Risk Management, Insurance and the Climate Crisis

Paul Mahony, 1 December 2013

Images: M. Todesco, Cryospheric Processes Laboratory, City College New York City, http://cryocity.org/ and Image: Jhanz (Dreamstime.com

Introduction

This is an extended version of a presentation I gave as guest speaker to a group of Monash University students in the subject "Principles of Risk Transfer BFF5031" (Dept of Banking and Finance) on 31st August 2013.

I have previously commented on likelihood and consequences in relation to climate change in various articles and presentations.

I have used many of the slides in this presentation elsewhere, and have included them again for completeness. The material will soon be used for a more extensive discussion paper.

An edited version is used for presentations due to time constraints.

For more information, please see terrastendo.net.

Paul Mahony 2013

Version 2, 3rd December, 2013: Inclusion of banner on Greenland moulin slide (# 54)
Version 3, 5th December, 2013: Inclusion of slide on valuing our natural capital (# 192)
Version 4, 11th February, 2013: Additional slide on hail (#129)

Some thoughts on climate-related risk management

Paul Mahony 2013

Some thoughts on climate-related risk management

> ***"Perhaps the greatest flaw in the climate debate has been our inability, or refusal, to address risk and uncertainty realistically."***

Some thoughts on climate-related risk management

"Perhaps the greatest flaw in the climate debate has been our inability, or refusal, to address risk and uncertainty realistically."

"Scientists are giving increasingly urgent warnings on the mounting evidence of human-induced warming and the need for rapid carbon emission reductions."

Some thoughts on climate-related risk management

"Perhaps the greatest flaw in the climate debate has been our inability, or refusal, to address risk and uncertainty realistically."

"Scientists are giving increasingly urgent warnings on the mounting evidence of human-induced warming and the need for rapid carbon emission reductions."

"Officialdom chooses to ignore these warnings, preferring policy based on 'political realism', shorthand for hoping the problem will go away."

Some thoughts on climate-related risk management

"Perhaps the greatest flaw in the climate debate has been our inability, or refusal, to address risk and uncertainty realistically."

"Scientists are giving increasingly urgent warnings on the mounting evidence of human-induced warming and the need for rapid carbon emission reductions."

"Officialdom chooses to ignore these warnings, preferring policy based on 'political realism', shorthand for hoping the problem will go away."

"Business, supposedly the experts on risk management, should take leadership, but have abrogated any responsibility, given that realistic action will require a fundamental redesign of the economic system, undermining established vested interests."

Some thoughts on climate-related risk management

"Perhaps the greatest flaw in the climate debate has been our inability, or refusal, to address risk and uncertainty realistically."

"Scientists are giving increasingly urgent warnings on the mounting evidence of human-induced warming and the need for rapid carbon emission reductions."

"Officialdom chooses to ignore these warnings, preferring policy based on 'political realism', shorthand for hoping the problem will go away."

"Business, supposedly the experts on risk management, should take leadership, but have abrogated any responsibility, given that realistic action will require a fundamental redesign of the economic system, undermining established vested interests."

"The result is that nobody is seriously addressing the strategic risks to which we are exposed."

Some thoughts on climate-related risk management

"Perhaps the greatest flaw in the climate debate has been our inability, or refusal, to address risk and uncertainty realistically."

"Scientists are giv… evide… reduc… …ission

Ian Dunlop, 2012
Former international oil, gas and coal industry executive.

"Offici… …chooses to ignore these warnings, preferring policy based on 'political realism', shorthand for hoping the problem will go away."

"Business, supposedly the experts on risk management, should take leadership, but have abrogated any responsibility, given that realistic action will require a fundamental redesign of the economic system, undermining established vested interests."

"The result is that nobody is seriously addressing the strategic risks to which we are exposed."

Some thoughts on climate-related risk management

"Perhaps the greatest flaw in the climate debate has been our inability, or refusal, to address risk and uncertainty realistically."

"Scientists are giv… evide… reduc… …ission

"Offici… …chooses to ignore these warnings, preferring policy based on 'political realism', shorthand for hoping the problem will…

"Busines… leade… will r… …action estab… …system, undermining

"The result is that nobody is seriously addressing the strategic risks to which we are exposed."

Ian Dunlop, 2012
Former international oil, gas and coal industry executive.

Roles included Chair of the Australian Coal Association and CEO of the Australian Institute of Company Directors.

Michael E. Porter and Forest L. Reinhardt, Harvard Business School, 2007

Michael E. Porter and Forest L. Reinhardt, *"Grist: A strategic approach to climate",* Harvard Business Review, Oct 2007

Michael E. Porter and Forest L. Reinhardt, Harvard Business School, 2007

"Companies that persist in treating climate change solely as a corporate social responsibility issue, rather than a business problem, will risk the greatest consequences."

Michael E. Porter and Forest L. Reinhardt, *"Grist: A strategic approach to climate",* Harvard Business Review, Oct 2007

Michael E. Porter and Forest L. Reinhardt, Harvard Business School, 2007

"Companies that persist in treating climate change solely as a corporate social responsibility issue, rather than a business problem, will risk the greatest consequences."

". . . The effects of climate on companies' operations are now so tangible and certain that the issue is best addressed with the tools of the strategist, not the philanthropist."

Michael E. Porter and Forest L. Reinhardt, *"Grist: A strategic approach to climate",* Harvard Business Review, Oct 2007

Some quotes

Some quotes

"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."

Some quotes

"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

President Lyndon Johnson, 1965 message to Congress, cited in The Science Show, ABC Radio National, 8 January, 2011, *"Naomi Oreskes – Merchants of Doubt".*
Seal of the President of the United States © Americanspirit | Dreamstime.com

Some quotes

"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**

President Lyndon Johnson, 1965 message to Congress, cited in The Science Show, ABC Radio National, 8 January, 2011, *"Naomi Oreskes – Merchants of Doubt".*

Some more quotes

Some more quotes

"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."

Some more quotes

"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."

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

What are we doing to the planet?

Some developments in late 2011

Some developments in late 2011

Arctic sea ice

Nov 2011: Summer sea ice second lowest on record. (2012 set a new low.)

Some developments in late 2011

Arctic sea ice

Nov 2011: Summer sea ice second lowest on record. (2012 set a new low.)

Permafrost

Dec 2011: "Astonishing" and unprecedented releases of methane.

Some developments in late 2011

Arctic sea ice

Nov 2011: Summer sea ice second lowest on record. (2012 set a new low.)

Permafrost

Dec 2011: "Astonishing" and unprecedented releases of methane.

Global greenhouse gas emissions

Nov 2011: 2010 highest percentage increase on record.

Some developments in late 2011

Arctic sea ice

Nov 2011: Summer sea ice second lowest on record. (2012 set a new low.)

Permafrost

Dec 2011: "Astonishing" and unprecedented releases of methane.

Global greenhouse gas emissions

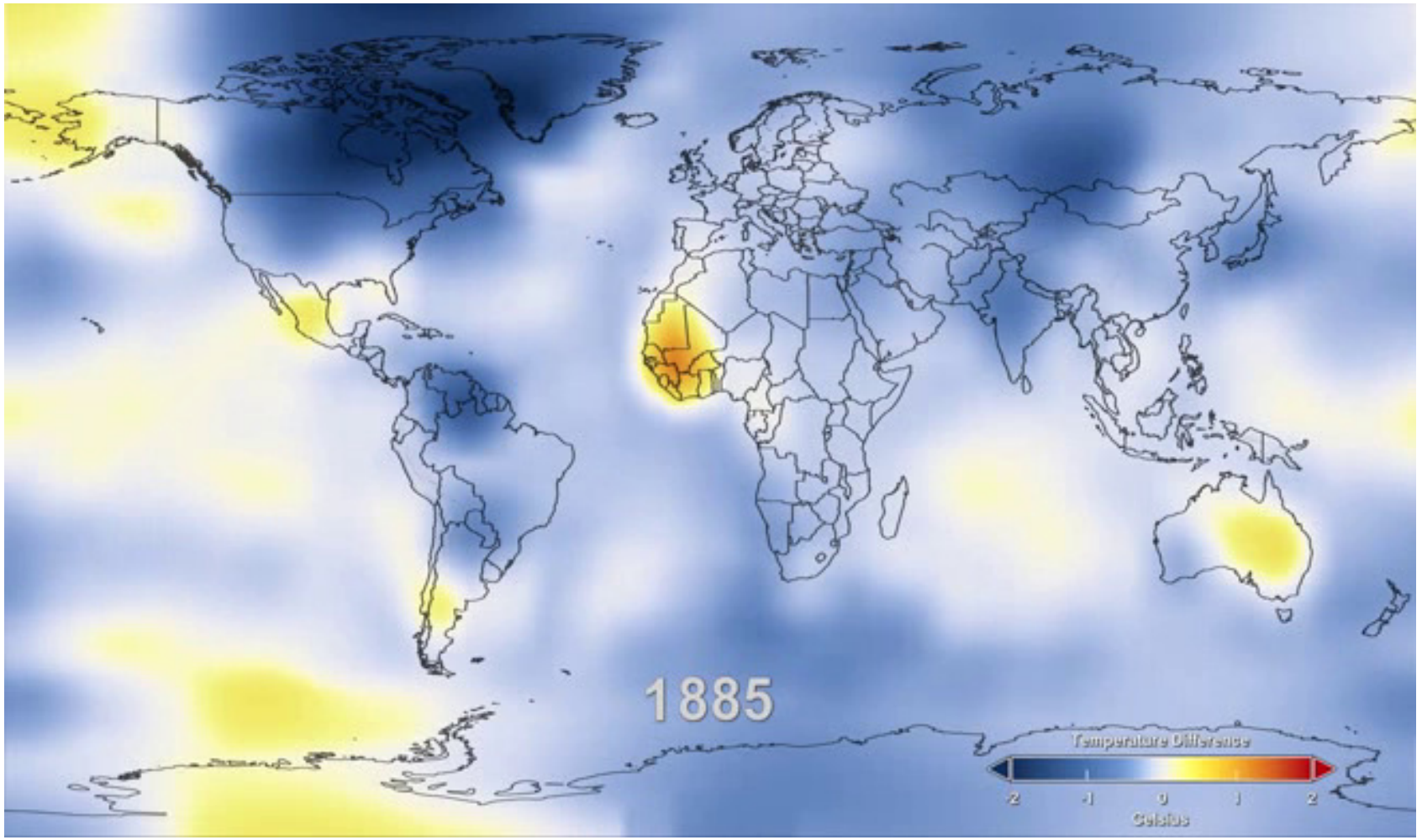
Nov 2011: 2010 highest percentage increase on record.

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.

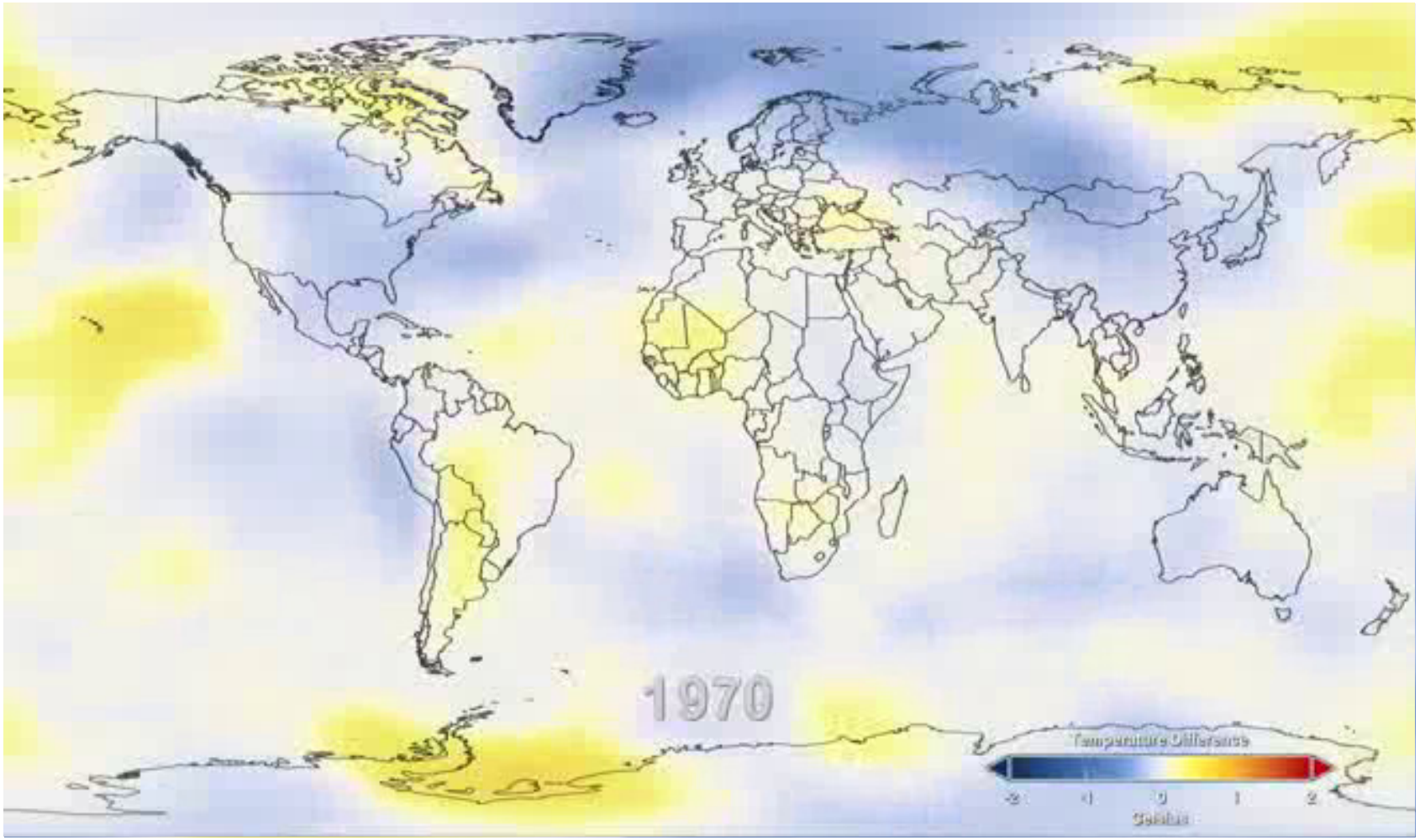
Our warming planet

Our warming planet



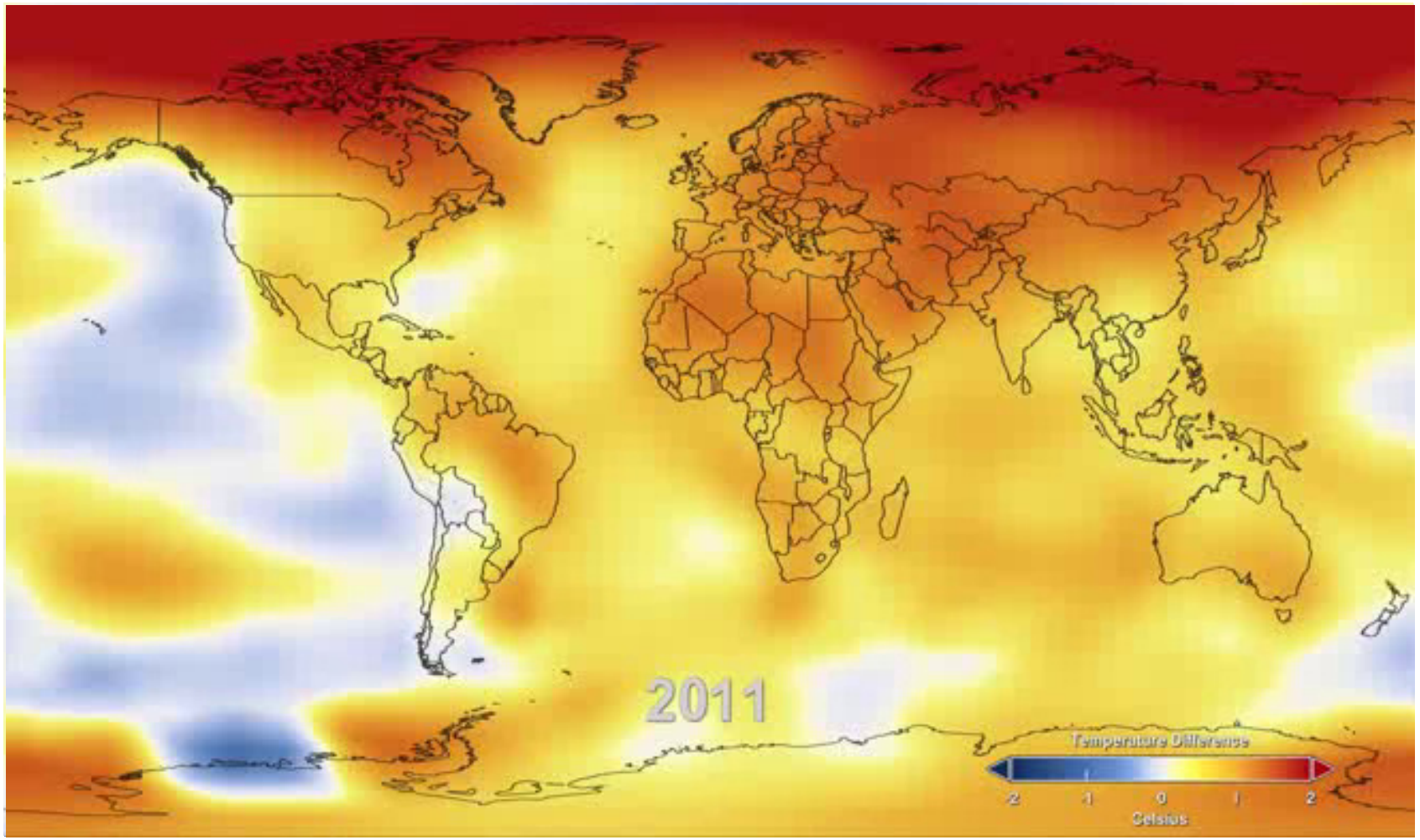
http://www.nasa.gov/multimedia/videogallery/index.html?media_id=123437001

Our warming planet



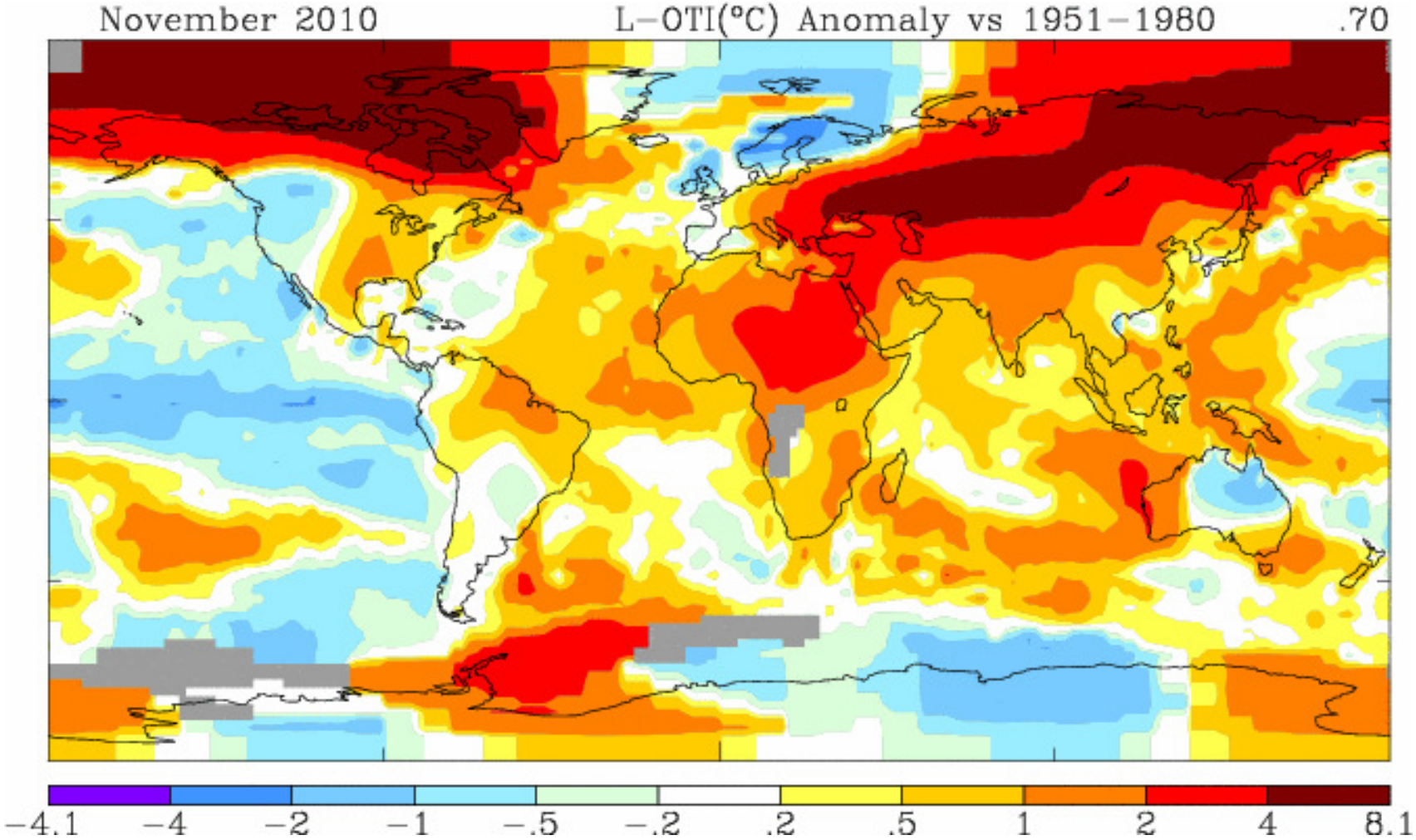
http://www.nasa.gov/multimedia/videogallery/index.html?media_id=123437001

Our warming planet



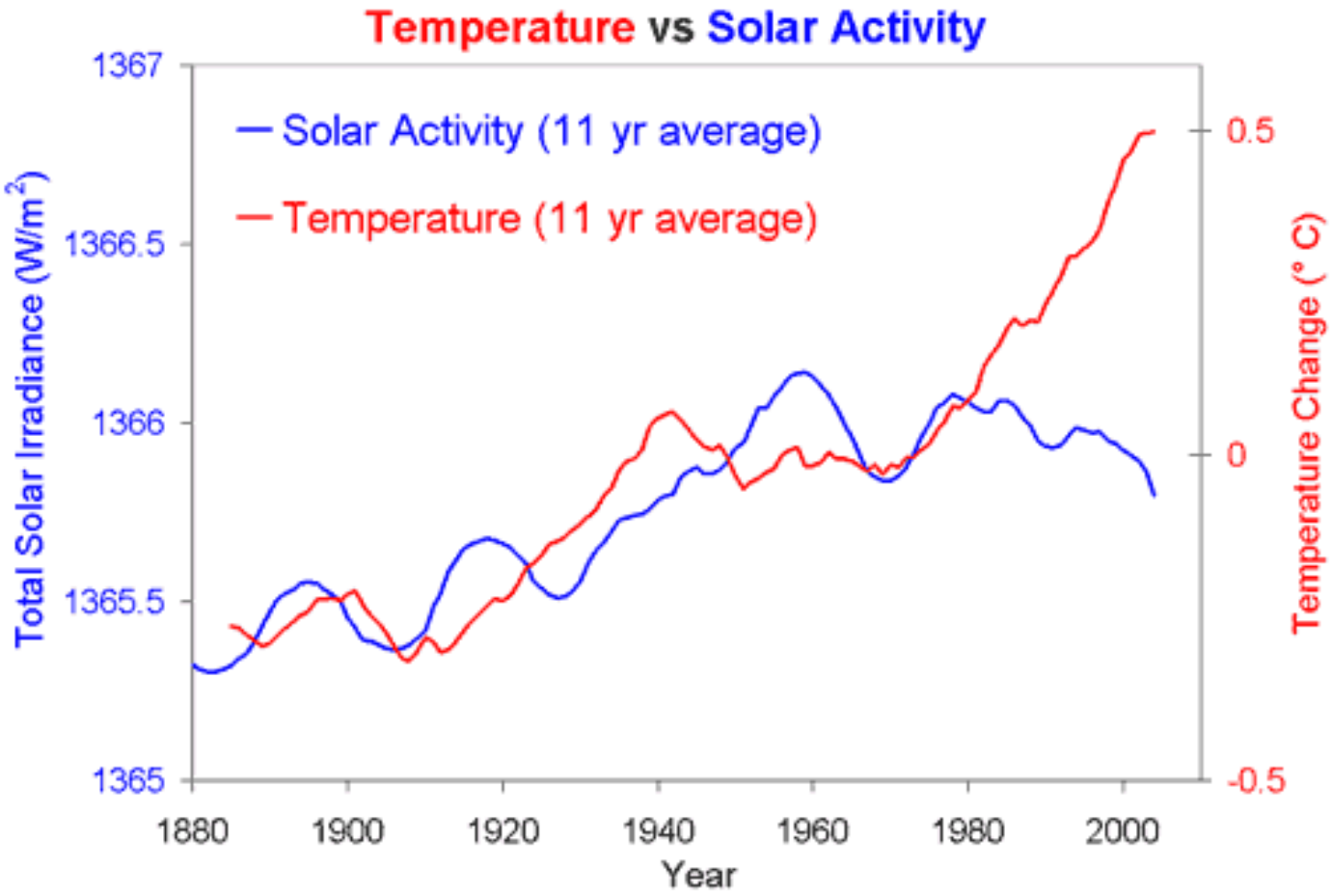
http://www.nasa.gov/multimedia/videogallery/index.html?media_id=123437001

Our warming planet



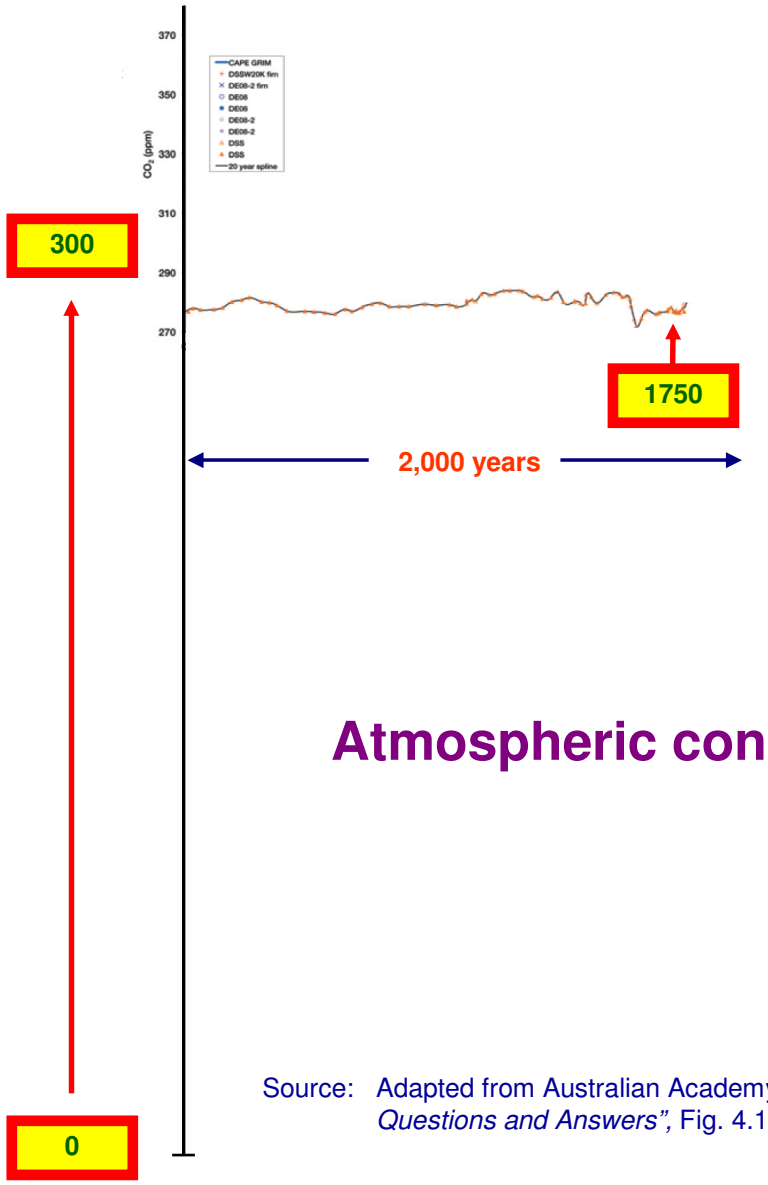
NASA Goddard Institute for Space Studies Surface Temperature Analysis, http://data.giss.nasa.gov/cgi-bin/gistemp/do_nmap.py?year_last=2012&month_last=1&sat=4&sst=1&type=anoms&mean_gen=11&year1=2010&year2=2010&base1=1951&base2=1980&radius=1200&pol=reg

Our warming planet



Skeptical Science http://skepticalscience.com/solar-activity-sunspots-global-warming.htm

