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Salinity changes in the Atlantic: Confirmation from proxy records in corals and sclerosponges

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Recent studies have indicated that there has been a significant increase in salinity of the sub-tropical Atlantic over the past 40 years [1]. At the same time there has been freshening of the water in extreme northern and southern latitudes. Such changes may have important implication for changing the amount of North Atlantic Deep Water (NADW) formation and consequent influence on climate. We have used the oxygen isotopic composition of sclerosponges and corals collected from the Bahamas and the Cape Verde Islands to investigate this trend and to extend measurement of salinity to the late portion of the 19th century. The Sr/Ca ratio has been used to remove the influence of changes in temperature over the same time period. These sclerosponge and coral data also show an increase in salinity over the past 40 years [1], but indicate that the salinity increase observed in the instrumental record has not been continuous. Rather the salinity has shown fluctuations around the present day mean since 1890. These fluctuations appear to be correlated with the North Atlantic Oscillation (NAO). While our data show an increase over the same time period as indicated in the literature [1], the magnitude of the increase is greater (1.5 vs. 0.4). There are several explanations for this difference including (i) an incorrect conversion between changes in the oxygen isotopic composition and salinity, (ii) possible contribution of evaporated water in the Bahamas, and (iii) migration or expansion of the salinity maximum located in the sub-tropical Atlantic gyre.

References

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Validity of coral reconstructions of surface-ocean $^{13}C/^{12}C$ and carbonate saturation state

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Recent research suggests that future decreases in the carbonate saturation state of surface seawater associated with the projected build-up of atmospheric CO_2 could cause a global decline in coral reef-building capacity. Whether significant reductions in coral calcification are underway is a matter of considerable debate. Multi-century records of skeletal calcification extracted from massive corals have the potential to reconstruct the progressive effect of anthropogenic changes in carbonate saturation on coral reefs. However, early marine aragonite cements are commonly precipitated from porewaters in the basal portions of massive coral skeletons and, if undetected, could result in apparent non-linear reductions in coral calcification toward the present. To address this issue, we present records of coral skeletal density, extension rate, calcification rate, $\delta^{13}C$, and $\delta^{18}O$ for well preserved and diagenetically altered coral cores spanning ~1830-1994 AD at Ningaloo Reef Marine Park, Western Australia. The record for the pristine coral shows no significant decrease in skeletal density or $\delta^{13}C$ indicative of anthropogenic changes in carbonate saturation state or $\delta^{13}C$ of surface seawater (oceanic Suess effect). In contrast, progressive addition of early marine inorganic aragonite toward the base of the altered coral produces an apparent ~25% decrease in skeletal density toward the present, which misleadingly matches the non-linear 20th century decrease in coral calcification predicted by recent modeling and experimental studies. In addition, the diagenetic aragonite is enriched in ^{13}C, relative to coral aragonite, resulting in a non-linear decrease in $\delta^{13}C$ toward the present that mimics the decrease in $\delta^{13}C$ expected from the oceanic Suess effect. Taken together, these diagenetic changes in skeletal density and $\delta^{13}C$ could be misinterpreted to reflect changes in surface-ocean carbonate saturation state driven by the 20th century build-up of atmospheric CO_2.