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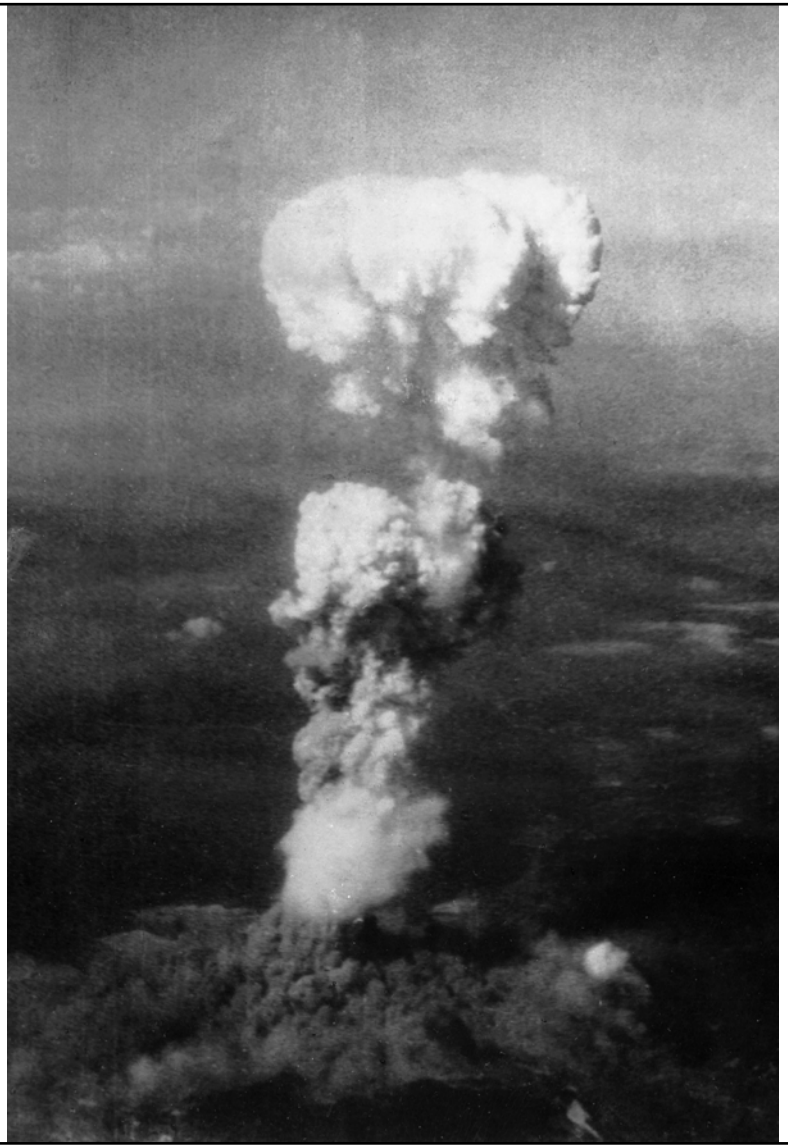

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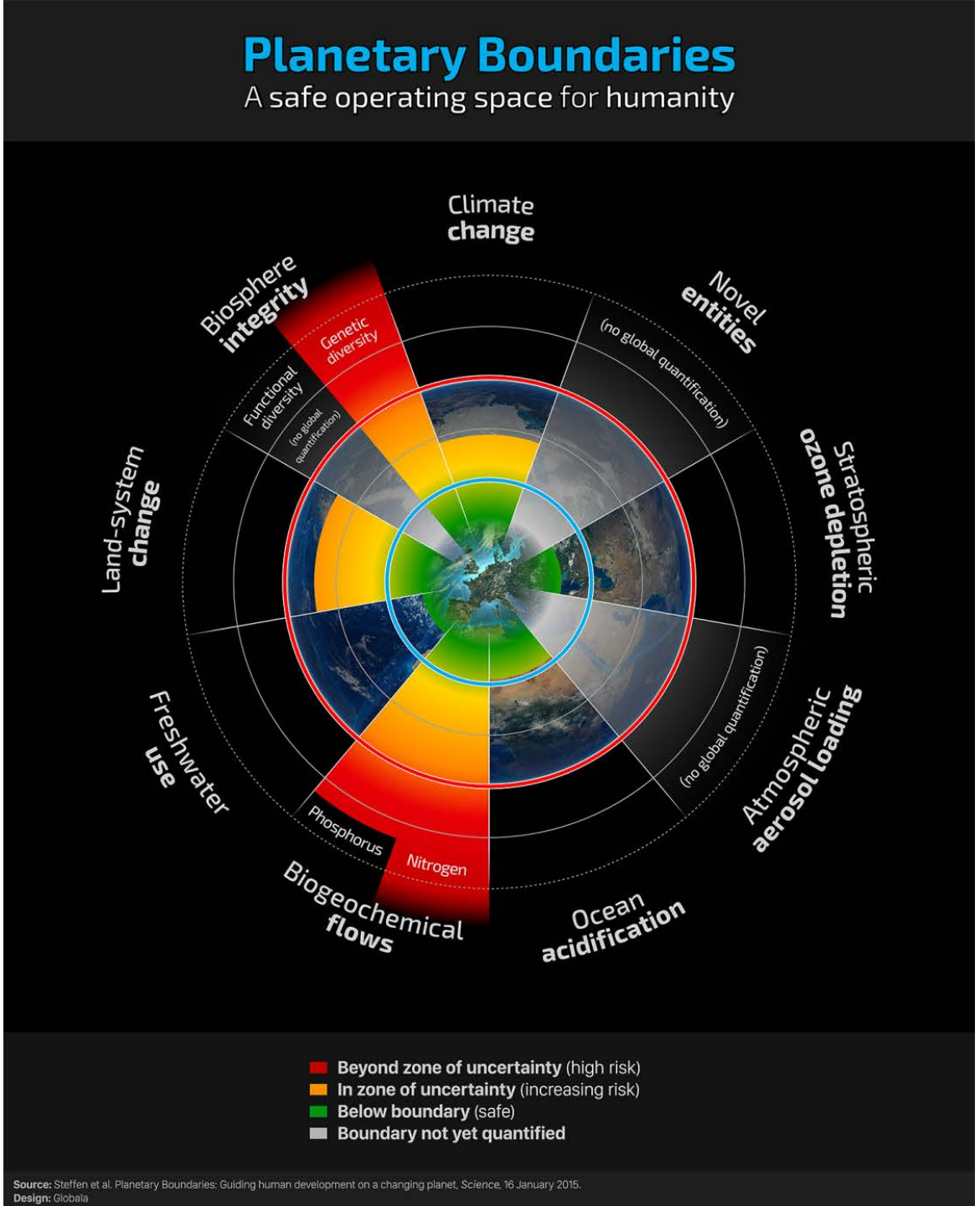
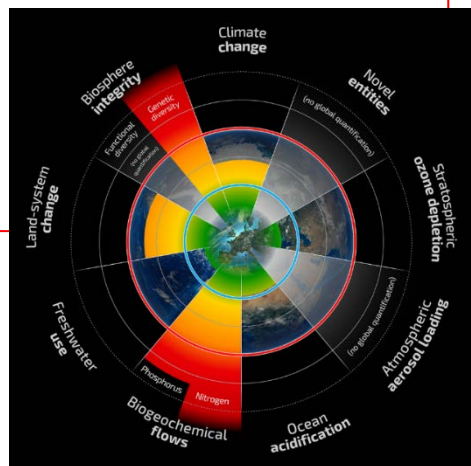
Překročení hranic?



II. Globální změna klimatu

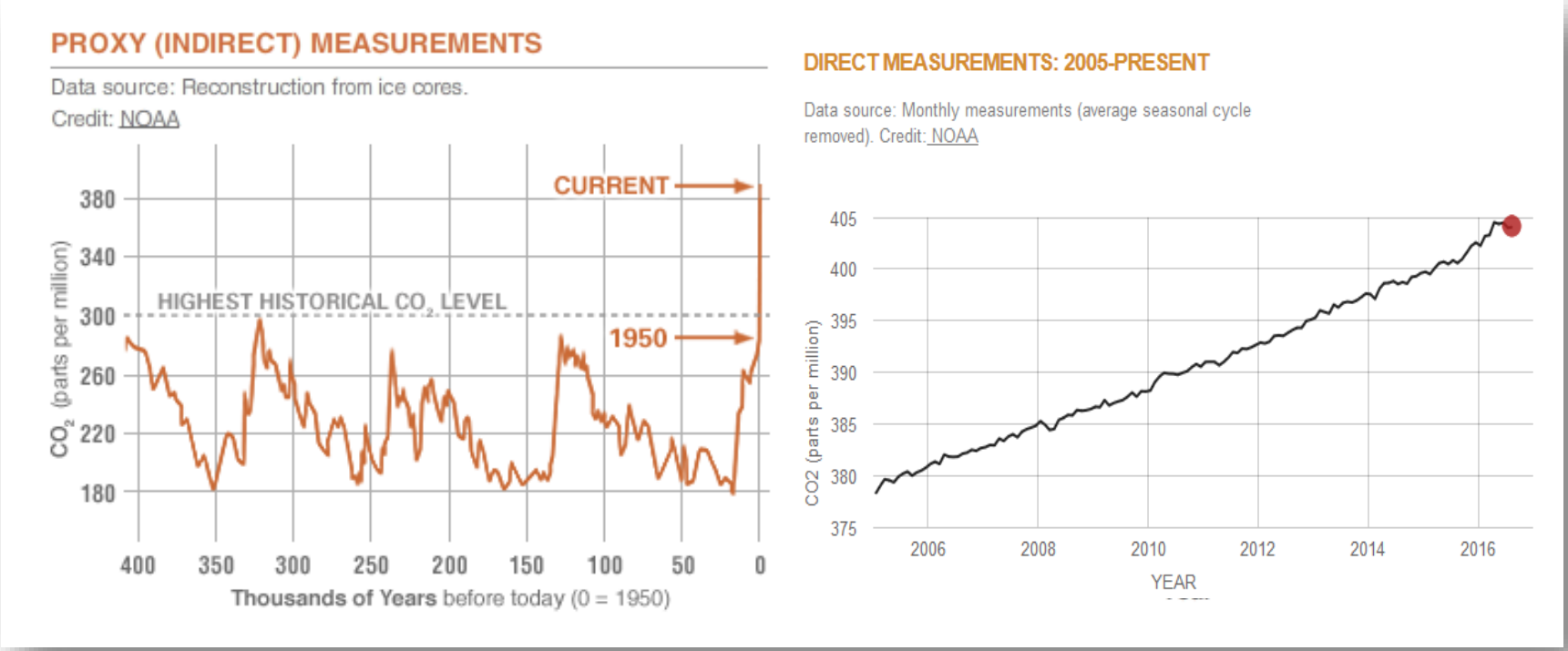
Earth System process	Control variable	Threshold avoided or influenced by slow variable	Planetary Boundary (zone of uncertainty)	State of knowledge*
Climate change	Atmospheric CO_2 concentration, ppm; Energy imbalance at Earth's surface, W m^{-2}	Loss of polar ice sheets. Regional climate disruptions. Loss of glacial freshwater supplies. Weakening of carbon sinks.	Atmospheric CO_2 concentration: 350 ppm (350–550 ppm) Energy imbalance:+1 W m^{-2} (+1.0–+1.5 W m^{-2})	1. Ample scientific evidence. 2. Multiple sub-system thresholds. 3. Debate on position of boundary.

Boundary: Atmospheric CO_2 concentration no higher than 350 ppm
Pre-industrial level: 280 ppm
Current level: 387 ppm
Diagnosis: Boundary exceeded



Růst koncentrace CO_2

- Koncentrace CO_2 – 416 ppm (2021) = ? %
- koncentrace CO_2 vzrostla o 35 % od roku 1950 (310 ppm)
- spalování fosilních paliv zodpovídá za asi 80 % nárůstu



Skleníkový jev - historie

Tyndall Centre for Climate Change Research

Tipněte rok, kdy byl popsán skleníkový jev v atmosféře?

Skleníkový jev - historie

1824 – Joseph Fourier popsal skleníkový jev v atmosféře

1861 – John Tyndall určil vodní páru a další plyny za skleníkové

Tyndall Centre for Climate Change Research

1896 – Svante Arhenius řekl hypotézu o zvýšení intenzity skleníkového jevu vlivem produkce CO_2 spalováním fos. paliv

- prognóza o vzrůstu o několik stuňů °C při zdvojnásobení konc. GHG stále platí

Skleníkový jev - historie

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- prgonóza o vzrůstu o několik stuňů °C při zdvojnásobení konc. GHG stále platí

1957 – oceánograf Roger Revelle a chemik Hans Suess ukázali, že oceány nedokáží absorbovat veškerý CO_2 produkovaný lidmi

"Human beings are now carrying out a large scale geophysical experiment.„

Skleníkový jev a… politika

1972 – *UNCHE, Stockholm.* Změna klimatu se stává prioritní mezinárodní agendou

1990 – 1st report IPCC – „vzrůst teploty o 0,3-0,6 °C je i díky vlivu člověka“

1992 – *Earth summit* – Rámcová úmluva o CC

2005 – Kyótský protokol

2013 - 5th – report IPCC -„ vědci jsou si z 95% jisti, že jsou lidé dominantní příčinou vzrůstu teploty od roku 1950“

2016, 4.11. – Pařížská dohoda vstoupila v platnost

2021 – 6th report IPCC – 1. část

2021 – 31.10.-12.11. UN CC C Glasgow

UN CLIMATE CHANGE CONFERENCE UK 2021

IN PARTNERSHIP WITH ITALY

Skleníkový jev a globální změna klimatu

Skleníkový jev a globální změna klimatu

- skleníkový jev - přirozený atmosférický jev nutný pro život

- skl. jev tlumí vysoké výkyvy teplot mezi nocí a dnem a zajišťuje příznivé klima pro život

-117 °C x 100 °C

How Do Greenhouse Gases Actually Work?

Video ;-)

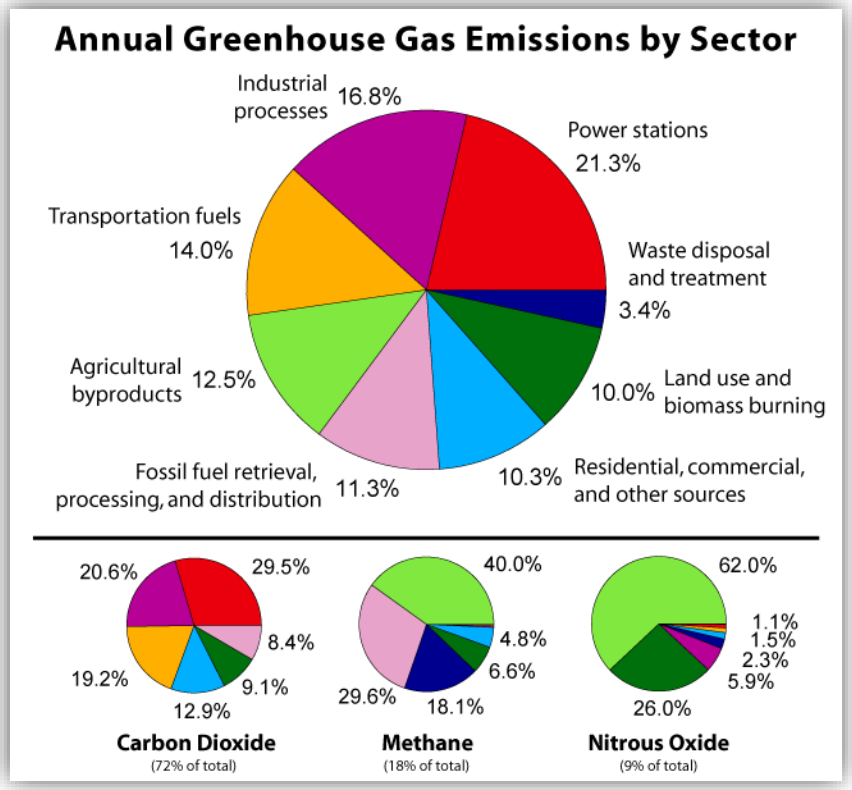
Skleníkové plyny *(greenhouse gases)*

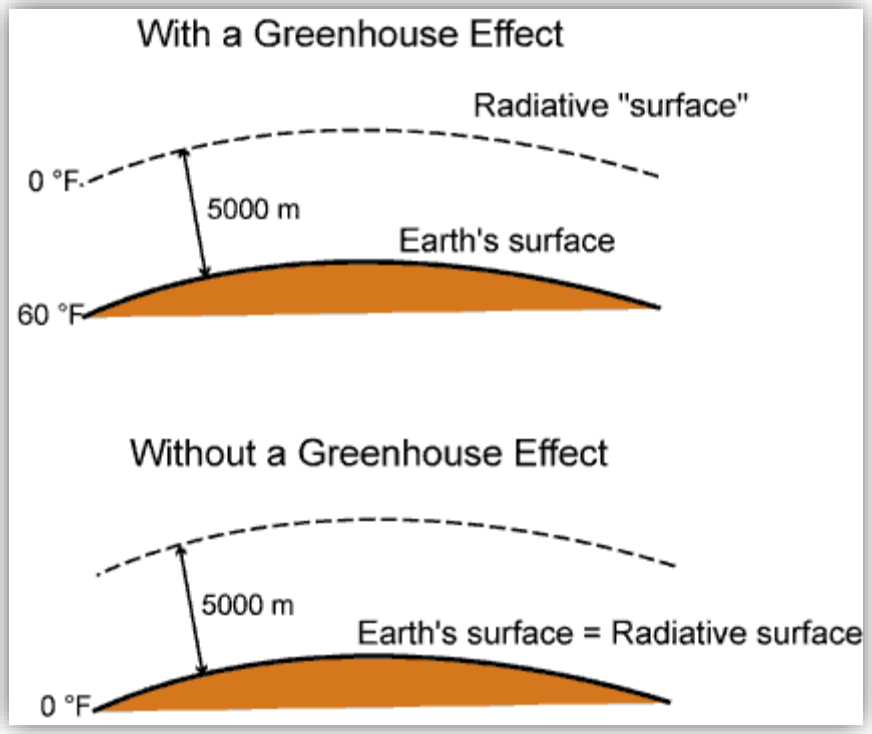
Jaké znáte skleníkové plyny?