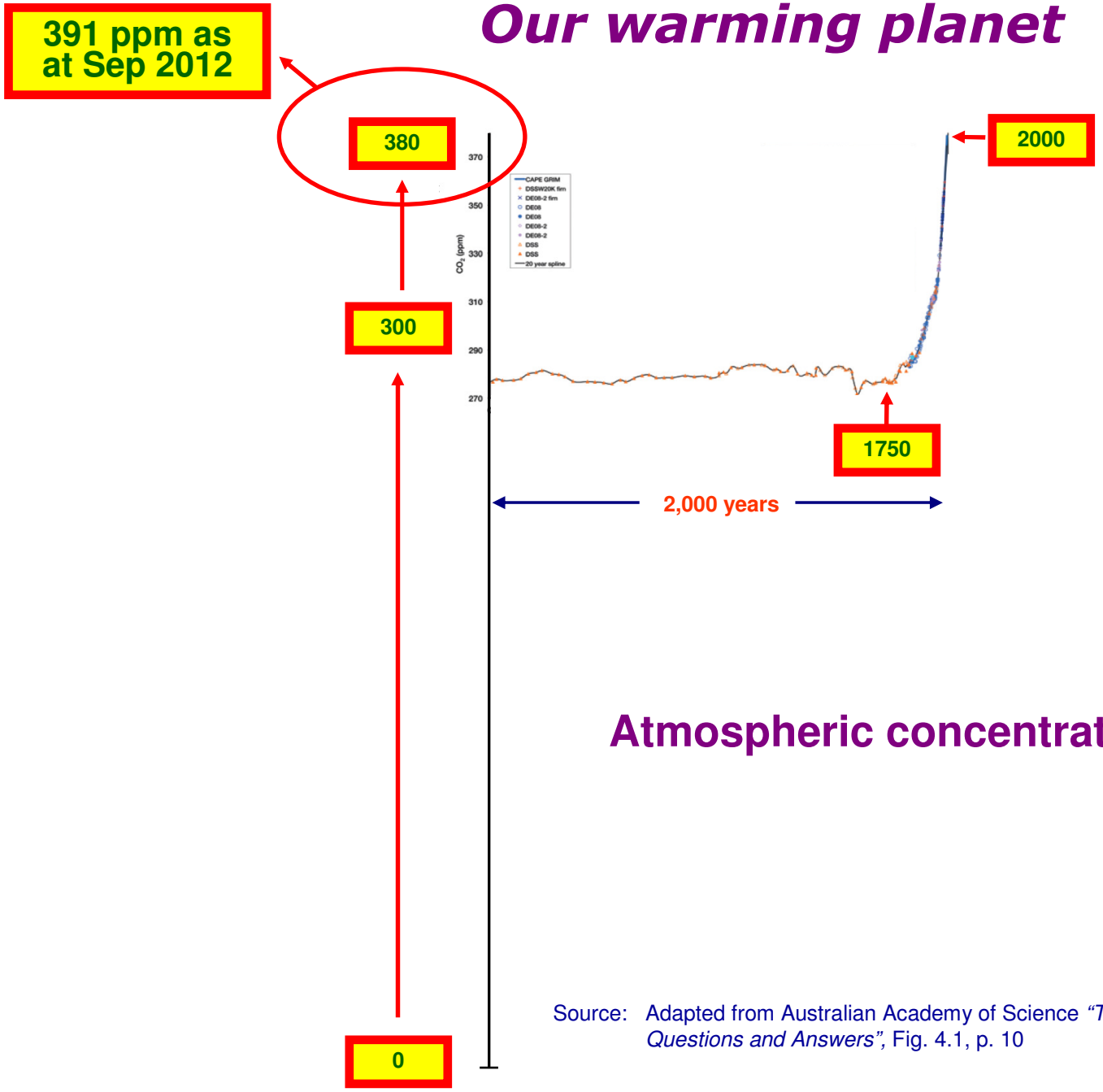
Our warming planet



Atmospheric concentrations of CO2

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

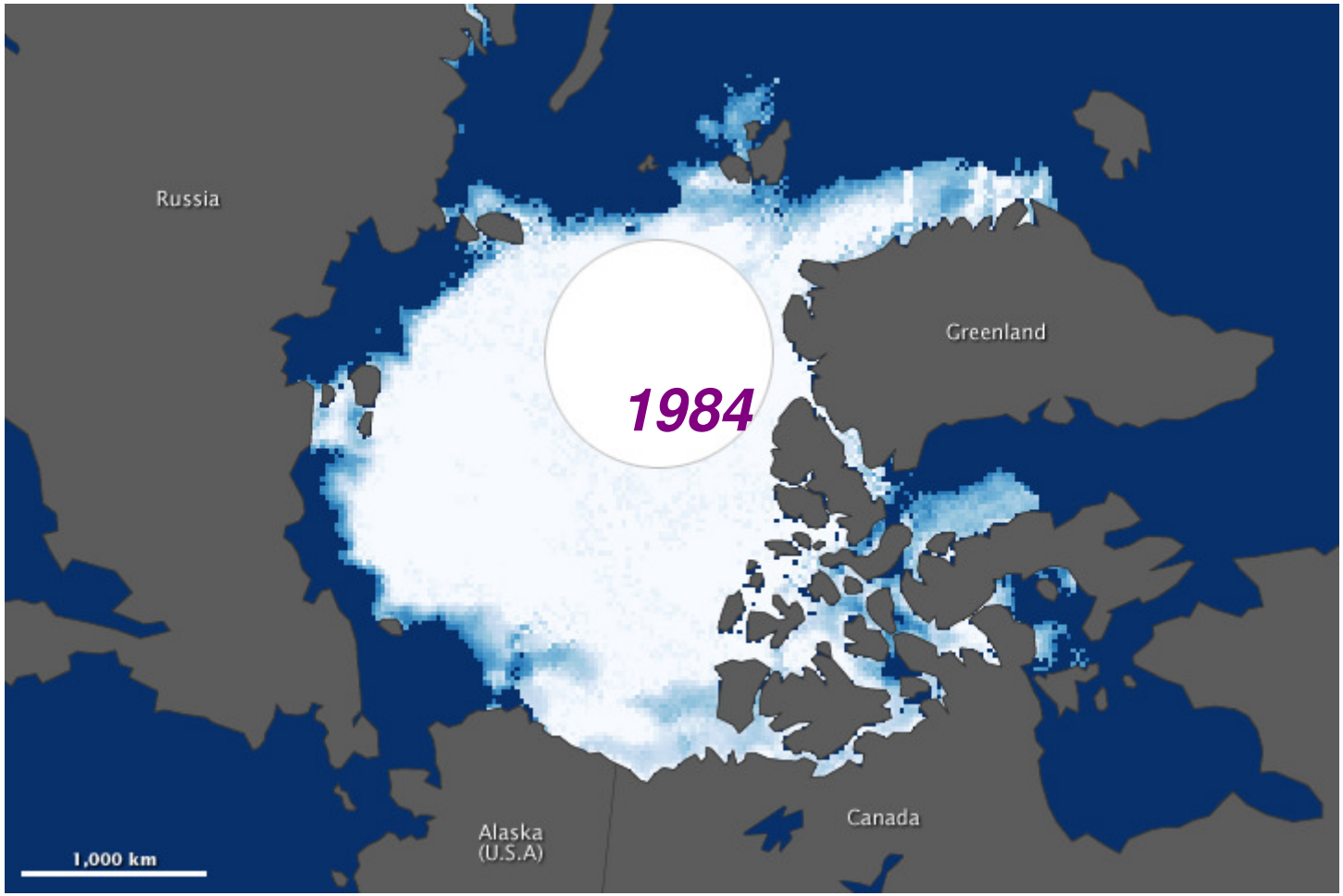
Our warming planet



Atmospheric concentrations of CO2

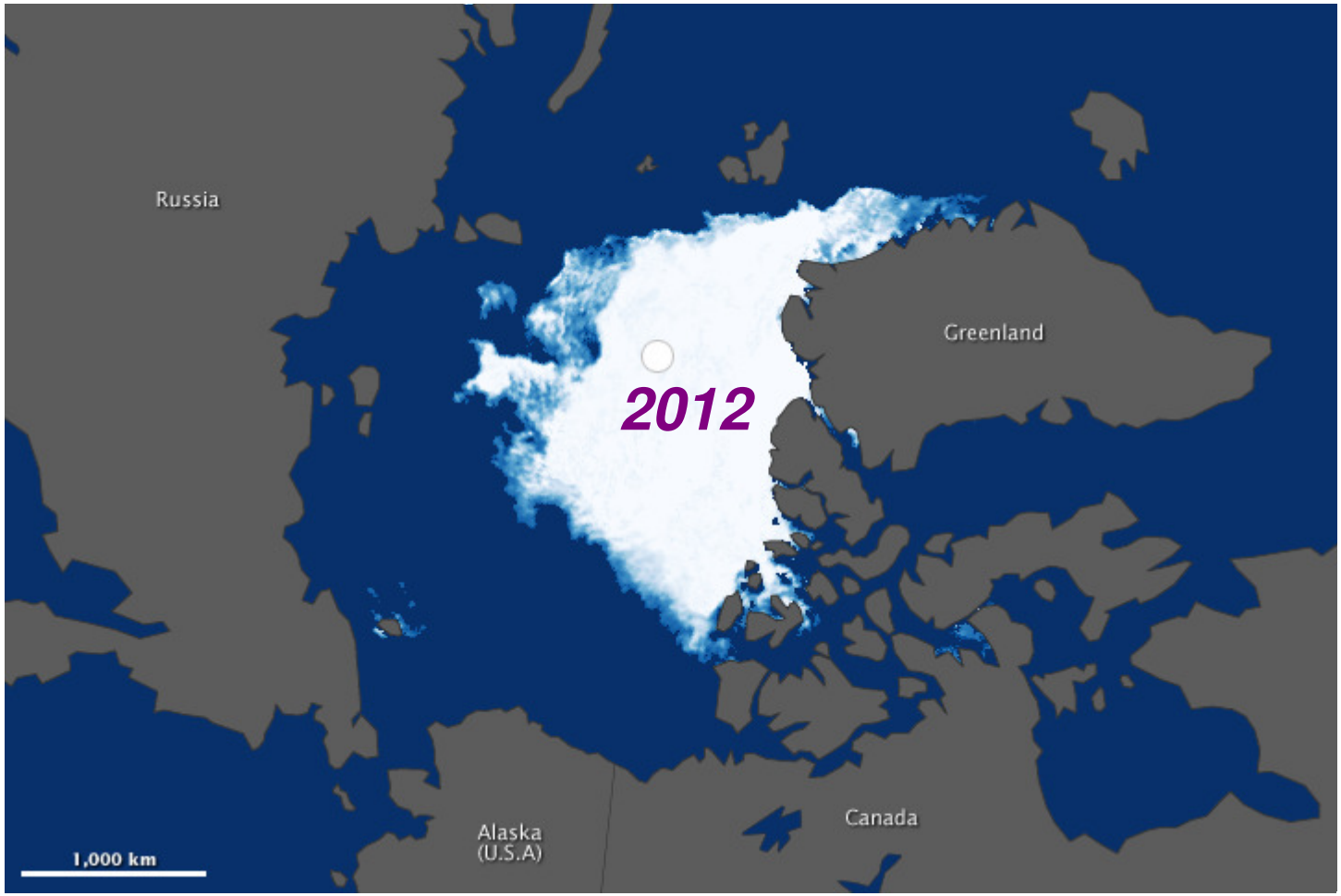
Source: Adapted from Australian Academy of Science *"The Science of Climate Change: Questions and Answers"*, Fig. 4.1, p. 10

The Arctic "Big Melt"



NASA Earth Observatory, http://earthobservatory.nasa.gov/IOTD/view.php?id=79256&src=eorss-iotd

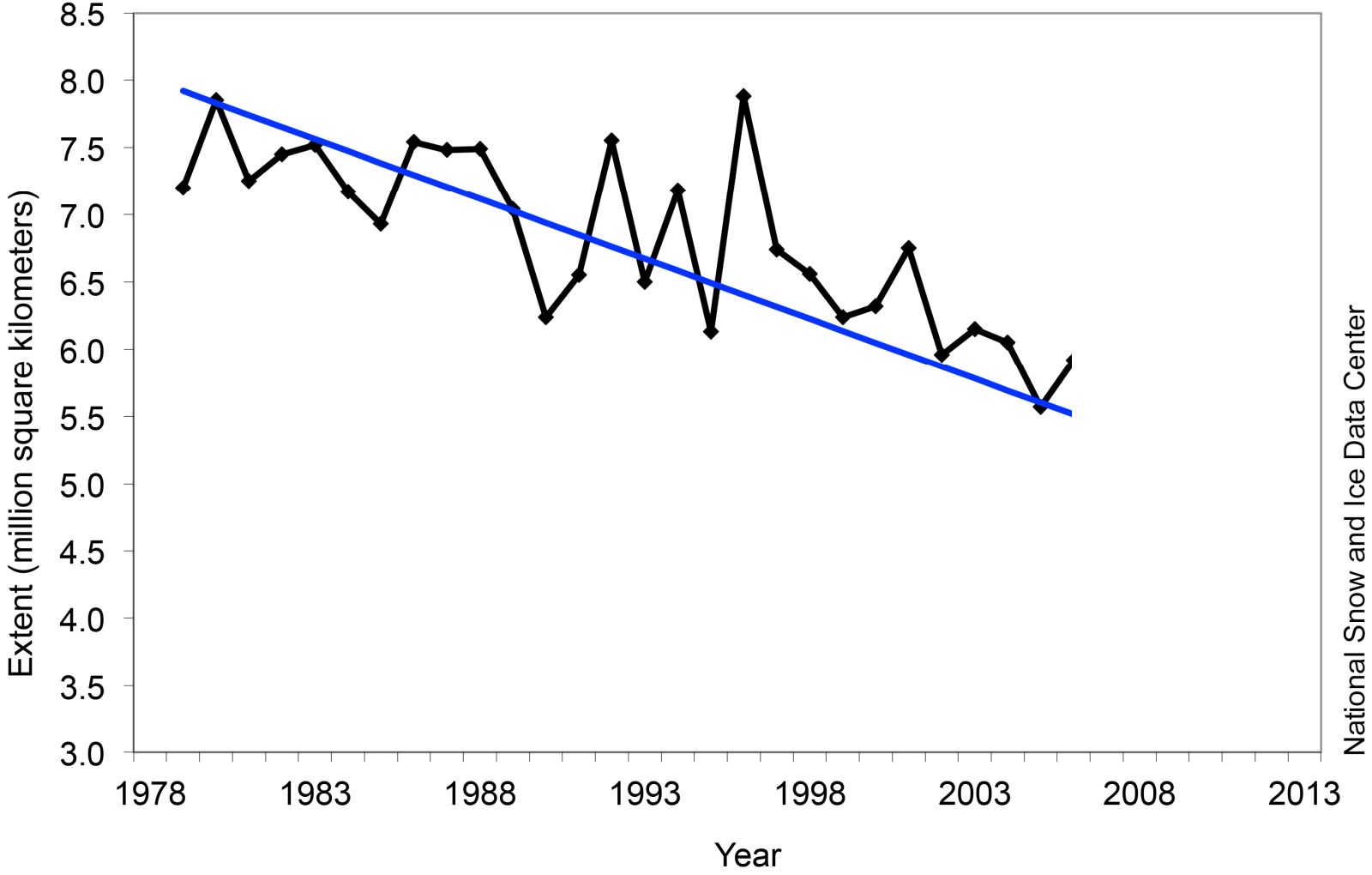
The Arctic "Big Melt"



NASA Earth Observatory, http://earthobservatory.nasa.gov/IOTD/view.php?id=79256&src=eorss-iotd

The Arctic "Big Melt"

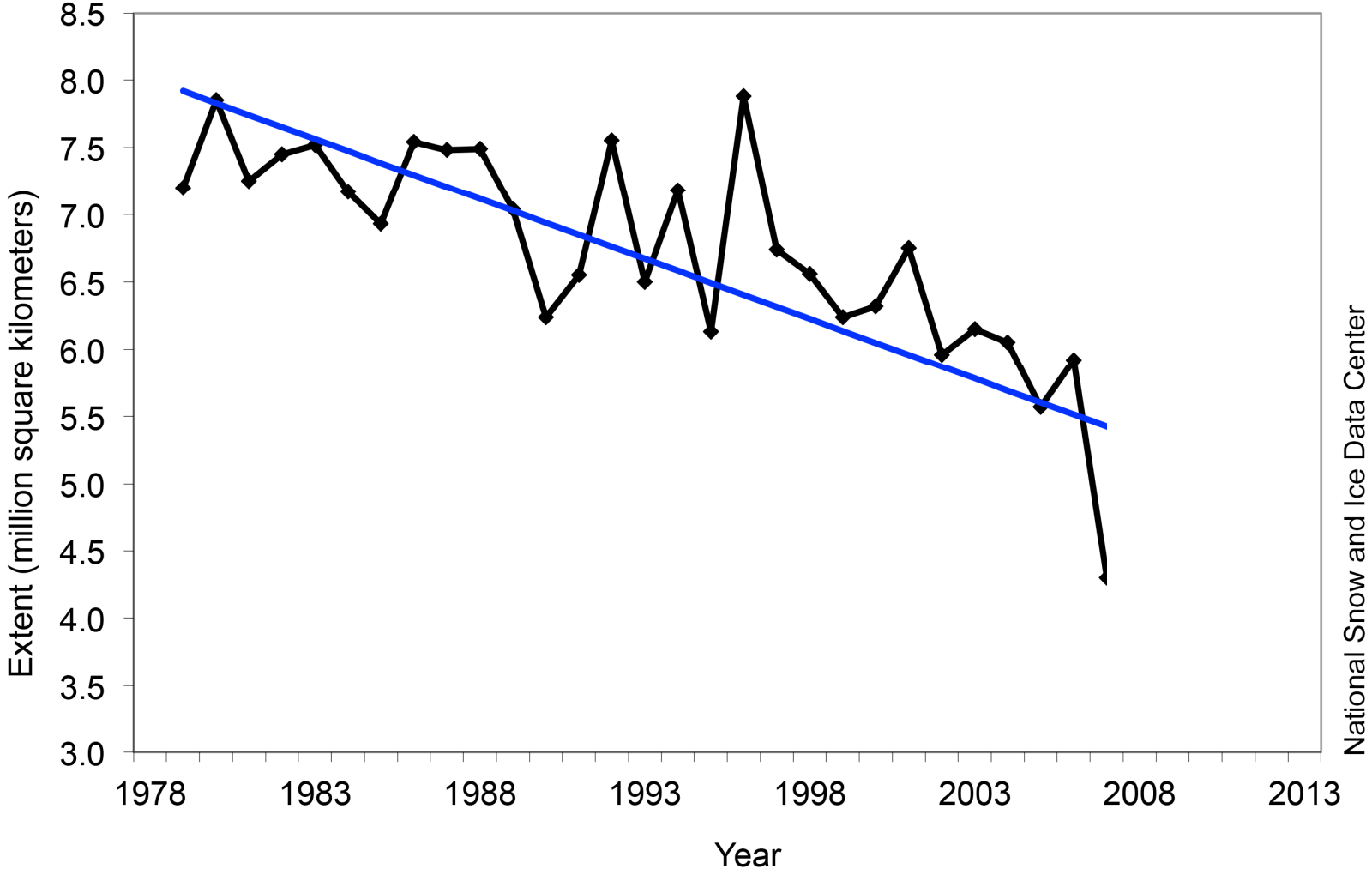
Average Monthly Arctic Sea Ice Extent
September 1979 - 2013



National Snow & Ice Data Center, A better year for the cryosphere, http://nsidc.org/arcticseaicenews/2013/10/a-better-year-for-the-cryosphere/

The Arctic "Big Melt"

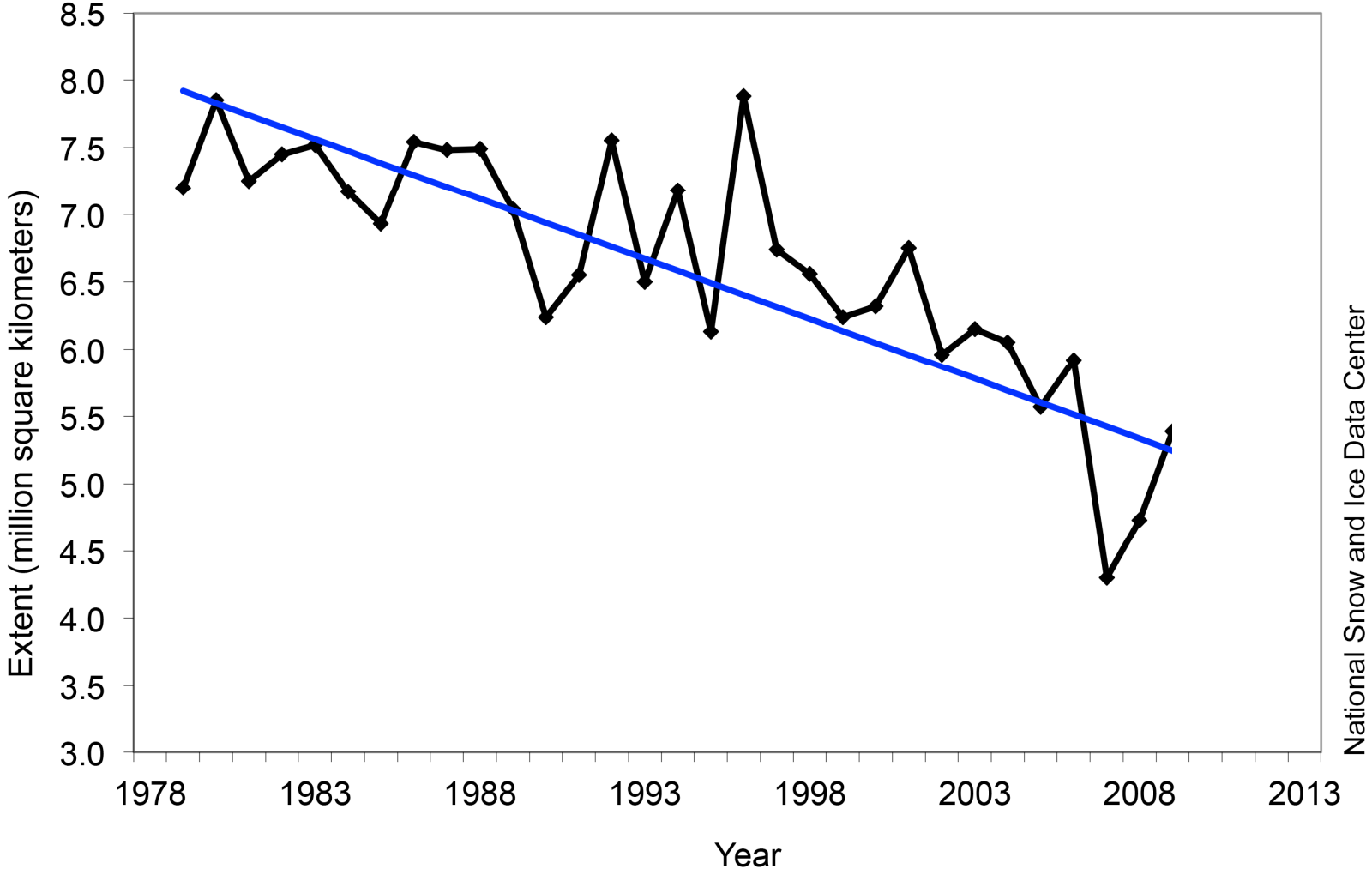
Average Monthly Arctic Sea Ice Extent
September 1979 - 2013



National Snow & Ice Data Center, A better year for the cryosphere, http://nsidc.org/arcticseaicenews/2013/10/a-better-year-for-the-cryosphere/

The Arctic "Big Melt"

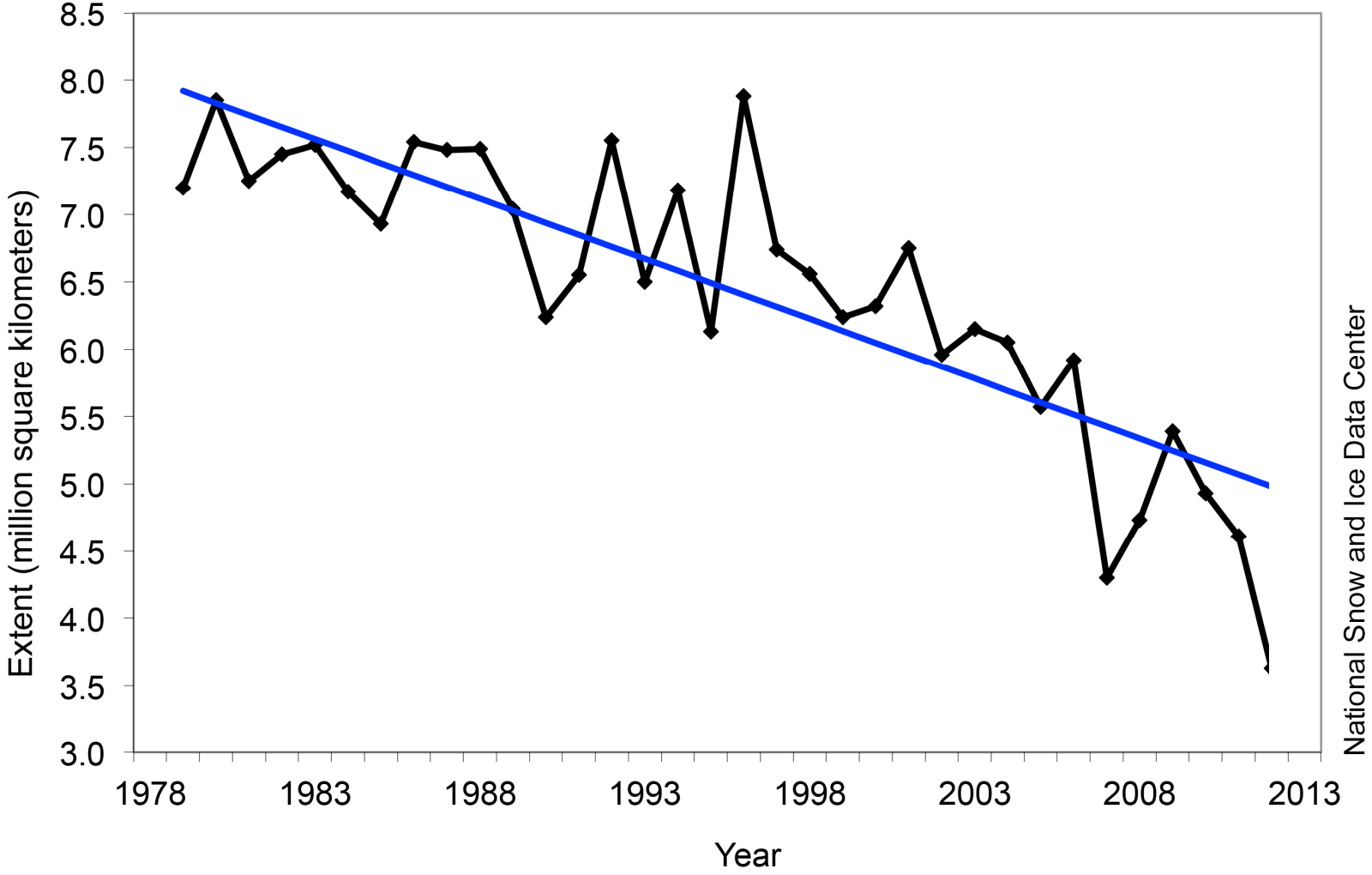
Average Monthly Arctic Sea Ice Extent
September 1979 - 2013



National Snow & Ice Data Center, A better year for the cryosphere, http://nsidc.org/arcticseaicenews/2013/10/a-better-year-for-the-cryosphere/

The Arctic "Big Melt"

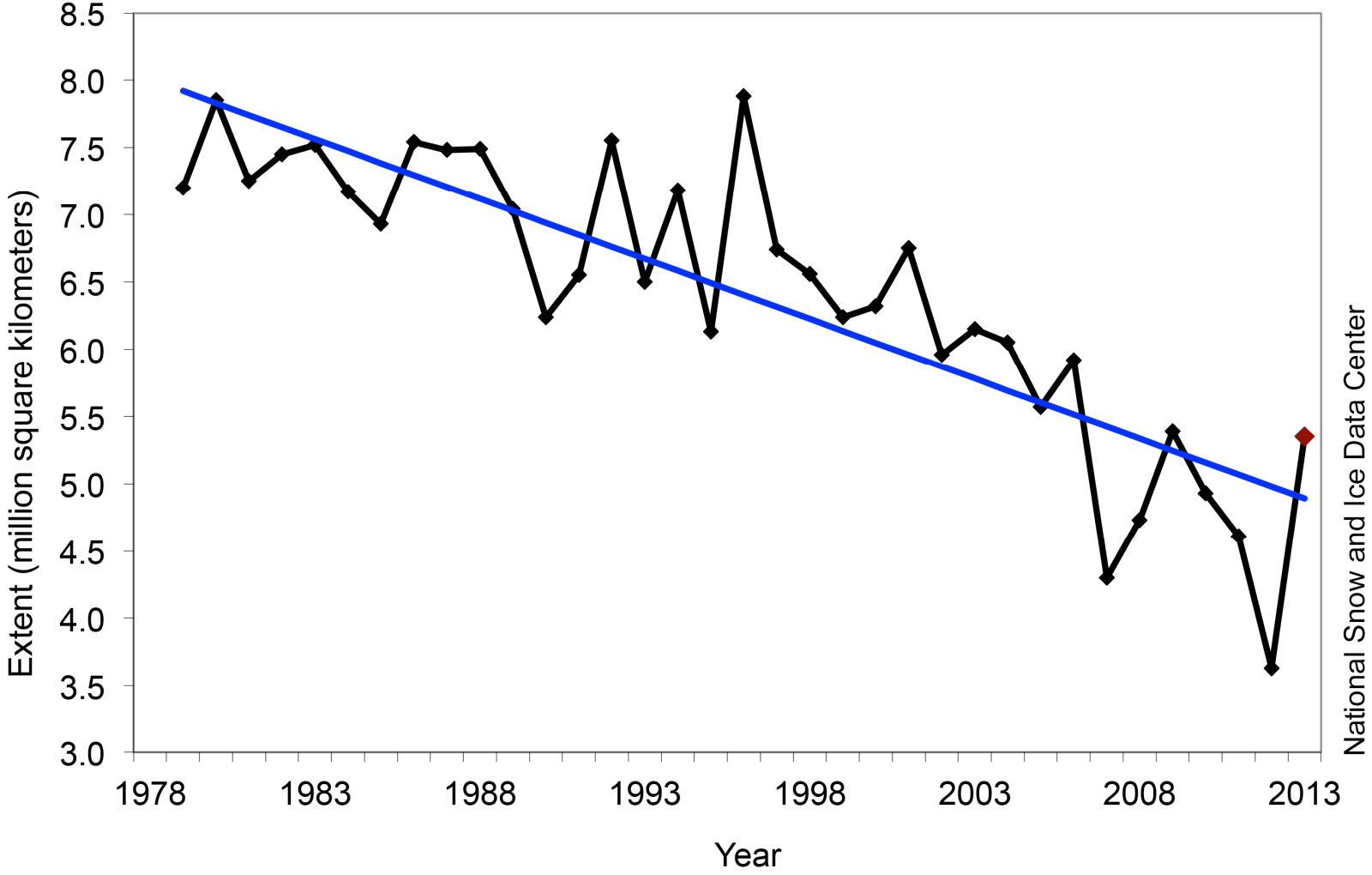
Average Monthly Arctic Sea Ice Extent
September 1979 - 2013



National Snow & Ice Data Center, A better year for the cryosphere, http://nsidc.org/arcticseaicenews/2013/10/a-better-year-for-the-cryosphere/

The Arctic "Big Melt"

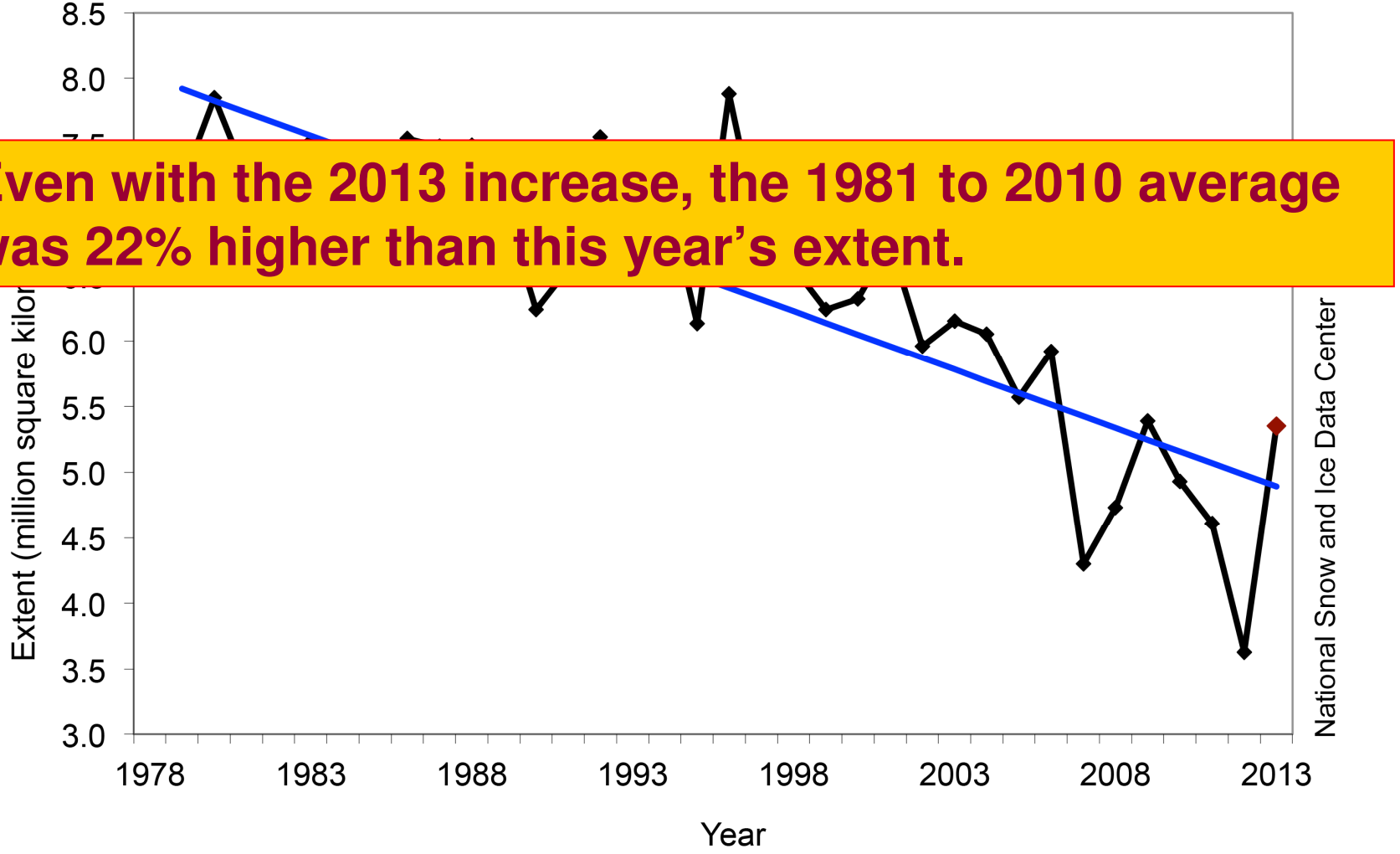
Average Monthly Arctic Sea Ice Extent
September 1979 - 2013



National Snow & Ice Data Center, A better year for the cryosphere, http://nsidc.org/arcticseaicenews/2013/10/a-better-year-for-the-cryosphere/

The Arctic "Big Melt"

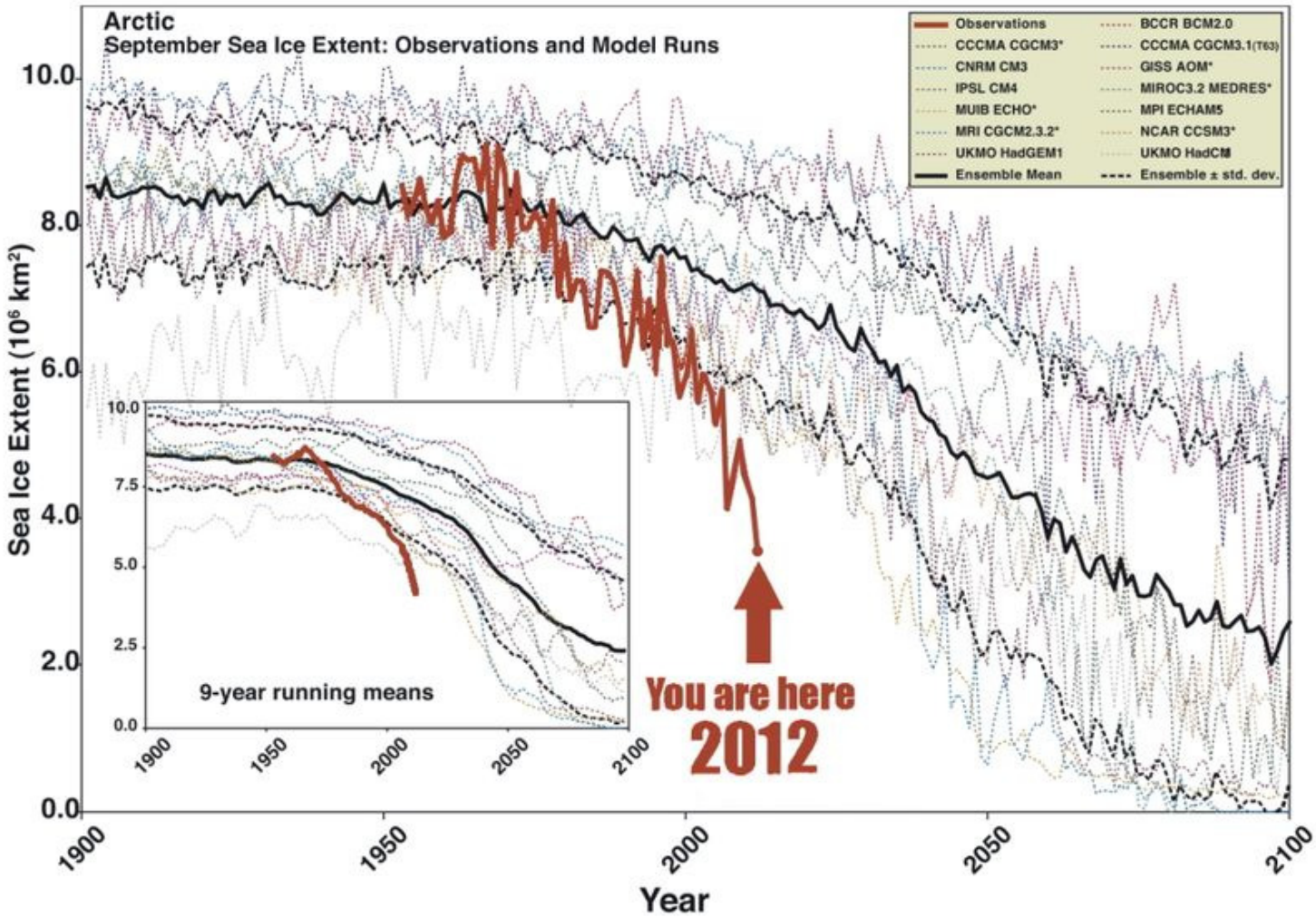
Average Monthly Arctic Sea Ice Extent
September 1979 - 2013



Even with the 2013 increase, the 1981 to 2010 average was 22% higher than this year's extent.

