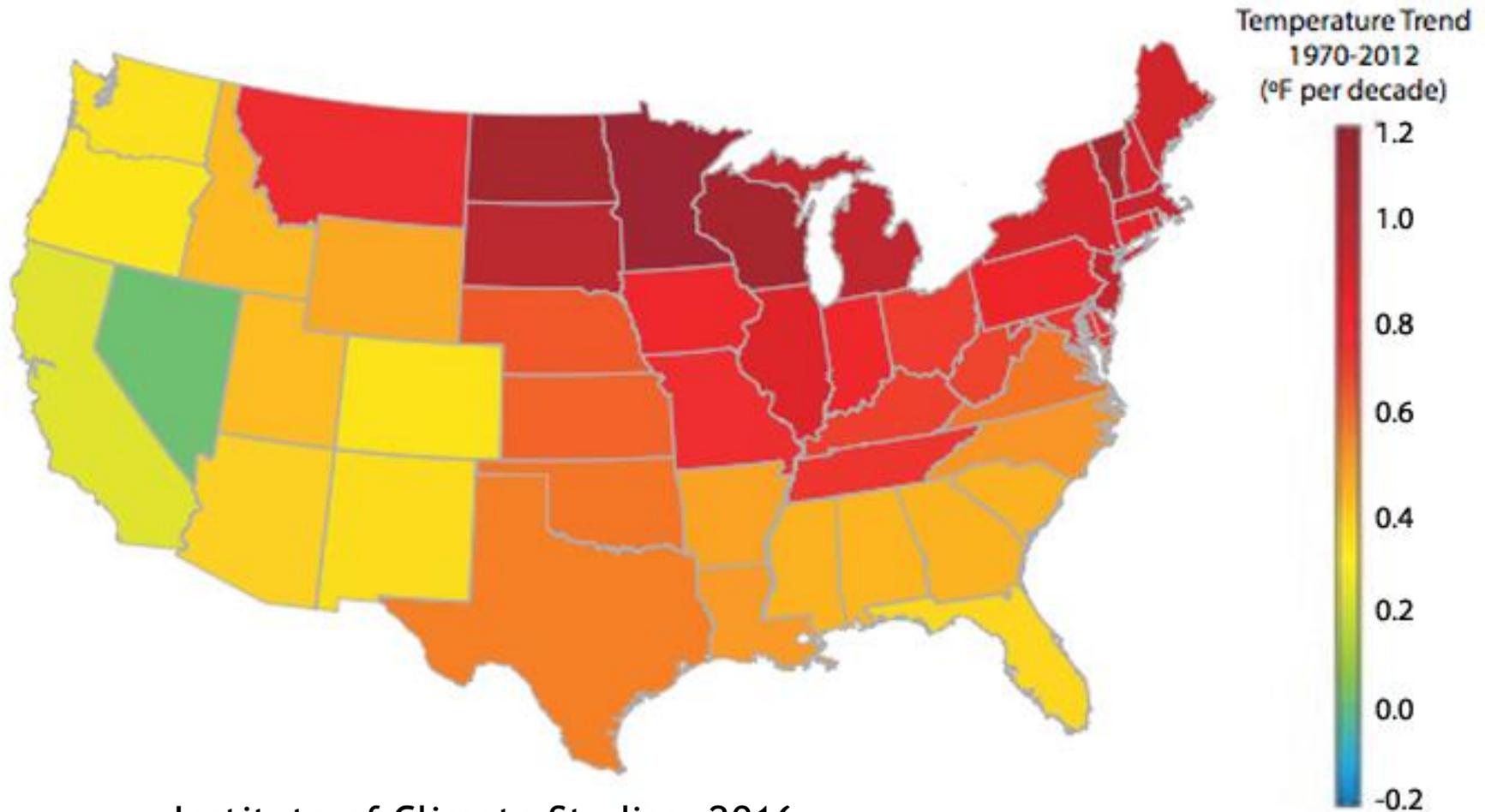


# *Collaborative Research on Changing New England Winters Impacts on Low Volume Roads*

*Jennifer Jacobs, Jillian Crowley, Jo Daniel, Curt Grimm & Alli Puchlopek, UNH  
Heather Miller, University of Massachusetts, Dartmouth  
Anne Stoner, Texas Tech University*



