The USEPA: A Pioneer in Valuing Environmental Benefits

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September 8, 2022

How Has EPA Advanced Environmental Benefit Estimation?

- Through the Section 812 Studies of the Benefits and Costs of the Clean Air Act
  - B&C of the CAA, 1970-1990
  - B&C of the 1990 CAAA, 1990-2010
  - B&C of the 1990 CAAA, 1990-2020
- In BenMAP – A tool for calculating and valuing the health impacts of changes in PM and O3
- By estimating the Social Cost of Carbon

THE SECTION 812 STUDIES

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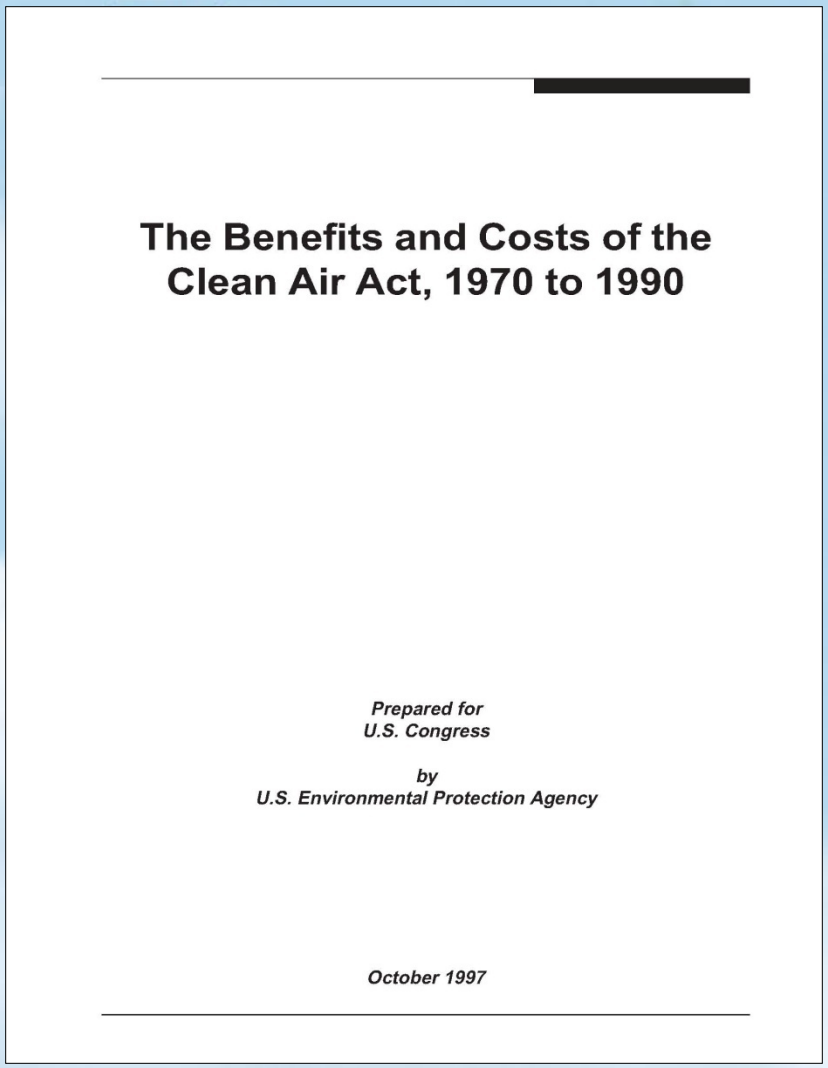
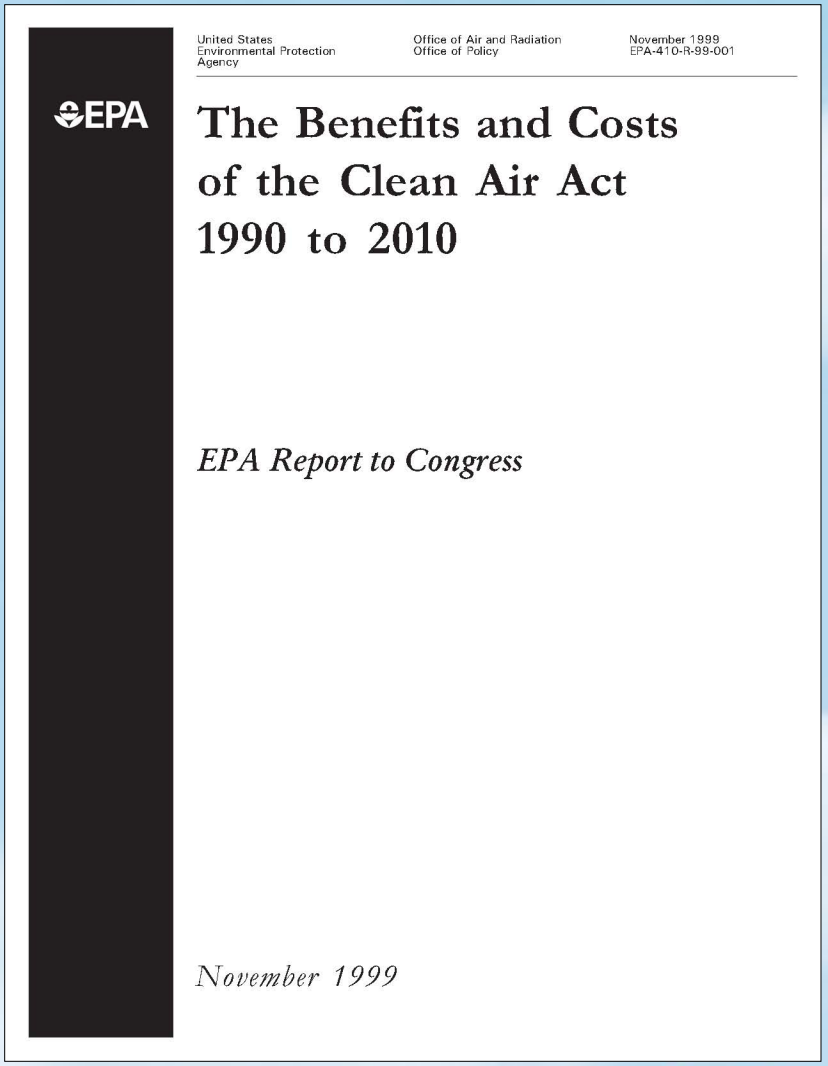


