Climate Change: Updated IPCC Insight (6th Assessment Report)

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Former IPCC Vice-Chair (2008 - 2015)

Twitter: @JPvanYpersele

Invitation dans le cours de la Pre Sandra Soares (Analysis and Mitigation of Floods), UCLouvain, Louvain-la-Neuve, 20 octobre 2021

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The Essential Truth About Climate Change in Ten Words

The basic facts of climate change, established over decades of research, can be summarized in five key points:

IT'S REAL	Global warming is happening.
IT'S US	Human activity is the main cause.
EXPERTS AGREE	There's scientific consensus on human-caused global warming.
IT'S BAD	The impacts are serious and affect people.
THERE'S HOPE	We have the technology needed to avoid the worst climate impacts.

Source: @JohnfoCook

Donald J. Trump
@realDonaldTrump

Suivre

The concept of global warming was created by and for the Chinese in order to make U.S. manufacturing non-competitive.

Voir la traduction

RETWEETS 99 789 J'AIME 63 394

11:15 - 6 nov. 2012

100 k 63 k

In the USA alone, organizations which sow doubt about climate change spend almost a billion dollars/year! (Brulle 2014, average numbers for 2003-2010)

The European Union fares a little better, but many Brussels lobbyists try to dilute the EU environmental efforts (see the car industry…)

@JPvanYpersele

Why the IPCC ?

Established by WMO and UNEP in 1988

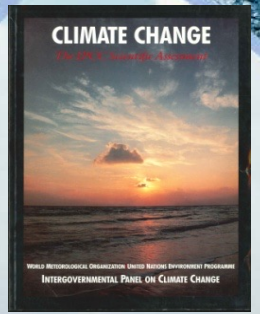
to provide policy-makers with an objective source of information about

- causes of climate change,
- potential environmental and socio-economic impacts,
- possible response options (adaptation & mitigation).

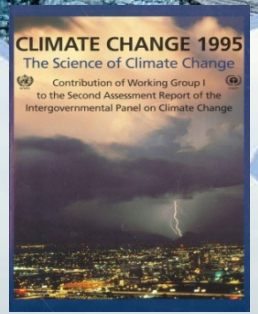
WMO=World Meteorological Organization

UNEP= United Nations Environment Programme

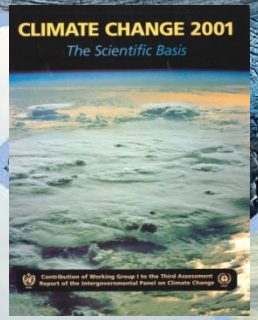
IPCC Assessment Reports



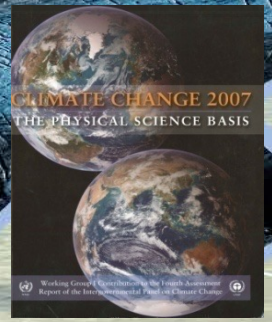
FAR 1990



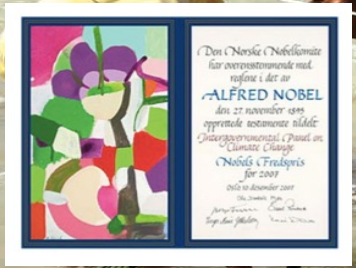
SAR 1995

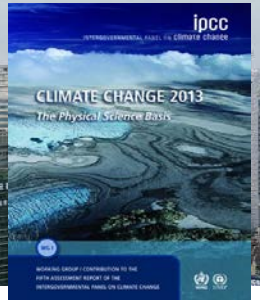


TAR 2001

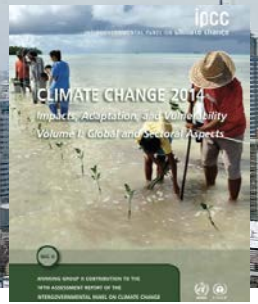


AR4 2007

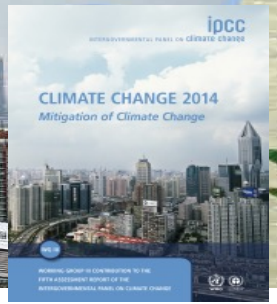




AR5 WGI 2013



AR5 WGII 2014



AR5 WGIII 2014

ipcc
INTERGOVERNMENTAL PANEL ON climate change

WMO UNEP

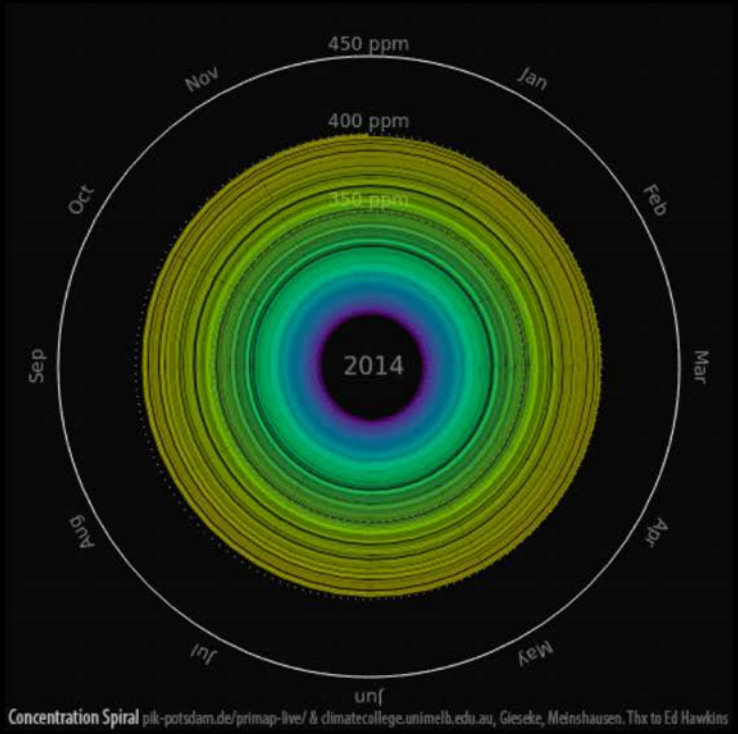
Key processes

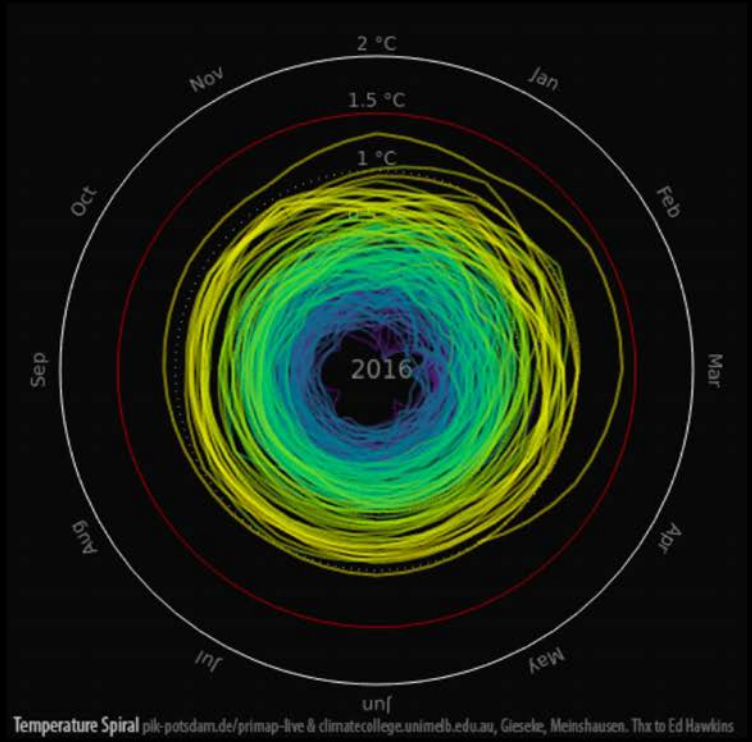
Fact: Because we use the atmosphere as a dustbin for our greenhouse gases, we thicken the insulation layer around the planet

That is why we must cut emissions
to ZERO as soon as possible

@JPvanYpersele

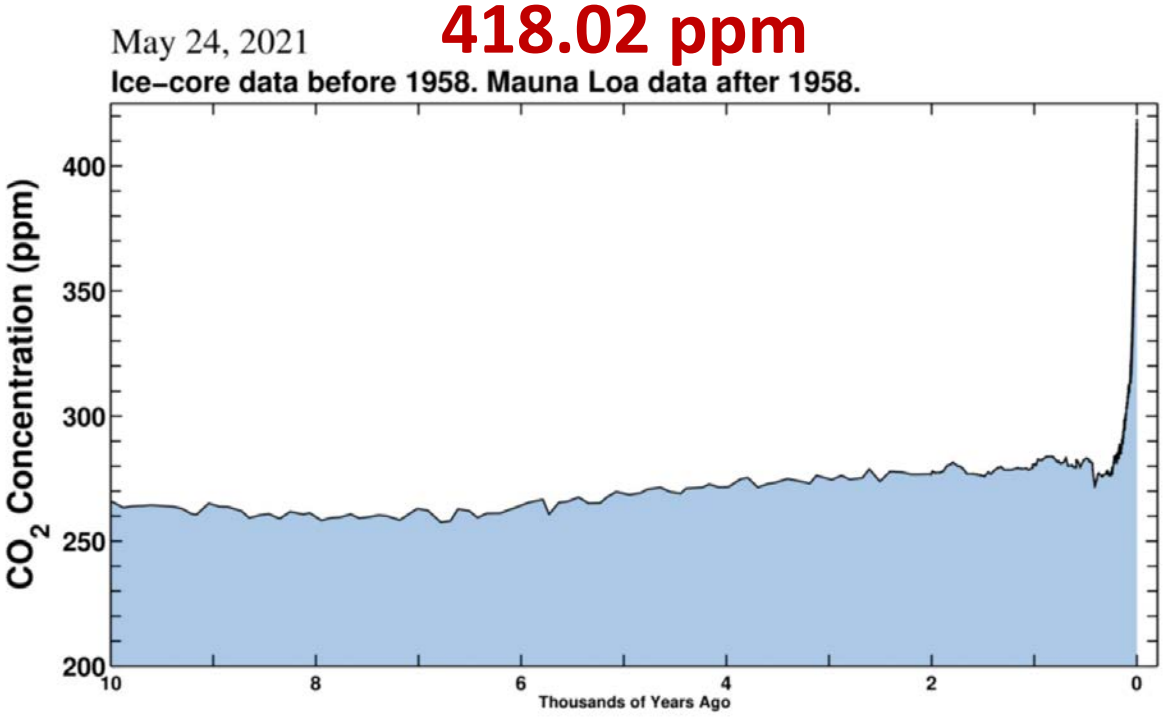
CO_2 Concentration and Temperature spirals





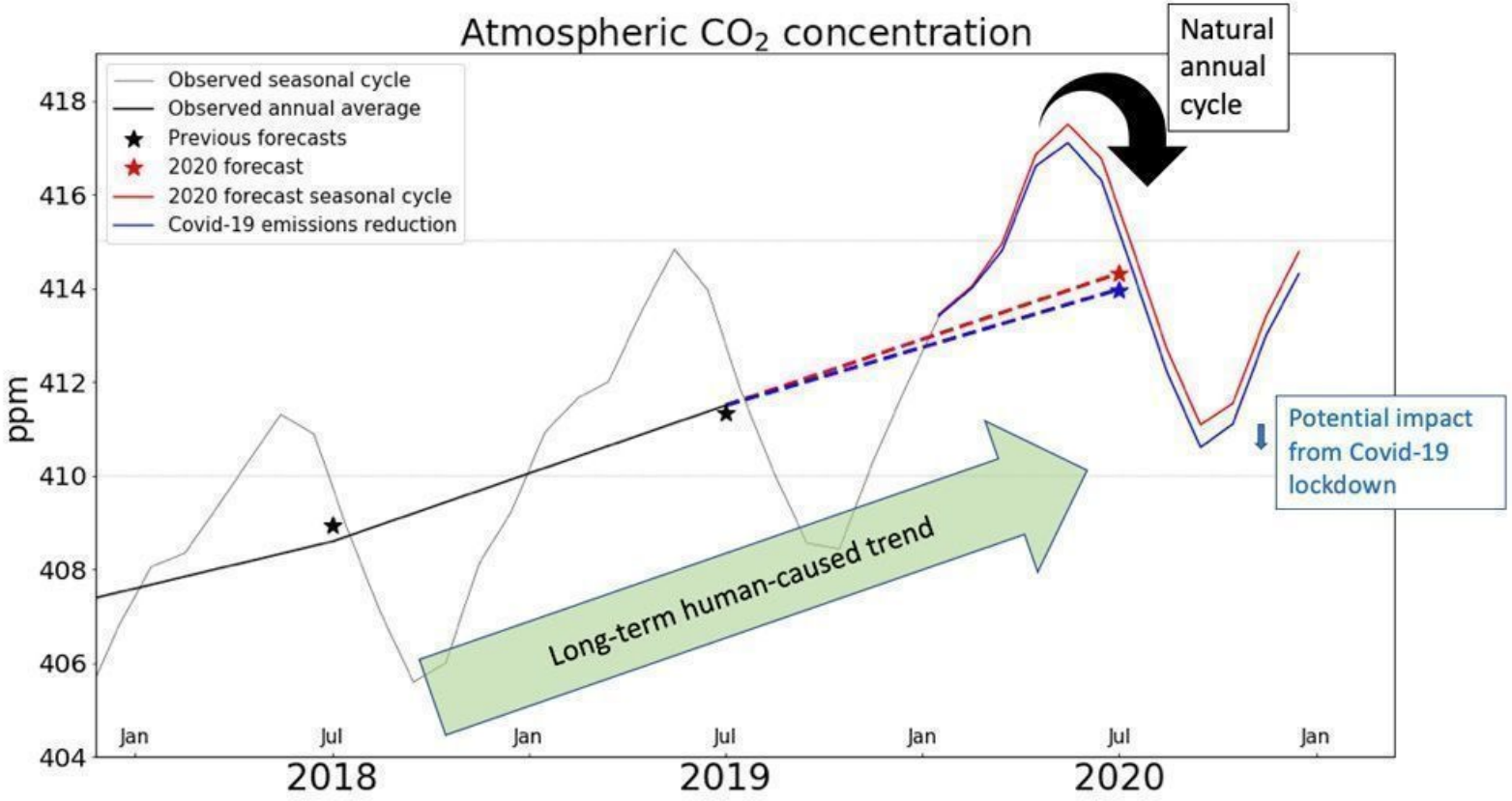
CO_2 Concentration since 1850 and Global Mean Temperature in °C relative to 1850 – 1900
Graph: Ed Hawkins (Climate Lab Book) – Data: HadCRUT4 global temperature dataset
Animation available on http://openclimatedata.net/climate-spirals/concentration-temperature/

Concentration en CO_2, 24 mai 2021 (courbe de Keeling)



