Translating Scientific Conclusions about Climate Risk for Public Audiences

AAAS Conference on Climate Literacy

La Jolla, California

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Tom Bowman

Bowman Design Group

bowman global change. Sustainable Transformations

Top National Policy Issues

Climate change is real	Good
Human activities cause climate change	Good
The net effects will be harmful	Good
We can solve the problem	Poor
I am certain about this	Poor

Source: Jon Krosnick, Stanford University

Key Misconceptions about Climate Change

The immediacy and scale of risk

The scale of mitigation required

Whether viable solutions exist

Whether we make effective personal and civic choices

Sources: Maibach, Roser-Renouf, Leiserowitz; Krosnick

Audience Tests

With Climate Scientists & Informal Science Institutions

Aquariums Talk about Climate Change 2009

Monterey Bay Aquarium 2009

Ocean on the Edge National Workshop

Business Conferences

Event Design Summit 2009

Exhibitor Show 2008, 2009

Society of Environmental Graphic Designers 2009

Professional Convention Management Association 2009

Exhibit Resources Keynote Event 2009

Exhibit Designers & Producers Association 2008

Green Event Summit 2008

Public Lectures

University of California, Davis 2009

Scripps Institution of Oceanography 2009

University of Redlands 2008, 2009

Redlands High School 2008

The Climate Choice

Limit + Odds = Emissions Trajectory

Limit: Where shall we draw the line on consequences?

Odds: How certain do we want to be about staying below our chosen limit?

Emissions Trajectory: The rate and depth of emissions cuts

The Climate Choice

Limit + Odds = Emissions Trajectory

Emissions Trajectory → Options/Tradeoffs

The Cause of the Problem

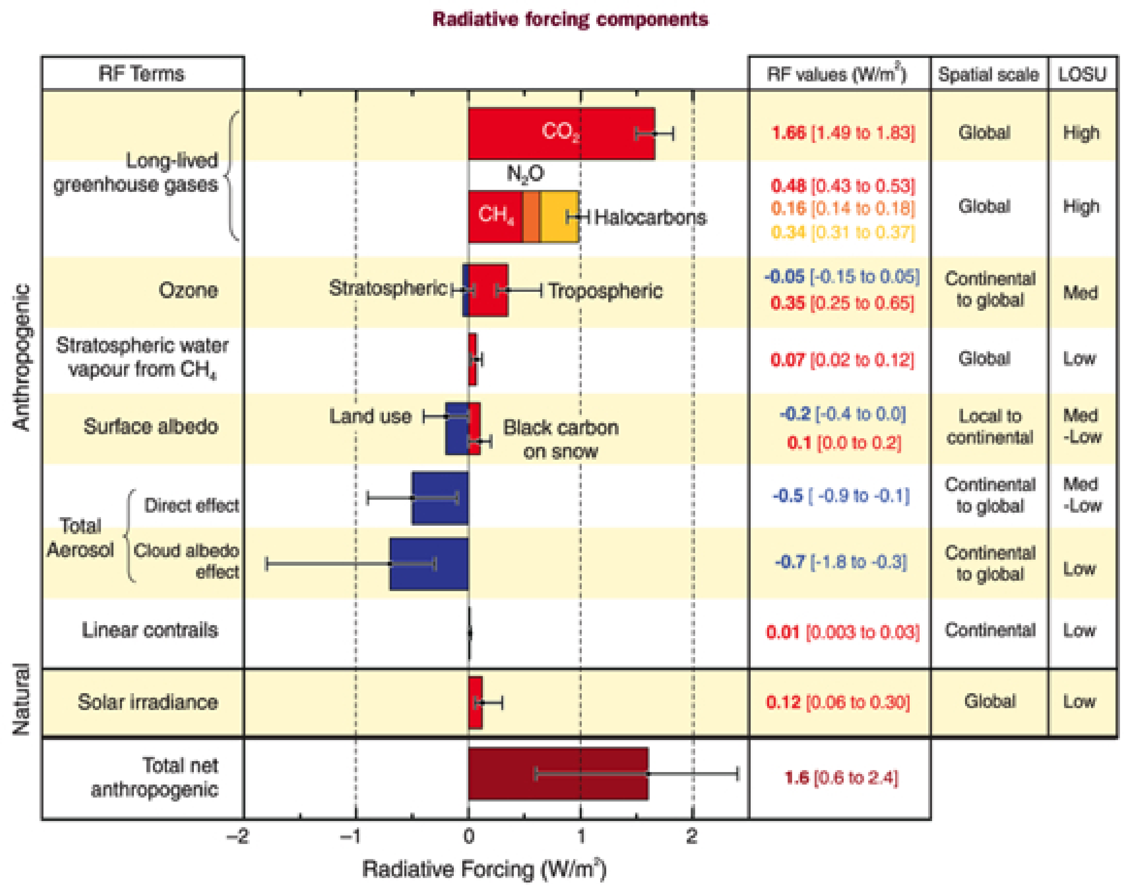


Figure 2.4. *Global average radiative forcing (RF) in 2005 (best estimates and 5 to 95% uncertainty ranges) with respect to 1750 for CO_2, CH_4, N_2O and other important agents and mechanisms, together with the typical geographical extent (spatial scale) of the forcing and the assessed level of scientific understanding (LOSU). Aerosols from explosive volcanic eruptions contribute an additional episodic cooling term for a few years following an eruption. The range for linear contrails does not include other possible effects of aviation on cloudiness. (WGI Figure SPM.2)*

