Climate Change: Diagnosis, Prognosis, and Urgency of Treatment

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Agora Urban Master Class, Brussels Academy, BOZAR, 20 November 2019

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

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).

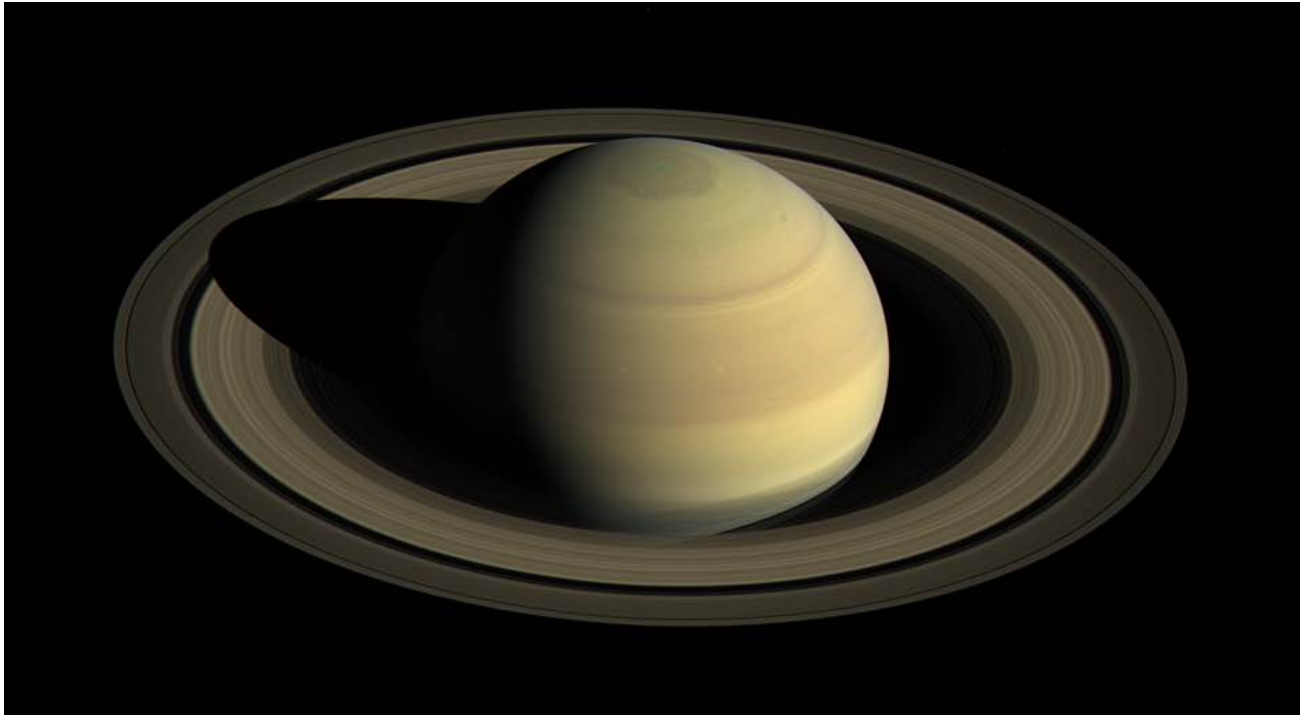
WMO=World Meteorological Organization

UNEP= United Nations Environment Programme

Source: @JohnfoCook

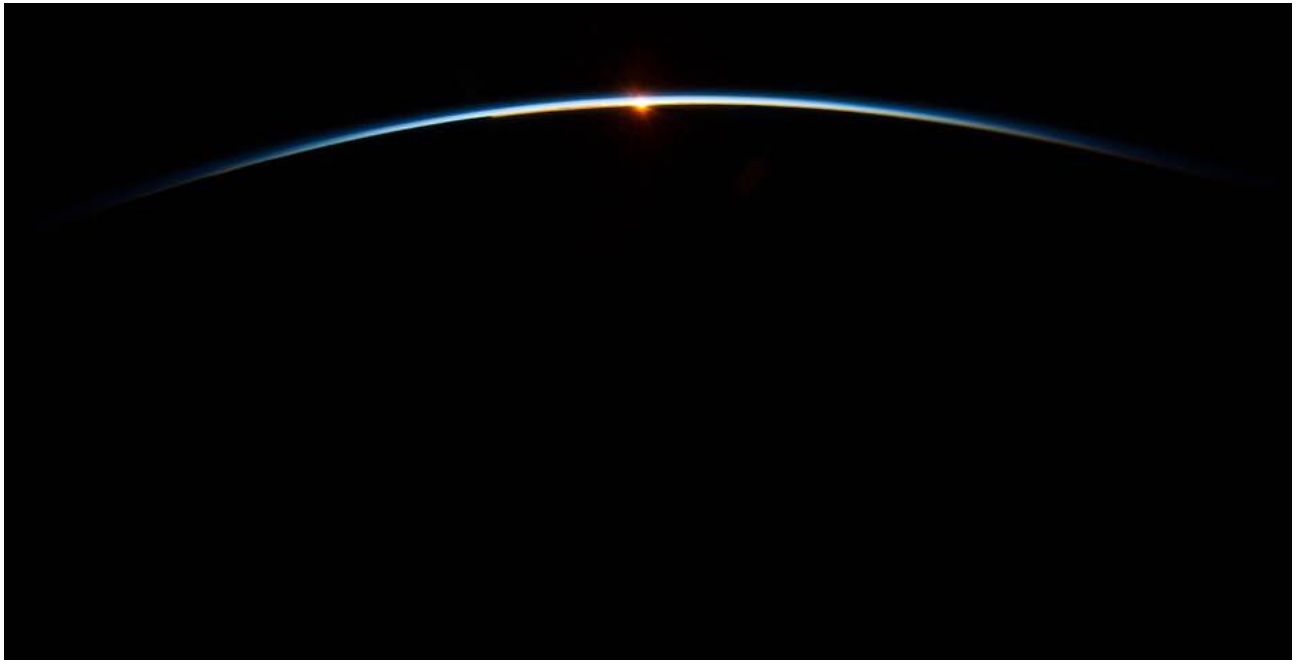
Diagnosis

Saturn, as seen on 25-4-2016 from a 3 million km distance by the Cassini satellite launched in October 1997, 40 years after Sputnik



That small blue dot is the Earth, a seen from Cassini, orbiting Saturn, 1.44 billion km from us, on 19-7-2013

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



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(vanyp@climate.be)

Fact n° 1: 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

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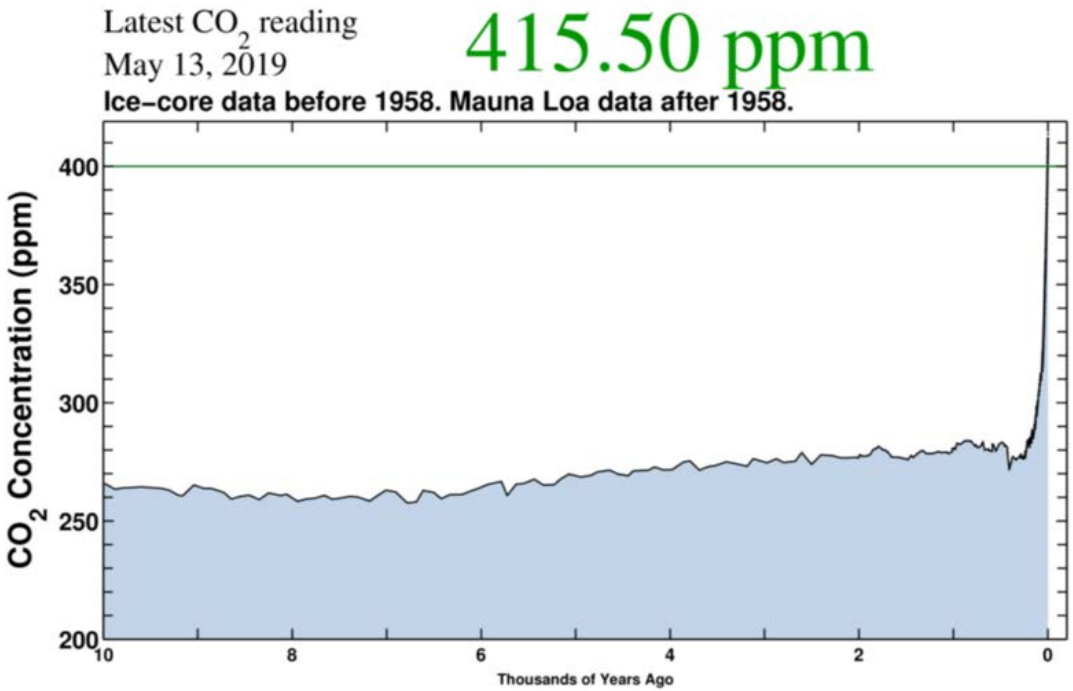
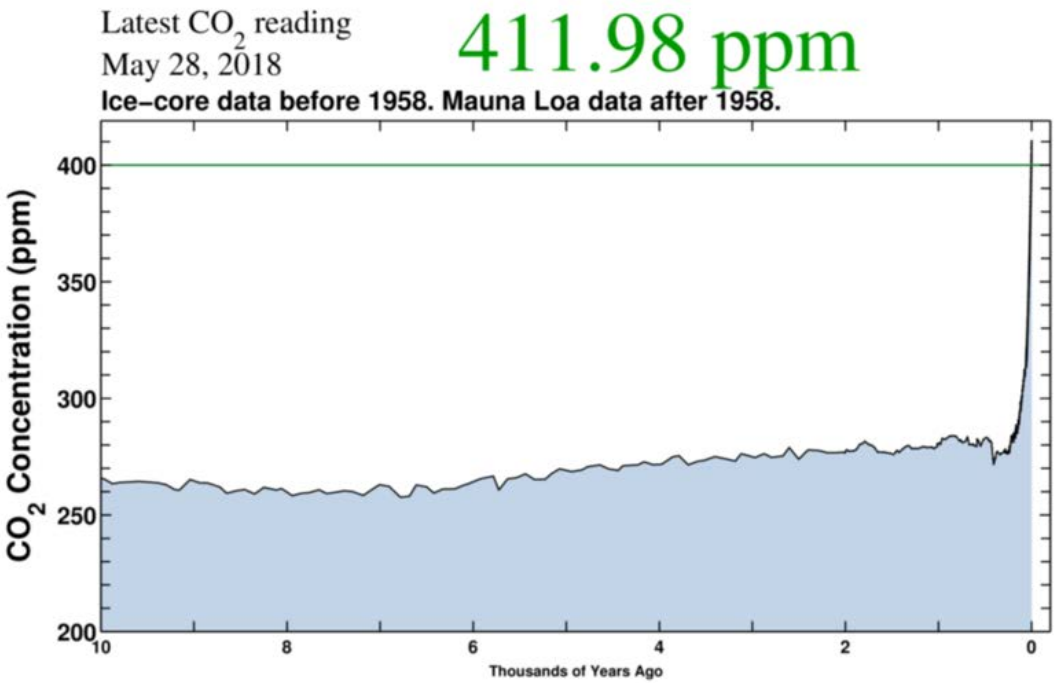
CO_2 Concentration, 13 May 2019 (Keeling curve)

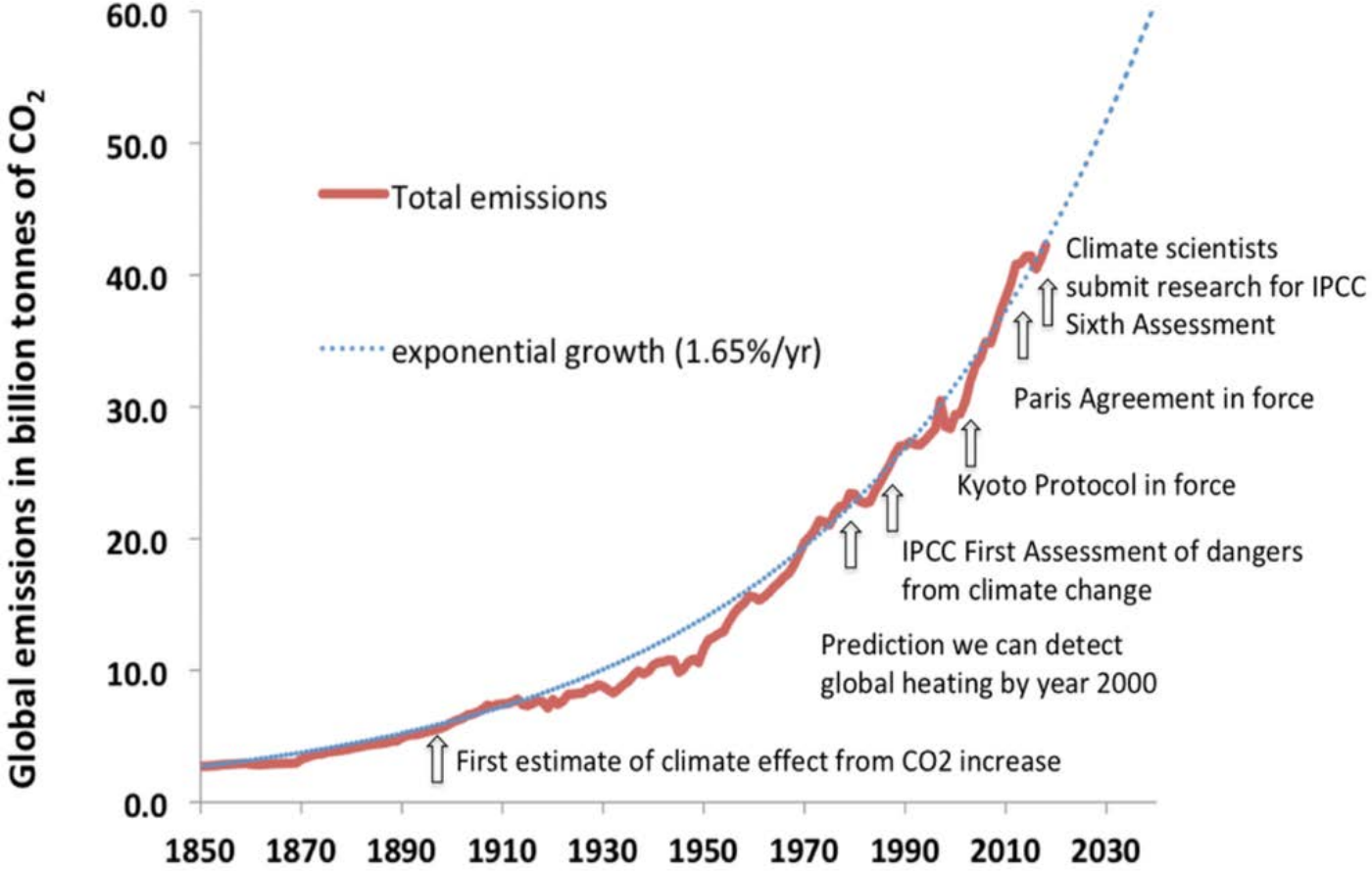


Source: scripps.ucsd.edu/programs/keelingcurve/

CO_2 Concentration, 28 May 2018 (Keeling curve)



