Hong Kong City Hall, 25th June 2011

Human-induced global warming: Why I am sceptical

Professor Ian Plimer

Earth and Environmental Sciences, The University of Adelaide
Emeritus Professor of Earth Sciences, The University of Melbourne

1

Constant cyclical climate change

Known Cycles	
Variable	tectonic, PDO
143 million year	galactic
100,000 years	orbital
41,000 years	orbital
23,000 years	orbital
1,500 years	solar
210 years	solar
87 years	solar
22 years	solar
18.7 years	lunar
11 years	solar

The next climate change: The future is written in the past

Pleistocene ice age	110,000 to 14,700 years ago
Bölling	14,700 to 13,900 years ago
Older Dryas	13,900 to 13,600 years ago
Allerød	13,600 to 12,900 years ago
Younger Dryas	12,900 to 11,600 years ago
Holocene warming	11,600 to 8,500 years ago
Egyptian cooling	8,500 to 8,000 years ago
Holocene Warming	8,000 to 5,600 years ago
Akkadian cooling	5,600 to 3,500 years ago
Minoan Warming	3,500 to 3,200 years ago
Bronze Age Cooling	3,200 to 2,500 years ago
Roman Warming	500 BC to 535 AD
Dark Ages	535 AD to 900 AD
Medieval Warming	900 AD to 1300 AD
Little Ice Age	1300 AD to 1850 AD
Modern Warming	1850 AD to ....

Spiral galactic arm encounters

✦ Pongolian	?
✦ Huronian (? Snowball Earth)	Sagittarius-Carina Arm
✦ Neoproterozoic (Snowball Earth)	Sagittarius-Carina Arm
✦ Ordovician-Silurian	Perseus Arm
✦ Carboniferous-Permian	Norma Arm
✦ Jurassic-Cretaceous	Scutum-Crux Arm
✦ Miocene	Sagittarius-Carina Arm
✦ Quaternary	Orion Arm

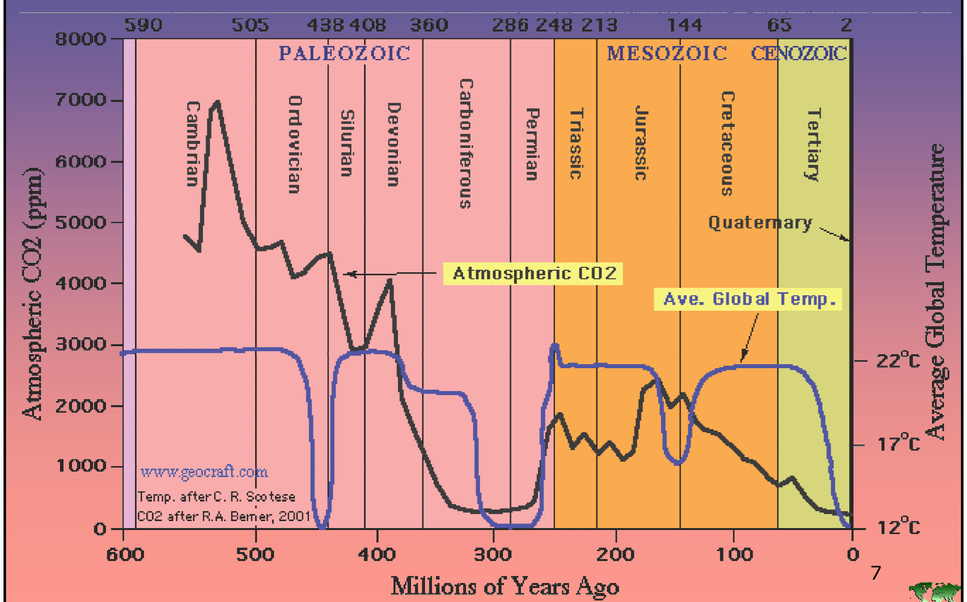
Increased dust and cosmic radiation giving low level clouds

800-600 Ma glacial detritus

Flinders Ranges 800-600 Ma

If $[CO_2]$ high, then dolomite $CaMg(CO_3)_2$

Climate change over time (geological scale)

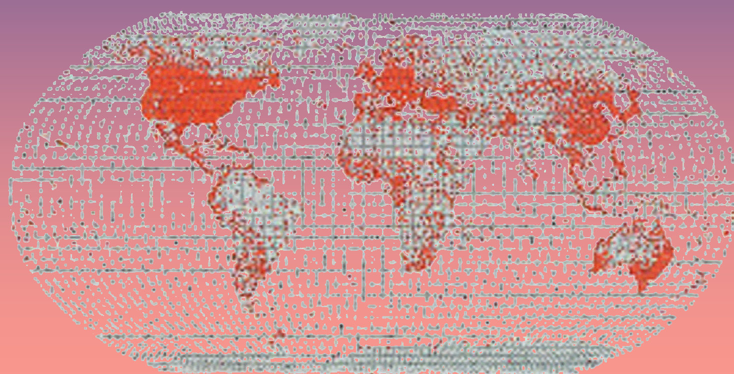


7

Great Barrier Reef, 400 Ma Napier Range

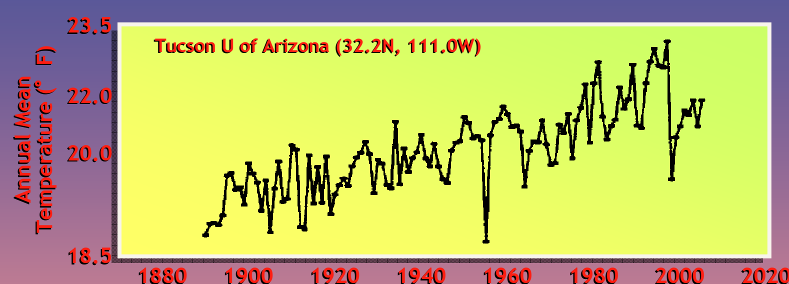
Temperature

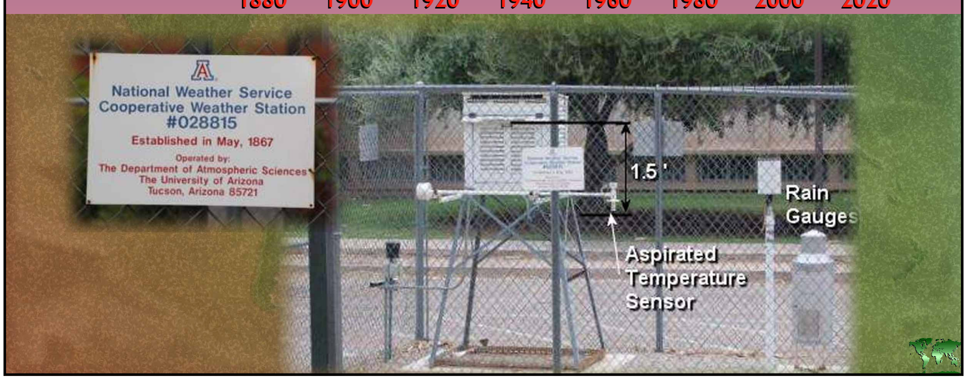
Location, location, location…..



