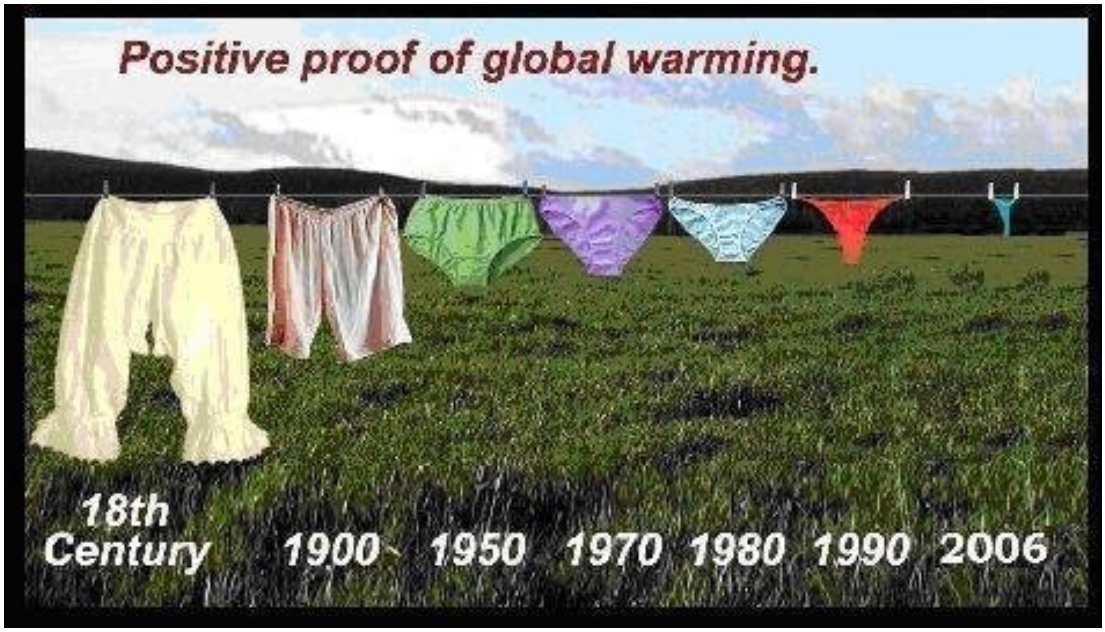
An Almanac of the Atmosphere

being

A random walk through observation, calculation and estimation of changes to the climate.

Compiled 22 September 2009

Positive Proof of Global Warming



HEALTHY POLAR BEARS TOO!

A splendid example of a member of an expanding population of polar bears. Polar bears in Norway's remote Svalbard archipelago photographed by Steve Kaslowski.

