



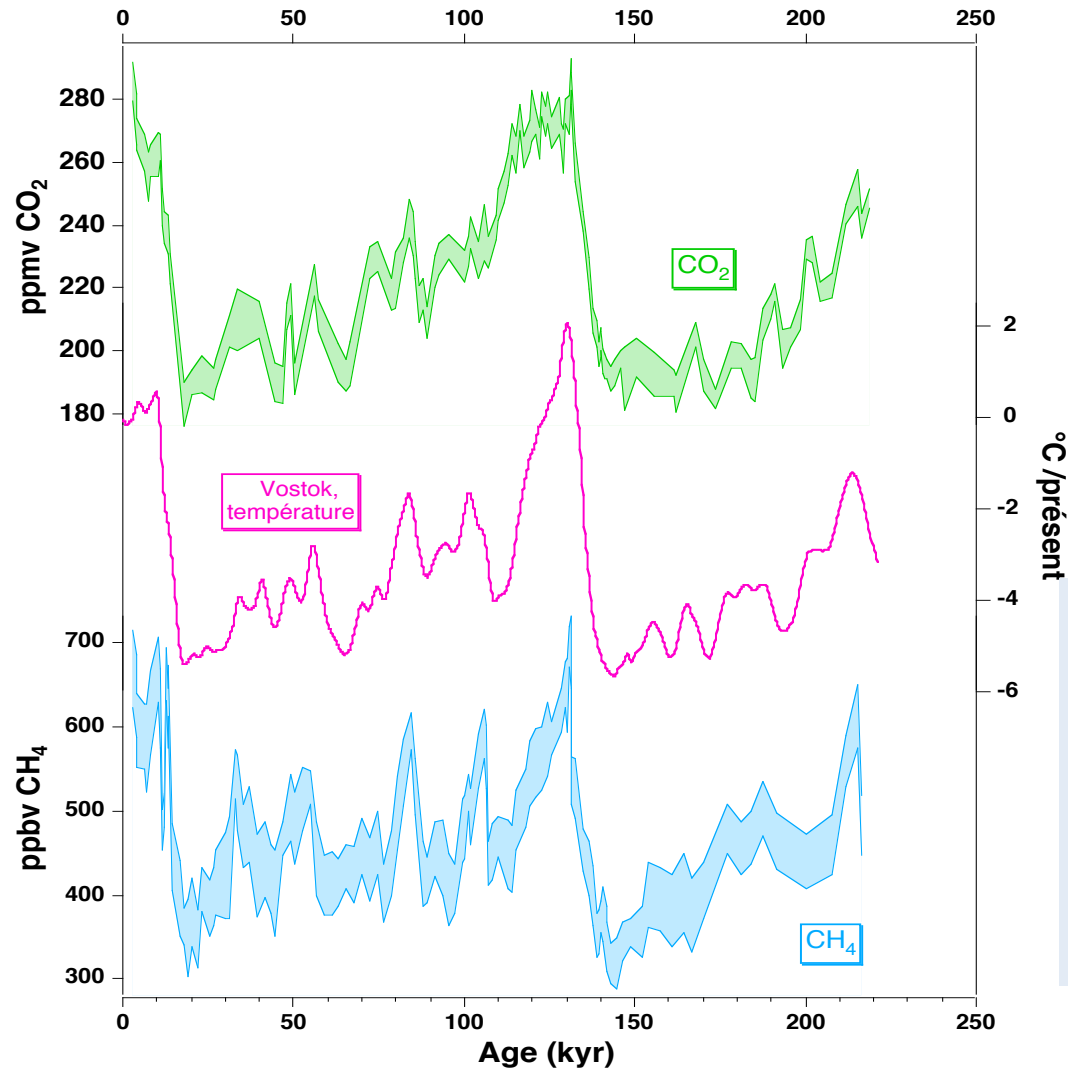
Global warming

**The need for a new model of development
and the key role of higher education**

Jean Jouzel,

**Vice-chair of IPCC WK1 from 2002 to 2015,
Emeritus research director at CEA (LSCE/IPSL)**

Awareness dates from the 70s and 80s thanks to climate modellers
Climate sensitivity (CO₂ doubling) between 1.5 et 4.5°C



Deep drilling in Antarctica Vostok (1987)

- Confirmation of the major role of insolation changes
- Link between greenhouse gases and climate (amplifier)

Intergovernmental Panel on Climate Change

Governments require information on climate change for negotiations (UNFCCC)

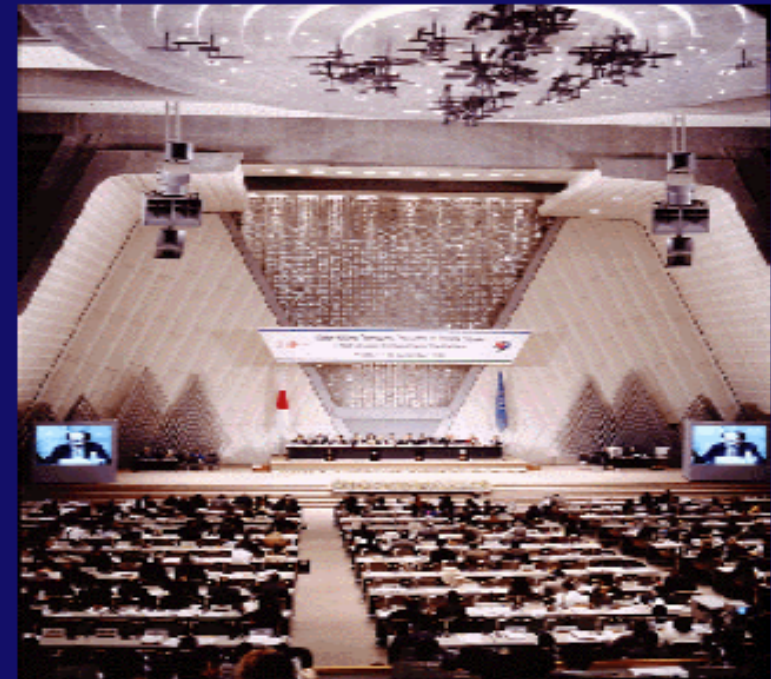
The IPCC formed in 1988 under auspices of the United Nations. Reports in 1990, 1995, 2001, 2007 and 2013 / 2014

Function is to provide assessments of the science of climate change. Bureau of 30 scientists (from 30 different countries)

Three groups Science, impacts and adaptation, mitigation

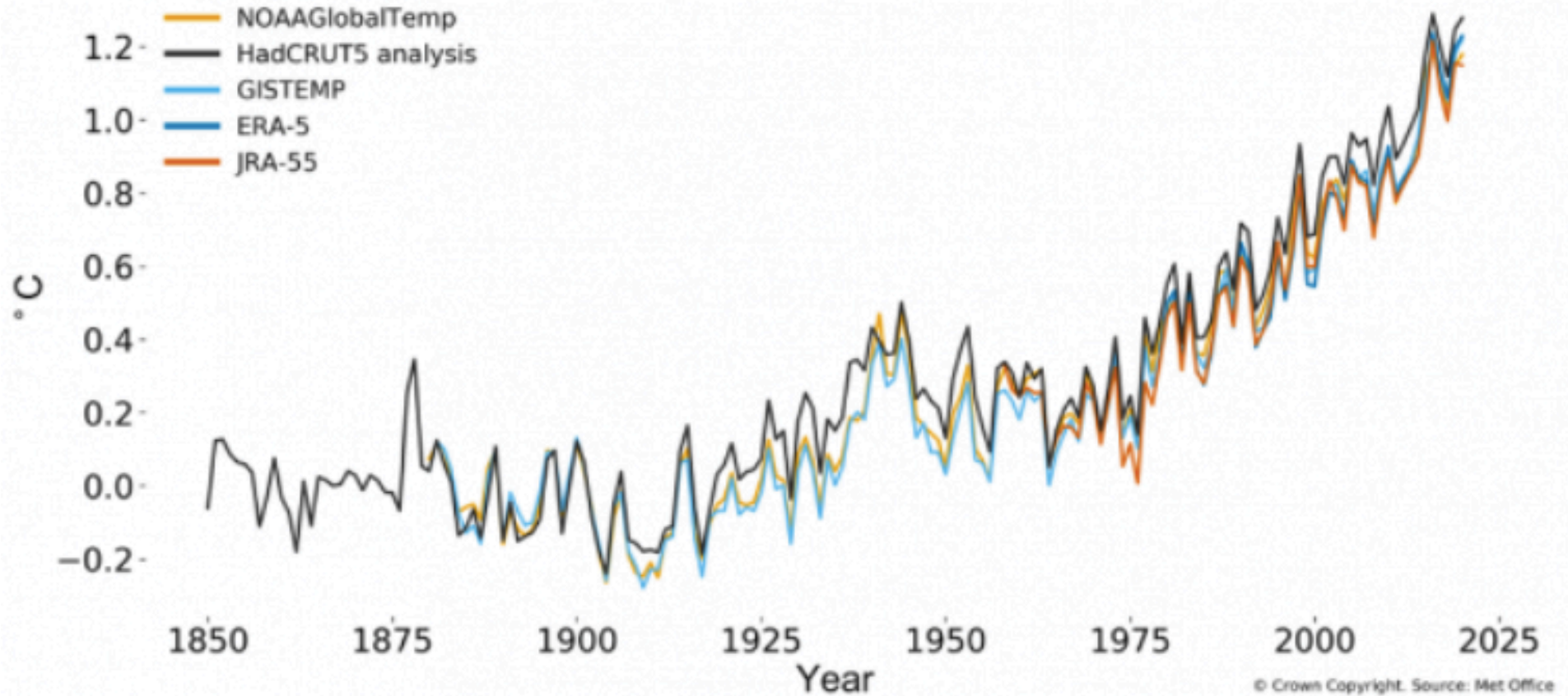
Scientific community contributes widely and on a voluntary basis.

