Systems Approaches to Managing Toxic Air Pollutants

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MIT JOINT PROGRAM SCIENCE POLICY GLOBAL CHANGE

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Conversations on Sociotechnical Systems Seminar series
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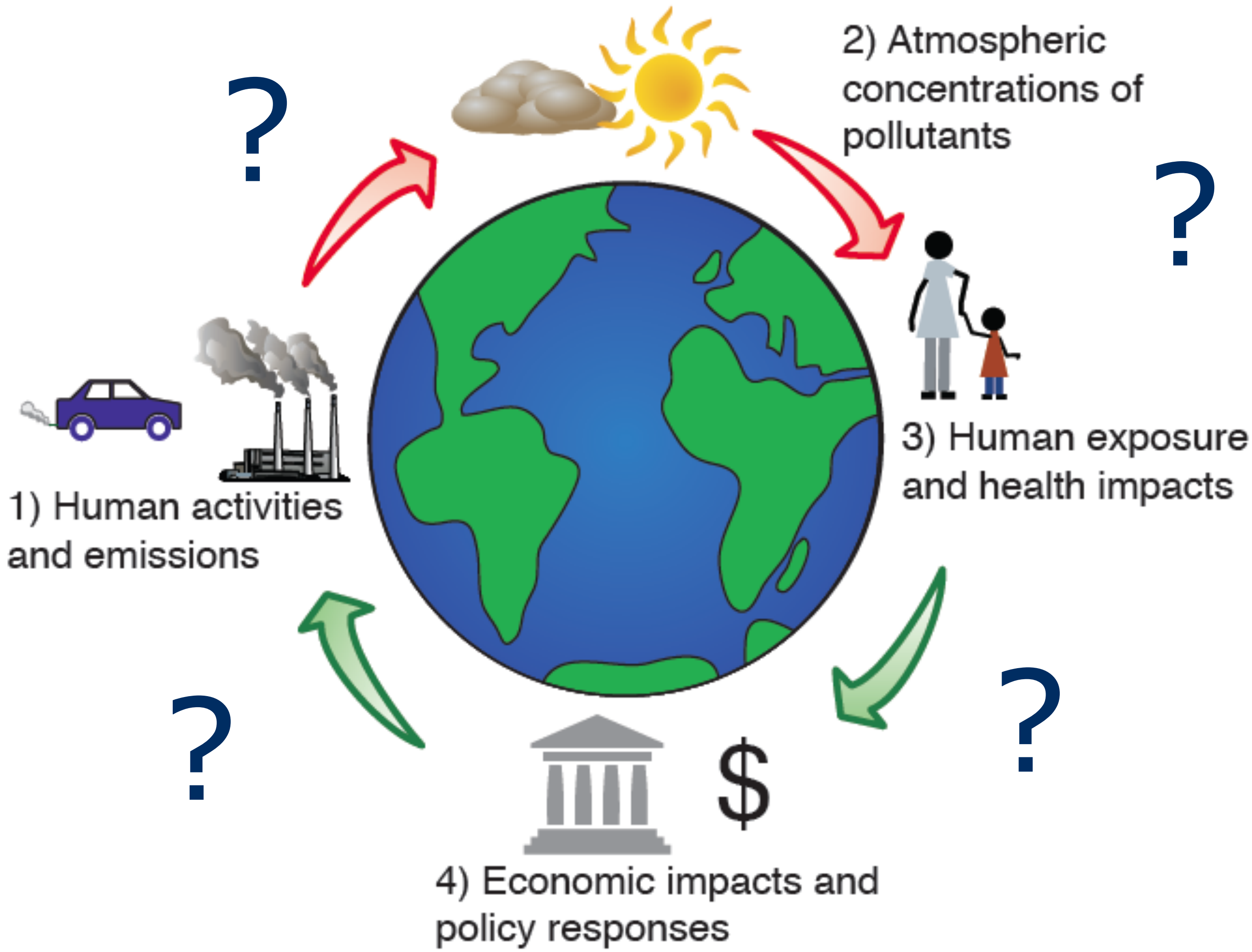
Toxic air is a major socio-technical

