FEATURE 10.4

Climate Interactive: "Sims" for Improving Our Thinking About Addressing Climate Change

ANDREW JONES AND ELIZABETH SAWIN

While real-time learning is the most durable feature of learning organizations, some issues require "practice fields" or simulations because the phenomena are complex, have long time lags, and have high-stakes consequences. In 2009, at the international meetings on climate change in Copenhagen, Climate Interactive provided negotiators with just this kind of a practice field to gauge the impact of different proposals. As people began to experiment with the simulations, it became clear that the audience of would-be users was enormous – well beyond the small pool of official country representatives. In this article, simulation architects Drew Jones and Elizabeth Sawin share the Climate Interactive story and their key learnings in creating a living microworld – freely available to anyone with internet access.

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How strong does a UN climate agreement need to be to protect the world's climate? How could the world transform its energy systems toward security and resilience? Given the urgent challenges of climate change, questions like these hold the keys to our future, and policymakers, businesses, and global citizens need ways to find timely and accurate answers. Climate Interactive is addressing this need by bringing together a community of modelers, scientists, writers, designers, corporations, and foundations to create, share, and use credible models, accessible simulations, and other media to improve the way leaders and citizens around the world think about climate and energy.

We're building "sims" (short for simulations) that are easy for climate analysts, communicators, and leaders to use and that provide immediate feedback, so users can see the results of different scenarios on atmospheric carbon levels and temperature. Our purpose is to get these sims and insights into the world as accessible products that can be tweaked, enhanced, translated, distributed, and used to create change around the world.

This work has changed policy, investments, and actions. One of our sims, C-ROADS, is being used directly in the United Nations' ongoing climate negotiations. The United States Department of State has used the C-ROADS simulator to understand the climate impacts of various country-level proposals and to share that understanding with other parties to the UN. Deputy Special Envoy Jonathan Pershing presented the C-ROADS analysis at UN meetings in Bonn and Copenhagen. And a team at Tsinghua University in Beijing has translated the sim into Chinese for use by government leaders.

Why Sims?

Responding to climate change requires all of us to think carefully about the future within a broad, complex, and interdependent context. One of the things we know about climate is that the economic, atmospheric, and social systems that drive it defy most human intuition. And because the worst-case outcomes of climate change are so disastrous, we need ways to understand the impacts of possible courses of action without waiting for those impacts to arrive. Simulation models are very good at helping with each of these challenges.

Don't such climate simulations already exist? Not really, at least not simple, quick simulations that use the best available science and serve as practical additions to real-time policy discussions. Most existing energy and climate models are extremely complex, take too long to run, and can't be used by non-scientists.

Our approach is to do two things:

1. Create Simulations. With project partners, including Ventana Systems and MIT, we are building a set of simulators with engaging interfaces and compelling output displays. These sims allow learners to deepen their understanding of climate dynamics step by step, from the most rudimentary "carbon accounting" to progressively more complex explorations of strategic options for reducing emissions and their likely effects. C-ROADS – an acronym for Climate Rapid Overview and Decision Support – is our full-scale, system dynamics simulation. Designed for decision makers, it is easily used by non-modelers and runs in less than 0.1 seconds on a laptop (Figure 1).

2. Enable a Broader Community to Create, Extend, and Share Simulations. Climate Interactive has built a platform to enable simulation use and sharing. We gather, document, post, and promote various climate simulations, videos, online learning tools, and role-playing policy exercises for use by other modelers and leaders.

Taking these steps means that our work can be adapted for use by corporate leaders, green investors, UN negotiators, or high school science classes in multiple languages and levels of scientific complexity. We hope to tap into the creativity and collective intelligence of many people around the world to improve our simulation interfaces and extend their impact through videos, podcasts, essays, and other media.

