Use of models for communication: the C-ROADS experience

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EMF
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  - Genesis of the idea
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  - Results
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Difficulty assessing proposals

"...delegates [in Bonn] complained that their heads were spinning as they were trying to understand the science and assumptions underlying the increasing number of proposals tabled for Annex I countries' emission reduction ranges."

"They all seem to use different base years and assumptions…: how can we make any sense of them?"

http://www.iisd.ca/vol12/enb12403e.html

Current Confirmed Proposals

Country	2020	2050	Other
Australia	5% below 2000	60% below 2000	20% renewable energy by 2020
Brazil	36% below business-as-usual		Amazon deforestation 70% below 2009 by 2017
China	Carbon intensity 45% below 2005		Increase forest coverage 40M Ha by 2020
EU	20% below 1990	80% below 1990	
Russia	20% below 1990	50% below 1990	
US	17% below 2005		

and so on ...

Compiled by Climate Interactive, Feb. 2 2010 release, http://climateinteractive.org/scoreboard/scoreboard-science-and-data

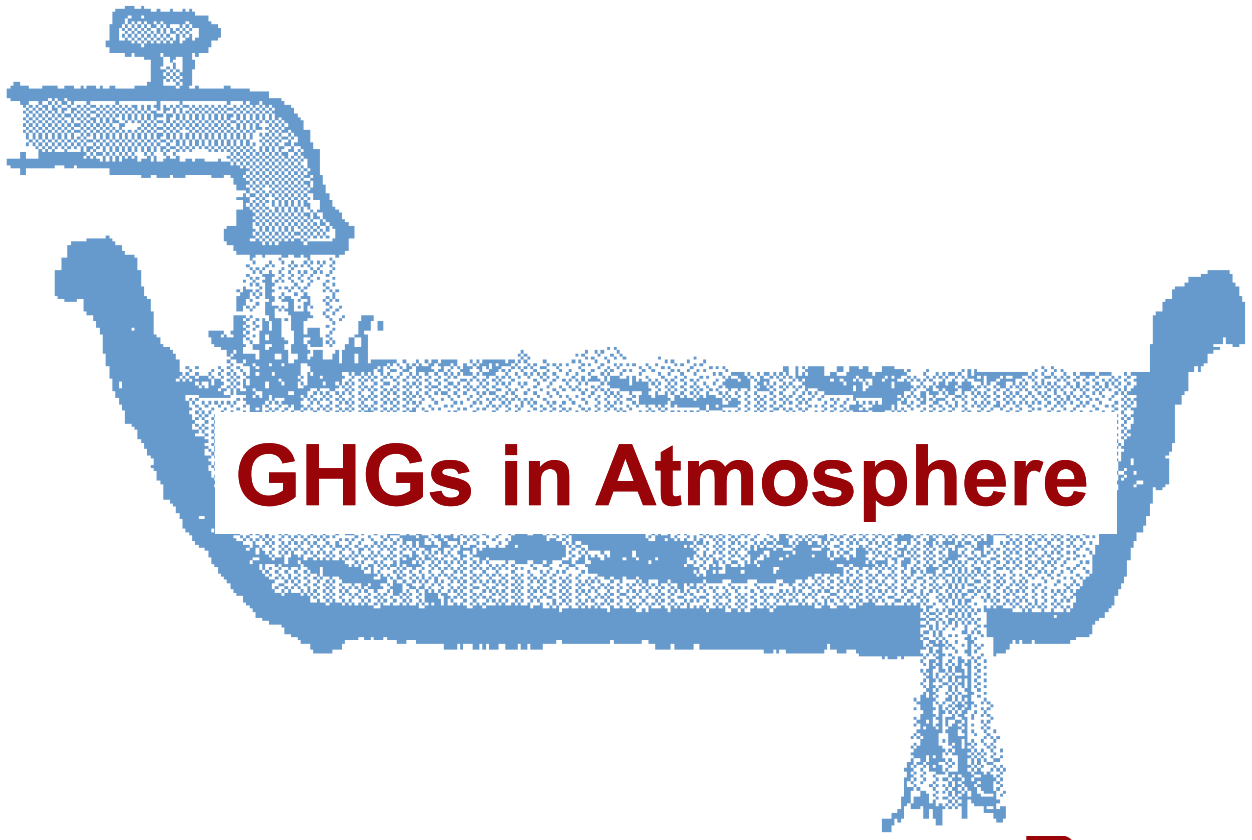
Policymaker Mental Models

"Currently, in the UNFCCC negotiation process, the concrete environmental consequences of the various positions are not clear to all of us.

There is a dangerous void of understanding of the short and long term impacts of the espoused …unwillingness to act on behalf of the Parties."

– Christiana Figueres, UNFCCC negotiator for Costa Rica (now UNFCC Secretary)

Atmospheric Greenhouse Gases (GHGs)



