

Tracking Toxic Air Pollutants: From Emissions to Impacts

Noelle E. Selin

Esther and Harold E. Edgerton Career Development Assistant
Professor of Engineering Systems and Atmospheric Chemistry
Massachusetts Institute of Technology

With: Tammy M. Thompson (now at Colorado State); Sebastian Rausch (now at ETH Zurich); Rebecca Saari (MIT); Amanda Giang (MIT)



Massachusetts Institute of Technology
Engineering Systems Division

University of New
Hampshire
Environmental Sciences
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<http://mit.edu/selingroup>

Toxic air is a major sustainability challenge



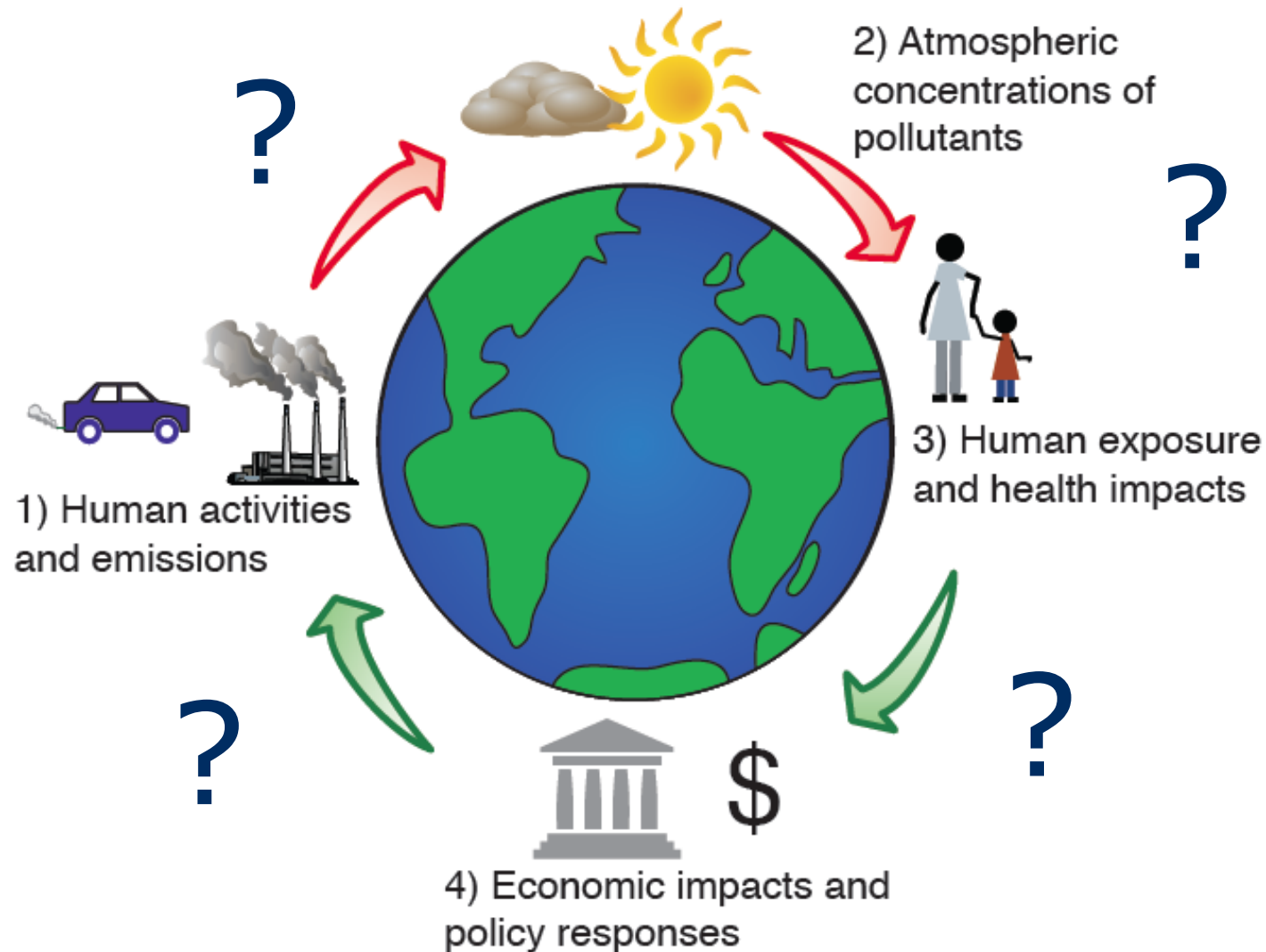
Outdoor air pollution is 7th largest cause of disease worldwide, according to Global Burden of Disease 2010

300,000+ newborns in the US each year at risk of learning disabilities due to elevated mercury exposure

