CLIMATE EMERGENCY INSTITUTE

The medical and human rights approach to global climate change

International Association for Society and Natural Resources
University of Alberta
10 June 2012.

Linking fossil fuel resource development with food security of committed global warming

Dr. Peter Carter
Environmental health policy

Linking fossil fuel resource development with key social impacts of committed global warming

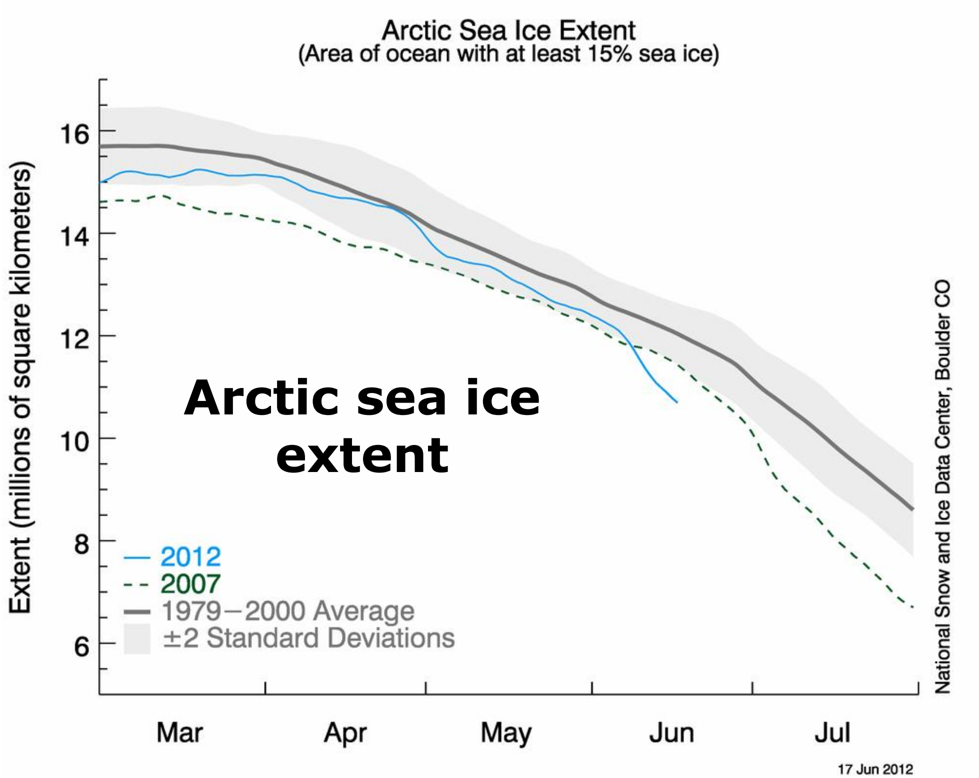
Dr. Peter Carter
Environmental health policy
petercarter46@shaw.ca

Thank you, ISSRM, for inviting me!

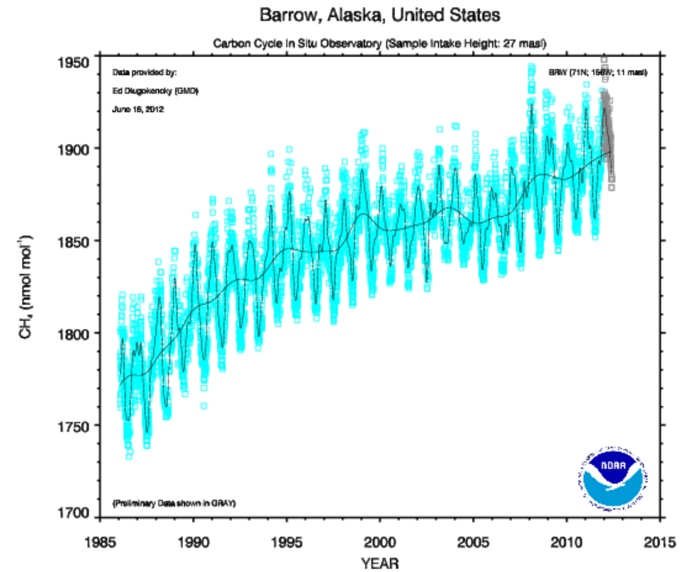
CLIMATE EMERGENCY INSTITUTE
The Medical and Human Rights Response to Global Climate Change
www.climateemergencyinstitute.com

Arctic Methane

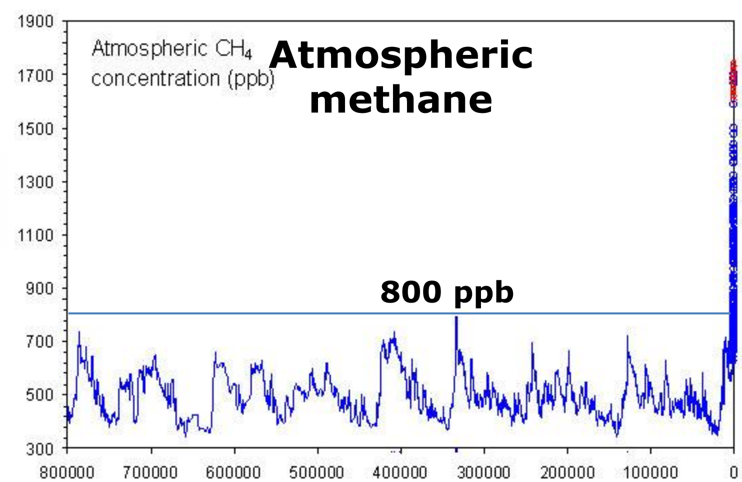
June 2012



Arctic atmospheric methane
Barrow Alaska
18 June 2012



1900 ppb



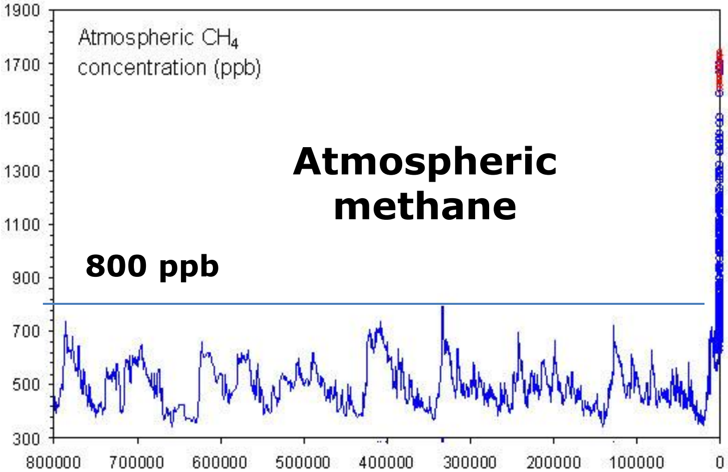
800,000 year ice core

CSIRO

Arctic Methane

Upper limit of atmospheric methane over past 800,000 years is 800 ppb

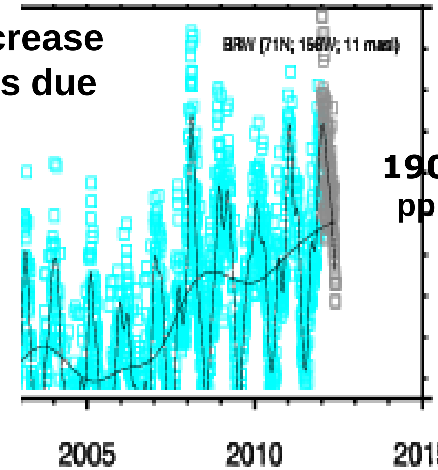
800,000 year ice core



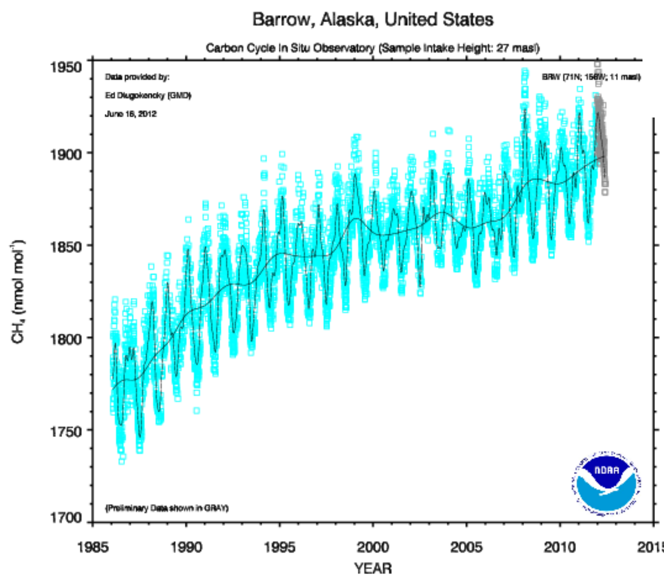
CSIRO

Arctic atmospheric methane Barrow Alaska
18 June 2012
1900 ppb

Methane increase since 2007 is due to feedback emissions



1900 ppb



1900 ppb

Websites for further background

For calculations sources and references

ClimateEmergencyInstitute.com/resources

OnlyZeroCarbon.org

ClimateChange-FoodSecurity.org

ArcticClimateEmergency.com

National Research Council

Climate Stabilization Targets 2010

http://www.nap.edu/openbook.php?record_id=12877&page=R1

IPCC 2007 Technical Summaries

Global climate change implications of food security is a neglected area of research when it should be priority research

OCEAN THERMAL LAG AND COMPARATIVE DYNAMICS OF DAMAGE TO AGRICULTURE FROM GLOBAL WARMING

Darwin C. Hall (2001)

Professor of Economics
Professor of Environmental Science & Policy

California State University
Darwin C. Hall, (2001) "Ocean thermal lag and comparative dynamics of damage to agriculture from global warming," Vol. Iss: 3, pp. 115 – 148
Emerald Group Publishing Limited
10.1016/S1569-3740(01)03018-8

Advances in the Economics of Environmental Resources book series
ISSN: 1569-3740
Series editor(s): Professor Richard Howarth

Why climate change commitment for natural resource managers?

- **Our number one natural resource is food.**
- **Today's situation on global climate change policy is that there is no limit on global warming and climate change commitment.**
- **Therefore the only source of possible global climate change mitigation (for mitigating world food losses) is the fossil fuel energy resource sector.**
- **We need to communicate the essential science to the energy resource sector.**

Key Messages

Todays' commitment

Cumulative atmospheric GHGs

|

GHG emissions

➡

4X

Heat

Climate disruption

Extreme weather

➡

Key Messages

- **We must approach global climate change today – from today's committed global warming (not just today's global average temperature increase).**
- **Today we are in a committed climate change world food security emergency.**

What is global warming commitment ?

The future will definitely be a lot hotter than the present due to very long lag times for best mitigation to take effect .

The much greater degree of global warming / climate change will last ‘forever’.

Climate change scientists warn of 4C global temperature rise

The Guardian 29 November 2010

Most vulnerable populations

At lower latitudes, especially seasonally dry and tropical regions, crop productivity is projected to decrease for even small local temperature increases –
global from pre-industrial 1 °C.

Al crops decline at 2°C.

IPCC 2007 impacts chart showing impacts of climate change on food and health security
- The two impacts are negatively synergistic
- These impacts increase with temperature

IPCC AR4 2007

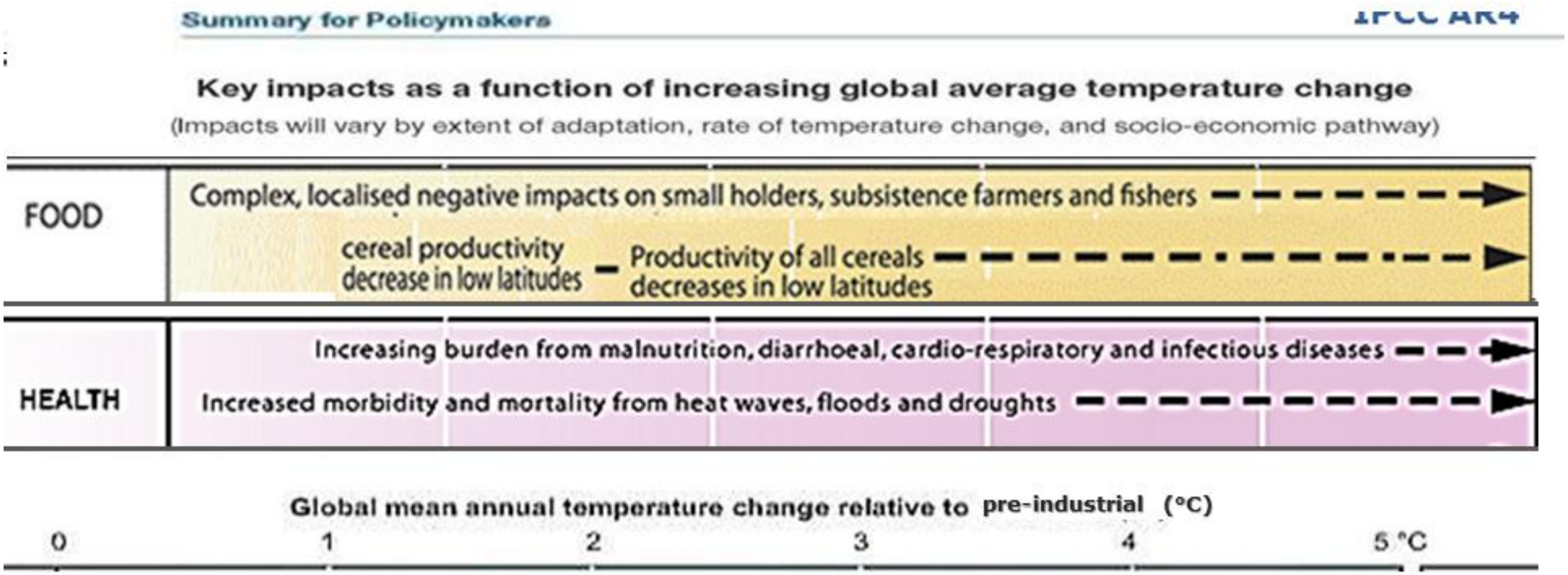


Figure SPM.2. *Illustrative examples of global impacts projected for climate changes (and sea level and atmospheric carbon dioxide where relevant) associated with different amounts of increase in global average surface temperature in the 21st century [T20.8]. The black lines link impacts, dotted arrows indicate impacts continuing with increasing temperature. Entries are placed so that the left-hand side of the text indicates the approximate onset of a given impact.*

Today's global warming commitment

according to our calculation from the climate system science

Global warming commitment by 2100 3.5° C

Eventual full warming commitment after 2100 5.4° C

Committed duration of global warming
1000s of years

Combination of
ocean heat retention
+
long atmospheric lifetime of CO_2
(20% lasts 1000 years)

"Climate changes that occur because of carbon dioxide increases are expected to persist for thousands of years even if emissions were to be halted at any point in time."
NRC, Climate Stabilization Targets, 2010

Susan Solomon, *Irreversible climate change due to carbon dioxide emissions*, PNAS 2009

What is global warming commitment ?

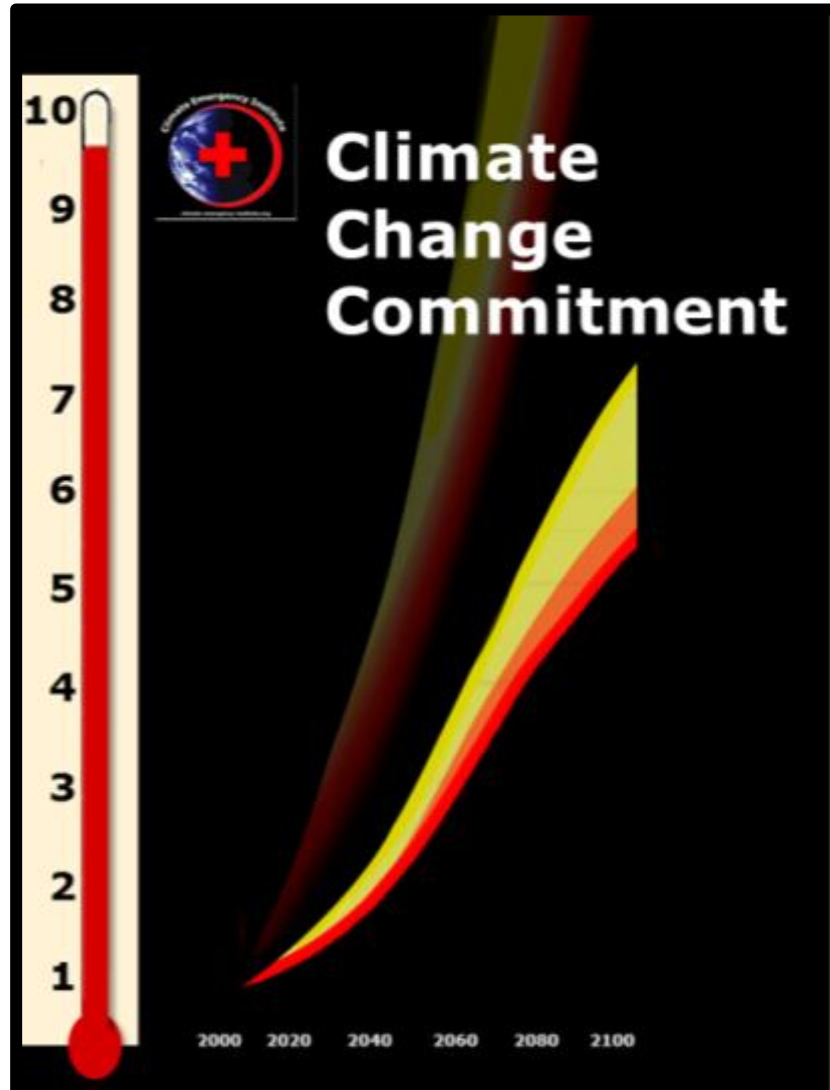
"If carbon dioxide equivalent concentrations were to be stabilized at some point in the future, there would be a lock-in to further warming of comparable magnitude to that already occurring at the time of stabilization."
– National Research Council, Climate Stabilization Targets, 2010

"Models predict that the realized temperature rise at any time is about 50% of the committed temperature rise."
– IPCC First Assessment Report, 1990

Committed global temperature increase: according to climate system science

Lags or delayed effects

1. Time from slashing emissions to atmospheric GHG & global temperature stabilization
2. Delayed warming from ocean heat lag
3. Deferred warming due to air pollution aerosol cooling
4. Additional warming from feedbacks



What is global warming commitment ?

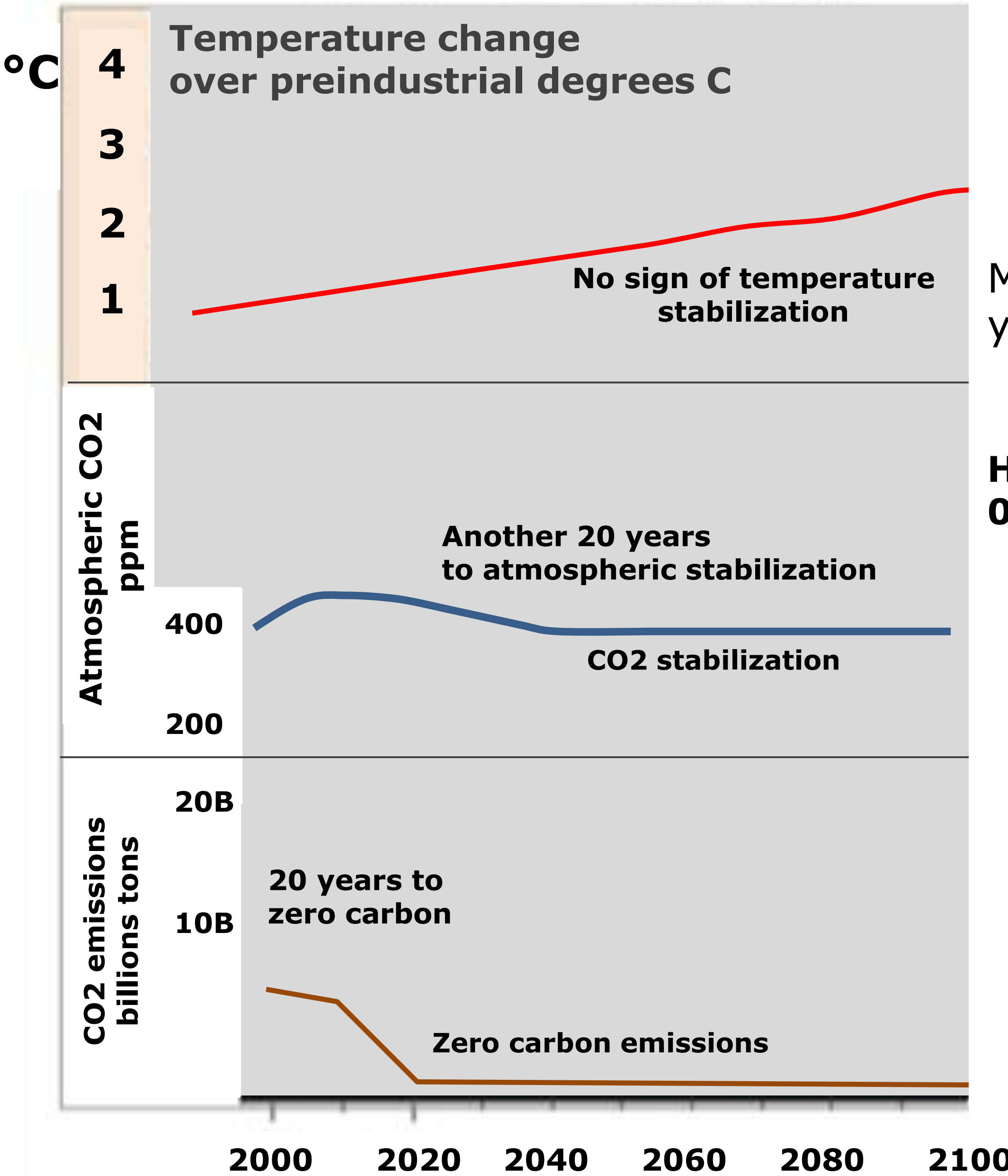
Climate system science

long lag times

Temperature increase
X2

takes 100s years

lasts for 1000s of years



95% reduction of emissions in 20 years

Time to stabilize atmospheric CO2 & global temperature

Most stringent IPCC scenario takes 60 years to zero carbon.

