

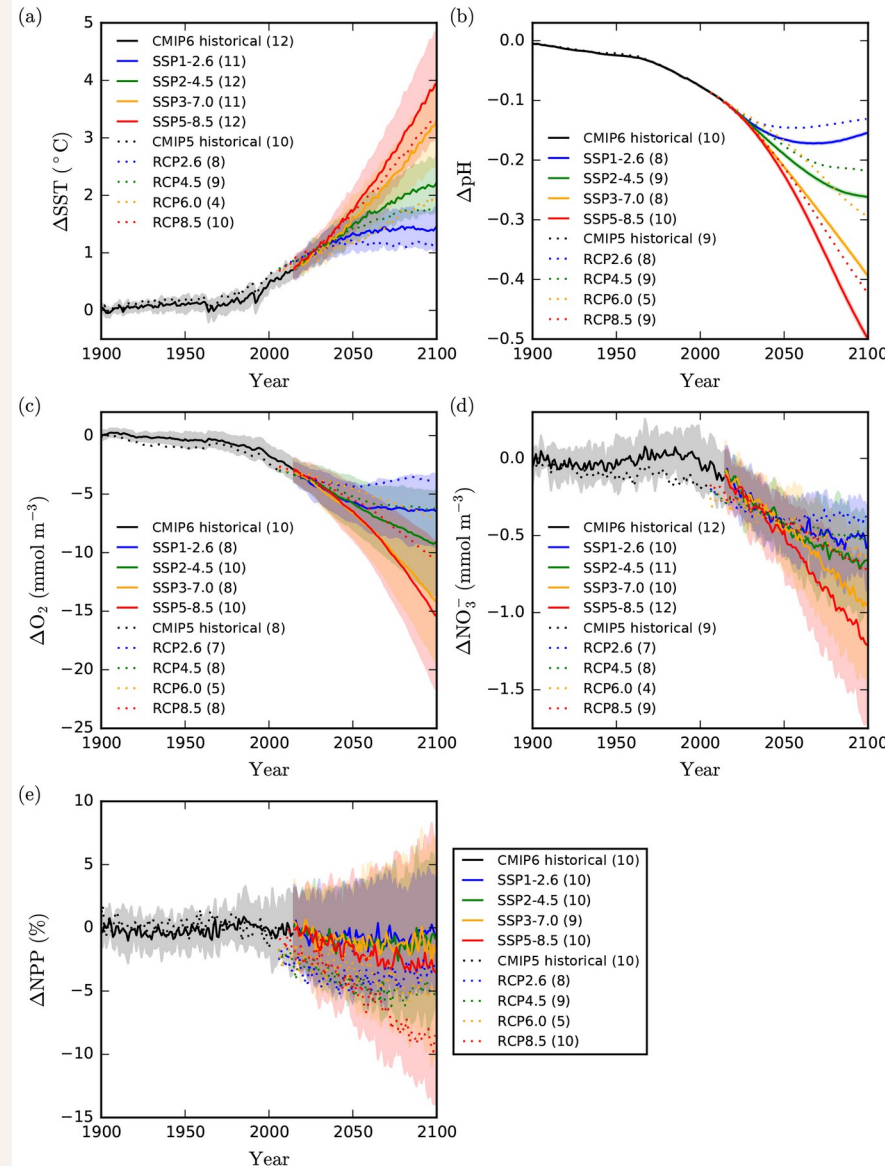
An underwater photograph of a vibrant coral reef. The scene is filled with various types of coral, including branching and brain corals, in shades of brown, orange, and purple. Numerous small, colorful fish are swimming throughout the water column. The water is clear and blue, with sunlight filtering through from the surface, creating a shimmering effect. The overall atmosphere is serene and natural.

