Improved approach for the reconstruction of past sea surface conditions based on dinocyst assemblage

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Dinocyst assemblages have been used to reconstruct hydrographic parameters such as temperature, salinity, sea ice cover and primary productivity. These reconstructions were based on the application of the modern analogue technique (MAT) using reference databases from the North Atlantic, the North Pacific and the Arctic Ocean. The last updated database includes 1492 sites and 64 taxa (see data at the address http://www.geotop.ca). MAT has been shown to provide reliable results, but the accuracy of reconstruction depends on the density of reference points, which is uneven as well in the geographical than in the hydrographical space. In order to circumvent this issue and to improve the reconstructions, we have standardized the distribution of sites in the three-dimension hydrographical space, here defined by summer temperature, salinity and sea ice cover. Using a hybrid method coupling the response surface method and MAT (revised MAT, Waelbroeck and al. Paleoceanography, 1998), we obtained an idealized database which includes virtual samples filling gaps in the hydrographical domain. The new database was developed from 37 or 64 taxa, excluding rare occurrences (i.e. taxa with a maximum percentage less than 15%). This virtual database contained 6000 data points. Validation tests indicate improved error or prediction from ± 1.89 to $\pm 0.85°$C for summer temperature, ± 2.33 to ± 1.10 for summer salinity and ± 1.75 to ± 0.69 month/year for sea ice cover.

The approach was applied to dinocyst data from two cores located in the Labrador Sea: HU-84-030-021 (58° 22.06 'N, 57° 30.42' W, -2853 m; de Vernal and al., J. Quat. Sci. 2001) and Hole 646B (58° 12.559 'N, 48° 22 147° W, -3450 m; Aksu et al., Proceedings of ODP 105, 1989). The reconstructed values were similar to those obtained with standard MAT, with the exception of a few points, which were initially characterized by no analogue situations. Moreover, the uncertainty defined from the maximum and minimum analogue values was reduced. Hence, the approach combining the response surface method and MAT appears suitable for paleoceanographical reconstructions based on dinocyst assemblages with improved error of prediction and better coverage of hydrographical conditions.