ClimateMARGO.jl

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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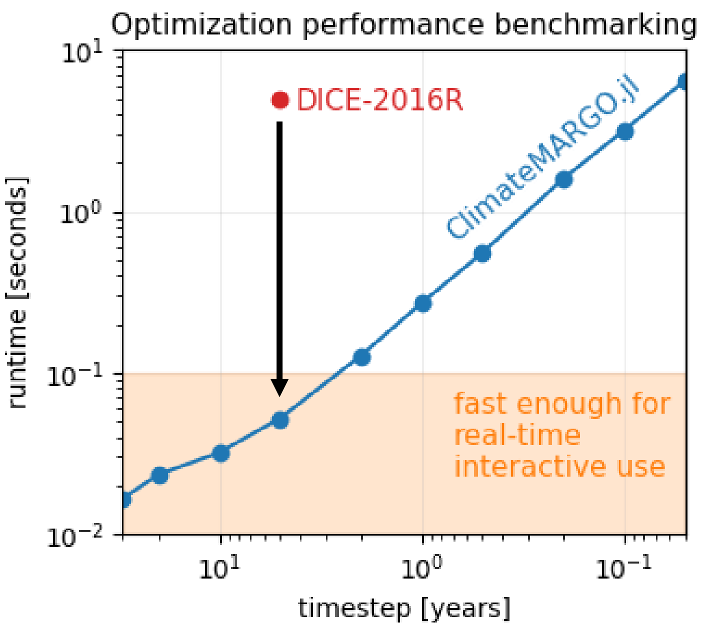
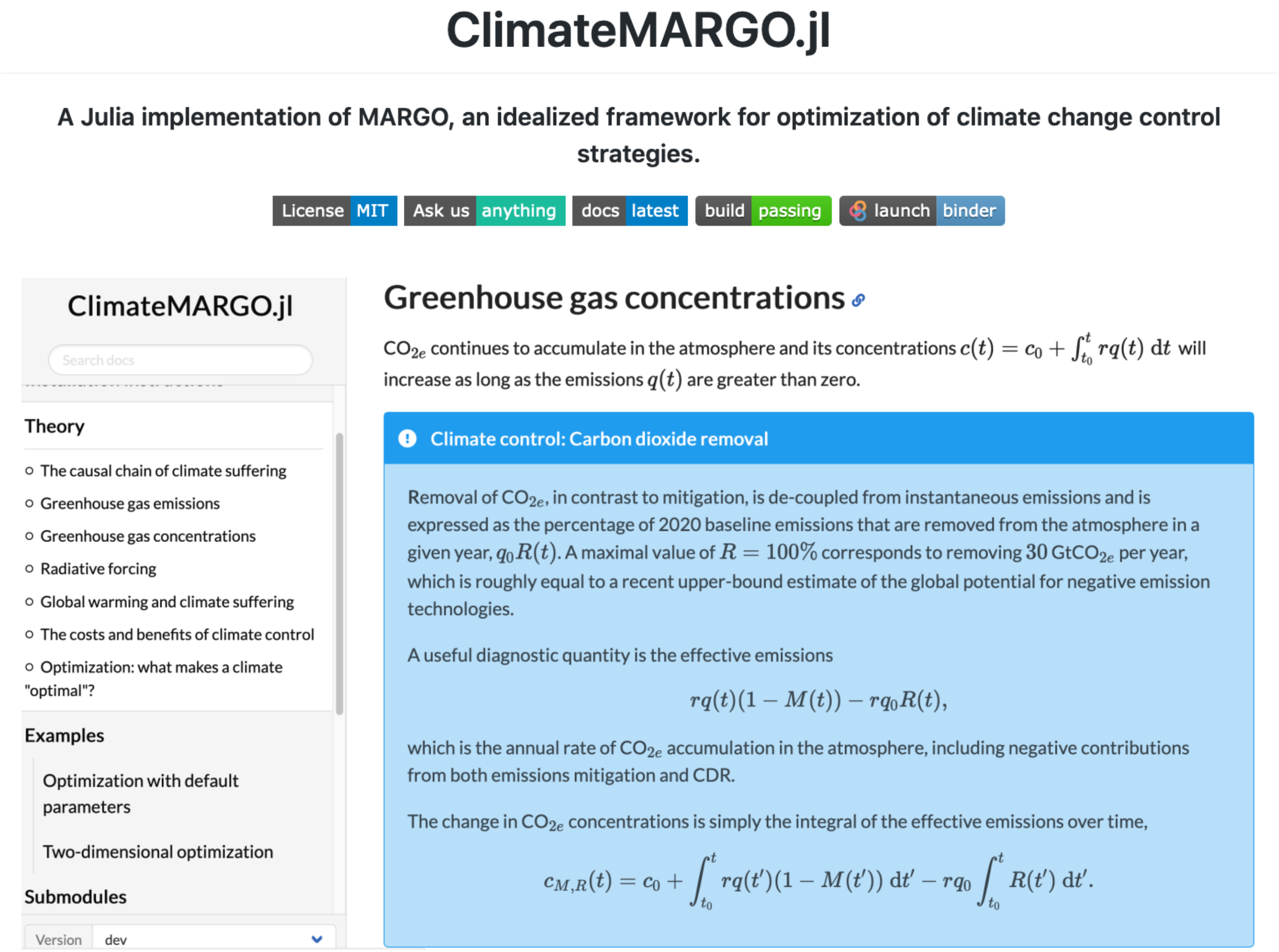
ClimateMARGO.jl

