

# The C-ROADS Model Experience

23 June 2009, Bekkjarvik

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- C-ROADS, C-LEARN & CCE
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- Delivery modes
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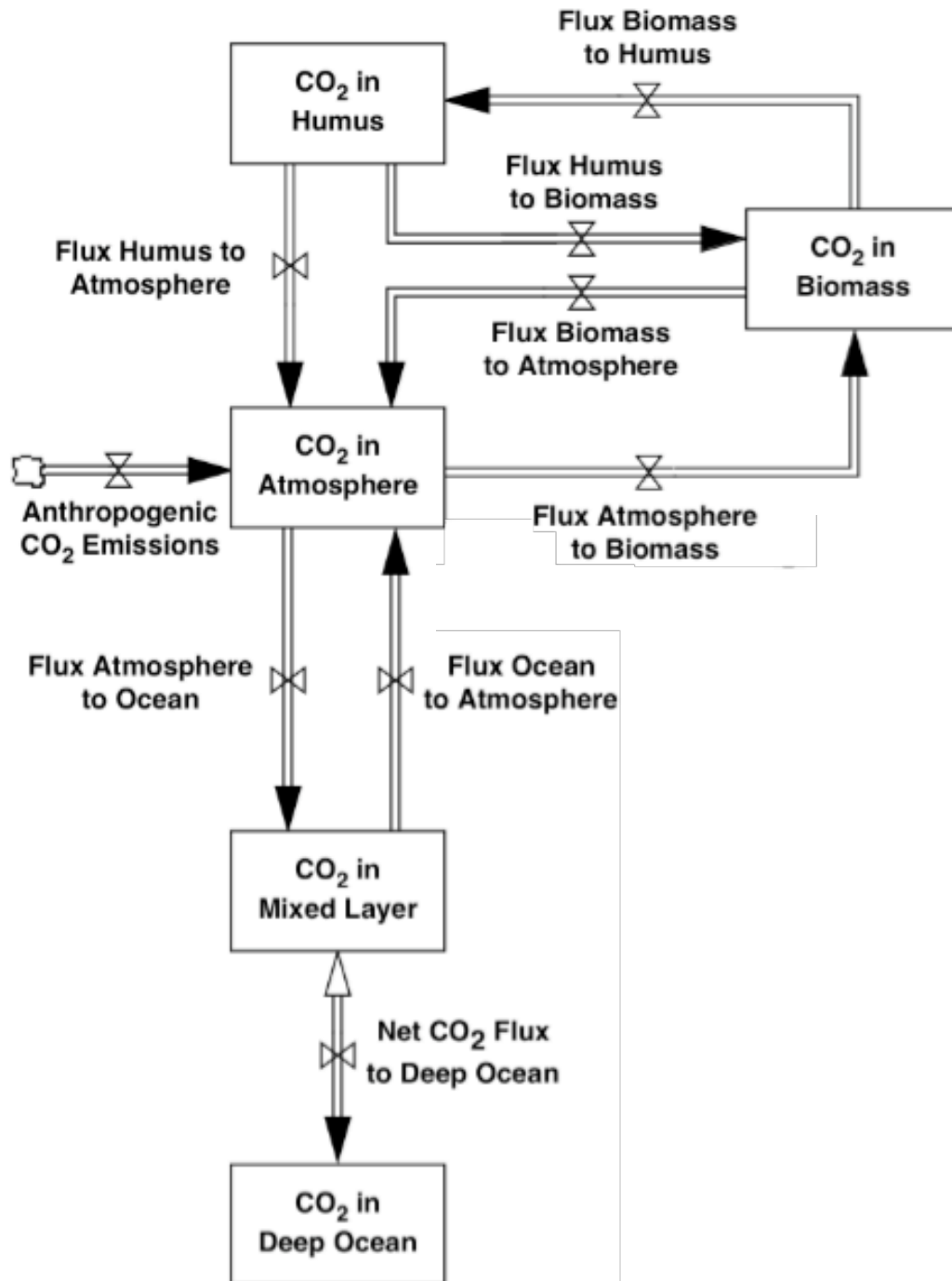
# Purpose

