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VALUING CLIMATE DAMAGES: UPDATING ESTIMATION OF THE SOCIAL COST OF CARBON DIOXIDE

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Study origin and description

The Interagency Working Group (IWG) on the social cost of carbon (SC-CO_2) requested this study to assist in future revisions of SC-CO_2 estimates.

Phase 1 - completed in January 2016 – focused narrowly on whether to update the equilibrium climate sensitivity and the presentation of uncertainty.

Phase 2 - committee examined potential approaches for a more comprehensive update to SC-CO_2 estimates to *ensure the estimates reflect the best available science.*

Phase 2 task specifics

Committee to focus on:

1. Assessing the available science and how it impacts choice of integrated assessment models and damage functions;
2. climate science modeling assumptions;
3. socioeconomic and emissions scenarios;
4. presentation of uncertainty; and
5. discounting.

Making recommendations on approaches to future updates of the SC-CO_2 estimates, as well as research recommendations

*Committee was not asked to estimate a value for the SC-CO_2

Background Information on the SC-CO_2

What is the social cost of carbon?

Social cost of carbon (SC-CO_2): the cost to society of adding 1-metric ton of CO_2 to the atmosphere in a particular year (in US dollars)

Measures the monetized value of the additional CO_2 (including both negative and positive impacts).

This includes, but is not limited to:

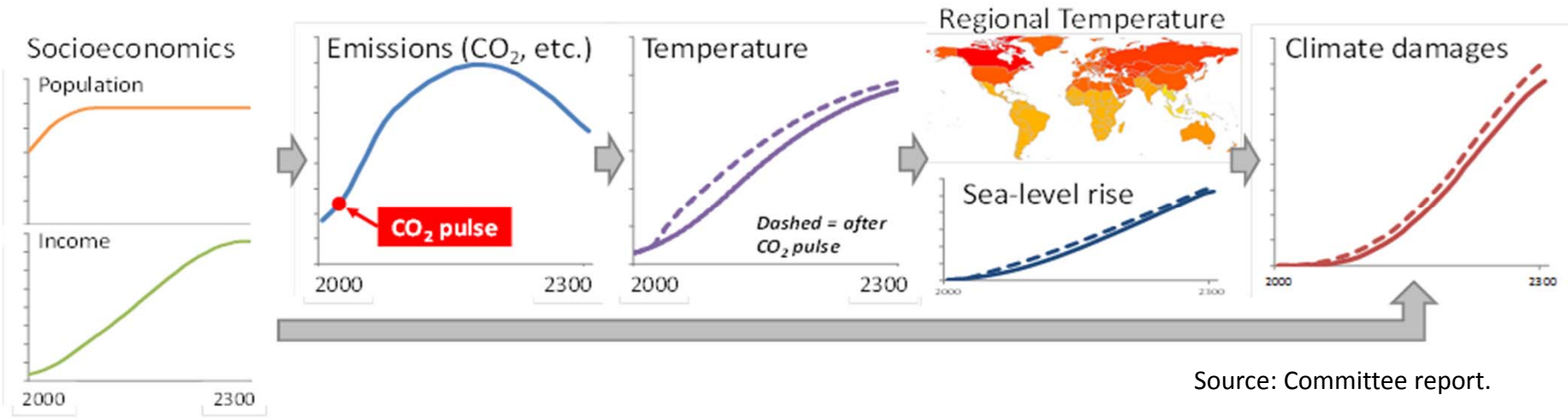
- Changes in net agricultural productivity
- Energy use
- Human health
- Property damage from increased flood risk
- Other impacts

What is the SC-CO_2 used for?

The SC-CO_2 is used to quantify the benefits of CO_2 emission reductions in regulatory impact analysis of federal regulations

- Executive Orders since 1981 have required quantifying the benefits and costs of federal regulations.
- A 2008 court ruling mandated the valuation of CO_2 emission reductions in federal regulations.
- Since then the SC-CO_2 has been used in dozens of regulatory impact analyses.

The 4 steps of SC-CO_2 estimation



Source: Committee report.

