The Infrastructure and Climate Network (ICNet)

What climate data, model output, and information do engineers want & need?

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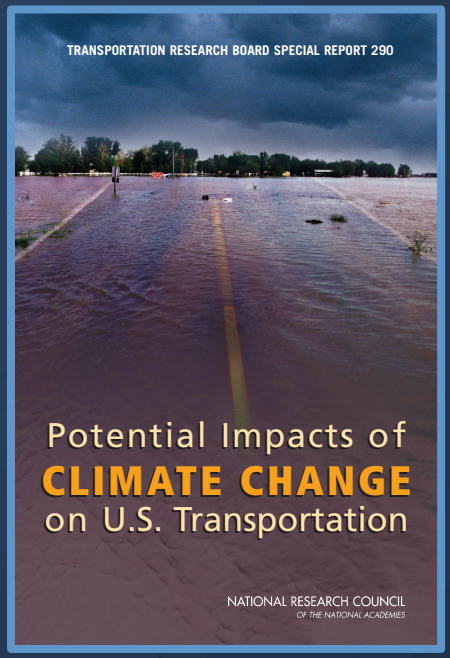
What is the ICNet?

Networks 100+ academics, students, & practitioners who are dedicated to accelerating climate science and transportation engineering research and adaptation in the Northeastern United States.

Focuses on climate change and sea level rise impacts research and adaptation for sustainable bridges, roads, railways, ports, and transportation networks.

Supported by the National Science Foundation since 2012



TRB Special Report 290, 2008

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Motivation & Implications

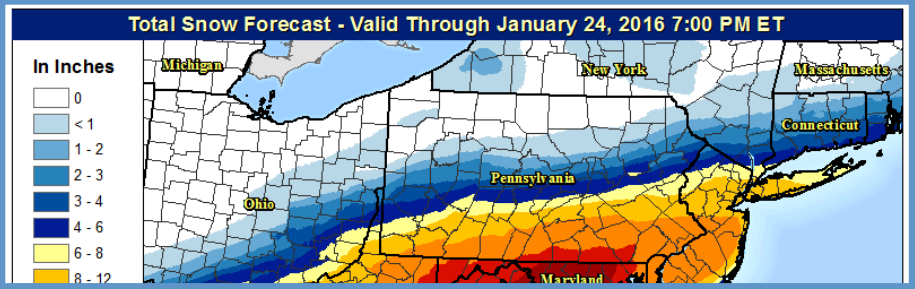
The U.S. spends nearly $200,000,000 per day building and rebuilding roads and bridges

Driving delays are expected to waste 7.3 billion gallons of fuel per year over the next two decades, increasing travelers' costs by $41,000,000,000, and add 73 million tons of carbon dioxide to the atmosphere.

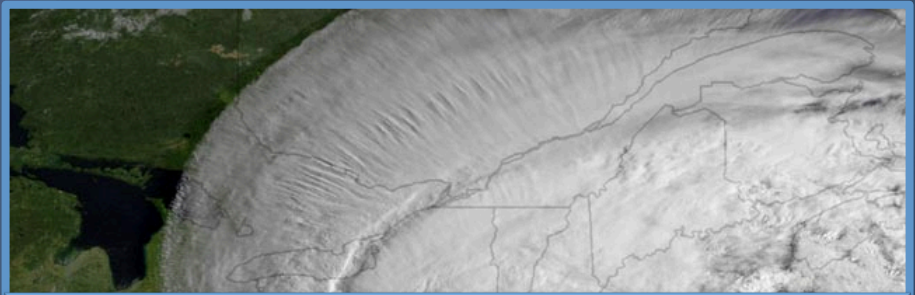
Climate and weather an important consideration in major road and bridge planning, design, and operations & maintenance

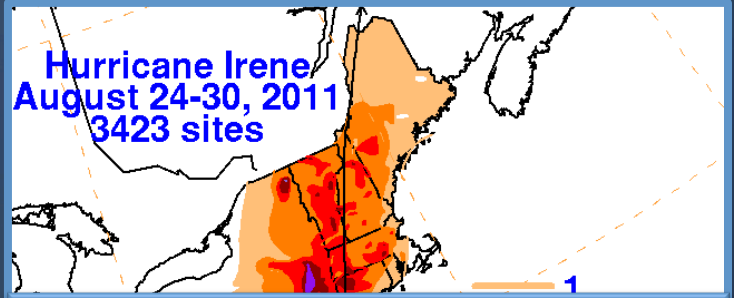
Very little information exists to guide roadway and bridge practitioners in light of climate change