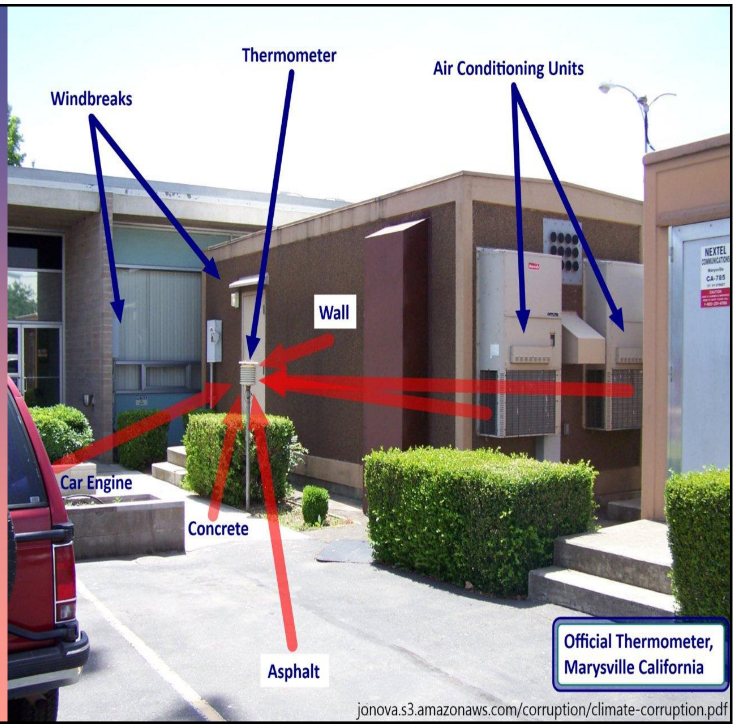
9

Urban heat island effect

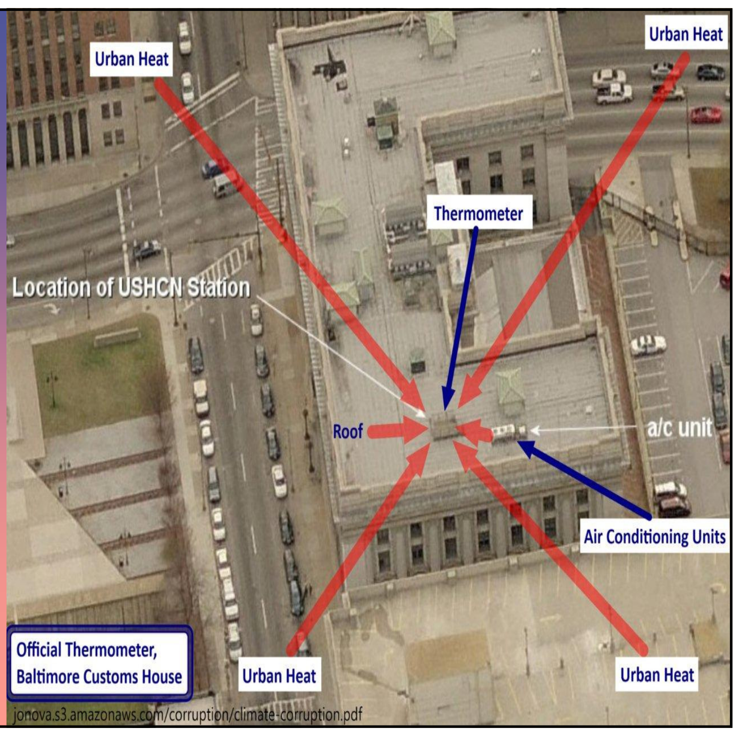




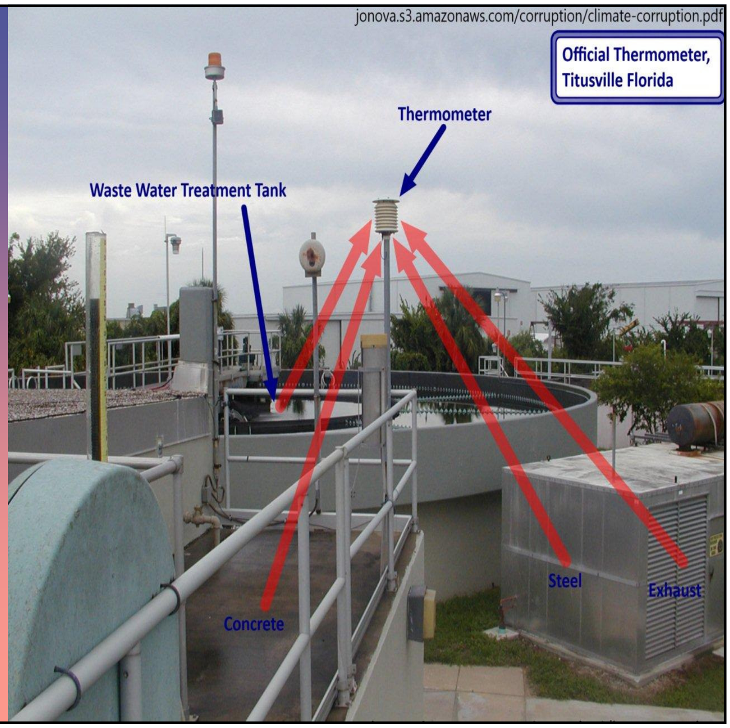
Marysville
(Ca., USA)



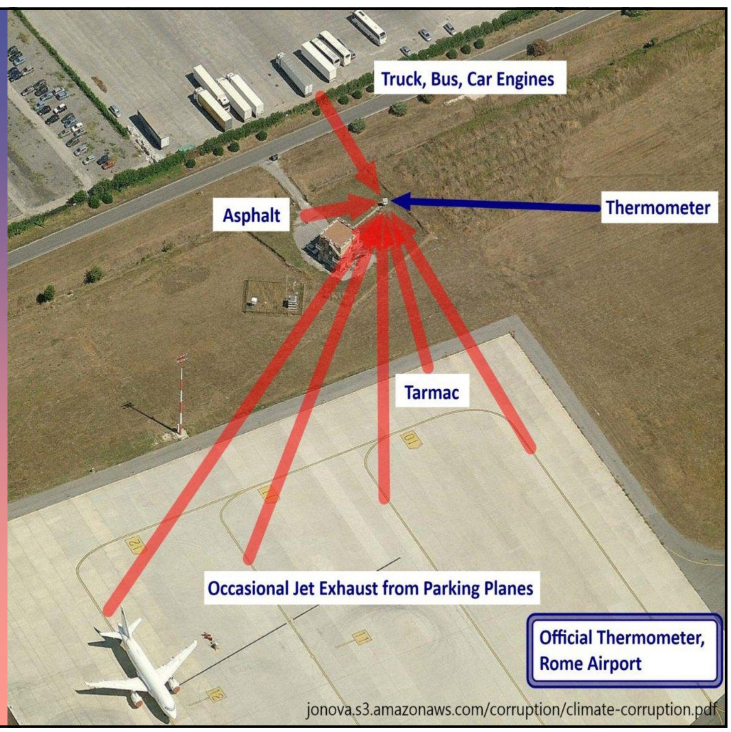
Baltimore
(USA)



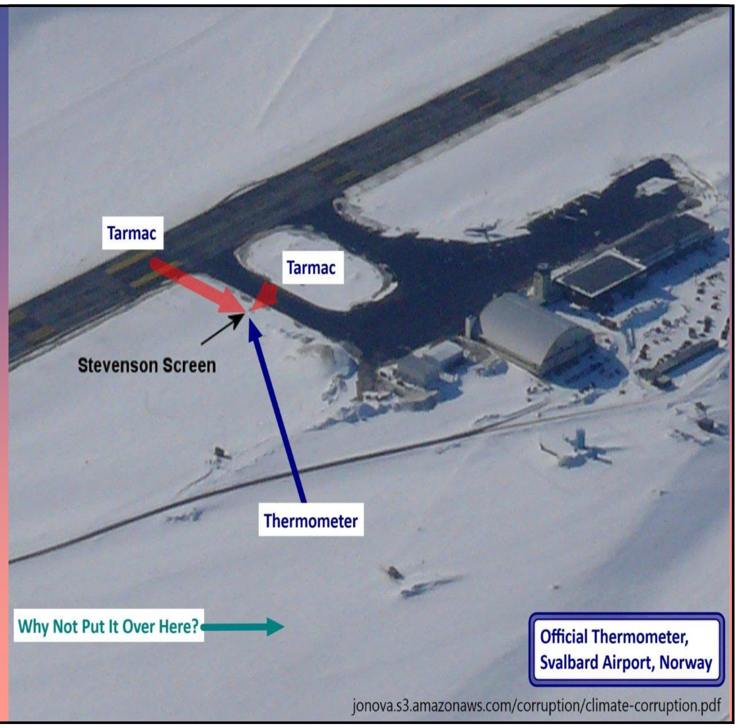
Titusville
(Fl., USA)



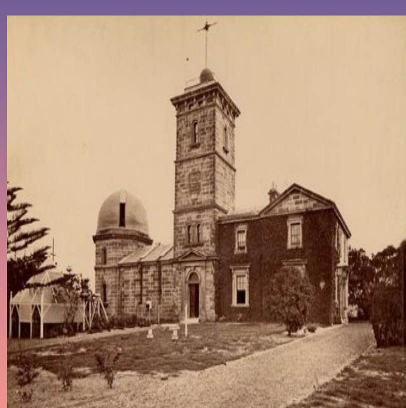
Rome
(Italy)

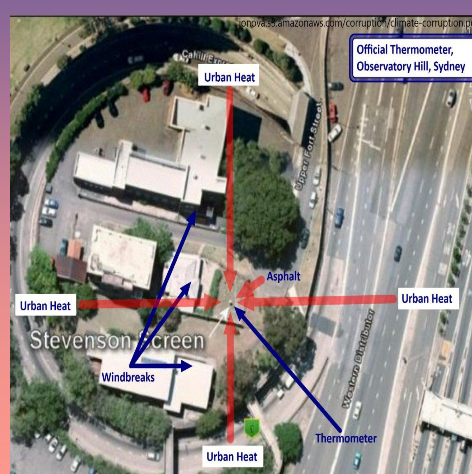


Svalbard (Norway)

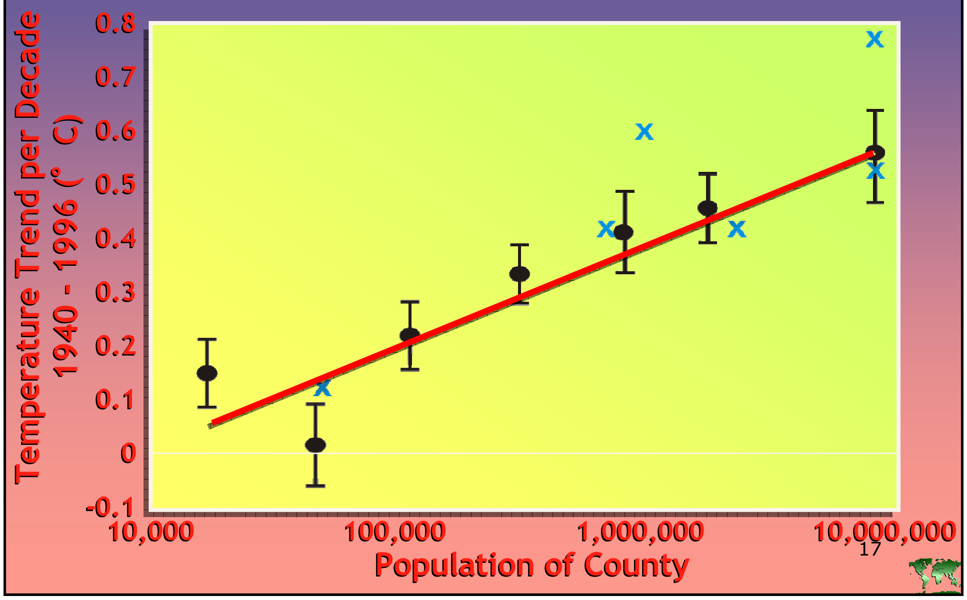


Sydney Observatory 1874 (60,000 people) and 2009 (4.5 M people)





What is really measured?



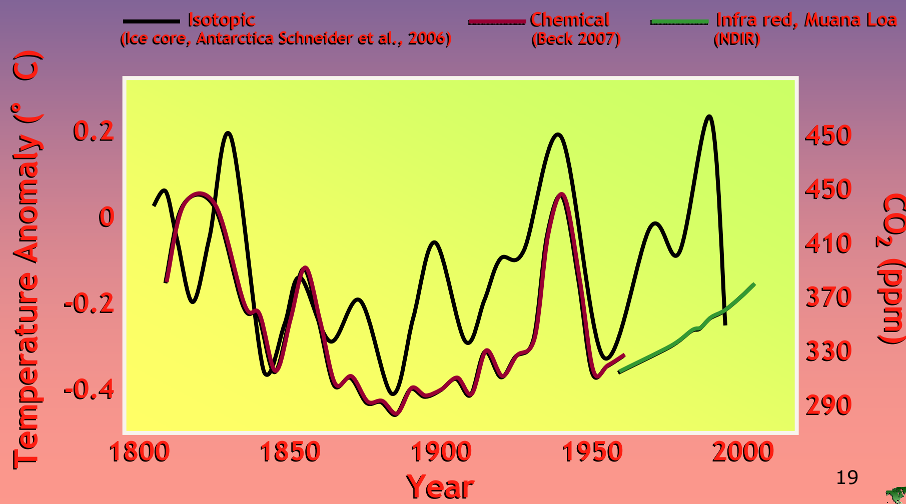
17

Land-based temperature measurements

- 86% US sites contaminated
- Sites moved or closed
- Historical measurements ±0.5° C
- Corrected data (urban heat island; other corrections)
- Uncertainty
- Poised for manipulation