170 YEARS OF ATMOSPHERIC MEASUREMENTS – 1840 TO 2010

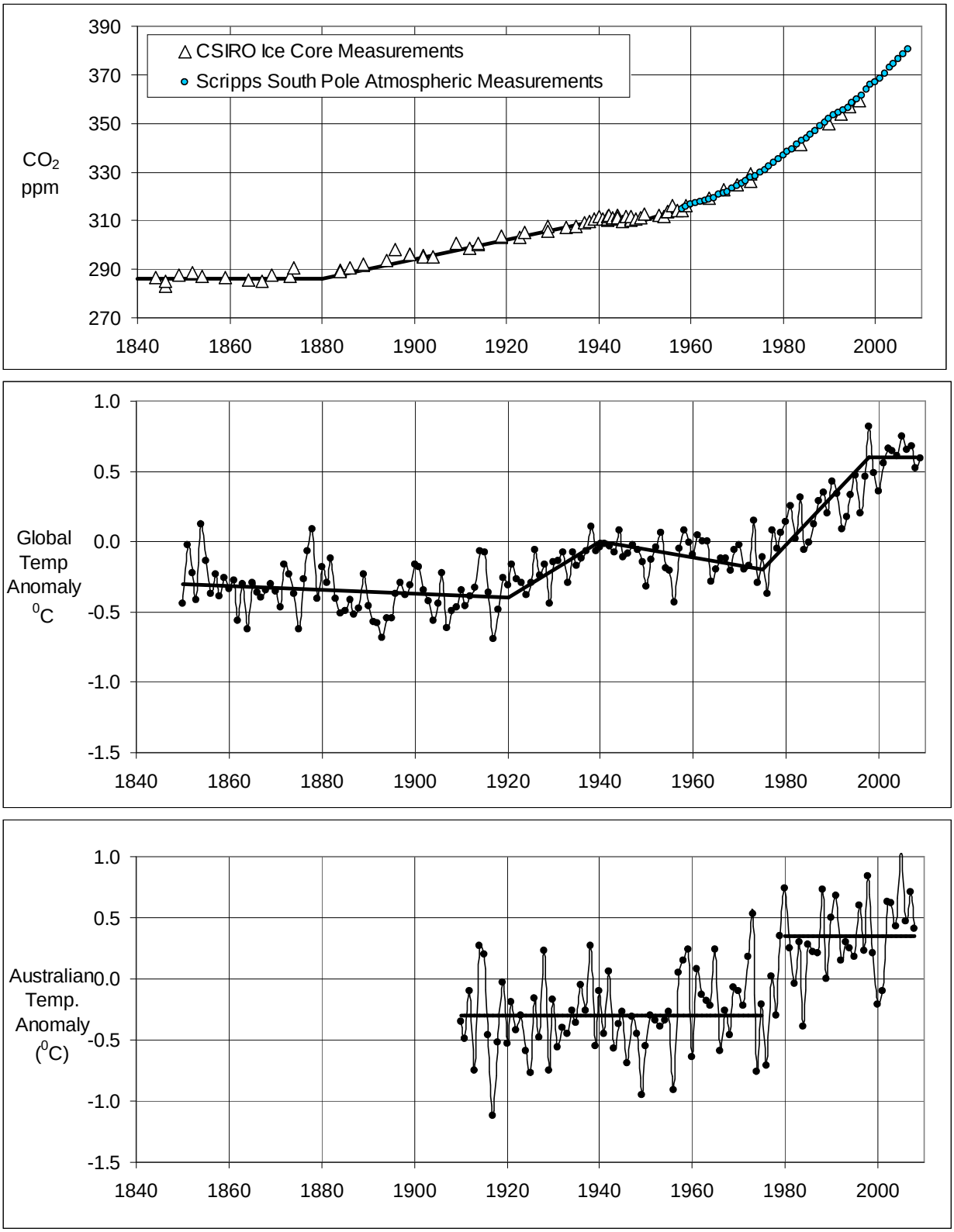


Figure 1: Top – *Ice core and atmospheric measurements of CO_2 concentration levels in Antarctica and at the South Pole. In the 1940s and early 1950s there was no increase in CO_2,* ***Middle –*** *Global temperatures estimated by the Hadley Centre of the UK Met Office. Solid lines indicate warming and cooling periods* ***and Bottom –*** *Australian temperature estimated by the Bureau of Meteorology. Note for the solid lines the 0.6^0C step is at the time of the Great Pacific Climate Shift in 1976.*

CO_2 IN THE ATMOSPHERE 1980 - 2008

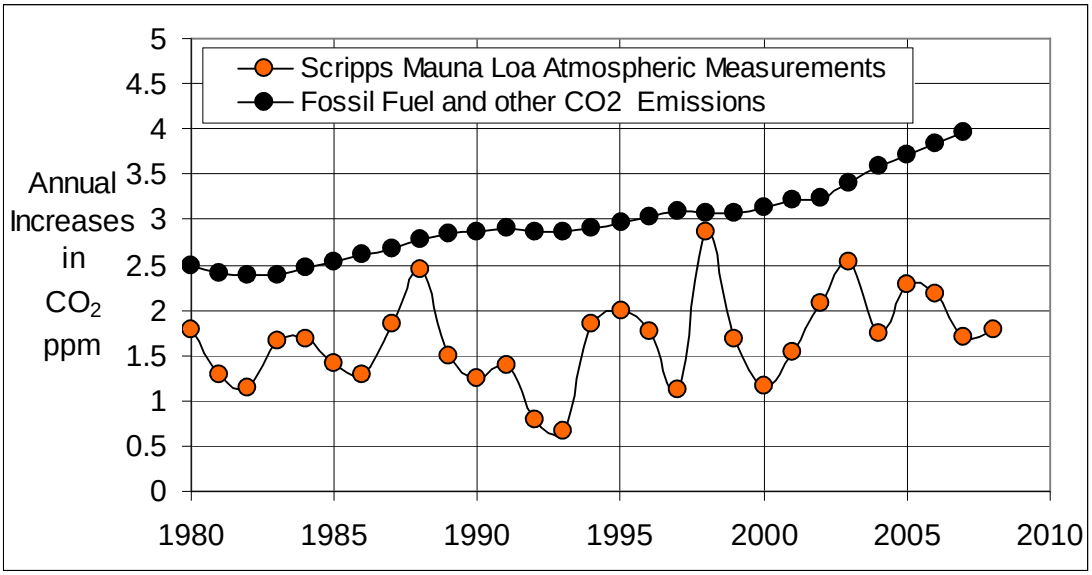


Figure 2: *Annual increases in atmospheric CO_2 concentrations measured at Mauna Loa, Hawaii (Scripps) and estimated annual emissions of CO_2 from human activity (Carbon Dioxide Information Analysis Center).*

ANNUAL GLOBAL TEMPERATURE ANOMALY 1980 TO 2009

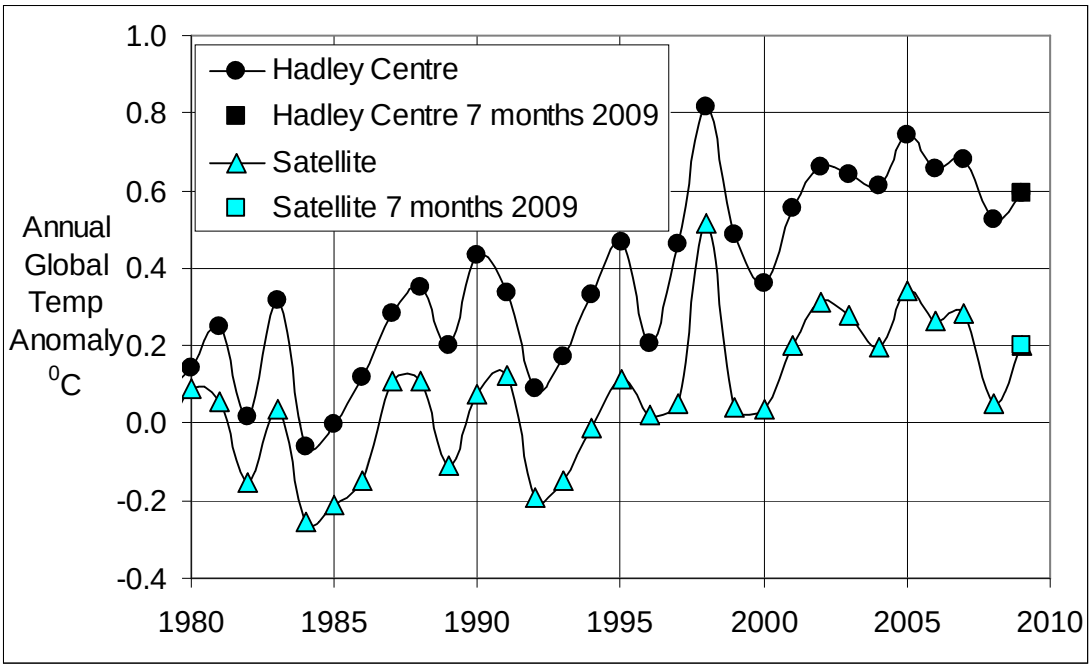


Figure 3 *Annual global temperature anomaly calculated from surface measurements (Hadley Centre of the UK Met Office) compared to the average for 1961 to 1990 and from satellite measurements (University of Alabama at Huntsville) compared to the satellite average for 1979 to 1998. Note that the year on year variations are in good agreement although the Hadley anomaly shows an increase of 0.1^{0}C per decade compared to the satellite values.*

The 1998 to 2008 data are compatible with no temperature change: Hadley +0.05 +/- 0.13 ^{0}C per decade and satellite (UAH) -0.05 +/- 0.15 ^{0}C per decade.