POTENTIAL IMPACTS OF SOLAR RADIATION MANAGEMENT ON GLOBAL FISH BIOMASS

**KELSEY ROBERTS¹,
JEROME GUIET²,
DANIELE BIANCHI², &
CHERYL HARRISON¹**

¹LSU, ²UCLA

Important climate drivers for marine ecosystem impacts



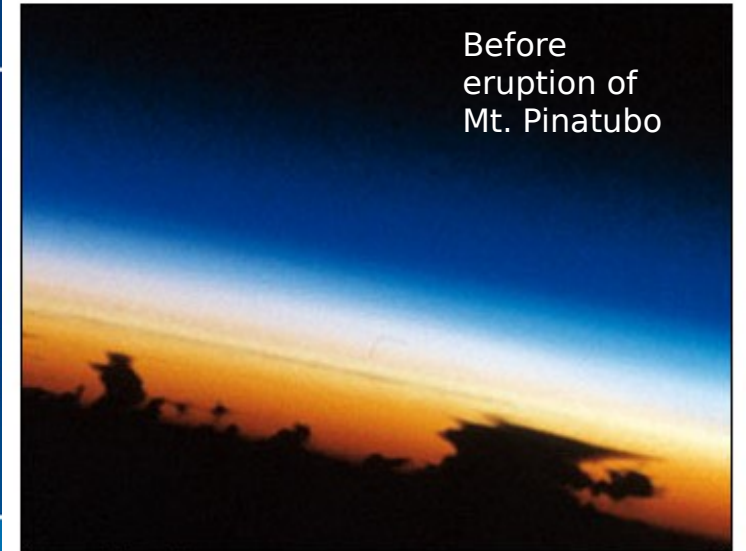
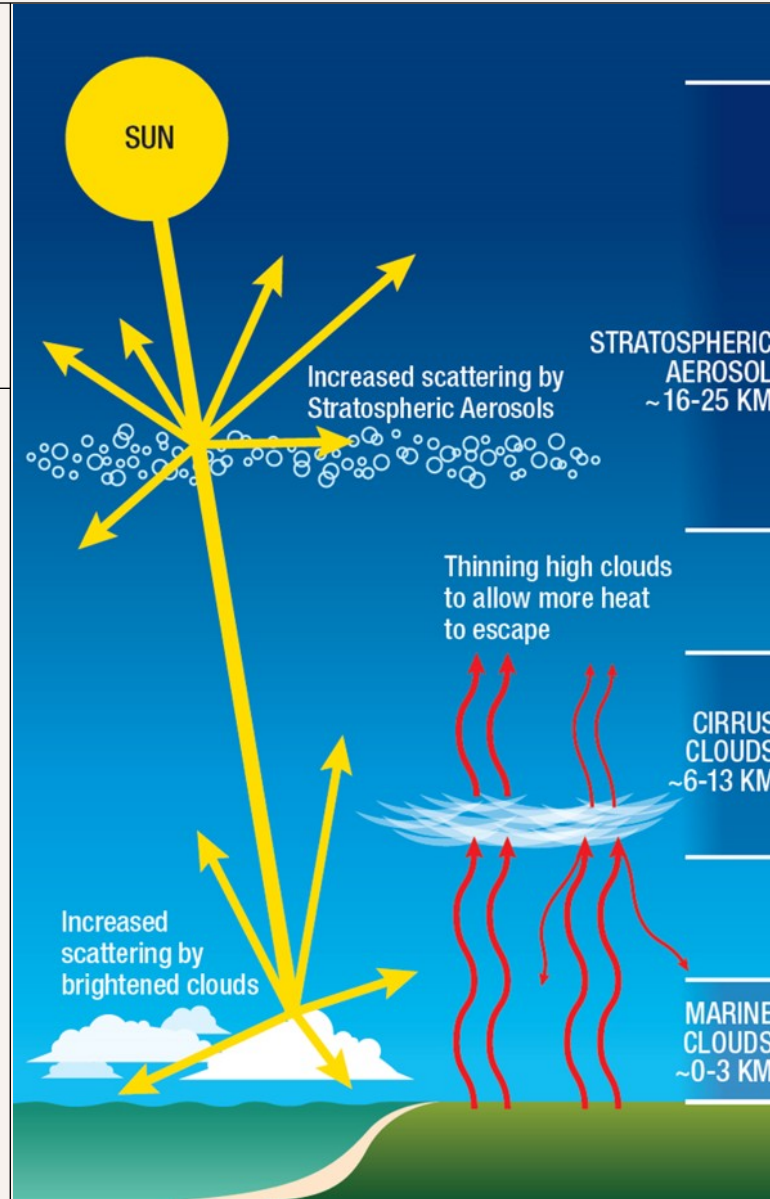
- a) Increasing SST
- b) Acidification
- c) Declining oxygenation
- d) Declining surface nutrients
- e) Uncertainty surrounding NPP response

What is solar radiation management (SRM)?

SRM = limiting radiation at the Earth's surface (in other words... 'turning down the sun')

1. Stratospheric aerosol injection (SAI) - increasing the number of liquid or solid particles (e.g., sulfate) in stratosphere to reflect sunlight (*analogue: volcanic eruptions*)
2. Marine cloud brightening (MCB) - increasing the reflectivity of low clouds over certain parts of the ocean (*analogue: ship tracks*)

Why do we care? Research & implementation is moving forward faster than oversight