Skleníkové plyny *(greenhouse gases)*

- nejdůležitější skleníkový plyn (po $H_2O(g)$ ~ 2/3 skleníkového jevu) je oxid uhličitý - **CO_2** (~ 20 % skleníkového efektu)

- zbylých 13 % skleníkového jevu – CH_4, O_3, N_2O, CFC a další látky





Skleníkové plyny *(greenhouse gases)*

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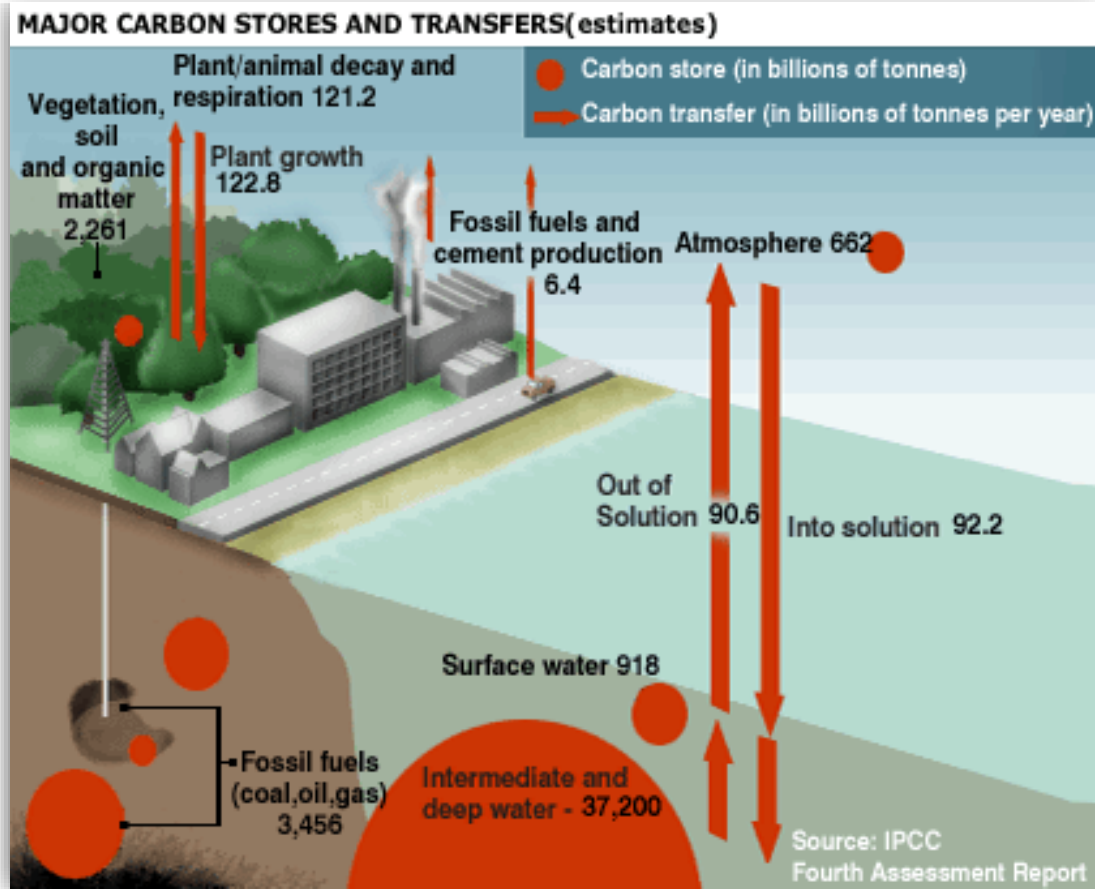
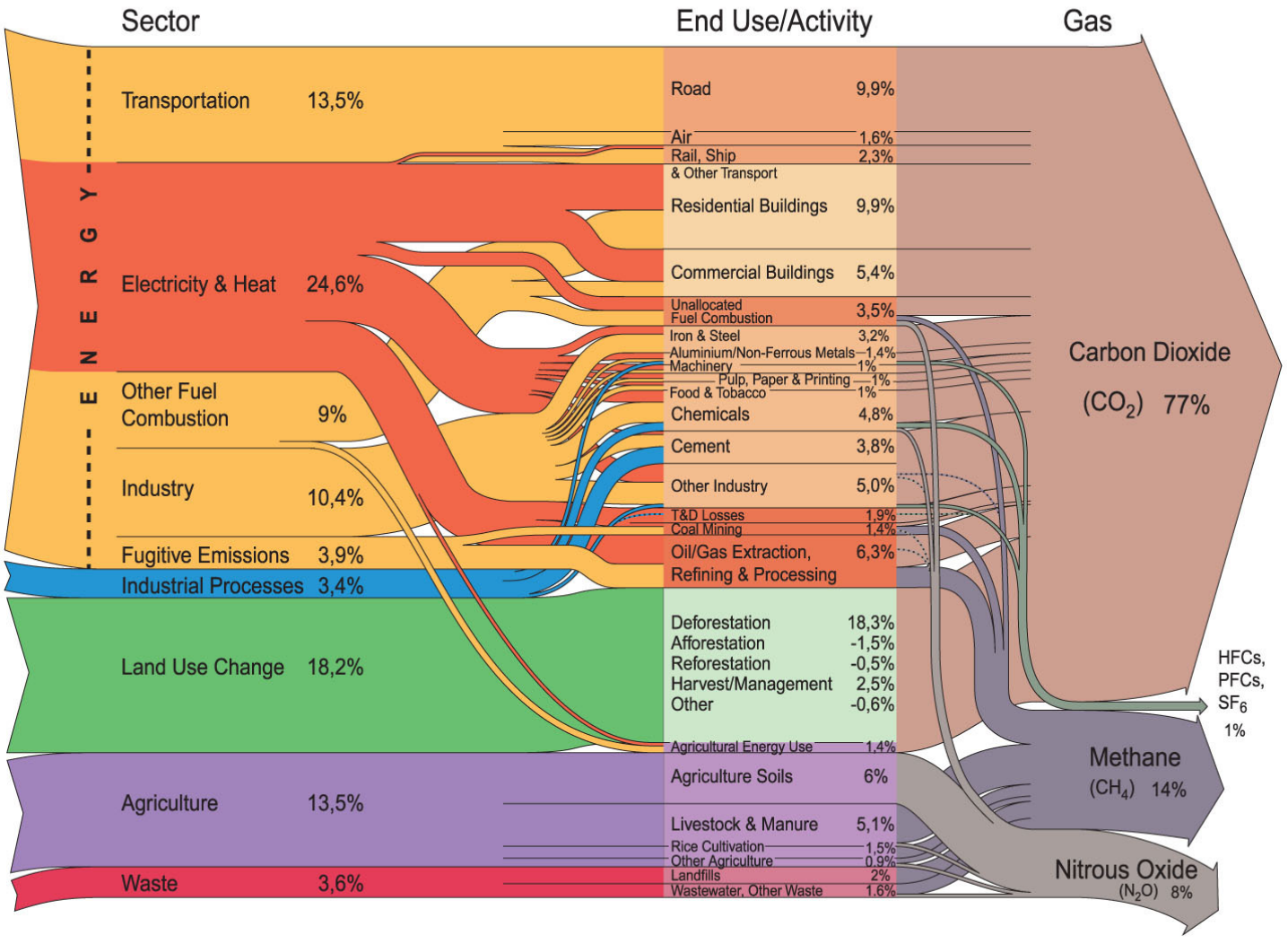
- zbylých 13 % skleníkového jevu – CH_4, O_3, N_2O, CFC a další látky

Problém

- růst koncentrace CO_2 v atmosféře narušením rovnováhy uvolňování a pohlcování CO_2 v geochemickém cyklu uhlíku



World Greenhouse gas emissions by sector



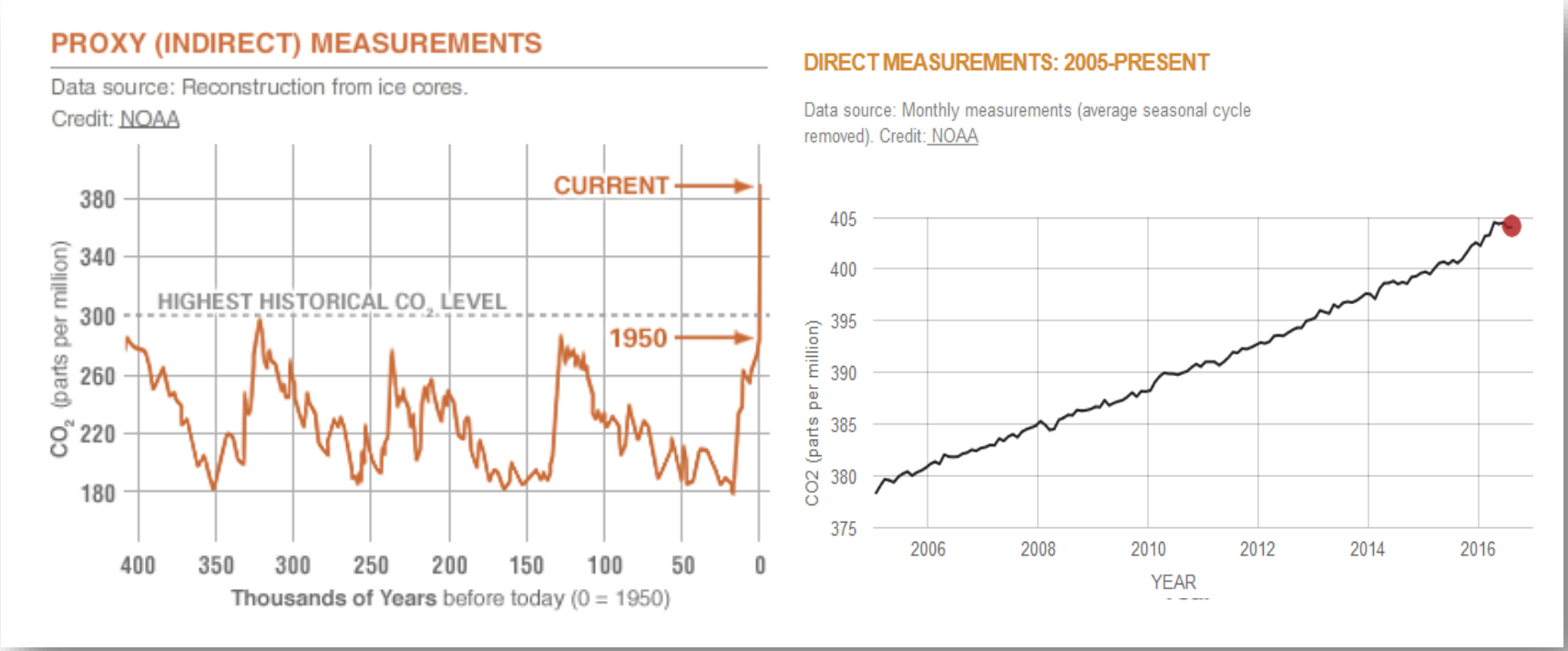
All data is for 2000. All calculations are based on CO_2 equivalents, using 100-year global warming potentials from the IPCC (1996), based on a total global estimate of 41 755 $MtCO_2$ equivalent. Land use change includes both emissions and absorptions. Dotted lines represent flows of less than 0.1% percent of total GHG emissions.

Source: World Resources Institute, Climate Analysis Indicator Tool (CAIT), Navigating the Numbers: Greenhouse Gas Data and International Climate Policy, December 2005; Intergovernmental Panel on Climate Change, 1996 (data for 2000).

Indikátory globálního oteplování a změny klimatu

Růst koncentrace CO_2

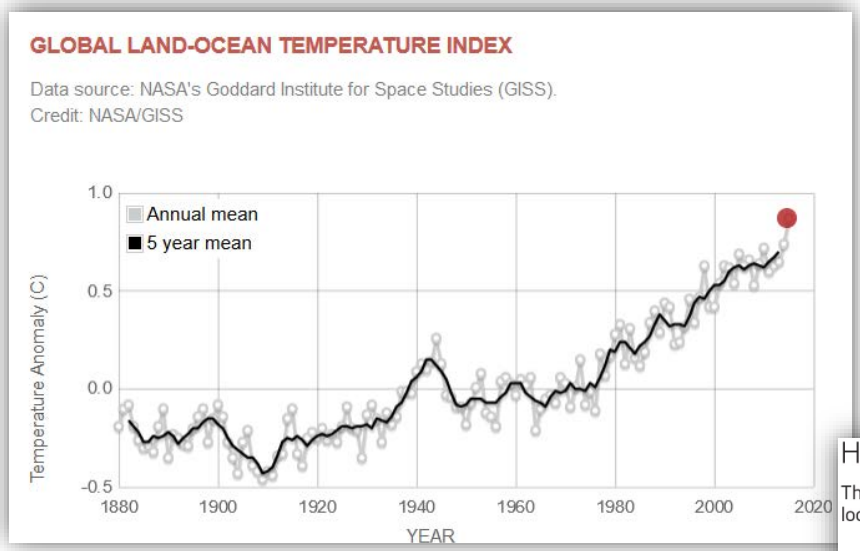
- Koncentrace CO_2 – 416 ppm (2016) = ? %
- koncentrace CO_2 vzrostla o 35 % od roku 1950 (310 ppm)
- spalování fosilních paliv zodpovídá za asi 80 % tohoto vzrůstu

