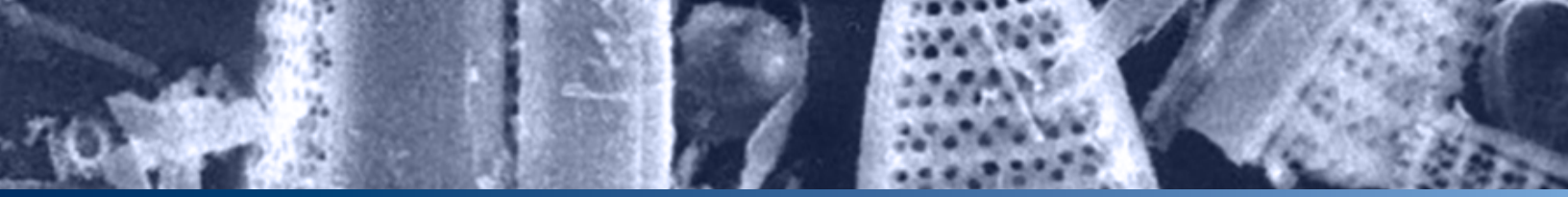


GLOBAL CHANGES

MIT JOINT PROGRAM ON THE SCIENCE & POLICY OF GLOBAL CHANGE

SPRING 2018 NEWSLETTER

OUR RESEARCH MISSION

At the Joint Program, our integrated team of natural and social scientists studies the interactions among human and Earth systems to provide a sound foundation of scientific knowledge. Such a foundation will aid decision-makers in confronting the interwoven challenges of future food, energy, water, climate and air pollution issues, among others.

Our mission is accomplished through:

- *Quantitative analyses of global changes and their social and environmental implications, achieved by employing and constantly improving an Integrated Global System Modeling (IGSM) framework;*
- *Independent assessments of potential responses to global risks through mitigation and adaptation measures;*
- *Outreach efforts to analysis groups, policymaking communities, and the public; and*
- *Cultivating a new generation of researchers with the skills to tackle complex global challenges in the future.*

In This Issue:

SAVE THE DATE: JOINT PROGRAM WORKSHOP SERIES

In December, 2017, the Joint Program launched a Workshop Series on leading-edge, actionable global change research. The objective of these workshops is to facilitate an ongoing dialogue on issues that span the Joint Program's research domain and are of particular interest to our sponsors and stakeholders. The first of the series, Water Resource Risks: Integrated Approaches to Support Action, was held December 6. Our next two offerings are:

May 16 • Understanding the Future of Agriculture In a World of Climate Change

June 7 • Scaling Low-Carbon Energy Technologies

MIT JOINT PROGRAM ON THE SCIENCE AND POLICY OF GLOBAL CHANGE

RONALD PRINN
JOHN REILLY
Co-Directors

SERGEY PALTSEV
C. ADAM SCHLOSSER
Deputy Directors

ANNE SLINN
Executive Director for Research

HORACIO CAPERAN
Executive Director for External Affairs

SPRING 2018 GLOBAL CHANGES

MARK DWORTZAN
Editor/Writer

JAMIE BARTHOLOMAY
Designer/Copy Editor

Climate extremes: Assessing risk, protecting infrastructure

The past three years have been the warmest on record, part of a long-term warming trend that shows no signs of abating. In concert with this trend, we have seen increasing numbers of extreme weather events, from prolonged heatwaves to tropical cyclones with record storm-surge levels and wind speeds. As global warming drives up atmospheric water vapor and evaporation rates, so-called "100-year storms" are occurring more frequently than advertised.

Extreme weather events pose serious risks not only to human lives but also to vital infrastructure and economic sectors. As climate change amplifies the frequency and intensity of these events, it's becoming increasingly important to establish long-term plans to protect urban infrastructure, utilities, refineries, the electric power grid, croplands and other vulnerable assets. Toward that end, the first step is to assess the risk (or odds of occurrence) of extreme weather events within particular regions.

Forecasting extreme events

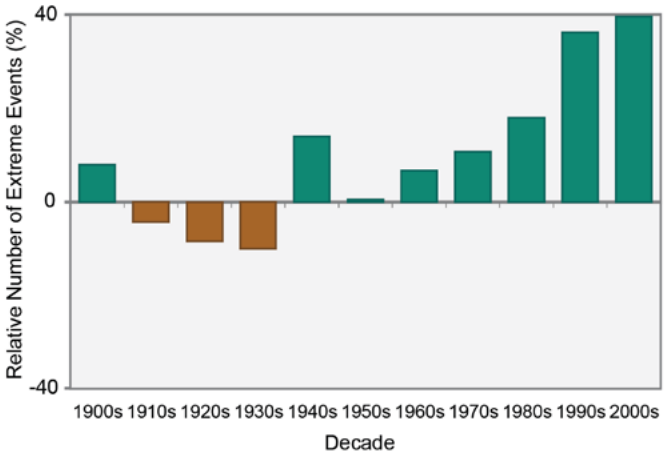
Ideally, that means using climate models to forecast these events. But it could take a decade or more before such models achieve the resolution and scientific sophistication needed to produce a reliable forecast. It's a big challenge in the climate community to go from predicting large-scale weather patterns—something that can be done with confidence—to predicting extremes, which require the capability to pinpoint the timing and location of unusual events. Meanwhile, there's a great urgency to get a handle on the likely frequency of extreme events in different regions in order to protect infrastructure. So what's the best thing to do?

