b30 Present concerns about the climate < carbon dioxide, methane >

> Before 1900, humans had little impact on earth and rock, compared with oceanic volcanoes, tectonic movements (mountain building) and glaciers. By the 1990s, we had surpassed all of them, moving 42 billion tons of rock and soil per year against 30 billion tons by volcanoes, 14 billion tons by tectonics and only 4.3 billion tons by glaciers. —Dick Teresi in his review of *An Environmental History of the Twentieth-Century World*, 2000, by J. R. McNeill.[1]
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> When I read the article [in which free-market economist Julian Simon rebutted many of the doomsday predictions that environmentalists have made about the planet] I thought 'hell, no.' I thought that obviously the environment is getting worse. But Simon said one irritating thing: go check the facts. —Bjørn Lomborg, author of *The Skeptical Environmentalist*, 2001.[2]
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> One American, asked to name the greatest invention of the 20th century, answered 'insulation.'[3]

In 1986, Peter Vitousek, Paul Ehrlich and Daniel Pauly calculated that humans already used 40% of the primary productivity of the land,[4] and recalculations in 2001 by Stuart Pimm arrive at the same sobering statistic.[5]

Weep for Thomas Midgely, Jr. (1889-1944) found strangled in ropes and pulleys he devised to get from bed after he had contracted polio. Chillingly before, *Freon,* his invention, escaped to the upper atmosphere where it weakens the ozone shield. Earlier, by the 1970s, elevated lead levels in most Americans followed from his 1921 finding that tetraethyl Pb put in gasoline stops hot-engine knock.[6]

Sunlight passes in though the atmosphere easily and changes the air's temperature little. Light absorbed by the ground is radiated as heat which out-going raises the air's temperature mostly by being trapped by water vapor (H_2O). So the atmosphere, as Jean-Baptiste Fourier described in 1822,[7] acts to trap radiated heat by a "greenhouse effect" (the inadequate analogy being: glass is transparent to light but is opaque to heat).[8] Long term variation of dry "greenhouse gases" like ozone (O_3) that slow heat's escape into space can be studied in detail as such are held in glacial-ice layers. Atmospheric carbon dioxide (CO_2) (normal concentration: 0.03 %) has increased (by 0.006 %) due to our use of fossil fuels (coal, oil, and natural gas) as a source of energy. Nitrous oxide (N_2O) emissions are increased by tilling soil and burning fuel. These vaporous by-products of civilization, could be accountable for having increased Earth's average surface air temperature 2/3 °C (= 1 °F) during the last century (***Figure b30.1***).[9] Another dry greenhouse gas is methane (CH_4) (normal atmospheric concentration: 0.0002 %) abundantly produced by cattle as the natural byproduct of digestion of cellulose in wood and other plant matter by their (ruminant) gut biota. (Though vastly exceeded by termites' similar symbiotic gut biota, methane output in soil is mightily scavenge by methane-eating bacteria for their nutrition and only that which diffuses from the colonies of mound-building termites escapes to account for a mere 1 % of the atmosphere's methane).[10]

Should we be concerned? Yes and no. Yes because Los Anglians have been concerned by a recent six year drought that limited abundances from the Sierras of water, which the city imports for its existence, and made incendiary the chaparral. However, the chaparral, which is adapted to burn on a natural (4 to 20 year) cycle were it not for urbanization, was itself not present during two "megadroughts" that, during the time of European Middle Ages mild climate, parched California lasting 140 and, the older, for 220 years! No, facetiously, for while a popular literary theme, of say, the destruction of London could be widely understood as the destruction of Western civilization itself, author Mike Davis can write "the obliteration of Los Angeles ... is often depicted as, or at least secretly experienced as, a victory for civilization." [11] And no, seriously, because for a good life, worrisome circumstances for which no relief is in sight recommend zen indifference.

A glacier's budget is the annual balance of winter snow accumulation and summer loss (by ablation). Long-term change in either, shifts where these, to either side of an elevation on a glacier (equilibrium-line altitude or ELA), add to zero. Temperature and precipitation are the principle determining factors of a glacier's volume. Lesser factors are cloud cover over the glacier, the wind blowing across its surface, the humidity of the air surrounding it, and the dust and rock in and on the glacier's ice. Yearly, 5 mm of global sealevel is received as snow by Antarctica's ice sheet and leaves

by sublimation and glacier calving.[12] A glacier's ELA is measurably higher or lower after long-term climate change. Atle Nesje and Svein Olaf Dahl in *Glaciers and Environmental Change*, 2000, retell that twentieth-century warming led to increases in ELAs and consequent ice shrinkage for most glaciers around the world. Montana's Glacier (soon to be a misnomer) National Park is losing the 26 glaciers that yet survive from the 150 a century ago. Norwegian glaciers, however, have experienced lowering ELAs during recent decades because of increased winter accumulation resulting from an extreme positive (stronger-than-average westerlies) phase in the North Atlantic Oscillation (making summers cool, winters mild, and an increase in precipitation).[13]

