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Dim waters: side effects of geoengineering using ocean albedo modification

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We use a Monte Carlo radiative transfer code to check how the recently proposed geoengineering by injection of clean or coated microbubbles into the ocean mixed layer would impact in-water light fields. We show that due to massive multiscattering inside a bubble cloud, coating the bubbles with surfactant, needed to stabilize them, would not increase their albedo change effectiveness as much as expected basing on their backscattering coefficients. However, the bubble effect on reflectance is larger than estimated previously using a discrete ordinate method of solving the radiative transfer problem. We show significant side effects of ocean albedo change needed to counter global warming expected in this century and beyond (reduction of euphotic zone depth by respectively 20% and 50% in the case of global ocean albedo change corresponding to -1.25 K and -6 K global surface temperature change and irradiance decrease at 10 m depth by respectively 40% and over 80%) even if all ocean surface was "brightened". We discuss the possible negative side effect of such in-water light dimming on marine life. We conclude that the proposed “ocean brightening” is in fact “ocean dimming” as concerns the marine environment, on a scale that in any other circumstances would be called catastrophic. Finally, we briefly discuss other possible side effect of making the surface ocean waters turbid (both optically and acoustically), of adding large amounts of surfactants to the surface ocean layers and of surface cooling of the ocean, especially within the tropics.