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The fate of added alkalinity in model scenarios of ocean alkalinization

Miriam Ferrer González and Tatiana Ilyina
Max Planck Institute for Meteorology, Hamburg, Germany (miriam.ferrer-gonzalez@mpimet.mpg.de)

The deliberate large-scale manipulation of the Earth's climate (geo-engineering) has been proposed to mitigate climate change and ocean acidification. Whilst the mitigation potential of these technologies could sound promising, they may also pose many environmental risks. Our research aims at exploring the ocean-based carbon dioxide removal method of alkalinity enhancement. Its mitigation potential to reduce atmospheric CO_2 and counteract the consequences of ocean acidification, risks and unintended consequences are studied. In order to tackle these questions, different scenarios are implemented in the state-of-the-art Earth system model of the Max Planck Institute for Meteorology. The model configuration is based on the 5th phase of the coupled model intercomparison project following a high CO_2 future climate change scenario RCP8.5 (in which radiative forcing rises to 8.5 W/m^2 in 2100). Two different scenarios are performed where the alkalinity is artificially added globally uniformly in the upper ocean. In the first scenario, alkalinity is increased as a pulse by doubling natural values of the first 12 meters. In the second scenario we add alkalinity into the same ocean layer such that the atmospheric CO_2 concentration is reduced from RCP8.5 to RCP4.5 levels (with the radiative forcing of 4.5 W/m^2 in 2100). We investigate the fate of the added alkalinity in these two scenarios and compare the differences in alkalinity budgets. In order to increase oceanic CO_2 uptake from the atmosphere, enhanced alkalinity has to stay in the upper ocean. Once the alkalinity is added, it will become part of the biogeochemical cycles and it will be distributed with the ocean currents. Therefore, we are particularly interested in the residence time of the added alkalinity at the surface. Variations in CO_2 partial pressure, seawater pH and saturation state of carbonate minerals produced in the implemented scenarios will be presented. Collateral changes in ocean biogeochemistry and climate will be also discussed.