

Climate change tipping points and their implications

Paul Mahony
Melbourne, Australia
First presented on 15th March 2012

Some recent developments

Arctic sea ice

Nov 2011: Summer sea ice second lowest on record

Permafrost

Dec 2011: “Astonishing” and unprecedented releases of methane

Global greenhouse gas emissions

Nov 2011: 2010 highest percentage increase on record



International Energy Agency

Nov 2011: The world is on the brink of irreversible climate change . . . in five years global warming will hit a point of no return after which it will be impossible to reverse the process.

Presentation outline

The science, incl. amplifying feedbacks

Tipping points, incl. examples and recent developments:

- ***Arctic sea ice***
- ***Greenland ice cap***
- ***Methane clathrates/hydrates***
 - ***Permafrost***
 - ***Ocean sediments***

Implications

Denialism and media reporting

Essential Measures

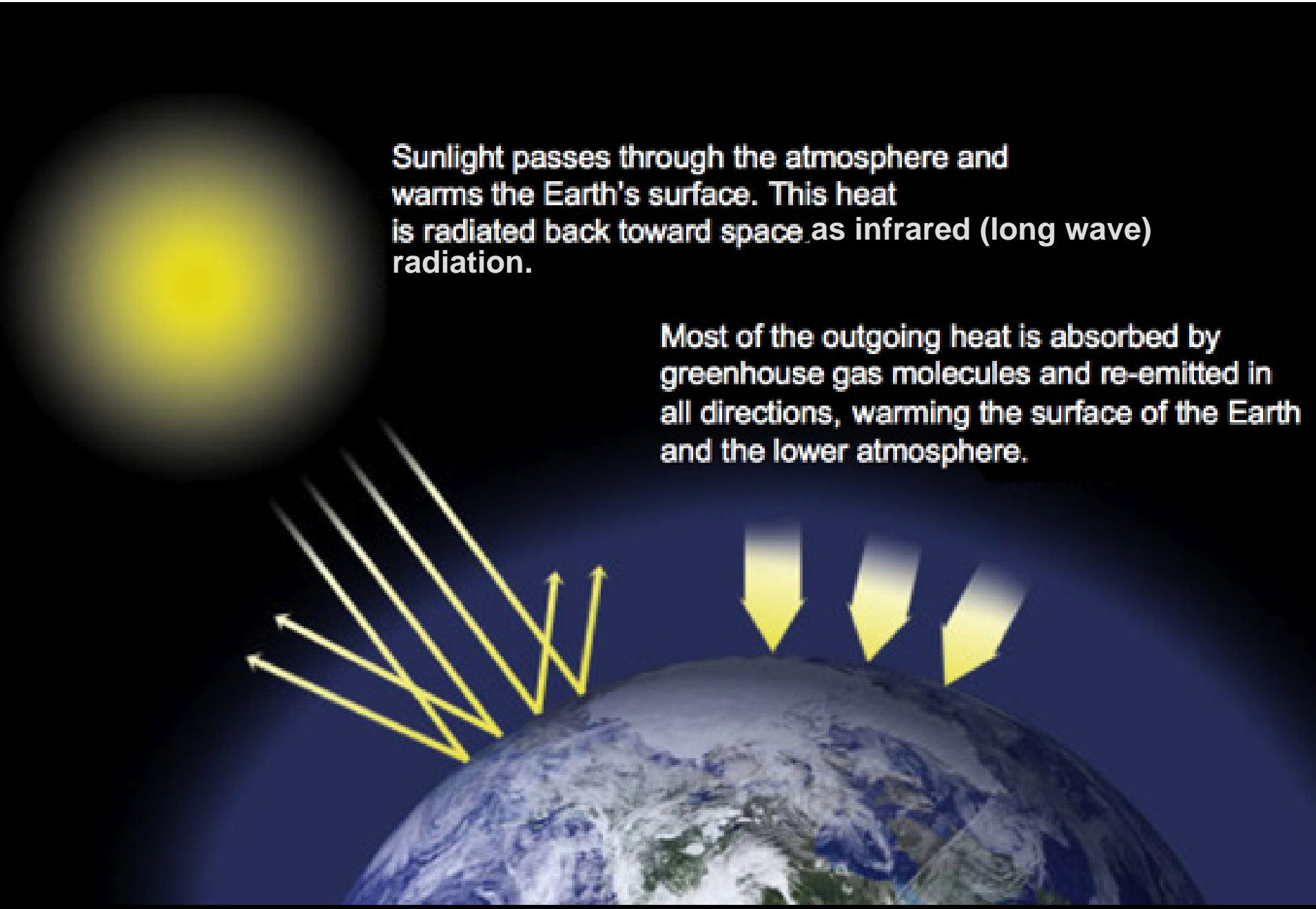
Conclusion

Some of the fundamental science



- Climate change is not just a theory, it is a **scientific fact**, like **gravity** or the **orbit of the Earth around the sun**.

Prof. Nicholas Low, University of Melbourne



Sunlight passes through the atmosphere and warms the Earth's surface. This heat is radiated back toward space as infrared (long wave) radiation.

Most of the outgoing heat is absorbed by greenhouse gas molecules and re-emitted in all directions, warming the surface of the Earth and the lower atmosphere.

Some of the fundamental science



There's no disagreement about

THE PHYSICS OF RADIATIVE TRANSFER

and the fact that adding infra red absorbing gases to the atmosphere is going to make the atmosphere

MORE OPAQUE IN THE THERMAL SPECTRUM,

in the long waves.

That will

REDUCE HEAT RADIATION TO SPACE

and if you reduce the radiation to space, given the fact that the amount of energy coming from the sun is unchanged, then you have to warm up the planet.

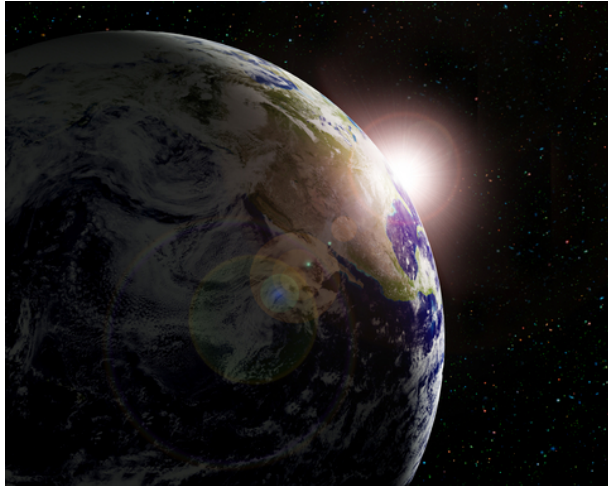
You've got an

ENERGY IMBALANCE and

UNTIL THE PLANET WARMS UP ENOUGH TO RADIATE THAT ENERGY AWAY, IT'S GOING TO CONTINUE TO GET WARMER.

Dr James Hansen, Director, Goddard Institute for Space Studies, NASA interviewed on Late Night Live, ABC Radio National (Australia), 8th March, 2010 and replayed 8th July, 2010. Image: © Pmakin | Dreamstime.com

Some of the fundamental science



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and the fact that adding infra red absorbing gas to the atmosphere is going to make the atmosphere

MORE OPAQUE IN THE INFRARED

in the

That will

REDUCE HEAT LOSS

“SO THE BASIC PHYSICS IS VERY HARD TO DISPUTE”
Dr James Hansen, Director, Goddard Institute for Space Studies, NASA

to space, given the fact that the amount of energy coming from the sun is constant, then you have to warm up the planet.

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Dr James Hansen, Director, Goddard Institute for Space Studies, NASA interviewed on Late Night Live, ABC Radio National (Australia), 8th March, 2010 and replayed 8th July, 2010. Image: © Pmakin | Dreamstime.com

Some of the fundamental science



- I now find it difficult to understand how a person of reasonable intelligence is unable to accept the **reality** and the **urgency** of the **looming climate crisis**.

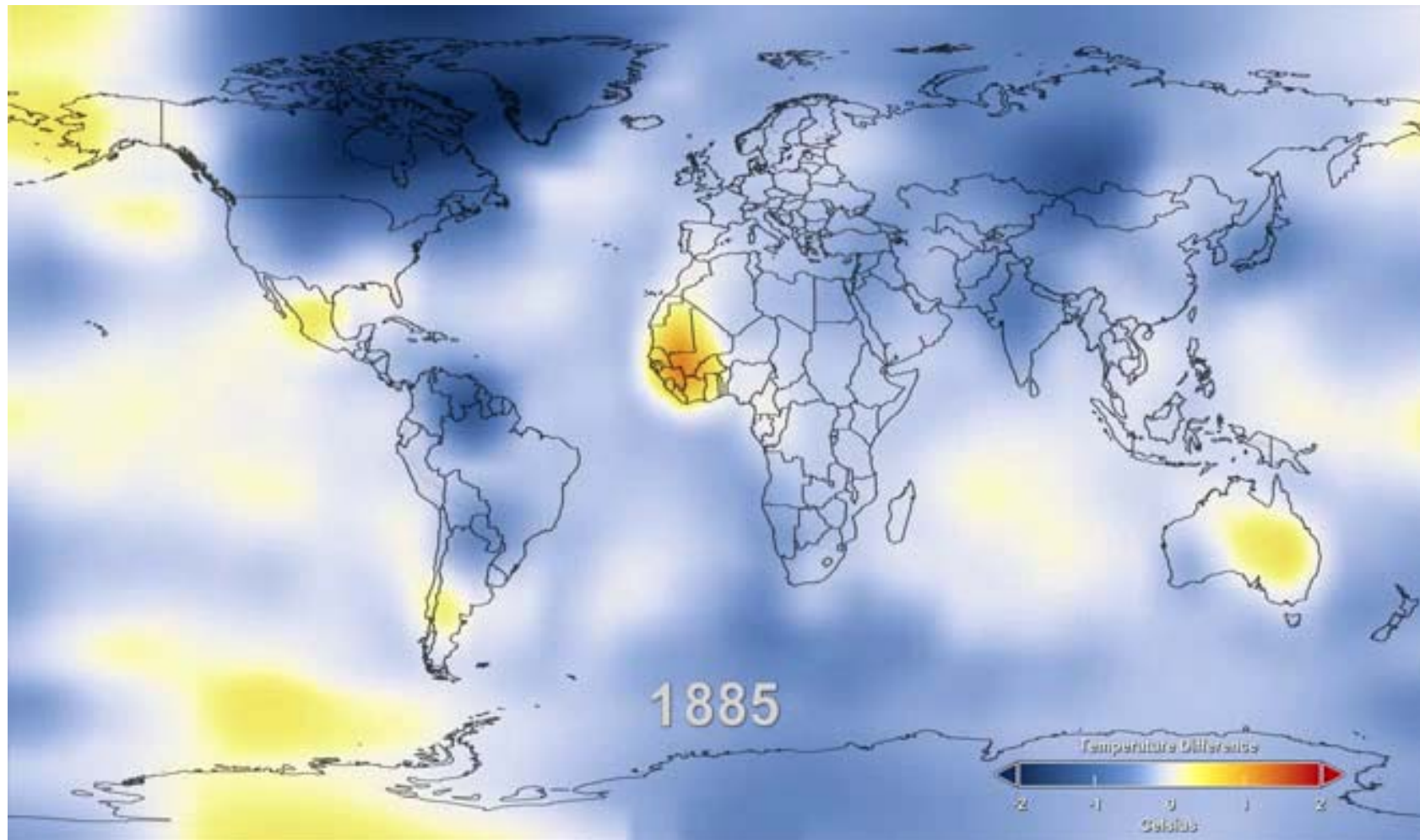
- . . . the problem is the unwillingness or incapacity to accept the truth of an argument **of almost embarrassing simplicity**.

Prof. Robert Manne, La Trobe University

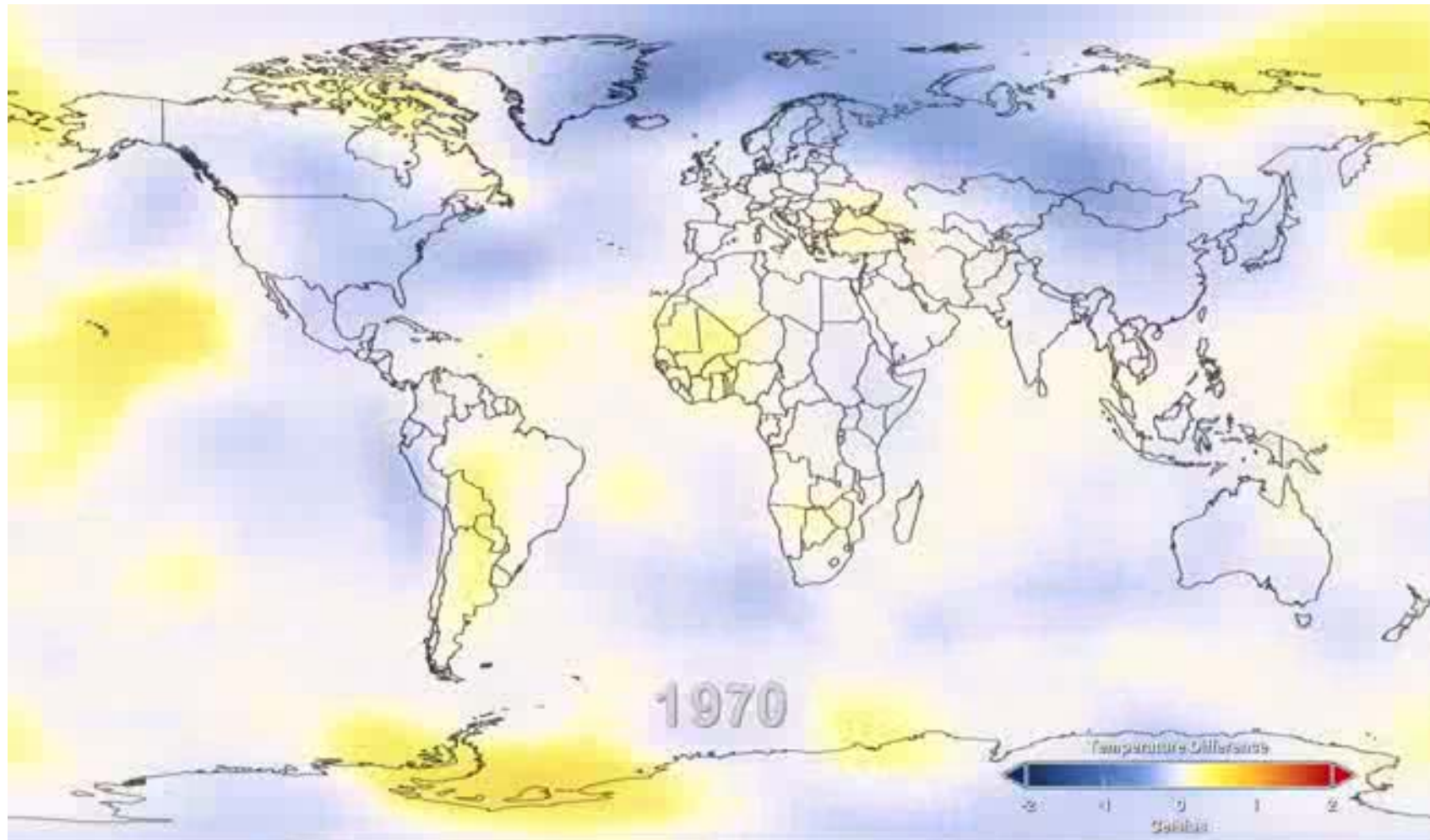
Manne, R., "How can climate change denialism be explained?", The Monthly, 8 Dec, 2011, <http://www.themonthly.com.au/blog-how-can-climate-change-denialism-be-explained-robert-manne-4386>