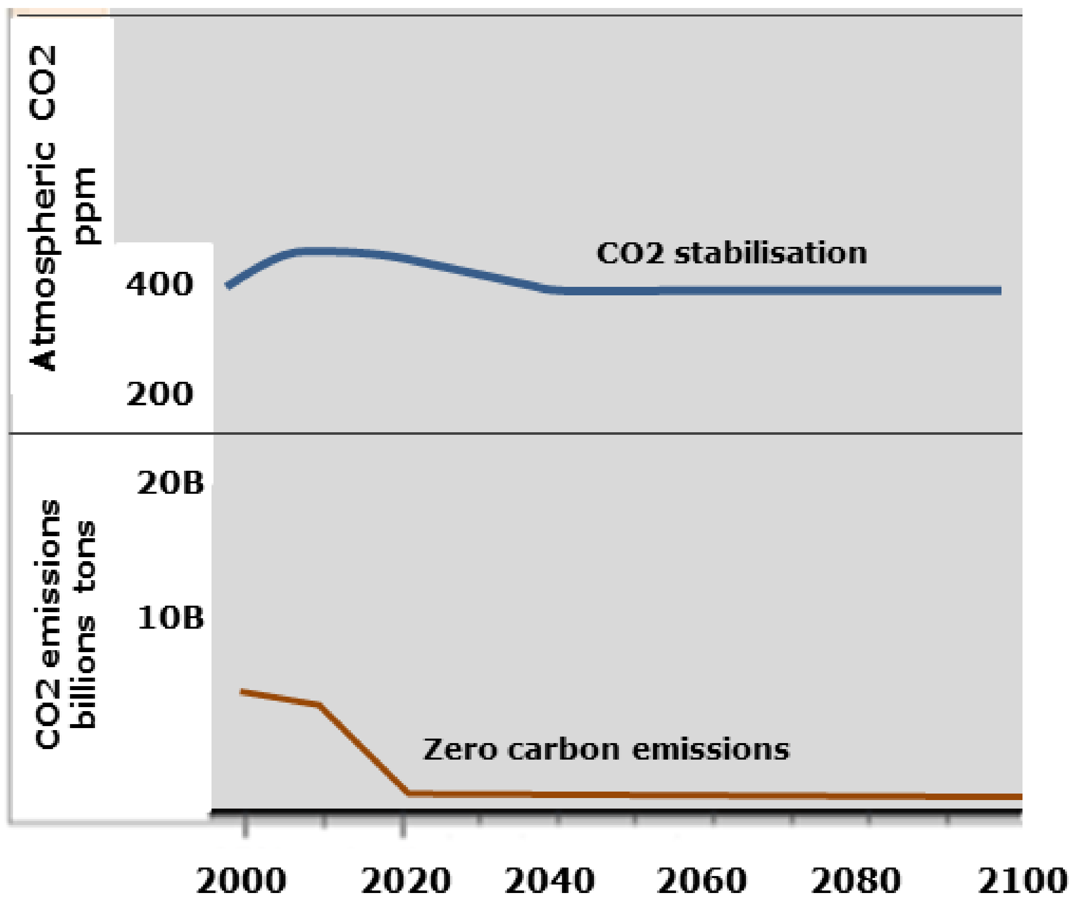
Highly optimistic 40 years is another 0.8°C.

<u>40 years or +0.8°C</u>

Source: Climate Interactive IPCC 2007

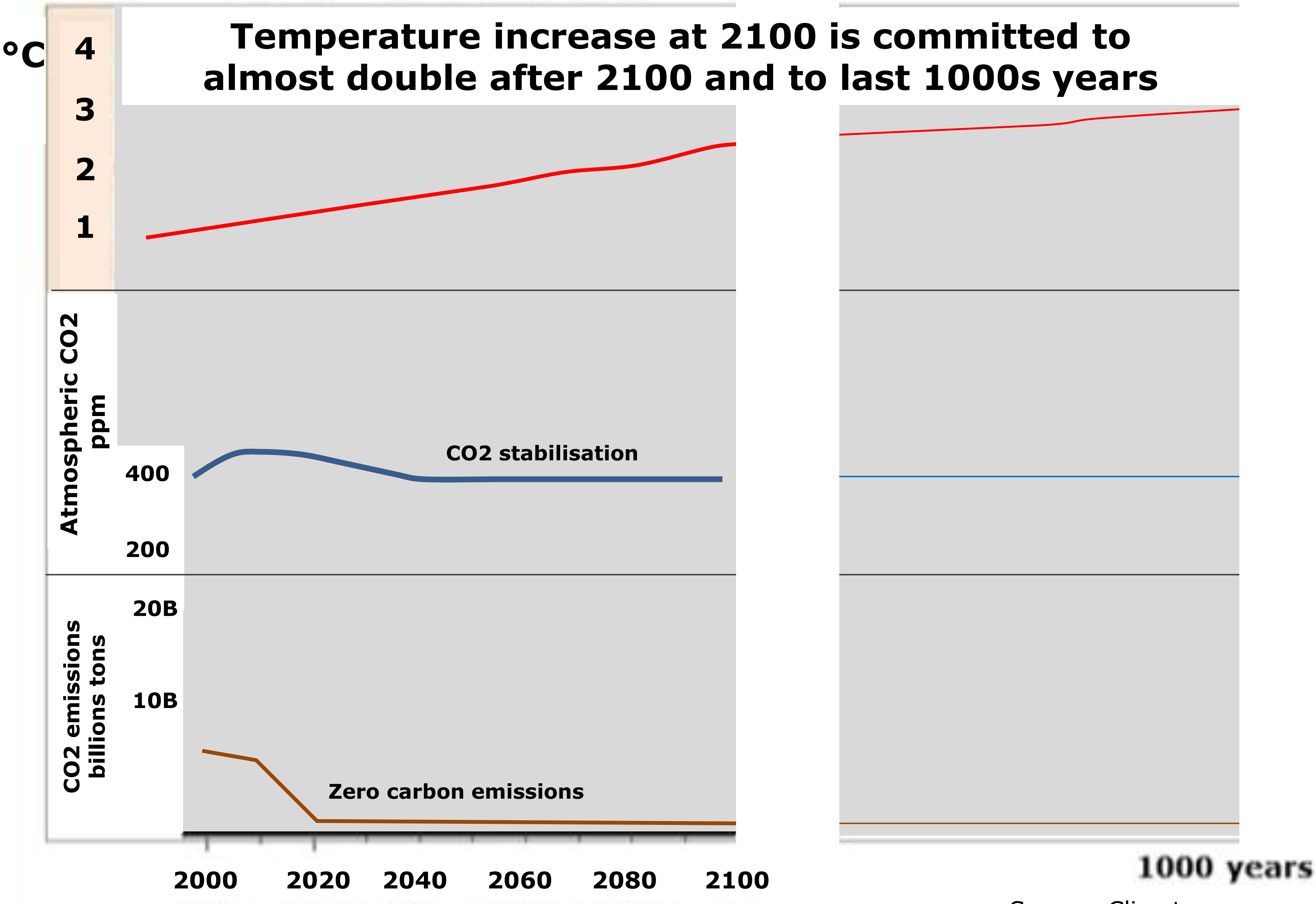
Note: it takes zero carbon emissions to stabilize atmospheric CO2

Till the policy target is zero carbon there is no limit to warming



95% reduction of emissions in 20 years

Temperature increase at 2100 is committed to almost double after 2100 and to last 1000s years



95% reduction of emissions in 20 years

Source: Climate Interactive IPCC 2007

3⁰C Commitment Forever

Total long-term commitment

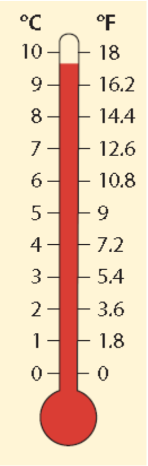
Today
0.8°C

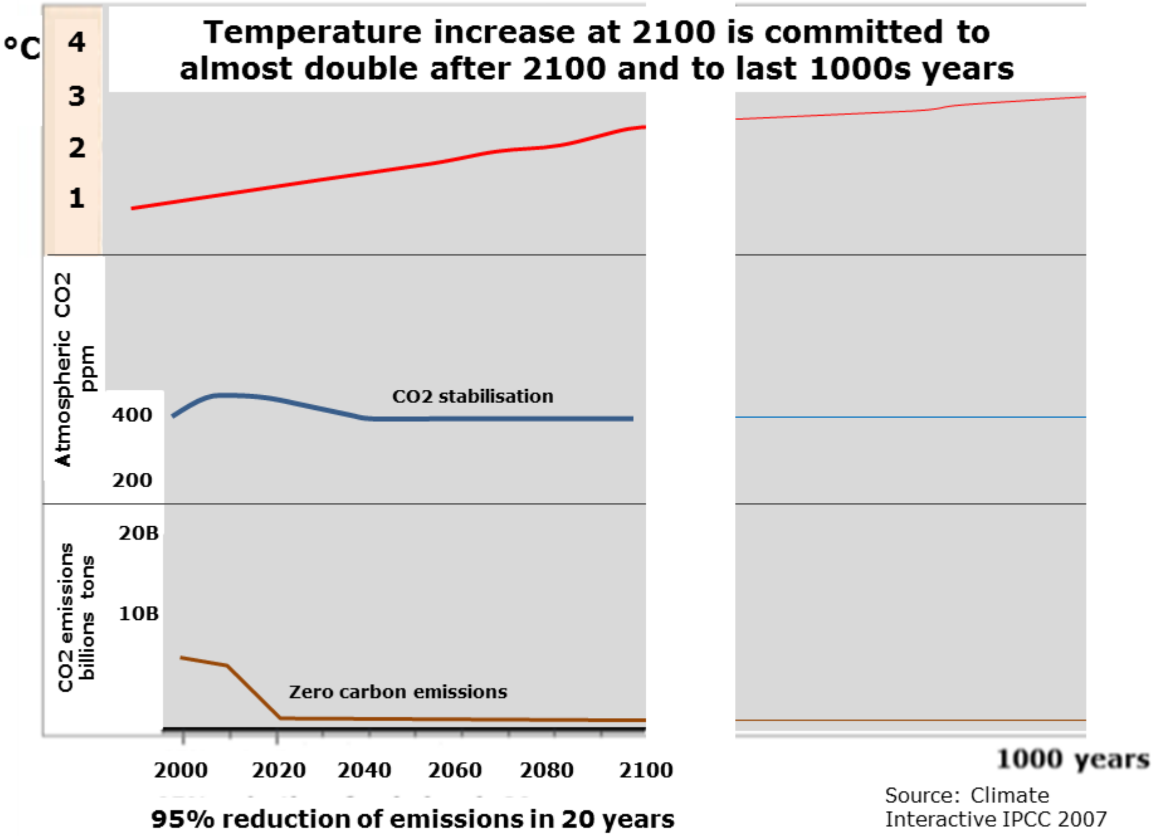
Emissions cut
to stabilization
+ 0.8°C
1.6°C

Ocean lag
almost double
3.0°C

Commitment by 2100

Ocean heat lag
0.5°C to 2100
2.1°C by 2100

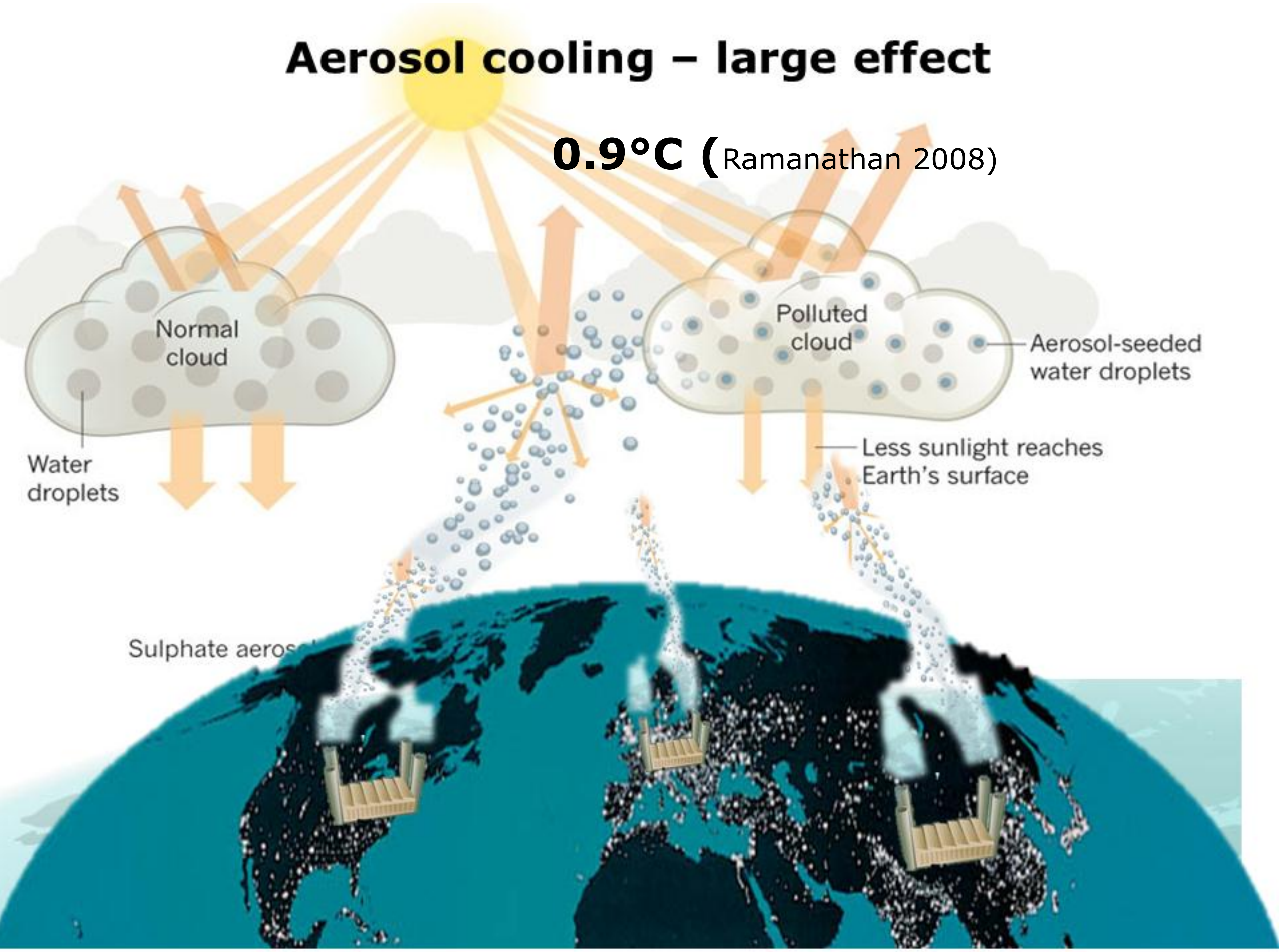




Source: Climate Interactive IPCC 2007

Aerosol cooling – large effect

0.9°C (Ramanathan 2008)

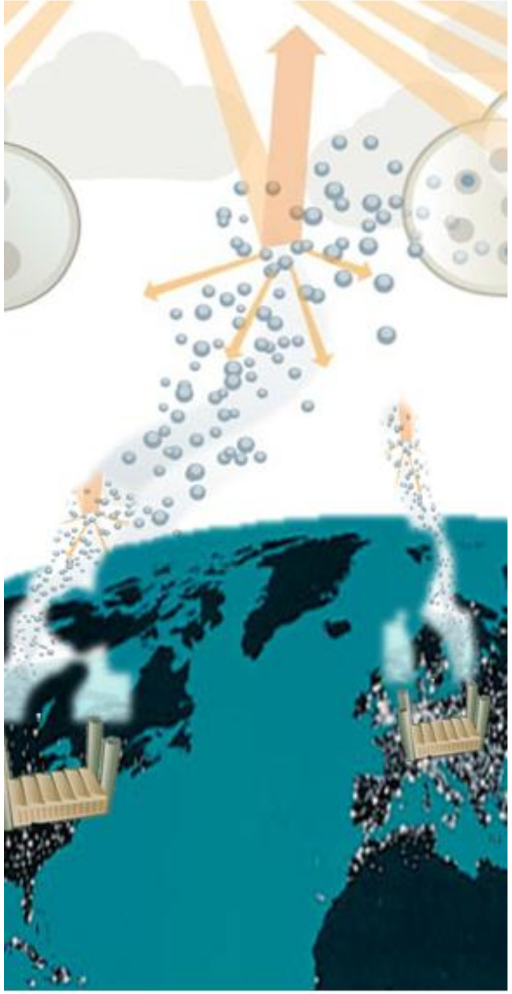


Add committed deferred warming due to aerosol cooling

4C for ever

(It's a definite commitment because of zero carbon.)

Total long-term commitment	
	Add in deferred warming of aerosol cooling
Today **0.8°C** Emissions cut to stabilization **<u>+ 0.8°C</u>** **1.6°C** Ocean lag <u>almost double</u> **3.0°C**	**3.0** **<u>+0.9°C</u>** **3.9°C**
Commitment by 2100	
Ocean heat lag <u>0.5°C</u> 2100 **2.1°C by 2100**	**2.1** **<u>+0.9°C</u>** **3.0°C**



Add committed warming due to feedbacks

Commitment by 2100

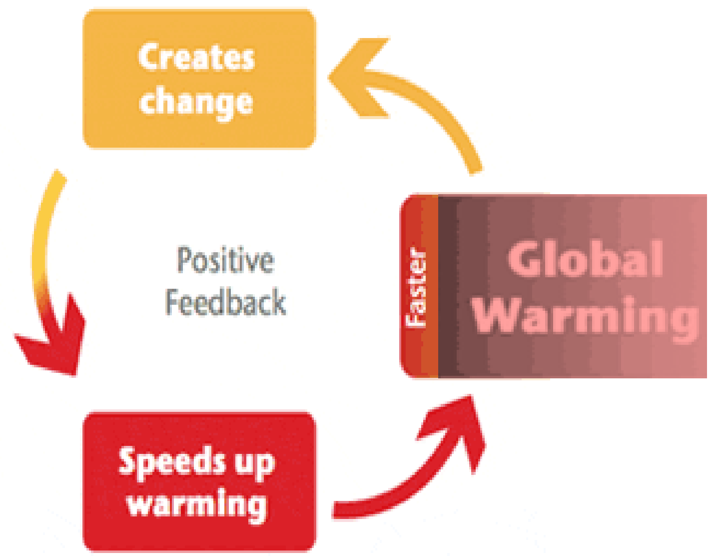
Terrestrial carbon feedback

3.0°C
+0.5°C (IPCC >1C by 2100)
3.5°C

Total long-term commitment after 2100

With Arctic feedbacks

3.9°C
+1.5°C
5.4 C

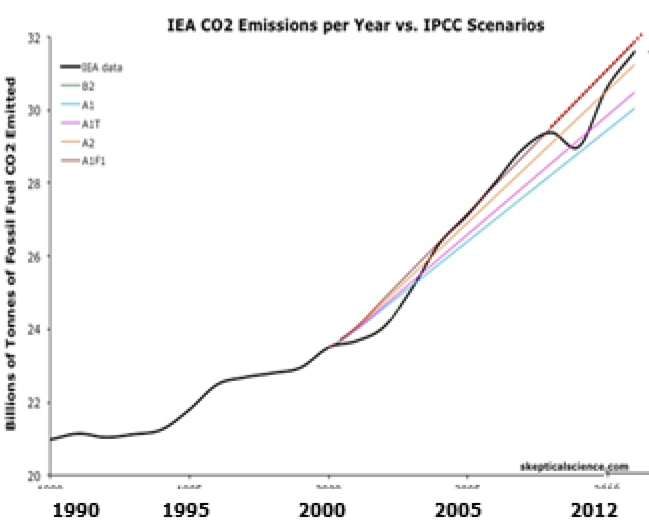


Committed global temperature increase: current energy economy scenario

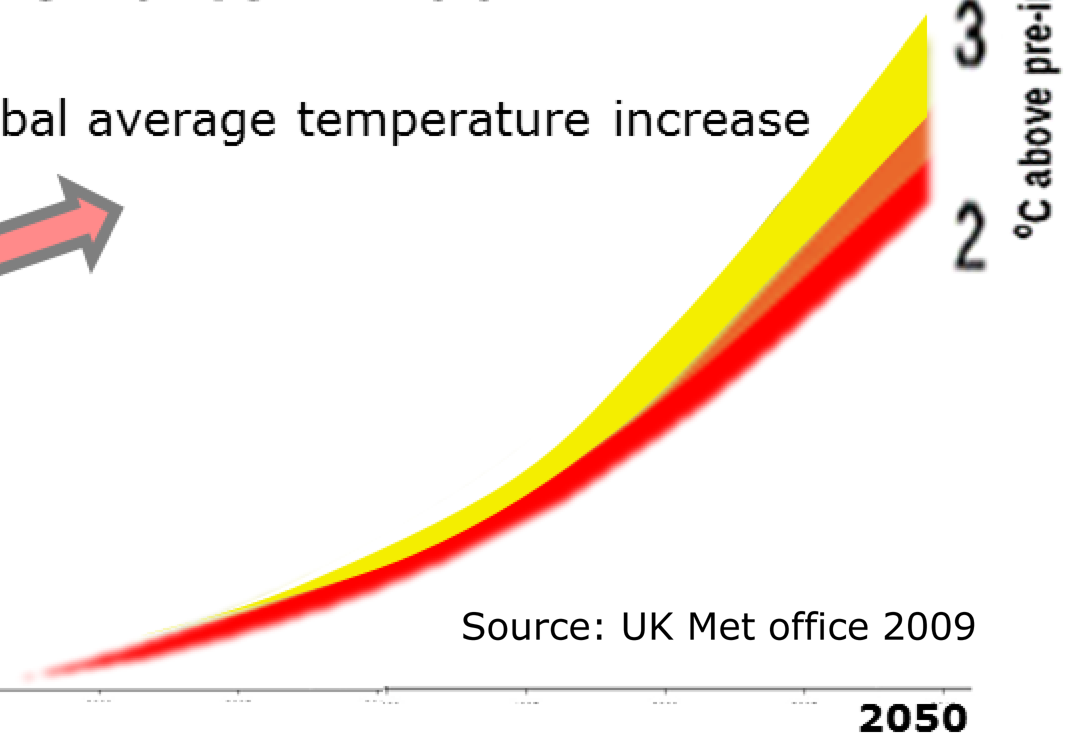
Fixed on the worst case high emissions scenario