# Winter-Warming Accelerated in Every State But One



Institute of Climate Studies, 2016



University of  
New Hampshire

# Motivation

- Seasonal freeze-thaw (FT) occurs each spring in over half of all land totaling over **50 million km<sup>2</sup>** globally.
- Within that landscape, an **extensive road network** is embedded that constitutes a significant portion of the land area.
- In the United States alone, approximately **half of the 4.8 million km of low-volume roads** are located in seasonal frost areas.



University of  
New Hampshire

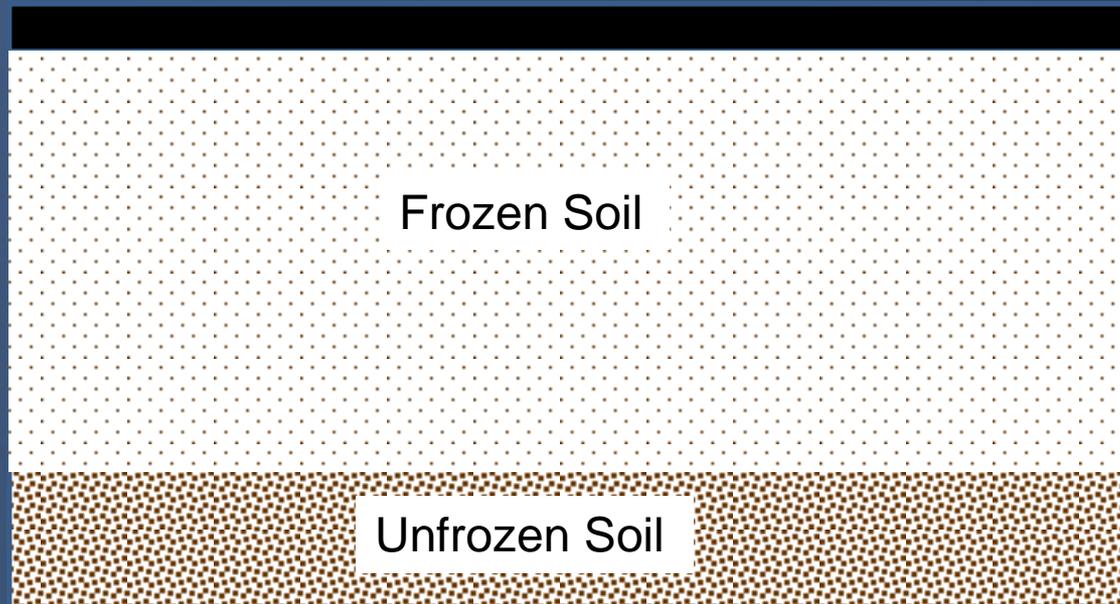
# Study Goals and Methods

- **Science Question:** How will climate change affect freeze-thaw beneath roadways?
- **Applications Question:** How will these changes affect DOTs' operations & maintenance and do existing policies support their ability to adapt to future conditions?
- **Applications Goal:** Develop and document best availability data sets, methods and analysis process using the Infrastructure and Climate Network's (theICNet.org) expertise



