

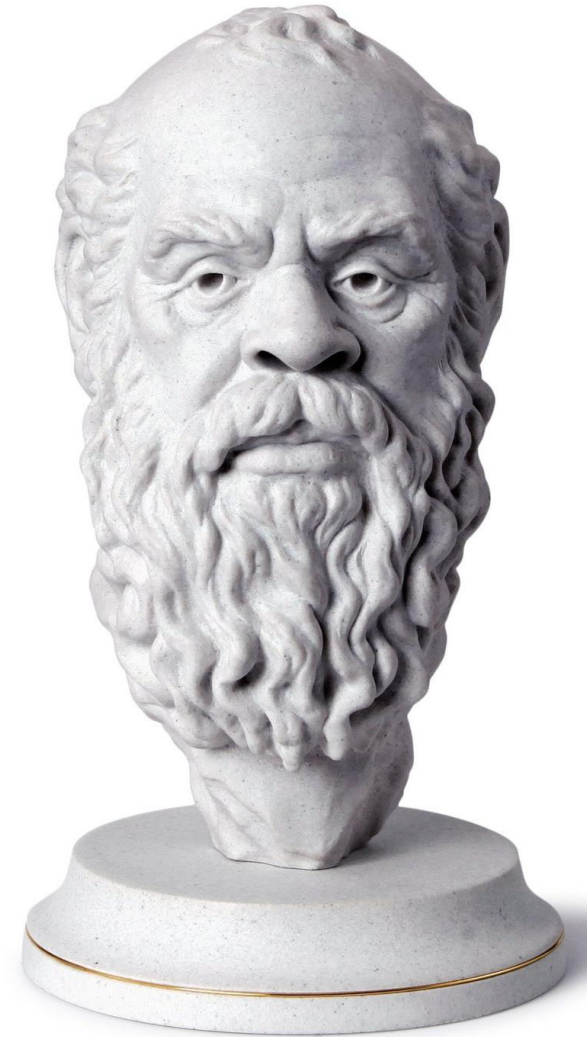
# Ethics and governance of solar geoengineering research: a bioethical analysis of the SCoPEX small outdoor experiment

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Global Forum for Bioethics in Research (GFBR)  
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# Disclaimer & veracity statement

- My knowledge of **medicine and public health** is very, very limited (most of it learned on the job).
- My knowledge of **climate science** is very, very, very limited (2 years, part-time dedication).
- The opinions expressed here are personal and do not necessarily coincide with the opinion of the institutions that fund my research.

