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Ocean Acidification: Past, Present, and Future

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The oceans have absorbed 30-40% of the carbon dioxide emitted by humans over the past two centuries. This equates to nearly 500 billion metric tons of carbon dioxide, equivalent in weight to about 28 inches of water (ca. 70 cm) across the whole State of Texas. As a result, surface ocean pH has already dropped by 0.1 units relative to preindustrial levels and is expected to drop by 0.3 units until year 2100 under business as USual scenarios. This acidification process is expected to have detrimental consequences for a variety of marine organisms. I will give a perspective on ocean chemistry changes in the past and how rates of past acidification events compare to the present rate of ocean acidification caused by humans. Furthermore, I will present future projections of ocean chemistry changes for various CO_2 emission scenarios and discuss changes in parameters relevant to marine organisms such as pH and calcium carbonate saturation state. If alterations of ocean chemistry beyond certain threshold values are to be avoided in the future, specific CO_2 emission targets will be required. I will suggest values for those emission targets based on results from carbon cycle modeling efforts. Precise quantification of the severity and scope of ocean acidification effects on marine life requires extensive research because the range of tolerable pH changes for many marine organisms is not yet known. However, laboratory and mesocosm studies indicate that a decrease of 0.2-0.3 units in seawater pH inhibits or slows calcification in many marine organisms including corals, foraminifera, and some calcareous plankton. Finally, I will discuss possible future implications of ocean acidification for marine organisms. If future increases in seawater acidity will affect calcification in, for instance, coral reef environments such that erosion will outweigh accretion, then loss of structural stability of reefs could be the consequence with further negative implications for reef communities as well as shore protection. Reduced calcification in shellfish such as oysters and mussels could impact worldwide commercial aquaculture production, including potential economic losses.