Full report, technical summary and summary for policymakers (approved by government representatives) + Synthesis report



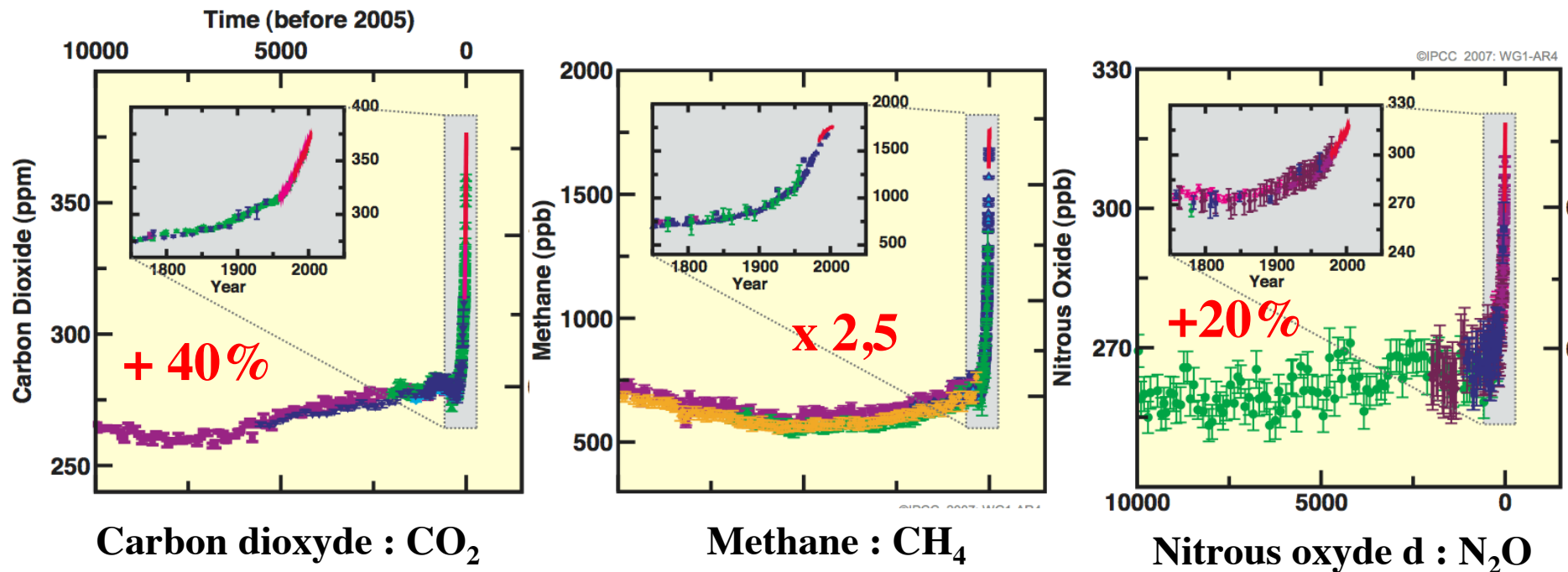
Where are we ? : Sixth report : 2021 - 2023

Global mean temperature difference from 1850-1900 (° C)



**The last 8 years have been
the warmest years since 1870**

Not a surprise



IN 2022 : 416 ppm

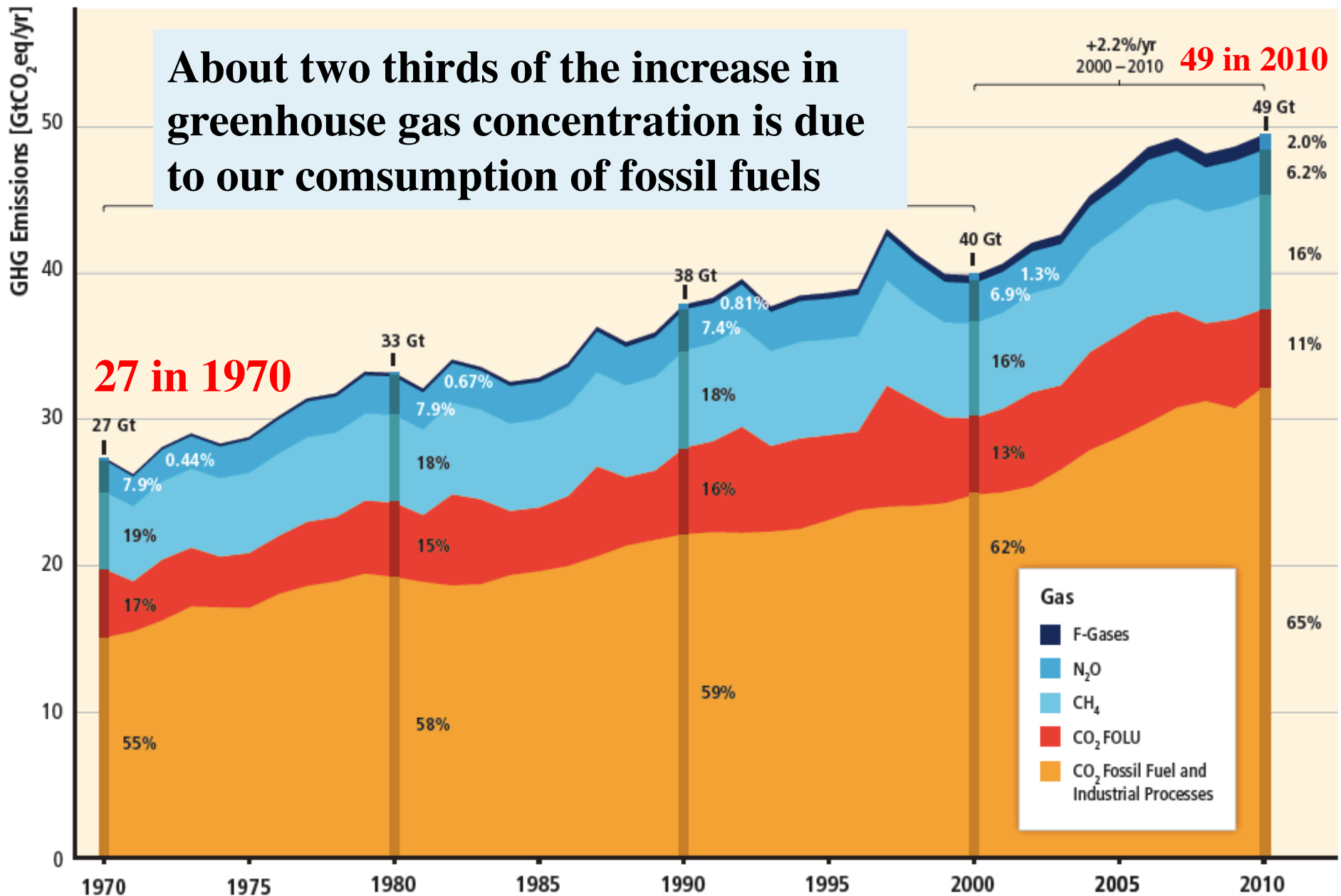
1908 ppb

335 ppb

- Since the beginning of the industrial era, human activities have led to an increase of greenhouse gases (GHG) which leads to an accumulation of heat in the climate system
- 2019 : CO₂ (fossils 37 GtC + deforestation 6 + cement 1 ~ 2) ; Other (CH₄, N₂O, .. ~ 12)
- Forcing due to GHG and aerosols has increased by ~ 1% (2,3 W/m²). This increase is due for large part to fossil fuels + agriculture

