



A simple model for assessing climate control trade-offs and responding to unanticipated climate outcomes

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A simple model for assessing climate control trade-offs and responding to unanticipated climate outcomes

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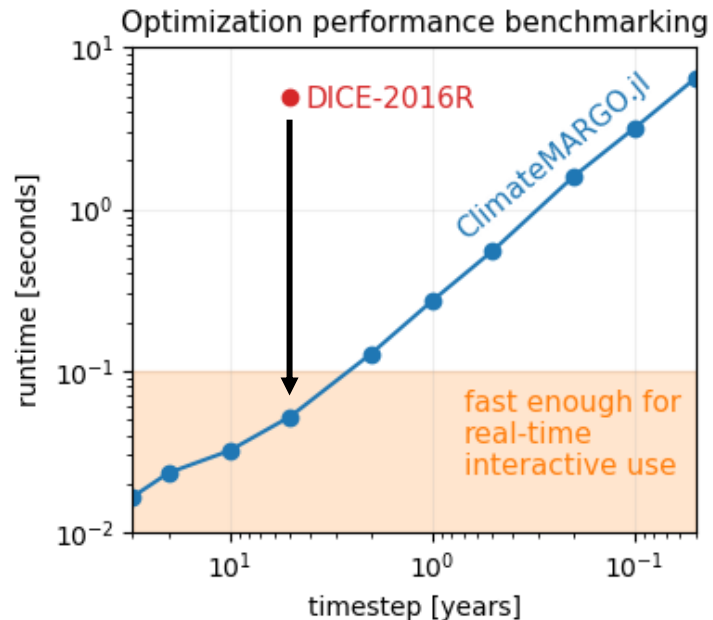
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ClimateMARGO.jl

- Free for all
- Transparently developed
- Well-documented
- Understandable by beginners
- Efficient and fast
- Flexible and extendable
- Reactive web-app for teaching and outreach



ClimateMARGO.jl

A Julia implementation of MARGO, an idealized framework for optimization of climate change control strategies.

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ClimateMARGO.jl

Search docs

Theory

- The causal chain of climate suffering
- Greenhouse gas emissions
- Greenhouse gas concentrations
- Radiative forcing
- Global warming and climate suffering
- The costs and benefits of climate control
- Optimization: what makes a climate "optimal"?

Examples

- Optimization with default parameters
- Two-dimensional optimization

Submodules

Version dev

Greenhouse gas concentrations

CO_{2e} continues to accumulate in the atmosphere and its concentrations $c(t) = c_0 + \int_{t_0}^t r q(t) dt$ will increase as long as the emissions $q(t)$ are greater than zero.

Climate control: Carbon dioxide removal

Removal of CO_{2e}, in contrast to mitigation, is de-coupled from instantaneous emissions and is expressed as the percentage of 2020 baseline emissions that are removed from the atmosphere in a given year, $q_0 R(t)$. A maximal value of $R = 100\%$ corresponds to removing 30 GtCO_{2e} per year, which is roughly equal to a recent upper-bound estimate of the global potential for negative emission technologies.