SURFACE ENERGY CHANGES FROM CO_2 IN THE ATMOSPHERE

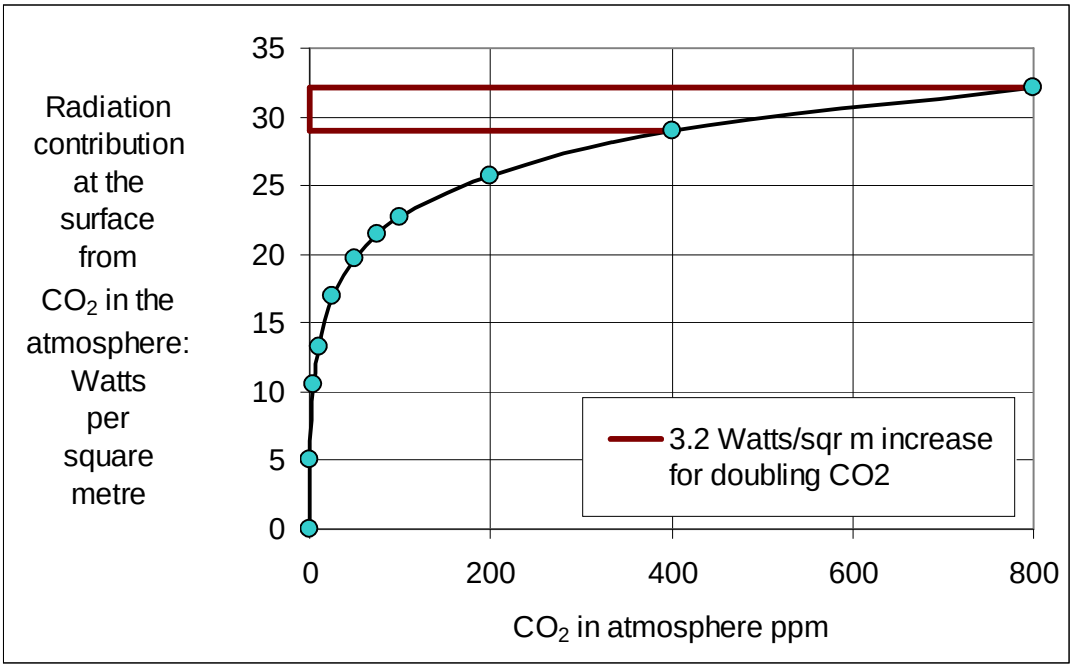


Figure 4 *As the concentration of CO_2 increases, there is increased radiation back to the surface of the earth (the greenhouse effect). This is measured in Watts per square metre (left axis). However the relationship is not linear. In fact doubling the concentration of CO_2 from 400 ppm to 800 ppm only increases the radiation from CO_2 at the surface by some 10% or 3.2 Watts per square metre. (Results derived for US standard atmosphere and cloudless sky from MODTRANS, a University of Chicago on-line calculator of energy in the atmosphere. MODTRANS is an international and IPCC accepted standard for atmospheric calculations).*

TEMPERATURE CHANGES AT THE SURFACE FROM CHANGES IN CO_2 CONCENTRATIONS

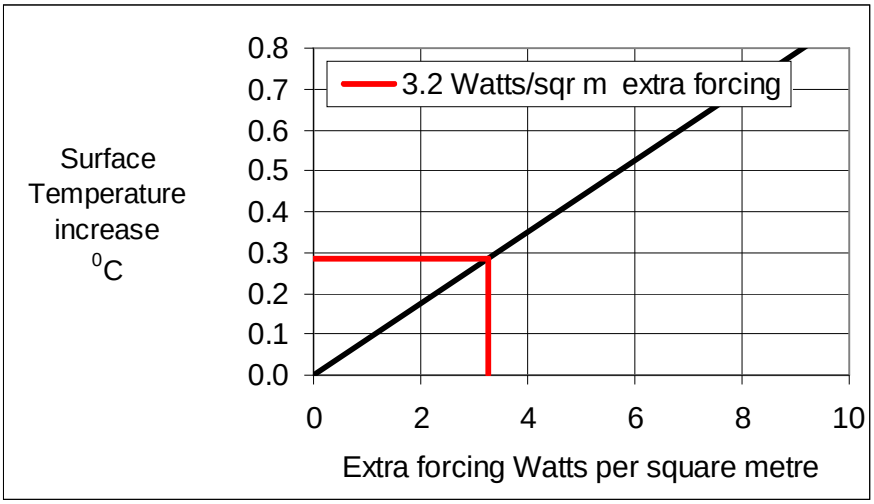
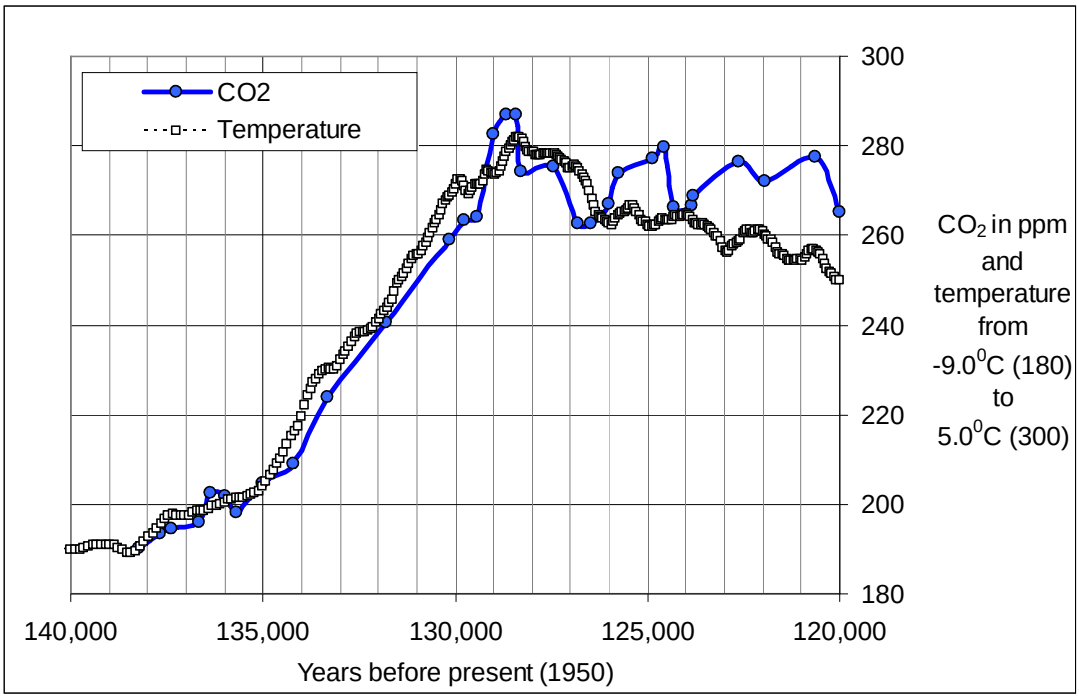