IPCC 2007 Synthesis Report 2.4

Where We're Headed

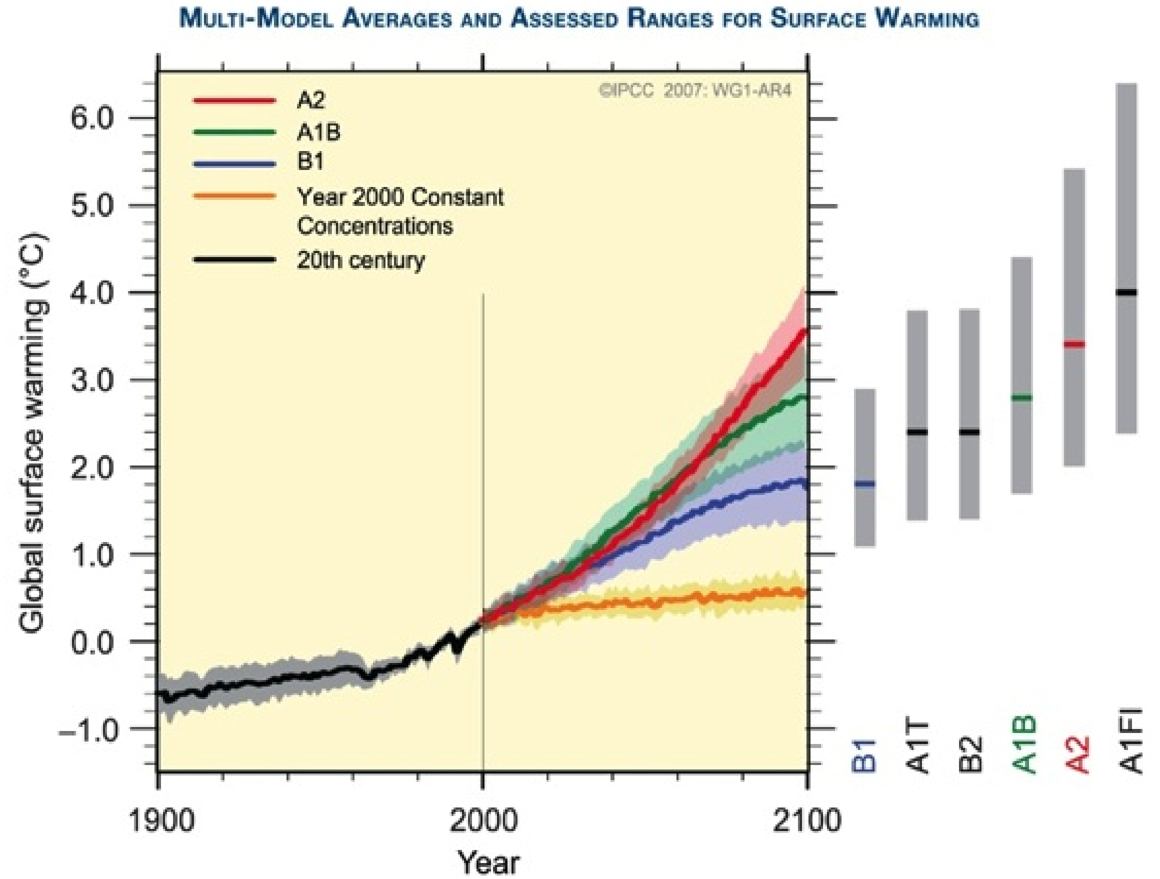
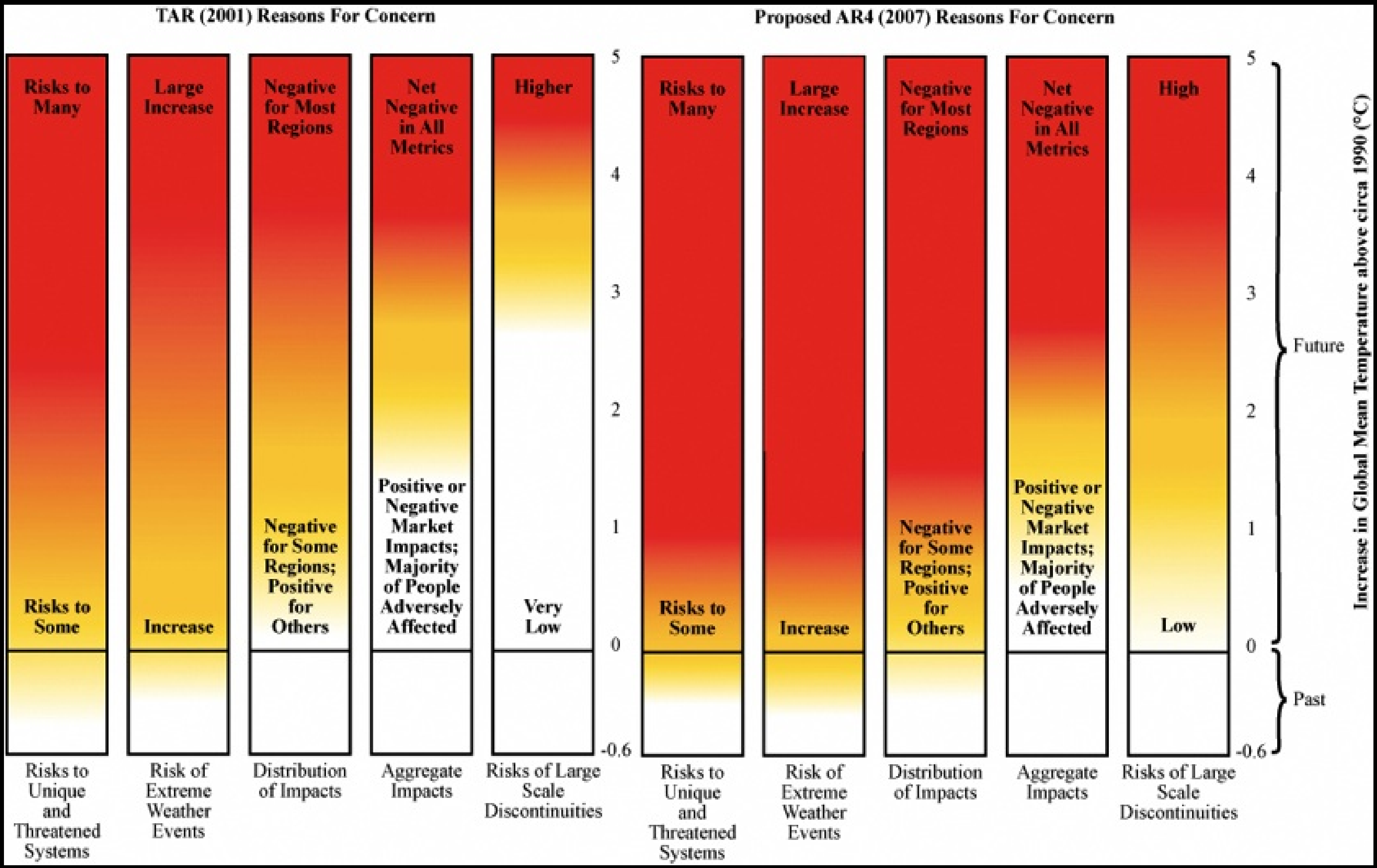


Figure SPM.5. *Solid lines are multi-model global averages of surface warming (relative to 1980–1999) for the scenarios A2, A1B and B1, shown as continuations of the 20th century simulations. Shading denotes the ±1 standard deviation range of individual model annual averages. The orange line is for the experiment where concentrations were held constant at year 2000 values. The grey bars at right indicate the best estimate (solid line within each bar) and the* ***likely*** *range assessed for the six SRES marker scenarios. The assessment of the best estimate and* ***likely*** *ranges in the grey bars includes the AOGCMs in the left part of the figure, as well as results from a hierarchy of independent models and observational constraints. {Figures 10.4 and 10.29}*

