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A process study on Climate Engineering by Thinning of Arctic Winter Cirrus Clouds

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Convection-permitting simulations for a limited area of the hibernal Arctic were performed with the atmospheric modeling system ICON-ART.
We aim at clarifying the microphysical processes triggered by introducing artificial aerosol particles into the upper troposphere with the aim of modifying cirrus clouds in the framework of climate engineering.
Former modeling studies investigating the climate effect of this method were performed with simplifying assumptions and much coarser resolution, reaching partly contradicting conclusions concerning the methods effectiveness.
The primary effect of seeding is found to be a strong reduction of ice crystal number concentrations in cirrus clouds, leading to increased outgoing longwave radiative fluxes at the top of the atmosphere, thereby creating a cooling effect.
Furthermore, a secondary effect is found, as ice crystals formed from the injected seeding aerosol particles lead to enhanced riming of cloud droplets within the planetary boundary layer, hence effectively reducing the coverage of mixed-phase clouds, thus generating additional cooling by increased upward longwave radiative fluxes at the surface.
The efficacy of seeding cirrus clouds proves to be relatively independent from the atmospheric background conditions, scales with the seeding aerosol number concentrations and is highest for large aerosol particles.