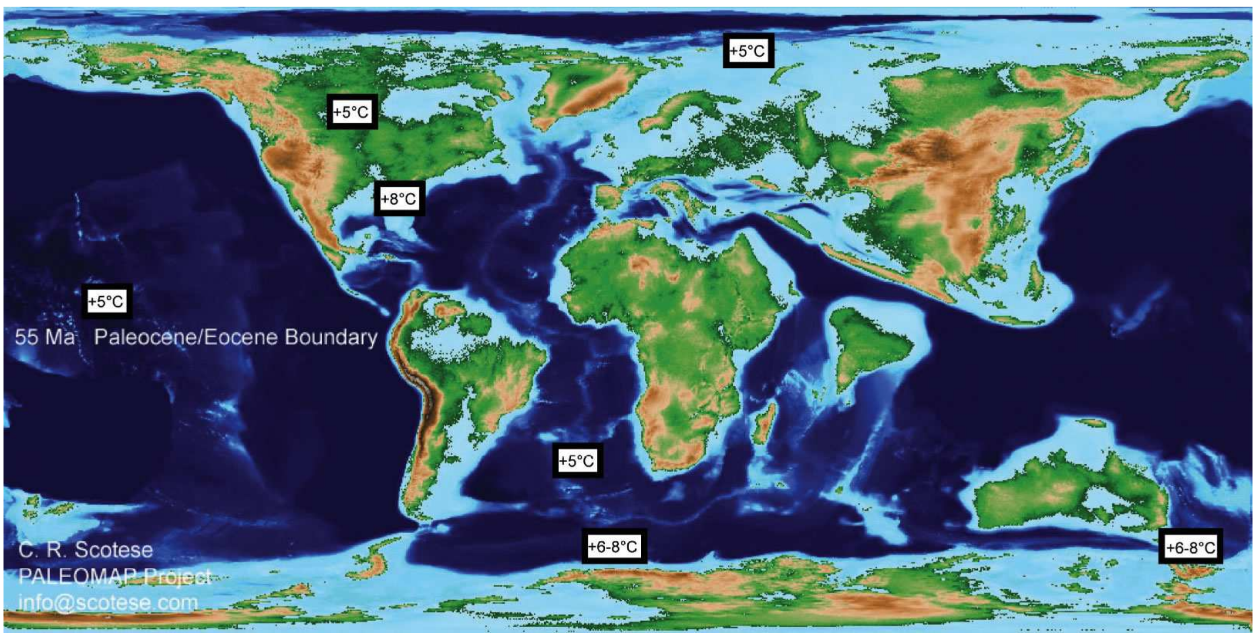
17 March 2013

Atmospheric CO2 and mass extinctions: implications for global warming



The Paleocene-Eocene thermal maxium

http://www.uta.edu/faculty/awinguth/petm_research/petm_home.html

Throughout the Phanerozoic (542 million years ago to the present) major mass extinction of species closely coincided with abrupt rises of atmospheric carbon dioxide and ocean acidity (pH), at rates to which species could not adapt. These events, triggered by asteroid impacts, massive volcanic activity, eruption of methane, ocean anoxia and extreme rates of glaciation (Figures 1 and 2) [1, 2, 3, 4], bear direct implications to the current rise of CO2, at rates unprecedented over the last 65 million years (Figure 2).

CO_2 levels have risen to near 396.80 ppm at Mouna Loa (February, 2013, compared to 393.54 ppm in February 2012, i.e. at the unprecedented rate of 3.26 ppm/year) (http://www.esrl.noaa.gov/gmd/ccgg/trends/), and near 400 ppm over the Arctic [5]. At this rate the upper stability threshold of the Antarctic ice sheet, defined at about 500 – 600 ppm CO_2 [6, 7] would be reached later this century, although hysteresis of the ice sheets may slow-down melting.

Global carbon reserves, including coal, oil, oil shale, tar sands, gas and coal-seam gas, well more than 10,000 billion ton carbon (GtC), are capable of raising atmospheric CO_2 levels to higher than 1000 ppm (Figure 5). Such rise in atmospheric radiative forcing will be similar to that of the Paleocene-Eocene boundary thermal maximum (PETM) about 55 million years-ago (Figures 1, 2 and 4) but at rates surpassing those of the PETM by about an order of magnitude (Figure 2).

