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Overview of the Global Change Assessment Model (GCAM)

JOINT GLOBAL CHANGE RESEARCH INSTITUTE
PACIFIC NORTHWEST NATIONAL LABORATORY & UNIVERSITY OF MARYLAND

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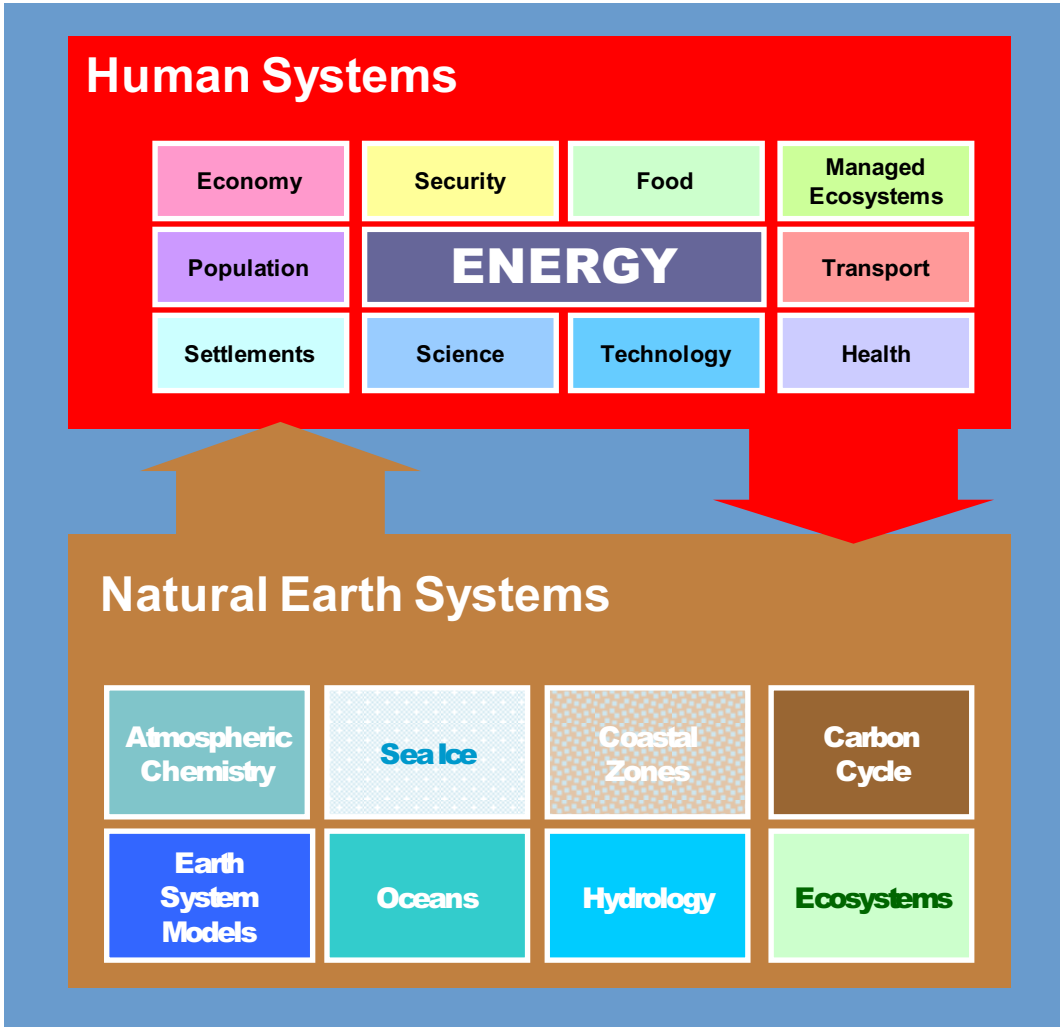
What is an Integrated Assessment Model (IAM)?