Image: © Pmakin | Dreamstime.com

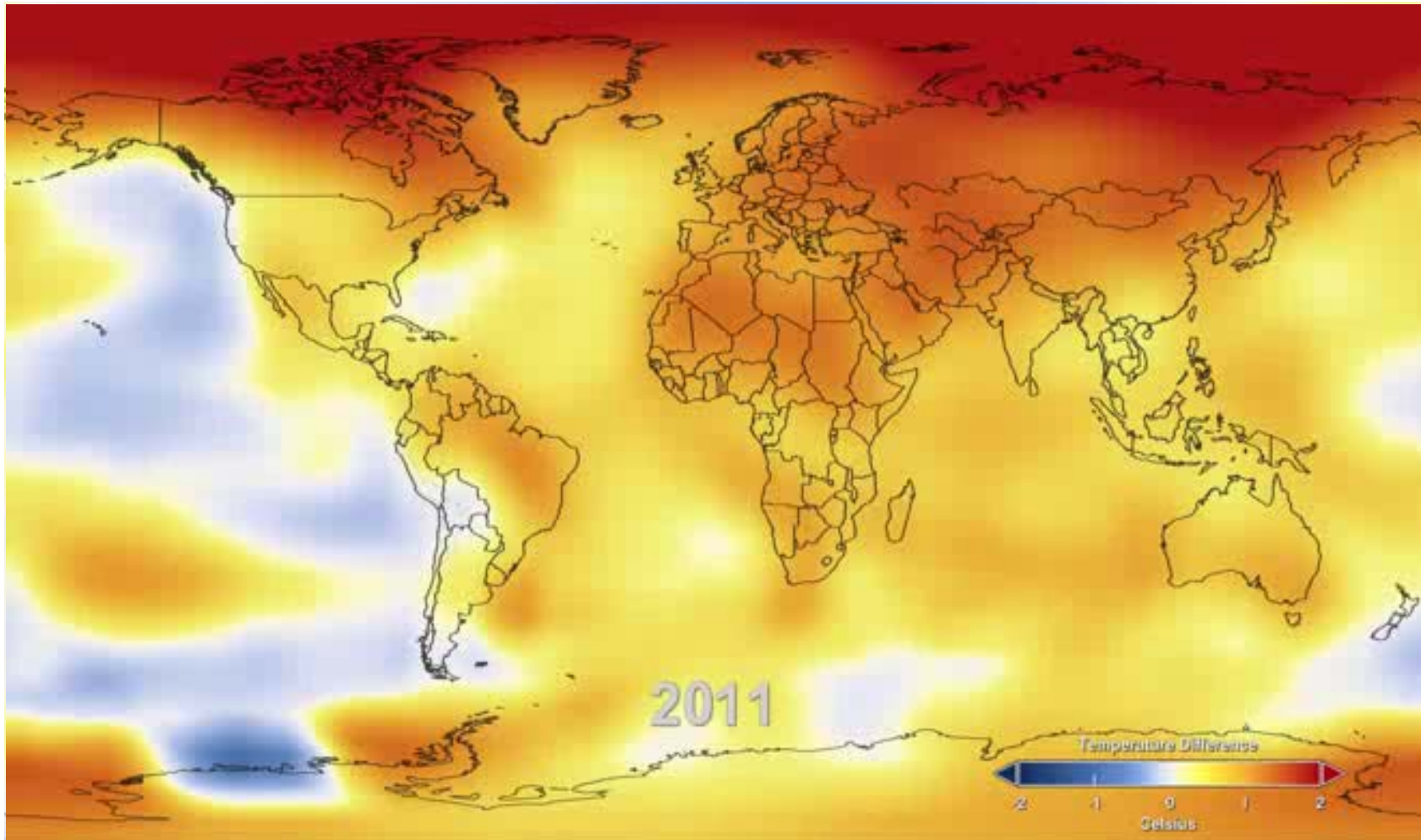
Our warming planet



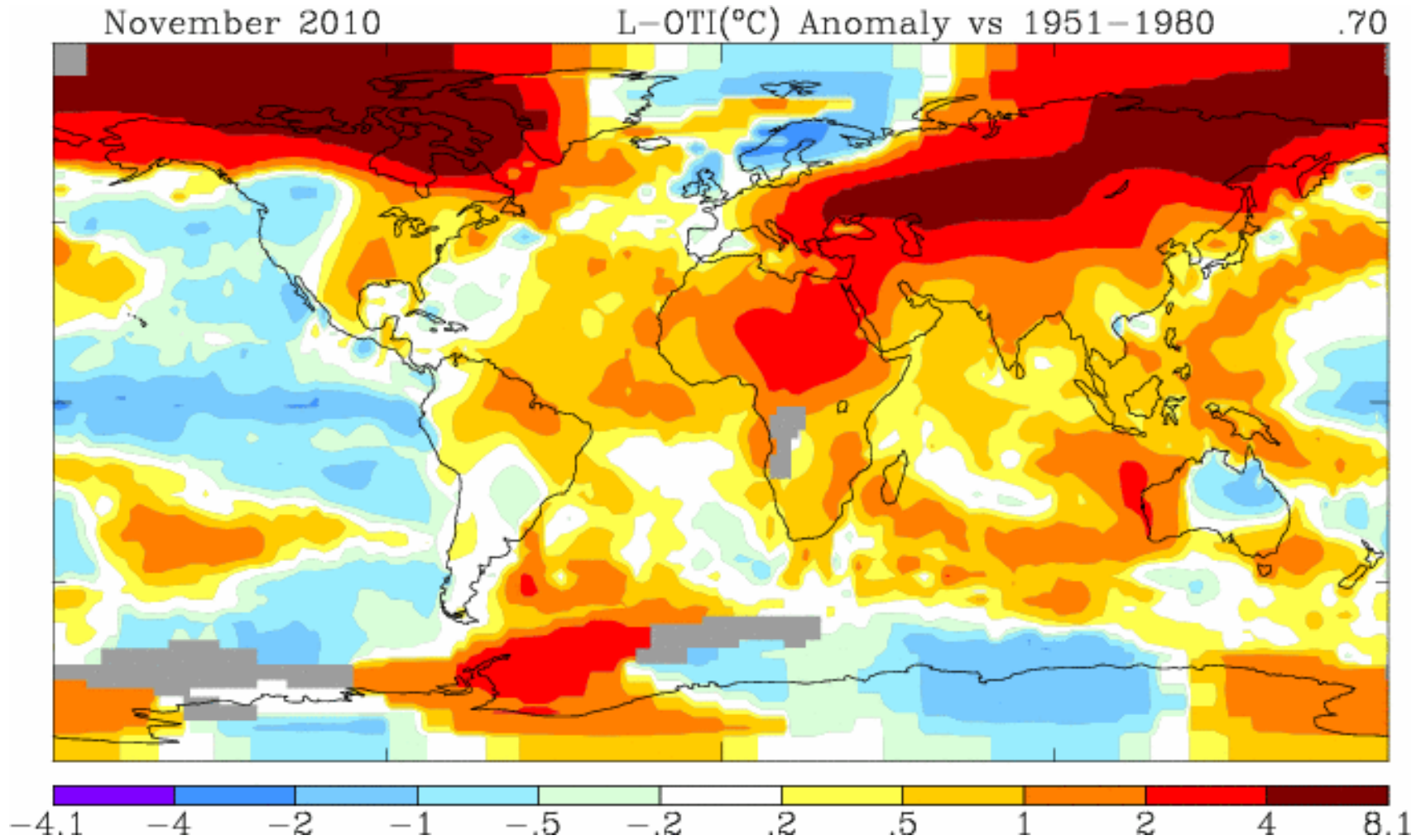
Our warming planet



Our warming planet



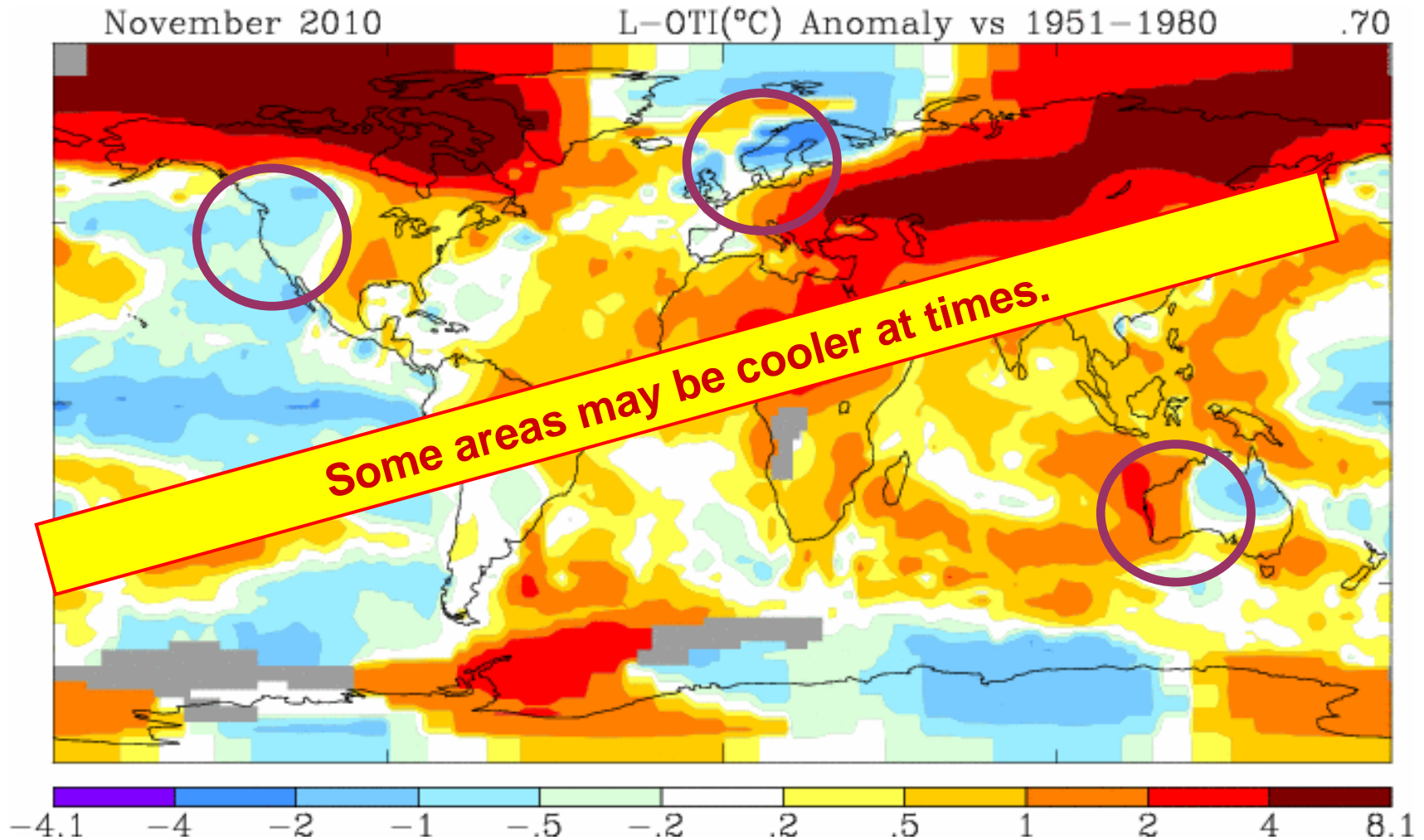
Our warming planet



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NASA Goddard Institute for Space Studies Surface Temperature Analysis, http://data.giss.nasa.gov/cgi-bin/gistemp/do_nmap.py?year_last=2012&month_last=1&sat=4&sst=1&type=anoms&mean_gen=11&year1=2010&year2=2010&base1=1951&base2=1980&radius=1200&pol=reg

Our warming planet



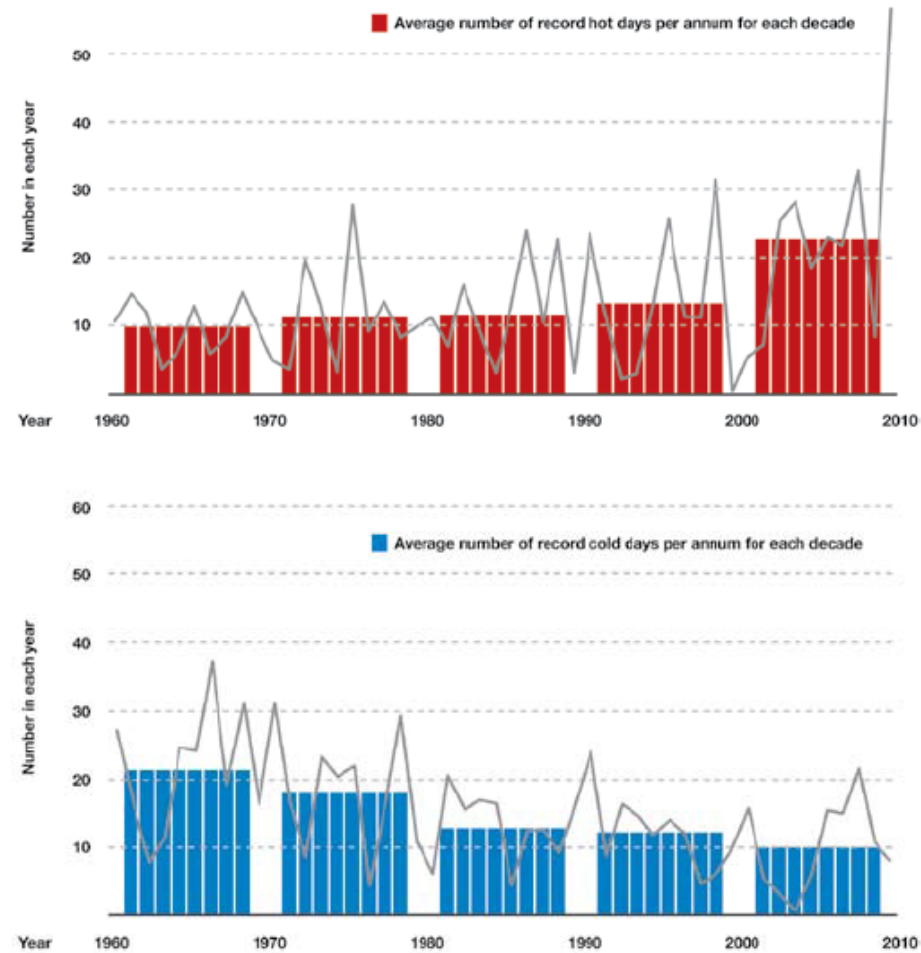
Tipping Point Definition

A critical threshold at which a small change in human activity can have large, long-term consequences for the Earth's climate system.



Science Daily, "Tipping Elements in Earth's Climate System", 4th Feb 2008 (Accessed 4 February 2012)
<http://www.sciencedaily.com/releases/2008/02/080204172224.htm>; Image: iStockphoto Jan Rysavy

Record number of hot and cold days in Australia since 1960



Source: CSIRO, "The Science of Climate Change: Questions and Answers", Fig. 3.3, p. 8

Carbon Dioxide (CO₂)



In the same way that a person's breath has nowhere to go when blown into a balloon, carbon dioxide emitted by human activities, which is not taken up by the biosphere or oceans, effectively has nowhere to go when released to the atmosphere in any conventional planning timescale.



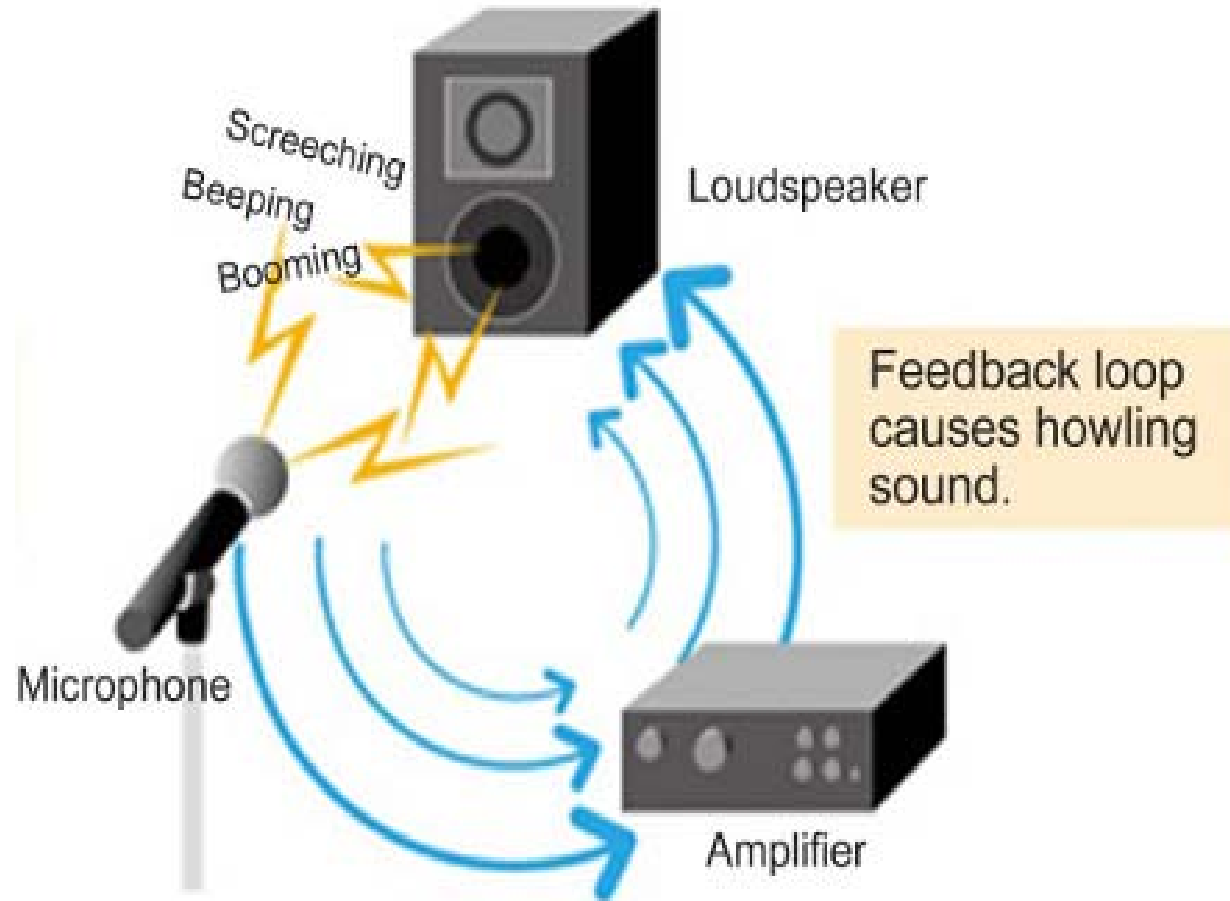
Image © Enrique Gomez | Dreamstime.com

Lady Gaga can introduce us to the concept of amplifying feedbacks.

Amplifying Feedbacks in Sound System

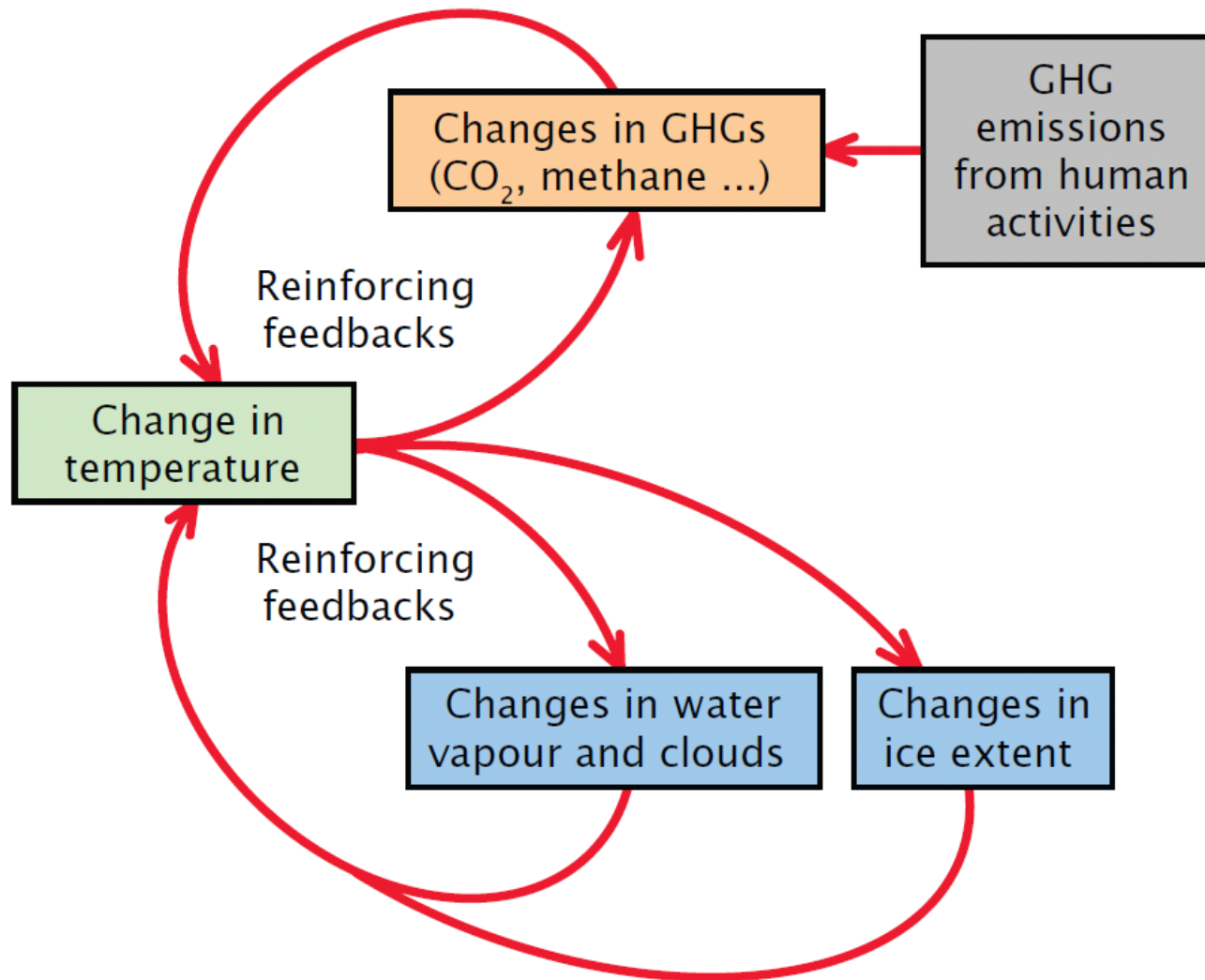


Let's
assume the
microphone
is Lady
Gaga's

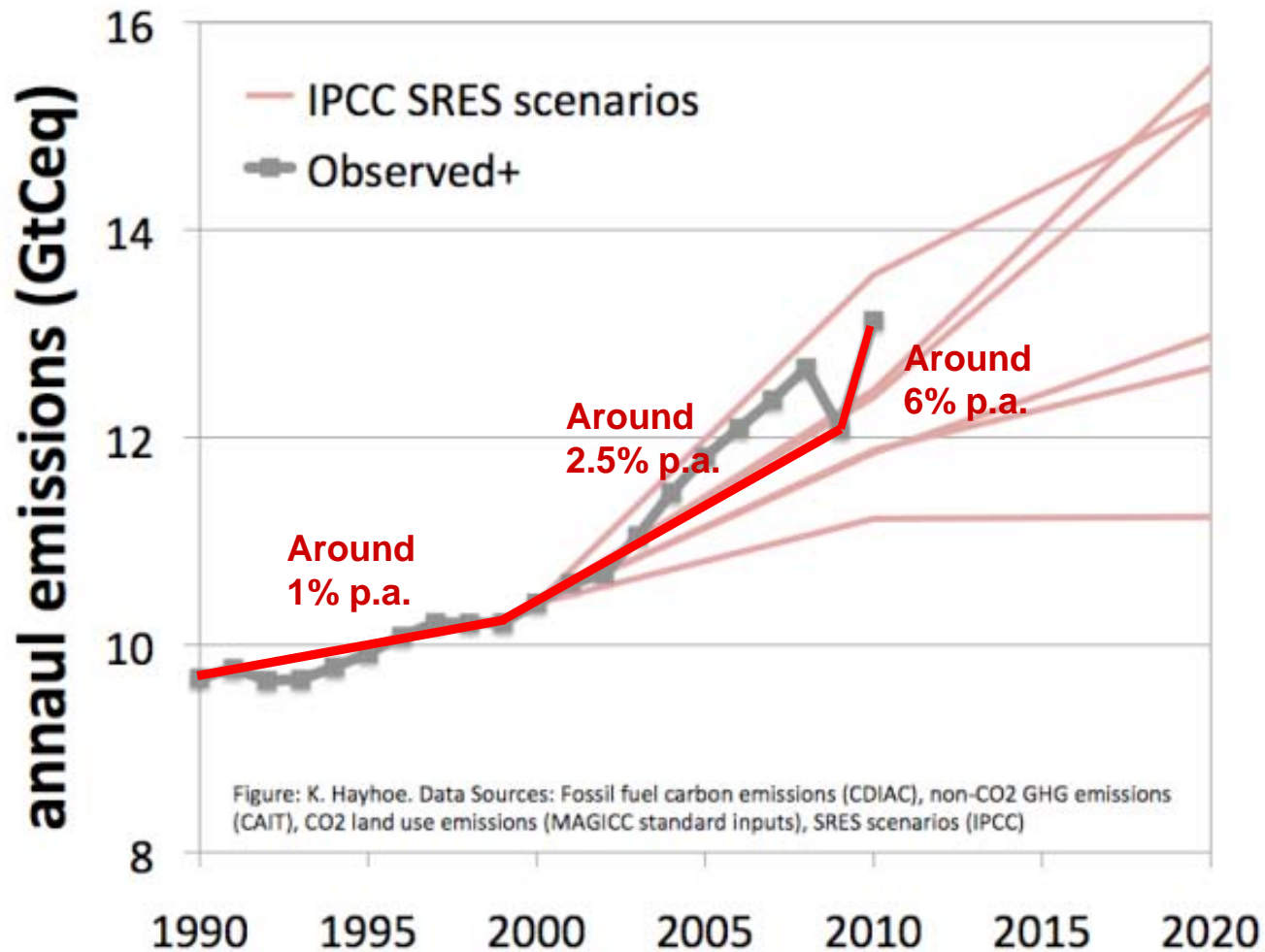


Sound system image courtesy of TOA Corporation, <http://www.toa.jp/>
Lady Gaga image © Enrique Gomez | Dreamstime.com

