Mobile Vehicle Road and Weather Observation Quality Check Methods

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Outline

- Motivation for developing quality checks for maintenance trucks
- Development of the quality check tests
- Case Studies
- Results
- Summary
- Next Steps

Motivation

- Current road weather observations are in static locations leaving data gaps in between RWIS.
- Many maintenance trucks have been equipped with Mobile Data Collection and Automatic Vehicle Location (MDC/AVL) units that collect data. The shortcoming of these data is the unverified accuracy of the received data.

Data Collected from MDC/AVL Vehicles

The most common data elements that are recorded from the MDC/AVL units include **Vehicle Identifier, Time, Location,** Lane Identifier, Maintenance Data and Observations.

Maintenance data:

- Plow position
- Material applied
- Material Form
- Application rate
- Application rate units

Observation:

- Road condition
- **Road Temperature (Optional)**
- Precipitation (Optional)
- Visibility and Obstruction (Optional)
- **Air Temperature (Optional)**

- **Bolded** items are used in the quality checking algorithm.

Quality Check Comparison

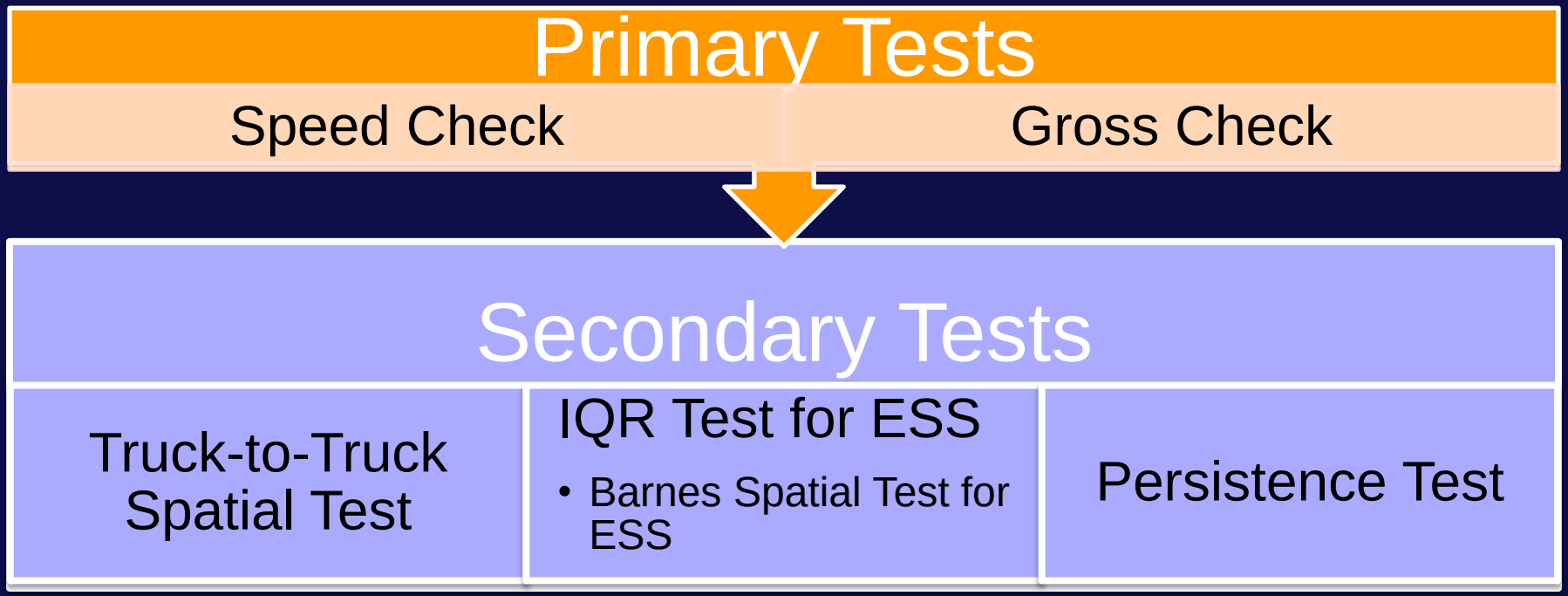
Clarus System Quality Checks	Proposed Mobile ESS Quality Checks
•Sensor range test	
•Climate range test	•Speed Check (*Time Step)
•Time step test	•Gross Check (*Sensor Range)
•Like instrument test	•Persistence Test
•Persistence test	•Inter-Quartile Range (IQR) Test for ESS
•IQR spatial test	•Barnes Spatial Test for ESS
•Barnes spatial test	•Truck-to-truck-Spatial Test
•Dew point temperature test	•Truck-to-Model-Spatial Test**
•Sea level pressure test	
•Precipitation estimation test	

* Denotes different name but similar test.