IAMs integrate representations of multiple human and natural Earth systems

- IAMs provide insights that would be otherwise unavailable from disciplinary research
- IAMs capture interactions between complex and highly nonlinear systems
- IAMs provide natural science researchers with information about human systems such as GHG emissions, land use and land cover
- IAMs support national, international, regional, and private-sector decisions



The Global Change Assessment Model (GCAM) is a "High-Resolution" IA Model

High-Resolution Models and Modeling Teams

Model	Home Institution
AIM Asia Integrated Model	National Institutes for Environmental Studies, Tsukuba Japan
GCAM Global Change Assessment Model	Joint Global Change Research Institute, PNNL, College Park, MD
IGSM Integrated Global System Model	Joint Program, MIT, Cambridge, MA
IMAGE The Integrated Model to Assess the Global Environment	PBL Netherlands Environmental Assessment Agency, Bildhoven, The Netherlands
MESSAGE Model for Energy Supply Strategy Alternatives and their General Environmental Impact	International Institute for Applied Systems Analysis; Laxenburg, Austria
REMIND Regionalized Model of Investments and Technological Development	Potsdam Institute for Climate Impacts Research; Potsdam, Germany

General Characteristics of High-Resolution, Global Integrated Assessment Models

- High-resolution, global IA models are:
  - Global in scope
  - Include representations of energy and agricultural/land use systems
  - Include all anthropogenic sources of emissions
  - Include some representation of the climate system

- However, there is significant variation across models as to their:
  - Spatial resolution
  - Inclusion of gases and substances
  - Energy system detail
  - Representation of agriculture and land-use
  - Economic assumptions
  - Degree of foresight
  - Sophistication of the earth system component
  - Degree of integration of model components

Integrated Assessment Research and Model Development is Problem Driven

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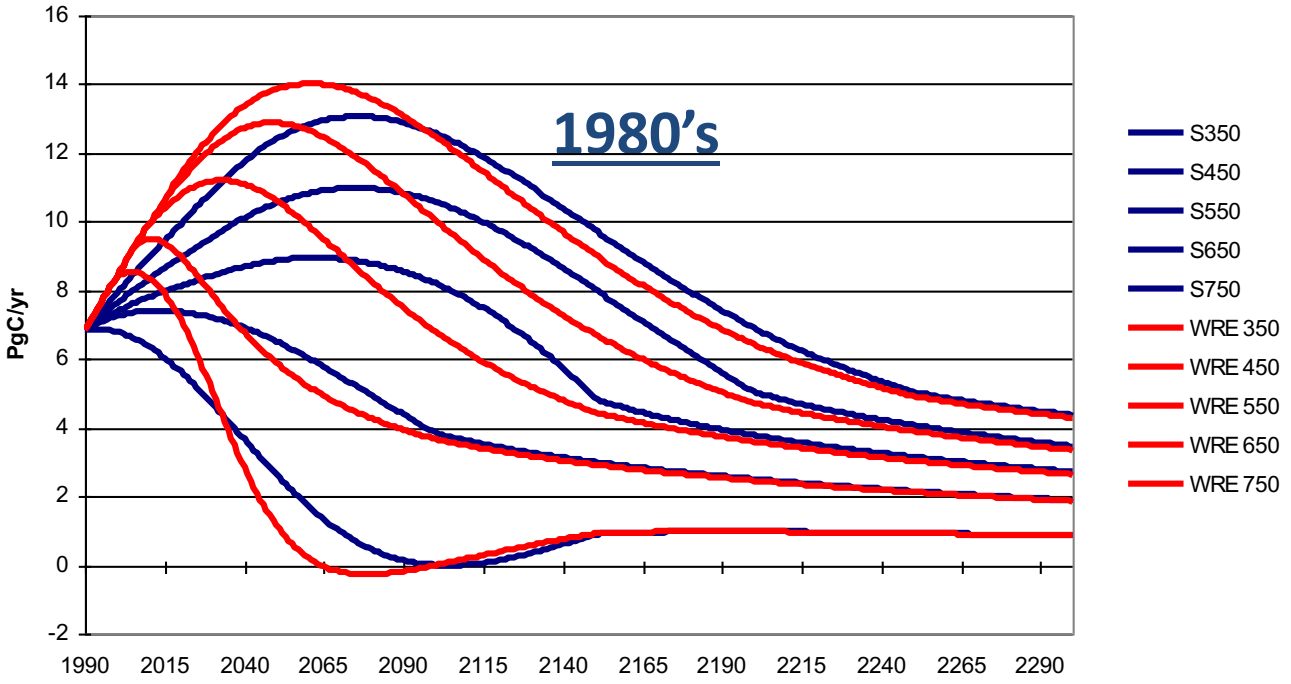
energy-economy-climate