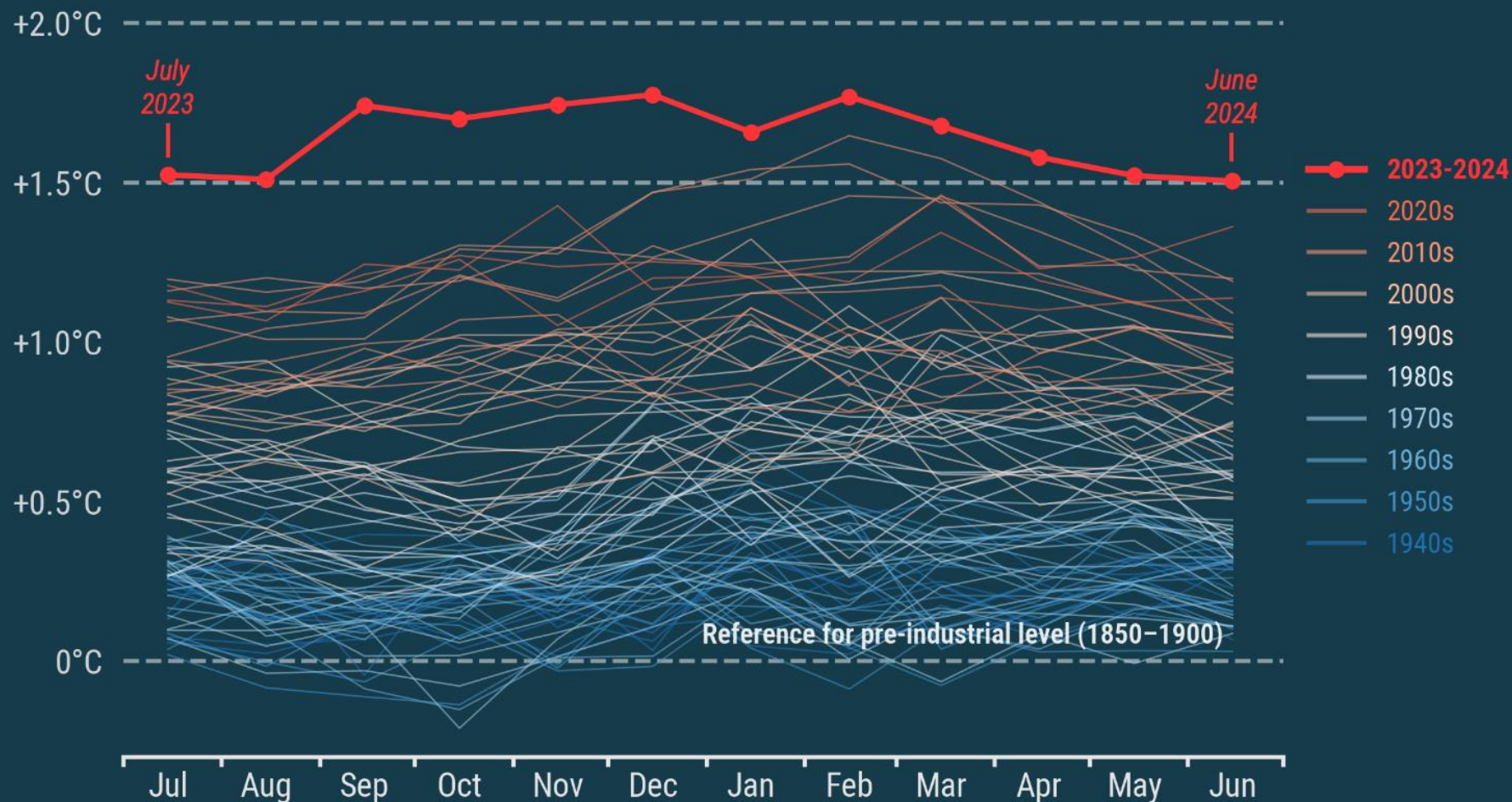


Socrates by André Waiga

The problem

# Monthly global surface temperature increase above pre-industrial

Data: ERA5 1940–2024 • Reference period: 1850-1900 • Credit: C3S/ECMWF



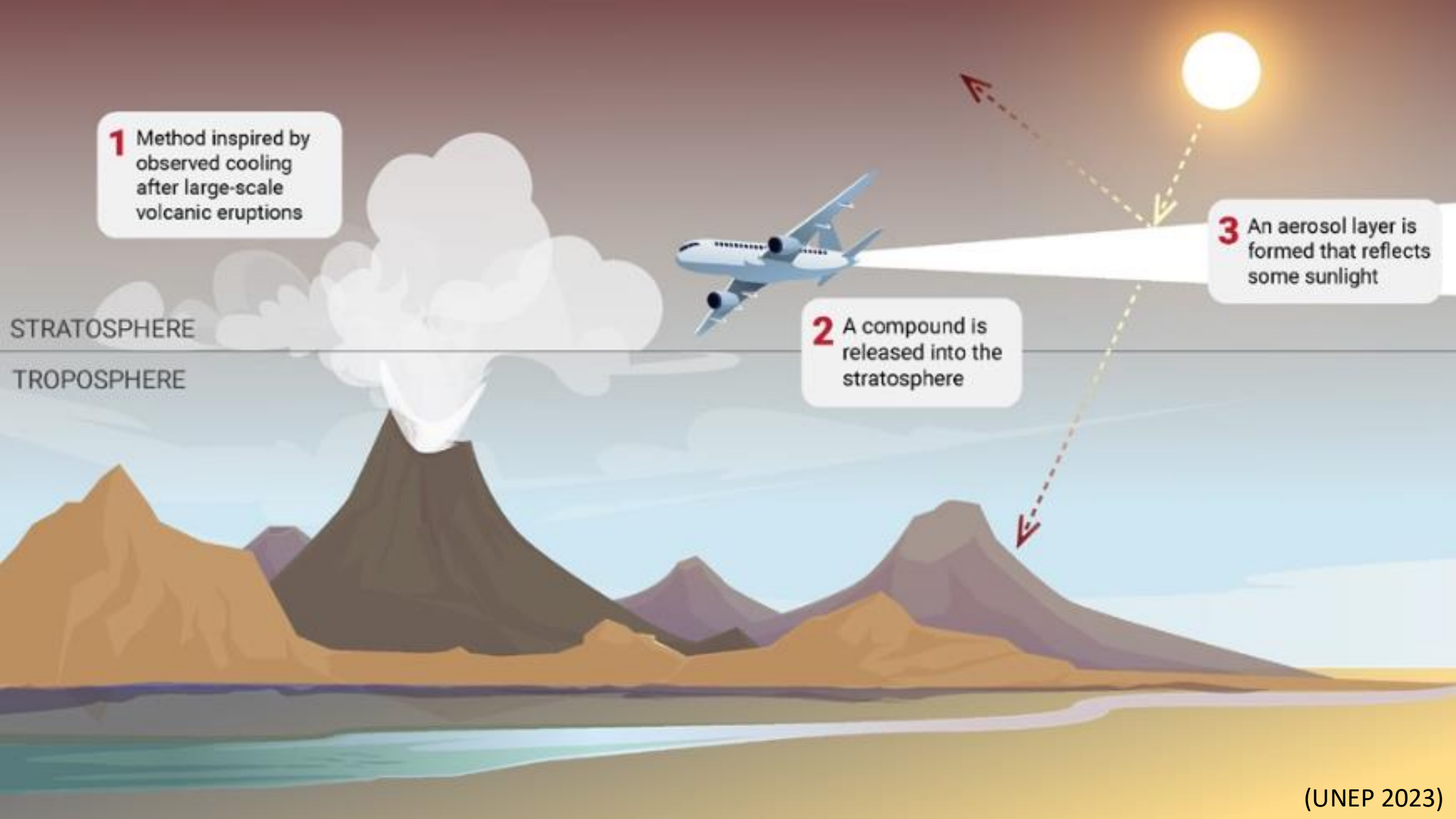
“For the first time [...] the global surface temperature reached or exceeded 1.5 °C above the 1850-1900 [pre-industrial] average, for 12 consecutive months” (C3S 2024)



PROGRAMME OF THE  
EUROPEAN UNION



A climate intervention?  
Planetary-scale deployment of  
stratospheric aerosol injection  
(SAI) to actively cool the Earth's  
surface



