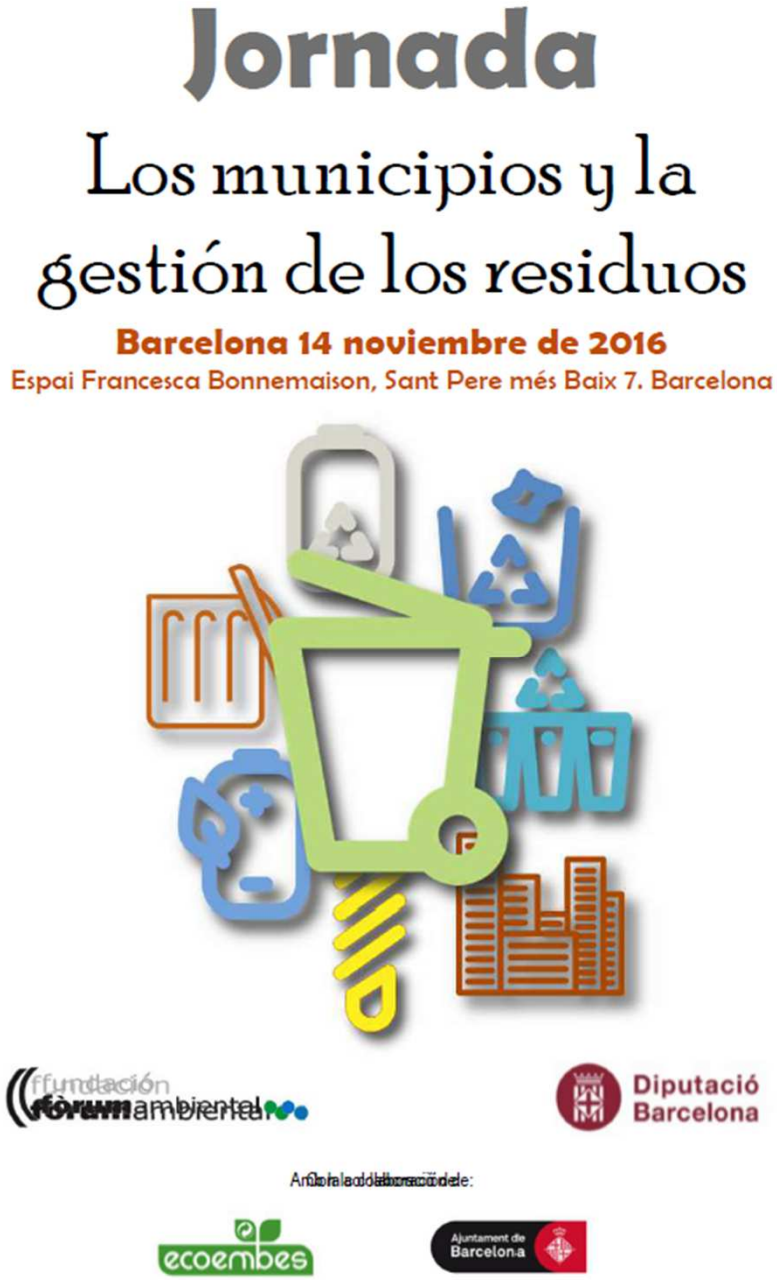
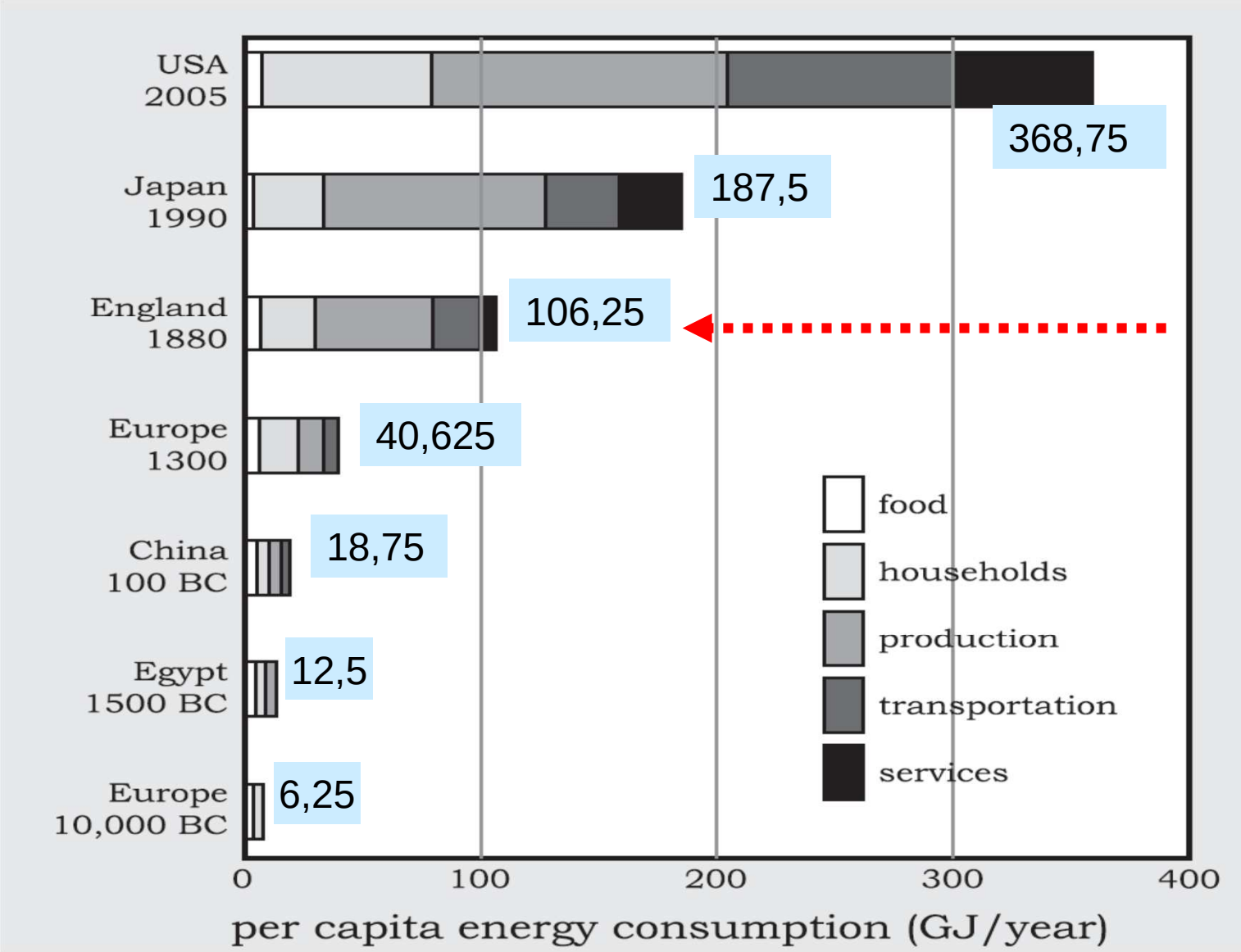


“El hombre del hidrocarburo, el calentamiento global, la gran aceleración y los límites del planeta”

Mariano Marzo
Dept. Dinámica de la Tierra y del Océano,
Facultad de Ciencias de la Tierra,
Universidad de Barcelona

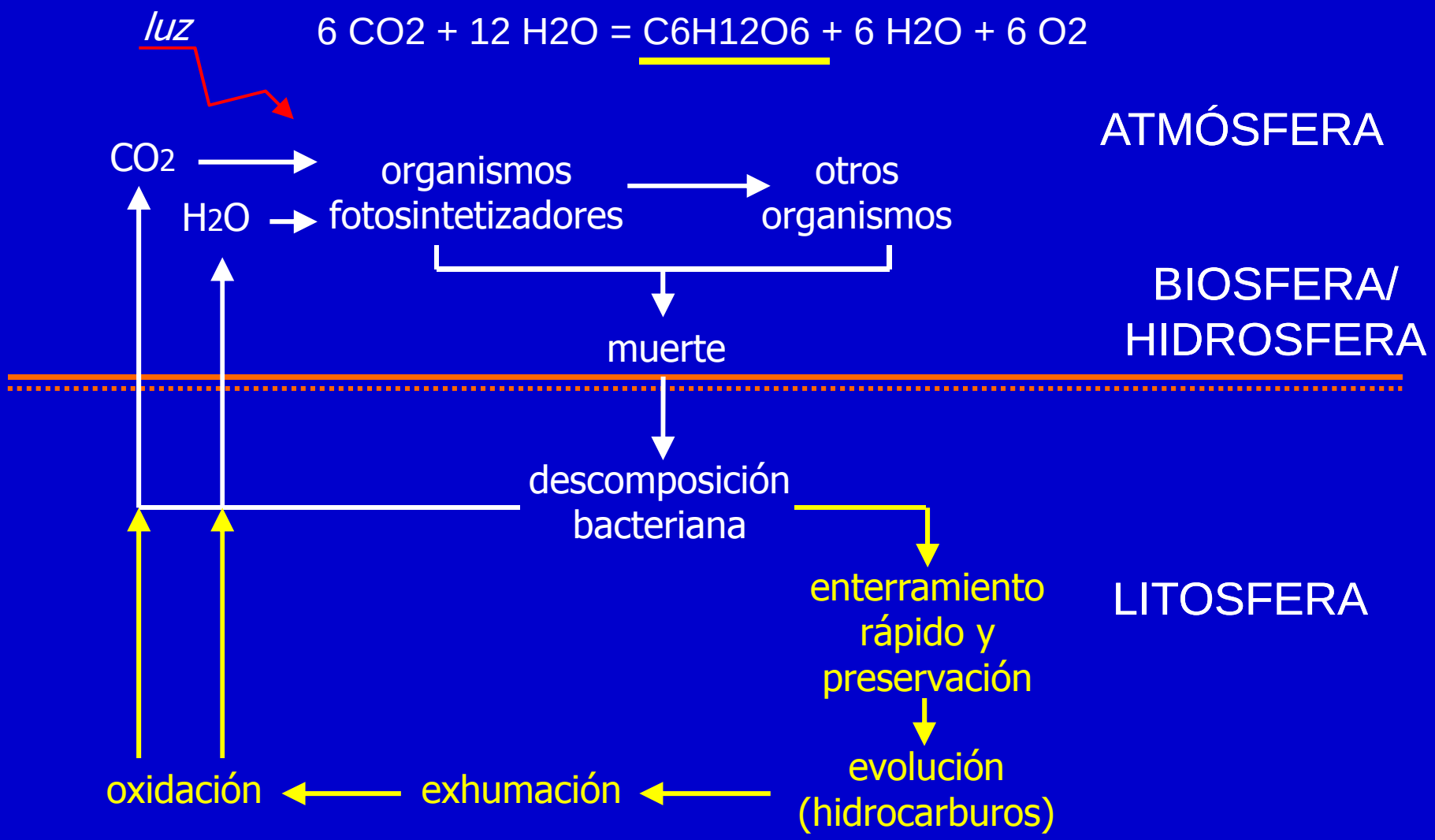
Evolución del consumo energético per cápita (GJ /año) en los últimos 10.000 años