Projections of emissions and concentrations



Integrated Assessment Research and Model Development is Problem Driven

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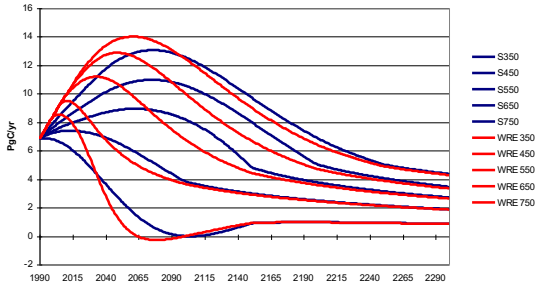
1980's

Projections of emissions and concentrations

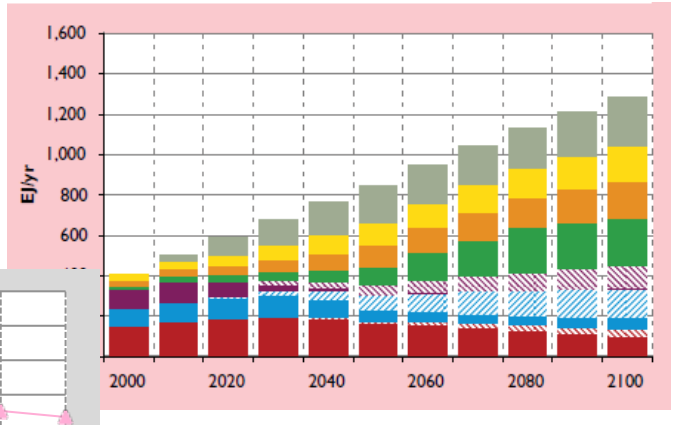


ENERGY-ECONOMY-climate

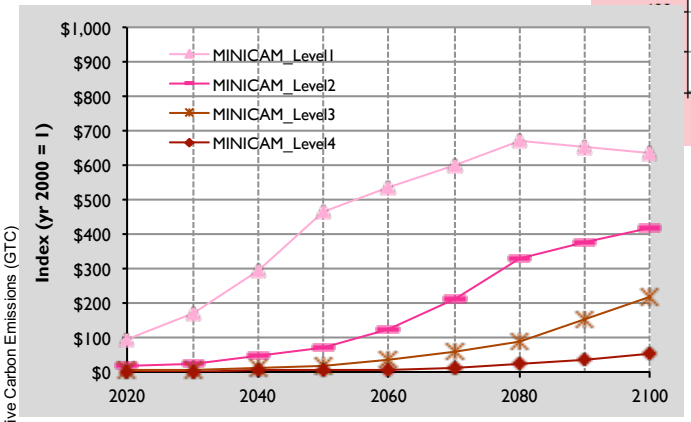
1990's through 2000's

Energy, Technology, and Mitigation

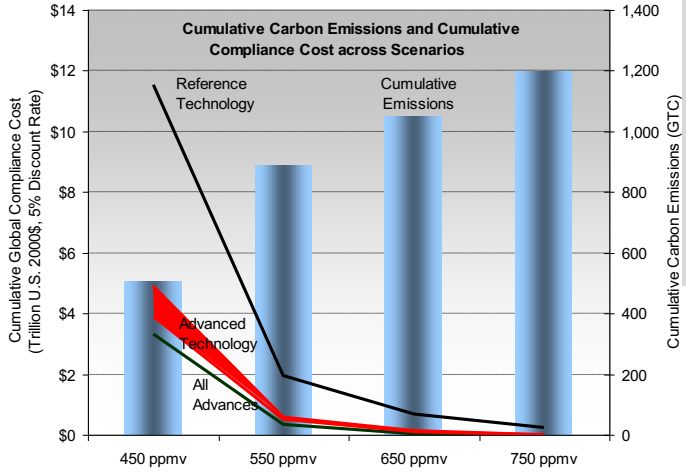
Energy Systems



Carbon Prices



Value of Technology



Examples of Current Questions for the IA Community

- Type 1: Where are the NDCs taking us? How to implement and ramp up action? What's actually realistic for different countries?
- Type 2: How will these mitigation activities link to the other societal goals (e.g., SDGs)? Will they be limited by energy-water-land constraints?
- Type 3: How can we plan investments and strategy taking into account climate impacts and a broad range of additional stressors and dynamics?
- Type 4: Where are the biggest future climate-related national security risks, domestically and internationally?
- Can you help us interpret and understand this stuff? What's the confidence in any of this?