Here at the Joint Program, we strategically combine two highly effective tools: multiple climate projections (to produce a range of forecasts) and observational data. What climate models do well is to project large-scale global atmospheric circulation patterns. Once we associate past occurrence of those patterns with past extreme events, we can then use those same patterns to pinpoint future extreme events. Because our approach is based on observations and models rather than on modeling alone, we achieve a much greater consensus among multiple climate model projections. As a result, we can more confidently determine the odds of an extreme event occurring within a particular region and timeframe under different policy scenarios. Knowing those odds can, in turn, enable decision-makers to make plans to protect at-risk infrastructure.

Assessing risk to urban infrastructure, power and agriculture

Using this approach, Joint Program Deputy Director Adam Schlosser and Research Scientist Xiang Gao have found that if the global average surface temperature rises by 4 degrees Celsius (a typical "business-as-usual" scenario) by 2100, California will experience on average three more extreme precipitation events per winter than the current average of six. Such findings suggest the need to accelerate preparations for protection from major flooding and landslides in that state in the coming decades.

Gao and Schlosser have also applied the technique to predict changes in the frequency of heatwaves, a key consideration for the long-term maintenance of large power transformers (LPT), critical electric power grid components that can fail under prolonged heat exposure. In a study of the potential impact of global warming and corresponding shifts in summertime hot days on LPT lifetime at an LPT location in the U.S. Northeast, they found that end-of-century mean global warming projections of approximately 2 degrees (a climate policy-driven scenario) and 4 degrees would result in a mean reduction in expected transformer lifetime of 20 to 40 percent. They are now expanding this work to cover the entire Northeastern U.S., with the ultimate goal of developing U.S.-wide and global assessment capabilities. Their efforts could help guide long-term LPT maintenance and avoid major power outages.



Observed U.S. trend in heavy precipitation. One measure of a heavy precipitation event is a 2-day precipitation total that is exceeded on average only once in a five-year period, also known as a once-in-five-year event. As this extreme precipitation index for 1901–2012 shows, the occurrence of such events has become much more common in recent decades. Changes are compared to the period 1901–1960, and do not include Alaska or Hawaii. The 2000s decade (far right bar) includes 2001–2012.

Source: Kunkel et al. (2013) (DOI: 10.1175/BAMS-D-11-00262.1)

Heatwaves threaten not only the distribution of electric power but also its generation. A Joint Program Report led by Joint Program Research Scientist Kenneth Strzepek explores the impact of high temperatures on thermoelectric power plants, which rely on river water for cooling. Prolonged heatwaves can lead to extreme river temperatures and low-flow conditions that could shut down these plants. Our researchers are now working to determine optimal decision pathways that adapt the landscapes of generation, transmission and distribution systems to minimize risks.

We have developed other risk assessment tools to analyze the threat posed by extreme weather events, including drought, to the agriculture sector. For example, a study led by Joint Program Research Scientist Elodie Blanc projected severe water shortages in the Southwestern U.S. by 2050 under a business-as-usual scenario. Another Joint Program study led by our former postdoctoral associate Amy Dale projected the likely effects of drought on corn yields in Africa. Speaking of drought, Sarah Fletcher, a PhD student at the MIT Institute for Data, Systems and Society, has collaborated with Strzepek to advance an adaptive, flexible infrastructure design framework to enable economical decision-making for water storage systems under uncertainty. Fletcher's award-winning work could help planners prepare for droughts by adding water-storage capacity as conditions evolve.

As the globe continues to warm and extreme events proliferate, risk assessment and planning becomes increasingly critical to the long-term protection of valuable assets around the world. The more we invest in science-based risk assessment and protection planning now, the more resilient our built environment—and all that depends on it—is likely to be for years to come.

—Ronald Prinn and John Reilly, Co-Directors

MIT Joint Program News Releases:
Latest research developments and their implications

MIT Joint Program in the Media:
Latest coverage of our research

The following summaries are listed by primary research focus area, but may span multiple research focus areas.

