



**Meridian**  
Environmental Technology Inc.  
An Iteris Company



# Use Case #1: Enhanced Road Weather Content Enabled by *Clarus*

Sept. 8, 2011

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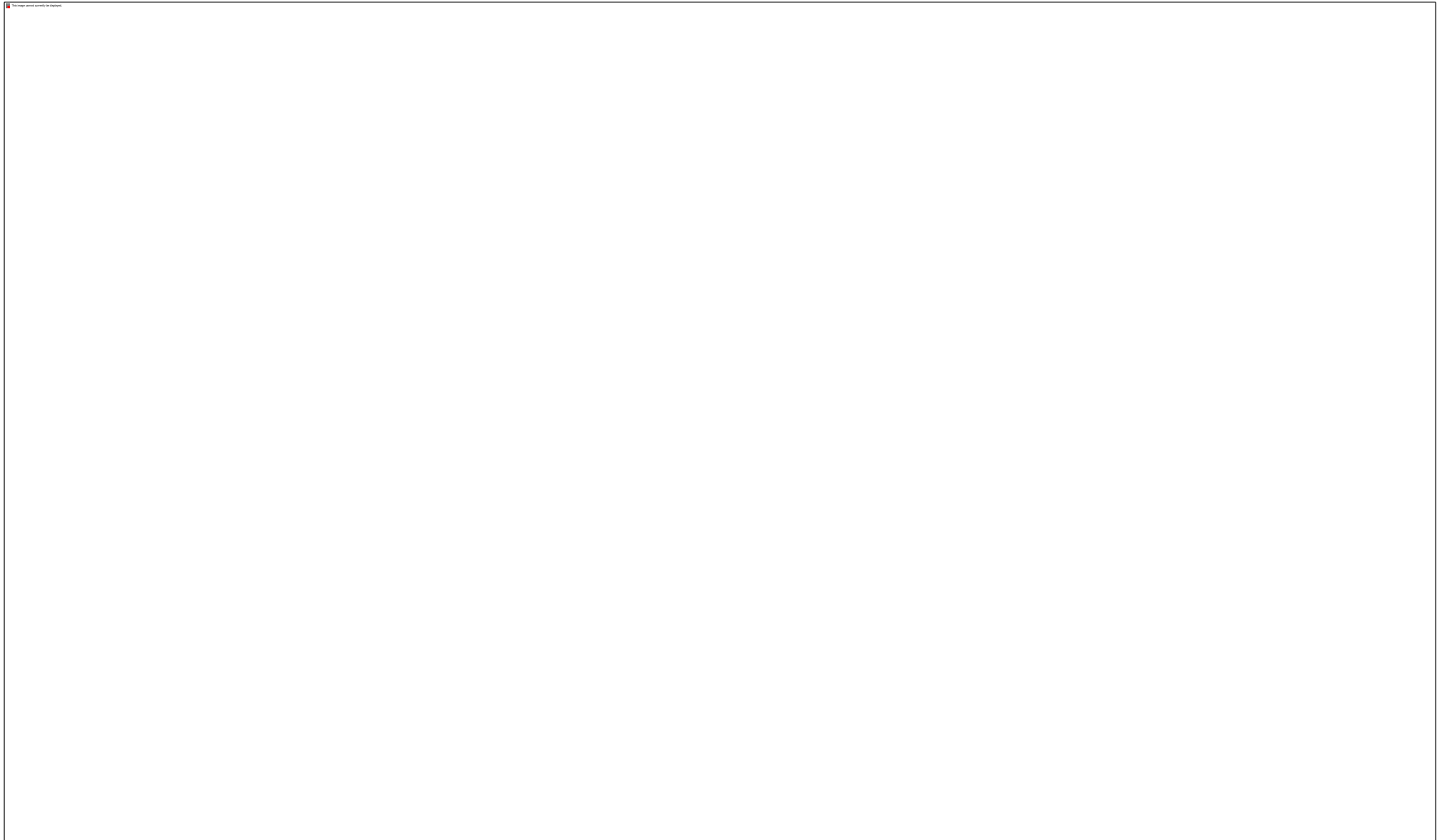
Providing Tomorrow's Technology Today

# Meridian Team



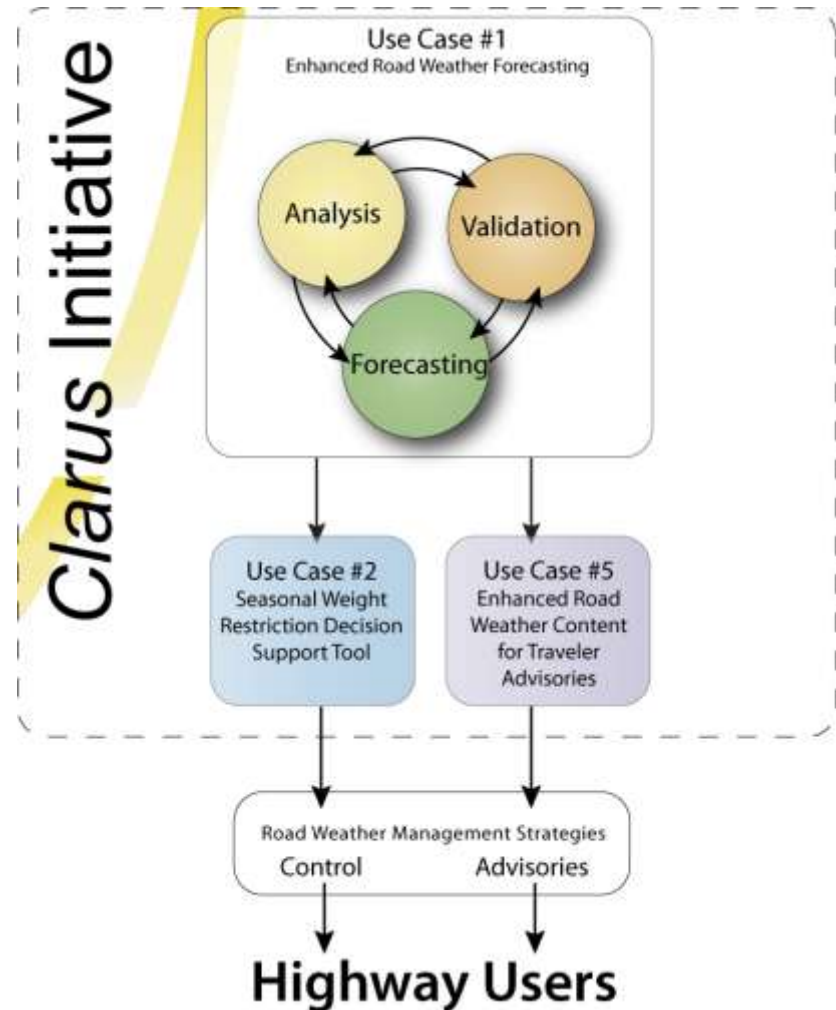
- Meridian Environmental Technology, Inc.
- Iteris, Inc.
- University of North Dakota
- The Meridian Team's Partner States
  - Idaho Transportation Department
  - Minnesota Department of Transportation
  - Montana Transportation Department
  - North Dakota Department of Transportation
  - South Dakota Department of Transportation

