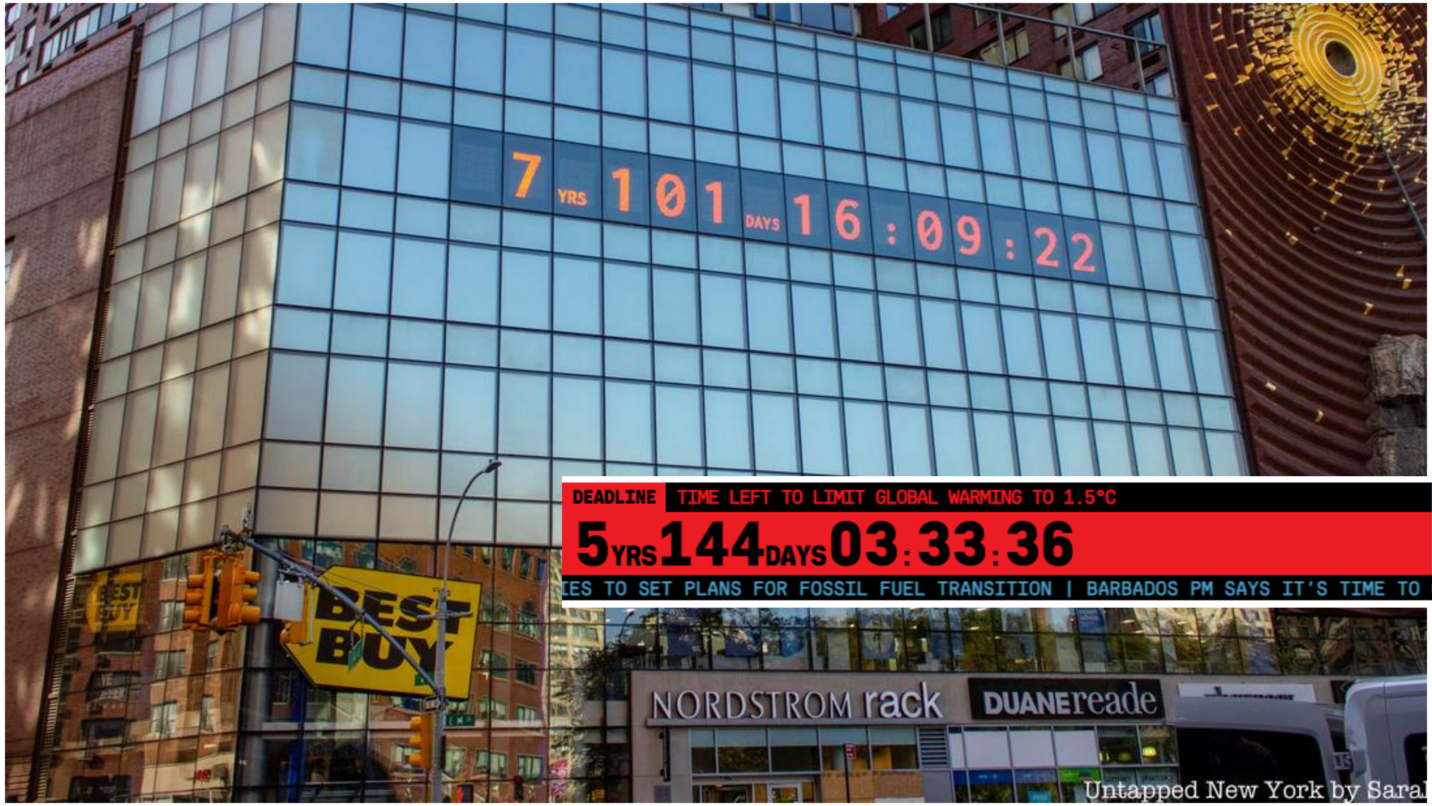
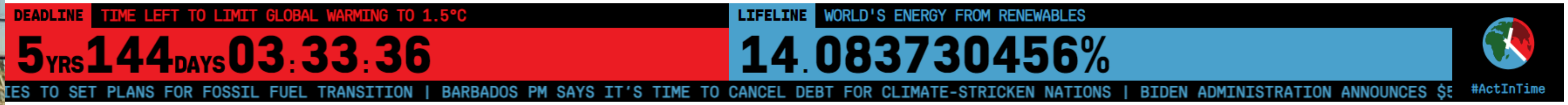
- GHG

Climate Clock – Time Square, New York

https://climateclock.world/





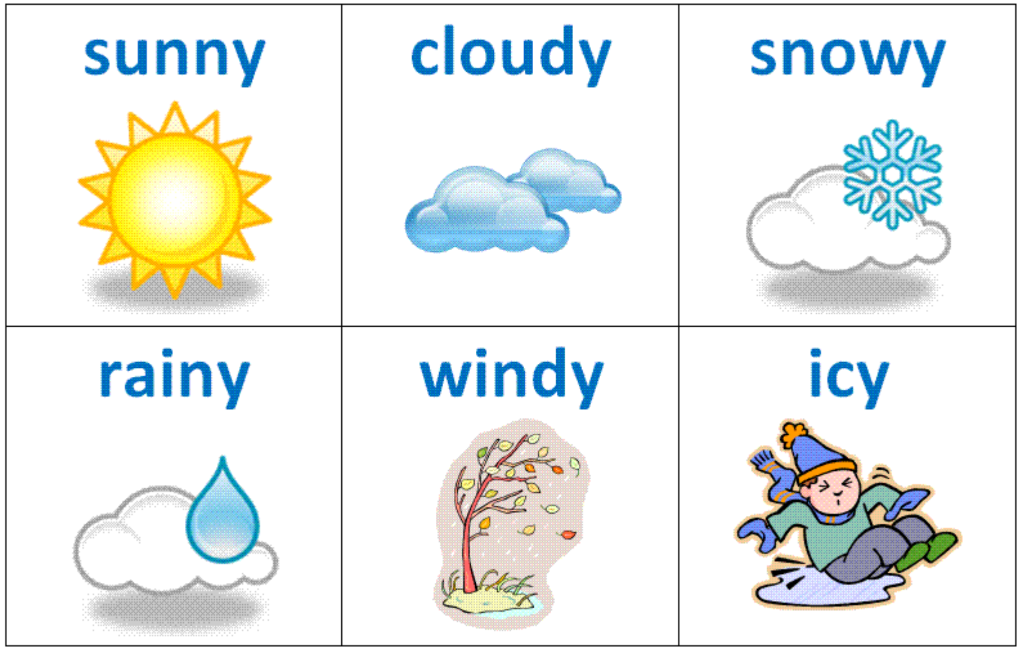
The Climate Clock shows two numbers. The first, in red, is a timer, counting down how long it will take, at current rates of emissions, to burn through our “carbon budget” — the amount of CO2 that can still be released into the atmosphere while limiting global warming to 1.5°C above pre-industrial levels. This is our deadline, the time we have left to take decisive action to keep warming under the 1.5°C threshold. The second number, in green, is tracking the growing % of the world’s energy currently supplied from renewable sources. This is our lifeline. Simply put, we need to get our lifeline to 100% before our deadline reaches 0.

BASICS OF CLIMATE CHANGE

WEATHER:

current state of the atmosphere

Weather



CLIMATE:

the average 30-year weather patterns of a region (World Meteorological Association).

The time scale is important because it is more complicated to have a forecast in a specific moment in a specific square meter of the planet at different altitudes than in a period of 10 or hundred years

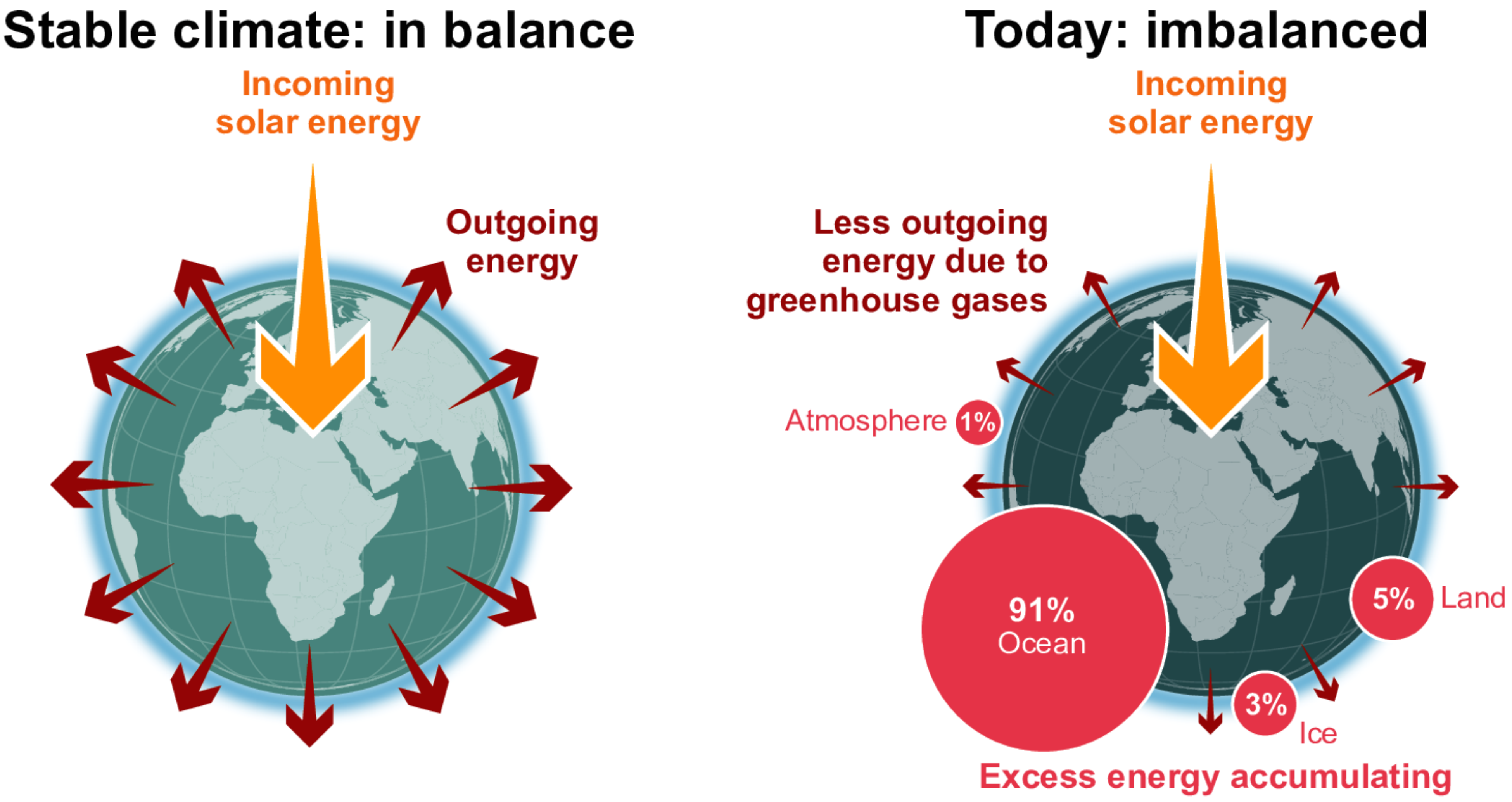
To predict wheather and climate, you have to take into account the same 9 parameters

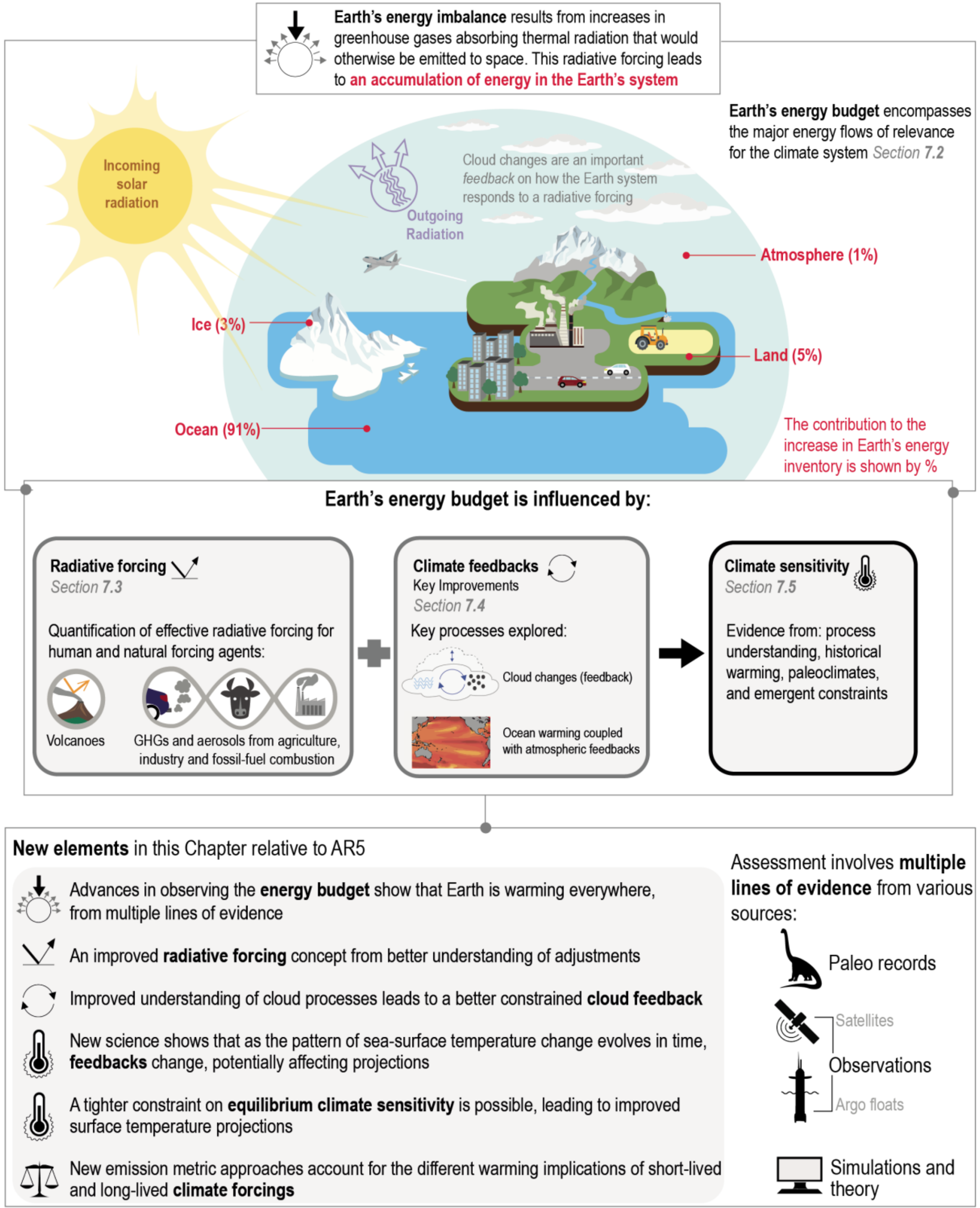
temperature, rain fall, humidity, evaporation, transpiration, wind speed and direction, sunlight irradiation coming in and sunlight reflection (also called albedo) and air pressure.

COMPLETELY DIFFERENT WAYS TO INTEGRATE THIS INFORMATION

FAQ 7.1: **The Earth's energy budget and climate change**

Since at least 1970, there has been a persistent imbalance in the energy flows that has led to excess energy being absorbed by different components of the climate system.



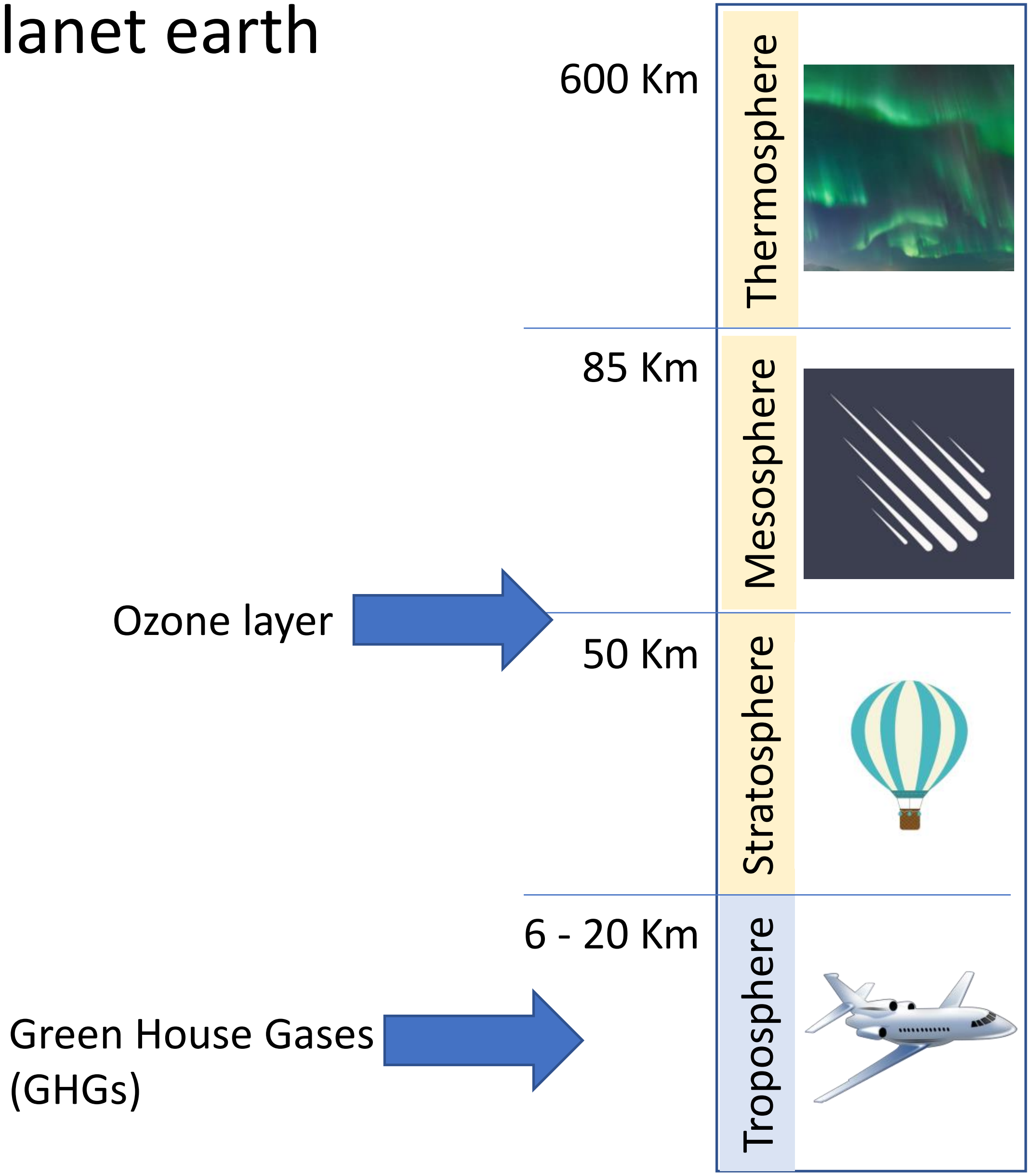

Earth's energy imbalance results from increases in greenhouse gases absorbing thermal radiation that would otherwise be emitted to space. This radiative forcing leads to an accumulation of energy in the Earth's system
Earth's energy budget encompasses the major energy flows of relevance for the climate system Section 7.2
Incoming solar radiation
Cloud changes are an important feedback on how the Earth system responds to a radiative forcing
Outgoing Radiation
Atmosphere (1%)
Ice (3%)
Land (5%)
Ocean (91%)
The contribution to the increase in Earth's energy inventory is shown by %
Earth's energy budget is influenced by:
Radiative forcing
Section 7.3
Quantification of effective radiative forcing for human and natural forcing agents:
Volcanoes
GHGs and aerosols from agriculture, industry and fossil-fuel combustion
Climate feedbacks
Key Improvements
Section 7.4
Key processes explored:
Cloud changes (feedback)
Ocean warming coupled with atmospheric feedbacks
Climate sensitivity
Section 7.5
Evidence from: process understanding, historical warming, paleoclimates, and emergent constraints
New elements in this Chapter relative to AR5
Advances in observing the energy budget show that Earth is warming everywhere, from multiple lines of evidence
An improved radiative forcing concept from better understanding of adjustments
Improved understanding of cloud processes leads to a better constrained cloud feedback
New science shows that as the pattern of sea-surface temperature change evolves in time, feedbacks change, potentially affecting projections
A tighter constraint on equilibrium climate sensitivity is possible, leading to improved surface temperature projections
New emission metric approaches account for the different warming implications of short-lived and long-lived climate forcings
Assessment involves multiple lines of evidence from various sources:
Paleo records
Satellites
Observations
Argo floats
Simulations and theory

- Atmosphere is the envelope of gas around planet earth (10000 km)

Where are Green House Gases (GHGs) located?