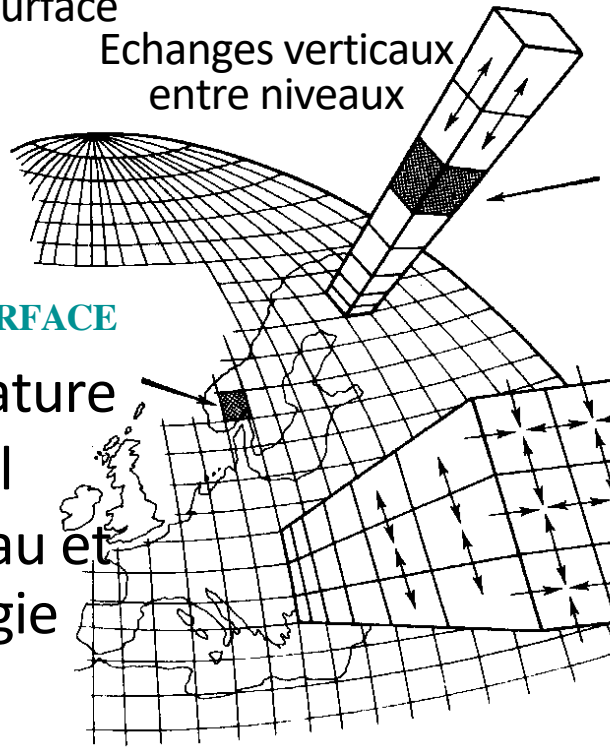
Source: scripps.ucsd.edu/programs/keelingcurve/



Source: Wolfgang Knorr, in The Conversation (2019)

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

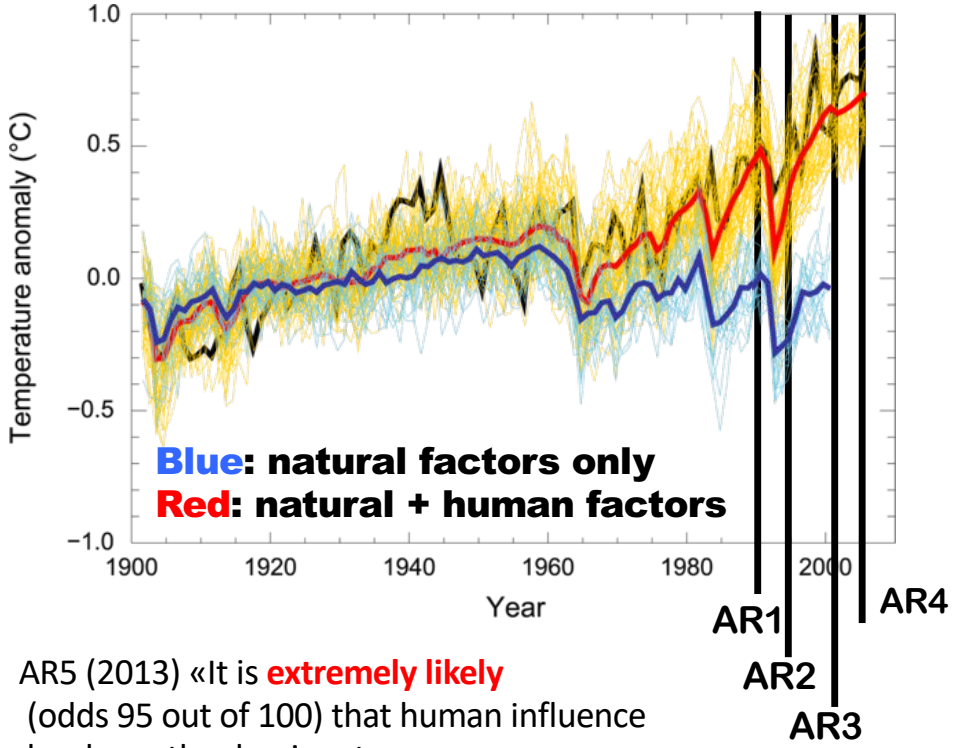
A Progression of Understanding: Greater and Greater Certainty in Attribution

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"

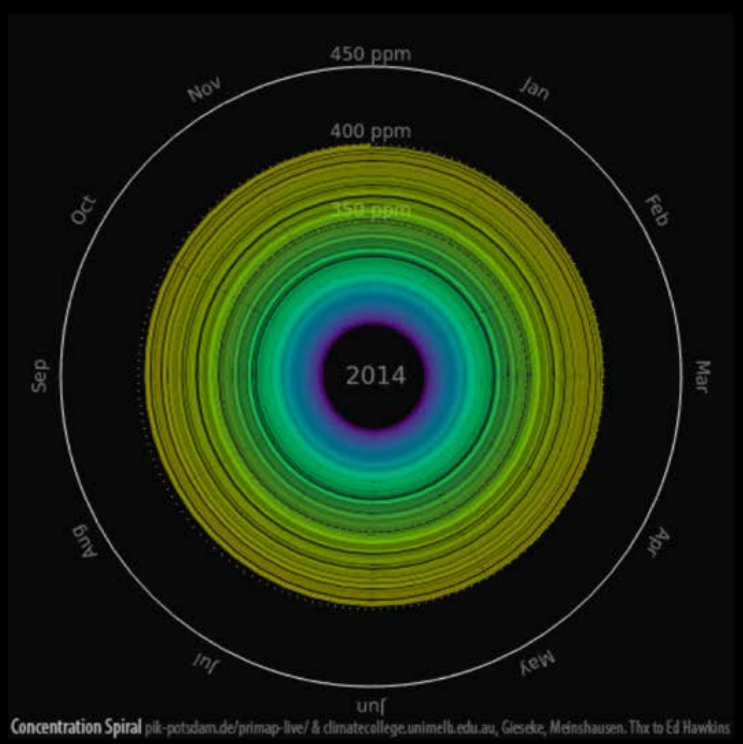
AR4 (2007): "most of the warming is **very likely** (odds 9 out of 10) due to greenhouse gases"

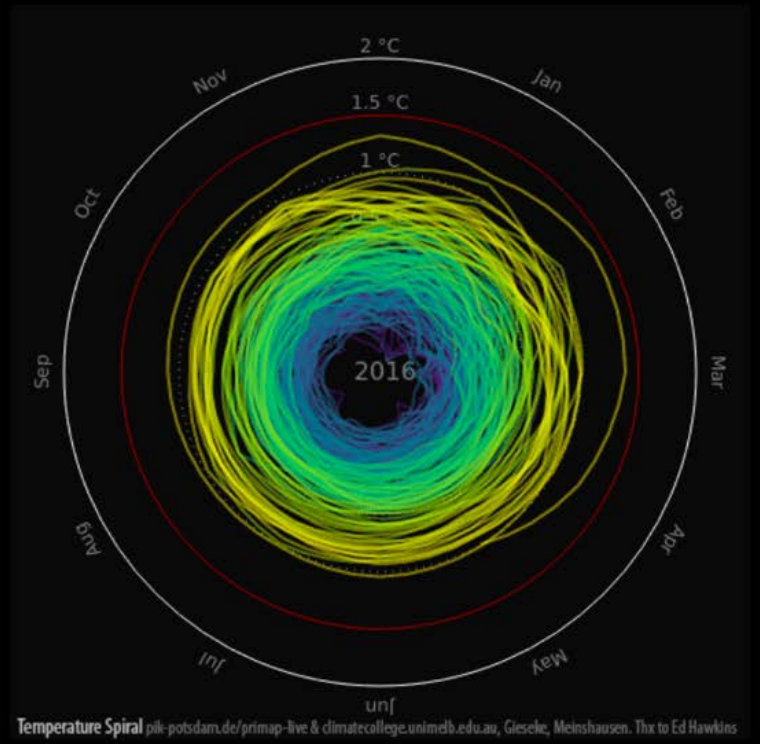


AR5 (2013) «It is **extremely likely** (odds 95 out of 100) that human influence has been the dominant cause… »

Fact n° 2: We have changed the composition of the atmosphere and disturbed the climate system

CO_2 Concentration and Temperature spirals



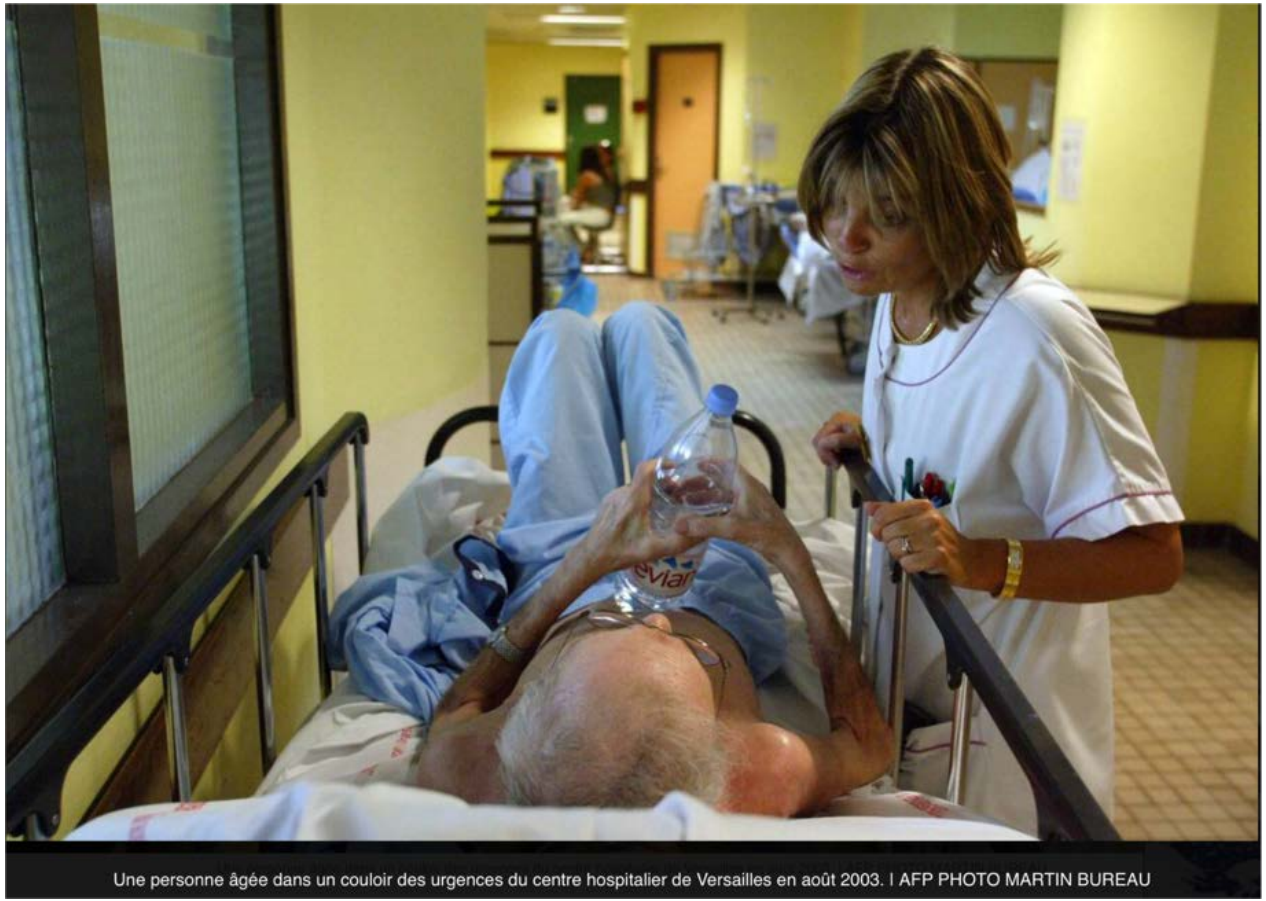


CO_2 Concentration since 1850 and Global Mean Temperature in °C relative to 1850 – 1900
Graph: Ed Hawkins (Climate Lab Book) – Data: HadCRUT4 global temperature dataset
Animation available on http://openclimatedata.net/climate-spirals/concentration-temperature/