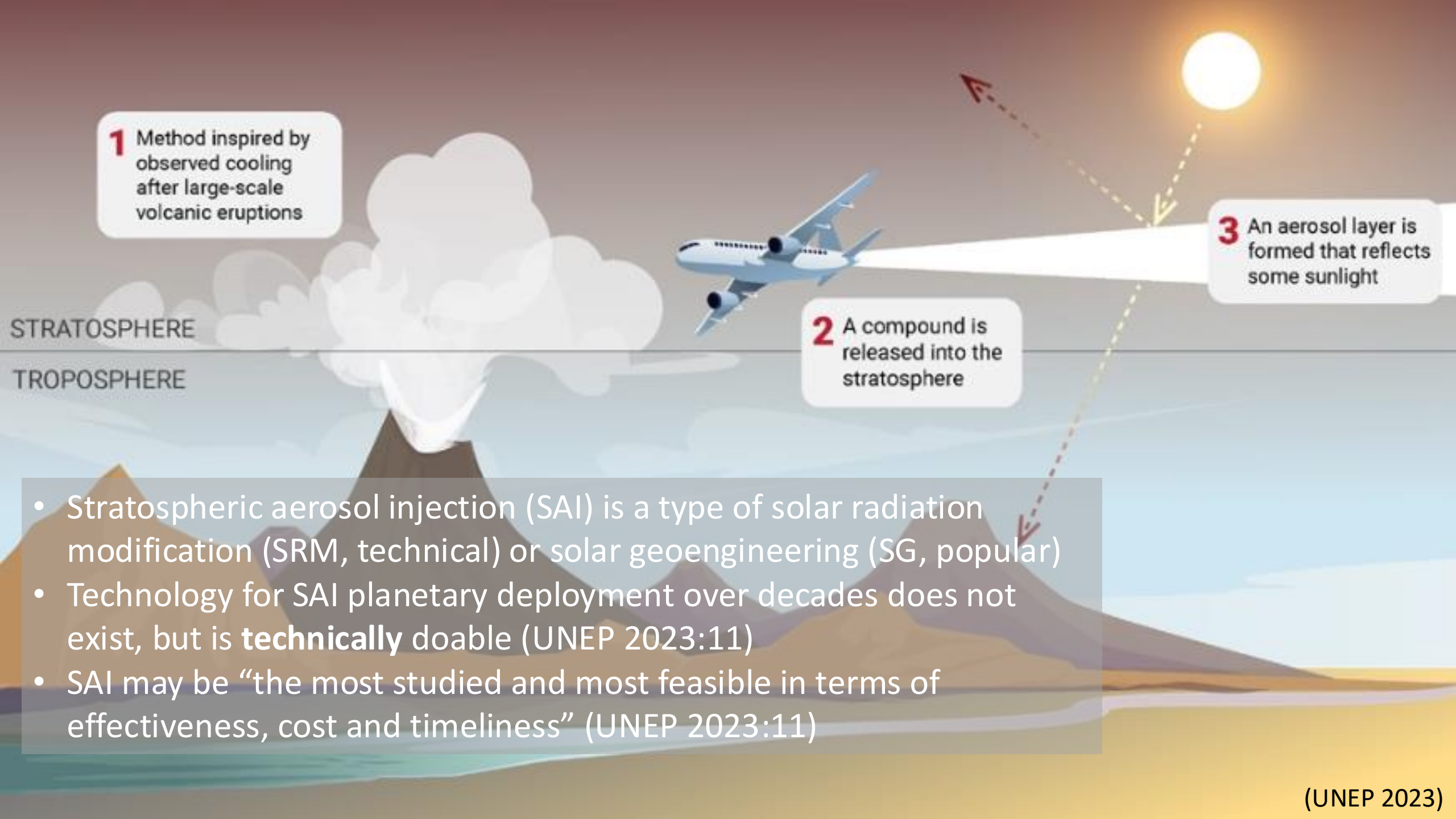
**1** Method inspired by observed cooling after large-scale volcanic eruptions

**2** A compound is released into the stratosphere

**3** An aerosol layer is formed that reflects some sunlight

STRATOSPHERE

TROPOSPHERE



1 Method inspired by observed cooling after large-scale volcanic eruptions

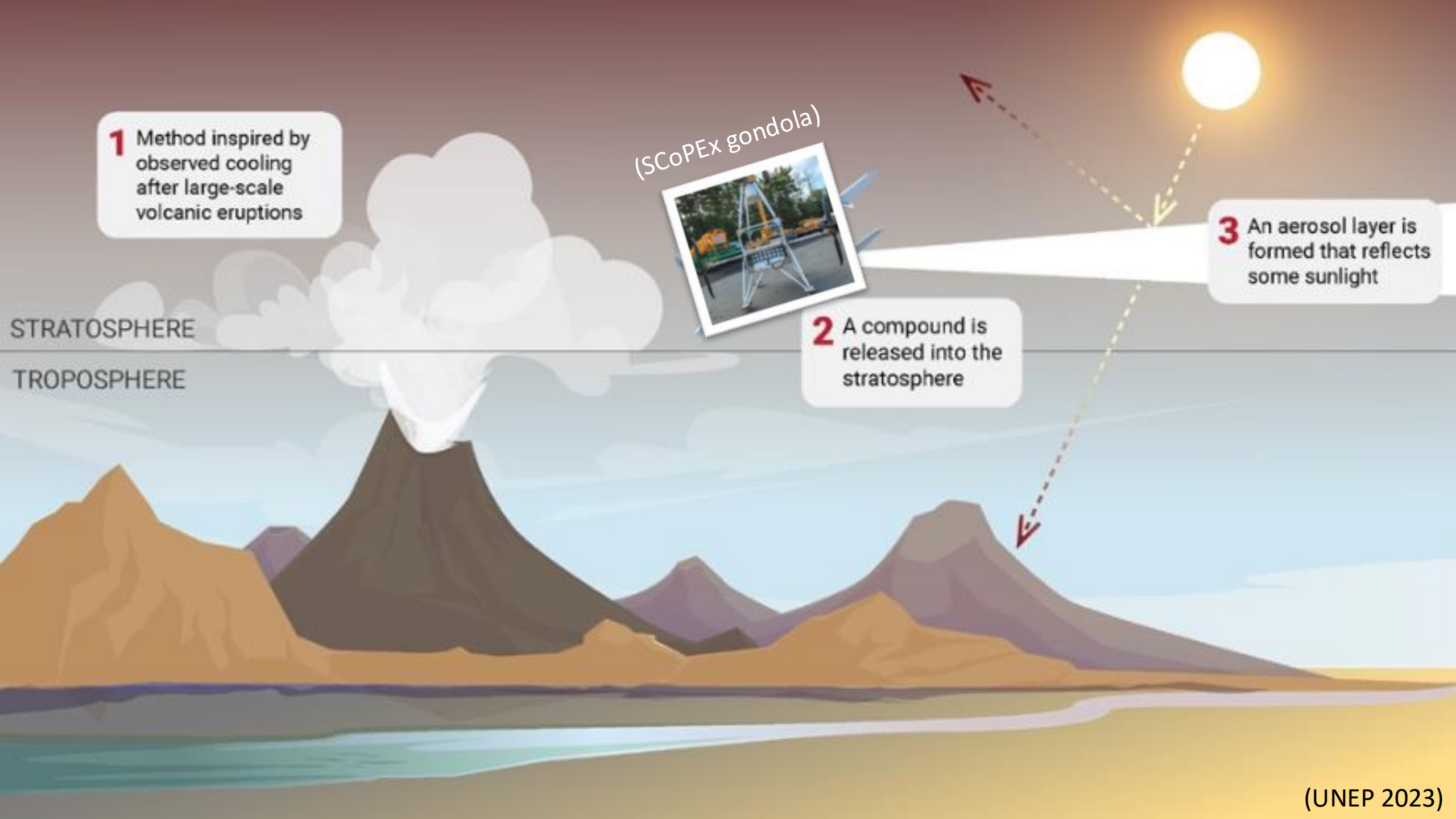
2 A compound is released into the stratosphere