Amplifying Feedbacks in Climate System



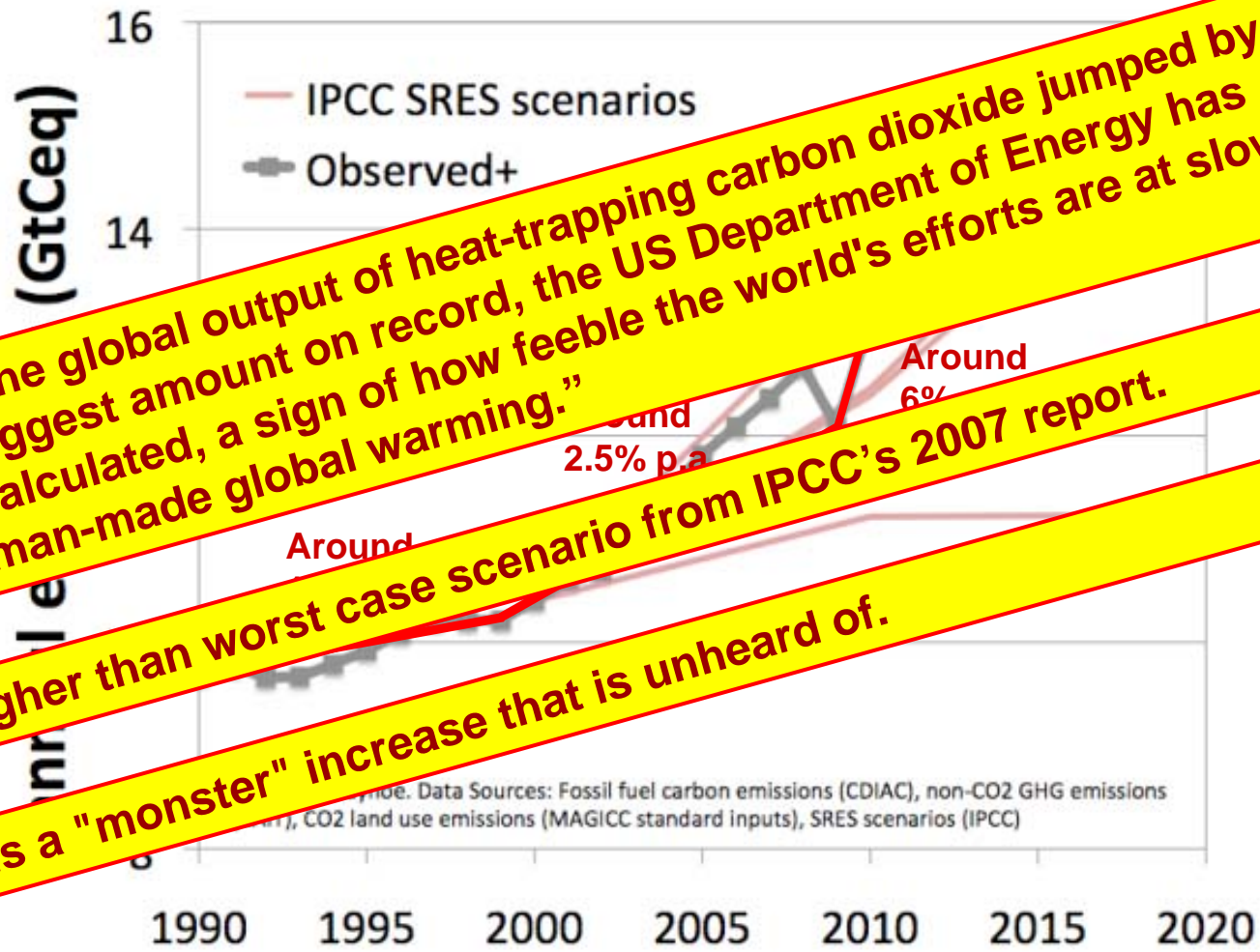
Atmospheric Greenhouse Gas Emissions (Annual)



Borenstein, S, "Biggest jump ever in global warming gases", The Age, 4 Nov, 2012, <http://news.theage.com.au/breaking-news-world/biggest-jump-ever-in-global-warming-gases-20111104-1myf5.html>

Chart: Katharine Hayhoe, Atmospheric Scientist, cited in Brook, B. "Depressing climate-related trends – But who gets It?", 6 Nov 2011, <http://bravenewclimate.com/2011/11/06/depressing-climate-trends/>, Original <http://twitpic.com/7b8v2j>

Atmospheric Greenhouse Gas Emissions (Annual)



“The global output of heat-trapping carbon dioxide jumped by the biggest amount on record, the US Department of Energy has calculated, a sign of how feeble the world's efforts are at slowing man-made global warming.”

Higher than worst case scenario from IPCC's 2007 report.

It is a "monster" increase that is unheard of.

Borenstein, S, “Biggest jump ever in global warming gases”, The Age, 4 Nov, 2012, <http://news.theage.com.au/breaking-news-world/biggest-jump-ever-in-global-warming-gases-20111104-1myf5.html>

Chart: Katharine Hayhoe, Atmospheric Scientist, cited in Brook, B. “Depressing climate-related trends – But who gets It?”, 6 Nov 2011, <http://bravenewclimate.com/2011/11/06/depressing-climate-trends/>, Original <http://twitpic.com/7b8v2j>

Temperature Change

Comments from NASA's Goddard Institute for Space Studies

- The year 2011 was the 9th warmest in the GISS analysis.
- It was cooled by a moderately strong La Nina.
- **Nine of the ten warmest years have been in the 21st century.**
- The only exception was **1998**, which was warmed by the strongest El Nino of the past century.
- The 5-year running mean global temperature hints at a slowdown in the global warming rate during the past few years. However:
 - La Nina phase dominant for the past three years.
 - Deepest solar minimum in the period of satellite data.

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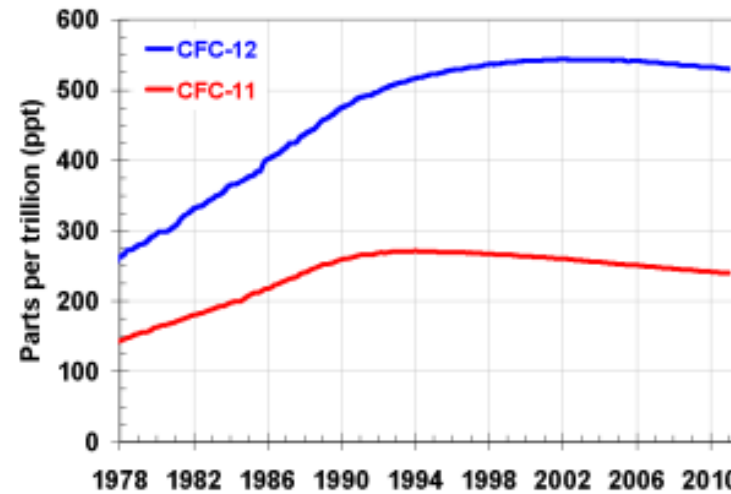
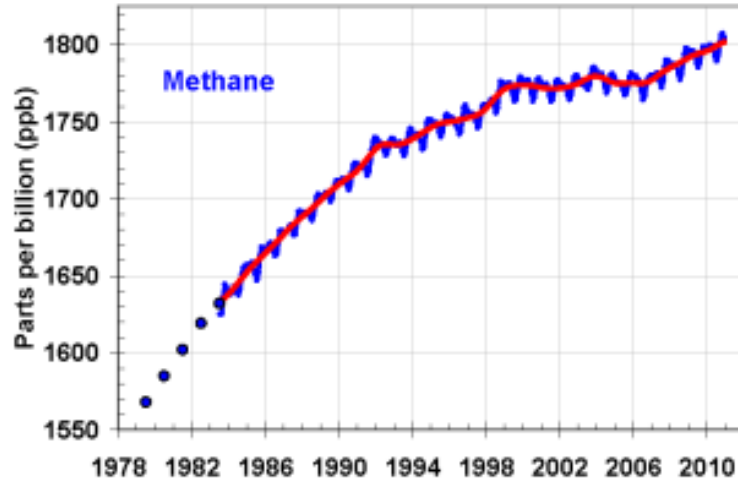
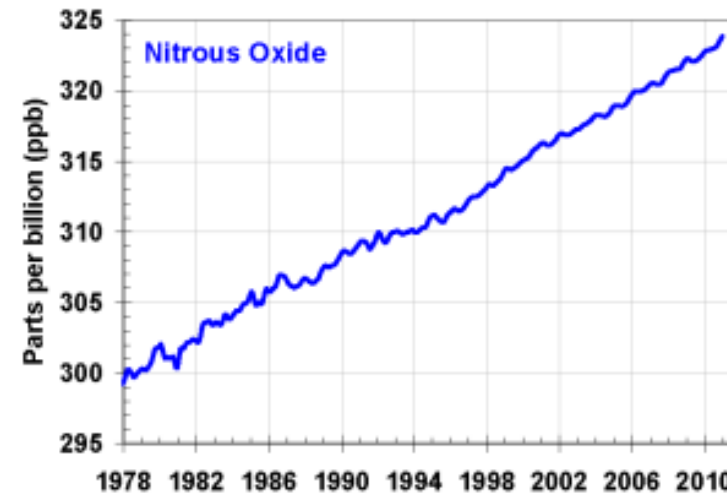
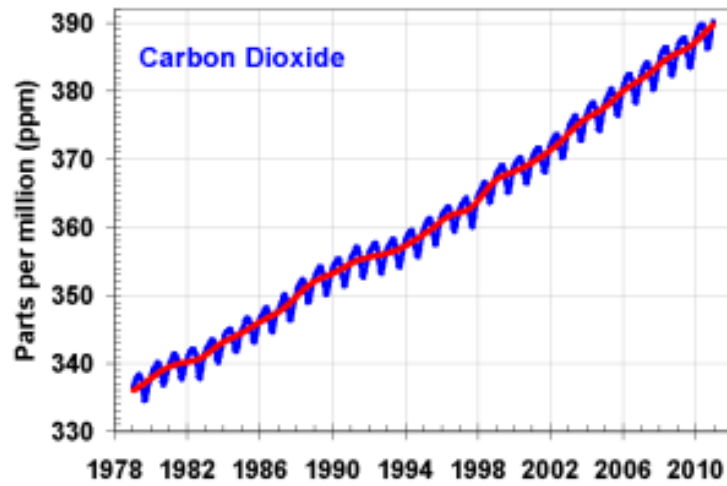
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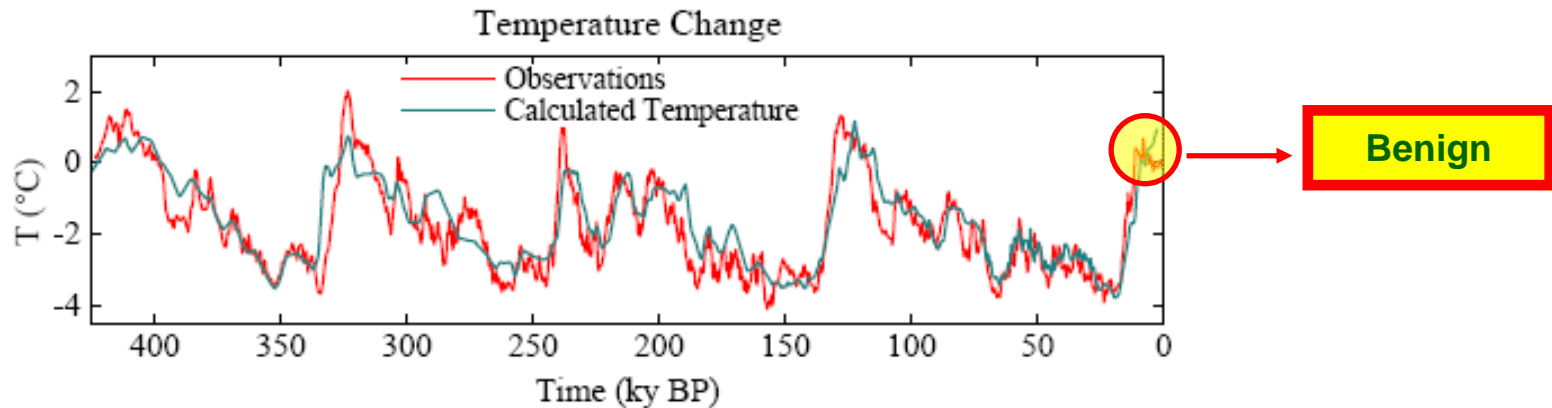
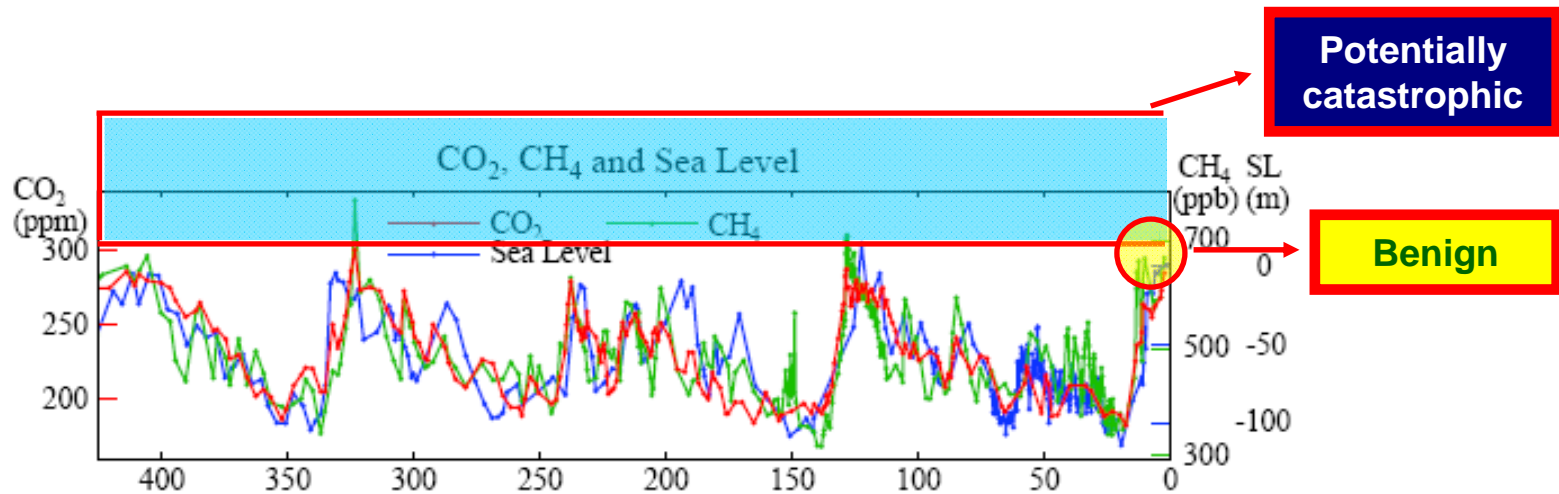
“We conclude that the slowdown of warming is likely to prove illusory, with more rapid warming appearing over the next few years.” Hansen, J, et al, ibid

- ...warming mean global temperature hints at a slowdown in the warming rate during the past few years. However:
- La Nina phase dominant for the past three years.
 - Deepest solar minimum in the period of satellite data.

Greenhouse Gas Concentrations



GHGs, sea levels and temperature

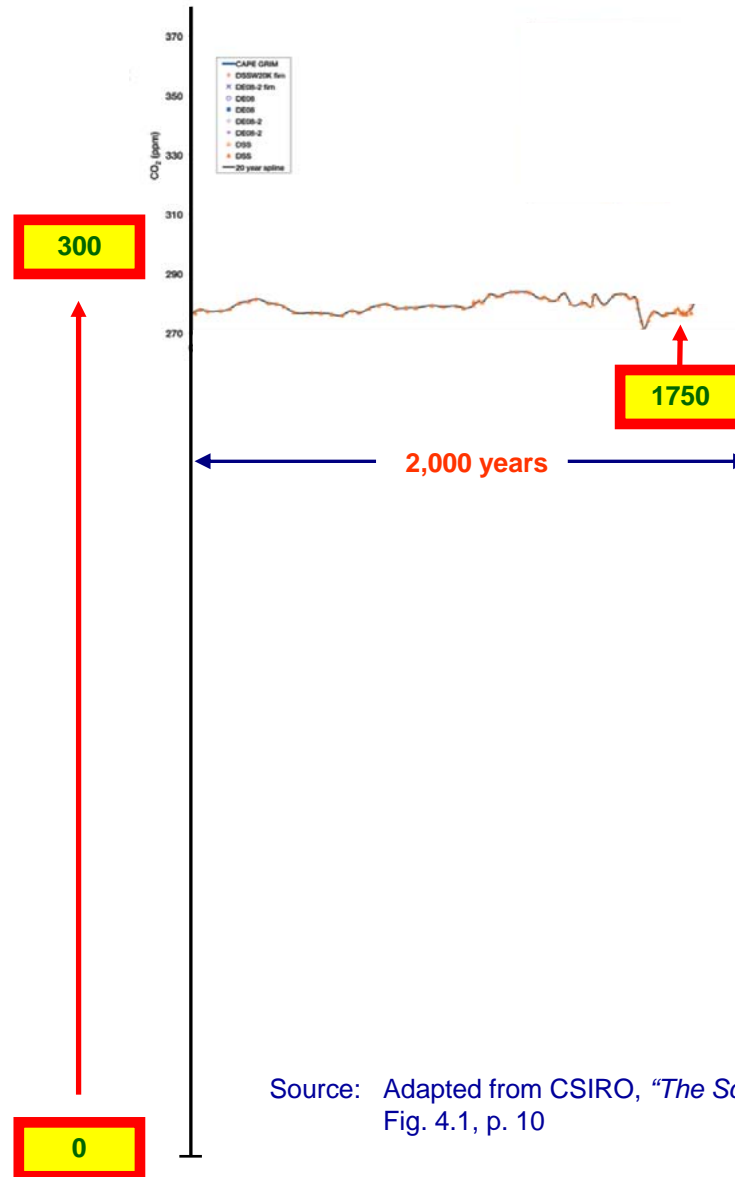


Note: The shaded circles include the 10,000 years (approx.) of human civilisation.

Source: Hansen, J. et al "Target Atmospheric CO₂: Where Should Humanity Aim?", 2008

http://pubs.giss.nasa.gov/abstracts/2008/Hansen_etal.html

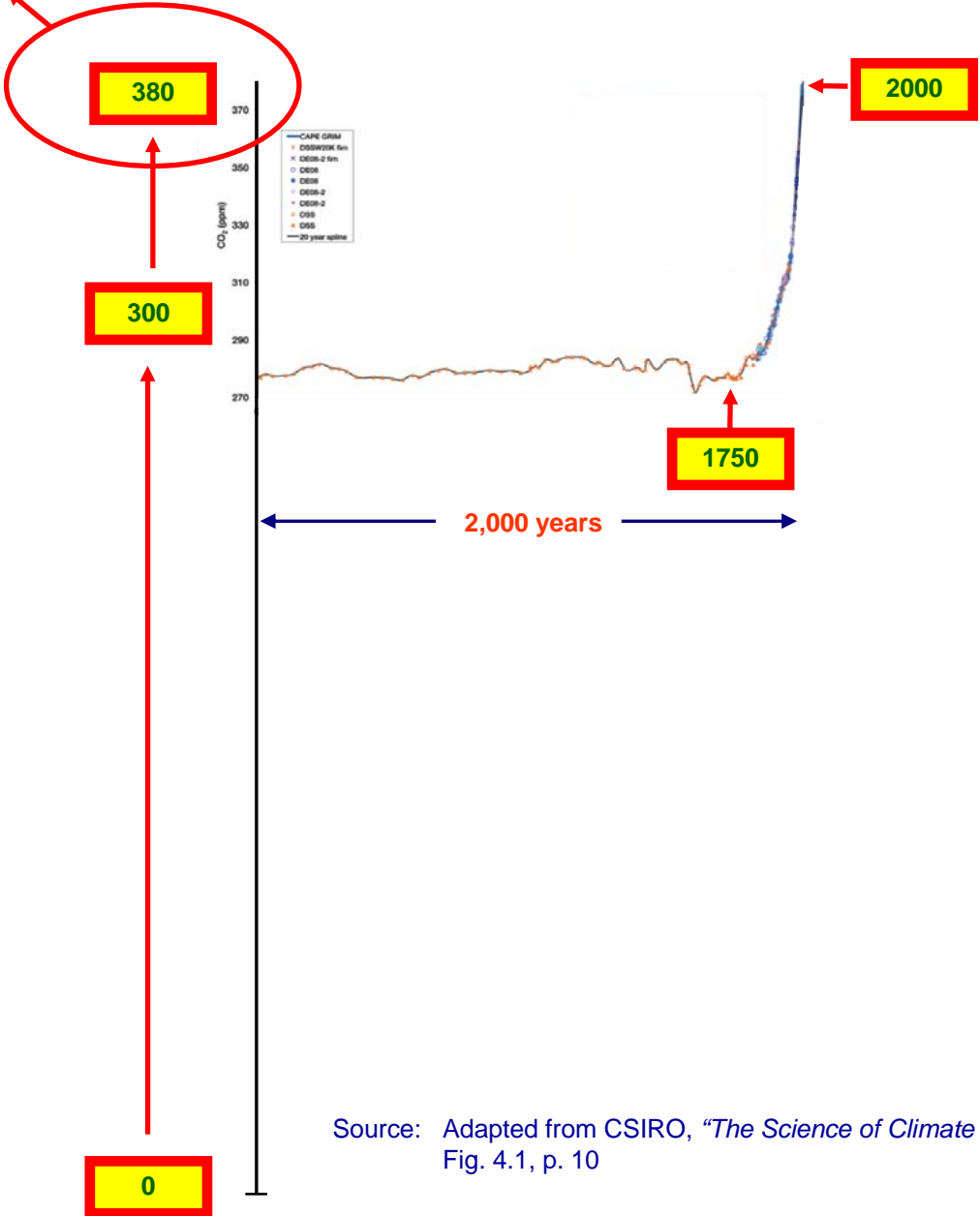
Atmospheric concentrations of CO2



Source: Adapted from CSIRO, "The Science of Climate Change: Questions and Answers", Fig. 4.1, p. 10

Atmospheric concentrations of CO2

394 ppm as at Mar 2012



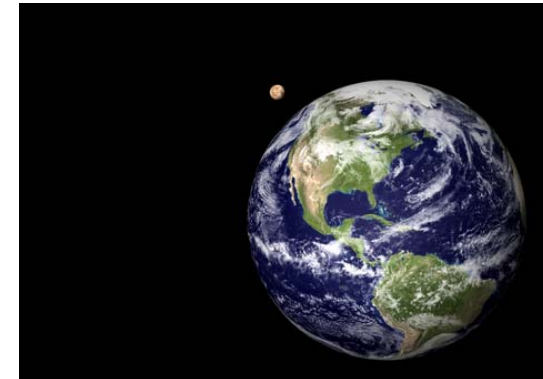
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Source: Adapted from CSIRO, "The Science of Climate Change: Questions and Answers", Fig. 4.1, p. 10

The need is urgent!

