

Environmental Sensor Station Data Control & Evaluation

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Outline

- **Environmental Sensor Stations**
 - **Quality Control**
 - AWIPS (MADIS)
 - Statistical
 - Kalman Filtering
 - **Validation**
 - UND STWRC Road Weather Field Research Facility
 - **Summary**
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Environmental Sensor Stations

- Currently there are about 2300 ESS in the US.
- DOT's use ESS data to make maintenance decisions in order to maintain the highest mobility and safety while minimizing cost
- Recently the validity of the data generated by ESS has been called into question



Quality Control

Pavement Temperature

- **What are the challenges associated with the quality control of pavement temperature?**
 - No current method of quality control exists
 - Rapid changes in both space and time.
 - Spatial techniques are not applicable
 - No 'simple' relationships exist.
 - In the atmosphere you can use hydrostatic, geostrophic
 - Pavement temperature depends on multiple variables that would require the use of a complex model

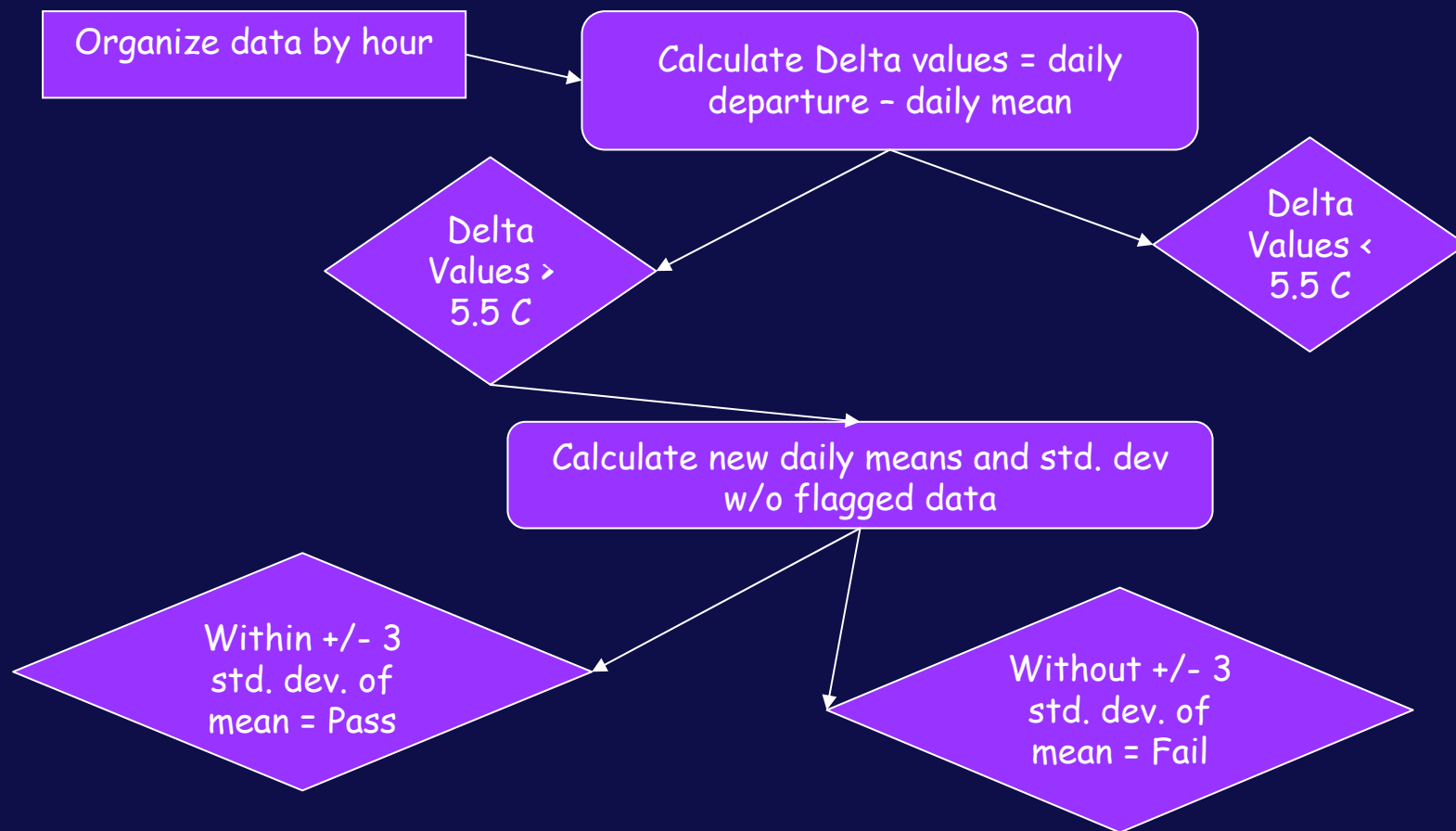
Quality Control

- **Current methods for atmospheric variables**
 - gross error
 - temporal consistency
 - internal consistency
 - “buddy check” or spatial continuity
- **Methods used in this study**
 - AWIPS (MADIS)
 - Statistical
 - Kalman filtering

