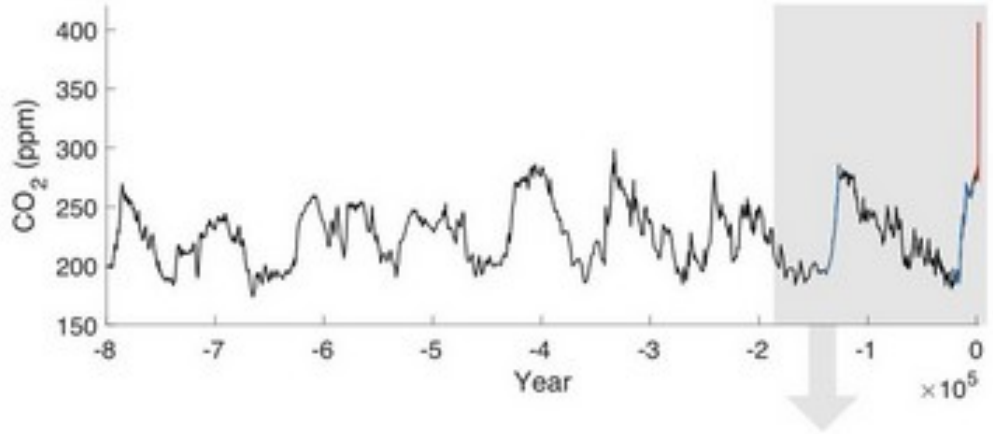
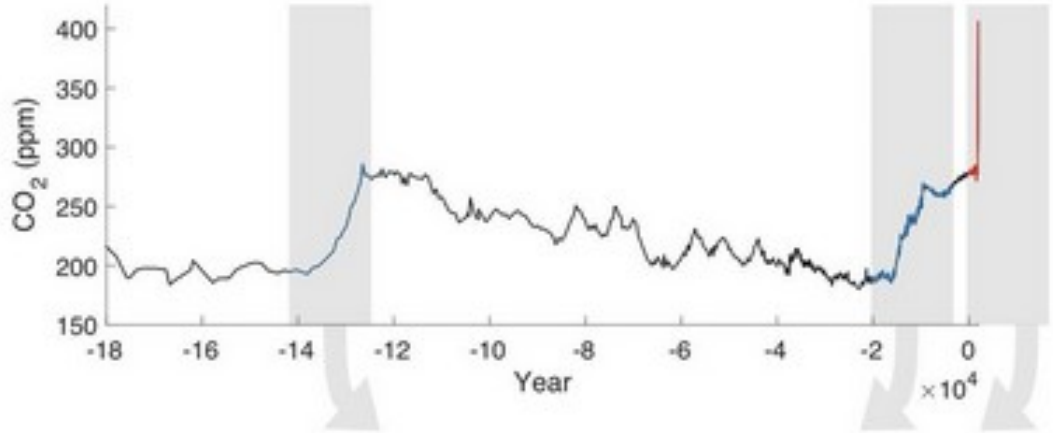
Escenaris climàtics, punts d'inflexió i impactes al món

Jofre Carnicer
Universitat de Barcelona
CREAF

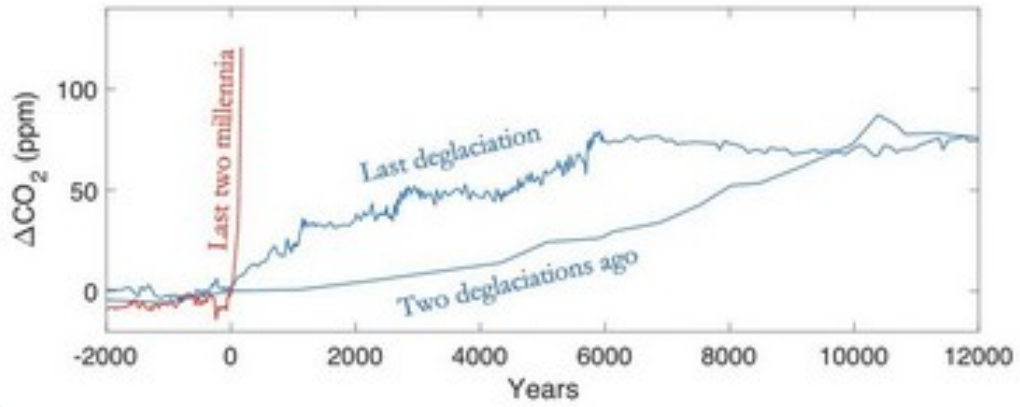
El canvi climàtic és un fet observable i sense precedents



CO_2 over the last 800,000 years

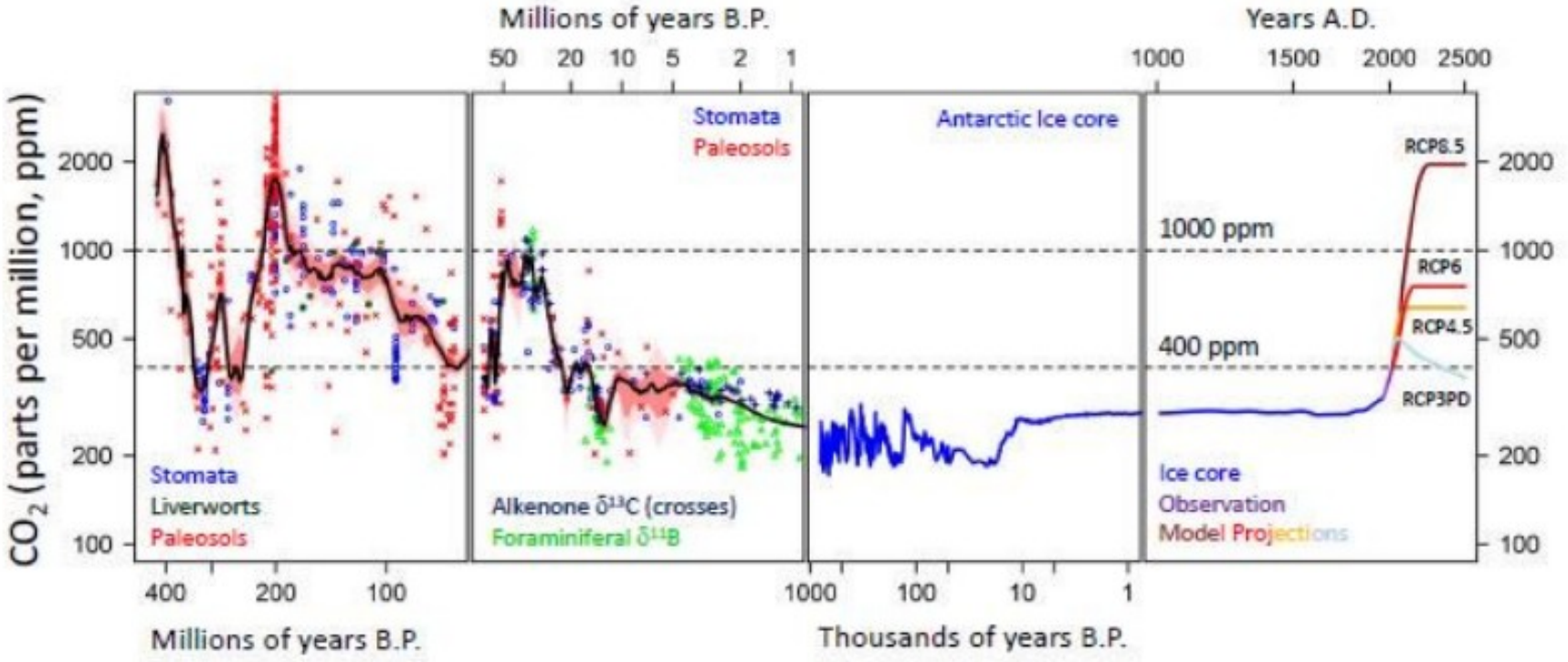


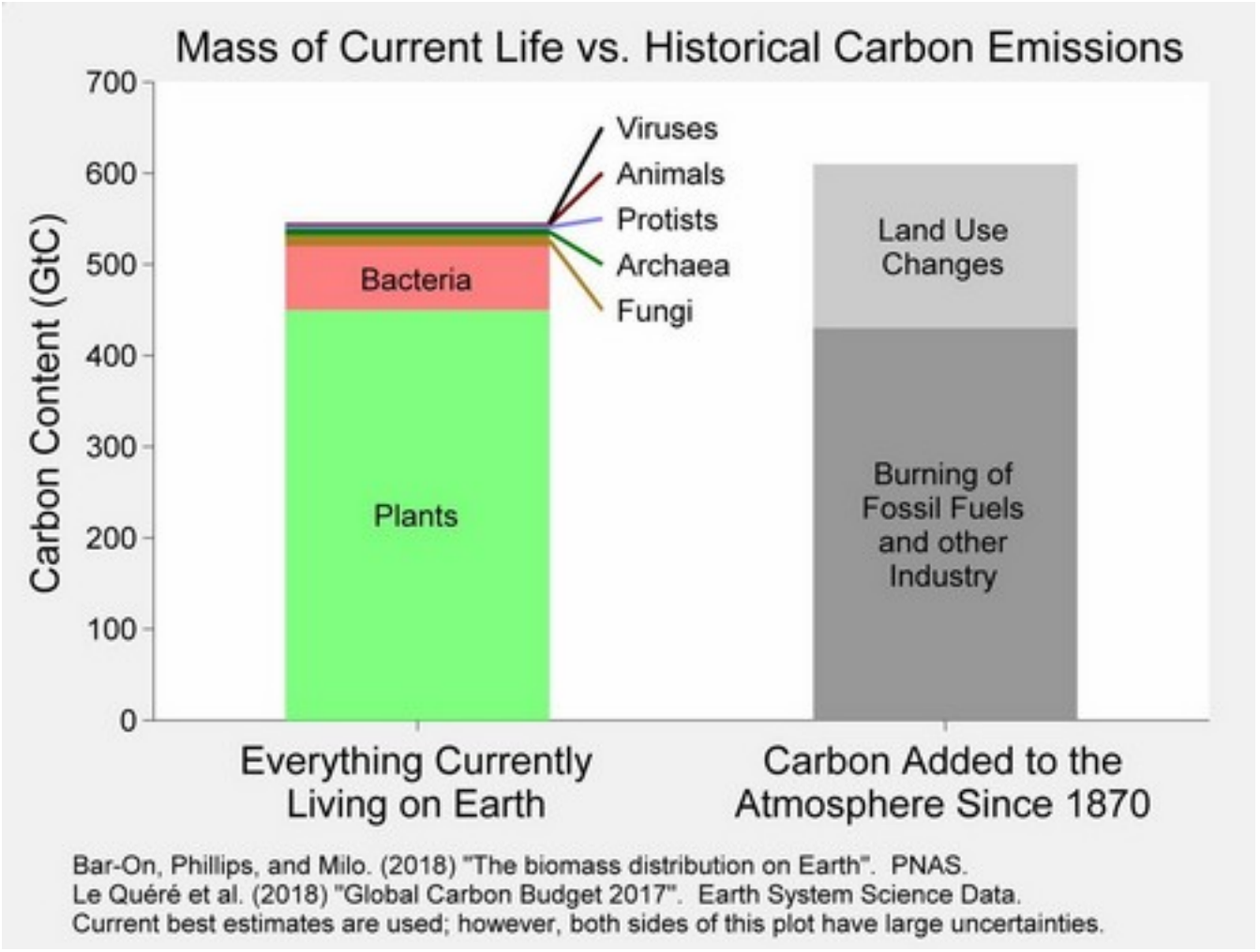
CO_2 over the last 180,000 years



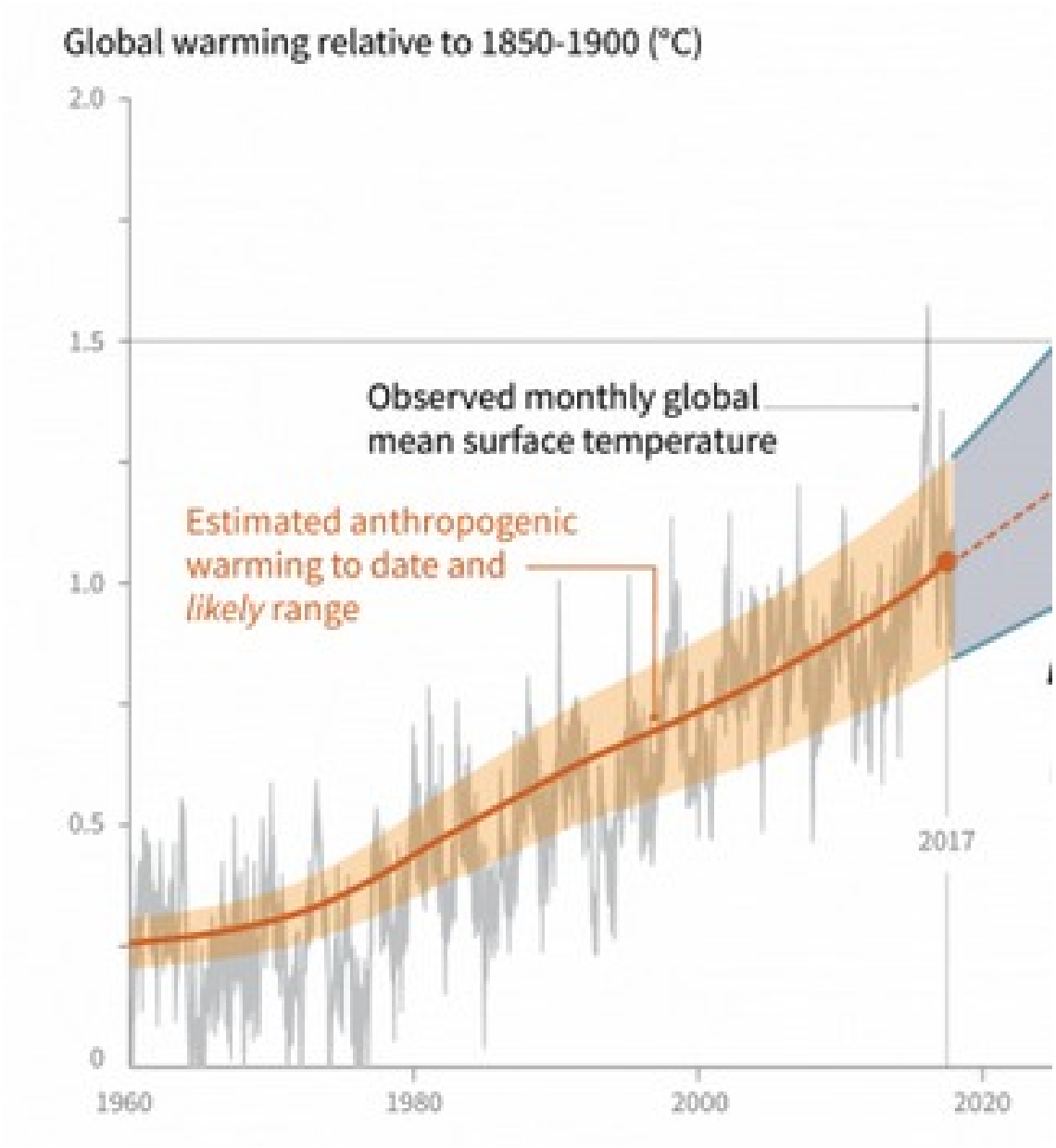
CO_2 changes in 14,000 year windows

@OceansClimateCU

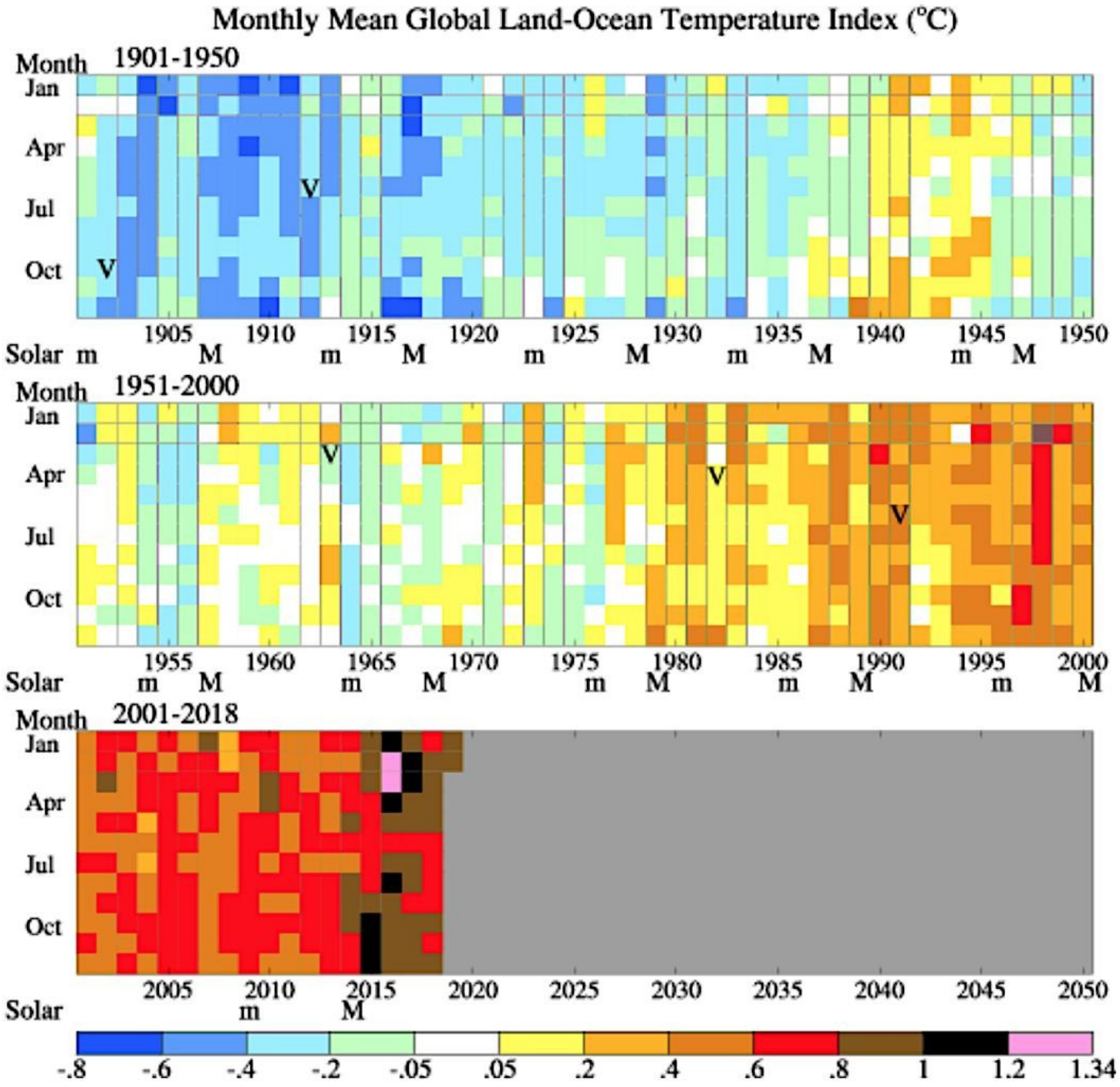

Millions of years B.P.
50 20 10 5 2 1
Years A.D.
1000 1500 2000 2500
CO_2 (parts per million, ppm)
2000
1000
500
200
100
Stomata
Paleosols
Antarctic Ice core
RCP8.5
RCP6
RCP4.5
RCP3PD
1000 ppm
400 ppm
Stomata
Liverworts
Paleosols
Alkenone $\delta^{13}C$ (crosses)
Foraminiferal $\delta^{11}B$
Ice core
Observation
Model Projections
400 200 100
Millions of years B.P.
1000 100 10 1
Thousands of years B.P.

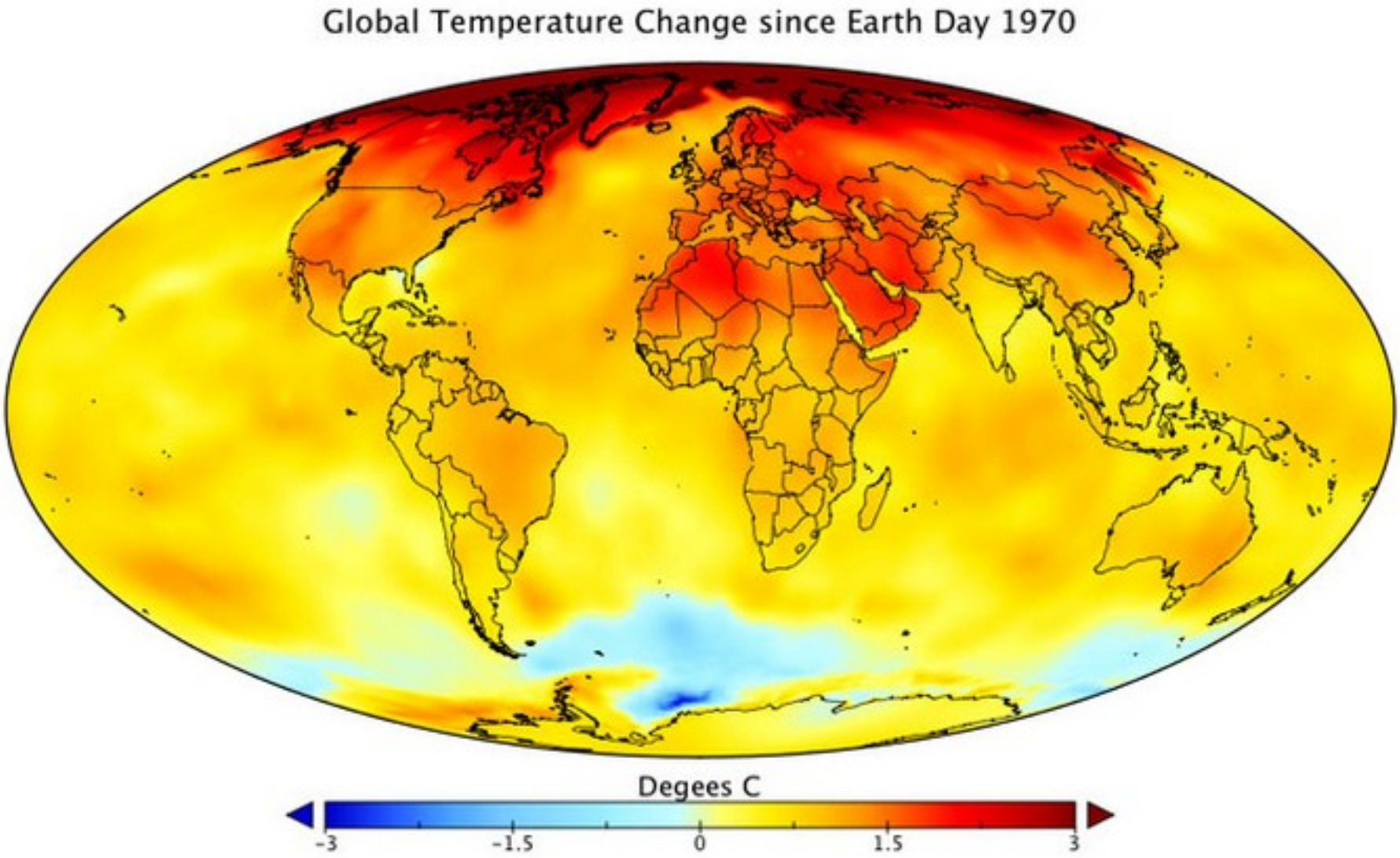


Bar-On, Phillips, and Milo. (2018) "The biomass distribution on Earth". PNAS.
Le Quéré et al. (2018) "Global Carbon Budget 2017". Earth System Science Data.
Current best estimates are used; however, both sides of this plot have large uncertainties.

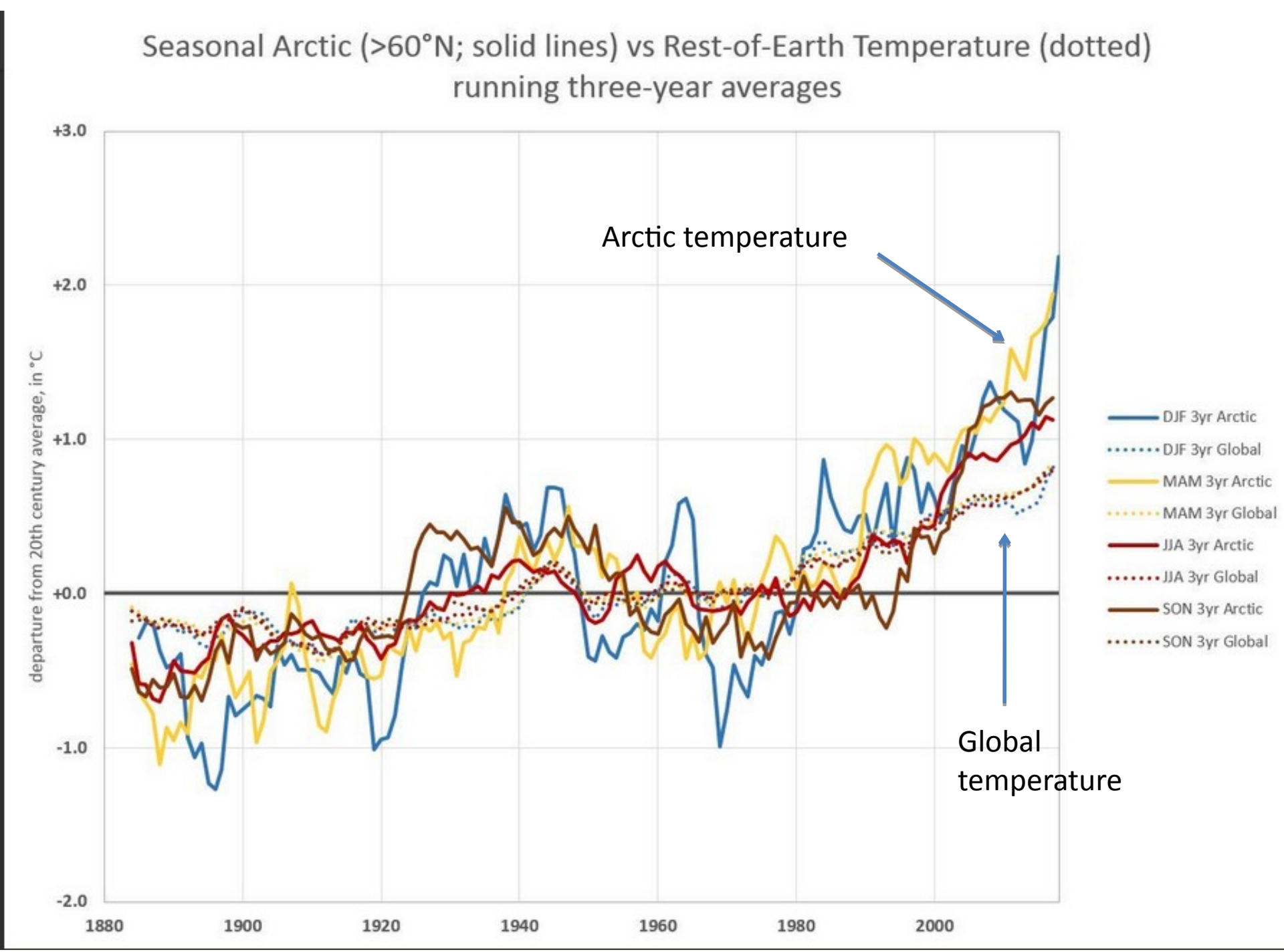


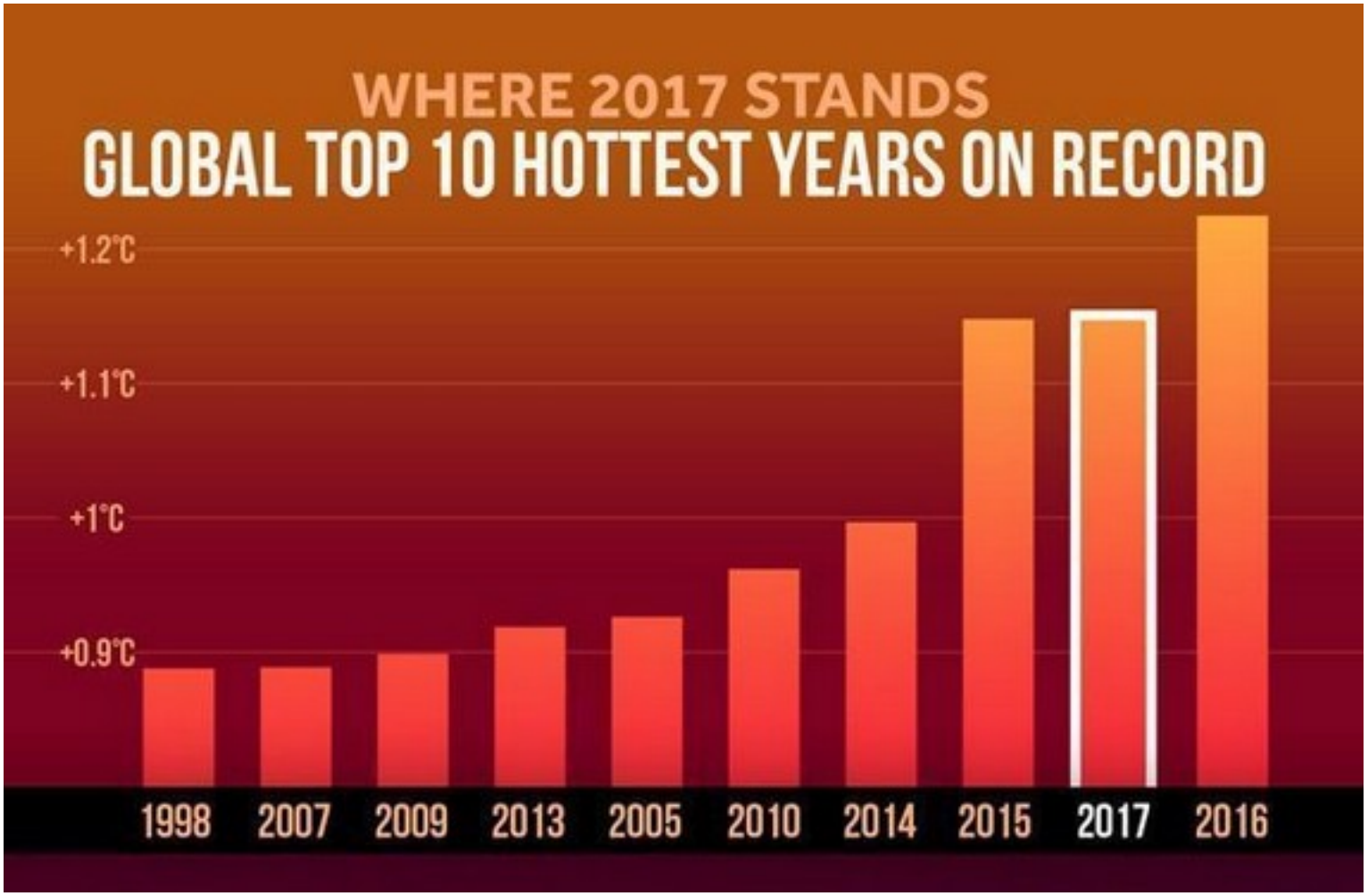
IPCC 2018 SR 1.5 ºC

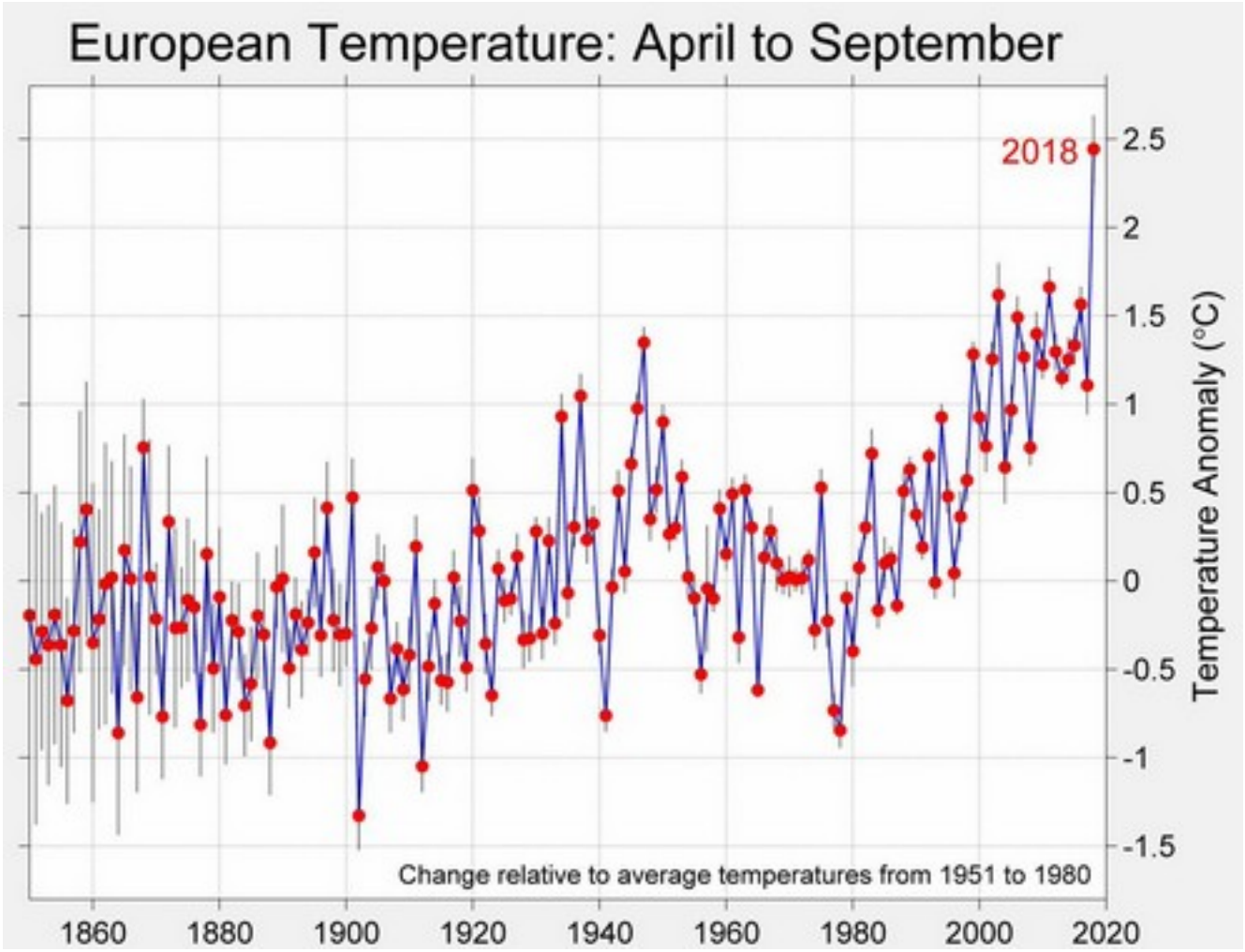

Monthly Mean Global Land-Ocean Temperature Index (°C)
Month
1901-1950
Jan
Apr
Jul
Oct
V
V
1905
1910
1915
1920
1925
1930
1935
1940
1945
1950
Solar m M m M m M m M m M
Month
1951-2000
Jan
Apr
Jul
Oct
V
V
V
1955
1960
1965
1970
1975
1980
1985
1990
1995
2000
Solar m M m M m M m M m M
Month
2001-2018
Jan
Apr
Jul
Oct
2005
2010
2015
2020
2025
2030
2035
2040
2045
2050
Solar m M
-.8
-.6
-.4
-.2
-.05
.05
.2
.4
.6
.8
1
1.2
1.34



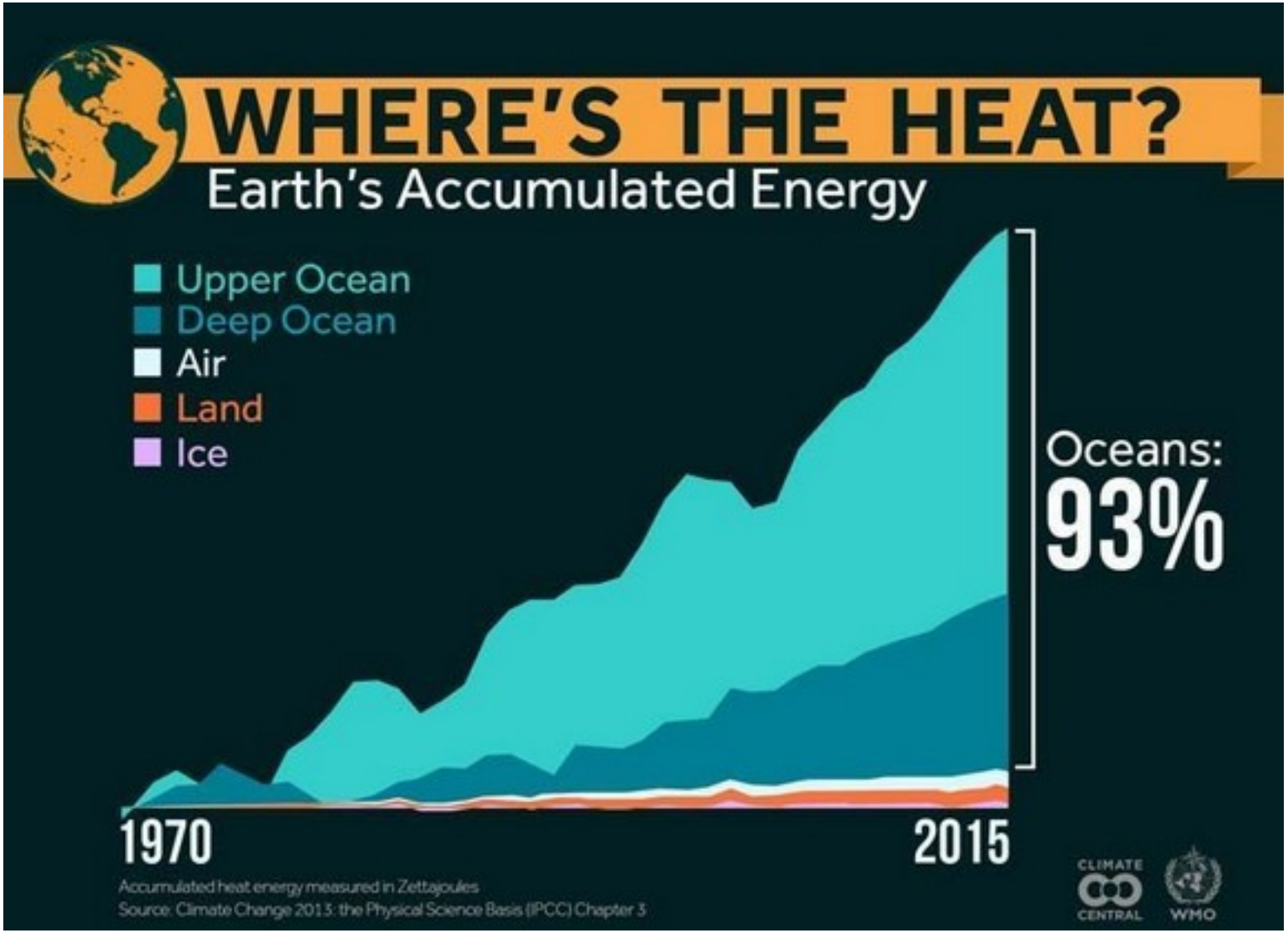
IPCC 2018 SR 1.5 ºC

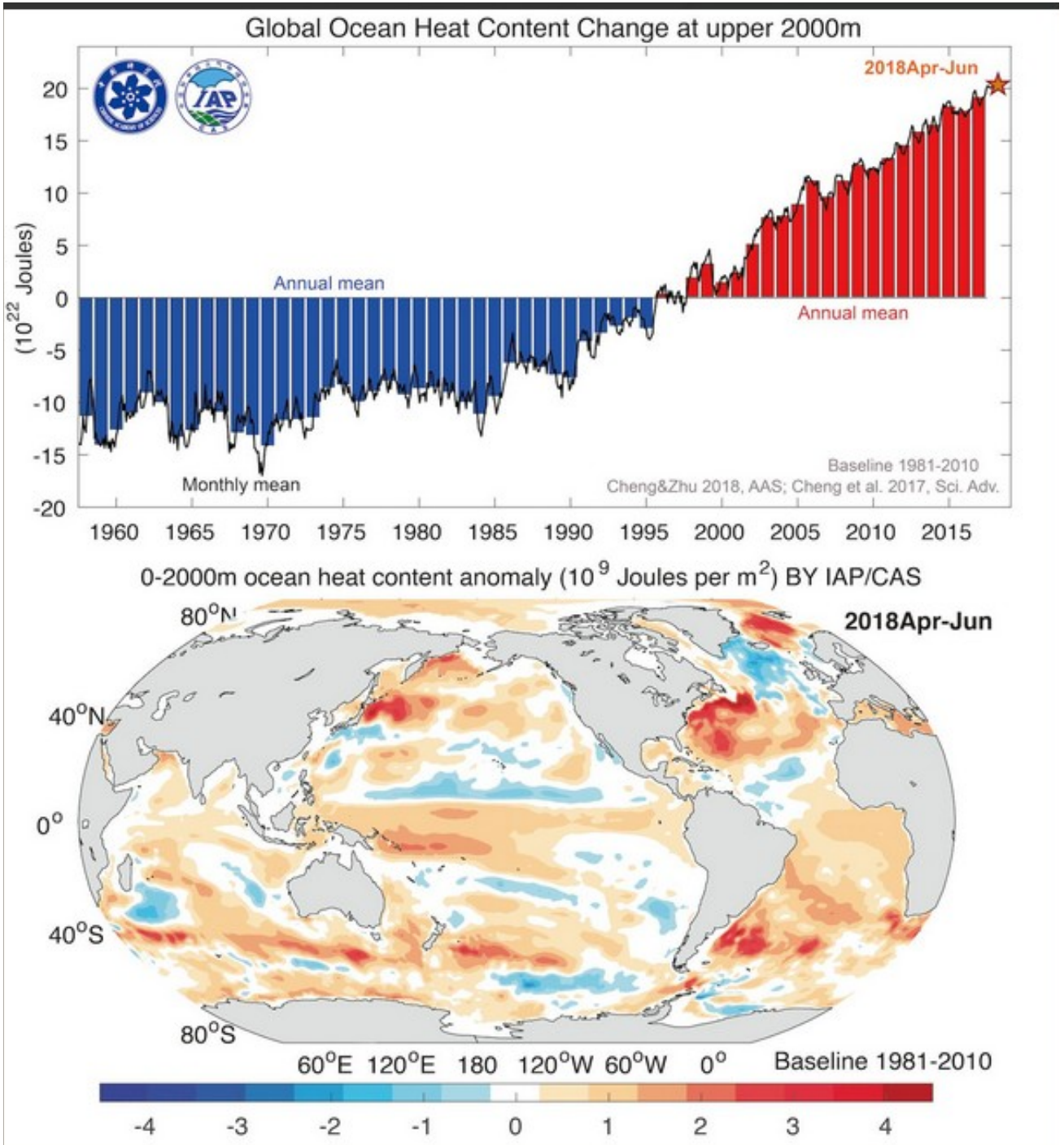

Seasonal Arctic (>60°N; solid lines) vs Rest-of-Earth Temperature (dotted)
running three-year averages
departure from 20th century average, in °C
+3.0
+2.0
+1.0
+0.0
-1.0
-2.0
1880
1900
1920
1940
1960
1980
2000
Arctic temperature
Global temperature
DJF 3yr Arctic
DJF 3yr Global
MAM 3yr Arctic
MAM 3yr Global
JJA 3yr Arctic
JJA 3yr Global
SON 3yr Arctic
SON 3yr Global


WHERE 2017 STANDS
GLOBAL TOP 10 HOTTEST YEARS ON RECORD
+1.2°C
+1.1°C
+1°C
+0.9°C
1998
2007
2009
2013
2005
2010
2014
2015
2017
2016


European Temperature: April to September
2018
2.5
2
1.5
1
0.5
0
-0.5
-1
-1.5
Temperature Anomaly (°C)
Change relative to average temperatures from 1951 to 1980
1860
1880
1900
1920
1940
1960
1980
2000
2020

Entenem el funcionament de la biosfera?


WHERE'S THE HEAT?
Earth's Accumulated Energy
Upper Ocean
Deep Ocean
Air
Land
Ice
Oceans:
93%
1970
2015
Accumulated heat energy measured in Zettajoules
Source: Climate Change 2013: the Physical Science Basis (IPCC) Chapter 3
CLIMATE CENTRAL
WMO


Global Ocean Heat Content Change at upper 2000m
2018Apr-Jun
Annual mean
Annual mean
Monthly mean
Baseline 1981-2010
Cheng&Zhu 2018, AAS; Cheng et al. 2017, Sci. Adv.
(10^22 Joules)
20
15
10
5
0
-5
-10
-15
-20
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
0-2000m ocean heat content anomaly (10^9 Joules per m^2) BY IAP/CAS
2018Apr-Jun
80°N
40°N
0°
40°S
80°S
60°E
120°E
180
120°W
60°W
0°
Baseline 1981-2010
-4
-3
-2
-1
0
1
2
3
4

CLIMATE

Varying planetary heat sink led to global-warming slowdown and acceleration

Xianyao Chen[1,2] and Ka-Kit Tung[2]*

A vacillating global heat sink at intermediate ocean depths is associated with different climate regimes of surface warming under anthropogenic forcing: The latter part of the 20th century saw rapid global warming as more heat stayed near the surface. In the 21st century, surface warming slowed as more heat moved into deeper oceans. In situ and reanalyzed data are used to trace the pathways of ocean heat uptake. In addition to the shallow La Niña–like patterns in the Pacific that were the previous focus, we found that the slowdown is mainly caused by heat transported to deeper layers in the Atlantic and the Southern oceans, initiated by a recurrent salinity anomaly in the subpolar North Atlantic. Cooling periods associated with the latter deeper heat-sequestration mechanism historically lasted 20 to 35 years.