A useful diagnostic quantity is the effective emissions

$$r q(t)(1 - M(t)) - r q_0 R(t),$$

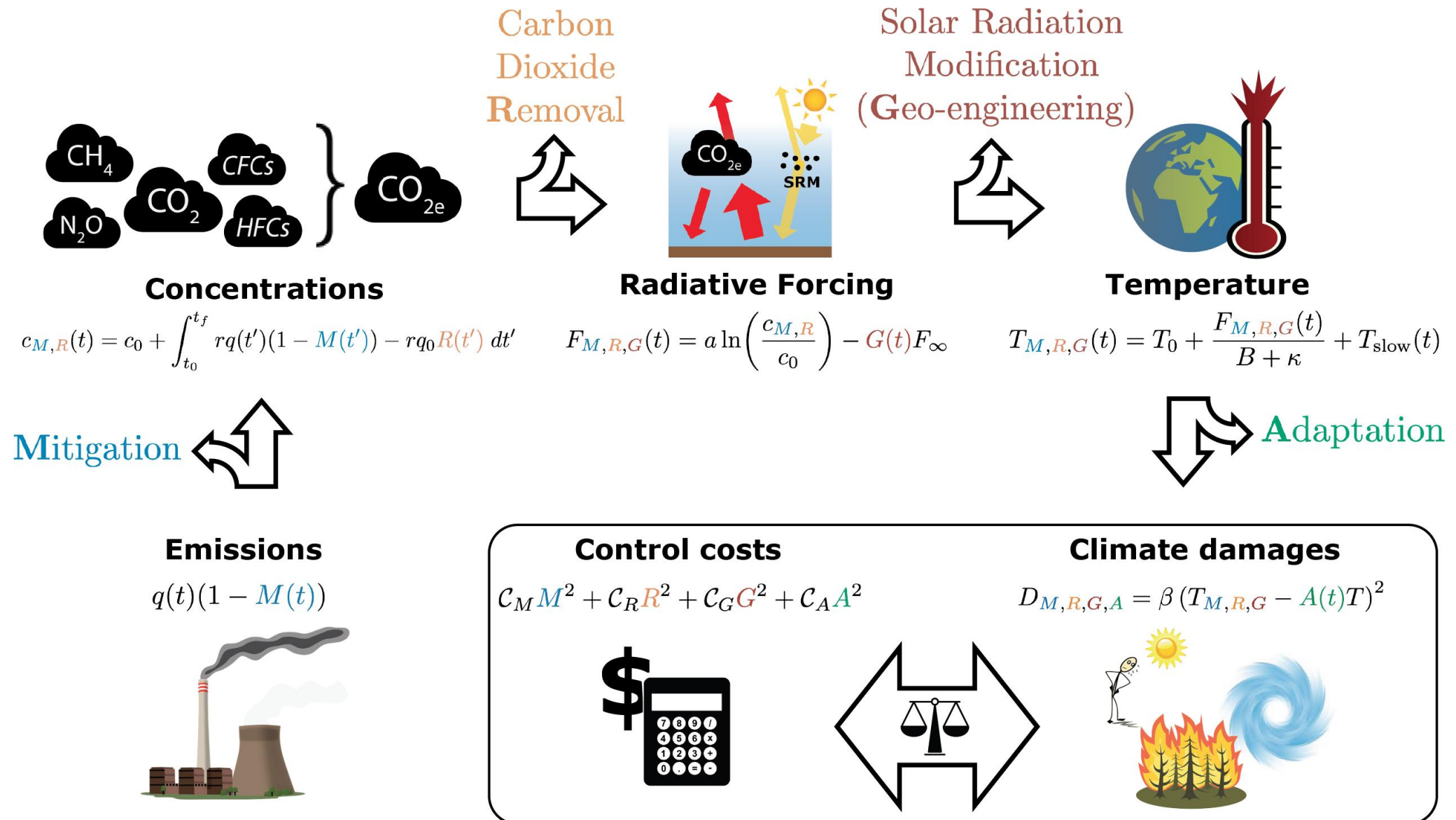
which is the annual rate of CO_{2e} accumulation in the atmosphere, including negative contributions from both emissions mitigation and CDR.

The change in CO_{2e} concentrations is simply the integral of the effective emissions over time,