National Snow & Ice Data Center, A better year for the cryosphere, http://nsidc.org/arcticseaicenews/2013/10/a-better-year-for-the-cryosphere/

The Arctic "Big Melt" – Projected vs Actual Arctic Summer Sea Ice



Cited in Romm, J. "An Illustrated Guide to the Science of Global Warming Impacts: How We Know Inaction Is the Gravest Threat Humanity Faces", Climate Progress, 14 Oct, 2012 http://thinkprogress.org/climate/2012/10/14/1009121/science-of-global-warming-impacts-guide/. Originally from http://neven1.typepad.com/blog/2012/09/models-are-improving-but-can-they-catch-up.html, adapted from http://climatecrocks.com/2011/09/09/graph-of-the-day-arctic-ice-melt-how-much-faster-than-predicted/ which in turn based on Stroeve et al. http://www.agu.org/pubs/crossref/2007/2007GL029703.shtml

The Arctic "Big Melt"

Volume (area and thickness)

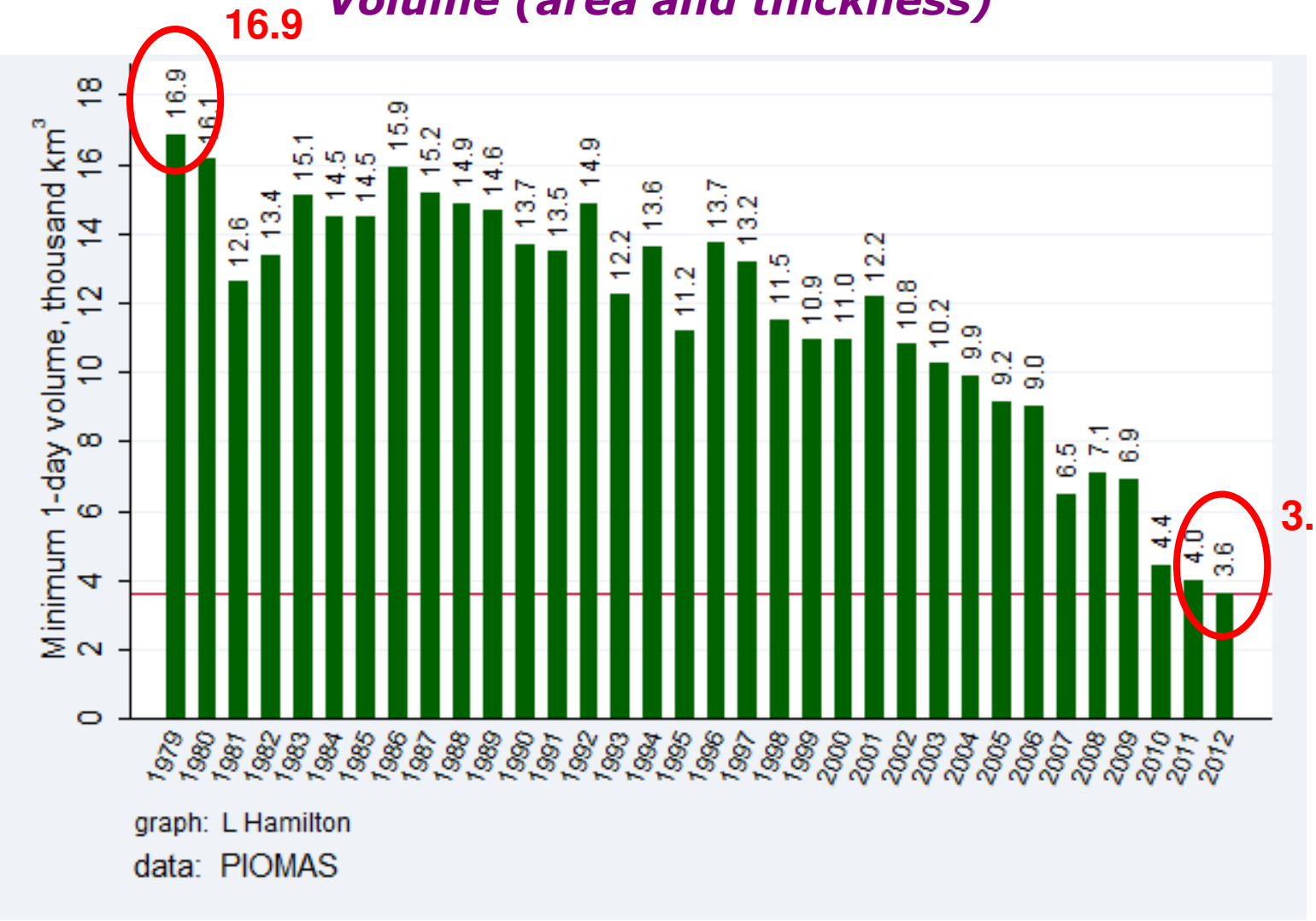
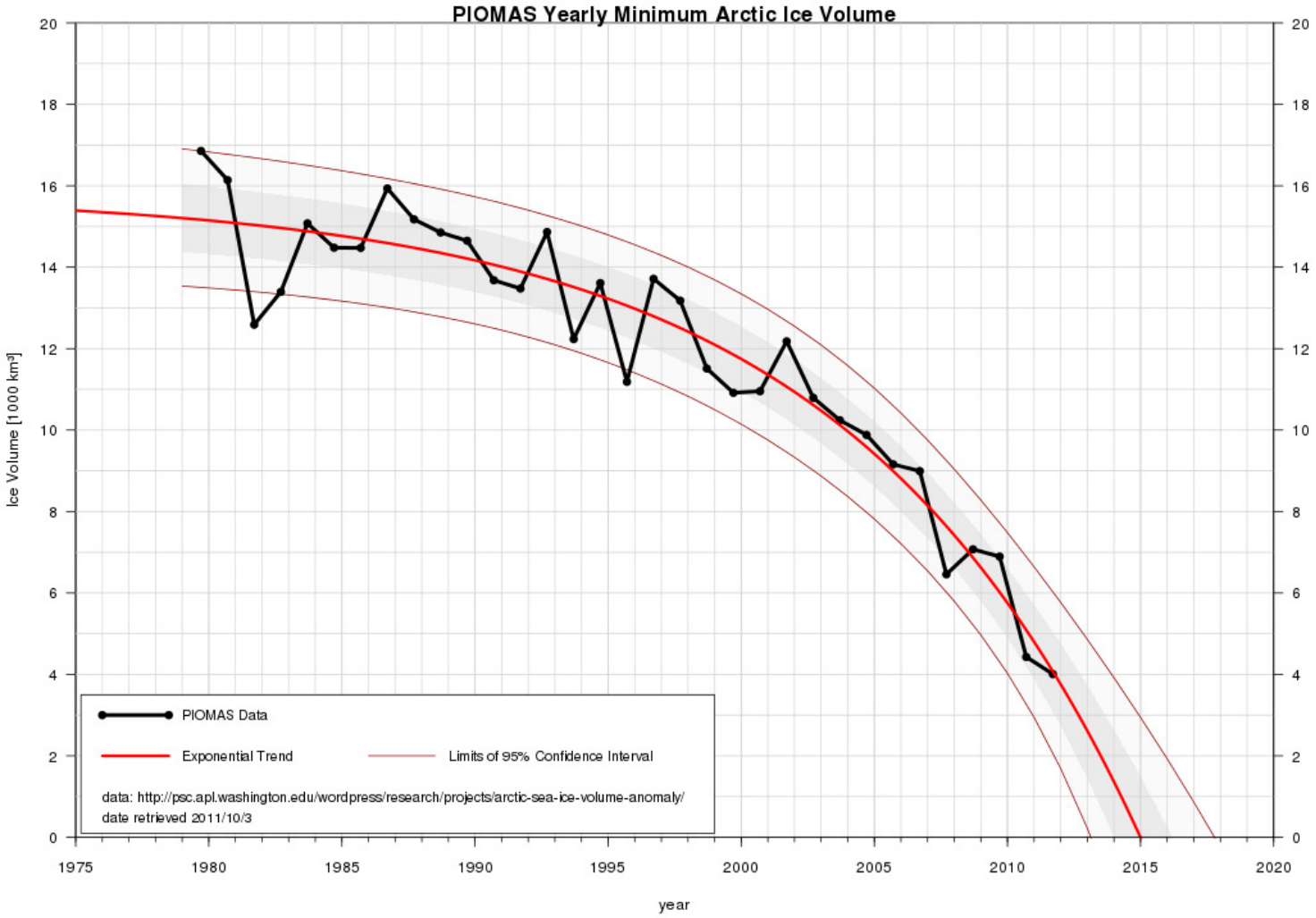


Chart by L. Hamilton, based on Pan-Arctic Ice Ocean Modeling and Assimilation System (PIOMAS) data from the Polar Science Center http://psc.apl.washington.edu/wordpress/research/projects/arctic-sea-ice-volume-anomaly/, cited in Romm, J, "Experts Warn Of 'Near Ice-Free Arctic In Summer' In A Decade", 6 September, 2012, The Energy Collective, http://theenergycollective.com/josephromm/110216/death-spiral-watch-experts-warn-near-ice-free-arctic-summer-decade-if-volume-trend

The Arctic "Big Melt" – Exponential Trending



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

The Arctic "Big Melt"

"The extra open water already created by the retreating ice allows bigger waves to be generated by storms, which are sweeping away the surviving ice. It is truly the case that it will be all gone by 2015. The consequences are enormous and represent a huge boost to global warming."
Peter Wadhams, professor of ocean physics at Cambridge University

David Spratt, "Big call: Cambridge prof. predicts Arctic summer sea ice 'all gone by 2015'", 30 Aug 2012, http://www.climatecodered.org/2012/08/big-call-cambridge-prof-predicts-arctic.html

What are the implications for the Greenland ice sheet?

The Arctic "Big Melt"

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.

The Arctic "Big Melt"

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.

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

The Arctic "Big Melt"

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.

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

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

The Arctic "Big Melt"

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.

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

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

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

Hansen, J., *"Storms of my granchildren"*, p. 164

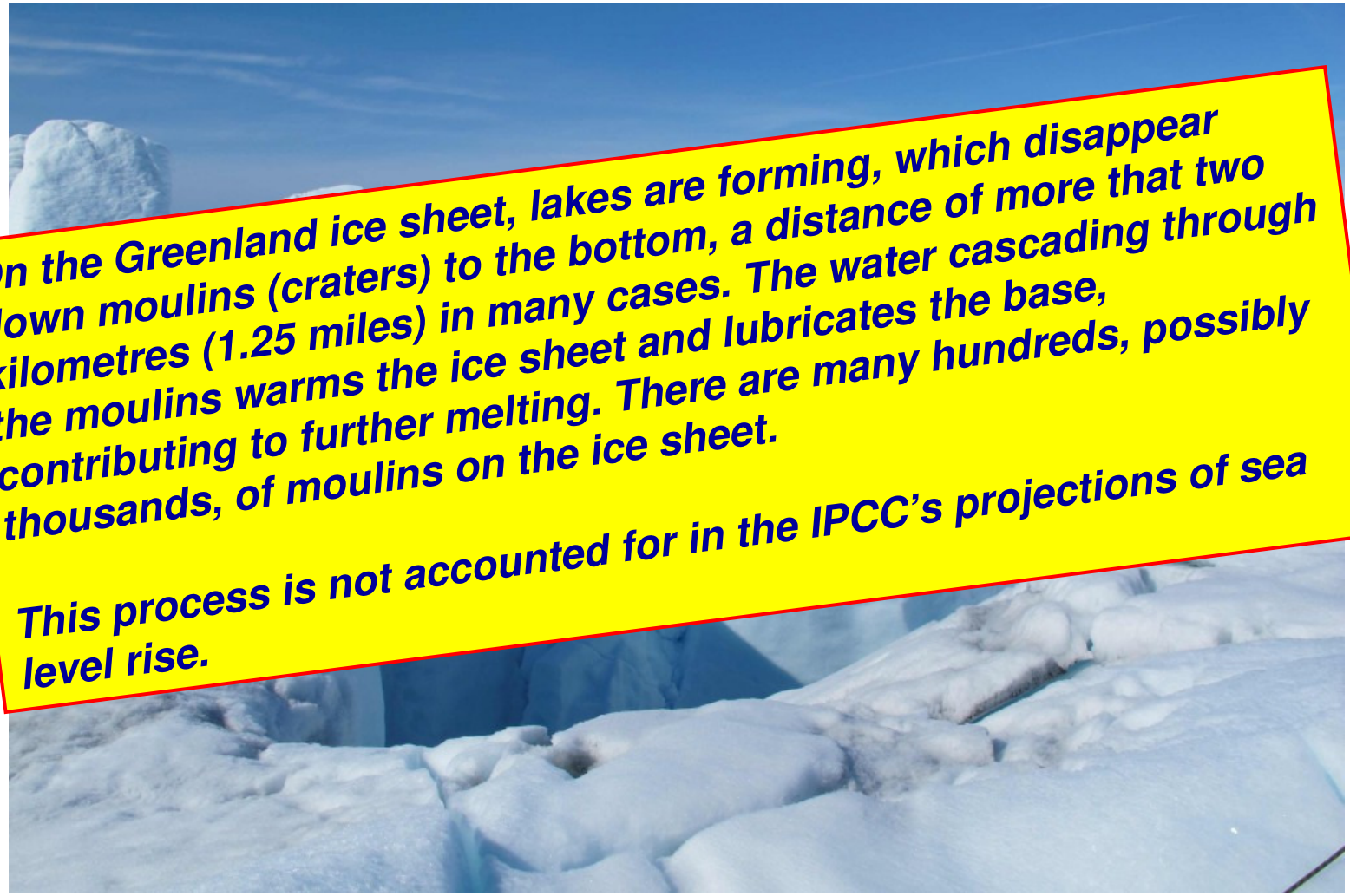
Greenland Ice Sheet

Scale comparison of Greenland (the largest island) and Australia (the smallest continent) by Joanna Serah, 26 Oct 2011, http://en.wikipedia.org/wiki/File:Australia-Greenland_Overlay.png

Greenland Ice Sheet

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

Greenland Ice Sheet



On the Greenland ice sheet, lakes are forming, which disappear down moulins (craters) to the bottom, a distance of more that two kilometres (1.25 miles) in many cases. The water cascading through the moulins warms the ice sheet and lubricates the base, contributing to further melting. There are many hundreds, possibly thousands, of moulins on the ice sheet.

This process is not accounted for in the IPCC's projections of sea level rise.

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

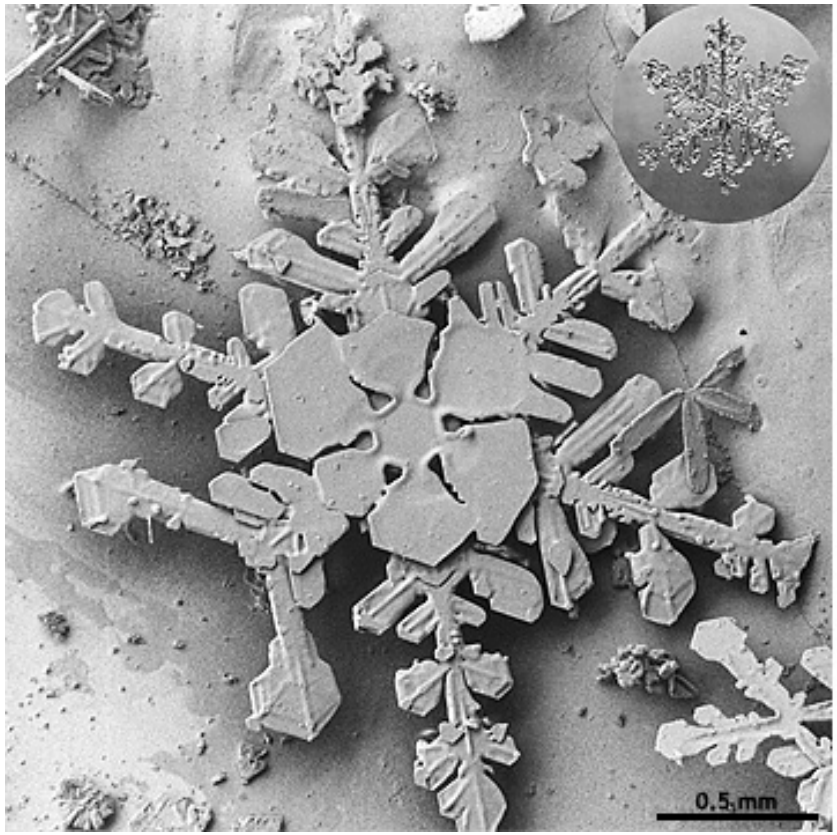
Greenland Ice Sheet

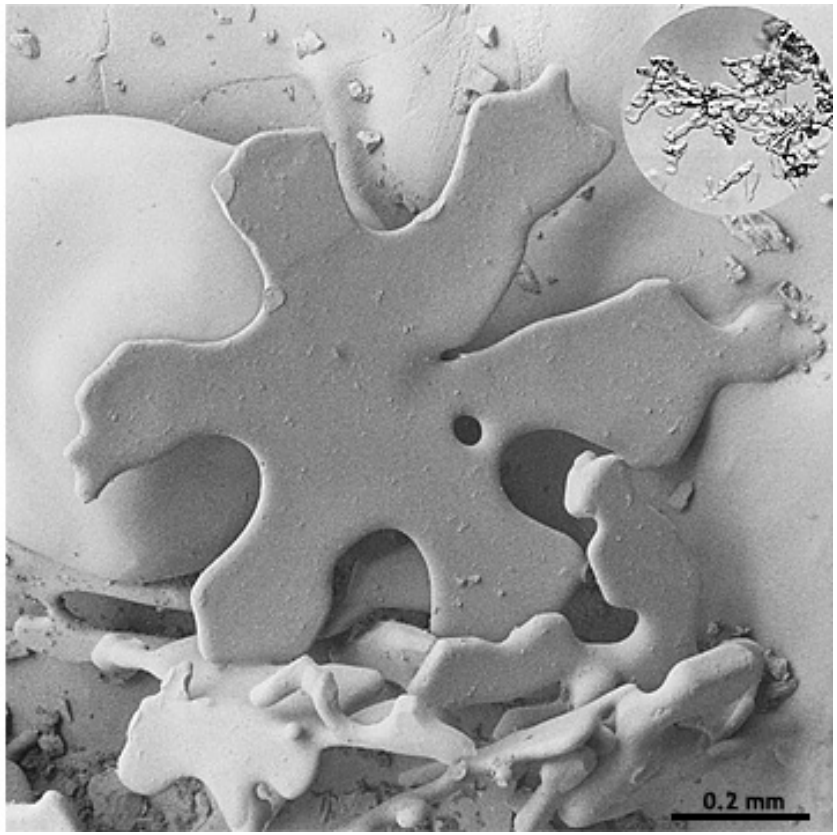
NOAA Climate Services, http://www.climatewatch.noaa.gov/article/2011/greenland-ice-sheet-getting-darker-2

Greenland Ice Sheet

NOAA Climate Services, http://www.climatewatch.noaa.gov/article/2011/greenland-ice-sheet-getting-darker-2

Greenland Ice Sheet





NOAA Climate Services, http://www.climatewatch.noaa.gov/article/2011/greenland-ice-sheet-getting-darker-2

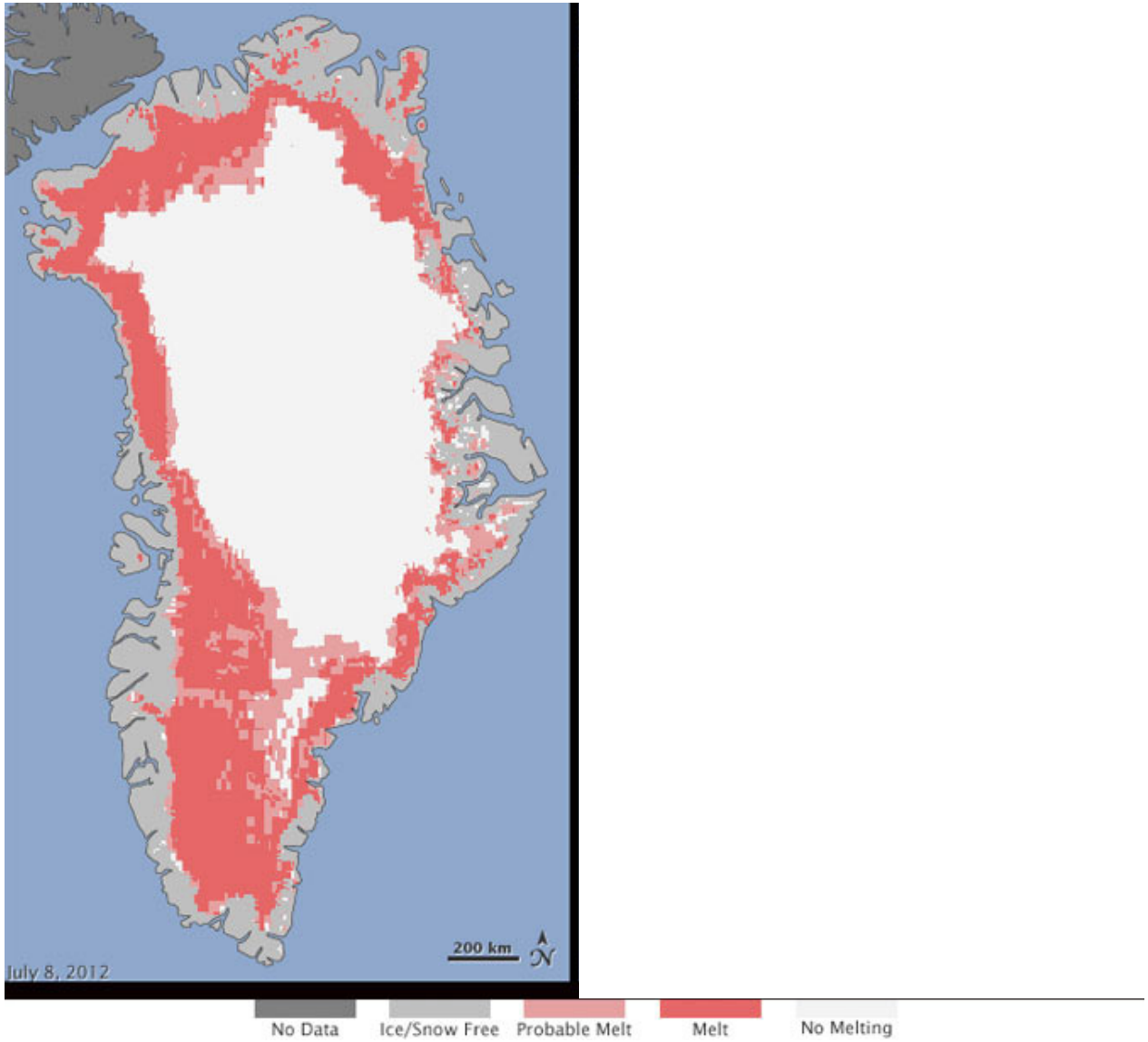
Greenland Ice Sheet

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

Ice mass loss of over 250 cubic km per annum

Salter, J. *"Scientists capture dramatic footage of Arctic glaciers melting in hours"*, The Telegraph, 20 February 2009,http://www.telegraph.co.uk/earth/environment/climatechange/4734859/Scientists-capture-dramatic-footage-of-Arctic-glaciers-melting-in-hours.html and Hansen, J, "Storms of my Grandchildren", Bloomsbury, 2009, 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.)

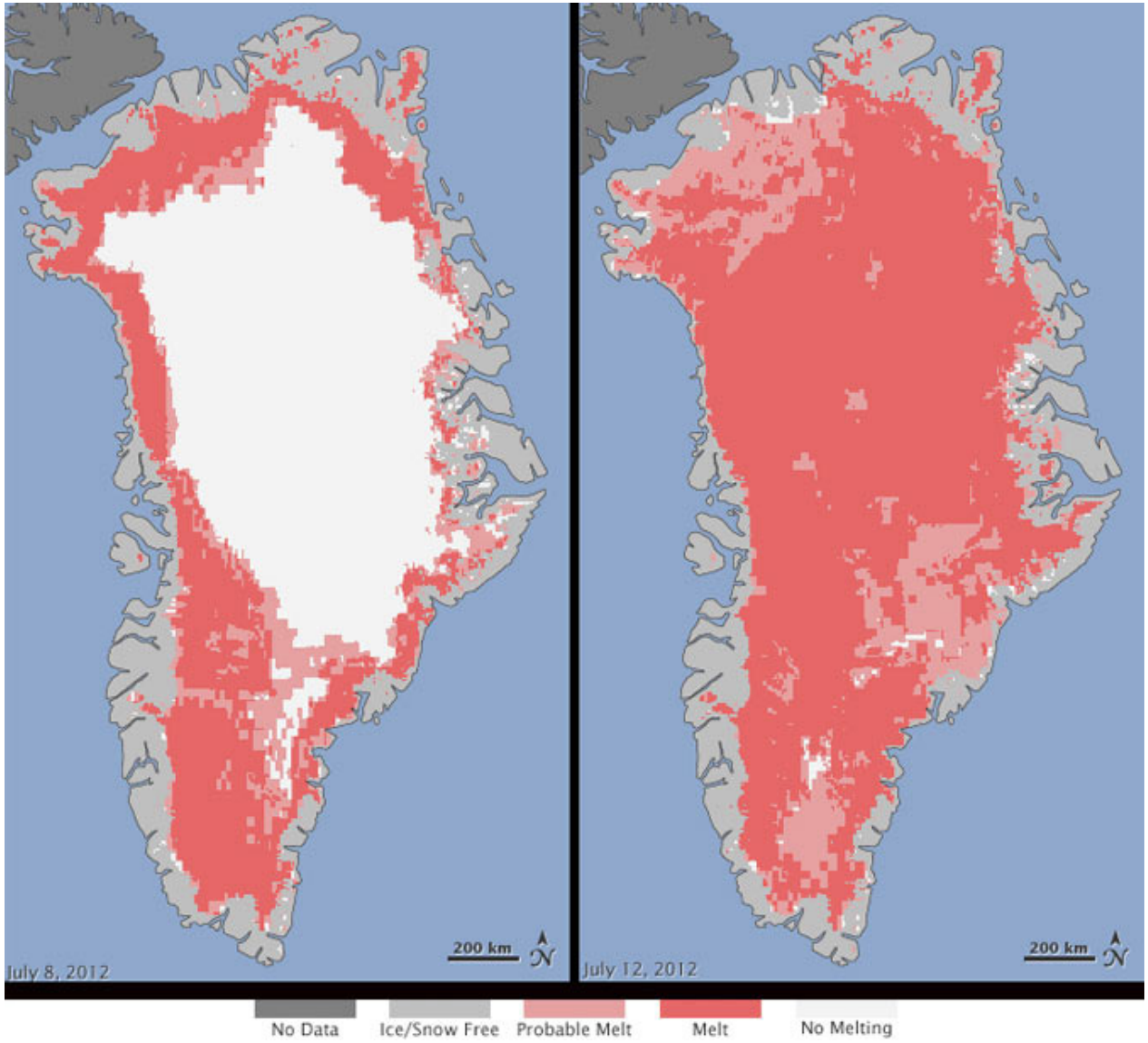
The Arctic "Big Melt"



http://www.nasa.gov/topics/earth/features/greenland-melt.html

"Greenland Melting Breaks Record Four Weeks Before Season's End", ScienceDaily, 15 August, 2012, http://www.sciencedaily.com/releases/2012/08/120815121318.htm

The Arctic "Big Melt"

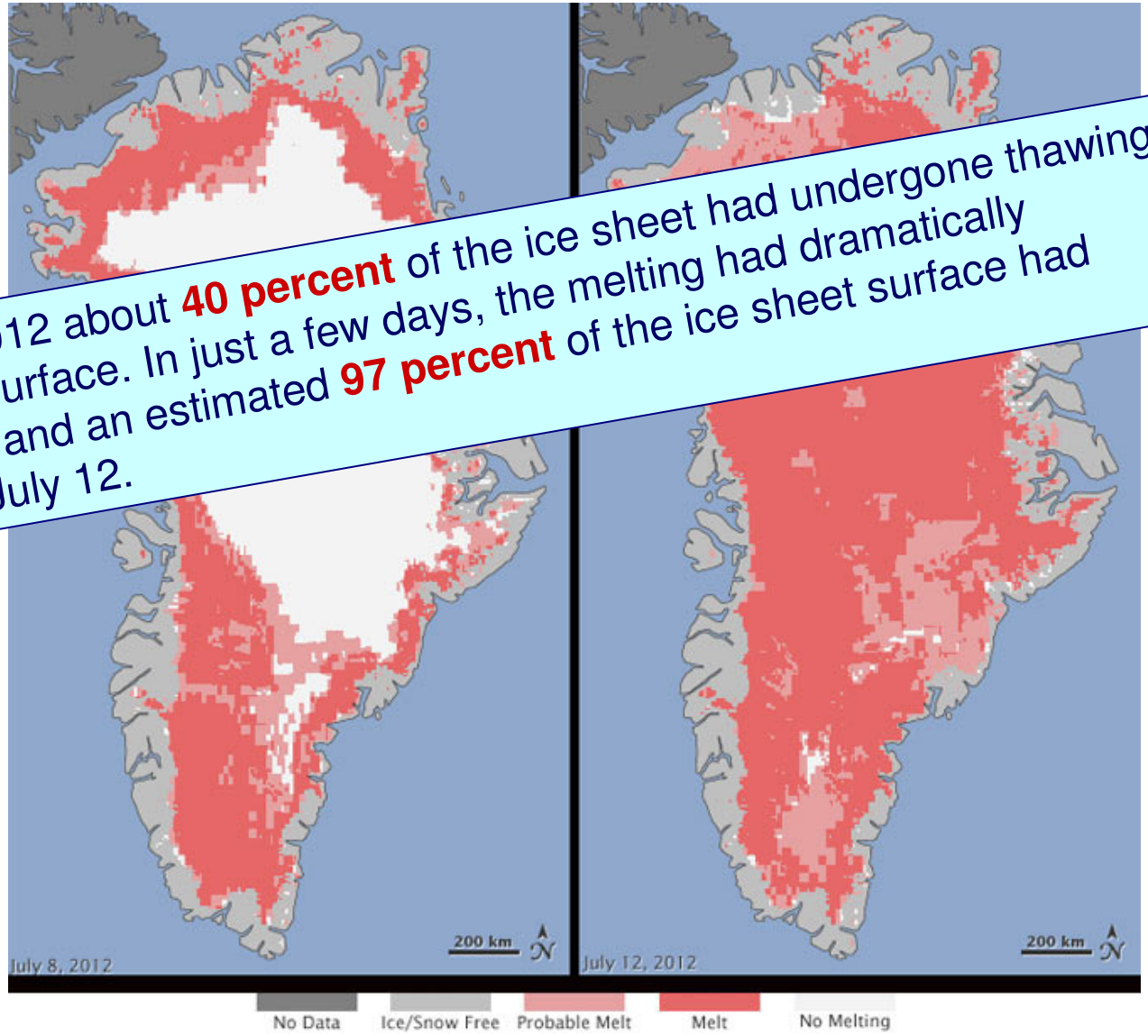


http://www.nasa.gov/topics/earth/features/greenland-melt.html

"Greenland Melting Breaks Record Four Weeks Before Season's End", ScienceDaily, 15 August, 2012, http://www.sciencedaily.com/releases/2012/08/120815121318.htm

The Arctic "Big Melt"

On July 8, 2012 about **40 percent** of the ice sheet had undergone thawing at or near the surface. In just a few days, the melting had dramatically accelerated and an estimated **97 percent** of the ice sheet surface had thawed by July 12.