- Improve mental models of dynamics of accumulation of heat and carbon



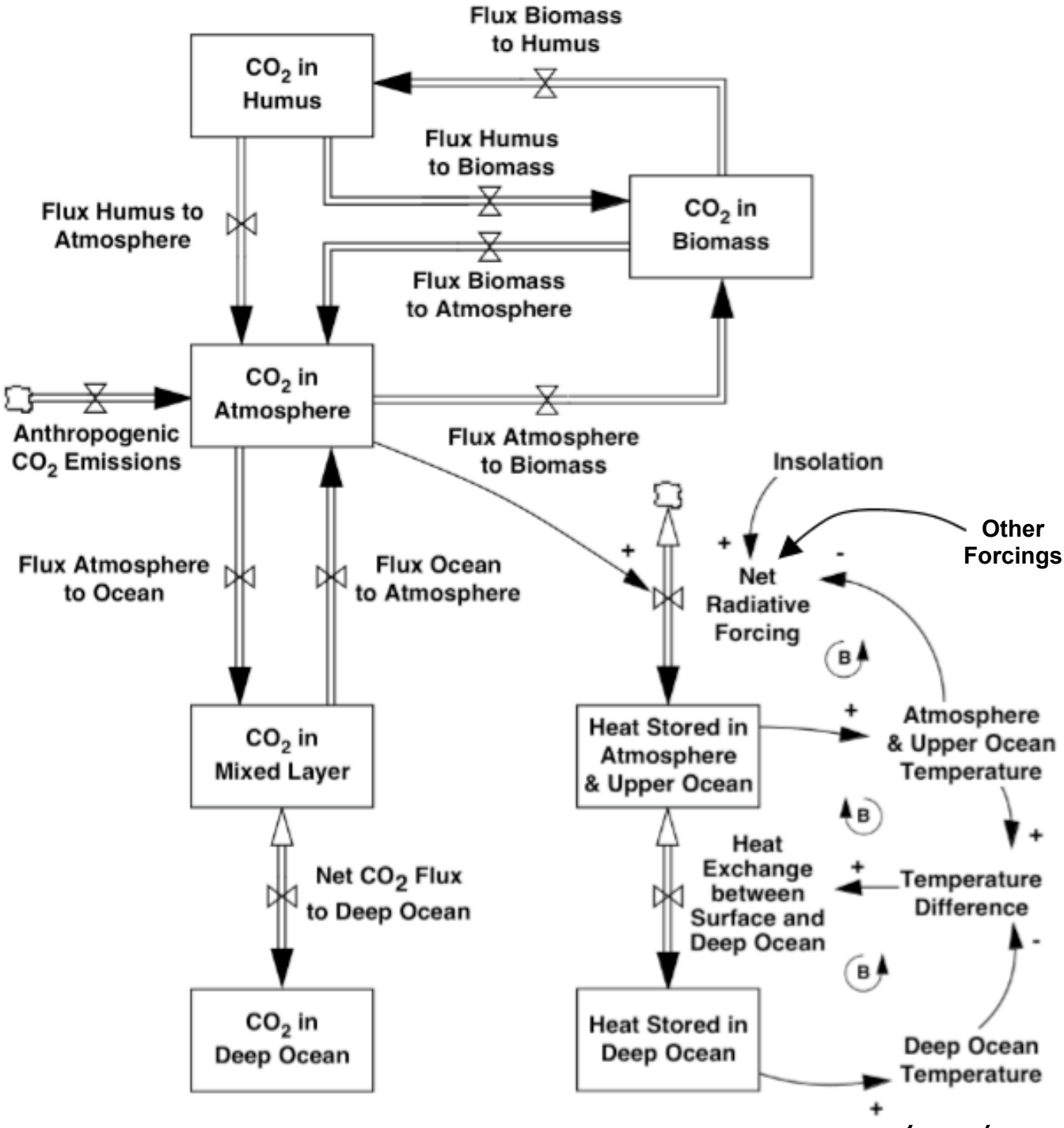
- Facilitate “adding up the bill” to determine whether current national proposals add up to significant global mitigation

# Carbon Cycle

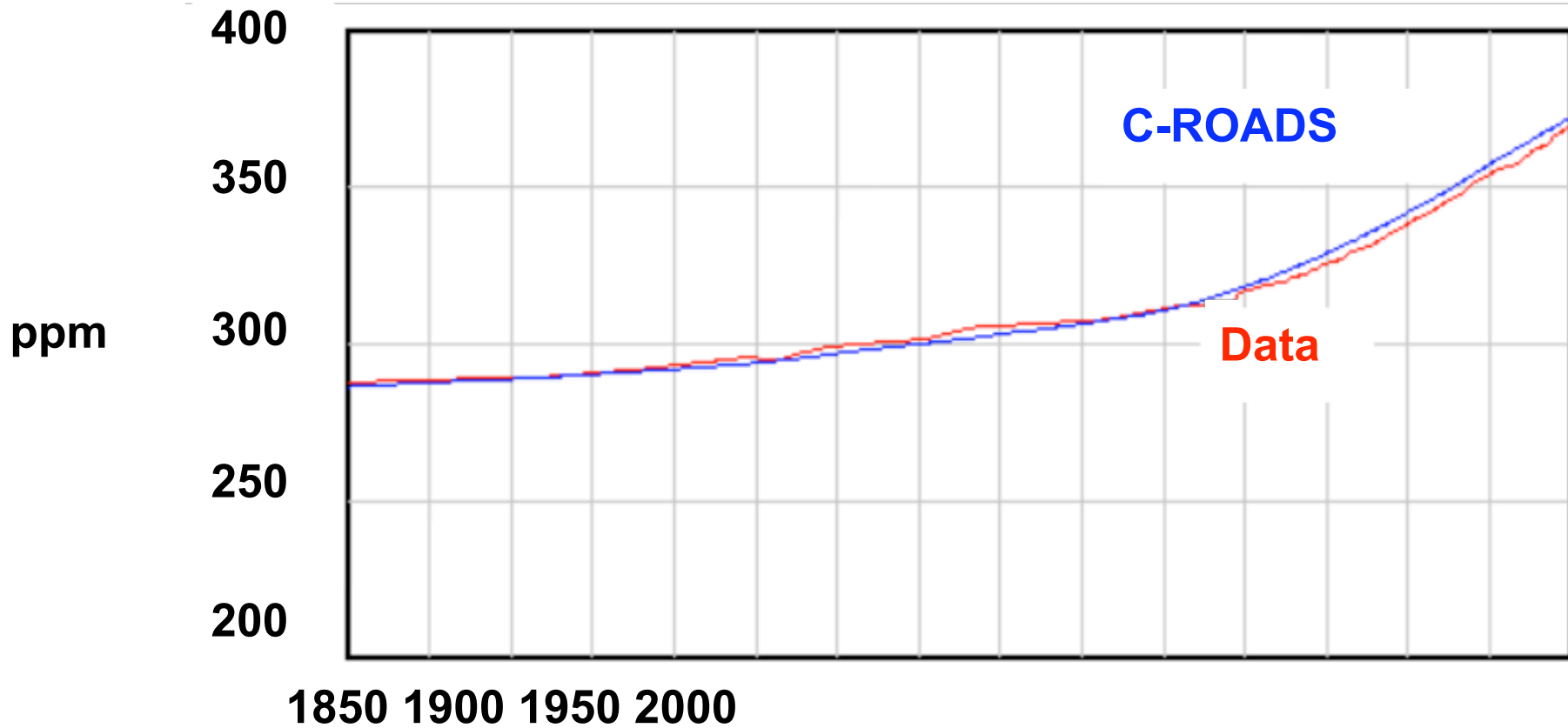


- Atmosphere
- Two biosphere compartments
- Ocean:
  - Mixed layer
  - 10 deep ocean layers

