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Assessing time uncertainty and sediment mixing using three-dimensional high-resolution radiocarbon measurements from a marine boxcore

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Assessing the effects of sediment inhomogeneity on the core stratigraphy and on proxy records is essential to perform reliable climate reconstructions from marine sediments. Inhomogeneities can stem from sediment mixing (e.g., bioturbation) which destroys the temporally layered climatic information stored in proxy carrier. Thus, in addition to the measurement error, the time-uncertainty in radiocarbon-dated sediments must be taken into account for depth-age modelling in order to obtain an unambiguous time scale.

Here, we present a case-study based on a boxcore (OR1-1218-C2-BC) from the South China Sea (2208 m water depth) covering the last 20 kyr. The boxcore was divided into nine sub-cores by a grid of 3 x 3 (each sub-core is 8 x 8 cm with a length of 34 cm), yielding a total surface area of 576 cm^2. This sampling scheme offers the possibility for detailed, three-dimensional analyses on small spatial scales. Radiocarbon measurements were performed in every sub-core for seven depth layers, each with a fraction of 200 crushed and well mixed foraminifera (*Trilobatus sacculifer*, 250 – 350 µm) to study the horizontal sediment heterogeneity. In addition, small sample (5 specimen) replicate radiocarbon measurements from a single sediment sample allow to estimate the age heterogeneity within a 1 cm sediment slice and thus the vertical mixing from bioturbation. The replicate radiocarbon dates suggest a bioturbation depth of around 12 cm; however, the downcore radiocarbon dates show no clear sign of a well-mixed bioturbation layer. Using statistical analysis (e.g., spatial correlation measures and variance analyses), we separate the errors from the radiocarbon measurements, the finite sample size and both the vertical and horizontal heterogeneity. Comparing the radiocarbon dates in the sub-cores indicates a small horizontal heterogeneity compared to the vertical mixing.

The three-dimensional data set allows us to quantify the effect introduced by (post-depositional)

sediment mixing on the age-estimate as well as on the proxy signal and to discuss the effects on low-sedimentation climate records. This will provide a better quantification of uncertainties within proxy time series.