The Benefits and Costs of the Clean Air Act, 1970 to 1990

Prepared for
U.S. Congress

by
U.S. Environmental Protection Agency

October 1997



United States Environmental Protection Agency | Office of Air and Radiation, Office of Policy | November 1999, EPA-410-R-99-001

EPA

The Benefits and Costs of the Clean Air Act 1990 to 2010

EPA Report to Congress

November 1999

www.epa.gov/cleanairactbenefits

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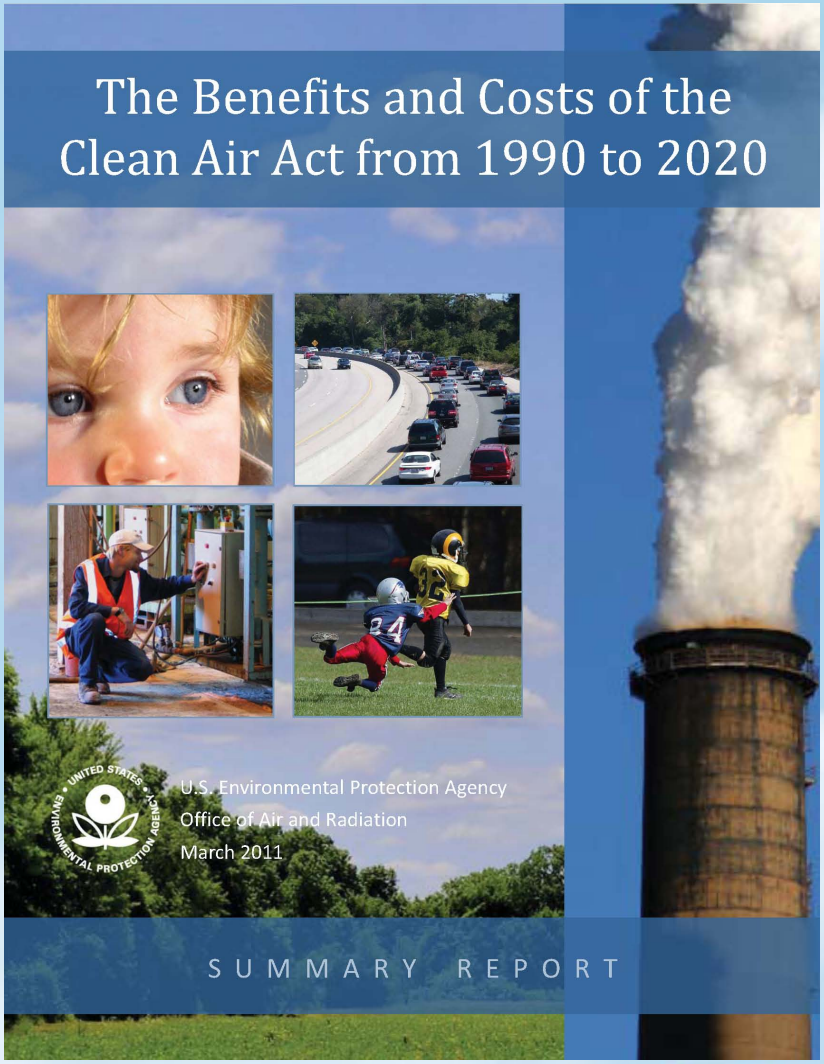
The Benefits and Costs of the Clean Air Act from 1990 to 2020