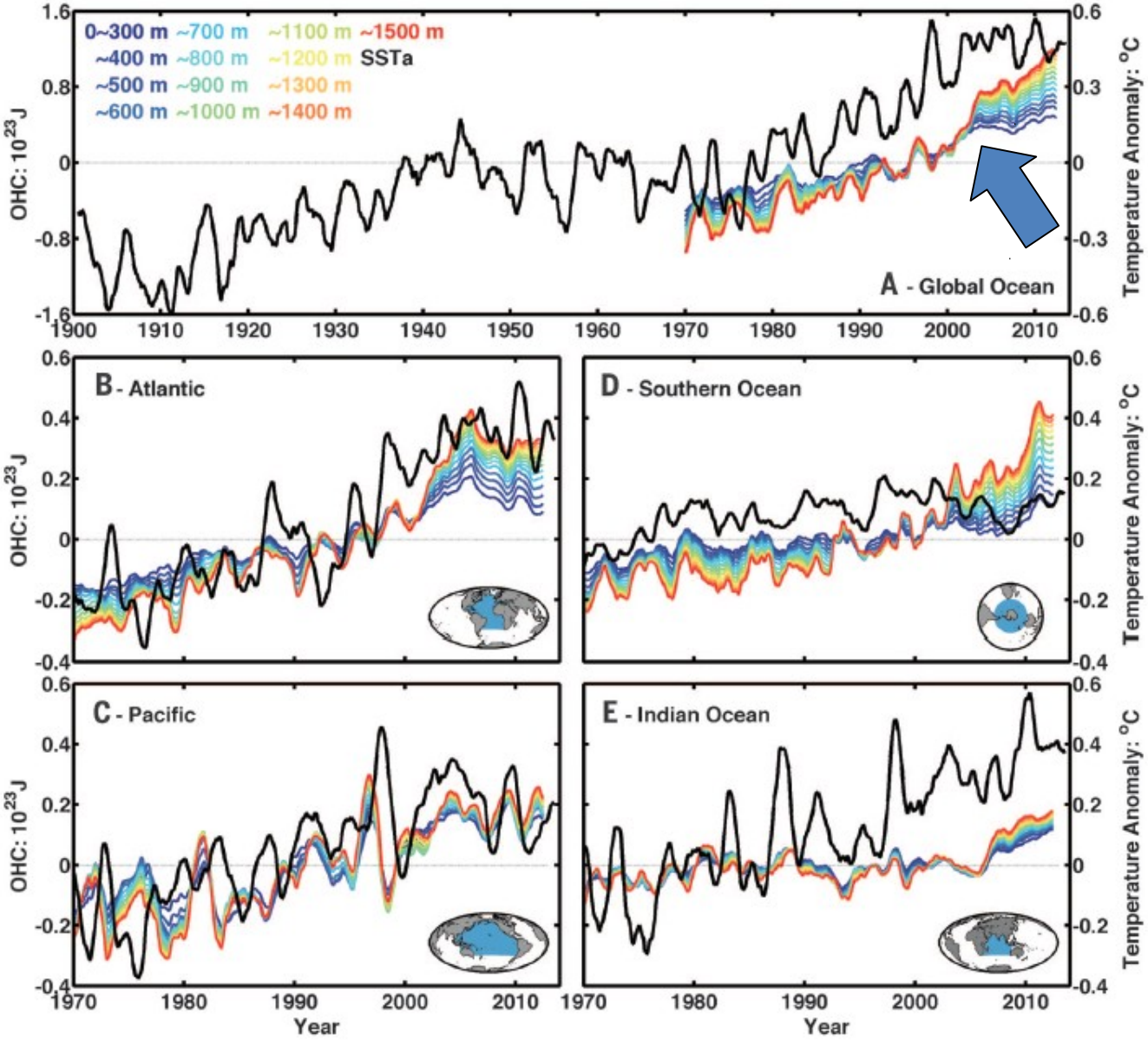
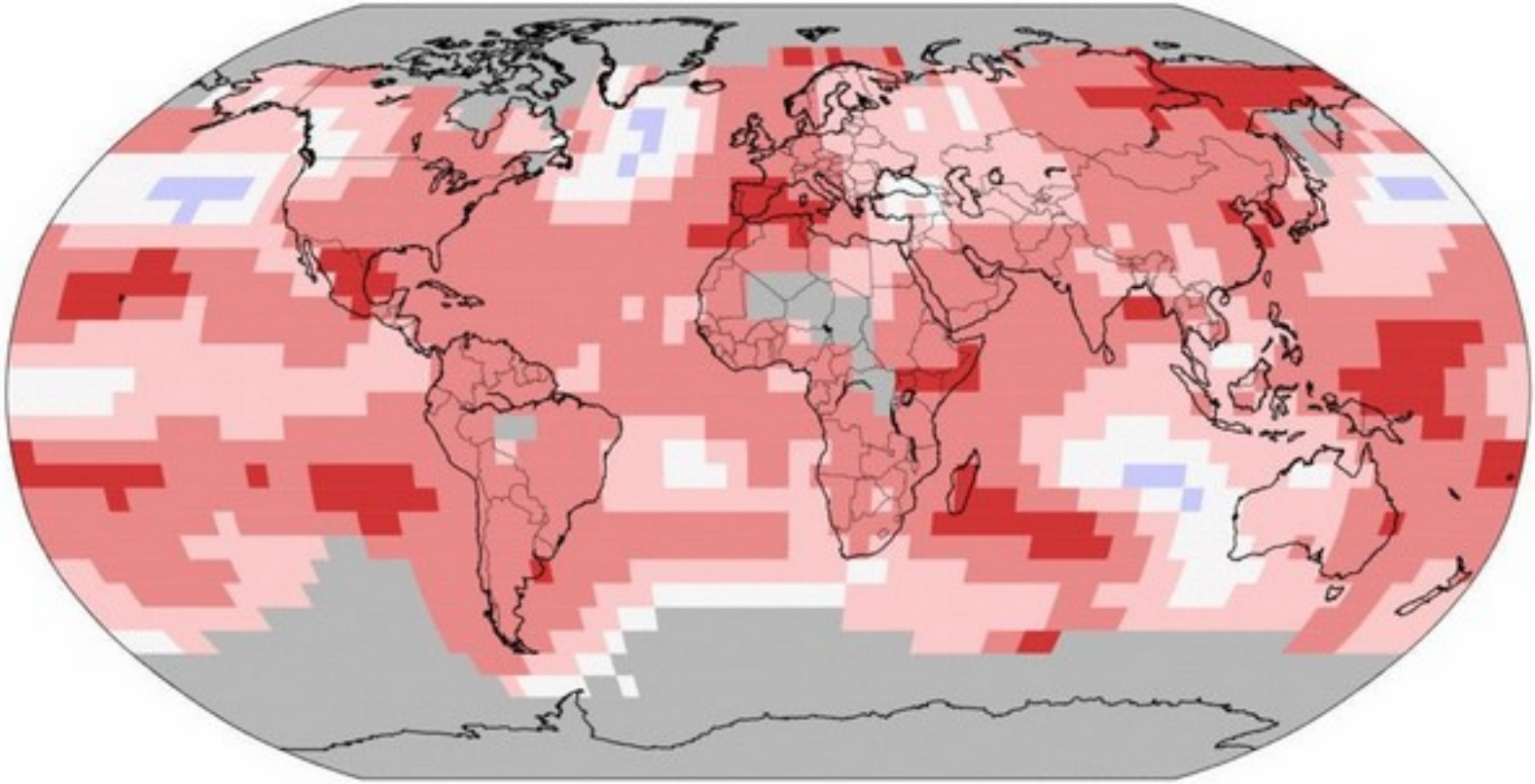


Fig. 1. Integrated OHC. Integrated from the surface to different indicated depths in the global ocean (**A**), the Atlantic (**B**), the Pacific (**C**), the Southern Ocean (**D**), and the Indian Ocean (**E**). Shown is the 12-month running mean deviation from the climatological mean (1970 to 2012) for each layer, so attention should not be focused on the absolute distance between the curves but should be on their relative changes in time. Color lines show the OHC in the left scale, in units of 10^{23} J. The black line shows the mean SST up to 2013. (Insets) The division of the globe into the Pacific, the Atlantic, the Indian Ocean, and the Southern Ocean. Although shown in the figure, data in the earlier decades were not as reliable (see Data and Materials and Methods); the discussion in the text is focused on the better-observed regions and periods.

Land & Ocean Temperature Percentiles Jan–Jun 2017

NOAA's National Centers for Environmental Information

Data Source: GHCN–M version 3.3.0 & ERSST version 4.0.0



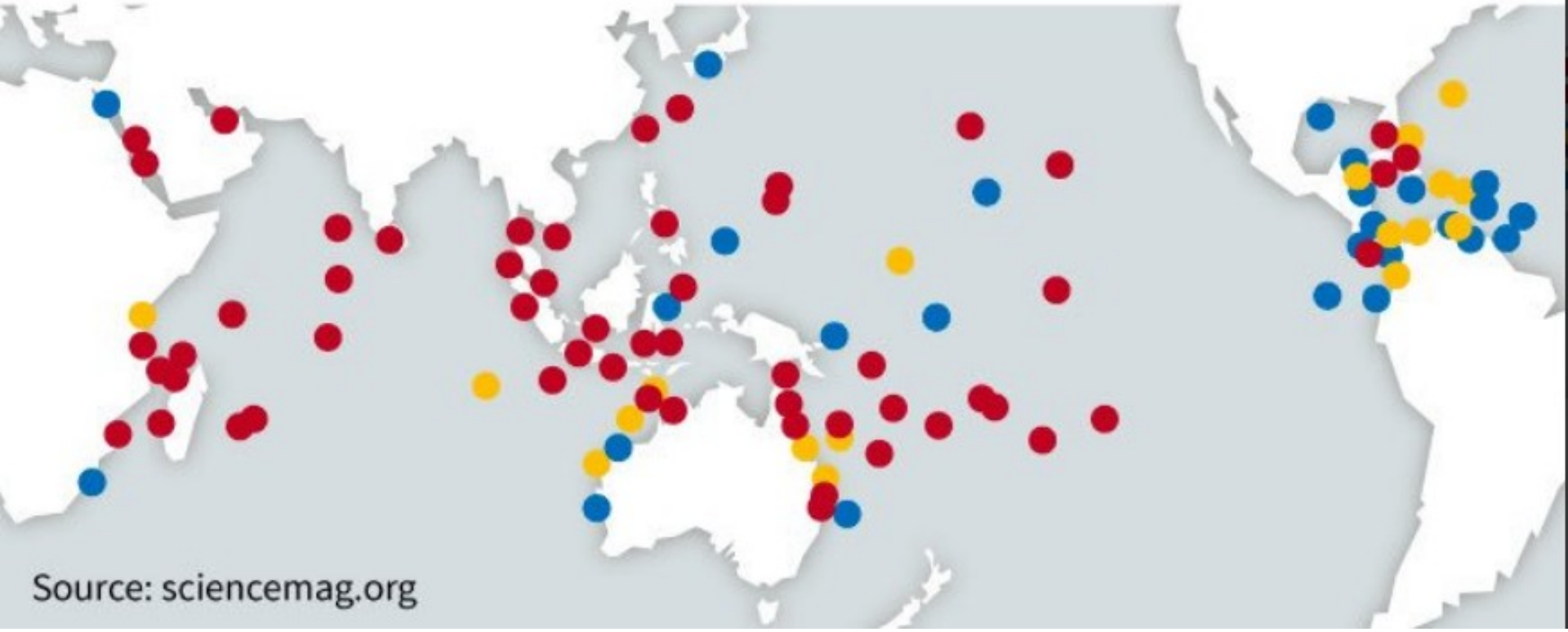
Record Coldest | Much Cooler than Average | Cooler than Average | Near Average | Warmer than Average | Much Warmer than Average | Record Warmest

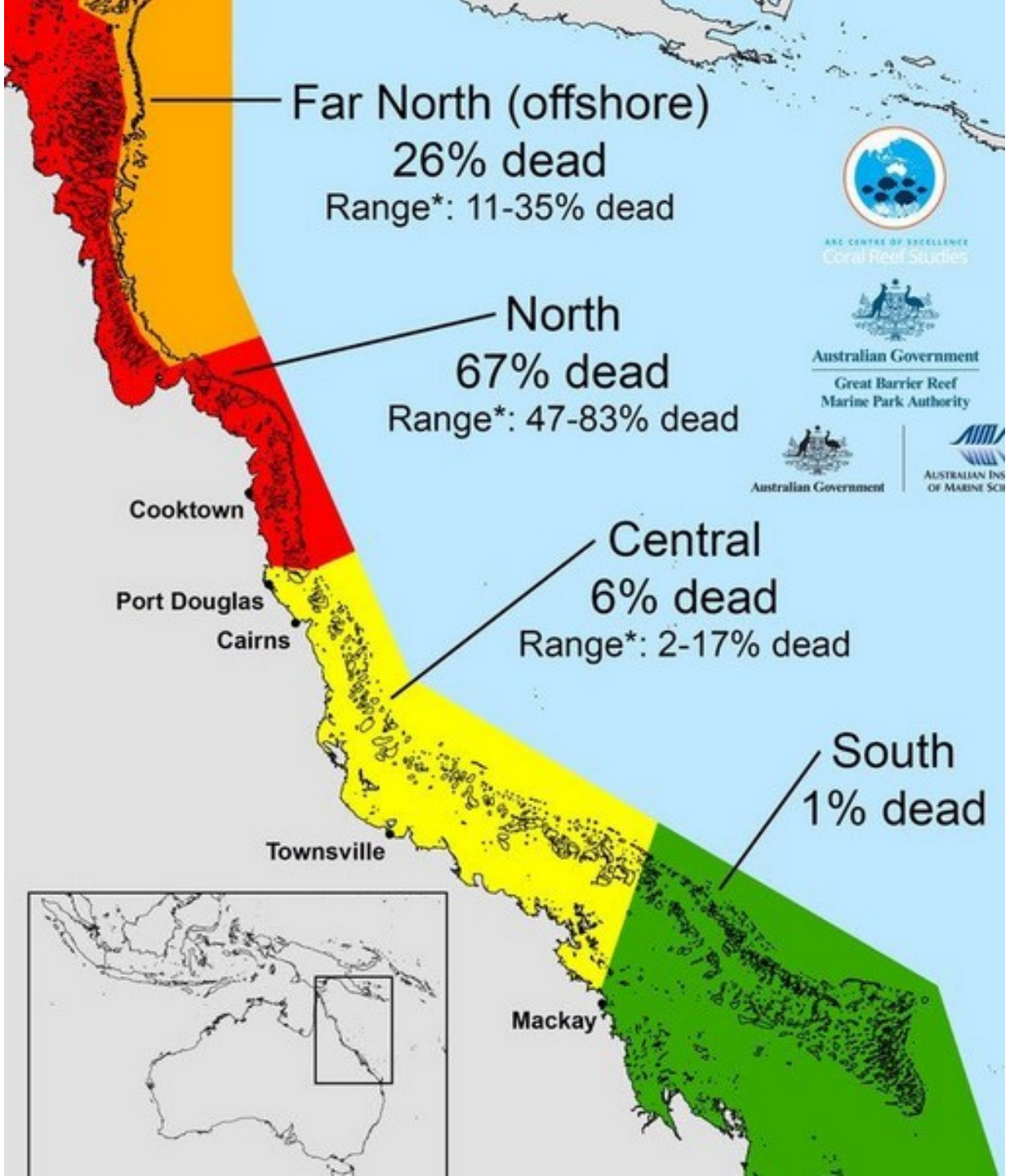
Wed Jul 12 07:08:38 EDT 201

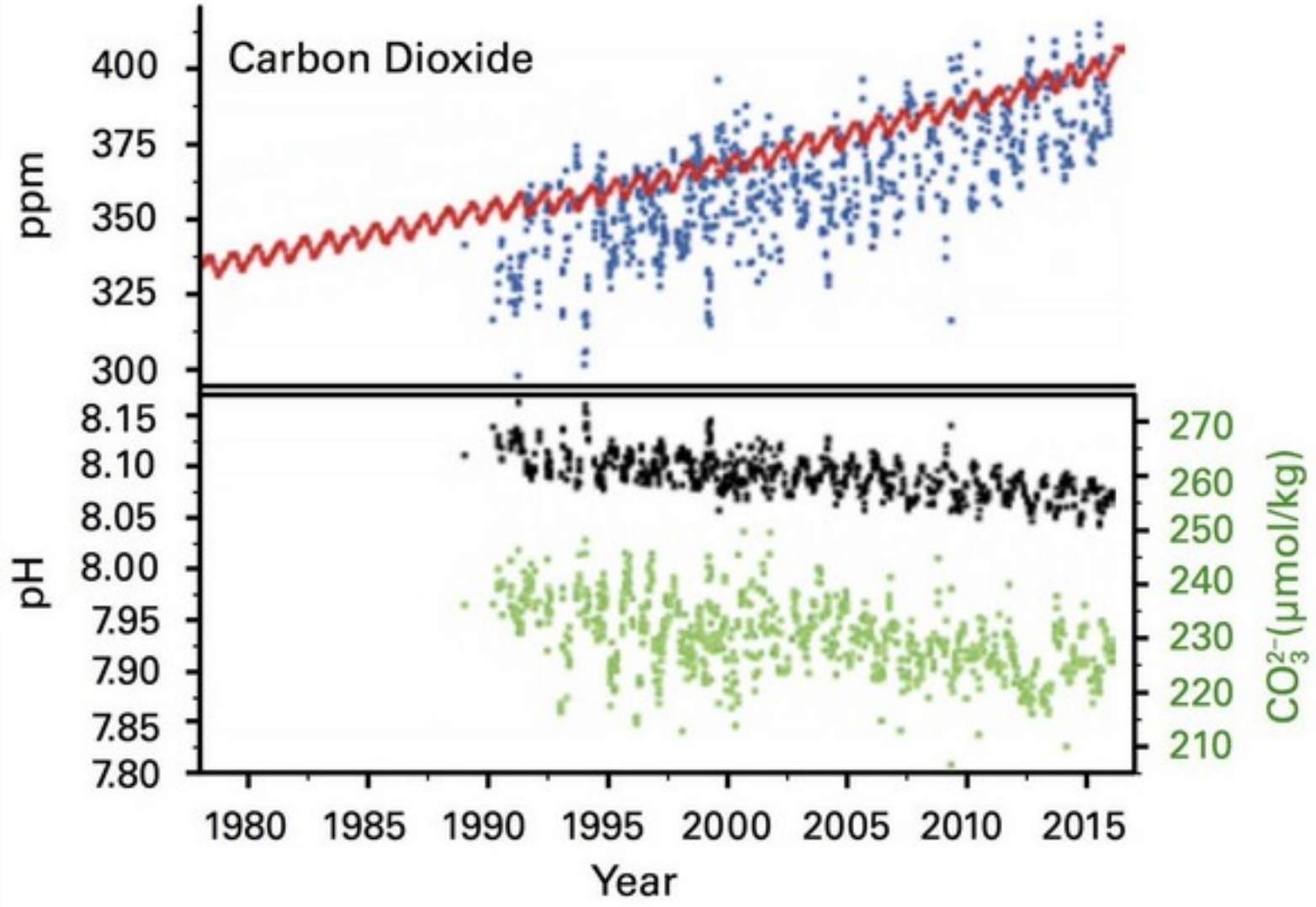
Recent coral bleaching

The global extent of mass bleaching of 100 reefs observed in 2015 and 2016

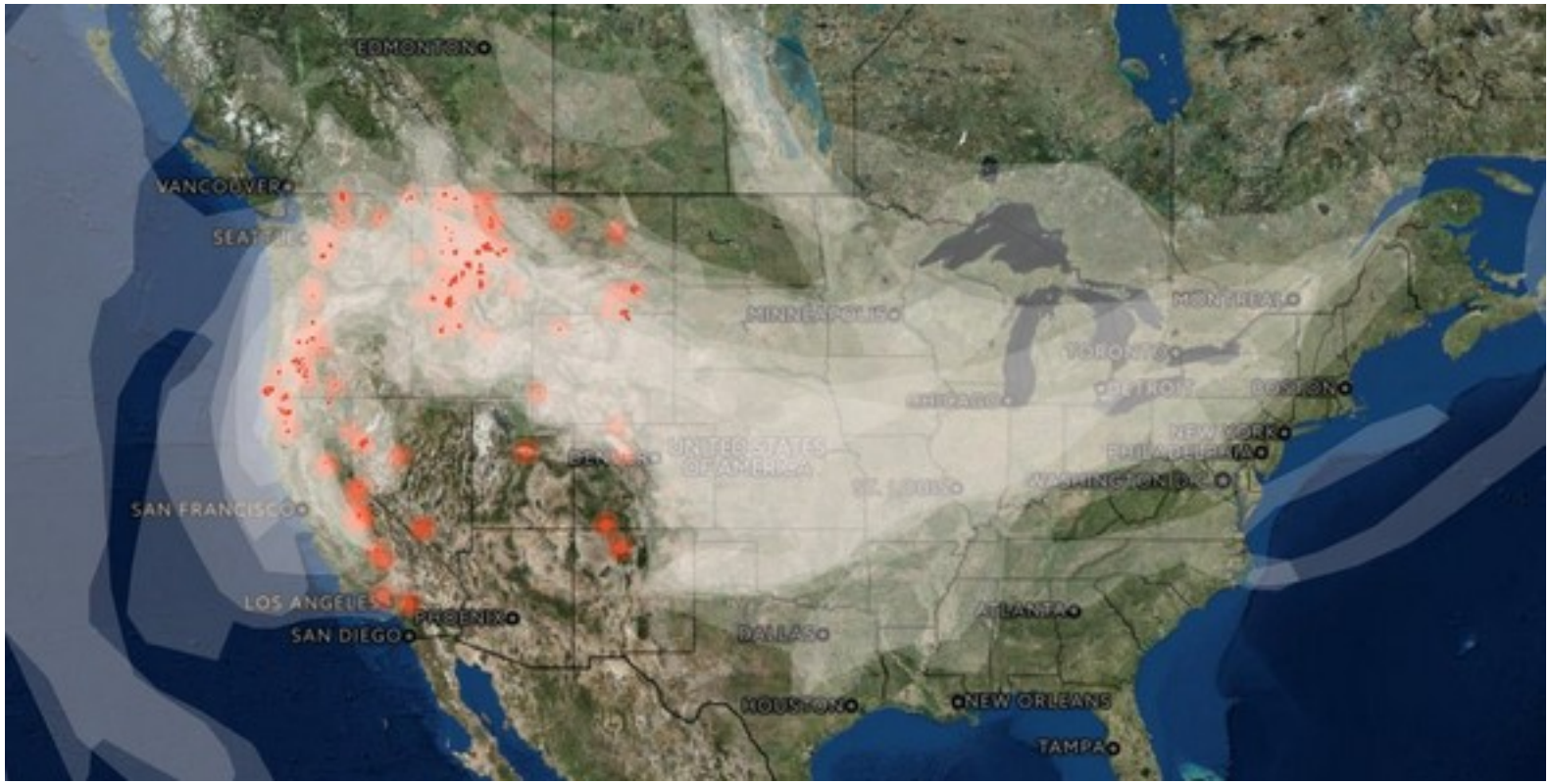
No bleaching **Moderate (<30%)** **Severe (>30% coral) affected**



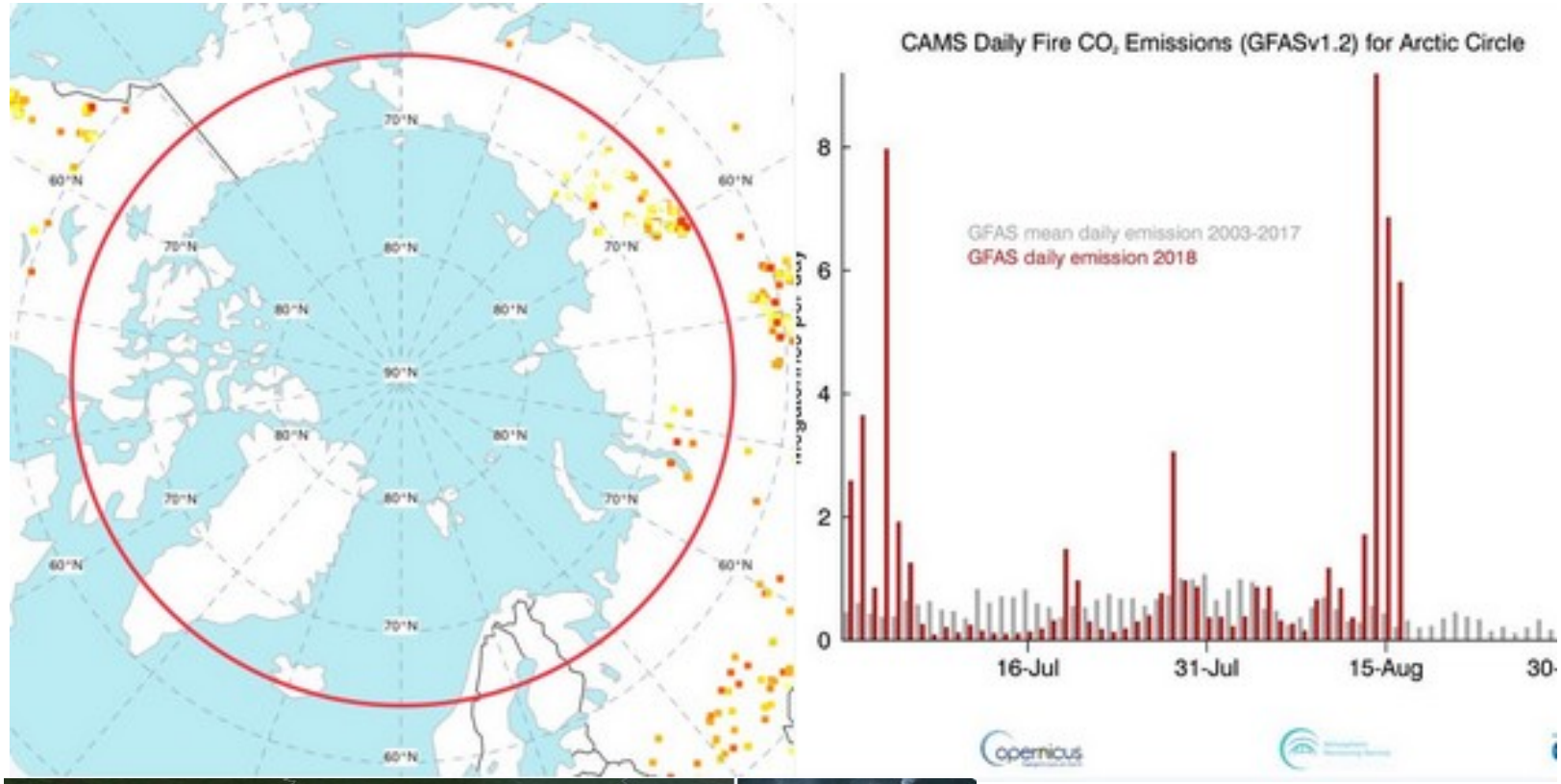

Far North (offshore)
26% dead
Range*: 11-35% dead
North
67% dead
Range*: 47-83% dead
Central
6% dead
Range*: 2-17% dead
South
1% dead
Cooktown
Port Douglas
Cairns
Townsville
Mackay
ARC CENTRE OF EXCELLENCE
Coral Reef Studies
Australian Government
Great Barrier Reef
Marine Park Authority
Australian Government

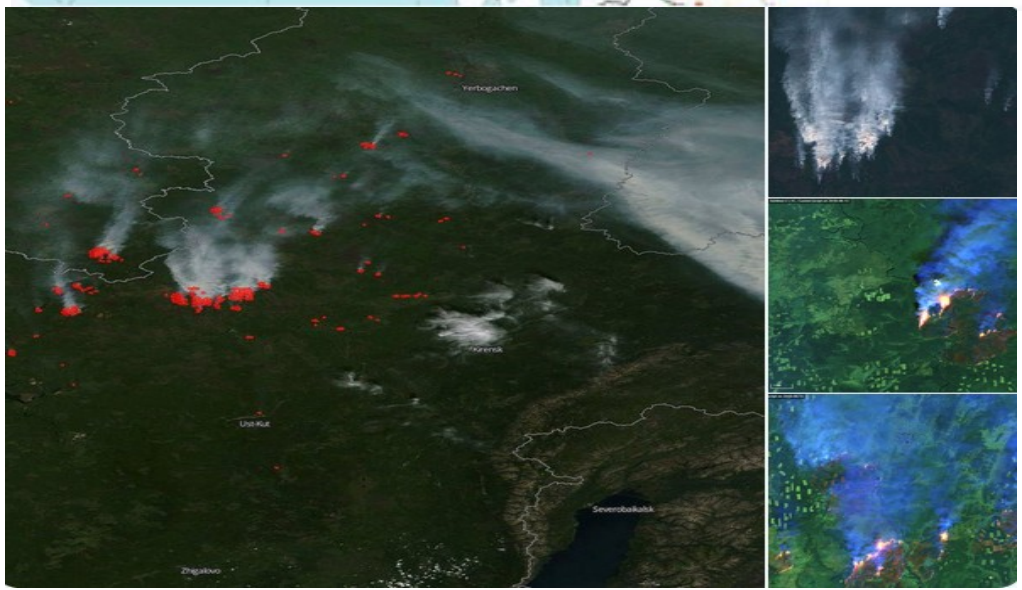

Carbon Dioxide
ppm
400
375
350
325
300
pH
8.15
8.10
8.05
8.00
7.95
7.90
7.85
7.80
270
260
250
240
230
220
210
CO_3^{2-}(µmol/kg)
1980
1985
1990
1995
2000
2005
2010
2015
Year

5 sept. 2017

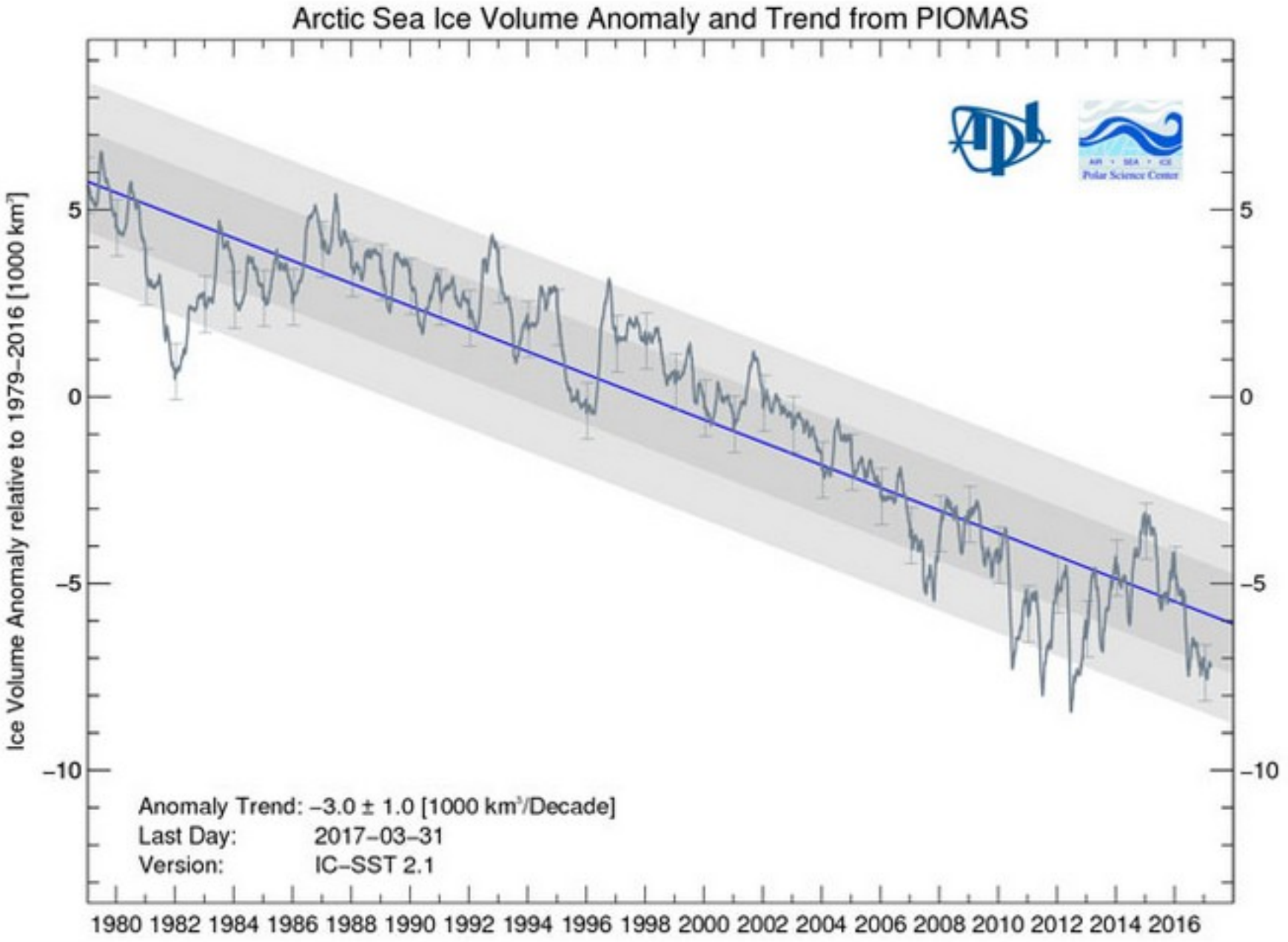


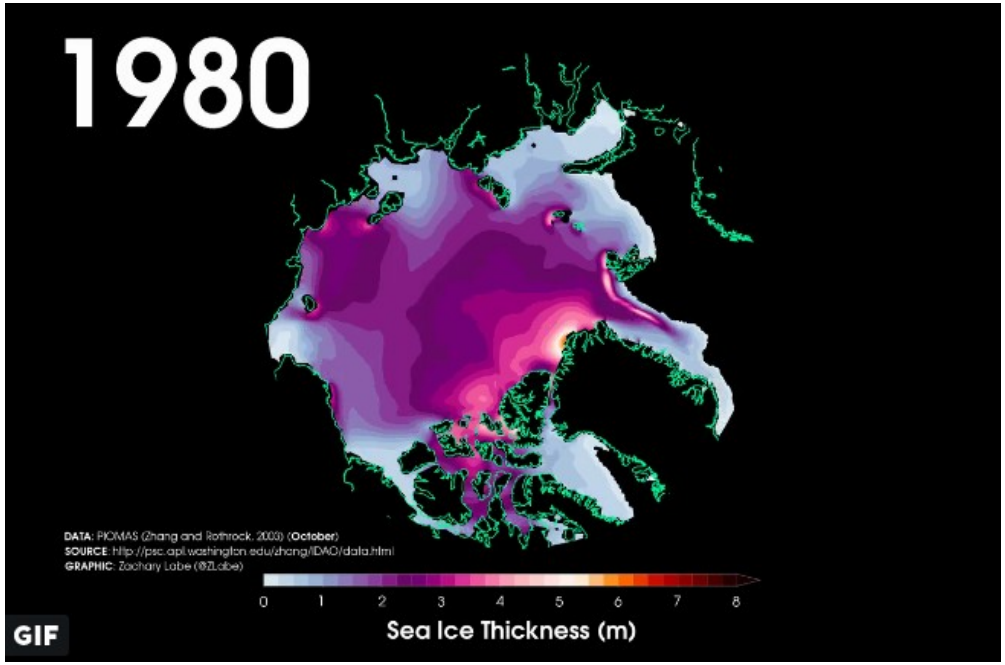
Widespread fires affecting Western US

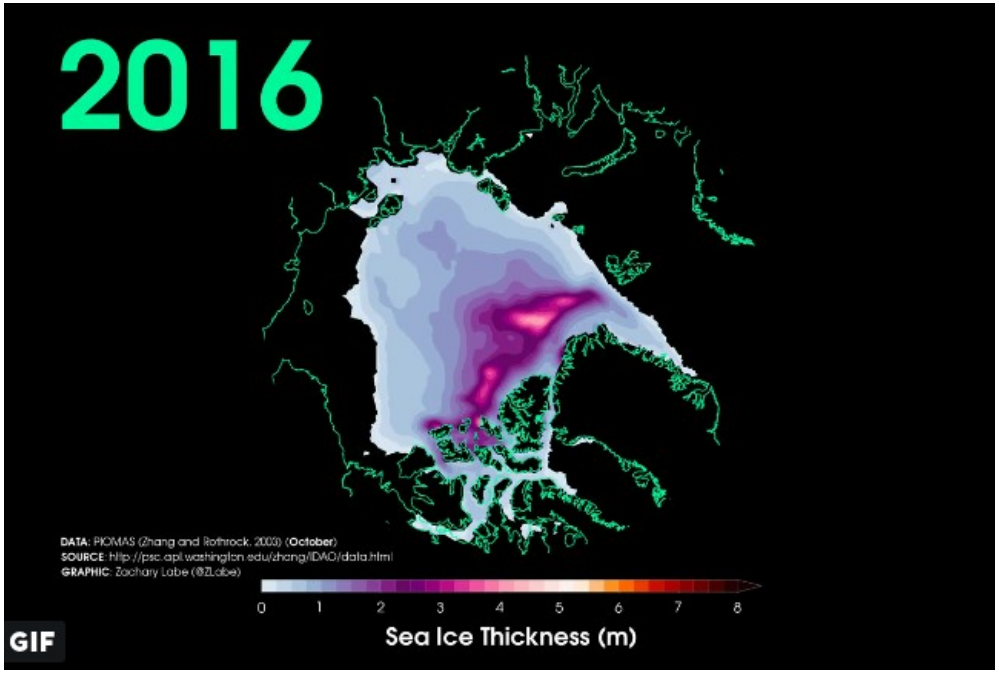

CAMS Daily Fire CO_2 Emissions (GFASv1.2) for Arctic Circle
GFAS mean daily emission 2003-2017
GFAS daily emission 2018
16-Jul
31-Jul
15-Aug
0
2
4
6
8
70°N
60°N
80°N
90°N


Yerbogachen
Ust-Kut
Severobaikalsk
Zhigalovo

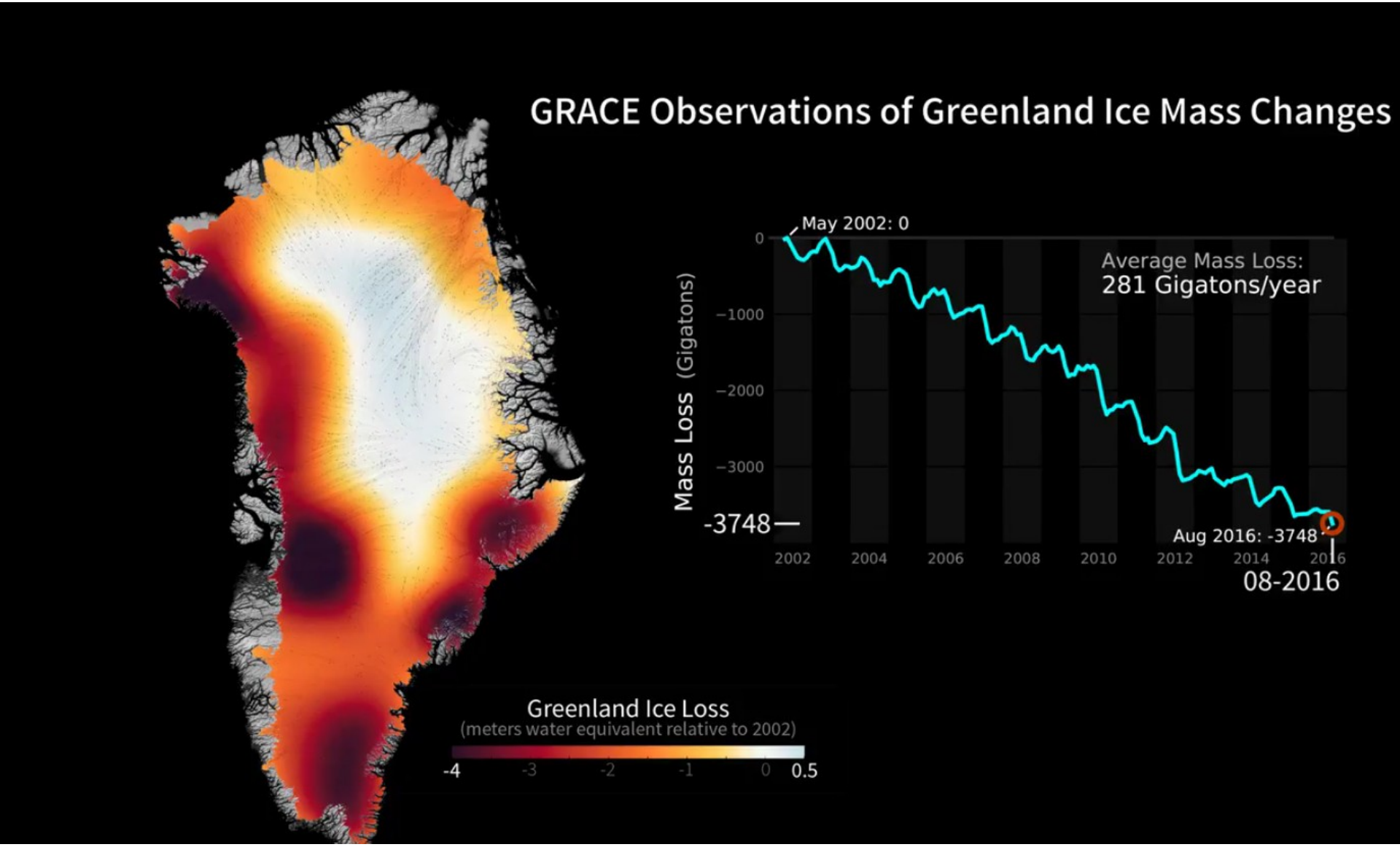
2018 fires


Arctic Sea Ice Volume Anomaly and Trend from PIOMAS
Ice Volume Anomaly relative to 1979–2016 [1000 km³]
5
0
−5
−10
Anomaly Trend: −3.0 ± 1.0 [1000 km³/Decade]
Last Day: 2017-03-31
Version: IC-SST 2.1
1980 1982 1984 1986 1988 1990 1992 1994 1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016

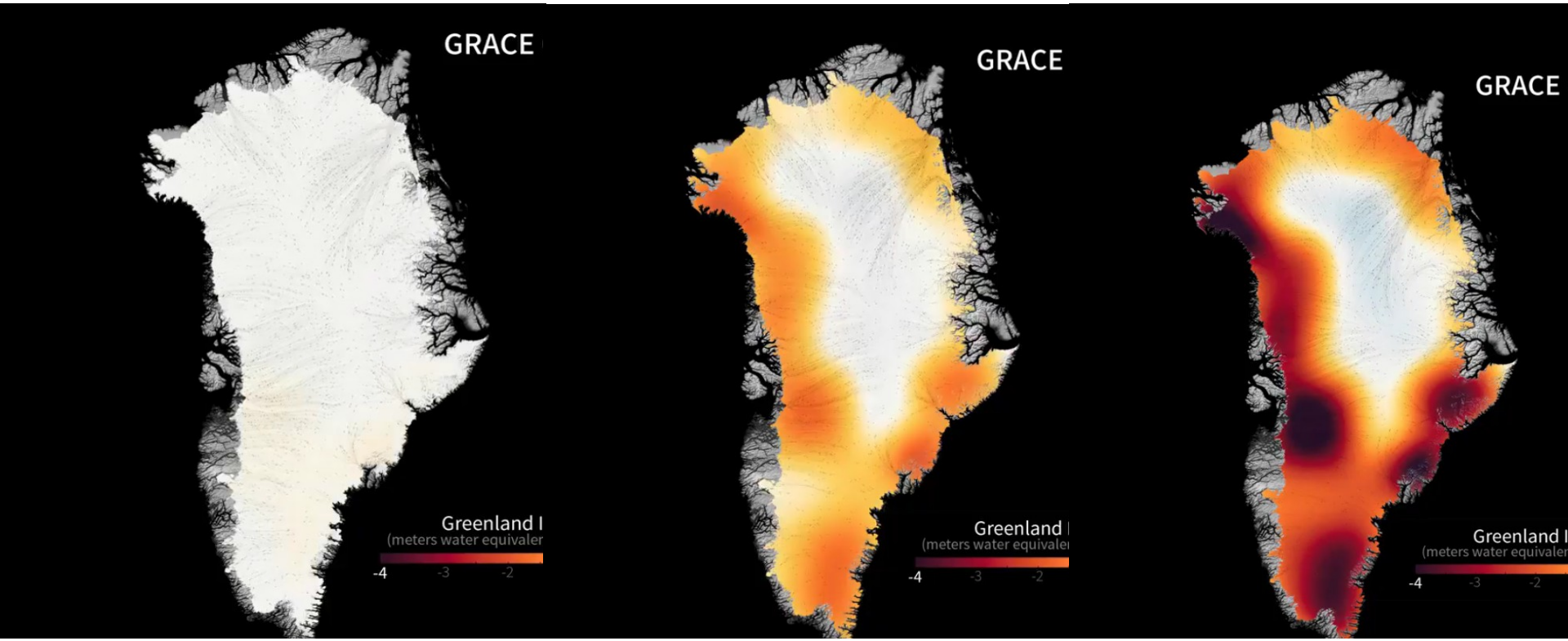

1980
DATA: PIOMAS (Zhang and Rothrock, 2003) (October)
SOURCE: http://psc.apl.washington.edu/zhang/IDAO/data.html
GRAPHIC: Zachary Labe (@ZLabe)
0 1 2 3 4 5 6 7 8
Sea Ice Thickness (m)
GIF


2016
DATA: PIOMAS (Zhang and Rothrock, 2003) (October)
SOURCE: http://psc.apl.washington.edu/zhang/IDAO/data.html
GRAPHIC: Zachary Labe (@ZLabe)
0 1 2 3 4 5 6 7 8
Sea Ice Thickness (m)
GIF