The PETM event about 55 million years ago saw the release of approximately 2000 to 3000 billion tons of carbon to the atmosphere, in the form of methane (CH_4), leading to extinction of about 35-50 percent of benthic foraminifera (Figure 3) [6]. The consequences of the PETM event in terms of temperature rise and ocean acidity are shown in Figure 4 and in the Frontispiece.

Based on the amount of carbon already emitted and which could continue to be released to the atmosphere (Figure 5), current climate trends could be tracking toward PETM-like conditions. Many species may be unable to adapt to the extreme rate of current rise in greenhouse gases and temperatures. The rapid opening of the Arctic Sea ice, melting of Greenland and west Antarctic ice sheets, and rising spate of floods, heat waves, fires and other extreme weather events [9, 10] may signify a shift in state of the climate, crossing tipping points [11]

The extreme changes in state of the terrestrial climate continue to be confused with short-term variations in the weather, as observed by Hansen [9], who states:

"*The greatest barrier to public recognition of human-made climate change is probably the natural variability of local climate. How can a person discern long-term climate change, given the notorious variability of local weather and climate from day to day and year to year*?"

Vested interests, bent on extracting every economically accessible ton of carbon from the ground (see Figure 5), benefit from the confusion between the weather and the climate, perpetrated by mouthpieces who ignore the basic laws of physics and chemistry of the atmosphere, misrepresent climate science and falsify empirical measurements and direct observations in nature.

By analogy to medical science analyzing blood count as diagnosis for cancer, climate science uses the greenhouse gas levels of the atmosphere, pH levels of the ocean, variations in solar insolation, aerosol concentrations, clouding, state of the continental ice sheets, position of climate zones and many other parameters to determine the trend of the climate. The results of these tests, conducted by thousands of peer-reviewed scientists world-wide, have to date been ignored, at the greatest peril to humanity and nature.

Continuing emissions contravene international laws regarding crimes against humanity [12] and related International and Australian covenants [13]. In the absence of an effective global mitigation effort, governments world-wide are now presiding over the demise of future generations and of nature, tracking toward one of the greatest mass extinction events nature has seen.