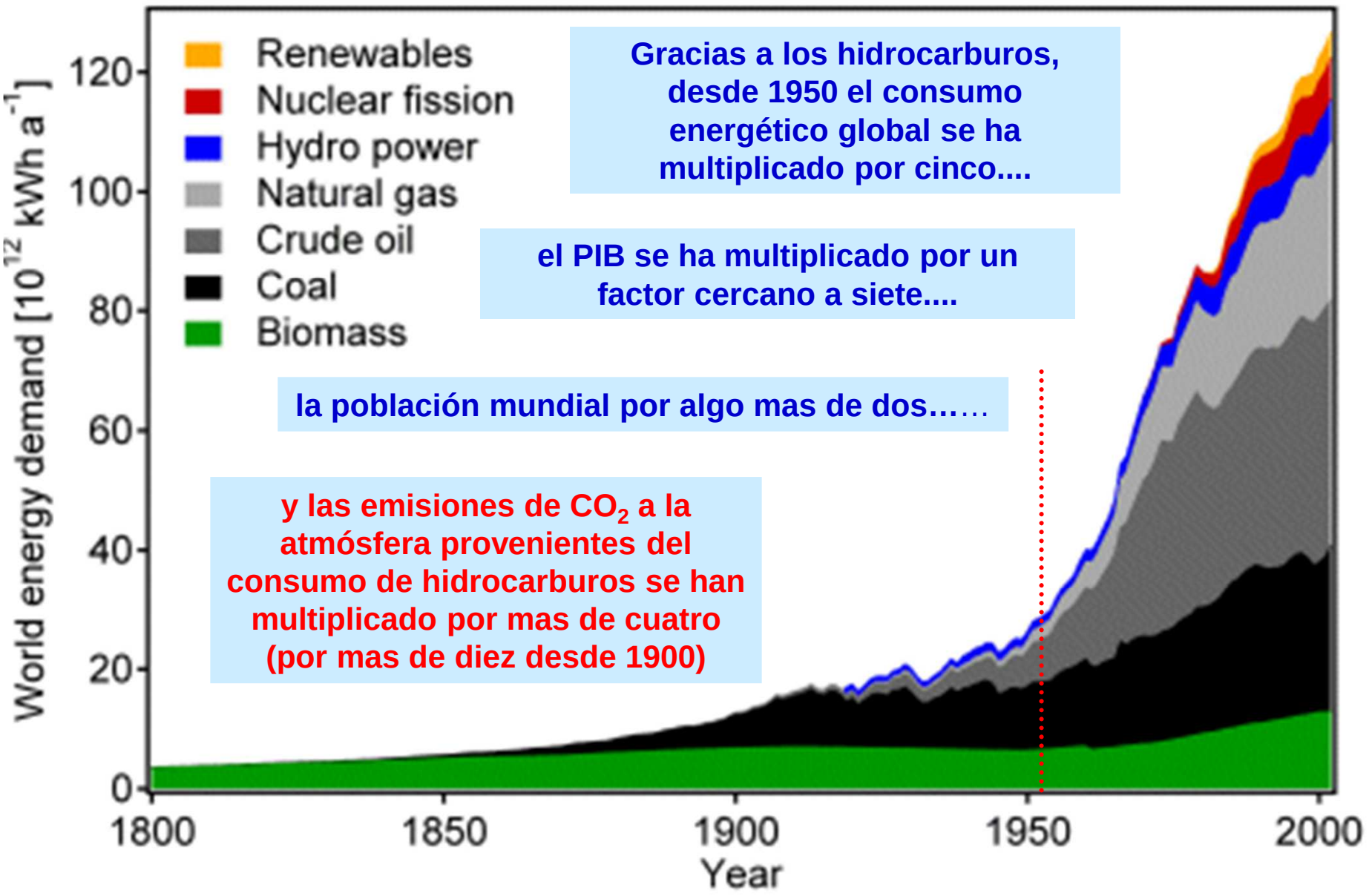
V. Smil, 2010

La herencia solar

Origen de la materia orgánica y de los hidrocarburos



“El hombre del hidrocarburo”
Petróleo, gas y carbón, 2014 = 86,3%



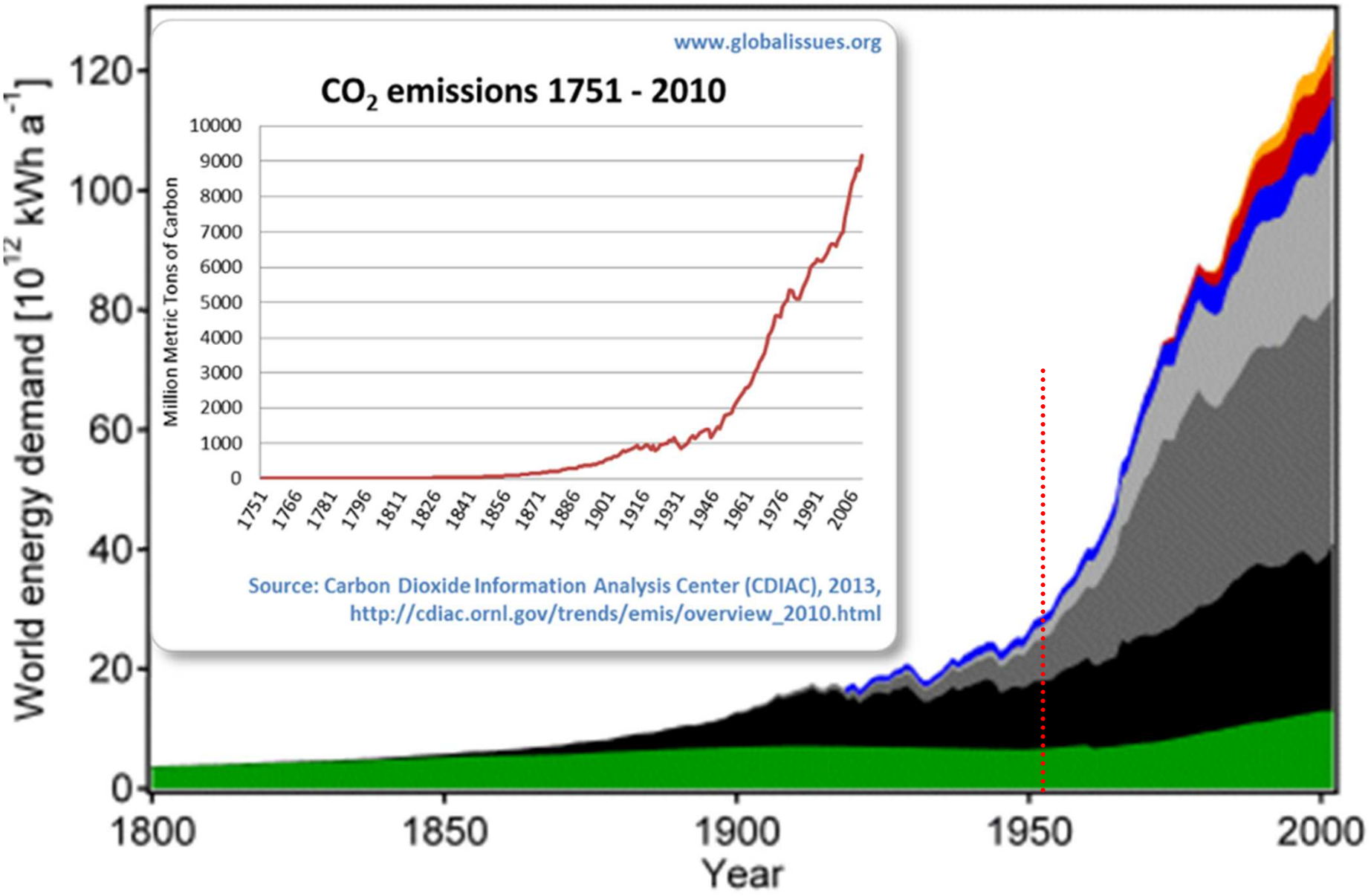
Gracias a los hidrocarburos, desde 1950 el consumo energético global se ha multiplicado por cinco....

el PIB se ha multiplicado por un factor cercano a siete....

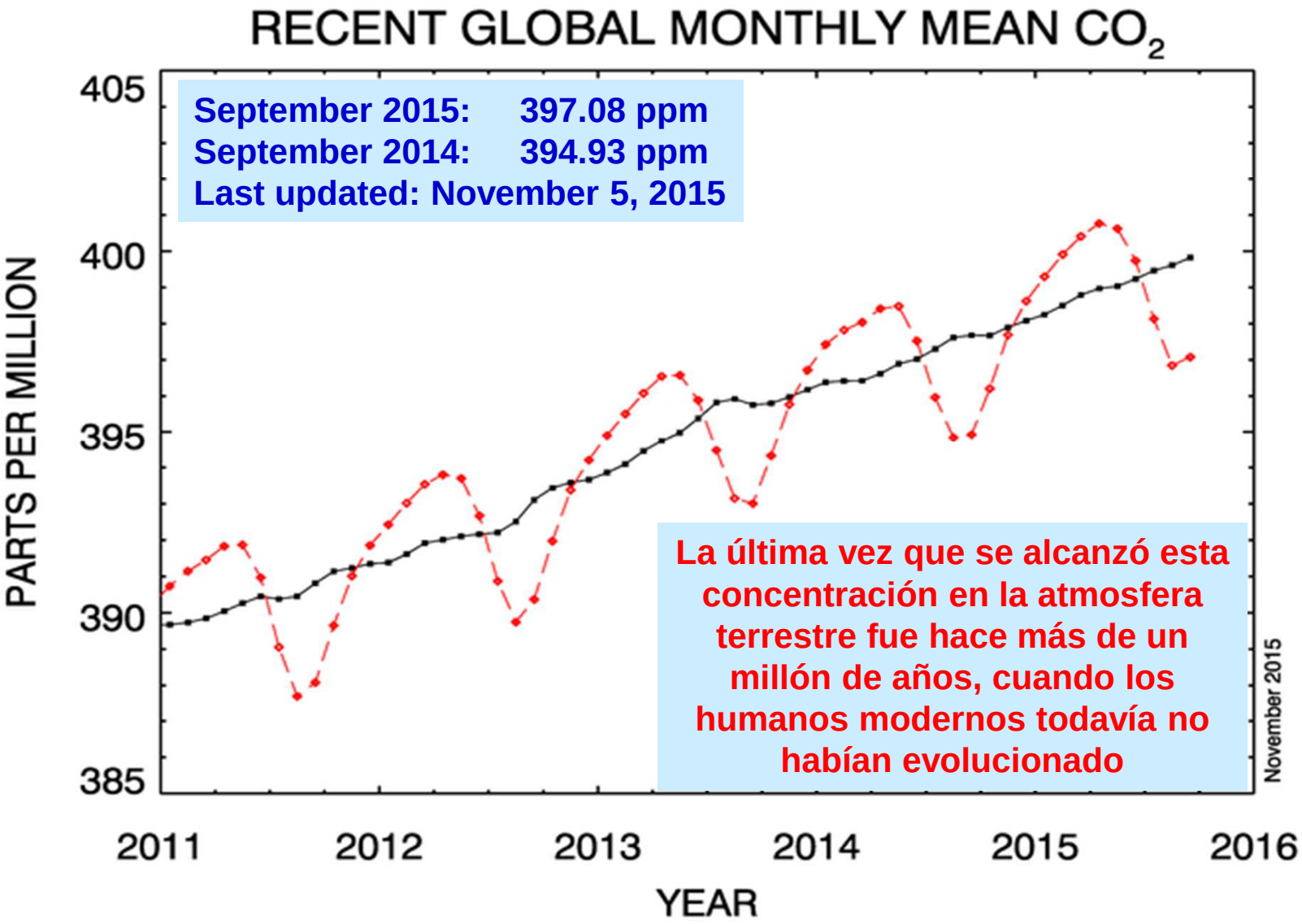
la población mundial por algo mas de dos……

y las emisiones de CO_2 a la atmósfera provenientes del consumo de hidrocarburos se han multiplicado por mas de cuatro (por mas de diez desde 1900)

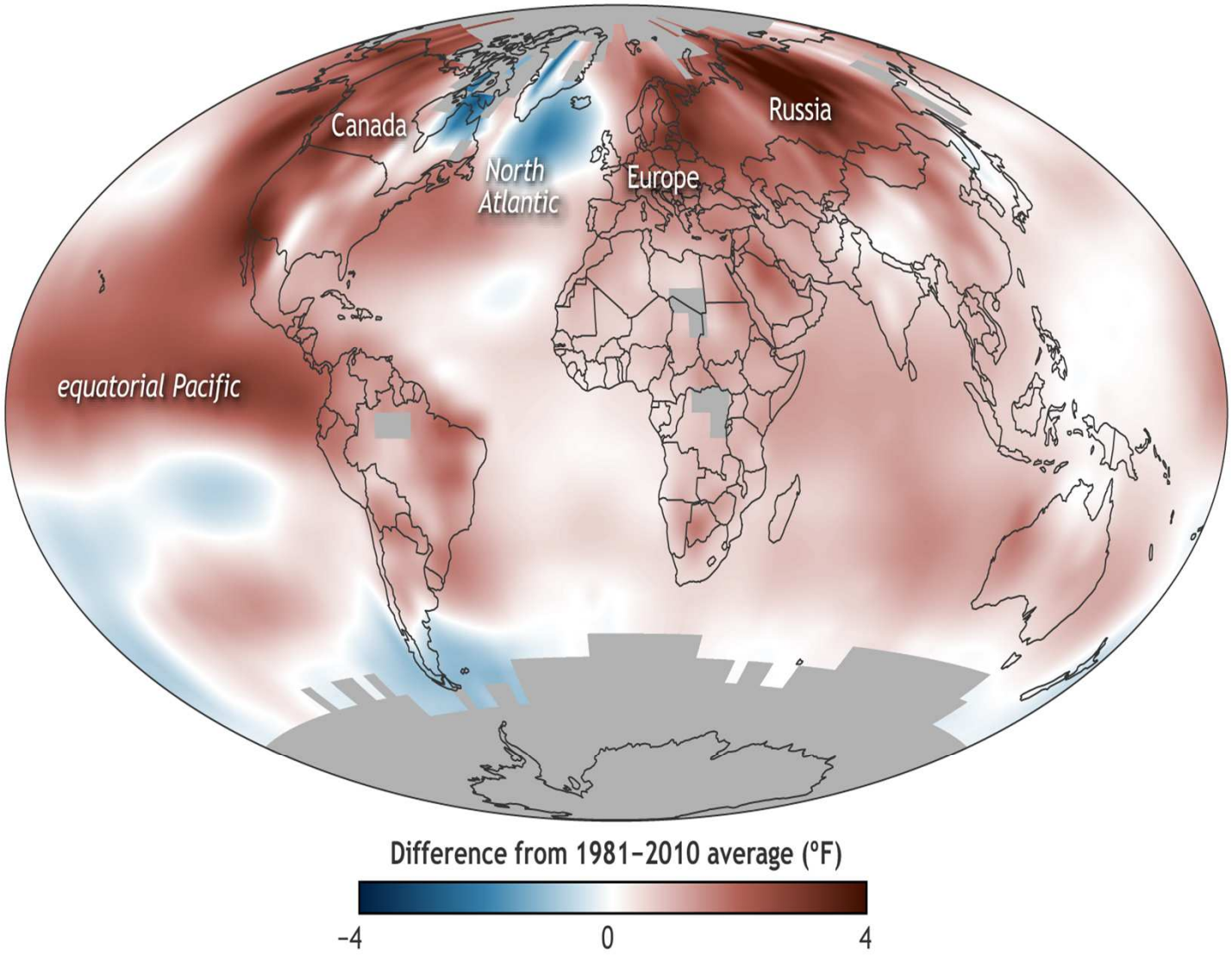
“El hombre del hidrocarburo”
Petróleo, gas y carbón, 2014 = 86,3%



