Are we ready for Global Cooling?

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Dows Lake Toastmasters Presentation
14 March 2006

from "Climate Change: What Makes Sense?: A critical review of the challenges and options for the future" June 2004
(never completed, published)

Starter questions: **(true or false and why)**

What do you think is the "current, prevailing" opinion in Canada?

1. If not for mankind, temperatures and greenhouse gases (GHGs) would stabilize to their "natural" levels.

2. Temperatures today are about as high as they ever have been since life began Earth, and higher than they have been since civilization began.

3. What is, BY FAR, the most important GHG?

4. Industrialization has driven greenhouse gases (GHGs) to levels higher than they have ever been.

Some popular misconceptions (contentious)

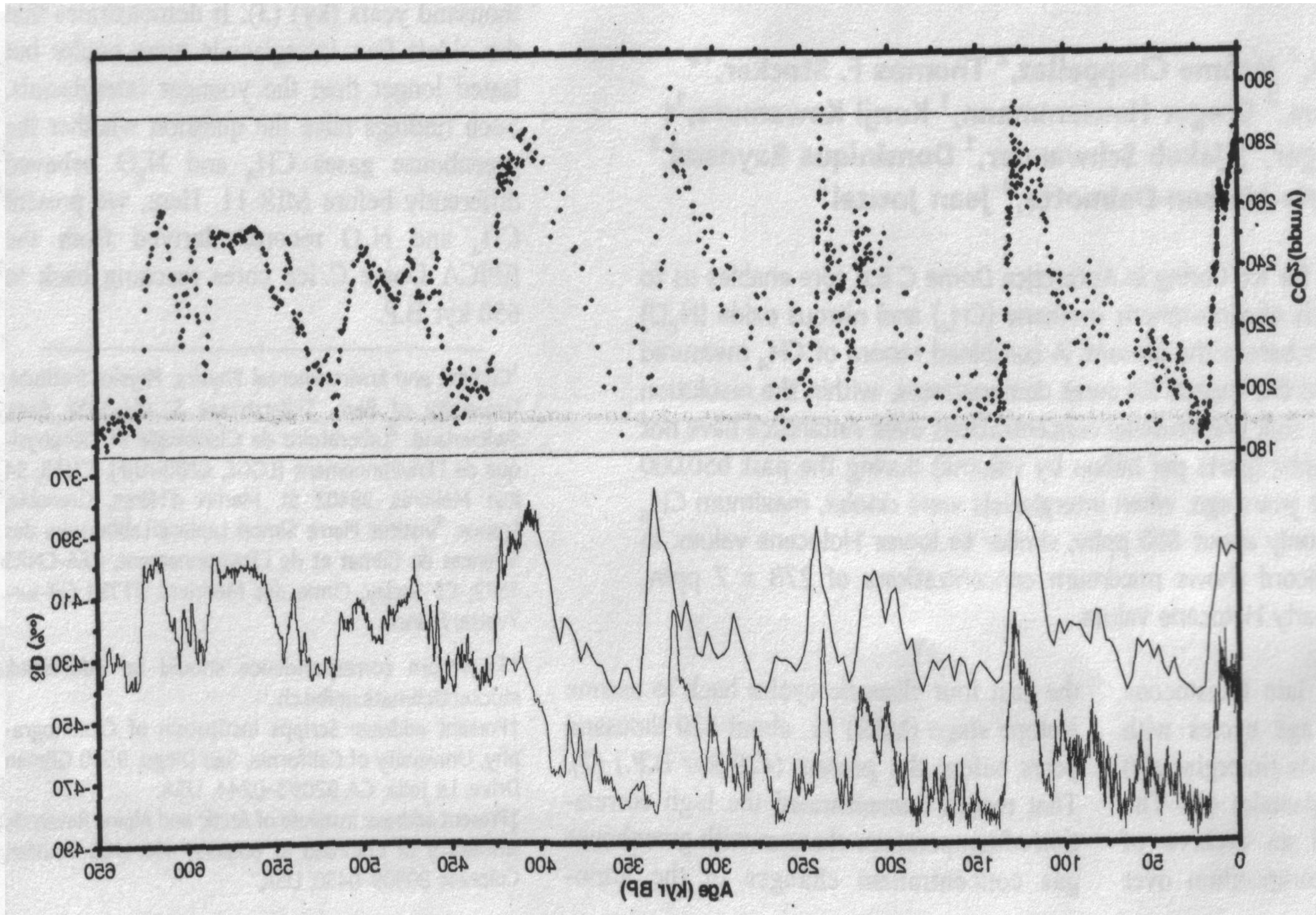
climate is "naturally stable"	climate always has changed, it is changing, and it always will change,...irrespective of anthropogenic effects
recent temperature changes are large	recent and projected T changes due to anthropogenic effects are modest in scale and rapidity compared to "natural" changes across all timescales
CO2 is the most important GHG	Water vapour is, by far. (plus ice, cloud) CO2 concentrations have >10 times higher during our Phanerozoic (last 570 My).
CO2 correlates with temperature since ~1850	Other than a general rise in both variables, CO2 does NOT correlate very well with T (solar irradiance does)!!!
CO2 drives temperature	**Temperature drives CO2!!!** but perhaps there is a "minor extra delta-T" in the last 20 or 30 years?
the "precautionary principle" demands radical action to combat global warming	Adaptation continues to be the key response by mankind – as it always has been! **Probability of radical cooling compared to warming!?!**

Glacial Period

EPICA ice cores, Antarctica - Temperature, CO2

(graph flipped to show time increasing to the right)

Fig. 4. A composite CO_2 record over six and a half ice age cycles, back to 650,000 years B.P. The record results from the combination of CO_2 data from three Antarctic ice cores: Dome C (black), 0 to 22 kyr B.P. (*9*, *11*) and 390 to 650 kyr B.P. [this work including data from 31 depth intervals over termination V of (*1*)]; Vostok (blue), 0 to 420 kyr B.P. (*5*, *7*), and Taylor Dome (light green), 20 to 62 yr B.P. (*8*). Black line indicates δD from Dome C, 0 to 400 kyr B.P. (*1*) and 400 to 650 kyr B.P. (*18*). Blue line indicates δD from Vostok, 0 to 420 kyr B.P. (*7*).