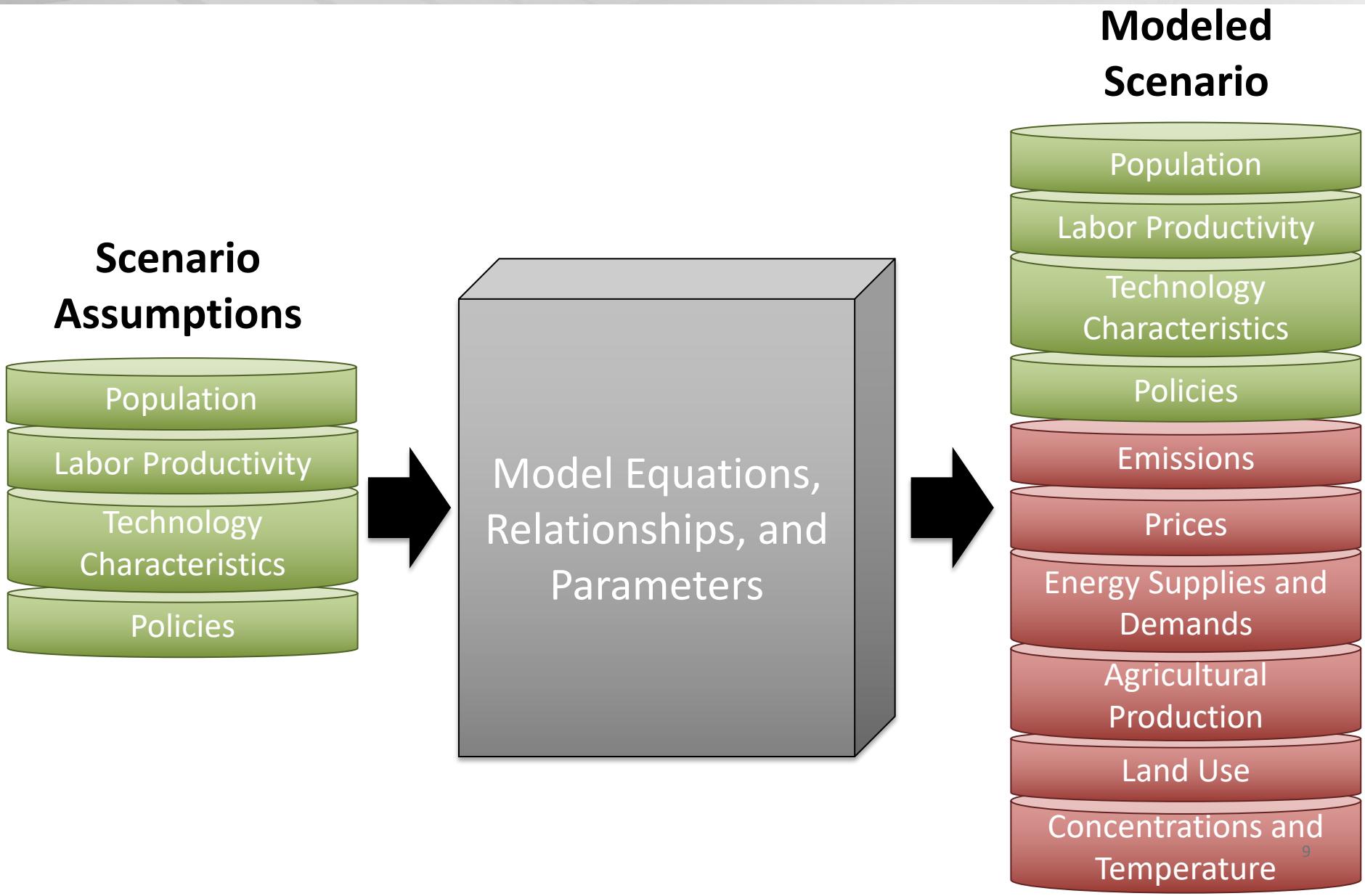
Incorporating climate impacts, adaptation, and vulnerability