1. Troposphere
2. Stratosphere
3. Thermosphere
4. Mesosphere

- Atmosphere is the envelope of gas around planet earth (10000 km)



Weather and climate are limited to the lowest part of atmosphere

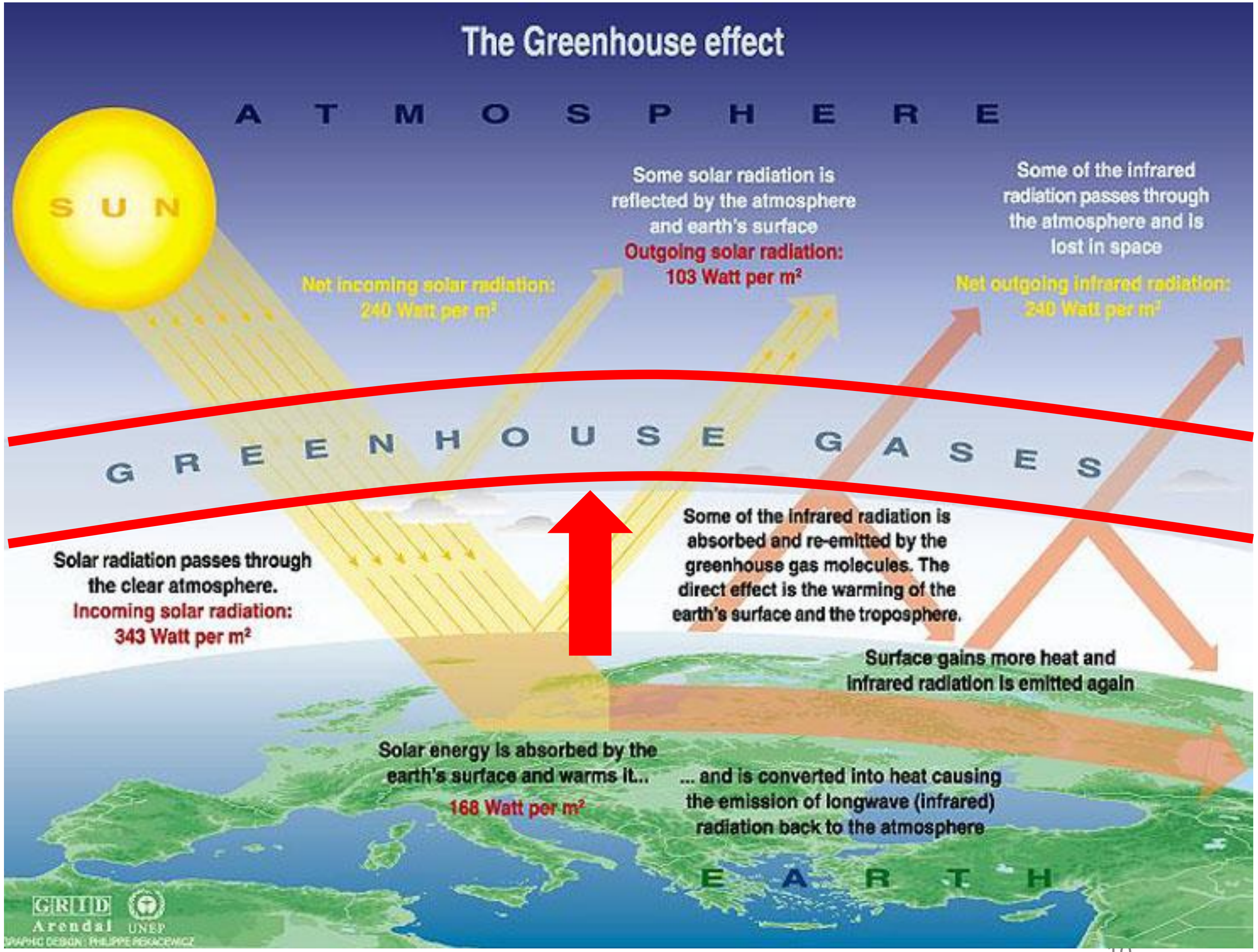
In a house made of glass the solar radiation gets in and part of it is kept inside

Greenhouse gases from human activities are the most significant driver of observed climate change since the mid-20th century.
(United States Environmental Protection Agency; EPA)

Worldwide, net emissions of greenhouse gases from human activities increased by 35 % from 1990 to 2010. Emissions of carbon dioxide, which account for about three-fourths of total emissions, increased by 42 % over this period. The majority of the world's emissions result from **electricity generation, transportation, and other forms of energy production and use**.

General Introduction – greenhouse effect

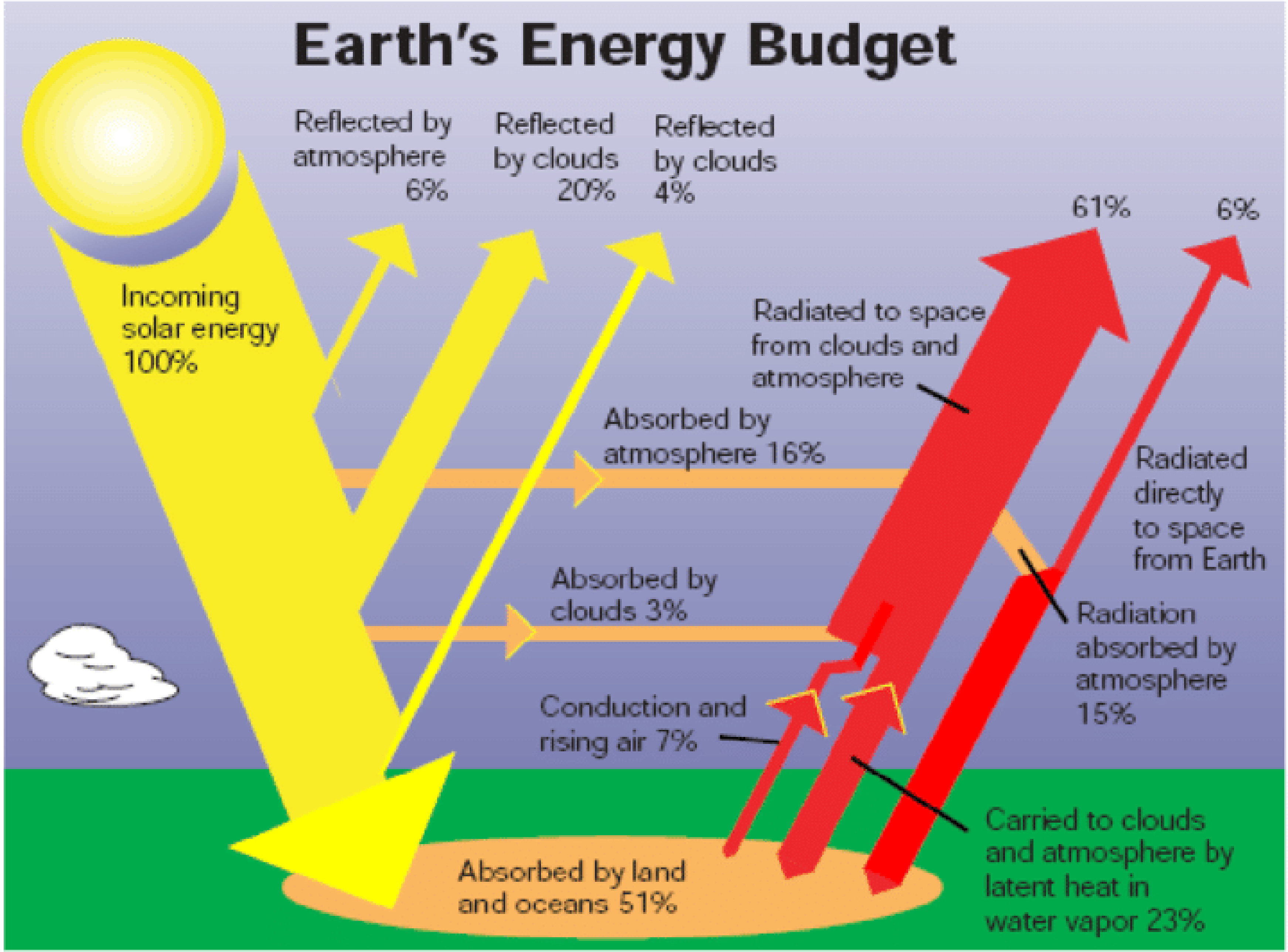
Greenhouse gases are gases in the atmosphere such as water vapour, carbon dioxide, methane and nitrous oxide that can **absorb infrared radiation**, trapping heat in the atmosphere. This greenhouse effect means that emissions of greenhouse gases due to human activity cause global warming.



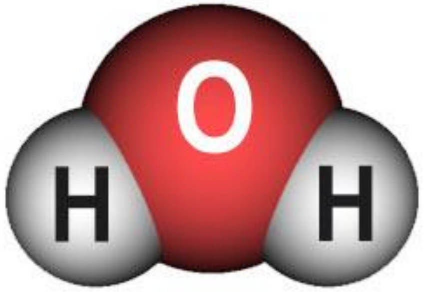
Similar to a greenhouse, at 10 km height in the atmosphere there is something behaving like a glass surface in a greenhouse.

These gases are necessary for life on earth.

Mankind produced and encreased these gases in the atmosphere

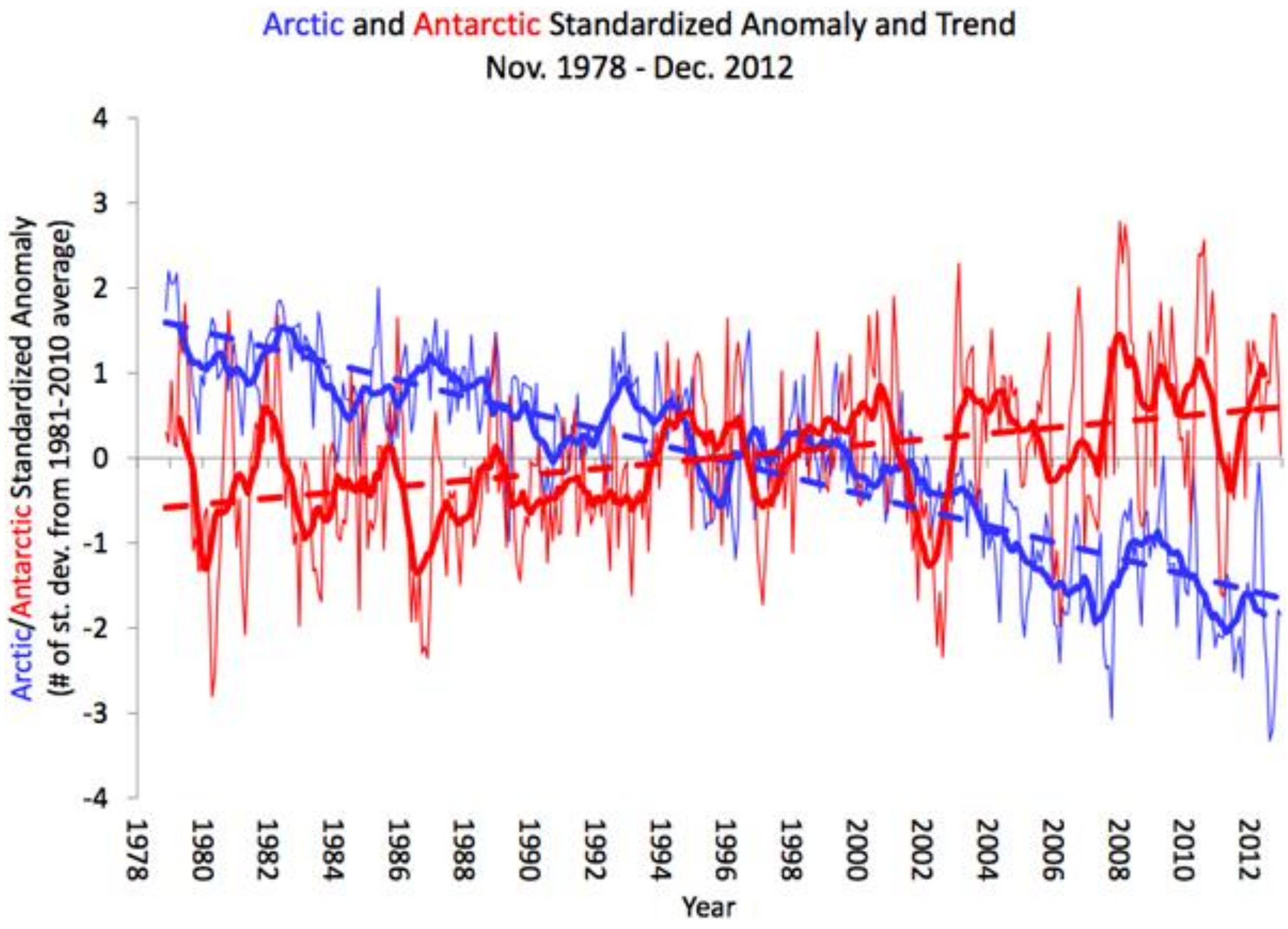

Earth's Energy Budget
Reflected by atmosphere 6%
Reflected by clouds 20%
Reflected by clouds 4%
61%
6%
Incoming solar energy 100%
Radiated to space from clouds and atmosphere
Absorbed by atmosphere 16%
Radiated directly to space from Earth
Absorbed by clouds 3%
Radiation absorbed by atmosphere 15%
Conduction and rising air 7%
Carried to clouds and atmosphere by latent heat in water vapor 23%
Absorbed by land and oceans 51%

What are the main greenhouse gases?



Water vapor (H_2O)

Water vapor. The most abundant greenhouse gas, but importantly, it acts as a feedback to the climate. Water vapor increases as the Earth's atmosphere warms, but so does the possibility of clouds and precipitation, making these some of the most important feedback mechanisms to the greenhouse effect.



Arctic and Antarctic Sea Ice Extent Anomalies, 1979-2012: Arctic sea ice extent underwent a strong decline from 1979 to 2012, but Antarctic sea ice underwent a slight increase, although some regions of the Antarctic experienced strong declining trends in sea ice extent. Thick lines indicate 12-month running means, and thin lines indicate monthly anomalies. Image by National Snow and Ice Data Center, University of Colorado, Boulder.

SPECIAL REPORT: SPECIAL REPORT ON THE OCEAN AND CRYOSPHERE IN A CHANGING CLIMATE

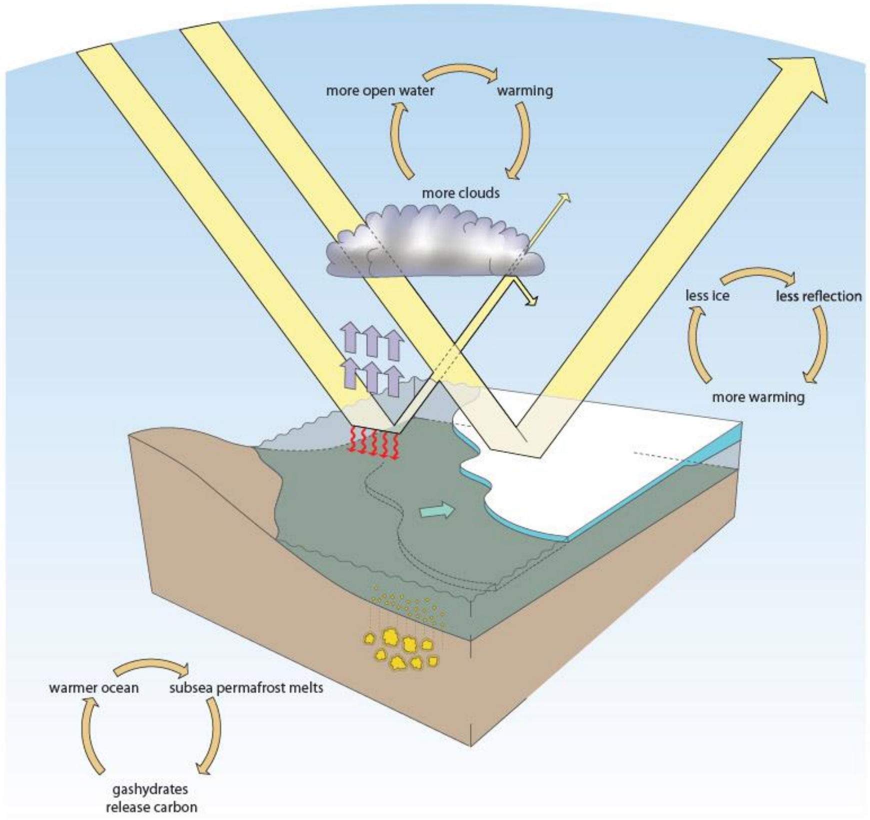
CH 03

Polar regions

DOWNLOAD (PDF, 9 MB) | AUTHORS | FAQ | FIGURES

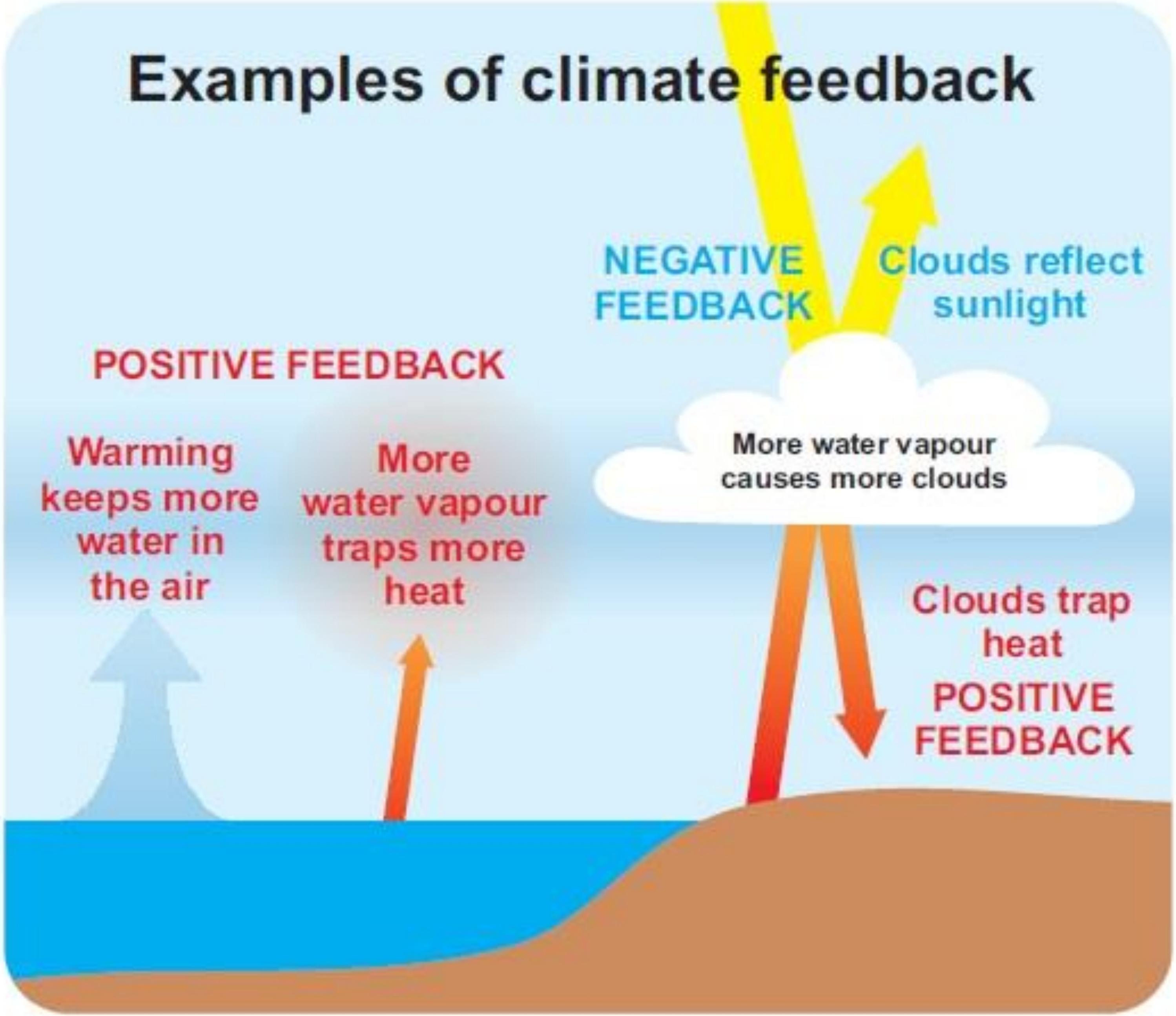
3.2 Changes, Consequences and Impacts
3.3 Polar Ice Sheets and Glaciers: Changes, Consequences and Impacts
3.4 Arctic Snow, Freshwater Ice and Permafrost: Changes, Consequences and Impacts
3.5 Human Responses to Climate Change in Polar Regions
3.6 Synopsis
3.7 Key Knowledge Gaps and Uncertainties
+ Acknowledgements
C Citation
SM Supplementary Material

With the exception of Antarctic sea-ice, increasing by 1% a year, nearly all the ice on the planet is melting. As the white surfaces decrease in area, less energy is reflected into space, and the Earth will warm up even more.



The loss of Arctic ice is of particular concern. The loss of ice triggers a **positive feedback**. By exposing the ocean surface to sunlight, the water warms up. This melts the ice from underneath, while man-made CO2 in the atmosphere warms the surface. Humidity also increases; **water vapor is a powerful greenhouse gas**. More ice therefore melts, which exposes more water, which melts more ice from underneath…

This loop fuels itself, the effect getting more and more pronounced. This is a good example of a positive feedback. Increased water vapor also has another effect, which is to increase the amount of **cloud**. As mentioned already, clouds can increase albedo (a negative feedback), but also warming (a positive feedback).


Examples of climate feedback
NEGATIVE FEEDBACK
Clouds reflect sunlight
POSITIVE FEEDBACK
Warming keeps more water in the air
More water vapour traps more heat
More water vapour causes more clouds
Clouds trap heat
POSITIVE FEEDBACK

Artic ice:

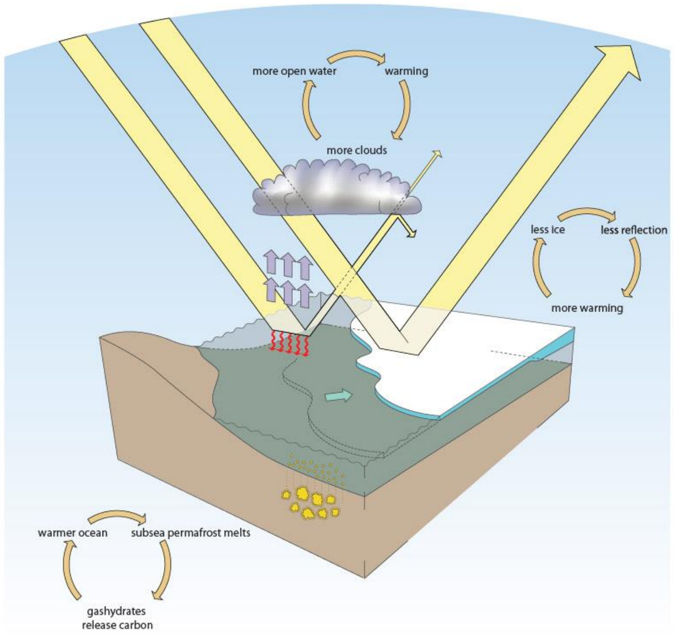
- plays an important ecosystem service for Earth
- Artic ice keep earth cool
- Artic ice is an important storage of carbon

Artic ice decreases

Sea levels does not authomatically encrease, this is not flooding our cities

i. Albedo decreases (i.e. reflectivity decreases)

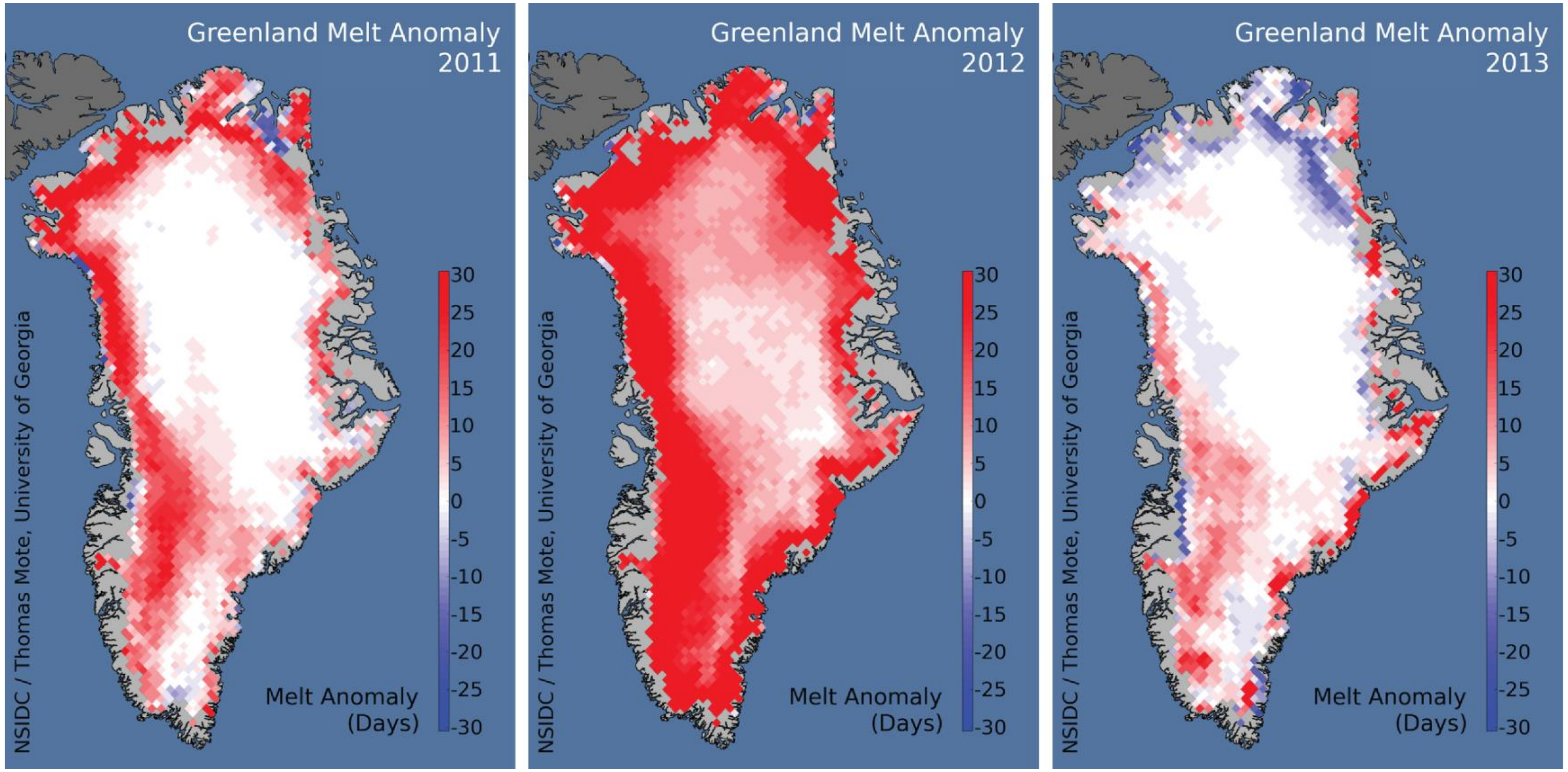
ii. Open oceans absorb sunlight and sun energy



Because sea ice has a bright surface, 50-70 percent of incoming energy is reflected back into space. As sea ice melts in the summer, it exposes the dark ocean surface. Instead of reflecting 50-70 percent of the sunlight, it absorbs 90 percent of the sunlight. As the ocean warms, global temperatures rise further.