Courtesy of John Sterman, MIT

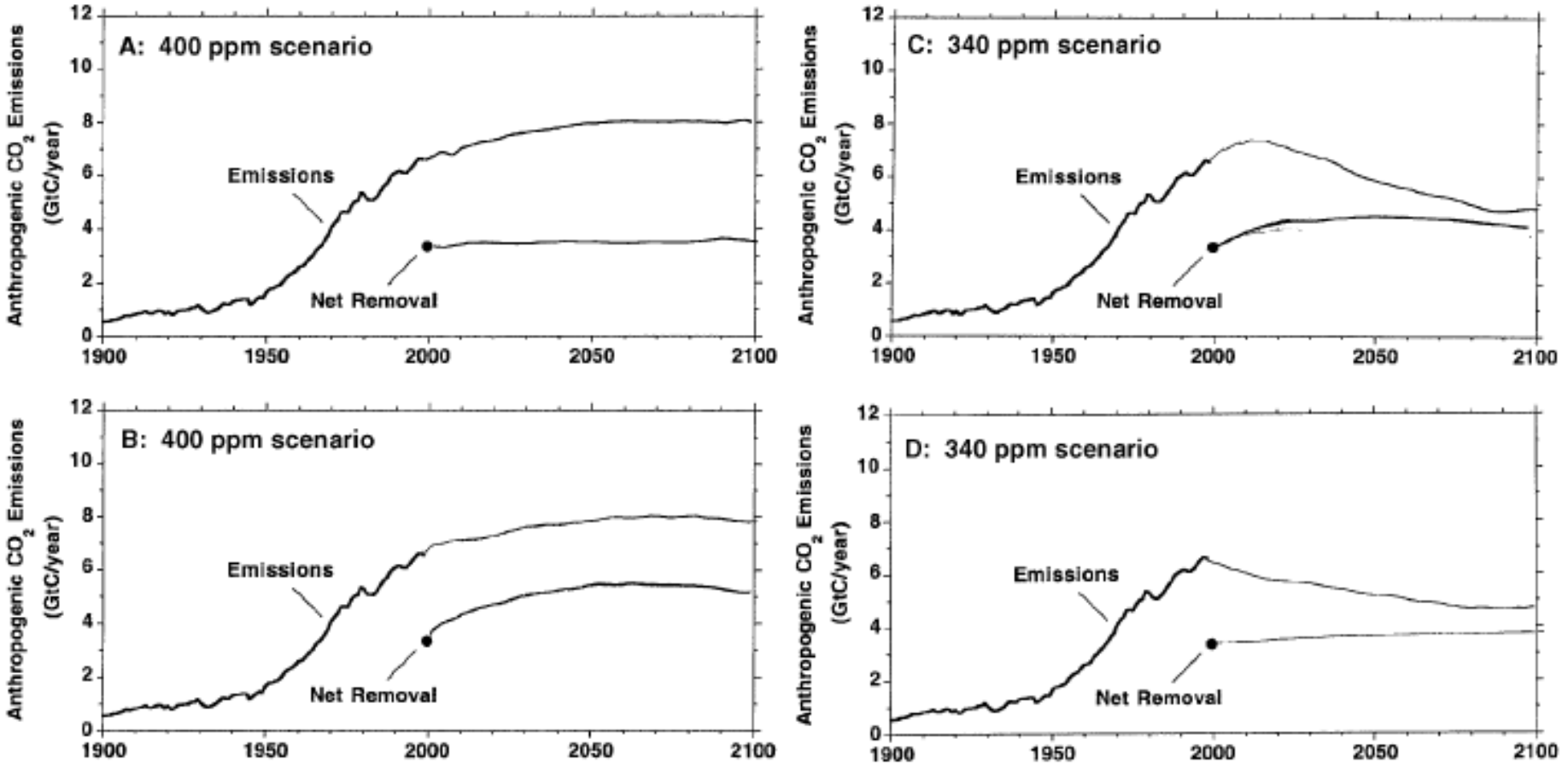
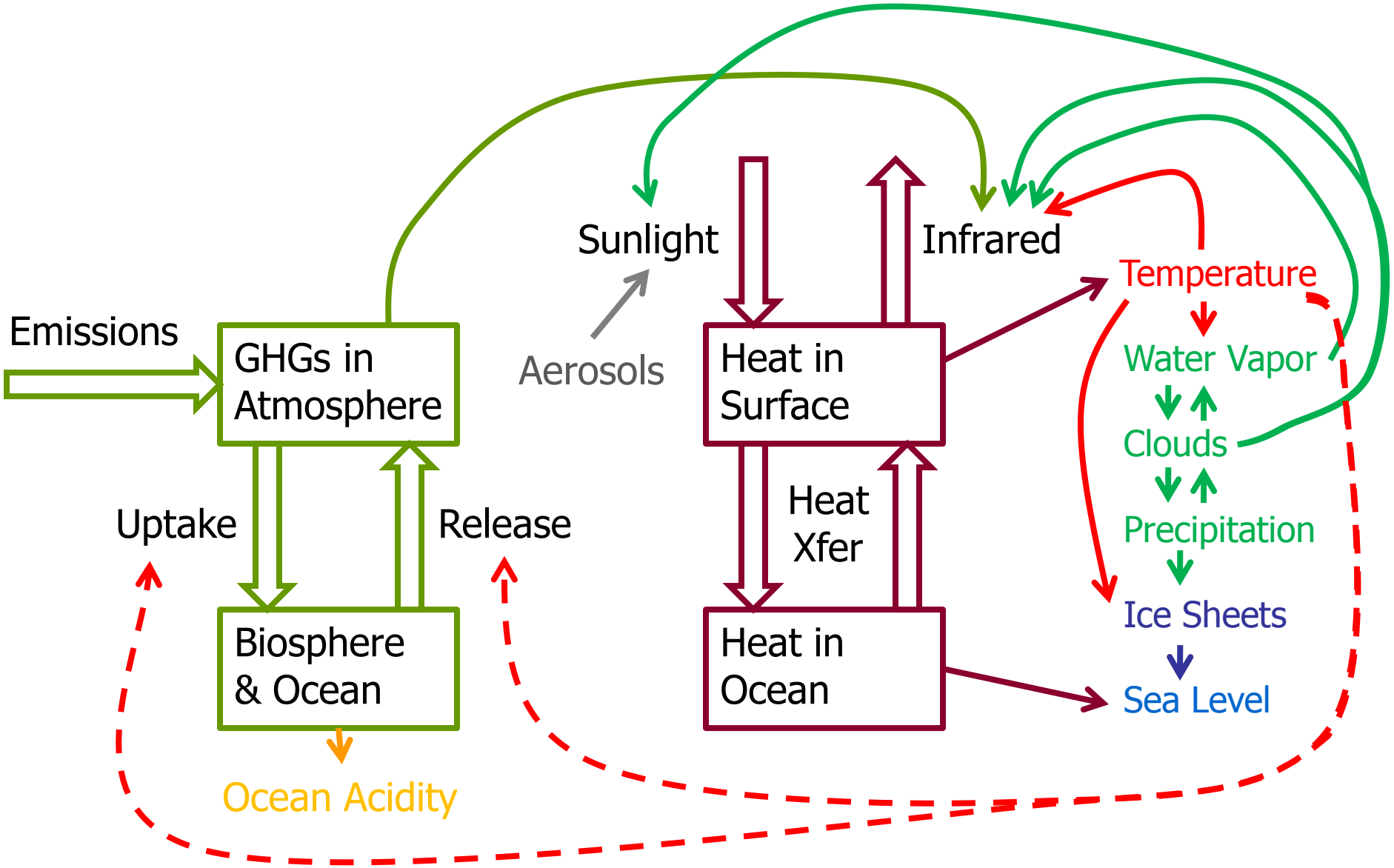
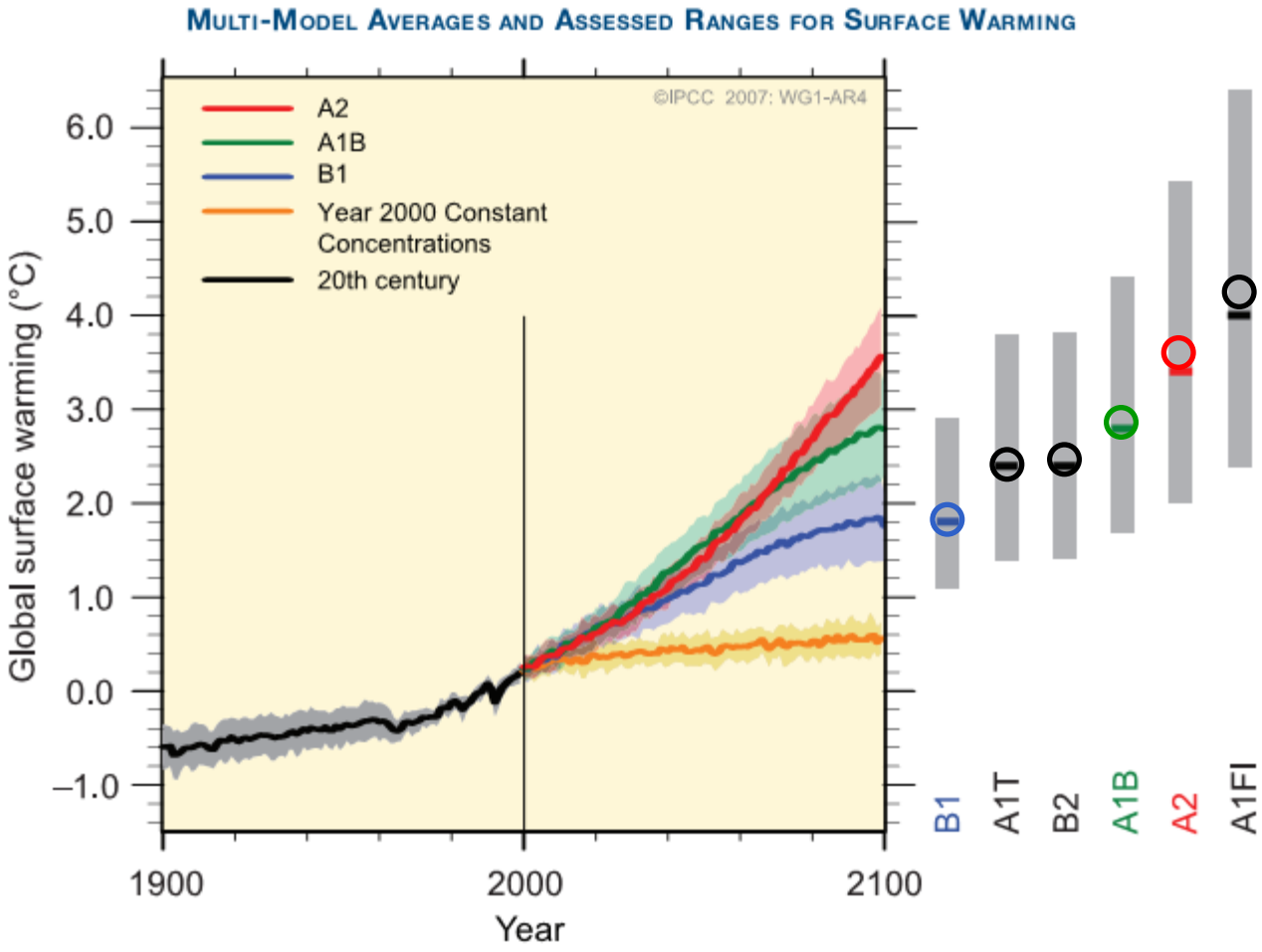


Fig. 2 Typical responses, illustrating pattern matching. (A, B): 400 ppm case. Note that both subjects select emissions $E \gg$ net removal R in 2100, though atmospheric CO_2 is unchanging by 2100, which requires $E = R$. (C, D): 340 ppm case. Note that the subjects select emissions paths such that $E > R$ throughout, though declining atmospheric CO_2 requires $E < R$. In all four cases subjects chose emissions paths that match the atmospheric CO_2 path in the scenario.