University of  
New Hampshire

During late fall, soils begin freezing  
from pavement surface downward

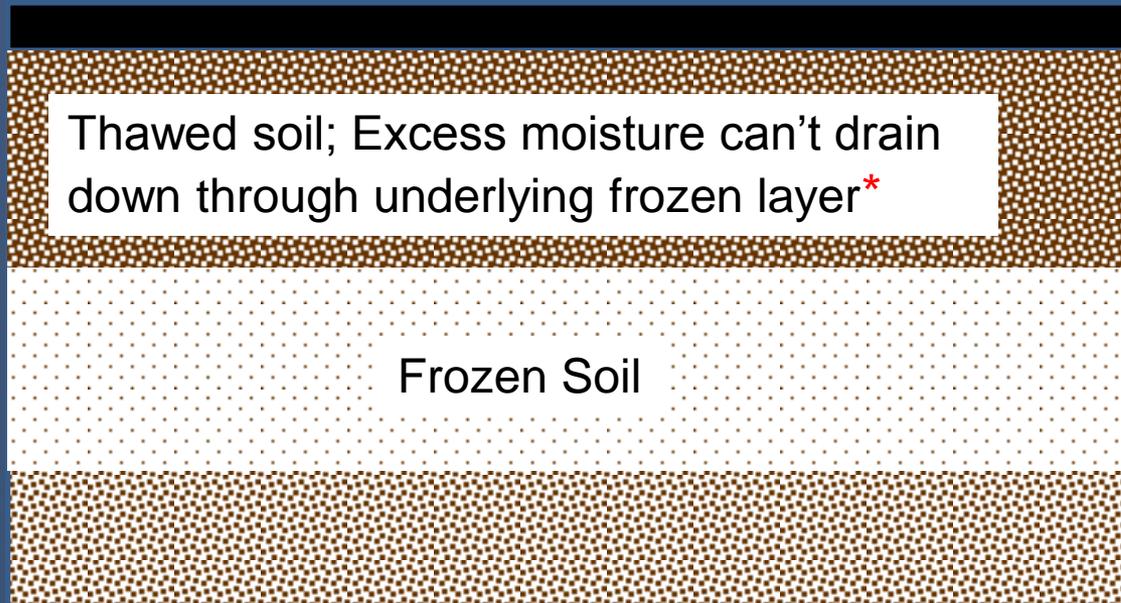


DOTs take advantage of increased  
strength & stiffness of frozen soil:  
Apply Winter Weight Premiums  
(WWP)