+2–3°C by 2050
+5.5°C by 2100
+10°C after 2100

CO2 emissions

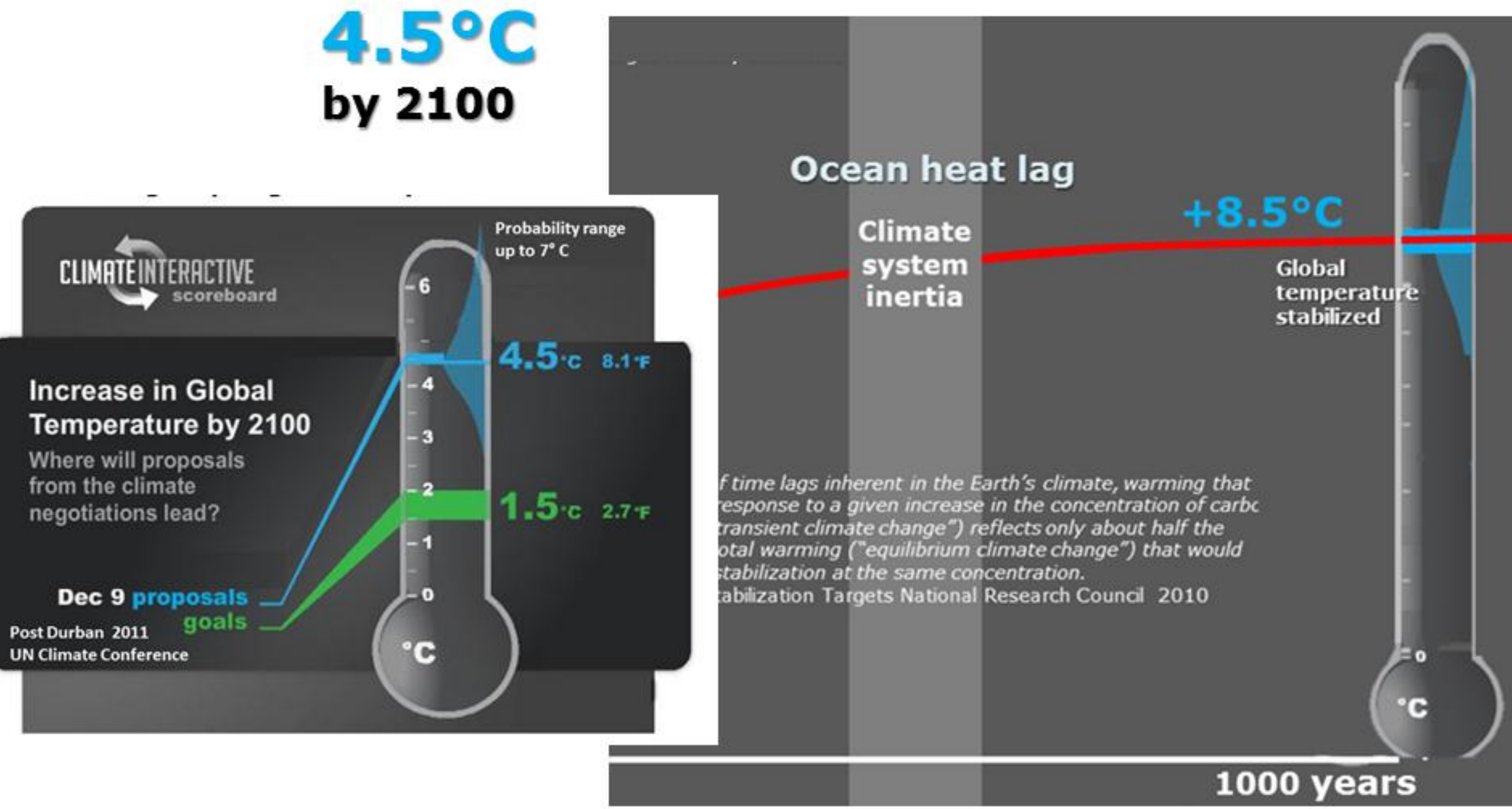


Global average temperature increase



Committed global temperature increase due to climate policy

Combined national United Nations emissions cut pledges assuming all pledges are implemented in full



**Committed global average surface temperature increase
(and climate change)**

↓

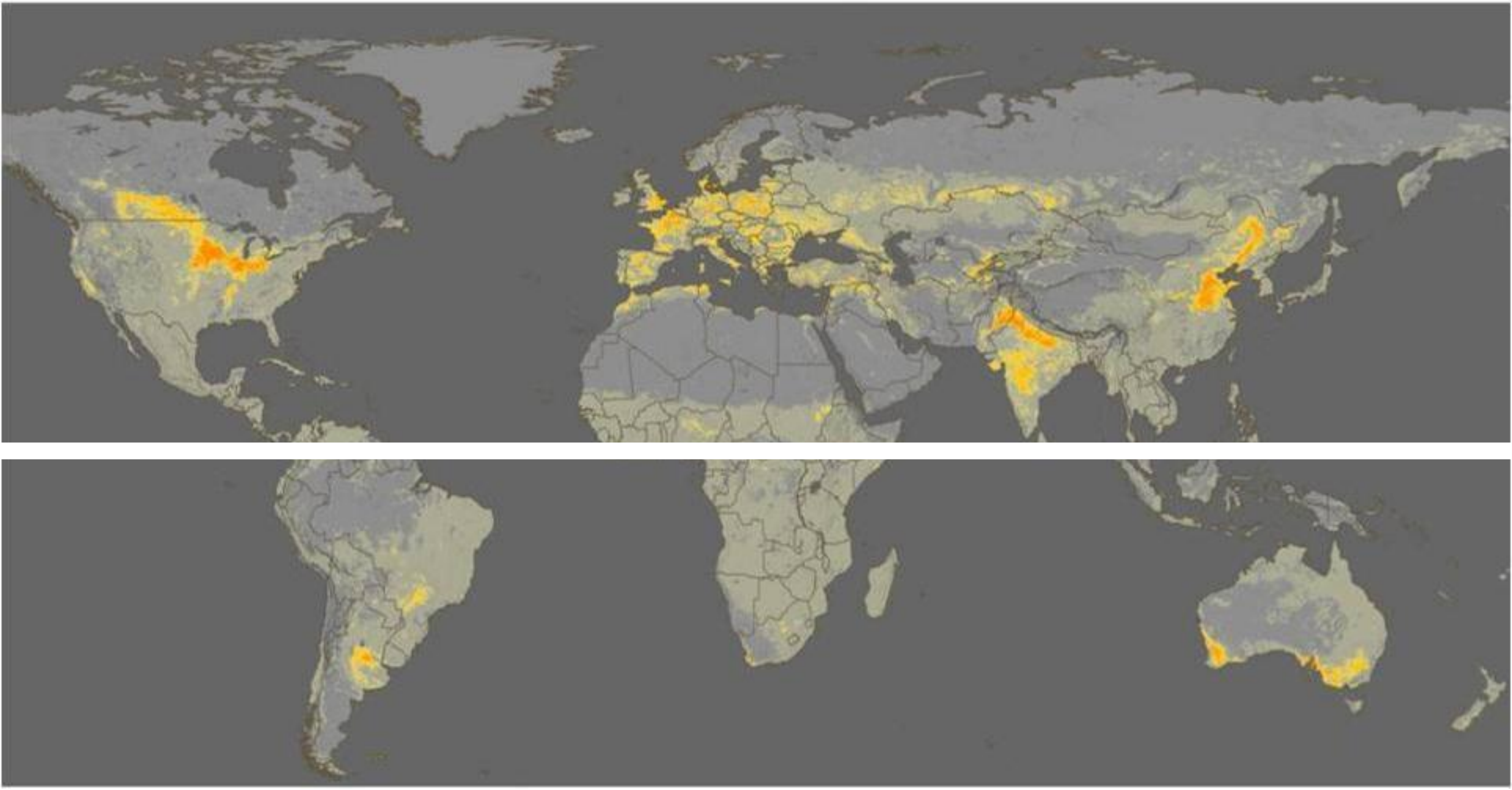
**Committed impacts and risks
to environmental/population health**

Any impacts to the least vulnerable regions have severe impacts to the most vulnerable populations

Any climate change compromise to the best northern hemisphere food production regions will have immediate, severe effects on the most vulnerable populations – billions of people.

High world foods prices
No food aid

Crop Intensity (NASA)



Committed global average surface temperature increase (and climate change)

Food production losses

Multiple adverse effects of global warming and climate change on crop yields

(only about half are captured by the models)

(omit benefits as they are only "*may be moderate*" and "*brief*" – IPCC 2007)

Committed temperature increase from feedbacks

Warming causes more warming

↓

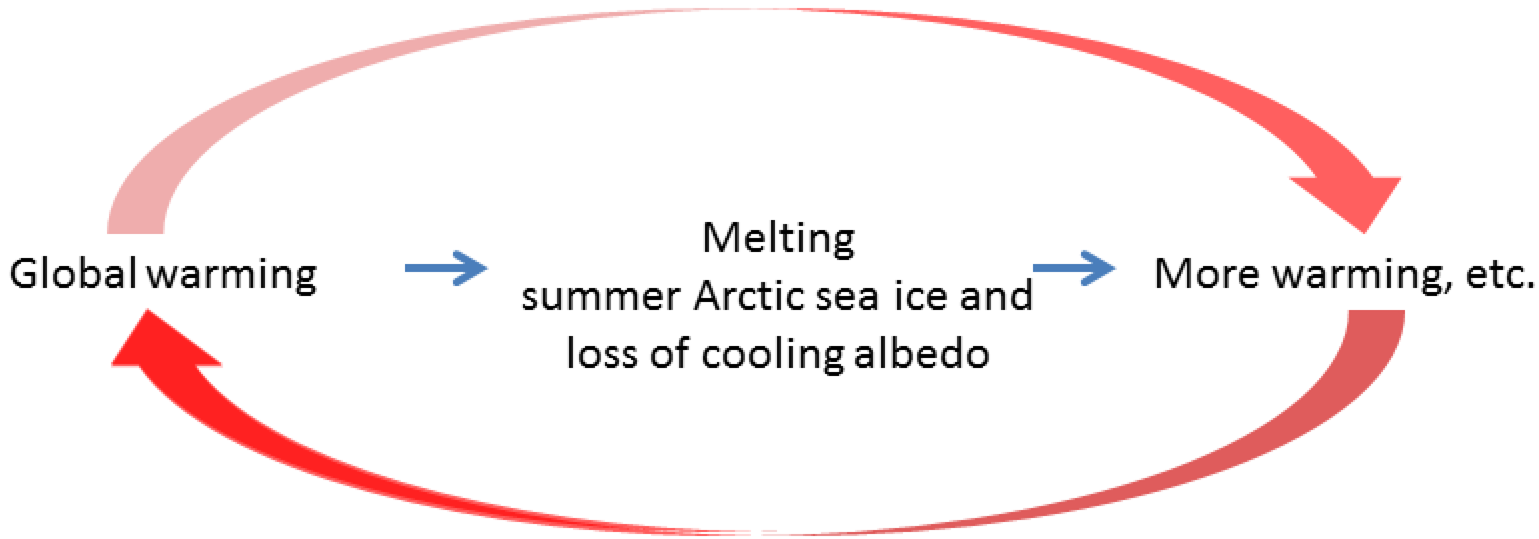
Feedbacks

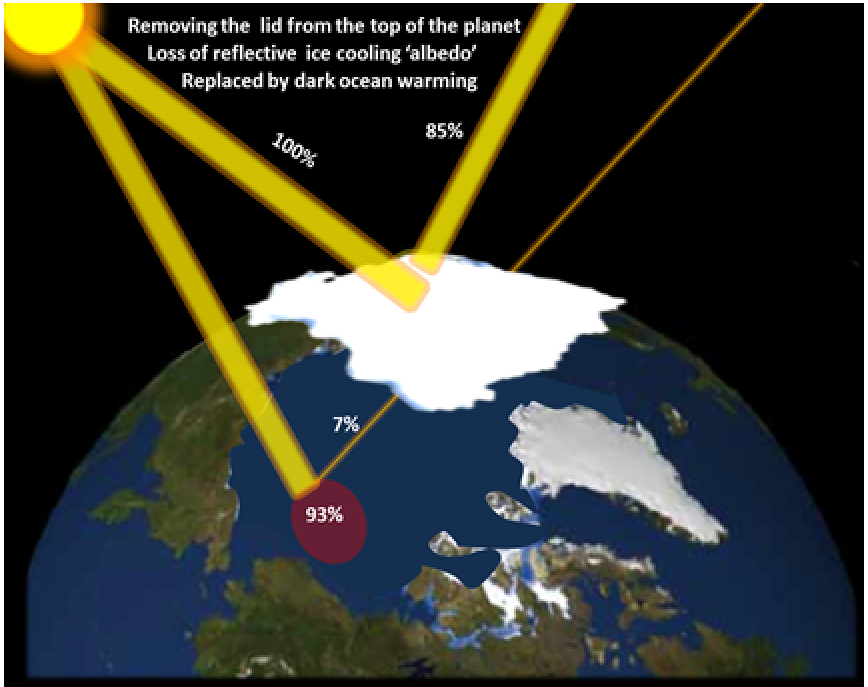
Largest positive (bad) climate system feedbacks

– Arctic –

are not in the models

Arctic Climate Feedbacks





Arctic snow and summer sea ice cooling albedo is the air conditioner of the entire northern hemisphere

Committed global average surface temperature increase

Feedbacks
Largest positive (bad) climate system feedbacks – in the Arctic

Food production losses
Multiple adverse effects of global warming and climate change on crop yields

Committed global average surface temperature increase

Feedbacks
Largest
Arctic

Food production losses
Multiple adverse effects of global warming and climate change on crop yields

Committed impacts and risks to environmental/population health

Global climate change impacts on crops

- **Multiple adverse impacts**

- **Reduces yields in all regions**
- **Some regions are affected earlier than others**

- **As temperatures increase, yields decrease**

Any impacts to the least vulnerable regions have severe impacts to most vulnerable populations

Any climate change compromise to the best northern hemisphere food production regions will have immediate, severe effects on the most vulnerable populations – billions of people.