Greenland


GRACE Observations of Greenland Ice Mass Changes
May 2002: 0
Average Mass Loss:
281 Gigatons/year
Mass Loss (Gigatons)
0
−1000
−2000
−3000
-3748
Aug 2016: -3748
2002
2004
2006
2008
2010
2012
2014
2016
08-2016
Greenland Ice Loss
(meters water equivalent relative to 2002)
-4
-3
-2
-1
0
0.5

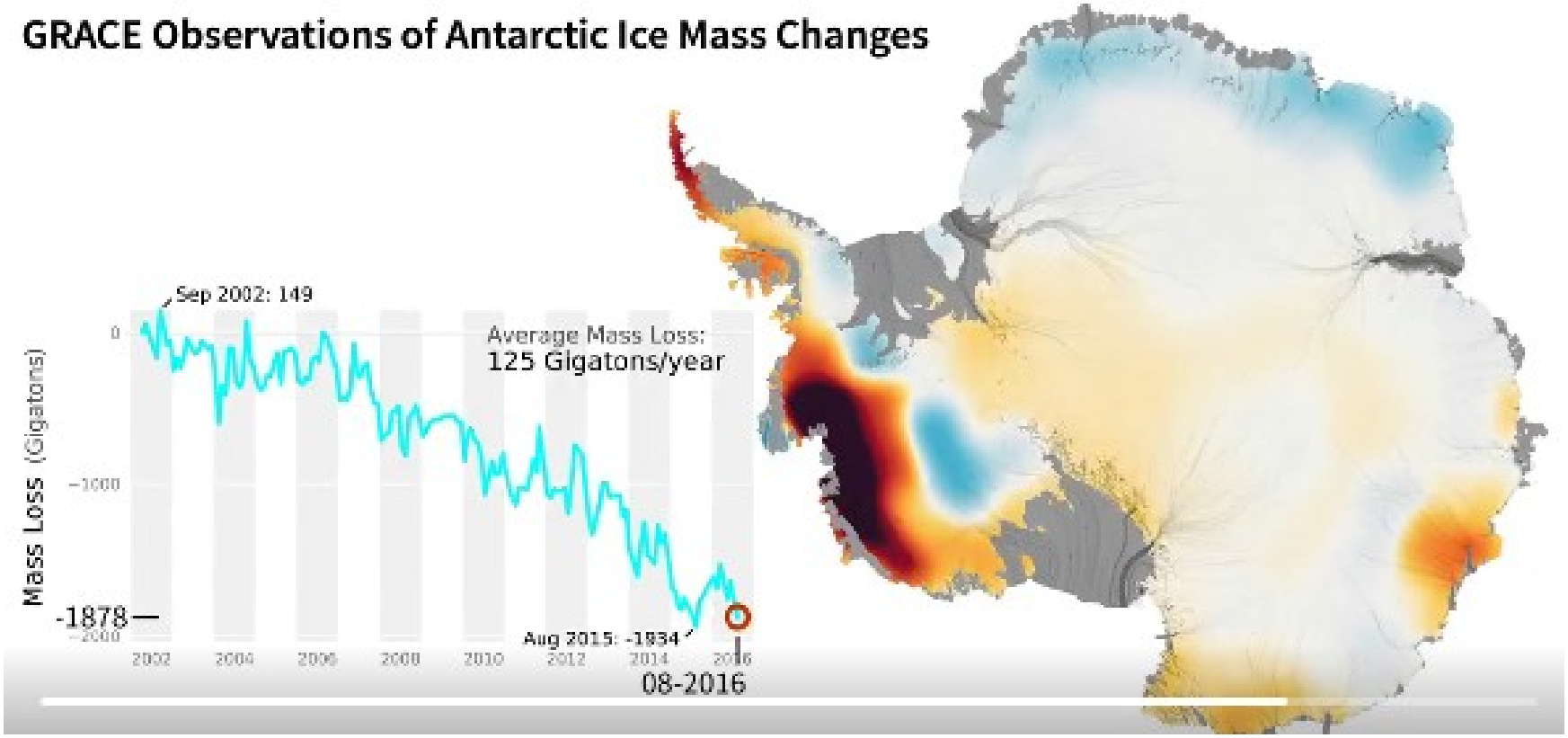
Greenland



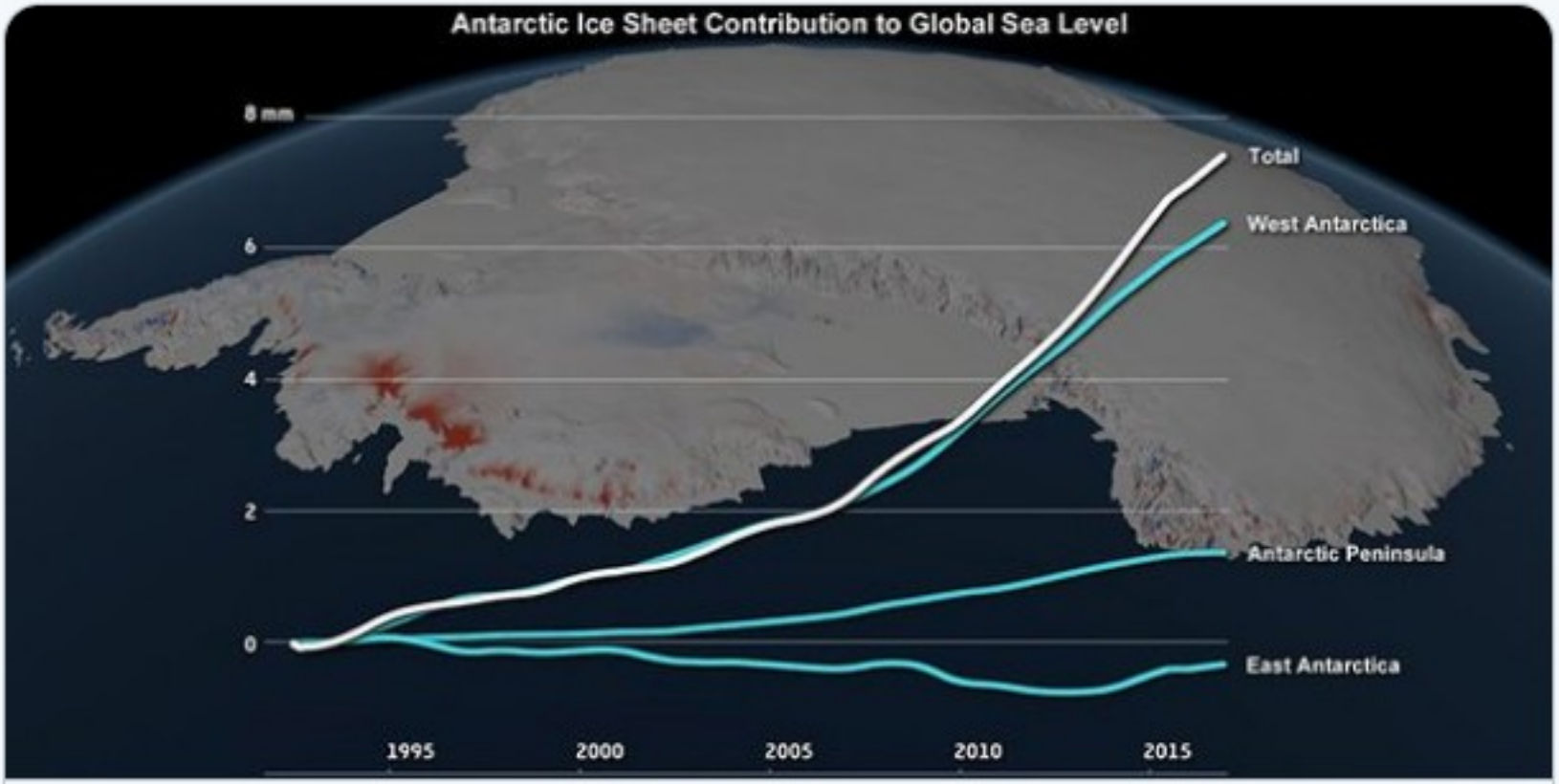
2002

2011

2016

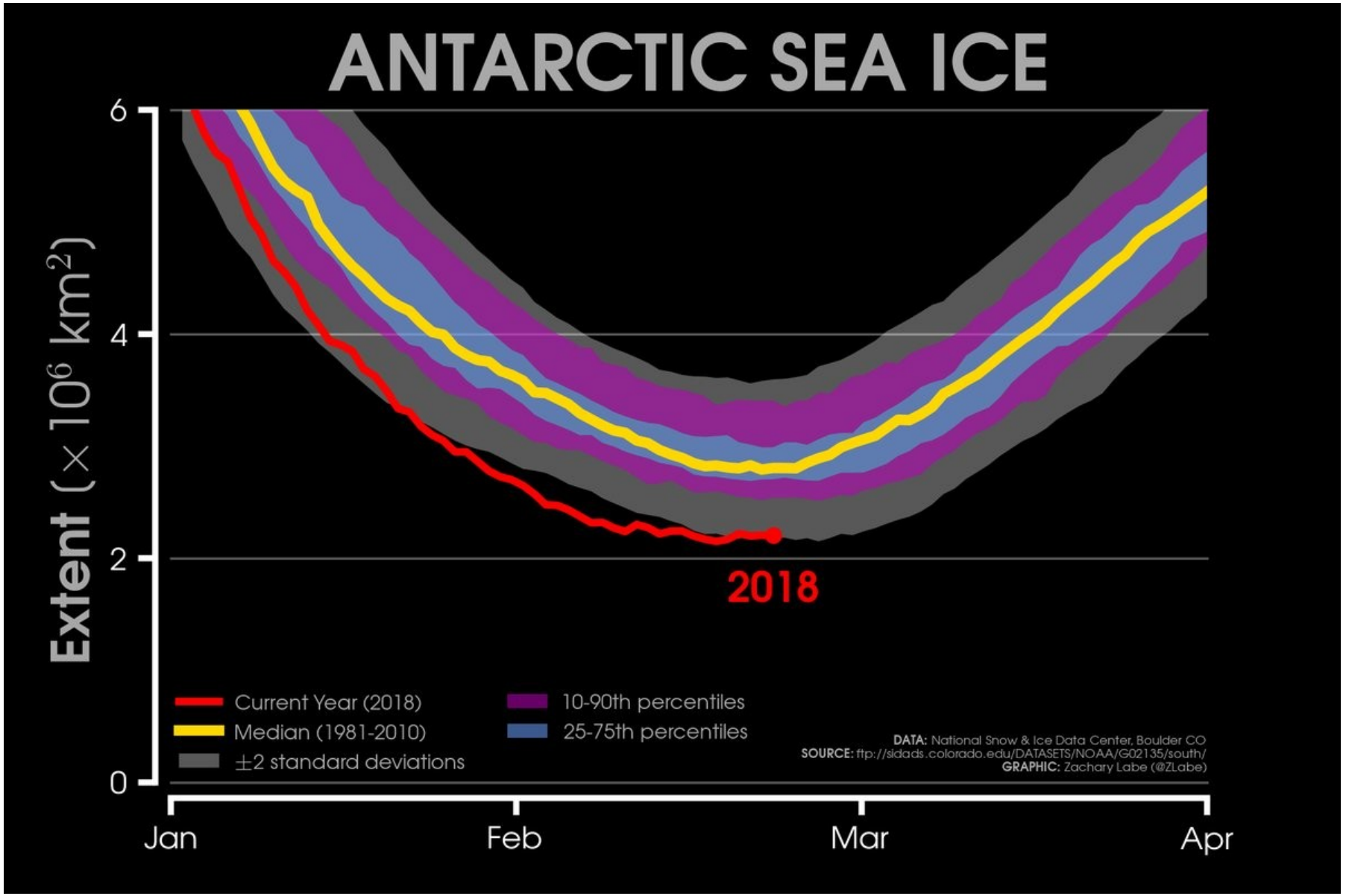

GRACE Observations of Antarctic Ice Mass Changes
Sep 2002: 149
Average Mass Loss:
125 Gigatons/year
Mass Loss (Gigatons)
0
-1000
-1878
-2000
Aug 2015: -1834
2002
2004
2006
2008
2010
2012
2014
2016
08-2016

Ice losses from Antarctica have tripled since 2012, increasing global sea levels by 0.12 inch (3 millimeters) in that timeframe alone, according to a major new international climate assessment funded by @NASA and @esa.

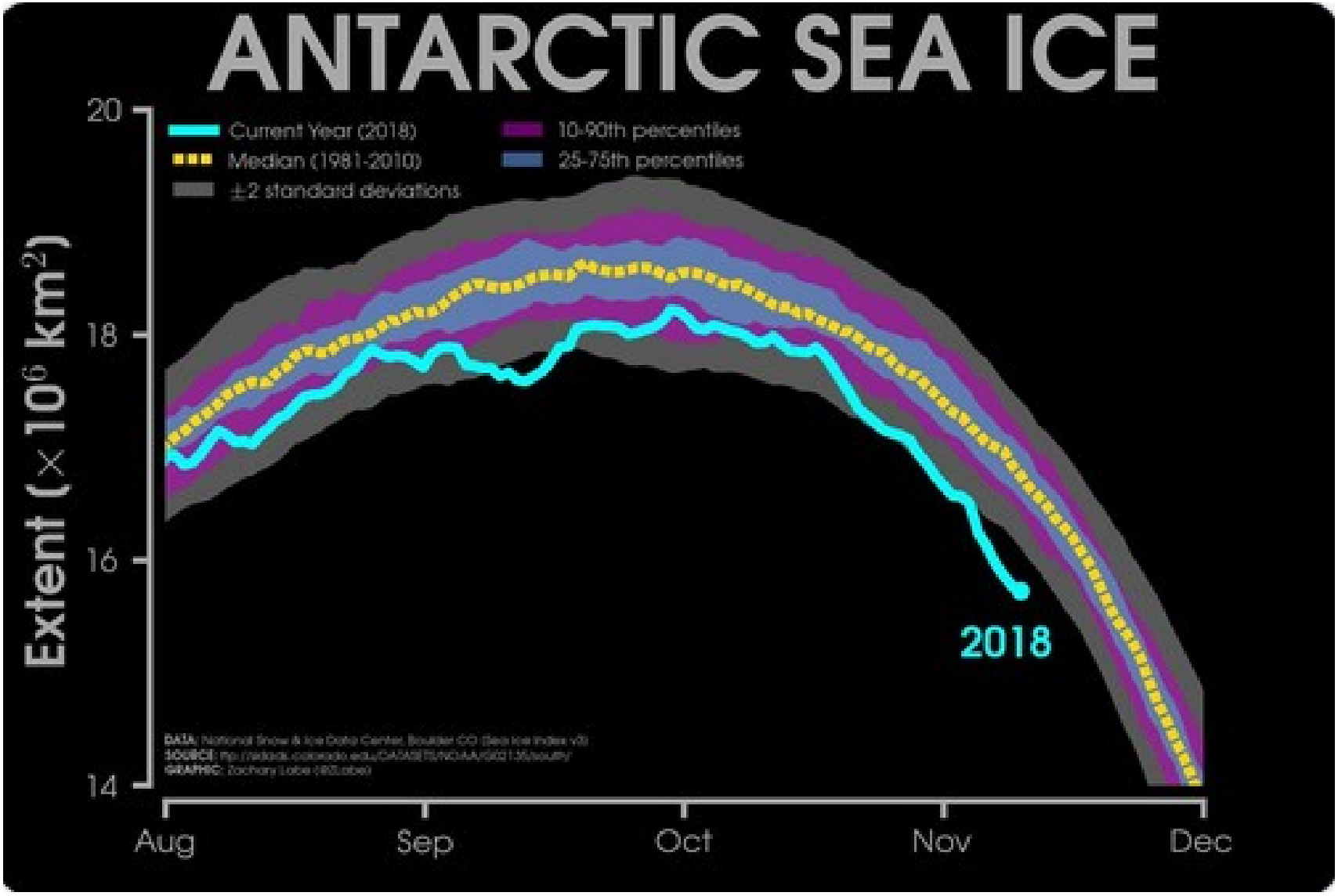


Ramp-up in Antarctic ice loss speeds sea level rise

Ice losses from Antarctica have tripled since 2012, increasing global sea levels by 0.12 inch (3 millimeters) in that timeframe alone, according to ...



Lars Kaleschke 2018

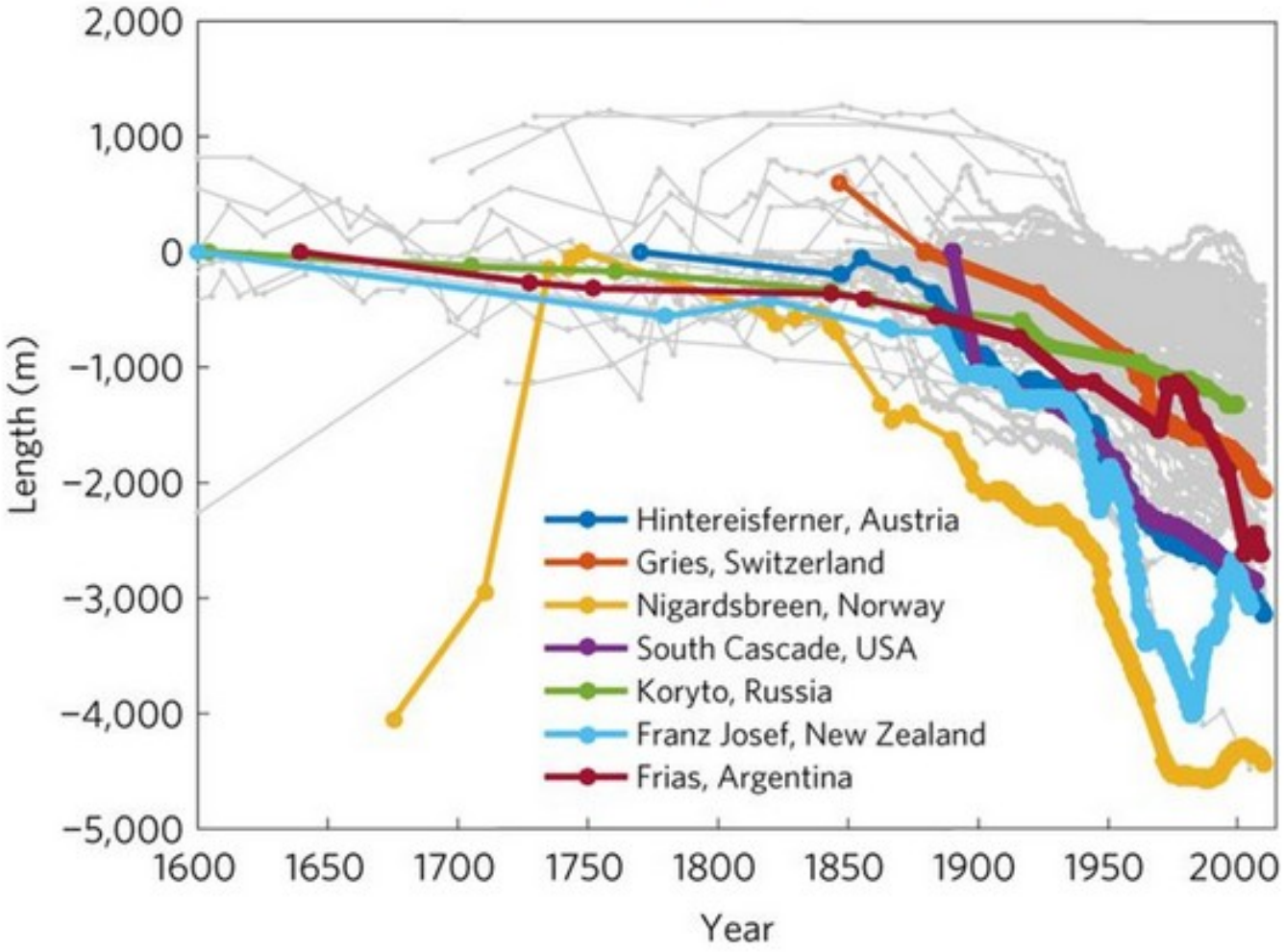

ANTARCTIC SEA ICE
Current Year (2018)
Median (1981-2010)
±2 standard deviations
10-90th percentiles
25-75th percentiles
Extent (×10^6 km^2)
20
18
16
14
2018
Aug
Sep
Oct
Nov
Dec

Centennial glacier retreat as categorical evidence of regional climate change

Gerard H. Roe, Marcia B. Baker & Florian Herla

Nature Geoscience **10**, 95–99 (2017) | Download Citation

Figure 1: The global record of glacier lengths[5], for 158 glaciers with 20 or more individual observations (shown as dots).



Depenem climàticament de la biosfera?

Fate of anthropogenic CO_2 emissions (2008–2017)

Sources

34.4 $GtCO_2$/yr

87%

13%

5.3 $GtCO_2$/yr

= Sinks

17.3 $GtCO_2$/yr

44%

29%

11.6 $GtCO_2$/yr

22%

8.9 $GtCO_2$/yr

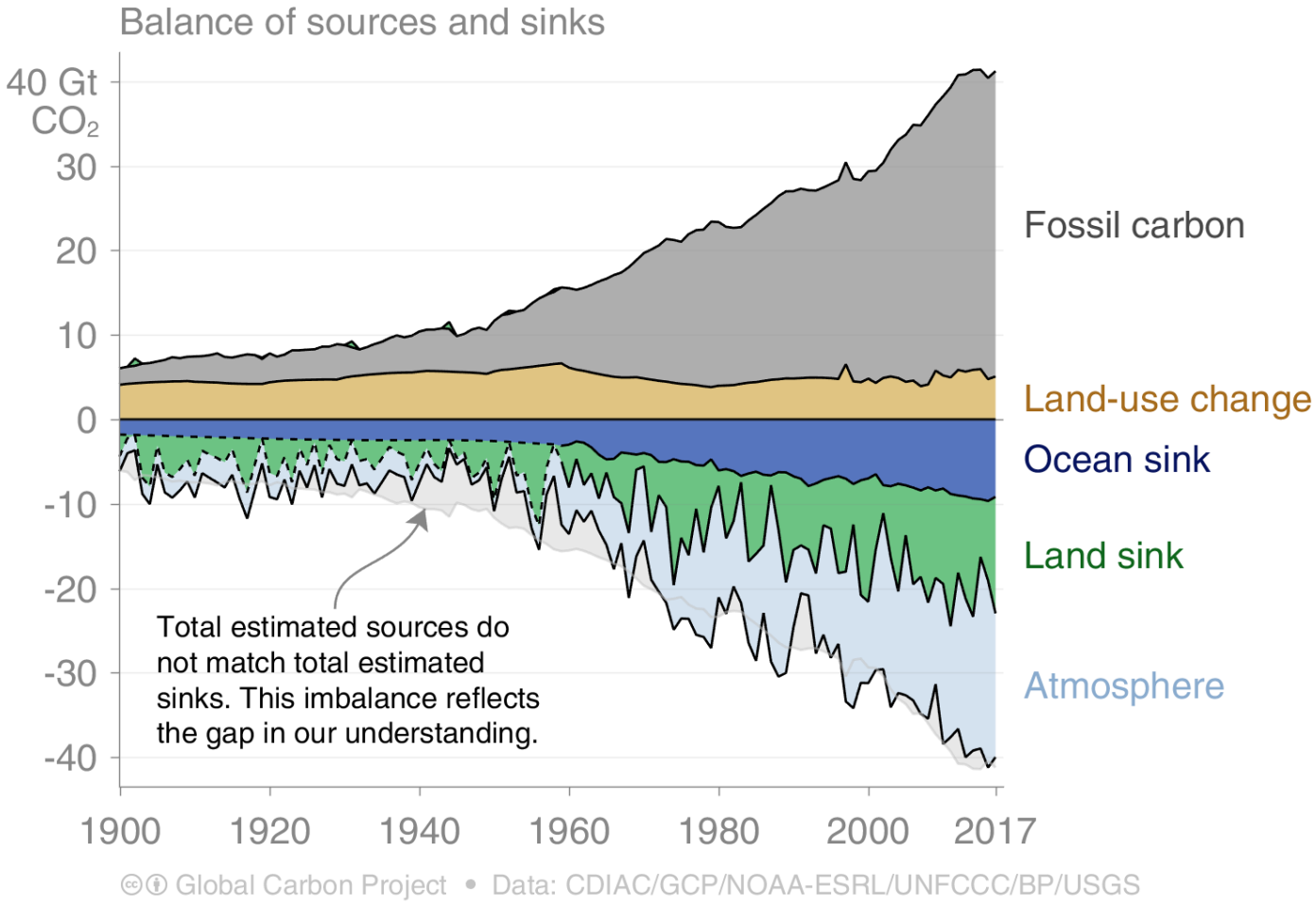
Budget Imbalance:
(the difference between estimated sources & sinks)

5%

1.9 $GtCO_2$/yr

Global carbon budget

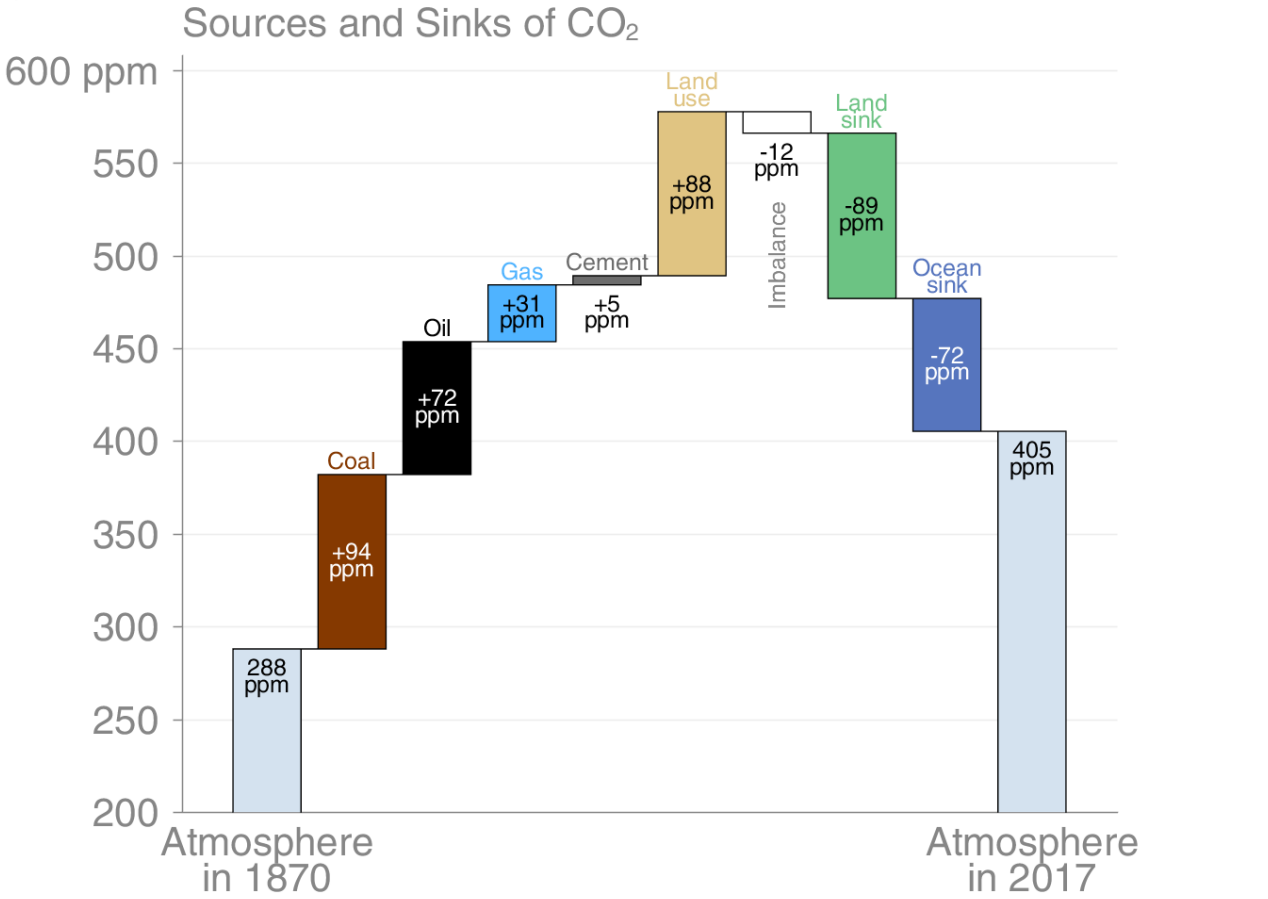
Carbon emissions are partitioned among the atmosphere and carbon sinks on land and in the ocean
The "imbalance" between total emissions and total sinks reflects the gap in our understanding



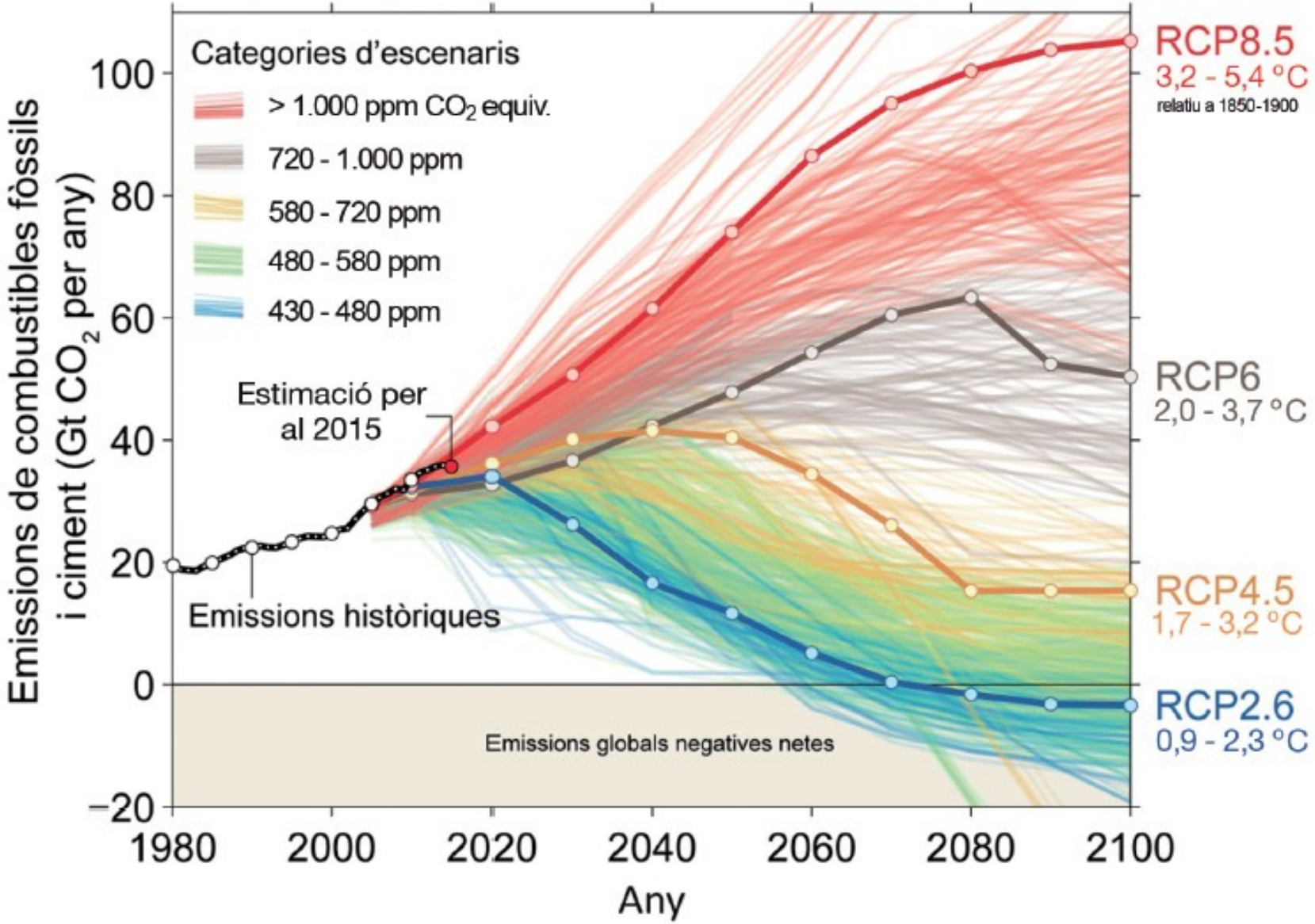
Source: CDIAC; NOAA-ESRL; Houghton and Nassikas 2017; Hansis et al 2015; Joos et al 2013; Khatiwala et al. 2013; DeVries 2014; Le Quéré et al 2018; Global Carbon Budget 2018

Global carbon budget

The cumulative contributions to the global carbon budget from 1870

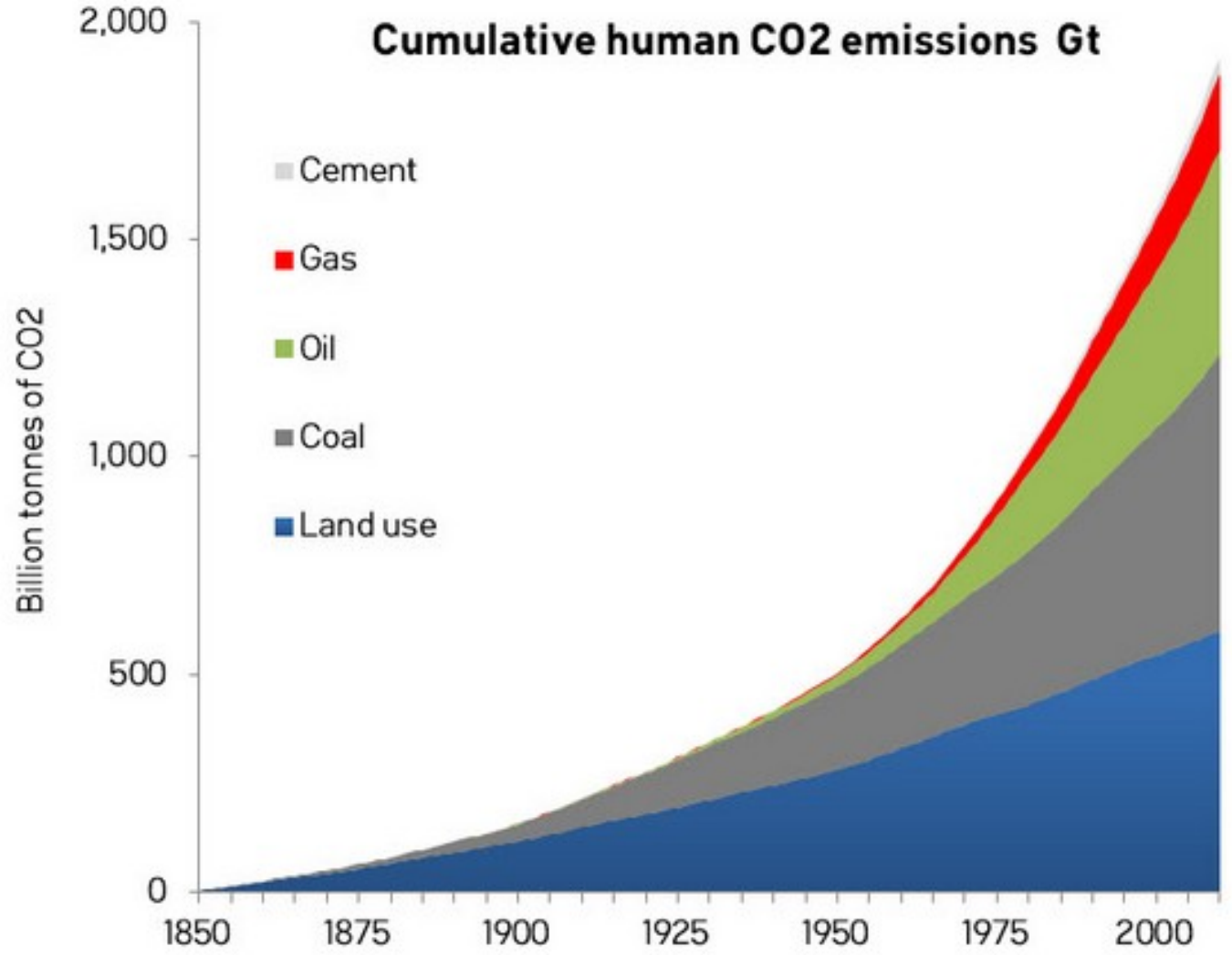


Escenaris futurs i punts d'inflexió


Categories d'escenaris
> 1.000 ppm CO_2 equiv.
720 - 1.000 ppm
580 - 720 ppm
480 - 580 ppm
430 - 480 ppm
Estimació per al 2015
Emissions històriques
Emissions globals negatives netes
RCP8.5
3,2 - 5,4 °C
relatiu a 1850-1900
RCP6
2,0 - 3,7 °C
RCP4.5
1,7 - 3,2 °C
RCP2.6
0,9 - 2,3 °C
Emissions de combustibles fòssils i ciment (Gt CO_2 per any)
100
80
60
40
20
0
−20
1980
2000
2020
2040
2060
2080
2100
Any

- L’acord de París. Que cal fer per anar a un món amb <2 ºC d’augment de temperatura?

Emissions de CO_2 acumulades



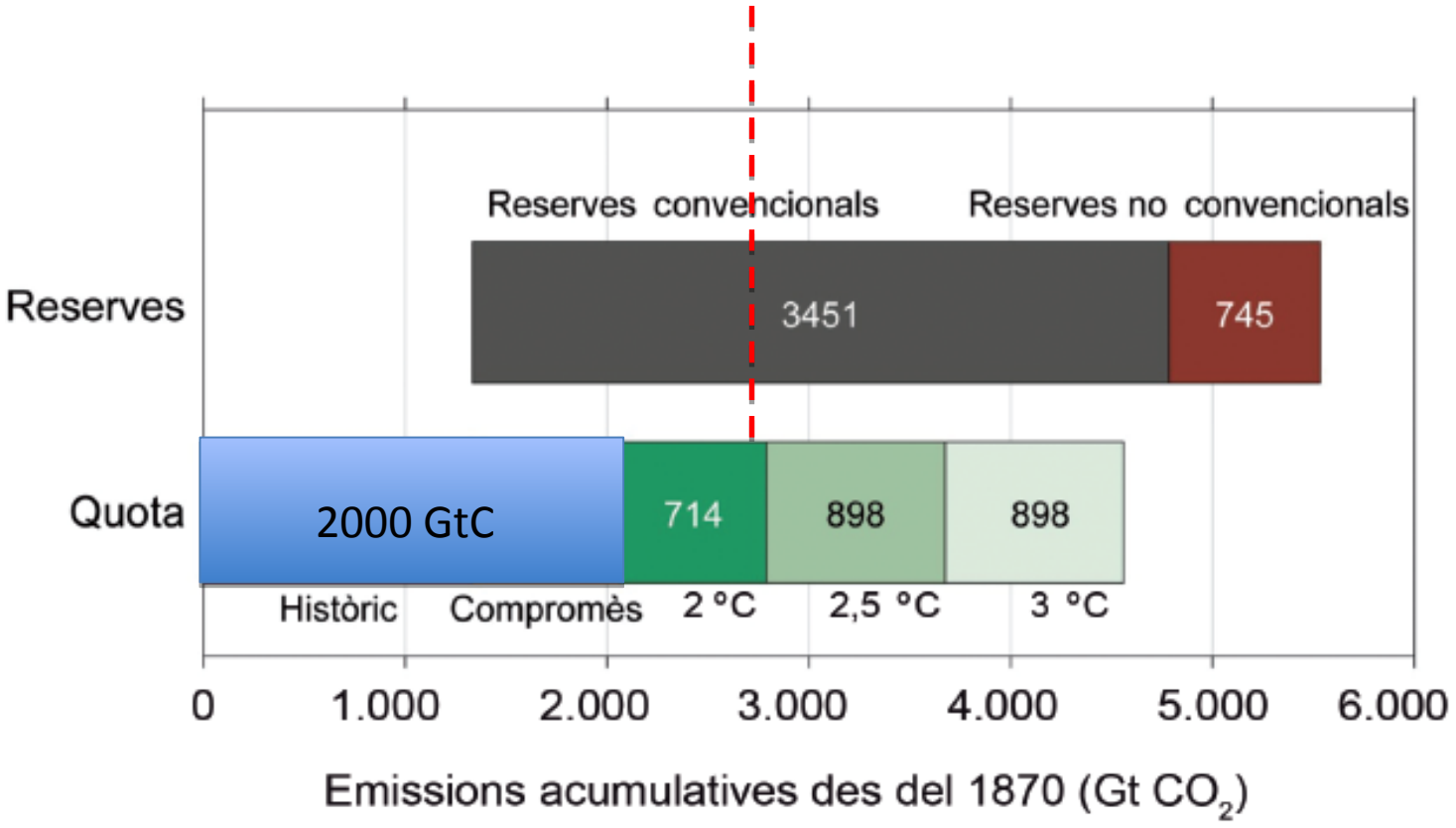
2000 GtC

Acord París

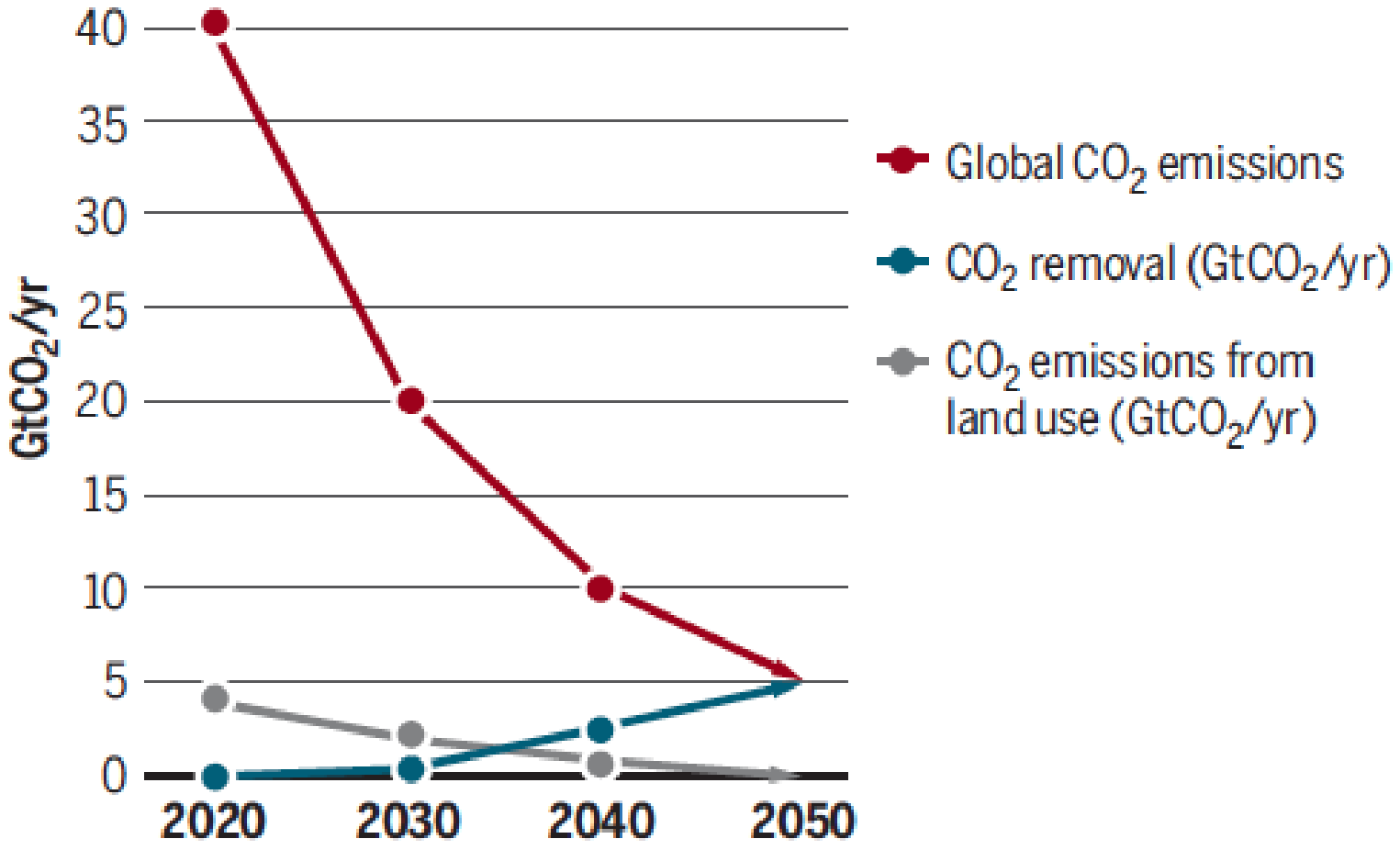
<800 GtC

Implicacions de l'acord de París

Keep it on the ground: les bases científiques.