# Radiative Balance

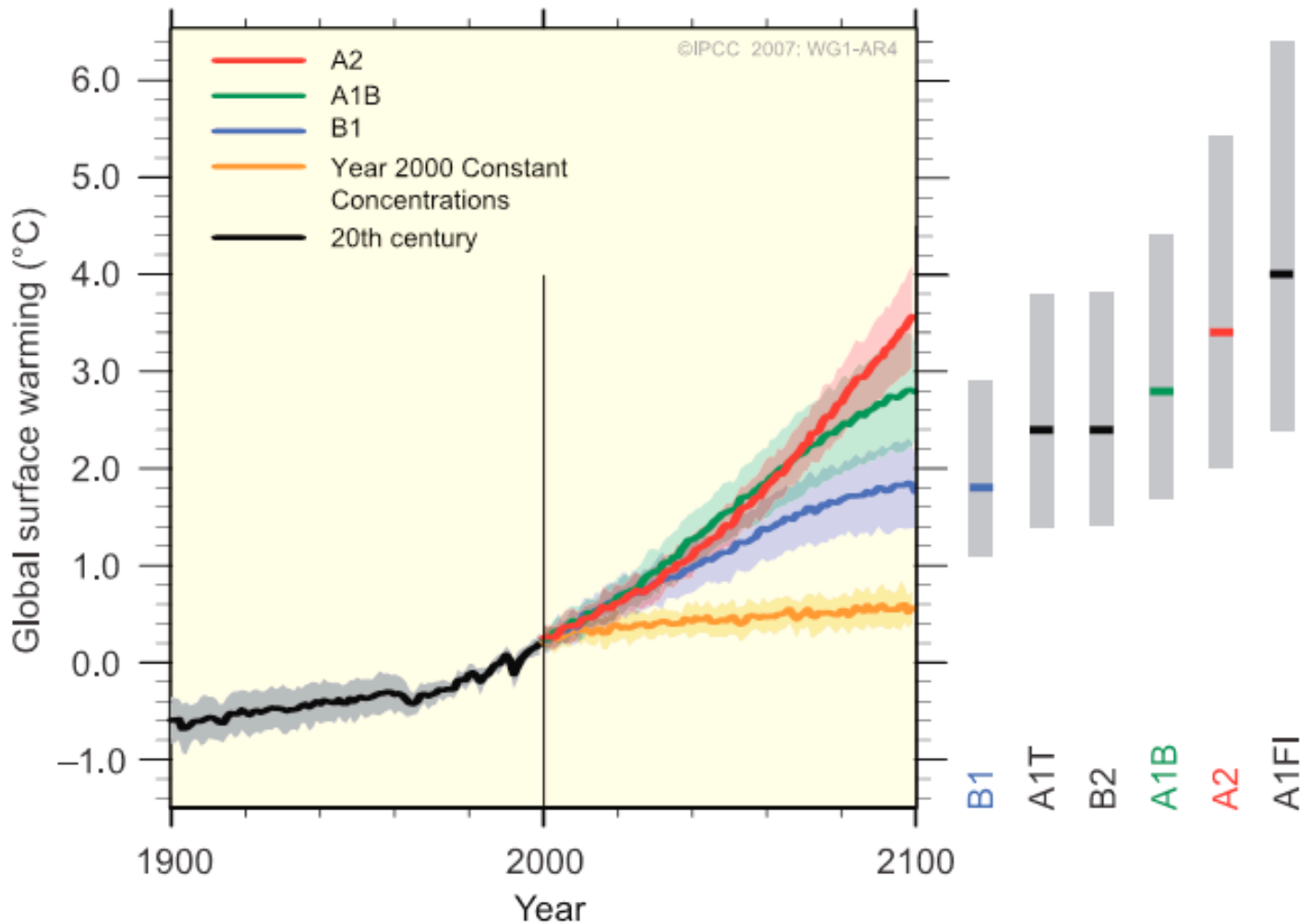


# Atmospheric CO<sub>2</sub> vs. History

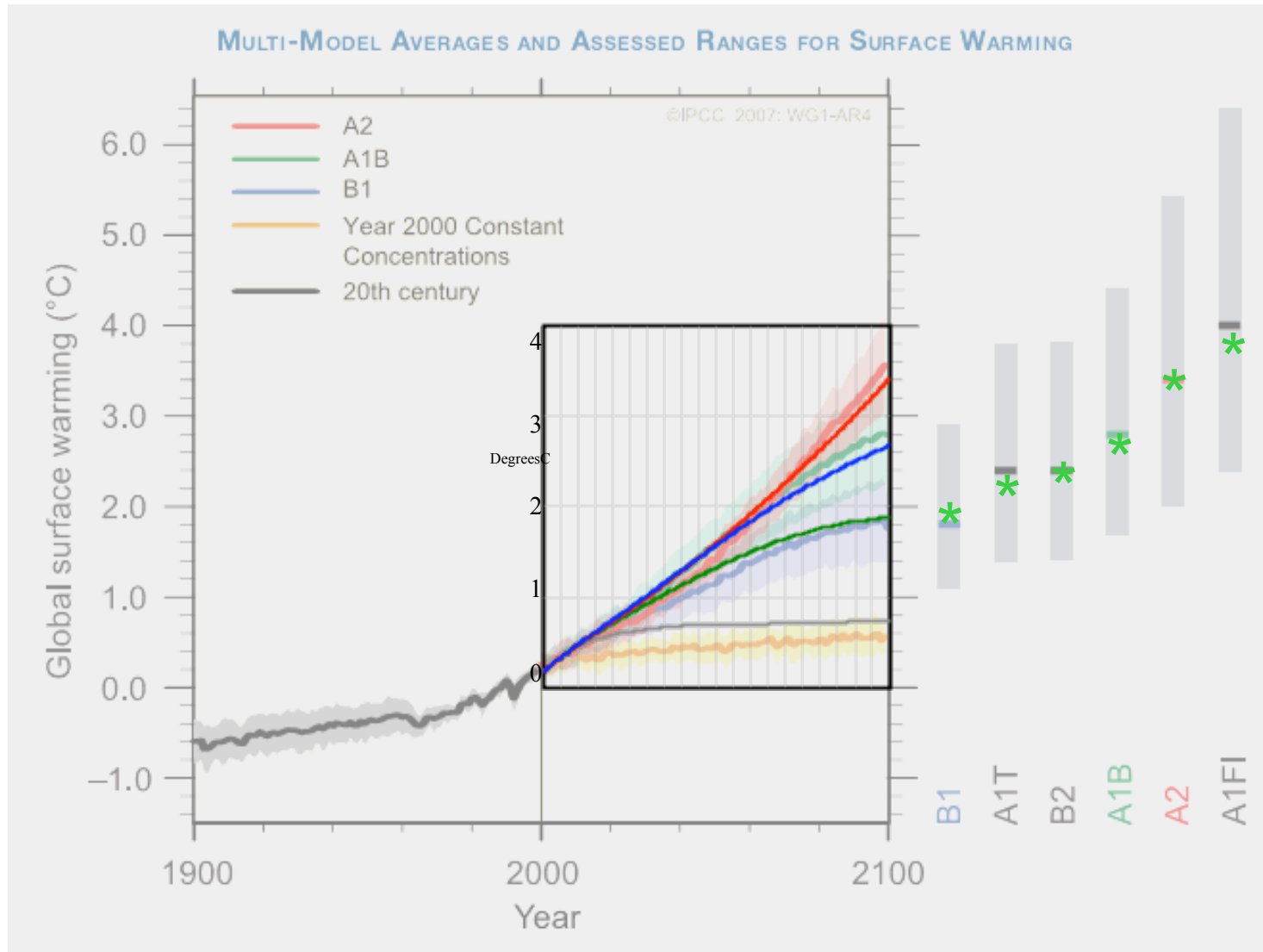


# C-ROADS Projections vs. AR4 Ensemble

MULTI-MODEL AVERAGES AND ASSESSED RANGES FOR SURFACE WARMING



# C-ROADS Projections vs. AR4 Ensemble





# Delivery Modes

- Internet – C-LEARN
- Desktop – C-ROADS
- Simulation game – Copenhagen Climate Exercise

# Audiences

- Top down