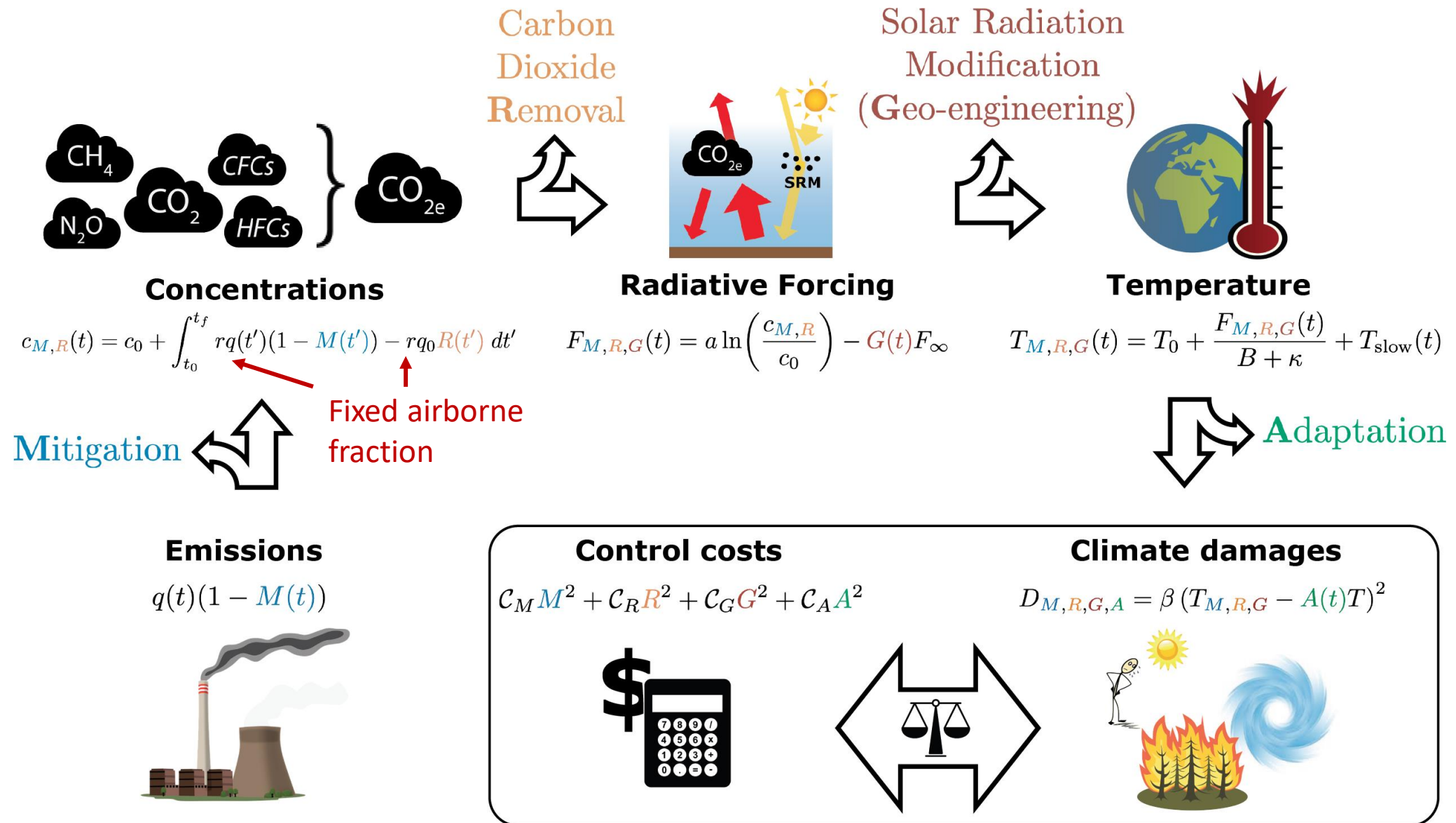
$$c_{M,R}(t) = c_0 + \int_{t_0}^t r q(t')(1 - M(t')) dt' - r q_0 \int_{t_0}^t R(t') dt'.$$

