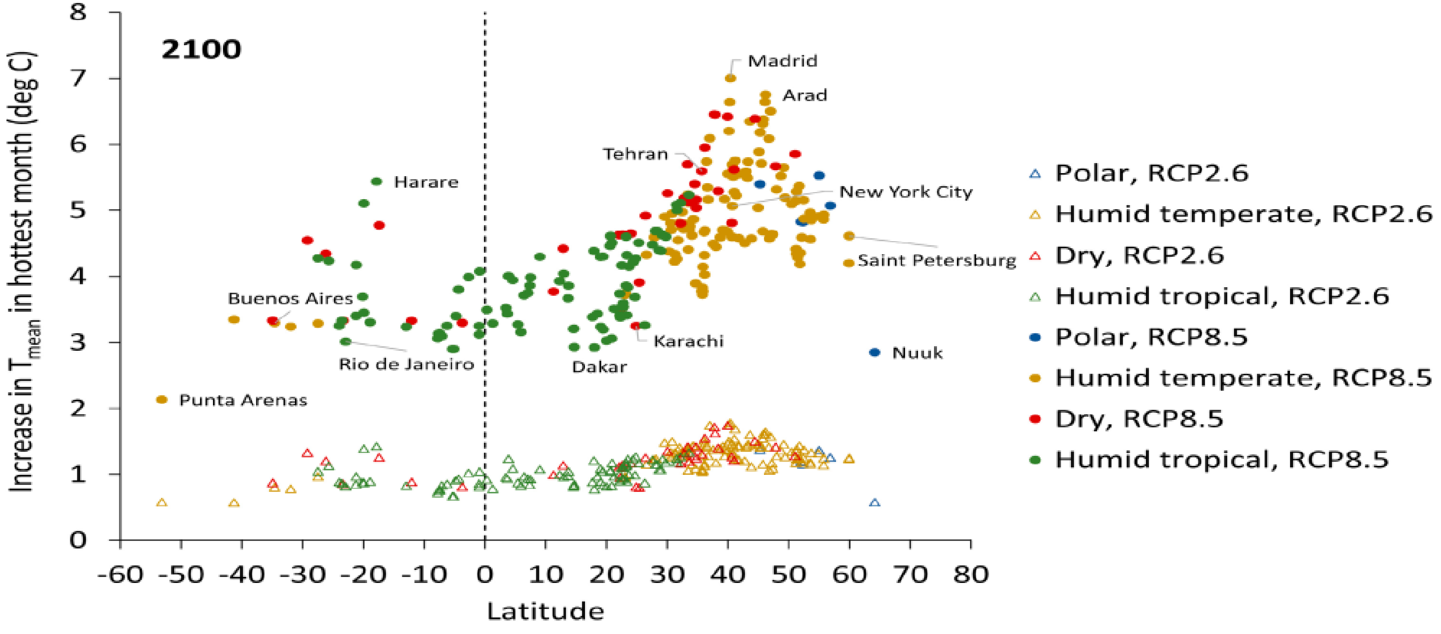


Projected changes in annual (left) and summer (right) precipitation (%) in the period 2071-2100 compared to the baseline period 1971-2000 for the forcing scenario RCP 8.5. Model simulations are based on the multi-model ensemble average of RCM simulations from the EURO-CORDEX initiative.

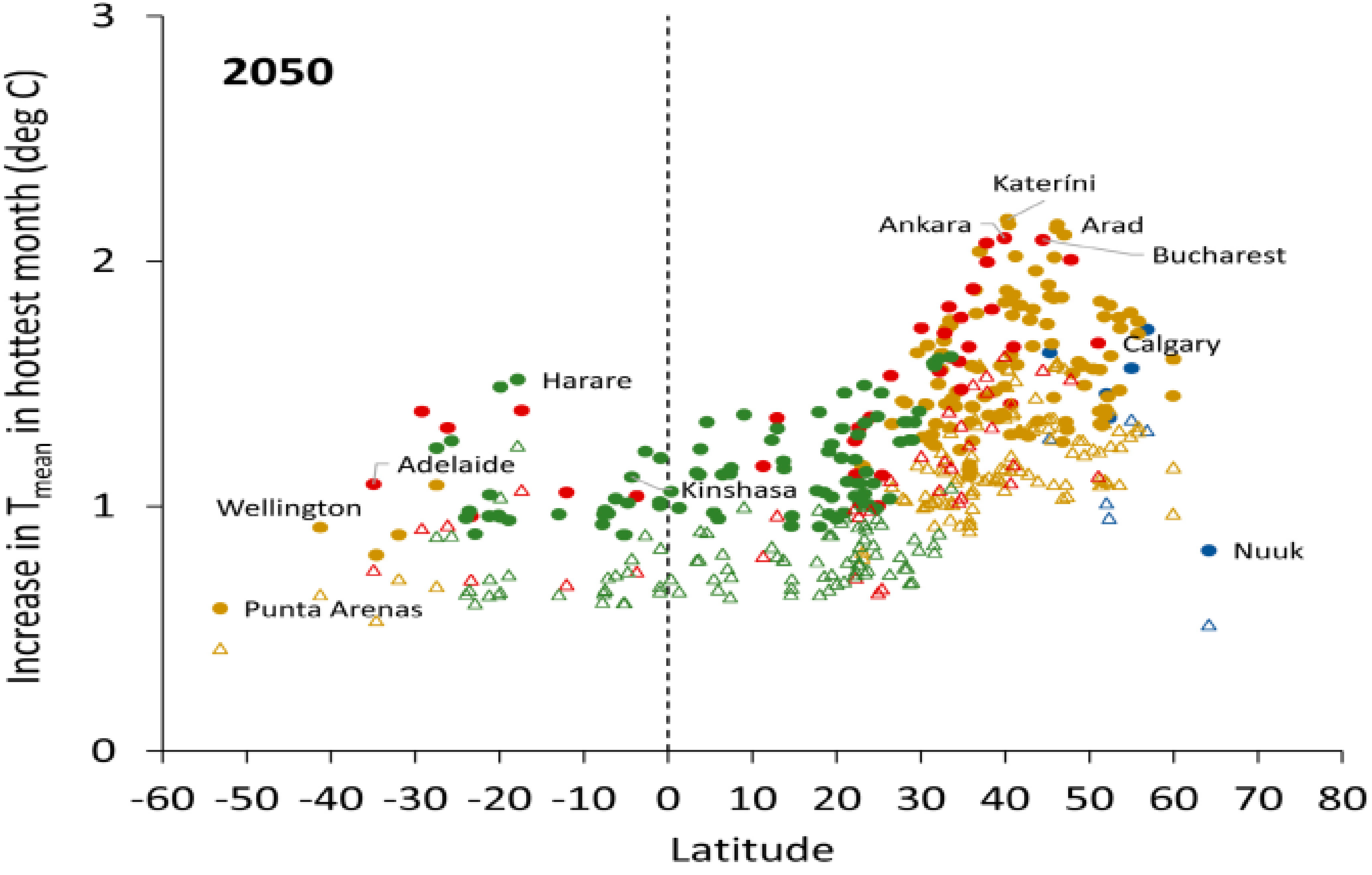
Aumento da temperature média no mês mais quente em 2050 e em 2100 nas cidades da base de dados SHUE nos cénarios climáticos RCP2.6 e RCP8.5
(Milner et al Climate 2018)



(a)