University of  
New Hampshire

# In late winter/early spring, soils begin thawing



Critical Period:  
Reduced strength & stiffness

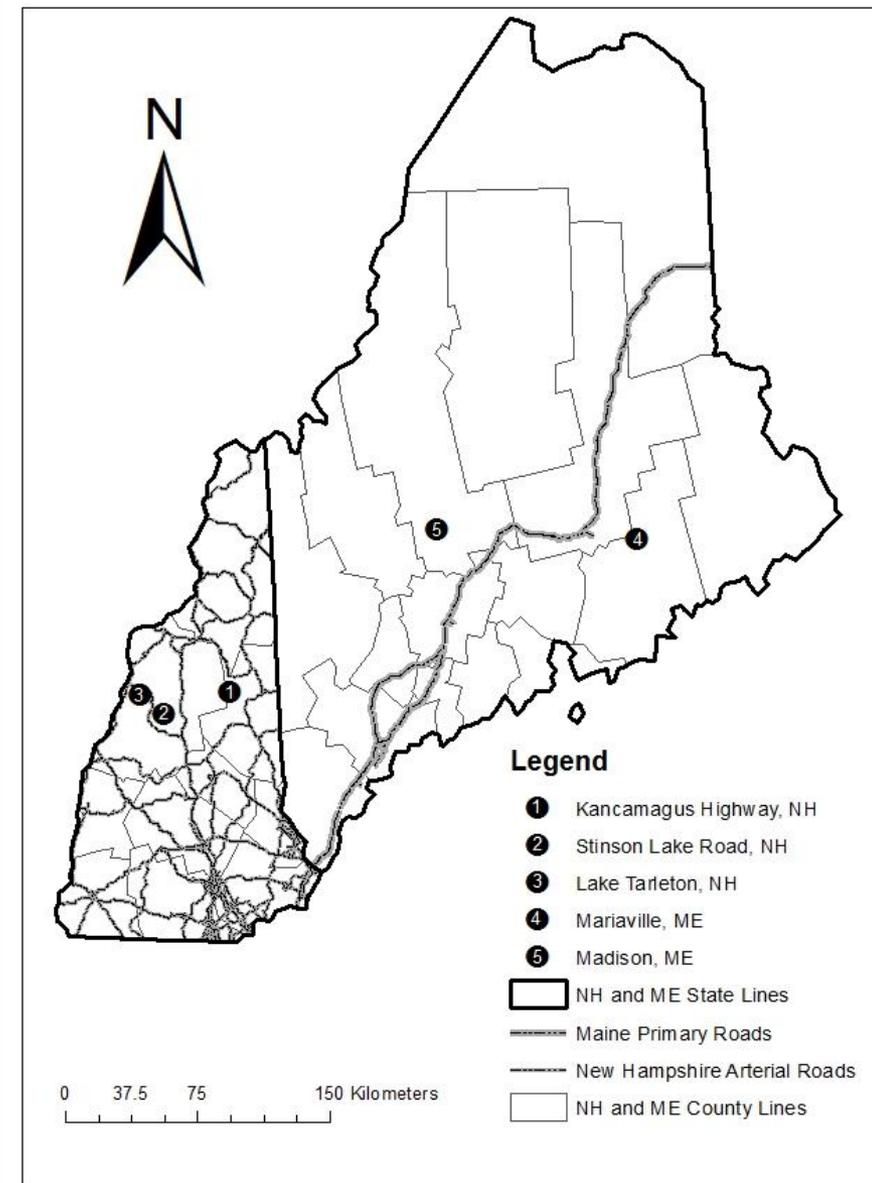
DOTs Apply Spring Load Restrictions (SLR)



