Status of Climate : Global to Regional

Diagnosis, Prognosis, and Urgency of Treatment

Jean-Pascal van Ypersele

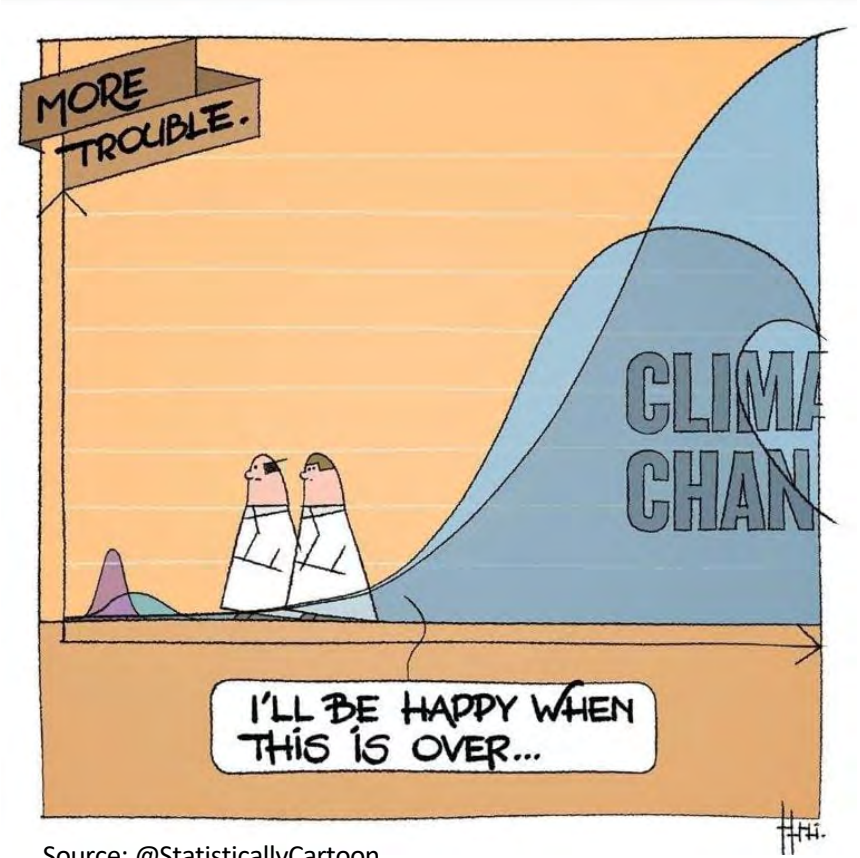
UCLouvain, Belgium

IPCC Vice-Chair from 2008 to 2015

Twitter: @JPvanYpersele

Royal Meteorological Institute, Brussels (in virtual space),
15 October 2020

Thanks to the Walloon government for supporting www.plateforme-wallonne-giec.be
& my team at UCLouvain



Source: @StatisticallyCartoon

@JPvanYpersele

Donald J. Trump
@realDonaldTrump

Suivre

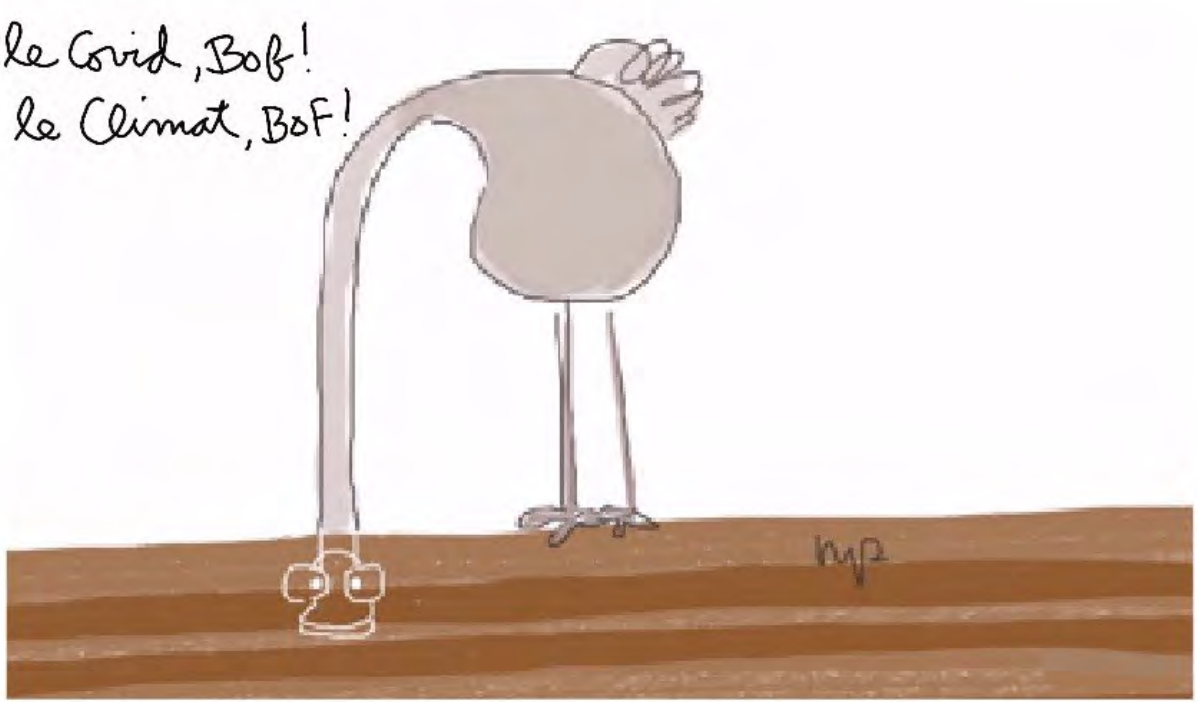
The concept of global warming was created by and for the Chinese in order to make U.S. manufacturing non-competitive.

Voir la traduction

RETWEETS 99 789 J'AIME 63 394

11:15 - 6 nov. 2012

100 k 63 k



Source: ?

@JPvanYpersele

Why the IPCC ?

Established by WMO and UNEP in 1988

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

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

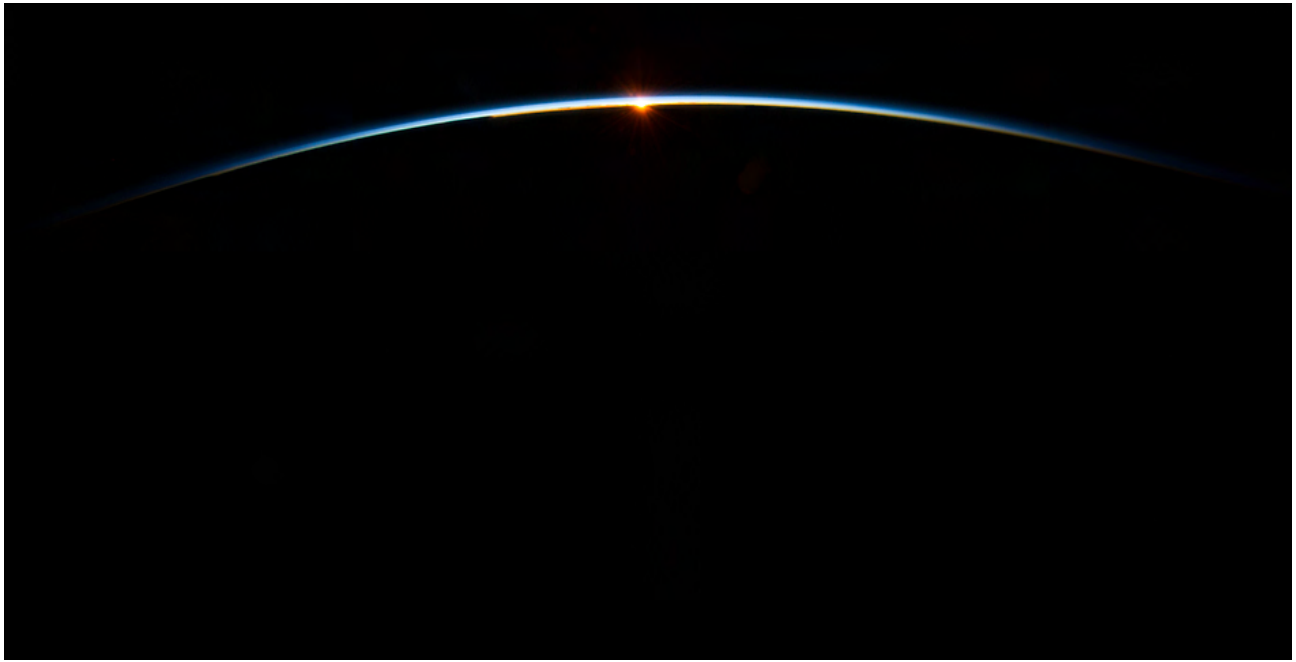
WMO=World Meteorological Organization

UNEP= United Nations Environment Programme

Source: @JohnfoCook

Diagnosis

Our atmosphere is thin and fragile (as seen by ISS crew on 31 July 2013)



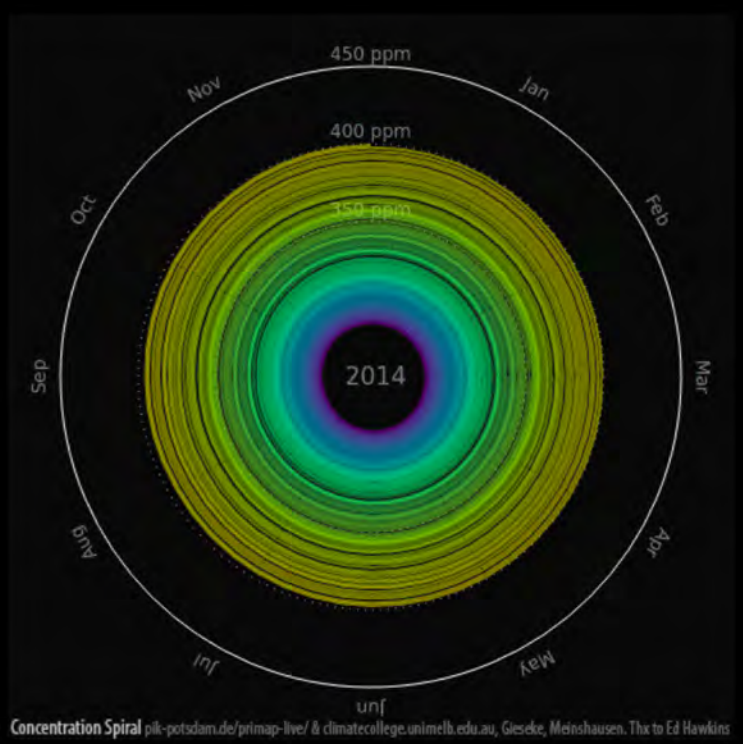
Jean-Pascal van Ypersele
(vanyp@climate.be)

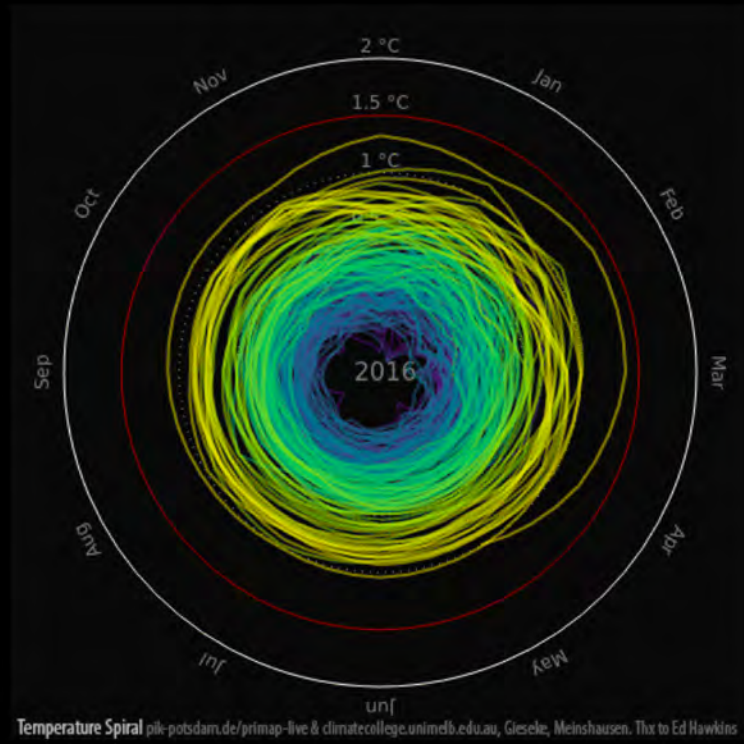
Fact: Because we use the atmosphere as a dustbin for our greenhouse gases, we thicken the insulation layer around the planet

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

@JPvanYpersele

CO_2 Concentration and Temperature spirals

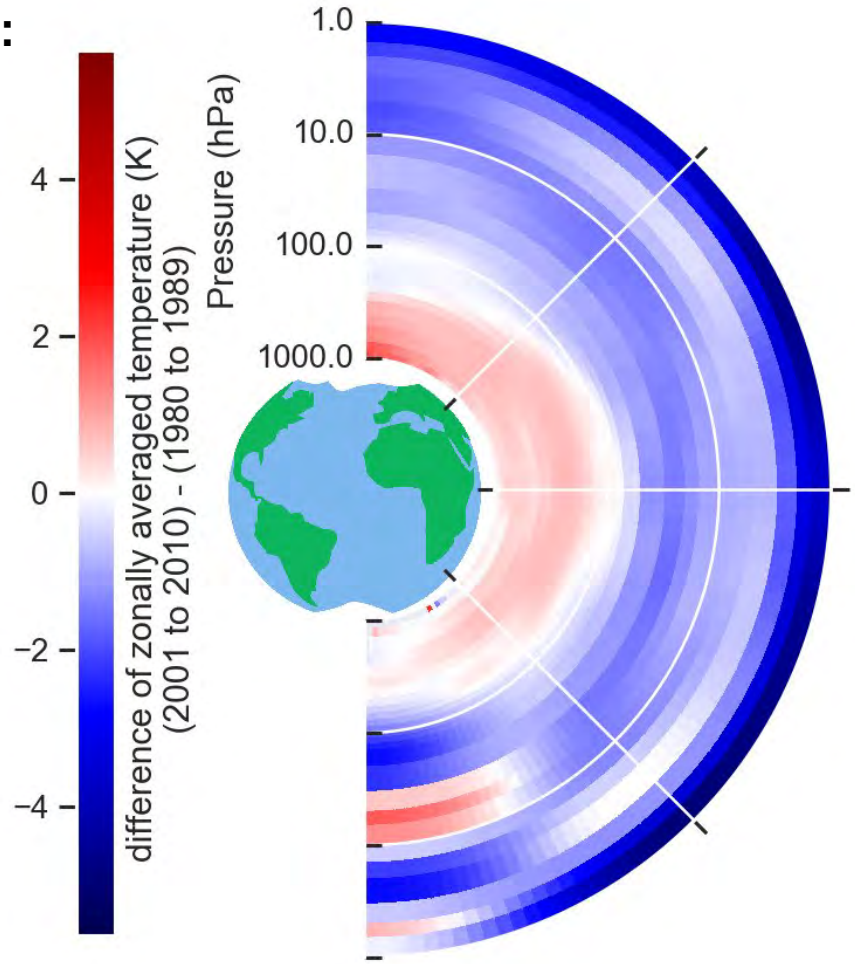




CO_2 Concentration since 1850 and Global Mean Temperature in °C relative to 1850 – 1900
Graph: Ed Hawkins (Climate Lab Book) – Data: HadCRUT4 global temperature dataset
Animation available on http://openclimatedata.net/climate-spirals/concentration-temperature/

