

# Winter Road Maintenance Decision Support System (MDSS) Prototype Development



*Presented by*

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*National Center for Atmospheric Research*



## MDSS Objective

To utilize state-of-the-art atmospheric science and engineering approaches to address and improve the performance of the road maintenance practitioner.



## Current Capabilities and Practice

The highway maintenance managers currently use newspapers, Weather Channel, USA Today, NWS, and private meteorologists to make decisions.

Road weather information systems are not integrated with road management systems. The winter road maintenance decision process is generally reactive in nature.



## MDSS Goals

- Capitalize on existing road weather data sources.
- Augment data sources where they are weak.
- Fuse data to make an integrated and understandable presentation of road conditions.
- Provide diagnostic and prognostic information.



## **MDSS Goals (continued)**

- **Provide display capability for the condition of the roadway.**
- **Develop a decision support tool that provides recommendations on road maintenance courses of action together with anticipated consequences of action or inaction.**
- **Provide all the above on a single platform.**



## Project Schedule

**FY2000:** Requirements Analysis  
Technology Review by Labs

**FY2001:** Conceptual Prototype Development  
(storyboard concepts & user feedback)

**FY2002:** Functional Prototype Development  
Demonstration  
Documentation  
Technology Release

## MDSS Project Constraints

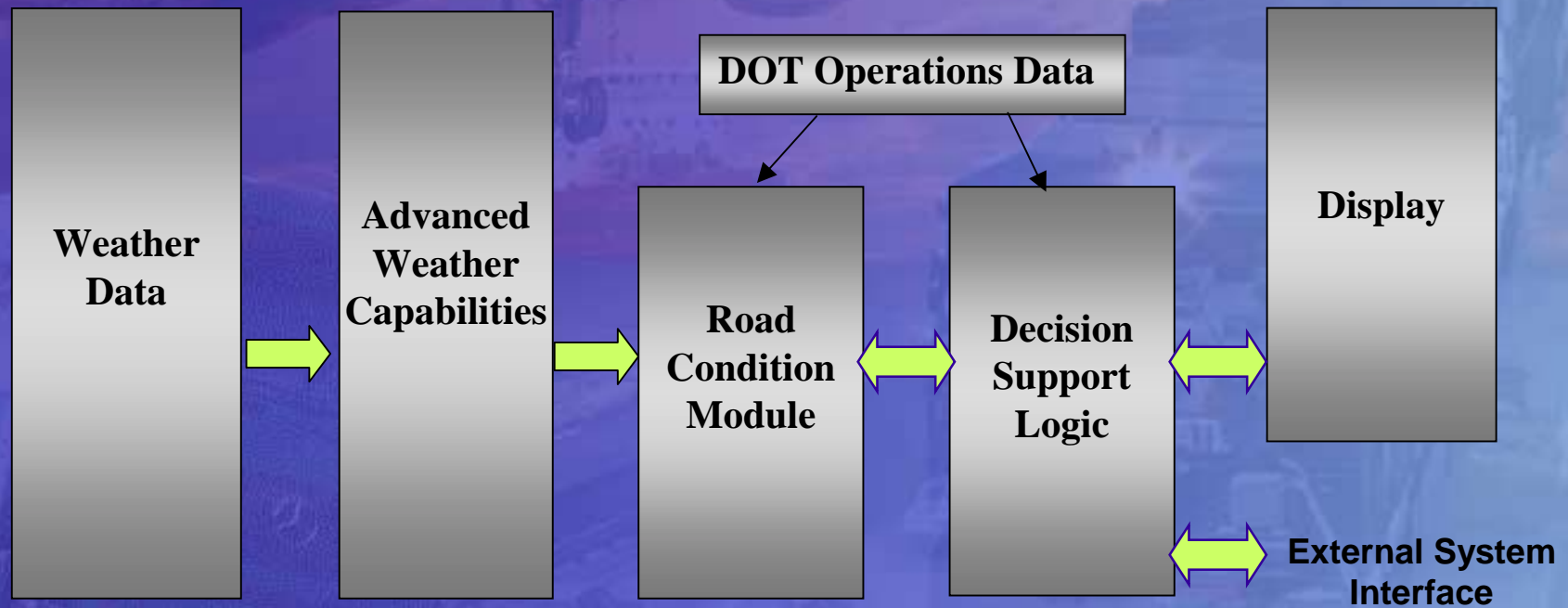
- **Development period:** 2-Years
- **Development resources:** \$1.8M
- **System complexity:** Multiple Labs
- **Maturity of core components**
- **Operational data availability and integration**
- **Disparity in user requirements**
- **Complicated validation process**
- **Complicated technology transfer process**



An aerial photograph of a highway interchange, overlaid with a semi-transparent blue filter. A large semi-truck is visible on the right side of the road, and a carpool lane sign is visible on the left. The text "MDSS Functional Prototype Components" is centered over the image in white.

# MDSS Functional Prototype Components

# MDSS Prototype Components



# MDSS Prototype Focus Areas

## Weather Component Focus :

- Event start and stop times
- Surface temperature
- Precipitation type
- Precipitation rate
- Precipitation accumulation
- Conditional probabilities
- Surface wind speed
- Surface wind direction
- Surface visibility



# MDSS Prototype Focus Areas

## Road Component Focus:

- Pavement temperature and trends
- Pavement chemical concentration
- Road mobility index
- Pavement contamination (liquid, snow, ice, etc.)

