

# **Current and Future Changes in Climate and Weather Extremes**

**Jean-Pascal van Ypersele**

**Université catholique de Louvain (UCLouvain),  
Belgium**

**IPCC Vice-Chair from 2008 to 2015**

**Twitter: @JPvanYpersele**

**European Environment Agency - European Trade Union Institute Webinar  
« Climate Change Mitigation and Adaptation: Challenges and  
Opportunities », online, 13 September 2021**

**Thanks to the Walloon government for supporting [www.plateforme-wallonne-giec.be](http://www.plateforme-wallonne-giec.be)  
& my team at UCLouvain**

# 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  
IT'S US  
EXPERTS AGREE  
IT'S BAD  
THERE'S HOPE

Global warming is happening.

Human activity is the main cause.

There's scientific consensus on human-caused global warming.

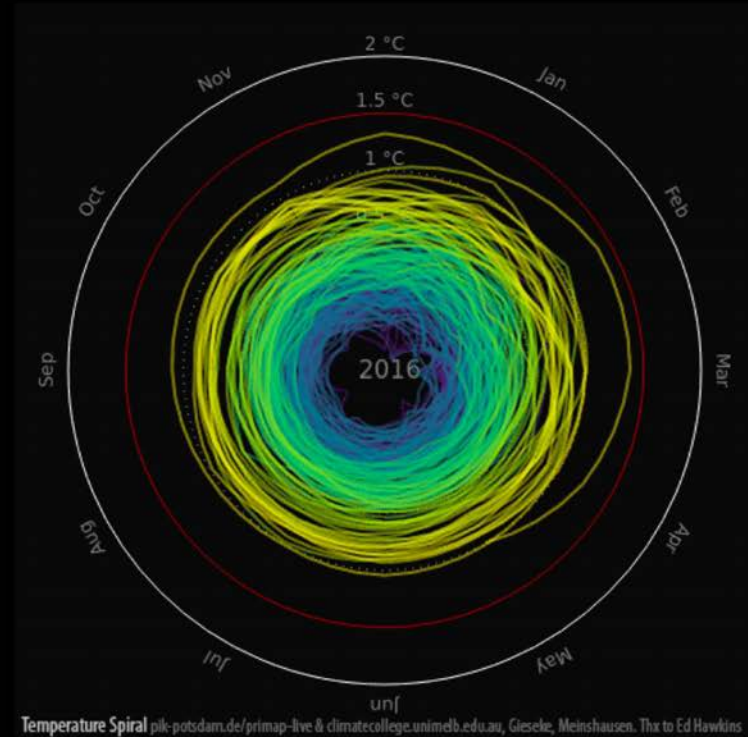
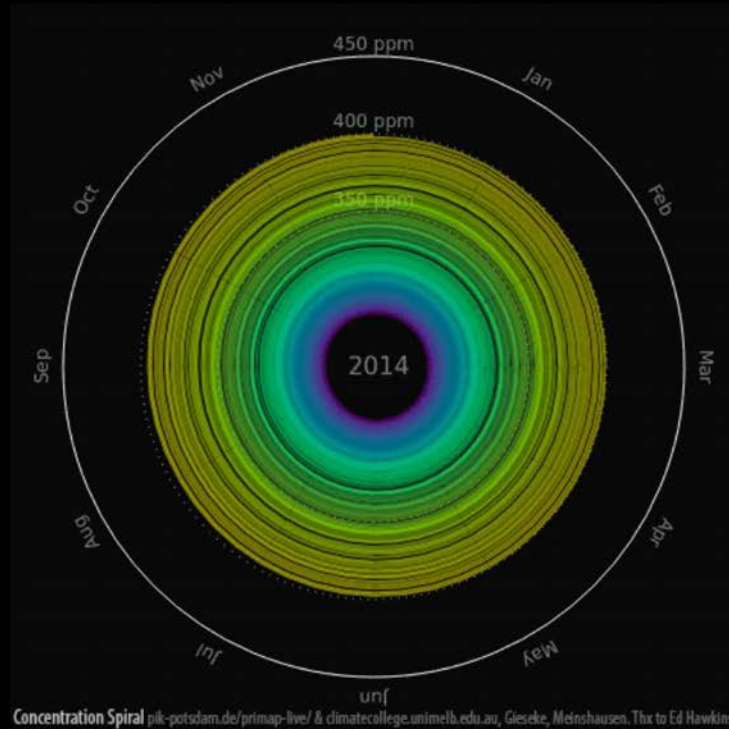
The impacts are serious and affect people.

We have the technology needed to avoid the worst climate impacts.

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

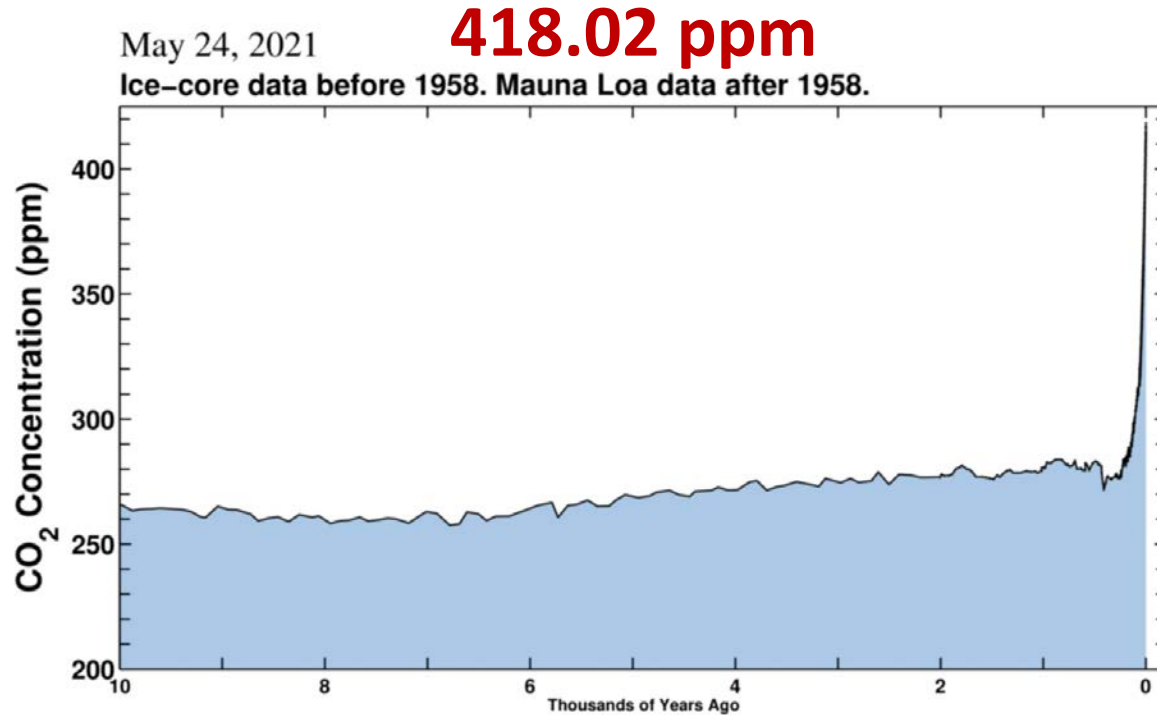
**That is why we must cut emissions to ZERO as soon as possible**

# CO<sub>2</sub> Concentration and Temperature spirals



CO<sub>2</sub> 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/>

# CO<sub>2</sub> Concentration 24 May 2021 (Keeling curve + last 10000 years)

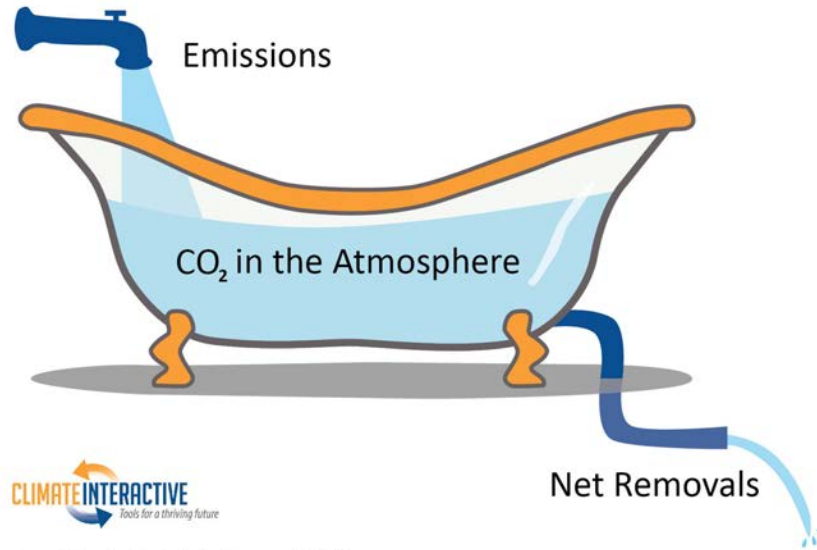


Source: [scripps.ucsd.edu/programs/keelingcurve/](https://scripps.ucsd.edu/programs/keelingcurve/)

**Fact: The changing composition of the atmosphere and the resulting climate change are due to our usage of fossil fuels, cement, and to deforestation**

