Effects of climate change on reef communities, carbonate production and sediment systems in the remote Chagos Archipelago

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Abstract:
The complex structural framework and associated sediment production by calcifying organisms on coral reefs provide key geo-ecological functions such as coastal protection and beach nourishment that are especially important for low-lying islands. Since global coral bleaching events have substantial impacts on reef communities, even in areas characterized by minimal local human impacts, reef islands are highly vulnerable to climate change. Thus, with the ongoing degradation of coral reef ecosystems and sea-level rise, a better understanding of reef-derived carbonate production and sediment supply has become increasingly important. To assess climate impacts on benthic communities and how this affects local carbonate and sediment production, we assess variations in the reef and sediment composition along with local carbonate and sediment production states in the remote Chagos Archipelago, central Indian Ocean. This group of atolls is hardly affected by local anthropogenic impacts, but nonetheless exposed to global ocean warming. We further use benthic foraminifera as sensitive bioindicators that allow us to reconstruct past and recent environmental conditions, and estimate their contribution to sediment production. While impacts of the recent global corals bleaching event 2015/2016 have severely reduced coral cover, altered benthic communities and diminished calcium carbonate production on these reefs, all sites were on a trajectory of recovery in 2021. Yet, the extent of recovery varied between atolls and sites. Similarly, the contribution of different carbonate producers to the sediments showed spatial variability between atolls, likely reflecting the ecological transitions in local communities such as increased proportions of the calcifying green algae Halimeda or benthic foraminifera. Long-term shifts linked to climate change impacts were also shown by comparison of recent foraminiferal communities to pre-coral bleaching assemblages, from species common in coral-dominated habitats in samples from 1979 to those indicating more algae-dominated communities. Further climate change-related impacts may progress shifts in benthic communities and related changes in carbonate and sediment production around coral reefs, with important implications for associated ecosystems and islands.