IPCC 2007 Figure SPM.5

The Risks We Face



IPCC 2001 Burning Embers

The Risks We Face

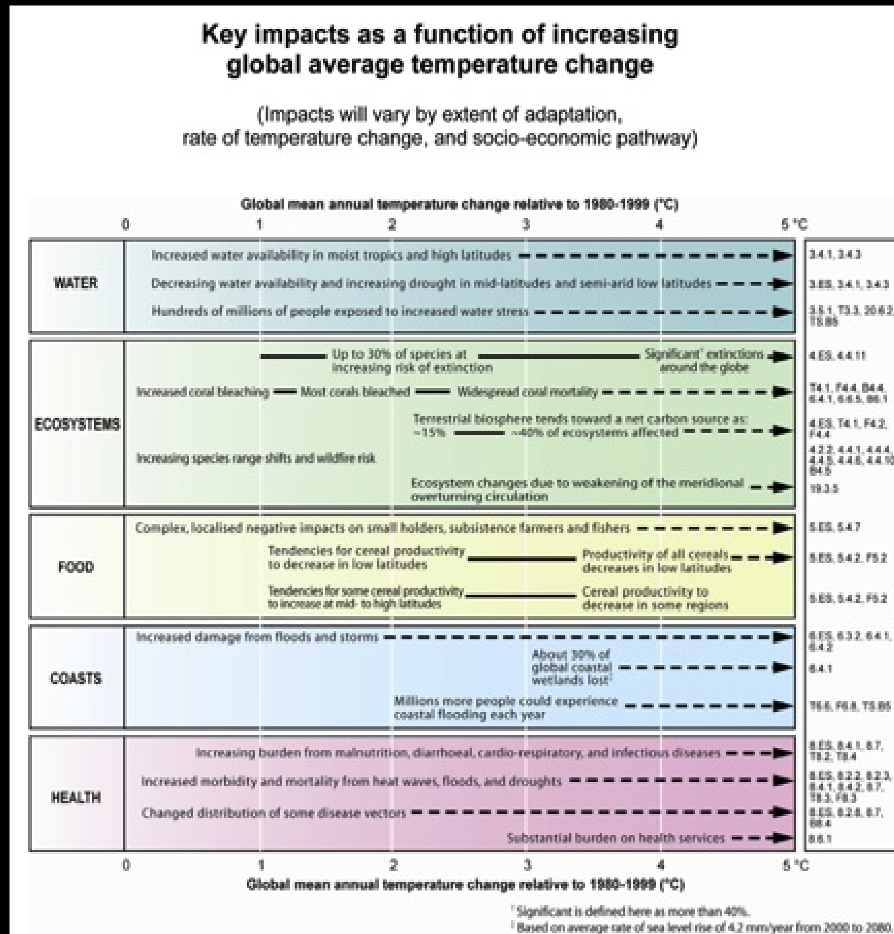


Table SPM-1. Illustrative examples of global impacts projected for climate changes (and sea-level and atmospheric carbon dioxide where relevant) associated with different amounts of increase in global average surface temperature in the 21st century [T20.7]. The black lines link impacts, dotted arrows indicate impacts continuing with increasing temperature. Entries are placed so that the left hand side of text indicates approximate onset of a given impact. Quantitative entries for water scarcity and flooding represent the additional impacts of climate change relative to the conditions projected across the range of Special Report on Scenarios (SRES) scenarios A1FI, A2, B1 and B2 (see Endbox 3). Adaptation to climate change is not included in these estimations. All entries are from published studies recorded in the chapters of the Assessment. Sources are given in the right hand column of the Table. Confidence levels for all statements are high.

IPCC 2007 WGIII, Table SPM-1

The Risks We Face

Table 4.1. *Projected impacts of climate change on ecosystems and population systems as reported in the literature for different levels of global mean annual temperature rise, ΔT_g, relative to pre-industrial climate – mean and range (event numbers as used in Figure 4.4 and Appendix 4.1). The global temperature change values are used as an indicator of the other associated climate changes that match particular amounts of ΔT_g, e.g., precipitation change and, where considered, change in the concentration of greenhouse gases in the atmosphere. Projections from the literature were harmonised into a common framework by down/upscaling (where necessary) from local to global temperature rise using multiple GCMs, and by using a common global mean temperature reference point for the year 1990 (after Warren, 2006). Whilst some of the literature relates impacts directly to global mean temperature rises or particular GCM scenarios, many studies give only local temperature rises, ΔT_{reg}, and hence require upscaling. The thirteen GCM output data sets used are taken from the IPCC DDC at http://www.ipcc-data.org/.*

No.[i]	ΔT_g above pre-ind [ii]	ΔT_g above pre-ind [iii] (range)	ΔT_{reg} above 1990 (range)	Impacts to unique or widespread ecosystems or population systems	Region	Ref. no.
1	0.6			Increased coral bleaching	Caribbean, Indian Ocean, Great Barrier Reef	2
2	0.6			Amphibian extinctions/extinction risks on mountains due to climate-change-induced disease outbreaks	Costa Rica, Spain, Australia	52, 54
3	<1.0			Marine ecosystems affected by continued reductions in krill possibly impacting Adelie penguin populations; Arctic ecosystems increasingly damaged	Antarctica, Arctic	42, 11, 14
4	1.3	1.1-1.6	1	8% loss freshwater fish habitat, 15% loss in Rocky Mountains, 9% loss of salmon	N. America	13
5	1.6	1.2-2.0	0.7-1.5	9-31% (mean 18%) of species committed to extinction	Globe [iv]	1
6	1.6			Bioclimatic envelopes eventually exceeded, leading to 10% transformation of global ecosystems; loss of 47% wooded tundra, 23% cool conifer forest, 21% scrubland, 15% grassland/steppe, 14% savanna, 13% tundra and 12% temperate deciduous forest. Ecosystems variously lose 2-47% areal extent.	Globe	6
7	1.6	1.1-2.1	1	Suitable climates for 25% of eucalypts exceeded	Australia	12
8	1.7	1-2.3	1°C SST	All coral reefs bleached	Great Barrier Reef, S.E. Asia, Caribbean	2
9	1.7	1.2-2.6		38-45% of the plants in the Cerrado committed to extinction	Brazil	1, 44
10	1.7	1.3-3		2-18% of the mammals, 2-8% of the birds and 1-11% of the butterflies committed to extinction	Mexico	1, 26
11	1.7	1.3-2.4	2	16% freshwater fish habitat loss, 28% loss in Rocky Mountains, 18% loss of salmon	N. America	13
12	<1.9	<1.6-2.4	<1	Range loss begins for golden bowerbird	Australia	4

[i] Same numbers as used in first column in Appendix 4.1.

[ii] The mean temperature change is taken directly from the literature, or is the central estimate of a range given in the literature, or is the mean of upscaling calculations (cf. caption).

[iii] The range of temperature change represents the uncertainty arising from the use of different GCM models to calculate global temperature change.

[iv] 20% of the Earth's land surface covered by study.