3 An aerosol layer is formed that reflects some sunlight

- Stratospheric aerosol injection (SAI) is a type of solar radiation modification (SRM, technical) or solar geoengineering (SG, popular)
- Technology for SAI planetary deployment over decades does not exist, but is **technically** doable (UNEP 2023:11)
- SAI may be “the most studied and most feasible in terms of effectiveness, cost and timeliness” (UNEP 2023:11)

On our way to planetary SAI?  
SCoPEX, a small scale  
outdoor experiment





**1** Method inspired by observed cooling after large-scale volcanic eruptions

(SCoPEX gondola)



**2** A compound is released into the stratosphere

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STRATOSPHERE

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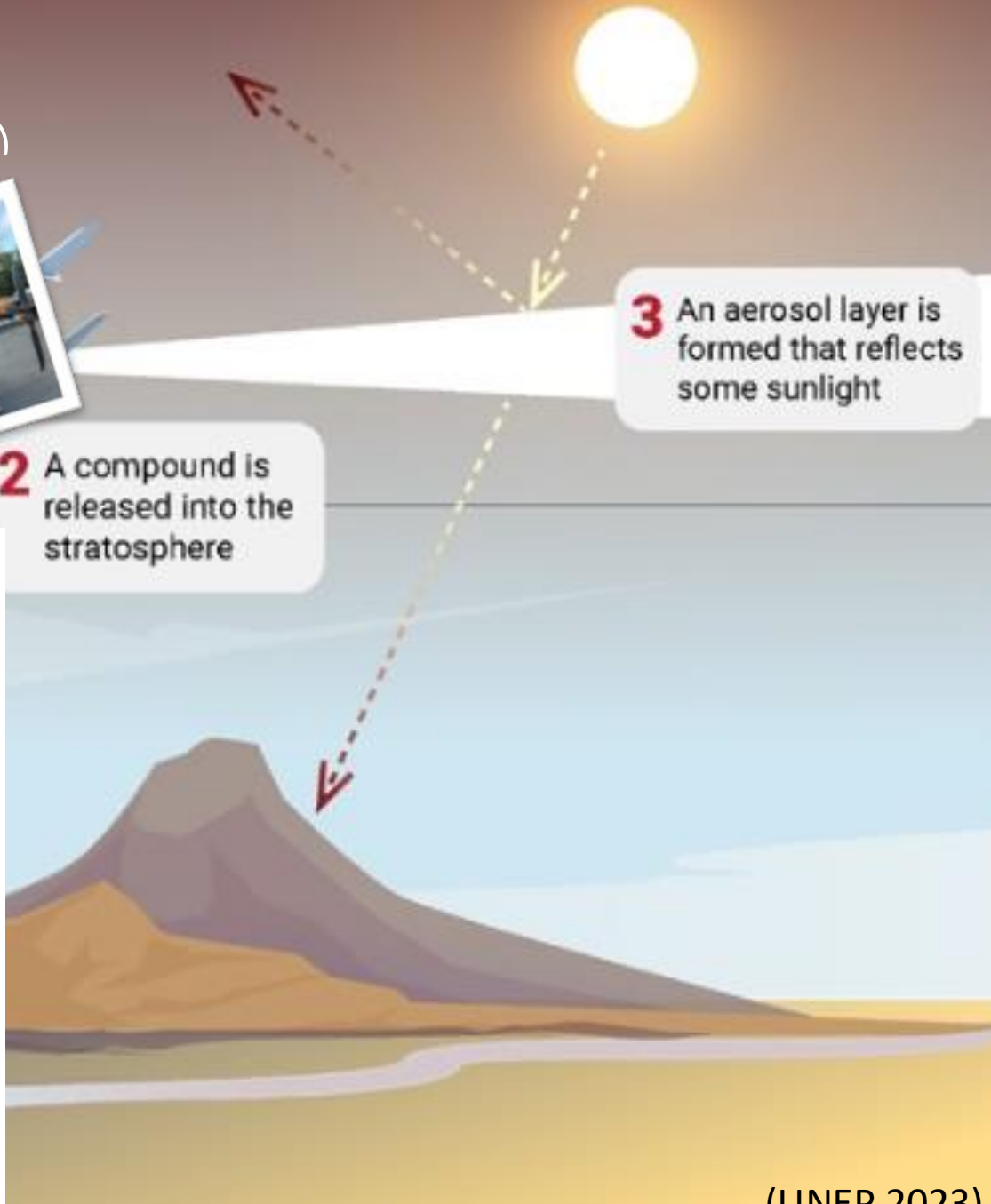
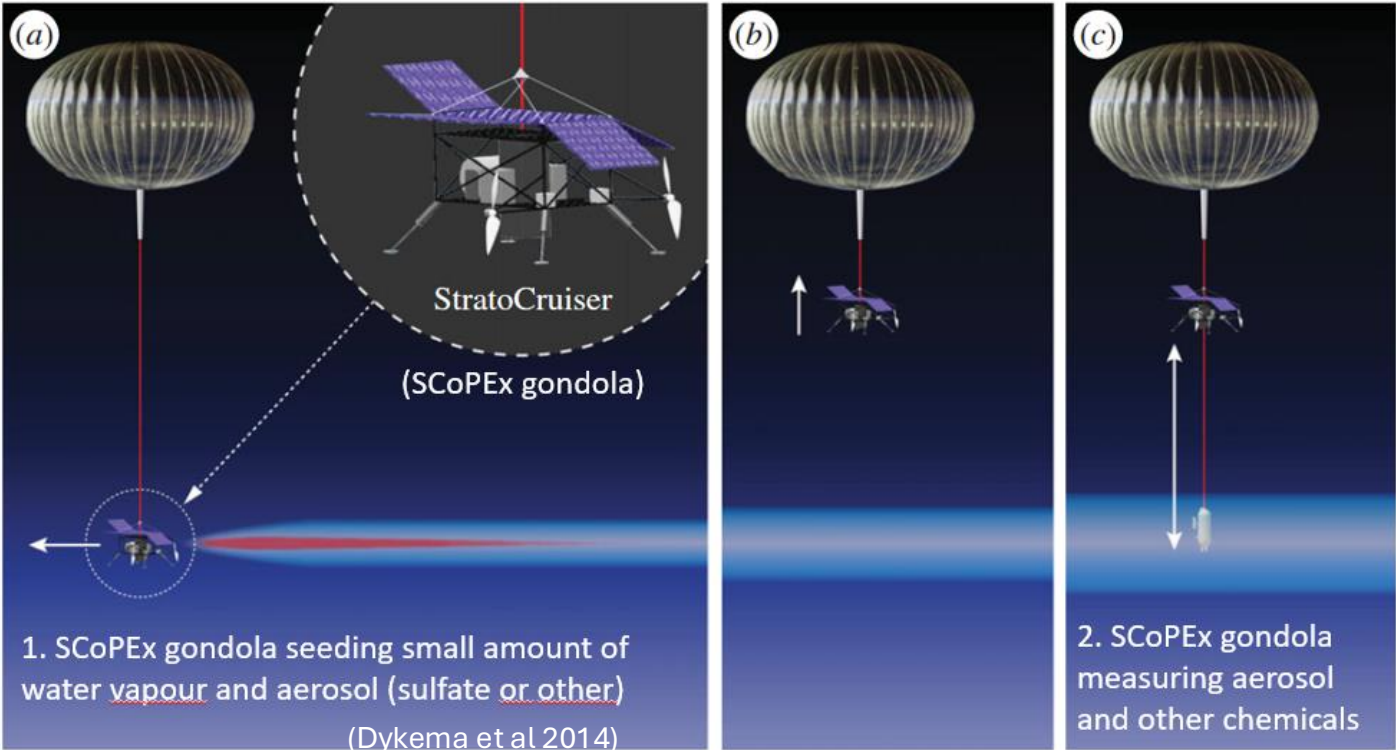
(SCoPEX gondola)



**3** An aerosol layer is formed that reflects some sunlight

**2** A compound is released into the stratosphere

STRATOSPHERE



# SCoPEx case 1: details

- **Main aim:** reduce uncertainty about chemical interactions and contribute knowledge generated by computer model and laboratory results,
- **Immediate risks of SCoPEx:** No significant physical risks to people or the environment from the 2 kg of aerosol deployment
- **Mediate risks of SCoPEx:** SG/SAI research activity may be a significant deterrence of ambitious mitigation policies (aka “moral hazard”, lock-in effects, etc.)
- **Aerosol 1:** sulfate, sulfur dioxide (SO<sub>2</sub>), naturally occurring in the stratosphere (e.g. Mount Pinatubo, human generated pollution)