COP25: Greenland's ice sheet melting seven times faster than in 1990s.

Greenland ice sheet is a vast body of ice covering 1,710,000 square kilometres, roughly 80% of the surface of Greenland. It is the second largest ice body in the world, after the Antarctic ice sheet.



PNAS

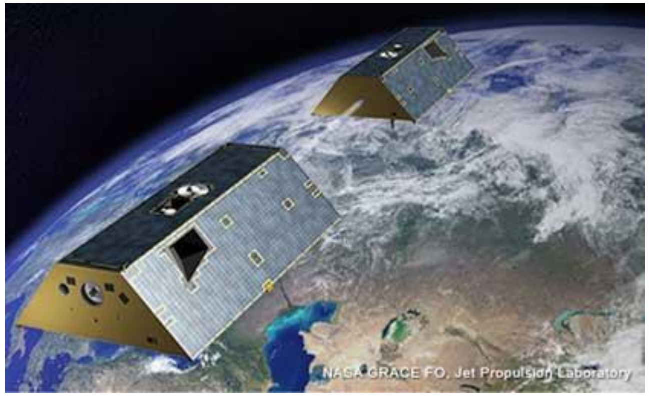
Accelerating changes in ice mass within Greenland, and the ice sheet's sensitivity to atmospheric forcing

Michael Bevis[a,1], Christopher Harig[b], Shfaqat A. Khan[c], Abel Brown[a], Frederik J. Simons[d], Michael Willis[e], Xavier Fettweis[f], Michiel R. van den Broeke[g], Finn Bo Madsen[c], Eric Kendrick[a], Dana J. Caccamise II[a], Tonie van Dam[h], Per Knudsen[c], and Thomas Nylen[i]

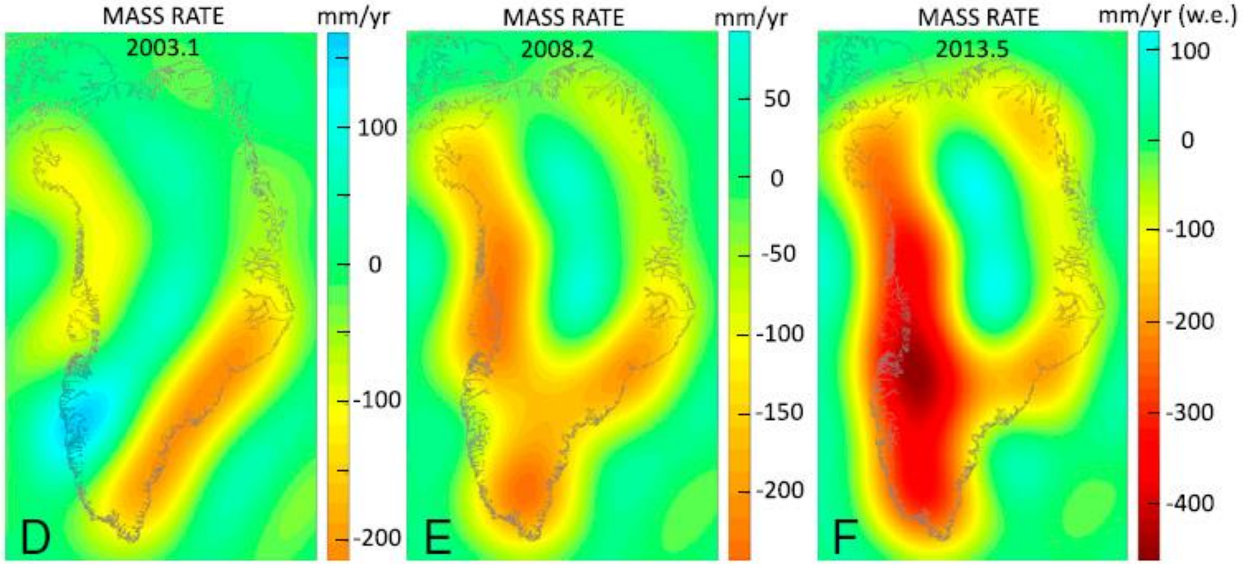
[a]School of Earth Sciences, Ohio State University, Columbus, OH 43210; [b]Department of Geosciences, University of Arizona, Tucson, AZ 85721; [c]DTU Space, National Space Institute, Danish Technical University, 2800 Kongens Lyngby, Denmark; [d]Department of Geosciences, Princeton University, Princeton, NJ 08544; [e]Department of Geological Sciences, University of Colorado, Boulder, CO 80309; [f]Department of Geography, University of Liège, 4000 Liège, Belgium; [g]Institute for Marine and Atmospheric Research, Utrecht University, 3508 TA Utrecht, The Netherlands; [h]Faculty of Sciences, University of Luxembourg, L-4365 Esch-sur-Alzette, Luxembourg; and [i]UNAVCO, Inc., Boulder, CO 80301

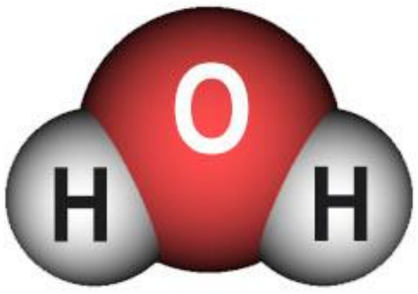
Gravity changes over time will be used to follow these individual water masses. In effect, gravity becomes a tracer to track water movement our eyes cannot see.

Data from the mission will be combined with observations from other NASA satellites

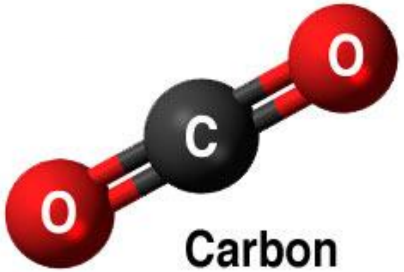


The recent deglaciation of Greenland is a response to both oceanic and atmospheric forcings. From 2000 to 2010, ice loss was concentrated in the southeast and northwest margins of the ice sheet, in large part due to the increasing discharge of marine-terminating outlet glaciers, emphasizing the importance of oceanic forcing. However, the largest sustained (~10 years) acceleration detected by Gravity Recovery and Climate Experiment (GRACE) occurred in southwest Greenland, an area largely devoid of such glaciers. The sustained acceleration and the subsequent, abrupt, and even stronger deceleration were mostly driven by changes in air temperature and solar radiation. Continued atmospheric warming will lead to southwest Greenland becoming a major contributor to sea level rise.



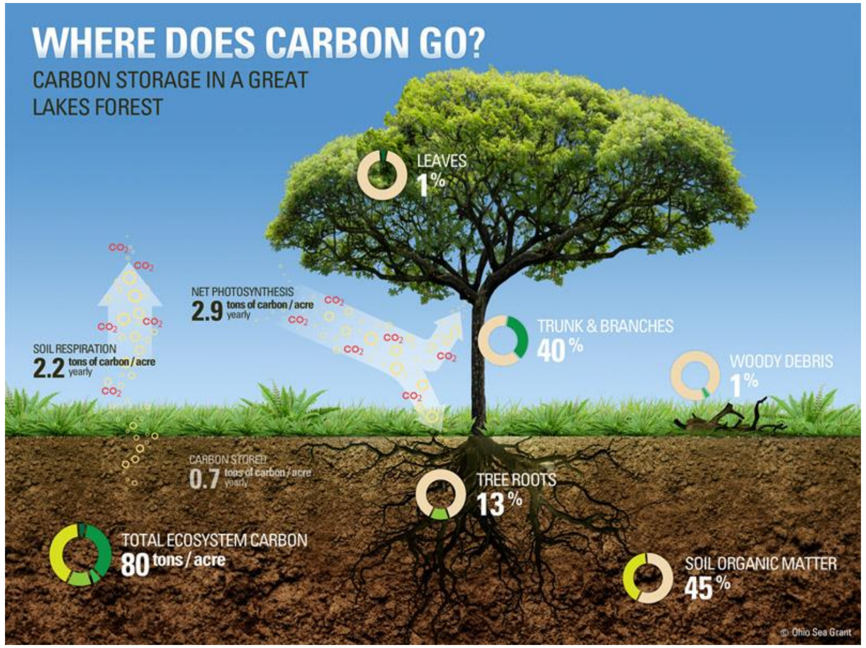


Water vapor (H_2O)



Carbon dioxide (CO_2)

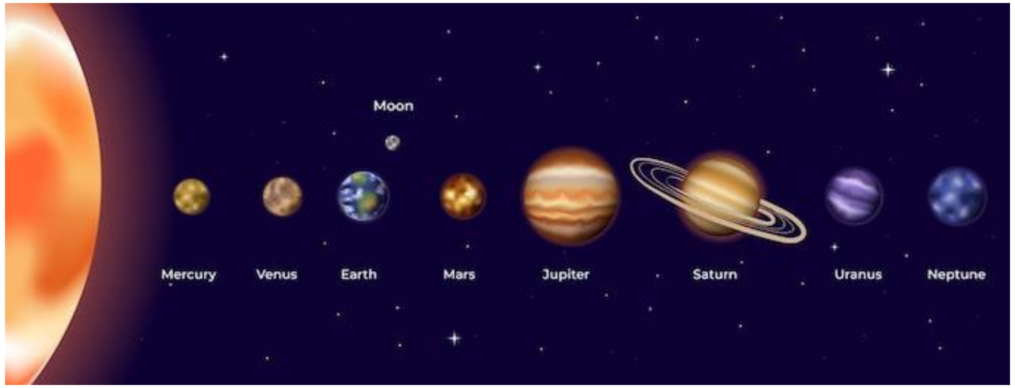
Carbon dioxide (CO_2) is released through natural processes such as respiration and volcano eruptions and through human activities such as deforestation, land use changes, and burning fossil fuels.



<u>Deforestation</u> and land use account for 1/3 of the excess greenhouse gas emission

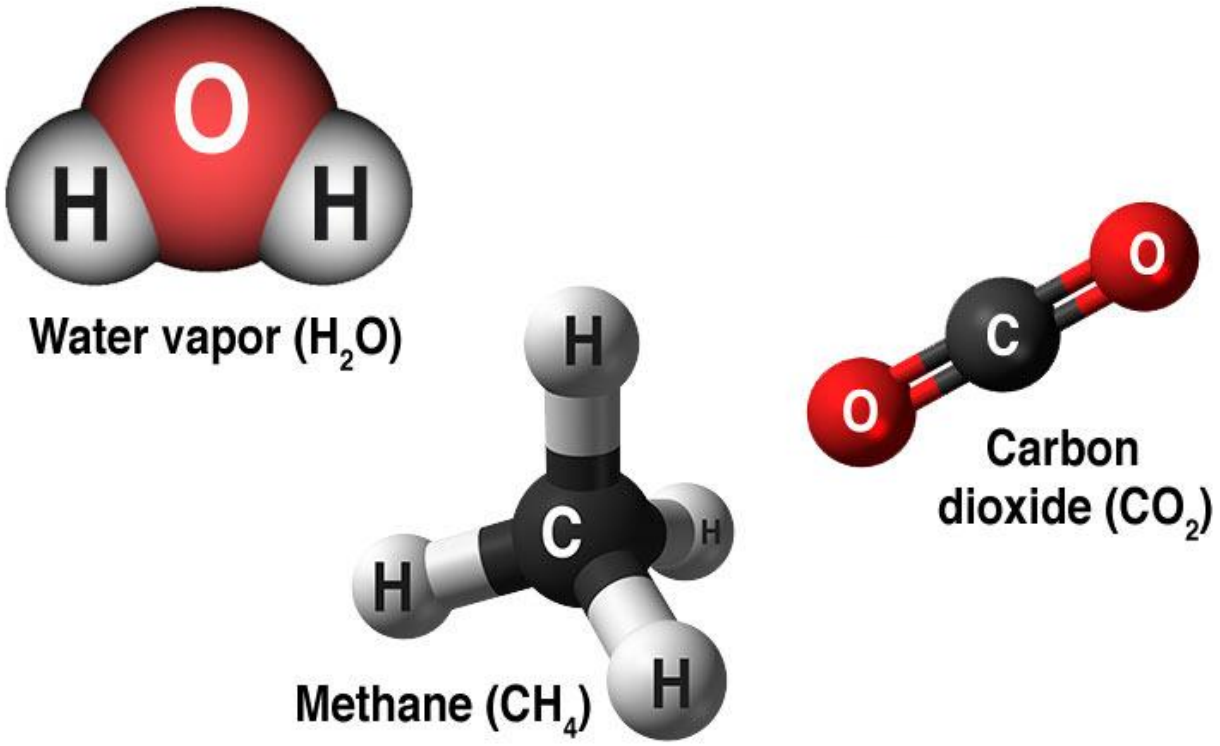
Mars

Low greenhouse effect: The planet Mars has a very **thin atmosphere, nearly all carbon dioxide**. Because of the low atmospheric pressure, and with little to no methane or water vapor to reinforce the weak greenhouse effect, Mars has a largely frozen surface that shows no evidence of life.

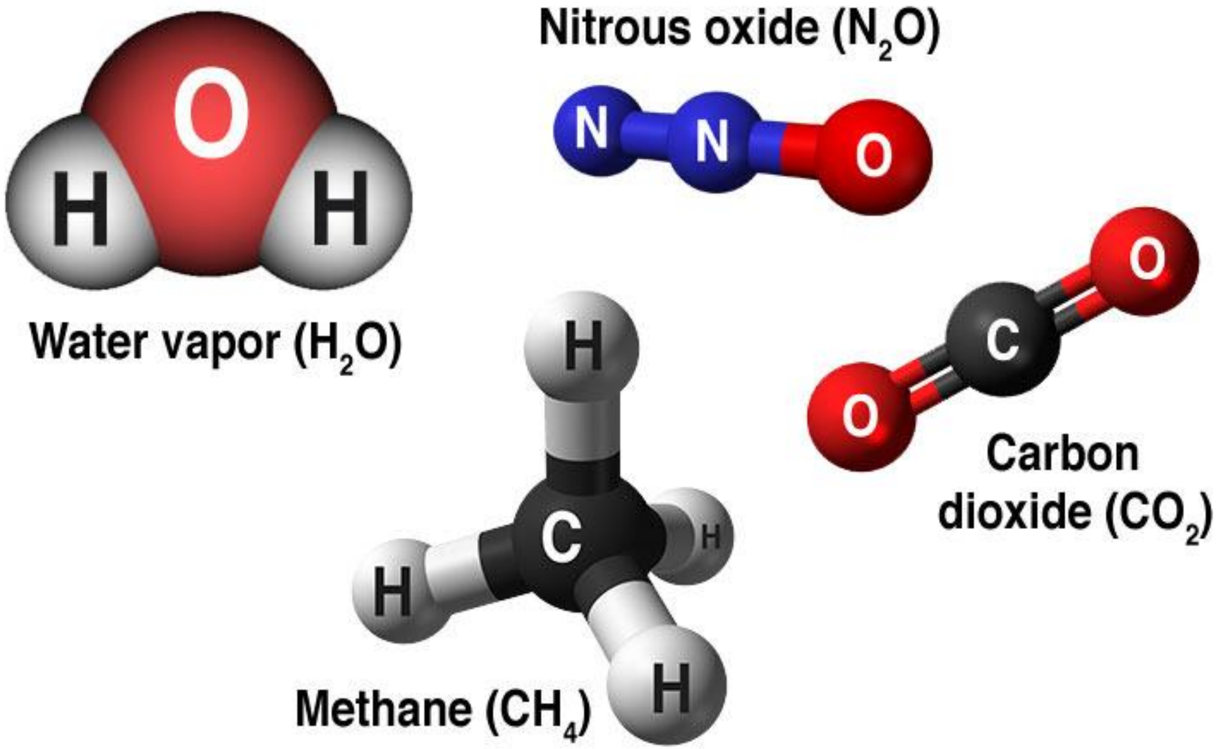


Venus

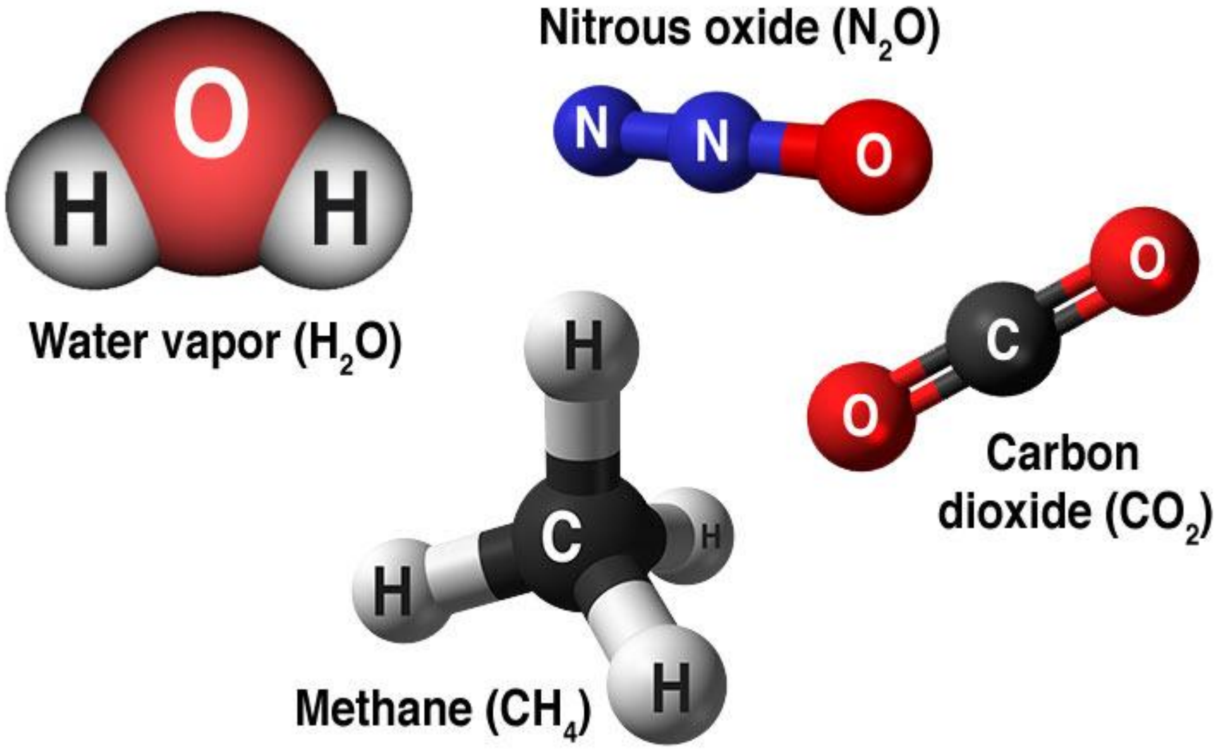
High greenhouse effect: The atmosphere of Venus, like Mars, is **nearly all carbon dioxide**. But Venus has about 154,000 times as much carbon dioxide in its atmosphere as Earth, producing a runaway greenhouse effect and a surface temperature hot enough to melt lead.

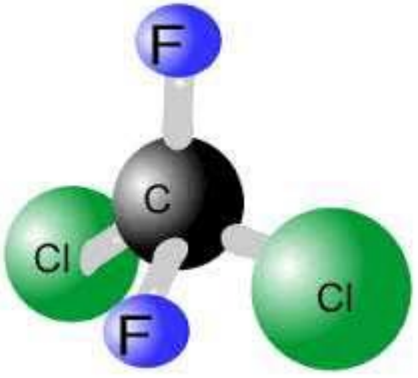


Methane. A hydrocarbon gas produced both through natural sources and human activities, including the decomposition of wastes in landfills, agriculture as well as ruminant digestion and manure management associated with domestic livestock.