Temperatures- the last 1,000 years

J. Veizer "Celestial climate driver: a perspective from four billion years of the carbon cycle" Geoscience Canada, vol 32, no 1, pp13-27, 2005. CAVEAT: gas diffusion effects in glaciers
(a) solar cycle length (b) cosmic ray flux © solar irradiance (e) atmospheric [CO2]

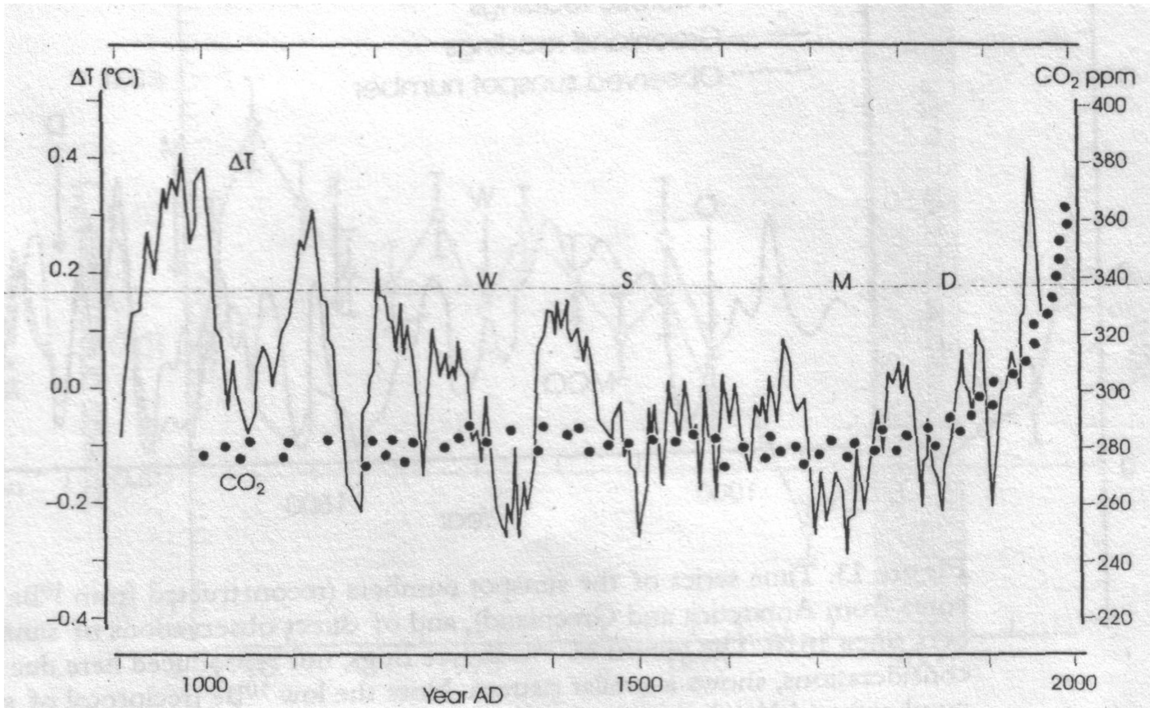
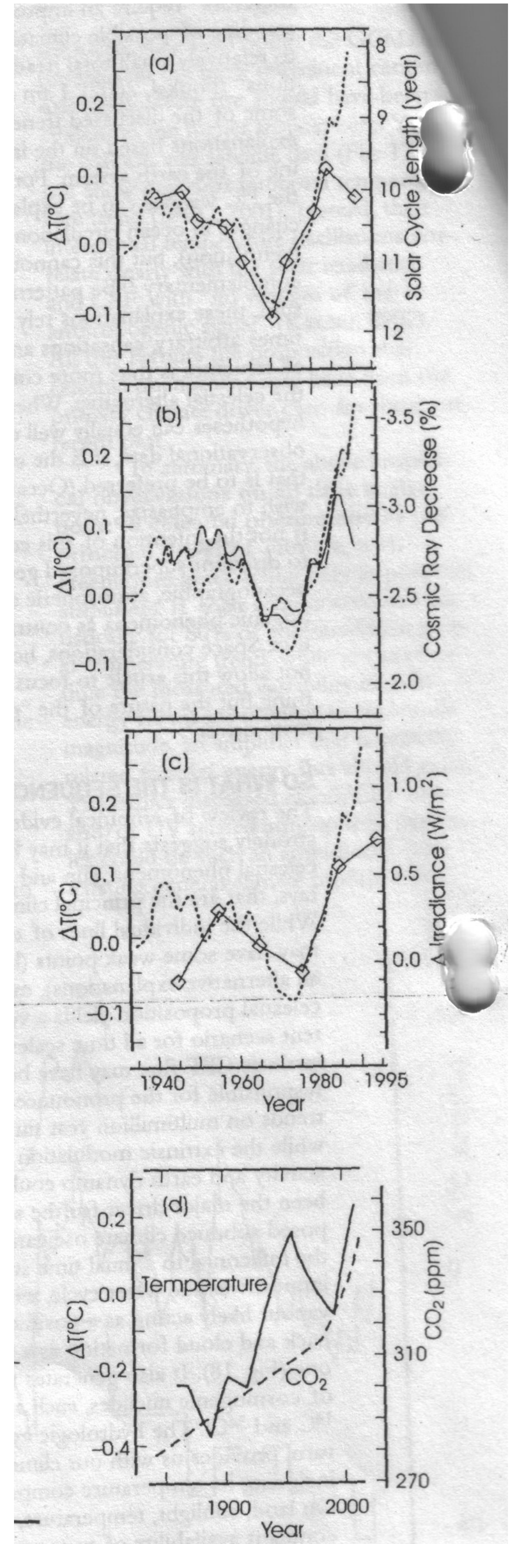
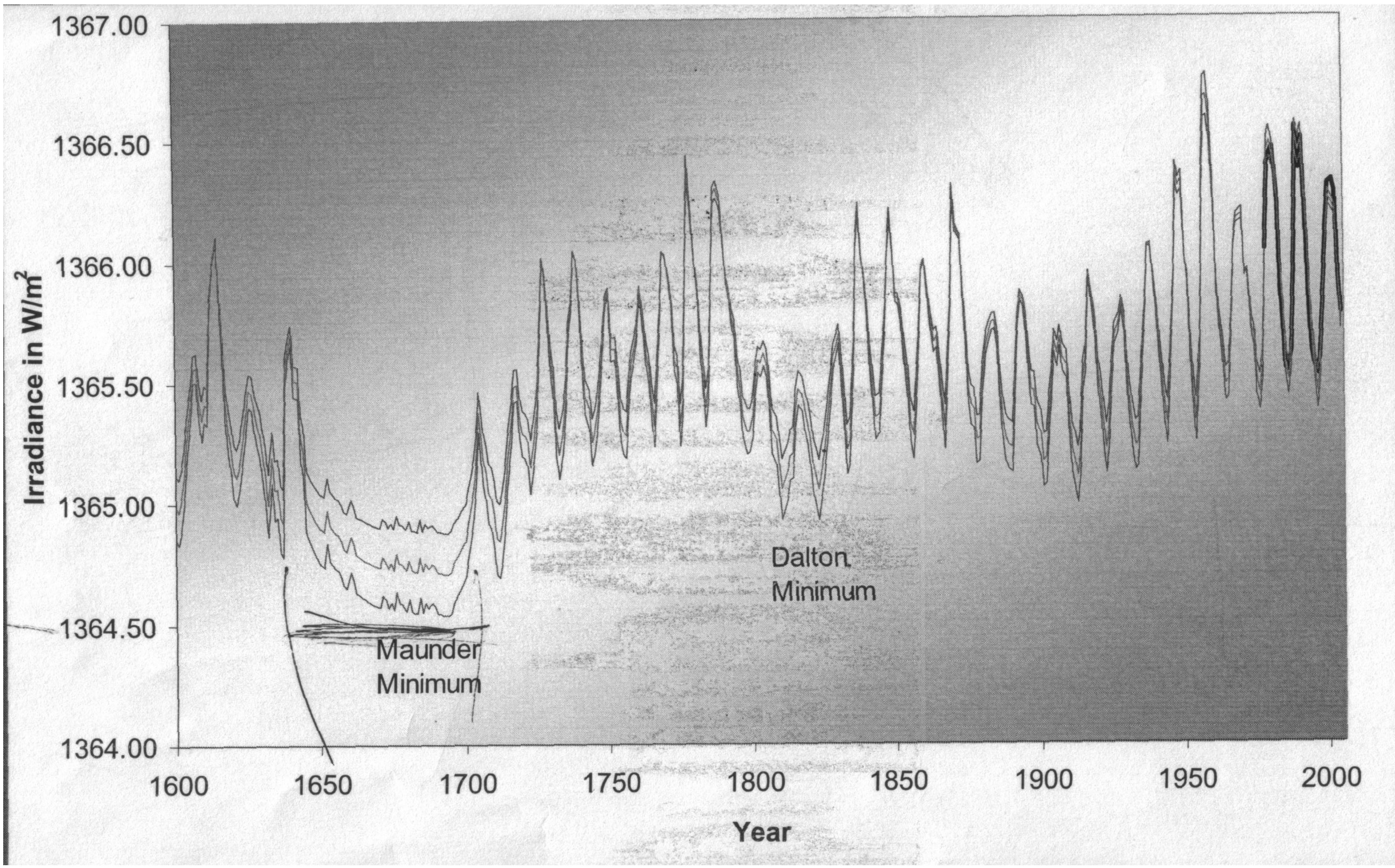