# Clarus Demonstration Use Cases



# Clarus Road Weather Support

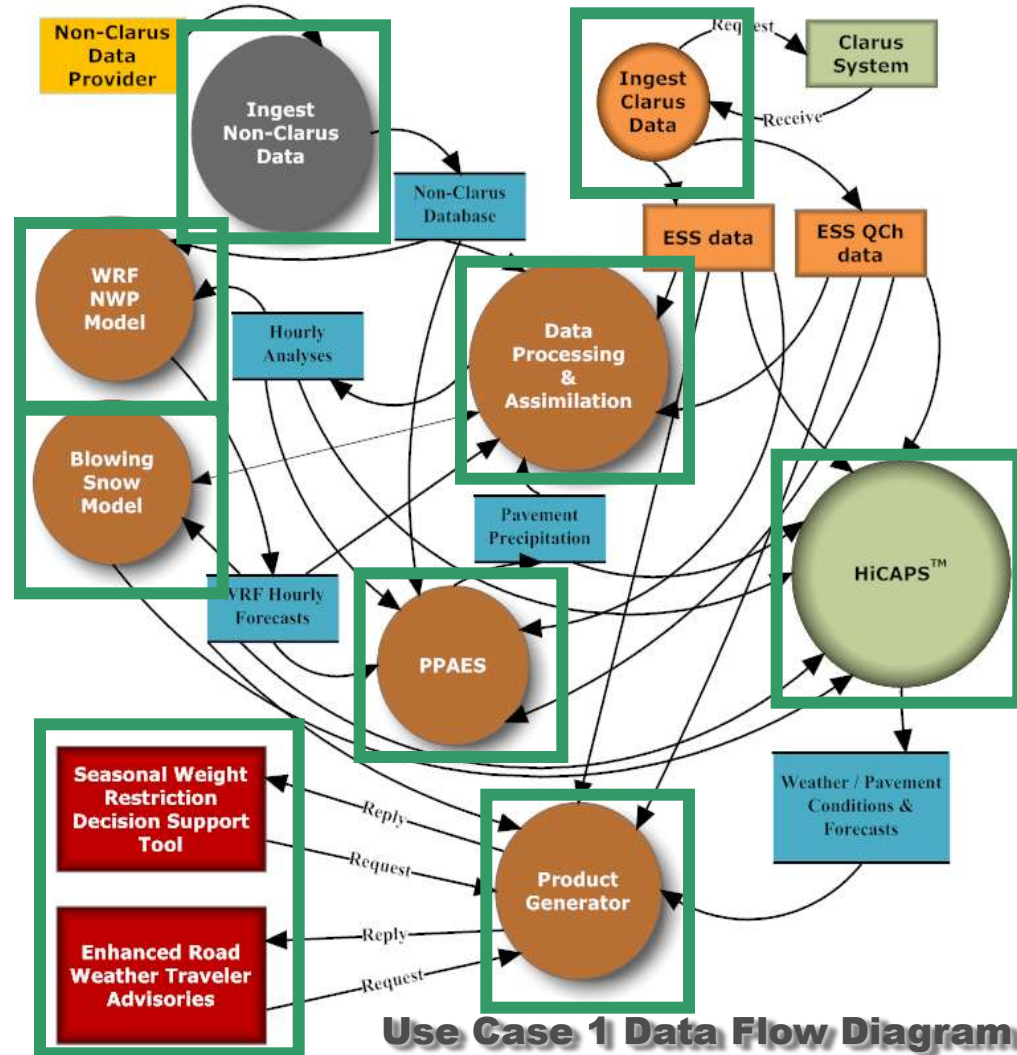
- Enhancing Road Weather Forecasting Methods Support:
  - Control Strategies (Use Case #2)
  - Advisory Strategies (Use Case #5)



# Clarus Enhanced Road Weather Forecasting

Forecasting framework composed of diverse data, analyses, and modeling systems supporting various end-user decision-making tools

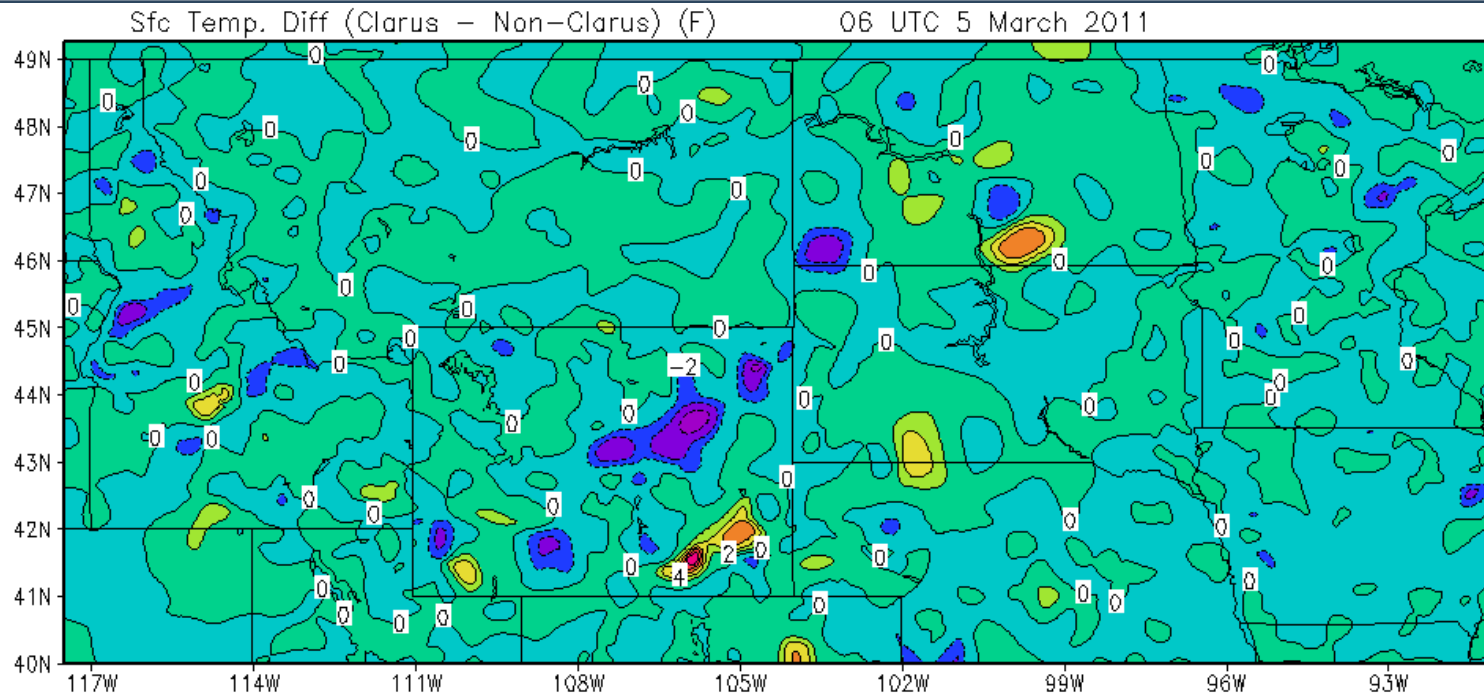
Enhancements derived from ESS atmospheric AND pavement observations



# Mesoscale Modeling Conceptual Design

- Challenge
  - How to appropriately incorporate ESS observations utilizing *Clarus* Quality Check flags within mesoscale modeling
  
- Solution:
  - Incorporate preprocessing methods to apply QCh flags to control data ingest into data assimilation methods used to initialize mesoscale models
  
- *Clarus* Enhancement:
  - Extends the availability of observations to low density observations areas

# Data Assimilation Results



- Large variations indicate both an local enhancement in temperatures and impacts of the distant-dependent objective analysis scheme
  - Improvements are isolated but significant for select areas

