

Cornell University

Fit for purpose?

CESM and Solar Radiation Modification

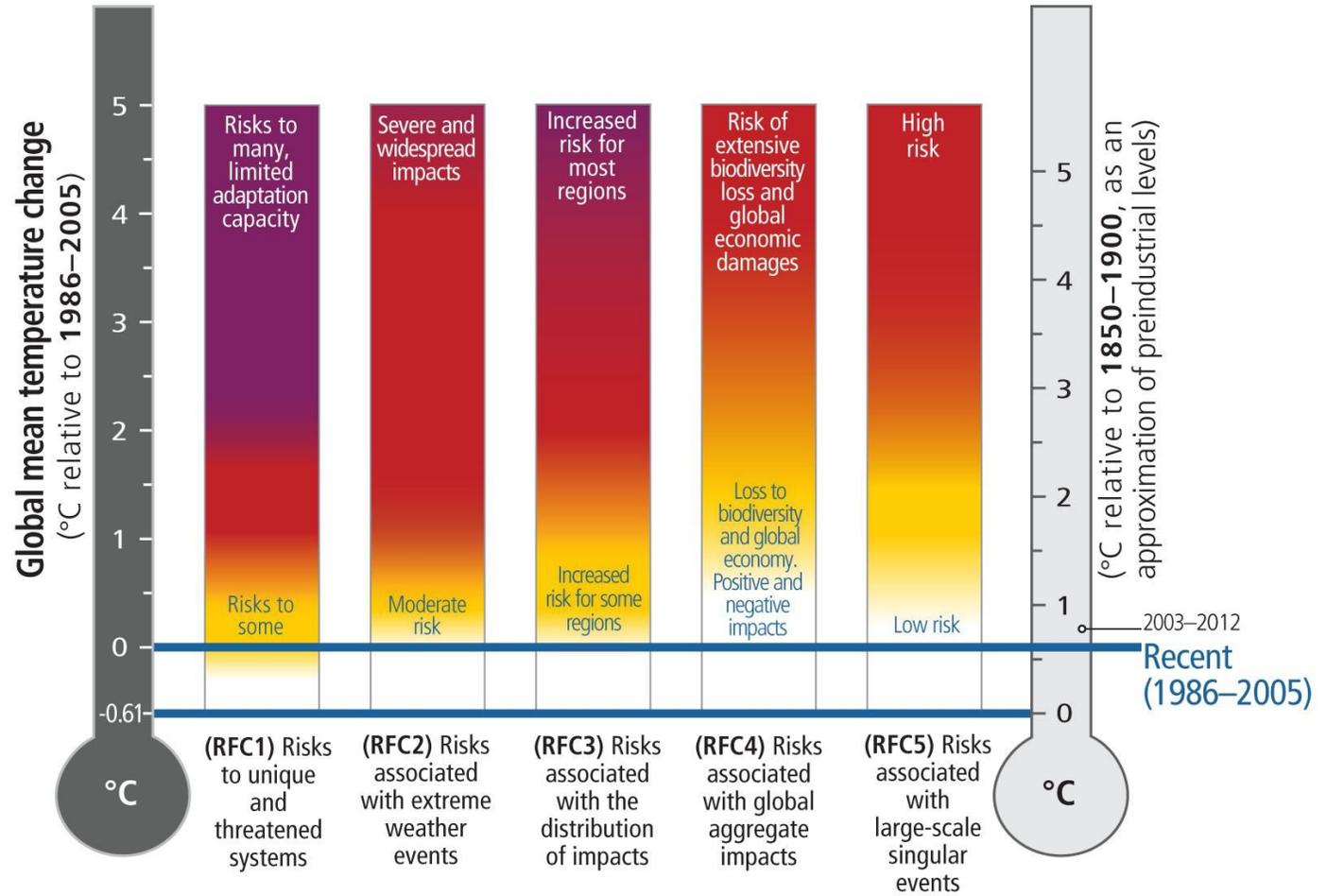
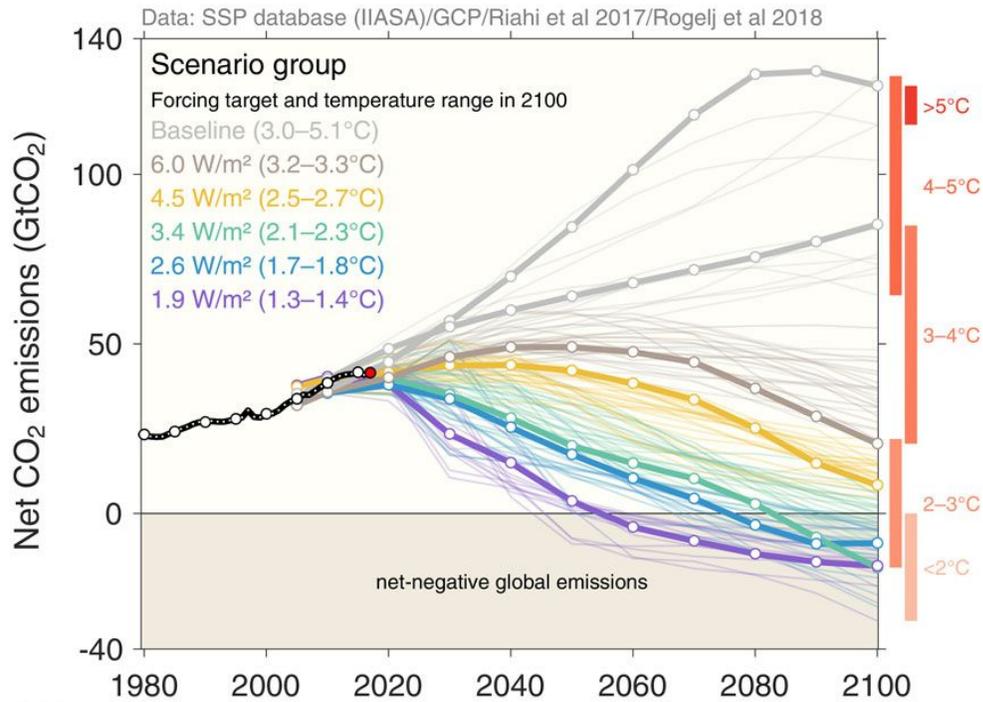
experiments

Daniele Vioni (dv224@cornell.edu)

Department of Earth and Atmospheric Sciences, Cornell University

CESM meeting
June 2023

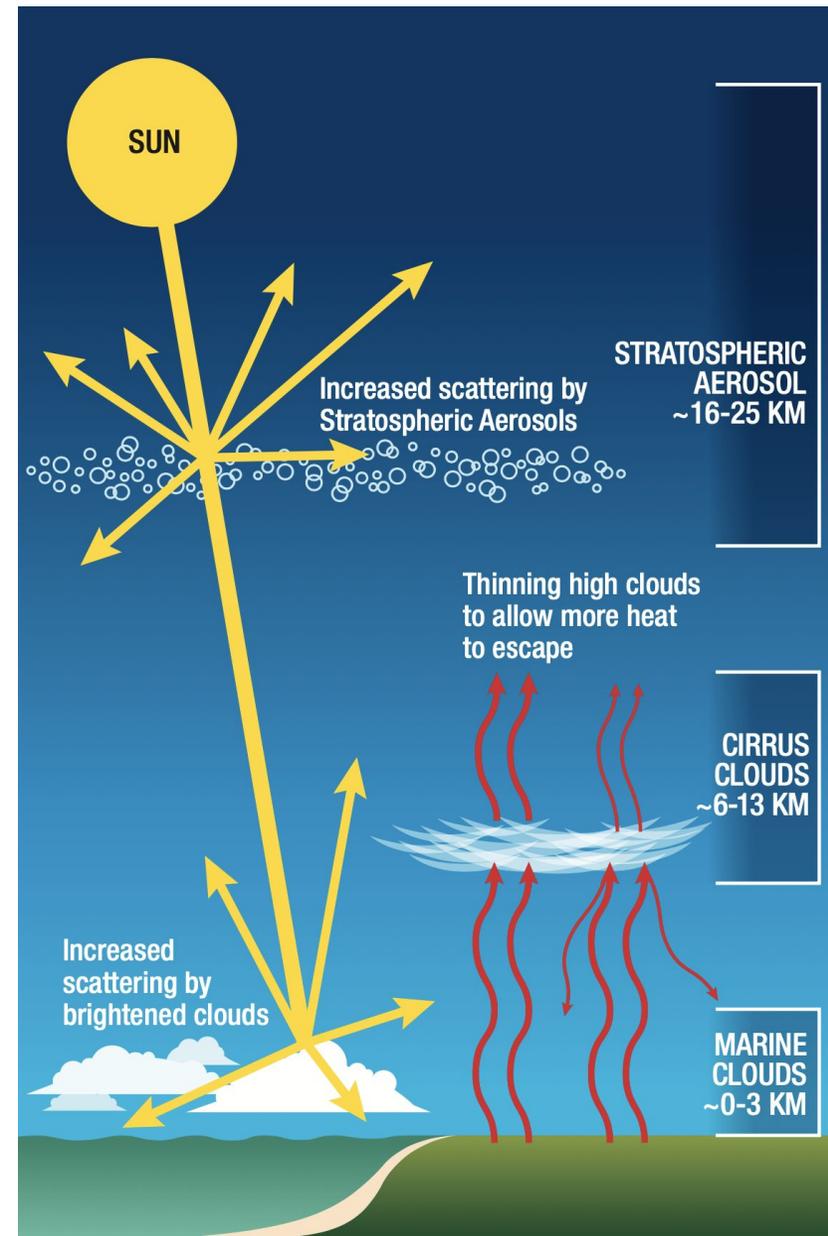
Why do we talk about Climate Intervention



Why do we talk about Climate Intervention

Solar Radiation Modification (SRM) (or Climate Engineering)