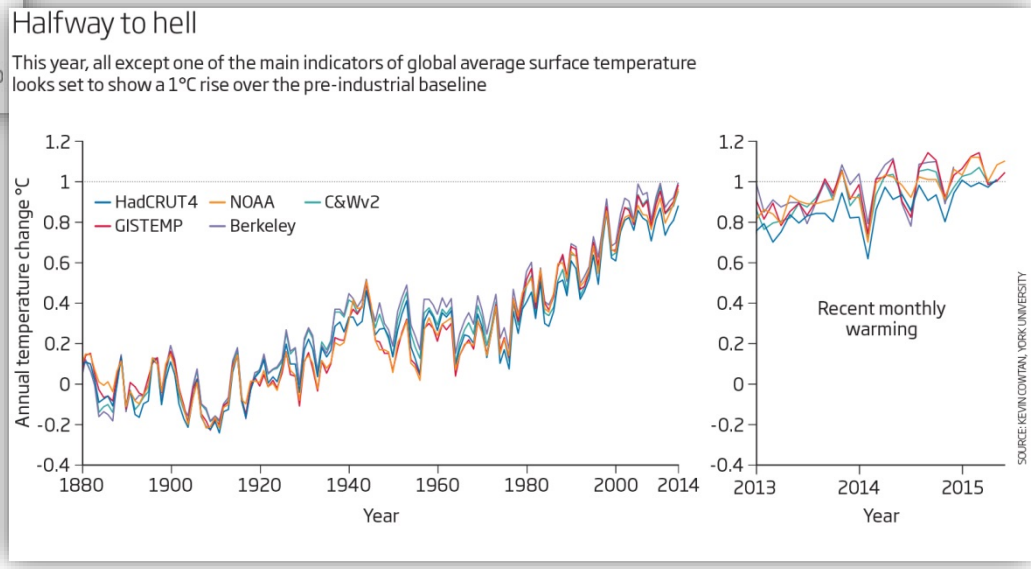


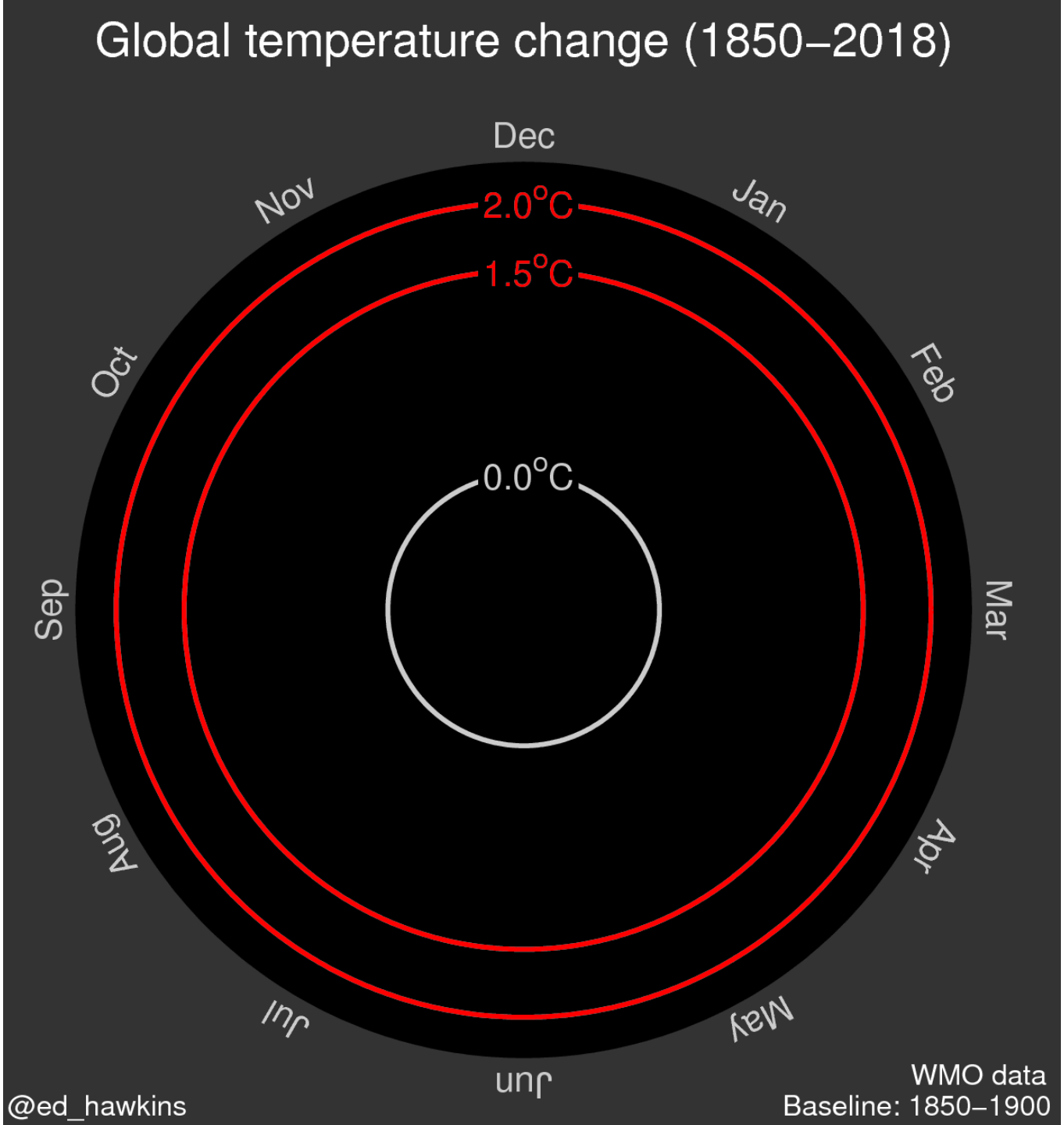
Jaký další parametry popisující klimatický systém (indikátory) by se daly měřit?

Další indikátory GW a změn klimatu

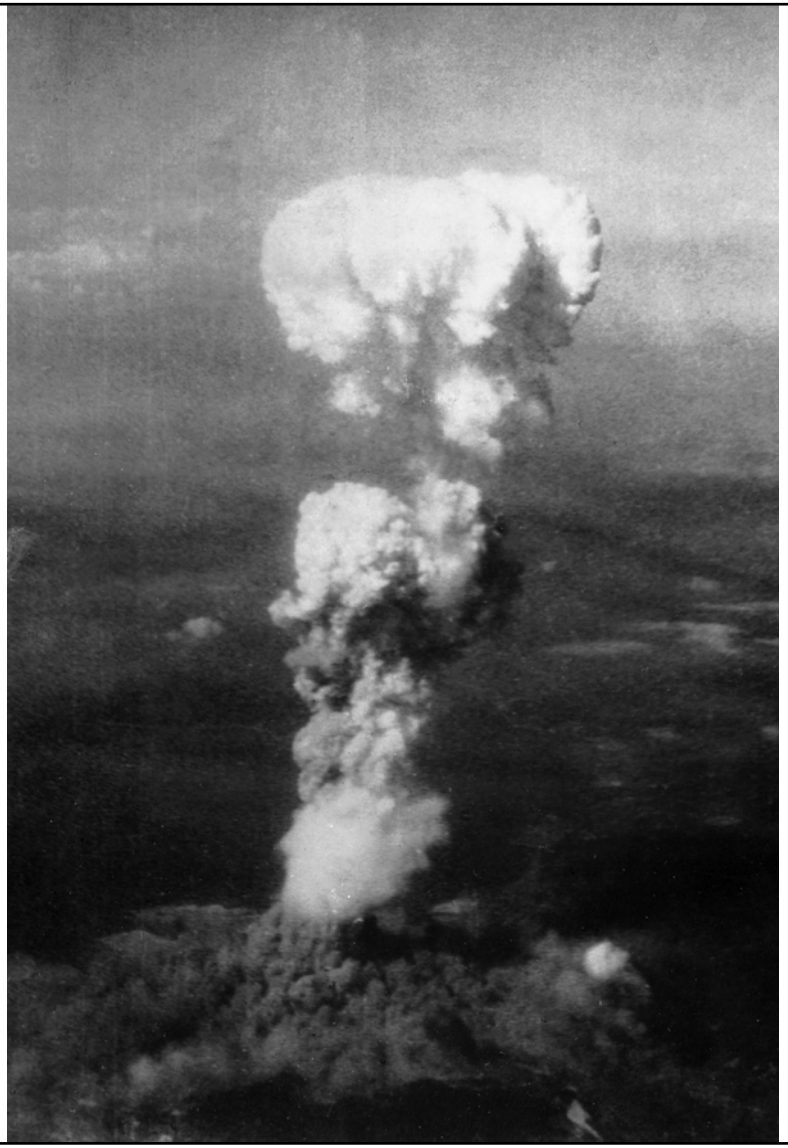
- teplota, zalednění severního ledového oceánu, zalednění severního a jižního pólu (pevnina), výška hladiny moří






Global temperature change (1850–2018)
Dec
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
2.0°C
1.5°C
0.0°C
@ed_hawkins
WMO data
Baseline: 1850–1900

4x

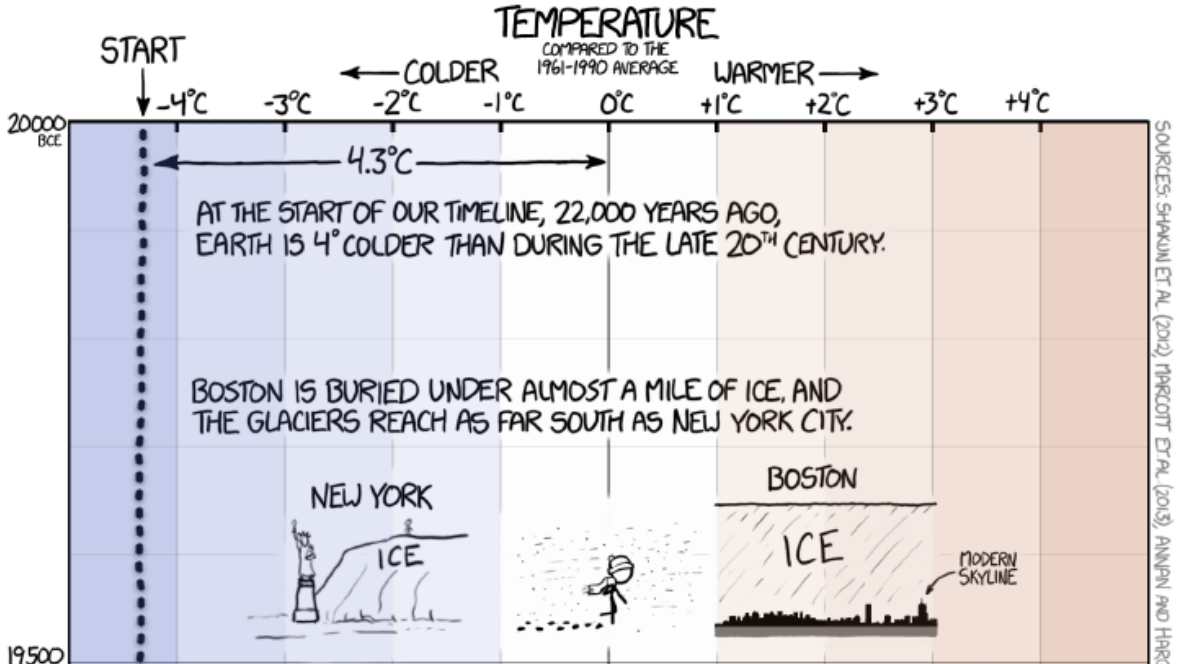


/s

A TIMELINE OF EARTH'S AVERAGE TEMPERATURE

SINCE THE LAST ICE AGE GLACIATION

WHEN PEOPLE SAY "THE CLIMATE HAS CHANGED BEFORE,"
THESE ARE THE KINDS OF CHANGES THEY'RE TALKING ABOUT.



SOURCES: SHAKUN ET AL. (2012), MARCOTT ET AL. (2013), ANNAN AND HARGREAVES (2013), HADCRUT4, IPCC

Úbytek ledu v Arktidě

Úbytek ledu v Arktidě - umožnění severní cesty

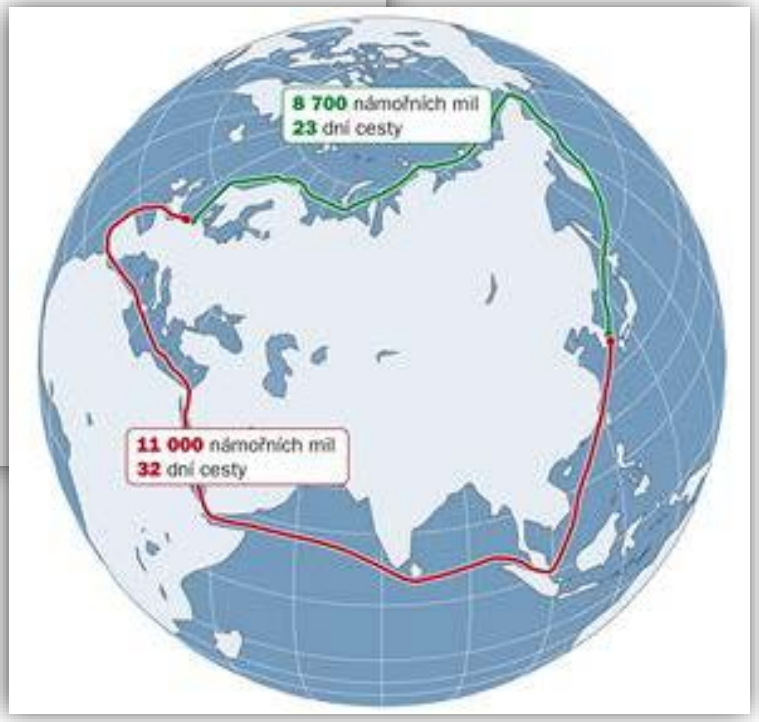
Ledy tají, lodě testují severní cestu z Asie do Evropy

10. září 2009 10:05

Projet s nákladem euroasijský kontinent přes Severní ledový oceán se zdá být dobrý nápad. Ušetříte peníze i dny cesty, které by spolkla cesta přes Suezský průplav. Nyní se o to pokouší první západní rejdařství. Proč až nyní, když jsou výhody tak zřejmé? Ona totiž dosud příroda nechtěla příliš spolupracovat.

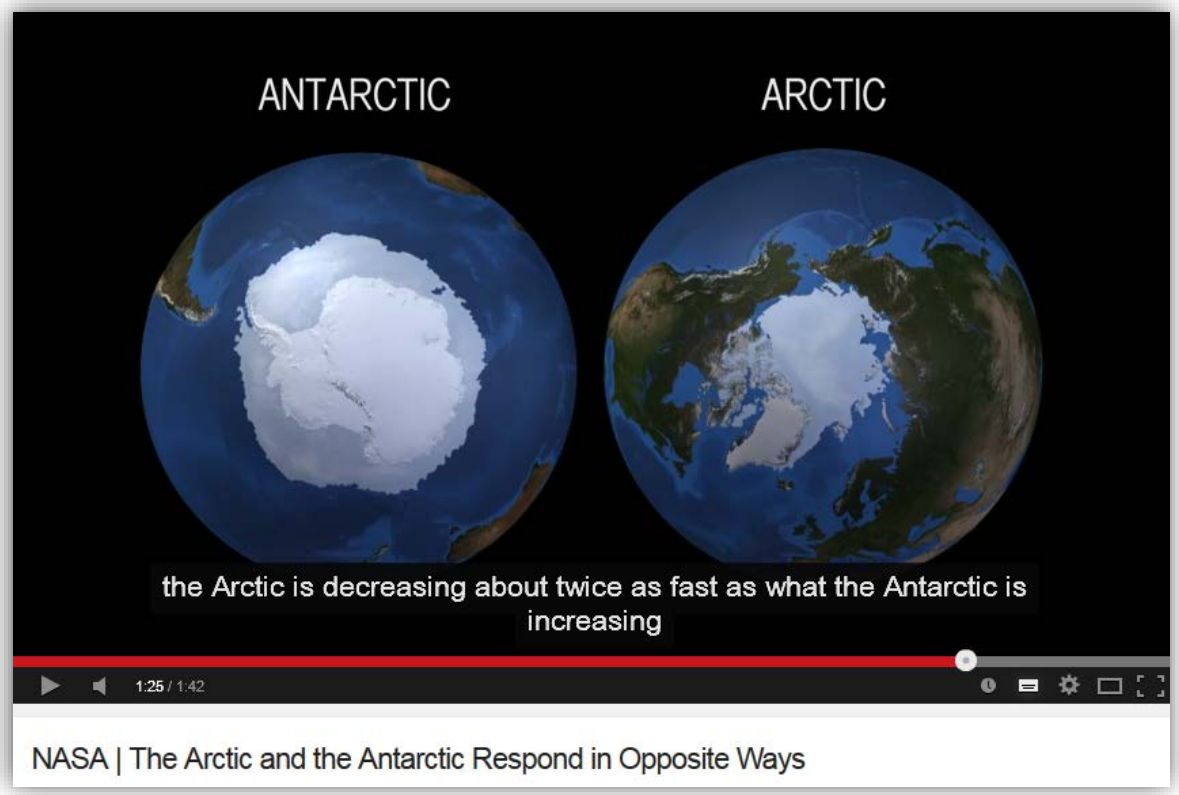
Dvě nákladní lodě hamburského rejdařství v Barentsově moři. | foto: Beluga Shipping

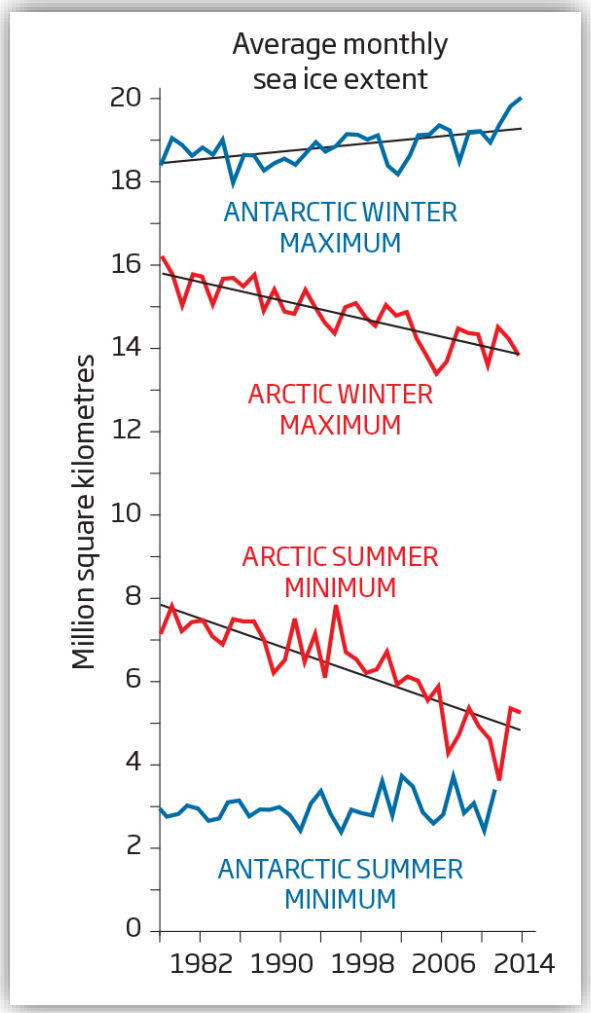
Cestu uvolnilo až globální oteplování, kvůli němuž již severní vody nezůstávají v jedné neproniknutelné krustě ledu, ale roztávají a rozpadají se tak, že jimi propluje nejen ledoborec, ale i nákladní loď. Alespoň v určitém období roku a na většině cesty.