Final Report – Rev. A

U.S. Environmental Protection Agency
Office of Air and Radiation

April 2011



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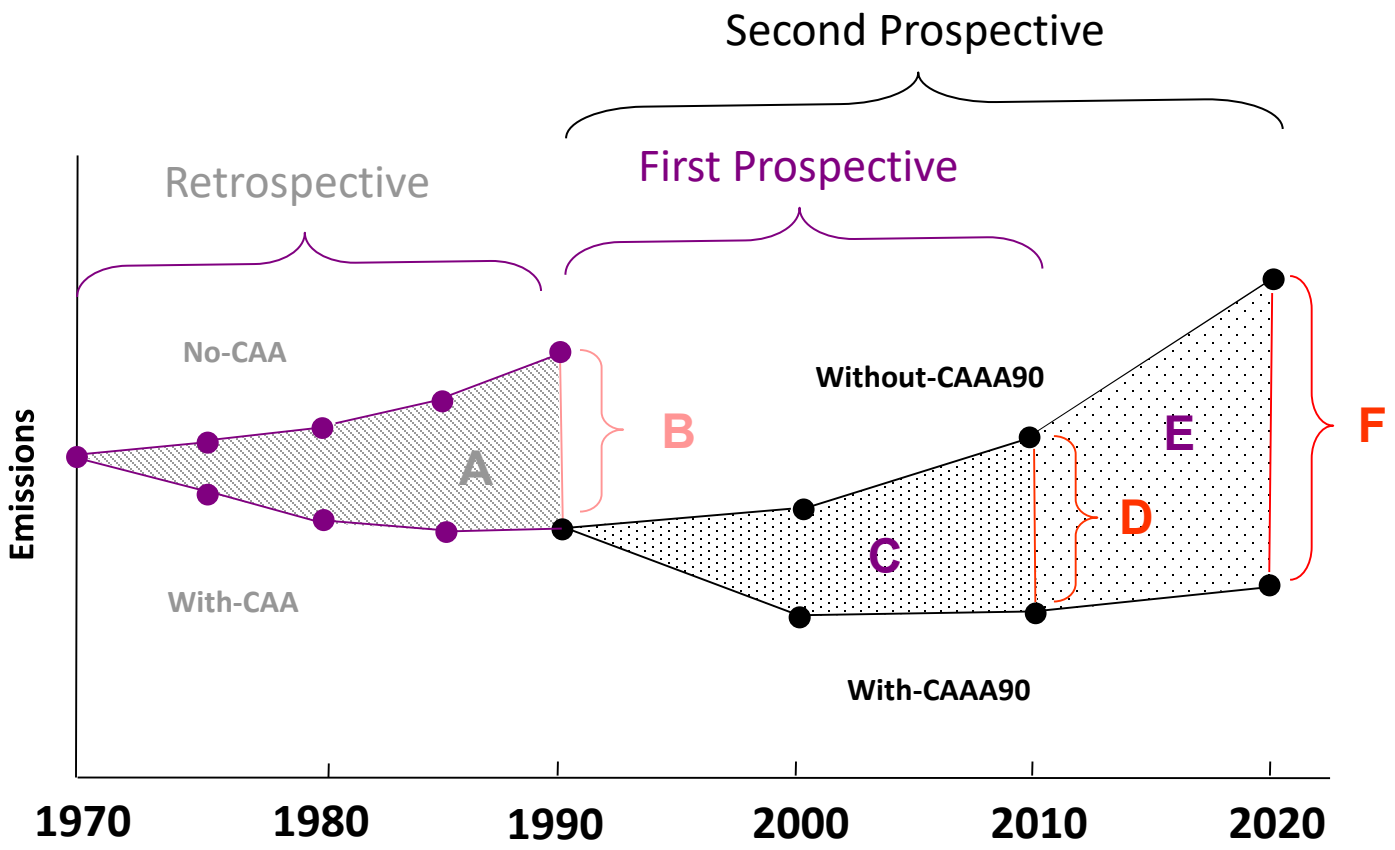
Mr. Ralph Morris … Environ International Corp

Section 812 Studies: Steps in the Benefits Analysis

1. Predict emissions of the criteria air pollutants with and without the CAA
2. Translate emissions into ambient air quality
3. Estimate impact of air quality on:
   - Health
   - Ecosystems
   - Agriculture
   - Visibility
4. Monetize impacts

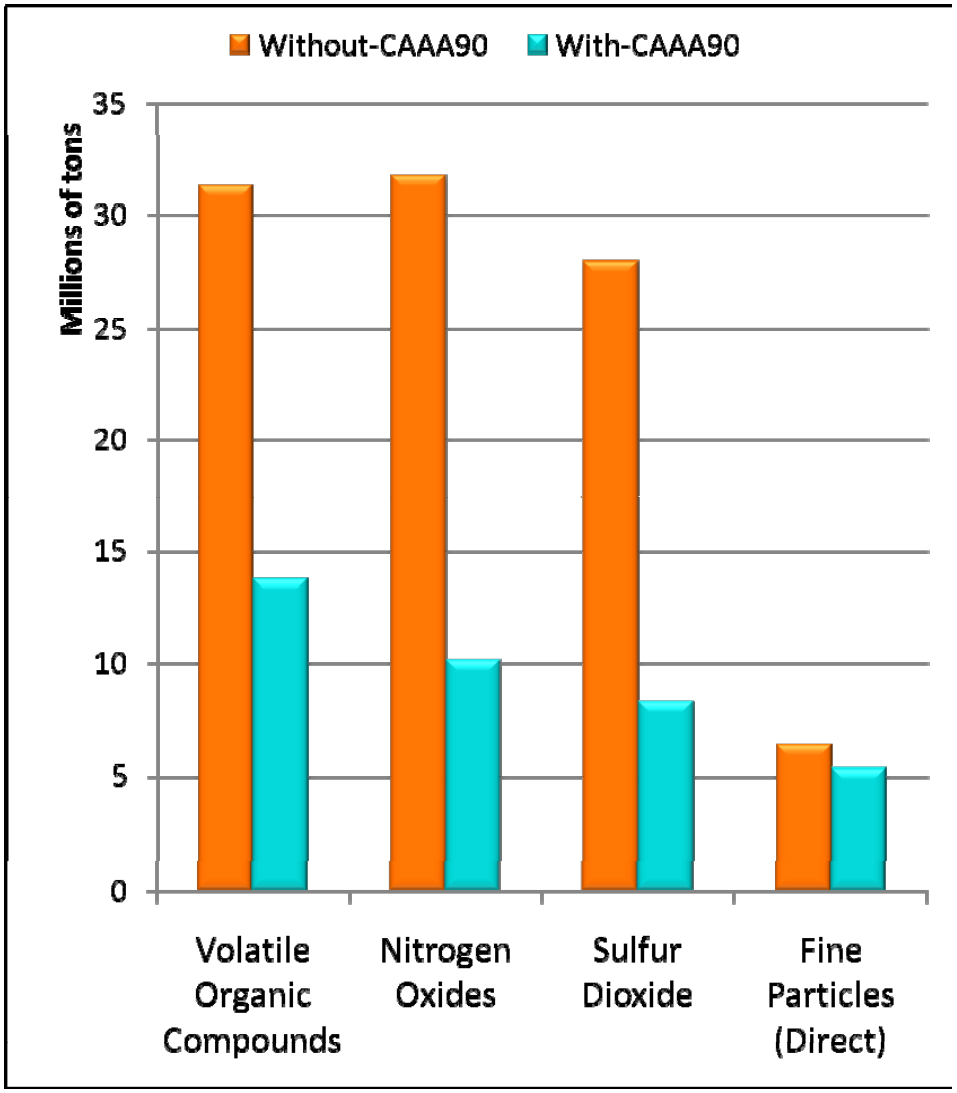
- Benefits = Impacts (without – with) the CAA