AWIPS (MADIS)

- **Three levels of quality control**
 - **Level 1: Gross Error Checks**
 - **Level 2: Temporal** and Internal Consistency Checks
 - Level 3: Spatial Consistency Checks
- **Flags set depending on whether each level was passed or failed**

Statistical Method



Kalman Filtering

- **Three independent predictions of variable**
 - Time series trend
 - Spatial trend
 - Prediction model
- **Average the three and compare the result to the actual data, if the difference is greater than the tolerance amount that data point fails**

Preliminary Results

- **Methods tested on ND RWIS data**
- **AWIPS/MADIS method (Oct 5, 2005 to Jan 12, 2006)**
 - Total: 45353
 - Pass: 40206 (89%)
 - Missing: 5147 (11%)
 - Fail: 0 (0%)
- **Statistical method (Nov 1, 2005 to Jan 12, 2006)**
 - Total: 33117
 - Pass: 29066 (88%)
 - Missing: 3745 (11%)
 - Fail: 306 (1%)
- **Kalman filtering (Oct 6, 2005 to May 30, 2006)**
 - Total: 156672
 - Pass: 86893 (56%)
 - Missing: 41263 (26%)
 - Fail: 28516 (18%)

Preliminary Findings

- **AWIPS/MADIS method failed no observations over the time period.**
 - Limits too generous
 - Spatial check (level 3) not applicable
- **Statistical Method**
 - Relies too heavily on spatial distribution
- **Kalman Filtering**
 - Most flexible
 - Uses a weighted average

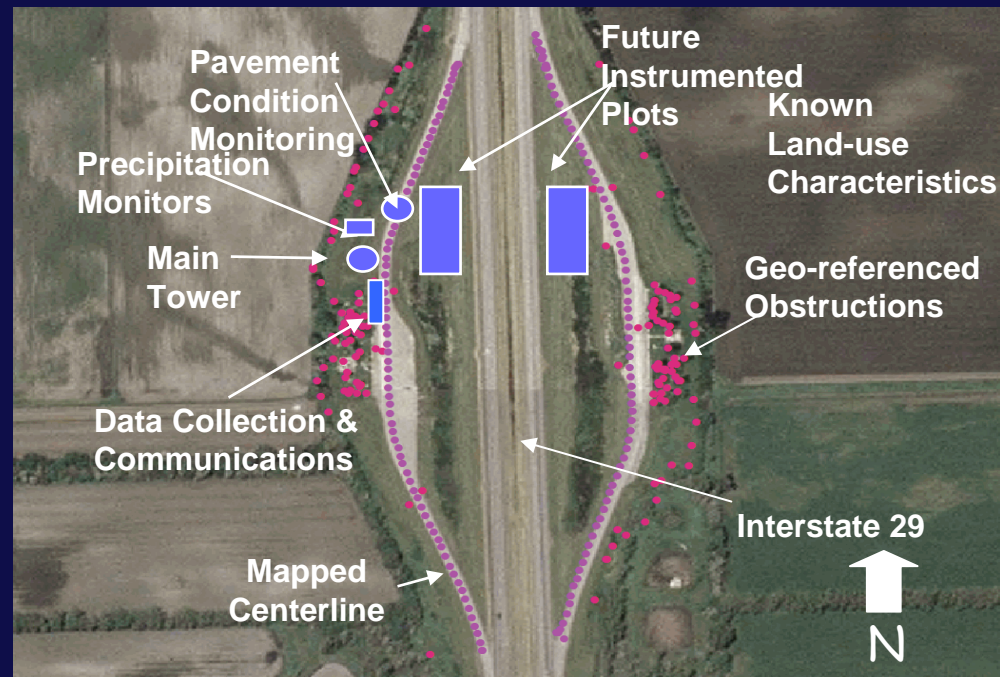
Validation

UND-STWRC Road Weather Field Research Facility

- **Resource for long-term studies in:**
 - Monitoring
 - Prediction
 - Validation
- of pavement and roadway weather conditions**

Road Weather Field Research Facility

- **Joint effort between state, university and private sectors**
 - UND
 - North Dakota DOT
 - Meridian Environmental Technology
- **Located on I-29 south of Grand Forks, ND.**