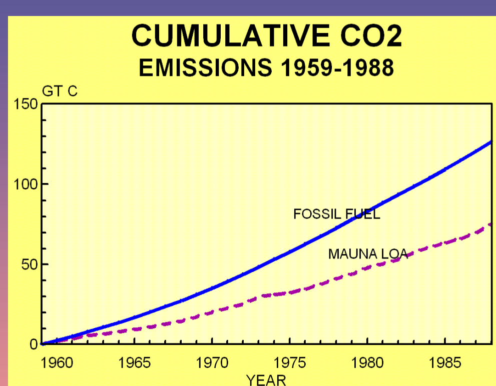
18

CO_2 measurements



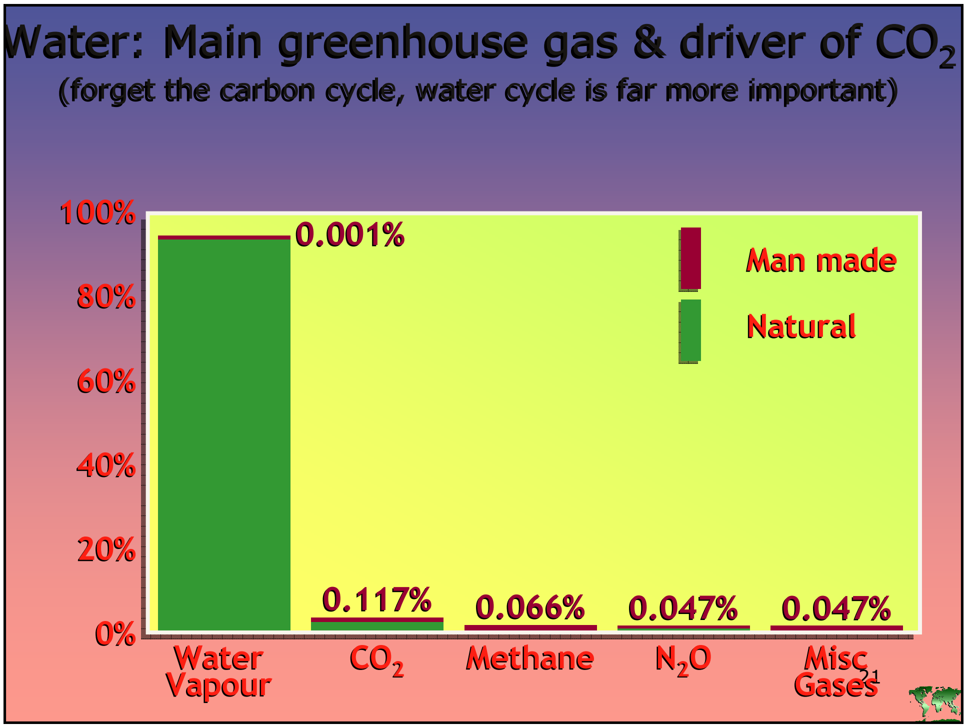
19

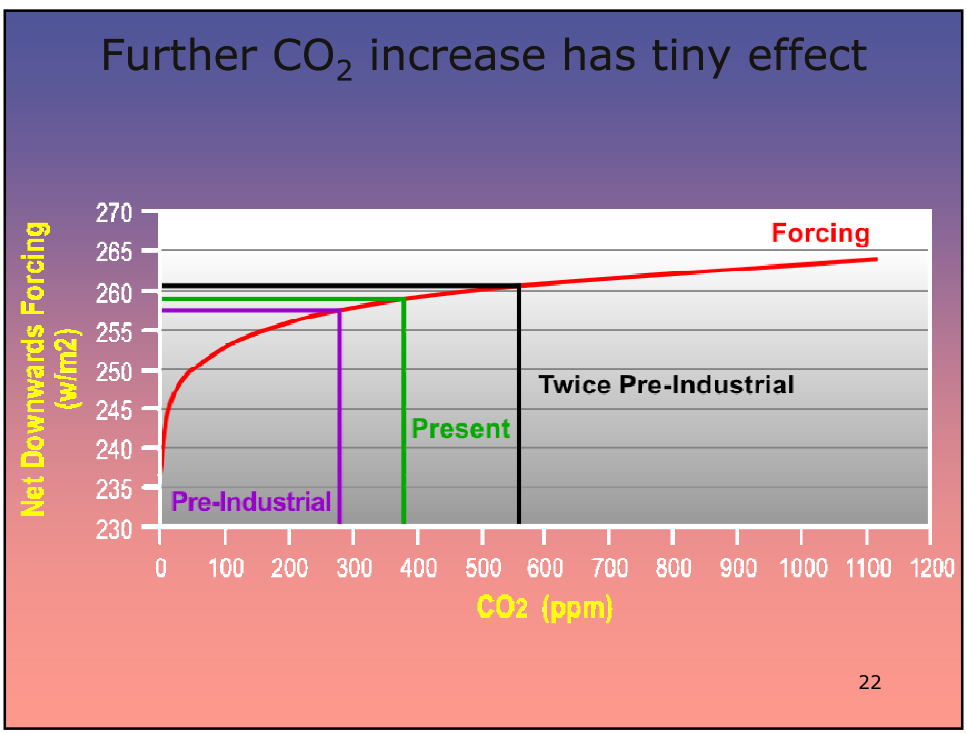
CO_2 measurement



1. CO_2 measurements near the top of CO_2-emitting active volcano , assumed representative of the world's CO_2
2. Most measurements rejected
3. There is a 50% error (3-4 Gt) vs. the expected CO_2 level from burning fossil fuel
4. Missing sink, disproves IPCC

20


Water: Main greenhouse gas & driver of CO2
(forget the carbon cycle, water cycle is far more important)
100%
80%
60%
40%
20%
0%
0.001%
Man made
Natural
0.117%
0.066%
0.047%
0.047%
Water Vapour
CO2
Methane
N2O
Misc Gases
21


Further CO2 increase has tiny effect
Net Downwards Forcing (w/m2)
270
265
260
255
250
245
240
235
230
Forcing
Twice Pre-Industrial
Present
Pre-Industrial
0
100
200
300
400
500
600
700
800
900
1000
1100
1200
CO2 (ppm)
22

Daily uses of CO_2

- Fire extinguishers
- Baking soda
- Soda drinks, beer, champagne (effervescense; added or from fermentation; the lower the temperature, the more CO_2 dissolves in water; brewery adds 3 litres CO_2 for 1 litre water)
- Neutralizing agent for acid lakes (limestone)
- Life jackets (gas expansion)
- Cooling agent
- Product of our breathing (breathe in 0.04% CO_2 and breathe out 4% CO_2)
- Invisible, non-toxic, no smell, no taste: NOT A POLLUTANT

Where do our CO_2 go?

- Air now has <0.04% CO_2, previous times CO_2 was >10% (yet no acid oceans, no runaway global warming, no extinctions)
- 50 times more CO_2 in the oceans than in air
- CO_2 emissions quickly dissolve in oceans (~5 years)
- Used by oceanic life and plants

Double CO_2, yields increase (wheat 60%, legumes 62%, fruits 33%, vegetables 51%, tubers 67%)

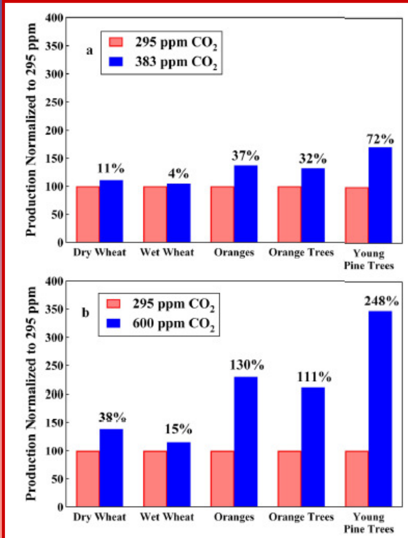
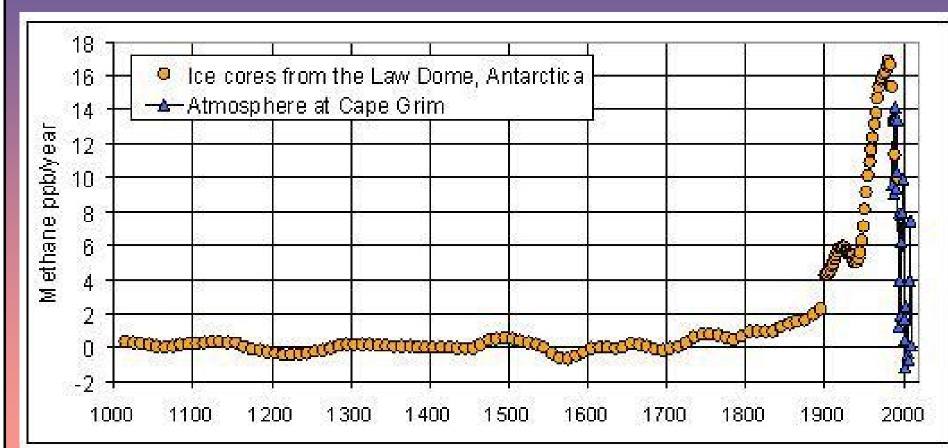


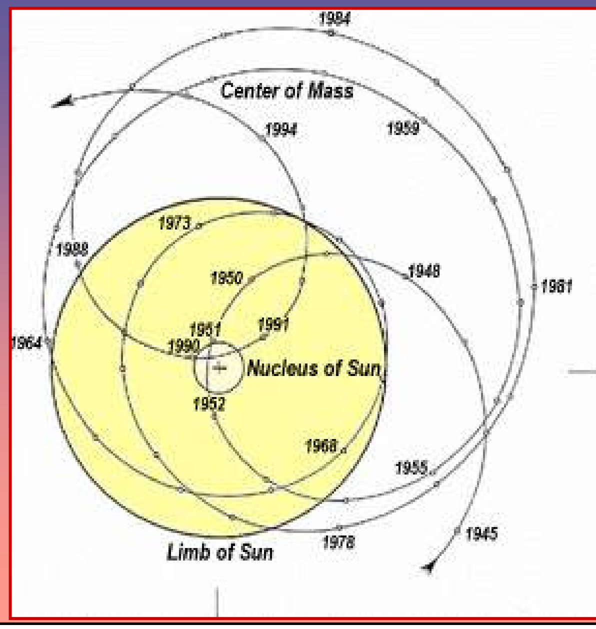
Figure 24: Calculated (1,2) growth rate enhancement of wheat, young orange trees, and very young pine trees already taking place as a result of atmospheric enrichment by CO_2 from 1885 to 2007 (a), and expected as a result of atmospheric enrichment by CO_2 to a level of 600 ppm (b).