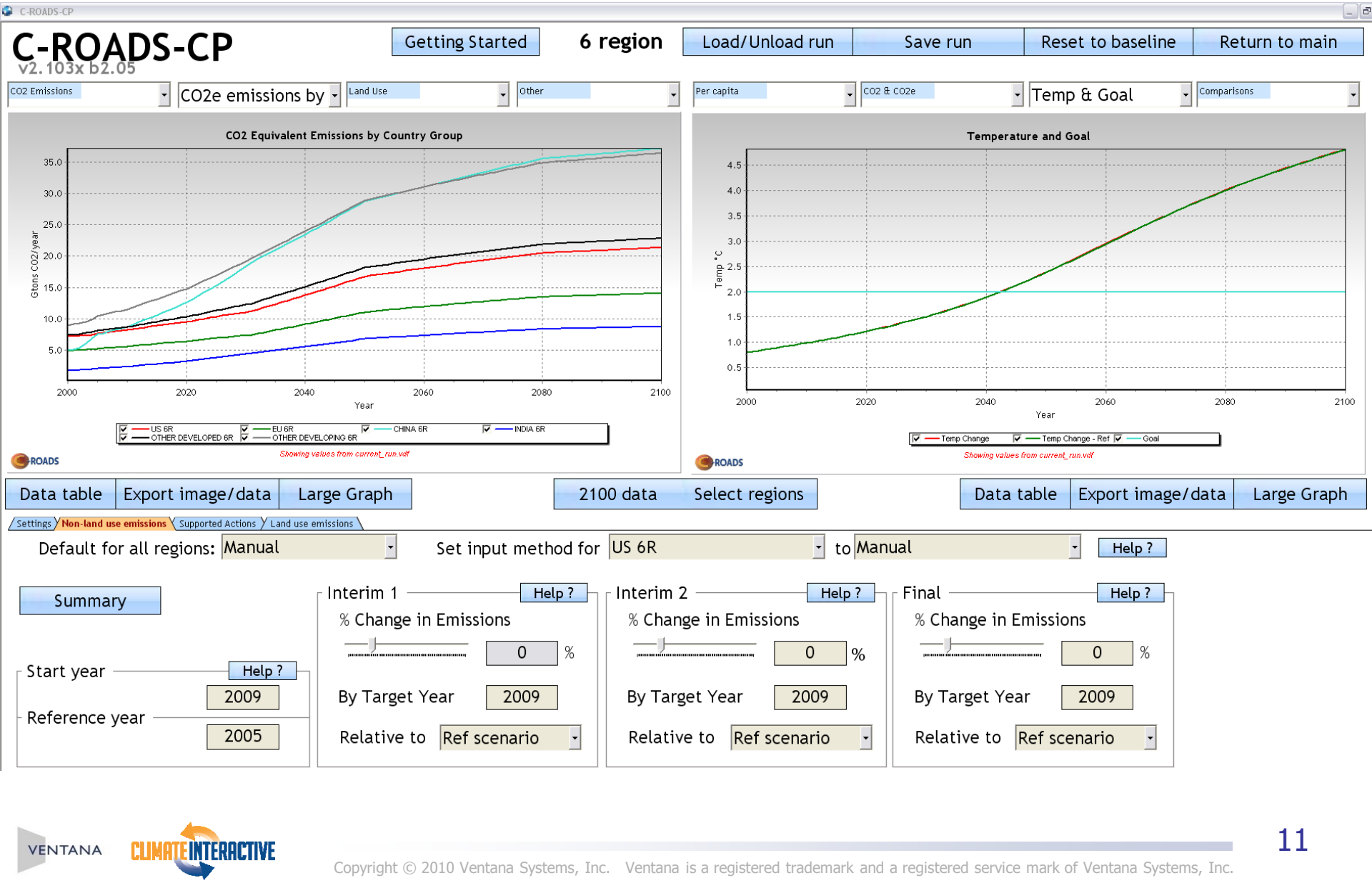
Complementing big models - Calibration to AR4 Scenarios



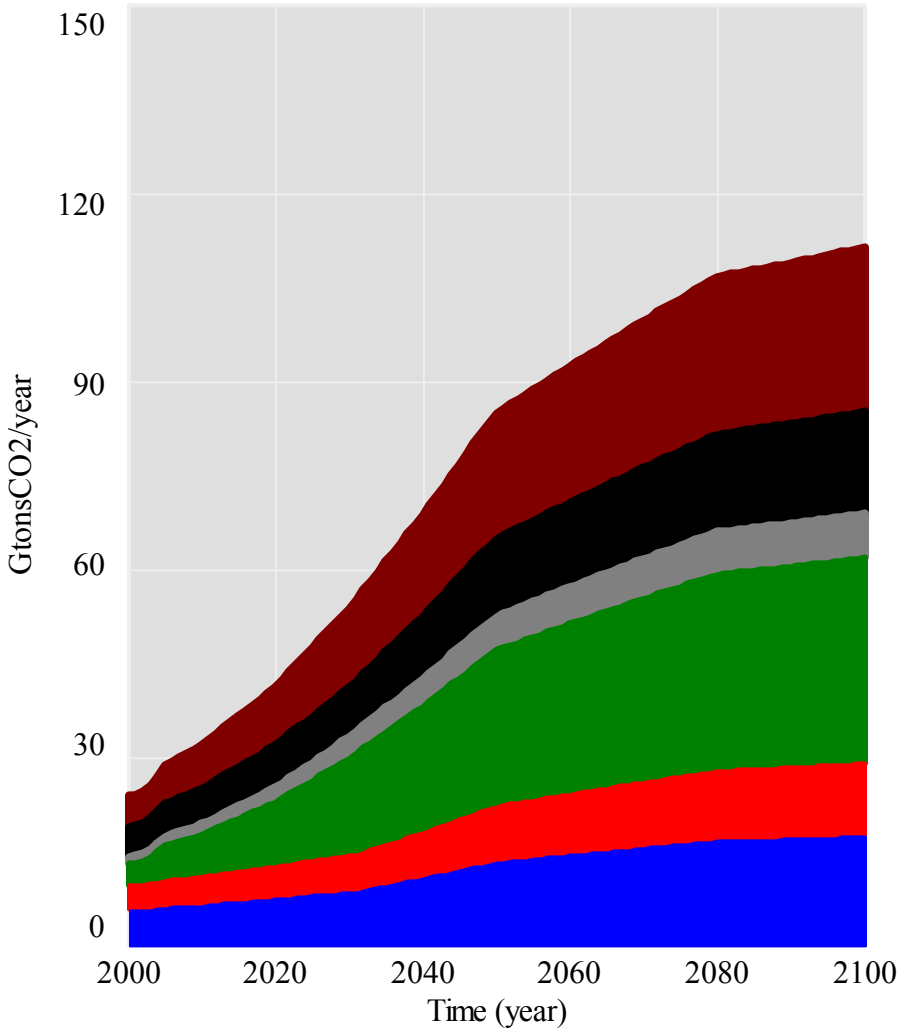
Similar Models

Model	Carbon Cycle	Climate	Notes
DICE (Nordhaus 1994)	1st order linear	2nd order linear (Schlesinger & Thompson 1982)	1st order versions don't conserve carbon; 3rd order version has problematic physical interpretation; linearity is unrealistic for high-emissions scenarios
DICE (Nordhaus 1999+)	3rd order linear		
Impulse response functions/convolutions (Various)	1st-5th order linear, characterizing response of larger model		Hard to explain in physical terms
Good Enough Tools (Socolow & Lam 2007)	1st-3rd order linear	NA	Calibrated to long-term response (beyond 2100); simpler versions don't conserve carbon
FAIR (den Elzen & Lucas 2005)	Image 2.2 biosphere, 2D ocean, MAGICC climate + alternative impulse response functions		Early versions run interactively, with interface
JCM (Matthews 2003)	Bern-HILDA carbon cycle, Wigley/Raper UDEP climate, regional impacts		Runs interactively, rich but complex interface
MAGICC/SCENGEN (Wigley 2005)	Intermediate complexity GHG cycles and climate; regional downscaling		Not real time; limited interface

