

# Yeah, There is a Difference

## Measuring Road Weather and Using it!

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# What are we going to talk about?

- The weather of course! But when and what matters!
- The weather before, during, and after a storm.
- The weather around frost.
- Let's start with nothing and build on it.
- When we are done you will know what information is *good* information!



There is weather...



And then there is  
road weather...

# Let's start at the beginning!



# You just got your fleet of new plows!



# But otherwise you are Anytown, USA



# Approaching winter storm



# Air temperature

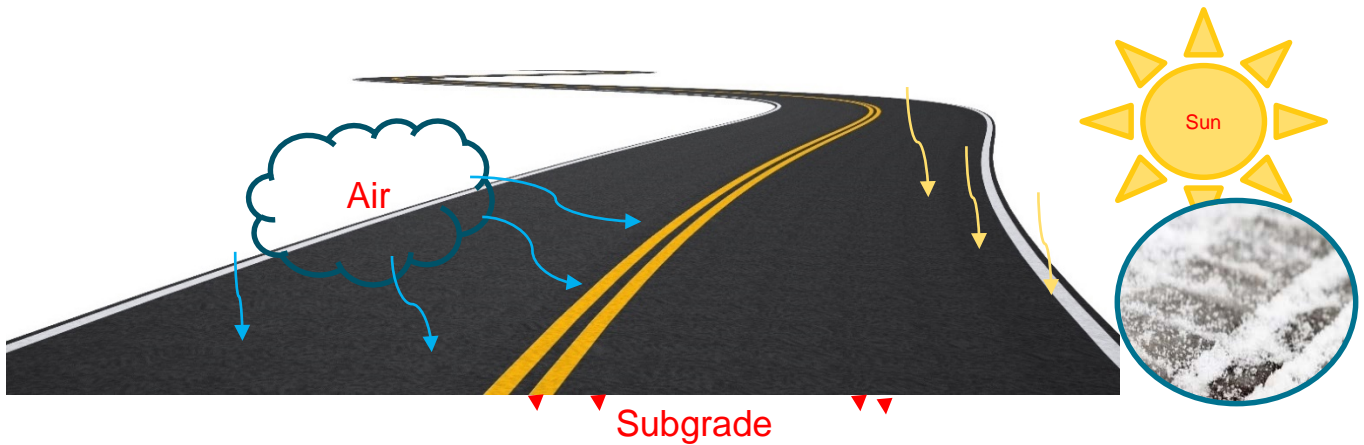
- Critical in telling us the type of precipitation.
- How do we measure it?
  - Measured from 6ft off the ground
  - In a white vented enclosure
- Combined with wind it has an impact on our road surface.





# Thermodynamics 101

- To understand how the air impacts our pavement we must understand how heat transfers from objects, **and** between the air and objects.