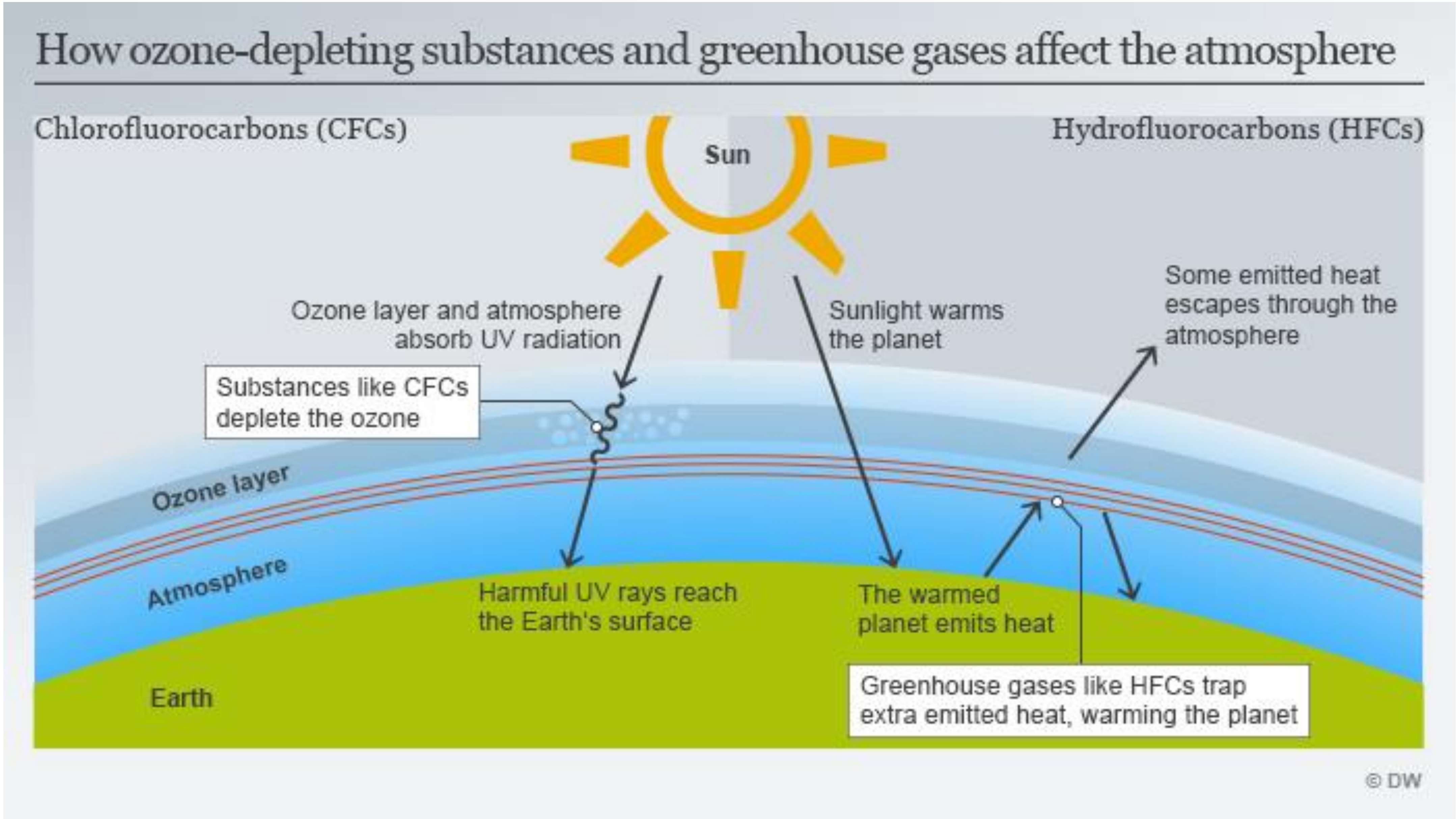
Nitrous oxide. A powerful greenhouse gas produced by soil cultivation practices, especially the use of commercial and organic fertilizers, fossil fuel combustion, nitric acid production, and biomass burning.



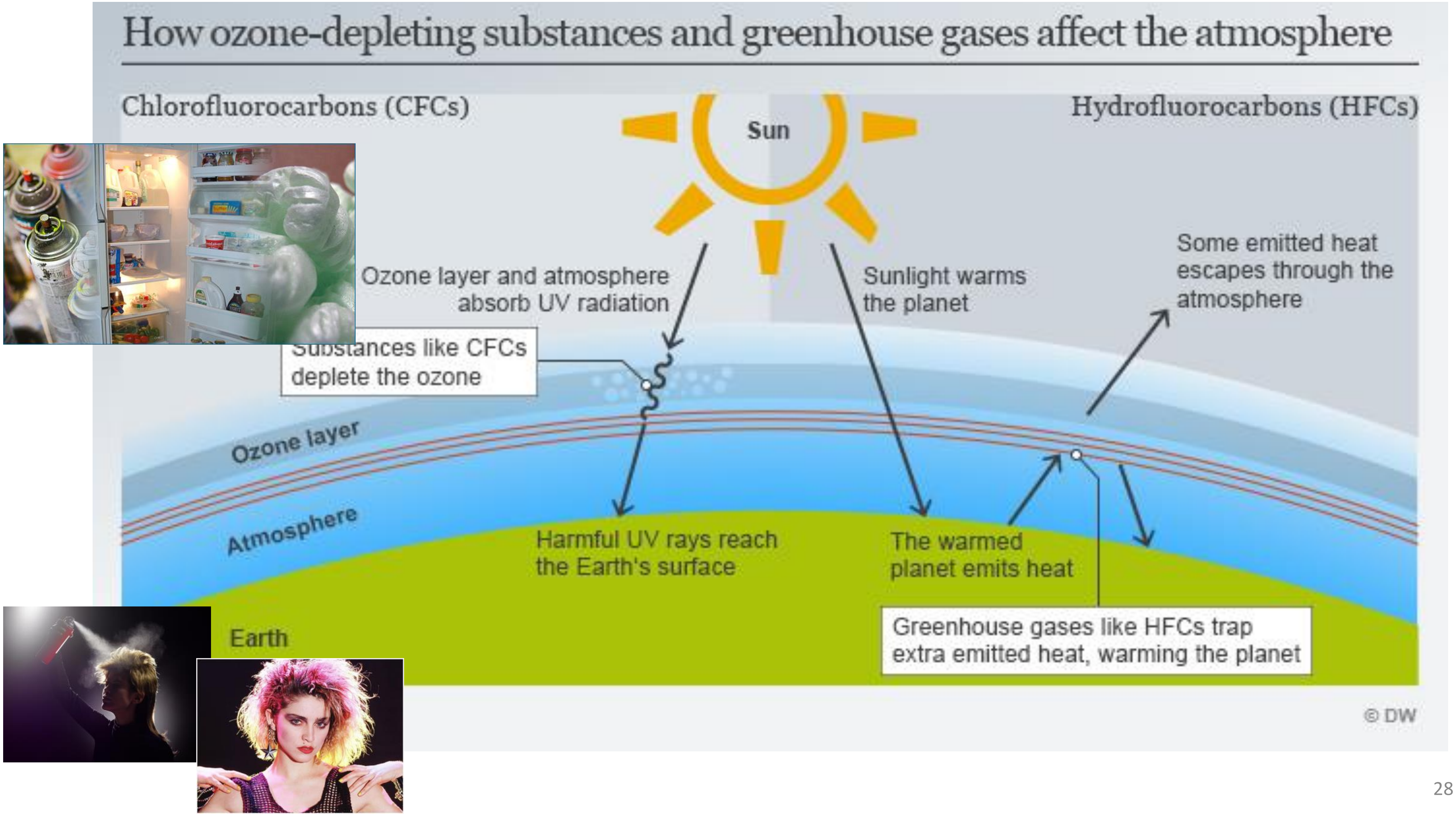


Chlorofluorocarbons (CFCs). Synthetic compounds entirely of industrial origin used in a number of applications, but now largely regulated in production and release to the atmosphere by international agreement for their ability to contribute to destruction of the ozone layer. They are also greenhouse gases.

Chlorofluorocarbons (CFCs) - Green positivity



Chlorofluorocarbons (CFCs)



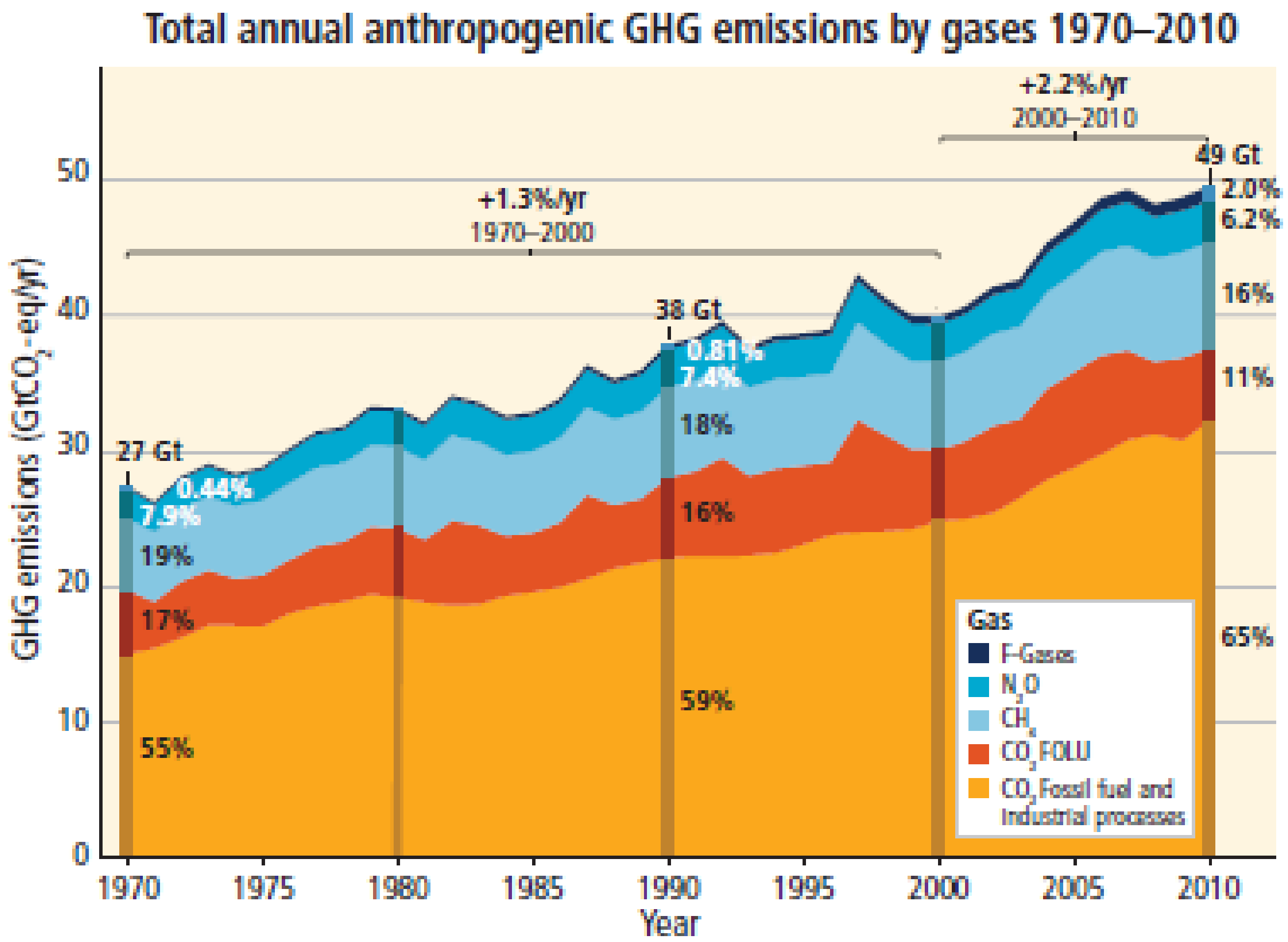
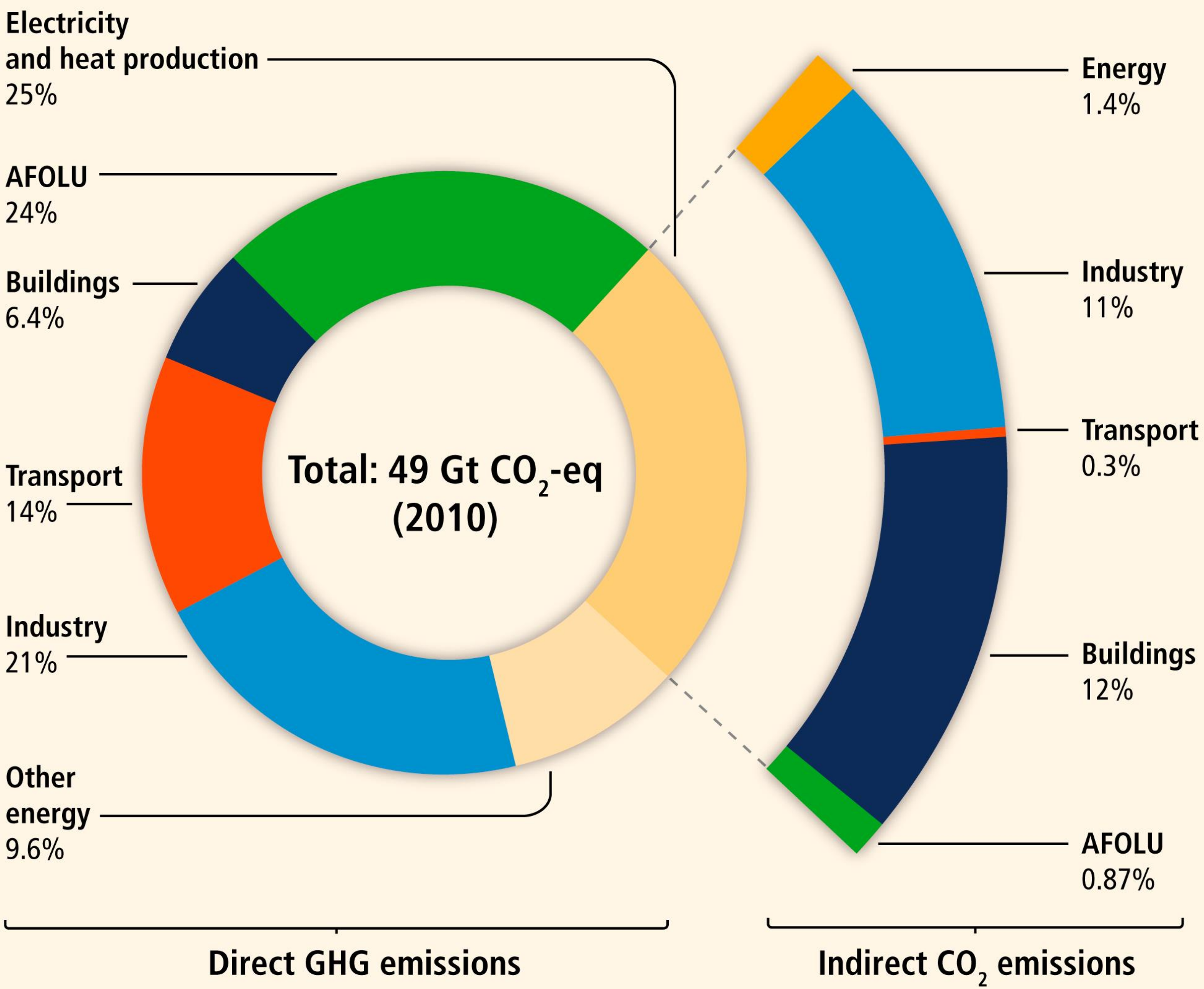


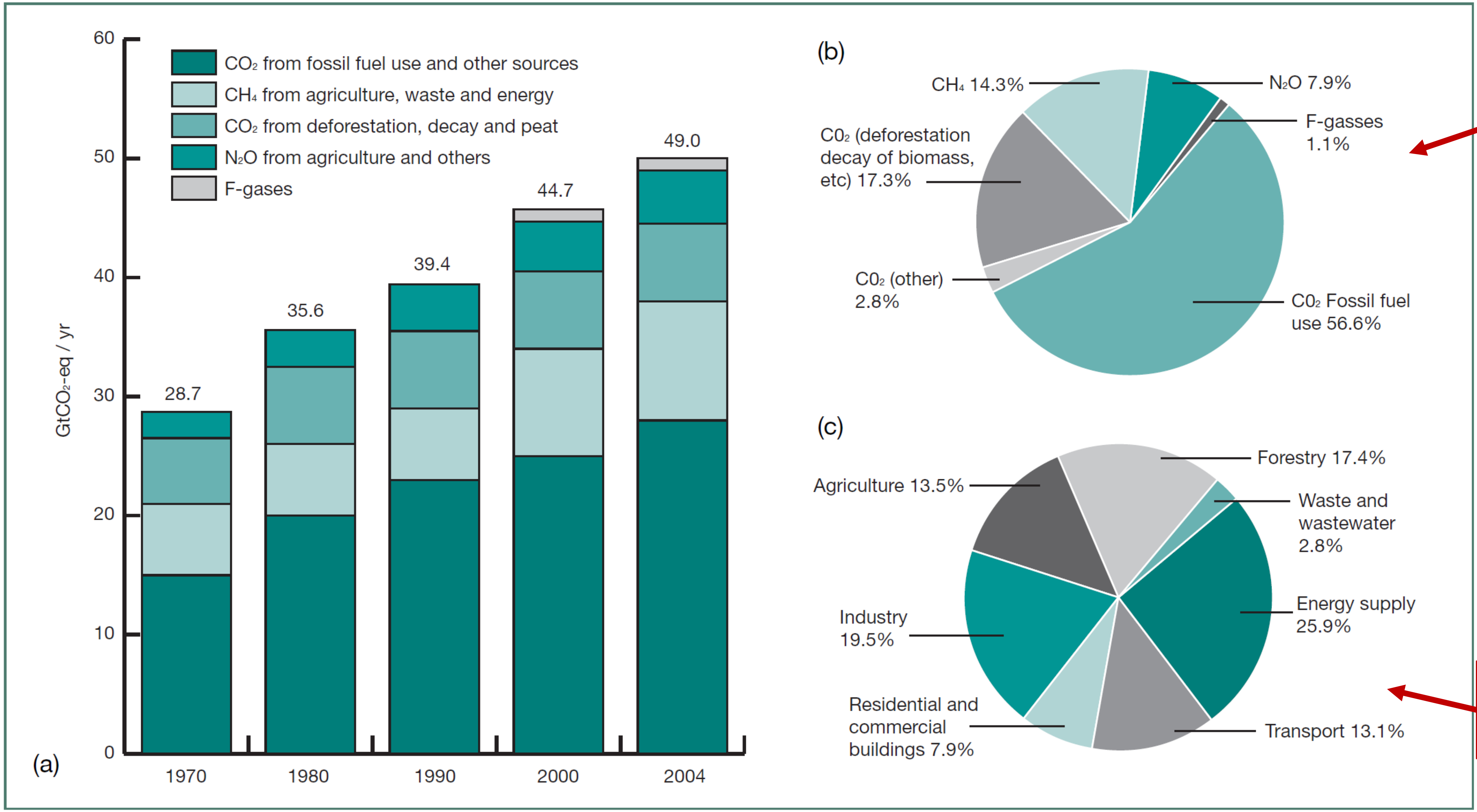
Figure SPM.2 | Total annual anthropogenic greenhouse gas (GHG) emissions (gigatonne of CO_2-equivalent per year, $GtCO_2$-eq/yr) for the period 1970 to 2010 by gases: CO_2 from fossil fuel combustion and industrial processes; CO_2 from Forestry and Other Land Use (FOLU); methane (CH_4); nitrous oxide (N_2O); fluorinated gases covered under the Kyoto Protocol (F-gases). Right hand side shows 2010 emissions, using alternatively CO_2-equivalent emission weightings based on IPCC Second Assessment Report (SAR) and AR5 values. Unless otherwise stated, CO_2-equivalent emissions in this report include the basket of Kyoto gases (CO_2, CH_4, N_2O as well as F-gases) calculated based on 100-year Global Warming Potential (GWP_{100}) values from the SAR (see Glossary). Using the most recent GWP_{100} values from the AR5 (right-hand bars) would result in higher total annual GHG emissions (52 $GtCO_2$-eq/yr) from an increased contribution of methane, but does not change the long-term trend significantly. *{Figure 1.6, Box 3.2}*

- **CO_2** from fossil fuel, industrial processes and FOLU (Foresty and Other Land Uses).
- **Methane**, mainly produced by animals and plants
- **Black carbon** not cited here and their role is much more debated
- **Nitrous oxide** from diesel and track and agriculture
- **F-gases**, fluorinated gases

Greenhouse gas emissions by economic sectors



General Introduction – which greenhouse gas we produce

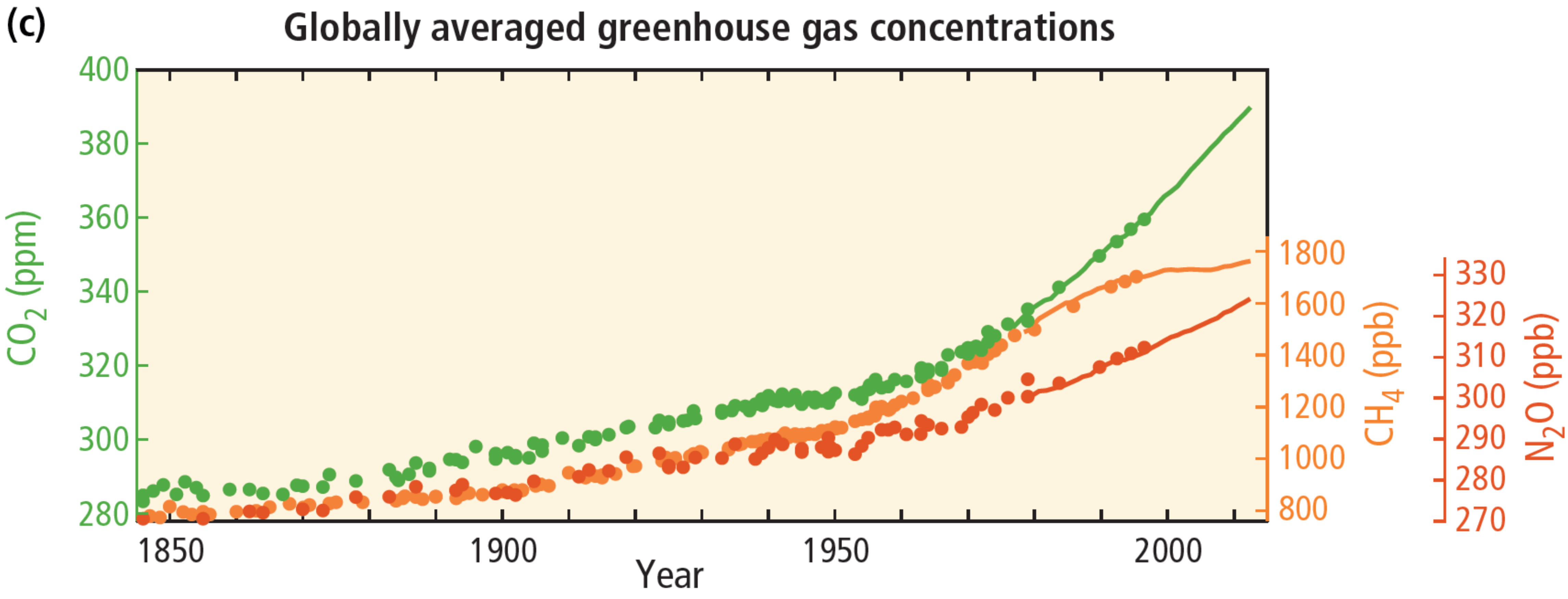


Focus on CO_2-eq

Focus on polluting sectors

Figure 1.2 - (a) Global annual emissions of anthropogenic greenhouse gases (GHGs) from 1970 to 2004. (b) Share of different anthropogenic GHGs in total emissions in 2004 in terms of CO_2-eq. (c) Share of different sectors in total anthropogenic GHG emissions in 2004 in terms of CO_2-eq. (forestry includes deforestation) (IPCC, 2007).