“ . . . the world stands . . .

on the edge of a precipice . . .



beyond which human actions will no longer be able to control in any meaningful way the trajectory of the climate system . . .”

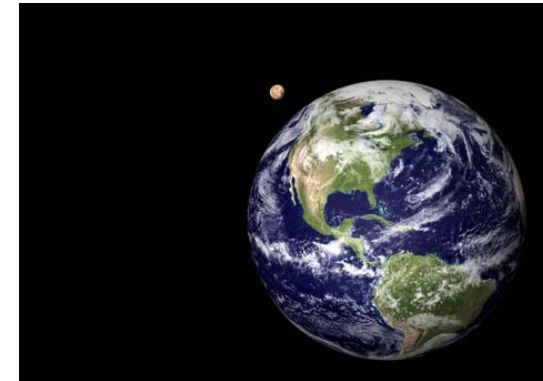
***David Spratt, co-author of
“Climate Code Red: the case
for emergency action”***

Source: “Global Warming – No more business as usual: This is an emergency!”, Environmental Activists’ Conference ’08: Climate Emergency – No More Business as Usual, 10 October, 2008, reproduced in Links International Journal of Socialist Renewal, <http://links.org.au/node/683> Image: Earth and moon © Cornelius20 | Dreamstime.com

The need is urgent!

How can we be on the precipice of such consequences while local climate change remains small compared to day-to-day weather fluctuations?

*The urgency derives from the nearness of **climate tipping points**, beyond which climate dynamics can cause rapid changes out of humanity's control.*



Dr James Hansen

Tipping Points

- **Arctic sea ice***
- **Greenland* and Antarctic ice sheets**
- **Glaciers**
- **Methane hydrates/clathrates (permafrost and ocean sediments)***
- **Forest destruction, incl. Amazon**
- **Atlantic Thermohaline Circulation (THC)**
- **El Nino-Southern Oscillation (ENSO)**
- **Indian Summer Monsoon (ISM)**
- **Sahara/Sahel and West African Monsoon (WAM)**

* Referred to in this presentation

Arctic Summer Sea Minimum

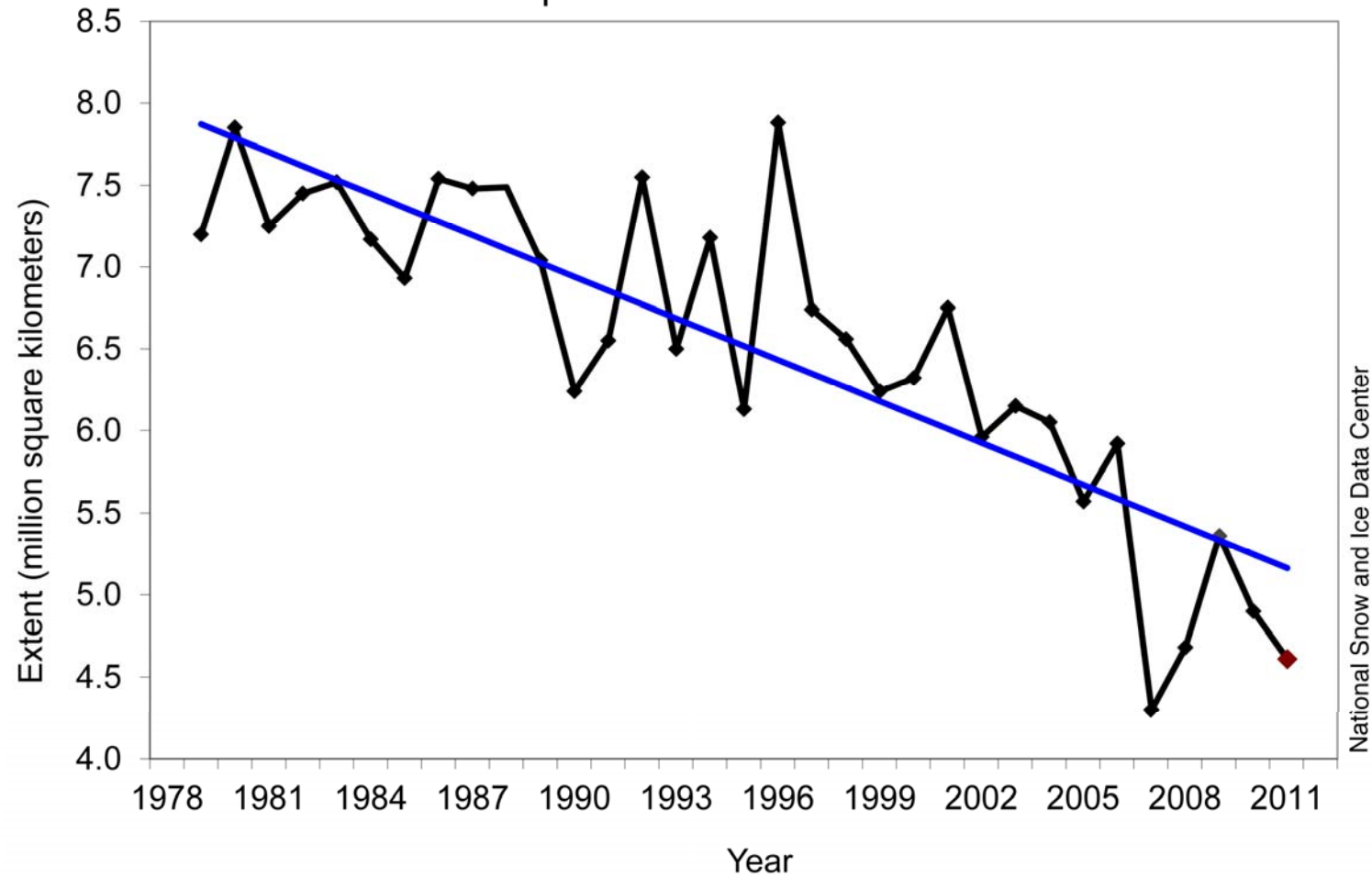


Arctic Summer Sea Minimum



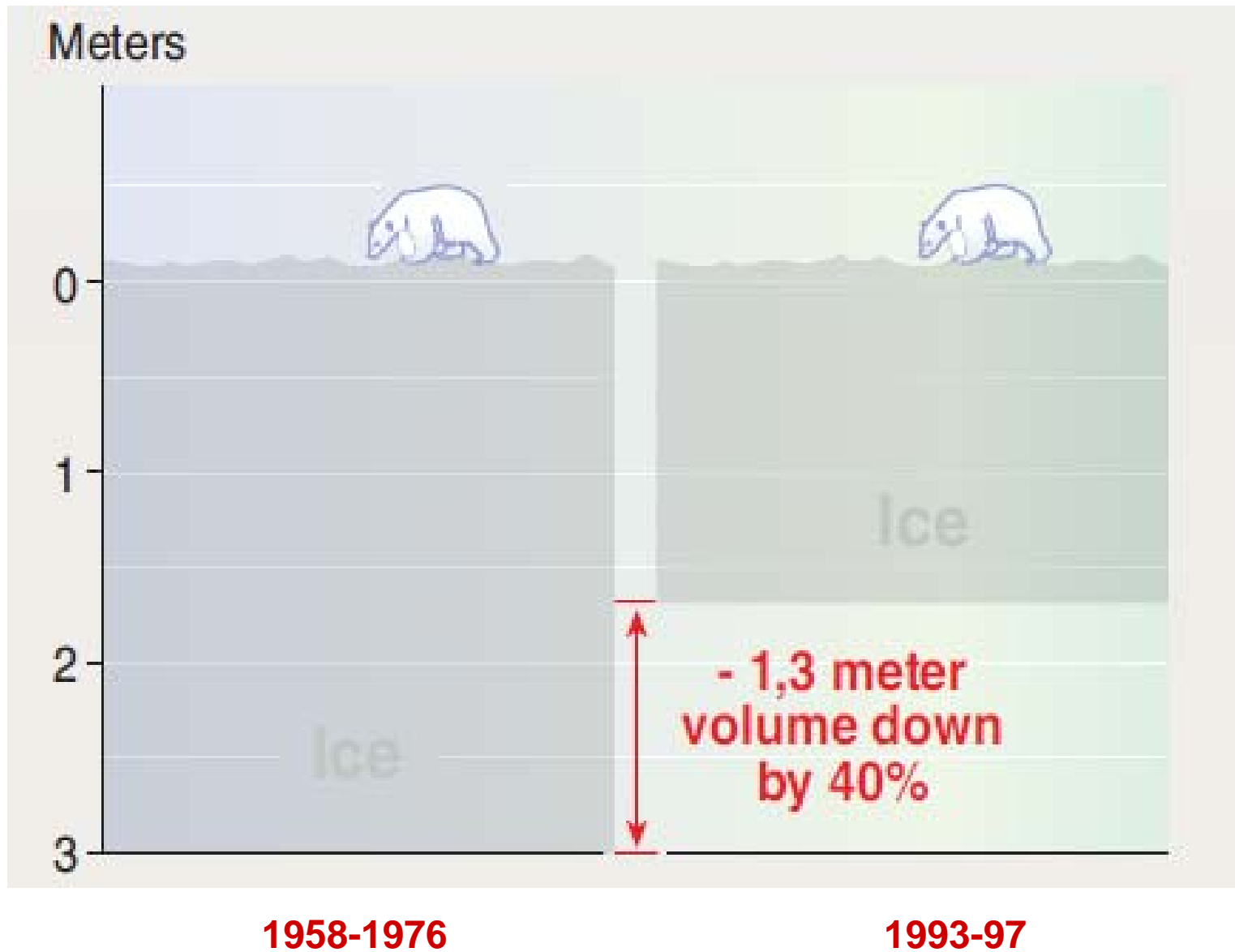
Arctic Summer Sea Ice

Average Monthly Arctic Sea Ice Extent
September 1979 to 2011

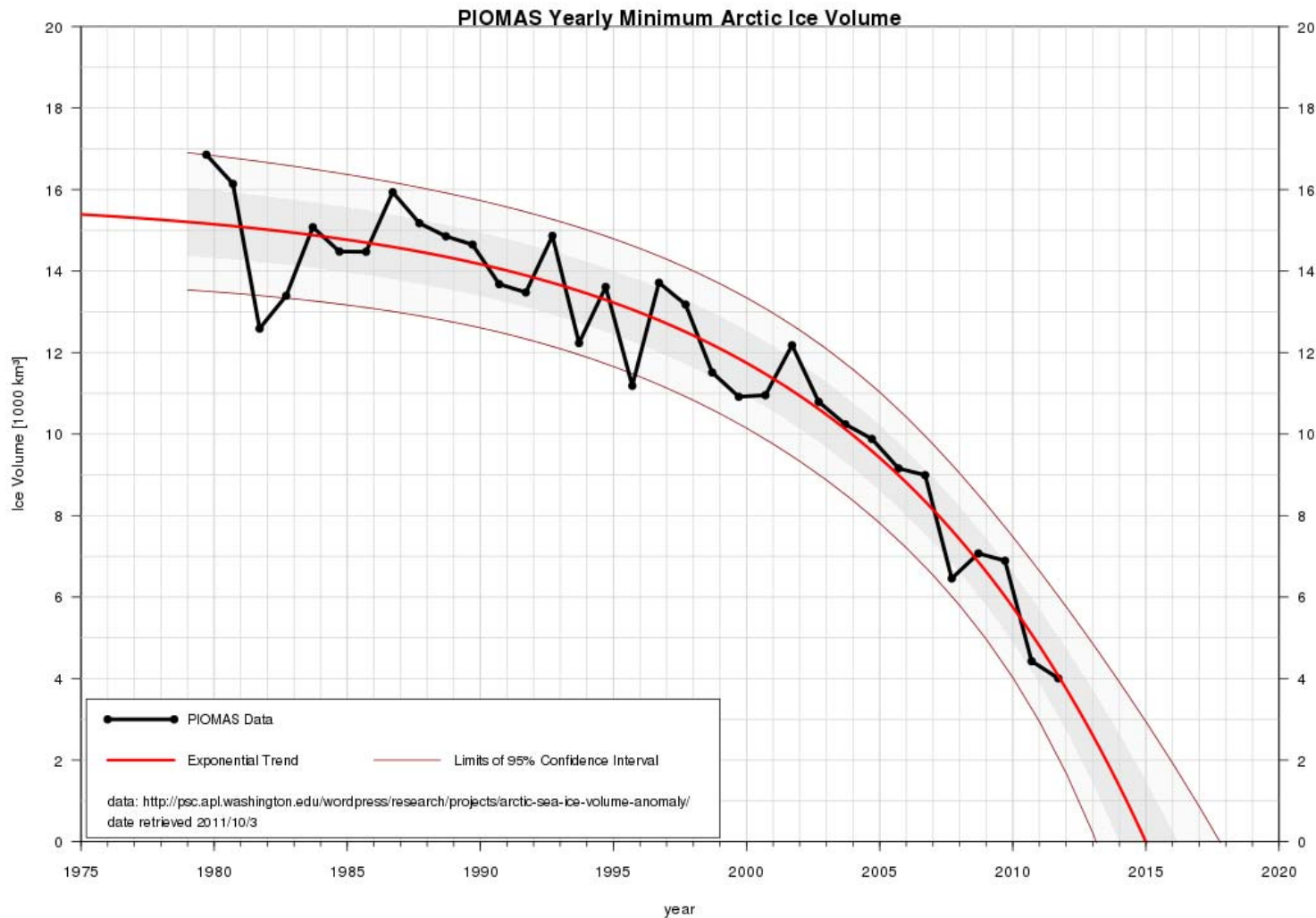


National Snow and Ice Data Center

Arctic Summer Sea Ice

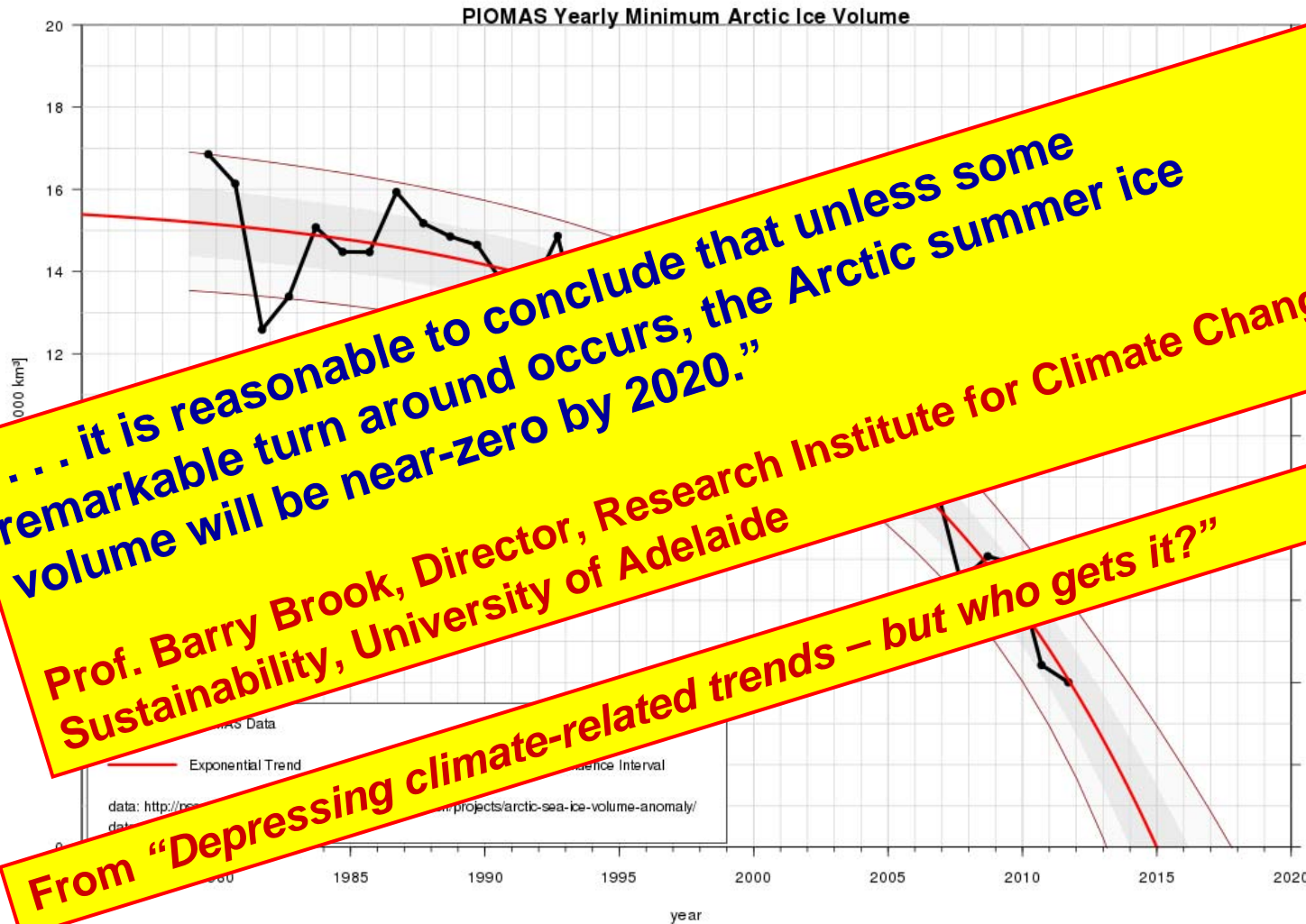


Arctic Summer Sea Ice



From Brook, B. "Depressing climate-related trends – but who gets it?", 6 Nov 2011
<http://bravenewclimate.com/2011/11/06/depressing-climate-trends/> based on Pan-Arctic Ice Ocean Modeling and Assimilation System (PIOMAS, Zhang and Rothrock, 2003) graphs from the Polar Science Center of the Applied Physics Laboratory at the University of Washington, <http://psc.apl.washington.edu/wordpress/research/projects/arctic-sea-ice-volume-anomaly/>, reported in <http://neven1.typepad.com/blog/2011/10/piomas-september-2011-volume-record-lower-still.html>

Arctic Summer Sea Ice



“... it is reasonable to conclude that unless some remarkable turn around occurs, the Arctic summer ice volume will be near-zero by 2020.”