Before eruption of Mt. Pinatubo

August 30, 1984



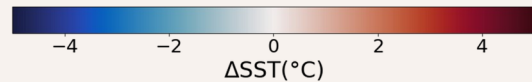
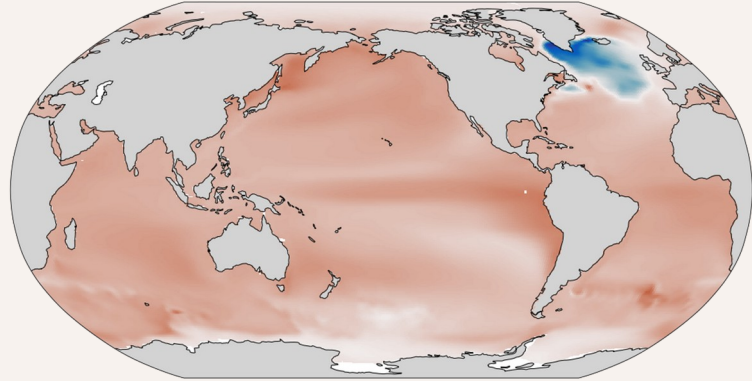
2 months after eruption

August 8, 1991

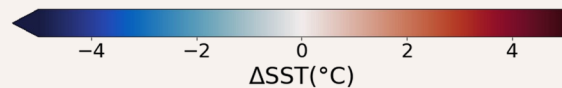
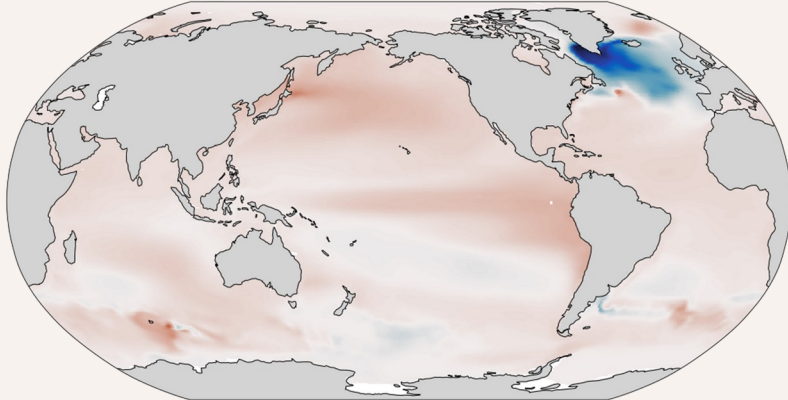
How does implementing SRM impact SST and NPP?

NO SRM

CESM 2060-2069 - CESM 2015-2024



ARISE 2060-2069 - CESM 2015-2024



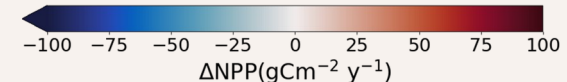
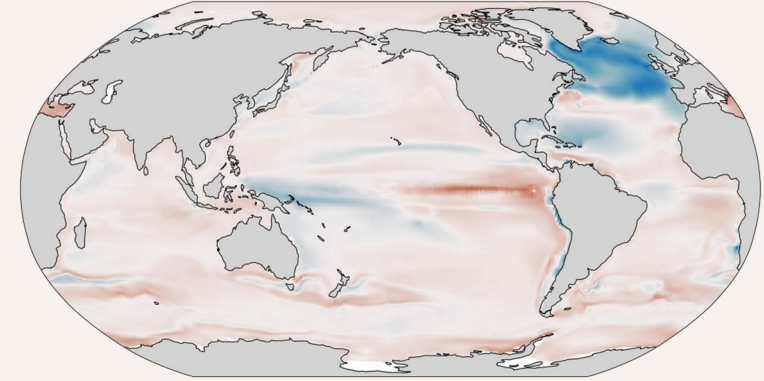
TEMPERATURE

➤ SAI can (mostly) bring temperature down to target (1.5 above pre-industrial)

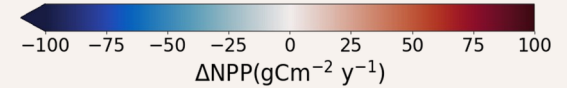
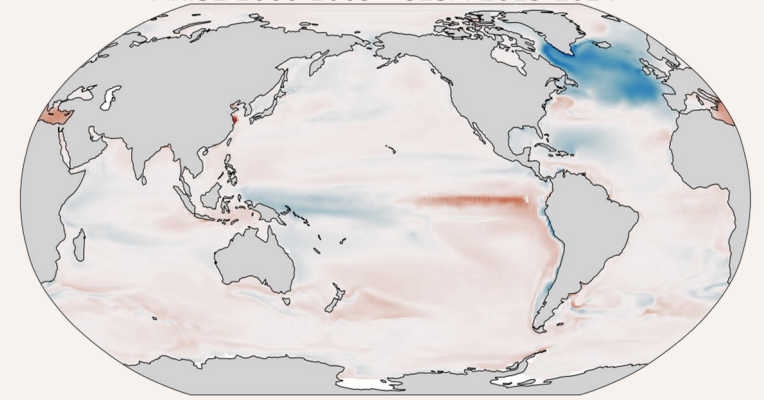
➤ 'Cold pool' in North Atlantic - we don't fully know what's going on here