# Findings (Mesoscale Modeling)



- *Clarus* data offer additional data to initialize the (road) weather environment
  - Greatest benefit to data assimilation for surface conditions in low density observation areas
  - Supports various real-time applications (i.e. blowing snow analyses)
  - Difficulties in applying the QCh flags in a cost effective and efficient manner
- Minor benefits to mesoscale modeling beyond initial hours
  - Non-surface conditions drive the surface state
  - Localized higher-resolution models (~1-km) hold more promise of utilizing greater volume of (surface) observations



# Research Needs / Gaps (Mesoscale Modeling)

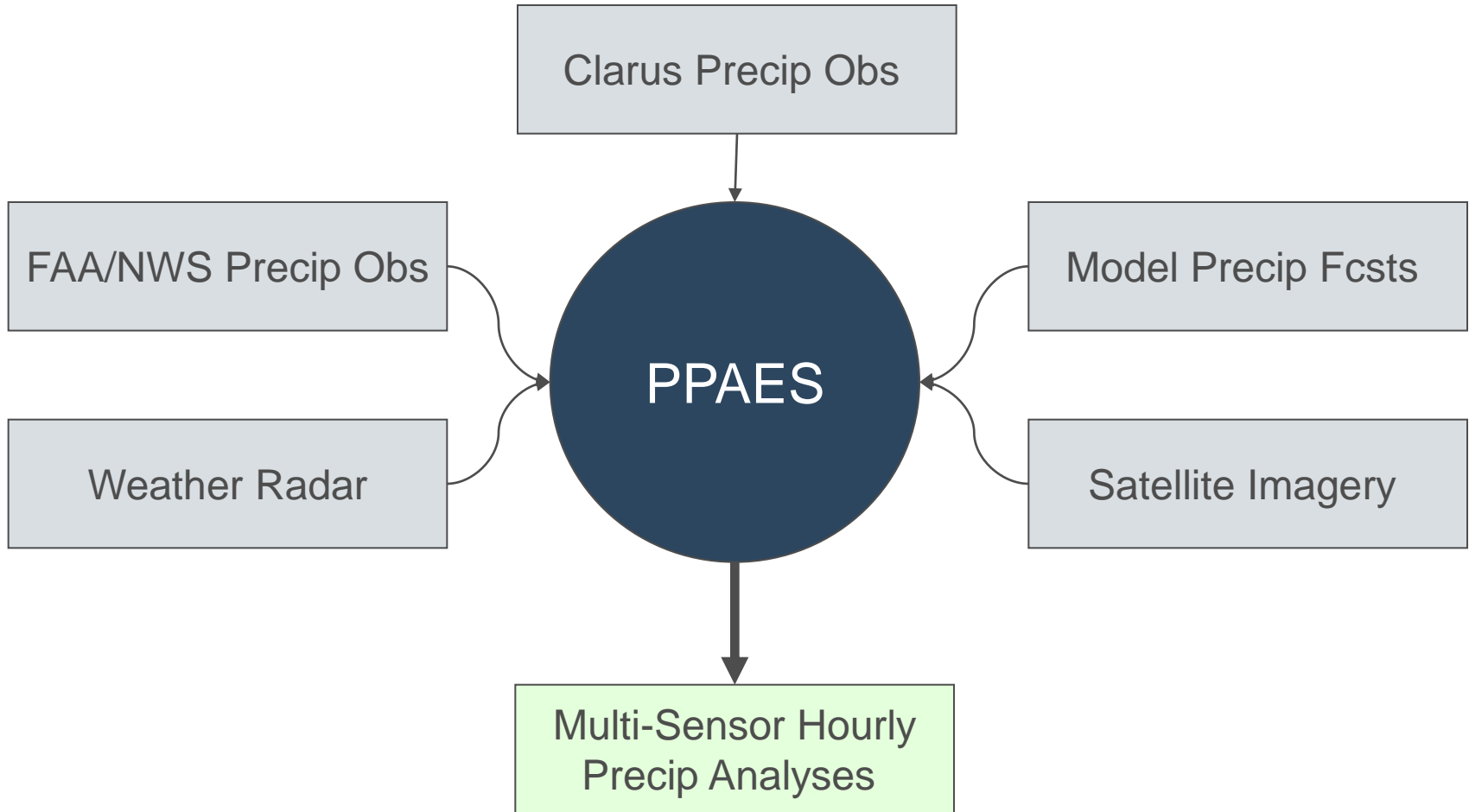
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- Need for improved boundary layer observations
- Improved methods to incorporate QCh flags in an objective (automated) manner
- Better focus (new paradigm) of mesoscale modeling specific to the roadway environment to derive greater benefit from surface observations
- Benefit-Cost study needed to identify the justification for expending higher costs required to operationally support high-resolution mesoscale models

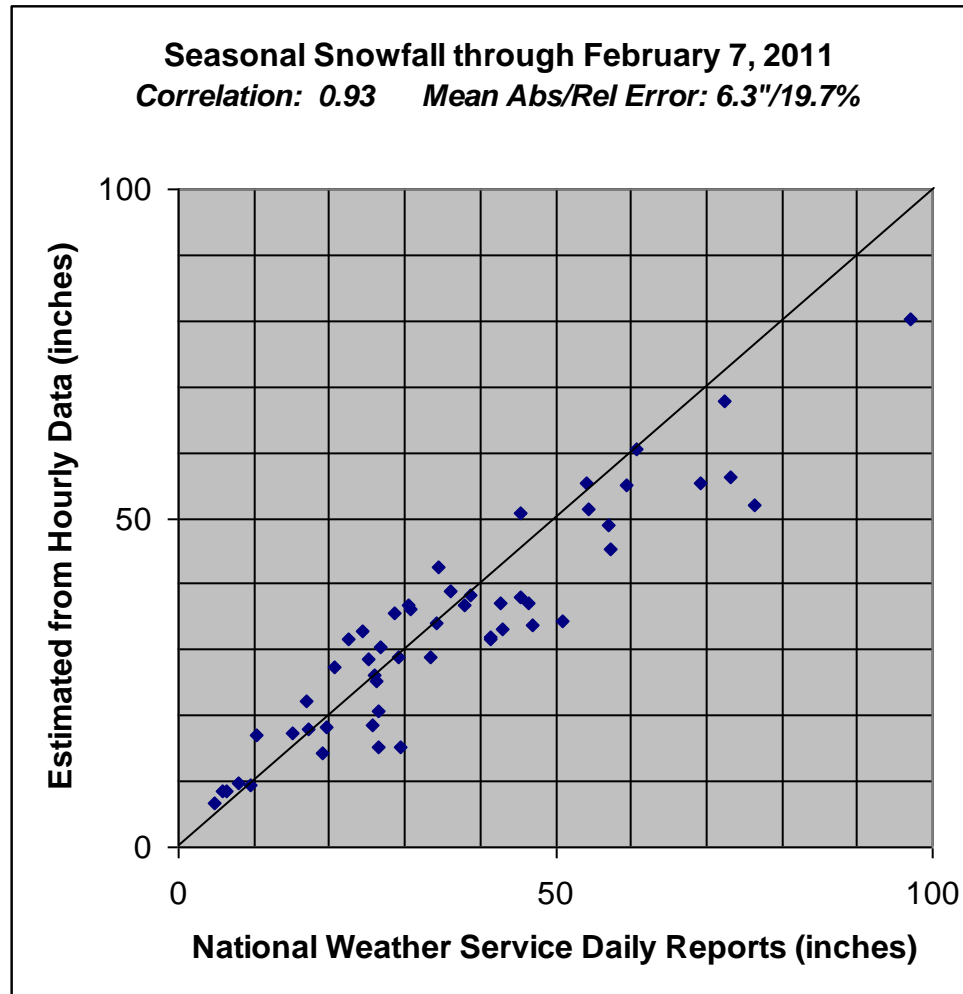
# PPAES Conceptual Design

- Challenge
  - Substantial benefits to be had from highly-detailed, rapidly-updating wintertime precipitation information, but...  
*...all the information resources suffer from unique problems*
  
- Solution:
  - Extend surface observations with remotely sensed (e.g., weather radar and satellite) and computer model data
  
- *Clarus* Enhancement:
  - Substantially extends the 'ground truth' surface-based observations of precipitation

# PPAES Conceptual Design



# PPAES Performance



# Findings (PPAES)

- Has shown considerable promise and is now being used to support operational road weather products
- Algorithms for integrating data to the maximum benefit are complex
- Quality control of surface observations is a *huge* issue
- There are significant differences in sensitivity amongst surface observing sites – can dominate the analysis!