A signature of anthropogenic warming:

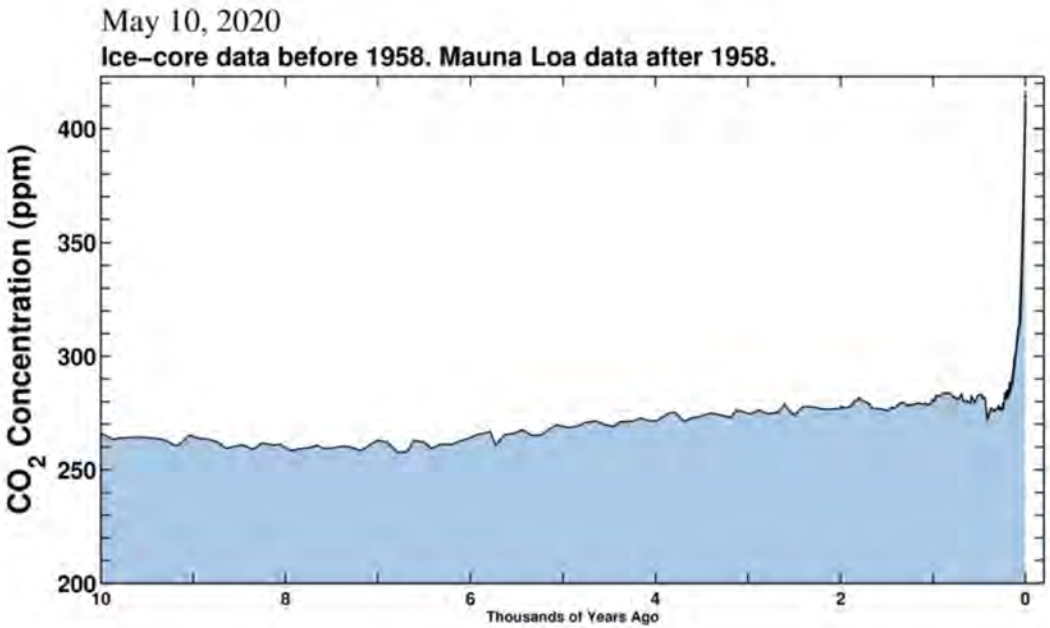
Atmospheric temperature evolution from the 1980's to the 2000's:
- the troposphere warms up,
- the stratosphere cools down,
as greenhouse gases trap infrared radiation near the surface



Source: @MattAtmosphere

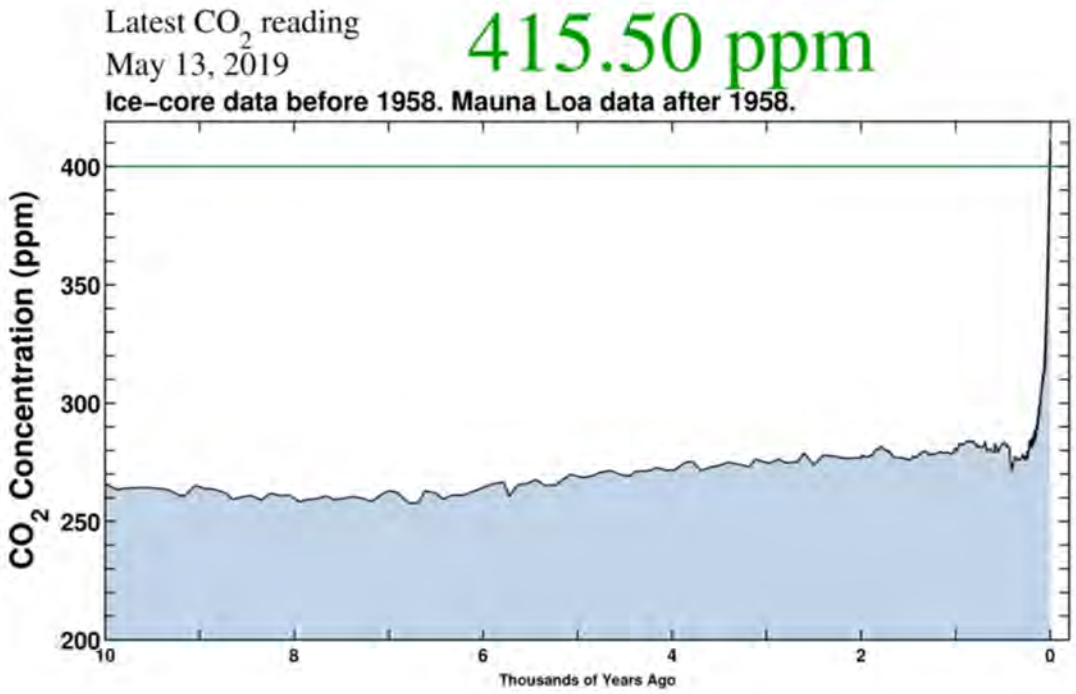
CO_2 Concentration, 10 May 2020 (Keeling curve + last 10000 years)

Latest CO_2 reading: 417.10 ppm



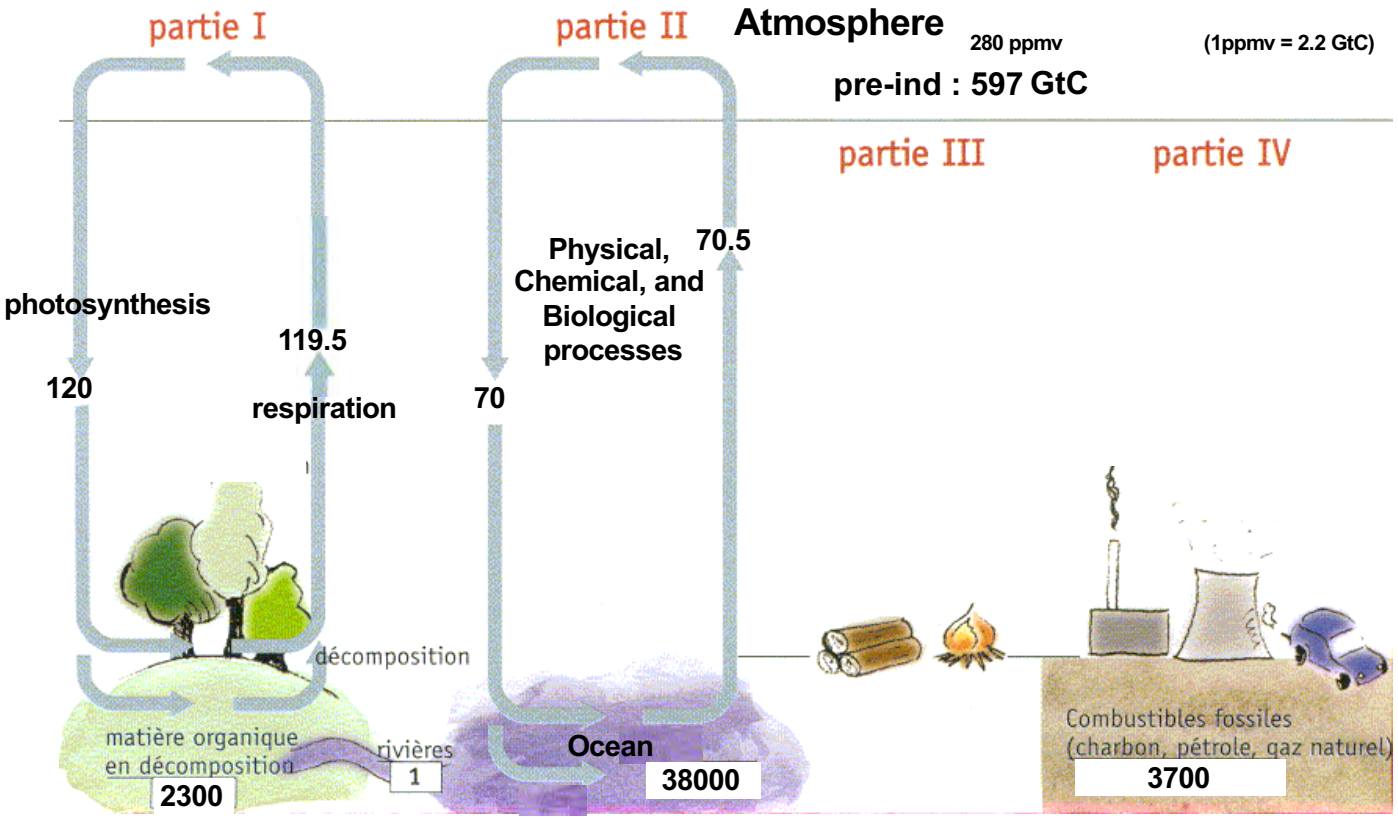
Source: Scripps.ucsd.edu/programs/keelingcurve/

CO_2 Concentration, 13 May 2019 (Keeling curve + last 10000 years)



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

Carbon cycle: unperturbed fluxes

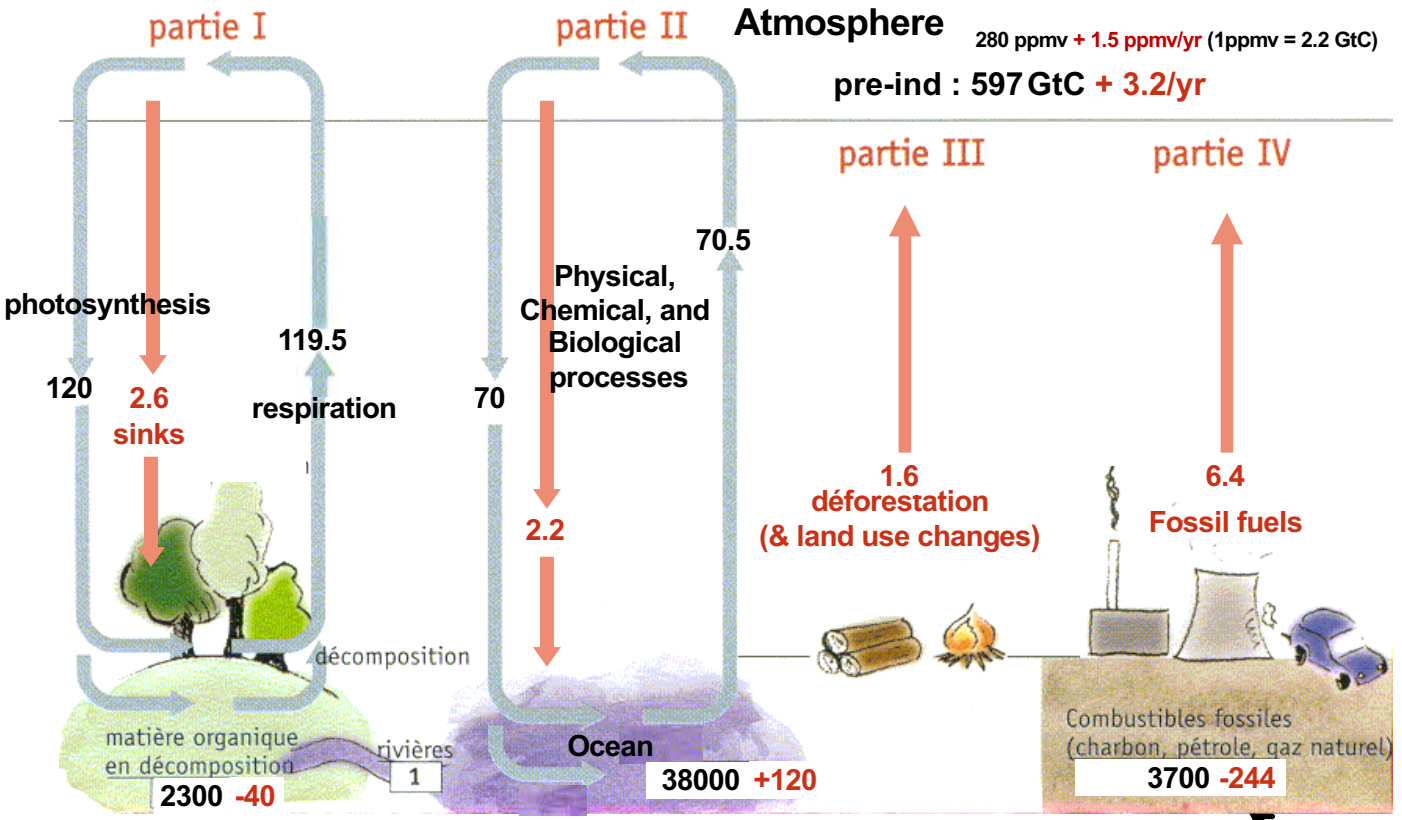


Units: GtC (billions tons of carbon) or GtC/year (multiply by 3.7 to get $GtCO_2$)