A Common Platform

One vision of our work is that all of the parties to climate decision making will be able to work together based on a shared understanding of how the physical parts of the climate system function. More than enough areas of disagreement and diverging interests exist on issues like historical responsibility for climate change and the fairest ways to share the burden of reducing emissions, so it is unfortunate when different ways of seeing the physics of the climate lead to controversy and misunderstanding as well. While we would never claim that C-ROADS is a perfect reflection of the real climate system (we'd argue that no model could be), the model is based on accepted climate science, and the user can easily change all of the inputs. If negotiating parties were to use a tool like C-ROADS, we believe that they would at least start from a common understanding of the key physical dynamics and limits of the climate. We hope that with people in a few key countries and many analysts who support UN negotiating teams experimenting with C-ROADS, the simulation can

C-ROADS

C-ROADS is a policymaker-oriented climate simulation that:

- Uses MIT-based technology
- Is designed for decision makers, not just scientists
- Runs in less than 0.1 seconds
- Is scientifically reviewed (committee chaired by Dr. Bob Watson, former head of the IPCC; committee members included Klaus Hasselmann and Stephen Schneider)
- Reproduces the response properties of state-of-the-art three-dimensional climate models very well
- Is flexible and adaptable to current policy questions
- Makes all equations available for use and open to scrutiny

help make climate negotiations more productive and more effective over the long run.

Climate Scoreboard

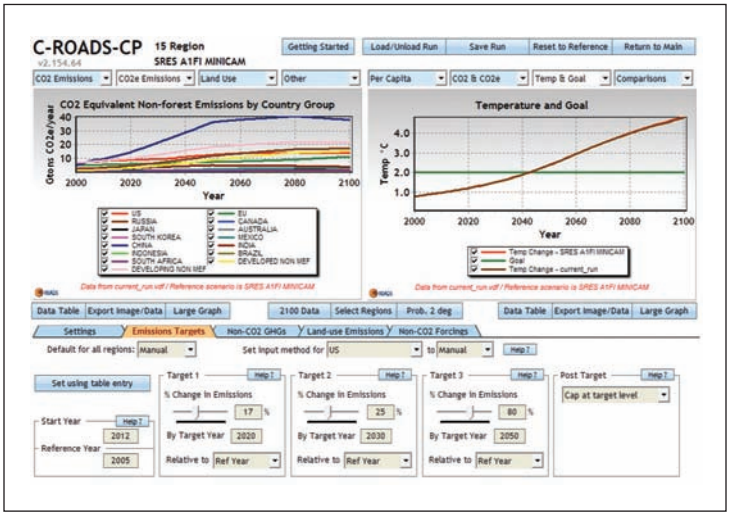
Just as decision makers and negotiators need ways to assess the proposals toward creating a global climate treaty, advocacy groups and citizens around the world also want to know how close current proposals bring the world to climate goals. With this need in mind, our team tracks the various proposals under consideration in the climate treaty process and reports our estimate of how close current proposals come to realizing climate goals via the Climate Scoreboard (Figure 2). We scan UNFCCC submissions and news sources from around the world to collect a list of what we call "current proposals" – possible scenarios for reducing greenhouse gas emissions by UNFCCC parties. We share our compilation and calculate the expected long-term impacts (in terms of GHG concentration, temperature increase, and sea-level rise) if those proposals were to be fully implemented. We then share the results via our webpage, Twitter, and partnerships with NGOs. We have also created an embeddable online widget that people can incorporate in their blogs and websites and that automatically updates when proposals in the treaty process change.

We believe that widely sharing the Climate Scoreboard – along with the C-ROADS simulator – can contribute to progress in climate negotiations. Without something like the Scoreboard to provide a reality check, negotiations too easily focus on the political challenge of dividing up the climate change effort, without really asking if the proposed effort is large enough in the first place.

What We've Learned

Our successes with C-ROADS and the Climate Scoreboard have grown out of the past 10–15 years of work by Sustainability Institute, MIT/Sloan, the Society for Organizational Learning, and Ventana Systems to use system dynamics modeling and systems thinking to create a more sustainable world. These efforts have had an impact in commodity systems, urban growth, agriculture, forestry,

FIGURE 1 **C-ROADS Control Panel**



The C-ROADS simulation is designed to help climate analysts improve their understanding of how various proposals will impact climate outcomes. Model users determine the path of net greenhouse gas (GHG) emissions at the country or regional level through 2100. The model calculates the path of atmospheric CO_2 and other GHG concentrations, global mean surface temperature, and sea level rise resulting from these emissions.