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

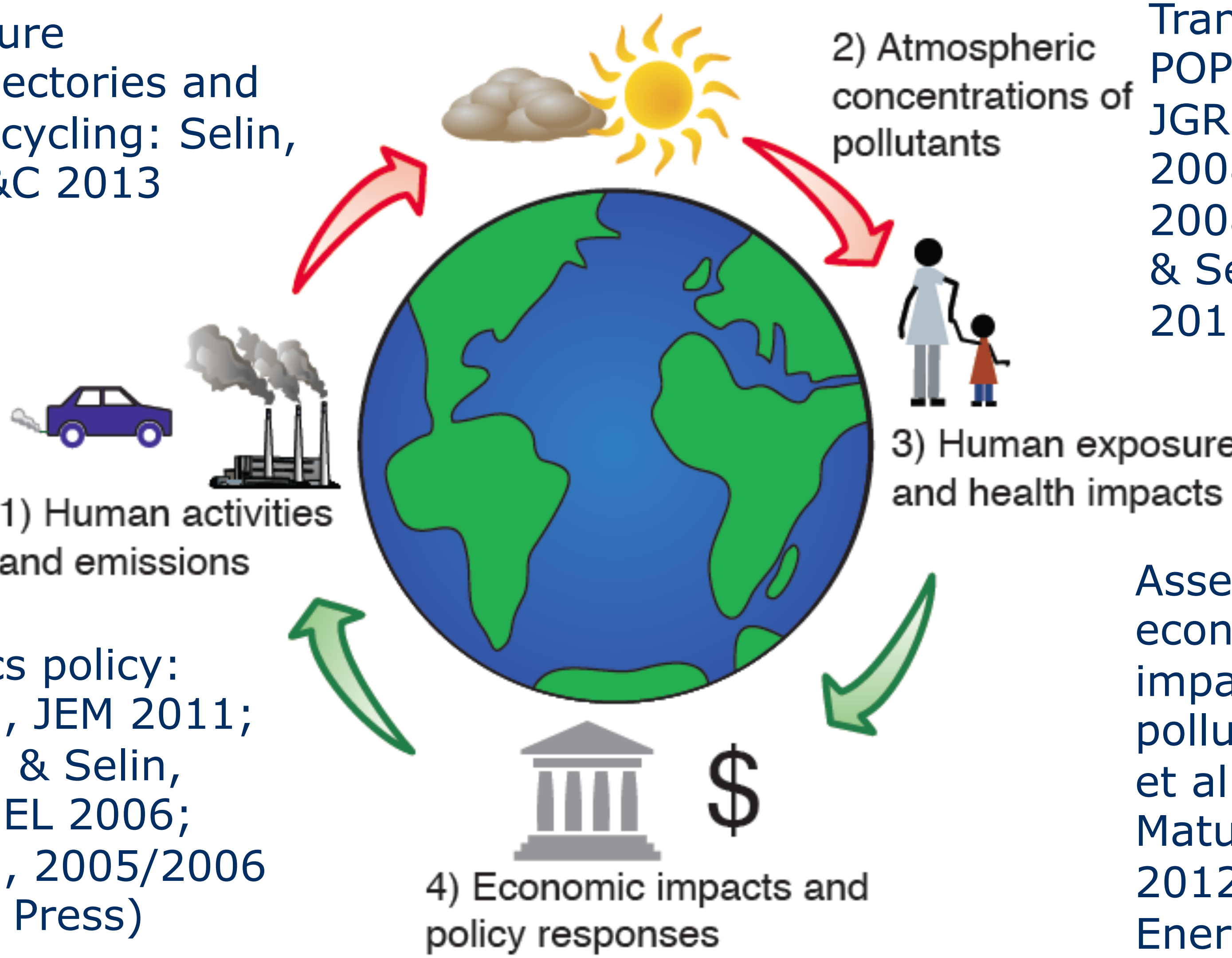
Designing efficient policy is complex



Research along the pathway

Future trajectories and Hg cycling: Selin, ET&C 2013

Transport of Hg/ POPs: Selin et al. JGR 2007, GBC 2008a; AE 2008b, Friedman & Selin ES&T 2012



Toxics policy: Selin, JEM 2011; Selin & Selin, RECIEL 2006; Selin, 2005/2006 (MIT Press)

Assessment of economic impacts of pollution: Selin et al. ERL 2009; Matus et al. GEC 2012; Nam et al. Energy Policy 2010

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

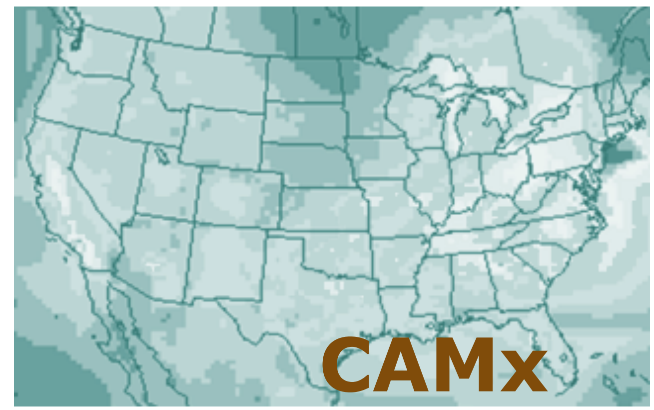
	Climate Warming	**Climate Cooling**	**Unknown**
Pollutant increase	Avoid ***Historical experience***	Benefits for some	?
Pollutant decrease	Benefits for some ***Historical experience***	“Win-win” policy space	?
Unknown	?	?	?

Improved Assessment Framework

Climate and Air pollution policy → Emissions → ***Atmospheric chemistry and transport***

Economy

Air Quality



Concentrations

BenMAP

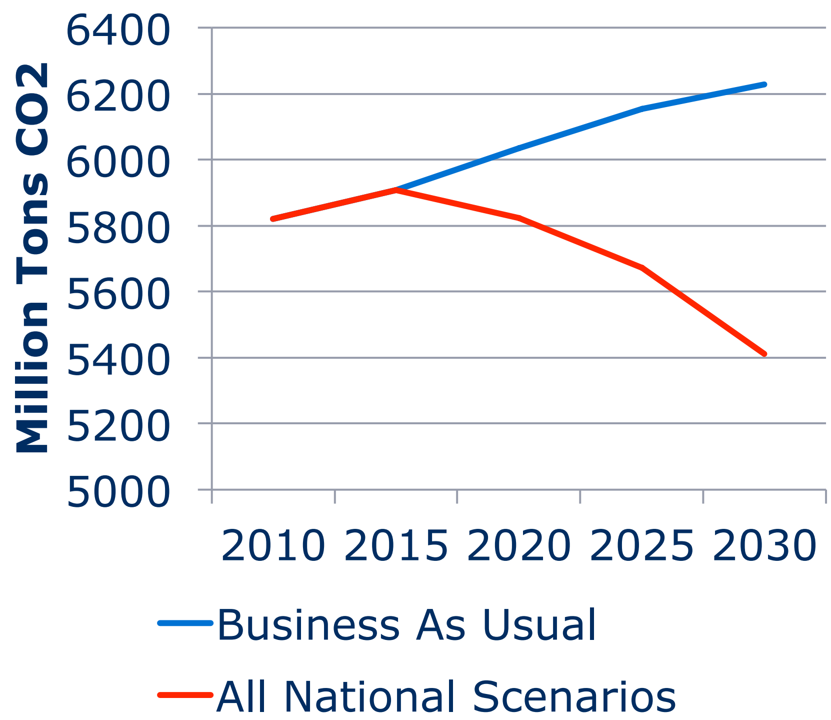
Health and Economic Impacts of Air Pollution

