Using a risk-risk framework to guide research and support decision making on the use or non-use of solar radiation modification

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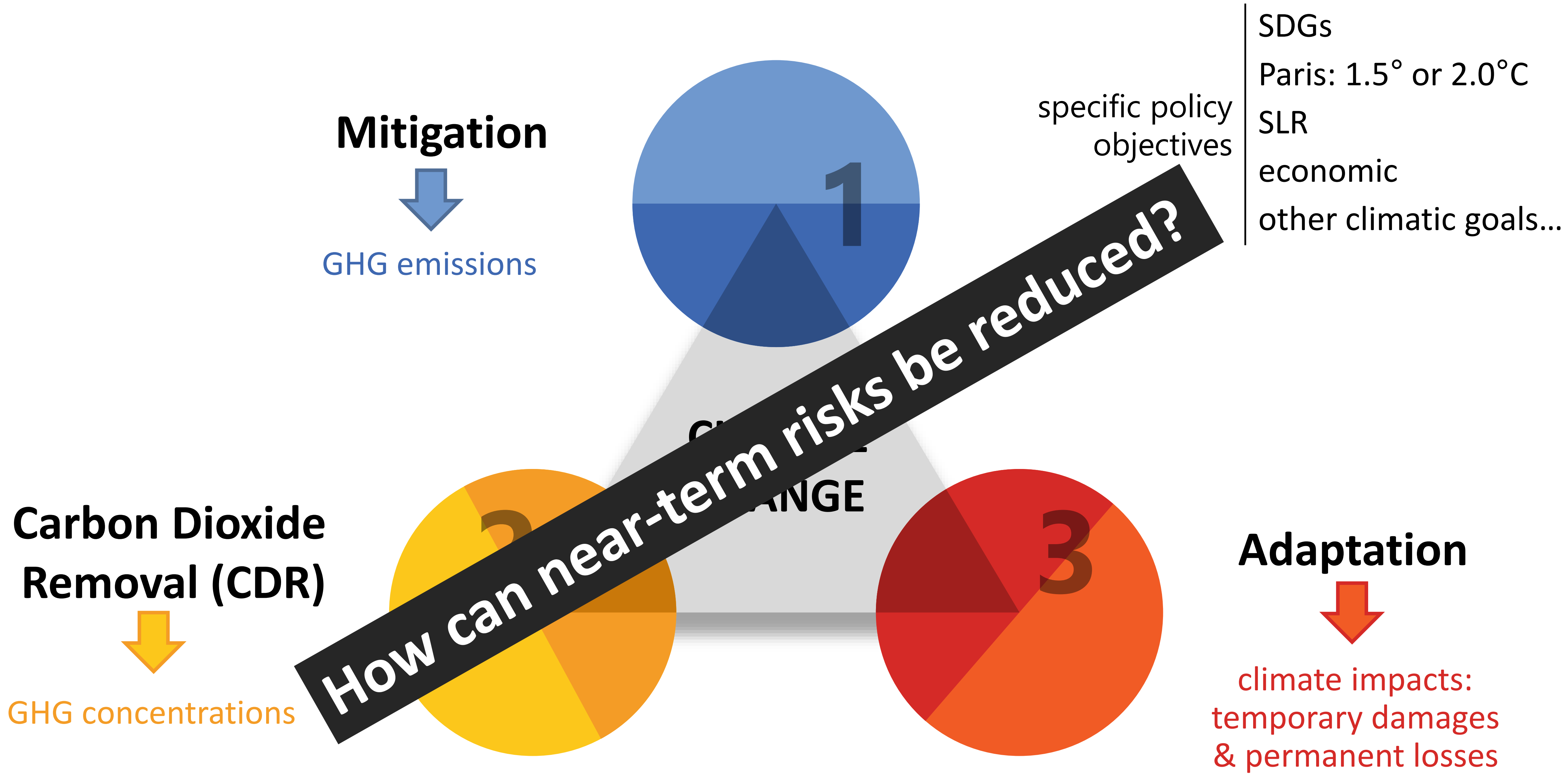
Climate change poses multiple, interacting risks to human society and the environment which are expected to worsen with additional warming