Extreme Events: Winter Storm “Jonas”
January 21-24, 2016

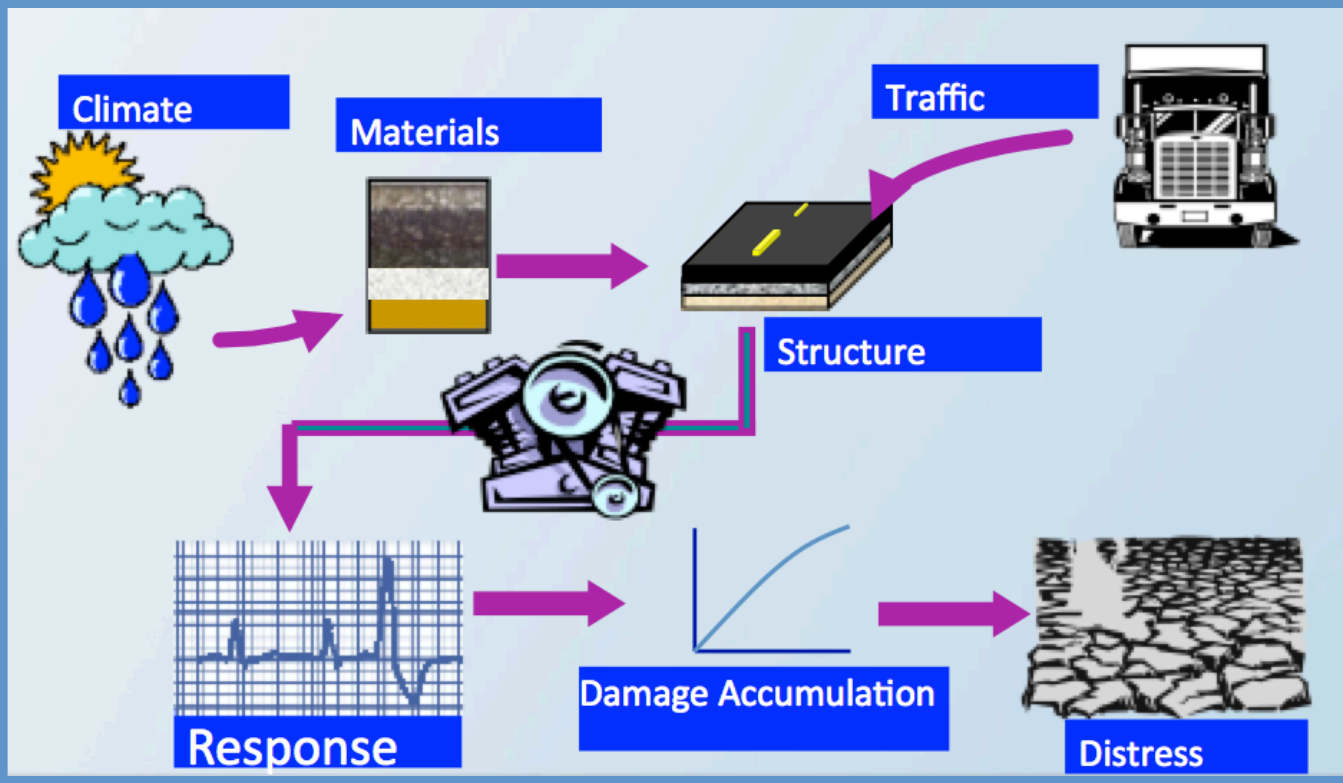


Extreme Weather Events: Hurricane Irene
August 24-30, 2011





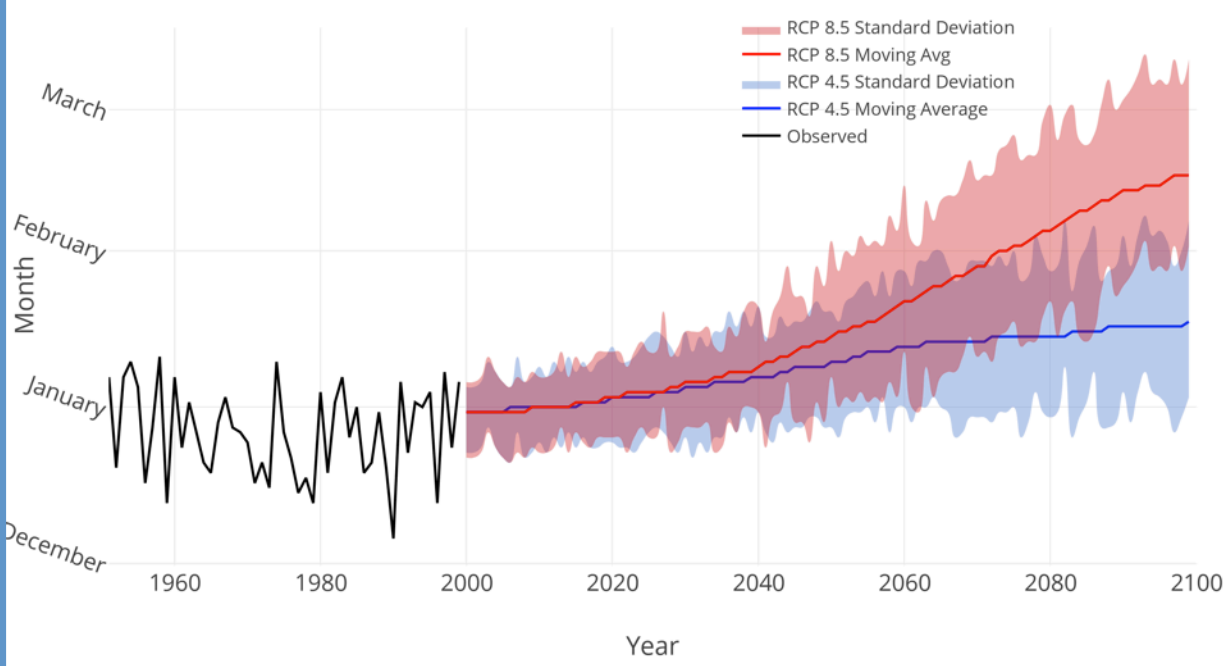
Climate Impacts: Pavement Rutting



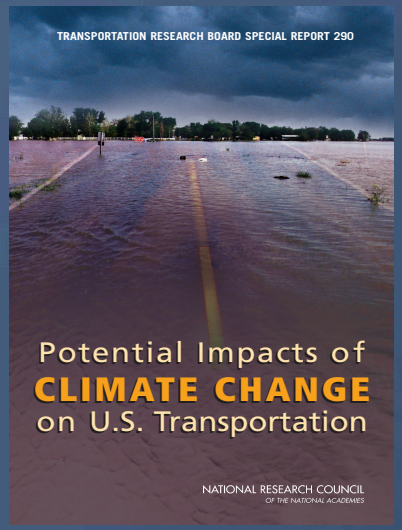
Climate Impacts: Freeze-Thaw and Roads

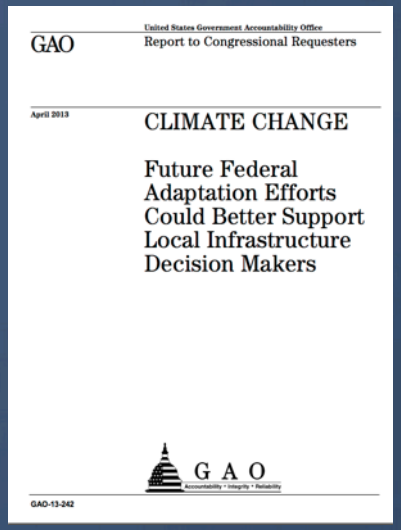
Frozen Soils Increase Road Strength and Stiffness