GREENHOUSE GASES CONCENTRATION IN ICE CORES FLUCTUATED BELOW 300 ppm IN THE LAST 400000 YEARS BEFORE 1900 WHEN THINGS CHANGED



CLIMATE CHANGE IS ALMOST IRREVERSIBLE AND TRANSGENERATIONAL

- On May 9, 2013, an instrument near the summit of Mauna Loa in Hawai'i, United States, recorded the amount of carbon dioxide (CO2) in the atmosphere exceeded 400 parts per million (ppm) for the first time in 55 years of measurement.
- The last time the concentration of CO2 was as high as 400 ppm was probably in the Pliocene Epoch, between 2.6 million and 5.3 million years ago.
- In 2016, an even more significant milestone was reached: The global annual minimum levels of CO2 in the atmosphere measured above 400 ppm.

NATIONAL GEOGRAPHIC | Education

ARTICLE | LEVELED

Climate Milestone: Earth's CO2 Level Passes 400 ppm

Today, greenhouse gasses in Earth's atmosphere are at their highest since the Pliocene Era, when sea levels were higher and Earth was warmer.

GRADES
4 - 12

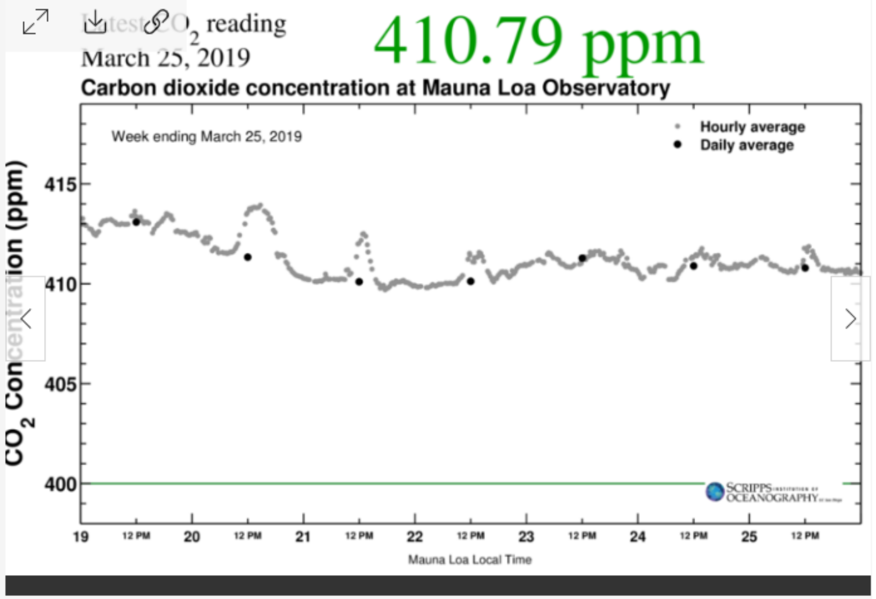
SUBJECTS
Chemistry, Climatology, Conservation

PHOTOGRAPH

Scripps CO2 2019

This graph visualizes data from the Scripps carbon dioxide (CO2) measurements recorded at the Mauna Loa Observatory.

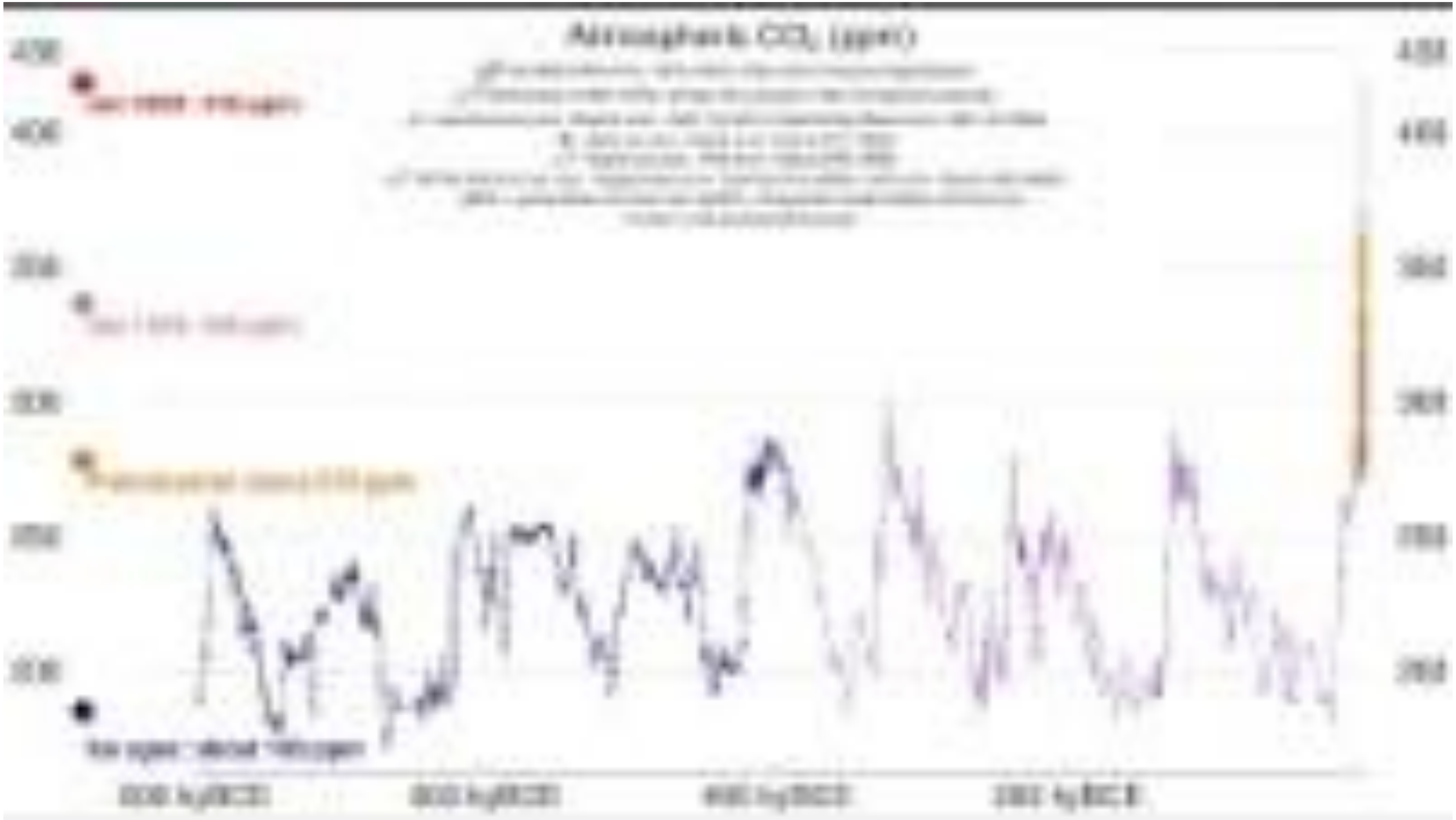
IMAGE BY THE SCRIPPS INSTITUTION OF OCEANOGRAPHY

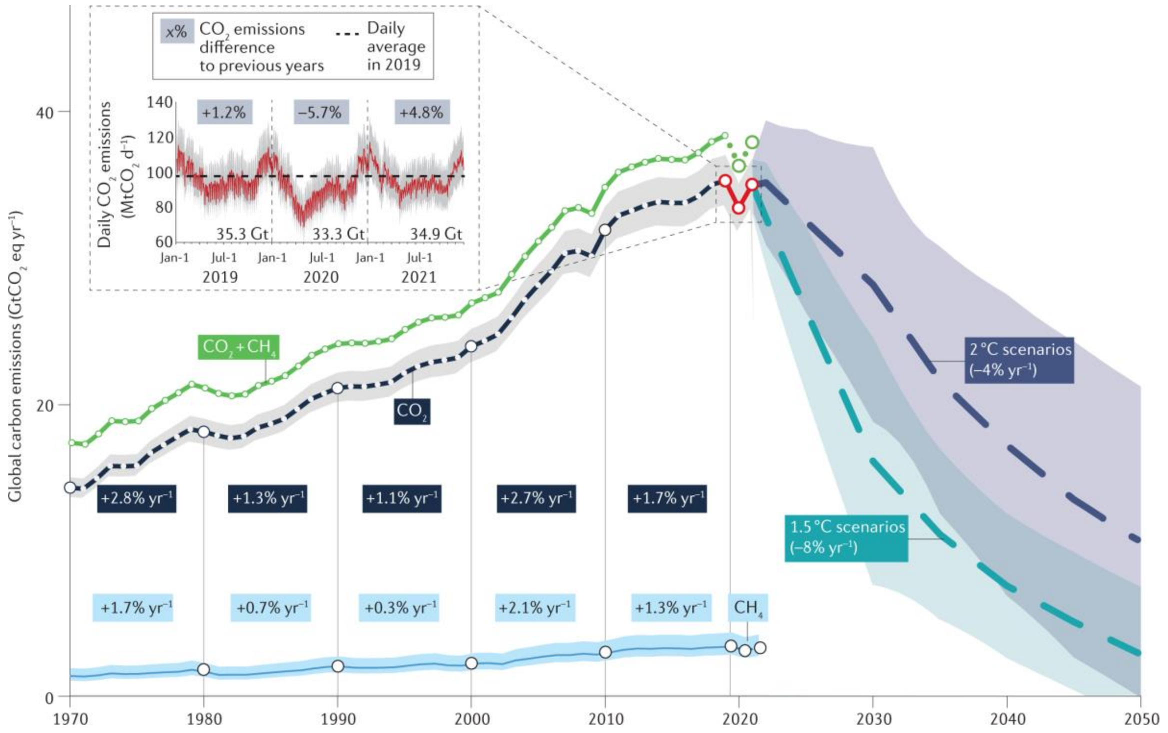


https://education.nationalgeographic.org/resource/climate-milestone-earths-co2-level-passes-400-ppm/

National Oceanic and Atmospheric Administration

https://www.youtube.com/watch?v=gbxEsG8g6BA





COMMENT

Check for updates

Monitoring global carbon emissions in 2021

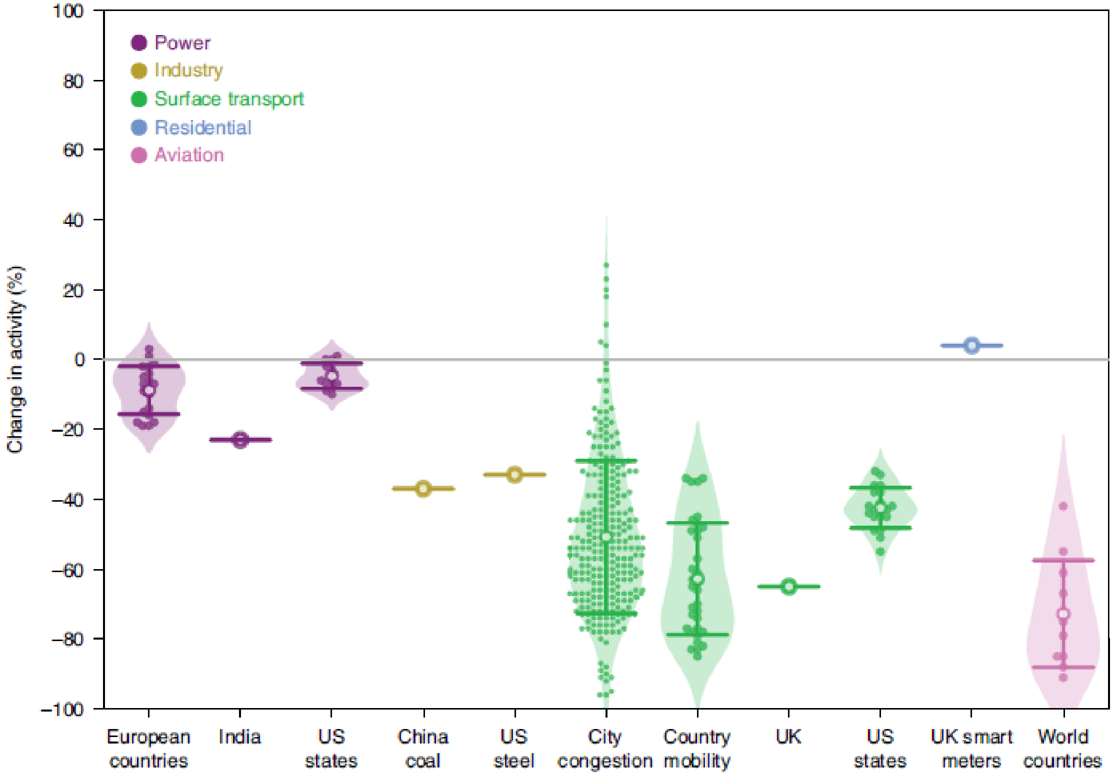
Zhu Liu[1]✉, Zhu Deng[1], Steven J. Davis[2], Clement Giron[3] and Philippe Ciais[4]

Following record-level declines in 2020, near-real-time data indicate that global CO_2 emissions rebounded by 4.8% in 2021, reaching 34.9 $GtCO_2$. These 2021 emissions consumed 8.7% of the remaining carbon budget for limiting anthropogenic warming to 1.5 °C, which if current trajectories continue, might be used up in 9.5 years at 67% likelihood.

nature climate change
ARTICLES
https://doi.org/10.1038/s41558-020-0797-x
Check for updates

Temporary reduction in daily global CO_2 emissions during the COVID-19 forced confinement

Corinne Le Quéré[1,2]✉, Robert B. Jackson[3,4,5], Matthew W. Jones[1,2], Adam J. P. Smith[1,2], Sam Abernethy[3,6], Robbie M. Andrew[7], Anthony J. De-Gol[1,2], David R. Willis[1,2], Yuli Shan[8], Josep G. Canadell[9], Pierre Friedlingstein[10,11], Felix Creutzig[12,13] and Glen P. Peters[7]



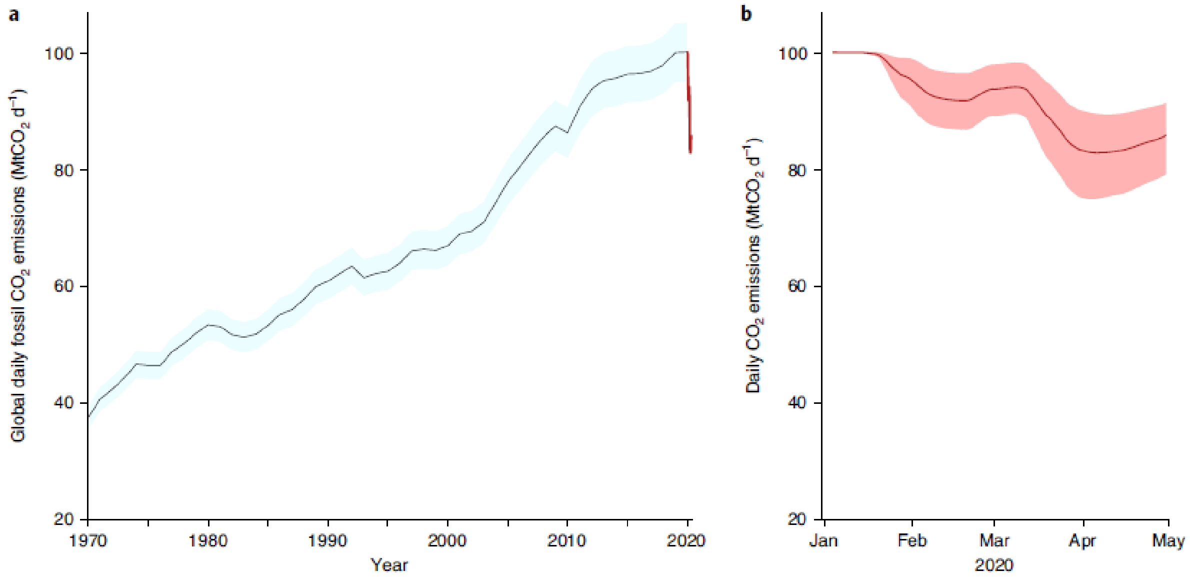


Fig. 3 | Global daily fossil CO_2 emissions ($MtCO_2\ d^{-1}$). **a**, Annual mean daily emissions in the period 1970–2019 (black line), updated from the Global Carbon Project[1,3] (Methods), with uncertainty of ±5% (±1σ; grey shading). The red line shows the daily emissions up to end of April 2020 estimated here. **b**, Daily CO_2 emissions in 2020 (red line, as in **a**) based on the CI and corresponding change in activity for each CI level (Fig. 2) and the uncertainty (red shading; Table 2). Daily emissions in 2020 are smoothed with a 7-d box filter to account for the transition between confinement levels.

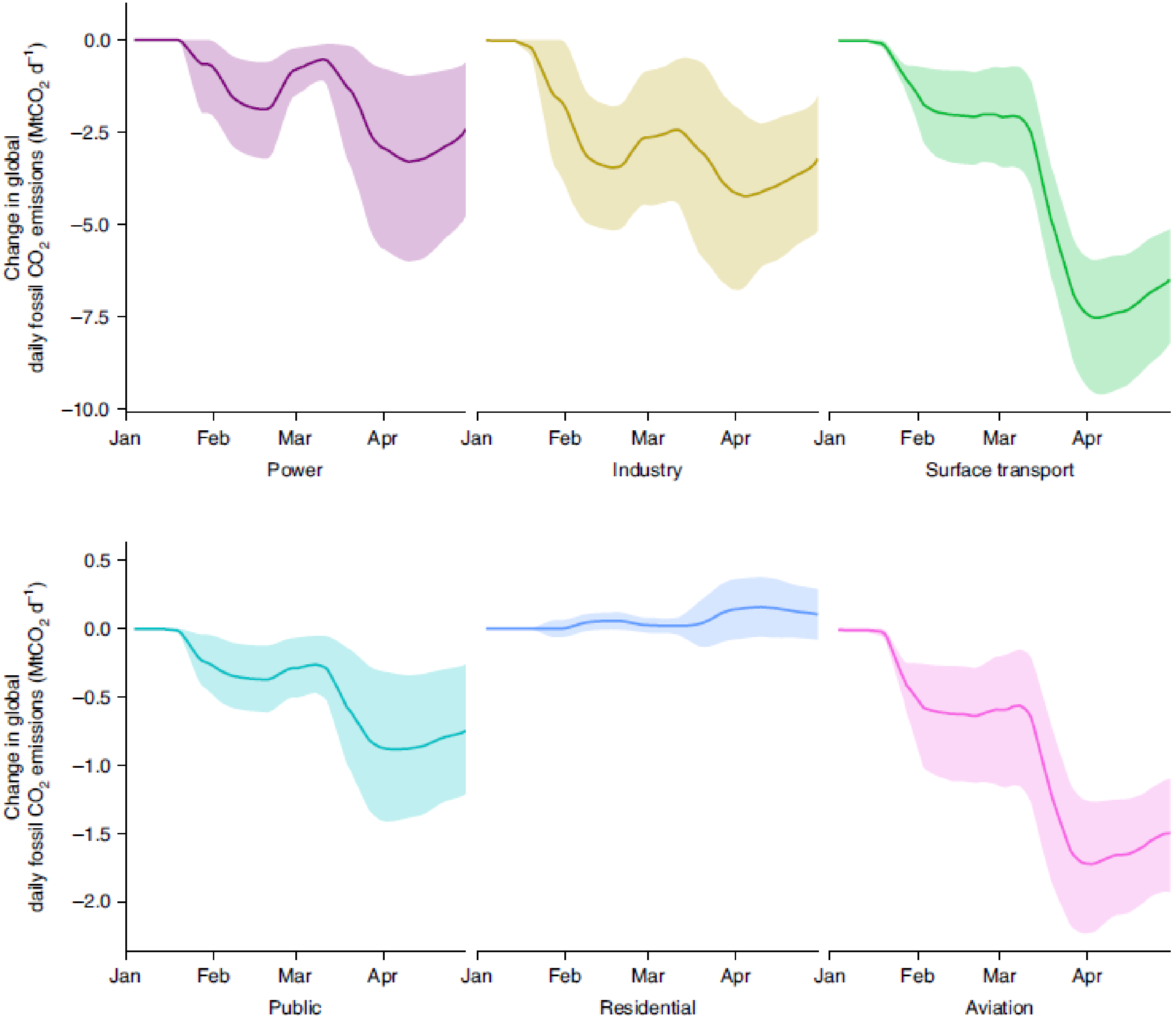


Fig. 4 | Change in global daily fossil CO_2 emissions by sector ($MtCO2\ d^{-1}$). The uncertainty ranges represent the full range of our estimates. Changes are relative to annual mean daily emissions from those sectors in 2019 (Methods). Daily emissions are smoothed with a 7-d box filter to account for the transition between confinement levels. Note the different ranges on the *y* axes in the upper and lower panels.