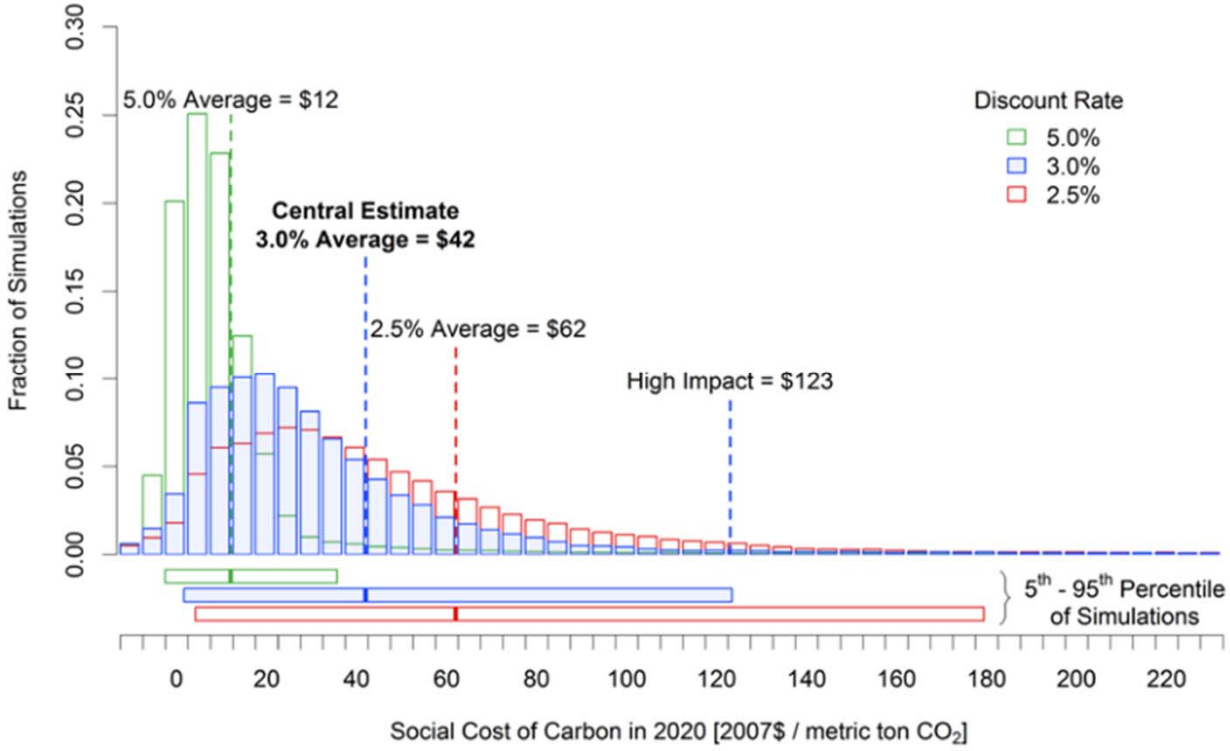
1. Projections of future population & GDP generate a CO_2 emissions path
2. CO_2 emissions path leads to predictions of mean global temperature change
3. Temperature change leads to damages, which are monetized and aggregated
4. Damages persist for many decades: discounting is used to sum them into a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

SC-CO_2 is the per-ton difference in present value of damages due to the pulse.

IWG estimation of the SC-CO_2

- The IWG used three integrated assessment models (SC-IAMs) from the peer-reviewed literature (DICE, FUND, and PAGE),
- five socioeconomic-emissions scenarios,
- a probability distribution for the equilibrium climate sensitivity, and
- three different constant discount rates (2.5%, 3.0%, 5.0%).