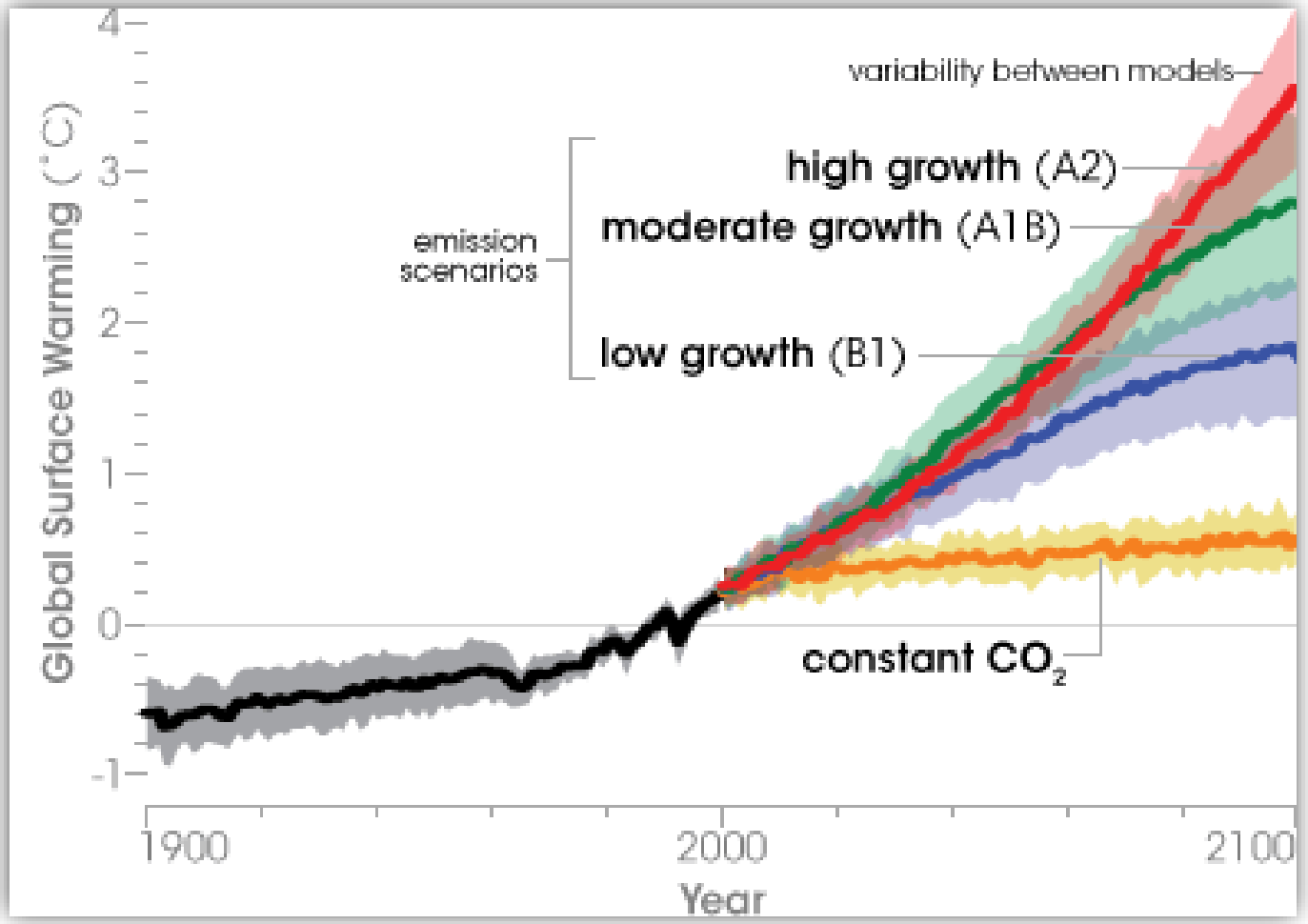
Nárůst zamrzání antarktického moře

- důsledek změny klimatu
- zintenzivnění chladných větrů z pevniny – ochlazení oceánu





Výhled růstu globální teploty do 2100



- vědecká vs. politická nejistota

Modelace x skutečné projevy

Climate change: It's even worse than we thought

(Image: Saul Loeb/AFP/Getty)

Five years ago, the last report of the Intergovernmental Panel on Climate Change painted a gloomy picture of our planet's future. As climate scientists gather evidence for the next report, due in 2014, **Michael Le Page** gives seven reasons why things are looking even grimmer

ARCTIC WARMING

The thick sea ice in the

EDITORIAL

Obama should fulfil his 2008 climate promises

Extreme events caused by warming are happening much sooner than we thought they would. It's time for Obama to act

Read more

CLIMATE CHANGE

Wiping out top predators messes up the climate

This week's issue

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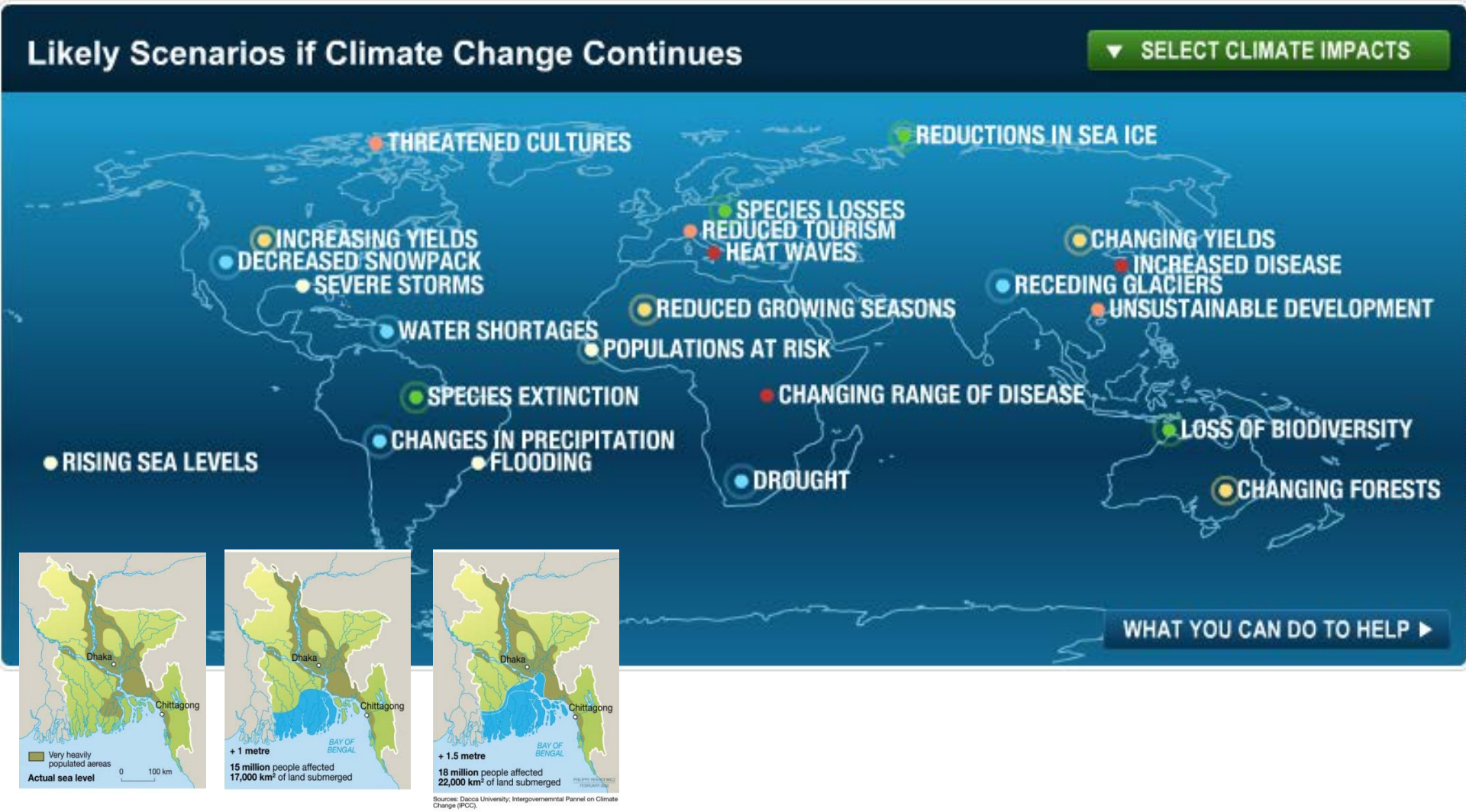
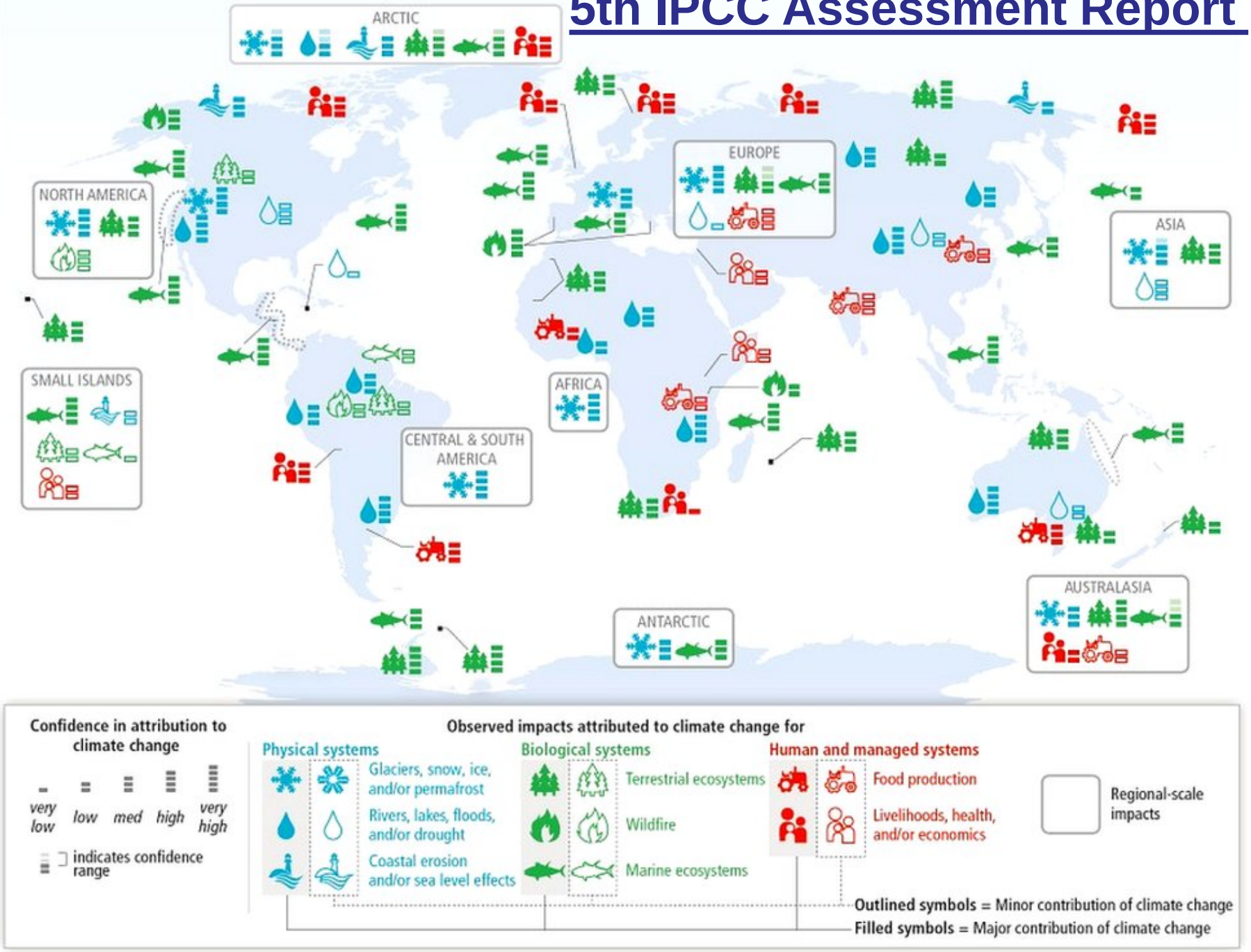
Důsledky změny klimatu