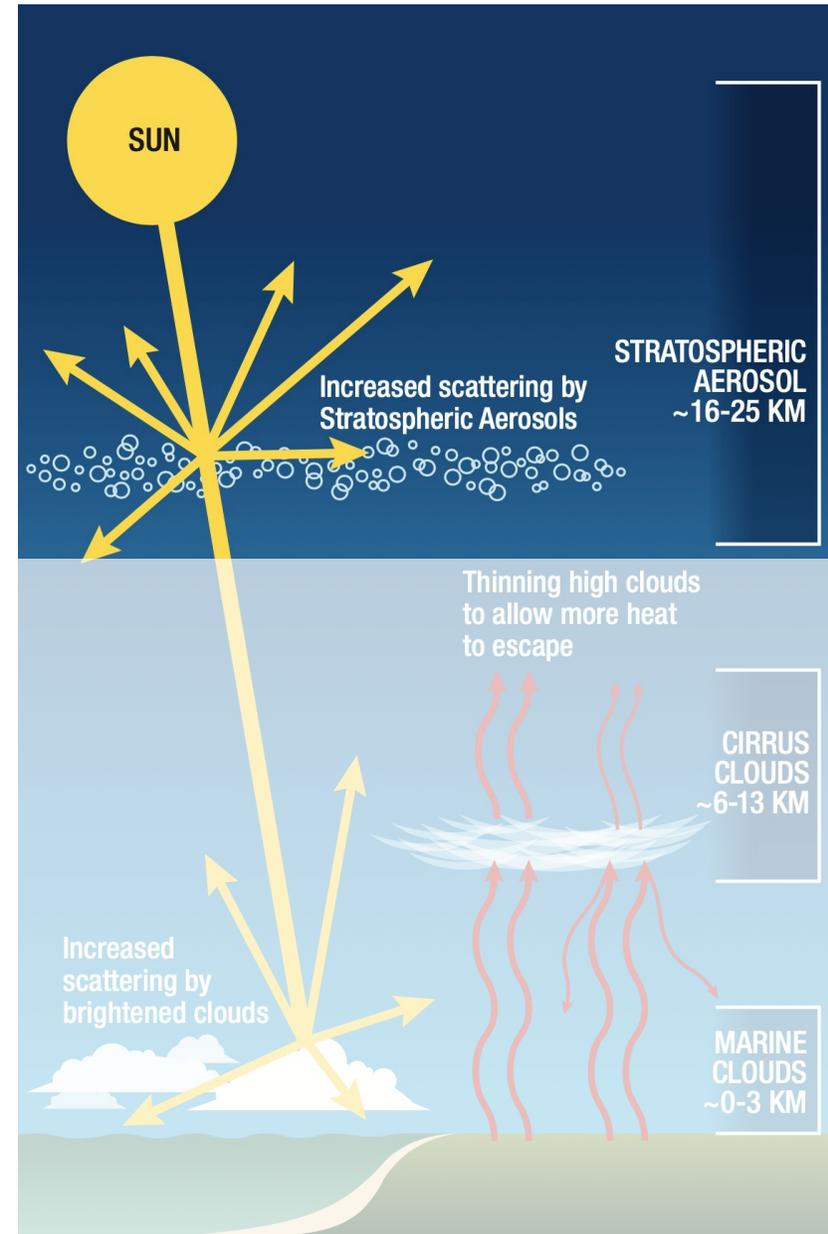
The deliberate modification of Earth's climate, through the reflection of a portion of the incoming solar radiation, in order to reduce some of the risks produced by global warming



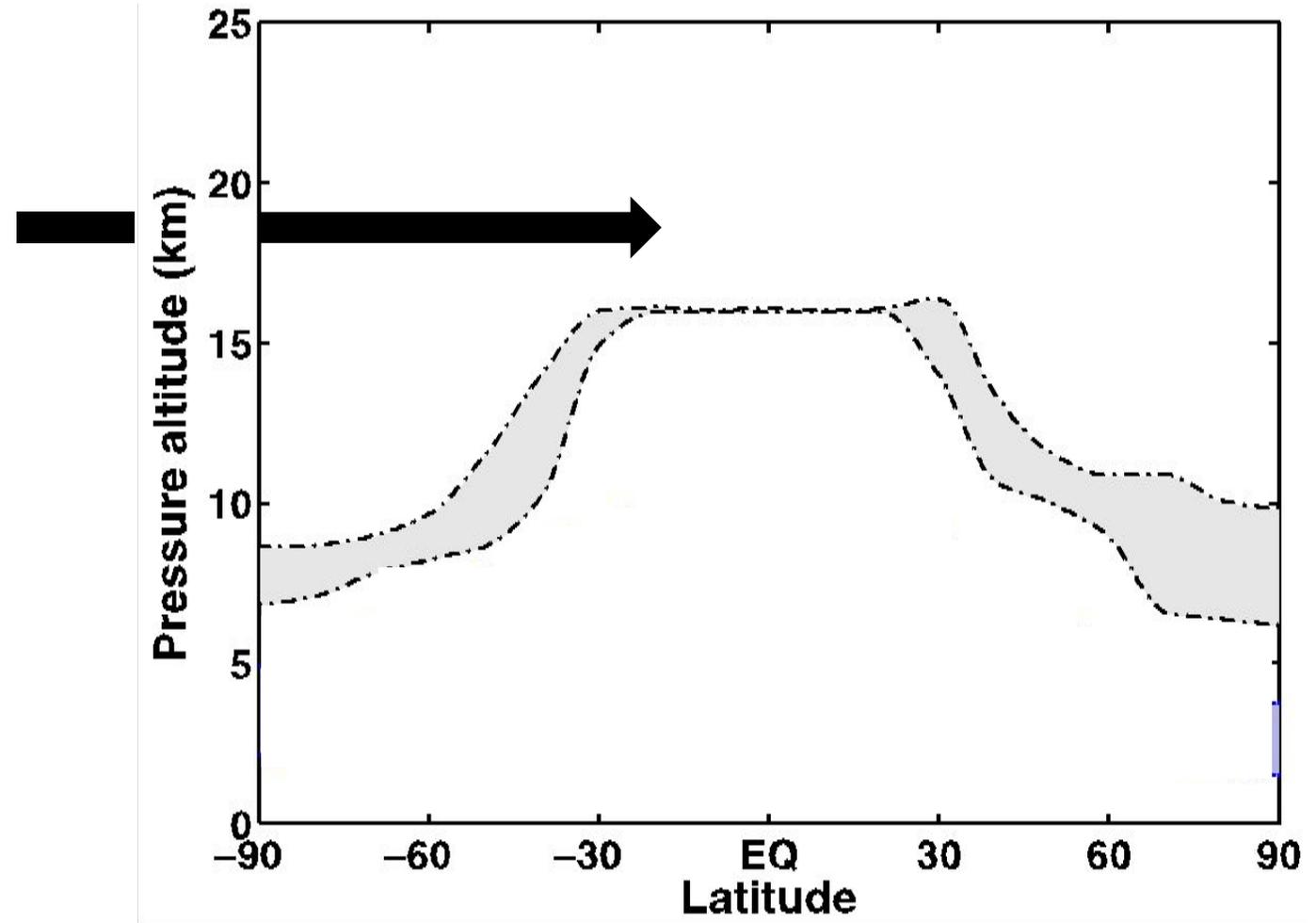
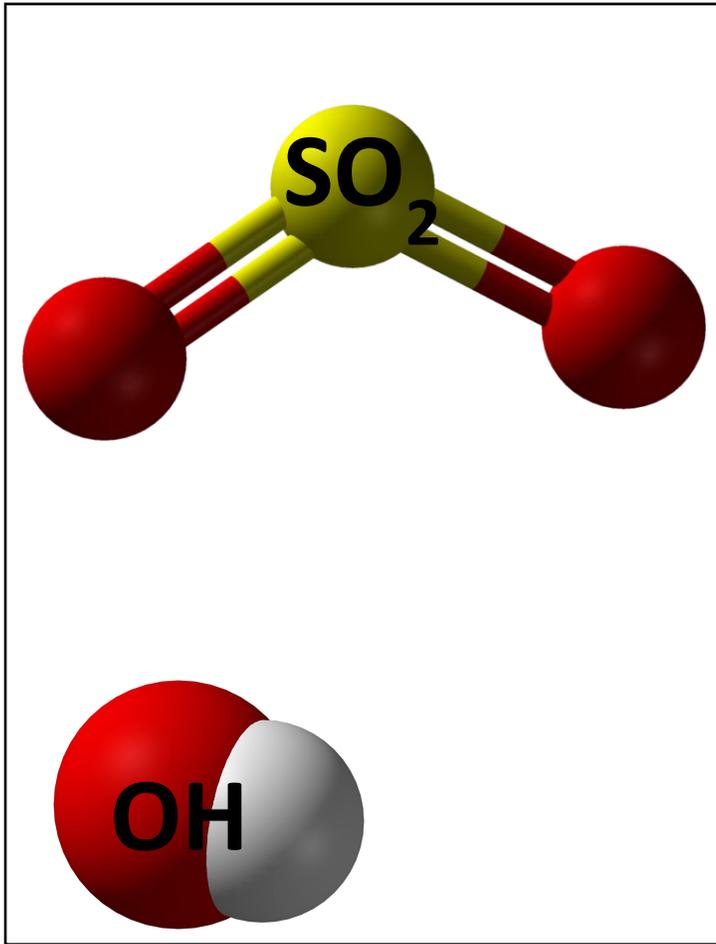
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Stratospheric Aerosol Injection

