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Long term variability of the CO_2 cycle (Abstract)

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Analysis of air bubbles trapped in ice cores indicates that the CO_2 concentration was smaller during cold periods than under warm interglacials. Under those long time scales, the atomospheric CO_2 concentration is slave of the ocean chemistry and circulation. We describe first the experimental evidences for changes in the ocean circulation and chemistry during the last 150,000 years, derived from stable isotope and AMS C-14 analysis of deep sea sediment cores. Using a simple ocean box-model, we explore then the impact of the major oceanic changes which occurred during the last glacial maximum on the CO_2 cycle:

−reduced NADW formation,
−enhanced Intermediate North Atlantic wate formation,
−enhanced flux of Antarctic Bottom Water,
−enhanced productivity of the ocean, including the Southern Ocean,
−changes in the $CaCO_3$ vs Organic Matter ratio in the new production.

Model simulations show that the observed atmospheric CO_2 concentration variations during glacial conditions cannot be explained only by these mechanisms if the modern oceanic production, which is used as a reference, is correctly estimated. Beyond a reevaluation of the modern oceanic productivity, additional mechanisms should be investigated, such as variations of the Redfield ratio or a better utilization of the oceanic nutrients under glacial conditions.

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