Code at github.com/ClimateMARGO

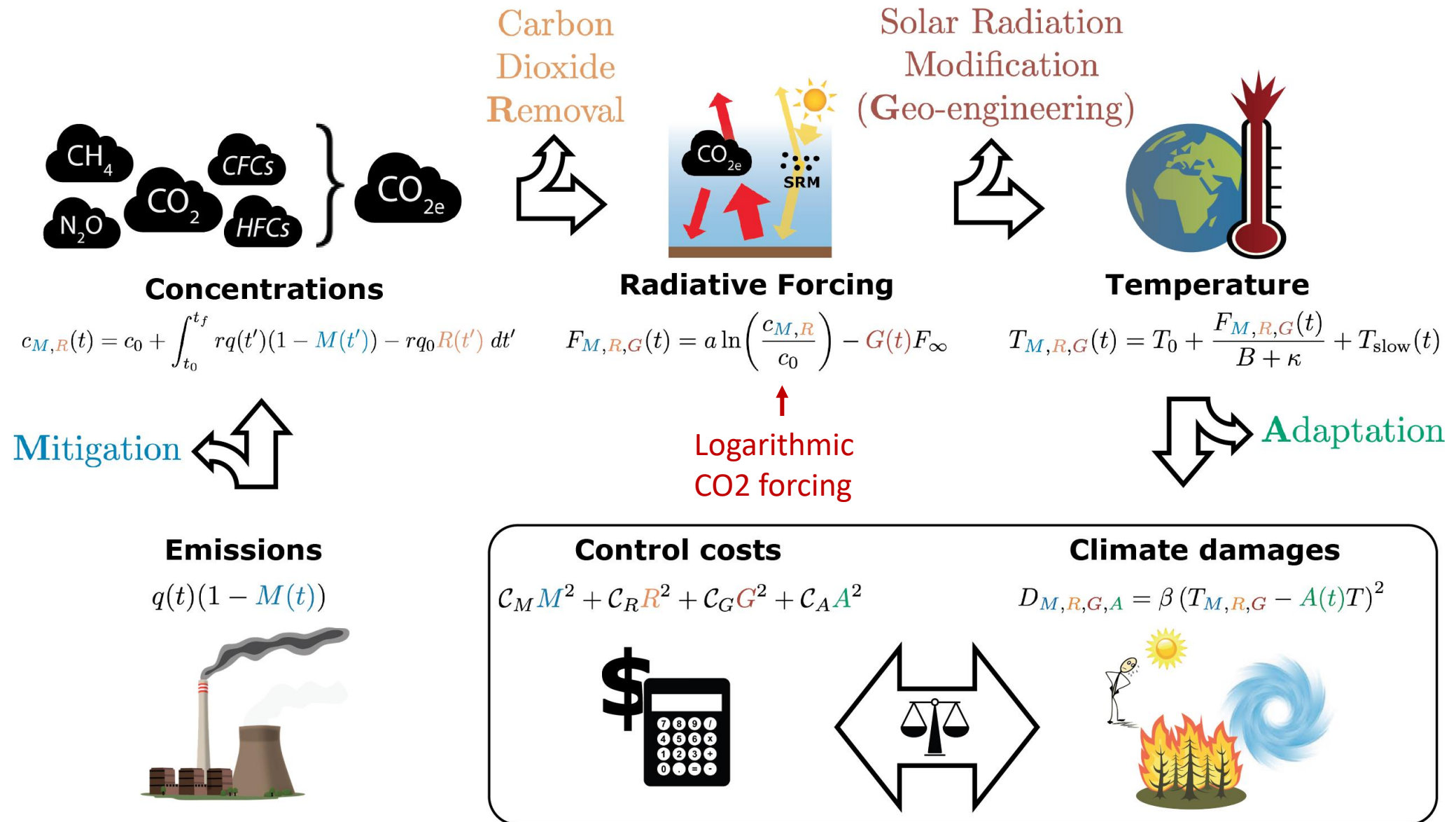
MARGO: a minimal model of the climate problem