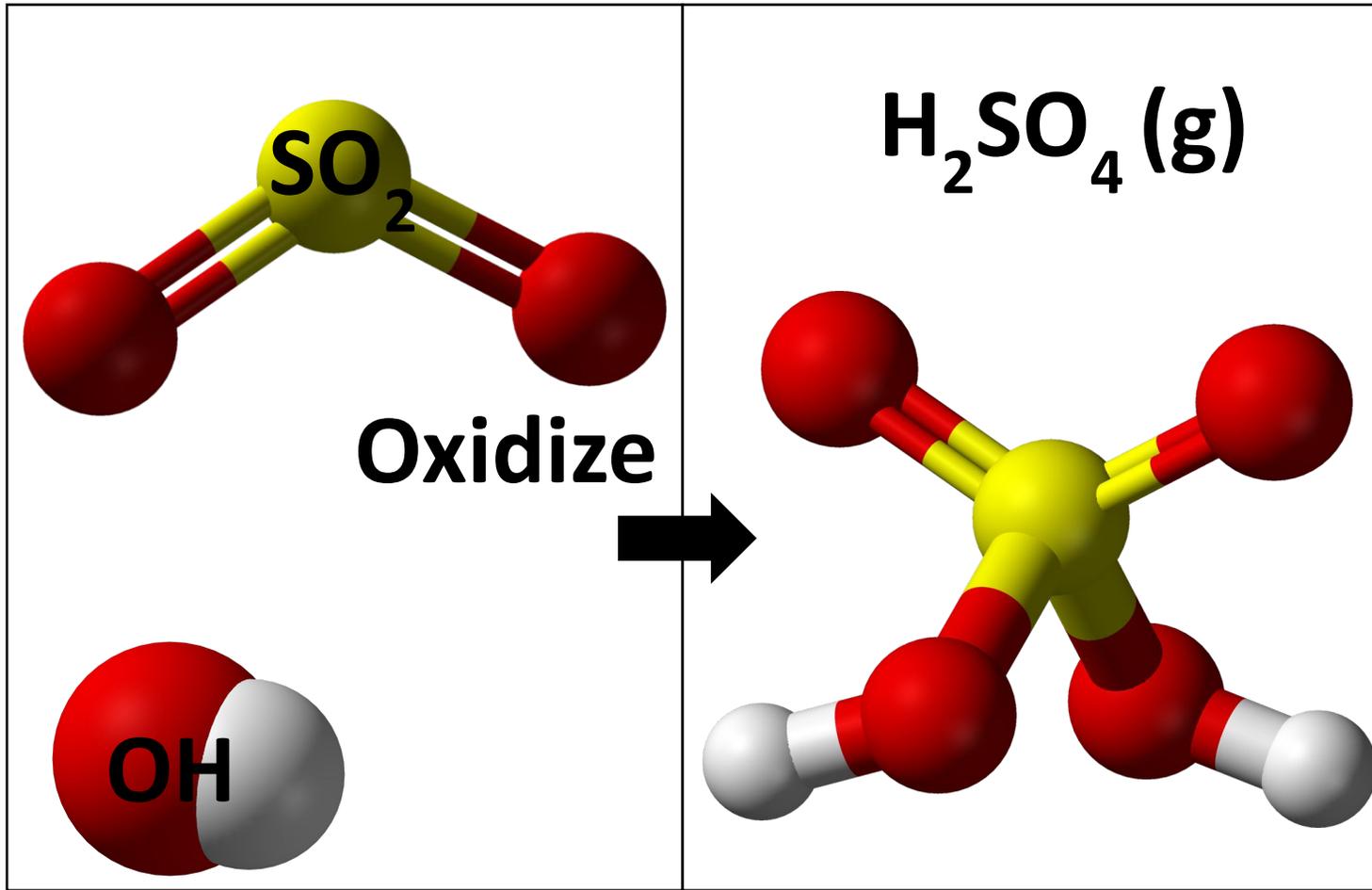
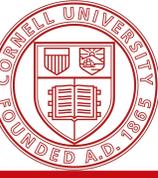
SRM done through the injection of sulfate aerosols precursors in the stratosphere, mimicking the effect of explosive volcanic eruptions



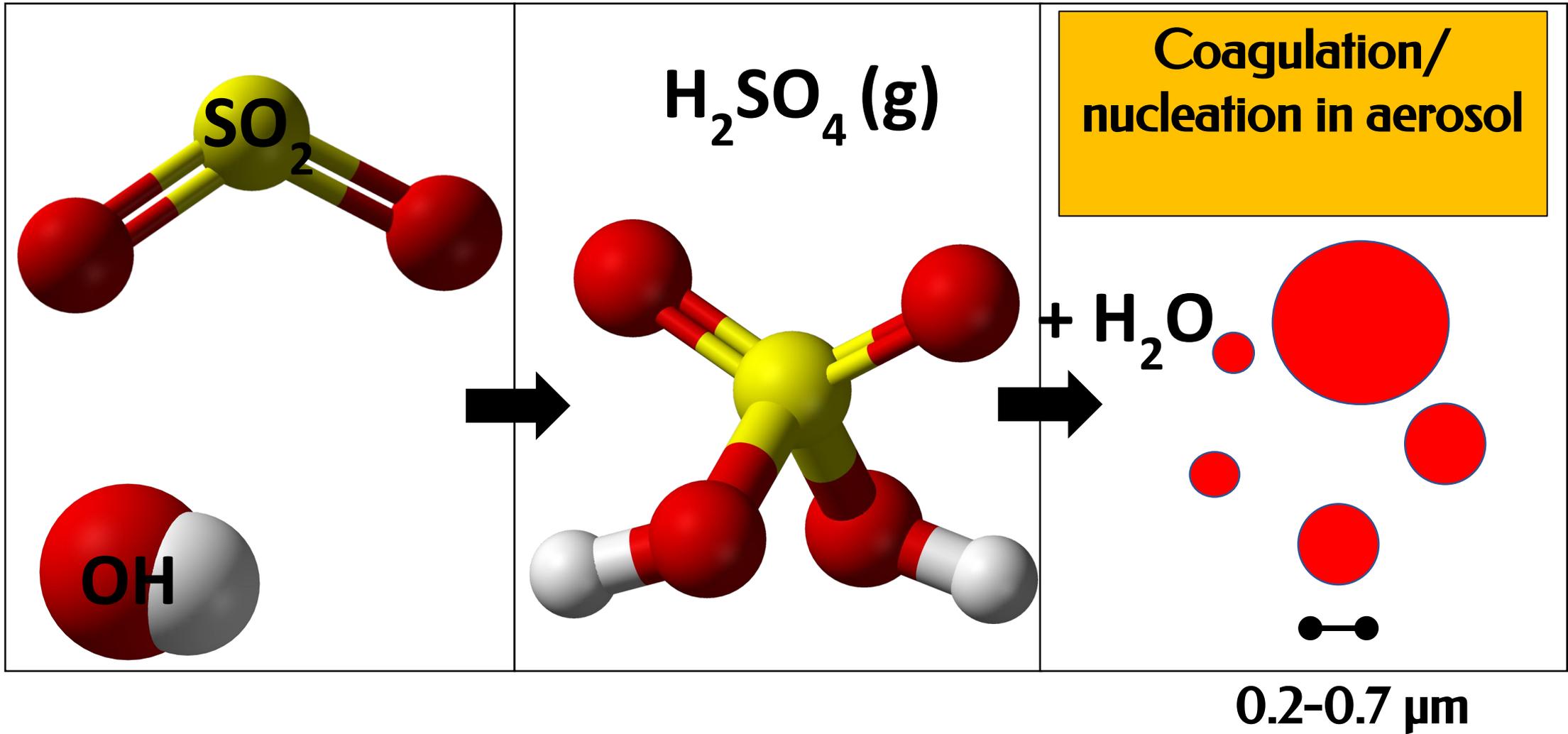
From SO₂ to the aerosol cloud



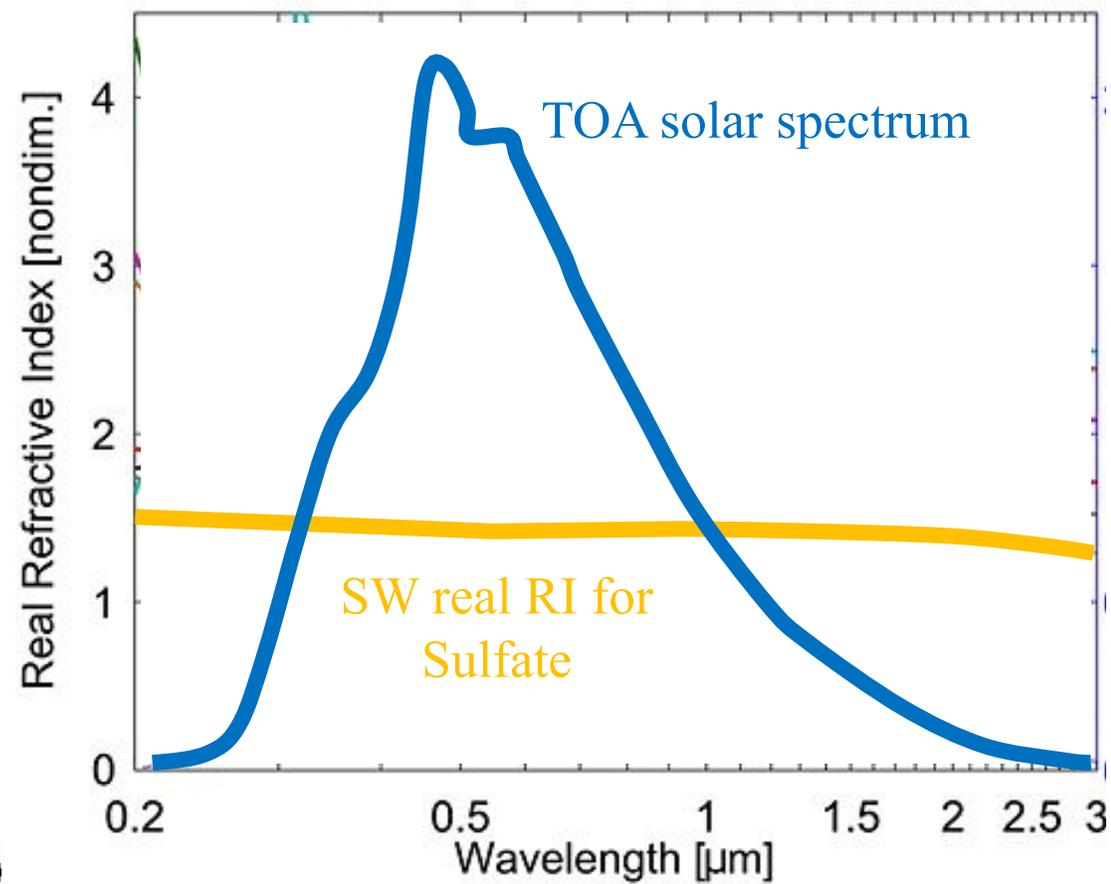
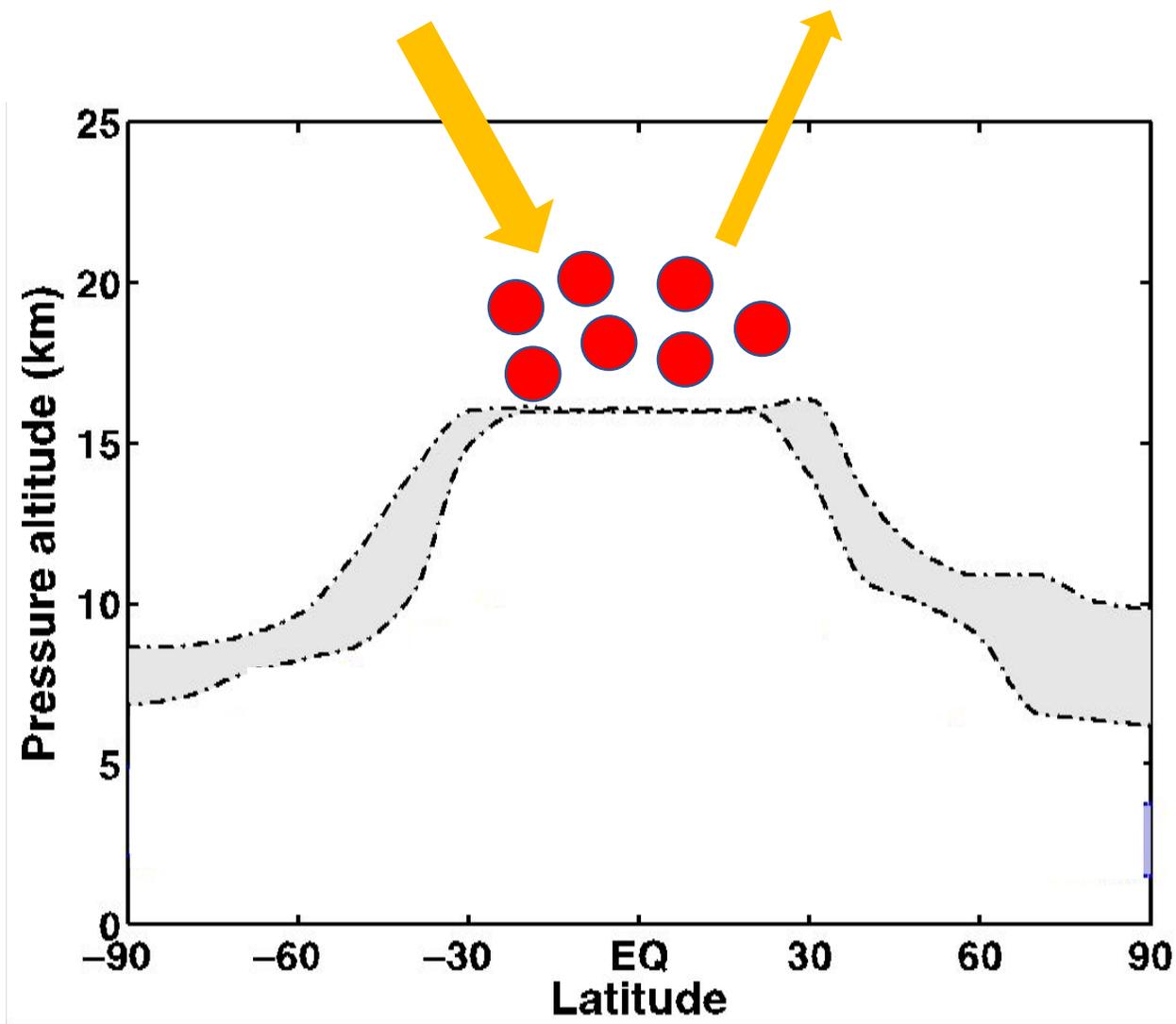
From SO₂ to the aerosol cloud