University of New Hampshire

# Study Sites

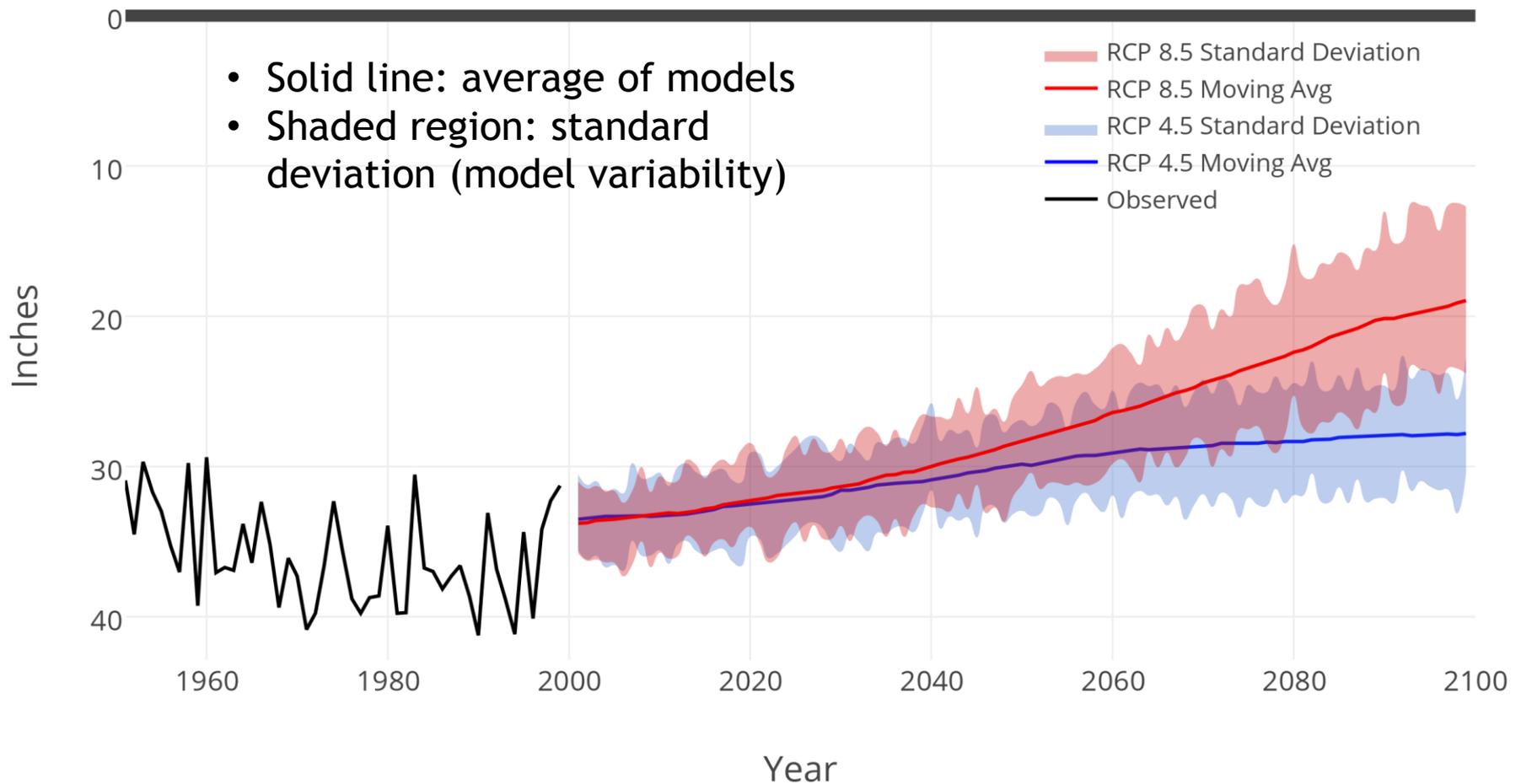
1. Kancamagus, NH (KAN)
1. Lake Tarleton, NH (LAK)
2. Stinson Lake Rd, NH (STI)
3. Mariaville, ME (MAR)
4. Madison, ME (MAD)



