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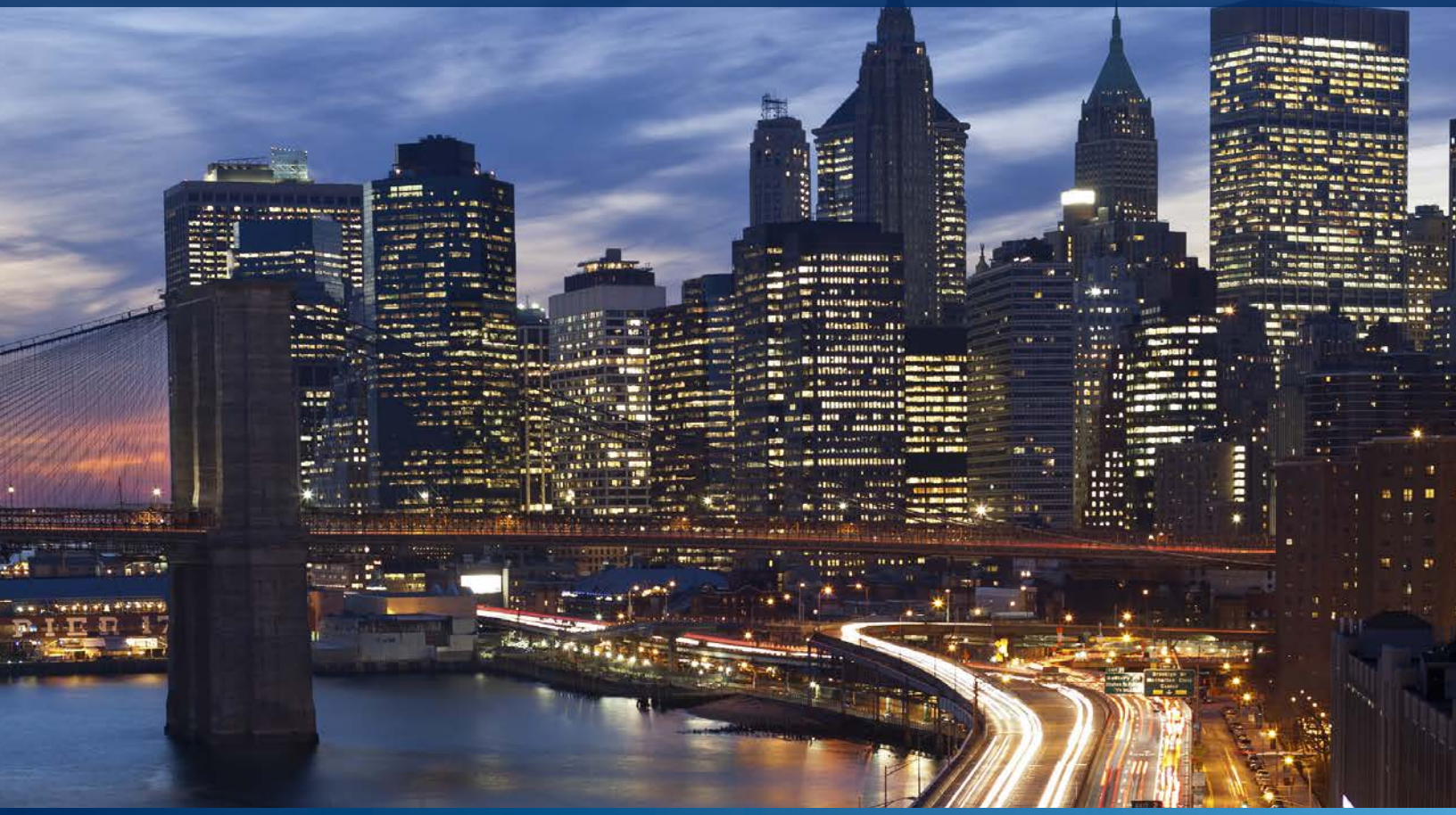


MIT JOINT PROGRAM ON THE SCIENCE AND POLICY of GLOBAL CHANGE

Global Changes

Spring 2014 | In this Issue

MISSION AND OBJECTIVES

Integrating natural and social science to further the international dialogue toward a global response to climate change

- Discover new interactions between natural and human climate system components
- Objectively assess uncertainty in economic and climate projections
- Critically and quantitatively analyze environmental management and policy proposals
- Improve methods to model, monitor and verify greenhouse gas emissions and climate impacts
- Understand the complex connections among the many forces that will shape our future

IN THIS ISSUE:

The State of Climate Policy Ahead of COP21

Climate negotiations are now focused toward COP21, set to take place in November 2015. The goal of COP21 is for countries to forge an international climate agreement for the post-2020 period, a follow-on from the Copenhagen-Durban negotiations that focused on actions through 2020. It is a major opportunity to reconcile the ambitious goal of avoiding a temperature increase of more than 2° C from preindustrial levels with what has so far been a reluctance on the part of most countries to implement mitigation measures that would actually meet such a target.

The broad expectation for COP21, which I share, is that the agreement will be more of the same. That is, countries will identify a variety of policies and measures they intend to undertake. They'll also likely identify an estimated numerical target they believe these policies and measures will achieve. For many developing countries, these may be intensity targets or reductions from an unidentified baseline of increasing emissions. All of this makes it much more difficult to assess the climate implications of the agreement. Measures may not achieve the intended targets, an intensity target is not an absolute constraint; a "baseline" emission path can be developed that would show reductions were met, but again, absolute emissions might still have increased substantially.

To give a window into the future, the Joint Program has begun to evaluate the approaches countries might take. We're asking: What specific measures might be proposed? How aggressive? How effective? How close will they get us to the 2° C target previously set? And how much of the carbon budget established by the IPCC will be used up by 2025 or 2030? We're looking forward to releasing a first look of our results from this analysis later this spring, and hope it will be part of the discussion among countries. Our expectation is that the measures we identify in this initial round will not add up to what is really needed, and hence may prod countries to offer more substantial efforts—leading us to a second round of analysis.

As part of our work, we're taking a hard look at the two most important players: the U.S. and China. In the case of the U.S., emissions dropped 7 percent from 2005 to 2011, and if they stay on that trend the U.S. is on a course to achieve its target of reducing emissions by 17 percent by 2020. However, this line of reasoning is deceiving and fails to take into account that in 2012 emissions increased once again, partly because of higher natural gas prices that led to more coal use and partly due to the recovering economy. Our analysis suggests the U.S. actually has a steep road ahead to reach its 2020 target.

But supposing it makes that target, what is a goal for post-2020? We sat down with the nation's chief climate negotiator Todd Stern to learn what the country might do going forward, and I think it is safe to say the U.S. is still working through what it might bring to the table. As for what it is doing now, efforts are being made to reduce emissions through new regulations—standards for new power plants, tougher rules for old plants, and updated standards for cars and heavy duty vehicles, to name a few.

Still, it is not clear the nation's current regulatory approach will be enough to reach the 17 percent emission reduction target, much less a further reduction in the post-2020 period. Some circles have discussed that such numerical targets for the U.S. could be to cut emissions by 30 percent or even 40 percent from 2005 levels by 2030. My view is that to achieve anything like those reductions, and to do so with relative efficiency, the U.S. will need to move to a broader carbon policy such as a carbon tax or cap-and-trade scheme. There are some that think the Obama Administration has the authority under the existing Clean Air Act to implement such a system, perhaps by establishing targets for states and letting states trade. If the administration is unwilling to make such a push, or unable to defend it in the courts, the task of authorizing new legislation lies in the hands of Congress, and will likely depend on the turn of midterm elections.

In many respects China is taking a more aggressive approach on climate than the U.S. China is experimenting with a cap-and-trade pilot program, and broad goals to reduce energy and GHG intensity, combined with support for low-carbon energy development. In addition, air and water pollution have reached levels that are causing widespread demands for pollution control by the public. Our analyses have found that if implemented, extending China's current commitments to reduce carbon intensity at a similar pace beyond 2020, combined with tougher air quality targets, could significantly slow the increase in China's CO_2 emissions over the coming decades. This could in turn result in an earlier peak, compared to a scenario with no new policy measures. Of course, pilot programs and goals are only effective if implemented on a large scale. And so, time will tell if this reasonably optimistic outlook comes to pass. (Learn more about China's efforts in comparison to those in the U.S. from Valerie Karplus: Page 13)

Even with some efforts underway in China and the U.S., emissions globally are still projected to be 95 percent higher by 2100 than they were in 2010, according to our latest Energy and Climate Outlook (based on Copenhagen pledges, and assuming those are met and retained through the end of the century). Most of these emissions will come from countries outside of the U.S., Europe, Australia, Japan, Canada and New Zealand. But while over time emissions from these developed countries become a smaller share of overall emissions—only 13 percent by 2100—the example these nations set will be critical to spurring progress in the rest of the world.