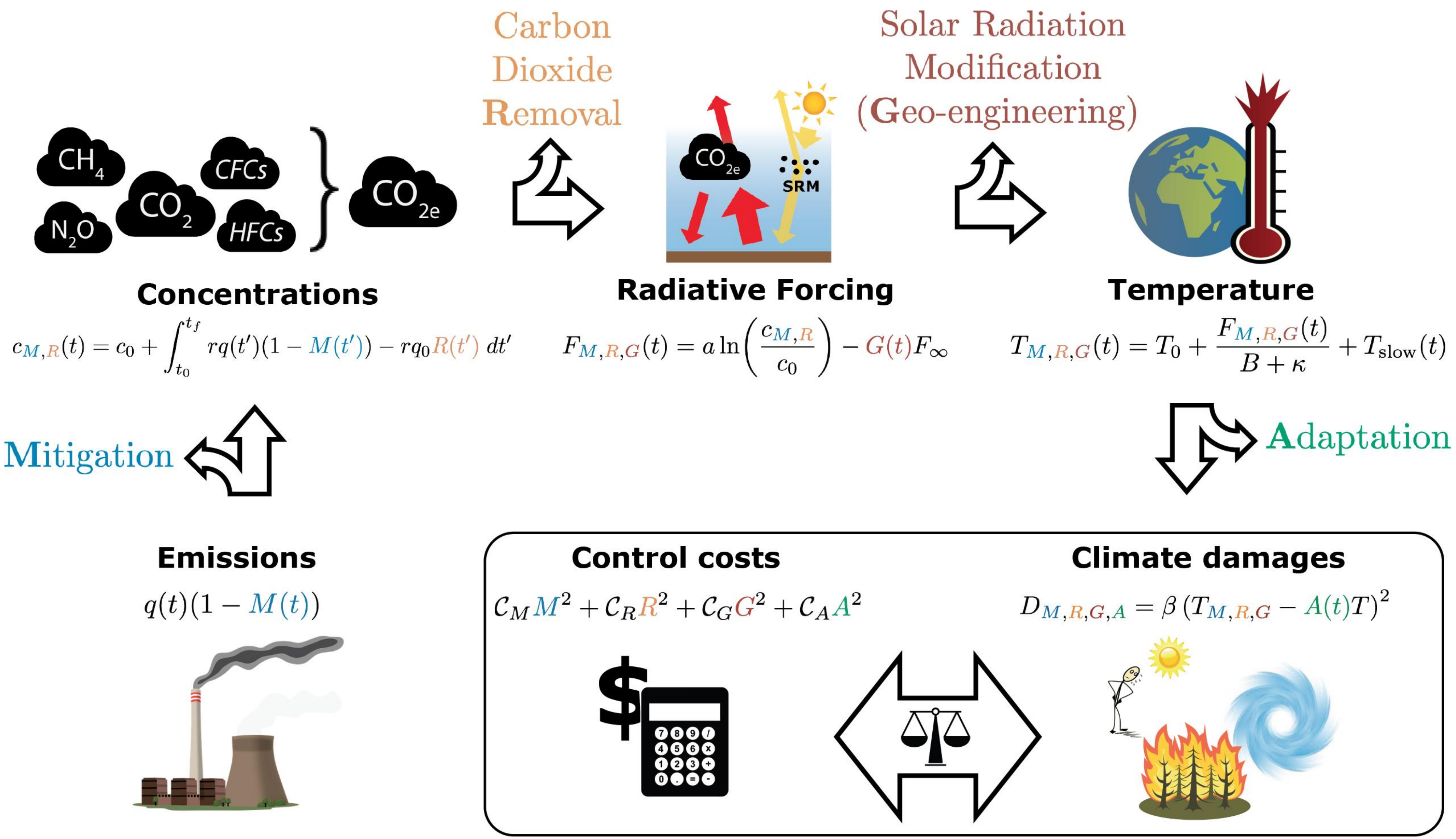
- Free for all
- Transparently developed
- Well-documented
- Understandable by beginners
- Efficient and fast
- Flexible and extendable
- Reactive web-app for teaching and outreach