# Research Needs / Gaps (PPAES)



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- Improved quality control techniques for precipitation observations
  - Not just to filter out blatantly bad observations, but also to identify sensor biases
  
- Improved RWIS maintenance programs, with more emphasis on uniform responsiveness from hardware



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# Seasonal Weight Restriction (SWR) Decision Support Tool Use Case 2

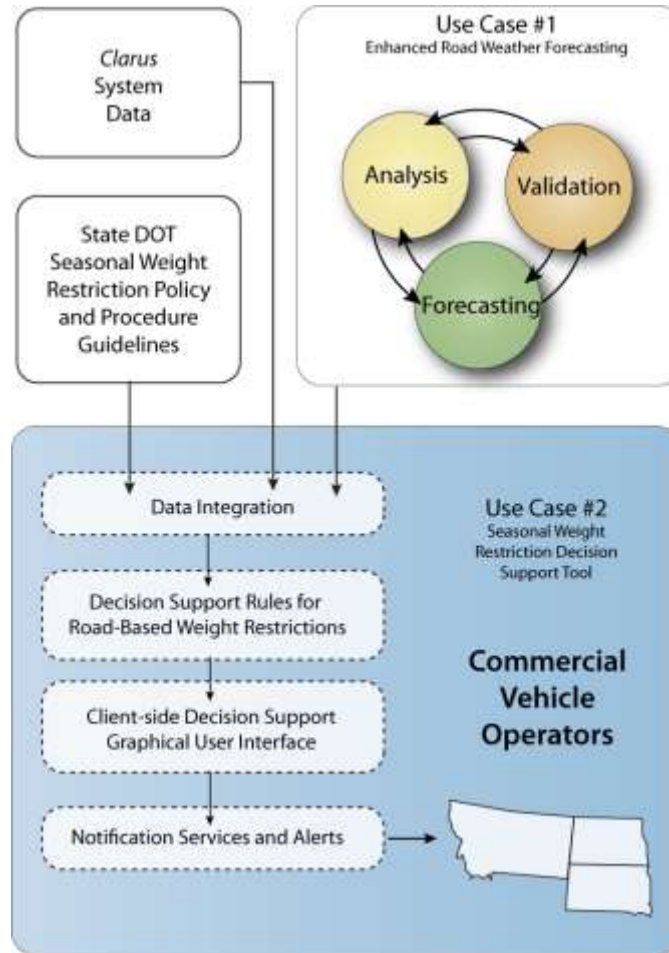
September 8, 2011

Bob Hart

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# SWR Design





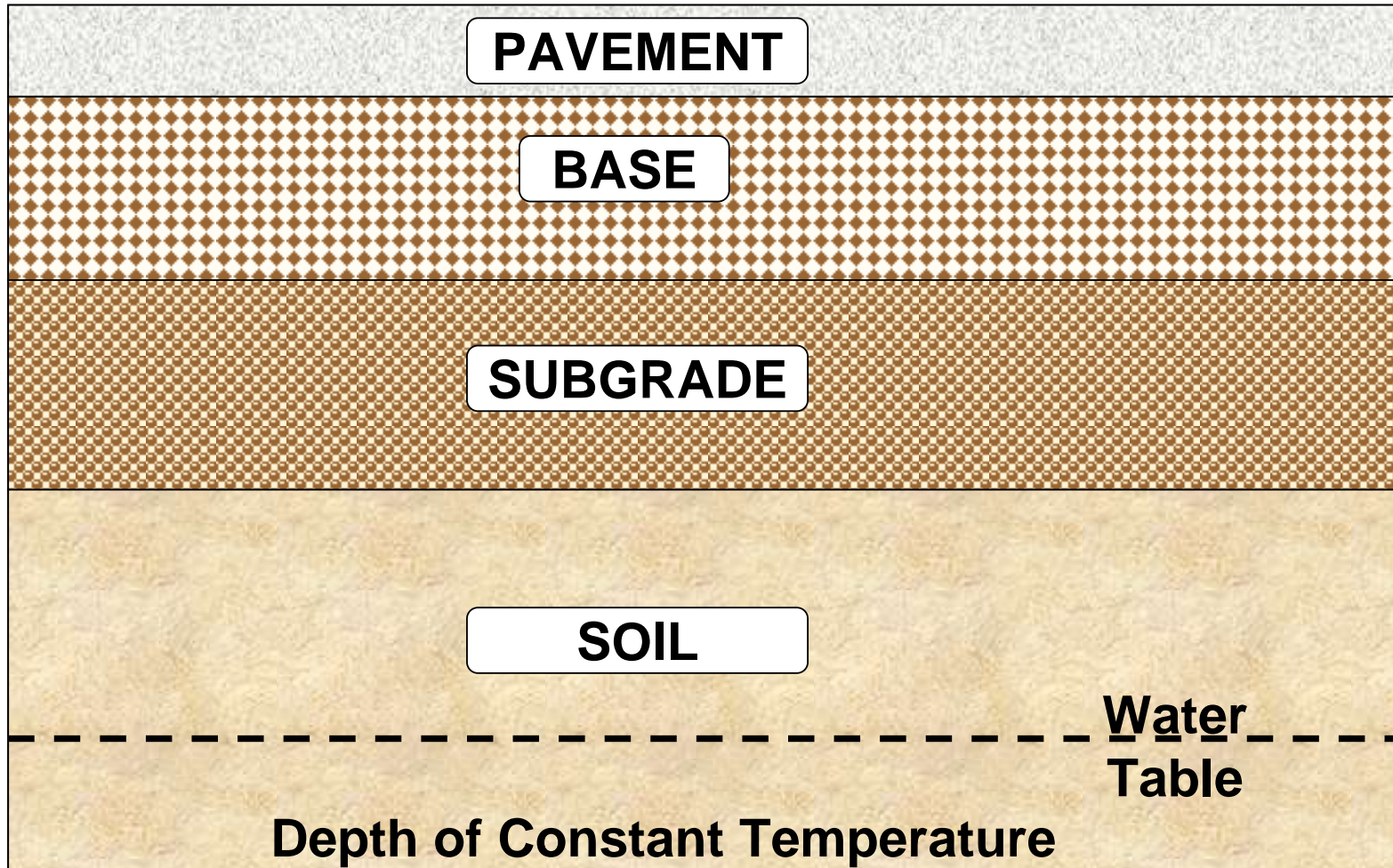
GFS

## Enhanced Integrated Climatic Model

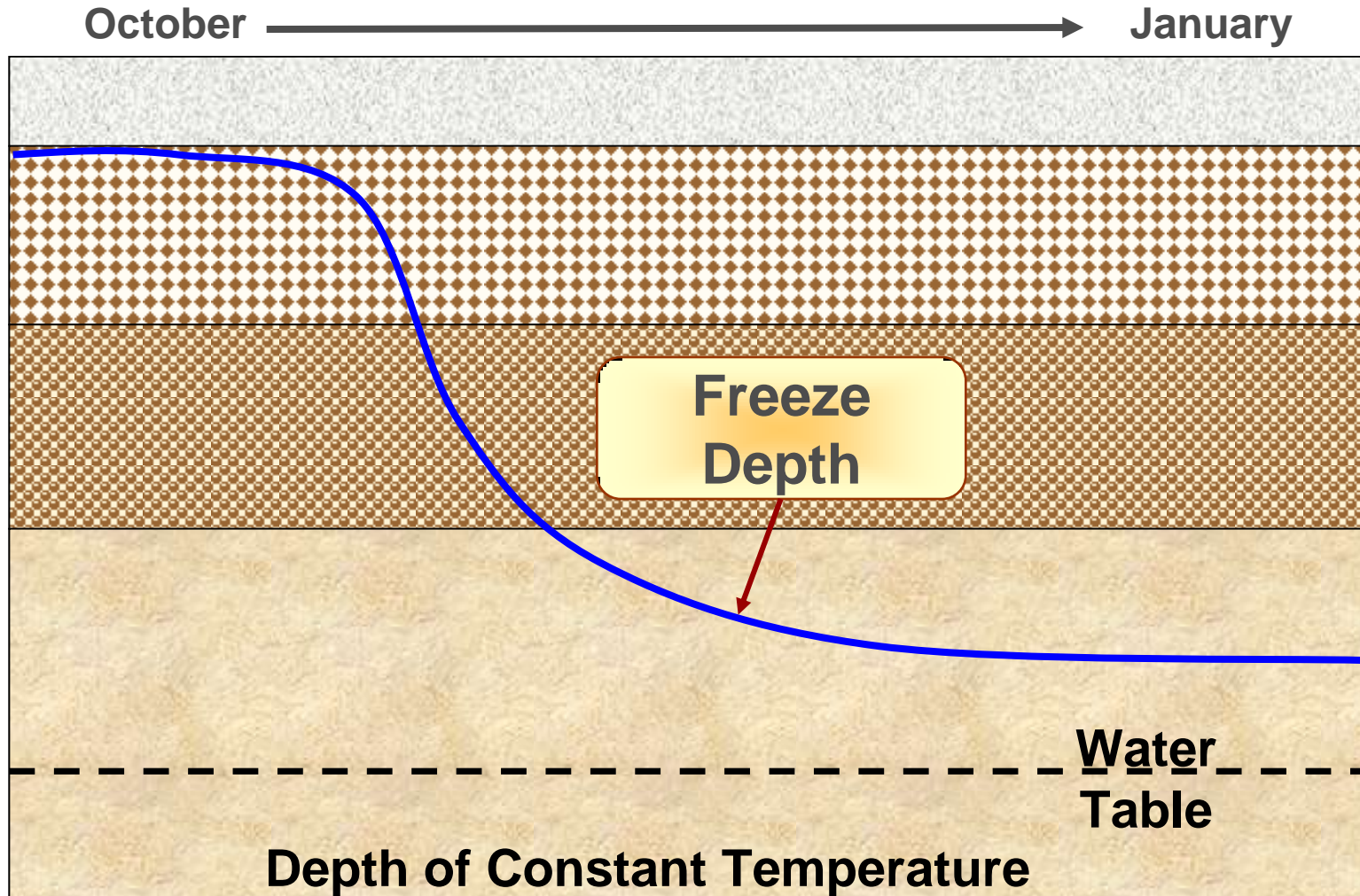
A research model comprised of:

- Climatic-Materials-Structures model developed at the University of Illinois
- Infiltration and Drainage model developed at the Texas Transportation Institute
- Frost Heave and Thaw Settlement model developed by the CRREL

