Paleo-depths reconstruction of the last 550,000 years based on the transfer function on recent and Quaternary benthic foraminifers of the East Corsica margin

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SUPPLEMENTARY MATERIAL

Complementary precisions about the method of transfer function

The study presented in our paper is based on foraminiferal transfer functions. In the bibliography, various studies using a transfer function and/or Modern analog technique (a type of transfer function used in paleoceanography to reconstruct past ocean properties from the composition of fossil assemblages extracted from deep-sea sediments) can be found. (Kucera, 2015).

For example :

Milker et al., (2011) have used the Weighted Averaging-Partial Least Squares (WA-PLS) regression method for the development of benthic foraminifera-based transfer functions, and the Modern Analog Technique (MAT) to test the robustness of the models.

Morigi et al (2005), have made a paleo-bathymetric reconstruction calculating the weighted mean water depth (MWD).

The peculiarity of our study is that we introduce a transfer function using a singular method that is developed in three phases: (1) calibration of a few number of model parameters compared to the calibration data points, (2) validation of the model on an independent set of data points and hence estimation of the intrinsic uncertainty of the model, (3) application of the model. Indeed, the method is original, but very simple. It is based on (1) a principal Components Analysis (PCA), in order to reduce the dimensions of the data set and to eliminate its redundancy and (2) of application based on the linear method of least squares interpolation. This is the first time that such approach is made on benthic foraminiferal transfer functions with a detailed description of all steps of computation.

Both PCA and least-squares-based interpolation are widely used and known as basic mathematical and statistical tools, in our study we used MatLab generic functions for the computations. We chose the index notation because we think that it is the most concise.

Indeed, in order to facilitate the understanding of the method, all calculating steps allowing one to obtain the function $H_{\mathrm{m},j}$ are detailed in this paper:

$$H_{\mathrm{m},j} = a_{\mathrm{c},0} + \mathbf{Z}_{jk} \cdot a_{c,k}$$

where $H_{\mathrm{m},j}$ is the modelled depth at each site j, $\mathbf{Z}_{jk}$ is the matrix containing the values of the principal components used in the model. Each line j is associated with a site; each column k is associated with an used principal component. Both the scalar $a_{\mathrm{c},0}$ and the vector $a_{\mathrm{c},k}$ are estimated by calibration based on least-squares interpolation.

Based on the assumption that depth may be a factor controlling the distribution of benthic microfauna assemblages (e.g. benthos foraminifera) on the one hand, and that the ecological requirements of recent species are applicable to fossil species, on the other hand, consequently, the recent depths of benthic foraminifers can serve as a model.

A PCA is applied in our study in a non-redundant way. It is classical and is only used in our study to check the capacity of each component to explain the depth.

References

Kucera, M., 2015. Modern Analog Techniques. In: Harff J., Meschede M., Petersen S., Thiede J. (Ed.s). Encyclopedia of Marine Geosciences. Springer, Dordrecht, The Netherlands.

Milker, Y., Schmiedl, G., Betzler, C., 2011. Paleobathymetric history of the Western Mediterranean Sea shelf during the latest glacial period and the Holocene: Quantitative reconstructions based on foraminiferal transfer functions. Palaeogeogr., Palaeoclimatol., Palaeoecol. 307, 324–338.

Morigi, C., Jorissen, F.J., Fraticelli, S., Horton, B.P., Principi, M., Sabbatini, A., Capotondi, L., Curzi, P.V., Negri, A., 2005. Benthic foraminiferal evidence for the formation of the Holocene mud-belt and bathymetrical evolution in the central Adriatic Sea. Mar. Micropaleontol. 57, 25–49.