# Evolution of the Maximum Frost Depth

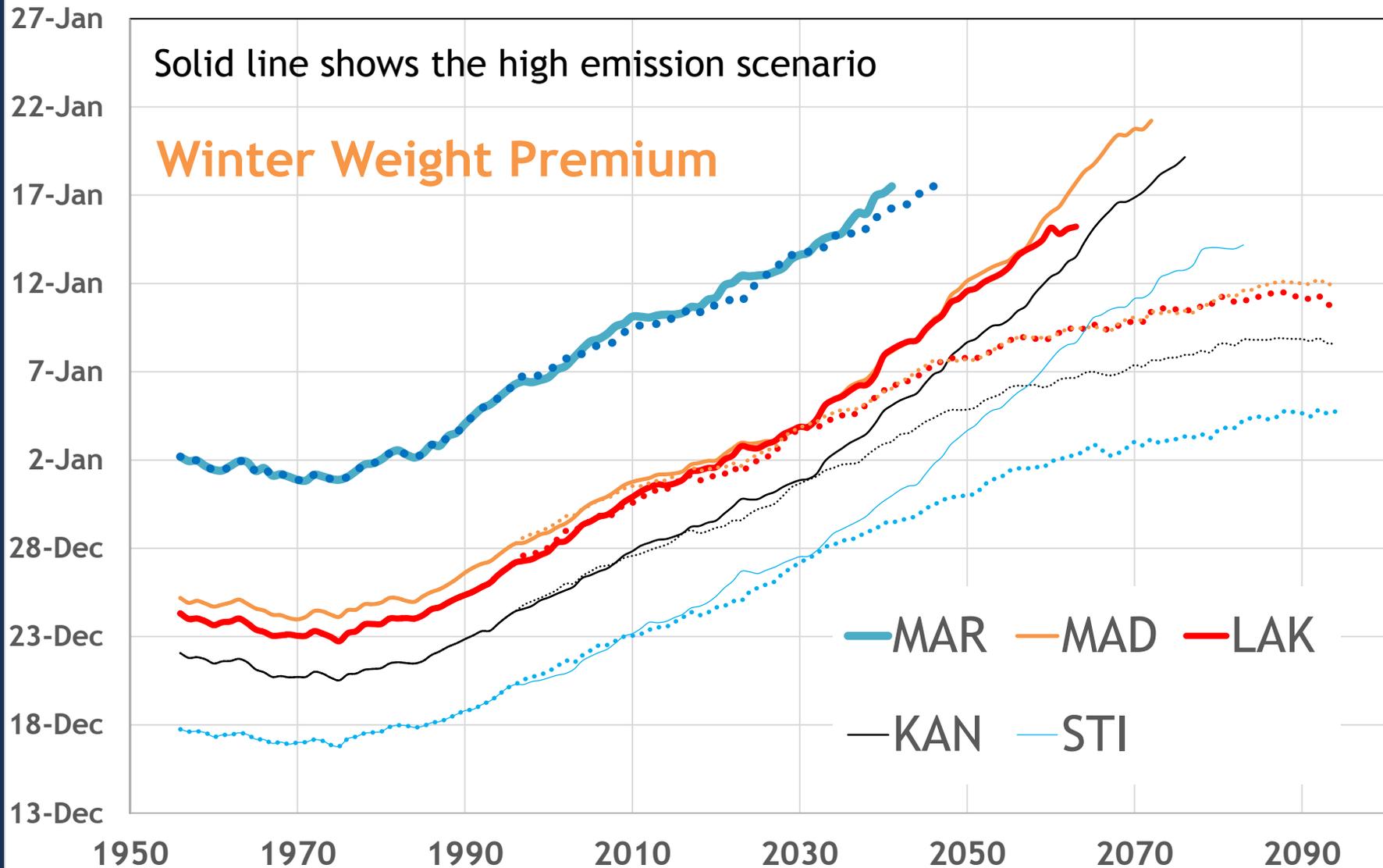
## 20 Climate Models using RCP 4.5 and RCP 8.5

Historical and Projected Maximum Frost Depth in Madison, ME Based on RCP 4.5 and RCP 8.5