Figure 5 *Increased radiation forcing results in an increased surface temperature. However with 70% of the earth's surface as ocean, evaporation reduces the temperature increase by approximately a factor of two. Doubling the CO_2 concentration to 800 ppm with a 3.2 Watts per square metre radiation increase, gives a surface temperature increase of 0.3 ^{0}C. IPCC modelling suggests that this level of CO_2 will be reached in 2100 with their "business-as-usual" projection.*

TEMPERATURES RISE BEFORE CO_2 CONCENTRATIONS AT THE END OF ICE AGES



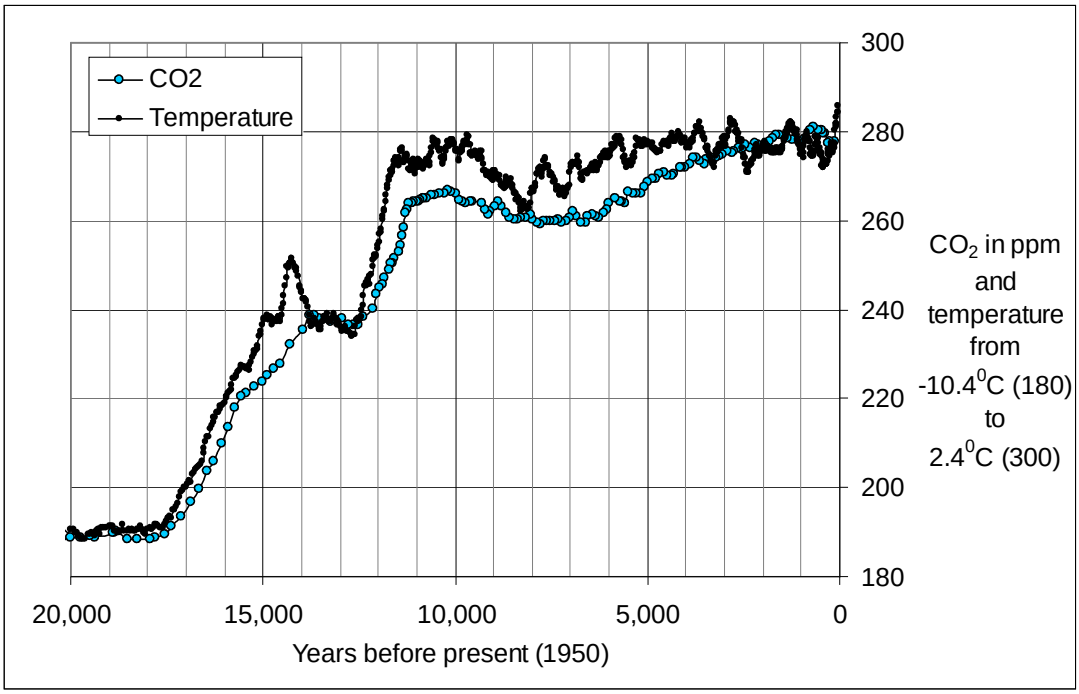


Figure 6 *Ice Core measurements at Vostok and EPICA in Antarctica. CO_2 measurements from air bubbles trapped in the ice. Temperatures estimated from changes in the oxygen and hydrogen isotope composition of the ice. Temperature rises lead CO_2 increases by several hundred years.* ***Top:*** *- End of the ice age 130,000 years before the present. Temperature increases by 6^0C. Note that temperature and CO_2 do not follow the same track after the end of the ice age. Temperature is likely to vary more with local conditions than CO_2. CO_2 levels come from a general sampling of the atmosphere. (Vostok measurements)* ***Bottom:*** *- End of the last ice age around 15,000 years before the present. Temperature increases by 8.5^0C. (EPICA measurements)*