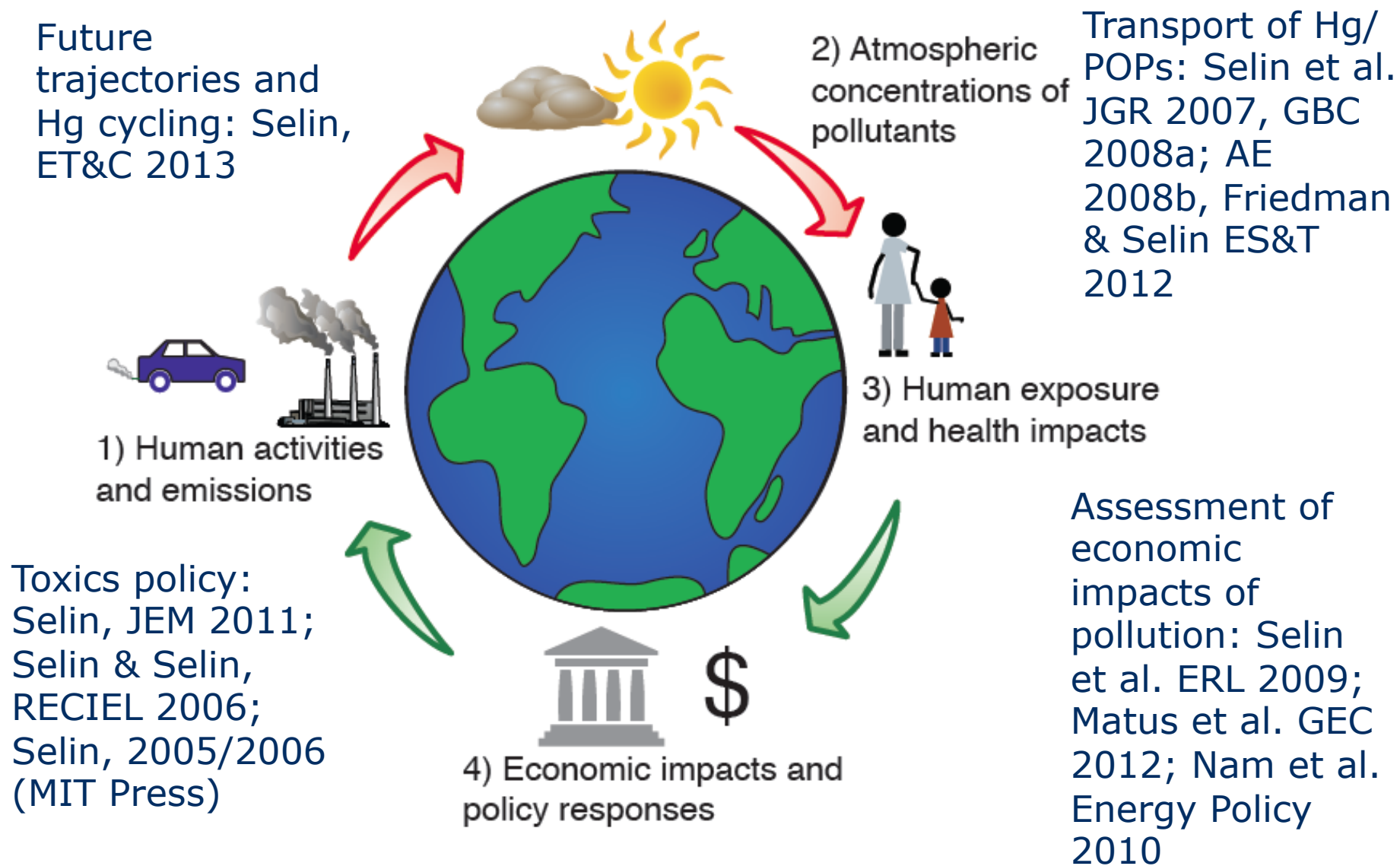


Industrialization emits substances that contribute to toxic air and worsens climate change

Designing efficient policy is complex



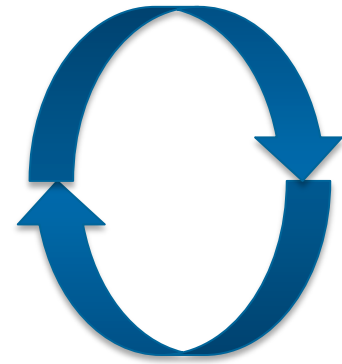
Research along the pathway



Research linking policies to impacts

How do we track the influence of policies on human impacts, accounting for real-world complexity?

Integrated Assessment: Policies-to-impacts sensitivity analysis



1) Assessing the air pollution co-benefits of climate policies

Thompson, Rausch, Saari, Selin, in final preparation for submission

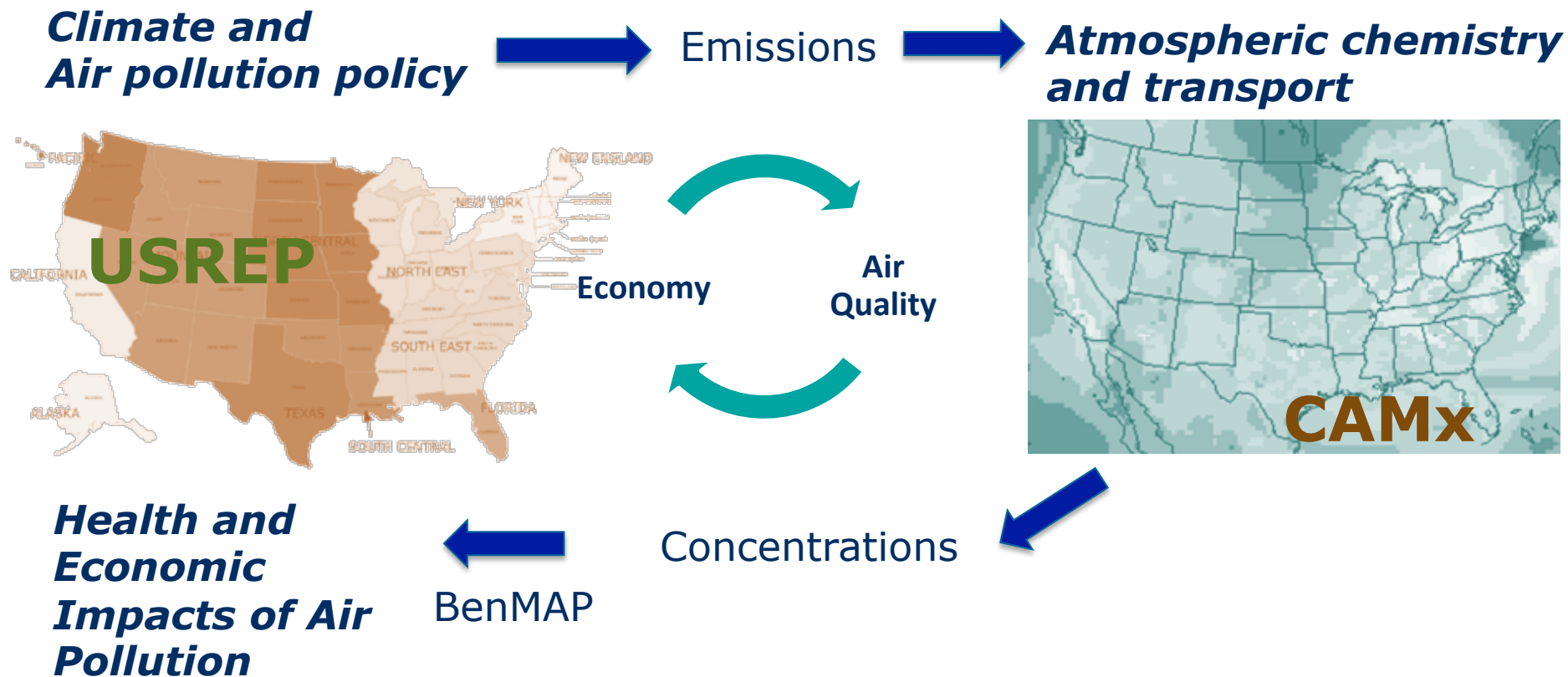
2) Quantifying the impacts of global mercury policies on the U.S.

Selin and Giang, in prep

1) Climate: Not all strategies are “win-win”

		Global Temperature Change		
Ozone and Particulate Matter Health Impacts		Climate Warming	Climate Cooling	Unknown
	Pollutant increase	Avoid <i>Historical experience</i>	Benefits for some	?
	Pollutant decrease	Benefits for some <i>Historical experience</i>	“Win-win” policy space	?
	Unknown	?	?	?