Code at github.com/ClimateMARGO

MARGO: a minimal model of the climate problem



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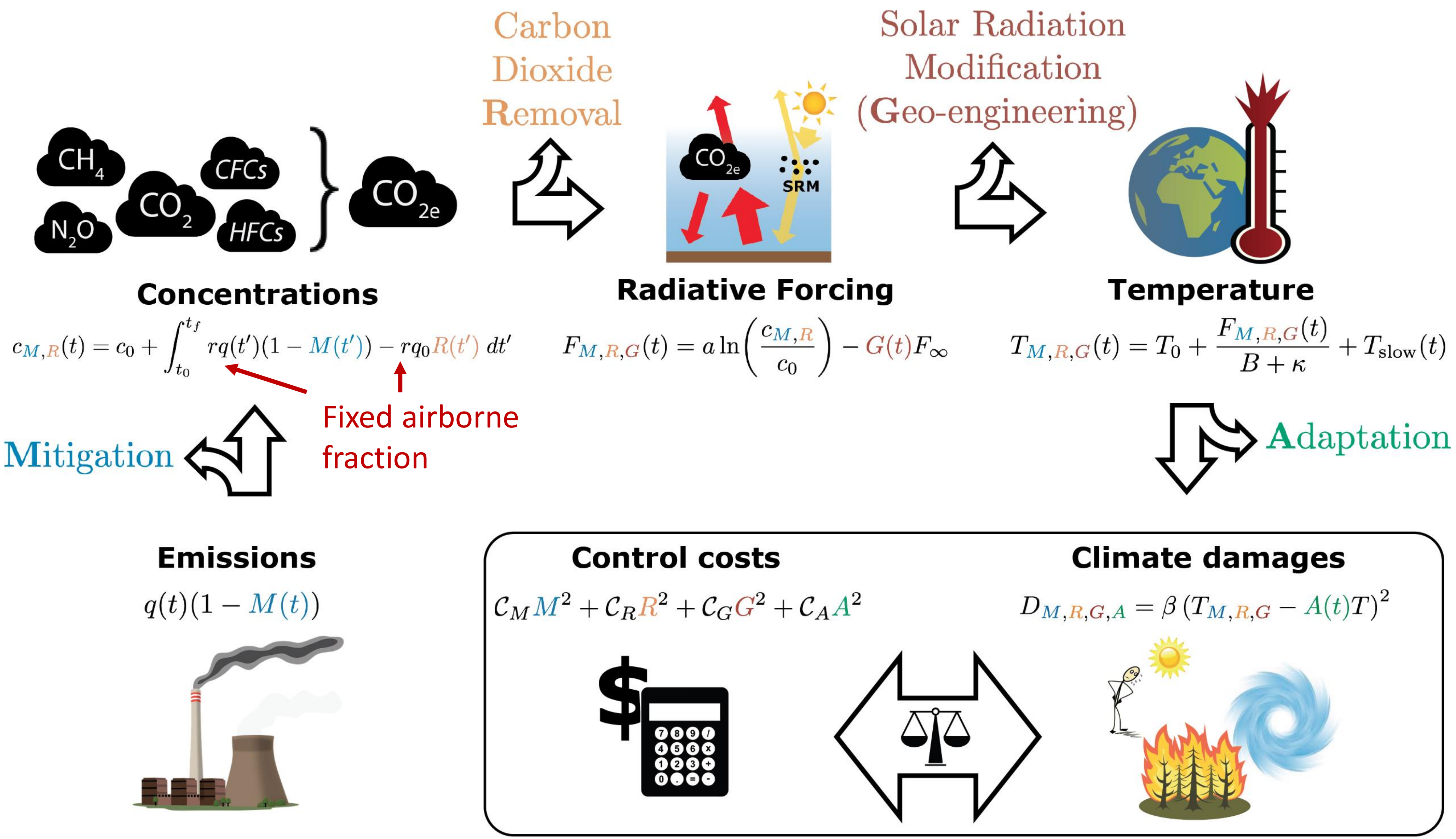
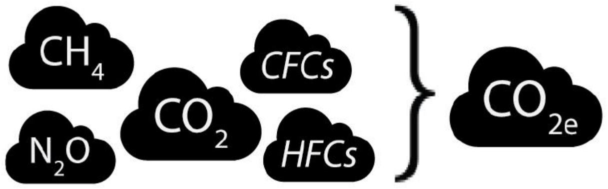
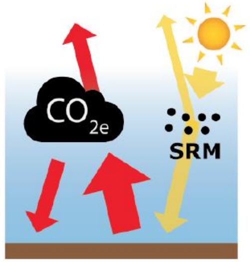


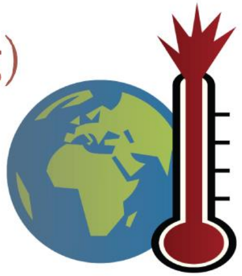
MARGO: a minimal model of the climate problem

Carbon Dioxide Removal

Solar Radiation Modification (Geo-engineering)