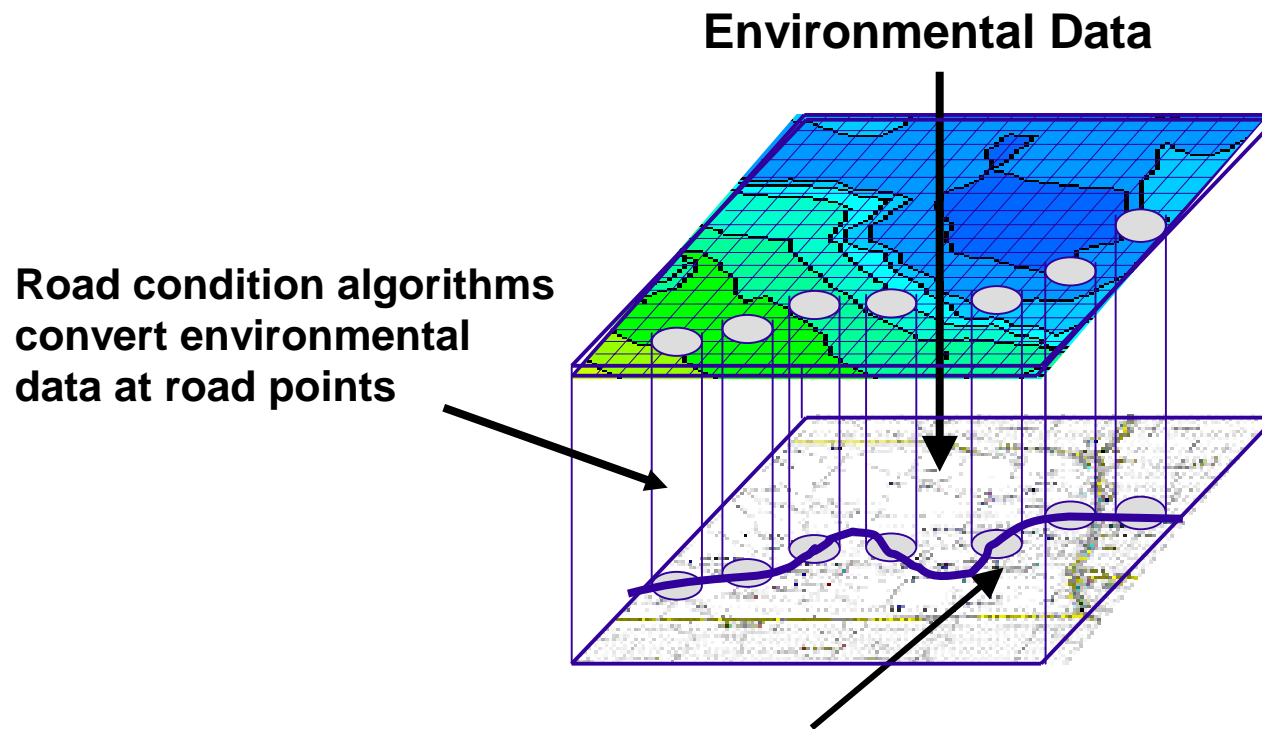


# MDSS Prototype Focus Areas

## Decision Support System Component Focus:

- Monitor weather & road conditions
- Monitor probability & intensity of weather threat
- Treatment options & timing
- Crew scheduling & managing crew shifts
- Dispatch crews to treat roadway
- Post event clean up