➤ NPP anomalies mitigated in some regions

CESM 2060-2069 - CESM 2015-2024

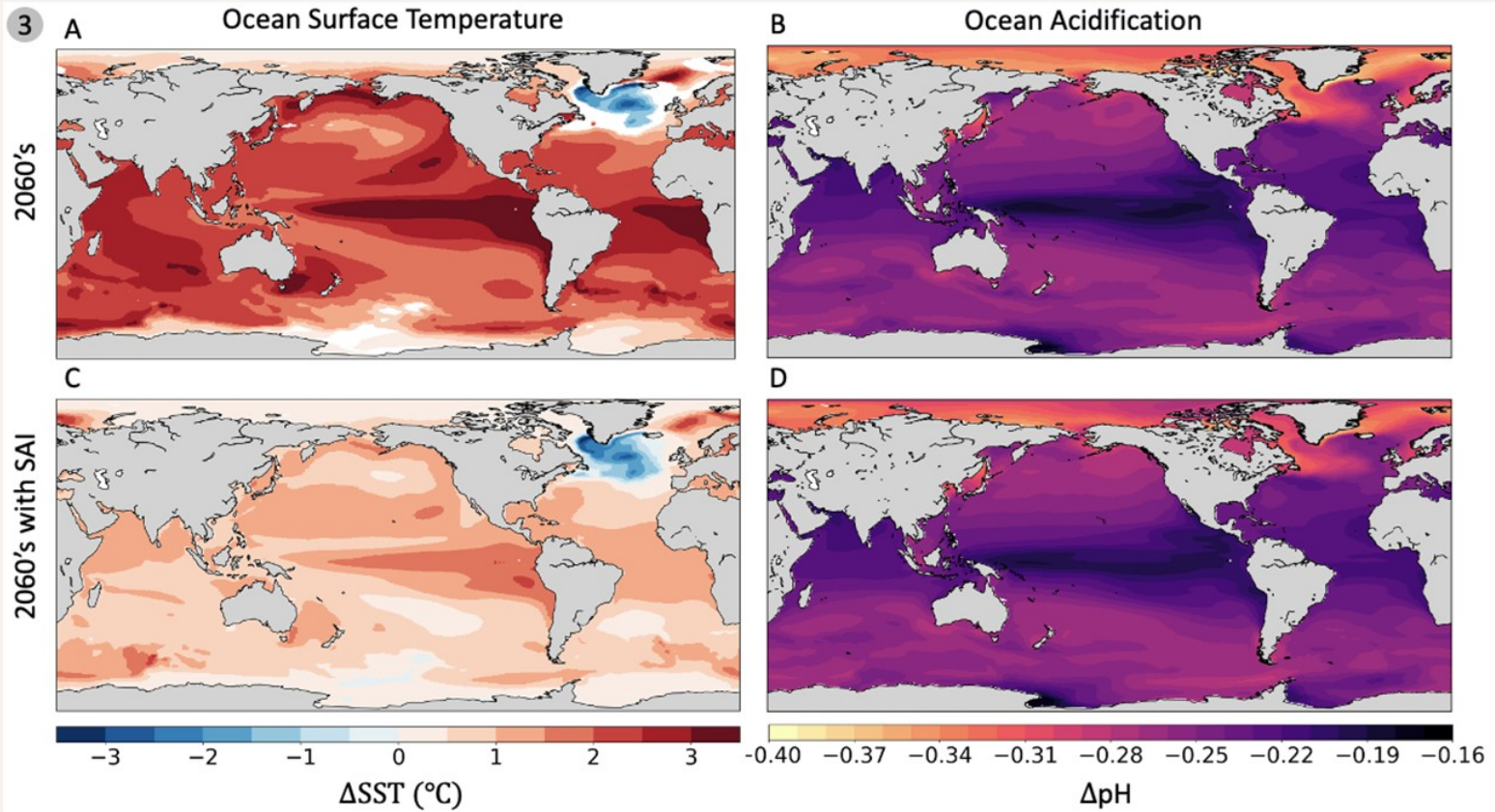


ARISE 2060-2069 - CESM 2015-2024

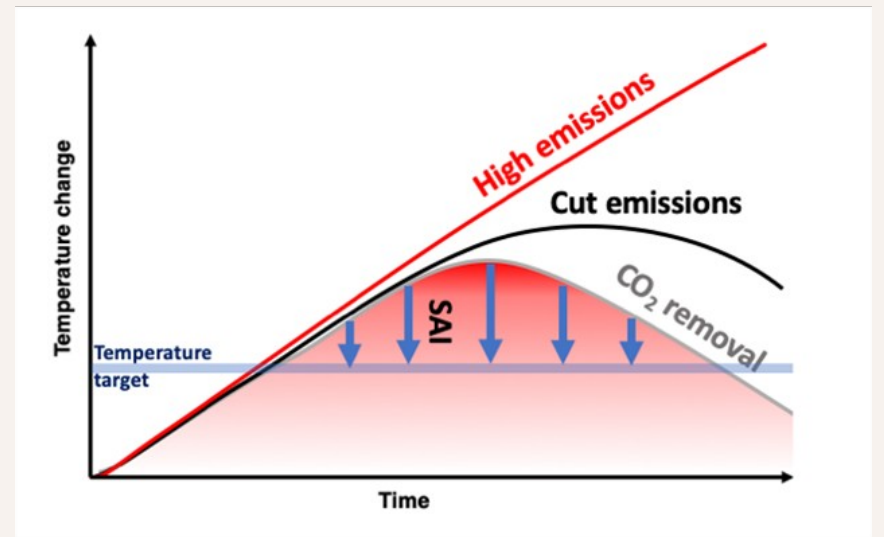


NPP

Solar radiation management does not mitigate ocean acidification



Overshoot “peak shaving”



*This also has the unfortunate side effect of lowering/worsening