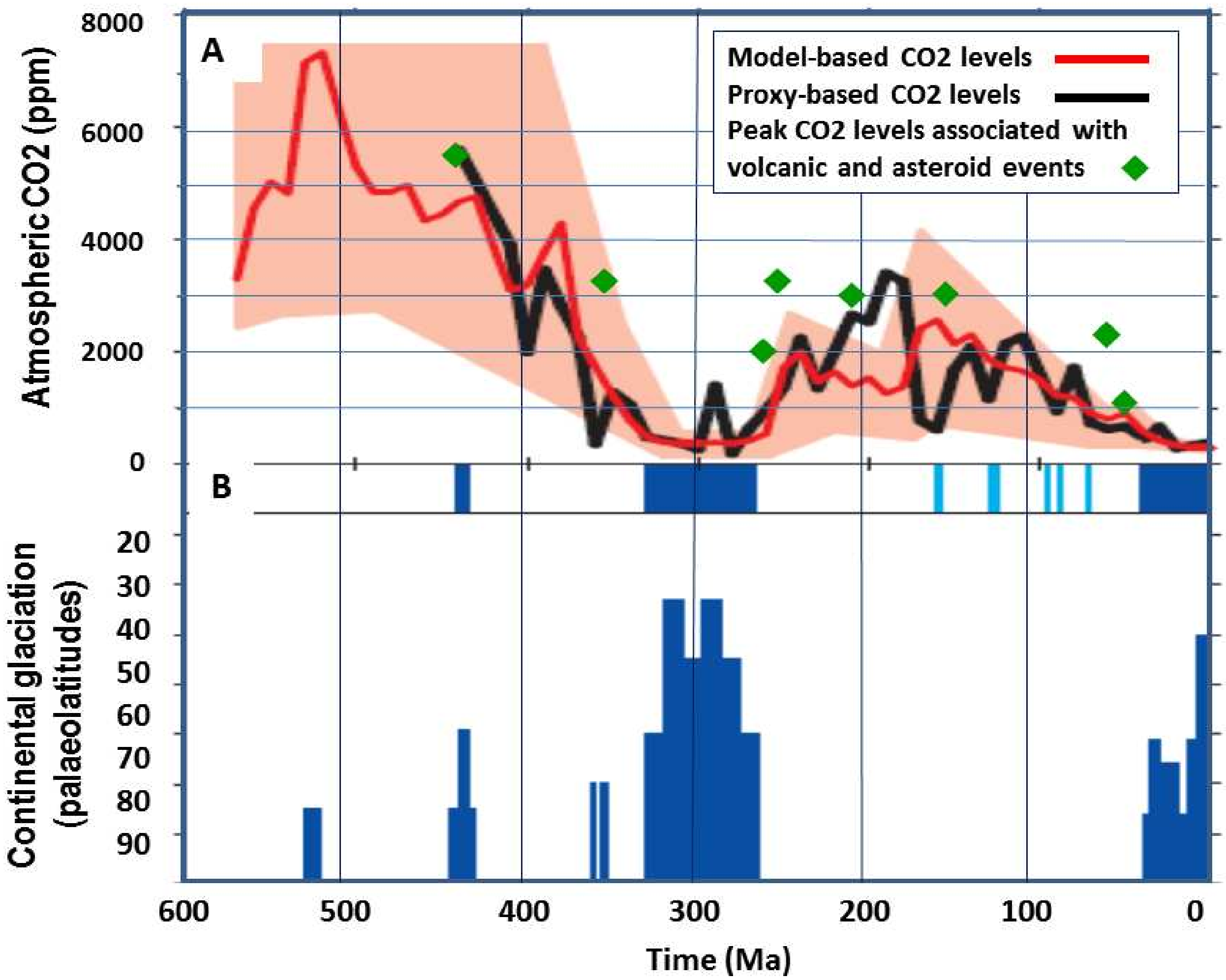


Figure 1. Trends in atmospheric CO2 and related glacial and interglacial periods since the Cambrian (542 million years ago), showing peaks in CO2 levels (green diamonds). CO2 data from Royer 2004 and 2006.