From SO₂ to the aerosol cloud

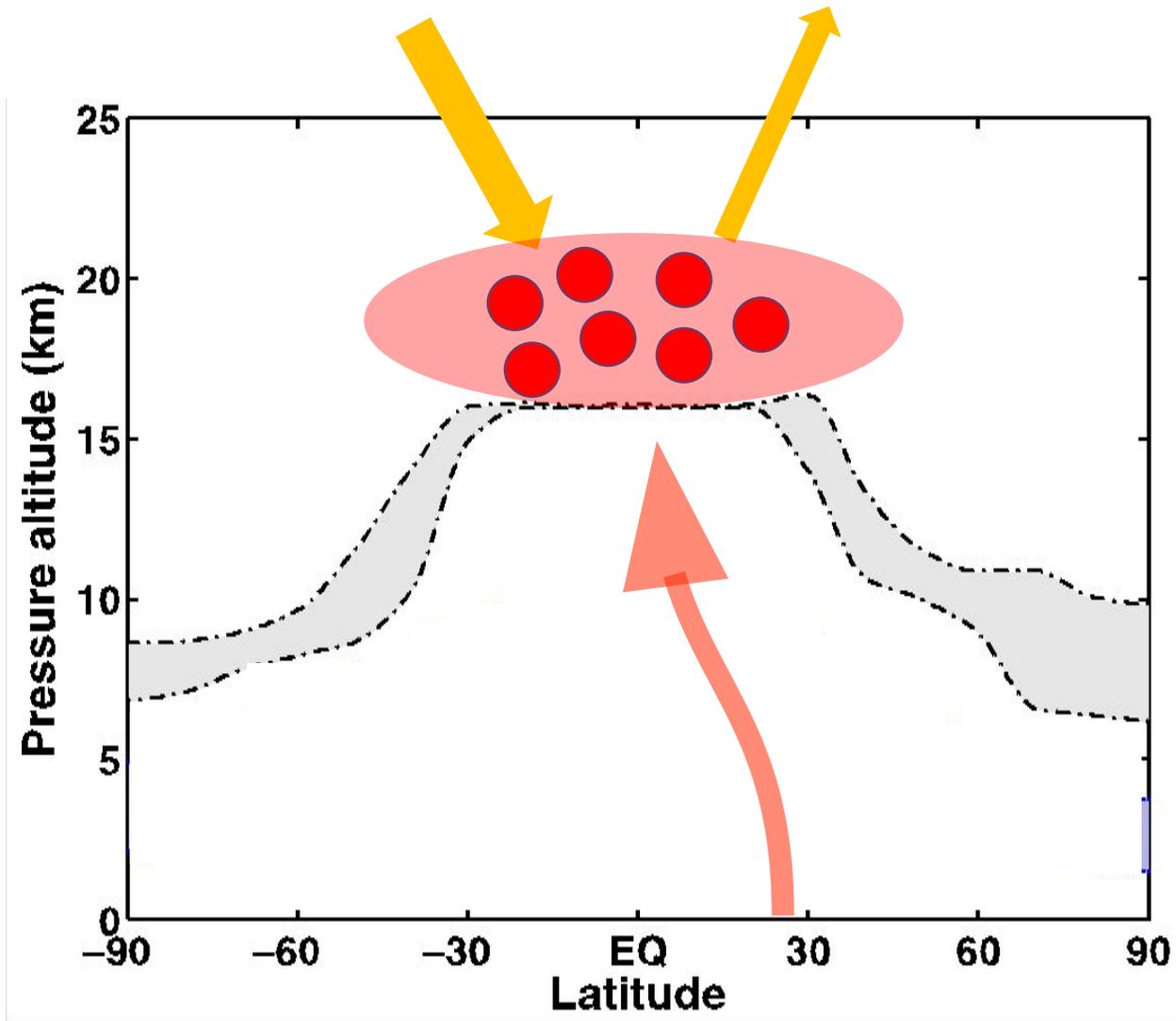
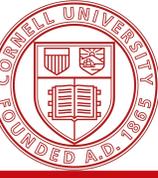