Figure 12. The temperature change (ΔT) and CO_2 records of the last millennium from a Greenland ice core (GISP2). Temperature was calculated from the 50 year smoothed record as T(°C) = 0.6906 δ^{18}O–13.68. The δ^{18}O database is available at ftp://ftp.ngdc.noaa.gov/paleo/icecore/greenland/summit/gisp2/isotopes/d18o1yr.txt. The detailed structure showing the coincidence of cold intervals with sun activity minima (W to D; Wolf, Spörer, Maunder, Dalton) may or may not be statistically valid because of the noisy nature of the proxy signals, but the overall trend is confirmed also by the borehole temperature profiles (Dahl-Jensen et al., 1998). Adapted from Berner and Streif (2000).



Solar irradiance – last 400 years

K. Tapping, D. Boteler, P. Charbonneau, A. Church, A. Manson, H. Paquette "Modelling solar magnetic activity and irradiance variability from the Maunder minimum to the present", unpublished draft presentation ?Jan06?



Back to Cooling?

- Chances are, the temperature will go down in fits and starts into the next ice age.
- During ~Richard Nixon's Presidential era, global cooling was a concern (there was a cooling trend from ~1940-1975, even while CO2 emissions were rapidly rising).
- While perceptions over the last 15 years have emphasized global warming (highest solar irradiance in 7 ky?), many scientists are revisiting the global cooling threat.
- Apparently a Russian scientist predicts we'll enter a Maunder-like minimum, starting in 7-10 years, which might take ~30 to 50 years to develop.