Increased "realism", particularly with regards to regional dynamics

GCAM has a long history…

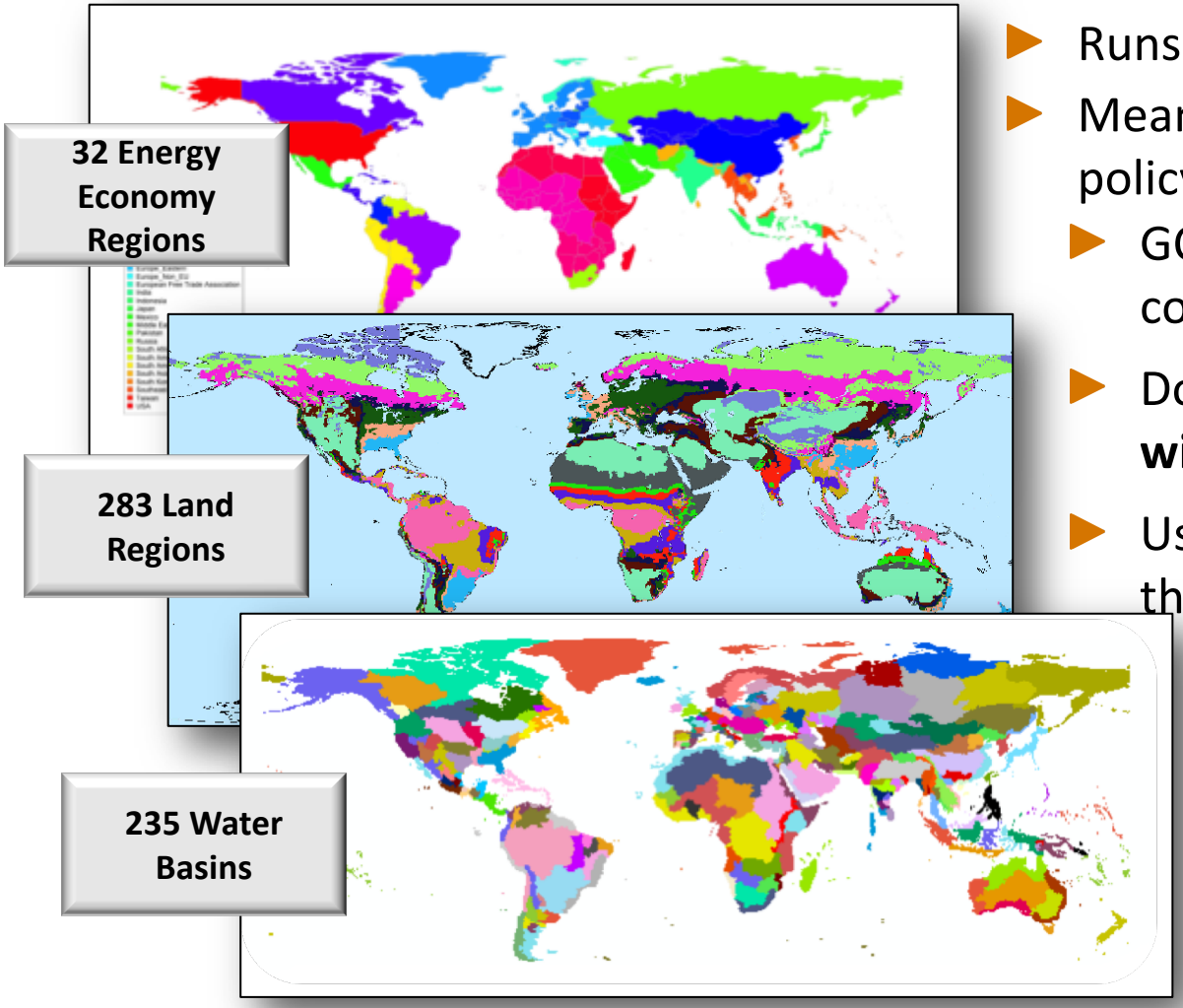
- GCAM was one of four models chosen to create the representative concentration pathways (RCPs) for the IPCC's AR5
- GCAM was one of six models chosen to create the shared socioeconomic pathways (SSPs)
- GCAM was one of three models used to create scenarios for Climate Change Science Program (CCSP)
- GCAM was a prominent tool for analysis in the Climate Change Technology Program (CCTP)
- GCAM has participated in virtually every major climate/energy/economics assessment over the last 20 years:
  - Every EMF study on climate
  - Every IPCC assessment
- GCAM has been used for strategic planning by energy and other private companies
- GCAM is now used by research institutions and governments internationally