Food, Water & Forestry

Water Resource Risks: Integrated Approaches to Support Actions

Joint Program workshop highlights pathways toward sustainable water resources

In order to take effective action to mitigate and/or adapt to rising socioeconomic and environmental risks to local water resources, decision-makers will need robust, prediction-based strategies and tools. Toward that end, the Joint Program convened a workshop "Water Resource Risks: Integrated Approaches to Support Actions," in December on the MIT campus. The workshop highlighted recent and ongoing Joint Program research on water-resource risk management and explored opportunities for program researchers and sponsors to work together.

GlobalFood+ Speed Talks advance more sustainable food systems

Joint Program researchers share findings at nexus of food, agriculture, environment and health

Three Joint Program-affiliated researchers delivered seven-minute presentations at the second annual Global Food+ symposium, held at Tufts University in downtown Boston in February. Joint Program Research Scientist Kenneth Strzepek spoke on "People, water and food in the Nile basin and the Zambezi valley;" Civil & Environmental Engineering Associate Professor Colette Heald discussed "Air pollution and global crop yields;" and Sarah Fletcher, a PhD candidate at the Institute for Data, Systems and Society (IDSS), presented "Flexible water supply planning under uncertainty."

Confronting our uncertain water future

MIT Water Summit panelist Kenneth Strzepek explores challenges and solutions

In November the 2017 MIT Water Summit convened experts from industry, academia, government and NGOs to examine critical issues at the food-water nexus. Presenters focused on the role of water in food production and how innovation, policy and technology can help communities to become more healthy and sustainable. Joint Program Research Scientist Kenneth Strzepek participated in a panel on our uncertain water future, which explored how climate change, politics and economics impact food production and water-resource availability, and strategies to address these impacts.

J-WAFS' inaugural seed grant projects come to a close

Joint Program projects advance water and food security

Joint Program researchers contributed to two now-completed projects funded by the Abdul Latif Jameel World Water and Food Security Lab (J-WAFS). One project produced an agricultural model that estimates crop yields and their response to climate-induced stress from water, soil-quality and temperature. The other used models to improve our understanding of how mercury contamination occurs in rice in China, and the environmental and anthropogenic factors that intensify it.

Climate, food security and water: Interdisciplinary insights *(MIT ClimateX)*

Joint Program research scientists explore climate impact assessment tools

In Episode 11 of MIT ClimateX Climate Conversations, Joint Program research scientists Élodie Blanc and Erwan Monier discuss how climate modeling and collaborative research are used to assess climate impacts on regional agriculture, the economy and industry.

Sunset over the Zambezi River

Air Quality & Health

The big picture of Great Lakes mercury pollution

Joint Program researchers contribute to multidisciplinary study of regulatory impacts on Great Lakes mercury

For an Upper Peninsula tribal community whose water resources are impacted by mercury pollution, the big question is, "When can we eat the fish?" Guided by that question, a team of biogeochemical modelers, environmental engineers and social scientists including Joint Program-affiliated researchers Noelle Selin and Amanda Giang are using global-chemical transport models and local observations to better understand the impacts of existing and potential policies regulating Great Lakes mercury levels.


The Great Lakes

Noelle Selin: Tracing toxins around the world

Atmospheric chemist takes on pollutants and the global treaties written to control them

MIT News: "At MIT, Selin, a member of the Joint Program and the Center for Environmental Health Sciences, is using atmospheric chemistry models to understand how international environmental treaties and regulations affect the transport of toxins they aim to control. She is developing tools to trace the way emissions transform and move through the atmosphere, and how their behavior may affect human populations, under both no-policy and global-action scenarios." –Jennifer Chu

Infrastructure Resilience

Preventing the next blackout

MIT study projects potential impact of climate change on large power transformers in U.S. Northeast

To assess the risk of large power transformer (LPT) failure in coming decades, researchers from MIT's Joint Program and Lincoln Laboratory studied the potential impact of global warming and corresponding shifts in summertime hot days on LPT lifetime at an LPT location in the U.S. Northeast. They found that end-of-century mean global warming projections of approximately 2 degrees (a climate policy-driven scenario) and 4 degrees (a business-as-usual scenario) Celsius would result in a mean reduction in expected transformer lifetime of 20 to 40 percent.

Sarah Fletcher receives 2017 AGU Outstanding Student Paper Award

Paper advances adaptive urban water-supply planning approach

MIT Joint Program-affiliated researcher and Institute for Data, Systems, and Society (IDSS) PhD student Sarah Fletcher won a 2017 American Geophysical Union (AGU) Outstanding Student Paper Award for a paper advancing an integrated approach to urban water-supply infrastructure planning that could enable more efficient and sustainable water-supply planning in many regions facing groundwater stress. Fletcher presented the paper, which she co-authored with her advisor, Joint Program Research Scientist Kenneth Strzepek, at last December's AGU Meeting in New Orleans.

