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Geoengineering or Climate Intervention Research

at NCAR

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CESM Tutorial

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NCAR

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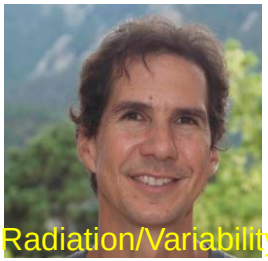

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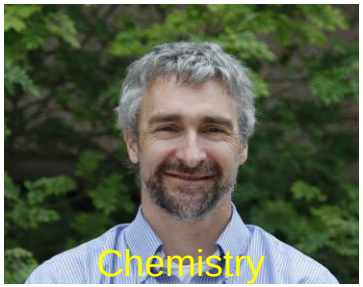

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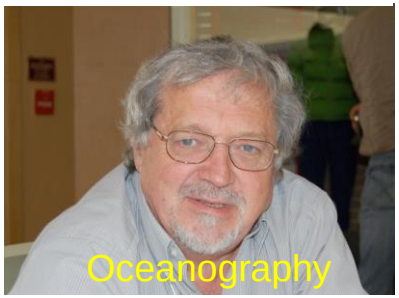

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NCAR
NATIONAL CENTER FOR ATMOSPHERIC RESEARCH

Why Climate Intervention Research?

Climate change:

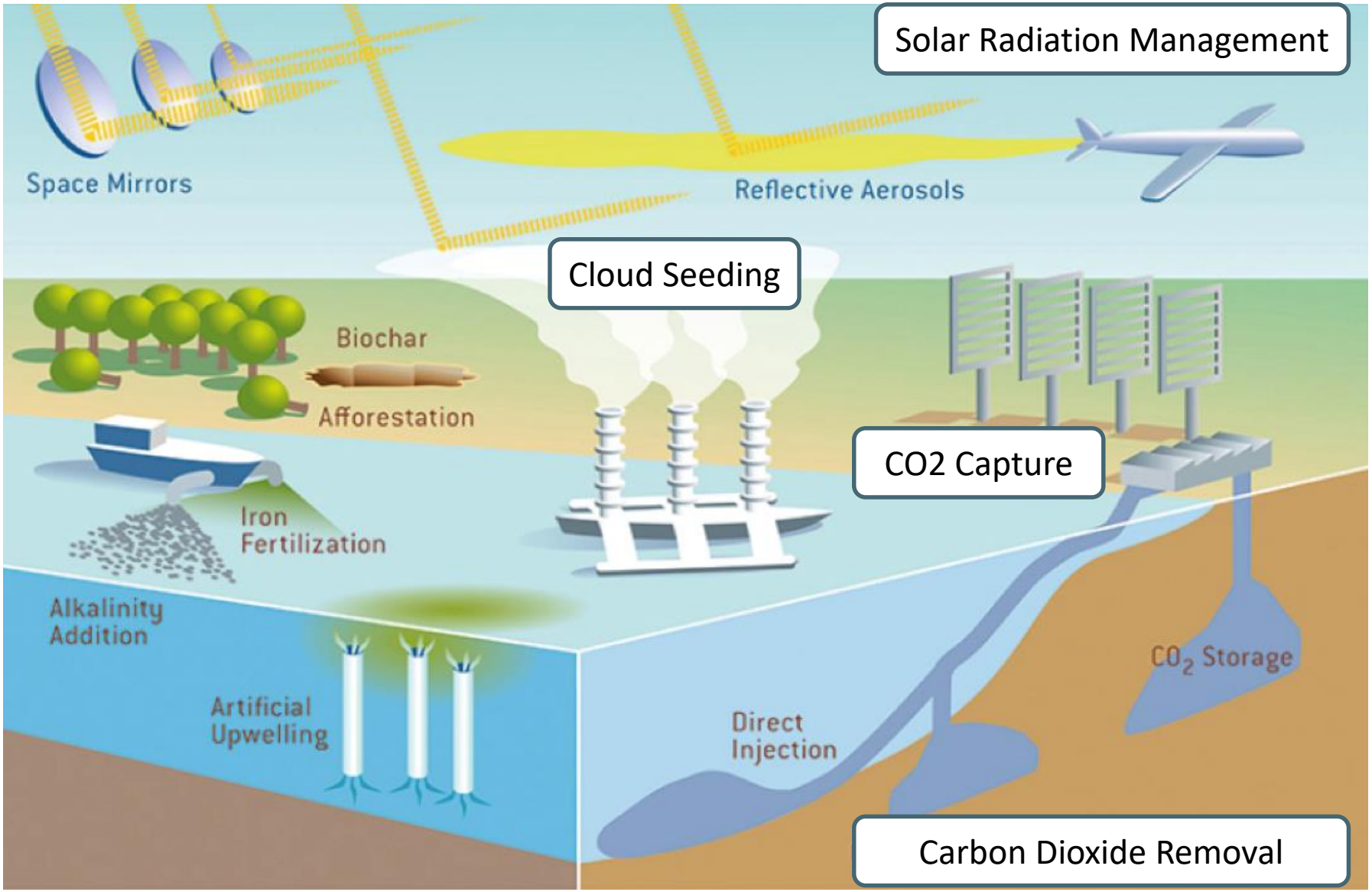
- Now: **300,000** deaths per year - affecting **300 million** people
- 2030: **500,000** deaths per year - **$600 billion** per year economic losses