vanyp@climate.be

Carbon cycle: perturbed by human activities

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

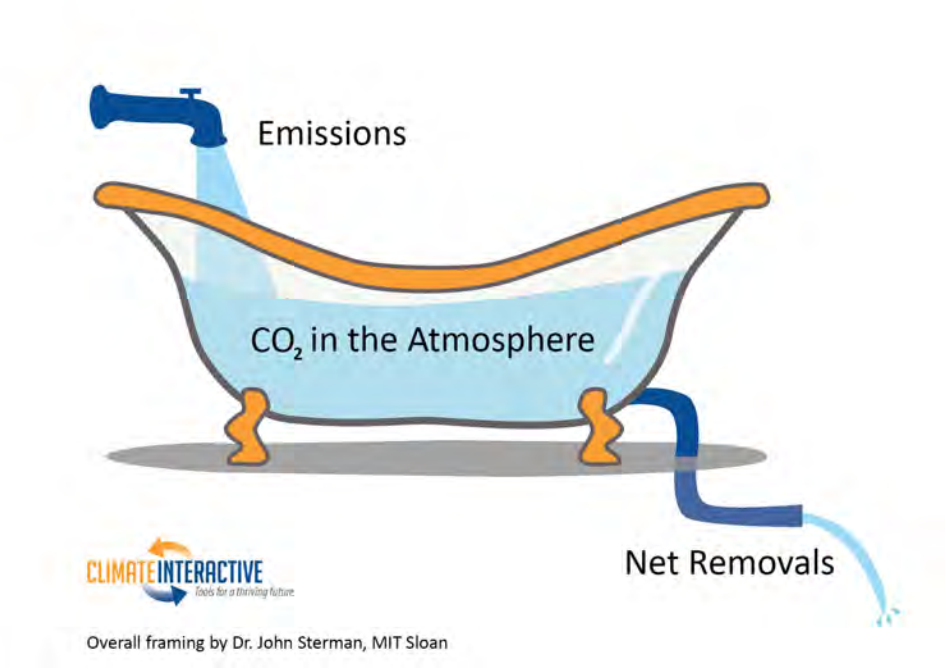


Units: GtC (billions tons of carbon) or GtC/year

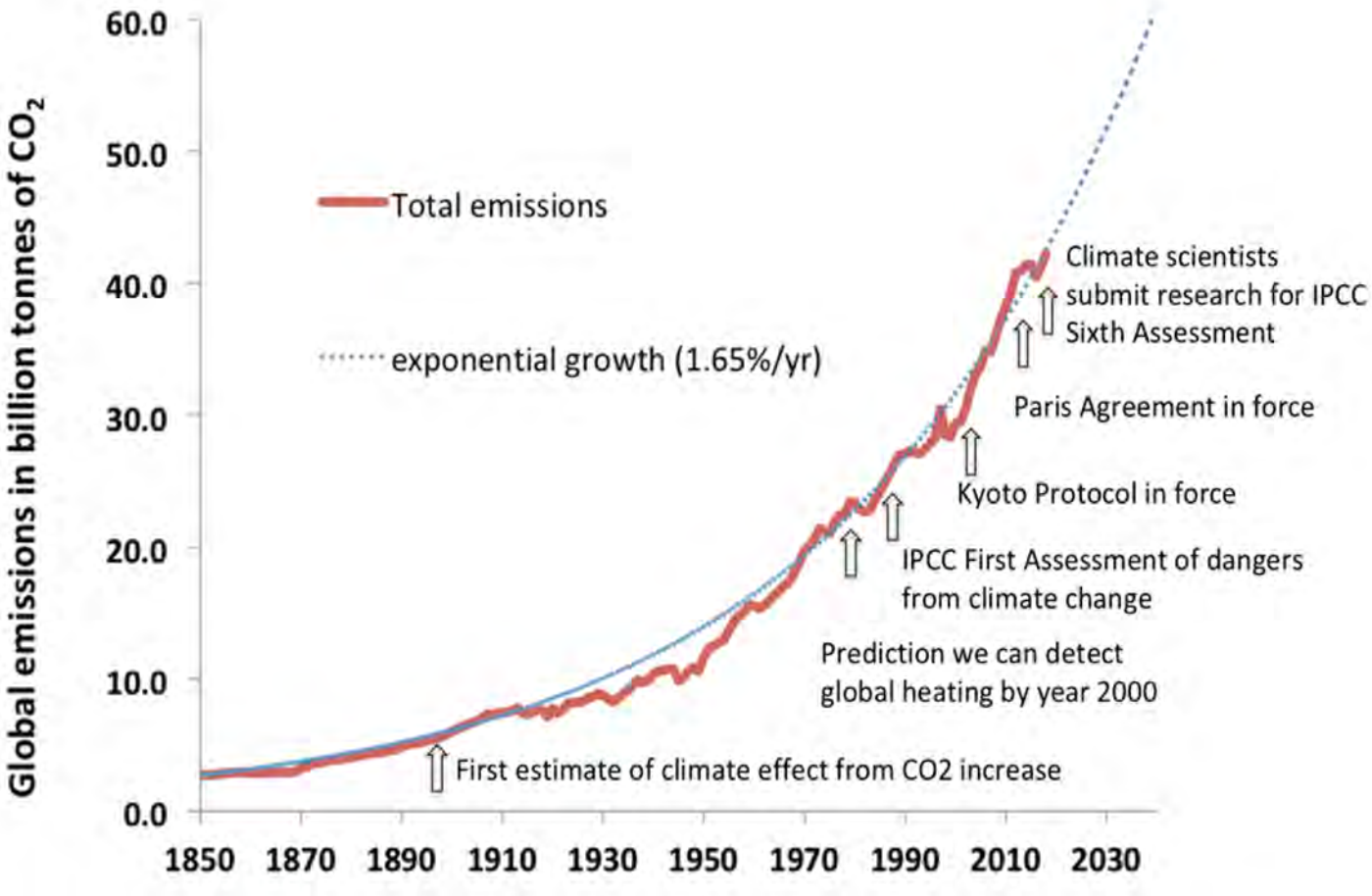
Stocks!

vanyp@climate.be

The Carbon Bathtub



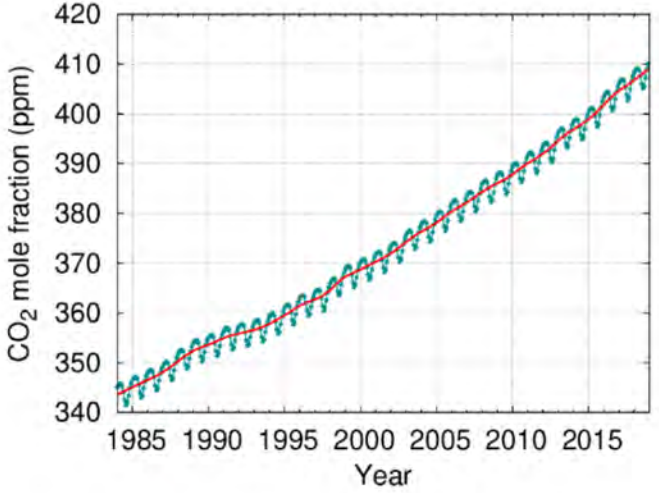
Source: @CarbonInteractive

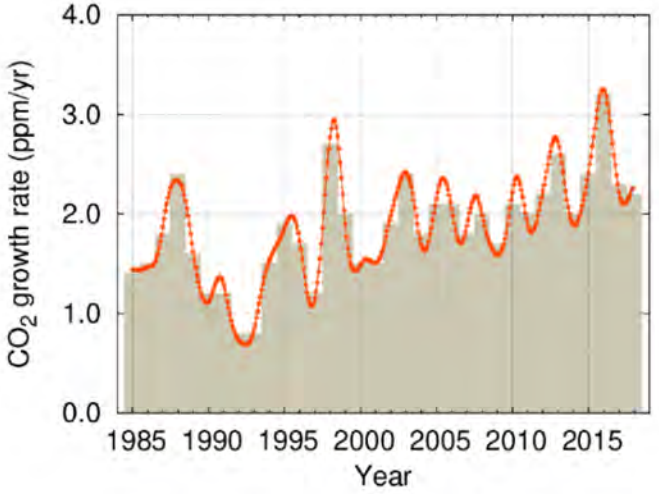


Source: Wolfgang Knorr, in The Conversation (2019)

The effect of the Covid-19 crisis will be negligible:

The estimated decline for 2020 due to the COVID-19 shutdown (4%–7% compared to 2019 levels, according to the Global Carbon Project) would result in a final change of 0.08 ppm to 0.23 ppm in the annual growth rate, well within the 1 ppm natural interannual variability.

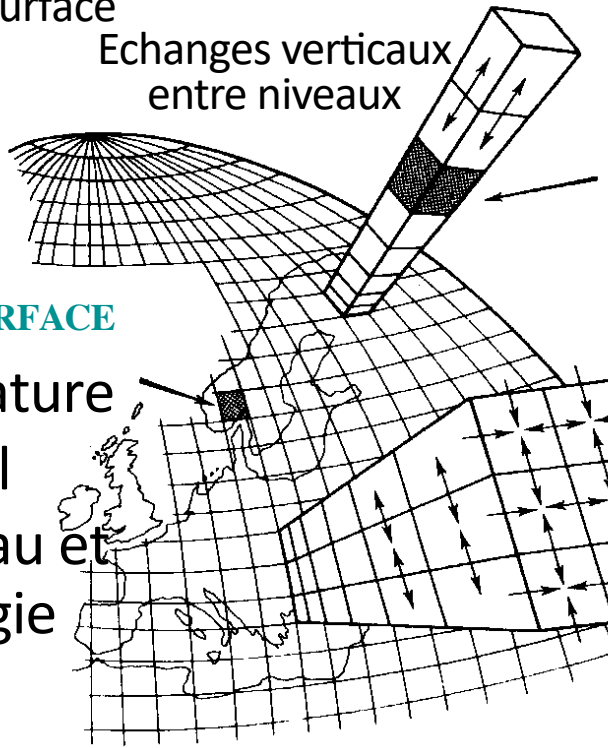




Source: « United Science » report (UN, 2020)

Modèles climatiques

Atmosphère et surface



DANS LA COLONNE ATMOSPHERIQUE

- Vecteurs vent
- Humidité
- Nuages
- Température
- Altitude

A LA SURFACE

- Température au sol
- Flux d'eau et d'énergie

Résolution typique ~ 2°x 2°(modèle global, atmosphère)
Intervalle de temps typique : ≤ 30 minutes

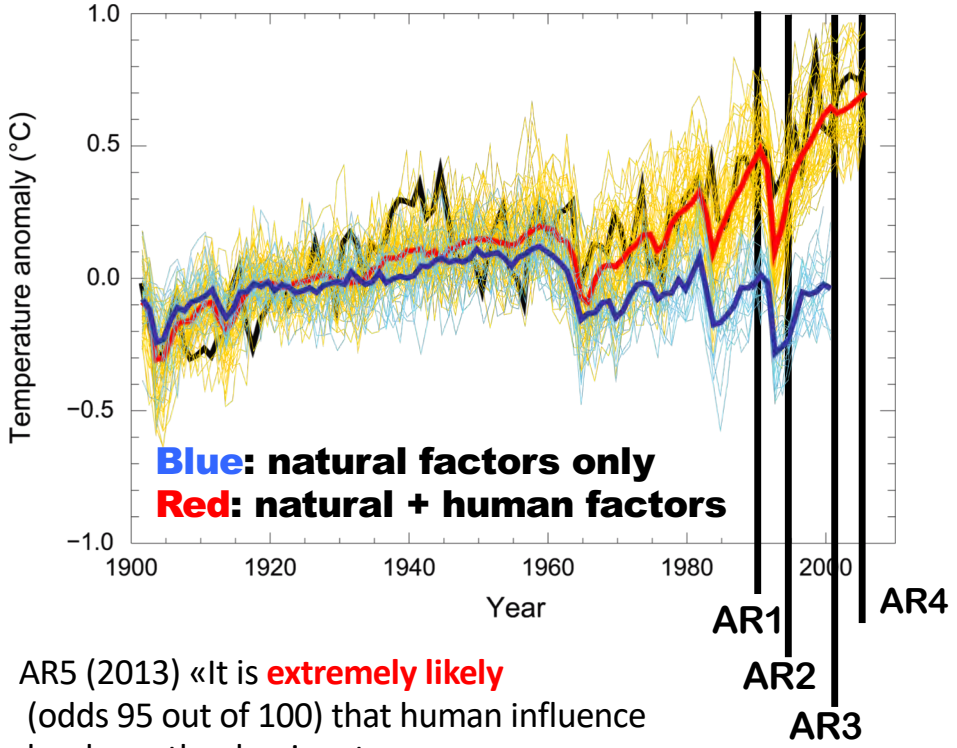
A Progression of Understanding: Greater and Greater Certainty in Attribution

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… »

What did climate models say, 40 years ago?

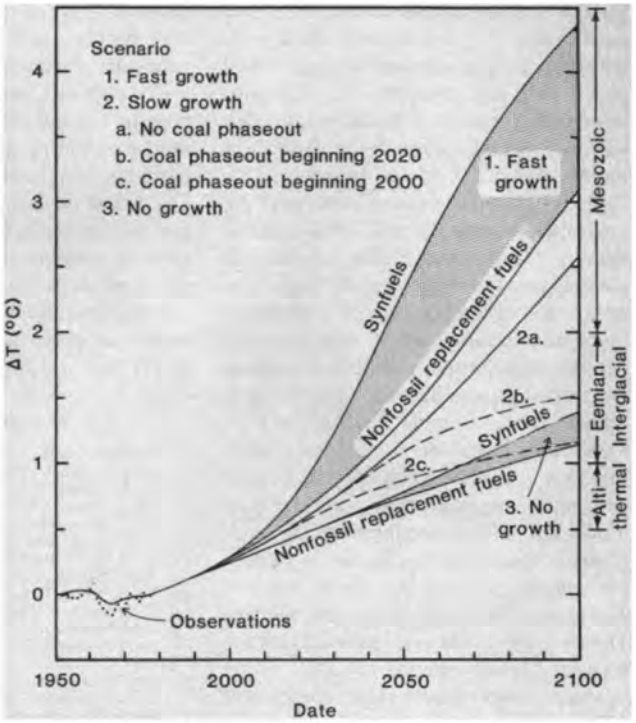
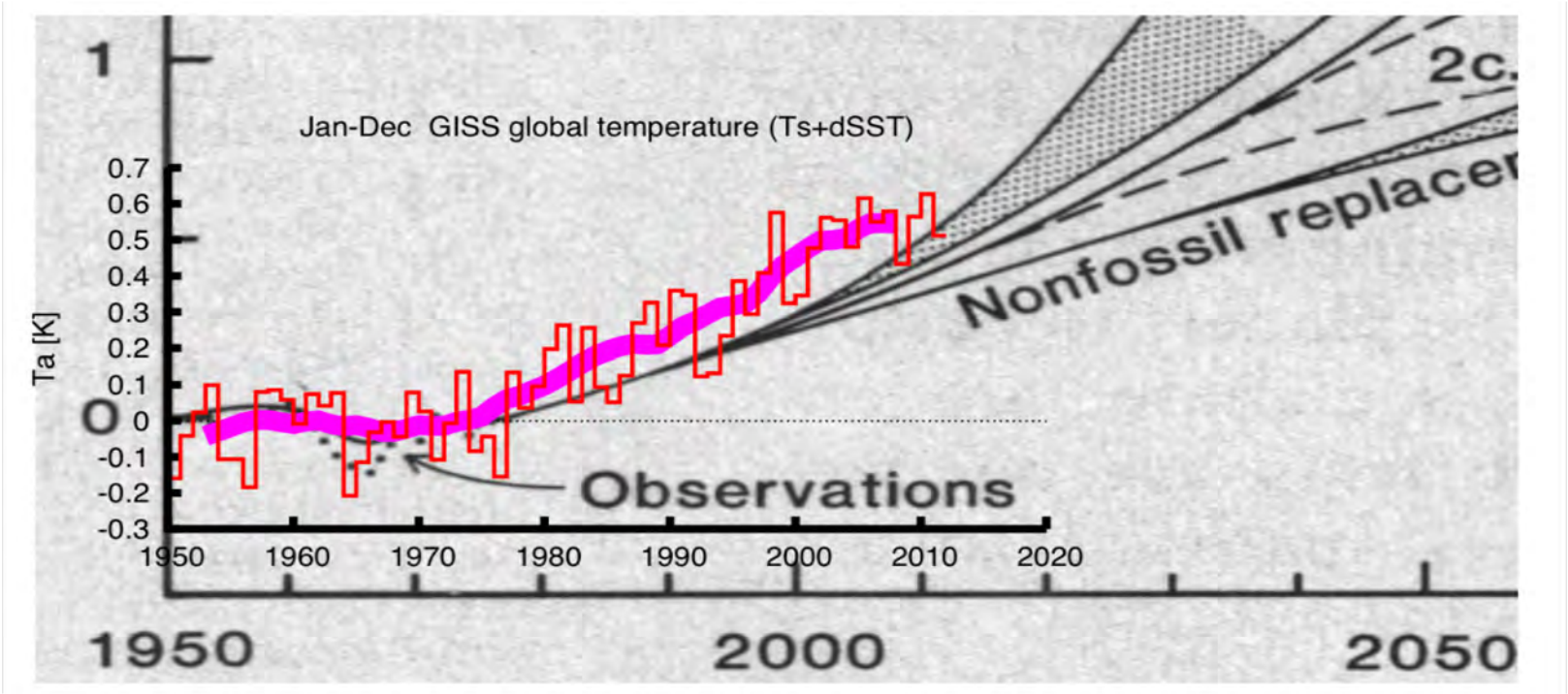


Fig. 6. Projections of global temperature. The diffusion coefficient beneath the ocean mixed layer is 1.2 cm^2 sec^{-1}, as required for best fit of the model and observations for the period 1880 to 1978. Estimated global mean warming in earlier warm periods is indicated on the right.