- **Aerosol 2:** calcium carbonate, a non-toxic chemical found in nature in limestone and eggshells, used as a common additive in paper & toothpaste.
  - More questionable scientific relevance for SAI large scale deployment

# SCoPEX case 2: abbreviated chronology

- SCoPEX, first proposed in 2014
  - Experiment explicitly related to the efficacy and safety of planetary use of SAI
  - ≠ use of Marine Cloud Brightening (MCB) to protect Australian Great Barrier Reef
    - regional aim, non-planetary deployment
- Cancellation in 2021 of a test flight in Sweden (no aerosol release)
  - Swedish environmental organization and the Saami Council – representing the **Sámi, a multi-national indigenous people of the Arctic region**– asked Harvard to suspend SAI research.
- Different visions about SRM research, deployment, funding as well as the lack of previous community engagement with Saami Council
  - Confounder 1. The Sámi have a long history of regional eugenic health policies and discrimination (Danielsson 2020)
  - Confounder 2. Participation of anti-SRM groups (e.g. ETC group) (Keith 2024)
  - Confounder 3. SCoPEX private funding by “billionaires”, not public funding (e.g. ARIA UK)
- Harvard halted SCoPEX, March 2024

SCoPEx:

a bioethical analysis of ethics  
and governance of SG research

# Fundamental questions

- What is an SRM experiment (research or deployment)?
- Is small-scale outdoor SAI research ethically permissible?
- Should low- and middle-income countries host small outdoor SAI research?
- Did SCoPEX have adequate community engagement and research governance?
- Are indigenous voices necessary against SRM?
- What are democratic societies' duty against misinformation on SRM?