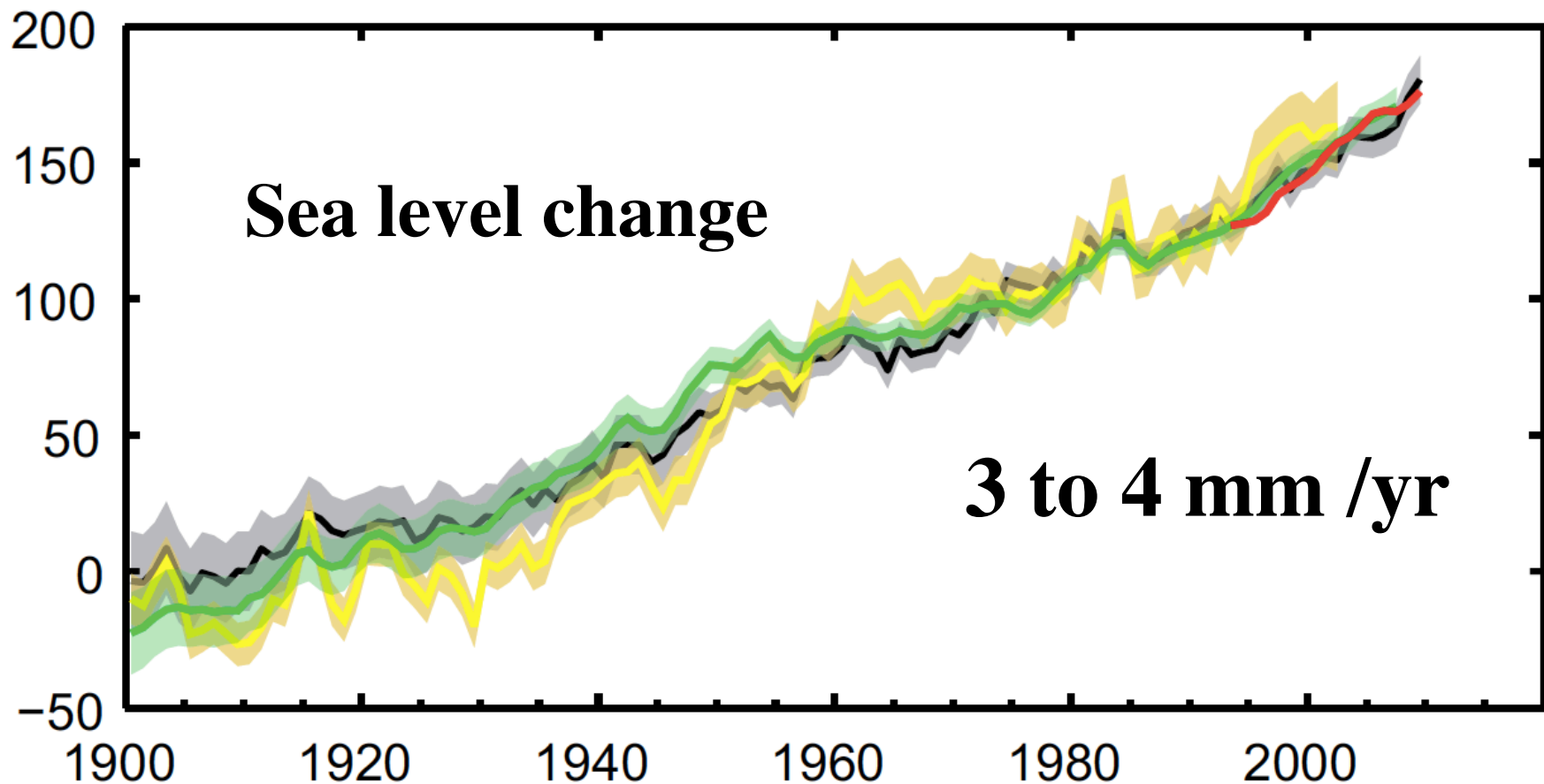
54 GtCO_{2eq} in 2019

Total Annual Anthropogenic GHG Emissions by Groups of Gases 1970–2010



93 % of this additional heat goes in the ocean

(Atmosphere : 1 % ; Cryosphere : 3 % , Continental surfaces : 3 %)



Warming is unequivocal and unprecedented
Entirely attributable to our activities (1.09 / 1.07°C)

Are human activities already modifying Earth' climate ?

IPCC (1990) Broad overview of climate change science, discussion of uncertainties and evidence for warming.

IPCC (1995) “The balance of evidence suggests a discernible human influence on global climate.”

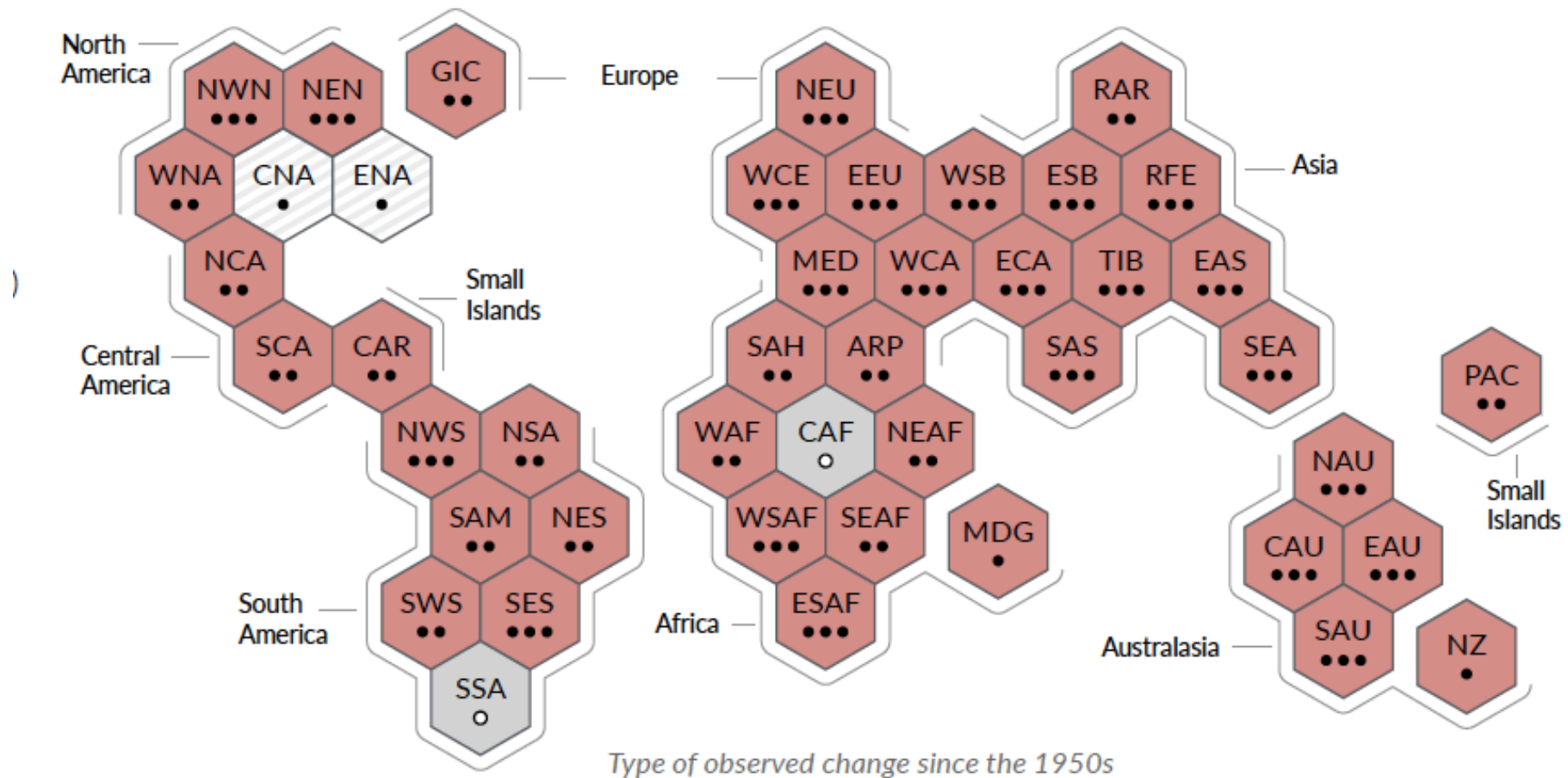
IPCC (2001) “Most of the warming of the past 50 years is likely (>66%) to be attributable to human activities.”

IPCC (2007) “Warming is unequivocal, and most of the warming of the past 50 years is very likely (90%) due to increases in greenhouse gases.”

IPCC (2014): It is *extremely likely* (95%) that human influence has been the dominant cause of the observed warming since the mid-20th century.

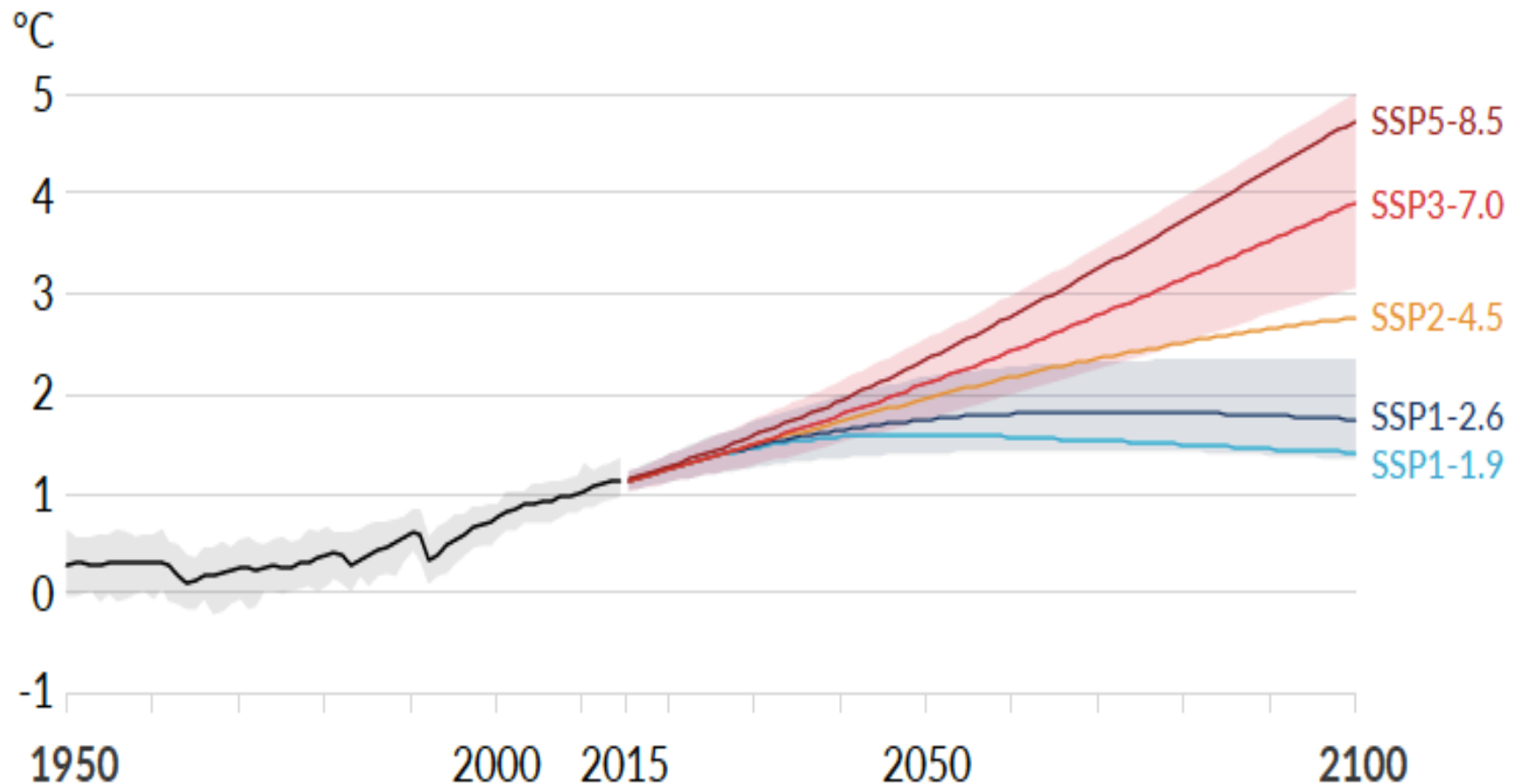
IPCC (2021): It is unequivocal that human influence has warmed the atmosphere, ocean and land.

