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The geoengineering potential of artificially enhanced silicate weathering of olivine

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Geoengineering is a proposed action to manipulate Earth's climate in order to counteract global warming from anthropogenic greenhouse gas emissions. We investigate in more detail the potential of a specific geoengineering technique, the carbon sequestration by artificially enhanced silicate weathering via the dissolution of olivine. This approach would not only operate against rising temperatures but would also oppose ocean acidification, because it influences the global climate via the carbon cycle. We here show the consequences of this technique for the chemistry of the surface ocean at rates necessary for geoengineering. We calculate that olivine dissolution has the potential to sequestrate up to one Pg C yr^{-1} directly, if olivine is distributed as fine powder over land areas of the humid tropics. The carbon sequestration potential is limited by the saturation concentration of silicic acid. In our calculations for the Amazon and Congo river catchments a maximum annual dissolution of 1.8 and 0.4 Pg of olivine seems possible, corresponding to the sequestration of 0.5 and 0.1 Pg C yr^{-1}. Open water dissolution of fine grained olivine and an enhancement of the biological pump by the rising riverine input of silicic acid might increase our estimate of the carbon sequestration, but additional research is needed here. We finally calculate with a carbon cycle model the consequences of sequestration rates of 1 to 5 Pg C yr^{-1} for the 21^{st} century by this technique. At maximum this technique would reduce global warming by 1 K and counteract ocean acidification by a rise in surface ocean pH by 0.1 in the year 2100.