Las concentraciones globales de CO_2 ya han superado puntualmente las 400 ppm



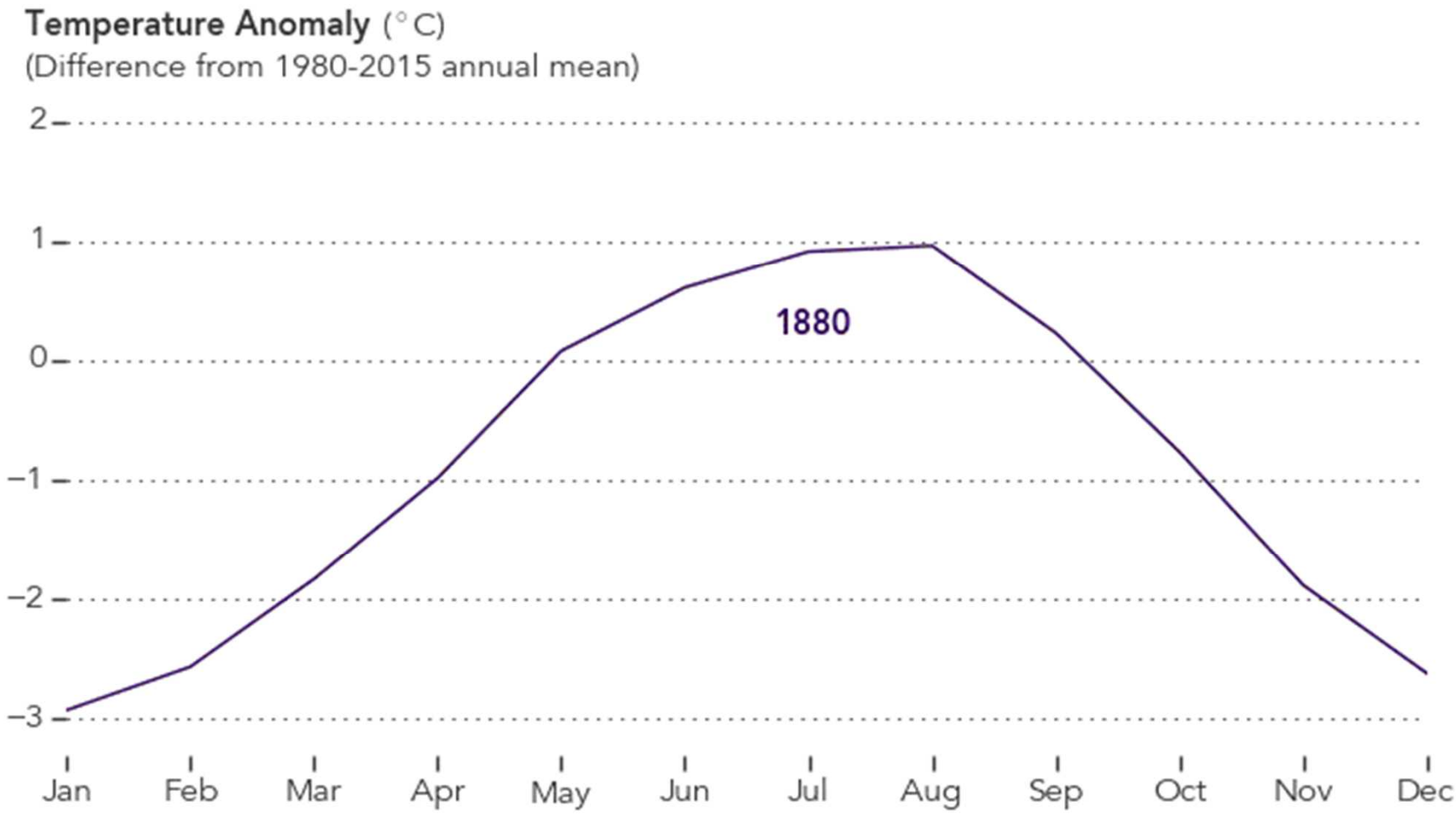
VERY FEW COOL SPOTS IN 2015



NEW HOTTEST YEAR ON RECORD

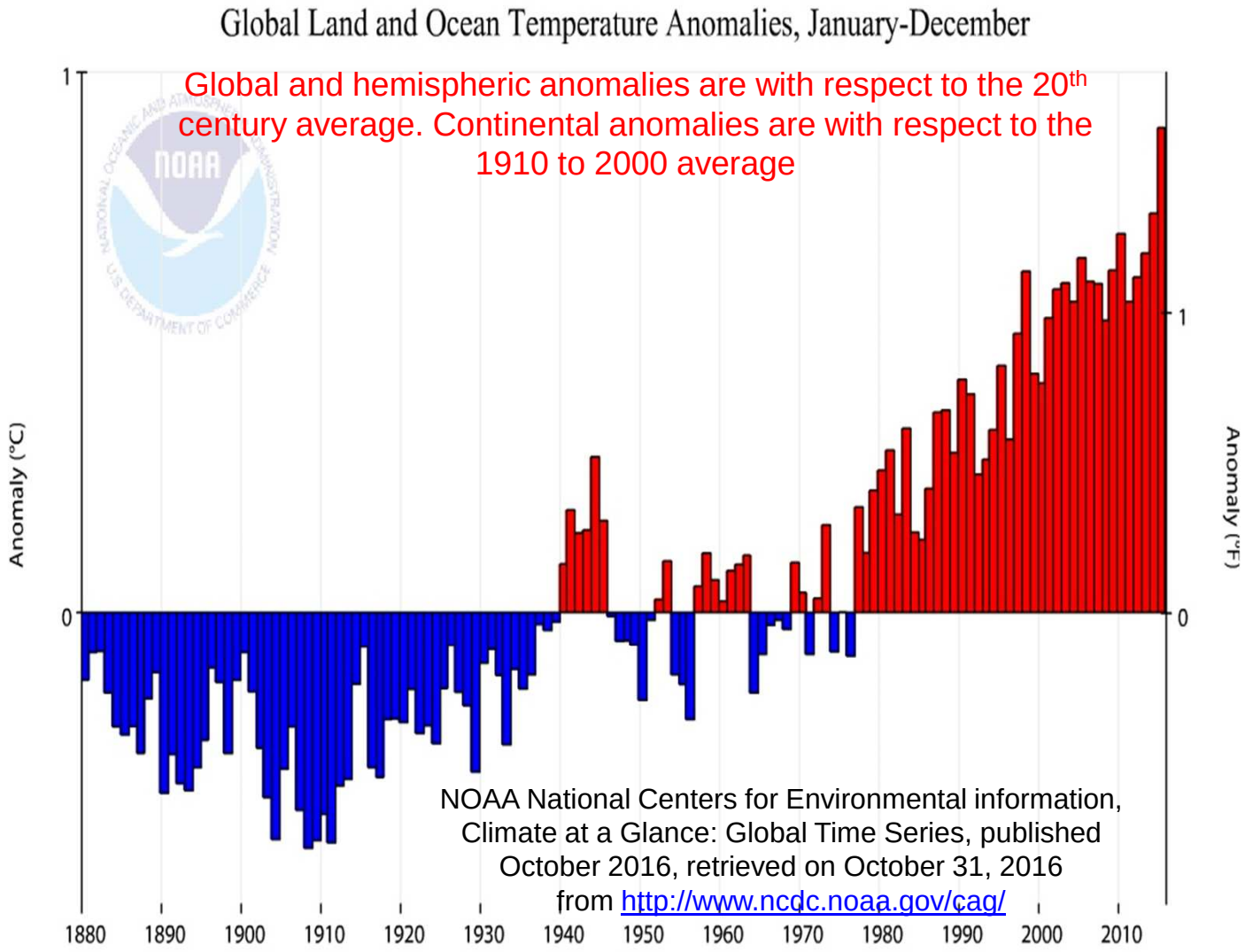
2016: el mes de agosto mas cálido en 136 años (NASA, Earth Observatory)

http://earthobservatory.nasa.gov/blogs/earthmatters/2016/09/12/heres-how-the-warmest-august-in-136-years-looks-in-chart-form/



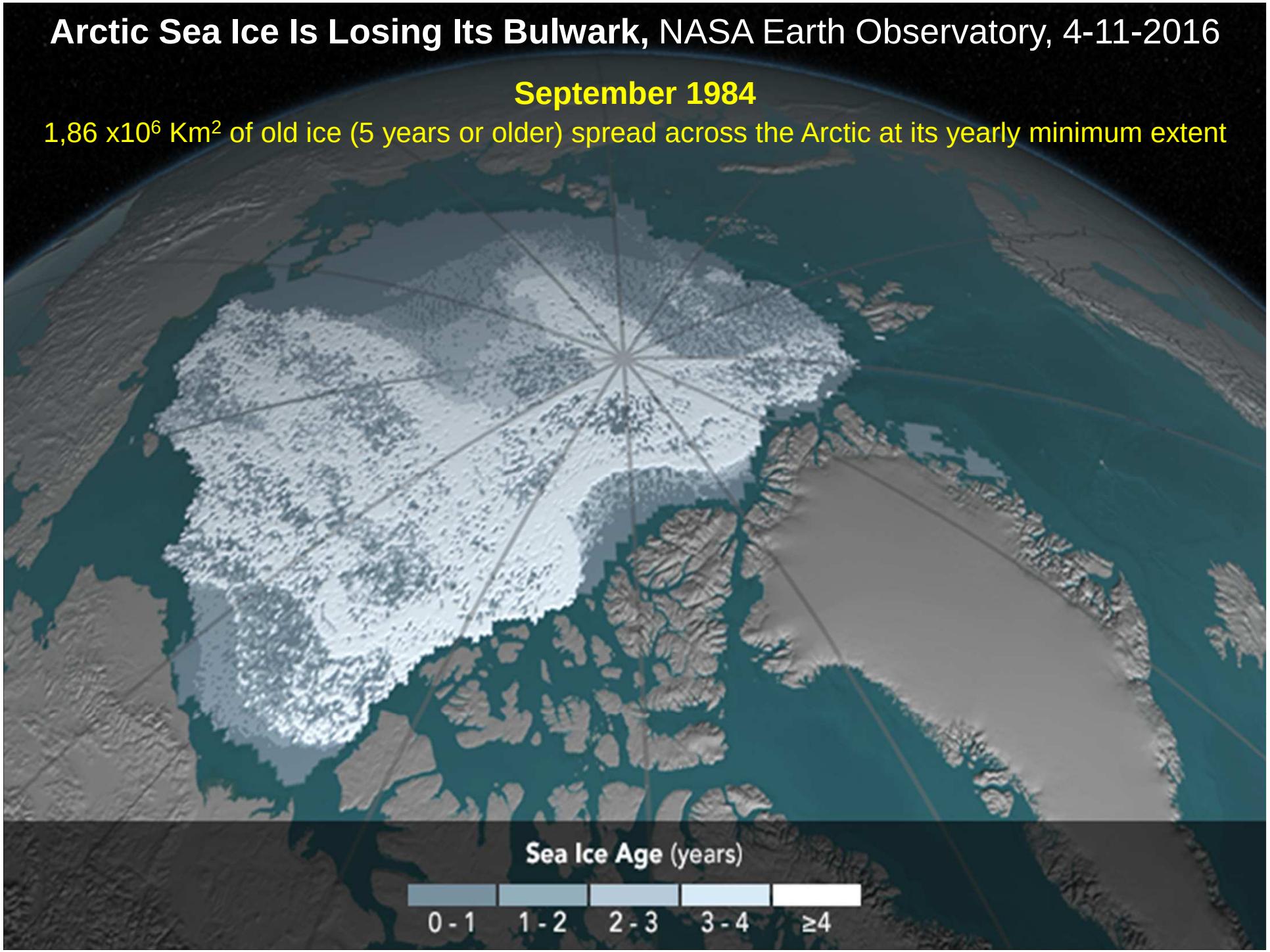
Una de las señales más evidentes del c. c. es el aumento de la temperatura media global durante las últimas décadas.

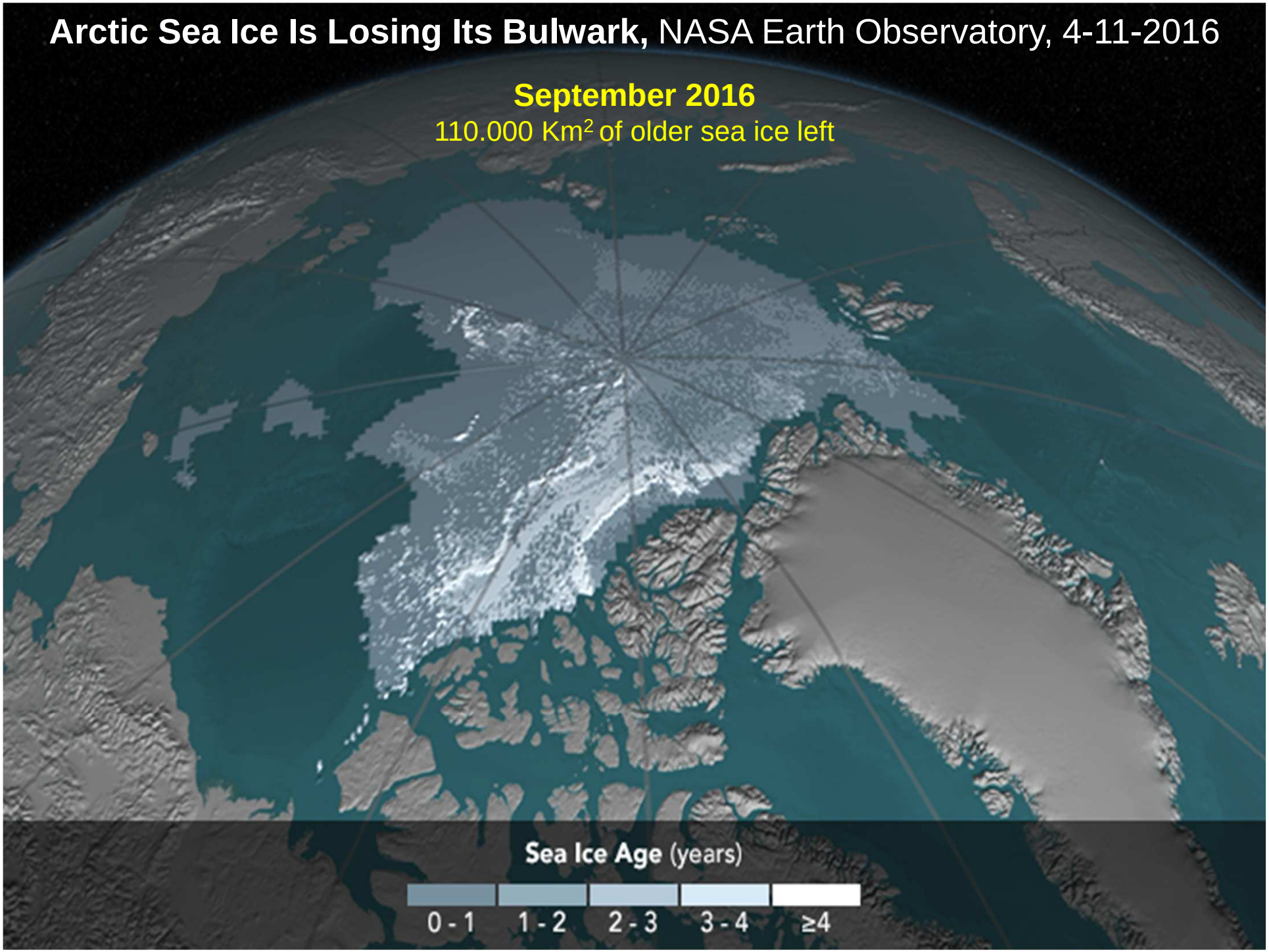
Comparing the average temperature of land, ocean, or land and ocean combined for any month or multi-month period to the average temperature for the same period over the 20th century shows if conditions are warmer or cooler than the past.



