

GREENHOUSE GAS (CO₂, CH₄) AND CLIMATE EVOLUTION SINCE 650KYRS DEDUCED FROM ANTARCTIC ICE CORES

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ABSTRACT

Ice cores are unique archives of past climatic and atmospheric conditions through the isotopic composition of the ice and the analysis of the air bubbles trapped. In 1999 Petit et al published the reconstruction of the Antarctic climate and atmospheric composition over the last 420 000 years from the Vostok ice core. This record covered the last four glacial inter glacial cycles back to the end of the marine interstadial 11 (MIS 11). It has revealed the close relationship between the atmospheric part of the carbon cycle and the climate. With CO₂ concentration oscillating between 180 and 280 ppmv during the last 4 climatic cycles. In a similar way the methane concentration followed closely temperature on glacial interglacial time scales, with millennial-scale structures during glacial times which appear out of phase with Antarctic temperature but, at least for the last glaciation, in phase with the Greenland rapid climatic oscillations, as revealed by the GISP and GRIP ice cores.

The recent Antarctic ice core recovered at Dome Concordia in the frame of the European program of EPICA has allowed to extend the climatic and atmospheric records back to 650 Kyr. CO₂ and CH₄ concentration have been measured mainly between 420 Kyr BP and 650 Kyr BP in order to extend the Vostok record. Compared to the last four glacial-interglacial cycles, the period between 420 ky and 650 ky is characterized by cooler but longer lasting interglacials and the new gas measurements show that the close correlation between deuterium and CO₂ or CH₄ persist unchanged during this period.

The partial pressure of the atmospheric carbon dioxide lies within the range of 260 ppmv during the interglacials instead of 280 ppmv and 190 ppmv during the glacial periods. The lowest value of the new record is found during MIS 16, one of the coldest glacials of the last 650 ky as seen in the marine-sediment records. However, in the Dome C ice core deuterium values are not exceptionally low for glacial conditions during MIS 16. Rapid CH₄ variations are also present the glacial periods, in particular during MIS 12. A clear 20-kyr periodicity is observed in the signal, notably imprinted during the warmer stage 13.

Finally the new Dome C-Vostok atmospheric CO₂-CH₄ record allows to test the greenhouse forcing during the different interglacials. In particular the Stage 11 is covered by the two cores and it can be compared to the Holocene. The record indicates that throughout the interglacial period values for carbon dioxide were close to the Earth's pre-industrial levels and that both sunlight and carbon dioxide may have helped to make MIS 11 exceptionally long.