Concentrations

$$c_{M,R}(t) = c_0 + \int_{t_0}^{t_f} rq(t')(1 - M(t')) - rq_0 R(t')\, dt'$$

Radiative Forcing

$$F_{M,R,G}(t) = a \ln\left(\frac{c_{M,R}}{c_0}\right) - G(t)F_\infty$$

Logarithmic CO2 forcing

Temperature

$$T_{M,R,G}(t) = T_0 + \frac{F_{M,R,G}(t)}{B + \kappa} + T_{\text{slow}}(t)$$

Mitigation

Adaptation

Emissions

$$q(t)(1 - M(t))$$

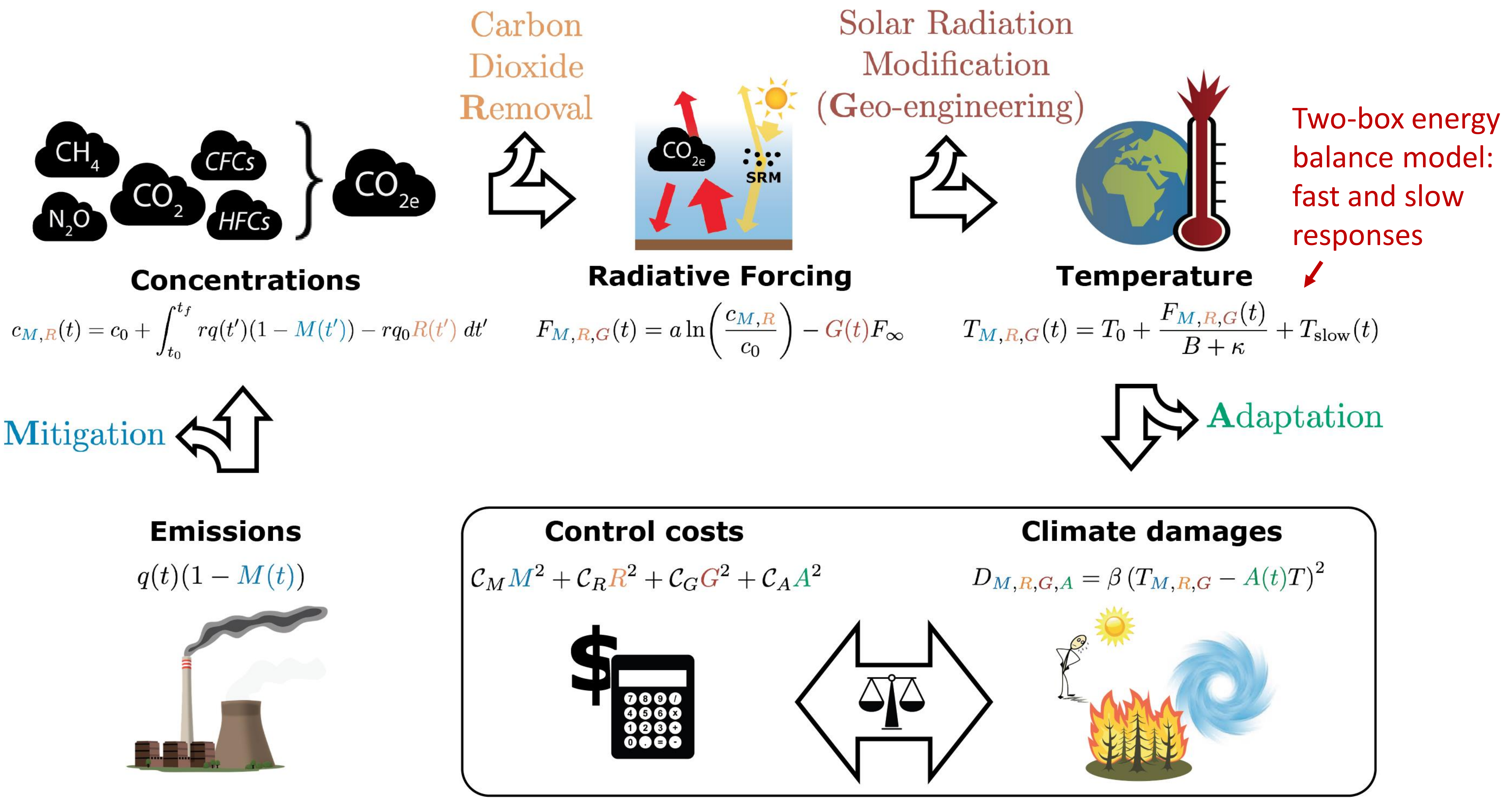
Control costs

$$\mathcal{C}_M M^2 + \mathcal{C}_R R^2 + \mathcal{C}_G G^2 + \mathcal{C}_A A^2$$