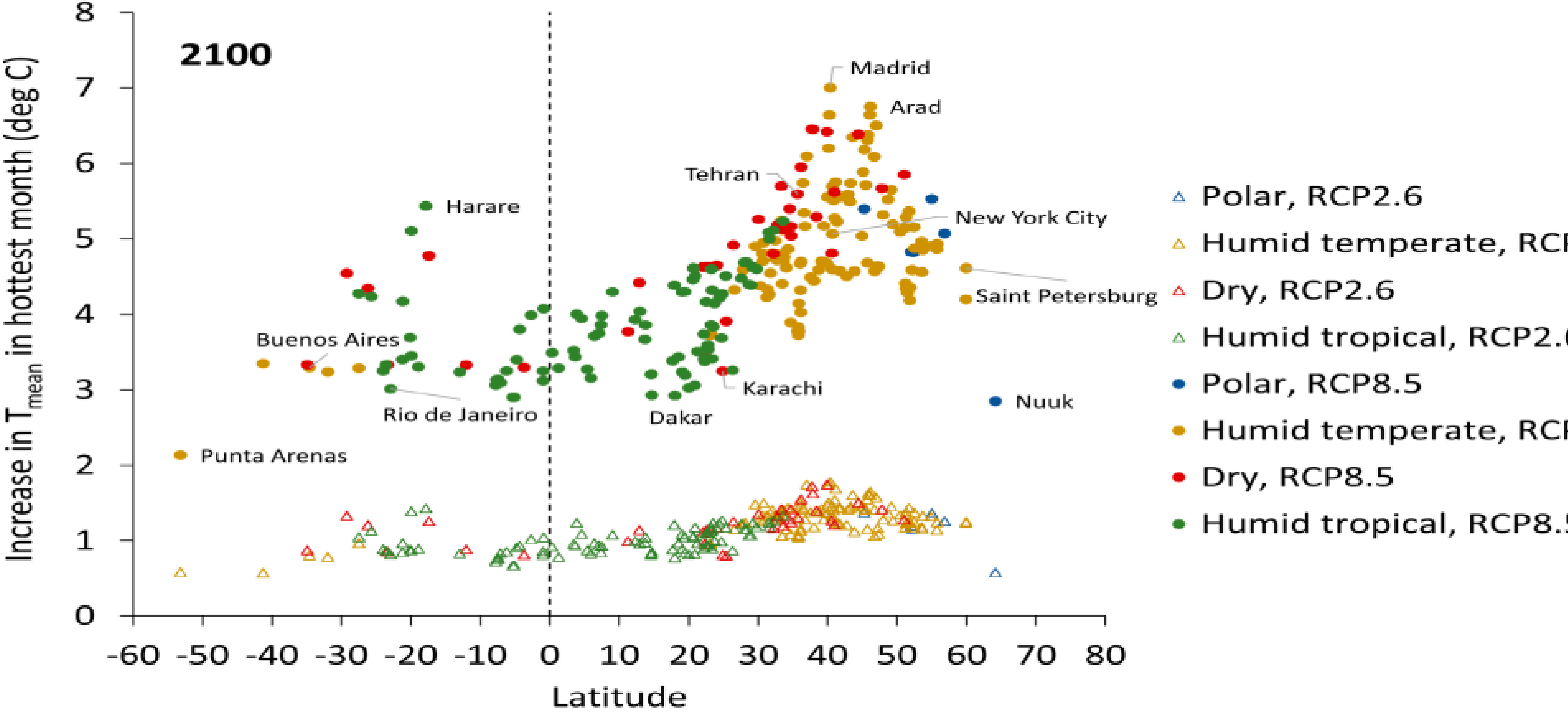


(b)


2050
Increase in T_{mean} in hottest month (deg C)
Latitude
Katerini
Ankara
Arad
Bucharest
Calgary
Harare
Adelaide
Kinshasa
Wellington
Nuuk
Punta Arenas
3
2
1
0
-60
-50
-40
-30
-20
-10
0
10
20
30
40
50
60
70
80

(a)

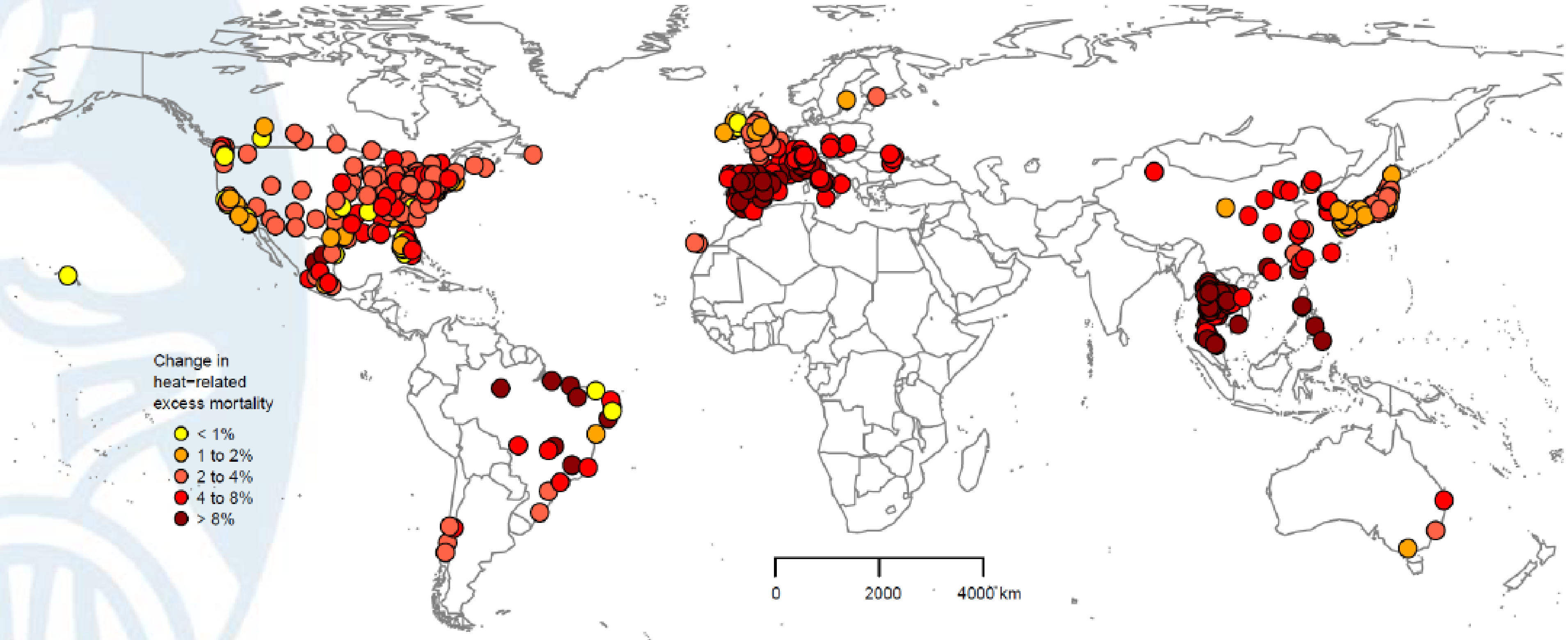
(a)


2100
Increase in T_{mean} in hottest month (deg C)
Latitude
Madrid
Arad
Tehran
Harare
New York City
Saint Petersburg
Buenos Aires
Karachi
Rio de Janeiro
Dakar
Nuuk
Punta Arenas
Polar, RCP2.6
Humid temperate, RCP
Dry, RCP2.6
Humid tropical, RCP2.
Polar, RCP8.5
Humid temperate, RCP
Dry, RCP8.5
Humid tropical, RCP8.
0
1
2
3
4
5
6
7
8
-60
-50
-40
-30
-20
-10
0
10
20
30
40
50
60
70
80

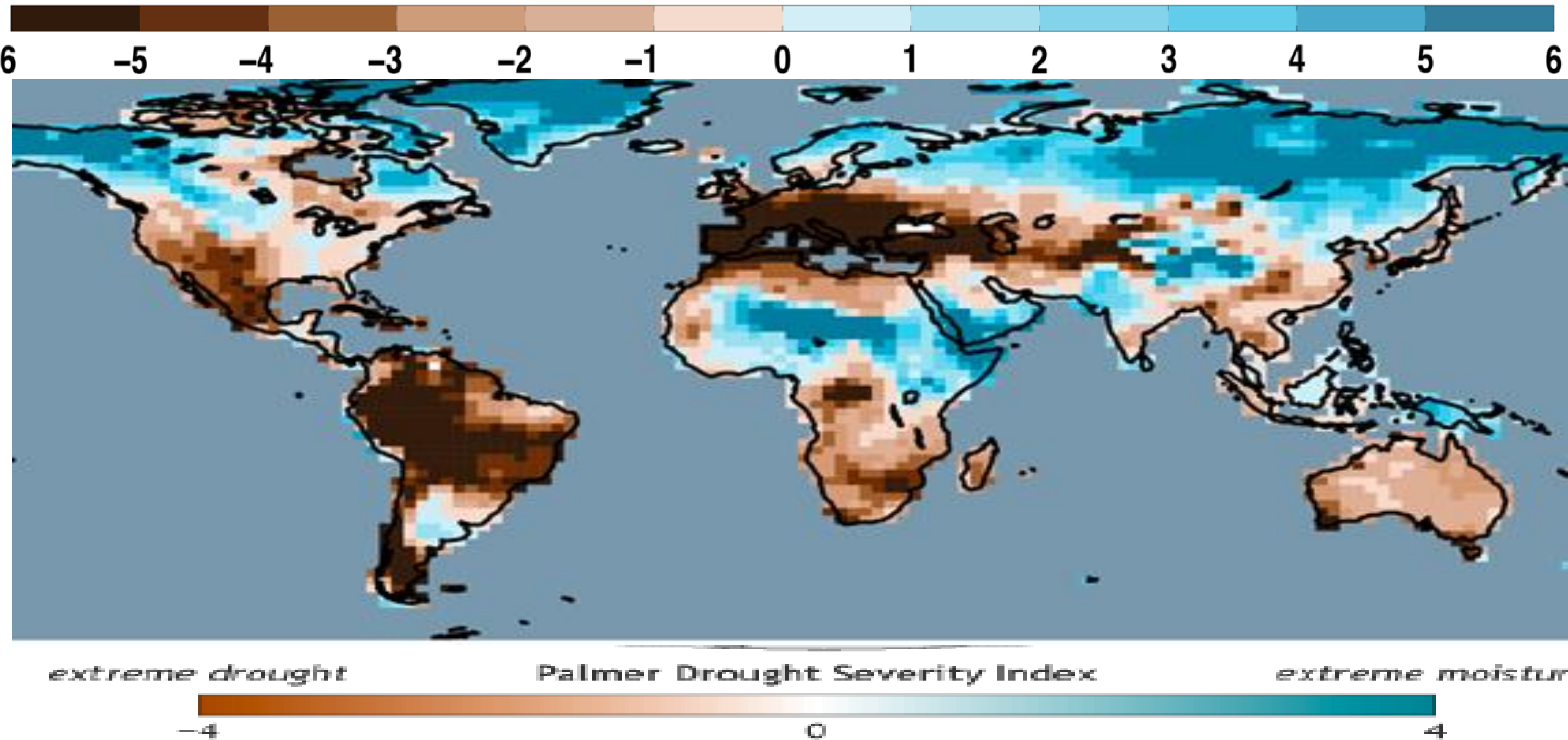
(b)