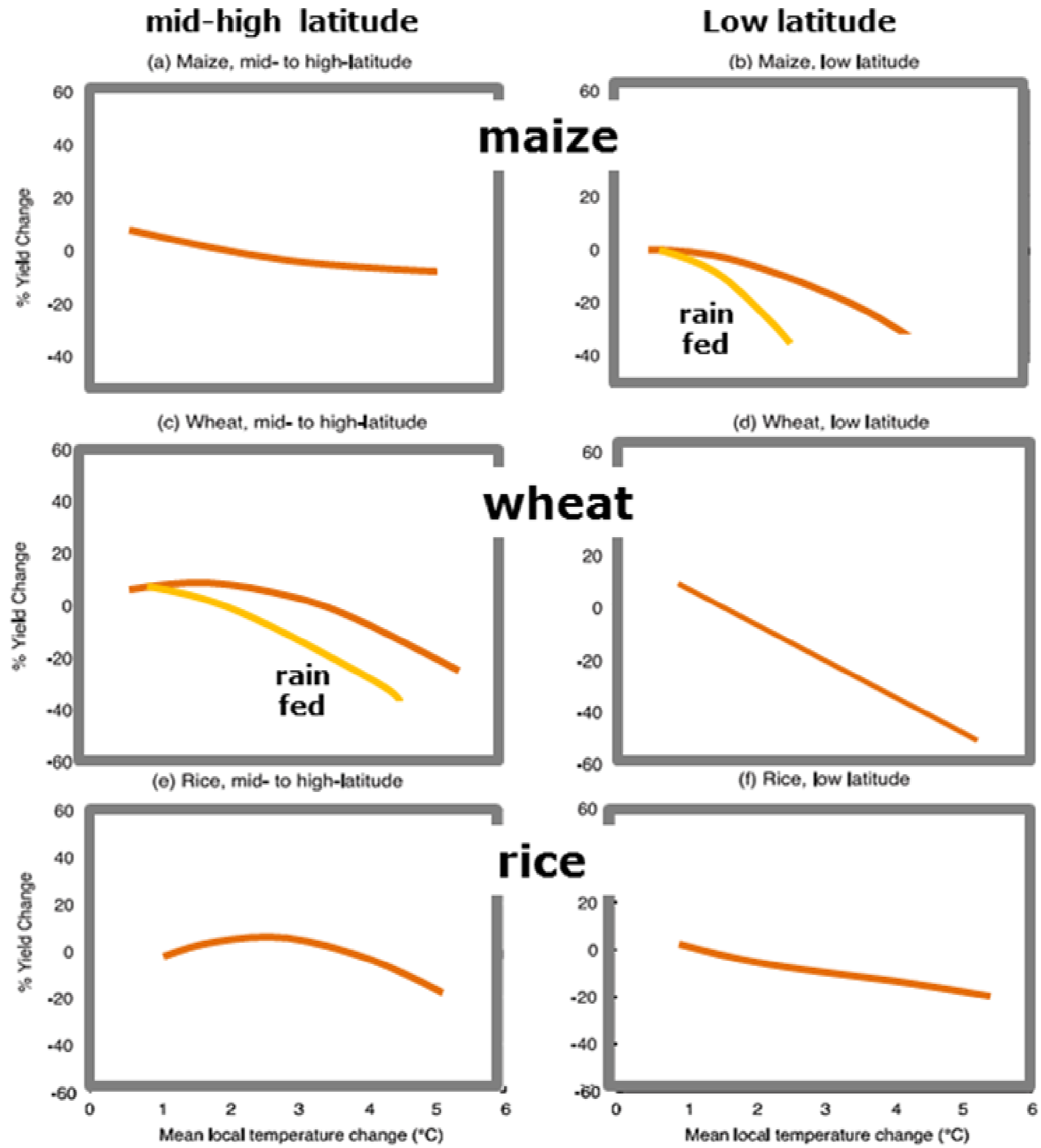
High world foods prices
No food aid

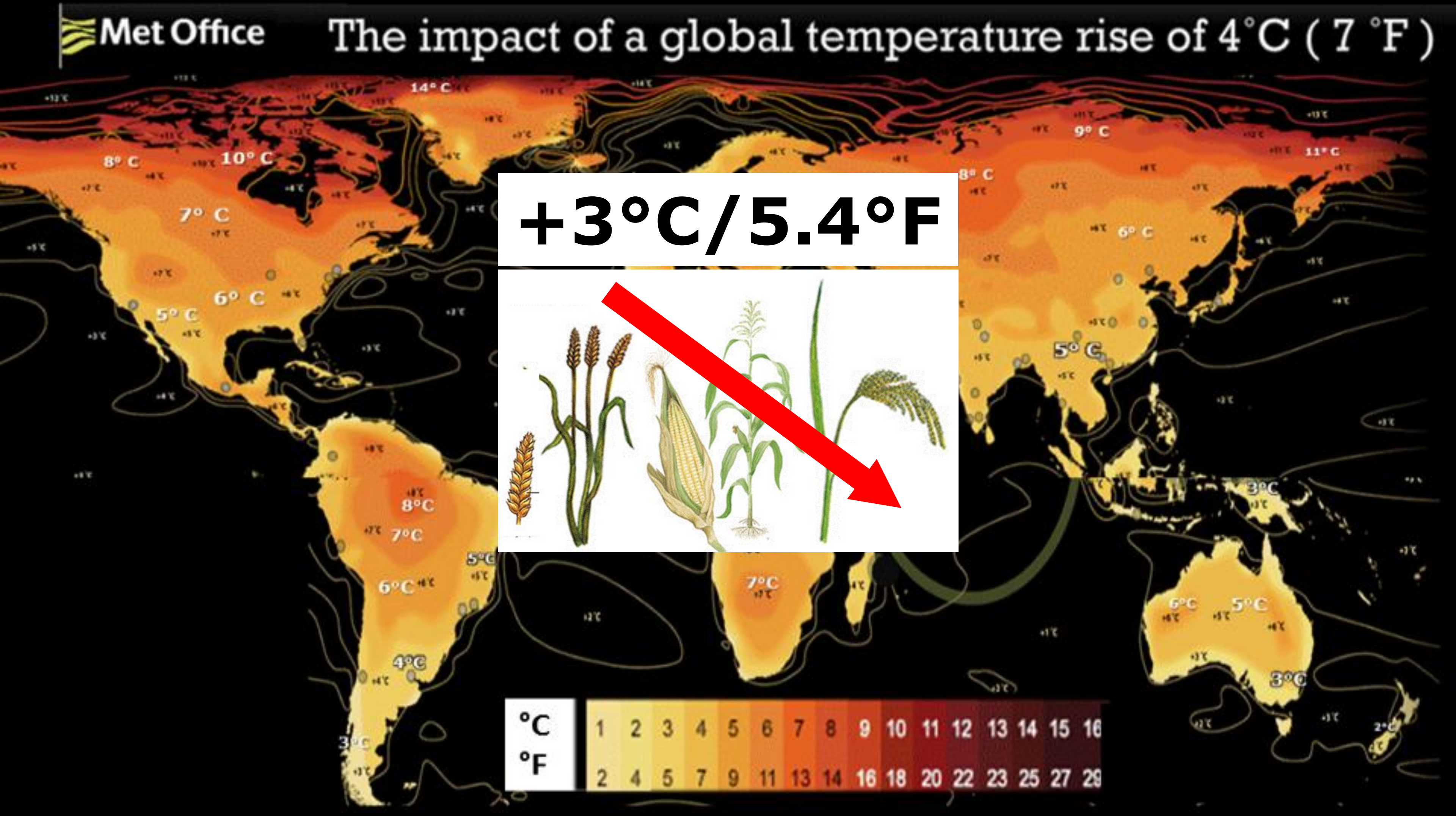
Climate crop models IPCC 2007

- **Reduces yields in all regions**

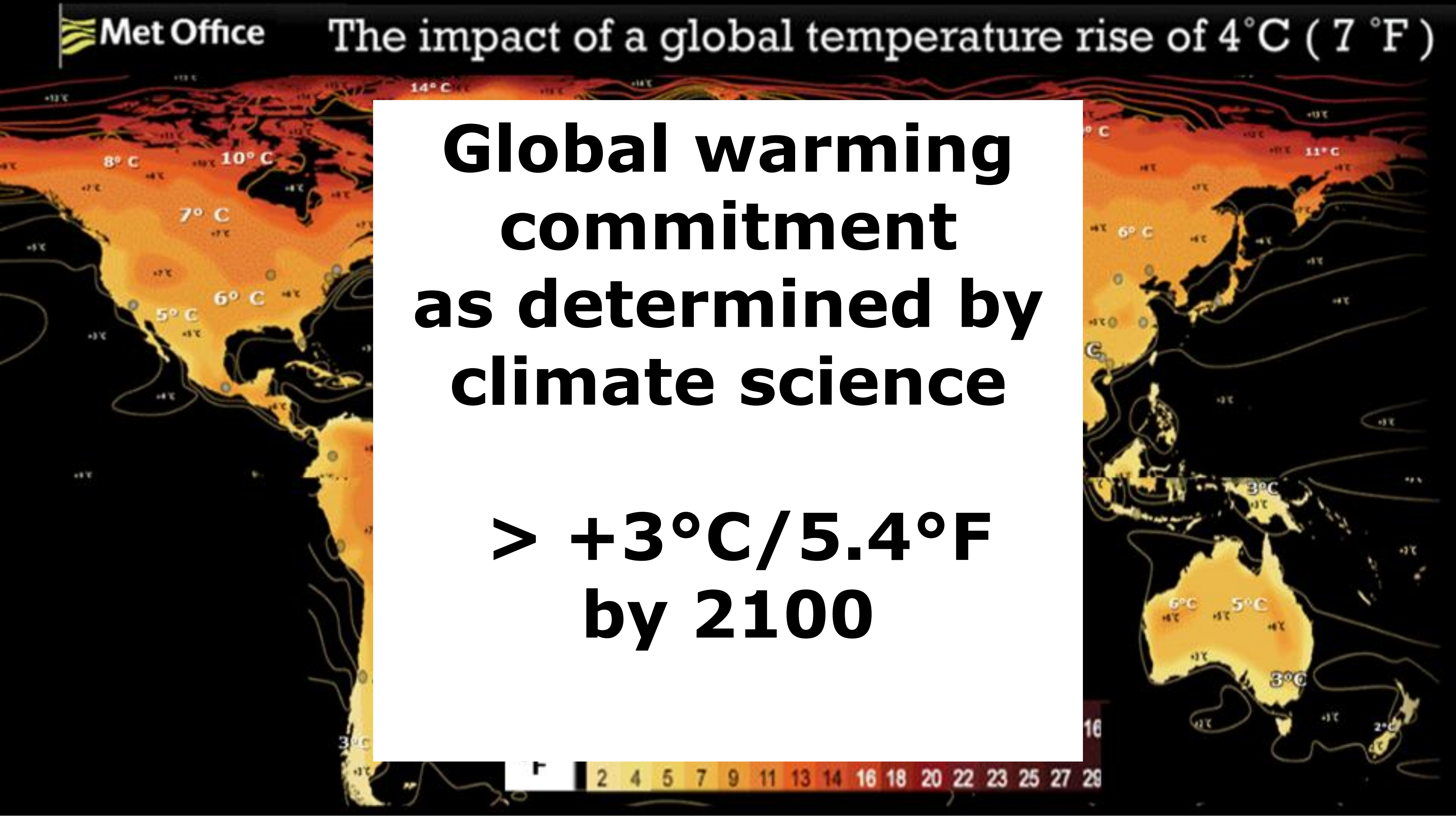
- **Some regions are affected earlier than others**

- **As temperatures increase, yields decrease**





Agricultural yields are expected to decrease for all major cereal crops in all major regions of production, once the global average temperature increases more than 3°C

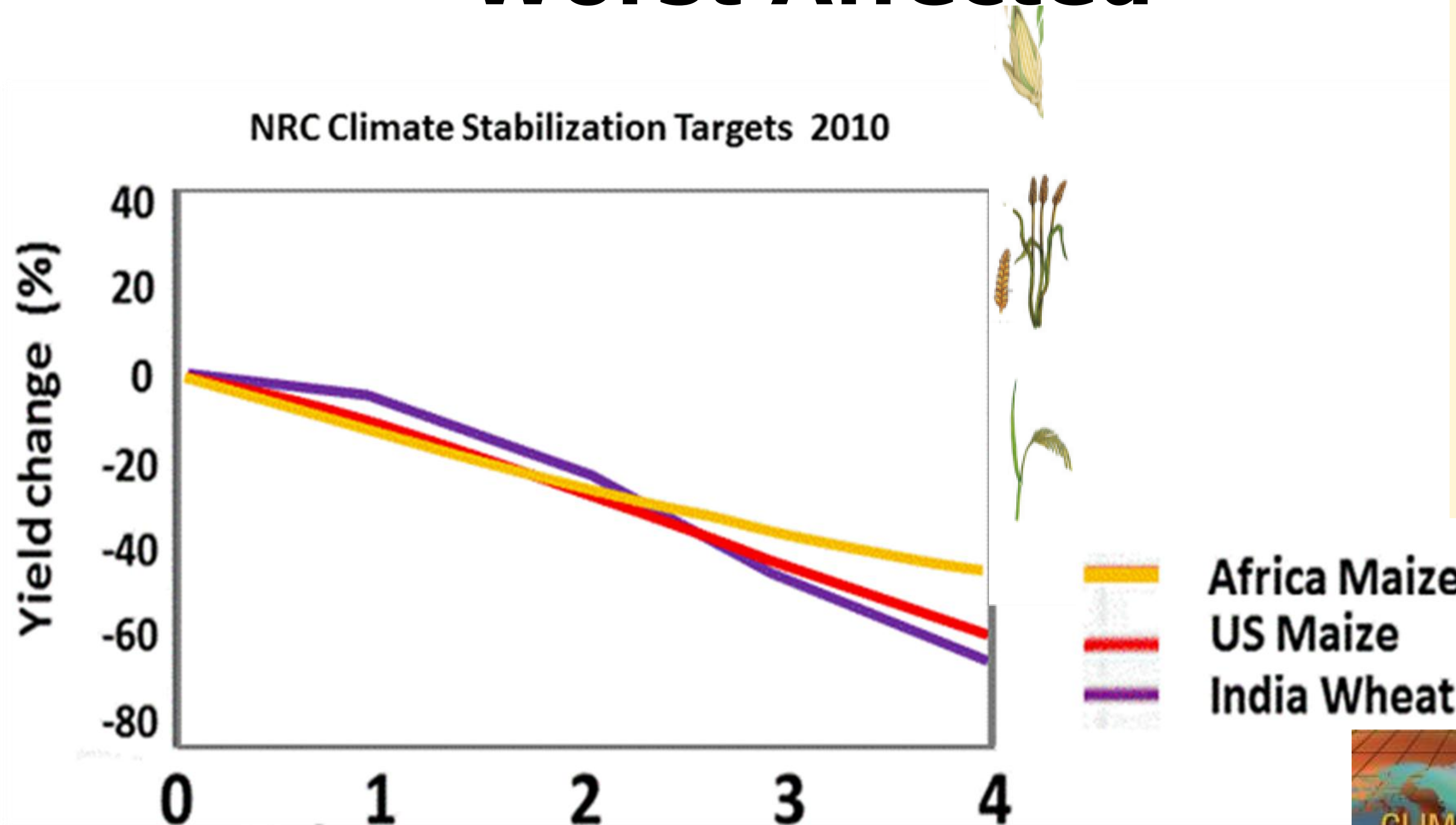


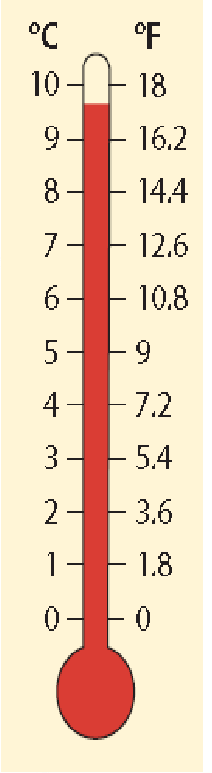
Global warming commitment as determined by climate science

> +3°C/5.4°F by 2100

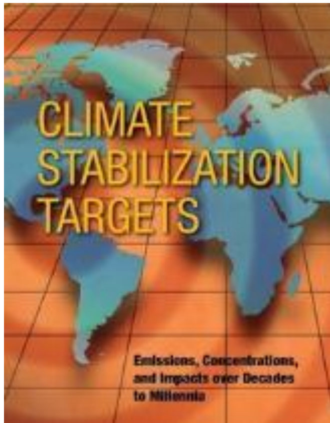
Agricultural yields are expected to decrease for all major cereal crops in all major regions of production, once the global average temperature increases more than 3°C

Worst Affected

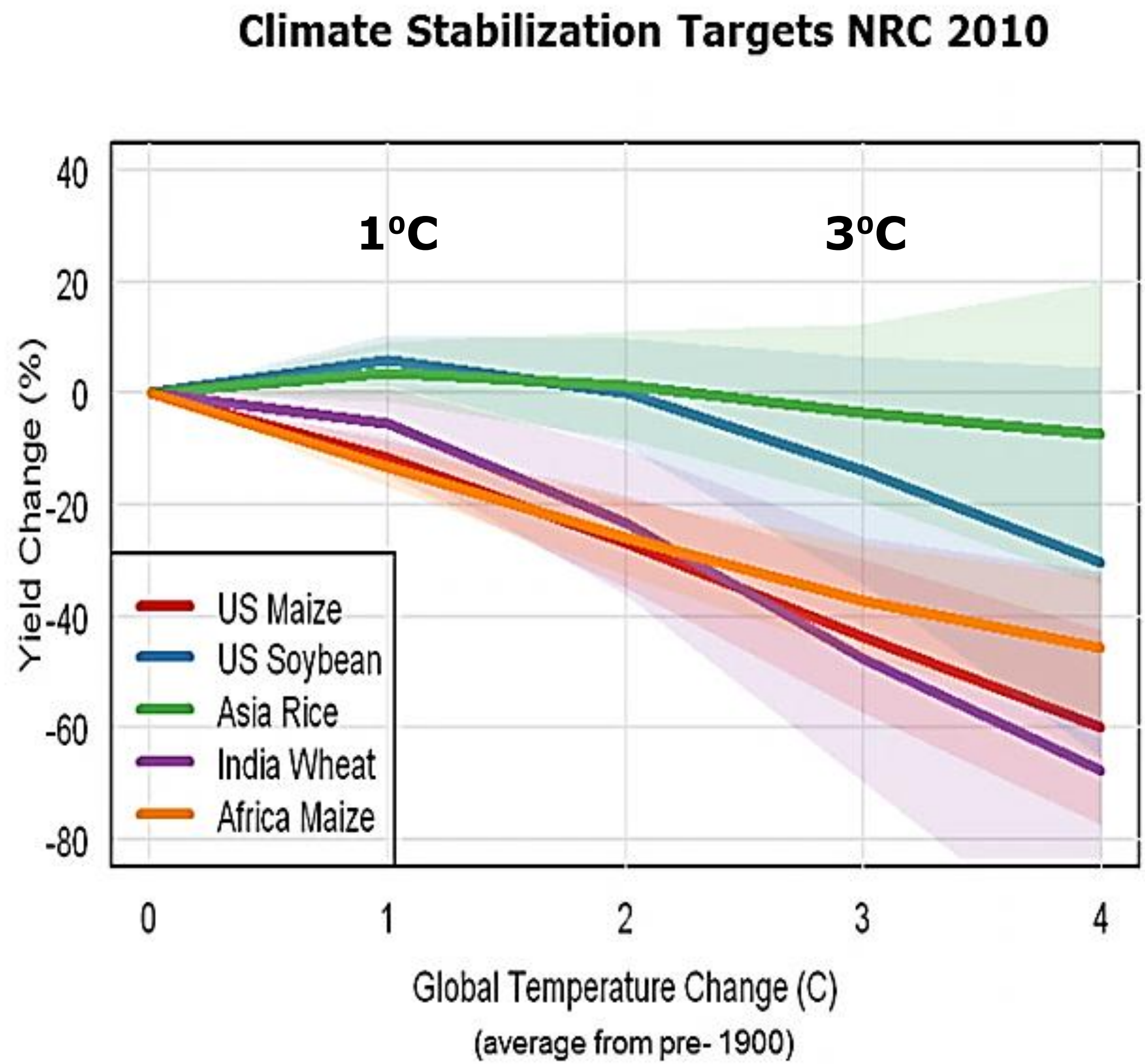


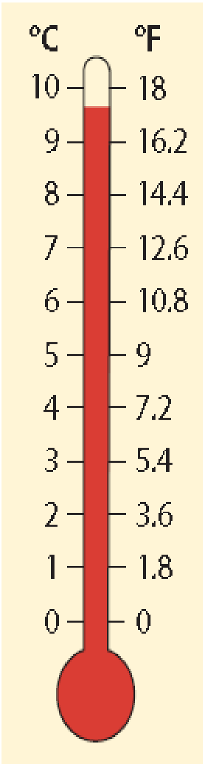


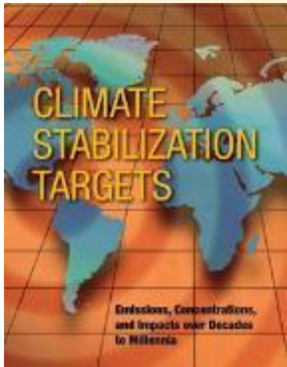
Global temperature increase from pre-industrial °C



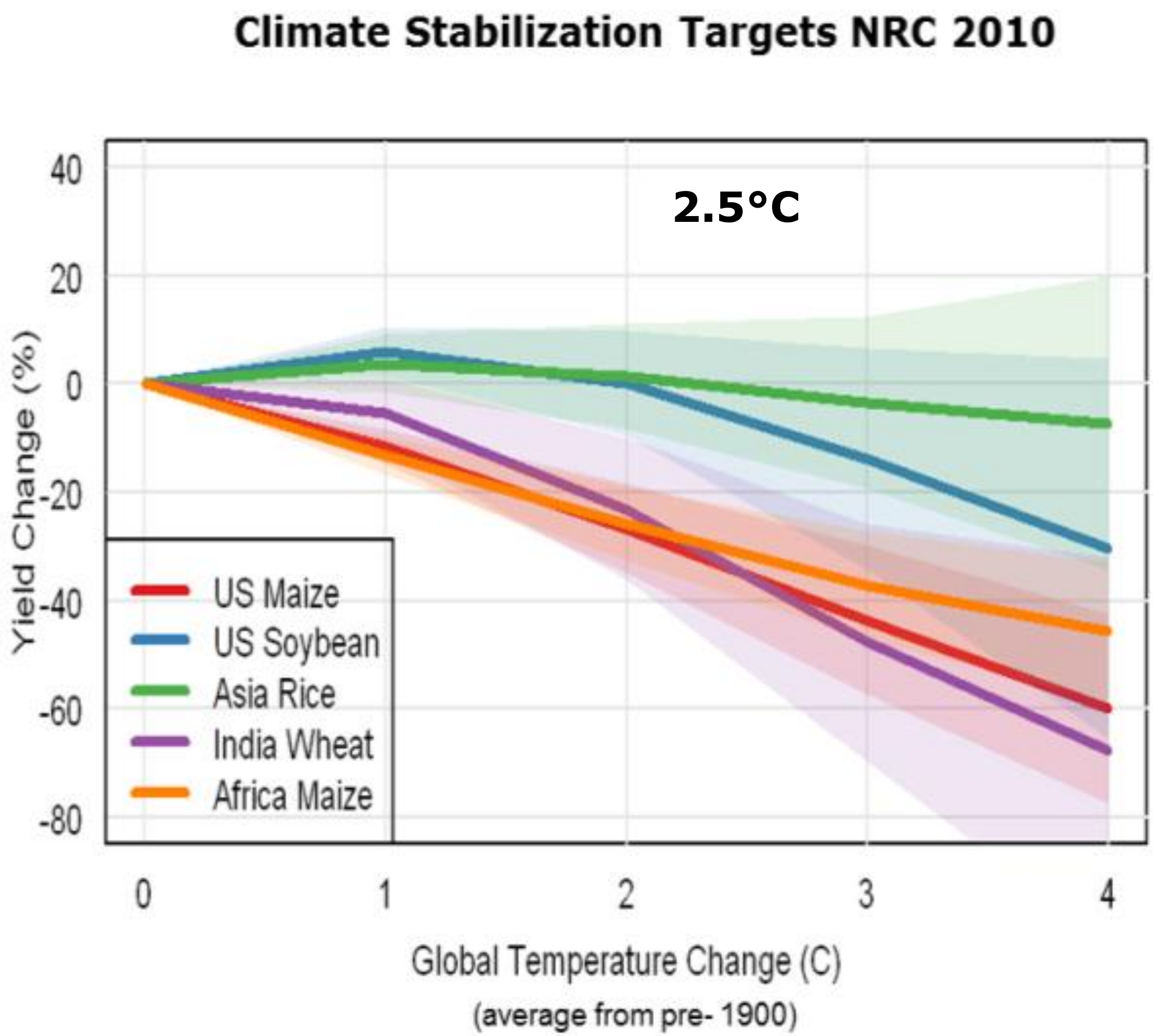
Most vulnerable region crops will have declined below baseline by +1.0°C with a 30% loss at +3°C

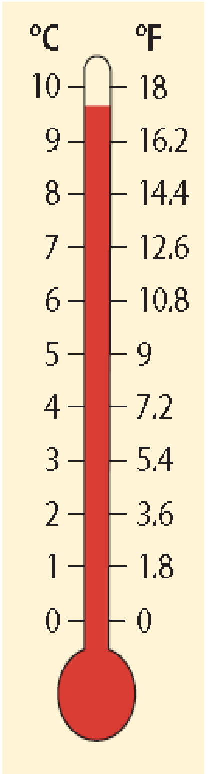




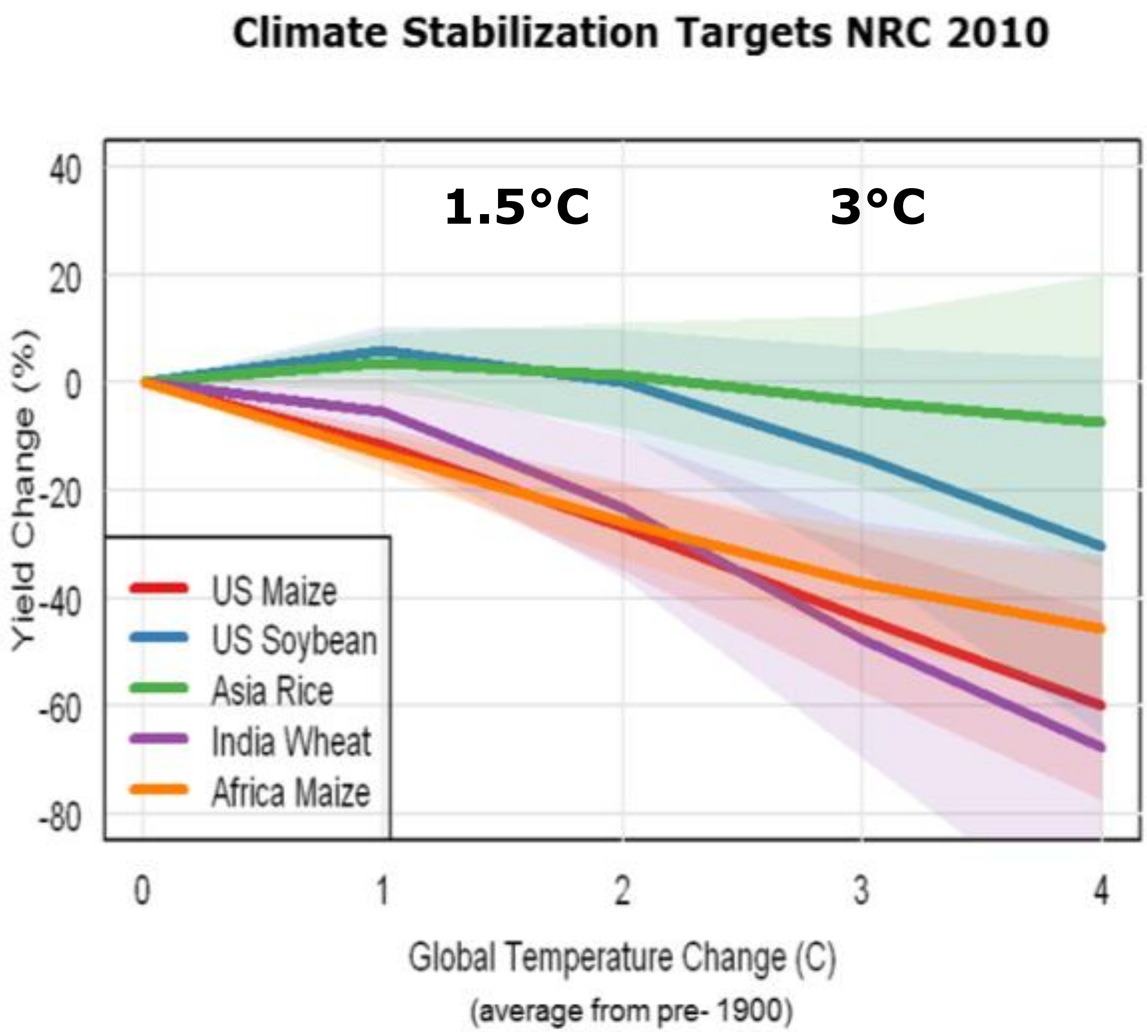


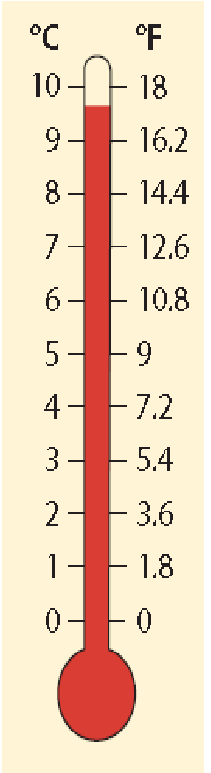
All crops in all regions will have declined below today's (2000) baseline at a temperature increase above 2.5°C