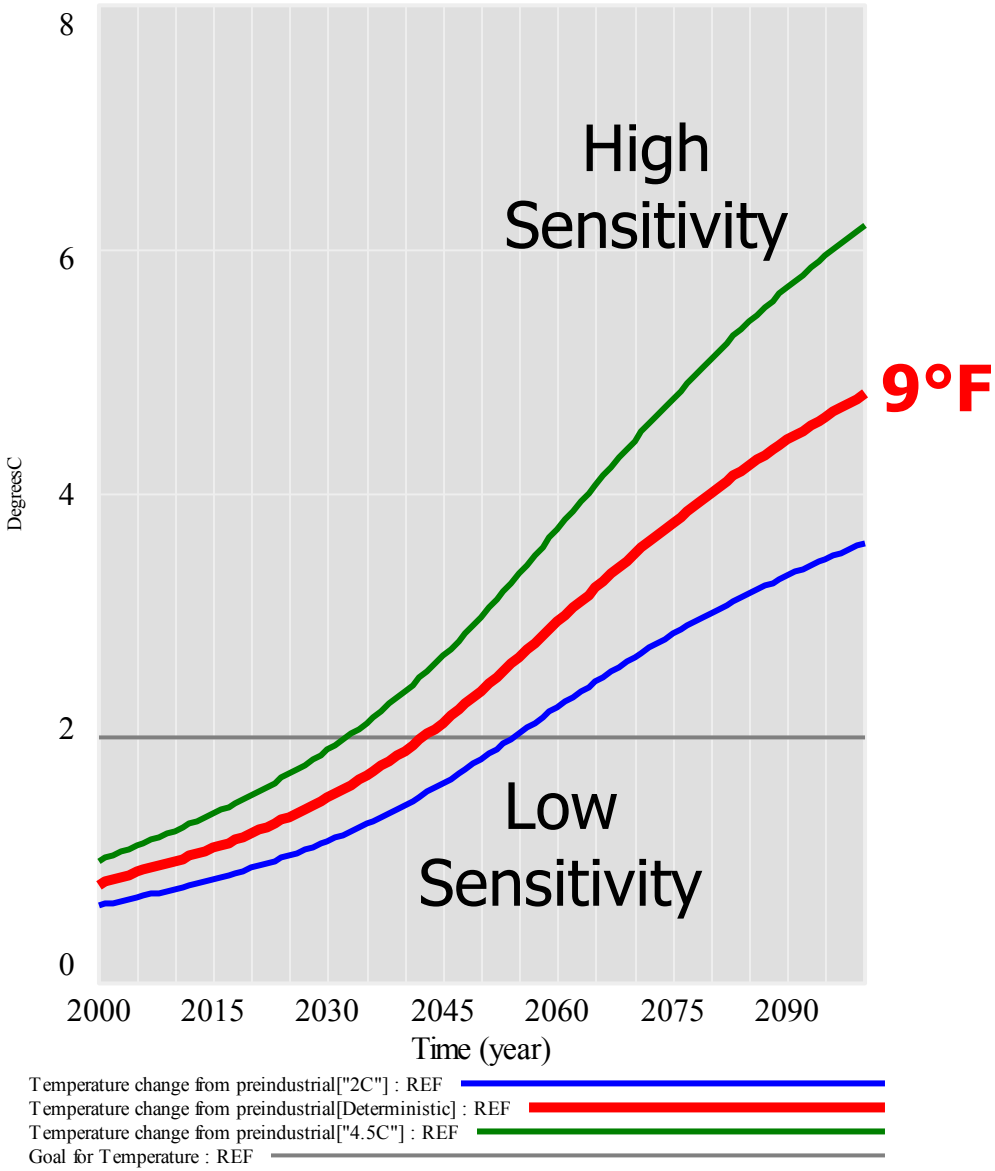
Desktop Interface



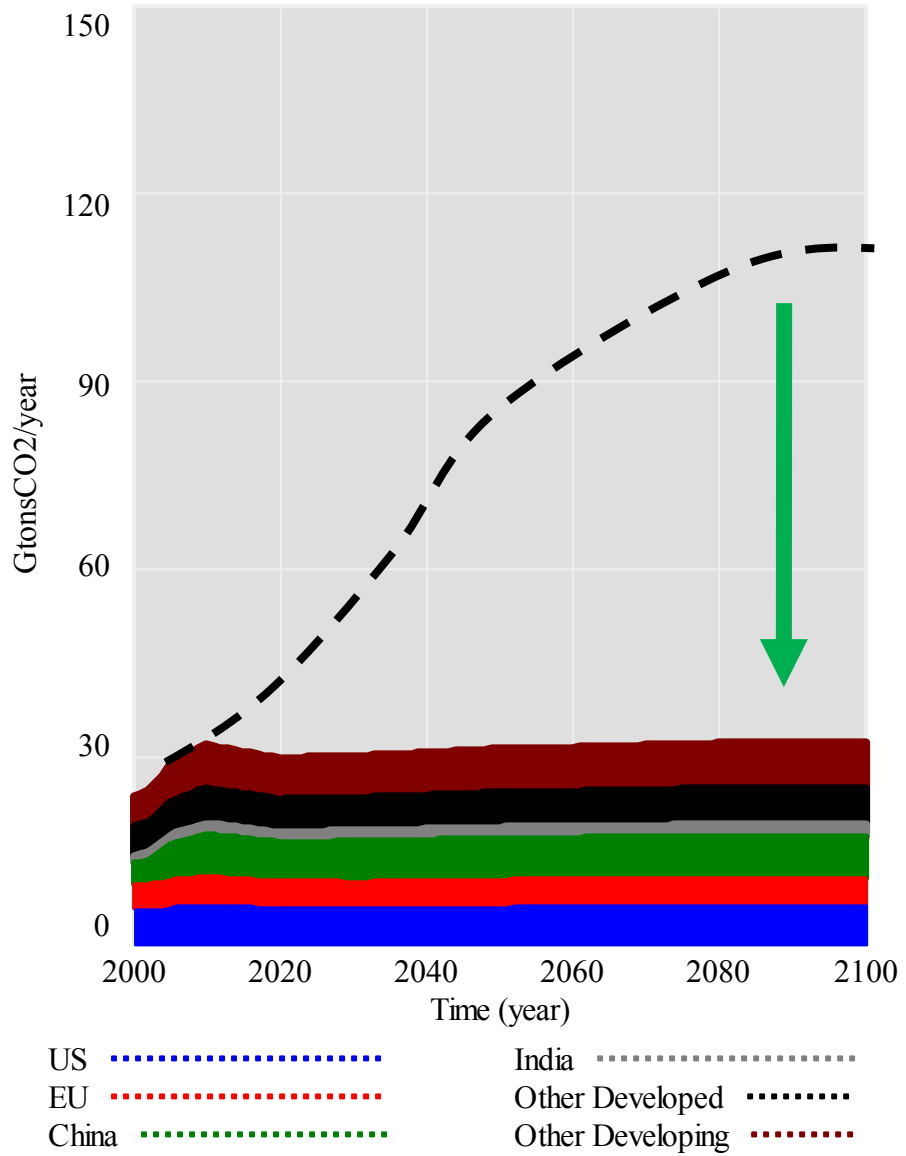
Emissions – Business as Usual



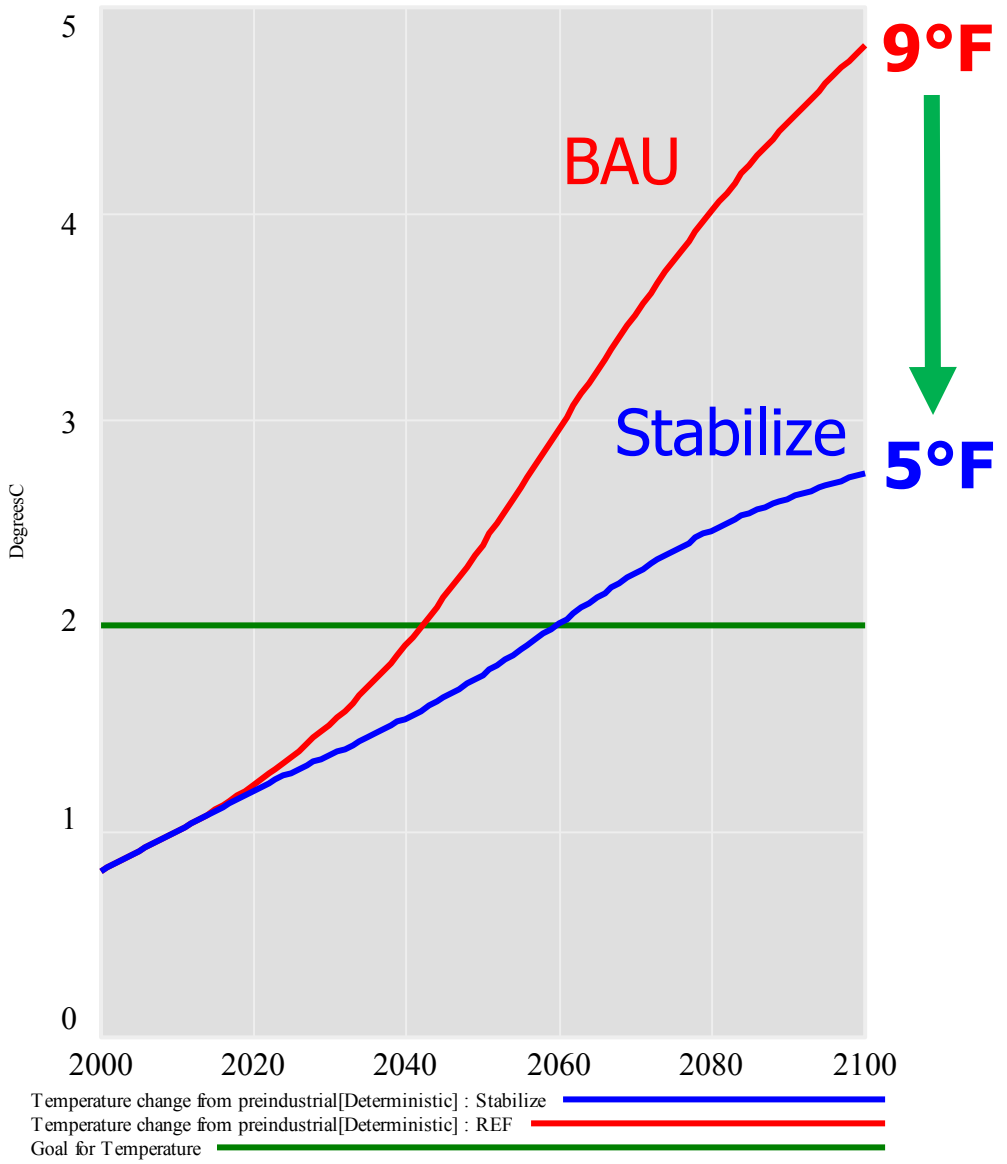
Temperature



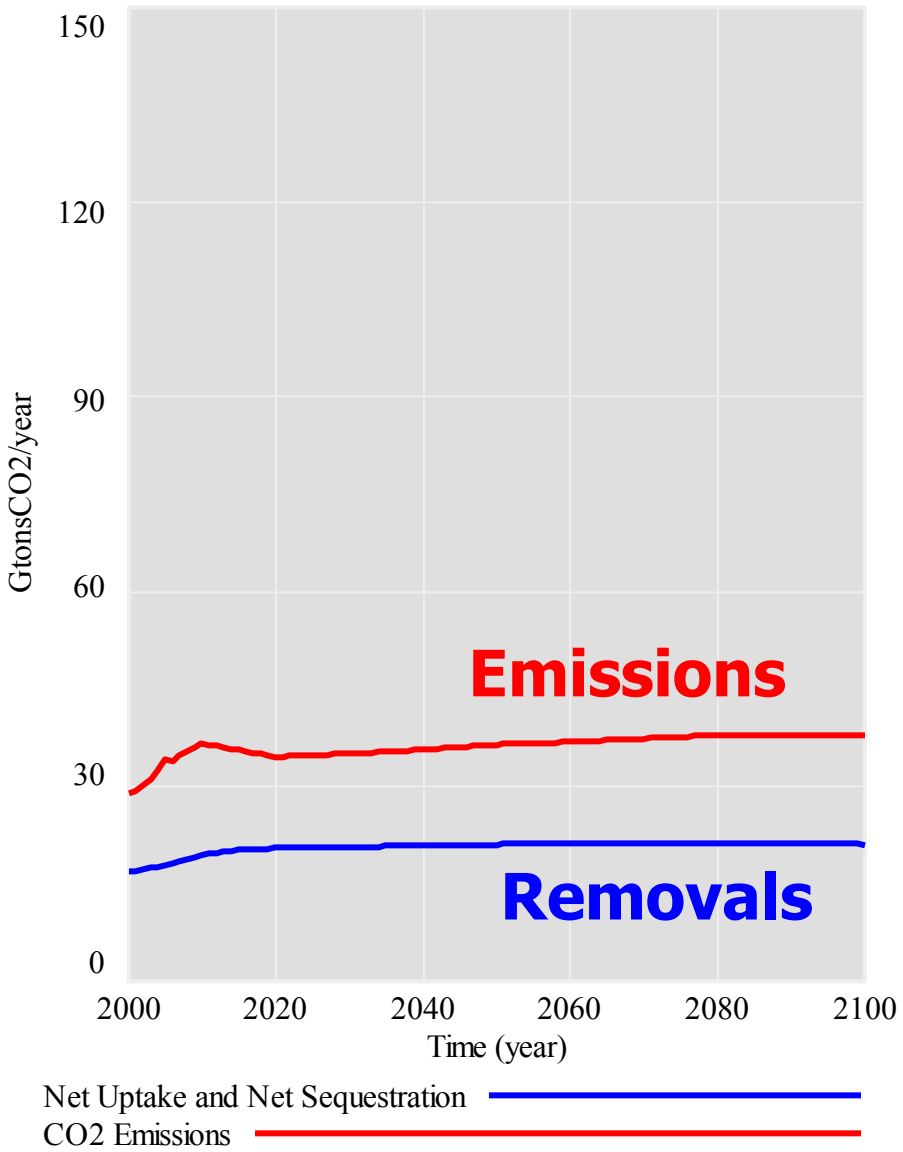
Emissions – Stabilized



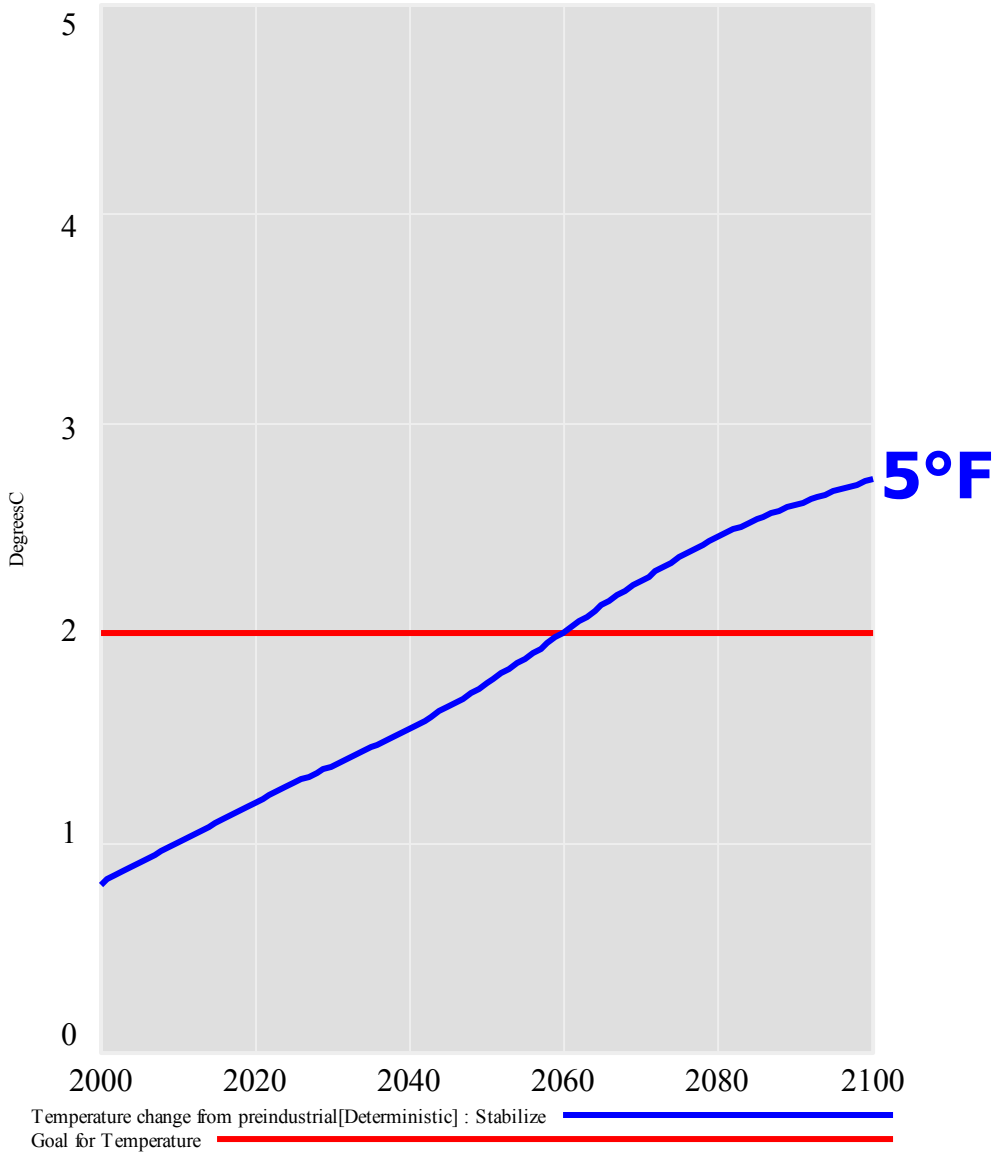