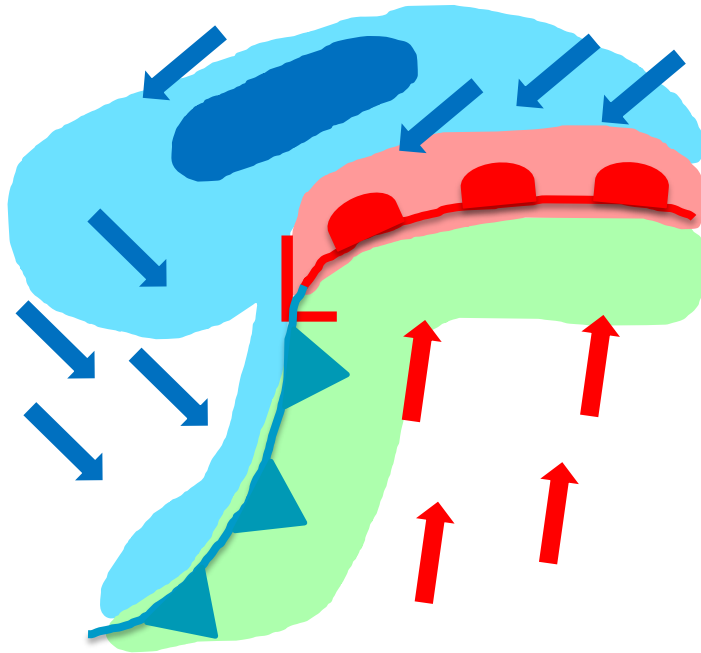


# Wind

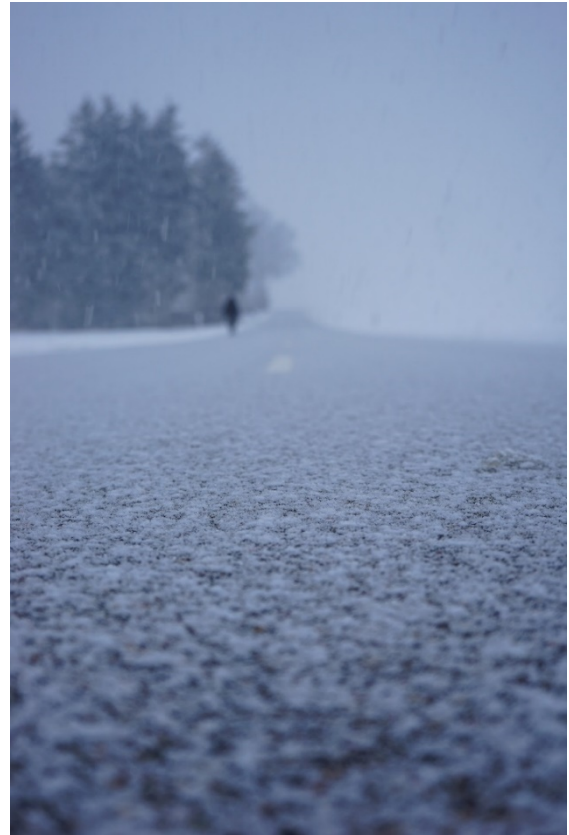


# Wind – An important piece of the weather

- Lows typical move from southwest to northwest.
- System may not always contain all of the precipitation types.
- Best snow is usually approx. **250 miles** north of center of low.
- Greatest uncertainty with forecast is located near center of low.



# When will it begin?



# We have lots of tools

- Weather Forecast
- Radar
- Media
- Dew Point ?

# Moisture in the atmosphere

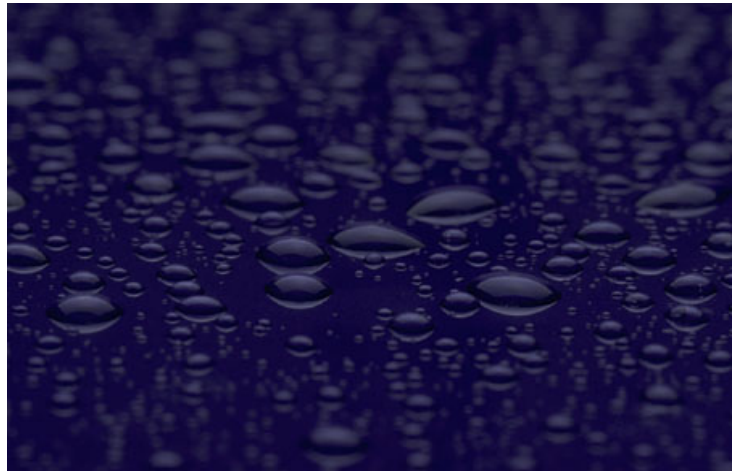
- Meteorologists have several parameters we use to note the amount of moisture in the air.
  - Relative humidity
  - Dew point
  - Wet bulb
- In the winter moisture can be hard to come by, so monitoring it is critical.