GLOBAL MEAN RADIATIVE FORCING

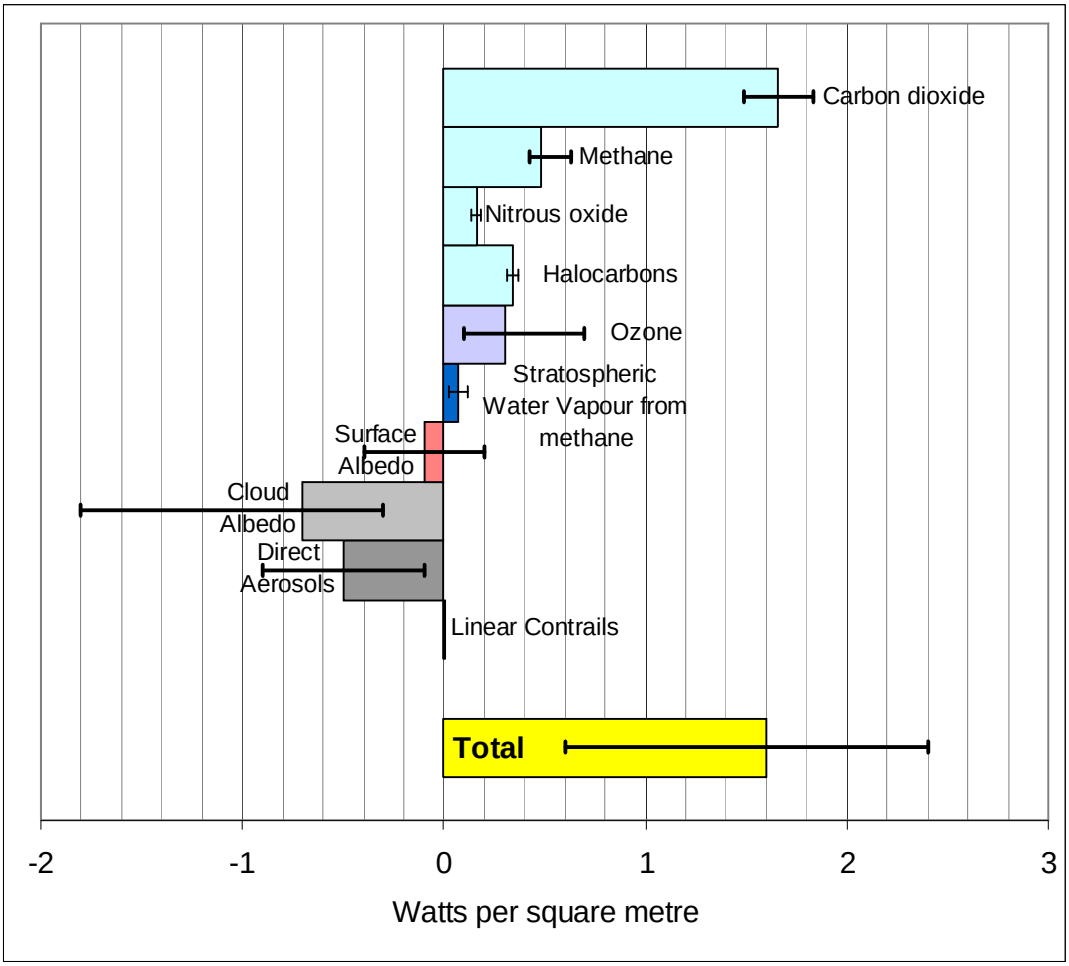


Figure 7: *Radiative forcings from various anthropogenic sources. This is the IPCC summary of the contributions from components of the atmosphere " the global average net effect of human activities since 1750 has been one of warming, with a radiative forcing of +1.6 [+0.6 to +2.4] W m^{-2} (see Figure SPM.2)". [IPCC-AR4 2007 WG1 Fig SPM.2]. Note the large uncertainties for aerosol and albedo forcing, exceeding the values of greenhouse gas forcing. Some components have over 100% uncertainty and are most likely from expert opinion rather than measurements of uncertainty.*

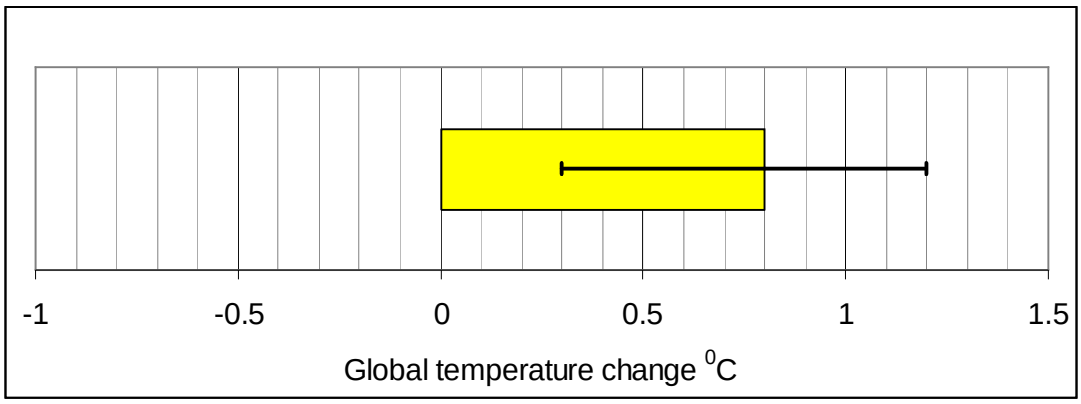


Figure 8: *IPCC inferred temperature increase of 0.8^{0}C since 1750. The temperature increase is the result of the 1.6 Watts per square metre estimated warming. Note the error bars that reflect the uncertainty in the temperature estimate are the compounded uncertainties of the radiation forcing where some components have over 100% uncertainty and are most likely from expert opinion rather than measurements of uncertainty.*