# Fundamental questions

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# What is an SG experiment (research or deployment)?



## Make Sunsets

- small-scale outdoor "cooling scheme" (deployment)
- stated main aim: benefit others

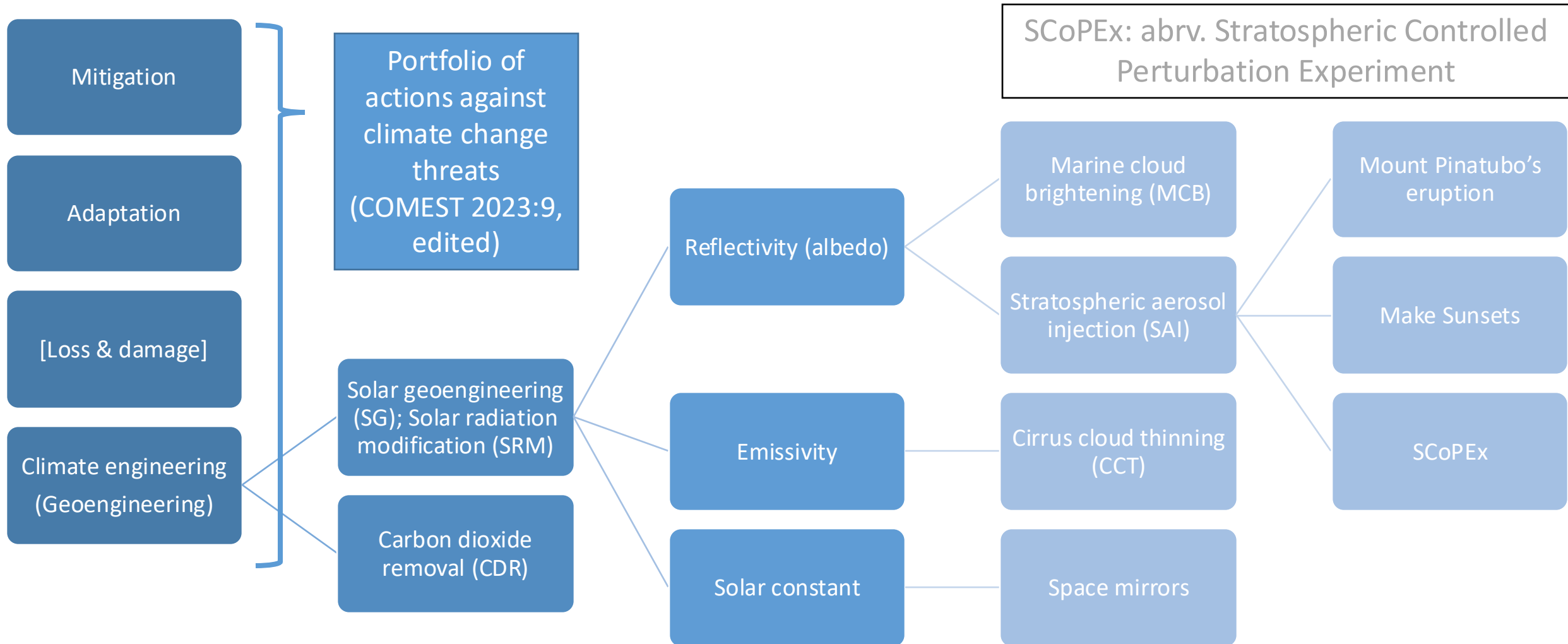


## SCoPEX

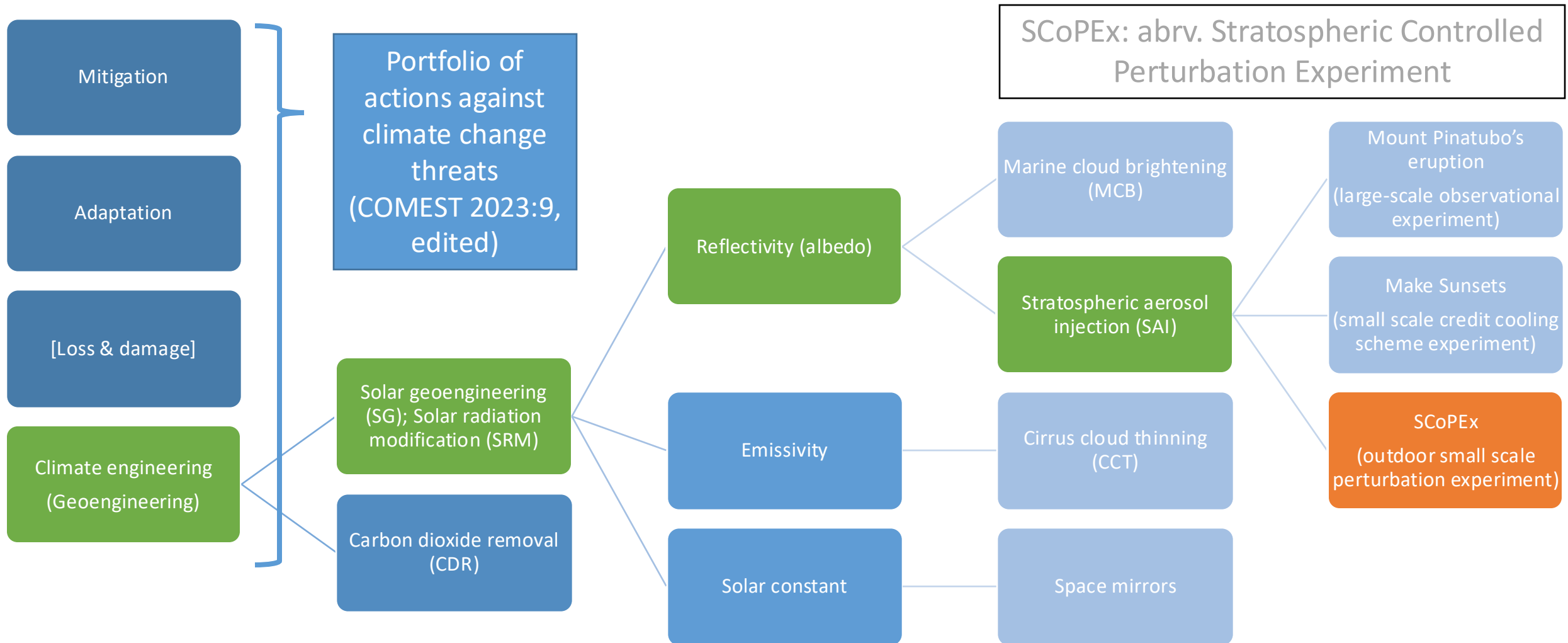
- small-scale outdoor perturbation experiment (research)
- stated main aim: reduce uncertainty, generate knowledge



# What is SCoPEx?



# SCoPEX: exemplary case of outdoor small-scale solar geoengineering (SG) research



# Is small-scale outdoor SAI research ethically permissible?

- Considered **ethically permissible** by authoritative international research ethics guidelines (COMEST-UNESCO 2023, AGU 2024).
  - Considered **ethically mandatory** (“moral imperative”) by significant authors (Lawrence & Crutzen 2017)?
- Considered **ethically forbidden** by “Non-Use Agreement” (NUA) defenders (Biermann et al. 2022) and other anti-SRM groups (e.g. ETC group, Heinrich-Böll Foundation [Germany’s green party related])

# Did SCoPEX have adequate community engagement and research governance?

POLICY FORUM

CLIMATE CHANGE




## Do small outdoor geoengineering experiments require governance?

Standardized and/or centralized proactive research governance can lessen tensions

By **Sikina Jinnah<sup>1</sup>, Shuchi Talati<sup>2</sup>, Louise Bedsworth<sup>3</sup>, Michael Gerrard<sup>4</sup>, Michael Kleeman<sup>5</sup>, Robert Lempert<sup>6</sup>, Katharine Mach<sup>7,8</sup>, Leonard Nurse<sup>9</sup>, Hosea Olayiwola Patrick<sup>10,11</sup>, Masahiro Sugiyama<sup>12</sup>**