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



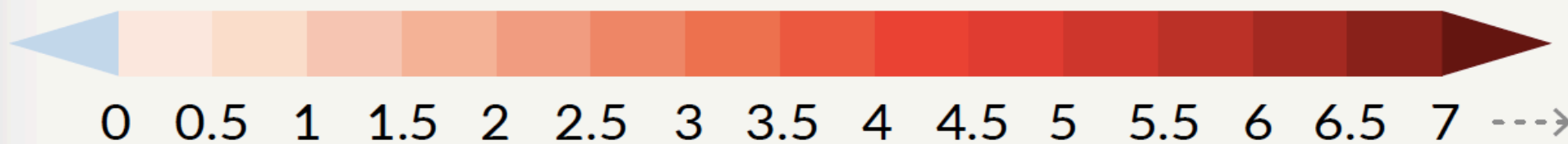
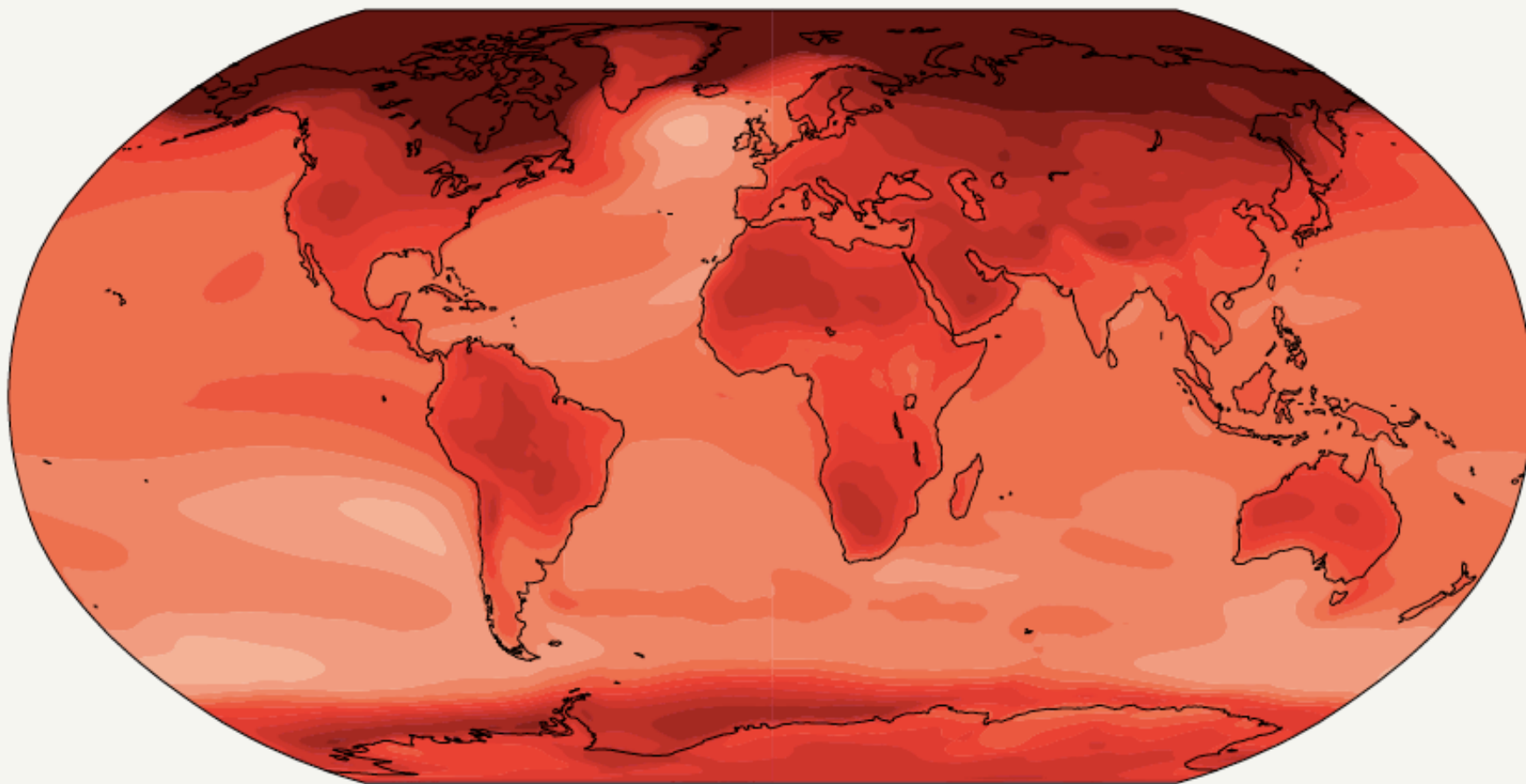
Around the Mediterranean region and in western Europe, heatwaves have increased and this is due to human activities (high level of confidence)

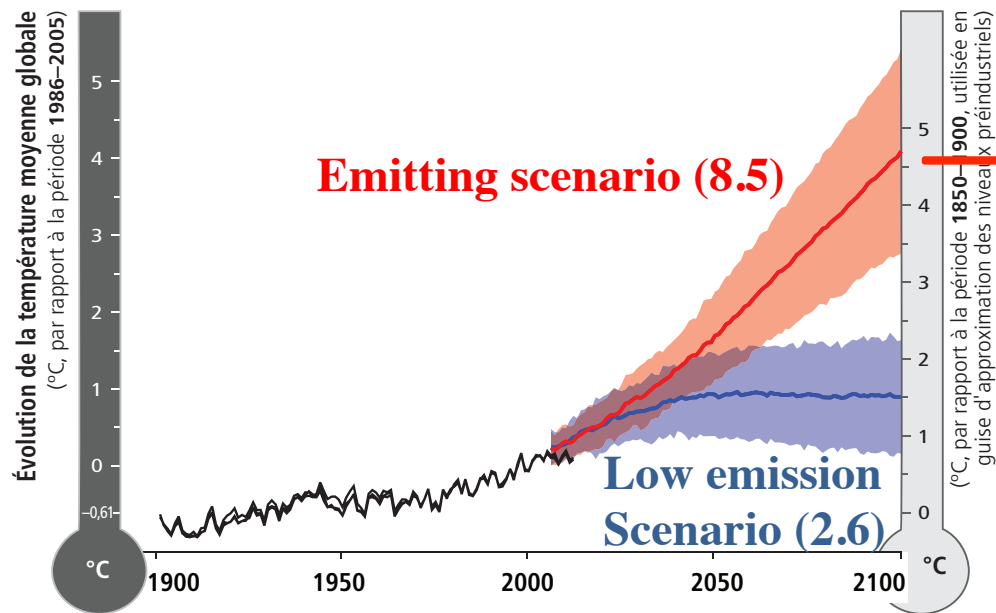
a) Global surface temperature change relative to 1850-1900



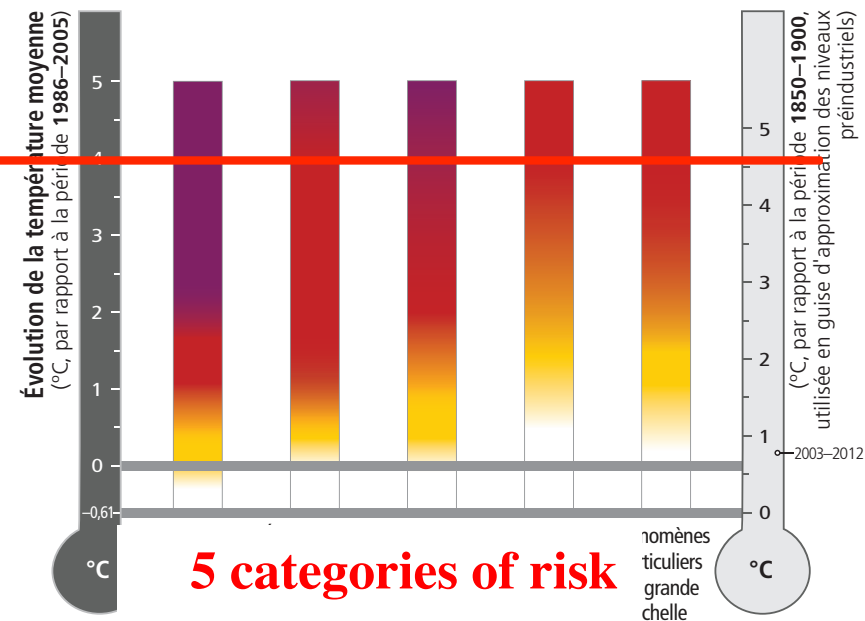
The fact that our scientific community has, over the last 40 years, correctly anticipated climate changes we experience today (rhythm of warming, acceleration of sea level rise, intensification of extremes events, ...) invite us to give credibility to projections of future climate change

Simulated change at 4 °C global warming





- Observée
- RCP 8,5 (scénario à émissions élevées)
- Chevauchement
- RCP 2,6 (scénario d'atténuation à émissions faibles)



