Climate Change: What Makes Sense?

A critical review of the challenges and options for the future

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Most people are believers, there are very few critical thinkers...

...most scientists are like most people

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The Litany: ...whereas environmentalists and many scientists would have you believe that everything is getting seriously worse, across almost the full gamut of environmental issues

things are actually getting better, no - much better...

approximate message of Bjorn Lomborg

How does one explain the failure of education and experience in overcoming group blindness?

...are scientists the new priests and monks?...? is populism ruining science?

Key Messages of the Presentation

1. **Climate Change**: the climate has always changed, it is changing, and it always will change

- anthropogenic (man-made) effects ?are barely? significant, but much smaller than "natural" variations

2. processes at different timescales

2. **Cause & effect:** simplistic, "natural", 1 ky view

1. Astronomy -> temperature -> climate (including CO2)
2. CO2 isn't a primary driver (and won't lead to a catastrophe)

3. **Adaptation:** the only "remedy" that makes sense

1. for anthropogenic <u>or</u> natural changes
2. pace further research over long term – no panic

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 - ?Milankovic? sunspot cycles, Maunder interval Milankovic = wobble of axis? Mann graph of temperatures used by IPCC
Modern Industrial Era (last 150 y)	?Anthropogenic – industrial emissions of CO2 ?Agriculture, Urbanization – land coverage/ use
Seasonal (last year!)	Astronomy – tilt of earth's axis temperature swings >60 Celcius in Canada

Timescales – why is history important?

To destroy some popular misconceptions

climate is "naturally stable"	climate always has changed, it is changing, and it always will change,...irrespective of anthropogenic effects
recent CO2 and 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 correlates with temperature since ~1850	Other than a general rise in both variables, CO2 does NOT correlate with T!!!
CO2 drives temperature	**Temperature drives CO2!!!**
CO2 is the main variable affecting temperature	CO2 is a minor variable at best, affecting T only indirectly. Many other variables affect T directly and/or are vastly more important than CO2.
the "precautionary principle" demands radical action	Adaptation continues to be the key response by mankind – as it always has been! Given the large natural swings in climate, eliminating anthropogenic CO2 effects wouldn't help much.