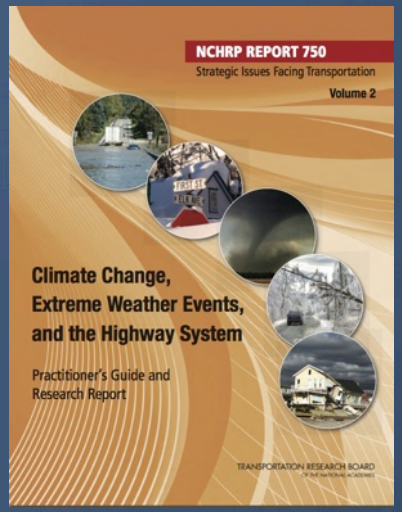
Date to apply winter weight premium in Madison, ME



Climate Change and Infrastructure







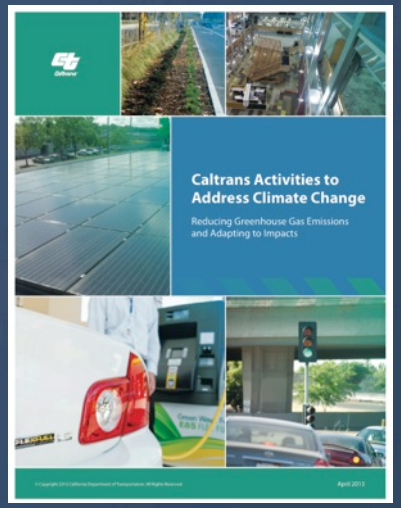


Table 12. Sea Level Rise Impacts on Surface Transportation

Impact	Planning	Design	Operation/Maintenance
Sea Level Rise			
• Coastal erosion **Coastal Erosion**	• Roadway washout • Damage to roadway substructure • Route closures • Travel delays	• Identify segments of roadway vulnerable to erosion • Address vulnerability in transportation plans	• Strengthen, heighten, and construct new seawalls and dikes • Use a combination of hard engineering (human-made structures) and soft engineering measures (implementing ecological principles and practices) to protect coastal infrastructure • Relocate highly affected or vulnerable infrastructure	• Repair damage as needed by emergency contract or permanent restoration project • Increase monitoring of infrastructure and conditions in coastal areas vulnerable to erosion • Repair/replace/restore affected infrastructure as needed • Increase erosion control • Prepare for weather-related delays and traffic disruptions • Prepare to provide alternative route information
• Coastal and inland tidal zone road flooding **Flooding**	• Flooding of roadways • Roadway damage • Road closures • Travel delays • Disruption of transit services	• Identify segments of roadway vulnerable to storm surge and sea level rise • Address vulnerability in transportation plans • Support land use policies that discourage development on shoreline • Plan and design more redundancy into the system	• Increase base elevation of infrastructure • Change to more resilient building materials • Build larger or additional drainage canals near coastal routes • Relocate sections of road • Strengthen, heighten, and construct new seawalls and dikes • Use a combination of hard engineering (human-made structures) and soft engineering measures (implementing ecological principles) to protect coastal infrastructure	• Repair damage as needed by emergency contract or permanent restoration project • Increase monitoring of infrastructure conditions during high tide and storm events • Ensure that drainage systems are adequate to accommodate flood conditions • Ensure that bridge openings/culverts are clear for appropriate flood management • During extreme precipitation events, continually monitor drainage systems • Prepare for weather-related delays and traffic disruptions • Prepare to provide alternative route information • Implement emergency operations response procedures
• Bridge scour **Bridge Scour**	• Compromised integrity of bridge structures • Bridge failure resulting in closure • Reduced bridge capacity	• Identify locations of bridges in areas vulnerable to sea level rise and bridge scour • Address vulnerabilities in transportation plans	• Protect bridge piers and abutments with riprap • Retrofit/replace/relocate existing bridges for new scour conditions	• Repair damage as needed by emergency contract or permanent restoration project • Increase monitoring for bridge pier and abutment scour