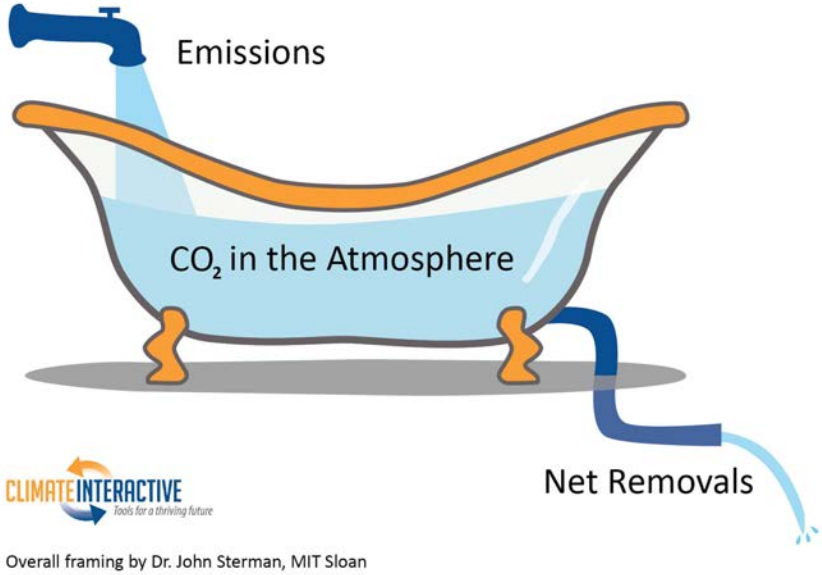
Source: scripps.ucsd.edu/programs/keelingcurve/

Confinement « Covid19 »: une effet très limité sur la concentration en CO_2



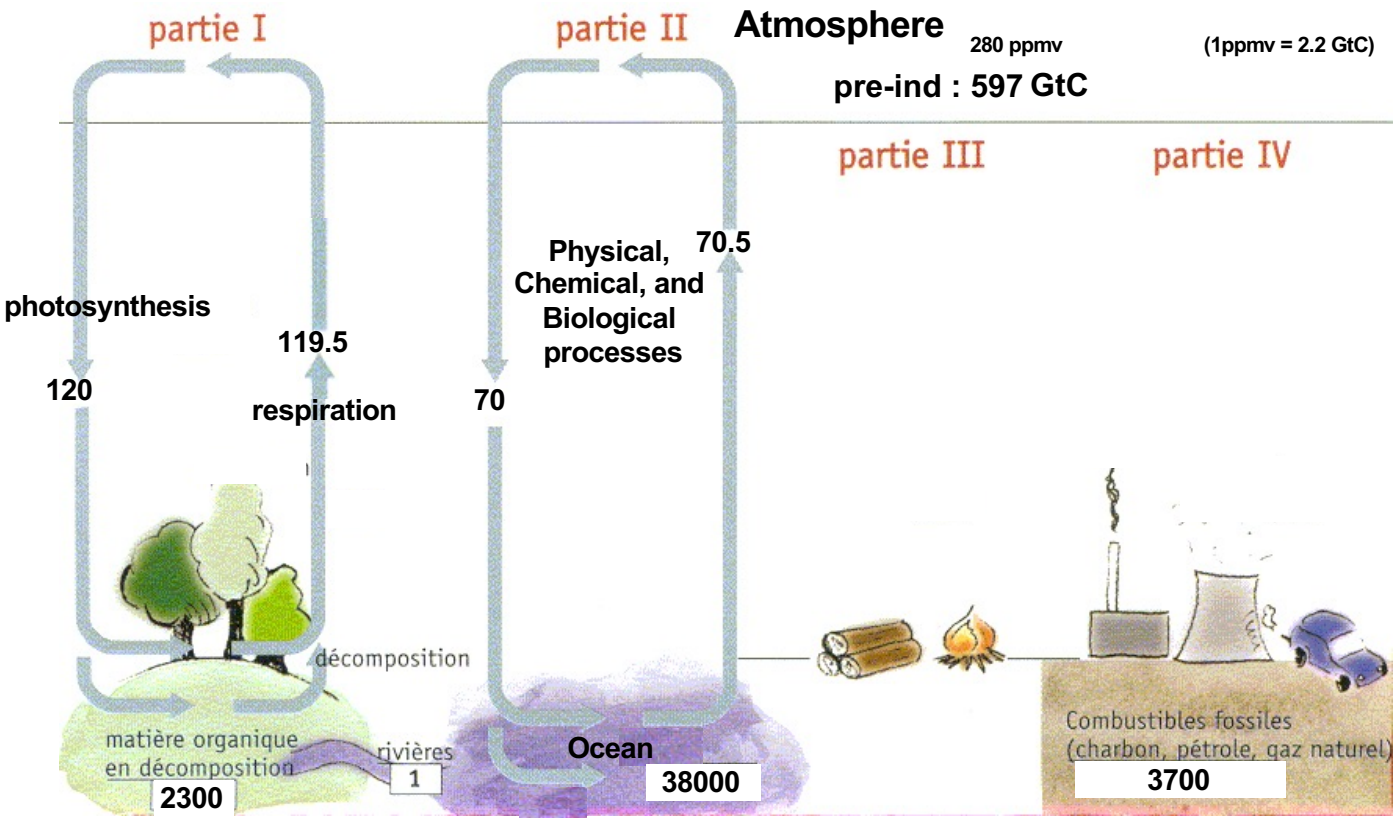
Source: @CarbonBrief, mai 2020 @JPvanYpersele

The Carbon Bathtub



Source: @CarbonInteractive

Carbon cycle: unperturbed fluxes

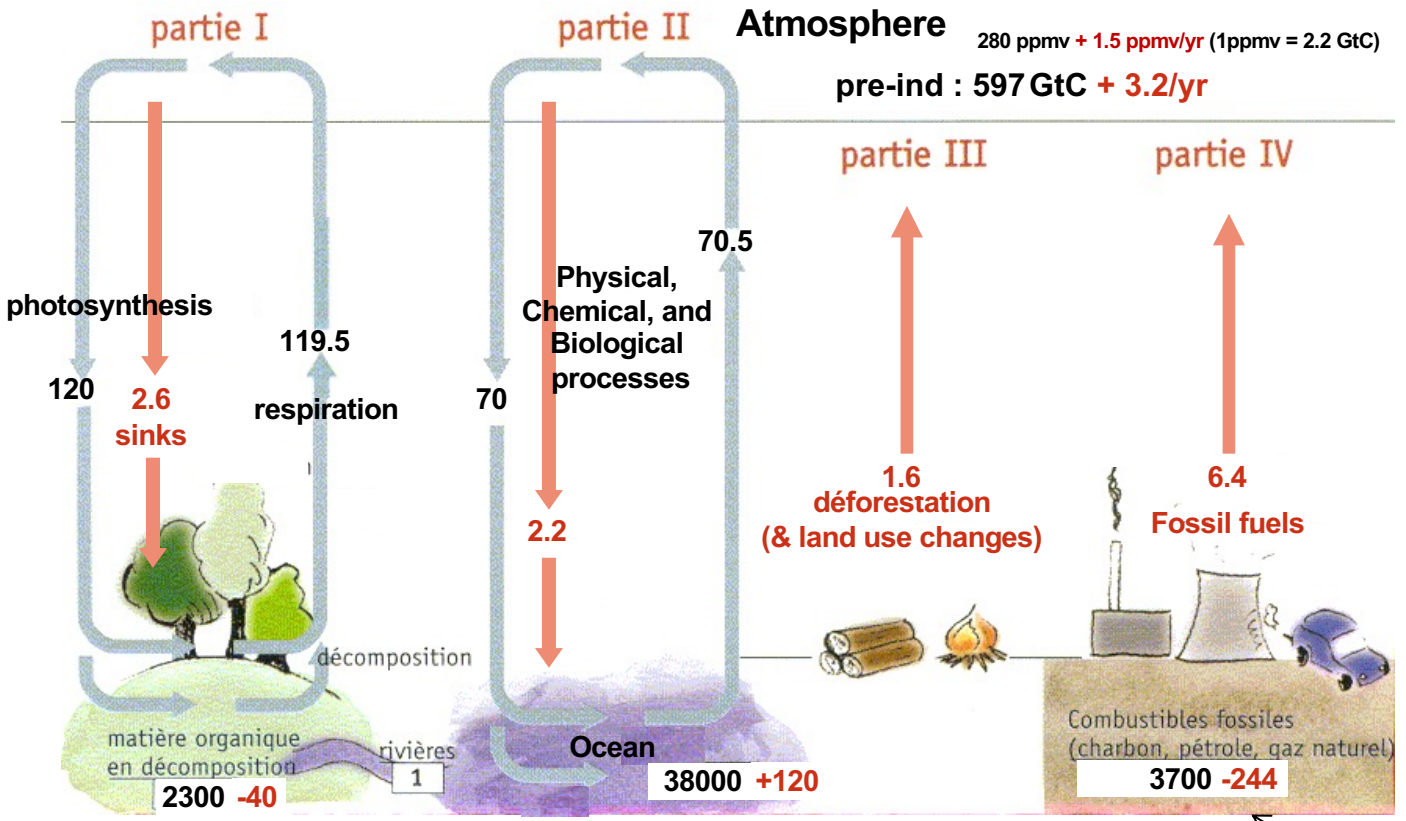


Units: GtC (billions tons of carbon) or GtC/year (multiply by 3.7 to get $GtCO_2$)

vanyp@climate.be

Carbon cycle: perturbed by human activities

(numbers for the decade 1990-1999s, based on IPCC AR4)



Units: GtC (billions tons of carbon) or GtC/year

Stocks!

vanyp@climate.be

Climatic Change: Are We on the Brink of a Pronounced Global Warming? (Broecker,1975)

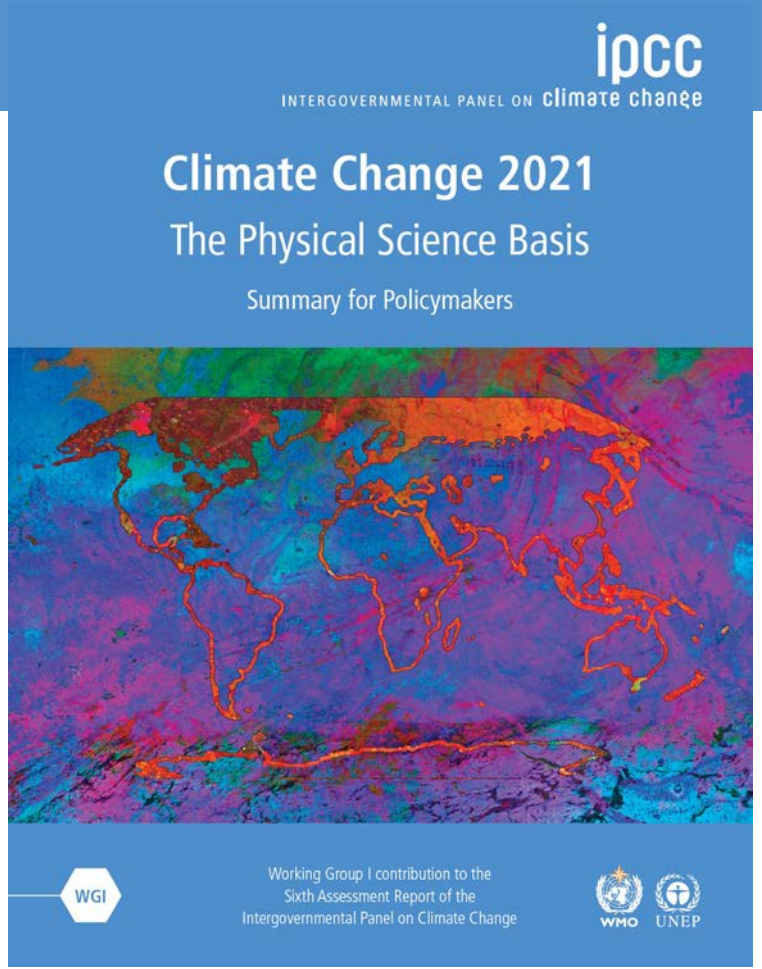
Table 1. Reconstruction and prediction of atmospheric CO_2 contents based on fuel consumption data.

Year	Chemical fuel CO_2 ($\times 10^{16}$ g)	Excess atmospheric CO_2* ($\times 10^{16}$ g)	Excess atmospheric CO_2 (%)	Excess atmospheric CO_2 (ppm)	CO_2 content of the atmosphere† (ppm)	Global temperature increase‡ (°C)
1900	3.8	1.9	0.9	2	295	0.02
1910	6.3	3.1	1.4	4	297	.04
1920	9.7	4.8	2.2	6	299	.07
1930	13.6	6.8	3.1	9	302	.09
1940	17.9	8.9	4.1	12	305	.11
1950	23.3	11.6	5.3	16	309	.15
1960	31.2	15.6	7.2	21	314§	.21
1970	44.0	22.0	10.2	29	322§	.29
1980‖	63	31	14	42	335	.42
1990‖	88	44	20	58	351	.58
2000‖	121	60	28	80	373	.80
2010‖	167	83	38	110	403	1.10

*On the assumption that 50 percent of the CO_2 produced by the burning of fuel remains in the atmosphere. †The preindustrial atmospheric partial pressure of CO_2 is assumed to be 293 ppm. ‡Assumes a 0.3°C global temperature increase for each 10 percent rise in the atmospheric CO_2 content. §Value observed on Hawaii for 1960, 314 ppm; value for 1970, 322 ppm (*8*). ‖Post-1972 growth rate taken to be 3 percent per year.

SIXTH ASSESSMENT REPORT

Working Group I – The Physical Science Basis



THE WGI AR6 BY THE NUMBERS:

Author Team

234 authors from **65** countries

28% women, **72%** men

30% new to the **IPCC**

Review Process

14,000 scientific publications assessed

78,000+ review comments

46 countries commented on Final Government Distribution

Key messages from the latest WGI AR6 IPCC Report:

A. The Current State of the Climate

A.1 It is unequivocal that human influence has warmed the atmosphere, ocean and land. Widespread and rapid changes in the atmosphere, ocean, cryosphere and biosphere have occurred.

A.2 The scale of recent changes across the climate system as a whole and the present state of many aspects of the climate system are unprecedented over many centuries to many thousands of years.

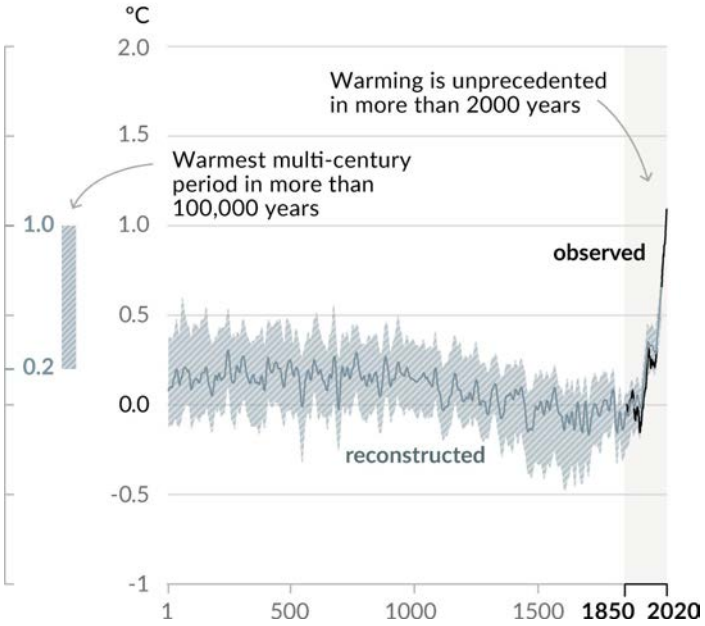
A.3 Human-induced climate change is already affecting many weather and climate extremes in every region across the globe. Evidence of observed changes in extremes such as heatwaves, heavy precipitation, droughts, and tropical cyclones, and, in particular, their attribution to human influence, has strengthened since the Fifth Assessment Report (AR5).