While there is uncertainty in the relationship of emissions to climate, to have much of a chance of meeting the 2° C target, emissions need to be cut by half by 2050 and continue to fall through the end of the century. The difference between a 95 percent increase in emissions by 2100 and a drop by 80 percent or more is a measure of the size of the task before us. ■

XXXVII MIT GLOBAL CHANGE FORUM
October 15–17, 2014, Cambridge, MA

Predicting the Future of Global Water Stress

MIT researchers find that by 2050 more than half the world's population will live in water-stressed areas and about a billion or more will not have sufficient water resources.

Population growth and increasing social pressures on global water resources have required communities around the globe to focus on the future of water availability. Global climate change is expected to further exacerbate the demands on water-stressed regions. In an effort to assess future water demands and the impacts of climate change, MIT researchers have used a new modeling tool to calculate the ability of global water resources to meet water needs through 2050.

The researchers expect 5 billion (52 percent) of the world's projected 9.7 billion people to live in water-stressed areas by 2050. They also expect about 1 billion more people to be living in areas where water demand exceeds surface-water supply. A large portion of these regions already face water stress—most notably India, Northern Africa and the Middle East.

The study applies the MIT Integrated Global System Model Water Resource System (IGSM-WRS), a modeling tool with the ability to assess both changing climate and socioeconomics—allowing the researchers to isolate these two influences. In studying the socioeconomic changes, they find population and economic growth are responsible for most of the increased water stress. Such changes will lead to an additional 1.8 billion people globally living in water-stressed regions.

"Our research highlights the substantial influence of socioeconomic growth on global water resources, potentially worsened by climate change," says Adam Schlosser, the assistant director of science research at the Joint Program on the Science and Policy of Global Change and lead author of the study. "Developing nations are expected to face the brunt of these rising water demands, with 80 percent of this additional 1.8 billion living in developing countries."

Looking at the influence of climate change alone, the researchers find a different result. Climate change will have a greater impact on water resources in developed countries. This is because, for instance, changes in precipitation patterns would limit water supplies needed for irrigation.

When researchers combine the climate and socioeconomic scenarios, a more complicated picture of future water resources emerges. For example, in India, researchers expect to see significant increases in precipitation, contributing to improved water supplies. However, India's projected population growth and economic development will cause water demands to outstrip surface-water supply.

"There is a growing need for modeling and analysis like this, which takes a comprehensive approach by studying the influence of both climatic and socioeconomic changes and their effects on both supply and demand projections," says Schlosser. "Our results underscore this need."

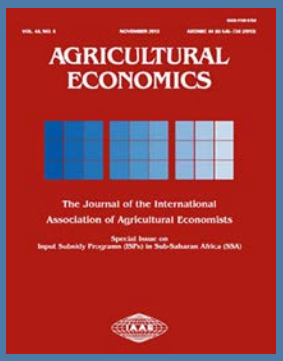
The MIT team plans to continue this work by focusing on specific regions and conducting more detailed analysis of future climate changes and risks to water systems. They plan to refine and add to the model as they research other regions of the globe. ■

Image credit: U.S. Geological Survey.

Schlosser, C.A., K.M. Strzepek, X. Gao, A. Gueneau, C. Fant, S. Paltsev, B. Rasheed, T. Smith-Greico, É. Blanc, H.D. Jacoby and J.M. Reilly, The Future of Global Water Stress: An Integrated Assessment, *JP Report 254*, January 2014.

MIT Joint Program Researchers Publish in Special Issue of *Agricultural Economics*

Agricultural Economics Volume 45, Issue 1 is a special issue containing articles on model performance in assessing the effects of climate change, bioenergy policy, and socioeconomics on agriculture. The contributions present results from a global economic model intercomparison activity undertaken as part of the AgMIP Project. MIT Joint Program researchers Élodie Blanc, Angelo Gurgel, Sergey Paltsev and John Reilly participated in this research.



- Agriculture and climate change in global scenarios: Why don't the models agree?, pages 85–101
- How much cropland is needed? Insights from a global agro-economic model comparison, pages 69–84
- Global economic models and food demand towards 2050: An intercomparison exercise, pages 51–67
- Why do global long-term scenarios for agriculture differ? An overview of the AgMIP global economic model intercomparison, pages 3–20

IN THE NEWS

Blue & Green Tomorrow reported on how 52 percent of global population is expected to live in 'water-stressed areas' by 2050. Read more: http://mitsha.re/ODDvjw

Water/Waste Processing Magazine reported on researchers using the MIT Integrated Global System Model Water Resource System (IGSM-WRS) to analyze the available water resources globally and compared those to projected water needs. Read more: http://mitsha.re/PIYJgi

Global Black Carbon Emissions Double Once Thought

MIT, Singapore researchers use a new method to find that black carbon emissions are much higher than previously estimated.

Black carbon is one of the most potent air pollutants that contributes to global climate change, and is produced by the incomplete combustion of fossil fuels and forest fires. While scientists have known about the role of black carbon for decades, there's been limited research to calculate global emissions. Now, MIT and National University of Singapore (NUS) researchers have developed a new method to calculate global black carbon emissions.

In a study published in the *Journal of Geophysical Research*, the researchers calculated the global total of black carbon emissions at 17 teragrams a year between 2000 and 2005. This result is significantly larger than the majority of global air pollution modeling studies, which employ a bottom-up approach. One such study found humans emitted only 7.5 teragrams of black carbon per year during the same five-year period—less than half the new estimate.

"Our results are the first to produce a global top-down estimation of the emissions of black carbon," says Chien Wang, a senior research scientist with the Joint Program on the Science and Policy of Global Change and co-author of the study.

The top-down method used by Wang and his co-author Dr. Jason Cohen of NUS relies on gathering data from air measurement stations and satellites to sufficiently cover every region of the globe. In this study, data was collected from 238 different stations. They then compiled this data and used inverse modeling to determine the emissions from each of the major pollution regions.

"Current emissions inventories are mainly obtained by adding up estimates of emissions from every sector of the economy and the environment to obtain a global estimate. This method creates uncertainty in the projections," says Wang. "Our method eliminates some of these uncertainties by more accurately factoring in population and economic changes around the globe."

The differences in the emissions estimates are most apparent in China and Southeast Asia. Wang predicts this is the result of the bottom-up method not capturing the rapid socioeconomic growth that has occurred in this region over the past 15 years.

Black carbon enters the atmosphere as small particles and warms the planet by absorbing heat and reducing the ability of the Earth to reflect light back out to space. Because black carbon plays a key role in air pollution and global climate change, it is essential for policymakers to have an accurate picture of the severity of the problem.

"This top-down method isn't perfect and still creates some unknowns in the estimates produced," Wang says, but he suggests that combining both approaches would potentially improve estimates and further eliminate uncertainty. "We hope this work will open the door to further efforts to better quantify and reduce uncertainty in black carbon emissions estimates." ■

Cohen, J.B. and C. Wang, Estimating global black carbon emissions using a top-down Kalman Filter approach, *Journal of Geophysical Research—Atmospheres*, 119: 1–17, doi: 10.1002/2013JD019912, 2014, Reprint 2014-1.

Uncovering the Costs of Climate Mitigation

MIT investigators search for the most informative methods to measure the costs of mitigating climate change.

Policies to curb greenhouse gas emissions will come at a cost to energy producers, industry and consumers. Policymakers around the globe are working to determine the most effective and cost-efficient way to reduce these emissions—from renewable energy subsidies and fuel-efficiency standards to carbon taxes and cap-and-trade policies.

To tackle this challenge, Sergey Paltsev from MIT and Pantelis Capros from the National Technical University of Athens have come together to assess which methods and metrics are best for calculating the cost of climate policies. In their study, published in *Climate Change Economics*, they find that there is no one ideal metric for climate mitigation policies, but measuring changes in consumer welfare is one of the most appropriate techniques.

"With many of these regulations, the total costs are often less visible to consumers because the true costs are not reflected in the price of energy, but distributed to other sectors of the economy," says Paltsev, the assistant director for economic research at the MIT Joint Program on the Science and Policy of Global Change. "The true measure of the cost of a policy is reflected in the change in consumers' behavior, something that economists call a 'change in welfare,' but it is hard to convey this measure to policymakers and the general public."