From SO₂ to the aerosol cloud

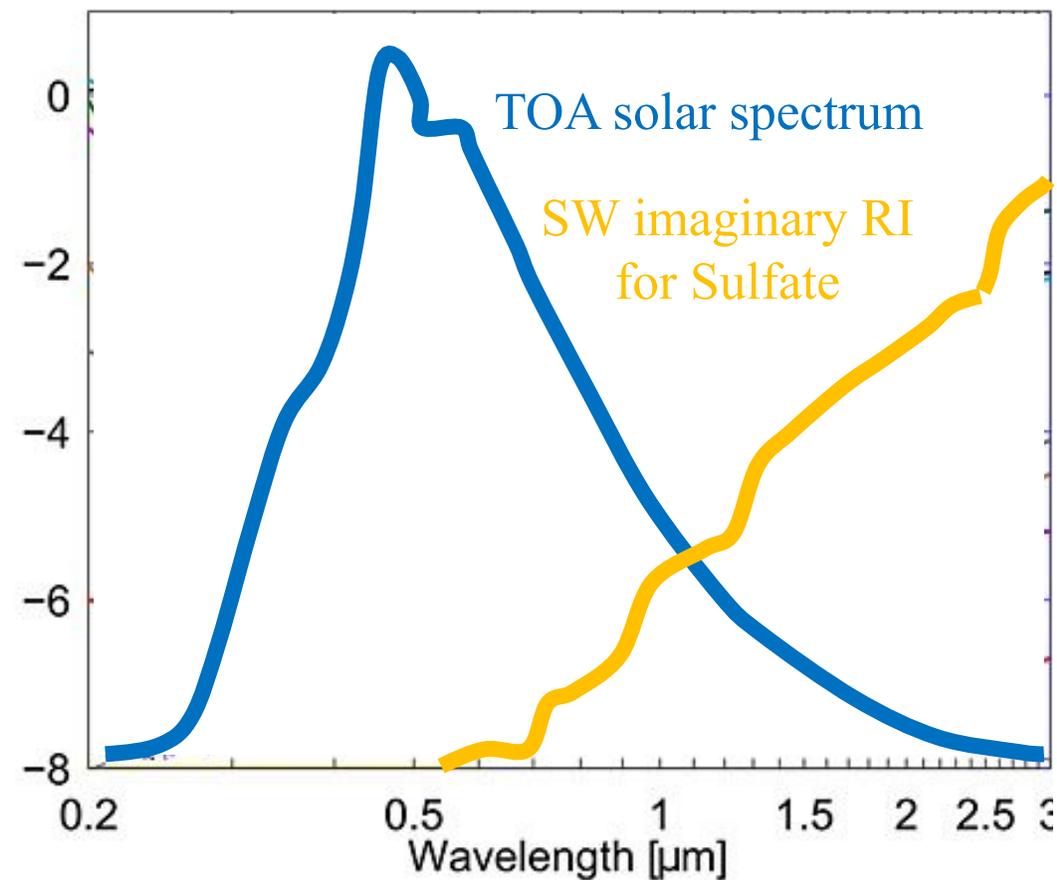
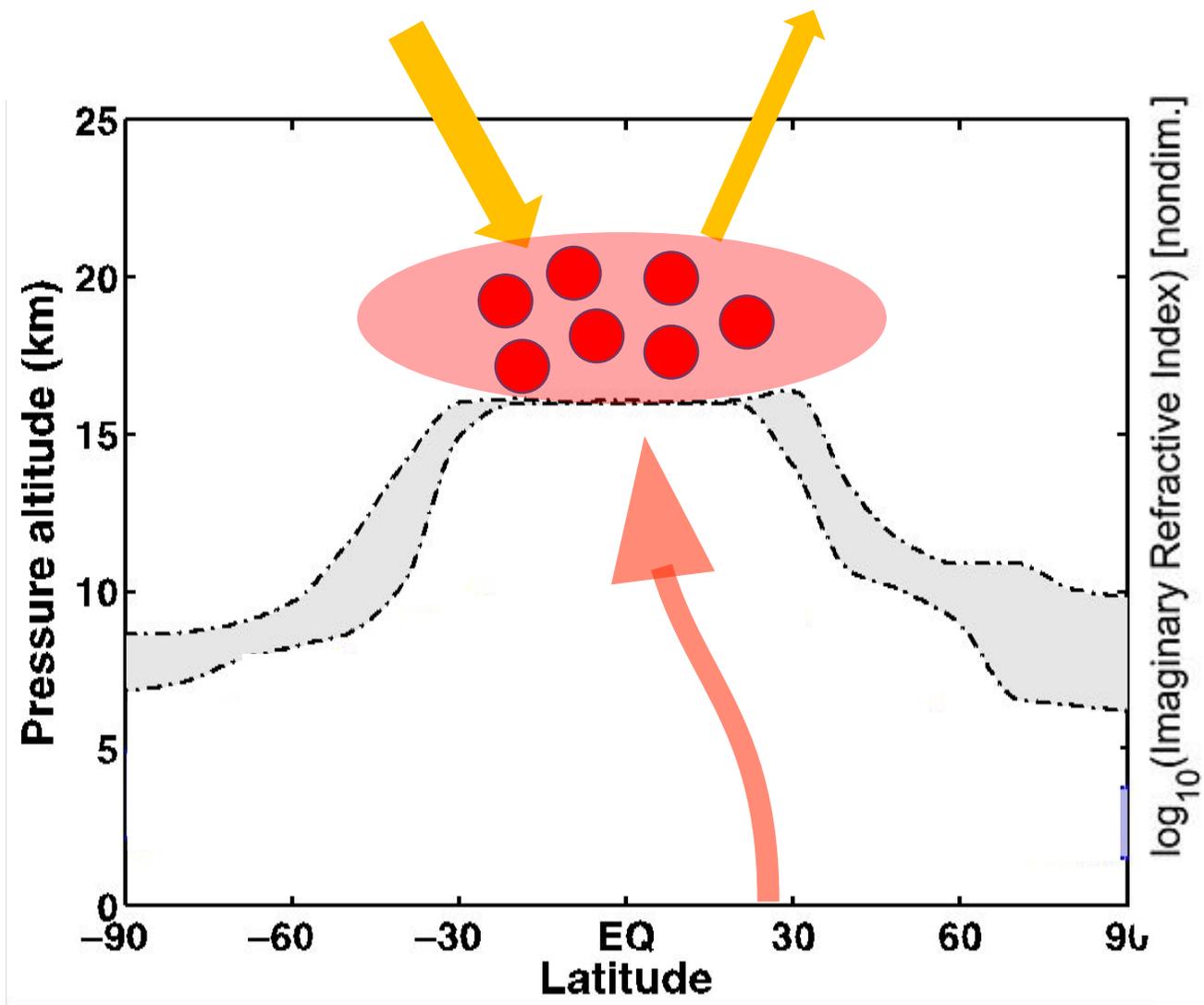