IPCC 2007 WGIII, Table 4.1

Paths & Choices

Table SPM.6. *Characteristics of post-TAR stabilisation scenarios and resulting long-term equilibrium global average temperature and the sea level rise component from thermal expansion only.[a] {Table 5.1}*

Category	CO_2 concentration at stabilisation (2005 = 379 ppm)[b]	CO_2-equivalent concentration at stabilisation including GHGs and aerosols (2005 = 375 ppm)[b]	Peaking year for CO_2 emissions[a,c]	Change in global CO_2 emissions in 2050 (percent of 2000 emissions)[a,c]	Global average temperature increase above pre-industrial at equilibrium, using 'best estimate' climate sensitivity[d, e]	Global average sea level rise above pre-industrial at equilibrium from thermal expansion only[f]	Number of assessed scenarios
	ppm	ppm	year	percent	°C	metres	
I	350 – 400	445 – 490	2000 – 2015	-85 to -50	2.0 – 2.4	0.4 – 1.4	6
II	400 – 440	490 – 535	2000 – 2020	-60 to -30	2.4 – 2.8	0.5 – 1.7	18
III	440 – 485	535 – 590	2010 – 2030	-30 to +5	2.8 – 3.2	0.6 – 1.9	21
IV	485 – 570	590 – 710	2020 – 2060	+10 to +60	3.2 – 4.0	0.6 – 2.4	118
V	570 – 660	710 – 855	2050 – 2080	+25 to +85	4.0 – 4.9	0.8 – 2.9	9
VI	660 – 790	855 – 1130	2060 – 2090	+90 to +140	4.9 – 6.1	1.0 – 3.7	5

Notes:

a) The emission reductions to meet a particular stabilisation level reported in the mitigation studies assessed here might be underestimated due to missing carbon cycle feedbacks (see also Topic 2.3).

b) Atmospheric CO_2 concentrations were 379ppm in 2005. The best estimate of total CO_2-eq concentration in 2005 for all long-lived GHGs is about 455ppm, while the corresponding value including the net effect of all anthropogenic forcing agents is 375ppm CO_2-eq.

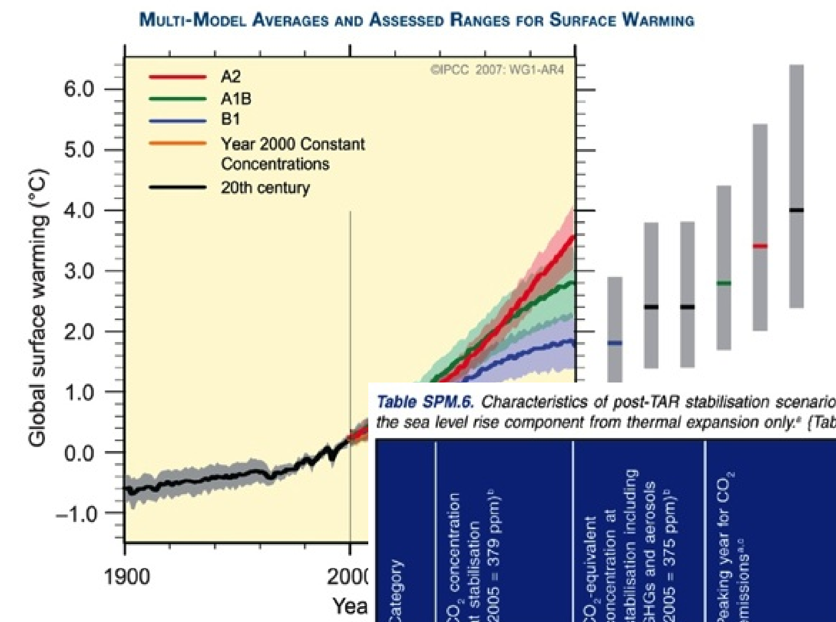
c) Ranges correspond to the 15th to 85th percentile of the post-TAR scenario distribution. CO_2 emissions are shown so multi-gas scenarios can be compared with CO_2-only scenarios (see Figure SPM.3).

d) The best estimate of climate sensitivity is 3°C.

e) Note that global average temperature at equilibrium is different from expected global average temperature at the time of stabilisation of GHG concentrations due to the inertia of the climate system. For the majority of scenarios assessed, stabilisation of GHG concentrations occurs between 2100 and 2150 (see also Footnote 21).

f) Equilibrium sea level rise is for the contribution from ocean thermal expansion only and does not reach equilibrium for at least many centuries. These values have been estimated using relatively simple climate models (one low-resolution AOGCM and several EMICs based on the best estimate of 3°C climate sensitivity) and do not include contributions from melting ice sheets, glaciers and ice caps. Long-term thermal expansion is projected to result in 0.2 to 0.6m per degree Celsius of global average warming above pre-industrial. (AOGCM refers to Atmosphere-Ocean General Circulation Model and EMICs to Earth System Models of Intermediate Complexity.)

IPCC 2007 Table SPM.6



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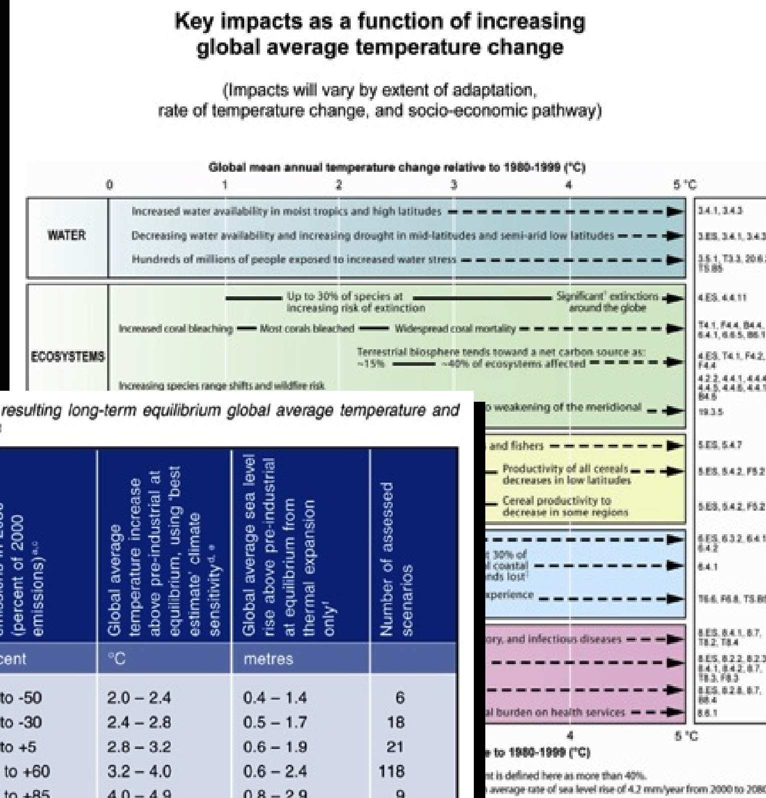