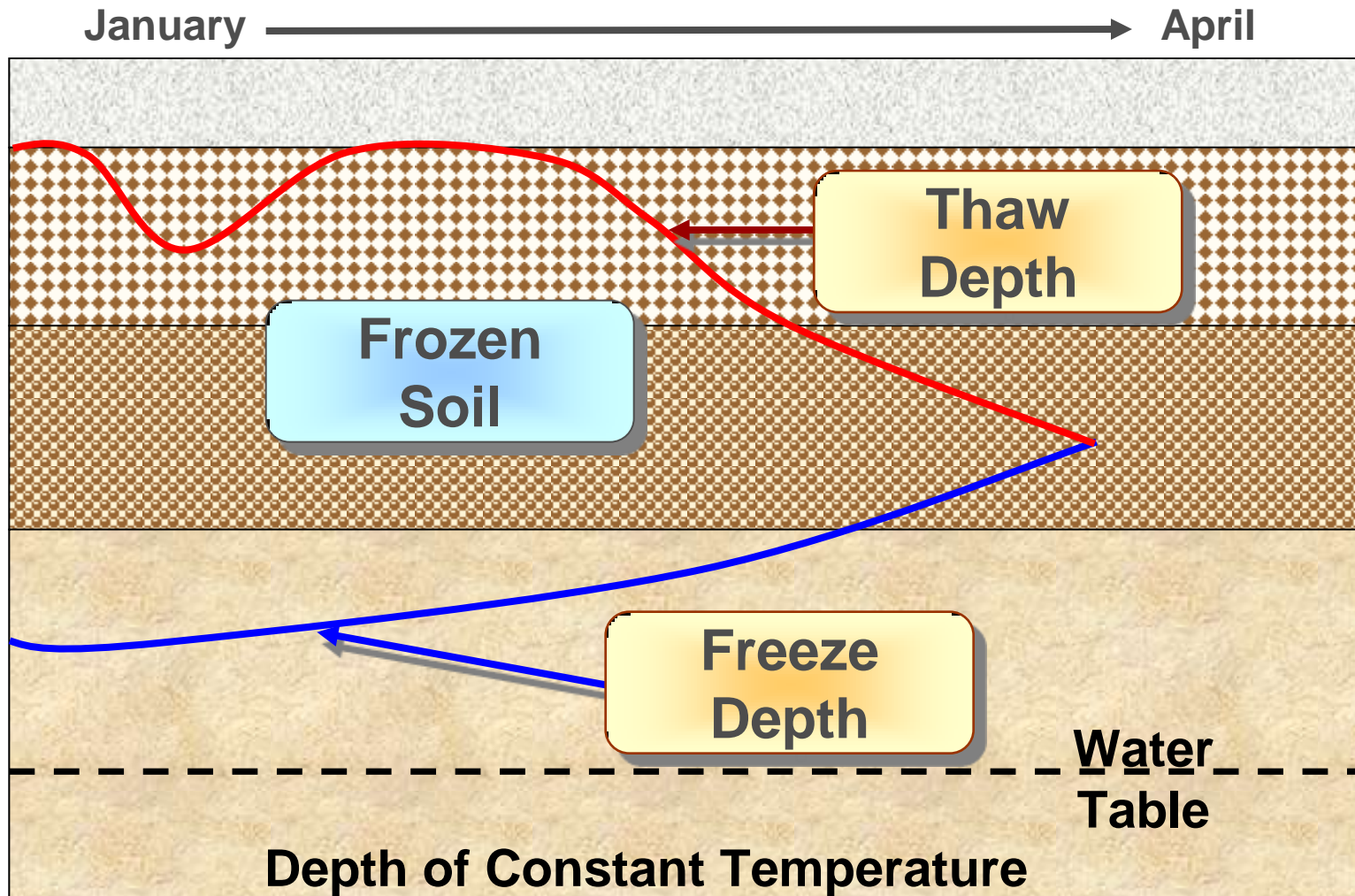
# EICM Concept - Profile



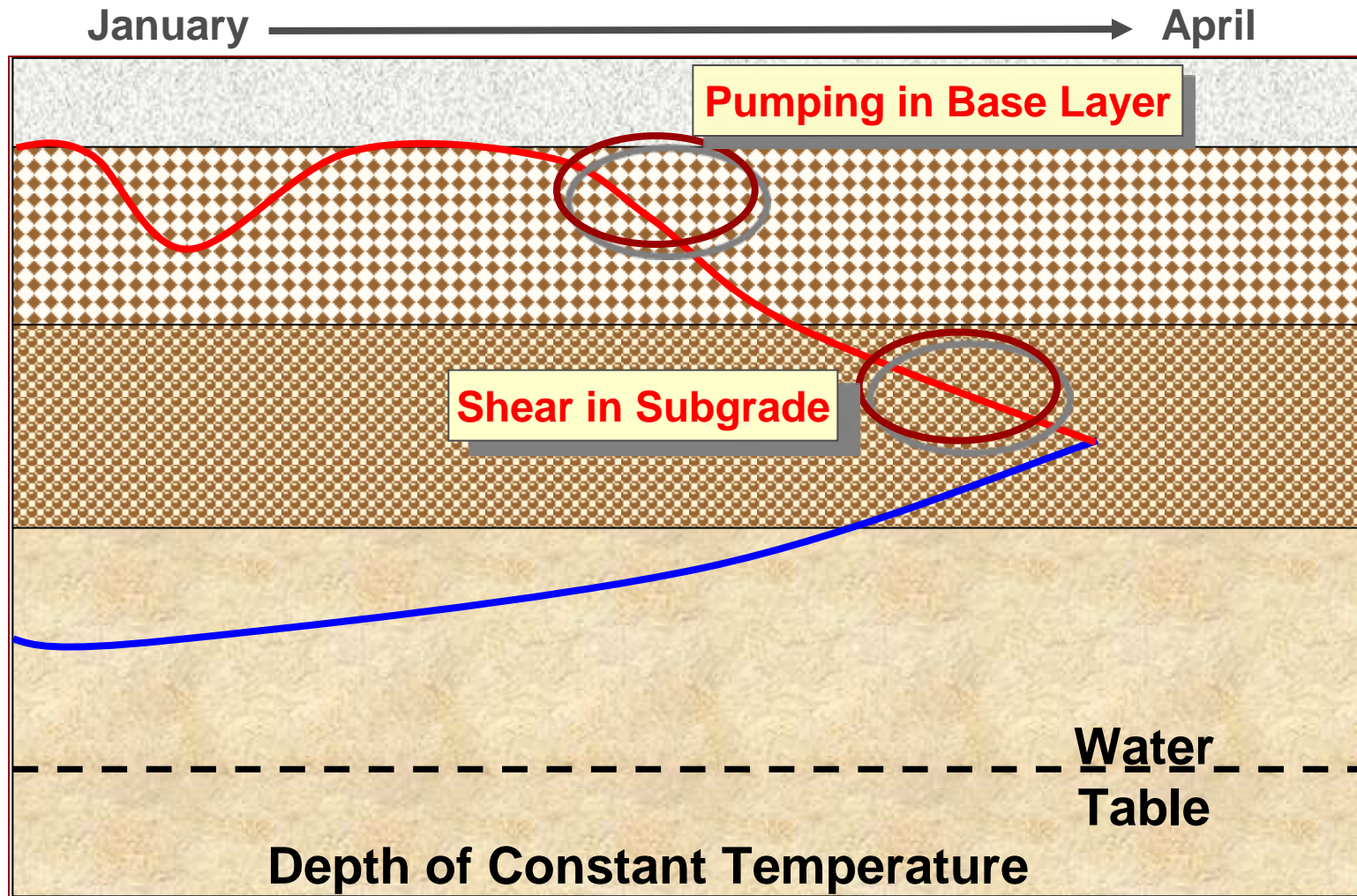
# EICM Concept - Freeze



# EICM Concept - Thaw