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

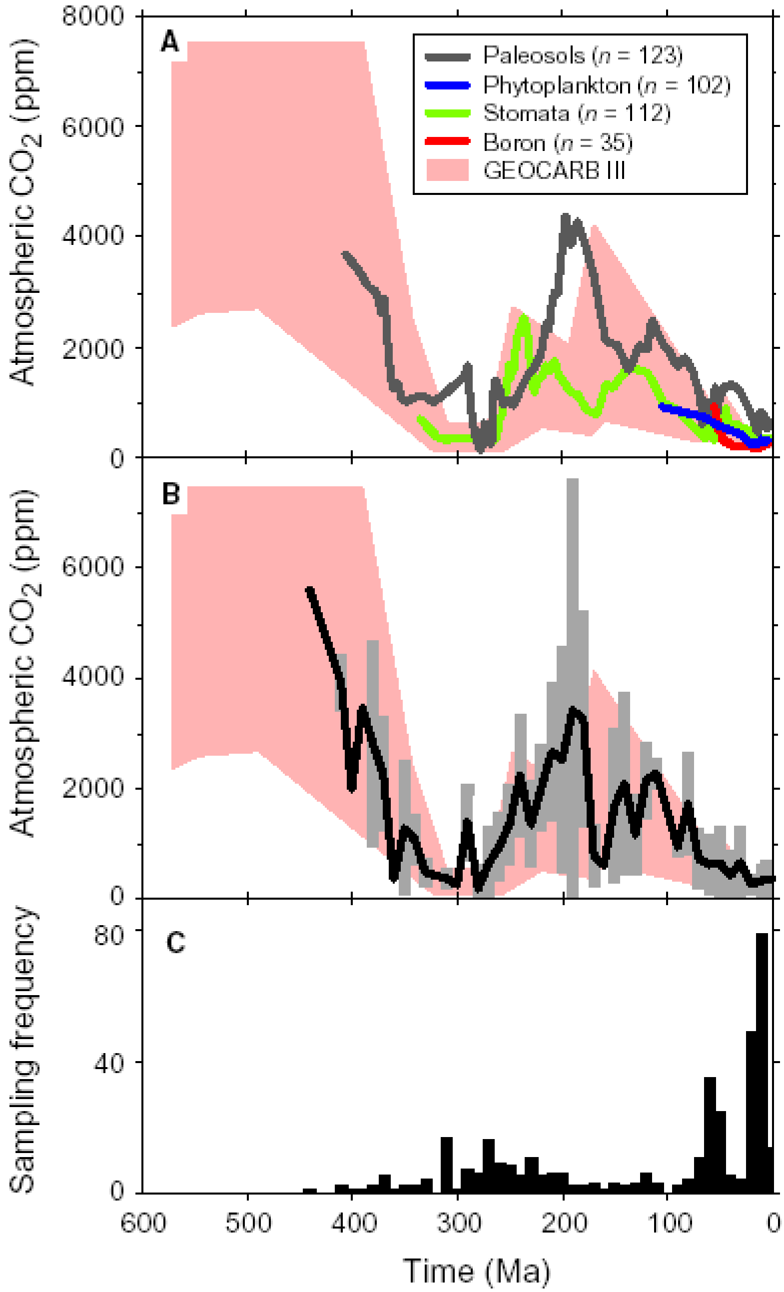


Figure 1. Details of CO_2 proxy data set used in this study. **A:** Five-point running averages of individual proxies (see footnote 1). Range in error of GEOCARB III model also shown for comparison. **B:** Combined atmospheric CO_2 concentration record as determined from multiple proxies in (A). Black curve represents average values in 10 m.y. time-steps. Gray boxes are standard deviations (± 1σ) 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