Carbon Policy Scenarios

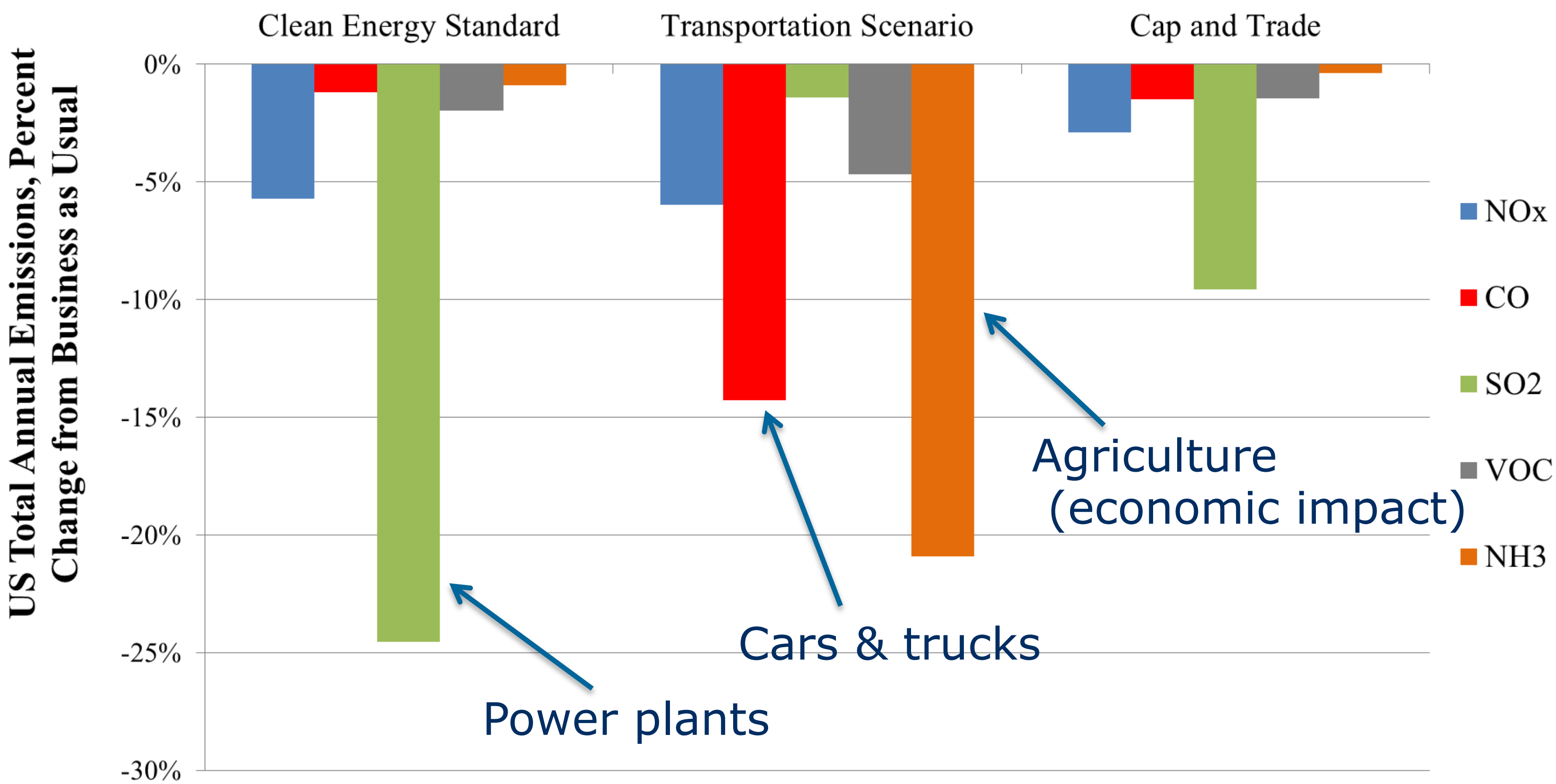
"Cap-and-Trade"
Clean Energy Standard
Transportation cap

Each scenario reduces CO_2 nationally 10% in 2030 relative to 2006 emissions.

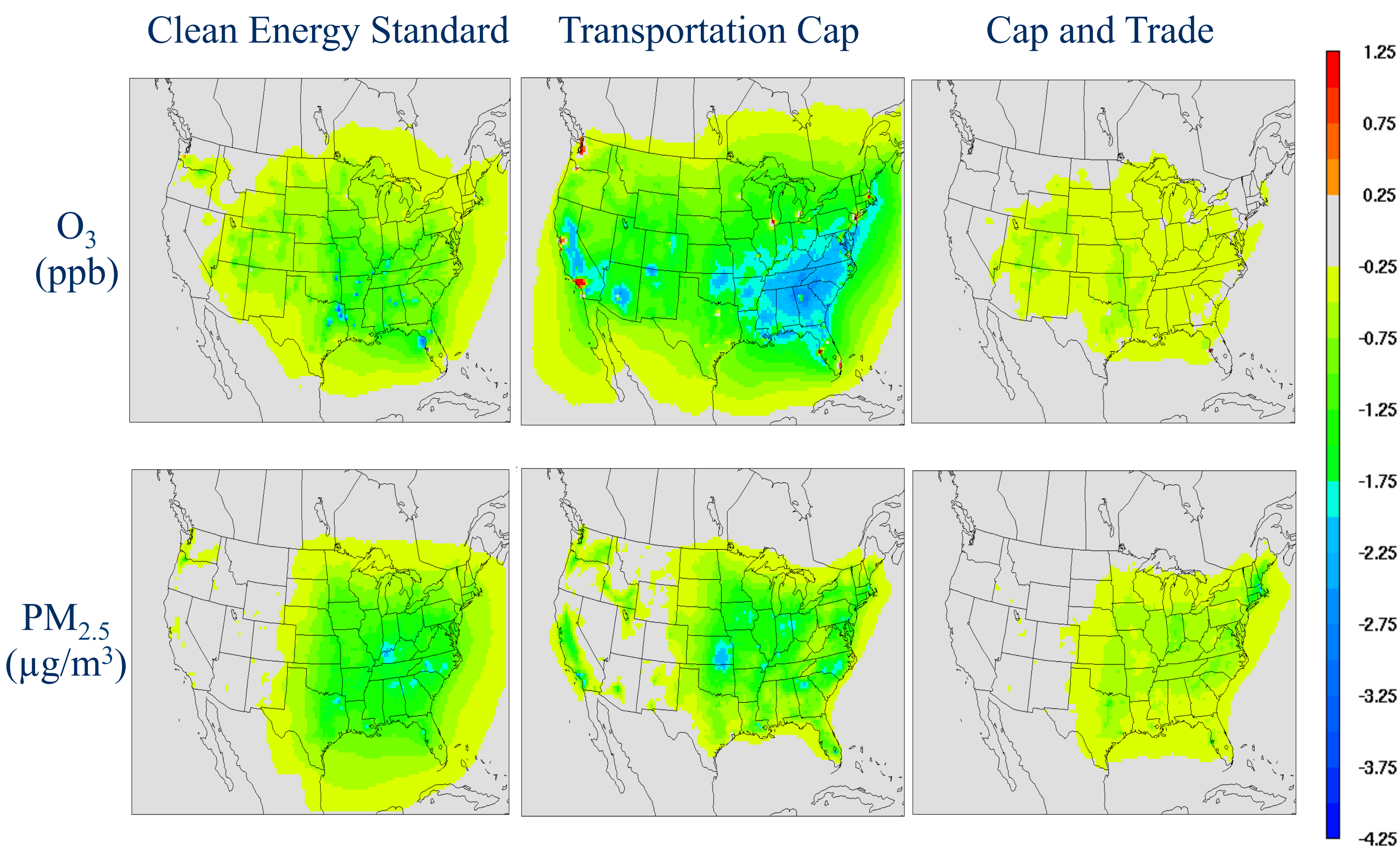
Different sources → different co-benefits?