MURRAY-DARLING BASIN YEARLY RAINFALL 1900 TO 2008

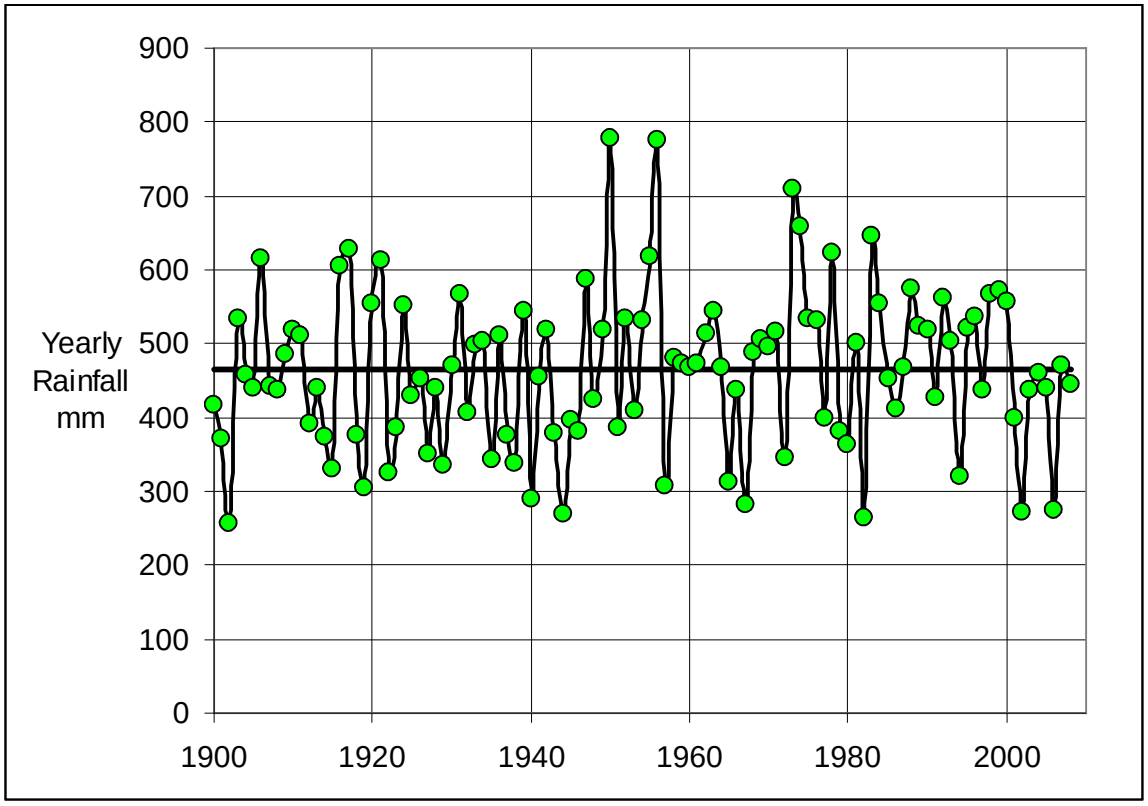


Figure 9: *Yearly rainfall in the Murray-Darling Basin. Mean value of 465 mm (solid line) and median 468 mm. There is no significant trend in rainfall through this period but with large variability- standard deviation of 106 mm with rainfall extremes of a minimum 257 mm and a maximum of 777 mm. It is therefore difficult to relate this to any temperature changes as shown in Figure 10.*

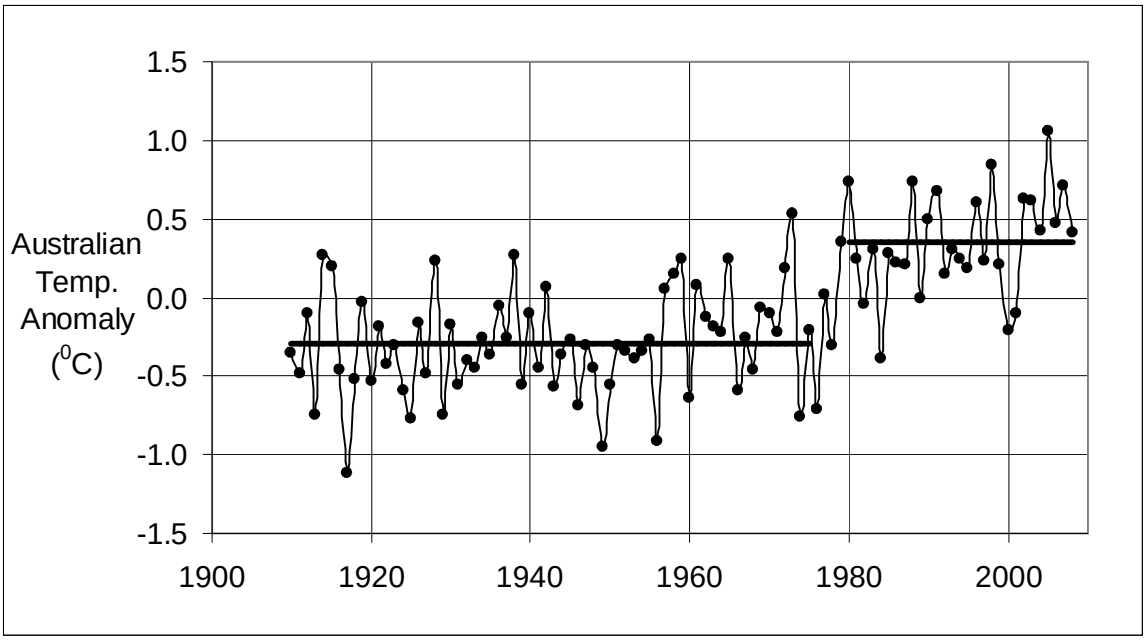


Figure 10– *Australian temperature anomaly estimated by the Bureau of Meteorology. The gap in the solid lines, a 0.6^{0}C step, is at the time of the Great Pacific Climate Shift of 1976.*

Extract from the Garnaut Climate Change Review Interim Report February 2008

The Australian climate has changed notably over the past 50 years. **There is no evidence for this- see below**

Annual mean temperature in Australia has increased by up to 0.7°C since 1950. According to the IPCC, there is a greater than 90 per cent probability that the warming observed since the 1950s is due to human activities (IPCC, 2007c).

The assignment of a probability has been made from a set of measurements and estimates that in part depend on expert opinion. That does not lend itself to an analysis of probability. A simple alternative explanation for Australia is most, that is 0.5^{0}C, of the temperature increase occurred at the time of the Great Pacific Climate Shift in 1976.

There has been a striking change in precipitation trends in Australia since the 1950s.

There has been an average increase of 40 +/-14 mm in rainfall since 1950 with 470 mm average annual rainfall.

There is no statistically significant difference in the trend for rainfall over Australia for fifty years before and after 1950. The difference in trend is 11 +/- 9 mm per decade, So the claimed change must refer to a redistribution of rainfall within Australia.

North-west Australia has seen an increase in annual rainfall of more than 30mm per decade, while decreases along parts of the east coast have exceeded 50mm.

Two intense periods of activity in 1974-1976 and 1999-2001 have skewed the northern region rainfall record, With these years excluded there is an average increase of 29+/-17 mm and the trend in rainfall has increased by 16 +/-11 mm per decade with annual rainfall of 500mm. For eastern Australia the difference is 21+/-20 mm and the trend difference has been an 18 +/-12 mm per decade decline from before to after 1950, hardly a striking change with annual rainfall of 600 mm. The Murray-Darling Basin shows no statistically significant change over this time with an average increase of 30+/-20 mm and a trend difference of -9 +/-13 mm per decade on annual rainfall of 460 mm.