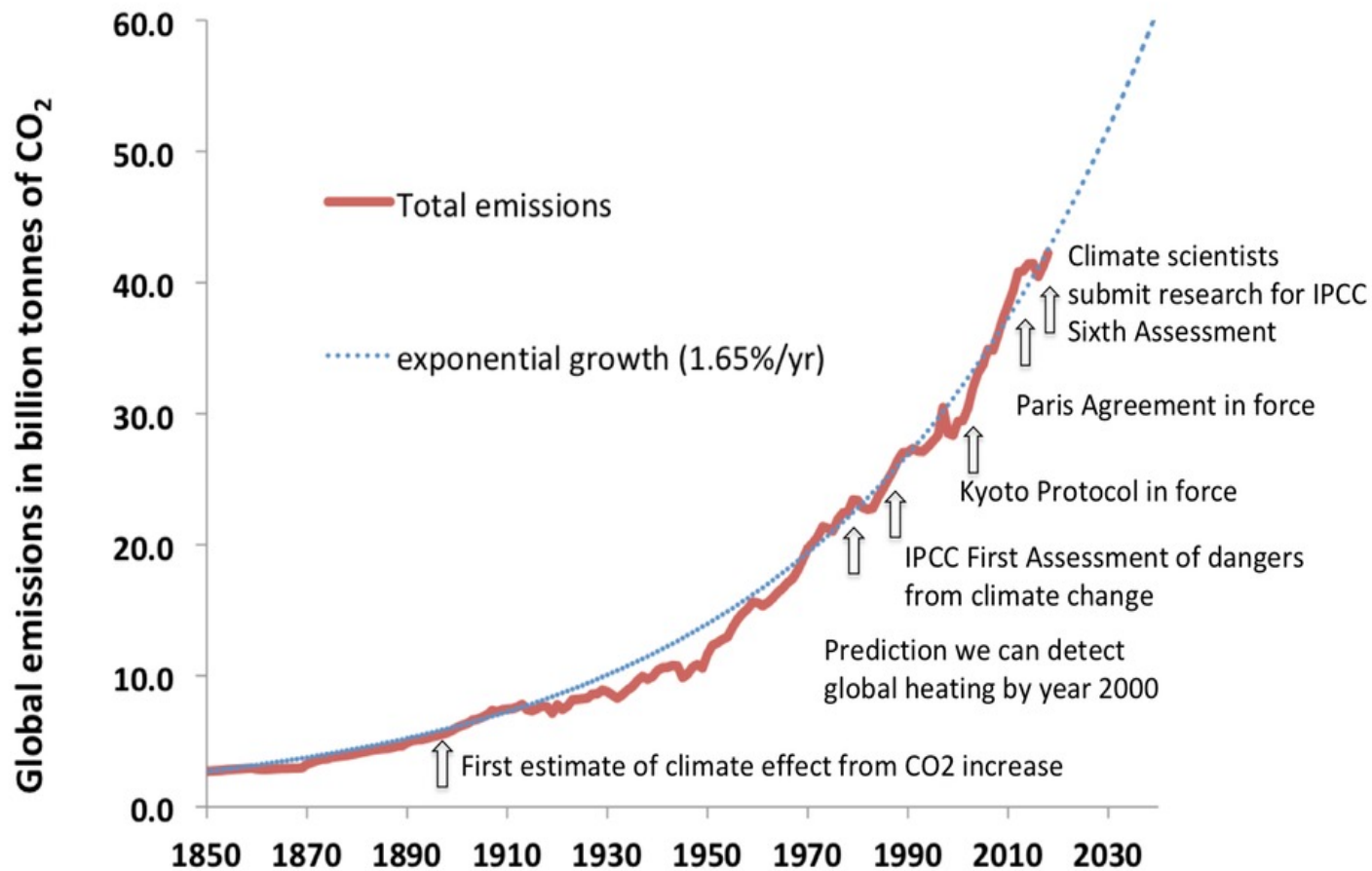
The science about this is now crystal clear

# The Carbon Bathtub



Overall framing by Dr. John Sterman, MIT Sloan

Source: @CarbonInteractive



Source: Wolfgang Knorr, in The Conversation (2019)



# SIXTH ASSESSMENT REPORT

Working Group I – The Physical Science Basis

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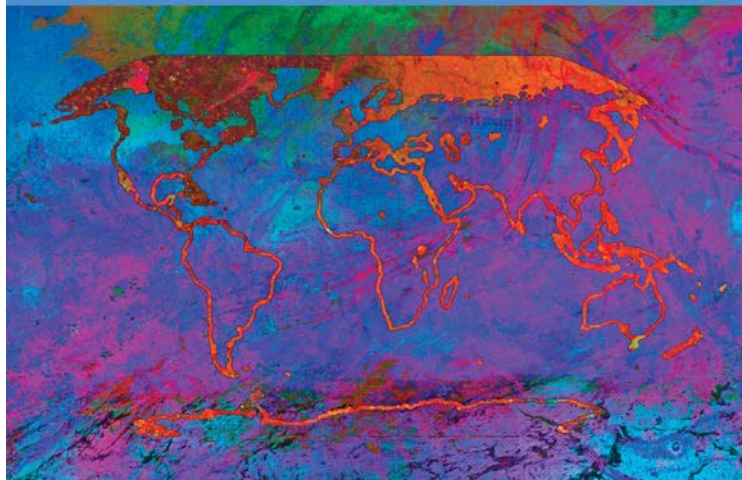
INTERGOVERNMENTAL PANEL ON climate change



## Climate Change 2021

### The Physical Science Basis

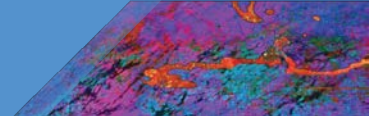
Summary for Policymakers



WGI

Working Group I contribution to the  
Sixth Assessment Report of the  
Intergovernmental Panel on Climate Change





## BY THE NUMBERS

### Author Team

**234** authors from **65** countries

**28%** women, **72%** men

**30%** new to the **IPCC**

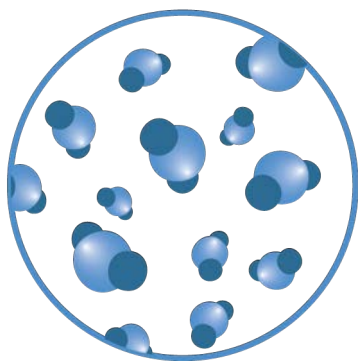
### Review Process

**14,000** scientific publications  
assessed

**78,000+** review comments

**46** countries commented on Final  
Government Distribution

**CO<sub>2</sub>**  
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**

# Progression of Understanding: Greater and Greater Certainty in Attribution

AR1 (1990): “unequivocal detection not likely for a decade”

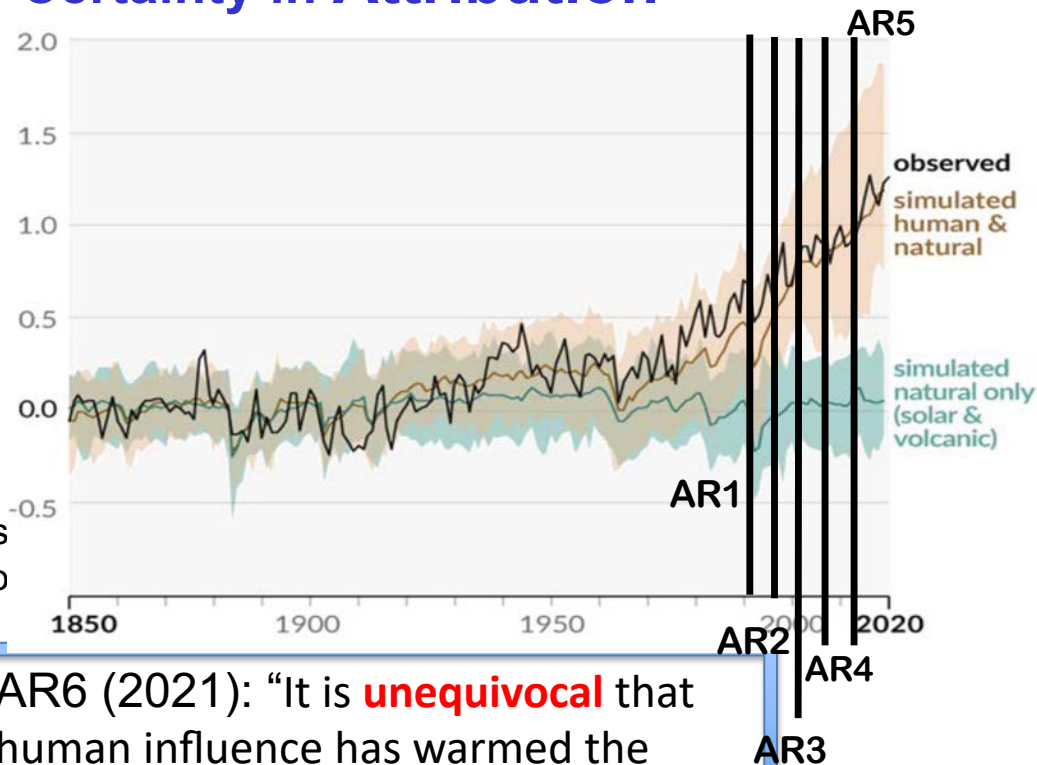
AR2 (1995): “balance of evidence suggests **discernible** human influence”

AR3 (2001): “most of the warming of the past 50 years is **likely** (odds 2 out of 3) due to human activities”

AR4 (2007): “most of the warming is **very likely** (odds 9 out of 10) due to greenhouse gases”