A.4 Improved knowledge of climate processes, paleoclimate evidence and the response of the climate system to increasing radiative forcing gives a best estimate of equilibrium climate sensitivity of 3°C, with a narrower range compared to AR5.

Human influence has warmed the climate at a rate that is unprecedented in at least the last 2000 years

Figure SPM.1

a) Change in global surface temperature (decadal average) as reconstructed (1-2000) and **observed** (1850-2020)



La progression de la certitude à propos de l'attribution du réchauffement aux facteurs humains

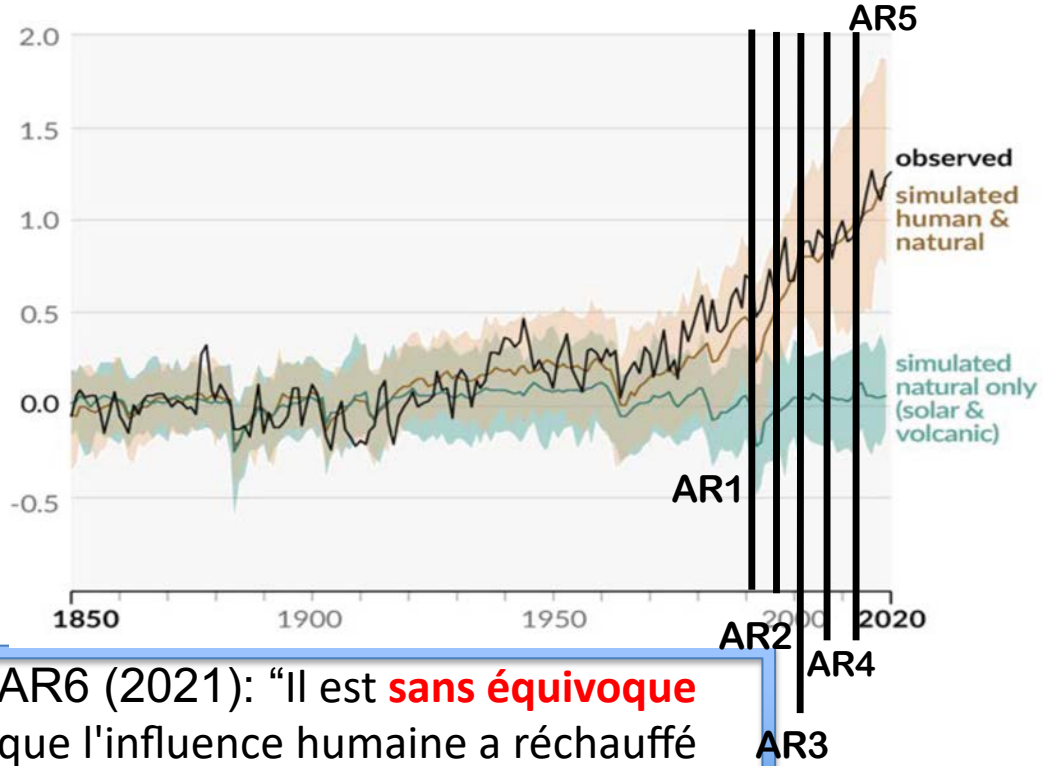
AR1 (1990): "Une détection **sans equivoque** prendra probablement plus d'une décennie"

AR2 (1995): "Un faisceau d'éléments suggère une influence humaine **perceptible** sur le climat"

AR3 (2001): "L'essentiel du réchauffement depuis 1950 est **probablement** (2 chances sur 3) dû aux activités humaines"

AR4 (2007): "L'essentiel du réchauffement depuis 2050 est **très probablement** (9 chances sur 10) dû aux gaz à effet de serre"

AR5 (2013): "Il est **extrêmement probable** (95 chances sur 100) que l'influence humaine a été la cause dominante…"

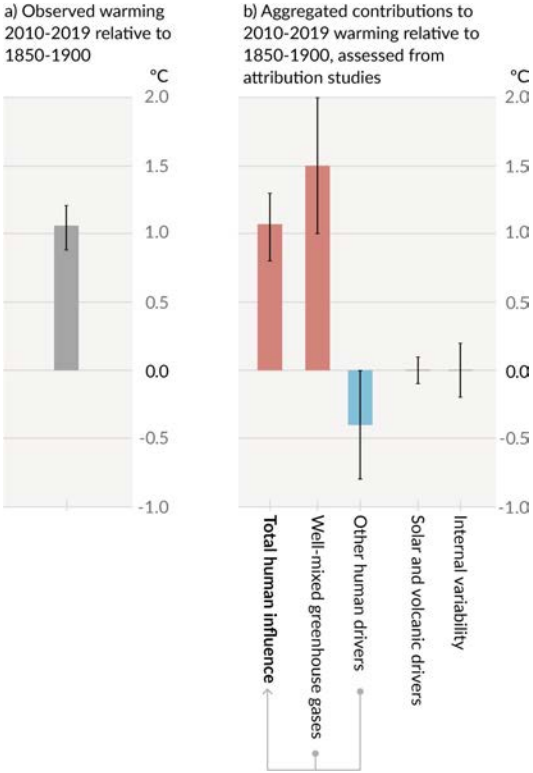


AR6 (2021): "Il est **sans équivoque** que l'influence humaine a réchauffé l'atmosphère, les océans et les terres."

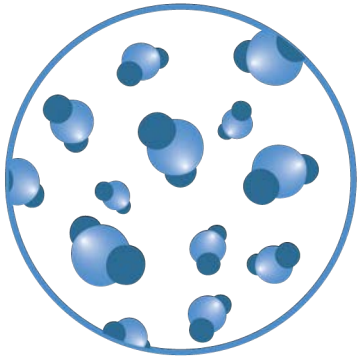
IPCC

Observed warming is driven by emissions from human activities, with greenhouse gas warming partly masked by aerosol cooling

Figure SPM.2



CO_2
concentration



Highest

in at least

2 million years

Sea level
rise

Fastest rates

in at least

3000 years

Arctic sea ice
area

Lowest level

in at least

1000 years

Glaciers
retreat

Unprecedented

in at least

2000 years

Human-induced climate change is already affecting many weather and climate extremes in every region across the globe

Extreme heat

More frequent

More intense

Heavy rainfall

More frequent

More intense

Drought

Increase in some regions

Fire weather

More frequent

Ocean

Warming

Acidifying

Losing oxygen

Photo Credits from left: 1. Luiz Guimaraes 2. Jonathan Ford 3. Peter Burdon 4. Ben Kuo 5. NOAA

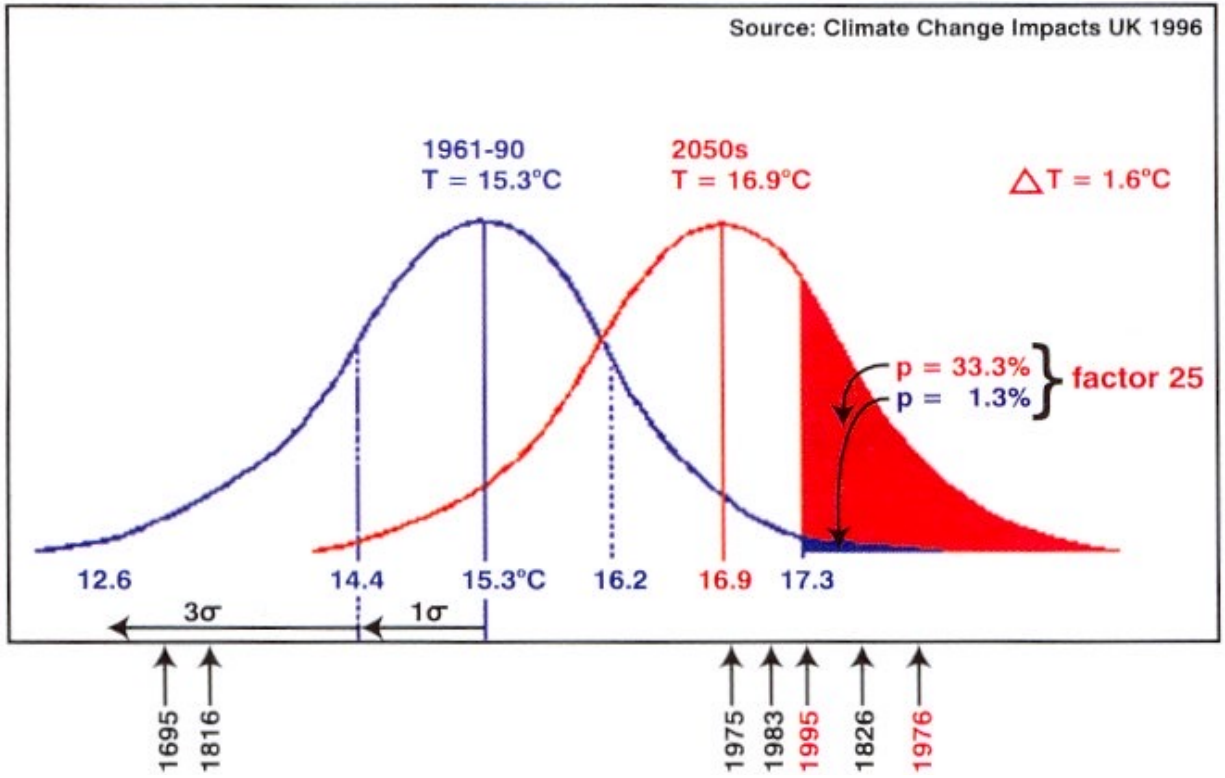
A.3 Human-induced climate change is already affecting many weather and climate extremes in every region across the globe

It is virtually certain that **hot extremes** (including heatwaves) have become more frequent and more intense across most land regions since the 1950s

The frequency and intensity of **heavy precipitation events** have increased since the 1950s over most land area (…) (high confidence), and human-induced climate change is likely the main driver.

Increasing Probabilities of Extremes

Example: Summer Temperatures in Central England



Observed changes in hot extremes since 1950

Figure SPM.3

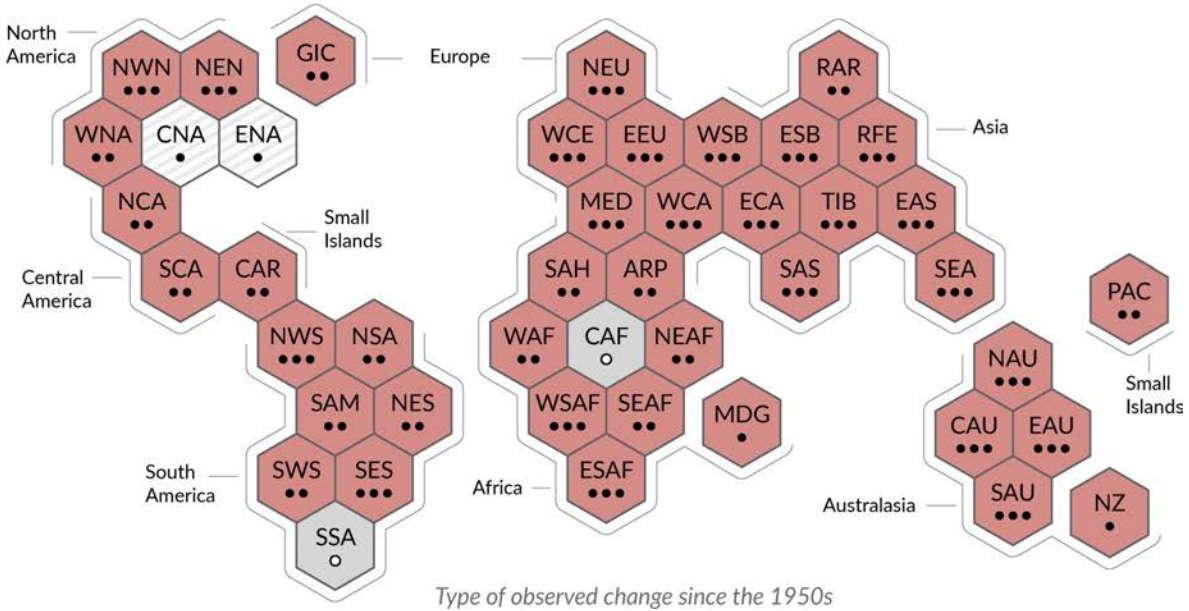
a) Synthesis of assessment of observed change in **hot extremes** and confidence in human contribution to the observed changes in the world's regions

Type of observed change in hot extremes

- Increase (41)
- Decrease (0)
- Low agreement in the type of change (2)
- Limited data and/or literature (2)

Confidence in human contribution to the observed change

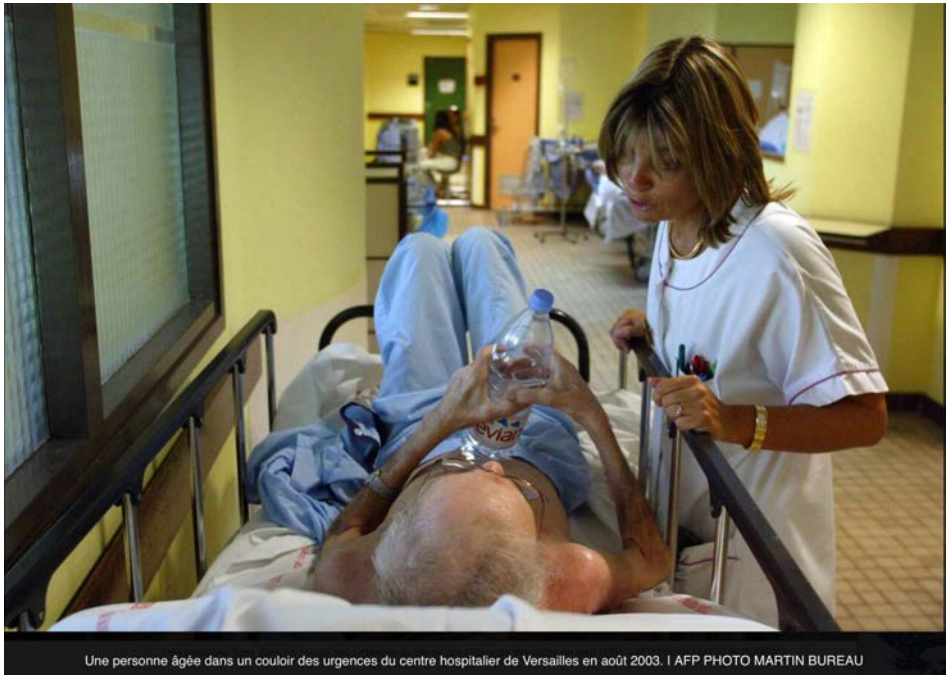
- ●●● High
- ●● Medium
- ● Low due to limited agreement
- ○ Low due to limited evidence