Flood risk under an uncertain future climate

Joint Program researcher assesses the threat to Cambridge and how stakeholders can prepare

A "Climate Resiliency Tabletop Exercise" convened in January at Harvard Law School focused on best practices for business continuity and coordination in response to a major flooding event in Cambridge. Joint Program Research Scientist Kenneth Strzepek wrapped up the workshop with a presentation on the underlying science of climate change and its likely impact on the frequency and intensity of major flooding events in Cambridge throughout the 21st century. He highlighted the critical value of emerging flood-risk science in helping stakeholders prepare for scenarios discussed in the tabletop exercise.

Tapping local innovators to advance climate solutions

Joint Program Co-Director serves as expert and panelist in two HUBweek events

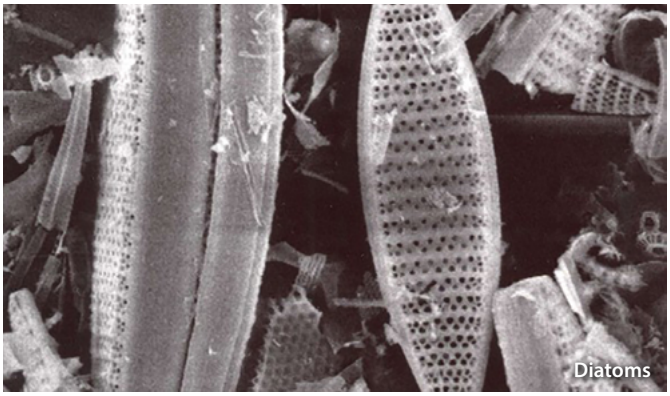
Joint Program Co-Director John Reilly contributed to two Boston HUBweek events designed to bring people together to brainstorm possible solutions to major global and local challenges and build a better future. For Deep Dive: Open Innovation on Climate Change, Reilly facilitated a conversation about how best to enable citizens of Greater Boston to confront the risks posed by climate change. Also serving as a panelist for Future Forum: A Rising Tide, he presented additional ways that the Boston area can prepare for the effects of climate change.

Natural Ecosystems

Diatoms' capacity to store carbon in the deep ocean is underestimated

Study suggests that these micro-algae play a key role in the biological carbon pump

Joint Program Principal Research Scientist Stephanie Dutkiewicz and co-authors of a new study maintain that ecosystem models should account for the diversity of diatoms to sharpen predictions of the fate of these micro-algae. The researchers argue that diatoms play a larger role than previously thought in the transfer of carbon dioxide from the surface to the deep ocean, known as the biological carbon pump.


Diatoms

Energy

Assessing the viability of a key climate mitigation technology

Study estimates Earth's capacity to store captured carbon

Carbon capture and storage (CCS) will only be a viable option for reducing greenhouse gas emissions if there's sufficient capacity throughout the world to store carbon dioxide (CO_2) underground. A study co-authored by a team of researchers at the MIT Energy Initiative (MITEI), MIT Joint Program and ExxonMobil has developed and applied a method for estimating the capacity of different regions around the world to store CO_2 underground based on minimal data gleaned from globally available data sources.

Charting the future of oil and gas in a decarbonizing world

Analytical method could enable more accurate energy scenarios

A research team including Joint Program Deputy Director Sergey Paltsev aimed to pinpoint the factors that determine the breakeven points of tight-oil production projects—essentially the oil price points at which revenue from sales equals the cost of production. Applying a systematic method they developed to understand the costs of oil production and how they change with time and circumstances, the team proposed a set of standard definitions for breakeven points at different stages of the oil production cycle.

Reducing risk in power generation planning (*Energy Futures*)

Why including non-carbon options is key

Using a tool they developed that evaluates decisions in the electric power sector under policy uncertainty, MIT Joint Program Research Scientist Jennifer Morris and colleagues showed that the optimal electricity sector investment for the next decade would allocate 20–30 percent of new generation to non-carbon sources.

Natural gas provides only a "short and narrow bridge" to a low-carbon future (*The Energy Collective*)

Joint Program Co-Director sees carbon-free energy as the long-term solution

"A serious commitment to long-run climate goals requires we stay focused on planning for a zero-carbon world," writes Joint Program Co-Director John Reilly in a commentary. "A short and narrow bridge in that direction may be tempting, but we must be careful in our crossing."


Hydraulic fracturing is an industrial process in which a mixture of water, sand, and chemicals is injected into a well at rates of up to 4,000 gallons per minute, at pressures up to 10,000 pounds per square inch.