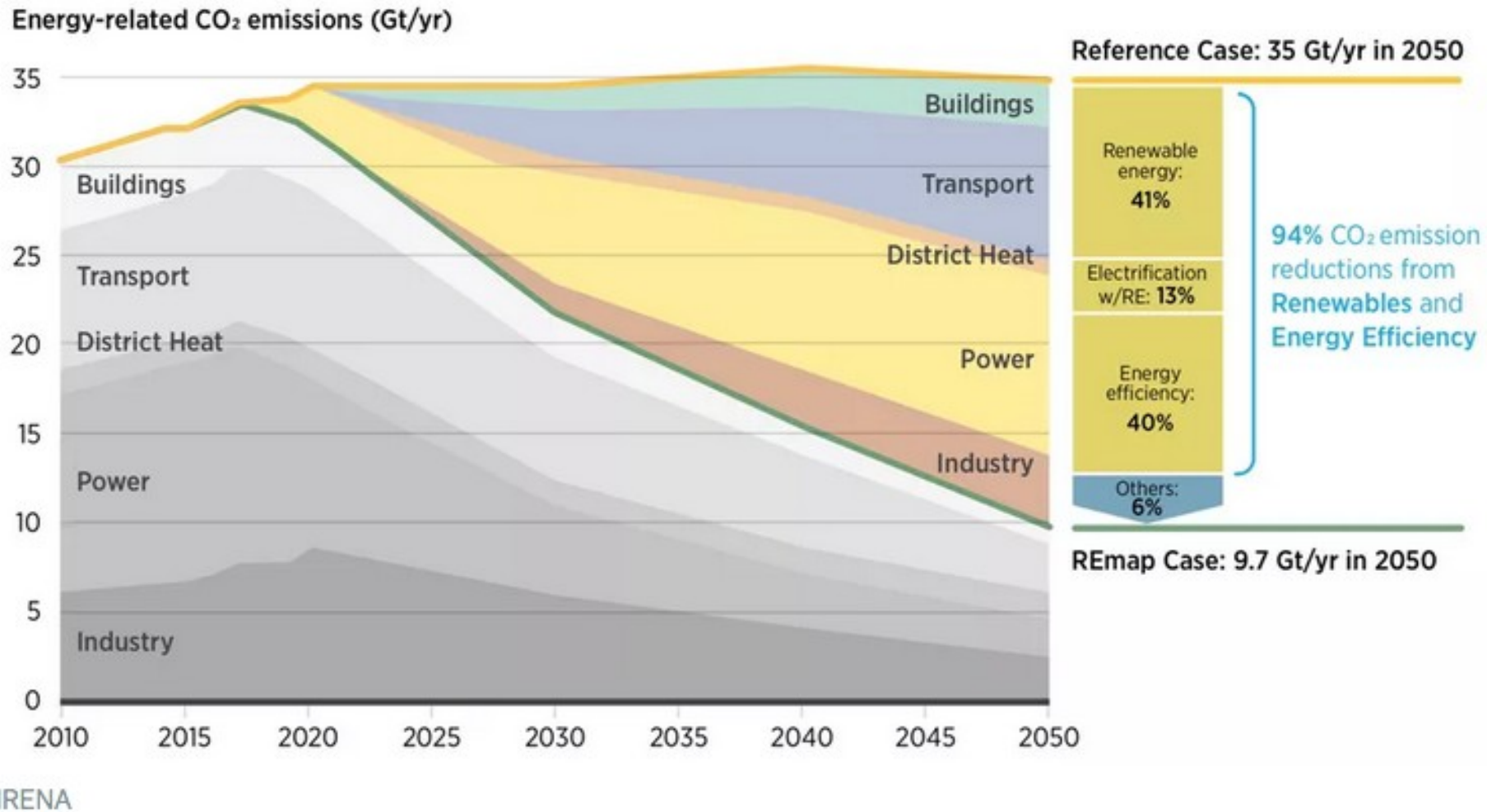


Global carbon law guiding decadal pathways

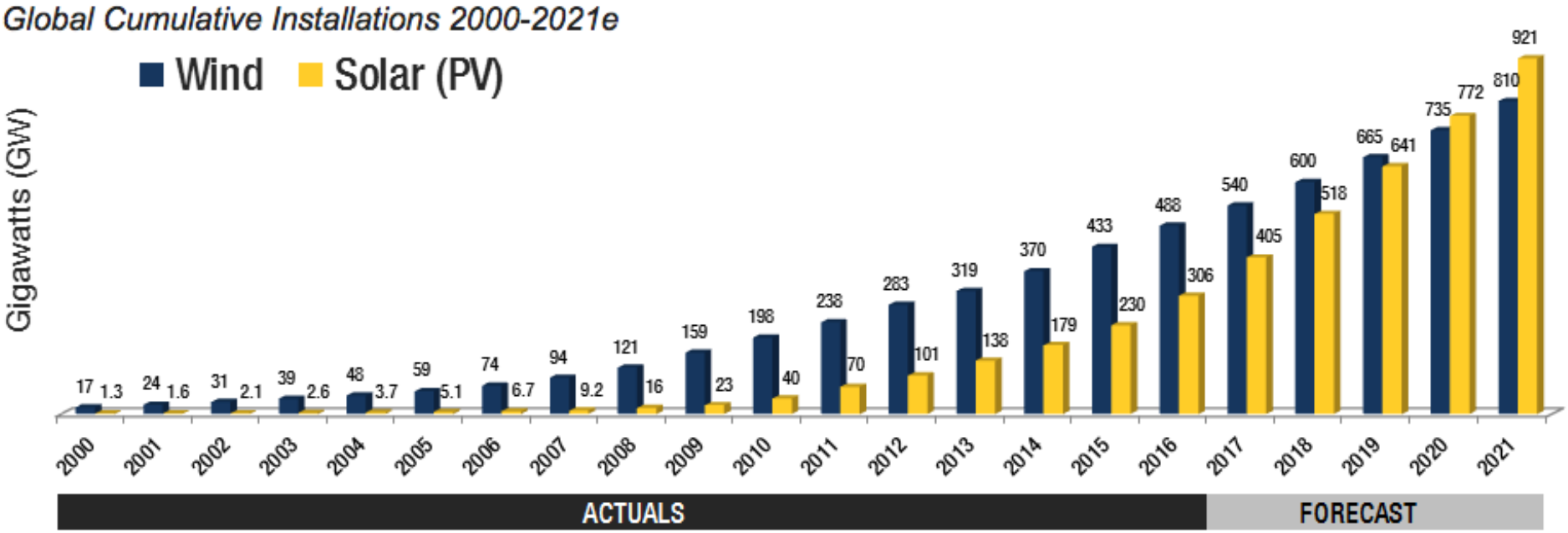


Rockström 2017, Science

Implica canvis d'estil de vida, transport i alimentació, decreixement, transició energètica a les energies renovables

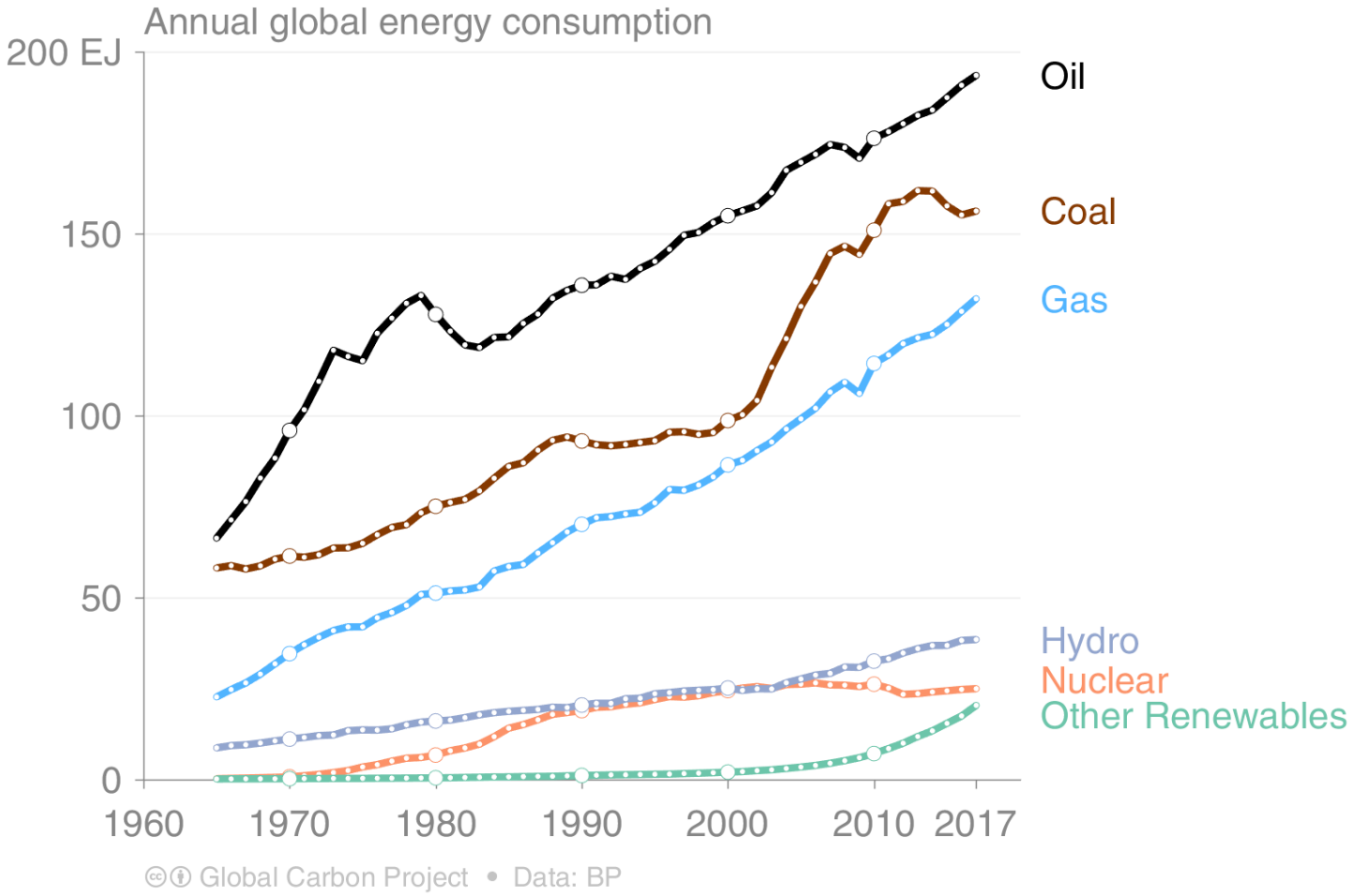


Wind & Solar (worldwide)	Wind Total Capacity	Wind New Installations	Solar Total Capacity	Solar New Installations
2018 Forecast:	600.5 GW	60.9 GW	518.3 GW	113.0 GW
2017 Preliminary:	539.6 GW	52.6 GW	405.3 GW	98.9 GW
2017-2018 Change	+11.3%	+15.8%	+27.9%	+14.3%

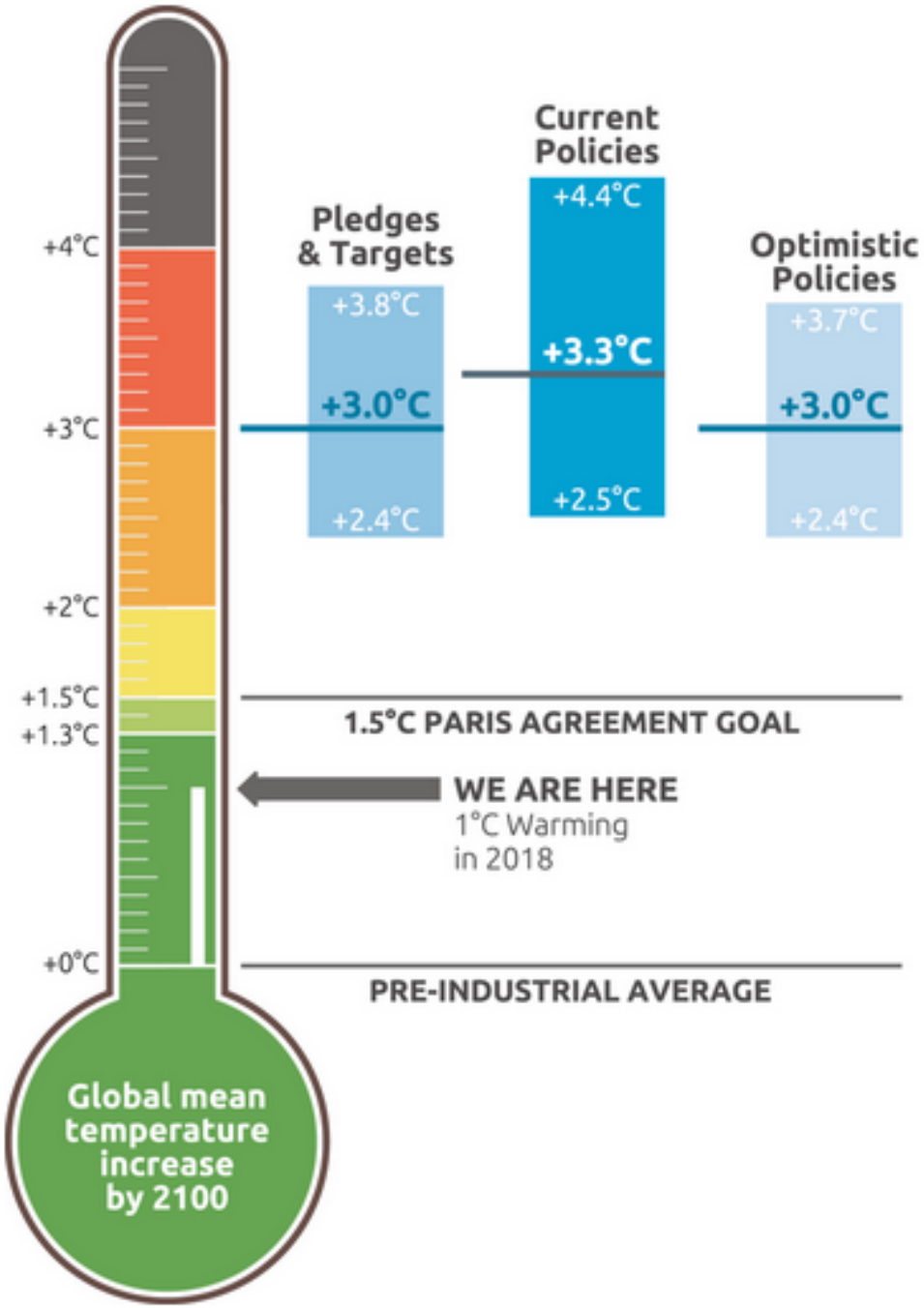


Energy use by source

Renewable energy is growing exponentially, but this growth has so far been too low to offset the growth in fossil energy consumption.



Estem complint l'acord de París?



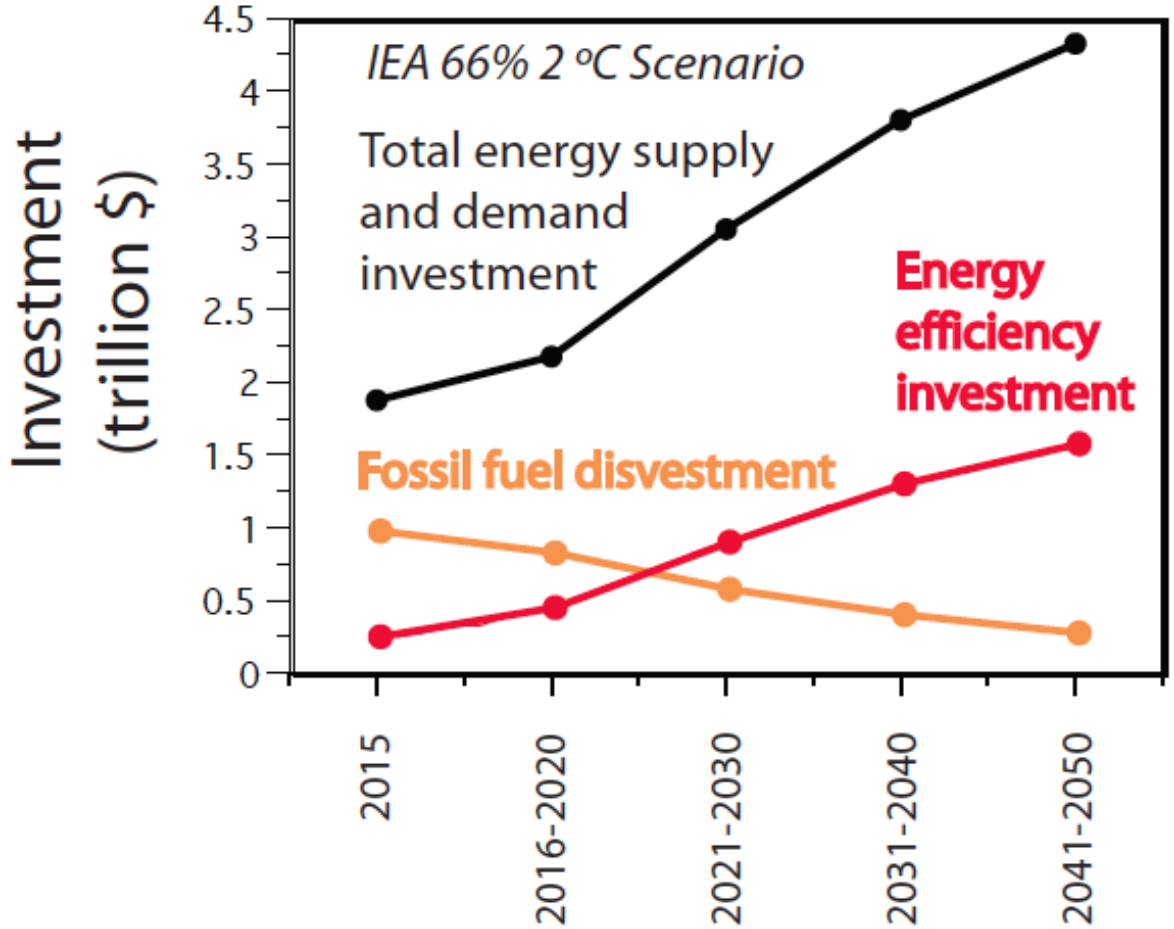
Climate Action Tracker

CAT warming projections

Global temperature increase by 2100

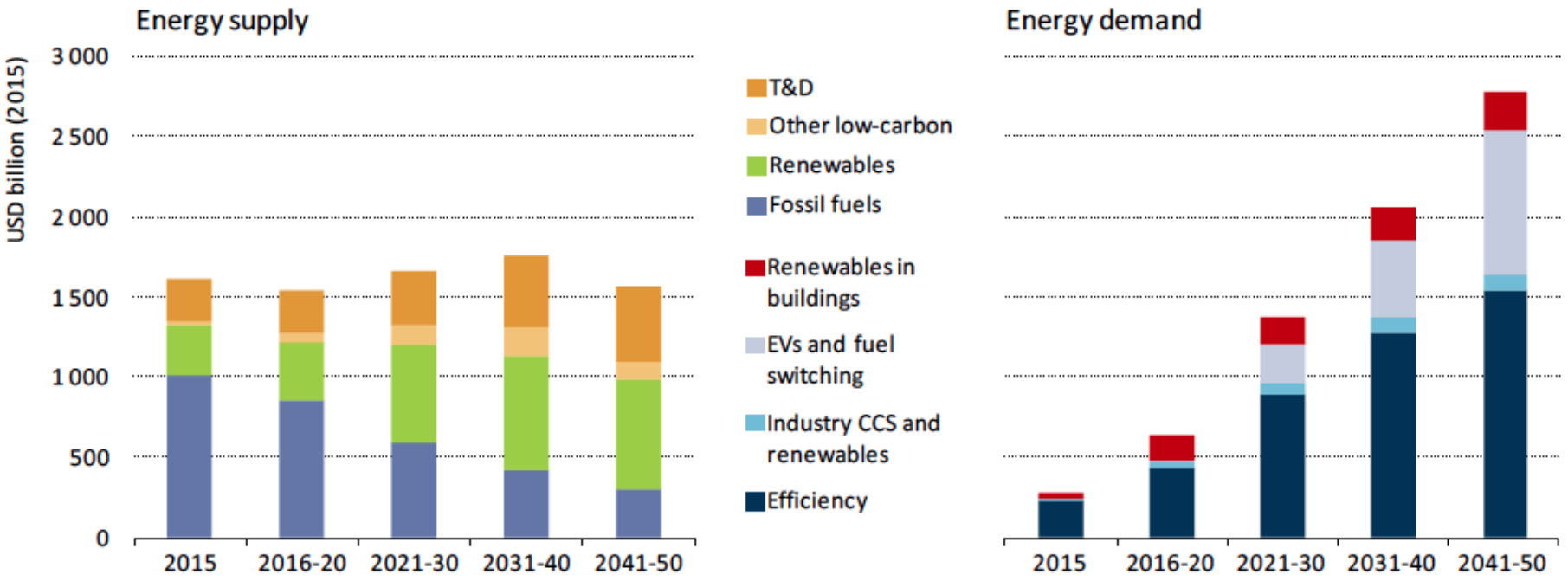
December 2018 Update

Sostenibilitat global i el el sistema financer



Carnicer et al. in prep

Figure ES.2 • Average annual global energy supply- and demand-side investment in the 66% 2°C Scenario



Note: T&D = transmission and distribution; EVs = electric vehicles; CCS = carbon capture and storage.

Key message • The level of supply-side investment remains broadly constant, but shifts away from fossil fuels. Demand-side investment in efficiency and low-carbon technologies ramps up to almost USD 3 trillion in the 2040s.

2016. FMI. La deuda global no financiera, aquella que incluye la deuda pública, la de los hogares y la de las empresas no financieras, ha alcanzado los **152 trillones de dólares**, **lo que representa un 225% del PIB** mundial y supone su nivel máximo histórico

Figure 1.1. Global Gross Debt
(Percent of GDP; weighted average)

Sources: Abbas and others 2010; Bank for International Settlements; Dealogic; IMF, *International Financial Statistics*; IMF, Standardized Reporting Forms; IMF, *World Economic Outlook*; Organisation for Economic Co-operation and Development; and IMF staff estimates.
Note: U.S. = United States.

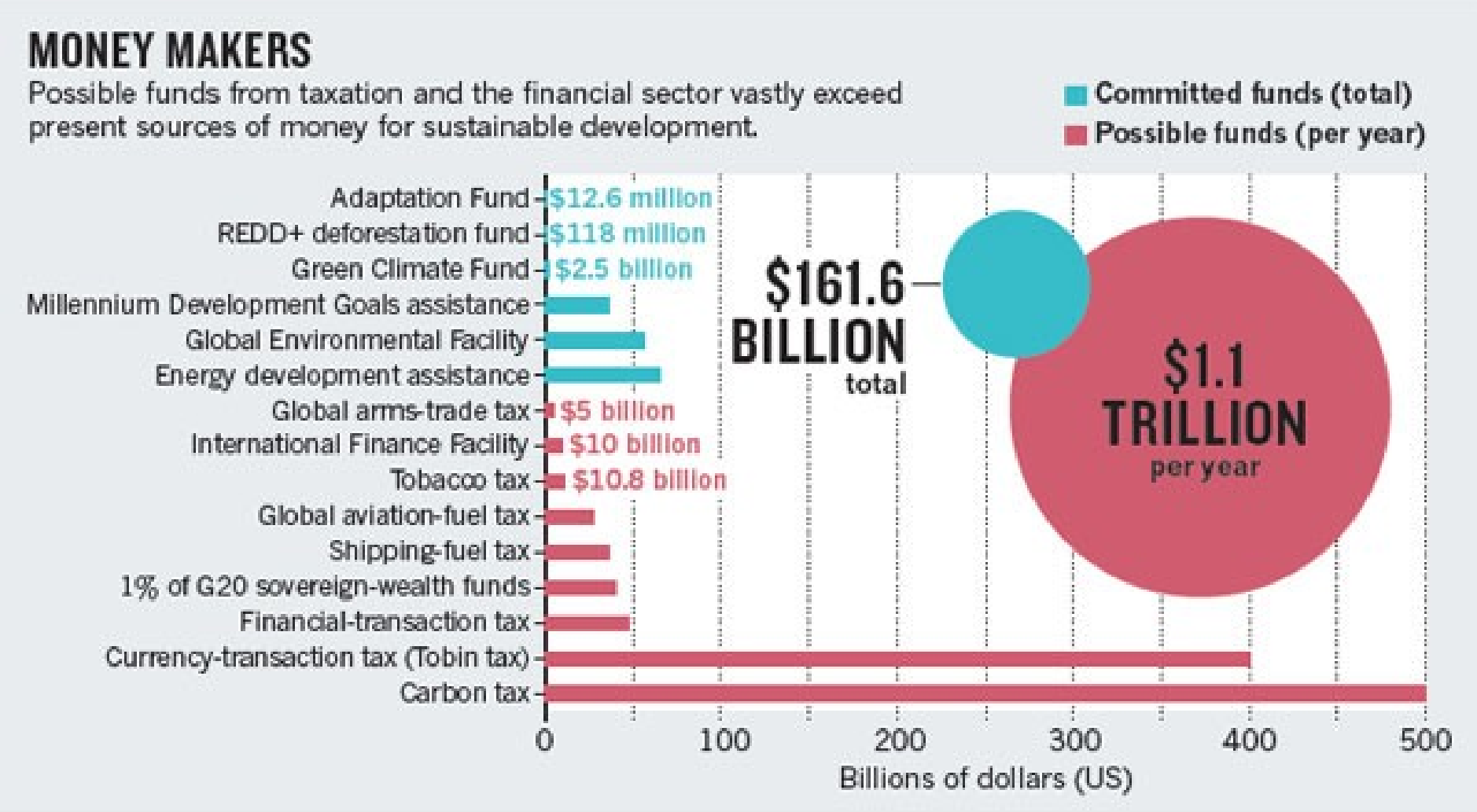
A global budget for sustainability and planetary boundaries

	Variables	Economic value (US $ trillions)
A. Economic Fluxes	World GDP (2011)	70.01
	Global Gross External Debt	61.50
	Annual global foreign exchange market turnover	1020
B. Economic Costs	Annual Costs of the UN Millennium Development Goals (MDGs)	0.19
	IPCC Baseline - Business-as usual-scenario 2011-2030 Annual mean investment in deploying renewable energies	0.14
	IPCC 450 ppm Stabilization Scenario 2011-2030 Annual mean investment in deploying renewable energies	0.61
	World annual cost of fossil-fuel consumption subsidies	0.31
	Estimated annual costs of global biodiversity conservation	0.317
	Annual costs of a global system of protected natural areas	0.018
C. Economic Funds and Financial Sources for Sustainability and Conservation	Copenhagen Green Climate commitment (projected annual emission by 2020)	0.1
	Clean Technology Fund and Strategic Climate Fund (CIF)	0.0065
	Global Environment Facility Annual Funds	0.0005
	Annual revenue from a global financial transaction tax (0.05%)	0.47-1.34
	Annual revenue from a global tax on foreign exchange markets (0.001 %)	0.007
	Increased emission of IMF Special Drawing Rights	0.1-0.3

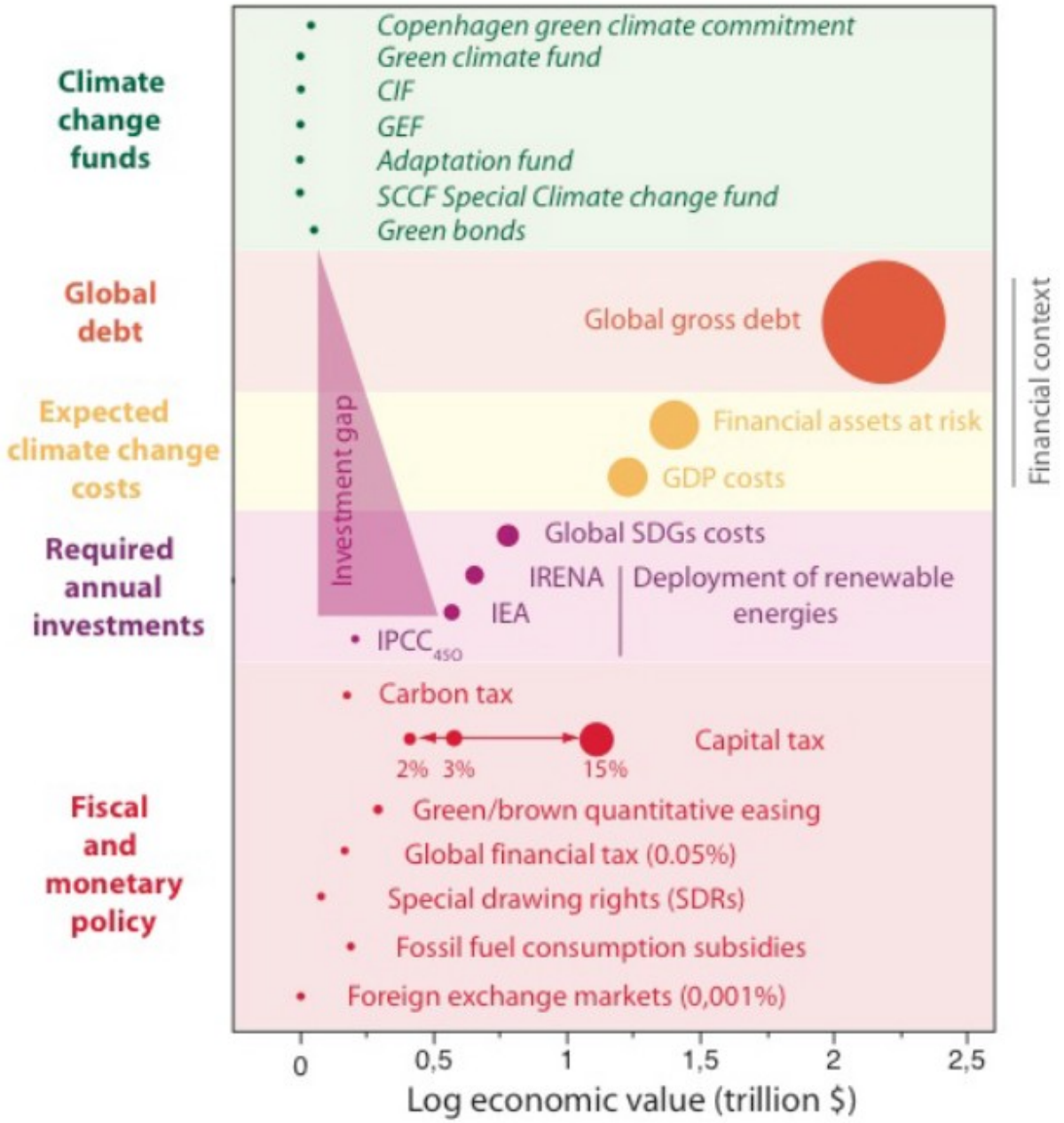
1 trillion US$

Carnicer and Peñuelas 2012, Energy Policy

A key role for global financial reforms and taxes

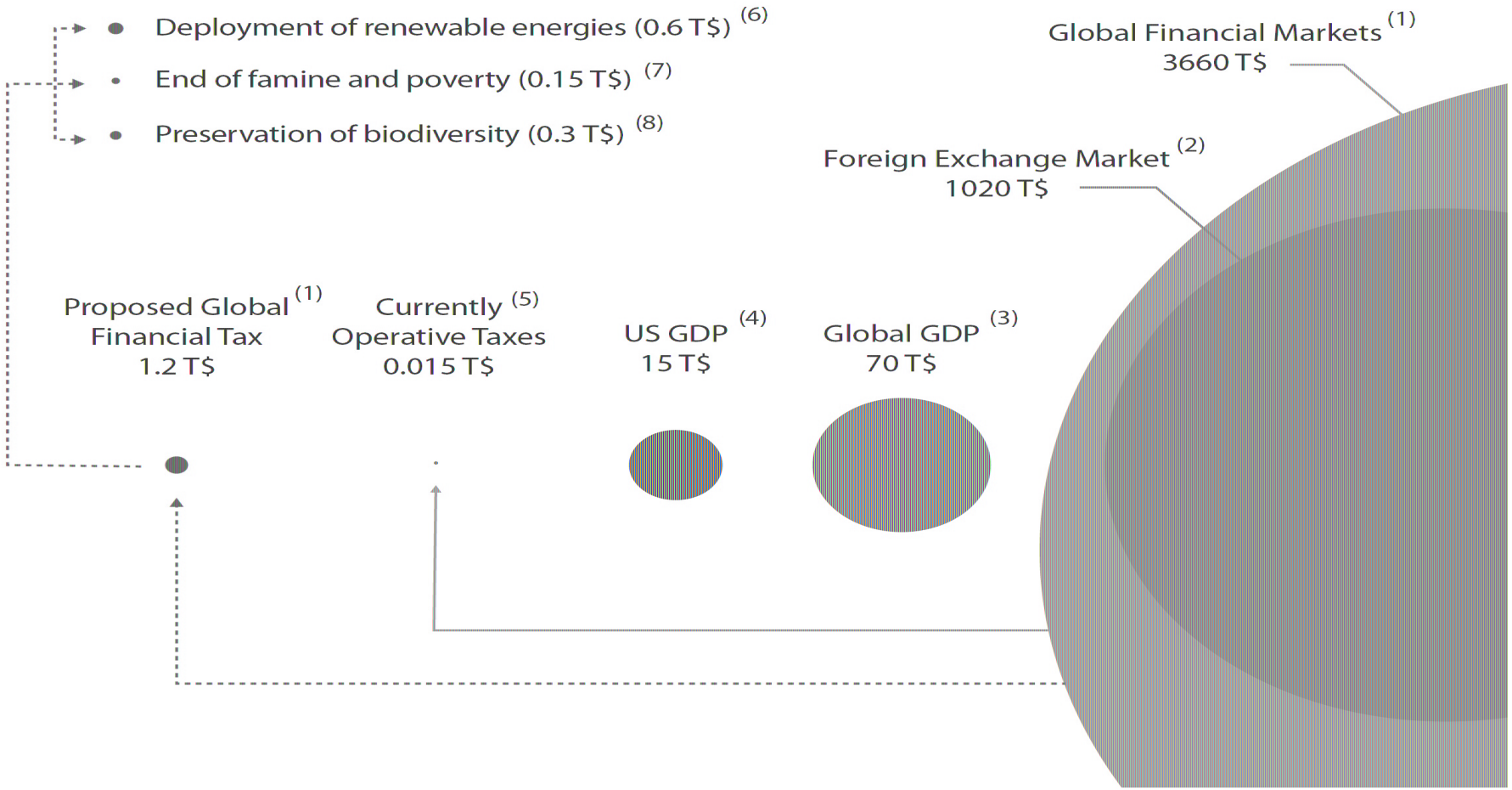


Barbier 2012, Nature



Carnicer et al. in prep

A key role for financial reforms and taxes

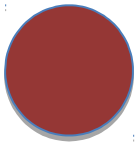


A global 0.05% tax on financial transactions would provide 1.2 US $ trillion (T$). These revenues could finance the energies, sustain the implementation of the UN Millennium Development Goals, ending famine and poverty, and biodiversity. Sources: (1) Stiglitz, J. et al., 2010; (2) Bank for International Settlemments, 2010; (3) International Mon Intelligence Agency (CIA), 2011; (5) Gates B, 2011; (6) International Panel on Climate Change (IPCC), 2012; (7) Unite 2005; (8) James, A. N., Gaston, K. J., Balmford, A. 2001.

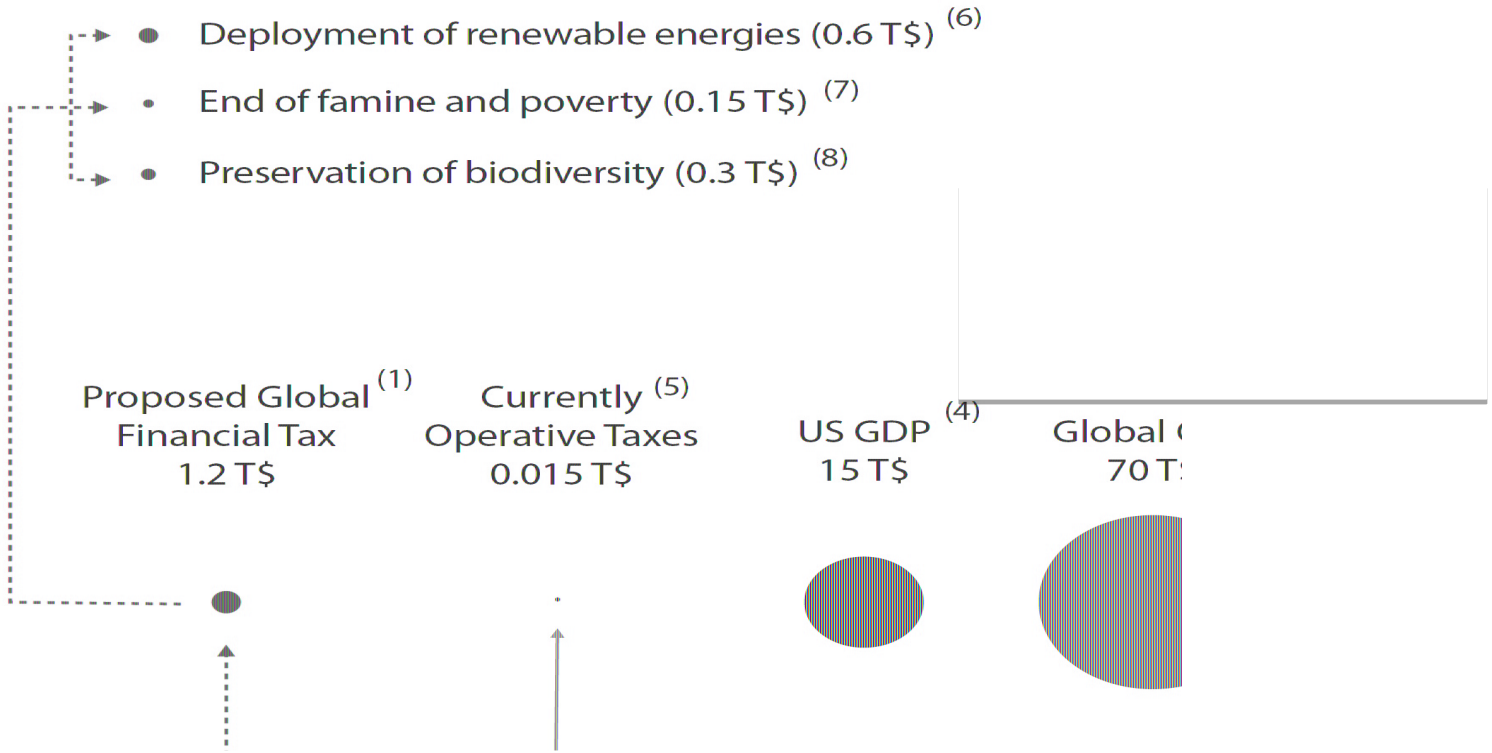
Carnicer and Peñuelas 2012, Energy Policy

A key role for financial reforms and taxes

Tax haven 21-32 T$



If such wealth earns 3% annually
and such capital gains were taxed at 30%,
it would generate between **0.19 T$ and 0.28 T$ in tax revenues**

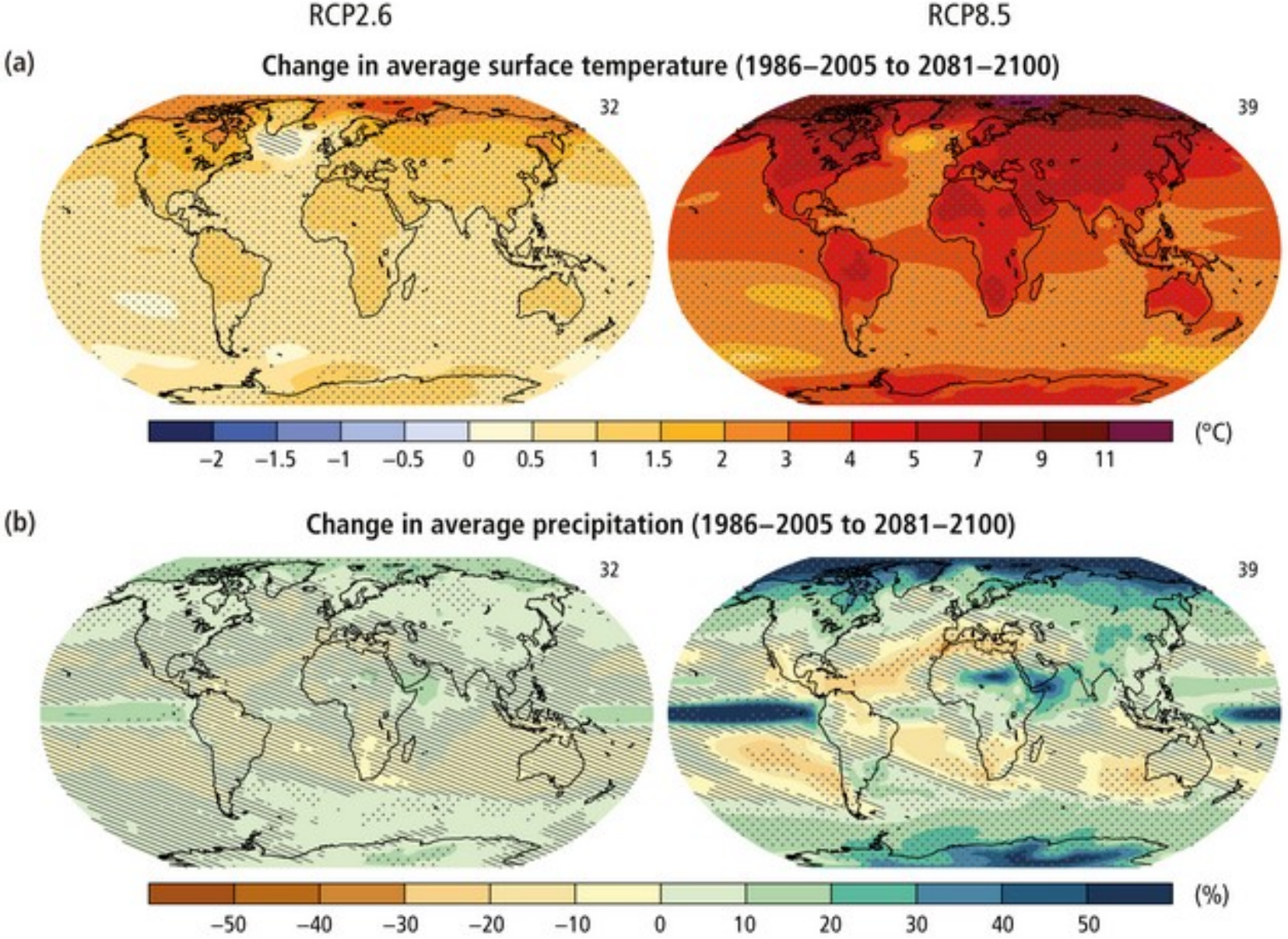


Carnicer and Peñuelas 2012, Energy Policy

Tax Justice Network, 2012

Punts d'inflexió en el sistema climàtic

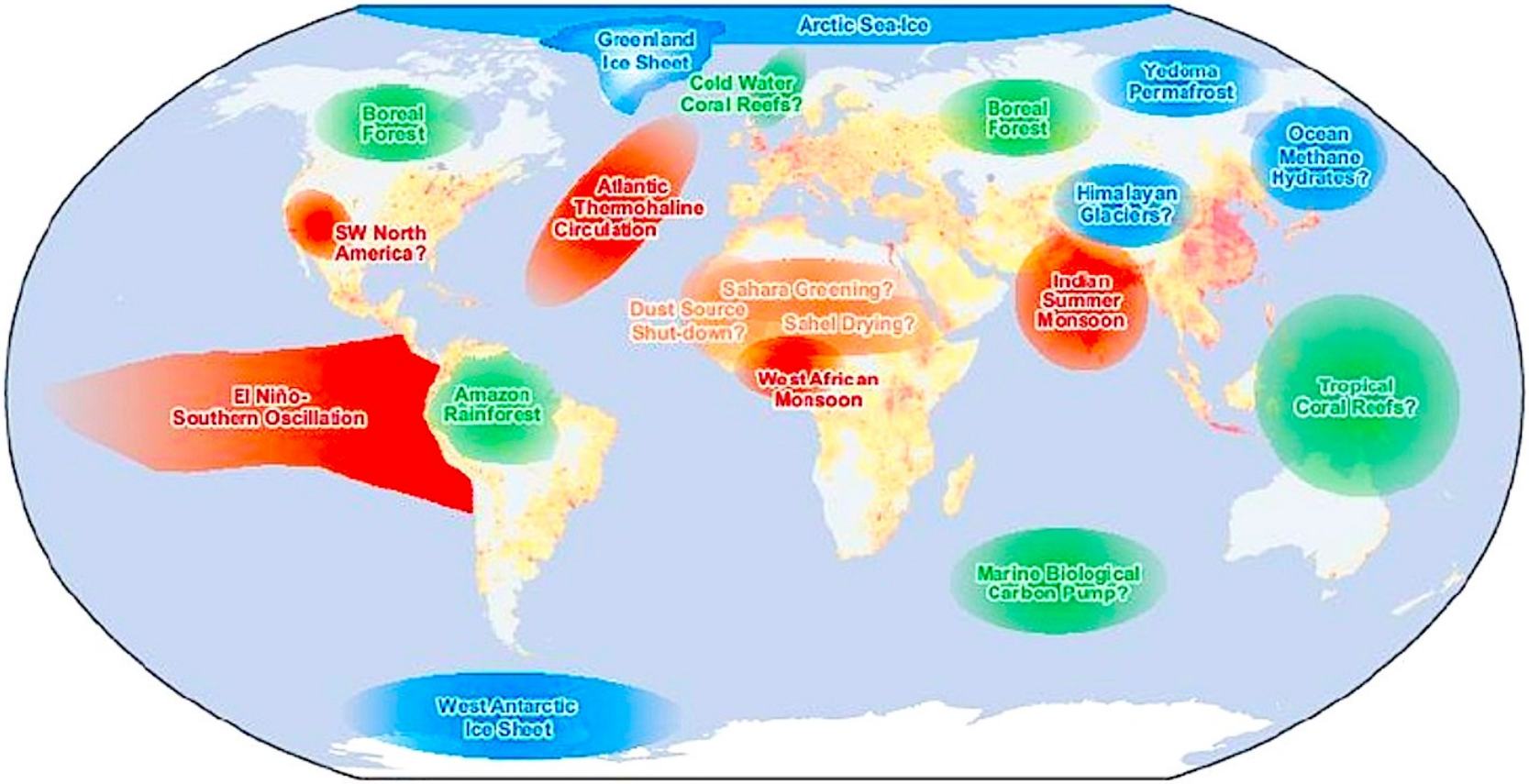
transicions crítiques

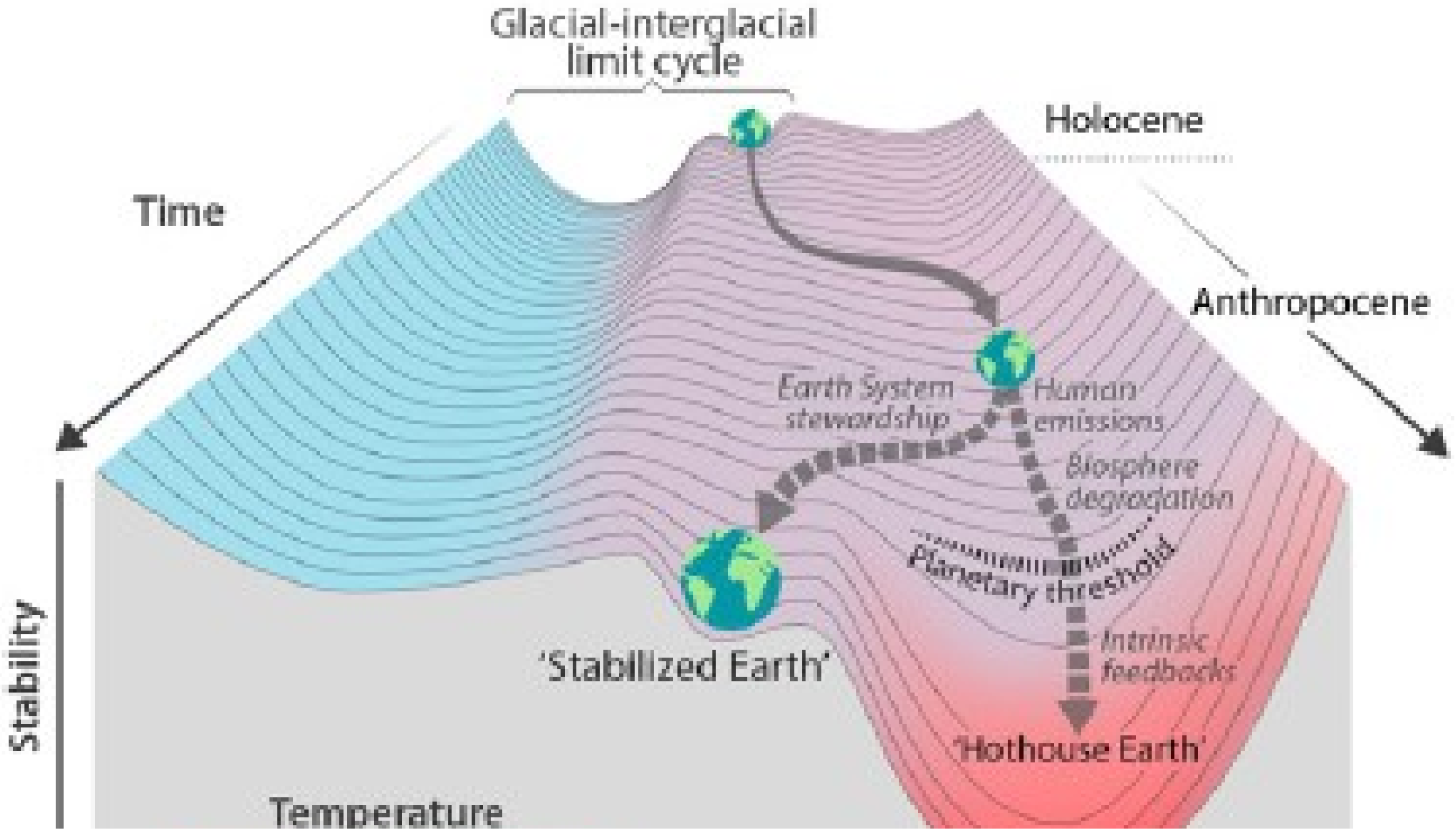

RCP2.6
RCP8.5
(a)
Change in average surface temperature (1986–2005 to 2081–2100)
32
39
−2 −1.5 −1 −0.5 0 0.5 1 1.5 2 3 4 5 7 9 11
(°C)
(b)
Change in average precipitation (1986–2005 to 2081–2100)
32
39
−50 −40 −30 −20 −10 0 10 20 30 40 50
(%)