El síndrome de la rana hervida

Arctic Sea Ice Is Losing Its Bulwark, NASA Earth Observatory, 4-11-2016




Arctic Sea Ice Is Losing Its Bulwark, NASA Earth Observatory, 4-11-2016
September 2016
110.000 Km2 of older sea ice left
Sea Ice Age (years)
0 - 1
1 - 2
2 - 3
3 - 4
≥4

La identidad de Kaya

$$CO2\uparrow = \left(P\, x \frac{PIB}{P} x \frac{E}{PIB} x \frac{CO2}{E} \right) - CO2\downarrow$$

$CO_2\uparrow$ = CO_2 neto antropogénico a la atmosfera

P = población mundial

PIB / P = renta per cápita global

E / PIB = intensidad energética mundial

CO_2 / E = intensidad de carbono del mix energético global

$CO_2\downarrow$= CO_2 secuestrado por medios naturales o inducidos

$$CO2\uparrow = \left(P\ x \frac{PIB}{P} x \frac{E}{PIB} x \frac{CO2}{E} \right) - CO2\downarrow$$

$CO_2\uparrow$ = CO_2 neto antropogénico a la atmosfera

P = población mundial

PIB / P = renta per cápita global

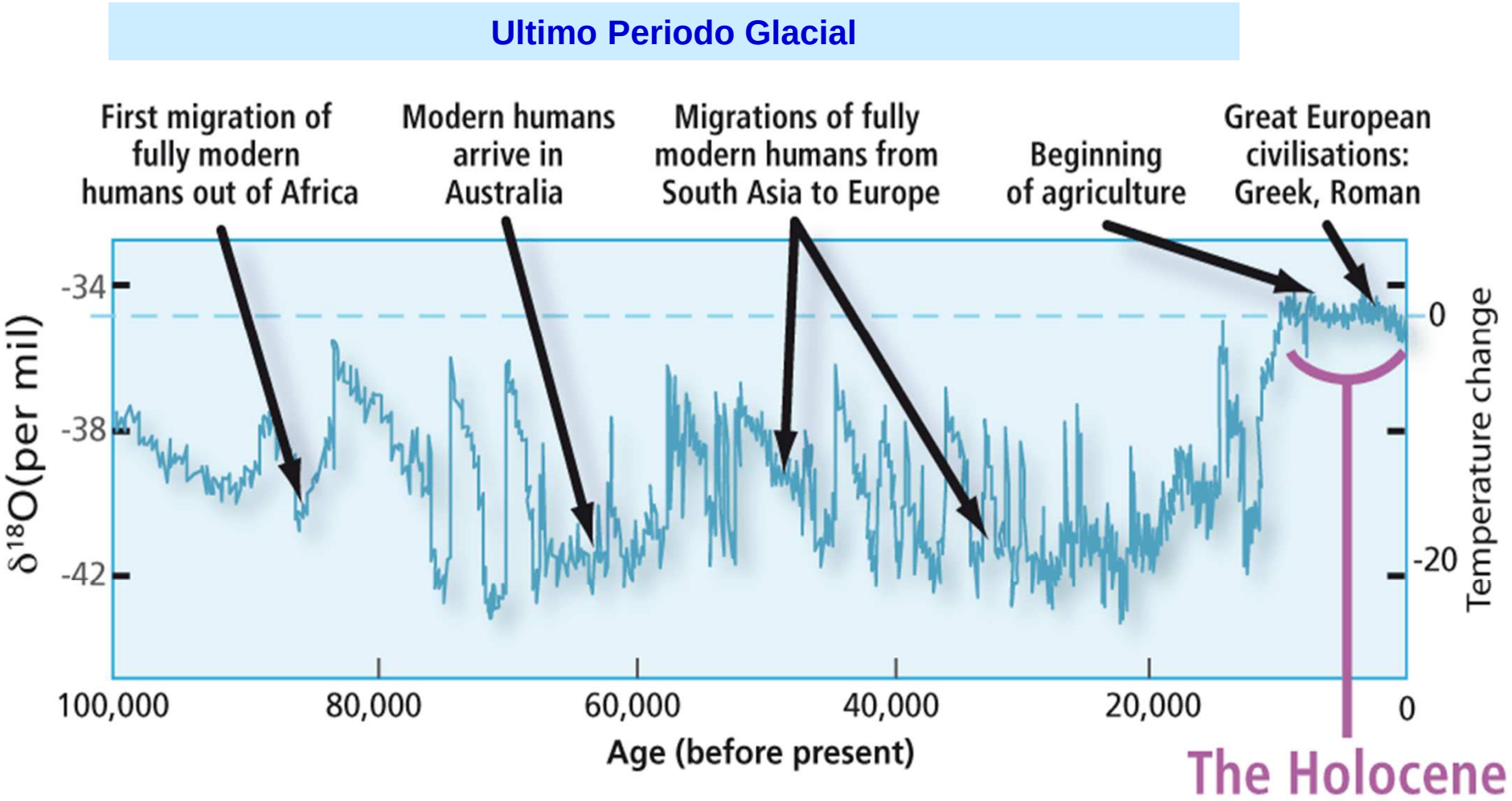
E / PIB = intensidad energética mundial

CO_2 / E = intensidad de carbono del mix energético global

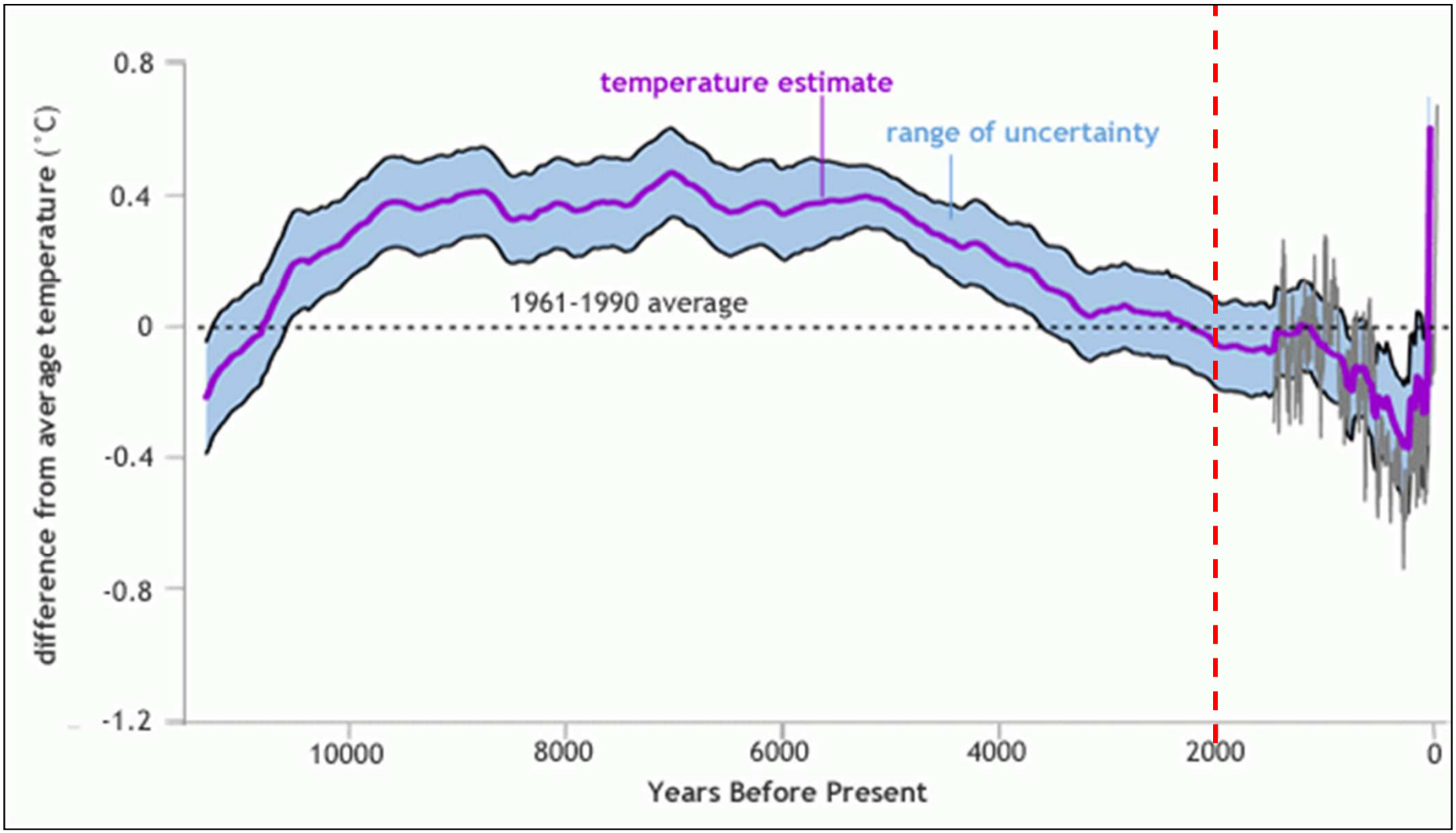
$CO_2\downarrow$= CO_2 secuestrado por medios naturales o inducidos


COP21, Paris 2-12-2016
Es imperativo avanzar hacia una economía descarbonizada y de baja intensidad energética
No va a ser fácil ni rápido
I+D+i
Newsweek, 6-13 September 2004

El Holoceno: un periodo “anormalmente” estable de la historia climática reciente. Hemos sido muy afortunados en los últimos 11.700 años!



Anomalías en la temperatura global durante los últimos 11.300 años en comparación con el promedio histórico (1961-1990).



The purple line shows the annual anomaly, and the light blue band shows the statistical uncertainty (one standard deviation). The gray line shows temperature from a separate analysis spanning the past 1,500 years. Image adapted from Figure 1(b) in Marcott et al. 2014

La actividad de los seres humanos están dejando su huella y transformando el planeta, de modo que geólogos y otros científicos discuten si dicha impronta es los suficientemente distintiva y perdurable para diferenciar una nueva época

Global Boundary Stratotype Section and Point (GSSP)
Turonian “golden spike”, Pueblo, Colorado (USA)

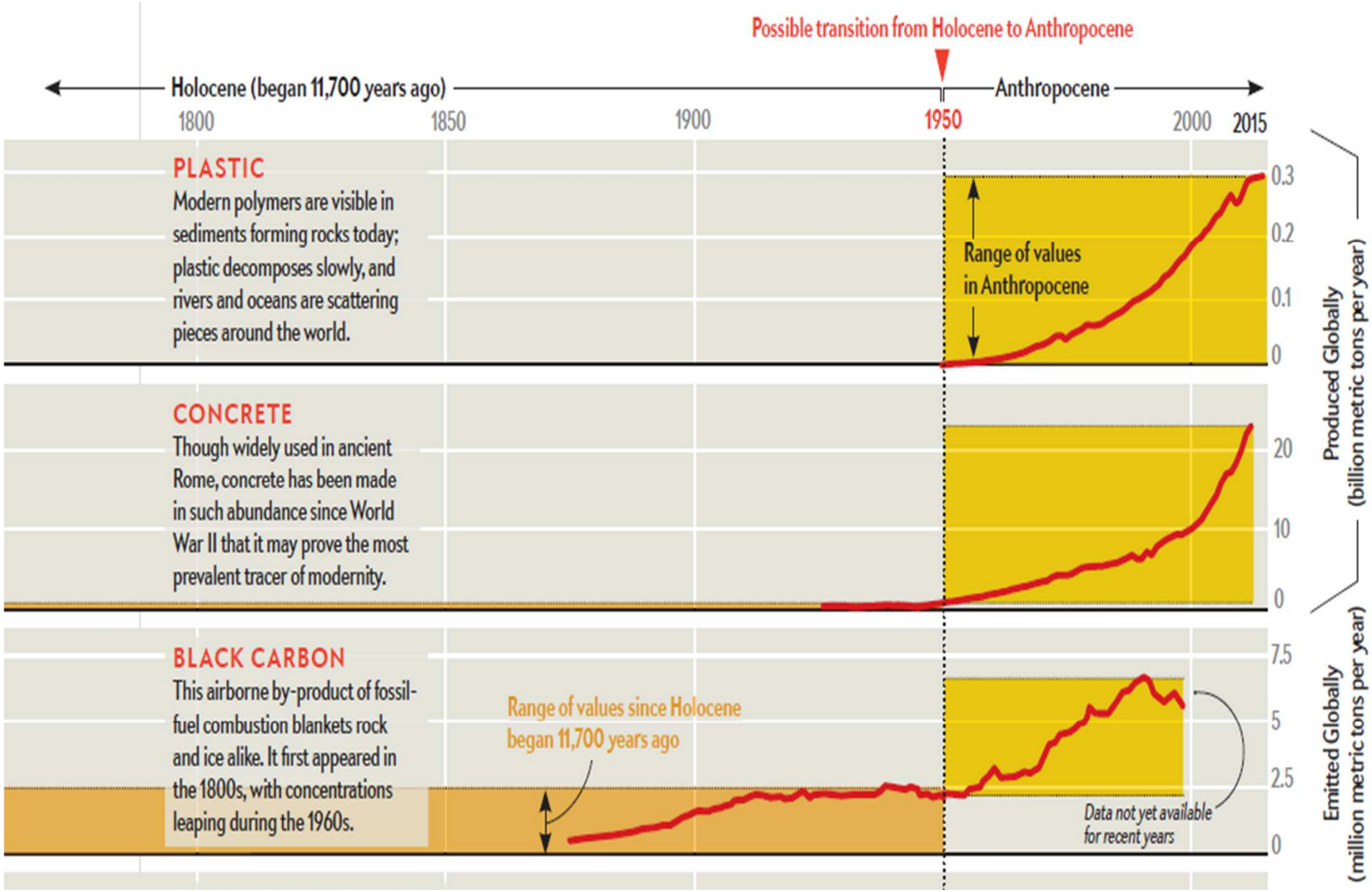
Residuos & “Tecnofósiles”