Climate change intervention strategy:

- Could save millions of lives and avoid billions in economic losses
- Would ideally work together with mitigation

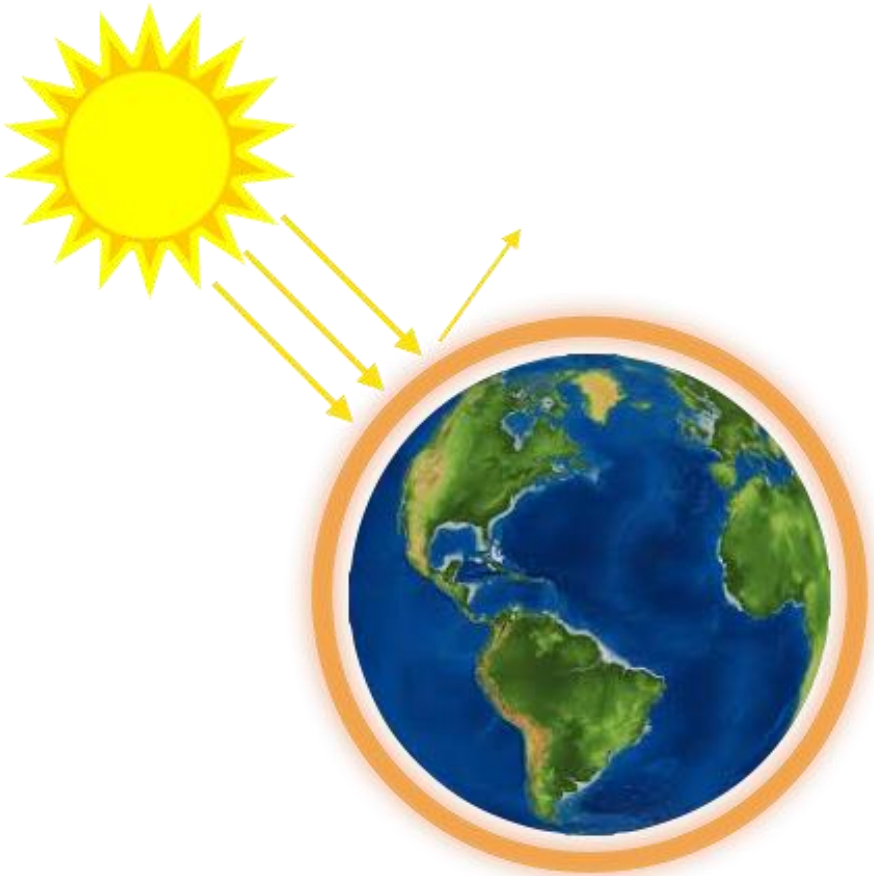


Climate Engineering/Intervention Strategies



Kiel Earth Institute

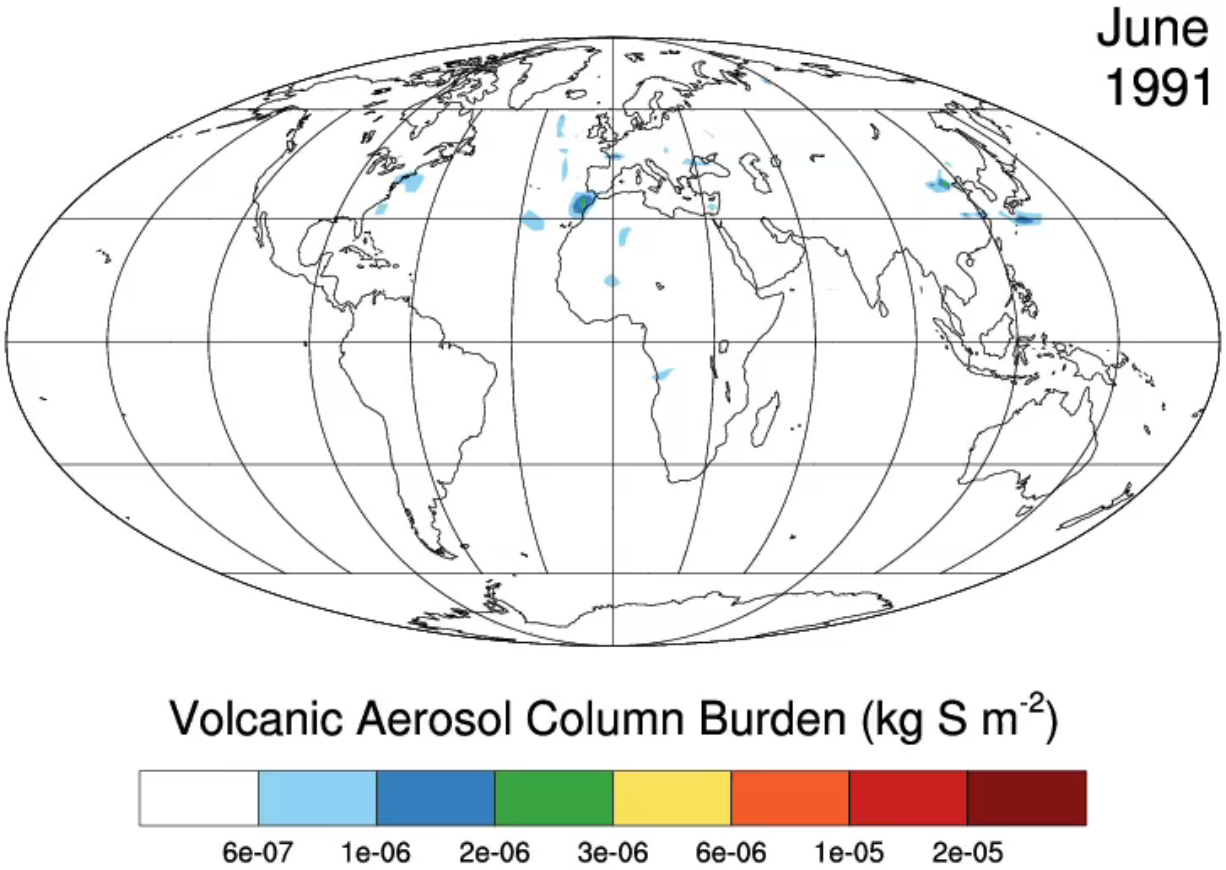
Solar Radiation Management (SRM) via Stratospheric Aerosol Modification



Aims to reduce incoming sunlight in order to counteract anthropogenic climate change

Natural Analog: Volcanoes

Natural SRM: Volcanoes



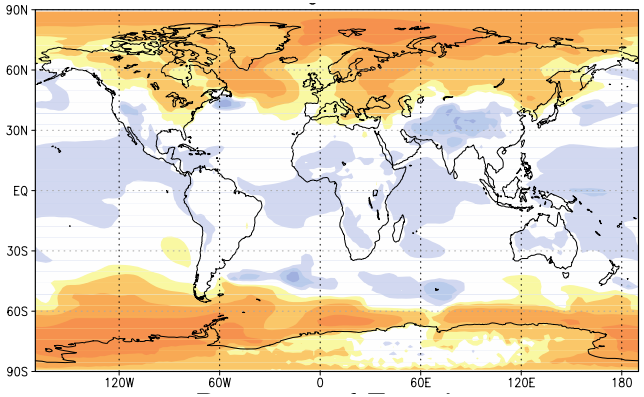
Volcanoes inject sulfur gas into the stratosphere

Resulting aerosols blanket the earth and reflect sunlight back to space

Climate Engineering Approaches

Past Approach:

Stratospheric sulfur injections → Examine impacts & side effects



Demonstrated decrease **global mean surface temperature, but** regional T changes and shifts in precipitation