Důsledky globální změny klimatu

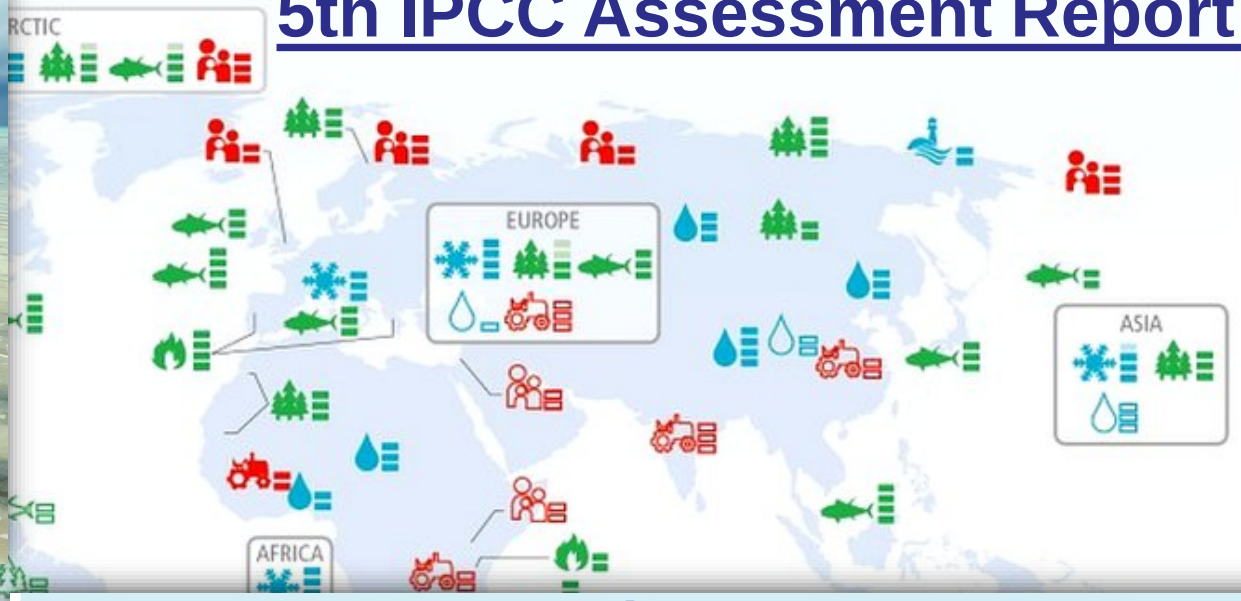
- regionálně specifické



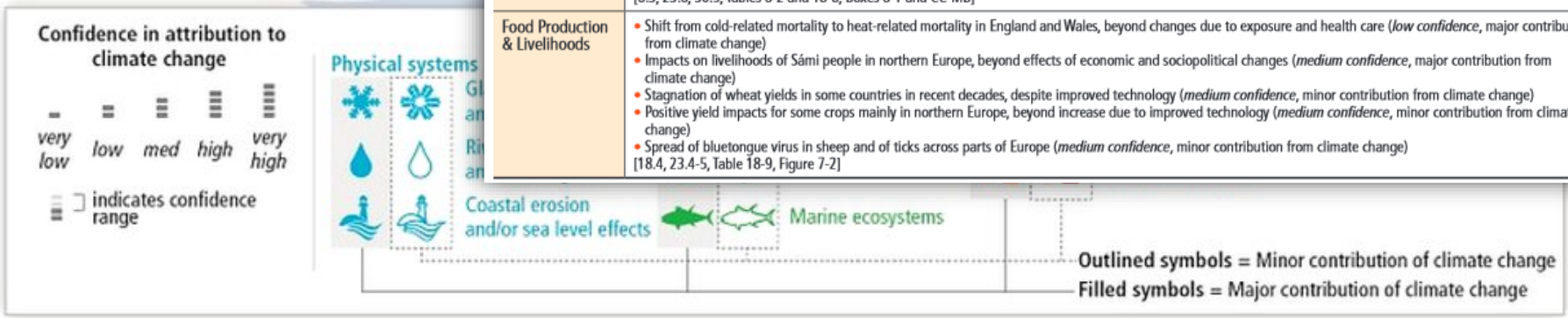
5th IPCC Assessment Report



5th IPCC Assessment Report



Europe	
Snow & Ice, Rivers & Lakes, Floods & Drought	• Retreat of Alpine, Scandinavian, and Icelandic glaciers (*high confidence*, major contribution from climate change) • Increase in rock slope failures in western Alps (*medium confidence*, major contribution from climate change) • Changed occurrence of extreme river discharges and floods (*very low confidence*, minor contribution from climate change) [18.3, 23.2-3, Tables 18-5 and 18-6; WGI AR5 4.3]
Terrestrial Ecosystems	• Earlier greening, leaf emergence, and fruiting in temperate and boreal trees (*high confidence*, major contribution from climate change) • Increased colonization of alien plant species in Europe, beyond a baseline of some invasion (*medium confidence*, major contribution from climate change) • Earlier arrival of migratory birds in Europe since 1970 (*medium confidence*, major contribution from climate change) • Upward shift in tree-line in Europe, beyond changes due to land use (*low confidence*, major contribution from climate change) • Increasing burnt forest areas during recent decades in Portugal and Greece, beyond some increase due to land use (*high confidence*, major contribution from climate change) [4.3, 18.3, Tables 18-7 and 23-6]
Coastal Erosion & Marine Ecosystems	• Northward distributional shifts of zooplankton, fishes, seabirds, and benthic invertebrates in northeast Atlantic (*high confidence*, major contribution from climate change) • Northward and depth shift in distribution of many fish species across European seas (*medium confidence*, major contribution from climate change) • Plankton phenology changes in northeast Atlantic (*medium confidence*, major contribution from climate change) • Spread of warm water species into the Mediterranean, beyond changes due to invasive species and human impacts (*medium confidence*, major contribution from climate change) [6.3, 23.6, 30.5, Tables 6-2 and 18-8, Boxes 6-1 and CC-MB]
Food Production & Livelihoods	• Shift from cold-related mortality to heat-related mortality in England and Wales, beyond changes due to exposure and health care (*low confidence*, major contribution from climate change) • Impacts on livelihoods of Sámi people in northern Europe, beyond effects of economic and sociopolitical changes (*medium confidence*, major contribution from climate change) • Stagnation of wheat yields in some countries in recent decades, despite improved technology (*medium confidence*, minor contribution from climate change) • Positive yield impacts for some crops mainly in northern Europe, beyond increase due to improved technology (*medium confidence*, minor contribution from climate change) • Spread of bluetongue virus in sheep and of ticks across parts of Europe (*medium confidence*, minor contribution from climate change) [18.4, 23.4-5, Table 18-9, Figure 7-2]



Projevy klimatické změny - shrnutí

Současné trendy vyvolané klimatickou změnou. Pravděpodobnost výskytu: Very likely >90 %, Likely >60 % .

Phenomena	Likelihood that trend occurred in late 20th century
Cold days, cold nights and frost less frequent over land areas	Very likely
More frequent hot days and nights	Very likely
Heat waves more frequent over most land areas	Likely
Increased incidence of extreme high sea level *	Likely
Global area affected by drought has increased (since 1970s)	Likely in some regions
Increase in intense tropical cyclone activity in North Atlantic (since 1970)	Likely in some regions

* Excluding tsunamis, which are not due to climate change.

Budoucí trendy vyvolané klimatickou změnou.
Pravděpodobnost výskytu:
Virtually certain >99 %, Very likely >90 %, Likely >60 % .

Phenomena	Likelihood of trend
Contraction of snow cover areas, increased thaw in permafrost regions, decrease in sea ice extent	Virtually certain
Increased frequency of hot extremes, heat waves and heavy precipitation	Very likely to occur
Increase in tropical cyclone intensity	Likely to occur
Precipitation increases in high latitudes	Very likely to occur
Precipitation decreases in subtropical land regions	Very likely to occur
Decreased water resources in many semi-arid areas, including western U.S. and Mediterranean basin	High confidence

- Vědecký jazyk - strohý + pravděpodobnost ;-(

Očekávají se i nějaké pozitivní dopady globální změny klimatu?

Globální oteplování - kontroverze

People must hear both sides of the climate story

BJORN LOMBORG • HERALD SUN • APRIL 01, 2014 12:00AM

17

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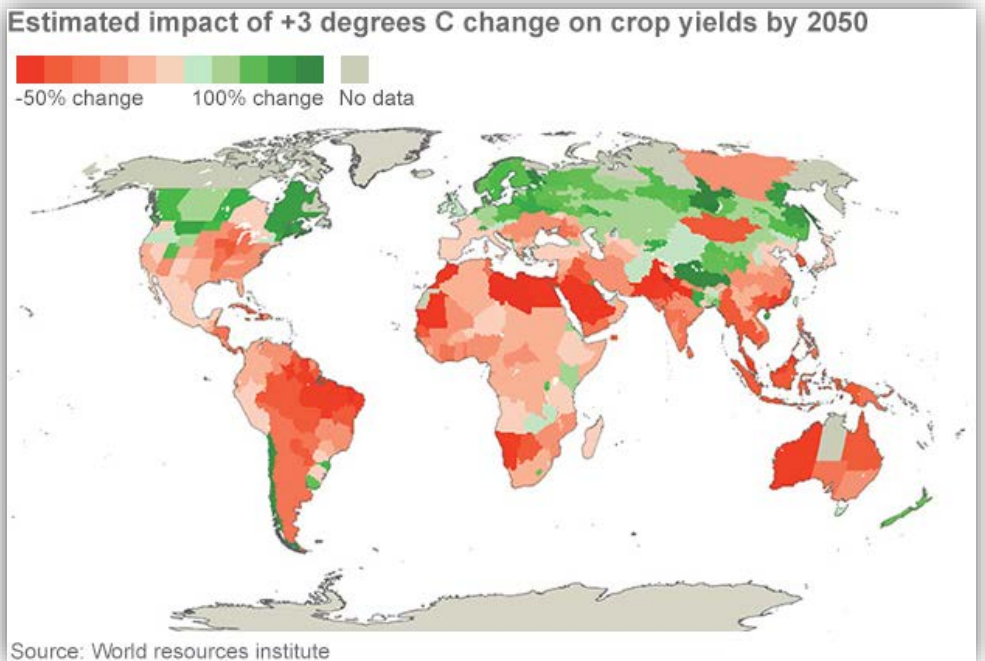
THE media's response to the latest instalment of the UN Climate Panel report will inevitably dwell on the negative effects of global warming — how it will reduce agricultural yields, increase heatwaves and drown communities.

Morální rozměr CC

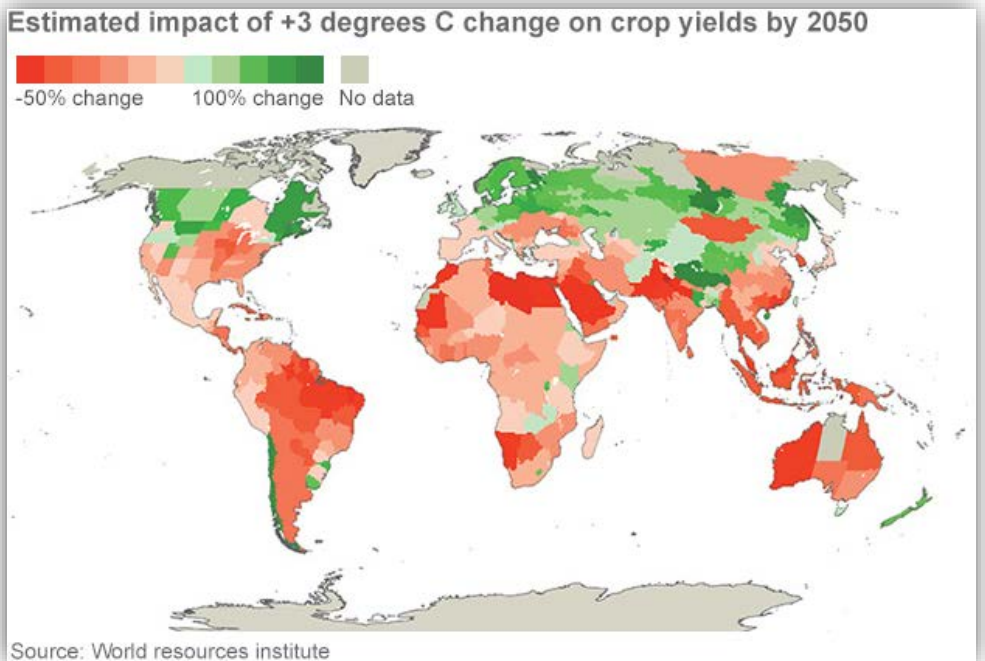
„...more heat will damage crop growth in many warmer climates, but it means better agricultural production in cold countries. And, CO_2 is a fertiliser — commercial greenhouses pump in extra CO_2 to grow bigger tomatoes. So overall, we can expect agriculture to gain from global warming in the short and medium term...“ B. Lomborg

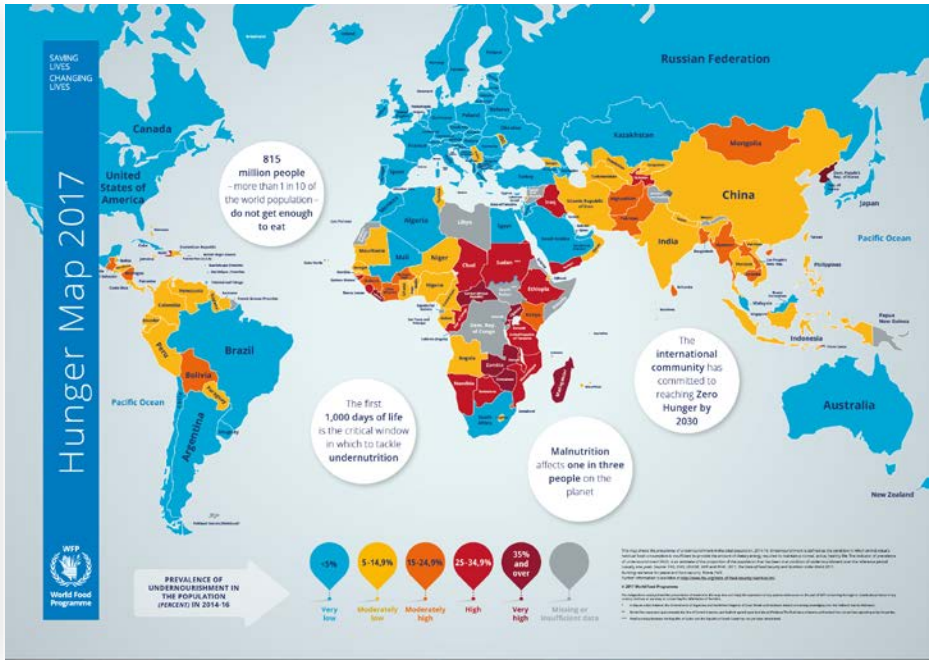


Námitka?

Morální rozměr CC

„...more heat will damage crop growth in many warmer climates, but it means better agricultural production in cold countries. And, CO_2 is a fertiliser — commercial greenhouses pump in extra CO_2 to grow bigger tomatoes. So overall, we can expect agriculture to gain from global warming in the short and medium term...“ B. Lomborg