Tipping elements in the climate system

University of East Anglia

Revised from original in Lenton et al. (2008) *PNAS* 105(6): 1786-1793




Glacial-interglacial
limit cycle
Holocene
Time
Anthropocene
Earth System
stewardship
Human
emissions
Biosphere
degradation
Planetary threshold
Intrinsic
feedbacks
'Stabilized Earth'
'Hothouse Earth'
Stability
Temperature

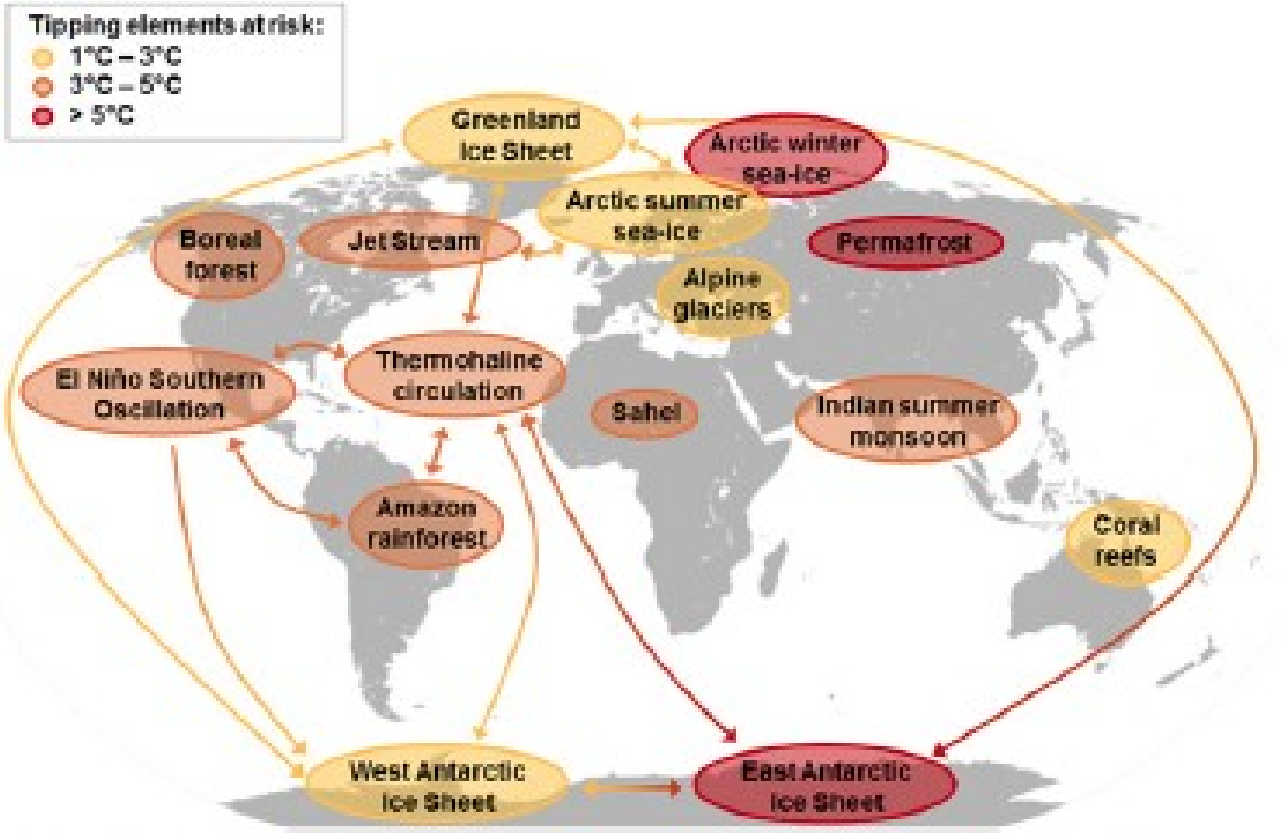


Fig. 3. Global map of potential tipping cascades. The individual tipping elements are color- coded according to estimated thresholds in global average surface temperature (tipping points) (12, 34). Arrows show the potential interactions among the tipping elements based on expert elicitation that could generate cascades. Note that, although the risk for tipping (loss of) the East Antarctic Ice Sheet is proposed at >5 °C, some marine-based sectors in East Antarctica may be vulnerable at lower temperatures (35–38).

Emissons, mitigació i impactes a Catalunya

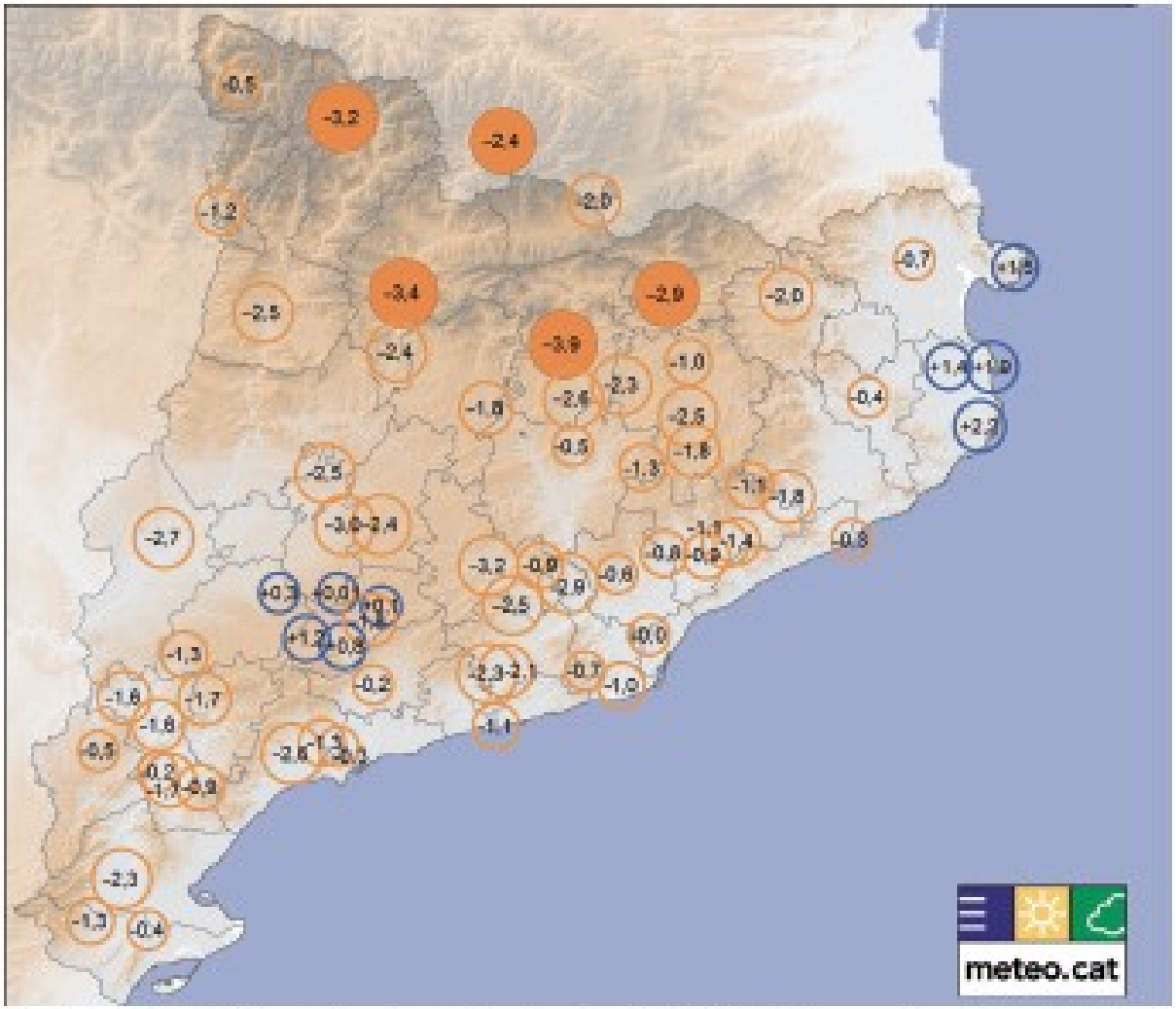


Figura 7. Tendencia de la precipitación media anual en Cataluña (1950-2014) expresada en %/decenio. El radio de la circunferencia es proporcional al porcentaje de cambio por decenio experimentado por la precipitación y el color indica el signo (azul = aumento, naranja = descenso). El círculo naranja indica que la tendencia es estadísticamente significativa según el test de Mann-Kendall ($p < 0,05$).

Fuente: *Boletín Anual de Indicadores Climáticos* correspondiente al año 2014.

TABLA 2. Variación de la temperatura y la precipitación en Cataluña según el territorio (1971-2000)

		Litoral/ Prelitoral	Interior	Pirineo	Cataluña
Temperatura (°C)	2012-2021	0,7	0,7	0,8	0,8
	2031-2050	1,4	1,4	1,6	1,4
Precipitación (%)	2012-2021	–2,4	0,7	–0,2	–2,4
	2031-2050	–8,3	–6,5	–5,3	–6,8

Nota: los valores son las medianas de las proyecciones climáticas efectuadas por diversos modelos y proyectos de alcance global y regional.

Fuente: Tercer informe sobre el cambio climático en Cataluña, 2016.

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Fuente: Tercer informe sobre el cambio climático en Cataluña, 2016.

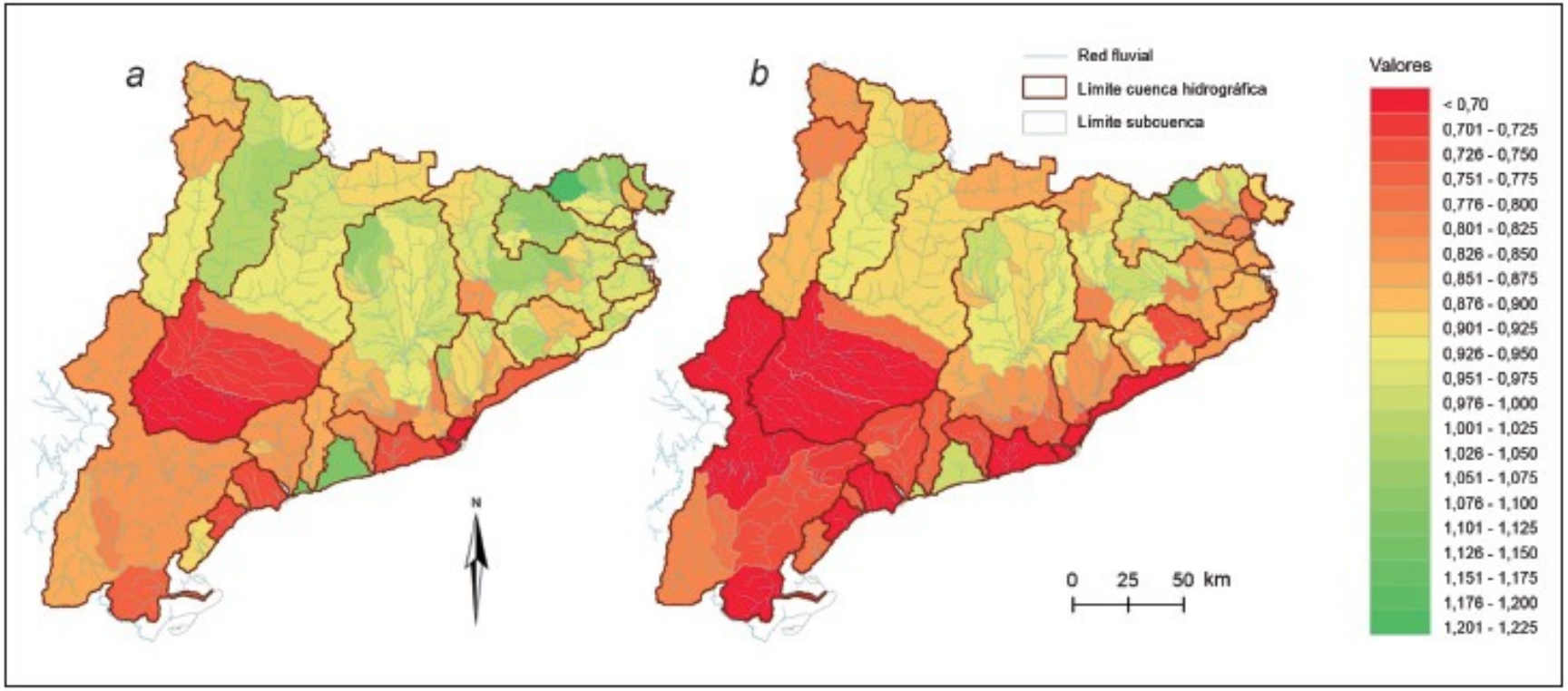


Figura 10. Distribución territorial de los recursos hídricos disponibles en Cataluña para los horizontes a) 2021 y b) 2050, mediante la relación del cociente *R/P* en cada horizonte y el valor actual basado en los datos registrados en 168 observatorios de Cataluña. La distribución de los usos del suelo actuales, como determinantes del componente evapotranspirativo del balance hídrico, también se ha considerado en el cálculo del recurso disponible total.

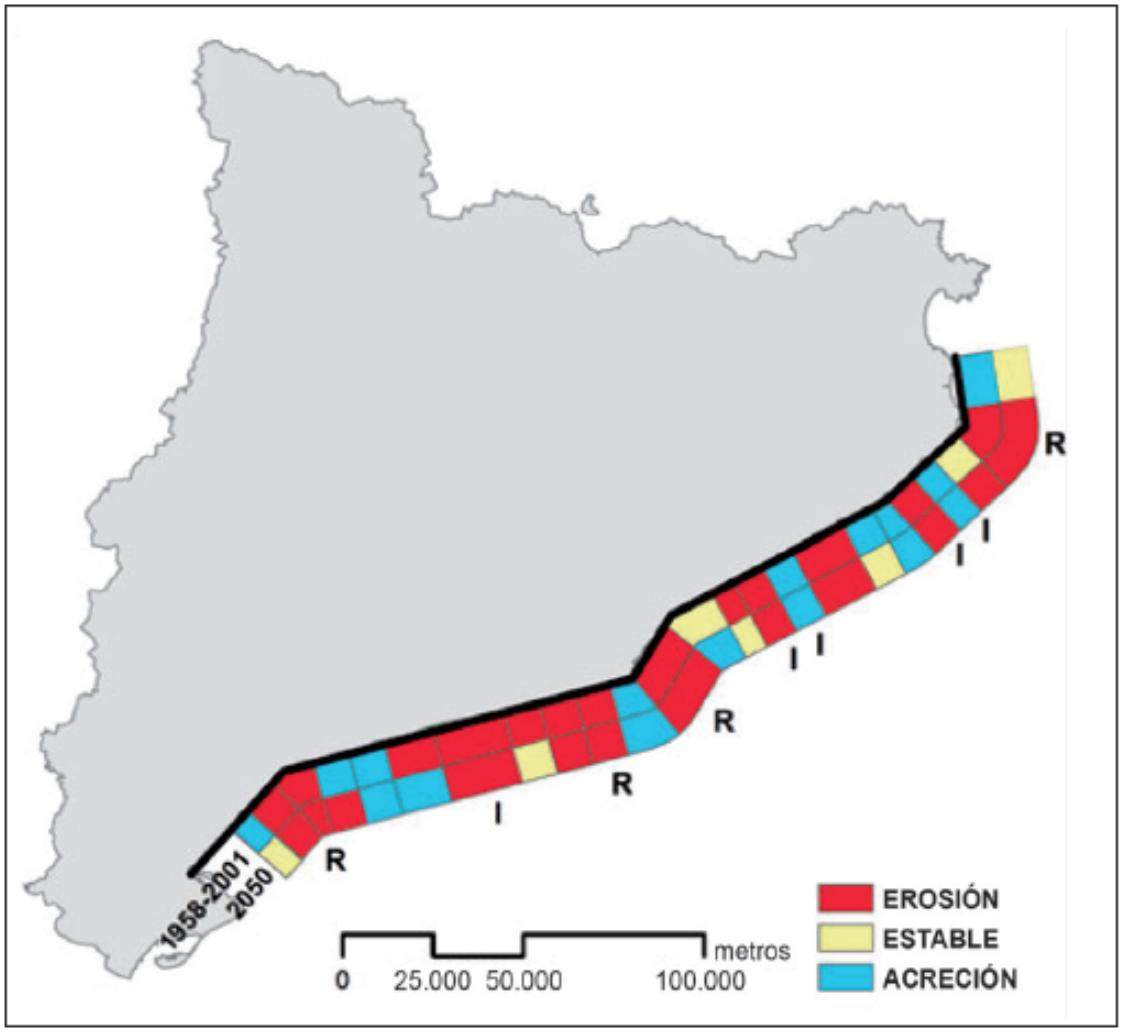


Figura 11. Comportamiento de la costa a medio plazo presente (periodo 1958-2001) y en un escenario de cambio climático, el año 2050. I (intensificación): designa tramos costeros donde el efecto del cambio climático intensifica la erosión. R (reducción): corresponde a tramos de costa donde el efecto del cambio climático produce una reducción de la erosión.

Fuente: Casas-Prat, M.; Sierra, J. P. «Trend analysis of wave direction and associated impacts on the Catalan coast». *Climatic Change*, 115, 2012, p. 667-691.

Figura 13. Evolución de la línea de borde de playa de la Barceloneta, causada por la subida del nivel del mar, considerando una playa de arena (caso teórico) y la existencia de infraestructuras rígidas (caso real).

Fuente: Tercer informe sobre el cambio climático en Cataluña, 2016.

A Catalunya…. Inventari emissions Generalitat

Comparem Catalunya, Espanya i Europa

Emissions de GEH	1990	2005	2010	2012	2013	2014	2015
	Milers de tones de CO_2 eq						
Catalunya	38.860	59.019	50.640	46.402	42.928	43.198	43.532
Espanya	287.828	439.556	356.761	351.817	322.874	324.215	335.662
UE-28	5.641.625	5.209.936	4.773.321	4.555.521	4.460.176	4.282.764	4.306.754

Respecte 1990

CAT	ESP	UE
+12,0%	+16,6%	-23,7%

Respecte 2014

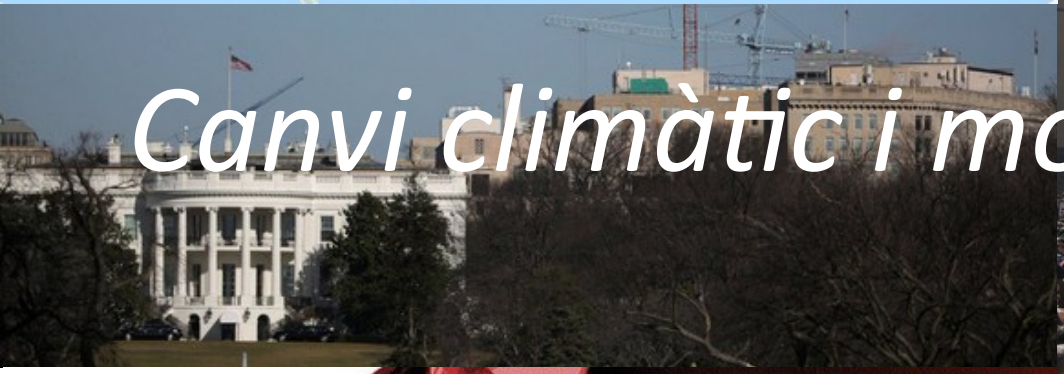
CAT	ESP	UE
+0,8%	+3,5%	+0,6%

Dades en gCO_2eq / €

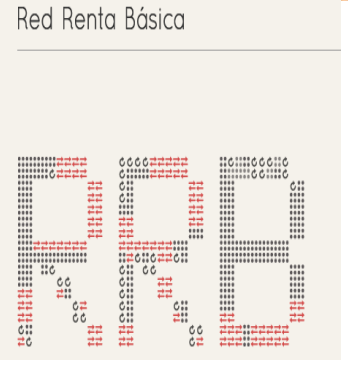
CAT	ESP	UE
202	312	293

Dades en tCO_2eq / càpita

CAT	ESP	UE
5,9	7,2	8,5



Canvi climàtic i moviments socials



Reptes pels moviments socials

Tres punts de reflexió, una invitació al debat

1- Comunicació, complexitat, missatges simples
i xarxes socials

2- Fiscalitat global i canvi climàtic

3- Moviments i accions per la cohesió social
i la igualtat. Aliances imprescindibles.
Transversalitat. Opinions múltiples.

4- Acció governamental, actors acadèmics,
actors socials. Dinàmiques post xoc

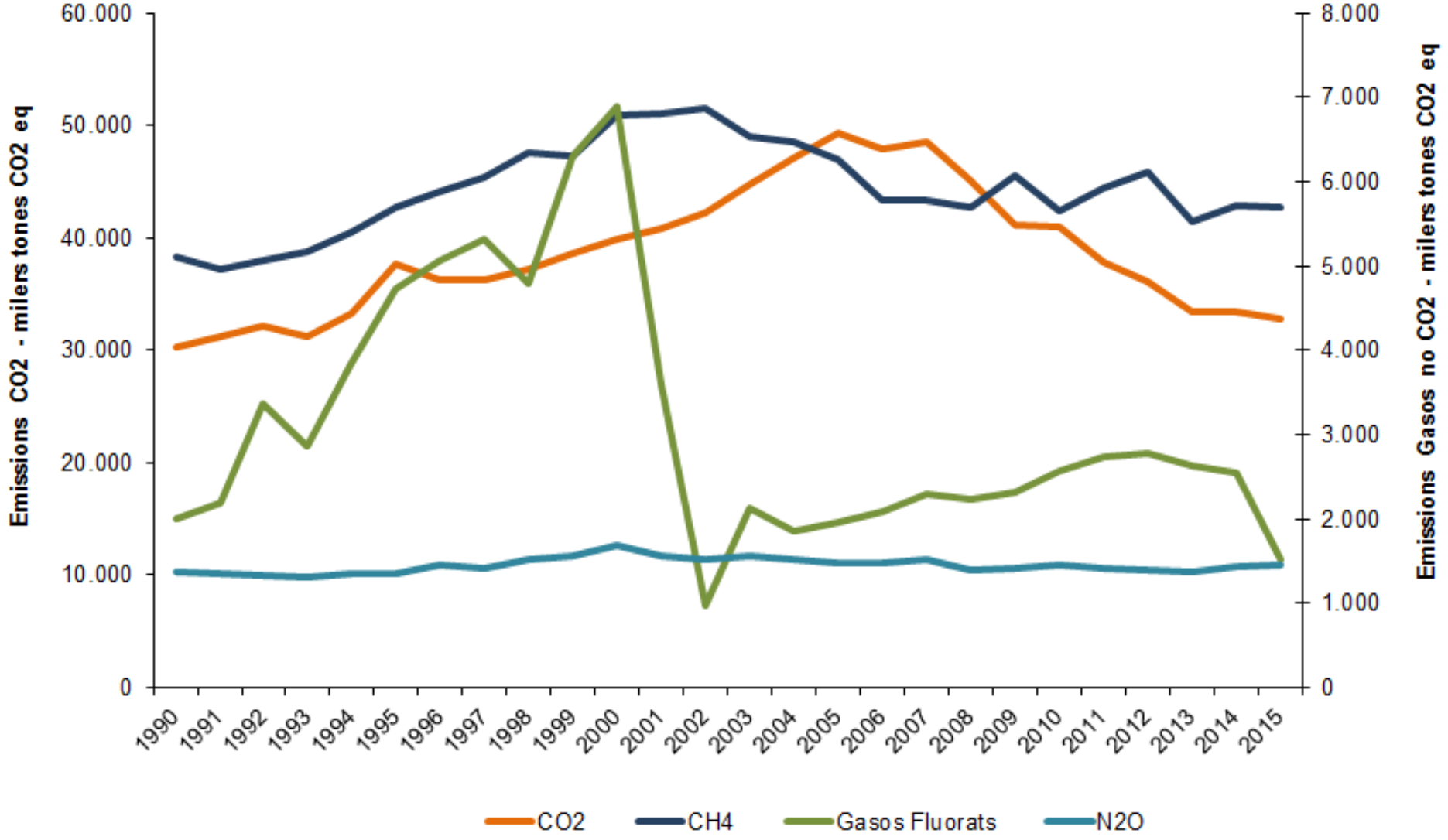
Canvi climàtic a Catalunya:

Gràcies

Inventari emissions - Generalitat de Catalunya

GLOBAL CARBON PROJECT

A Catalunya…. Inventari emissions Generalitat

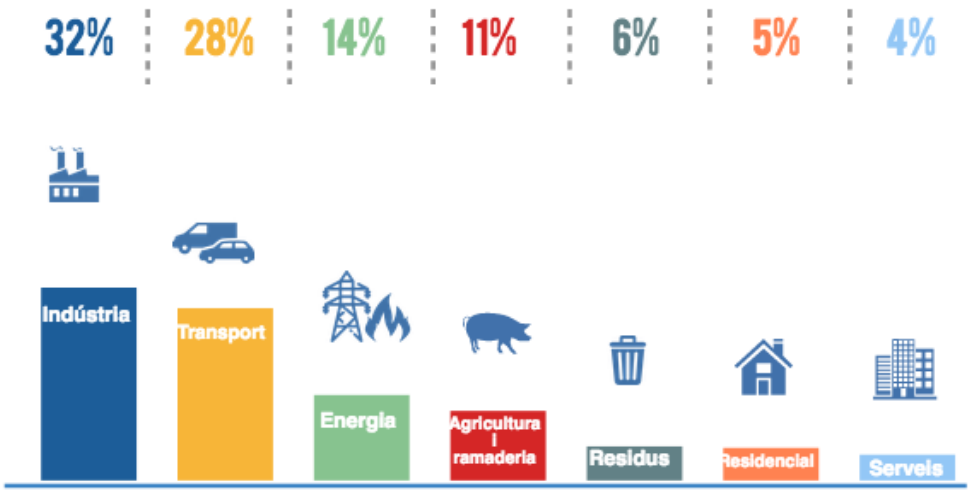


A Catalunya…. Inventari emissions Generalitat

Inventari d'emissions GEH a Catalunya - 2015

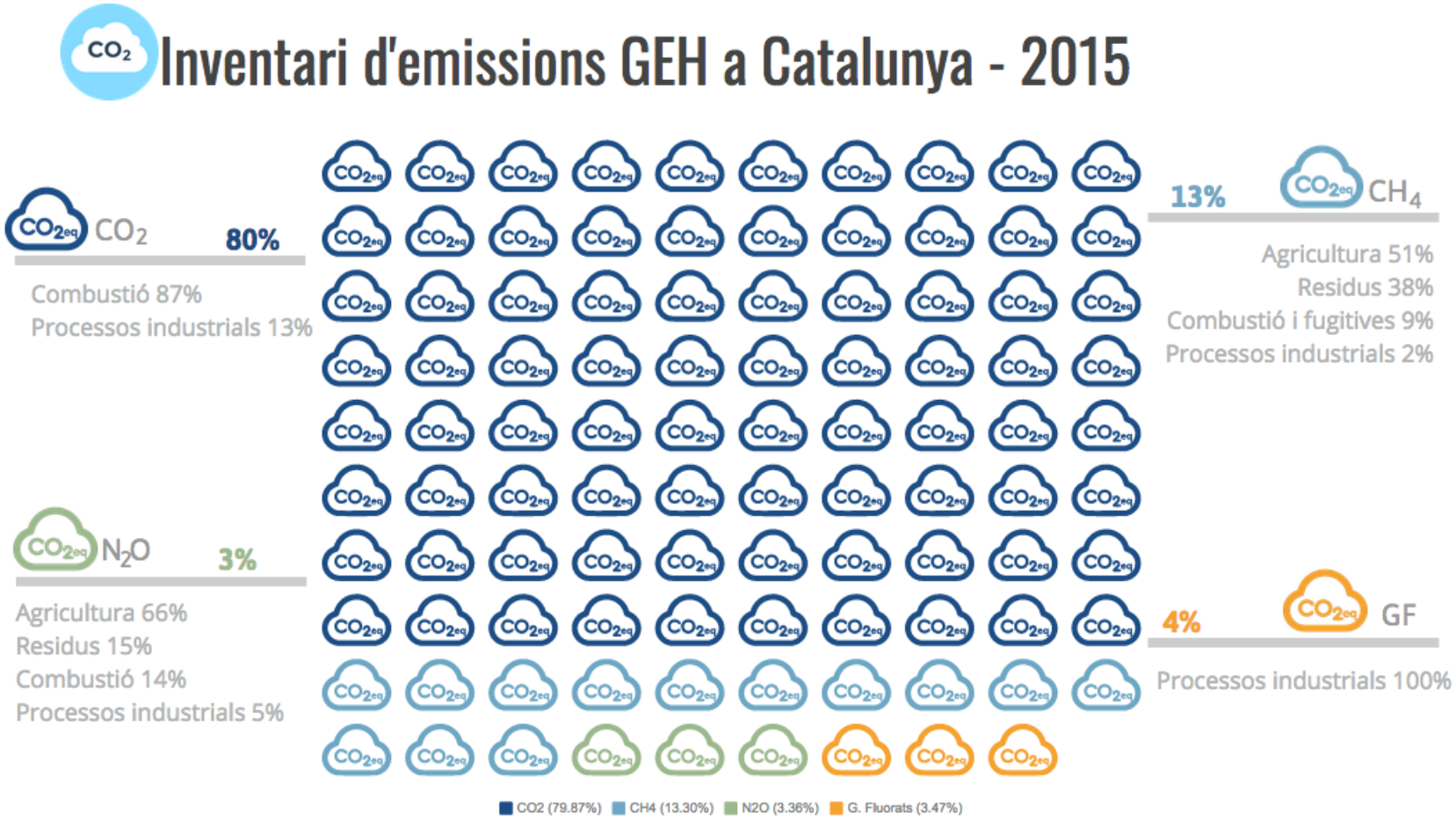
Emissions 2015, àmbits d'activitat

Àmbit d'activitat	Emissions de GEH. Milers de tones de CO_2eq
Producció i transformació energia	6.075
Indústria	13.705
Transport	12.243
Residencial	2.317
Serveis	1.832
Agricultura i Ramaderia	4.939
Residus	2.421
Total	43.532



Desagregació per demarcacions – 2015

A Catalunya…. Inventari emissions Generalitat



GLOBAL CARBON PROJECT

A Catalunya…. Inventari emissions Generalitat

Evolució de les emissions de la INDÚSTRIA a Catalunya. Període 1990-2015

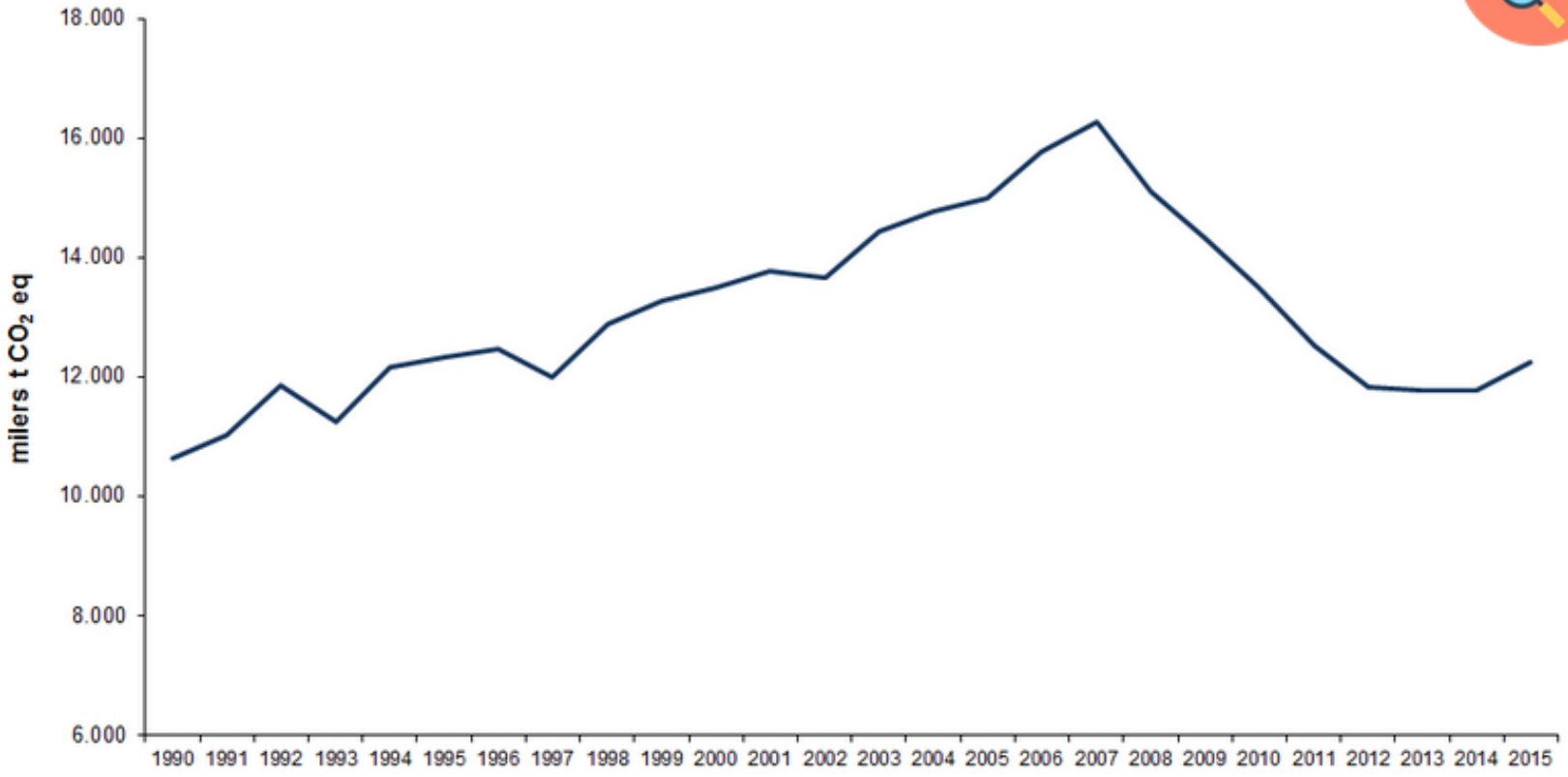
Any 2015: 13.705 milers t CO_2eq

-7,6% vs 1990

-6,6% vs 2014

RETORN

Evolució de les emissions del TRANSPORT a Catalunya. Període 1990-2015



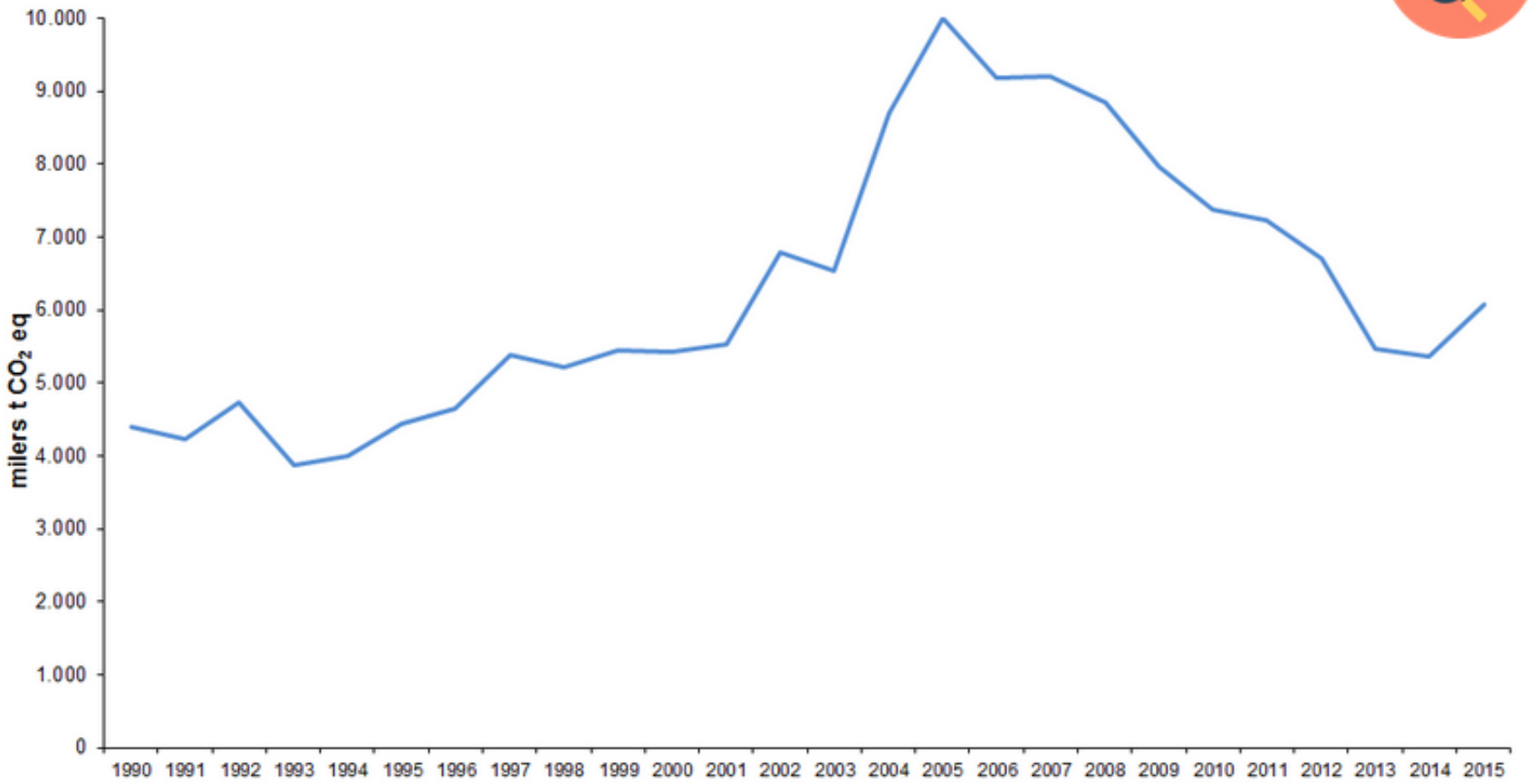
Any 2015: 12.243 milers t CO_2eq

+15,1% vs 1990

+3,9% vs 2014

RETORN

Evolució de les emissions de l'ENERGIA a Catalunya. Període 1990-2015



Any 2015: 6.075 milers t CO_2eq

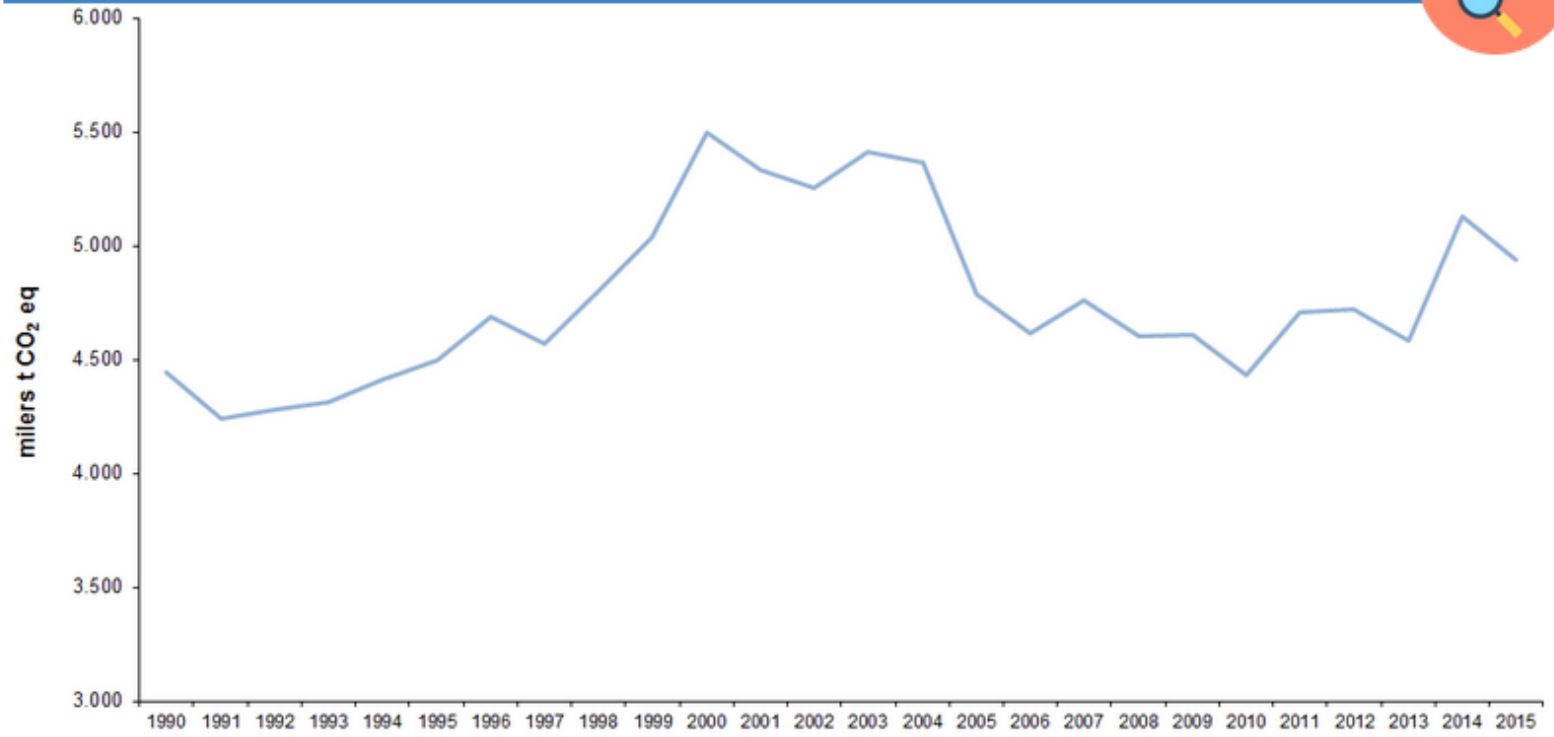
+38,0% vs 1990

+13,3% vs 2014

RETORN

A Catalunya…. Inventari emissions Generalitat

Evolució de les emissions de l'AGRICULTURA i la RAMADERIA a Catalunya. Període 1990-2015