Effect of a specific GHG on plant physiology and effect of plant cultivation on GHG emission

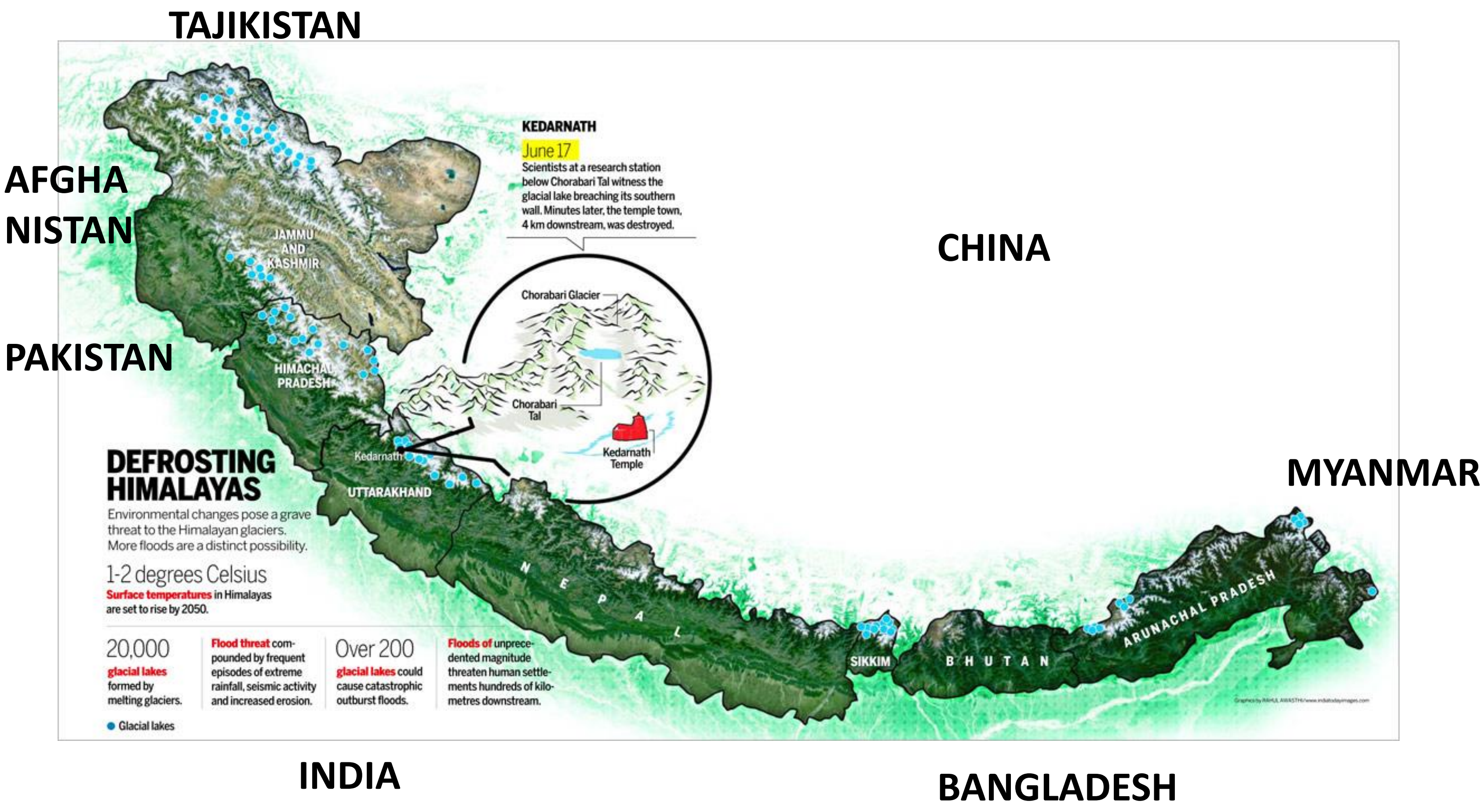
GRADUAL CHANGES

EXTREME CHANGES OF WEATHER

ABRUPT CLIMATE CHANGE

Warming is only one of many facets or parts of climate change, but there are OTHER **GRADUAL CHANGES**:

- Rain fall systems change (some area get more, some less than before)
- Oceans rise
- Oceans get warmer (of course if the globe is warming! But we have to think about that)
- Oceans get more sour beacause CO_2 dissolves more into them (not good for fish, O_2 content, coral reefs)
- Melting of glaciers (e.g. Himalaya feeding 1 billion people from China to Bangladesh)
- Weather is changing



The mountainous states of India, and the nations of Nepal and Bhutan share one of the world's greatest freshwater resources -- water from the snows of the Himalayas and the monsoons which the mountains create. **More than 1.4 billion people depend on water from the rivers of the Himalaya**, with the eastern rivers like the Ganges much more dependent on rain and groundwater than on direct flow from glaciers.

General rule: water stored as glacial ice is the region's hydrological "insurance," acting as a buffer against the hydrological impacts brought about by a changing climate, releasing the stored water to streams and rivers when it is most needed.

In less than 15 years the Marmolada glacier could be desappeared

ARTICLE

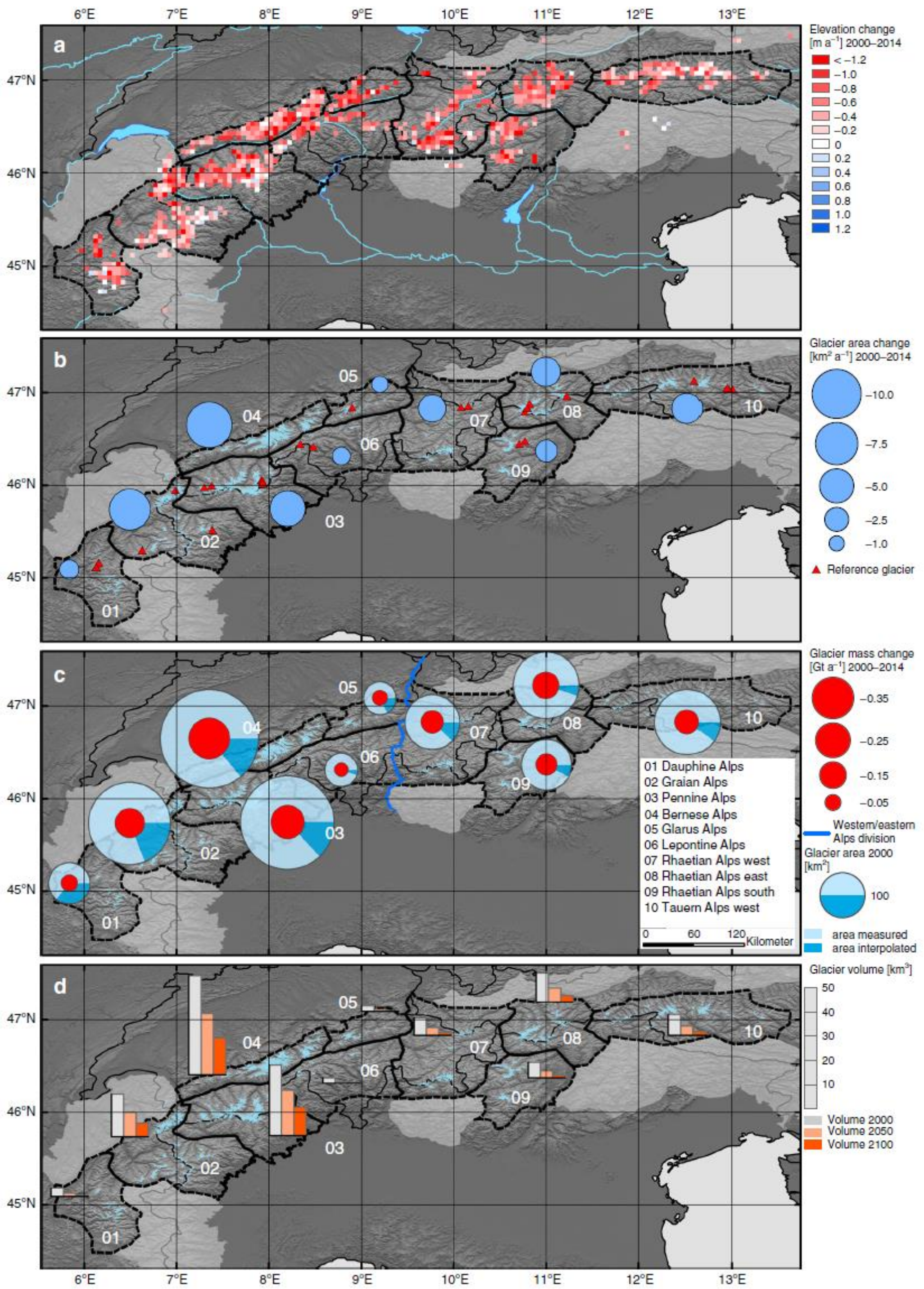
https://doi.org/10.1038/s41467-020-16818-0 OPEN

Check for updates

Rapid glacier retreat and downwasting throughout the European Alps in the early 21st century

Christian Sommer [1✉], Philipp Malz[1], Thorsten C. Seehaus [1], Stefan Lippl [1], Michael Zemp [2] & Matthias H. Braun [1]

Mountain glaciers are known to be strongly affected by global climate change. Here we compute temporally consistent changes in glacier area, surface elevation and ice mass over the entire European Alps between 2000 and 2014. We apply remote sensing techniques on an extensive database of optical and radar imagery covering 93% of the total Alpine glacier volume. Our results reveal rapid glacier retreat across the Alps ($-39\,km^2\,a^{-1}$) with regionally variable ice thickness changes (-0.5 to $-0.9\,m\,a^{-1}$). The strongest downwasting is observed in the Swiss Glarus and Lepontine Alps with specific mass change rates up to -1.03 m.w.e. a^{-1}. For the entire Alps a mass loss of $1.3 \pm 0.2\,Gt\,a^{-1}$ (2000–2014) is estimated. Compared to previous studies, our estimated mass changes are similar for the central Alps, but less negative for the lower mountain ranges. These observations provide important information for future research on various socio-economic impacts like water resource management, risk assessments and tourism.



Cambiamenti climatici, a Belluno il record negativo in Italia

Lo studio su un secolo di temperature: due gradi in più negli ultimi 17 anni; in Europa solo i Paesi del Nord vanno peggio. L'esperto: "Le Alpi soffrono molto il caldo". Effetto-salute non trascurabile

di ***Martina Reolon***

CLIMA RISCALDAMENTO GLOBALE

Ski resorts battle for a future as snow declines in climate crisis

International Ski Federation urged to cut emissions, while activists warn of damage through heavy use of snowmaking

Sandra Laville
Tue 26 Dec 2023 08.25 CET
Share

Cannon spraying snow in 2022 for a Zermatt-Cervinia cross-border alpine ski race. Photograph: Maxime Schmid/AP

After promising early dumps of snow in some areas of Europe this autumn, the pattern of recent years resumed and rain and sleet took over.

In the ski resorts of Morzine and Les Gets in the French Alps, the heavy rainfall meant that full opening of resorts was delayed until two days before Christmas, leaving the industry and the millions of tourists planning trips to stare at the sky in hope.

But no amount of wishing and hoping will overcome what is an existential threat to skiing in the Alps, an industry worth $30bn (£23.8bn) that provides the most popular ski destination in the world.

The science is clear, and is spelled out in carefully weighed-up peer reviewed reports. The most recent, this year, warned that at 2C of global heating above pre-industrial levels, 53% of the 28 European resorts examined would be at

THERE ARE ALSO **EXTREME CHANGES OF WEATHER**, not only gradual but drastic:

- Heat waves
- Floods
- Storms
- Landslides

Irma Hurricane, category 5
Deaths: 132
Damages: > $62.9 billion

THERE ARE ALSO **EXTREME CHANGES OF WEATHER**, not only gradual but drastic:

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THERE IS THE LAST TYPE OF CLIMATE CHANGE, THAT SHOULD NOT BE CONFUSED WITH A RAPID CHANGE BUT IT'S A HIGHER PROBABILITY OF **ABRUPT CLIMATE CHANGE**: THESE ARE SINGULAR EVENTS THAT IF THEY HAPPEN, THEY WILL HAVE A HUGE EFFECT ON THE ENTIRE GLOBE.

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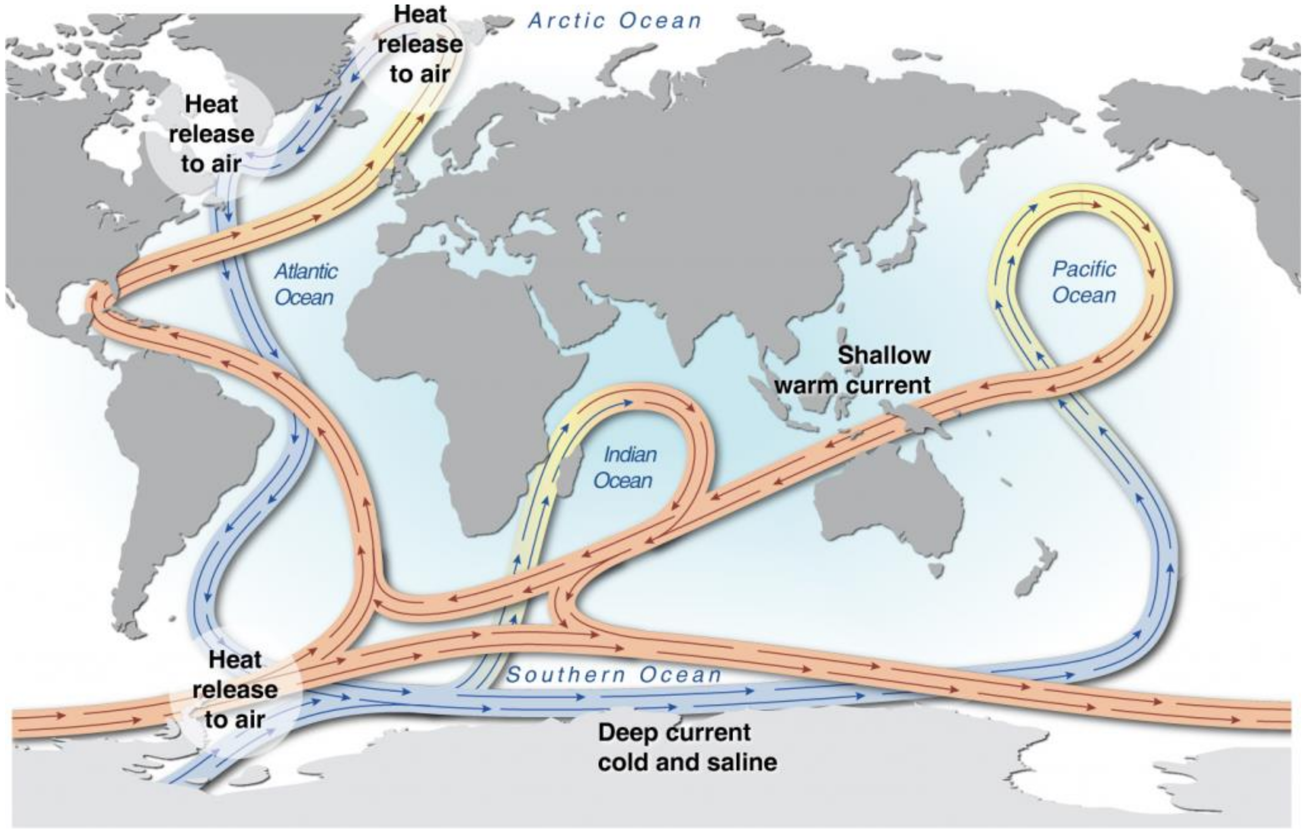


- GULF STREAM (equalizing system of ocean current) STOPS «thermohaline shutdown» generating more severe changes in temperature (regions that are hot would become hotter and cold regions would become colder). **Probability for this phenomenon become higher when we pump more energy in the atmosphere.**

Thermohaline circulation

- Thermo -> temperature
- Haline -> salinity

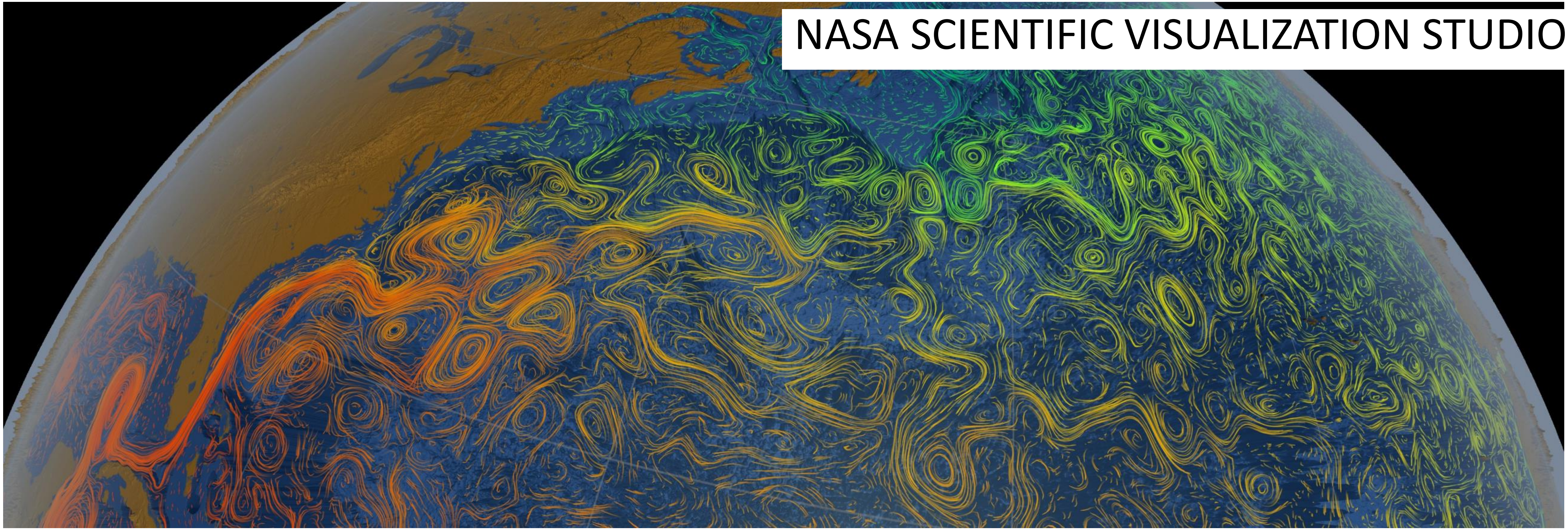
Both determine water density

Warm water rises

Cold water sinks

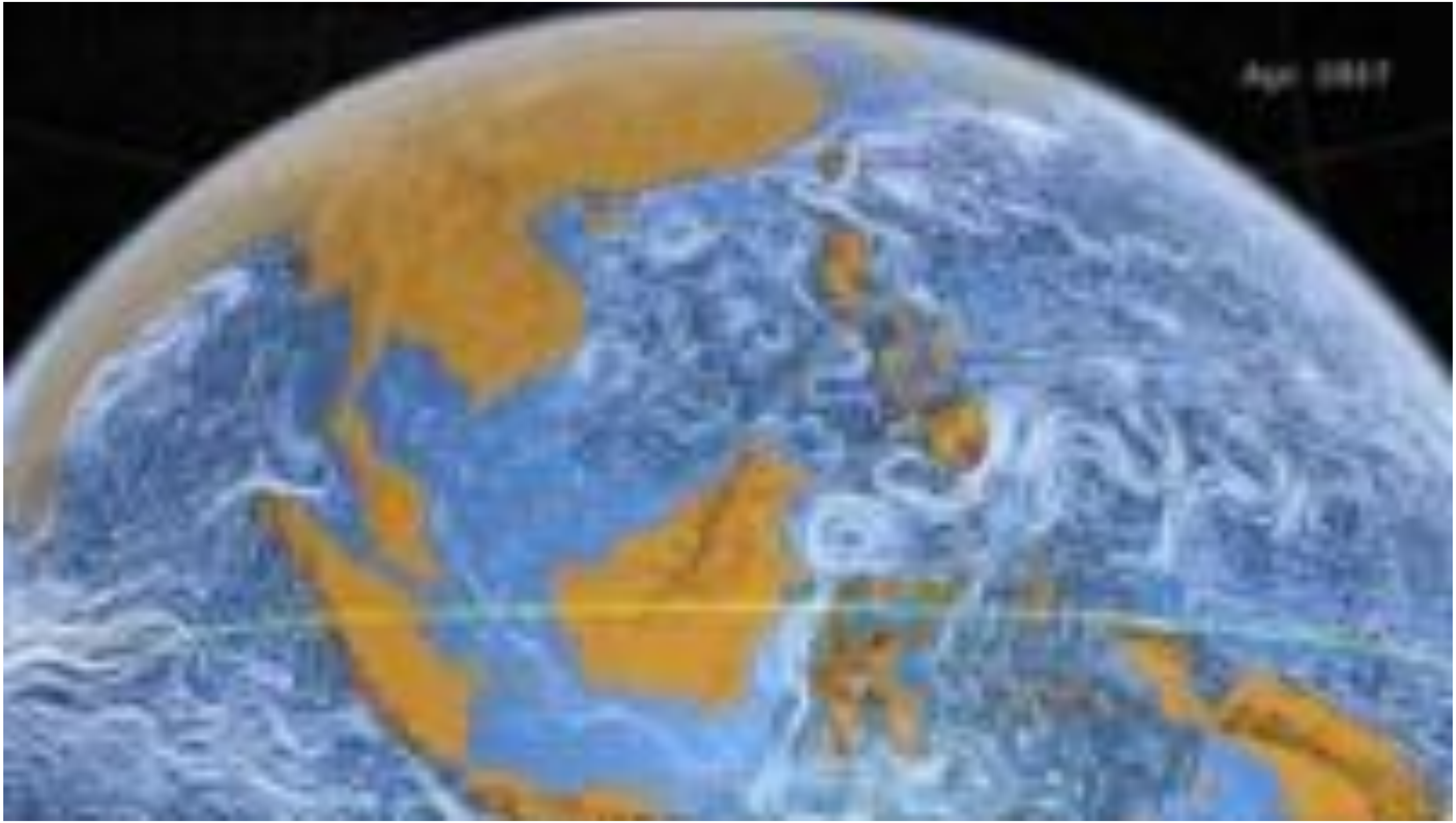
At the equator, there is more evaporation and salt concentration encreases.
There is where the Gulf Stream begins. It is important for EU climate.
Some numbers: 2 meter/second, 100000000 m^3 warm water / second

This visualization shows the **Gulf Stream** stretching from the Gulf of Mexico all the way over towards Western Europe. This visualization was designed for a very wide, high resolution display (e.g., a 5x3 hyperwall display). This visualization was produced using model output from **the joint MIT/JPL project entitled Estimating the Circulation and Climate of the Ocean, Phase II (ECCO2)**. ECCO2 uses the MIT general circulation model (MITgcm) to synthesize **satellite and in-situ data of the global ocean and sea-ice** at resolutions that begin to resolve ocean eddies and other narrow current systems, which transport heat and carbon in the oceans. The ECCO2 model simulates ocean flows at all depths, but only surface flows are used in this visualization.



https://www.youtube.com/watch?v=vP4QTyVQTUo

https://www.youtube.com/watch?v=CCmTY0PKGDs



Ocean Sci., 10, 683–691, 2014
www.ocean-sci.net/10/683/2014/
doi:10.5194/os-10-683-2014

Ocean Science
Open Access

- Changes in global water temperature
- Carbon distribution in the oceans
- Temperature of the atmosphere.