What do IA Models do?



What is GCAM?

- GCAM is a **global integrated assessment model**
- GCAM links **Economic**, **Energy**, **Land-use**, **Water**, and **Earth** systems



- Runs in **5-year time-steps**
- Meant to analyze consequences of policy actions and interdependencies
  - GCAM is an open-source community model
  - Documentation available at: **wiki.umd.edu/gcam**
  - Used to evaluate impacts of these threads:
    - *Socioeconomic development*
    - *Climate treaty compliance*
    - *Technology and resource developments*
    - *Energy policies*

What's inside GCAM?

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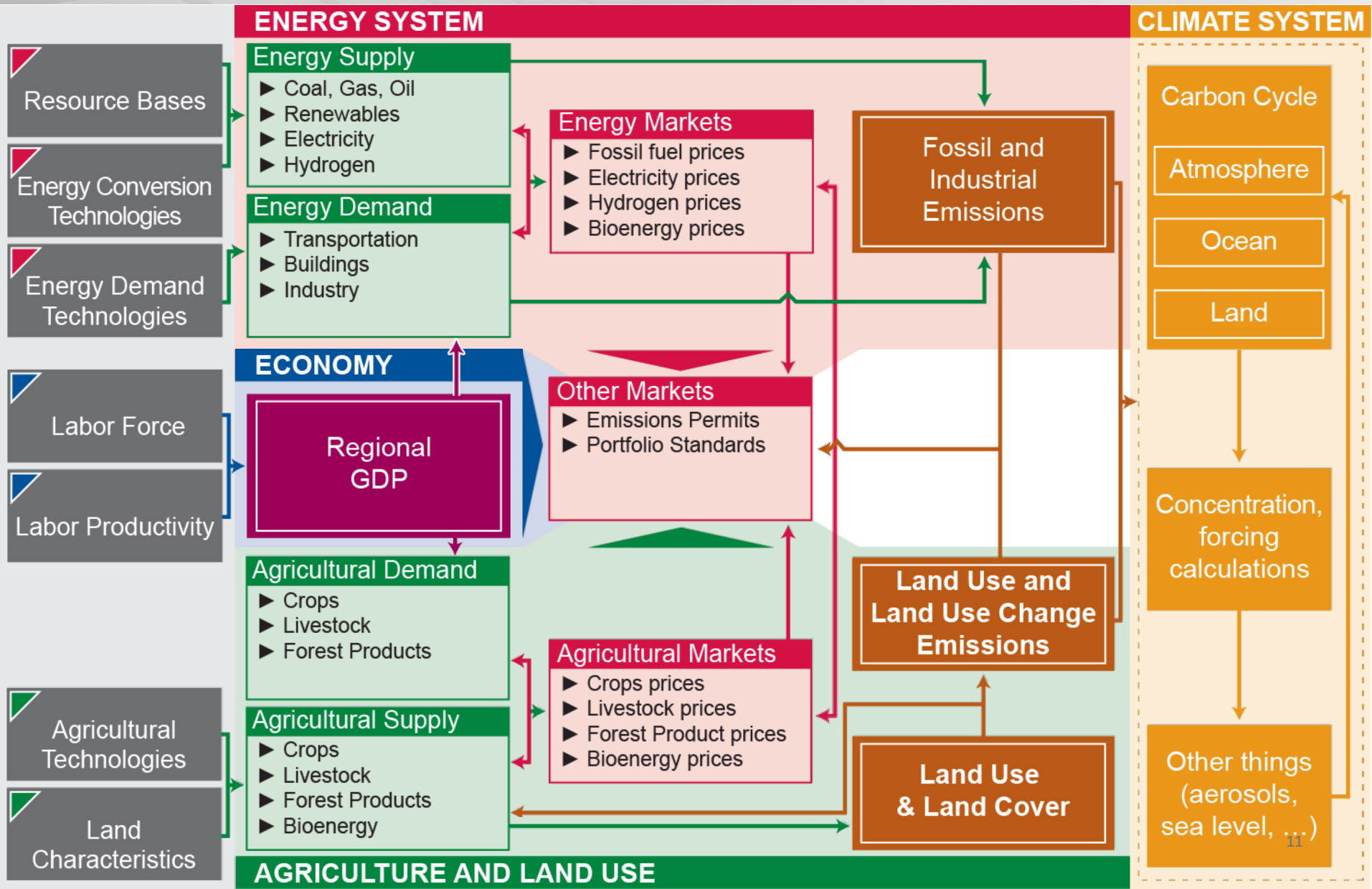


