Imminent ocean acidification in the Arctic projected with the NCAR carbon cycle-climate model

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About a quarter of the anthropogenic CO_2 emitted into the atmosphere is currently taken up by the ocean and modifies ocean pH and saturation states of sea water with respect to calcium carbonate minerals. We project future changes in pH and in the saturation state of the mineral aragonite using the NCAR carbon-cycle climate model CSM1.4-carbon and high (SRES A2) and low (B1) CO_2 emission scenarios for the 21st century. The annual mean global surface pH drops from 8.17 to 7.77 by year 2100 in the A2 scenario, with the largest changes found in the Arctic Ocean (-0.45 pH units). Undersaturation with respect to aragonite in the Arctic is imminent and starts already within the next decade for both scenarios. By the time atmospheric CO_2 exceeds 490 ppm (2040 in A2, 2050 in B1), more than half of the Arctic is undersaturated at the surface. By the end of the 21st century and for the A2 case, undersaturation in the Arctic Ocean also occurs with respect to calcite. Climate change is projected to amplify ocean acidification in the Arctic through changes in the freshwater balance and sea ice retreat. Simulations that have been extended to year 2500 and where emissions of carbon and other forcing agents are stopped hypothetically in year 2100 show that ocean acidification from business-as-usual 21^{th} century emissions is irreversible on human time scales, particularly in the Arctic Ocean.