  - International negotiators
  - National/regional decision makers
  - Advocates
  - Corporations
- Bottom up
  - Students/educators
  - General public

# Copenhagen Climate Exercise

## Engaging Diverse Leaders

Oil Executives at MIT



European Business Leaders in Greenland



EEA in Copenhagen



Corporate Executives with The Climate Group



Duke MBAs



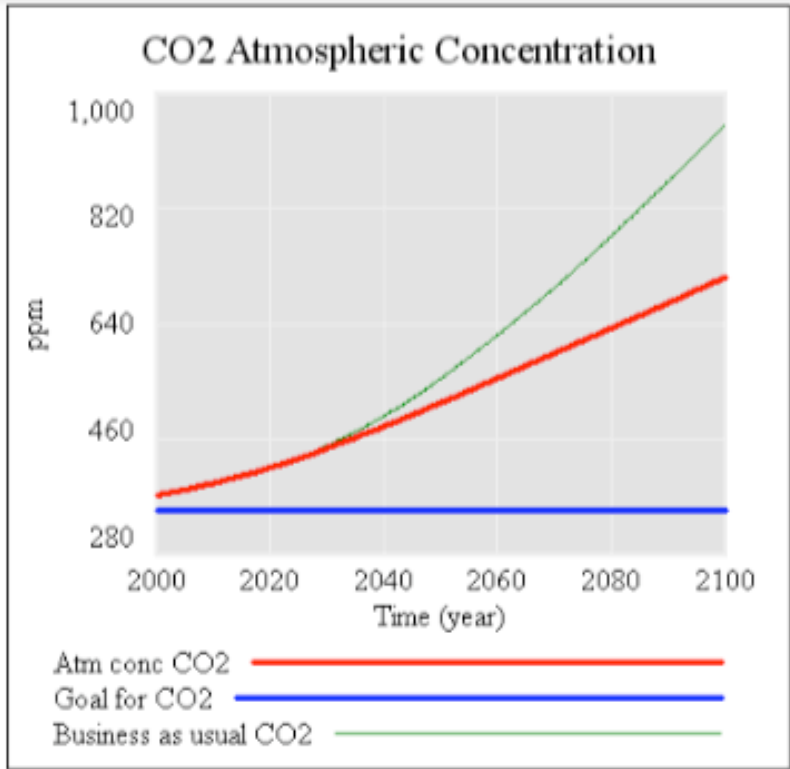
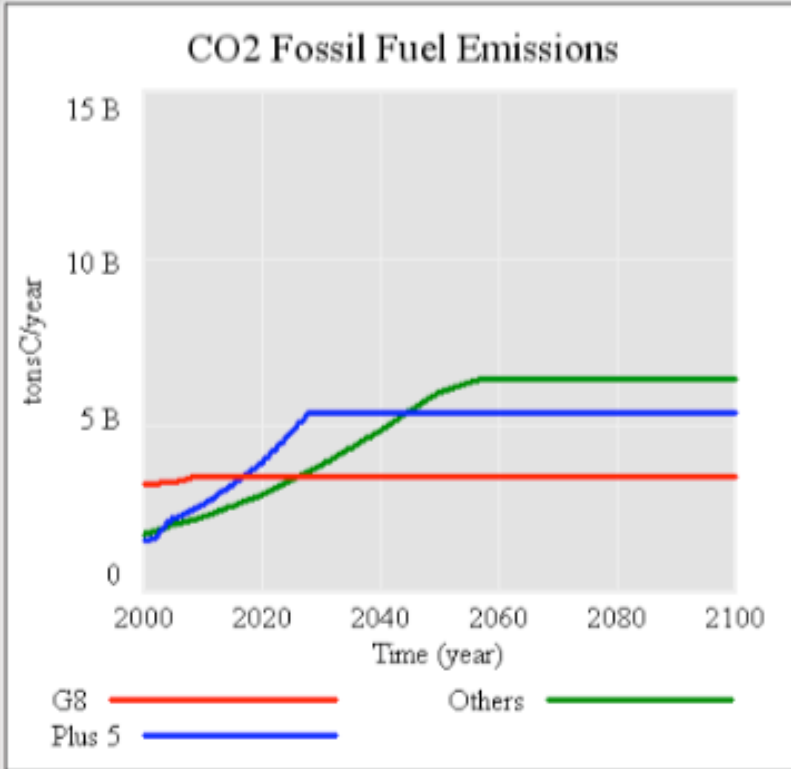
Plus:

- Citizen leaders in NH
- Civic leaders in Atlanta
- Society for Organizational Learning leaders

**C-ROADS**

# C-ROADS

- [Main \(3\) v2](#)
- [Main \(15\) v2](#)
- [Main \(MEF\) %](#)
- [Emissions](#)
- [Stacked \(3\)](#)
- [Stacked \(15\)](#)
- [Emission & Removals](#)
- [CO2](#) [CO2e](#)
- [Temp](#)
- [Sea Level](#)
- [Unit CO2](#)
- [Cumulative](#)
- [Controls](#)



## Reduce Fossil Fuel Emissions

	G8	Plus 5	Others
Stop Growth	2009	2028	2057
Start Reduction	2009	2009	2009
% Annual Reduction	0	0	0

## Reduce deforestation

Reduce emissions of non-CO2 GHGs

NO2 Index

CH4 Index

## Afforestation

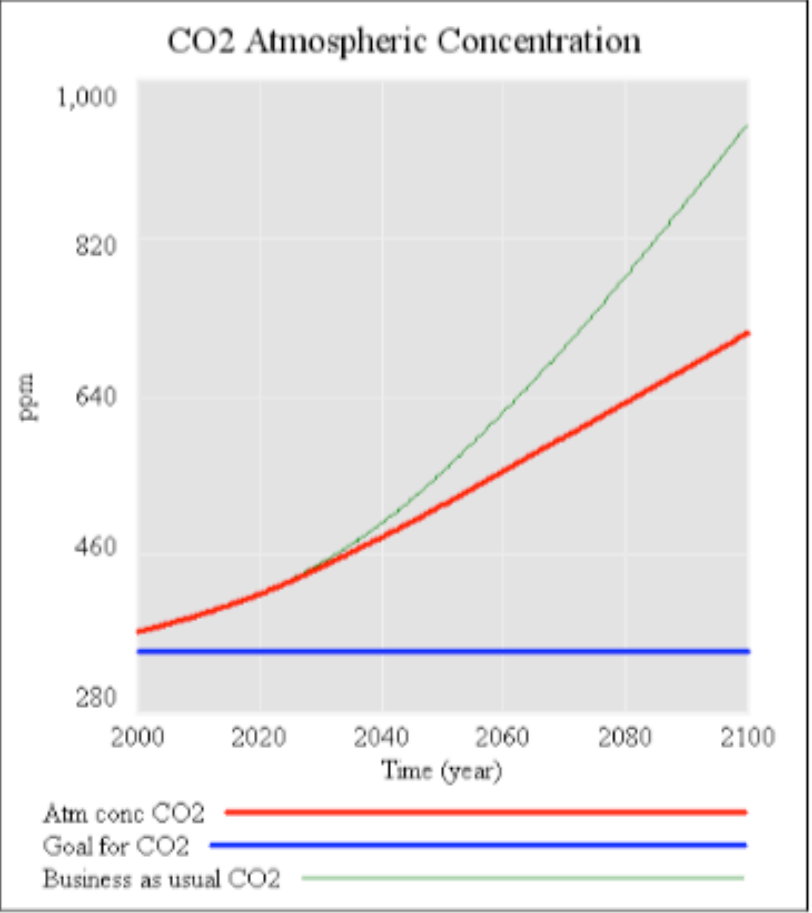
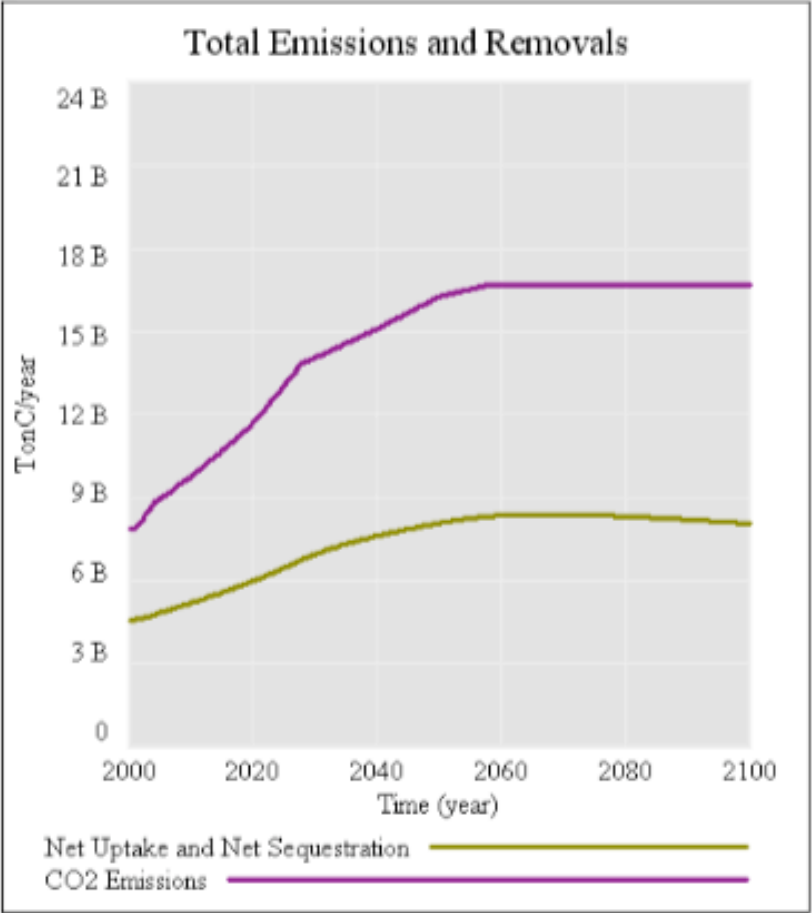
Set a goal for CO2 in the atmosphere