Temperature



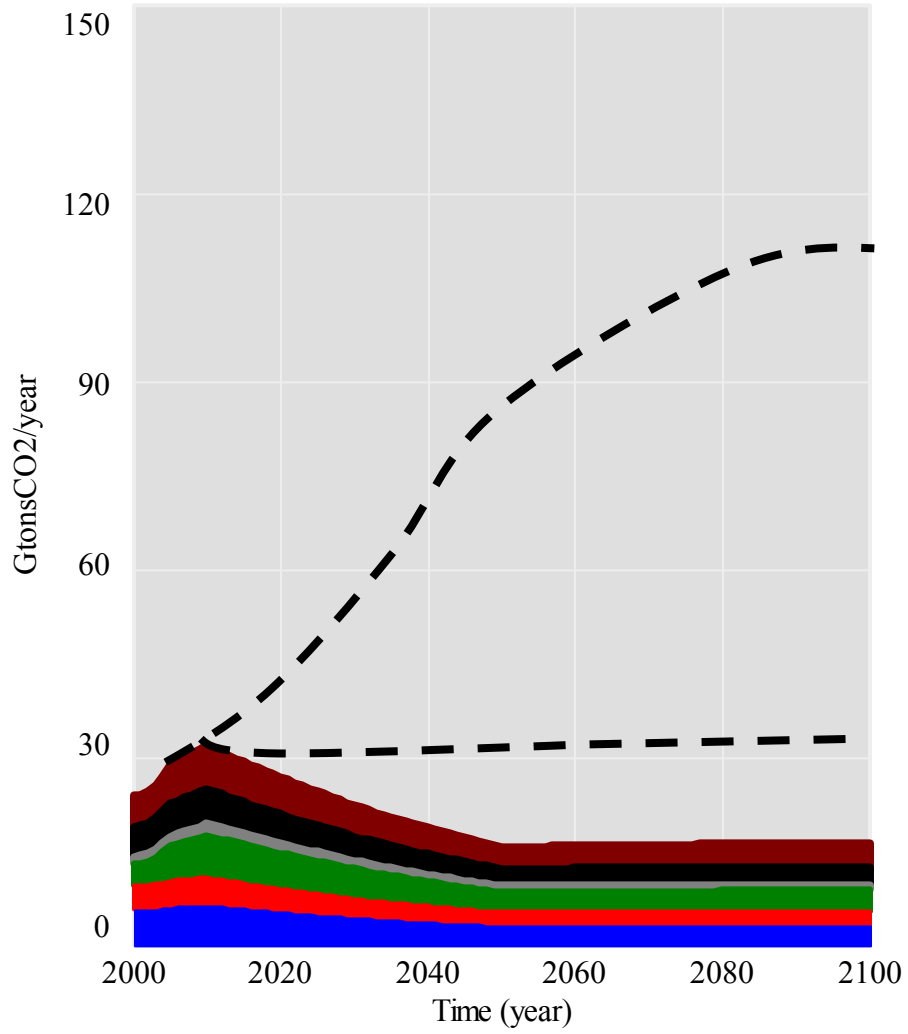
Emissions & Removals



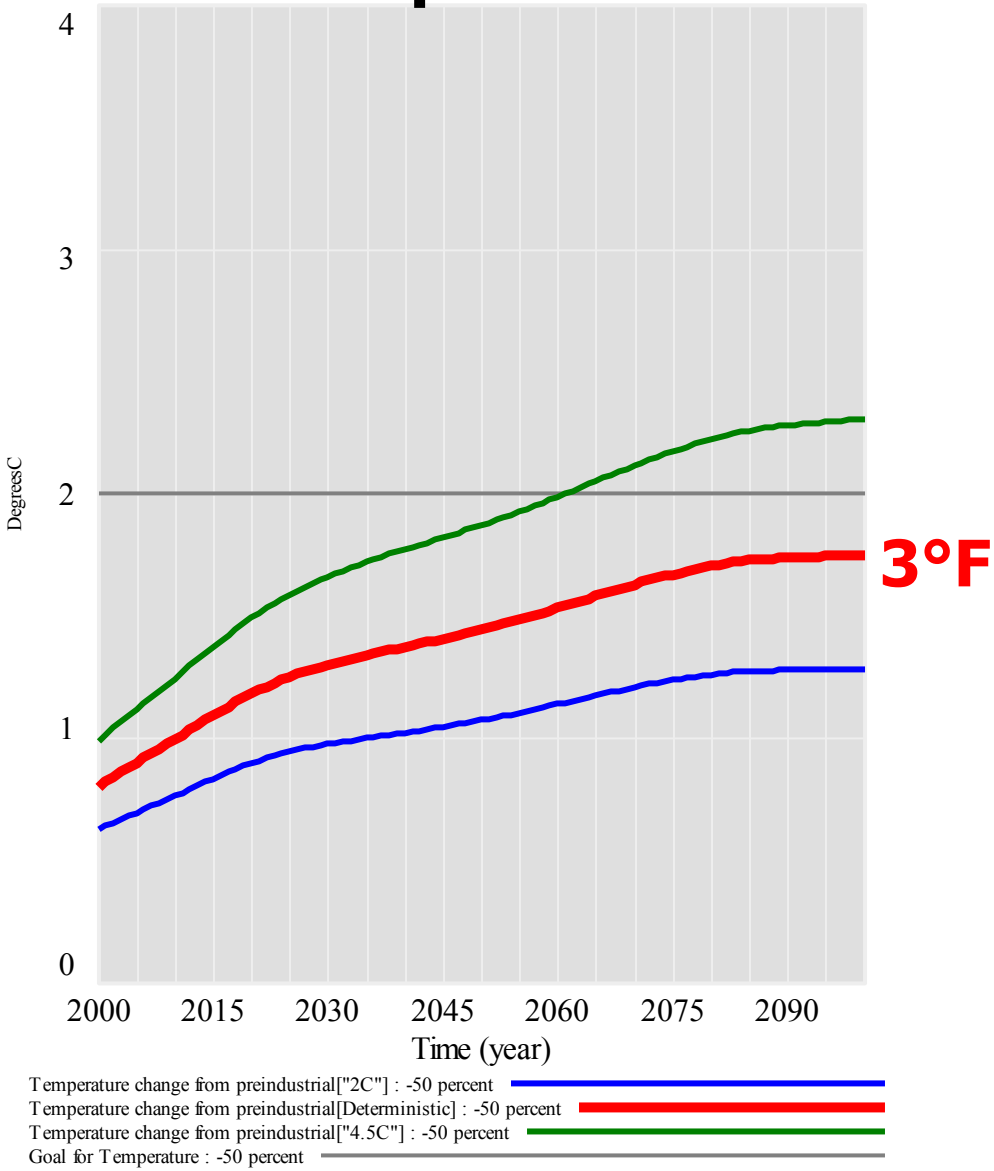
Temperature



Emissions – Cut 50%

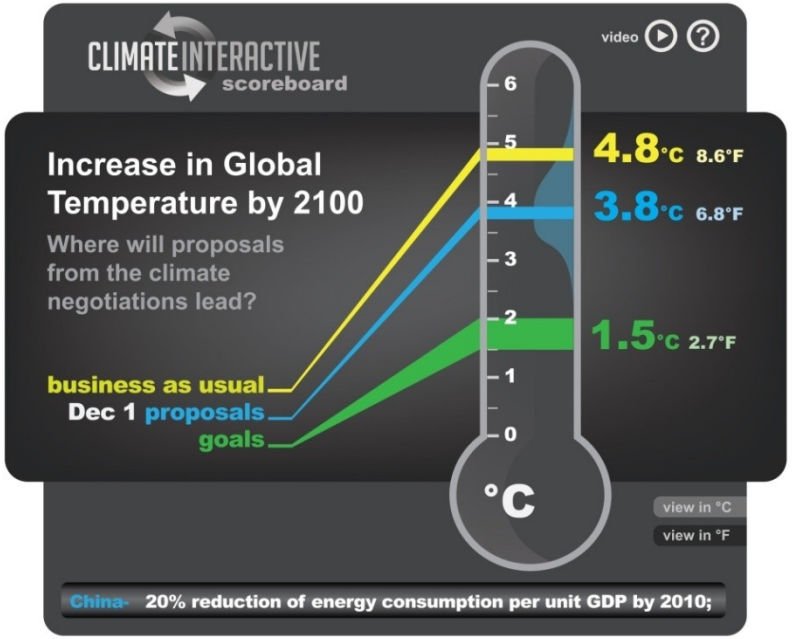


Temperature



C-ROADS at COP-15

- **President briefed by Science Advisor**
- **Scoreboard widget went viral**
- **Joint real-time analysis releases picked up by media, negotiators**
- **US State Dept used as common platform, picked up by other delegations**



"This capability, had it been available to me when we negotiated Kyoto, would have yielded a different outcome."