Improved Assessment Framework



Carbon Policy Scenarios

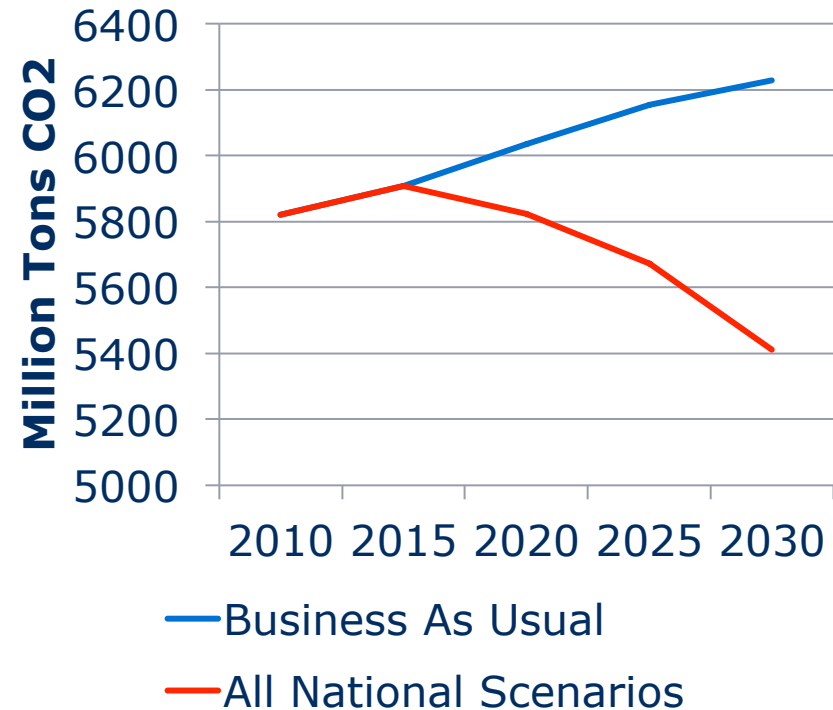
“Cap-and-Trade”

Clean Energy Standard

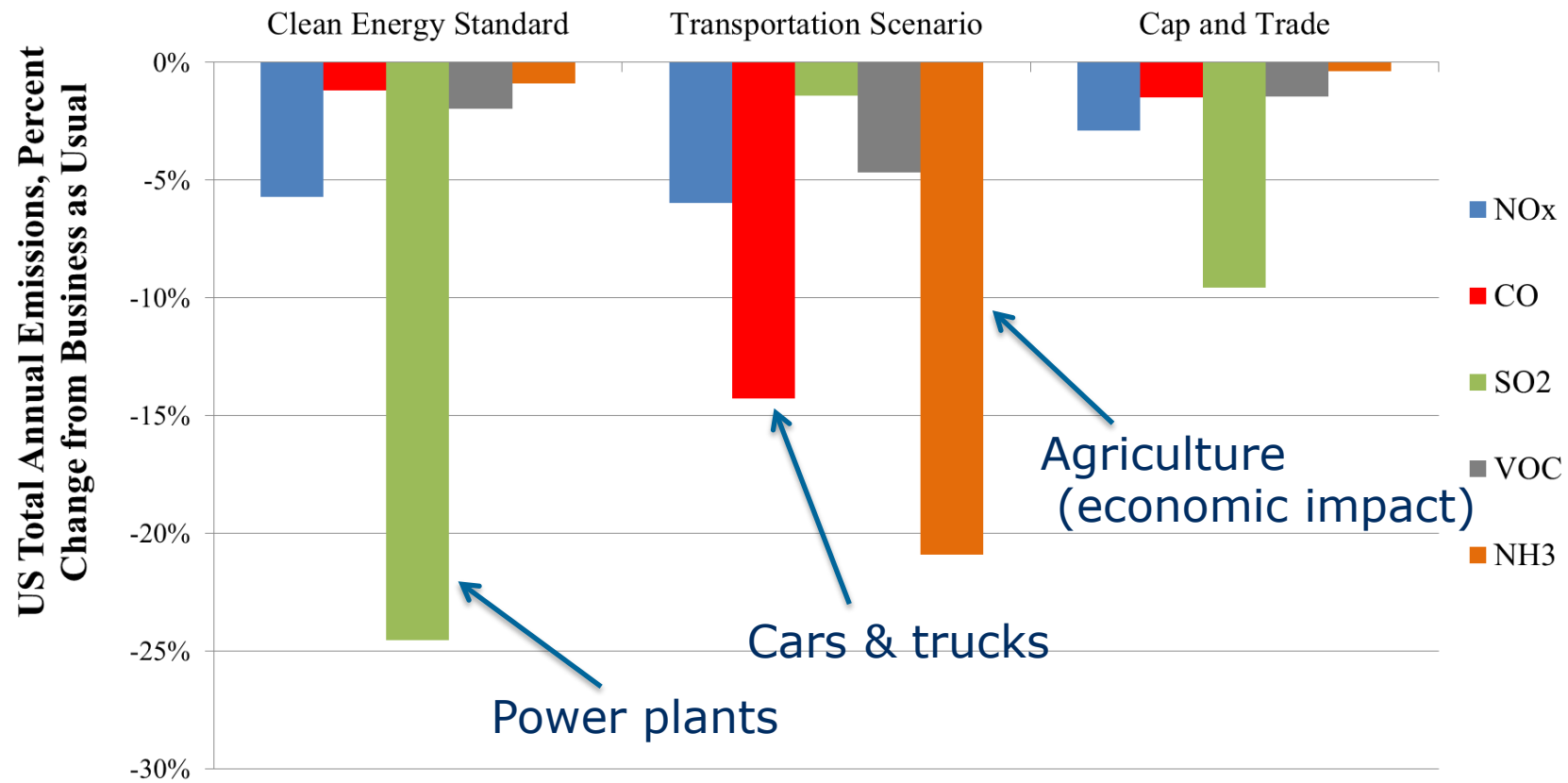
Transportation cap

Each scenario reduces CO₂ nationally 10% in 2030 relative to 2006 emissions.