Managing these risks requires a portfolio of policy responses

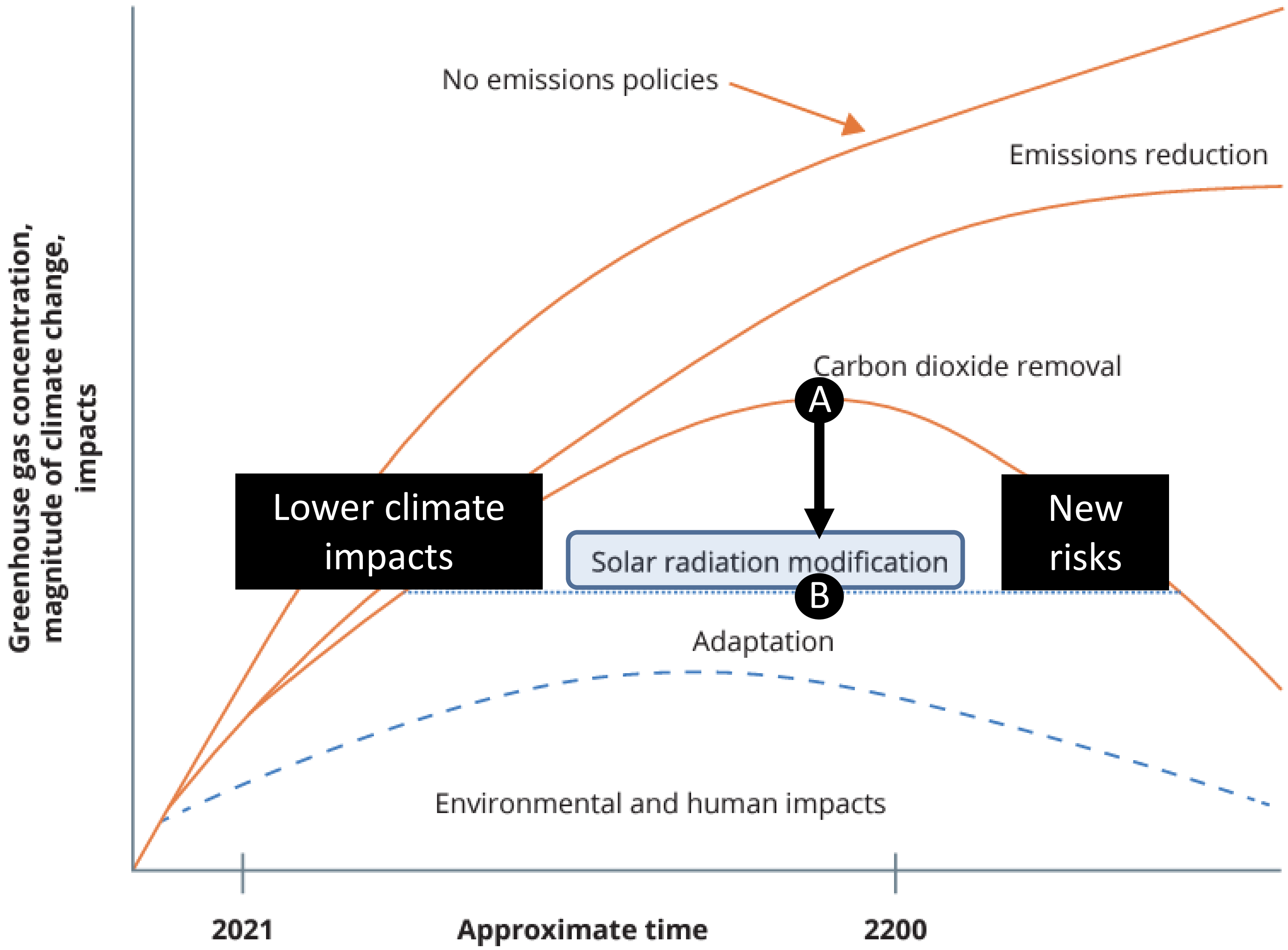
Existing risk management strategies

specific policy objectives	SDGs Paris: 1.5° or 2.0°C SLR economic other climatic goals…

Existing risk management strategies



The peak-shaving diagram



Reynolds et al. (2022)

Would SRM increase or decrease overall risk?

A key consideration in deciding whether to pursue SRM to offset global warming should be a comparison of the extent of climate risk that the technology is able to reduce against the severity of any countervailing risks that it may engender

The risk-risk framework aims to compare a world with SRM and a world without SRM in addressing climate change

The risk-risk framework

Risk types

Target risk: the particular risk that an action or policy aims to address
Countervailing risks: the additional risks that are produced in addressing the target risk
Non-target risk: ancillary reductions in non-target risks and other gains (co-benefits)