But we are forwarned by Julian Simon's *The Ultimate Resource*, 1996,[14] Bjørn Lomborg's *The Skeptical Environmentalist*, 2001,[2] and Christopher Horner's *Red Hot Lies*, 2008,[15] that politicization of ecology has created a dogmatic environmentalism that ignores the disparity between apocalyptic claims for the future of mankind based on short-term trends with figures issued from large organizations such as the United Nations Food and Agriculture Organization, and which, to quote Anthony Trewavas: "often or even usually show the opposite."[16]

In the absence of a well-constrained model for long-term climate, the effect of such climatic factors as CO_2 build up cannot be responsibly forecast. At the present, other than trying to maintain the status quo, no climatological hypothesis should establish government policy. Responsible though is the research and proposals for Long-term Ecological Research (LTER) begun in 1992. For the distant future, the geological record of the Pleistocene carries a clear message: Historical time since the Little Ice Age could turn out to be a Dansgaard-Oeschger (D-O) event, which is what glaciologist call a fast-warming climate shift of 5 to 8 °C in mean annual air temperature recorded in Greenland ice over a few decades *within a glacial period* to the beginning of a temperate episode that declines by cooling over several thousand years.[17] D-O cycles, with recurrence periods of a few hundreds to a few thousands of years, appear to be a persistent feature of Earth's climate as these cycles are found to have their counterpart-record in deepsea cores to over one million years ago.[18] In the jargon: **Gerard C. Bond** (1940-2005) has shown that ice armadas were launched from the Laurentide, Hudson Bay, ice sheet, and perhaps the Fennoscandian ice sheet, at the most intense cold phase of D-O cycle packages, and that each Heinrich event is followed by an abrupt warming which ultimately spawns a new package of D-O cycles (i.e. a Bond Cycle).[19]

Global cooling, and the return of ice sheets to their former extent can be expected. Warming has shortened glaciers within living memory (***Footnote b30.1***). In the near future cooling or warming is equally possible. During "super-interglacial" warm extremes at ~1 and at ~4 million years ago, the marine-based West Antarctic Ice Sheet collapsed and global sea level was more than 5 m higher than today.[20] Of concern is that warming could cause the ice sheet of Antarctica to vanish and result in a vastly more catastrophic rise in sealevel. However, on uniformitarian grounds, that concern is unjustified as the ice sheet covering Antarctica is to 2.2 km thick and in longevity it *greatly* predates the Pleistocene Ice Age. But the short term instability of world's climate is a legitimate concern. Ice sheets hold evidence of brutal climate swings on time scales as short as a decade. Some components that affect the climate, such as volcanism and Sun's known and unknown variable output, are uncontrollable. Others, such as the release of greenhouse gases and destruction of forests, can be addressed. Chemist Paul J. Crutzen in 2000 suggested "Anthropocene" for the human-dominated, geological epoch that began three hundred years ago when effects of humans became indelible in the *global* environment (analyses of air trapped in polar ice show that anthropogenic emissions of CO_2 and methane started to accumulate following James Watt's invention of the steam engine in 1784.[21]

According to Scott Lehman, Arctic field geologists have long suspected that the end of the present interglacial could have happened during the Little Ice Age (a "cold snap" that occurred a few hundred years ago) if semi-permanent snowfields that threatened to coalesce over the high plateaux of Labrador and Baffin Island, had. Then, "albedo feedback along with decreasing summer insolation

(on the decline locally for the past 9,000 years) might have triumphed over interglacial warmth. Numerical models suggest that such a chain of events can be unleashed with very little forcing." [22]

In this context, a slight weakening of the ocean circulation can be likened to a sledgehammer blow—one which could conceivably abruptly end the now (Holocene) interglacial. Such a possibility only adds to concerns about the potential impact of increased greenhouse forcing on the oceans.