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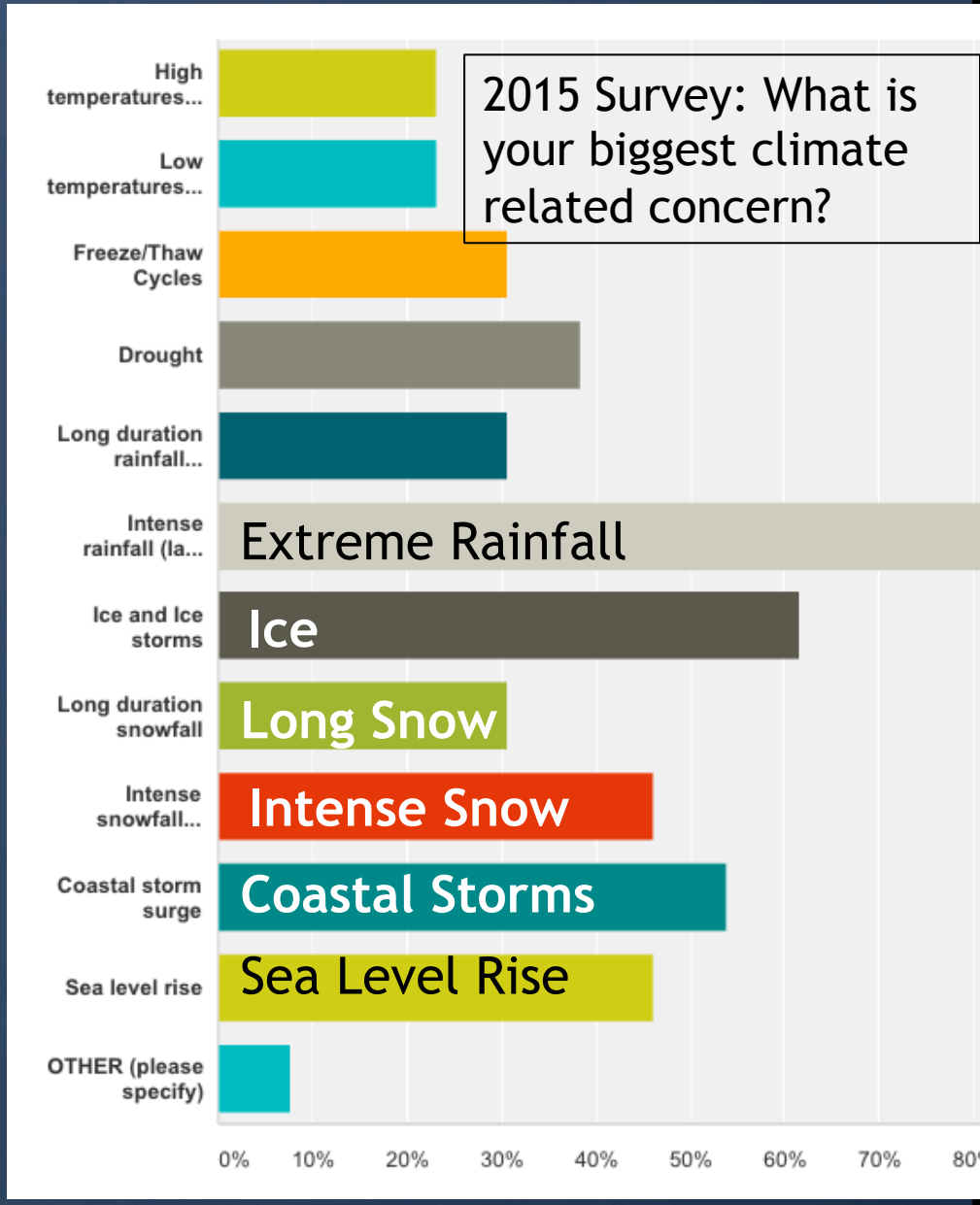
Eastern Region Department of Transportation Concerns



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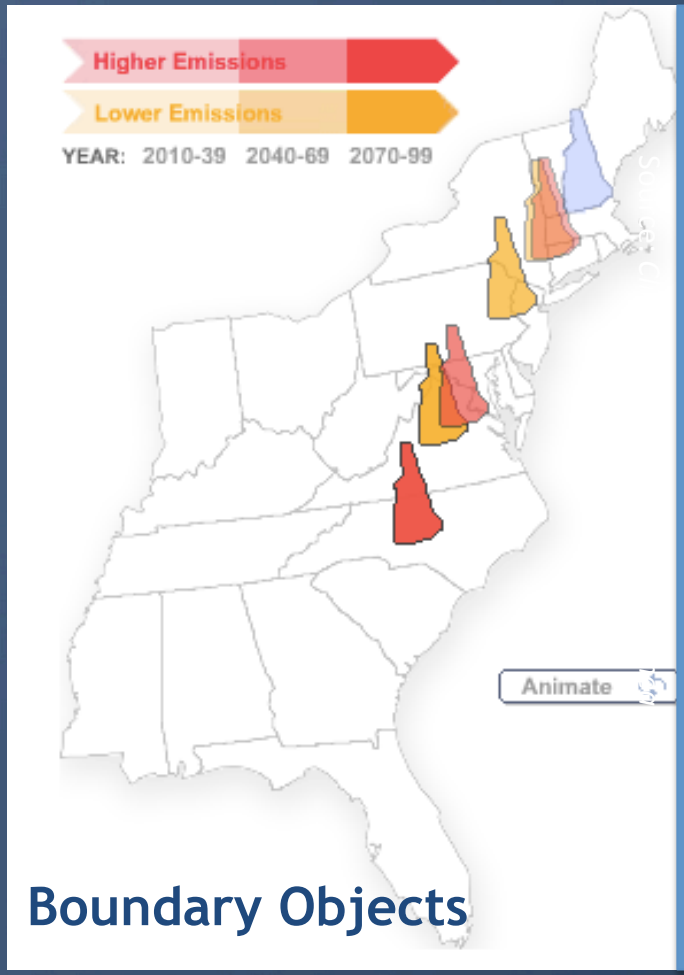
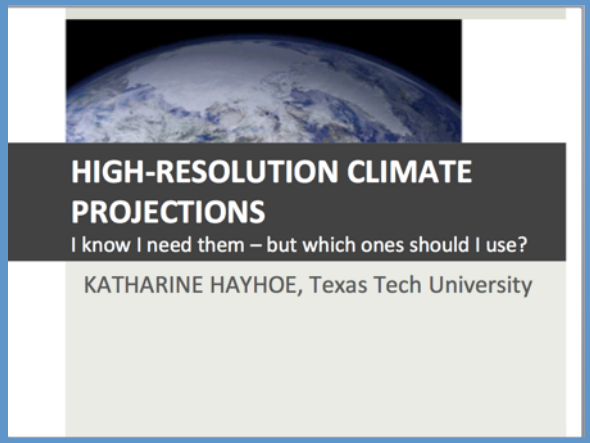
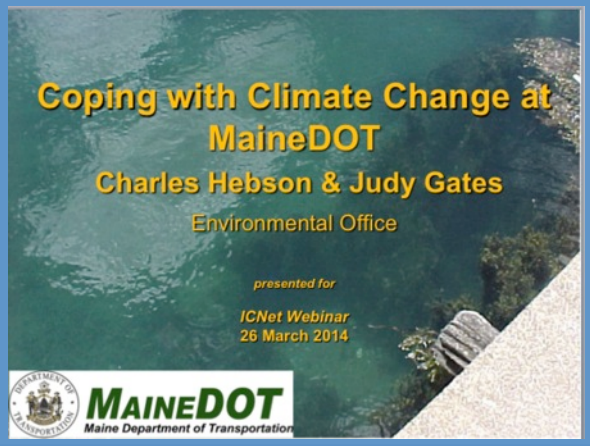
ICNet Foundation Tools