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

Heat waves kill



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

Floods cost

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

Fact n° 3: 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

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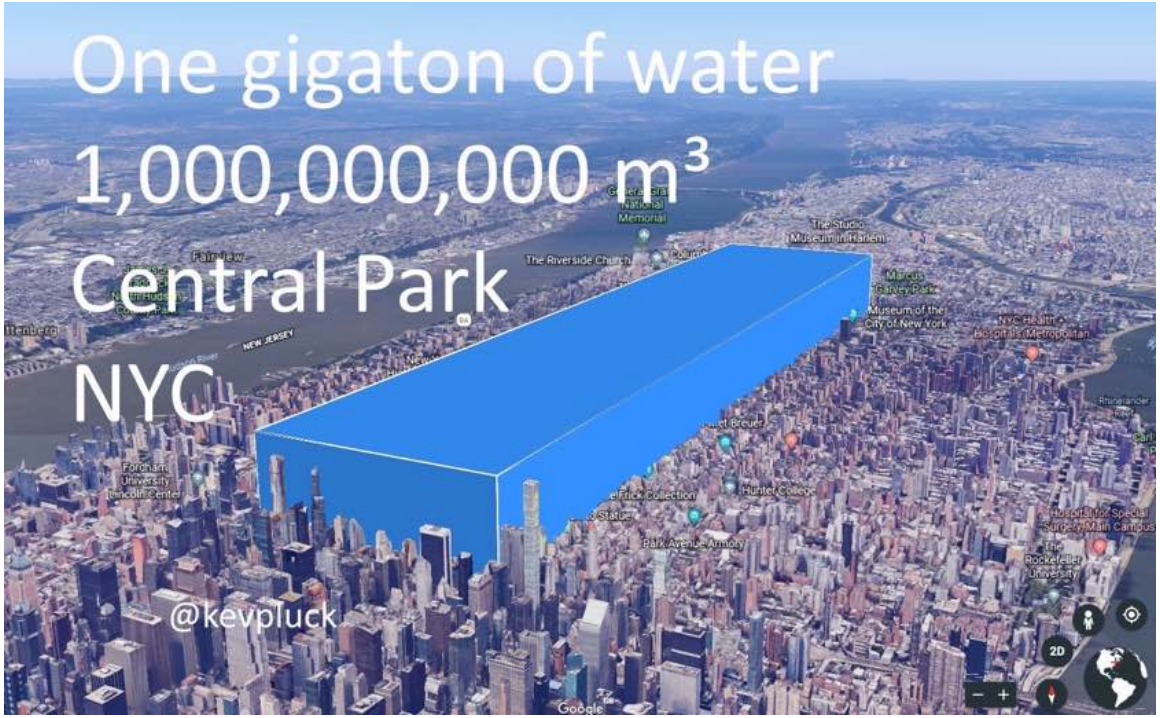
The Antarctic Ice Sheet presently loses 1 Gt of water every 1.5 day



Source: @Kevpluck, June 2018

Fact n° 4: World Health Organization (2018): Air pollution kills 7 million people per year (inc. 500 000 in Europe)

Sources of air pollution are broadly the same as those affecting climate: fossil fuels, wood and biomass combustion

Fine particulates from fossil fuel and wood burning kill

Photo: Jerzy Gorecki, Pixabay

Les enfants sont particulièrement vulnérables à la pollution

Photo: Indiatoday.in, 6-12-2017

Fact n° 5: Climate change impacts poor people first, but we are all on the same spaceship

Risk = Hazard x Vulnerability x Exposure

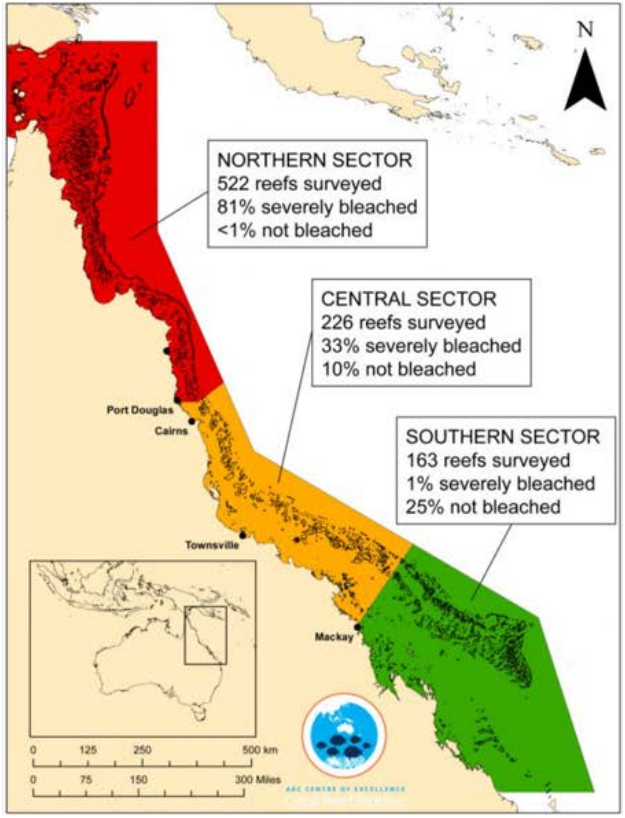
(Victims of New Orleans floods after Katrina in 2005)

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

Fact n° 6: 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

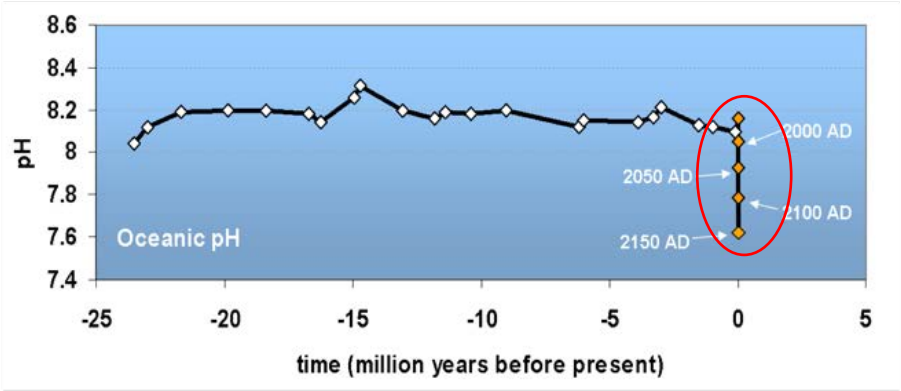
2016: Only 7% of the Great Barrier Reef has avoided coral bleaching



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

Fact n° 7: 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…)

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The « merchants of doubt » have evolved in their arguments:

- Existence of global warming
- Human responsability in the warming
- Uncertainties around the science
- More research needed before taking measures
- Cost of decarbonization
- Drawbacks from alternatives

(recent example: so-called enormous needs of cobalt for electric mobility reported on CNN; see critical analysis on https://www.desmogblog.com/2018/05/02/cnn-wrongly-blames-electric-cars-unethical-cobalt-mining)


20:10
3G
fr.euronews.com
euronews.
Les plantes captent
le CO_2 naturellement.
En savoir plus sur notre travail >>
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3G
fr.euronews.com
euronews.
Nous aidons l'industrie à le capter
grâce à la technologie.
En savoir plus sur notre travail >>
ExxonMobil

Fact n° 8: European Union spends at least 1 billion euros *per day* simply to buy fossil fuels outside its borders.

True, decarbonizing the EU economy will cost, but not doing it could cost much more in impacts. Saving these 400 billions €/year could offer many opportunities

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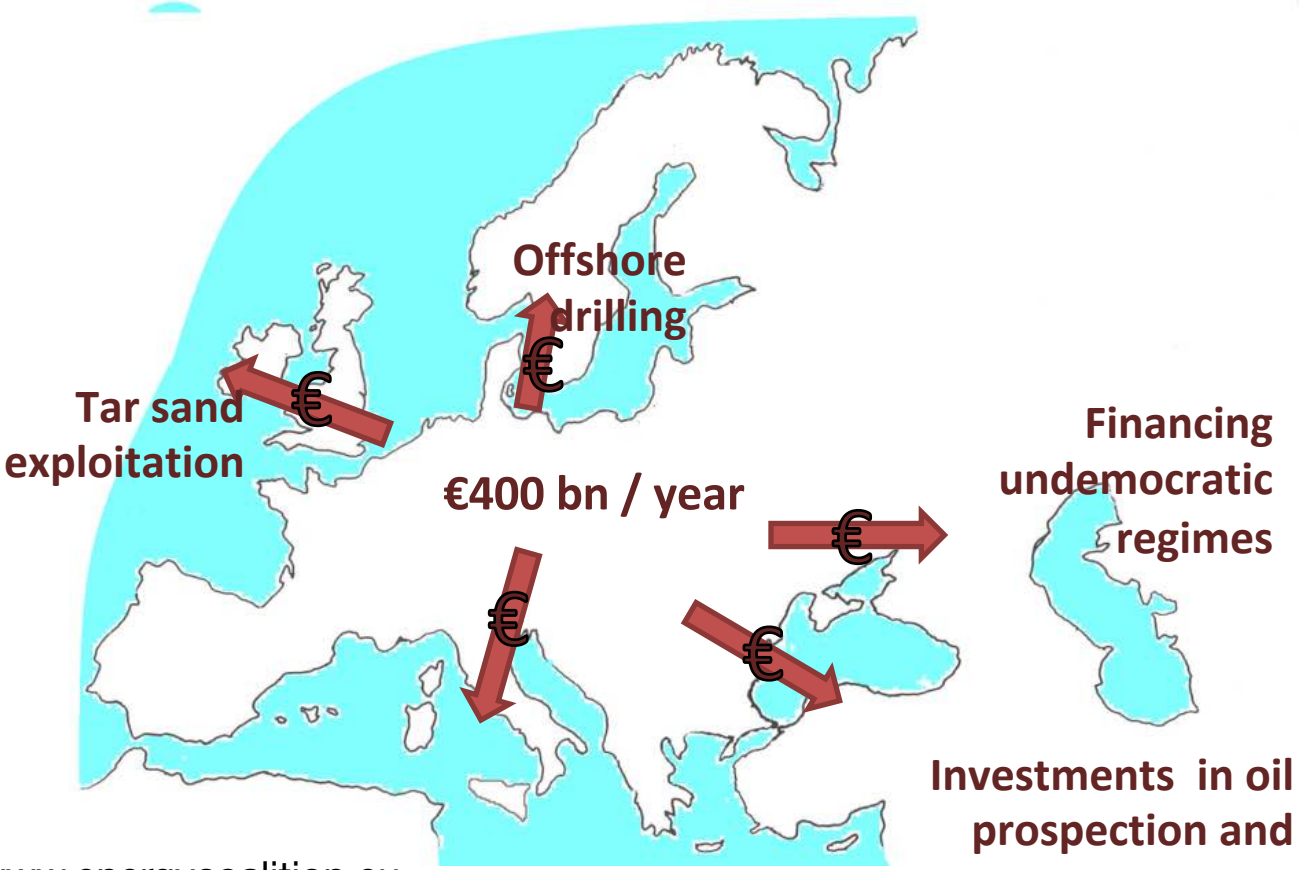
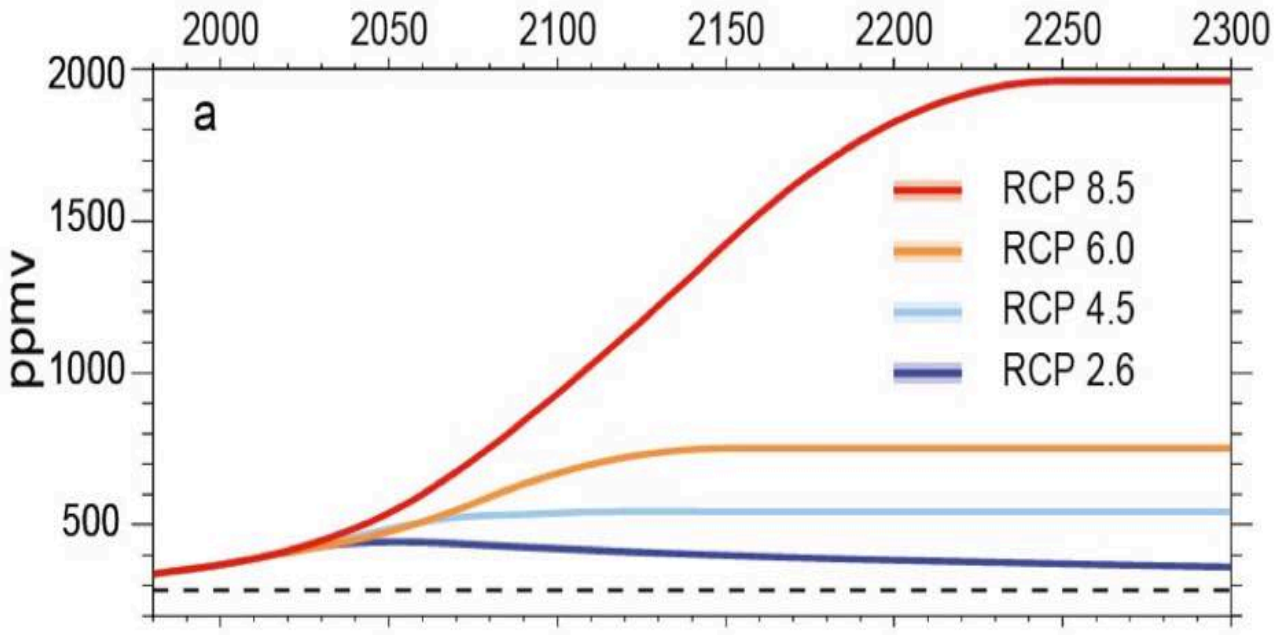
EU: annual cost of buying fossil fuels