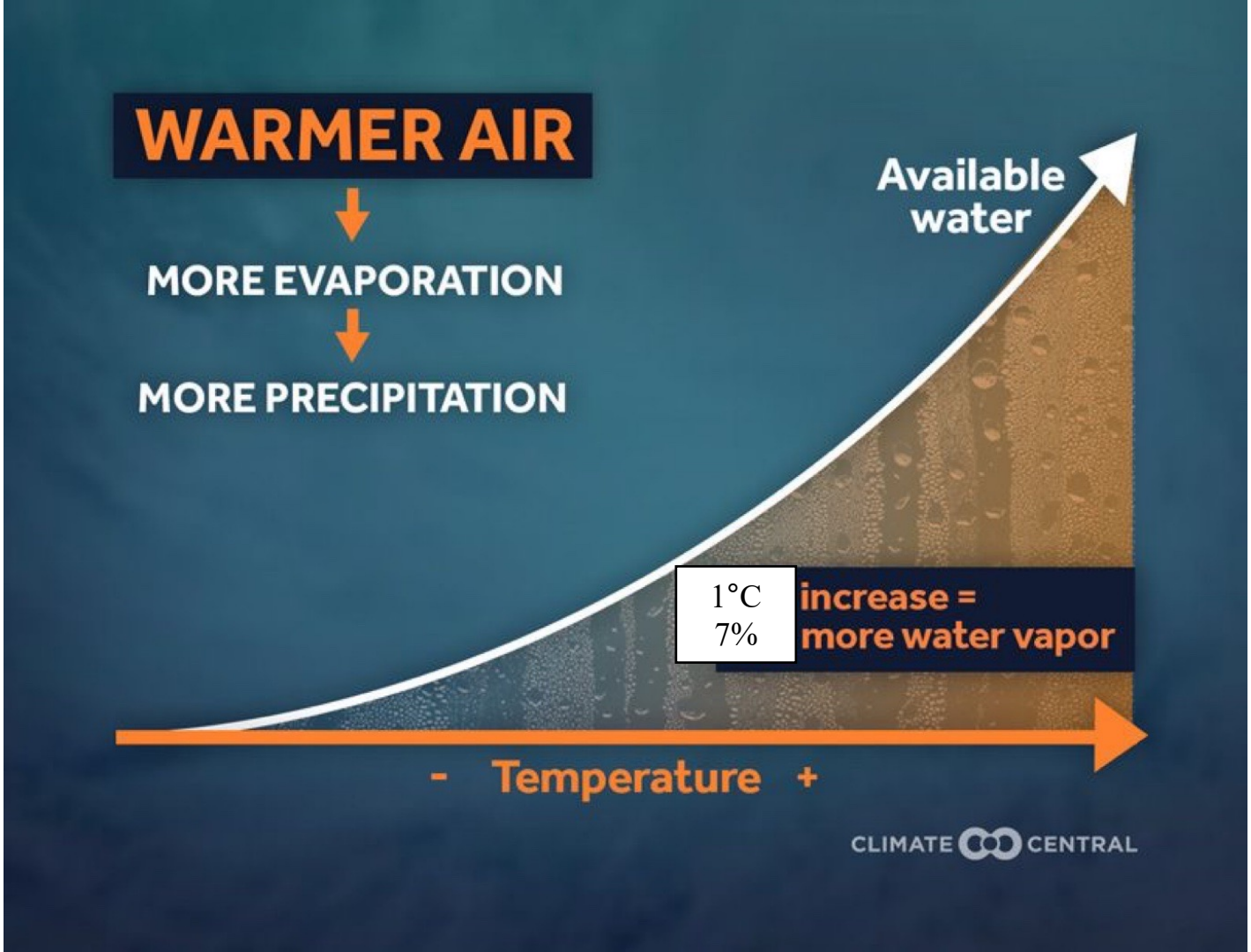
Les vagues de chaleur tuent

Canicule 2003: 70000 décès en Europe, dont 1200 en Belgique

Canicule 2020: 1400 décès en Belgique, combien en Europe ?



Une personne âgée dans un couloir des urgences du centre hospitalier de Versailles en août 2003. I AFP PHOTO MARTIN BUREAU


WARMER AIR
MORE EVAPORATION
MORE PRECIPITATION
Available water
1°C
7%
increase =
more water vapor
- Temperature +
CLIMATE CENTRAL

Observed changes in heavy precipitation since 1950

Figure SPM.3

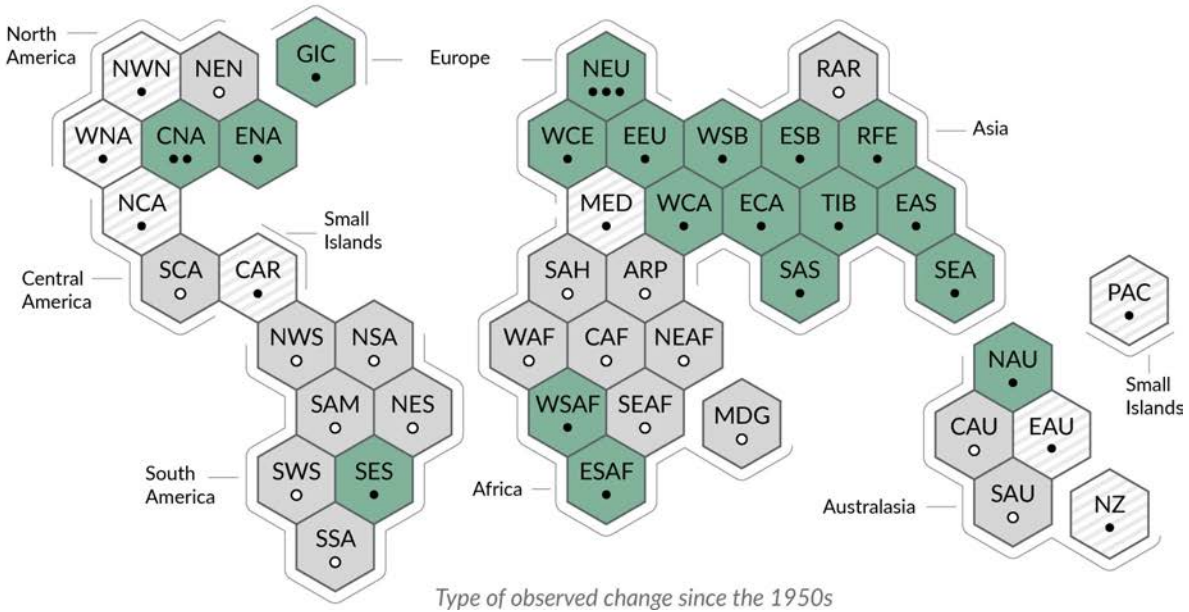
b) Synthesis of assessment of observed change in **heavy precipitation** and confidence in human contribution to the observed changes in the world's regions

Type of observed change
in heavy precipitation

- Increase (19)
- Decrease (0)
- Low agreement in the type of change (8)
- Limited data and/or literature (18)

Confidence in human contribution
to the observed change

- ●●● High
- ●● Medium
- ● Low due to limited agreement
- ○ Low due to limited evidence



Wallonia Floods, July 2021

Source:
VRT Nieuws

Figure SPM.3

Observed changes in agricultural and ecological drought since 1950

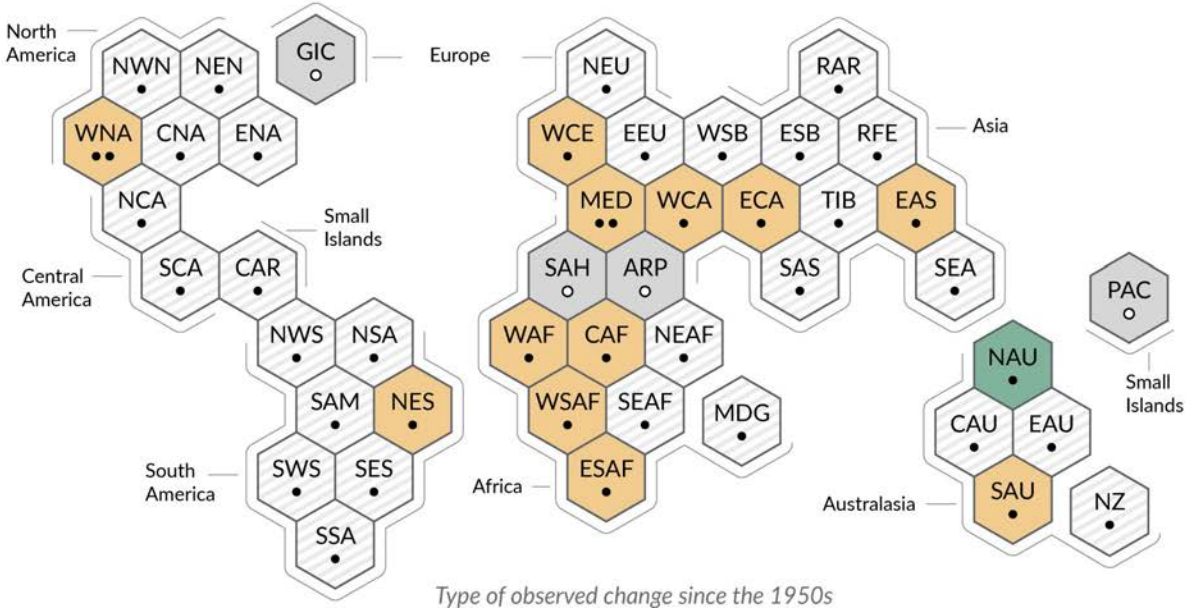
c) Synthesis of assessment of observed change in **agricultural and ecological drought** and confidence in human contribution to the observed changes in the world's regions

Type of observed change
in agricultural and ecological drought

- Increase (12)
- Decrease (1)
- Low agreement in the type of change (28)
- Limited data and/or literature (4)

Confidence in human contribution
to the observed change

- ●●● High
- ●● Medium
- ● Low due to limited agreement
- ○ Low due to limited evidence



Key messages from the latest WGI AR6 IPCC Report:

B. Possible Climate Futures

B.1 Global surface temperature will continue to increase until at least the mid-century under all emissions scenarios considered. Global warming of 1.5°C and 2°C will be exceeded during the 21st century unless deep reductions in carbon dioxide (CO_2) and other greenhouse gas emissions occur in the coming decades.

B.2 Many changes in the climate system become larger in direct relation to increasing global warming. They include increases in the frequency and intensity of hot extremes, marine heatwaves, and heavy precipitation, agricultural and ecological droughts in some regions, and proportion of intense tropical cyclones, as well as reductions in Arctic sea ice, snow cover and permafrost.

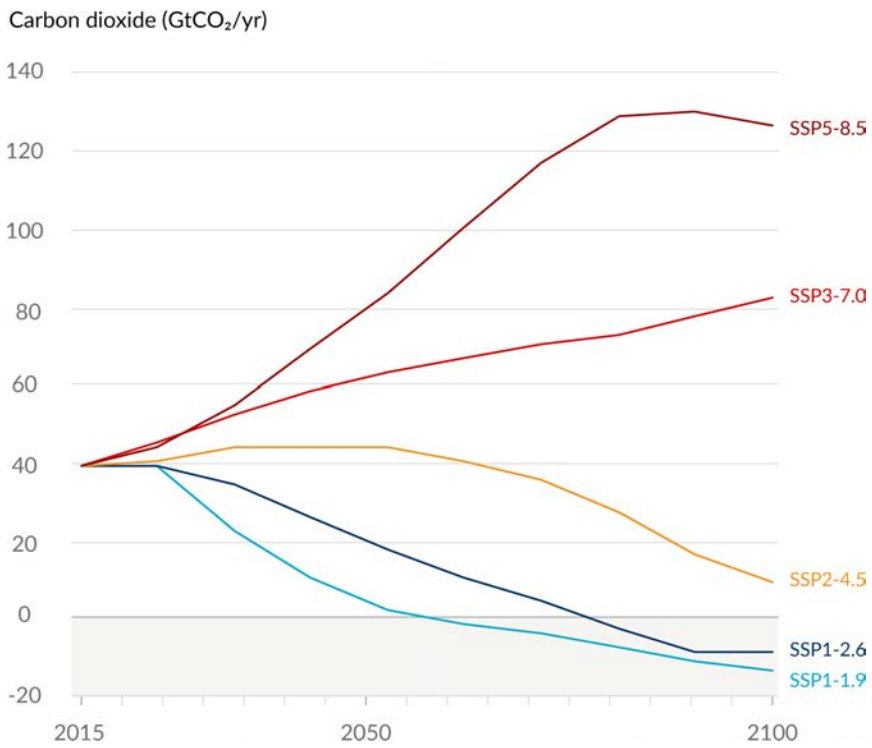
B.3 Continued global warming is projected to further intensify the global water cycle, including its variability, global monsoon precipitation and the severity of wet and dry events.

B.4 Under scenarios with increasing CO_2 emissions, the ocean and land carbon sinks are projected to be less effective at slowing the accumulation of CO_2 in the atmosphere.

B.5 Many changes due to past and future greenhouse gas emissions are irreversible for centuries to millennia, especially changes in the ocean, ice sheets and global sea level.