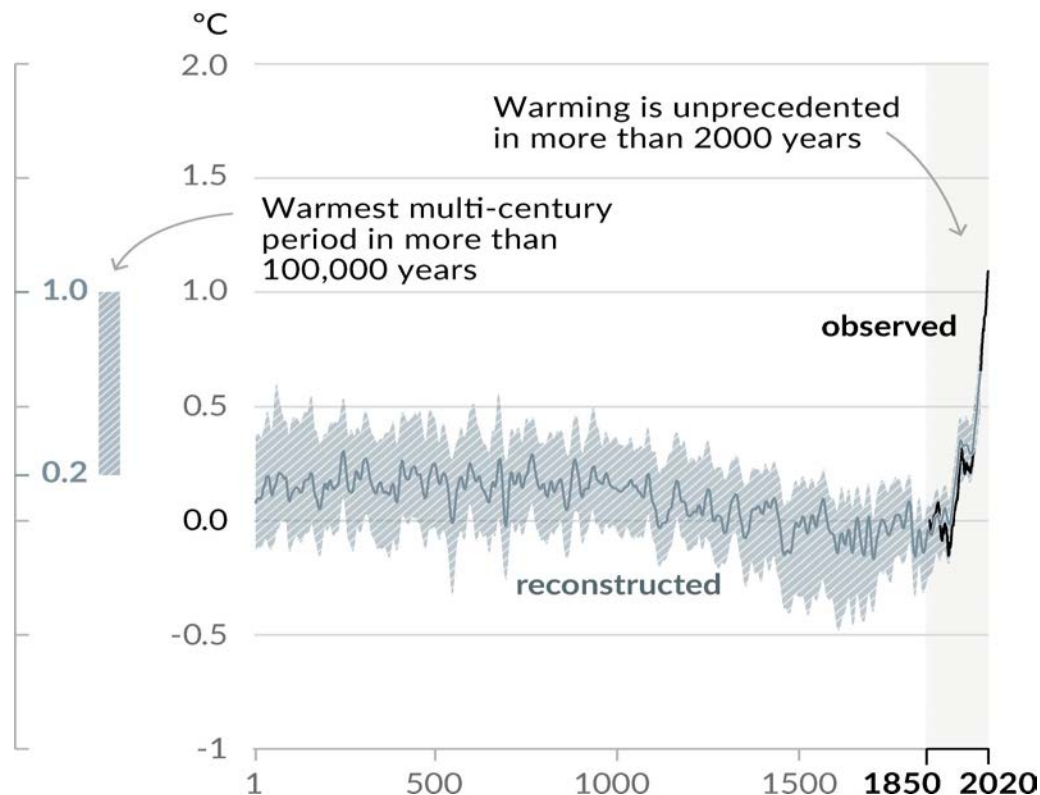
AR5 (2013) «It is **extremely likely** (odds 95 out of 100) that human influence has been the dominant cause... »

AR6 (2021): “It is **unequivocal** that human influence has warmed the atmosphere, ocean, and land.”



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

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



*Figure SPM.1*



## 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

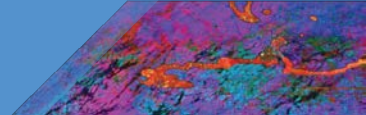


**Ocean**

Warming

Acidifying

Losing oxygen



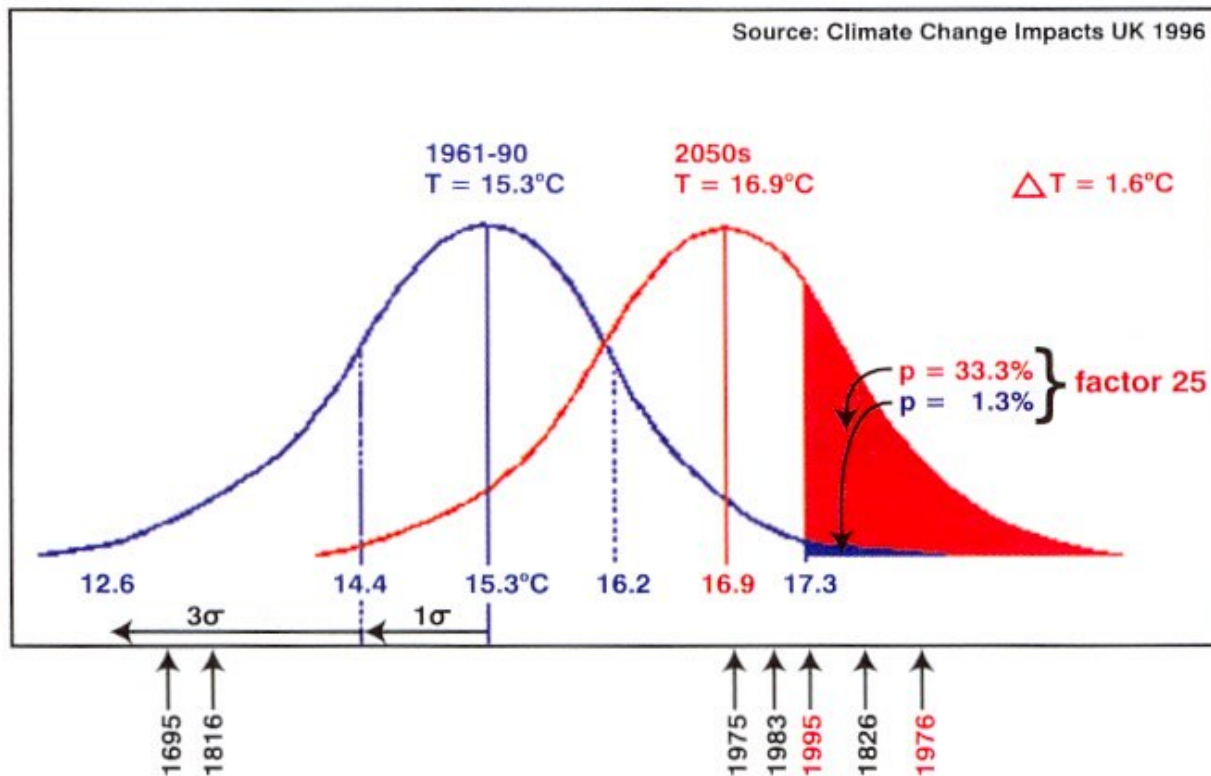
## **A.3 Human-induced climate change is already affecting many weather and climate extremes in every region across the globe**

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





# Heat waves kill (Ex: 2003 summer in EU: 70000 deaths)



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

# SIXTH ASSESSMENT REPORT

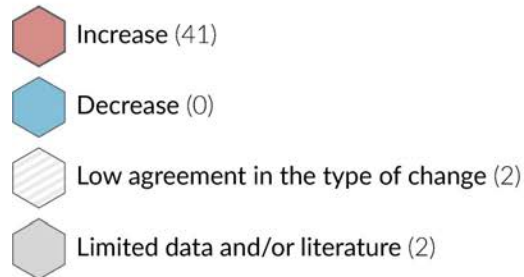
Working Group I – The Physical Science Basis

Climate change is already affecting every inhabited region across the globe, with human influence contributing to many observed changes in weather and climate extremes

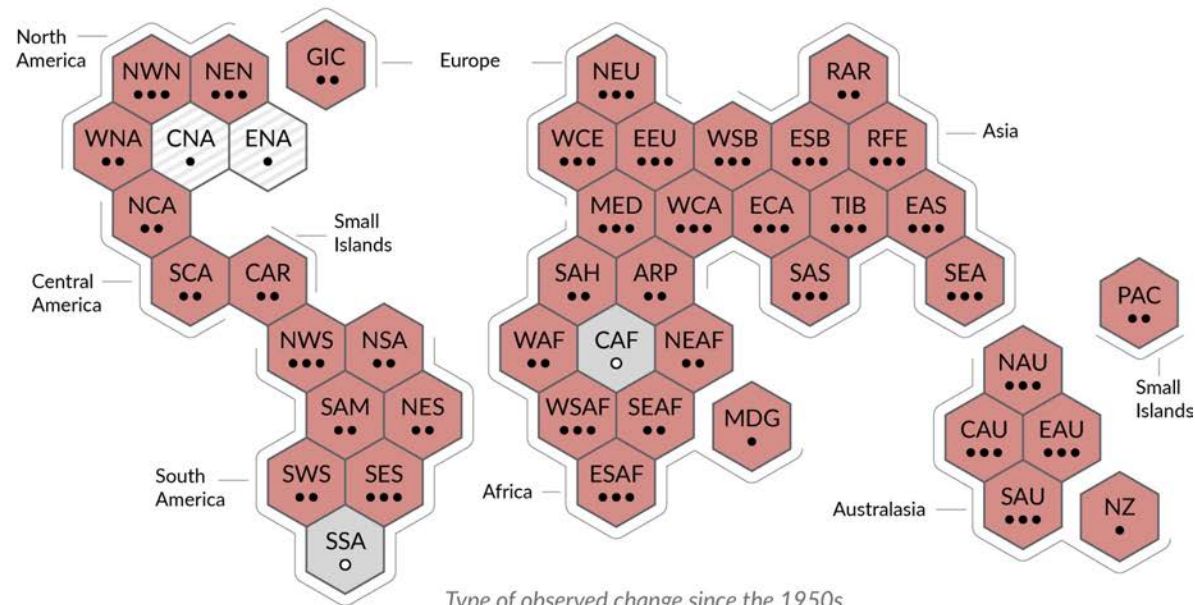
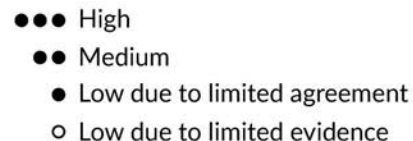
Figure SPM.3

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



Confidence in human contribution to the observed change



Type of observed change since the 1950s

**WARMER AIR**



**MORE EVAPORATION**



**MORE PRECIPITATION**

**Available  
water**

1°C  
7%

**increase =  
more water vapor**

**- Temperature +**

# SIXTH ASSESSMENT REPORT

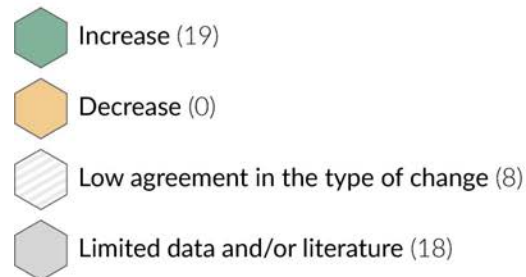
Working Group I – The Physical Science Basis

**Climate change is already affecting every inhabited region across the globe, with human influence contributing to many observed changes in weather and climate extremes**