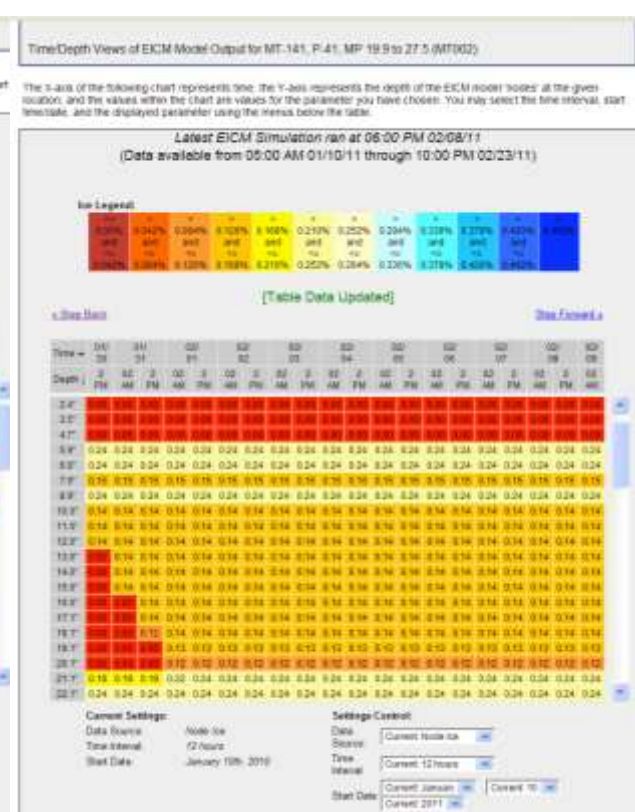
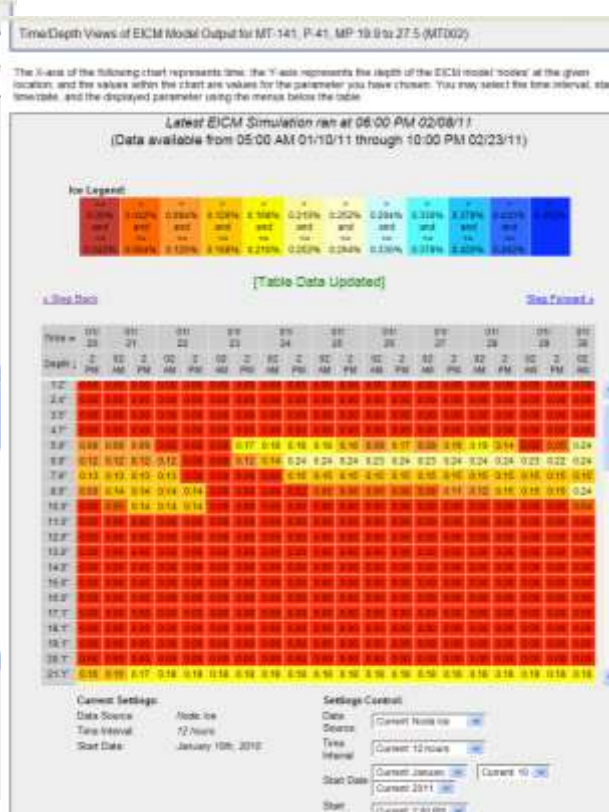
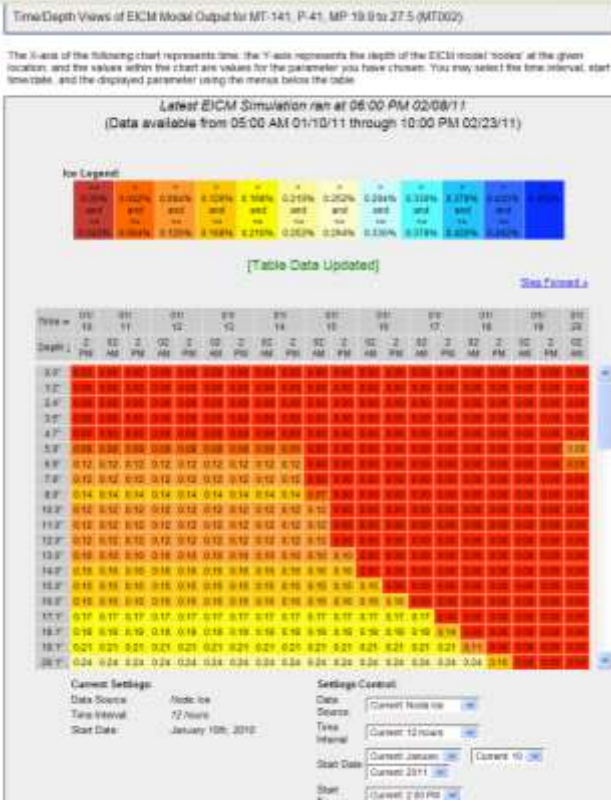
# EICM Concept – SWR Issues





