Postindustrial enhancement of aragonite undersaturation in the upper tropical and subtropical Atlantic Ocean: The role of fossil fuel CO2

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ABSTRACT: The dissolution of aragonite particles in the ocean primarily depends on the degree of undersaturation of seawater with respect to that mineral. Most of the upper Atlantic Ocean, particularly north of 308S and at depths of less than 2000 m, is supersaturated with respect to aragonite, whereas much of the deep Atlantic is undersaturated. Here we report, for the first time, shallow layers of aragonite-undersaturated water between 20° S and 15° N in the eastern tropical Atlantic. These layers are centered at 800 m and are surrounded by aragonite-supersaturated water above and below. This feature most likely results from a combination of chemical and biological processes including the uptake of anthropogenic CO_2 and the oxidation of organic matter falling from the highly productive overlying surface water. Reaction with protons resulting from these processes decreases the carbonate ion concentration and consequently the saturation state of the waters with respect to aragonite. The oceanic uptake of anthropogenic CO_2 during the industrial era has caused a significant increase in the size of the undersaturated layers. Future expansion will likely occur laterally to the west and south, where the degree of supersaturation is low compared to waters to the north. This expansion of the undersaturated layers is a prime example of how human activity during the industrial era has altered the upper ocean chemistry by injecting fossil fuel CO_2 into the ocean.