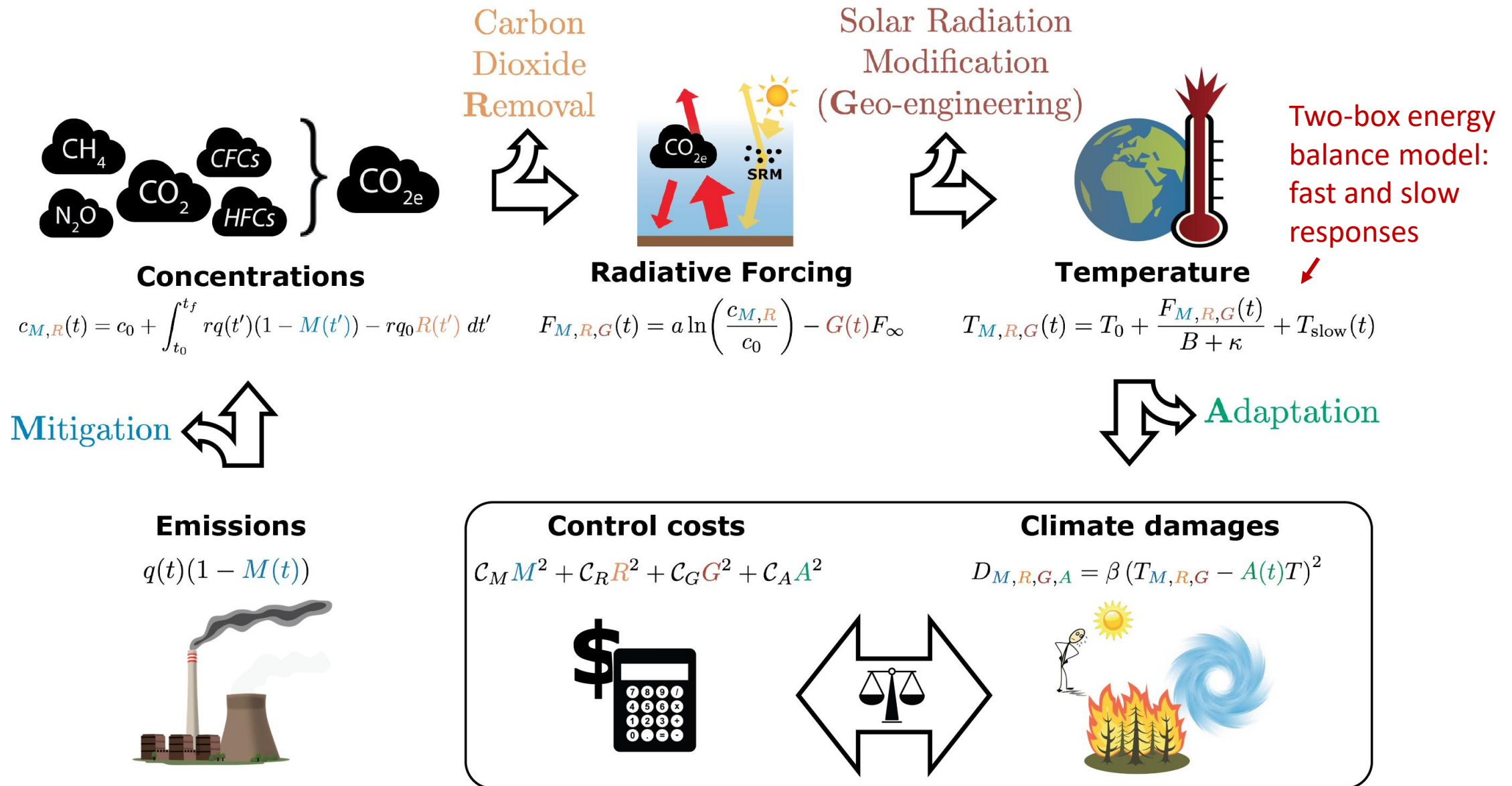
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