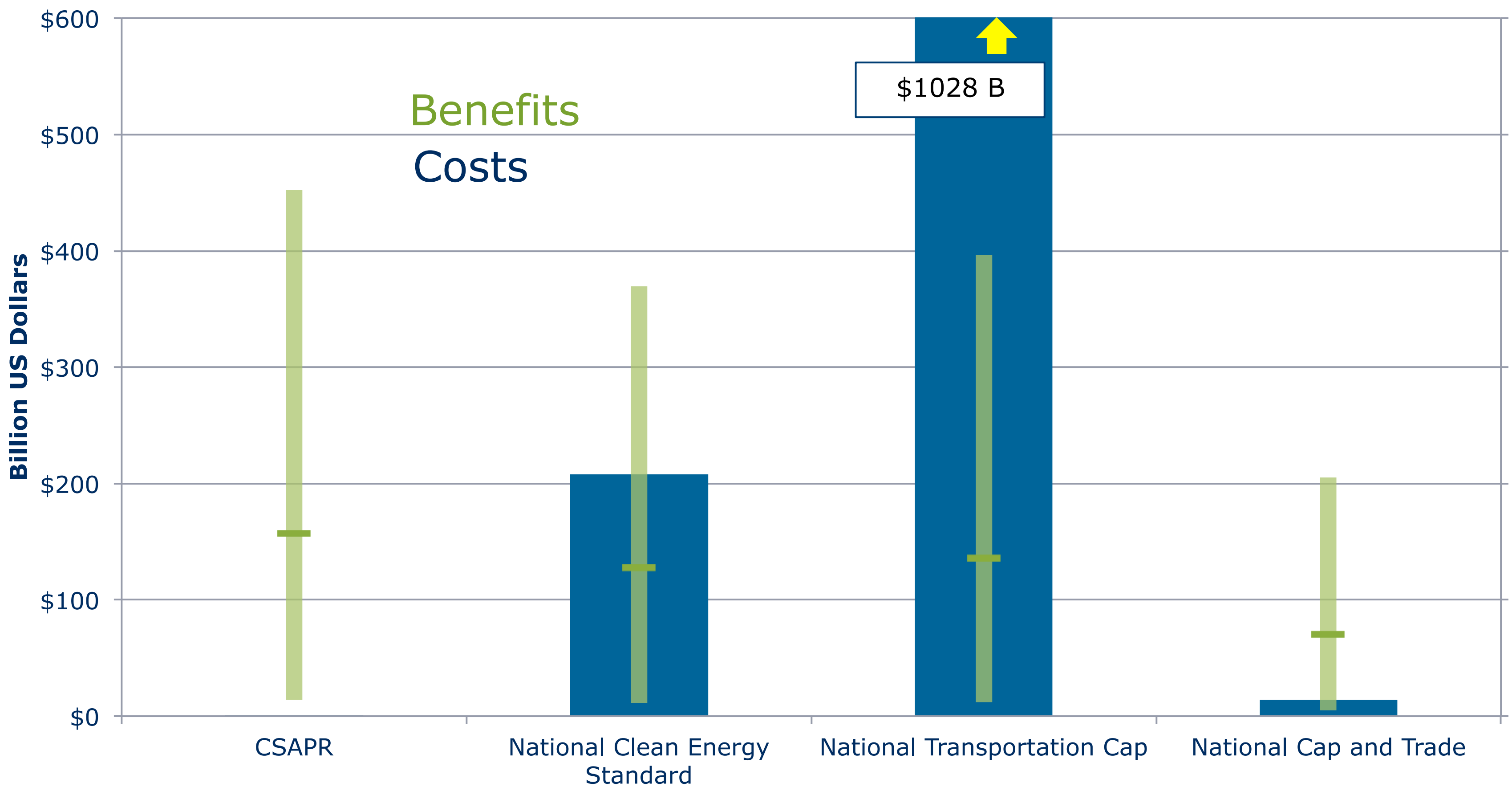
Carbon policies affect different pollutants



