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Model-based evaluation on oxygen isotopic ratio in seawater by dual proxy approach of coral proxy records

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Relationship between coral records and hydroclimatic information (i.e., precipitation and evaporation) are quantitatively investigated with the historical atmospheric isotope reanalysis dataset in this study.
Oxygen isotopic ratio (d18O) in seawater is inferable from the dual proxy approach with Sr/Ca and d18O of coral skeleton. Even though the d18O in seawater is an important indicator of precipitation, evaporation, and their isotopic ratios in tropical region, the relationship between coral records and hydroclimatic information has not been quantitatively well discussed because there are few observations.
In this study we present a new scheme to calculate d18O in seawater considering the effect of precipitation and evaporation with a one-dimensional budget model forced by the global isotope reanalysis dataset. The variations of d18O by the model calculation are consistently in good agreement with those derived from the coral in inland sea near the eastern coast of Philippine, where there is little river inflow. Moreover we tried to understand the impact of precipitation and evaporation on d18O in seawater and consequently on the signals of the coral. By our model-based evaluation, it is revealed that signals of the coral during dry season significantly correlate with the precipitation anomaly, which is strongly affected by ENSO. It is, therefore, demonstrated that the Sr/Ca ratio and d18O of the coral in the inland sea are indeed useful proxy for estimating the hydroclimatic information of precipitation and evaporation.

We also applied this model-based evaluation scheme to other coral records, but there were large discrepancies between the model calculation and the coral records. This fact suggests that d18O in seawater does not necessarily record the hydroclimatic information at that place. The deviations between the model calculation and the coral records thus arguably imply following two characteristics of a coral record.
1) In an open sea, the effect of inflow from the upper stream of the ocean current can be a considerable factor.
2) In an inland sea with large river inflow, the effect of terrestrial water is not negligible.
These implications strongly suggest that meaning of d18O signal in coral skeleton could be more understood through additional analyses in which lateral water movement by ocean current and/or rivers are taken into account.

Keywords: coral, palaeo-climate reconstruction, water isotope, tropical region, carbonate