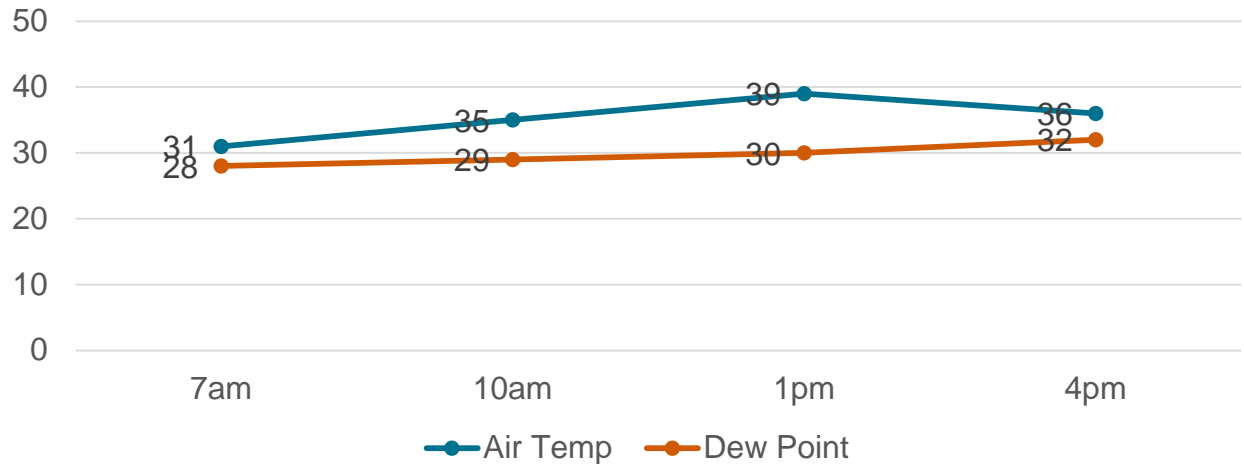
# Dew Point

- The temperature to which air must be cooled for saturation to occur.
- It is reported in degrees F or C.

So if it is 70°F in this room the dew point is some number less than or equal to 70°.



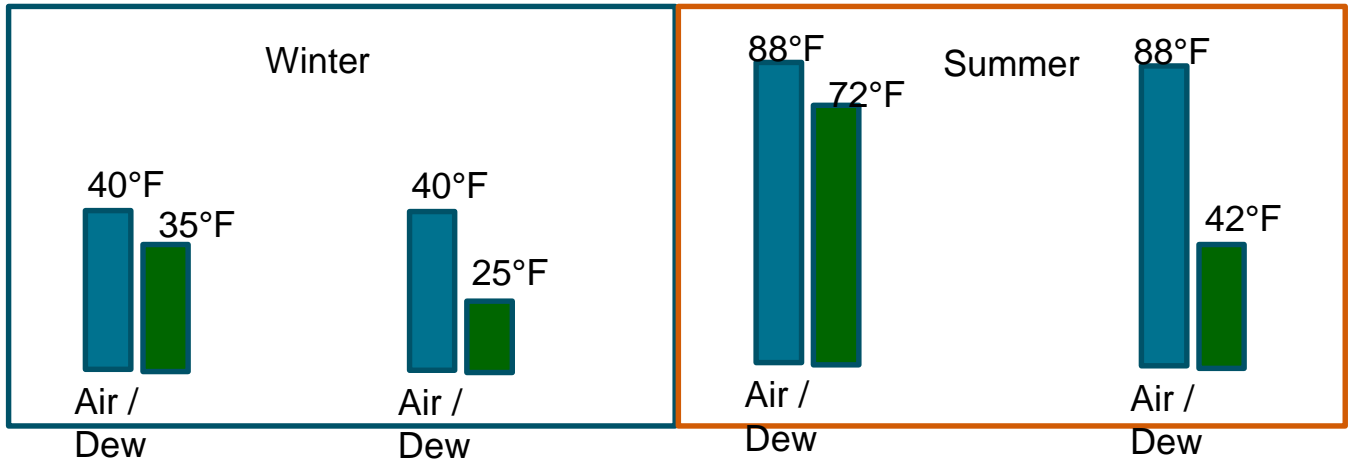
# Why is dew point easy to use?



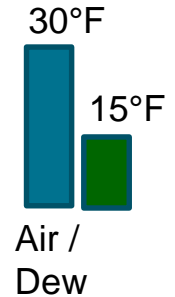


# Why is dew point so important?

- It gives you an **easier** way to see how moist is the atmosphere.