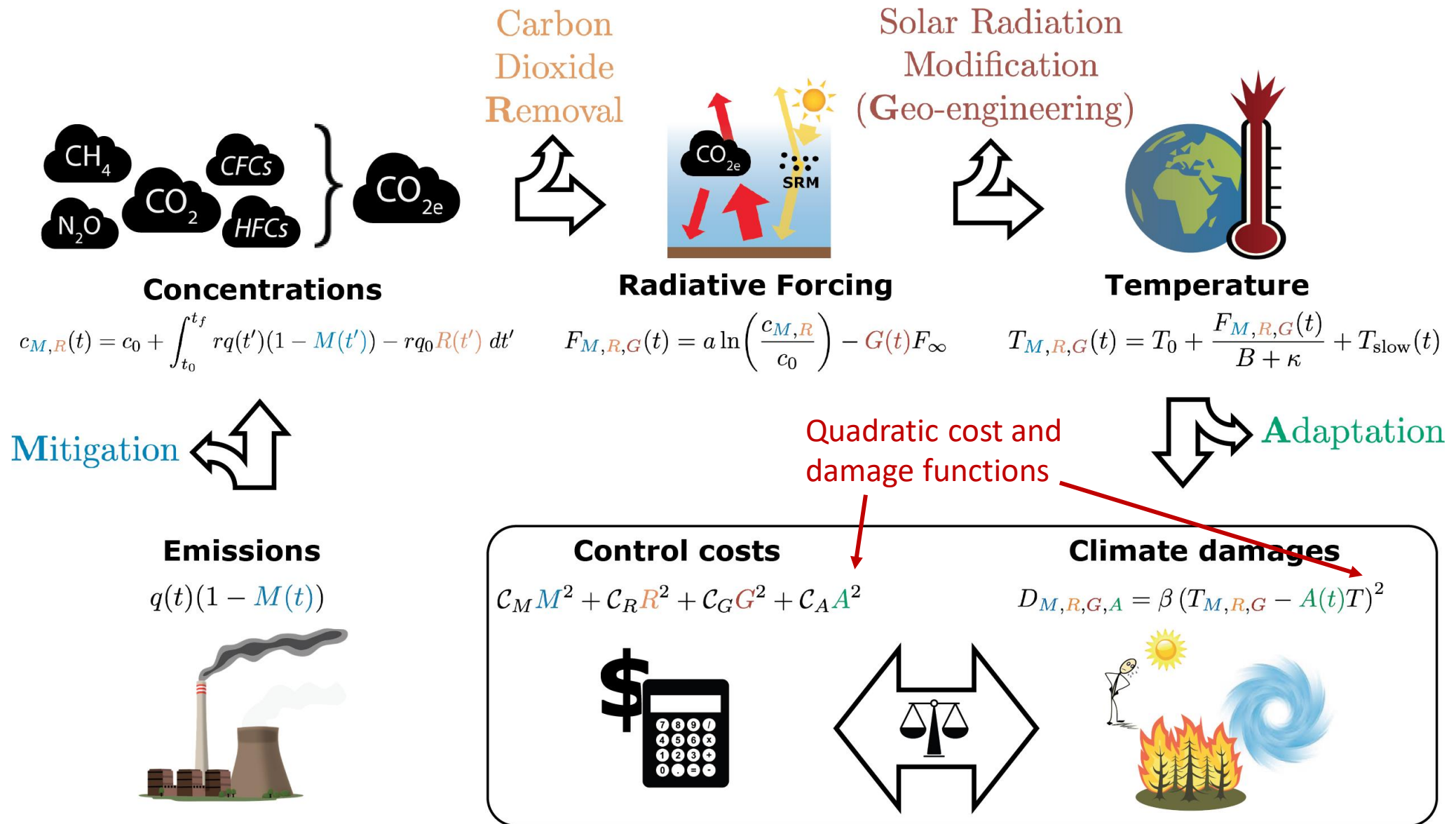