Prof. Barry Brook, Director, Research Institute for Climate Change & Sustainability, University of Adelaide

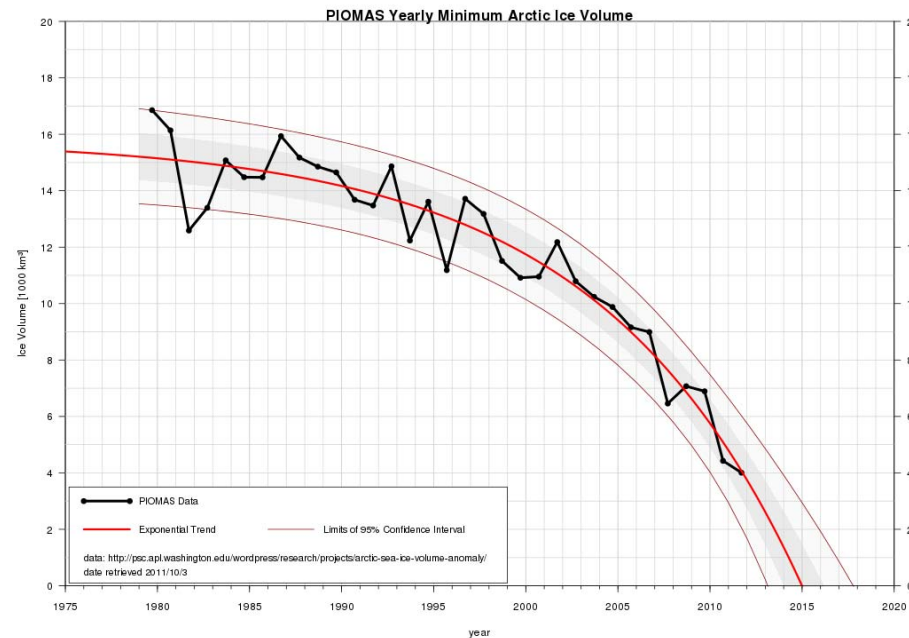
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Arctic Summer Sea Ice

David Spratt, Co-author of “*Climate Code Red: the case for emergency action*” and Damien Lawson:

The danger is that an ice-free state in the Arctic summer will kick the climate system into **run-on warming** and create an aberrant new climate state **many, many degrees hotter.**

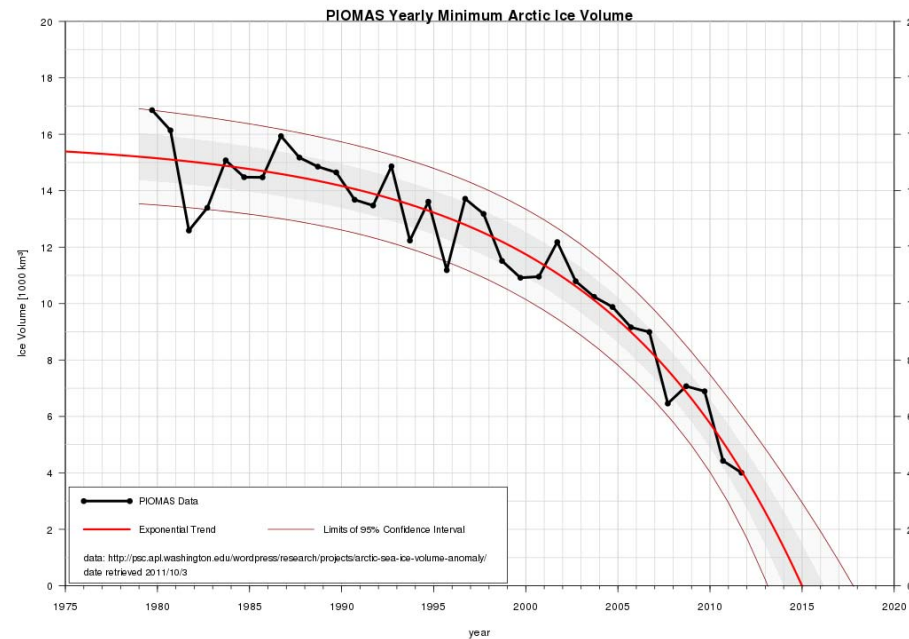


Spratt, D and Lawson, D, “Bubbling our way to the Apocalypse”, Rolling Stone, November 2008, pp. 53-55

Arctic Summer Sea Ice

David Spratt, Co-author of “*Climate Code Red: the case for emergency action*” and Damien Lawson:

The Arctic sea-ice is the first domino and it is falling fast.

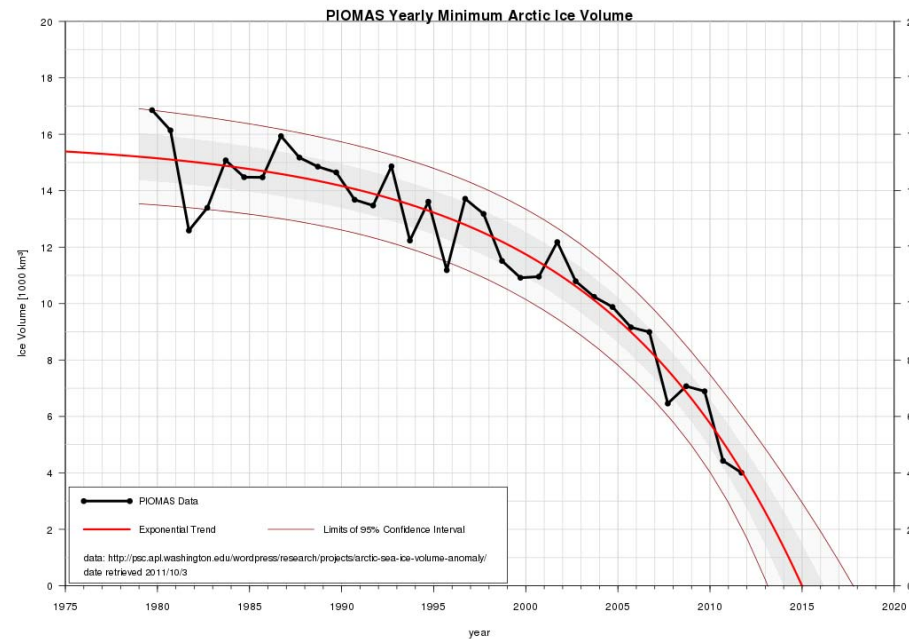


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Arctic Summer Sea Ice

David Spratt, Co-author of “*Climate Code Red: the case for emergency action*” and Damien Lawson:

Those dominoes include the **Greenland ice sheet.**

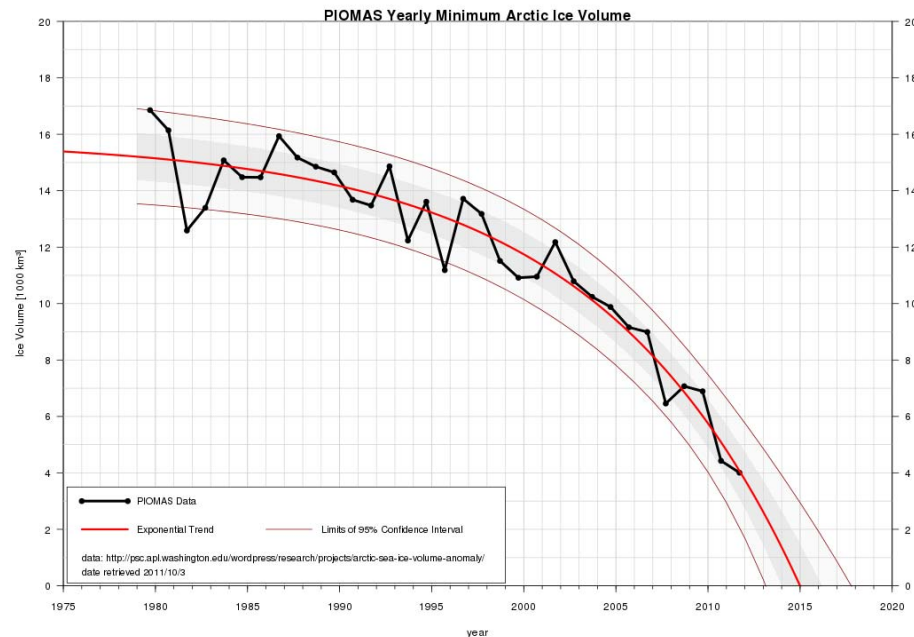


Spratt, D and Lawson, D, “Bubbling our way to the Apocalypse”, Rolling Stone, November 2008, pp. 53-55

Arctic Summer Sea Ice

Dr James Hansen:

“It is difficult to imagine how **the Greenland ice sheet** could survive if Arctic sea ice is lost entirely in the warm season.”



Quotation: Hansen, J., “*Storms of my grandchildren*”, p. 164

Chart included in Brook, B. “*Depressing climate-related trends – but who gets it?*”, 6 Nov 2011, <http://bravenewclimate.com/2011/11/06/depressing-climate-trends/>. Original contained in <http://neven1.typepad.com/blog/2011/10/piomas-september-2011-volume-record-lower-still.html> and based on Pan-Arctic Ice Ocean Modeling and Assimilation System (PIOMAS, Zhang and Rothrock, 2003) graphs from the Polar Science Center of the Applied Physics Laboratory at the University of Washington, <http://psc.apl.washington.edu/wordpress/research/projects/arctic-sea-ice-volume-anomaly>

Greenland Ice Sheet



Greenland Ice Sheet



Greenland Ice Sheet



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Image: Greenland mountains © Pierre Landry | Dreamstime.com

Greenland Ice Sheet



Paul Mahony 2012

M. Todesco, Cryospheric Processes Laboratory, City College New York City, <http://cryocity.org/>

Greenland Ice Sheet

Graphic video of Greenland torrents cascading down a moulin or crater to the base:

["Greenland Rapids" recorded in 2009 by researchers from the Cryospheric Processes Laboratory, City College, New York City](#)

As of 2009, the Greenland ice sheet was losing over 250 cubic kilometres of ice per year in a dynamic wet melting process, after neither gaining nor losing mass at a substantial rate as recently as the 1990's.

This dynamic melting process is not taken into account in the IPCC's projections of sea level rise. (Refer to subsequent slides.)

Video: M. Todesco, Cryospheric Processes Laboratory, City College New York City, <http://cryocity.org/http://www.youtube.com/watch?v=lGxLs8YV9MM&feature=related>

Comments on loss of ice mass: Hansen, J., *"Storms of my grandchildren"*, Bloomsbury, pp. 255-256 and p. 287. (An alternative ice loss figure to the quoted figure of 250 cubic km from p. 287 had been shown on p. 255 but the correct figure has been confirmed as 250 cubic km in emails of 15th and 16th June, 2011.)

Greenland Ice Sheet

A second video of Greenland torrents cascading down a moulin or crater to the base. This is from The Telegraph, UK:

[Scientists capture dramatic footage of Arctic glaciers melting in hours](#)

Greenland Ice Sheet

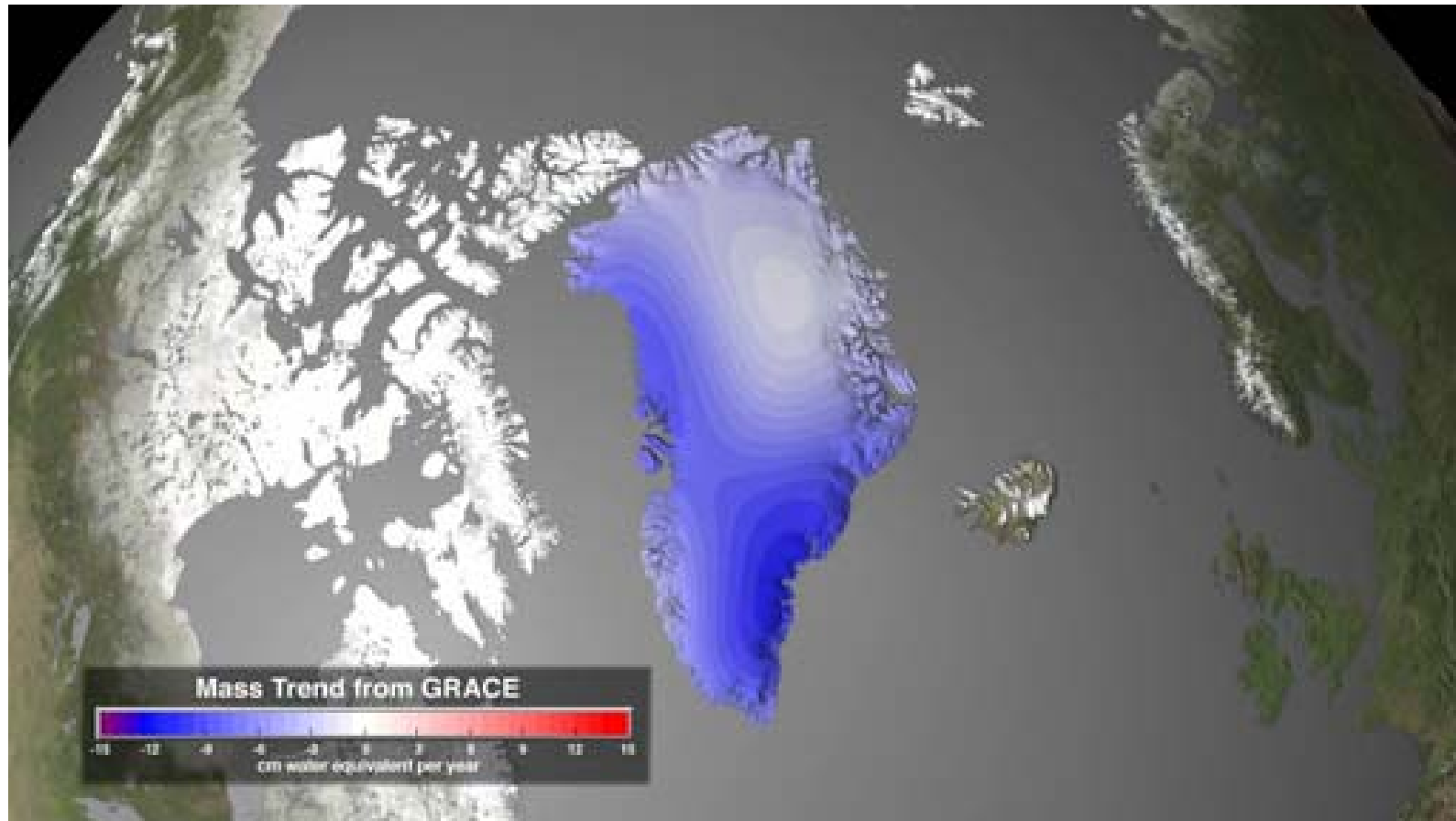


Greenland Ice Sheet



Greenland Ice Sheet

Mass change 2003-2010 (Blue indicates loss of ice mass.)



Greenland Ice Sheet



Greenland Ice Sheet

Virtually the entire ice sheet is colored in shades of blue, indicating that the ice sheet reflected as much as 20% less light this summer [2011] than it did in the early part of the last decade.



Difference from average reflectiveness (percent)



Greenland Ice Sheet

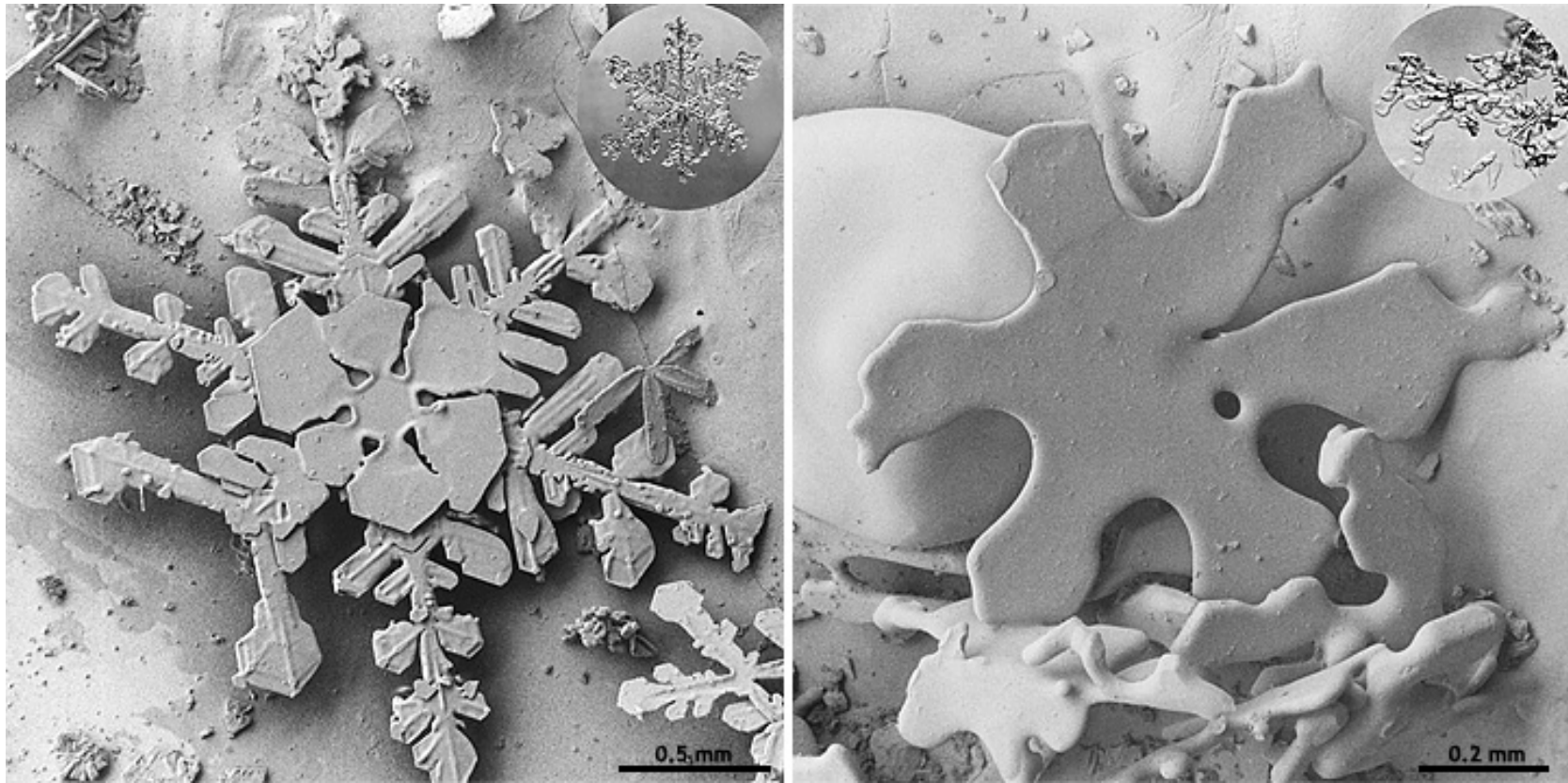


Greenland Ice Sheet

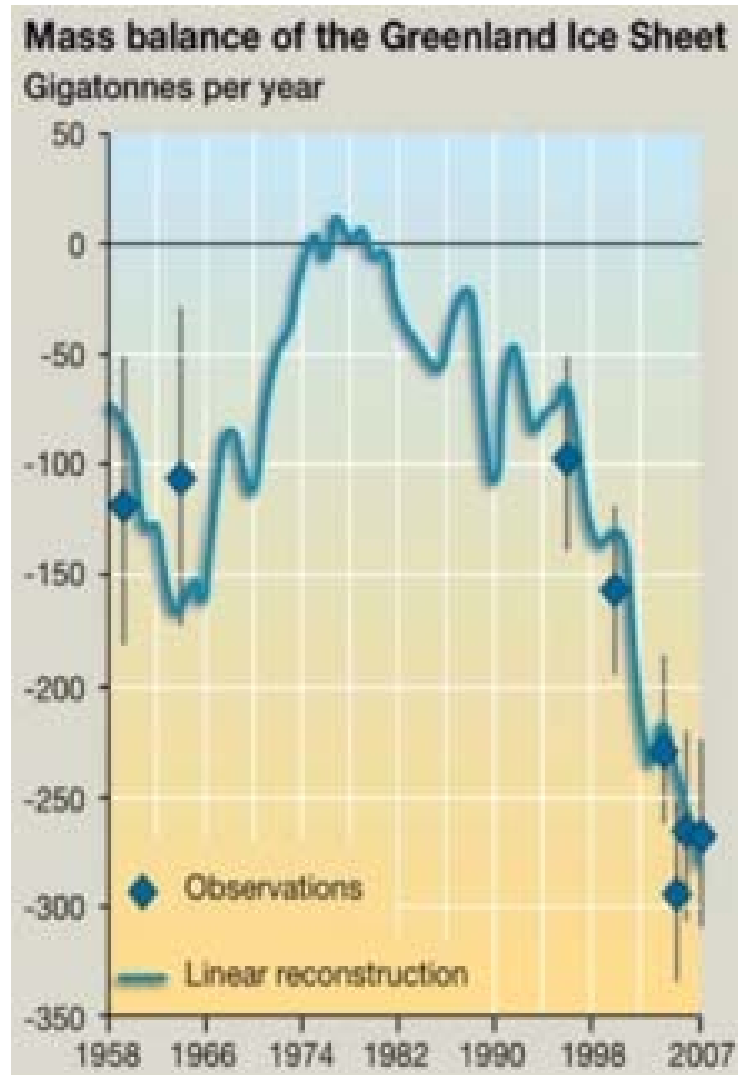


The darkening in the non-melting areas is due to changes in the shape and size of the ice crystals in the snowpack as its temperature rises.

Greenland Ice Sheet



Greenland Ice Sheet



Greenland Ice Sheet

If the annual water flows were poured over Germany . . .