# SWR Display - Pictograph

## Node % Ice 10 Jan – 9 Feb, 2011





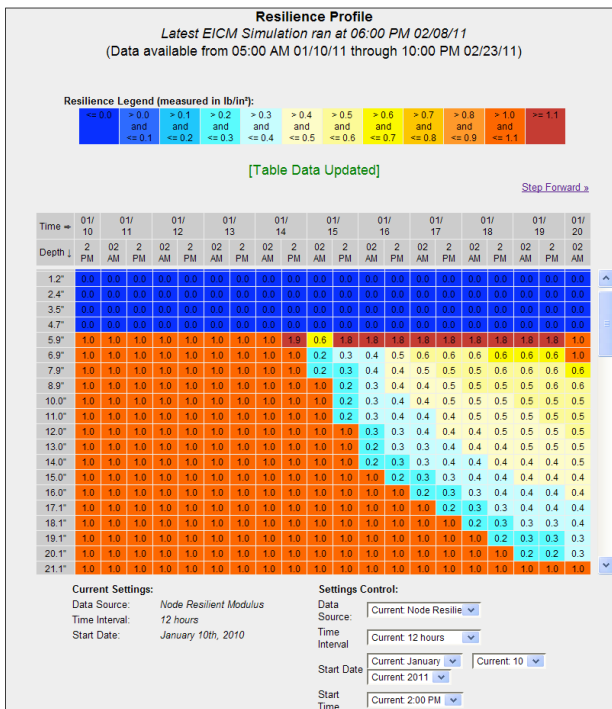


# SWR Display - Pictograph

## Node Resilient Modulus 10 Jan – 9 Feb, 2011

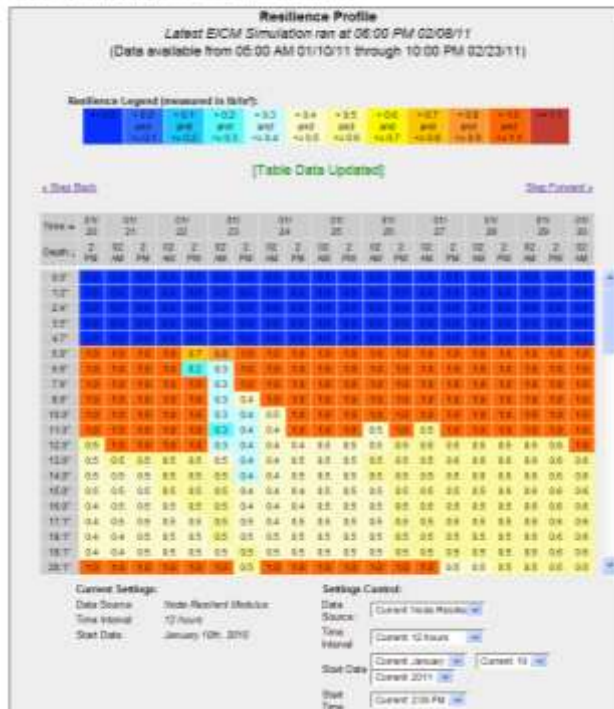
Time/Depth Views of EICM Model Output for MT-141, P-41, MP 19.9 to 27.5 (MT002)

The X-axis of the following chart represents time; the Y-axis represents the depth of the EICM model 'nodes' at the given location; and the values within the chart are values for the parameter you have chosen. You may select the time interval, start time/date, and the displayed parameter using the menus below the table.



