

The C-ROADS Simulator -- Climate Rapid Overview and Decision-Support

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the C-ROADS team

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C-ROADS Development Team

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- Dr. Phil Rice, Sustainability Institute
- Dr. Beth Sawin, Sustainability Institute
- Dr. Lori Siegel, Sustainability Institute
- Dr. John Sterman, MIT System Dynamics Group

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



Project Partners

Financial and In-kind Supporters



In-kind Supporters



C-ROADS Motivation: Difficulty Comparing Proposals and Estimating Aggregate Impact

- “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
- “...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?” commented one negotiator.”
 - Press Report
 - <http://www.iisd.ca/vol12/enb12403e.html>

The C-ROADS Simulator Is:

- A fast-running (runs in <1 second), highly aggregated, scientifically rigorous emissions/carbon-cycle/climate model designed for decision-makers and analysts
- In use by the US State Department's climate analytical team
- Flexible, allowing the user to control a variety of inputs
 - CO2 fossil fuel emissions for 2020, 2030, and 2050 by reference year or bau, deforestation and afforestation rates, other gasses, and scientific uncertainties
 - By interface or xls spreadsheet
- and view a range of outputs
 - World fossil fuel CO2 emissions, atmospheric CO2 levels, temperature, sea level, per capita emissions, cumulative emissions, and more
- For 6 or 17 global negotiating blocs
- Running easily on a laptop
- Designed to allow users to create their own confidential output in a variety of forms (graphical, xls files)
- Scientifically reviewed, grounded in and consistent with accepted climate science. Emerging from team out of MIT.
- Intended to be shared with all parties (US, EU and China so far)
- Open-box: equations and assumptions shared transparently

US State Dept. Deputy Special Envoy J. Pershing Presented C-ROADS in his Plenary to the UN in Bonn

UNFCCC Webcast
Bonn Climate Change Talks - March 2009
Seventh session of the AWG-KP and fifth session of the AWG-LCA

OnDemand Webcast

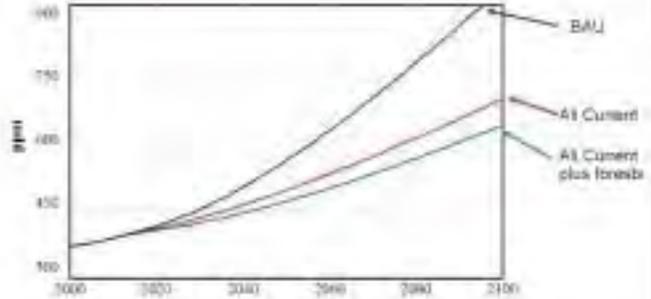
Plenary



Mr. Jonathan Pershing
United States of America

Organizer: UNFCCC
Type: Plenary
Date: 01 April 2009
Time: 10:00 CEST
Location: Saal Maritim

CO₂ in Atmosphere Would Continue to Increase



Year	BAU (ppm)	All Current (ppm)	All Current plus forests (ppm)
2000	370	370	370
2020	410	400	390
2040	470	440	420
2060	550	480	450
2080	650	530	480
2100	750	580	510

Source: Testimony of Dr. Robert Corell, Heinz Center for Science, Economics, and the Environment and Dr. John Sterman, Director of MIT System Dynamics Group

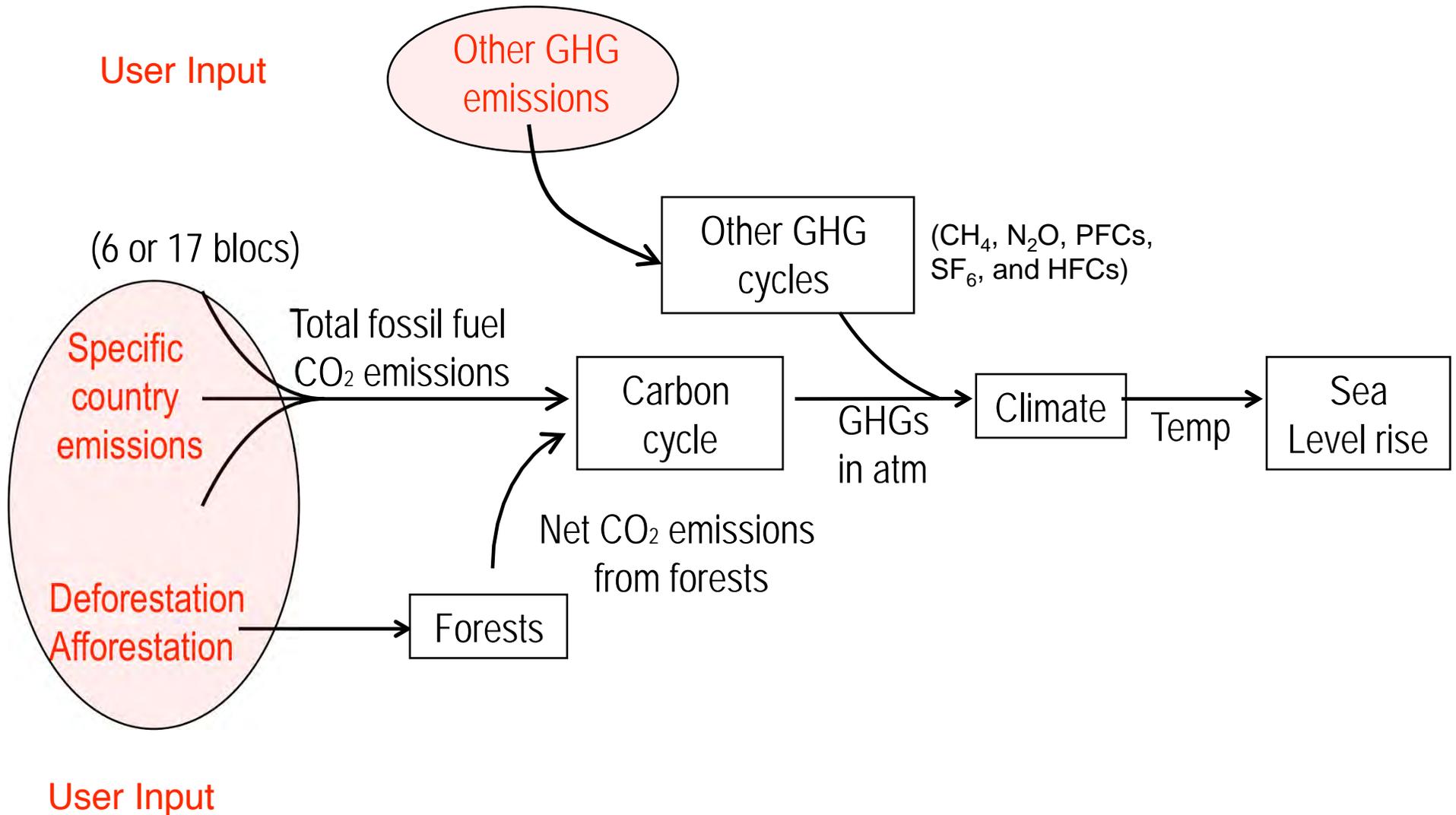
Slide 6 of 7

- “The message from [the simulation] to me is fairly clear. There is clearly a need to do more. We need to think about the financing component, we need to think about the opportunities, we need to think about taking additional actions. That’s now the effort to be followed.”