0.2-0.7 μm

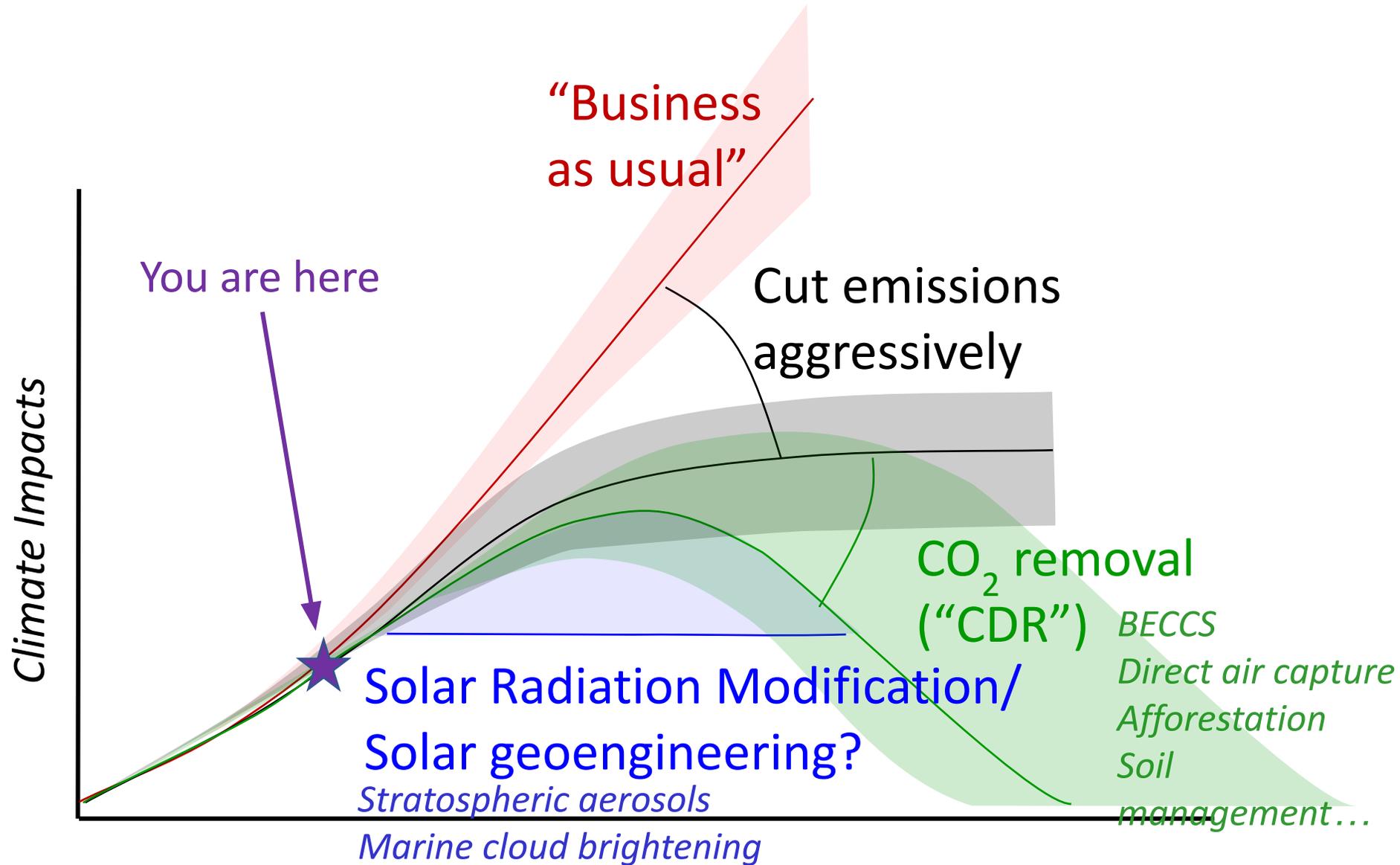
From SO₂ to the aerosol cloud



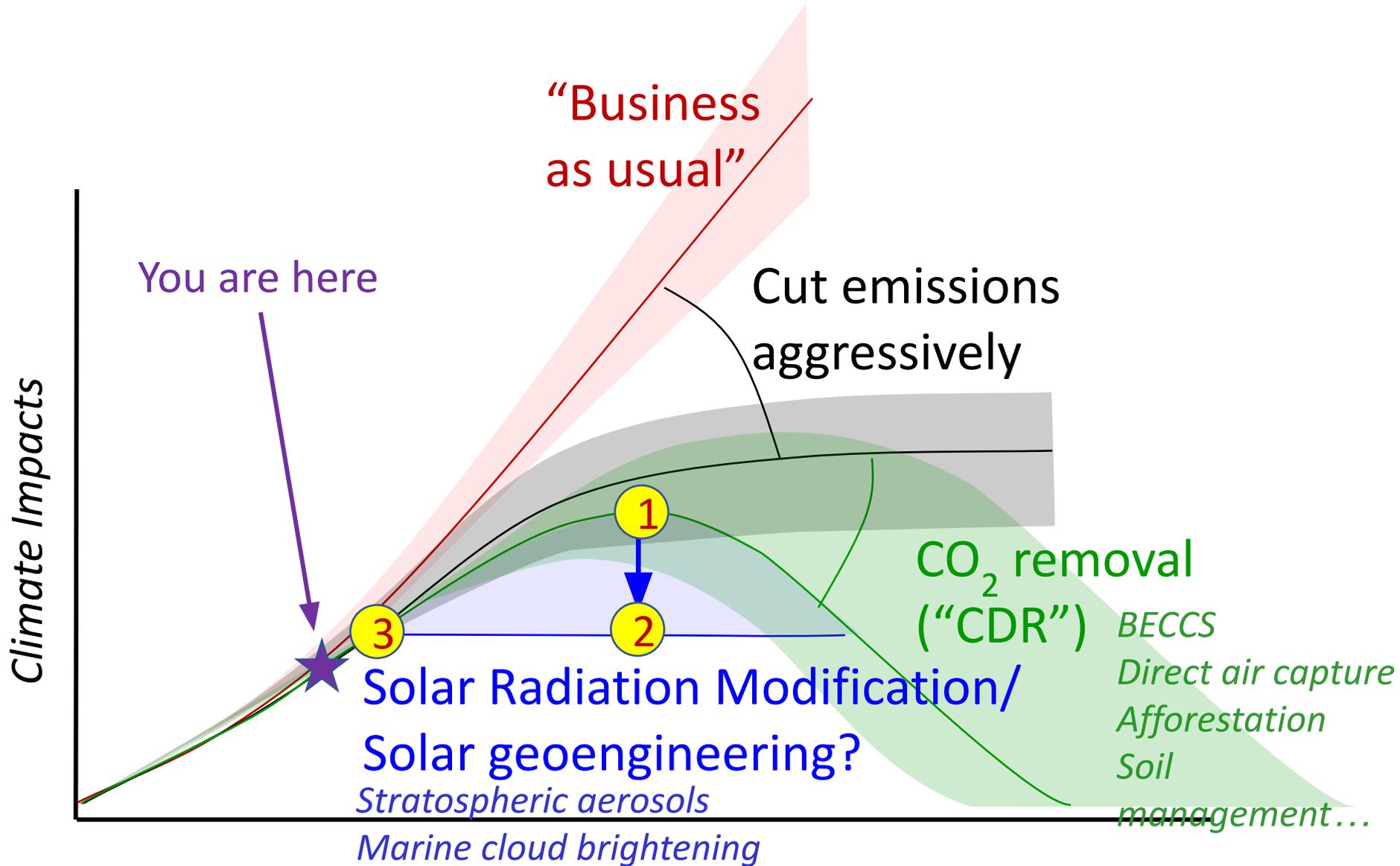
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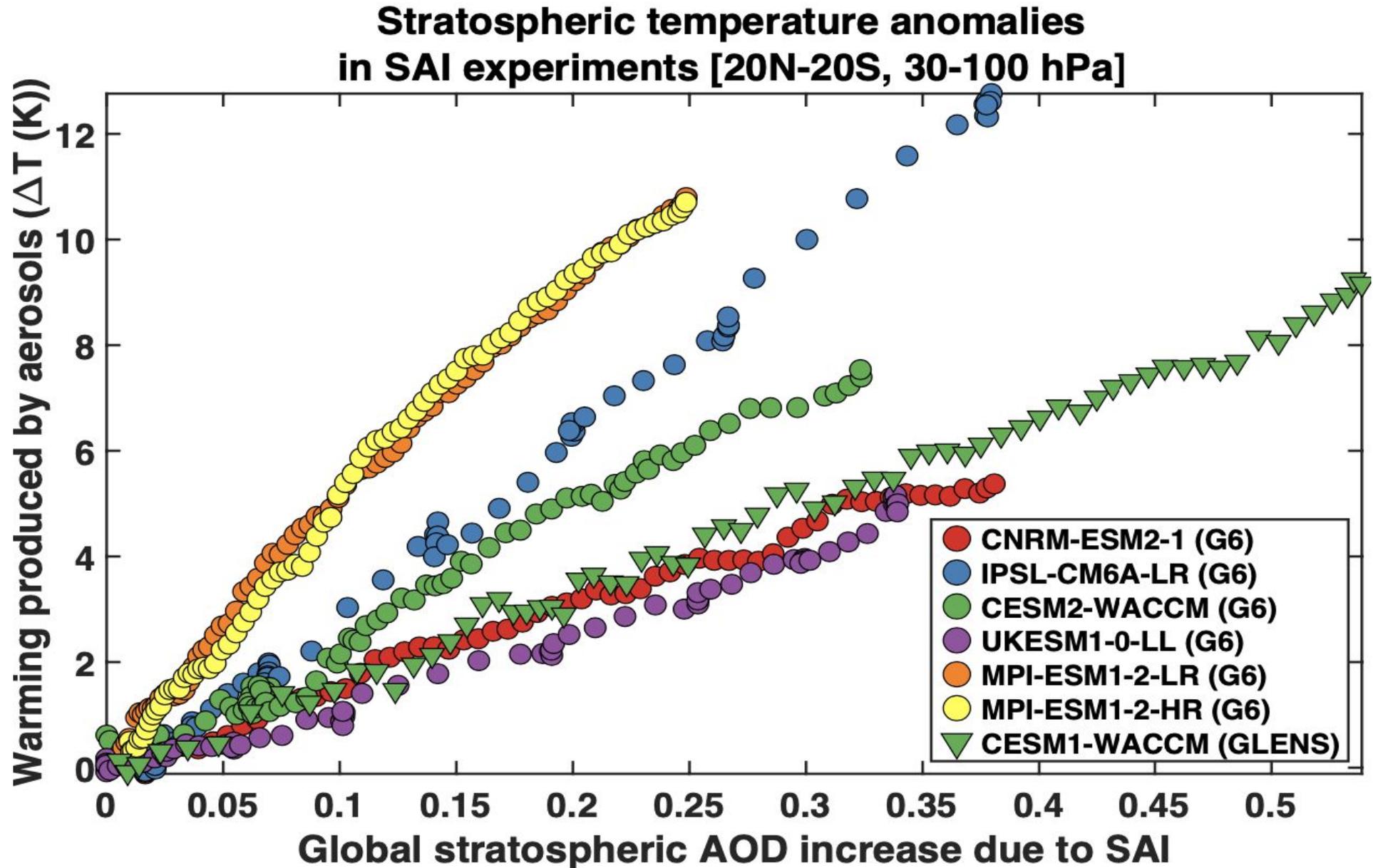
Why do we talk about Climate Intervention



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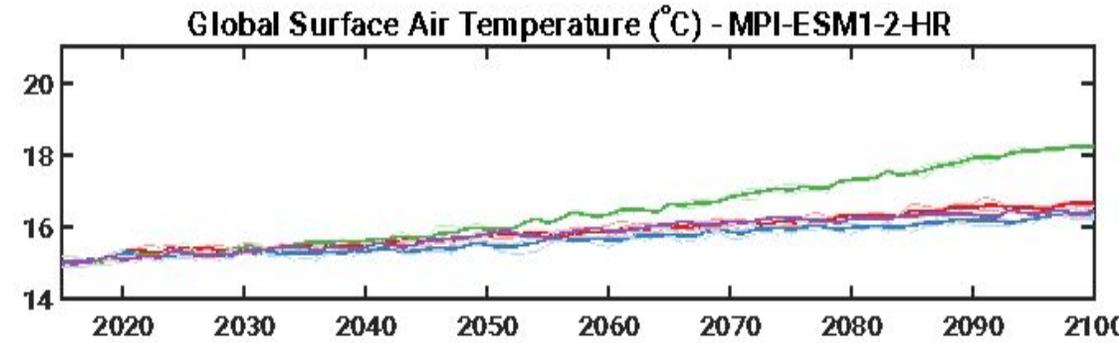
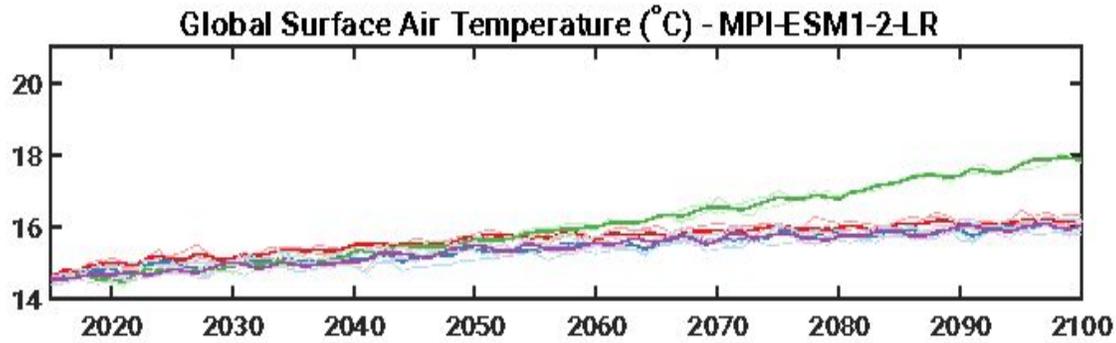
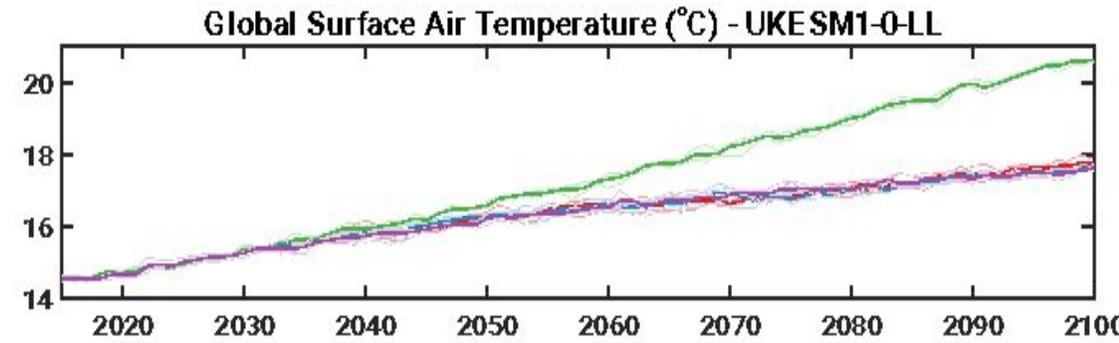
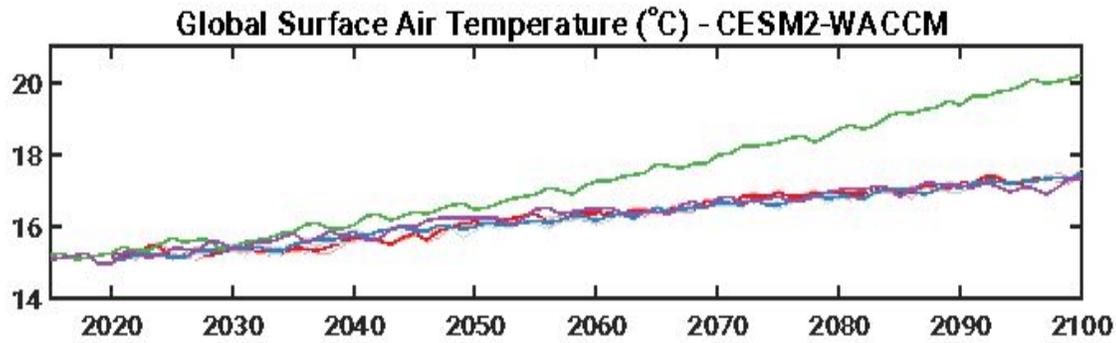
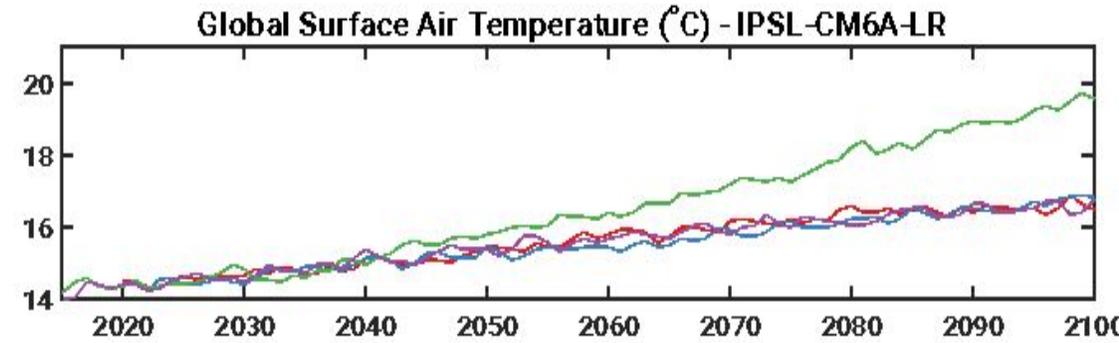
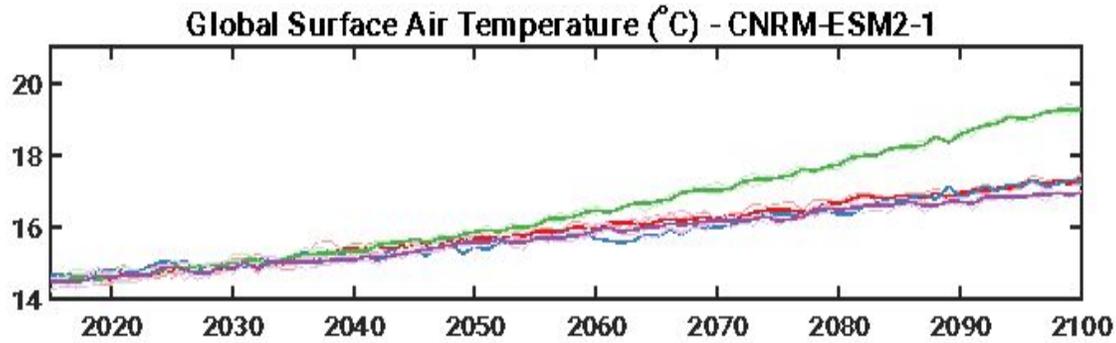
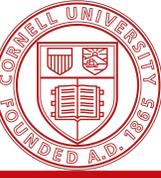
We're already been asked to do an SAI assessment...