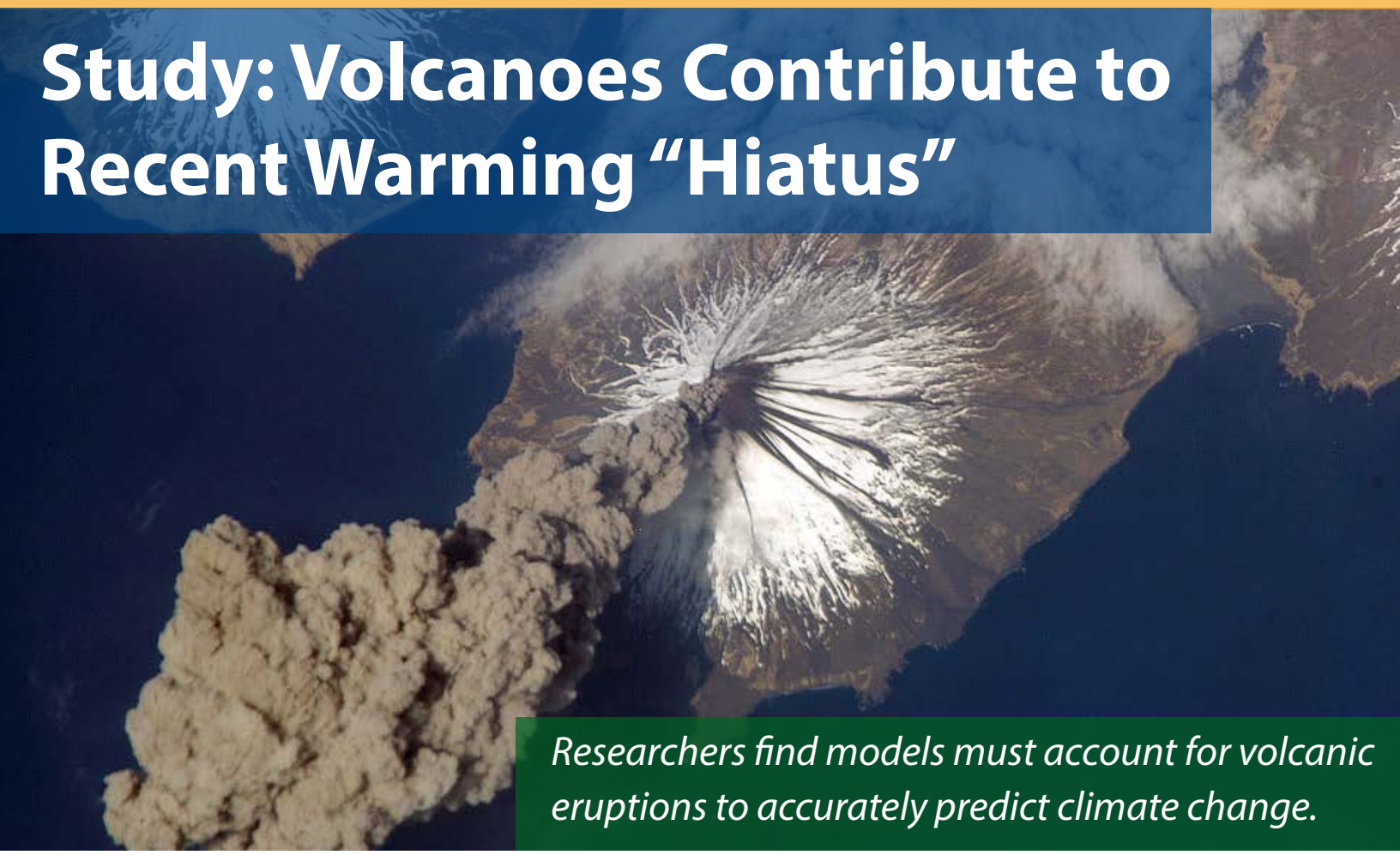
In the study, the researchers compare different concepts that are used to inform the public about the cost implications of climate change. They consider two major modeling types where costs are calculated, energy system models and macroeconomic models. Energy system models focus solely on the energy sector and treat the rest of the economy as a given. Macroeconomic models represent the energy system as part of the entire economy and provide more detailed information on the various sectors. Within these approaches there are a variety of metrics used to calculate the cost of a climate mitigation policy.

After studying the cost metrics associated with each modeling approach, the researchers compared the metrics used by a team of international researchers to better understand the impacts of the current EU emissions targets (the EU Energy Modeling Forum 28 study). They find that there are large variations in cost estimates, and most metrics are not directly comparable, which makes it difficult for policymakers to interpret the results of these studies.

Paltsev says there is no ideal metric for costs, but it's clear that some approaches are more effective than others. For example, carbon prices and marginal abatement cost curves are unable to reflect the full impact of the policy on the economy. In addition, energy system models do not always take into account the full cost of a climate policy—particularly the economic impacts of policies interacting with one another. The authors recognize that depending on the objectives, other metrics and modeling techniques may be appropriate. They conclude that measuring changes in consumer welfare or consumption is an effective approach that should be used by policymakers to evaluate climate policies. ■

Paltsev, S., P. Capros, Cost Concepts for Climate Change Mitigation, *Climate Change Economics*, 4(Suppl.1): 1340003, doi: 10.1142/ S2010007813400034, 2013, Reprint 2013-31.

Study: Volcanoes Contribute to Recent Warming "Hiatus"



Researchers find models must account for volcanic eruptions to accurately predict climate change.

By the late 1990s, scientists had observed more than two decades of rapid global warming, and expected the warming trend to continue. Instead, despite continuing increases in greenhouse gas emissions, the Earth's surface temperatures have remained nearly flat for the last 15 years. The International Panel on Climate Change (IPCC) verified this recent warming "hiatus" in its latest report.

Researchers around the globe have been working to understand this puzzle—looking at heat going into the oceans, changes in wind patterns, and other factors to explain why temperatures have stayed nearly stable, while greenhouse gas concentrations have continued to rise. In a study published in *Nature Geoscience*, a team of scientists from MIT and elsewhere around the U.S. report that volcanic eruptions have contributed to this recent cooling, and that most climate models have not accurately accounted for the effects of volcanic activity.

"This is the most comprehensive observational evaluation of the role of volcanic activity on climate in the early part of the 21st century," says co-author Susan Solomon, the Ellen Swallow Richards professor of atmospheric chemistry and climate science at MIT. "We assess the contributions of volcanoes on temperatures in the troposphere—the lowest layer of the atmosphere—and find they've certainly played some role in keeping the Earth cooler."

There are many components of the Earth's climate system that can increase or decrease the temperature of the globe. For example, while greenhouse gases cause warming, some types of small particles, known as aerosols, cause cooling. When volcanoes erupt explosively enough, they enhance these aerosols—a phenomenon referred to as "volcanic forcing."

"The recent slowdown in observed surface and tropospheric warming is a fascinating detective story," says Ben Santer, the lead author of the study and a climate scientist at Lawrence Livermore National Laboratory. "There is not a single culprit, as some scientists have claimed. Multiple factors are implicated. The real scientific challenge is to obtain hard quantitative estimates of the contributions of each of these factors to the so-called slowdown."

The researchers verified the cooling phenomenon by performing two different statistical tests to determine whether recent volcanic eruptions have cooling effects that can be distinguished from the intrinsic variability of the climate. The team found evidence for significant correlations between volcanic aerosol observations and satellite-based estimates of both tropospheric temperature and sunlight reflected by the particles off the top of the atmosphere.

"What's exciting in this work was that we could detect the influence of the volcanic aerosols in new ways. Using satellite observations confirmed the fact that the volcanic particles reflected a significant amount of the sun's energy out to space, and of course losing energy means cooling—and the tropospheric temperatures show that too," explains Solomon, who is also a researcher with MIT's Joint Program on the Science and Policy of Global Change. "There are still uncertainties in exactly how big the effects are, so there is more work to do."

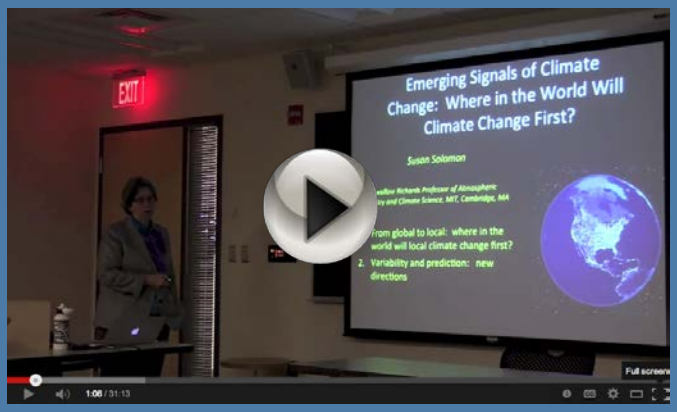
Alan Robock, a professor of environmental sciences at Rutgers University and a leading expert on the impacts of volcanic eruptions on climate, says these findings are an important part of the larger climate picture. "This paper reminds us that there are multiple causes of climate change, both natural and anthropogenic, and that we need to consider all of them when interpreting past climate and predicting future climate."

"Since none of the standard scenarios for evaluating future global warming include volcanic eruptions," Robock adds, "this paper will help us quantify the impacts of future large and small eruptions when they happen, and thus better interpret the role of humans in causing climate change."

This research was led by a team at Lawrence Livermore National Laboratory and builds upon work Solomon conducted in 2011, finding that aerosols in an upper layer of the atmosphere—the stratosphere—are persistently variable and must be included in climate models to accurately depict climate changes. ■

The research was supported by the U.S. Department of Energy.

Santer, B.D., C. Bonfils, J.F. Painter, M.D. Zelinka, C. Mears, S. Solomon, G.A. Schmidt, J.C. Fyfe, J.N.S. Cole, L. Nazarenko, K.E. Taylor and F.J. Wentz, Volcanic contribution to decadal changes in tropospheric temperature, *Nature Geoscience*, doi: 10.1038/ngeo2098, 2014.