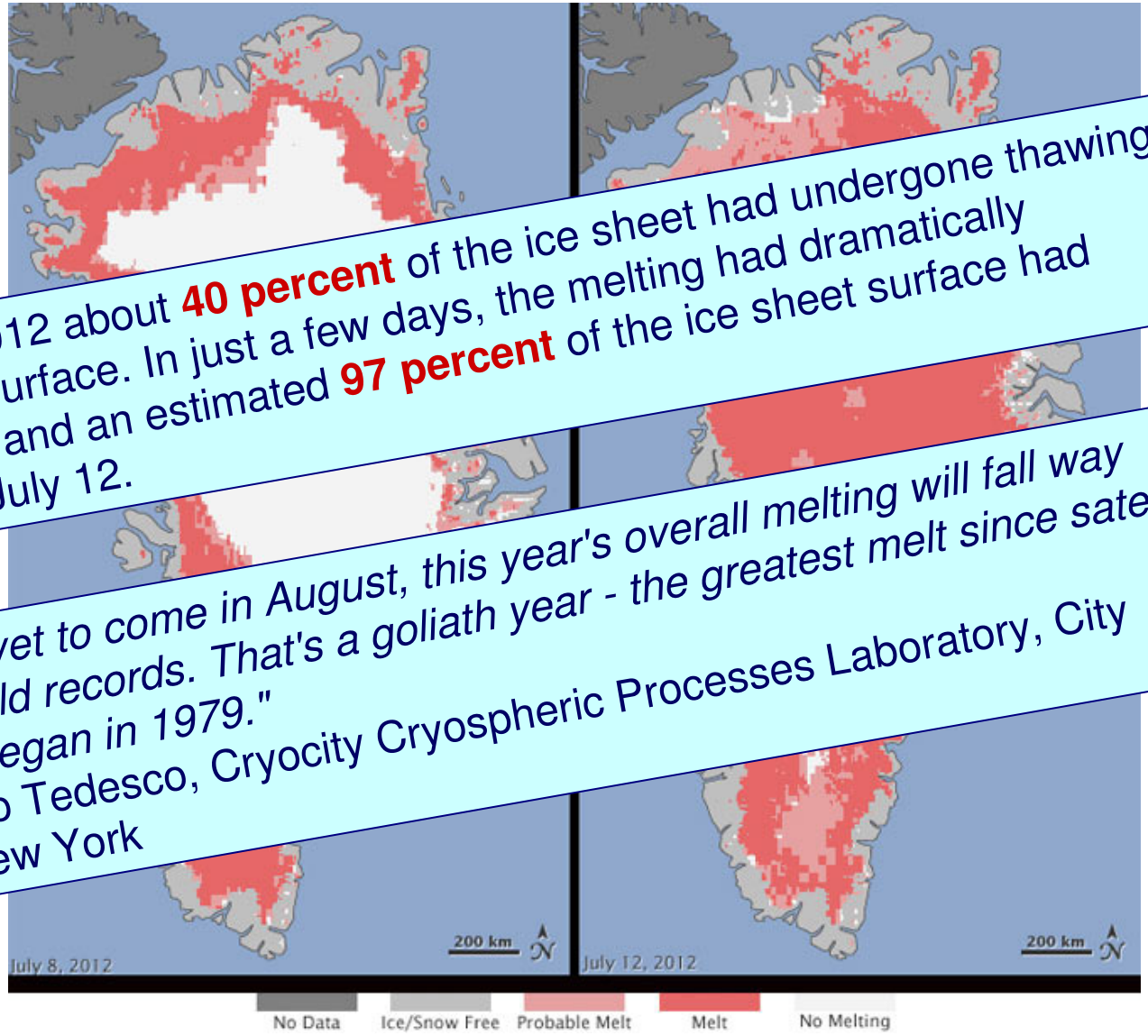
http://www.nasa.gov/topics/earth/features/greenland-melt.html

"Greenland Melting Breaks Record Four Weeks Before Season's End", ScienceDaily, 15 August, 2012, http://www.sciencedaily.com/releases/2012/08/120815121318.htm

The Arctic "Big Melt"

On July 8, 2012 about **40 percent** of the ice sheet had undergone thawing at or near the surface. In just a few days, the melting had dramatically accelerated and an estimated **97 percent** of the ice sheet surface had thawed by July 12.

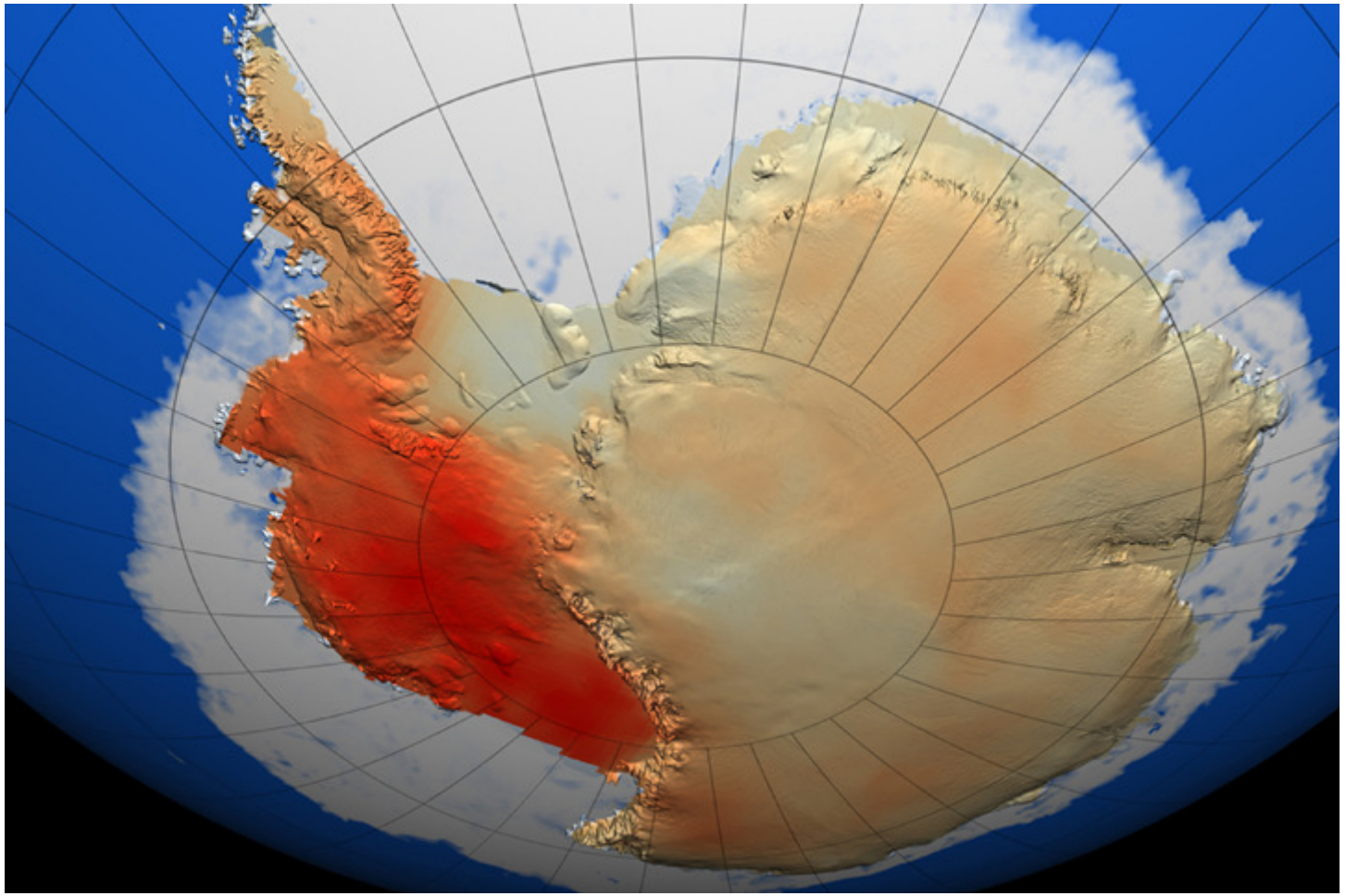
"With more yet to come in August, this year's overall melting will fall way above the old records. That's a goliath year - the greatest melt since satellite recording began in 1979."
Prof. Marco Tedesco, Cryocity Cryospheric Processes Laboratory, City College New York



http://www.nasa.gov/topics/earth/features/greenland-melt.html
"Greenland Melting Breaks Record Four Weeks Before Season's End", ScienceDaily, 15 August, 2012, http://www.sciencedaily.com/releases/2012/08/120815121318.htm

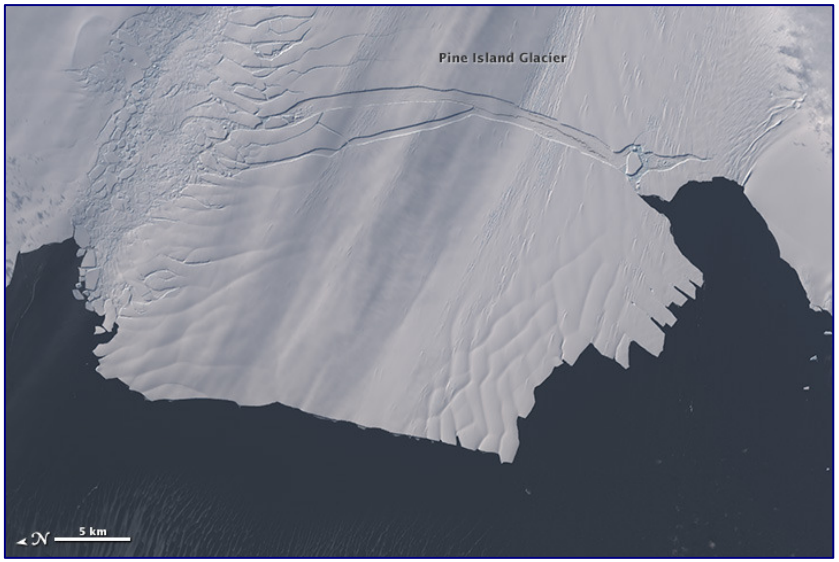
Antarctic Warming

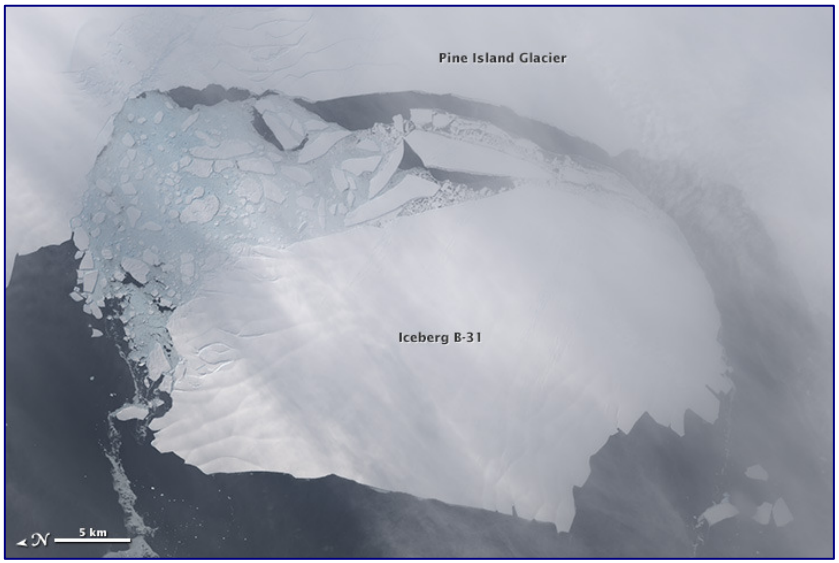
Antarctic Warming



NASA Earth Observatory, Antarctic Warming Trends, 23 Jan 2009, http://earthobservatory.nasa.gov/IOTD/view.php?id=36736

Antarctic Warming

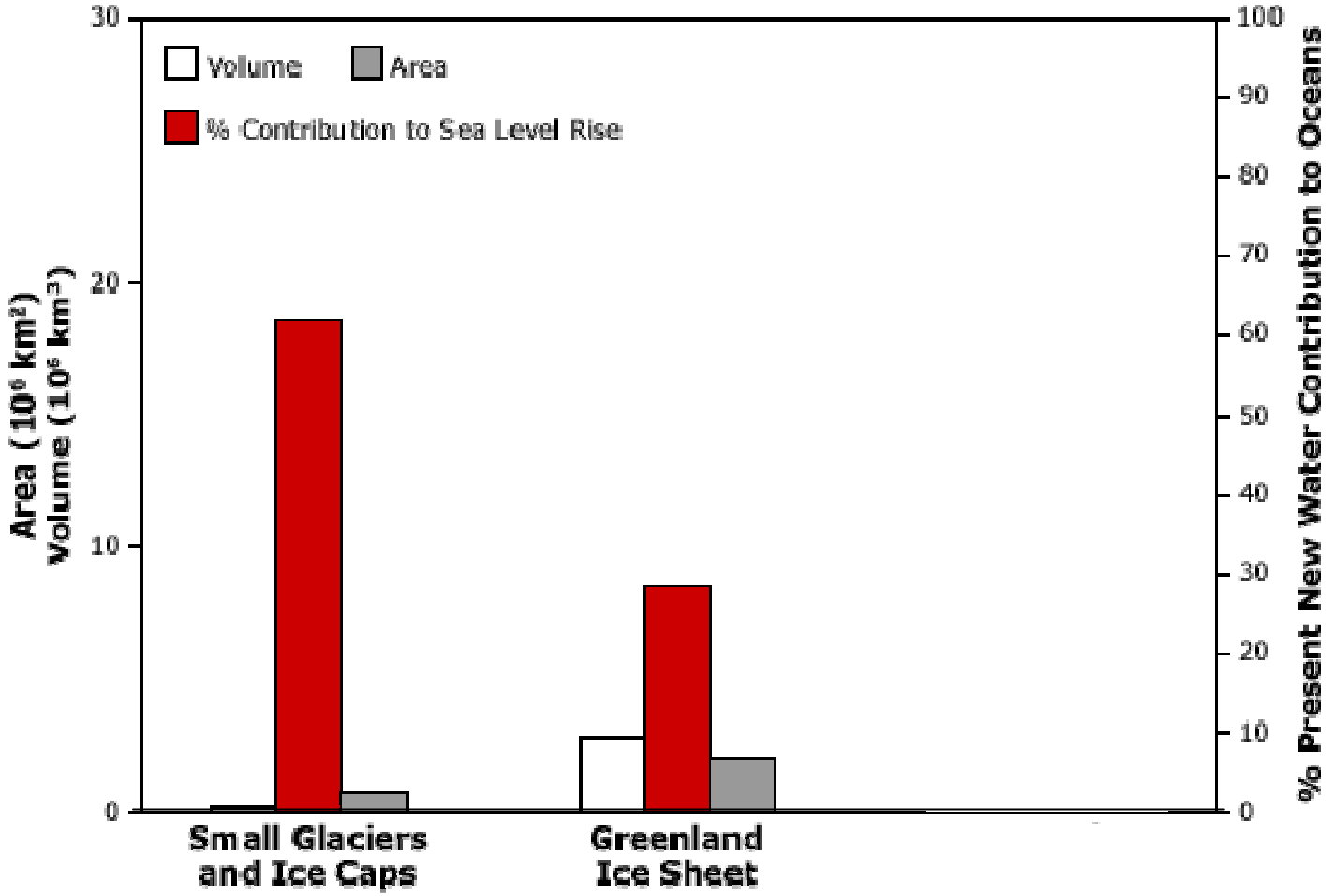




Between November 9–11, 2013, a large iceberg finally separated from the calving front of Antarctica's Pine Island Glacier . . . Named B-31 by the U.S. National Ice Center, the new iceberg is estimated to be 35 kilometers by 20 kilometers (21 by 12 miles), roughly the size of Singapore.

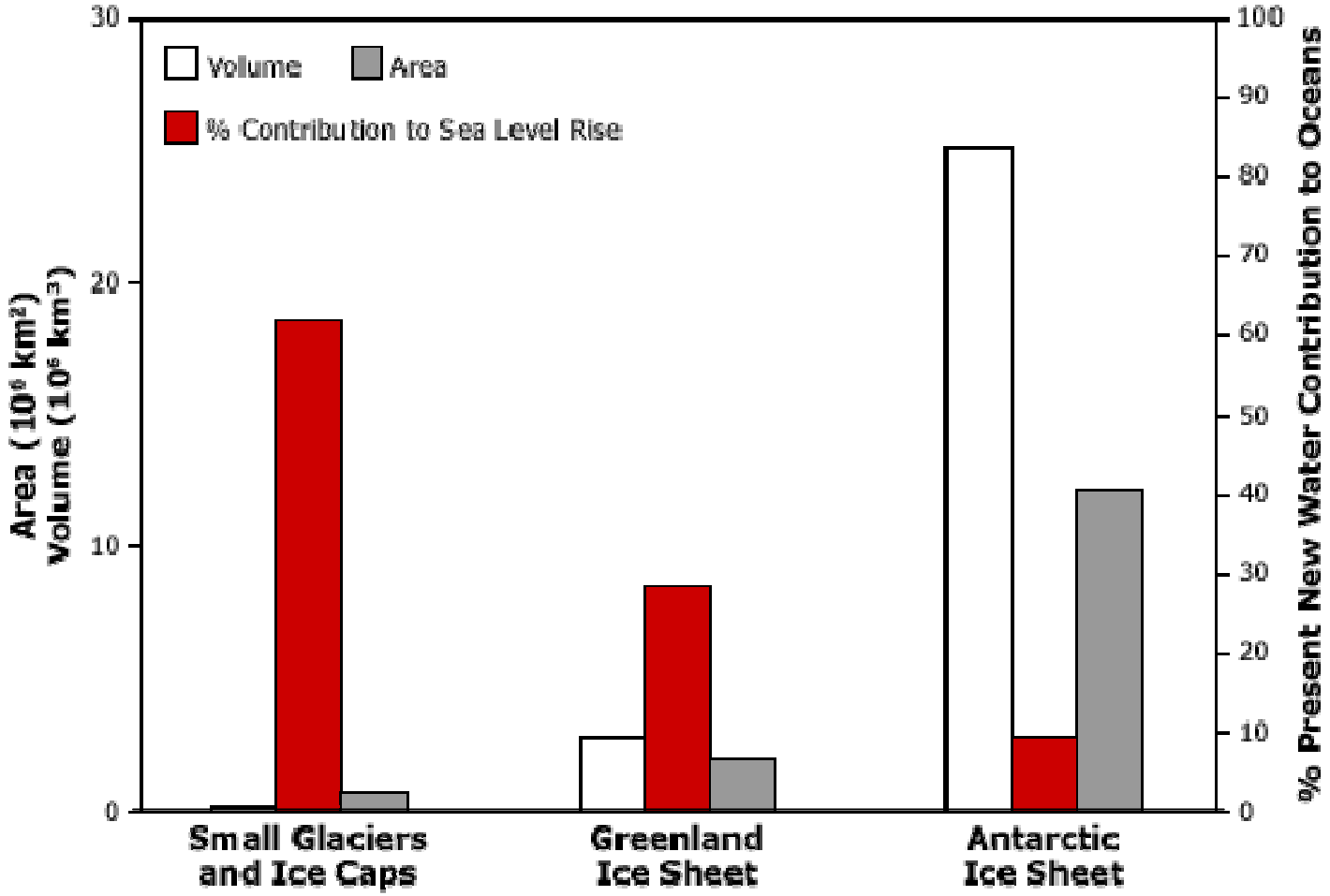
NASA Earth Observatory, Major Iceberg Cracks off Pine Island Glacier, http://earthobservatory.nasa.gov/IOTD/view.php?id=82392

All Ice Sheets and Glaciers



NSIDC, "The Contribution of the Cryosphere to Changes in Sea Level", http://nsidc.org/cryosphere/sotc/sea_level.html

All Ice Sheets and Glaciers



NSIDC, "The Contribution of the Cryosphere to Changes in Sea Level", http://nsidc.org/cryosphere/sotc/sea_level.html

Global sea level rise

Projections to 2100:

IPCC:	Up to 1 metre (but higher values cannot be excluded)
Vermeer and Rahmstorf:	nearly 2 metres
Hansen:	**Likely several metres (see next slide) if we continue with "business as usual", depending on impact of negative (diminishing) feedbacks.**

Impacts:

Experienced through **"high sea-level events"** .

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

Increased likelihood with **0.5 of a metre**: **100 to 1,000 fold increase**

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

Spratt, D, "NASA climate chief demolishes denialist claims on sea levels", 26 Oct 2012, http://www.climatecodered.org/2012/10/nasa-climate-chief-demolishes-denialist.html and Hansen, J & Sato, M "Update of Greenland Ice Sheet Mass Loss: Exponential?", 26 Dec 2012

Global sea level rise

What about IPCC's projection of less than 1 metre?

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.

Spratt, D and Sutton, P, "Climate Code Red: The case for emergency action", Scribe, 2008, p. 47

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".

Spratt, D, "Global Warming – No more business as usual: This is an emergency!", Environmental Activists' Conference 2008: Climate Emergency – No More Business as Usual, 10 October, 2008, reproduced in Links International Journal of Socialist Renewal, http://links.org.au/node/683 (Accessed 4 February 2012)

Permafrost

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 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

Dramatic and unprecedented

"We carried out checks at about 115 stationary points and discovered methane fields of a fantastic scale - I think on a scale not seen before. Some of the plumes were a kilometre or more wide and the emissions went directly into the atmosphere - the concentration was a hundred times higher than normal,"

Dr Igor Semiletov of the International Arctic Research Centre at the University of Alaska Fairbanks

…ever before witnessed the scale and force of the methane being released from beneath the Arctic seabed.

Reuters, "Arctic methane release could cost economy $60 trillion: Study", 24 July, 2013

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

Cambridge University and Erasmus University (Netherlands):

Scenario of 50 gigatonne release of methane from under East Siberian Sea over a decade

An "economic time-bomb"

Increase global climate change impacts by $60 trillion

Annual value of global economy is $70 trillion

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

Reuters, "Arctic methane release could cost economy $60 trillion: Study", 24 July, 2013

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)

Some tangible results of changes in the Arctic, Antarctica and elsewhere in the form of extreme weather events

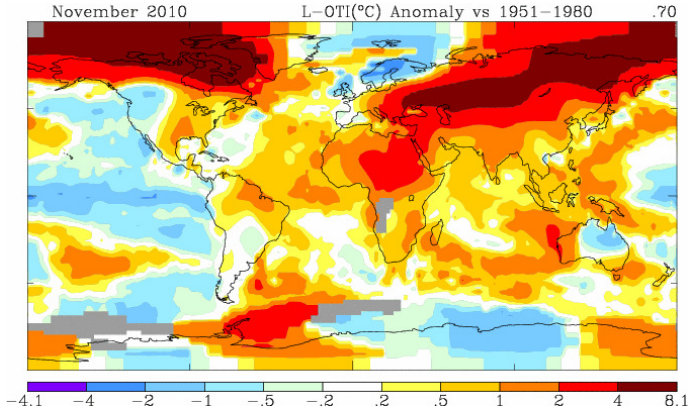
Extreme Weather (Storms)

"Further warming of the Greenland ice sheet and of the west and east Antarctic ice sheets may lead to pulses of ice-melt water which will cool adjacent ocean basins."

"The bulk of the continents continue to heat, due to a rise in greenhouse gases, feedbacks from fires, methane release from permafrost and reduction of CO2 intake by warming oceans."

"The resultant ocean-land temperature polarity generates storms, reflected in the title of James Hansen's book, 'Storms of my grandchildren'."

"Similar conditions developed in November 2010 as north Siberia and Canada warmed to above 4°C relative to 1951-1980 while snow storms occurred in the North Atlantic."



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).

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

Extreme Weather (Storms)

Also:

Latent heat (more prevalent with more water vapour and provides more energy to fuel storms)

Warm land mass (and moisture in the atmosphere behind the warm front) and colder oceans elsewhere from melting ice (previous slide)

Hansen, J., “Storms of my grandchildren”, Bloomsbury, 2009, pp. 253-257 and Image: Jhanz (Dreamstime.com)

The link between extreme weather and global warming – Kevin Trenberth

I find it systematically tends to get underplayed . . .
Because one of the opening statements . . . is ***"Well you can't attribute a single event to climate change."***

Dr. Kevin Trenberth, former head of the Climate Analysis Section of the National Center for Atmospheric Research, quoted in Romm, J. "Tornadoes, Extreme Weather And Climate Change, Revisited", Climate Progress, 21 May, 2013
http://thinkprogress.org/climate/2013/05/21/2040221/tornadoes-extreme-weather-and-climate-change-revisited/

The link between extreme weather and global warming – Kevin Trenberth

I find it systematically tends to get underplayed . . . Because one of the opening statements . . . is ***"Well you can't attribute a single event to climate change."***

But there is a **systematic influence** on all of these weather events now-a-days 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, former head of the Climate Analysis Section of the National Center for Atmospheric Research, quoted in Romm, J. "Tornadoes, Extreme Weather And Climate Change, Revisited", Climate Progress, 21 May, 2013
http://thinkprogress.org/climate/2013/05/21/2040221/tornadoes-extreme-weather-and-climate-change-revisited/

The link between extreme weather and global warming – Kevin Trenberth

It's about a 4% extra amount, it invigorates the storms, it provides plenty of moisture for these storms and it's unfortunate that the public is not associating these with the fact that **this is one manifestation of climate change**.

Dr. Kevin Trenberth, former head of the Climate Analysis Section of the National Center for Atmospheric Research, quoted in Romm, J. "Tornadoes, Extreme Weather And Climate Change, Revisited", Climate Progress, 21 May, 2013
http://thinkprogress.org/climate/2013/05/21/2040221/tornadoes-extreme-weather-and-climate-change-revisited/

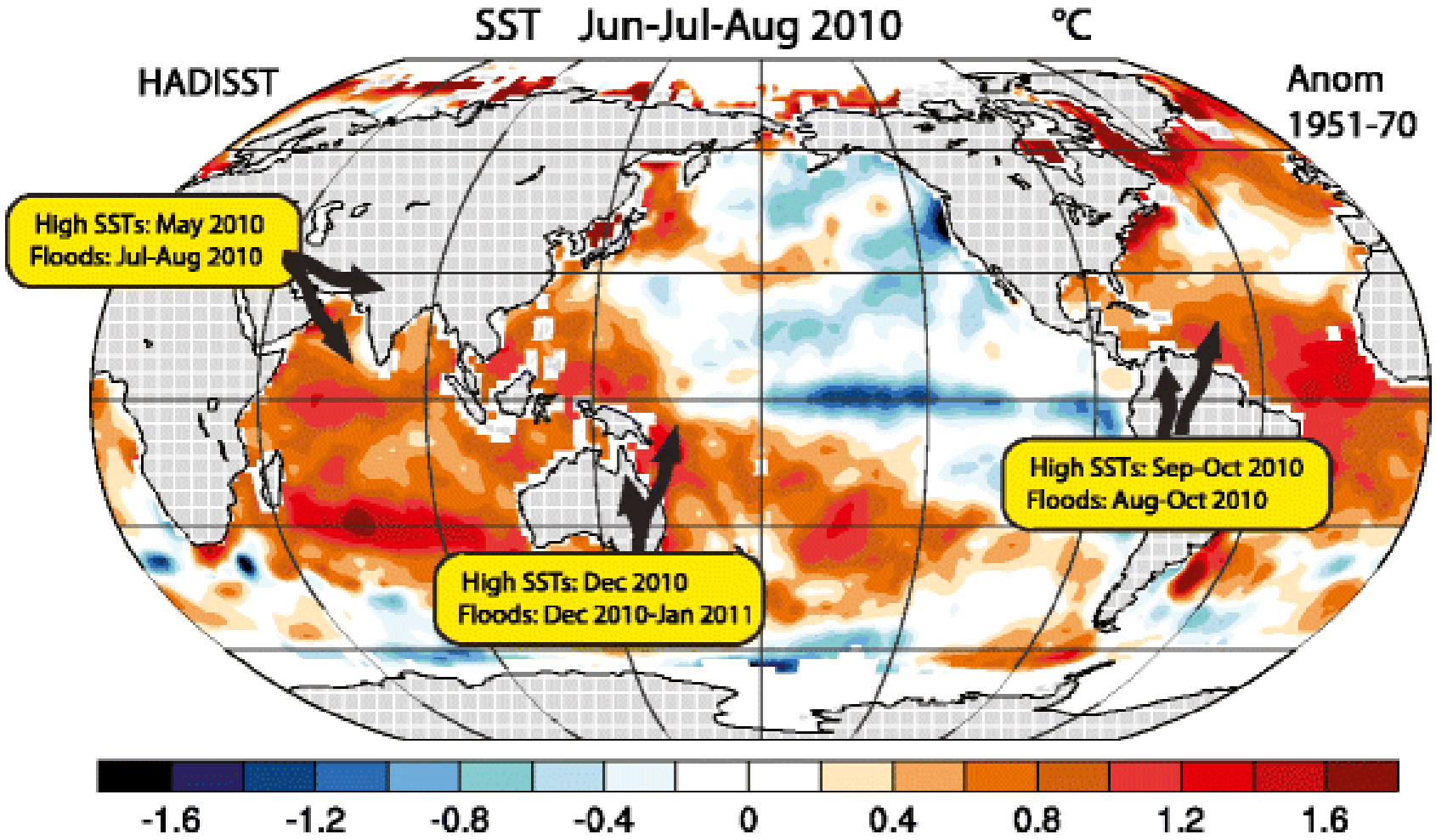
The link between extreme weather and global warming – Kevin Trenberth

It's about a 4% extra amount, it invigorates the storms, it provides plenty of moisture for these storms and it's unfortunate that the public is not associating these with the fact that **this is one manifestation of climate change**.

And the prospects are that these kinds of ***things will only get bigger and worse in the future***.