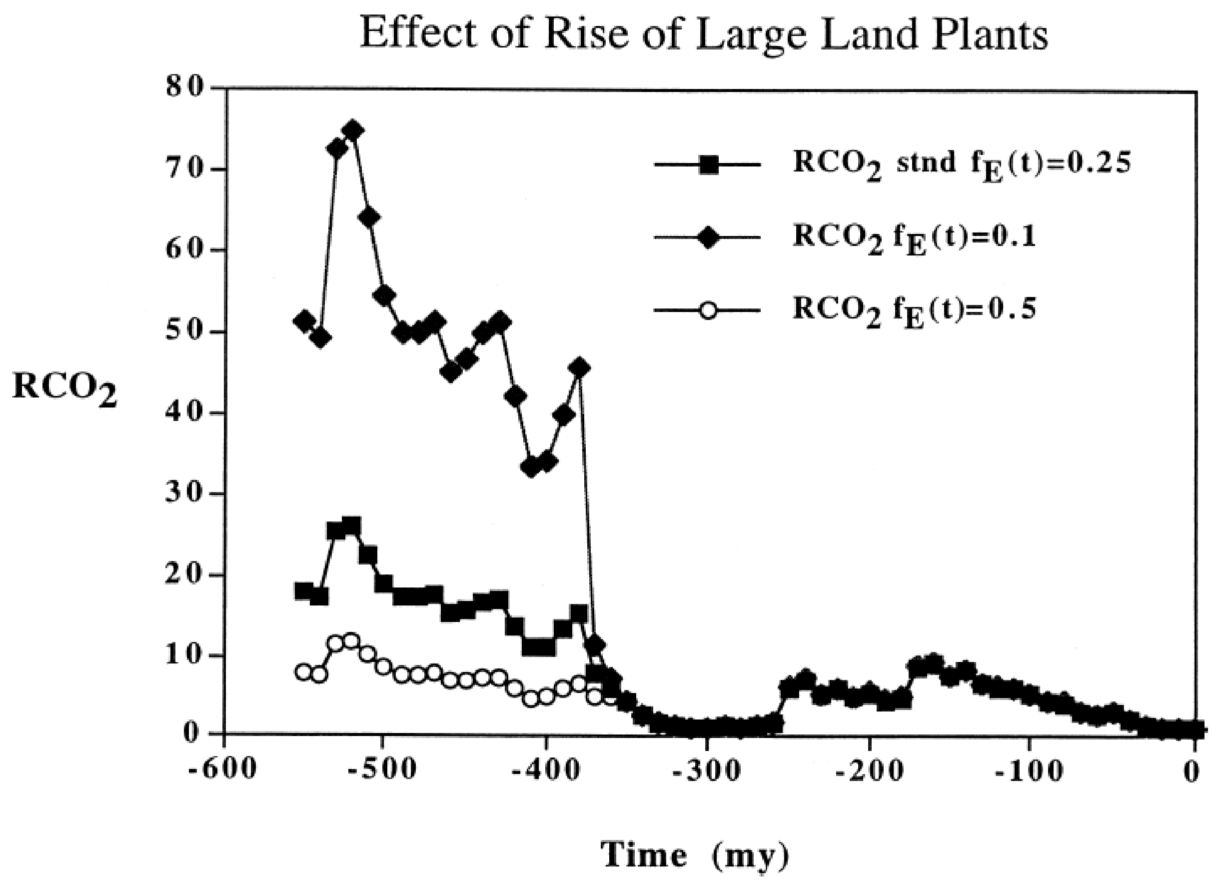
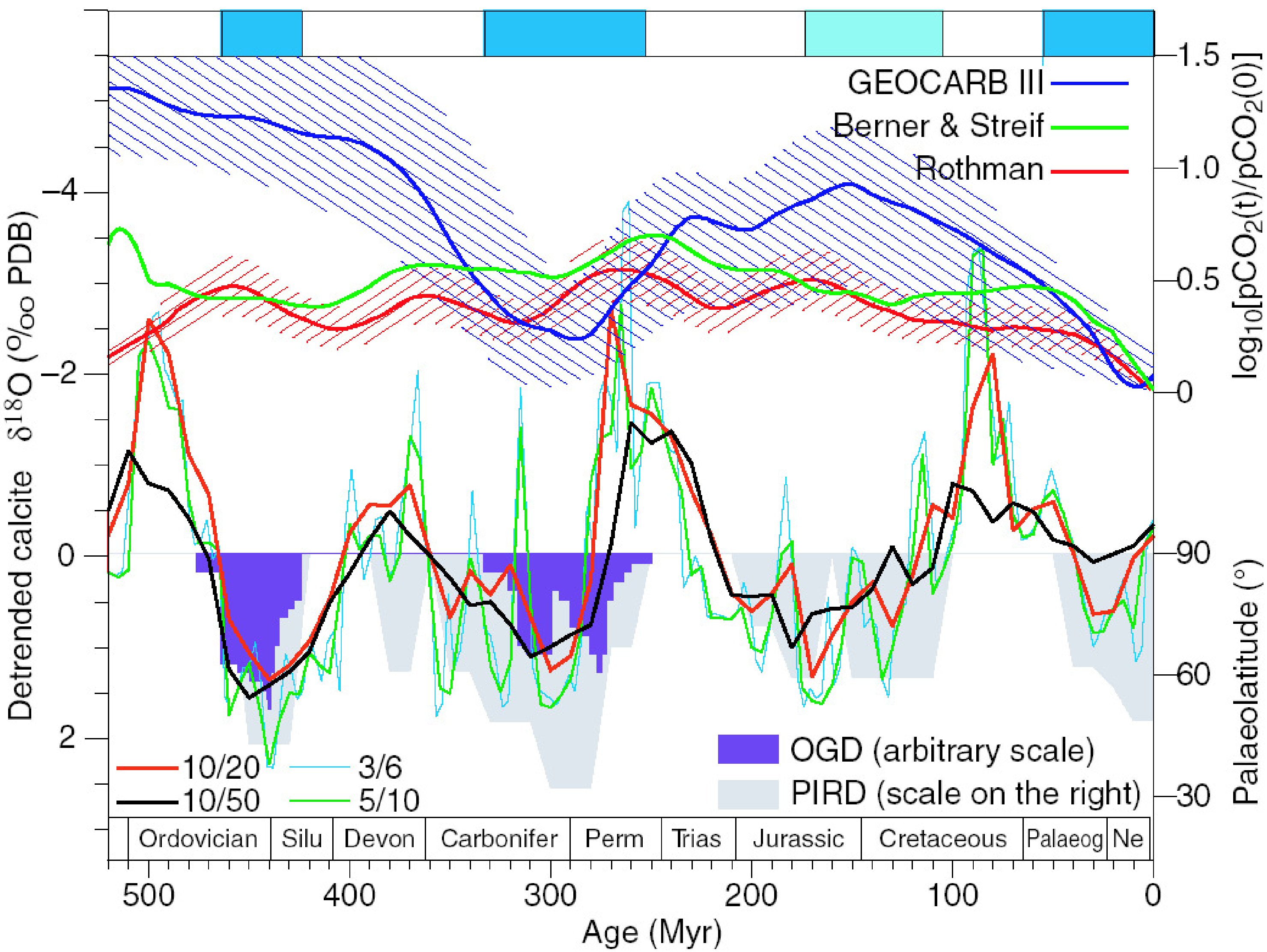