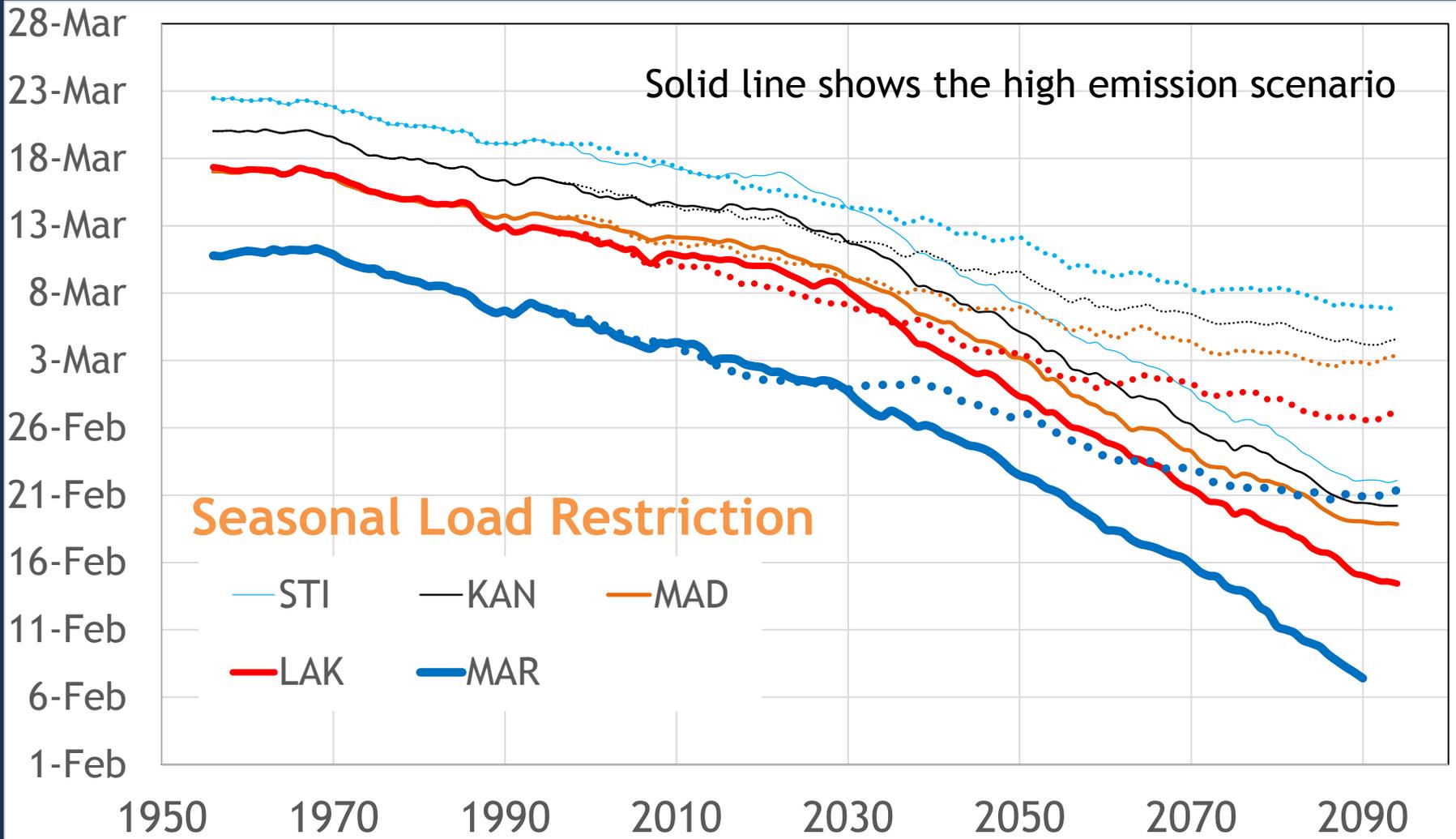
# Evolution of CFI Threshold Exceedence Dates

