

Title: Stratospheric geoengineering with black carbon aerosols

Abstract: We use ModelE2, the National Aeronautics and Space Administration's Goddard Institute for Space Studies general circulation model of Earth's climate, to calculate the effects of injecting 1 Tg of black carbon aerosols each year into the middle stratosphere to evaluate its potential as a geoengineering strategy. The aerosol radiative forcing, the effectiveness of geoengineering at cooling the surface, and the magnitude of the side effects, are strongly dependent upon the aerosol size and the altitude of injection. The primary consequence is stratospheric heating, sometimes in excess of 60°C. The heating also lofts the aerosols, allowing them to reach the mesopause. This heating causes destruction of the ozone layer, once case resulting in a 30% globally averaged ozone loss within a decade after implementation. Penetration of ultraviolet radiation to lower altitudes allows for some reformation of the ozone layer in the tropics, but not enough to compensate for the loss. The heating induces a strong Arctic polar vortex, creating an Arctic ozone hole and forcing a positive mode of the Arctic Oscillation. The Antarctic ozone hole shows a slight recovery in the austral spring, despite an increase in winter polar stratospheric clouds. Perturbations to the hydrologic cycle show an increase in soil moisture in many cases, although the reduction in sunlight and the surface cooling would likely have negative consequences for agriculture.

Bio: Ben is a postdoctoral fellow at the Carnegie Institution for Science's Department of Global Ecology in Stanford, California. His main research interests are the atmospheric science aspects of climate change and atmospheric radiative transfer. Specifically, most of his work has involved climate model simulations of aerosol radiative forcing from large volcanic eruptions and geoengineering. He has a bachelor's degree in mathematics from Northwestern University, a masters in mathematics from Purdue University, and a masters and Ph.D. in atmospheric science from Rutgers University.