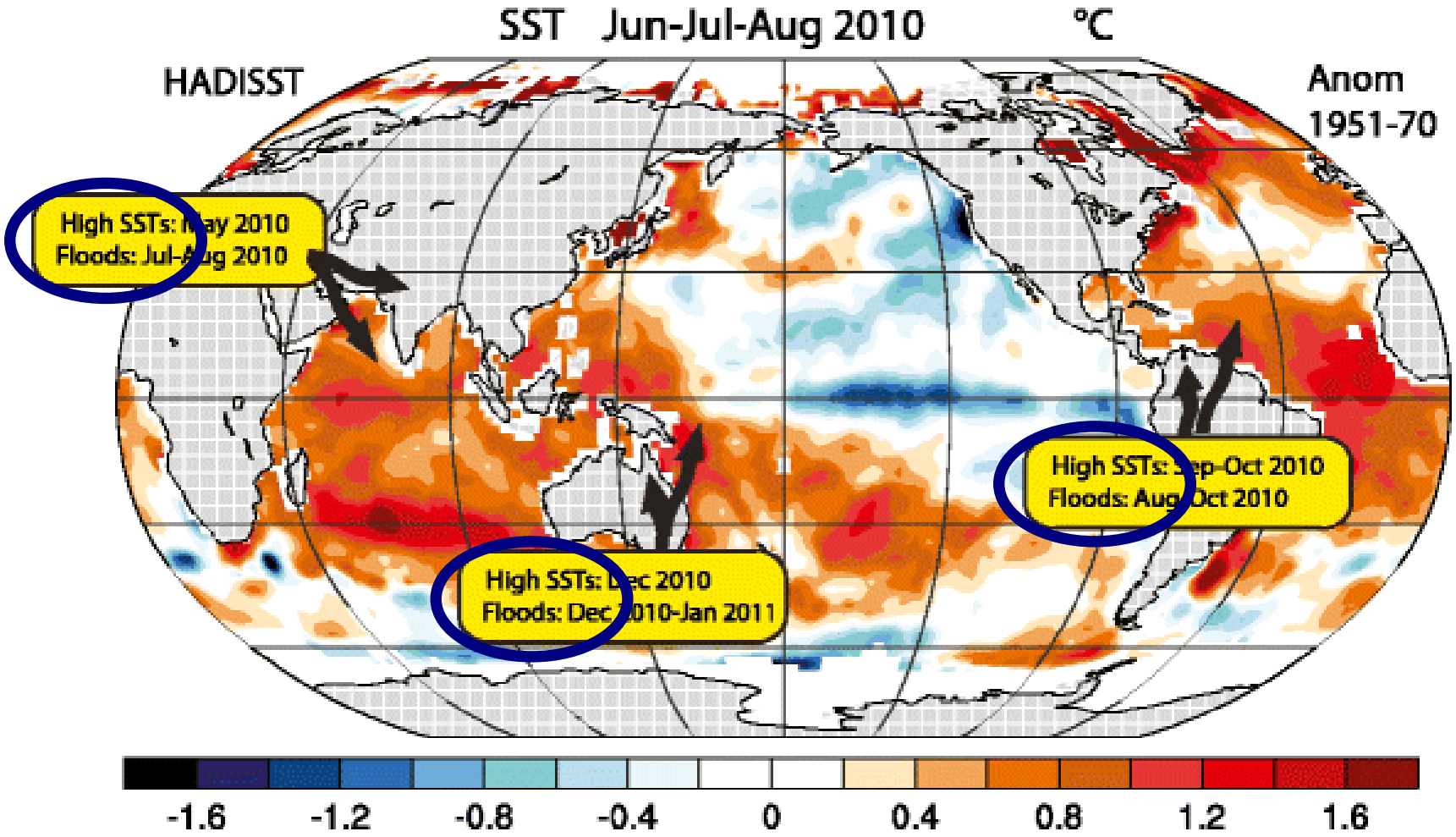
Dr. Kevin Trenberth, former head of the Climate Analysis Section of the National Center for Atmospheric Research, quoted in Romm, J. "Tornadoes, Extreme Weather And Climate Change, Revisited", Climate Progress, 21 May, 2013
http://thinkprogress.org/climate/2013/05/21/2040221/tornadoes-extreme-weather-and-climate-change-revisited/

High Sea Surface Temperatures and Floods – Kevin Trenberth (SST = "sea surface temperature")



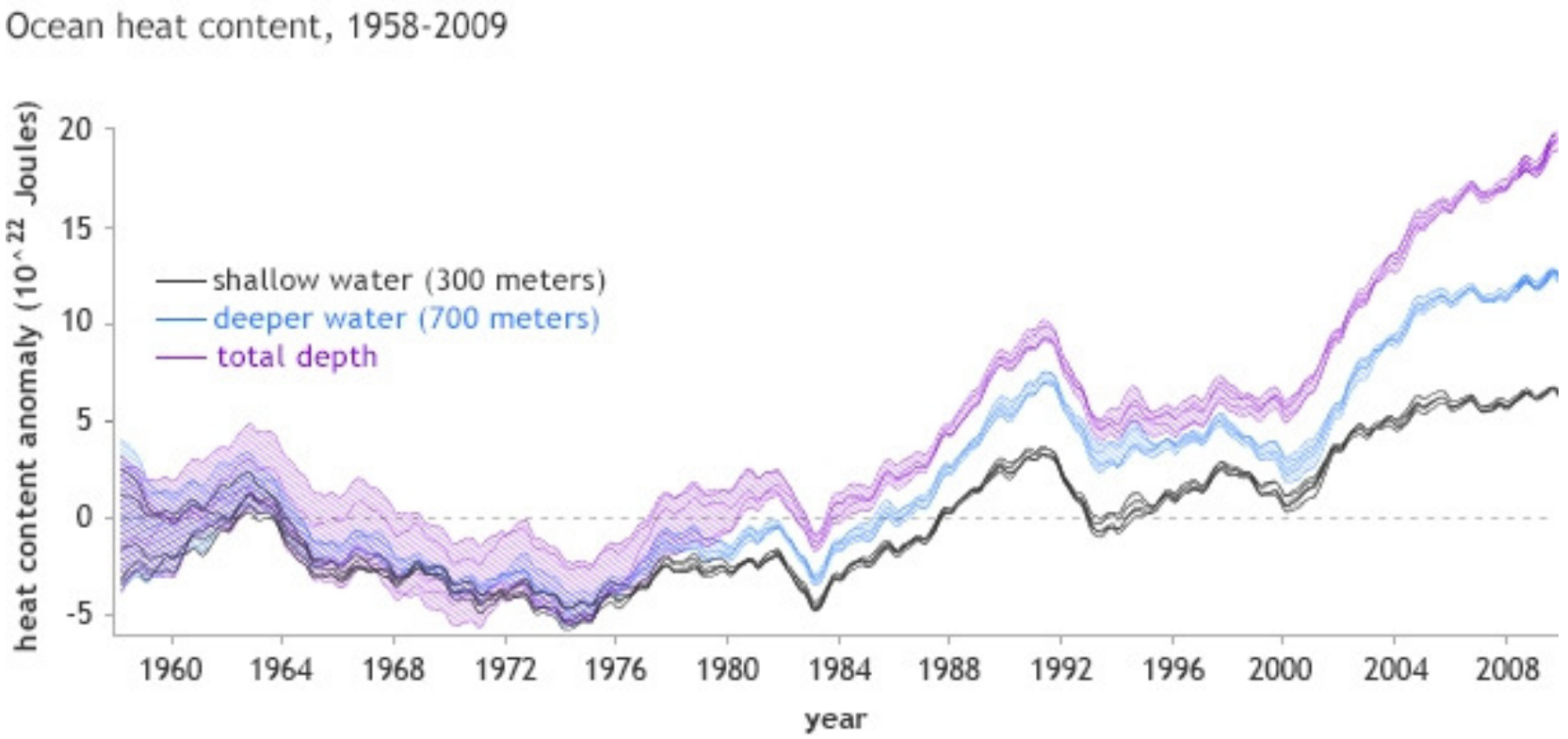
Dr. Kevin Trenberth, "Framing the way to relate climate extremes to climate change", Climatic Change, November 2012, Volume 115, Issue 2, pp 283-290, http://link.springer.com/article/10.1007%2Fs10584-012-0441-5/fulltext.html and http://download.springer.com/static/pdf/618/art%253A10.1007%252Fs10584-012-0441-5.pdf?auth66=1385578067_f8586f44b3eb6d6600165a7d12d3a6ae&ext=.pdf, cited in Romm, J., "Must-Read Trenberth: How to Relate Climate Extremes to Climatic Change", Climate Progress, 25 March, 2012, http://thinkprogress.org/climate/2012/03/25/451347/must-read-trenberth-how-to-relate-climate-extremes-to-climate-change/

High Sea Surface Temperatures and Floods – Kevin Trenberth (SST = "sea surface temperature")



Dr. Kevin Trenberth, "Framing the way to relate climate extremes to climate change", Climatic Change, November 2012, Volume 115, Issue 2, pp 283-290, http://link.springer.com/article/10.1007%2Fs10584-012-0441-5/fulltext.html and http://download.springer.com/static/pdf/618/art%253A10.1007%252Fs10584-012-0441-5.pdf?auth66=1385578067_f8586f44b3eb6d6600165a7d12d3a6ae&ext=.pdf, cited in Romm, J., "Must-Read Trenberth: How to Relate Climate Extremes to Climatic Change", Climate Progress, 25 March, 2012, http://thinkprogress.org/climate/2012/03/25/451347/must-read-trenberth-how-to-relate-climate-extremes-to-climate-change/

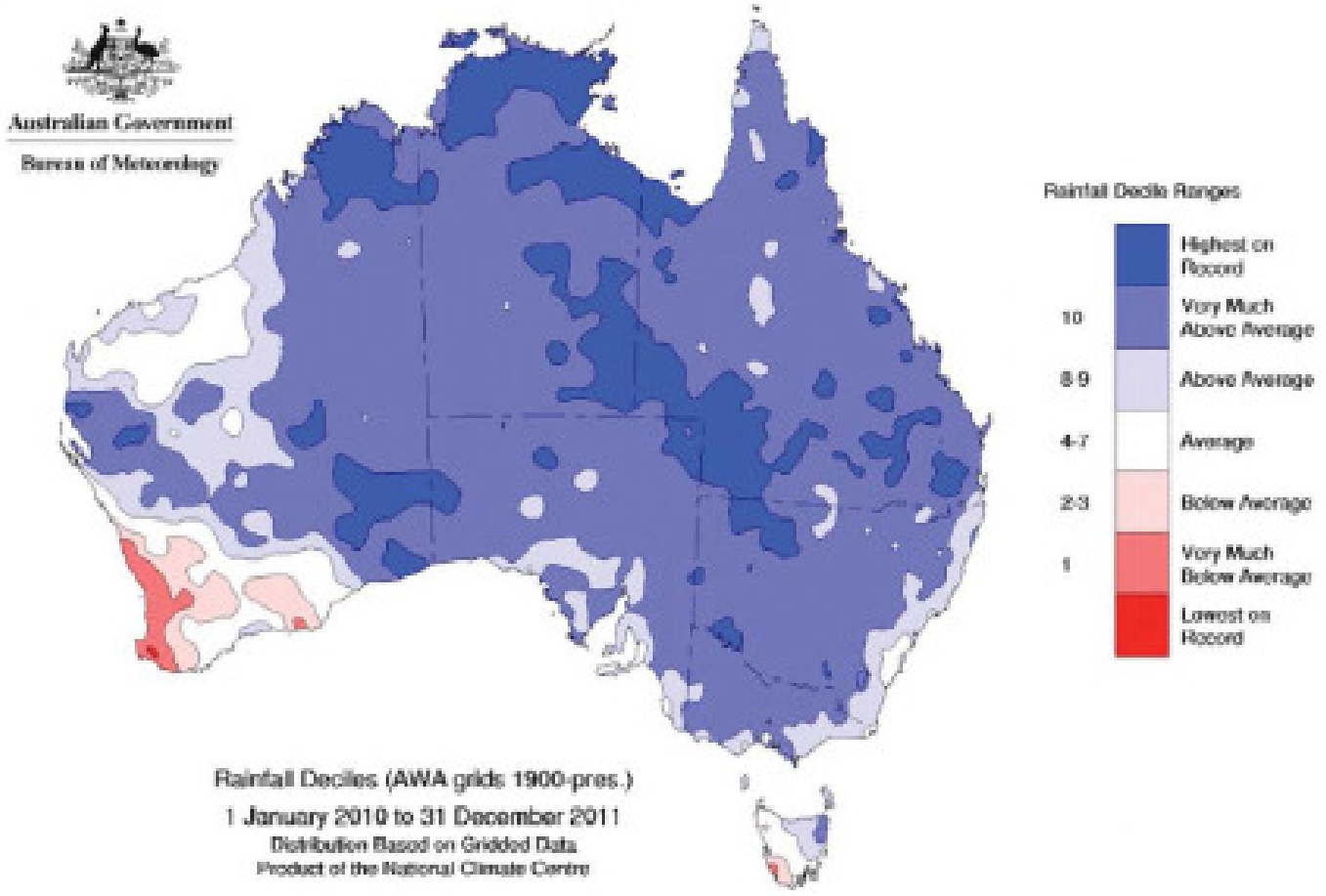
Ocean Warming



NOAA, *"Why did Earth's surface temperature stop rising in the past decade?",* 8 Nov 2013, http://www.climate.gov/news-features/climate-qa/why-did-earth%E2%80%99s-surface-temperature-stop-rising-past-decade Adapted from Magdalena A. Balmaseda, Kevin E. Trenberth, Erland Källé, *"Distinctive climate signals in reanalysis of global ocean heat content",* Geophysical Research Letters, Volume 40, Issue 9, pages 1754–1759, 16 May 2013 http://onlinelibrary.wiley.com/doi/10.1002/grl.50382/abstract and http://www.cgd.ucar.edu/cas/Trenberth/website-archive/trenberth.papers-moved/Balmaseda_Trenberth_Kallen_grl_13.pdf

Evidence from CSIRO and BOM

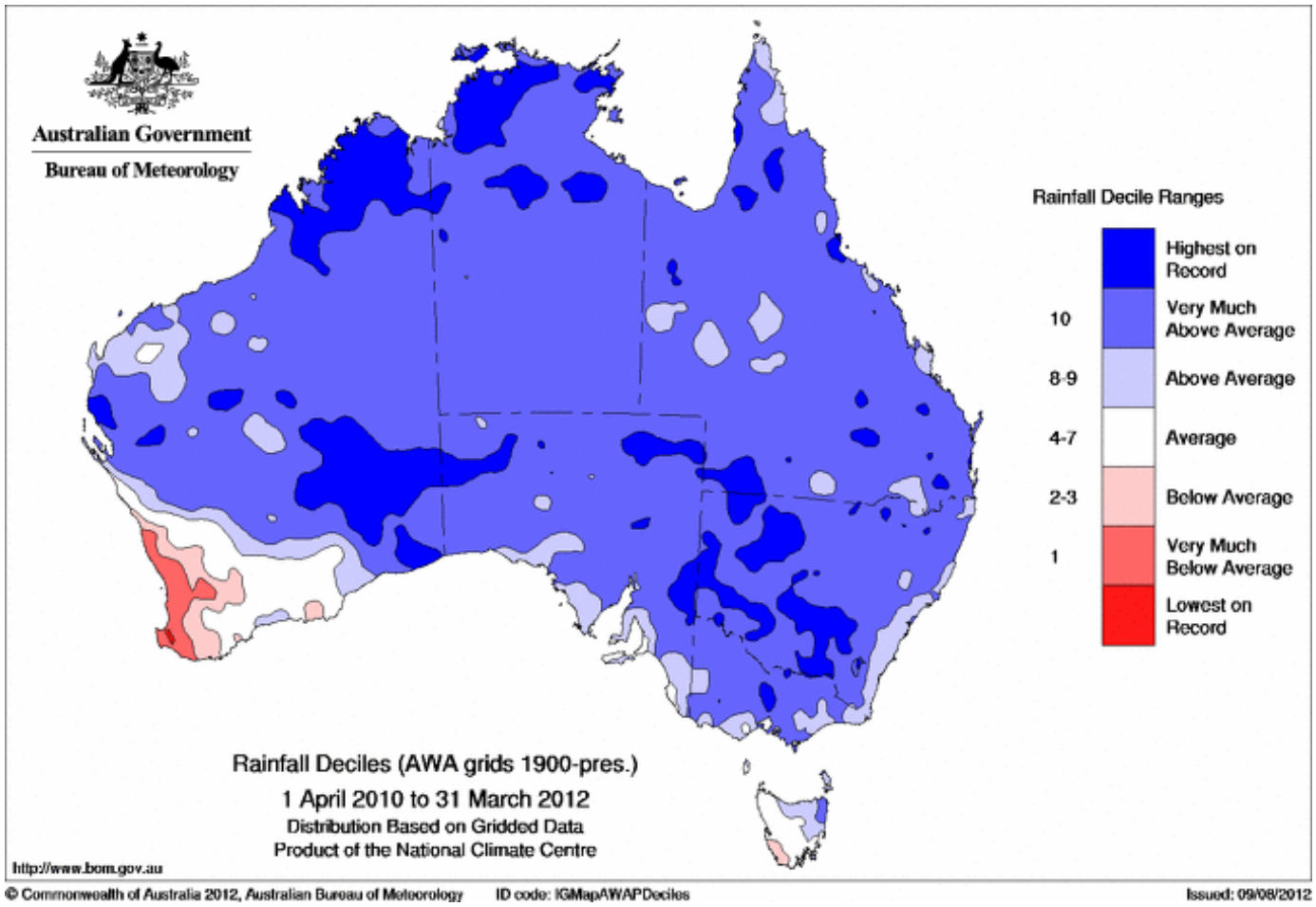
Record and above average rainfall 2 years to Mar '12



Source: Bureau of Meteorology

Evidence from CSIRO and BOM

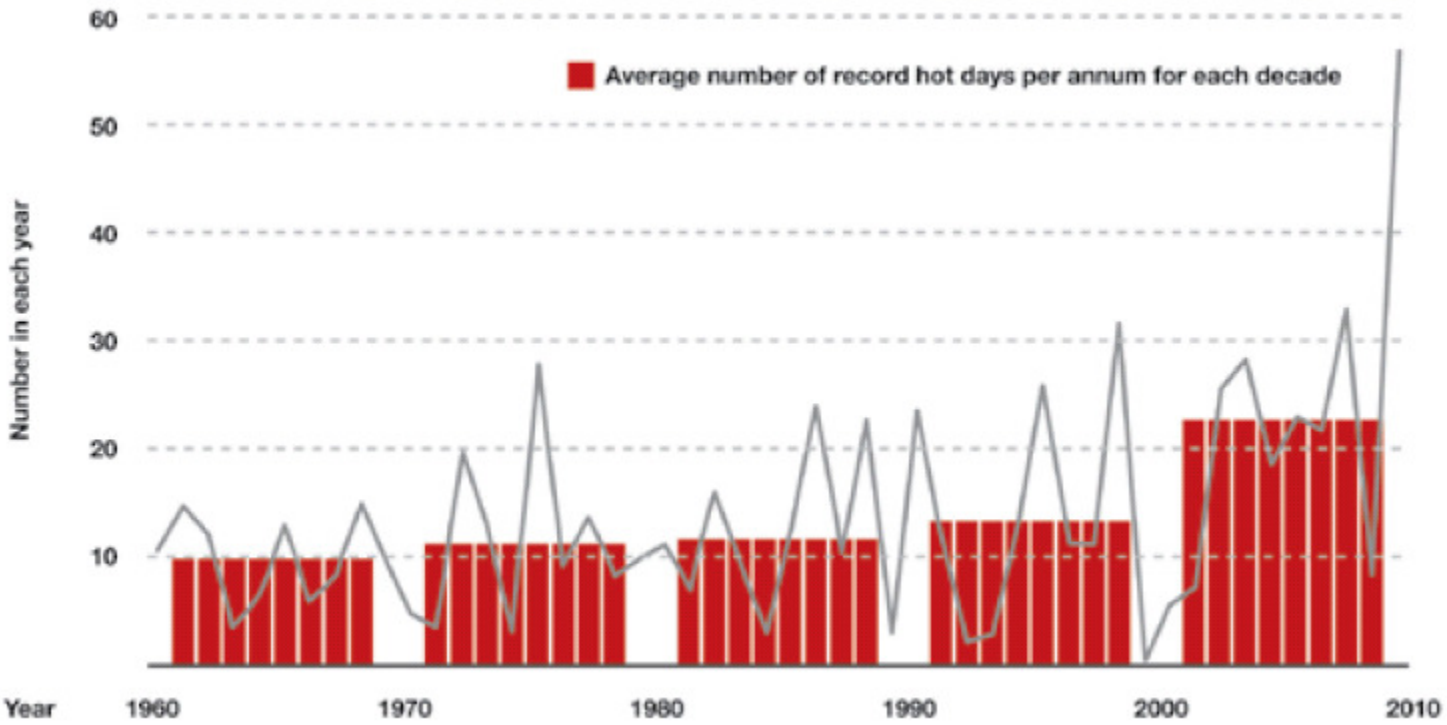
Record and above average rainfall 1 Jan ’97 – 31/12/11



Source: Bureau of Meteorology cited in Climate Commission “Critical Decade: Extreme Weather”

Evidence from CSIRO and BOM

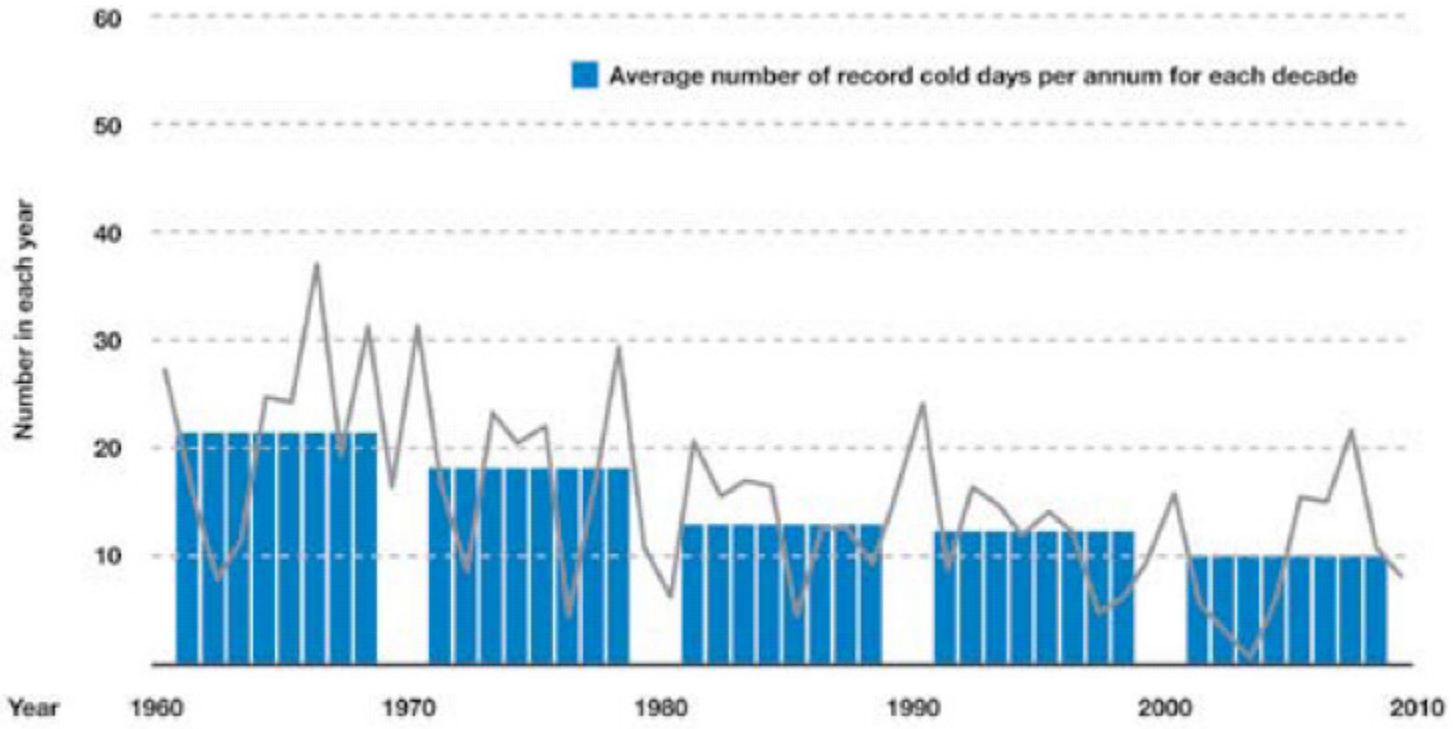
Record hot days



Source: CSIRO and Bureau of Meteorology, cited in Australian Academy of Science, *"The Science of Climate Change: Questions and Answers"*, Aug 2010, Fig 3.3 http://www.science.org.au/reports/climatechange2010.pdf

Evidence from CSIRO and BOM

Record cold days

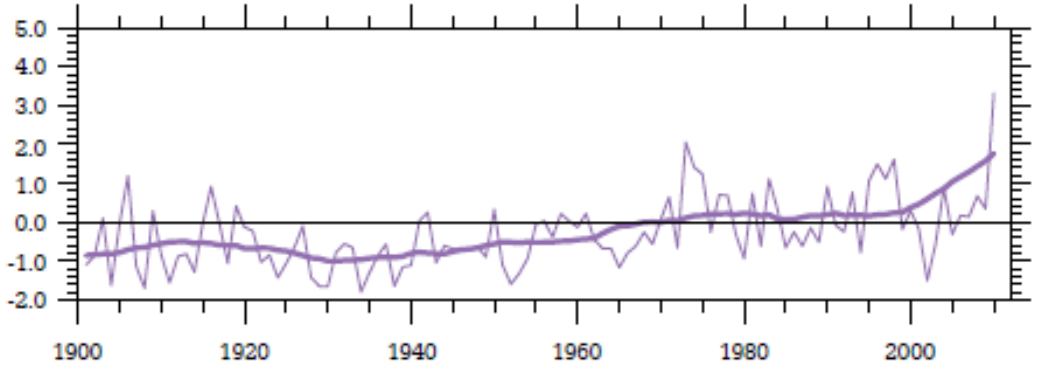


Source: CSIRO and Bureau of Meteorology, cited in Australian Academy of Science, *"The Science of Climate Change: Questions and Answers"*, Aug 2010, Fig 3.3 http://www.science.org.au/reports/climatechange2010.pdf

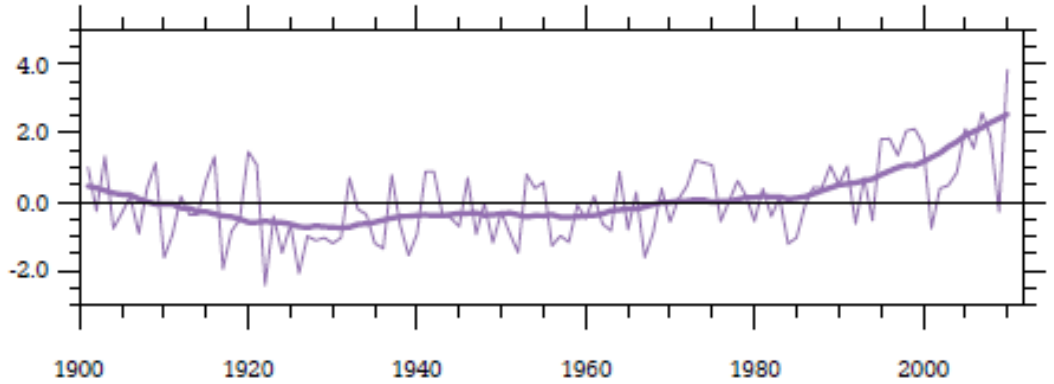
Evidence from Climate Commission

Global average rainfall trends 1900 – 2010

(a) the number of heavy precipitation days



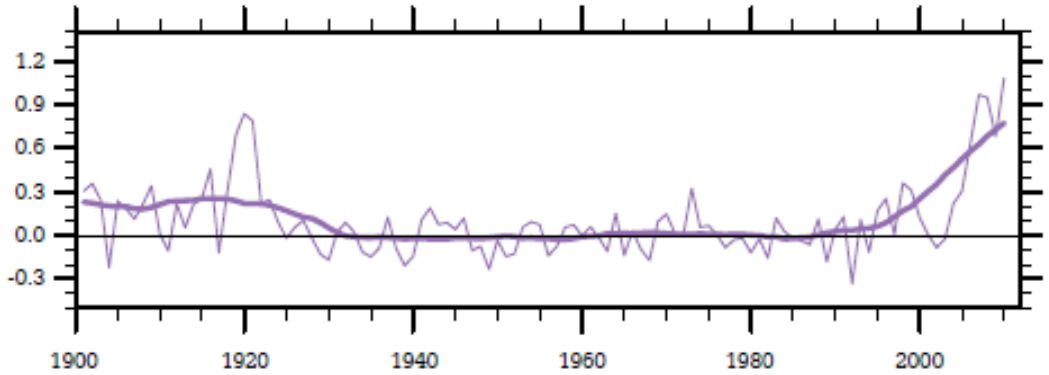
(b) the contribution from very wet days to the total rainfall, in percentage



Source: Donat, M.G., et al (2013a). Updated analyses of temperature and precipitation extreme indices since the beginning of the twentieth century: The HadEX2 dataset, Journal of Geophysical Research: Atmosphere 118 doi:10.1002/jgrd.50150, cited in Climate Commission" Critical Decade: Extreme Weather", April 2013

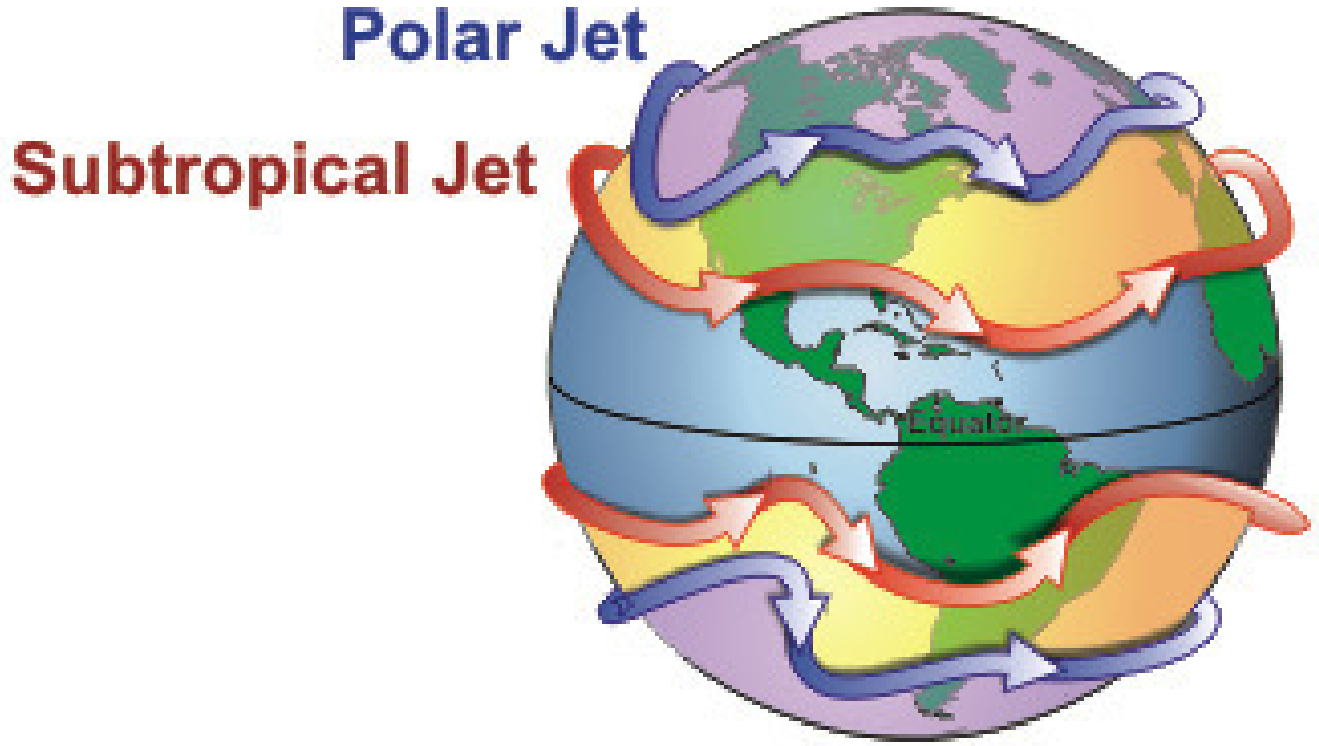
Evidence from Climate Commission

(c) a simple rainfall intensity index in mm per day (index defined in Donat et al. 2013).



Source: Donat, M.G., et al (2013a). Updated analyses of temperature and precipitation extreme indices since the beginning of the twentieth century: The HadEX2 dataset, Journal of Geophysical Research: Atmosphere 118 doi:10.1002/jgrd.50150, cited in Climate Commission" Critical Decade: Extreme Weather", April 2013

Extreme Weather



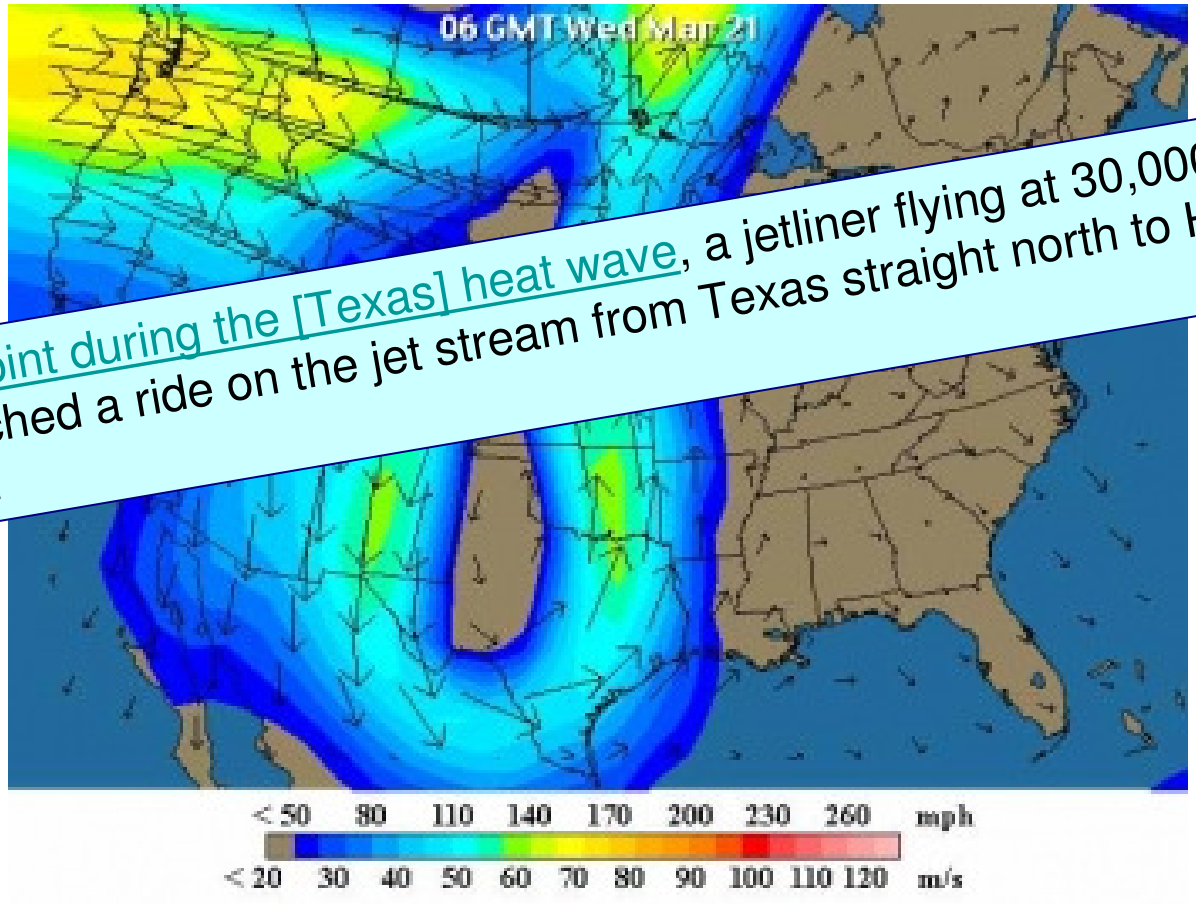
The jet stream is becoming "wavier," with steeper troughs and higher ridges.