Impact of a 30 % reduction in Atlantic meridional overturning during 2009–2010

H. L. Bryden[1], B. A. King[2], G. D. McCarthy[2], and E. L. McDonagh[2]

[1]National Oceanography Centre Southampton, University of Southampton, Empress Dock, Southampton, UK
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Correspondence to: H. L. Bryden (h.bryden@noc.soton.ac.uk)

Received: 12 February 2014 – Published in Ocean Sci. Discuss.: 6 March 2014
Revised: 10 June 2014 – Accepted: 12 June 2014 – Published: 6 August 2014

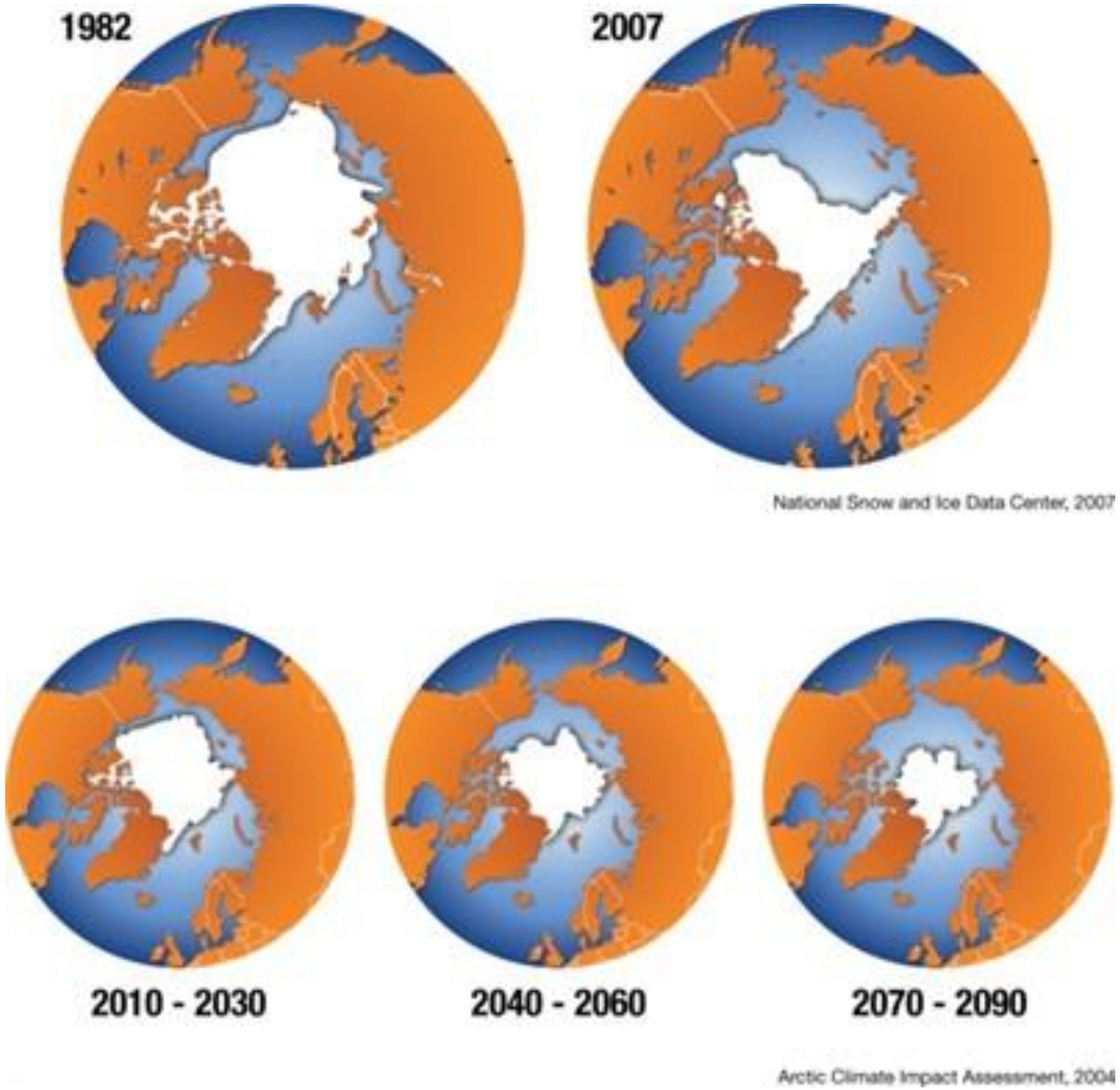
Vol 438|1 December 2005|**doi:10.1038/nature04385** nature

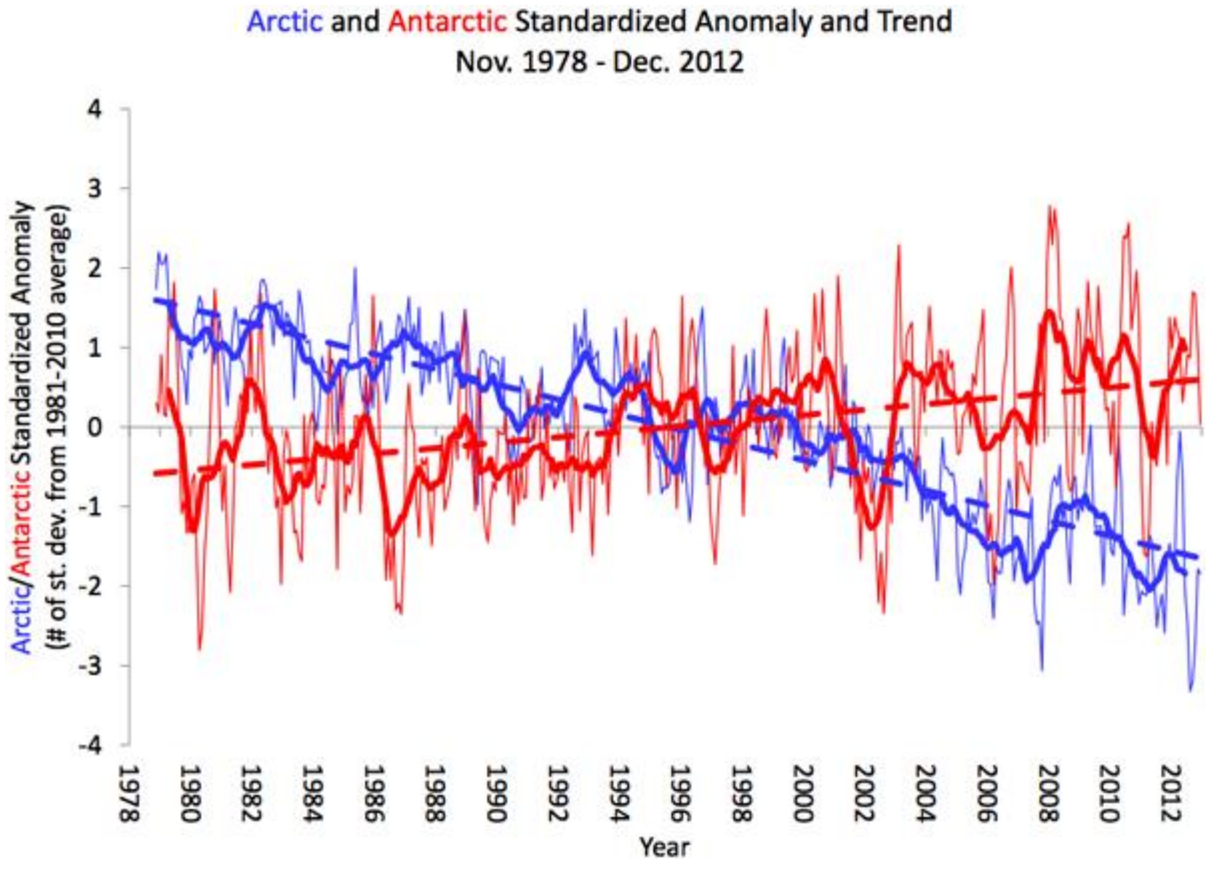
LETTERS

Slowing of the Atlantic meridional overturning circulation at 25° N

Harry L. Bryden[1], Hannah R. Longworth[1] & Stuart A. Cunningham[1]

ARTIC DECREASE





Arctic and Antarctic Sea Ice Extent Anomalies, 1979-2012: Arctic sea ice extent underwent a strong decline from 1979 to 2012, but Antarctic sea ice underwent a slight increase, although some regions of the Antarctic experienced strong declining trends in sea ice extent. Thick lines indicate 12-month running means, and thin lines indicate monthly anomalies.
Image by National Snow and Ice Data Center, University of Colorado, Boulder.

ANOTHER ABRUPT CLIMATE CHANGE: the falling down of Antarctic ice fields in the water there will be an encrease in ocean level in between 6 and 60 meters.

- **This probability is low but it becomes higher and higher proportionally to the amount of energy that mankind pump in the atmosphere.**

Two Antarctic ice shelves on the verge of collapsing—the Pine Island Glacier (shown) and the Thwaites Glacier—will cause the ultimate collapse of the entire West Antarctic Ice Sheet, a new study shows. NASA/Maria-José Viñas

Just a nudge could collapse West Antarctic Ice Sheet, raise sea levels 3 meters

By Carolyn Gramling | Nov. 2, 2015 , 3:00 PM

The total amount of Antartic ice is apparently increasing.

Could this lead to higher instability?

"There is not a model out there that is getting it right, because they all have caveats. I think the discussion is ongoing, and is only going to be more interesting with time."

Abrupt Climate Change

structural weakening

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NEW RESEARCH IN Physical Sciences | Social Sciences

RESEARCH ARTICLE

Damage accelerates ice shelf instability and mass loss in Amundsen Sea Embayment

Stef Lhermitte, Sainan Sun, Christopher Shuman, Bert Wouters, Frank Pattyn, Jan Wuite, Etienne Berthier, and Thomas Nagler

PNAS October 6, 2020 117 (40) 24735-24741; first published September 14, 2020;
https://doi.org/10.1073/pnas.1912890117

Edited by Chad Greene, NASA Jet Propulsion Laboratory, Pasadena, CA, and accepted by Editorial Board Member Jean Jouzel July 29, 2020 (received for review July 29, 2019)

Article | Figures & SI | Info & Metrics | PDF

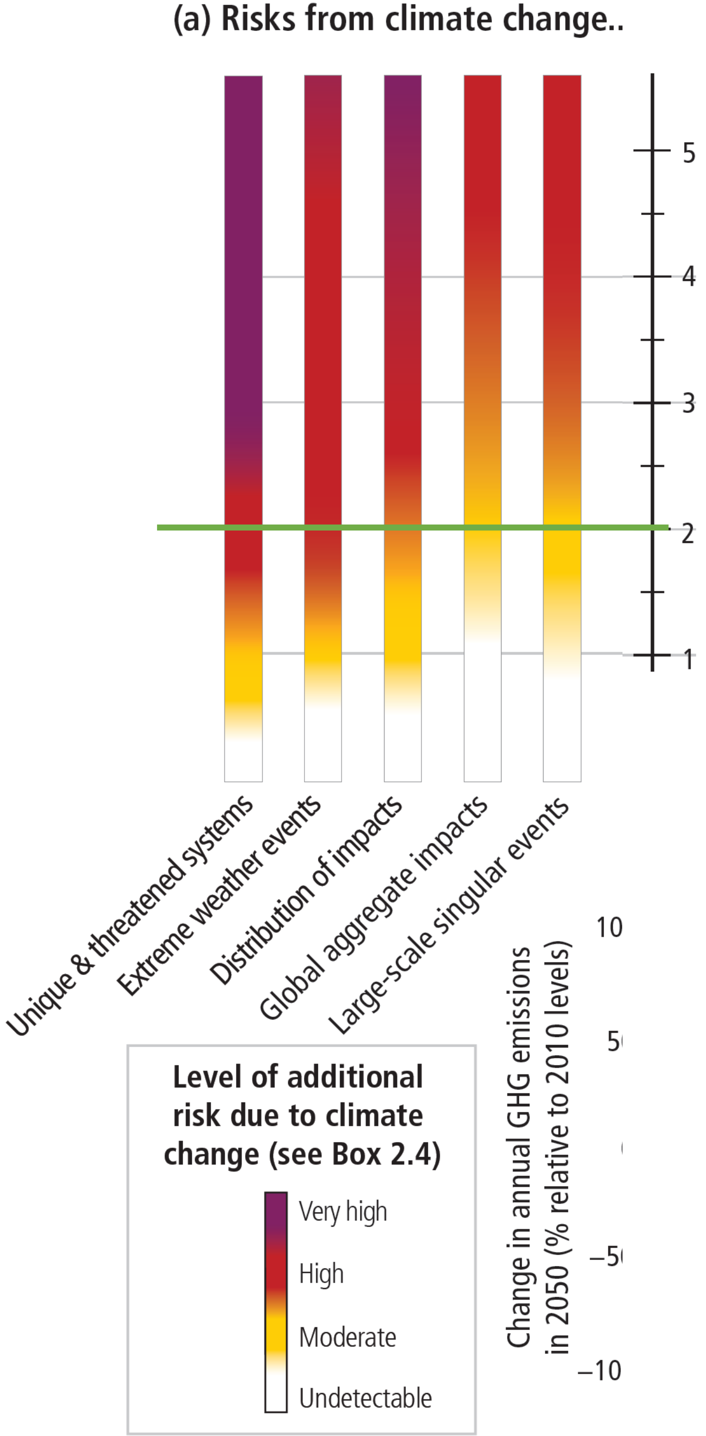
Significance

Some predictions are complex, but most of the time dealing with climate change is a matter of prediction

There are anyway some basic rules

CLIMATE CHANGE IS ALMOST IRREVERSIBLE AND TRANSGENERATIONAL

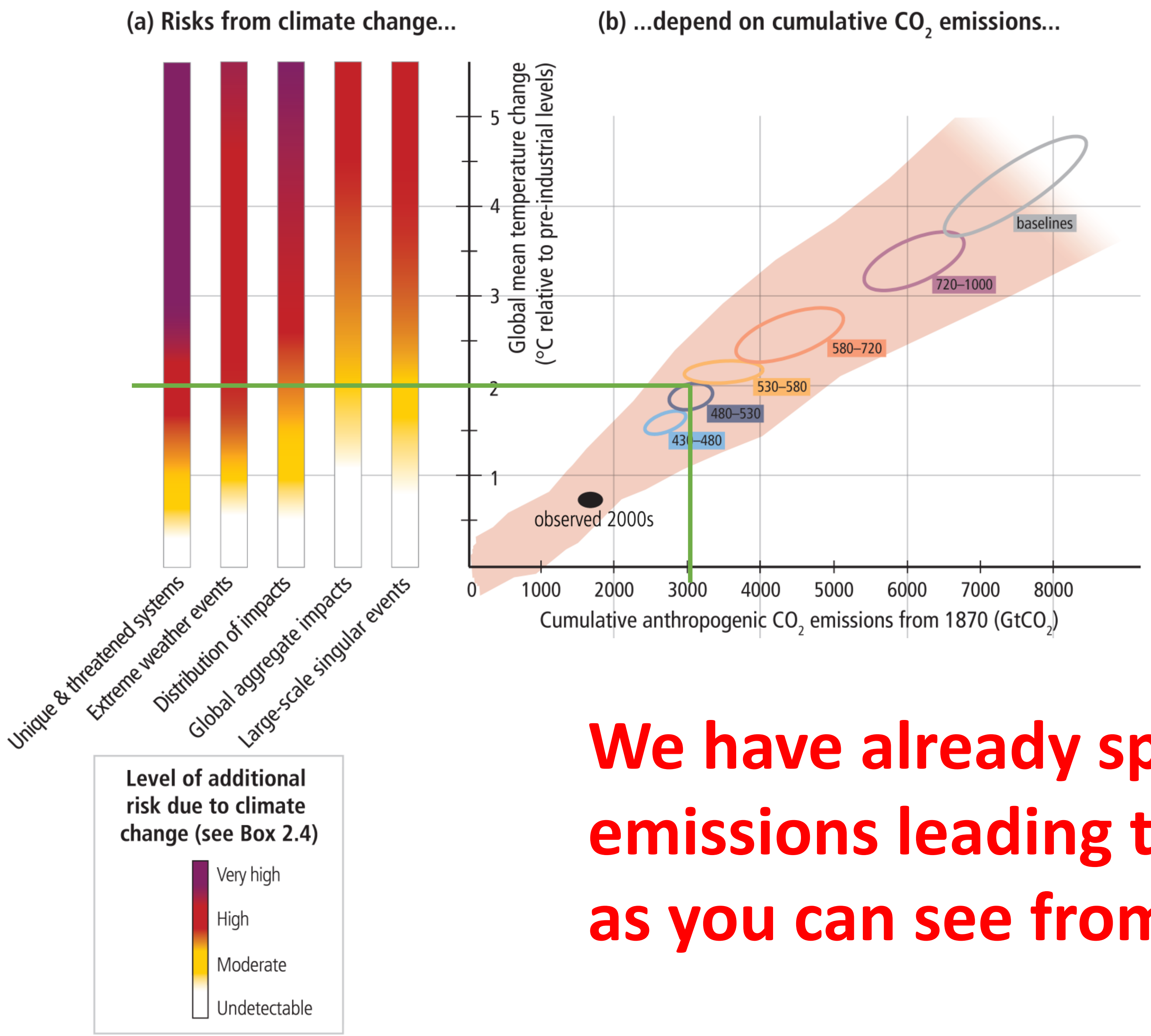
Why 2°C level is a reference for everyone? Why every scientist and politicians agrees that we should not go beyond?



FROM THE LEFT TO THE RIGHT

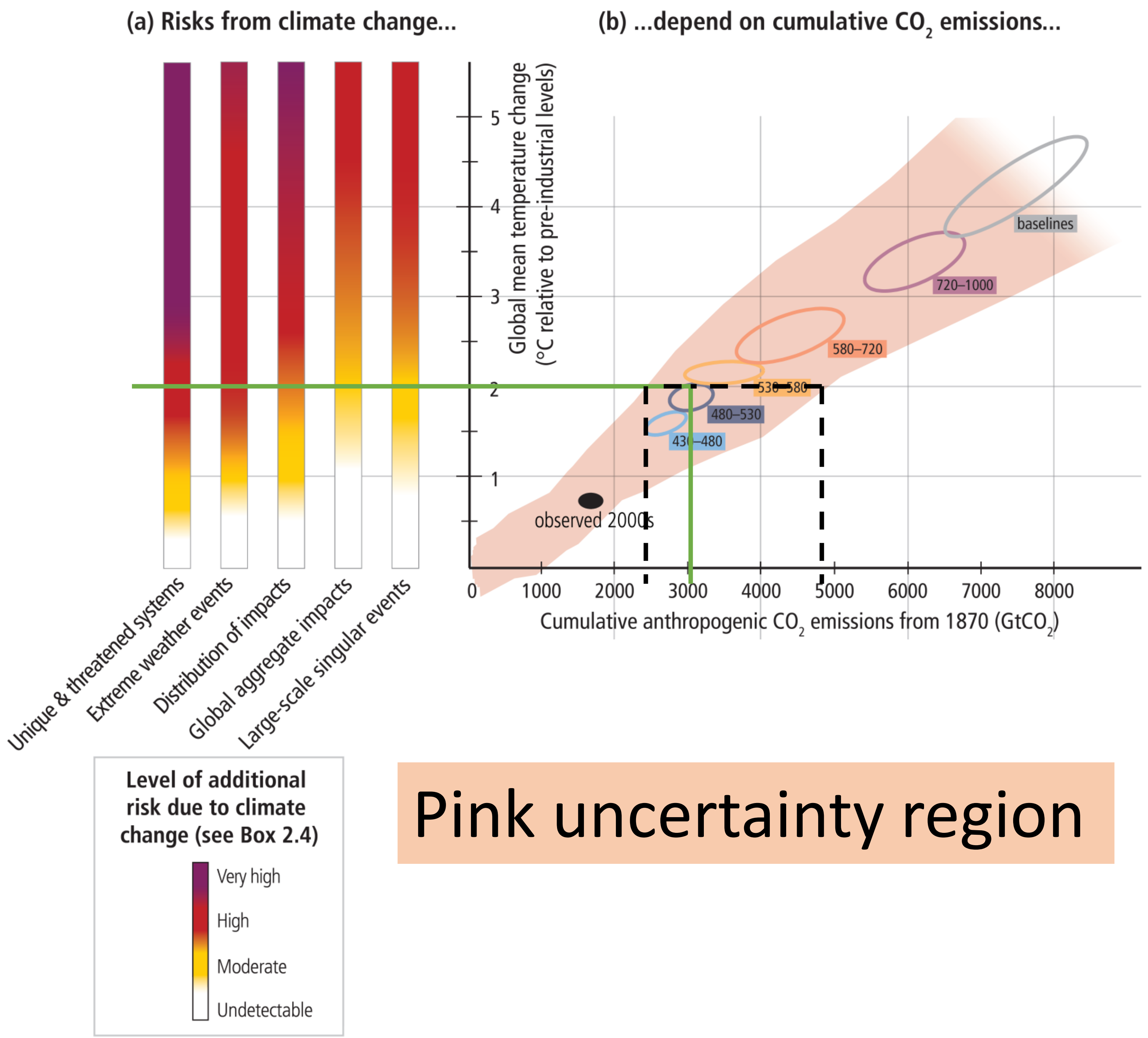
1. **Unique & threatened systems:** loss of species and biodiversity
2. **Extreme weather events:** as the temperature increases as there is more energy in the atmosphere
3. **Distribution of impacts:** more heat for example in the north pole and in the south pole. There will be an ill distribution of rainfalls.
4. **Global aggregate impacts:** health is only one aspect even though it is one of those we all care more (personal health and health of our close related). There is also agriculture and forests to take account of.
5. **Large-scale singular events:** golf stream and oceans sudden encrease.

Two degrees is conventional level to low probability of most dramatic events, moderate effects on health even if we will have already high risk in the loss of biodiversity and extreme events.