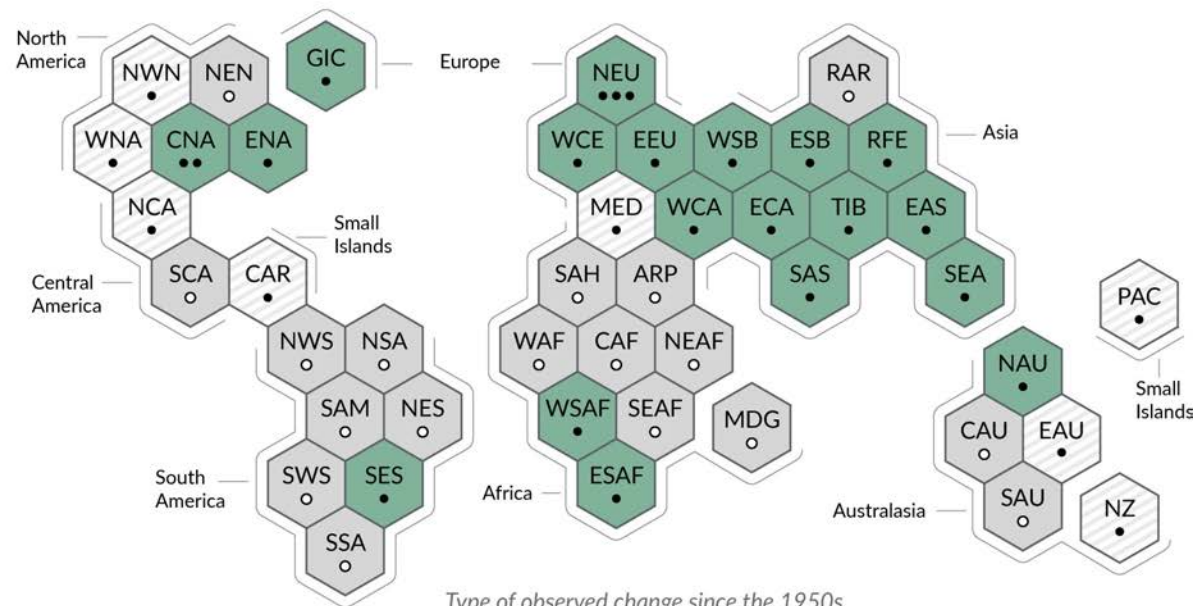
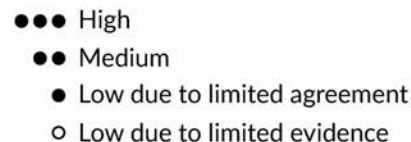
*Figure SPM.3*

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



Confidence in human contribution to the observed change



Type of observed change since the 1950s



## Wallonia Floods, July 2021



Source:  
VRT Nieuws

# SIXTH ASSESSMENT REPORT

Working Group I – The Physical Science Basis

**Climate change is already affecting every inhabited region across the globe, with human influence contributing to many observed changes in weather and climate extremes**

Figure SPM.3

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)

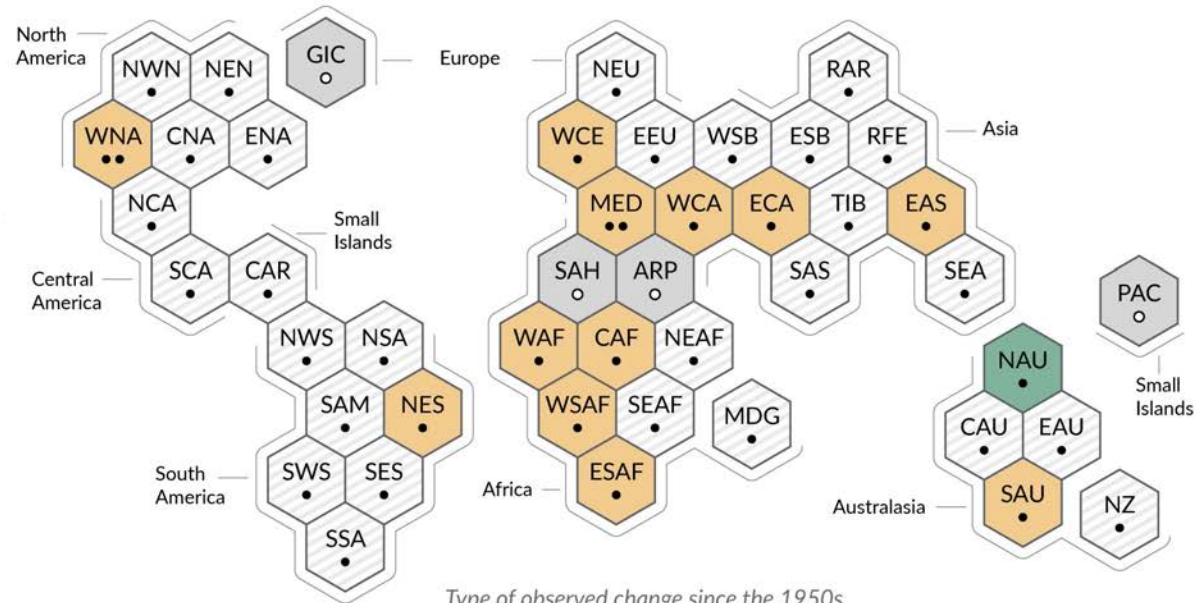
Confidence in human contribution  
to the observed change

●●● High

●● Medium

● Low due to limited agreement

○ Low due to limited evidence



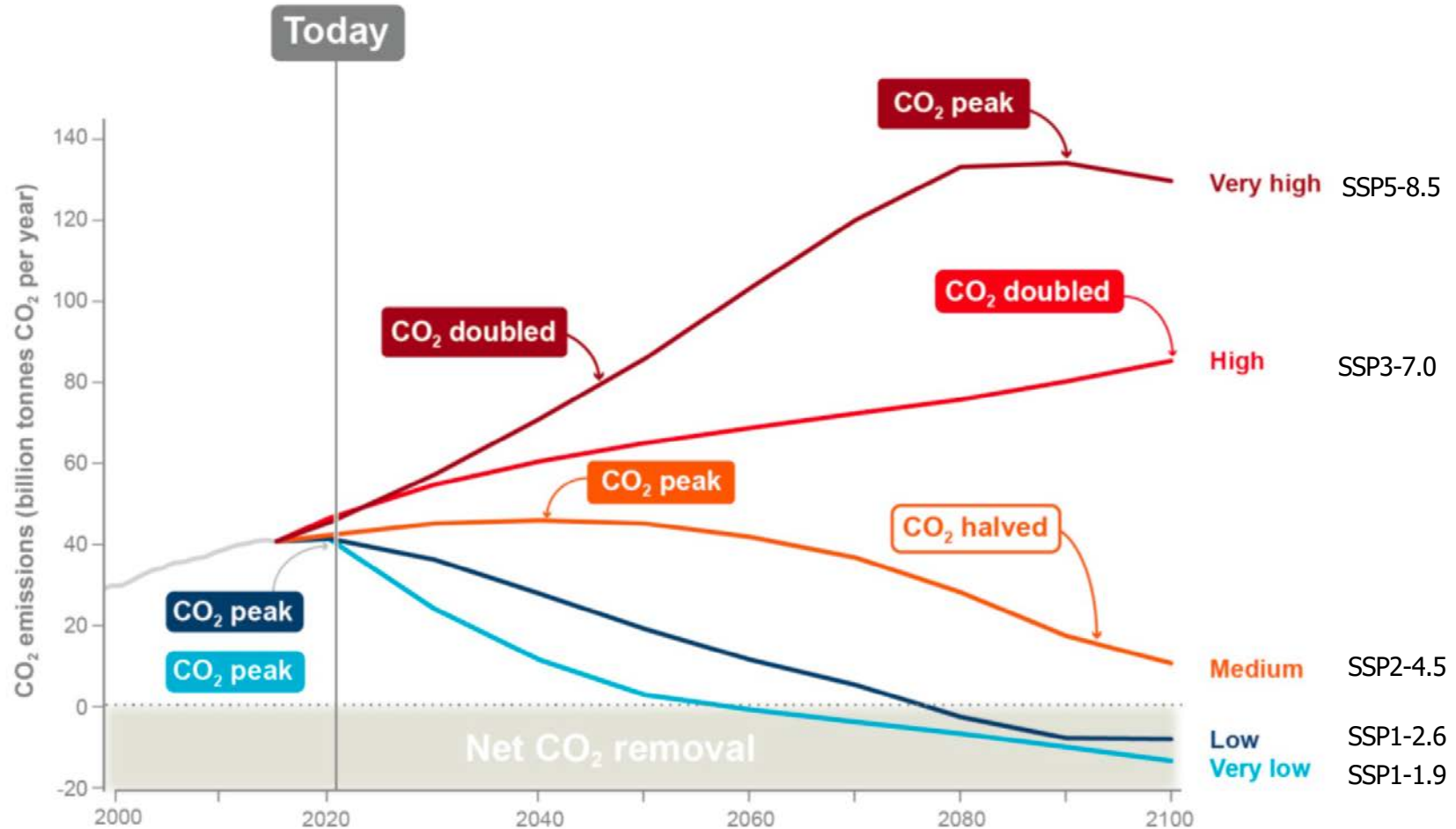
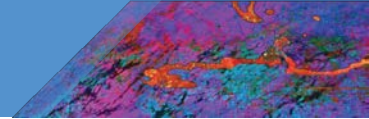
Type of observed change since the 1950s