Earth System Science

Joint Program researchers share recent findings at AGU Fall Meeting

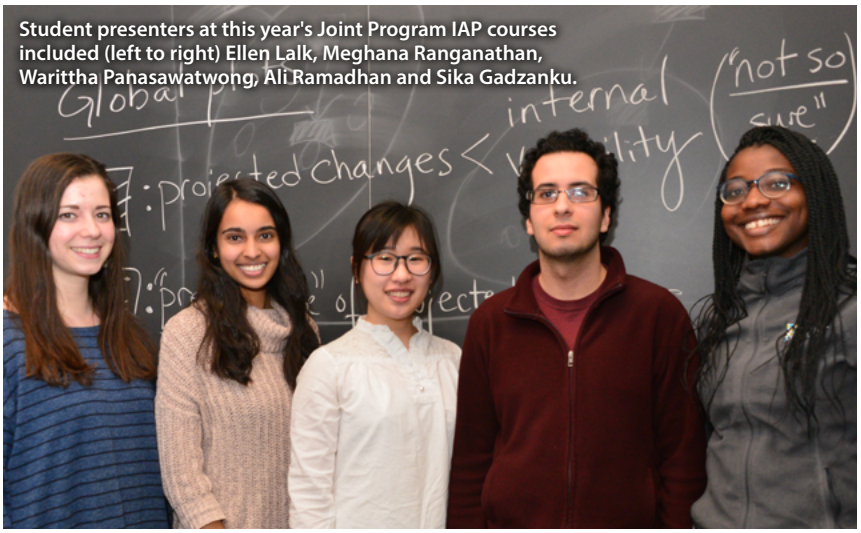
Presentations center on Earth system science, infrastructure resilience and air quality

Researchers and affiliates of the Joint Program convened and chaired two sessions and delivered or contributed to 21 oral or poster presentations at the American Geophysical Union (AGU) 2017 Fall Meeting in December in New Orleans. Joint Program studies featured in this year's sessions, talks and posters covered several of the program's research focus areas, and the program's core research tool, the Integrated Global System Modeling (IGSM) framework.

Little growth observed in India's methane emissions

Results emerge from first large-scale study to use observations of methane concentration in the country's atmosphere

In one of the largest independent studies of its kind, an international team of scientists including Joint Program Co-Director Ronald Prinn has found little growth in India's methane emissions over the past few years and that the nation's reporting of these emissions has been accurate. Commenting on the study, which was published in *Nature Communications*, Prinn stressed the need for countries to accurately and transparently quantify their greenhouse gas emissions.



Student presenters at this year's Joint Program IAP courses included (left to right) Ellen Lalk, Meghana Ranganathan, Warittha Panasawatwong, Ali Ramadhan and Sika Gadzanku.

Climate science and policy, 2018

Joint Program IAP courses review fundamentals and explore emerging trends

In January seven Joint Program-affiliated graduate students presented seven courses on climate science and policy as part of the 2018 MIT Independent Activities Period (IAP). Held annually, this Joint Program series provides a fast-paced, accessible introduction to the Earth's climate system and the links between scientific and societal aspects of climate change. In an additional IAP seminar, an eighth graduate student focused on water management for future climate scenarios.

Meltdown Earth? (*NowThis*)

Joint Program Co-Director discusses worst-case scenarios

Joint Program Co-Director John Reilly, former U.S. Vice President Albert Gore and other experts explore extreme implications of climate change in a video in the *NowThis: Apocalypse* online series.

Does climate change cause extreme weather events? (*Smithsonian*)

It's a challenge to attribute any one storm or heat wave to climate change, but scientists are getting closer

Joint Program Deputy Director C. Adam Schlosser comments on the degree of confidence by which scientists can attribute extreme weather events to anthropogenic climate change.

Climate Policy

Rethinking how we count carbon emissions

New method could sharpen international climate policy design

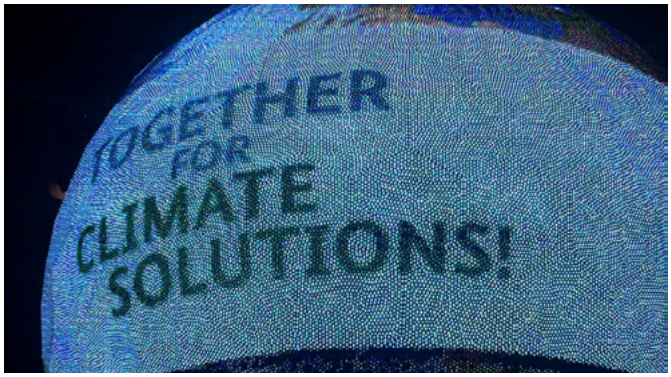
A new Joint Program-led study presents a pathway to more accurate and consistent estimates of embodied emissions—those produced in commercial products' manufacture, assembly and transport. Such assessments are more likely to inspire the confidence of signatory states and nations considering proposed emissions reduction policies that target embodied emissions.