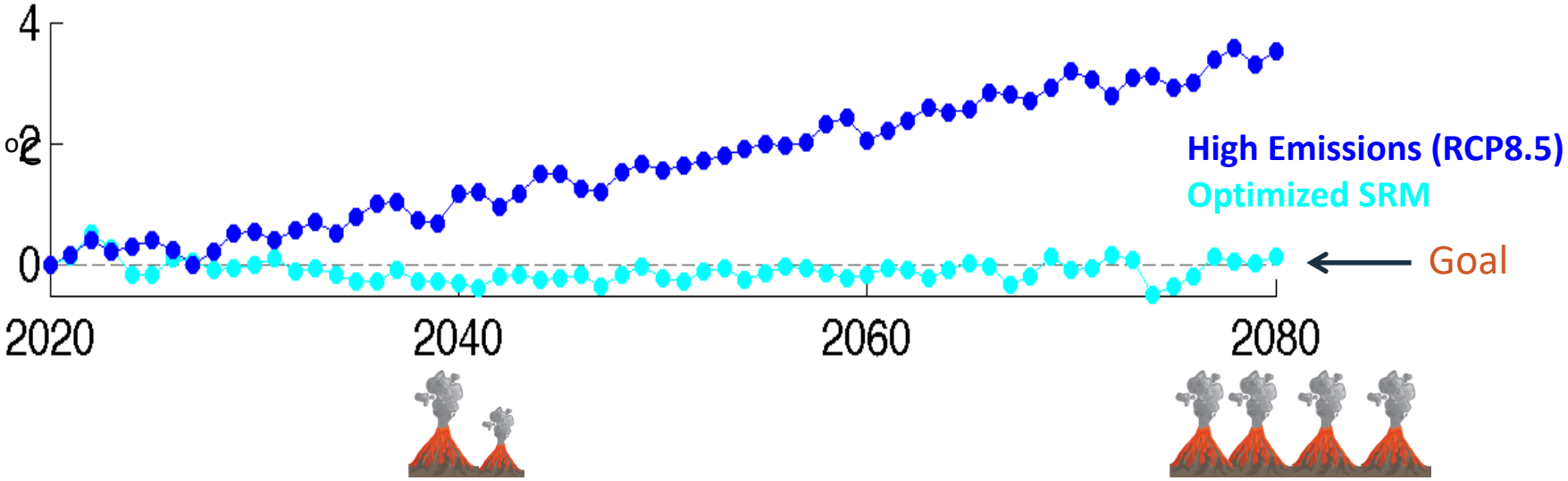
New Approach:

Set climate goals → Choose sulfur injections to meet goals → Reduce risks & examine side effects

Developed optimization algorithm to meet multiple climate goals
Ran simulations with WACCM

CESM1(WACCM) simulation with optimized SRM

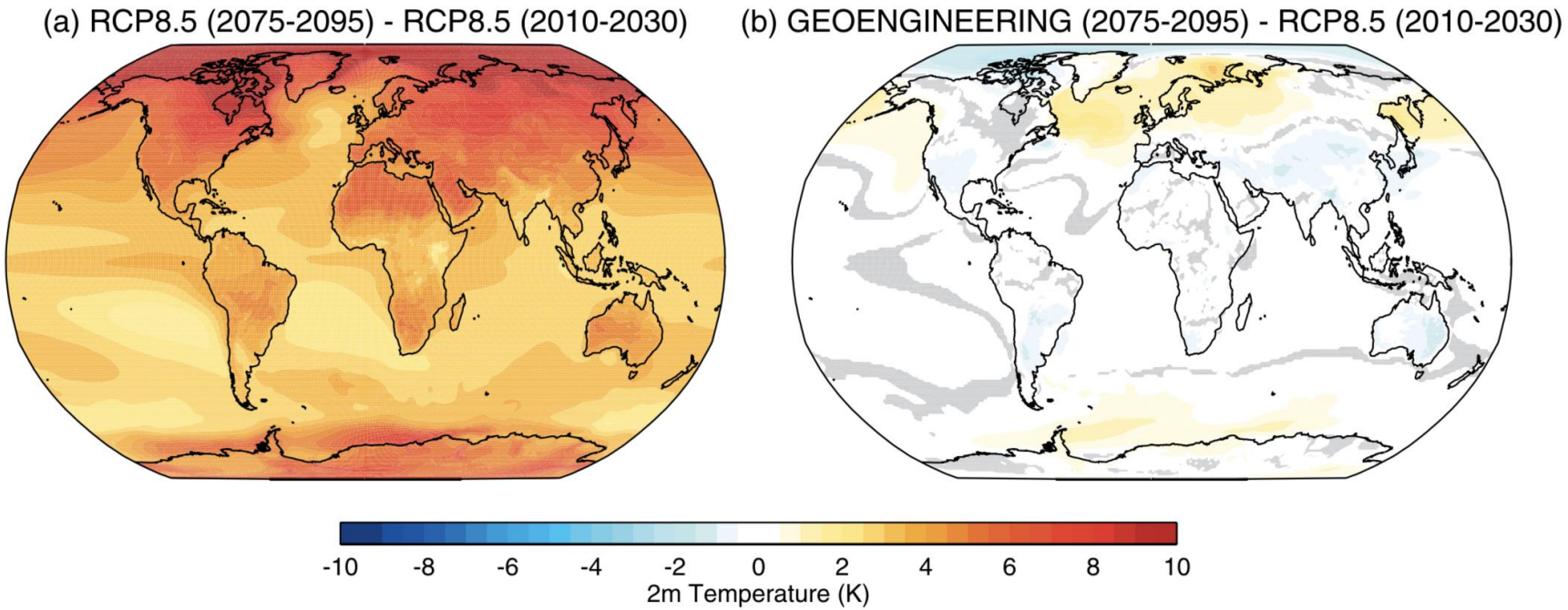
Global Mean Temperature Deviation from 2020