**Computer troubles have caused this test to not be run.

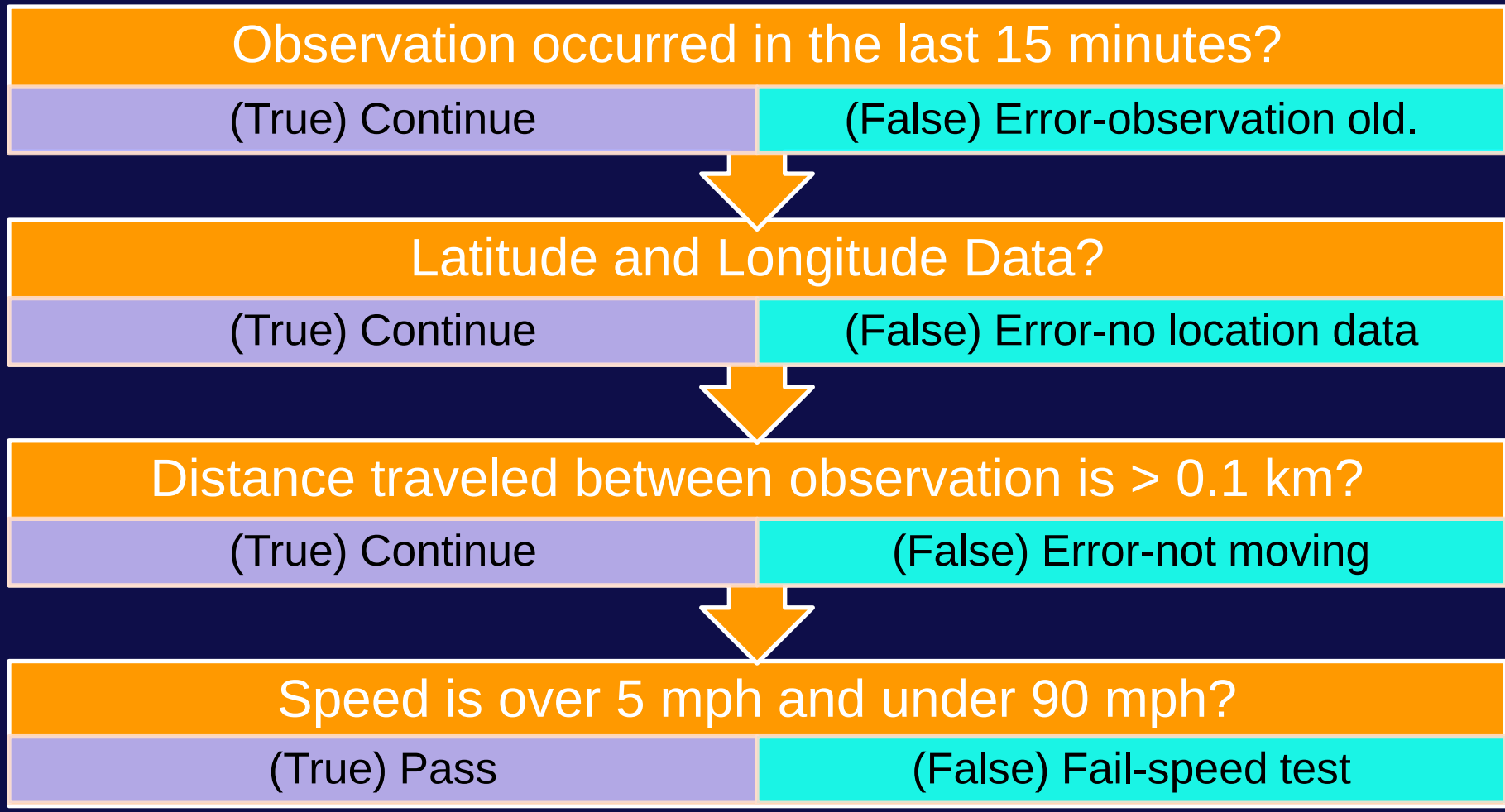
Quality Check Sequence

- **The quality check algorithm begins with primary tests.**
  - If they pass then secondary tests are performed.