Source: 2016 IWG Technical Support Document

The Committee's Conclusions and Recommendations

Organization of the final Phase 2 report

Ch. 1: Introduction

Ch. 2: Overview of the proposed SC-CO_2 modeling framework

Ch. 3-6: Specific recommendations for each of the 4 key modeling steps in the near term (2-3 years) and the longer term

- Socioeconomic module
- Climate module
- Damages module
- Discounting module

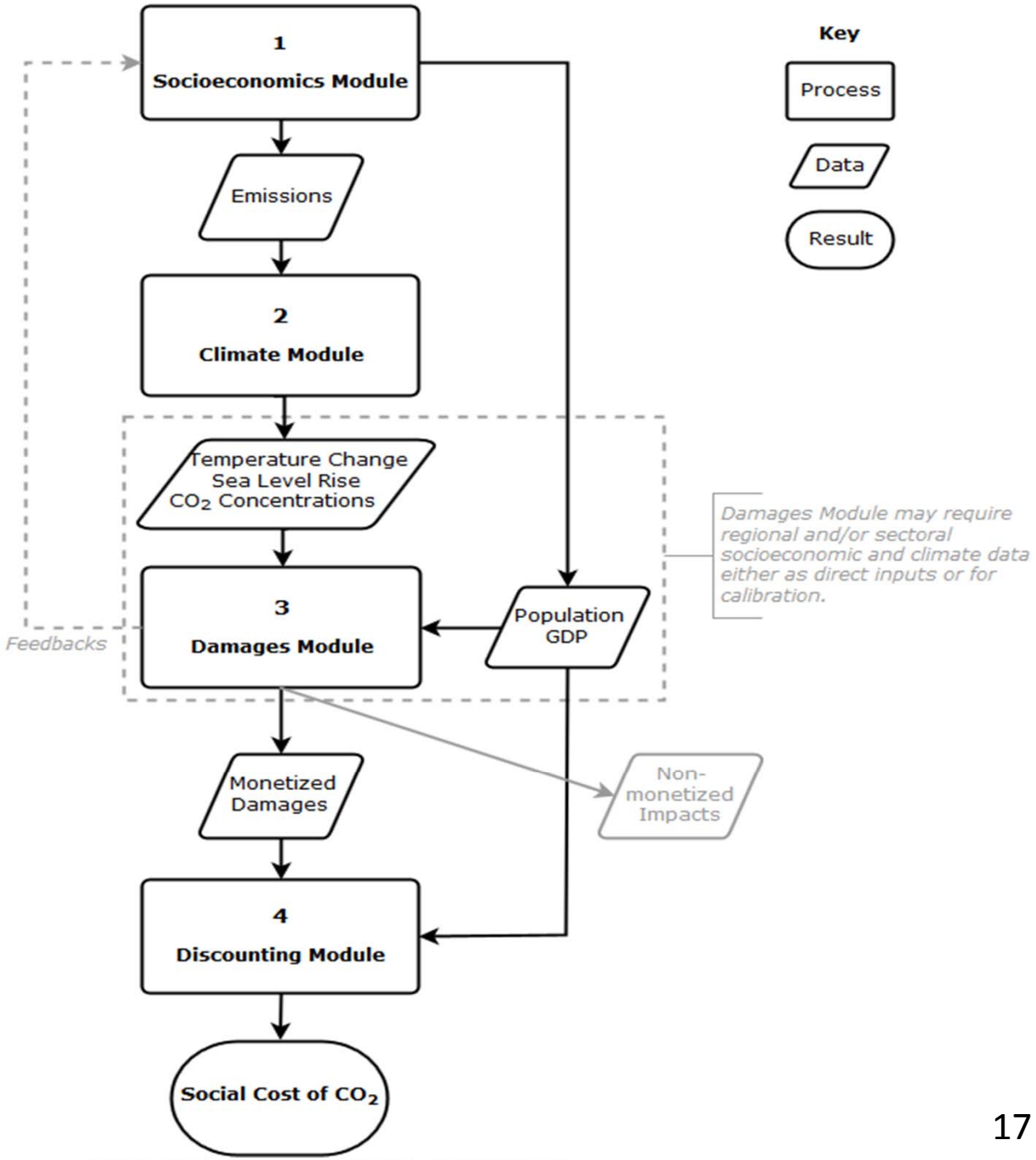
Ch. 7: Directions for future research

An integrated, modular framework (Conc. 2-1, 2-2, Rec. 2-1)

"Unbundle" the process of SC-CO_2 estimation into 4 modular steps that are integrated with one another.