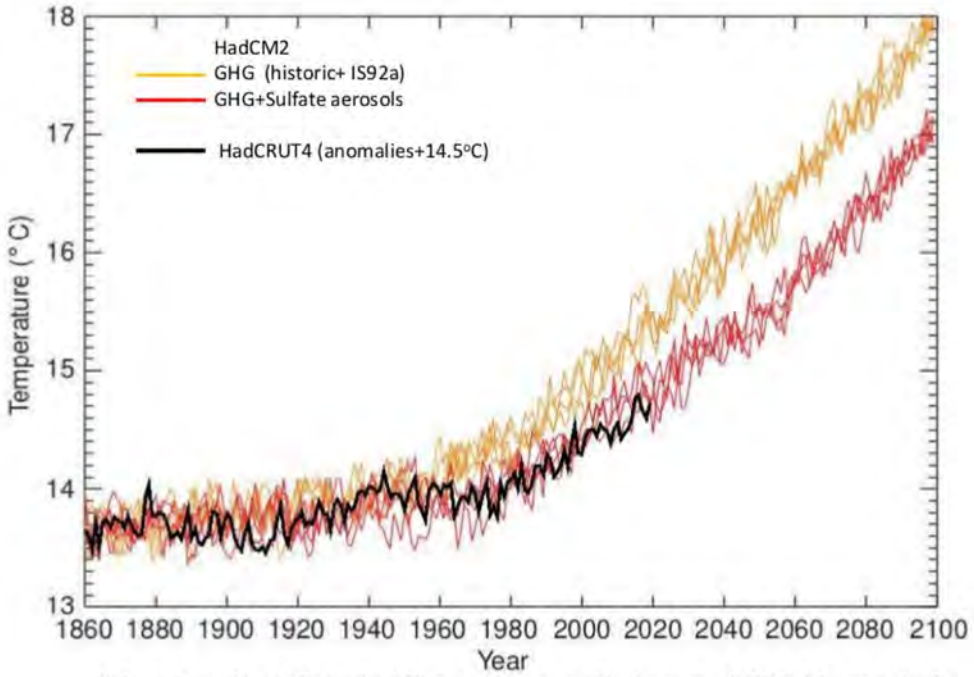
Hansen et al. (1981, Science)

Model results are close to reality



Hansen et al. (1981, Science), observations added by www.realclimate.org)

Comparing a 1997 climate projection with reality until 2020:



Adapted version of figure in "Climate Change and its Impacts: A Global Perspective", Met Office, Dec 1997

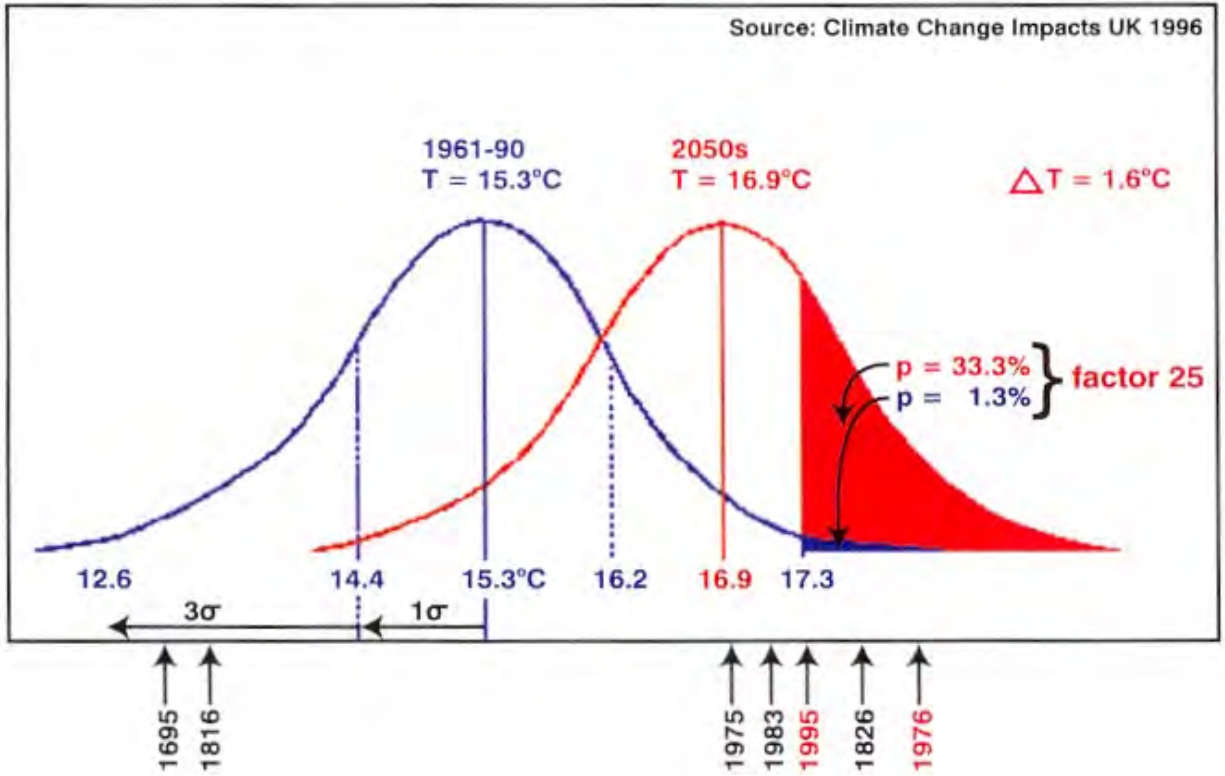
Source: @RichardBetts

Since 1950, extreme hot days and heavy precipitation have become more common

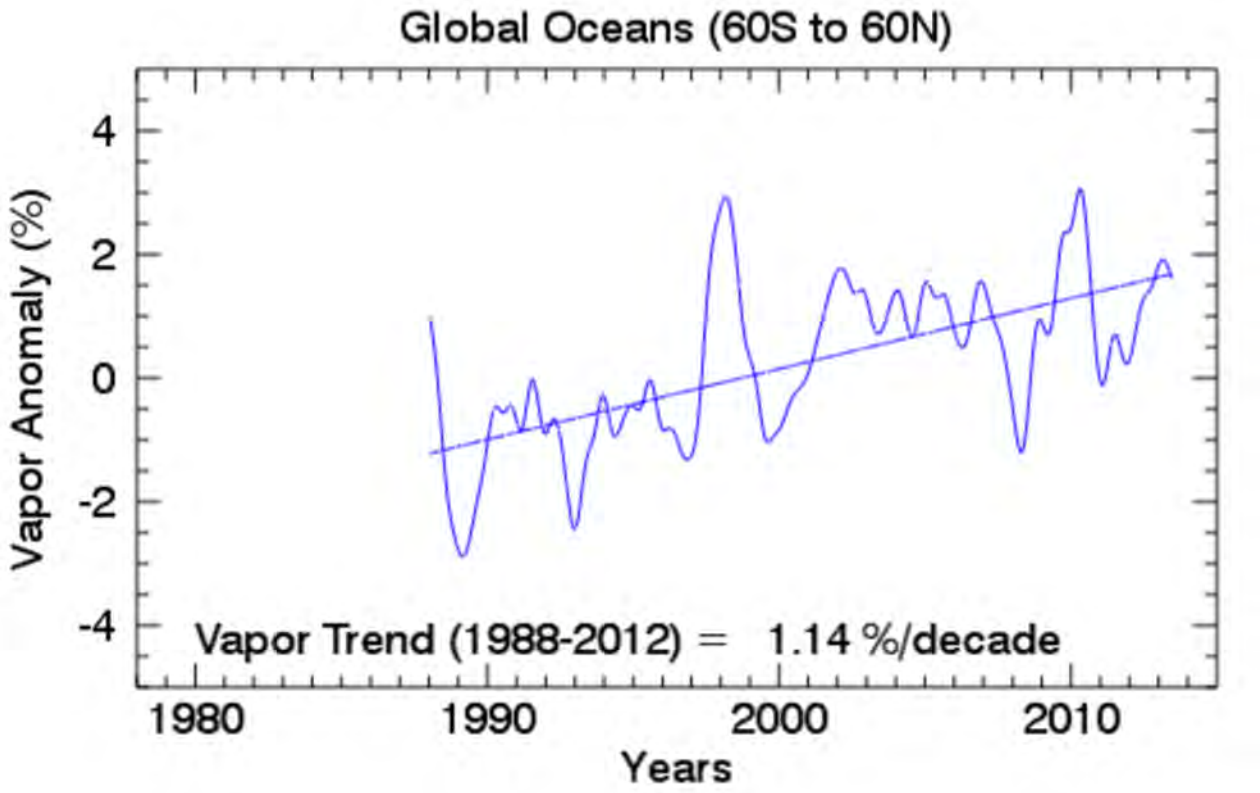
There is evidence that anthropogenic influences, including increasing atmospheric greenhouse gas concentrations, have changed these extremes

Increasing Probabilities of Extremes

Example: Summer Temperatures in Central England



Total Column Water Vapor Over Ocean

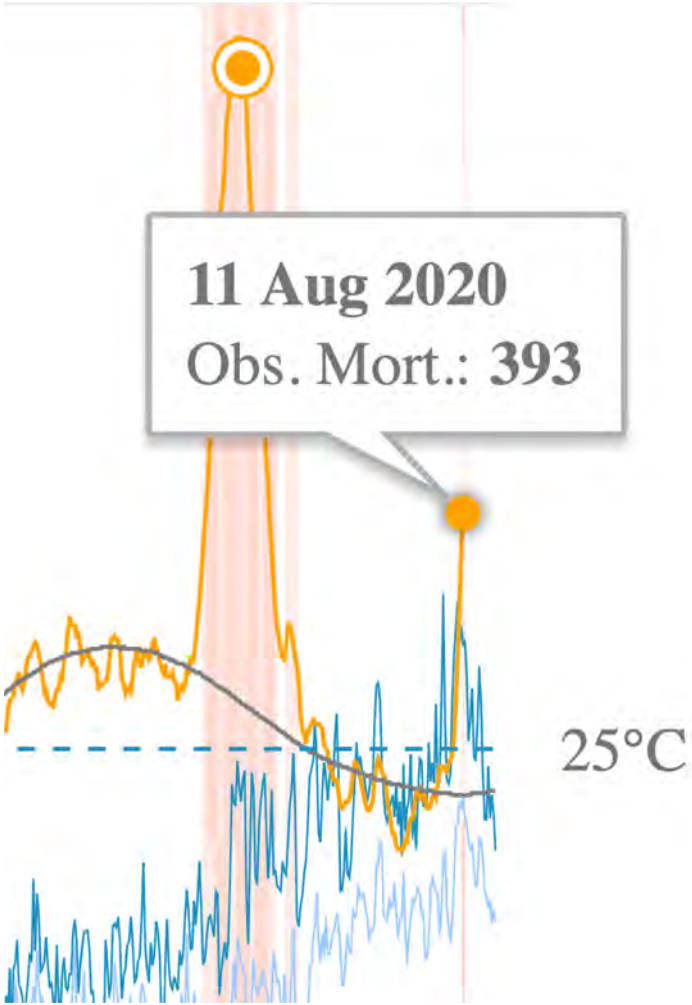


Source: www.remss.com

Heat waves kill

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

Décès dus à la canicule d'août 2020 en Belgique: plus de 1400 d'après Sciensano



Floods in France, October 2020

Les tombes du cimetière de Saint-Dalmas-de-Tende ont été emportés par les eaux après les inondations qui ont causé des dégâts considérables dans le département des Alpes-Maritimes. (Photo : FABIEN NOVIAL/AFP via Getty Images)

ACTUALITÉS

Alpes-Maritimes : 150 corps du cimetière du village de Tende emportés par les crues lors de la tempête Alex

Fact: Climate change impacts poor people first, but we are all on the same spaceship

@JPvanYpersele

Risk = Hazard x Vulnerability x Exposure

(Victims of New Orleans floods after Katrina in 2005)

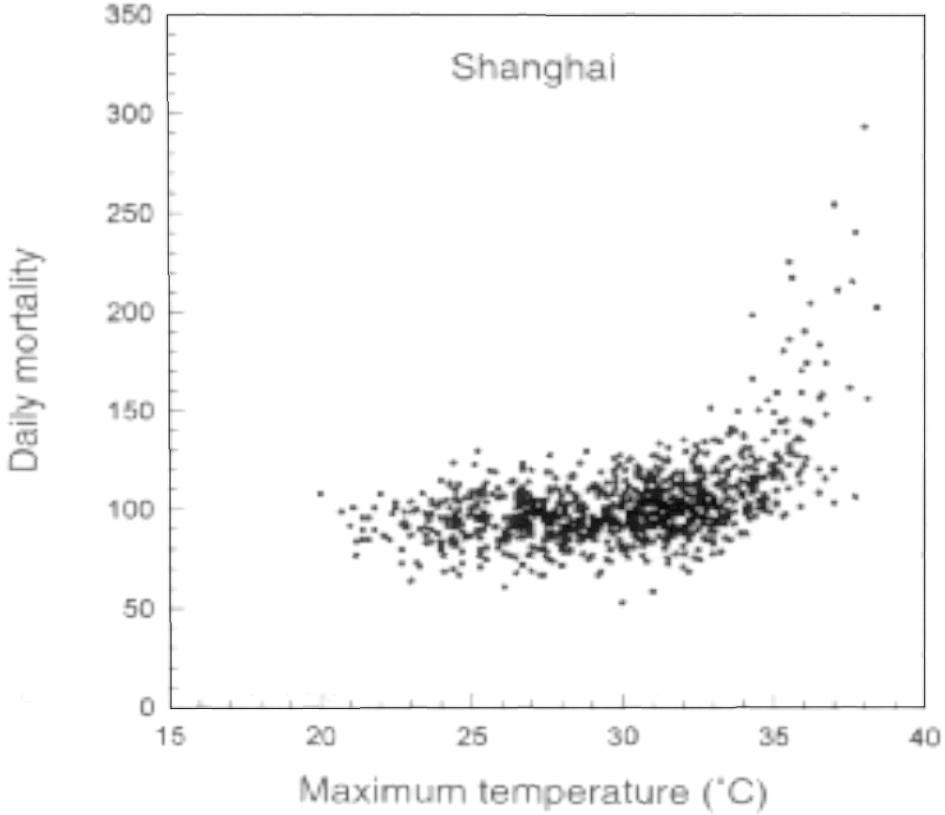
AP Photo - Lisa Krantz (http://lisakrantz.com/hurricane-katrina/zspbn1k4cn17phidupe4f9x5t1mzdr)

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.