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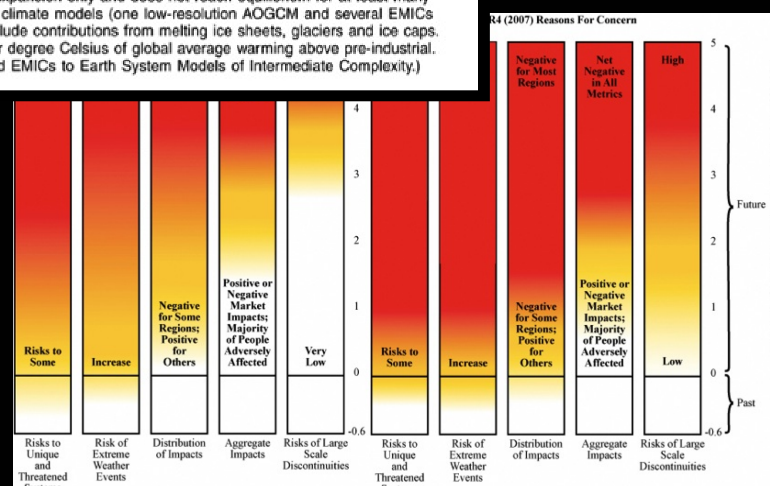
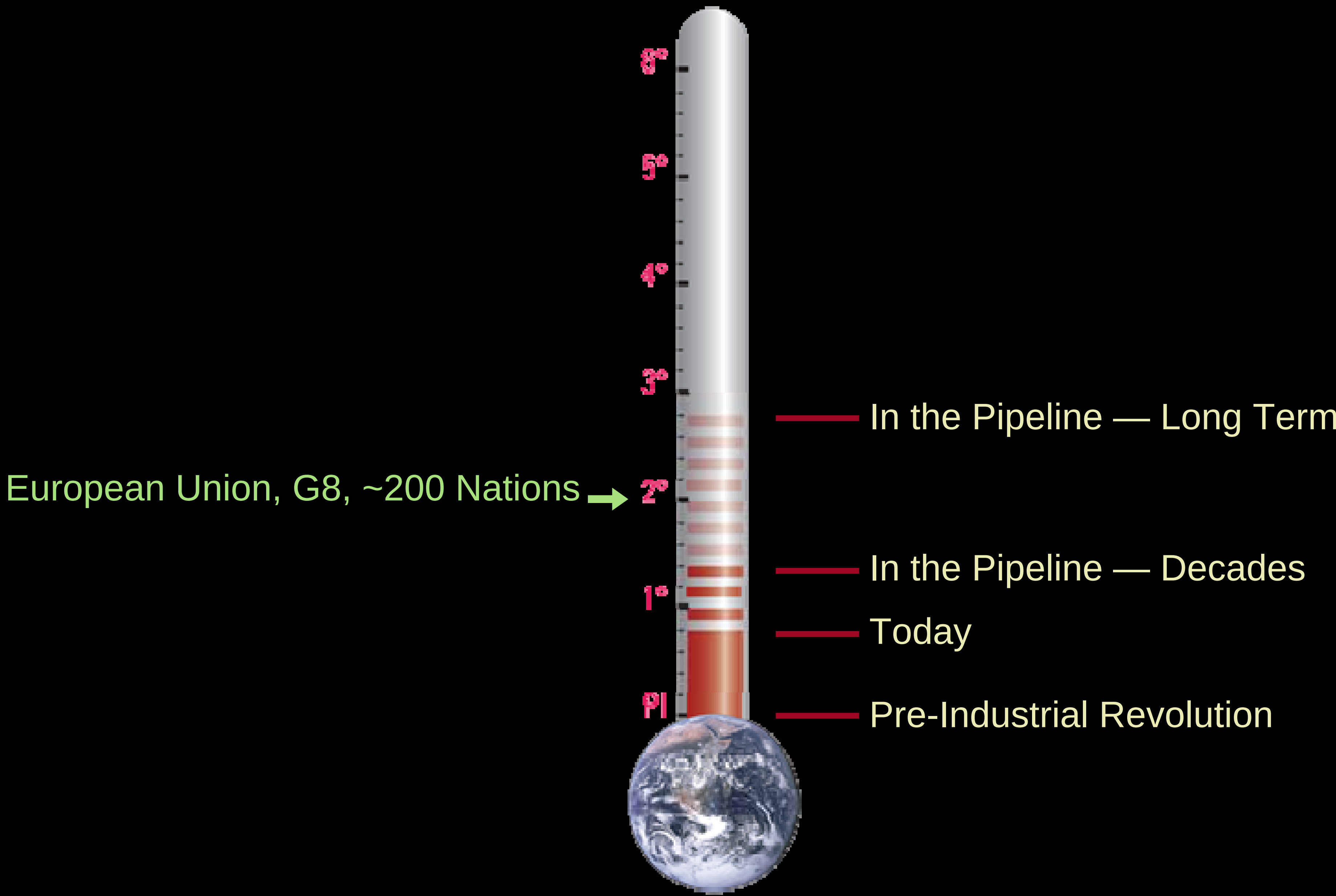