Ocean acidification, coral reefs

Climate extremes : Droughts, floods, heat waves, cyclones

Irreversible processes : Sea-level, permafrost

Biodiversity, agriculture, ecosystems, pollution, health,

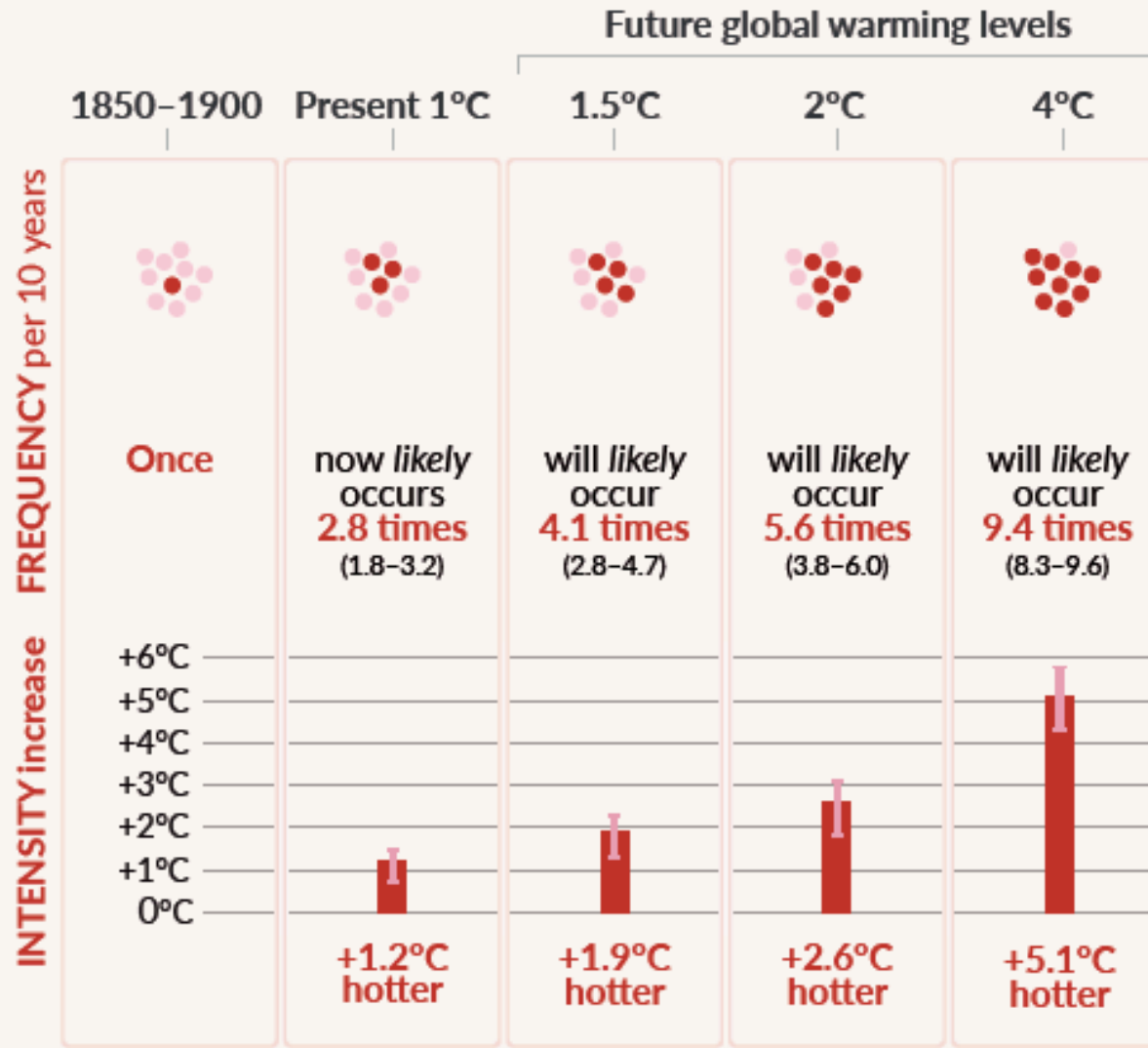
Populations : Climate refugees, water resources, food security, security

Increase of inequalities

Hot temperature extremes over land

10-year event

Frequency and increase in intensity of extreme temperature event that occurred once in 10 years on average in a climate without human influence