WATCH INTERNAL RESEARCH SEMINAR VIDEOS

Solomon also presented her research at one of the Joint Program's weekly research seminars. Now sponsors can view this and other private seminars on the sponsors-only website. Watch the latest videos at: http://globalchange.mit.edu/sponsors-only/home

IN THE NEWS

A number of news outlets from around the world covered this exciting new research in *Nature Geoscience* on the contribution of volcanoes to the recent warming "hiatus." Read what *Reuters*, *UPI*, *International Business Times*, and *LA Times* had to say about this groundbreaking research: http://mitsha.re/1dAj2kW

Also watch the *TIME Magazine* video about this study: http://mitsha.re/ODHtIL

More Efficient Ways to Power our Flights

MIT researchers find a biofuel target for U.S. aviation makes progress, but a price on carbon or a carbon offset scheme would provide more bang for the buck.

As countries try to protect their domestic air carriers from a European Union proposal that would put a price on the emissions they release over European airspace, the global aviation industry is working to curb those emissions. Industry-wide, air carriers set a goal to be carbon neutral by 2020 and cut their emissions in half by 2050. One way they'll meet this goal is through the use of biofuels.

"Biofuels release significantly fewer emissions than conventional fuel, and could reduce fuel price volatility for airlines," says Niven Winchester, an environmental economist at the Joint Program on the Science and Policy of Global Change and the lead author of a study looking at the costs and efficiency of making the switch.

To meet the global targets, the U.S. Federal Aviation Administration has set its own goal to use one billion gallons of renewable biofuels each year starting in 2018. Because the goal includes U.S. Air Force and Navy carriers, which consume the vast majority of fuel, commercial airlines are responsible for just 35 percent of the target (350 million gallons). In studying this target, Winchester and his co-authors find that while a carbon tax or cap-and-trade system—as the Europeans have employed—would be the most efficient way to reduce emissions, there are ways to cut the costs of using biofuels. The study was published in the December 2013 issue of *Transportation Research*.

"The cost of abating emissions in the aviation sector is higher than in other sectors, so a broad cap-and-trade or carbon price policy that covers a variety of sectors would spread out those costs

and allow for improvements in technology and infrastructure," Winchester says. "But because employing a carbon tax or cap-and-trade appears to be politically infeasible at this time in the U.S., we looked for other ways to reduce emissions."

The researchers find that growing biofuel crops in rotation with food crops, as research from the U.S. Department of Agriculture suggests, can reduce the cost of biofuels. Pennycress, for example, is a winter annual crop that could potentially be grown in the Midwest in rotation with summer corn and spring soybean crops.

The researchers found that without any policy to constrain emissions, airlines will spend $3.41 per gallon of fuel in 2020, or about $71 billion for the year. Using biofuels that are not grown in rotation with food crops would cost $6.08 per gallon —almost double the cost of conventional fuel. But because the biofuel target for commercial aviation represents only 1.7 percent of total fuel purchased by the industry, the average fuel costs for commercial carriers would increase by only $0.04 per gallon. While a seemingly small change, airlines would spend $830 million more per year on fuel. That price tag becomes significantly smaller when biofuels are grown as rotation crops. In this scenario, the average fuel costs could increase by as little as less than one cent per gallon—raising total annual fuel costs by about $125 million.

Using rotation crops is not only a cheaper way of reaching the renewable target, it also delivers greater bang for the buck in terms of reducing emissions—costing just $50 per ton of CO_2 abated versus $400 per ton without their use. But again, it's far from the most efficient option: a broad carbon tax or cap-and-trade system. Under the European Union's Emissions Trading System, CO_2 cost $5 per ton in mid-2013, and is predicted to cost $7 per ton in 2018.

"Because biofuels would account for such a small portion of the total fuel used by commercial aviation, meeting the goal would have only a minor impact on the price of jet fuel. But it would also have a minor impact on emissions," Winchester says. "A broad cap-and-trade policy or a carbon offsetting scheme, as is currently being promoted by the International Air Transport Association, would reduce emissions at a lower cost by allowing aviation to tap into low-cost abatement options in other industries." ■

The study was funded by the U.S. Federal Aviation Administration.

Winchester, N., D. McConnachie, C. Wollersheim and I.A. Waitz, Economic and emissions impacts of renewable fuel goals for aviation in the US, *Transportation Research Part A: Policy and Practice*, 58(2013): 116–128, 2013, Reprint 2013-27.

2013 ANNUAL REPORT: FUTURE DIRECTIONS

In the 2013 annual report, the Joint Program leadership outlined 5 major research efforts for 2014. This list reflects a wide set of diverse capabilities and ongoing efforts.

1. An update of our uncertainty analysis to incorporate new model developments, the most recent data and observations, and a revised outlook for economic and emissions growth.
2. Redoubled efforts to better understand ocean circulation and biology given its importance in the observed variability and rate of atmospheric warming.
3. Study of the implications of the likely proposals of major countries and regions for COP21, and evaluation of those proposals against stated goals of the negotiation process.
4. Continued and broadened efforts to evaluate water, energy, food, and land interactions and the effects of global environmental change on these systems.
5. Development of an enhanced Global Land System to better represent the complex interaction and feedback among climate change, extreme climate events, the water cycle, carbon budgets and land-use change as these can lead to non-linear and/or threshold responses.

To read the complete 2013 Annual Report visit: http://globalchange.mit.edu/sponsors-only/reports

Impact of Renewable Energy on Thermoelectric Cooling Water Use

Water use and energy production are intrinsically linked, as thermoelectric cooling uses large quantities of water, often withdrawn from rivers and lakes. Water withdrawn for use in energy production makes up nearly half of all water withdrawals in the United States. As the electricity generation mix changes to include more renewables, it will doubtless affect how much water is withdrawn from aquatic ecosystems, and how that water is consumed during electricity production. MIT Joint Program Researchers have developed a modeling tool to assess these changes. The model, called WiCTS (Withdrawal and Consumption for Thermoelectric Systems), estimates the amount of water used by a variety of electricity generation technologies at the regional level.

In a study published in the *Journal of the American Water Resources Association*, researchers use WiCTS in a case study to evaluate changes in future water use caused by increased use of renewable technologies, such as wind, solar, geothermal and nuclear. They find that at the national level, as the proportion of renewables in the electricity mix increases water withdrawals decrease. At the state level, WiCTS' ability to provide regional results reveals a more complex picture of future water use. Decreases in water withdrawals are concentrated in water-rich areas. Water-stressed areas, on the other hand, are more likely to see water withdrawals and consumption increase as the result of a switch to renewables. Coastal areas that rely on withdrawals of salt water for cooling will see an overall decrease in water withdrawals, but will see an increase in their fresh water withdrawals. These results suggest that in some regions the use of dry cooling technologies, though more expensive, may be beneficial in limiting water scarcity. ■

Baker, J., K.M. Strzepek, W. Farmer, C.A. Schlosser, Quantifying the Impact of Renewable Energy Futures on Cooling Water Use, *Journal of the American Water Resources Association*, in press.

CONGRATULATIONS

Noelle Selin, research scientist and assistant professor in the Engineering Systems Division and Earth, Atmospheric and Planetary Sciences, was recently appointed to the Global Young Academy, an international group of 200 young scientists selected based on research excellence and commitment to impact. Through GYA, members are linked to the senior international academy network, meet outstanding leaders of the international science community and may be nominated to contribute to international policy statements and working groups. Appointments are for a period of four years.

Selin's research focuses on using atmospheric chemistry modeling to inform decision-making strategies on air pollution, climate change and toxic substances including mercury and persistent organic pollutants. She has also published articles and book chapters on the interactions between science and policy in international environmental negotiations, in particular focusing on global efforts to regulate hazardous chemicals and persistent organic pollutants.

Selin, who will be formally appointed at a GYA symposium on May 21st, says she is very much looking forward to leveraging her new appointment to expand the reach of her science-policy work and educational initiatives.

Sharpening our Climate Game

Valerie J. Karplus is a research scientist at the MIT Joint Program on the Science and Policy of Global Change and the director of the Tsinghua-MIT China Energy and Climate Project.

By: Valerie J. Karplus

For decades, the U.S. has spearheaded smart environmental ideas. But when it comes to tackling climate change, we're at a serious risk of falling behind a rising global powerhouse: China.

Chinese leaders see strong economic incentives to take the actions Washington has been tiptoeing around for decades. The country is piloting limited emissions trading on the way to a national program, while we have not revisited the idea since the Waxman-Markey Bill died in 2009. But what happens if Beijing acts and we don't? Many policymakers shrug, arguing that climate policy in China would raise production costs and help U.S. products compete.

This argument is dead wrong. Where advanced industrialized countries see high climate policy costs in the form of slower growth and politically unpalatable economic shifts, China's leaders see benefits. If decision-makers in the U.S. looked harder they might see the benefits of raising their game too. Instead, we continue to play carbon whac-a-mole with vehicle regulations and renewables in the power sector—piecemeal policies that research proves offer less bang for the buck than a simple price on carbon. Meanwhile, China is putting industrial leaders on notice to clean up or clear out.