812 Scenarios -- Schematic



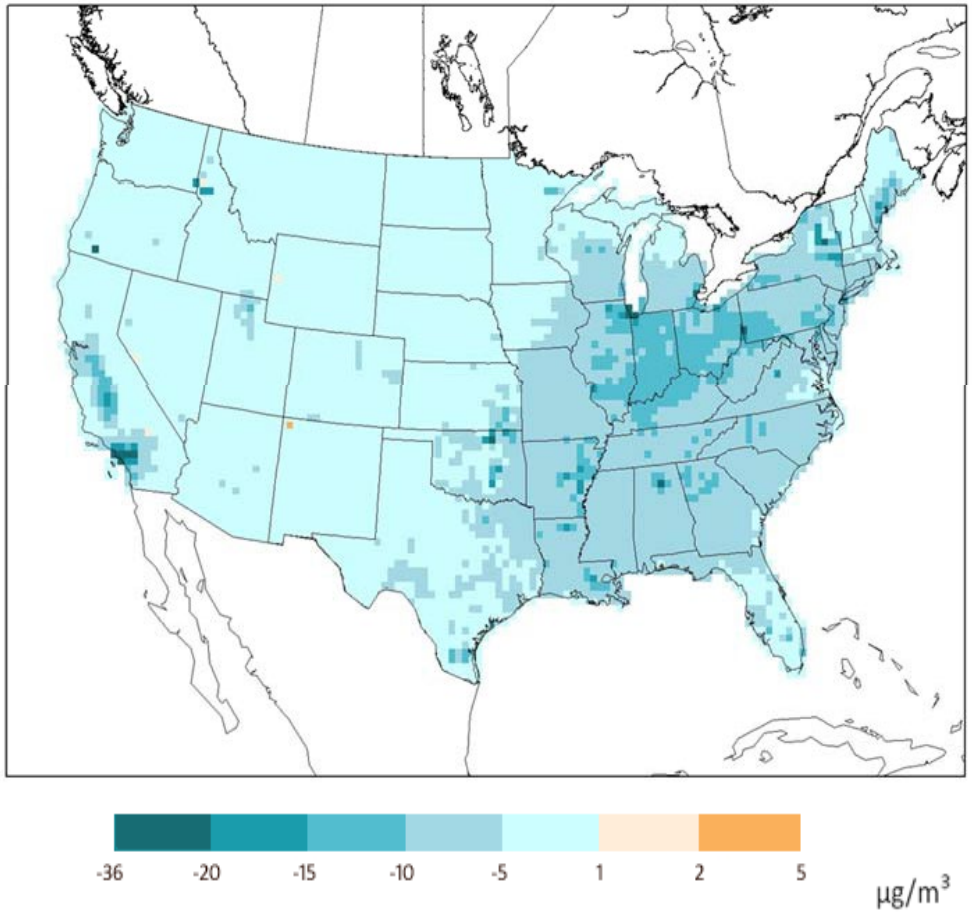
Clean Air Act Section 812 Second Prospective Study.

Exhibit 6. Year 2020 key pollutant emissions under the *With-CAAA90* and *Without-CAAA90* scenarios. (In millions of short tons).



Clean Air Act Section 812 Second Prospective Study.

Exhibit 7. Difference in annual average fine particle (PM2.5) concentrations between the *With-CAAA90* and *Without-CAAA90* scenarios for 2020.



Section 812 Studies: Impacts and Damages

- Ambient PM and O3 concentrations with and without the CAA estimated at 36kmx36km resolution
- Damage function approach used to quantify benefits of PM and O3 reductions
  - Together with baseline population data and incidence of mortality and morbidity, health impacts associated with change in concentrations were calculated
  - Estimates of impacts on visibility in National Parks and in MSAs, on crops, timber and fishing days also calculated

Section 812 Studies: Calculation of Health Benefits

- Reductions in premature mortality due to lower PM2.5, O3
  - Using Pope et al. and Dockery et al. studies for PM in retrospective and first prospective studies
  - Using expert elicitation in B&C of CAAA 1990-2020
- Reductions in chronic bronchitis, acute bronchitis, heart attacks, asthma attacks, hospital admissions, restricted activity days

Clean Air Act Section 812 Second Prospective Study.

Exhibit 8. Differences in key health effects outcomes associated with fine particles (PM2.5) and ozone between the *With-CAAA90* and *Without- CAAA90*.

Health Effect Reductions (PM2.5 & Ozone Only)	Pollutant(s)	Year 2010	Year 2020
PM2.5 Adult Mortality	PM	160,000	230,000
PM2.5 Infant Mortality	PM	230	280
Ozone Mortality	Ozone	4,300	7,100
Chronic Bronchitis	PM	54,000	75,000
Acute Bronchitis	PM	130,000	180,000
Acute Myocardial Infarction	PM	130,000	200,000
Asthma Exacerbation	PM	1,700,000	2,400,000
Hospital Admissions	PM, Ozone	86,000	135,000
Emergency Room Visits	PM, Ozone	86,000	120,000
Restricted Activity Days	PM, Ozone	84,000,000	110,000,000
School Loss Days	Ozone	3,200,000	5,400,000
Lost Work Days	PM	13,000,000	17,000,000

