



Air-climate-energy investigations with a state-level Integrated Assessment Model: GCAM-USA

Office of Research and Development

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Abstract

The Global Change Assessment Model (GCAM) is a global integrated assessment model used for exploring future scenarios and examining strategies that address air pollution, climate change, and energy goals. GCAM includes technology-rich representations of the energy, transportation, building, and agricultural sectors, which are linked to representations of the economy, climate, and land use systems. For various scenarios, GCAM produces estimates of technology adoption, fuel use, and climate and air pollutants.

GCAM has been used in high-profile applications, including the production of the Representative Concentration Pathway 4.5 W/m² scenario. A new version, GCAM-USA, represents the U.S. at the state-level within the coupled global model.

We describe GCAM-USA and highlight updates to more fully account for U.S. air quality regulations, as well as to generate scenarios exploring the air-climate-energy nexus. Finally, we describe efforts to integrate GCAM-USA into the Office of Research and Development's GLIMPSE project.

Science questions

How can we simultaneously achieve air quality management, ecosystem conservation, and climate change mitigation goals?

What are the implications of state-level energy efficiency and renewable energy measures on greenhouse gas emissions and air quality?

What are the broader health and environmental impacts of different pathways for meeting society's energy needs?

Impacts under consideration include

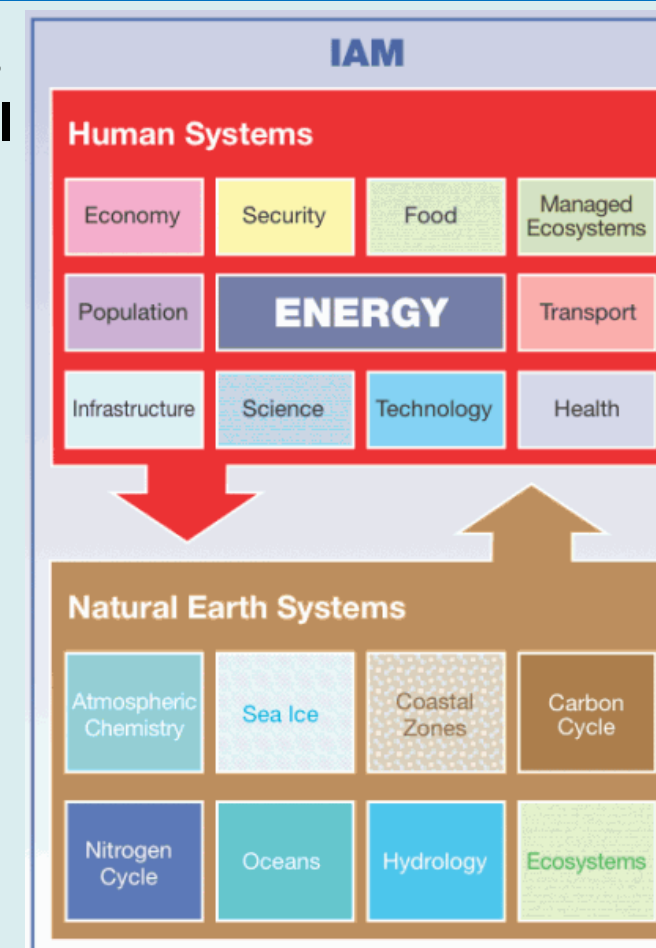
- Air quality and resulting human health effects
- Agricultural damage to crops/timber
- Ecosystem impacts from N and S deposition
- Water use by agricultural and energy sectors

What is an integrated assessment model?

Integrated Assessment Models (IAMs) provide a computational framework for evaluating future global and societal changes, such as:

- Population growth and migration
- Economic growth and transformation
- Technology development
- Energy resource costs
- Climate change
- Land use change
- Energy, climate and environmental policy

IAMs have a long track record, including application to climate change mitigation studies.

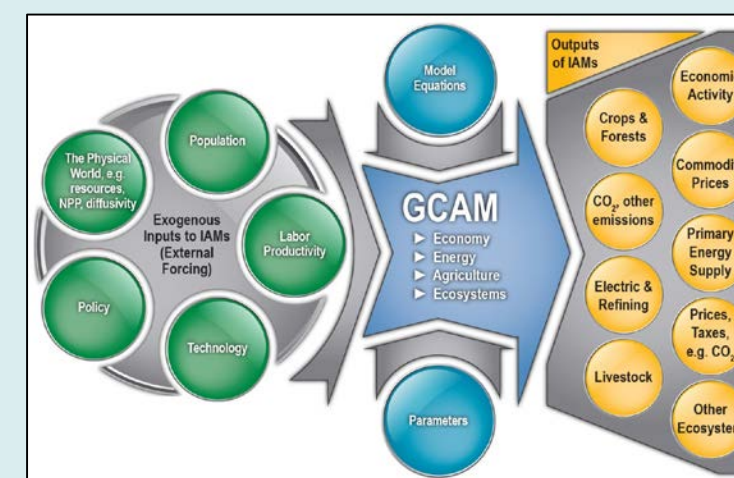


Why GCAM-USA?