Fig. 5. Effect on RCO_2 of variation of the quantitative effect of the Devonian rise of large vascular land plants on continental weathering. The standard value for the early Paleozoic of the plant weathering factor $f_E(t) = 0.25$ is based on the field results of Moulton, West, and Berner (2000). Note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

cosmic radiative flux and Phanerozoic Climate not the right graph



C4 Plants

Carbon dioxide starvation T. E. Cerling and others 161

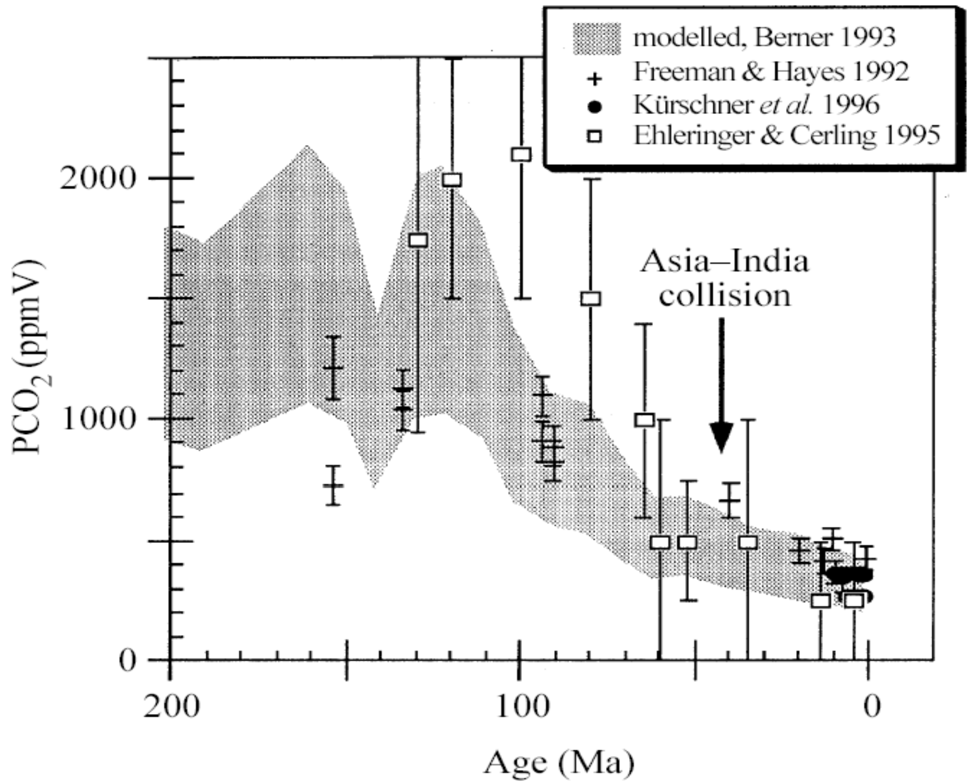
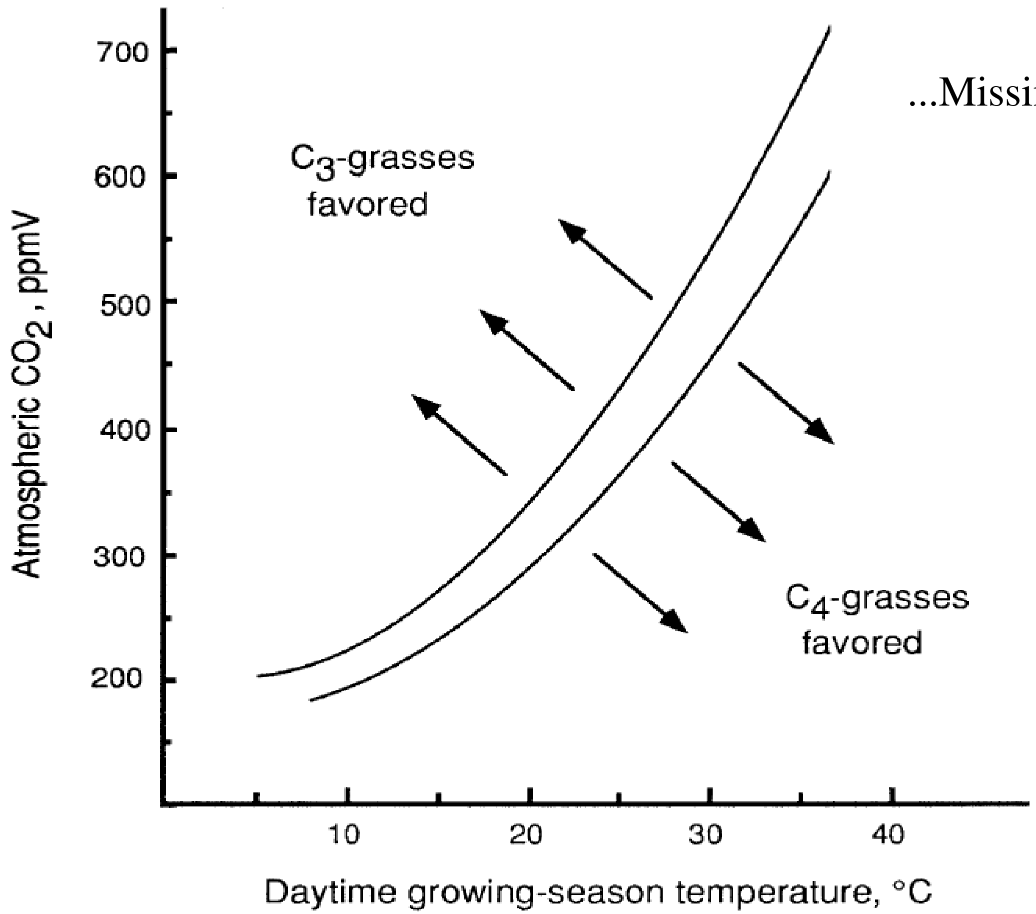