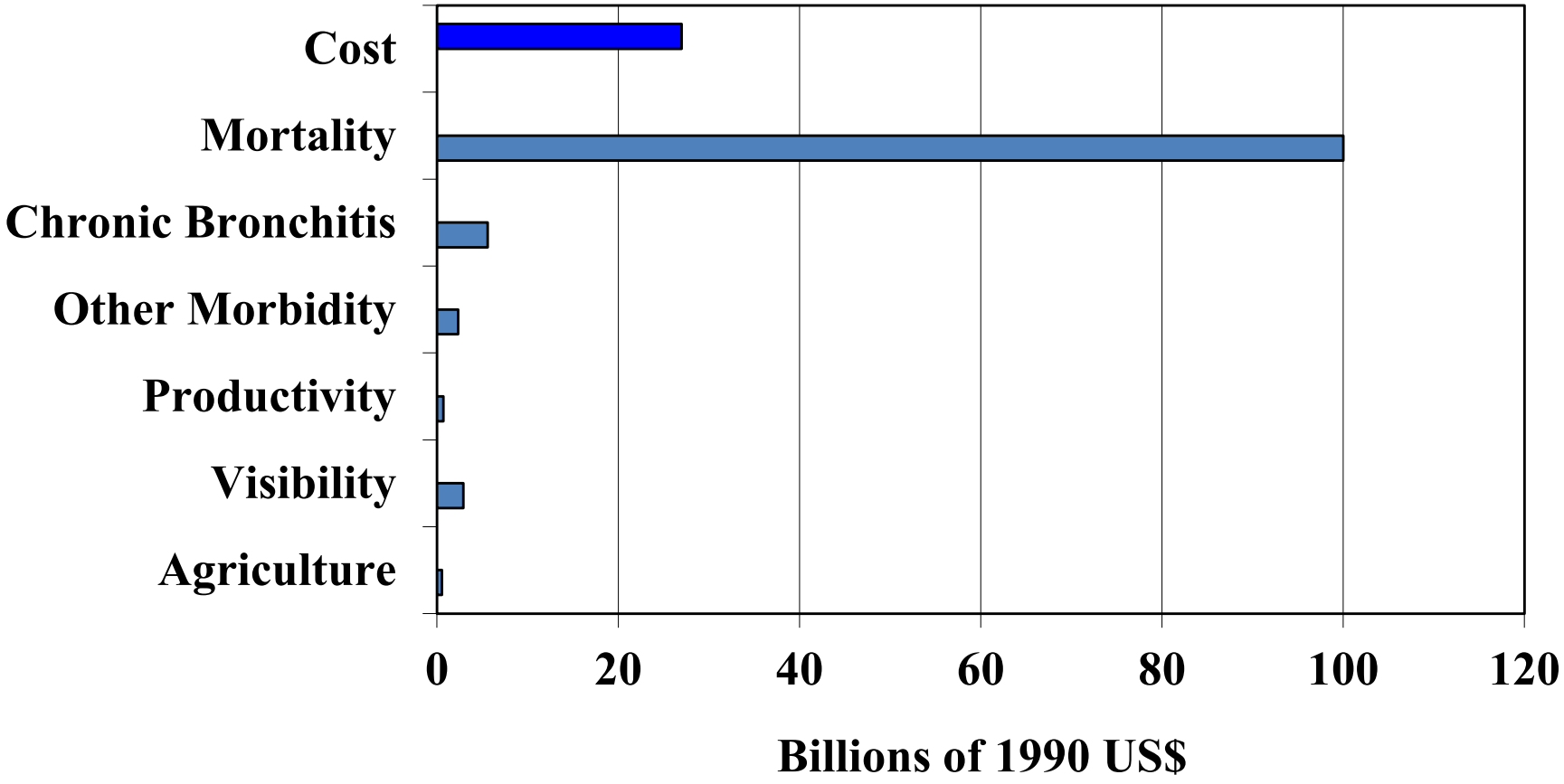
Section 812 Studies: Valuation of Mortality Risks

- The Value per Statistical Life (VSL) plays a key role in valuing air pollution benefits
  - VSL = the sum of what people would pay to reduce mortality risks that sum to one life saved
- EPA estimated the VSL in the Retrospective Study as $4.8M (1990 USD) = $9.5M (2020 USD)
  - Weibull distribution fit to 26 VSL estimates from 22 studies: 17 hedonic wage studies, 5 contingent valuation studies

Section 812 Studies: Valuation of Other Health Benefits

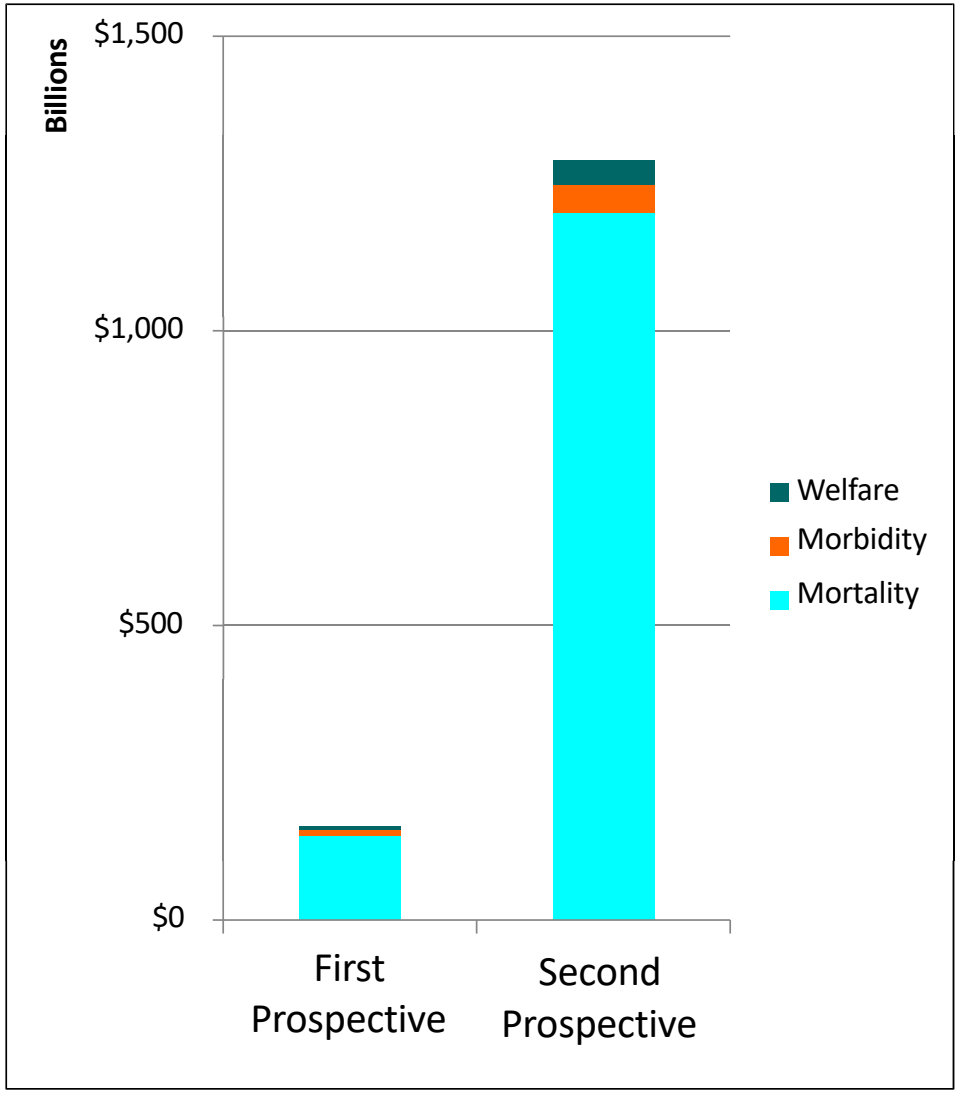
- Chronic bronchitis valued used risk-risk tradeoffs
- Non-fatal heart attacks and hospital admissions valued using direct and indirect costs of illness
- Symptom days and asthma episodes valued using willingness to pay studies