# SIXTH ASSESSMENT REPORT

Working Group I – The Physical Science Basis

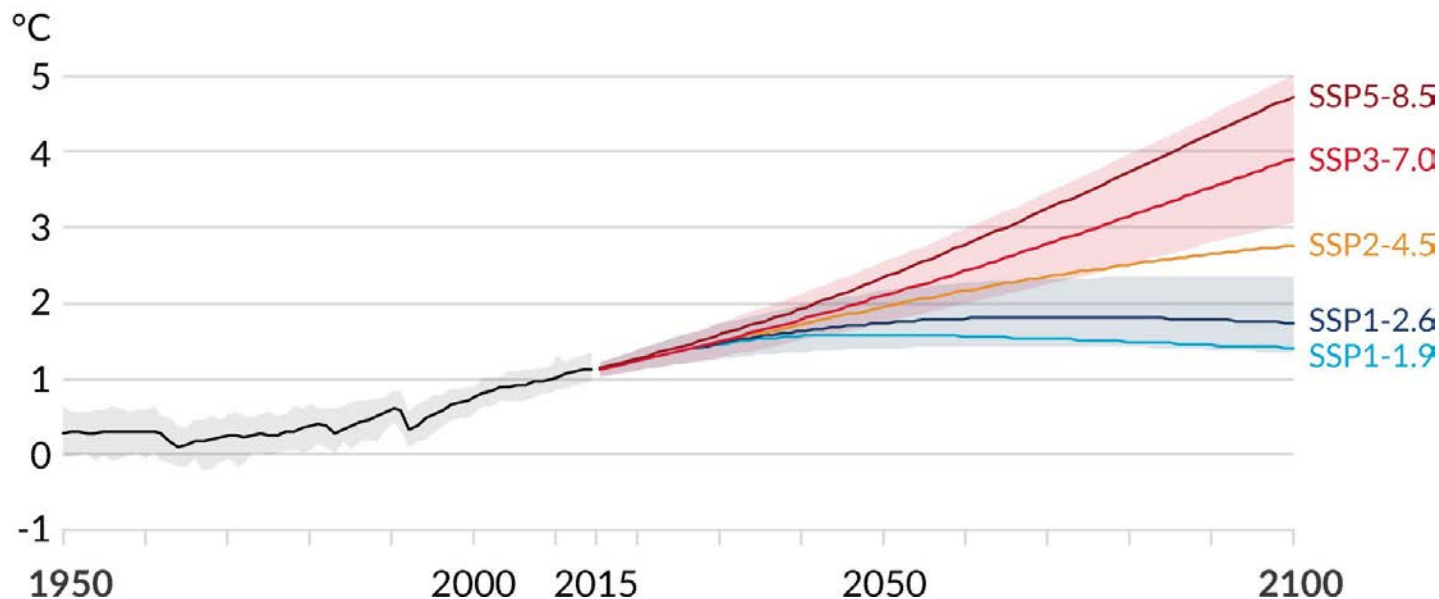
ipcc

INTERGOVERNMENTAL PANEL ON climate change



## Human activities affect all the major climate system components, *Figure SPM.8* with some responding over decades and others over centuries

a) Global surface temperature change relative to 1850-1900





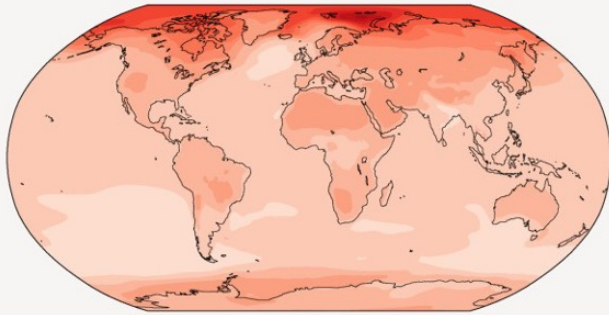
# SIXTH ASSESSMENT REPORT

Working Group I – The Physical Science Basis

**Across warming levels, land areas warm more than oceans, and the Arctic and Antarctica warm more than the tropics**

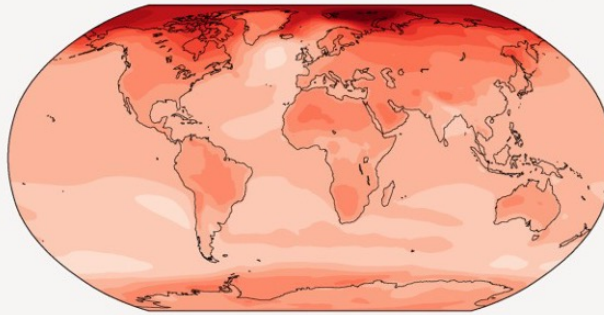
**+1.5°C**

Simulated change at 1.5 °C global warming



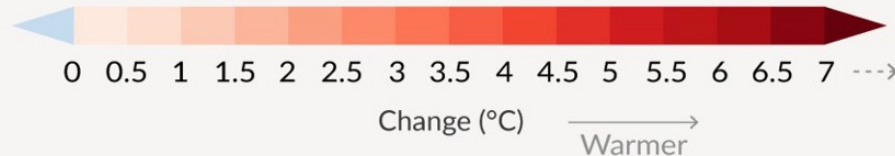
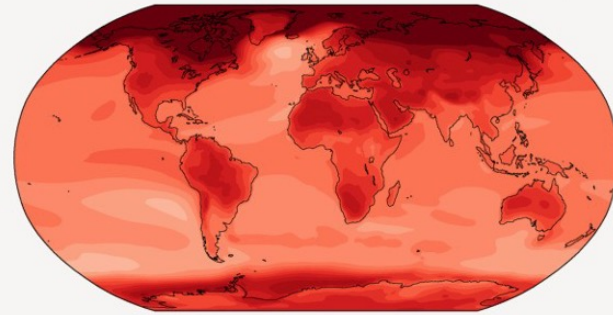
**+2°C**