Weather systems are progressing more slowly, raising the chances for long-duration extreme events

Image: National Weather Service JetStream - Online School for Weather http://www.srh.noaa.gov/jetstream/global/jet.htm

Jennifer A. Francis, Stephen J. Vavrus, "Evidence linking Arctic amplification to extreme weather in mid-latitudes", Geophysical Research Letters Volume 39, Issue 6, March 2012, http://onlinelibrary.wiley.com/doi/10.1029/2012GL051000/abstract cited in Freedman, A., "Arctic Warming is Altering Weather Patterns, Study Shows", 30 Sep, 2012, http://www.climatecentral.org/news/arctic-warming-is-altering-weather-patterns-study-shows/

Extreme Weather



At one point during the [Texas] heat wave, a jetliner flying at 30,000 feet could have hitched a ride on the jet stream from Texas straight north to Hudson Bay, Canada.

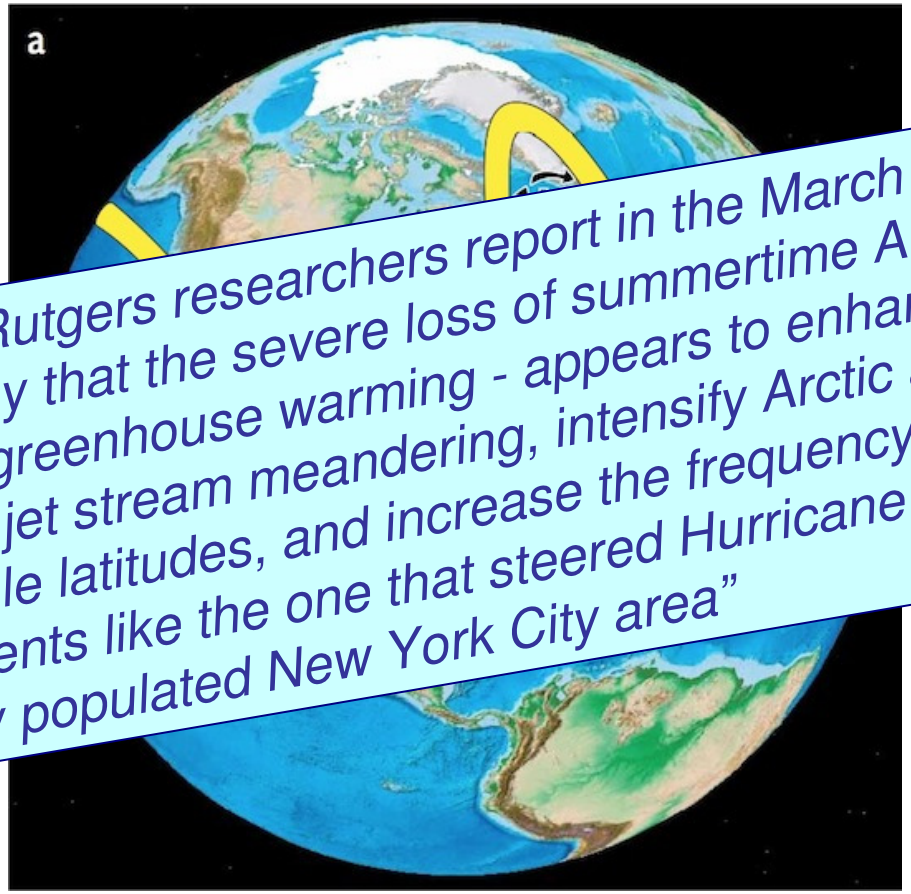
Image: From Weatherunderground, cited in Freedman, A., "Arctic Warming is Altering Weather Patterns, Study Shows", 30 Sep, 2012, http://www.climatecentral.org/news/arctic-warming-is-altering-weather-patterns-study-shows/

Jennifer A. Francis, Stephen J. Vavrus, "Evidence linking Arctic amplification to extreme weather in mid-latitudes", Geophysical Research Letters Volume 39, Issue 6, March 2012, http://onlinelibrary.wiley.com/doi/10.1029/2012GL051000/abstract cited in Freedman, A., "Arctic Warming is Altering Weather Patterns, Study Shows", 30 Sep, 2012, http://www.climatecentral.org/news/arctic-warming-is-altering-weather-patterns-study-shows/

Superstorm Sandy October 2012

Greene, C.H., J.A. Francis, and B.C. Monger. 2013. "Superstorm Sandy: A series of unfortunate events?" Oceanography 26(1):8–9, http://dx.doi.org/10.5670/oceanog.2013.11 and http://www.tos.org/oceanography/archive/26-1_greene.pdf , cited in "How Arctic Ice Loss Amplified Superstorm Sandy — Oceanography Journal", Joe Romm, Climate Progress, 15 March, 2013 http://thinkprogress.org/climate/2013/03/15/1725461/how-arctic-ice-loss-amplified-superstorm-sandy-oceanography-journal/

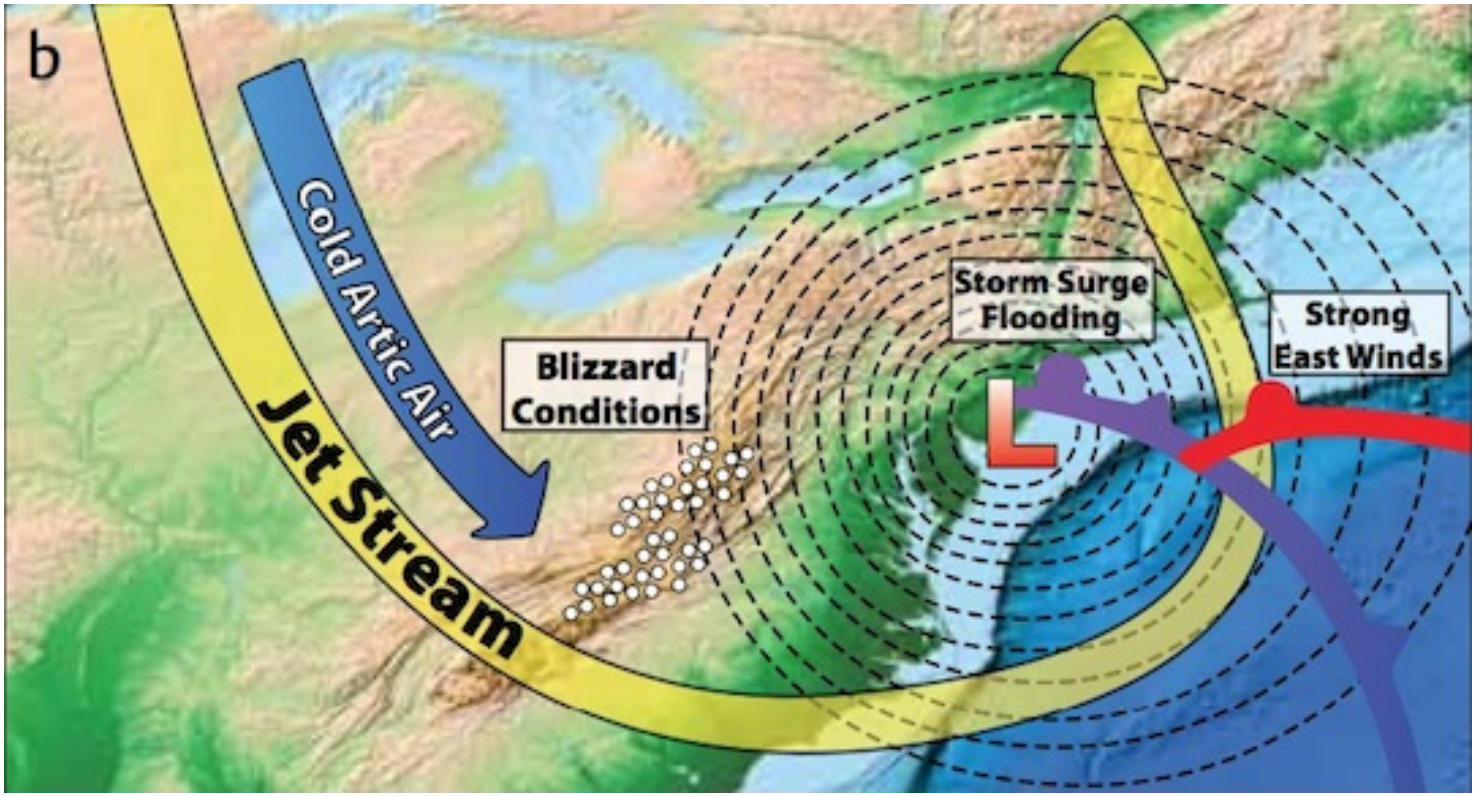
Superstorm Sandy October 2012



"Cornell and Rutgers researchers report in the March issue of Oceanography that the severe loss of summertime Arctic sea ice - attributed to greenhouse warming - appears to enhance Northern Hemisphere jet stream meandering, intensify Arctic air mass invasions toward middle latitudes, and increase the frequency of atmospheric blocking events like the one that steered Hurricane Sandy west into the densely populated New York City area"

Greene, C.H., J.A. Francis, and B.C. Monger. 2013. "Superstorm Sandy: A series of unfortunate events?" Oceanography 26(1):8–9, http://dx.doi.org/10.5670/oceanog.2013.11 and http://www.tos.org/oceanography/archive/26-1_greene.pdf , cited in "How Arctic Ice Loss Amplified Superstorm Sandy — Oceanography Journal", Joe Romm, Climate Progress, 15 March, 2013 http://thinkprogress.org/climate/2013/03/15/1725461/how-arctic-ice-loss-amplified-superstorm-sandy-oceanography-journal/

Superstorm Sandy October 2012



Greene, C.H., J.A. Francis, and B.C. Monger. 2013. "Superstorm Sandy: A series of unfortunate events?" Oceanography 26(1):8–9, http://dx.doi.org/10.5670/oceanog.2013.11 and http://www.tos.org/oceanography/archive/26-1_greene.pdf , cited in "How Arctic Ice Loss Amplified Superstorm Sandy — Oceanography Journal", Joe Romm, Climate Progress, 15 March, 2013 http://thinkprogress.org/climate/2013/03/15/1725461/how-arctic-ice-loss-amplified-superstorm-sandy-oceanography-journal/

Natural Catastrophes 1980 – 2012 (Munich Re)

Period	Event	Affected Area	Overall losses	Insured losses	Fatalities
			US$ m, original values		
11.3.2011	Earthquake, tsunami	Japan: Honshu, Aomori, Tohoku; Miyagi, Sendai; Fukushima, Mito; Ibaraki; Tochigi, Utsunomiya	210,000	40,000	15,840
25-30.8.2005	Hurricane Katrina, storm surge	USA: LA, New Orleans, Slidell; MS, Biloxi, Pascagoula, Waveland, Gulfport	125,000	62,200	1,322
17.1.1995	Earthquake	Japan: Hyogo, Kobe, Osaka, Kyoto	100,000	3,000	6,430
12.5.2008	Earthquake	China: Sichuan, Mianyang, Beichuan, Wenchuan, Shifang, Chengdu, Guangyuan, Ngawa, Ya'an	85,000	300	84,000
24-31.10.2012	Hurricane Sandy, storm surge	Bahamas, Cuba, Dominican Republic, Haiti, Jamaica, Puerto Rico, USA, Canada	65,000	30,000	210
17.1.1994	Earthquake	USA: CA, Northridge, Los Angeles, San Fernando Valley, Ventura, Orange	44,000	15,300	61
1.8-15.11.2011	Floods	Thailand: Phichit, Nakhon Sawan, Phra Nakhon Si Ayuttaya, Pathumthani, Nonthaburi, Bangkok	43,000	16,000	813
6-14.9.2008	Hurricane Ike	Cuba, Haiti, Dominican Republic, Turks and Caicos Islands, Bahamas, USA	38,000	18,500	170
May - Sept 1998	Floods	China: Jangtsekiang, Songhua Jiang	30,700	1,000	4,159
27.2.2010	Earthquake, tsunami	Chile: Bió Bió, Concepción, Talcahuano, Coronel, Dichato, Chillán; Del Maule, Talca, Curicó	30,000	8,000	520

As at: March 2013

Natural Catastrophes - Australia (2011 Dollars)

Event	Year	Location	State	Loss (AUD$)	Normalised Loss* (2011) (AUD$)
Hailstorms	1999	Sydney	NSW	1,700,000,000	4,296,000,000
Tropical Cyclone Tracy	1974	Darwin	NT	200,000,000	4,090,000,000
Earthquake	1989	Newcastle	NSW	862,000,000	3,240,000,000
Flood	1974	Brisbane	QLD	68,000,000	2,645,000,000
Flood	2010/11	Multiple	QLD	2,380,000,000	2,380,000,000
Hailstorm	1985	Brisbane	QLD	180,000,000	2,063,000,000
Ash Wednesday Bushfires	1983	Multiple	VIC/SA	176,000,000	1,796,000,000
Severe Storm	2007	Multiple	NSW	1,480,000,000	1,742,000,000
Tropical Cyclone Madge	1973	Multiple	QLD/NT/WA	30,000,000	1,492,000,000
Tropical Cyclone Yasi	2011	Multiple	QLD	1,300,000,000	1,352,000,000

Insurance Council of Australia, “Catastrophe Events and the Community”, http://www.insurancecouncil.com.au/issue-submissions/issues/catastrophe-events

Change in risk levels
(likelihood and consequences)

High and Extreme Risk - Maplecroft

Maplecroft is a US-based risk consulting firm providing a portfolio of risk analytics, country risk research, mapping and risk calculator technology to multinational corporations, financial institutions, governments and NGOs.

Maplecroft: http://maplecroft.com/about/introducing-maplecroft/

High and Extreme Risk - Maplecroft

31% of global economic output will be based in countries facing **'high' or 'extreme' risks** from the impacts of climate change by 2025.

That's a **50% increase** on current levels and more than double **since** Maplecroft began researching the issue in **2008**.

Includes 67 countries whose estimated combined output of $44 trillion will come under increasing threat from the physical impacts of more frequent and extreme climate-related events, such as **severe storms, flooding or drought**.

Extreme risk cities: Dhaka, Bangladesh; **Manila**, Philippines; **Bangkok**, Thailand; **Yangon**, Myanmar; **Jakarta**, Indonesia; **Ho Chi Minh City**, Vietnam; and **Kolkata (Calcutta)**, India

Maplecroft: http://maplecroft.com/about/news/ccvi_2013.html; http://maplecroft.com/portfolio/new-analysis/2013/10/30/31-global-economic-output-forecast-face-high-or-extreme-climate-change-risks-2025-maplecroft-risk-atlas/

Image: Monsoon flooding in Bangkok, October 2011 © Thor Jorgen Udvang | Dreamstime.com

High and Extreme Risk - Maplecroft

31% of global economic output will be based in countries facing **'high' or 'extreme' risks** from the impacts of climate change by 2025.

That's ... ls ... t

". . . global brands investing heavily in vulnerable growth markets . . . "
James Allan, Head of Environment at Maplecroft.

In ... combined output of $44 trillion will co... threat from the physical impacts of more frequent and extreme climate-related events, such as **severe storms, flooding or drought**.

Extreme risk cities: Dhaka, Bangladesh; **Manila**, Philippines; **Bangkok**, Thailand; **Yangon**, Myanmar; **Jakarta**, Indonesia; **Ho Chi Minh City**, Vietnam; and **Kolkata (Calcutta)**, India

Maplecroft: http://maplecroft.com/about/news/ccvi_2013.html; http://maplecroft.com/portfolio/new-analysis/2013/10/30/31-global-economic-output-forecast-face-high-or-extreme-climate-change-risks-2025-maplecroft-risk-atlas/
Image: Monsoon flooding in Bangkok, October 2011 © Thor Jorgen Udvang | Dreamstime.com

High and Extreme Risk - Maplecroft

Extreme risk countries include: Nigeria, Cambodia, Philippines, Indonesia, Thailand, China, India, Pakistan and Vietnam.

High risk countries include: Indonesia, Thailand, Kenya and China.

Maplecroft: http://maplecroft.com/about/news/ccvi_2013.html; http://maplecroft.com/portfolio/new-analysis/2013/10/30/31-global-economic-output-forecast-face-high-or-extreme-climate-change-risks-2025-maplecroft-risk-atlas/

Image: Monsoon flooding in Bangkok, October 2011 © Thor Jorgen Udvang | Dreamstime.com

High and Extreme Risk - Maplecroft

Extreme risk countries include: Nigeria, Cambodia, Philippines, Indonesia, Thailand, China, India, Pak… Vietnam

…ia,

"Shenzhen and the Pearl River Delta, [including] cities of Guangzhou, Dongguan and Foshan . . . China's manufacturing heartland, are among the most exposed . . ." Maplecroft.

Maplecroft: http://maplecroft.com/about/news/ccvi_2013.html; http://maplecroft.com/portfolio/new-analysis/2013/10/30/31-global-economic-output-forecast-face-high-or-extreme-climate-change-risks-2025-maplecroft-risk-atlas/

Image: Monsoon flooding in Bangkok, October 2011 © Thor Jorgen Udvang | Dreamstime.com

High and Extreme Risk - Maplecroft

Extreme risk countries include: Nigeria, Cambodia, Philippines, Indonesia, Thailand, China, India, Pakistan, Vietnam, [illegible]a,

"The appearance of so many 'high risk' Chinese cities is of particular concern to companies using the country as a manufacturing base. Water stress . . ." Maplecroft.

Maplecroft: http://maplecroft.com/about/news/ccvi_2013.html; http://maplecroft.com/portfolio/new-analysis/2013/10/30/31-global-economic-output-forecast-face-high-or-extreme-climate-change-risks-2025-maplecroft-risk-atlas/

Image: Monsoon flooding in Bangkok, October 2011 © Thor Jorgen Udvang | Dreamstime.com

High and Extreme Risk

Extreme risk count

geria,

a,

" . . . the scientifically conservative 2007 [IPCC] report said that the Himalayan glaciers might be gone by mid-century. ONE-SIXTH OF THE EARTH'S POPULATION RELIES ON THE MELTING OF GLACIERS AND SEASONAL SNOW PACKS FOR WATER." David Spratt, co-author "Climate Code Red: the case for emergency action"

Maplecroft: http://maplecroft.com/about/news/ccvi_2013.html; http://maplecroft.com/portfolio/new-analysis/2013/10/30/31-global-economic-output-forecast-face-high-or-extreme-climate-change-risks-2025-maplecroft-risk-atlas/
Image: Monsoon flooding in Bangkok, October 2011 © Thor Jorgen Udvang | Dreamstime.com

"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

High and Extreme Risk

Extreme risk countries include: Nigeria, Cambodia, Philippines, Indonesia, Thailand, China, India, [illegible]

"In China, 23 per cent of the population lives in the western regions, where glacial melt provides the principal dry season water source." David Spratt, co-author "Climate Code Red: the case for emergency action"

Maplecroft: http://maplecroft.com/about/news/ccvi_2013.html; http://maplecroft.com/portfolio/new-analysis/2013/10/30/31-global-economic-output-forecast-face-high-or-extreme-climate-change-risks-2025-maplecroft-risk-atlas/

Image: Monsoon flooding in Bangkok, October 2011 © Thor Jorgen Udvang | Dreamstime.com

"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

High and Extreme Risk

Extreme risk countries include: Nigeria, Cambodia, Philippines, Indonesia, Thailand, China, [illegible] ia,

"The implications of the loss of the Himalayan ice sheet are GLOBAL AND MIND-NUMBING, but such a calamity rarely rates a mention in Australia."

David Spratt, co-author "Climate Code Red: the case for emergency action"

Maplecroft: http://maplecroft.com/about/news/ccvi_2013.html; http://maplecroft.com/portfolio/new-analysis/2013/10/30/31-global-economic-output-forecast-face-high-or-extreme-climate-change-risks-2025-maplecroft-risk-atlas/

Image: Monsoon flooding in Bangkok, October 2011 © Thor Jorgen Udvang | Dreamstime.com

"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

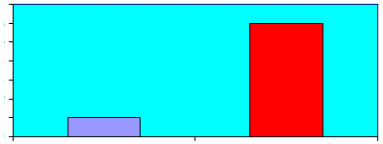
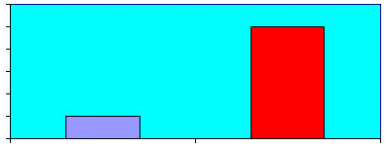
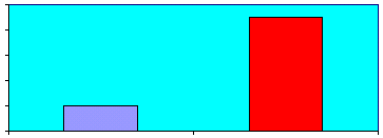
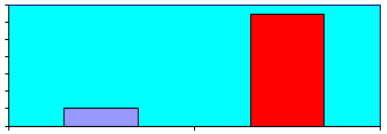
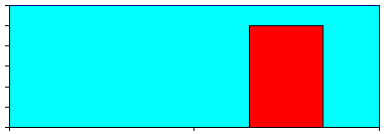
Image: Earth and moon © Cornelius20 | Dreamstime.com

Some changes in likelihood or consequences from climate change

Description	Impact
European heatwaves 2003 (35,000+ deaths, losses of €13 billion)[1]	6 fold
Australia's record-breaking temperatures of 2012/13[2]	5 fold
Increased frequency of Katrina-strength (or greater) hurricanes for every 1°C rise in temperature[3]	2 - 7 fold
Increased building damage from 25% increase in wind speed (40-50k to 50-60k)[4]	650%
50 cm rise in sea level = increase in frequency of extreme inundation events.[5]	Typically several hundred - 1,000 fold

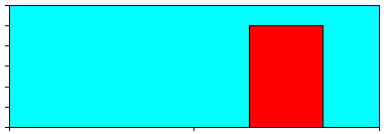
Ref: 1. Dr Myles Allen, Oxford University; 2. Sophie Lewis & David Karoly, Melbourne University; 3. Aslak Grinsted et al, University of Copenhagen (in PNAS); 4. Insurance Australia Group from ANU/IGCC report; 5. Australian Climate Commission "The Critical Decade: Extreme Weather"

Some changes in likelihood or consequences from climate change

Description	Impact
European heatwaves 2003 (35,000+ deaths, losses of €13 billion): 6 fold.[1]	
Australia's record-breaking temperatures of 2012/13: 5 fold.[2]	
Increased frequency of Katrina-strength (or greater) hurricanes for every 1°C rise in temperature: 2 - 7 fold.[3]	
Increased building damage from 25% increase in wind speed (40-50k to 50-60k)[4]	
50 cm rise in sea level = increase in frequency of extreme inundation events.[5]	

Ref: 1. Dr Myles Allen, Oxford University; 2. Sophie Lewis & David Karoly, Melbourne University; 3. Aslak Grinsted et al, University of Copenhagen (in PNAS); 4. Insurance Australia Group from ANU/IGCC report; 5. Australian Climate Commission "The Critical Decade: Extreme Weather"

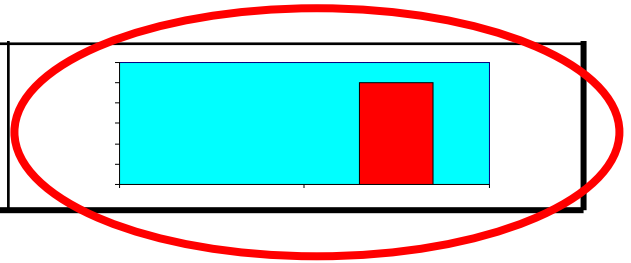
Some changes in likelihood or consequences from climate change

50 cm rise in sea level = increase in frequency of extreme inundation events.[5]	

Ref: Australian Climate Commission "The Critical Decade: Extreme Weather", p. 51

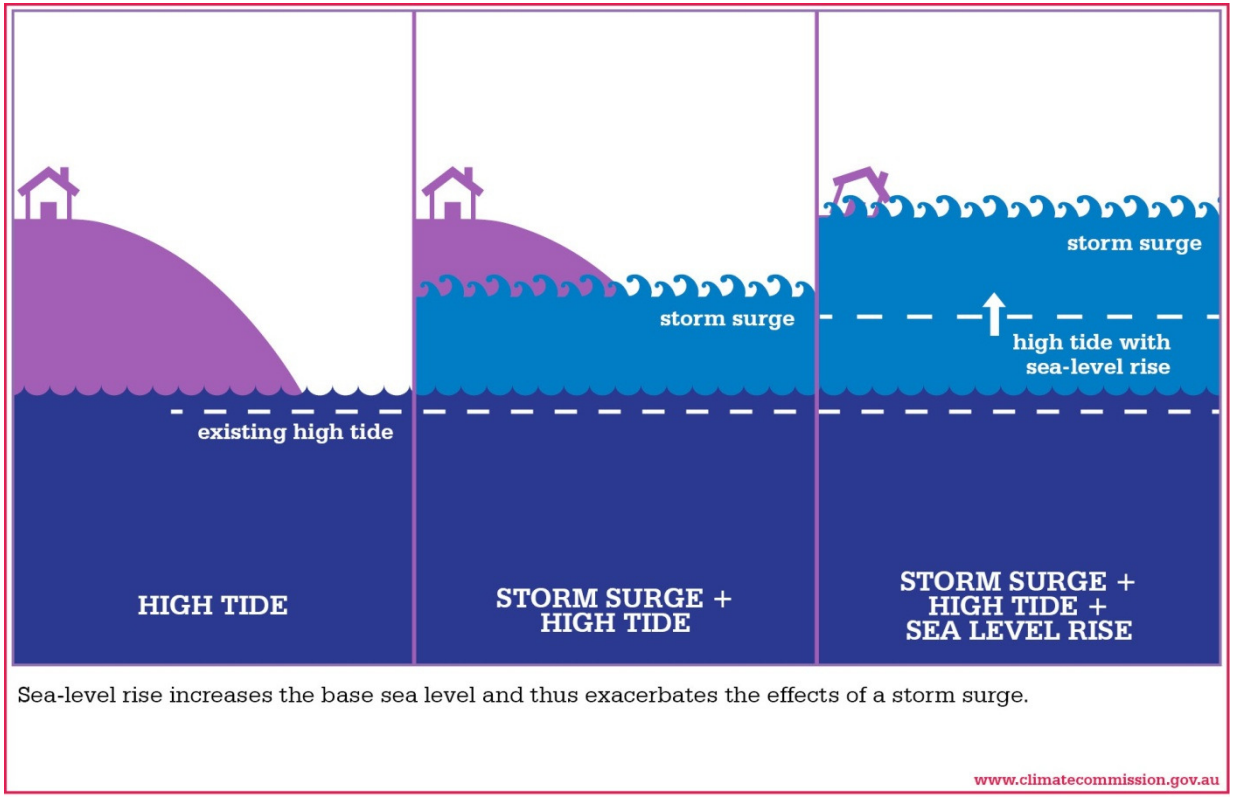
Some changes in likelihood or consequences from climate change

50 cm rise in sea level = increase in frequency of extreme inundation events.[5]

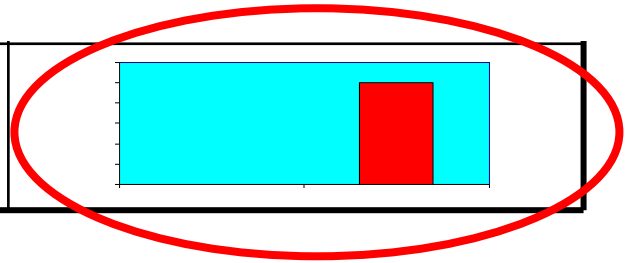


Ref: Australian Climate Commission "The Critical Decade: Extreme Weather", p. 51

Some changes in likelihood or consequences from climate change



50 cm rise in sea level = increase in frequency of extreme inundation events.[5]

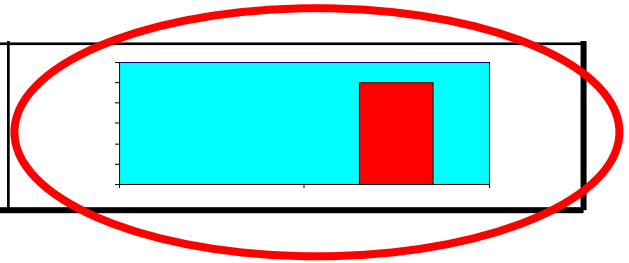


Ref: Australian Climate Commission "The Critical Decade: Extreme Weather", p. 51

Some changes in likelihood or consequences from climate change

Increase in frequency of extreme inundation event **several hundred to 1,000 times.**

50 cm rise in sea level = increase in frequency of extreme inundation events.[5]



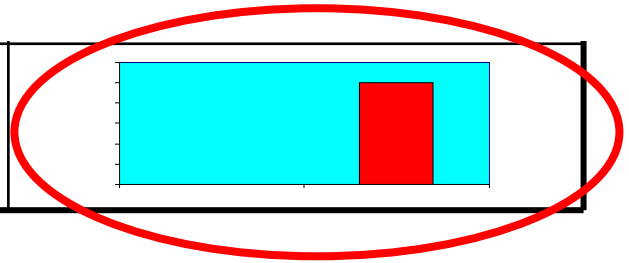
Ref: Australian Climate Commission "The Critical Decade: Extreme Weather", p. 51

Some changes in likelihood or consequences from climate change

Increase in frequency of extreme inundation event **several hundred to 1,000 times.**

Sydney = **1,000 times.**

50 cm rise in sea level = increase in frequency of extreme inundation events.[5]



Ref: Australian Climate Commission "The Critical Decade: Extreme Weather", p. 51

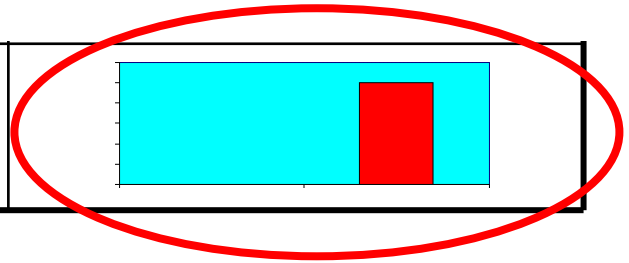
Some changes in likelihood or consequences from climate change

Increase in frequency of extreme inundation event **several hundred to 1,000 times.**

Sydney = **1,000 times.**

A **1 in 100 year event** will occur almost **monthly**.

50 cm rise in sea level = increase in frequency of extreme inundation events.[5]



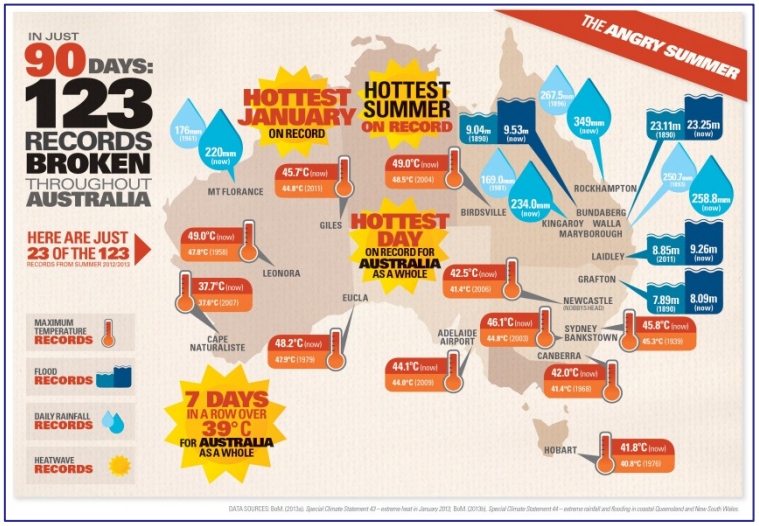
Ref: Australian Climate Commission "The Critical Decade: Extreme Weather", p. 51

Some changes in likelihood or consequences from climate change

Australia's record-smashing "angry summer" of 2012/13 (123 records)

Some changes in likelihood or consequences from climate change

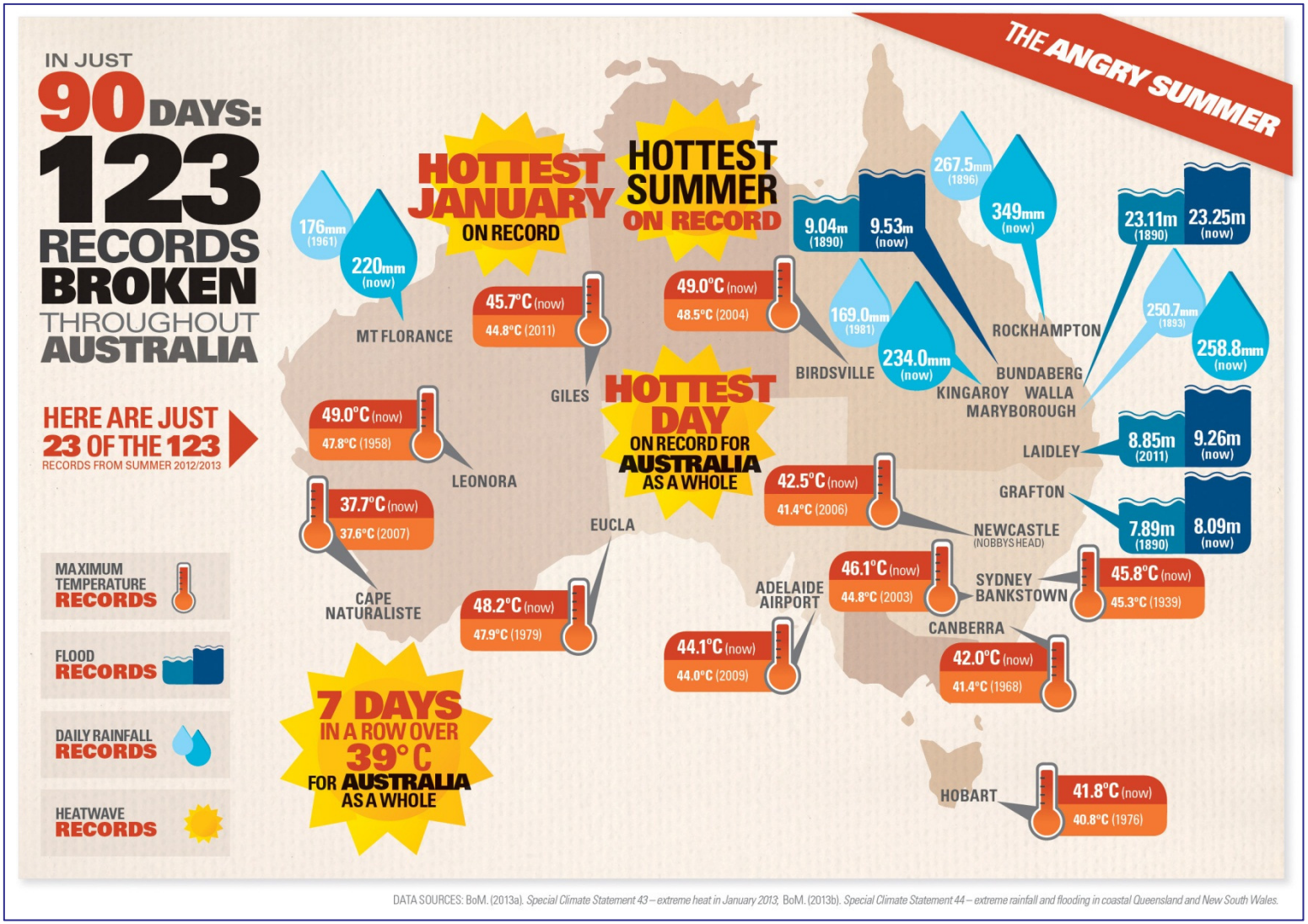
Australia's record-smashing "angry summer" of 2012/13 (123 records)



"Statistically, there is a 1 in 500 chance that we are talking about natural variation causing all these new records."