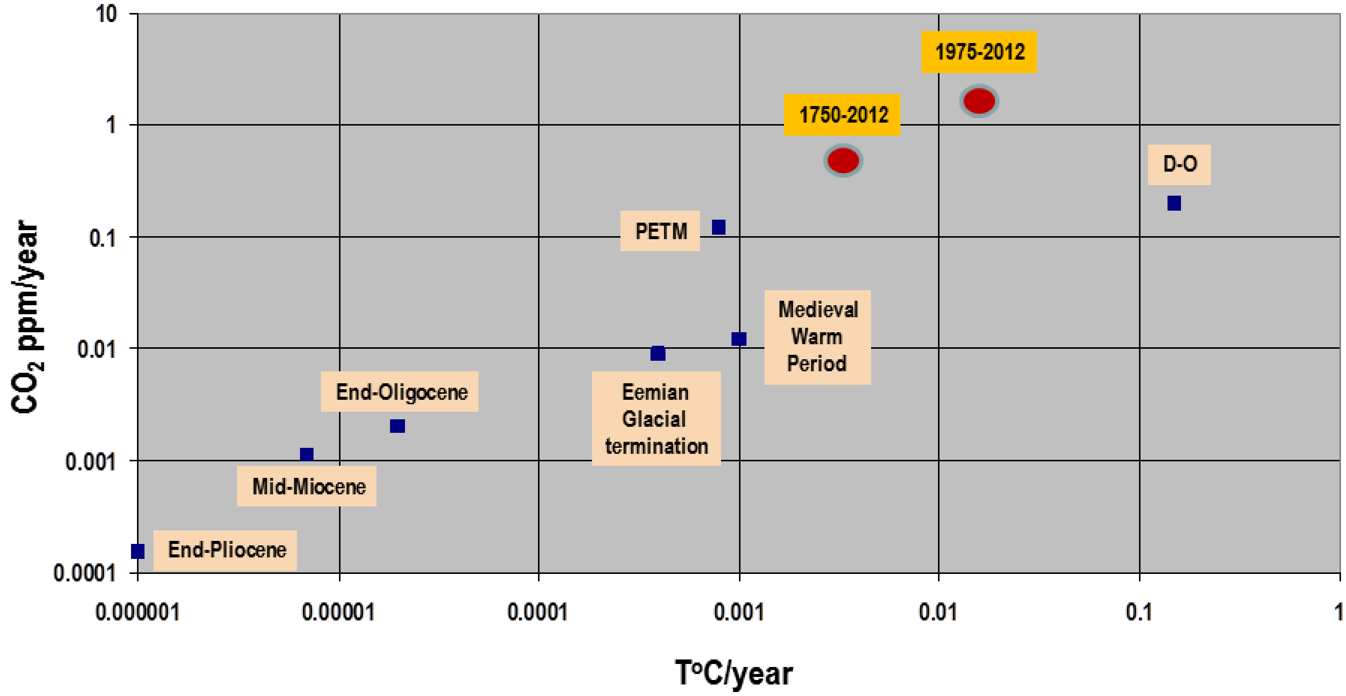


Figure 2. Relations between CO2 rise rates and mean global temperature rise rates during warming periods, including the Paleocene-Eocene Thermal Maximum, Oligocene, Miocene, late Pliocene, Eemian (glacial termination), Dansgaard-Oeschger cycles, Medieval Warming Period, 1750-2012 and 1975-2012 periods.

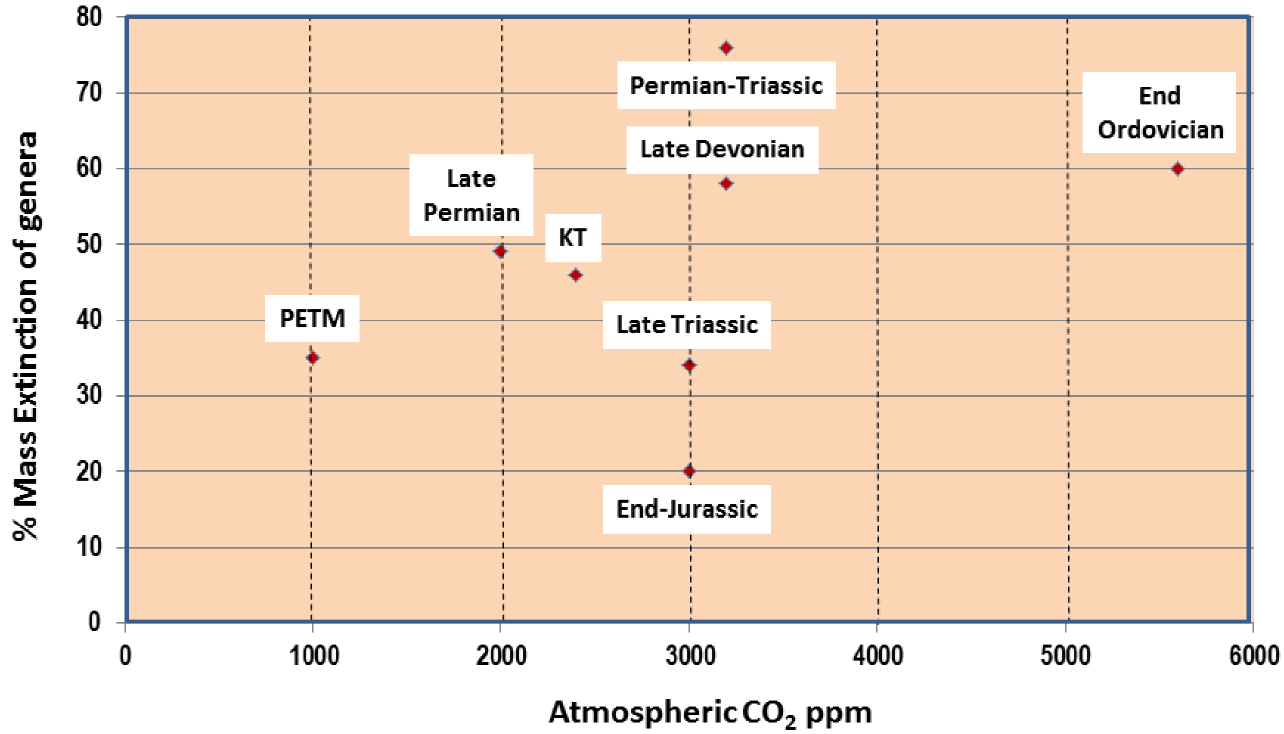


Figure 3. Plot of percent mass extinction of genera versus atmospheric CO2 levels at several stages of Earth history

