The deep-time blueprints and consequences of the Anthropocene

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Of all the factors which allow life on Earth one stands out—the presence of liquid water, permitted by the planet's unique orbital position around the sun, its active tectonic and volcanic nature and its evolving atmospheric composition, regulating surface temperatures in the range of about -90 to 58^{o} Celsius. The atmosphere, mediating the carbon, oxygen and nitrogen cycles, acts as lungs of the biosphere, allowing the existence of an aqueous medium where metabolic microbiological processes occur—from chemo-bacteria around volcanic fumaroles, to nanobes in deep crustal fractures, to near-surface phototrophs. The histories of the atmosphere and of life are thus interdependent.

From an initial Venus-like atmosphere dominated by CO_2, CO, SO_2, N2O, CH_4, H_2 and likely H_2S, the sequestration of CO2 and the build-up of nitrogen—a stable non-reactive gas—have led to intermittent ice ages from at least as early as ~3.0 Ga. Detailed investigations of the carbon, oxygen and sulphur cycles using a range of proxies, including leaf pore stomata, isotopic indices (d13C, d34S, and 87/86Sr), as well as geochemical mass balance modeling, provide detailed evidence of major trends as well as distinct events in the atmosphere-ocean-land system during the Palaeozoic and Mesozoic eras (542–65 Ma), including greenhouse Earth periods (CO2 ~2,000–5,000 ppm) and glacial phases (CO2 <500 ppm), with implications for biological evolution.

Early conflicts between uniformitarian and gradual theories of evolution (James Hutton: 1726–1797; Charles Lyell: 1797–1875) and catastrophic theory (Cuvier: 1769–1832) have been progressively resolved by advanced paleontological, sedimentary, volcanic and asteroid impact studies and by paleo-climate studies coupled with precise isotopic age determinations, indicating periods of gradual evolution were interrupted by abrupt events which have transformed the habitat of plants and organisms and resulted in mass extinction of species.

The phenomenon of a biological species perpetrating a mass extinction of species through the fastest-rate climate change known, at least during the last 65 million years, cannot be reconciled with established principles Darwinian evolution. While the great late dinosaurs, having survived for nearly 200 million years, vanished unaware through an asteroid strike that raised global temperature by 7.5 degrees C [1] (Figure 1), Homo sapiens over only a couple of centuries raised mean global temperature by near to 2 degrees C and is proceeding toward 4 degrees C (Figure 2), despite warnings by its own scientists [2, 3].