FIGURE 2 **Climate Scoreboard**

In the Climate Scoreboard, the yellow "business-as-usual" line represents the estimated global temperature increase in 2100 if greenhouse gas emissions are not reduced. The blue "proposals" line represents the estimated global temperature increase in 2100 if the current proposals were enacted. The shaded blue curve shows the uncertainty in the climate system's response to emissions. C-ROADS is used to calculate the position of the blue line. When proposals change, we update our analysis, and the position of the blue shifts. The green "goals" line represents the goal of limiting the temperature increase to 1.5°–2.0°C

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diabetes, energy, and manufacturing. Several key lessons have emerged from our more recent climate and energy work, lessons that shed light on what it takes to ensure that simulations and systems diagrams lead to results, not just interesting insights.

Lesson #1: Iterate your simulation rapidly to meet user needs.

We've learned to think like a software company, not a scientist. Even though we *are* scientists, we have found great value in testing our simulations with real decision makers, hearing their disappointments, and quickly improving the sim. These beta testers would point out the many gaps between our simulation and how the *real* conversation was being framed, measured, and captured (we heard "We don't think about it that way" and "That doesn't help us" hundreds of times). We would then stay up late adjusting our sim for a presentation the next day or week. Given that Tom Fiddaman started this model in 1993 as his Ph.D. thesis, we likely have created approximately 500 versions of the simulation over the years.

Lesson #2: Convert your simulation into multiple forms to reach diverse audiences.

In past projects, we aimed toward a single model with a single interface that we used to engage diverse users, learners, and leaders. At least partly due to the diverse nature of our intended audience (e.g., government, business, nongovernmental organizations, citizens, youth), through open source–style sharing, we and our partners have adapted C-ROADS into approximately a dozen forms, including:

- A technical version created in modeling software for our own analysis
- A freestanding version for climate analysts
- A simplified online version for anyone in the world via Forio Business Simulation – "C-Learn"
- A shareable widget (the "Climate Scoreboard") and three other online tools that deliver core insights
- A simulation embedded in two "touch table" science museum exhibits
- An iPhone/iPad version – "Climate Pathways"
- A "Mock UN" role-playing game now led by 10 facilitators in the U.S. and Europe – "World Climate"

We have been surprised by the need for and power of such liberal adaptation of the model – people truly require a sim that is customized to the questions they have and the way they learn. Negotiators and citizens may care about the same

question – do the current proposals add up to enough emissions reductions? – but they need the information in quite different forms.

Lesson #3: Focus on delivering insights that improve mental models.

We've also learned that there are times when we need to think like a scientist, not a software company. For the past decade, our team has kept a list of the top 10 or so misunderstandings of climate dynamics held by decision makers and citizens. For example, as John Sterman and Linda Booth Sweeney proved in a study, most people incorrectly believe that stabilizing emissions of CO_2 would lead to a stabilization of the climate (in fact, it would merely cause the climate to deteriorate less rapidly). Thus, we have designed all our simulations with the goal of helping users improve their mental models or understanding of how the system behaves over time.

Notice how this lesson contrasts with our Lesson #1: Here, we are advocating that change agents who use simulations not just respond to user demands, but actively guide the conversation in the direction of insights that will lead to actions that improve system performance. We have found that when we tilt the simulation too far toward ensuring that users have certain insights, decision makers see it as being merely an academic exercise. When we too closely mirror decision makers' current thinking, we don't leave enough room for discovery of new policy options. Balancing Lessons #1 and #3 and navigating the trade-offs between them continues to be an area of learning and exploration for our team, and is more of an art than a science.

Lesson #4: Make sure the simulation evolves in step with developments in the real world.

C-ROADS will likely never become a finished product. As climate scientists improve our understanding of how the atmosphere, oceans, and biosphere interact and how greenhouse gas emissions influence the planet, we continually improve and add to the equations in the simulation. And, as the conversation within the international climate treaty dialogue changes, our team finds itself adding new policy scenarios and building new model structure to explore opportunities for transforming the energy system toward renewable energy.

C-ROADS and the Climate Scorecard have proven to be effective tools in aiding policymakers and building shared understanding of the magnitude of the challenges we face and the relative effectiveness of different proposed interventions. By sharing them more widely, we hope to help all of us – from ordinary citizens to climate treaty negotiators – understand and accomplish the actions that can help stabilize the climate system. ■

ABOUT THE AUTHORS

Andrew Jones is co-director of Climate Interactive. In 2008, he and a group of colleagues received the "ASysT Prize" for "a significant accomplishment achieved through the application of systems thinking to a problem of U.S. national significance." *apjones@climateinteractive.org*

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