Attributes of GCAM-USA that align with project goals include:

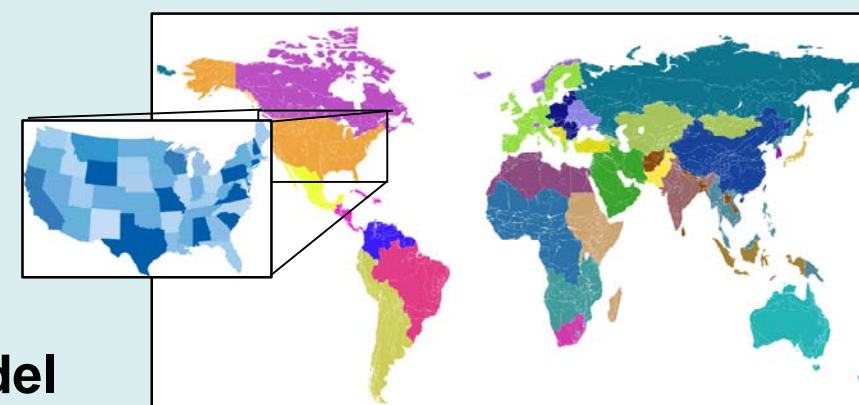
Sectoral coverage

- Electricity production
- Buildings
- Industry
- Transportation
- Agriculture
- Land use
- Land cover



Spatial coverage

- Global, 32 regions
- U.S. region sub-divided by state
- Scenarios can model U.S. in global context



Pollutant coverage

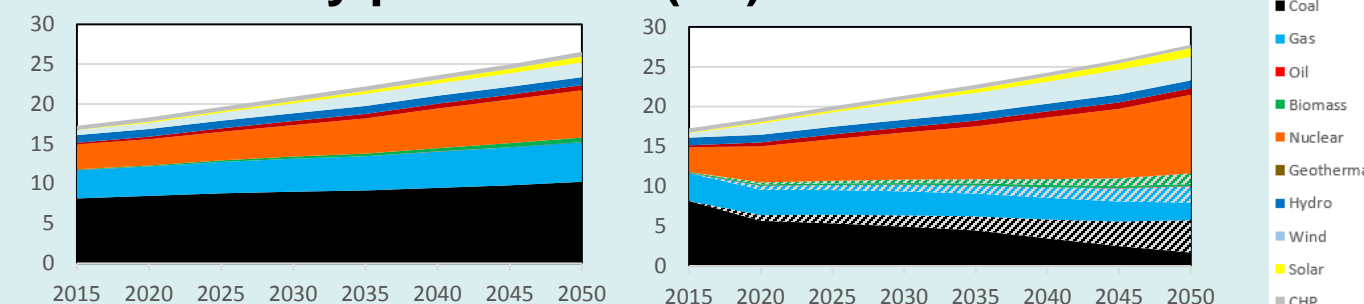
- Greenhouse gases: CO₂, CH₄, N₂O, HFCs
- Short-lived forcers: BC, OC, SO₂
- Criteria pollutants: NOx, SO₂, PM, CO, NH₃

Other factors

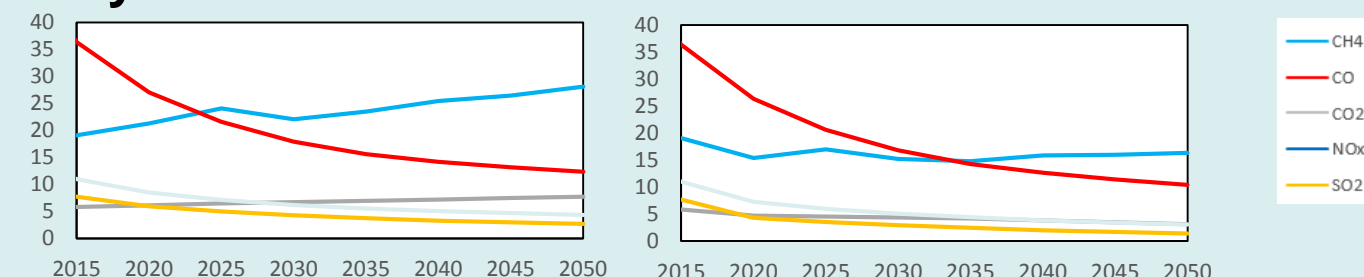
- Models through 2100
- Open source
- Freely available
- Typically < 1hr runtime
- Readily extensible, incl. graphical interface