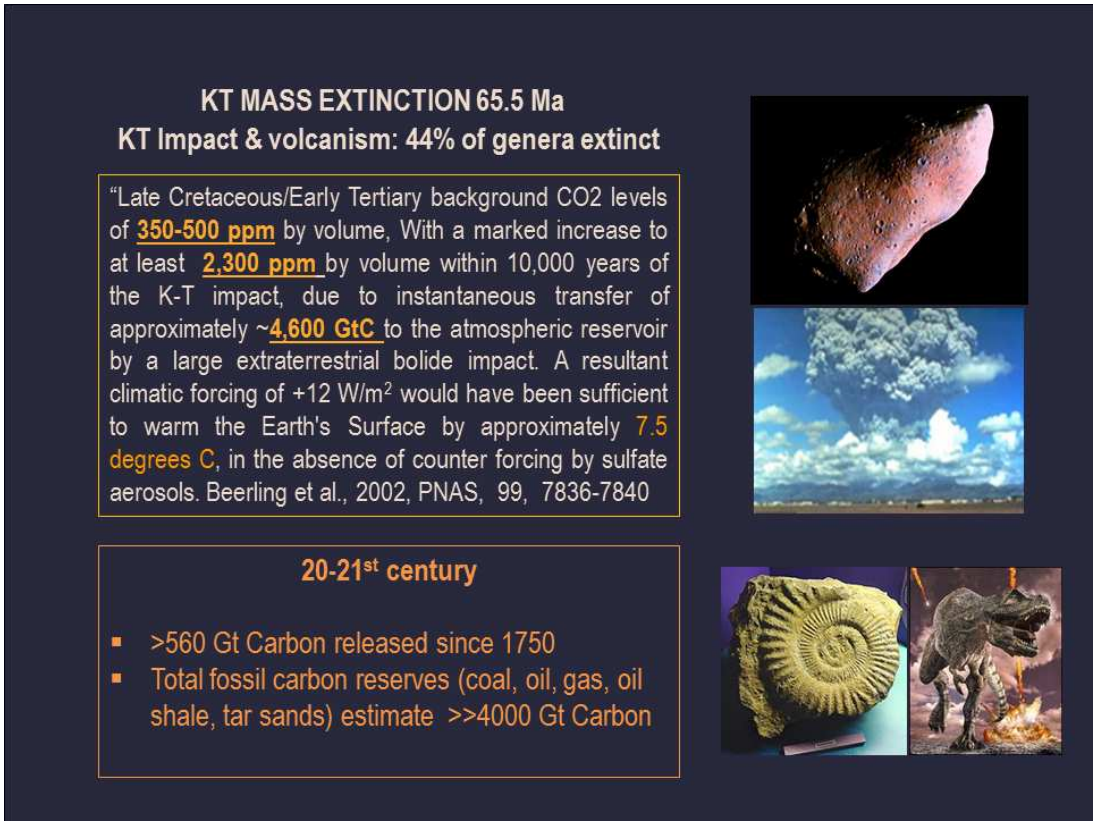

Figure 1 – The K-T (65 million years ago) extinction event

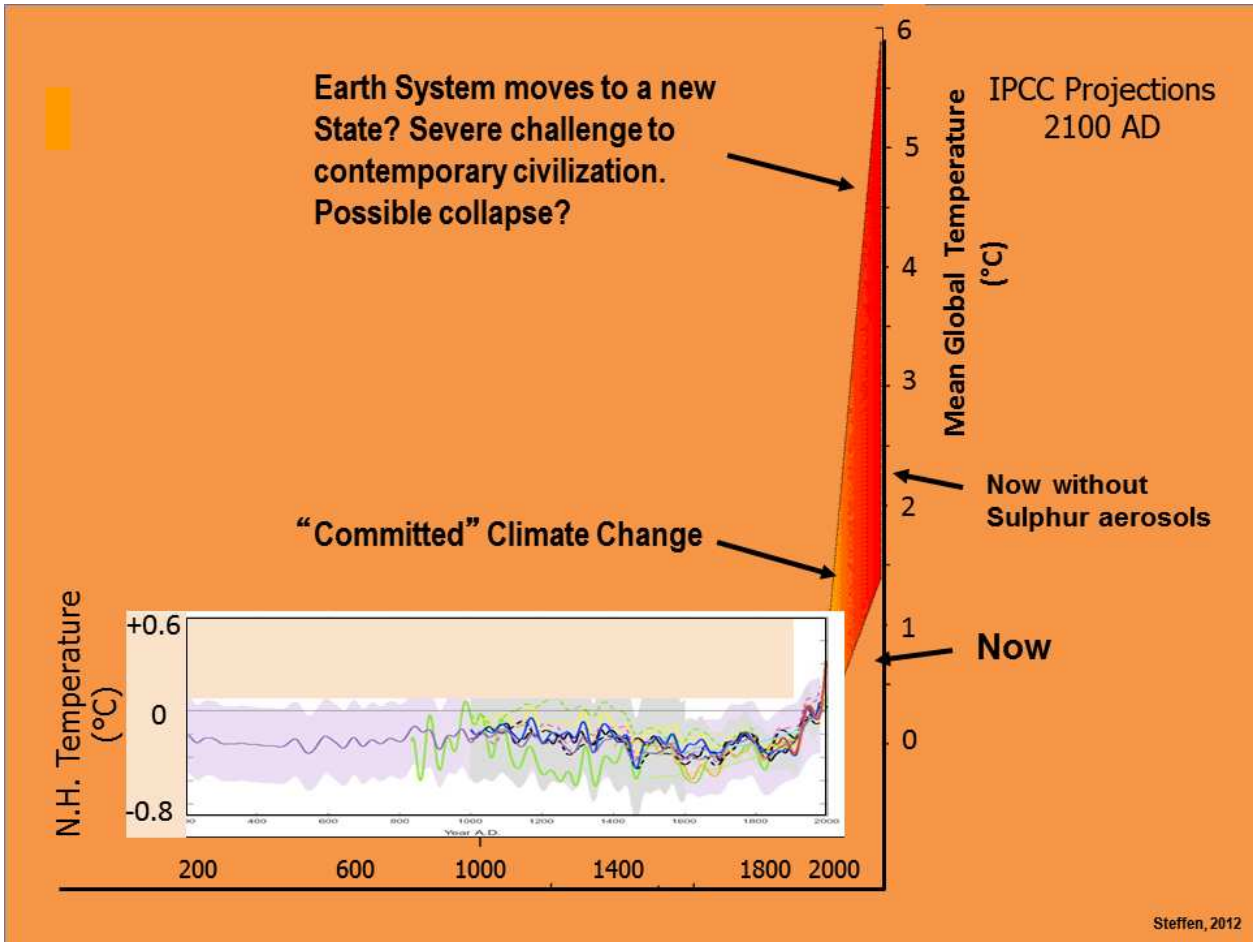

Figure 2. Climate shift induced by the Anthropocene

A lethal combination of vested interests, pseudoscience misrepresentations, ideological fundamentalism, Orwellian newspeak, political cowardice and simple denial is preventing the fast-track application of science and technology for development world-wide of non-polluting energy utilities, aimed at averting a collapse of climate conditions and natural systems which allowed the development of agriculture at the outset of the Neolithic. A growing realization that humans are less than likely to undertake a global effort to arrest runaway warming is leading to an exploration of the root factors underlying the current planetary crisis [4].

The origins and consequences of mass extinctions of species is mostly interpreted in terms of extreme shifts in state of the atmosphere-ocean system related to external forcing such as volcanism, asteroid impacts or massive methane release [5]. A new book "*Evolution of the*