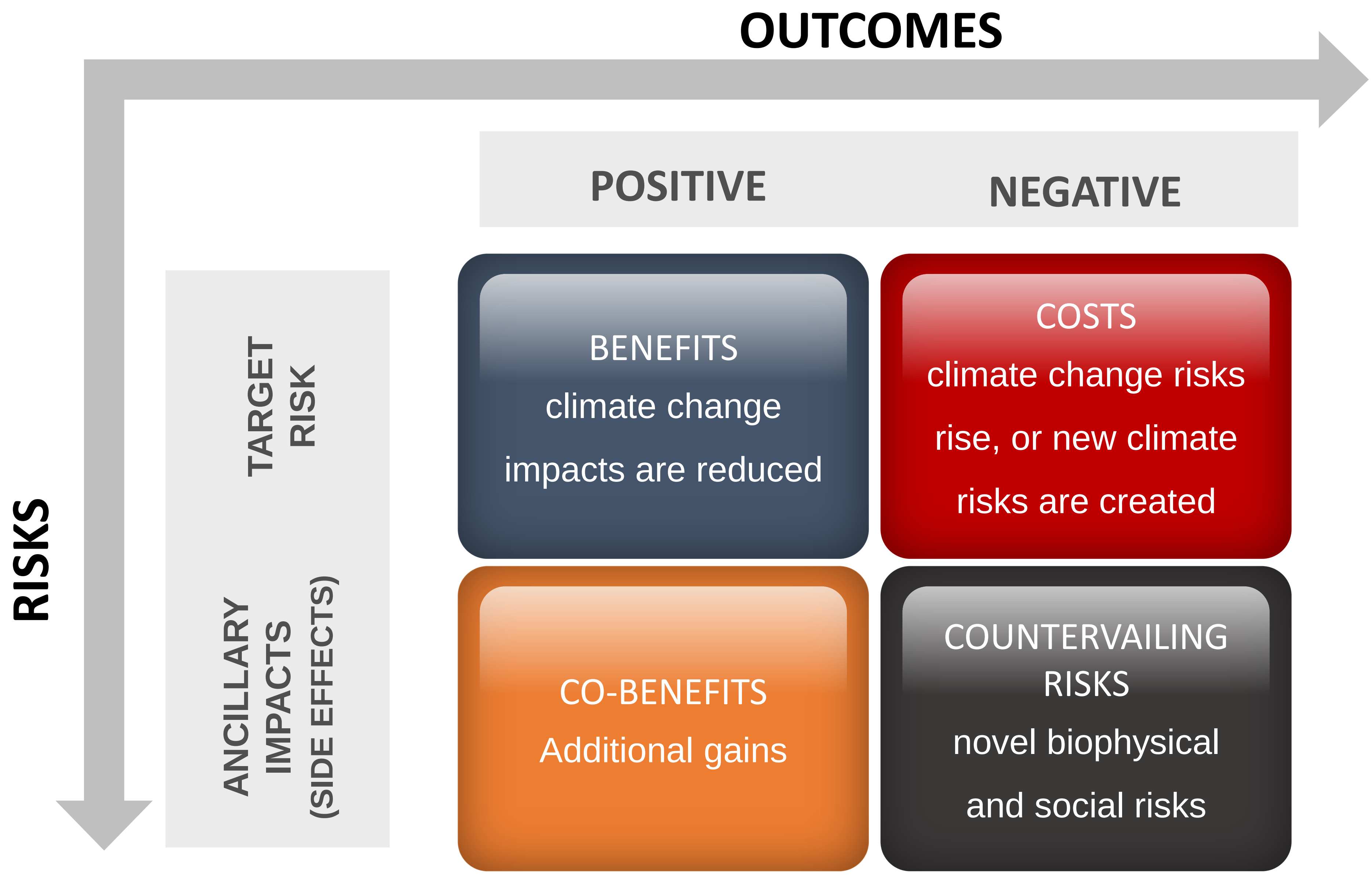
Risk measures

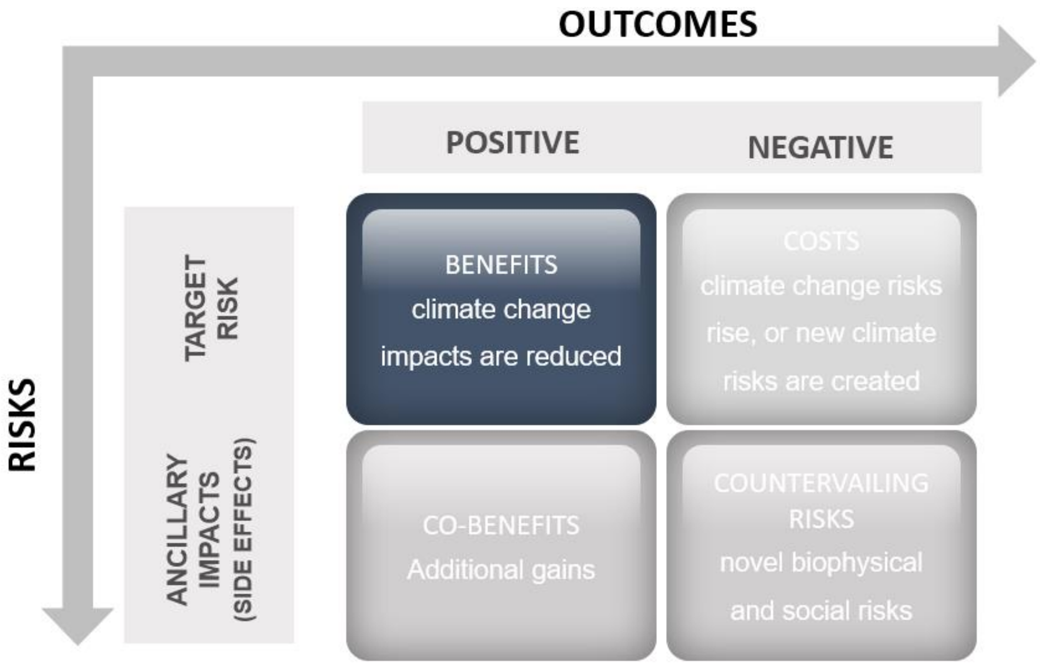
Magnitude
Likelihood
Timing
Distribution of consequences

The risk-risk framework

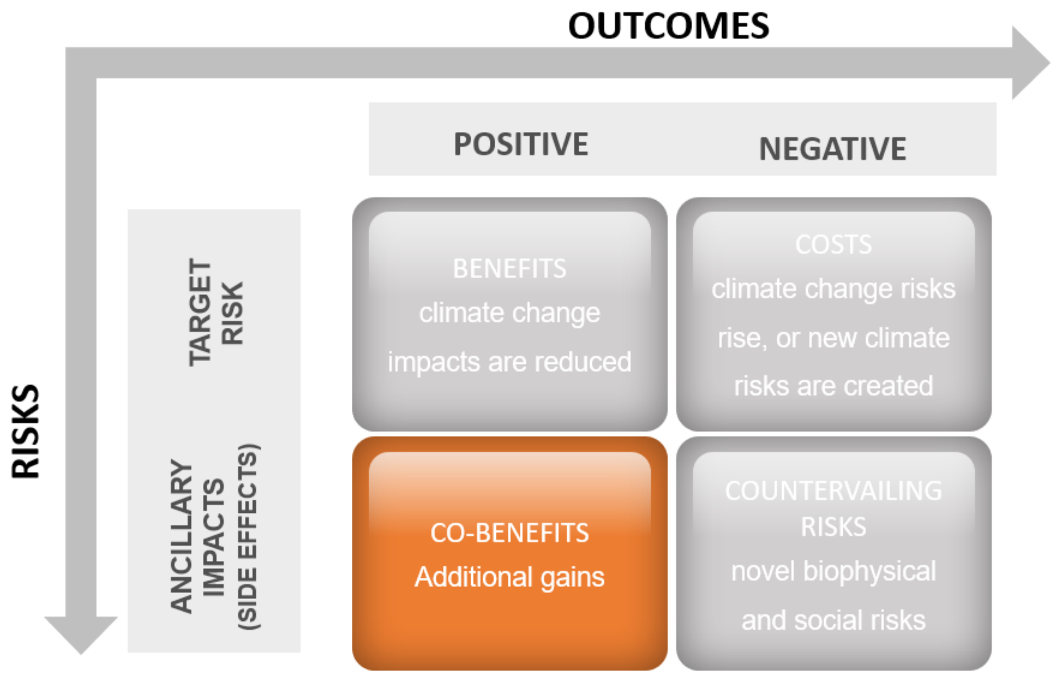
The risk-risk framework helps to think beyond the benefits (reduction in target risk) and costs (direct costs for reducing the target risk), and brings side effects (countervailing risks and co-benefits) into consideration