Taking their foot off the growth accelerator, China's leaders see climate policy as consistent with smart moves aimed at helping China transition from a heavy industry, and primarily investment-driven economy, to a high technology, high value added service-based economy. This would not only help China's leaders clear the skies at home, but position them as a stronger competitor to the service-based economy of the U.S.

The Chinese government also believes a climate policy offers an effective way to coordinate the activities of diverse local interests in ways that support its economic transition. China's leaders see this as a way to support economic growth, while in the U.S. economic growth lags.

"China's leaders see this as a way to support economic growth, while in the U.S. our economy lags."

At the same time, climate policy in China will spur investments in efficiency and low-carbon technology in an economy that faces huge opportunities to use energy more productively. China's businesses will gain expertise in delivering cheaper, less polluting low-carbon energy that will enhance their competitiveness in the long run. At risk of falling behind in the climate game, the U.S. should be revisiting the rules, instead of lamenting the high profile defeats of government-backed companies like Solyndra.

But it's not too late for us to catch up.

As climate negotiators prepare to discuss the commitments all countries are expected to lay out by the end of 2015 to reduce greenhouse gases, the U.S. has another chance to show we can still be environmental leaders. By implementing a sensible, economy-wide charge on emissions of carbon and other greenhouse gases, and using the revenues to offset looming costs on other fronts, balance out our debt, and compensate vulnerable groups, we'll see wins for our economy, health and climate. But this window of opportunity is rapidly closing.

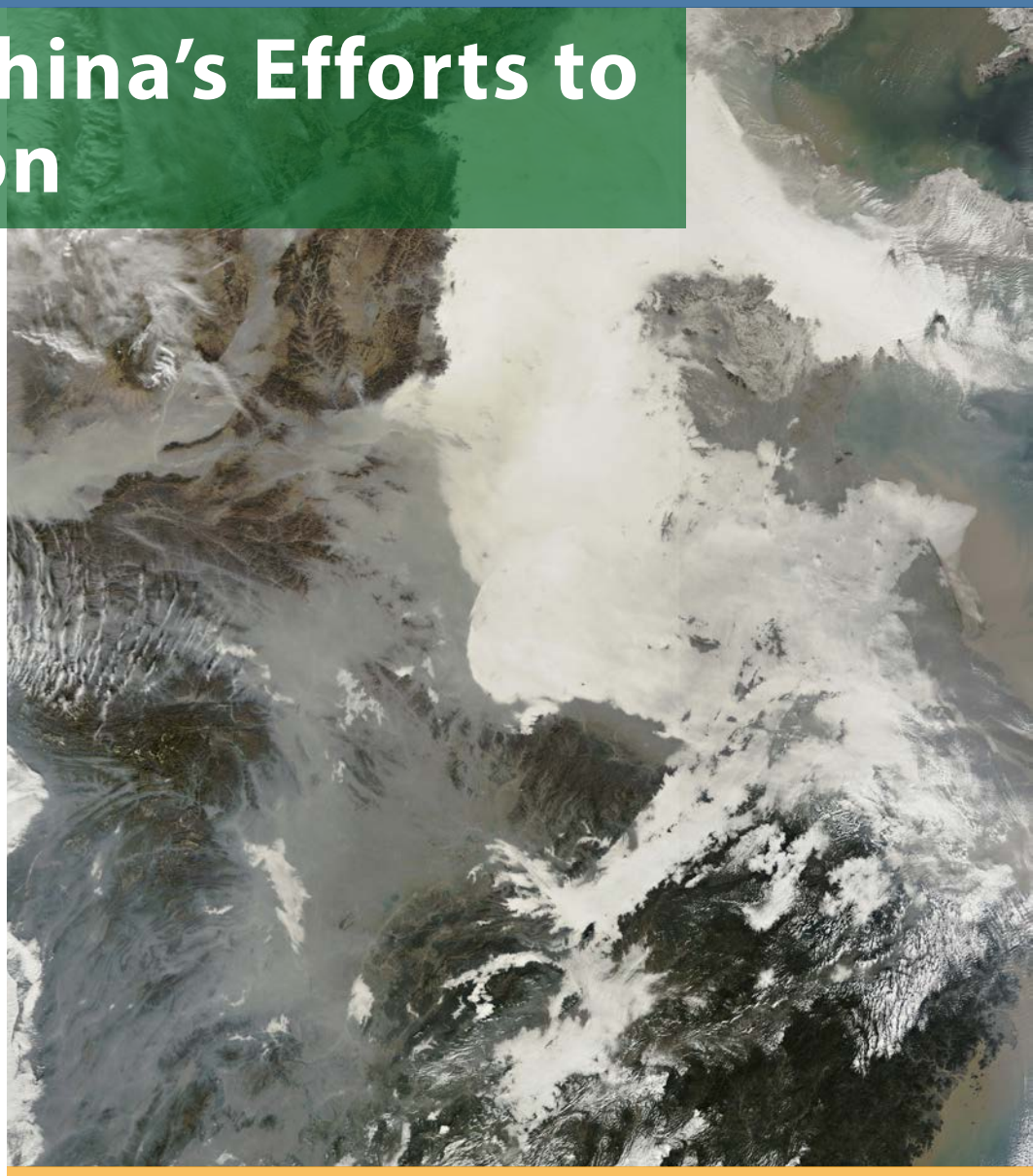
For the U.S., China's incentives for action may be an inconvenient truth. ■

WELCOME GENERAL MOTORS

In January, General Motors became a new sponsor of the Joint Program. To see our complete list of sponsors visit: http://globalchange.mit.edu/sponsors/all

China Energy and Climate Project

Assessing China's Efforts to Trade Carbon



Tsinghua, MIT researchers shed light on the policy steps needed to reduce the barriers to implementing an effective national emissions trading system.

China has the world's largest carbon footprint and the government is taking action. In an effort to reduce carbon emissions—using a market-based approach—the Chinese government is implementing an emissions trading system (ETS) pilot program in seven cities and provinces under the Twelfth Five-Year Plan passed in 2011. These new pilots are in various stages of implementation—five have officially launched and the remaining two are expected to launch later this year. It is too early to judge the potential for success of these new pilots, but the goal is to have the trading system firmly established before 2015.

In research published in *Energy Policy*, Tsinghua University and MIT researchers came together to analyze the current pilots, identify challenges that have emerged and outline the important steps needed to bring this system to a national scale.

"The Chinese government is interested in using market-based measures like the ETS to minimize the costs of reducing energy consumption and carbon emissions, while balancing equity goals," says Da Zhang, the lead author of the study and a researcher at the Tsinghua-MIT China Energy and Climate Project. "This pilot program serves as an important first step in working towards a national effort to address global climate change."

While China's emissions trading efforts display a commitment to reducing CO_2 emissions, the researchers explain that there are a series of policies that need to be implemented at the national level to help build the necessary institutions and structures for an effective ETS.

According to their analysis, they find that the Chinese

government needs to create legislation that sets penalties for exceeding CO_2 limits and coordinate the implementation of the ETS pilots with other national and provincial climate, energy and economic policies.

In assessing the pilots, the researchers find that the ETS pilot designs vary widely, with different demographics, priorities and industries covered under the plans.

"Policymakers believe this process will allow local communities to experiment with trading for different industries and tailor their ETS to meet their diverse needs—instead of imposing a one-size-fits-all policy for all of China," says Zhang, a PhD student at Tsinghua University.

For example, only in Shanghai will aviation be included, and only in Tianjin will the oil and gas exploration sector be covered. But at a national level, there will need to be better coordination and an eye towards planning for a national ETS.

"We recommend an expert assessment team be appointed by multiple agencies to help identify interactions between policies and avoid redundancies," says Valerie Karplus, co-author of the study and the director of the Tsinghua-MIT China Energy and Climate Project.

"Transparent and independent reporting of carbon emissions is also crucial to a successful ETS," Karplus explains. It will take a long time to build capacity at the local and national levels to train agencies to monitor, report and verify data, but, Karplus says this will be essential to strengthening the reduction efforts.

"A sustained effort to develop an ETS in China is likely to deliver great benefits—nationally and globally—and I hope our research can help policymakers refine and improve their current efforts," says Zhang. ■

NASA Earth Observatory image of air pollution over Bejing and Tianjin, January 2013.

Zhang, D., V.J. Karplus, C. Cassisa, and X. Zhang , Emissions Trading in China: Progress and Prospects, *Energy Policy*, in press, 2014.

ARCHIVE OF TRANSPORTATION WEBINAR

Vehicle Fuel Economy Standards: A global policy update and implications

Presented by Valerie J. Karplus on March 20th

This webinar reviewed the current status of fuel economy standards for new light-duty vehicles around the world. In particular, it focused on recent developments in the European Union and the United States, including progress toward meeting the latest standards as stringency increases as well as any midstream revisions of targets. This work builds on past work in the Joint Program on the cost effectiveness of vehicle fuel economy standards.