Influenza pandemics and solar activity

K. Tapping, unplublished

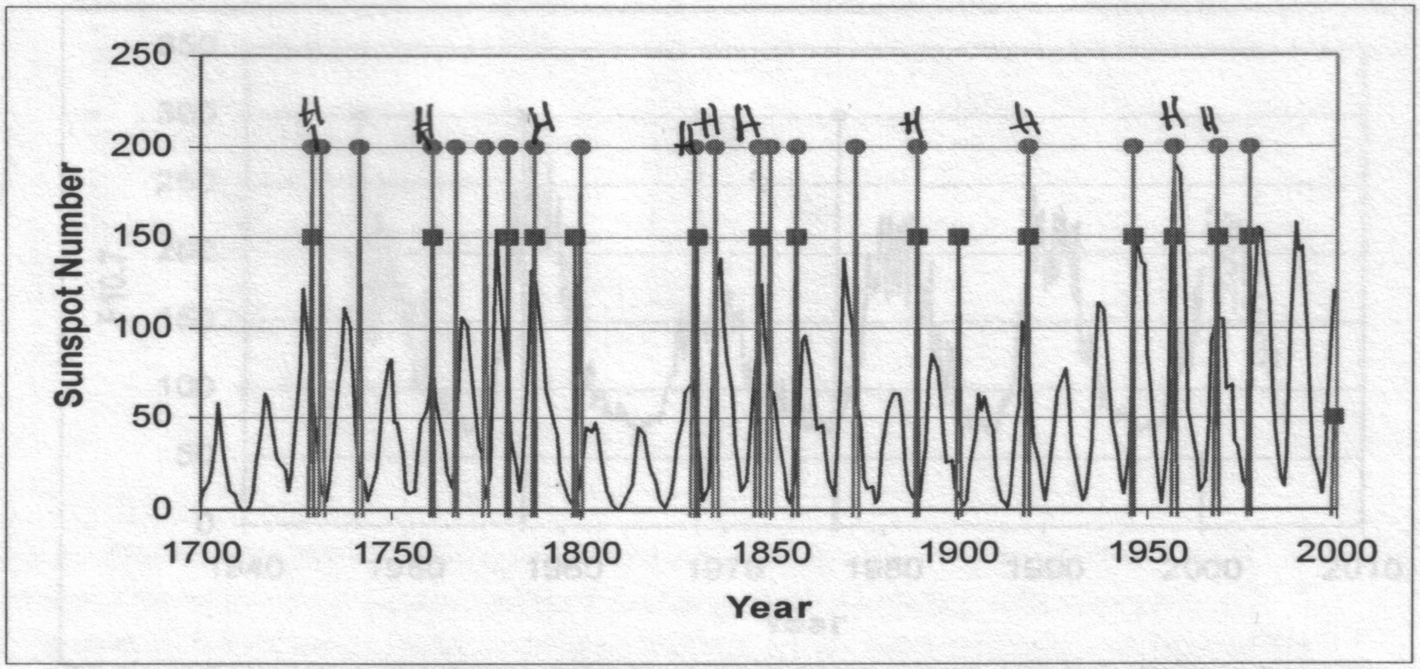


Figure 1: A plot of start years of pandemics (shown as spikes) and sunspot number. Pandemics listed by Garrett (1994) are shown as spikes to 200, topped with diamonds, and those listed by Potter (1998) as spikes to 150, topped with squares. The square at the 50 level, in 1999, represents the flu epidemic of 1999-.

Influenza pandemics & solar phase

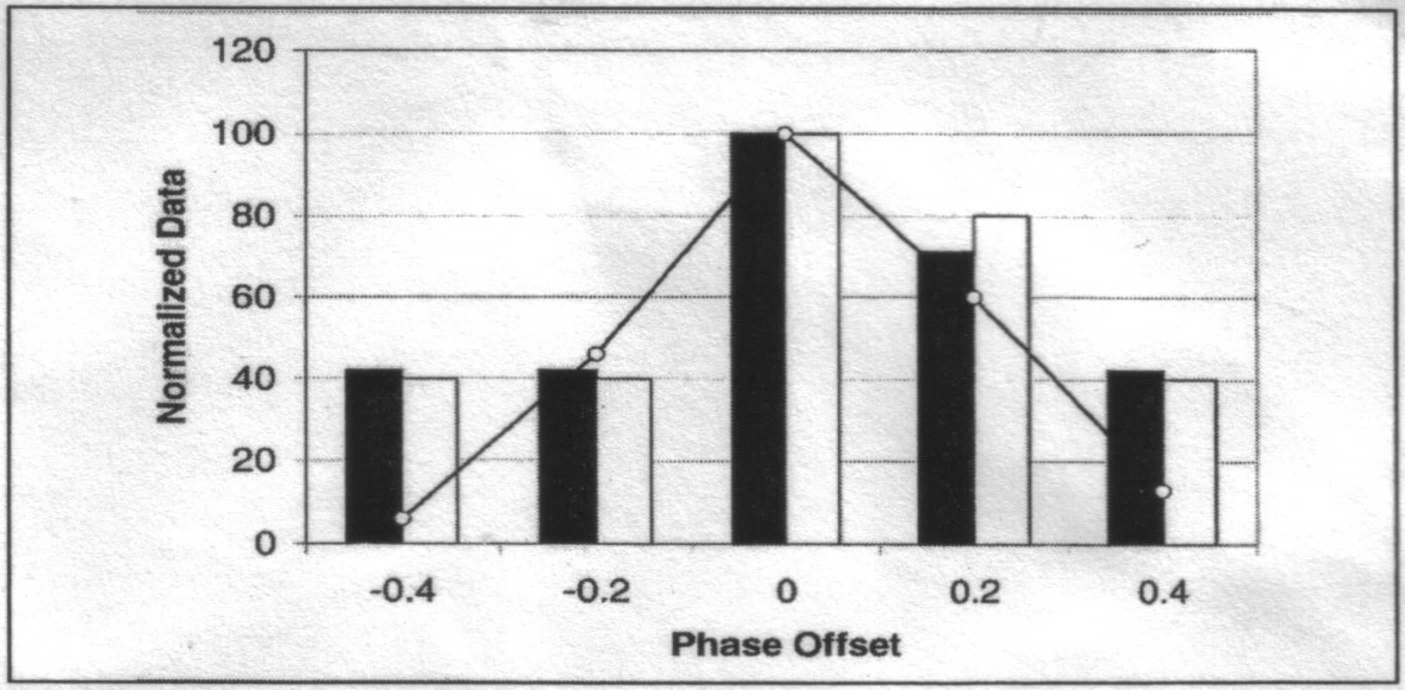


Figure 1) *The two distributions of pandemic count versus phase offset scaled to a peak value of 100. Pandemics listed by Garrett (4) and Potter (5) are shown, respectively, in solid black and white. The circles connected by solid lines show an average solar activity cycle, also scaled to have a peak value of 100*

Consequences of Global Cooling

- Agricultural productivity – down in a big way
- Influenza – possibility of severe pandemics, as these have occurred in the past, and "normal pandemics" are associated with the solar cycle.
- Plagues (bubonic, smallpox, cholera) – may be associated with solar minima?
- Similar questions as for global warming?
- Energy consumption – big increase in heating for temperate climates (but less A/C)
- History shows these events aren't kind, unlike warming.