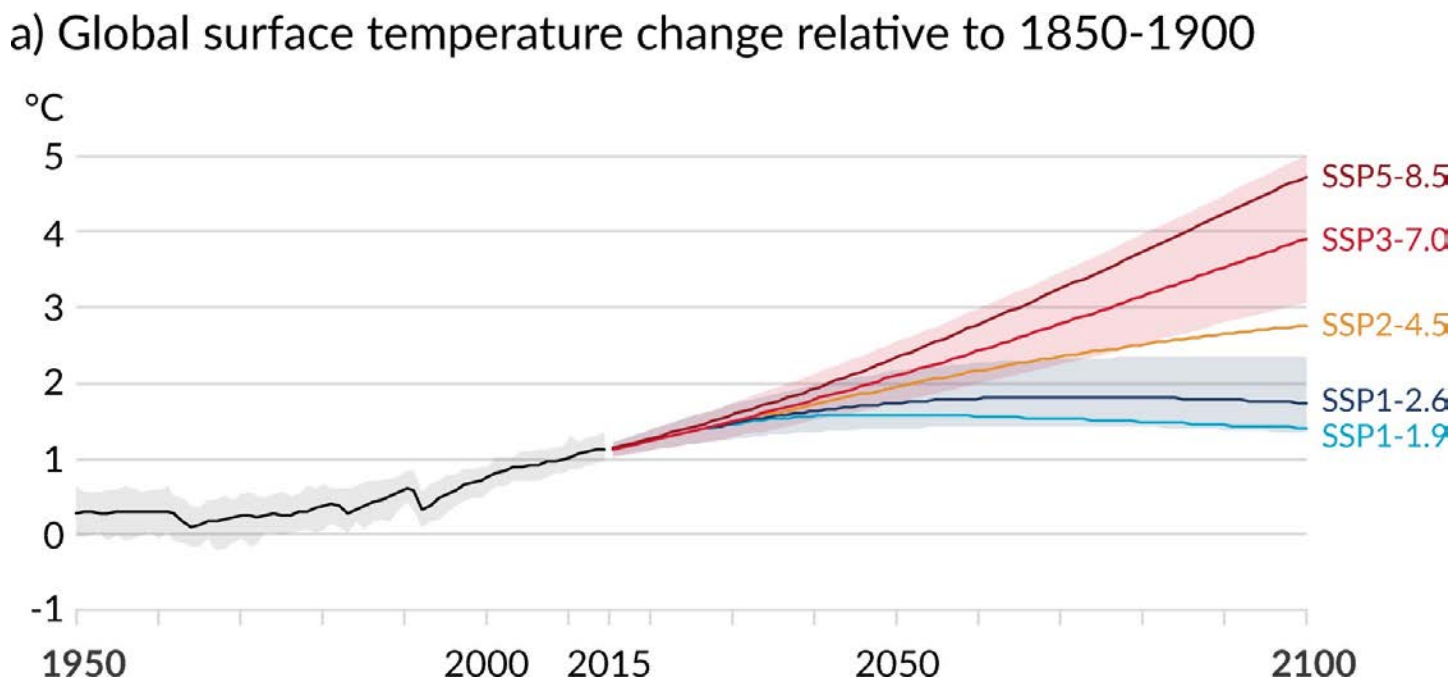
Future emissions cause future additional warming, with total warming dominated by past and future CO_2 emissions

Figure SPM.4

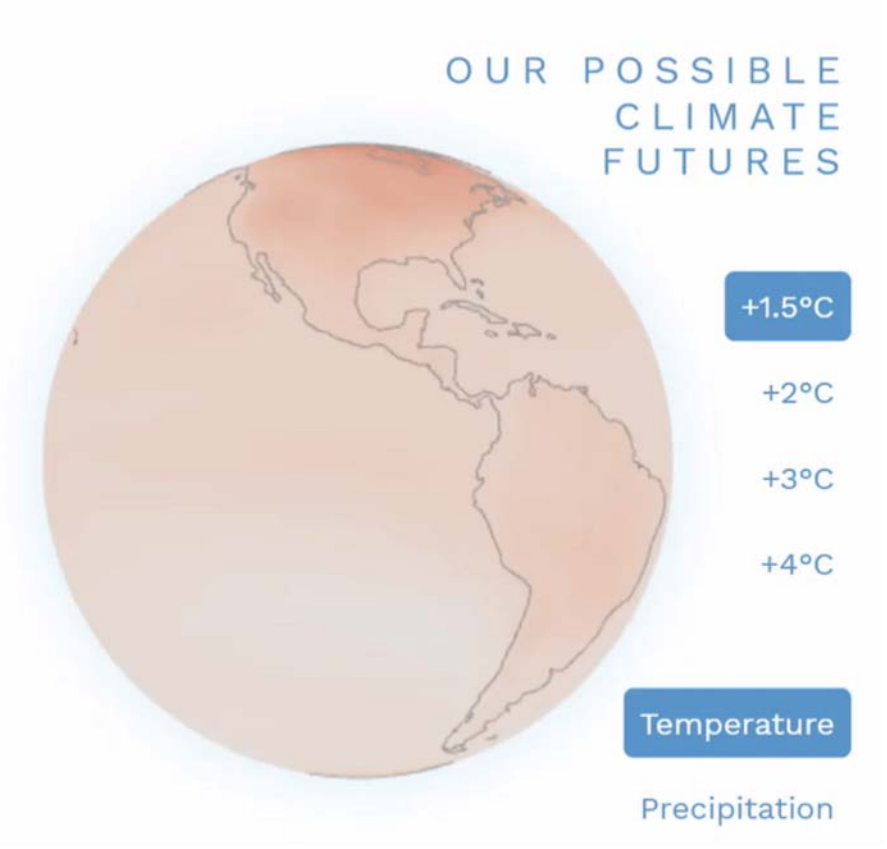


Human activities affect all the major climate system components, with some responding over decades and others over centuries

Figure SPM.8



Interactive atlas



https://interactive-atlas.ipcc.ch/

#IPCCData #IPCCAtlas

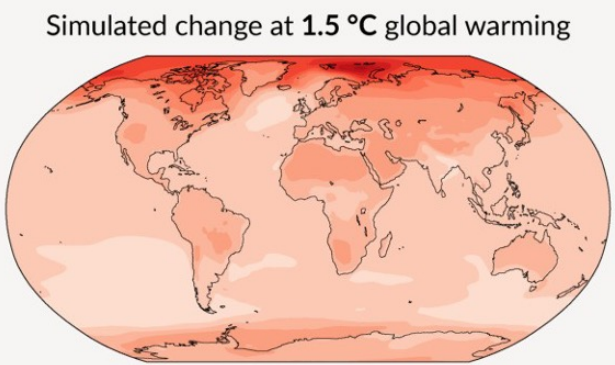
Changes in global surface temperature for the five illustrative emissions scenarios considered

Table SPM.1

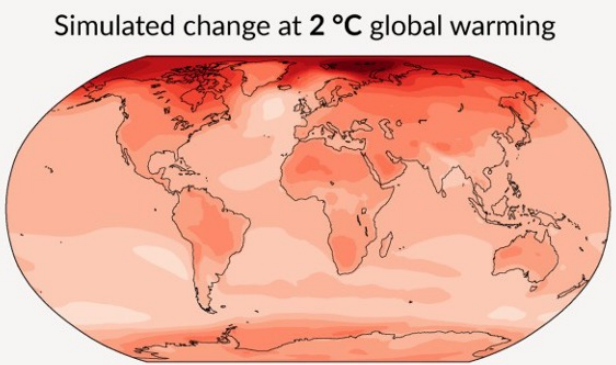
	Near term, 2021–2040		Mid-term, 2041–2060		Long term, 2081–2100	
Scenario	Best estimate (°C)	*Very likely* range (°C)	Best estimate (°C)	*Very likely* range (°C)	Best estimate (°C)	*Very likely* range (°C)
SSP1-1.9	1.5	1.2 to 1.7	1.6	1.2 to 2.0	1.4	1.0 to 1.8
SSP1-2.6	1.5	1.2 to 1.8	1.7	1.3 to 2.2	1.8	1.3 to 2.4
SSP2-4.5	1.5	1.2 to 1.8	2.0	1.6 to 2.5	2.7	2.1 to 3.5
SSP3-7.0	1.5	1.2 to 1.8	2.1	1.7 to 2.6	3.6	2.8 to 4.6
SSP5-8.5	1.6	1.3 to 1.9	2.4	1.9 to 3.0	4.4	3.3 to 5.7

À tous les niveaux de réchauffement, les terres s'échauffent plus vite que l'océan, et l'Arctique et l'Antarctique davantage que les régions tropicales

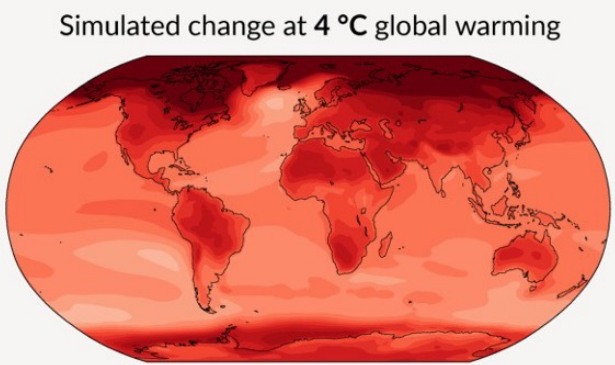
+1.5° C

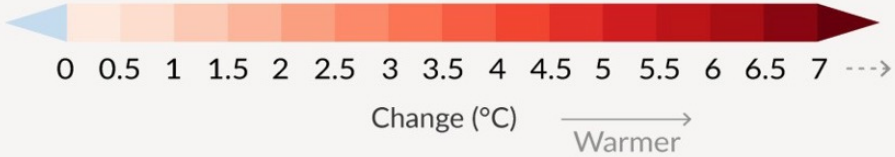


+2° C



+4° C





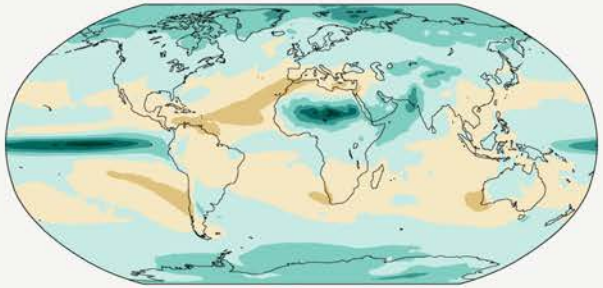
La quantité totale annuelle de précipitations augmentera aux latitudes élevées, dans le Pacifique équatorial et dans une partie des régions à mousson, et diminuera dans une partie des régions sous-tropicales et tropicales

c) Annual mean precipitation change (%) relative to 1850-1900

Precipitation is projected to increase over high latitudes, the equatorial Pacific and parts of the monsoon regions, but decrease over parts of the subtropics and in limited areas of the tropics.

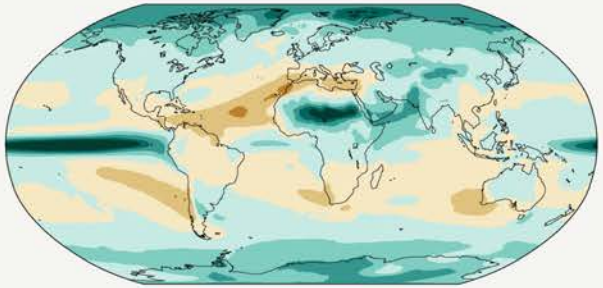
+1.5° C

Simulated change at **1.5 °C** global warming



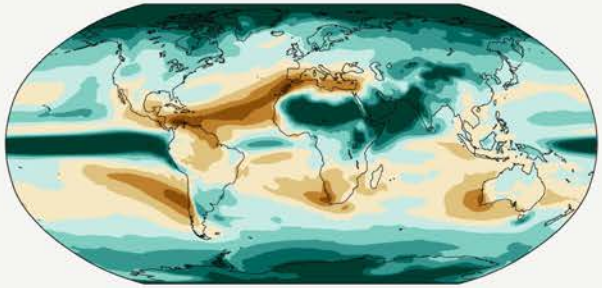
+2° C

Simulated change at **2 °C** global warming

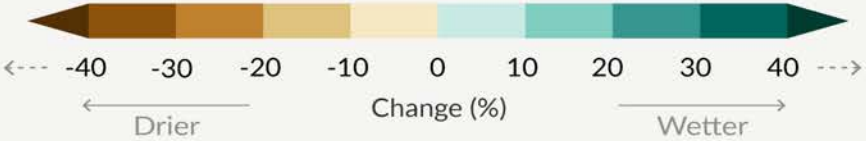


+4° C

Simulated change at **4 °C** global warming

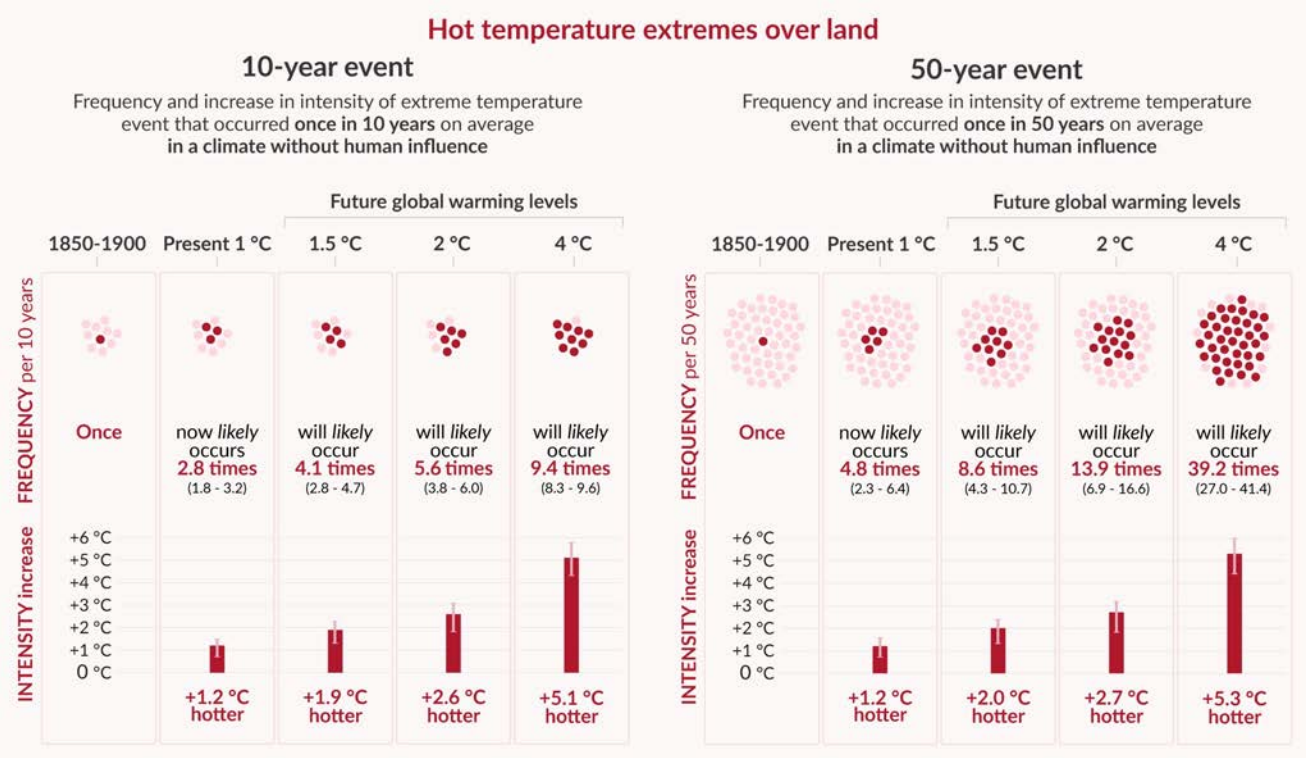


Relatively small absolute changes may appear as large % changes in regions with dry baseline conditions



Projected changes in extremes are larger in frequency and intensity with every additional increment of global warming

