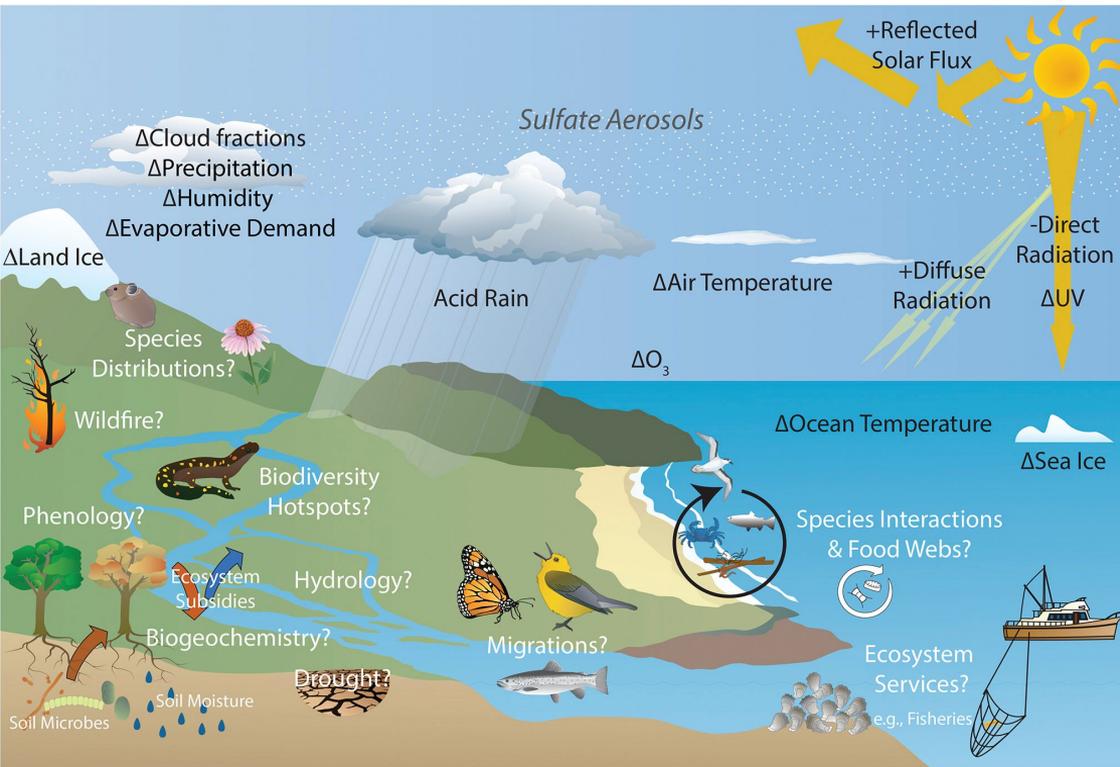


Potential Ecological Impacts of Climate Intervention



- While climate research has focused on predicted **climate effects of SRM**, few studies have investigated **impacts that SRM would have on ecological systems**
- **Impacts and risks posed by SRM would vary** by implementation scenario, anthropogenic climate effects, geographic region, and by ecosystem, community, population, and organism
- A **transdisciplinary approach** is essential, and **new modeling paradigms are required**, to represent complex interactions across Earth system components, scales, and ecological systems

Although some effects of SRM with SAI on climate are known from certain SAI scenarios, the effects of SAI on ecological systems are largely unknown. Adopted from Zarnetske et al. (2021).

Geoengineering Increases the Global Land Carbon Sink

Objective: To examine stratospheric aerosol intervention (SAI) impacts on plant productivity and terrestrial biogeochemistry.

Approach: Analyze and compare simulation results from the Stratospheric Aerosol Geoengineering Large Ensemble (GLENS) project from 2010 to 2097 under RCP8.5 with and without SAI.

Results/Impacts: In this scenario, SAI causes terrestrial ecosystems to store an additional 79 Pg C globally as a result of lower ecosystem respiration and diminished disturbance effects by the end of the 21st century, yielding as much as a 4% reduction in atmospheric CO₂ mole fraction that progressively reduces the SAI effort required to stabilize surface temperature.

Yang, C.-E., F. M. Hoffman, D. M. Ricciuto, S. Tilmes, L. Xia, D. G. MacMartin, B. Kravitz, J. H. Richter, M. Mills, and J. S. Fu (2020), Assessing Terrestrial Biogeochemical Feedbacks in a Strategically Geoengineered Climate, *Environ. Res. Lett.*, doi:[10.1088/1748-9326/abacf7](https://doi.org/10.1088/1748-9326/abacf7).

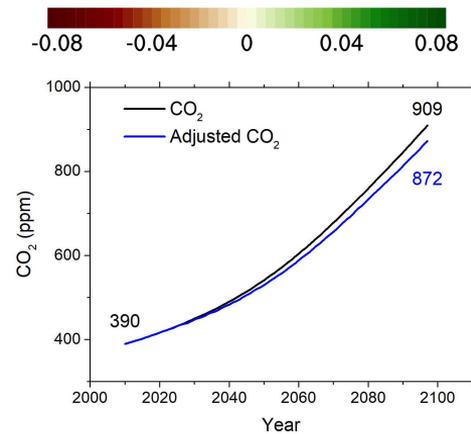
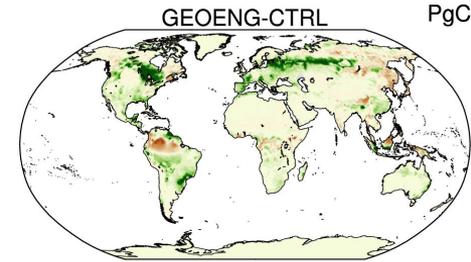


Figure: The larger sink under SAI increased land C storage by 79 Pg C by 2097, which would reduce the projected atmospheric CO₂ level.

Exploring Feedbacks of SAI

- To fill research gaps in understanding Earth system feedbacks of SAI on ecosystems, we are conducting a series of increasingly complex geoengineering simulations with **DOE's Energy Exascale Earth System Model (E3SM)**
- **Simulations will mimic effects of CDR, SAI, and CDR plus SAI**
- Start with SSP5-3.4-OS mid-range overshoot CO₂ trajectory from CMIP6, which prescribes a drawdown of CO₂
- Global surface temperatures will rise by >2.5°C around 2040, **above the 2°C threshold that may induce irreversible impacts**
- Next, introduce SAI to simultaneously cool the surface until drawdown is sufficient to assure <2°C warming, called **temperature "peak shaving"**
- Quantify feedbacks from reducing, not increasing, atmospheric CO₂, **but this may not capture all the as-yet-unobserved processes**