# Translation of Environmental Data to Road Condition Information



# MDSS Functional Prototype Components

Eight primary components

Ensemble Forecasting  
FSL



Mesoscale Weather Models  
FSL/NSSL



Maintenance Decision Support System

Road Weather Forecast System - NCAR

Road Chemical Concentration - CRREL

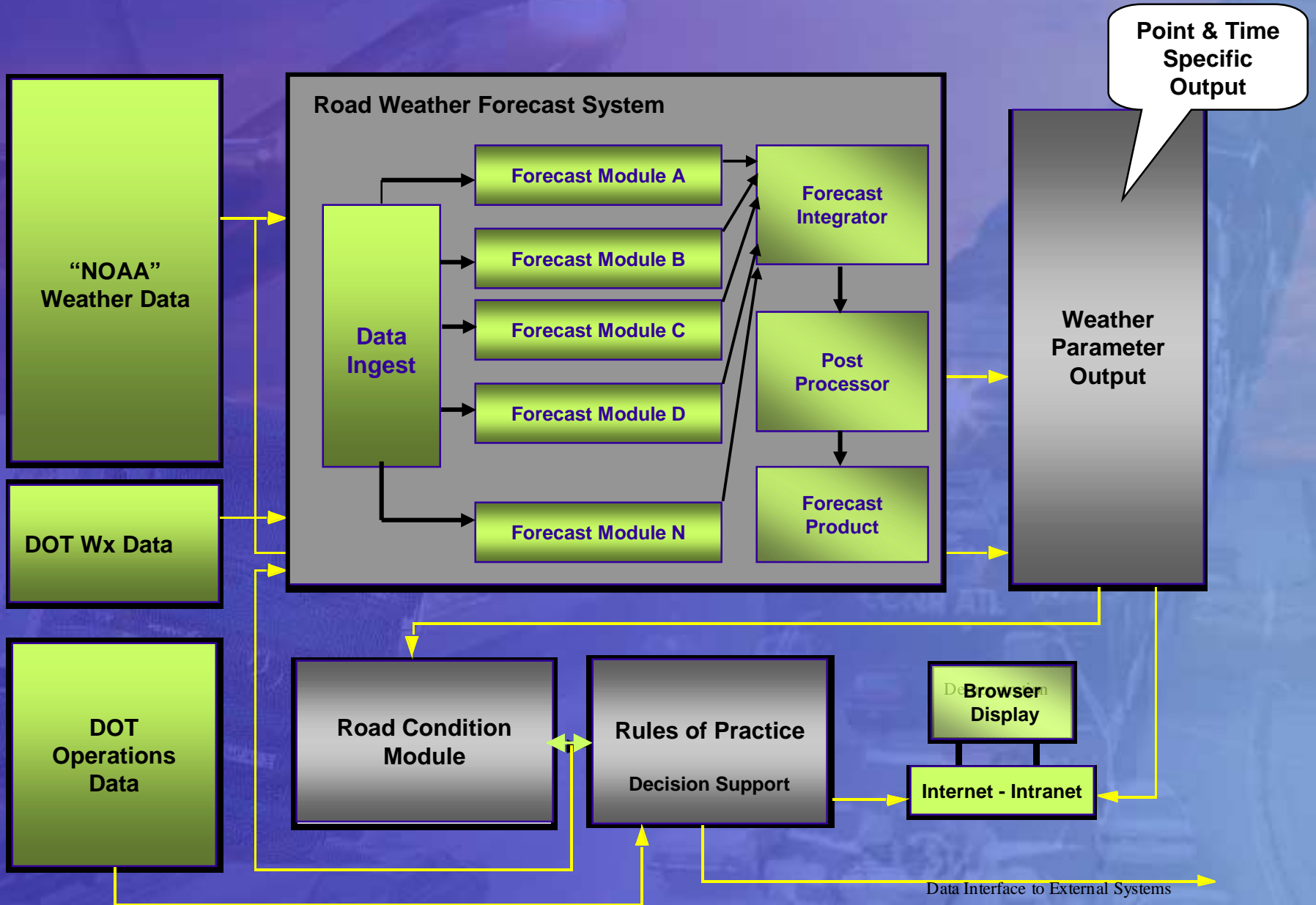
Road Mobility Index - CRREL

Road Surface Temperature - CRREL

Rules of Practice Module – CRREL & LL

Precipitation Type - NSSL

# Engineering Approach for MDSS

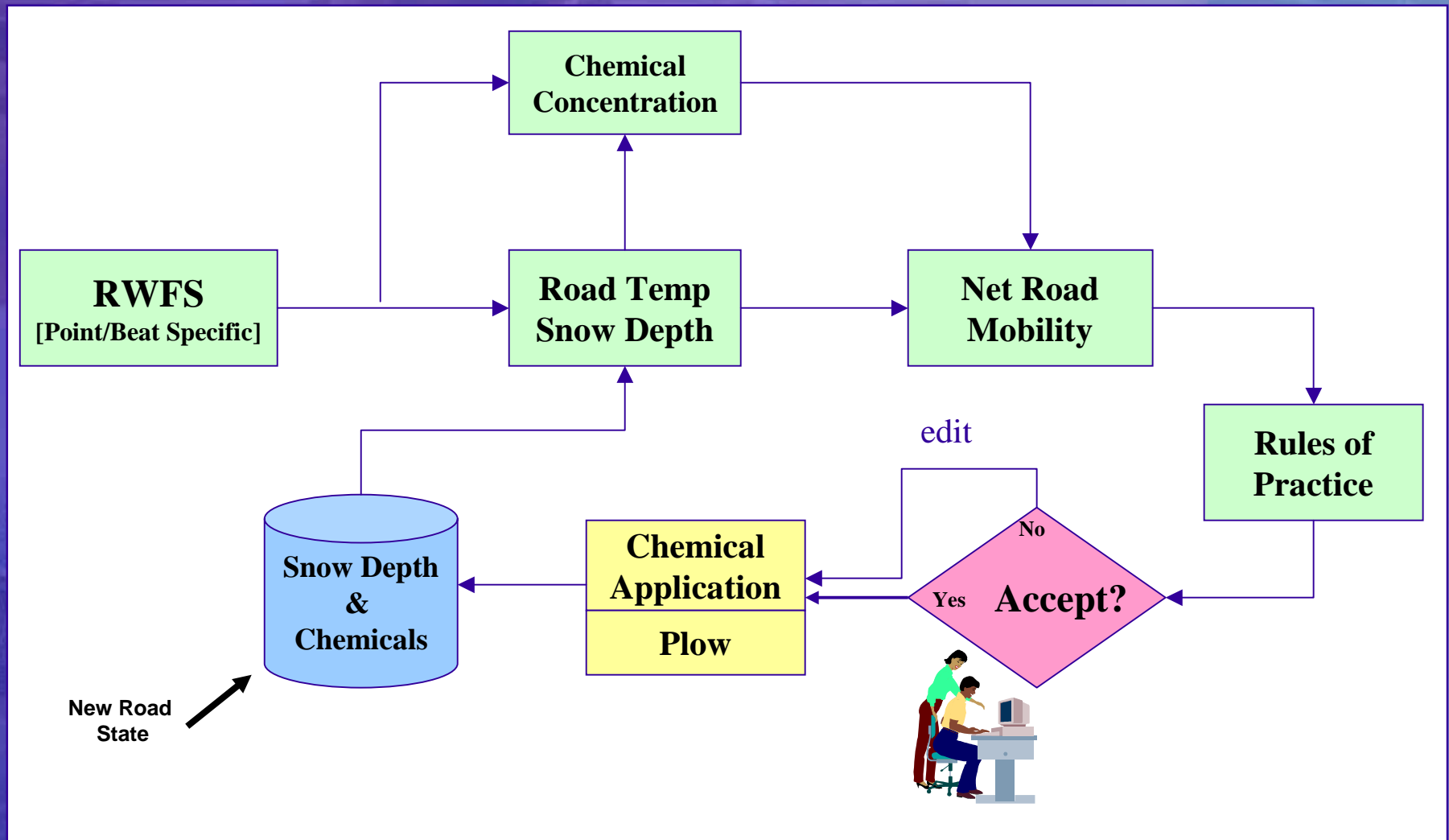


## Functional Prototype - Cycles

The functional prototype will operate in three primary modes:

- 1) Provide results with no maintenance actions.
- 2) Provide results based on automated maintenance recommendations (rules of practice).
- 3) Allow user to modify maintenance recommendations.

# MDSS Functional Prototype System Flow



# MDSS Component Overview



# National Center for Atmospheric Research Research Application Program

## Road Weather Forecast System



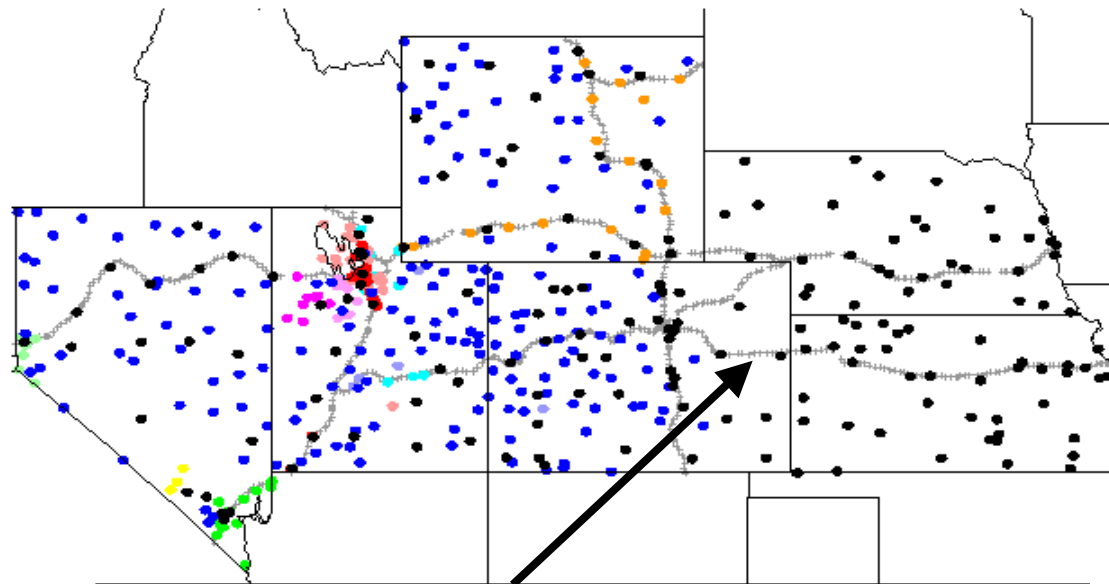
NCAR/RAP

# Sample Environmental Prediction Sites

All observational weather data are necessary to improve forecasts!