Simulated change at 2 °C global warming



**+4°C**

Simulated change at 4 °C global warming

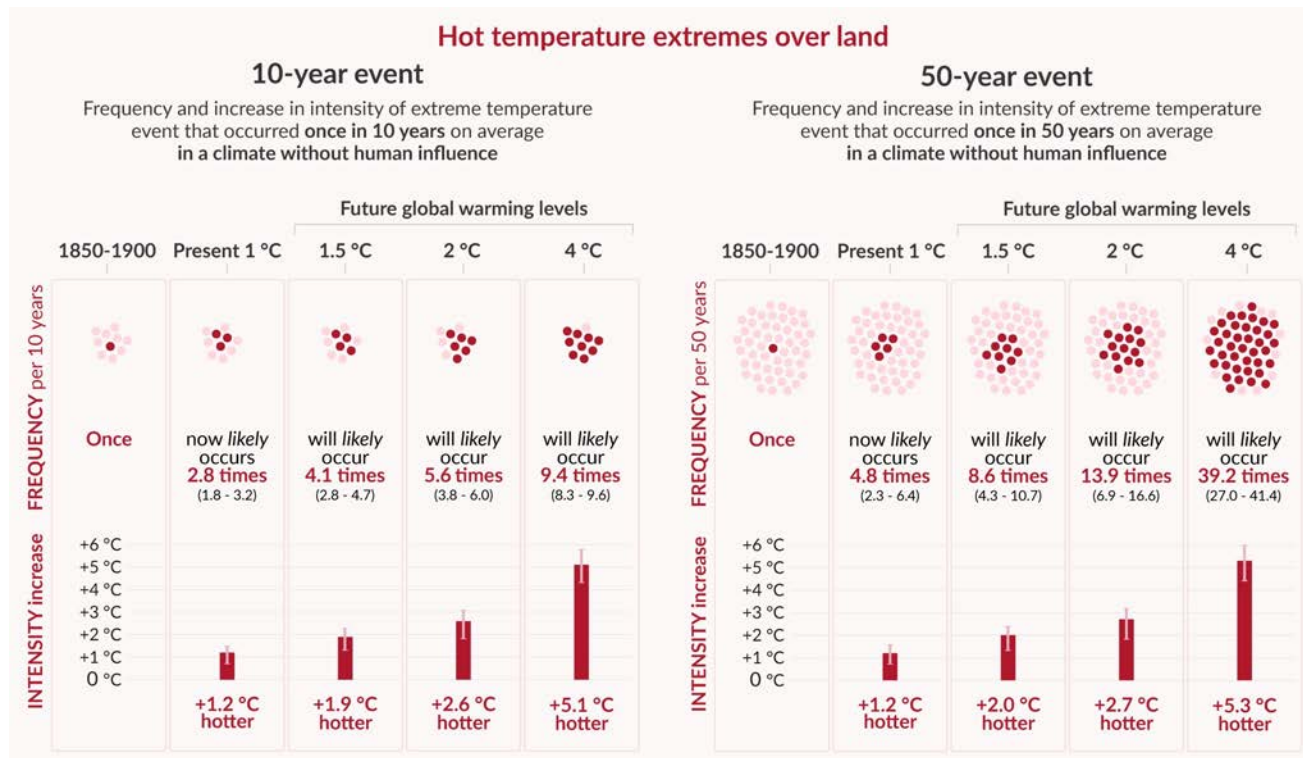


# SIXTH ASSESSMENT REPORT

Working Group I – The Physical Science Basis

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

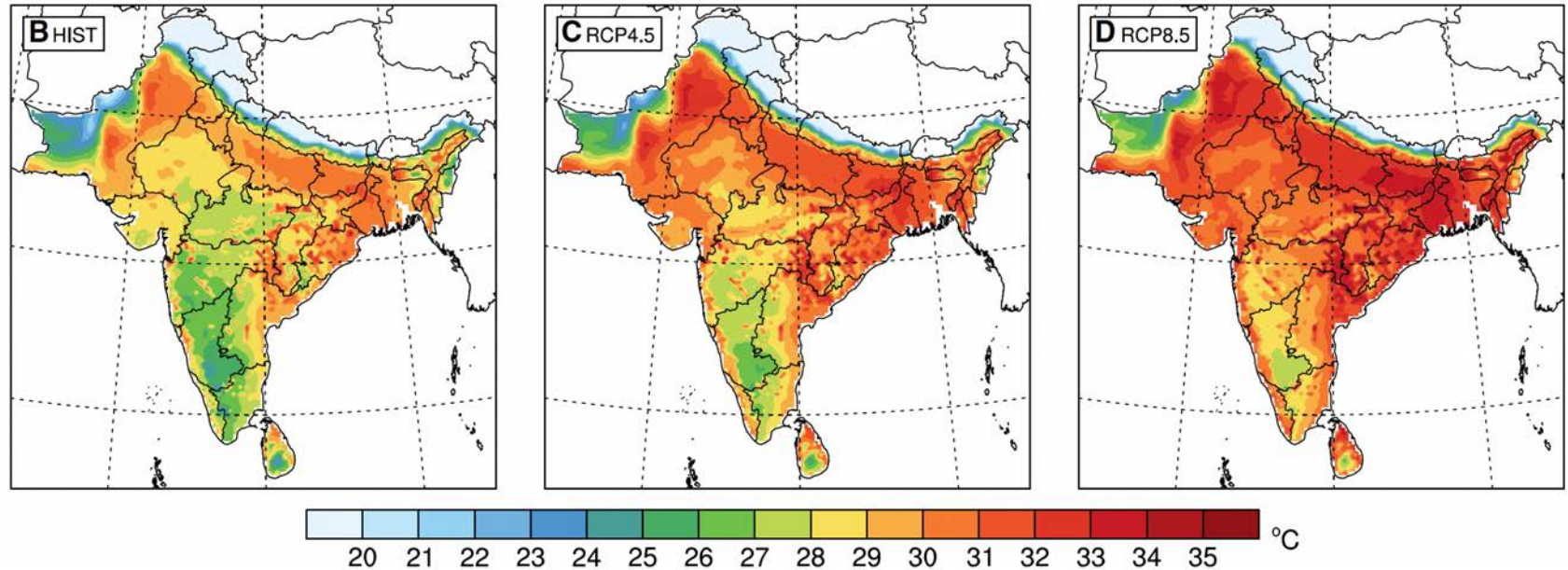
Figure SPM.6



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

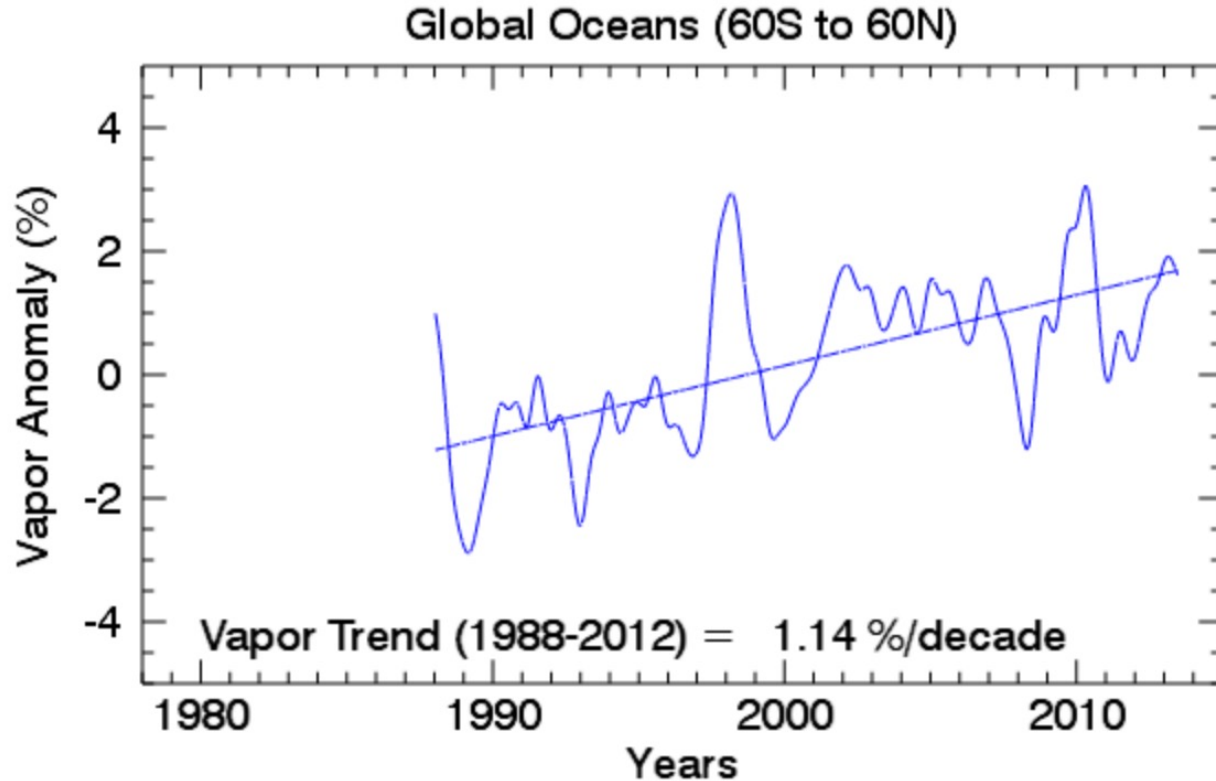
- « Human exposure to TW of around 35°C for even a few hours will result in death even for the fittest of humans under shaded, well-ventilated conditions »
- « Under the RCP4.5 scenario, no regions are projected to exceed 35°C; however, vast regions of South Asia are projected to experience episodes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

# 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).

# Total Column Water Vapor Over Ocean





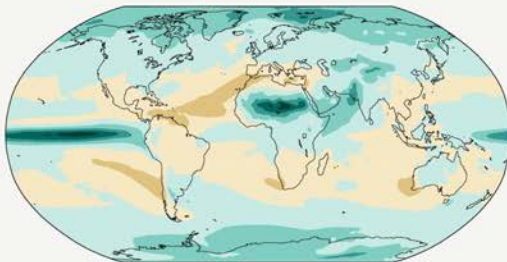
## With every increment of global warming, changes get larger in regional mean temperature, precipitation and soil moisture

Figure SPM.5

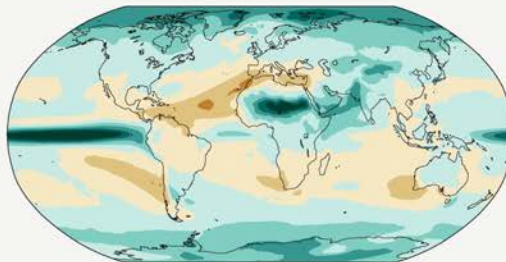
### c) Annual mean precipitation change (%) relative to 1850-1900

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.

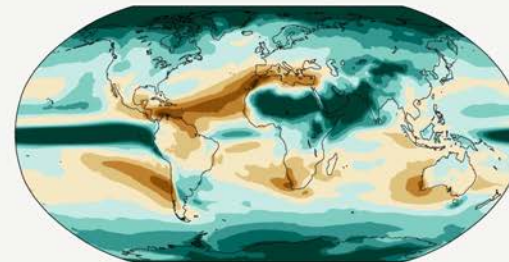
Simulated change at 1.5 °C global warming



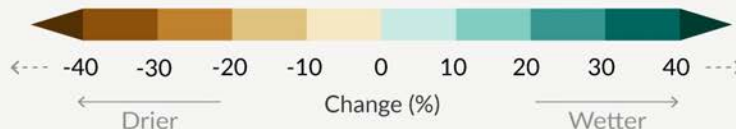
Simulated change at 2 °C global warming



Simulated change at 4 °C global warming



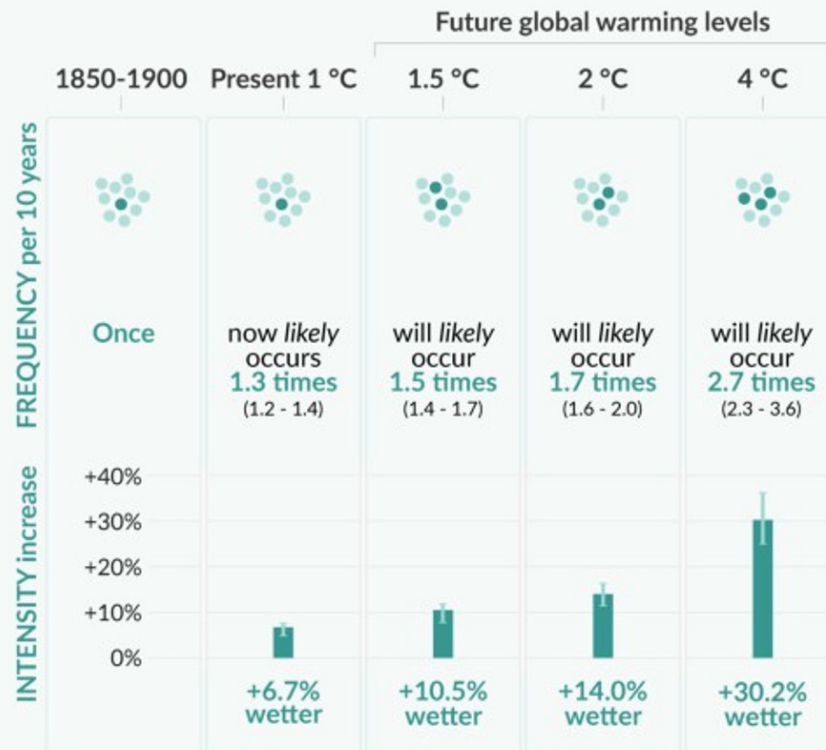
Relatively small absolute changes may appear as large % changes in regions with dry baseline conditions



## Heavy precipitation over land

### 10-year event

Frequency and increase in intensity of heavy 1-day precipitation event that occurred **once in 10 years** on average in a climate without human influence

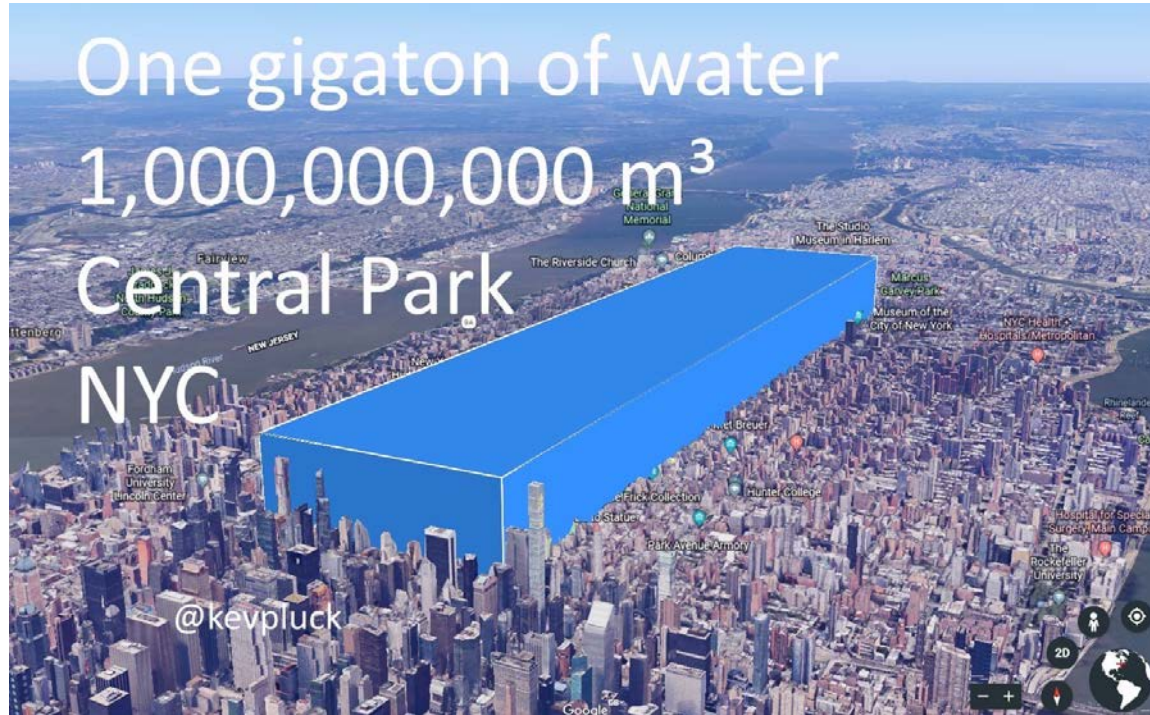


**Fact: Average temperature is on its way to exceed the « conservation temperature » for the Greenland and (some of the) Antarctic ice sheet**