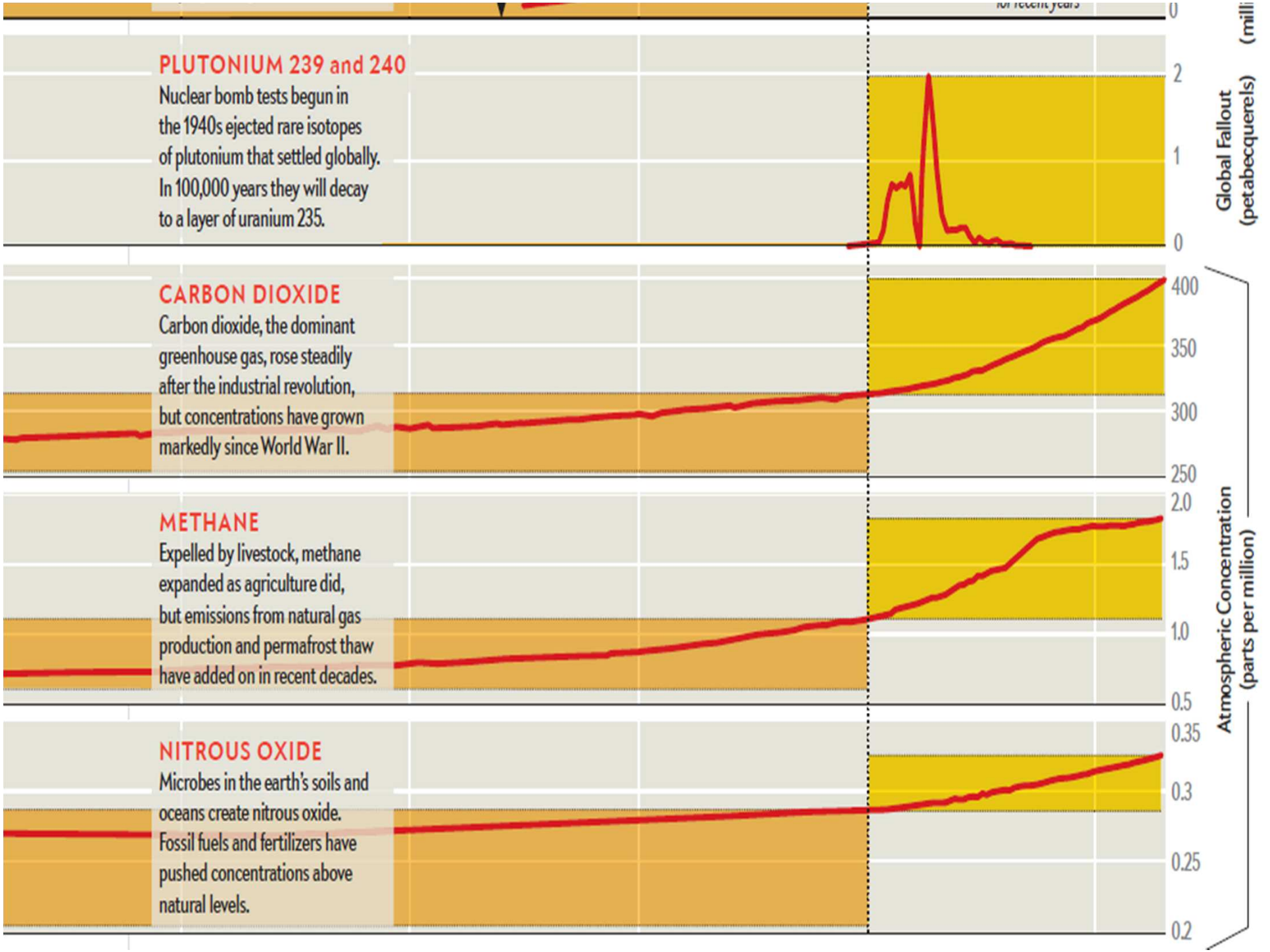
Roca actual en un playa de Hawai

Los detritus de la humanidad moderna son tan ubicuos que nuestros “tecnofósiles" -como p.e. plástico y cemento- estarán presentes en muchas de las rocas que se están formando en la actualidad.

“Plastiglomerado” constituido por cantos de lava, trozos de red (colores azul-verdoso y rojizo) y un fragmento de cuerda de plástico derretido (amarillo). Lápiz para escala (inferior izquierda)

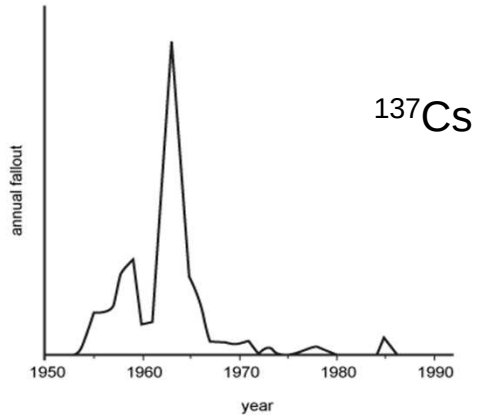
Límite Holoceno Antropoceno en la década de 1950 (?)



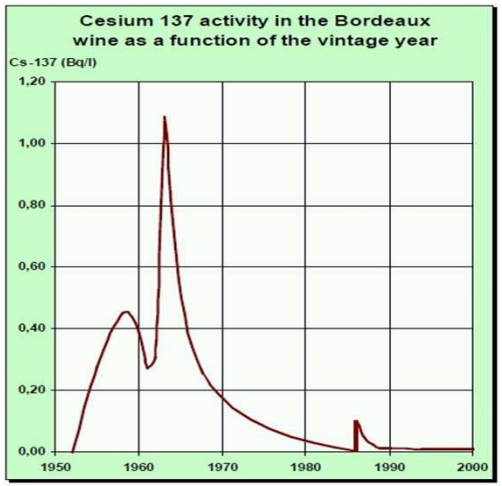

for recent years
0
PLUTONIUM 239 and 240
Nuclear bomb tests begun in the 1940s ejected rare isotopes of plutonium that settled globally. In 100,000 years they will decay to a layer of uranium 235.
2
1
0
Global Fallout (petabecquerels)
(milli
CARBON DIOXIDE
Carbon dioxide, the dominant greenhouse gas, rose steadily after the industrial revolution, but concentrations have grown markedly since World War II.
400
350
300
250
METHANE
Expelled by livestock, methane expanded as agriculture did, but emissions from natural gas production and permafrost thaw have added on in recent decades.
2.0
1.5
1.0
0.5
NITROUS OXIDE
Microbes in the earth's soils and oceans create nitrous oxide. Fossil fuels and fertilizers have pushed concentrations above natural levels.
0.35
0.3
0.25
0.2
Atmospheric Concentration (parts per million)

Alamogordo, New México, USA, 16 Julio 1945 y lluvia de radionucleidos

(Waters, *et al*., 2014)