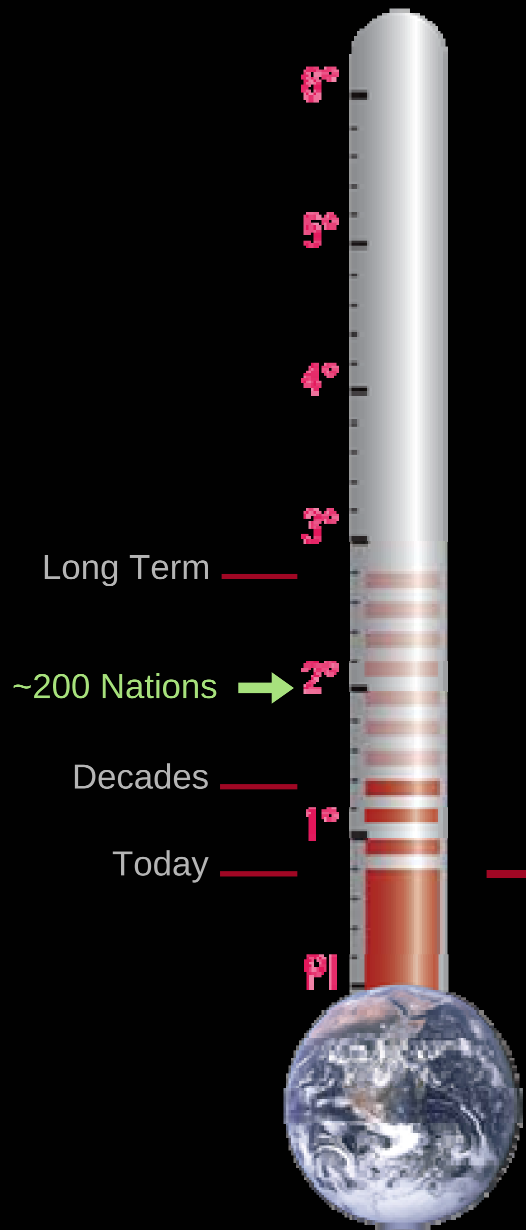
	TOPIC	REGION	IMPACT	Degree of Confidence (%)	Range of °C above Pre-industrial	°C above Pre-industrial (mean)	°C above 2000 (mean)	°C above Today (mean)	Source
7									
9							(0.6°C above pre-industial)	(2008 - 0.8°C above PI)	"Today" temp per Michael Mann
10									
11						**6°**	**5.4°**	**5.2°**	
12									
13	Ecosystems	N. America	Habitat losses in USA: 62 - 100% for birds at 4 major coastal sites			5.2°	4.6°	4.4°	AR4 WGII, p. 245, Table 4.1
14									
15	Coasts		Reconfiguration of coastlines worldwide			5.4°	4.8°	4.6°	AR4 WGII, p. 66, TS.3
16									
17						**5°**	**4.4°**	**4.2°**	
18									
19	Water	Global	Water stress: up to 3.2 billion more people			4.7°	4.1°	3.9°	AR4 WGII, p. 66, TS.3
20									
21	Summary	GLOBAL	Major increases in vulnerability, exceeding the adaptive capacity of many systems	90%		>~4.6°	>~4°	>~2.8°	AR4 WGII, Chpt. 19, Exec Sum, p. 781
22	Coasts	KEY Vulnerability - Global	Near-total deglaciation of Greenland (over centuries)	80%		>~4.6°	>~4°	>~2.8°	AR4 WGII, Chpt. 19, p. 789, Table 19.1
23	Ecosystems	KEY Vulnerability - Global	Extinction of many freshwater species; major changes in limnology of lakes; increased salinity of insland lakes	80%		>~4.6°	>~4°	>~2.8°	AR4 WGII, Chpt. 19, p. 789, Table 19.1
24	Coasts	Global	Increased flood risk: up to 15 million more people each year			>~4.6°	>~4°	>~3.8°	AR4 WGII, p. 66, TS.3; WGII SPM, p. 13, SPM-1
25									
26	Economy	Global	Lost global GDP: 1 - 5%			4.6°	4°	3.8°	AR4 WGII, p. 65
27									
28	Ecosystems	KEY Vulnerability - Global	40% – 70% of species extinct	80%		>~4.4°	>~3.8°	>~3.6°	AR4 WGII, p. 66, TS.3; Chapt. 19, p. 788, Table 19.1
29									
30	Ecosystems	Global	~40% of ecosystems transformed			4.4°	3.8°	3.6°	AR4 WGII, p. 37, TS.6; p. 66, TS.3
31	Coasts	Global	Reconfiguration of coastlines worldwide			~4.4°	~3.8°	~3.6°	AR4 WGII, p. 66, TS.3
32									
33	Food	Global	Cereal production declines worldwide (onset)			~4.2°	~3.5°	~3.3°	AR4 WGII, p. 66, TS.3
34									
35	Ecosystems	Australia	Committed to extinction: 38 - 67% frogs, 48 - 80% mammals, 43 - 64% reptiles, 49 - 72% birds in Queensland; 85 - 90% habitat lost			>4°	>3.4°	>3.2°	AR4 WGII, p. 245, Table 4.1
36	Ecosystems	New Zealand	Extinction: 32 - 63% alpine flora likely (200 - 300 species)	90% for range	3.0 - 5.1°	4°	3.4°	3.2°	AR4 WGII, p. 245, Table 4.1
37									
38						**4°**	**3.4°**	**3.2°**	
39									

Where Do We Stand?



Sources: IPCC 2007; Hansen, et. al. 2008

What Are the Risks?



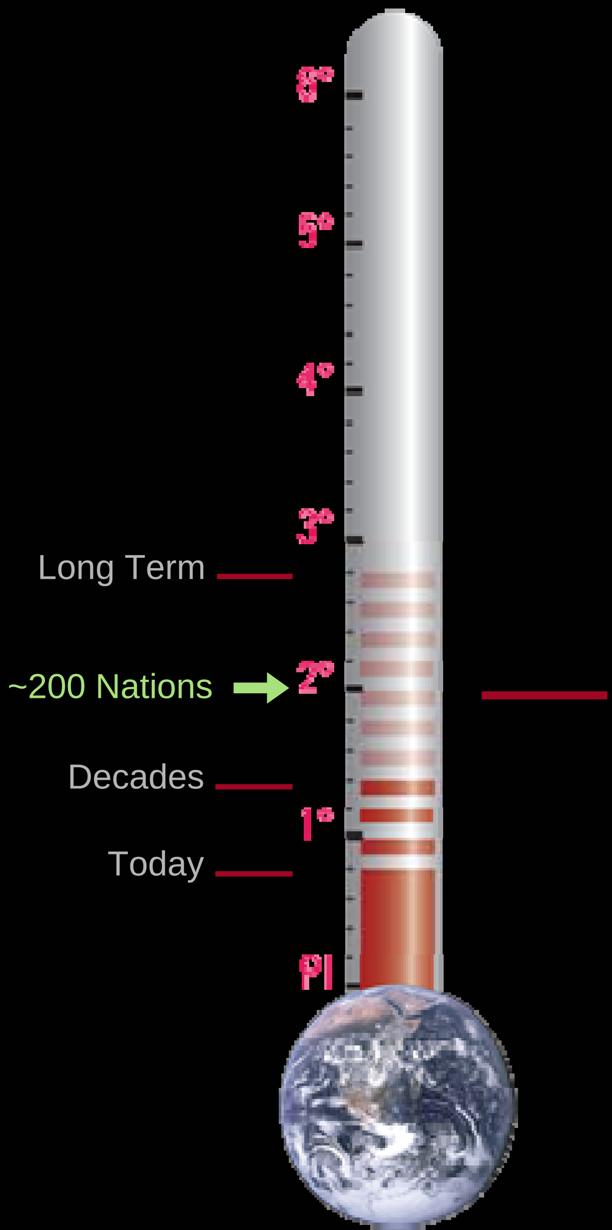
Increasing extinctions and coral bleaching, wildfires, droughts, storm damage along coastlines

Increasing mortality from heat waves, drought, and floods; shifting ranges of some disease vectors

25 million climate refugees

Sources: IPCC 2007

What Are the Risks?



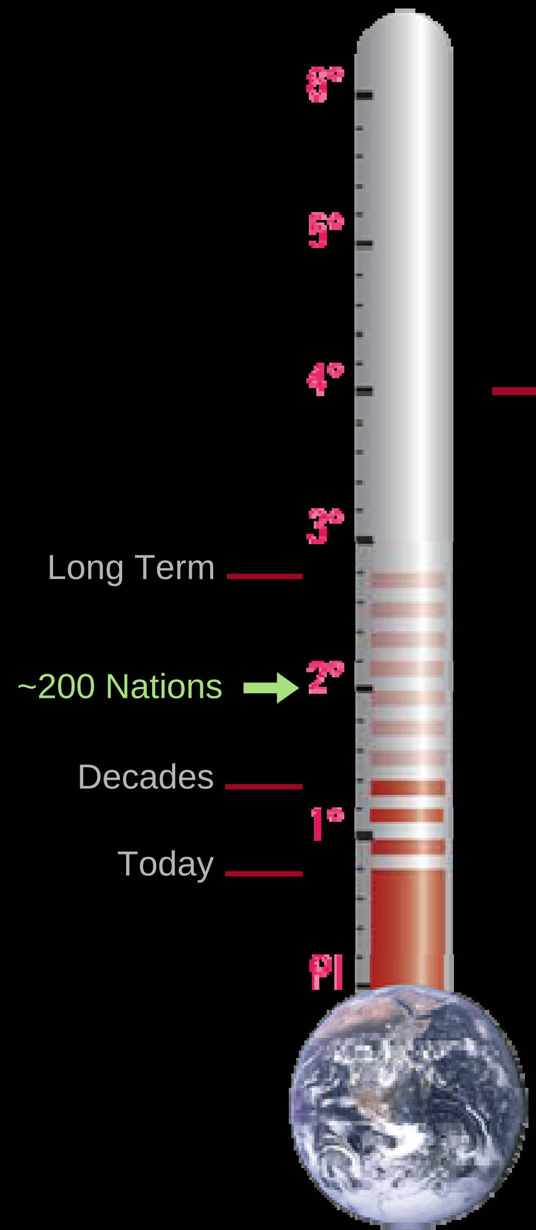
9–31% of species committed to extinction,
all corals bleached