Deploying SRM as a response to climate change

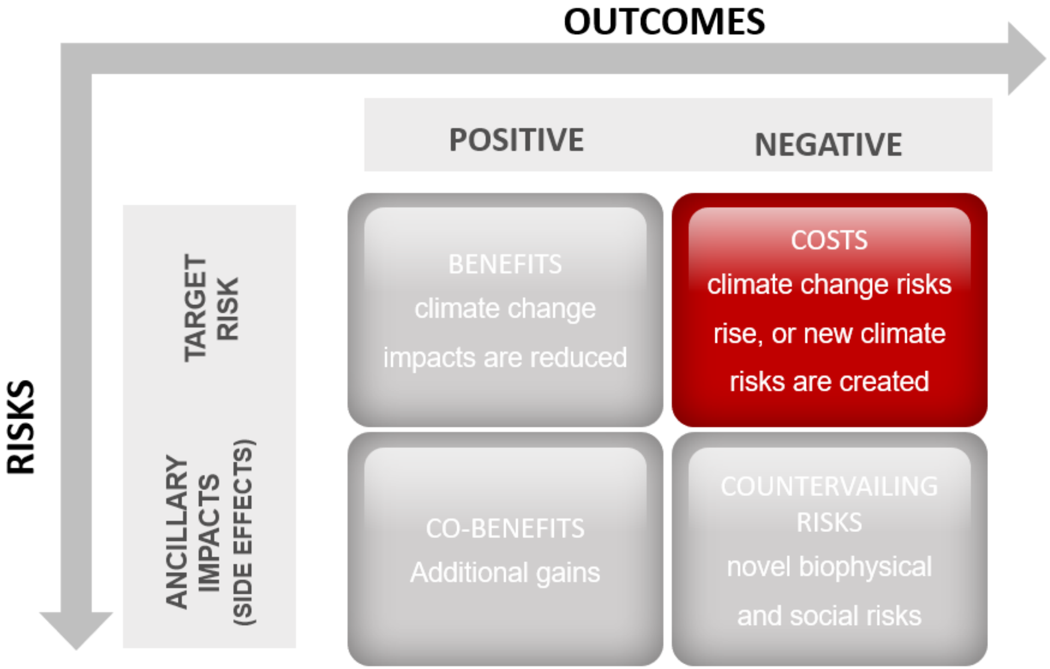




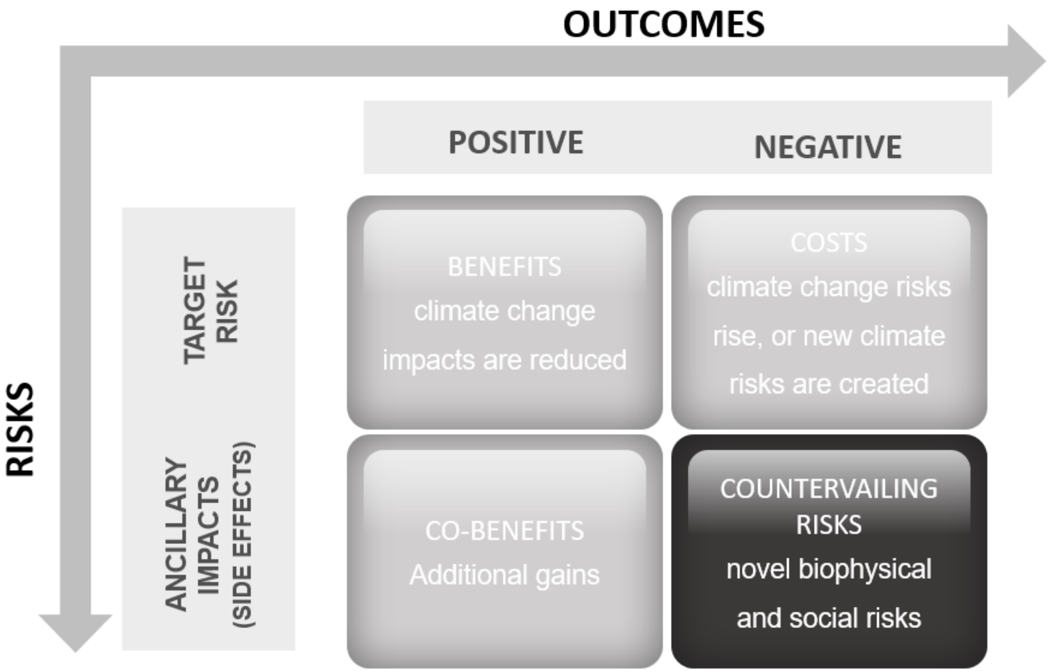
Climatic benefits	• reduction in the frequency and intensity of extremes of temperature and precipitation • slowed melting of Arctic sea ice and mountain glaciers • reduced loss of the Greenland and Antarctic ice sheets slowed sea level rise • reduced weakening of the Atlantic meridional overturning circulation reduction in the intensity of tropical cyclones



Co-benefits	• reduced tropospheric ozone • increase in water availability over land in the tropical regions (MCB)



Costs	• unintended climate changes (unintended warming or excessive cooling due to uncertainty in our estimates of the amount of SAI needed) • regional precipitation changes