Relationship between maximum temperature and mortality in Shanghai, China, 1980-89



Référence : CILIMATE CHANGE AND HUMAN HEALTH, 1996

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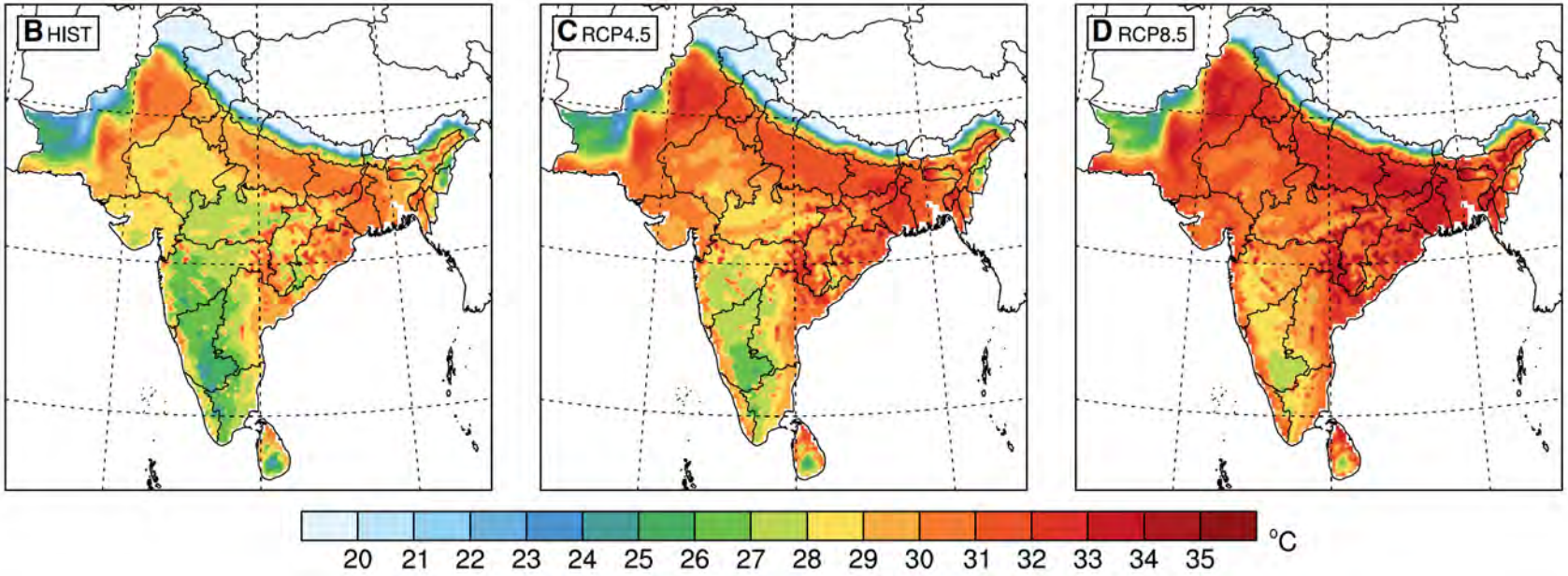
(vanyp@climate.be)

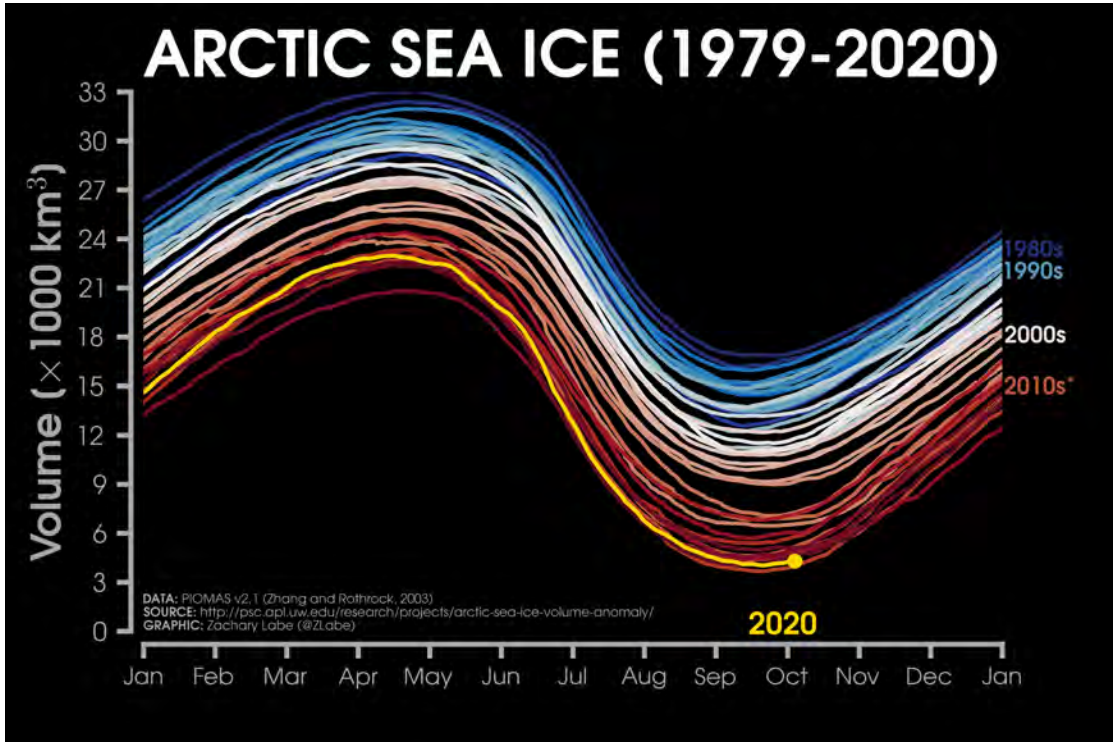
Evolution of daily maximum wet-bulb temperature, TWmax (°C)



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.

Arctic sea-ice *volume* 1979-2020



Source: @ZLabe

Plateau Glacier (1961)
(Alaska)

http://www.weather.com/news/science/environment/alaskas-glaciers-capturing-earth-changing-our-eyes-20131125?cm_ven=Email&cm_cat=ENVIRONMENT_us_share

Plateau Glacier (2003)
(Alaska)

http://www.weather.com/news/science/environment/alaskas-glaciers-capturing-earth-changing-our-eyes-20131125?cm_ven=Email&cm_cat=ENVIRONMENT_us_share

Les glaciers, d'un siècle à l'autre

Rédaction : Philippe Marbaix et Bruna Gaino

La Mer de Glace (massif du Mont-Blanc, France)

1919

Photo : Walter Mittelholzer, ETH-Bibliothek Zürich

2019

Photo : Dr Kieran Baxter, Université de Dundee

20-7-2020

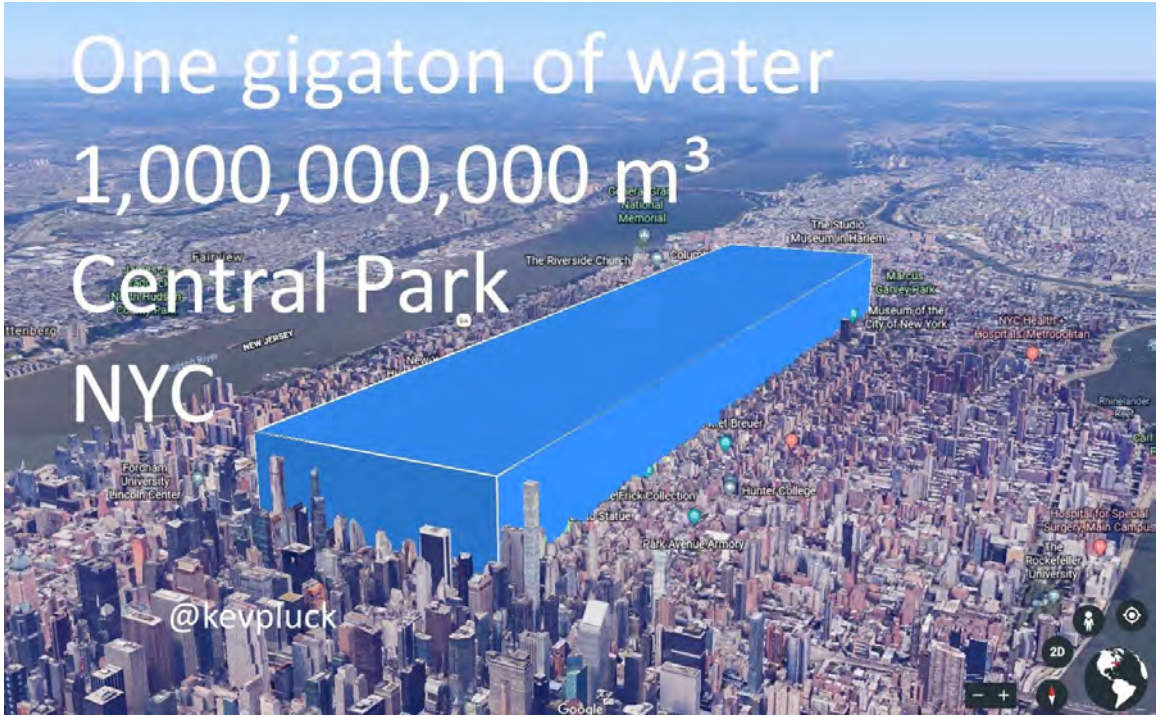
Photo: @RaphvanYpersele (Instagram)

Fact : Average temperature is probably 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

@JPvanYpersele

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



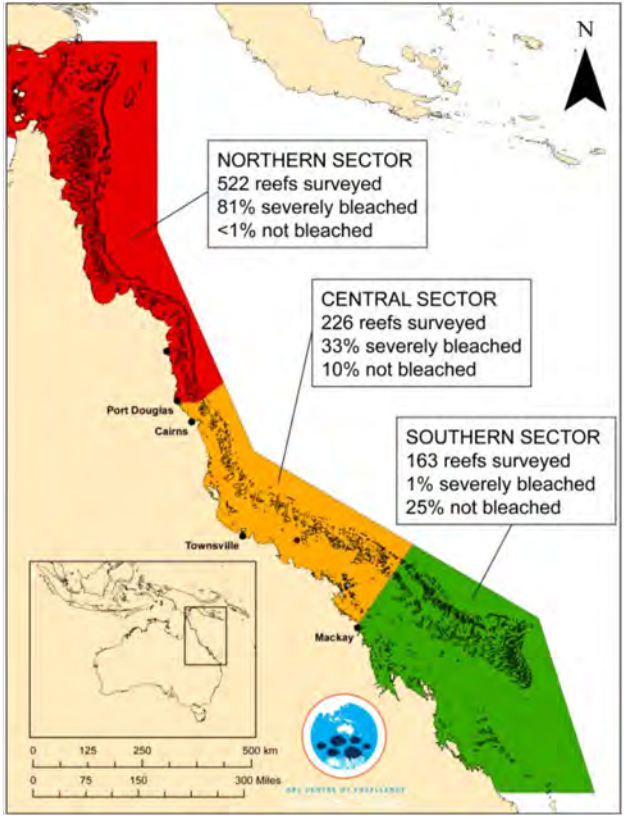
Source: @Kevpluck, June 2018

Fact: Ecosystems suffer more and more, while our wellbeing depends on their good state

The « Sixth Extinction » has started, and climate change is one of the causing factors

@JPvanYpersele

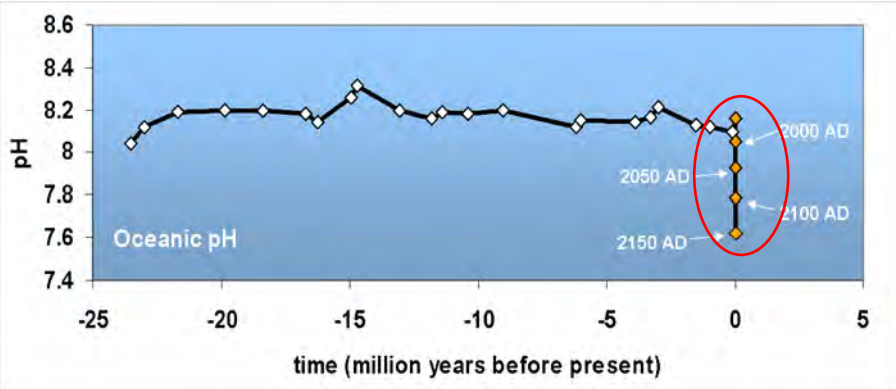
2016: Only 7% of the Great Barrier Reef has avoided coral bleaching



JCU Australia - ARC Centre of Excellence for Coral Reef Studies / Tom Bridge and James Kerry

Oceans are Acidifying Fast …….