Climate damages

$$D_{M,R,G,A} = \beta \left(T_{M,R,G} - A(t)T\right)^2$$

MARGO: a minimal model of the climate problem



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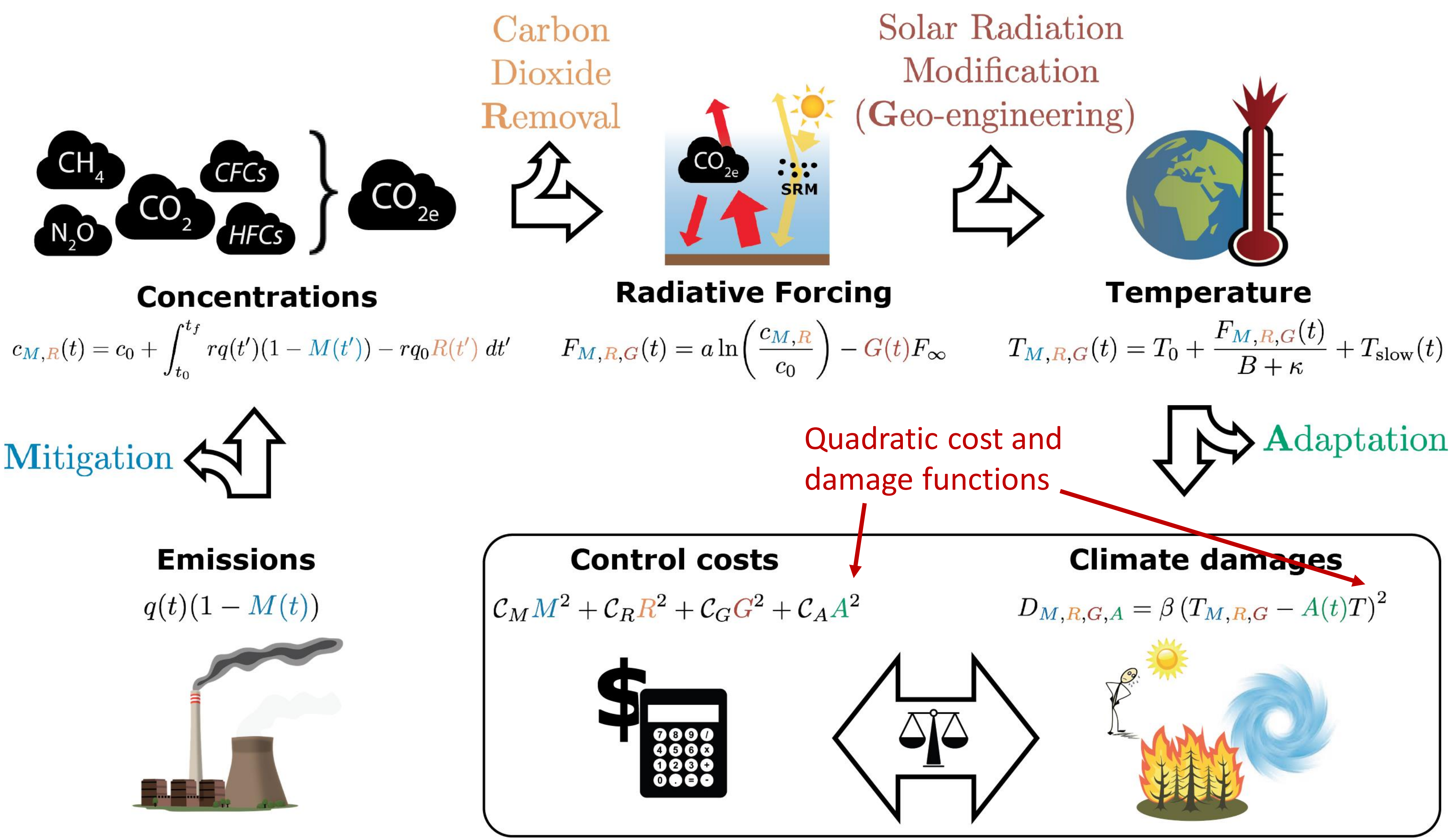
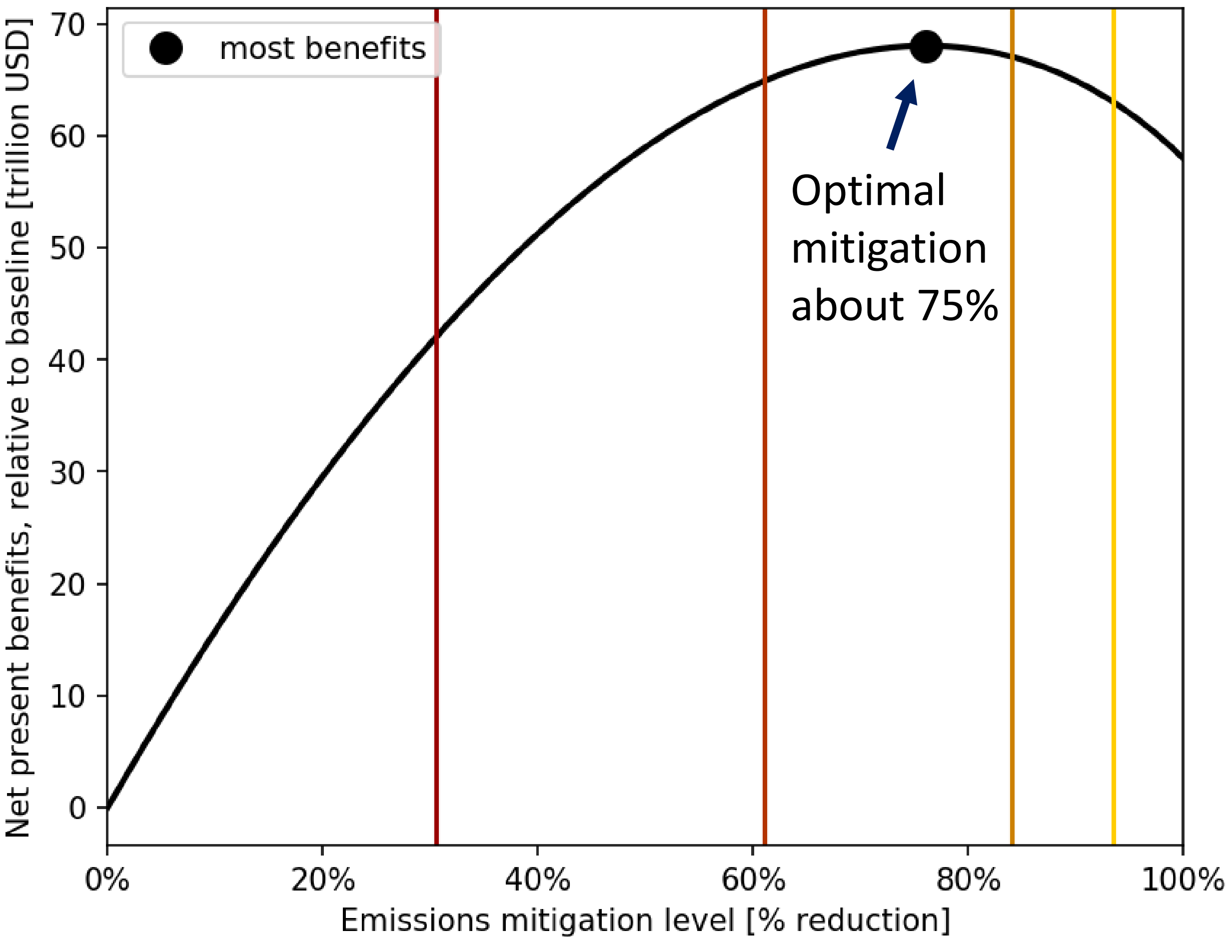