AGGRE (3 fo

Policy (1 fo

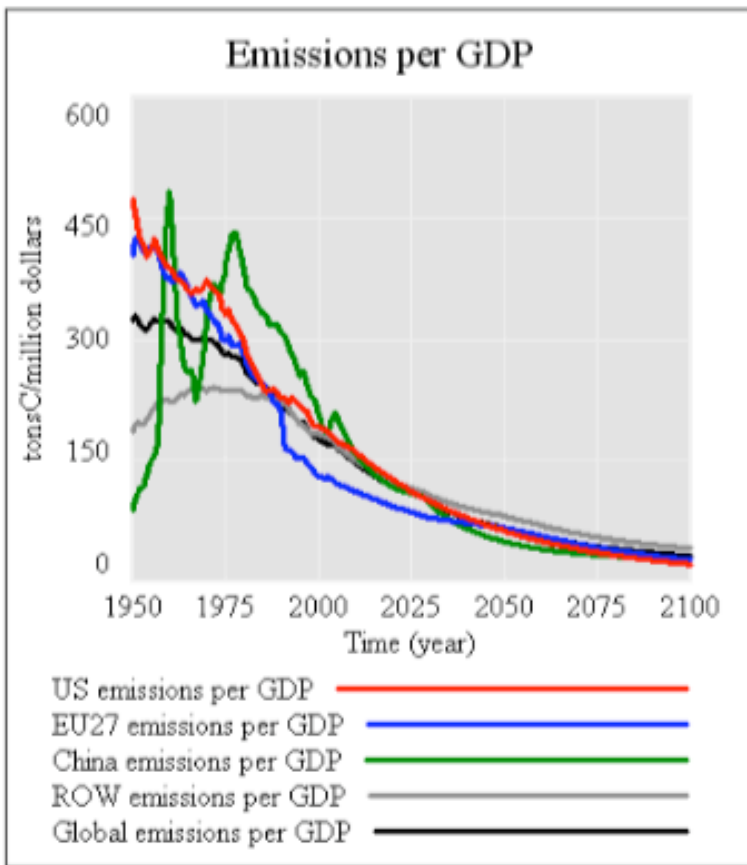
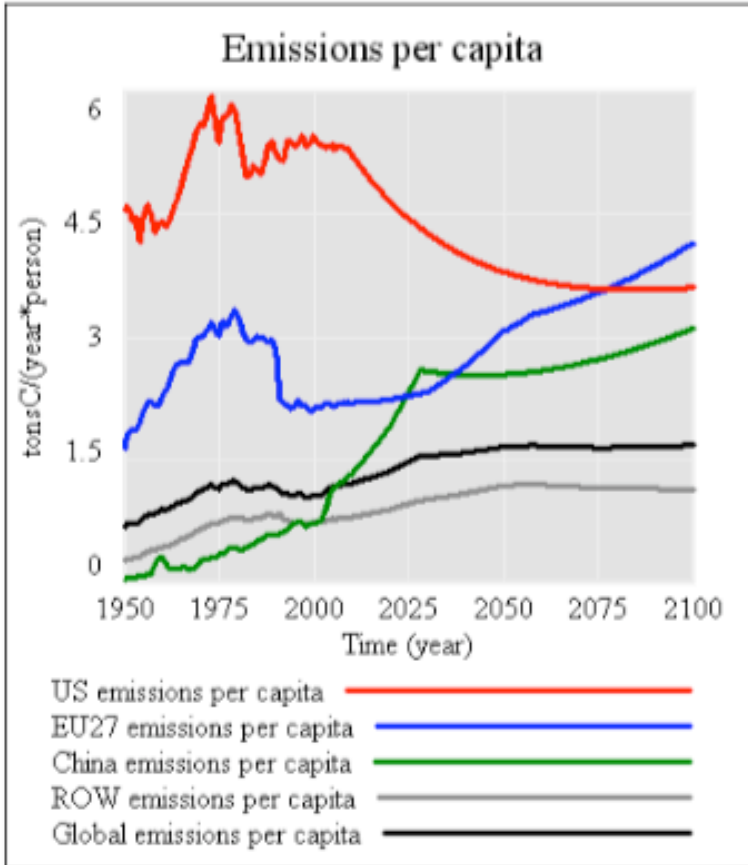
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- Cumulative
- Controls
- CLIMATE INTERACTIVE
- Sustainability Institute
- VENTANA systems, inc.



# C-ROADS

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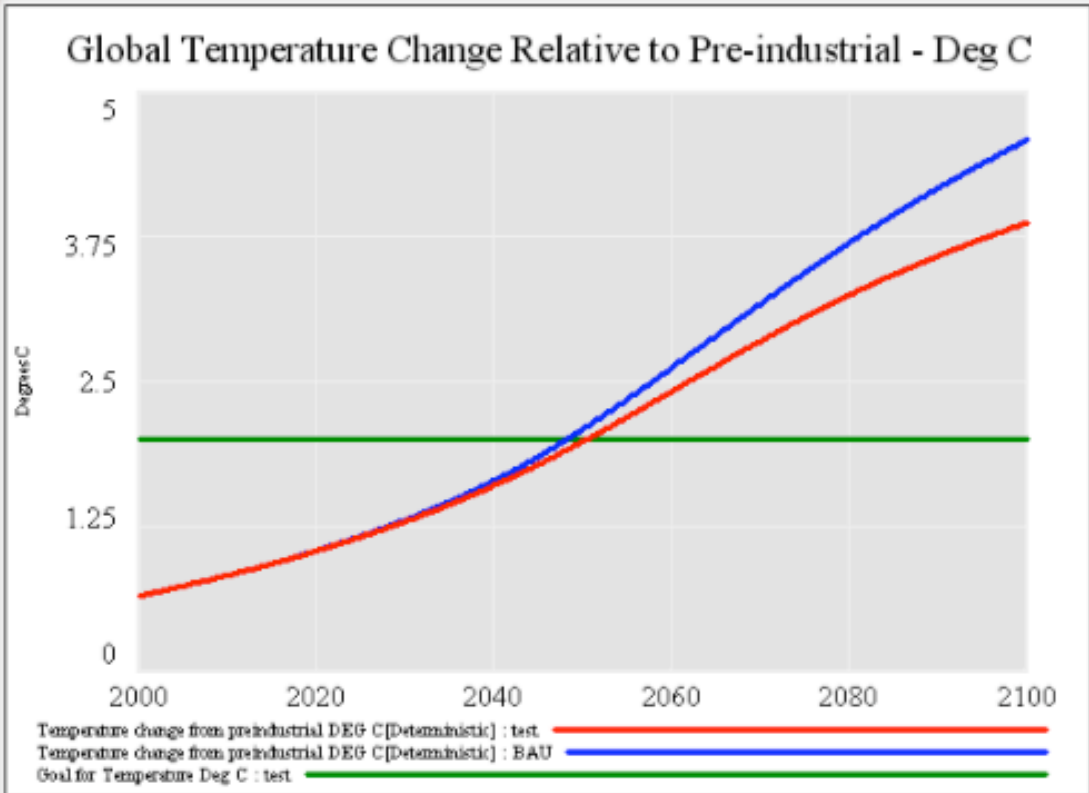
Policy for each group