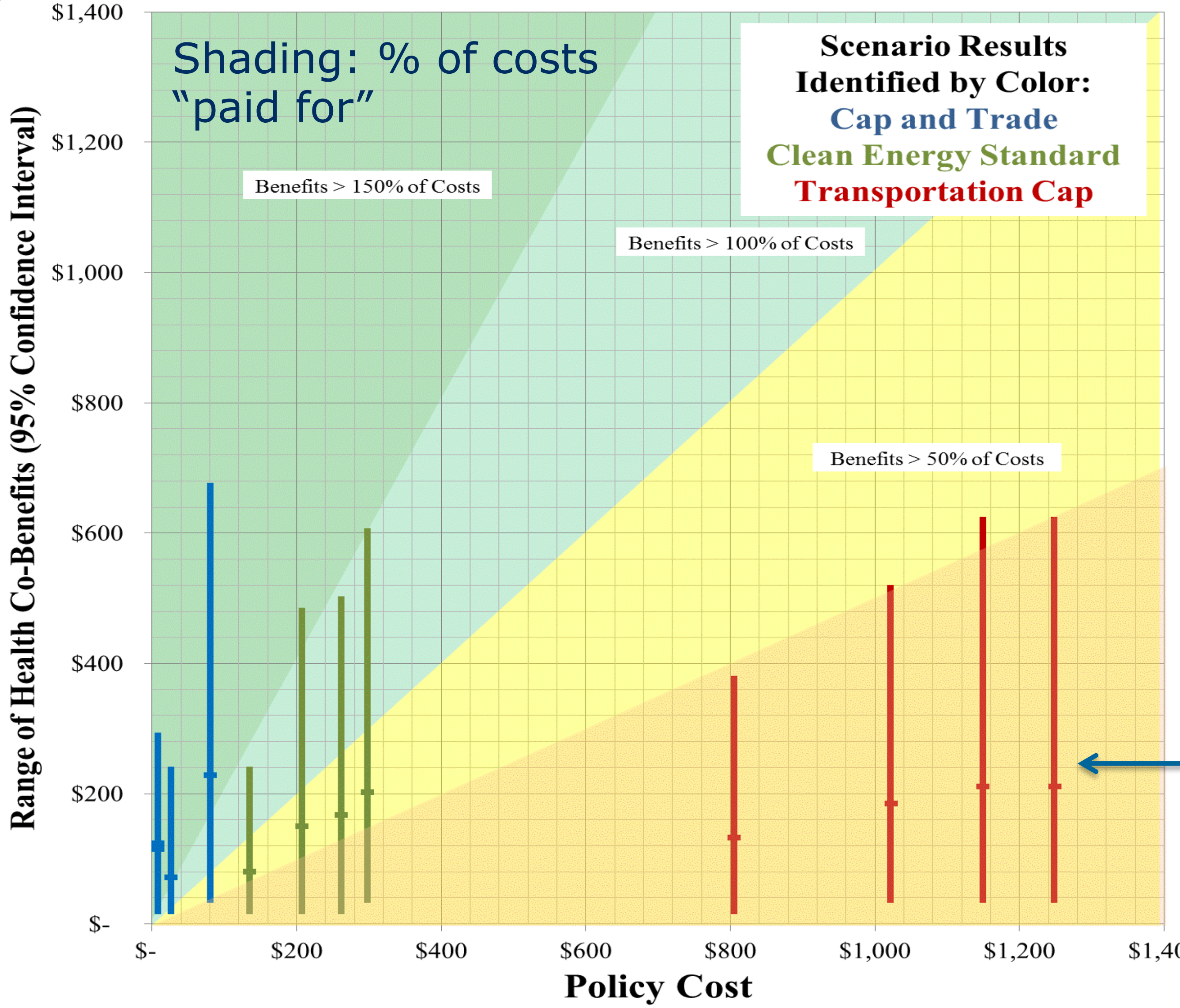
Ozone and PM decrease substantially



Results suggest "win-win" opportunities



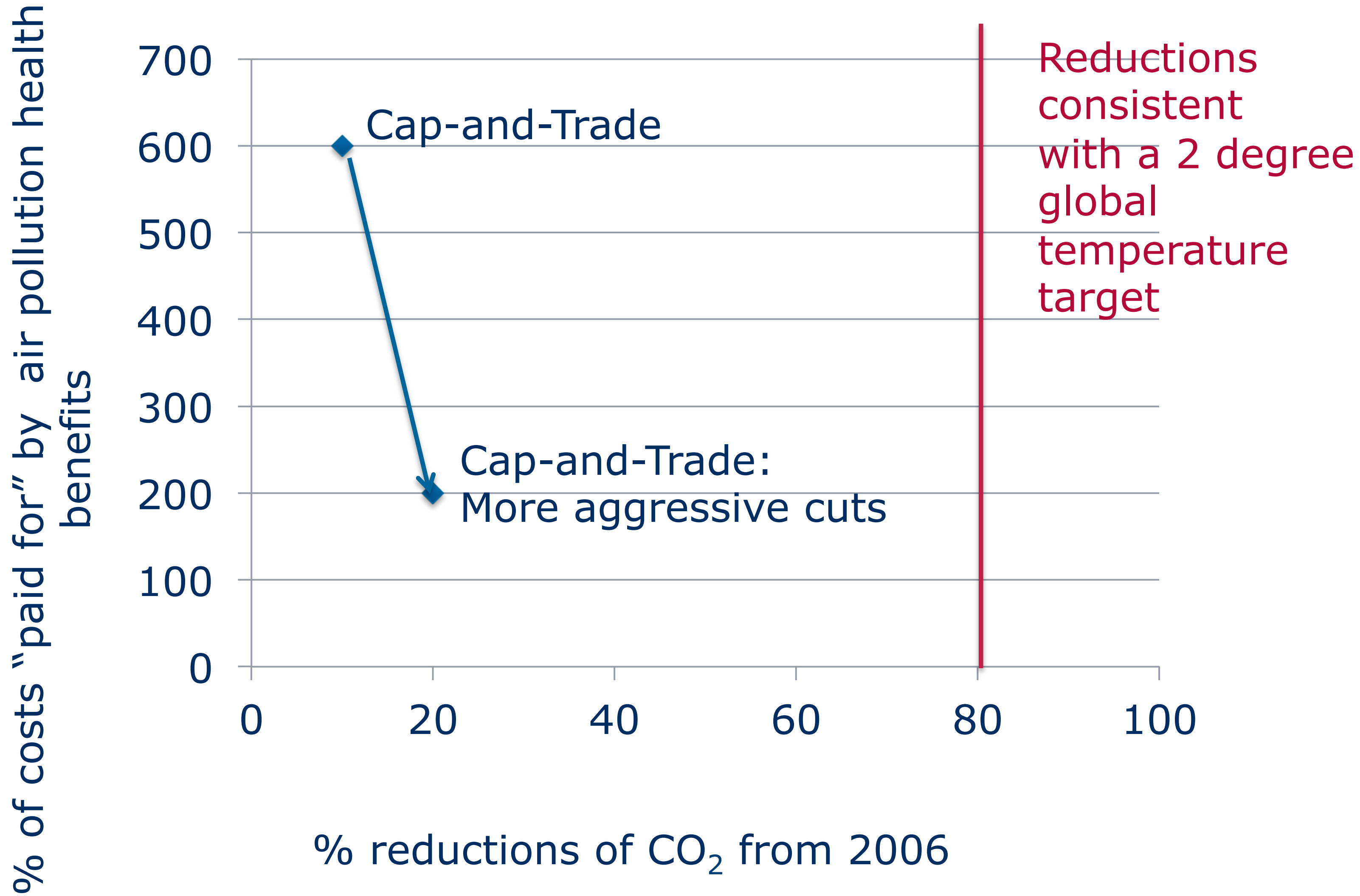
Policies-to-impacts sensitivity analysis