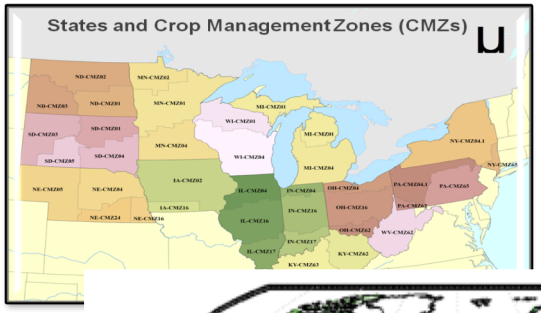
Frequently Asked Questions

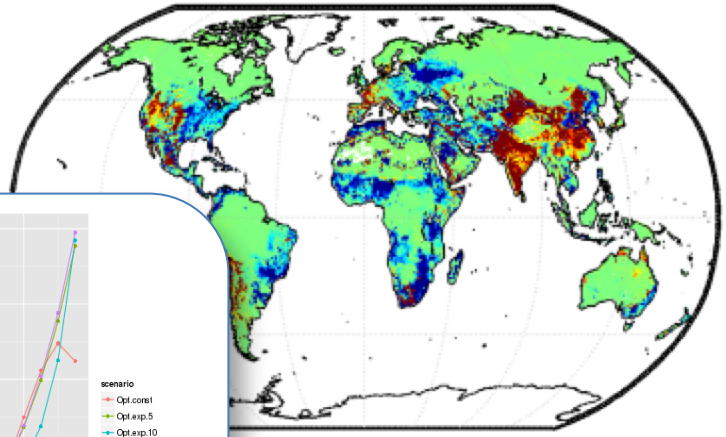
- Common question:
  - Does GCAM optimize?

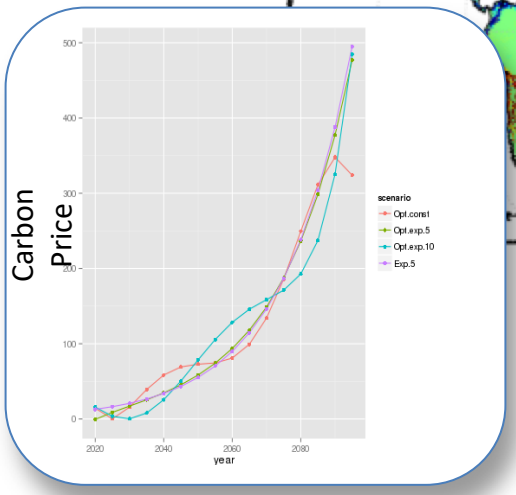
- Answer:
  - Not exactly.
  - GCAM is a market equilibrium model, so it adjusts prices until supplies and demands are equal
  - However, GCAM assumes that producers maximize profit and consumers minimize cost
  - And, under certain conditions, welfare economics tells us that market equilibria are (Pareto) optimal
  - GCAM is not intertemporally optimizing

What can you do with GCAM?