Source: www.energycoalition.eu

Prognosis

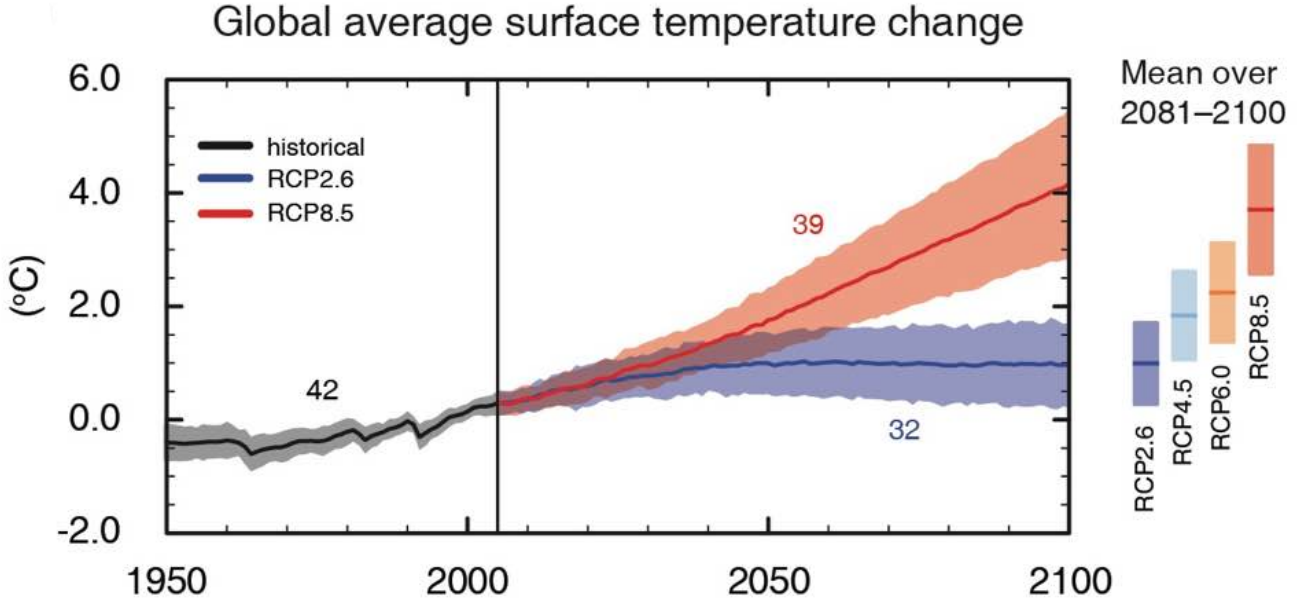
RCP Scenarios: Atmospheric CO_2 concentration



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

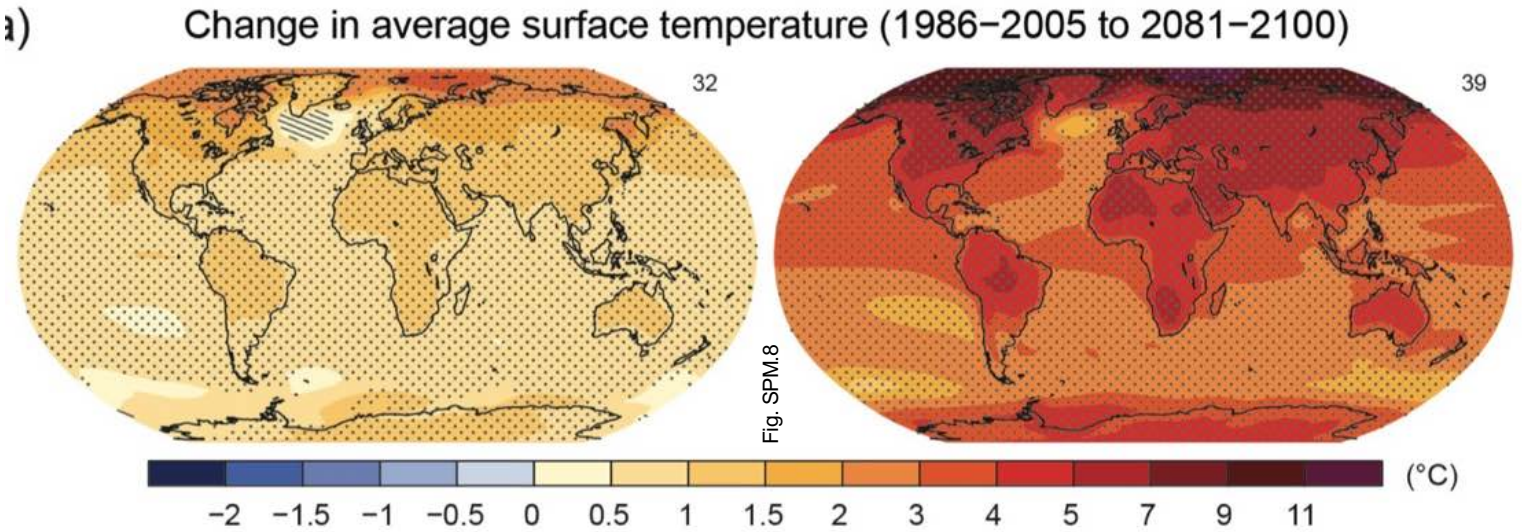
AR5, chapter 12. WGI

Projected global temperature increase during 21st century



(IPCC 2013, Fig. SPM.7a)

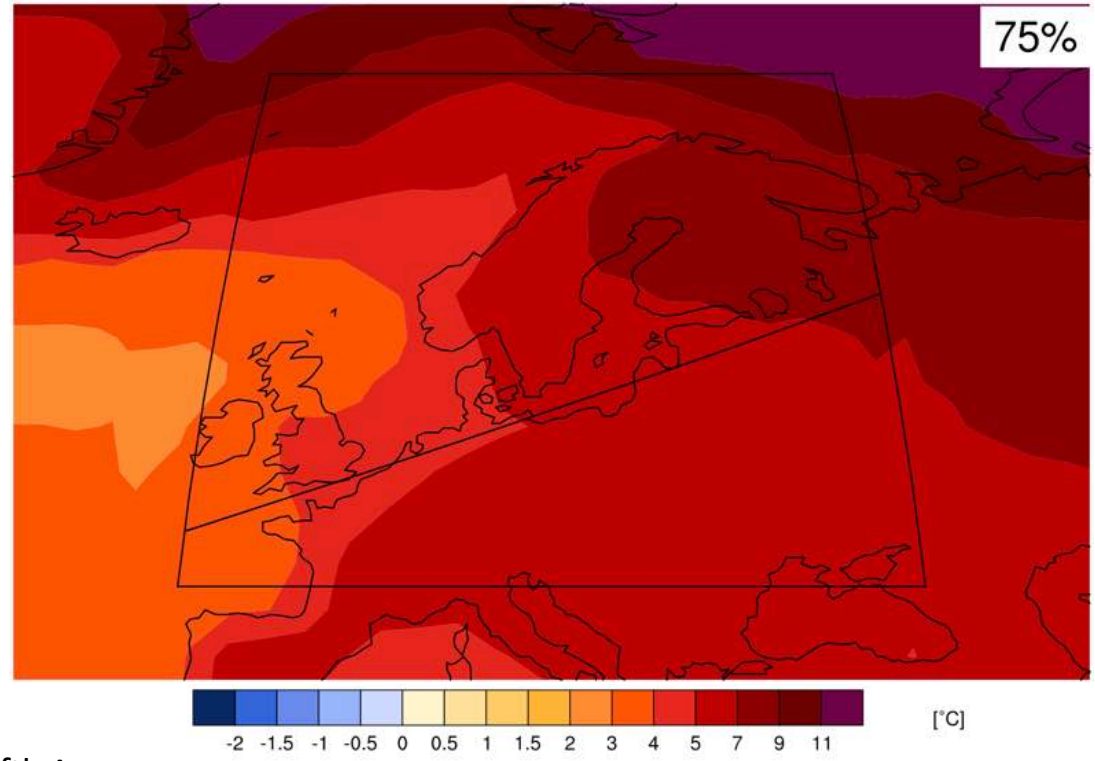
RCP2.6 RCP8.5



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).

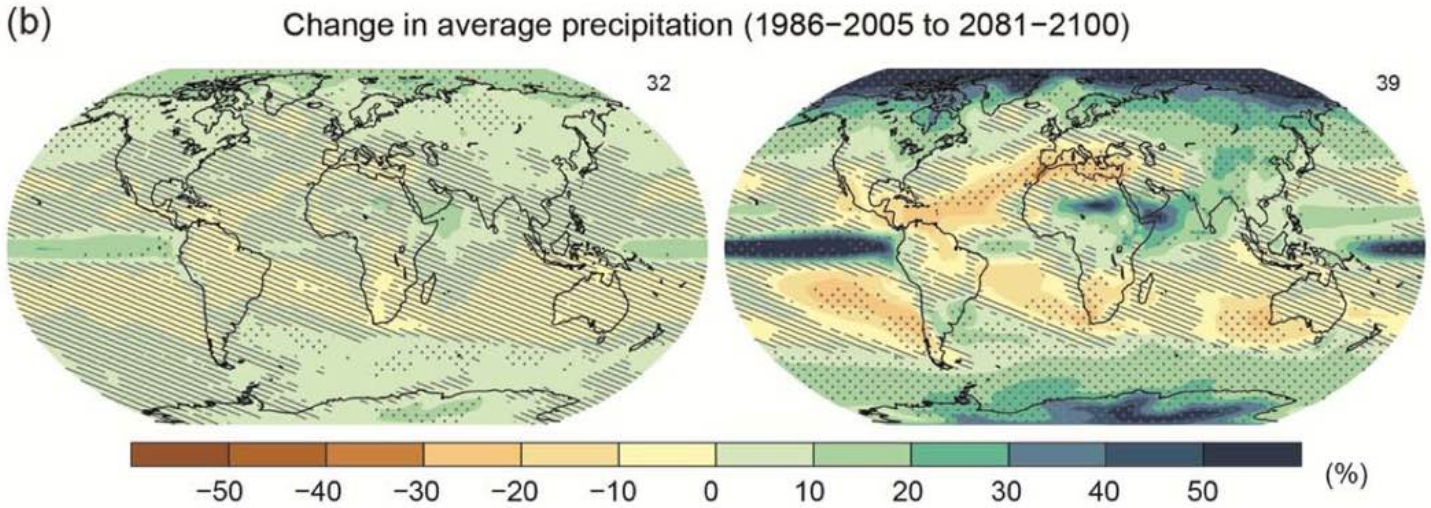
Stippling [pointillés] indicates regions where the multi-model mean is large compared to natural internal variability (i.e., greater than two standard deviations of natural internal variability in 20-year means) and where at least 90% of models agree on the sign of change

