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The global carbon cycle and its changes over glacial–interglacial cycles

Carbon is an essential element for life, food and energy. It is also a key component of greenhouse gases and, thus, plays an important role in past and present climatic changes. The concentration of greenhouse gases, mostly CO_2 and CH_4, in the atmosphere is increasing rapidly. This trend will continue in the future and, according to scenarios recently established by the IPCC working group I (Houghton et al., 2001), will even be reinforced at least until the second half of the 21st century. As a result of this change in the radiative forcing of the planet, the global mean surface air temperature has increased by approximately 0.6 °C over the 20th century and is projected to rise by 1.4 to 5.8 °C between 1990 and 2100. Important changes in precipitation and extreme events are also expected. Precipitation will increase globally, but regionally substantial reductions are forecasted in some areas, as in the Mediterranean basin. These climate changes will impact the carbon cycle, including terrestrial vegetation and marine biology, possibly leading to unexpected feedback on the carbon and, hence, greenhouse gas budgets of the atmosphere. Consequently, the reliability of future climate projections heavily depends on our understanding of the carbon cycle and its two-way interaction with the climate system. This understanding is still limited, especially regarding biological subsystems or side processes which have been disregarded up to now, because they are thought to operate at longer timescales. The models currently used for future projections are calibrated on the present-day system and validated at most on the period for which we have instrumental climatic data, mostly the 20th century. This means that we are actually extrapolating climate from two know points (the end of the 19th and 20th centuries) which are very close from each other in the climatic space, especially in regard to the projected future changes. It is urgent that we acquire a four-dimensional understanding of the carbon cycle and climate systems, i.e., both in space and time. The Pleistocene is the most recent period of the Earth's history, where the climate underwent both rapid and longer-term fluctuations comparable in magnitude to the changes forecasted for the future, although the forcing factors were different. The Pleistocene and, more generally, the Quaternary as well as earlier periods of the Earth's history, such as the Pliocene and the Miocene, provide a laboratory for improving our understanding of the coupled carbon cycle–climate system and for testing our models.

This special issue of *Global and Planetary Change* presents a series of papers dealing with the global carbon cycle and its changes over the Quaternary. This publication is organised by the Carbon Commission of the International Union for Quaternary Research (INQUA). The Carbon Commission was created in 1995 at the XV INQUA Congress held in Berlin. Its objective is to gain a better understanding of the global carbon cycle by establishing the carbon budget of its surface components during the Pleistocene and Holocene epochs. It focuses mainly on land reservoirs, such as vegetation, soils, peats, rivers, underground waters, and includes the continental shelf. The aim is to quantify the contribution of these continental reservoirs to the glacial–interglacial changes of ocean and atmosphere carbon budgets. The commission involves a series of working groups dealing with the various reservoirs and/or processes as well as with modelling. This volume results from two symposia organised by the Carbon Commission in 1999 during the European Union of Geosciences 10th meeting (EUG 10) held in

Strasbourg, France, and the XVI INQUA Congress held in Durban, South Africa.

Most papers in the volume deal with the past carbon cycle both in the marine and terrestrial environments. However, a few papers do not analyse past changes, but attempt to describe some specific features of the modern carbon cycle, which are today still poorly known quantitatively, such as karst dissolution, tropical soil carbon, the isotopic budget of methane-producing lake sediments and carbon degassing from the lithosphere. Consistently, with the overall structure of the INQUA Carbon Commission, the papers are organised on a reservoir basis. The volume starts with a **global** study in which the carbon exchange fluxes between the atmosphere, the ocean and the biosphere over the last three glacial–interglacial cycles are reconstructed with a model on the basis of marine isotopic data (Ikeda et al.). It then focuses on specific reservoirs. Two studies relate to the **ocean** including the pelagic environment with an investigation of carbonate preservation in the Nordic Seas during the last five glacial–interglacial cycles (Helmke and Bauch) and the continental shelf with a study of the carbon flux in the South China Sea off Hong Kong (Yim et al.). The next paper by Faure et al. analyses the possibility that **groundwater** discharged to the ocean may have been higher at times of lowered sea level, leading to abundant springs (coastal oasis) on the emerged continental shelf during ice ages. Coastal oases may have affected the glacial carbon budget through the release of groundwater carbon in the ocean and the presence of more abundant vegetation on the emerged shelf. This is followed by an analytical and modelling study of early diagenesis and carbon isotopic composition of a **lake sediment** (Ogrinc et al.). The next study by Bird and Cali presents a revised high resolution oxygen-isotope chronology and discusses its importance for **biomass burning** in Africa. The next two papers relate to **soils**, with a mapping of total carbon in the soils of the Congo (Schwartz and Namri) and the carbon isotopic composition of charcoal and soils of the São Paulo state of Brazil and its implications for paleovegetation (Gouveia et al.). Afterwards, come some analyses of **vegetation** changes from the last glacial maximum (LGM) to the Holocene or the present: H. Behling estimates the increase of carbon storage in South American tropical forest ecosystems during the last deglaciation, while Otto et al. present LGM vegetation reconstructions made with a global vegetation model. The remaining papers deal with **rock/lithospheric** processes. Jones et al. and Munhoven address the question of the importance of rock chemical weathering for the carbon and alkalinity budget of the ocean and the atmospheric CO_2 changes over the glacial–interglacial cycles. Ph. Gombert analyses the role of karst dissolution in the present-day global carbon budget. Finally, Mörner and Etiope provide a literature review of lithospheric carbon degassing estimates and suggest that a significant disequilibrium exists today between CO_2 degassing and silicate weathering.

It is really a success for us that this special issue deals with essentially all components of the carbon cycle and encompasses all timescales relevant to its Quaternary history. It points to the need for a multi-timescales and multi-reservoirs analysis of global changes.

References

Houghton, J.T., Ding, Y., Griggs, D.J., Noguer, M., Van der Linden, P.J., Xiaosu, D. (Eds.), 2001. Climate Change 2001: The Scientific Basis. Contribution of Working Group I to the Third Assessment Report of the Intergovernmental Panel on Climate Change (IPCC). Cambridge Univ. Press, United Kingdom.

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