Figure SPM.6

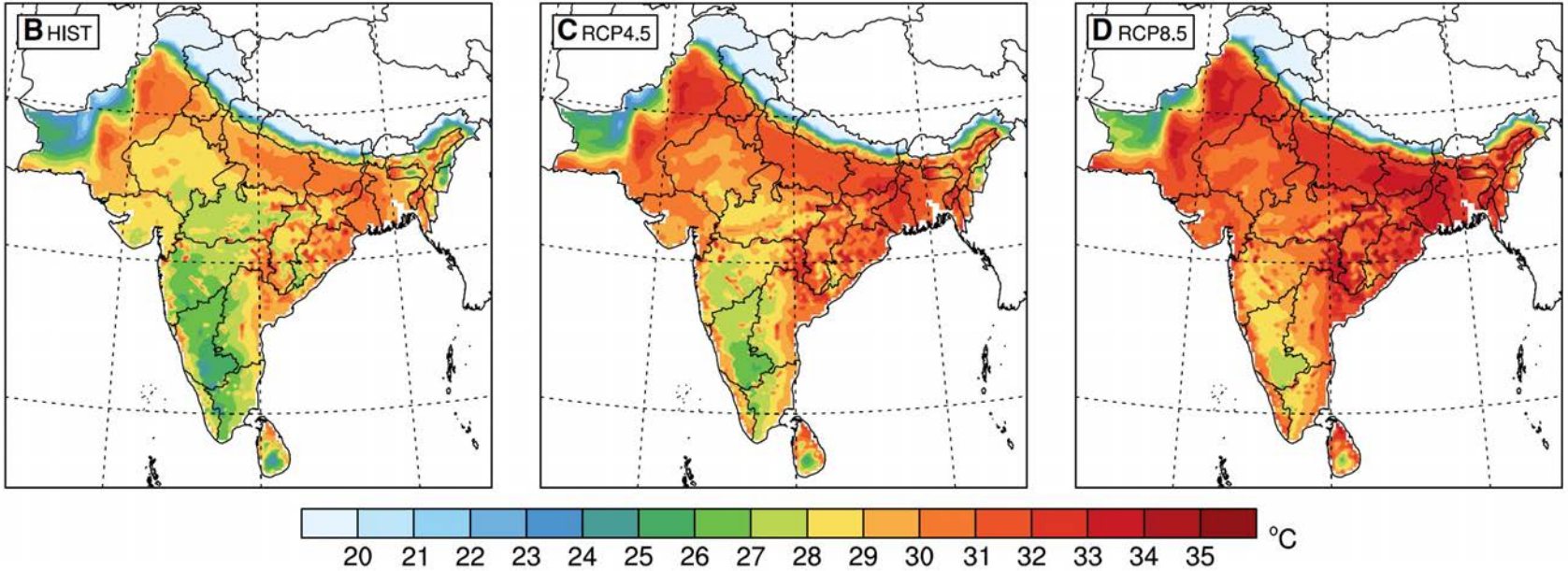


Evolution of daily maximum wet-bulb temperature, TWmax (°C)

- « Human exposure to TW of around 35°C for even a few hours will result in death even for the fittest of humans under shaded, well-ventilated conditions »
- « Under the RCP4.5 scenario, no regions are projected to exceed 35°C; however, vast regions of South Asia are projected to experience episodes exceeding 31°C, which is considered extremely dangerous for most humans »

Source: Im et al., 2017 « Deadly heat waves projected in the densely populated agricultural regions of South Asia », Science advances.

Evolution of daily maximum wet-bulb temperature, TWmax (° C)



Spatial distributions of bias-corrected ensemble averaged 30-year TWmax for each GHG scenario: HIST (1976–2005) (B), RCP4.5 (2071–2100) (C), and RCP8.5 (2071–2100) (D).

Source: Im et al., 2017 « Deadly heat waves projected in the densely populated agricultural regions of South Asia », Science advances.

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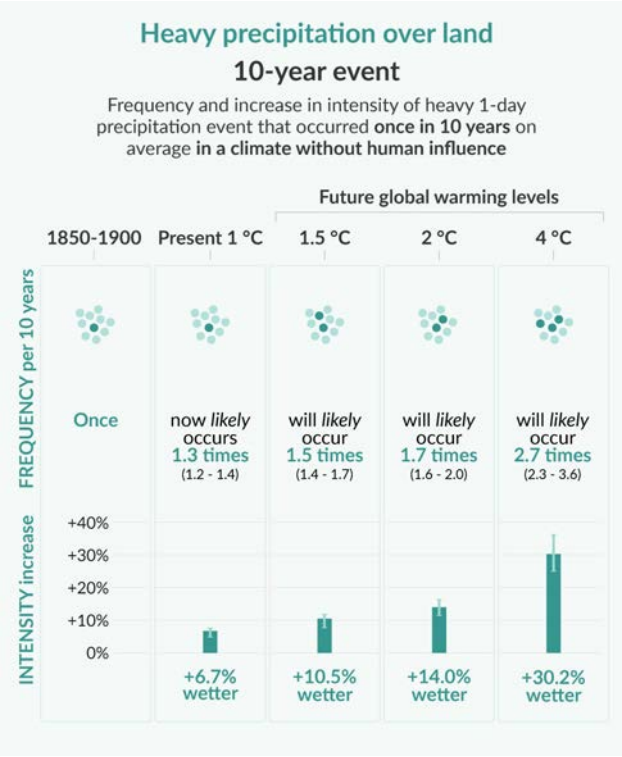
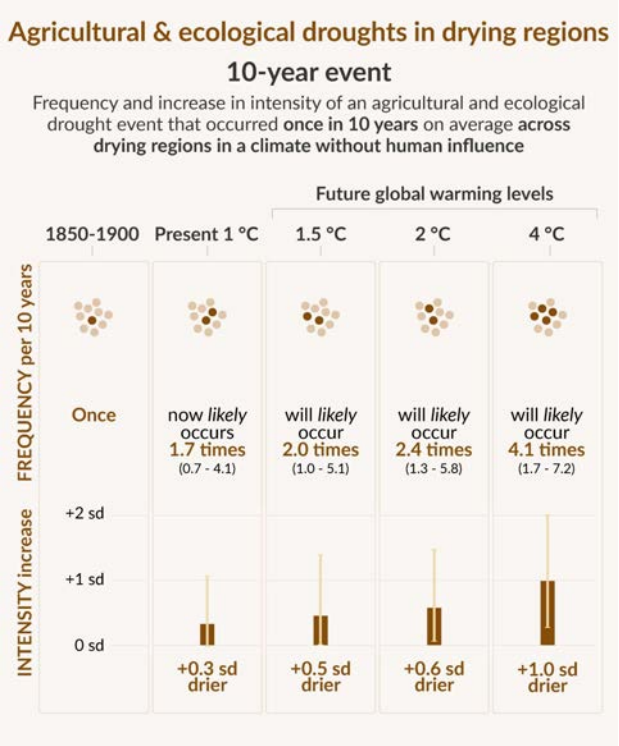
Figure SPM.6



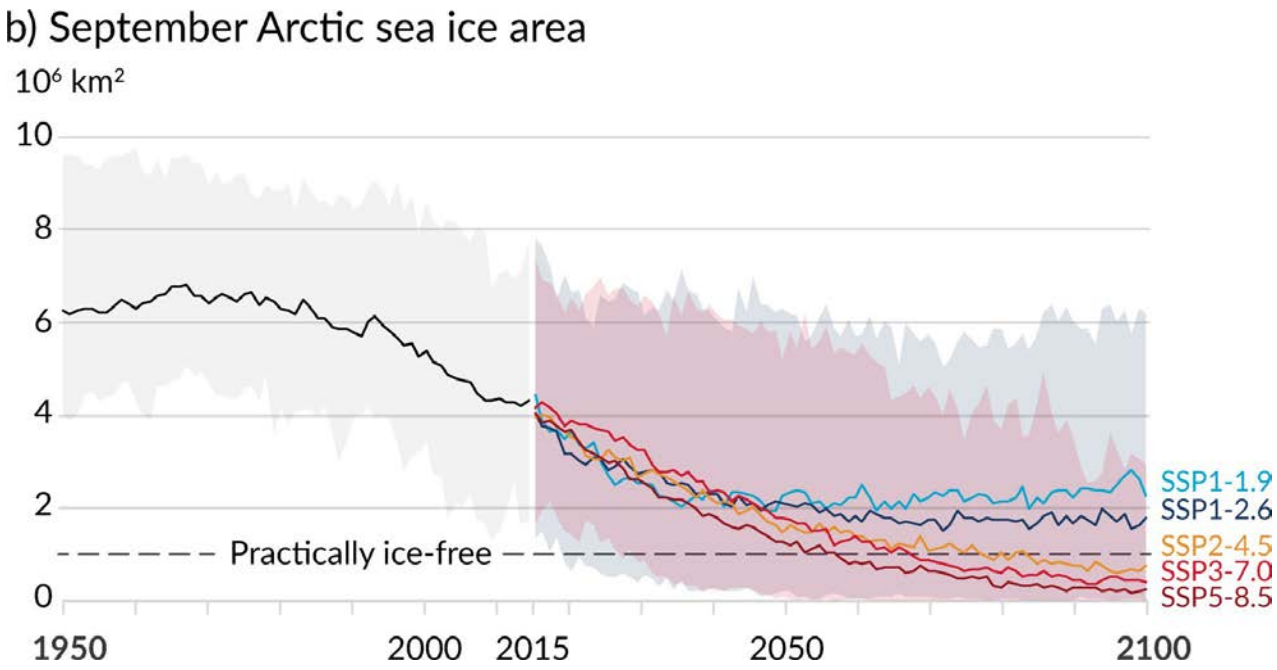
Projected changes in extremes are larger in frequency and intensity with every additional increment of global warming

Figure SPM.6



Human activities affect all the major climate system components, with some responding over decades and others over centuries

Figure SPM.8



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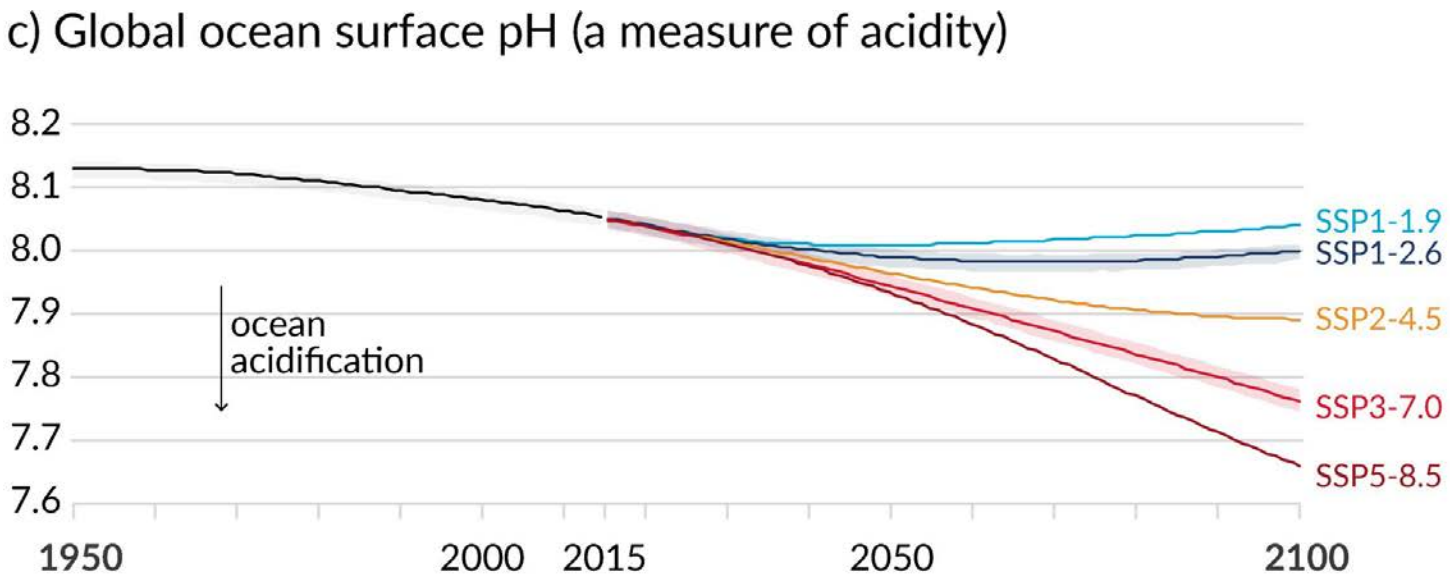
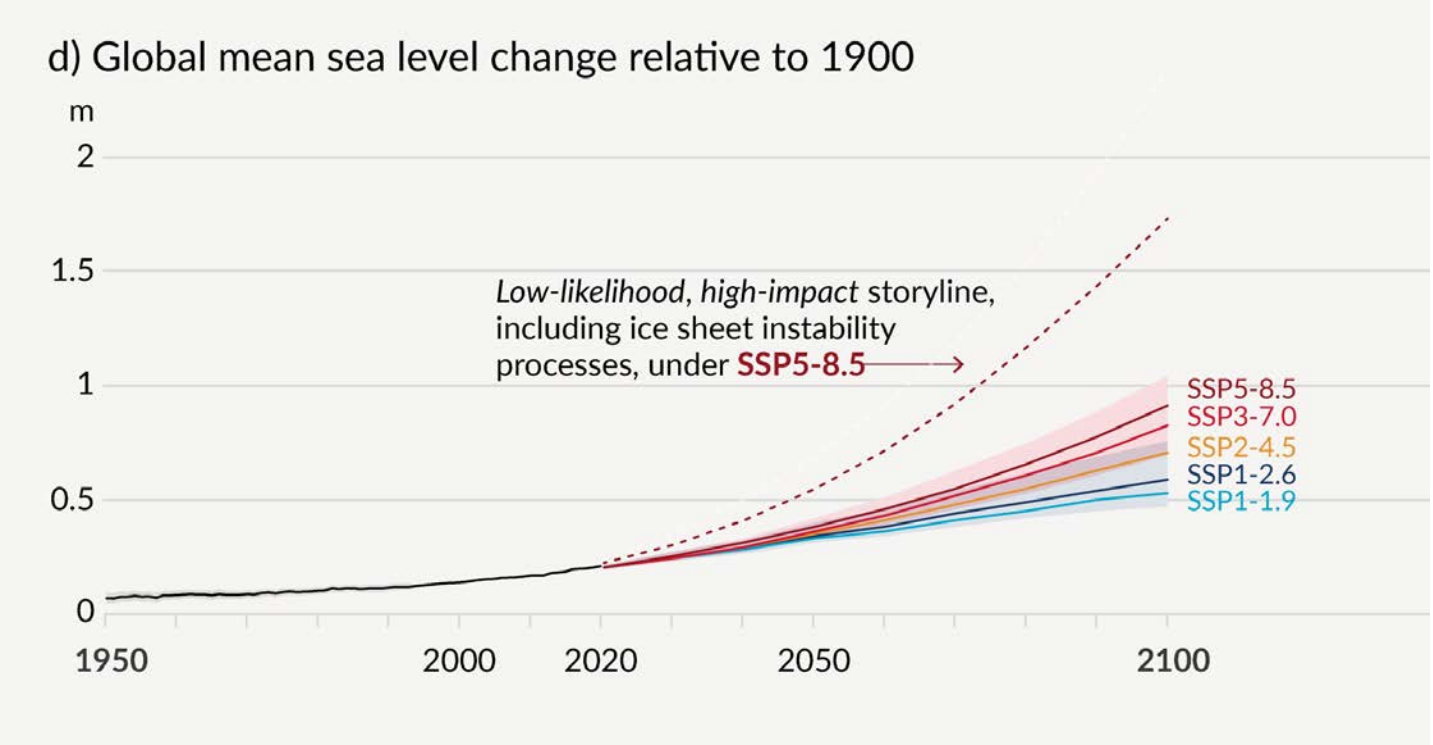