Any 2015: 4.939 milers t CO_2eq

+11,1% vs 1990

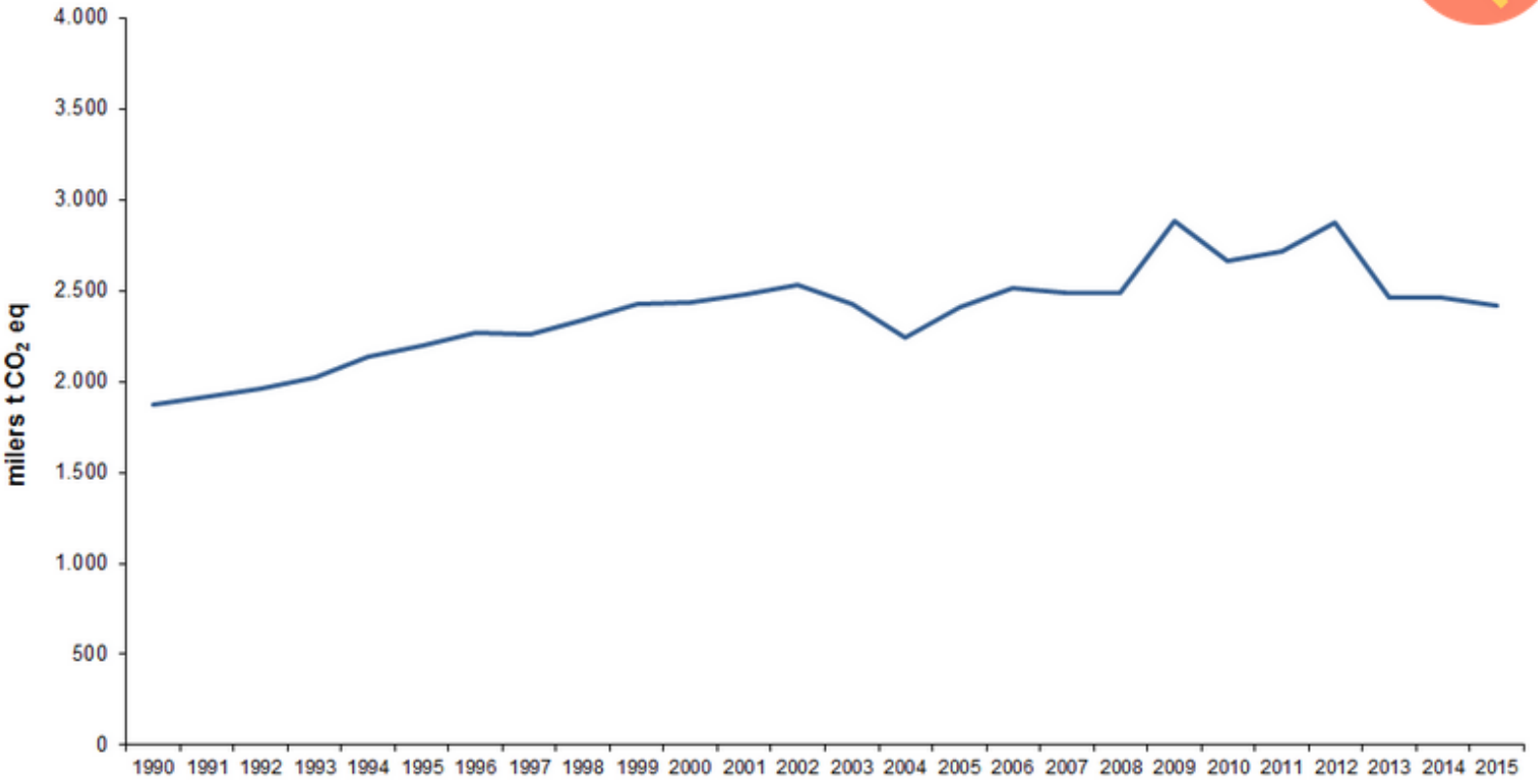
-3,8% vs 2014

RETORN

GLOBAL CARBON

A Catalunya.... Inventari emissions Generalitat

Evolució de les emissions dels RESIDUS a Catalunya. Període 1990-2015



Any 2015: 2.421 milers t CO_2eq

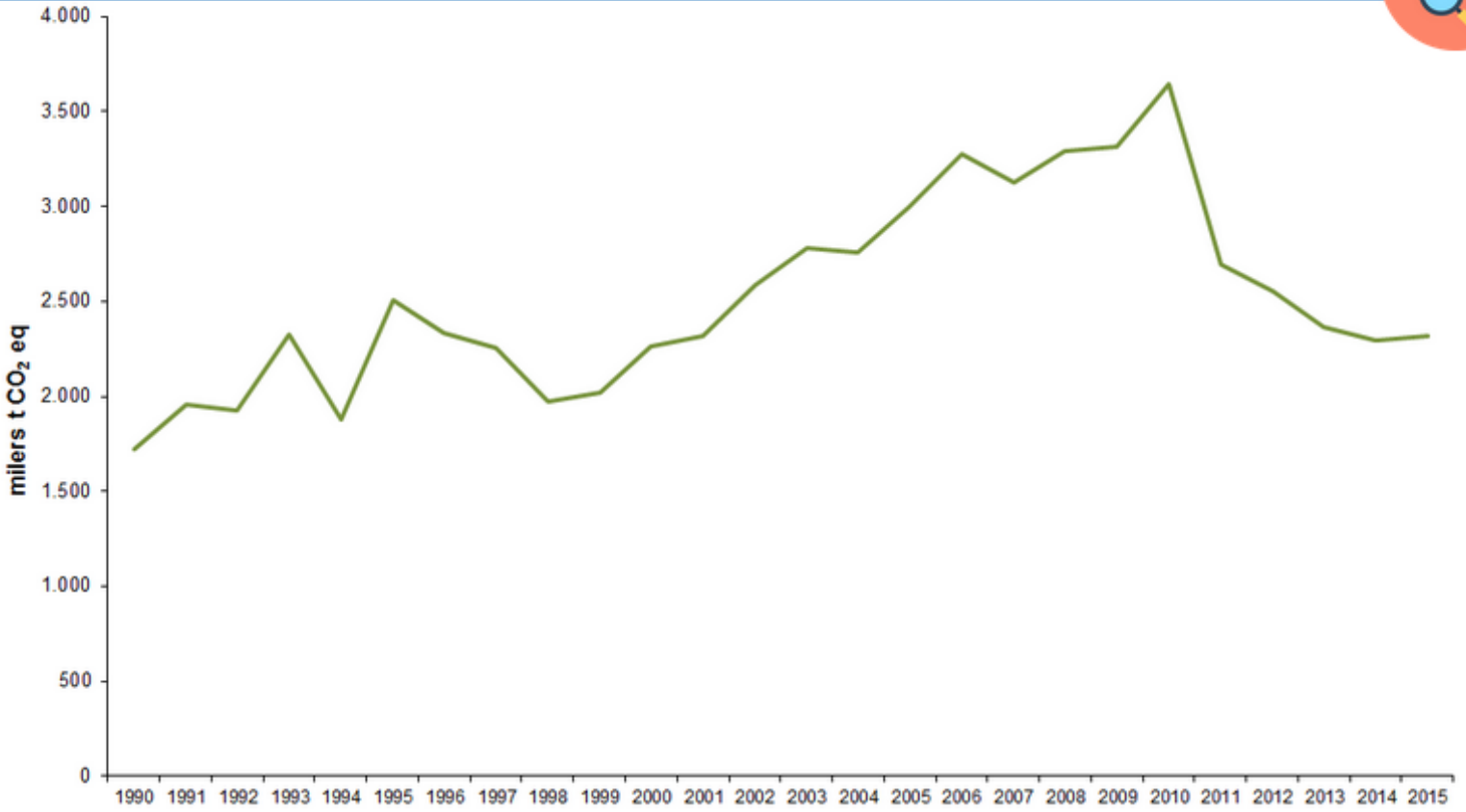
+28,9% vs 1990

-1,6% vs 2014

RETORN

A Catalunya…. Inventari emissions Generalitat

Evolució de les emissions de l'àmbit RESIDENCIAL a Catalunya. Període 1990-2015



Any 2015: 2.317 milers t CO_2eq

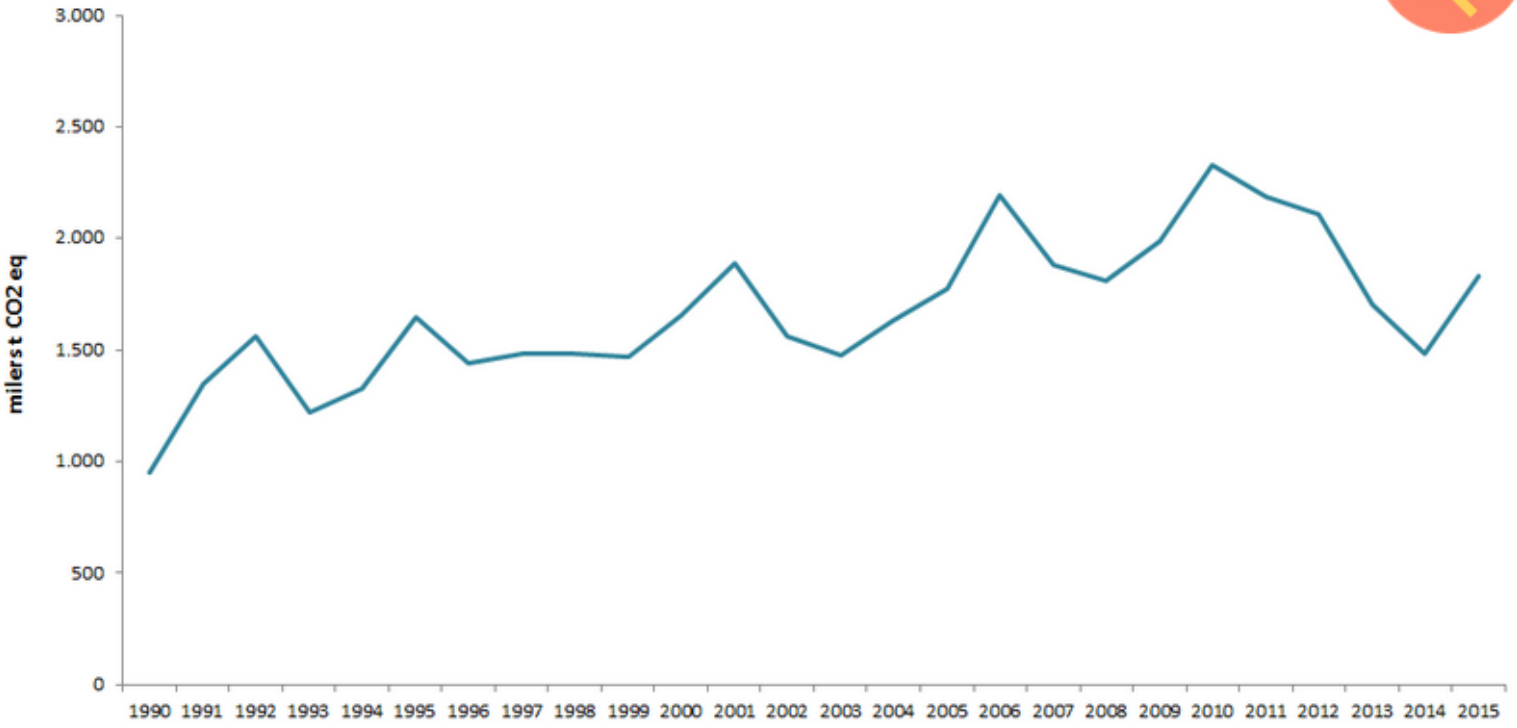
+34,9% vs 1990

-1,1% vs 2014

RETORN

A Catalunya…. Inventari emissions Generalitat

Evolució de les emissions de l'àmbit SERVEIS a Catalunya. Període 1990-2015



Any 2015: 1.832 milers t CO_2eq

+92,5% vs 1990

+23,5% vs 2014

RETORN

A Catalunya…. Inventari emissions Generalitat

Comparem Catalunya, Espanya i Europa

Emissions de GEH	1990	2005	2010	2012	2013	2014	2015
	Milers de tones de CO_2 eq						
Catalunya	38.860	59.019	50.640	46.402	42.928	43.198	43.532
Espanya	287.828	439.556	356.761	351.817	322.874	324.215	335.662
UE-28	5.641.625	5.209.936	4.773.321	4.555.521	4.460.176	4.282.764	4.306.754

Respecte 1990

CAT	ESP	UE
+12,0%	+16,6%	-23,7%

Respecte 2014

CAT	ESP	UE
+0,8%	+3,5%	+0,6%

Dades en gCO_2eq / €

CAT	ESP	UE
202	312	293

Dades en tCO_2eq / càpita

CAT	ESP	UE
5,9	7,2	8,5

Materials addicionals

GLOBAL CARBON PROJECT

All the data is shown in billion tonnes CO_2 ($GtCO_2$)

1 Gigatonne (Gt) = 1 billion tonnes = 1×10^{15}g = 1 Petagram (Pg)

1 kg carbon (C) = 3.664 kg carbon dioxide (CO_2)

1 GtC = 3.664 billion tonnes CO_2 = 3.664 $GtCO_2$

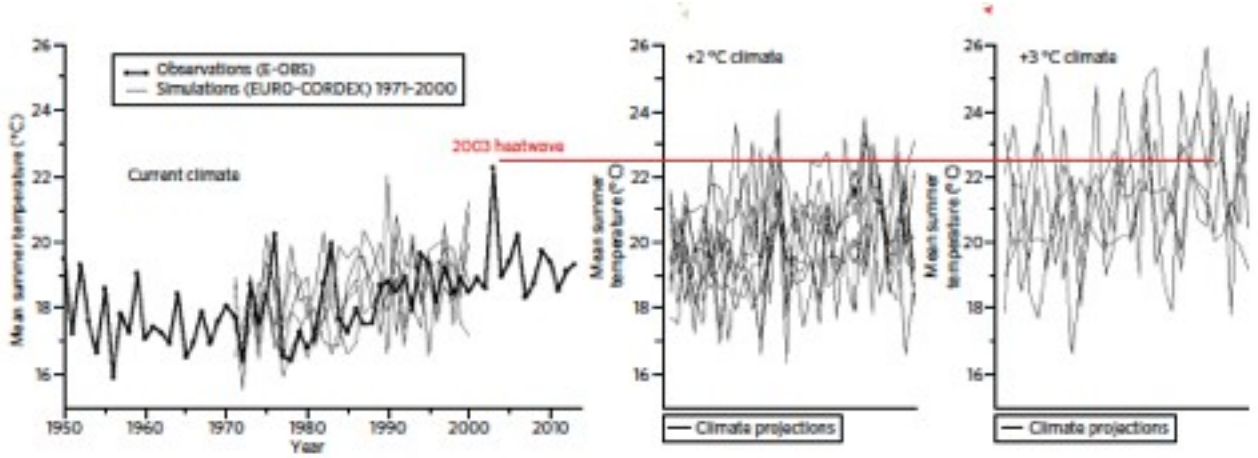


Fig. 3 | Schematics showing the impacts and feedbacks of the drivers of global change on C sinks by their effects on productivity and C residence time. Solid lines represent the assumed mechanisms by which the various drivers operate, and dashed lines indicate how they actually operate or could change in the future towards saturation. The drivers may help to keep the climate within sustainable limits, depending on their respective strengths, and help to avoid abrupt shifts—such as, for example, passing from a scenario of 2 °C warming in which the summer climate of Europe would still have rare 2003-like heatwaves (6%), to a scenario of 3 °C warming, with one summer 2003-like heatwave occurring every 4 years The lower part of the figure shows observations (E-OBS[69]) and regional climate projections (EURO-CORDEX[70]) of mean summer temperatures in the Paris area, the temperature periods being defined according to the methodology used for the IMPACT2C project, described previously[71]. See also the IMPACT2C atlas (https://www.atlas.impact2c.eu/en/). NPP, net primary productivity.

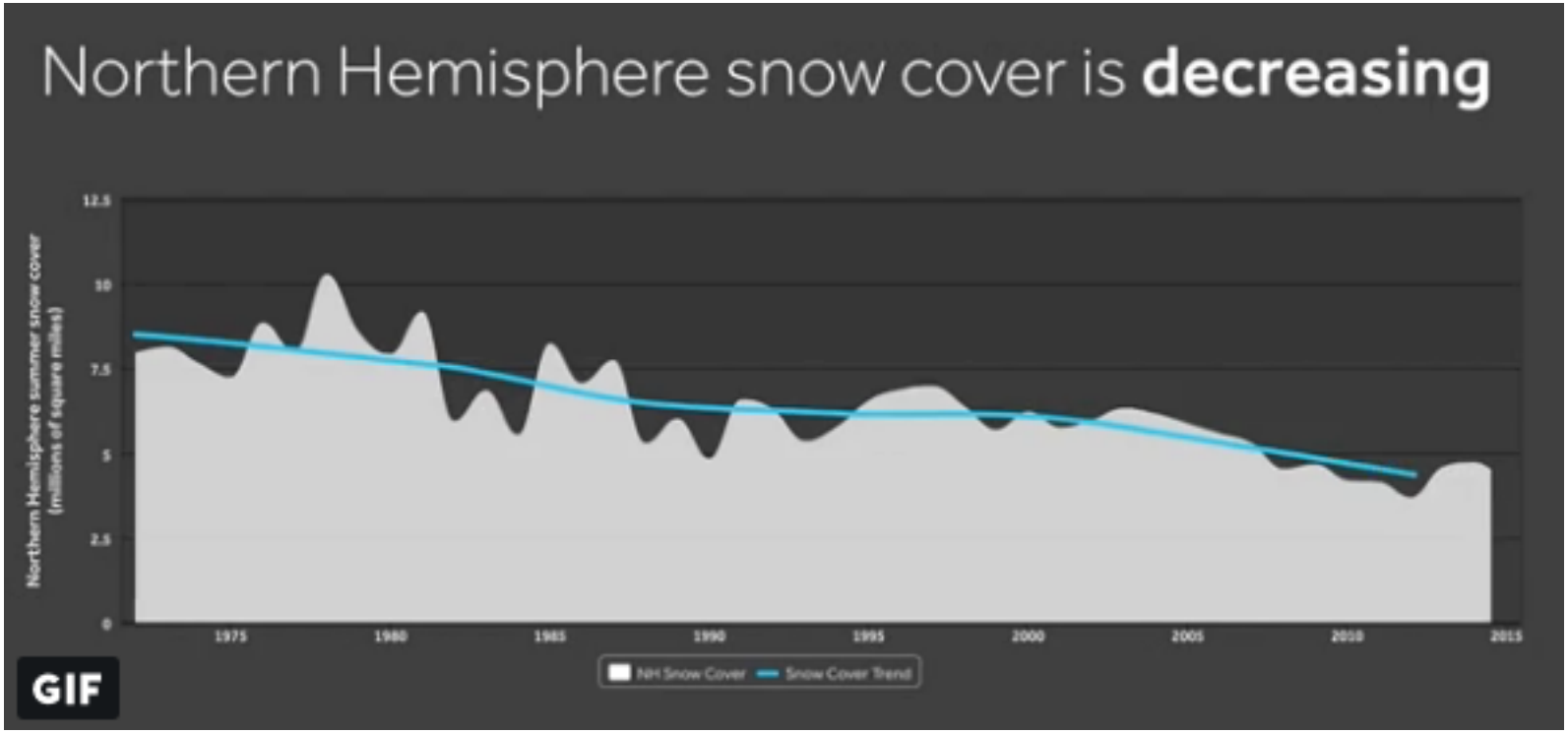
Adressing global sustainability challenges and planetary boundaries, including the preservation of biodiversity and the reduction of CO_2 emissions, requires the explicit consideration of current dynamics in **the energy and financial sectors.**

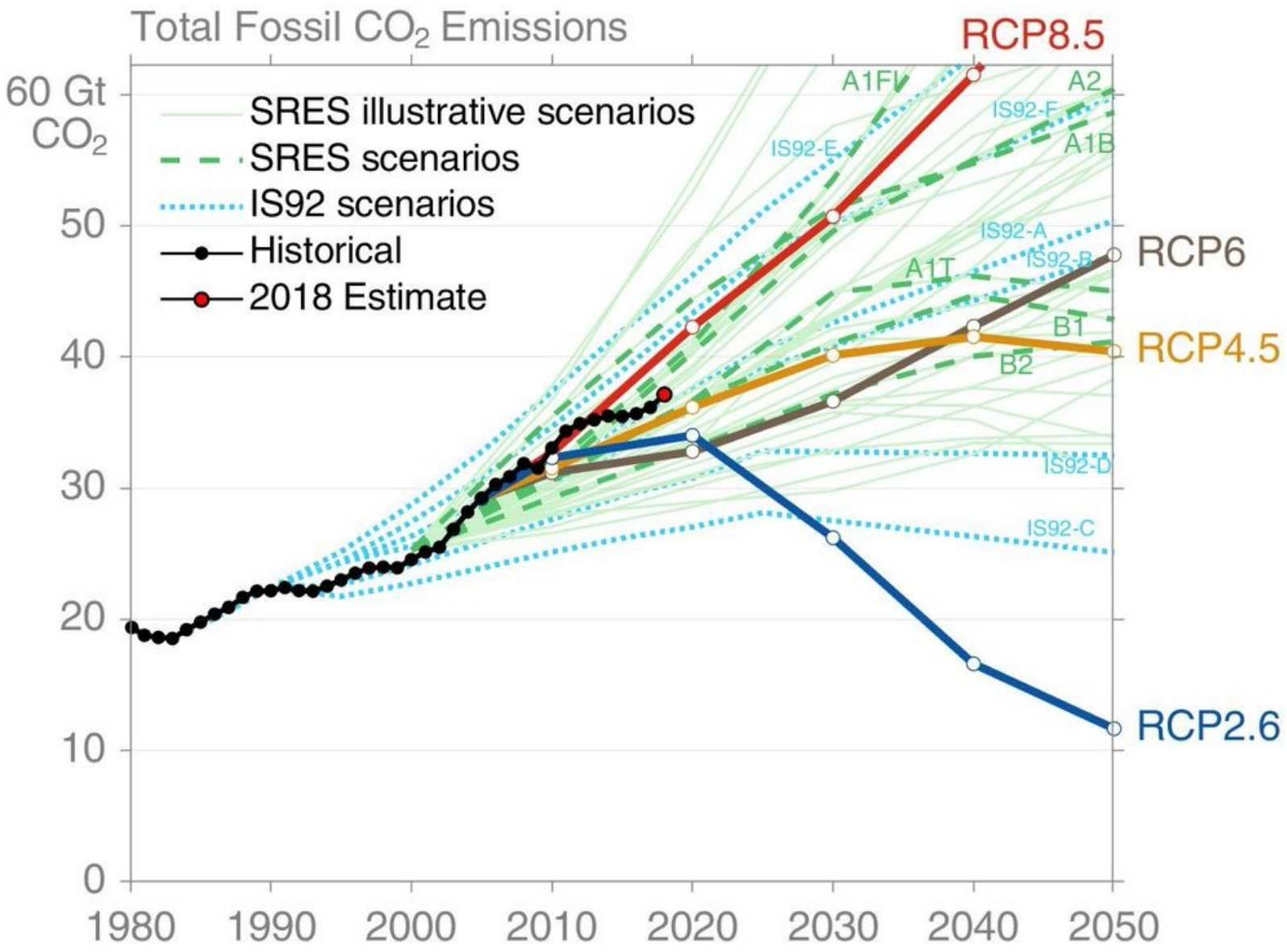
A **global budget** for sustainability, including human basic needs, biodiversity policies and a shift towards renewable energy **requires an investment of 1-4 trillion $.**

The global financial system has a huge size (2000-3000 T$) and remains largely **unregulated, untaxed**. Financial regulation and taxation could be a key, major step towards sustainability.

Many countries are largely **endebted**. **Debt** should be considered a key issue in global sustainability scenarios.

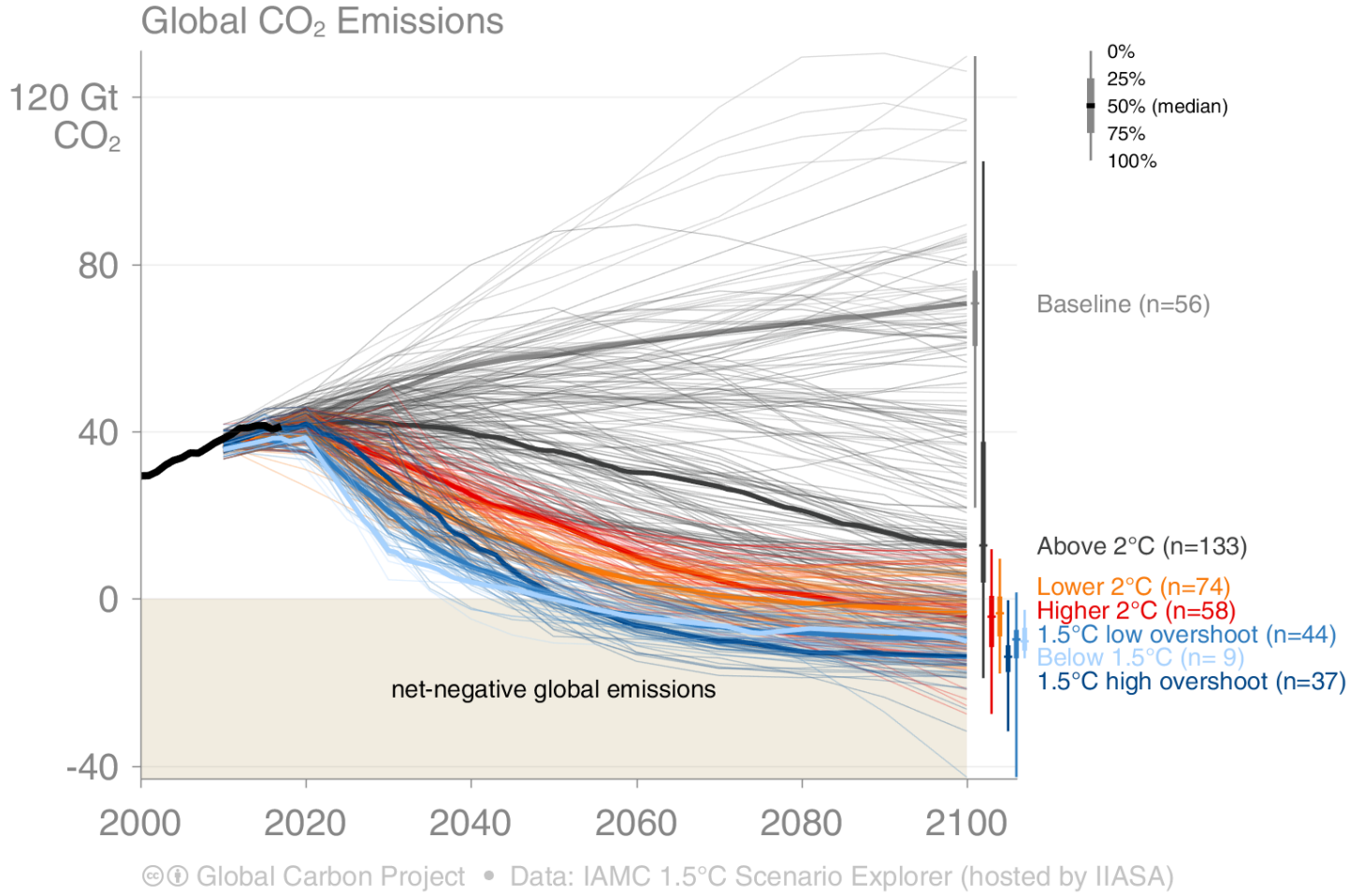
Tax havens sustain around 19-28 T$, nearly half of the global GDP (70 T$). **Closing and strictly regulating tax havens** remains as a key, major challenge for global financial sustainability.


Northern Hemisphere snow cover is decreasing
Northern Hemisphere summer snow cover (millions of square miles)
12.5
10
7.5
5
2.5
0
1975
1980
1985
1990
1995
2000
2005
2010
2015
NH Snow Cover
Snow Cover Trend
GIF


Total Fossil CO_2 Emissions
60 Gt CO_2
50
40
30
20
10
0
1980
1990
2000
2010
2020
2030
2040
2050
SRES illustrative scenarios
SRES scenarios
IS92 scenarios
Historical
2018 Estimate
RCP8.5
A1FI
A2
IS92-F
IS92-E
A1B
IS92-A
RCP6
A1T
IS92-B
B1
RCP4.5
B2
IS92-D
IS92-C
RCP2.6

The IPCC Special Report on "Global Warming of 1.5°C"

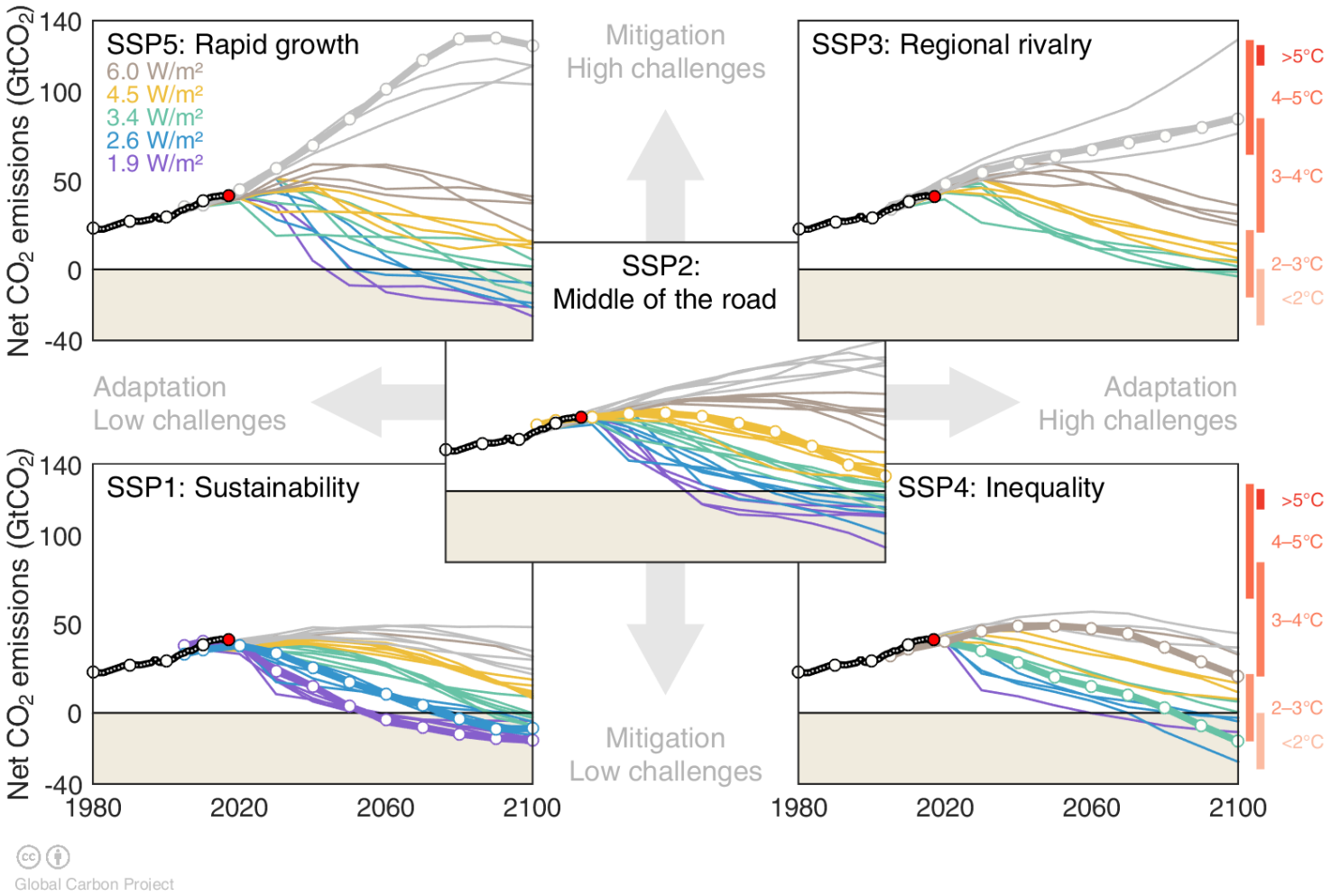
The IPCC Special Report on "Global Warming of 1.5°C" presented new scenarios:
1.5°C scenarios require halving emissions by ~2030, net-zero by ~2050, and negative thereafter



Net emissions include those from land-use change and bioenergy with CCS.

Shared Socioeconomic Pathways (SSPs)

The Shared Socioeconomic Pathways (SSPs) are a set of five socioeconomic narratives that are used by Integrated Assessment Models to estimate potential future emission pathways

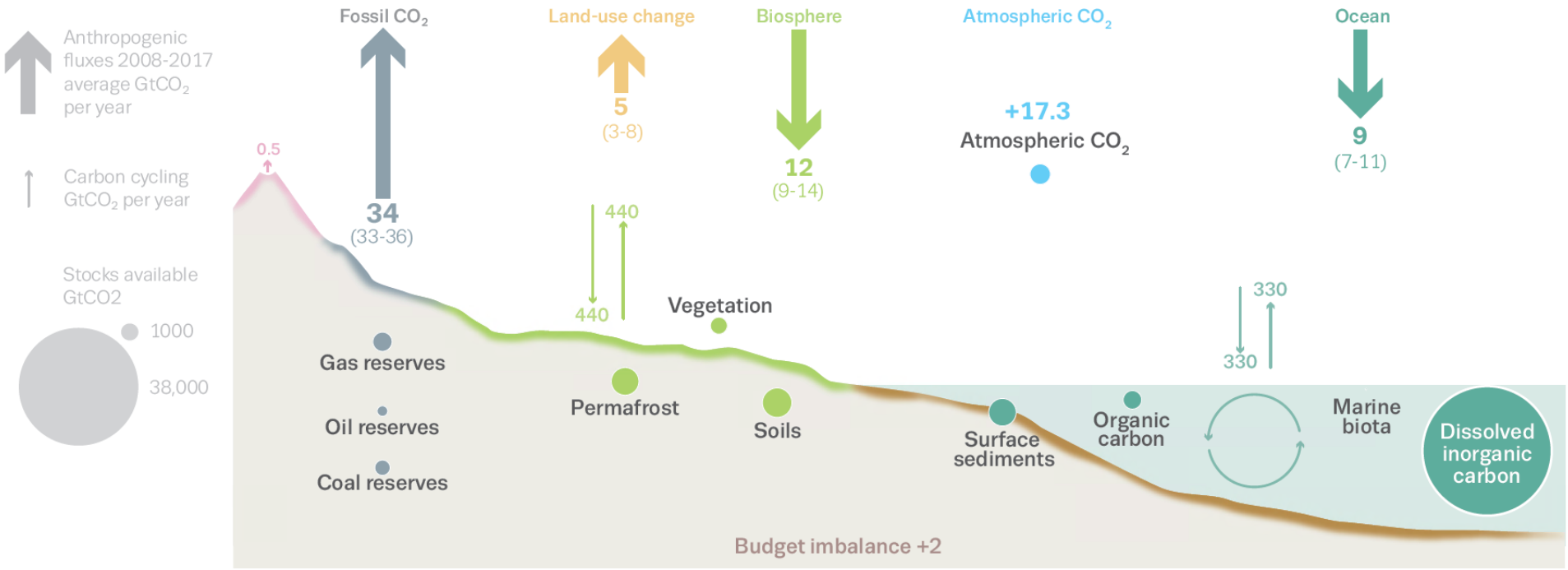


Marker Scenarios are in bold. Net emissions include those from land-use change and bioenergy with CCS.

Source: Riahi et al. 2016; Rogelj et al. 2018; IIASA SSP Database; Global Carbon Budget 2018

Anthropogenic perturbation of the global carbon cycle

Perturbation of the global carbon cycle caused by anthropogenic activities, averaged globally for the decade 2008–2017 ($GtCO_2$/yr)



The budget imbalance is the difference between the estimated emissions and sinks.

Source: CDIAC; NOAA-ESRL; Le Quéré et al 2018; Ciais et al. 2013; Global Carbon Budget 2018

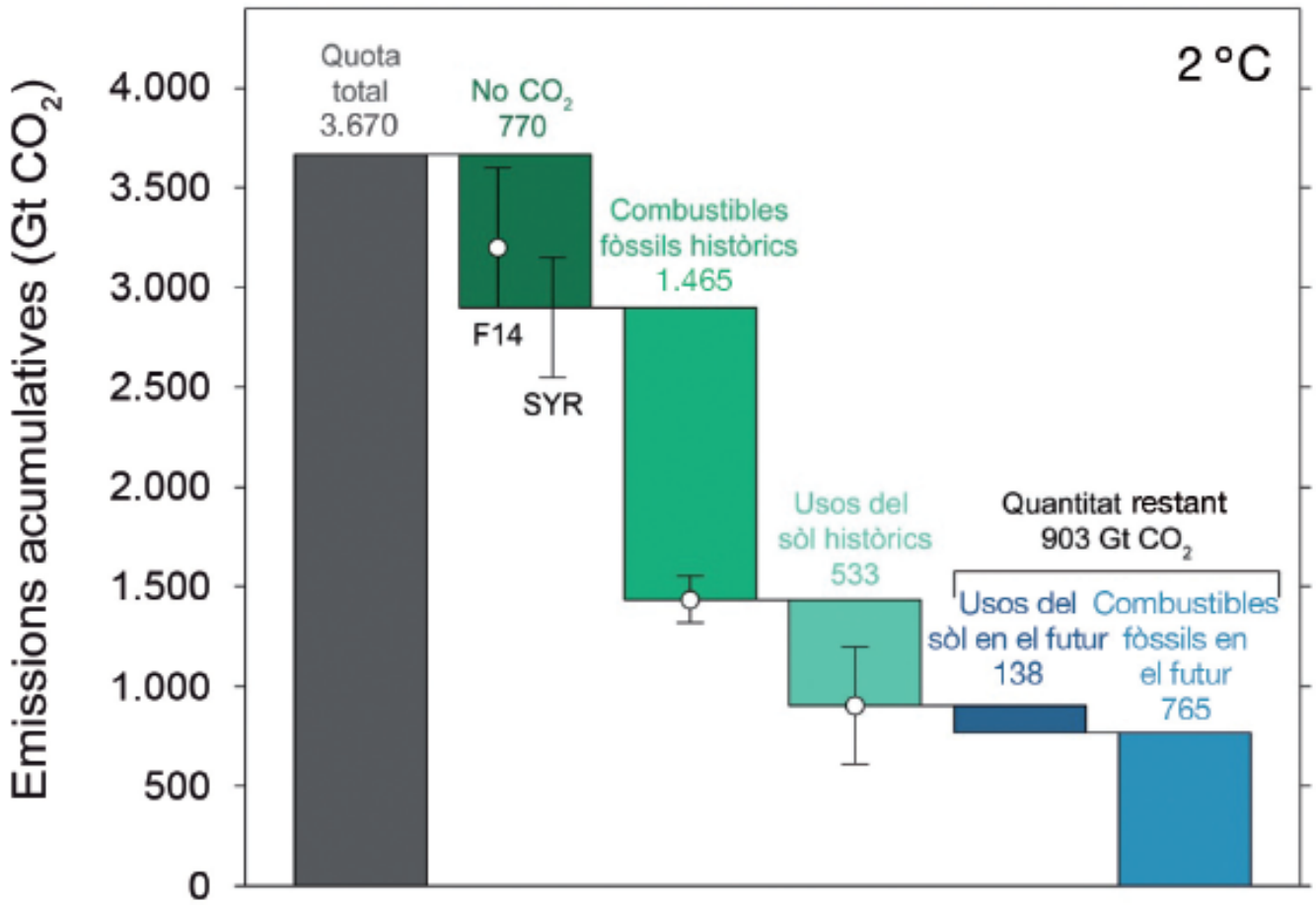
Emetem anualment 37 Gt CO_2

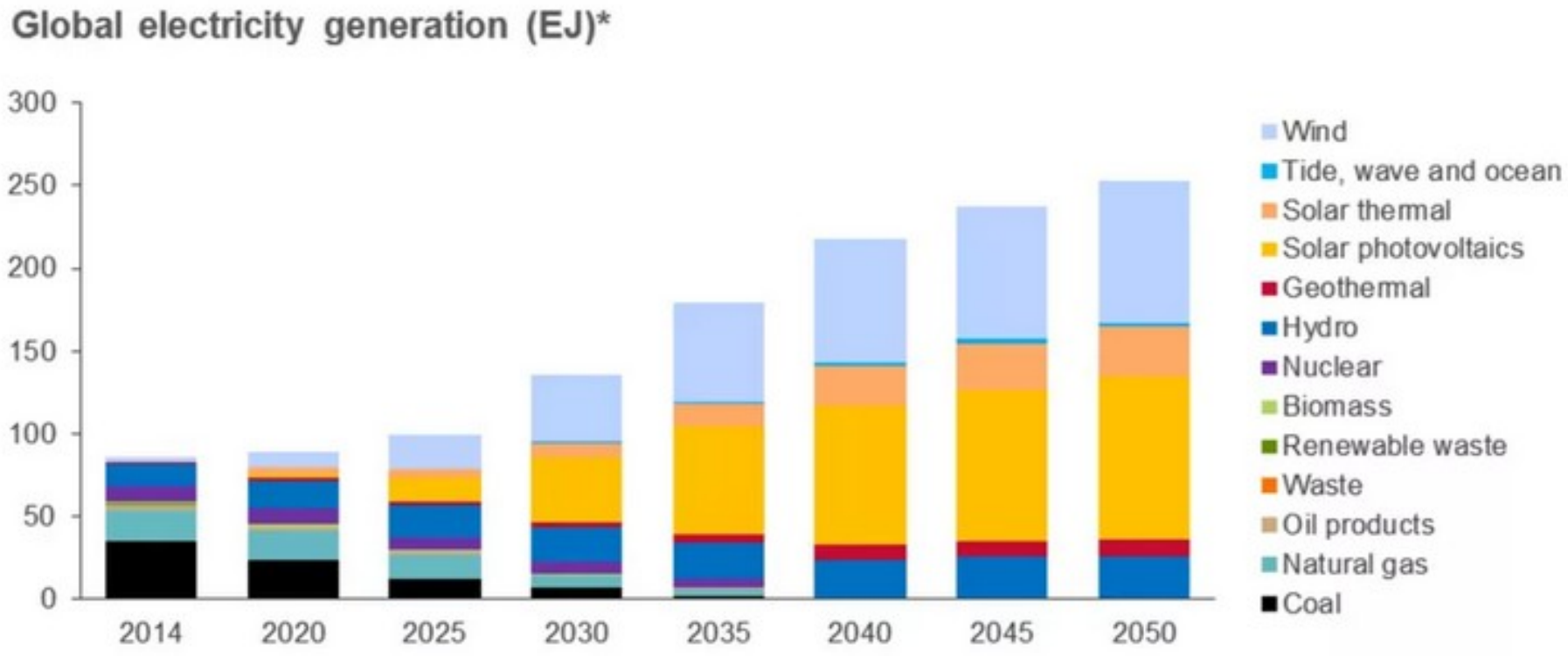
D'acord amb **IPCC-AR5**, la quota d'emissions
que es poden emetre sense superar els 2 ºC és:

590 Gt CO_2 a 1.240 Gt CO_2

Si les emissions actuals de 40 Gt CO2 per any
continuen, aquest balanç quedaria exhaurit
entre quinze i trenta anys.

(Rogelj et al., 2016; quota amb una probabilitat > 66 %)

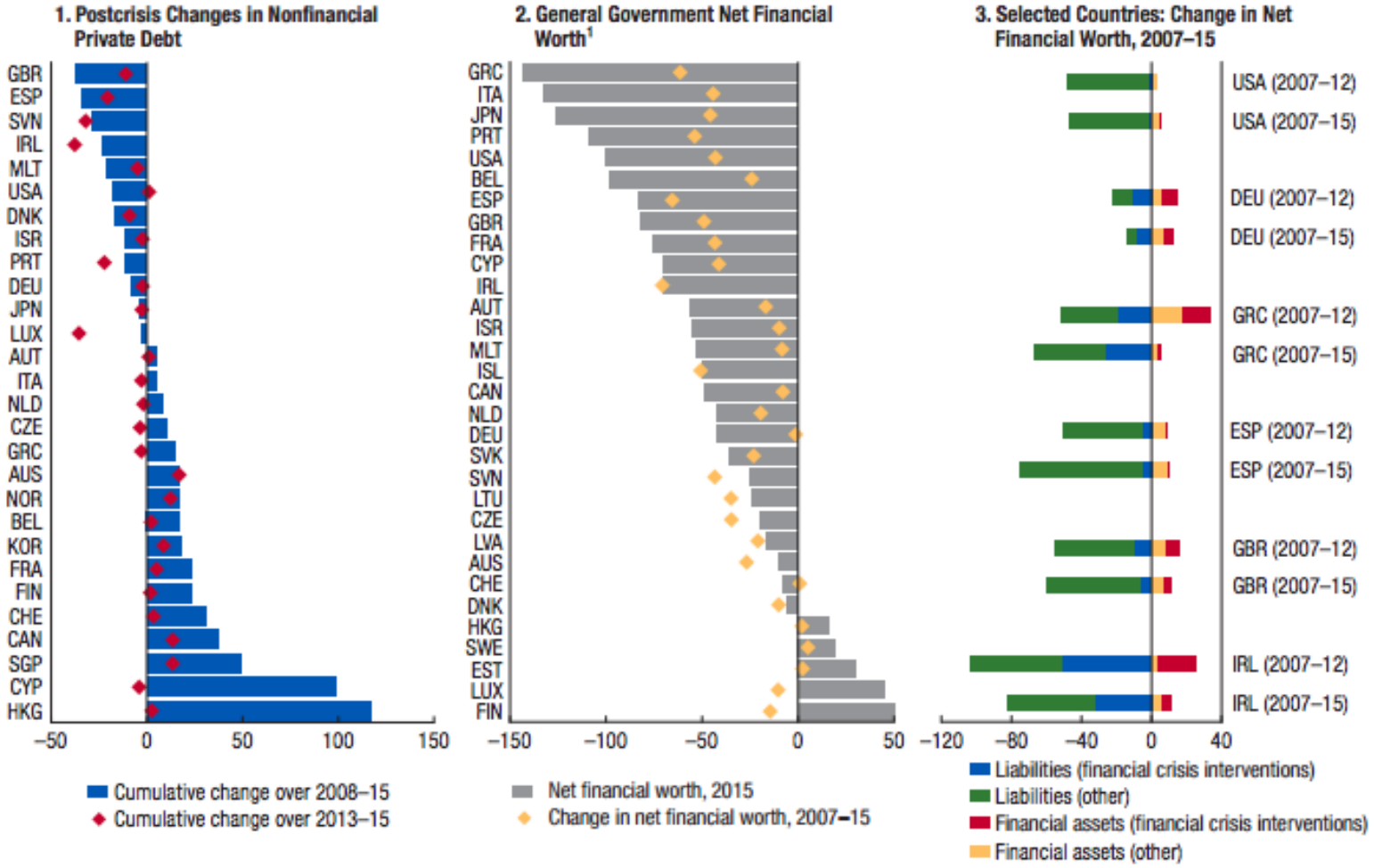

2 °C
Quota total 3.670
No CO_2 770
Combustibles fòssils històrics 1.465
F14
SYR
Usos del sòl històrics 533
Quantitat restant 903 Gt CO_2
Usos del sòl en el futur 138
Combustibles fòssils en el futur 765
Emissions acumulatives (Gt CO_2)
4.000
3.500
3.000
2.500
2.000
1.500
1.000
500
0



*Part of the electricity is used to produced hydrogen, which is subsequently used for backup power generation and in the industry and transport sectors. The electricity generation from hydrogen is not visualized in the figure above.