Watch the archived version on the sponsors-only website at: http://globalchange.mit.edu/sponsors-only/webinar/#archive

The Tsinghua-MIT China Energy and Climate Project is a collaborative effort between the MIT Joint Program on the Science and Policy of Global Change and the Institute for Energy, Environment and Economy at Tsinghua University in Beijing, China. This group is working to analyze the impact of existing and proposed energy and climate policies in China on technology, energy use, the environment and economic welfare.
Learn more: http://globalchange.mit.edu/CECP

Calculating China's Carbon Emissions from Trade

Tsinghua, MIT researchers find China's plan to restructure the economy will have limited impact on reducing global CO_2 emissions associated with the production and trade of goods.

China is the world's second largest national economy and its largest exporter. This growth has come at a cost, with energy demands and associated environmental damages on the rise. China is now the world leader in consumer energy use and CO_2 emissions. As countries around the globe work to reduce carbon emissions, policymakers are interested in measuring and ultimately reducing emissions associated with the relocation of industry and manufacturing overseas.

In a study released in the March issue of *Energy Economics,* researchers at Tsinghua University and MIT developed a new model to determine if policy proposals could help reduce carbon emissions associated with goods exported from China. They found that taxes on energy-intensive exports and policies encouraging the Chinese economy to shift from industry to services are ineffective in significantly reducing total CO_2 emissions, because the same goods would still be produced elsewhere.

"Developed countries are discussing the possibility of imposing a trade tariff on emissions embodied in imported goods in an effort to prevent the relocation of high-emitting industries overseas and to shore up domestic competitiveness," says Tianyu Qi, a PhD student at Tsinghua University and the lead author of the study. "It is important to understand how vulnerable the Chinese economy is to such a policy."

Approximately 22 percent of China's CO_2 emissions are the result of net exports. These emissions are categorized as "trade-embodied" emissions because they are produced as a result of goods and services that are exported.

In their analysis, the researchers considered the impacts of two policies that are similar to measures included in China's Twelfth Five-Year Plan. The first policy is a tax on energy-intensive exports and the second policy involves incentivizing a shift in China's economy away from industry and towards services.

"In exploring these policies—both of which are advertised as carbon-reducing strategies—we find that neither would have a significant impact on total global emissions because reduced production in China is partially offset by increased production elsewhere," says Qi, also a researcher with the MIT-Tsinghua China Energy and Climate Project.

If policymakers want to simply reduce emissions associated with China's trade, the researchers suggest policies that support economic structural changes.

"A policy that targets the expansion of domestic demand, along with a shift toward services, is more effective at reducing China's export-embodied CO_2 emissions," says Valerie Karplus, co-author of the study and the director of the Tsinghua-MIT China Energy and Climate Project. "This will in turn reduce China's exposure to potential tariffs on embodied carbon imposed overseas."

Karplus explains that such a move is not a long-term solution to reducing CO_2 emissions and would ultimately shift production of many industrial products to other nations—shifting emissions along with them.

The researchers also find that the EU, the U.S. and Japan are the largest net recipients of trade-embodied CO_2 emissions. In addition, the researchers expected energy-intensive industries such as steel and aluminum production to be responsible for most of the CO_2 emissions associated with China's trade, but instead they found the production of machinery and equipment to be the main culprit.

"This is because China exports large volumes of machinery and equipment products, such as refrigerators and televisions, even though commodities such as aluminum and steel are more CO_2-intensive than these products," explains Niven Winchester, an environmental economist in MIT's Joint Program on the Science and Policy of Global Change and a co-author of the study.

To analyze the impact of policies on CO_2 emissions, the MIT-Tsinghua China Energy and Climate Project developed a new model called the China-in-Global Energy Model, or C-GEM. C-GEM disaggregates China's 30 provinces and details the entire energy system. The model also includes global trade data to measure the interactions between China and the global economy. ■

Qi, T., N. Winchester, V.J. Karplus and X. Zhang, Will economic restructuring in China reduce trade-embodied CO_2 emissions?, *Energy Economics*, 42(March): 204–212, 2014, Reprint 2014-14.

COMMENTARY

Transforming China's Grid, *The Energy Collective*

Michael Davidson, a doctoral student with the China Energy and Climate Project, critically examines China's efforts to reinvent and decarbonize its power sector and other energy goals. He recently wrote two pieces as part of a new *Energy Collective* column: "East Winds, with Michael Davidson."

China's Electricity Sector at a Glance: 2013
February 3, 2014
http://mitsha.re/1qpkdwf

Spilled Wind: An Update on China's Wind Integration Challenges
March 4, 2014
http://mitsha.re/1qpknUt

CECP THIRD ANNUAL STAKEHOLDER'S MEETING

June 10, 2014, 9:30 a.m. - 1:30 p.m, Wenjin Hotel, Beijing

The purpose of this meeting is to present recent research to members of the policy community and a broader audience of industry and academic stakeholders, including CECP's new analysis "Towards COP 21 and Beyond: An Energy Outlook for China." To RSVP, email: vkarplus@mit.edu

"Part of the problem is all the publicity on global warming has sent out a message that global warming is highly politicized, and has nothing to do with science. Nothing could be further from the truth."

Kerry Emanuel: Bringing Global Warming Science from Classroom to World

Climate change is widely recognized as one of the foremost challenges of this century—one with major repercussions for energy, health, agriculture, and more. Kerry Emanuel, MIT's Cecil and Ida Green Professor of Atmospheric Science, therefore feels it is his duty as a citizen and scientist to educate a broad audience on the possible impacts of climate change.

Emanuel is no stranger to the task. For decades, he has educated students, politicians, the media, and even climate skeptics about the science behind climate change. Named one of *Time* magazine's 100 most influential people of 2006, Emanuel recently wrote a book geared toward educating the public on the subject: *What We Know About Climate Change*. He is also a co-founder and director of the Lorenz Center, a climate think tank housed within MIT's Department of Earth, Atmospheric and Planetary Sciences.

In spring 2014, Emanuel took his role as public educator one step further with the launch of 12.340x Global Warming Science, a new massive open online course (MOOC) from MIT's edX platform that aims to provide a solid scientific foundation for understanding what is really happening with climate change.

The class is aimed at sophomores and juniors from all over the world, in particular, those who have taken electrodynamics, classical mechanics, and some thermodynamics. It's a serious science course, says Emanuel, which distinguishes it from the handful of other online courses currently being taught beyond MIT on the subject of climate change, most of which have a large policy component.

Emanuel's approach to teaching the class maintains a clear boundary between the science and the policy of climate change.

"Part of the problem is all the publicity on global warming has sent out a message that global warming is highly politicized, and has nothing to do with science," he said in a recent interview. "Nothing could be further from the truth."

Emanuel is pleased with the number of students who have shown an interest in the course: More than 10,000 are registered this semester.

He says one of the benefits of the online class is that students can sign up and take the class wherever they live. This semester he has students from all over the world, including India, Bangladesh and several African countries.

"It allows me to reach people who might be very bright, very engaged, possibly future leaders in the field, who otherwise don't have the opportunity to take a real college course at a

real college because of financial, political, or other reasons," Emanuel says. "This opens up a world to them. If they're motivated, I think they can get just as much, if not more, out of the edX platform as someone taking it in the classroom."

In addition to helping Emanuel reach future leaders in the field who don't have the means to attend MIT, the online course has special features intended to enhance the learning experience beyond what a traditional physical classroom can support. One of those features is an online discussion and help forum where students working on problem sets can ask other students or teaching assistants for help. The answers to questions are then voted on by other participants, providing a natural system of selecting the best comments.

Another notable feature of the class is the opportunity for students to work with a simple, interactive climate model that takes inputs such as solar radiation and atmospheric greenhouse gas content and calculates the temperatures of the Earth's surface and atmosphere. Users can change variables such as the intensity of sunlight, the time of year, the greenhouse gas concentrations, and more to see how they affect climate change and learn by comparing scenarios they generate themselves.

What has stunned Emanuel about the edX class is that it has spurred interest in the physical classroom version of Global Warming Science—a class within the Energy Studies Minor that Emanuel and his co-instructor, MIT Professor of Physics and Planetary Science Sara Seager, decided not to offer this spring after enrollments were low for several years.

"Ironically, it seems that the MOOC is drawing more MIT students to have an interest in the classroom course," Emanuel says, surmising that he will probably offer the physical classroom version of the class again next year.

Striking balance

Throughout his time educating politicians and the public about climate change, Emanuel has found himself side-by-side with climate skeptics on multiple occasions. Most recently, he was invited to give a talk at an event hosted by conservative Christians, who often find themselves at odds with other conservative groups because of their yearning to protect nature.

To address the concerns of climate skeptics in the room, Emanuel did what he normally does when in such situations.

"You can't give them a climate education in 30 minutes," Emanuel says. "But what you can do is talk to them about the way scientists look at the problem, from a societal standpoint, and that's by framing the problem in terms of risk assessment and management…How much insurance are you willing to pay out to avoid a low probability, but very, very high impact event?"