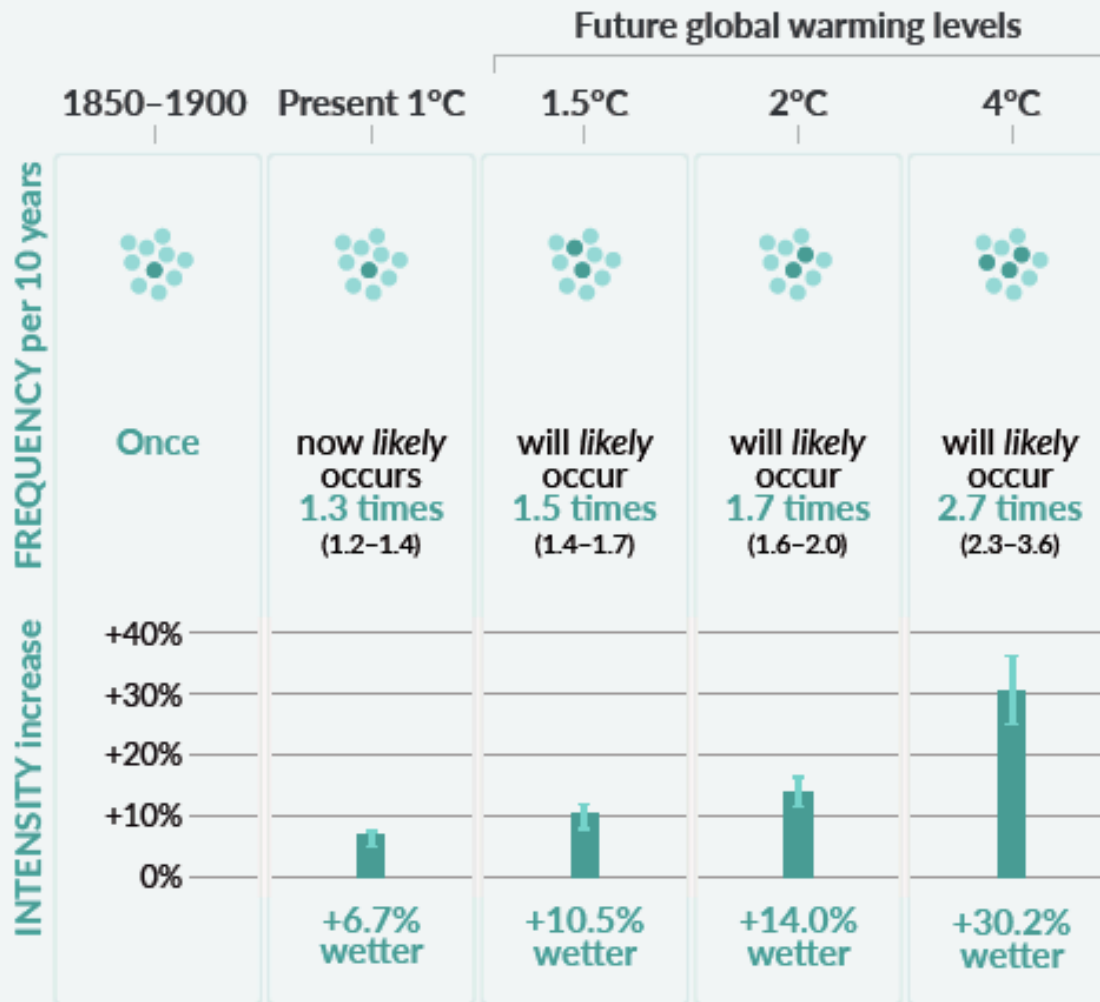


Heatwaves

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

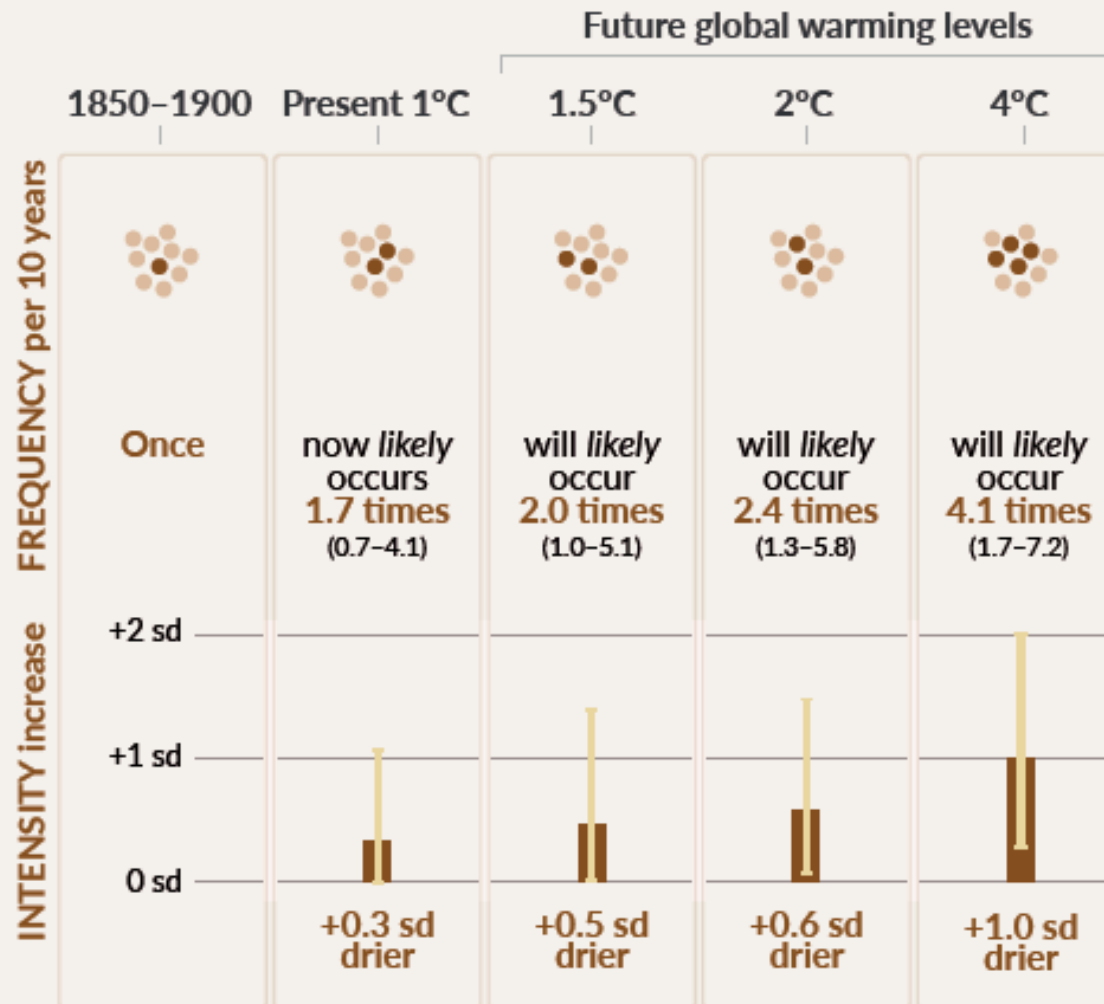


Heavy precipitation

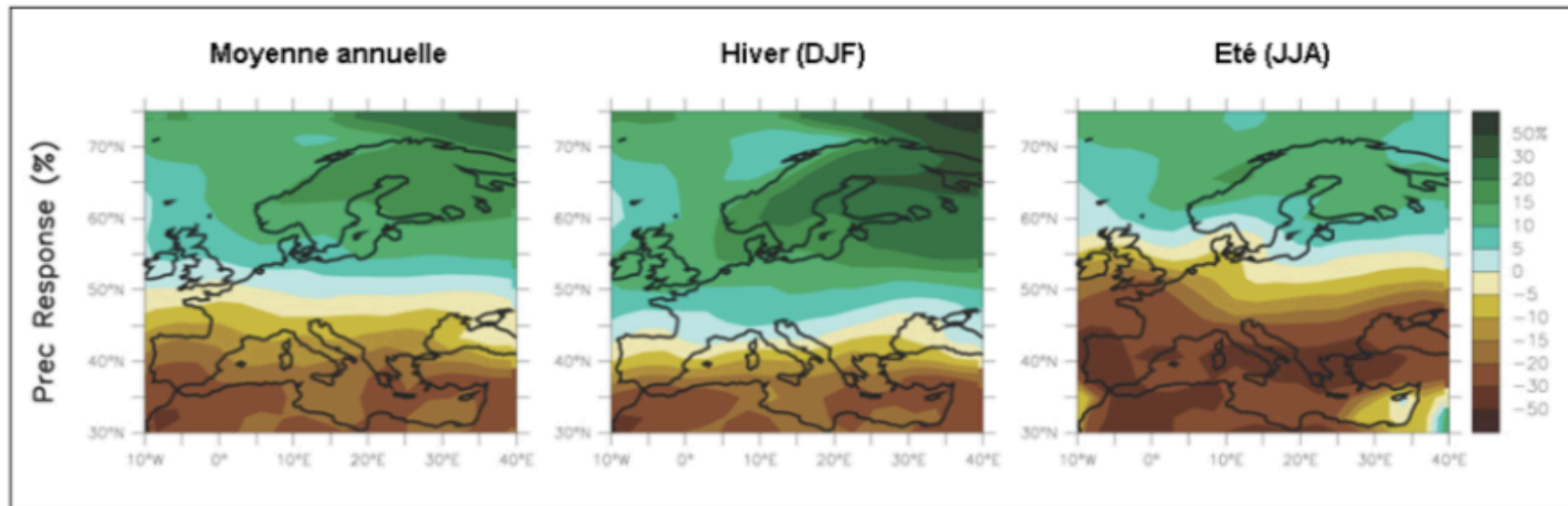
Agricultural & ecological droughts in drying regions

10-year event

Frequency and increase in intensity of an agricultural and ecological drought event that occurred once in 10 years on average across drying regions in a climate without human influence

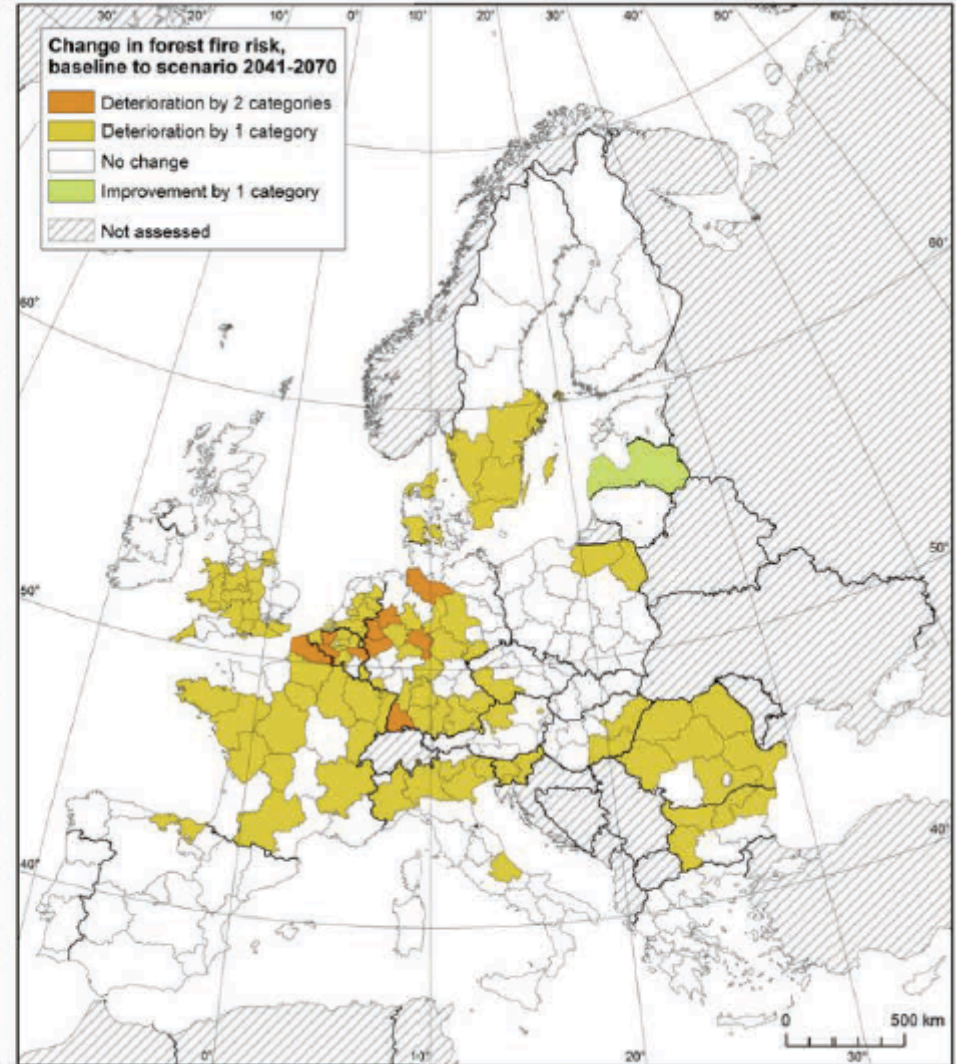
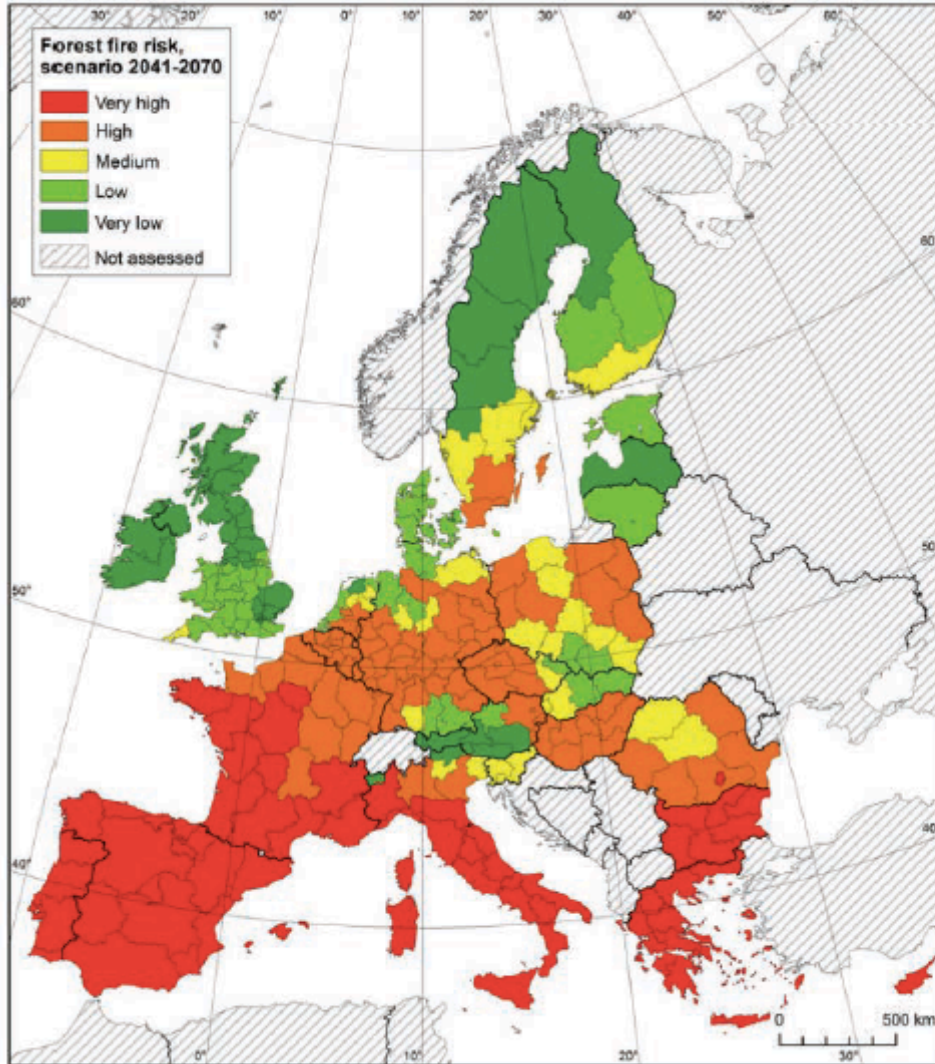


