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Transient nature of the Earth's climate and the implications on the interpretation of benthic δ^{18}O records

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From the marine benthic δ^{18}O records it is known that the Earth's climate has experienced significant variability over the past 40 Million years. In general, a number of assumptions are often needed to disentangle the benthic δ^{18}O data into its temperature and ice-volume contributions. In this study, a transient (1-D ice-sheet) model is used which overcomes these shortcomings by relating temperature to the benthic δ^{18}O data, leading to a self-consistent and continuous record of δ^{18}O, temperature and sea level. The contribution of land ice to benthic δ^{18}O is examined with a set of sensitivity experiments, varying the mean δ^{18}O of the ice for different ice sheets. It is shown that the scaling factor of sea-water δ^{18}O (δ_w) to sea level is not constant over the long time scales. Although, our sensitivity experiments do show that over the long time scale, the general assumed 1.0-1.1 ‰ per 100 meters of sea level is in reasonable agreement with our model results, using a constant value can significantly influence the interpretation of the data record. Moreover, the sea-level (ice volume) response to temperature (ΔS/ΔT) is shown to vary through time, with the largest response found when variations in Antarctic ice volume dominates the sea-level variations during the Oligocene to Early Miocene. Furthermore, this response is quite large compared to the individual response of ice sheets during the Plio-Pleistocene, whereas the combined ΔS/ΔT in this period is comparable to that during the Oligocene. Accordingly, the transient behaviour is very important for the interpretation of data records, with respect to climate sensitivity and climate change during the past 40 Million years.