aragonite saturation – you could end up with a cooler but more acidic ocean

We need impact assessments

NCAR

COMMUNITY CLIMATE
INTERVENTION STRATEGIES

CCIS

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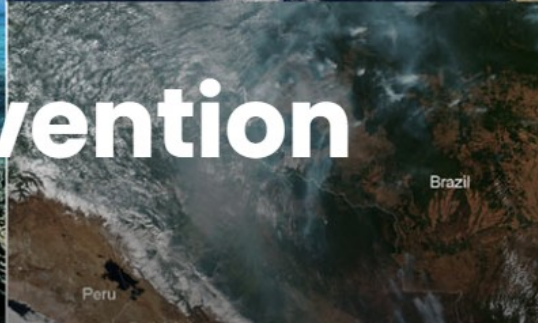
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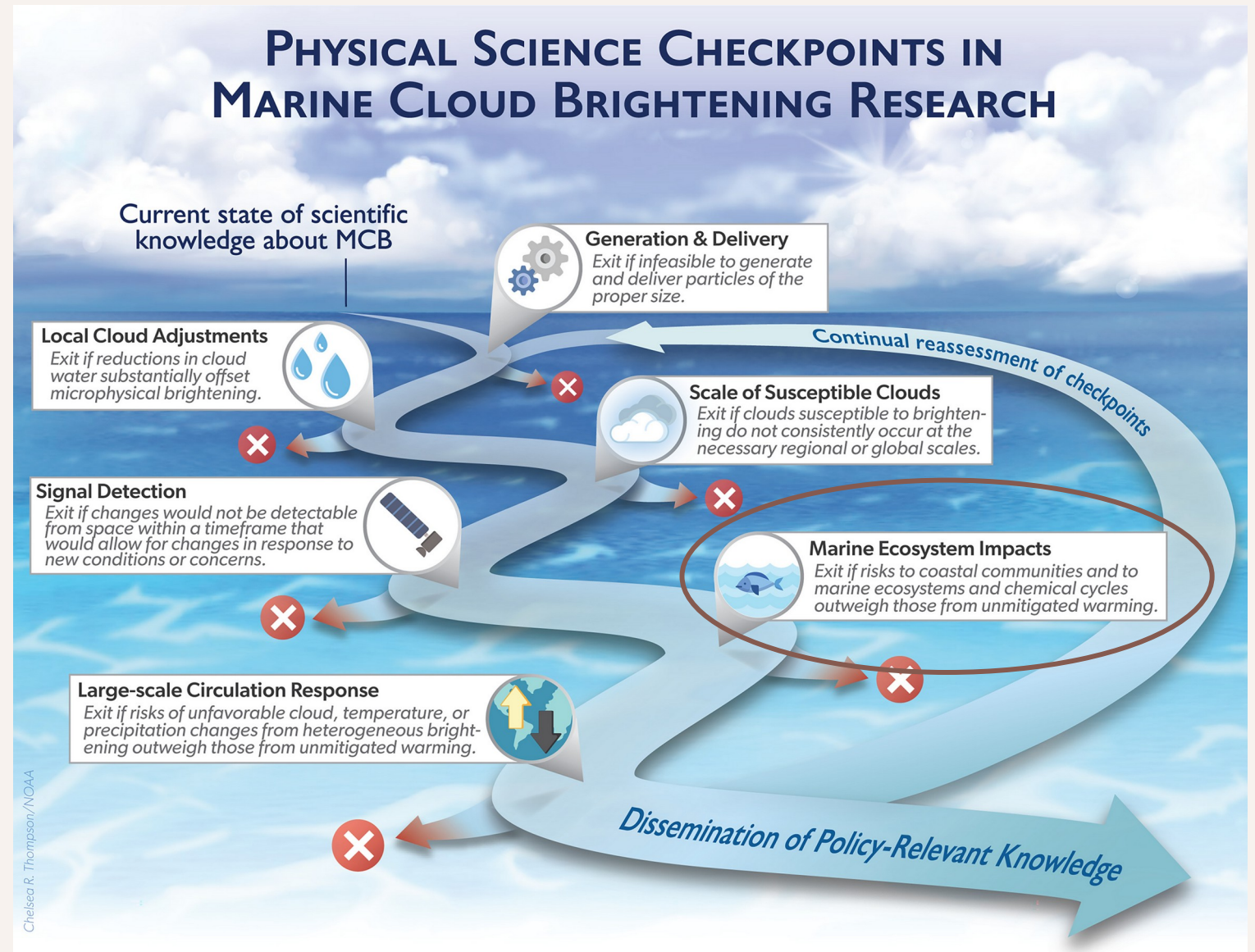