There is therefore a very high risk that average sea level would increase by several metres over the next century or two



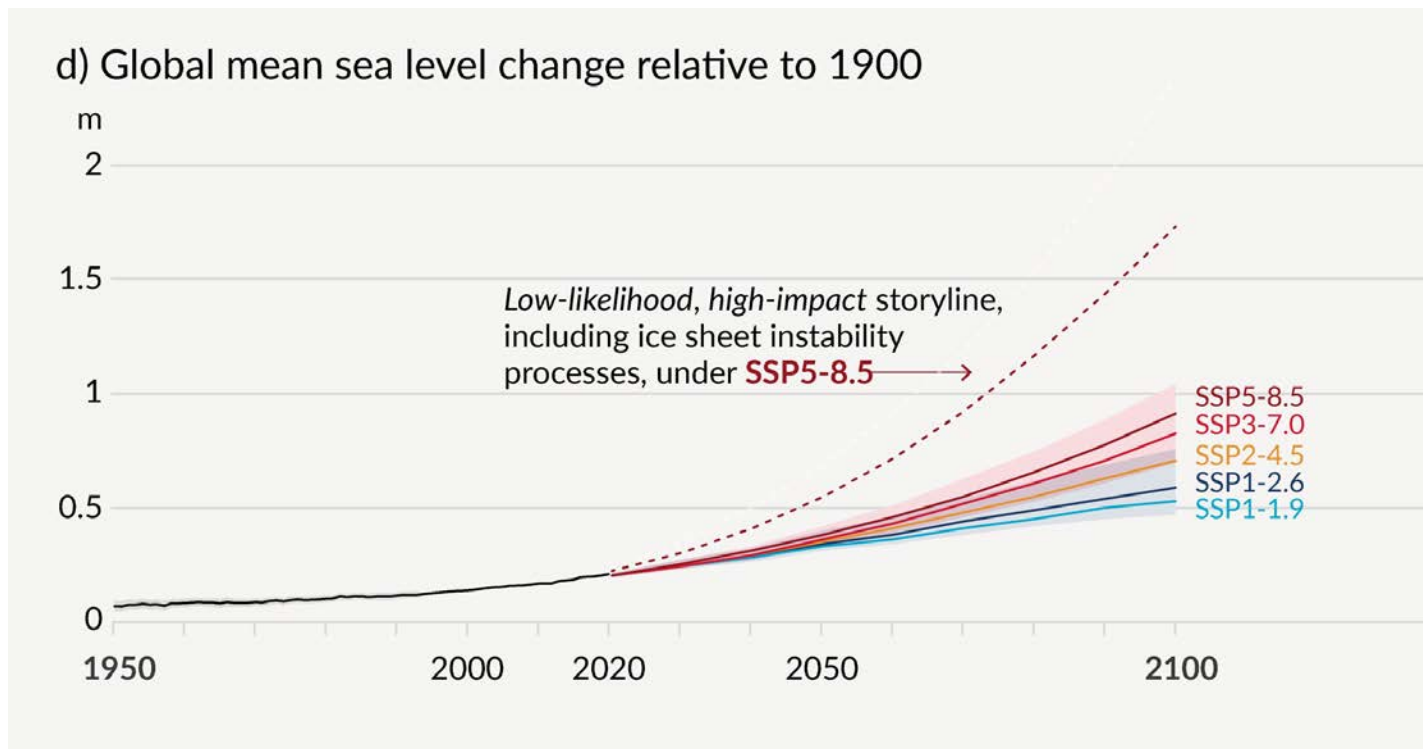
**The Antarctic Ice Sheet presently loses 1 Gt of ice every 1.5 day**



Source: @Kevpluck, June 2018

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

Figure SPM.8

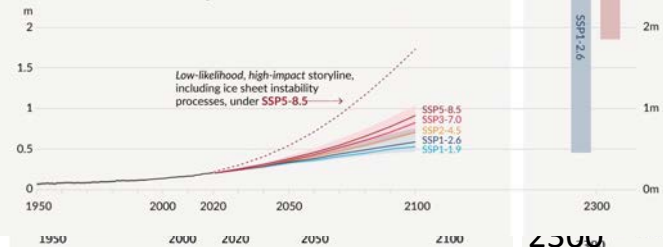


# SIXTH ASSESSMENT REPORT

Working Group I – The Physical Science Basis

« Sea level rise **greater than 15 m** cannot be ruled out with high emissions »

d) Global mean sea level change relative to 1900



e) Global mean sea level change in 2300 relative to 1900

Sea level rise greater than 15m cannot be ruled out with high emissions



7 m

2 m

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

Figure SPM.9

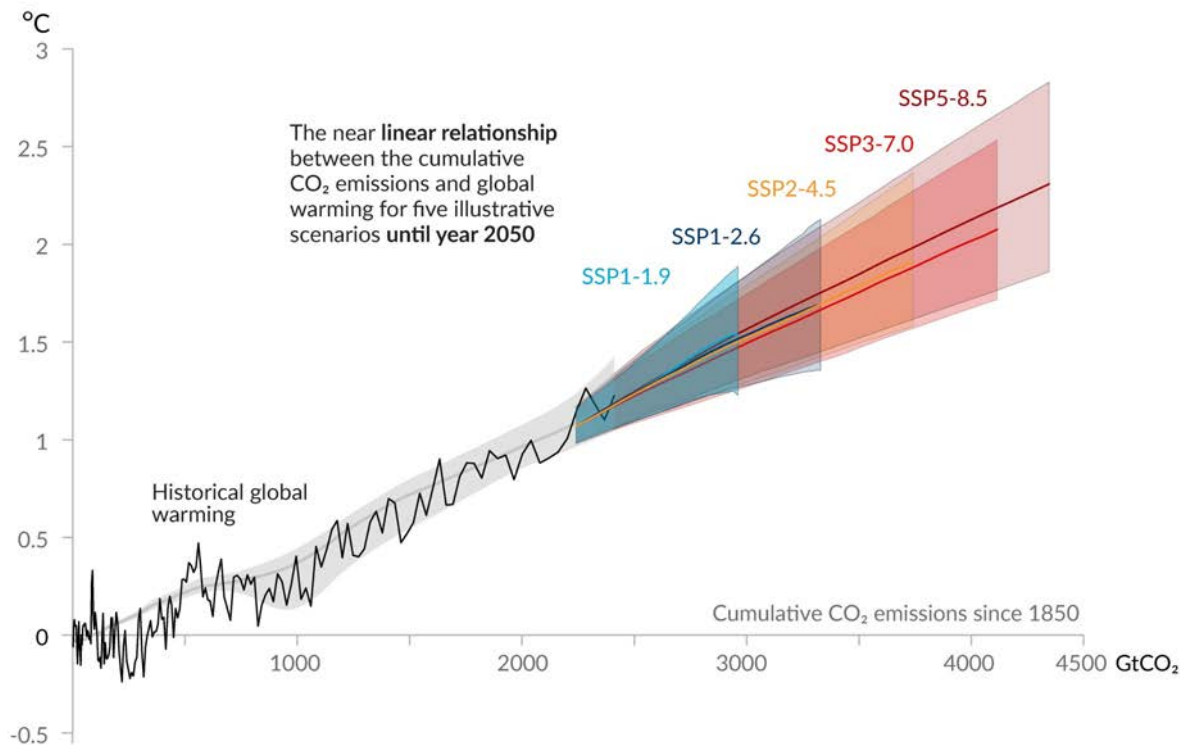
Number of land & coastal regions (a) and open-ocean regions (b) where each climatic impact-driver (CID) is projected to **increase** or **decrease** with **high confidence** (dark shade) or **medium confidence** (light shade)