Figure 1. Modelled and calculated CO_2 levels from 200 Ma to the present. The model is from Berner (1991, 1994, 1997), and calculated values are based on marine biomarkers (Freeman & Hayes 1992), stomatal densities (Kürschner *et al*. 1996), and pedogenic carbonates (Ehleringer & Cerling 1995). Other modelling experiments (Barron *et al*. 1989, 1993) favour CO_2 levels $>$1200 ppmv for the Cretaceous.

C4/ C3 Plant Crossover

162 T. E. Cerling and others *Carbon dioxide starvation*

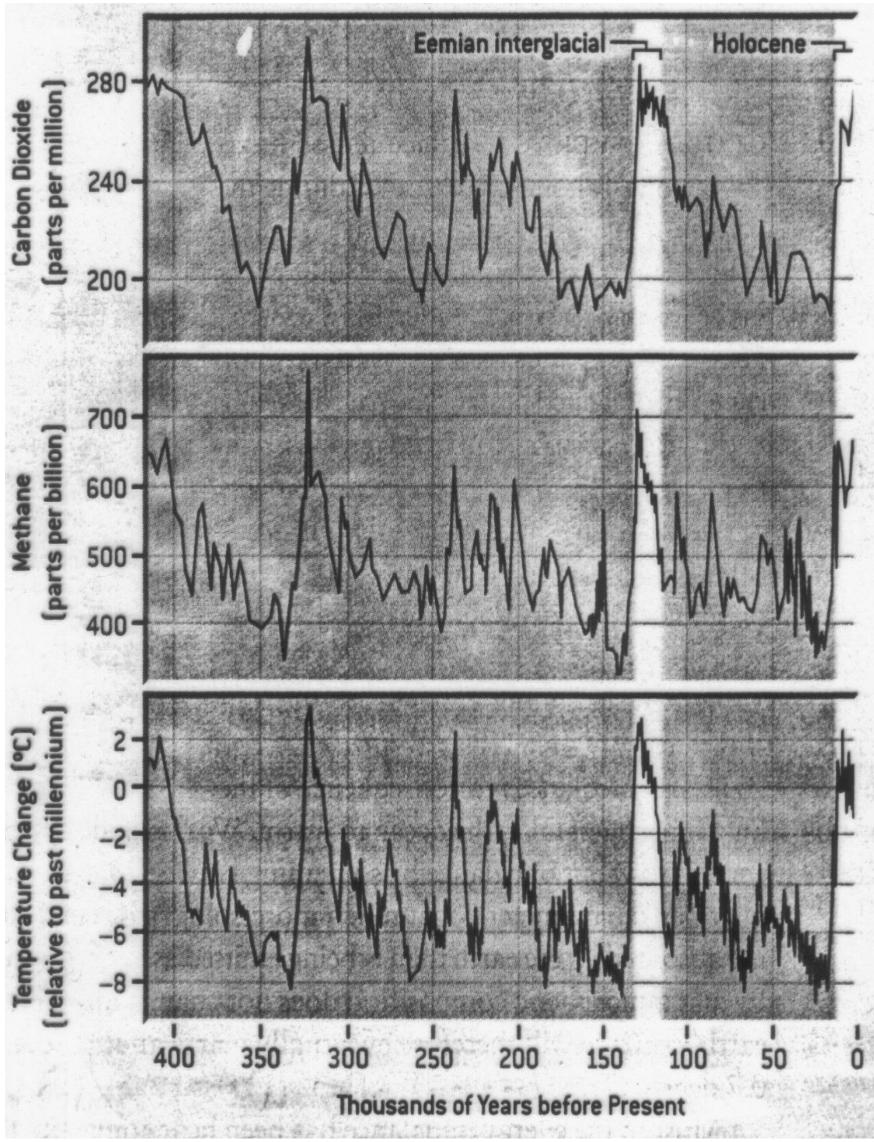


...Missing humidity

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).