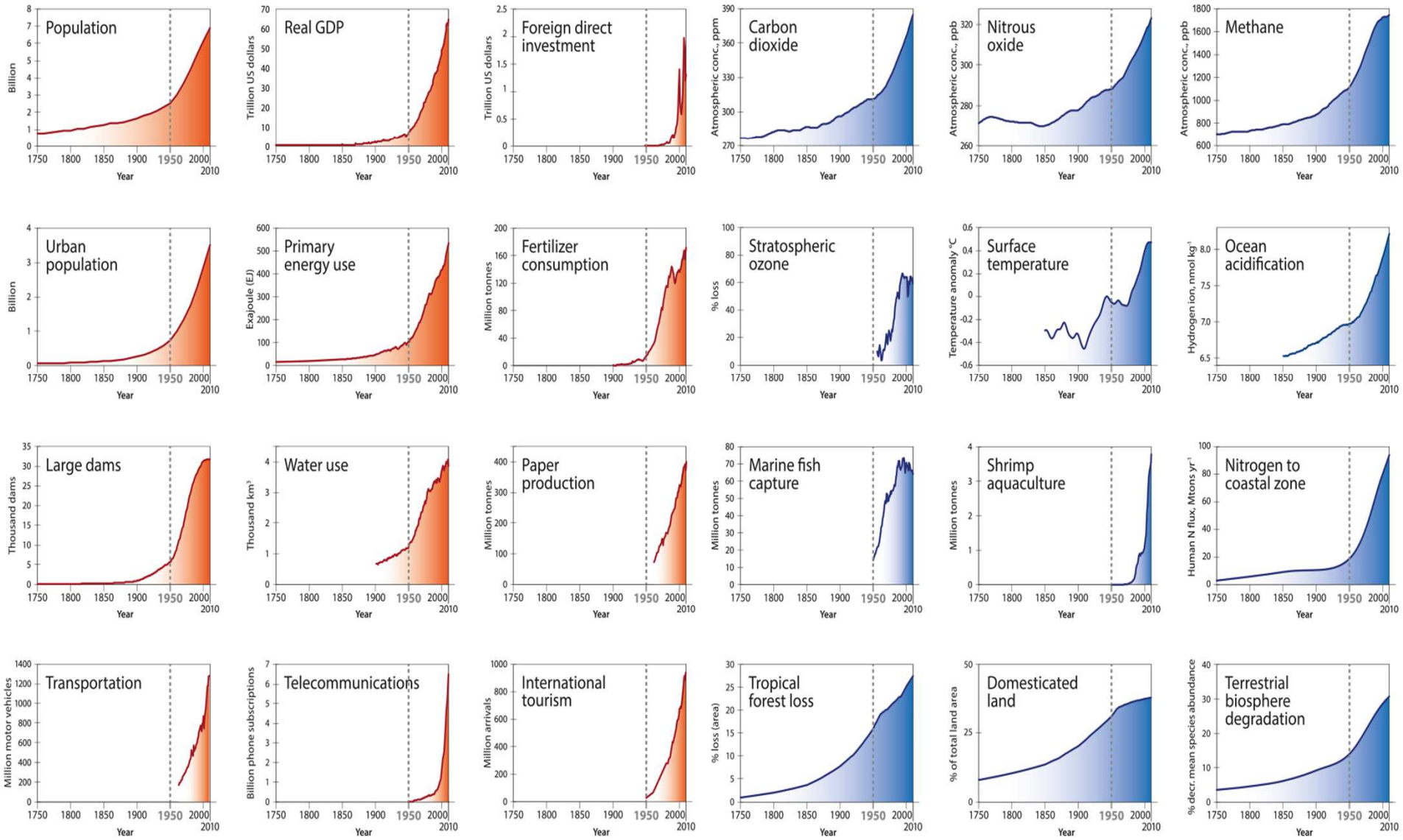


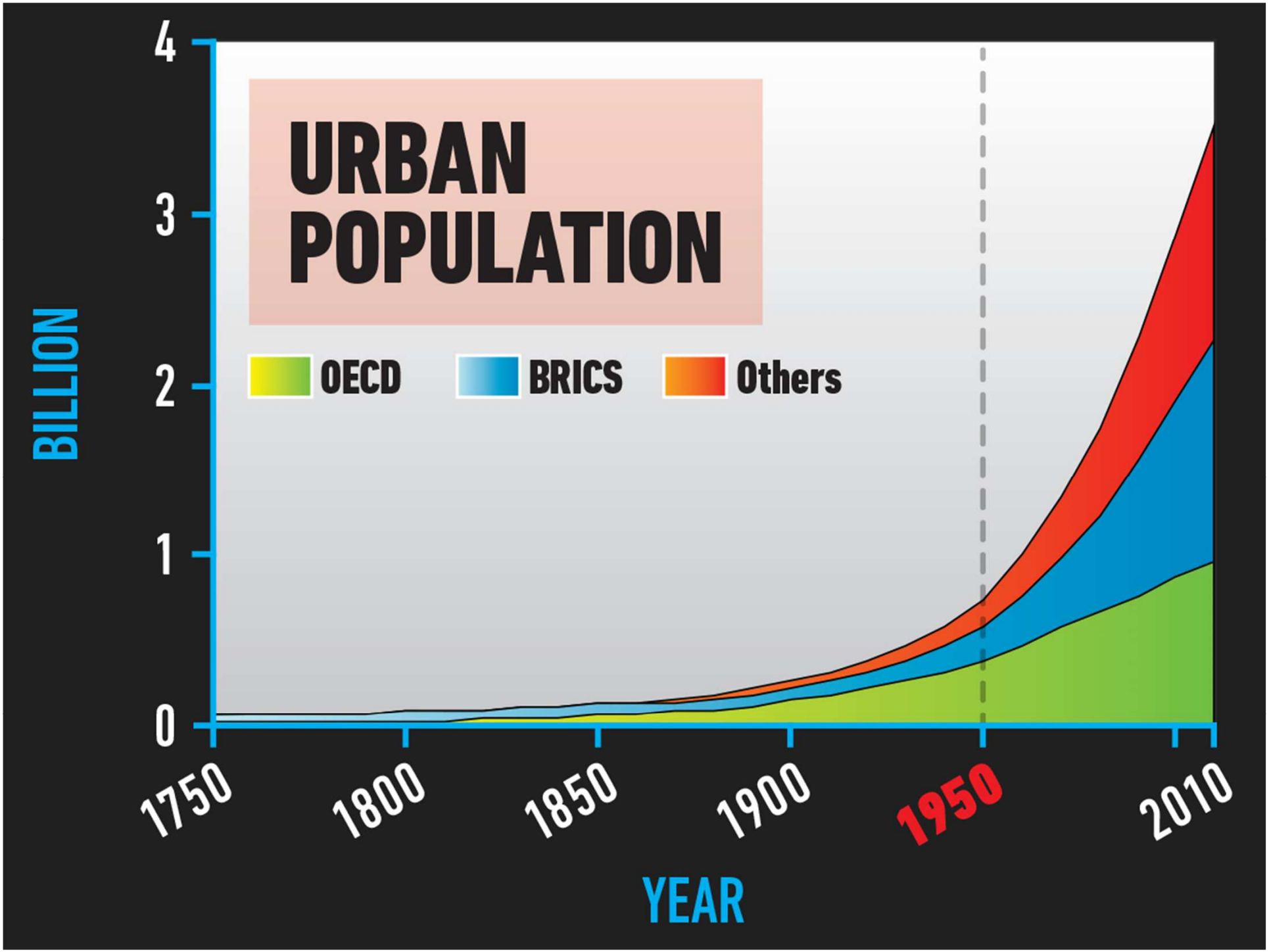
^{137}Cs

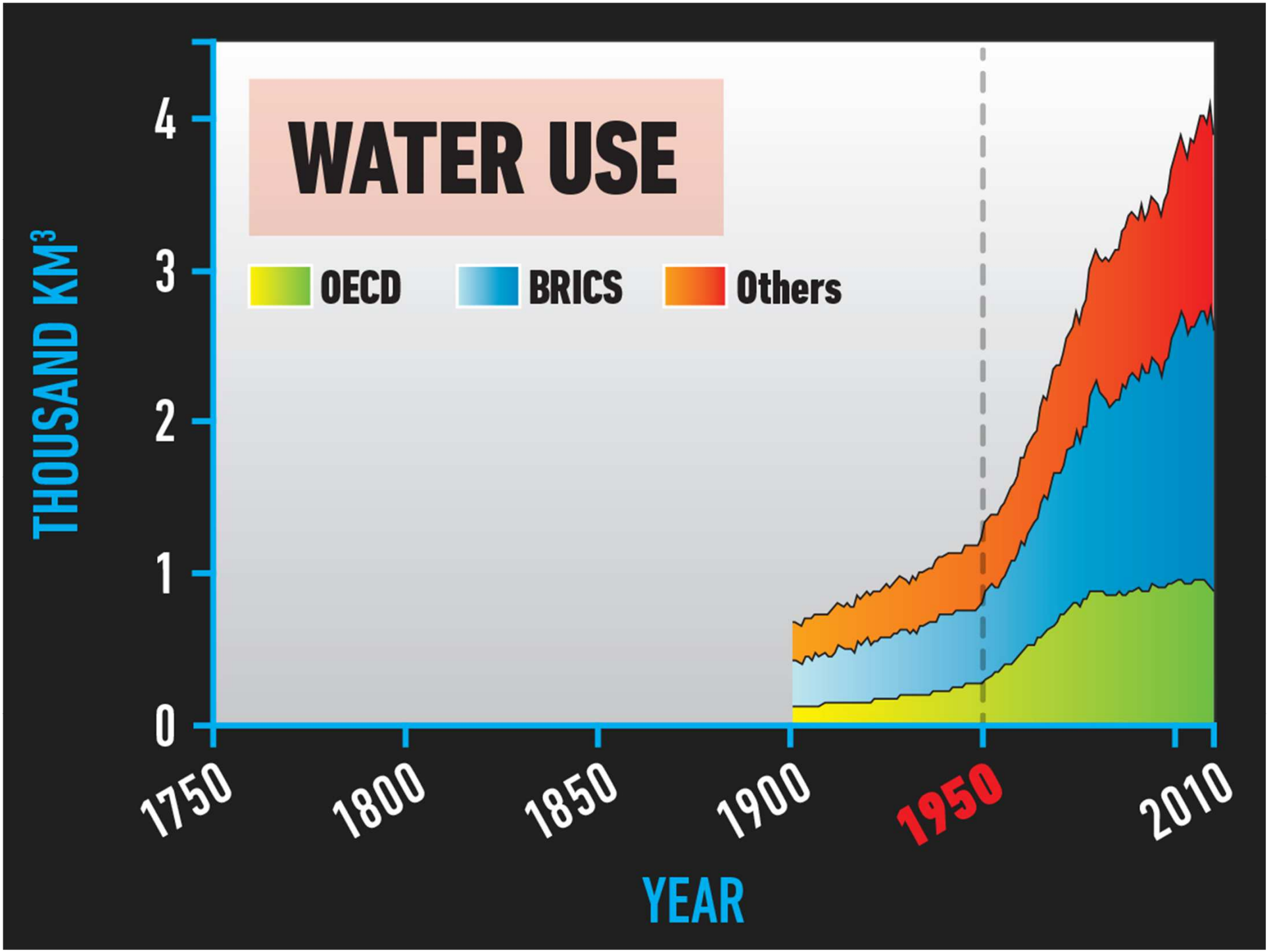


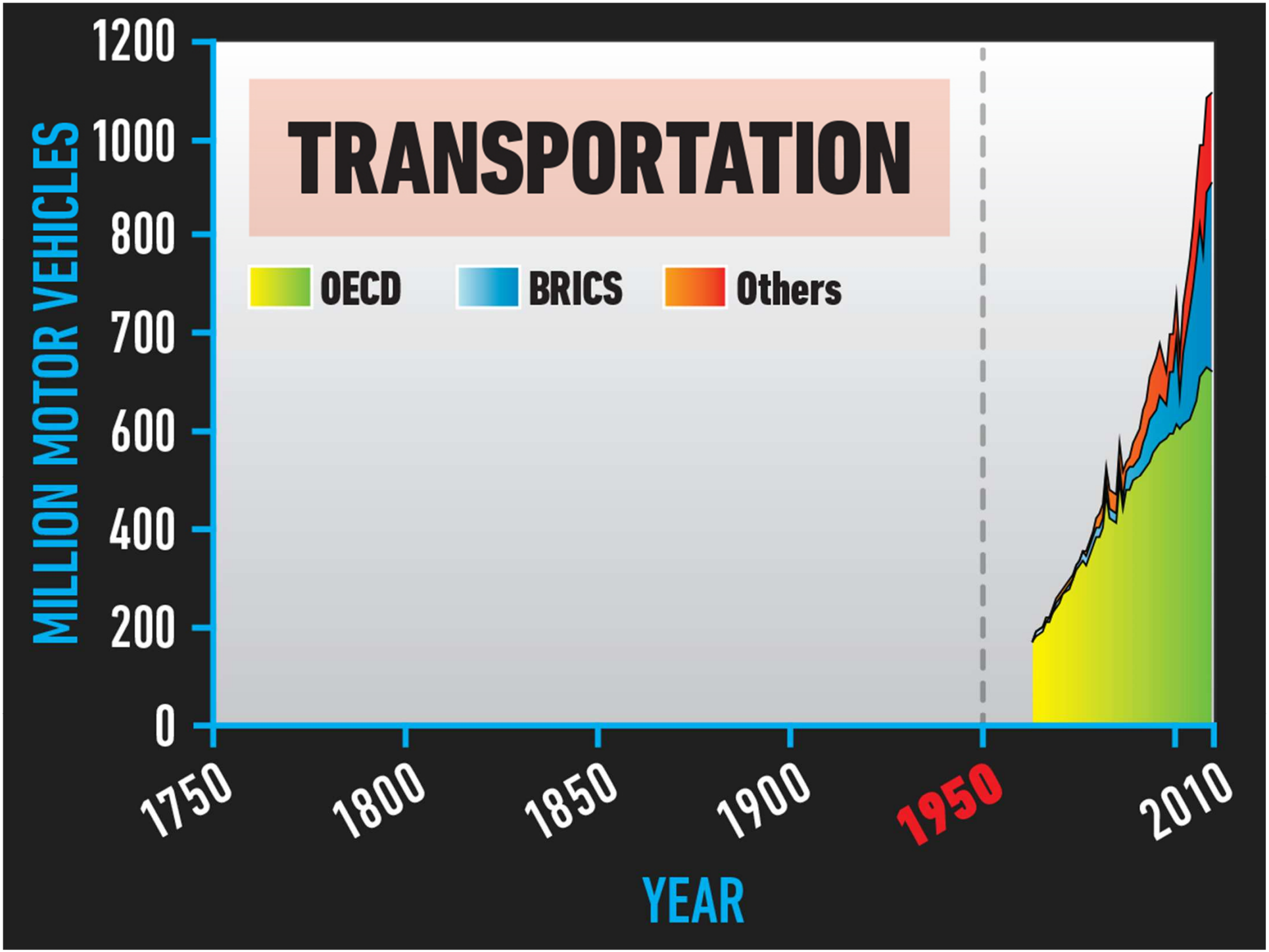
La gran aceleración

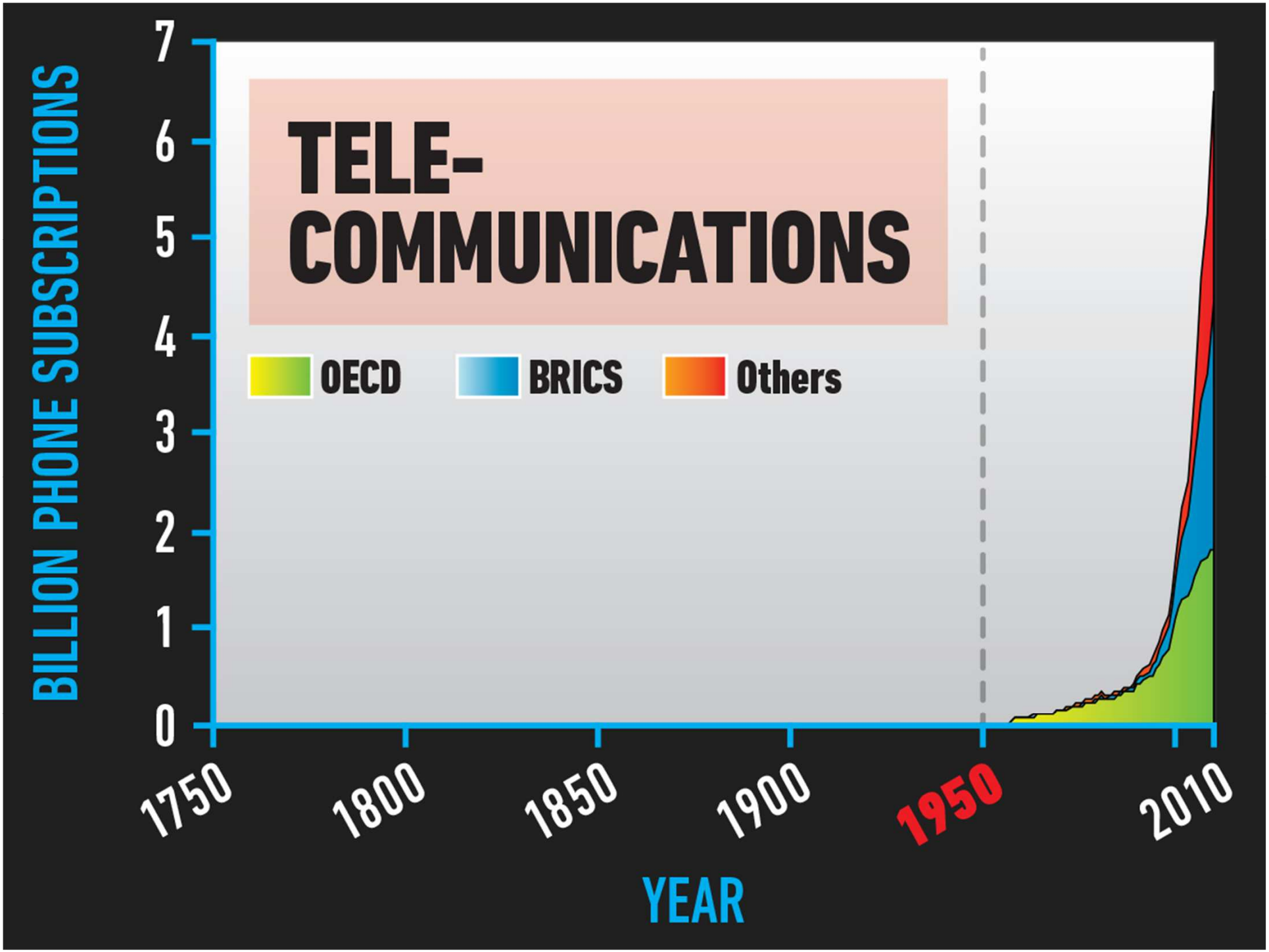
Steffen et al. (2015), The Anthropocene Review