Changes in pH over the last 25 million years



"Today is a rare event in the history of the World"

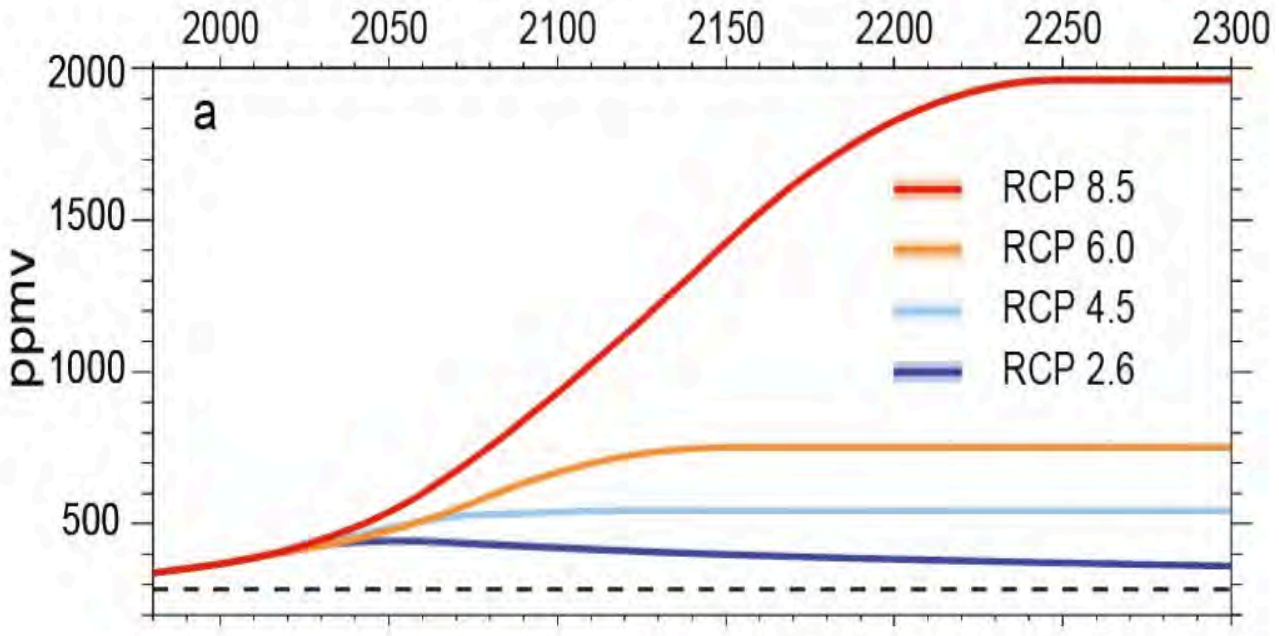
- **It is happening now, at a speed and to a level not experienced by marine organisms for about 60 million years**
- **Mass extinctions linked to previous ocean acidification events**
- **Takes 10,000's of years to recover**

Turley et al. 2006

Slide courtesy of Carol Turley, PML

Prognosis

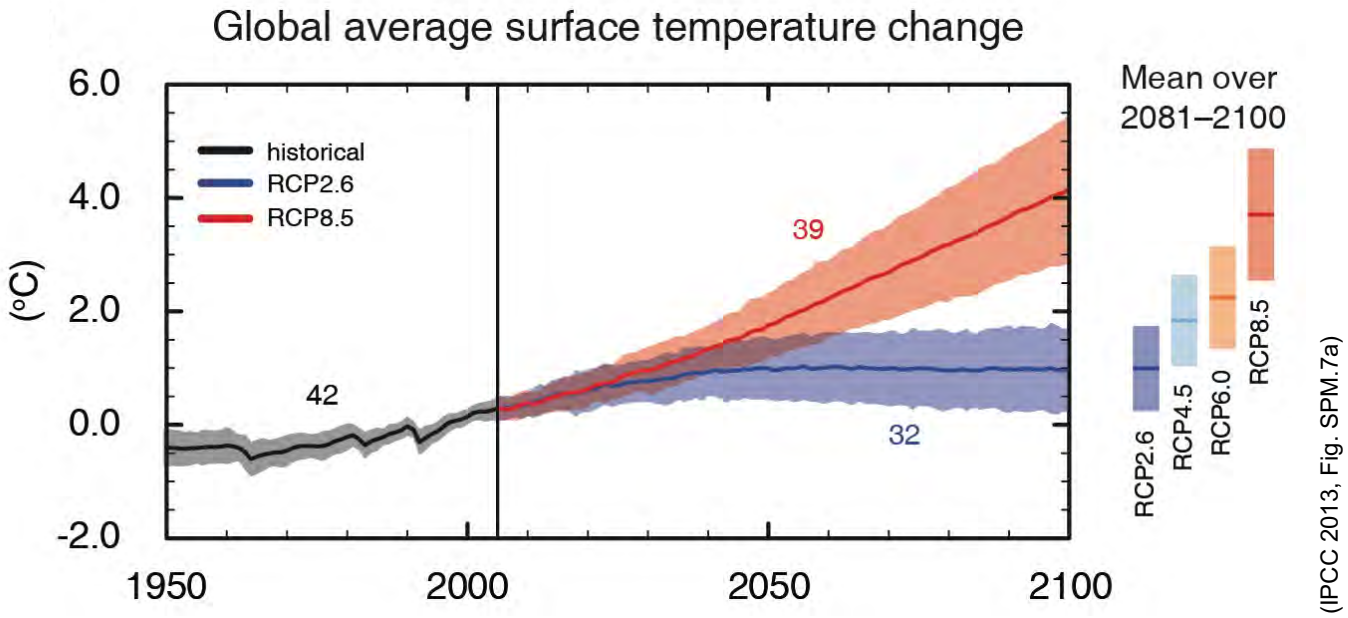
RCP Scenarios: Atmospheric CO_2 concentration



Three stabilisation scenarios: RCP 2.6 to 6
One Business-as-usual scenario: RCP 8.5

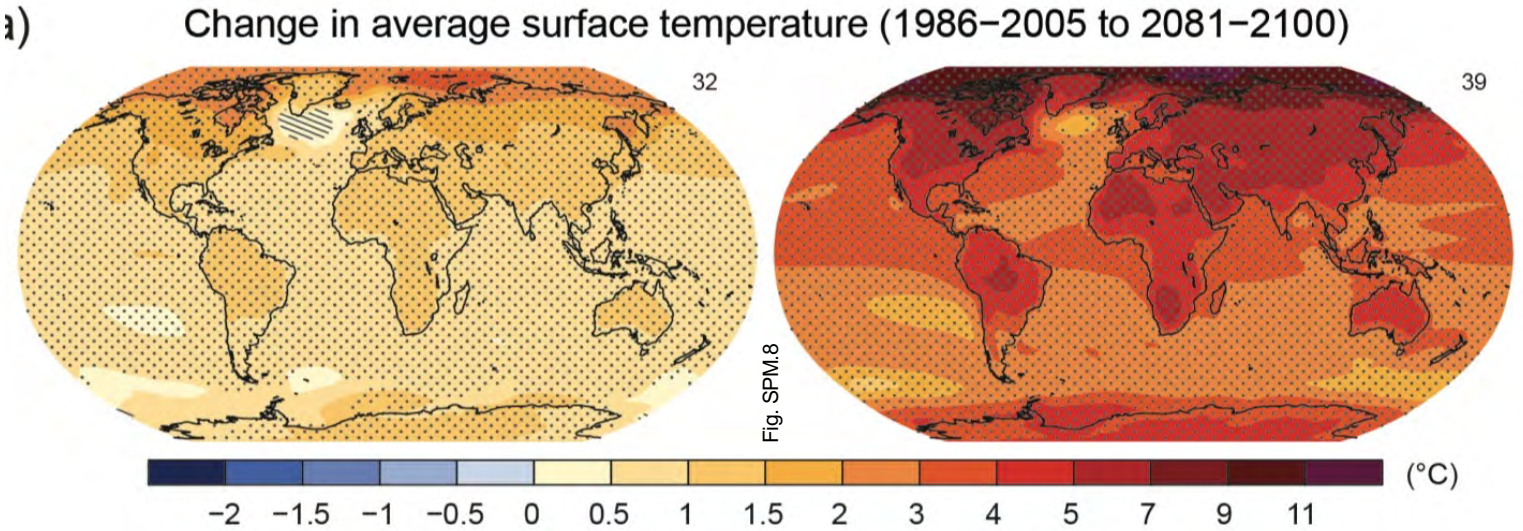
AR5, chapter 12. WGI

Projected global temperature increase during 21st century



(IPCC 2013, Fig. SPM.7a)

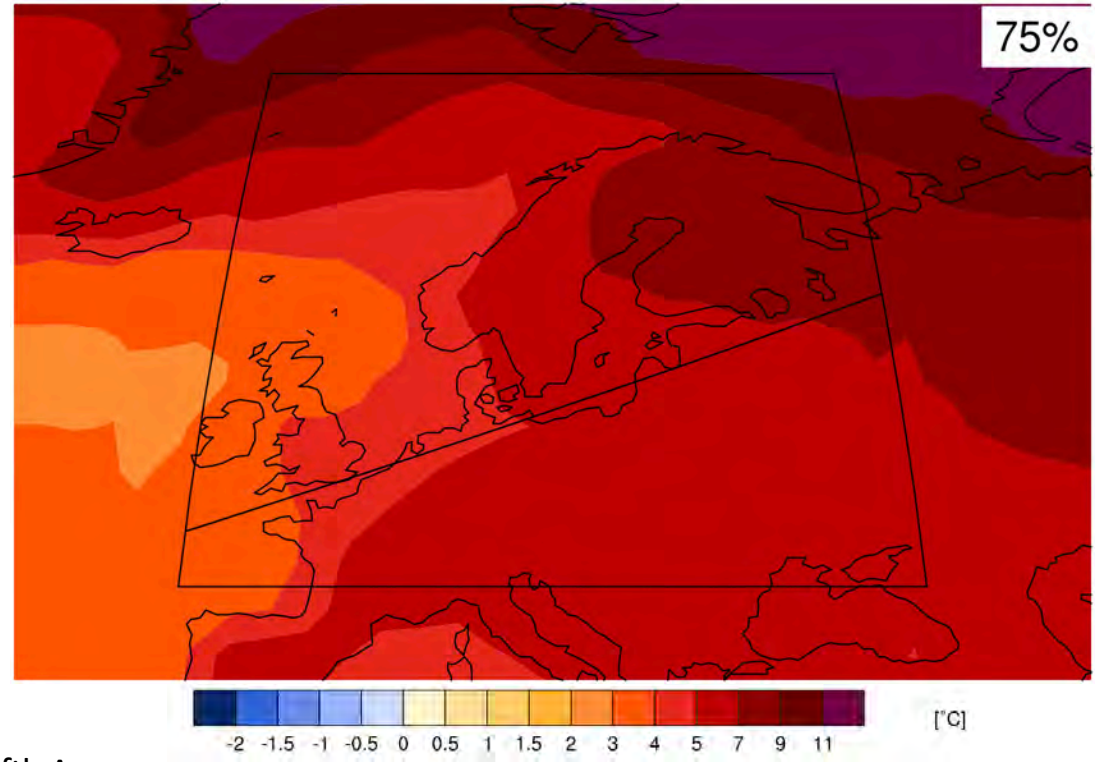
RCP2.6 RCP8.5



Hatching [hachures] indicates regions where the multi-model mean is small compared to natural internal variability (i.e., less than one standard deviation of natural internal variability in 20-year means).

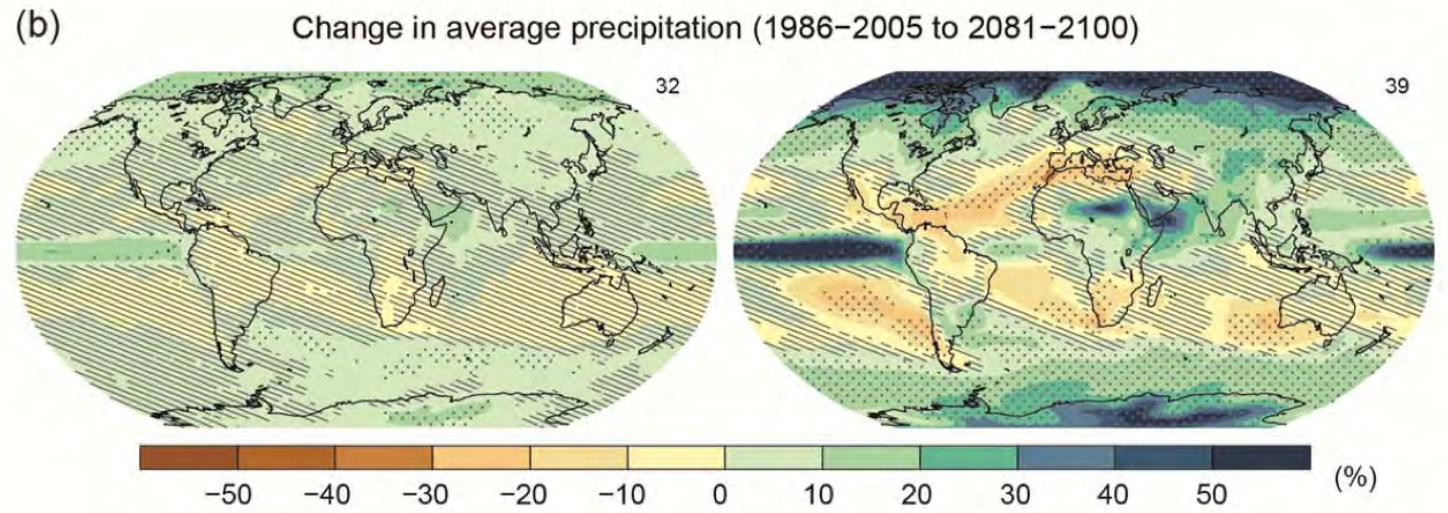
Stippling [pointillés] indicates regions where the multi-model mean is large compared to natural internal variability (i.e., greater than two standard deviations of natural internal variability in 20-year means) and where at least 90% of models agree on the sign of change

North Europe - Map of temperature changes: 2081–2100 with respect to 1986–2005 in the RCP8.5 scenario (annual)



IPCC WG1 Fifth Assessment Report (Final Draft)

Projected Change in Precipitation



Hatching indicates regions where *the multi-model mean is small compared to natural internal variability* (i.e., less than one standard deviation of natural internal variability in 20-year means).
Stippling indicates regions where the multi-model mean is large compared to natural internal variability (i.e., greater than two standard deviations of natural internal variability in 20-year means) and where at least 90% of models agree on the sign of change