Countervailing risks	*Biophysical:* • increased acid deposition in pristine areas in the high latitudes • effects on stratospheric ozone • light diffusion and dimming • increase in salt deposition over land (MCB) *Social:* • potential for international conflict and other societal risks • potential interactions with a major volcanic eruption • shock of sudden termination

SRM deployment would not occur in isolation, so its benefits and risks would depend on:

- the particular goals of the SRM deployment
- the background emissions pathway and adaptation plans being followed
- the sustainable development goals pursued
- the governance framework

level of residual climate risk that might be addressed by SRM

minimize these climate risks, maximize additional gains, and limit its own added climate and countervailing risks

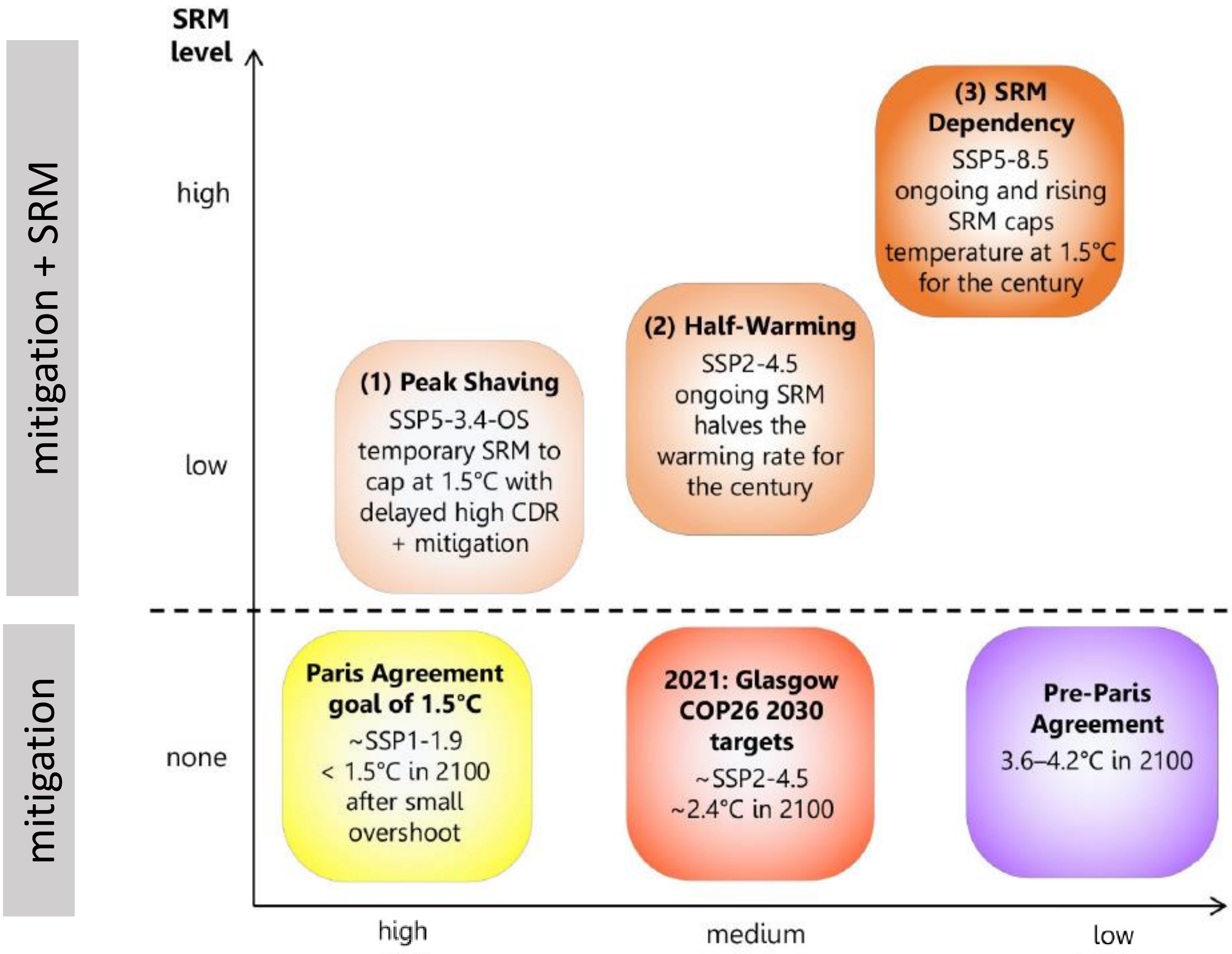
Three illustrative policy scenarios

(1) Peak Shaving
High mitigation + some SRM

(2) Half Warming
Moderate mitigation + some SRM

(3) Half Warming
Low mitigation + high SRM

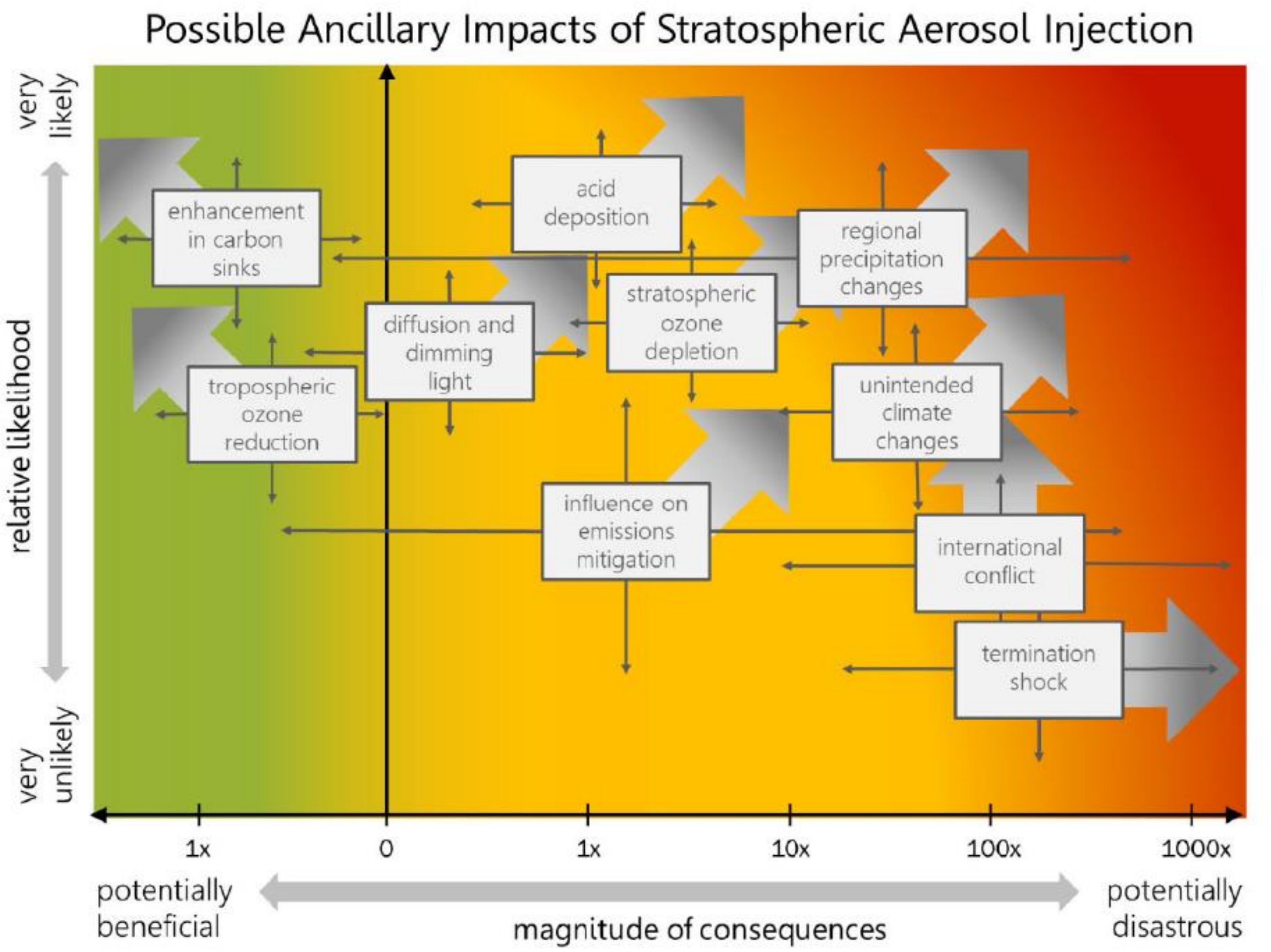
All SRM scenarios assume that SRM is deployed in 2040 (when the world is at roughly 1.5°C of warming).



Felgenhauer et al. (2022)

Relative severity of ancillary impacts of SRM

While all the potential ancillary impacts of SRM, both positive and negative, are highly uncertain, **it is useful to attempt to position them on a risk matrix to prioritize further investigation**



Likelihood and consequences of impacts resulting from a "low" level of SAI (e.g., peak-shaving scenario), with "error bars" suggesting the extent of uncertainty in these estimates.