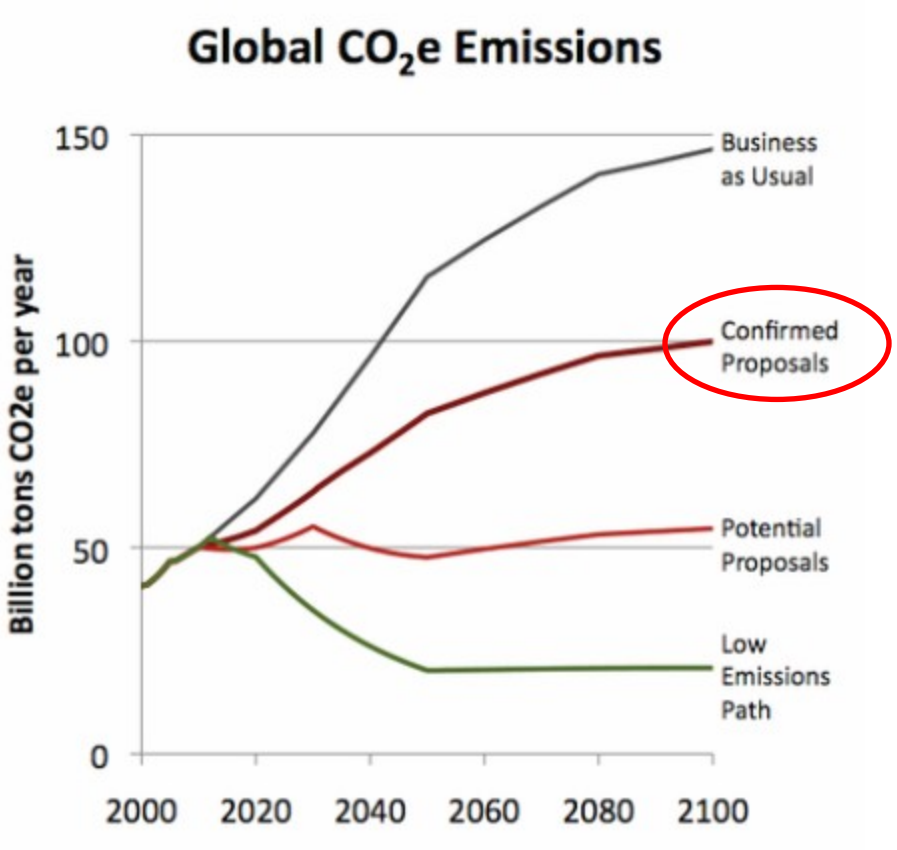
Tim Wirth, President, UN Foundation, former Senator

The world wasn't ready

- **Negotiators didn't have the mandate to achieve a meaningful agreement**

Result: as of recently,

+7 degrees F in 2100



Related Activities

- **C-ROADS**
  - Talks – TEDx, …
  - Science museums
  - World Climate Exercise
  - Ongoing assessment of current proposals
- **Provincial emissions in China**
- **MIT Climate Collaboratorium**

Reflections & Questions

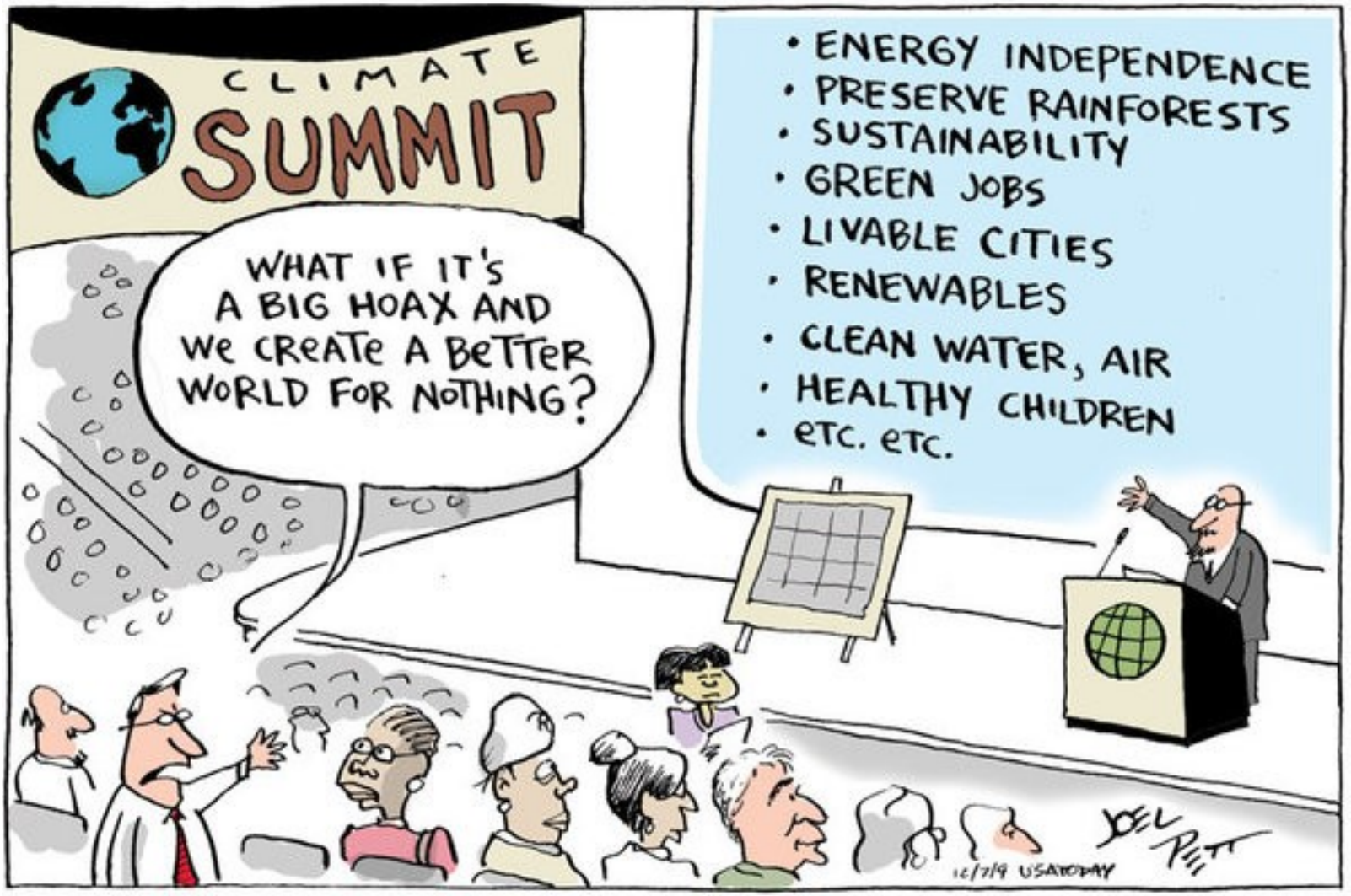
Strategies that worked for us

- **Focus on user needs**
- **Serving untapped audiences**
- **Sharing through intermediaries**
- **Iterative rollout (learning along the way)**
- **Simplicity and transparency**
- **Open source**
- **Aggressive promotion**
- **Broad partnership (nonprofits, foundations, scientists, businesses)**

Clients & Approaches

	Channel	Mode of use	Tool	Theory of change
Negotiators	Direct	Interactive	Desktop software	
Public	Web developers	Server software	Web widgets, code	
	Media		Press release	
	Science museums	Interactive exhibits	Code, response surfaces	
	Direct	Online models	Web software	
CEOs, thought leaders	NGO workshops	Simulation games	World Climate Exercise	

Articulating a Positive Vision



The generic challenge: help people to manage complex systems

- **Evaluate specific decisions**
  - Connect actions to outcomes
  - Formalize the "physics" of the world, so politics can focus on questions of values and distribution
- **Promote sound decision making principles**
  - Economic, dynamic, statistical, logical, **...**
- **Improve mental models**
- **Facilitate good process**

Where is the decision maker appetite?

- **Impacts**
- **Assessment of sectoral activities and policies**
  - how many wind turbines, nuclear plants, ... needed to achieve xxx?
  - does a 2020 "low hanging fruit" pathway facilitate 2050 transformation?
- **Assessment of actual instruments**
  - linked fee in APA, strategic reserve in ACES (control systems designed by lawyers)
  - LCFS (predominant tools are open loop)
  - quick turnaround is important
- **Tools for developing countries**

What mental models could IAMs improve?

- **Concrete topics**
  - Capital turnover constraints
  - Market-mediated indirect effects (e.g., leakage)
  - Green jobs
  - Technology
  - …
- **General principles**
  - Timing of action
  - Response to uncertainty
  - Enabling tradeoffs
  - Decentralizing decisions
  - …

Working as a community

- Open source
- Attract funding for deep analysis by making results more valuable
- Tool guidance (model web portal)
  - Ready links to metadata, interpretation, papers
  - Social networks among users, modelers, funders
- Provide pathways from simple to complex models (gateway drug)
- Sharing through metamodeling

Some challenges of pervasive, open modeling

- **How do we make results relevant for people who don't like graphs?**
- **How can we promote appropriate use?**
  - Promote intelligent experimentation and combination of tools and results?
  - Convey the limits of model validity?
    - Aggregation
    - Uncertainty
    - 1st best representations of 2nd best phenomena
  - Avoid emergence of propaganda and errors?
  - Translate economic and scientific jargon?
- **How can we make big models transparent?**

www.climateinteractive.org

C-ROADS Development Team

- **Tom Fiddaman, Ventana Systems**
- **Travis Franck, Tufts University**
- **Andrew Jones, Sustainability Institute**
- **Stephanie McCauley, Sustainability Institute**
- **Phil Rice, Sustainability Institute**
- **Beth Sawin, Sustainability Institute**
- **Lori Siegel, Sustainability Institute**
- **John Sterman, MIT Sloan School of Management**

With key partners such as Bob Corell and the Climate Action Initiative

CAI
CLIMATE ACTION INITIATIVE

Sustainability Institute

MITSloan
MANAGEMENT

VENTANA
systems, inc.