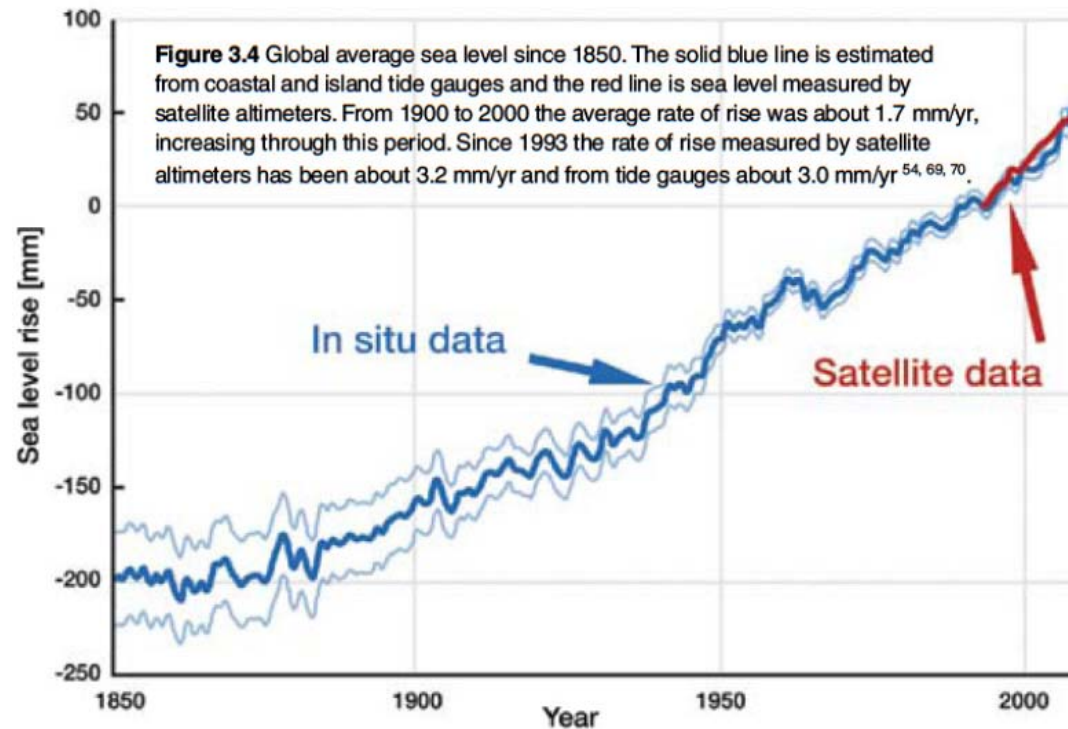


Based on ice mass loss of 250 cubic km per annum



0.71 metres

Average sea level



Causes:

- 40% from thermal expansion of oceans due to warming
- 35% from melting of continental glaciers and ice caps
- 25% from melting of Greenland and Antarctic ice sheets

Image: CSIRO, "The Science of Climate Change: Questions and Answers", August, 2010, Fig. 3.4, p. 9
<http://www.science.org.au/reports/climatechange2010.pdf>

Causes: Steffen, W, "The Critical Decade: Climate Science, risks and responses", Climate Commission, Fig. 8, p. 12 <http://climatecommission.gov.au/topics/the-critical-decade/>

Global sea level rise

Projections to 2100:

IPCC:	0.19 m – 0.59 m (but higher values cannot be excluded)
Vermeer and Rahmstorf:	nearly 2 m
Hansen:	Potentially several metres (see next slide)

Impacts:

Experienced through **“high sea-level events”** .

A combination of sea-level rise, high tide and storm surge.

Modest rises in sea-level, e.g. **50 cm**, can lead to lead to **very high multiplying factors – sometimes 100 times or more** – in the frequency of occurrences of high sea-level events

Steffen, W., *“The Critical Decade: Climate Science, risks and responses”*, Climate Commission, Fig. 8, p. 12
<http://climatecommission.gov.au/topics/the-critical-decade/>

Hansen, J., *“Storms of my grandchildren”*, pp. 255-256 and p. 287. (An alternative ice loss figure to the quoted figure of 250 cubic km from p. 287 had been shown on p. 255 but the correct figure has been confirmed as 250 cubic km in emails of 15/6/11 and 16/6/11.)

Global sea level rise

What about IPCC's projection of 0.19 metres – 0.59 metres?

Only allows for certain short feedback mechanisms, e.g. changes in:

- water vapour
- clouds
- sea ice

Does not allow for slow feedbacks, e.g.:

- ice sheet dynamics;
- changes in vegetation cover;
- permafrost melting; and
- carbon-cycle feedbacks.

Global sea level rise

What about IPCC's projection of 0.19 metres – 0.59 metres?

James Hansen:

- Current sea level increase around 3 centimetres per decade.
- If ice sheet disintegration continues to double every decade, we will be faced with sea level rise of **several meters this century**.
- IPCC treats sea level change basically as a linear process. It is more realistic that ice sheet disintegration will be **non-linear**, which is typical of a system that can collapse.

Global sea level rise

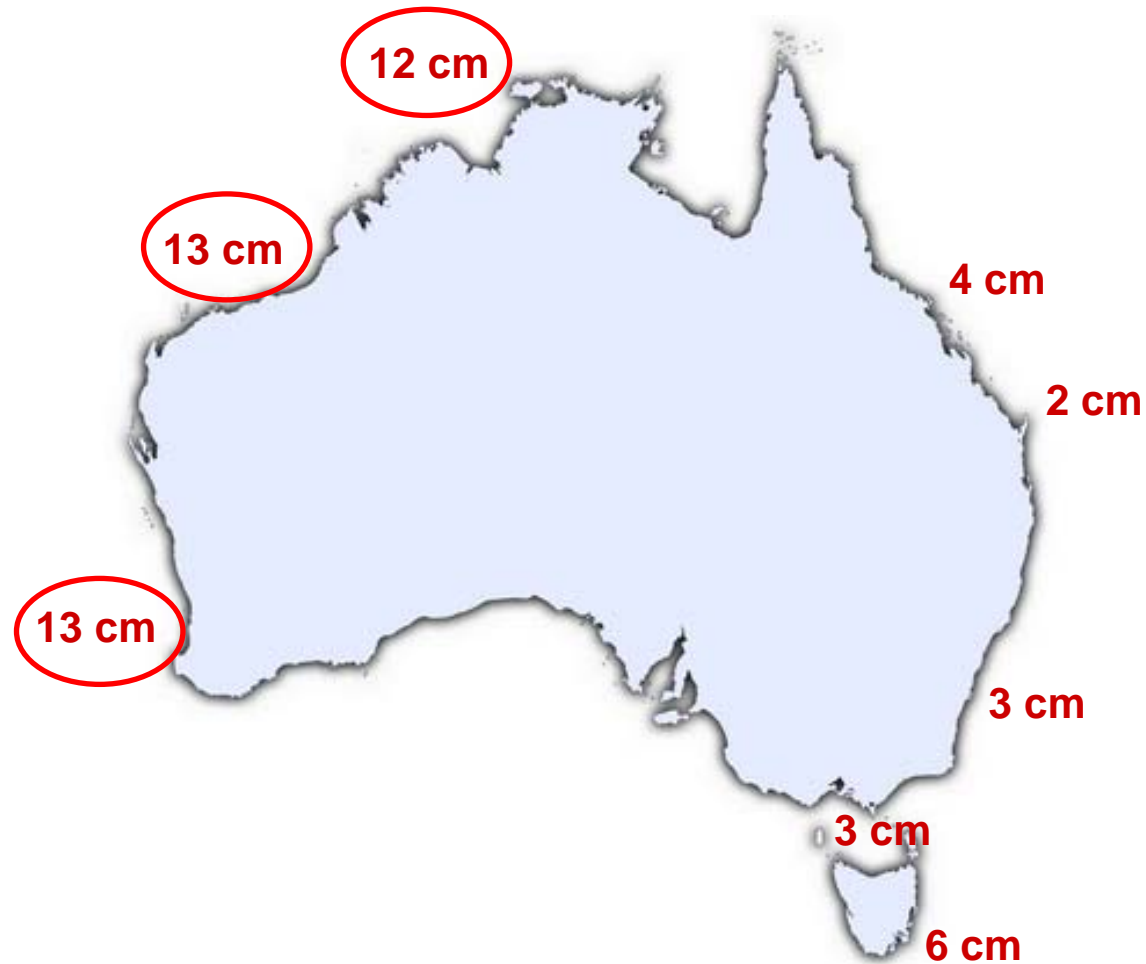
Tim Flannery, Australian Climate Change Commissioner and former Australian of the Year:

IPCC is “painfully conservative”

because it

“works by consensus and includes government representatives from the United States, China and Saudi Arabia, all of whom must assent to every word of every finding”.

Approx. Sea Level Rise 1992 – 2008 (approx.)



Derived from NTC 2008, cited in Steffen, W, "The Critical Decade: Climate Science, risks and responses", Climate Commission, Fig. 8, p. 12 <http://climatecommission.gov.au/topics/the-critical-decade/>
Map image: Australia light blue map © Skvooor | Dreamstime.com

Permafrost



Permafrost



Permafrost

- **Dramatic and unprecedented** plumes of methane . . . have been seen bubbling to the surface of the Arctic Ocean by scientists undertaking an extensive survey of the region.
- The scale and volume of the methane release has **astonished** the head of the Russian research team who has been surveying the seabed of the east Siberian Arctic Shelf off northern Russia for nearly 20 years.
- Igor Semiletov of the International Arctic Research Centre at the University of Alaska Fairbanks . . . said that he **has never before witnessed the scale and force of the methane being released from beneath the Arctic seabed.**

Connor, S, "Vast methane 'plumes' seen in Arctic ocean as sea ice retreats", The Independent, 13 December, 2011, <http://www.independent.co.uk/news/science/vast-methane-plumes-seen-in-arctic-ocean-as-sea-ice-retreats-6276278.html> (Accessed 4 February 2012)

Permafrost

Dramatic and unprecedented

astonished

has never before witnessed the scale and force of the methane being released from beneath the Arctic seabed.

Connor, S, "Vast methane 'plumes' seen in Arctic ocean as sea ice retreats", The Independent, 13 December, 2011, <http://www.independent.co.uk/news/science/vast-methane-plumes-seen-in-arctic-ocean-as-sea-ice-retreats-6276278.html> (Accessed 4 February 2012)

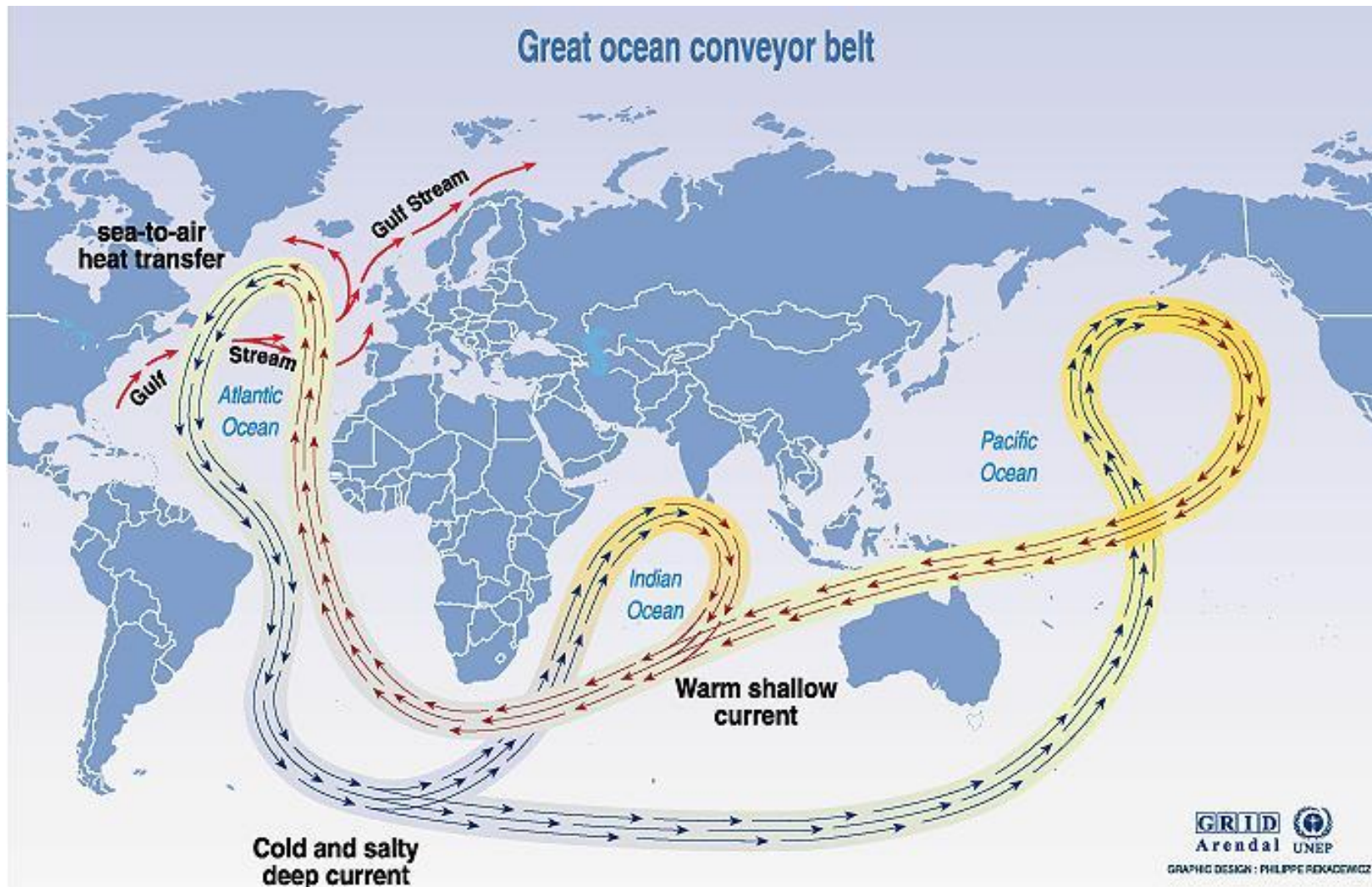
Permafrost

A dramatic example of methane coming to the surface from melting permafrost:

[Hunting for methane with Katey Walter Anthony, University of Alaska, Fairbanks](#)

<http://www.youtube.com/watch?v=YegdEOSQotE&NR=1&feature=endscreen>

Methane Clathrates/Hydrates



Source: Broecker, 1991, in Climate change 1995, impacts, adaptations and mitigation of climate change: scientific-technical analyses, contribution of working group 2 to the second assessment report of the intergovernmental panel on climate change, UNEP and WMO, Cambridge press university, 1996.

What are insurers saying?

Climate change has nothing to do with the recent string of natural disasters that have cost insurance companies more than \$3.6 billion.

"The catastrophe events that have taken place this year, the floods in Queensland, the fires, have nothing to do with climate change. They are part of Australia's really long history of floods, fires, droughts."

QBE Chair, Belinda Hutchinson, 19 April, 2011

On the other hand:

“It’s not the right question to ask if this storm or that storm is due to global warming, or is it natural variability.

Nowadays, there’s always an element of both.... there is a systematic influence on all of these weather events nowadays because of the fact that **there is [more] water vapor lurking around in the atmosphere** than there used to be say 30 years ago.”

Dr Kevin Trenberth, US National Center Atmospheric Research

Dr Kevin Trenberth, US Nat. Center Atmospheric Research, cited in Spratt, D, “Bridging the gap between science and politics”, Climate Action Summit, 9 April, 2011

What are scientists saying?

Western European heatwave of 2003, caused 35,000 premature deaths and €13.1 billion in losses.

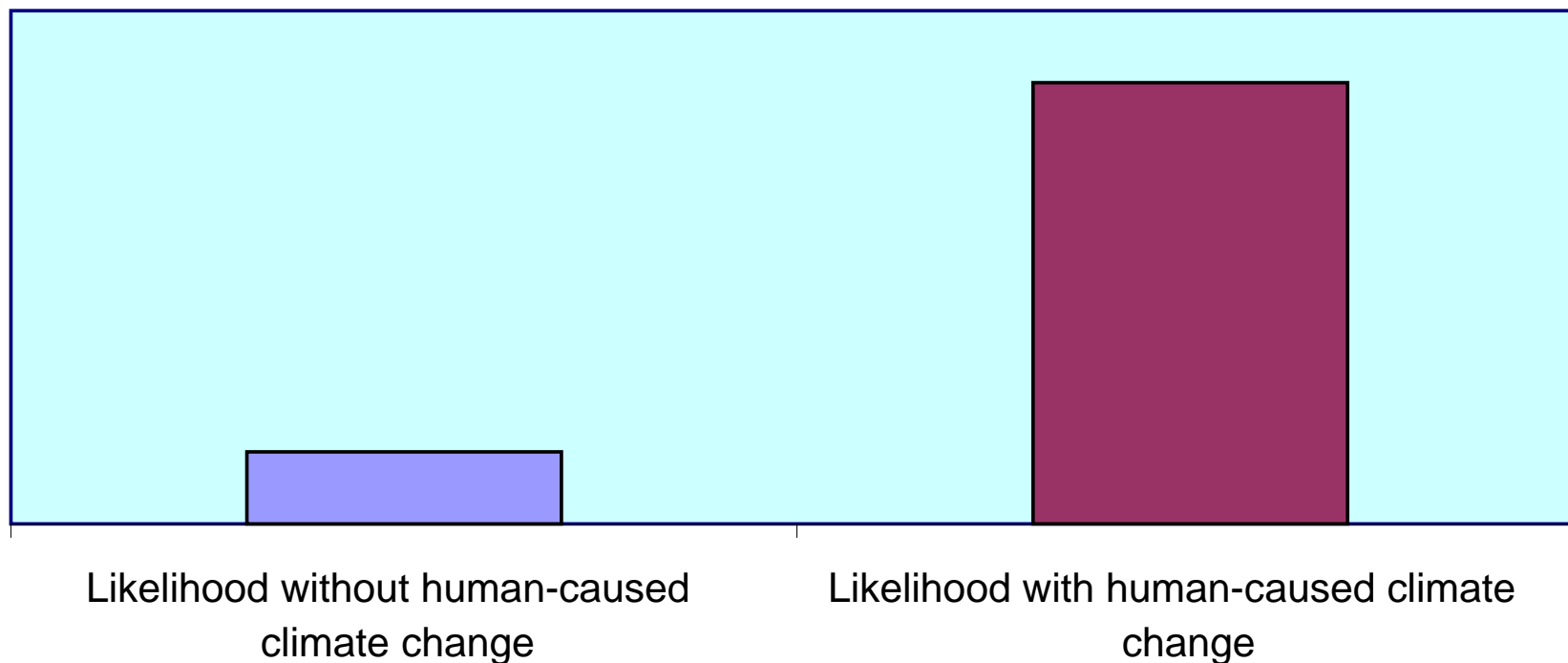
This was a large, extreme weather event that could have happened without human-caused climate change.

Human-caused climate change made the heatwave about six times more likely than it would otherwise have been.

Dr Myles Allen and colleagues, Oxford University

Dr Myles Allen and colleagues, Oxford University, cited in “Cuts in emissions are at a premium” by Liam Phelan lecturer in environmental studies at the University of Newcastle.

Relative likelihood of Western European heatwave of 2003 (35,000 premature deaths and €13.1 billion in losses)



Dr Myles Allen and colleagues, Oxford University, cited in “Cuts in emissions are at a premium” by Liam Phelan lecturer in environmental studies at the University of Newcastle, <http://www.smh.com.au/opinion/society-and-culture/cuts-in-emissions-are-at-a-premium-20110124-1a2ul.html>

Victorian floods (Australia), 12-14 Jan 2011

“Yarra bursts banks as floods hit Melbourne”, The Age, 14 Jan 2011

The total precipitable water in the atmosphere in Melbourne on 13 Jan was 65.0 mm, well in excess of the previous record of 54.5 mm

20% above previous record

What is Munich Re saying?

We assume that the annual loss amount attributable to climate change is already in the **LOW DOUBLE-DIGIT BILLION EURO RANGE**. And the figure is bound to rise dramatically in future.