Global crop yield is at risk of decline at a global temperature increase of 1.5°C and can accommodate no more than 3°C before beginning to decline (below baseline). – IPCC 2007





Arctic Positive (Bad) Climate Feedbacks

Arctic snow and summer sea ice cooling albedo is the air conditioner of the entire northern hemisphere

Projected impacts on the northern hemisphere from loss of snow and summer sea ice albedo cooling

Increasing:

- **climate variability**
- **extreme weather events**
- **drought**

Operant Arctic methane feedbacks at +0.8°C

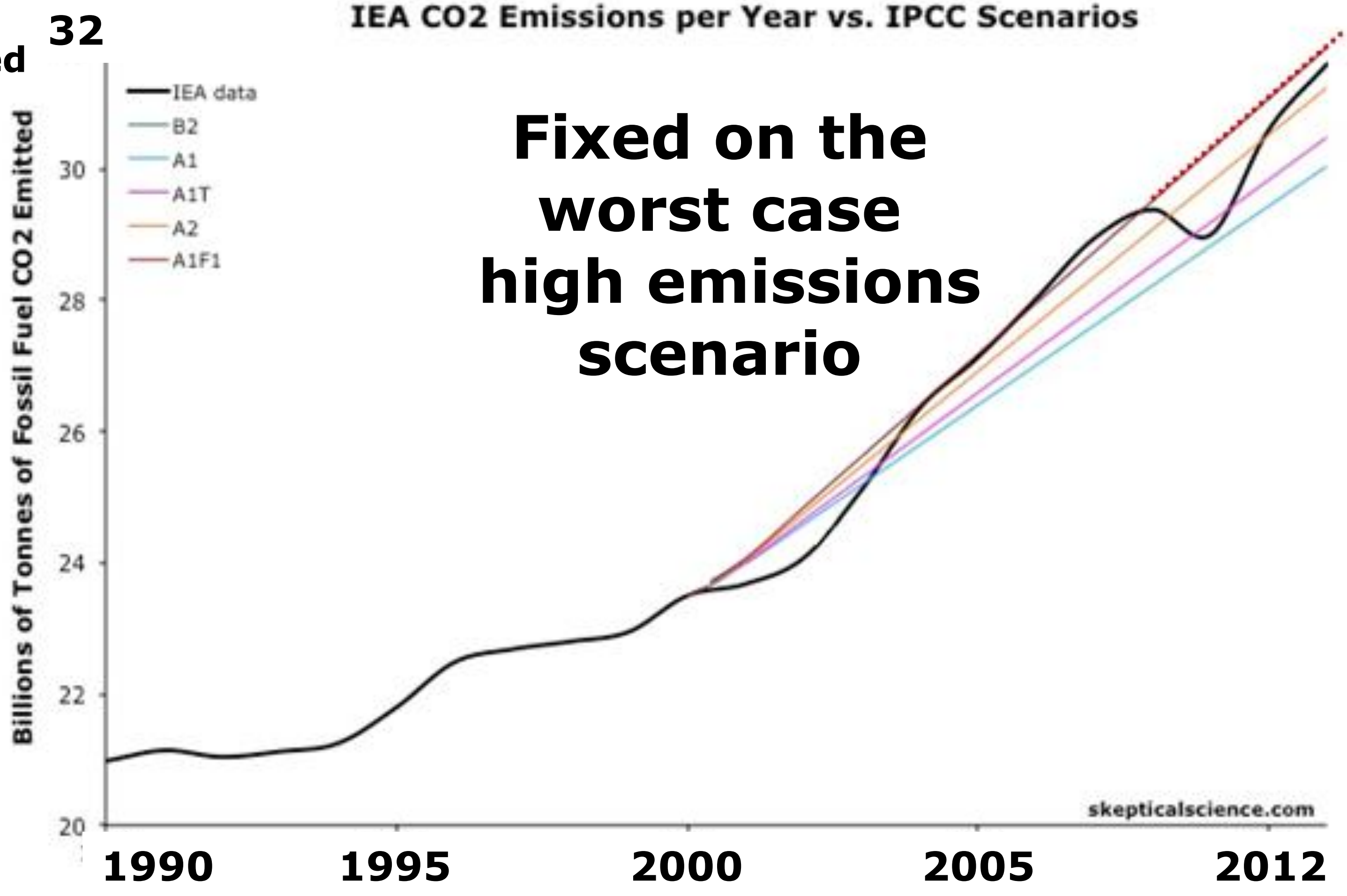
Methane (72 x CO2 over 20 years)

Feedback emissions increase rate of global warming

Committed global temperature increase according to current world energy economy scenario

Committed global temperature increase: current energy economy scenario

Billions of tonnes of fossil fuel CO2 emitted



Committed global temperature increase: current energy economy scenario

International Energy Agency, *Tracking Clean Energy Progress*, 2012

Energy Technology Perspectives 2012 excerpt as IEA input to the Clean Energy Ministerial:

"The current trend of increasing emissions is unbroken with no stabilization of GHG [greenhouse gas] concentrations in sight."

If this continues, "*energy use will almost double in 2050, compared with 2009, and total GHG emissions will rise even more.*

"Long-term temperature rise (by 2100) is likely to be at least 6ºC."

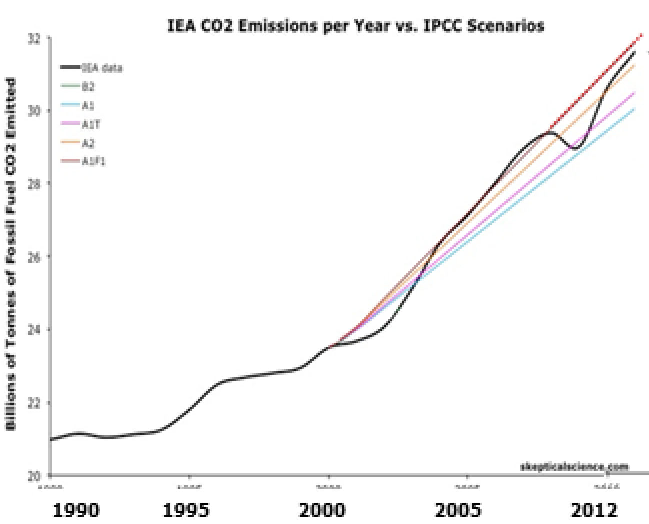
Committed global temperature increase: current energy economy scenario

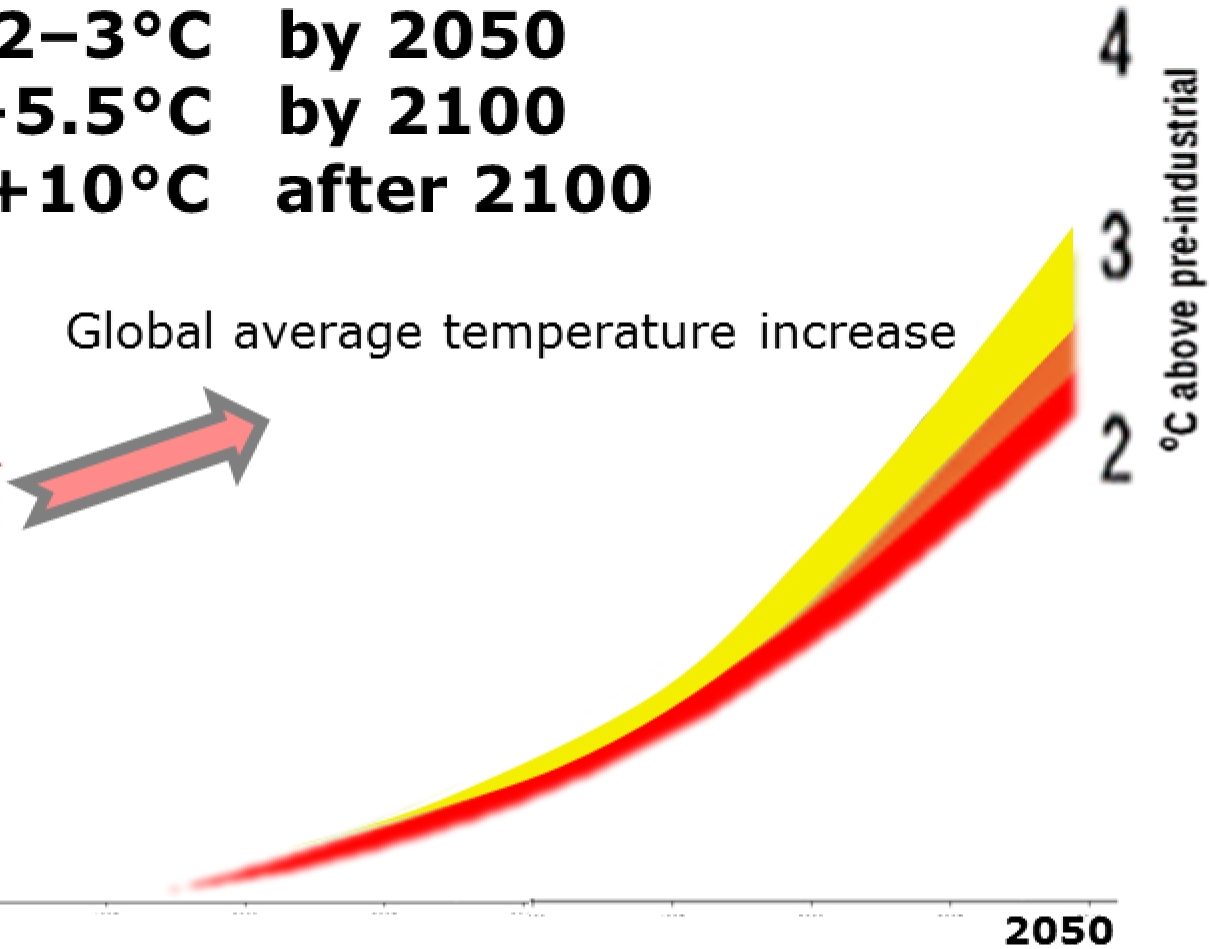
Fixed on the worst case high emissions scenario

+2–3°C by 2050
+5.5°C by 2100
+10°C after 2100

CO2 emissions

Global average temperature increase





Committed global temperature increase: current world energy economy

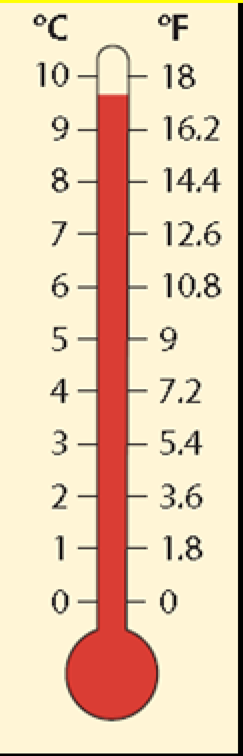
Today we're fixed on IPCC's 'worst case' emissions socio- economic scenario, A1F1

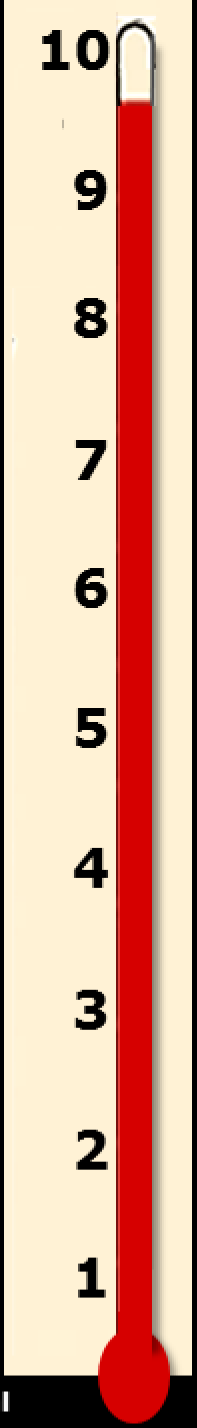
Excludes Arctic methane carbon feedback emissions, which will boost rate of warming faster

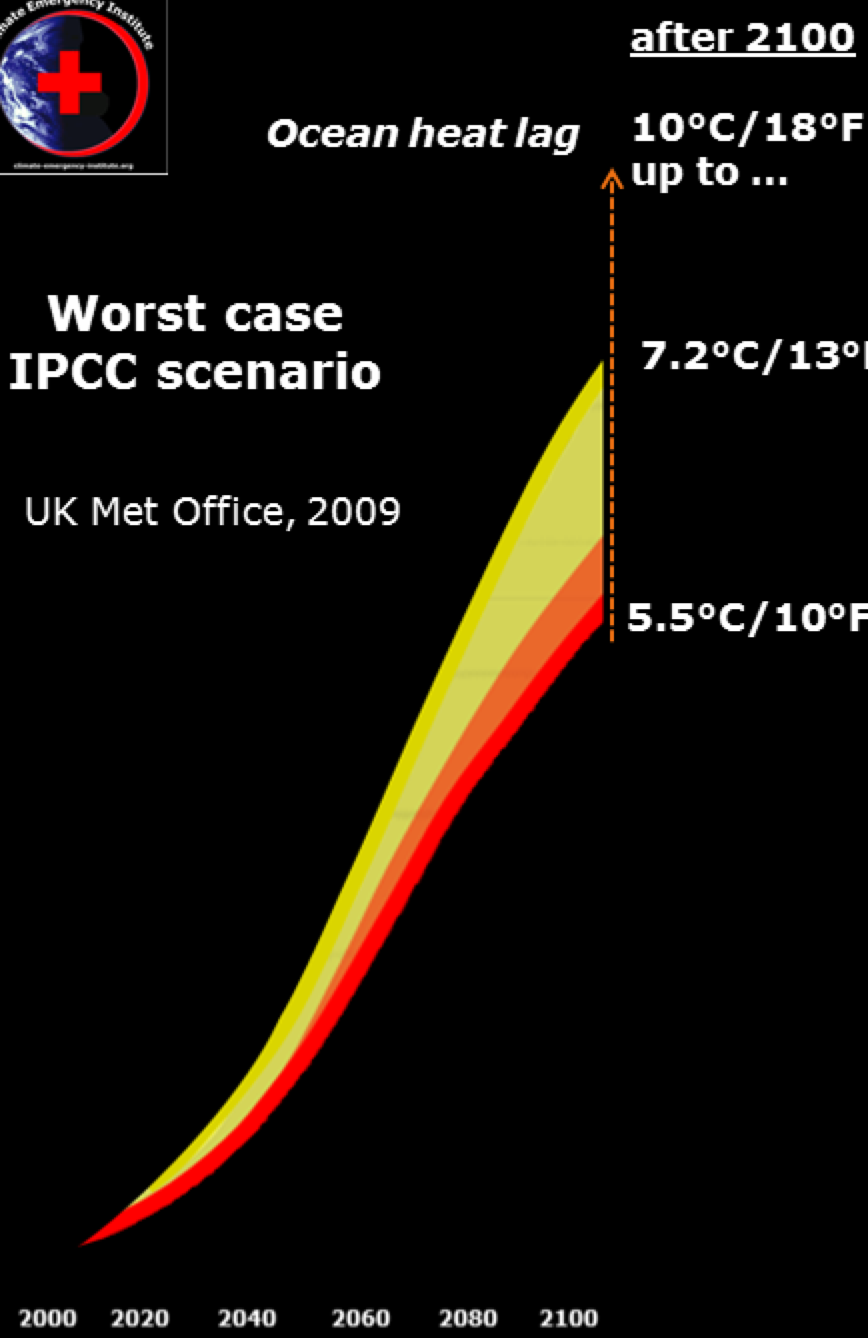
UK Met Office 2009
A1F1 scenario

by 2100

+5.5°C/10°F
up to 7.2°C/13°F



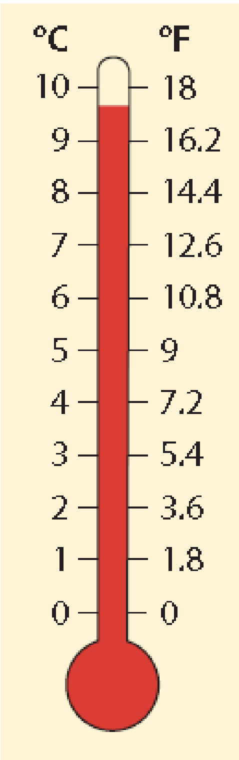


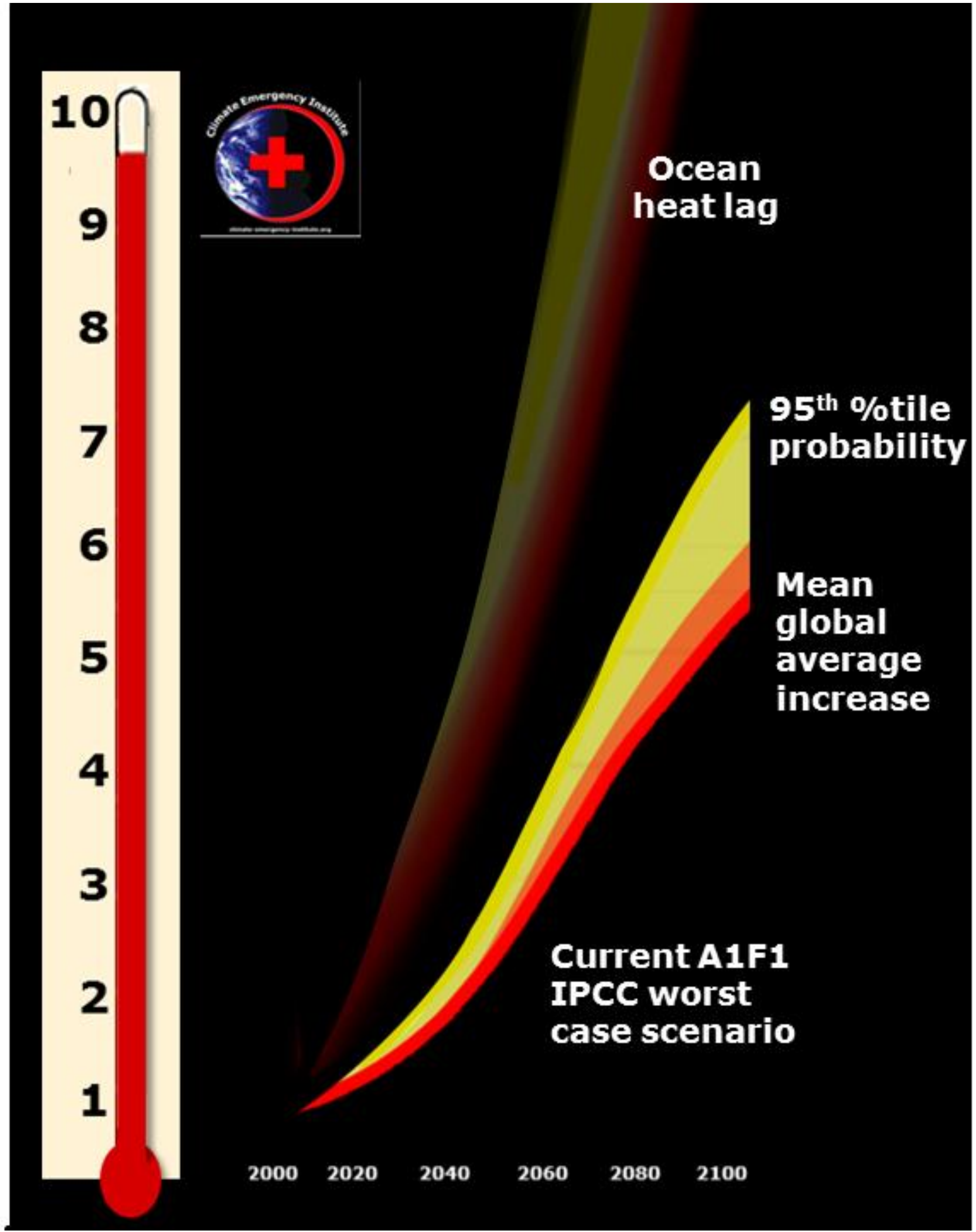


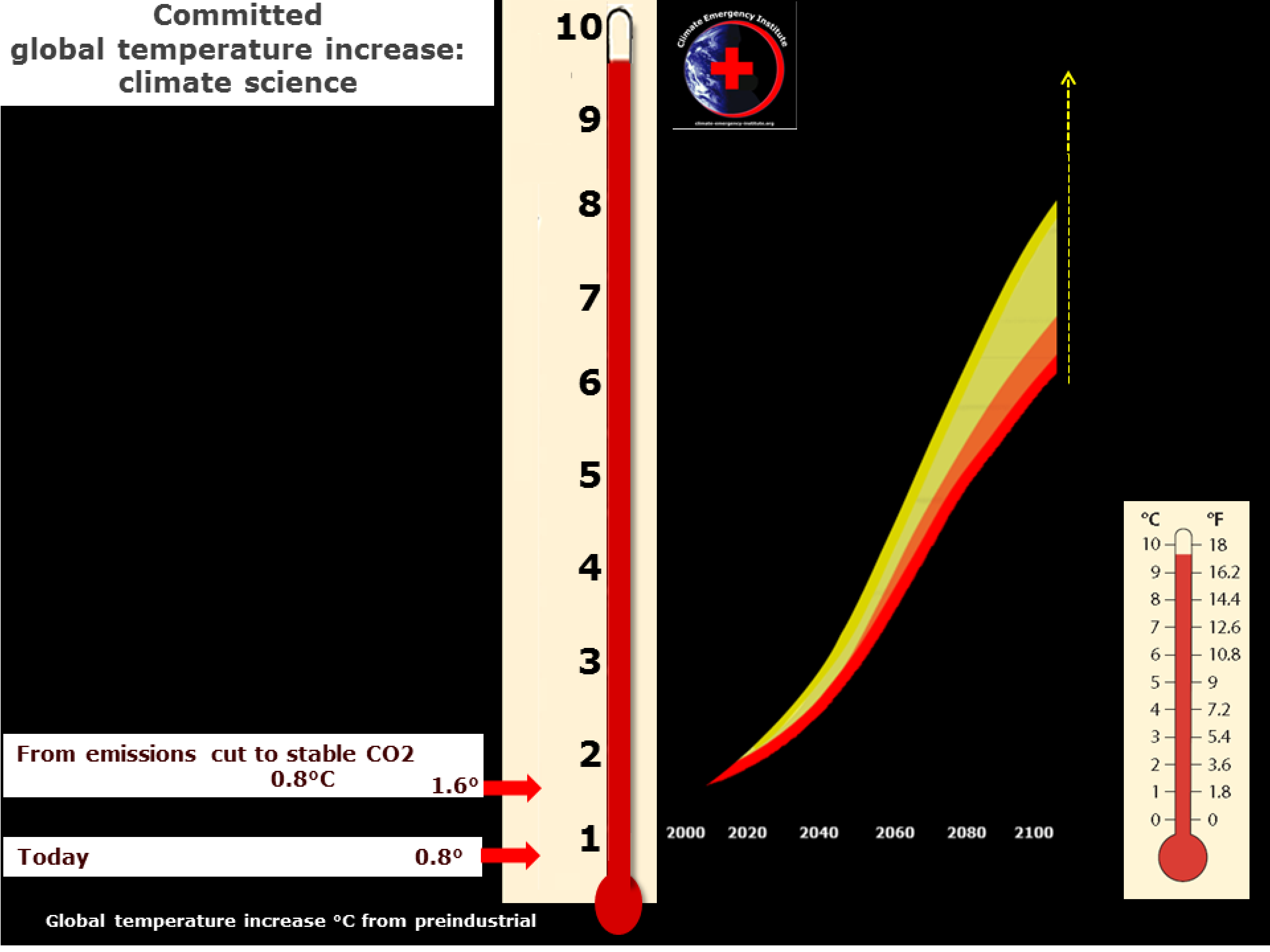
Global temperature increase °C from preindustrial