Change in Heat-Related Excess Mortality under RCP 8.5

% change: 2090-99 compared to 2010-19, based on mortality and temperature time-series in **451 cities**



Gasparrini et al., Lancet Planetary Health 2017

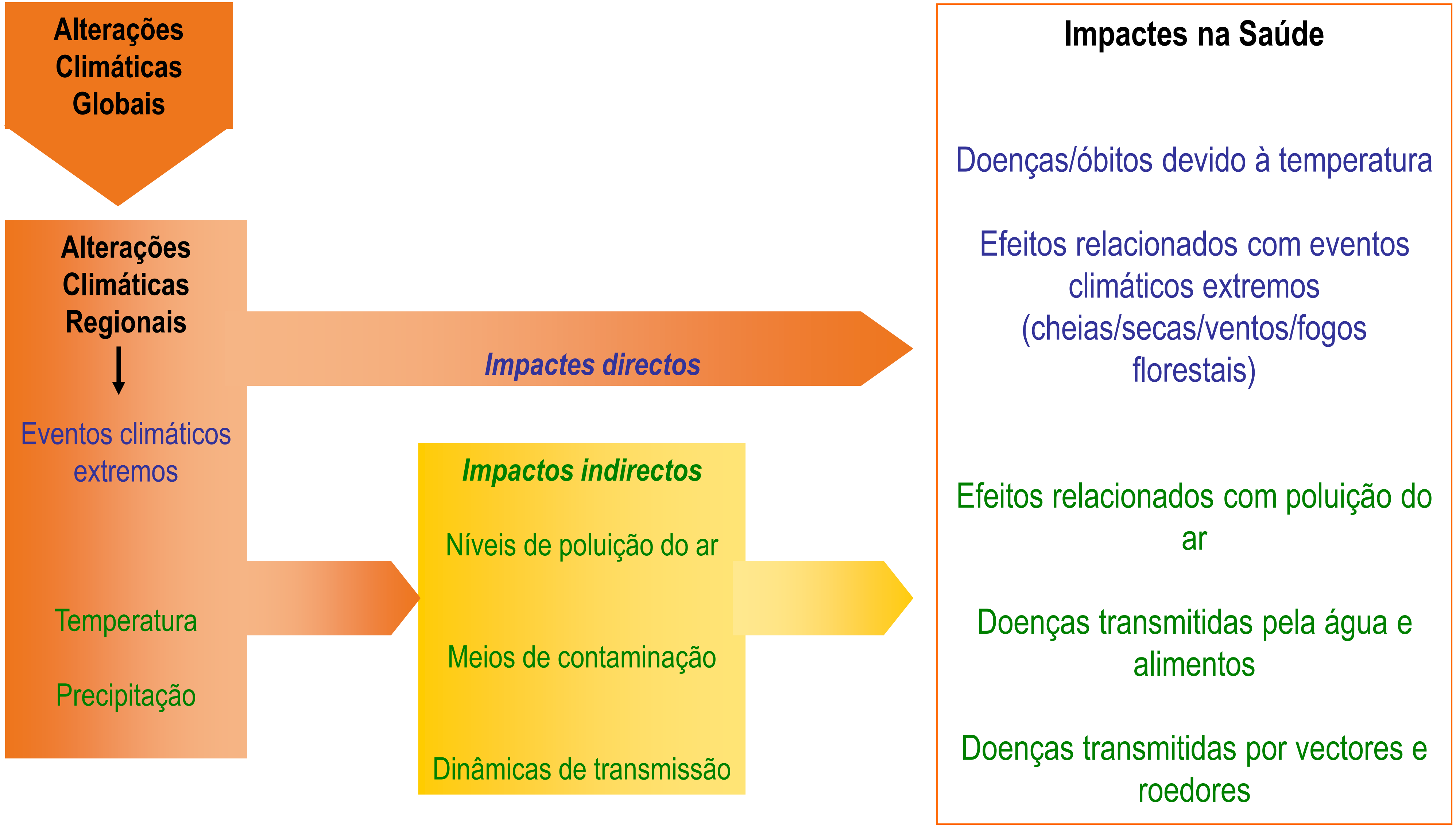


__Projected Drought:__ 2100- 4^0C

NOAA-Princeton Model. Cook et al, 2014

Identificação de Possíveis Impactes na Saúde Pública em Portugal

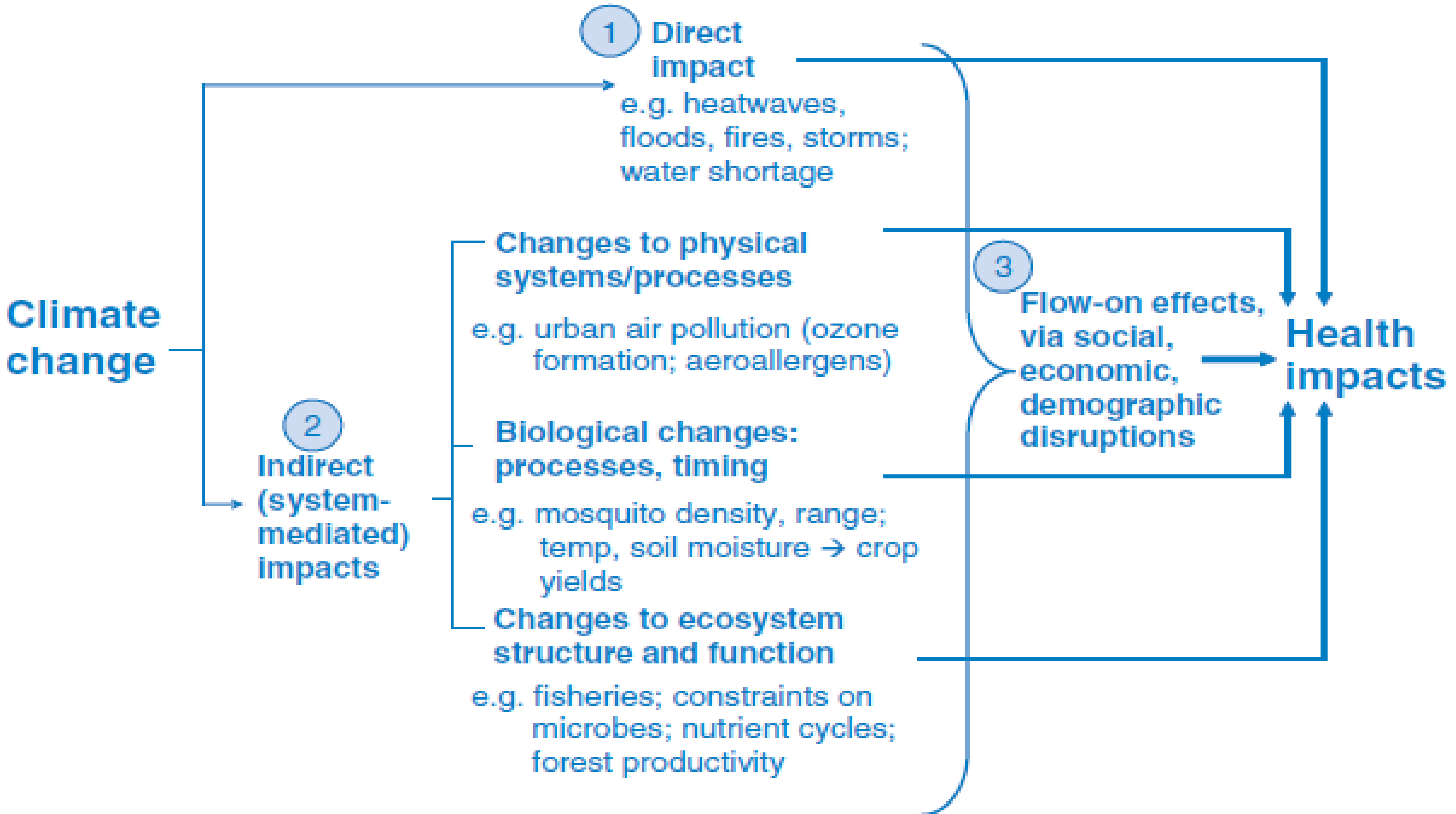
Fonte: Projeto SIAM, 2002



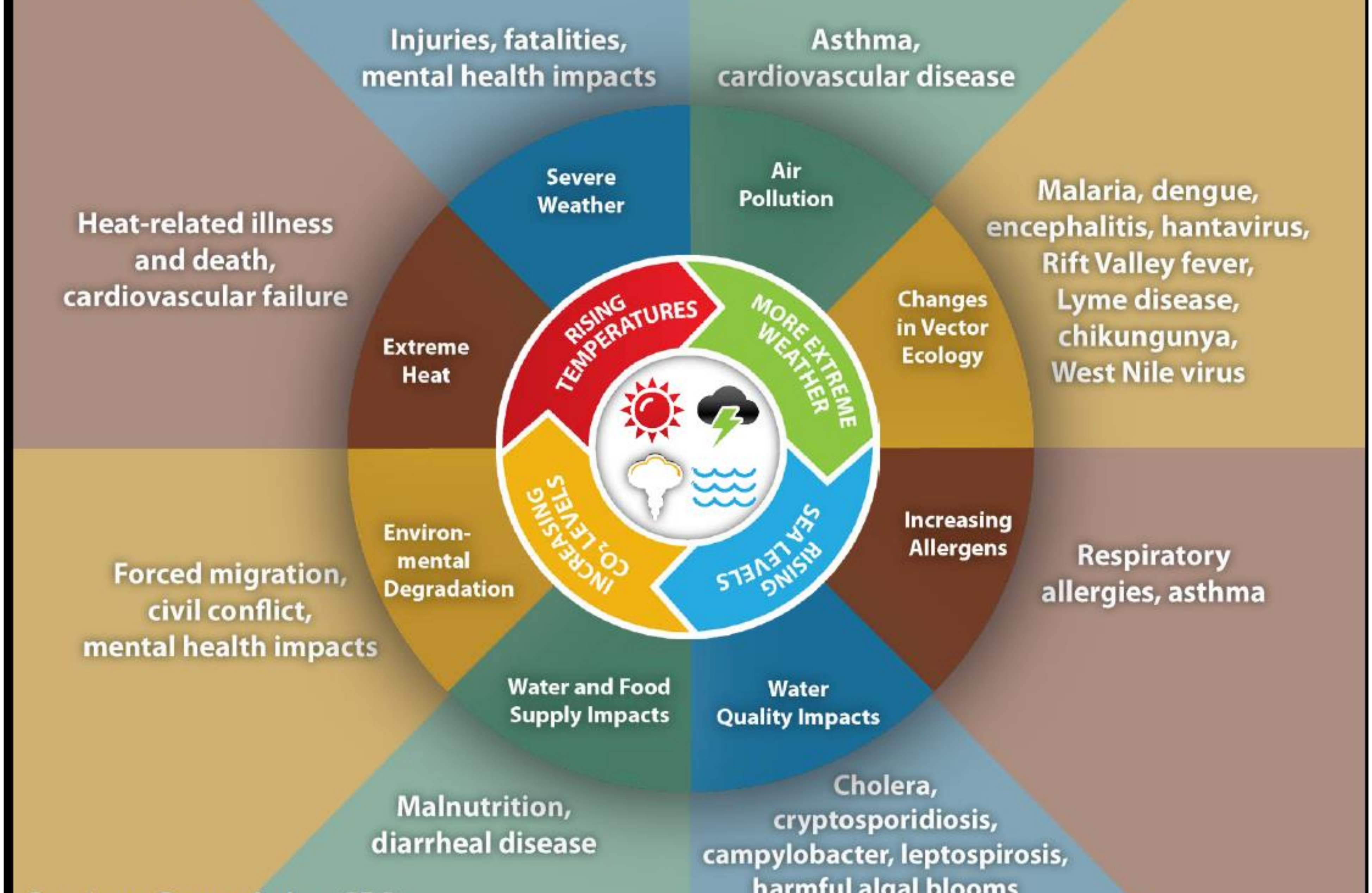
HEALTH INCONVENIENCE

Pathways between climate change and human health

(McMichael 2009)