Visualizing MARGO's optimization problems in one dimension

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)

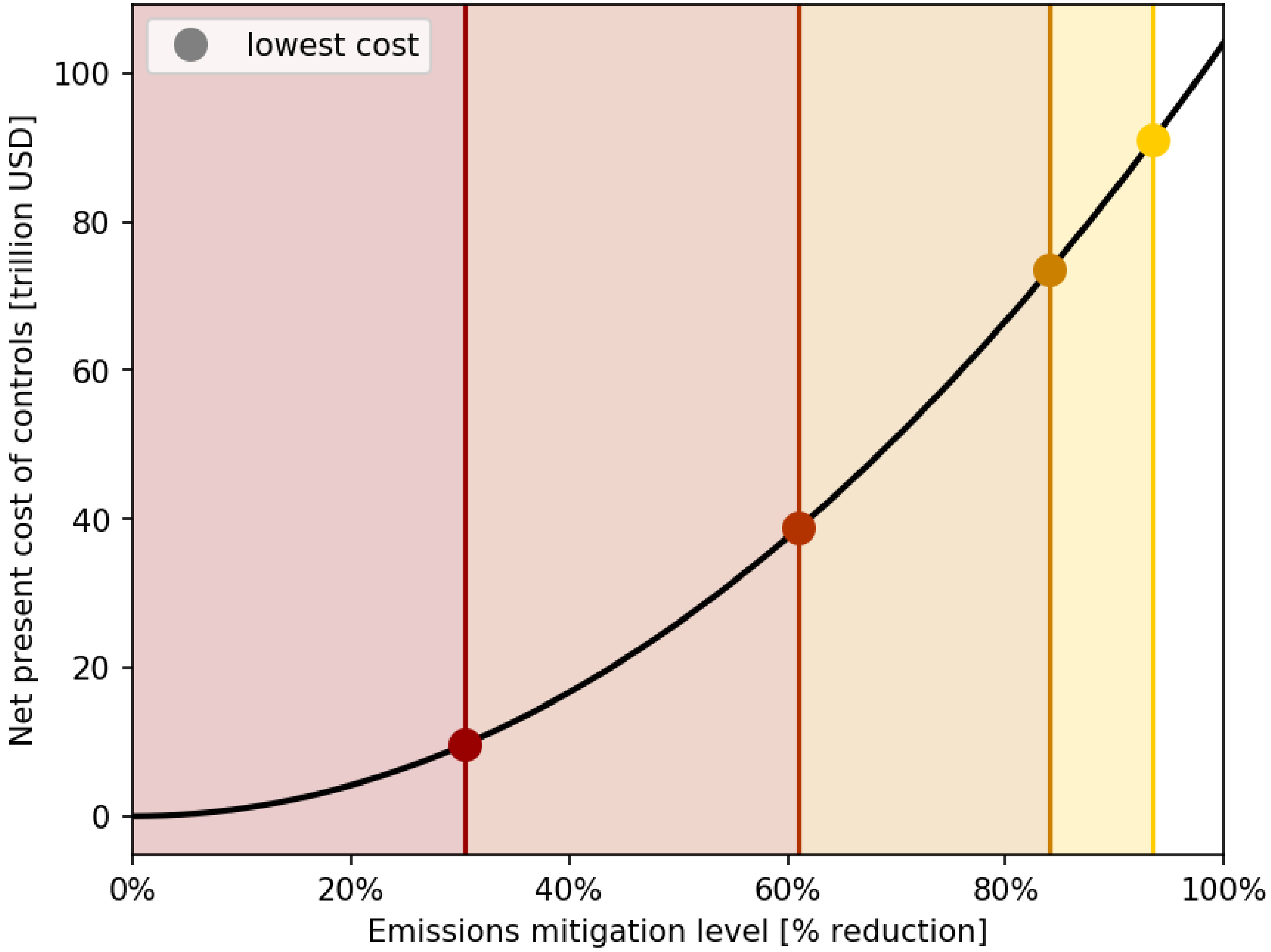
$$\max \left\{ \int_{t_0}^{t_f} \left(\mathcal{B}_{M,R,G,A} - \mathcal{C}_{M,R,G,A}\right) (1+\rho)^{-(t-t_0)} \, \mathrm{d}t \right\},$$

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

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

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

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

Reduce dimensions by:

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