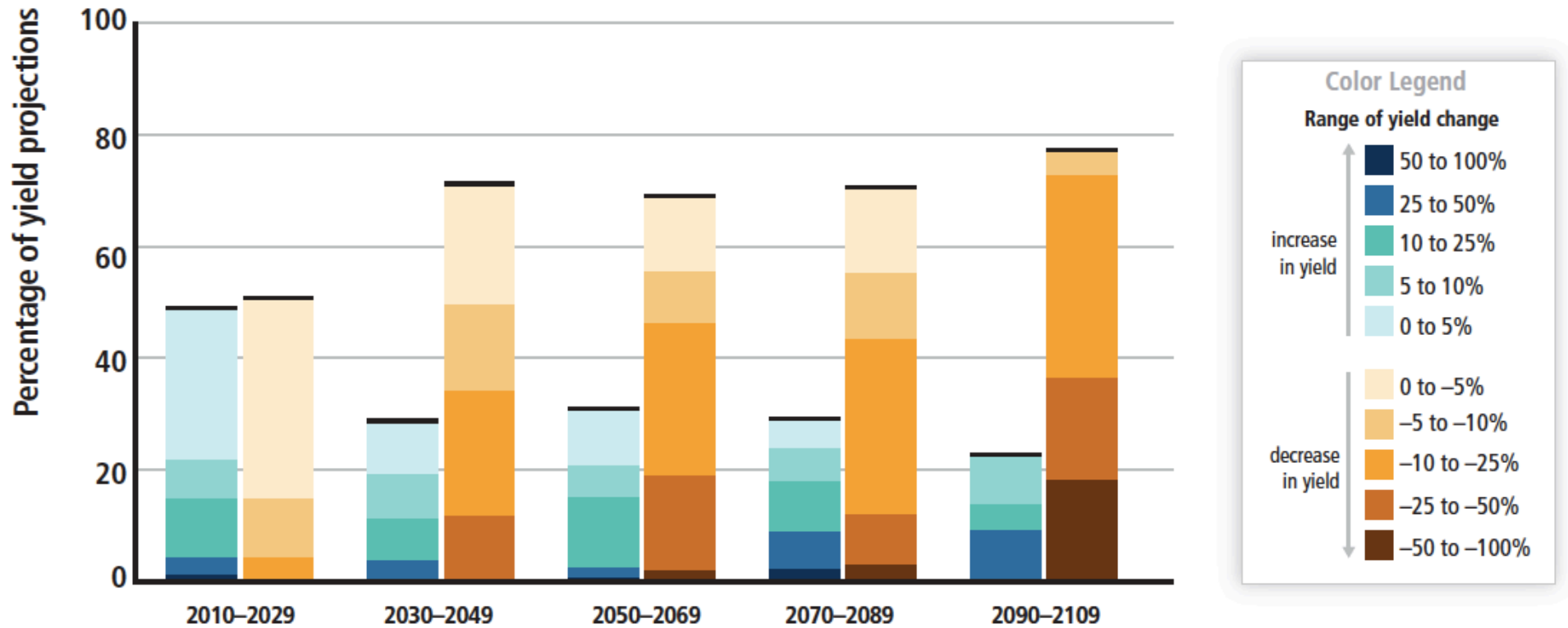
Droughts



- **Model projections indicate that the Hadley Circulation will shift its downward branch poleward in both the Hemispheres, with associated drying.**
- **Wetter conditions are projected at high latitudes**

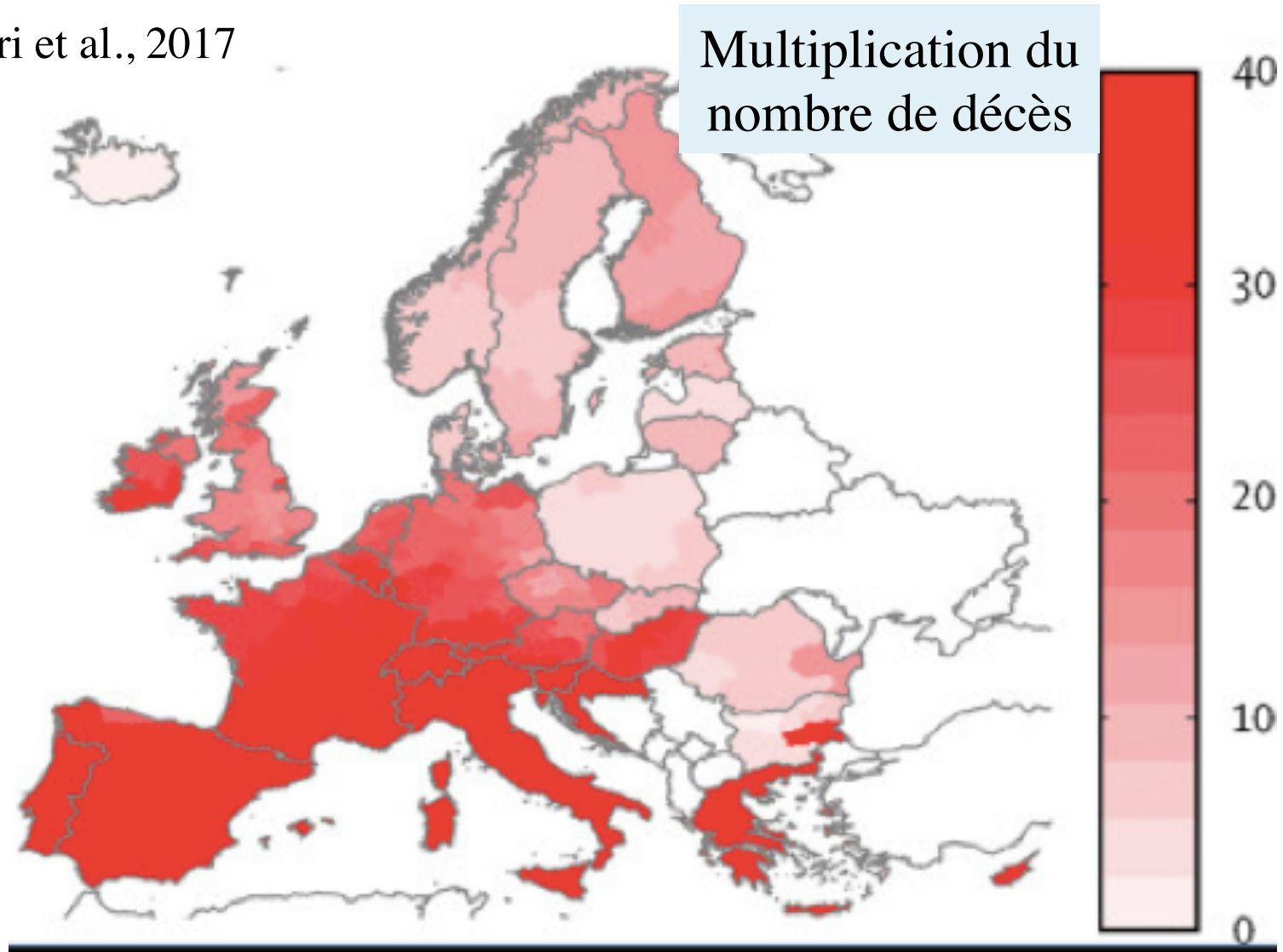
Risks of forest fires (scénario A1B : 2041/2070)





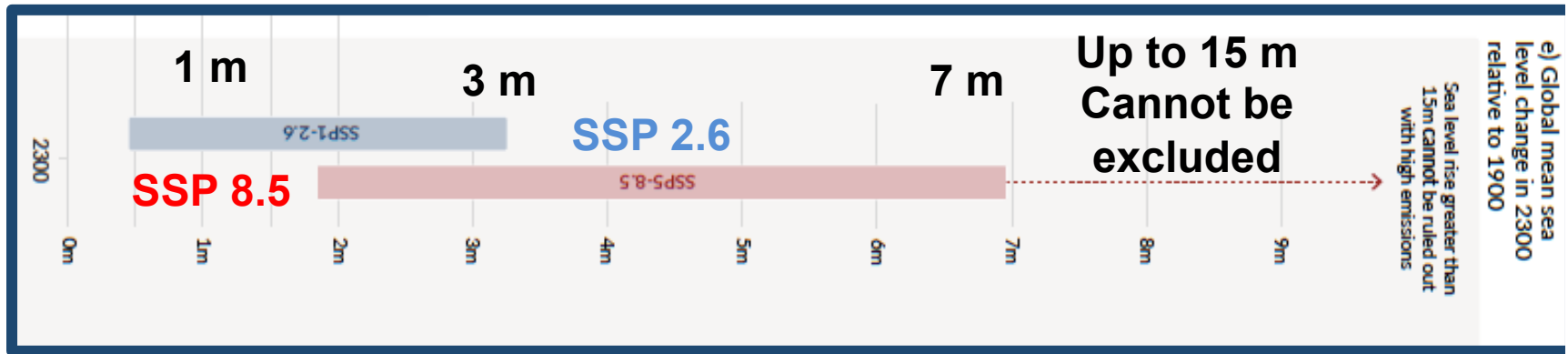
Summary of projected changes in crop yields, due to climate change over the 21st century.