The Climate Collaboratorium:

Harnessing Collective Intelligence to Address Global Climate Change

http://climatecollaboratorium.org

Thomas W. Malone

MIT

Collaborators

- **Robert Laubacher**
- **Josh Introne**
- **Mark Klein**
- **Hal Abelson**
- **John Sterman**
- **Gary Olson (UC Irvine)**

Philosophy & Approach

- **Collective intelligence technologies have the potential to**
  - Help educate the public about the real issues in climate change
  - Help vastly more people be constructively involved in developing climate change policies
  - Help us, as a species, make wiser choices about climate change
- **Combine three forms of collective intelligence infrastructure:**
  - Collaborative simulation modeling
  - On-line debates
  - Collective decision-making
- **Honest broker not advocacy**
  - Wikipedia-like "neutral point of view"

Collaborative simulation modeling

- **Users can run simulation models with their own choice of parameters.**
- **These simulation runs can be saved, shared, and discussed.**
  - Soon, users will be able to contribute new models, too.
- **The simulation runs are parts of *plans* for dealing with global climate change.**
  - Plans also include various other information such as why the simulation parameters are plausible and the results desirable.
- **Non-interactive models are made accessible via response surfaces**

Integration of Simulation, Debates & Collective Decision Making

- **On-line debates for key issues that underlie the plans**
- **Each plan can specify the positions it takes on these debates**
- **Users can vote for:**
  - Plans (including simulation runs) they prefer
  - Positions (in debates) with which they agree

Climate Collaboratorium

Harnessing the world's intelligence to save the planet

New User? Register here

log in | about | help | feedback

Home | Plans | Models | Debates | Community | Resources

What plan should be adopted at the UN climate talks?

Finalized Plans (For Voting) | *Plans under development*

What are plans?

Create a New Plan

Select Columns | Filter Plans | Enable filter

Name	Votes ▼	Date published	CO2 Concentration (ppm in 2100)	Temperature Change (°C in 2100)	Mitigation cost (%GDP in 2100)	Damage cost (%GDP in 2100)	*Vote for Plan*
350 ppm or bust	42%	11/16/09	356	2.0	1.4% to 16.0%	0.2% to 1.6%	
IEA 450 ppm scenario	31%	11/23/09	480	2.8	1.1% to 11.6%	0.3% to 3.4%	
Drew Jones TED plan	7%	11/23/09	396	2.3	1.4% to 16.0%	0.2% to 2.2%	
Business as Usual	6%	11/23/09	951	4.6	-0.1% to 0.0%	0.9% to 10.4%	

Model Index

What are models?

Name	Description
MIT Composite model	The MIT Composite Model incorporates all the other models included in the launch version of the Collaboratorium. Its foundation is **C-LEARN**; all the other models rely on outputs from C-LEARN as their inputs. The other models provide additional projections on the economic and physical impacts of climate change.
C-LEARN	**C-LEARN** is a simplified, Web-accessible version of the Climate Rapid Overview and Decision Support (**C-ROADS**), a lightweight climate simulator developed by the **Sustainability Institute**, **Ventana Systems**, and the **System Dynamics Group** at the **MIT Sloan School of Management**, as part of the **Climate Interactive** effort.
C-LEARN sea level	C-LEARN includes a module that projects the rise in sea level that will result from increases in global temperature. For computational reasons, this module is implemented as a separate model in the Collaboratorium, using identical equations.
IGSM	Estimates of the **mitigation costs** associated with varying levels of emission reductions are generated through use of a **response surface** derived from runs of **MIT's Integrated Global System Model (IGSM)**.
MERGE	Estimates of the **mitigation costs** associated with varying levels of emission reductions are generated through use of a **MERGE**, a model developed by the **Electronic Power Research Institute (EPRI)** and **Stanford University**.
MiniCAM	Estimates of the **mitigation costs** associated with varying levels of emission reductions are generated through use of a **MiniCAM**, a model developed by the **Pacific Northwest National Laboratory** and the **University of Maryland**.
DICE	DICE is an integrated assessment model. The Collaboratorium uses a **response surface** based on the damage function in DICE, which estimates the costs of damages caused by varying increases in global mean temperature (GMT), which estimates the costs of future damages caused by varying increases in global mean temperature (GMT).
PAGE	PAGE is an integrated assessment model. The Collaboratorium uses a **response surface** based on PAGE?s damage function, which estimates the costs of future damages caused by varying increases in global mean temperature (GMT).
IPCC AR4	The Intergovernmental Panel on Climate Change (IPCC) issued its Fourth Assessment Report (AR4) in 2007. The **Technical Summary** of the report prepared by IPCC Working Group II summarizes the projected physical impacts of climate change.
Tyndall Center	During the preparation of the Stern Review, the Tyndall Centre for Climate Change Research was charged with undertaking a study that projected the physical impacts of rising global temperatures.

How can the burden of climate change mitigation be shared equitably?

Position		Votes (11)	Vote
Rich countries should lead the way	3	90 %	✓
Rich countries are responsible for the problem.	0		
Rich countries have technology and the means to disseminate it.	0		
This will cause others to follow suit	0		
This is fair in light of per capita emissions	0		
This lets developing countries focus on reducing poverty	0		
This is hard to sell politically	0		
The burden should be shared equally among rich and poor countries.	0	9 %	✓
This is easier to sell politically	1		
Economic growth will suffer	0		
Developing countries won't agree to this	0		

Position

Rich countries should lead the way

Edit | Remove

Vote for this position

Developed countries should cut emissions more and faster. And they should provide financial and technology transfers to help developing countries reduce emissions.

Comments

+show help

I think this is a reasonable and responsible approach. Remove

By jintrone on 1/23/10 12:26 AM

I also agree that the rich should lead the way because we are the ones that waste the most energy. Most of us pay little attention to our consumption. We can greatly reduce our contribution to climate change by just being aware and "trimming the fat" in our everyday lives. For instance, the next time you leave a room, turn the lights off. :grin: Remove

By kat-a.-donnelly on 1/27/10 7:09 AM

i totally agree with you... Remove

By carolenina on 4/15/10 11:52 AM

Add your comment here:

Community design approach - Roles

- **Expert reviewers**
  - Expert advisory board
  - Expert council
- **Software developers**
  - Model developers
  - Opens source developers

- **Moderators**
- **Policy makers**

- **General public**
  - Climate junkies
  - Policy junkies
  - Students
  - Artists
  - …

Expert Advisory Board

- **John Christy (U Alabama)**
- **Henry Jacoby (MIT)**
- **Stephen Kosslyn (Harvard)**
- **James McCarthy (Harvard)**
- **Michael Prather (UC Irvine)**
- **Gavin Schmidt (NASA)**
- **Robert Socolow (Princeton)**
- **Susan Solomon (NOAA)**
- **Robert Watson (Univ. of East Anglia, UK)**

Expert Council

- Markus Amann
- Shoibal Chakravarty
- John Christy
- Martin Heimann
- Henry Jacoby
- Stephen Kosslyn
- James McCarthy
- William Moomaw
- Michael Prather
- Richard Richels
- Jayant Sathaye
- Gavin Schmidt
- Robert Socolow
- Susan Solomon
- Massimo Tavoni
- Robert Watson
- Mort Webster
- Tom Wigley
- Gary Yohe
- Charles Zender
- Kirsten Zickfield

Key observations from usage experience

- **With very little active promotion, a suitably designed website for solving the problems of global climate change can attract substantial interest from the general public and relevant experts around the world.**
- **Three previously unrelated technologies can be combined in a clean and surprisingly synergistic way to help create plans for dealing with global climate change:**
  - Computer simulation
  - On-line debates
  - Electronic voting
- **In many cases, developing a community of users for a site is at least as important as developing software for the site.**
- **Simply letting the public vote on which plans are most desirable is not a sufficient approach for finding feasible plans.**
- **The most popular plan ("350 ppm or bust") is--according to most experts--not feasible.**

Plans

- **Soon: annual multi-round contests for best plans**
  - Preliminary rounds – experts judge plans for feasibility and variety
  - Final round – public votes on which plans are most desirable
  - First contest planned for Sep – Nov 2010
- **Longer term research opportunities**
  - Combining multiple simulation models developed in different places
  - Reflecting uncertainties and risks in predictions
  - Sharing many different kinds of data for modeling
  - *Many* collaboration technology design issues
    - On-line deliberation, electronic voting, community design…
  - …