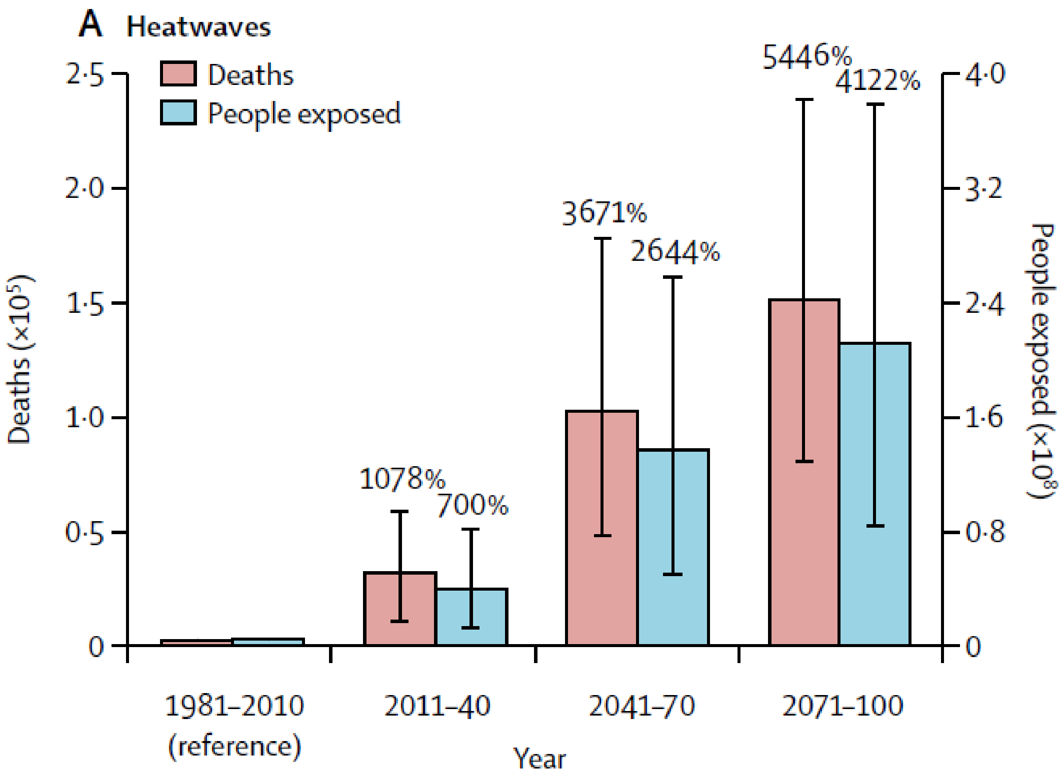


Impact of Climate Change on Human Health

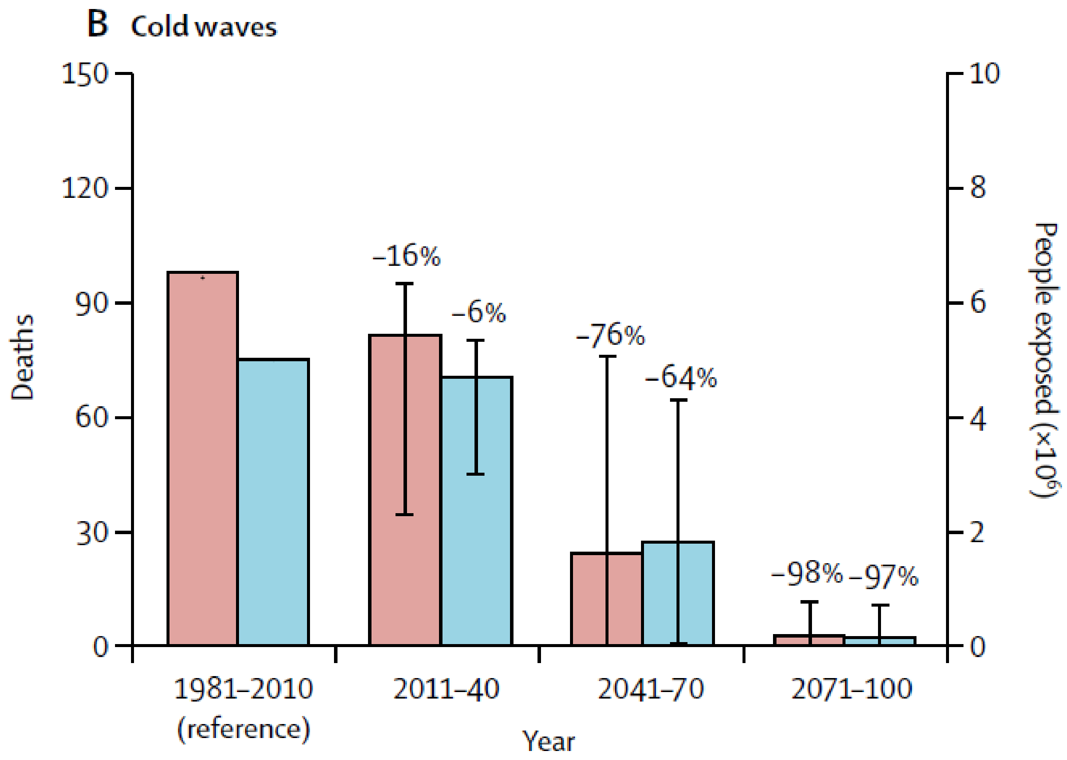


Courtesy: George Luber, CDC

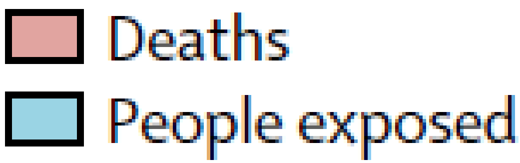
Ondas de calor



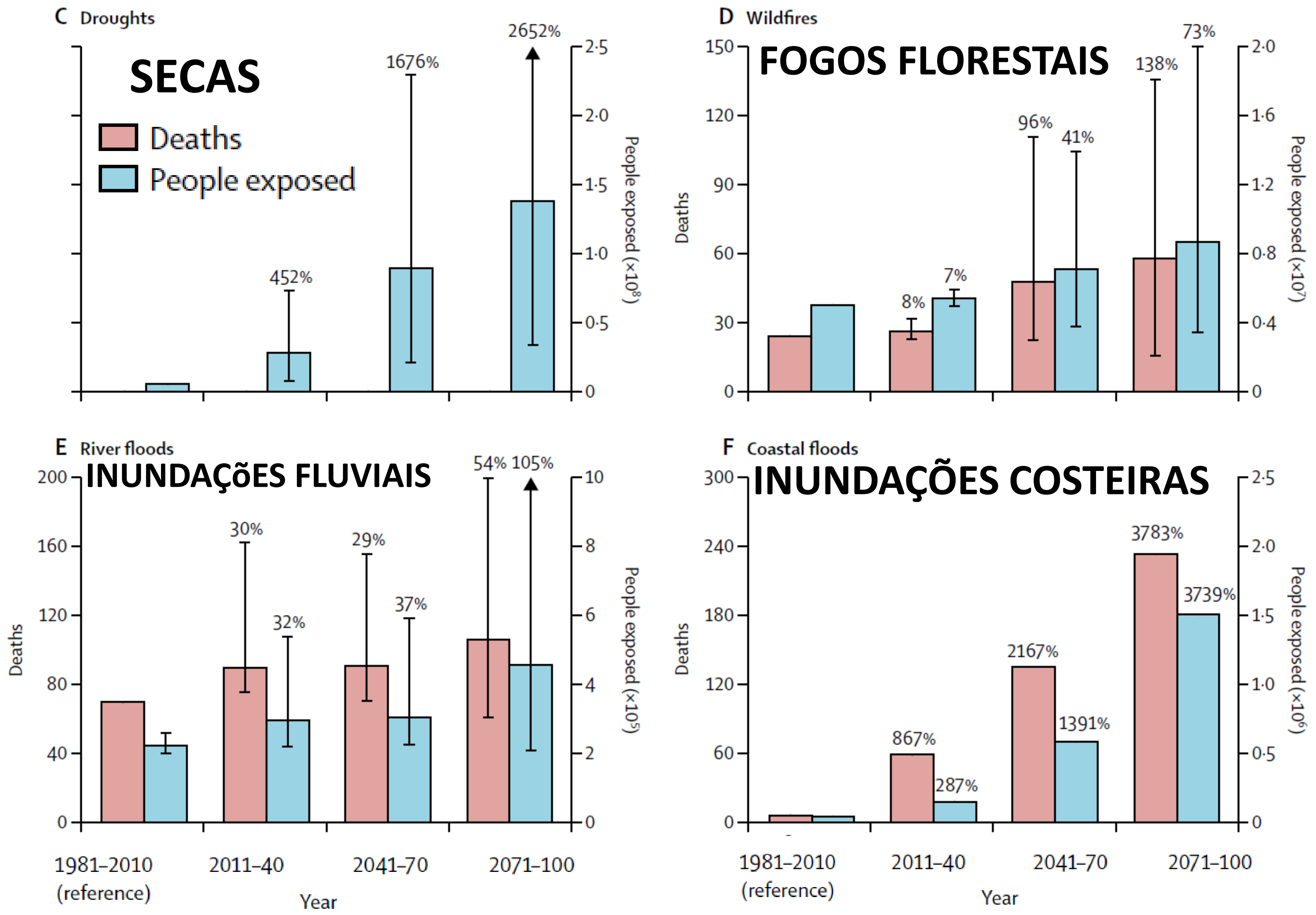
Ondas de frio



Número de pessoas expostas e número de mortes na Europa



Forzieri et al., 2017


C Droughts
SECAS
Deaths
People exposed
452%
1676%
2652%
People exposed (×10⁸)
D Wildfires
FOGOS FLORESTAIS
Deaths
8%
7%
96%
41%
138%
73%
People exposed (×10⁷)
E River floods
INUNDAÇõES FLUVIAIS
Deaths
30%
32%
29%
37%
54% 105%
People exposed (×10⁵)
F Coastal floods
INUNDAÇÕES COSTEIRAS
Deaths
867%
287%
2167%
1391%
3783%
3739%
People exposed (×10⁶)
1981–2010 (reference)
2011–40
2041–70
2071–100
Year

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National Assessment of Human Health Effects of Climate Change in Portugal: Approach and Key Findings

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In this study we investigated the potential impact of climate change in Portugal on heat-related mortality, air pollution–related health effects, and selected vectorborne diseases. The assessment used climate scenarios from two regional climate models for a range of future time periods. The annual heat-related death rates in Lisbon may increase from between 5.4 and 6 per 100,000 in 1980–1998 to between 8.5 and 12.1 by the 2020s and to a maximum of 29.5 by the 2050s, if no adaptations occur. The projected warmer and more variable weather may result in better dispersion of nitrogen dioxide levels in winter, whereas the higher temperatures may reduce air quality during the warmer months by increasing tropospheric ozone levels. We estimated the future risk of zoonoses using ecologic scenarios to describe future changes in vectors and parasites. Malaria and schistosomiasis, which are currently not endemic in Portugal, are more sensitive to the introduction of infected vectors than to temperature changes. Higher temperatures may increase the transmission risk of zoonoses that are currently endemic to Portugal, such as leishmaniasis, Lyme disease, and Mediterranean spotted fever. *Key words:* climate change, disease, health impact assessment, Portugal. *Environ Health Perspect* 114:1950–1956 (2006). doi:10.1289/ehp.8431 available via *http://dx.doi.org/* [Online 11 July 2006]

vectorborne diseases, we focused on establishing the role of climate/weather on the pathways that lead to human exposure. For example, in the air pollution–related health impact assessment, we investigated the relationships between weather and air pollution levels. In the vectorborne assessment, we focused on the relationships between climate and vector survival/activity and/or parasite development. These relationships were then applied using risk assessment methods to estimate the burden of disease under different scenarios. The sections that follow describe these relationships in more detail as well as how they were applied in the risk assessment process.