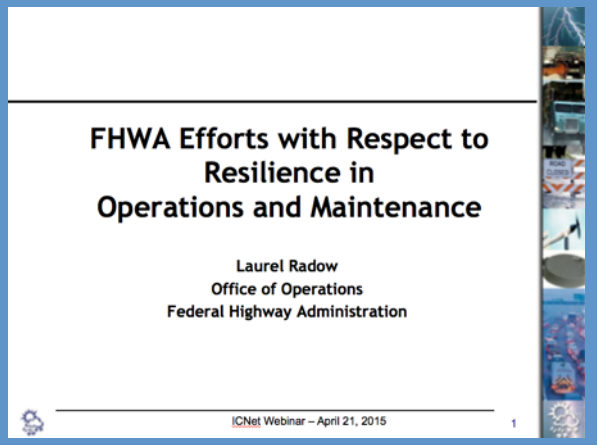


Boundary Objects

ICNet Webinar Series http://theicnet.org/?page_id=24







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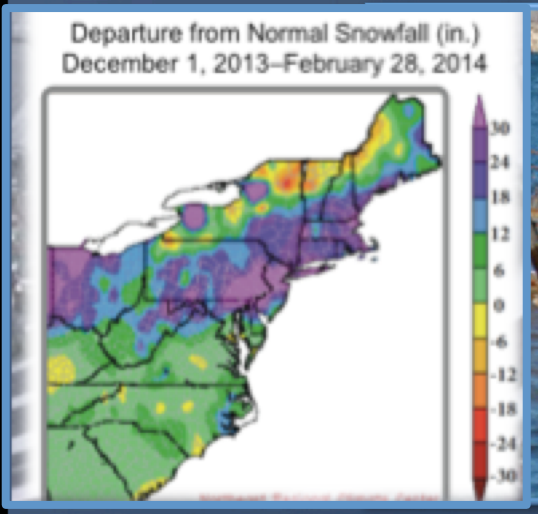
Transportation Community Climate Indicators

Precipitation

- Annual Average
- Spring Average
- Summer Average
- Fall Average
- Winter Average
- Days per year over 2 in.
- Days per year over 3 in.
- Maximum daily
- Maximum weekly

Temperature

- Annual Average
- Spring Average (MIN & MAX)
- Summer Average (MIN & MAX)
- Fall Average (MIN & MAX)
- Winter Average (MIN & MAX)
- Maximum
- Minimum
- Days over 95^0F



Olympian Drive, Champaign, IL: Buckling of pavement during extreme heat. Image: The Champaign-Urbana News Gazette