Methane
(Law Dome ice core and CSIRO measurements, Cape Grim)



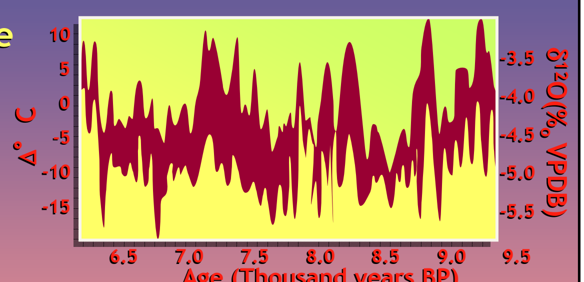
Our restless sun: solar wobbles

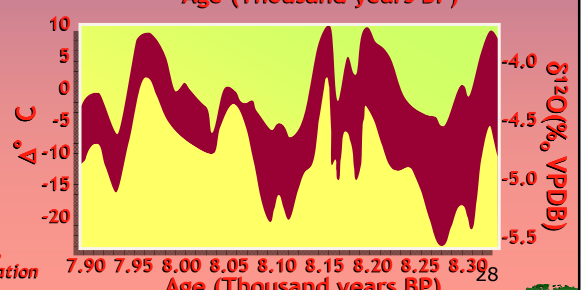
Gravity
Solar variability



Solar-driven climate cycles

Solar - climate linkage at centennial scale



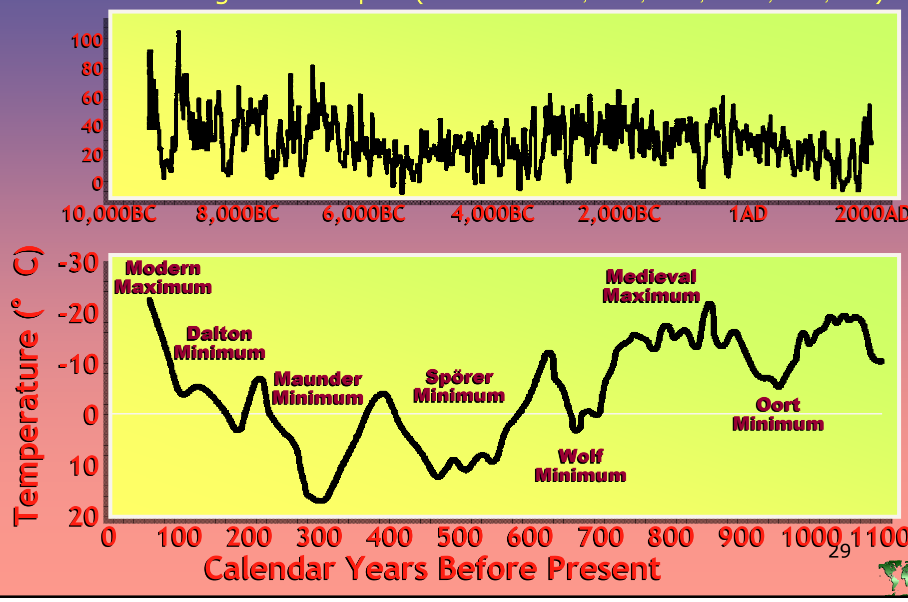


Close correlation between solar eruptions, driving the solar wind, and tropical circulation and rainfall (from Neff et al., 2001)

28

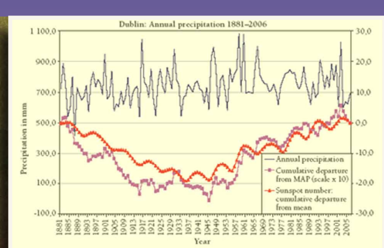
Temperature proxy

Cosmogenic isotopes (C^{14}; also Be^{10}, Al^{26}, Cl^{36}, Ca^{41}, Ti^{44}, I^{129})

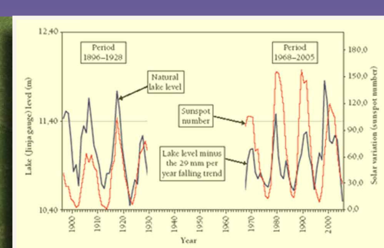


29

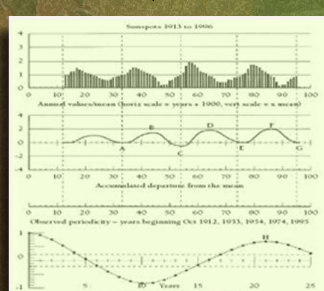
Solar-driven rainfall, river flows and lake levels

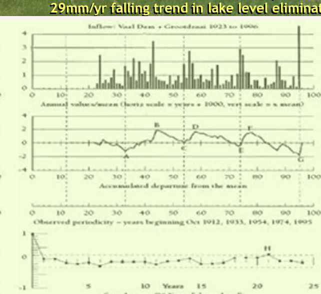


Comparison between Annual Rainfall in Dublin, Ireland and annual sunspot numbers



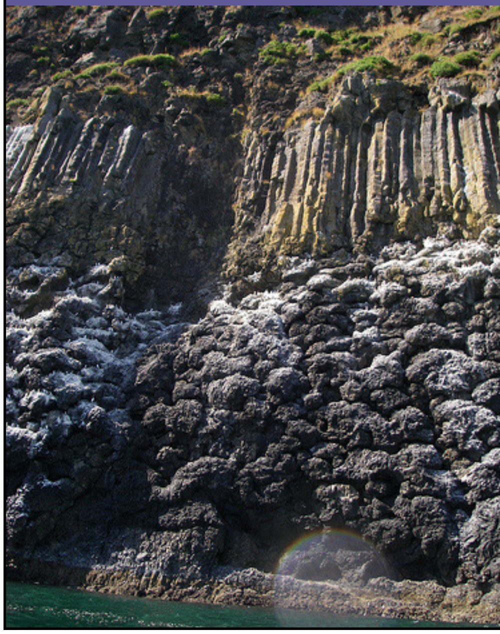
Levels of Lake Victoria from 1896-1928 and from 1968-2005 compared to solar variation in the form of sunspot number indices, but with the 29mm/yr falling trend in lake level eliminated from the latter data.





Comparison of the characteristics of annual sunspot numbers with corresponding characteristics of the annual flow in the Vaal River

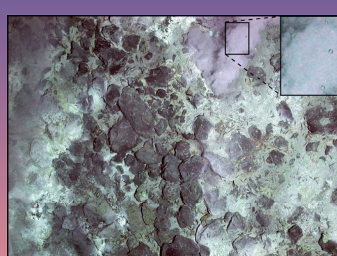
Submarine basaltic volcanism



31

Submarine basaltic volcanoes

Vent CO_2 (gas and liquid) exhalation



32

Submarine basaltic volcanicity

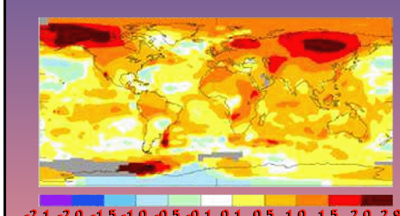
- Lava, hot springs, gas vents
- 64,000 km mid ocean ridges (10,000 km^3 water for cooling per annum; buffers seawater)
- Seamounts (>3,477,403* million > 0.1 km high), off axis volcanoes (cf 800 terrestrial felsic volcanoes)
- Slow spreading (Gakkel Ridge basalts; >13.5% CO_2; explosive [1999])
- No monitoring; gas measurements from 20 basaltic volcanoes, total emissions calculated at 0.08% of annual human emissions
- Upwelling thousands of years later

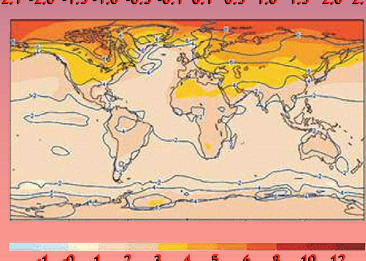
33

*Hiller & Watts (2007)

Model surface changes

1955-2005 Annual Mean (0.59)



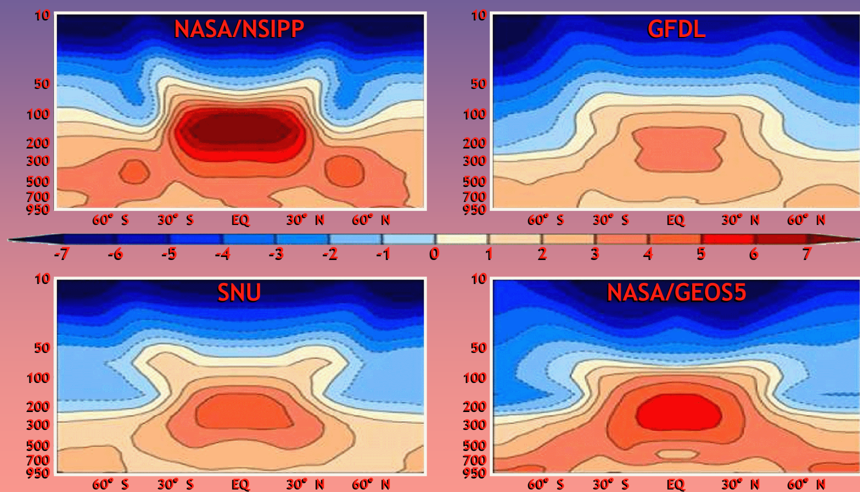


Observed change:
- Largest warming over Siberia
- Also northwestern North America
- Cooling over much of Antarctica

Modelled future change:
- Largest warming over Arctic Ocean

This is NOT a match!

Models: Atmospheric temperature change by doubling [CO_2]

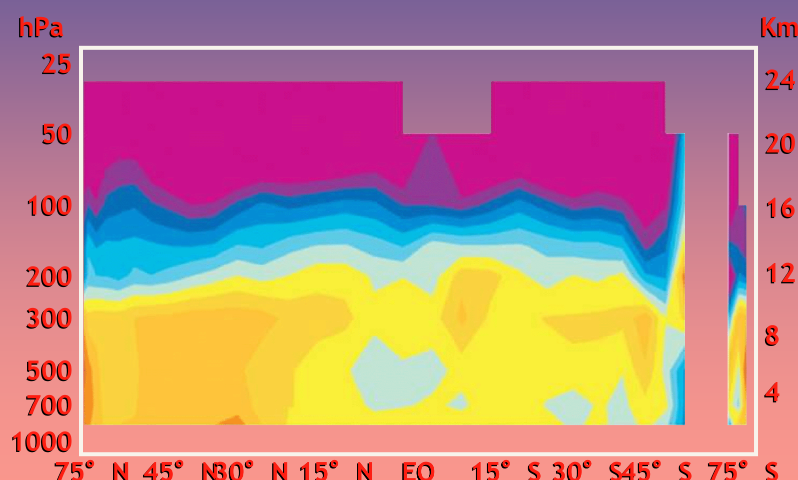


Zonally-averaged distributions of predicted temperature change in ° K at CO_2 doubling (2xCO_2-control), as a function of latitude and pressure level, for four general-circulation models (Lee et al., 2007)