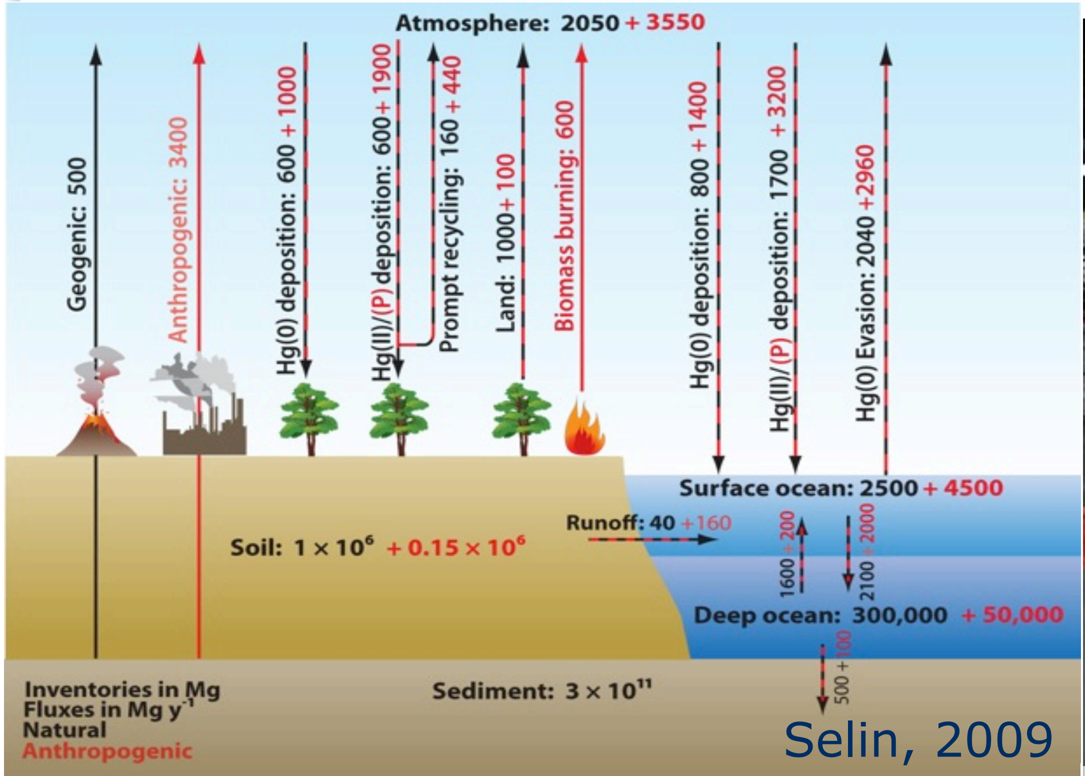
Cost and economic uncertainty is substantial and can determine how much air pollution benefits can "pay for" climate policies

Each line is a different economic model sensitivity case

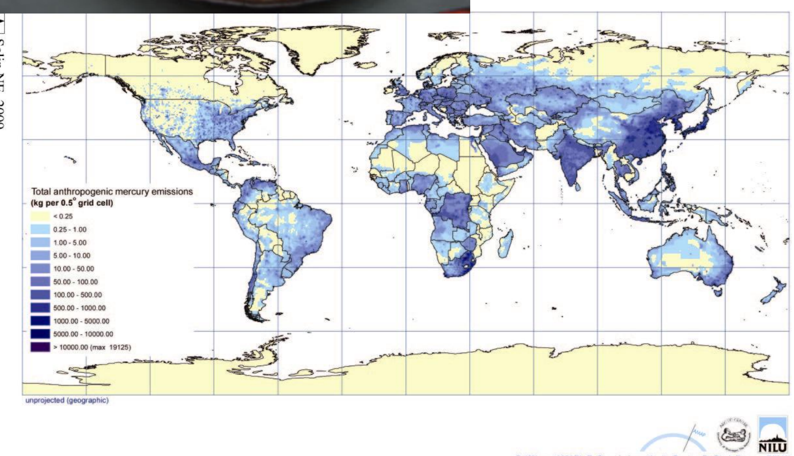
Win-win for now…what about the future?



2) Mercury: Newest Environmental Treaty



Selin NE. 2009. Annu. Rev. Environ. Resour. 34:43–63



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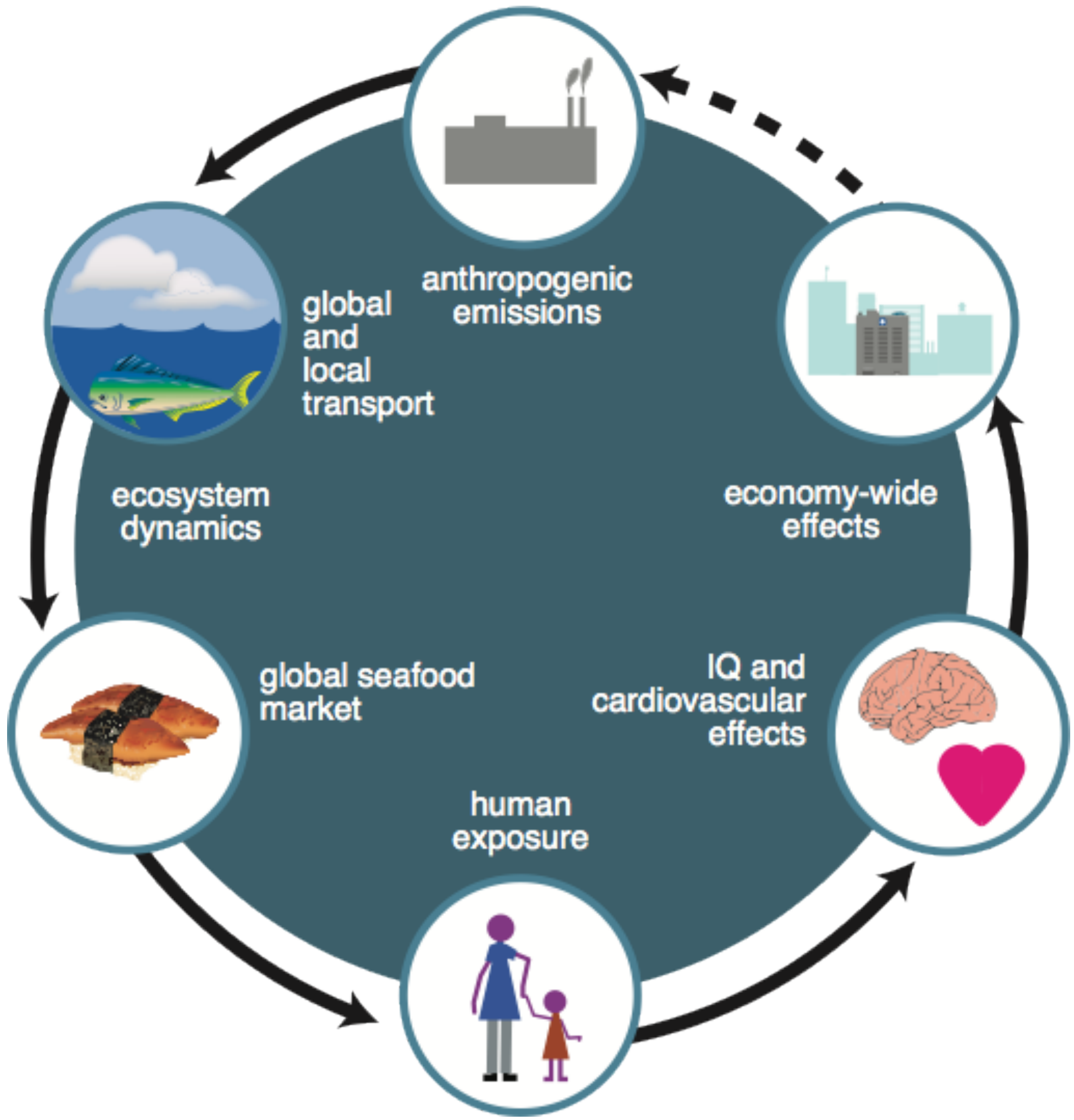
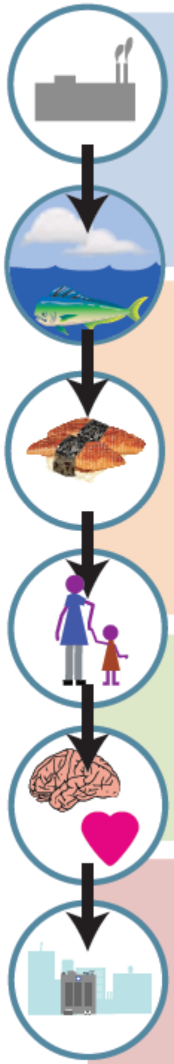
Tracking emissions to impacts is more