- **Prices and production quantities**:
  - Energy sectors
  - Transportation
  - Primary energy resources
  - Agricultural products
- **Land use**
  - Crops (by type)
  - Pasture
  - Unmanaged
- **Water demand**
  - Raw demand by sector
  - Response to scarcity
- **Greenhouse gases**
- **Economic cost of policies**
  - Economic loss
  - Income transfer







The Global Change Assessment Model

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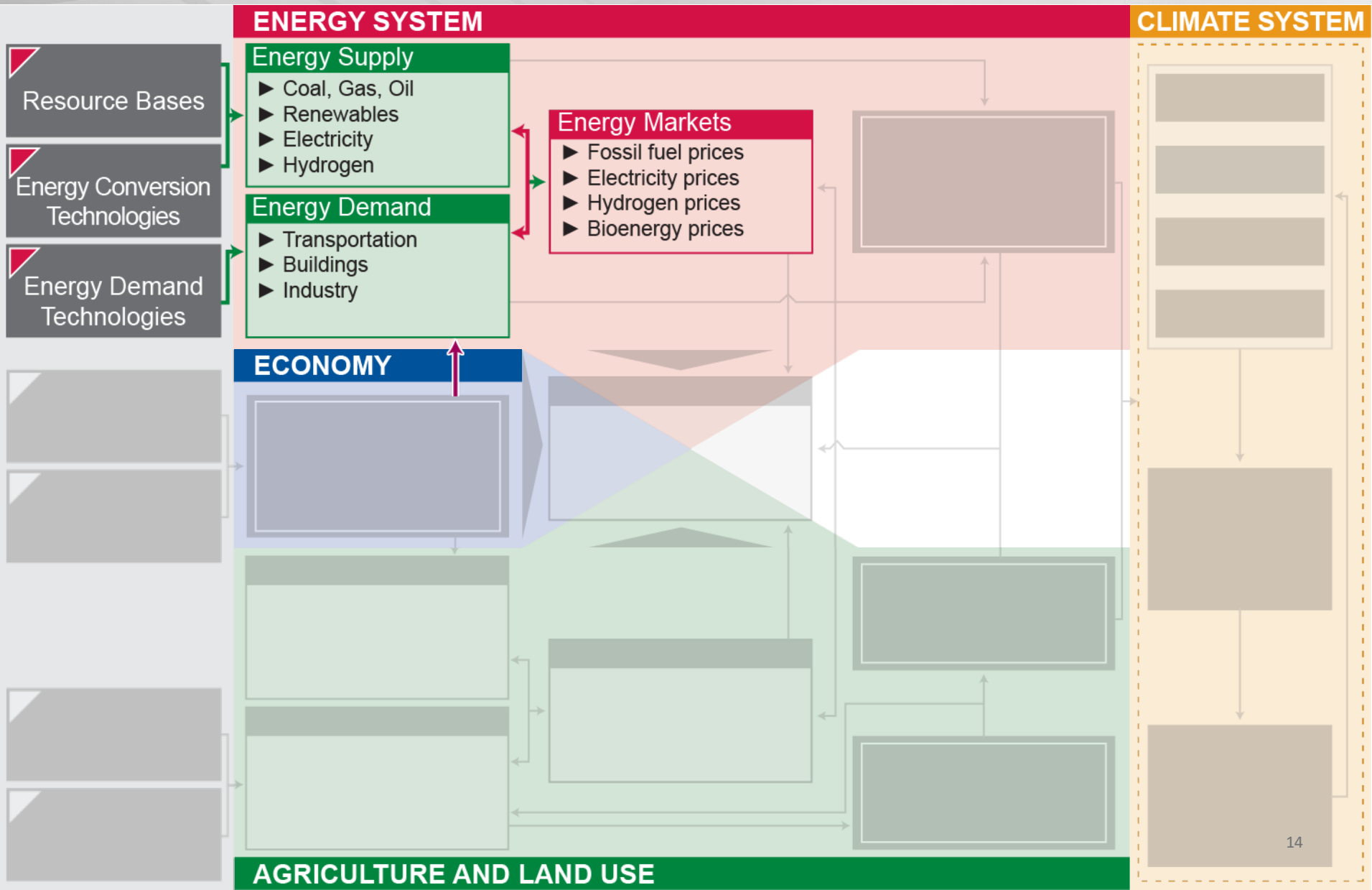

The Energy System: Structure