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Using the FRIDA Framework to Evaluate Endogenous Human-Climate Responses to Climate Intervention Scenarios

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The gap between current greenhouse gas (GHG) mitigation efforts and the objective of limiting warming to 1.5°C persists because mitigation is often delayed, incomplete across sources, constrained by carbon-intensive infrastructure, unevenly distributed globally, and insufficiently responsive to non-CO GHGs, land-use change, and climate feedbacks; consequently, climate intervention technologies might be required to complement mitigation efforts. Solar Radiation Modification (SRM) has been proposed as a complementary approach that cools the planet by reflecting a fraction of incoming solar radiation, notably through Stratospheric Aerosol Injection (SAI). Because SRM has not been deployed, assessment relies predominantly on modeling; however, Earth System Models and Integrated Assessment Models (IAMs) face limitations in representing dynamic climate–human feedbacks and are computationally intensive for extensive scenario exploration. This study adapts the system dynamics FRIDA framework—a fully coupled model integrating radiation balance, carbon and water cycles with demographics, economy, land use and agriculture, energy, resources (concrete), and behavioral change—to simulate SRM, focusing

Abbreviations: GHG, greenhouse gases; SRM, solar radiation modification; SAI, stratospheric aerosol injection; IAM, integrated assessment model.

on incorporating SAI. Overall, the adapted FRIDA model can reproduce the intended physical effect of SAI within an integrated assessment framework; however future work should extend SAI-linked feedbacks across all human-system modules to evaluate impacts beyond direct climate outcomes.

KEYWORDS
Climate Intervention, Solar Radiation Modification, Stratospheric Aerosol Injection, Climate Change