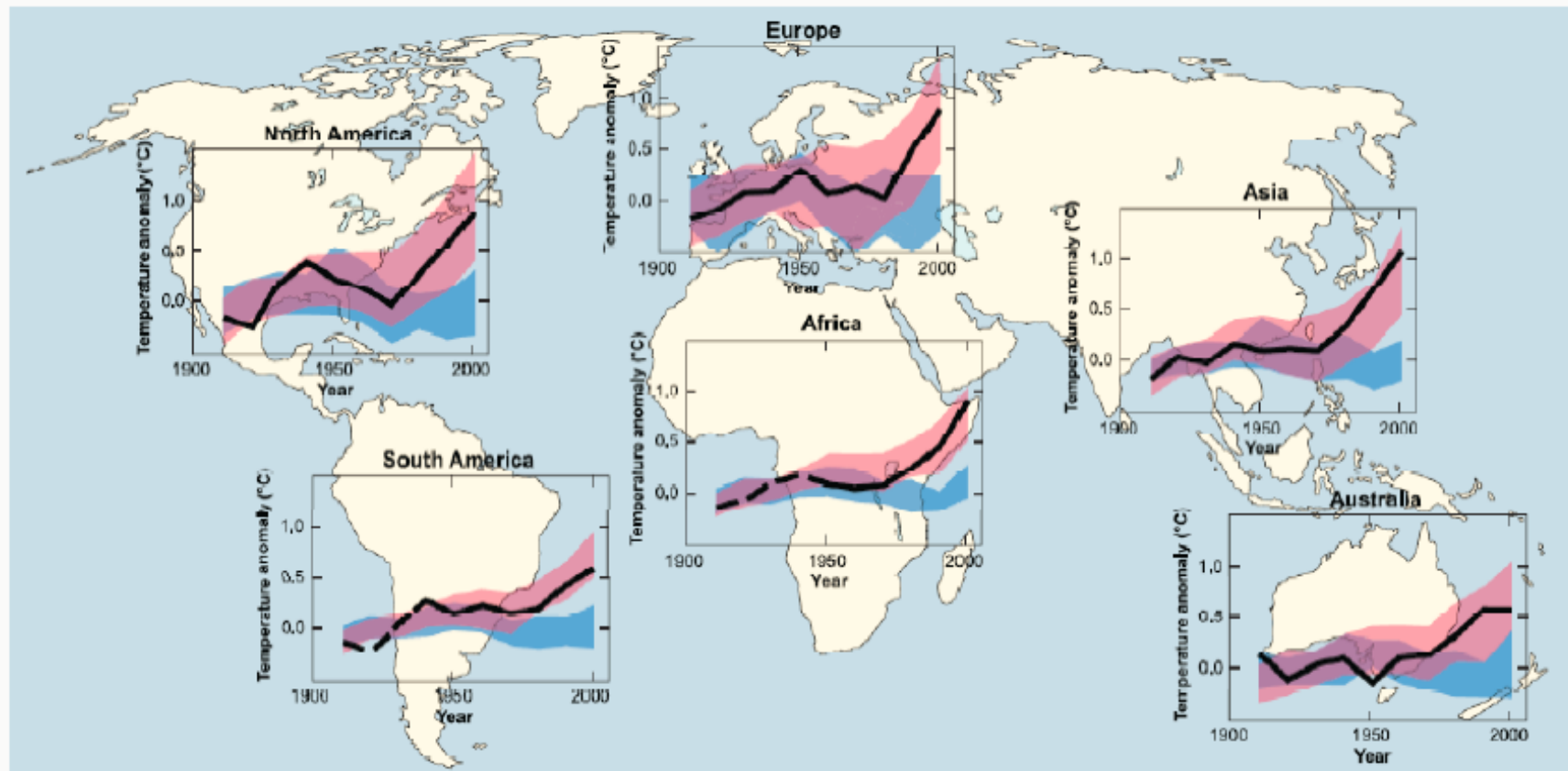
Climate change is a global problem and a challenge for humankind. If the players do nothing but pursue their national interests . . .

. . . WE ARE HEADED FOR A CLIMATE CATASTROPHE.



Nikolaus von Bomhard, CEO of Munich Re, 21 Dec, 2009,
http://www.munichre.com/en/group/focus/climate_change/strategy_and_policy/after_copenhagen/default.aspx

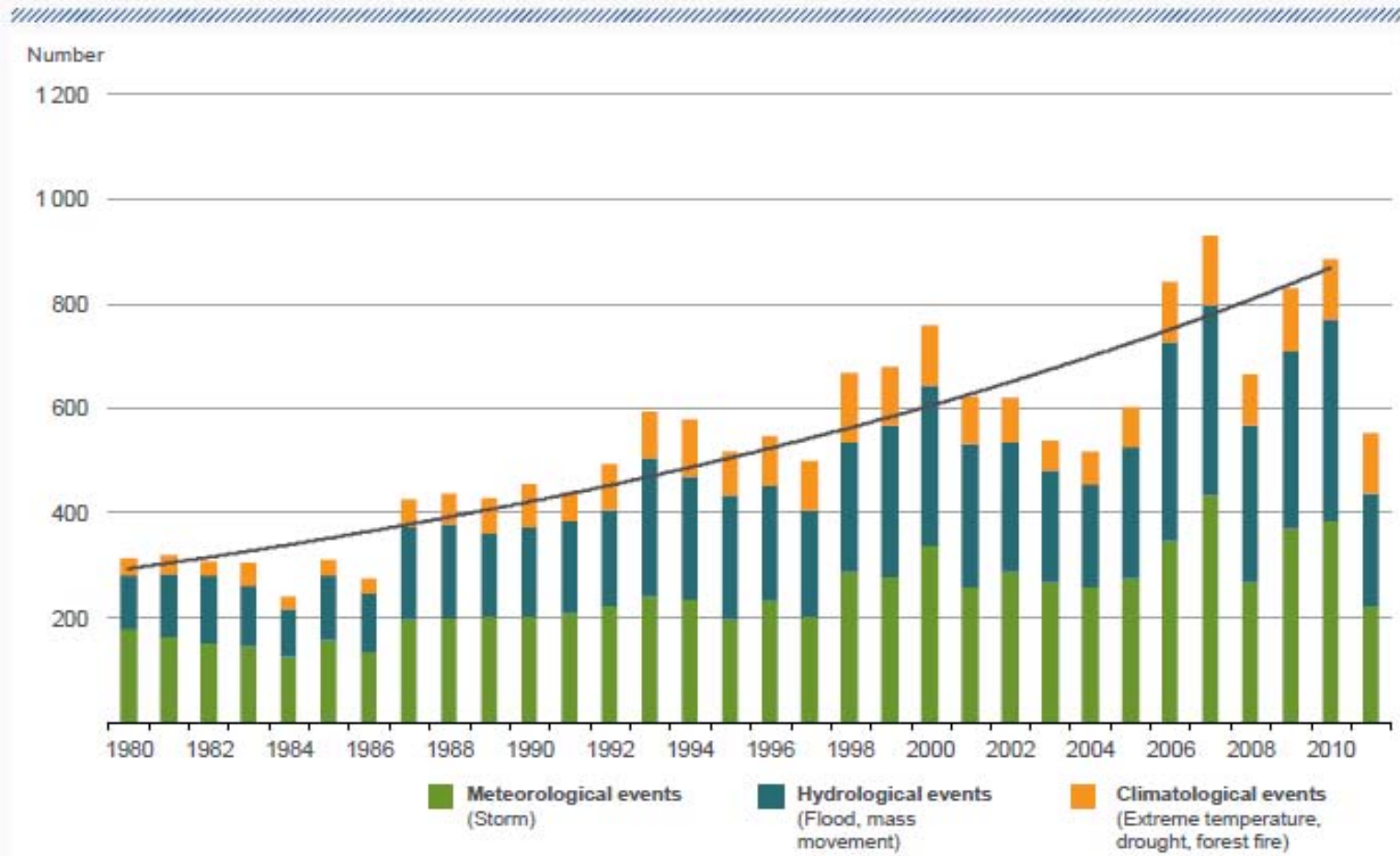
What is Munich Re saying?



- Ten-year mean temperatures 1900–2000
- Simulation range for climate models that take only natural factors into account
- Simulation range for climate models that take anthropogenic factors into account as well

Extreme weather events

Number of weather catastrophes worldwide 1980–2011 (2011 Jan. to Sept.)

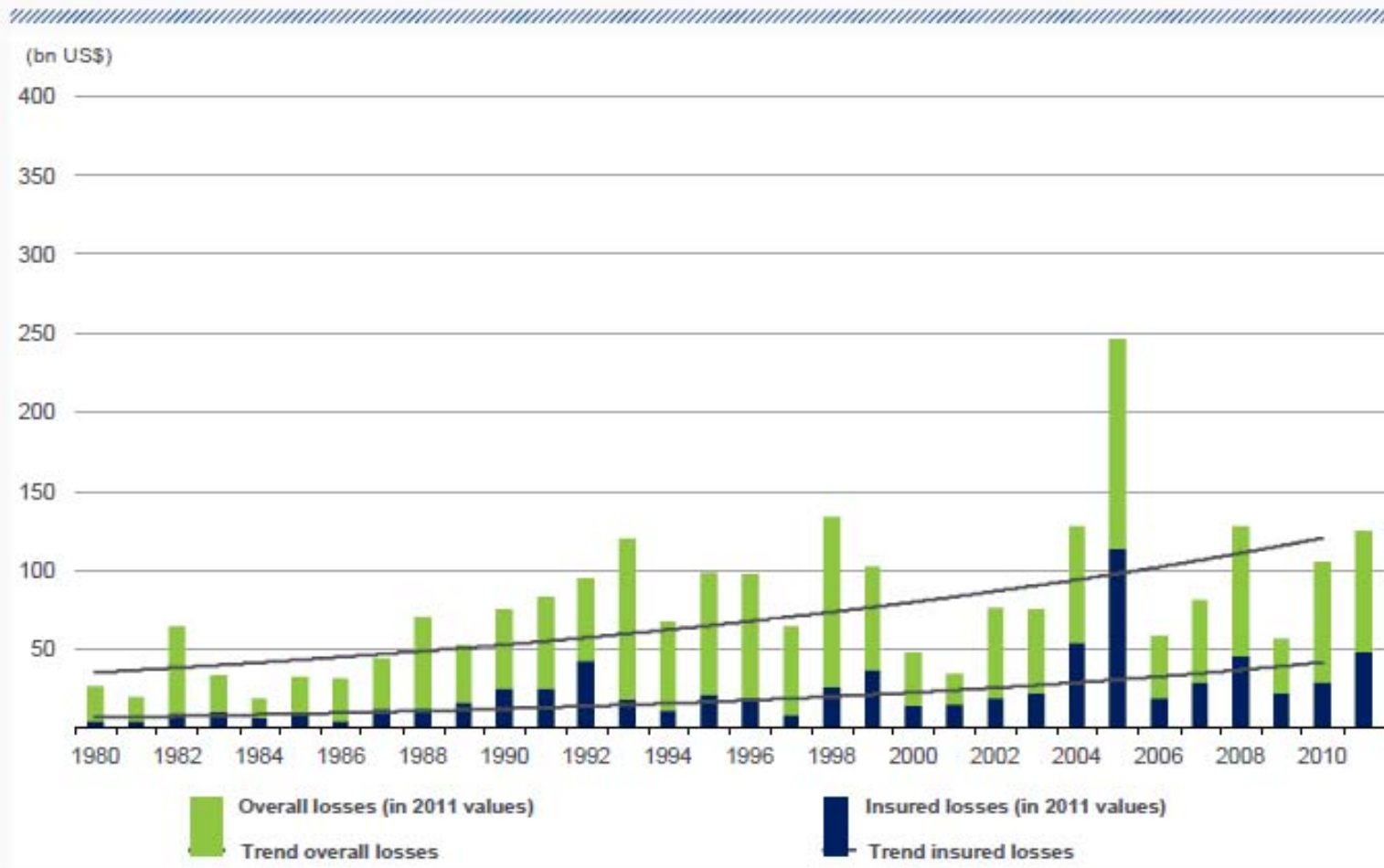


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12

Extreme weather events

Losses from weather catastrophes worldwide 1980–2011 (2011 Jan. to Sept.)

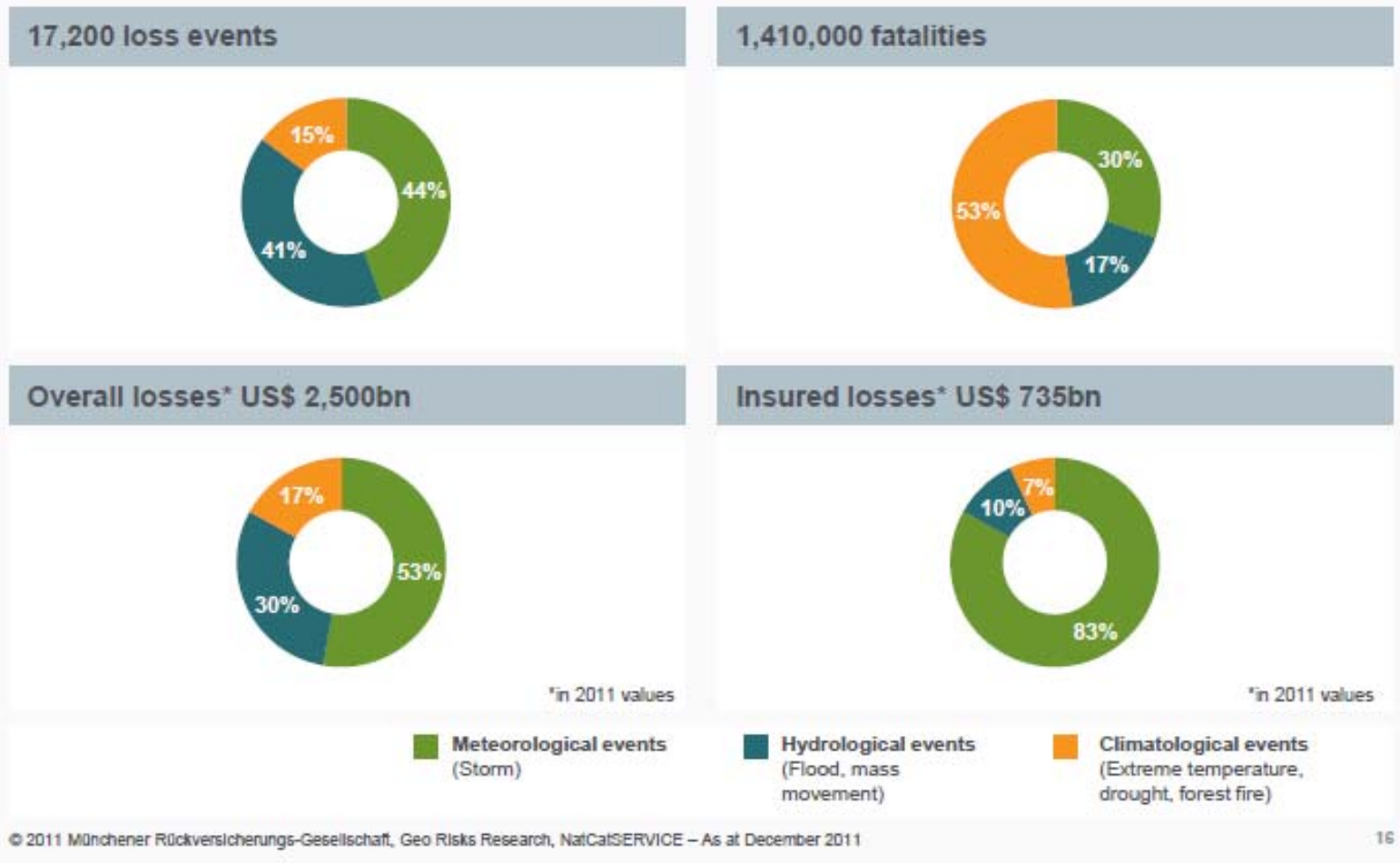


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Extreme weather events

Percentage distribution of weather catastrophes worldwide 1980–2011 (2011 Jan. to Sept.)



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What about others?

“Not only is it real, it's here, and its effects are giving rise to a frighteningly new global phenomenon: the man-made natural disaster.”

What about others?

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Barack Obama, 3 April 2006



Barack Obama, 3 April 2006, cited in Spratt, D, “Bridging the gap between science and politics”, Climate Action Summit, 9 April, 2011, <http://www.climateactioncentre.org/sites/default/files/1104%20-recent-science.pdf>
Image: President Barack Obama © Kurniawan1972 | Dreamstime.com

. . . and others?

“This generation has altered the composition of the atmosphere on a global scale through a steady increase in carbon dioxide from the burning of fossil fuels.”

. . . and others?

“This generation has altered the composition of the atmosphere on a global scale through a steady increase in carbon dioxide from the burning of fossil fuels.”

President Lyndon Johnson, 1965

Additional Points

Ice-melt water cools ocean basins. Continents continue to heat due to increasing greenhouse gases and feedbacks. The resultant ocean-land temperature polarity generates storms.

A 10% increase in wind speed = 33% increase in destructive capacity.

50 cm rise in sea-level = **very high multiplying factors** in the frequency of high sea-level events – **sometimes 100 times or more**

4 degree temperature increase = a planet that cannot support more than 1 billion people (currently 7 billion)

Stabilization [of CO₂ concentrations] much below 650 ppmv CO₂-e is improbable.

That equates to + 2–3 degrees C; 13 - 37 metres sea level rise; permanent El-Nino

Glikson, A, "As emissions rise, we may be heading for an ice-free planet", The Conversation, 18 Jan 2012

Hansen, J, "Storms of my grandchildren"

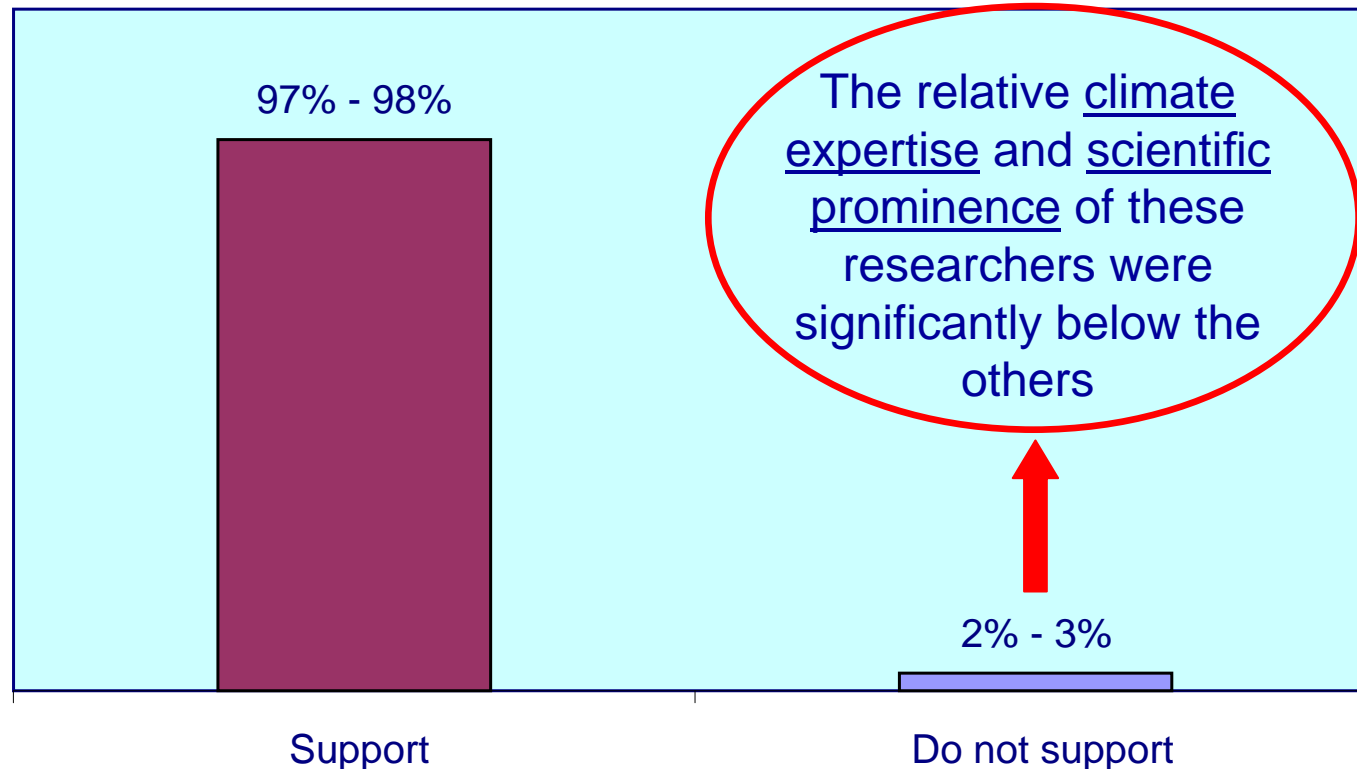
Schelnhuber, H.J., cited in Spratt, D

Tyndall Centre, cited in Glikson, A "Dangerous Climate Change"

Denialism

Support for IPCC's position on human-caused climate change among climate researchers most actively publishing in the field

Based on a dataset of 1,372 climate researchers and their publication and citation data. Data set compiled from lists that included Ian Plimer, Bob Carter and Fred Singer.