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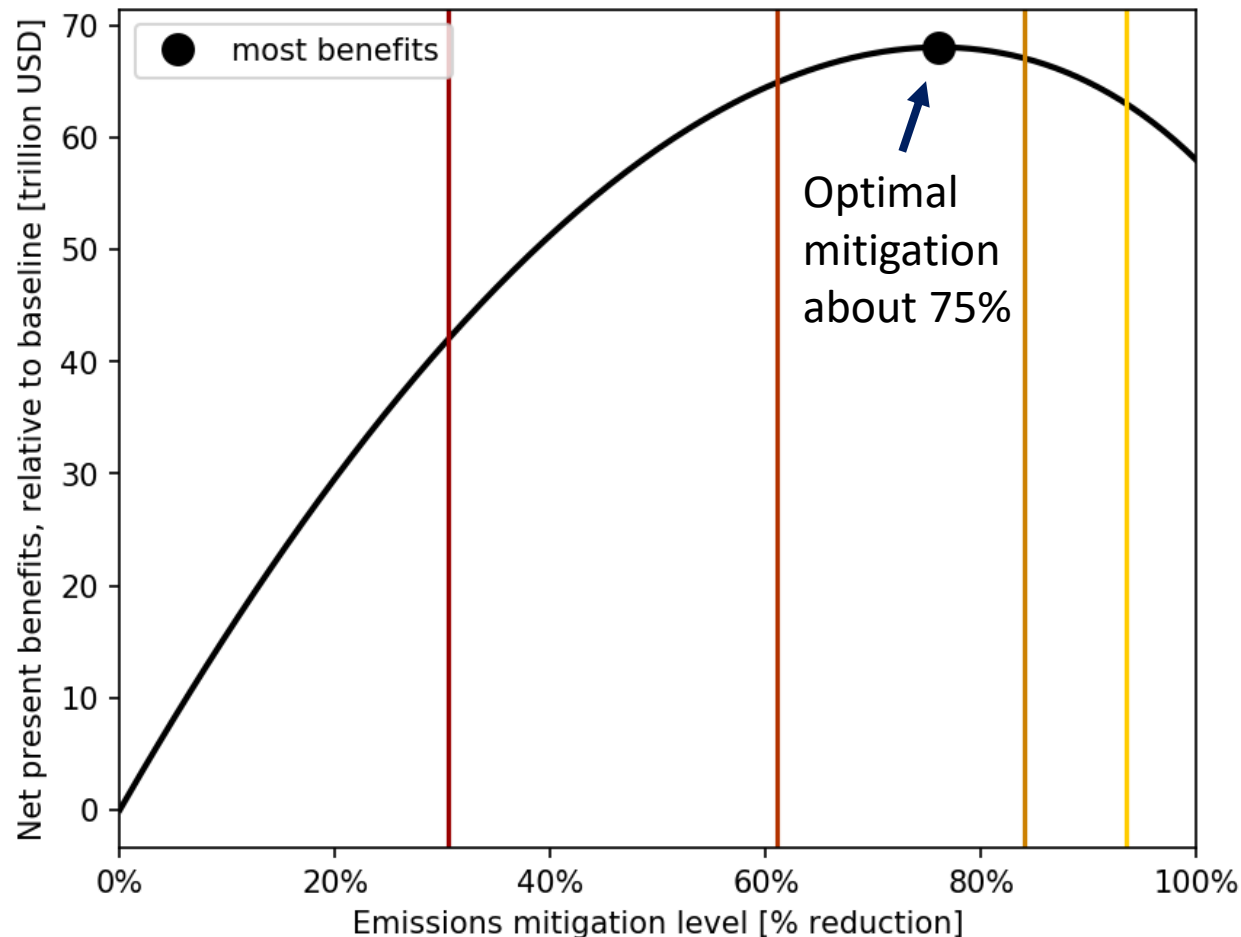


