To pdf - GCAM

From IAMC-Documentation

Reference card - GCAM

Contents

The reference card is a clearly defined description of model features. The numerous options have been organized into a limited amount of default and model specific (non default) options. In addition some features are described by a short clarifying text.

Legend:

- ☐ not implemented
- ☑ **implemented**
- ☑ **implemented (not default option)**

⚠ ***Note:*** *The documentation of GCAM is 'in preparation' and is not yet 'published'!*

About

Name and version GCAM

Institution and users

University of Maryland (University of Maryland), United States of America, www.umd.edu.

Documentation GCAM documentation consists of a referencecard and detailed model documentation

Model scope and methods

Model documentation: Model scope and methods - GCAM

Objective GCAM is an integrated, multi-sector model that explores both human and Earth system dynamics. The role of models like GCAM is to bring multiple human and physical Earth systems together in one place to shed light on system interactions and provide scientific insights that would not otherwise be available from the pursuit of traditional disciplinary scientific research alone. GCAM is constructed to explore these interactions in a single computational platform with a sufficiently low computational requirement to allow for broad explorations of scenarios and uncertainties. Components of GCAM are designed to capture the behavior of human and physical systems, but they do not necessarily include the most detailed process-scale representations of its constituent components. On the other hand, model components in principle provide a faithful representation of the best current scientific understanding of underlying behavior.

Concept GCAM allows users to explore what-if scenarios, quantifying the implications of possible future conditions. These outputs are not predictions of the future; they are a way of analyzing the potential impacts of different assumptions about future conditions. GCAM reads in external “scenario assumptions” about key drivers (e.g., population, economic activity, technology, and policies) and then assesses the implications of these assumptions on key scientific or decision-relevant outcomes (e.g., commodity prices, energy use, land use, water use, emissions, and concentrations). Developing and quantifying a single set of scenario assumptions is the most common way that a model such as GCAM is used to explore scientific and assessment questions. However, another class of question that GCAM has taken up is the systematic representation of uncertainty. As early as the 1980s, GCAM was used to map the implications of uncertain key input assumptions and parameters into implied distributions of outputs, such as greenhouse gas emissions, energy use, energy prices, and trade patterns. A range of techniques has been employed using GCAM to explore the potential range of future outcomes. Techniques include scenarios analysis, sensitivity analysis, and Monte Carlo simulations. Exploring and understanding the role of uncertainty in shaping events remains an important research use of GCAM.

Solution method Recursive dynamic solution method

Anticipation GCAM is a dynamic recursive model, meaning that decision-makers do not know the future when making a decision today. After it solves each period, the model then uses the resulting state of the world, including the consequences of decisions made in that period - such as resource depletion, capital stock retirements and installations, and changes to the landscape - and then moves to the next time step and performs the same exercise. For long-lived investments, decision-makers may account for future profit streams, but those estimates would be based on current prices. For some parts of the model, economic agents use prior experience to form expectations based on multi-period experiences.

Temporal dimension Base year:2010, time steps:5-year (default), minimum time step is 1-year, horizon: 2100

Spatial dimension Number of regions:32 (default)

1. USA
2. Canada
3. Mexico
4. Australia_NZ
5. Japan
6. South Korea
7. EU-12
8. EU-15
9. European Free Trade Association
10. Europe_Non_EU
11. Europe_Eastern
12. Russia
13. China
14. Taiwan
15. Central Asia
16. South Asia
17. Southeast Asia
18. Indonesia
19. India
20. Pakistan
21. Middle East
22. Africa_Eastern
23. Africa_Northern
24. Africa_Southern
25. Africa_Western
26. South Africa
27. Argentina
28. Brazil
29. Central America and Caribbean
30. Colombia
31. South America_Northern
32. South America_Southern

Note: Dimensionality is flexible and can be expanded by adding additional information about regions. For example, a version of GCAM exists with 82 regions that include 50 states, the District of Columbia and the remaining 31 non-US regions.

Policy implementation GCAM can be used to understand the implication of interactions between assumptions about the implications of interactions between inputs (population, labor productivity, technology availability and performance, resource availability, and policies) with energy, economy, land-use and land cover, water, atmosphere and climate. It tracks physical flows of energy production, transformation, trade, and use, agricultural production, trade and consumption, land use, land cover, and the sources and disposition of water resources. A key feature is that the system is coupled in code and solved as a reconciled system.