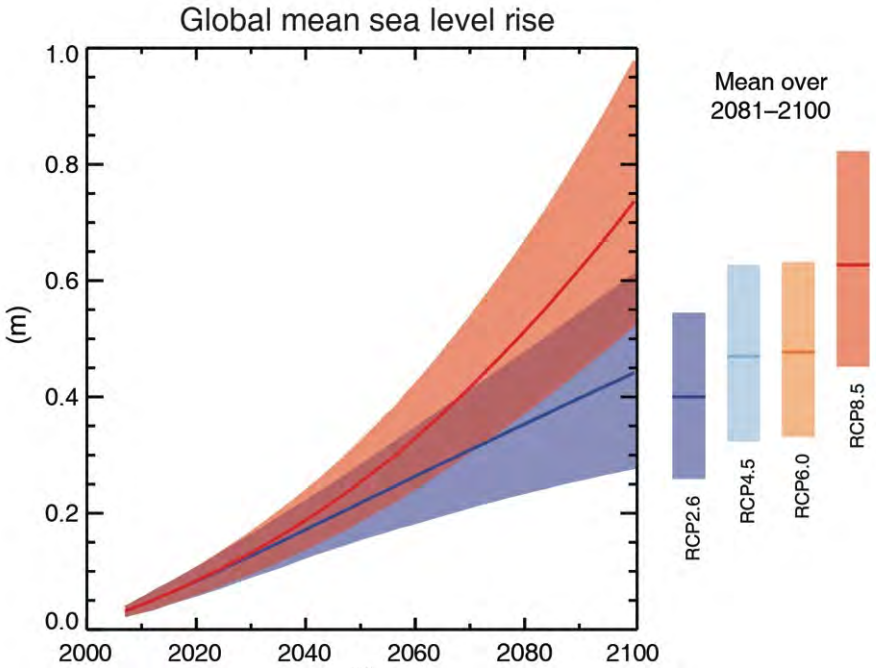


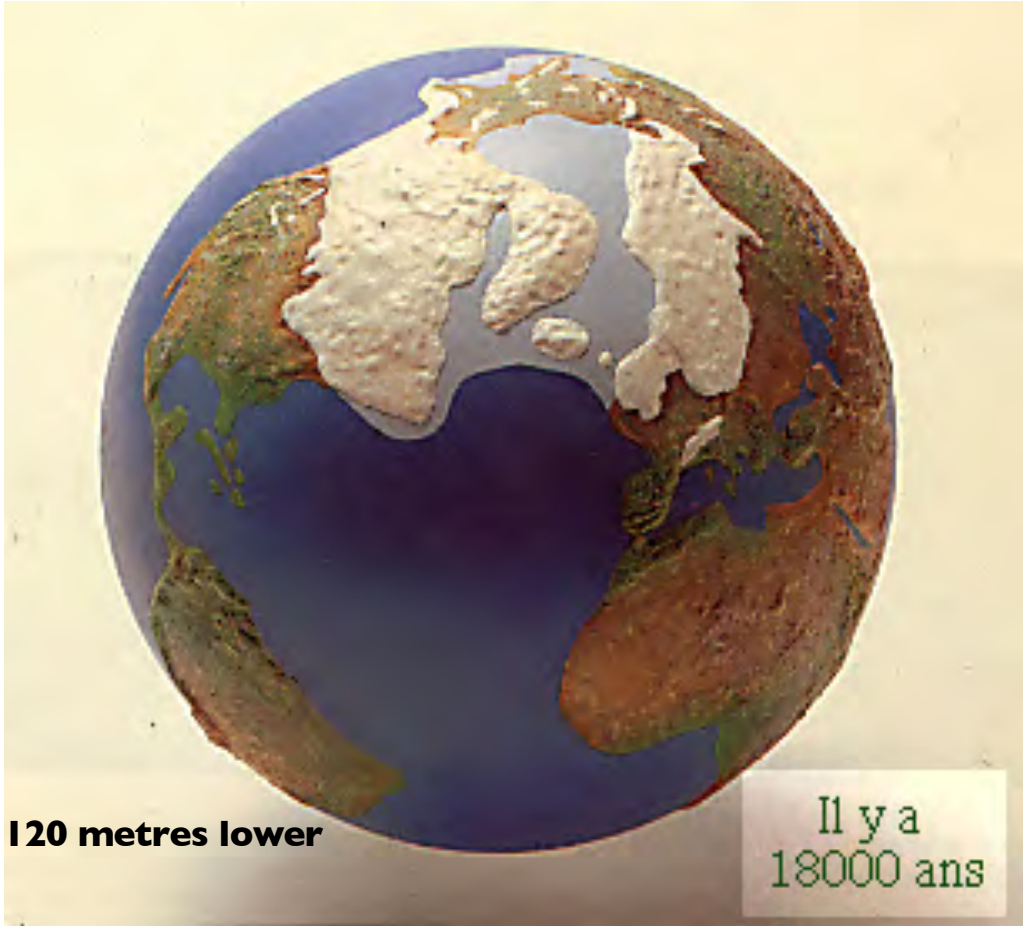
Fig. SPM.9

RCP2.6 (2081-2100), *likely* range: **26 to 55 cm**

RCP8.5 (in 2100), *likely* range: **52 to 98 cm**

18-20000 years ago (Last Glacial Maximum)

With permission from Dr. S. Joussaume, in « Climat d'hier à demain », CNRS éditions.



Sea level: 120 metres lower

Today, with +4-5° C globally

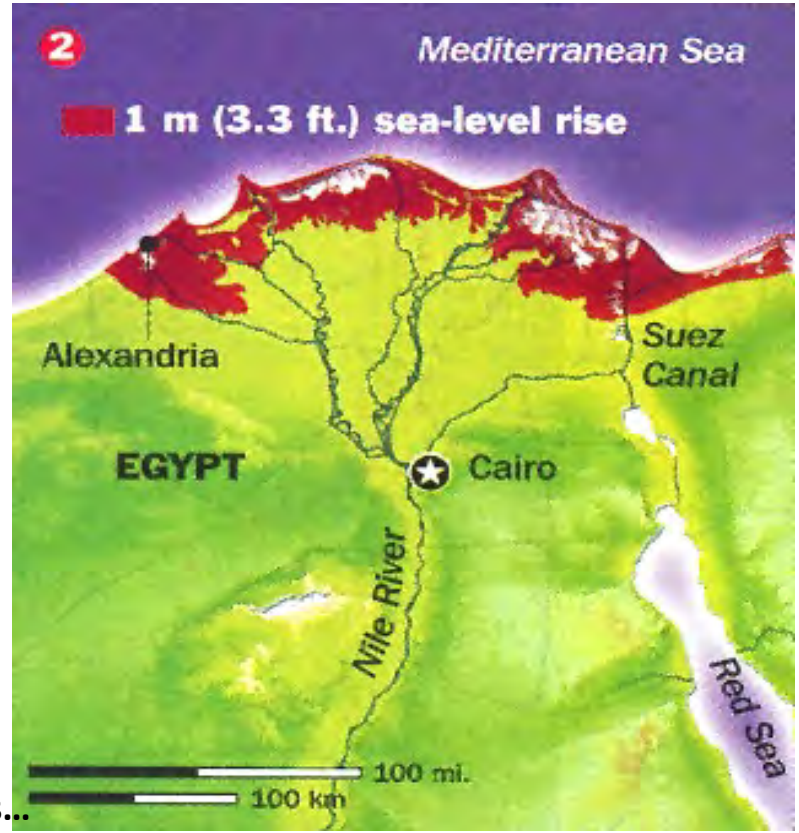
With permission from Dr. S. Joussaume, in « Climat d'hier à demain », CNRS éditions.

With 1 metre sea-level rise: 63000 ha below sea-level in Belgium (likely in 22nd century, not impossible in 21st century)

(NB: flooded area depends on protection)

Source: N. Dendoncker (Dépt de Géographie, UCL), J.P. van Ypersele et P. Marbaix (Dépt de Physique, UCL)

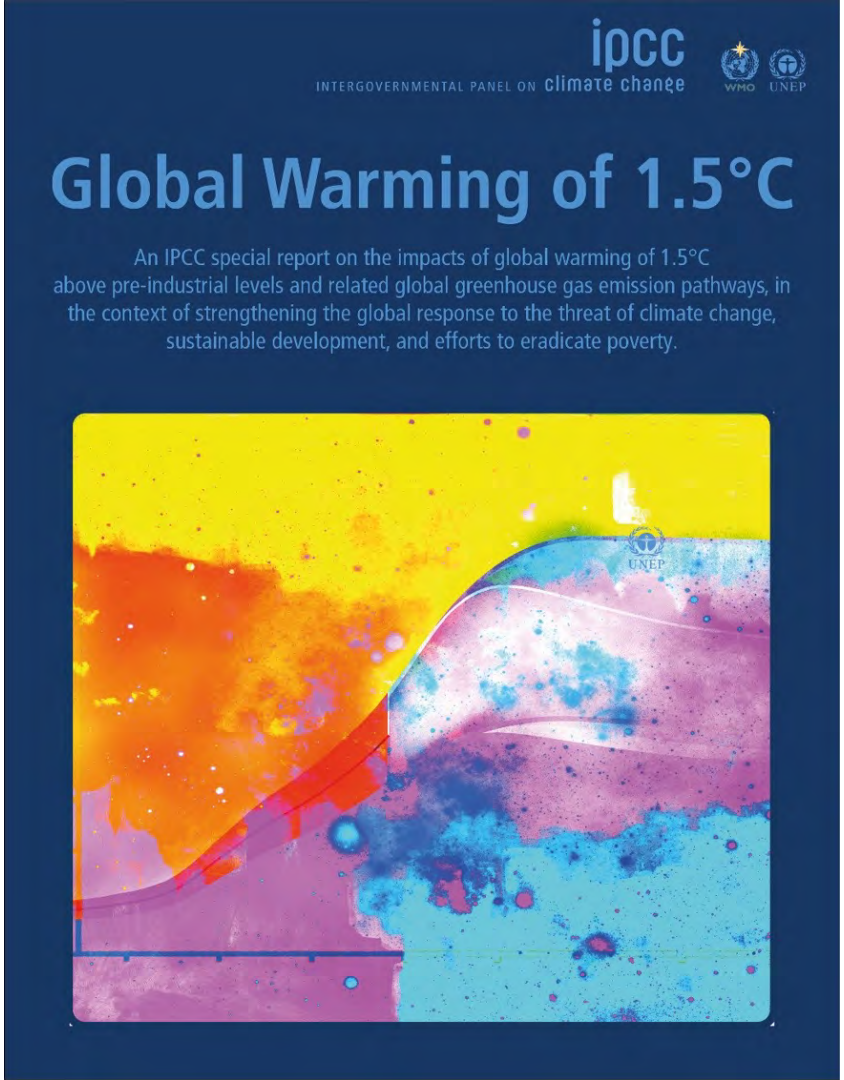
Effects on the Nile Delta, where more than 10 million people live less than 1 m above sea level



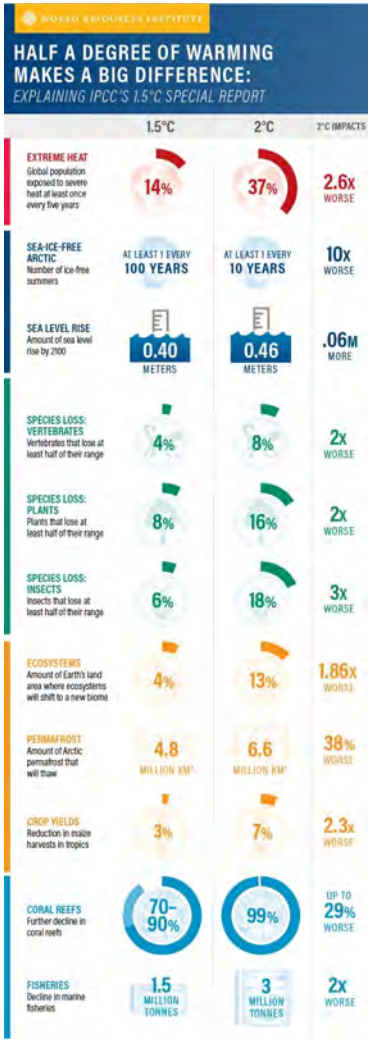
NB: + 1 m is possible in the next 100 years…

(Time 2001)

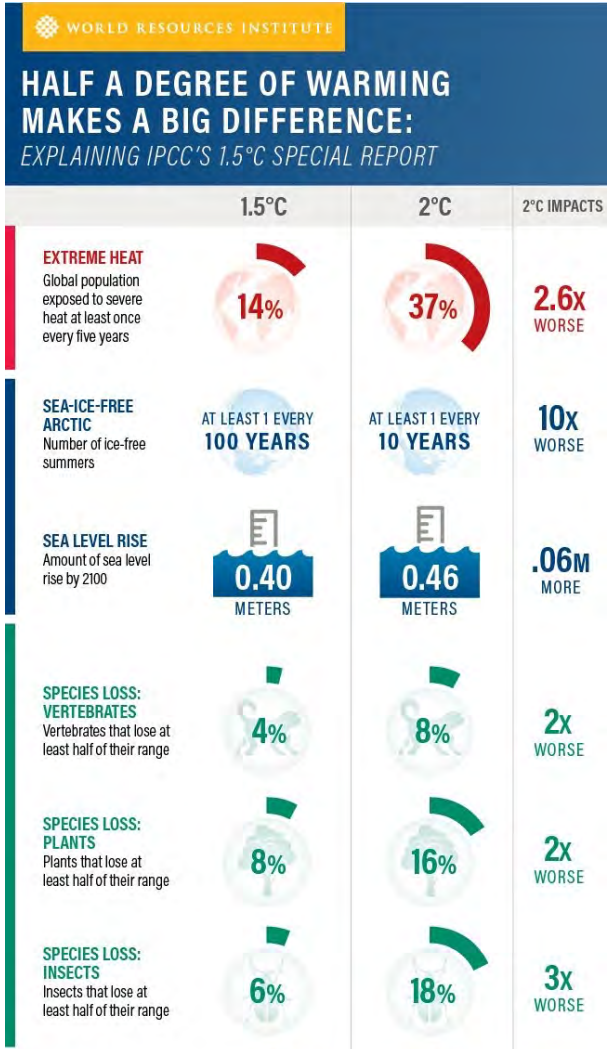
The SR15


ipcc
INTERGOVERNMENTAL PANEL ON climate change
WMO UNEP
Global Warming of 1.5°C
An IPCC special report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty.
UNEP

Responsibility for content: WRI



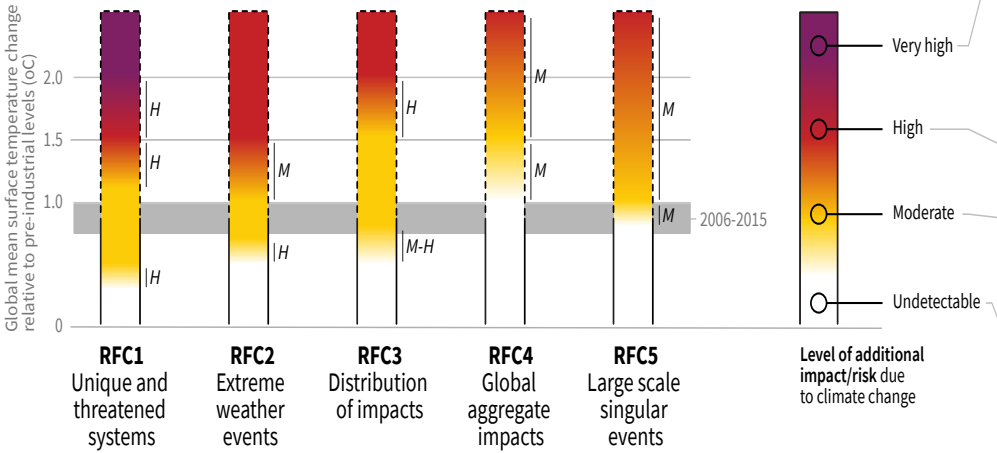
Responsibility for content: WRI



How the level of global warming affects impacts and/or risks associated with the Reasons for Concern (RFCs) and selected natural, managed and human systems

Five Reasons For Concern (RFCs) illustrate the impacts and risks of different levels of global warming for people, economies and ecosystems across sectors and regions.