While it is not yet possible to attribute all the rainfall changes to anthropogenic climate change, some of the changes are likely to be at least partly due to increases in greenhouse gases (CSIRO and BOM, 2007).

It is also possible that firstly there have been no significant changes in rainfall and second that the temperature increase is a symptom of ocean temperature changes.

References

1 Quirk, Tom, (2009) The Australian temperature anomaly, 1910 – 2000, Energy & Environment 20, pp 97-100

2 Time series on the Bureau of Meteorology website**:** **http://www.bom.gov.au/cgi-bin/climate/change/timeseries.cgi**

GLOBAL SEA LEVEL CHANGES

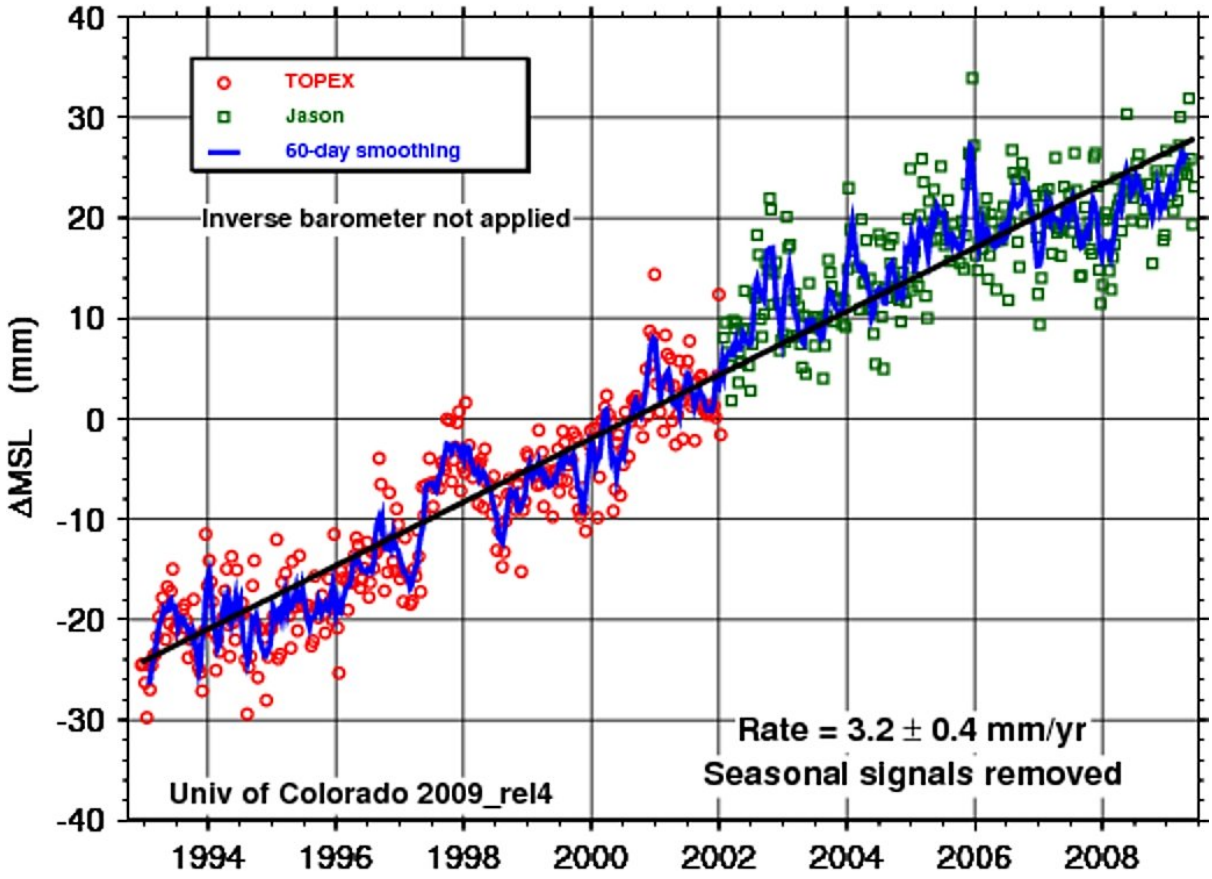
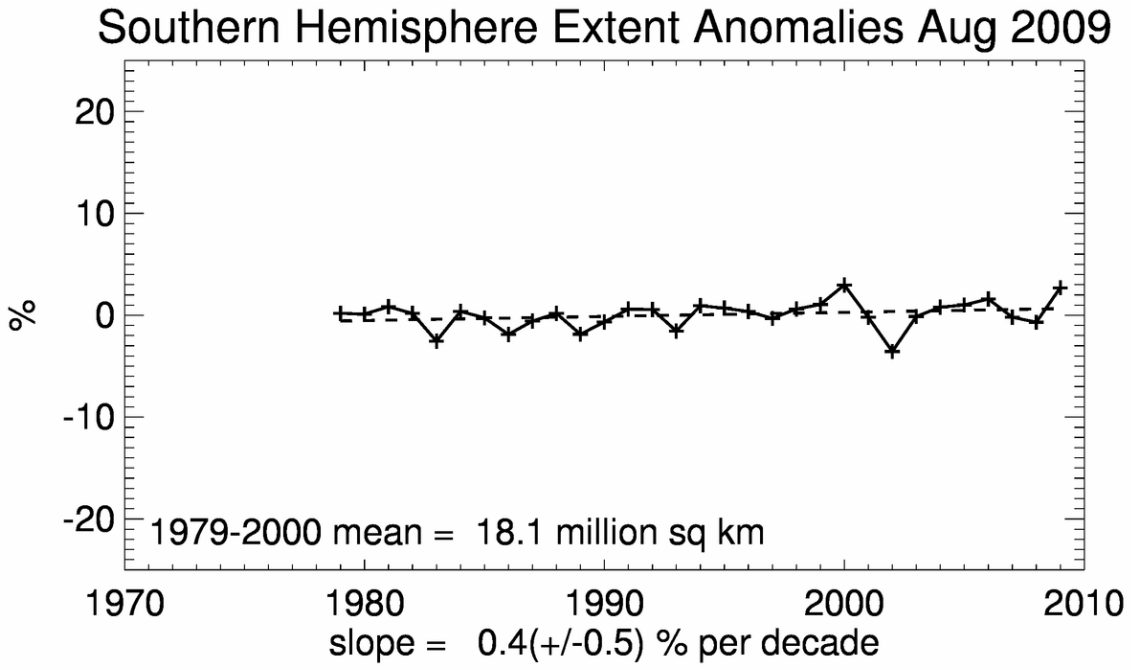