Socio economic drivers

Model documentation: Socio-economic drivers - GCAM

Exogenous drivers

- ☐ Exogenous GDP
- ☐ Total Factor Productivity
- ☐ Labour Productivity
- ☐ Capital Technical progress
- ☐ Energy Technical progress
- ☐ Materials Technical progress
- ☐ GDP per capita

Development

- ☐ GDP per capita
- ☐ Income distribution in a region
- ☐ Urbanisation rate
- ☐ Education level
- ☐ Labour participation rate

Macro economy

Model documentation: Macro-economy - GCAM

Economic sectors

- ☐ Agriculture
- ☐ Industry
- ☐ Energy
- ☐ Transport
- ☐ Services

Cost measures

- ☐ GDP loss
- ☐ Welfare loss
- ☐ Consumption loss
- ☐ Area under MAC
- ☐ Energy system costs

Trade

- ☐ Coal
- ☐ Oil
- ☐ Gas
- ☐ Uranium
- ☐ Electricity
- ☐ Bioenergy crops
- ☐ Food crops
- ☐ Capital
- ☐ Emissions permits
- ☐ Non-energy goods

Energy

Model documentation: Energy - GCAM

Resource use

- ☐ Coal
- ☐ Oil
- ☐ Gas
- ☐ Uranium
- ☐ Biomass

Electricity technologies

- ☐ Coal
- ☐ Gas
- ☐ Oil
- ☐ Nuclear
- ☐ Biomass
- ☐ Wind
- ☐ Solar PV
- ☐ CCS

Conversion technologies

- ☐ CHP
- ☐ Heat pumps
- ☐ Hydrogen
- ☐ Fuel to gas
- ☐ Fuel to liquid

Grid and infrastructure

- ☐ Electricity
- ☐ Gas
- ☐ Heat
- ☐ CO2
- ☐ H2

Energy technology substitution	☐ Discrete technology choices ☐ Expansion and decline constraints	☐ System integration constraints
Energy service sectors	☐ Transportation ☐ Industry	☐ Residential and commercial

Land-use

Model documentation: Land-use - GCAM; Non-climate sustainability dimension - GCAM

Other resources

Model documentation: Non-climate sustainability dimension - GCAM

Other resources	☐ Water ☐ Metals	☐ Cement

Emissions and climate

Model documentation: Emissions - GCAM; Climate - GCAM

Green house gasses	☐ CO2 ☐ CH4 ☐ N2O	☐ HFCs ☐ CFCs ☐ SF6
Pollutants	☐ NOx ☐ SOx ☐ BC	☐ OC ☐ Ozone
Climate indicators	☐ CO2e concentration (ppm) ☐ Radiative Forcing (W/m^2)	☐ Temperature change (°C) ☐ Climate damages $ or equivalent

Model Documentation - GCAM

1) Model scope and methods - GCAM

1.1) Model concept, solver and details - GCAM

1.3) Temporal dimension - GCAM

1.4) Spatial dimension - GCAM

1.5) Policy - GCAM

2) Socio-economic drivers - GCAM

2.1) Population - GCAM

2.2) Economic activity - GCAM

3) Macro-economy - GCAM

3.1) Production system and representation of economic sectors - GCAM

3.2) Capital and labour markets - GCAM

3.3) Monetary instruments - GCAM

3.4) Trade - GCAM

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4.1) Energy resource endowments - GCAM

4.1.1) Fossil energy resources - GCAM

4.1.2) Uranium and other fissile resources - GCAM

4.1.3) Bioenergy - GCAM

4.1.4) Non-biomass renewables - GCAM

4.2) Energy conversion - GCAM

4.2.1) Electricity - GCAM

4.2.2) Heat - GCAM

4.2.3) Gaseous fuels - GCAM

4.2.4) Liquid fuels - GCAM

4.2.5) Solid fuels - GCAM

4.2.6) Grid, pipelines and other infrastructure - GCAM

4.3) Energy end-use - GCAM

4.3.1) Transport - GCAM

4.3.2) Residential and commercial sectors - GCAM

4.3.3) Industrial sector - GCAM

4.3.4) Other end-use - GCAM

4.4) Energy demand - GCAM

4.5) Technological change in energy - GCAM

5) Land-use - GCAM

5.1) Agriculture - GCAM

5.2) Forestry - GCAM

5.3) Land-use change - GCAM

5.4) Bioenergy land-use - GCAM

5.5) Other land-use - GCAM

5.6) Agricultural demand - GCAM

5.7) Technological change in land-use - GCAM

6) Emissions - GCAM

6.1) GHGs - GCAM

6.2) Pollutants and non-GHG forcing agents - GCAM

6.3) Carbon dioxide removal (CDR) options - GCAM

7) Climate - GCAM

7.1) Modelling of climate indicators - GCAM

7.2) Climate damages, temperature changes - GCAM

8) Non-climate sustainability dimension - GCAM

8.1) Air pollution and health - GCAM

8.2) Water - GCAM

8.3) Other materials - GCAM

8.4) Other sustainability dimensions - GCAM

9) Appendices - GCAM

9.1) Mathematical model description - GCAM

9.2) Data - GCAM

10) References - GCAM