Emanuel also encourages Democrats and Republicans alike to fight the fights worth fighting—the ones that are rational and need action from lawmakers. He gives nuclear power as one example of a fight that leaders should take up. Last year, Emanuel and three other top climate scientists wrote an open letter to world leaders in support of the development of safer nuclear power systems.

"I'll say to [conservative skeptics], if you want to fight the left, don't fight this battle, fight other battles. You should be out there fighting for nuclear power, which the left is opposed to, irrationally. You should be out there fighting to get research on carbon sequestration," Emanuel says. "I'd rather see someone fighting those battles than trying to deny that there's a problem, because those battles might become a bipartisan, intelligent conversation about our mixture of energy sources. But if we keep fighting the old fight, nobody is going to do anything at all. "

He comments, "I'm always horrified when ideology trumps evidence and reason."

Emanuel has always been guided by a strict adherence to reason. When he was growing up in the 1960's and 70's, he found that those who argued irrationally tended to be on the left. So he became a Republican. But over the last decade or so, he switched to become a registered independent.

"All the excesses, as far as I can see, are on the right now. I didn't change so much. They changed," Emanuel says.

But it wasn't politics that attracted Emanuel to the challenge of climate change to begin with, and it surely won't be politics that keeps him battling for more public awareness. As always, Emanuel remains focused on the science and hopes decision makers will as well.

"We have people wholly ignorant of science who are making important decisions in this country. And their constituents aren't necessarily any better educated on this subject. That's going to be the downfall of us," Emanuel says. "I do feel a duty as a citizen to try to get education on the subject to a much broader audience."■

Student Spotlights

Michael Davidson: Wind Integration Challenges in Northeastern China

Early in his academic career, Michael Davidson recognized the importance of understanding both the science and policy of energy technologies. As a student at Case Western Reserve, Davidson researched alternative energy materials while studying physics and math. He then spent a summer in Washington, D.C., using his knowledge of Japanese to work on international relations legislation for a small think tank.

"When I left undergrad I was looking for opportunities to explore the intersections of these topics," explains Davidson, a Technology and Policy Program (TPP) masters student who will graduate in June and continue on for his PhD.

After undergrad, Davidson went to China on a Fulbright Scholarship and studied the development impacts of energy access policies. This experience began a commitment to researching the challenges of renewable energy policy for the world's largest greenhouse gas emitter—leading him to MIT, where Davidson is now a Research Assistant for the MIT-Tsinghua China Energy and Climate Project.

"I wouldn't have come to MIT if I wasn't able to be on the China Project because it is a unique combination of this broad focus on technology and policy, but also a dedicated focus on China, which is pretty rare in this field," Davidson says.

He believes renewables are the major game-changer in efforts to reduce carbon emissions around the world. In particular, he says most future climate projections rely on

estimates of renewable power utilization, while there is still so much unknown on how to successfully bring these resources to scale. China plays a vital role in this effort.

"China is obviously the most important actor from the perspective of long-term climate change, and this plays out in foreign policy, its economy, as well as the scaling up of renewable energy," says Davidson. "If you can't get renewables to work in China, it will matter much less what you can accomplish elsewhere to mitigate carbon emissions."

Davidson focuses his research on wind resources in northeastern China, where about 20–30 percent of wind resources are being wasted because of a host of technical and regulatory barriers to integrating wind power.

"It involves a whole mess of different stakeholders—the grid, other generators, governments, consumers, industry. It's just a lot of different players. It's actually a really technical and complicated modeling challenge." This challenge was very appealing to Davidson—who likes thinking about complex systems.

Coal is the major energy source in the northeast, which has led to significant air pollution challenges. Because of technical constraints, coal-fired plants are not able to transition fast enough to meet the variability of wind. Other barriers to integration include co-generation power and heat plants, policies guaranteeing coal plants a certain percentage of the power sector, and other historical policies that benefit incumbent generators. As a result, this region has lost out on the benefits of wind power, despite abundant wind resources.

To tackle this challenge, Davidson built an operational power systems model where he is able to simulate what each generator is doing every hour—turning on, turning off, ramping up, ramping down. He then added a layer simulating wind power generation using data from NASA's MERRA data set, which is gives hourly data for a 31-year timespan.

Once he built the model, Davidson was able to model the optimal amount of wind energy that the power system could produce and compare that to the actual amount of wind power generated over a year.

Davidson's research demonstrates that technical constraints alone cannot explain the high rates of curtailment seen in the northeastern region of China. In addition, he is able to dig deeper and quantify how each policy is affecting wind generation.

"This research will have important implications for policymakers who are looking to decarbonize and reduce China's dependence on coal," says Davidson, who hopes his findings will provide recommendations for ways to reform the power sector in both the short and long term.

Davidson will complete his thesis in May and present this research at the third annual CECP stakeholders' meeting in June of this year. He will then continue on in the China Project and pursue his PhD in the Engineering Systems Division. ■

IN THE NEWS

On January 21st, Michael Davidson was interviewed by Channel NewsAsia about the challenges of reforming China's energy sector. He discussed the potential impact of state-owned enterprise reform on the power sector.

More: http://mitsha.re/1eSuQQb

Anna Agarwal: Risk Management in Energy Projects

When Anna Agarwal came to MIT to pursue graduate studies in civil and environmental engineering she wanted to better understand the challenges of the energy sector and work to develop solutions for the future. Following an internship at the Planning Commission for the government of India, Agarwal quickly embraced MIT's many energy courses, student clubs and research programs.

After serving in the leadership of the MIT Energy Club and taking courses in energy and climate change, Agarwal knew she wanted to research the engineering, technological, policy and economic decisions that make up energy systems.

"I took the global climate change course (12.348J/15.026J Global Climate Change: Economics, Science, and Policy), which Ron Prinn and Jake Jacoby were teaching at the time," says Agarwal, who will complete her PhD this spring. "All of these classes and experiences made me more informed and excited about climate change issues."

Agarwal grew up in India and completed her undergraduate studies at the Indian Institute of Technology in Delhi.

During her time at MIT, Agarwal has been a research assistant in the Center for Energy and Environmental Policy Research (CEEPR) and worked with John Parsons on maximizing the value of large energy capital projects in the face of various risks. Agarwal was interested in learning how social science and finance determine the success or failure of large energy systems.

"Energy is a very interesting area because there are a lot challenging engineering problems and it is also a very important topic in the current times—growing energy demands, problems with energy supply and challenges of climate change. These are not just interesting, but also important topics to work on."

For her masters, she developed a decision-making framework for complex systems—where she could account for uncertainties and regulations. This project allowed her to combine her interest in engineering and technological systems with new knowledge in regulations and risk.

Agarwal built on this research with her PhD thesis on risk management for carbon capture and sequestration (CCS) projects.

"CCS is projected to play a key role in reducing global greenhouse gas emissions, but the IPCC finds the actual deployment of CCS might be limited because of the various risks and uncertainties involved," explains Agarwal.

"These projects involve large up-front investments, and future cash flows are subject to a lot of uncertainty. So it's very important that the up-front risk-management processes that you develop account for these uncertainties to maximize the financial returns."

Unfortunately, for most capital projects, underperformance is more of a rule than an exception and as a result, there are significant financial losses. In an effort to shed more light on this problem, Agarwal developed a risk management framework that takes into account external risk factors, like volatility in the market, and internal inefficiencies arising from conflicts of interest between project entities.

She then applied her risk management framework to a CCS and enhanced oil recovery (EOR) project to analyze the risks and uncertainties. She analyzed an integrated project that included all phases of CCS: CO_2 capture, transport and storage.

"We found that the internal efficiencies are particularly influenced by the contract terms that link the different entities involved in the project," says Agarwal. "Contract terms determine how the project cash flows will be distributed among the involved entities, how each entity is exposed to risk and what are the incentives for optimal performance."

Agarwal finds that efficient contract structures that empower each entity to make decisions that maximize the overall integrated project value are the most effective in optimizing large capital energy projects. She was also able to quantitatively demonstrate the importance of contract structures in managing both internal and external risk factors.

The framework that Agarwal developed will help businesses and policymakers effectively evaluate optimal risk management decisions and incentive structures to encourage the commercial deployment of CCS.

Currently, Agarwal is working to apply some of her thesis experience to Sergey Paltsev's research on evaluating the risk of natural gas investments in Cyprus. She was grateful for the opportunity to see her research be applied to a project that was used ultimately by industry and policymakers.

Agarwal credits the Joint Program, CEEPR and the MIT Energy Initiative with giving her the tools to understand the economics and finance aspects of deploying large-scale energy technologies.

"You see engineers and economists working together addressing these problems. This interdisciplinary nature makes the Joint Program, CEEPR, and MIT unique. You get a lot of flexibility and encouragement to do this type of work," says Agarwal.

Agarwal will graduate this June and plans to continue to work on enabling the energy sector to address the many economic, political and environmental challenges they face. ■

EDUCATION & OUTREACH

John Reilly recently spoke on a few panels about integrated assessments, climate policies and risks to food and agriculture.