Addenda

Timescales for global mean temperatures

Phanerozoic Era (last 570 My)	?Astronomy – passage through the spirals of the galaxy? Geology – mountain formation Botany – gynosperms to angiosperms 130 to 80 my ago Extremely high [CO2] levels OK – 25 times present day levels
Rise of C4 plants (last 8 My)	Botany – C4 grasslands/ steppes, preconcentrate CO2 ?what happened to marine biology?
Glacial record (last 400 ky)	Astronomy - insolation and orbital precession –> effect of Jupiter, Saturn, Venus
Agricultural Age (last 8 ky)	Agriculture – clearance of forests
From the ?Renaissance (last 700 y)	Astronomy - sunspot cycles, Maunder minimum volcanic eruptions, pandemics, ?massive wars?
Modern Industrial Era (last 150 y)	Anthropogenic – industrial emissions of CO2 Agriculture, Urbanization – land coverage/ use
Seasonal (last year!)	temperature swings >60 Celcius in Canada

Plant mediation of [CO2]?

T.E. Cerling, J.R. Ehleringer, J.M. Harris "Carbon dioxide starvation, the development of C4 ecosystems, and mammalian evolution" Phil TransRSocLondB vol 353, pp159-171, 1998

C4 grasses expanded over last 6 to 8 Million years

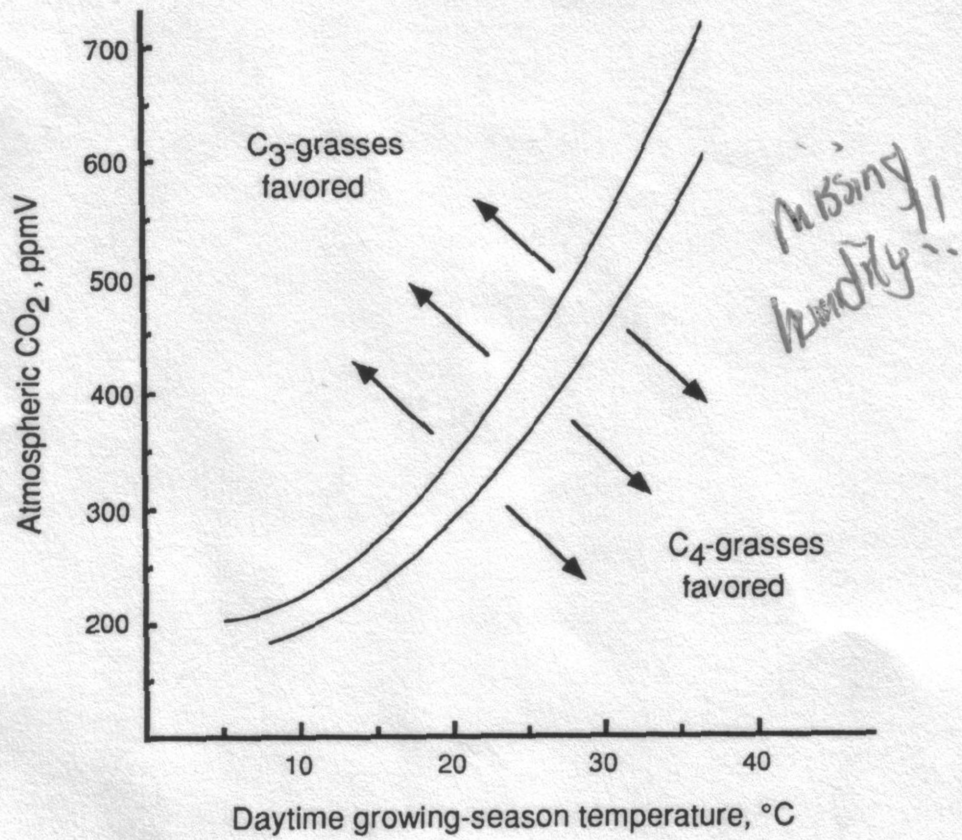


Figure 2. Crossover model of C_3/C_4 photosynthesis based on quantum yield of C_3 and C_4 plants. Modified from Cerling *et al.* (1997) and Ehleringer *et al.* (1997).

Solar Variability since 1500

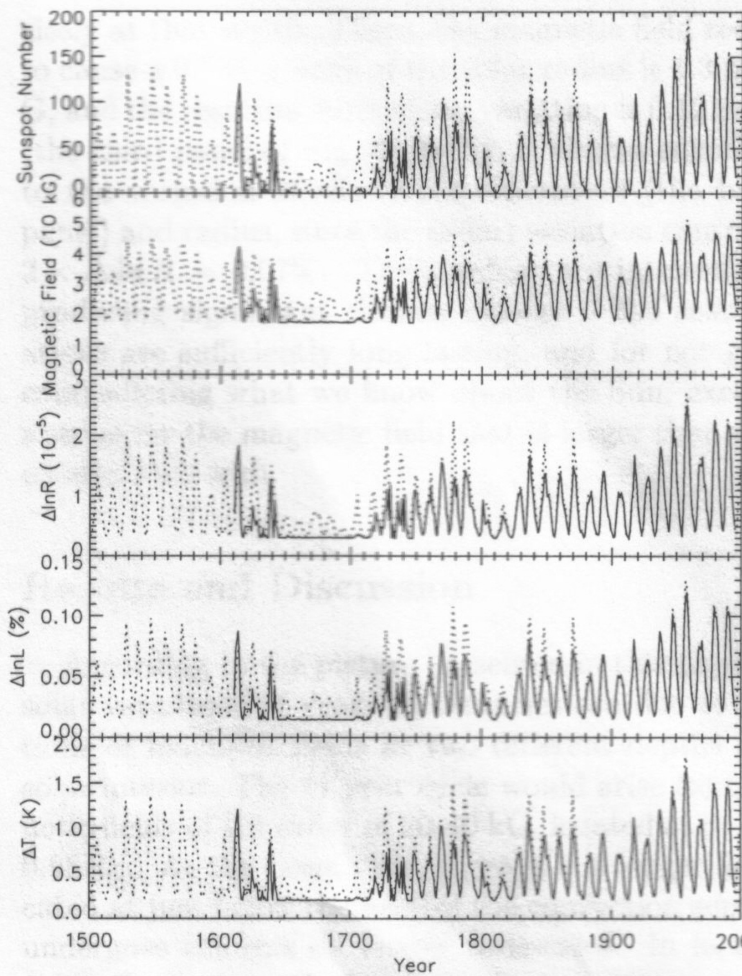


Figure 3. Solar variability in the past five centuries (dotted curve corresponds to the Zürich sunspot number R_Z) and in the past four centuries (solid curve corresponds to the group sunspot number R_G). kG stands for kilo-Gauss, L for total solar luminosity, T for solar effective temperature, R for solar radius.

