1 | SCIENTIFIC FEASIBILITY OF CLIMATE ENGINEERING IDEAS

The role of iron during the open ocean dissolution of olivine in a simulated CO_2 removal experiment

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One CO_2 removal mechanism proposed as geoengineering approach is enhanced silicate weathering. We here follow up on previous simulation experiments on the open ocean dissolution of olivine, a well-distributed magnesium-iron-silicate and focus on the role of iron. Olivine is known to contain a magnesium:iron ratio of ~9:1. Iron is a micronutrient and in various areas of the ocean marine biology is iron-limited. It is thus expected that olivine dissolution as a large-scale geoengineering application for CO_2 removal would increase the iron input into the ocean with implications for marine biology. With the numerical simulation of the marine ecosystem and biogeochemistry model RECOM-2 embedded in the ocean general circulation model MITgcm the potential changes in the marine biological productivity via associated iron fertilization were analysed. Since it is not clear how much of the iron contained in olivine will be lost by colloid formation and aggregation before becoming biologically available we show in sensitivity experiments that already the availability of 0.1% of the iron enhances the oceanic carbon uptake connected with the olivine dissolution by 20% compared to similar experiments in which the effect of iron is neglected. Results saturate at an increase in marine carbon uptake rate of 35% if 1% or more of the dissolved iron would be biologically available. For an addition of 3 Pg/yr of olivine with a 1% solubility the additional biologically available iron in the surface ocean would be 2.4 Tg/yr, which is 10x larger than the dissolved iron input by dust. The effect of such an iron fertilization would lead in certain areas to species shifts in the phytoplankton communities with diatoms being one of the winners and effects would be largest in the Southern Ocean.