The smallest and most abundant photosynthetic microbe on Earth is *Prochlorococcus marinus*.[23] One tablespoon of seawater may contain 10,000 of this cyanobacterium. It and other species of *Prochlorococcus* make up nearly a third of the ocean biomass that uses light to make food. Their ecologies are depth adjusted. One strain of *P. marinus*, MED4, with1,700 genes (some code for an enzyme that repairs damage to its DNA caused by exposure to ultraviolet light) lives in rather brightly lit surface waters. Another strain, MIT9313, with the 2,400 genes (some code for enzymes capable of utilizing the nitrite present in deeper waters but absent from the surface waters of the open ocean, and some code for enzymes that handle sugars) but fewer of their genes are activated by light than in MED4. The carbon dioxide-consuming activity of all *Prochlorococcus*, along with other phytoplankton, regulates CO_2 in the atmosphere (kept O_2-full at 21%) by sequestration-burial of their sunken dead in seafloor anaerobic ooze. Penny Chisholm summarizes: "If all the phytoplankton suddenly died, the CO_2 concentration in the atmosphere would increase two- to three-fold." [24]

"The ocean contains fifty times as much CO_2 as the atmosphere, and the pH and pCO_2 of the ocean are actually buffered (stabilized) by vast reserves of carbon stored as calcium carbonate in deepsea sediments," writes David Archer, and "the ultimate sink for the fossil fuel CO_2 will be to enter the ocean and dissolve sedimentary calcium carbonate. At the end of the last ice age, for example, carbon was removed from the atmosphere by growth of forests. The oceanic CO_2 exhale that resulted is documented by a "spike" of calcium carbonate preservation in sediments (the counter-intuitive backwards behavior is caused by the systematics of carbonate pH equilibrium chemistry)." [25]

The history of atmospheric CO_2 is recorded by the gas content in Antarctic ice cores from Vostok Station to 440,000 years ago and from EPICA Dome C to 800,000 years ago (***Figure b30.2***).[26] In these, atmospheric CO_2, which in the best of planned futures is projected to plateau at 550 ppmv (it reached 375 ppmv in 2005)[27] did not, before the advent of fossil fuels, exceed 290 ppmv during peak interglacial warmths and was 80–100 ppmv lower again during peak glacial colds. The history of global ice-volume is known from oxygen isotopes in benthic foraminifera from deepsea sediment cores. When these two histories are plotted so that ice ages (peaks in continental ice volume) appear as sealevel minima, clear correspondences are evident.[28] ❑

Musings Knowledge of the basic science involved is a necessary, not a sufficient, condition for intelligent decision making. In a time of cloning, bioterrorism, global warming, stem cell research, nuclear energy, GM (genetically modified) crops as papaya given a gene by Dennis Gonsalves to resist ringspot virus,[29] and euthanasia, asking scientists to explain recent developments in their fields is no longer adequate. Loren Graham in his review of Gerarl Piel's *The Age of Science*, 2001, posits: "A new kind of science journalism is called for that will neither praise nor condemn science, but instead help [people] sort their way through these extremely difficult issues." [30]

Cued by James Robert Brown's *Who Rules in Science*, 2002, we should separate conceptually: "science" which is "that body of current theories that purport to truly describe the world (or at least to systematize our experience)" with its metier in "the institution of science, the vast collection of universities, research establishments, and government agencies"; and, "technology and applied science, [which is] the attempt to control and manipulate the world in the pursuit of our practical goals." [31]

"If one cannot distinguish between scientific 'stories' on an empirical basis, one is more likely to be swayed by aesthetic factors" John Horgan observes in *Undiscovered mind*, 2002, and cites the example of Freud whose rhetorical talents friends and foes acknowledge.[32] "A genius" wrote Hans Eysenck in 1985, "not of science but of propaganda, not of rigorous proof but of persuasion, not of design of experiments but of literary art. His place is not, as he claimed, with Copernicus and Darwin but with Hans Christian Andersen and the Brothers Grimm, tellers of fairy tales." [33]

To Socrates' first question of ethics: How should we live? What makes a life go well? To answer, Philip Kitcher, in *Science, Truth, and Democracy*, 2002, **first** exposes relativists, subjectivists, antirealists, and postmodernists who recruit with such as Tom Lehrer's: "'Once the rockets are up, who cares where they come down? / That's not my department,' says Wernher von Braun," and Richard Rorty's incredible claim that "only a sentence can be

relevant to the truth of another sentence" (which Galen Strawson explains means "So don't appeal to the way the world is, for there is no such thing") and **second** answers: *Science* in its search for *Truth* should be guided by *Democracy* (i.e., not by physical constants & laws that are discovered but by what is humanly changeable—wider representation of social groups in science projects, choices of research programs to fund, and which technologies to use or avoid).[34]