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

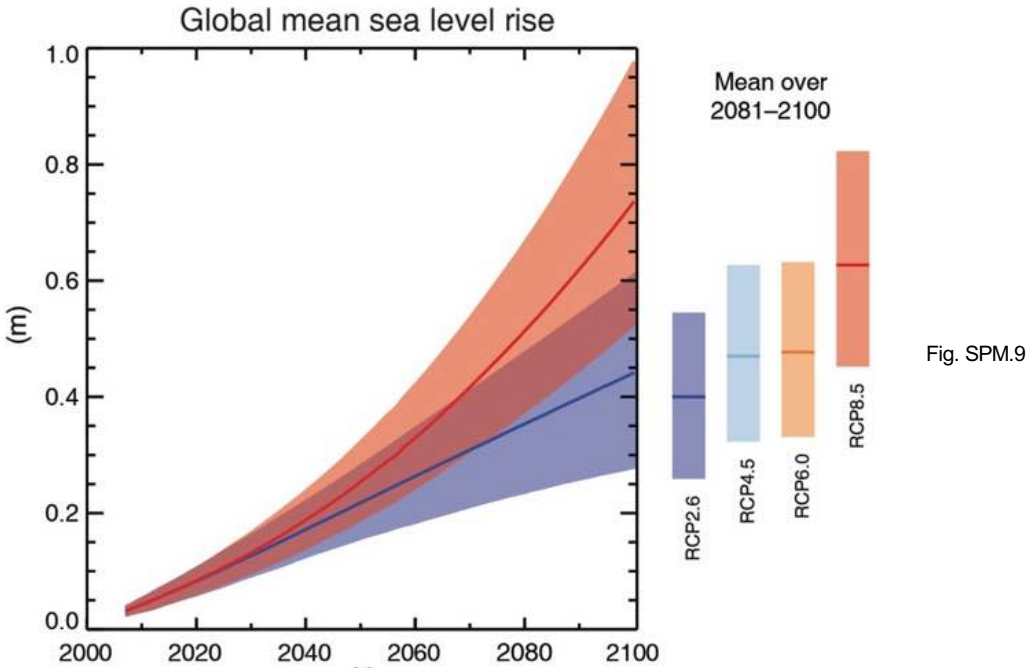


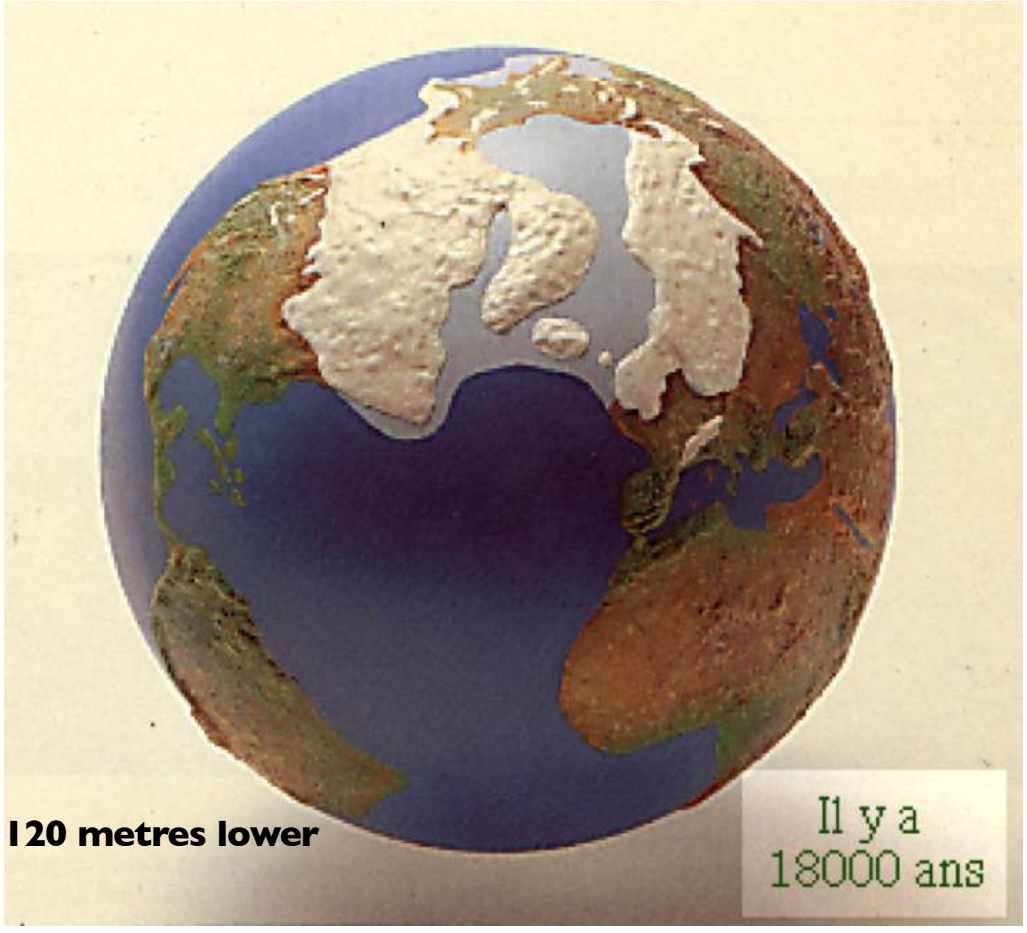
Fig. SPM.9

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)

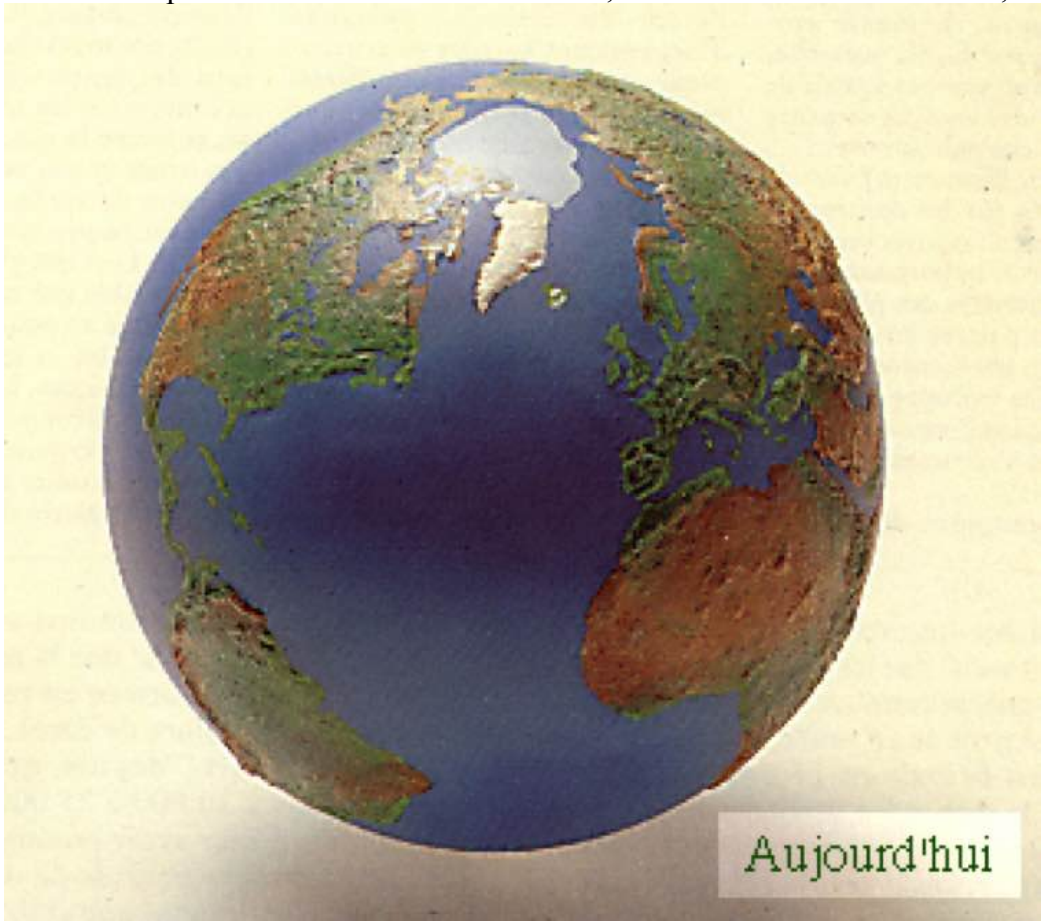
With permission from Dr. S. Joussaume, in « Climat d'hier à demain », CNRS éditions.



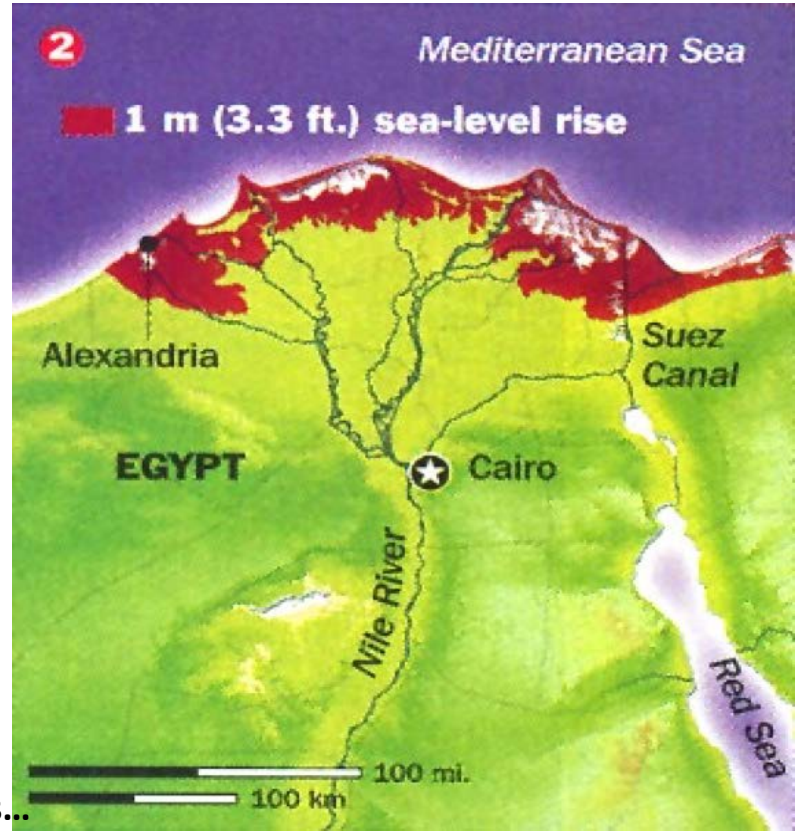
Sea level: 120 metres lower

Today, with +4-5° C globally

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



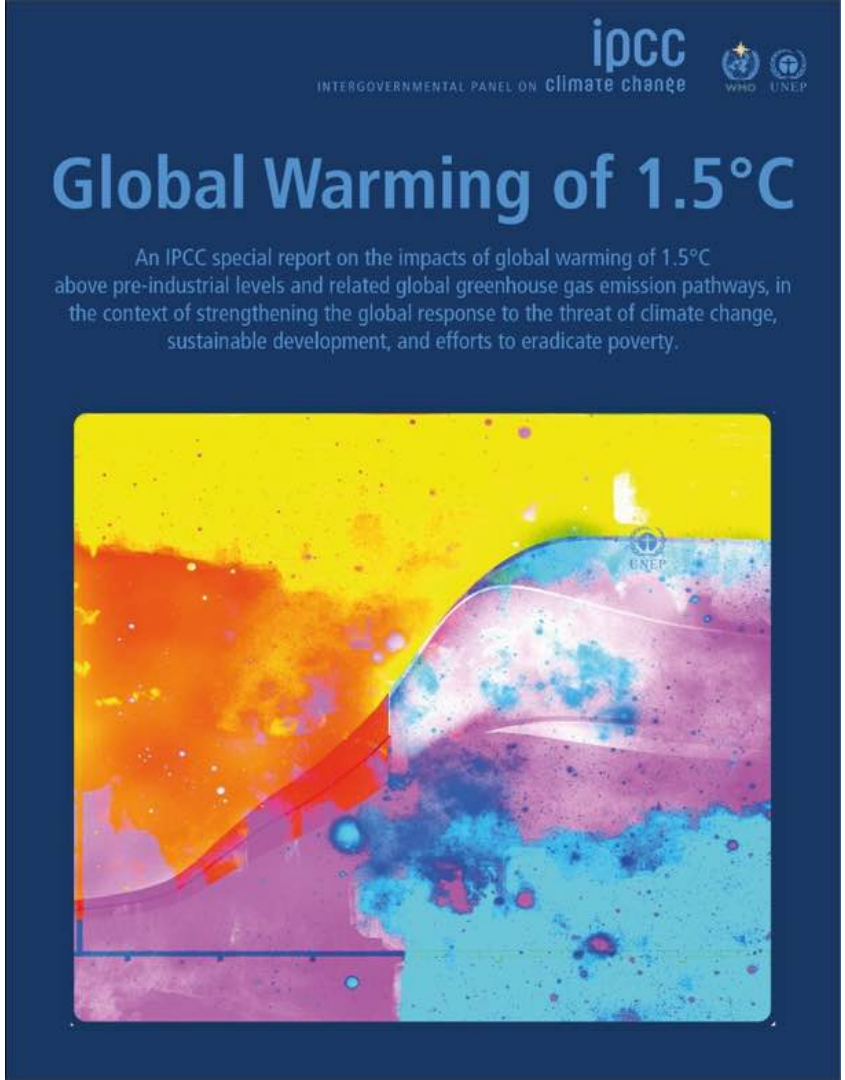
Effects on the Nile Delta, where more than 10 million people live less than 1 m above sea level

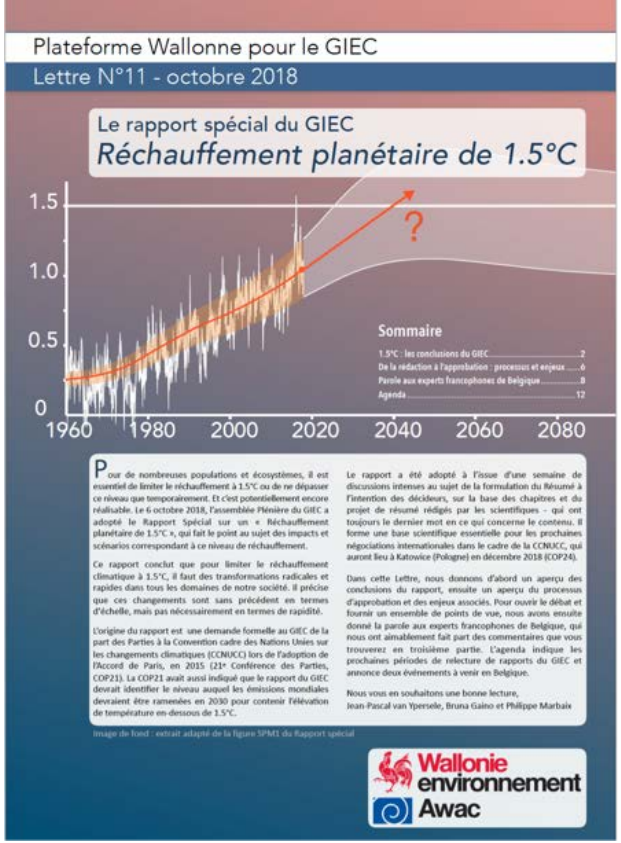


NB: + 1 m is possible in the next 100 years…

(Time 2001)

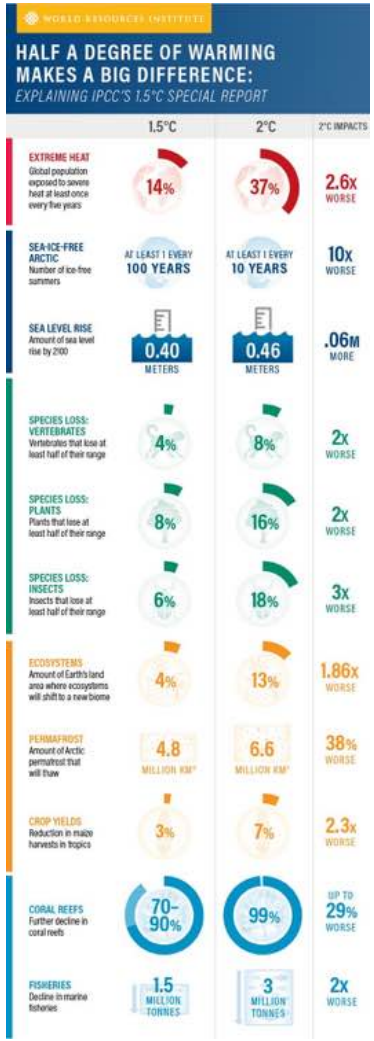
The SR15


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



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

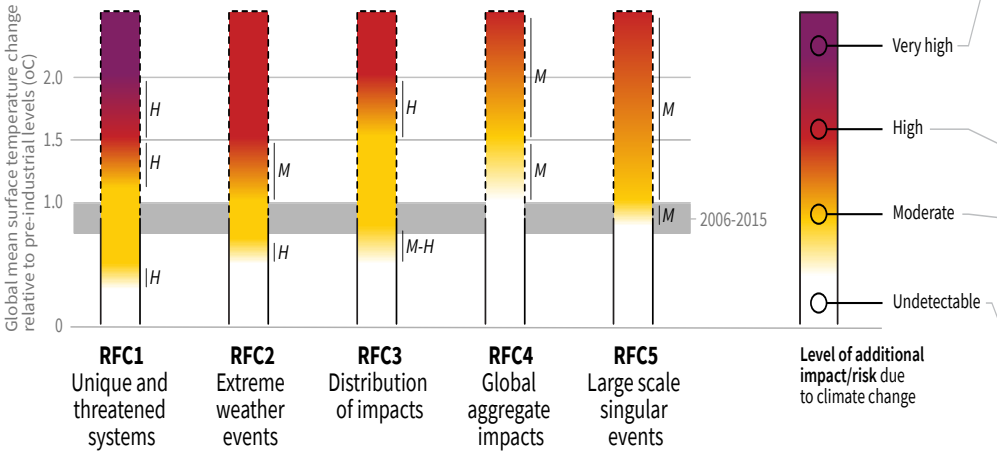
Responsibility for content: WRI



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.