20 Climate Models using RCP 4.5 and RCP 8.5



# Evolution of CTI Threshold Exceedence Dates

20 Climate Models using RCP 4.5 and RCP 8.5

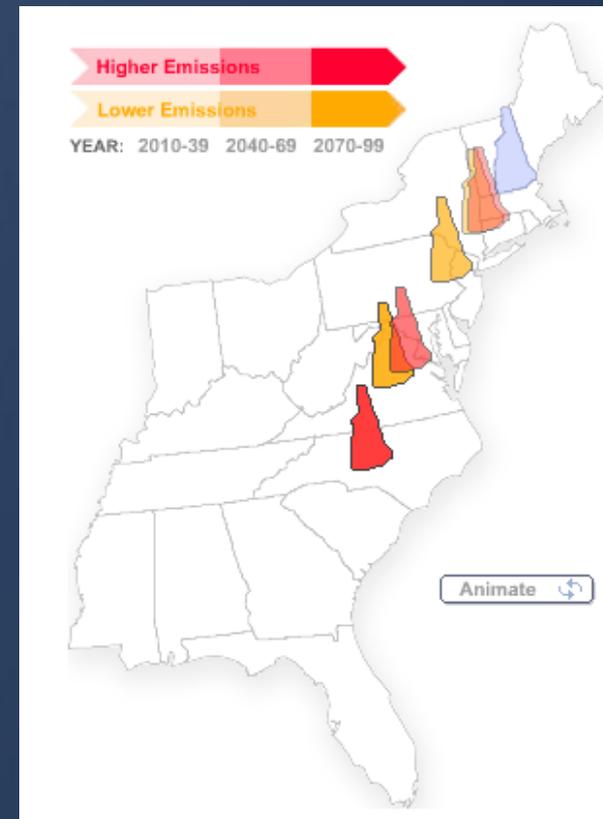


# Implications for Adaptation

Semi-structured interviews with 20 DOT and road agents across the U.S. with most from New England municipalities and states to gather SLR/WWP policies and practices.

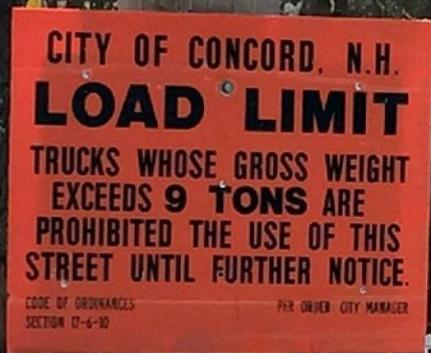
Three themes emerged

1. Disconnection between changing weather patterns and climate change views
2. Adaptability is linked to SLR/WWP policy
3. Enforcement may be as important as SLR/WWP policy



# Winter Road Policies Differ By State & Impact Ability to Adapt

1. Home Rule 👍
2. Legislated Dates 👉
3. Industry or Political Driven 👎



## §2953. CLOSING OF ROADS IN WINTER

**1. Announcement of winter closing of roads.** The municipal officers may on their own initiative or upon petition by 7 legal voters of the municipality, at any time between May 1st and October 31st of each year, set forth that any road or roads, or portion thereof, in the municipality are so located with respect to population, use and travel thereon, that it is unnecessary to keep the road or roads maintained and open to travel during the months of November, December, January, February, March and April or any part thereof.

[ 1981, c. 215, (NEW) .]

**2. Notice and hearing.** Prior to an announcement under subsection 1, the municipal officers shall hold a hearing on the proposed winter closing of a road or roads or portion thereof. The municipal officers shall place a written notice of the hearing in some conspicuous, public place in the municipality at least 10 days before the hearing.

[ 1981, c. 215, (NEW) .]

**3. Order of closing.** After a hearing under subsection 2, the municipal officers shall file with the municipal clerk any order specifying the location of the road, the months or portions thereof for which the road shall be closed and for how many years, not to exceed 10, the closing shall be operative. The legislative body of the municipality shall by vote either approve each order or provide that orders so made by the municipal officers shall be a final determination.

[ 1981, c. 215, (NEW) .]



# Conclusions

Changing winter temperatures will impact existing road networks' ability to support heavier traffic and change the timing of winter weight premiums and spring load restrictions.

The ability to adapt to the changing conditions is highly dependent on existing & future policies.

This study's results for existing low volume road networks has broader value for transport globally and seasonal access to sensitive lands.



# Acknowledgements

We would like to acknowledge ICNet for providing the resources, contacts and funding for the research. We would also like to acknowledge the National Science Foundation support via the RCN-SEES: Engineering Research Collaboratory for Sustainable Infrastructure in a Changing Climate CBET 1231326 and the REU supplement.

REU Students: Masoumeh Khalkhali, Ashley Filion, Tova Levin

David Orr and Christopher Cabral are gratefully acknowledged for their work on the Modified Model 158 spreadsheet. That work was funded, in part, by the US Department of Transportation Cooperative Agreements No RITA-RS-11-H-UMDA and No RITA-RS-14-H-UMDA

*The ICNet is a network over 100 academics, students, and practitioners who are dedicated to accelerating climate science and engineering research in the Northeastern United States ([theICNet.org](http://theICNet.org))*