Health Impacts in the Future: The Use of Scenarios

Table 1. Climate sensitive health outcomes selected: reason for concerns and data available.

Health outcome	Reasons for concern	Data available
Heat-related mortality	1,906 excess daily deaths during 1981 heat wave in Portugal (Garcia et al. 1999) Increasing elderly population and urbanization	Daily mortality (all causes) for Lisbon during 1980–1998 (Instituto Nacional de Estatística 2000) Daily climate data set for Lisbon [Instituto de Meteorolgia (IM) 2000]
Air pollution–related health effects	Prevalence rate of childhood asthma is 10% and for rhinitis 27% (Allergonet 2000) Respiratory disorders contribute to 16% of all deaths [Direcção Geral da Saúde (DGS) 2001a]	Daily NO_2 and O_3 concentrations in Lisbon [Direcção Geral do Ambiente (DGA) 2000]
	Air quality guidelines for NO_2 and O_3 are often exceeded in urban regions	Daily climate data set for Lisbon (IM 2000).
Vectorborne diseases		
Malaria	Disease endemic in the past; currently an annual average of 80 imported malaria cases are reported (incidence of 0.8 per 100,000) (DGS 2001b) Malaria-competent vector is widespread and abundant (Ribeiro et al. 1988)	Vector survival– and parasite developmental rate–temperature relationships (Martens 1998)
WNV fever	Virus isolated from competent mosquito in 1996 (Fernandes et al. 1998) Competent vectors are widespread and abundant (Ribeiro et al. 1988)	Vector survival–temperature relationships (Martens 1998)
Leishmaniasis	Endemic disease with annual average of 15 cases reported (incidence of 0.15/100,000) (DGS 2001b) Competent vectors present (Pires 2000) Reservoir hosts (dogs) with *Leishmania infantum* infection prevalence up to 11.4% (Campino et al. 1995)	Vector activity– and survival-temperature relationships (Rioux et al. 1985; Tesh et al.1992; Theodor 1936)
Lyme disease	Endemic disease with 20 cases hospitalized during 1994–1999 [Instituto de Gestão Informática e Financeira da Saúde (IGIF) 2000] Competent vector and suitable hosts present (Caeiro 1999)	Vector activity–temperature relationship (Caeiro 1992; Sonenshine 1993)
Mediterranean spotted fever	Endemic disease with annual average of 800–1,000 cases reported (incidence of 9.8 per 100,000) (DGS 2001b) Competent vector widespread and abundant (Caeiro 1999) Reservoir hosts (dogs) with infection prevalence up to 85.5% (Bacellar et al. 1995)	Monthly number of reported cases (DGS 2001b)
Schistosomiasis	Disease endemic in the past, currently an annual average of 35 imported cases hospitalized (IGIF 2000) Competent vector present (Grácio 1981)	Vector survival– and parasite development–temperature relationships (Martens 1998)

