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Paleoceanography of marine isotope stage 31 (ca. 1.07 Ma) in the Labrador Sea based on palynological, microfaunal and isotopic data

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We have documented the paleoceanography of marine isotope stage (MIS) 31 (ca. 1.07 Ma) at IODP Site 1305 off southwest Greenland in the Labrador Sea, based on dinocyst and foraminifer populations in addition to isotopic measurements in planktonic foraminiferal shells. The planktonic foraminifer assemblages are dominated by the mesopelagic species *Neogloboquadrina pachyderma* sinistral (Nps). Current interpretations of Nps dominance would thus point to a polar type environment. However, dinocyst assemblages are dominated by *Operculodinium centrocarpum*, *Nematosphaeropsis labyrinthus* and *Bitectatodinium tepikiense,* which rather indicate temperate-subpolar environnement conditions in the photic zone. Assuming that Nps ecological requirements were unchanged, reconciling the two observations lead to hypothesize a strong stratification of the surface water layer over a subsurface water mass, with Nps ocupying the pycnocline in between. We tentatively applied the modern analogue technique (MAT) to reconstruct surface water conditions from the dinocyst assemblages. Good analogues are found in the modern dinocyst database (n=1492), notably along the southeast Canadian margins and northwest European margins. They indicate a low salinity in the surface waters (32-34.5), a large seasonal amplitude of temperatures with cool winters (3-6˚C) and mild summer (10-15˚C). Stable isotope measurements in Nps point to δ^{18}O ranging 1.5-2.2‰ throughout most of the interval, thus significantly lower than those measured during the Holocene (>2.2‰ at this very site. Benthic isotopic values (∼3.2‰ are in accordance with the global stack of Lisiecki and Raymo (*Paleoceanography,* 2005). This suggests the presence of relatively warm water intermediate mass in between the bottom and surface water masses. The isotopic, micropaleontological and dinocyst results together show that conditions were unfavorable for convection and intermediate or deep water formation in the Labrador Sea during this interval.