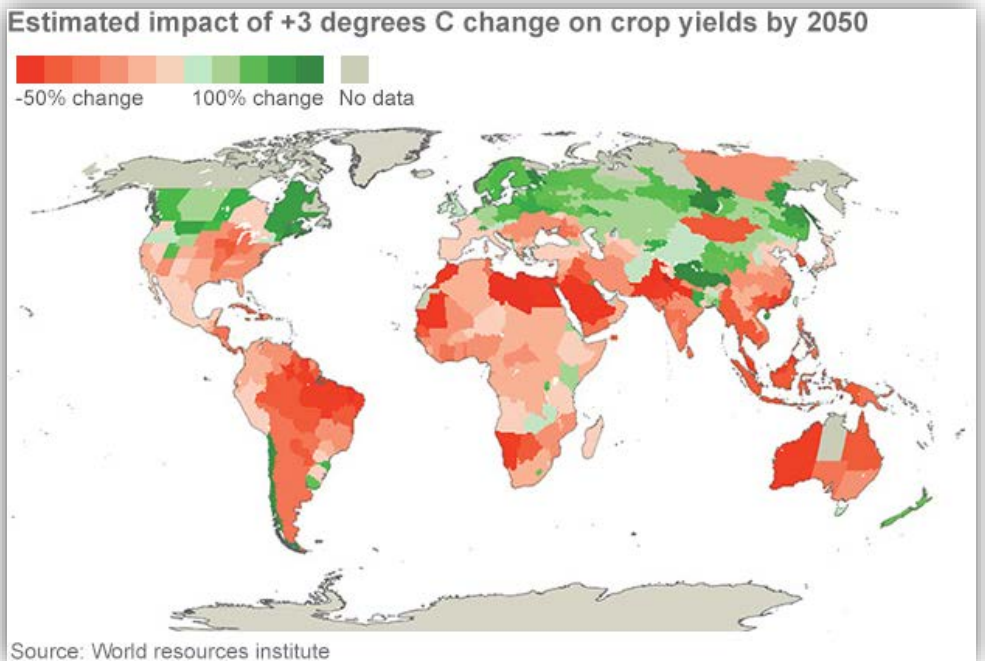


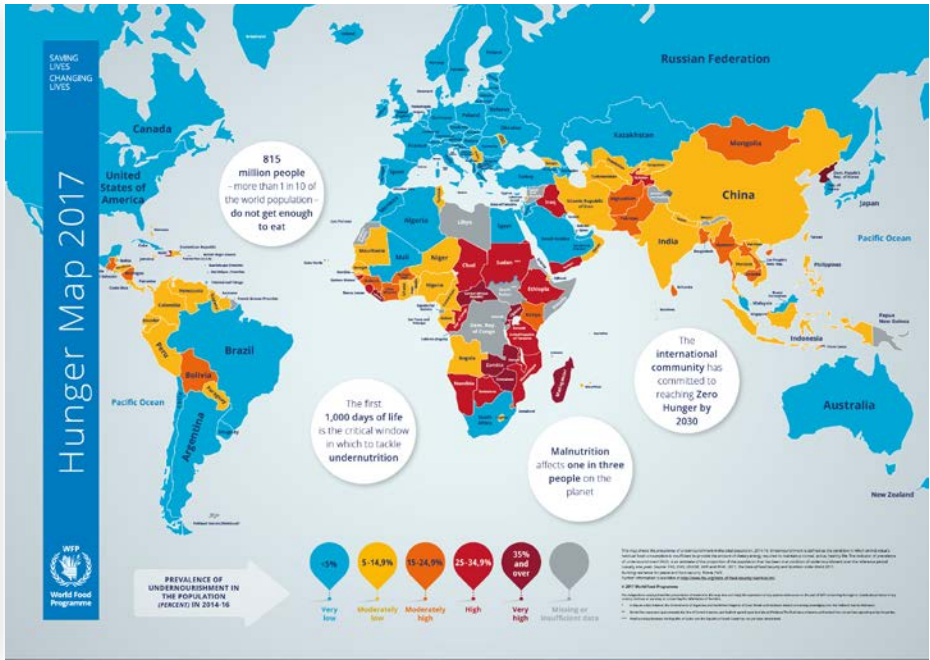


Morální rozměr CC

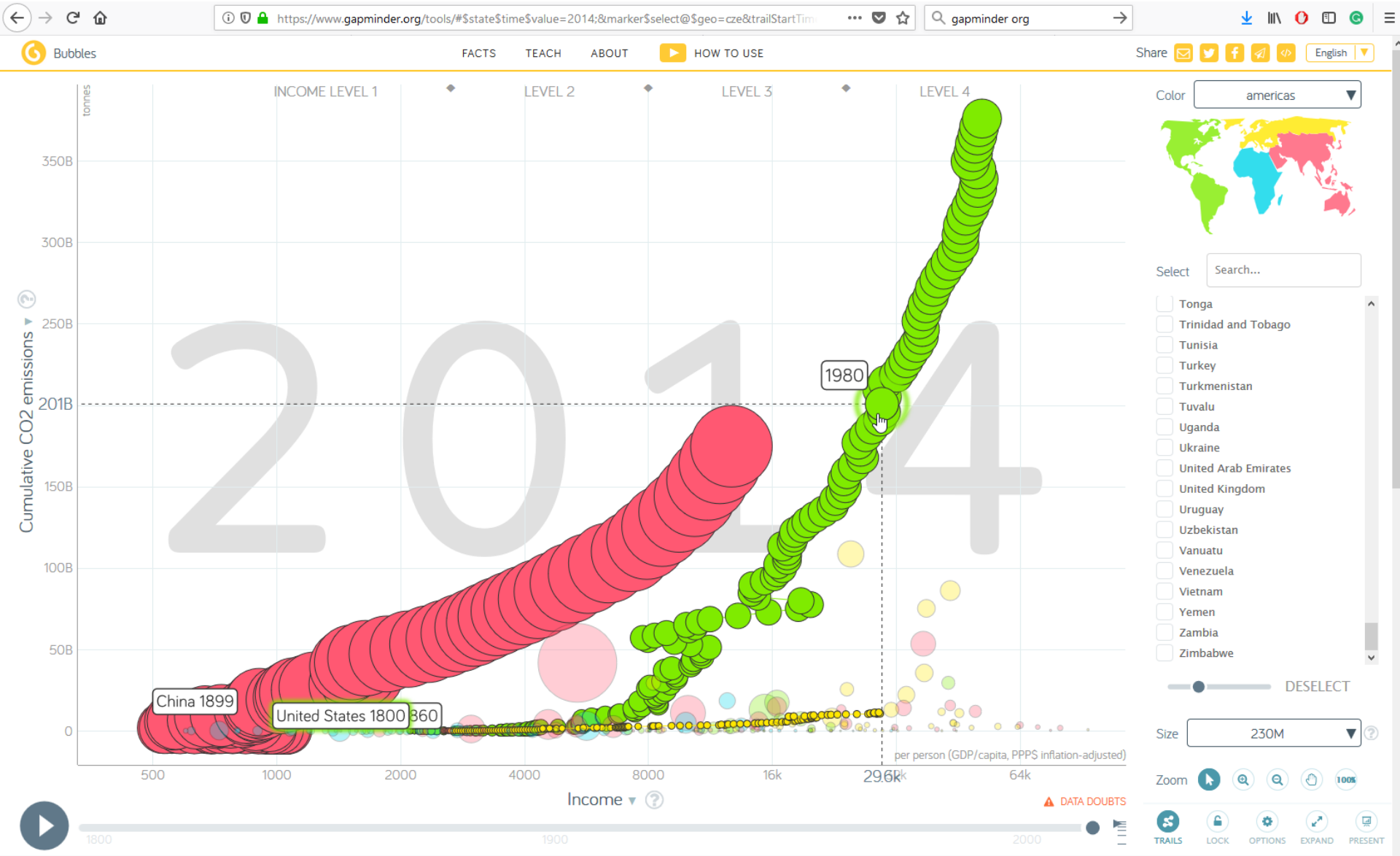
„...more heat will damage crop growth in many warmer climates, but it means better agricultural production in cold countries. And, CO_2 is a fertiliser — commercial greenhouses pump in extra CO_2 to grow bigger tomatoes. So overall, we can expect agriculture to gain from global warming in the short and medium term...“ B. Lomborg

– nárůst produkce v zemích kde je již dnes nadprodukce, pokles produkce v rozvojových zemích s nedostatkem potravin





Zodpovědnost řešení x historie emisí

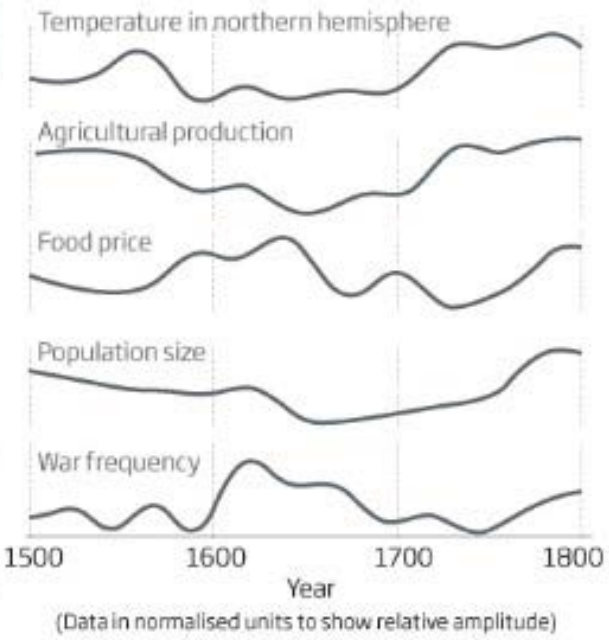


Climate change: The great civilisation destroyer?

War and unrest, and the collapse of many mighty empires, often followed changes in local climes. Is this more than a coincidence?

More than coincidence?

The decline and fall of many civilisations coincided with periods of climate change, and there are also correlations between climate change, population size and the frequency of wars, as data from Europe shows (right)



Zvyšování teploty atmosféry – možná řešení?

Co s tím?

Top

Zvyšování teploty atmosféry – řešení?

The Nobel Peace Prize 2007
Intergovernmental Panel on Climate Change , Al Gore

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The Nobel Peace Prize 2007

IPCC
INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE
WMO UNEP

Intergovernmental Panel on Climate Change (IPCC)
Prize share: 1/2

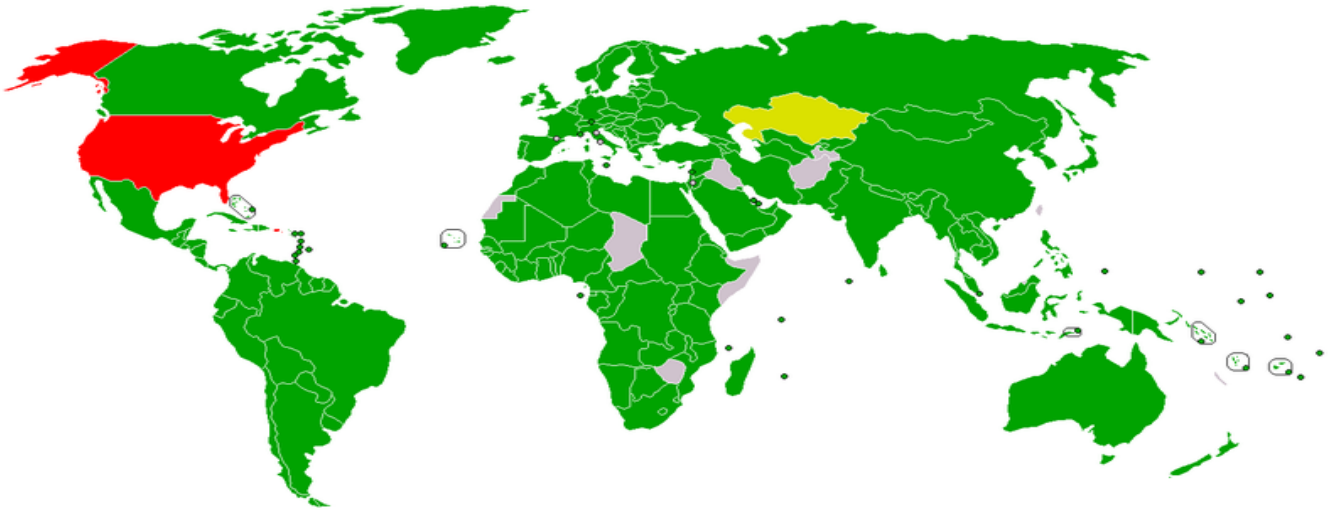
Photo: Ken Opprann
Albert Arnold (Al) Gore Jr.
Prize share: 1/2

The Nobel Peace Prize 2007 was awarded jointly to Intergovernmental Panel on Climate Change (IPCC) and Albert Arnold (Al) Gore Jr. *"for their efforts to build up and disseminate greater knowledge about man-made climate change, and to lay the foundations for the measures that are needed to counteract such change"*

Zvyšování teploty atmosféry – řešení?

- snížit emise skleníkových plynů, především CO_2

- v roce 1997 v **Kjótu** podepsán protokol k **Rámcové úmluvě OSN o klimatických změnách** z roku 1992
- úmluva vstoupila v platnost 2005
- průmyslově vyspělé státy se zavázaly snížit emise skleníkových plynů do roku 2012 o 5,2 % ve srovnání s rokem 1990
- procenta snížení jsou pro jednotlivé státy různá
- EU se zavázala k 8% snížení, stejně tak i ČR – ratifikace 2002



Kyótský protokol – řešení?

- EU se zavázala k 8% redukci

Výsledek?

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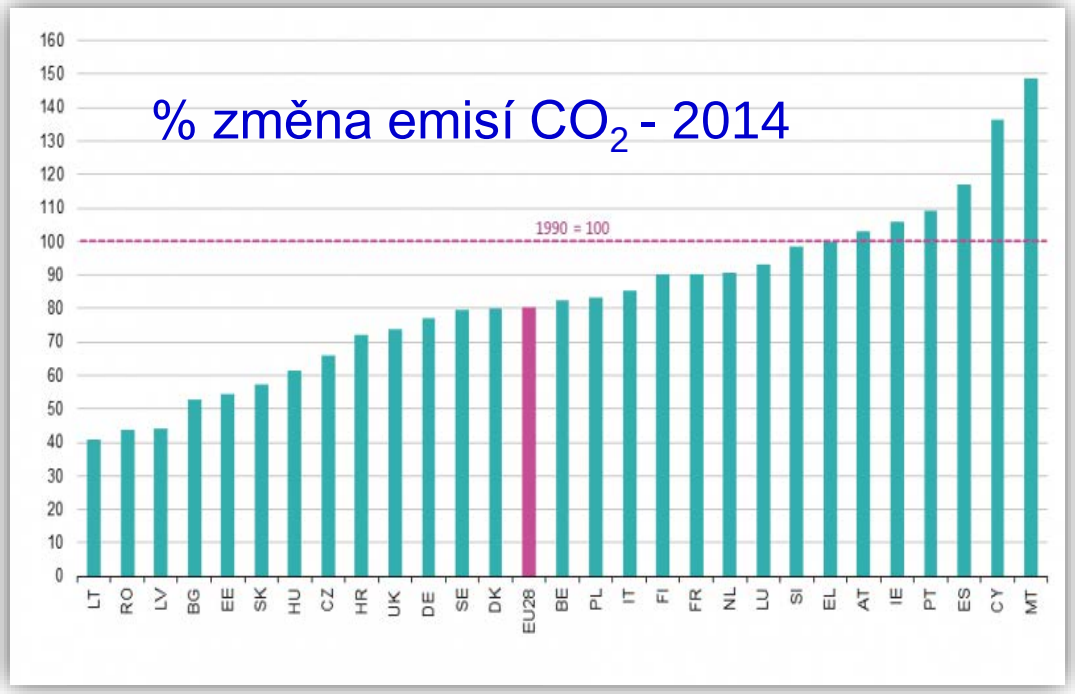
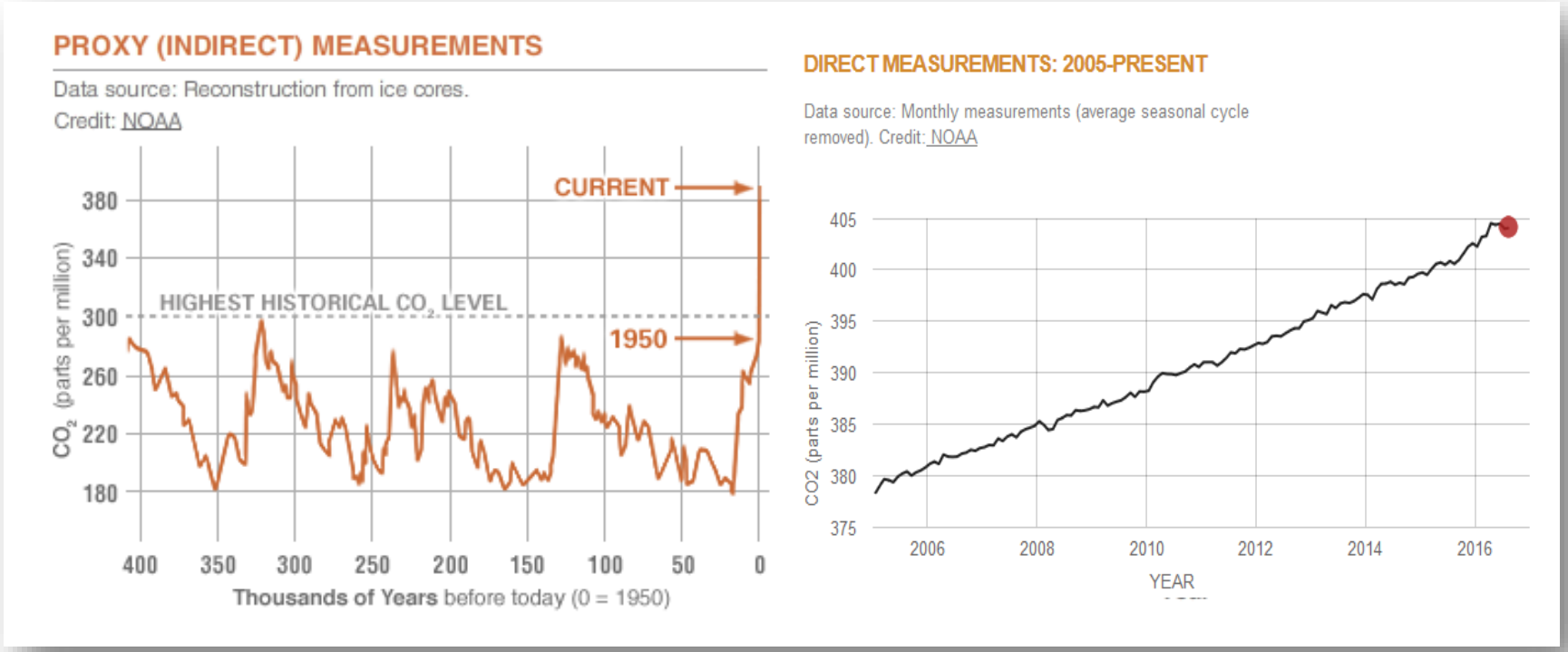


Účinek Kjótského protokolu?



Nutno přitvrdit!

% změna emisí CO_2 - 2014

- 2012 v Dauhá dojednán dodatek
- prodloužení Kjótského protokolu do roku 2020
- zároveň se určité země (EU a pár dalších států) zavázaly k dalšímu snižování emisí $CO_{2\ ekv.}$
- EU např. o 20-30 % ve srovnání s rokem 1990

Politika ochrany klimatu v ČR (2017)

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Politika ochrany klimatu v ČR (2017)

Závazky ČR zohledňují závazky EU

Naplňování cílů snižování emisí skleníkových plynů pro roky 2020 a 2030 je implementováno prostřednictvím evropské legislativy pro emise zahrnuté do systému EU ETS a pro sektory mimo EU ETS. EU přijala následující redukční cíle:

> snížit emise skleníkových plynů o **20 % do roku 2020** v porovnání s rokem 1990
> snížit emise skleníkových plynů minimálně o **40 % do roku 2030** v porovnání s rokem 1990

V delším časovém horizontu EU plánuje přechod na nízkoemisní hospodářství:

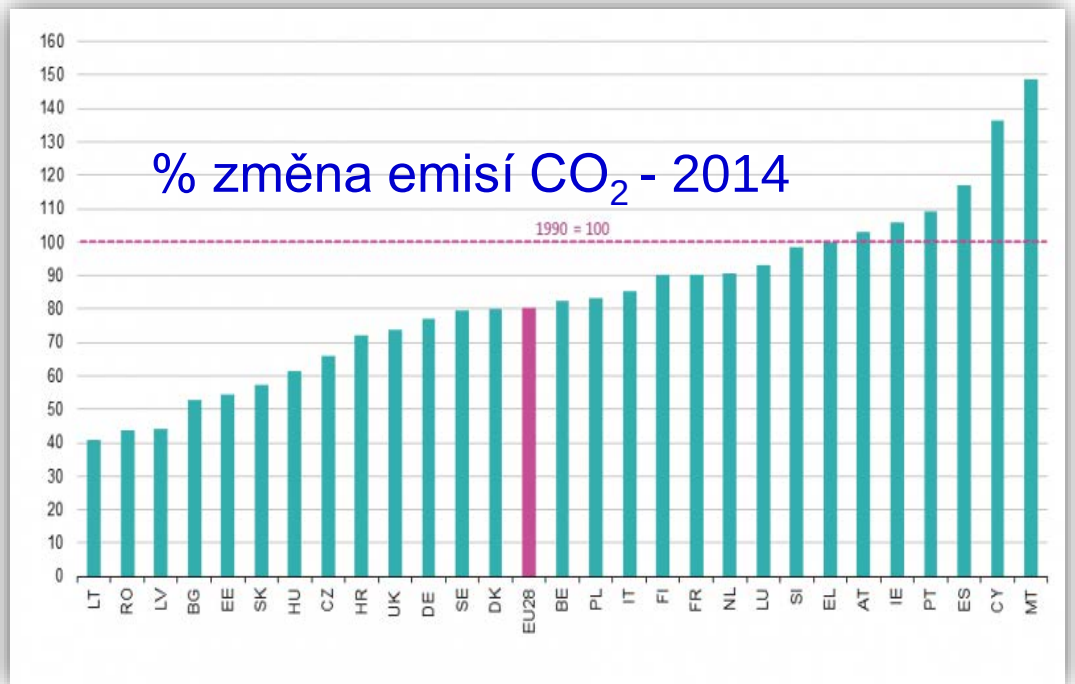
> snížení emisí skleníkových plynů o **80–95 % do roku 2050** v porovnání s rokem 1990