Fonte Environmental Health Perspectives • VOLUME 114 | NUMBER 12 | December 2006

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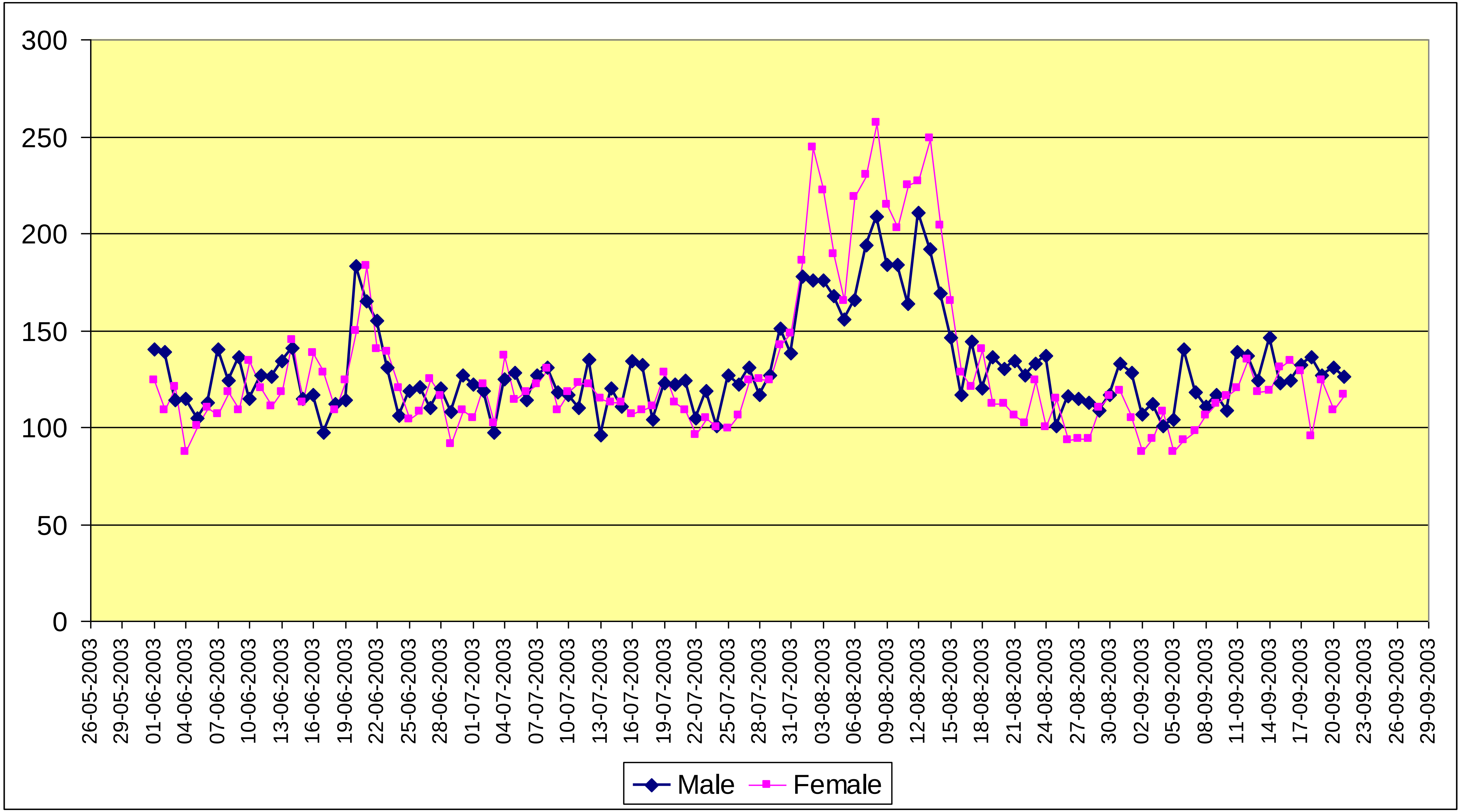
Evaluating the impact of extreme temperature based indices in the 2003 heatwave excessive mortality in Portugal

Ricardo M. Trigo[a,b,*], *Alexandre M. Ramos*[a,h], *Paulo J. Nogueira*[c], *Filipe D. Santos*[d], *Ricardo Garcia-Herrera*[e], *Célia Gouveia*[a,f], *Fátima E. Santo*[g]

Projeto IMPACTE 2006-2009



The 2003 heat wave observed results in Portugal changed the knowledge about heat wave impacts on gender. Women had more mortality (even in rates). Fonte IMPACTE

Fonte Projeto IMPACTE

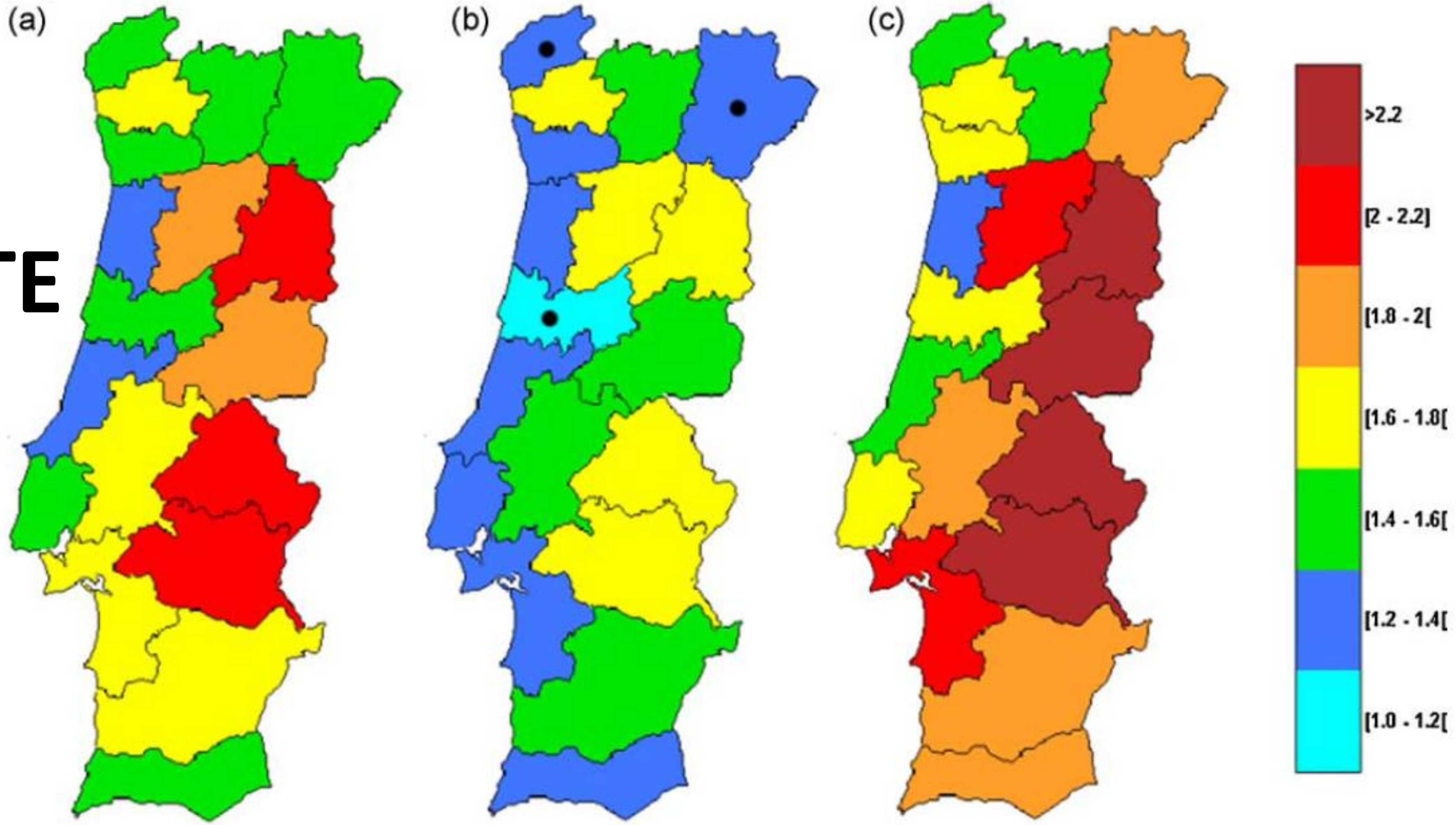


Fig. 3 – Spatial variability of the observed/expected (O/E) ratio per district, considering (a) the total population, (b) male and (c) female population. All the increments are statistically significant (5% significance level) except those identified with the black dots.