Figure 9. Projected global electricity demand developments in our decarbonisation scenario

Figure 1.4. Advanced Economies: Debt Developments
(Percent of GDP)



Sources: Bank for International Settlements; Dealogic; Eurostat; IMF, *Government Finance Statistics*; IMF, *International Financial Statistics*; IMF, Standardized Reporting Forms; IMF, *World Economic Outlook*; Organisation for Economic Co-operation and Development; and IMF staff estimates.
Note: Data labels in the figure use International Organization for Standardization (ISO) country codes.
[1]Data are from 2007 to latest available. For Switzerland, latest available data are for 2013. For Hong Kong Special Administrative Region, Iceland, Israel, and Japan, latest available data are for 2014. For all others, data are for 2015.

Net financial worth is any asset owned minus any debt owed. Net worth can be a negative number if one's debt owed is greater than the value of the assets owned

General government gross debt (Percent of GDP, 2018)

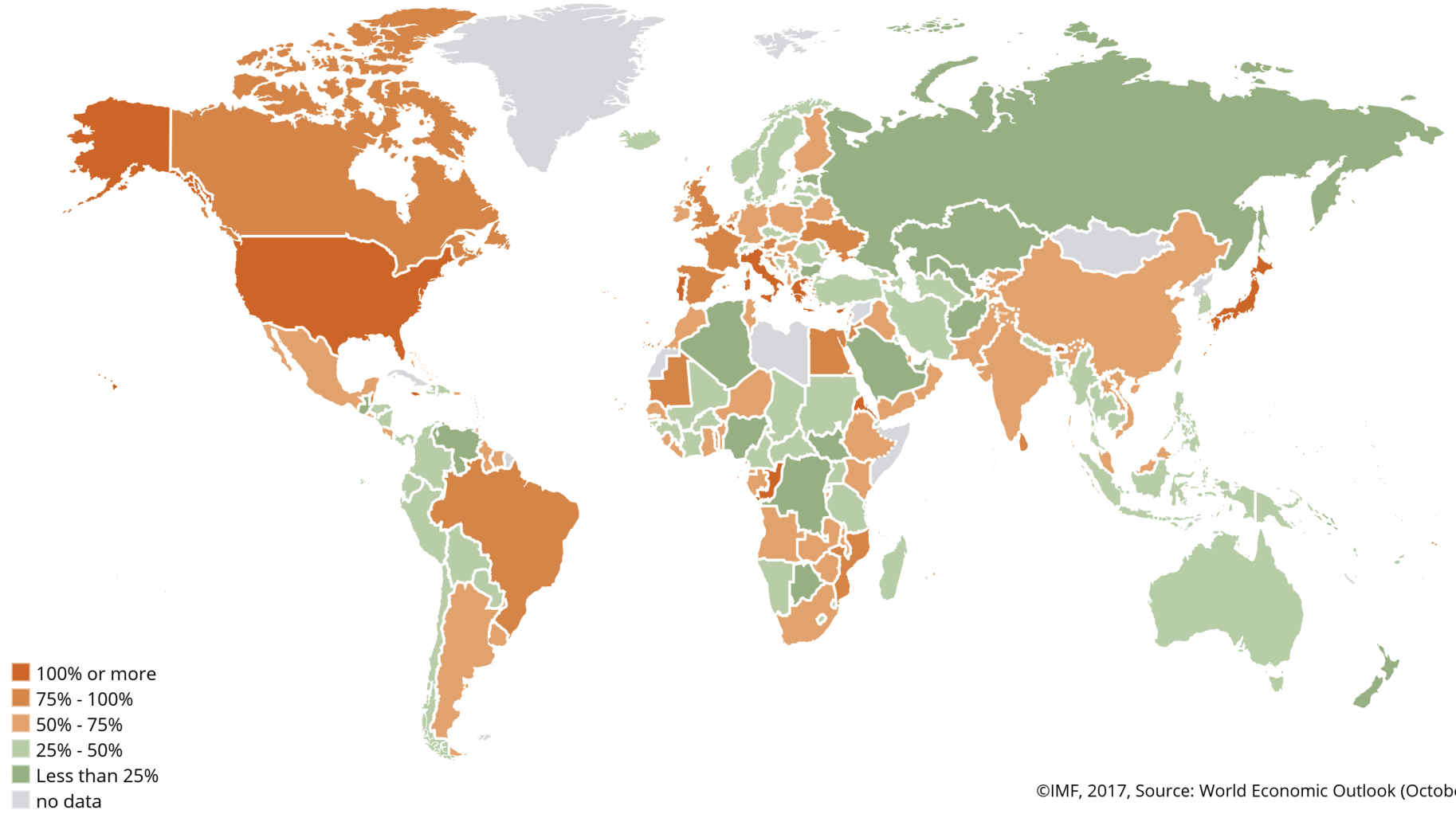
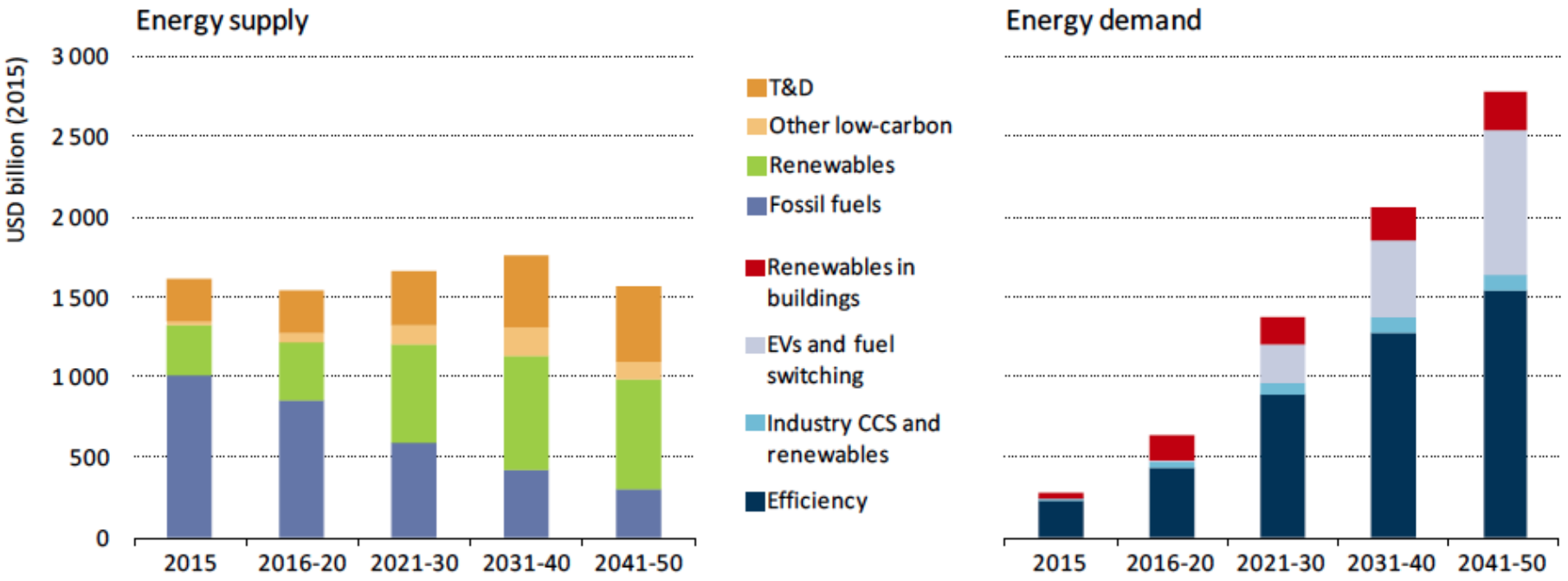
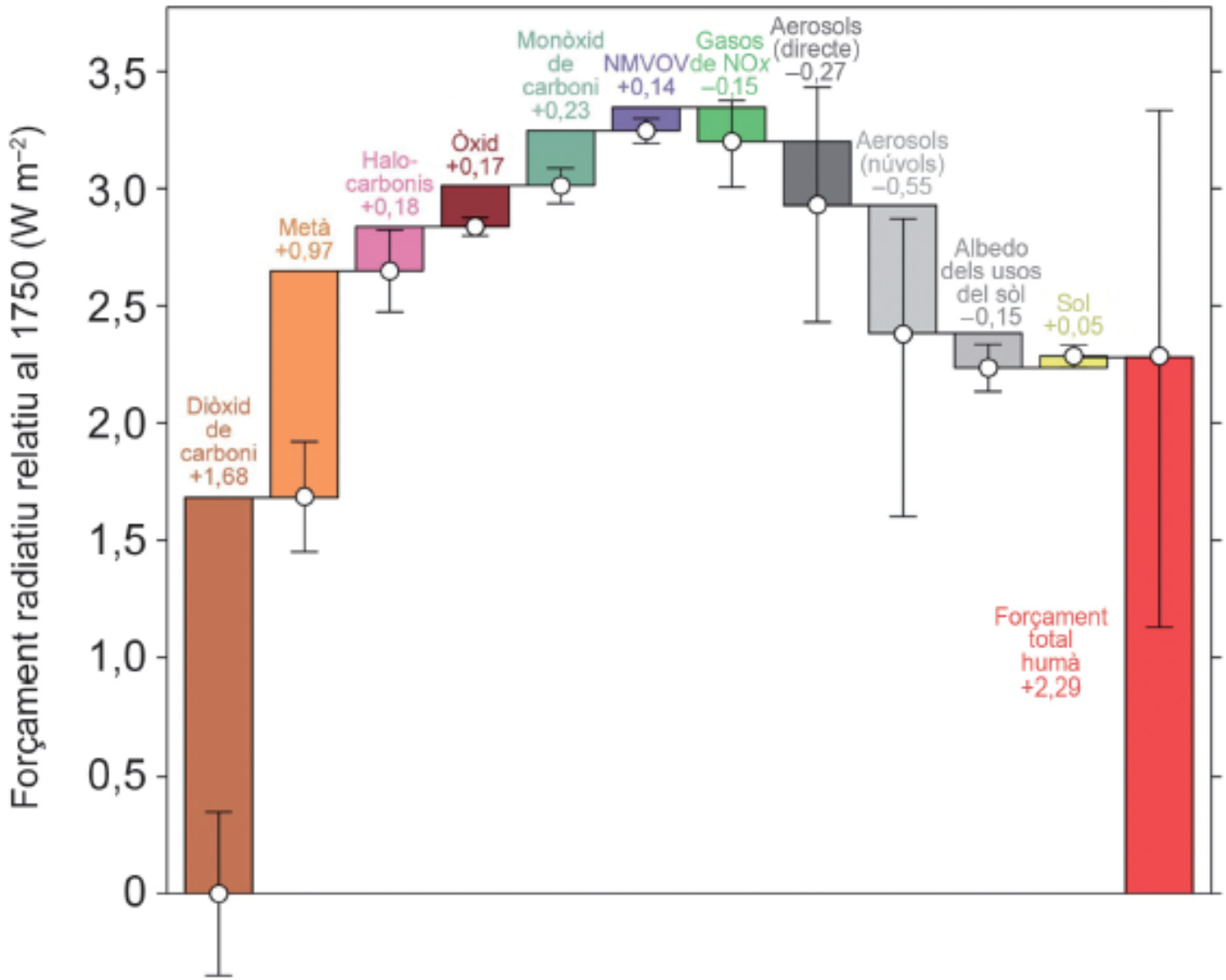


Figure ES.2 • Average annual global energy supply- and demand-side investment in the 66% 2°C Scenario



Note: T&D = transmission and distribution; EVs = electric vehicles; CCS = carbon capture and storage.

Key message • The level of supply-side investment remains broadly constant, but shifts away from fossil fuels. Demand-side investment in efficiency and low-carbon technologies ramps up to almost USD 3 trillion in the 2040s.


Forçament radiatiu relatiu al 1750 (W m⁻²)
3,5
3,0
2,5
2,0
1,5
1,0
0,5
0
Diòxid de carboni +1,68
Metà +0,97
Halo-carbonis +0,18
Òxid +0,17
Monòxid de carboni +0,23
NMVOV +0,14
Gasos de NOx –0,15
Aerosols (directe) –0,27
Aerosols (núvols) –0,55
Albedo dels usos del sòl –0,15
Sol +0,05
Forçament total humà +2,29

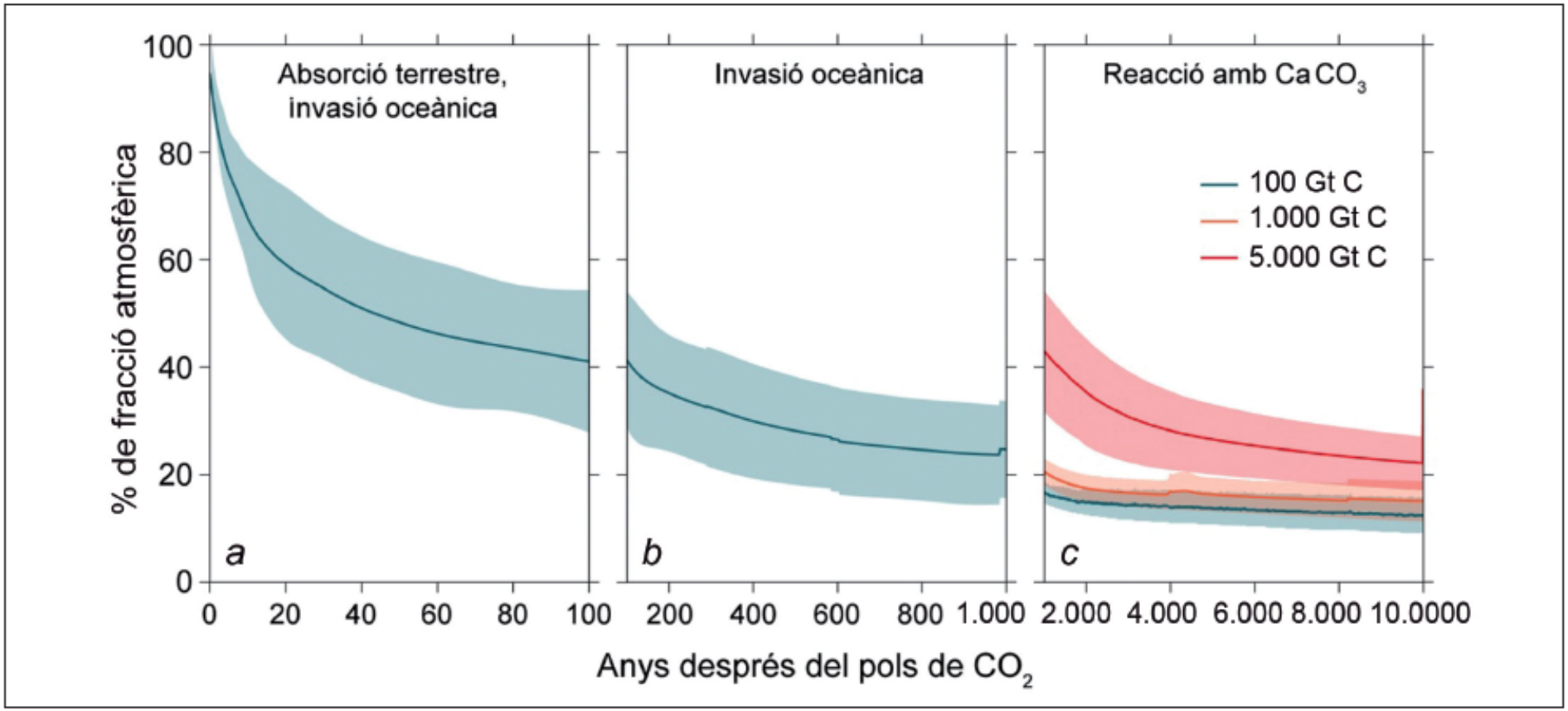


FIGURA 1.4. Permanència del CO_2 emès a l'atmosfera després d'una emissió massiva puntual d'acord amb models biogeoquímics (Ciais *et al.*, 2013).

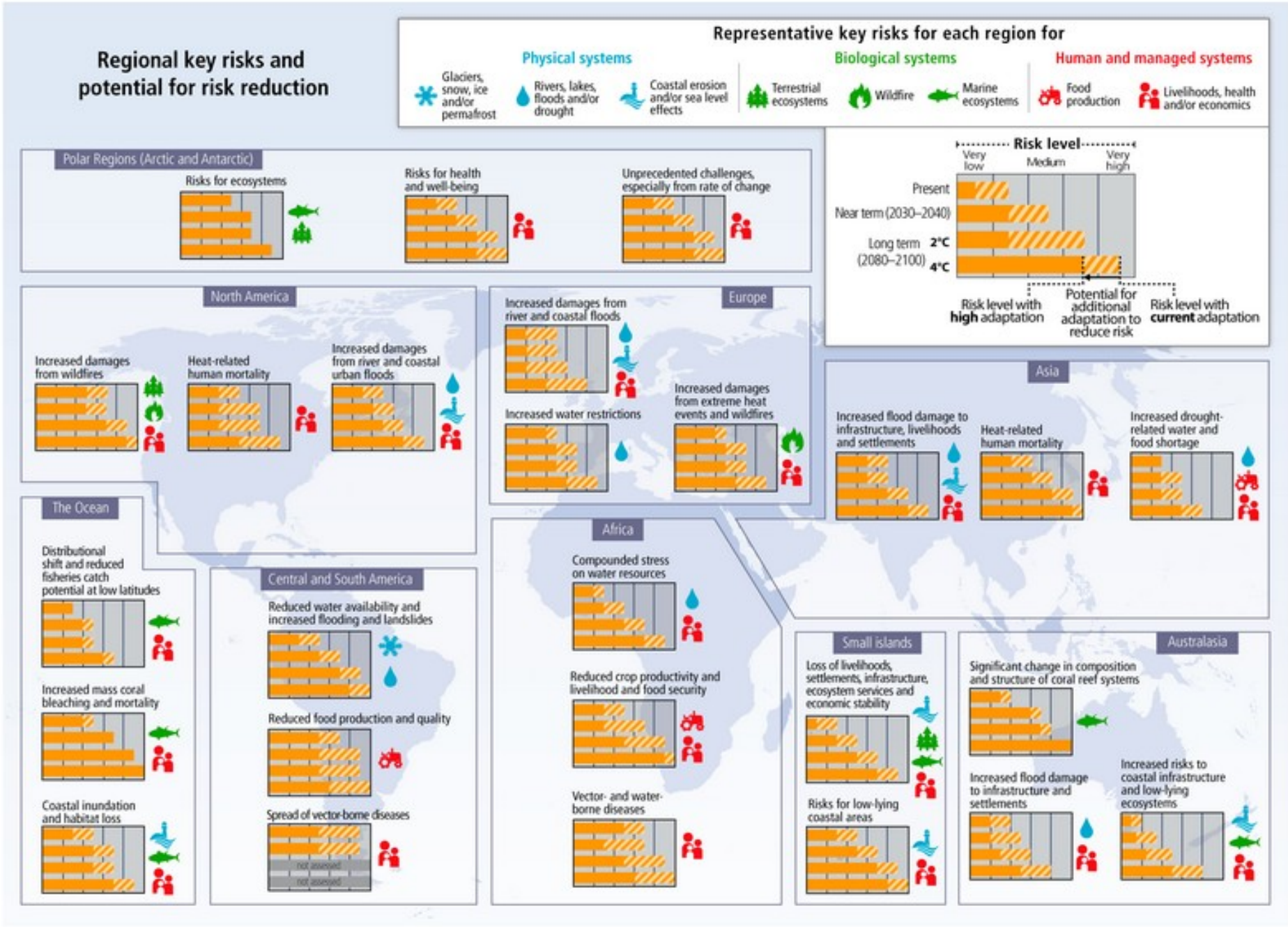

Regional key risks and potential for risk reduction
Representative key risks for each region for
Physical systems
Glaciers, snow, ice and/or permafrost
Rivers, lakes, floods and/or drought
Coastal erosion and/or sea level effects
Biological systems
Terrestrial ecosystems
Wildfire
Marine ecosystems
Human and managed systems
Food production
Livelihoods, health and/or economics
Polar Regions (Arctic and Antarctic)
Risks for ecosystems
Risks for health and well-being
Unprecedented challenges, especially from rate of change
Risk level
Very low
Medium
Very high
Present
Near term (2030–2040)
Long term (2080–2100)
2°C
4°C
Risk level with high adaptation
Potential for additional adaptation to reduce risk
Risk level with current adaptation
North America
Increased damages from wildfires
Heat-related human mortality
Increased damages from river and coastal urban floods
Europe
Increased damages from river and coastal floods
Increased water restrictions
Increased damages from extreme heat events and wildfires
Asia
Increased flood damage to infrastructure, livelihoods and settlements
Heat-related human mortality
Increased drought-related water and food shortage
The Ocean
Distributional shift and reduced fisheries catch potential at low latitudes
Increased mass coral bleaching and mortality
Coastal inundation and habitat loss
Central and South America
Reduced water availability and increased flooding and landslides
Reduced food production and quality
Spread of vector-borne diseases
not assessed
not assessed
Africa
Compounded stress on water resources
Reduced crop productivity and livelihood and food security
Vector- and water-borne diseases
Small islands
Loss of livelihoods, settlements, infrastructure, ecosystem services and economic stability
Risks for low-lying coastal areas
Australasia
Significant change in composition and structure of coral reef systems
Increased flood damage to infrastructure and settlements
Increased risks to coastal infrastructure and low-lying ecosystems

Figure 2.4

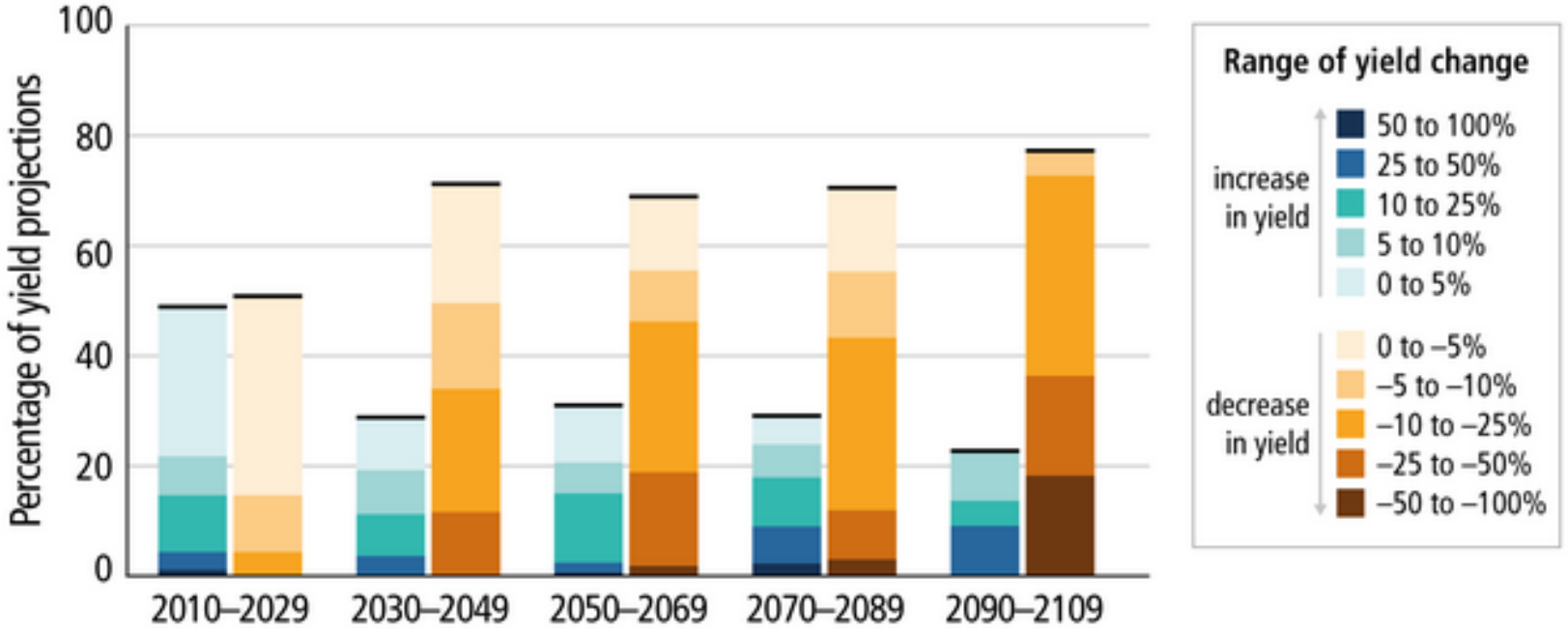


Figure 2.7 I Summary of projected changes in crop yields (mostly wheat, maize, rice, and soy) due to climate change over the 21st century. The figure combines 1090 data points from crop model projections, covering different emission scenarios, tropical and temperate regions, and adaptation and no-adaptation cases. The projections are sorted into the 20-year periods (horizontal axis) during which their midpoint occurs. Changes in crop yields are relative to late 20th century levels, and data for each time period sum to 100%. Relatively few studies have considered impacts on cropping systems for scenarios where global mean temperatures increase by 4°C or more. *{WGII Figure SPM.7}*

(a)

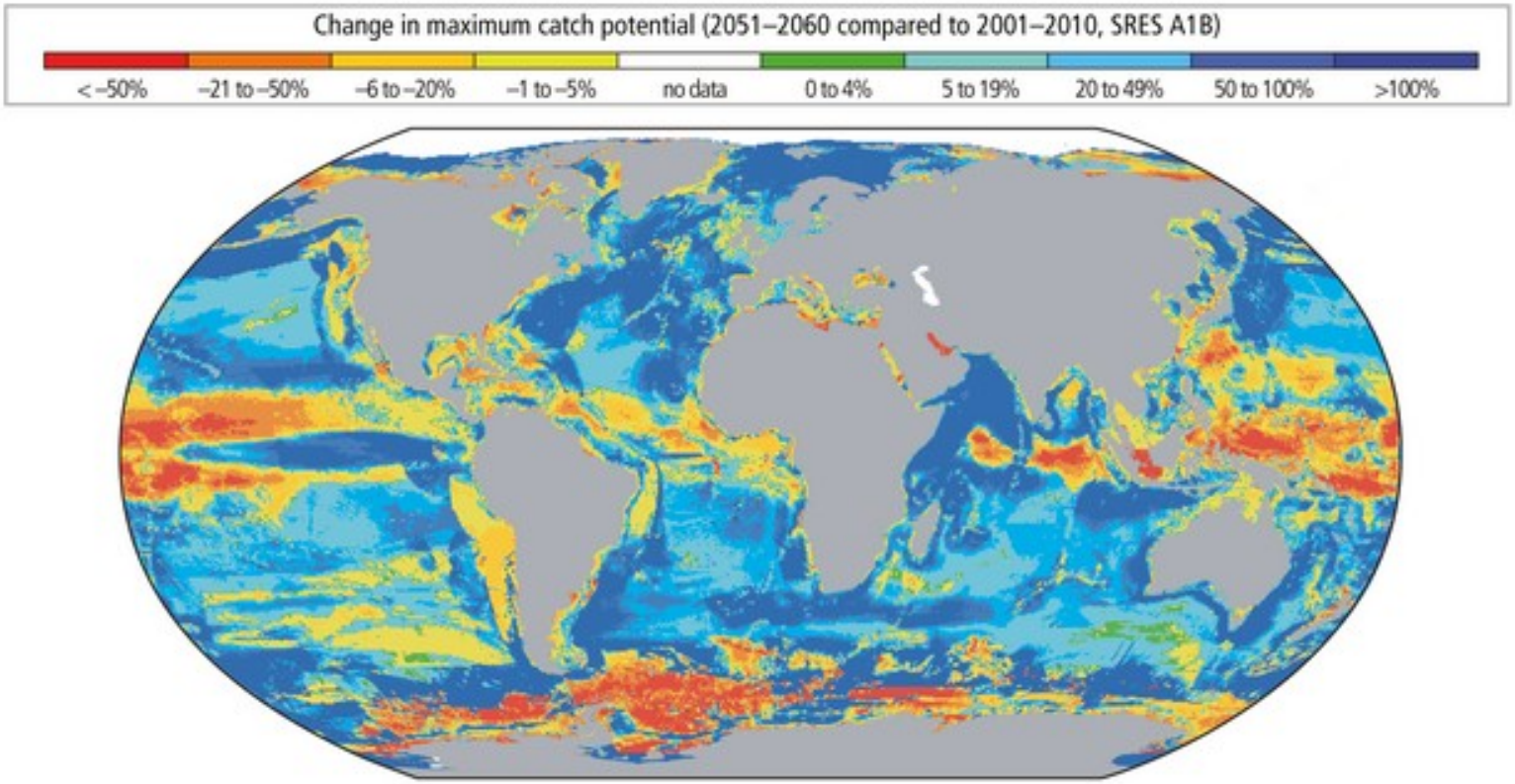
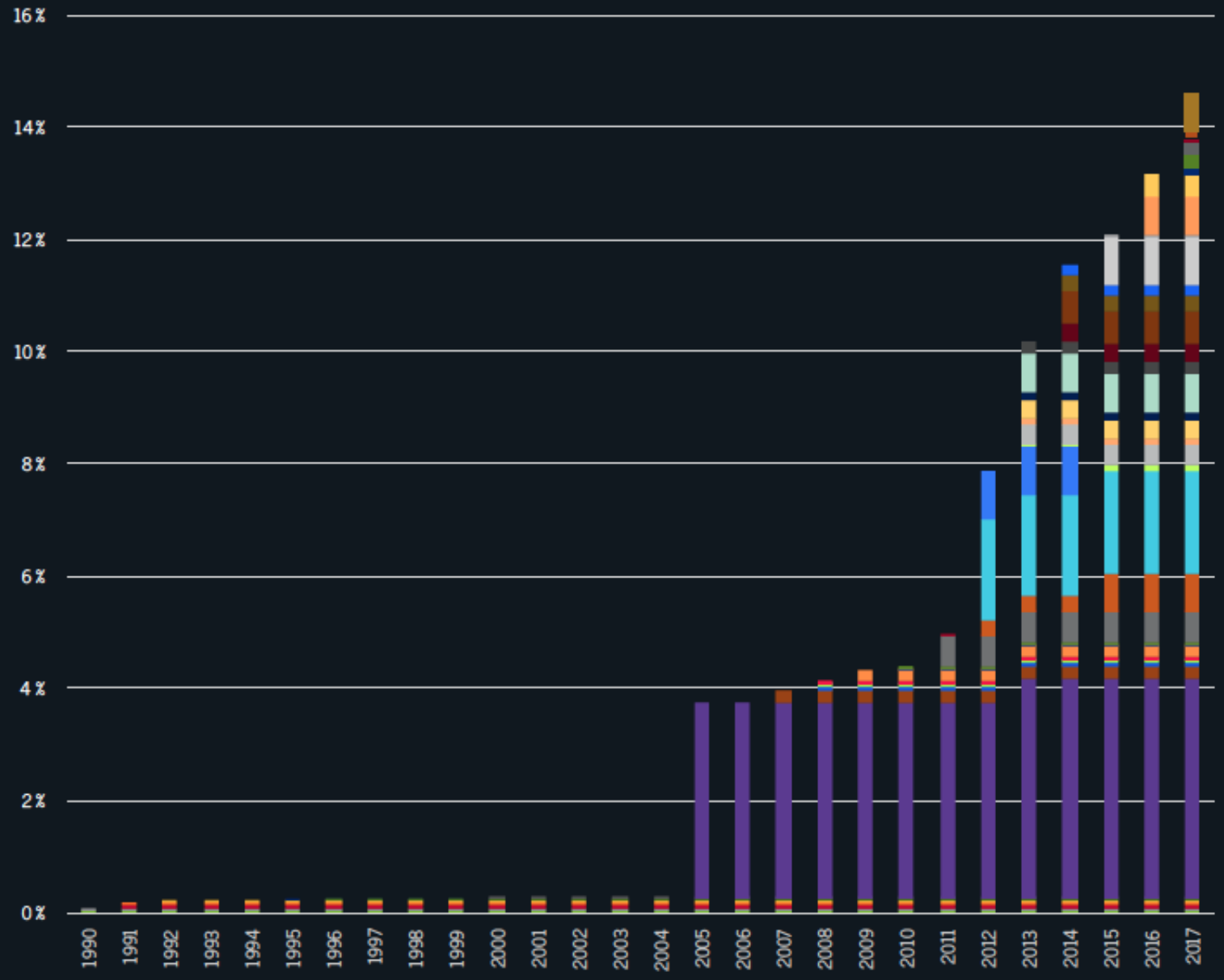

Change in maximum catch potential (2051–2060 compared to 2001–2010, SRES A1B)
< –50%
–21 to –50%
–6 to –20%
–1 to –5%
no data
0 to 4%
5 to 19%
20 to 49%
50 to 100%
>100%

Figure 4: Regional, National, and Subnational Carbon-Pricing Initiatives—Share of Global GHG Emissions Covered



Reaccions institucionals a l'Acord de Paris

Institucions Europees. Parlament europeu. Comissió Europea

Activitat recent del Parlament Europeu
Estrategies climàtiques 2020 i 2030
Sistema de Comerç d'Emissions Europeu (EU ETS)

Ministeri de la Transició Energètica (Espanya)

Llei de canvi climàtic i transició energètica (2018-2019)
Pla Nacional Integrat d'Energia i Clima (2018- 2019)
Derogació de l'Impost al sol

Reaccions institucionals recents a l'Acord de Paris.

Institucions Europees. Parlament europeu.

Gener 2018.

L'Eurocambra aposta per elevar al **35%** l'objectiu d'energies renovables a la UE el 2030.

Impostos al sol. Eurocambra aprova una esmena per permetre el consum d'electricitat de fonts renovables de producció pròpia i que roman dins dels seus locals "sense estar subjectes a impostos, taxes tributs de cap tipus "

Electrificació transport. El 90% de les gasolineres a les carreteres dintre de les xarxes transeuropees hauran d'estar equipades amb punts de recàrrega per a vehicles elèctrics al final de 2022

Reaccions institucionals a l'Acord de Paris.

Institucions Europees.
Parlament europeu. Comissió Europea

Estrategies climàtiques 2020 i 2030

Sistema de Comerç d'Emissions Europeu (EU ETS)

Climate strategies & targets

The EU has set itself targets for reducing its greenhouse gas emissions progressively up to 2050.

Key climate and energy targets are set in the:

- 2020 climate and energy package
- 2030 climate and energy framework

These targets are defined to put the EU on the way to achieve the transformation towards a low-carbon economy as detailed in the 2050 low-carbon roadmap.

The EU tracks its progress on cutting emissions through regular monitoring and reporting.

Before proposing new policies, the Commission carefully assesses their potential impacts.

2020 climate & energy package

The 2020 package is a set of binding legislation to ensure the EU meets its climate and energy targets for the year 2020.

The package sets three key targets:

- 20**%** cut in **greenhouse gas** emissions (from 1990 levels)
- 20% of EU energy from **renewables**
- 20% improvement in **energy efficiency**

The targets were set by EU leaders in 2007 and enacted in legislation in 2009. They are also headline targets of the Europe 2020 strategy for smart, sustainable and inclusive growth.

The EU is taking action in several areas to meet the targets.

2030 climate & energy framework

Policy | Documentation

The 2030 climate and energy framework sets three key targets for the year 2030:

- At least 40% cuts in **greenhouse gas emissions** (from 1990 levels)
- At least 27% share for **renewable energy**
- At least 27% improvement in **energy efficiency**

The framework was adopted by EU leaders in October 2014. It builds on the 2020 climate and energy package.

It is also in line with the longer term perspective set out in the Roadmap for moving to a competitive low carbon economy in 2050, the Energy Roadmap 2050 and the Transport White Paper.

Emissions trading system (ETS)

The EU emissions trading system is the EU's **key tool** for cutting greenhouse gas emissions from large-scale facilities in the power and industry sectors, as well as the aviation sector.

The ETS covers around **45% of the EU's greenhouse gas emissions**.

In 2020, the target is for the emissions from these sectors to be **21% lower** than in 2005.

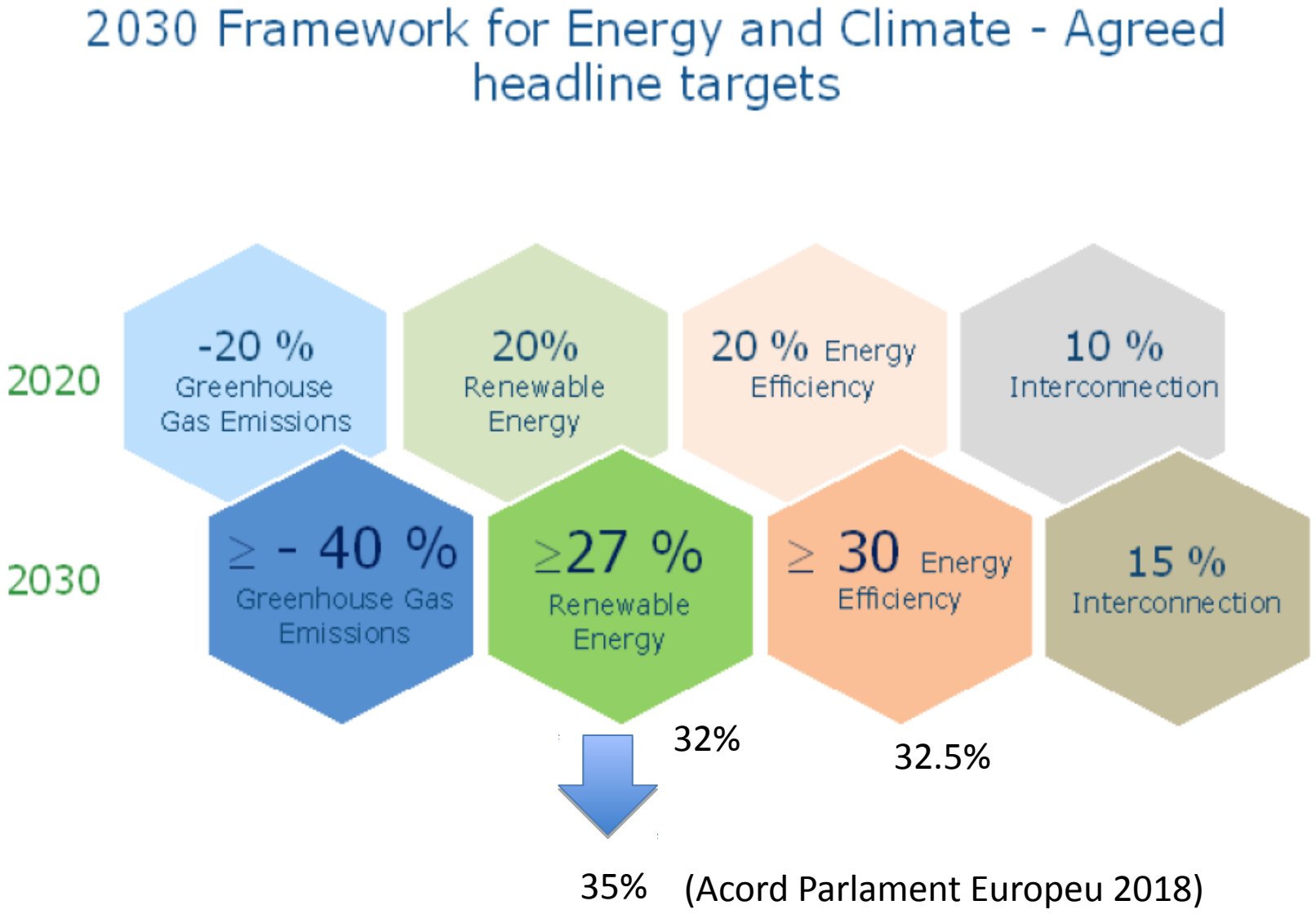
National emission reduction targets

This covers the **sectors not in the ETS** – accounting for some **55% of total EU emissions** – such as:

- housing
- agriculture
- waste
- transport (excluding aviation).

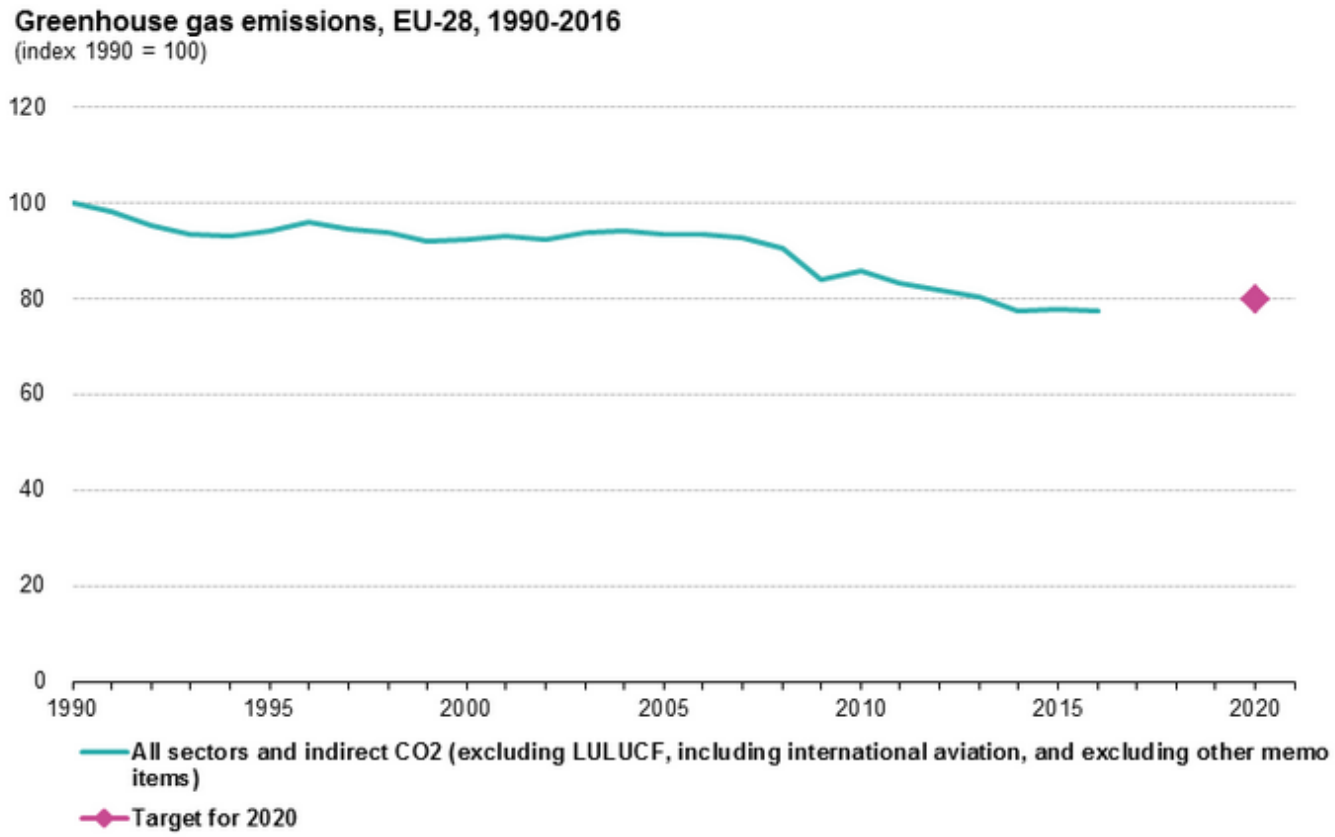
EU countries have taken on binding annual targets until 2020 for cutting emissions in these sectors (compared to 2005), under the "Effort-sharing decision".