The system will be designed utilize all data available including: DOT, NWS, DoD, air quality, and hydrology networks.

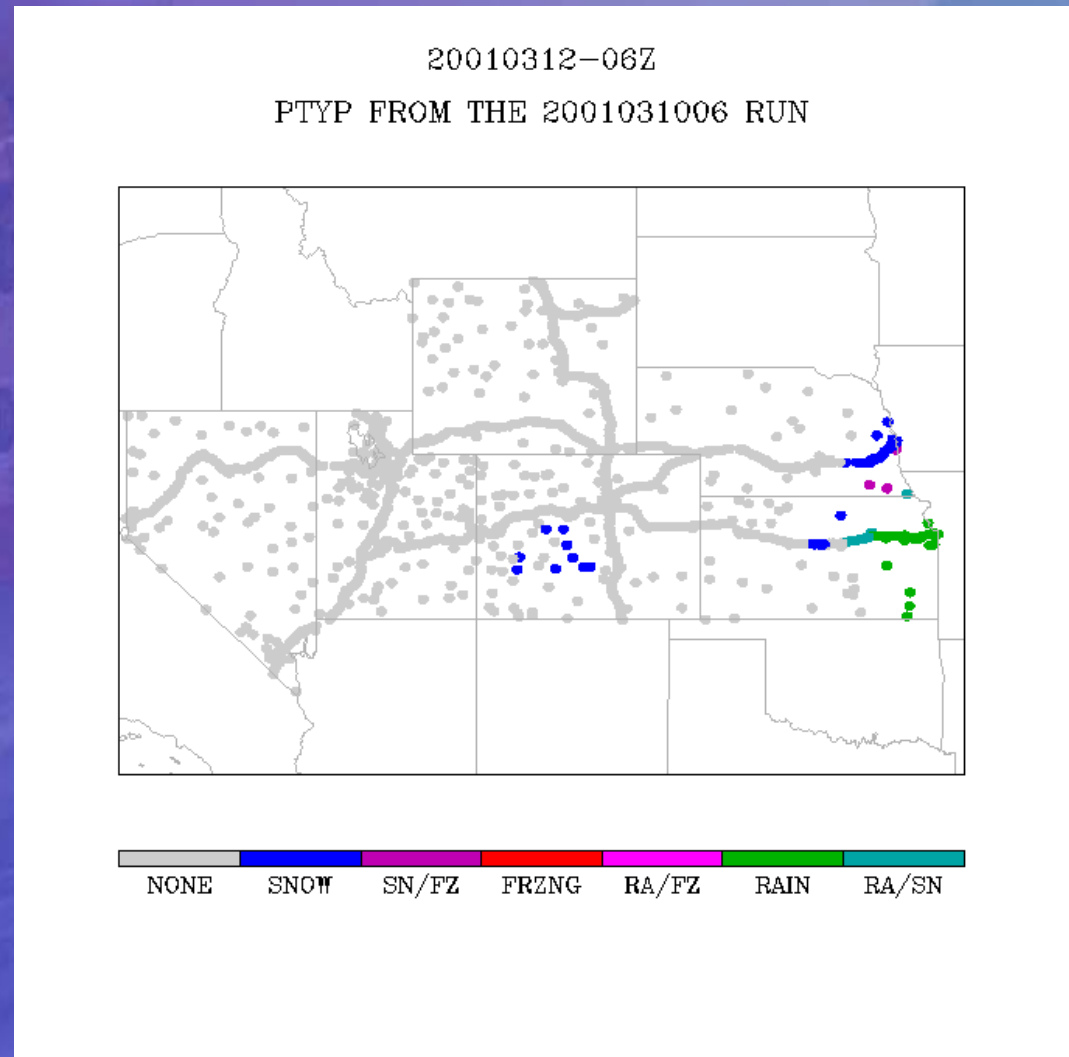
STATION & HIGHWAY LOCATIONS



Environmental prediction parameters will be generated along the road.

INTRST   NWS   RAWS   REC   CLARK   NDOT   AIRQ  
SNOWNET   DUGWAY   TOOLE   UDOT   WDOT   ARL

**The Road Weather Forecast System will generate point specific forecasts of environmental parameters along road corridors.**



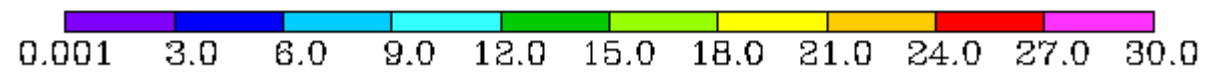
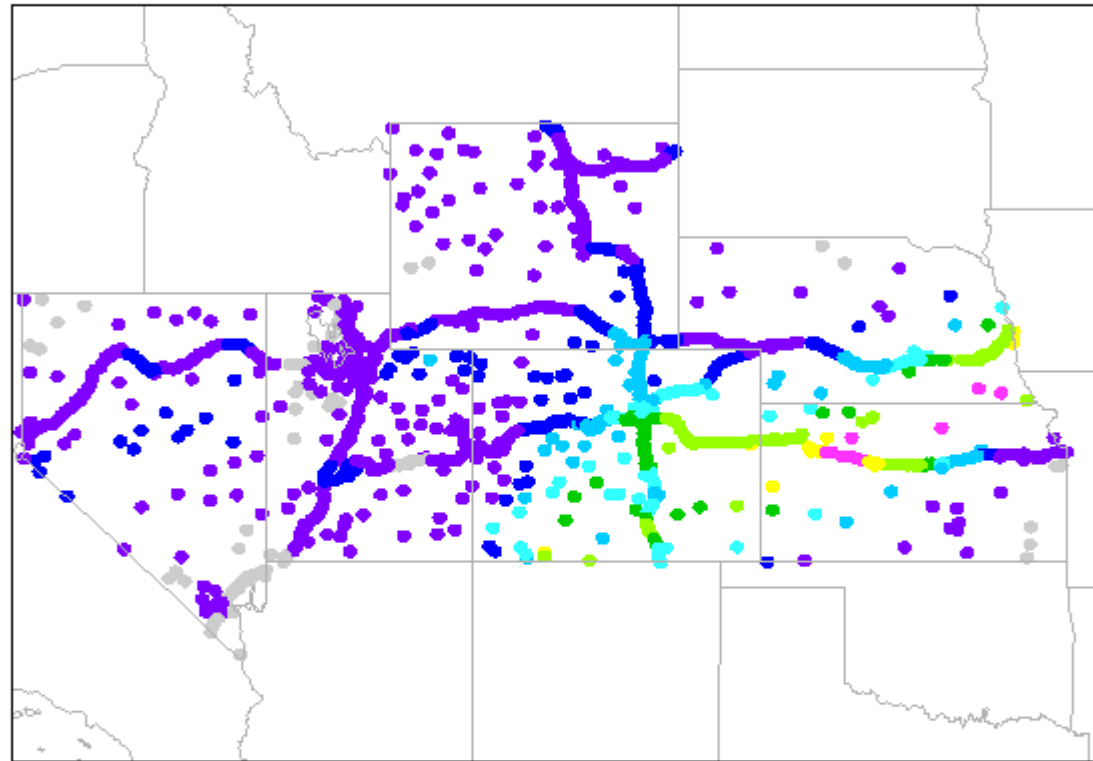
**Example: Precipitation Type**