Helping Mexico design an effective climate policy

MIT researchers are working with the Mexican government on carbon-pricing options to meet the country's Paris Agreement climate goals

An MIT study led by Michael Mehling, deputy director of the Center for Energy and Environmental Policy Research (CEEPR), and Joint Program research assistant Emil Dimantchev, a graduate student in the MIT Technology and Policy Program, explored how Mexico can implement a cap-and-trade program alongside its existing carbon tax. The researchers found

CLIMATE POLICY - CONT'D



that by adding a relatively low carbon price—$3 per ton of emissions in 2030—to its existing climate policies, Mexico could meet its Paris Agreement emissions reduction target.

Is Massachusetts ready for carbon pricing?

Panel at MIT explores benefits, costs and political challenges

In January a panel at MIT explored the benefits, costs and political challenges involved in translating carbon pricing from concept into law in Massachusetts and beyond. Hosted by the student-led MIT Climate Action Team, the panel discussion included state legislators spearheading carbon-pricing bills and three experts affiliated with the Joint Program—Department of Urban Studies and Planning Associate Professor Janelle Knox-Hayes, Joint Program Co-Director John Reilly, and CEEPR Director Christopher Knittel.

The art and science of immersive climate change storytelling

Joint Program Co-Director mentors 360° video journalists

Why do we talk about global change and not just global climate change? What would be the most effective actions to limit the impacts of climate change? What kind of climate change stories would scientists like to read? These are among the questions posed to Joint Program Co-Director John Reilly in the first of a series of mentorship sessions for journalists enrolled in a new program on the use of 360° video to produce immersive stories on climate change.

Scientists: Action needed on climate (*US News & World Report*)

Various studies suggest the problem of rising temperatures is growing

Carbon pricing is needed to incent industries to reduce planet-warming greenhouse gas emissions, but few regions have set sufficiently high prices, say Joint Program Co-Director John Reilly and CEEPR Deputy Director Michael Mehling.

AP FACT CHECK: Trump sees himself outperforming history (*Associated Press*)

Joint Program founding Co-Director corrects U.S. president's misinterpretation of Paris Agreement

"The Paris Agreement does NOT ... impose specific differential action among countries regarding greenhouse emissions abatement," says Henry "Jake" Jacoby.

US and Them: America, the elephant in room at climate talks (*US News & World Report*)

Joint Program co-founder expresses concern about the transparency of emissions reporting

Without the U.S. pushing for stricter rules and more openness on how Paris Agreement signatories report their emissions reduction progress, reporting will be less transparent, says Joint Program founding Co-Director Henry "Jake" Jacoby.

What will it take for the U.S. to rejoin the Paris Agreement? (*Economic Times*)

Joint Program Co-Director cites negative consequences of withdrawal

Joint Program Co-Director Ronald Prinn, in India to deliver a lecture on climate change as part of the Centenary Celebration of Bose Institute, points to key factors that could spur the U.S. to rejoin the landmark climate accord.

Let's hold off on praising China's new carbon-pricing market (*Grist*)

Commentary cites Joint Program research assistant's analysis

In a series of tweets after China's announcement of its new carbon-trading market, Joint Program research assistant/climate policy analyst Emil Dimantchev reinforced his earlier assessment that it's premature to call China's new policy ambitious. "The policy is still missing the crucial features that will determine whether it will be a success," he tweeted.

Regional Analysis

China's National Carbon Dioxide Emissions Trading System: Innovations, Issues and Challenges

Valerie Karplus contributes to special journal issue

With China's cap-and-trade system slated for launch by the end of 2017, MIT Sloan School of Management Assistant Professor Valerie Karplus, a Joint Program-affiliated faculty member, served as one of three managing editors—and as a paper co-author—for a special issue on the subject in the journal *Economics of Energy and Environmental Policy*.


Coal-fired electric plant, Henan Province, China

REGIONAL ANALYSIS - CONT'D

The Grand Ethiopian Renaissance Dam and the Nile Basin: Implications for Transboundary Water Cooperation

Joint Program researcher co-authors book chapter analyzing economic impacts on Egypt

As it builds the Grand Ethiopian Renaissance Dam (GERD) on the Blue Nile, Ethiopia looks forward to producing a significant amount of hydropower, but there's concern that the filling of the GERD reservoir could reduce the reliability of Nile River water flowing downstream to Egypt, posing a serious risk to its economy. Joint Program Research Scientist Kenneth Strzepek and two co-authors quantify this risk in a new book chapter, "Analyzing the economy-wide impacts on Egypt of alternative GERD filling policies."