Exploring climate intervention
strategies



RESEARCH AIM: the potential tradeoffs of SRM on marine ecosystems must be explored to determine plausible scenarios or provide 'exit ramps' for discontinuing research & avoiding implementation

SPECIFIC OBJECTIVE: explore how changes in SST and NPP under SRM scenarios impact global fish biomass distribution



Environmental Forcings

net primary production

water temperature

Growth-rate limiting terms

food energy potentially available to fish

maximum possible growth rate of individuals

Fish biomass spectra

small group

medium group

large group

growth

mortality

harvest

recruitment

$m_{\infty, \text{small}}$

$m_{\infty, \text{medium}}$

$m_{\infty, \text{large}}$

log(size)

Economic Forcings

catchability (q)

ex-vessel price (p)

cost per unit effort (c)

Regulation forcings

societal enforcement (S)

regulation target (E_{target})

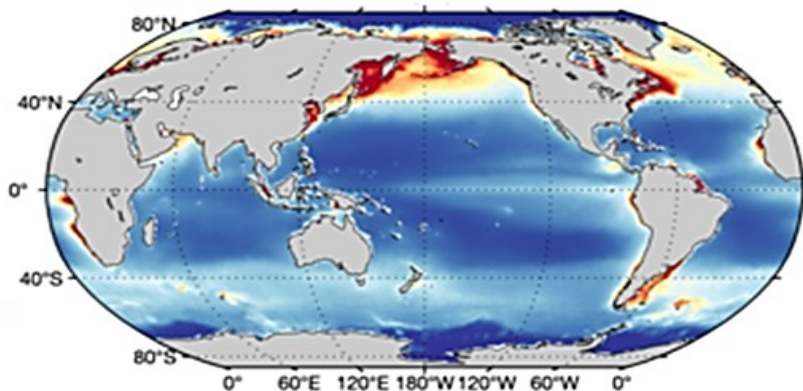
BOATS

BiOeconomic mArine
Trophic Size-spectrum
model

effort (E_{small})

effort (E_{medium})

effort (E_{large})