Glacial Period

Temperature, CO2, Methane



Agricultural Effects?

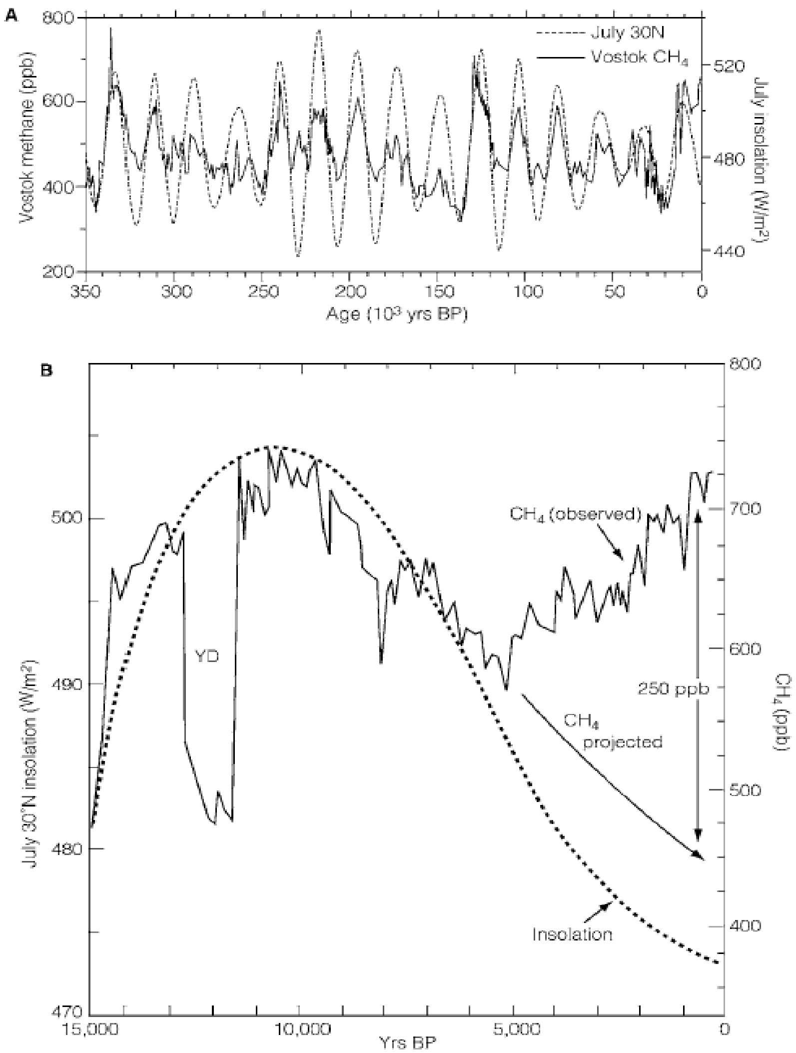


Figure 1. Comparison of July insolation values from Berger and Loutre (1996) with ice-core concentrations of atmospheric CH_4. (a) Long-term Vostok CH_4 record of Petit et al. (1999), using time scale of Ruddiman and Raymo (2003). (b) GRIP CH_4 record from Blunier et al. (1995), dated by counting annual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