2010 Clean Air Act Monetized Benefits 1st Prospective Study



Clean Air Act Section 812 Second Prospective Study

Exhibit 12. Comparison of 2010 Benefits from First and Second Prospective Studies. (In billions of year 2006 dollars)



Clean Air Act Section 812 Second Prospective Study.

Exhibit 9. Ecological and welfare effects included in primary estimates of benefits. For each effect in the table, the limited geographic range or the subset of effects included in the primary results is listed in parentheses.

Quantified Human Welfare and Ecological Effects	Pollutant(s)
Visibility in residential areas (metropolitan areas)	PM, Ozone
Visibility in recreational areas (large parks in three regions)	PM, Ozone
Commercial timber (commercially important tree species)	PM, Ozone
Agriculture (commercially important crops)	Ozone
Recreational fishing (Adirondacks)	Acid Deposition
Materials damage (a few acid-sensitive materials)	Sulfur Oxides

Section 812 Studies: Summary of NMV Achievements

- Studies linked regulations to emissions and emissions to air quality, at a fine spatial scale
- Refined a framework for estimating the impact of changes in ambient air pollution on health
  - And then valuing these impacts
  - This codified in BenMAP
- Developed an estimate of the VSL that EPA continued to rely on for many years

BenMAP

Environmental Benefits Ma ×

www.epa.gov/benmap

EPA United States Environmental Protection Agency

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Environmental Benefits Mapping and Analysis Program – Community Edition (BenMAP-CE)

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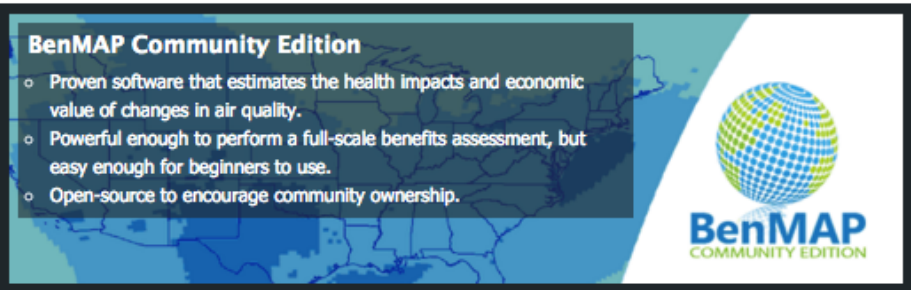


BenMAP-CE enables users to load their own data or use pre-loaded datasets for the U.S. and China, including

- Air quality data
- Demographic data
- Economic values
- Concentration-response relationships

BenMAP-CE is a open-source computer program that calculates the number and economic value of air pollution-related deaths and illnesses. The software incorporates a database that includes many of the concentration-response relationships, population files, and health and economic data needed to quantify these impacts.

Basic Information

- How BenMAP-CE Estimates the Health and Economic Effects of Air Pollution
- Questions BenMAP-CE Can Help Answer

Downloads and Tools

- Downloads
- Reduced-Form Tools for Calculating PM2.5 Benefits

How Analysts Have Run BenMAP-CE

- Applications: Articles and Presentations

How Can I Get Help?

- Training Materials
- Manual and Appendices for BenMAP-CE

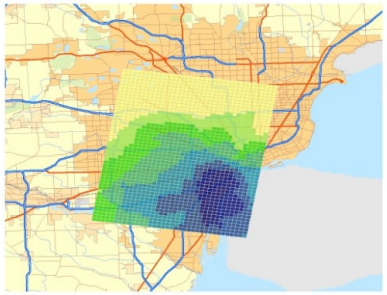
Contact Us to ask a question, provide feedback, or report a problem.

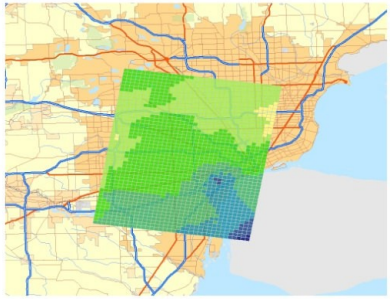
What Is BenMAP?