In March 2024, Harvard University publicly announced the cancellation of its proposed Stratospheric Controlled Perturbation Experiment (SCoPEX), which would have been the world's first outdoor stratospheric aerosol injection (SAI) experiment. SAI, a type of solar geoengineering (SG), seeks to cool the planet by releasing aerosols into the stratosphere to reflect sunlight. The co-authors here are members of the independent advisory committee (AC) convened by Harvard in 2019 to develop a research governance framework for SCoPEX. We frame below the importance of SCoPEX and SG governance and summa-

# Are indigenous voices necessary against SG?

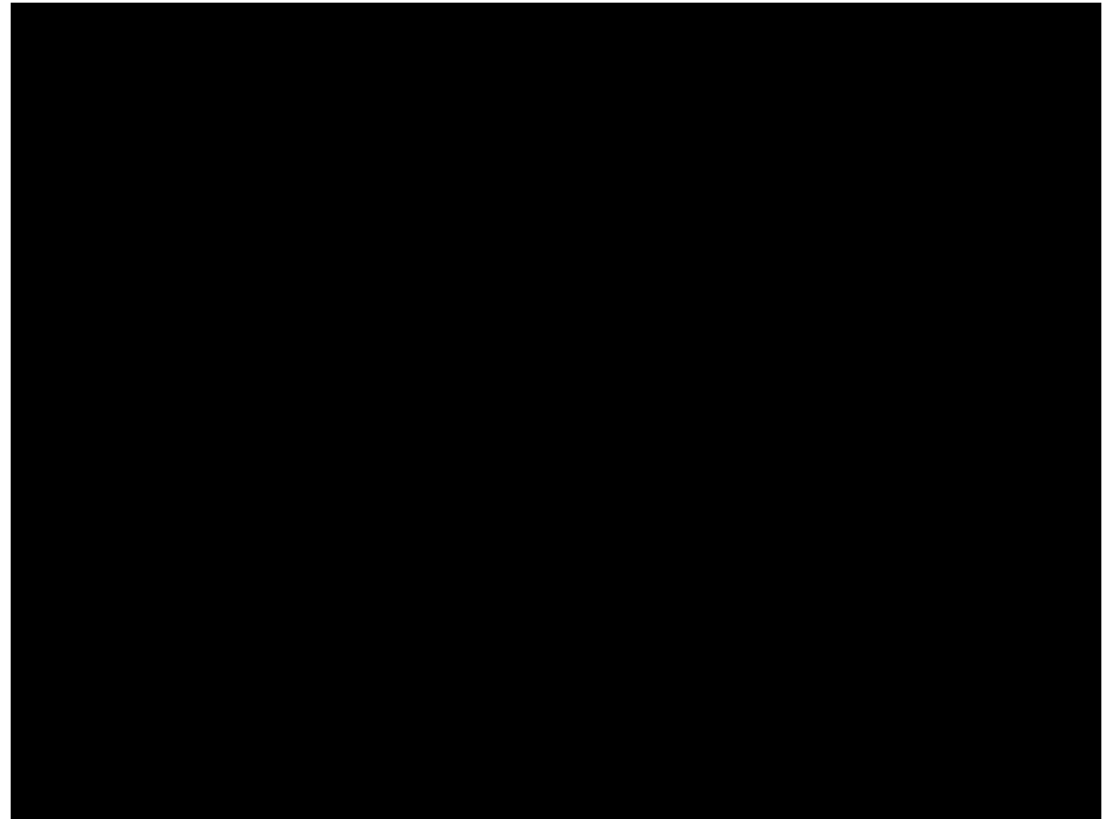
	Indigenous	Non-Indigenous
Against SG research ?	 <p><b>C2GTalk</b> Why did the Saami Council oppose Harvard's SCoPEX experiment? <b>Åsa Larsson Blind</b> Vice-President of the Saami Council</p>	<p><i>The New York Times</i></p> <hr/> <p><b><i>California City Leaders End Cloud-Brightening Test, Overruling Staff</i></b></p> <p>The City Council in Alameda, Calif., voted to stop tests of a device that could one day cool the Earth. Scientists and city staff had previously concluded the tests posed no risk.</p>
In favor of SG research ?	 <p>Pirita Näkkäläjarvi, President Saami Parliament of Finland</p>	 <p>Frank Keutsch, SCoPEX PI (Gelles 2024)</p>