# MDSS

## Snow depth Accumulation

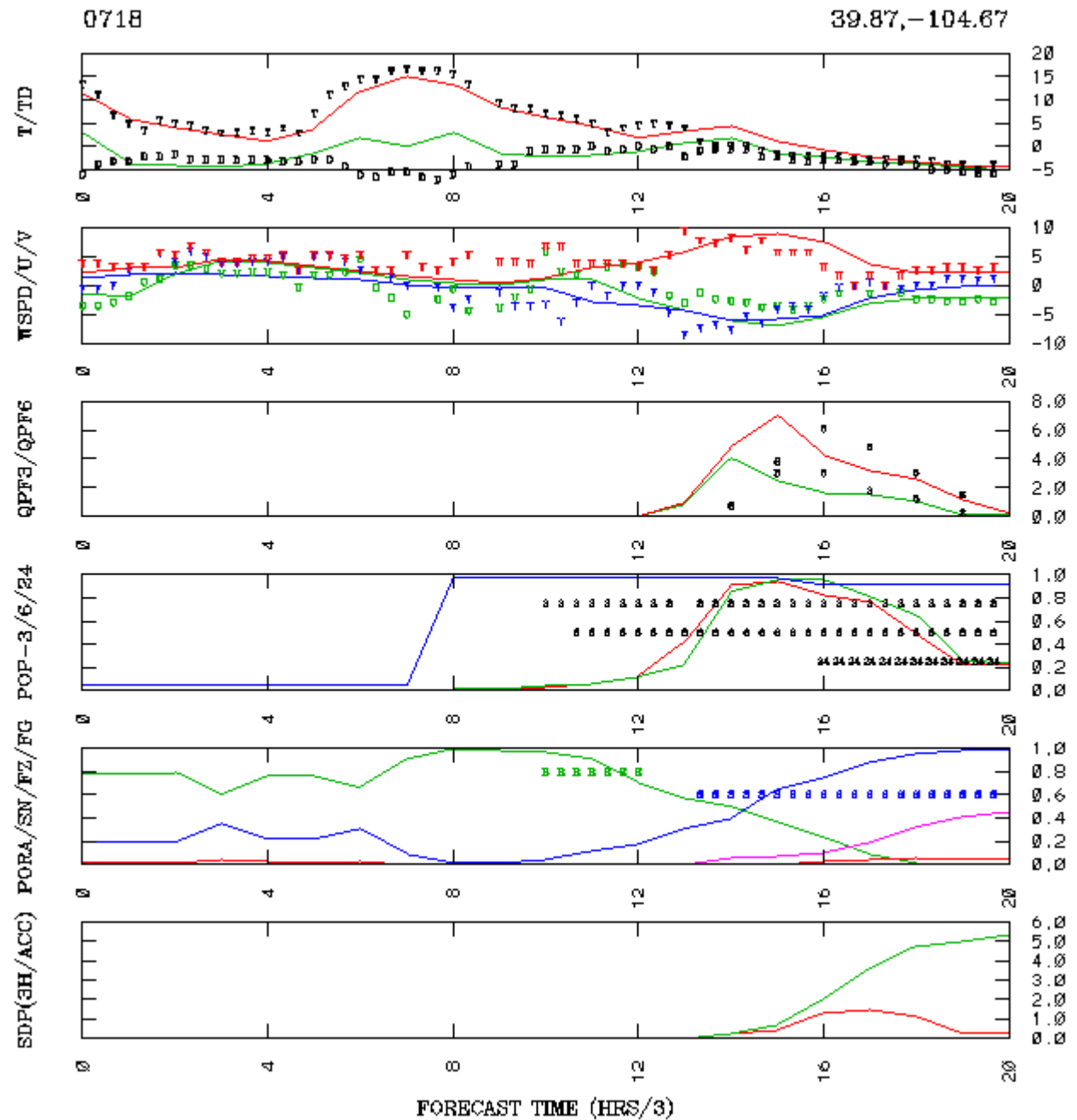
20010312-12Z

ACCUSNWD FROM 2001031006 RUN



# MDSS

## Single Point Time Series



**NOAA  
Forecast Systems Laboratory  
&  
National Severe Storms Laboratory**

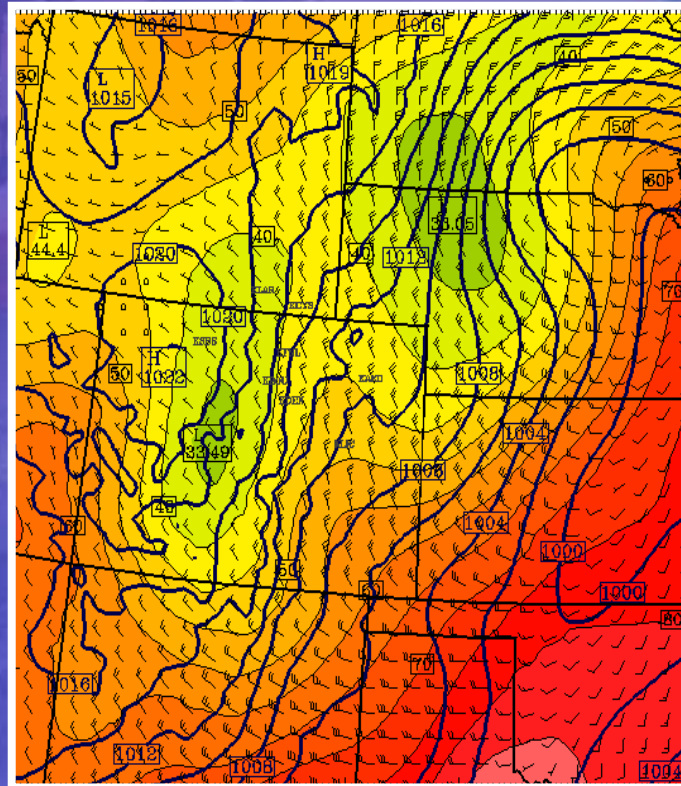
**Mesoscale Modeling  
&  
Ensemble  
Forecast System**