- Each module would be developed based on expertise within the relevant disciplines and to reflect the state of scientific knowledge relevant to that part of the analysis .
- Provides a transparent articulation of the inputs, outputs, uncertainties, and linkages among the different steps.
- Can improve control over characterization of uncertainty within the steps and through an integrated framework for propagating uncertainty through the estimation process.

An integrated, modular approach for estimating the SC-CO_2 (Fig 2-1)



Over-arching criteria for SC-CO_2 estimation (Rec. 2-2)

- **Scientific basis:** Modules should be consistent with scientific knowledge in the current, peer-reviewed literature.
- **Uncertainty characterization:** Key uncertainties—including functional form, parameter assumptions, and data inputs—should be adequately represented. Uncertainties not quantified should be identified.
- **Transparency:** Documentation should allow people to understand and assess the modules, including which features are evidence-based or judgment-based. Model code should be available to researchers.

Domestic and global SC-CO_2

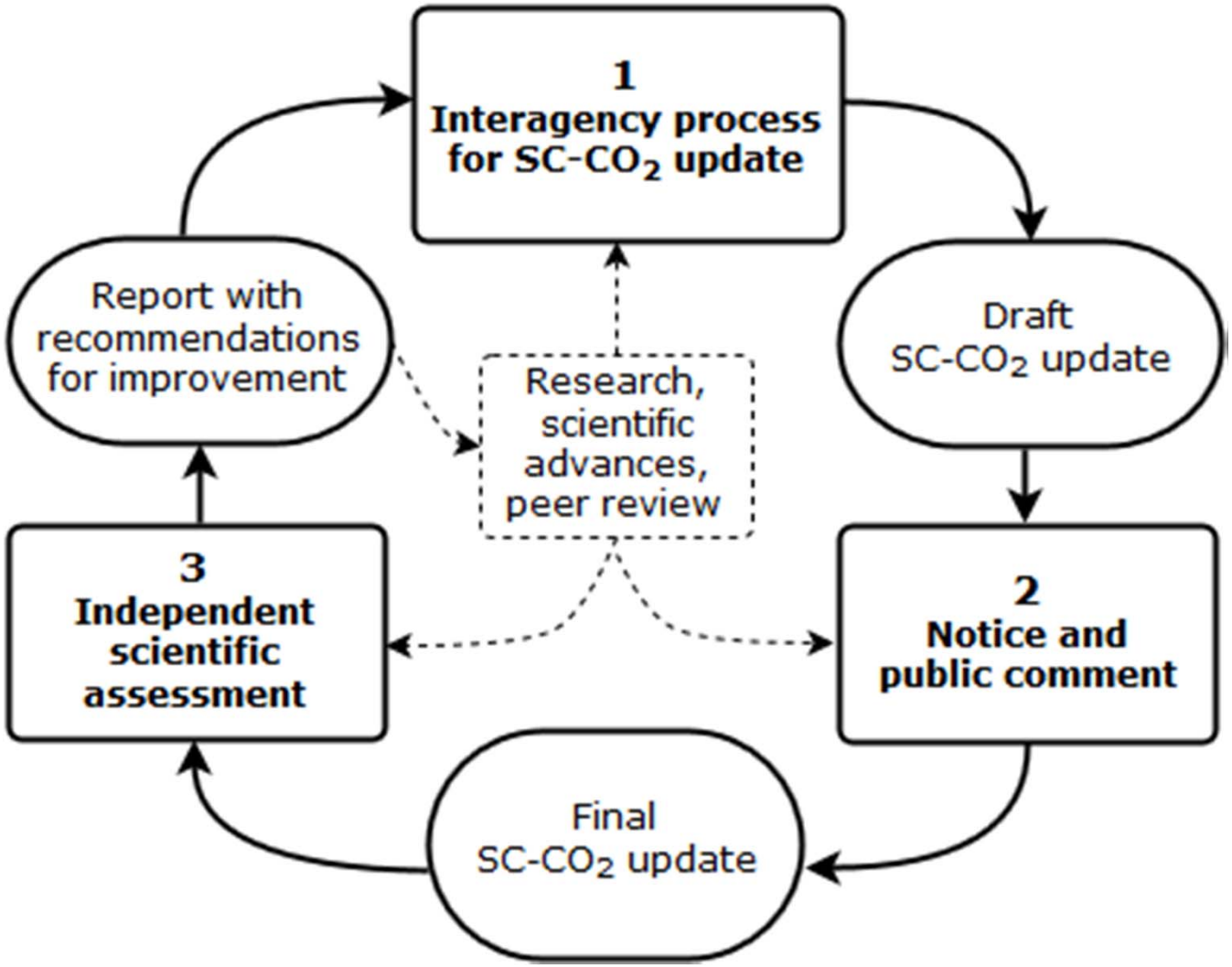
- **IWG has focused on estimating a global SC-CO_2, as has the peer-reviewed literature**
  - CO_2 impacts are global, regardless of where emissions occur.
  - Climate impacts in other countries may affect the United States (e.g., global migration, economic and/or political destabilization).
  - US emission reductions encourage reciprocal actions by other countries.
- **Difficulties in computing a US-only estimate (Conc. 2-4)**
  - Important to consider what constitutes domestic impact in the context of a global pollutant that has international implications that affect the US.
  - Need an SC-CO_2 framework that adequately captures these interactions.
  - Existing SC-IAM methodologies do not model all relevant interactions among regions.
  - In estimating a domestic SC-CO_2 need to consider potential implications of climate impacts on other countries and actions by other countries.