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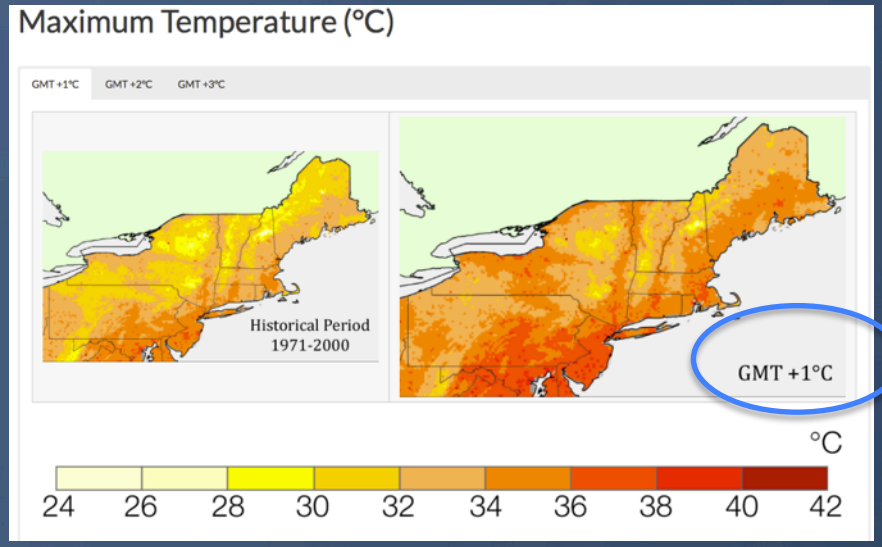
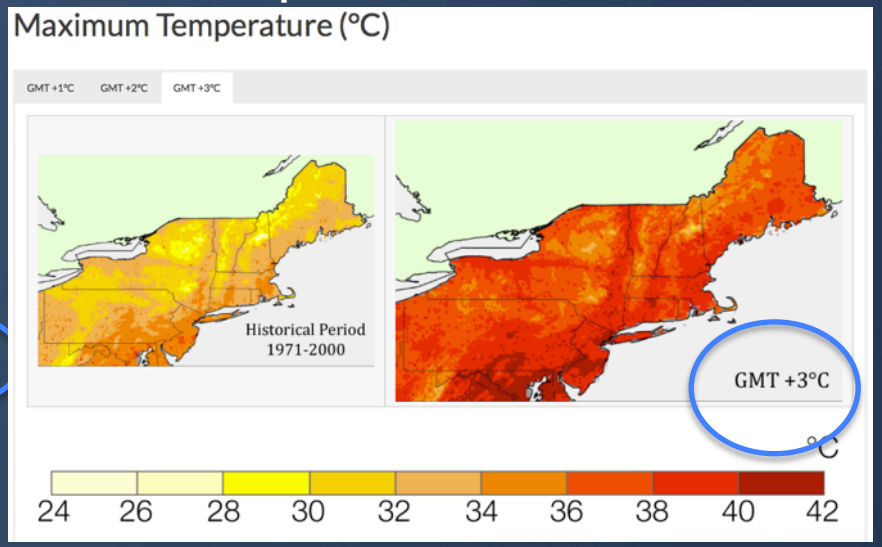
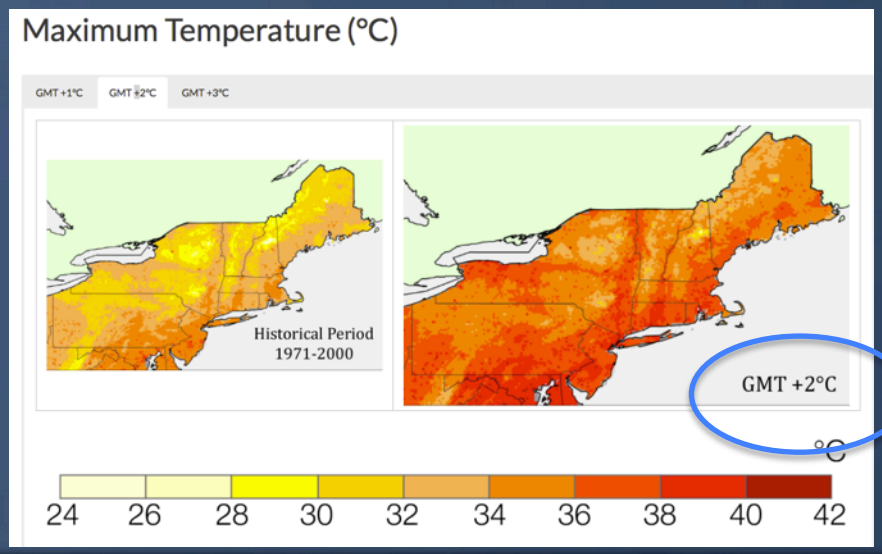
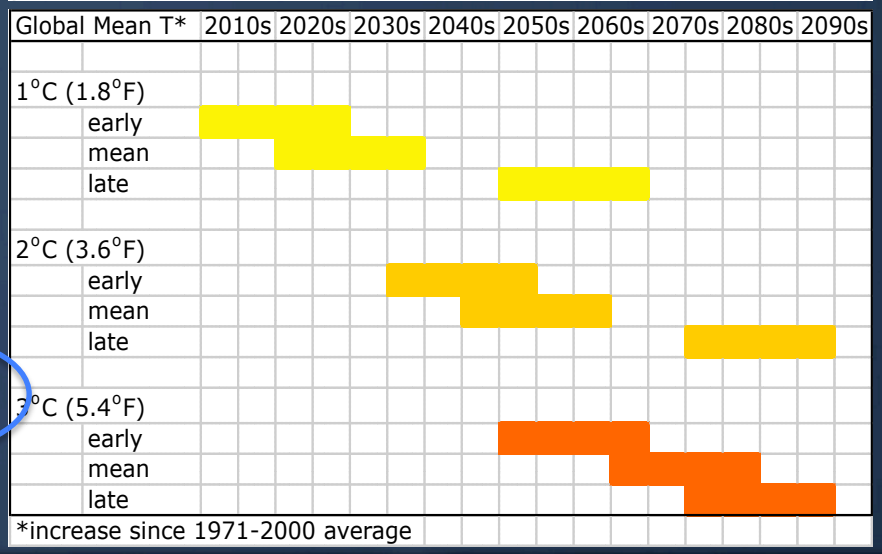
ICNet Climate Maps

Referenced to Global Mean Temp









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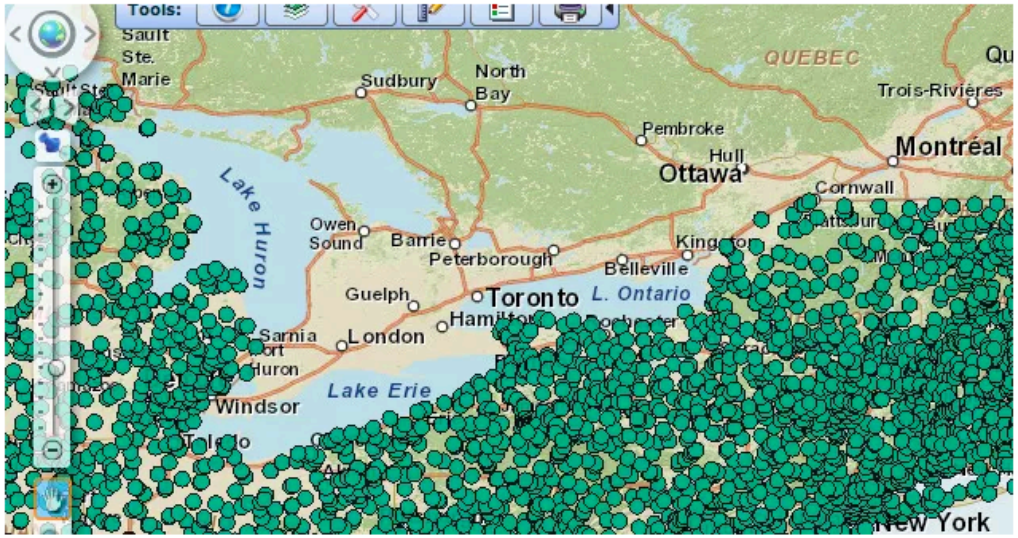
ICNet Research Grade Tools