Phanerozoic CO2

Royer et al – critique of Veizer&Shaviv

note;
 Current [co2]=250-350 PPM i.e. 1/25 of past levels
the previous low is due to what at 350 My
authors do not explain t cycles

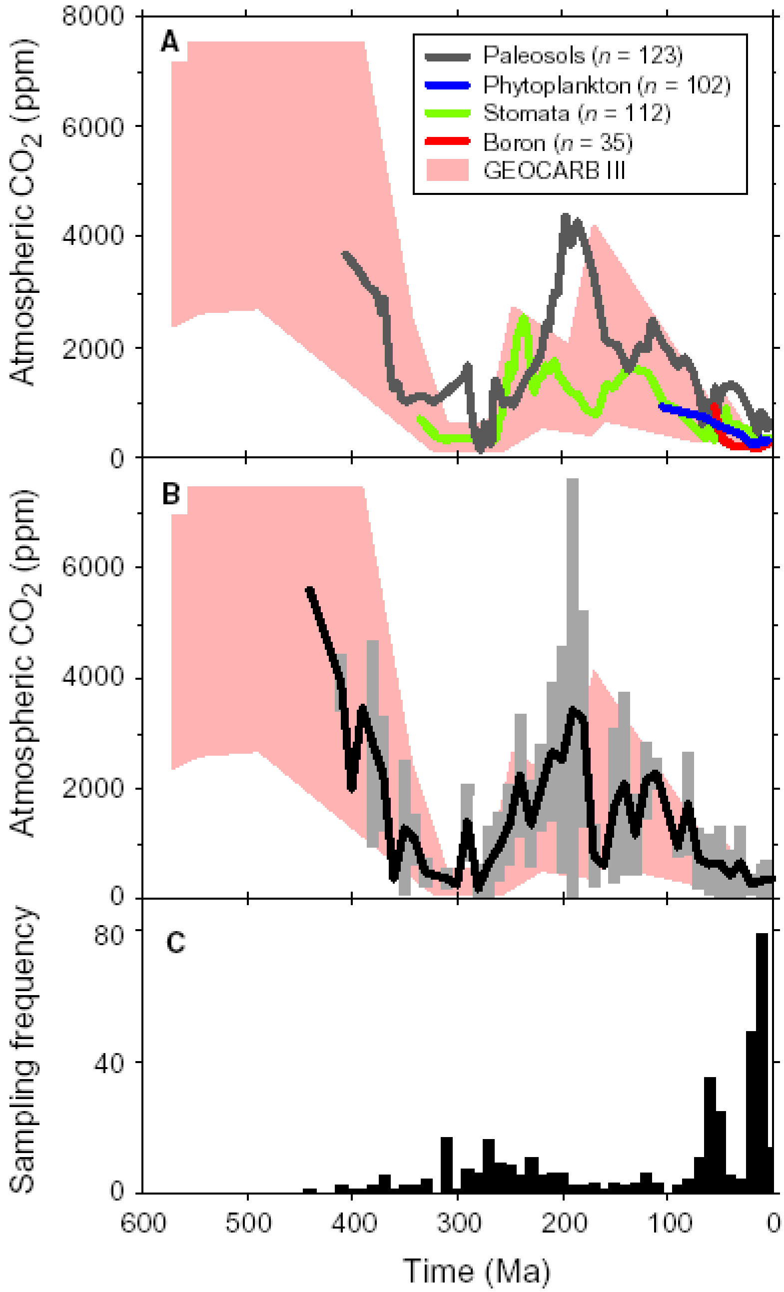


Figure 1. Details of CO_2 proxy data set used in this study. **A:** Five-point running averages of individual proxies (see footnote 1). Range in error of GEOCARB III model also shown for comparison. **B:** Combined atmospheric CO_2 concentration record as determined from multiple proxies in (A). Black curve represents average values in 10 m.y. time-steps. Gray boxes are standard deviations ($\pm 1\sigma$) for each time-step. **C:** Frequency distribution of CO_2 data set, expressed in 10 m.y. time-steps. All data are calibrated to the timescale of Harland et al. (1990).