Committed global temperature increase: according to climate system science

Committed global temperature increase: according to climate system science






Committed
global temperature increase:
climate science
Climate Emergency Institute
10
9
8
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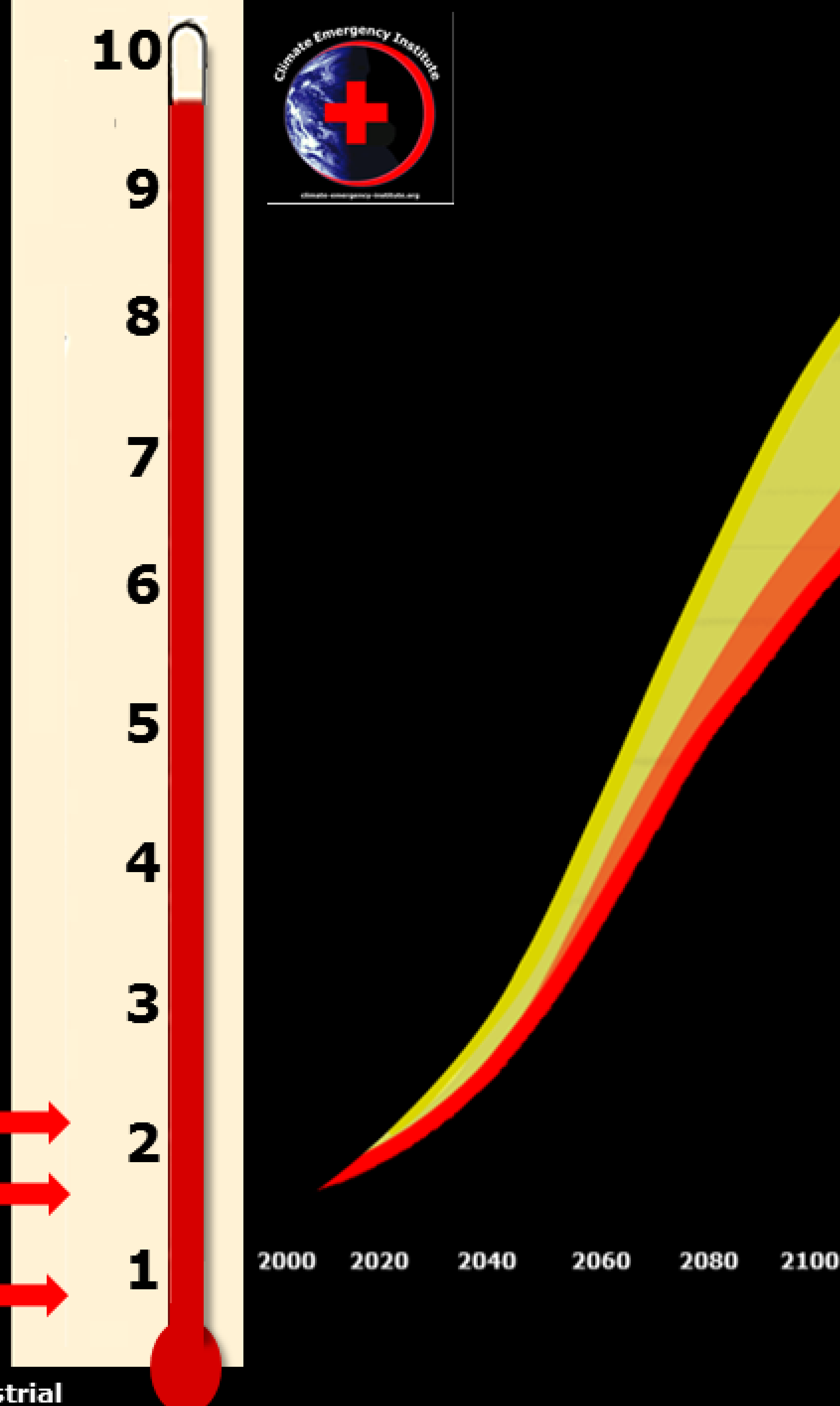
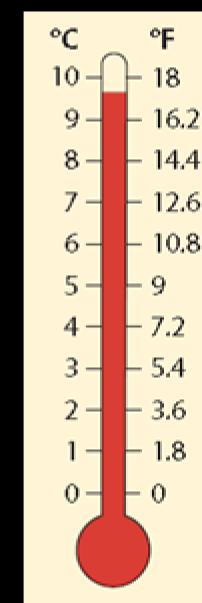
5
4
3
2
1
From emissions cut to stable CO2
0.8°C
1.6°
Today
0.8°
2000
2020
2040
2060
2080
2100
°C
°F
10 18
9 16.2
8 14.4
7 12.6
6 10.8
5 9
4 7.2
3 5.4
2 3.6
1 1.8
0 0
Global temperature increase °C from preindustrial

Committed global temperature increase according to the climate science



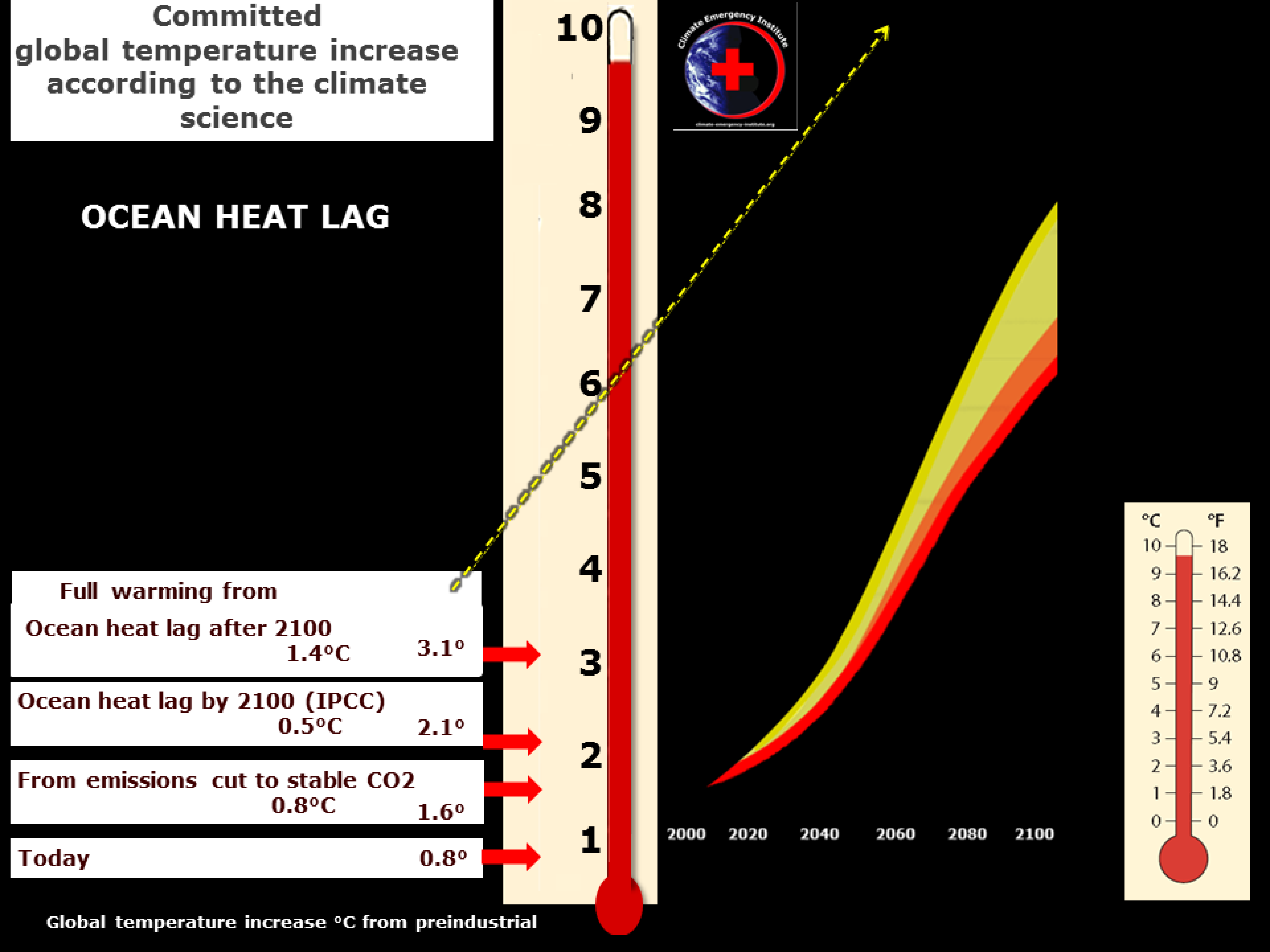


Ocean heat lag by 2100 (IPCC)
0.5°C 2.1°

From emissions cut to stable CO2
0.8°C 1.6°

Today 0.8°

Global temperature increase °C from preindustrial



Committed global temperature increase according to the climate science
OCEAN HEAT LAG
Full warming from
Ocean heat lag after 2100 1.4°C 3.1°
Ocean heat lag by 2100 (IPCC) 0.5°C 2.1°
From emissions cut to stable CO2 0.8°C 1.6°
Today 0.8°
Global temperature increase °C from preindustrial
10
9
8
7
6
5
4
3
2
1
2000
2020
2040
2060
2080
2100
°C
°F
10 18
9 16.2
8 14.4
7 12.6
6 10.8
5 9
4 7.2
3 5.4
2 3.6
1 1.8
0 0

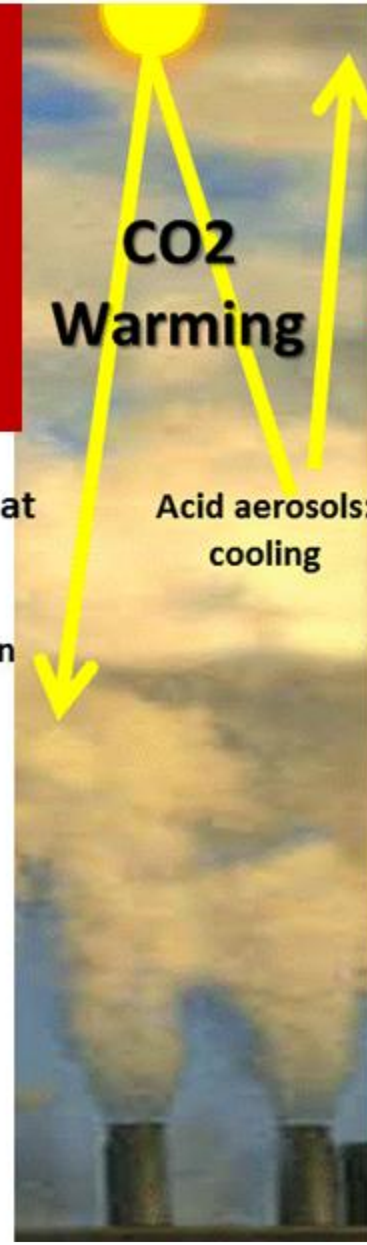
Aerosol cooling: fossil fuel emissions effects on global temperature

WARMING

- CO_2
- Black carbon soot (air pollution)
- Ground level ozone (air pollution)

COOLING

- Aerosols (air pollution)