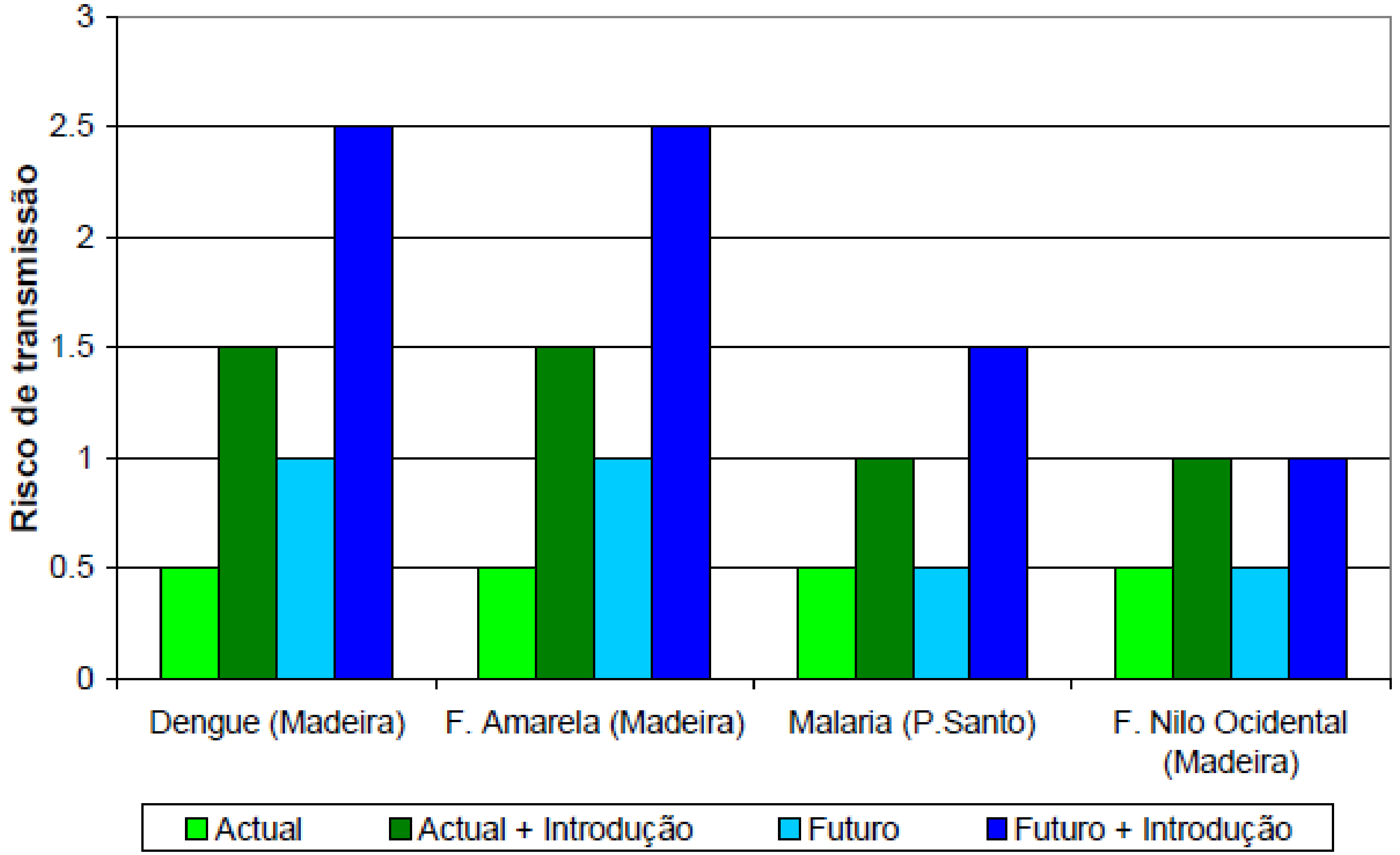
Estratégia Regional de Adaptação às Alterações Climáticas

Madeira, CLIMAAT II,
Impactos e medidas de Adaptação às Alterações Climáticas no Arquipélago da Madeira,
Direcção Regional do Ambiente da Madeira, Funchal, 2006,
http://www.sra.pt/files/PDF/Destaques/Brochura CLIMAAT_II_ MadeiraFINAL.pdf

Nesta Estratégia alertou-se para o aumento do risco de Dengue devido em parte às alterações climáticas

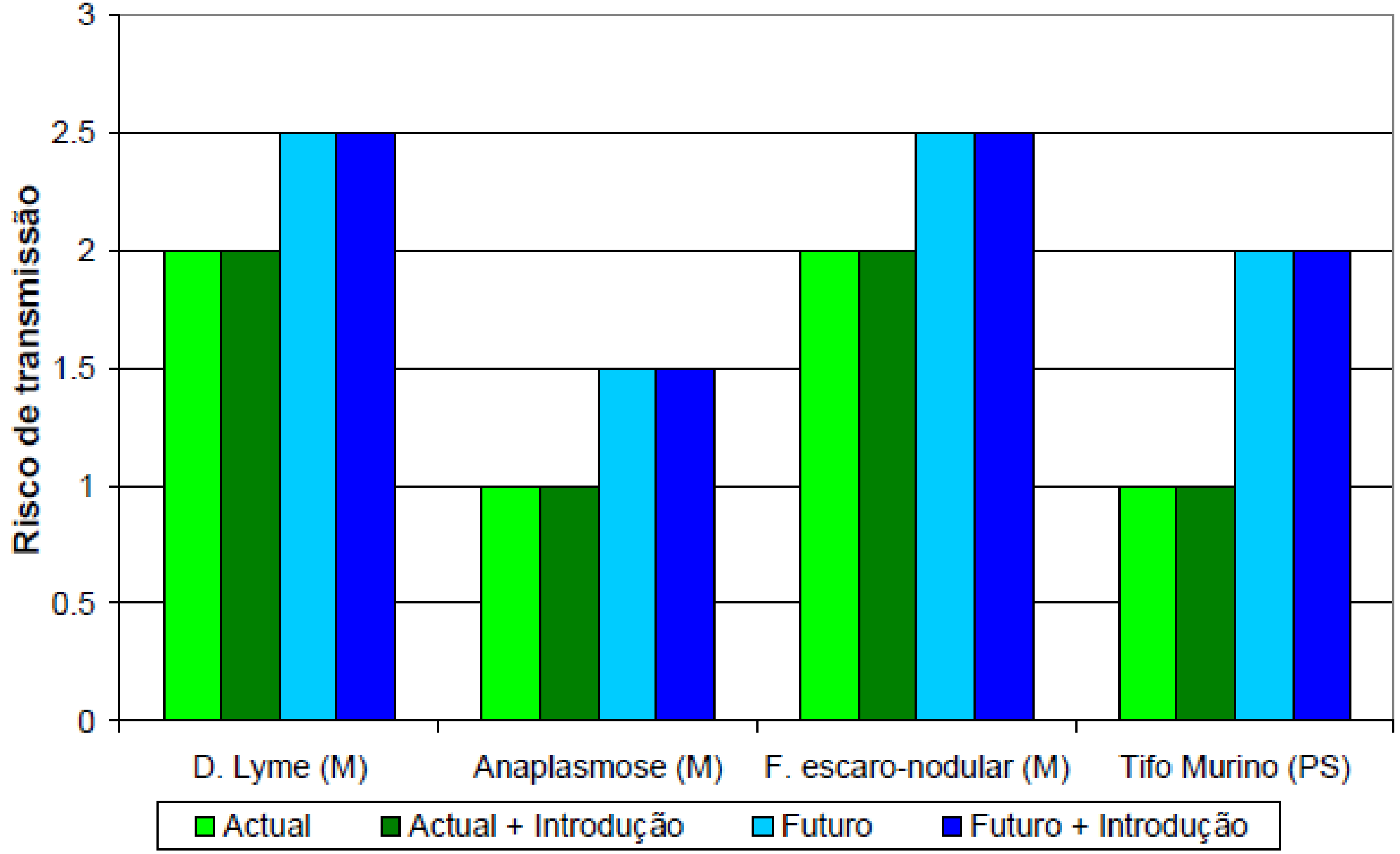
Doenças transmitidas por mosquitos

Fonte: Projeto CLIMAAT II, MADEIRA, 2006



Níveis de risco de transmissão de doenças transmitidas por mosquitos na RAM.
(0.5 = risco muito baixo, 1 = risco baixo, 2 = risco médio, 3 = risco alto).

Fonte: Projeto CLIMAAT II, MADEIRA, 2006



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(0.5 = risco muito baixo, 1 = risco baixo, 2 = risco médio, 3 = risco alto).