35

Empirical measurements: Radiosonde

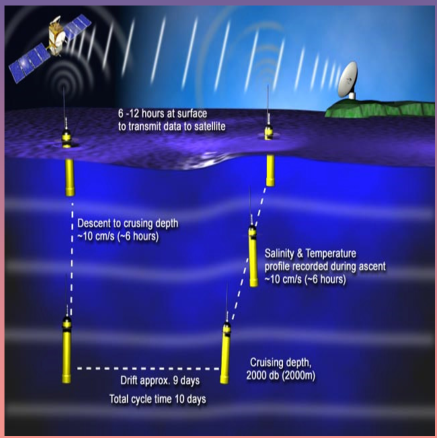
No "greenhouse warming" signature is observed in reality

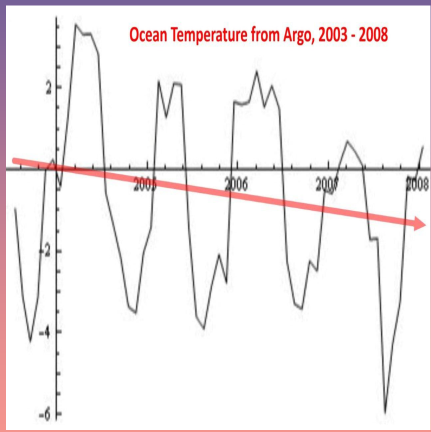


36

Source: HadAT2 radiosonde observations, from CCSP (2006), p116, fig. 5.7E

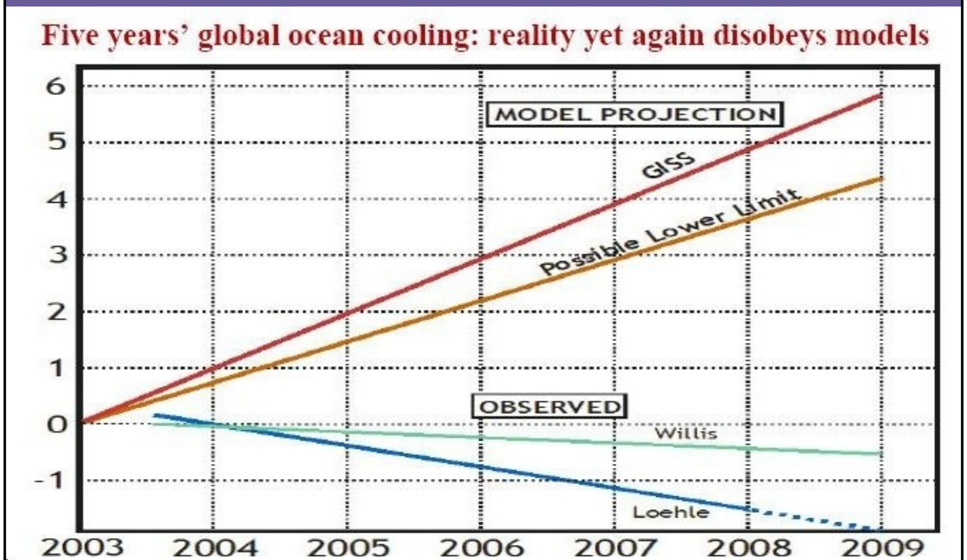
Argo buoys





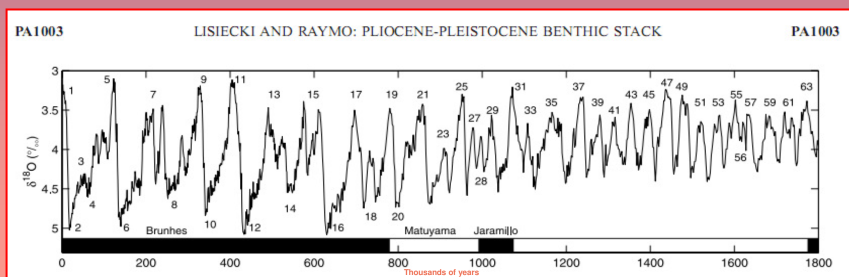
37

Models and empirical measurements



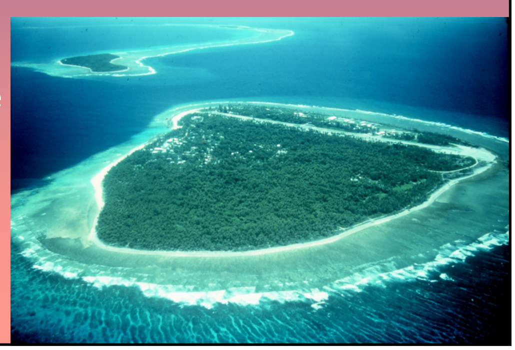
Ocean warmings and coolings

- Were past warmings due to humans?
- Normal for oceans to cool and warm
- Ocean temperature not static

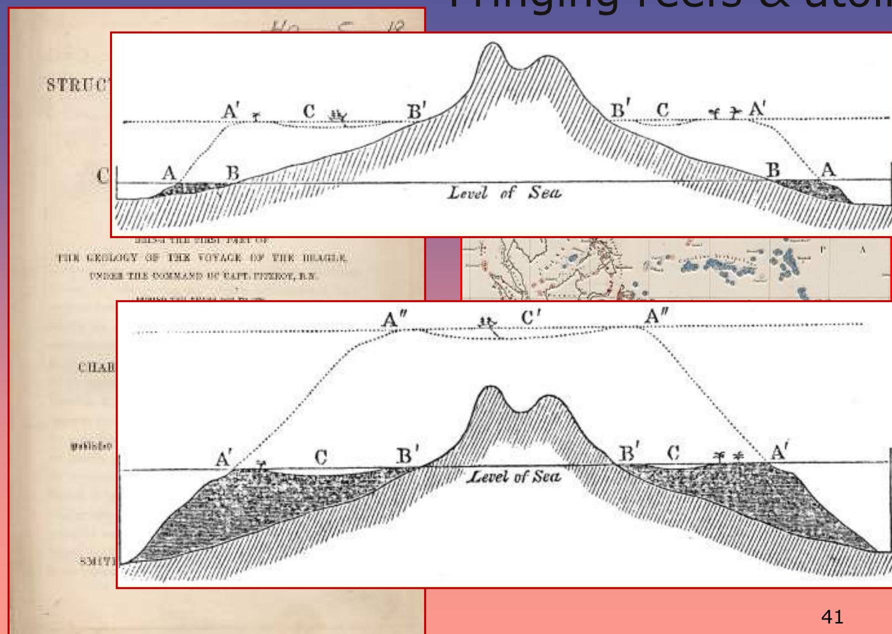


Sea levels (SL)

- SL always changing (Neoproterozoic glaciation ±1500 m, Quaternary glaciation ±130 m)
- 116,000-128,000 years bp SL +7m
- 6,000 years bp SL in Indian/Pacific Oceans +2m
- Atolls rise as SL rises
- Many reasons for SL change



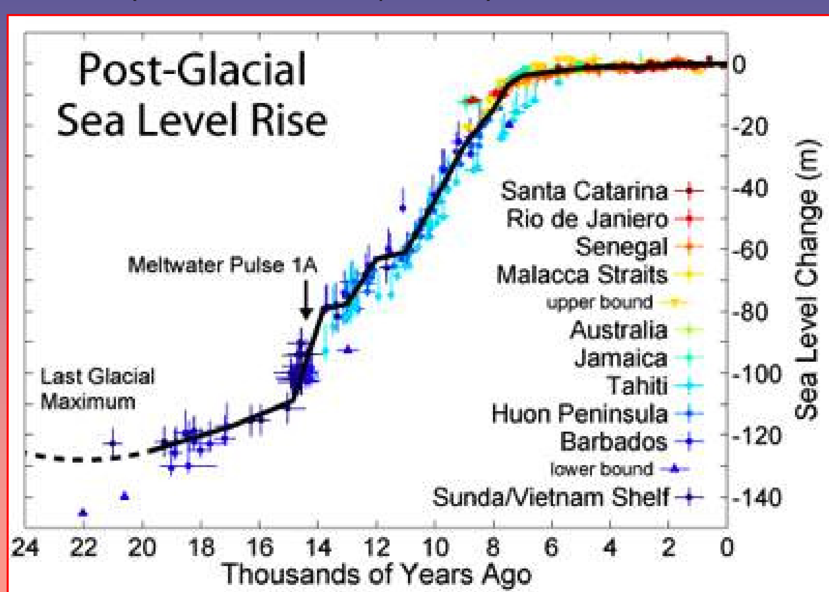
Fringing reefs & atolls



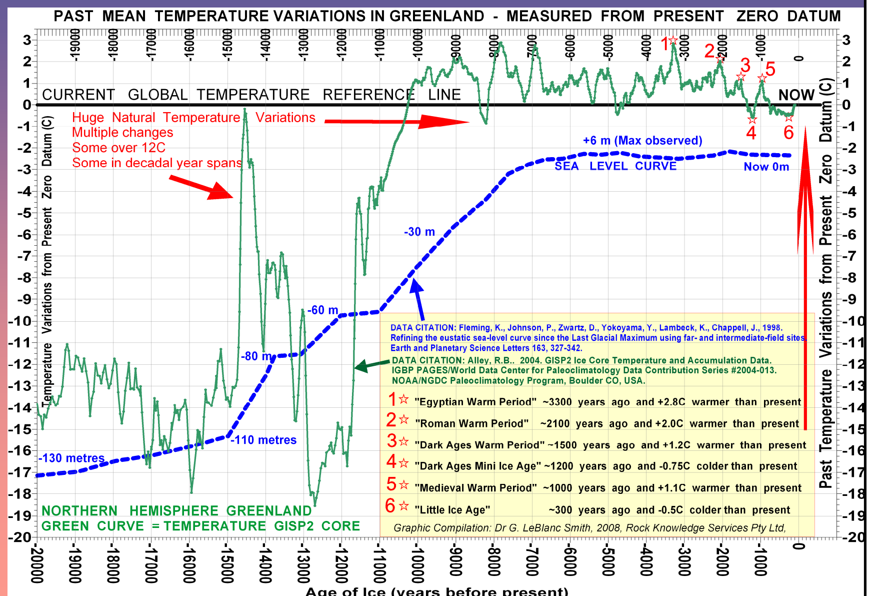
41

Global eustatic sea level rise

(Toscana and Macintyre 2003)