Energizing global environmental cooperation (*MIT Spectrum*)

How Valerie Karplus and her transpacific team helped to put climate-critical commitments on the table

Karplus: "I see our role as being a provider of analysis as well as a catalyst for stronger cooperation between nations when it comes to the management of critical infrastructures like energy."

Existing only from the Nile, Egypt fears disaster from a dam (*Bloomberg/Associated Press*)

Joint Program research scientist Kenneth Strzepek comments on the impact of Ethiopian dam on Egypt's water supply

Strzepek: "If everybody is working together, if there is trust, it is possible to have win-win."

Modeling Tools

Projecting the impacts of climate change

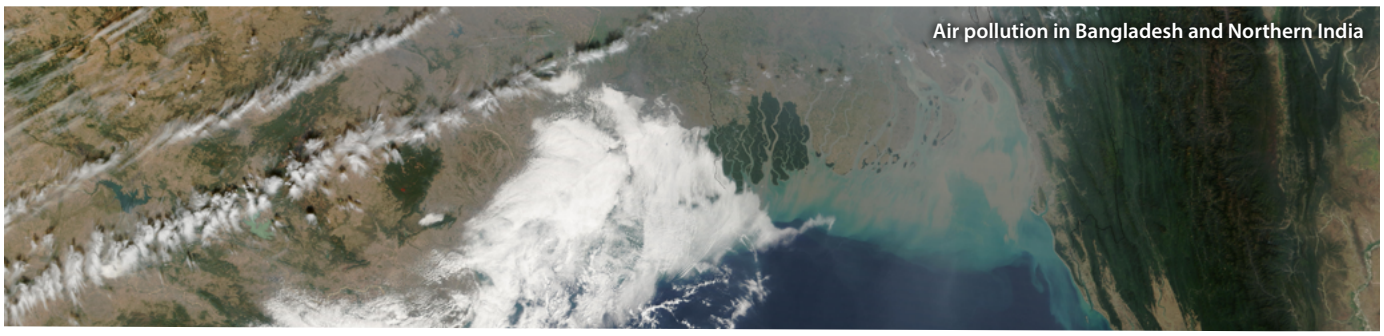
Researchers advocate for improved modeling approach

Today's gold standard for climate impact assessments—model intercomparison projects (MIPs)—fall short in many ways. Joint Program researchers propose an alternative method that only a handful of other groups are now pursuing: a self-consistent modeling framework to assess climate impacts across multiple regions and sectors. A new study published in *Nature Communications* describes implementation of the method and provides illustrative examples.

Framing uncertainty (*MIT Spectrum*)

A landmark platform models the range of ways a changing climate may affect humanity, and vice versa

"It's becoming ever more apparent that things we used to study separately are all interconnected," says Joint Program Co-Director Ronald Prinn. "Meanwhile, environmental changes are occurring far faster than expected, which is another way of saying the need for the [Integrated Global System Modeling] IGSM [framework] is now greater than ever."



Air pollution in Bangladesh and Northern India

Milestones

Joint Program research featured in journal's "Editor's Choice" column. In January 2018, a paper co-authored by affiliated researcher and Institute for Data, Systems and Society (IDSS) PhD student Sarah Fletcher and Joint Program Research Scientist Kenneth Strzepek was featured in the "Editor's Choice" column in the *Journal of Water Resources Planning and Management*.

Jessica Farrell named 2018 Presidential Management Fellow. Farrell is a Joint Program research assistant and IDSS Technology and Policy Program student. The Fellowship is awarded to promising graduate students who show leadership potential and wish to pursue roles in government. Awardees are matched with federal opportunities to serve while they are pursuing their degrees.

Susan Solomon wins 2018 Crafoord Prize in Geosciences. Solomon, an affiliated researcher, was one of two climate researchers to win the 2018 Crafoord Prize in Geosciences. The Royal Swedish Academy of Sciences recognized Solomon "for fundamental contributions to understanding the role of atmospheric trace gases in Earth's climate system."

Susan Solomon and Timothy Cronin recognized by MIT with named professorships in the Department of Earth, Atmospheric and Planetary Sciences (EAPS). Solomon was named Lee and Geraldine Martin Professor of Environmental Studies. Cronin, a climate physicist, was named as the Kerr-McGee Career Development Professor.

–Helen Hill, EAPS; IDSS; MIT School of Engineering

New Research Projects

Identifying Threats and Reducing Risks of Health Damage from Dust Storms under a Changing Climate across the Arabian Peninsula

Sponsor: King Abdulaziz City for Science and Technology (KACST)

Leaders: Adam Schlosser (MIT), Adnan AlSaati (KACST)

Duration: 2 years

This threat and impact on human health of dust storms has received growing attention across the Middle East. High levels of aluminum, heavy metals, as well as bacteria, fungi and viruses in samples of the ultrafine, and therefore lung-penetrable, dust have been detected. To predict how the risks to human health and well-being will change over the coming decades, the researchers will bring together a high-resolution regional climate model and an integrated model of the global human and Earth systems.