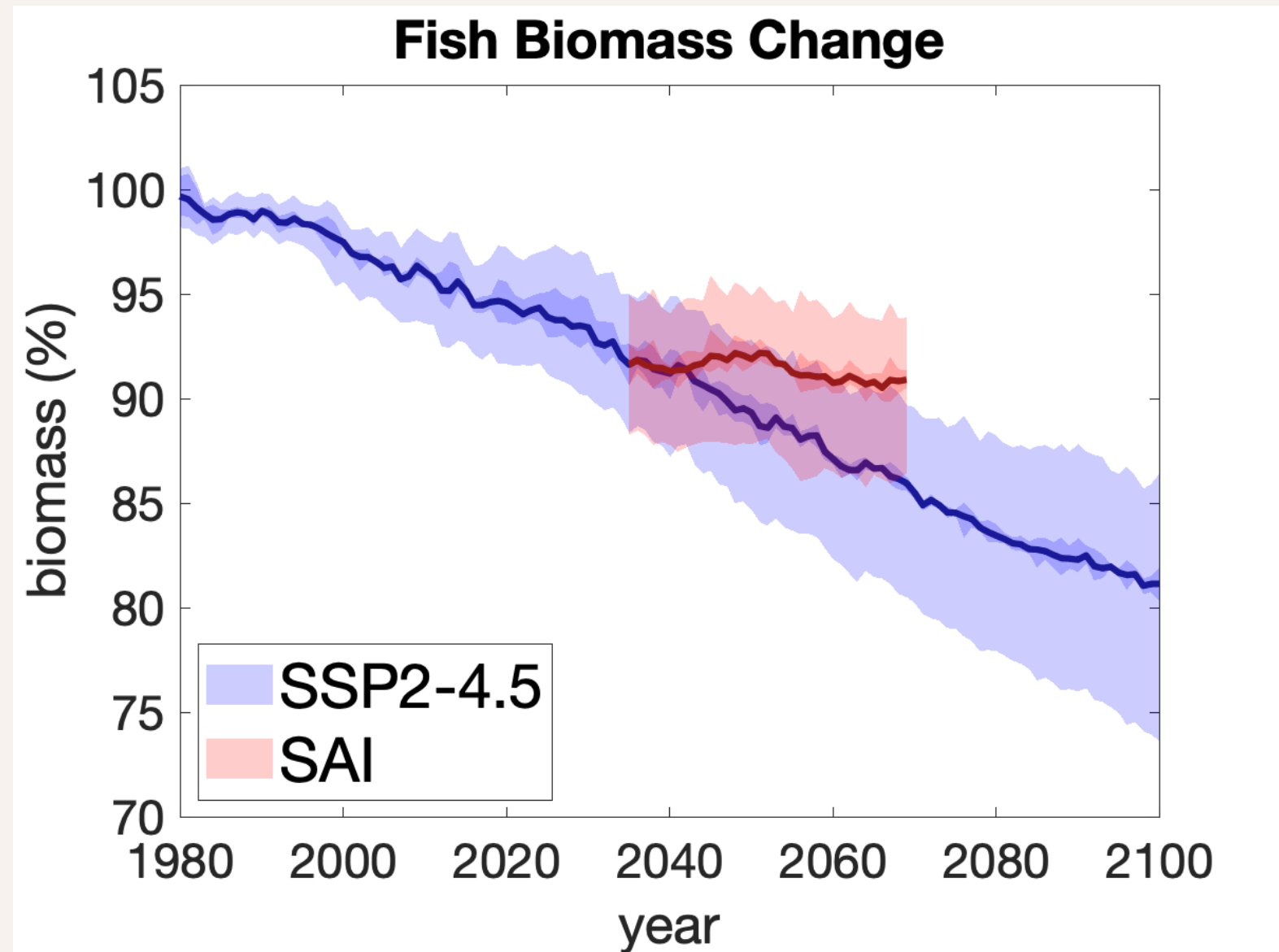


see Carozza et al. (2016; 2017) *GMD*; *PLOS ONE*
Scherrer and Galbraith (2020) *ICES-JMS*

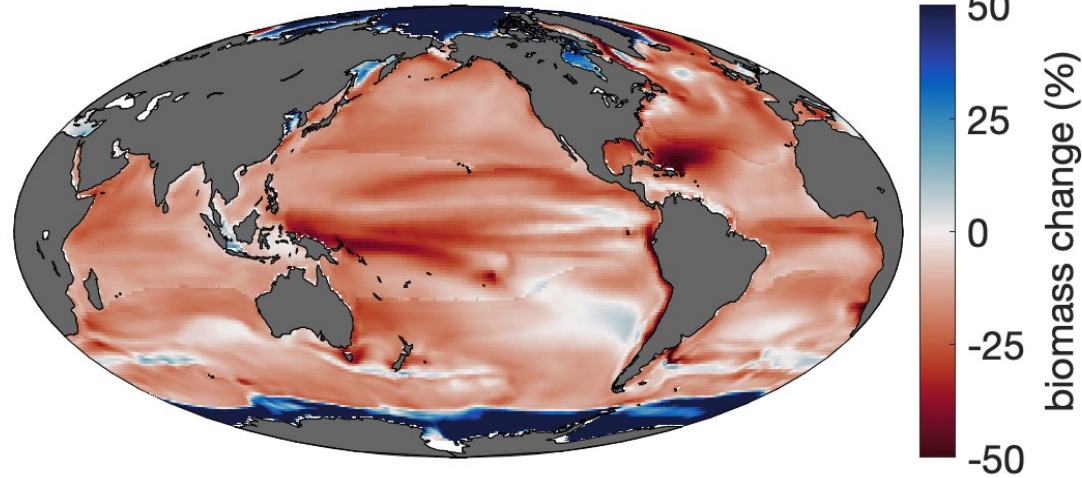
Biomass change
relative to pre-
industrial control