Solar heat + Fossil fuel combustion pollution

Tropospheric (ground level) ozone: warming

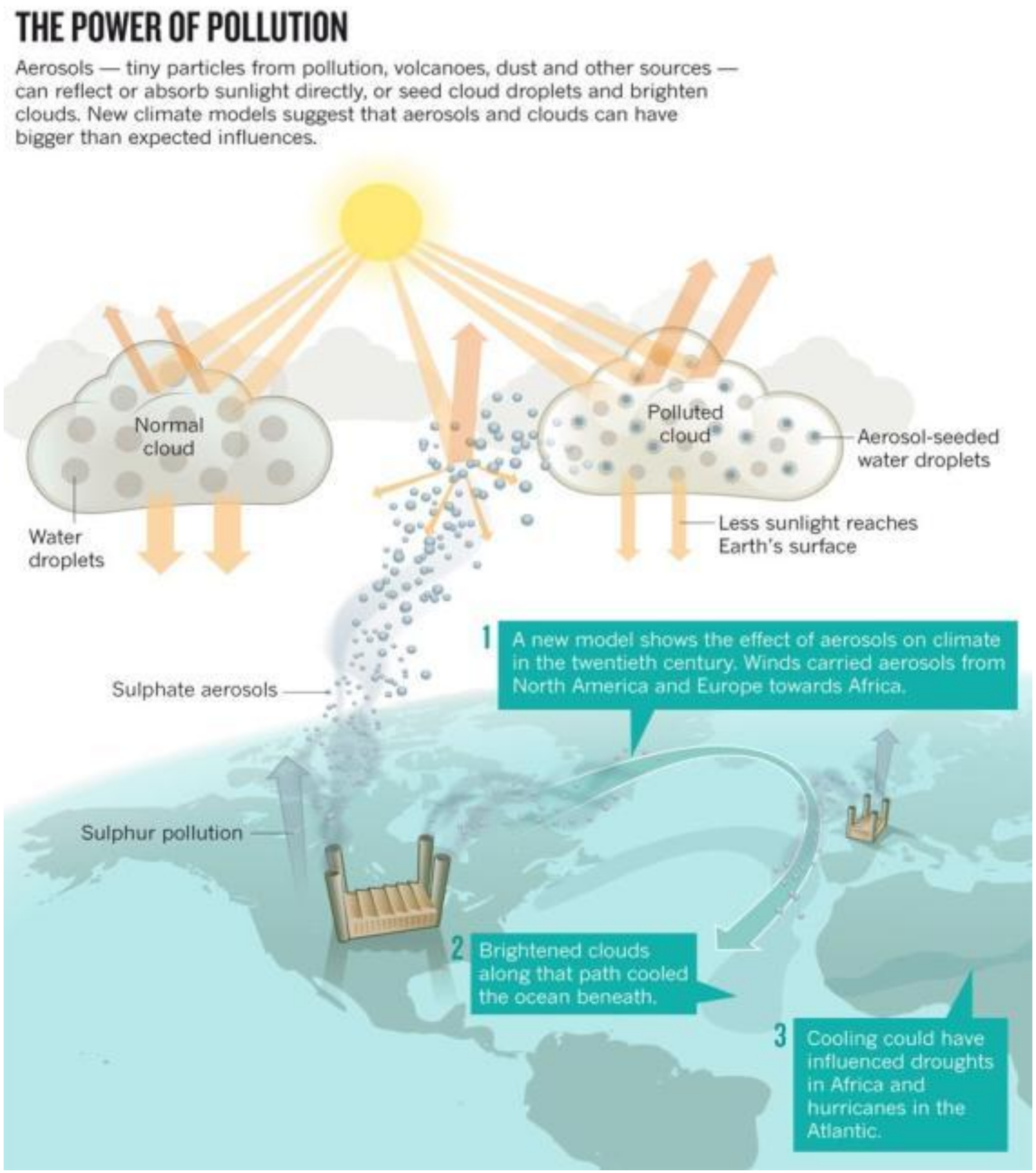
Increases with warming

Carbon feedback by green plant toxicity

Black carbon (soot): warming

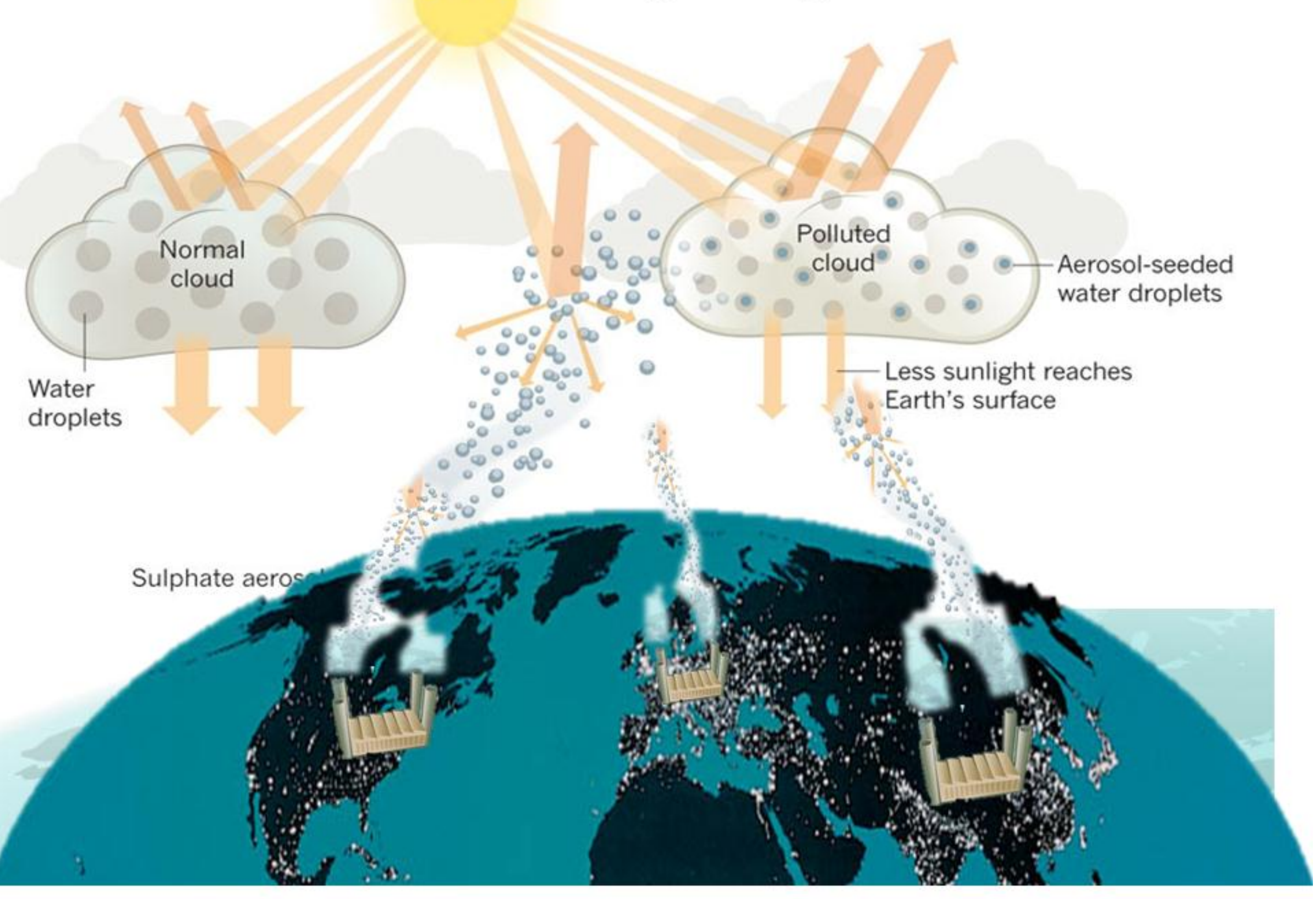
Fossil fuel combustion pollution

Aerosol cooling – large effect



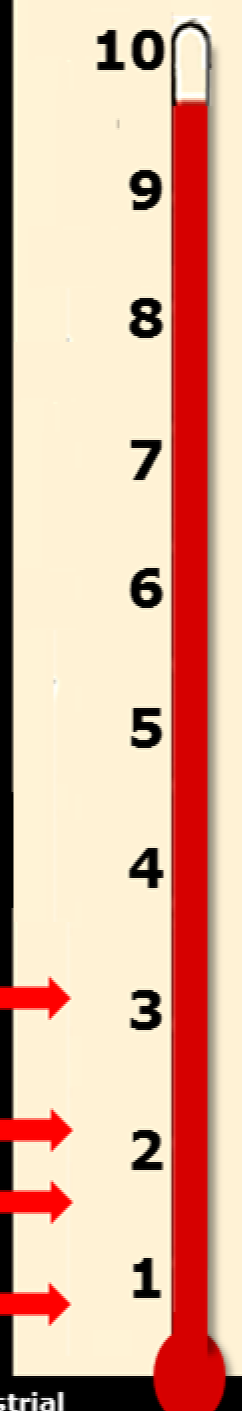
Scientific American, 2012

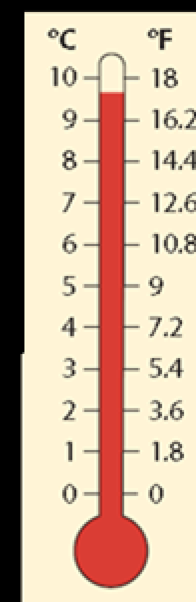
Aerosol cooling – large effect



Committed global temperature increase according to the climate science

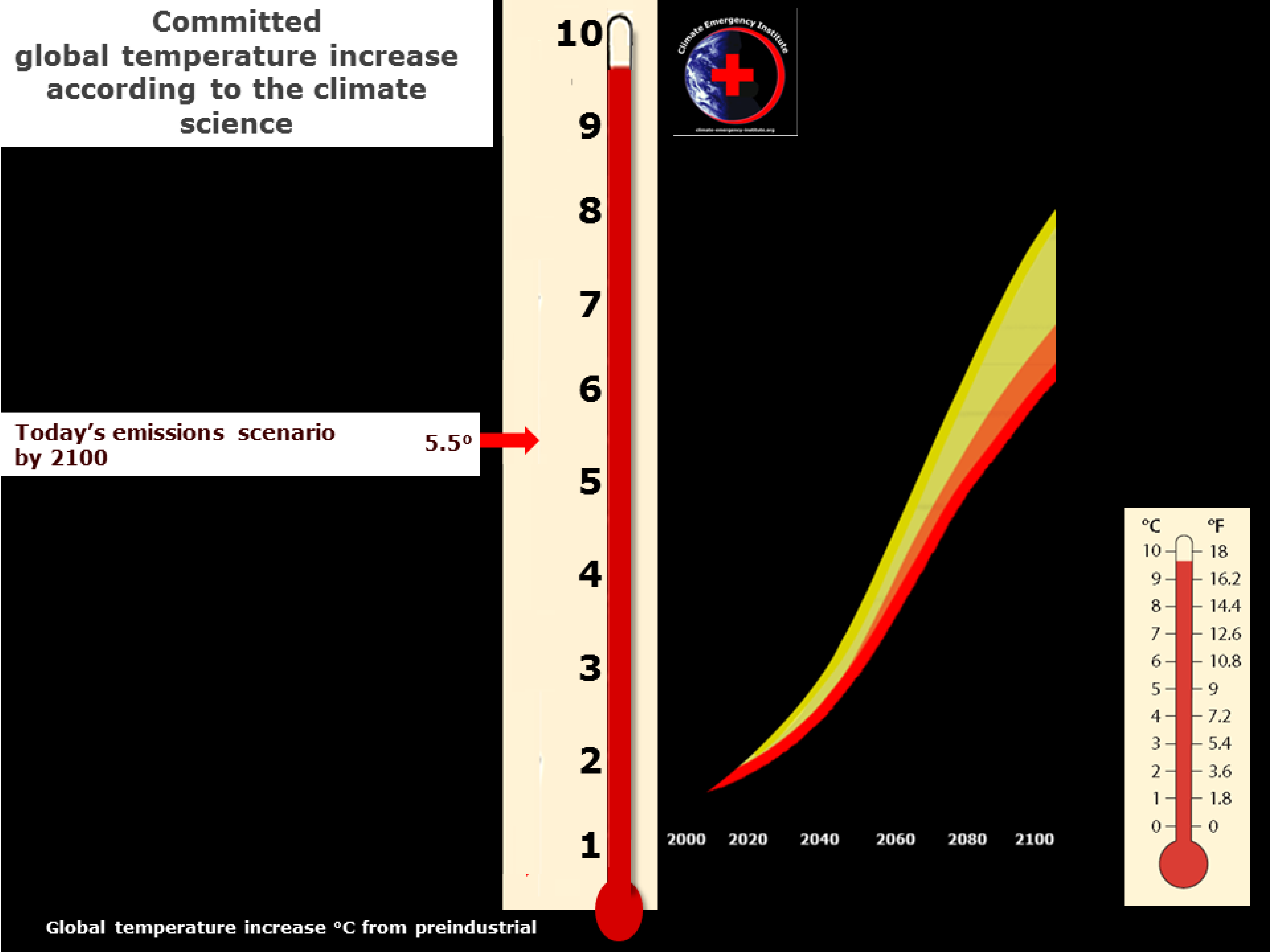
By 2100

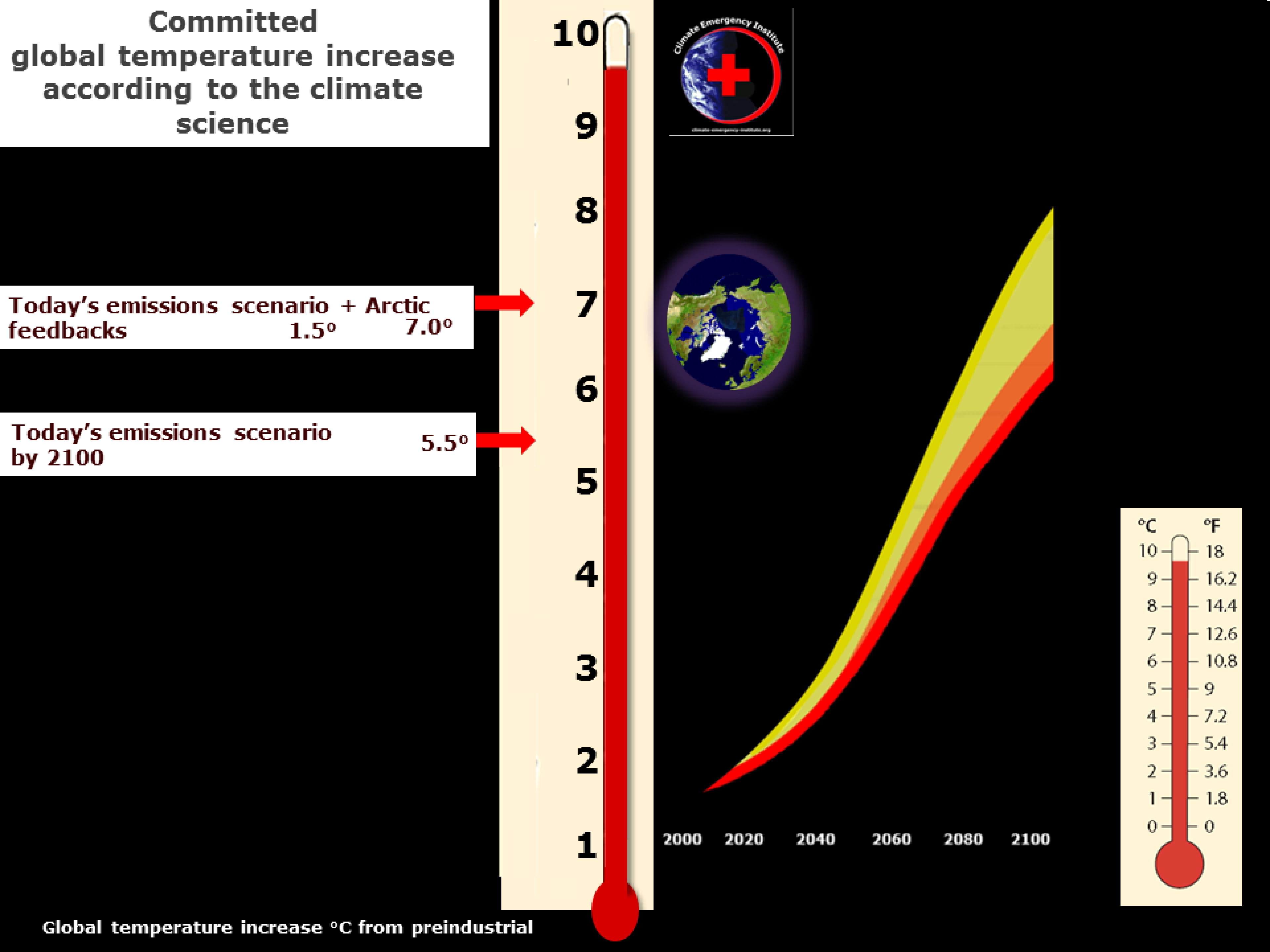


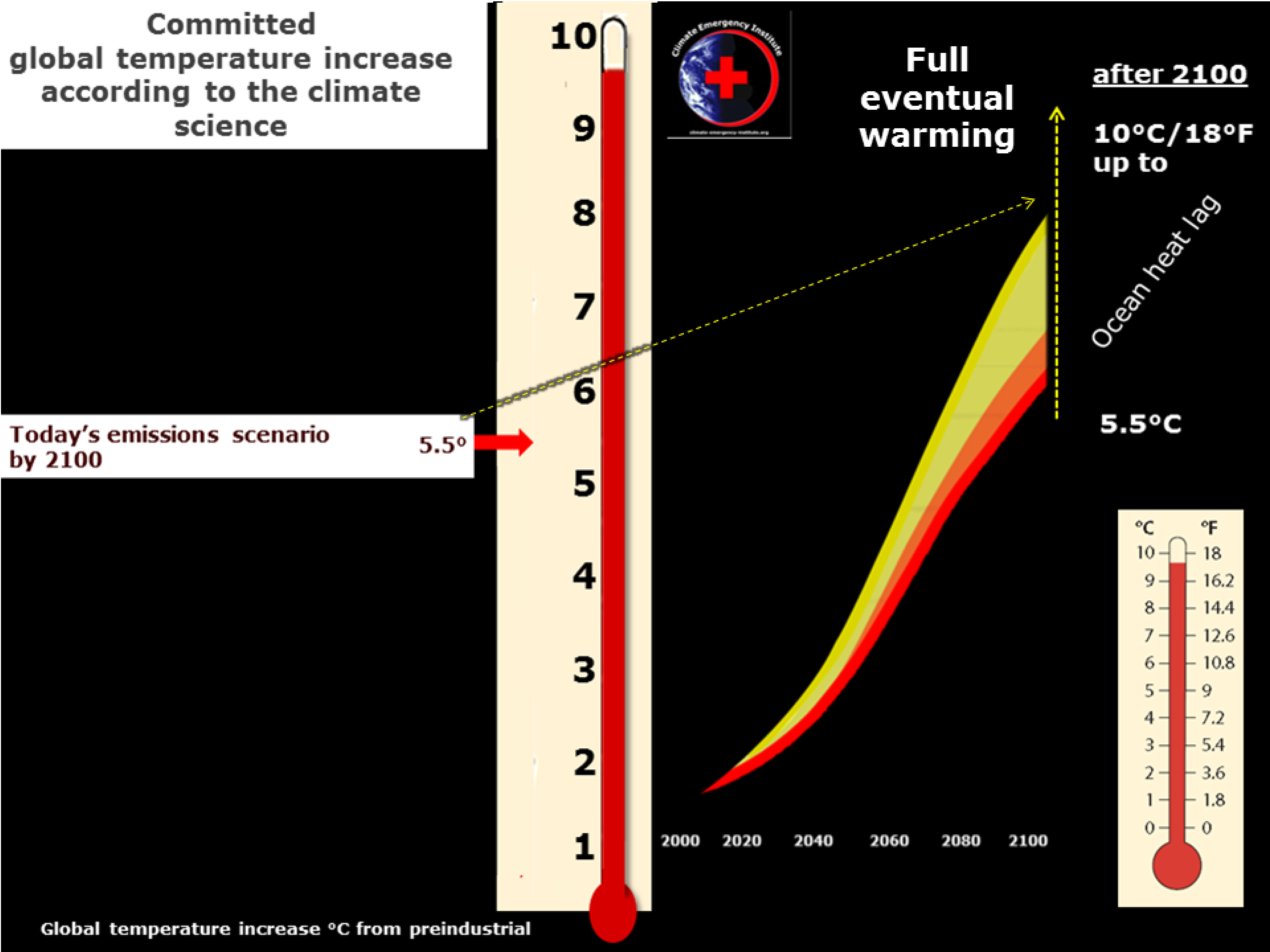


Unmasking fossil fuel air pollution aerosol cooling	0.9°C	3.0°
Ocean heat lag by 2100 (IPCC)	0.5°C	2.1°
From emissions cut to stable CO2	0.8°C	1.6°
Today		0.8°

Global temperature increase °C from preindustrial


Committed global temperature increase according to the climate science
Today's emissions scenario by 2100
5.5°
10
9
8
7
6
5
4
3
2
1
Climate Emergency Institute
2000
2020
2040
2060
2080
2100
°C
°F
10
9
8
7
6
5
4
3
2
1
0
18
16.2
14.4
12.6
10.8
9
7.2
5.4
3.6
1.8
0
Global temperature increase °C from preindustrial


Committed global temperature increase according to the climate science
Climate Emergency Institute
Today's emissions scenario + Arctic feedbacks 1.5° 7.0°
Today's emissions scenario by 2100 5.5°
10
9
8
7
6
5
4
3
2
1
2000
2020
2040
2060
2080
2100
°C
°F
10 18
9 16.2
8 14.4
7 12.6
6 10.8
5 9
4 7.2
3 5.4
2 3.6
1 1.8
0 0
Global temperature increase °C from preindustrial


Committed global temperature increase according to the climate science
10
9
8
7
6
5
4
3
2
1
Today's emissions scenario by 2100
5.5°
Climate Emergency Institute
Full eventual warming
after 2100
10°C/18°F up to
Ocean heat lag
5.5°C
2000
2020
2040
2060
2080
2100
°C
°F
10 18
9 16.2
8 14.4
7 12.6
6 10.8
5 9
4 7.2
3 5.4
2 3.6
1 1.8
0 0
Global temperature increase °C from preindustrial

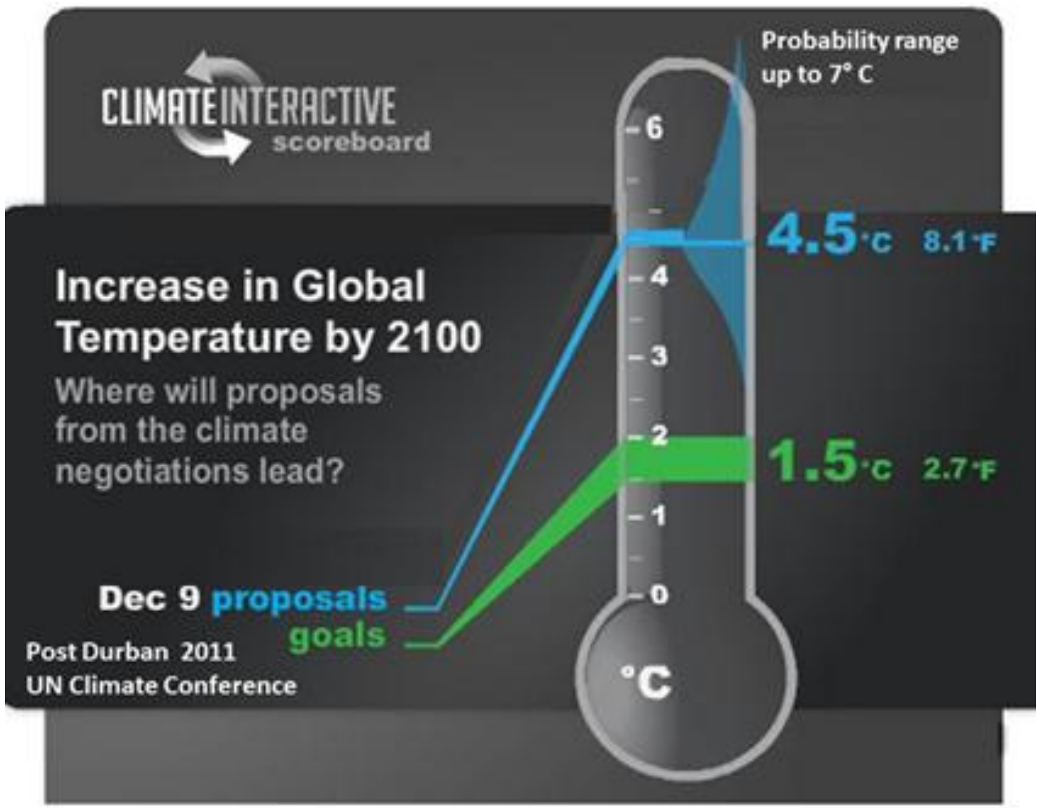
Committed global temperature increase due to climate policy

Committed global temperature increase by climate policy

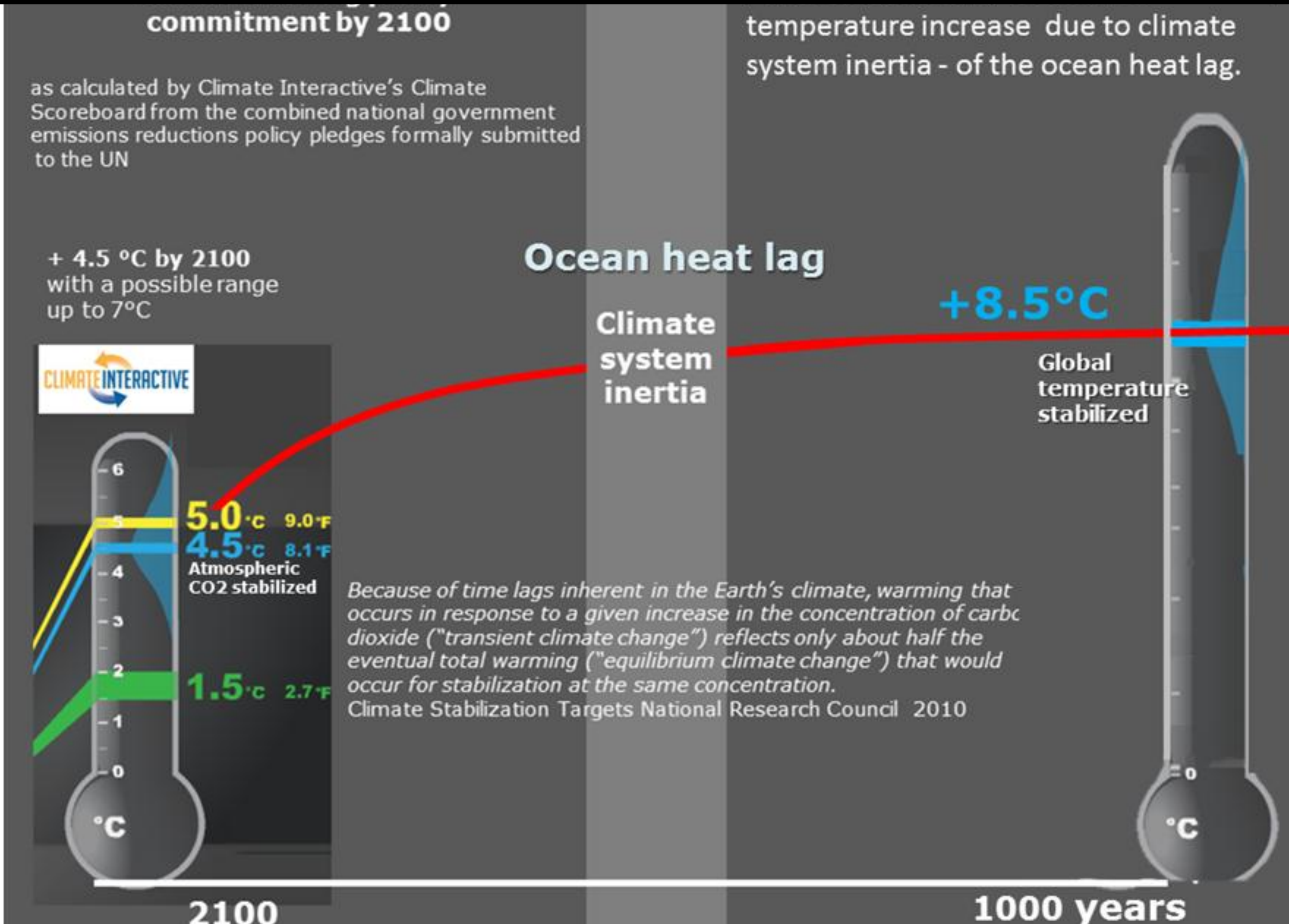
Combined national United Nations emissions cut pledges assuming all pledges are implemented in full