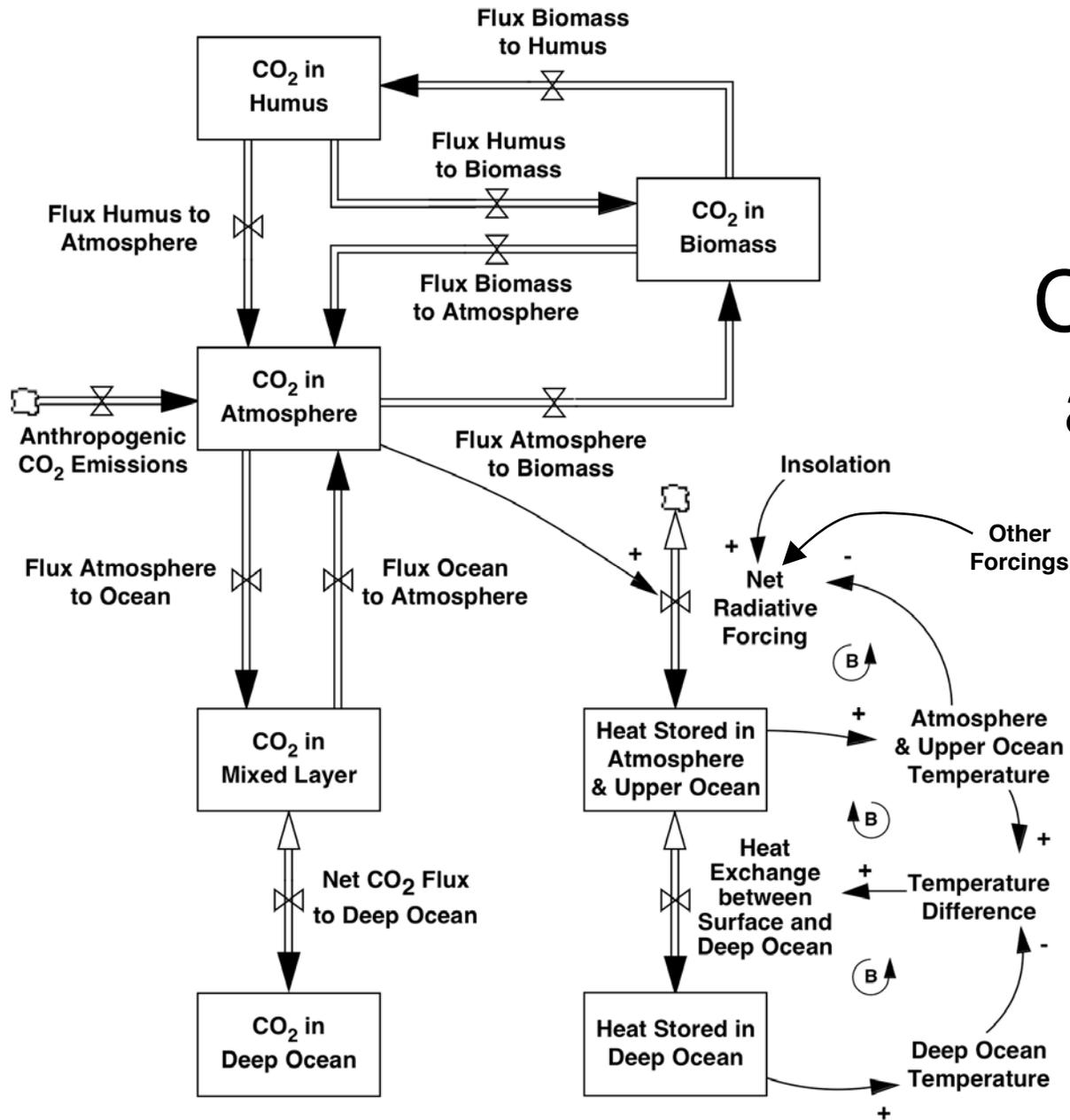
Quotes

- [Speaking of C-ROADS]: “This capability, had it been available to me when we negotiated Kyoto, would have yielded a different outcome.”
 - **Tim Wirth**, President, UN Foundation, and former U.S. Senator
- "With C-ROADS, we can adjust policy assumptions in real-time, through an intuitive interface. This makes it much easier to assess the environmental integrity of various proposed emissions targets and to discuss how complementary emissions targets might achieve a climate goal, or to evaluate how changes in an emissions targets might affect global temperature through the 21st century.”
 - **Analyst**, Office of Global Change, U.S. Department of State
- “To stay on track, fast-running climate models, like C-ROADS, help negotiators to control a variety of critical in-puts (CO2 levels, targets, emissions rates, deforestation etc) and immediately view a range of out-puts (temperature rise, world CO2 emissions, per capita emissions etc). This will show them how far or close they are getting to keeping within a 2 DegC rise. This will produce an immediate and sobering feedback to negotiators.”
 - **Christine Loh**, former legislator, Hong Kong
- For the first time, with C-ROADS, we have a way to capture on the spot the implications of the key decisions that will be made around the follow-up to Kyoto with sobering and powerful results.
 - **Prof. Jacqueline McGlade**, Executive Director, European Environment Agency, Denmark

C-ROADS Model Structure



C-ROADS Simulates a Carbon Cycle and Climate Sector



C-ROADS Scientific Review Panel

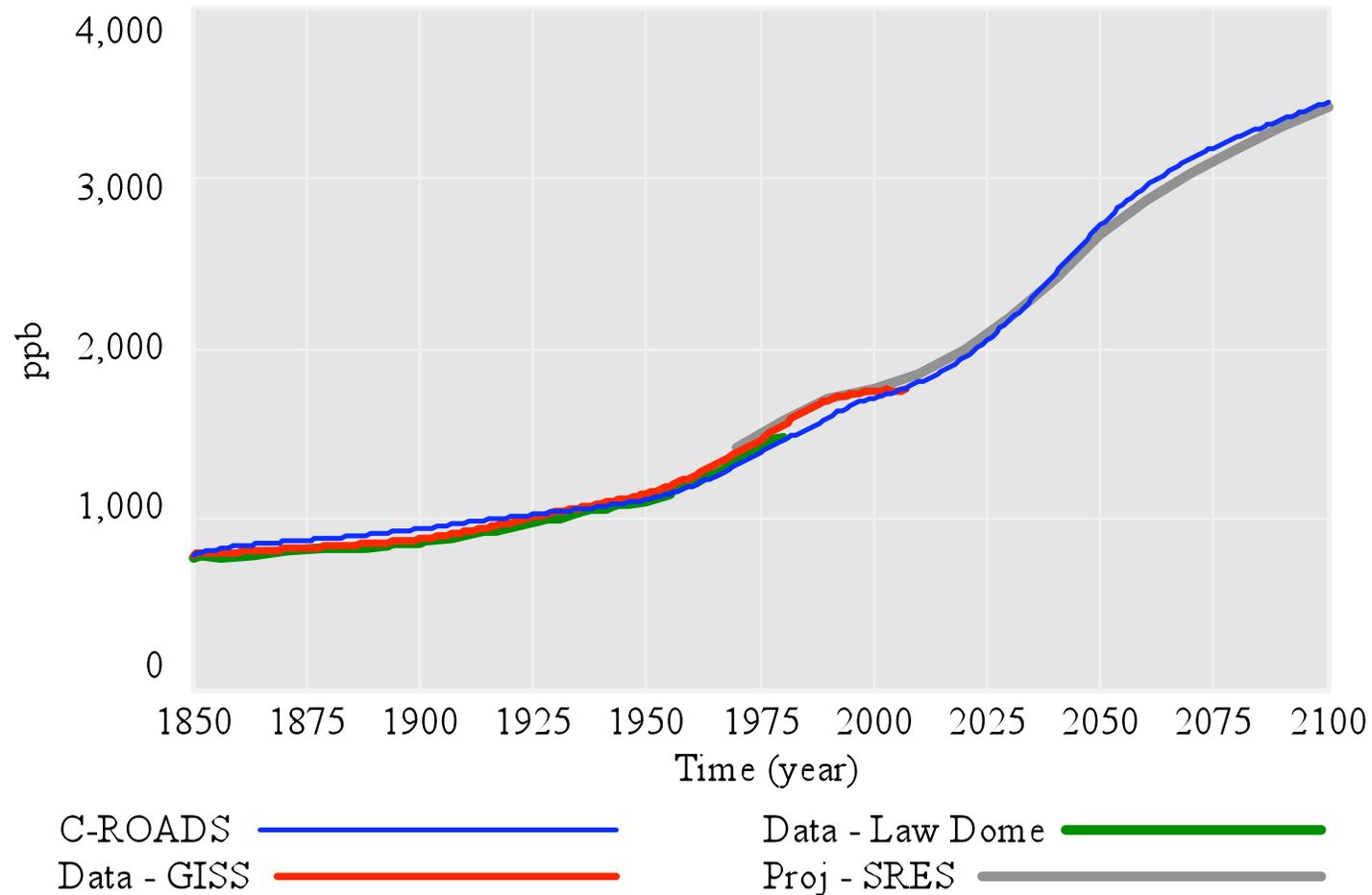
- Dr. Robert Watson Department for Environment, Food and Rural Affairs
(DEFRA) and former chair, IPCC
- Eric Beinhocker McKinsey Global Institute
- Dr. Klaus Hasselmann Max-Planck Institut für Meteorologie
- Dr. David Lane London School of Economics
- Dr. Jørgen Randers Norwegian School of Management (BI)
- Dr. Stephen Schneider Stanford University
- Dr. Bert de Vries Netherlands Environmental Assessment Agency,
RIVM