Atmosphere, Fire and the Anthropocene Climate Event Horizon" [6] traces milestones in the development of the atmosphere, oceans and biosphere from about 3.5 billion years-ago, through natural cataclysms, all the way to the Anthropocene—a geological era triggered by a species which has uniquely mastered ignition.

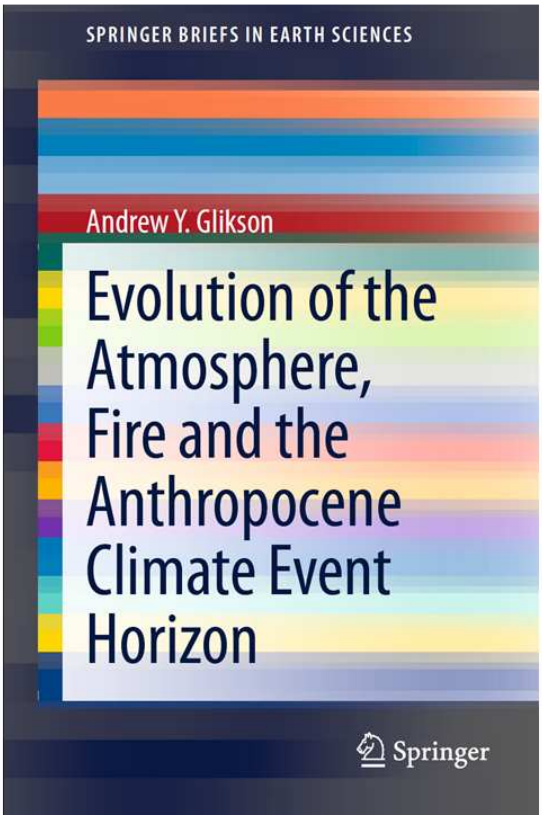

Figure 3. Evolution of the Atmosphere, Fire and the Anthropocene Climate Event Horizon

The advent of plants on land surfaces since about 420 million years-ago created an interface between carbon-rich organic layers and an oxygen-rich atmosphere, flammable Earth surfaces [7] undergoing recurrent fires triggered by lightning, volcanic eruptions, high-temperature combustion of peat and, finally, ignition by humans, constituting the blueprint for the Anthropocene

For a species to control ignition and energy output, leading to increase in entropy in nature by orders of magnitude, constitutes a biological and cultural blueprint which determines its future. Evolved in relatively sheltered sub-tropical rift valleys, unique among all genera the genus Homo learnt how to ignite and transfer fire and through this to modify extensive land surfaces of Earth, with consequences for the composition of the atmosphere, a process culminating in the Anthropocene and in the Sixth mass extinction of species [8].

