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Decadal climate variation recorded in modern global carbonate archives (brachiopods, molluscs)

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The progress of the Earth's warming trend has rapidly accelerated in the last few decades due to the increase in emission of anthropogenic greenhouse gases. The exchange of heat between the atmosphere and seawater has consequently elevated the rate of temperature buildup in the low and high latitude ocean. Records of the variation in seawater temperature in response to local and global changes in climate are preserved within the carbonate structures of marine biogenic archives. Investigating the isotopic composition of the archives' growth increments documents the magnitude of sea surface temperature (SST) change.
A long-term (1956-2012) record of temperature change in sub-tropical seawater was acquired from the giant clam Tridacna maxima collected from the Red Sea in conjunction with published results of the oyster Hyotissa hyotis (Titschack et al., 2010). Variation in polar-subpolar SST was obtained from the brachiopod Magellania venosa recovered from the coastal area of southern Chile, and from the proxy record of Hemithiris psittacea of Hudson Bay (Brand et al., 2014). The former reveals a long-term (1961-2012) time-series of Antarctic-induced oceanographic change in the southern hemisphere, while the latter represents a trend of Hudson Bay seawater SST in the northern hemisphere.
Evaluation of the isotopic compositions confirms the equilibrium incorporation of oxygen isotopes with respect to ambient seawater in brachiopods and some bivalves. A general trend of decreasing δ18O values in the Red Sea molluscs is observed, indicating an increase in tropical seawater temperature of about 0.79ºC since 1988. The δ18O values of the polar-subpolar brachiopods display similar depletion slopes but of larger magnitudes than that of the Red Sea archives. This signifies a rise in seawater temperature of about 1.47ºC in Hudson Bay since 1991, and about 2.08ºC in southern Chile since 1988.
The 2013 IPCC report suggests an increase in SST of +0.094ºC per decade (average of HadISST, COBE-SST, ERSSTv3b, HadSST3) for the last 33 years (1979-2012) for the global ocean. The change in Red Sea SST of +0.79°C for the last 24 years is 3.5 times higher per decade than that the global ocean, which is attributed to its semi-isolated oceanographic setting, locally prevailing aridity, and elevated evaporation. Conversely, the higher rate of change in SSTs recorded by the southern Chile (x9.3/decade) and Hudson Bay (x7.4/decade) brachiopods do not represent local impacts but rather polar atmospheric heat accumulation (e.g., changes in feedback mechanisms).
The rate at which polar temperatures have risen since 1988 represents a fundamental environmental hazard of great societal concern. It impacts not only duration and extent of polar ice cover, ocean stratification, marine ecosystems, seawater level, and coastal erosion, but more importantly the life cycle and livelihood of its inhabitants (animal and human alike).