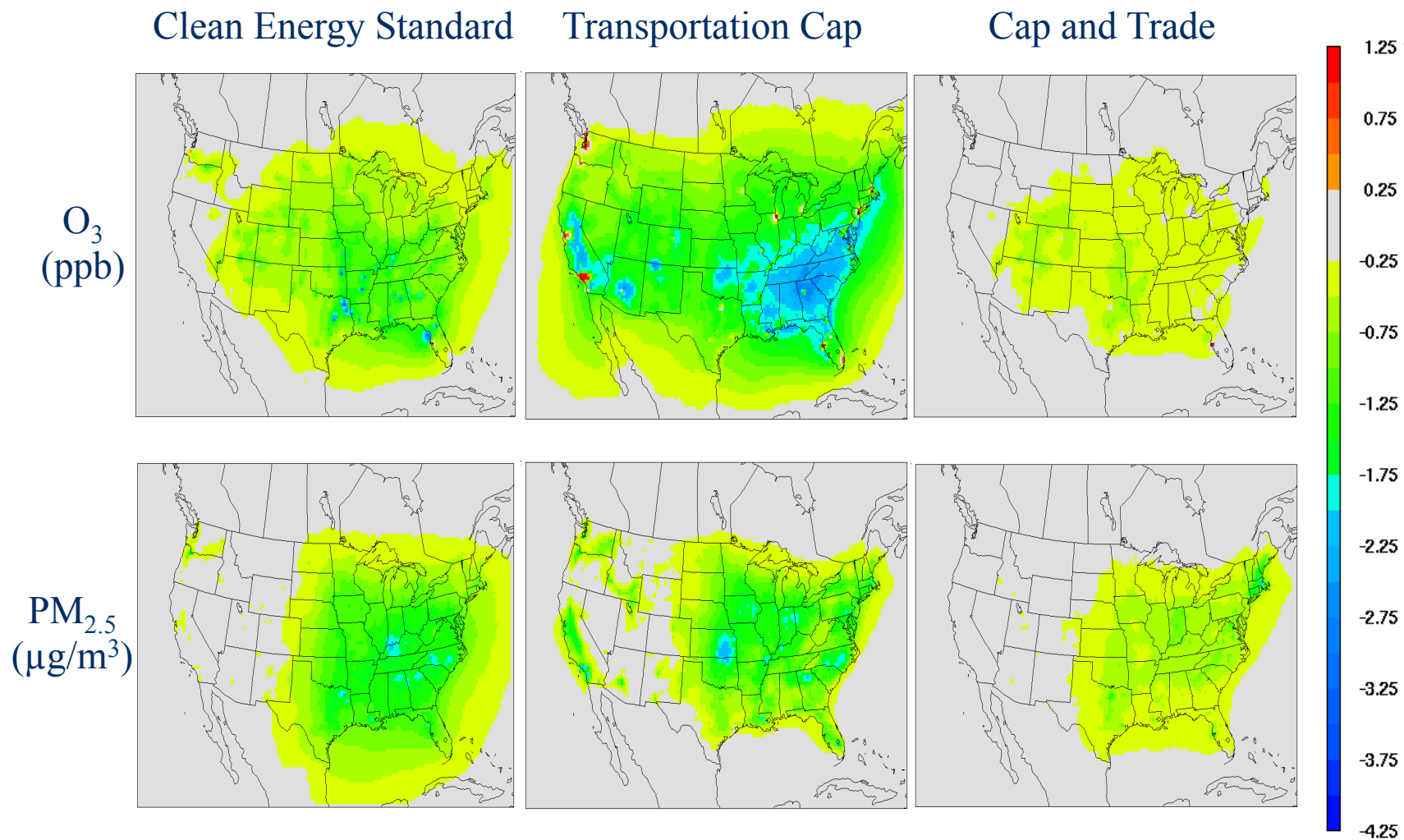
Different sources → different co-benefits?



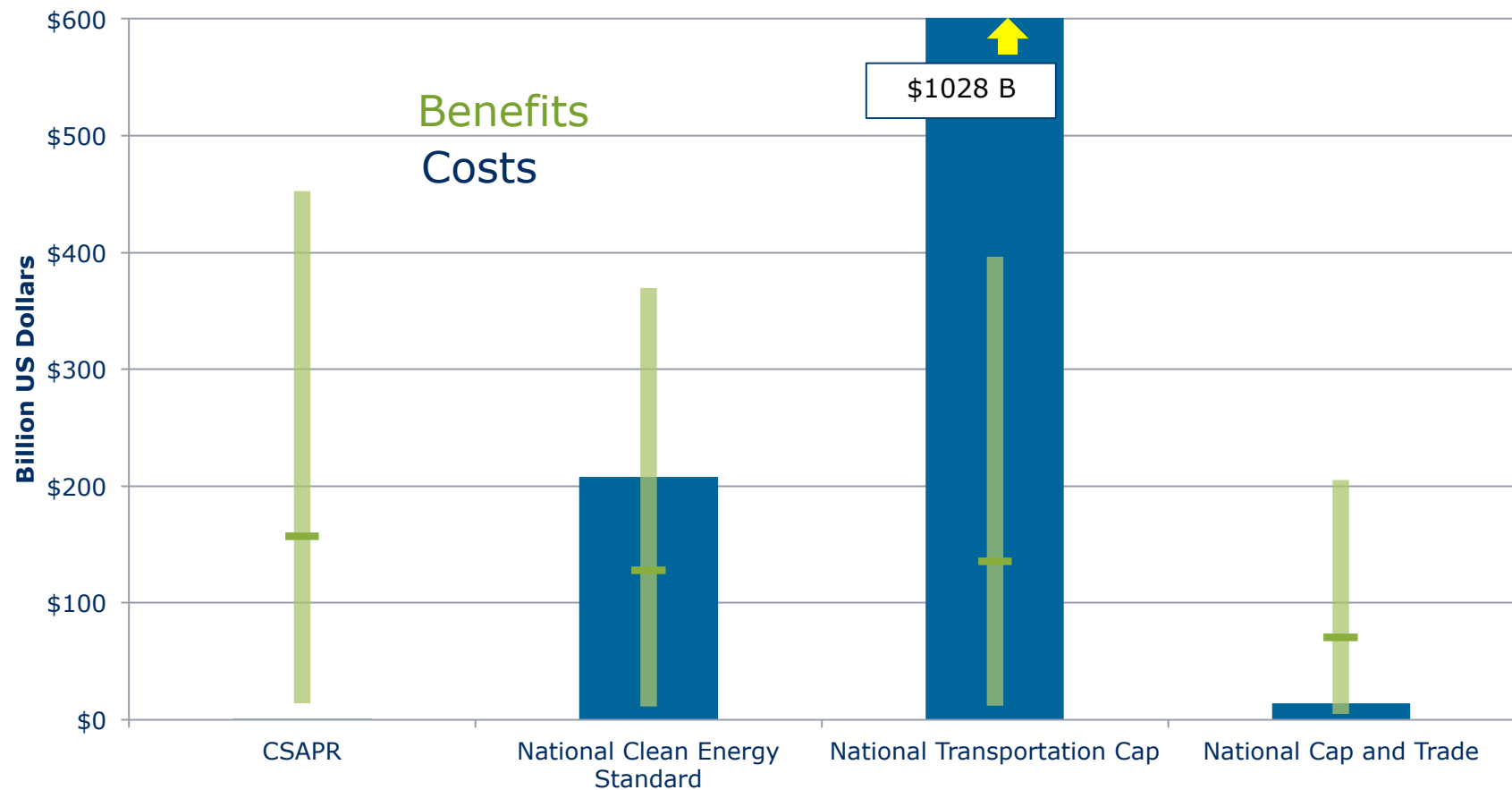
Carbon policies affect different pollutants