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PLOS | NEGLECTED TROPICAL DISEASES

The 2012 Madeira Dengue Outbreak: Epidemiological Determinants and Future Epidemic Potential

José Lourenço[1,2*], Mario Recker[3]

1 Medical Research Council Centre for Outbreak Analysis and Modelling, Department of Infectious Disease Epidemiology, School of Public Health, Imperial College London, London, United Kingdom, 2 Department of Zoology, University of Oxford, Oxford, United Kingdom, 3 College of Engineering, Mathematics & Physical Sciences, University of Exeter, Penryn Campus, Penryn, United Kingdom

Citation: Lourenço J, Recker M (2014) The 2012 Madeira Dengue Outbreak: Epidemiological Determinants and Future Epidemic Potential. PLoS Negl Trop Dis 8(8): e3083. doi:10.1371/journal.pntd.0003083

Medidas de Adaptação: Saúde

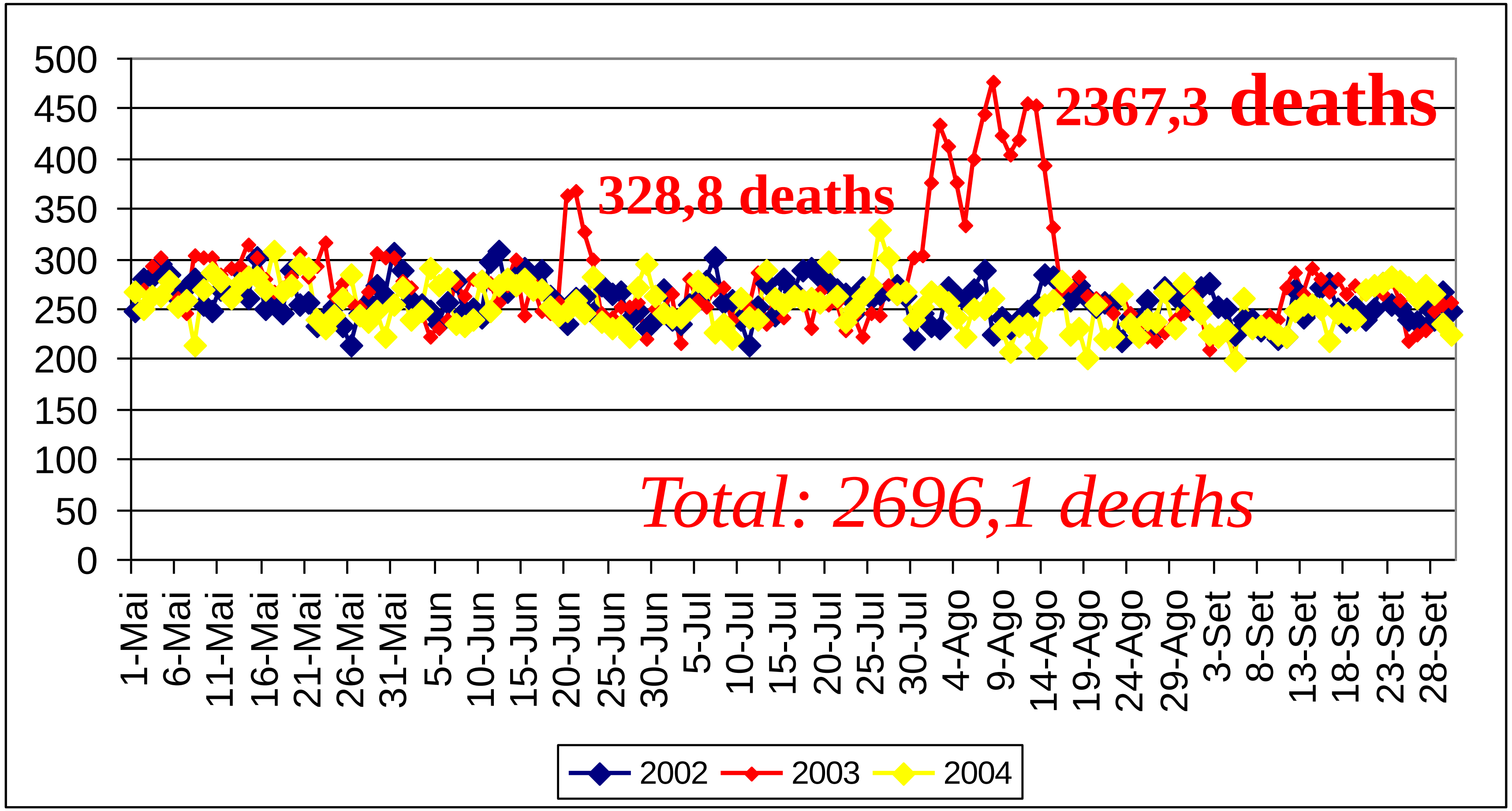
- Dados & ciência
- Programas de monitorização & vigilância epidemiológica
- Sensibilização dos profissionais & publico
- Programas de controlo (vectores)
- Sistemas de alerta & resposta

Fonte: SIAM

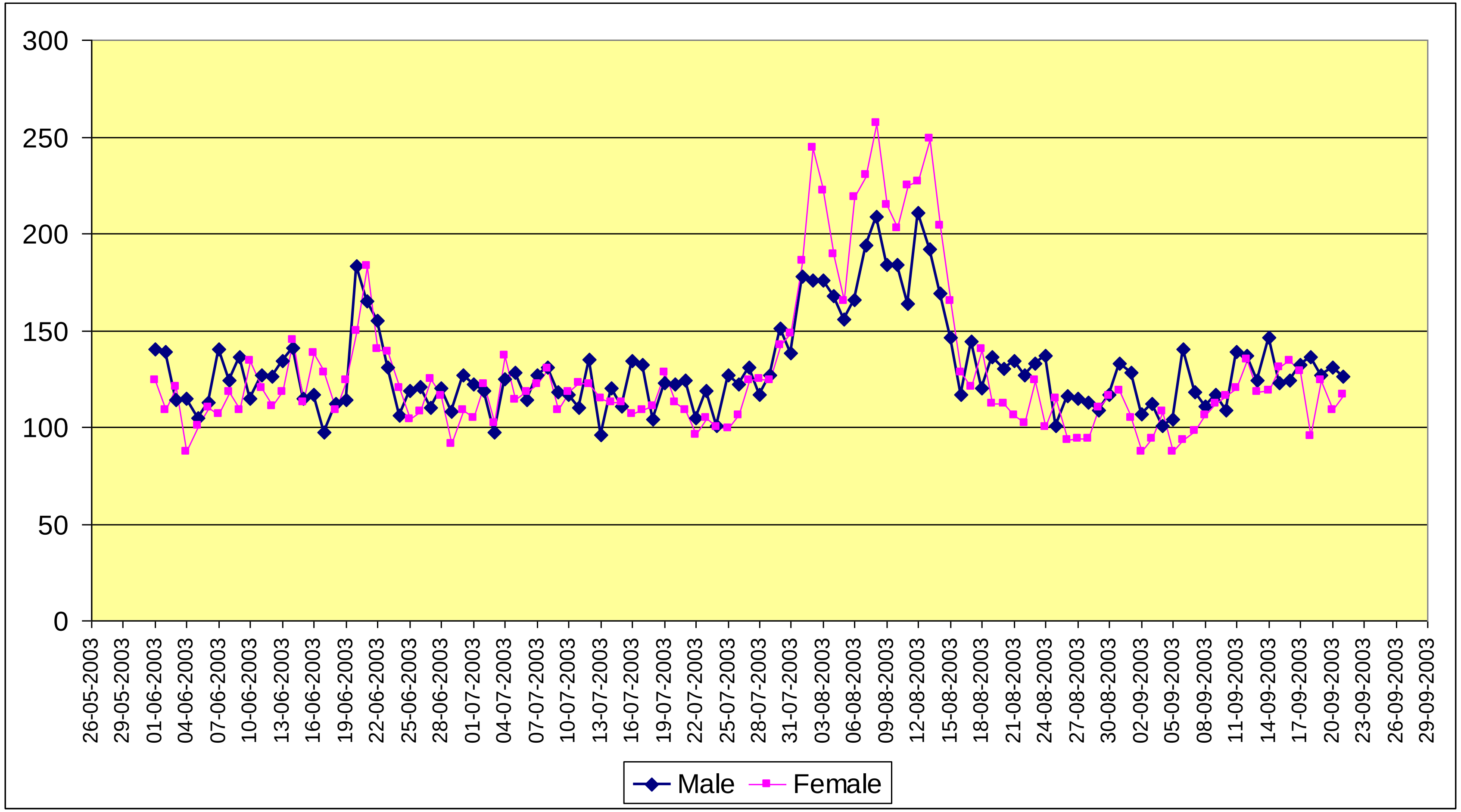
Obrigado pela vossa atenção

Heat wave July-August 2003

comparisons with adjacent years



Men vs Women
Summer 2003



The 2003 heat wave observed results changed the knowledge about heat wave impacts on gender. Women had more mortality (even in rates)

[Severe] Heat waves in Portugal

DATE	Excess Deaths Estimate	CI 95%
12 - 20 June 1981	1906,2	(1636,2; 2176,2)
12 - 21 July 1991	1001,8	(909,1 ; 1094,5)
30 July to 15 August 2003	1952,7	(1866,1; 2039,3)
30 July to 16 August 2003	2367,3	(2271,9; 2462,6)
10 - 27 July 2006	1123	(876 ; 1381)

Direct calculations using previous and next years data

Estimates correct usings mortality rates

Early estimates using VDM system

[Moderate] Heat waves in Portugal

DATE	Excess Deaths Estimate	CI 95%
14 - 25 July 1990	690,4	(397,6 ; 1028,2)
19 - 28 May 1991	475,1	(377,9 ; 572,2)
14 - 18 June 2000	340,2	(304,1; 376,4)
26 May - 2 June 2001	522,1	(477,4; 566,9)
20 - 23 de June 2003	328,8	(293,3; 364,4)
27 July - 4 August 2004 (Algarve)	80	(47 ; 119)
26 - 27 July 2004 (Portugal Continental)	114,9	(93,9 ; 135,9)
3 - 7 August + 12 - 16 August 2005	461,8	(410,2 ; 518,4)

Direct calculations using previous and next years data

Early estimates using VDM system