Conclusion of Scientific Review Panel

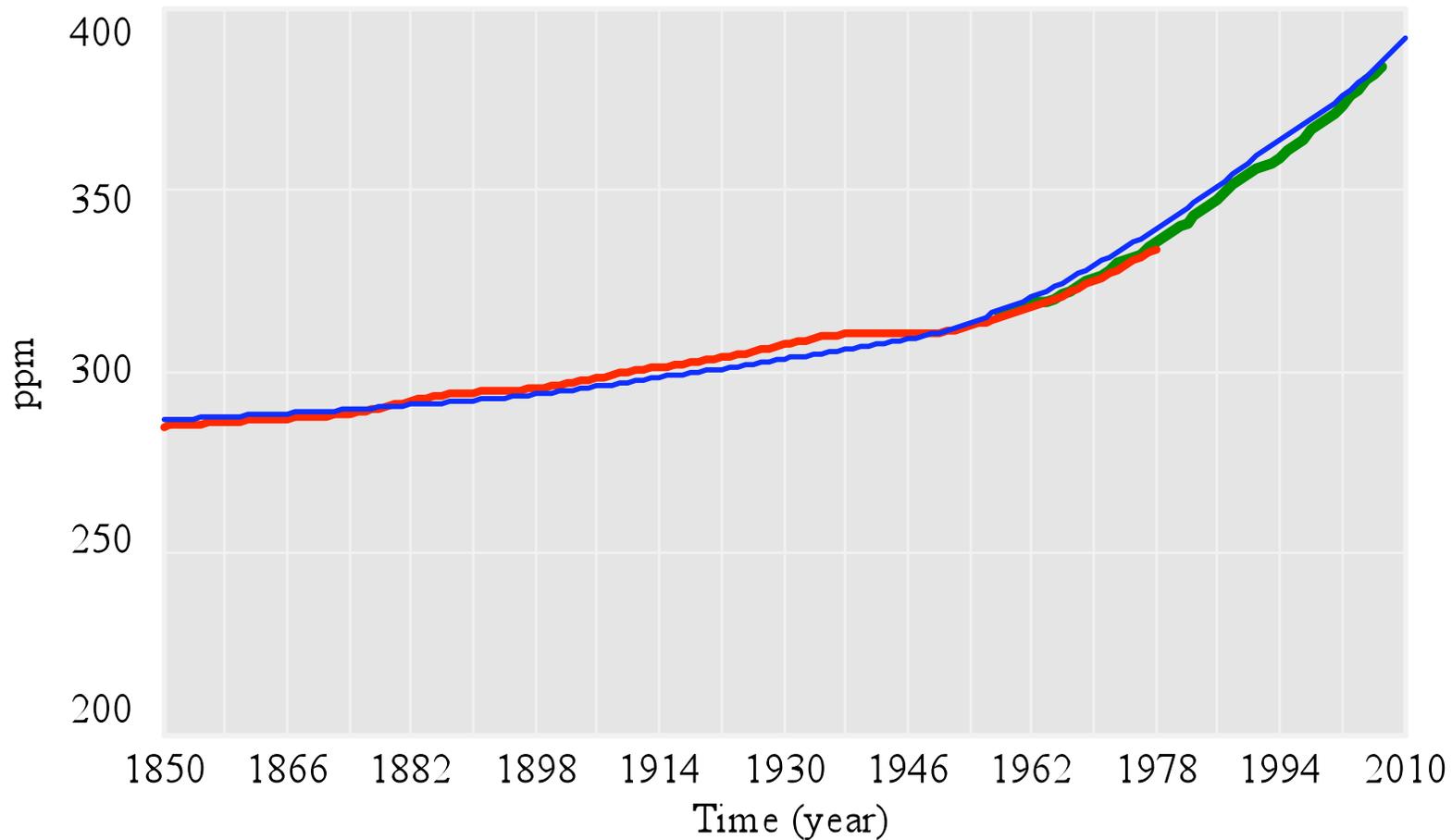
The C-ROADS model

- “reproduces the response properties of state-of-the-art three dimensional climate models very well”
- “Given the model’s capabilities and its close alignment with a range of scenarios published in the Fourth Assessment Report of the IPCC we support its widespread use among a broad range of users and recommend that it be considered as an official United Nations tool.”

C-ROADS Produces Methane Concentration Results Consistent with History and SRES Forecasts