William R. L. Anderegg, James W. Prall, Jacob Harold, and Stephen H. Schneider, "Expert Credibility in Climate Change", *Proceedings of the National Academy of Sciences*, 21 June, 2010, www.pnas.org/cgi/doi/10.1073/pnas.1003187107 and <http://www.pnas.org/content/early/2010/06/04/1003187107.full.pdf+html>

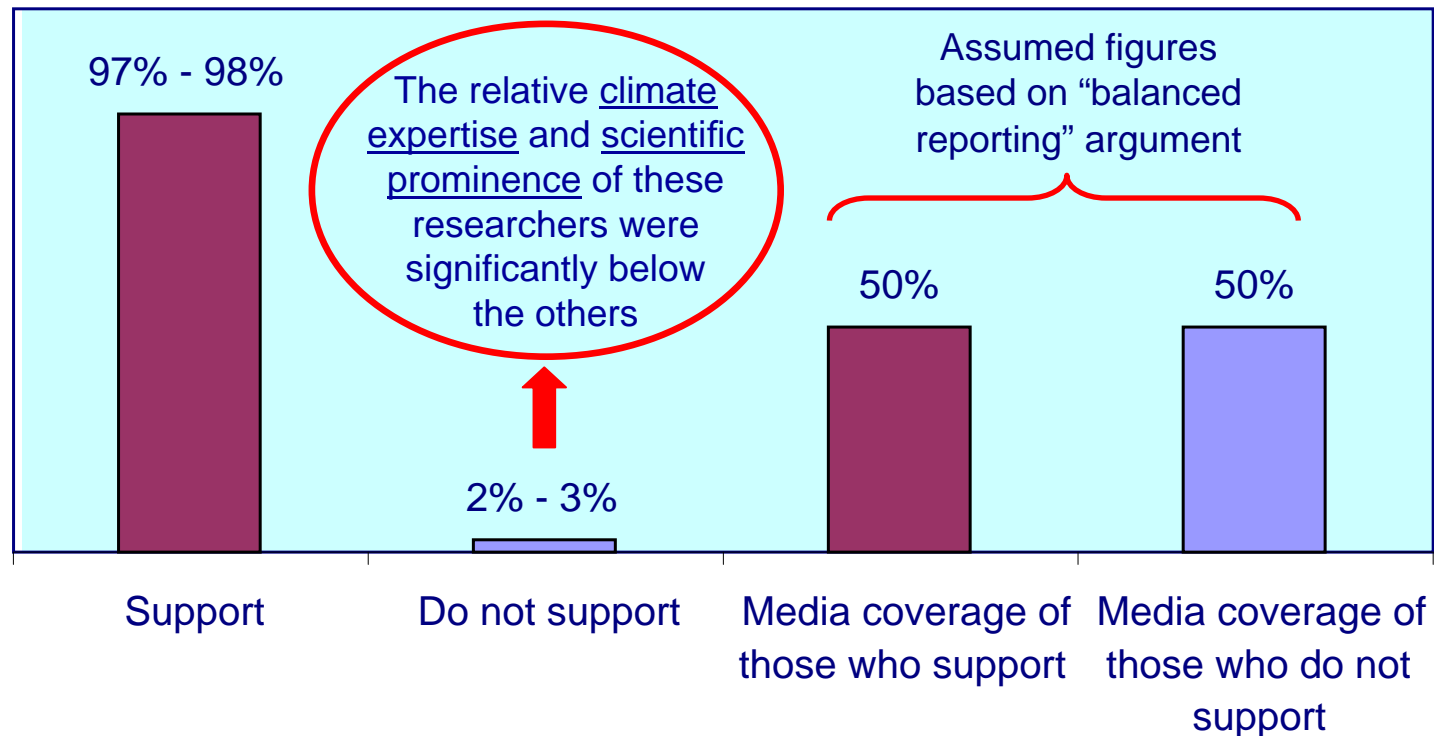
Denialism

Support for IPCC's position on human-caused climate change among climate researchers most actively publishing in the field

versus

Relevant media coverage

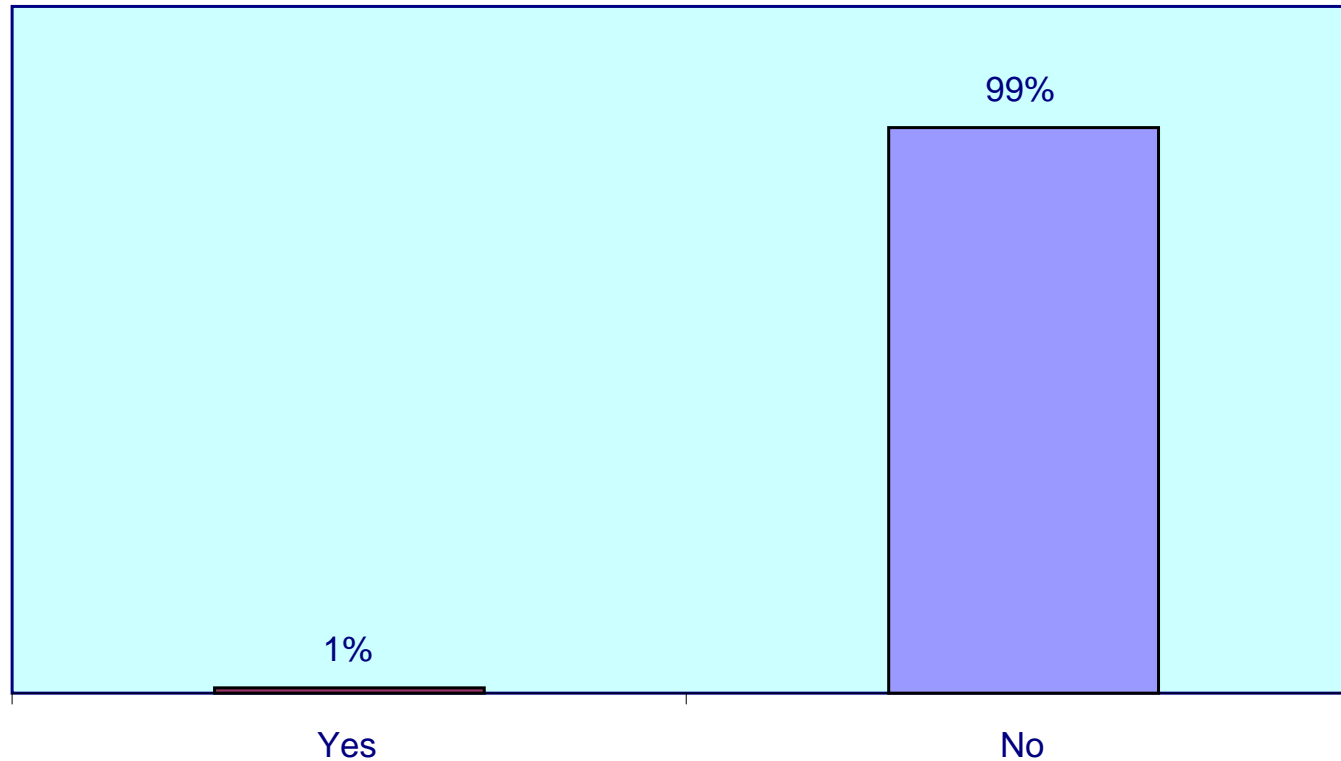
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Denialism

Percentage of Americans who consider climate change to be their country's most urgent problem



Denialism

S. Fred Singer: prominent denier and Heartland Institute “expert”

In challenging EPA (USA) re second-hand tobacco (1993):

“If we do not carefully delineate the government’s role in regulating dangers, there is essentially no limit to how much government can ultimately control our lives.”

In challenging the science of the ozone hole involving regulation of CFC emissions (1989):

“And then there are those with hidden agendas of their own, not just to save the environment, but to change our economic system. Some of these coercive utopians are socialists, some are technology-hating luddites, and most have a great desire to regulate on as large a scale as possible.”

Prof. Naomi Oreskes, co-author of “Merchants of Doubt” on The Science Show, ABC Radio National, 8 January, 2011
<http://www.abc.net.au/radionational/programs/scienceshow/naomi-oreskes---merchants-of-doubt/3012690>

Fred Singer’s Heartland Institute connection:
http://www.sourcewatch.org/index.php?title=Heartland_Institute/Global_warming_experts

Denialism

S. Fred Singer: prominent denier and Heartland Institute “expert”

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What if we had adopted Fred Singer’s position on CFC’s?

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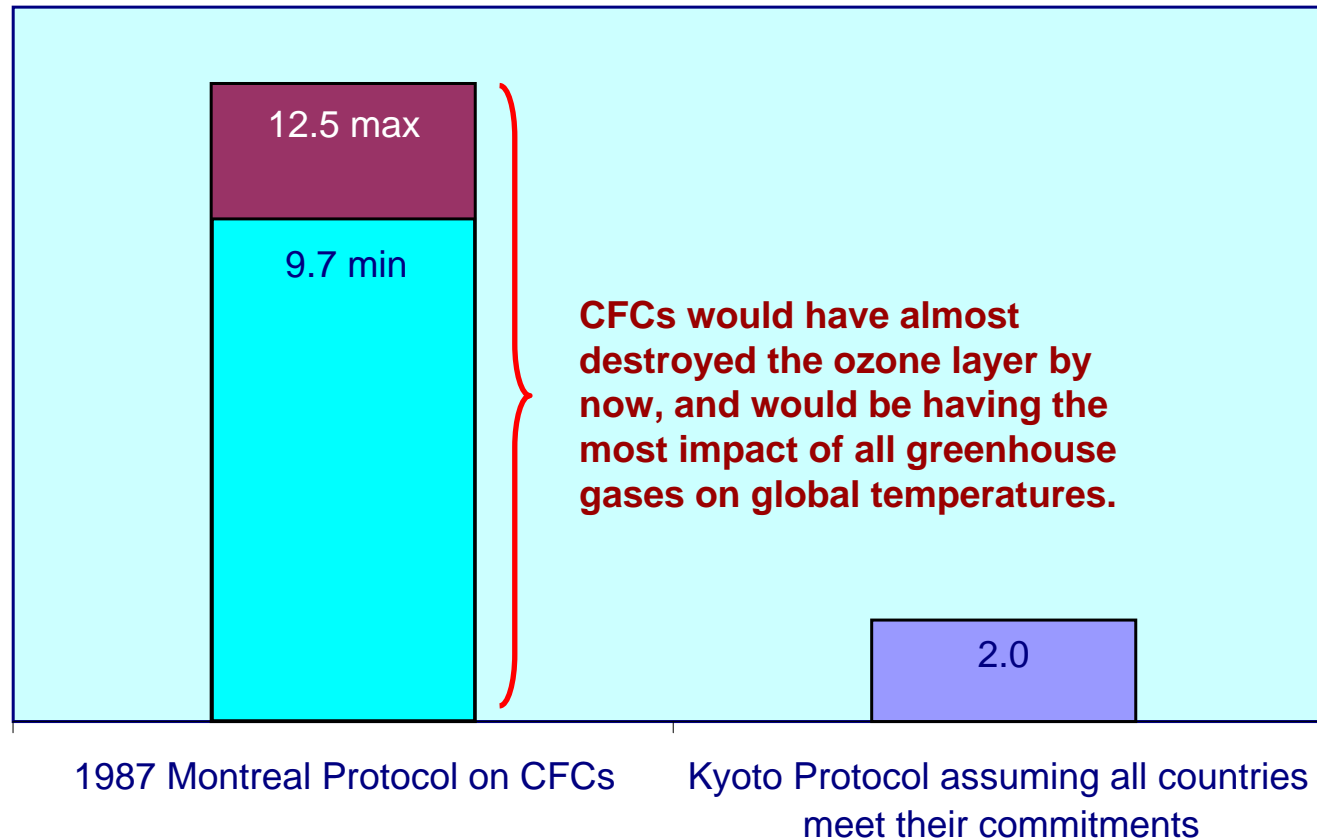
Prof. Naomi Oreskes, co-author of “Merchants of Doubt” on The Science Show, ABC Radio National, 8 January, 2011
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Denialism

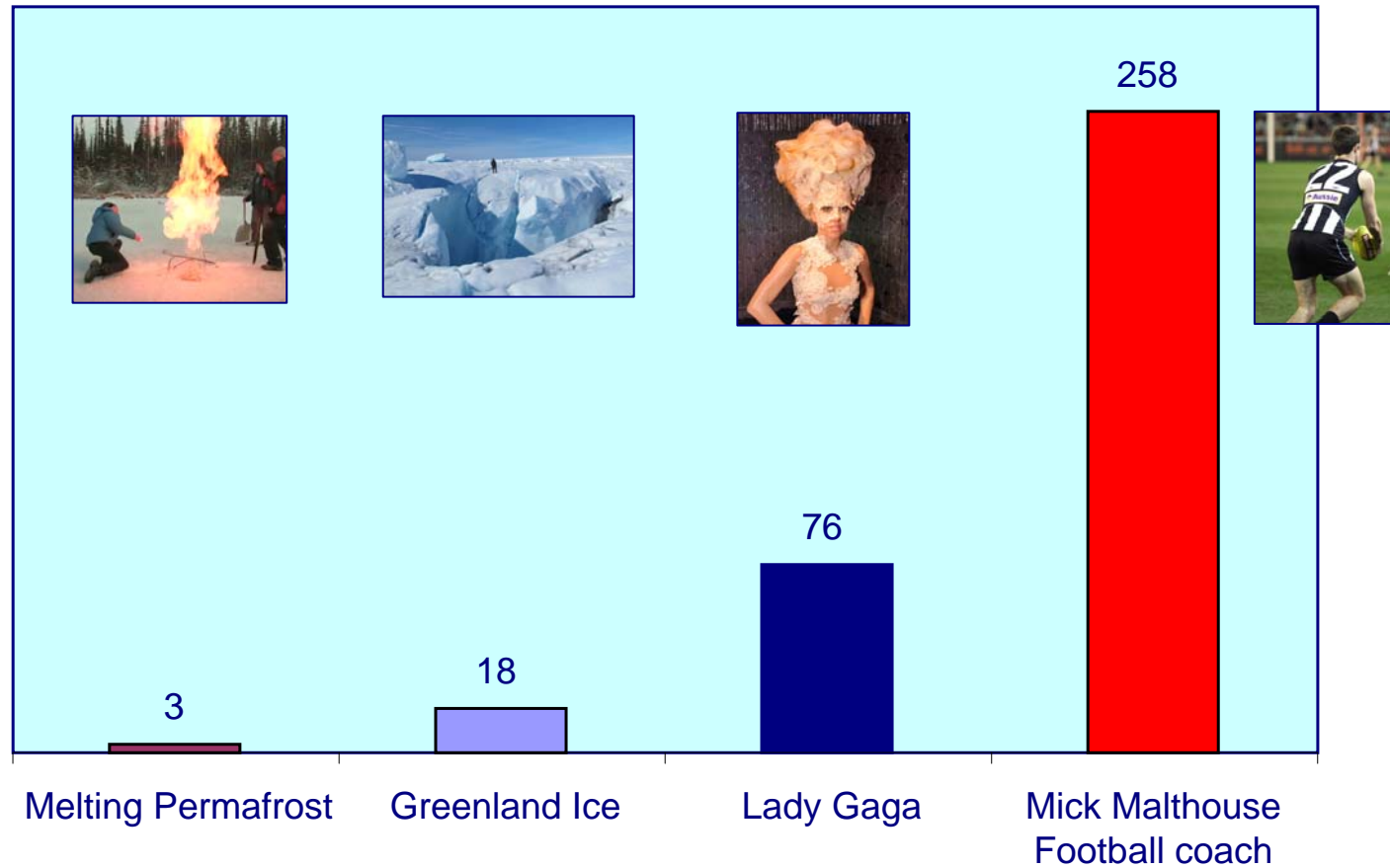
What if we had adopted Fred Singer's position on CFC's?

Annual CO2-equivalent emissions prevented by 2012 (billion tonnes)



Media

No. of articles in The Age Newspaper 1 Dec '10 to 30 Nov '11

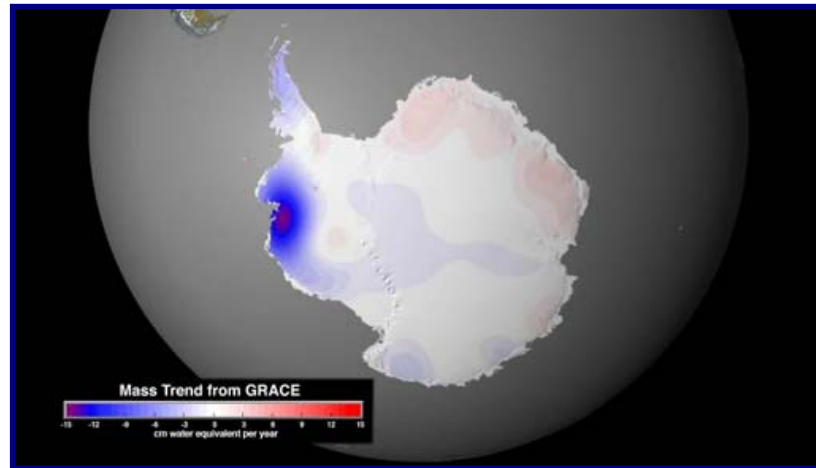


Media

What about other news?

An example

Nature Geoscience reports that West Antarctica's Pine Island Glacier is now melting 50 percent faster than in 1994



Coverage in Australia's newspapers:



Jo Chandler, "When science is undone by fiction", The Age, 29 June 2011

Image: NASA "GRACE Mission Measures Global Ice Mass Changes",
http://www.nasa.gov/multimedia/videogallery/index.html?media_id=131826971

Denialism

Prof. Ian Plimer: author “Heaven and Earth”

Comments on the book from Prof. Ian Enting, University of Melbourne



- numerous internal inconsistencies
 - key data are unattributed
 - the content of references is often misquoted
 - misrepresents the content of IPCC reports
-
- misrepresents the operation of the IPCC and the authorship of IPCC reports
 - misrepresents data records
 - Misrepresents data from cited sources

Denialism

Prof. Ian Plimer: author “*Heaven and Earth*”

Comments on the book from Prof. Kurt Lambeck, President of the Australian Academy of Sciences



- “Heaven and Earth” is not a work of science. It is an opinion piece of an author who happens to be a scientist.
- . . . the concept that hundreds of researchers are conspiring to defraud the world’s policy-makers requires a level of conspiracy theory that not even Dan Brown has reached.

Denialism

Prof. Ian Plimer: author “*Heaven and Earth*”

Comments on the book from Michael Ashley, Professor of Astrophysics, University of New South Wales



- If Plimer is right, then **it would rank as one of the greatest discoveries of the century** and would almost certainly earn him a **Nobel Prize**.

This is the scale of Plimer’s claim.

- The arguments that Plimer advances in the 503 pages and 2,311 footnotes . . . are nonsense. The book is largely **a collection of contrarian ideas and conspiracy theories that are rife in the blogosphere**. The writing is rambling and repetitive; the arguments **flawed and illogical**.

Essential Measures

James Hansen – Essential Measures

1. *End coal-fired power.*

2. *Massive reforestation.*

Required to
reduce CO2
concentrations to
< 350 ppm
(currently 394
ppm)

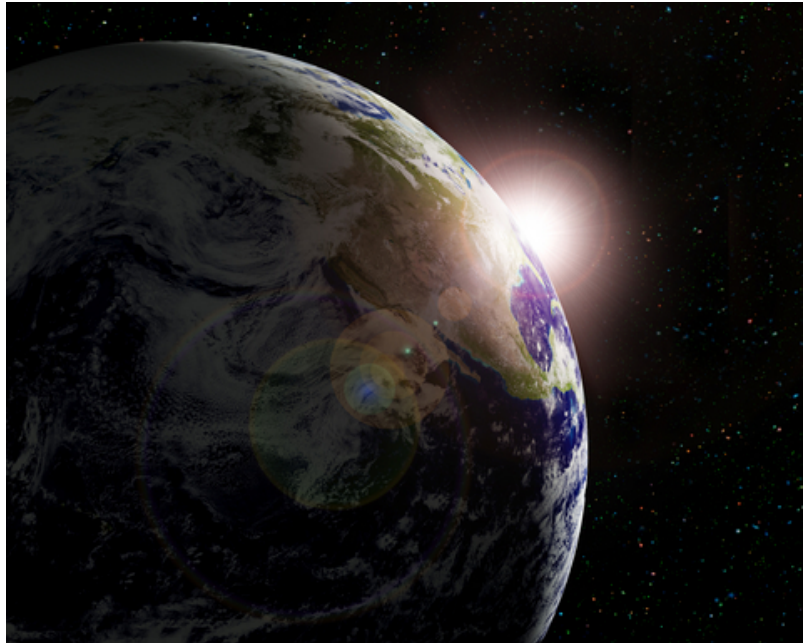


3. *Significantly reduce non-CO2 forcings, e.g. methane, nitrous oxide, tropospheric ozone and black carbon.*

Source: Hansen, J; Sato, M; Kharecha, P; Beerling, D; Berner, R; Masson-Delmotte, V; Pagani, M; Raymo, M; Royer, D.L.; and Zachos, J.C. "Target Atmospheric CO2: Where Should Humanity Aim?", 2008. http://www.columbia.edu/~jeh1/2008/TargetCO2_20080407.pdf
Images: Rainforest © Pavol Kmeto | Dreamstime.com; Coal fired future © ascione | iStockphoto

Some thoughts to conclude

Dr Andrew Glikson, earth and paleoclimate scientist at Australian National University



- *Contrarian claims by sceptics, misrepresenting direct observations in nature and ignoring the laws of physics, have been adopted by neo-conservative political parties.*
- *A corporate media maintains a 'balance' between facts and fiction.*
- *The best that governments seem to do is devise cosmetic solutions, or promise further discussions, while time is running out.*
- ***GOOD PLANETS ARE HARD TO COME BY.***

Source: Glikson, A., "As emissions rise, we may be heading for an ice-free planet", The Conversation, 18 January, 2012, <http://theconversation.edu.au/as-emissions-rise-we-may-be-heading-for-an-ice-free-planet-4893> (Accessed 4 February 2012)

Image: © Pmakin | Dreamstime.com