Greenland sea level rise

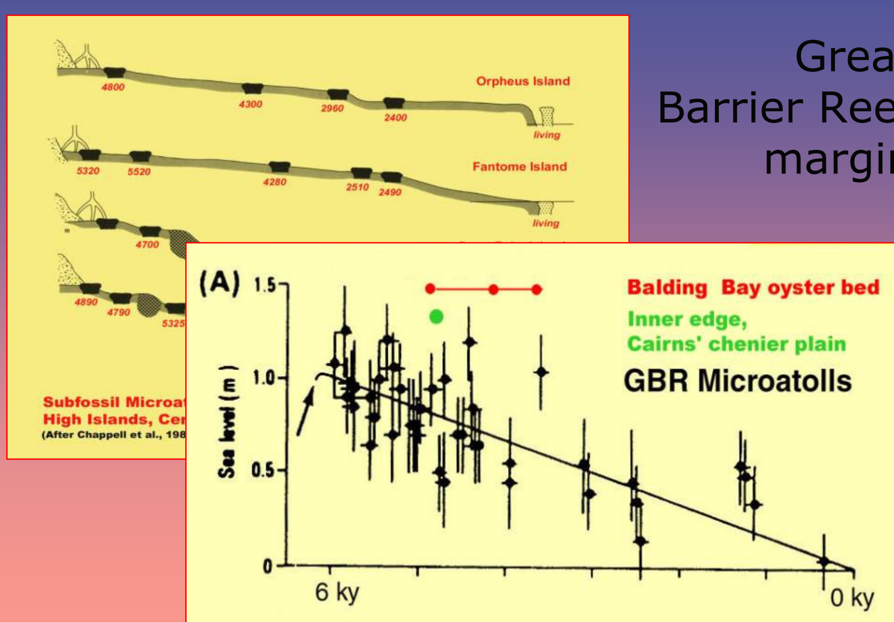


Balding Bay, Great Barrier Reef coast

Holocene highstand oyster beds

Holocene highstand coral microatolls

Great Barrier Reef margin



46

Holocene glacio-isostatic rebound

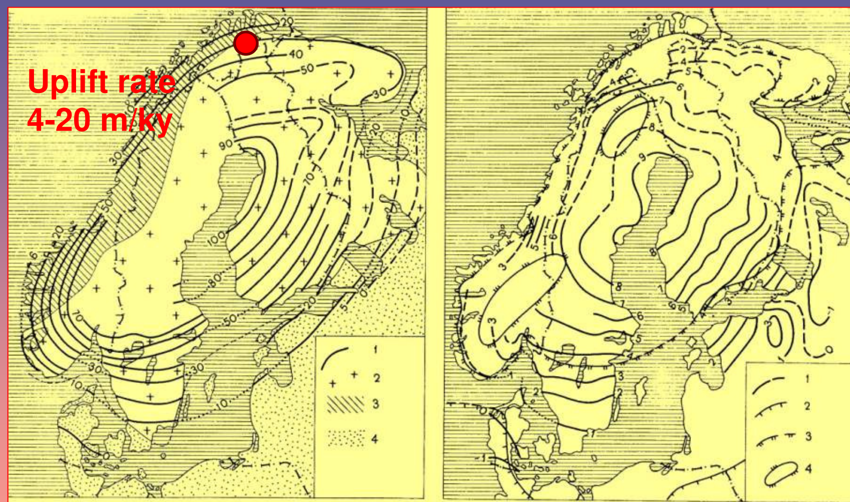
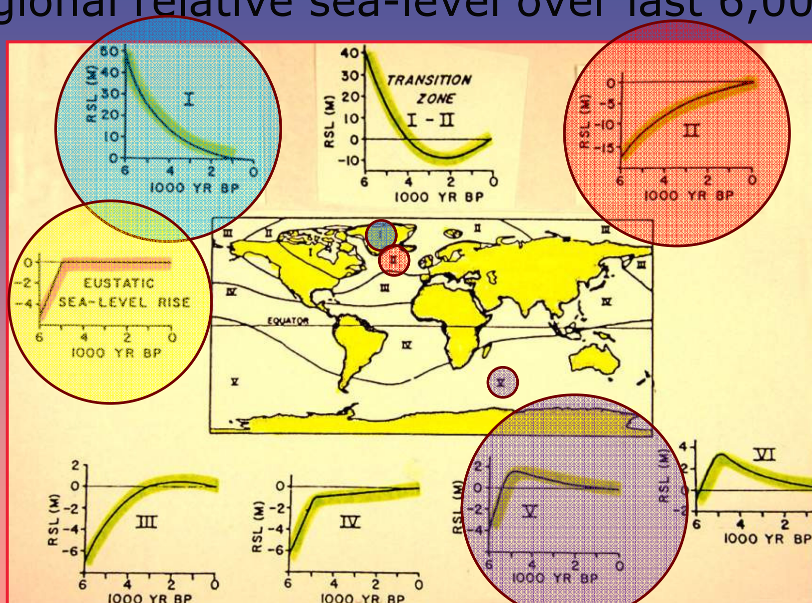


Fig. 1. Schemes of Holocene (A) and recent (B) crustal movements in Fennoscandia
A. 1, isolines of uplift since Middle Holocene (about 6000 yr), in metres; 2, crystalline rocks of the PreCambrian within the Baltic shield; 3, Caledonides; 4, Paleozoic and Mezozoic strata on the platform
B. 1, isolines of rate of recent movements, in mm/yr; 2, boundary line of the Würm (Valdaj) ice sheet; 3, limit of the ice sheet about 10,000 yr BP; 4, ice sheet remnants about 8000 yr BP

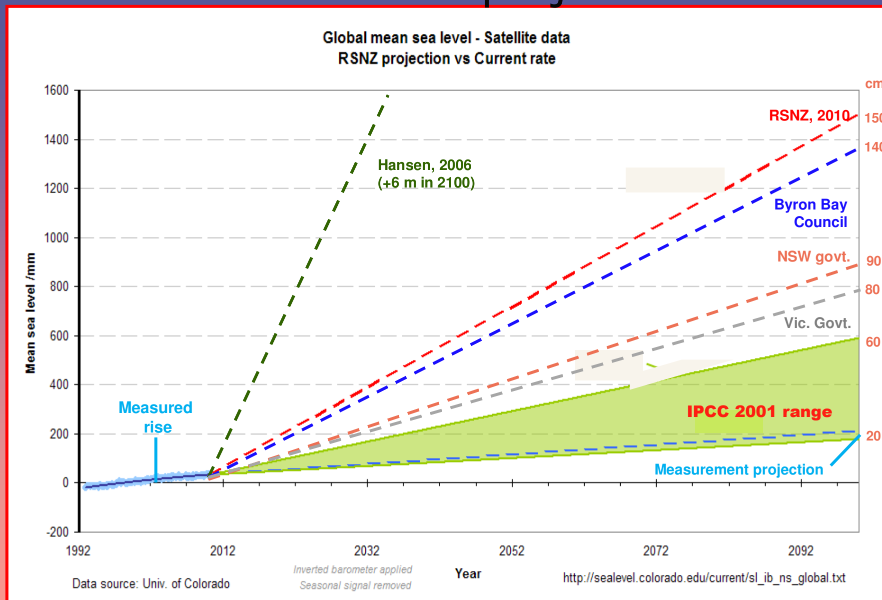
Regional relative sea-level over last 6,000yr



48

Clark, J.A. & Lingle, C.S. 1979 Predicted relative sea-level changes (18,000 Years B.P. to present) caused by late-glacial retreat of the Antarctic ice sheet. Quaternary Research 11, 279-298.

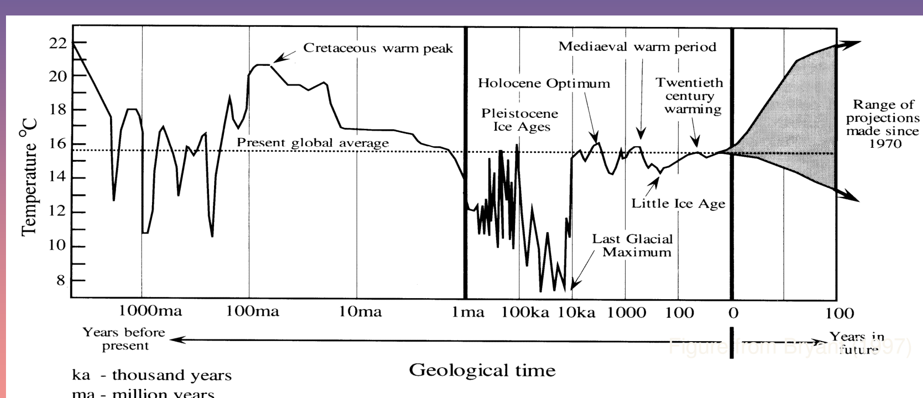
Global mean sea level projections to 2100