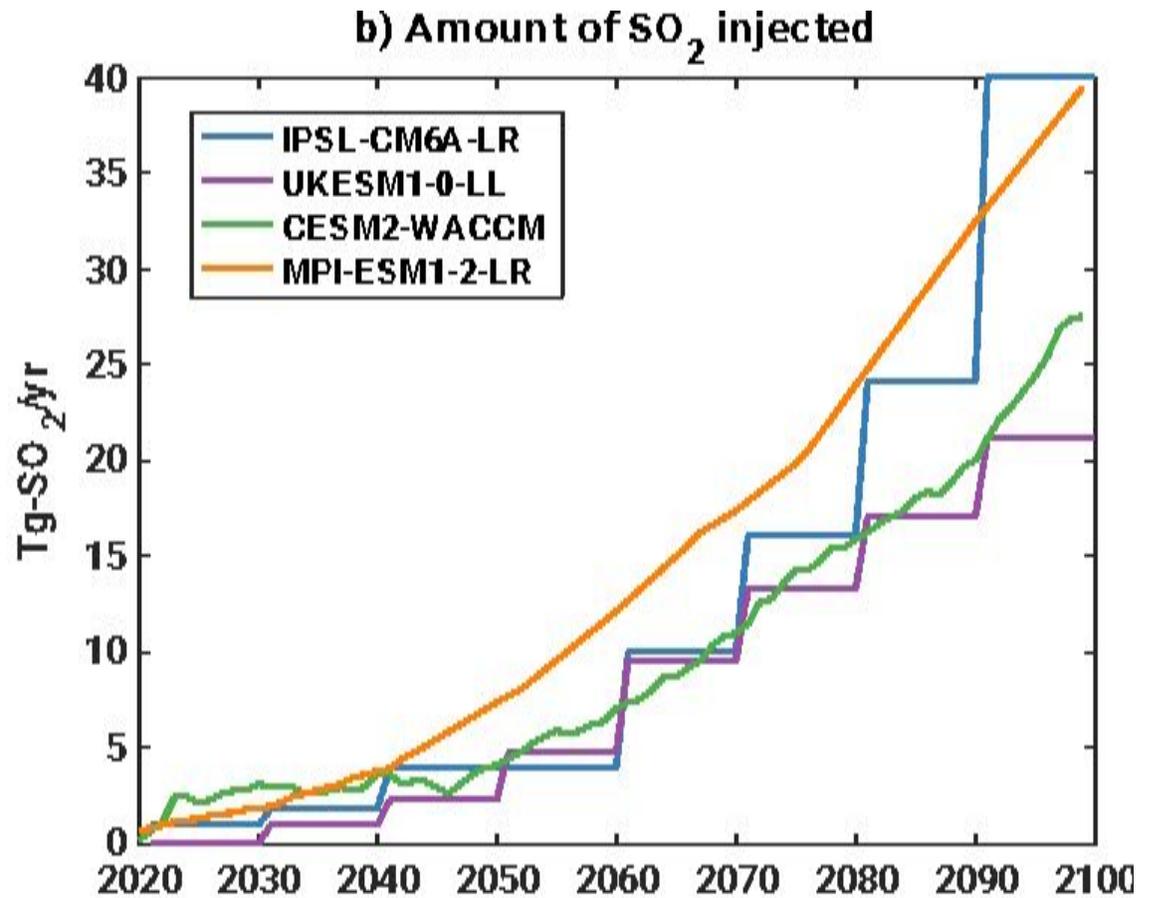
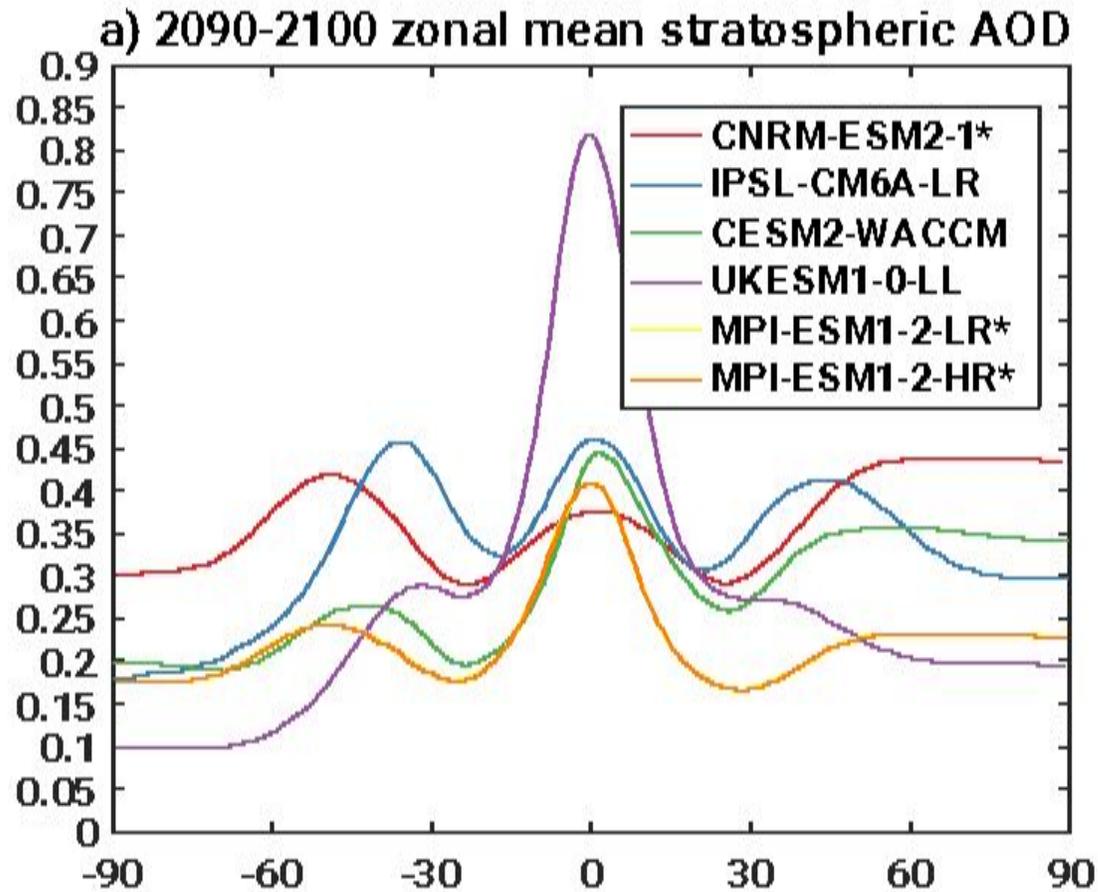
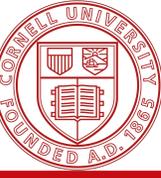
Tilmes,
Visioni et al.,
2021 ACP