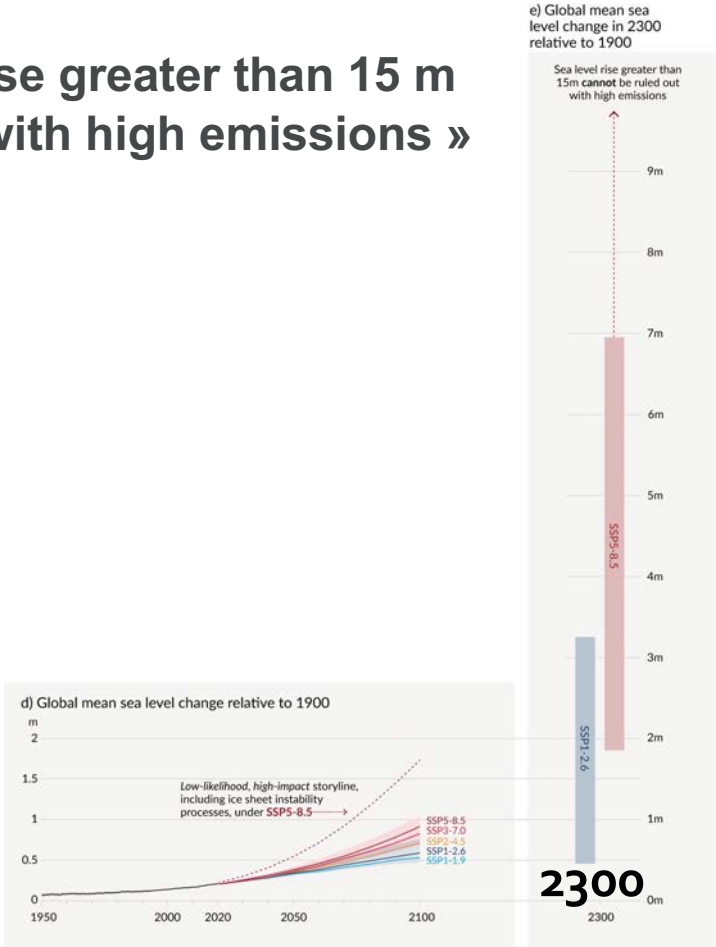
Human activities affect all the major climate system components, with some responding over decades and others over centuries

Figure SPM.8



« In 2300, sea level rise greater than 15 m cannot be ruled out with high emissions »

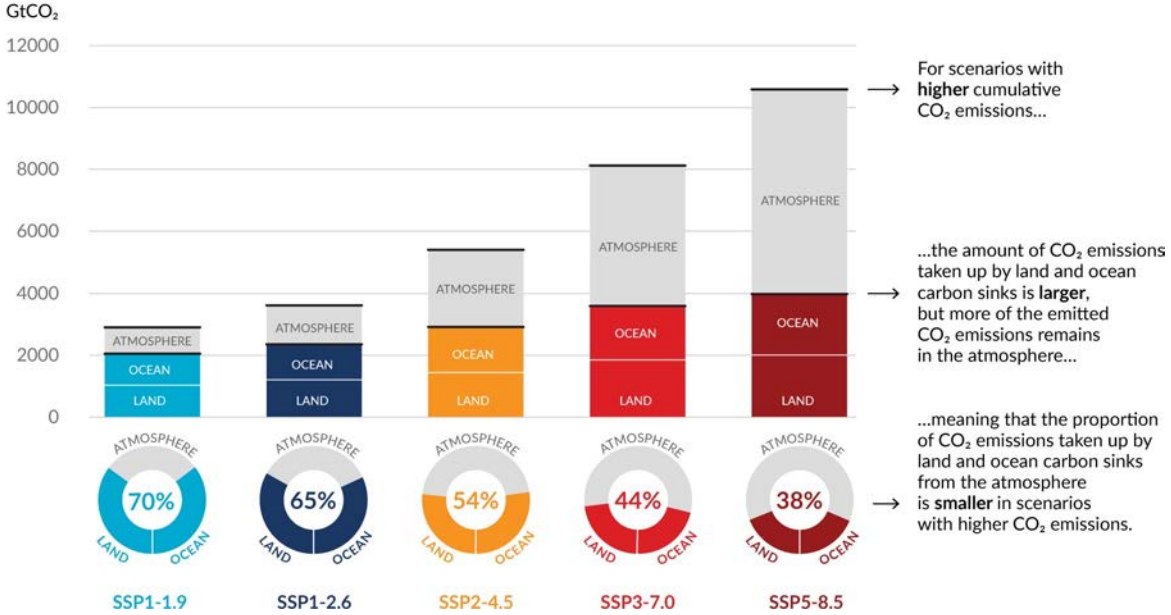
Figure SPM.8



The proportion of CO_2 emissions taken up by land and ocean carbon sinks is smaller in scenarios with higher cumulative CO_2 emissions

Figure SPM.7

Total cumulative CO_2 emissions **taken up by land and oceans** (colours) and remaining in the atmosphere (grey) under the five illustrative scenarios from 1850 to 2100



Key messages from the latest WGI AR6 IPCC Report:

C. Climate Information for Risk Assessment and Regional Adaptation

C.1 Natural drivers and internal variability will modulate human-caused changes, especially at regional scales and in the near term, with little effect on centennial global warming. These modulations are important to consider in planning for the full range of possible changes.

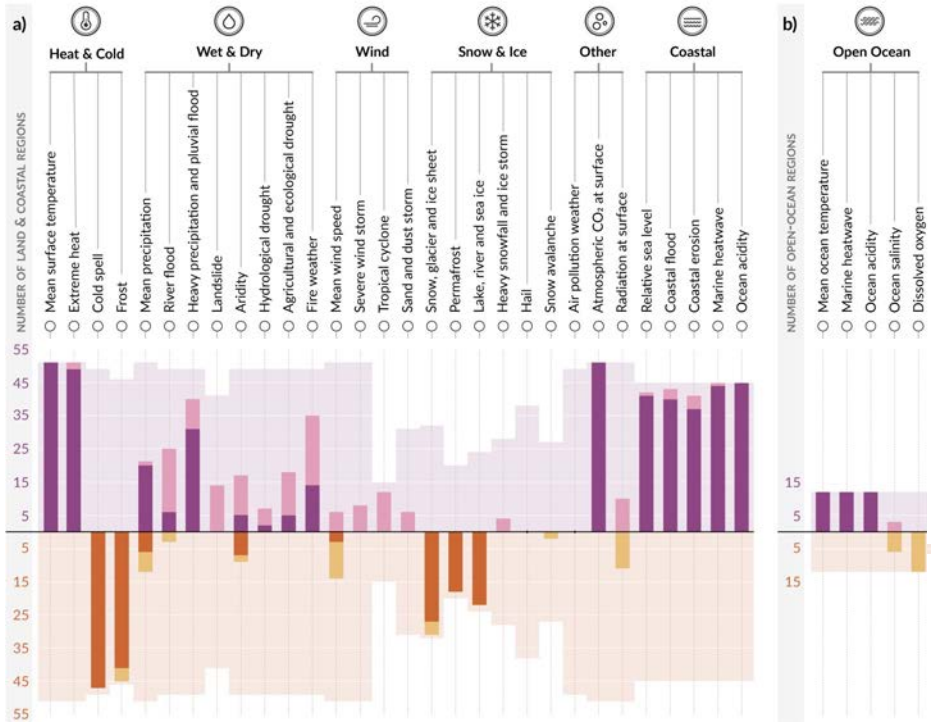
C.2 With further global warming, every region is projected to increasingly experience concurrent and multiple changes in climatic impact-drivers. Changes in several climatic impact-drivers would be more widespread at 2°C compared to 1.5°C global warming and even more widespread and/or pronounced for higher warming levels.

C.3 Low-likelihood outcomes, such as ice sheet collapse, abrupt ocean circulation changes, some compound extreme events and warming substantially larger than the assessed *very likely* range of future warming cannot be ruled out and are part of risk assessment.

Multiple climatic impact-drivers are projected to change in all regions of the world

Figure SPM.9

Number of land & coastal regions (a) and **open-ocean regions** (b) where each **climatic impact-driver** (CID) is projected to increase or decrease with ***high*** *confidence* (dark shade) or ***medium*** *confidence* (light shade)



ASSESSED FUTURE CHANGES

Changes refer to a 20–30 year period centred around 2050 and/or consistent with 2°C global warming compared to a similar period within 1960-2014 or 1850-1900.

BAR CHART LEGEND

- Regions with ***high*** *confidence* increase
- Regions with ***medium*** *confidence* increase
- Regions with ***high*** *confidence* decrease
- Regions with ***medium*** *confidence* decrease

LIGHTER-SHADED 'ENVELOPE' LEGEND

The height of the lighter shaded 'envelope' behind each bar represents the maximum number of regions for which each CID is relevant. The envelope is symmetrical about the x-axis showing the maximum possible number of relevant regions for CID increase (upper part) or decrease (lower part).

Key messages from the latest WGI AR6 IPCC Report:

D. Limiting Future Climate Change

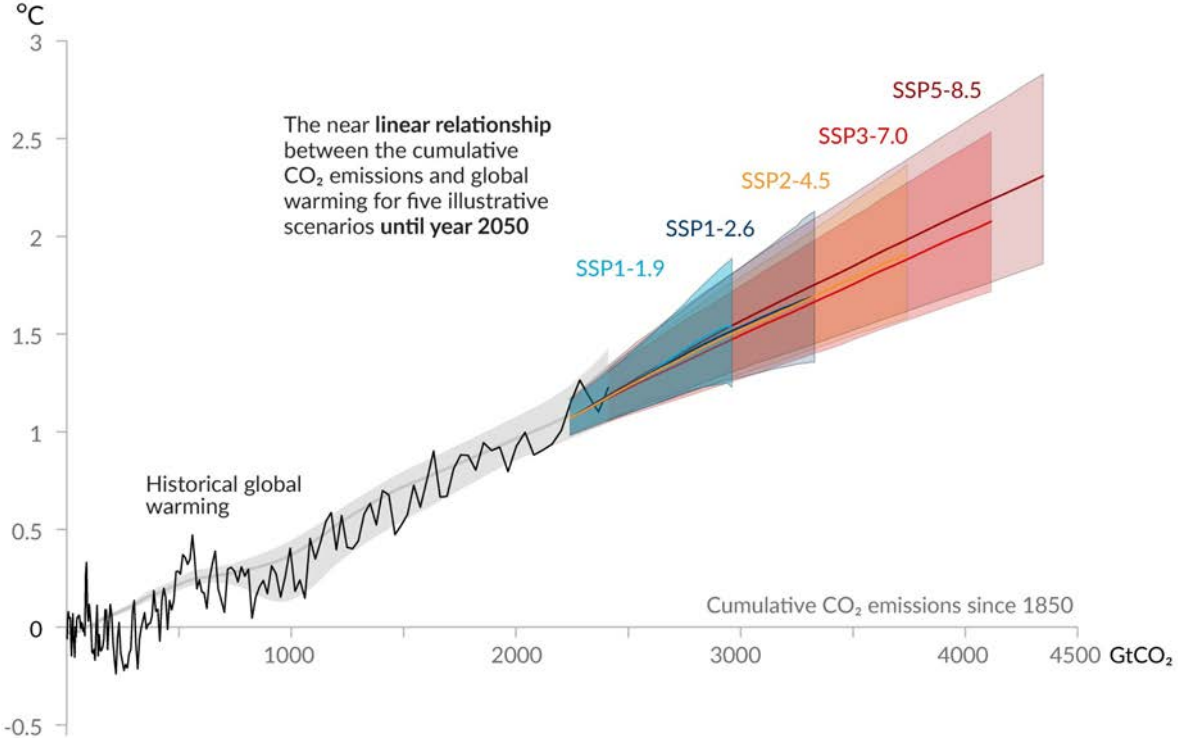
D.1 From a physical science perspective, limiting human-induced global warming to a specific level requires limiting cumulative CO_2 emissions, reaching at least net zero CO_2 emissions, along with strong reductions in other greenhouse gas emissions. Strong, rapid and sustained reductions in CH_4 emissions would also limit the warming effect resulting from declining aerosol pollution and would improve air quality.

D.2 Scenarios with low or very low greenhouse gas (GHG) emissions (SSP1-1.9 and SSP1-2.6) lead within years to discernible effects on greenhouse gas and aerosol concentrations, and air quality, relative to high and very high GHG emissions scenarios (SSP3-7.0 or SSP5-8.5). Under these contrasting scenarios, discernible differences in trends of global surface temperature would begin to emerge from natural variability within around 20 years, and over longer time periods for many other climatic impact-drivers (*high confidence*).

