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Limited-area climate engineering: Climate response outside the target area

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Radiation management (RM) has been recognized as one of the climate engineering (CE) interventions to mitigate the global warming. Here we investigated the feasibility of CE at a local scale in space and time (Limited-area climate engineering, LCE) with the presumption that cloud modification is technically possible and is suitable for local mitigation, using a climate model (MPI-ESM). RM is implemented locally in the climate model by the brightening of low-level clouds (solar radiation management, SRM) and thinning or dissipation of cirrus (terrestrial radiation management, TRM) to a period of 30 years (1850 - 1879). It resulted in a net local radiative forcing of -12.26 Wm−2 and a local cooling of -0.91K, with residual changes in some regions outside the target area. Surface temperature (SAT) extremes (90th and 10th percentile) show negative anomalies in the experimental region, as expected. However, substantial climate impacts are also simulated outside the target area. As a prominent example, the lower percentile of the SAT demonstrates an Arctic warming. This warming is found to be due to an anomalous intrusion of warm mid-latitude air mass to higher latitude by the weakening of westerly due to enhanced local cooling through LCE. Further, pronounced precipitation is also noticeable across the globe, especially in the eastern Pacific, which is associated with the intensity of the local LCE cooling. The dominant extreme cooling episode leads to the equatorial wind convergence and warming in the central Pacific which enhances the convection, thus the precipitation.