Australian Climate Commissioner Prof Will Steffen, The Age 4 Mar 2013, *"Climate change a key factor in extreme weather, experts say"*

The Angry Summer

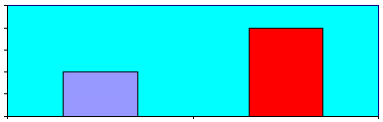
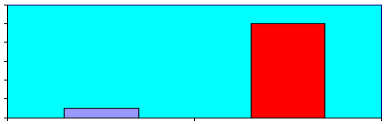
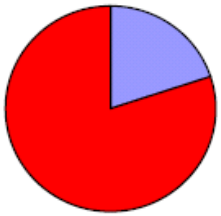
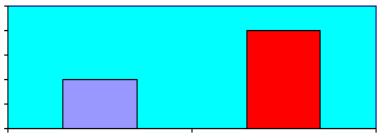


Some changes in likelihood or consequences from climate change

Description	Impact
Increased frequency of Category 4 and 5 Atlantic hurricanes by 2100[1]	Double
Increased frequency of extreme weather events[2]	10 fold
Probability that 2010 Moscow heat wave (11,000 deaths) caused by climate change[3]	80%
Increased frequency of abnormally wet or dry summer weather in southeastern USA[4]	Double

Ref: 1. Climate change, MSNBC, "Study: stronger hurricanes loom. Fewer expected but bigger storms to bring more damage", commenting on Knutson et al (2010), 21 February 2010: http://www.msnbc.msn.com/id/35506750/ns/us_news-environment/ and Knutuson, et al "Tropical cyclones and climate change", Nature Geosciences, 3, 157 - 163 (2010): http://www.nature.com/ngeo/journal/v3/n3/abs/ngeo779.html; 2. Tullus, Paul, "Global Warming: An exclusive look at James Hansen's Scary New Math", Time Science & Space, 10 May 2012 http://science.time.com/2012/05/10/global-warming-an-exclusive-look-at-james-hansens-scary-new-math/; 3. Tullus, Paul, ibid.; 4. Romm, J., Climate Progress, 28 Oct 2010, http://thinkprogress.org/climate/2010/10/28/206947/global-warming-extreme-wet-dry-summer-weather-in-southeast-droughts-and-deluges/

Some changes in likelihood or consequences from climate change

Description	Impact
Increased frequency of Category 4 and 5 Atlantic hurricanes by 2100: Double.[1]	
Increased frequency of extreme weather events: 10 fold.[2]	
Probability that 2010 Moscow heat wave (11,000 deaths) caused by climate change: 80%.[3]	
Increased frequency of abnormally wet or dry summer weather in SE USA[4]	

Ref: 1. Climate change, MSNBC, "Study: stronger hurricanes loom. Fewer expected but bigger storms to bring more damage", commenting on Knutson et al (2010), 21 February 2010: http://www.msnbc.msn.com/id/35506750/ns/us_news-environment/ and Knutuson, et al "Tropical cyclones and climate change", Nature Geosciences, 3, 157 - 163 (2010): http://www.nature.com/ngeo/journal/v3/n3/abs/ngeo779.html; 2. Tullus, Paul, "Global Warming: An exclusive look at James Hansen's Scary New Math", Time Science & Space, 10 May 2012 http://science.time.com/2012/05/10/global-warming-an-exclusive-look-at-james-hansens-scary-new-math/; 3. Tullus, Paul, ibid.; 4. Romm, J., Climate Progress, 28 Oct 2010, http://thinkprogress.org/climate/2010/10/28/206947/global-warming-extreme-wet-dry-summer-weather-in-southeast-droughts-and-deluges/

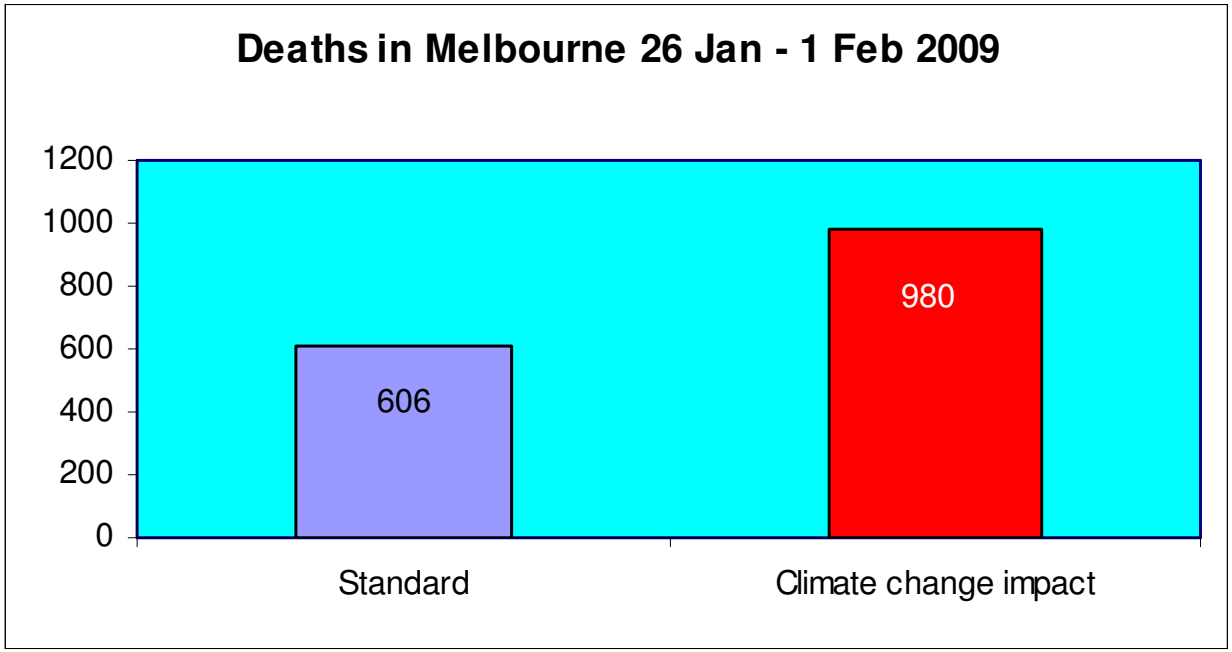
Some changes in likelihood or consequences from climate change

Melbourne, Australia, 26 Jan – 1 Feb 2009.
3 consecutive days above 43°C. 980 deaths = 62% above average for that period.

Victorian Government Department of Human Service, 2009, *"January 2009 Heatwave in Victoria: an Assessment of Health Impacts"*, http://docs.health.vic.gov.au/docs/doc/F7EEA4050981101ACA257AD80074AE8B/%24FILE/heat_health_impact_rpt_Vic2009.pdf

Some changes in likelihood or consequences from climate change

Melbourne, Australia, 26 Jan – 1 Feb 2009.
3 consecutive days above 43°C. 980 deaths = 62% above average for that period.



Victorian Government Department of Human Service, 2009, *"January 2009 Heatwave in Victoria: an Assessment of Health Impacts"*, http://docs.health.vic.gov.au/docs/doc/F7EEA4050981101ACA257AD80074AE8B/%24FILE/heat_health_impact_rpt_Vic2009.pdf

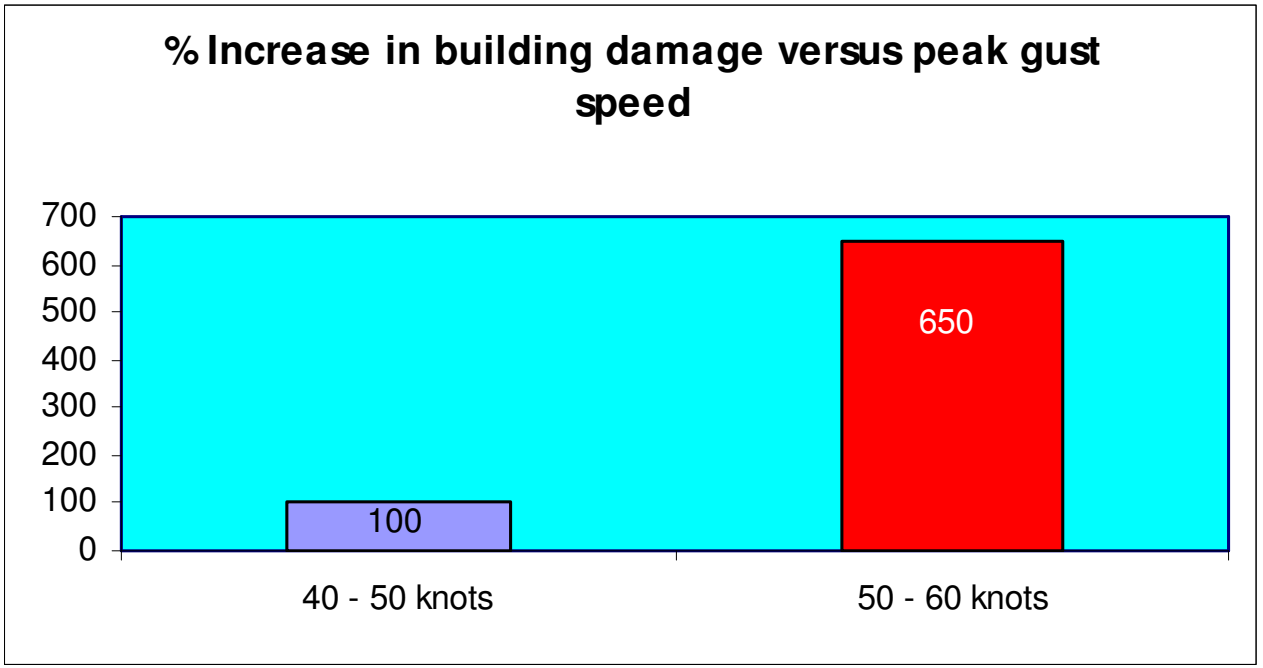
Some changes in likelihood or consequences from climate change

650% increase in building damage from 25% increase in peak gust speed from 40 - 50 to 50 - 60 knots.

Ref: Insurance Australia Group, cited in Smith, M.H., "Assessing Climate Change Risk and Opportunities for Investors: Property and Construction Sector", p.7

Some changes in likelihood or consequences from climate change

650% increase in building damage from 25% increase in peak gust speed from 40 - 50 to 50 - 60 knots.



Ref: Insurance Australia Group, cited in Smith, M.H., "Assessing Climate Change Risk and Opportunities for Investors: Property and Construction Sector", p.7

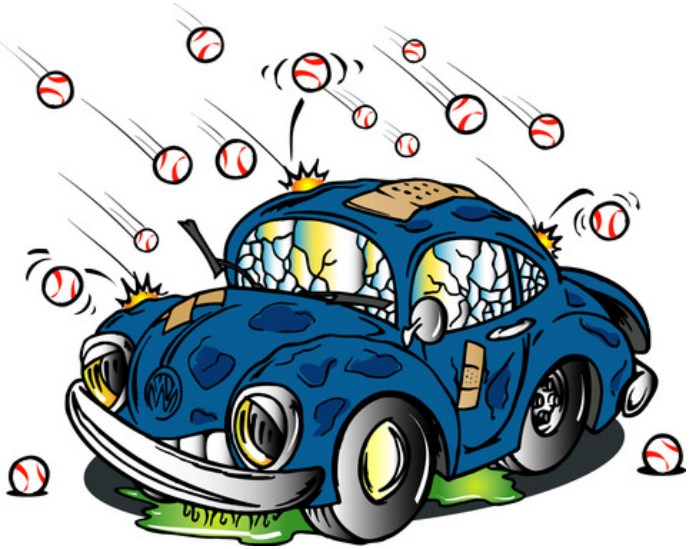
Some changes in likelihood or consequences from climate change

Another example: *"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, 20% above the previous record of 54.5 mm

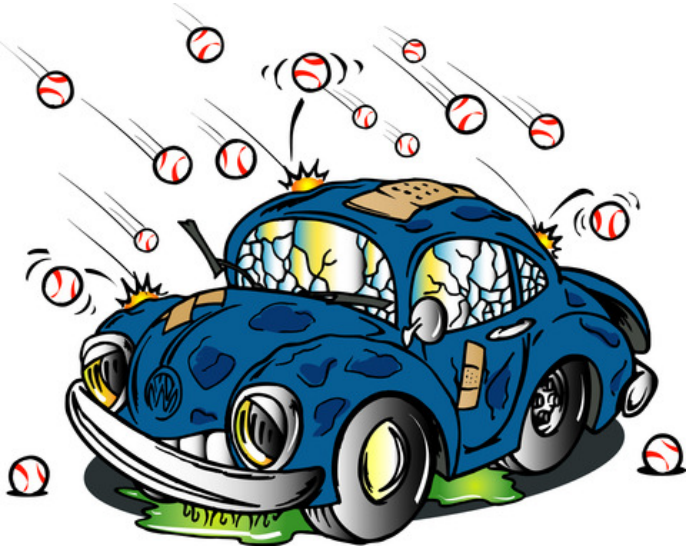
Karoly, Prof. David, School of Earth Sciences, University of Melbourne, "The recent extreme weather in eastern Australia: A sign of climate change or the response to La Niña?", 23rd April, 2011 at Firbank Grammar, Brighton

Some changes in likelihood or consequences from climate change



Ref: ANU/IGCC, "Assessing Climate Change Risks and Opportunities for Investors: Property and Construction"
Australian Climate Commission, Apr 2013, "The Critical Decade: Extreme Weather", p. 56

More comments on likelihood or consequences from climate change

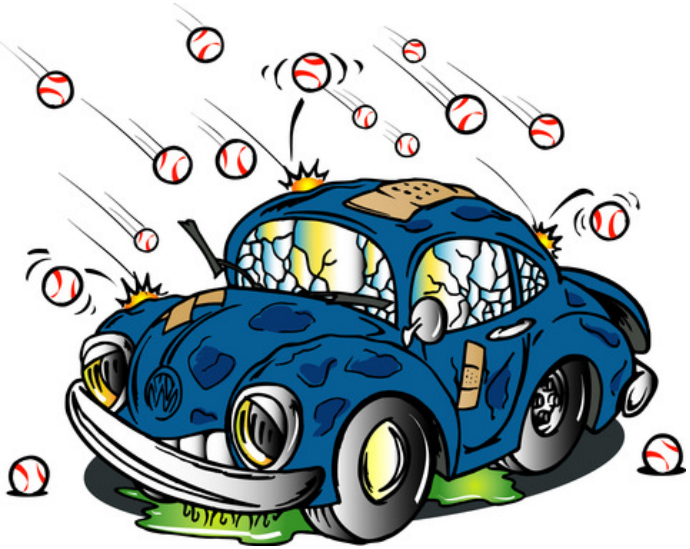


Modelling estimates 20% increase in hail storm frequency by 2050 for Sydney region.

Australia's costliest storm: Hail damage, Sydney, 14 April, 1999. In one hour, damage of $4.3 billion (2011 dollars).

ANU/IGCC, "Assessing Climate Change Risks and Opportunities for Investors: Property and Construction" Australian Climate Commission, Apr 2013, "The Critical Decade: Extreme Weather", p. 56; Image: Car hit by Hail © Robert Ruggiero | Dreamstime.com

More comments on likelihood or consequences from climate change



IAG Insurance Australia: ***We could see a doubling of hailstorms with hailstones greater than 10 centimetres in diameter in the greater Sydney region over the next 50 years.***

Submission to 2013 Senate inquiry into preparedness for extreme weather events

Hannam, P. "Costs soar for reinsurers", Sydney Morning Herald, 18 Feb, 2013, http://www.smh.com.au/business/costs-soar-for-reinsurers-20130217-2el7q.html

More comments on likelihood or consequences from climate change

"The climate dice are now loaded to a degree that the perceptive person (old enough to remember the climate of 1951-1980) should be able to recognize the existence of climate change."

Dr James Hansen, cited in Freedman, A. "NASA scientist Hansen warns "climate dice" already loaded for more extreme weather", Washington Post, 17 Nov 2011

Some benefits of meaningful action

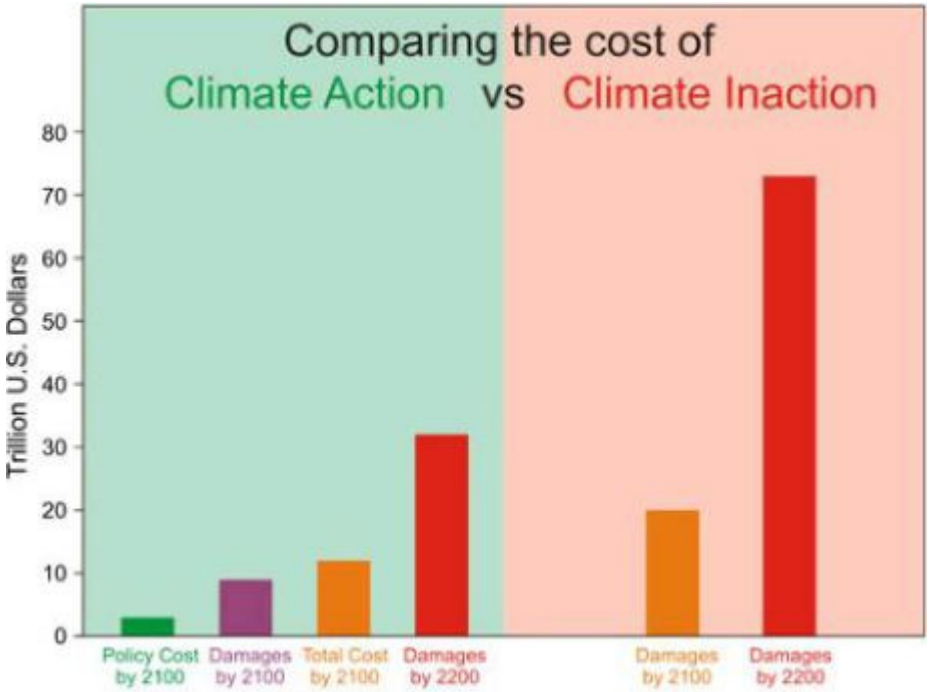
The benefits of meaningful action

Mean benefit to cost ratio of proactive climate change adaptation measures estimated at 60:1 for Construction and Property sector.

Parry, M. et al "Assessing the costs of adaptation to climate change: A review of UNFCCC and other recent estimates", Imperial College, Grantham Institute for Climate Change, UK, cited in ANU/IGCC "Assessing Climate Change Risks and Opportunities for Investors: Property and Construction Sector", p. 10

The benefits of meaningful action

"When it comes to climate change we have the option to choose our desired combination of mitigation, adaptation, and suffering . . . climate change consequences from carbon emissions are already costing our society hundreds of billions of dollars every year. Research by the German Institute for Economic Research and Watkiss et al. 2005 have concluded that choosing mitigation above adaption would save us tens of trillions of dollars."



Skeptical Science, "Exxon-Mobil CEO Downplays the Global Warming Threat", 13th July, 2012, http://www.skepticalscience.com/exxon-mobi-ceo-denies-climate-threat.html citing German Institute for Economic Research and Watkiss et al. 2005

Implications for certain industries

Some Impacts by Industry – Property & Construction

$159 billion worth of Australian buildings vulnerable to sea level rise, incl. **8,000 commercial, 6,000 industrial and 274,000 residential.**

Modelling indicates **Category 5 cyclone striking Cairns** = **$8 billion** in property damage and business interruption.

Australian Industry Group-Housing Industry Association's Performance of Construction index at **35.6** in Mar 2012 due to **rain delays** from spring 2010 to 2012, adding to construction costs. (A figure below 50 = contraction.)

Jan 2007 bushfires **reduced Victoria's power supply by one-third**, cutting electricity to 200,000 homes and commercial properties.

ANU/IGCC, "Assessing Climate Change Risks and Opportunities for Investors: Property and Construction"

Some Impacts by Industry – Mining

Cyclone Yasi and flood in 2011 shut down **85%** of Qld coal mines, costing **$2.5 billion.**

Open coal mine fire at **Hazelwood** power station in Victoria from bushfire in 2006. 2 km long and weeks to control.

Heat stress long recognised as an issues for the mining industry. No. 1 weather-related cause of death in the US and responsible for more than 35,000 deaths in Europe in heatwave of 2003.

Extreme rain and flooding can cause tailing dams to fail, with resultant legal liabilities.

ANU/IGCC, "Assessing Climate Change Risks and Opportunities for Investors: Mining and Minerals Processing"; Image: mining helmet with lamp vector illustration © Miguel angel Salinas salinas | Dreamstime.com

Some Impacts by Industry – Oil & Gas

Storm surge from **Hurricane Katrina** closed oil production in Gulf of Mexico for **six months**, cutting annual US oil production by **20%**.

Up to 50% of Australia's refineries are on the coast not far above sea level.

Gorgon LNG project off WA severely impacted by cyclones and other weather events, contributing to construction cost blow-outs of **US$15 billion**.

Coal seam gas industry will require **7,600 gigalitres of groundwater** over next two decades = one-third of annual flow from Murray-Darling river system.

ANU/IGCC, "Assessing Climate Change Risks and Opportunities for Investors: Oil and Gas"; Image: Oil and gas industry - refinery at twilight - factory – petroche © Tomas1111 | Dreamstime.com

Some Impacts by Industry – Oil & Gas

Storm surge from **Hurricane Katrina** closed oil production in Gulf of Mexico for **six months**, cutting annual US oil production by **20%**.

Up to 50% of Australia's refineries are on the coast not far above sea level.

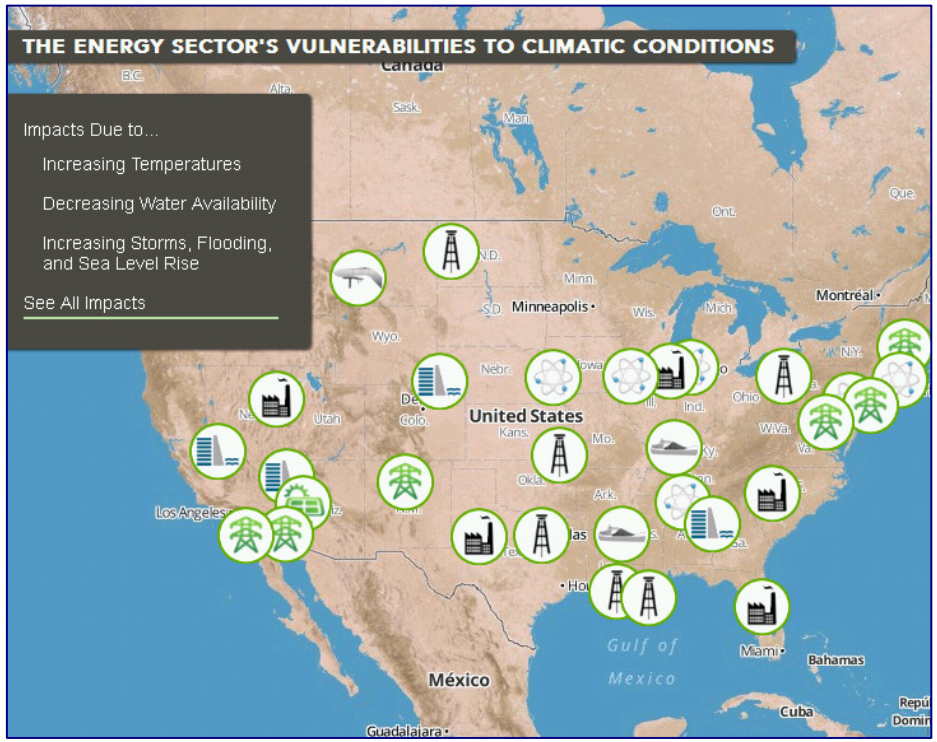
Gorgon LNG project off WA severely impacted by cyclones and other weather events, contributing to construction cost blow-outs of **US$15 billion**.

Coal seam gas industry will require **7,600 gigalitres of groundwater** over next two decades = one-third of annual flow from Murray-Darling river system.

There's more than a little irony in all this.

ANU/IGCC, "Assessing Climate Change Risks and Opportunities for Investors: Oil and Gas"; Image: Oil and gas industry - refinery at twilight - factory – petroche © Tomas1111 | Dreamstime.com

Some Impacts by Industry – Utilities



Increased risk of shutdowns at coal, natural gas and nuclear power plants due to **decreased water availability** affecting cooling at thermoelectric power plants.

Higher risks to energy infrastructure along coasts due to **sea level rise**, **increasing intensity of storms**, **higher storm surge** and **flooding**.

Power lines, transformers and electricity distribution systems face increasing risks of damage from **hurricanes**, **storms** and **wildfires** that are growing more frequent and intense.

April Saylor, US Dept of Energy, "Climate Change: Effects on Our Energy", 11 July 2013, http://energy.gov/articles/climate-change-effects-our-energy#all

Note: Some map locations are approximate.

Can we rely on planning regulators?

Can we rely on planning regulators?

"There is a growing recognition of how inadequate current regulatory frameworks are to protect company assets and operations from more intense extreme weather events"

"State governments and local councils . . . Differ considerably in their approach to climate change risk for new and existing construction and property projects."

"Even after the Black Saturday bushfires, there is no consistent approach to bushfire risk reduction in building codes across Australia."

"Australia lacks a cohesive national coastal planning framework."

ANU/Investor Group on Climate Change, "Assessing Climate Change Risks and Opportunities for Investors: Property and Construction"
Australian Climate Commission, Apr 2013, "The Critical Decade: Extreme Weather", p. 10
Also http://www.igcc.org.au/about Image: Dog Rescue © 1000words | Dreamstime.com

Can we rely on planning regulators?

"There is a growing recognition of how inadequate current regulatory frameworks are to protect company assets and operations from more intense extreme weather events"

From report commission by Investor Group on Climate Change, a collaboration of Australian and New Zealand investors focussing on the impact that climate change has on the financial value of investments. The group represents institutional investors, with total funds under management of approximately $1 trillion, and others in the investment community interested in the impact of climate change on investments.

bushfires, there is no approach to bushfire risk reduction in building codes across Australia."

"Australia lacks a cohesive national coastal planning framework."

Paul Mahony 2013

ANU/Investor Group on Climate Change, "Assessing Climate Change Risks and Opportunities for Investors: Property and Construction"
Australian Climate Commission, Apr 2013, "The Critical Decade: Extreme Weather", p. 10
Also http://www.igcc.org.au/about; Image: Dog Rescue © 1000words | Dreamstime.com

Can we rely on planning regulators?

"We shouldn't regard this [Brisbane January 2011 flood] as freakish," said Professor Ed Blakely, who ran the recovery of New Orleans after hurricane Katrina and was involved in New York's after 9/11. "We should assume they are going to occur because of climate change. They are becoming increasingly frequent and far more devastating."

He warned it was also time to examine the need for Queenslanders to "retreat from the coast" to escape rising sea levels.

"I warned people in Brisbane before hurricane Katrina that this could happen. I had all the CSIRO data that showed a flood that looked very much like the flood that happened. They scoffed."

Karen Kissane, "Disaster expert urges a retreat from the coast", The Age, 15 January 2011: http://www.theage.com.au/national/disaster-expert-urges-a-retreat-from-the-coast-20110114-19rcg.html; Image: Dog Rescue © 1000words | Dreamstime.com

Can we rely on planning regulators?

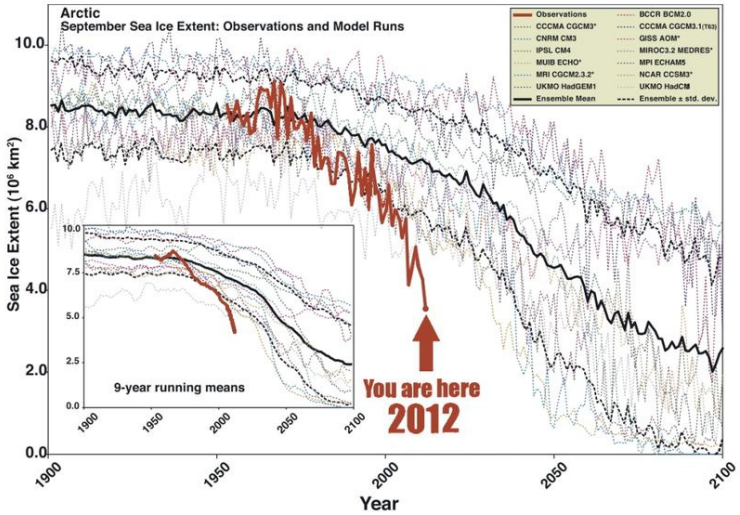
"Waterfront communities from Southbank to the Mornington Peninsula face a damage bill of more than $1 billion from severe storms and rising sea levels over the next 90 years, according to a confidential climate change report."

Cameron Houston, *"Climate Change Bill of $1b for suburbs",* The Age, 21 Oct 2012 http://www.theage.com.au/victoria/climate-change-bill-of-1b-for-suburbs-20121020-27yli.html; Image: Dog Rescue © 1000words | Dreamstime.com

Can we rely on planning regulators?

"Waterfront communities from Southbank to the Mornington Peninsula face a damage bill of more than $1 billion from severe storms and rising sea levels over the next 90 years, according to a confidential climate change report."

90 years or sooner? Remember actual Arctic sea ice loss vs projected, and the impact on Greenland.



Cameron Houston, *"Climate Change Bill of $1b for suburbs"*, The Age, 21 Oct 2012 http://www.theage.com.au/victoria/climate-change-bill-of-1b-for-suburbs-20121020-27yli.html; Image: Dog Rescue © 1000words | Dreamstime.com

Can we rely on planning regulators?

The Age newspaper reported that the Victorian state government would *"wind back rules making new property developments in seaside towns plan for sea-level rises caused by climate change,* ***arguing they have hampered rural growth."***

"The changes [would] require 20 centimetres of sea-level rise by 2040 to be considered in new urban development in coastal towns such as Lakes Entrance, Port Lonsdale and Port Fairy."

Regulators and their insurers need to consider the ***legal liability risk***.

Tom Arup, "State eases sea level regulations", The Age, 6 June 2012, http://www.theage.com.au/victoria/state-eases-sea-level-regulations-20120605-1zu9i.html; Image: Dog Rescue © 1000words | Dreamstime.com

Some insurance industry participants are unconvinced of increased likelihood and frequency of extreme events, but members of the former Australian Climate Commission and others have a different view.

What are insurers saying?

QBE Chair, Belinda Hutchinson, 19 April, 2011

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

"QBE blames La Nina for disasters", Gareth Hutchens, Sydney Morning Herald, 20/04/11, http://www.smh.com.au/business/qbe-blames-la-nina-for-disasters-20110419-1dng1.html

What are insurers saying?