49

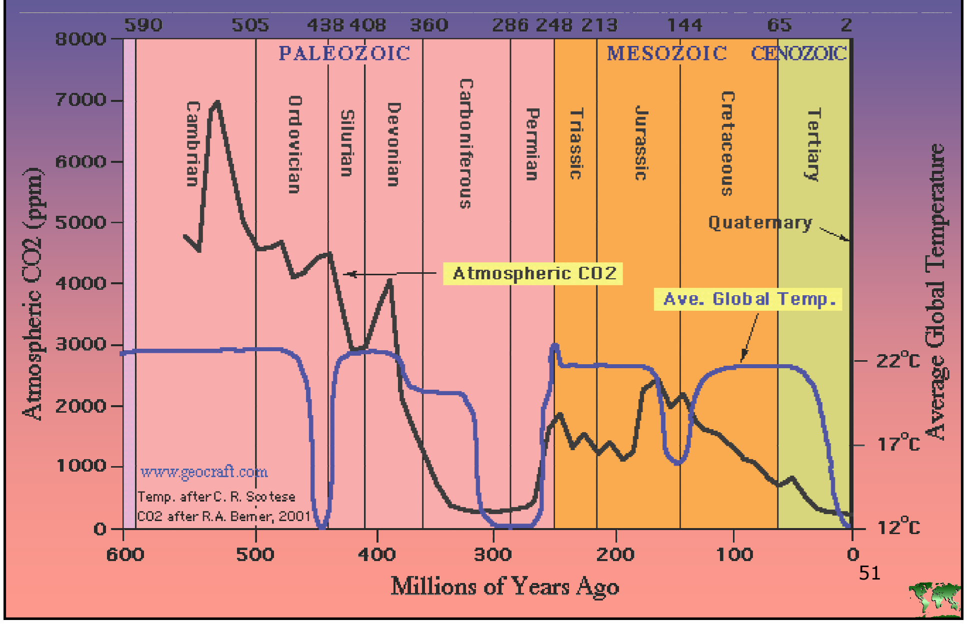
Graph after Bob Dedekind

Temperature over history of Earth

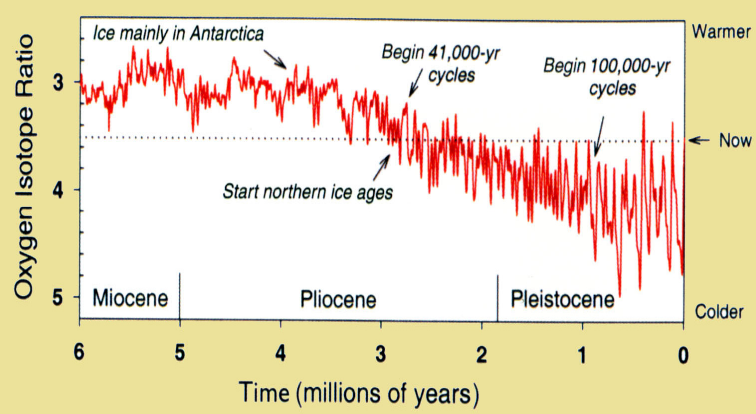


50

Climate change: Last 20% of time

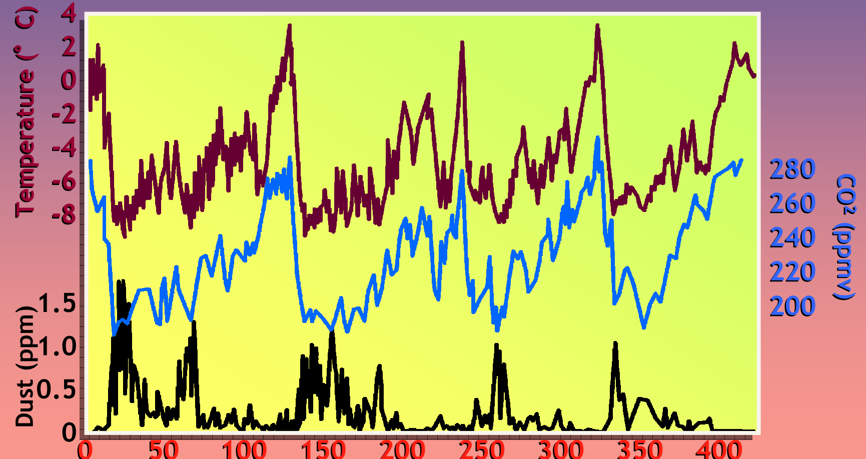


Is the rate of modern climate change unprecedented? (ODP drilling)

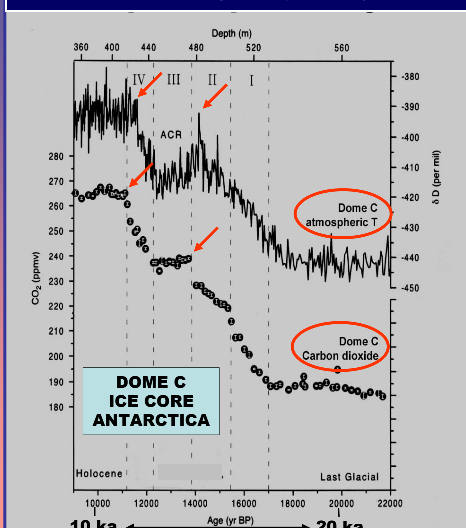


Temperature –CO_2 relationship

$H_2O_{(vap)}$ buffer to maximum and minimum temperature



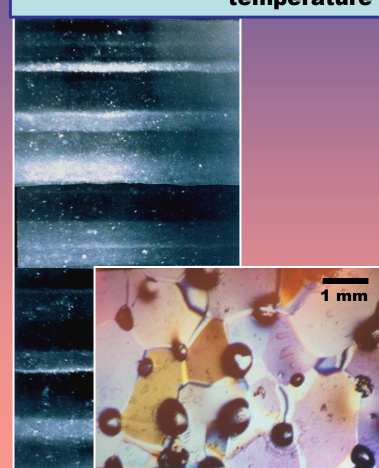
DOES CO_2 LEAD OR LAG TEMPERATURE CHANGE?



Monnin et al.,
SCIENCE VOL 291 5 JANUARY 2001

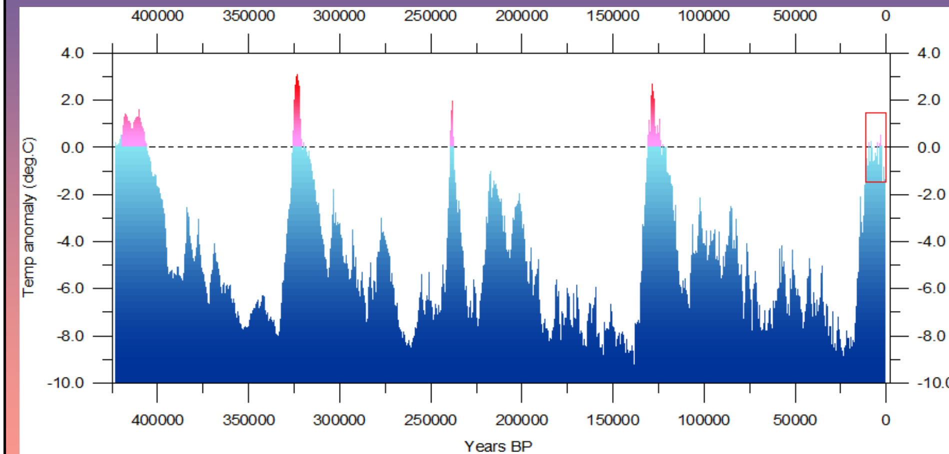
In ice cores, changes in T precede changes in CO_2 by ~800-2000 yrs.

CO_2 does NOT force temperature



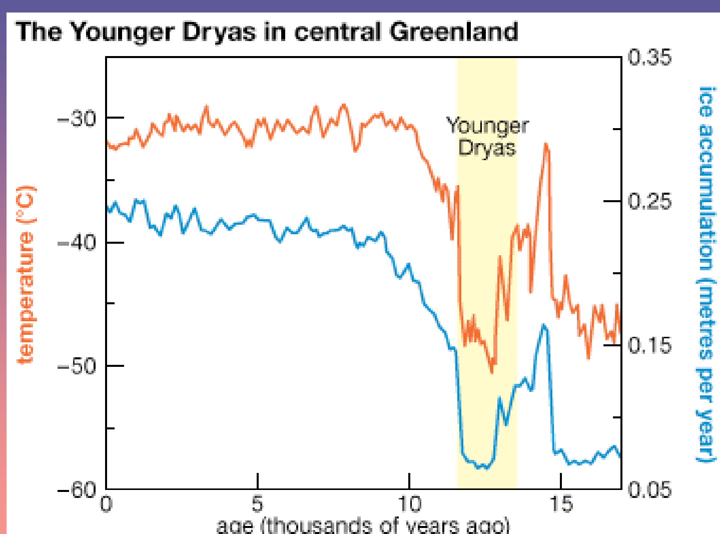
Is the speed and degree of modern climate change unprecedented?

(Vostok ice core; Salamatin *et al*. 1998; Petit *et al*. 2001)



55

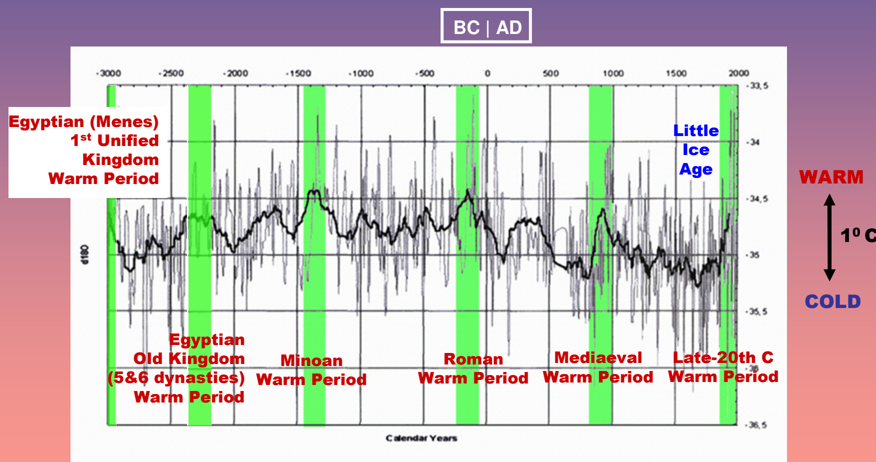
Cold snaps and warming



Source: Lamont-Doherty Earth Observatory at the Earth Institute of Columbia University and *Abrupt Climate Change: Inevitable Surprises*, National Academy of Sciences, Committee on Abrupt Climate Change, 2002

56

Is the magnitude of late 20thC temperature change unusual? (Greenland ice core)



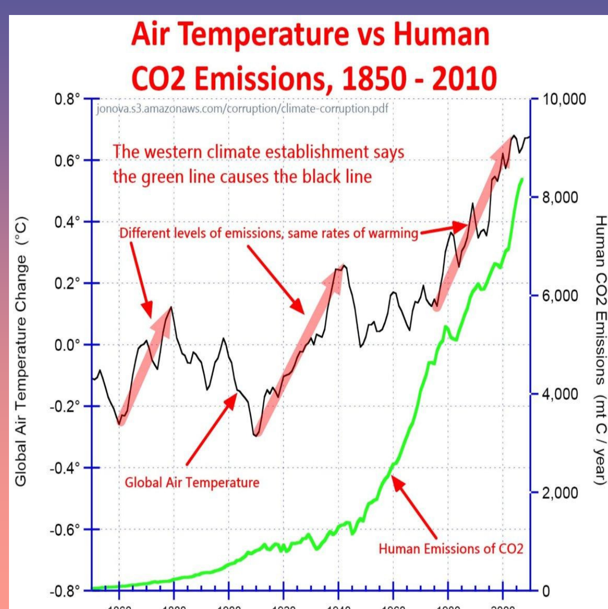
Grootes, P.M., Stuiver, M., White, J.W.C., Johnsen, S.J., Jouzel J., Comparison of oxygen isotope records from the GISP and GRIP Greenland ice cores. Nature 366, 1993, pp. 552-554.

57

Slide after A. Illarionov, Powerpoint presentation, December 2004.

Rates of change and CO_2

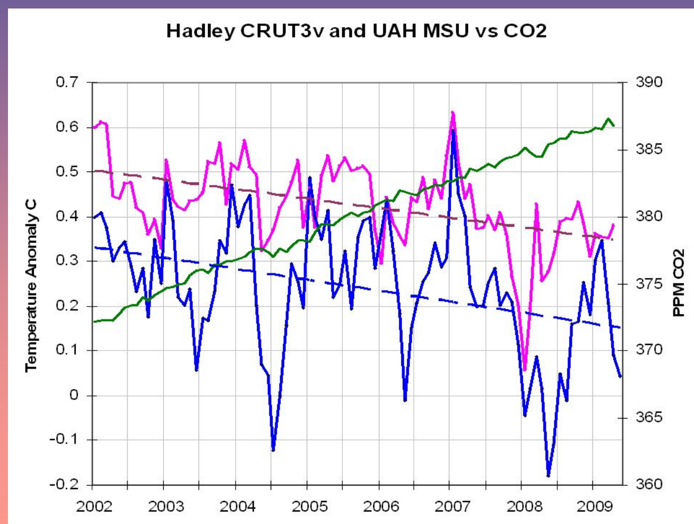
(no correlation hence no causation)



58

Cooling with increasing CO_2

(no correlation hence no causation)



59

What does the history of the planet tell us?