And WMO
Assessment,
2022

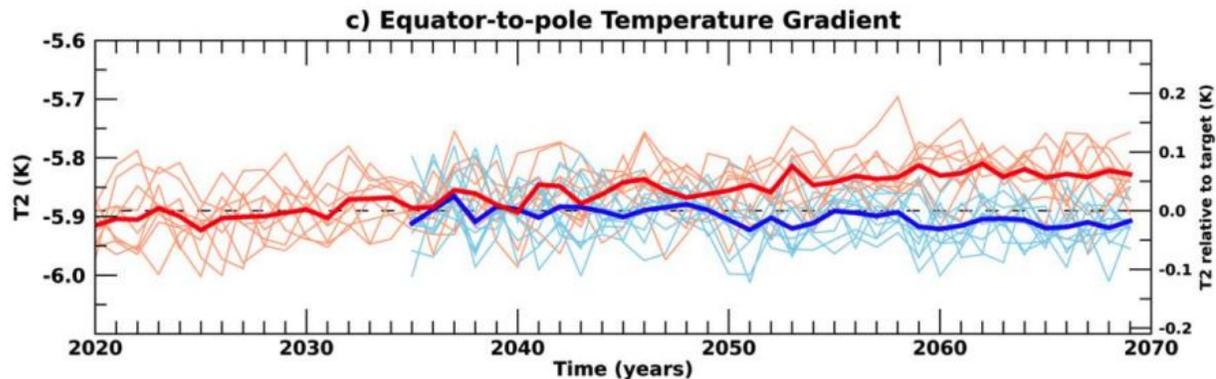
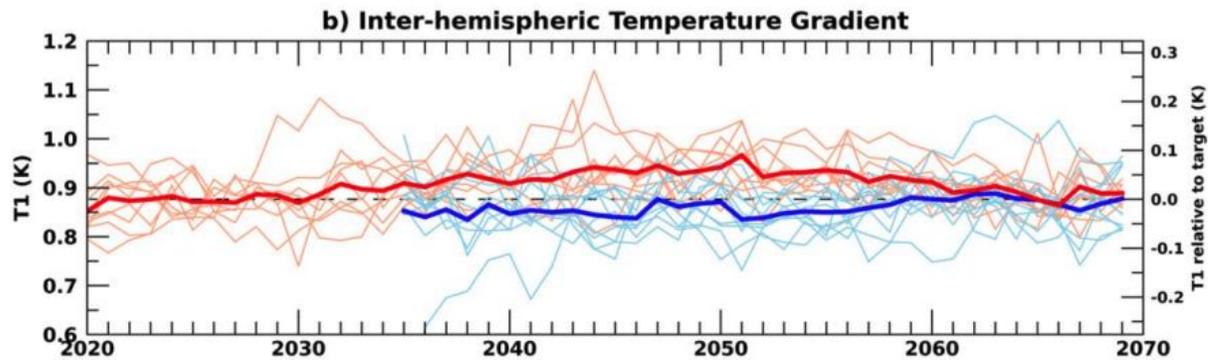
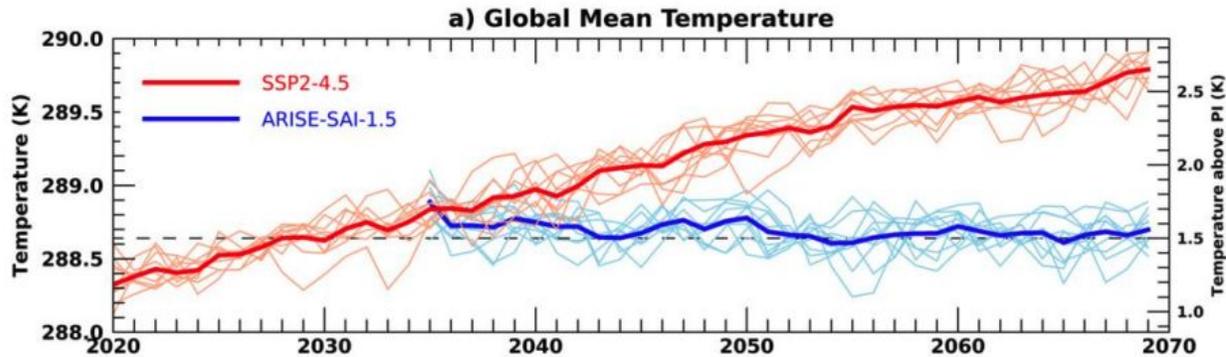
Comparing across climate models (GeoMIP)



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Approaching the problem with large ensembles: ARISE



Assessing Responses and Impacts of Solar climate intervention on the Earth system with stratospheric aerosol injection (ARISE-SAI): protocol and initial results from the first simulations

Jadwiga H. Richter¹, Daniele Visoni², Douglas G. MacMartin², David A. Bailey¹, Nan Rosenbloom¹, Brian Dobbins¹, Walker R. Lee², Mari Tye¹, Jean-Francois Lamarque¹

What questions is SAI supposed to answer??

- **Specific changes to stratospheric composition/dynamics**
- **Feasibility (potential for it to work, exploring the space)**
- **Specific surface changes even if it cools globally**

What questions is SAI supposed to answer??

- **Specific changes to stratospheric composition/dynamics**

Need a model like WACCM, with high top, good representation of stratospheric aerosols (CARMA?), good chemistry, good representation of features like QBO, polar vortex

- **Feasibility (potential for it to work, exploring the space)**

- **Specific surface changes even if it cools globally**

What questions is SAI supposed to answer??

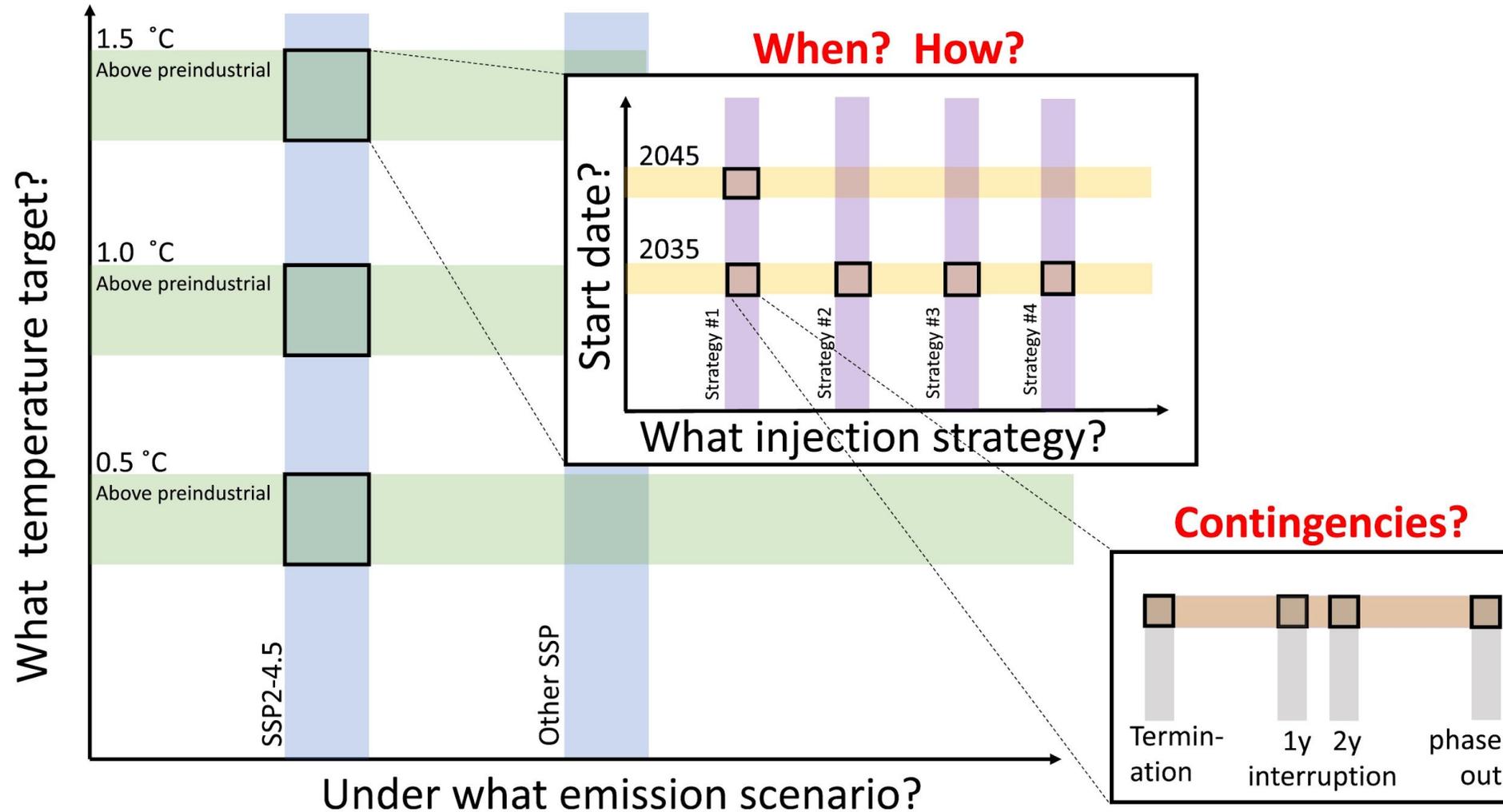
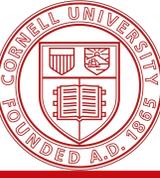
- **Specific changes to stratospheric composition/dynamics**

- **Feasibility (potential for it to work, exploring the space)**

A fast but reliable model that allow us to explore a space of potentially policy-relevant scenarios that is much larger than the one from climate change (like WACCM 2 degrees, need to test it!)

- **Specific surface changes even if it cools globally**

A new scenario framework to evaluate SAI impacts



What questions is SAI supposed to answer??

- **Specific changes to stratospheric composition/dynamics**
- **Feasibility (potential for it to work, exploring the space)**
- **Specific surface changes even if it cools globally**

People clearly want to know what impact this would have on a specific climatic feature (i.e. Indian Monsoon): this needs a higher resolution model, large ensembles to capture signal, potentially S2S setups to understand detectability of specific events

So what do we do?

- **Without a doubt CESM(WACCM) has done a lot of this work already and should continue going forward (also based on the strategic plan 😊).**

More people interested are always needed!

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3.3.d Research to advance development and analysis of climate change mitigation, intervention, and adaptation strategies

Given the risks posed by climate change, NCAR must improve and use its Earth system science knowledge and capabilities to provide scientifically sound and timely information on the likely effects of proposed climate mitigation and intervention strategies. We must also provide relevant information to policy makers as they consider ways to help people adapt to ongoing and future climatic changes. To help address these societal needs, NCAR will:

- ***Contribute relevant information to policy and decision makers on possible pathways to limit global warming to 1.5° or 2°C by***
 - Advancing understanding of how the Earth's climate system responds to various natural and human-generated influences, including improving estimation of climate sensitivity and the risks of tipping points and unintended consequences.
 - Combining models and observations to assess the performance of natural Earth system carbon sinks.
 - Identifying climate mitigation strategies and developing comprehensive modeling assessments of their efficacy and associated uncertainties.

So what do we do?

- **Without a doubt CESM(WACCM) has done a lot of this work already and should continue going forward (also based on the strategic plan 😊)**
- **Can one model do it all? Should one model do it all? Do we need to have all processes coupled, or come up with a different “framework”?**

So what do we do?

- **Without a doubt CESM(WACCM) has done a lot of this work already and should continue going forward (also based on the strategic plan 😊)**
- **Can one model do it all? Should one model do it all? Do we need to have all processes coupled, or come up with a different “framework”?**
- **If not, what should the community focus on?**
- **If yes, what resources does NCAR need to support this?**