Figure 11 *The global mean sea level graph was made using satellite altimetry and processed by the University of Colorado at Boulder. Note that the rate of increase is 3.2 +/- 0.4 mm/year for1992 to 2009 but falls to 2.0+/- 0.4 mm/year for 2002-2009. These values are compatible with IPCC predictions to 2100.*

Long-term mean sea level change is a variable of considerable interest in the studies of global climate change. The measurement of long-term changes in global mean sea level can provide an important corroboration of predictions by climate models of global warming. Long term sea level variations are primarily determined with two different methods. Over the last century, global sea level change has typically been estimated from tide gauge measurements by long-term averaging. Alternatively, satellite altimeter measurements can be combined with precisely known spacecraft orbits to provide an improved measurement of global sea level change.

Since August 1992 the satellite altimeters have been measuring sea level on a global basis with unprecedented accuracy. The TOPEX/POSEIDON (T/P) satellite mission provided observations of sea level change from 1992 until 2005. Jason-1, launched in late 2001 as the successor to T/P, continues this record by providing an estimate of global mean sea level every 10 days with an uncertainty of 3-4 mm. The latest mean sea level time series and maps of regional sea level change can be found on this site. Concurrent tide gauge calibrations are used to estimate altimeter drift. Sea level measurements for specific locations can be obtained from our Interactive Wizard. Details on how these results are computed can be found in the documentation and the bibliography. Please contact us for further information



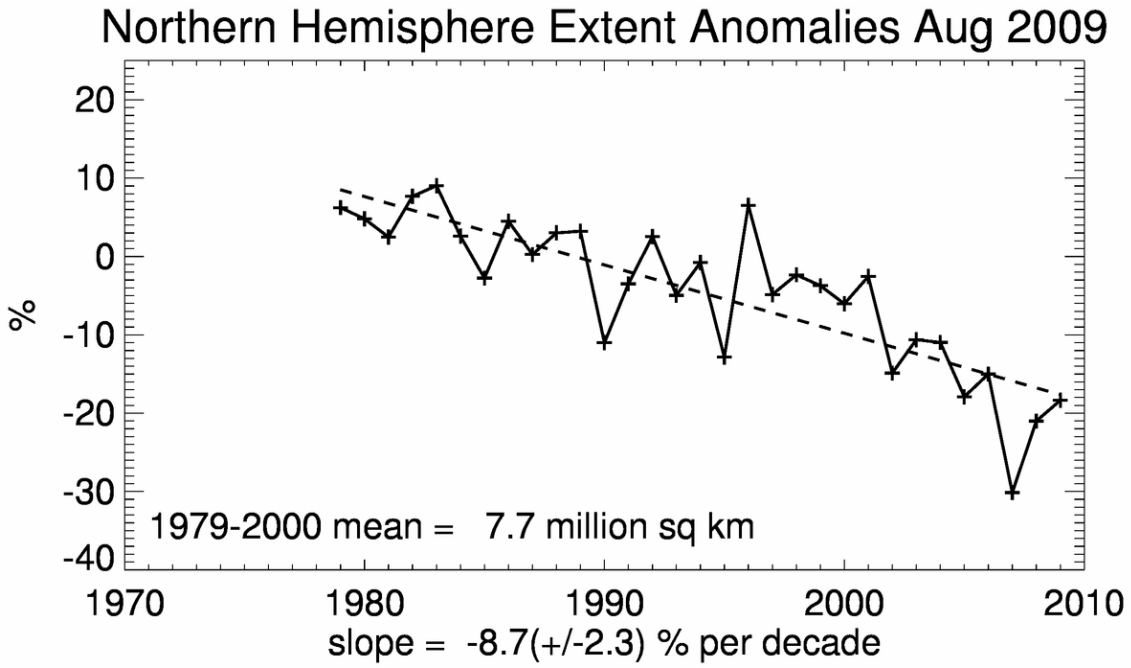
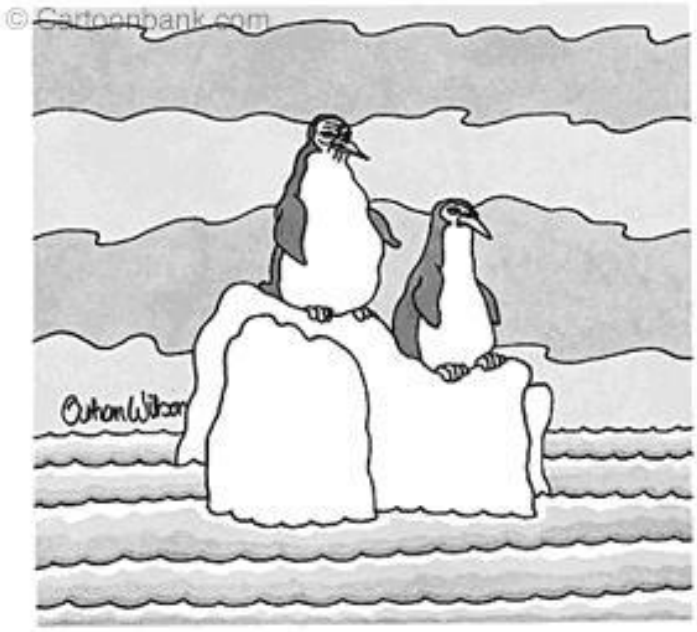


Figure 12 *Arctic and Antarctica ice extent. Note that the slopes for the fitted straight lines give the change per decade.*

Data from National Snow and Ice Data Center: http://nsidc.org/data/seaice_index/



"Call this an iceberg? When I was a kid we wouldn't have called this an iceberg!"

From the New Yorker