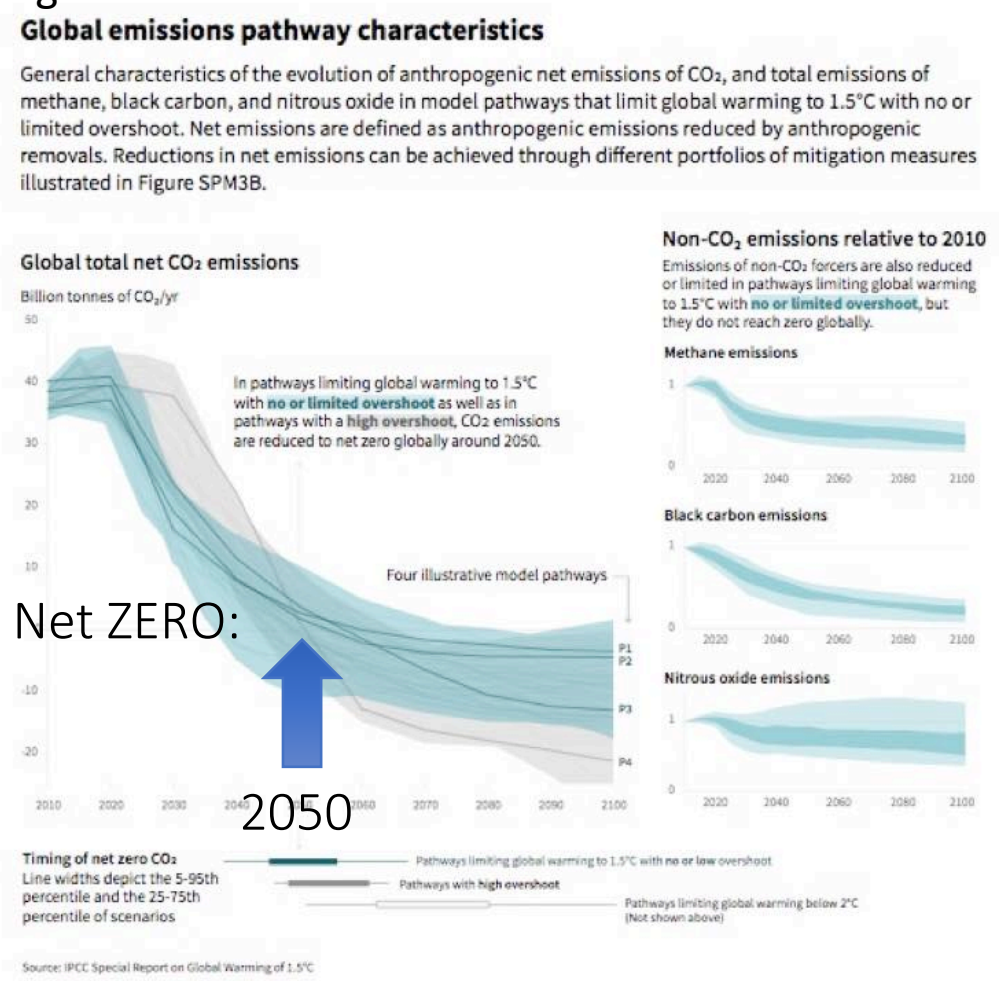
Yellow indicates that impacts/risks are detectable and attributable to climate change with at least medium confidence.

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

Urgency of Treatment

I want you to panic… and act

To stay below 1.5°C warm:ing:



Source: IPCC SR15

Greenhouse gas emissions pathways

- To limit warming to 1.5° C, CO_2 emissions fall by about 45% by 2030 (from 2010 levels)
  - Compared to 20% for 2° C
- To limit warming to 1.5° C, CO_2 emissions would need to reach 'net zero' around 2050
  - Compared to around 2075 for 2° C
- Reducing non-CO_2 emissions would have direct and immediate health benefits

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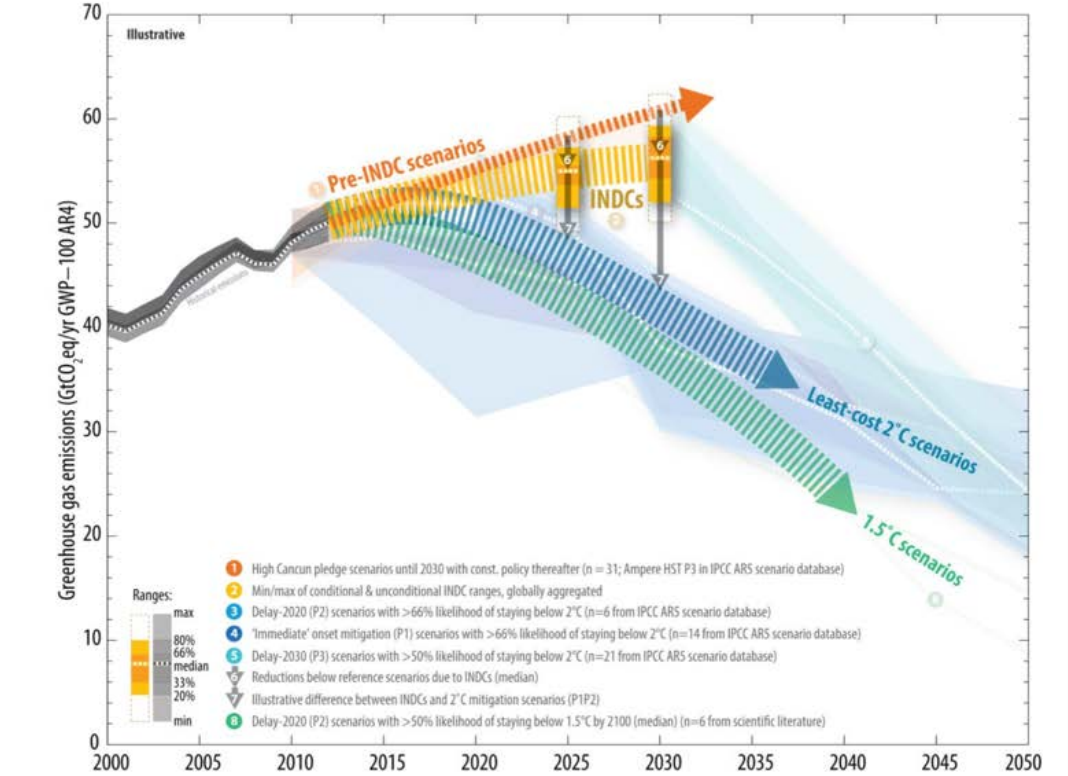
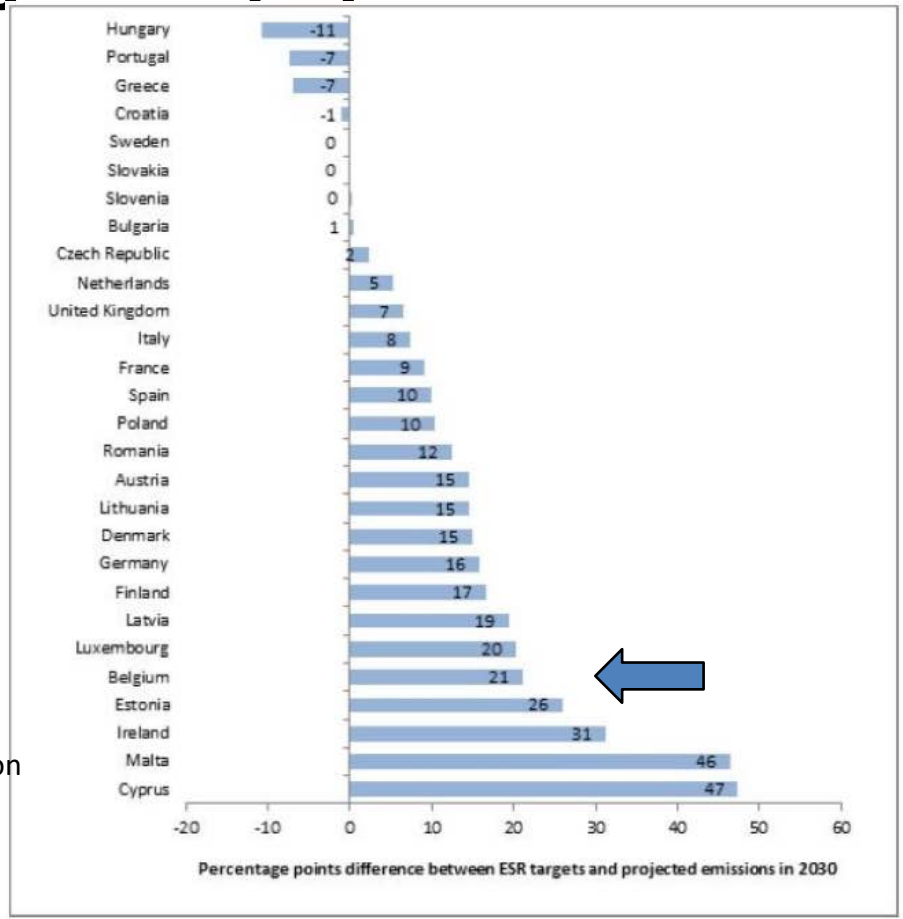
Comparison of global emission levels in 2025 and 2030 resulting from the implementation of the intended nationally determined contributions



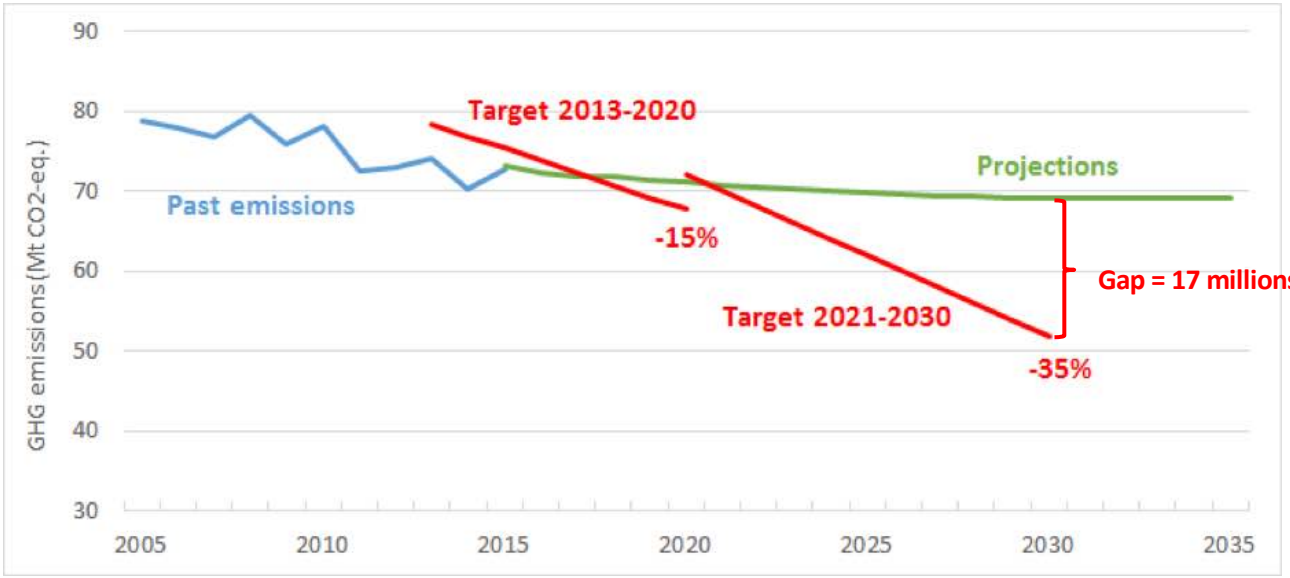
UNFCCC, Aggregate effect of the intended nationally determined contributions: an update
http://unfccc.int/resource/docs/2016/cop22/eng/02.pdf

Percentage points difference between ESR targets and projected emissions in 2030



Source:
European Commission (2019)

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.