- Earth always changes
- Climate change is normal
- Climate change occurred well before humans were on Earth
- The rate of climate change today is no different from thousands, millions or billions of years ago
- >80% time, Earth has been warmer and wetter than at present
- Ice is rare
- Carbon dioxide the gas of life, not a pollutant

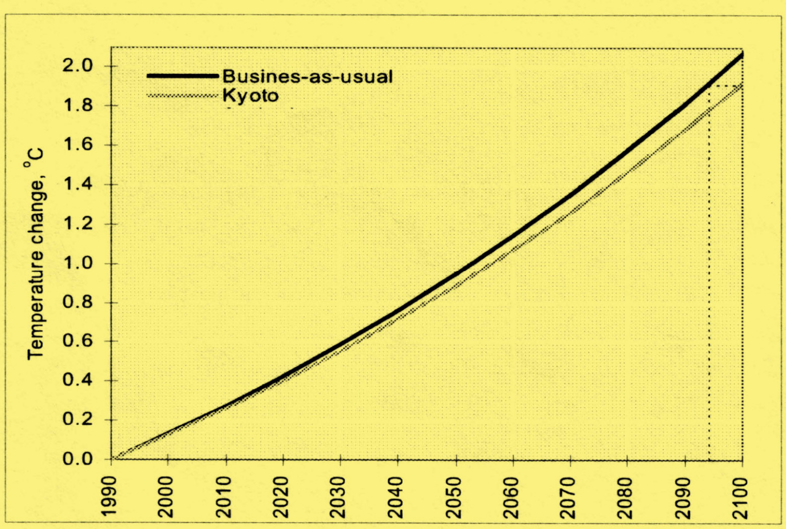
60

CO_2: the gas of life

- CO_2 gas of life, increase beneficial
- Part of massive natural cycle (mantle-atmosphere-oceans-organisms-sediments)
- Atmospheric CO_2 short temporary stock, marine reservoir 50x larger governs atmospheric CO_2
- Heat stored in oceans and thermostat effect of clouds
- Carbon isotopes show ~3% atmospheric CO_2 anthropogenic, small effect compared to total

61

Does Kyoto change anything?



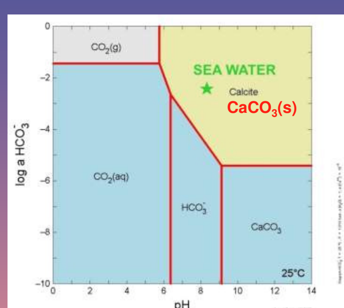
Acid oceans: When the planet runs out of rocks, the oceans become acid

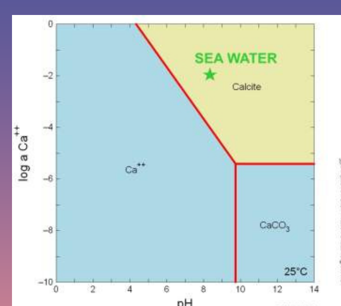
$$2Ca^{2+} + 2HCO_3^- + KAl_2AlSi_3O_{10}(OH)_2 + 4H_2O = 3Al^{3+} + K^+ + 6SiO_2 + 12H_2O$$
$$2KAlSi_3O_8 + 2H^+ + H_2O = Al_2Si_2O_5(OH)_4 + 2K_+ + 4SiO_2$$
$$2NaAlSi_3O_8 + 2H^+ + H_2O = Al_2Si_2O_5(OH)_4 + 2K^+ + 4SiO_2$$
$$CaAl_2Si_2O_8 + 2H^+ + H_2O = Al_2Si_2O_5(OH)_4 + Ca^{2+}$$
$$KAl_2AlSi_3O_{10}(OH)_2 + 3Si(OH)_4 + 10H^+ = 3Al^{3+} + K^+ + 6SiO_2 + 12H_2O$$
$$CO_2 + CaSiO_3 = CaCO_3 + SiO_2$$
$$CO_2 + FeSiO_3 = FeCO_3 + SiO_2$$
$$CO_2 + MgSiO_3 = MgCO_3 + SiO_2$$

- In the oceans, CO_2 exists as dissolved gas (1%), HCO_3^- (93%) and CO_3^{2-} (8%)
- Ocean pH is 7.9 to 8.2
- Rainwater pH is 5.6

63

~~Ocean-carbonate system~~

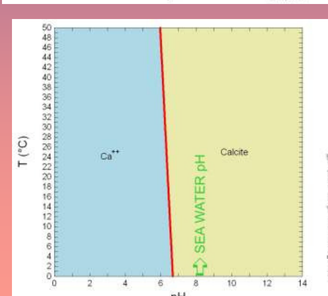




Increasing the amount of CO_2(g) alone will not dissolve $CaCO_3$ (s).

pH must be decreased by 2 log units (100x H^+ concentration) in order to dissolve $CaCO_3$ at 25° C.

At 0° C the pH must be decreased by 1.5 units.



Volcanicity, CO_2 and carbonate precipitation

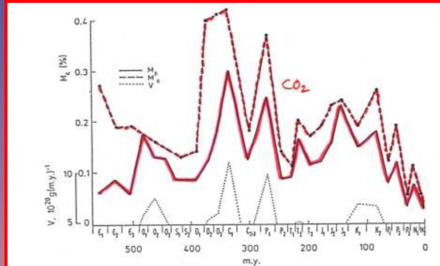


Fig. 24. Changes in carbon dioxide concentration (M_c, M_c') and the rate of formation of volcanic rocks (V) during the Phanerozoic

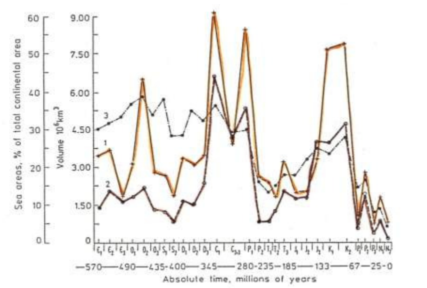
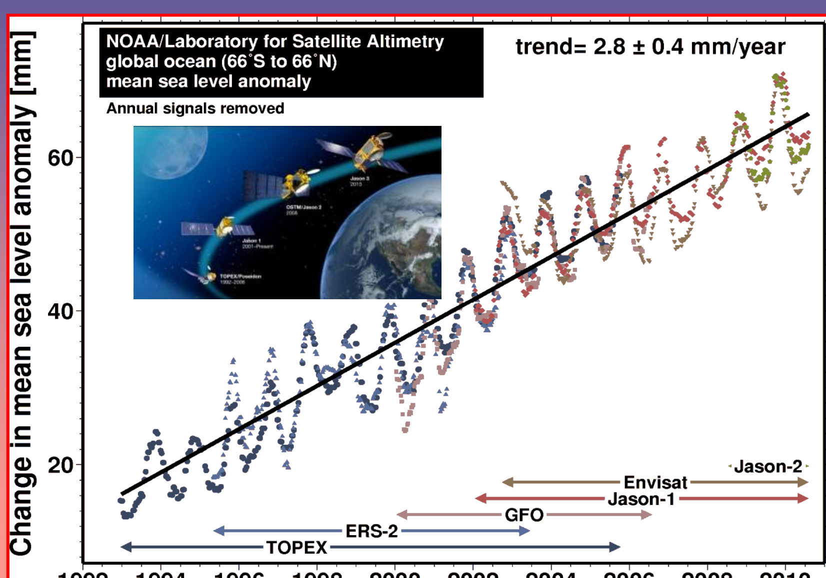


Fig. 14. Time changes in volcanogenic rock volumes (1), CO_2 buried in synchronous carbonate rocks (2) and the ratio (%) of the continental sea area to the total area of the continents (3)

65

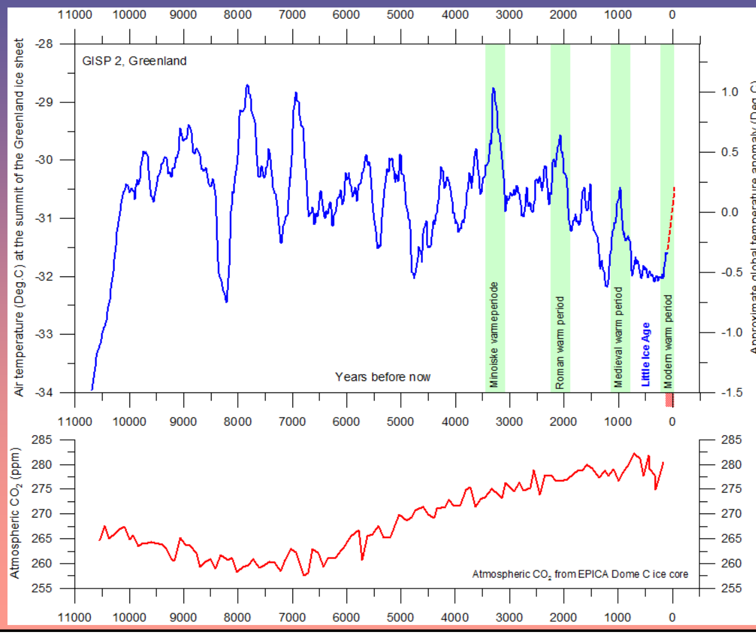
Satellite measurements

(not measuring the same feature as tide gauges)



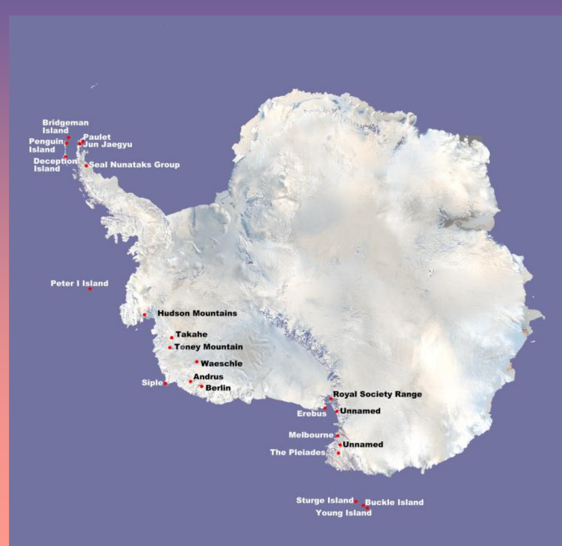
Past warmings (Vostok ice core)

(Petit *et al*. 2001)



Subglacial terrestrial volcanicity

Antarctica (felsic), Iceland (mafic)



68

Plastic substrate

Crust sinks when loaded with water, ice, sediment, mountains

Crust rises when unloaded

Local crustal sinking (e.g. Holland; Lydia, Turkey) and crustal rising (Scandinavia, Scotland; Efeses, Turkey)

Global and local sea levels