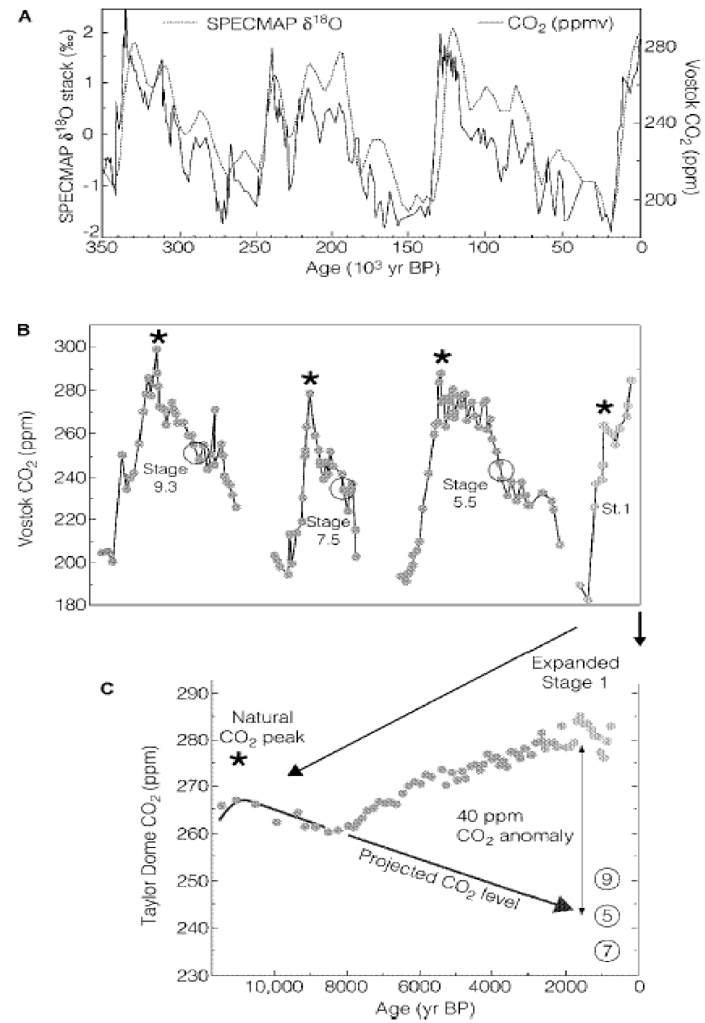


Figure 2. Concentrations of atmospheric CO_2 in Antarctic ice cores. (a) CO_2 trends from Vostok ice record of Petit et al. (1999) using time scale of Ruddiman and Raymo (2003). Marine $\delta^{18}O$ signal from SPECMAP (Imbrie et al., 1984). (b) CO_2 trends during 4 deglacial-interglacial intervals. 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.

Solar Variability since ?Renaissance?

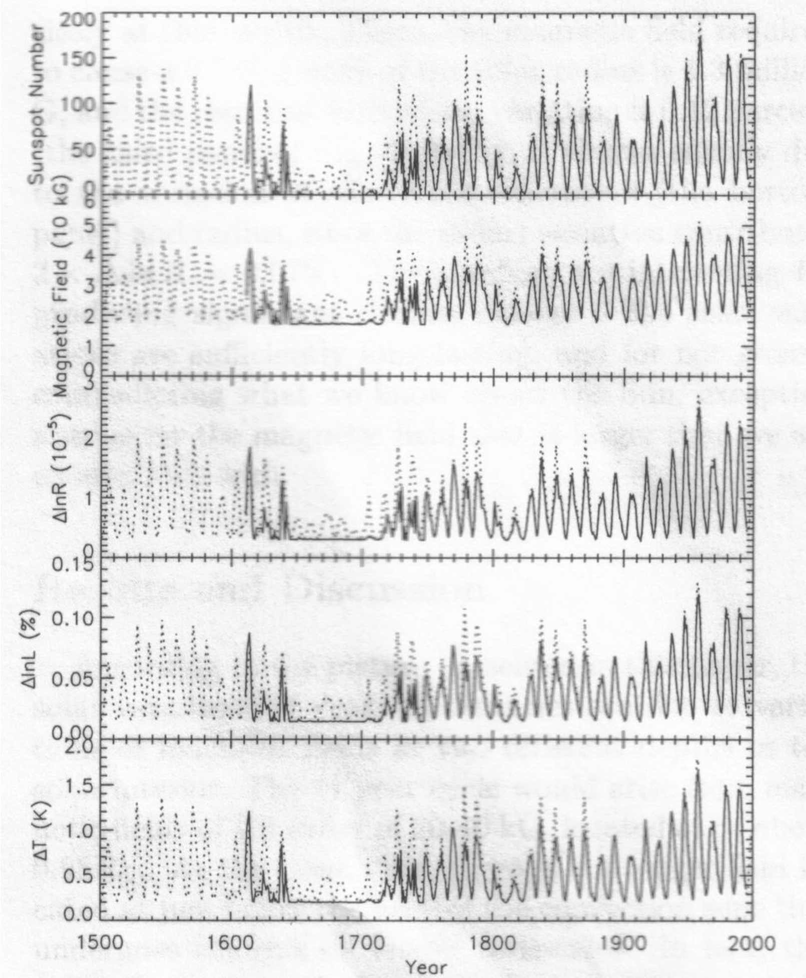


Figure 3. Solar variability in the past five centuries (dotted curve corresponds to the Zürich sunspot number R_Z) and in the past four centuries (solid curve conrresponds to the group sunspot number R_G). kG stands for kilo-Gauss, L for total solar luminosity, T for solar effective temperature, R for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

