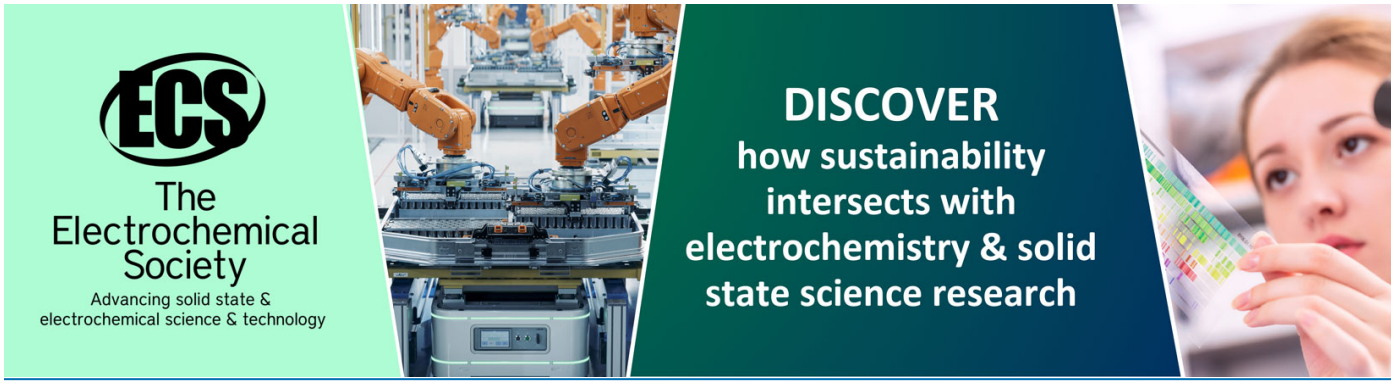
Changes in underwater sound propagation caused by ocean acidification



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Low-frequency sound (up to ~10 kHz), which is produced both by natural phenomena (e.g. rain, wind, waves or sea ice) and by human activities (e.g. use of sonar systems, shipping, and construction) can travel over thousands of kilometers in the ocean. This property is extensively used for human technical applications, as well as by marine mammals for social interactions. Sound attenuation in the low-frequency range is primarily due to boric acid relaxation and is a function of the seawater pH. As anthropogenic carbon dioxide (CO2) invades the ocean, the seawater becomes less alkaline and its pH decreases, a process termed ocean acidification. Surface ocean pH has already fallen by about 0.1 units compared to preindustrial levels as a result of oceanic uptake of anthropogenic CO2. Model studies predict a further decrease in the pH by about 0.6 units in the next 300 years. This changes borate ion speciation, reducing the sound absorption coefficient, and thus making oceans noisier in the audible range. We use a global carbon cycle model HAMOCC to calculate and project changes in seawater sound absorption resulting from ocean acidification during the years 1800-2300. The model is forced with anthropogenic CO2 emissions according to the 'Business as Usual' IPCC scenario A1B, which peak at about 16 GtC/yr in the year 2050 and decline afterwards. Based on model predictions, we aim at quantifying the magnitude and the time scale of changes in the underwater acoustics caused by ocean acidification. Along with the ongoing increase of human activities at sea, decreased sound absorption in the audible range will amplify the ambient noise level in the oceans. Our focus is to determine where in the ocean and at what depth these perturbations will occur. Our model projections of changes in the underwater sound absorption can be used to study the yet unknown implications for marine life, scientific, commercial, and naval applications that are based on ocean acoustics.