- GIS Software linking:
  - Population
  - Ambient air quality (PM2.5, O3)
  - Baseline incidence of mortality and morbidity
  - Catalogue of concentration-response functions
  - Catalogue of valuation endpoints
- User can calculate and value:
  - Health impacts of baseline PM2.5, O3
  - Impact of policies that alter PM2.5,O3
- A platform now used in many countries

Baseline Air Quality

Post-Policy Scenario Air Quality





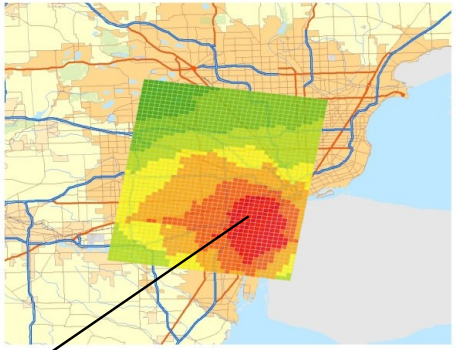
$$\Delta Y = Yo\,(1-e^{-\beta \Delta PM}) * Pop$$

U.S. Version

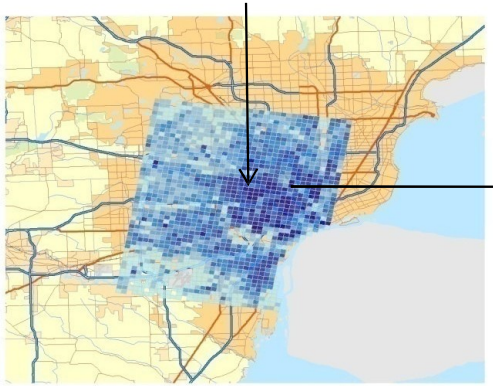
BenMAP

Environmental Benefits Mapping and Analysis Program

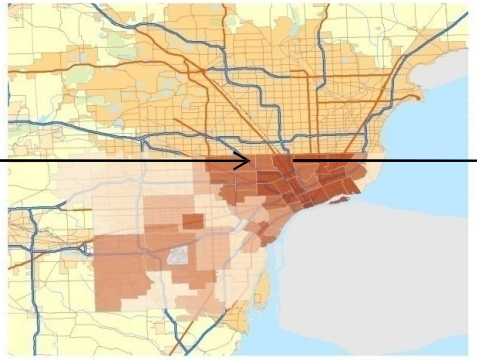
Incremental Air Quality Improvement



$PM_{2.5}$ Reduction



Population Ages 18-65



Background Incidence Rate

Effect Estimate

Mortality Reduction

International Use of BenMAP

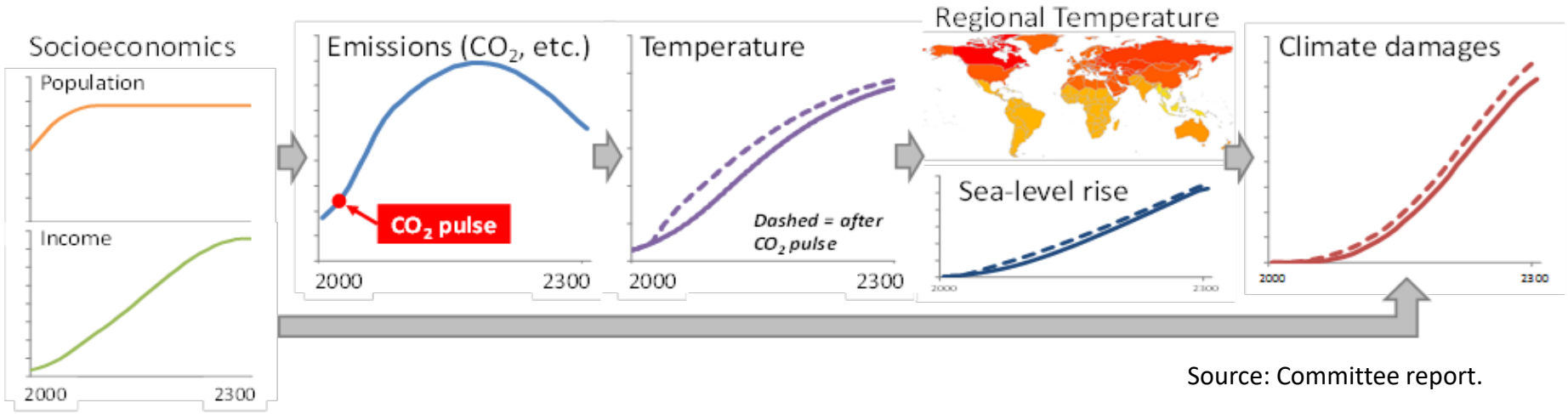
- BenMap Community Edition contains data for China
  - 2011 Partnership with South China U. of Technology
- Able to calculate impacts of changes in PM2.5 given data and concentration-response functions from the Global Burden of Disease
- BenMAP has been used to analyze policies in:
  - Santiago, Mexico City, Lima-Callao, Tehran, Bangkok

THE SOCIAL COST OF CARBON

What Is the Social Cost of Carbon?

- The present value of global damages from emitting a ton of CO_2 into the atmosphere in a particular year
- Including, but not limited to:
  - Changes in net agricultural productivity
  - Energy use
  - Human health
  - Property damage from increased flood risk
  - Other impacts
- The valuation problem from hell!

The 4 steps of SCC estimation



Source: Committee report.