- Demonstrated that multiple goals could be met in CESM
- Injections up to 40 megatons **SO_2 per year** (~ 4 Mt. Pinatubo eruptions)
- Injections mainly at 30S and 30N; a little at 15S and 15N

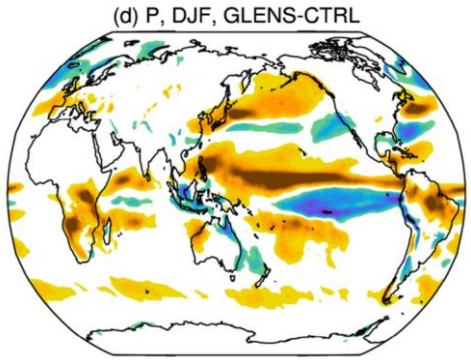
Geoengineering Large Ensemble (GLENS)

20-ensemble members: Geoengineering with feedback

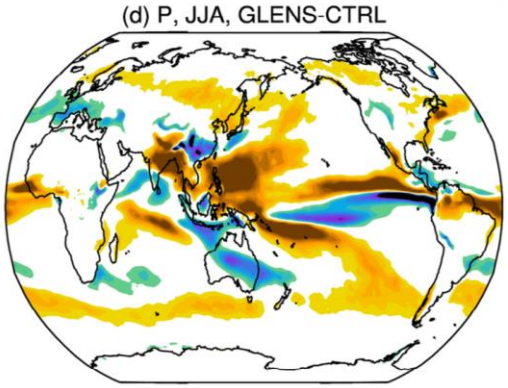


http://www.cesm.ucar.edu/experiments/cesm1.2/GLE/

Precipitation and Aridity

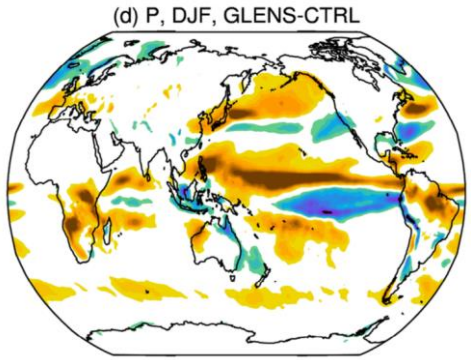


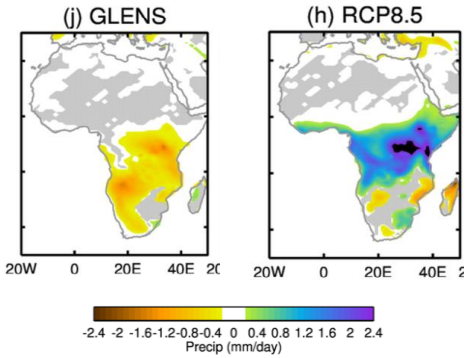
Mostly changes over oceans

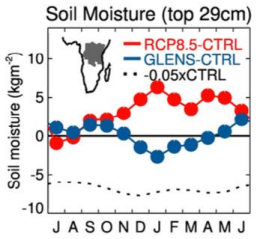


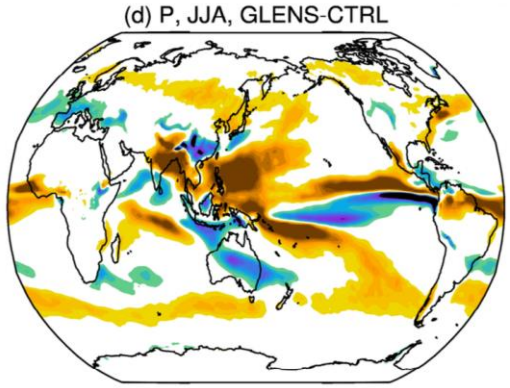
Simpson et al. 2019 (in prep)