Climate Model Comparison Tool

Resources

Choosing Climate Models

- Statistically Downscaled Output: download the Excel file
- Regional Model Output: download the Excel file
- Observational DataSets: download Excel file
- Station Observation Data: visit the NOAA website



Climate Model Intercomparison Project

- About CMIP: visit the CMIP website
- Raw Output for CMIP3 and CMIP5: download the Excel file

theICNet.org

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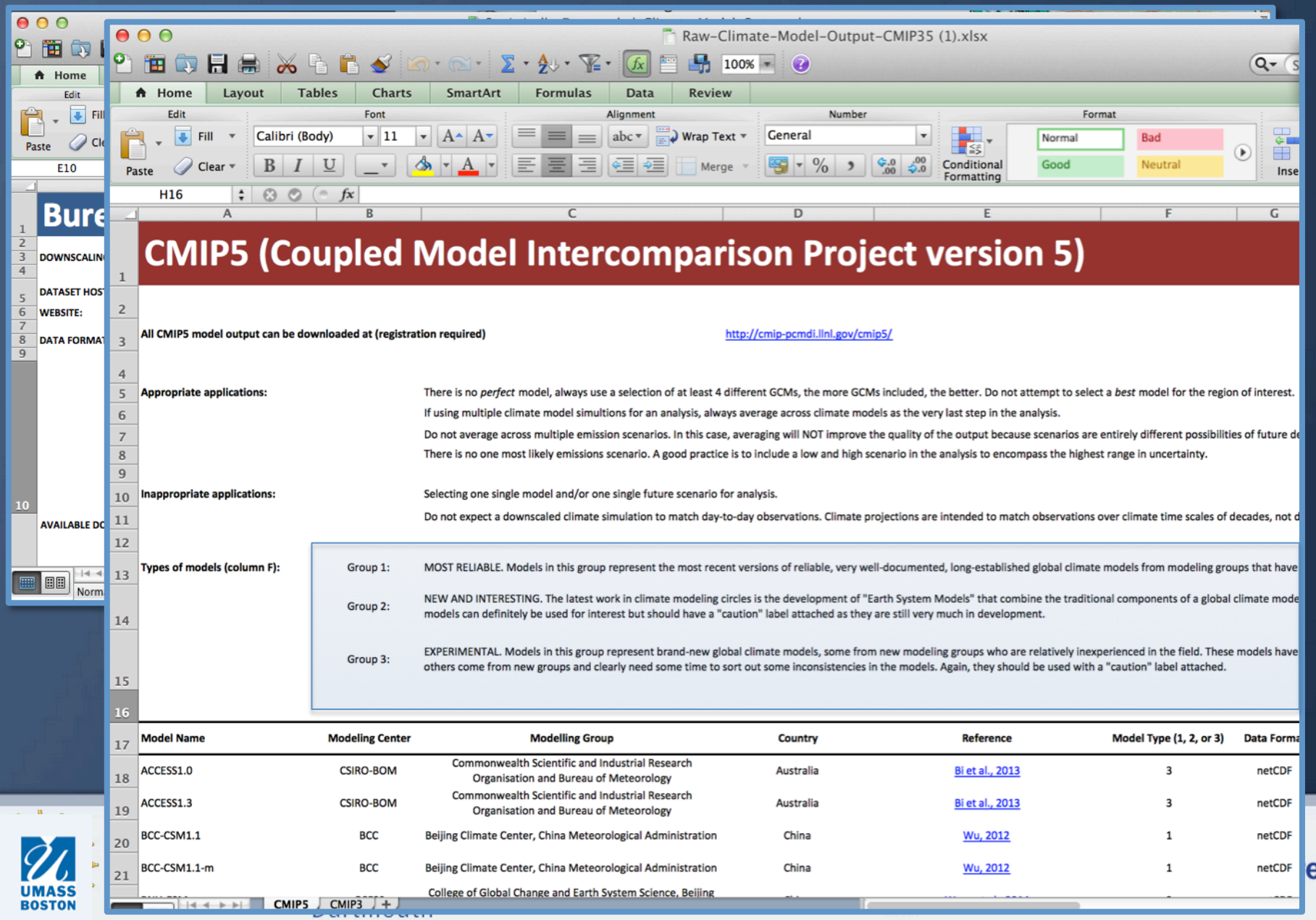
Climate Model Output Source & Selection



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Application of Climate Model Output

The ICNet Research Guide

About this guide

This guide contains introductory information and specific methods for understanding and conducting research at the interface of climate change and transportation infrastructure. It is designed to be accessible for professionals and academics in the transportation or climate science sectors. It could also serve as an introduction for graduate and undergraduate students to the issues in climate science and transportation engineering. The Infrastructure and Climate Network (ICNet) created this guide for its members and others interested in advancing research on climate and infrastructure. More about the ICNet.

Why is climate change and infrastructure research important?

Our infrastructure is built on the assumption that the climate will stay stable, water levels along shore roads will remain consistent, and bridges will be subjected to floods with known levels and frequencies. The 2014 Intergovernmental Panel on Climate Change, among other scientific organizations, has reported that the climate is warming, in large part due to human activity. Increasing temperatures, precipitation, and rising sea levels will affect our roads, bridges, and other transportation infrastructure, with implications for public safety and the economy. Accurate, relevant scientific information is needed to effectively plan and design resilient infrastructure for communities now and in the future.