Yale Climate and Energy Institute Conference
"Uncertainty in Climate Change: A Conversation with Climate Scientists and Economists," Yale University
http://mitsha.re/1kPoMg1

KCRW Interview
Greenhouse Gas Emissions and America's Climate Change Deniers http://mitsha.re/1kPpmuf

Voice of Russia
Climate change: who stands to win and who to lose?
http://mitsha.re/1kPpJ82

The Environment @ MIT

2014 Global Change Independent Activities Period (IAP) Courses

Global Change Science

On January 23rd, students Daniel Rothenberg and Daniel Gilford of EAPS introduced the fundamentals of climate science and provided an overview of what climate scientists know about our current and future climate. The talk covered the greenhouse effect, introduced the human-induced and natural climate forcing components such as greenhouse gas emissions, ozone, volcanic eruptions, aerosols, and short lived climate pollutants. Emphasis was on the complexity and uncertainty regarding current understanding and future projections of the earth's climate. The link between climate and extreme weather was also discussed.

Economics and Policy of Global Change

On January 30th, students Arthur Yip and Michael Davidson of TPP and ESD outlined how energy use and greenhouse gas emissions are linked to the world economy and the technologies we use, how climate change impacts affect us, and the mitigation and adaptation instruments available. The course also surveyed policies in place, and major challenges and opportunities as the world works toward coordinated action. One of the presenters attended the recent UN climate talks held in Poland and reflected on next steps toward a new global climate agreement in 2015. More: **http://mitsha.re/1hURWtI**

The Role of the Free Market in Solving the Climate Crisis

On November 19th, John Reilly participated in a panel sponsored by the Massachusetts League of Women Voters on Pricing Carbon. Some of Boston's preeminent scholars and economists explained how a revenue-neutral carbon tax could revolutionize the economy and unite Republicans and Democrats in the fight against climate change.
Watch the video from the event: **http://mitsha.re/I5bpu3**

MIT Energy Conference

Biofuels and Batteries as Leading Alternatives: Powering our Transportation Future

On February 21st, John Reilly moderated a panel on the future of transportation with Lee Lynd (Mascoma), Ramon Gonzalez (ARPA-E), William Chernicoff (Toyota), and Ulrich Schulz (General Motors). Biofuels were envisioned to dominate the future of post-fossil transportation fuels; however, recent advances in batteries and electric vehicles have exerted intense pressure on the market. This panel examined how the government, biofuels producers, and the auto industry view the future of these competing classes of technology, and asks whether current policies promote a level playing field to drive long-term sustainability.

Policy and Economics of Carbon Panel

On February 22nd, John Reilly moderated a panel on the policy and economics of carbon with Michael Wara (Stanford), A. Denny Ellerman (MIT CEEPR), Greg Jason (Cargill) and Ken Kimmell (RGGI). While a national carbon credit trading scheme remains elusive, carbon markets are still viewed as an important policy tool for combating climate change. Experience has shown that good design is critical in developing a market that achieves the creators' objectives. These past experiences, along with the insights of economic, policy, and business experts, must be considered when crafting the carbon market programs of the future.
More: **http://mitsha.re/1hUWsIt**

GEOENGINEERING: SCIENCE & GOVERNANCE

Sponsored by the MIT Joint Program and the Harvard University Center for the Environment

Geoengineering's Brave New World

On February 20th, Scott Barrett, the Lenfest-Earth Institute Professor of Natural Resource Economics at Columbia University presented on the types of policies and international treaties that would have to be implemented for successful global engagement on geoengineering. Scott Barrett is a leading scholar on transnational and global challenges, ranging from climate change to disease eradication. His research focuses on how institutions like norms, customary law, resolutions, and treaties can be used to promote international cooperation. He has advised a number of international organizations, including the United Nations, the World Bank, the OECD, the European Commission, and the International Task Force on Global Public Goods. More: **http://mitsha.re/MEIVcH**

Exploration of Marine Cloud Brightening

In this presentation on March 13th, Phil Rasch, Chief Scientist for Climate Science at the Pacific Northwest National Laboratory discussed his latest research exploring marine cloud brightening. He reviewed some of his Large Eddy Simulation (LES) modeling work on aerosol injections and mixing in the stable high-latitude boundary layer and their impact on mixed-phase clouds. He then connected this work to recent and proposed observations and field experiments, and to global modeling studies. More: **http://mitsha.re/1lzlX5o**

To Frack or Not to Frack: The Shale Gas Revolution and Its Discontents

On March 4th, Henry "Jake" Jacoby, Professor of Management, Emeritus in the MIT Sloan School of Management and a co-founder of the MIT Joint Program on the Science and Policy of Global Change spoke at the Walden Forum's spring lecture "To Frack or Not to Frack: the Shale Gas Revolution and Its Discontents." The discussion covered the risks and rewards and the facts and fears of shale gas. In addition, Jake discussed how, going forward, policymakers can effectively manage a technology that has, in a very few years, become a major component of the U.S. energy system, and is likely to remain so for decades to come.
More: **http://mitsha.re/1cVzyl5**

WorldBoston: Food Secuirty and Climate Change

On March 11th, John Reilly presented with Dr. Calestous Juma, Director of the Science, Technology, and Globalization Project at Harvard's Belfer Center on food, climate and population growth. The event was held at the Boston Public Library and was sponsored by WorldBoston. Currently a sixth of the world's population suffers from chronic hunger, and a changing climate threatens to wreak havoc on already insecure and vulnerable populations. As food and water become scarce, and once fertile land becomes barren, the U.S. finds itself faced with new challenges in securing the globe. The U.S. is getting ready, but can it lead the way to climate reform? More. **http://www.worldboston.org/**

UPCOMING EVENTS
Learn about our upcoming events and programs
http://mitsha.re/1bSjgls

XXXVI MIT Global Change Forum
Preparing for Climate Extremes
29–31 January 2014
The Biltmore Hotel, Coral Gables, FL

Wednesday	7:00 – 8:00 pm	**Keynote Address**
	Dr. Jerry M. Melillo, *Distinguished Scientist, Director Emeritus, The Ecosystems Center, Marine Biological Laboratory, Woods Hole, Massachusetts*	
Thursday	8:30 –10:00 am	**Coastal Infrastructure & Severe Tropical Storms**
	Professor Stephen P. Leatherman, *Florida International University*	
	Mr. Brent Dorsey, *Entergy Corporation* ***(Presentation available by individual request to speaker)***	
Thursday	10:30 – 12:00 pm	**Floods & Droughts**
	Professor David T. Allen, *University of Texas, Austin* ***(Presentation available online)***	
	Dr. Kenneth Strzepek, *MIT Joint Program* ***(Presentation available online)***	
Thursday	2:00 – 3:30 pm	**Arctic & Energy Vulnerability**
	Professor Daniel M. White, *University of Alaska, Fairbanks* ***(Presentation available by individual request to speaker)***	
	Mr. Beez Hazen, *Northern Engineering & Scientific, Alaska*	
Thursday	4:00 – 5:30 pm	**Health, Heat Waves & Air Pollution**
	Dr. George Luber, *Centers for Disease Control & Prevention*	
	Dr. Tammy M. Thompson, *Colorado State University*	
Friday	8:30 – 10:00 am	**Preparation for COP 2015: U.S. and China**
	Dr. Valerie Karplus, *MIT Joint Program* ***(Presentation available online)***	
	Dr. John Reilly, *MIT Joint Program* ***(Presentation available online)***	
Friday	10:30 – 12:30 pm	**The Outlook for COP 2015**
	Dr. Phil Sharp, *Resources for the Future*	
	Ms. Melissa Low, *National University of Singapore*	
	Dr. Juan Carlos Belausteguigoitia Rius, *Centro Mario Molina, Mexico*	
	Mr. Stig O. Svenningsen, *Norwegian Ministry of Petroleum and Energy*	

To access available presentations visit:
http://globalchange.mit.edu/sponsors-only/forum/archive

Coming and Going

Alexandra Cosseron was a visiting student from Ecole Polytechnique and returned home to complete her studies.

Anna Agarwal graduates in June and will pursue a job in the energy field.

Evan Couzo and **Fernando Garcia Menendez** accepted post doctoral appointments with Noelle Selin.

Simon Koesler, a student of Prof. Andreas Löschel, from the Centre for European Economic Reaserch joined us as a visiting student working on economic modeling with Sergey Paltsev.

Megan Lickley has taken a leave to pursue research in Central Africa.

Michael Mehling has been appointed the new executive director for CEEPR, replacing **John Parsons**.

Alli Gold Roberts resigned as communications assistant and accepted a job as policy associate at Ceres.

Newly-Released Joint Program Reports

Report 258: Characterization of the Wind Power Resource in Europe and its Intermittency

Report 257: Equity and Emissions Trading in China

Report 256: The Potential Wind Power Resource in Australia: A New Perspective

Report 255: The Mercury Game: Evaluating a Negotiation Simulation that Teaches Students about Science–Policy Interactions

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February 14, *Wall Street Journal,* California's Auto-Emissions Policy Hits a Tesla Pothole

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