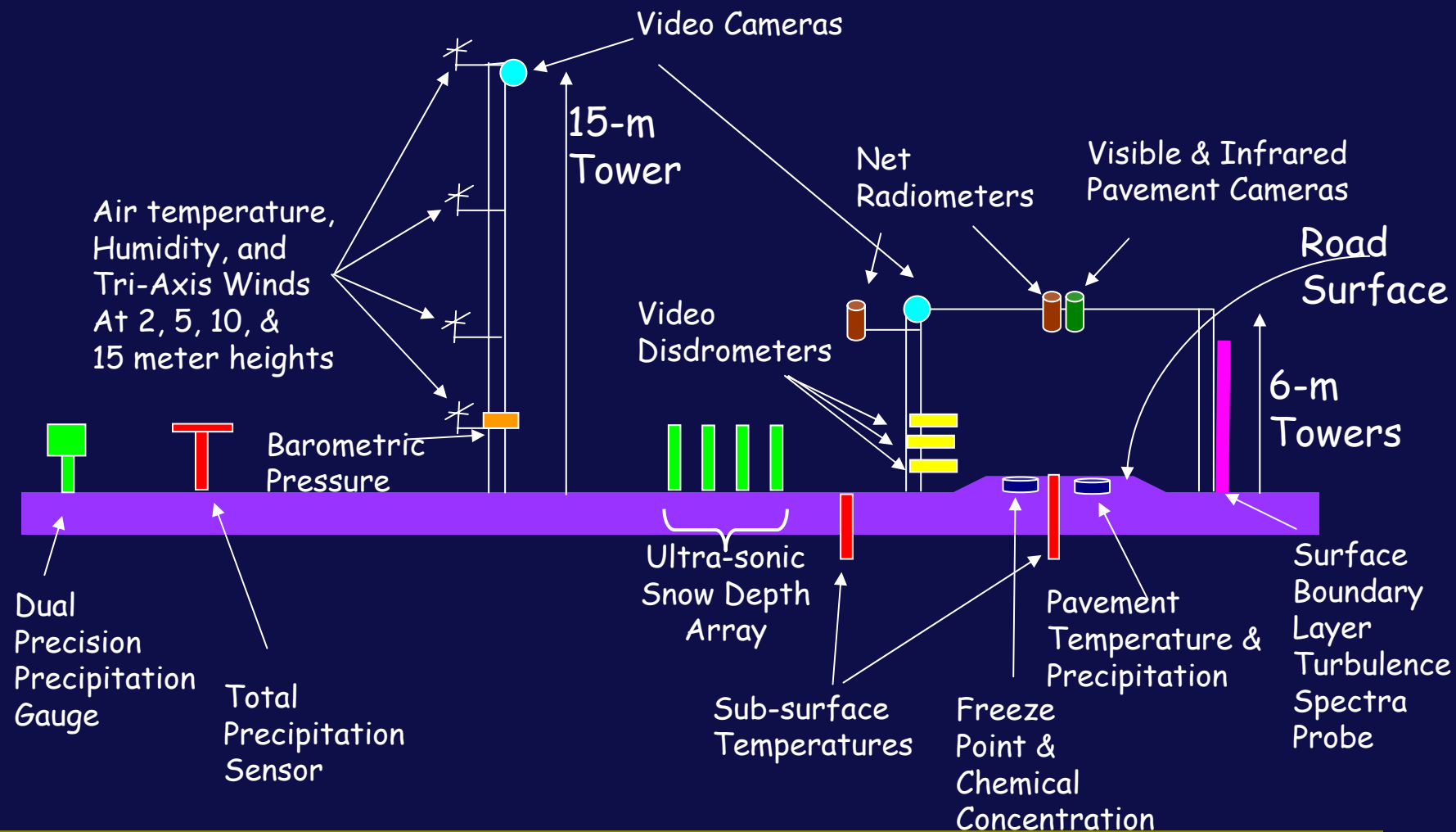
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Research Collaborations

- **Goodrich Laser Remote Sensing System (LRSS)**
 - Vaisala
- **Ice Hawk**
 - Vaisala
- **Video Disdrometer**
 - NASA
- **Ice Turtle**
 - ThomTech Design
- **Friction Wheel**
 - Ohio DOT

Surface Transportation Weather Field Research Facility



<http://stwrc.und.edu/fieldsite/live>

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Data Collection

- Atmospheric
- Road Weather
- Frequency

Atmospheric

- **Temperature/RH**
 - Four Levels: 2, 5, 10, & 15 meters
- **Wind Speed and Direction**
 - Four Levels: 2, 5, 10, & 15 meters
- **Barometric Pressure**
 - 2 meters
- **Precipitation**
 - Accumulated Precipitation
 - Precipitation Rate
- **Snow Depth**
- **Snow Pack Temperature**

Road Weather

- **Road Condition**
 - Ice, Wet, Dry, Moist
- **Chemical Concentration**
 - NaCl
- **Freeze Point Temperature**
- **Pavement and Subpavement Temperatures**
- **Net Radiation**
- **Blowing Snow**
 - Video disdrometers
- **Video Capabilities (visibility)**
 - Facing downward towards the in-pavement sensors and disdrometers.
 - Facing south looking down access road towards the interstate.

Frequency

- **10 minutes – UND subsurface temperature probe**
- **2 minutes – Lufft pavement data**
- **1 minute – Snow depth sensors and snowpack temperature**
- **15 seconds – Ice Turtle pavement temperature**
- **10 seconds – Atmospheric, net radiation, and accumulated precipitation**
- **1 second – Precipitation rate**

- **Data from the disdrometers is collected after each storm event.**

Data Usage

- **The data collected from the Road Weather Field Research Facility is used for research by the STWRC as well as for research by entities outside of the university.**

Summary

- **ESS data is essential to DOT decision making**
- **This data needs to be quality controlled and validated**
 - AWIPS (MADIS)
 - Statistical
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Thank You!