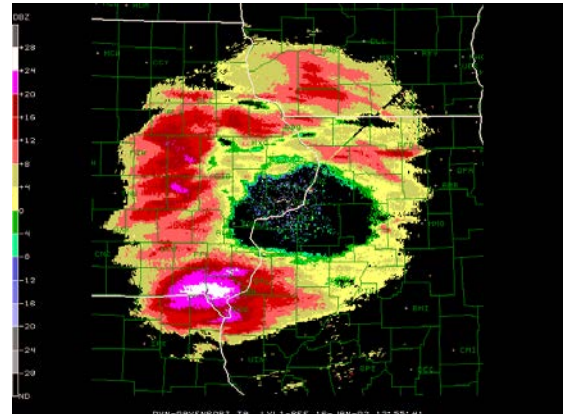


# In *Winter* it can signal the start of snow

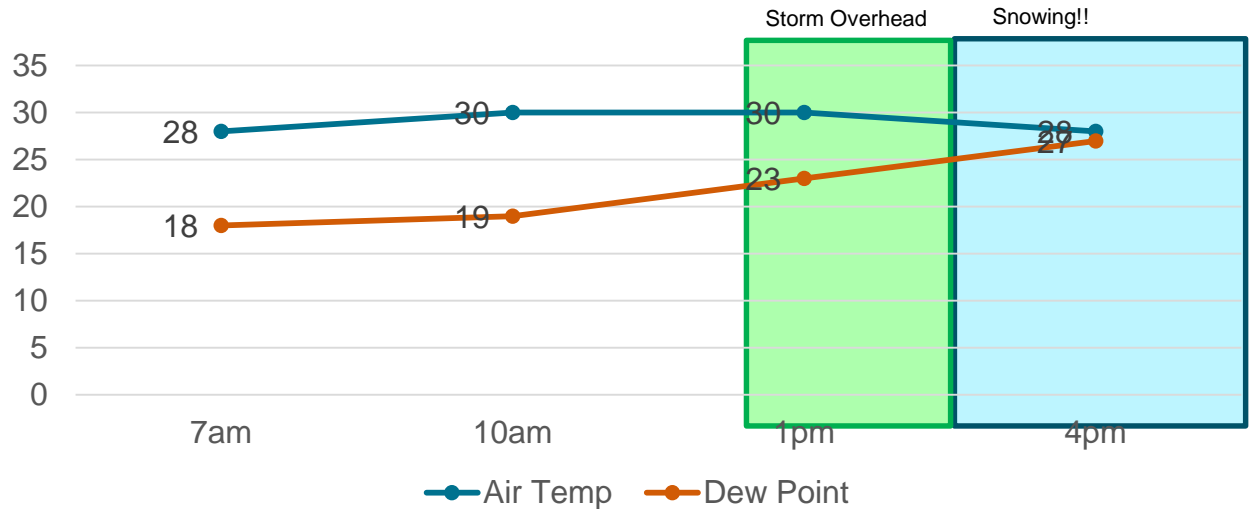


# Radar can be misleading

- Radar “sees” moisture, it does not know if it is reaching the ground.
- Forecast models still do a horrible job at timing saturation.



# Watch the dew point!



# You don't plow the air or 6ft off the ground!

- Using the air temperature to predict if snow will stick is dangerous.
- Thermodynamics tells us the road surface *will* be different.
- Chemical effectiveness is going to occur at the *surface* temperature.
- What can we use to detect?

# Our eyes

- For most of us they have never let us down
- They tell us what we need to know
- Helps us make all sorts of decisions
  
- They cannot tell differences in temperature
- They cannot see how slippery is something
- Our eyes are fooled by changes in light, especially at night



# We have two choices

1. Place a thermometer in the road surface.
2. Use an infrared sensor above the surface.



# Handheld infrared gun

- Easy to use! Point and shoot!
- Cheap!
- No training necessary!
  
- Sensor must be acclimated to environment
- Not originally designed for outdoor use
- Typical accuracy comments:
  - $\pm 4^{\circ}\text{F}$  from  $32^{\circ}\text{F}$  to  $55^{\circ}\text{F}$
  - Assumes ambient operations temperature of  $73^{\circ}\text{F}$  to  $77^{\circ}\text{F}$
  - One model does not work below  $32^{\circ}\text{F}$





# Embedded pavement sensors

- Placed directly in the road to measure pavement temperature.
- Detects road chemicals and freezing point of solution
- System archives data for later analysis.



# Mobile weather sensors

- Extremely popular because of cost and ease of use.
- Allows user to see entire road not just one spot.
  - Basic System is air and pavement temperature
  - Advanced System adds dew point, friction, and road condition.
- Not as accurate as fixed.