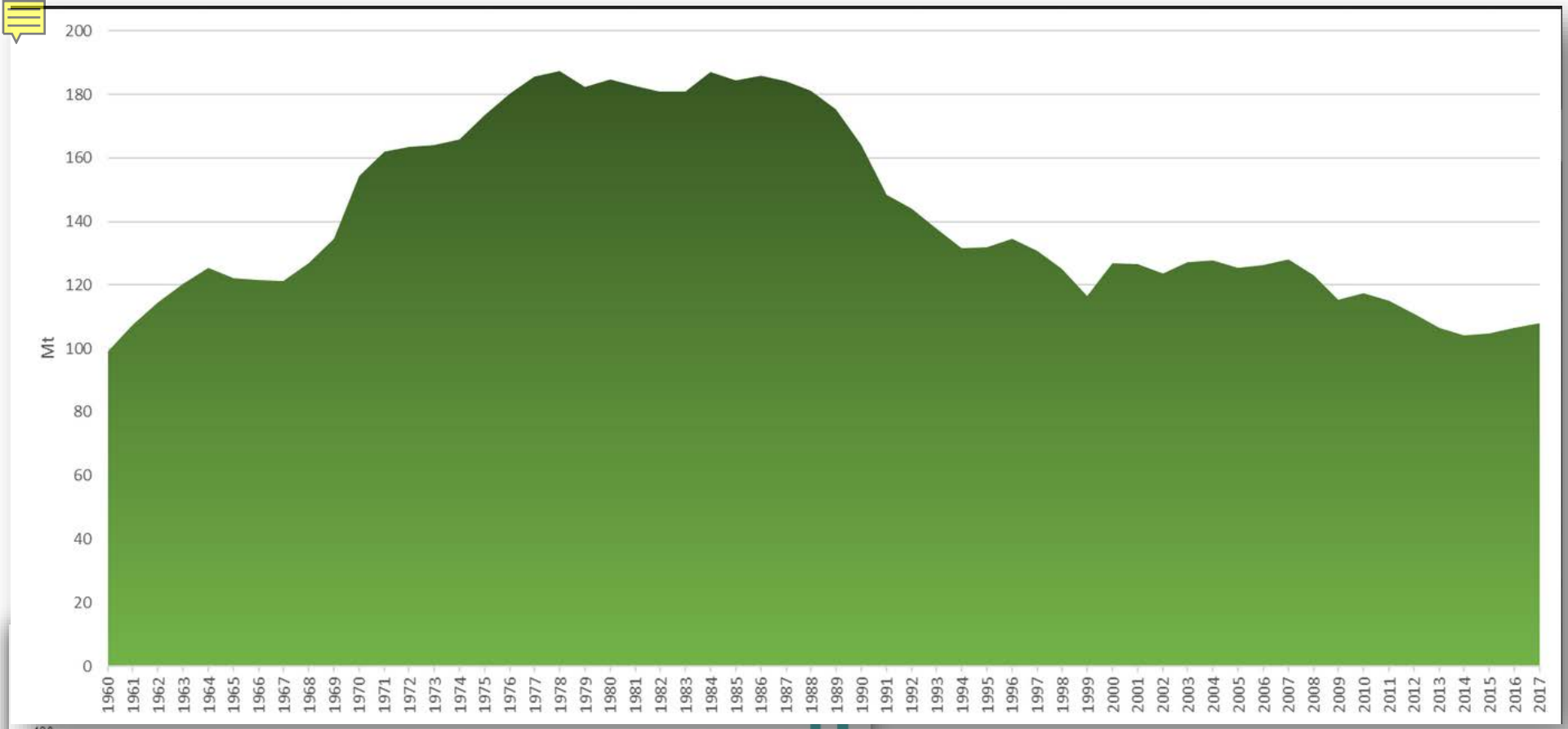
Je to reálné?

Kyótský protokol – řešení?

- EU se zavázala k 8% redukci (2012 x 1990)

Výsledek?




Mt
200
180
160
140
120
100
80
60
40
20
0
1960 1961 1962 1963 1964 1965 1966 1967 1968 1969 1970 1971 1972 1973 1974 1975 1976 1977 1978 1979 1980 1981 1982 1983 1984 1985 1986 1987 1988 1989 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017

% změna emisí CO_2 - 2014
1990 = 100
130
120
110
100
90
80
70
60
50
40
30
20
10
0
LT RO LV BG EE SK HU CZ HR UK DE SE DK EU28 BE PL IT FI FR NL LU SI EL AT IE PT ES CY MT

Pařížská dohoda (2015)

- naváže na Kjótský protokol od roku 2020
- cíl: Zamezit růstu teploty o 2 °C oproti předindustr. období
- platnost - 55/55, podepsaly již USA, Čína, Indie...
- vstoupila v platnost 4.11.2016

Metody snižování emisí CO_2

- stěžejní je **snížení spotřeby fosilních paliv**
  - zefektivnění průmyslových výrob
  - ukončení neefektivních výrob
  - úspora energií a surovin jako taková
- ekonomickým nástrojem snižování emisí CO_2 jsou Obchodovatelná emisní povolení

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-fixace vzdušného CO_2 do biomasy (např. podpora výsadby lesních porostů, atd.) x zemědělská plocha

-biopaliva ?

-geoinženýring?

Transforming Earth

It is now possible to identify the methods and locations where planetary geoengineering will have to take place

T — PLANT TREES
Plant forests and regularly harvest them. Trees are a carbon sink as long as they are growing, and not allowed to rot.

Location: unused farmland

BE — BECCS (Bioenergy with carbon capture and storage)
Suck out atmospheric CO2 by growing biofuel crops like sugar cane, burn them for energy, capture the resulting CO2, and bury it.

Location: the tropics, where growth is fastest

B — BIOCHAR
Burn plant material without oxygen to make charcoal-like "biochar". This carbon store can then be buried in soil, where it acts as a fertiliser.

Location: anywhere with rich plant growth

DA — DAC (Direct air capture)
Build shipping-container-sized boxes full of a chemical "sponge" that sucks CO2 out of the air, ready for burial. You may need 100 million of them.

Location: windy and dry areas. More wind means more air is driven through the boxes, increasing uptake

IF — IRON FERTILISATION
Trigger photosynthetic plankton blooms in the ocean by dumping iron into areas that don't have much. If the plankton sinks, carbon is stored.

Location: iron-depleted regions of the ocean

OL — OCEAN LIMING
Throw lime into the ocean. It reacts with dissolved CO2 to form carbonates. This may also help corals by reducing ocean acidification.

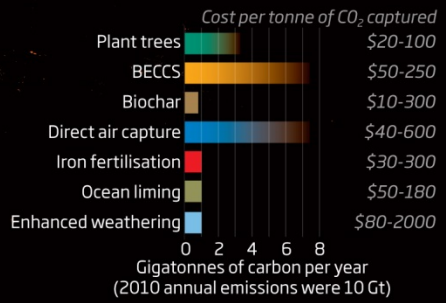
Location: coral habitats

EW — ENHANCED WEATHERING
Crush common minerals like olivine to powder to increase surface area for reacting with CO2 and water.

Location: proceeds fastest in warm, wet conditions, so areas such as humid coasts and rivers are best

Annual carbon savings by 2100

Bars show maximum possible for each technology



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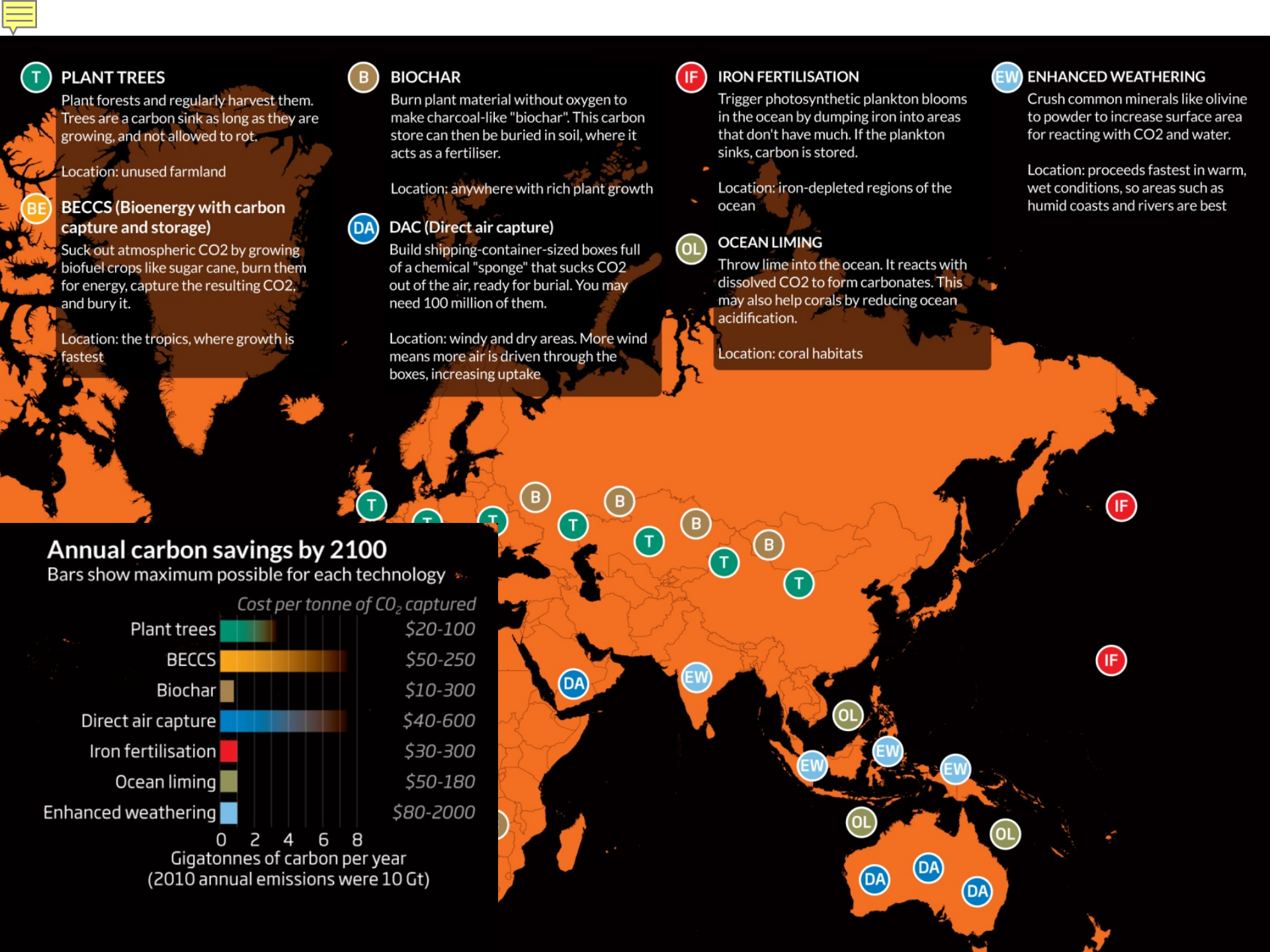

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Su[illegible]

Locati[illegible] fastest

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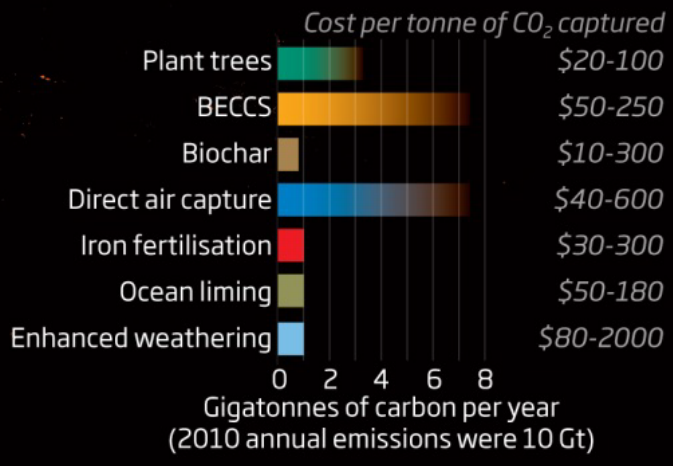
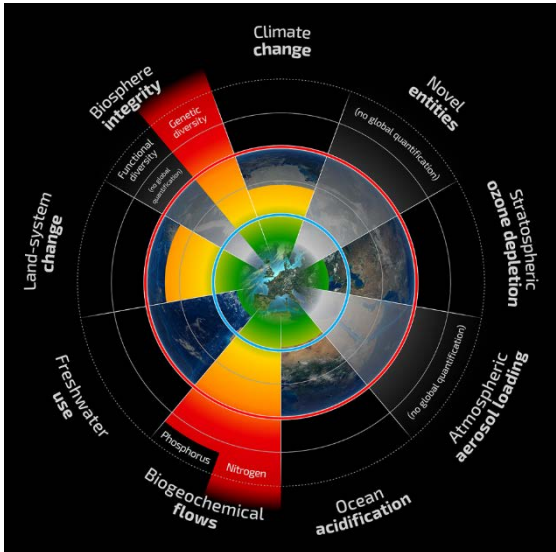
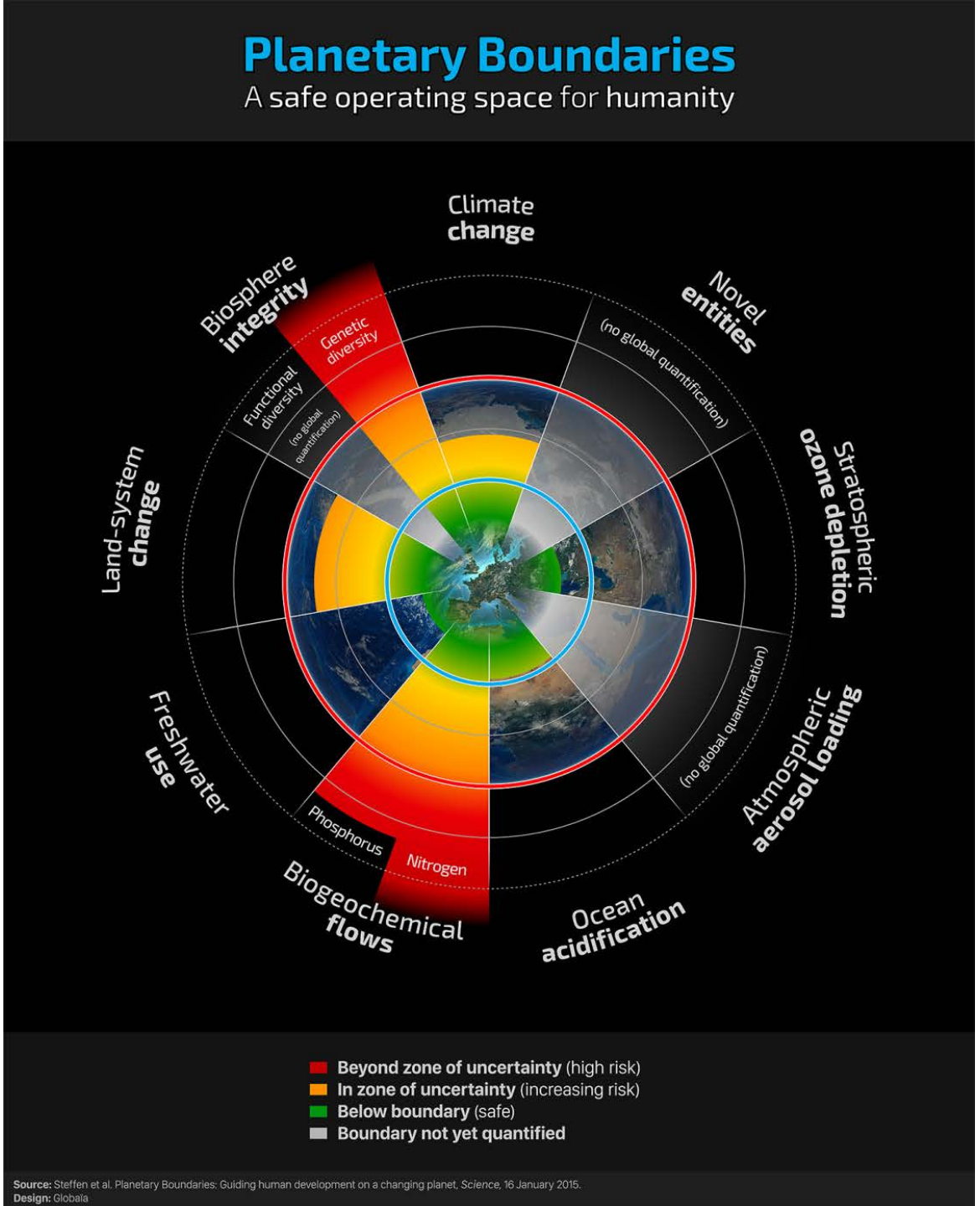


