Ocean Acidification - How will ongoing ocean acidification affect marine life?

Scientists use the geologic record to look back into the future, in order to evaluate effects of ocean acidification on whole marine ecosystems during carbon cycle perturbations (Pelejero et al. 2010). Fortuitously, calcification rates vary most immediately by decreased carbonate saturation (Fig. 1), having left a fossil record in the form of limestone and calcareous nanofossil and calcareous nannoplankton (coccolithophores) provide information on the effects of ocean acidification on calcifiers in surface oceans, benthic foraminifera and ostracodes in the deep sea, and corals, calcareous algae, echinoderms, bivalves and gastropods in shelf environments (Kessling and Simpson 2013). In the past we can find clues about future ocean acidification! To look at a world with CO2 levels higher than today (>389 ppm) we need to go back into “Deep Time” (Kump et al. 2009, NRC 2011). During transitions from glacial to interglacial periods over the last 2.6 million years (Ma), atmospheric CO2 levels increased by ~90 ppm over a few thousand years, but from ~175 to ~185 ppm, i.e. well below present levels. Atmospheric CO2 levels may not have been above ~400 ppm for the last 35 Ma, the time since when ice sheets existed on Antarctica. The Deep Time warm worlds were not perfect analogs for the near future, among other reasons because life has evolved since then, but nevertheless may provide useful insights.

The long-term high pCO2 and low pH levels in Deep Time did not result in low carbonate saturation states (SI) of sea water, because on time scales of 10-100,000 years the buffering of CaCO3 in marine sediments balances the cations released by rock weathering on land, and deep-sea carbonate dissolution buffers the ocean. Even in Pliocene (4 Ma) and during smaller “hyperthermals” in the Paleogene (~5-40 Ma) (McIntyre and Wing 2011) all these events resemble our possible future, with OAEs, global warming, ocean acidification and deoxygenation, thus various stresses affecting the biota. Severe extinctions (including reef biota) occurred at the P/Tri and Tertiary boundaries, i.e. before the evolution of ocean buffering. These early geological events are well suited to provide insight in processes following C-release at rates too rapid for buffering. Later acidification episodes were not associated with severe extinction of calcifying organisms, although a few OAEs, during the Paleocene-Eocene Thermal Maximum (PETM), caused a severe and long-term effects on oceanic anoxic biota.

The best approximations of CO2 emissions following C-release at rates too rapid for buffering. These early geological events are well suited to provide insight in processes following C-release at rates too rapid for buffering.