Geocarb Model

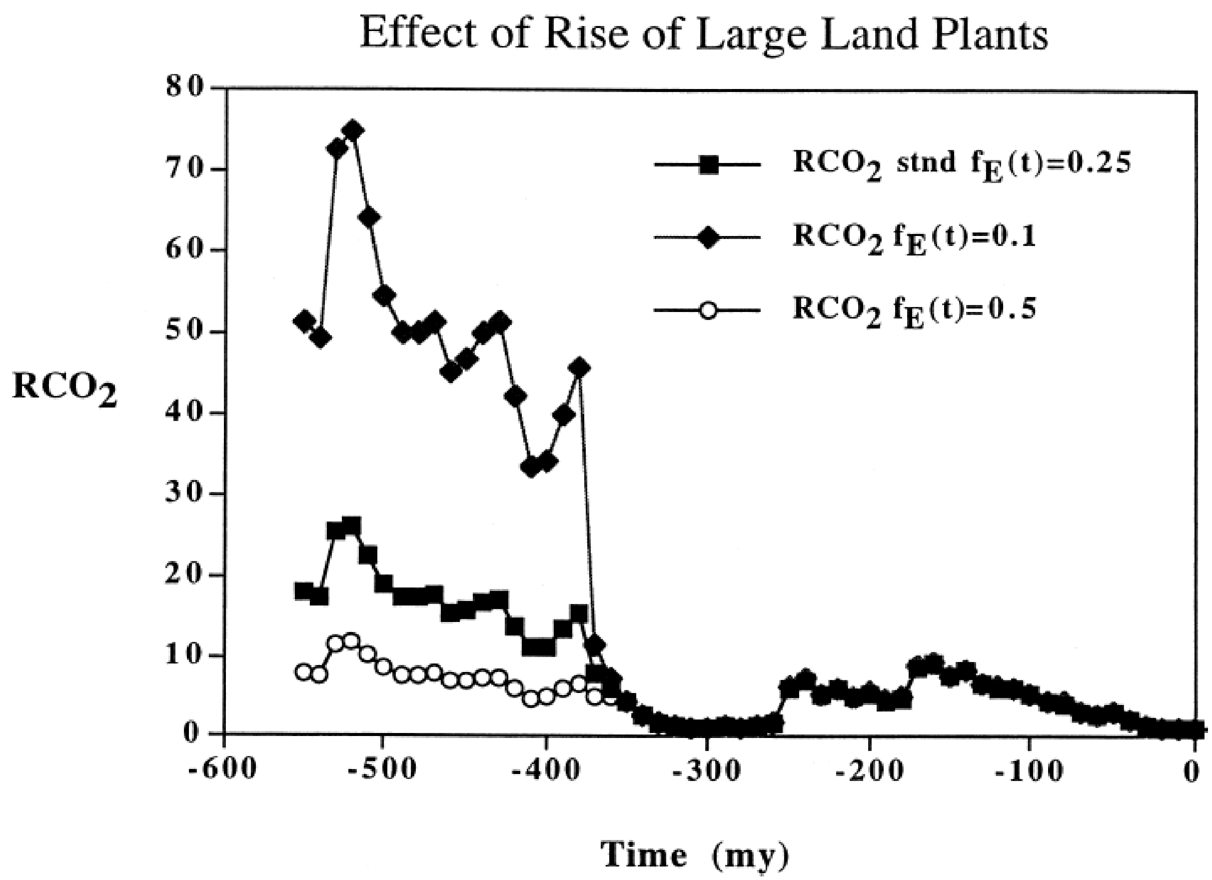


Fig. 5. Effect on RCO_2 of variation of the quantitative effect of the Devonian rise of large vascular land plants on continental weathering. The standard value for the early Paleozoic of the plant weathering factor $f_E(t) = 0.25$ is based on the field results of Moulton, West, and Berner (2000). Note enlarged vertical scale compared to other figures.

Agricultural Effects?

THE ANTHROPOGENIC GREENHOUSE ERA BEGAN THOUSANDS OF YEARS AGO 263

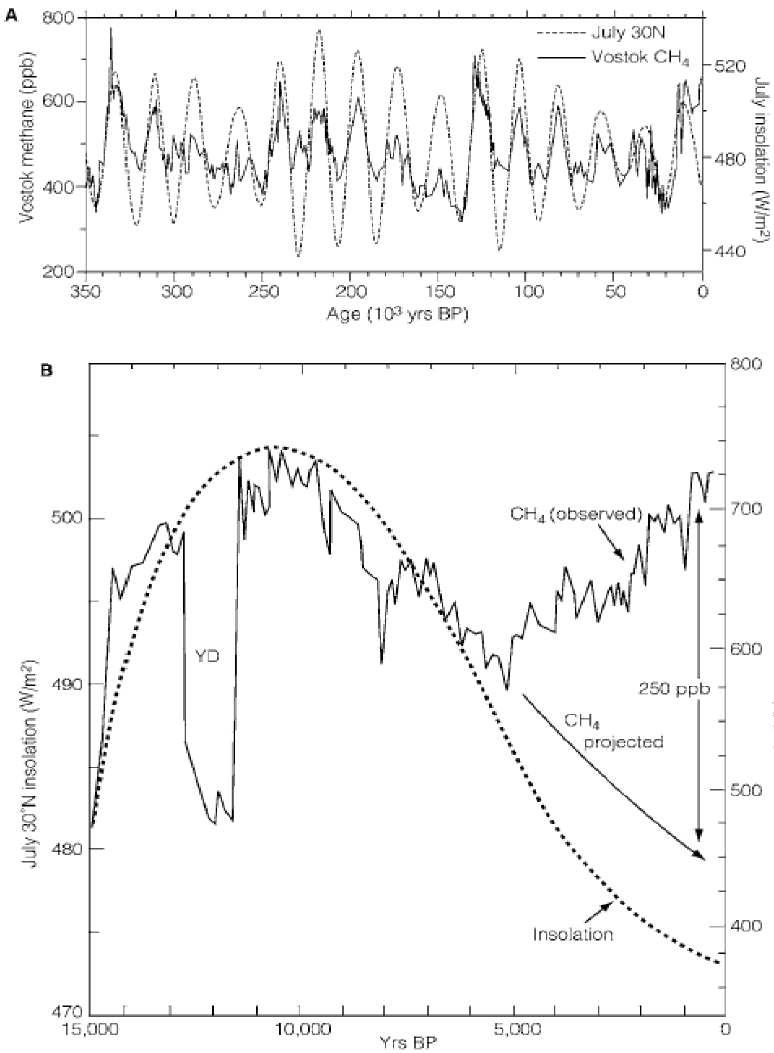


Figure 1. Comparison of July insolation values from Berger and Loutre (1996) with ice-core concentrations of atmospheric CH_4. (a) Long-term Vostok CH_4 record of Petit et al. (1999), using time scale of Ruddiman and Raymo (2003). (b) GRIP CH_4 record from Blunier et al. (1995), dated by counting annual layers. Early Holocene CH_4 trend projected in late Holocene to values reached during previous early-interglacial CH_4 minima.