C-ROADS Produces CO₂ Concentration Results Consistent with Historical Records

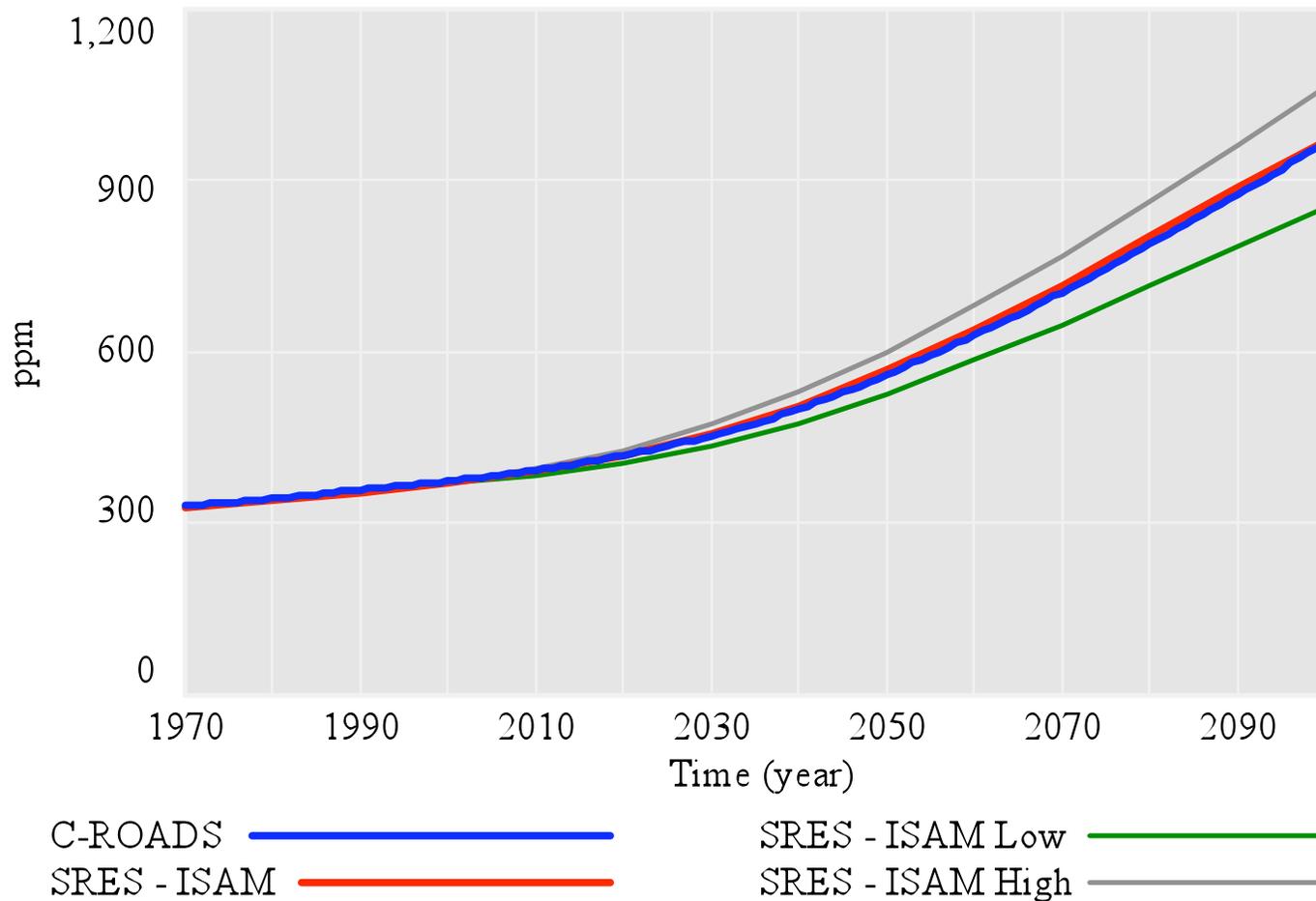


C-ROADS 

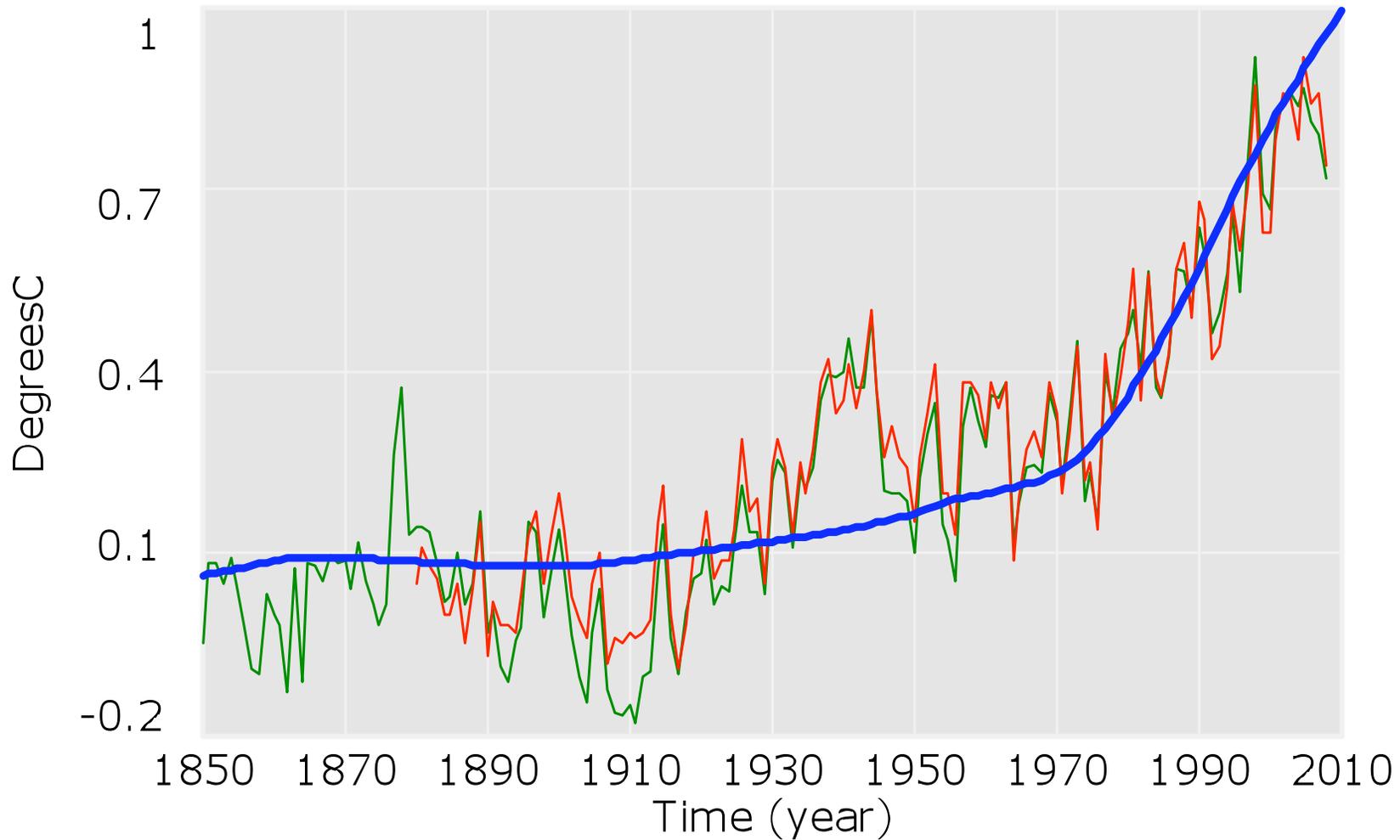
Data - Law Dome 

Data - Mauna Loa 

C-ROADS Produces CO₂ Concentration Forecasts Consistent with SRES Results



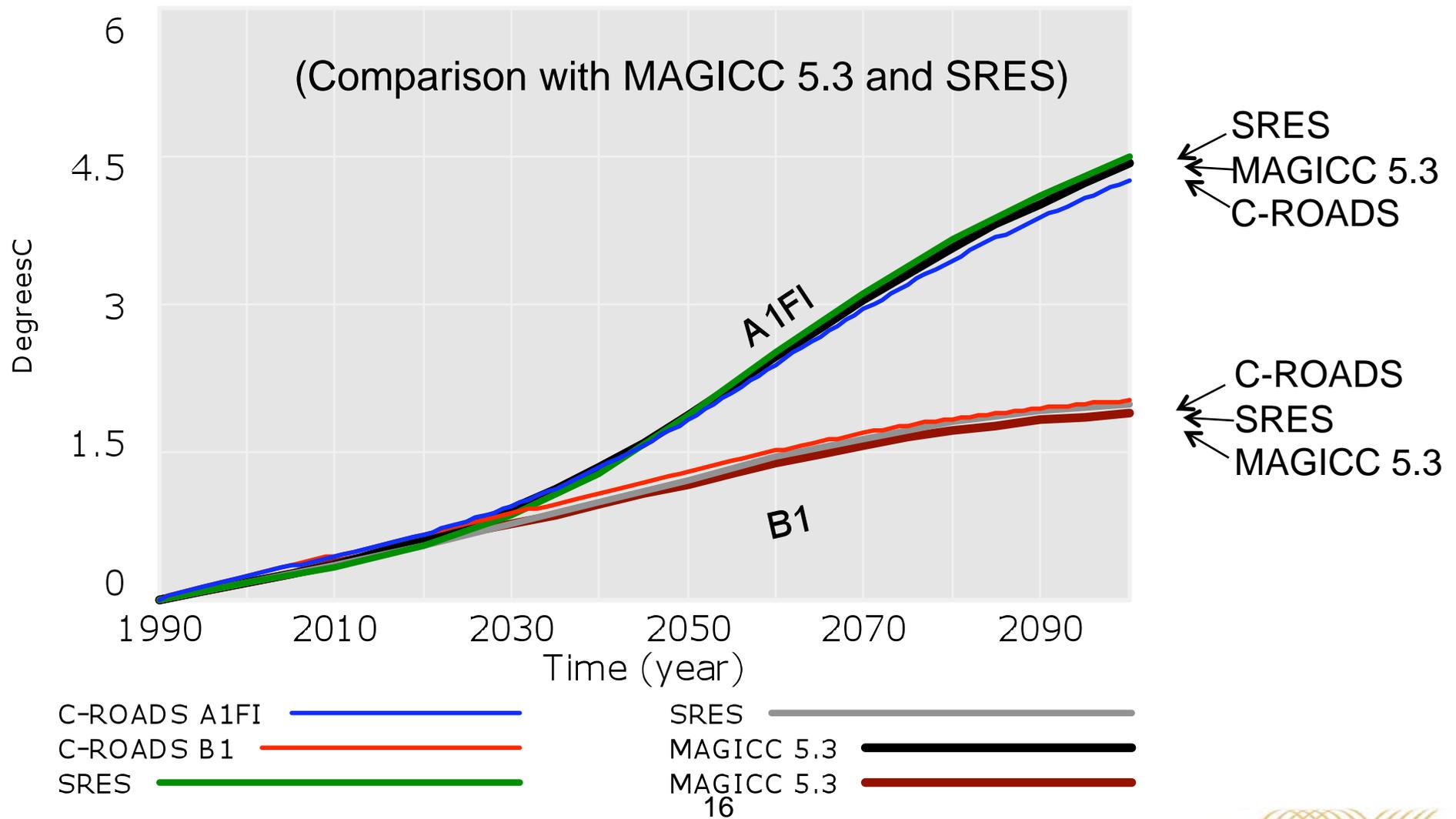
C-ROADS Produces Temperature Results Consistent with Historical Records



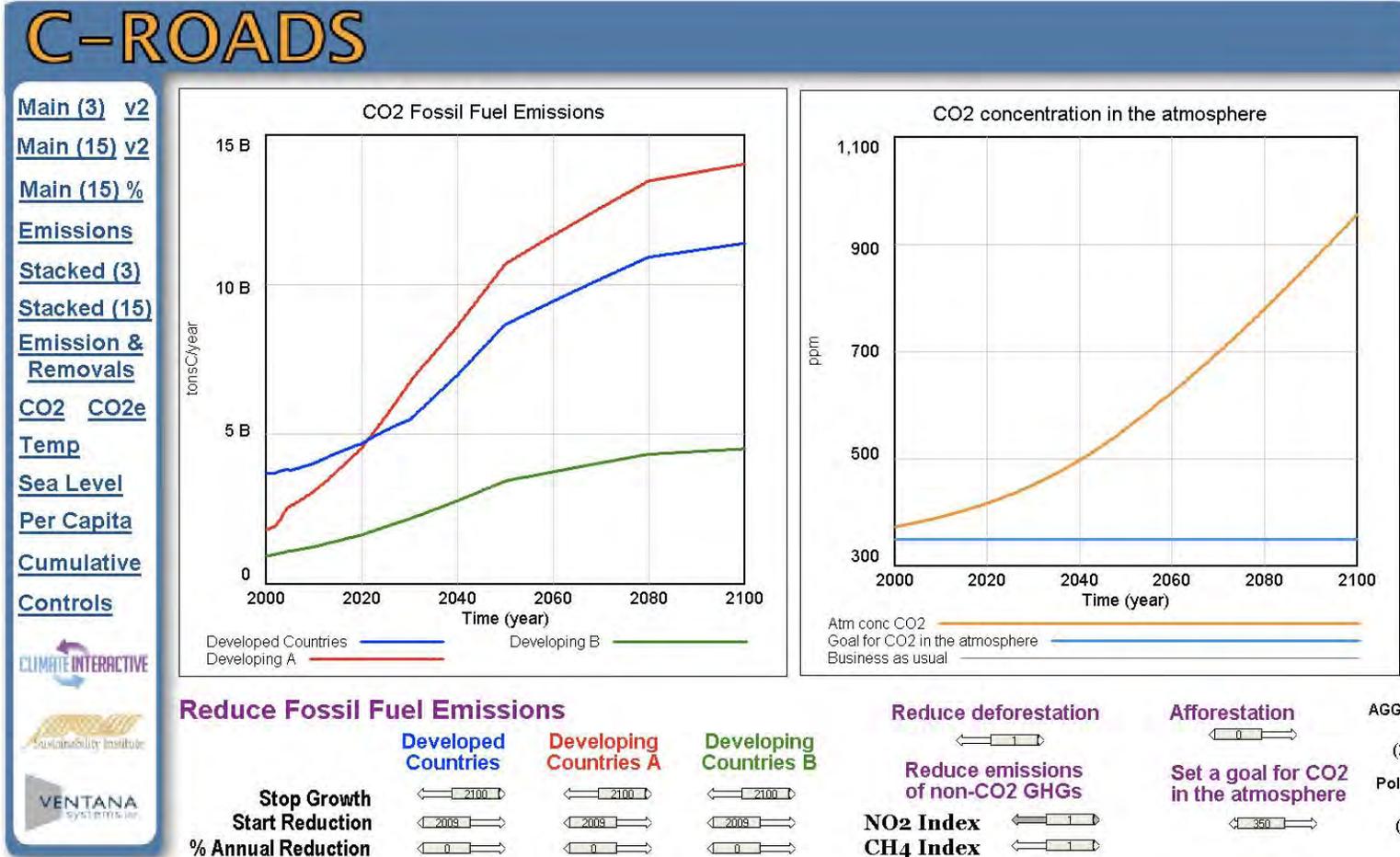
C-ROADS 
GISTEMP 

HADCRUT3 

When Input with High and Low Emissions, C-ROADS Produces Temperature Output Consistent with the Models in IPCC's AR4



The Simpler Version of the Interface



The Interface for the “Common Platform” Version

C-ROADS-CP v2.103x b2.05

Getting Started **6 region** Load/Unload run Save run Reset to baseline Return to main

CO2 Emissions CO2e emissions Land Use Other Per capita CO2 & CO2e Temp & Goal Comparisons

CO2 Equivalent Emissions by Country Group

Showing values from current_run.vdf

Temperature and Goal

Showing values from current_run.vdf

Data table Export image/data Large Graph 2100 data Select regions Data table Export image/data Large Graph

Settings **Non-land use emissions** Supported Actions Land use emissions

Default for all regions: Manual Set input method for US 6R to Manual Help ?

Summary

Start year: 2009 Help ?

Reference year: 2005

Interim 1 Help ?

% Change in Emissions: -17 %

By Target Year: 2020

Relative to: Ref year

Interim 2 Help ?

