EGU2020-3642
https://doi.org/10.5194/egusphere-egu2020-3642
EGU General Assembly 2020

Can Radiocarbon Records lead to Quantitative Estimates of Deep-Ocean Ventilation Rates with Error Estimates in the Geologic Past?

Olivier Marchal[1], Ning Zhao[2], and Faith Duffy[1]
[1]Woods Hole Oceanographic Institution, Geology and Geophysics, Woods Hole, United States of America (omarchal@whoi.edu)
[2]Max Planck Institute for Chemistry, University of Mainz, Germany

Over the past two decades, an impressive amount of radiocarbon age measurements on samples of fossil benthic foraminifera and deep-sea corals have been published in the literature. These measurements are commonly used to draw inferences about changes in the ventilation of deep oceanic basins during the last deglacial period. Lacking in most previous studies, however, are quantitative estimates of deep-ocean paleo-ventilation rates and quantitative estimates of their errors, leading to potential over-interpretation and sterile debate. Moreover, most previous studies were concerned with the interpretation of individual records with low or no regard for other records available for the same time interval.

Here we present an effort to go beyond the qualitative interpretation of single radiocarbon records by analyzing an updated compilation of ^{14}C age data using recursive least-squares (RLS) methods (a Kalman filter and a related smoother). In stark contrast with other methods of data analysis, RLS methods can provide an estimate of the history of the state of the physical system of interest and an estimate of the error in this history, which are consistent (in the least-squares sense) with times series of data and with a dynamical model, given estimates of the statistics of the errors in the data and in the model. Our current compilation includes 1,698 deep water ^{14}C age data for the past 40 kyr based on fossil samples of benthic foraminifera, deep□sea corals, deep□dwelling planktonic foraminifera, bivalves, and spiral shells. The geographic distribution of the samples is very irregular, with most of them originating from near the margins and with large regions devoid of any data. The depths of the samples vary from about 250 m to about 5,000 m. In our study, the potential of RLS methods to estimate the history of deep-ocean ventilation rates and their errors from deep water ^{14}C age data is explored for a number of abyssal layers in the Atlantic Ocean during the deglacial interval from 20 to 10 kyr BP. The approach used to apply the powerful but computationally expensive RLS methods to the analysis of geologic time series is described, the least-squares estimates of ventilation rate history in different layers are reported, and their significance in the light of their error estimates is discussed.