MARGO: a minimal model of the climate problem



Visualizing MARGO's optimization problems in one dimension

Cost-benefit analysis: maximizing the net benefit of mitigation



Benefit = avoided damages

$$\mathcal{B} = D - D_{M,R,G,A} = \beta(T^2 - (T_{M,R,G,A})^2).$$

Maximize net benefits (benefits minus costs)

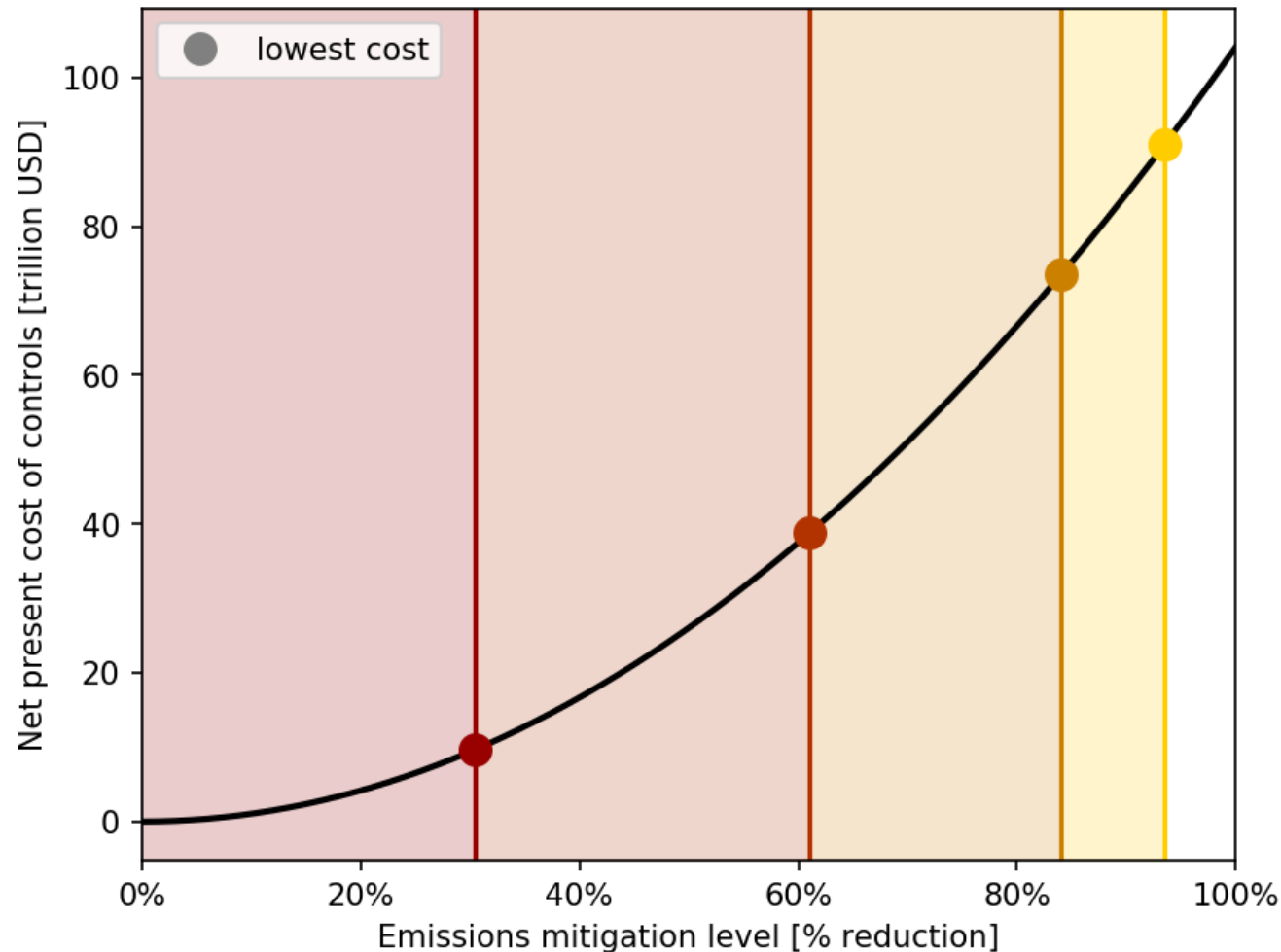
$$\max \left\{ \int_{t_0}^{t_f} (\mathcal{B}_{M,R,G,A} - \mathcal{C}_{M,R,G,A}) (1 + \rho)^{-(t-t_0)} dt \right\},$$

Reduce dimensions by:

- Fixing $M(t) = M_0$ constant
- Removing other controls: $R = G = A = 0$

Visualizing MARGO's optimization problems in one dimension

Cost-effectiveness analysis: minimizing the cost of mitigation, subject to a temperature goal



Minimize control costs

$$\min \left\{ \int_{t_0}^{t_f} \mathcal{C}_{M,R,G,A} (1 + \rho)^{-(t-t_0)} dt \right\}$$

subject to a policy constraint (e.g. temperature threshold)

$$T_{M,R,G,A} < T^*,$$

Reduce dimensions by:

- Fixing $M(t) = M_0$ constant
- Removing other controls: $R = G = A = 0$