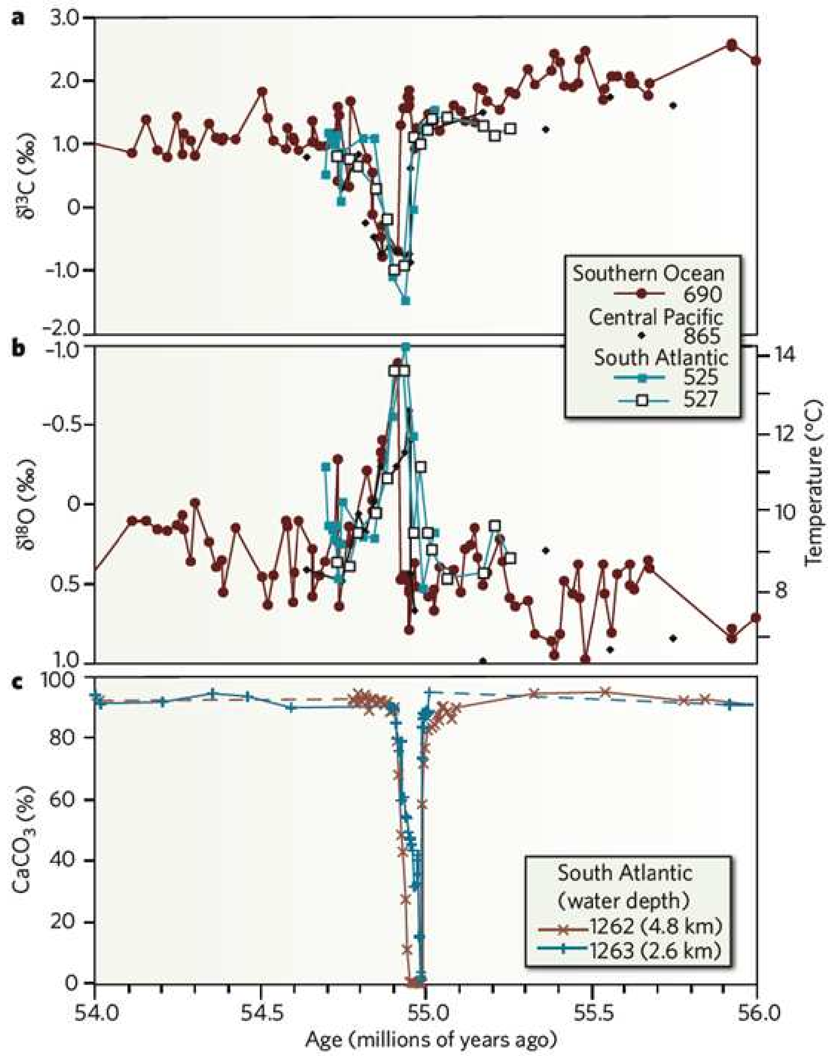
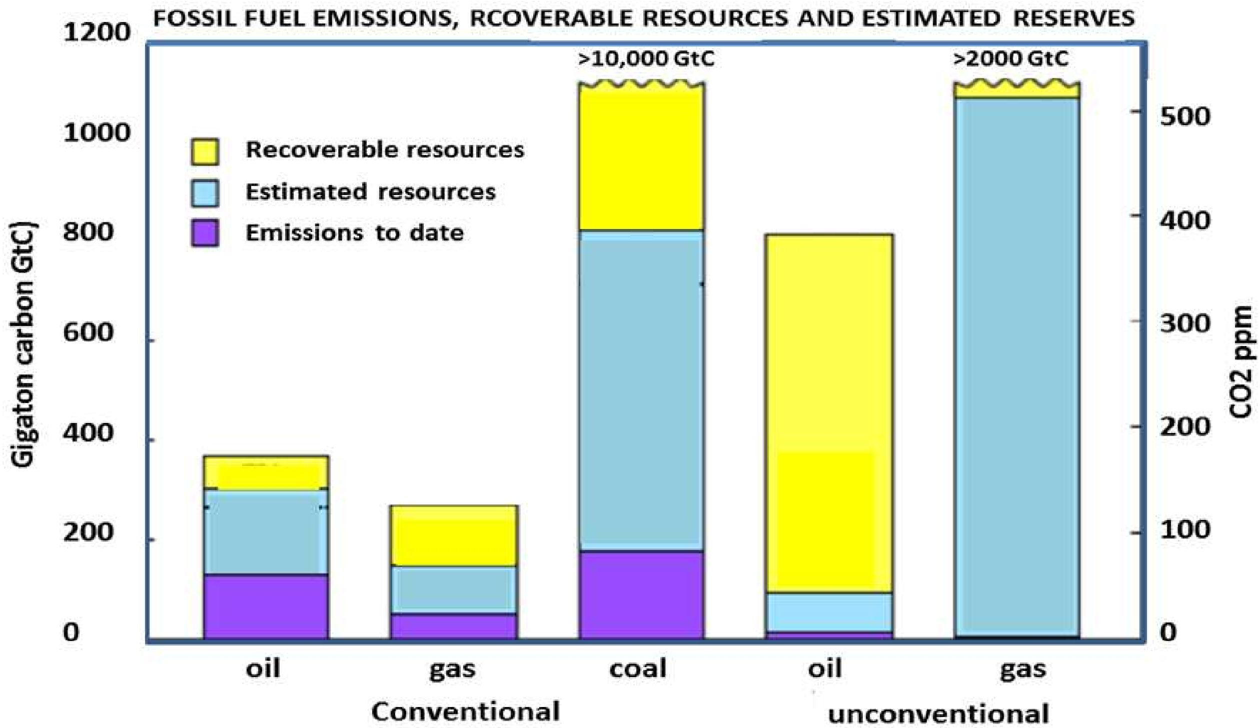