1. Projections of future population & GDP generate a CO_2 emissions path
2. CO_2 emissions path leads to predictions of mean global temperature change
3. Temperature change leads to damages, which are monetized and aggregated
4. Damages persist for many decades: discounting is used to sum them into a single present value

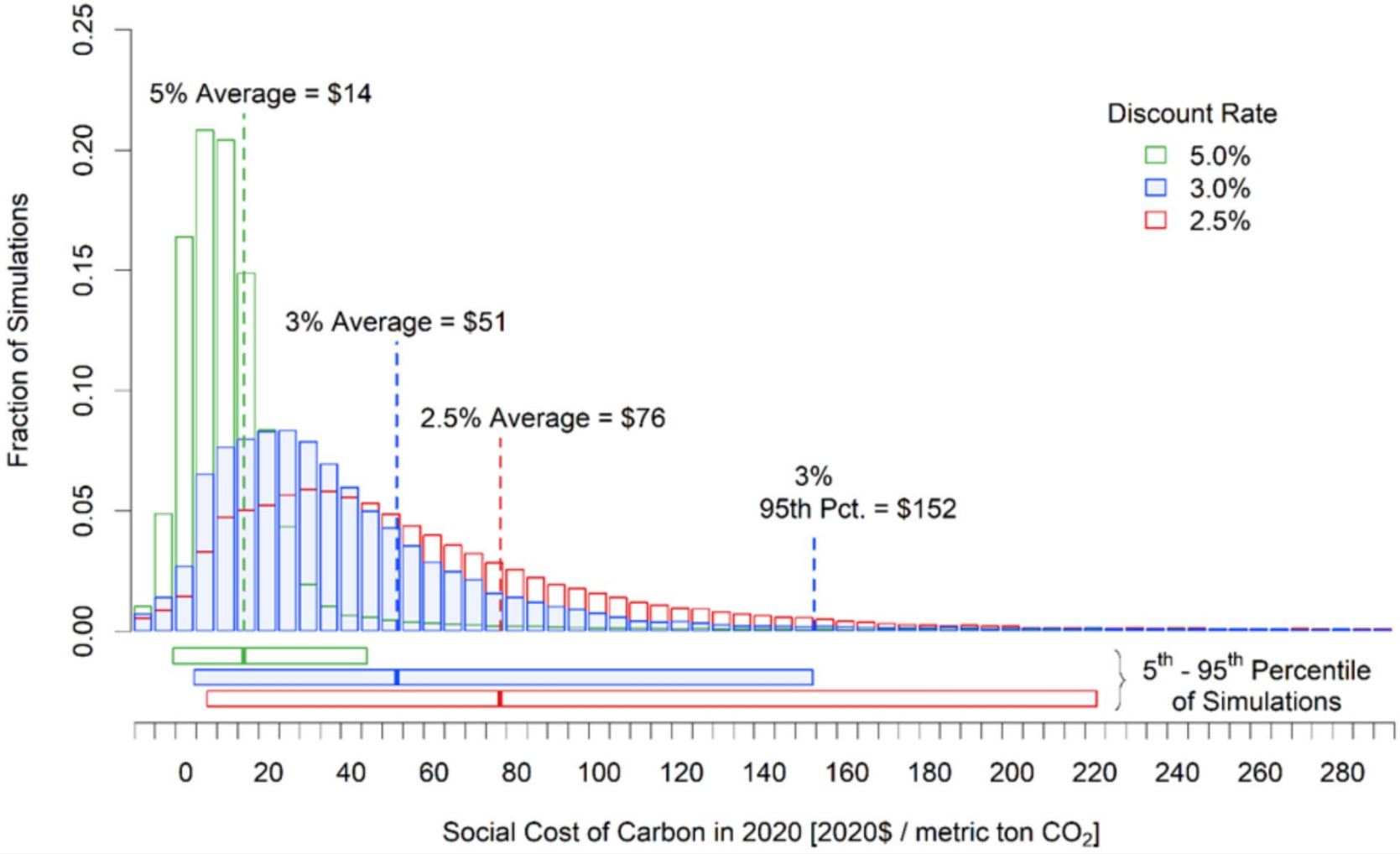
This 4-step procedure is done with both baseline emissions and with a small additional amount (a pulse) of CO_2 emissions in a particular year.

SCC is the per-ton difference in present value of damages due to the pulse.

US Government Calculation of the SCC

- Inter-agency Working Group produced first estimates in 2010 and refined them through 2016
- Combined results from 3 IAMs: DICE, FUND and PAGE
  - Using 5 equally weighted socio-economic scenarios
  - Using a common distribution over climate sensitivity
  - Preserving uncertainty in damage (and other) parameters in FUND and PAGE
- 150,000 Monte Carlo runs for each of 3 discount rates
  - 2.5%, 3.0%, 5.0%
  - Next slide shows distribution of results for all discount rates

Frequency Distribution of Current SCC Estimates in 2020$



US Interim SCC Estimates. February 2021

Social Cost of CO_2, 2020 – 2050 (in 2020 dollars per metric ton of CO_2)

	Discount Rate and Statistic			
Emissions Year	5% Average	3% Average	2.5% Average	3% 95th Percentile
2020	14	51	76	152
2030	19	62	89	187
2040	25	73	103	225
2050	32	85	116	260

The Significance of the SCC

- SCC has been used in over 100 RIAs
- Has been used by 11 states in electricity planning
  - To value future electricity needs (CO, MN, NV, WA)
  - To value distributed energy resources (CA, ME, MD)
  - To value zero emission credit payments (IL, NJ, NY)
- US SCC adopted by Canada, cited by NGOs, WB
- The advice that the IWG requested from the NAS-NRC to improve calculation of the SCC has spurred additional research

Conclusions

- The USEPA has pioneered the development of tools to measure and value reductions in ambient air pollution
  - These tools have been used extensively in the US and internationally
  - EPA has also sponsored research to value health outcomes, using stated preference methods:
  - Cameron & DeShazo; Alberini et al.; Corso, Hammitt & Graham; Hammitt & Graham; Chestnut, Rowe & Breffle; Viscusi, Huber & Bell and others
- EPA's work on estimating the SCC—a very difficult problem—has furthered our understanding of climate damages