Every tonne of CO_2 emissions adds to global warming

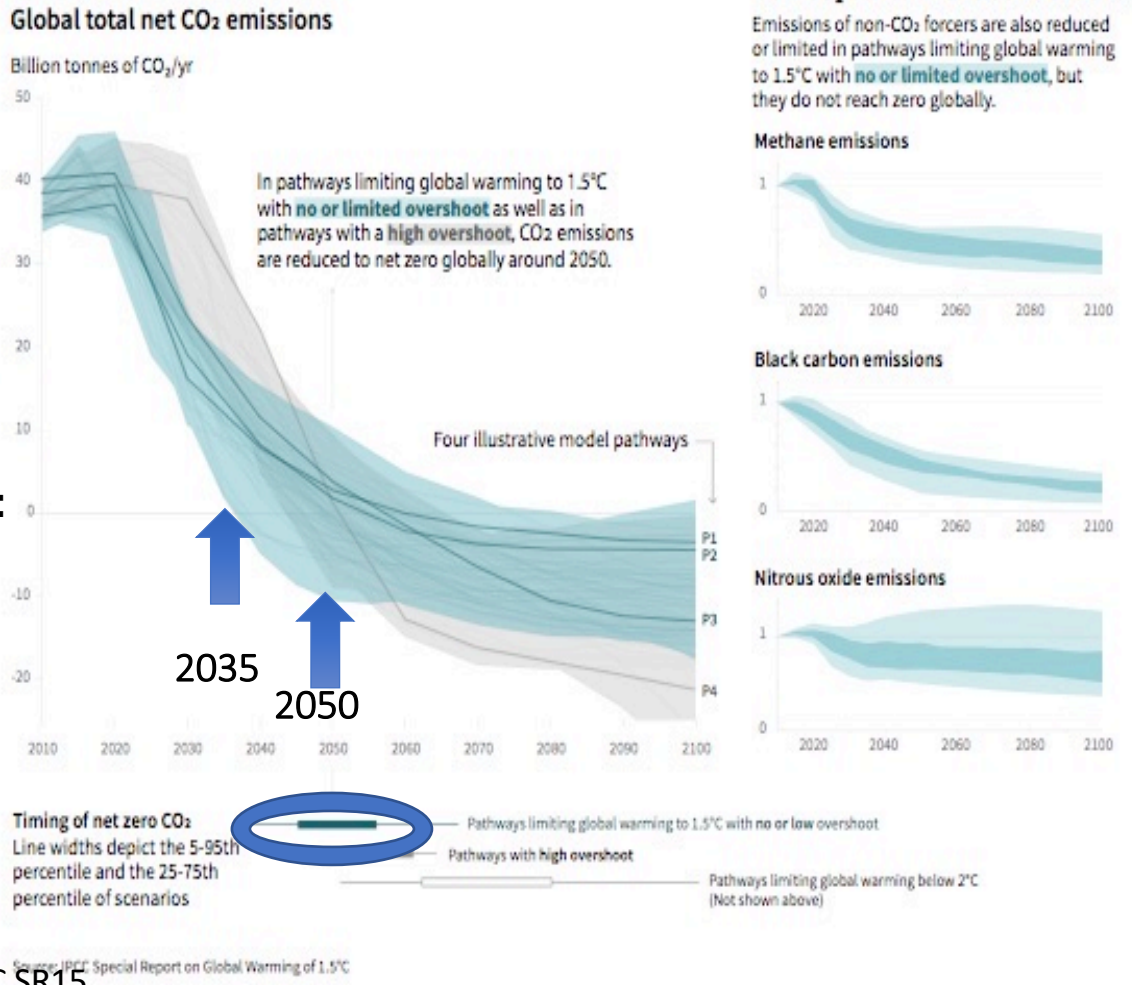
Figure SPM.10

Global surface temperature increase since 1850-1900 (°C) as a function of cumulative CO_2 emissions ($GtCO_2$)



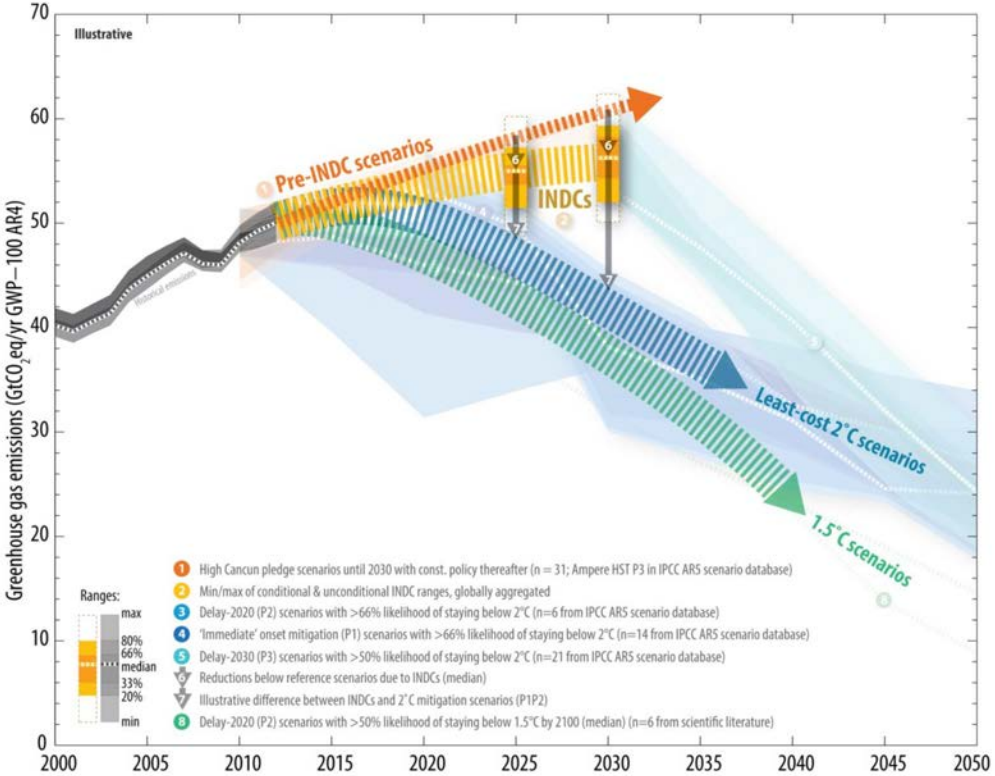
Emission pathways compatible with below 1.5° C warming:

Net ZERO:



Source: IPCC SR15

Comparison of global emission levels in 2025 and 2030 resulting from the implementation of the intended nationally determined contributions



UNFCCC, Aggregate effect of the intended nationally determined contributions: an update
http://unfccc.int/resource/docs/2016/cop22/eng/02.pdf

RCP2.6 **RCP8.5**

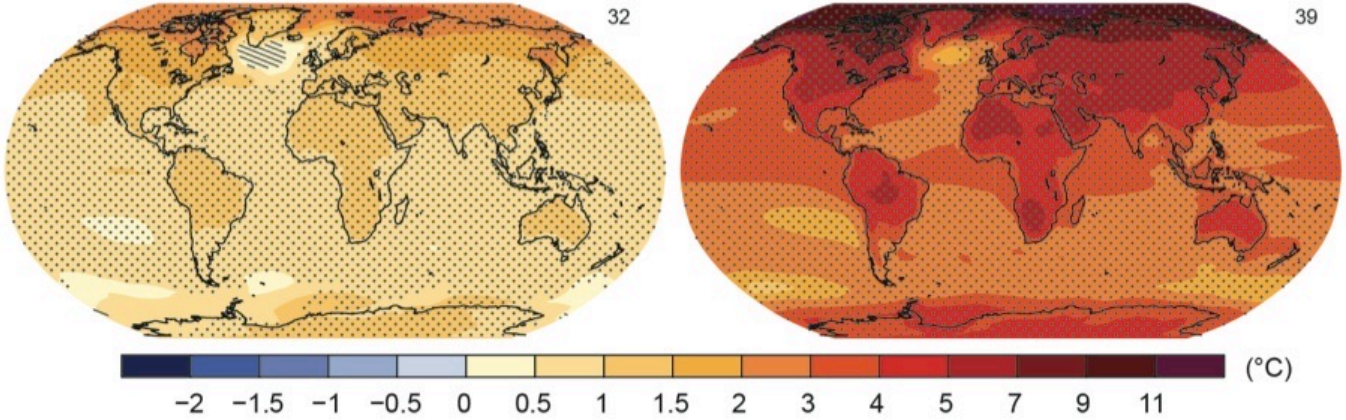


Fig. SPM.8

Humanity has the choice

SUSTAINABLE DEVELOPMENT GOALS

Conclusions

The IPCC AR6 WGI report confirmed that the inhabitability of the Earth is at stake due to climate change

Adaptation is key, and resources need to be much better shared and managed, but adaptation will not be sufficient at all

Stabilizing the temperature as close as possible to no more than 1.5°C above the pre-industrial is essential, and requires to move away quickly from fossil fuels, and to stop deforestation

The challenge is huge: transform the world in a few decades so that the whole world activities are decarbonized, while poverty and hunger are eliminated

Addressing this challenge opens so many opportunities, including opportunities to address in a synergistic manner other societal goals, such as the 17 Sustainable Development Goals.

Ecrit pour les jeunes (et moins jeunes), avec des liens vers des ressources utiles

Plateforme Wallonne pour le GIEC

Lettre N°13 - avril 2019

'Sauver le climat' : les bases

Suite à l'intense mobilisation des jeunes, les changements climatiques ont fait l'objet de beaucoup d'attention au cours des derniers mois. Elèves du secondaire, étudiants, professeurs, parents et grand-parents sont descendus dans la rue pour montrer leur désarroi face à la lenteur de l'action vis-à-vis des changements climatiques.

Nous nous réjouissons de cette mobilisation, car notre rôle nous met encore plus fréquemment que l'ensemble de la population en position de témoin des risques que font courir les changements climatiques, ainsi que de l'ampleur des efforts nécessaires pour mettre en œuvre les objectifs que se sont fixés les membres des Nations Unies à Paris en 2015 (COP21).

Une démarche essentielle en faveur de ces jeunes est de les aider à se former, à appréhender les principaux éléments de la problématique du climat, et plus largement, de l'influence de nos activités sur notre environnement et sur le futur de l'humanité. L'éducation est un des instruments essentiels pour évoluer vers une société plus durable et plus juste.

Pour y contribuer, nous présentons ici une brève synthèse de la problématique et une sélection de références commentées. Nous espérons que cette Lettre aidera enseignants et élèves à disposer d'une base d'information solide et ainsi à prendre leur part dans la solution à ce problème planétaire : agir à leur niveau et favoriser l'action dans leur entourage et au niveau sociétal.

Plusieurs témoignages d'élèves ou de professeurs sont également présentés.

Nous vous souhaitons une bonne lecture !

Jean-Pascal van Ypersele, Philippe Marbaix et Bruna Gaino

Sommaire

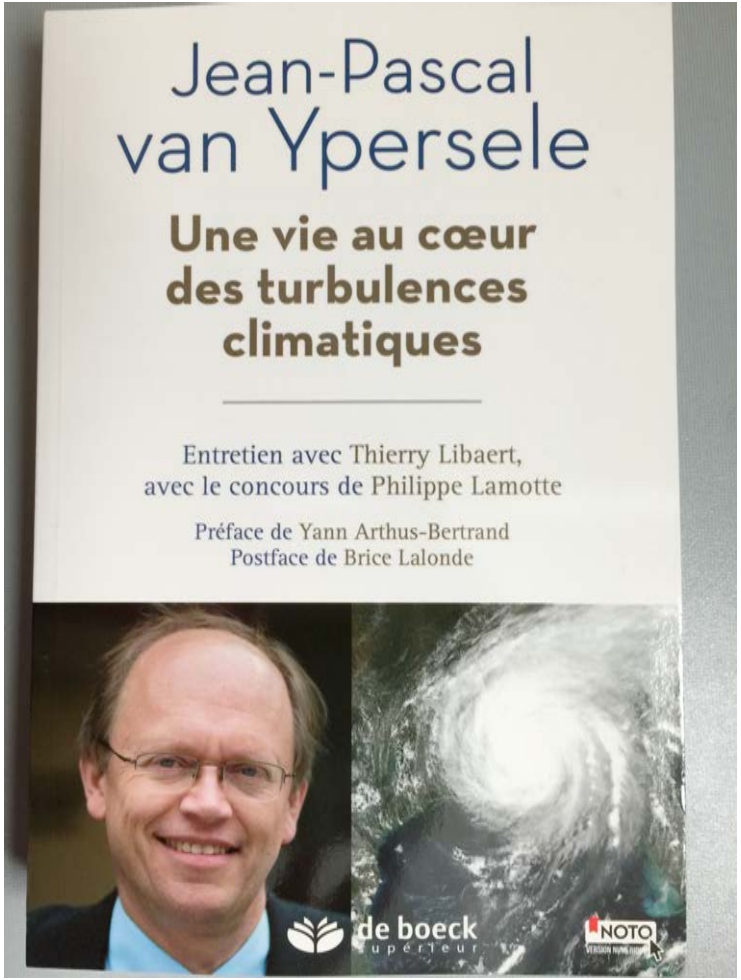
Wallonie environnement Awac

Disponible gratuitement, 6X/an: www.plateforme-wallonne-giec.be

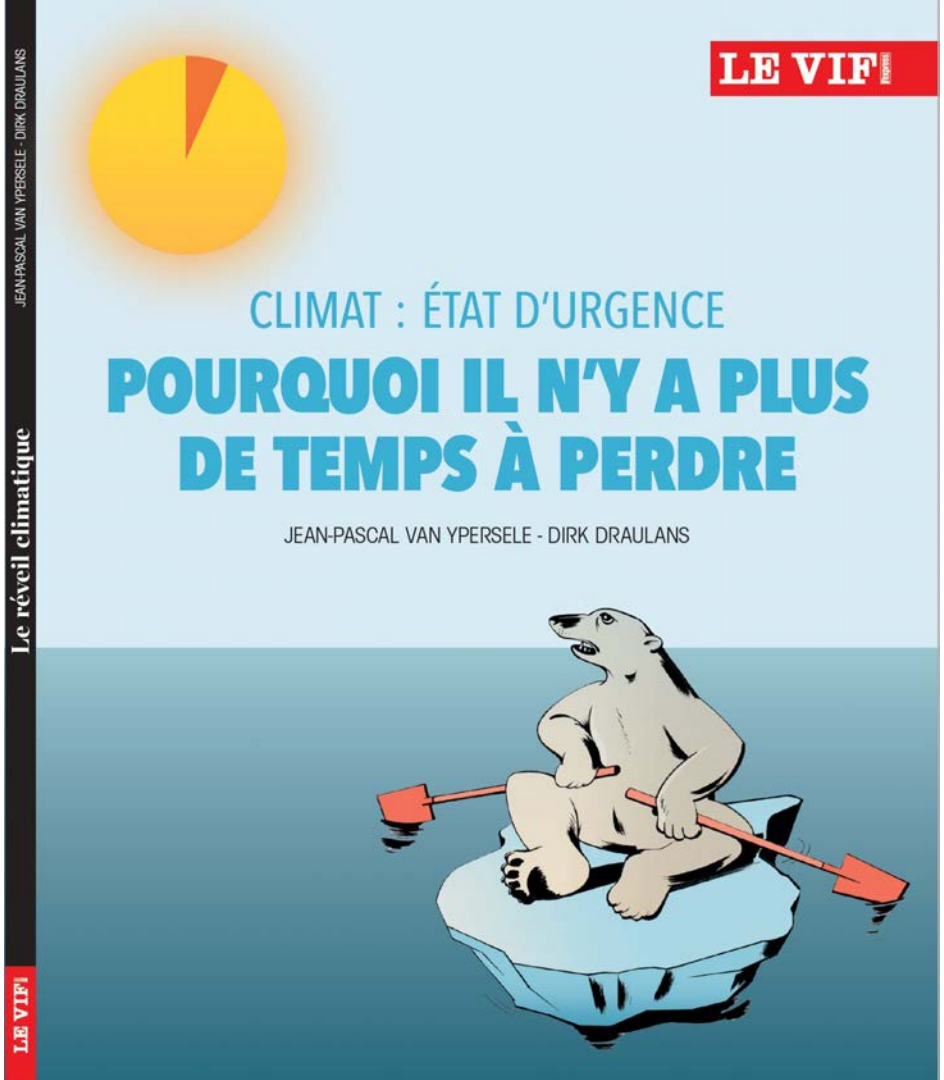
Pour en savoir plus:

Je vous invite à lire mon livre !

Publié chez De Boeck supérieur



Gratuit sur
www.levif.be/reveil-climatique



Pour en savoir plus :

- www.ipcc.ch : GIEC ou IPCC
- www.climate.be/vanyp : mes dias
- www.plateforme-wallonne-giec.be : Plateforme wallonne pour le GIEC (e.a., Lettre d'information)
- www.skepticalscience.com : réponses aux semeurs de doute
- https://diplomatie.belgium.be/sites/default/files/downloads/rapport_climat_van_ypersele_2008_fr.pdf : Rapport Climat – Coop. Développement

- **Sur Twitter: @JPvanYpersele @IPCC_CH**

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