Figure 4. The Paleocene-Eocene Thermal Maximum (PETM) represented by sediments in the Southern Ocean, central Pacific and South Atlantic oceans. The data indicate (a) deposition of an organic matter-rich layer consequent on extinction of marine organisms; (b) lowering of δ18O values representing an increase in temperature and (c) a sharp decline in carbonate contents of sediments representing a decrease in pH and increase in acidity (Zachos et al., 2008) [6]



CO2 emissions by fossil fuels (1 ppm CO2 ~ 2.12 GtC).
Estimated reserves and potentially recoverable resources are from EIA (9) and GAC (10).
http://www.columbia.edu/~jeh1/mailings/2012/20120330_SlovenianPresident.pdf

Figure 5. CO_2 emissions from fossil fuels (2.12 GtC ~ 1 ppm CO_2). Estimated reserves and potentially recoverable resources

[1] http://www.amazon.com/Under-Green-Sky-Warming-Extinctions/dp/0061137928

[2] http://www.tandfonline.com/doi/full/10.1080/08120090500170393

[3] http://books.google.com.au/books/about/Mass_Extinctions_and_Their_Aftermath.html?id=06yrErJt_NsC&redir_esc=y

[4] http://adsabs.harvard.edu/abs/2005E%26PSL.236..933G

[5] http://researchmatters.noaa.gov/news/Pages/arcticCO2.aspx

[6] www.ldeo.columbia.edu/~peter/site/Seminar_files/Zachos.2001.pdf
http://www.nature.com/nature/journal/v451/n7176/full/nature06588.html

[7] http://specialpapers.gsapubs.org/content/452/169.abstract
http://scholar.google.com.au/scholar?q=Climate+threshold+at+the+Eocene-Oligocene+transition:&hl=en&as_sdt=0&as_vis=1&oi=scholart&sa=X&ei=bblDUc3SMYKhmQXm5oCQAg&ved=0CCsQgQMwAA

[8] www.columbia.edu/~jeh1/.../2012/20120330_SlovenianPresident.pdf

[9] www.pnas.org/content/early/2012/07/30/1205276109.full.pdf+html

[10] http://www.aph.gov.au/Parliamentary_Business/Committees/Senate_Committees?url=ec_ctte/extreme_weather/index.htm

[11] http://www.pnas.org/content/105/6/1786.abstract

[12] http://en.wikipedia.org/wiki/Crimes_against_humanity

[13] http://www2.ohchr.org/english/law/ccpr.htm,
http://www.austlii.edu.au/au/legis/cth/consol_act/coaca430/s119.html