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

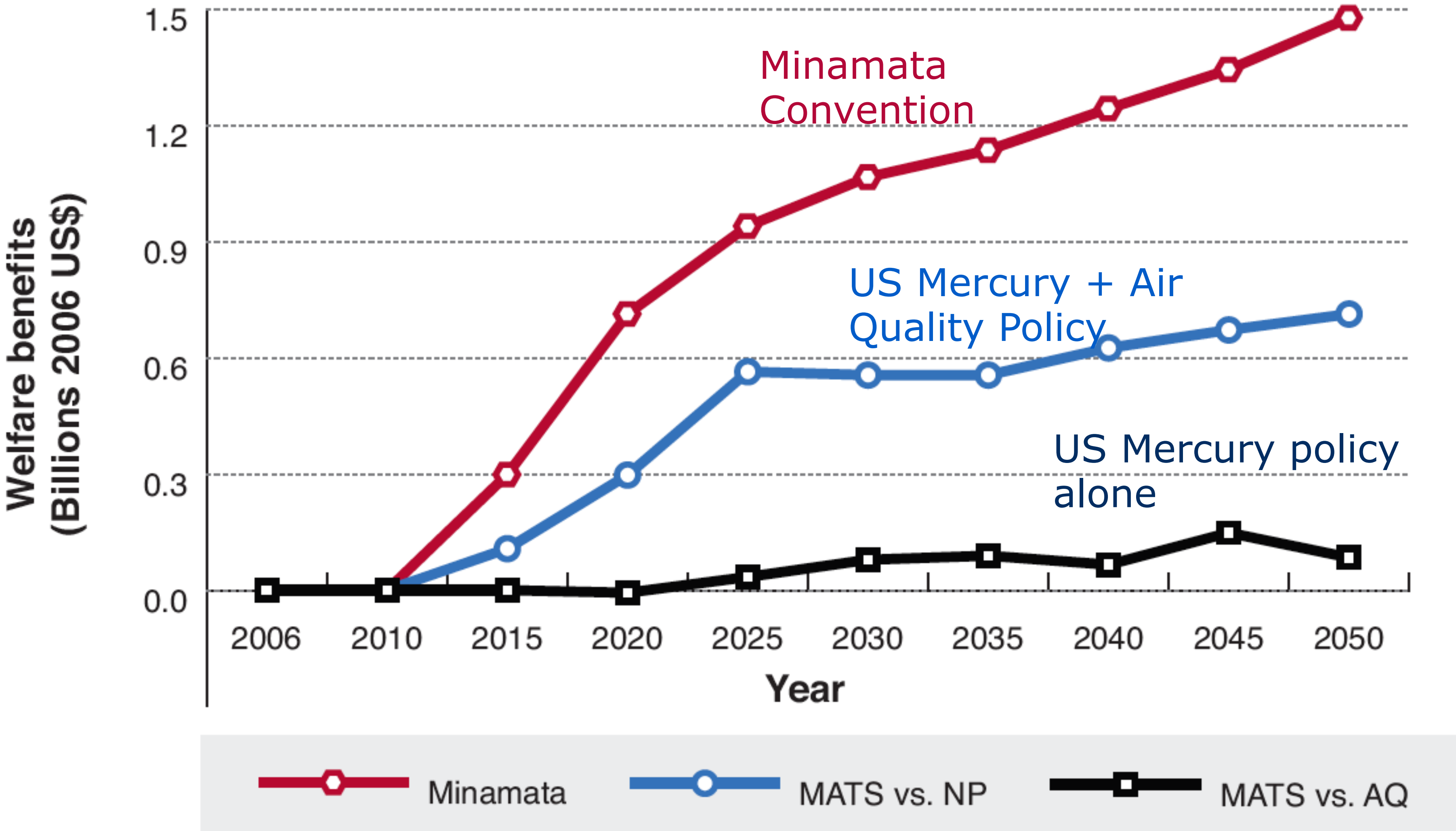
Rice et al. 2010, Axelrad et al. 2007, Budtz-Jorgensen et al. 2007, Virtanen et al. 2005, Roman et al. 2011, Guallar et al. 2002