Acord de Paris. **Institucions Europees. Parlament europeu. Comissió Europea**



File:Greenhouse gas emissions, EU-28, 1990-2016 (index 1990 = 100).png

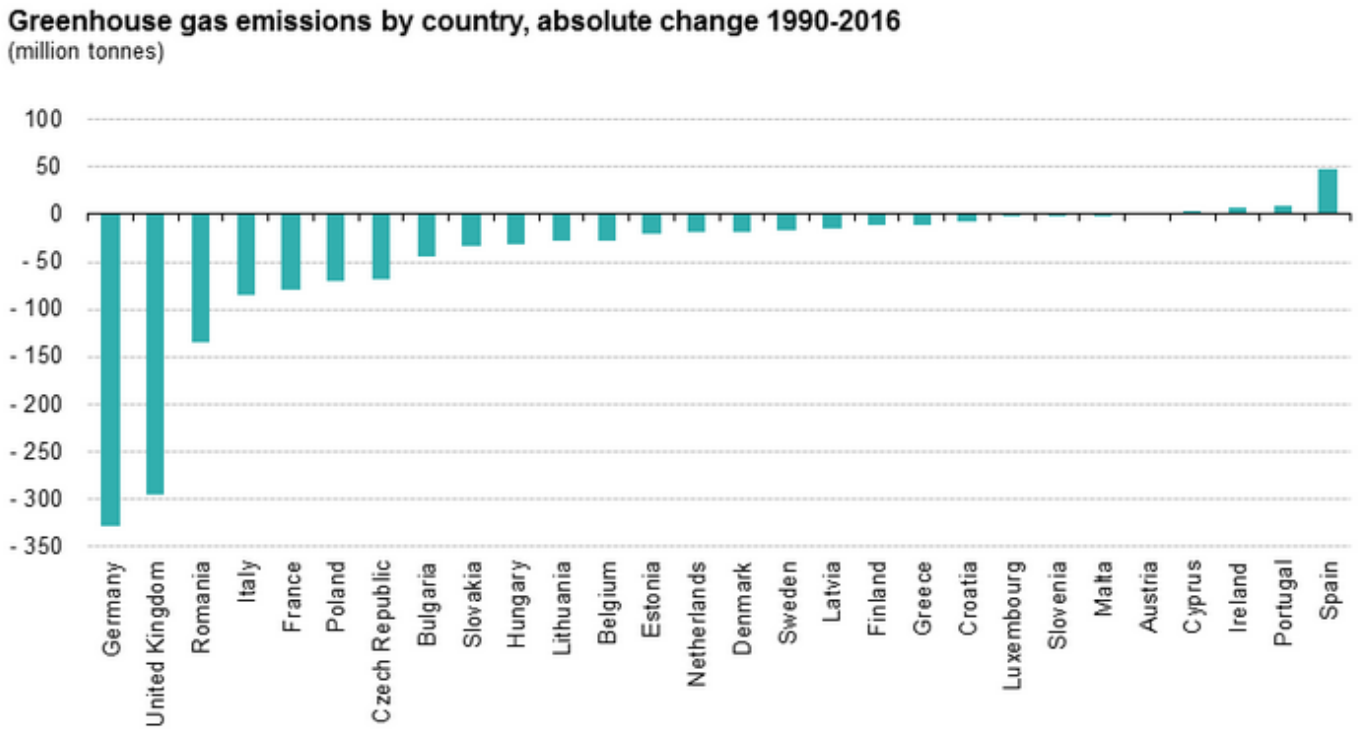
File File history File usage



Trends in Europe.
20-**20**-20 objective

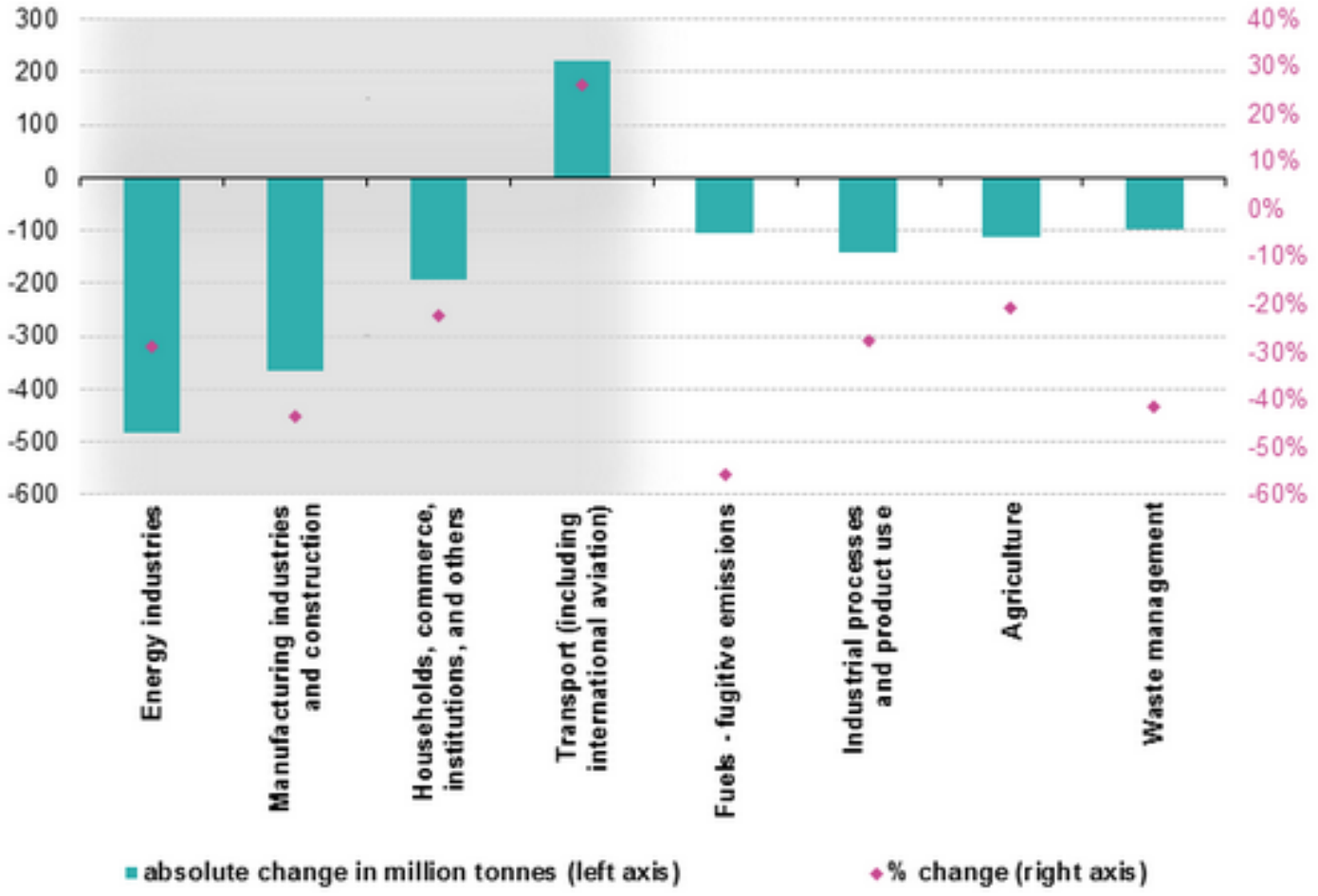
File:Greenhouse gas emissions by country, absolute change 1990-2016 (million tonnes).png

File File history File usage



Trends in Europe.
20-**20**-20 objective

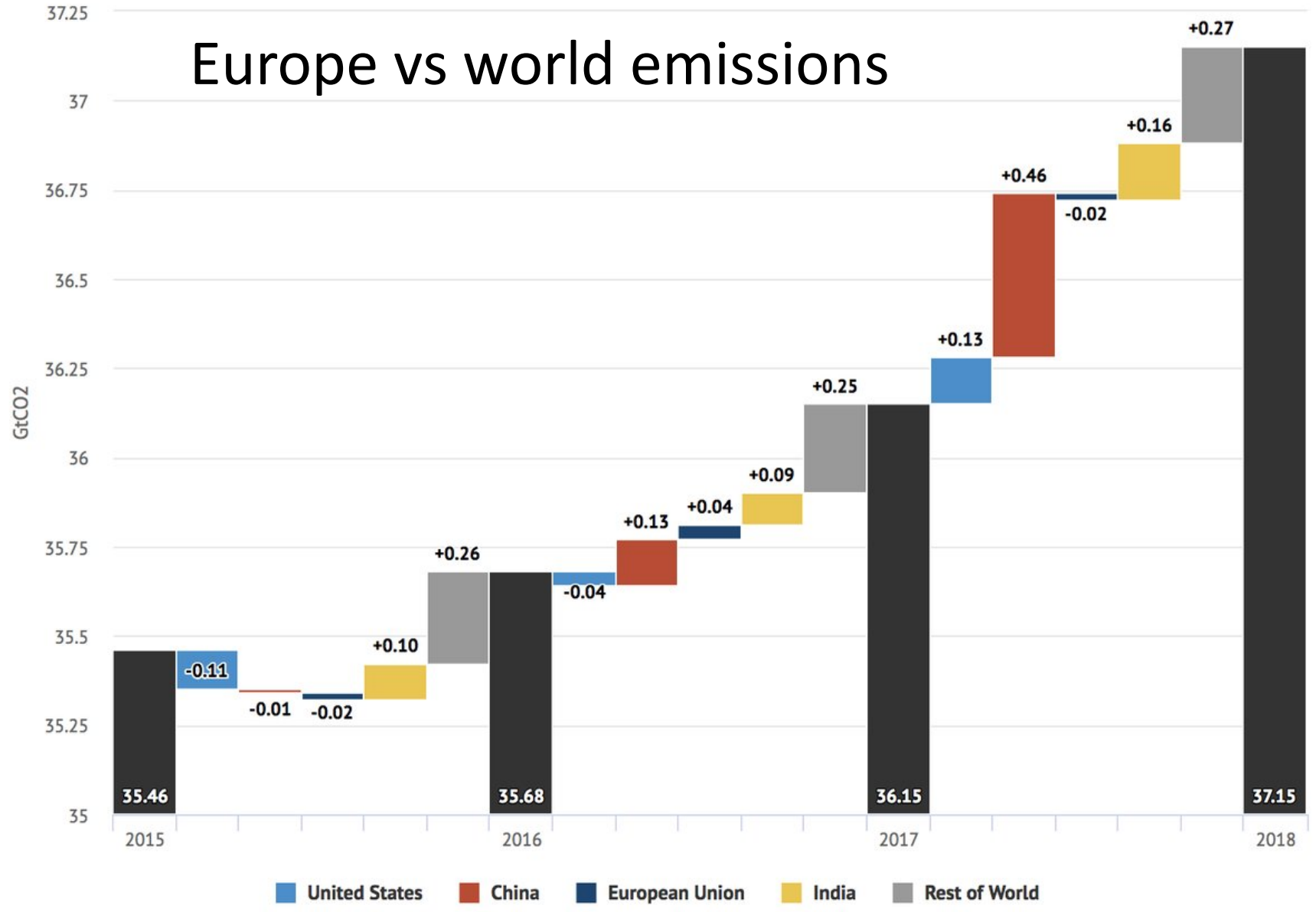
Greenhouse gas emissions by IPCC source sector, EU-28, change from 1990 to 2016
(million tonnes of CO2 equivalent and % change)



Note: fuel combustion as a source of GHG emissions is indicated by the grey background shading
Source: EEA, republished by Eurostat (online data code: env_air_gge)

Trends in Europe.
20-**20**-20 objective

Europe vs world emissions



Acord de Paris. Institucions Europees. Parlament europeu. Comissió Europea

Trends in Europe. 20-**20**-20 objective

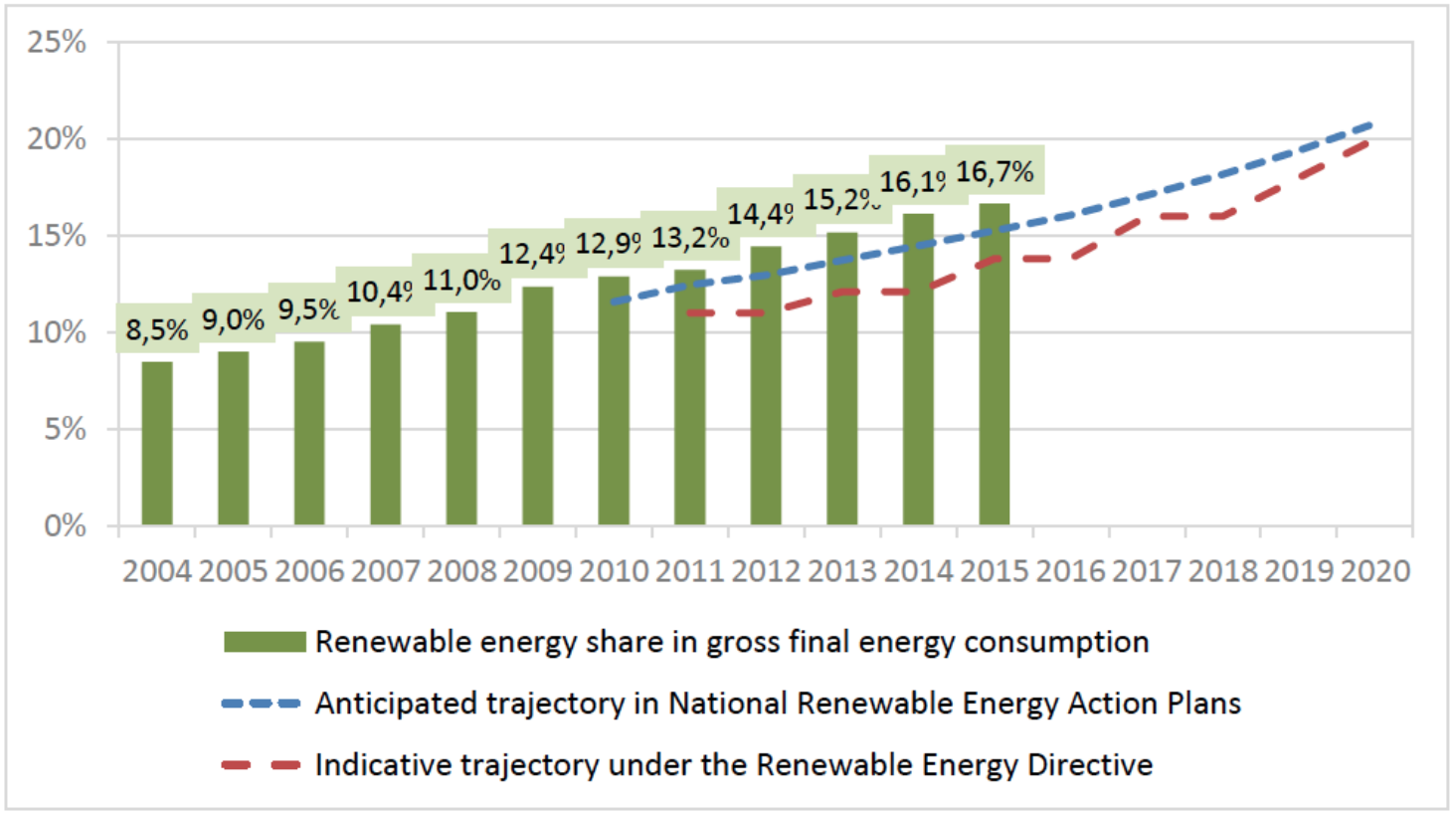


Figure 1: Renewable energy shares in EU gross final energy consumption vs. Renewable Energy Directive and National Renewable Energy Action Plan trajectories

Summary

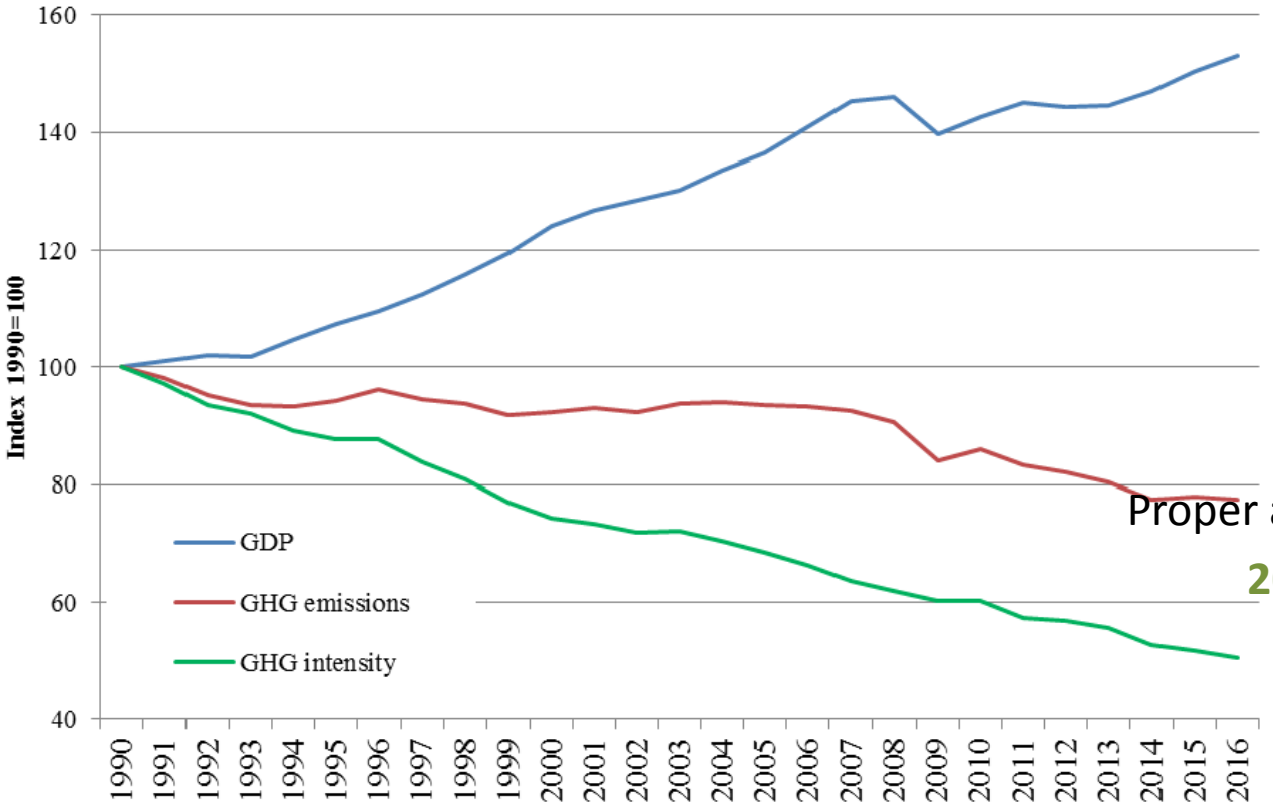
Trends in Europe. 20-**20**-20 objective

The overall development of total GHG emissions is clearly on the right path; in 2016 total GHG emissions equalled 4.4 billion tonnes of CO2-equivalent compared with 5.7 billion tonnes in 1990**, a decrease of 1.3 billion tonnes, or 22 %.**

EU is well on track to reduce its GHG emissions and has **already surpassed its target of a reduction by 20 %** that was set for 2020. However, the EU's **ambitious target for 2030, a reduction of GHG emissions by at least 40 % compared with 1990 levels**, implies that this downward trend has to be maintained and even reinforced.

A continuous decrease of GHG emissions should not be taken for granted can be seen from the recent developments in the trend, **with GHG emissions increasing slightly from 2014 to 2015**.

Reducció del consum d'energia en relació a la unitat de PIB (GDP)



Trends in Europe. 20-**20**-20 objective

Proper a l'objectiu **20**-20-20

Figure 2: Changes in EU GDP (in real terms), EU greenhouse gas (GHG) emissions, and EU GHG emissions intensity of the economy (ratio between emissions and GDP) Index (1990 = 100)

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Institucions Europees. Parlament europeu. Comissió Europea.

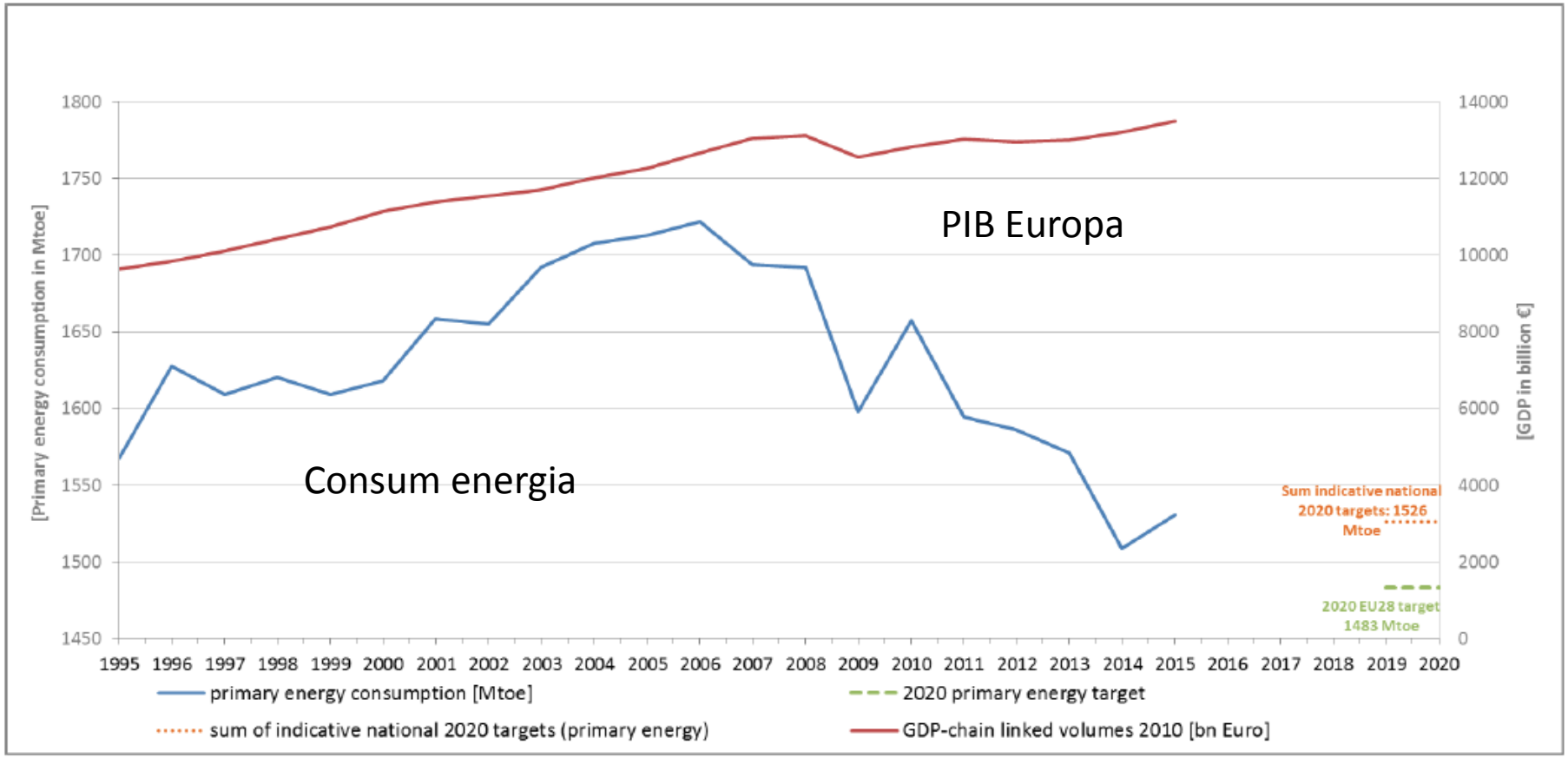


Figure 3: Evolution of GDP and primary energy consumption in the EU 28. Source: Eurostat

Trends in Catalonia 20-**20**-20 objective

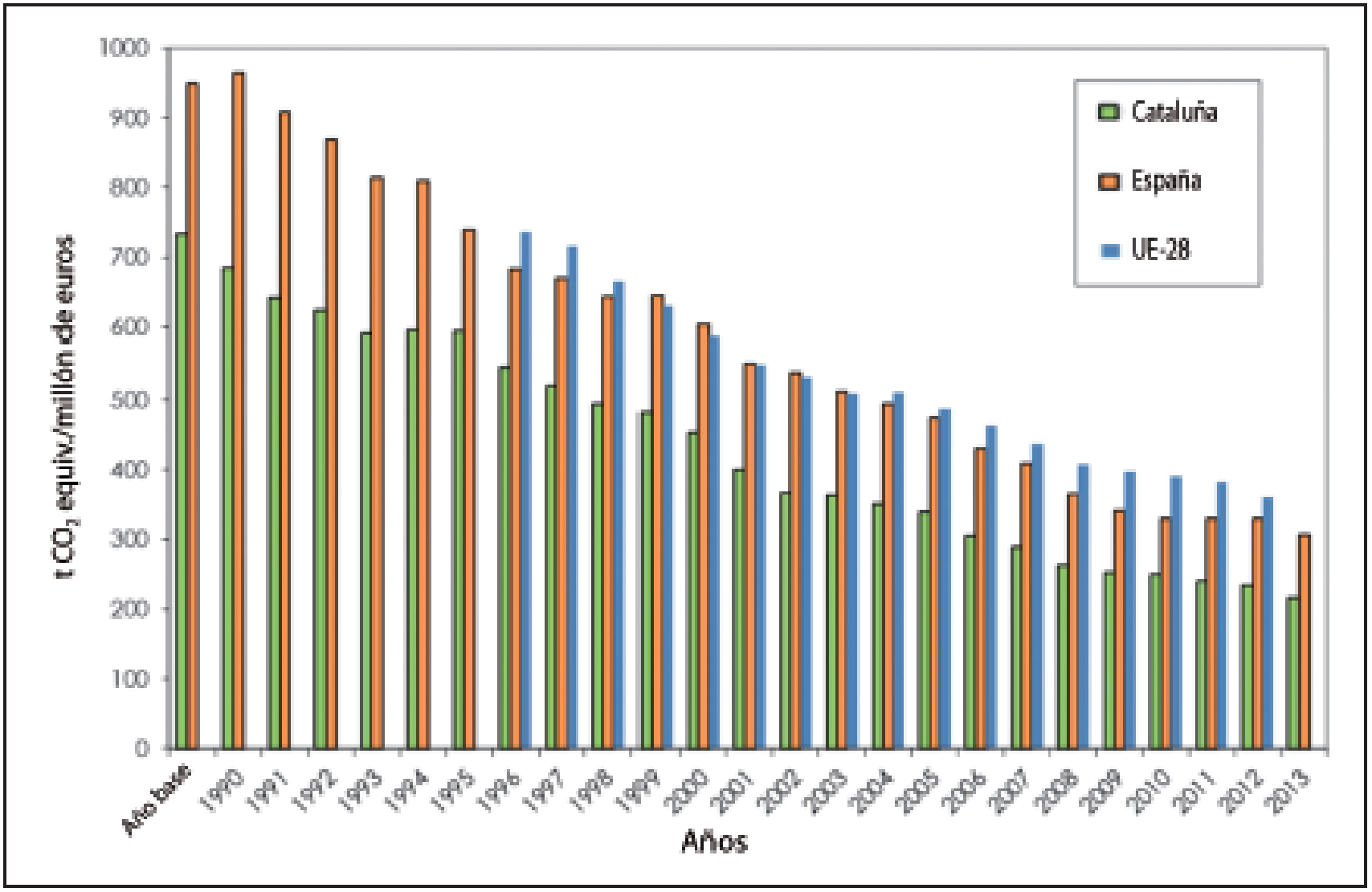


Figura 5. Evolución de la relación entre las emisiones de GEI y el PIB para Cataluña, España y Europa para el periodo 1990-2012.

Fuente: INE, Idescat y Eurostat.

Reaccions institucionals a l'Acord de París.

Ministeri de la Transició Energètica (Espanya)

Tendències recents en les emissions de CO_2

Llei de canvi climàtic i transició energètica (2018-2019)

Plà Nacional Integrat d'Energia i Clima (2018- 2019)

Derogació de l'Impost al sol

Reaccions als acords de París. El cas d'Espanya.

Tendències recents en les emissions de CO_2

Reducció d'emissions (dades recents):

A Espanya tenim un **17% més d'emissions que el 1990 (289 millons** de tones de CO_2 equivalent)

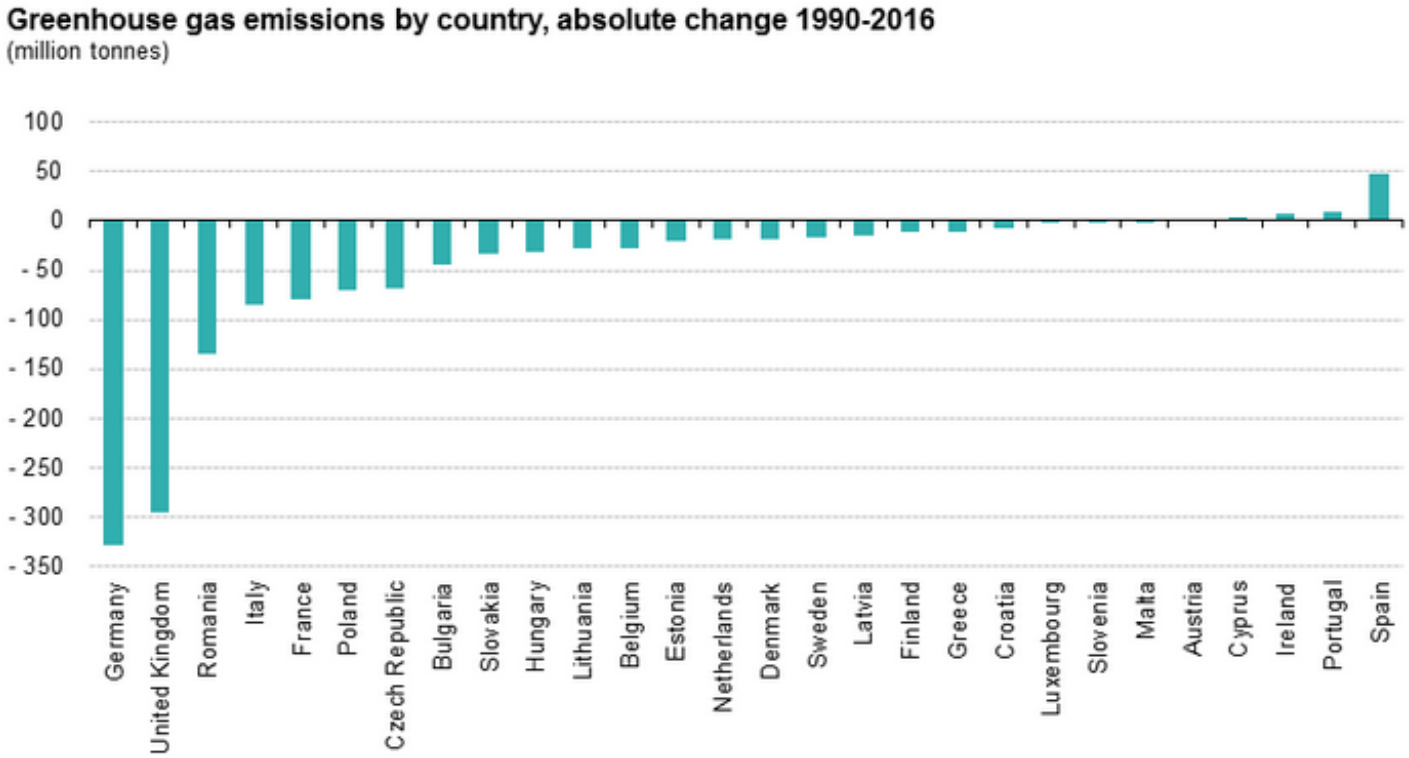
2017. Segons l'Inventari Espanyol d'Emissions de Gasos d'Efecte Hivernacle les emissions van arribar a les **338.800.000** de tones de CO_2 equivalent.

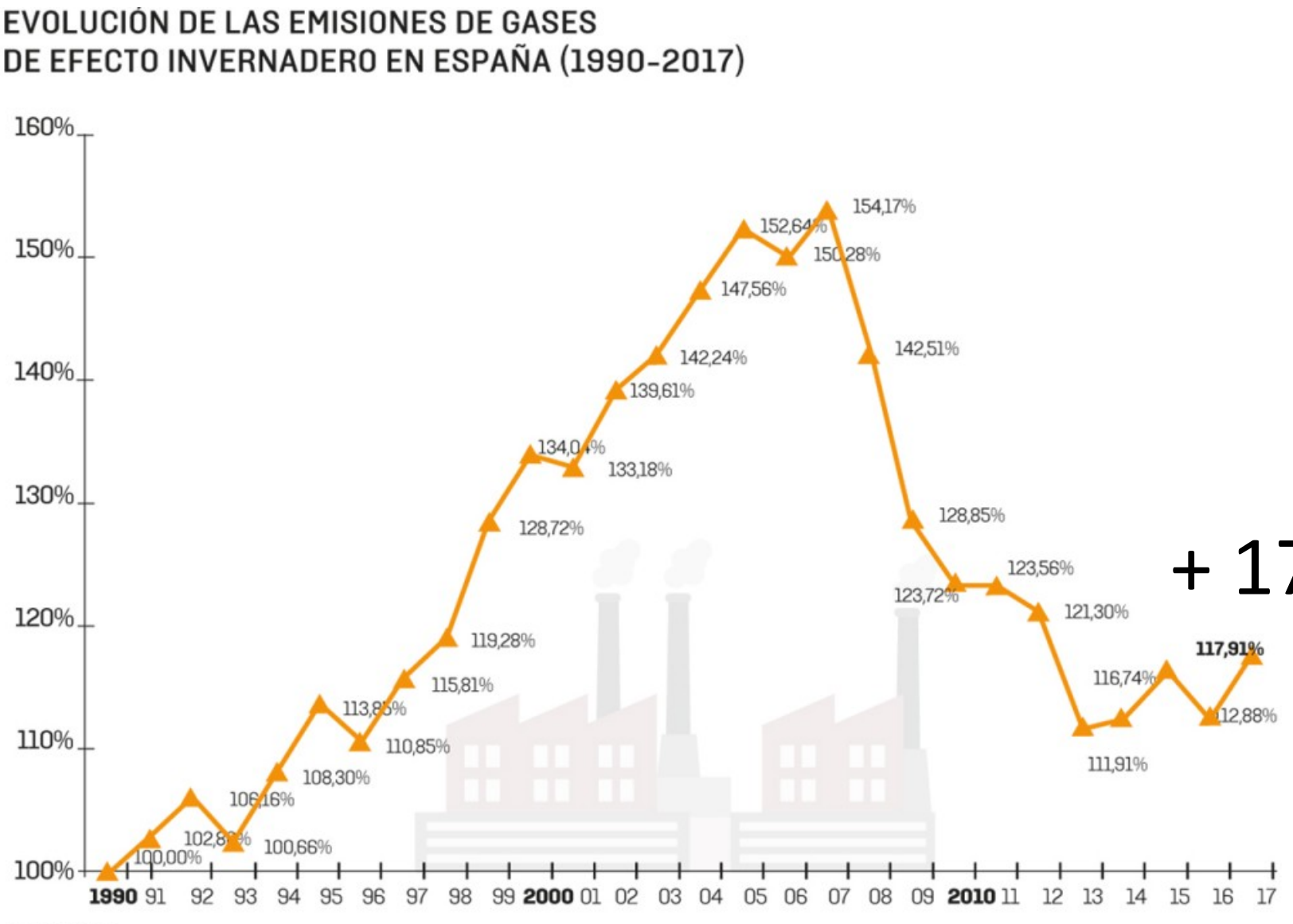
Suposa un **augment d'un 4,4%** respecte a l'any 2016.

Es tracta del major augment interanual des de 2002.

File:Greenhouse gas emissions by country, absolute change 1990-2016 (million tonnes).png

File File history File usage





+ 17%

289 millons t.e. CO2

339

Reaccions als acords de París. El cas d'Espanya.

Ministeri per a la Transició Ecològica (2018-2019)

Accions prioritàries:

I. **Llei de canvi climàtic y transició energètica**

II. **"Plan nacional integrado de energía y clima"**

III. **Derogació de l'impost al sol**

Desembre 2018- 2019…

Presentado el nuevo Plan Nacional Integrado de Energía y Clima

Febrer 2019

El presidente del Gobierno, Pedro Sánchez, ha sido el encargado de presentar, junto a la ministra Teresa Ribera, el paquete de Energía y Clima.

Este miércoles, **20 de febrero**, el **presidente del Gobierno**, Pedro Sánchez, y la **ministra para la Transición Ecológica**, Teresa Ribera, han **presentado el "paquete de clima"**, que incluye el **Plan Nacional Integrado de Energía y Clima** (PNIEC), la **Ley de Cambio Climático y Transición Energética**, y la **Estrategia para una Transición Justa**.

El PNIEC define **lo que debe hacer España hasta 2030 para alcanzar los objetivos de eficiencia energética** (32,5%) **y energías renovables** (40%) comprometidos con la Unión Europea. Es parte del denominado "paquete de clima" que incluye, además, la Ley de Cambio Climático y la Estrategia de Transición Justa. Juntos conforman la **columna vertebral de la política energética hasta 2030**. "El Plan es **un documento, por tanto, fundamental**, que pone negro sobre blanco la hoja de ruta a seguir en el próximo decenio, para llevar a cabo la transición hacia una economía baja en carbono", según explican fuentes de la Asociación de Empresas de Eficiencia Energética (A3e).

Ministeri per a la Transició Ecològica

Llei de canvi climàtic y transició energètica.

Compromisos:

El **2030** l'economia d'Espanya hauria d'emetre al voltant de 230 milions de tones de CO_2 equivalent. És a dir, cent milions tones menys que ara.

Planteja una reducció del voltant d'un **20% sobre el nivell de 1990** per al 2030, que traduït a les xifres d'avui (2018) significaria un descens d'una mica més d'un **37- 45%**

Ministeri per a la Transició Ecològica

“Plan Nacional Integrado de Energía y Clima”

Presentat a la comissió europea a desembre 2018 (fi de termini)

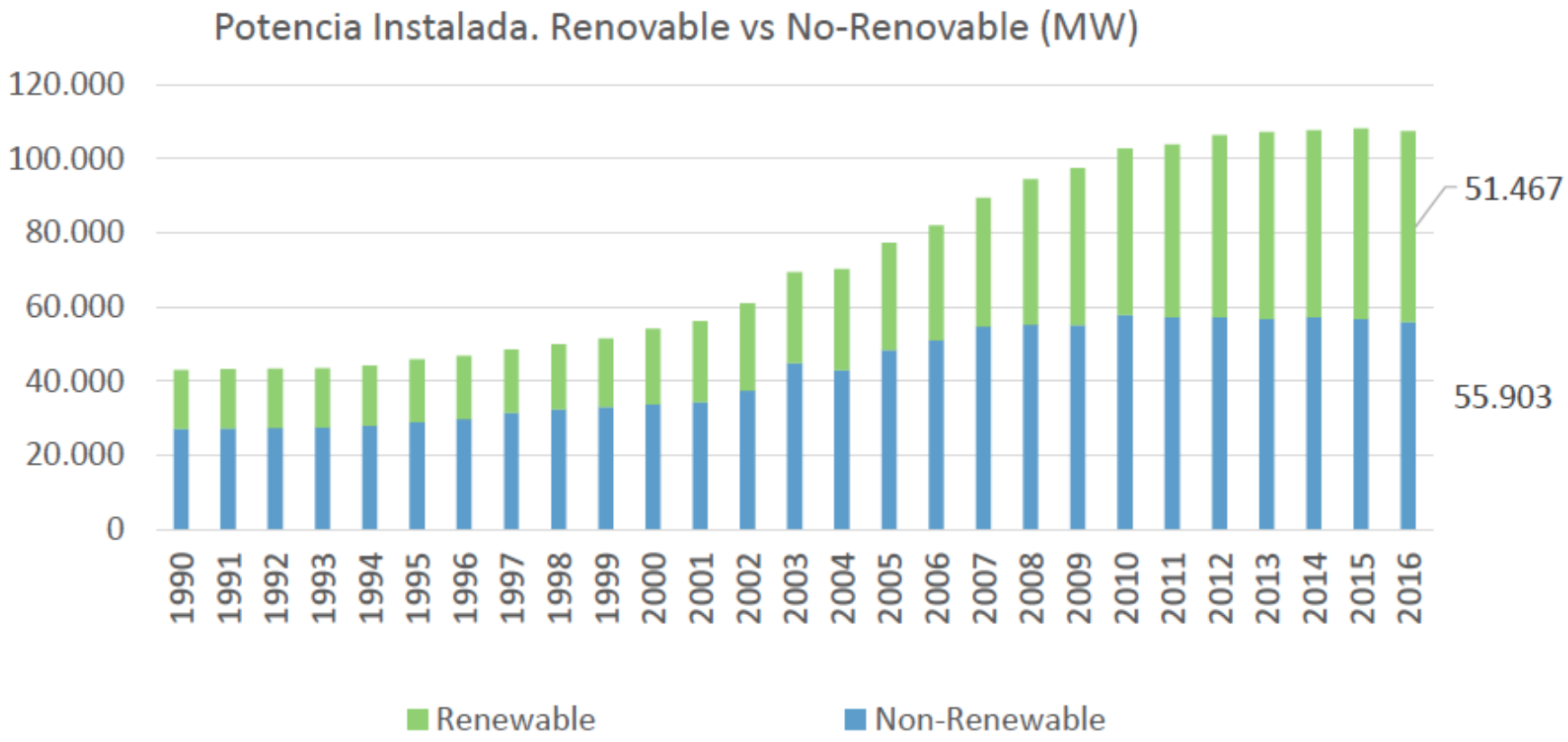
Espanya haurà d'instal·lar 50.000 MW 'verds' fins al 2030 per assolir un objectiu del 35% de renovables fixat pel Parlament Europeu

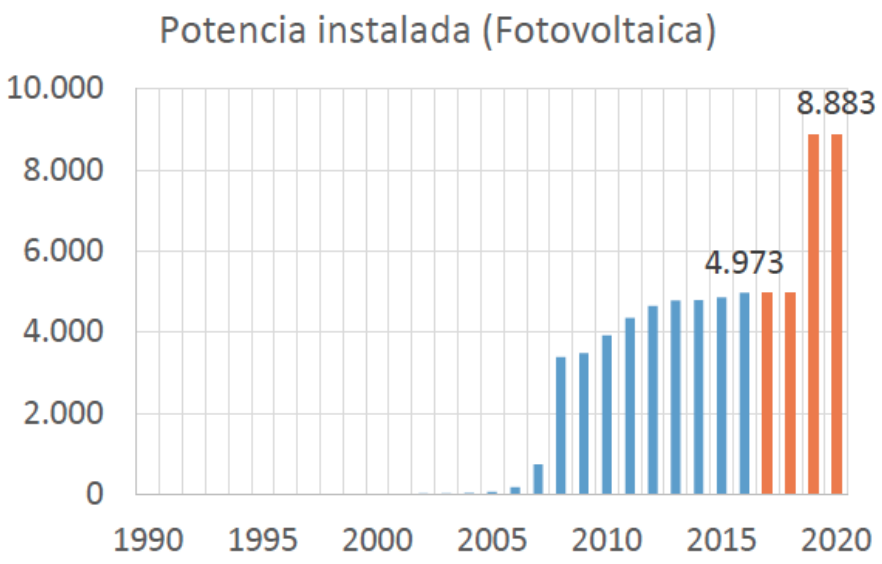
Implica la instal·lació de l'ordre de **5.000 MW a l'any** d'energies renovables fins al 2030, per complir l'objectiu que, almenys el 35% de l'energia final sigui renovable llavors

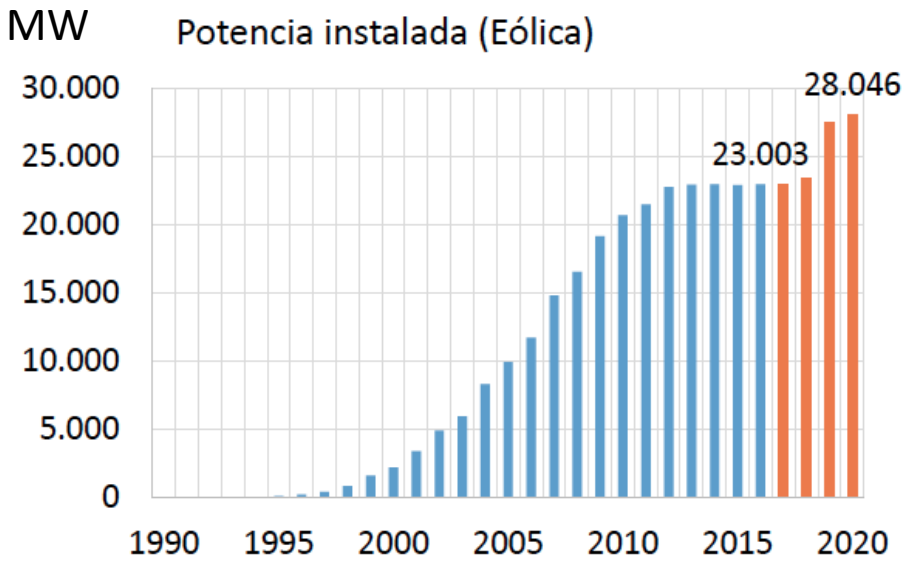
Xifres, on som?: El 2017 a Espanya es van instal·lar **135 MW** de nova potència fotovoltaica, davant els 55 MW instal·lats el 2016 i als 49 MW del 2015, segons la Unió Espanyola Fotovoltaica (UNEF).

Alemanya va instal·lar 1.750 MW de nova potència fotovoltaica a 2017; Països Baixos, 853 MW; Bèlgica, 264 MW. Diferència unordre de magnitud.

SECTOR ELÉCTRICO




Potencia instalada (Fotovoltaica)
10.000
8.000
6.000
4.000
2.000
0
1990
1995
2000
2005
2010
2015
2020
4.973
8.883


MW
Potencia instalada (Eólica)
30.000
25.000
20.000
15.000
10.000
5.000
0
1990
1995
2000
2005
2010
2015
2020
23.003
28.046

Canvi de tendència en la transició energètica?

CONCESIÓN DE NUEVOS DERECHOS ECONÓMICOS 2015-2017. GENERACIÓN ELÉCTRICA RENOVABLE

- **2015**: Cogeneración, hidráulica y Biomasa [120 MW]
- **2016**: Eólica en Canarias [450 MW]
- **2016:** Subasta de Eólica [500 MW] y Biomasa [200 MW]
- **2017**: Subasta tecnológicamente neutra: Eólica, Fotovoltaica y Otras [3.000 MW]
- **2017**: Subasta tecnológicamente neutra: Eólica, Fotovoltaica [5.000 MW]

Periodo 2015-2017: nuevos derechos concedidos a **9.300 MW**