Allocation method

Pct Change in  
Global FF Emissions

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Time (year)	2100
2100 Temp Deg C	3.9
2100 Temp Deg F	7
Temp GCP	28

Time (year)	Annual CO2 chang
2050	0.013

Biostim Coeff Mean      Eddy Diff Coeff Mean      Climate Sensitivity to 2x CO2

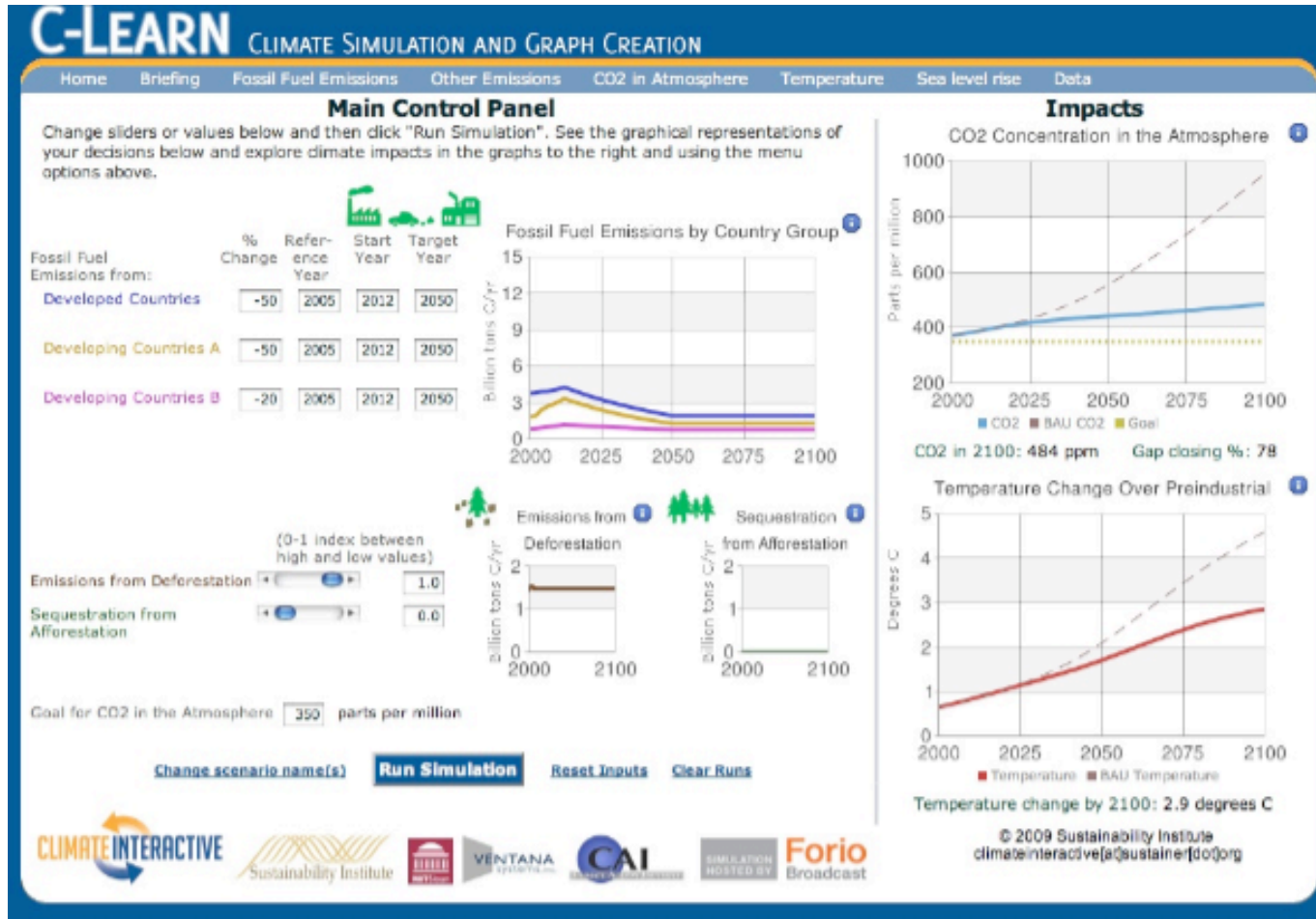
GHG switch

N2O Index      N2O pct change

CH4 Index      CH4 pct change



# C-LEARN - Globally-Accessible Online Freeware



And we will share:

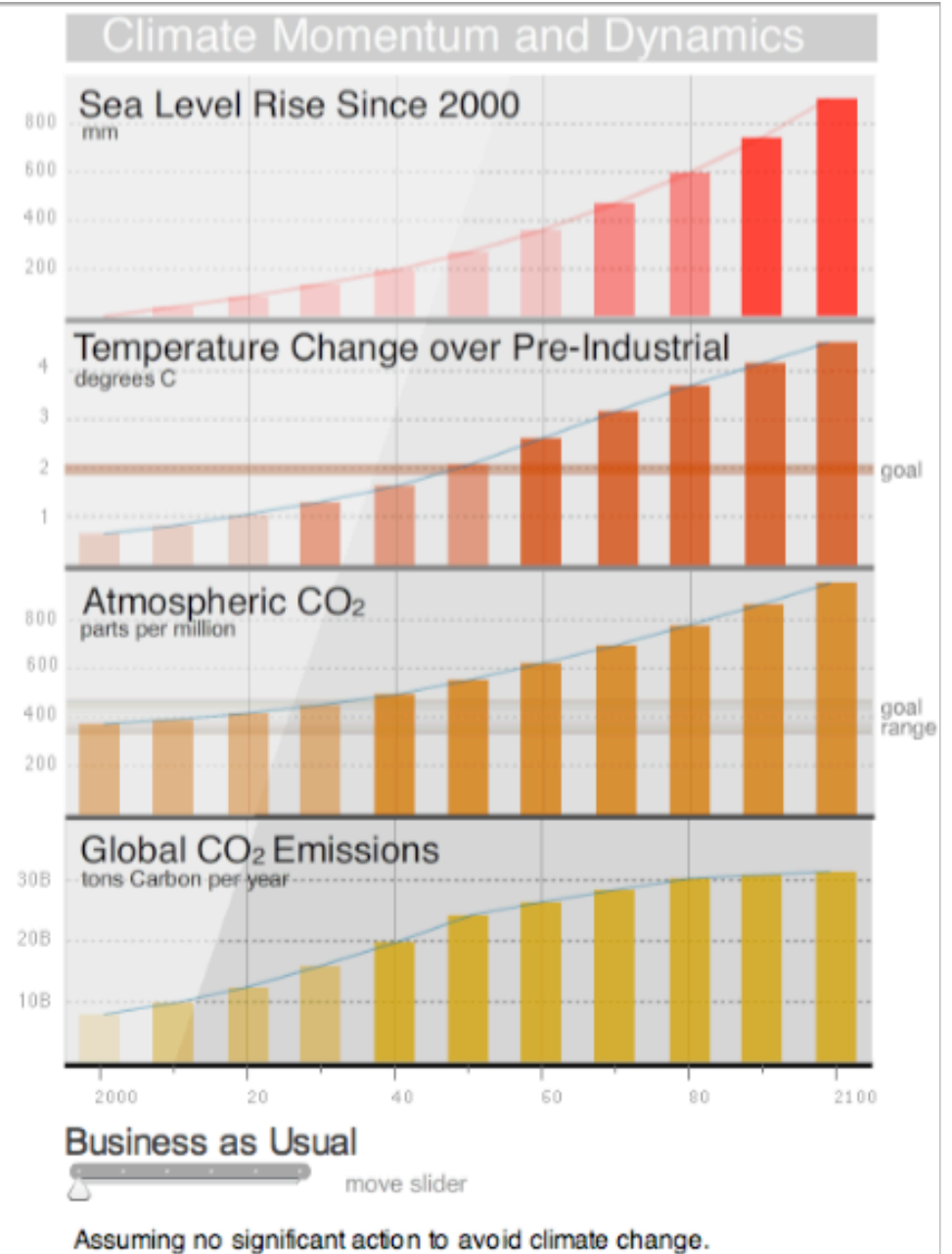
1. All equations
2. Simulation in Vensim software (with a GPL license)
3. Code to the xhtml interface (with a GPL license)
4. Graph sets with data behind them

Launched May 2009

Available at: [www.climateinteractive.org](http://www.climateinteractive.org)

# Prototype “Flash” Animation for rapid diffusion

- Built using Edward Tufte’s information design approach
- Modeled after NY Times’ online graphics



# Lessons

- It would be helpful to outsource science components to scientists
- Users have widely varying learning styles and interface needs
- Development of interfaces responsive to user needs is a lot of work
- Self-documentation reduces workload and improves transparency
- Decision makers can imagine more policy instruments than modelers can implement
  - Appetite for detail should not always be satisfied
  - Portfolio of many simple models helps
- Client-side code's speed is valuable, and some users need private models
- Uncertainty is difficult, but critical to convey

# Similar Tools & Initiatives

- FAIR (MNP – Netherlands)
- JCM (Java Climate Model, Ben Matthews)
- MAGICC (Wigley, Raper et al.)
- NICCS (Hooss et al.)
- SiMCaP, PRIMAP (Hare, Meinshausen et al.)
- Radically Open Modeling (Malone, MIT)
- Carbon Counter (Deutsche Bank)



# More Mental Models to be Improved

- Tipping points, positive feedbacks
- Capital turnover
- Interpretation of MAC curves
- Embodied emissions
- Technology development & diffusion
- Economic growth dynamics
- Effects of policy instruments
  - Compensating feedback (taxes & markets, rebound effect)
  - Intensity vs. absolute targets
  - Implications of behavior and diversity
- Connection of climate to other problems
- Role of natural variability and other noise
- Nature of evidence about climate

# Visions: What If...?

- An international network of analysts use a common suite of models to assess and discuss proposals, no modeler needed.
- Millions of people play a free climate game on their iPhone.
- Analysts and advocates have access to a set of graphs that shows the “state of the global deal” in temperature and sea level rise terms, continuously updated.
- A suite of engaging tools shows how to build a new economy with low-carbon transportation, electricity, buildings, lifestyles, and policies?
- A climate advocate in China can ask “what if” questions of a free, online, international simulation tool, in Chinese.
- Google Earth includes an interactive layer where users can change global emissions and see maps of spatial impacts.
- Youth leaders in 132 countries run “Mock UN” summits using a free online sim, guided by a free online facilitator’s guide.

# Useful Attributes of Models & Modeling Environments

- Speed
- Transparency
  - Structural/operational description
  - Causal tracing
  - Visualization
  - Self-documentation
- Interoperability
  - Cross-platform
  - Web & standalone implementation
- Collaboration
  - Open licensing
  - Integration with discussion
- Quality control
  - Reality checks
  - Dimensional consistency
- Advanced analysis
  - Uncertainty
  - Data fitting/estimation
  - Optimization
  - Experimental design