Simulated impacts and side effects of multi-centennial climate engineering

Andreas Oschlies // GEOMAR Helmholtz Centre for Ocean Research Kiel
David Keller // GEOMAR Helmholtz Centre for Ocean Research Kiel

Whether referred to as a potential emergency operation or prudent precautionary measure, climate engineering would, if ever deployed, almost certainly be carried out for many decades and probably many centuries in order to have a lasting impact on climate. Most modeling studies performed so far focused on simulations covering this century, corresponding to the time scale typically considered by international climate policy and the IPCC. However, stopping potential climate engineering at the end of this century would, in the absence of drastic CO_2 emission cuts, probably not be a safe option for at least some of the currently discussed methods. Longer-term consequences of committed changes and exit strategies have to be accounted for in any comprehensive assessment of climate engineering. Here we report results of simulations with an intermediate complexity Earth system climate model (UVic ESCM), in which we extend climate engineering deployment until the year 3000, for an RCP/ECP 8.5 business-as-usual CO_2 emission scenario with emissions peaking in the year 2100, ramping down to a few GtC/yr by 2250 and to zero emissions by year 3000. The climate engineering schemes tested include a reduction in solar irradiance, ocean alkalinization, ocean iron fertilization, artificial upwelling, and afforestation. We find that their efficiencies, side effects and termination effects exhibit considerable differences on the millennial time scale considered here with respect to earlier studies restricting the analysis to the 21st century.