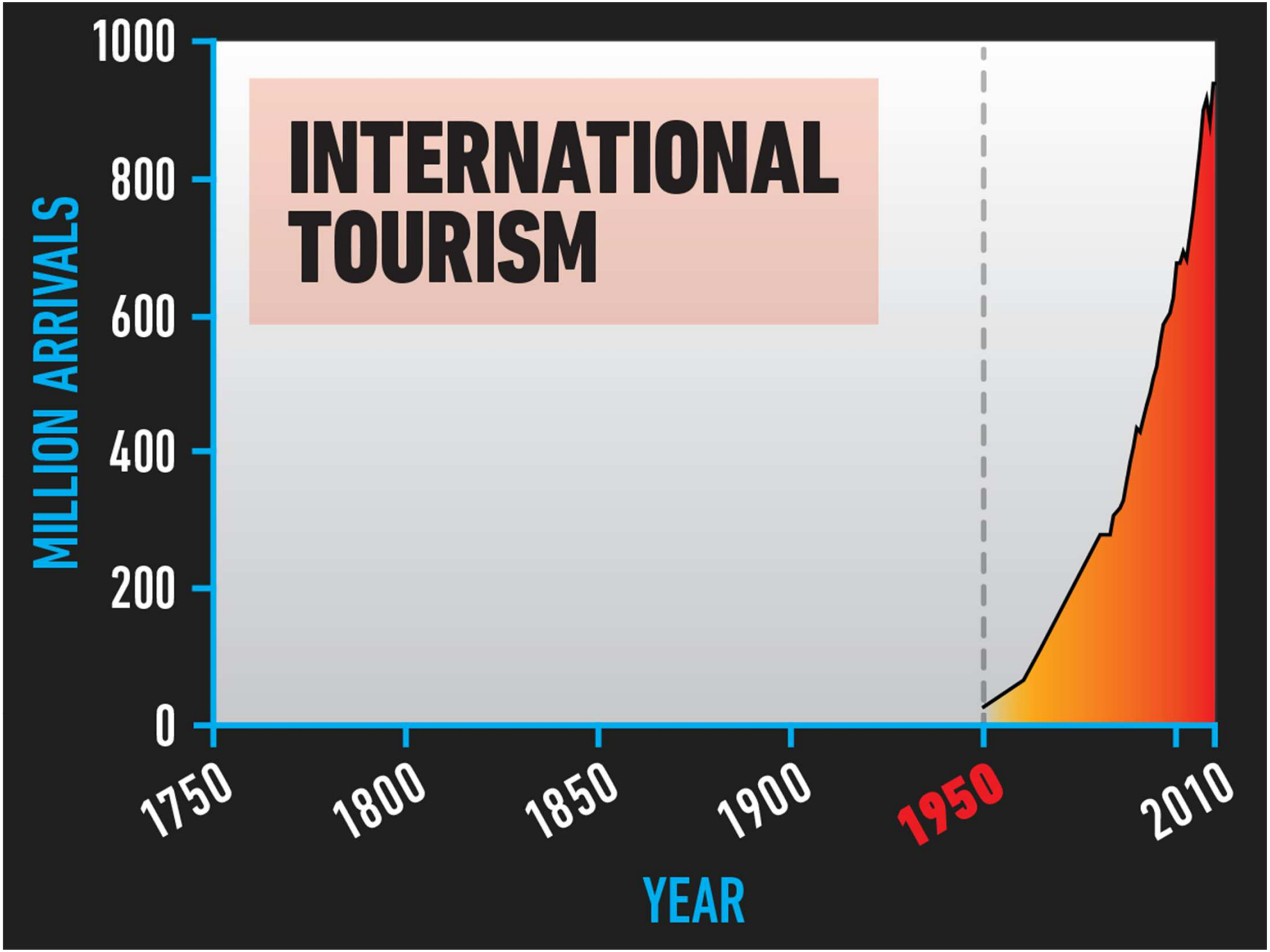


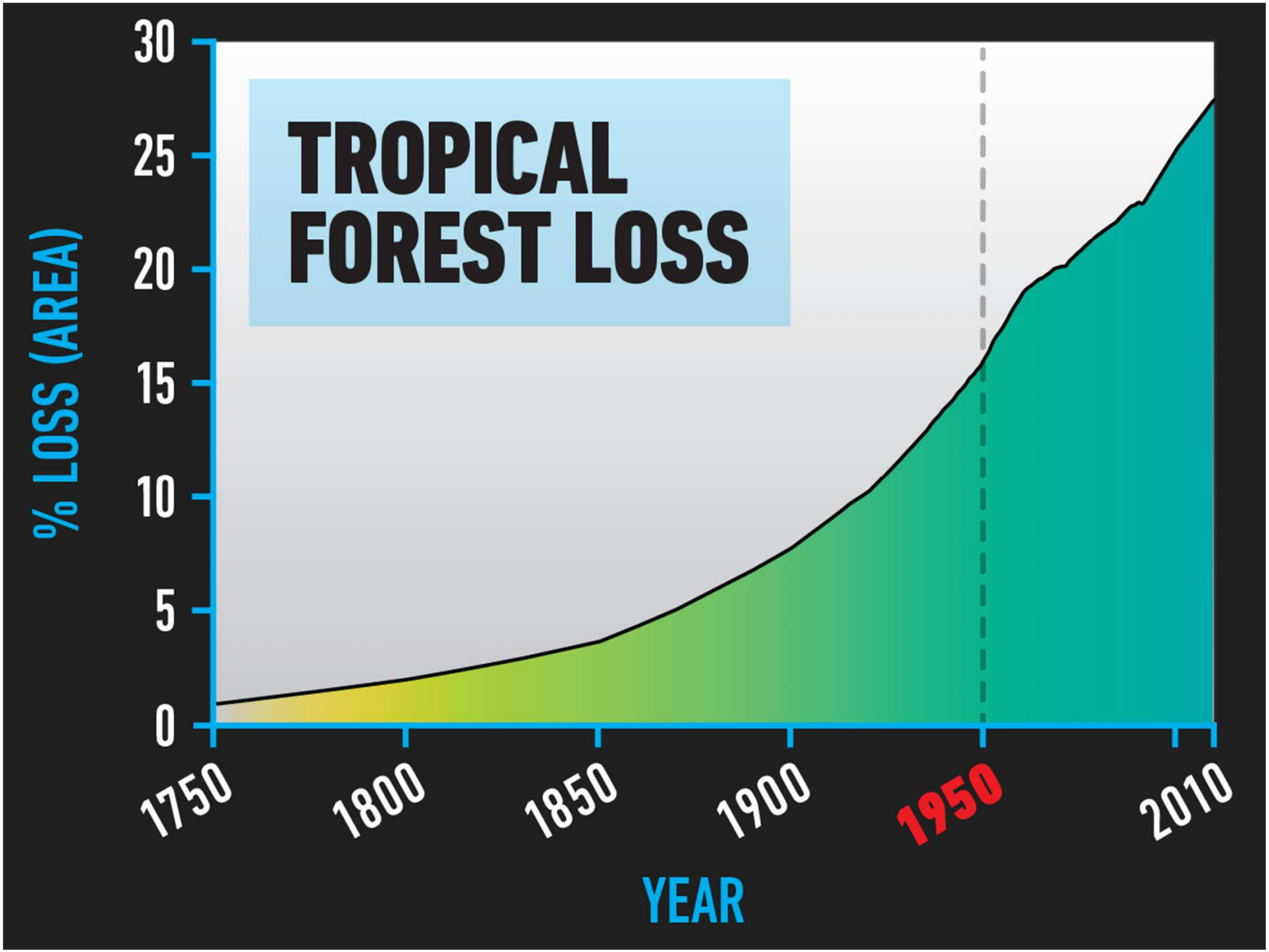

URBAN POPULATION
OECD
BRICS
Others
BILLION
4
3
2
1
0
1750
1800
1850
1900
1950
2010
YEAR

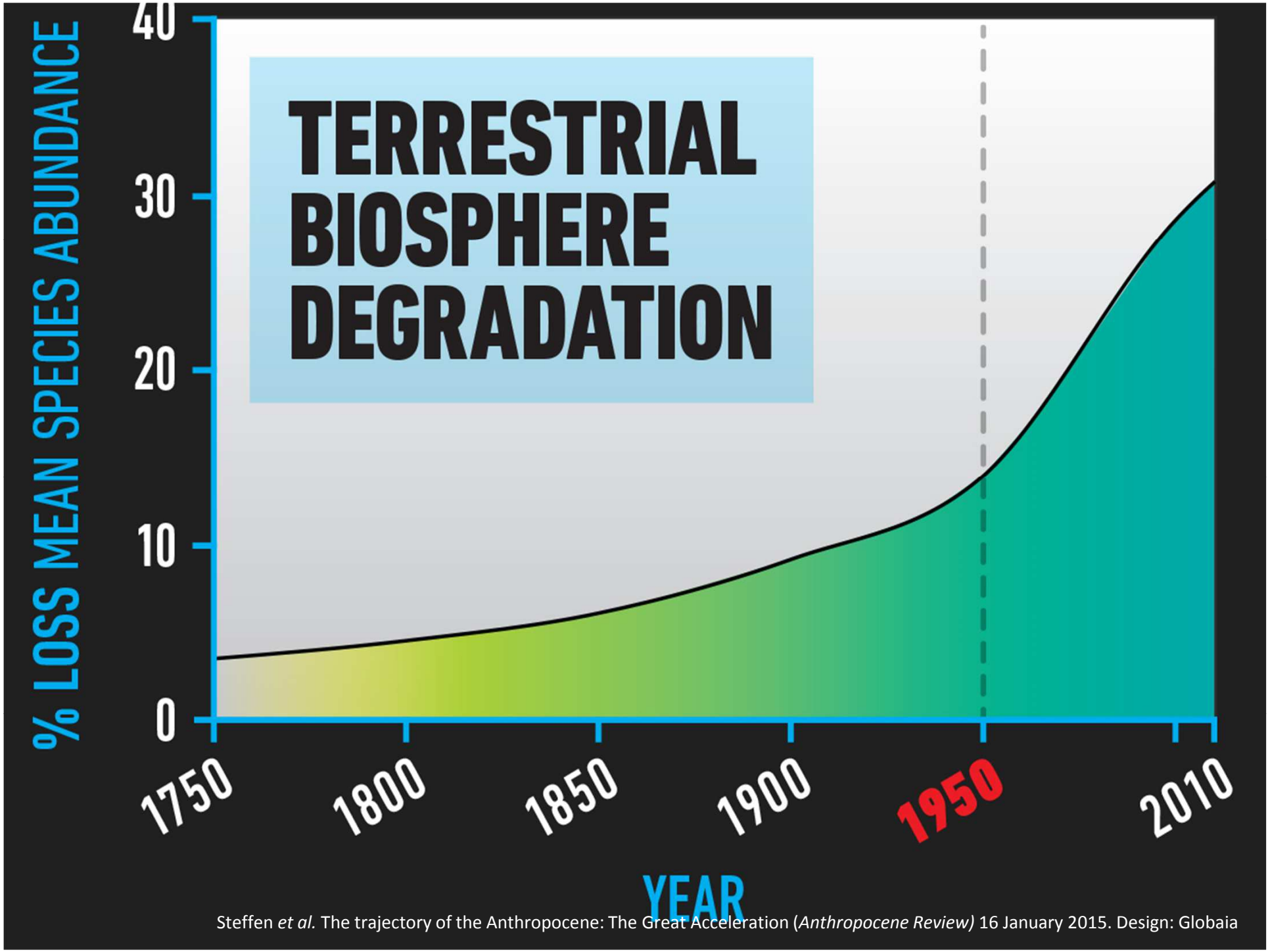

WATER USE
OECD
BRICS
Others
THOUSAND KM³
0
1
2
3
4
1750
1800
1850
1900
1950
2010
YEAR


TRANSPORTATION
OECD
BRICS
Others
MILLION MOTOR VEHICLES
1200
1000
800
700
600
400
200
0
1750
1800
1850
1900
1950
2010
YEAR