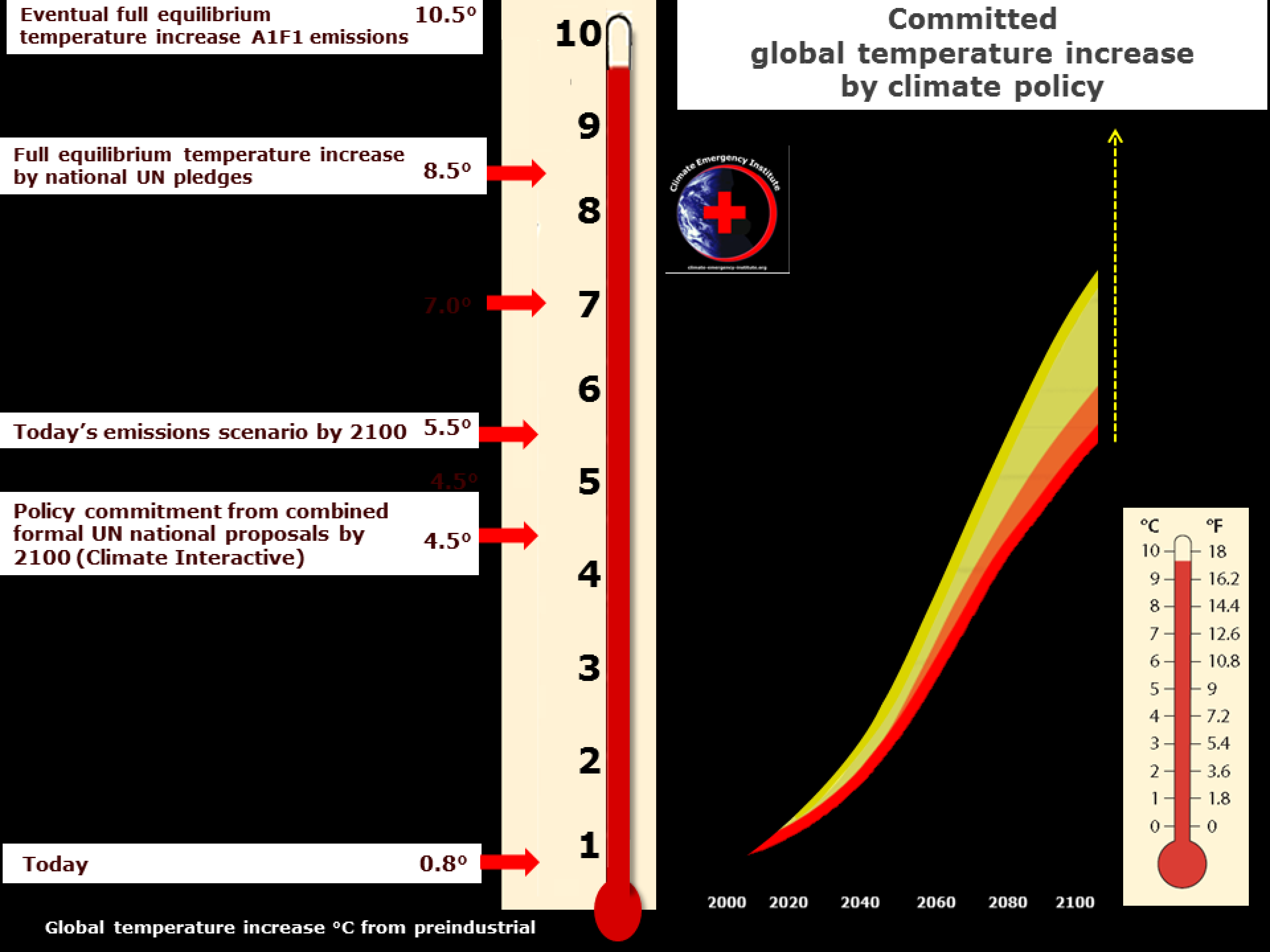
4.5°C

by 2100



Committed global temperature increase by climate policy




Committed global temperature increase by climate policy
Eventual full equilibrium temperature increase A1F1 emissions 10.5°
Full equilibrium temperature increase by national UN pledges 8.5°
7.0°
Today's emissions scenario by 2100 5.5°
4.5°
Policy commitment from combined formal UN national proposals by 2100 (Climate Interactive) 4.5°
Today 0.8°
10
9
8
7
6
5
4
3
2
1
Global temperature increase °C from preindustrial
Climate Emergency Institute
2000
2020
2040
2060
2080
2100
°C
°F
10
9
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16.2
14.4
12.6
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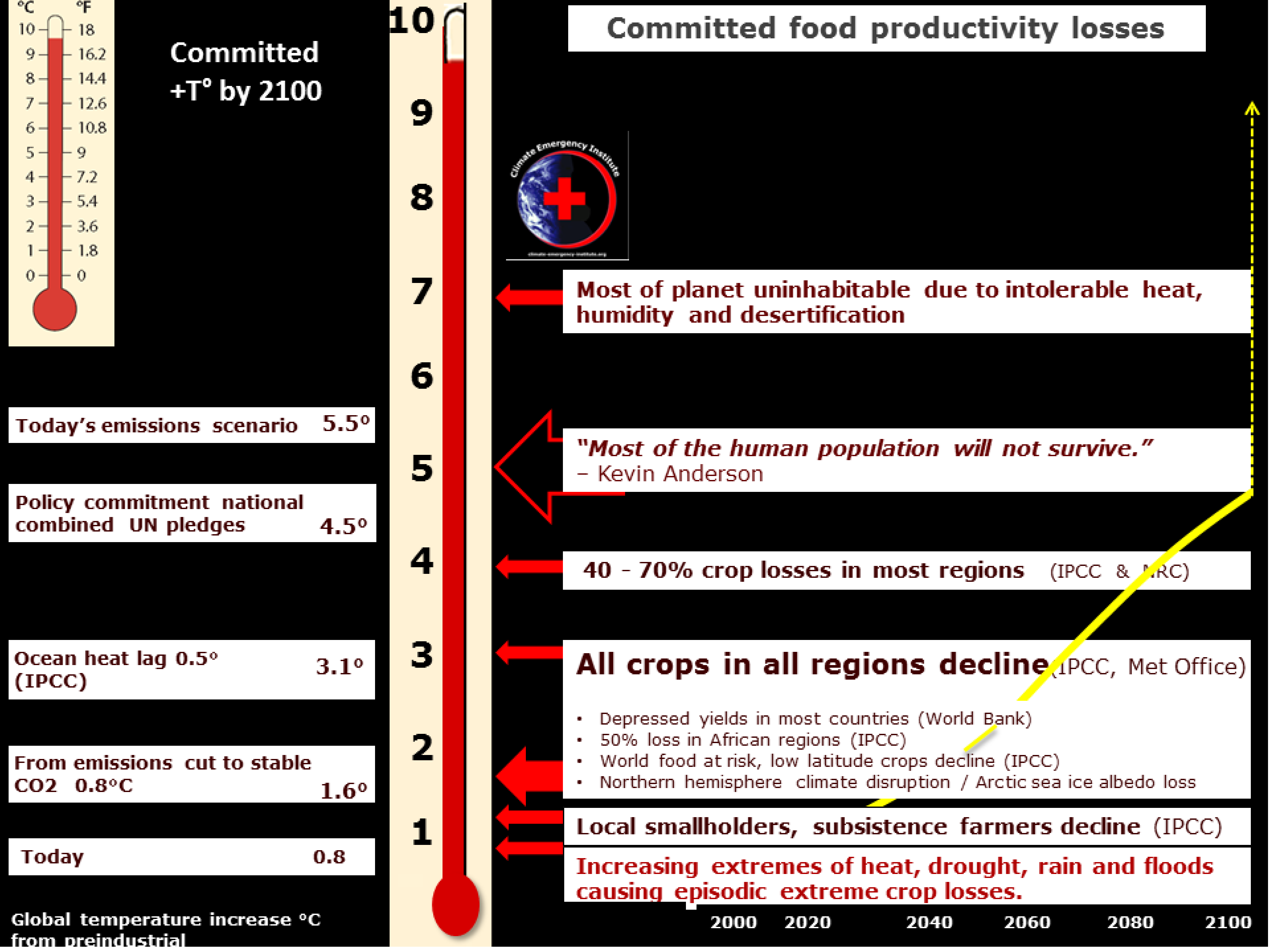
5.4
3.6
1.8
0



°C °F
10 18
9 16.2
8 14.4
7 12.6
6 10.8
5 9
4 7.2
3 5.4
2 3.6
1 1.8
0 0
Committed
+T° by 2100
Committed food productivity losses
Climate Emergency Institute
Most of planet uninhabitable due to intolerable heat, humidity and desertification
"Most of the human population will not survive."
– Kevin Anderson
40 - 70% crop losses in most regions (IPCC & RC)
All crops in all regions decline (IPCC, Met Office)
Depressed yields in most countries (World Bank)
50% loss in African regions (IPCC)
World food at risk, low latitude crops decline (IPCC)
Northern hemisphere climate disruption / Arctic sea ice albedo loss
Local smallholders, subsistence farmers decline (IPCC)
Increasing extremes of heat, drought, rain and floods causing episodic extreme crop losses.
Today's emissions scenario 5.5°
Policy commitment national combined UN pledges 4.5°
Ocean heat lag 0.5° (IPCC) 3.1°
From emissions cut to stable CO2 0.8°C 1.6°
Today 0.8
10
9
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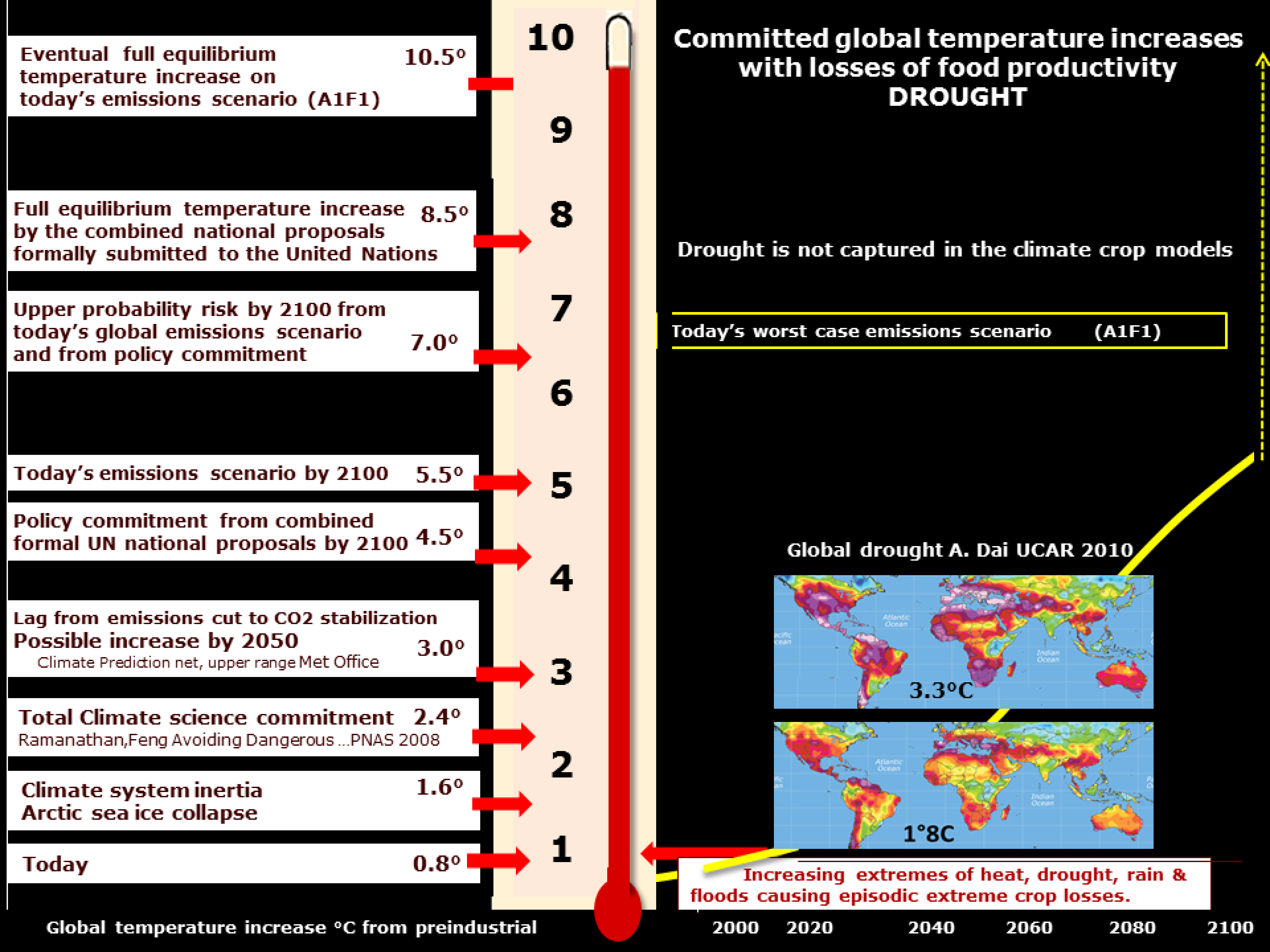
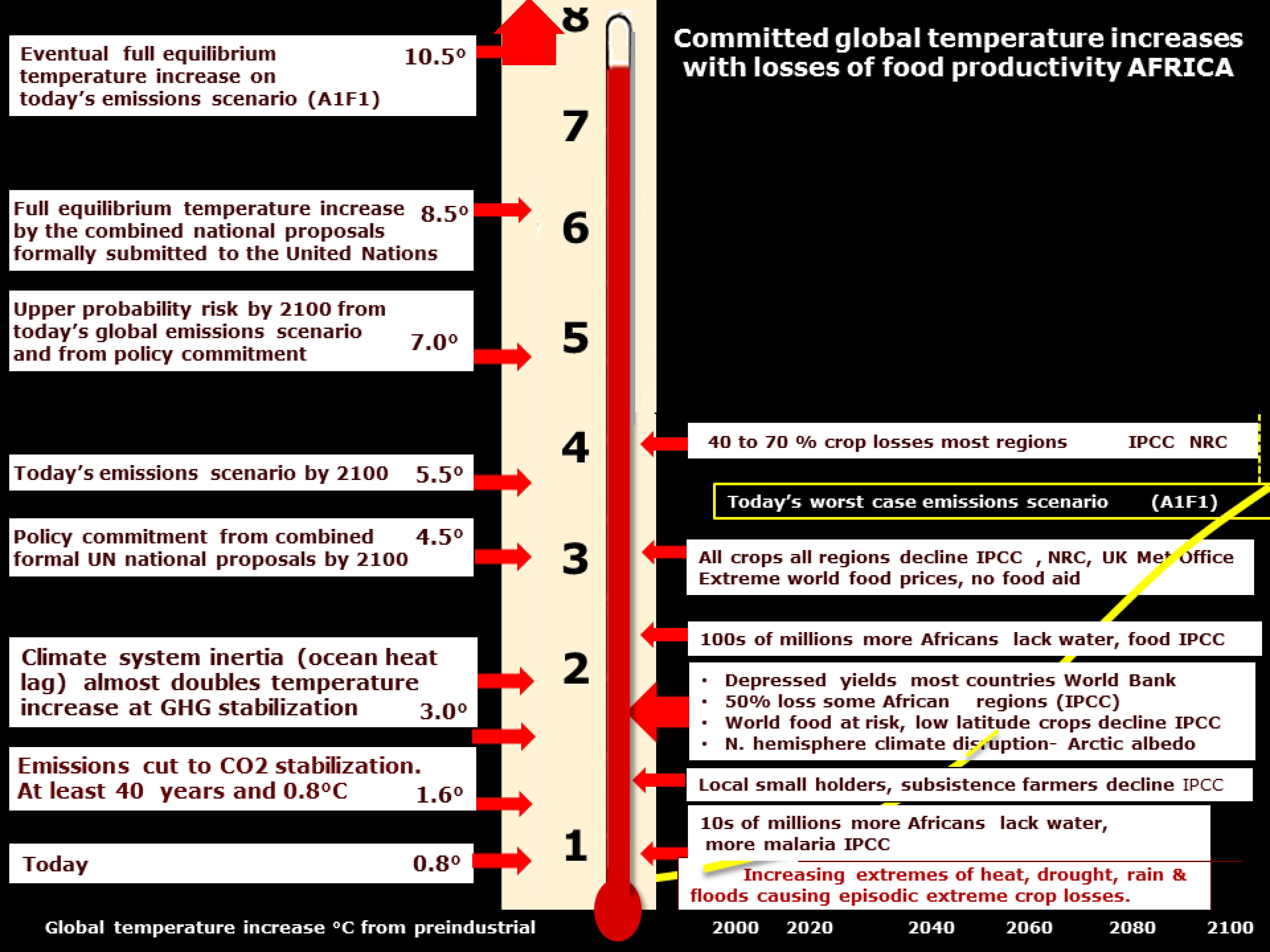
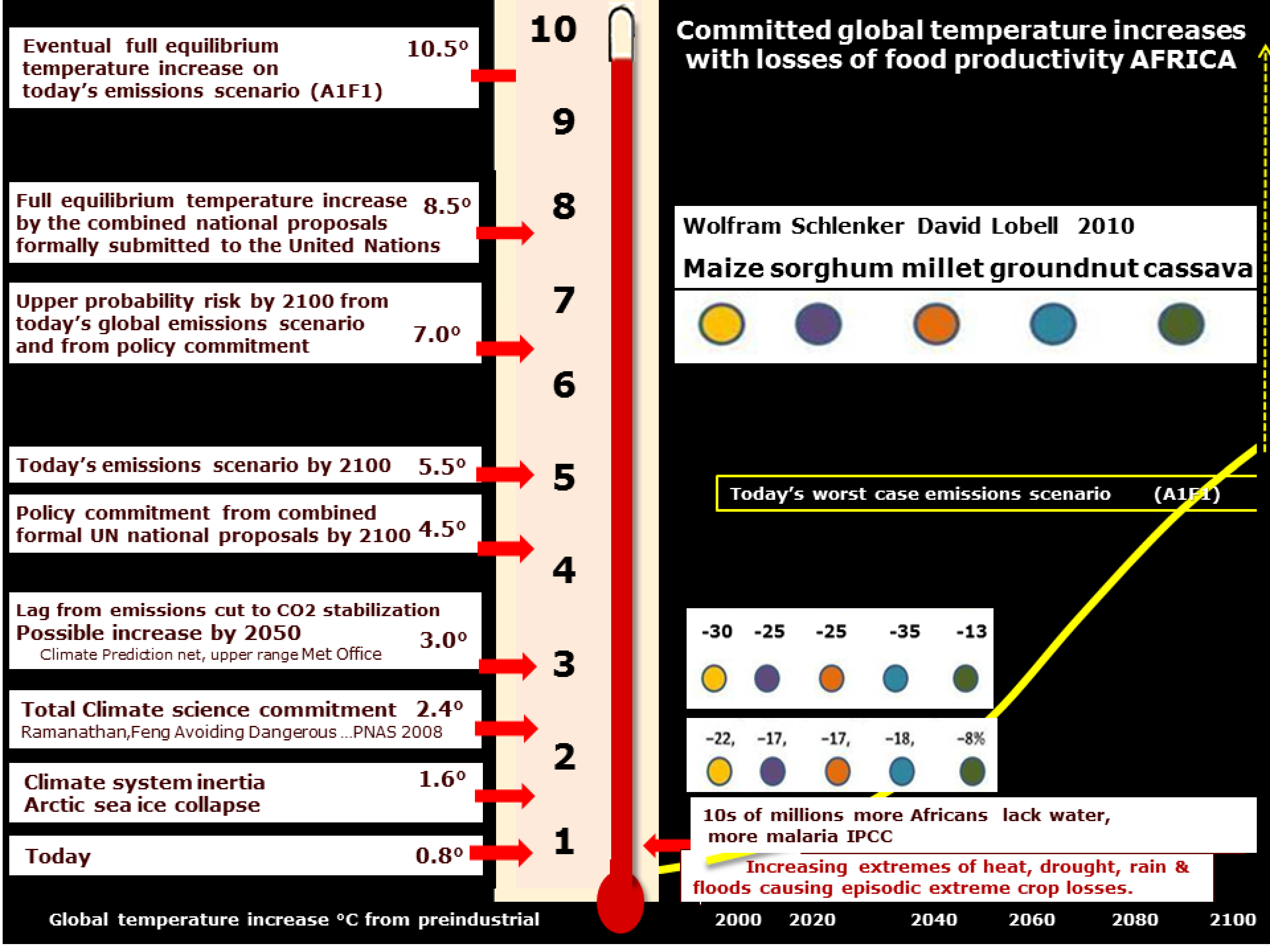
2
1
2000 2020 2040 2060 2080 2100
Global temperature increase °C from preindustrial


Committed global temperature increases with losses of food productivity
DROUGHT
Eventual full equilibrium temperature increase on today's emissions scenario (A1F1) 10.5°
Full equilibrium temperature increase by the combined national proposals formally submitted to the United Nations 8.5°
Upper probability risk by 2100 from today's global emissions scenario and from policy commitment 7.0°
Today's emissions scenario by 2100 5.5°
Policy commitment from combined formal UN national proposals by 2100 4.5°
Lag from emissions cut to CO2 stabilization
Possible increase by 2050 3.0°
Climate Prediction net, upper range Met Office
Total Climate science commitment 2.4°
Ramanathan,Feng Avoiding Dangerous ...PNAS 2008
Climate system inertia
Arctic sea ice collapse 1.6°
Today 0.8°
10
9
8
7
6
5
4
3
2
1
Drought is not captured in the climate crop models
Today's worst case emissions scenario (A1F1)
Global drought A. Dai UCAR 2010
3.3°C
1°8C
Increasing extremes of heat, drought, rain & floods causing episodic extreme crop losses.
Global temperature increase °C from preindustrial
2000
2020
2040
2060
2080
2100


Committed global temperature increases with losses of food productivity AFRICA
Eventual full equilibrium temperature increase on today's emissions scenario (A1F1) 10.5°
Full equilibrium temperature increase by the combined national proposals formally submitted to the United Nations 8.5°
Upper probability risk by 2100 from today's global emissions scenario and from policy commitment 7.0°
Today's emissions scenario by 2100 5.5°
Policy commitment from combined formal UN national proposals by 2100 4.5°
Climate system inertia (ocean heat lag) almost doubles temperature increase at GHG stabilization 3.0°
Emissions cut to CO2 stabilization. At least 40 years and 0.8°C 1.6°
Today 0.8°
8
7
6
5
4
3
2
1
40 to 70 % crop losses most regions IPCC NRC
Today's worst case emissions scenario (A1F1)
All crops all regions decline IPCC , NRC, UK Met Office
Extreme world food prices, no food aid
100s of millions more Africans lack water, food IPCC
• Depressed yields most countries World Bank
• 50% loss some African regions (IPCC)
• World food at risk, low latitude crops decline IPCC
• N. hemisphere climate disruption- Arctic albedo
Local small holders, subsistence farmers decline IPCC
10s of millions more Africans lack water, more malaria IPCC
Increasing extremes of heat, drought, rain & floods causing episodic extreme crop losses.
Global temperature increase °C from preindustrial
2000 2020 2040 2060 2080 2100



Committed global temperature increases with losses of food productivity AFRICA
Eventual full equilibrium temperature increase on today's emissions scenario (A1F1) 10.5°
Full equilibrium temperature increase by the combined national proposals formally submitted to the United Nations 8.5°
Upper probability risk by 2100 from today's global emissions scenario and from policy commitment 7.0°
Today's emissions scenario by 2100 5.5°
Policy commitment from combined formal UN national proposals by 2100 4.5°
Lag from emissions cut to CO2 stabilization
Possible increase by 2050 3.0°
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Total Climate science commitment 2.4°
Ramanathan,Feng Avoiding Dangerous ...PNAS 2008
Climate system inertia
Arctic sea ice collapse 1.6°
Today 0.8°
10
9
8
7
6
5
4
3
2
1
Wolfram Schlenker David Lobell 2010
Maize sorghum millet groundnut cassava
Today's worst case emissions scenario (A1F1)
-30 -25 -25 -35 -13
-22, -17, -17, -18, -8%
10s of millions more Africans lack water, more malaria IPCC
Increasing extremes of heat, drought, rain & floods causing episodic extreme crop losses.
Global temperature increase °C from preindustrial
2000 2020 2040 2060 2080 2100

The Big Picture