Extending previous work focused on health effects over the Kingdom of Saudi Arabia, they will combine the Weather Research and Forecast (WRF) model with the MIT Integrated Global System Modeling (IGSM) framework to perform high-resolution regional climate simulations of the future and address the questions: *What are the health implications of dust storms induced by climate change? Can mitigation avert the more serious risks? What adaptive measures would be most effective to reduce the risk of severe health consequences?*

PATHWAYS TO PARIS: Latin America

Sponsor: General Electric (via the MIT Energy Initiative)

Collaboration: Led by MIT Joint Program, involving MIT Center for Energy and Environmental Policy Research (CEEPR)

Leader: Sergey Paltsev

Duration: 1 year

Most signatories of the Paris Agreement are refining their Nationally Determined Contributions (NDCs) for the 2018 Facilitative Dialogue that will be held at the 24th session of the Conference of the Parties (COP24) in Katowice, Poland in December 2018. National strategies for compliance with NDCs are evolving: countries can deploy a wide range of policies to bridge the gap between current emission trajectories and NDC goals. MIT will conduct a gap analysis between current emission levels and NDC targets at a national level for selected countries in Latin America. As part of this assessment, MIT will identify key challenges to compliance and suggest regionally applicable policy and technology solutions, with a focus on the electricity sector. Based on its modeling and insights, and expertise on low-carbon technologies from General Electric and representatives from Latin American countries, MIT will produce a Pathways to Paris: Latin America report. The report will clearly identify recommendations on technology pathways countries can take, and policy reforms they should consider, which are relevant for Latin American countries and which provide insight to enable them to reduce emissions from their baseline trajectory as well as improve energy security in the electric power sector. Findings from the study will be delivered at the 2018 Facilitative Dialogue.

Urban Water Management of Riyadh: Response to Extreme Events, Flood Protection and Water Harvesting

Sponsor: King Abdulaziz City for Science and Technology (KACST)

Leader: Kenneth Strzepek

Duration: 2 years

This project will produce long-term analysis to help enable decision-makers in Riyadh to mount an effective response to extreme weather events in the coming decades, as well as to develop flood protection and water harvesting plans. Researchers will combine the WRF model with the MIT IGSM framework to perform high-resolution regional climate simulations of the future and address the questions: *What are the potential damages to infrastructure of extreme weather events induced by climate change? Can mitigation avert the more serious risks? What adaptive measures would be most effective to reduce these risks?*

Clean Air Effects of Renewable Energy Policies

Sponsor: MIT International Policy Lab

Leaders: Emil Dimantchev and Sergey Paltsev

Duration: 1 year

This project aims to inform the implementation of clean energy standards in subnational jurisdictions with a focus on the U.S. The research quantifies the costs and benefits of clean energy standards in U.S. states by combining the Joint Program's USREP computable equilibrium model with an air pollution model. This modeling framework injects into the policy debate unique insights about the total economic cost of such policies and their main economic benefit: the health effects of cleaner air. The project also assesses how these costs and benefits are distributed among states.

Energy-at-Scale: Scenario Assessment

Sponsor: Shell

Leader: Sergey Paltsev

Duration: TBD

The Paris Agreement has set a target of keeping the global average temperature well below 2 degrees Celsius relative to preindustrial levels. The Agreement also aims to reach the global peaking of greenhouse gas emissions as soon as possible and to achieve a balance between anthropogenic emissions by sources and removal of greenhouse gases by sinks in the second half of the century. This project will apply the MIT Joint Program's analytical tools to assess scenarios of future low-carbon energy development to provide new insights on the changing global climate. We will explore the emissions profiles of carbon dioxide and other greenhouse gases needed to achieve the long-term targets of the Paris Agreement.

Photo Credits:

p 2: Andrew Ashton

p 3: Jeff Schmaltz, MODIS Rapid Response Team, NASA/GSFC

p 4: (1) UBO Sébastien Hervé; (2) Robert L. Kleinberg

p 5: Dimonika Bray

p 6: German Development Institute; V.T. Polywoda

p 7: Jacques Descloitres, MODIS Rapid Response Team, NASA/GSFC

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Massachusetts Institute of Technology
77 Massachusetts Ave., E19–411
Cambridge, MA 02139 USA

T (617) 253–7492 F (617) 253–9845
globalchange@mit.edu
http://globalchange.mit.edu