QBE Chair, Belinda Hutchinson, 19 April, 2011

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 blames La Nina for disasters", Gareth Hutchens, Sydney Morning Herald, 20/04/11, http://www.smh.com.au/business/qbe-blames-la-nina-for-disasters-20110419-1dng1.html

What are insurers saying?

Insurance Council of Australia, January 2013

". . . the scale and extent of extreme weather events in Australia . . . are not increasing and are not unprecedented."

"Australia has a long record of fire, floods, storms and cyclones."

Argues that we should focus on *exposure* and *vulnerability*, rather than *hazard* (frequency and intensity)

Paul Mahony 2013

Insurance Council of Australia, Submission to Senate Standing Committee on Environment and Communications: Recent trends in and preparedness for extreme weather events, dated 14 Jan 2012 but seems to be 14 Jan 2013

What are insurers saying?

Insurance Council of Australia, January 2013

". . . the scale and ext
Australia

Australian Climate Commission:

Australia has long had a highly variable climate of droughts and heavy rains, and this pattern is likely to continue in the future.

However, climate change is likely to increase the severity of these extreme weather events.

Australian Climate Commission "The Critical Decade: Extreme Weather" April 2013

on *exposure* and
than *hazard* (frequency and
i

Paul Mahony 2013

Insurance Council of Australia, Submission to Senate Standing Committee on Environment and Communications: Recent trends in and preparedness for extreme weather events, dated 14 Jan 2012 but seems to be 14 Jan 2013

What are insurers saying?

Insurance Council of Australia, January 2013

". . . the scale and ext
Australia

Australian Climate Commission:

The duration and frequency of heatwaves in Australia have increased, and the hottest days during a heatwave have become even hotter.

Australian Climate Commission "The Critical Decade: Extreme Weather" April 2013

oods, storms and

gues that we should focus on *exposure* and *vulnerability*, rather than *hazard* (frequency and intensity)

Insurance Council of Australia, Submission to Senate Standing Committee on Environment and Communications: Recent trends in and preparedness for extreme weather events, dated 14 Jan 2012 but seems to be 14 Jan 2013

What are insurers saying?

Insurance Council of Australia, January 2013

". . . the scale and ext
Australia

Australian Climate Commission:

Australia has a long history of fire and already faces the regular risk of serious and extreme fire danger conditions.

The projections for future indicate a significant increase in dangerous fire weather for southeast Australia.

Australian Climate Commission "The Critical Decade: Extreme Weather" April 2013

ould focus on *exposure* and
***ability*, rather than *hazard* (frequency and intensity)**

Paul Mahony 2013

Insurance Council of Australia, Submission to Senate Standing Committee on Environment and Communications: Recent trends in and preparedness for extreme weather events, dated 14 Jan 2012 but seems to be 14 Jan 2013

What are insurers saying?

Insurance Council of Australia, January 201

“. . . the scale an

Austr

A ... **and**

w ... **(frequency and**

in

ANU / Investor Group on Climate Change:

Oscillation between El Nino and La Nina underpins why Australia has always been the land “of droughts and flooding rains”.

The latest climate science suggests it is highly likely this oscillation between drought and flood will become more extreme and intense.

Dr Michael Smith, Australian National University, “Assessing Climate Change Risks and Opportunities for Investors – Property and Construction Sector, p. 7”

Paul Mahony 2013

Insurance Council of Australia, Submission to Senate Standing Committee on Environment and Communications: Recent trends in and preparedness for extreme weather events, dated 14 Jan 2012 but seems to be 14 Jan 2013

What are insurers saying?

Insurance Council of Australia, Jan 2013

“. . . the scale an

Austr

A

w

in

y and

Insurance Australia Group:

IAG, which sells insurance under the CGU, NRMA and RACV brands . . . states on its website that “historical claims and weather data” could not be used as a guide for current and future risk as reliably as in the past.

“We are seeing new extremes in events occurring at an ever increasing rate. Of particular concern is the rate at which things are changing” the site says.

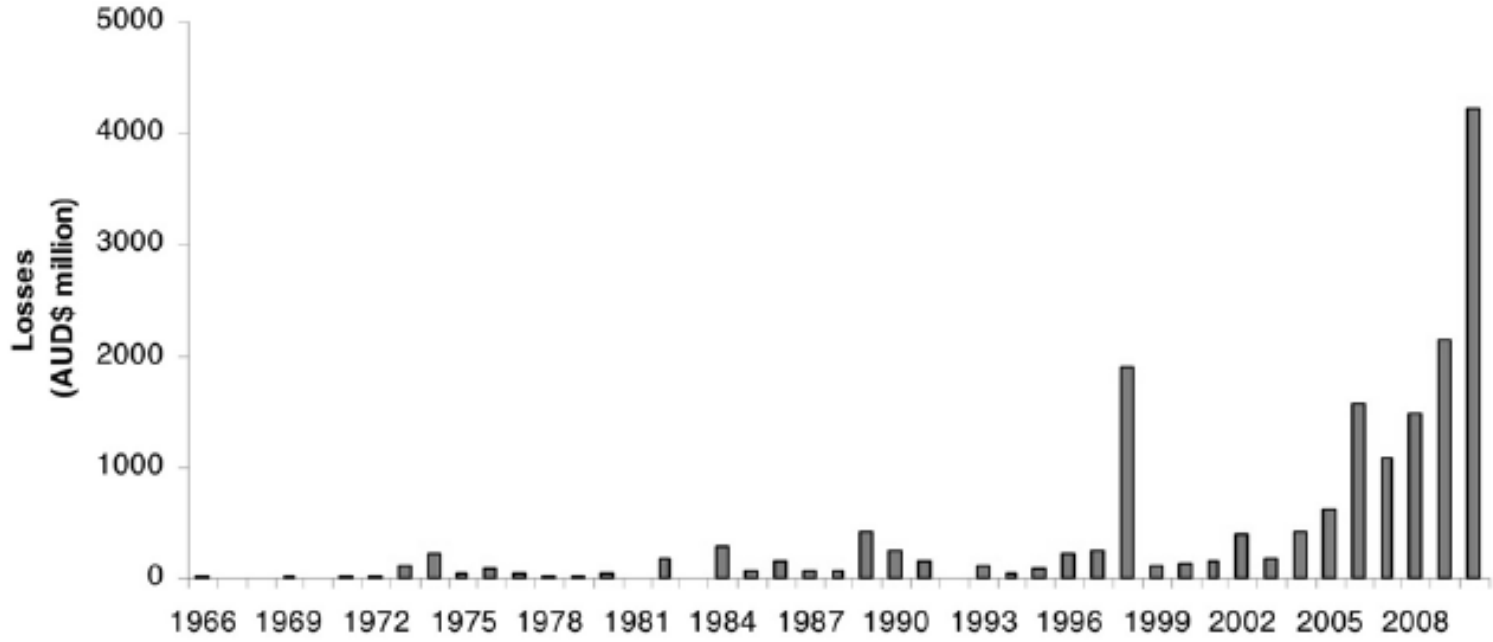
From “QBE blames La Nina for disasters”, Gareth Hutchens, Sydney Morning Herald, 20/04/11, http://www.smh.com.au/business/qbe-blames-la-nina-for-disasters-20110419-1dng1.html

Insu… …uncil of Australia, Submission to Senate Standing Committee on Environment and Communications: Recent trends in and preparedness for extreme weather events, dated 14 Jan 2012 but seems to be 14 Jan 2013

What are insurers saying?

Insurance Council of Australia, Jan 2013

Insurance losses due to extreme weather events over last 40yrs (Source: Risk Frontiers Analysis of ICA Data)

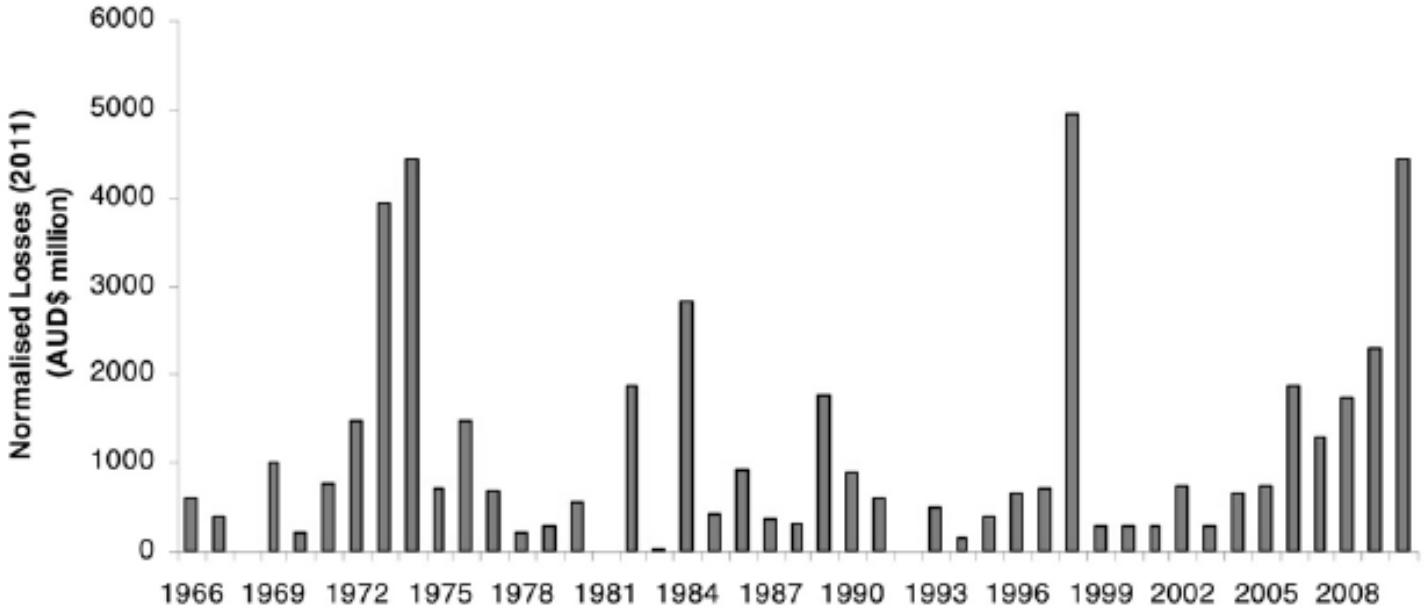


Insurance Council of Australia, Submission to Senate Standing Committee on Environment and Communications: Recent trends in and preparedness for extreme weather events, dated 14 Jan 2012 but seems to be 14 Jan 2013

What are insurers saying?

Insurance Council of Australia, Jan 2013

Insurance losses due to extreme weather events over last 40yrs Nomalised (Source: Risk Frontiers Analysis of ICA Data)



Normalised for changes: in the number of dwellings in a location; the average size and value of dwellings; building age; and Building Code improvements.

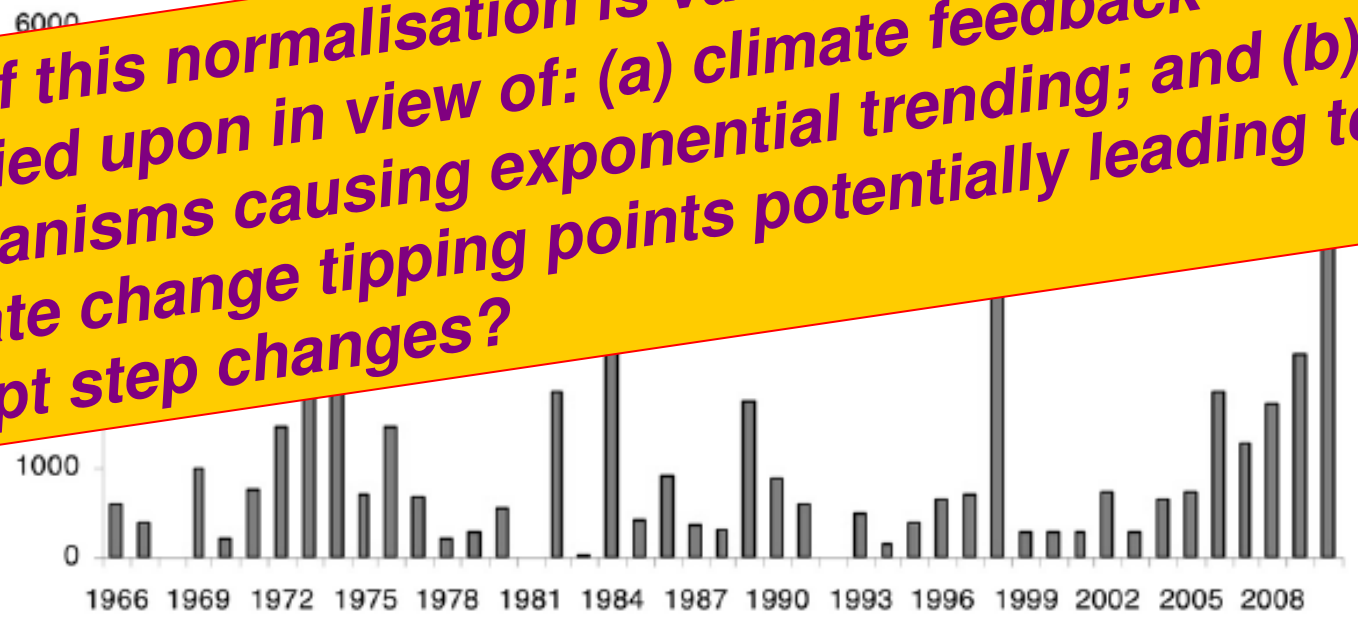
Insurance Council of Australia, Submission to Senate Standing Committee on Environment and Communications: Recent trends in and preparedness for extreme weather events

What are insurers saying?

Insurance Council of Australia, Jan 2013

Insurance losses due to extreme weather events over last 40yrs Nomalised (Source: Risk Frontiers Analysis of ICA Data)

Even if this normalisation is valid, can past experience be relied upon in view of: (a) climate feedback mechanisms causing exponential trending; and (b) climate change tipping points potentially leading to abrupt step changes?



Normalised for changes: in the number of dwellings in a location; the average size and value of dwellings; building age; and Building Code improvements.

Insurance Council of Australia, Submission to Senate Standing Committee on Environment and Communications: Recent trends in and preparedness for extreme weather events

What are insurers saying?

Insurance Council of Australia, Jan 2013

The increasing cost of insured losses over time is explained predominantly by growth in the number of insured buildings exposed and the nature of those buildings, rather than increased frequency or intensity of extreme events. ***[Munich Re has a different view in relation to storm events. See subsequent slides.]***

Argues that the insurance mechanism must be maintained as a price signal to encourage adaptive behaviour. ***[Compare with Munich Re.]***

Insurance Council of Australia, Submission to Senate Standing Committee on Environment and Communications: Recent trends in and preparedness for extreme weather events

What are insurers saying?

Insurance Council of Australia in relation to Climate Commission's *"The Critical Decade: Extreme Weather"* Report (Insurance News, 15 April, 2013)

- ICA has shown "polite interest" only.
- Insurers look just one or two years ahead.
- Link between climate change and extreme weather needs to be established with "full certainty".
- The data is insufficient at this point for insurers to act on it.
- No insurer covers gradual change in sea level or other anticipated impacts of global warming.

Insurance News, "Climate change: a catalyst for extreme weather", 15 April 2013

What are insurers saying?

Insurance Council of Australia in relation to Climate Commission's *"The Critical Decade: Extreme Weather"* Report (Insurance N

Why look just one or two years ahead?

- ...ge and extreme weather needs ...tablished with "full certainty".
- The data is insufficient at this point for insurers to act on it.
- No insurer covers gradual change in sea level or other anticipated impacts of global warming.

Insurance News, "Climate change: a catalyst for extreme weather", 15 April 2013

What are insurers saying?

Insurance Council of Australia in relation to Climate Commission's *"The Critical Decade: Extreme Weather"* Report (Insurance N

Why look just one or two years ahead?

- ...ge and extreme weather need ...tablished with "full certainty"
- The data is insuffici...
- N...

Besides, the events are happening now!

Insurance News, "Climate change: a catalyst for extreme weather", 15 April 2013

What are insurers saying?

Insurance Council of Australia in relation to Climate Commission's *"The Critical Decade: Extreme Weather"* Report (Insurance Ne

Why the need for "full certainty" in a business based on probabilities?

- ...only.
- ...look just one or two years ahead.
- Link between climate change and extreme weather needs to be established with "full certainty".
- The data is insufficient at this point for insurers to act on it.
- No insurer covers gradual change in sea level or other anticipated impacts of global warming.

Insurance News, "Climate change: a catalyst for extreme weather", 15 April 2013

What are insurers saying?

Insurance Council of Australia in relation to Climate Commission's *"The Critical Decade: Extreme Weather"* Report (Insurance News, 15

So no insurer covers gradual change in sea level or other anticipated impacts of global warming.

- ...just one or two years ahead.
- Link between climate change and ...
  to be established ...

What about storm surge, bushfire, flood, storm damage, hail, etc? Remember the "Angry Summer"!

...for insurers to act on it.

...gradual change in sea level or other anticipated impacts of global warming.

Insurance News, "Climate change: a catalyst for extreme weather", 15 April 2013

What are insurers <u>and others</u> saying?

Insurance Council of Australia in relation
Commission's *"The C*

Insurance system responses are consistent with earlier international political economy perspective that reflects a linear understanding of the Earth system, whereas a non-linear understanding is required.

- one of two years ahead.
- Link between climate change and extreme weather needs to be established with "full certainty".
- The data is insufficient at this point for insurers to act on it.
- No insurer covers gradual change in sea level or other anticipated impacts of global warming.

Insurance News, "Climate change: a catalyst for extreme weather", 15 April 2013

Liam Phelan, Macquarie University, *"The relationship between anthropogenic climate change and the insurance system: Imperatives, options and reflections on theory",* 4 Aug 2010 (PhD Thesis)

What are insurers <u>and others</u> saying?

Insurance Council of Australia in relation
Commission's *"The*

Insurance system responses are consistent with earlier international political economy perspective that reflects a linear understanding of the Earth system, whereas a non-linear understanding is required.

Climate change undermines the basis of the insurance system, i.e. the capacity to pool and spread financial risk on the basis of known probabilities.

Link between climat
one of two years ahead
to act on it.
change in sea level or other
anticipated impacts of global warming.

Insurance News, "Climate change: a catalyst for extreme weather", 15 April 2013

Liam Phelan, Macquarie University, *"The relationship between anthropogenic climate change and the insurance system: Imperatives, options and reflections on theory"*, 4 Aug 2010 (PhD Thesis)

What are insurers <u>and others</u> saying?

Insurance Council of Australia in relation
Commission's *"The*

Insurance system responses are consistent with earlier international political economy perspective that reflects a linear understanding of the Earth system, whereas a non-linear understanding is required.

Link between climate
one of two years ahead

Climate change undermines the basis of the insurance system, i.e. the capacity to pool and spread financial risk on the basis of known probabilities.

anticipated impacts of glo
ers to act on it.
change in sea level

Climate change is a globally coherent phenomenon of unprecedented magnitude.
Liam Phelan, Macquarie University

News, "Climate change: a catalyst for extreme weather", 15 April 2013

Liam Phelan, Macquarie University, *"The relationship between anthropogenic climate change and the insurance system: Imperatives, options and reflections on theory"*, 4 Aug 2010 (PhD Thesis)

What are insurers <u>and others</u> saying?

Insurance Council of A

"Strong and ecologically effective mitigation is the only viable basis for the insurance system to manage its medium and long-term climate risk."

pril, 2013)

ICA has shown "polite interest" only.

- Insurers look just one or two years ahead.
- Link between climate change and extreme weather needs to be established with "full certainty".
- The data is insufficient at this point for insurers to act on it.
- No insurer covers gradual change in sea level or other anticipated impacts of global warming.

Insurance News, "Climate change: a catalyst for extreme weather", 15 April 2013

Liam Phelan, Macquarie University, *"The relationship between anthropogenic climate change and the insurance system: Imperatives, options and reflections on theory",* 4 Aug 2010 (PhD Thesis)

What are insurers and others saying?

Insurance Council of A

C

“Strong and ecologically effective mitigation is the only viable basis for the insurance system to manage its medium and long-term climate risk.”

pril, 2013)

ICA has shown “polite intere

- Insurers

“Anthropogenic climate change is by definition of our own making, and an accelerating catastrophe that will continue to impact humans and our societies. Unmitigated, anthropogenic climate change promises impacts that will be felt comprehensively, if unevenly, across all populations. The system that provides insurance, along with the rest of human activities, is vulnerable.”

Liam Phelan, Macquarie University

, Climate change: a catalyst for extreme weather”, 15 April 2013

Liam Phelan, Macquarie University, *“The relationship between anthropogenic climate change and the insurance system: Imperatives, options and reflections on theory”,* 4 Aug 2010 (PhD Thesis)

What are insurers <u>and others</u> saying?

Insurance Council of Australi… Commissi…

- ICA has sh…

Further comments from Liam Phelan in The Sydney Morning Herald while lecturer in environmental studies at Newcastle University.

…surance News, 15 April, 2013)

"… climate change can mean insurance for weather risks - including extreme events - shifts from affordable to barely affordable, and eventually the risks become uninsurable … insurance for weather risks operates as though past events are a reliable guide to future experience. This remains true as long as the Earth (including its climate) stays in its currently stable state, one that is familiar to humans through the course of human history. Human-caused climate change means shifting the state of Earth, perhaps comparatively suddenly, from its familiar state into an alternative - and perhaps radically different - state."

Insurance News, "Climate change: a catalyst for extreme weather", 15 April 2013

Liam Phelan, "Cuts in emissions are at a premium", The Age, 25 Jan 2011, http://www.smh.com.au/federal-politics/society-and-culture/cuts-in-emissions-are-at-a-premium-20110124-1a2ul.html

Findings of Senate Enquiry *"Recent trends in and preparedness for extreme weather events"*, August 2013

Extreme weather events are likely to increase in frequency and will potentially intensify in the future as a result of climate change.

Hannam, P., "Extreme weather likely to increase and intensify, report finds", The Sydney Morning Herald, 7 Aug 2013, http://www.smh.com.au/environment/climate-change/extreme-weather-likely-to-increase-and-intensify-report-finds-20130807-2rggq.html

Standard Flood Definition - Australia

"The covering of normally dry land by water that has escaped or been released from the normal confines of: any lake, or any river, creek or other natural watercourse, whether or not altered or modified; or any reservoir, canal, or dam."

Applies to: home building and home contents; small business; and strata title insurance contracts.

Transition period of two years from 18th June, 2012.

If insurers provide flood coverage, they are required to use the new definition.

Press Release No. 030 (undated) from Minister for Financial Services & Superannuation, http://ministers.treasury.gov.au/DisplayDocs.aspx?doc=pressreleases/2012/030.htm&pageID=&min=brs&Year=2012&DocType=0 and Insurance News "Flood definition becomes law", 18th June, 2012, http://insurancenews.com.au/local/flood-definition-becomes-law

Most American insurers are unprepared

Few American insurers ready for climate change

Few American insurers ready for climate change

Climate risk survey of 184 American insurance companies in the Property and Casualty; Life and Annuity; and Health sectors conducted by insurance regulators in California, New York and Washington, and reported by sustainability advocacy group Ceres.

"Insurer Climate Risk Disclosure Survey 2012", Ceres, March 2013, http://www.ceres.org/resources/reports/naic-report/view
The Age, 8 March 2013, *"Few insurers prepared for climate change: Ceres",* http://www.theage.com.au/business/carbon-economy/few-insurers-prepared-for-climate-change-ceres-20130308-2fpbw.html (From Bloomberg)
Mark A. Hoffman, *"Insurance industry has made 'uneven' response to climate risks: Ceres",* Business Insurance, 7 March 2013, http://www.businessinsurance.com/article/20130307/NEWS04/130309871#full_story

Few American insurers ready for climate change

Climate risk survey of 184 American insurance companies in the Property and Casualty; Life and Annuity; and Health sectors conducted by insurance regulators in California, New York and Washington, and reported by sustainability advocacy group Ceres.

Almost all of the 184 companies responding showed significant weakness in their preparedness to address the effects climate change may have on their business.

"Insurer Climate Risk Disclosure Survey 2012", Ceres, March 2013, http://www.ceres.org/resources/reports/naic-report/view
The Age, 8 March 2013, *"Few insurers prepared for climate change: Ceres"*, http://www.theage.com.au/business/carbon-economy/few-insurers-prepared-for-climate-change-ceres-20130308-2fpbw.html (From Bloomberg)
Mark A. Hoffman, *"Insurance industry has made 'uneven' response to climate risks: Ceres"*, Business Insurance, 7 March 2013, http://www.businessinsurance.com/article/20130307/NEWS04/130309871#full_story

Few American insurers ready for climate change

Climate risk survey of 184 American insurance companies in the Property and Casualty; Life and Annuity; and Health sectors conducted by insurance regulators in California, New York and Washington, and reported by sustainability advocacy group Ceres.

Almost all of the 184 companies responding showed significant weakness in their preparedness to address the effects climate change may have on their business.

Only 23 demonstrated a comprehensive climate change strategy

"Insurer Climate Risk Disclosure Survey 2012", Ceres, March 2013, http://www.ceres.org/resources/reports/naic-report/view
The Age, 8 March 2013, *"Few insurers prepared for climate change: Ceres"*, http://www.theage.com.au/business/carbon-economy/few-insurers-prepared-for-climate-change-ceres-20130308-2fpbw.html (From Bloomberg)
Mark A. Hoffman, *"Insurance industry has made 'uneven' response to climate risks: Ceres"*, Business Insurance, 7 March 2013, http://www.businessinsurance.com/article/20130307/NEWS04/130309871#full_story

Few American insurers ready for climate change

Climate risk survey of 184 American insurance companies in the Property and Casualty; Life and Annuity; and Health sectors conducted by insurance regulators in California, New York and Washington, and reported by sustainability advocacy group Ceres.

Almost all of the 184 companies responding showed significant weakness in their preparedness to address the effects climate change may have on their business.

Only 23 demonstrated a comprehensive climate change strategy

88 viewed climate change as a potential future loss driver, even though scientific assessments such as the recent IPCC Extreme Events report and draft National Climate Assessment emphasise that climate change is already amplifying extreme events that lead to insured losses

"Insurer Climate Risk Disclosure Survey 2012", Ceres, March 2013, http://www.ceres.org/resources/reports/naic-report/view
The Age, 8 March 2013, *"Few insurers prepared for climate change: Ceres"*, http://www.theage.com.au/business/carbon-economy/few-insurers-prepared-for-climate-change-ceres-20130308-2fpbw.html (From Bloomberg)
Mark A. Hoffman, *"Insurance industry has made 'uneven' response to climate risks: Ceres"*, Business Insurance, 7 March 2013, http://www.businessinsurance.com/article/20130307/NEWS04/130309871#full_story

Major reinsurers are extremely concerned

What is Munich Re saying?

What is Munich Re saying?

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

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?

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?

Munich Re: Increases in weather-related disasters 1980 - 2011

North America:	**5 fold**
Australia:	**4 fold**
Asia:	**4 fold**
Africa:	**2.5 fold**
Europe:	**2 fold**
South America:	**1.5 fold**

Munich Re Press Release, 17 Oct, 2012
http://www.munichre.com/en/media_relations/press_releases/2012/2012_10_17_press_release.aspx except Australia, The Age, 27 Oct 2012 "Worsening weather battering bottom line"
http://www.theage.com.au/environment/climate-change/worsening-weather-battering-bottom-line-20121026-28azy.html

What is Munich Re saying?

Munich Re: Increases in weather-relat… 1980 - 2011

For thunderstorm-related losses, the analysis reveals increasing volatility and a significant long-term upward trend in the normalized figures over the last 40 years, adjusted for factors such as increasing values, population growth and inflation.

	4 fold
Africa:	**2.5 fold**
Europe:	**2 fold**
South America:	**1.5 fold**

Munich Re Press Release, 17 Oct, 2012
http://www.munichre.com/en/media_relations/press_releases/2012/2012_10_17_press_release.aspx except Australia, The Age, 27 Oct 2012 "Worsening weather battering bottom line"
http://www.theage.com.au/environment/climate-change/worsening-weather-battering-bottom-line-20121026-28azy.html

What is Munich Re saying?

Munich Re: Increases in weather-relat
1980 - 2011

For thunderstorm-related losses, the analysis reveals increasing volatility and a significant long-term upward trend in the normalized figures over the last 40 years, adjusted for factors such as increasing values, population growth and inflation.

4 fold

Climate change-related increases in hazards - unlike increases in exposure - are not automatically reflected in premiums. In order to realize a sustainable model of insurance, it is crucially important for us as risk managers to learn about this risk of change and find improved solutions for adaptation [and] mitigation.

Muni… Oct, 2012
http:/…munichre.com/en/media_relations/press_releases/2012/2012_10_17_press_release.aspx except Australia, The Age, 27 Oct 2012 "Worsening weather battering bottom line"
http://www.theage.com.au/environment/climate-change/worsening-weather-battering-bottom-line-20121026-28azy.html

What's driving the "soft" insurance market (favourable to buyers)

So what's driving the "soft" insurance market (with generally competitive rates and broad coverage)?

Despite US$ 190 billion in insured losses over 2.5 years, third party capital has kept the market competitive: hedge funds, pension funds, endowments and trusts.

Best's Special Report: The Capital Challenge: Reinsurance Capacity Overshadows Market, 26 Aug 2013, http://www3.ambest.com/frames/frameserver.asp?site=press&tab=1&altsrc=14&altnum=&refnum=65504648774946556657

So what's driving the "soft" insurance market (with generally competitive rates and broad coverage)?

Despite US$ 190 billion in insured losses over 2.5 years, third party capital has kept the market competitive: hedge funds, pension funds, endowments and trusts.

US$ 45 billion of additional capacity in recent years, representing 14% of the current global property limit, lured by the relatively favourable returns and uncorrelated risk that the reinsurance business offers.

Best's Special Report: The Capital Challenge: Reinsurance Capacity Overshadows Market, 26 Aug 2013, http://www3.ambest.com/frames/frameserver.asp?site=press&tab=1&altsrc=14&altnum=&refnum=65504648774946556657

So what's driving the "soft" insurance market (with generally competitive rates and broad coverage)?

Despite US$ 190 billion in insured losses over 2.5 years, third party capital has kept the market competitive: hedge funds, pension funds, endowments and trusts.

US$ 45 billion of additional capacity in recent years, representing 14% of the current global property limit, lured by the relatively favourable returns and uncorrelated risk that the reinsurance business offers.

Combined with relatively sanguine attitude of many insurance industry participants, as referred to earlier.

Best's Special Report: The Capital Challenge: Reinsurance Capacity Overshadows Market, 26 Aug 2013, http://www3.ambest.com/frames/frameserver.asp?site=press&tab=1&altsrc=14&altnum=&refnum=65504648774946556657

So what's driving the "soft" insurance market (with generally competitive rates and broad coverage)?

Despite US$ 190 billion in insured losses over 2.5 years, third party capital has kept the market competitive: hedge funds, pension funds, endowments and trusts.

US$ 45 billion of additional capacity in recent years, representing 14% of the current global property limit, lured by the relatively favourable returns and uncorrelated risk that the reinsurance business offers.

Combined with relatively sanguine attitude of many insurance industry participants, as referred to earlier.

Note: There have been some coverage restrictions and higher premium in certain high hazard zones.

Best's Special Report: The Capital Challenge: Reinsurance Capacity Overshadows Market, 26 Aug 2013, http://www3.ambest.com/frames/frameserver.asp?site=press&tab=1&altsrc=14&altnum=&refnum=65504648774946556657

Valuing our natural capital

Valuing our natural capital

Jane Gleeson-White, author of *"Numbers Rule the World":*

"Today, some economists, accountants, politicians and environmental activists are beginning to re-think [the] old way of valuing nature, and are re-conceiving it as natural capital."

"In 2012, the UN adopted a new international standard to give natural capital equal status to GDP. And next December, an international body will publish its guidelines for a new corporate accounting paradigm which includes natural capital."

Scientific American: UN wants *"governments to force companies to disclose their dependence on natural capital and the impact they have on it by disclosures in annual financial reports. They also want penalties for companies not doing so and tax incentives for those who protect natural capital as part of their business."*

ABC Radio National, 3rd September, 2013, http://www.abc.net.au/radionational/programs/bigideas/numbers-rule-the-world/4881098
Brown, P and the Daily Climate, "Banks Put a Price on Earth's Life Support", Scientific American, 30 August, 2013,
Above cited in Mahony, P, "Quantifying the cost of environmental damage", http://terrastendo.net/2013/10/04/quantifying-the-cost-of-environmental-damage/
Image: Tranquil River © Robyn Mackenzie | Dreamstime.com

Some thoughts to conclude

The need is urgent

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

Sources: 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: Earth © Pmakin | Dreamstime.com

The need is urgent

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."

Sources: 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: Earth © Pmakin | Dreamstime.com

The need is urgent

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."

Sources: 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: Earth © Pmakin | Dreamstime.com

The need is urgent

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."

Sources: 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: Earth © Pmakin | Dreamstime.com

The need is urgent

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

"GOOD PLANETS ARE HARD TO COME BY!"

"Contrarian claims by scepti
misrepresenting cli
nature
aintains a
tween facts and fiction."

"The best that governments seem to do is devise cosmetic solutions, or promise further discussions, while time is running out."

Sources: 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: Earth © Pmakin | Dreamstime.com