Illustrative GCAM results

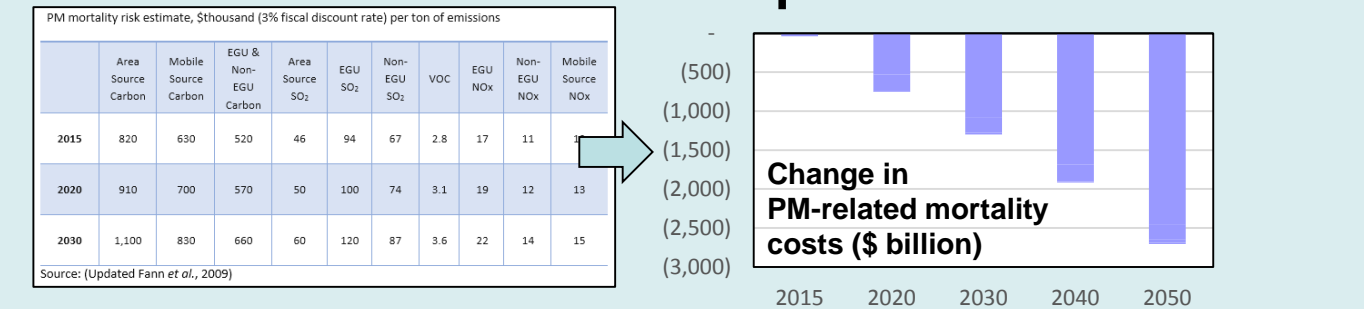
U.S. electricity production (EJ) for two scenarios



System-wide emissions under each scenario



Assessment of impacts

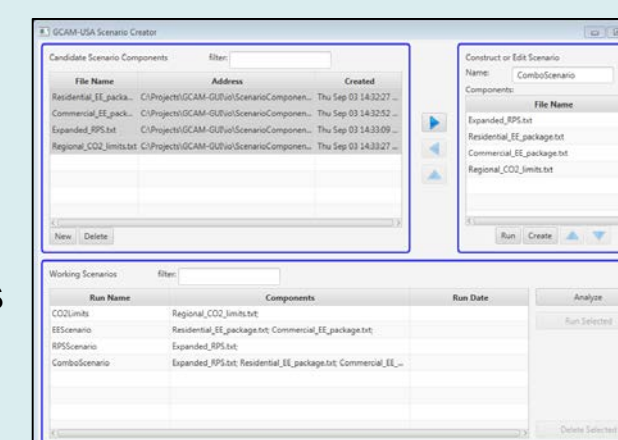


Results provided for illustrative purposes only

Ongoing enhancements to GCAM-USA

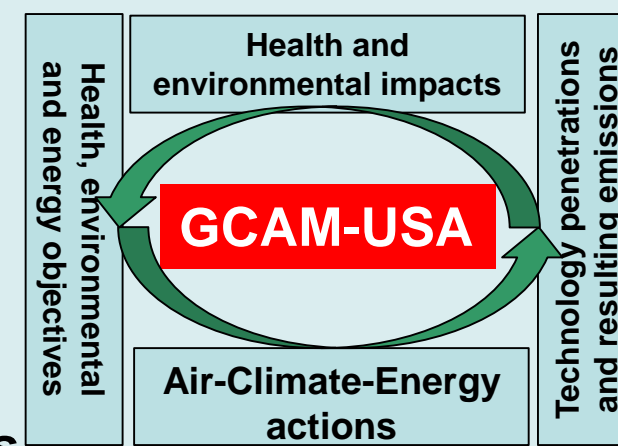
Interface for scenario development

- Develop and manage scenario components: e.g., state-level energy efficiency and renewable energy measures
- Construct and execute scenarios



Exploring optimal technology pathways

- Harmonize emission factors with EPA assumptions
- Incorporate impact factors e.g., health effects, water use, agricultural and ecosystem impacts
- Optimize actions over impacts



For more information

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