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New insights into sea surface temperature and sea ice variability in the Pacific Southern Ocean since the last glacial

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The scarcity of paleoceanographic data from the Pacific Southern Ocean has hampered the understanding of signal propagation across the Southern Ocean and its connection with other ocean basins, the physical and biological impact on the global carbon cycle and atmospheric CO_2 variability, and the effect of West Antarctic Ice Sheet history on Southern Ocean and global ocean circulation. A set of new sediment cores recovered during R/V Polarstern expeditions now allows for comprehensive studies of the Subantarctic and Antarctic Pacific (180°W -110°W) surface ocean physical parameters development since the last glacial. This includes quantitative estimates of sea surface temperature (SST) and sea ice concentration (SIC) derived from diatom-based transfer functions.
Resulting data display a distinct last glacial east-west gradient in summer SST and winter SIC, with strongest surface water cooling and enhanced sea ice extent in the sector north of the Ross Sea. In this sector the last glacial permanent winter sea ice field was extended by ca. 5° in latitude compared to present and its distribution mimics bottom topography. A similar expansion of last glacial winter sea ice was found in the Atlantic sector [1]. Gradual warming starts as early as 25-20 ka BP, which is in accordance with the first retreat of Antarctic ice sheets [2,3]. As recorded in the Atlantic sector [4] and in Antarctic ice cores [5] a distinct warming and sea ice retreat occurs around 18-17 ka and culminates around 15 ka BP. The concomitant enhanced biogenic opal sedimentation is in concert with the post-glacial atmospheric CO_2 increase. The following cooling (ACR) is not well pronounced, especially in the eastern sector, whereas the Antarctic Holocene Optimum is represented in all studied cores, thus represents an overall southern-high latitude warming event. After 3 ka BP we observe a re-establishment of colder surface waters together with an expansion of the winter sea ice field, possibly related to an enhancement of the Ross cold-water gyre. Interestingly, the Holocene records indicate winter sea ice expansion beyond the satellite derived modern sea ice edge.

[1] Gersonde et al. 2005. Quat. Sci. Rev. 24, 869-896; [2] Smith et al. 2011. Quat. Sci. Rev. 30, 488-505; [3] Anderson et al. 2002. Quat. Sci. Rev., 21, 49-70; [4] Bianchi, C. and Gersonde, R., 2004. Earth Plan. Sci. Let. 228, 407-424; [5] EPICA community members, 2004. Nature 429, 623-628.