



Irrigation as a geoengineering tool

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The term geoengineering is commonly used to denominate deliberate, large-scale, technical interventions in the Earth System to counteract the ongoing global warming. Carbon Dioxide Removal (CDR) and Solar Radiation Management (SRM) had been discussed as the two principal categories of possible geoengineering methods. Here we study irrigation as a potential geoengineering tool. It can not only remove CO₂ from the atmosphere (as CDR) by enhancing plant growth or increase the Earth's albedo (as SRM) by increasing cloud/snow cover, but it also redistributes heat from the surface to higher tropospheric levels. Therefore, irrigation is substantially different from CDR/SRM and should be examined as a separate method.

We investigate the potential of irrigation to cool the Earth by means of simulations with the Max-Planck-Institute Earth System Model (MPIESM1.2, the version used for CMIP6) including a coupled atmosphere/ocean general circulation model and an interactive carbon cycle. A simple irrigation scheme is implemented in this model, which takes water from local surface runoff and drainage, stores it in a local irrigation reservoir, and puts it on the surface whenever this is not completely wet and water is still available in the irrigation reservoir. Activation of this scheme on all land area results in a considerable climate change in only a decade: it decreases global 2m temperature by almost 1°C, doubles arctic sea ice volume, and strengthens the Atlantic Meridional Overturning Circulation by about 15%. In particular, the boreal land area is cooled down by about 4°C, indicating a strong climate impact of irrigation at high latitudes, where irrigation is commonly not applied. At the same time global land carbon increases mainly due to a reduction in autotrophic respiration, which decreases atmospheric CO₂ concentration by about 6 ppm.