266 WILLIAM F. RUDDIMAN

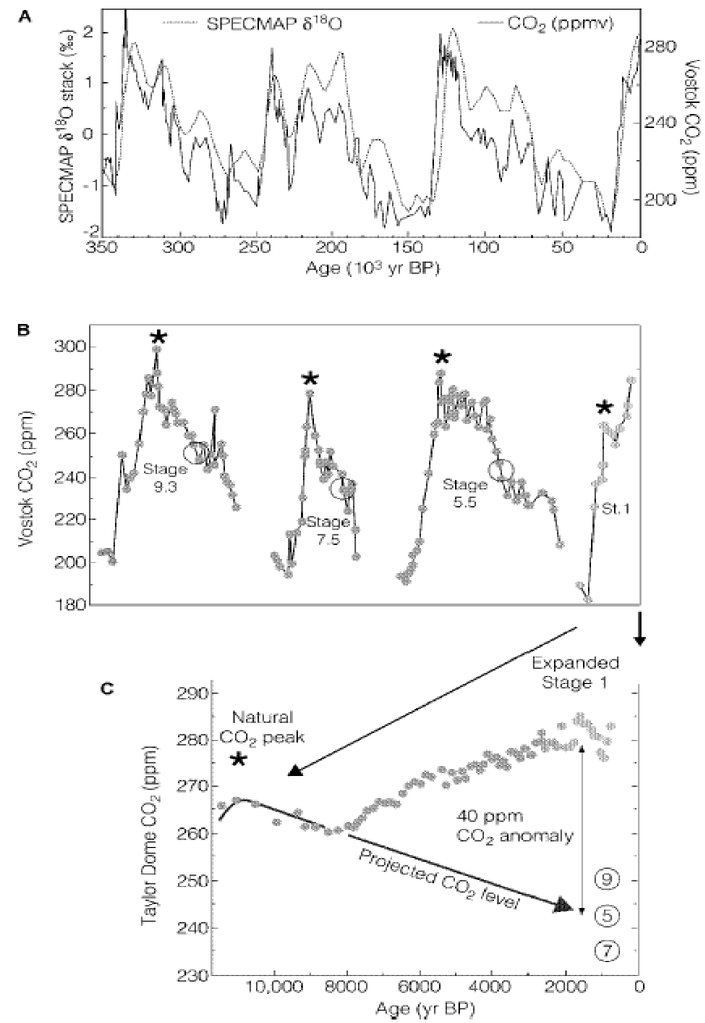


Figure 2. Concentrations of atmospheric CO_2 in Antarctic ice cores. (a) CO_2 trends from Vostok ice record of Petit et al. (1999) using time scale of Ruddiman and Raymo (2003). Marine $\delta^{18}O$ signal from SPECMAP (Imbrie et al., 1984). (b) CO_2 trends during 4 deglacial-interglacial intervals. Asterisks mark late-deglacial CO_2 maxima; circles show positions of early-interglacial CH_4 minima that follow 11,000 years later during insolation minima similar to today. (c) High-resolution CO_2 record from Taylor Dome of Indermuhle et al. (1999). Early-Holocene CO_2 trend projected during late Holocene toward circled values reached during previous interglaciations.

Sunspots – last 120 years

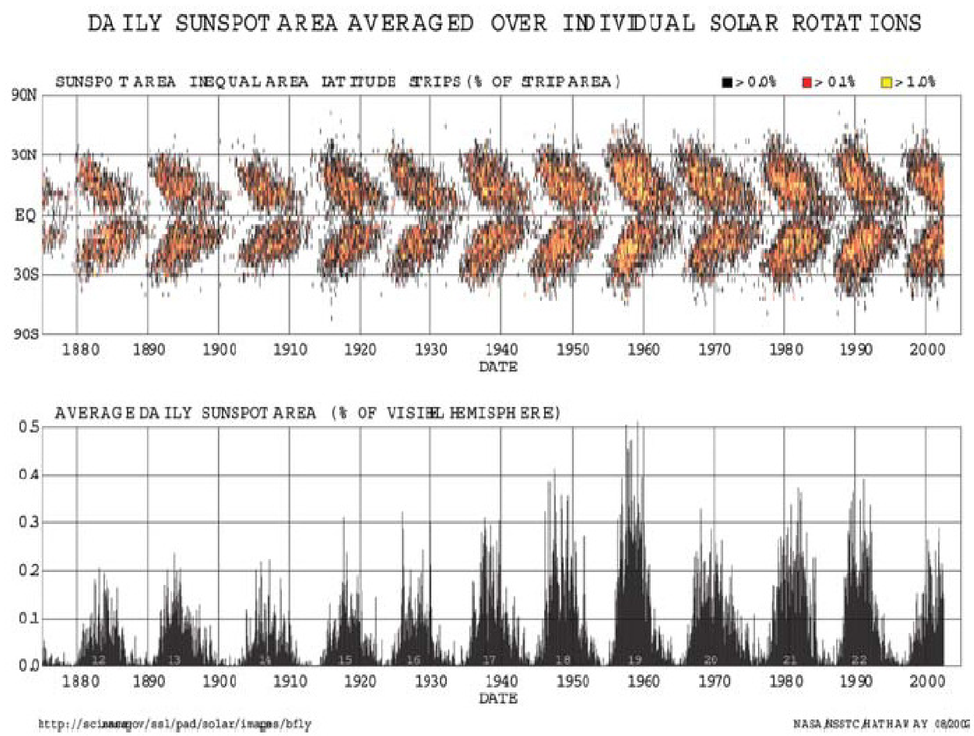


Fig. 2.1. Butterfly diagram (*upper panel*) and record of relative solar surface area covered by sunspots (*lower panel*). *Upper panel*: the vertical axis indicates solar latitude, the horizontal axis time. If a sunspot or a group of sunspots is present within a certain latitude band and a given time interval, then this portion of the diagram is shaded, with the colour of the shading indicating the area covered by the sunspots. (Figure courtesy of D. Hathaway, http://science.nasa.gov/ssl/pad/solar/sunspots.htm).

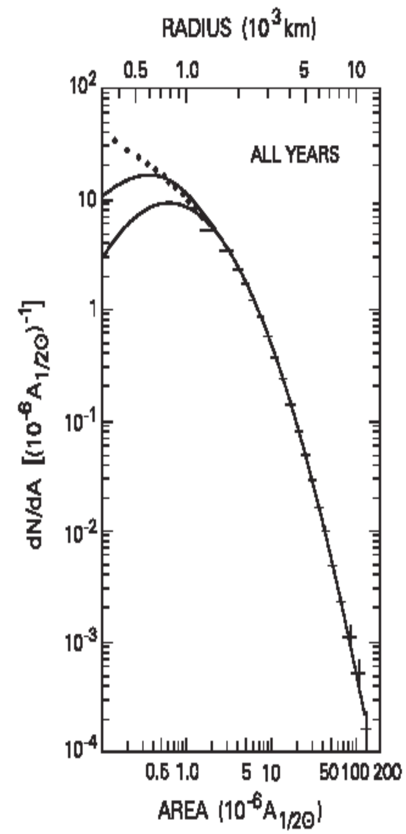


Fig. 2.2. Overall size spectrum for the Mt. Wilson data set of 24615 sunspots (*crosses*). Unreliable smaller sizes are denoted by filled circles. Upper and lower lognormal fits to the crosses have also been sketched (adapted from Bogdan et al. 1988, by permission).