Hominin evolution in Africa occurred during a transition from tropical to dry climates punctuated by alternating periods of extreme orbital forcing-induced glacial-interglacial cycles, suggesting variability selection of Hominids [9]. Since the Neolithic and throughout history cultivation and agriculture based civilizations concentrated along rivers, or above groundwater reservoirs, depended critically on availability of water, which in turn depended on the climate, including annual river rhythms, the effects of forests on microclimate, soil erosion, and in some parts of the world such as southeast Asia on volcanic regimes.

Nature includes species whose activities are capable of devastating habitats, examples include toxic viruses, methane (CH_4) and hydrogen sulphide (H_2S)-emitting bacteria, fire ant armies, locust swarms and rabbit populations. Host-destroying organisms include species of fungi, worms, arthropods, annelids and vertebrates, cf. oxpeckers and vampire bats. The mastery of fire has enabled the genus Homo to magnify its potential to harness and release energy by orders of magnitude, increasing entropy in nature on a scale unprecedented in the Cenozoic (since 65 Ma). From the mid-20th century, the splitting of the atom allowed humans to trigger a chain reaction potentially devastating much of the biosphere.

Since the onset of the industrial age in the 18th century and accelerating since the mid-1980s, the release of more than 560 billion ton of carbon (GtC) through industrial emission and land clearing has triggered unprecedented developments in the terrestrial climate at a rate faster by an order of magnitude than natural geological warming events. Whereas comparisons can be made with the Paleocene-Eocene Thermal Maximum of ~55 Ma, the scale and rate of modern global warming may compare more closely with those triggered by major volcanic and asteroid impact events. The non-linear nature of current climate change, multiple feedbacks and their synergy are

driving the climate to uncharted territory and possible tipping points. A species able to magnify its entropy effect in nature by orders of magnitude, as the genus Homo has done through mastery of fire and the splitting of the atom, needs to be a perfectly wise and controlled species, lest its invention gets out of hand.

[1] http://press.princeton.edu/titles/8650.html

[2] http://resources.news.com.au/files/2011/05/22/1226060/682675-aus-news-file-climate-change-11-05-22.pdf

[3] http://www.pik-potsdam.de/news/press-releases/archive/2012/4-degrees-briefing-for-the-world-bank-the-risks-of-a-future-without-climate-policy

[4] http://en.wikipedia.org/wiki/Six_Degrees:_Our_Future_on_a_Hotter_Planet; http://www.amazon.com/The-Flooded-Earth-Future-Without/dp/B004NSVFOA/ref=pd_bxgy_b_img_y ; http://www.bookdepository.com/book/9781598743340?redirected=true&gclid=COjesc7Qz7oCFcJopAod8XEA9g

[5] http://www.amazon.com/Under-Green-Sky-Warming-Extinctions/dp/0061137928 ; https://theconversation.com/another-link-between-co2-and-mass-extinctions-of-species-12906 ; http://planet.uwc.ac.za/nisl/Biodiversity/Temporary%20Transfers/Biodiversity/Chapters/Info%20to%20use/Chapter%205/GliksonAsteroid.pdf ; http://www.nature.com/nature/journal/v451/n7176/full/nature06588.html

[6] http://www.springer.com/earth+sciences+and+geography/earth+system+sciences/book/978-94-007-7331-8

[7] http://www.sciencemag.org/content/324/5926/481.abstract

[8] http://www.actionbioscience.org/newfrontiers/eldredge2.html

[9] http://www.amazon.com/Dawn-Human-Culture-Richard-Klein/dp/0471252522