# Forecast Systems Laboratory Ensemble Forecasting

**Models:**      **Initialization:**

Eta              AVN  
MM5             Eta  
RAMS            RUC



**9-Member  
Output**



**Road  
Weather  
Forecast  
System**

# Cold Regions Research and Environmental Laboratory

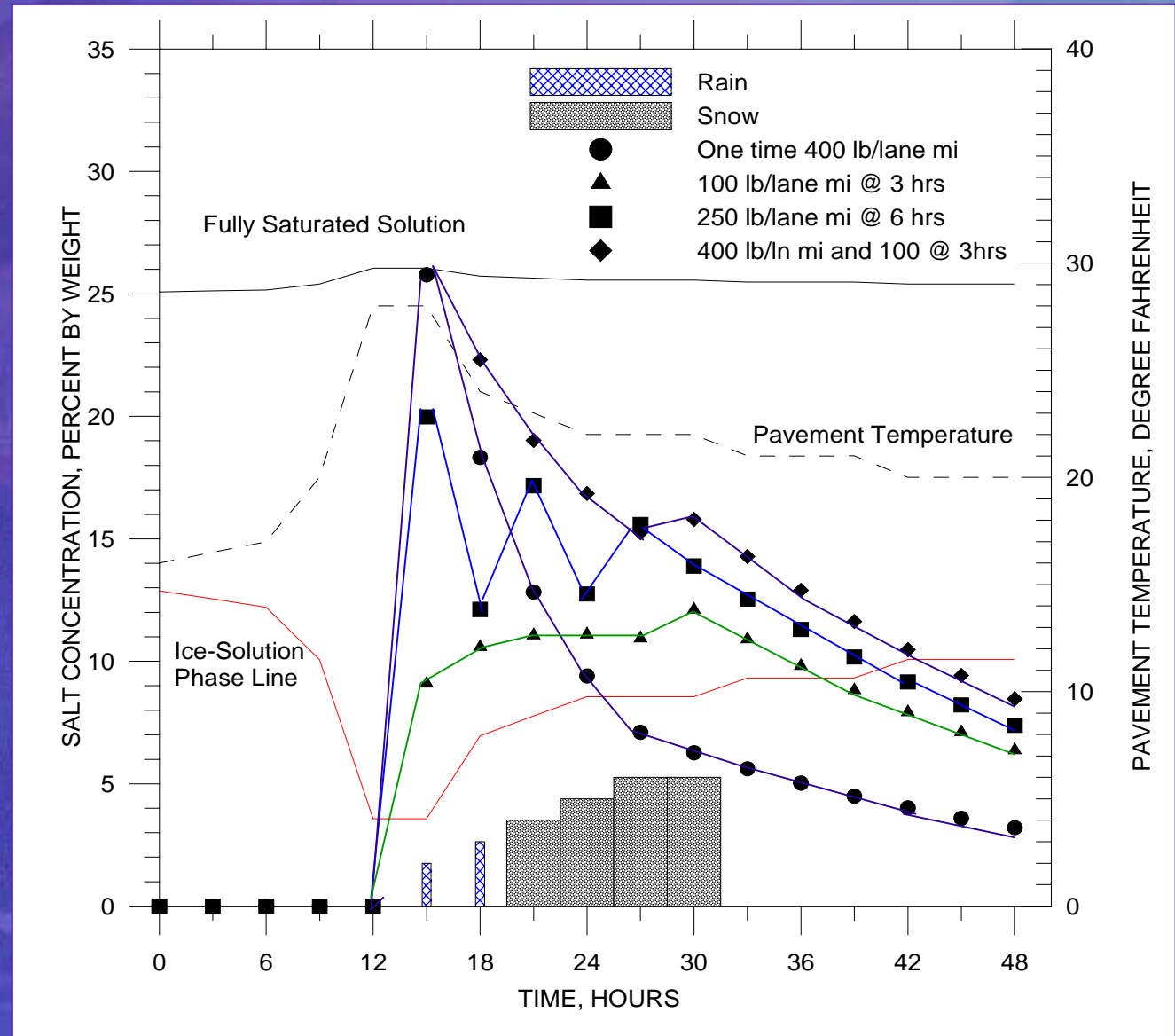
CRREL



Welcome to the US Army Corps of Engineers  
Engineer Research and Development Center  
Cold Regions Research and Engineering Laboratory