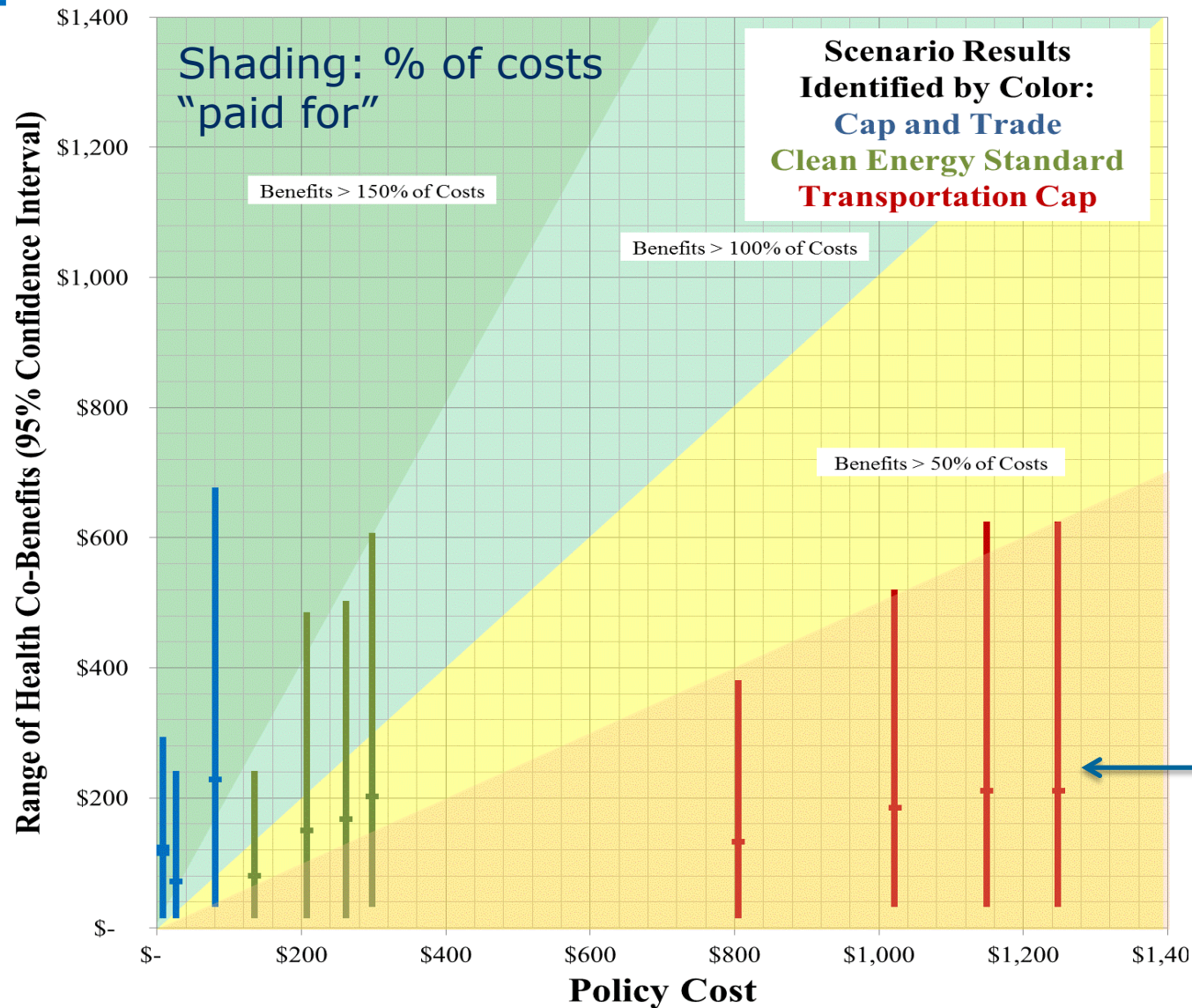
Ozone and PM decrease substantially



Results suggest “win-win” opportunities



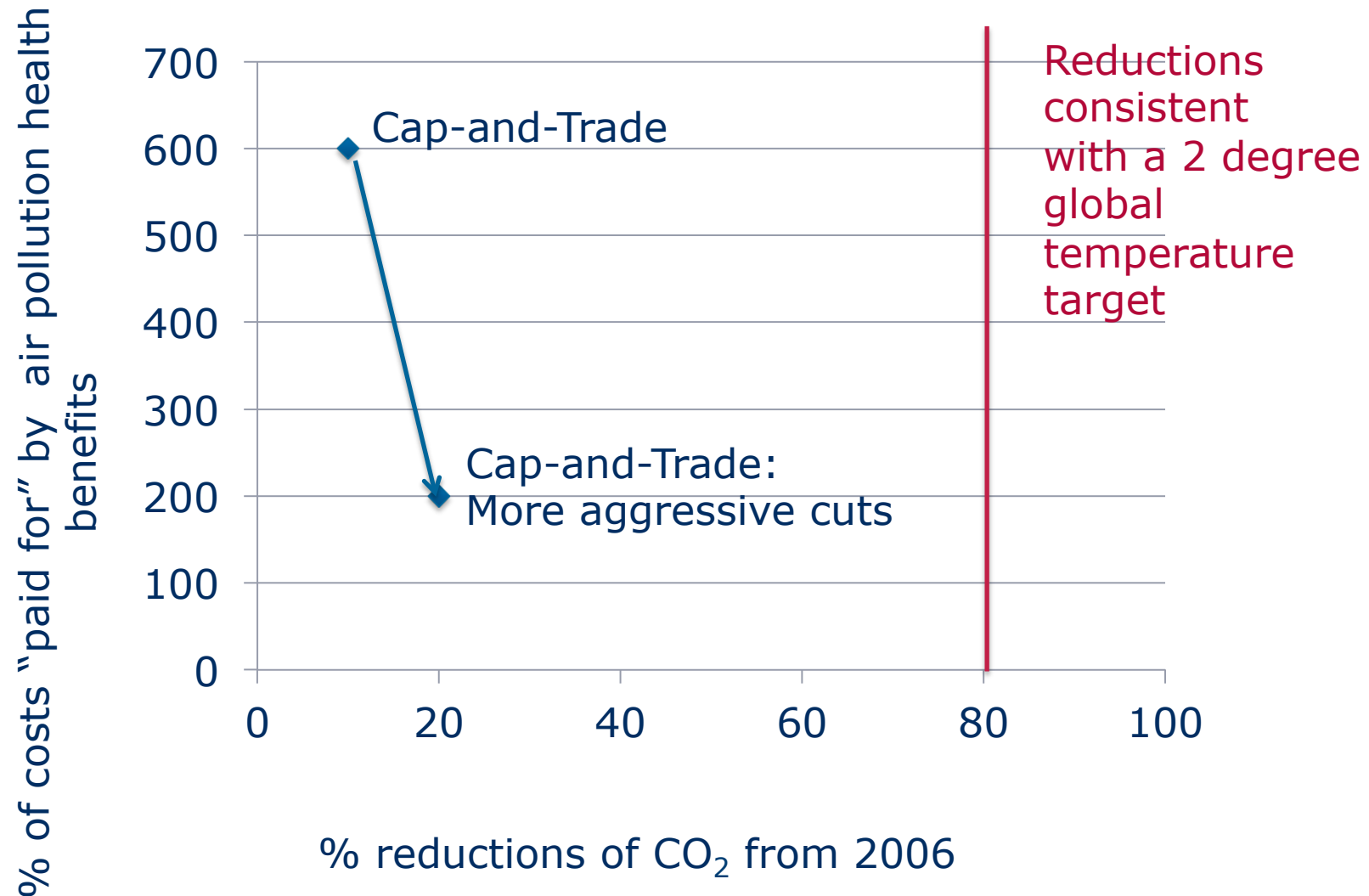
Policies-to-impacts sensitivity analysis