Wrong graph!
... I need Tapping's or some other T vs sunspot vs other
...need to show Mann/IPCC fraud

Sunspots – last 120 years

Sunspots: An overview 157

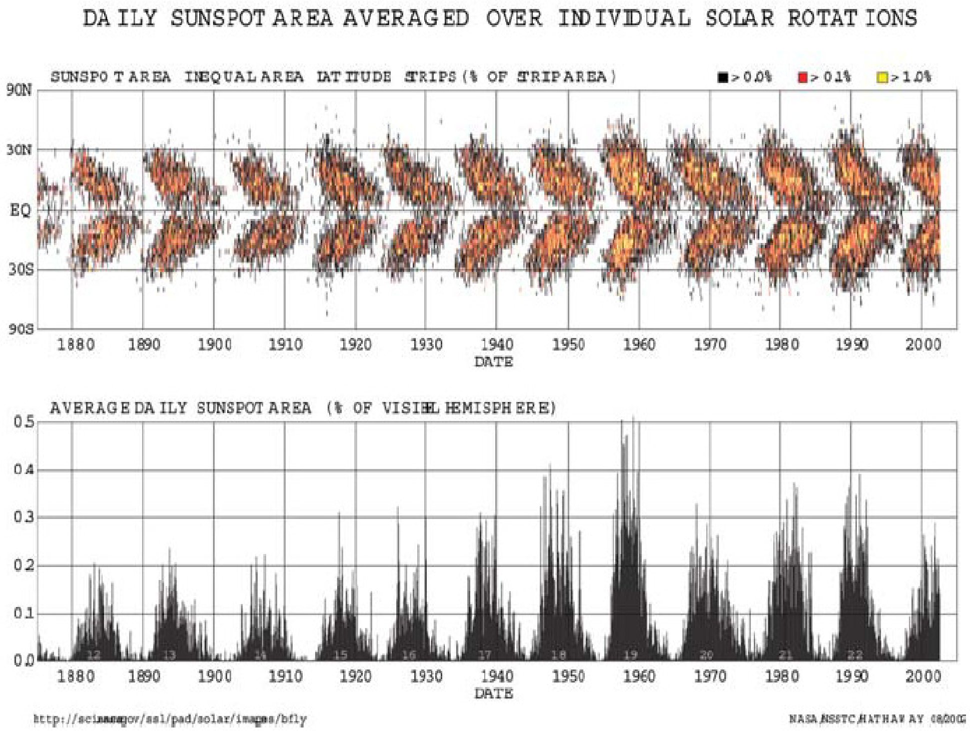


Fig. 2.1. Butterfly diagram (*upper panel*) and record of relative solar surface area covered by sunspots (*lower panel*). *Upper panel*: the vertical axis indicates solar latitude, the horizontal axis time. If a sunspot or a group of sunspots is present within a certain latitude band and a given time 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).

162 S.K. Solanki

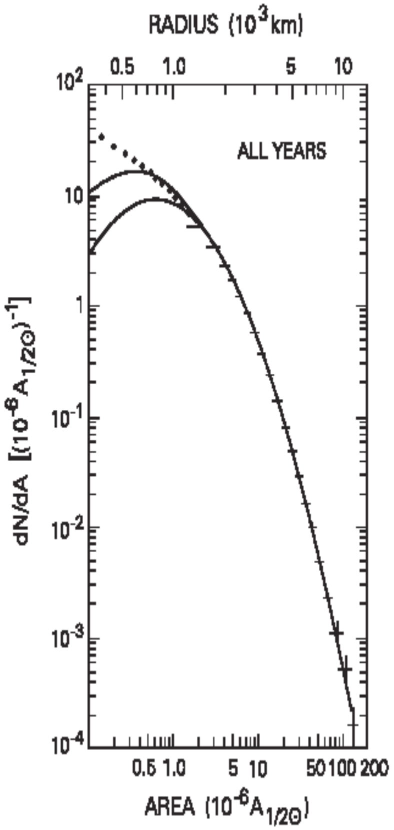


Fig. 2.2. Overall size spectrum for the Mt. Wilson data set of 24615 sunspots (*crosses*). Unreliable smaller sizes are denoted by filled circles. Upper and lower lognormal fits to the crosses have also been sketched (adapted from Bogdan et al. 1988, by permission).

Seasonal Temperatures – Ottawa

...I need a graph of average Ottawa temperatures...