



## **"Days of future passed" - climate change and carbon cycle history (Jean Baptiste Lamarck Medal Lecture)**

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With the beginning of the fossil fuel age in the 19th century mankind has become an important geological agent on a global scale. For the first time in human history action of man has an impact on global biogeochemical cycles. Increasing CO<sub>2</sub> concentrations will result in a perturbation of global carbon cycling coupled with climate change. Investigations of past changes in carbon cycling and in climate will improve our predictions of future climate. Increasing atmospheric CO<sub>2</sub> concentrations will drive climate into a mode of operation, which may resemble climate conditions in the deep geological past. Pliocene climate will give insight into 400ppm world with higher global sea level than today. Doubling of pre-industrial atmospheric CO<sub>2</sub> levels will shift the climate system into a state resembling greenhouse climate in the Early Cenozoic or even in the Cretaceous. Carbon isotope geochemistry serves as tool for tracing the pathway of the carbon cycle through geological time. Globally registered negative C-isotope anomalies in the C-isotope record are interpreted as signatures of rapid addition (10<sup>3</sup> to a few 10<sup>4</sup> years) of CO<sub>2</sub> to the ocean-atmosphere system. Positive C-isotope excursions following negative spikes record the slow post-perturbation recovery of the biosphere at time scales of 10<sup>5</sup> to 10<sup>6</sup> years. Duration of C-cycle perturbations in earth history cannot be directly compared with rapid perturbation characterizing the Anthropocene. However, the investigation of greenhouse pulses in the geological past provides insight into different climate states, it allows to identify tipping points in past climate systems and it offers the opportunity to learn about response reactions of the biosphere to rapid changes in global carbon cycling. Sudden injection of massive amounts of carbon dioxide into the atmosphere is recorded in C-isotope record of the Early Cretaceous. The Aptian carbon cycle perturbation triggered changes in temperature and in global hydrological cycling. Changes in physical and chemical oceanography are reflected in widespread black shale deposition ("Oceanic Anoxic Event 1a"), in carbonate platform drowning and in biocalcification crises. "Days of future passed" (Moody Blues, 1967) reminds us that the past provides essential information needed for decisions to be made in the interest of mankind's future.