Postmodernists who read, for example, Hutton's metaphysical *Theory of the Earth*, 1795, do not wish to understand how its kernel of truth (that Earth is provably vastly older than historical time) can be rescued from amid the dross by Playfair, for its furtherance by Lyell and those who have followed, to arrive at what geology now is. With an agenda to humble science, the carpings of postmodernists (social constructivists) are made bleatings by Steven Weinberg, who in *Facing up to Science and Its Cultural Adversaries*, 2001, essays that cultural influences present at early stages of theory development are later refined away "like slag from ore."[35]

Footnote b30.1 Vanishing subtropical and tropical glaciers at altitudes of 6,000 meters and higher, are glaciers of New Guinea and Kenya, and ice sheets on the Tibetan plateau and the Andean Altiplano (where in Quelccaya's ice sheet, Peru, cored with no time to loose by Lonnie Thompson, archived sequences of "favorable" wet periods and "adverse" dry periods suggest to archaeologists explanations for the rise and fall of various pre-Incan societies).[36]

Figure b30.1 Measurements reveal that the world's climate has warmed since 1880 and carbon dioxide concentration in the atmosphere has increased.[37] However, climate modeling is yet too imprecise to know how much of the climate change (if any, as CO_2 change has lagged (*follows after*) temperature change by 800 years)[38] to attribute to the increase in CO_2. So quantitative prediction of climate change to steer environmental policy is not an option.

Yet, as David S. Gutzler puts it: "Waiting for the attribution and prediction problems to be solved, which is the current de facto policy, is itself an important policy decision and should be acknowledged as such."[39]

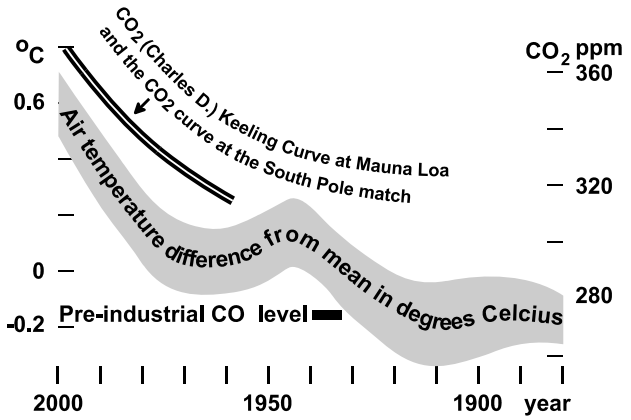
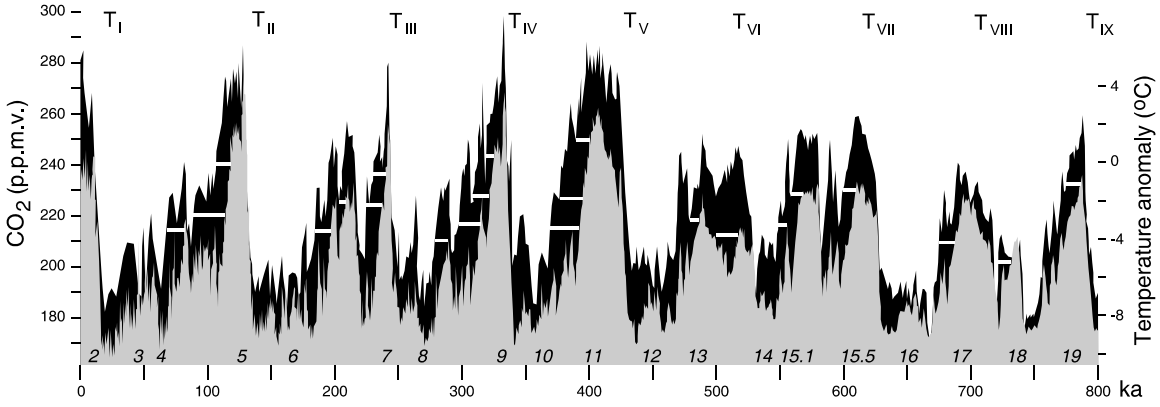


Figure b30.2 [40] Histories of atmosphere CO_2 levels (black-filed curve) and EPICA Dome C temperature change (superimposed grey-filled curve). Evident is a 100,000 year cyclicity and a lag averaging 12,000 years in the fall of CO_2 following temperature declines (as measured in 22 places, shown by the white horizontal lines that range from 5000 to 24,000 years).



Recommended readings: *The History of Global Warming*, 2003, by S. R. Weart, who describes its discovery, and investigation, beginning in the nineteenth century.[41] Then evaluate Al Gore's *Earth in the Balance*, 1992, call to action,[42] and *The Satanic Gases*, 2000, call to inaction,[43] by P. J. Michaels & R. C. Balling. Jr.