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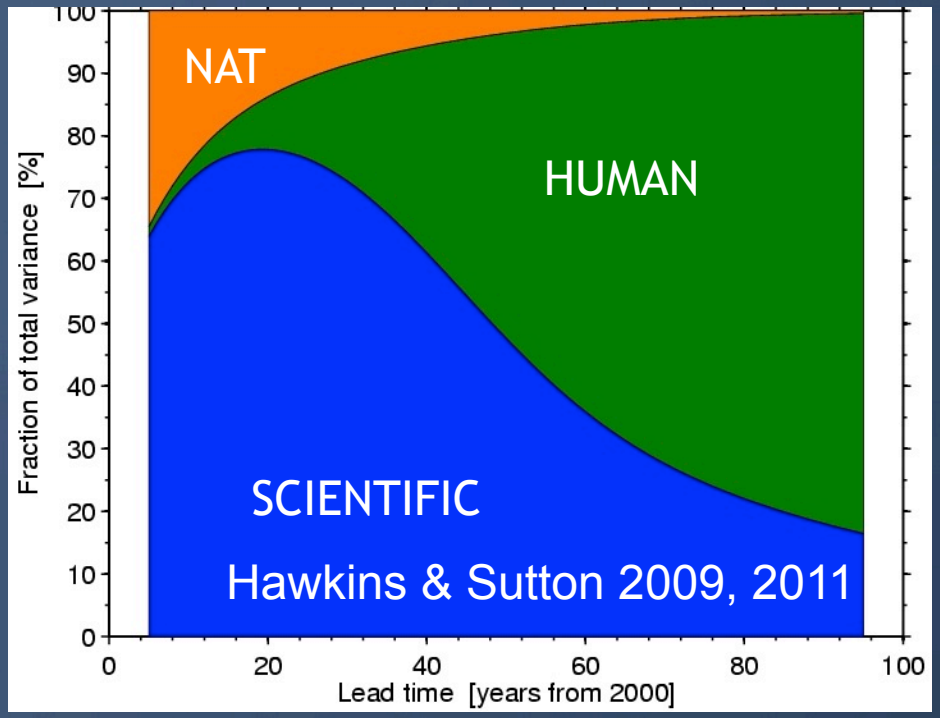
Methods to Characterize Uncertainty Relative Importance by Source

Climate Models & Observations: Global Temperature

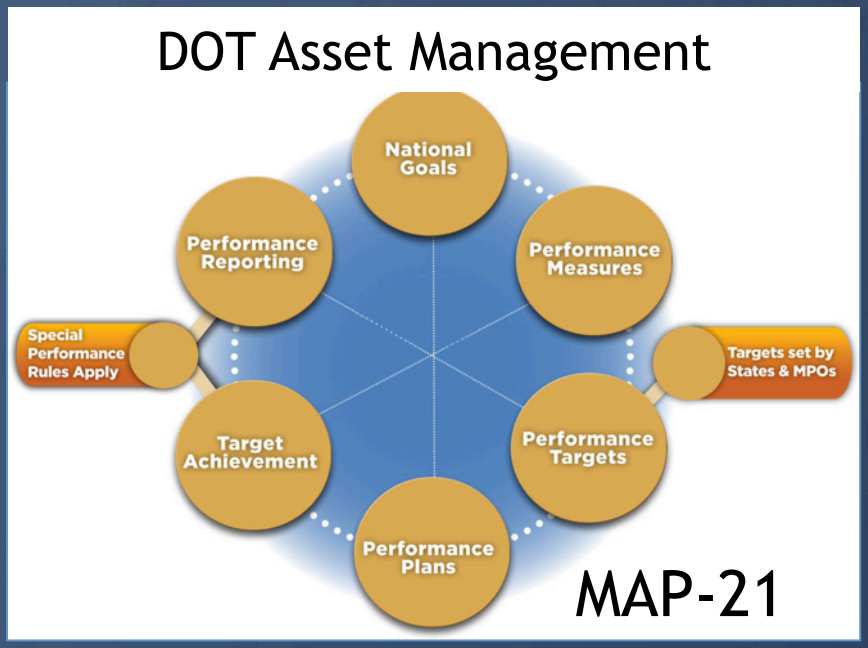


Transportation: Planning, Design, Operations & Maintenance

- Materials
- Design Guides
- Performance Models

Priority Upcoming Climate Data & Products Needs

- *Flooding Standards & Climate Change*
- *Uncertainty Quantification*
- *Linking DOT Assets & Weather/ Climate*



The White House
Office of the Press Secretary

For Immediate Release — January 30, 2015

Executive Order – Establishing a Federal Flood Risk Management Standard and a Process for Further Soliciting and Considering Stakeholder Input

EXECUTIVE ORDER

ESTABLISHING A FEDERAL FLOOD RISK MANAGEMENT STANDARD AND A PROCESS FOR FURTHER SOLICITING AND CONSIDERING STAKEHOLDER INPUT

By the authority vested in me as President by the Constitution and the laws of the United States of America, and in order to improve the Nation's resilience to current and future flood risk, I hereby direct the following:

Section 1. Policy. It is the policy of the United States to improve the resilience of communities and Federal assets against the impacts of flooding. These impacts are anticipated to increase over time due to the effects of climate change and other threats. Losses caused by flooding affect the environment, our economic prosperity, and public health and safety, each of which affects our national security.

The Federal Government must take action, informed by the best-available and actionable science, to improve the Nation's preparedness and resilience against flooding. Executive Order 11988 of May 24, 1977 (Floodplain Management), requires executive departments and agencies (agencies) to avoid, to the extent possible, the long- and short-term adverse impacts associated with the occupancy and modification of floodplains and to avoid direct or indirect support of floodplain development wherever there is a practicable alternative. The Federal Government has developed processes for evaluating the impacts of Federal actions in or affecting floodplains to implement Executive Order 11988.

Please use ICNet resources, contact ICNet, join ICNet, & refer peers to ICNet

ICNet 4th Annual Workshop
April 11 and 12, 2016
New Castle, NH

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Thank you

For more information, please visit theicnet.org or contact

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Acknowledgements

We would like to acknowledge the National Science Foundation support via the RCN-SEES: Engineering Research Collaboratory for Sustainable Infrastructure in a Changing Climate CBET 1231326, NSF SEES Fellowship for Anne Stoner, TTU and the REU supplement.

Special thanks to Ellen Mecray, NOAA for her service to ICNet

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