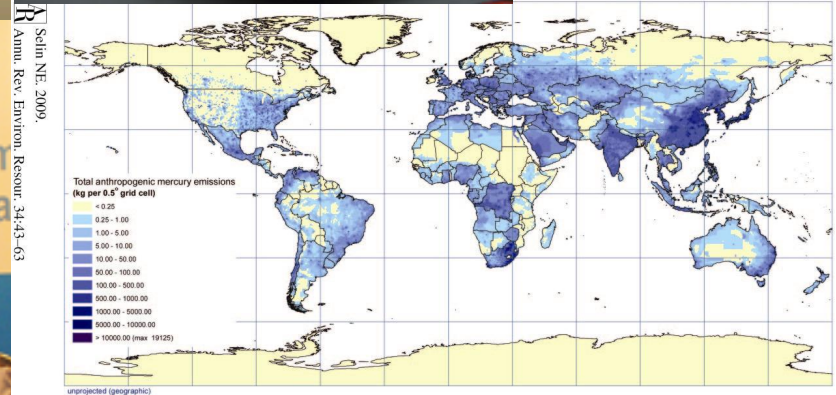
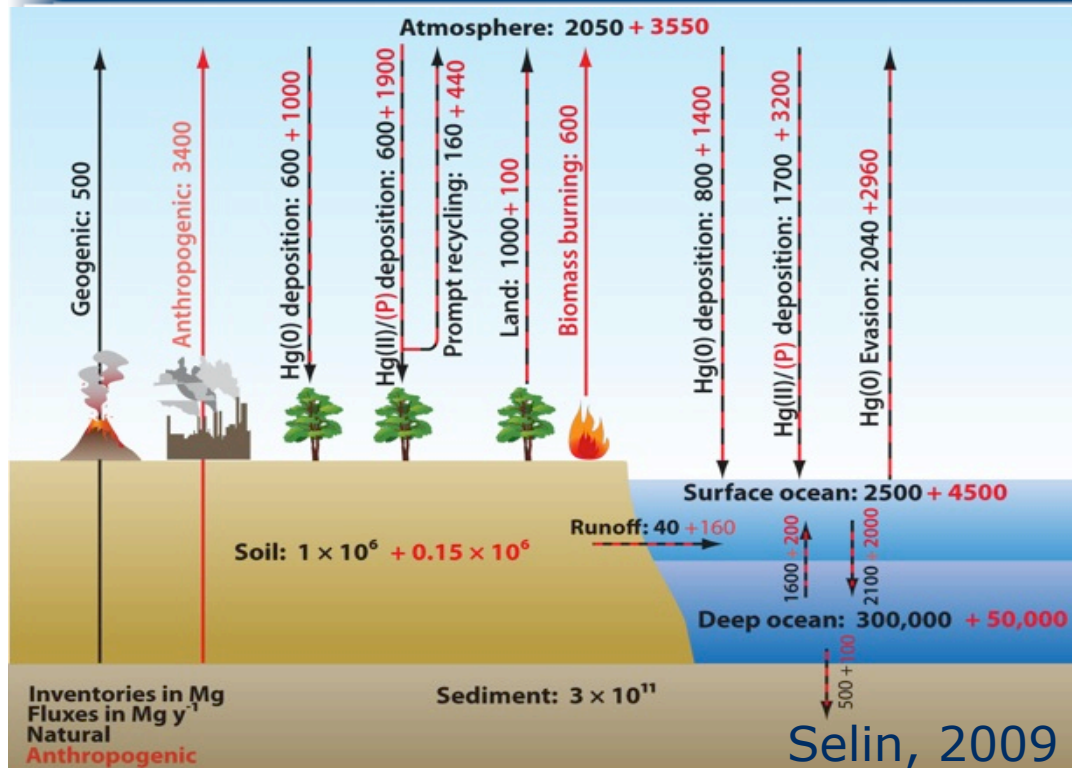
Cost and economic uncertainty is substantial and can determine how much air pollution benefits can "pay for" climate policies

Each line is a different economic model sensitivity case

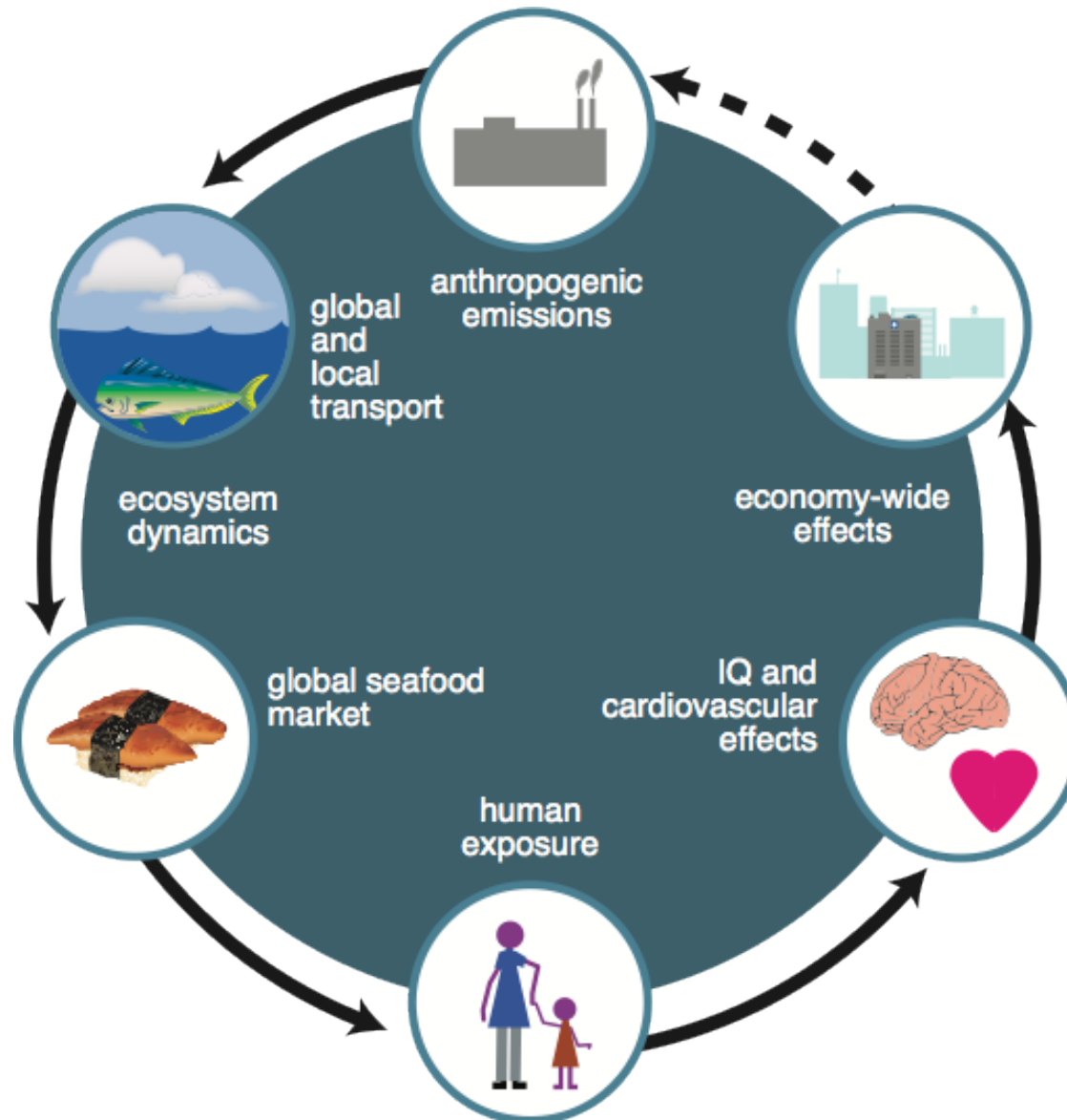
Win-win for now...what about the future?