% Change in Emissions: -50 %

By Target Year: 2030

Relative to: Ref year

Final Help ?

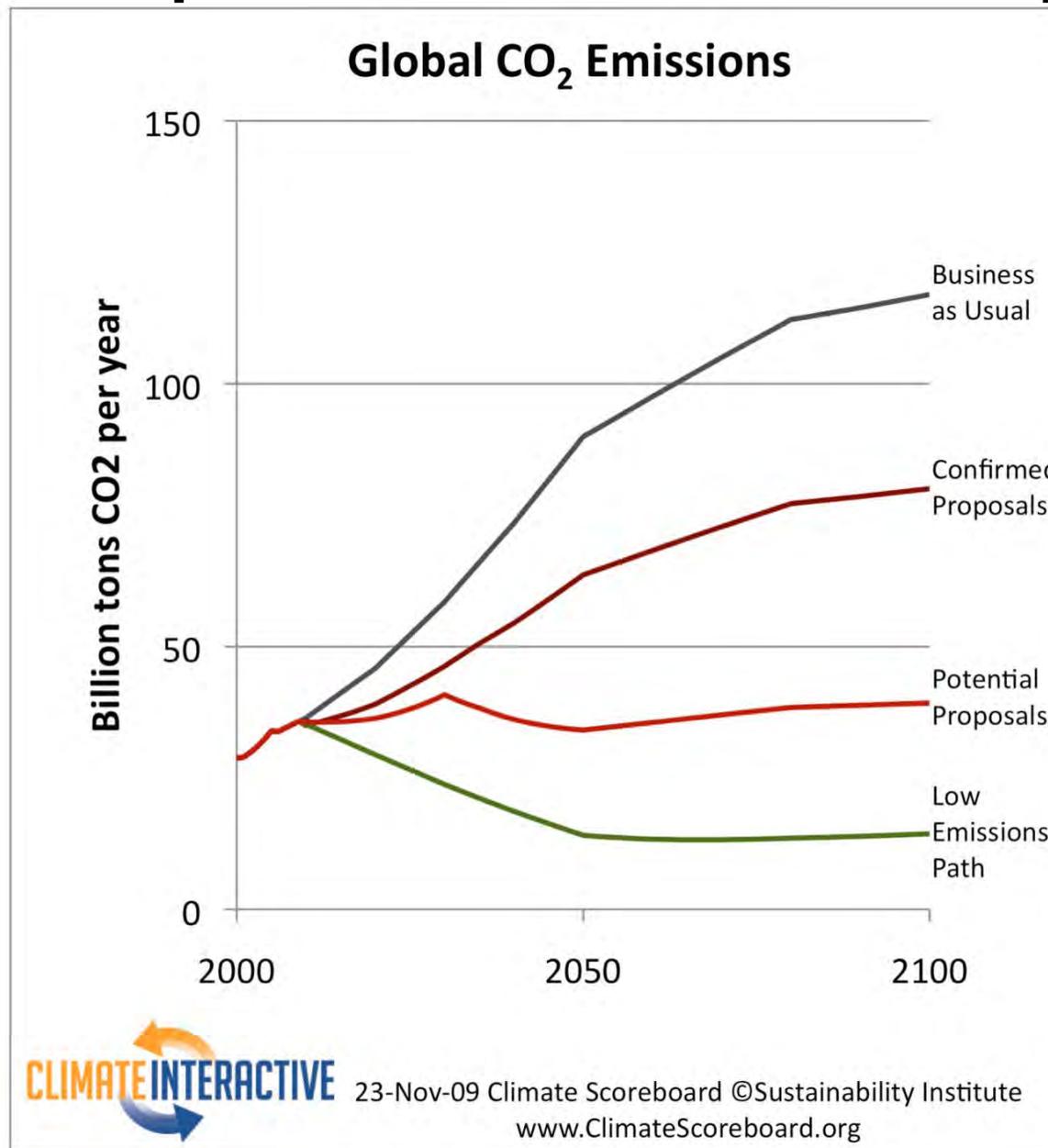
% Change in Emissions: -80 %

By Target Year: 2050

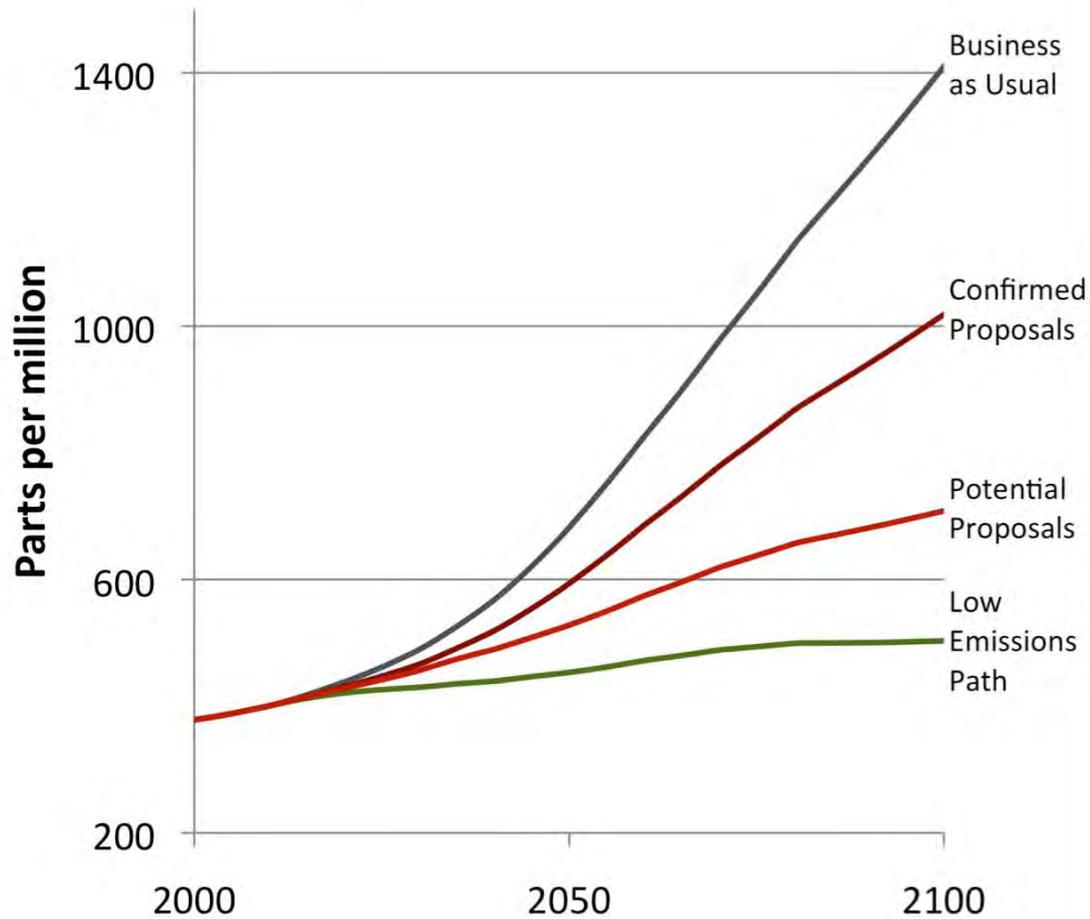
Relative to: Ref year

 institute

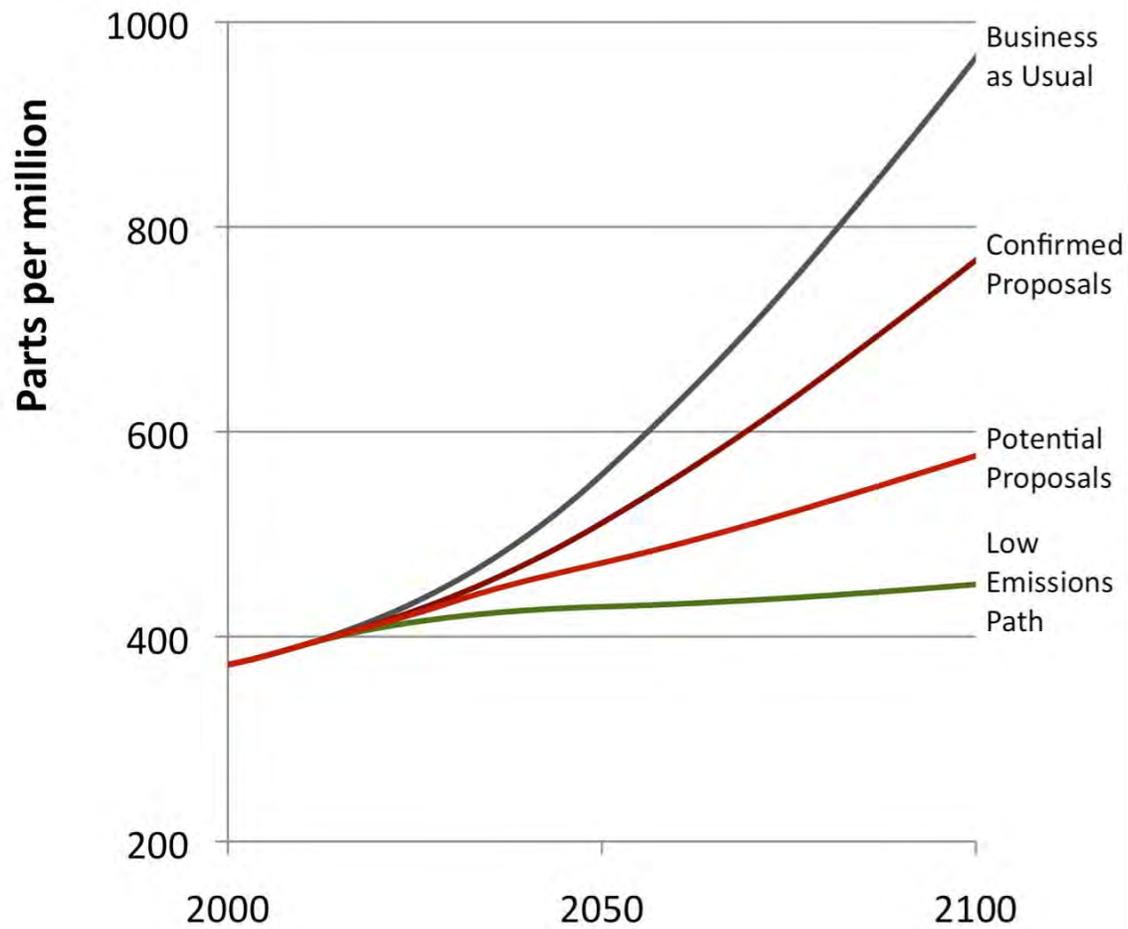
Example C-ROADS Output



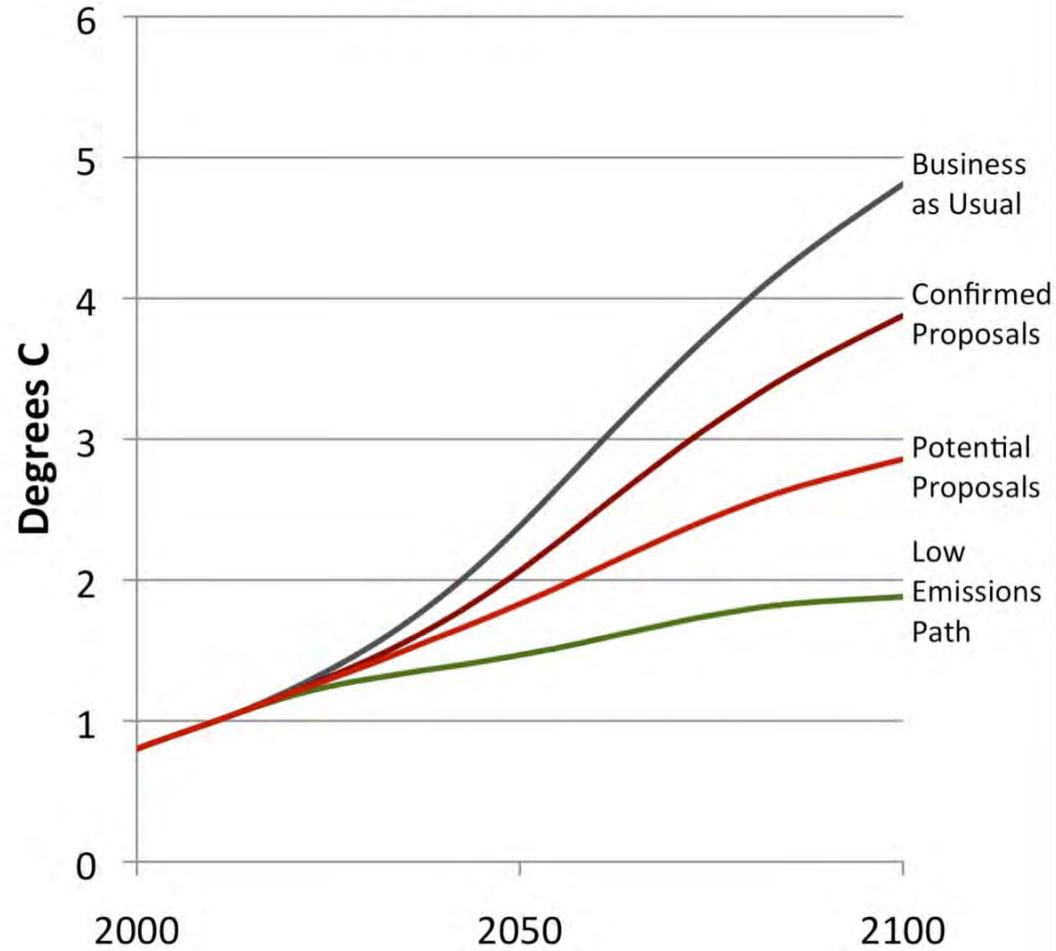
CO₂e in the Atmosphere



CO₂ in the Atmosphere



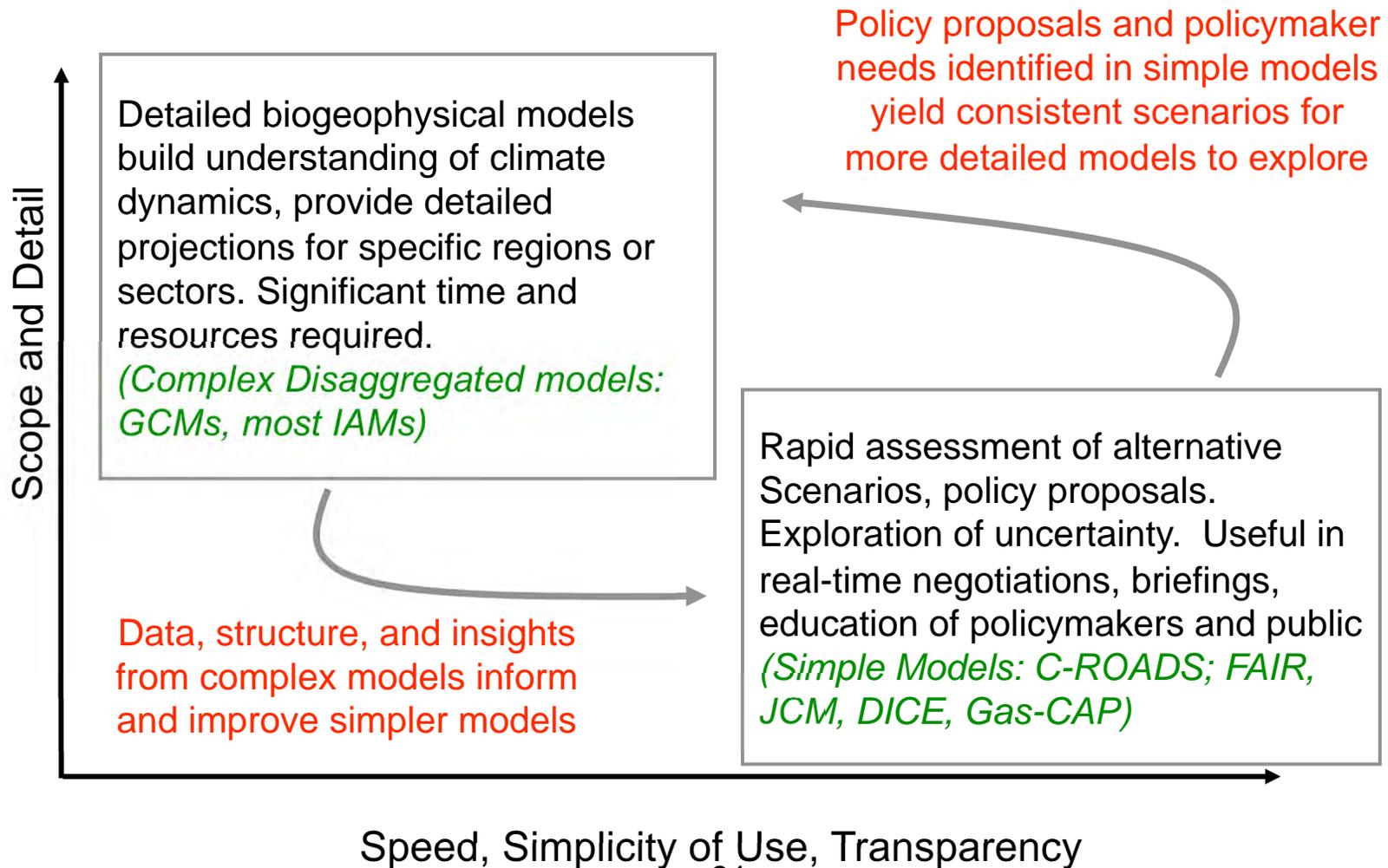
Temperature Change Over Pre-Industrial



Modeling Goals

