Evolution of the atmosphere/ocean system with implications for climate change

Andrew Glikson

Climate Change Institute, A.N.U
IPCC Reviewer and Honorary Professor, Geothermal Energy Center of Excellence, University of Queensland

The evolution of terrestrial climates depends critically on insolation, orbital forcing, atmospheric greenhouse gas levels (CO₂, CH₄, O₃, N₂O) and ocean-continent and orographic patterns, in turn controlled by tectonic history, as well as on abrupt events which include volcanism, methane eruption and extraterrestrial asteroid and comet impacts. Four of the large mass extinction events in the history of Earth (end-Devonian [~359 Ma], Permian-Triassic [252 Ma], end-Triassic [201 Ma], K-T boundary [65 Ma]) have been associated with rapid perturbations of the atmosphere, including aerosol levels and the carbon, oxygen and sulphur cycles, on which the biosphere depends, at rates to which many species could not adapt. The release to date of over 560 billion tons of carbon, through emissions and land clearing, is shifting the Earth's climate abruptly toward warmer Pliocene-like (5.3–2.6 Ma - >2°C above pre-industrial temperatures) and possibly Miocene-like (23.0 - 5.3 Ma - ~4°C above pre-industrial temperatures) conditions. The rise of atmospheric CO₂ at a mean rate of ~0.43 ppm/year since 1750 and a mean rate of ~1.7 ppm/year since 1975-1976, currently ~2 ppm/year, exceeds the fastest rates recorded in Cainozoic history. This has led to a rise in measured mean global temperature of ~0.8-0.9°C and more than twice as high when the transient masking effects of SO₂ aerosol are taken into account. Post-1750 climate change rates (4.3.10⁻¹ ppm CO₂/year; 3 to 9.10⁻³ °C/year) exceed those of peak greenhouse events such as the Paleocene-Eocene Thermal Event (PETM) (1.5.10⁻¹ ppm CO2/year; 5.10-4 °C/year), Oligocene to Pliocene global warming events (~8.10⁻⁵ - ~4.10⁻³ ppm CO₂/year; 2.10⁻⁶ - 4.10⁻⁵ °C/year) and glacial termination GHG rise and warming rates (~9.10⁻³ ppm CO₂/year and ~5.4.10⁻⁴ °C/year). An exception are warming rates during intra-glacial D-O (Dansgaard-Oeschger) cycles (~0.2 ppm CO₂/year; 0.01-0.2°C/year), possibly reflecting an enhanced intensity of orbital forcing effects during periods of low-CO₂ buffering. The increase in ice sheet melting rates, sea level rise rates and the frequency and intensity of extreme weather events around the globe constitute manifestations of GHG and temperature rise since 1750 and in particular since the mid-1980s.

1-2pm, Friday March 22nd in the Rountree Room (356), Building D26, UNSW.

aca.unsw.edu.au