Felgenhauer et al. (2022)

Key insights

- **Employing a risk-risk framework in policy analysis and decision-making concerning SRM would enable a more comprehensive assessment, comparison, and management of risks associated with climate change, emissions reductions, CDR, adaptation, and SRM**.

- As a supplement to GHG emissions reductions, CDR, and adaptation, **SRM has the potential to yield large direct benefits to humans and natural ecosystems** by lessening the near-term damages of climate change and lowering the chances of crossing catastrophic climate tipping points.

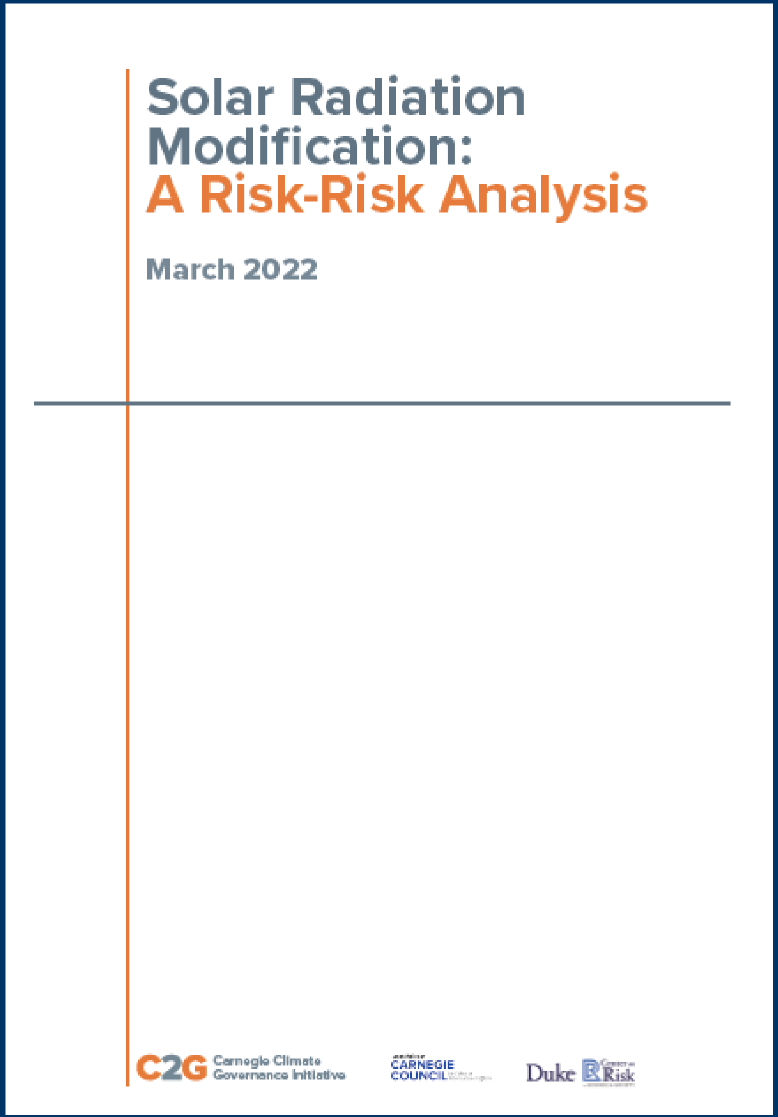
- **SRM could pose countervailing risks to biophysical systems**, including changes in stratospheric ozone and surface UV radiation, acid rain, and unintended changes in temperature and precipitation patterns. The extent of these risks could be controlled to some degree by appropriate design and governance of implementation.

- **SRM may also pose countervailing risks to societal systems**, including the risk of international conflict, the risk of rapid climate change resulting from unplanned sudden termination, and the risk of delaying or discouraging GHG emissions mitigation. Here too, the extent of these risks would depend on the design and governance of implementation.

- **Different levels of SRM may pose different implications for overall risk depending on the technology, its deployment, and governance**. Higher levels of SRM may be expected to yield greater decreases in temperature-associated climate target risks, but also increases in SRM's own countervailing risks.

- **Risk-risk analysis can help focus climate change risk management on broader societal objectives**, rather than on temperature goals alone. This can be important, as many climate impacts do not scale directly with temperature.

The report *Solar Radiation Modification: A Risk-Risk Analysis* along with Summary versions in English, French, Spanish and Chinese may be downloaded from the C2G website: https://www.c2g2.net/



Felgenhauer, T., Bala, G., Borsuk, M., Brune, M., Camilloni, I., Wiener, J.B., Xu, J. (2022). *Solar Radiation Modification: A Risk-Risk Analysis*, Carnegie Climate Governance Initiative (C2G), March, New York, NY