# Non-intrusive sensors

- Non-Intrusive is a very popular method for all road devices.
- In science we call measuring something from a distance remote sensing.
- Benefits of sensors:
  - Lower installation costs/cost to maintain
  - Safer for service and install
  - Accuracy similar to in-road sensors
  - Provides a new value – road friction

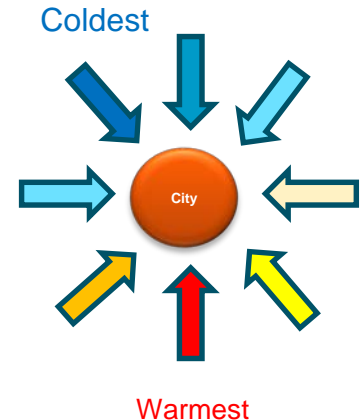


# The Storm is here!



# Air Temperature still is important

- Near the low pressure center, or as a front passes temperatures will vary the most.
- Winds play a vital part in temperature changes because “wind moves” colder and warmer air.
- Due to clouds and precipitation the sun is not really much of a factor on air temperature.
- Changes in air temperature will have a **slow** impact on road temperatures.



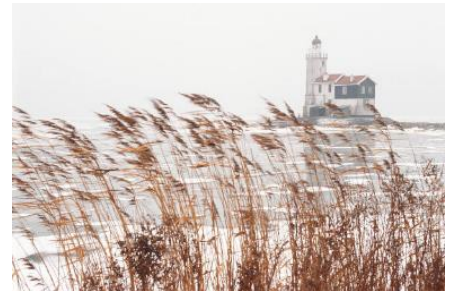
# Winds

- Wind during a storm creates two concerns:
  - Impacts air temperature changes based on direction
  - (Which leads to) changes in pavement temperature, especially in areas exposed to wind.



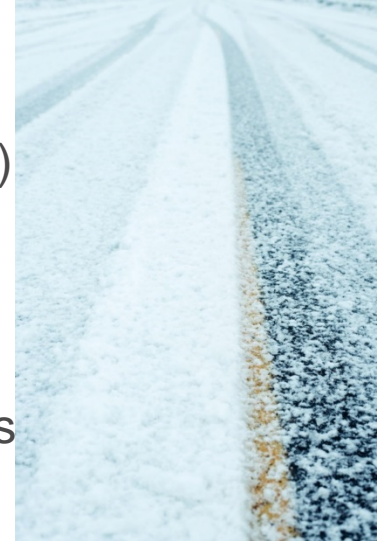
# Misconception of wind chill

- Wind Chill Factor was created by meteorologists to give people an idea of how cold it **feels** outside.
- The wind chill value itself has no meaning to object such as roads and bridges.
- For example  $-10^{\circ}\text{F}$  wind chill will not cool the bridge to  $-10^{\circ}\text{F}$ .
- However if the air is getting colder or warmer the pavement will respond.



# Pavement temperature

- Chemicals are working or not working based on this temperature!
- Surface is being impacted by:
  - rain or snow on surface (sleet is worse)
  - Plowing exposes surface to air temperature
  - Evaporation is a cooling process
  - Endothermic and exothermic chemicals are causing minor changes
  - If subsurface is 40°F or above heat is coming from below





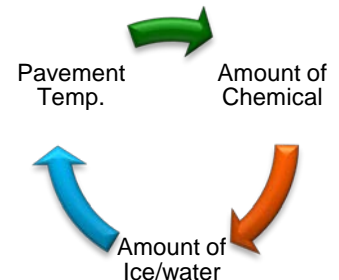
# Measuring surface temperature

- It becomes a little trickier, infrared sensors are now telling you the temperature of the water or ice, **which might be different.**
- Bridges and elevated surfaces will tend to match the air temperature.



# Condition of the Road

- Road condition becomes the key during an event.
- Drivers visually see road conditions and react.
- Vehicle performance is impacted when the **grip/friction** is reduced on the surface.
- Condition of the road is impacted:
  - Pavement temperature
  - Amount of chemical present vs. amount of ice/water



# Measuring road condition

- Road condition measuring is not easy. Why?



# What is the road condition?



Images :Courtesy of Duane Amsler

# Eyes again!

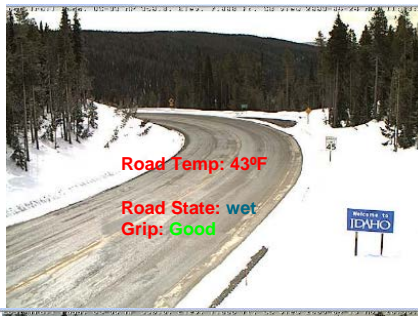
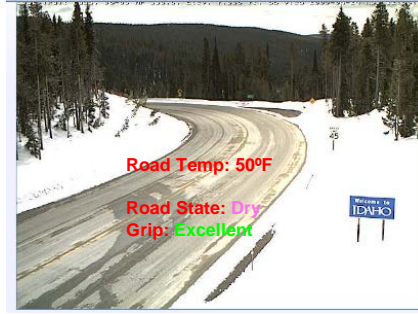
- There is too much that is **subjective** in a observation.
- We are using our eyes again which we know are not good at measuring much of anything.