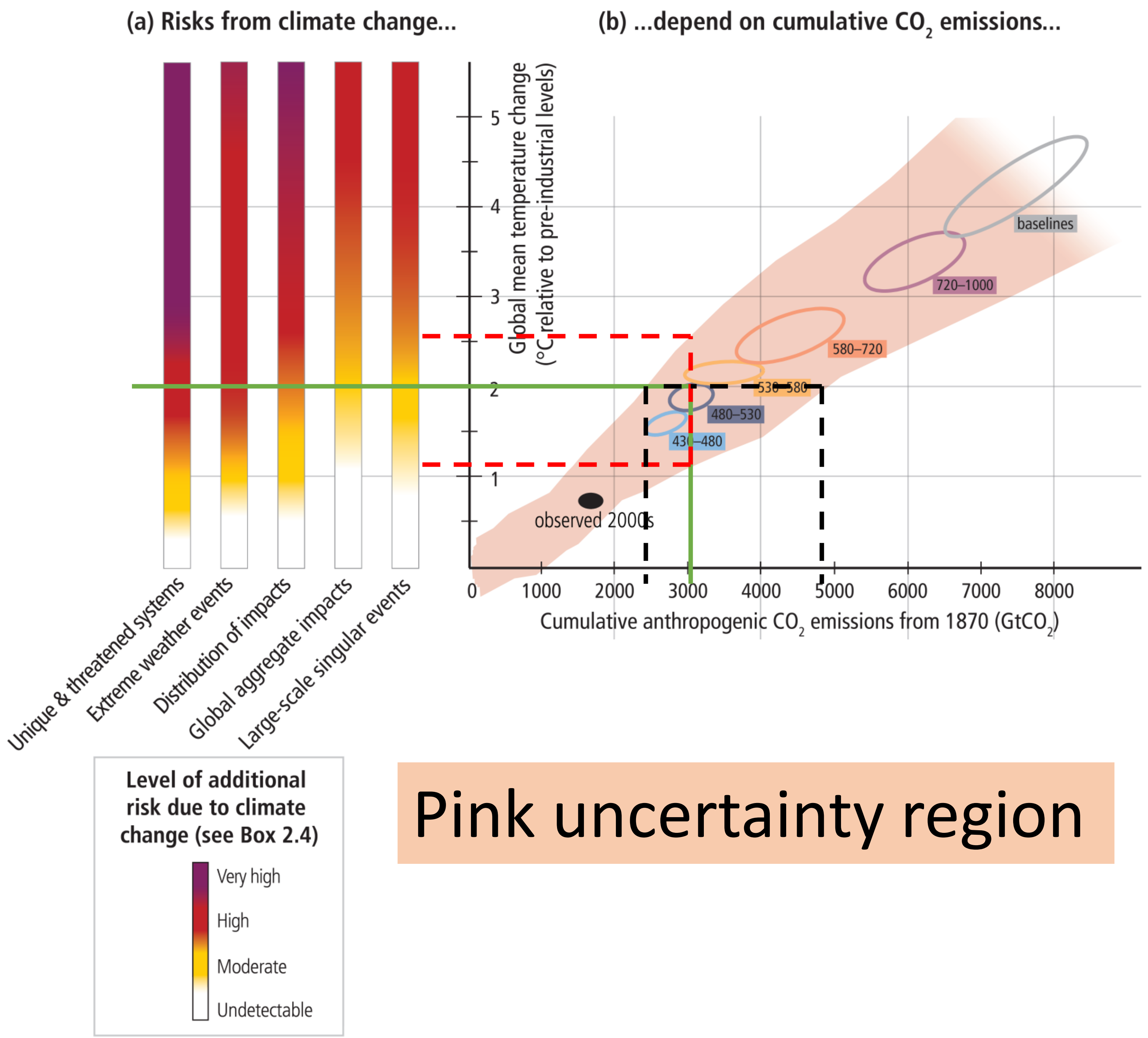
Global mean temperature change versus cumulative anthropogenic CO_2 emissions from 1870

We have already spent 2/3 of the emissions leading to a 2°C encrease as you can see from the observation.



For every scientist, there is always a degree of uncertainty.

We could live a 2°C encrease after pumping 4700 giga tons of CO2 in the atmosphere or pumping 2400.

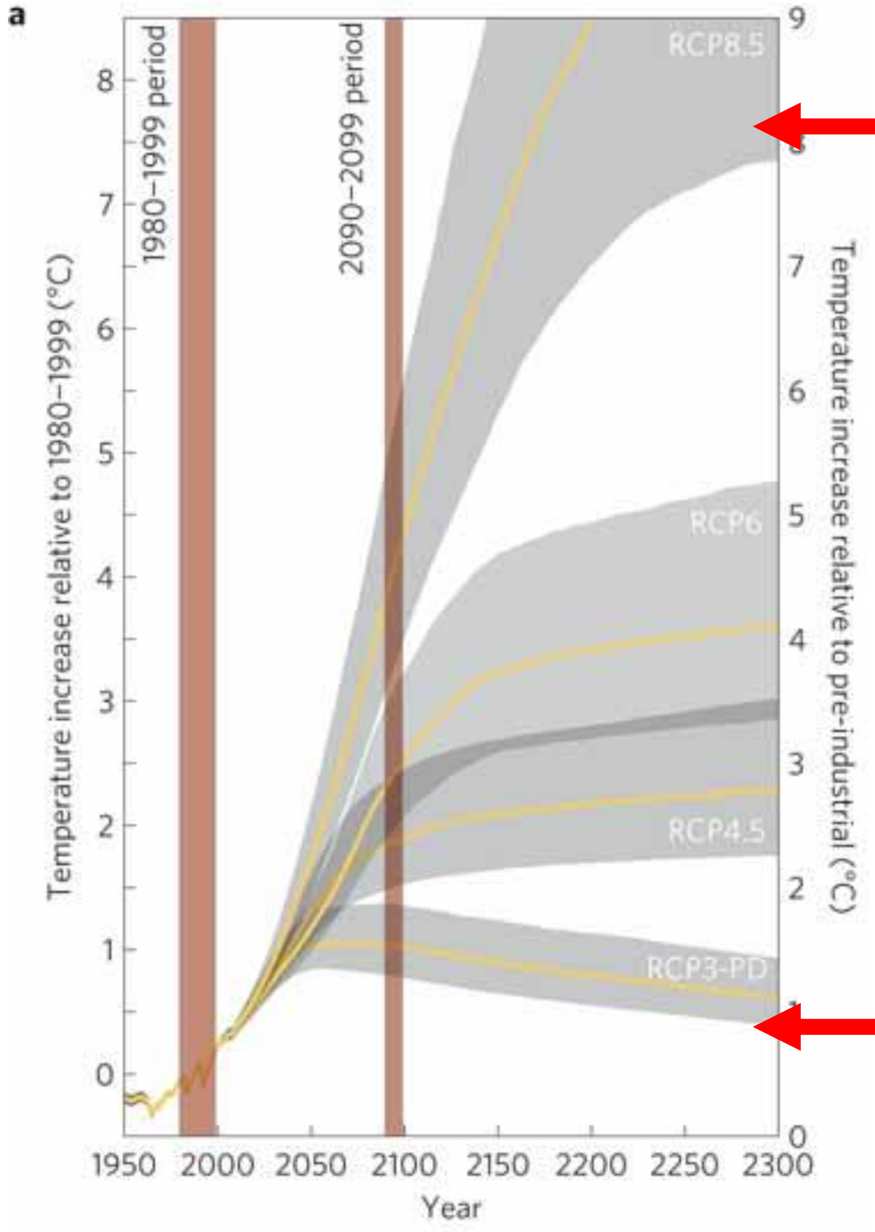


Pink uncertainty region

3000 Giga tons of CO_2 could correspond to 1.1°C or 2.6°C

3000 is the most likely level and therefore everybody agreed to work with it.

We know we have a budjet and it is better to use it carefully.



ABSENCE OF CLIMATE POLICY

Representative Concentration Pathways (RCPs) are four greenhouse gas concentration (not emissions) trajectories adopted by the IPCC

PROBABLY TOO LATE

Joeri Rogelj, Malte Meinshausen & Reto Knutti (Nature Climate Change 2, 248–253 (2012).

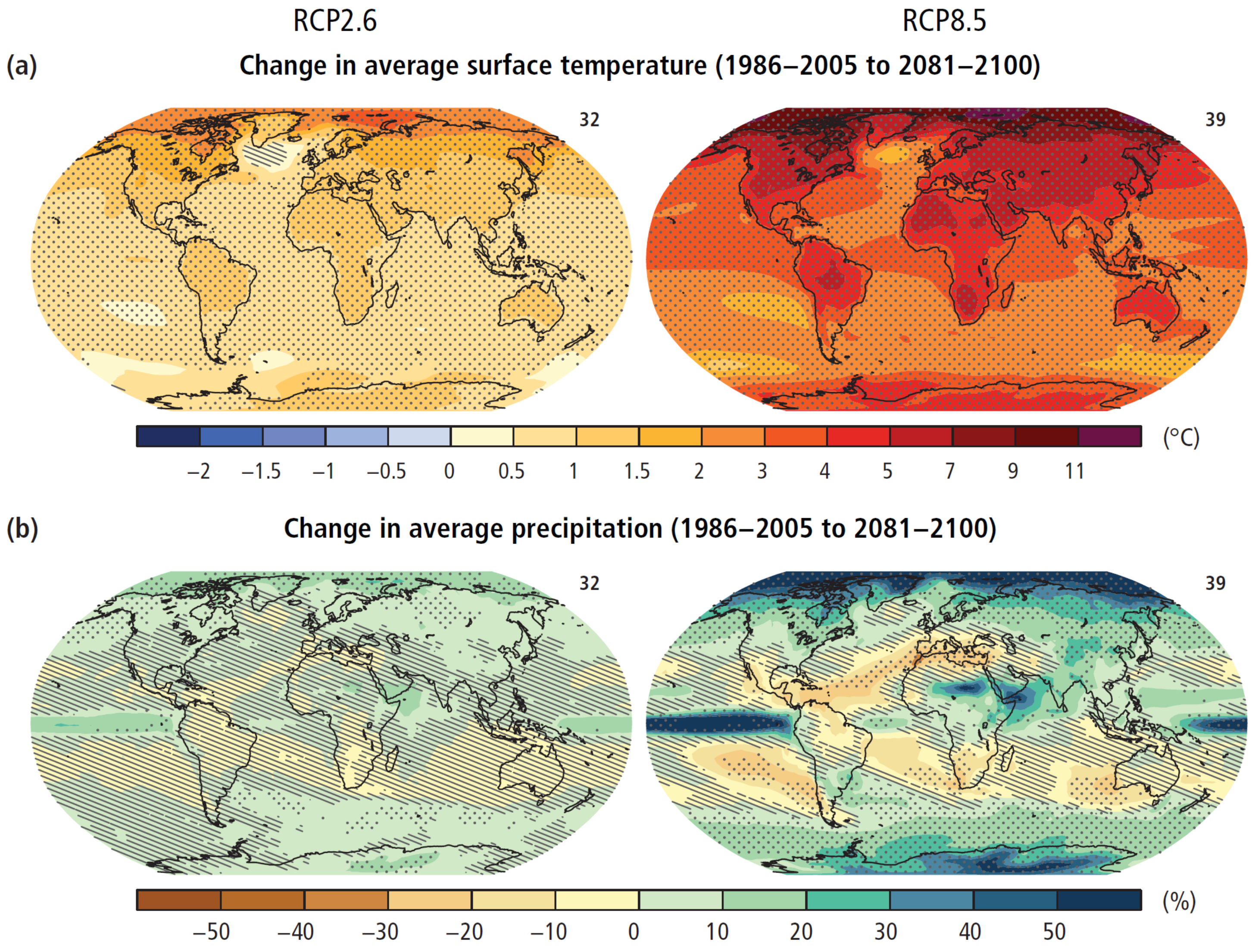
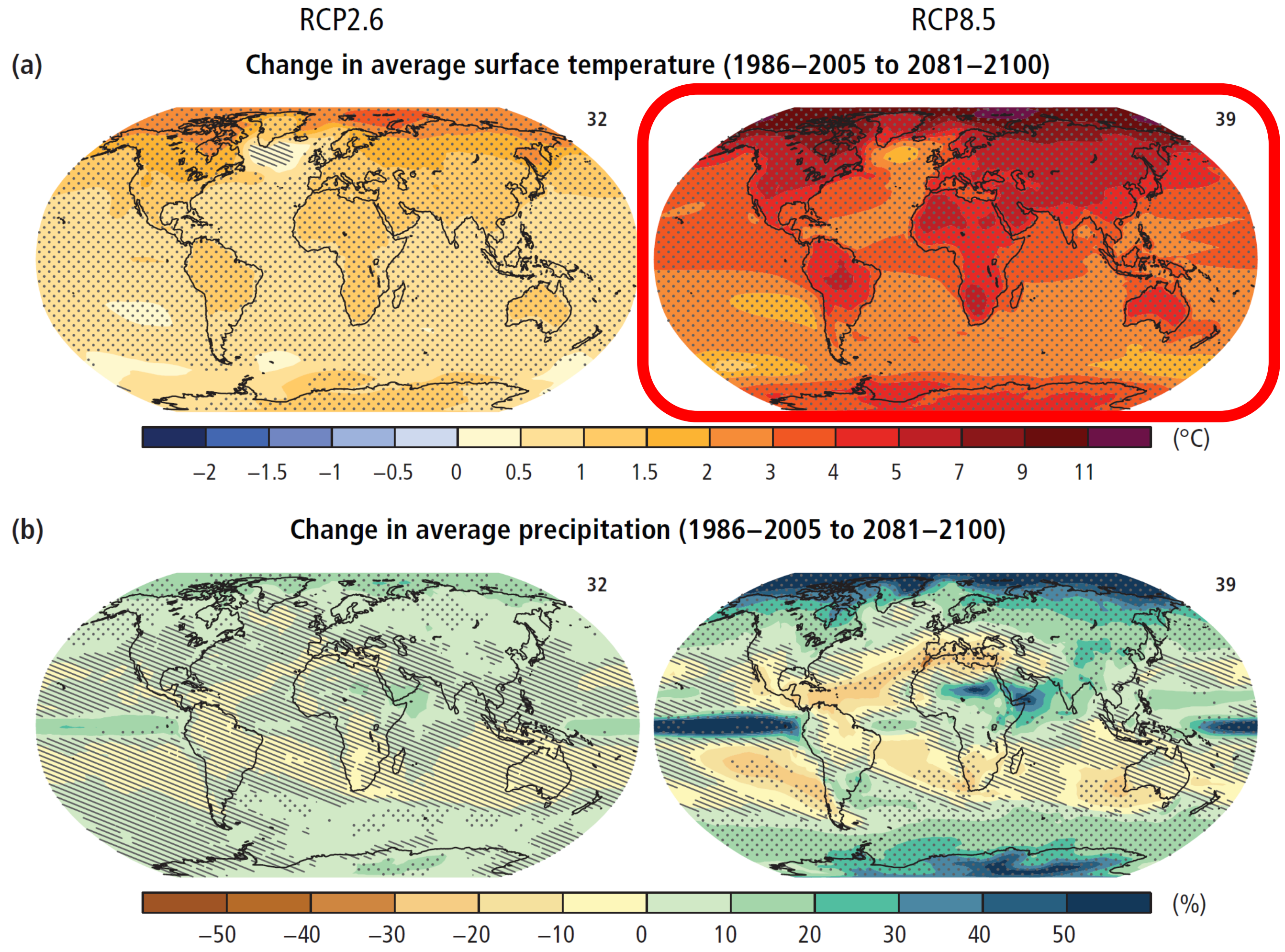


Figure SPM.7 | Change in average surface temperature **(a)** and change in average precipitation **(b)** based on multi-model mean projections for 2081–2100 relative to 1986–2005 under the RCP2.6 (left) and RCP8.5 (right) scenarios. The number of models used to calculate the multi-model mean is indicated in the upper right corner of each panel. Stippling (i.e., dots) shows regions where the projected change is large compared to natural internal variability and where at least 90% of models agree on the sign of change. Hatching (i.e., diagonal lines) shows regions where the projected change is less than one standard deviation of the natural internal variability. *{2.2, Figure 2.2}*

Example of RCP2.6 and RCP 8.5



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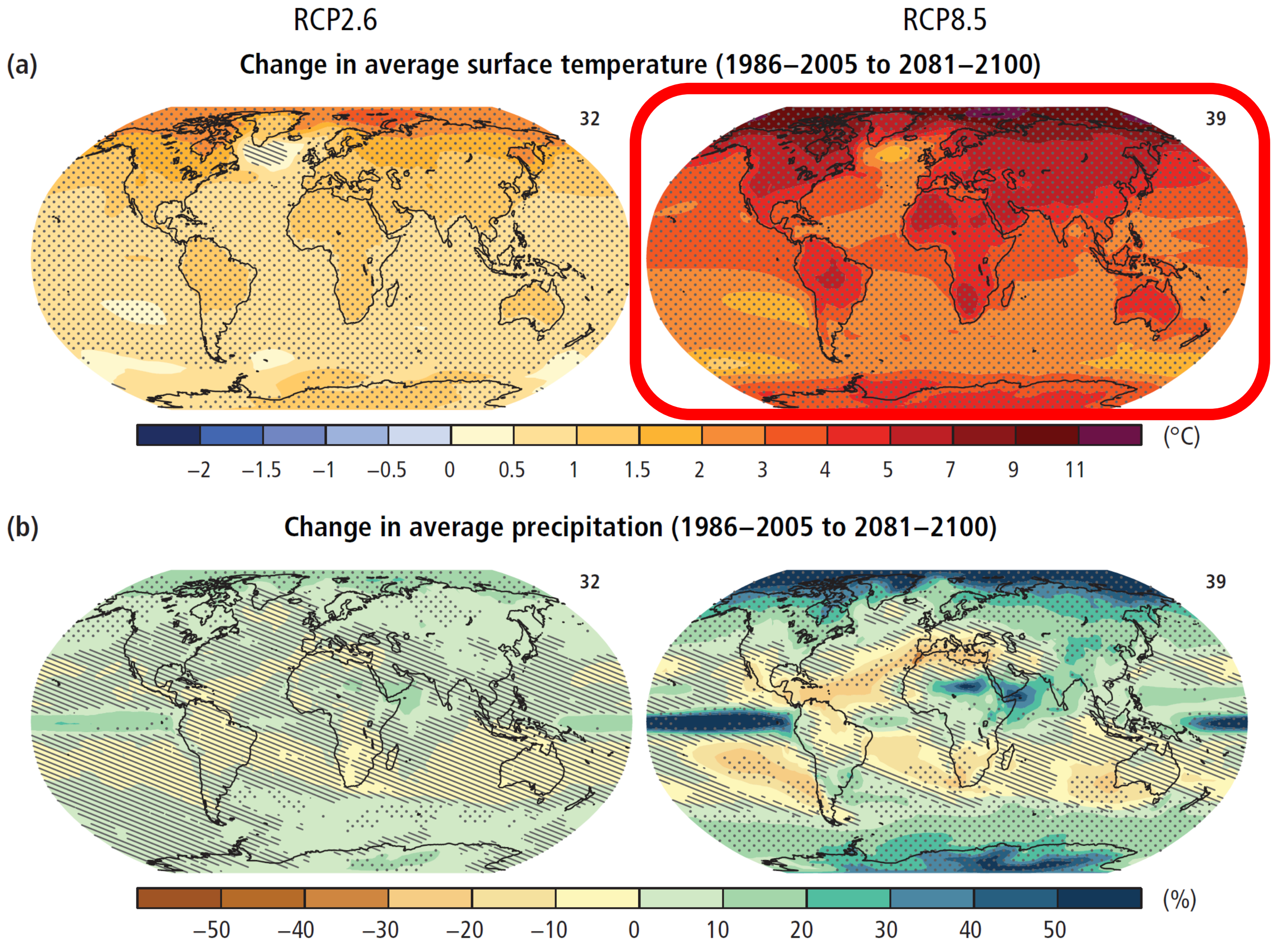
- Where the warming occurs more and the rainfall decreases
- Focus on the geographical display. The **first rule** is that highest encrease in temperature is predicted in the polar areas (8 to 11°C) where the ice is.
- **Second rule** is that high increase is expected at higher altitude again where ice is. Himalayas will suffer higher encrease as compared to Sub-Saharian Africa (2 to 3°C).

People here are already suffering and are at their physiological limits



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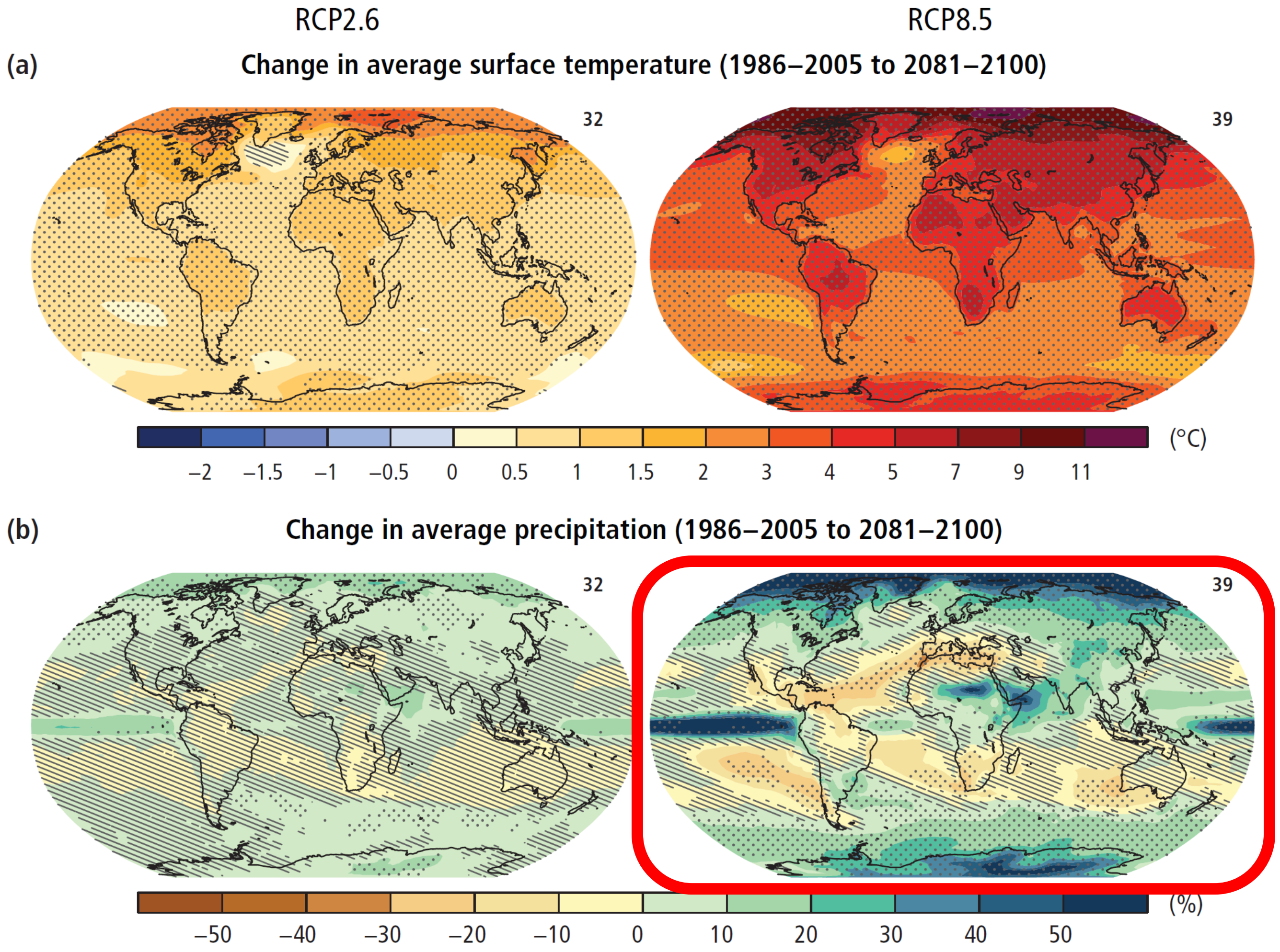
- **Third rule** is where you are in land you have more extreme changes as compared to those close to water (quite intuitive)



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- **Patchwork of areas from more dry (oceans, Australia) to more wetter (North pole, Asia, East Africa)**

It is a kind of misleading if we say Global Climate Change because Climate change is very different regionally resolved.

Where you are and what will strike you and when?

?