- Conformity with literature
- Balanced units of measure
- Conservation of physical quantities
- Documentation
- Transparency/traceability
- Fit to history
- Consistency with projections
- Representation of uncertainty

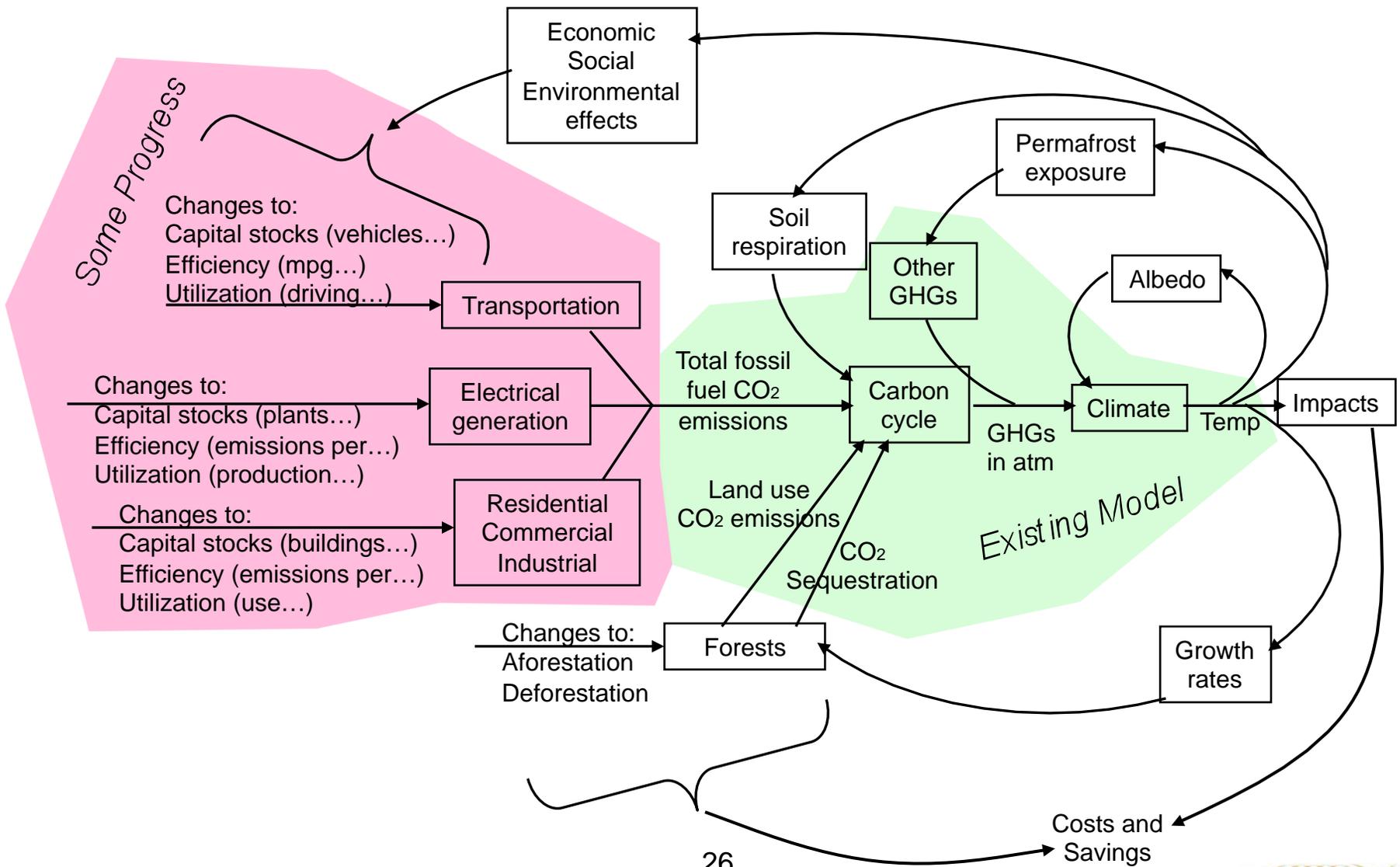
Our Goal is Complement More Disaggregated Models



Similar Models to C-ROADS

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

Current Scope and Potential Expansion



More information

- Model is copyright 2009 by Sustainability Institute and Ventana Systems
 - www.ventanasystems.com/
 - www.sustainer.org
- Documentation, scientific review and other materials at:
 - <http://www.climateinteractive.org>
- Models by Tom Fiddaman on which the model that created these runs were based
 - www.metasd.com/models/index.html#Climate
- Site for simulations and open source sharing
 - www.climateinteractive.org
- Project blog
 - climateinteractive.wordpress.com/
- For an interactive, online demonstration, contact
 - apjones@sustainer.org
 - bethsawin@sustainer.org