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Nations Unies
onférence sur les Changements Climatiques
COP21/CMP11
Paris, France
SECRETAIRE EXECUTIVE CCNUCC
PRESIDENT

The Paris Agreement (COP21, December 2015)

Vision

« …strengthen the **global response to the threat of climate change**, in the context of **sustainable development** and efforts to **eradicate poverty** »

Objectives

a) Holding the increase in the global average temperature:

- *« **to well below 2°C** above pre-industrial levels »*
- *« **pursuing 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) Adaptation and Mitigation

- *« **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) Finances

- *« Making **finance flows consistent** with a pathway towards low greenhouse gas emissions and climate-resilient development. »*

Solution n° 2: Economic actors must be confronted much more clearly with their responsibilities

Degrowth of climate-unfriendly activities must be accepted, while growth of activities helping climate protection and poverty eradication must be encouraged

Solution n° 3: The best understood language is the price. Destroying the environment must become more and more expensive. Collected funds must be used to help the decarbonization, and avoid impacting the poor disproportionately

EU Emission Trading System, CO_2 taxes, fines, internal CO_2 price (firms do « as if » CO_2 emission was expensive). NB: Price must match the effect desired!

Solution n° 4: Transition towards a clean and sustainable economy and energy system must be « just », and other synergies with the SDGs must be seeked

Ex : The Polish energy system cannot be transformed without facilitating the coal miners reconversion

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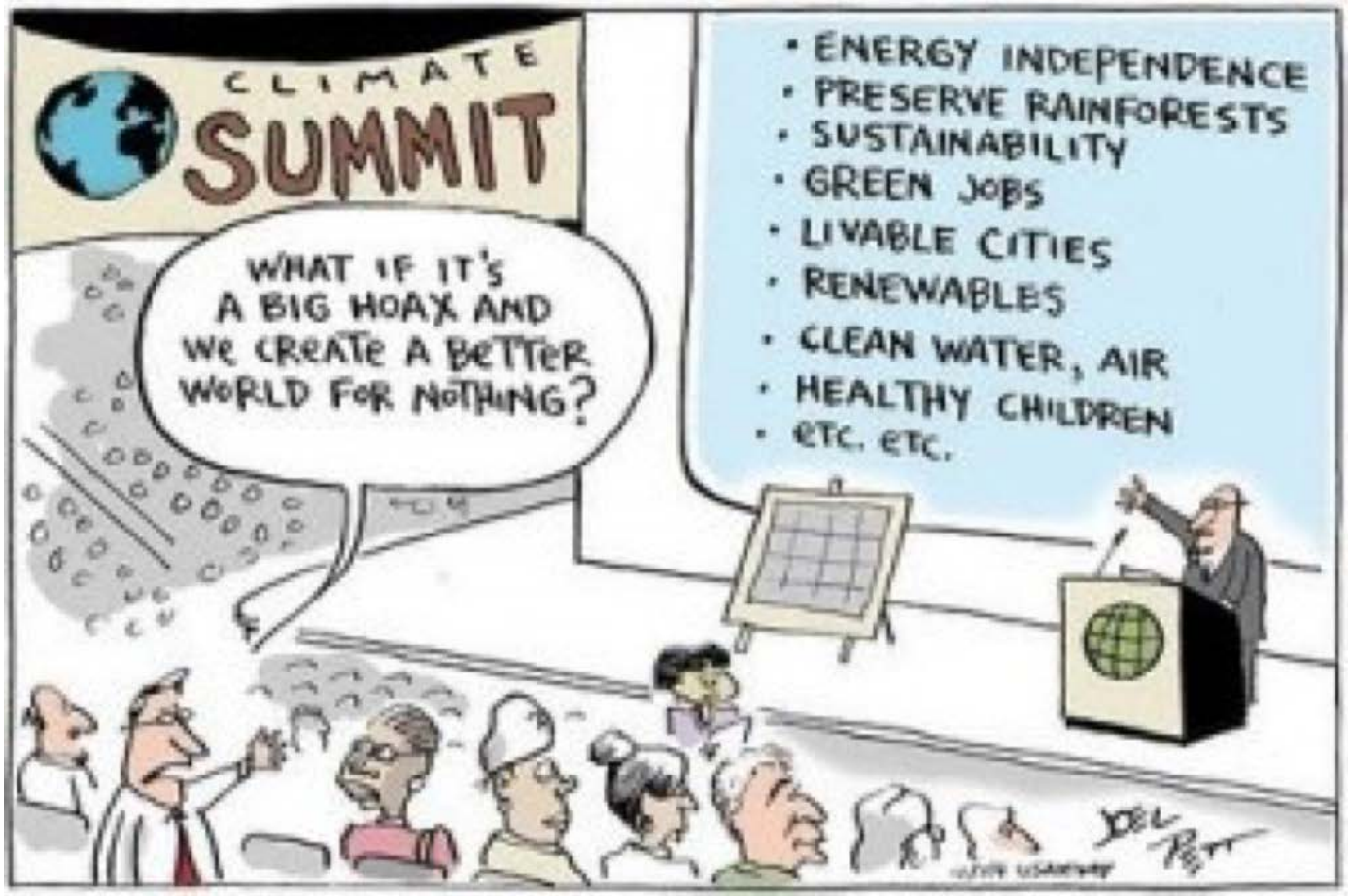
SUSTAINABLE DEVELOPMENT GOALS



Joel Pett, USA Today

Solution n° 5: Before looking at how to produce energy cleanly, much more attention must be given to reducing energy demand and efficiency, in all sectors

All production and consumption patterns must be reconsidered, helped by energy audits, etc.

- **Substantial reductions in emissions to stay under 2° C would require large changes in investment patterns e.g., from 2010 to 2029, in billions US dollars/year:** (mean numbers rounded, IPCC AR5 WGIII Fig SPM 9)
- **energy efficiency: +330**
- **renewables: + 90**
- **power plants w/ CCS: + 40**
- **nuclear: + 40**
- **power plants w/o CCS: - 60**
- **fossil fuel extraction: - 120**

Solution n° 6: Building sector: offers many opportunities in energy saving, economic activity, improving wellbeing…

Trying to practice what I « preach »:

- Energy audit before renovation
- Strong external insulation (wood fiber)
- Super-efficient windows
- Air tightiness + heat recovery ventilation system
- Ground-water heat pump replacing oil furnace
- Solar PV covering all consumption
- No tropical wood
- Small, used electric car

Trying to practice what I « preach »

Trying to practice what I « preach »

Solution n° 7: Mobility : much more space and priority to pedestrians, bicycles, and public transport; reduce priority given too long to individual transport in urban planning

Electrify remaining vehicles (with clean electricity). Fly less, only if essential.

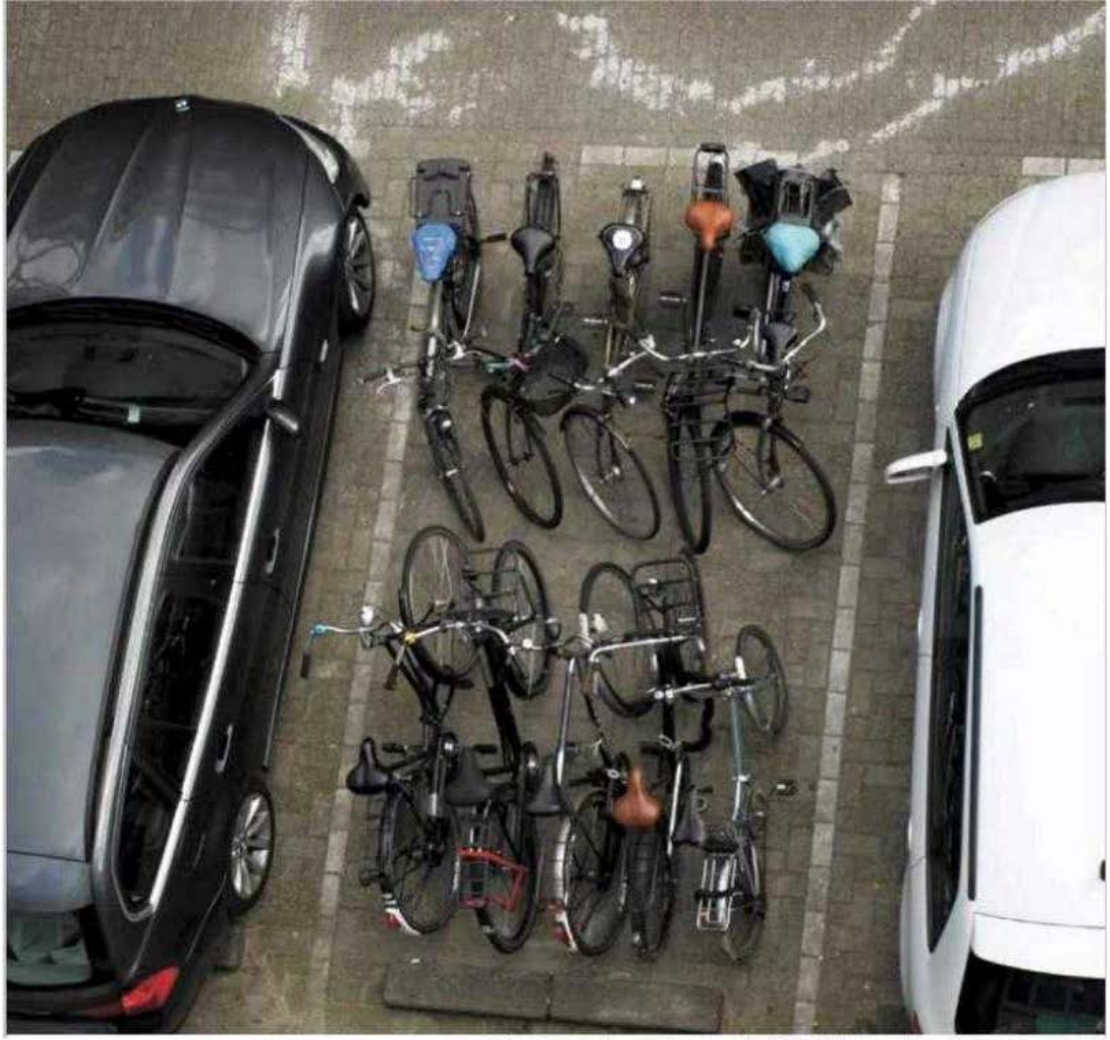


Foto Marieke de Lange / OEK (Fietsersbond Amsterdam)

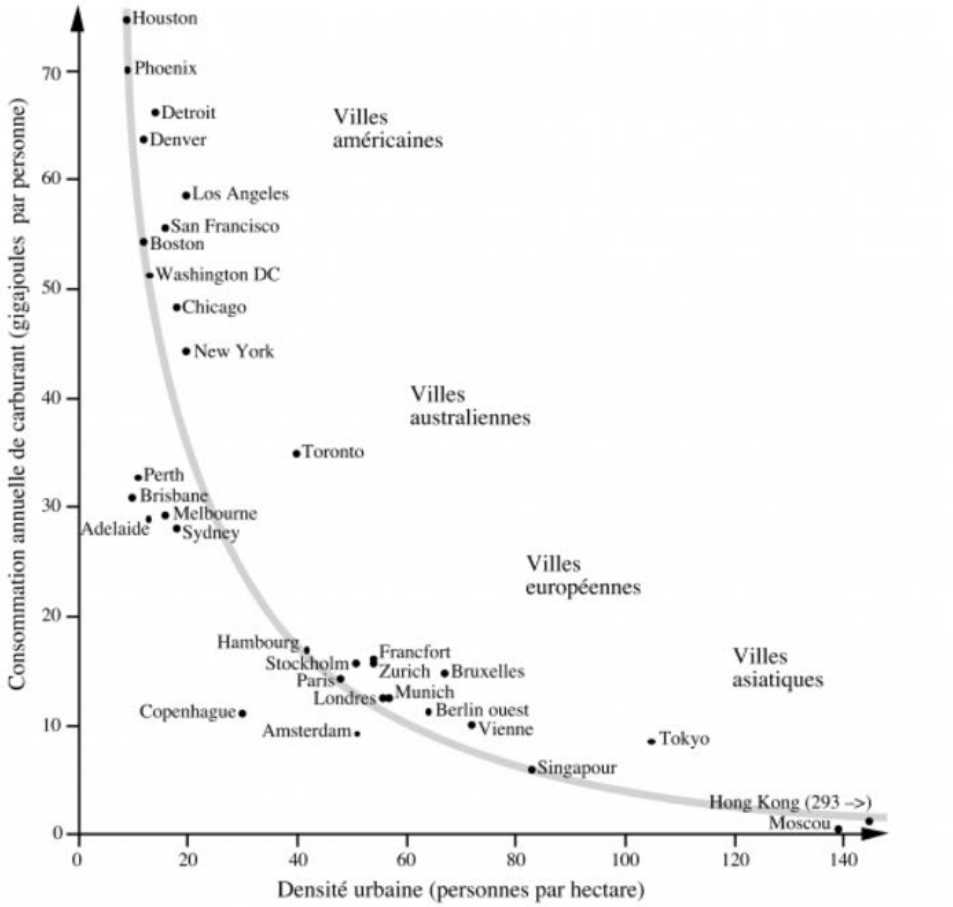


Figure III-1 : Consommation de carburant et densité urbaine, d'après Newman et Kenworthy (1989a), traduit en français par Heran (2001).

Solution n° 8: Food and agriculture. A possible change with big positive impact: eat less (red) meat and cheese, of better quality! Eat more plant-based food (produced cleanly)

…It is good for health as well!