Cereal production drops in tropics, rises globally; increasing malnutrition and burden of diarrheal, cardiorespiratory, and infectious diseases

Up to 1.7 billion more people face water stress

Sources: IPCC 2007

What Are the Risks?



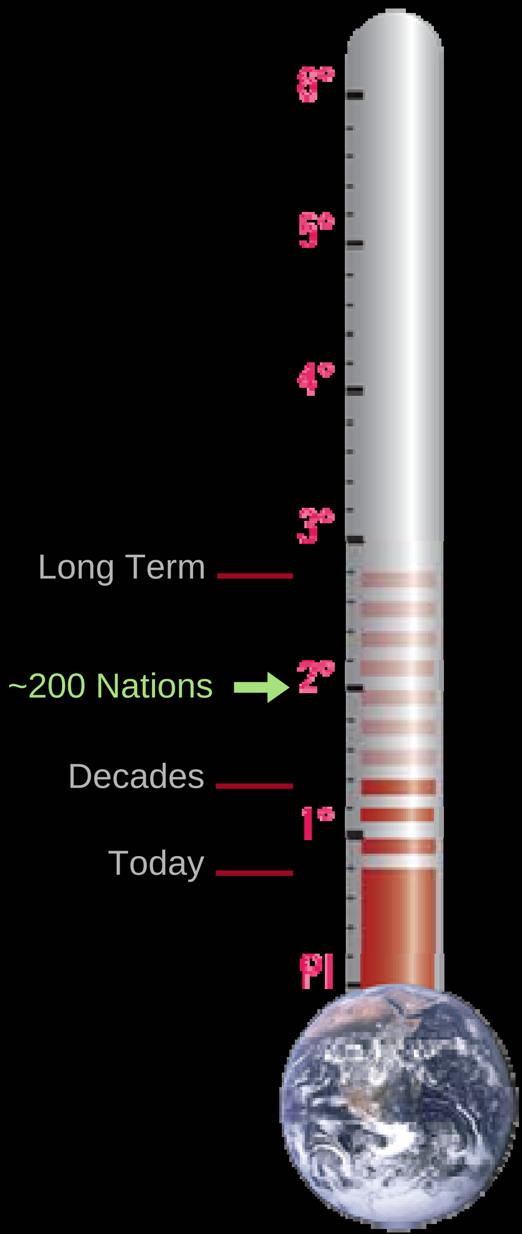
Corals extinct, 50% of nature reserves fail at their missions, 30% of coastal wetlands lost

Primarily negative economic impacts and substantial burden on health systems

Long-term commitment to several meters of sea level rise

Sources: IPCC 2007

What Are the Risks?



Where are the tipping points?

- *Polar ice loss*
- *Rainforest loss*
- *Northern forest loss*
- *Monsoon collapse*
- *Methane hydrate release*

Sources: IPCC 2007

The Climate Choice

Limit + Odds = Emissions Trajectory

Emissions Trajectory = Options + Tradeoffs

World War II

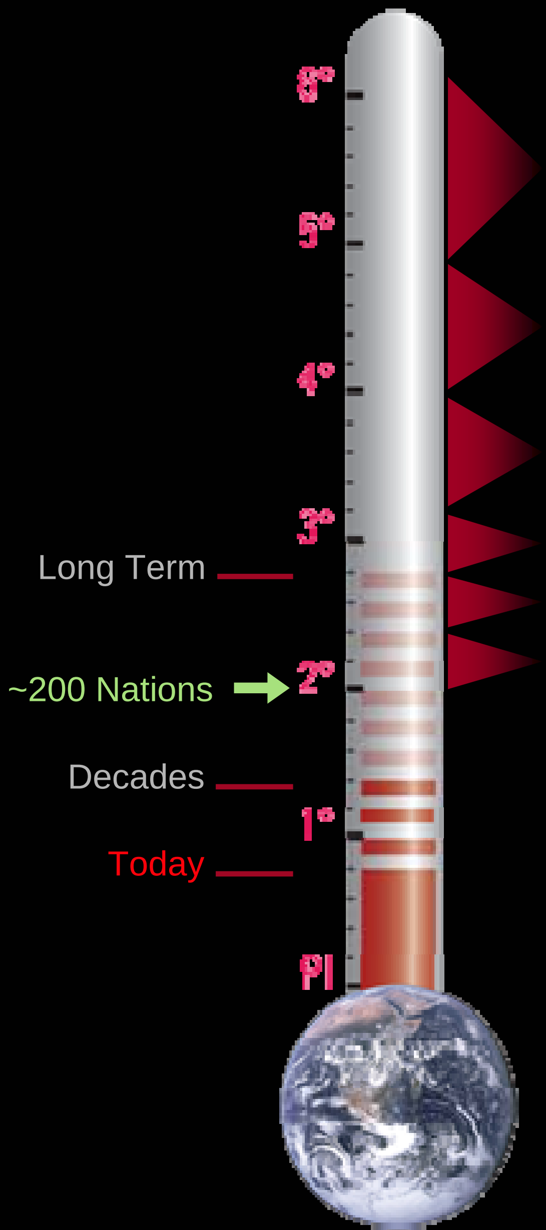
Total societal commitment to a single goal