IV. Okyselování oceánů

Earth-system process	Control variable(s)	Planetary boundary (zone of uncertainty)	Current value of control variable
Ocean acidification (R2009: same)	Carbonate ion concentration, average global surface ocean saturation state with respect to aragonite (Ω_{arag})	≥80% of the pre-industrial aragonite saturation state of mean surface ocean, including natural diel and seasonal variability (≥80%– ≥70%)	~84% of the pre-industrial aragonite saturation state



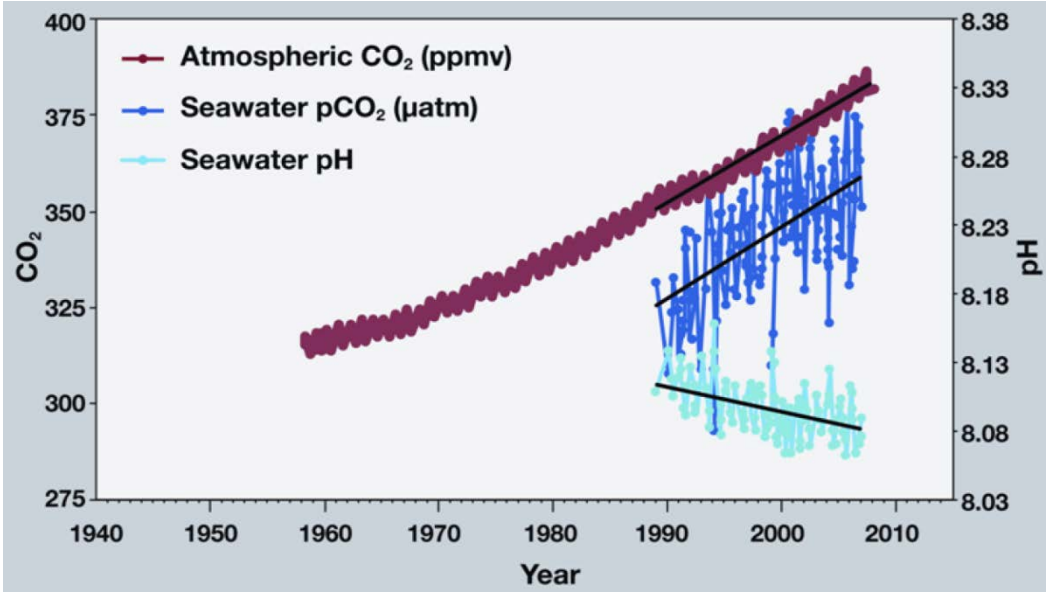
Překročení hranic?

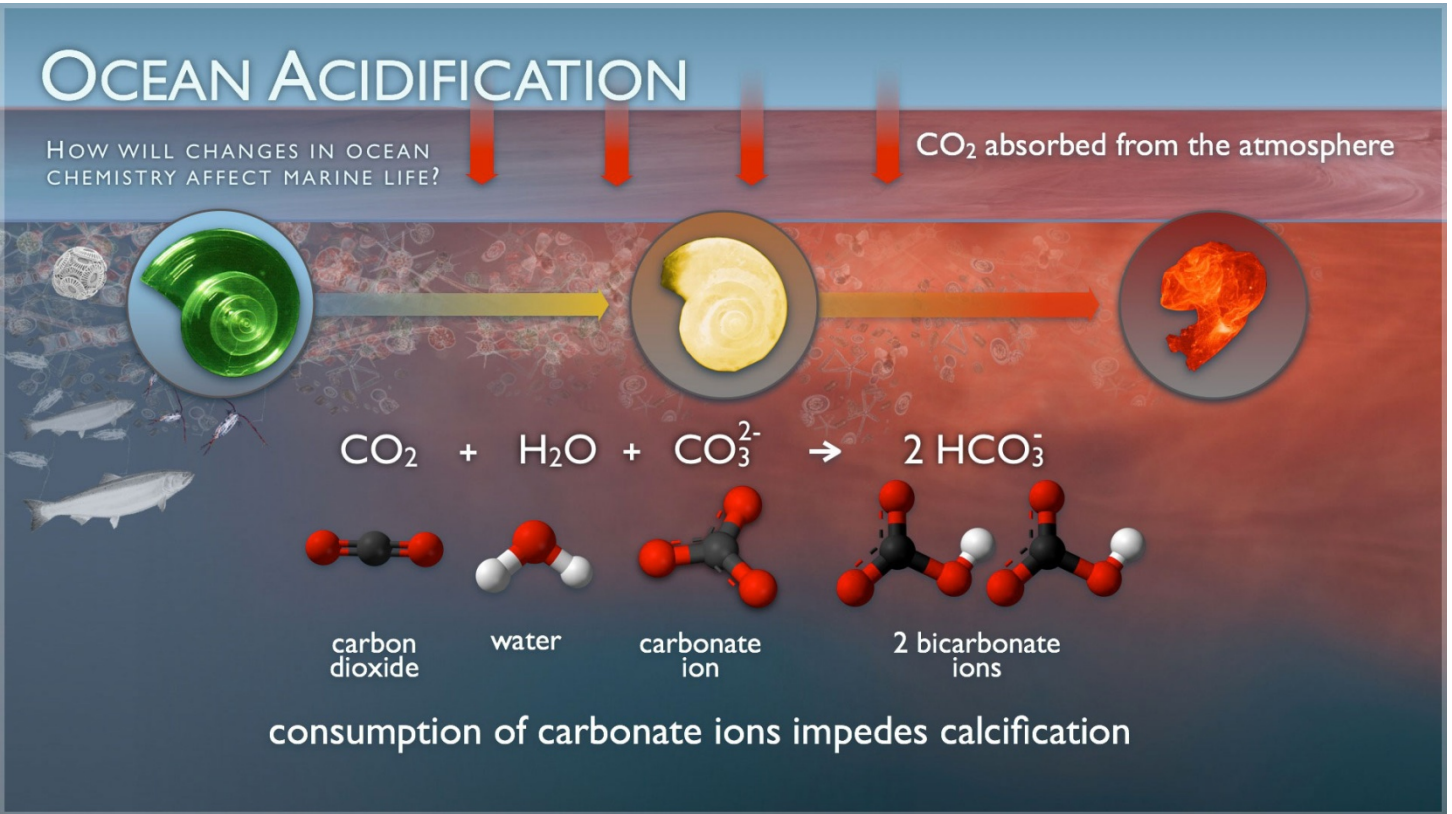


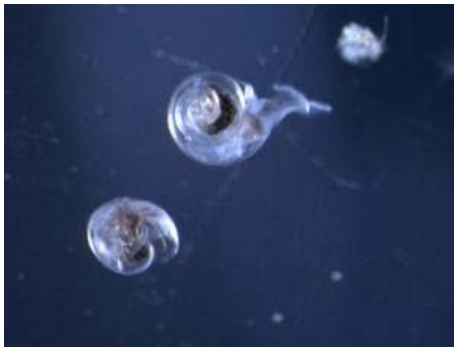
Co způsobuje okyselování oceánů?

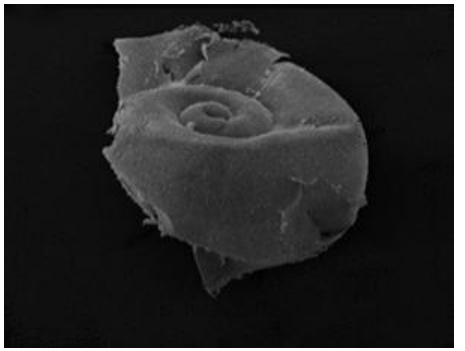
Okyselování oceánů

- čím je způsobené?

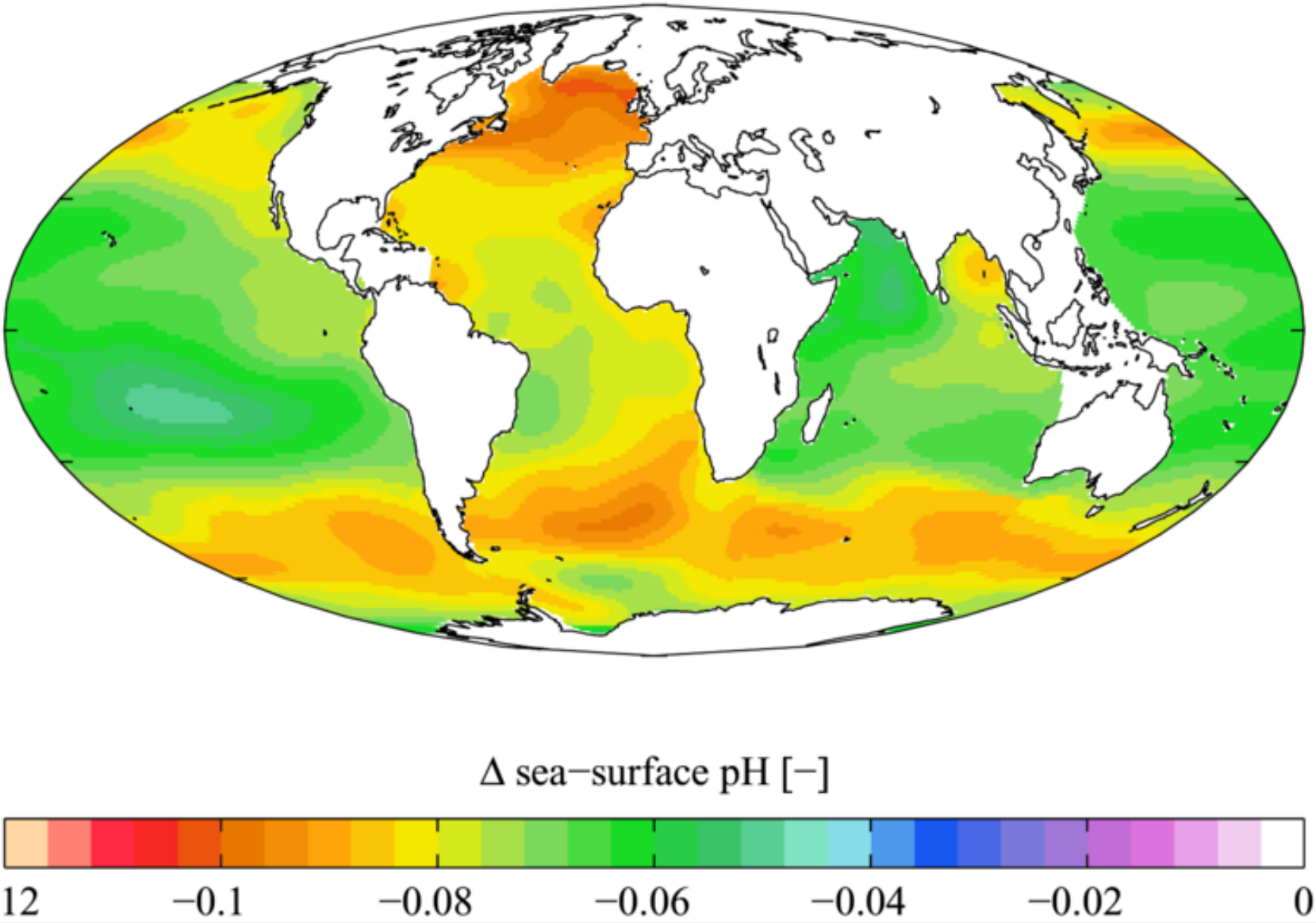




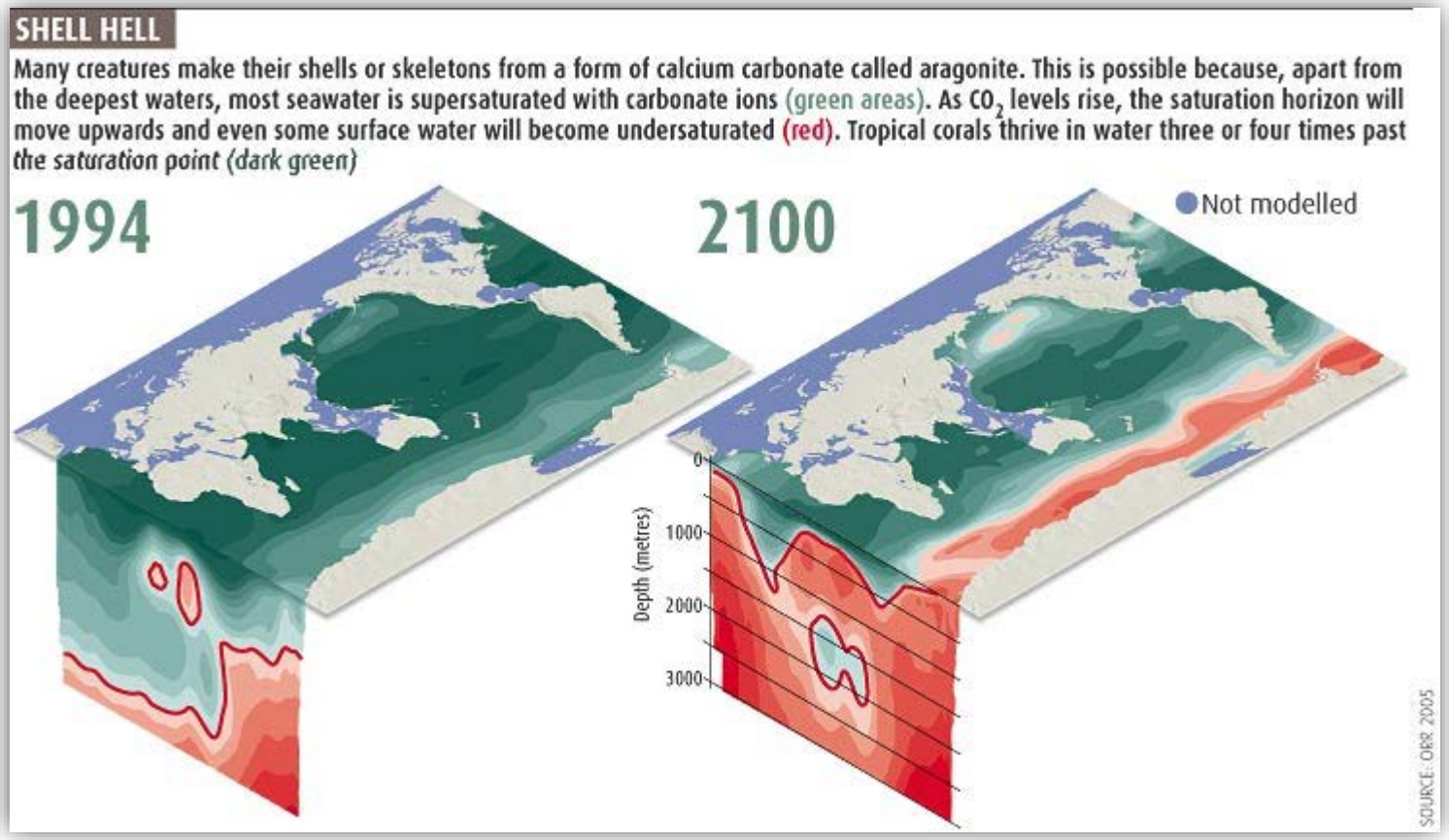




Změna pH oceánů 1700-2000



Změna pH oceánů - 3D rozvrstvení



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Natural lab shows sea's acid path

By Richard Black
Environment correspondent, BBC News website

Scientists study conditions at the bottom of the Mediterranean Sea

Natural carbon dioxide vents on the sea floor are showing scientists how carbon emissions will affect marine life.

Dissolved CO2 makes water more acidic, and around the vents, researchers saw a fall in species numbers, and snails with their

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26 March 2014 Last updated at 23:03 GMT Share

How climate change will acidify the oceans

By Roger Harrabin
BBC environment analyst, Normanby Island

Off the remote eastern tip of Papua New Guinea a natural phenomenon offers an alarming glimpse into the future of the oceans, as increasing concentrations of CO2 in the atmosphere make sea water more acidic.

Streams of volcanic CO2 bubbles emerge from deep under the seabed here, like a giant jacuzzi.

As the bubbles of carbon dioxide dissolve into the water, carbonic acid is

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One lonely man and his hoard of Nazi art

Malaysia plane: 10 questions that are still unresolved