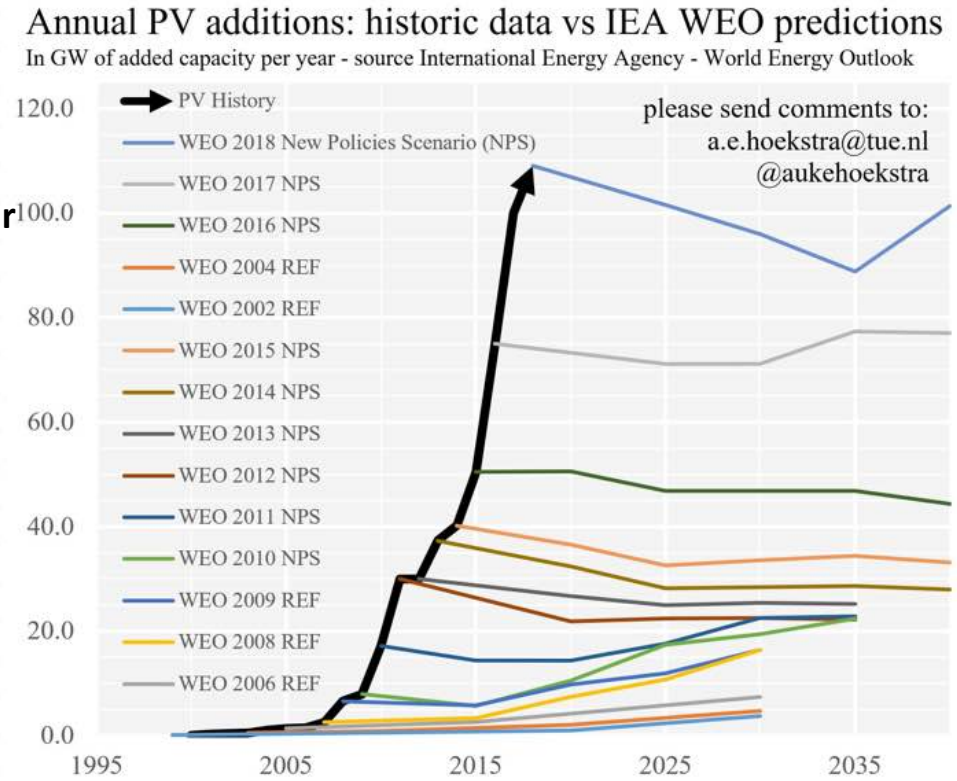
Solution n° 9: The Sun gives us in two hours about as much energy as the world uses in *one year*, all forms of energy considered

The cost of solar kWh is crashing, wind power, heat and electricity storage, and smart grids are moving forward

@JPvanYpersele

The International Energy Agency has missed that point…

GW capacity added per year



Solution n° 10: Banks and the finance sector increasingly see the opportunities in climate-friendly and ethical investments promoting the 17 Sustainable Development Goals

… but their ethical/green investments are still marginal for most banks

@JPvanYpersele

Yes, the planet got destroyed. But for a beautiful moment in time we created value for shareholders

"Yes, the planet got destroyed. But for a beautiful moment in time we created a lot of value for shareholders."

http://www.newyorker.com/humor/issuecartoons/2012/11/26/cartoons_20121119#slide=6

RCP2.6 RCP8.5

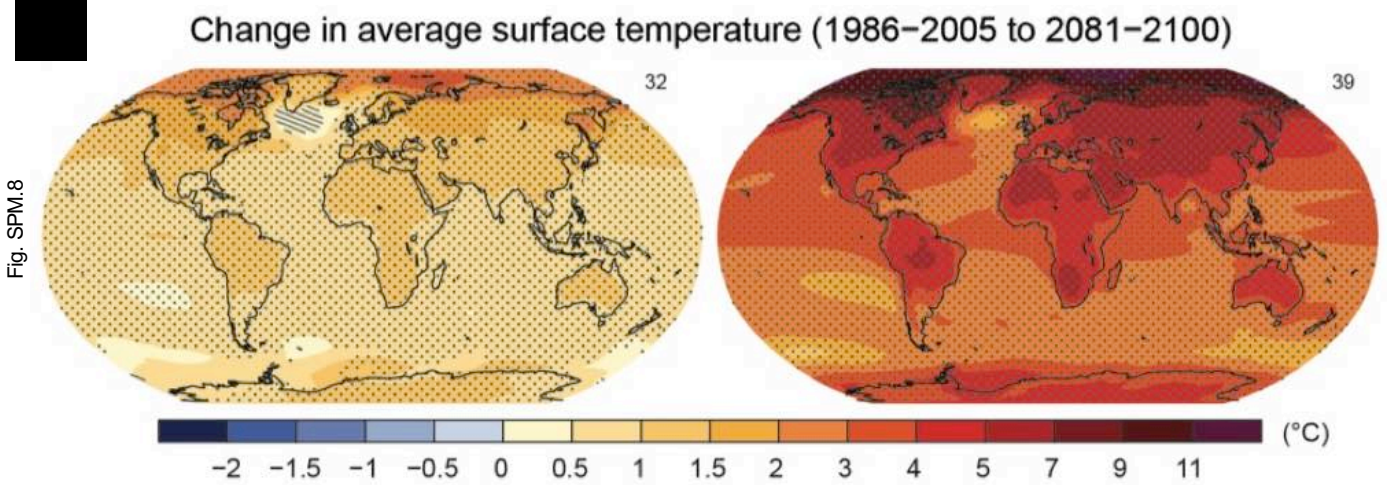


Fig. SPM.8

Humanity has the choice

This gives me hope:

Well-informed young people speaking truth to power

With @GretaThunberg at COP24

Greta is inconvenient, like the truth

Greta is inconvenient, like the truth[1]

Jean-Pascal van Ypersele (@JPvanYpersele)

Professor of climatology at the Université catholique de Louvain (Belgium)
Former IPCC Vice-Chair (2008-2015),
Member of the Académie royale de Belgique

Greta Thunberg is inconvenient, and has been the subject of renewed criticism since her speech to the United Nations in New York. Some, often older white men, criticize her appearance or her so-called "mental illness." They call her "unstable" and seem to take pride in bullying her.

But maybe they feel threatened because Greta is gifted. She understands the challenges of the climate crisis much better than most political or economic leaders.

I have seen this myself. As a physicist and climate scientist for nearly 40 years, and a former Vice-Chair of the Intergovernmental Panel on Climate Change (IPCC), I am no stranger to the climate crisis. But Greta has raised awareness about the climate crisis to a level never before seen.

I first saw Greta at the Katowice Climate Conference in December 2018. She was alone on a podium at a United Nations climate conference, answering questions from a host and the audience. She has no cards, but answers without hesitation, sometimes simply saying: "*I don't know, I'm only 15 years old, ask the experts.*" But she already knows a lot. She also recognizes that "*no one is too small to make a difference.*" I am blown away by the accuracy of her words, based on a serious knowledge of the mechanisms at work and the causes of the climate crisis.

A few days later, I heard Greta addressing the diplomats and negotiators in the plenary room. "*The year 2078, I will celebrate my seventy-fifth birthday. If I have children, then maybe they will spend that day with me. Maybe they will ask about you. Maybe they will ask why you didn't do anything, while there still was time to act. You say that you love your children above everything else. And yet you are stealing their future.*" The video of her speech was shared around the world.

In all my years working on climate change in the United States, Belgium, and with the IPCC, and having participated in each meeting of the UN's climate treaty, I had never heard such a strong and moving climate speech. Her heart was talking, and she was right.

Greta read the IPCC reports. She understands the immense risks that the accumulation of greenhouse gases poses to life on Earth. She does not confuse the ozone hole, air pollution or the daily weather forecast with the climate crisis.

Few leaders can say the same.

Greta speaks without any shame about her Asperger's syndrome. In fact, it probably helps her see the contradiction between the speeches of world leaders and their actions. With great emotional intelligence, she expresses her fear of this gap. A fear that is shared by millions of young people.

The adults who blame Greta for sharing her concern would do better to listen to this fear, and to take action. Many adults defend themselves by attacking or devaluing youth. They try to make people believe that the decarbonization Greta is demanding implies a return to the Stone Age and poverty. They believe that they must protect the status quo of unlimited economic growth that relies on fossil fuels—their status quo.

Clearly these critics of Greta and the climate strikers have not read the IPCC reports. A just energy and ecological transition can lead to a better quality of life for everyone, particularly if it's integrated with the pursuit of the 17 Sustainable Development Goals adopted by the United Nations in 2015. The recent UN Global Sustainable Development Report has just emphasized this point.

Greta is no longer alone, as she was at the beginning of the movement she started. In many countries, including the United States, young people are rising to the challenge through dialogue and collective non-violent action. Greta's leadership and ability to speak truth to power has earned her a nomination for the Nobel Peace Prize...and I hope she receives this prize of prizes.

We have so much to learn from them. It is our generation's short-term thinking and actions that have brought us to the brink. We must listen to these young people who dare to speak about their fears for their future, and stop believing that we know better than they do. We must change our attitudes, and utilize the technological, economic, and political tools that will make it possible to transform young people's fears into a force of hope for a sustainable and just future.

Those who refuse to do this have signed their own death wish – for themselves, their children and their grandchildren.

I support Greta because she supports life.

[1] Adapted from the tribune published in « Le Monde » on Octobre 1st 2019 (https://www.lemonde.fr/idees/article/2019/10/01/jean-pascal-van-ypersele-greta-derange-comme-la-verite_6013798_3232.html); this text is available on www.climate.be/vanyp

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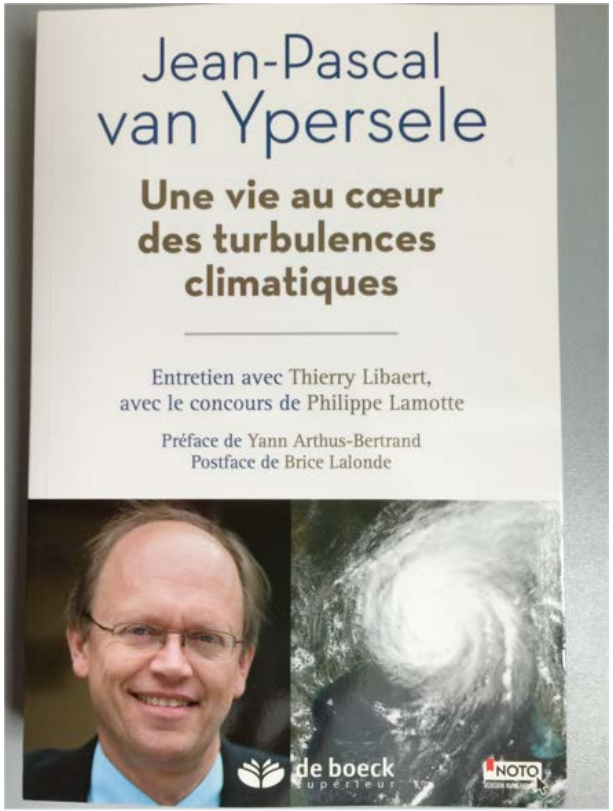
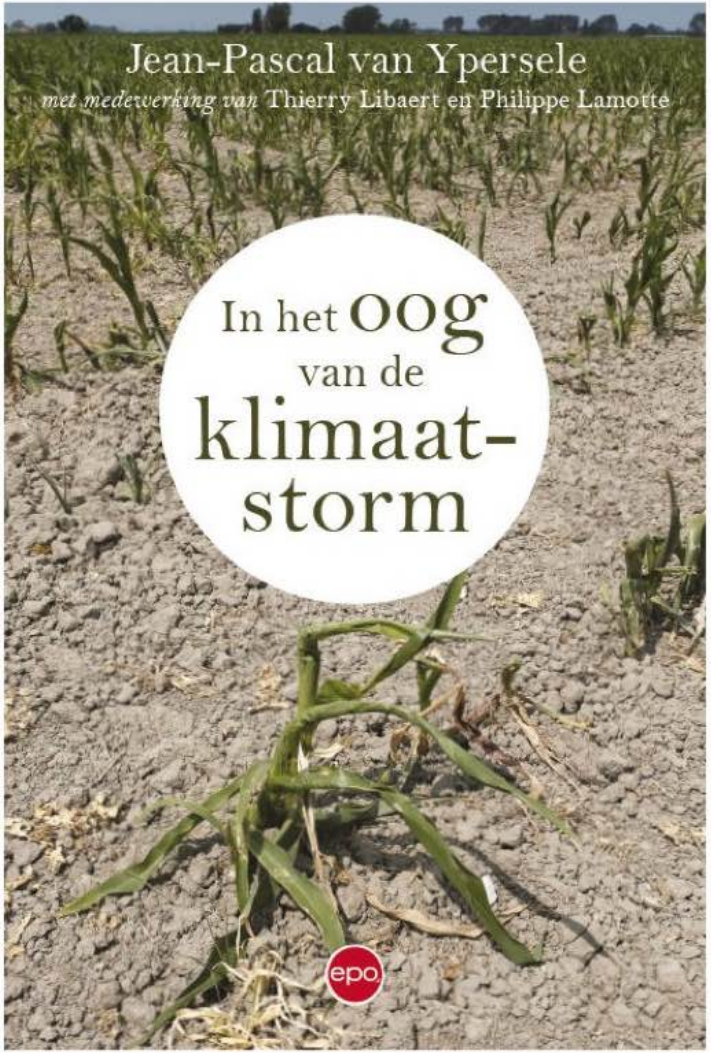


Bij EPO
(februari 2018)

Voorwoord:
Jill Peeters



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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