2) Mercury: Newest Environmental Treaty



Tracking emissions to impacts is more



Integrated Assessment for Mercury



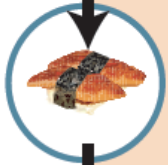
Chemical Transport Modelling: GEOS-Chem

Zhang et al. 2012, Corbitt et al. 2011, Streets et al. 2009, Amos et al. 2012



Ecosystem and Exposure Intake Modelling

Chen et al. 2012, Knightes et al. 2009, Mason et al. 2012, Sunderland and Mason 2007, Sunderland 2007, Pirrone et al. 2010, Mahaffey et al. 2009



Health Impacts Modelling

Rice et al. 2010, Axelrad et al. 2007, Budtz-Jorgensen et al. 2007, Virtanen et al. 2005, Roman et al. 2011, Guallar et al. 2002

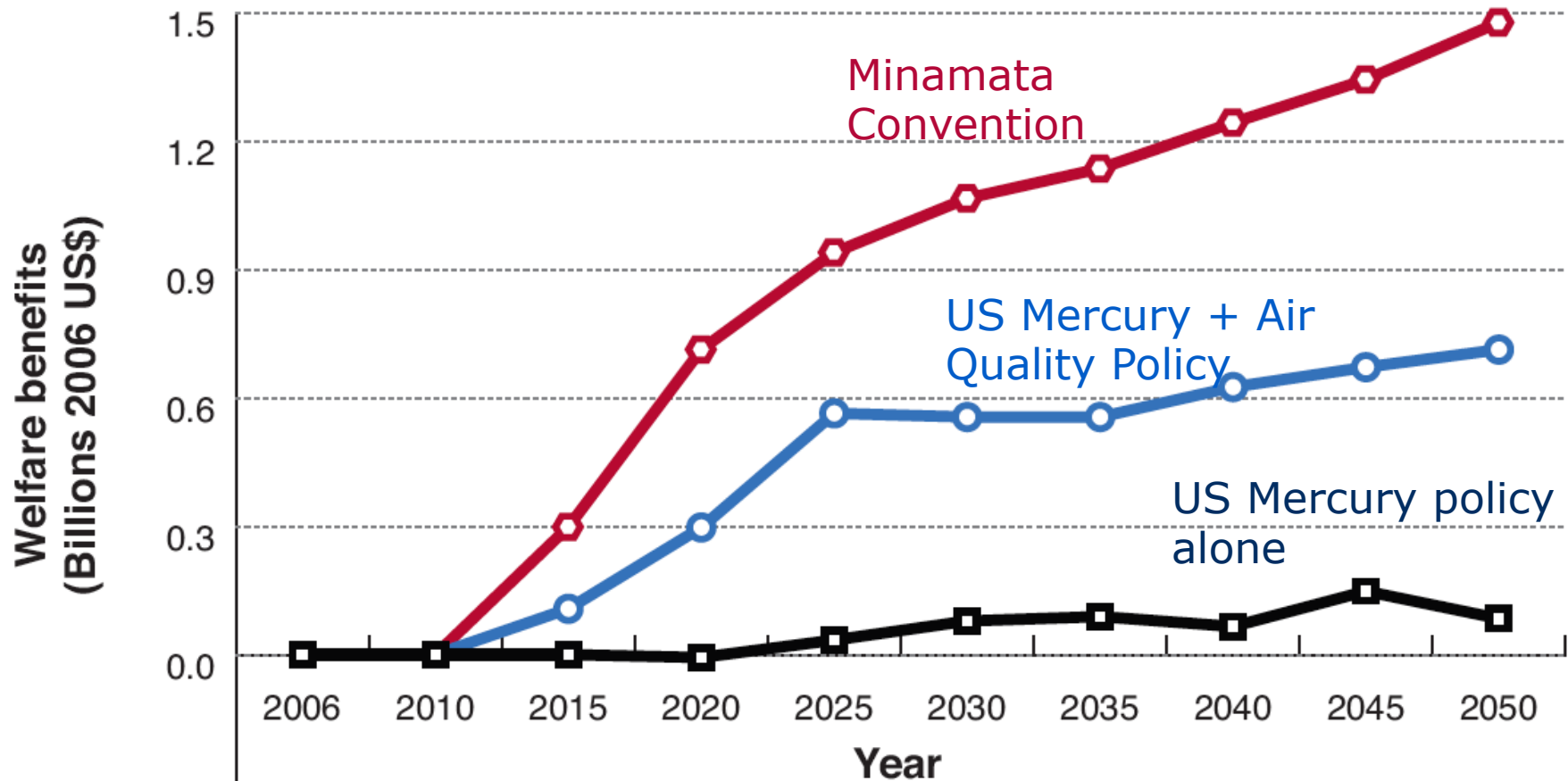


Economic Modelling: US Regional Energy and Environmental Policy Model (USREP)