Forzieri et al., 2017

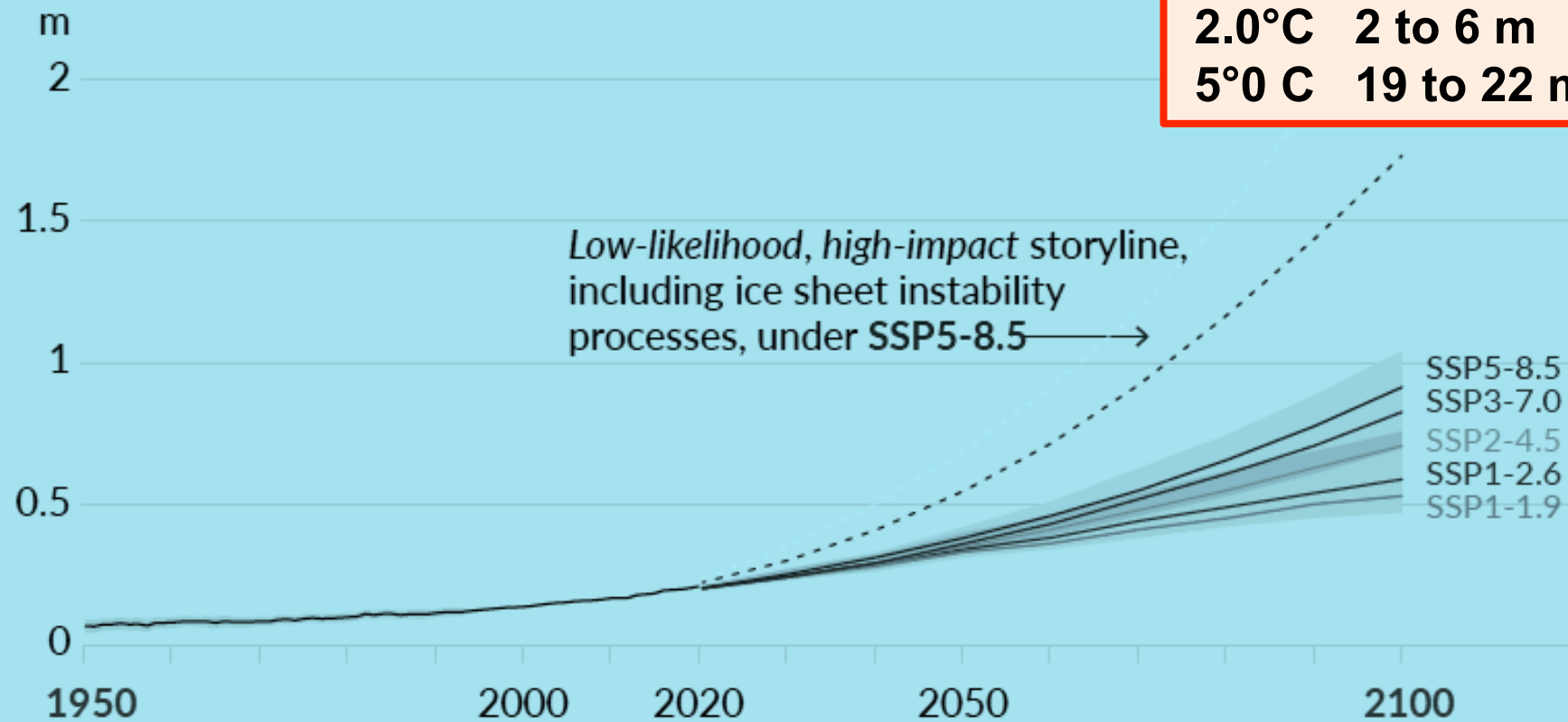


D'ici à 2100, deux Européens sur trois seraient affectés par des catastrophes climatiques (+ 3°C)

2300



d) Global mean sea level change relative to 1900



2000 years

1.5°C	2 to 3 m
2.0°C	2 to 6 m
5° C	19 to 22 m

Climate Convention (UNFCCC) launched in 1992, Rio Earth Summit

Ultimate objective of the Climate Convention (article 2) :

To achieve stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system. Such a level should be achieved within a time frame sufficient :

- to allow ecosystems to adapt naturally to climate change,
- to ensure that food production is not threatened
- to enable economic development to proceed in a sustainable manner.

First Conference of Parties : COP 1 Berlin 1995
COP 3 (1997) : Kyoto I ; COP 15 (2009) : Copenhagen

Climate Convention (UNFCCC) : Paris agreement :Article 2

- (a) Holding the increase in the global average temperature to well below 2 °C above pre-industrial levels and to pursue efforts to limit the temperature increase to 1.5 °C above pre-industrial levels, recognizing that this would significantly reduce the risks and impacts of climate change;
- (b) Increasing the ability to adapt to the adverse impacts of climate change and foster climate resilience and low greenhouse gas emissions development, in a manner that does not threaten food production;
- (c) Making finance flows consistent with a pathway towards low greenhouse gas emissions and climate-resilient development.

**IPCC Special Report
on
Global Warming of 1.5°C**

Where do we want to go?

At 1.5°C compared to 2°C:

- Less extreme weather where people live, including extreme heat and rainfall
- Slower rate of sea level rise, more time for adaptation
- Reduced risk of loss of terrestrial and marine biodiversity and species
- Smaller reductions in yields of maize, rice, wheat
- Global population exposed to water shortages up to 50% less

How do we get there?

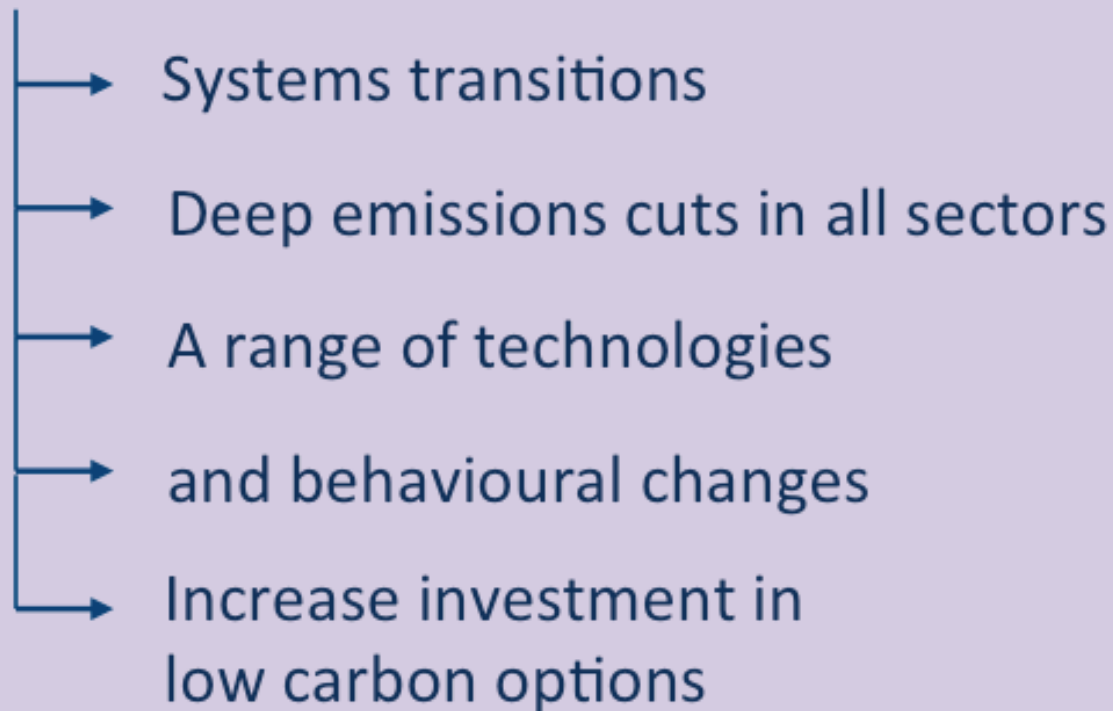
- Business as usual scenario would lead to a 4 to 5°C warming in 2100
- Current Paris commitments for 2030 would lead to a warming above 3 °C in 2100
- Until 2030, it would be necessary to increase these commitments by a factor of ~ 3 for the 2°C objective, and by a factor of ~ 5 for 1.5°C

Carbon Dioxide Removal (CDR)

- All pathways that limit global warming to 1.5 °C with limited or no overshoot use CDR

How do we get there?

- Limiting warming to 1.5°C would require changes on an unprecedented scale



Limiting warming to 1.5°C

Would require rapid, far-reaching and unprecedented changes in all systems

- A range of technologies and behavioural changes
- Scale up in annual investment in low carbon energy and energy efficiency by factor of five by 2050
- Renewables supply 70-85% of electricity in 2050
- Coal declines steeply, ~zero in electricity by 2050
- Oil and especially gas persist longer – gas use rises by 2050 in some pathways
- Deep emissions cuts in transport and buildings
- Changes in land use and urban planning

How do we get there?

- To limit warming to 1.5°C, CO₂ emissions fall by about 45% by 2030 (from 2010 levels)
 - ↳ *Compared to 20% for 2°C*
- To limit warming to 1.5°C, CO₂ emissions would need to reach 'net zero' around 2050
 - ↳ *Compared to around 2075 for 2°C*

**Global warming will lead
towards a new model of development**

Half a degree matters

Each year matters

Each choice matters

Where are we ?

- **Easier to adapt to 1.5°C rather than to 2°C**
- **Neutrality carbon required around 2075 for 2°C but around 2050 for 1.5°C**
- **More than 100 countries have adopted, in one way or another, carbon neutrality in 2050 (2060 for China ; 2070 for India and Saudi Arabia)**
- **But with the Paris agreement warming will reach around 3°C before 2100. Emissions in 2030 should be divided by a factor of 2.**

SNBC

	Evolution des émissions de GES (par rapport à 2015)		Résumé des orientations
	2030	2050	
Production d'énergie	-36 %	Zéro émission	Développer les énergies décarbonées
Transports	-31 %	Zéro émission	Décarboner la mobilité
Bâtiments	-53 %	Zéro émission	100 % du parc « bâtiment basse consommation » en moyenne
Agriculture	-20 %	-46 %	Favoriser les pratiques qui diminuent les émissions, comme l'agro-écologie
Déchets	-38 %	-66 %	Prévenir et valoriser les déchets
Industrie	-35 %	-81 %	Développer les filières industrielles sobres en carbone
Forêts et bois		+50 % absorption	Maximiser les puits de carbone et développer la bioéconomie



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RÉPUBLIQUE FRANÇAISE
MINISTÈRE
DE LA TRANSITION
ÉCOLOGIQUE
ET SOLIDAIRE

Climate convention

Only a small part of the recommendations have been taken into account in the 2021 climate law

Sensibiliser et former aux enjeux de la transition écologique et du développement durable dans l'enseignement supérieur

Rapport à **Frédérique Vidal**,
ministre de l'Enseignement supérieur,
de la Recherche et de l'Innovation

du groupe de travail
présidé par

Jean Jouzel



Plan climat-biodiversité et transition écologique de l'Enseignement supérieur et de la Recherche