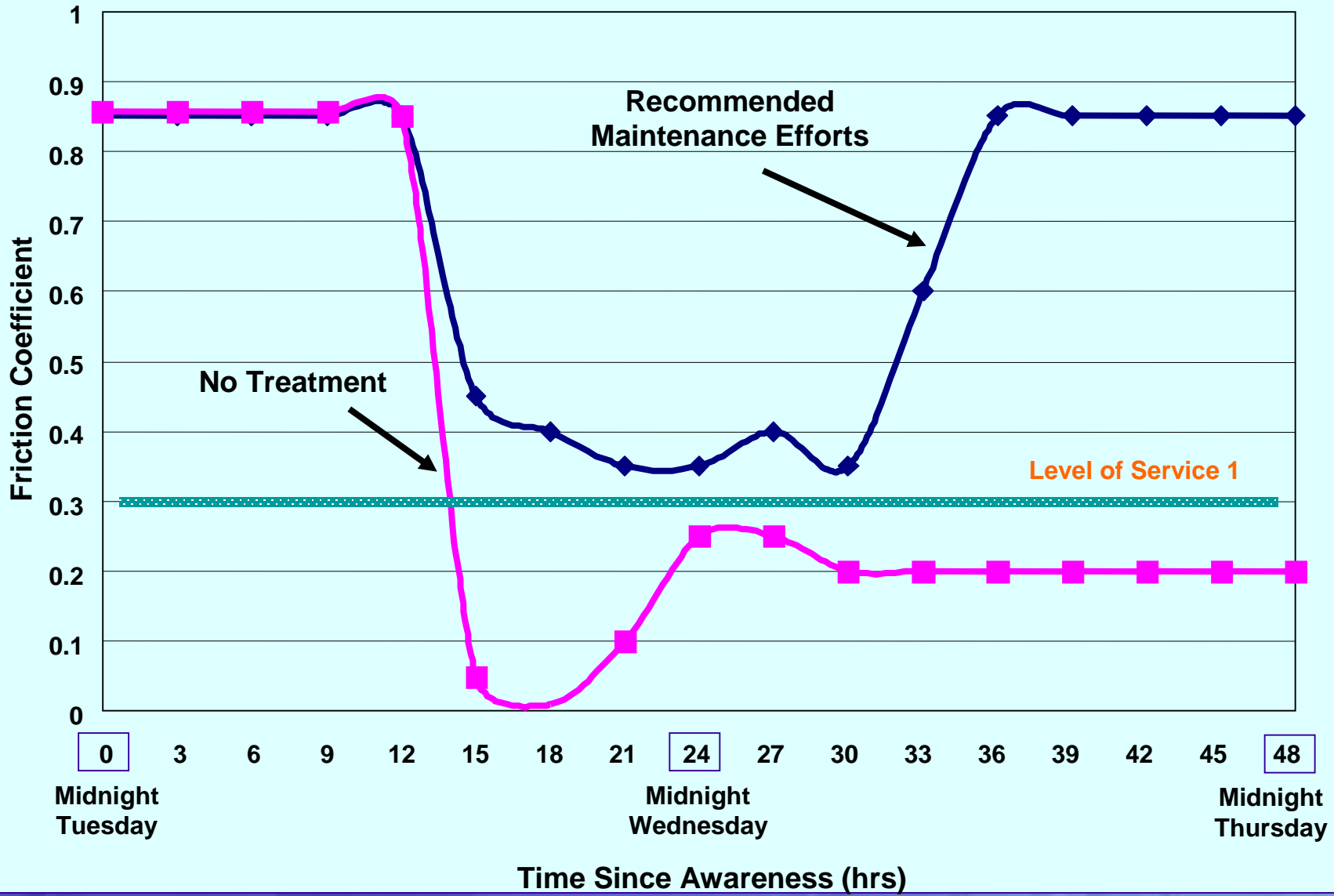
# CRREL - Salt Concentration Model

Illustrates the sensitivity of salt concentration with time during a predicted weather event for multiple treatment options.



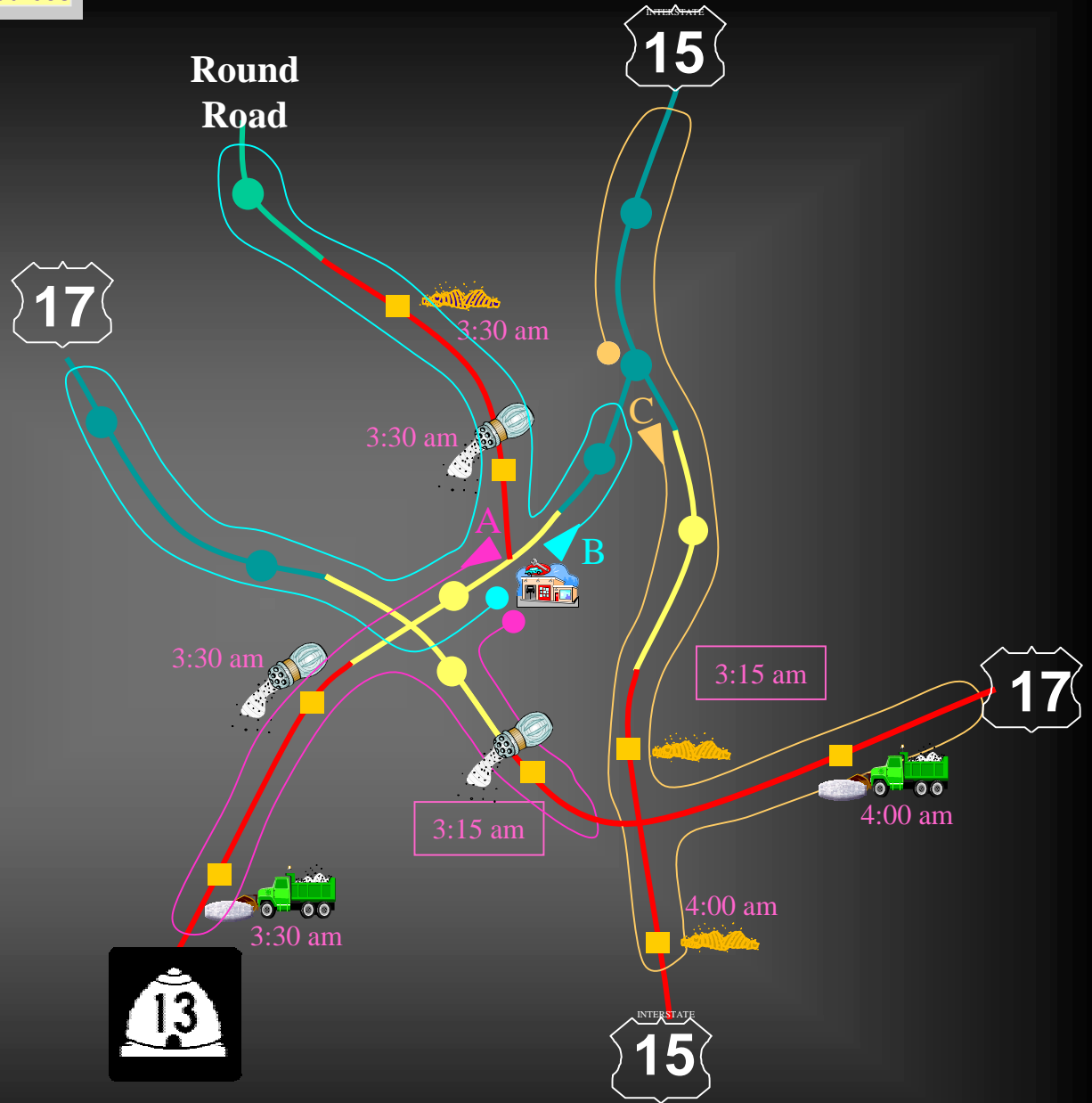
CRREL

### Two-Day Friction Coefficient History With and Without Treatment Prediction Point #3



# Game Plan

-  Crew
-  Trucks
-  Material Stocks
- Truck Routes
  - Standard
  - Custom
- Road Status
- Logistics Matrix



