Geophysical Research Abstracts, Vol. 8, 06414, 2006
SRef-ID: 1607-7962/gra/EGU06-A-06414

Glacial/interglacial changes in Southern Ocean biological productivity regimes and their relation to Antarctic ice core climate records

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Atmospheric CO_2 concentrations exhibit a repetitive pattern of gradual decline (to 180 ppm) and rapid increase (to 280 ppm) over the last four climate cycles that is correlated with temperature and dust deposition over Antarctica(Petit et al., 1999; EPICA, 2004; Siegenthaler et al., 2005). The contemporary Antarctic Circumpolar Current (ACC) is a weak CO_2 sink despite high nutrient levels because productivity is limited by iron availability. During glacial periods much greater iron availability should have significantly enhanced productivity and CO_2 drawdown (Martin, 1990). However, there is ongoing debate on the physical and biological mechanisms in the Southern Ocean causing the lowering of the glacial CO_2concentrations (Sigman and Boyle, 2000). Most paleochemical proxies indicate a latitudinal shift in the zone of enhanced glacial primary productivity and intensified CO_2 drawdown but no overall increase in biogenic export (e.g. Anderson et al., 2002; Frank et al., 2000). Other lines of explanation involve physical mechanisms restricting the Southern Ocean/atmosphere gas exchange via surface water stratification (Francois et al., 1997) or sea ice coverage (Stephens and Keeling, 2000). However, the validity of such hypotheses to represent the major or sole mechanism steering the CO_2 draw-down, has been questioned, based on theoretical grounds (Keeling and Visbeck, 2001) and numerical modeling (Maqueda and Rahmsdorf, 2002), respectively. Here we present evidence for last glacial Southern Ocean conditions from biological proxies. We could detect resting spores of the diatom genus *Chaetoceros* as a proxy to indicate iron induced extensive diatom blooms across the entire Atlantic sector of the ACC, particularly in the seasonal sea-ice covered zone (SIZ) during the last glacial (Abelmann et al., 2006). In addition, we used the ecological information of the radiolarian *Cycladophora davisiana* gathered from plankton and surface sediment investigations of the Sea of Okhotsk (Nimmergut and Abelmann, 2002; Abelmann and Nimmergut, 2005) to notify high glacial phytodetritus export in this area. The areal and downcore distribution patterns of these primary producer and phytodetritus feeding, deep living protozoans point to the occurrence of a high productive biological regime, dominated by fast growing thin-walled diatoms and non siliceous primary producer (e.g. *Phaeocystis*), which lead to high export of organic matter to the deep ocean. The dominance of the deep living radiolarian *Cyladophora davisiana* in glacial SIZ sediments indicates that organic carbon export to mesopelagic depths was at least ten-fold higher than today. We further show that there is a strong correlation between the occurrence of iron induced high productivity glacial systems in the SIZ and dust accumulation in the ice core record of EPICA Dome C during the last 600 kyrs.

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