Impacts and risks associated with the Reasons for Concern (RFCs)



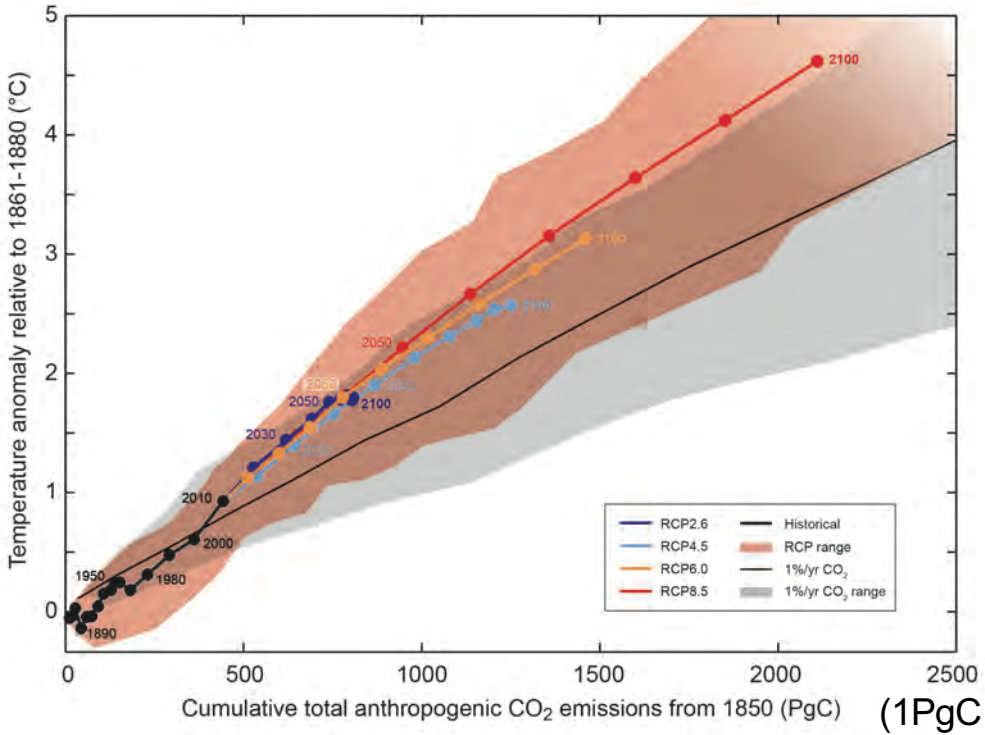
Purple indicates very high risks of severe impacts/risks and the presence of significant irreversibility or the persistence of climate-related hazards, combined with limited ability to adapt due to the nature of the hazard or impacts/risks.

Red indicates severe and widespread impacts/risks.

Yellow indicates that impacts/risks are detectable and attributable to climate change with at least medium confidence.

White indicates that no impacts are detectable and attributable to climate change.

Urgency of Treatment

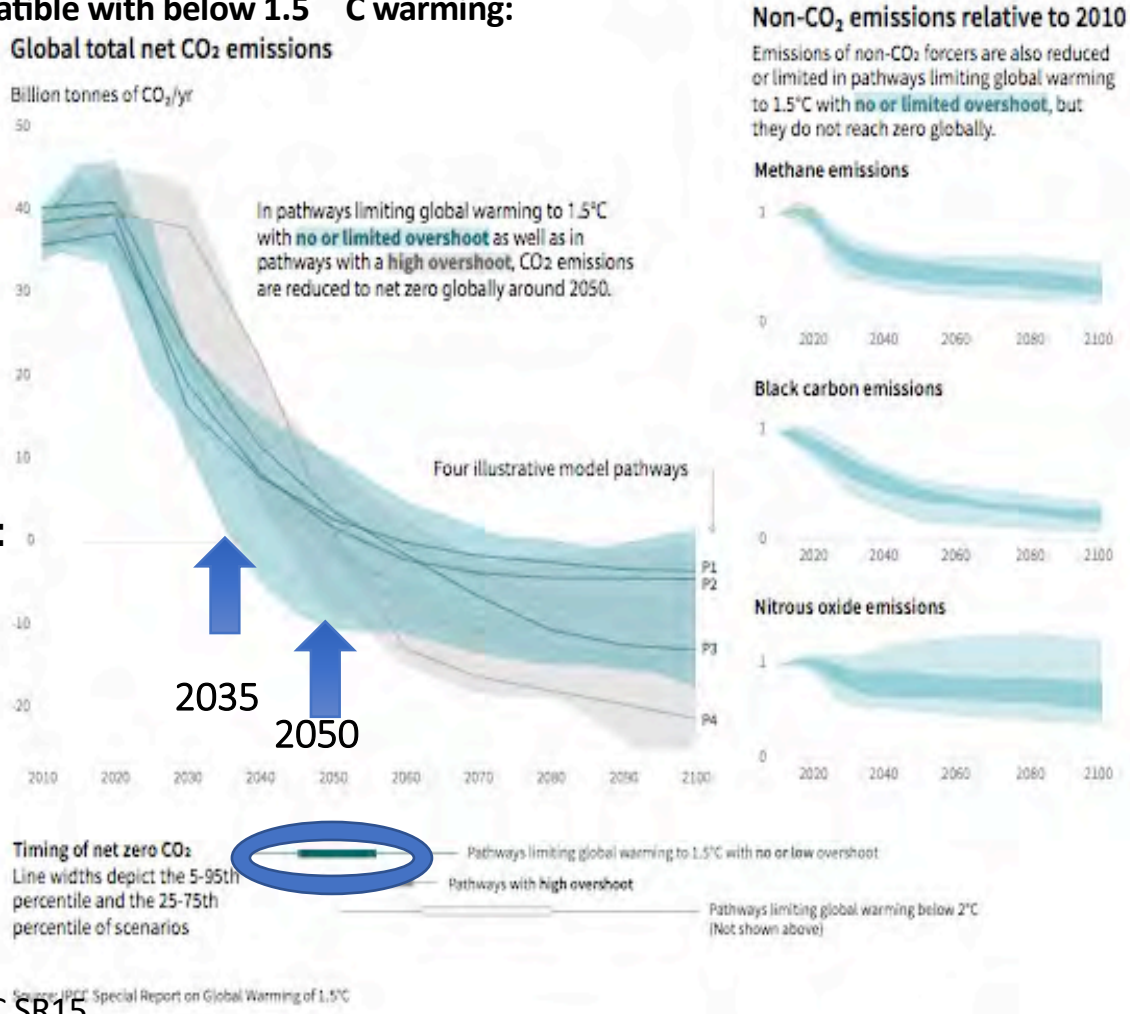


(IPCC 2013, Fig. SPM.10)

(1PgC = 1GtC)

Le total des émissions de CO_2 cumulées détermine dans une large mesure la moyenne globale du réchauffement en surface vers la fin du XXIème siècle et au delà

Emission pathways compatible with below 1.5° C warming:



Net ZERO:

Source: IPCC SR15

Greenhouse gas emissions pathways

- Limiting warming to 1.5° C would require changes on an unprecedented scale
  - Deep emissions cuts in all sectors
  - A range of technologies
  - Behavioural changes
  - Increase investment in low carbon options

Greenhouse gas emissions pathways

- Progress in renewables would need to mirrored in other sectors
- We would need to start taking carbon dioxide out of the atmosphere (Afforestation or other techniques)
- Implications for food security, ecosystems and biodiversity

Fact: The present national plans (NDCs) introduced ahead of the Paris Agreement are far from what is needed to respect the 1.5° C objective, and even to stay below 2° C warming

Please note that the Paris Agreement speaks about 1.5° C and « *well below* 2° C » warming, not 2° C

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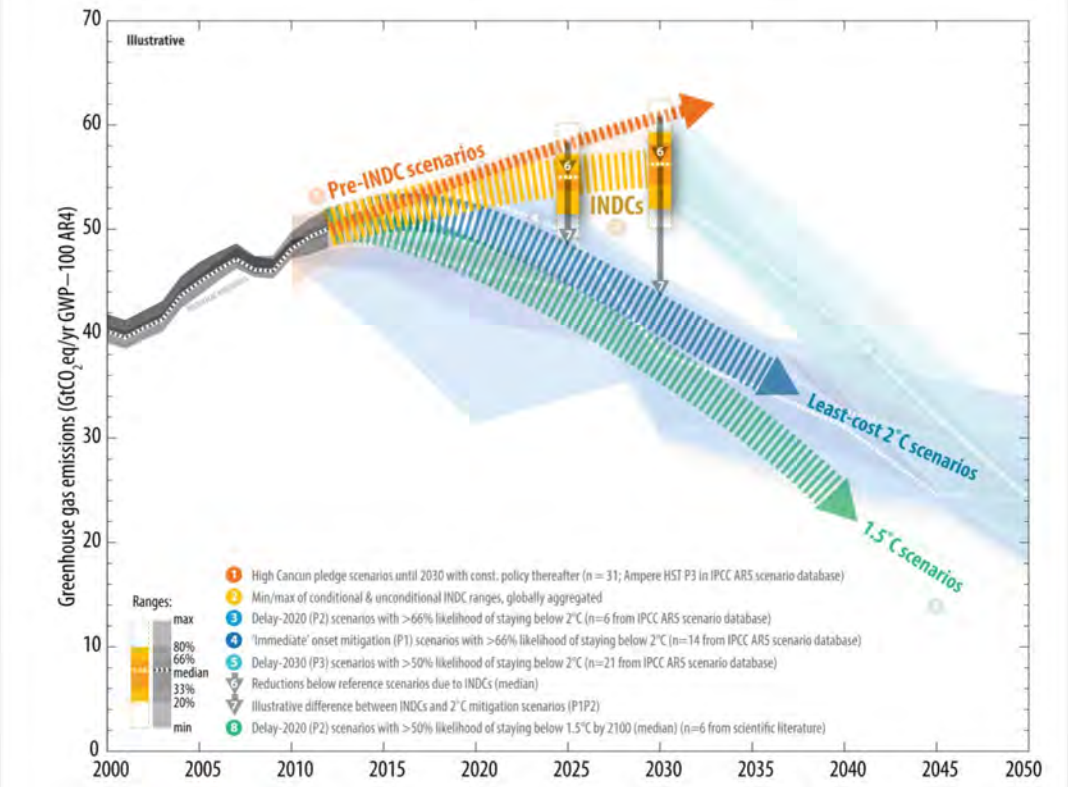
Comparison of global emission levels in 2025 and 2030 resulting from the implementation of the intended nationally determined contributions



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

Objectifs de la Belgique dans le cadre européen

- Evolution des émissions en Belgique et objectifs de réduction (secteurs non-ETS)
- (2005-2015: émissions réelles; 2015-2035: projections)

Source: Commission Nationale Climat (2017)

(Element) of solution n° 1: The survival of humanity and ecosystems must become a much higher political priority

… as if we were all running for our life.

@JPvanYpersele

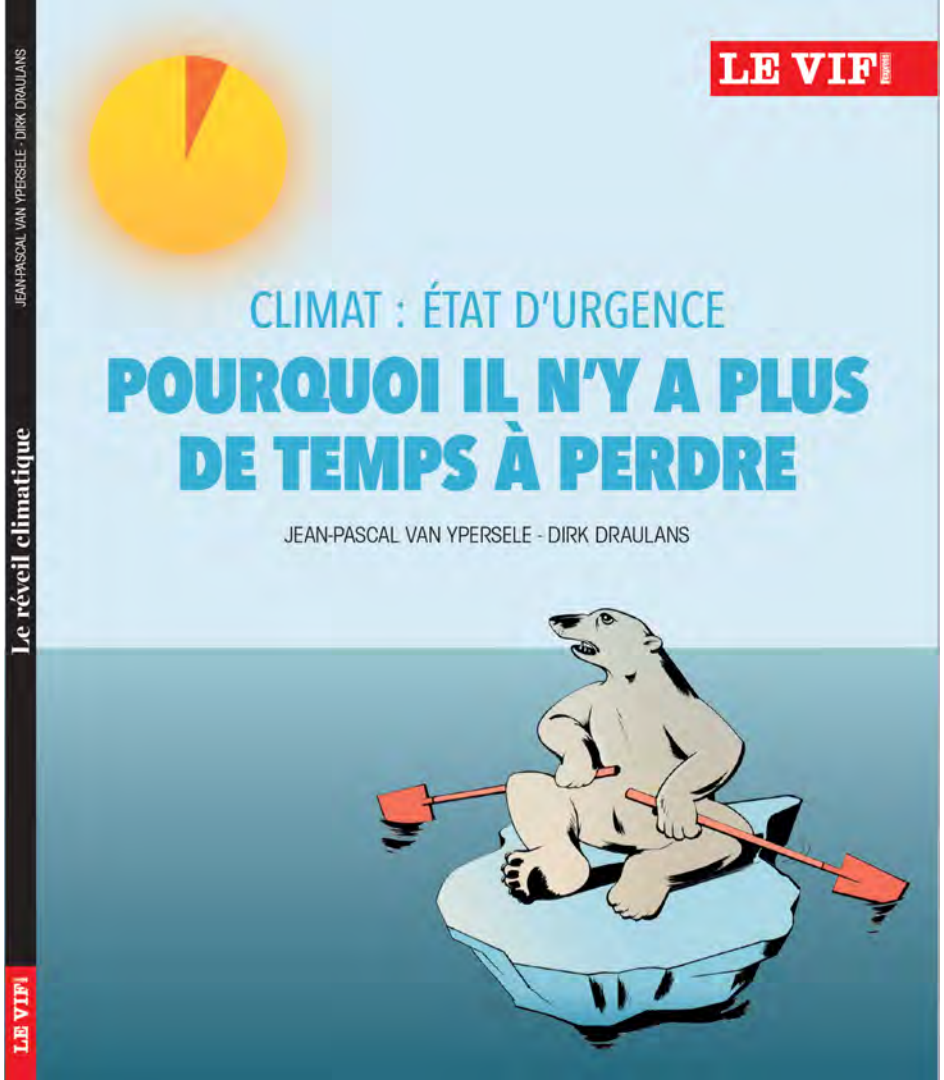
SUSTAINABLE DEVELOPMENT GOALS

Key messages of the « United in Science » report (UN, 2020)

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

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

Gratuit sur
www.levif.be/reveil-climatique



Gratis op
www.knack.be/klimaatalarm

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 KLIMAATALARM

HET KLIMAAT ALARM

Dirk Draulans en
Jean-Pascal van Ypersele

Knack

To go further :

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

Also :

- www.wechangeforlife.org : 250 Belgians experts speak
- www.klimaatpanel.be : our report (FR/NL) on behalf #YouthForClimate (14 May 2019)
- www.climate.be/vanyp : my note (in FR & NL) presented to the royal informers on 4 June 2019

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Site where my slides will be available:

- www.climate.be/vanyp/conferences

- **Twitter: @JPvanYpersele**
  @IPCC_CH