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

Rausch 2010, Saari et al. 2013

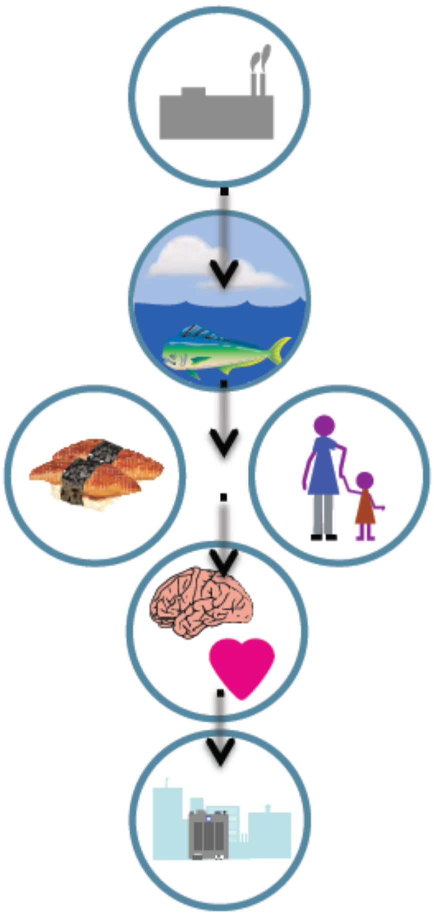
U.S. benefits from Minamata Convention

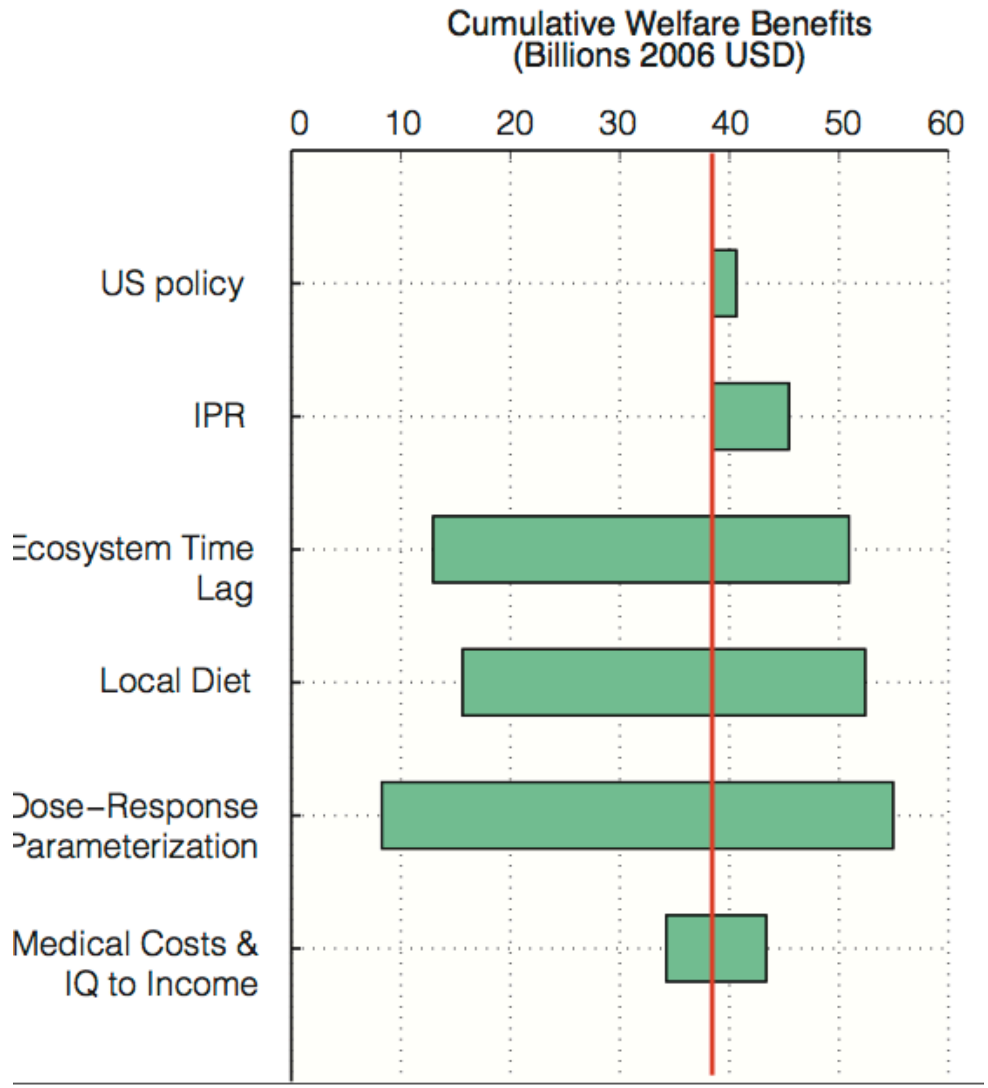
Cumulative benefits from Minamata: $38 billion



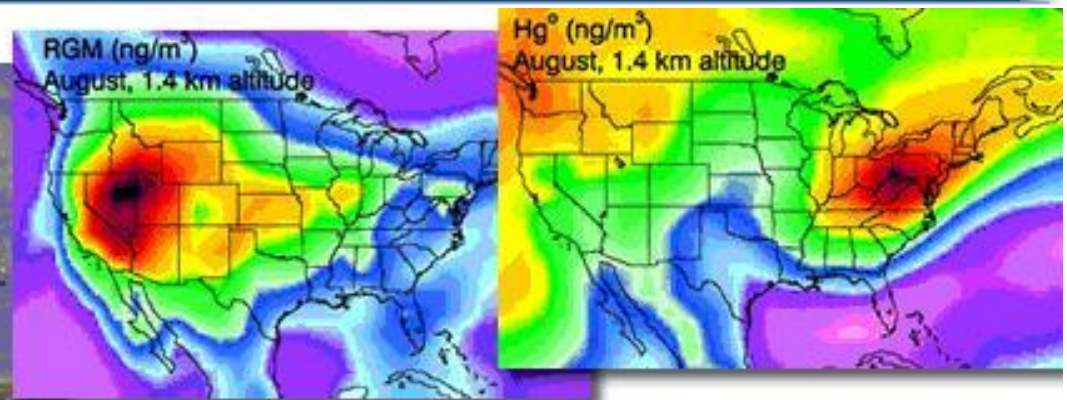
Discounted at 3%

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 (postdoc 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:**
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- **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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