Rausch 2010, Saari et al. 2013

U.S. benefits from Minamata Convention

Cumulative benefits from Minamata: \$38 billion



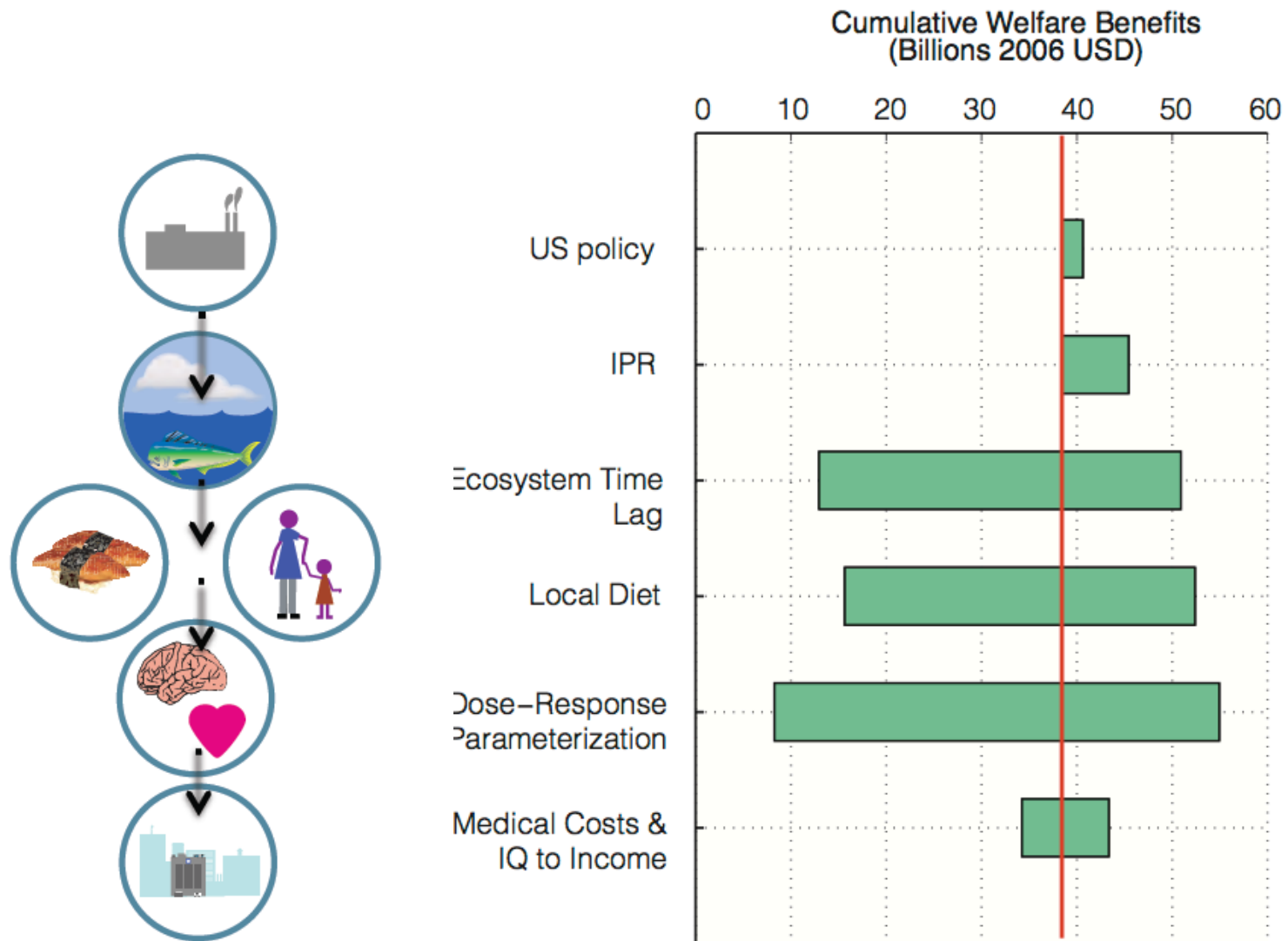
Minamata

MATS vs. NP

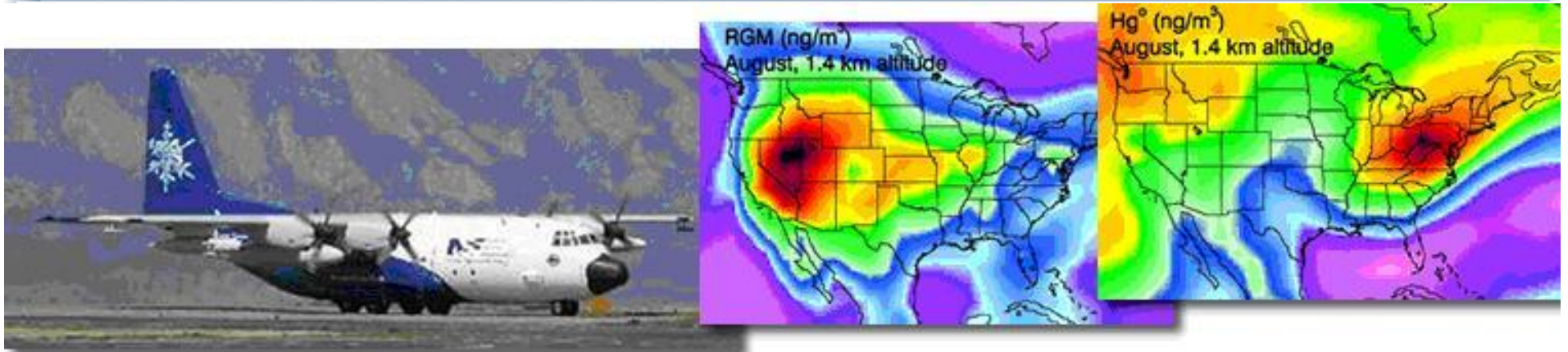
MATS vs. AQ

Discounted at 3%

Policies-to-impacts sensitivity analysis



Data Constraints for Modeling



Nitrogen, Oxidants, Mercury and Aerosol: Distributions, Sources and Sinks (NOMADSS) aircraft campaign,

June 1 – July 15, 2013, flying from Smyrna, TN

Noelle and Dr. Jesse Ambrose, UNH grad (now at University of Washington), who was running the DOHGS mercury instrument for NOMADSS, on the C-130



Integrating Research and Education



“Mercury Game”: interactive simulation of mercury global politics and science

Role-play game with 8-11 players: Should we negotiate a global treaty? Players include countries, NGOs, scientists

Available for free to download for classrooms at
<http://mit.edu/mercurygame>

Acknowledgments: Selin Group 2013

- **Postdocs:**

- Carey Friedman (PhD, URI): Transport and fate of persistent organic pollutants

- **Graduate Students:**

- Rebecca Saari, Engineering Systems 4th yr: Air pollution health impacts
- Ellen Czaika, Engineering Systems 4th yr: Sustainability decision-making
- Shaojie Song, Earth, Atmospheric & Planetary Sciences, 3rd yr: Mercury
- Colin Pike-Thackray, Earth, Atmospheric & Planetary Sciences, 3rd yr : POPs
- Amanda Giang, Engineering Systems, 1st yr: Mercury
- Mingwei Li, Earth, Atmospheric & Planetary Sciences, 1st yr: Air pollution transport
- Leah Stokes, Urban Studies/Planning DUSP 4th yr: Mercury science-policy (primary advisor: Larry Susskind)
- Jareth Holt, EAPS 4th yr: Air pollution uncertainties (co-advised with Susan Solomon)
- Corey Tucker, Technology and Policy Program, 1st yr: Mercury

- **Recent alumni:**

- Tammy Thompson (PhD, U. Texas): Regional-to-global atmospheric chemistry modeling, now at CIRA/Colorado State University as Research Scientist

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