## Every tonne of CO<sub>2</sub> emissions adds to global warming

Figure SPM.10

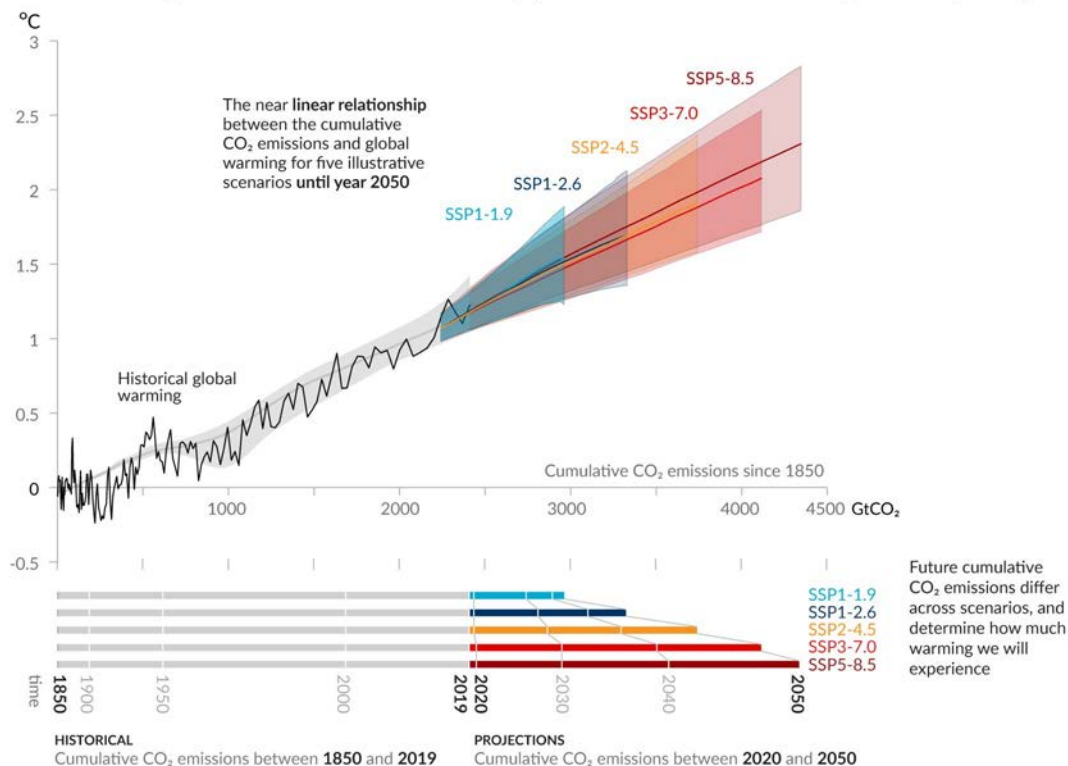
Global surface temperature increase since 1850-1900 (°C) as a function of cumulative CO<sub>2</sub> emissions (GtCO<sub>2</sub>)



# Every tonne of CO<sub>2</sub> emissions adds to global warming

Figure SPM.10

Global surface temperature increase since 1850-1900 (°C) as a function of cumulative CO<sub>2</sub> emissions (GtCO<sub>2</sub>)

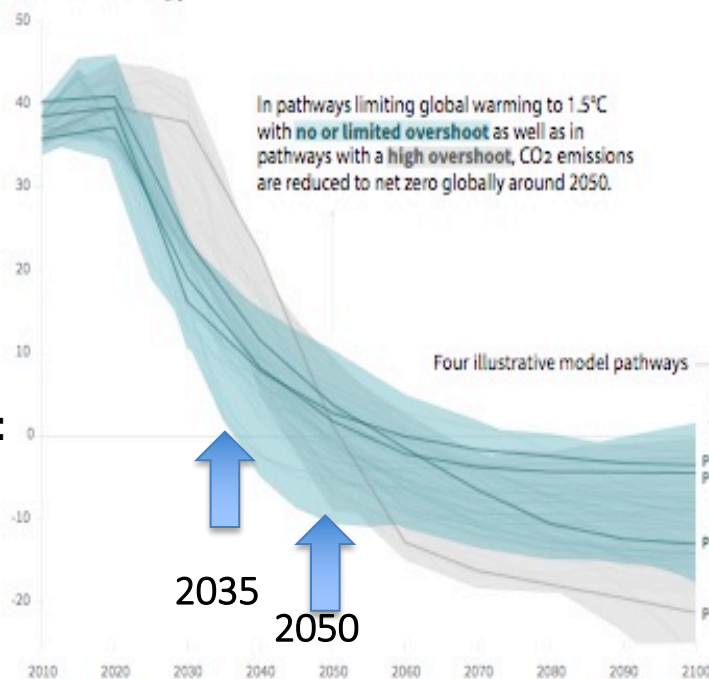




# Emission pathways compatible with below 1.5° C warming:

## Global total net CO<sub>2</sub> emissions

Billion tonnes of CO<sub>2</sub>/yr



**Net ZERO:**

### Timing of net zero CO<sub>2</sub>

Line widths depict the 5-95th percentile and the 25-75th percentile of scenarios



Pathways limiting global warming to 1.5°C with no or low overshoot

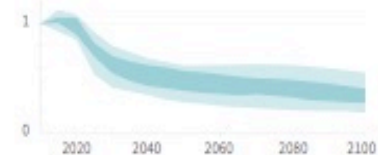
Pathways with high overshoot

Pathways limiting global warming below 2°C (Not shown above)

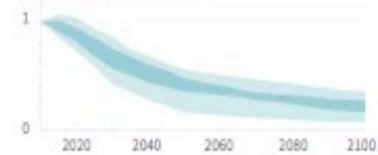
## Non-CO<sub>2</sub> emissions relative to 2010

Emissions of non-CO<sub>2</sub> forcings are also reduced or limited in pathways limiting global warming to 1.5°C with no or limited overshoot, but they do not reach zero globally.

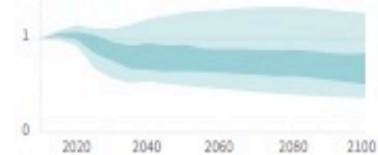
### Methane emissions



### Black carbon emissions

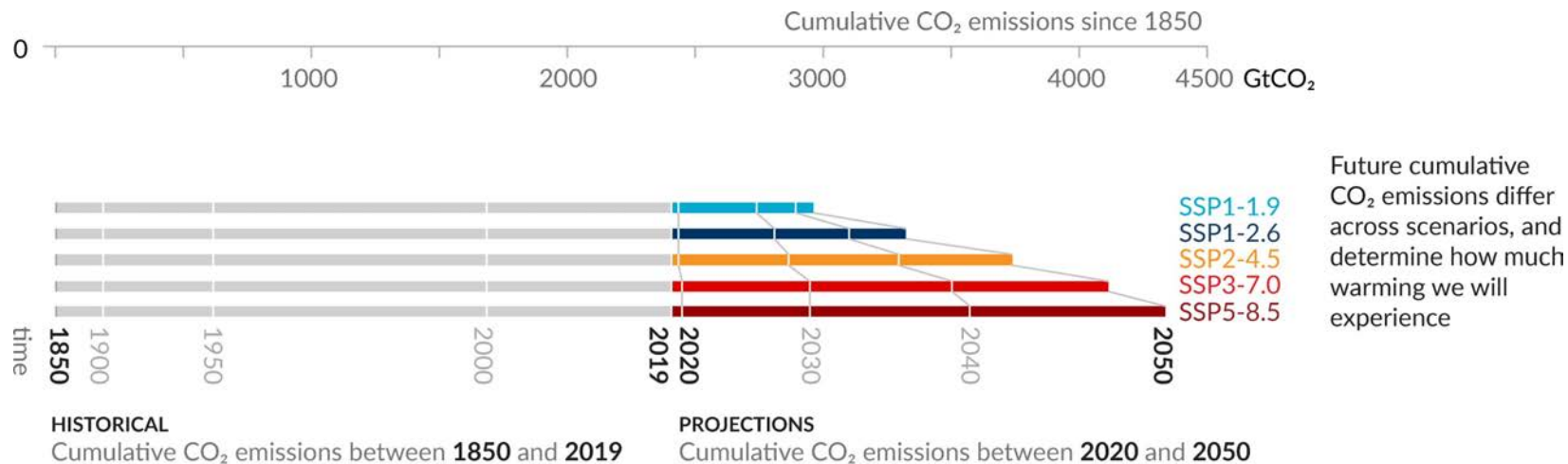


### Nitrous oxide emissions



## Every tonne of CO<sub>2</sub> emissions adds to global warming

Figure SPM.10





**Fact: It might become much worse,  
but the future climate is in our  
hands**



# SUSTAINABLE DEVELOPMENT GOALS



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



Disponible gratuitement, 6X/an: [www.plateforme-wallonne-giec.be](http://www.plateforme-wallonne-giec.be)

Gratuit sur  
[www.levif.be/reveil-climatique](http://www.levif.be/reveil-climatique)

Le réveil climatique

JEAN-PASCAL VAN YPERSELE - DIRK DRAULANS

LE VIF



LE VIF

# CLIMAT : ÉTAT D'URGENCE POURQUOI IL N'Y A PLUS DE TEMPS À PERDRE

JEAN-PASCAL VAN YPERSELE - DIRK DRAULANS



# DAT POLITICI OVER TWINTIG JAAR NIET KOMEN JANKEN DAT ZE HET NIET WISTEN.



**DIRK DRAULANS**

(1956) is bioloog, doctor in de wetenschappen en was gastonderzoeker aan de University of Oxford. Sinds 1987 is hij journalist bij Knack.



**JEAN-PASCAL  
VAN YPERSELE (1957)**

is fysicus en klimatoloog. Hij is hoogleraar klimatologie en milieuwetenschappen aan de UCLouvain en was ondervoorzitter van het Intergovernmental Panel on Climate Change (IPCC).

BIJLAGE BIJ KNACK VAN 16 SEPTEMBER 2020. MAG NIET LOS VERKOCHT WORDEN.

# HET KLIMAAT ALARM

Dirk Draulans en  
Jean-Pascal van Ypersele



**Knack**

HET KLIMAATALARM

Gratis op  
[www.knack.be/klimaatalarm](http://www.knack.be/klimaatalarm)

# To go further :

- [www.climate.be/vanyp](http://www.climate.be/vanyp) : my slides (under « conferences)
- [www.ipcc.ch](http://www.ipcc.ch) : IPCC
- [www.realclimate.org](http://www.realclimate.org) : answers to the merchants of doubt arguments
- [www.skepticalscience.com](http://www.skepticalscience.com) : same
- [www.plateforme-wallonne-giec.be](http://www.plateforme-wallonne-giec.be) : IPCC-related in French, Newsletter, latests on SR15, basic climate science
- **Twitter: @JPvanYpersele & @IPCC\_CH**



# Site where my slides will be available:



- [www.climate.be/vanyp/conferences](http://www.climate.be/vanyp/conferences)

- **Twitter: @JPvanYpersele**  
**@IPCC\_CH**