New economic and social relationships

New social norms

Universal public engagement

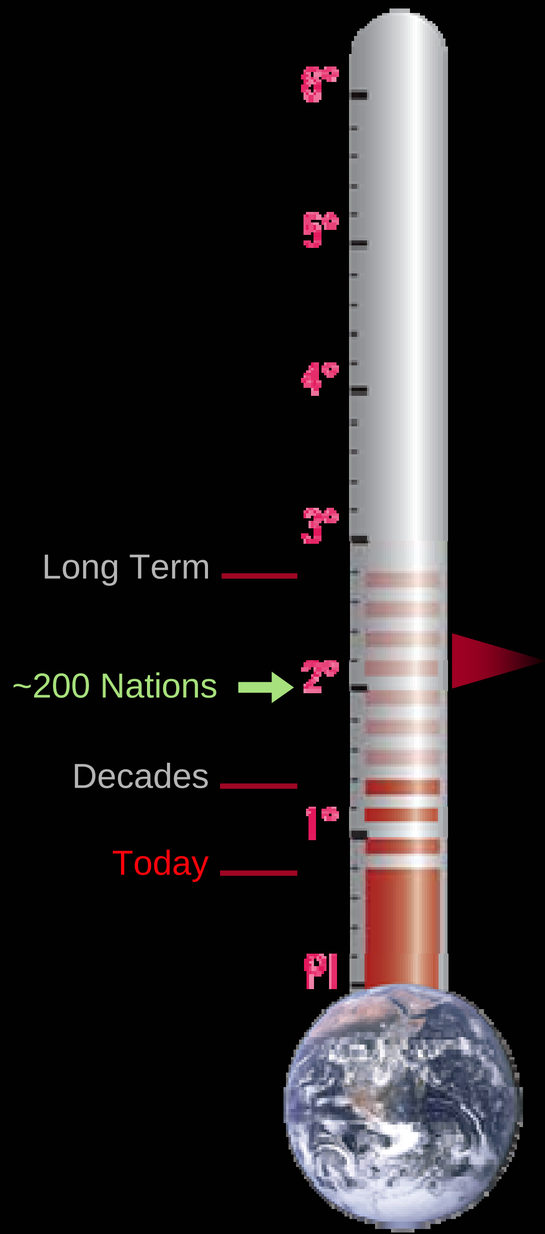
How Aggressive Should We Be in Response?



Peak Emissions Year	Emissions Change by 2050	CO_2 Stabilization
2060 – 2090	+90 to 140%	660 – 790 ppm
2050 – 2080	+25 to +85%	570 – 660 ppm
2020 – 2060	+10 to +60%	485 – 570 ppm
2010 – 2030	-30 to +5%	400 – 485 ppm
2000 – 2020	-30 to -60%	400 – 440 ppm
2000 – 2015	-50 to -85%	350 – 387 – 400 ppm

Assumes climate sensitivity is 3℃
Sources: IPCC 2007

How Aggressive Should We Be in Response?



Peak Emissions Year	Emissions Change by 2050	CO_2 Stabilization
2000 – 2015	-50 to -85%	350 – 387 – 400 ppm

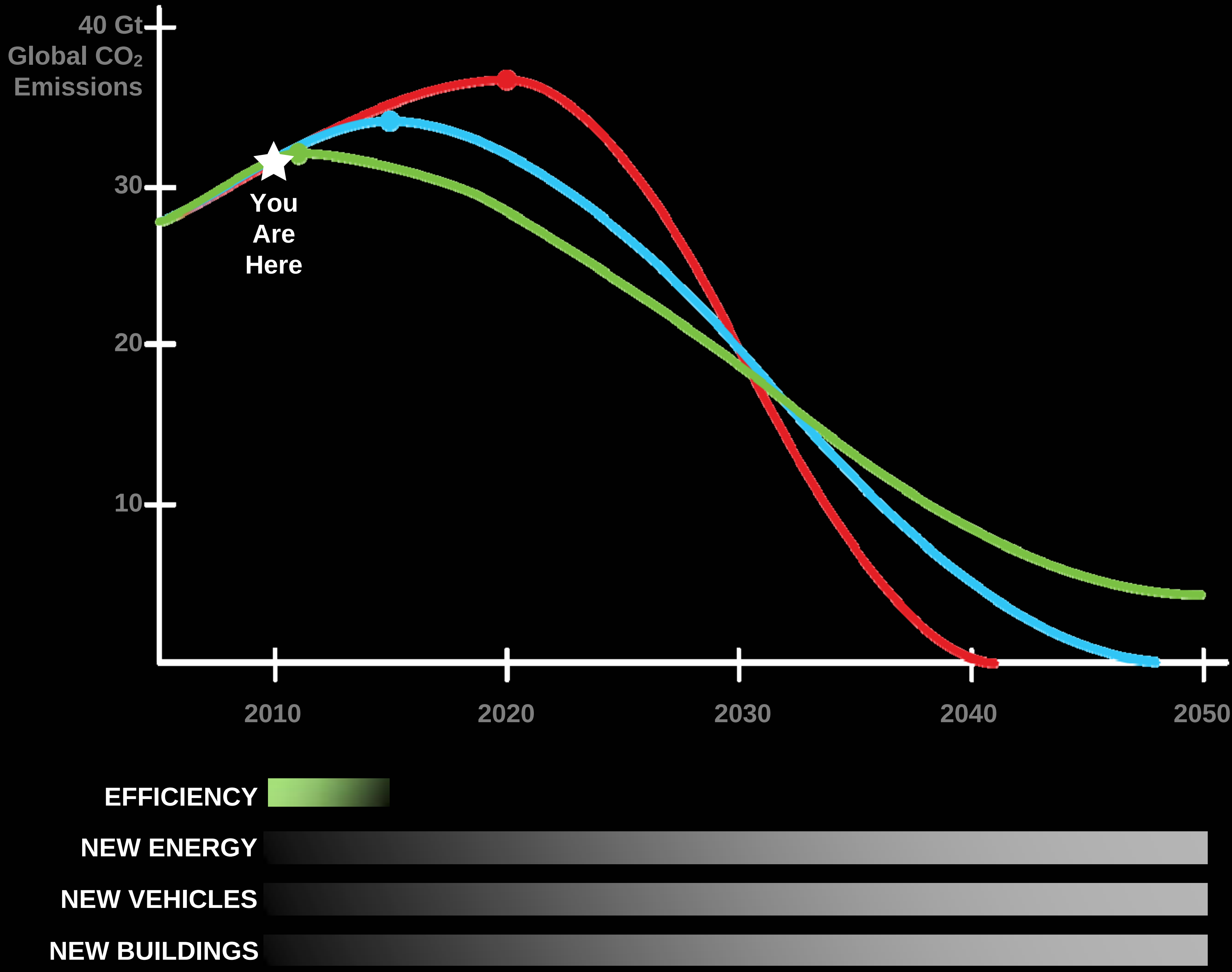
Assumes climate sensitivity is 3℃
Sources: IPCC 2007

Odds of Exceeding 2° C

As of Year 2000

If we emit...	Probability	Odds
1,437 Gt CO_2	50%	50/50
1,158 Gt	33%	1 in 3
1,000 Gt	25%	1 in 4
886 Gt	20%	1 in 5

Source: Meinshausen, et al, 2009



Graph: Meinshausen, et al. 2009

The Climate Choice

Limit + Odds = Emissions Trajectory

Emissions Trajectory = Options + Tradeoffs

Conclusions

1. Identify key public misperceptions

   We know what they are

2. Translate scientific graphic figures appropriately

   Partial success — in process

3. Test translations with various audiences

   Partial success — the next big effort