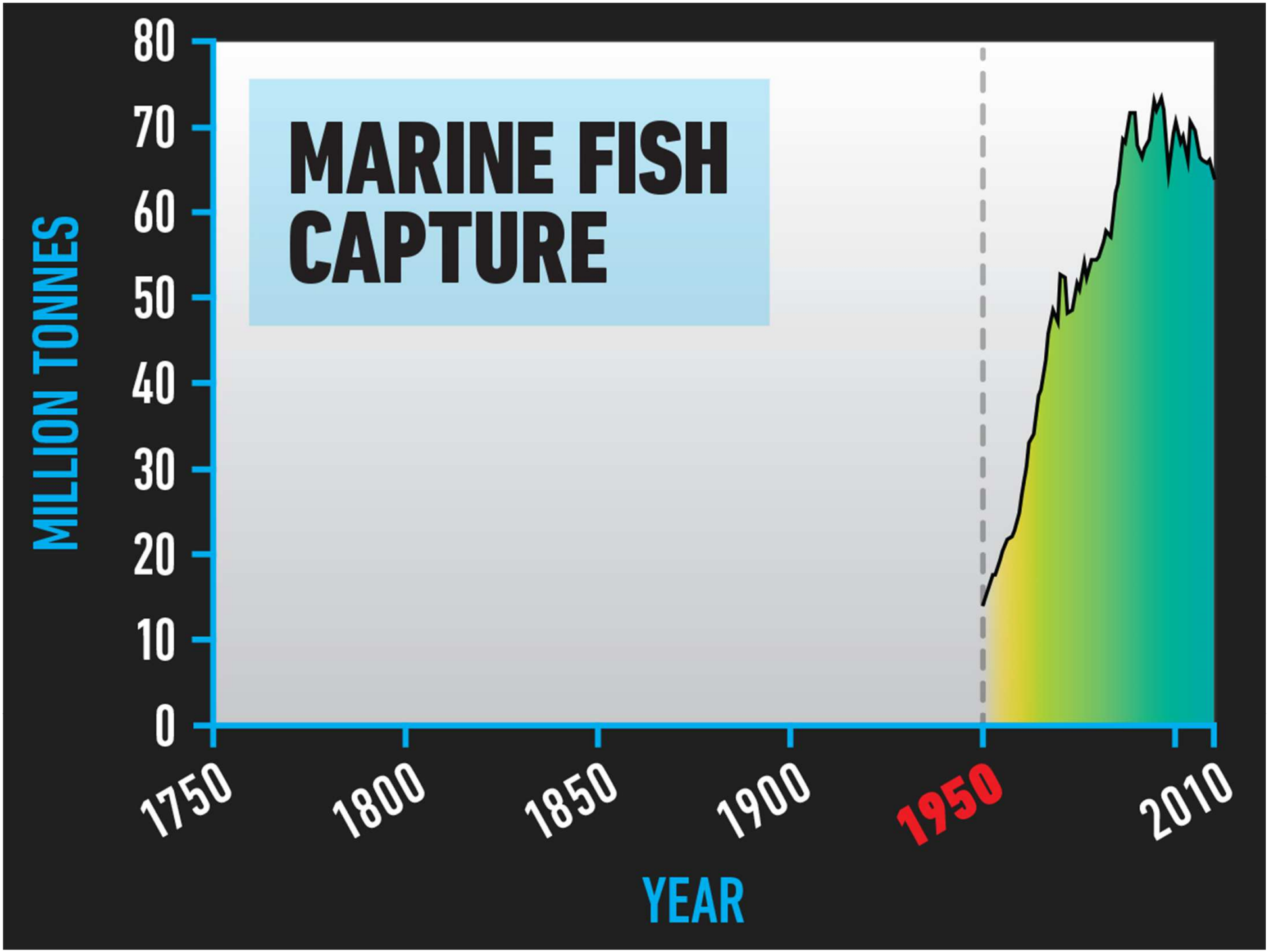

TELE-
COMMUNICATIONS
OECD
BRICS
Others
BILLION PHONE SUBSCRIPTIONS
0
1
2
3
4
5
6
7
1750
1800
1850
1900
1950
2010
YEAR

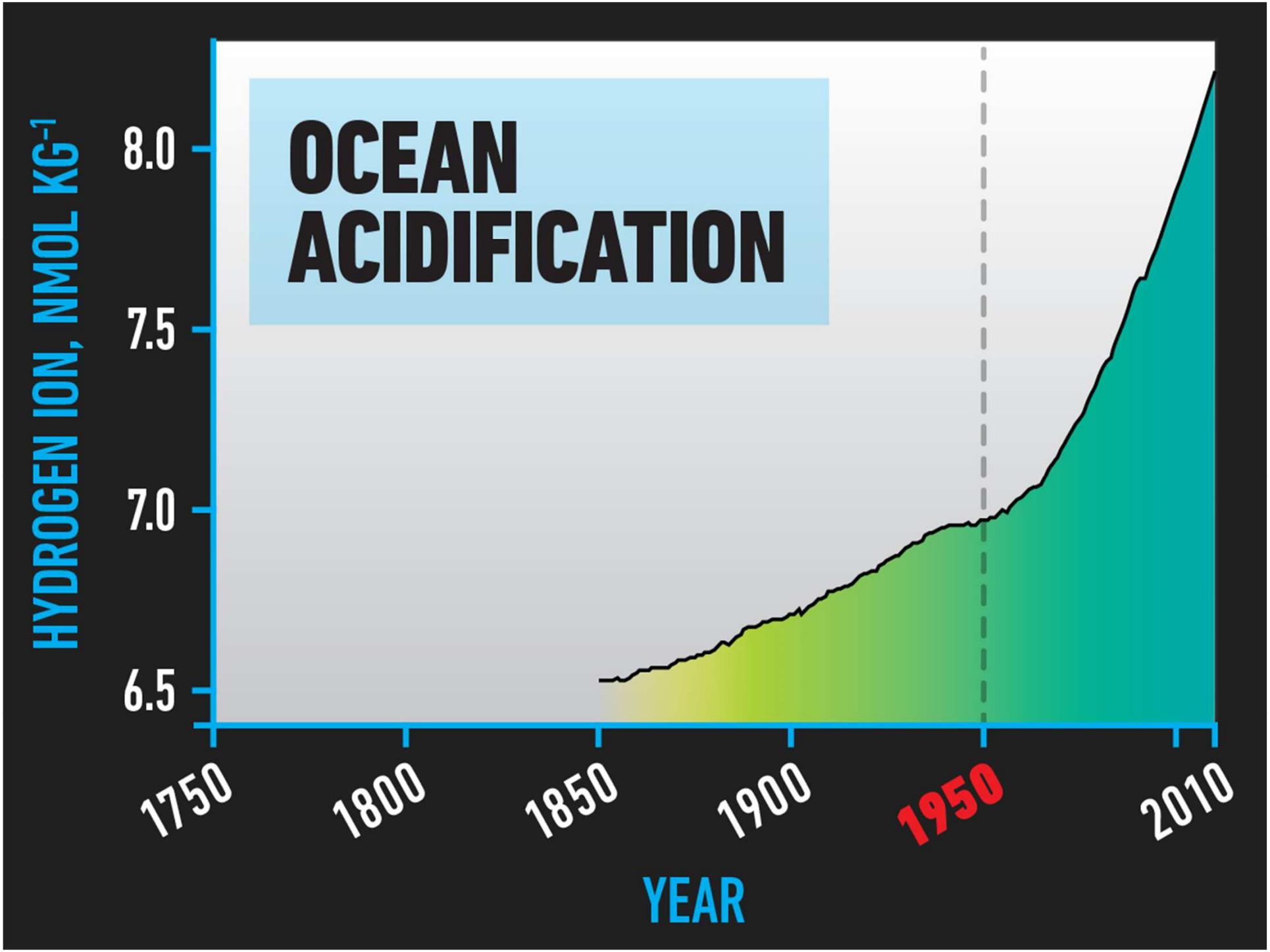

INTERNATIONAL TOURISM
MILLION ARRIVALS
1000
800
600
400
200
0
1750
1800
1850
1900
1950
2010
YEAR

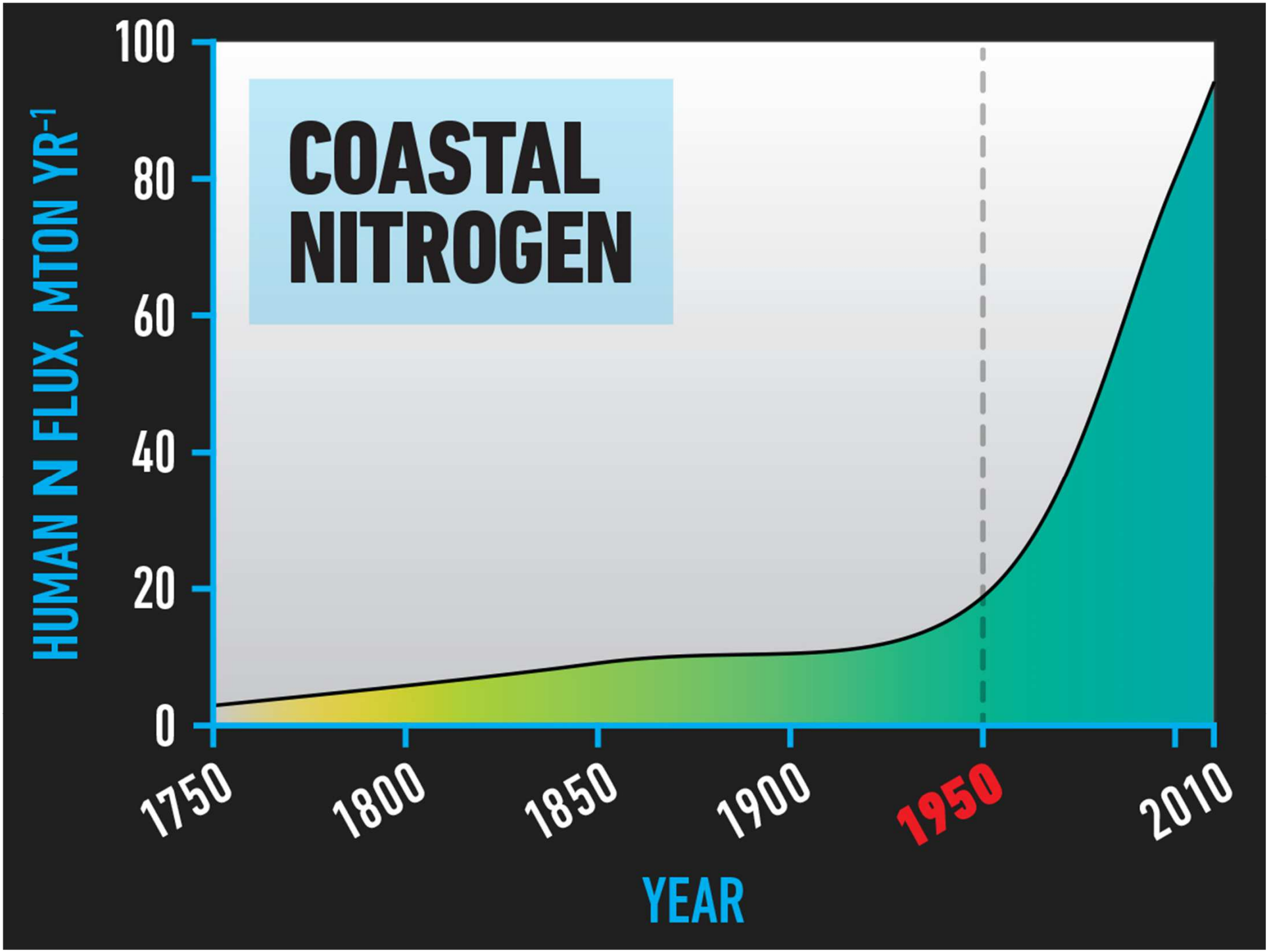

TROPICAL
FOREST LOSS
% LOSS (AREA)
30
25
20
15
10
5
0
1750
1800
1850
1900
1950
2010
YEAR



Steffen *et al.* The trajectory of the Anthropocene: The Great Acceleration (*Anthropocene Review)* 16 January 2015. Design: Globaia


MARINE FISH CAPTURE
MILLION TONNES
80
70
60
50
40
30
20
10
0
1750
1800
1850
1900
1950
2010
YEAR


OCEAN ACIDIFICATION
HYDROGEN ION, NMOL KG-1
8.0
7.5
7.0
6.5
1750
1800
1850
1900
1950
2010
YEAR


COASTAL NITROGEN
HUMAN N FLUX, MTON YR-1
100
80
60
40
20
0
1750
1800
1850
1900
1950
2010
YEAR

The trajectory of the Anthropocene: The Great Acceleration

Will Steffen, Wendy Broadgate, Lisa Deutsch ,Owen Gaffney and Cornelia Ludwig

20015 *Anthropocene Review*

Based on Steffen *et al.* (2004) Global Change and the Earth System

More information

www.igbp.net

www.stockholmresilience.org

www.futureearth.info

www.globaia.org

www.anthropocene.info

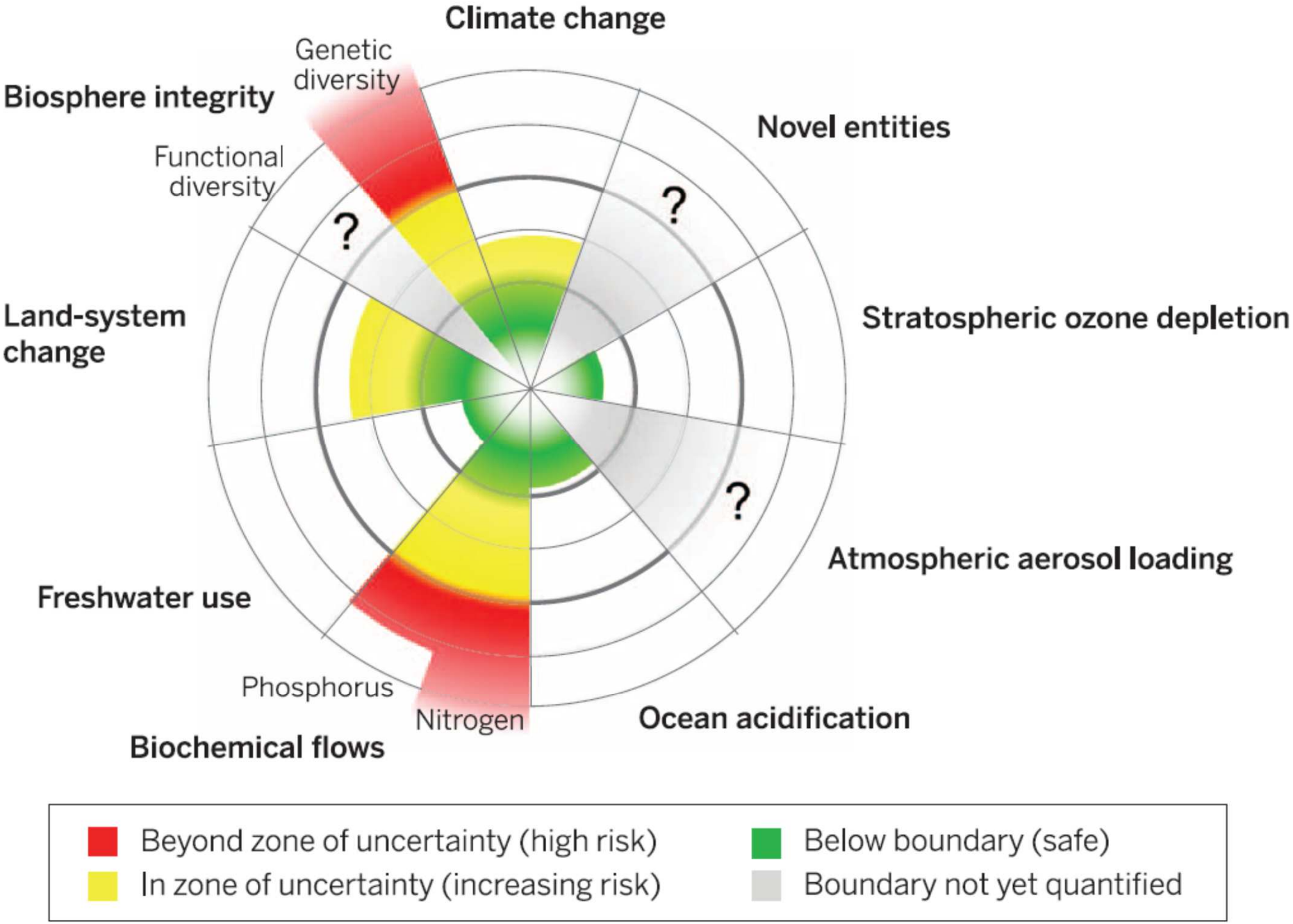
SCIENCE, 13 FEBRUARY 2015 • VOL 347 ISSUE 6223

RESEARCH ARTICLE

SUSTAINABILITY

Planetary boundaries: Guiding human development on a changing planet

Will Steffen,[1,2]* Katherine Richardson,[3] Johan Rockström,[1] Sarah E. Cornell,[1] Ingo Fetzer,[1] Elena M. Bennett,[4] Reinette Biggs,[1,5] Stephen R. Carpenter,[6] Wim de Vries,[7,8] Cynthia A. de Wit,[9] Carl Folke,[1,10] Dieter Gerten,[11] Jens Heinke,[11,12,13] Georgina M. Mace,[14] Linn M. Persson,[15] Veerabhadran Ramanathan,[16,17] Belinda Reyers,[1,18] Sverker Sörlin[19]


Climate change
Genetic diversity
Biosphere integrity
Novel entities
Functional diversity
?
?
Land-system change
Stratospheric ozone depletion
?
Atmospheric aerosol loading
Freshwater use
Phosphorus
Nitrogen
Ocean acidification
Biochemical flows
Beyond zone of uncertainty (high risk)
In zone of uncertainty (increasing risk)
Below boundary (safe)
Boundary not yet quantified

“Piensa globalmente, actúa localmente”

¿Pensamos globalmente, en términos del conjunto del sistema Tierra, cuando hablamos de sostenibilidad?

Tenemos que desarrollar una mentalidad planetaria

The first day or so we all pointed to our countries. The third or fourth day we were pointing to our continents. By the fifth day we were aware of only one Earth’

Sultan Bin Salman al-Saud, astronauta, 1985