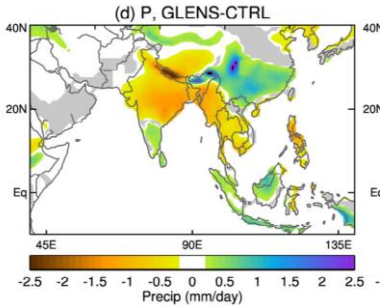
Precipitation and Aridity

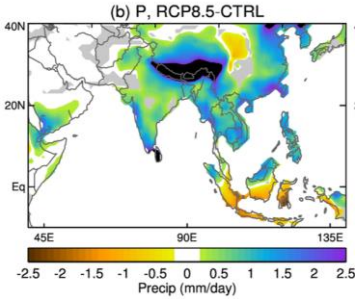


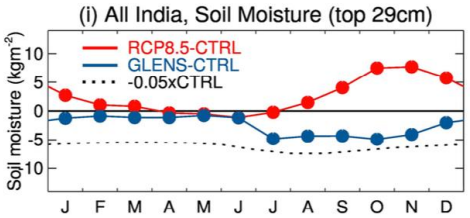






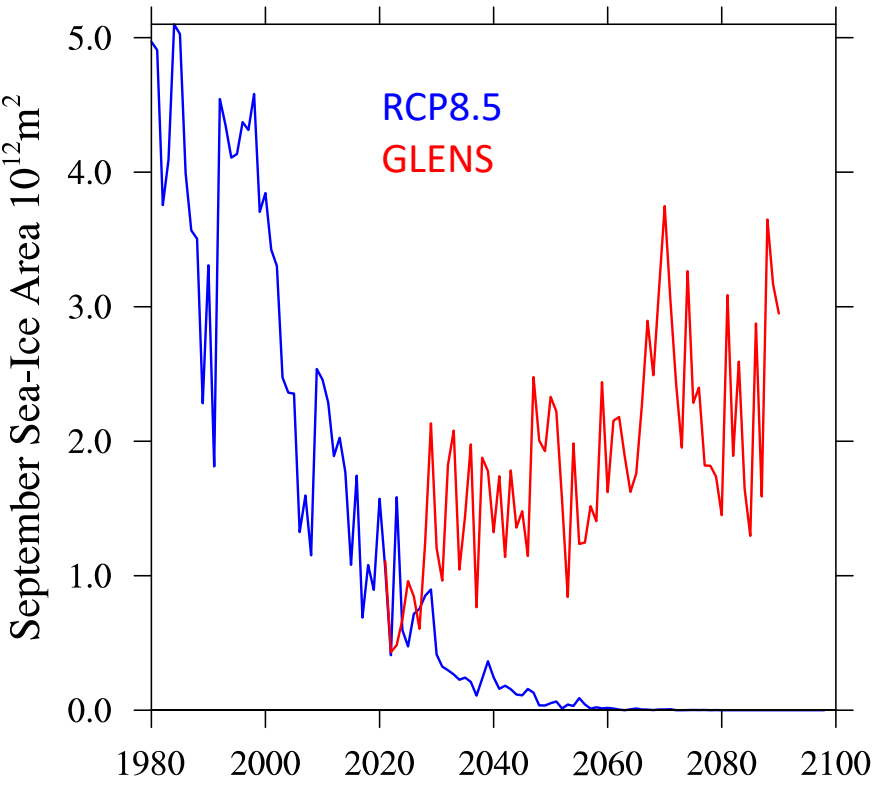






Simpson et al. 2019 (in prep)

September Arctic Sea-Ice



- Recovery of September Arctic Sea-Ice due to cooler Temperatures in high northern latitudes

Summary

- CESM(WACCM) allows for comprehensive evaluation of geoengineering on the Earth system, including the atmosphere, land, ocean

- Many risks and side effects of climate change can be reduced with an optimally designed SRM strategy, BUT side effects needs to be carefully investigated

- We don't know how robust our findings are - a lot more research is needed.

- Mitigation of emissions is the only cure for climate change, but SRM could potentially be a useful temporary measure to avoid the worst consequences of climate change.