IOP Conference Series: Earth and Environmental Science

Dangerous ocean acidification

IOP Conf. Series: Earth and Environmental Science **6** (2009) 072005 doi:10.1088/1755-1307/6/7/072005

S07.05

Dangerous ocean acidification

Andrew Ridgwell, D Schmidt
University of Bristol, School of Geographical Sciences, Bristol, UK

Drawing on past causal relationships between surface warming and global environmental impacts such as sea-level rise, that are imprinted in the geological record, provides a means of defining what degree of future warming that might reasonably be considered to constitute 'dangerous anthropogenic interference' with climate. The concept of dangerous climate change has proved highly influential, as the CO2 concentration in the atmosphere corresponding to a certain level of surface warming that we might wish to prevent provides a benchmark for CO2 emissions negotiations. However, the emission of fossil fuel CO2 to the atmosphere has important global impacts aside from that occurring via the radiative forcing of climate, as the dissolution of CO2 in seawater creates an acid and lowers pH – 'ocean acidification'. Although laboratory culture experiments have demonstrated impacts on marine organisms of changes in pH, these have been applied virtually instantaneously, thereby negating the possibility of adaptation. In contrast, ocean acidification and pH decline is taking place on the decadal-to-century time-scale of emissions. Laboratory experiments are thus unable to address the organism and ecosystem responses on the relevant time-scales. Without such information, we cannot know in advance at what level of CO2 emissions 'dangerous anthropogenic interference' with ocean geochemistry and marine ecosystems will take place. To address this we must turn to the geological record and specifically, the Paleocene-Eocene Thermal Maximum (PETM) – a well studied global warming transient known to be driven by the release of greenhouse gases. Critically, the biotic response to the ensuing ocean acidification is available and can be interrogated to constrain the likely future responses. Here we present the results of paired Earth system model predictions of marine geochemical changes in response to both past (PETM) and future CO2 release. We find the future rate of surface ocean acidification and environmental pressure on marine calcifiers very likely unprecedented in the past 65 millions years. However, of greater concern is the situation in the deep sea. Because (a) the rates of acidification between past (PETM) and future are comparable, and (b) there was widespread extinction of benthic organisms during the PETM, particular amongst calcifying foraminifera, one must conclude that a similar level of extinction is more likely than not in the future. On this basis we identify a cumulative upper limit to fossil fuel consumption of 1000-2000 PgC and a deep sea acidification of no more than 0.2 pH units to avoid 'dangerous' ocean acidification.