# Lost Trail Pass, Idaho : Guess the driving conditions on the following days?

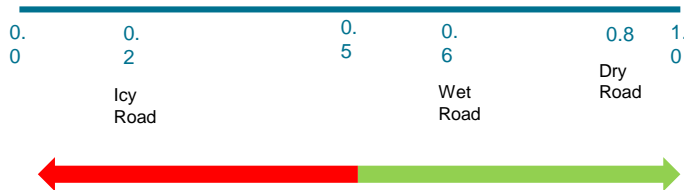


# Did you get them right?



# Friction/Grip

- Ultimately isn't that what we are wanting to know? How slippery is the street?
- Measuring friction also removes the **subjective** issues with people reporting conditions.
- Friction/grip is reported as the coefficient of friction:





# The Snow has ended...



# Wind and Blowing Snow

- Northwest winds are typical following a winter storm in most of the U.S.
- Increased wind speeds are usually caused by two factors
  - proximity to low pressure (storm)
  - diurnal (daytime) changes in wind
- Drier snowfall that has not a chance to melt and refreeze moves the most.
- Use weather data with wind information to monitor and track.



# Pavement temperature

- After the precipitation has ended the sky condition, winds and road condition begin to cause larger changes in temperature.
- **Cooling** will occur (if at night):
  - skies clear
  - winds weakening or blowing in cold air
  - surface has been plowed
- Warming will occur (if during the day):
  - skies clear
  - surface has been plowed
  - surface faces south
- Use pavement temperature tools to monitor



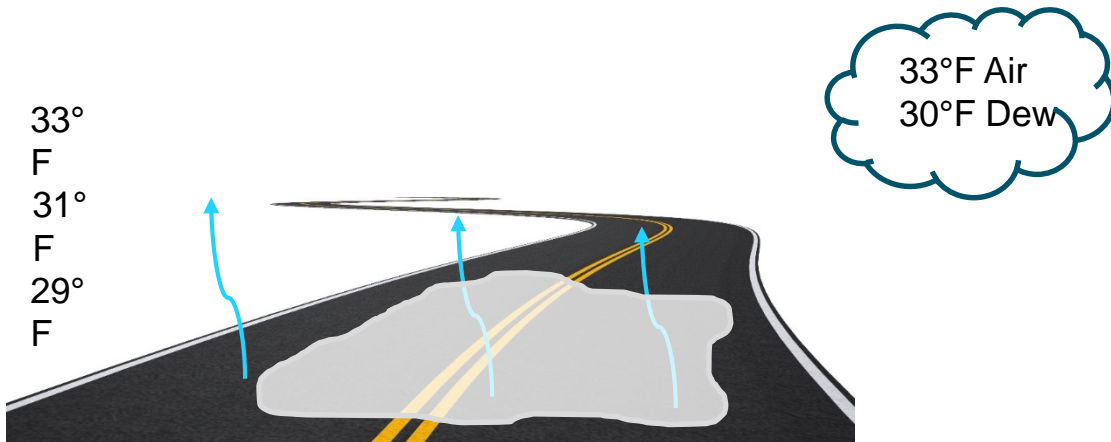
# Dew point

- Typically in the U.S. after an event has passed cold, dry air filters in behind the storm.
- A good North, Northwest, or Westerly wind keeps dew points low or even makes them lower.
- Streets dry quicker the drier the air (lower dew point).
- If winds weaken completely, change to a more southerly direction, and there was any melting of snow... **it is not all good!**



# Dew Point and Frost

- At night, as the air cools, heat also leaves the road surface. The road can cool faster than the air and thus fall below the dew point.



# Summary

- Understanding the weather is the first thing to overcoming when dealing with weather and winter maintenance.
- Next, make sure you have the correct tools.
- You can see that with each tool, or piece of information, you can react smarter to winter.