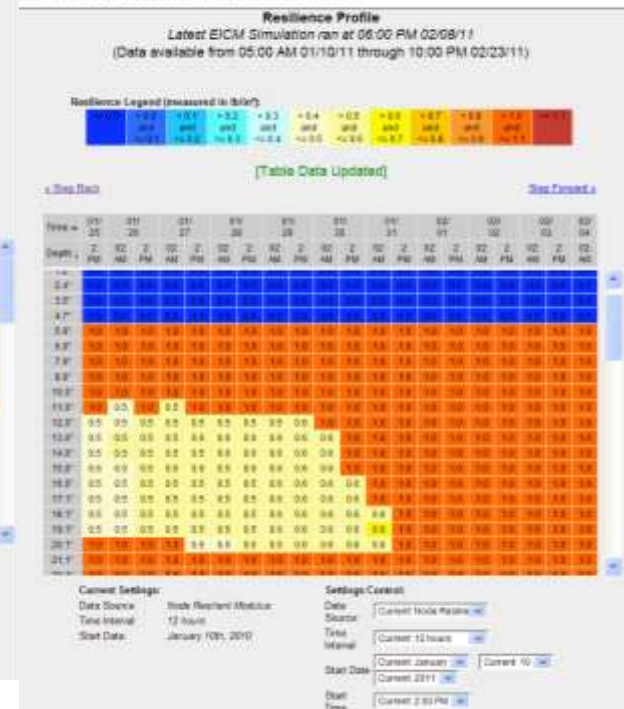
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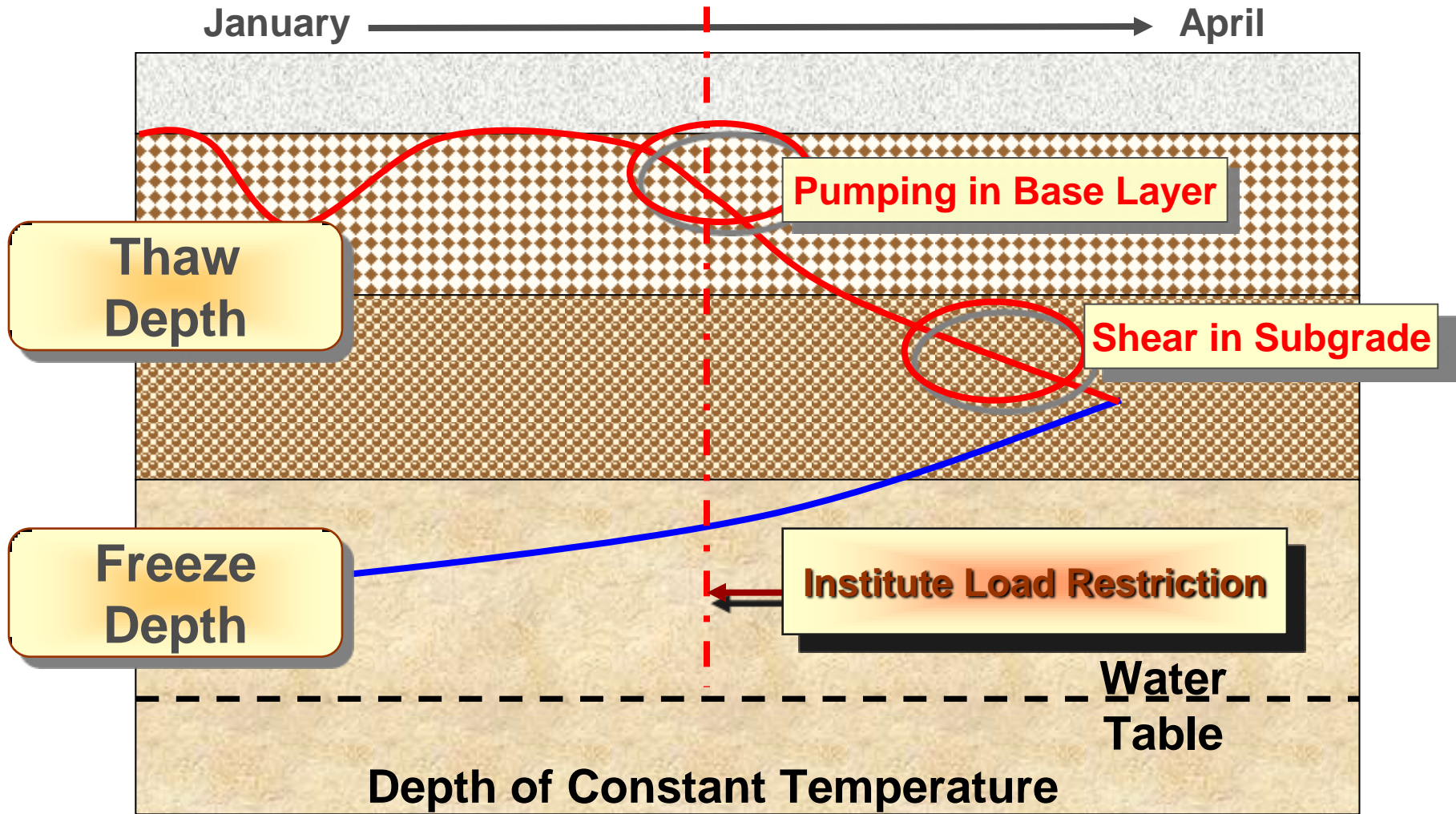


Time/Depth Views of EICM Model Output for MT-141, P-41, MP 19.9 to 27.5 (MT002)

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# Implementation of SWR



# SWR Display - TriState

**Clarus** Multi-State Regional Demonstration ✓ Clarus Enabled

[Tri-State Overview](#)  
» [Montana](#)  
» [North Dakota](#)  
» [South Dakota](#)  
» [SWR Control](#)





### Current Seasonal Weight Restriction (SWR) Overview

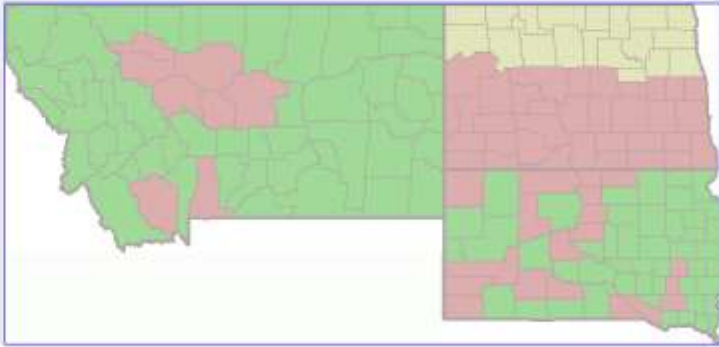
A multi-state view of active SWR information by county.

The colored regions on the map below depict the status of state-imposed Seasonal Weight Restrictions as reported by the states. The legend below the map explains which colors respond to which restrictions. Authorized persons within each participating state agency are encouraged to update this map regularly using the "SWR Control" link to the left.

Clicking within the boundaries of any of the states will direct you to more detailed information on conditions relevant to SWR for the chosen state.

#### Restriction Legend

 No Restrictions	 Restrictions Pending
 Restrictions in Place	 Removal of Restrictions pending



[South Dakota](#)

**March 29, 2011**

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# Node Resilient Modulus

## Resilient Modulus

- Drops rapidly after thawing takes place
- Typically to values around 0.2 lbs/cu ft
- Gradually increases as liquid redistributes in soil
- $RM \geq 0.4$  lbs/cu ft limits soil shearing

Time =>	01/	01/	01/	01/	01/	01/	01/	01/	01/	01/	01/	01/	01/	01/	01/	01/	01/	01/	01/	
12.0"	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.3	0.3	0.4	0.4	0.4	0.5	0.5	0.5	0.5
13.0"	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.2	0.3	0.3	0.4	0.4	0.4	0.5	0.5	0.5
14.0"	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.2	0.3	0.3	0.4	0.4	0.4	0.4	0.4	0.5
15.0"	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.2	0.3	0.3	0.4	0.4	0.4	0.4	0.4
16.0"	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.2	0.3	0.3	0.4	0.4	0.4	0.4
17.1"	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.2	0.3	0.3	0.4	0.4	0.4
18.1"	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.2	0.3	0.3	0.3	0.4
19.1"	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.2	0.3	0.3	0.3
20.1"	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.2	0.2	0.3
21.1"	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0

# Lifting Load Restrictions

Time =>	01/	01/	01/	01/	01/	01/	01/	01/	01/	01/	01/	01/	01/	01/	01/	01/	01/	01/	01/
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## Resilient Modulus Comparison to FrezTrax

- FrezTrax is an index based upon max/min temp
- Heat units used to create a freeze & thaw indices
- Freeze index (FI) increases to max in mid-winter
- Thaw index (TI) erodes effect of freeze index
- When  $FI - TI$  reaches near 0 threshold SWR are lifted
- Date when RM passed 0.4 was close to FrezTrax SWR lift date

20.1"	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.2	0.2	0.3
21.1"	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0

# Findings

- **EICM output provides a good representation of sub-pavement profile**
- **Sub-pavement freeze/thaw processes are quite complex**
- **EICM requires detailed construction information and responds differently to different construction profiles**
- **EICM had a cold bias from ~ 12” – 25”**

# Findings

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- **Several thaw & refreeze cycles occur during the winter**
- **EICM may provide significant value in determining when restrictions should be lifted**

# DOT Perspectives

- **The EICM output provides another resource for SWR decision**
- **The EICM forecast has reduced SWR decision anxiety**
- **The SWR guidance provides information about the restoration of subpavement structural stability**
  - **Not available from other resources**
  - **May be key to removal of weight restrictions**
- **The visualization of subsurface conditions helps in the SWR decision process**



# Contact Information

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