Darker shading is
the climate
ensemble
variability

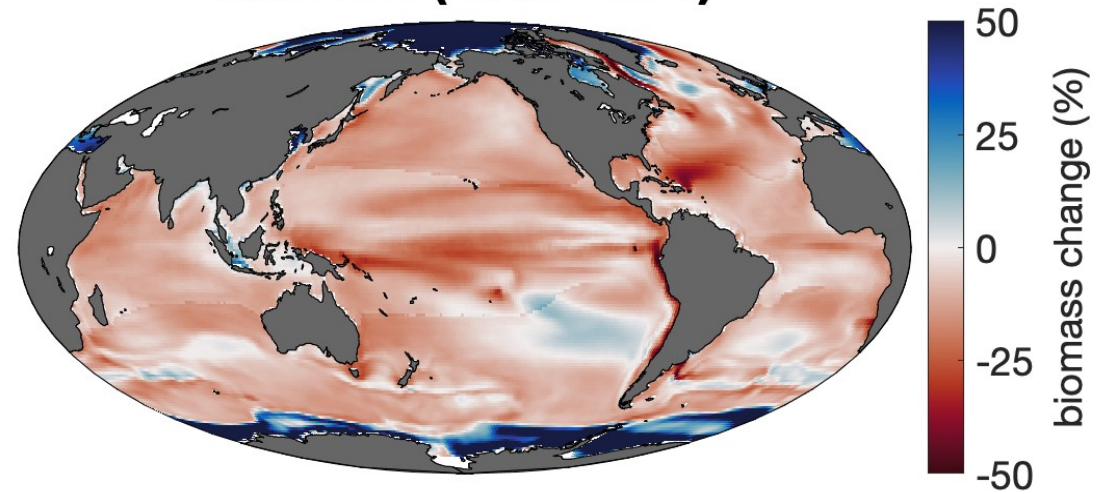
Lighter shading is
the BOATS
ensemble
variability



fish: SSP2-4.5 (2065-2070)



fish: SAI (2065-2070)



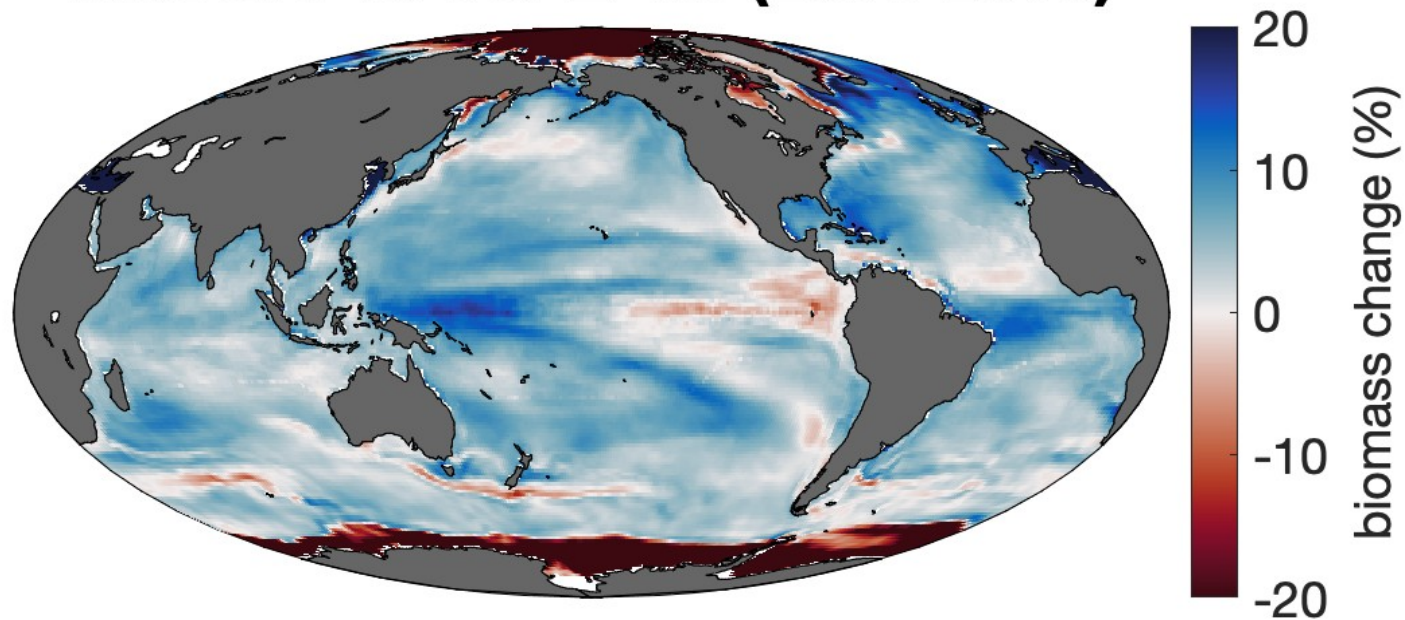
Spatial differences in biomass relative to pre-industrial control for averaged time period 2065-2070

Biomass change for SAI vs. SSP2-4.5



Up to 20% less
biomass change in
SAI vs. SSP2-4.5

fish: SAI vs SSP2-4.5 (2065-2070)



NEXT STEPS:

1. All ensemble members for SAI
2. MCB simulations and comparison with SAI output
3. Turn on socioeconomic drivers in BOATS
4. BOATS v1 vs. v2

kroberts3@lsu.edu