A regularized process to update SC-CO_2 estimates (Rec. 2-4)

- An update cycle of roughly **5 years balances the need to respond to evolving research with the need for a thorough and predictable process.**
- The IWG should establish a **three-step process** for updating the SC-CO_2 estimates.

1. Estimates should be revised drawing on internal and external technical expertise and incorporating scientific peer review.
2. Draft revisions to the SC-CO_2 methods and estimates should be subject to public notice and comment.
3. The government's approach to estimating the SC-CO_2 should be reviewed by an independent scientific assessment panel to identify improvements in future updates and research needs.

Regularized process for SC-CO_2 updates (Fig. 2-2)



Near-term and Longer-term Updates

Near-term Updates

Recommendations that would be feasible to implement in the next 2 to 3 years:

- **Socioeconomic module** should use statistical methods and expert elicitation for projecting distributions of GDP, population growth and emissions into the future
- **Climate module** should employ a simple Earth system model that satisfies well-defined diagnostic tests
- **Damages module** should improve and update existing damage functions drawing on recent scientific literature
- **Discounting module** should incorporate the relationship between discount rates and economic growth to account for uncertainty over long time periods

Longer-term Updates

- Longer-term steps for the development and improvement of each module are outlined along with characteristics that each future module should have.
- Feedbacks between the modules and interactions within each module should also be incorporated in the longer term.

Research priorities for SC-CO_2 estimation

The report outlines priorities for research to improve the socioeconomic, climate, and damages modules, including:

- Studies of interactions and feedbacks within the human-climate system. (Conc. 2-3)
- Quantification of the importance of feedbacks from damages to socioeconomic projections. (Conc. 3-1)
- Development of detailed structural economic models suitable for projections over long time horizons. (Conc. 3-1)
- Incorporation of more comprehensive climate models in the SC-CO_2 framework. (Conc. 4-5)
- Expansion of research on climate damage estimation. (Conc. 5-1)

Summary

- A modular approach should be adopted to allow relevant disciplinary expertise to shape each part of the SC-CO_2 analysis.
  - Output from each module should be presented in probabilistic form to facilitate uncertainty analysis of results.
  - Explicit probability distributions should be derived for socioeconomic inputs (GDP, population, emissions).
  - The climate module should represent temperature change over time and include sea-level rise and ocean pH components.
  - Damage functions should be updated to reflect recent literature.
  - The discounting approach should link discount rates to the uncertain rate of economic growth and, in turn, damages.
- Criteria regarding the scientific basis, characterization of uncertainty, and transparency should be applied.
- A regularized 3-step process should be established for updating the SC-CO_2 roughly every 5 years, informed by ongoing research.