**Sample: Route Specific Guidance**

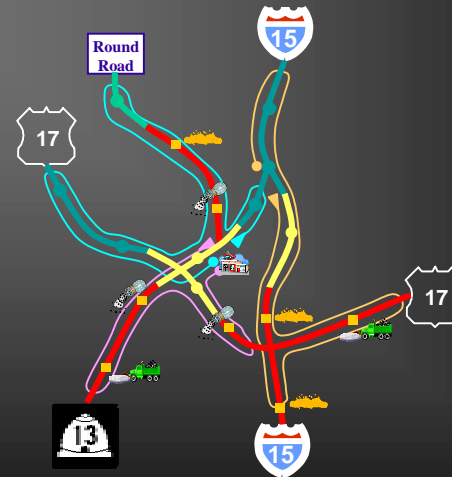
# Game Plan – Initial

BASED ON RECOMMENDED TREATMENTS

Call @	Route	Segment	Driver	Truck ID	Dress & Load	Treat. Start Time	Treat. Rate/TLM
9:00 pm Monday	A	2,3,4	Sam Salter	Mack X	midnight Mon/Tue NaCl, pw-8g. CaCl	3 :15 am Tuesday	400 lbs
Notes: Drive reverse route							
9:00 pm Monday	C	8,9,10	Polly Plowgirl	Mack Z	1:00 am Tuesday Sand (ballast)	3:15 am Tuesday	Plow only
9:00 pm Monday	B	6,7	Gary Grippy	<del>Mack Y</del> Ford	1:30 am Tuesday Seg. 7: Sand Seg. 6: NaCl	3:30 am Tuesday	1200 lbs 400 lbs
Notes:							

## Material Stocks

NaCl 	10 tons	5 tons to be used initial treatment
CaCl 	40 tons	
CaCl liquid 	250 gallons	30 gallons to be used initial treatment
Abrasives 	120 tons	11 tons to be used initial treatment



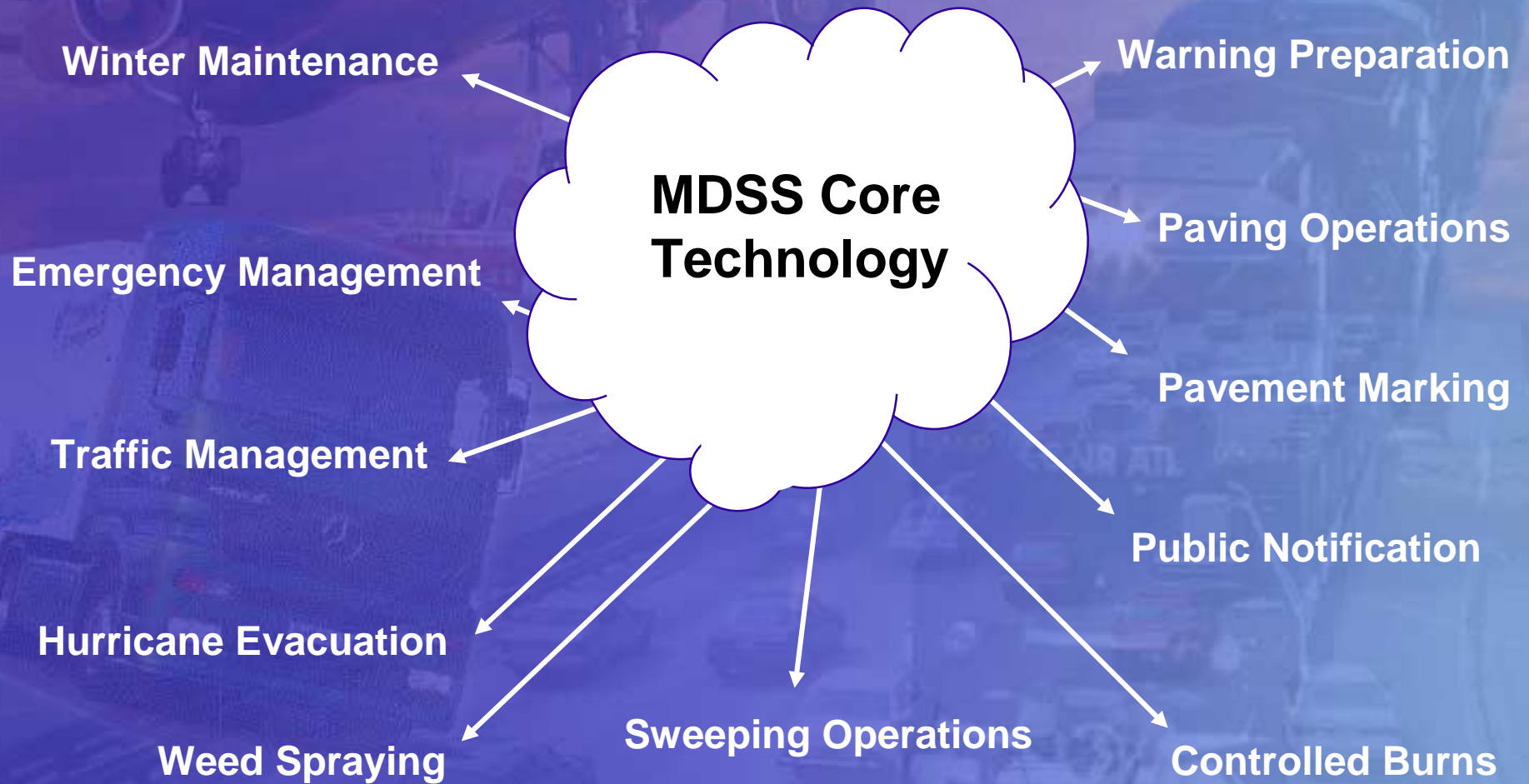


**What are the special features of the MDSS?**

## Special Features of the MDSS

- **Takes advantage of standard & road weather sensor data via intelligent data integration.**
- **Utilizes an automated, high resolution forecast system with advanced data fusion techniques.**
- **Merges environmental & operational data within the DSS.**
- **Provides decision guidance in decision space and provides recommended courses of action and allows users to evaluate other courses of action.**

# MDSS Technology Applications



# Summary

**The MDSS Project is an ambitious project that poses several challenges and risks.**

**Road weather initiatives require new and augmented research and development activities and the application of new techniques.**

**The meteorological community must also become smarter on the needs of the road maintenance manager as they pertain to weather related decision making.**