# Lessons on responsible innovation?

## The apprentice's lesson



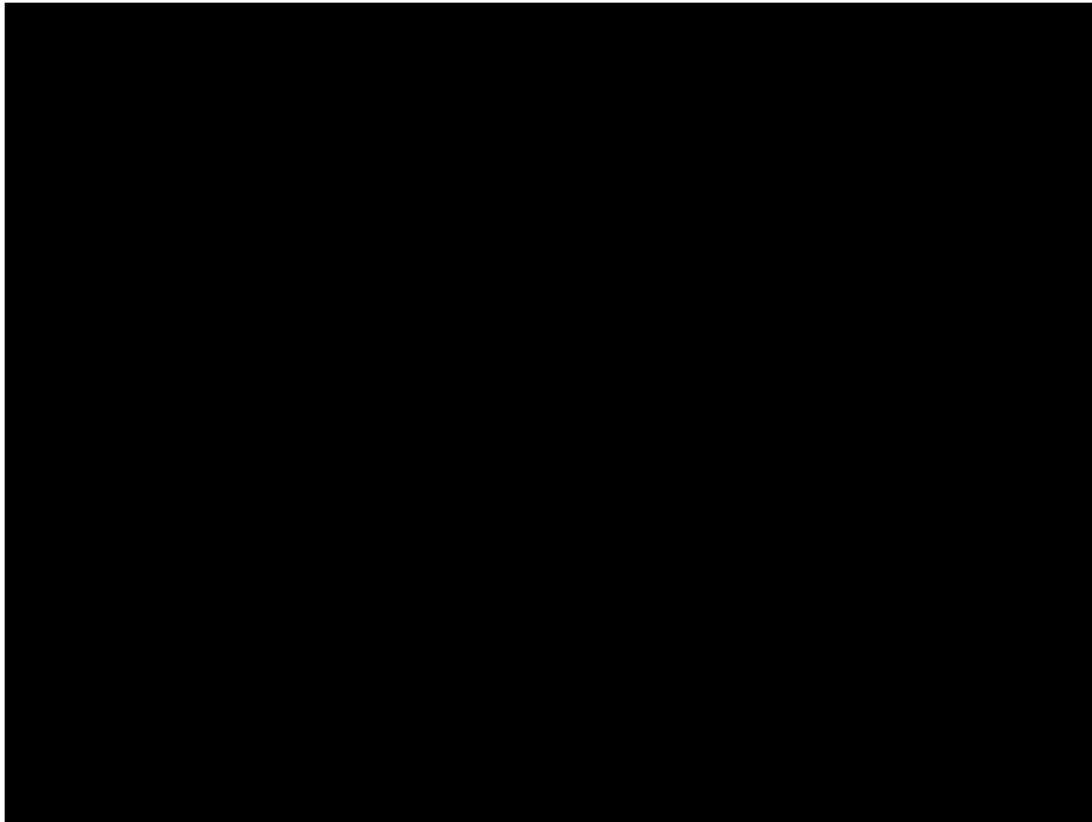
## The old master's lesson



*The Sorcerer's Apprentice (Goethe 1797), Fantasia (1940 film)*

# Lessons on responsible innovation?

## The apprentice's lesson



## The old master's lesson



*The Sorcerer's Apprentice (Goethe 1797), Fantasia (1940 film)*



iMuchas gracias!

The gondola for the SCoPEX project would provide maneuverability, release particles, and take measurements.

(Jinnah et al 2024)



# References

- The Copernicus Climate Change Service (C3S). (2024, July 17). *Why do we keep talking about 1.5°C and 2°C above the pre-industrial era?* News. <https://climate.copernicus.eu/why-do-we-keep-talking-about-15degc-and-2degc-above-pre-industrial-era>
- World Meteorological Organization (WMO). (2024, June 4). *Global temperature is likely to exceed 1.5°C above pre-industrial level temporarily in next 5 years.* World Meteorological Organization. <https://wmo.int/news/media-centre/global-temperature-likely-exceed-15degc-above-pre-industrial-level-temporarily-next-5-years>