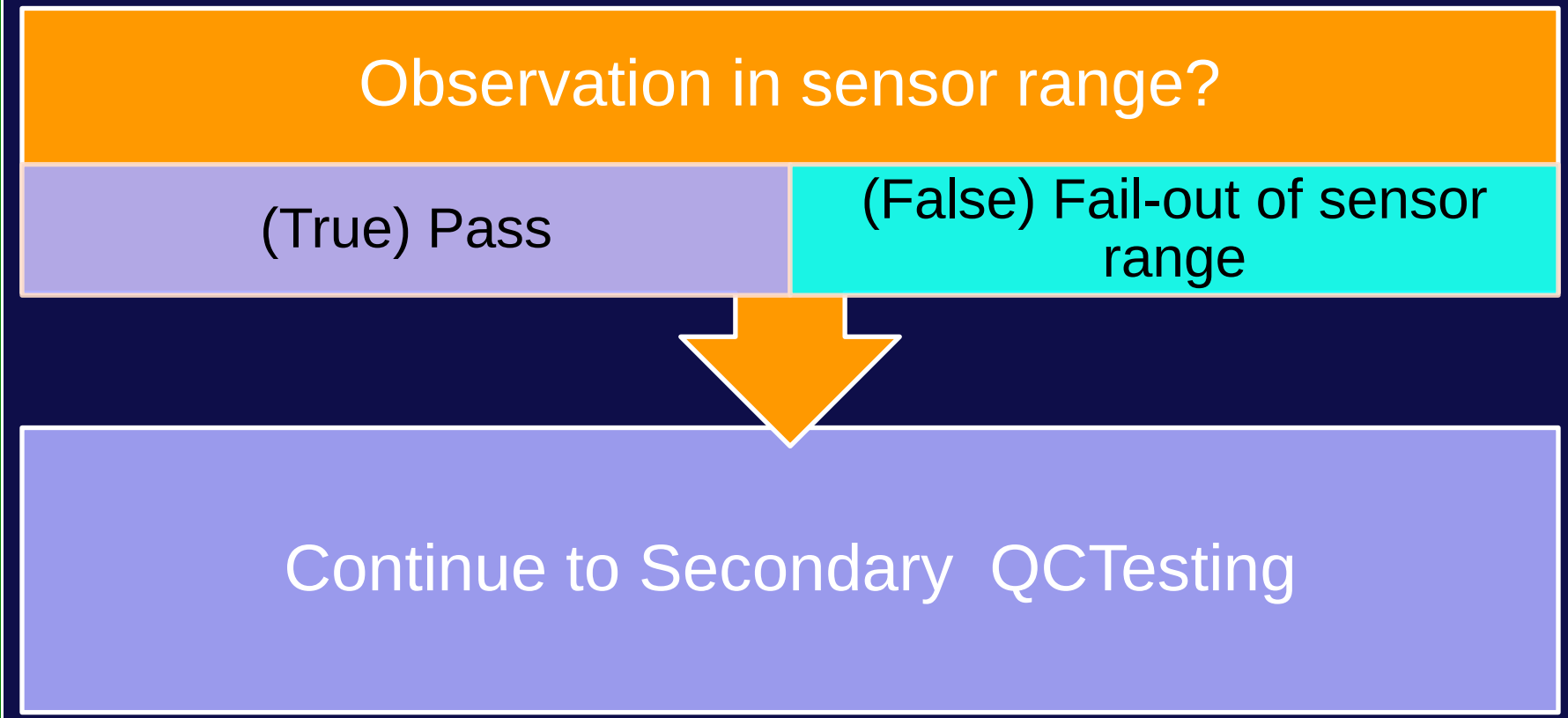
Primary Tests

- **Speed Test**

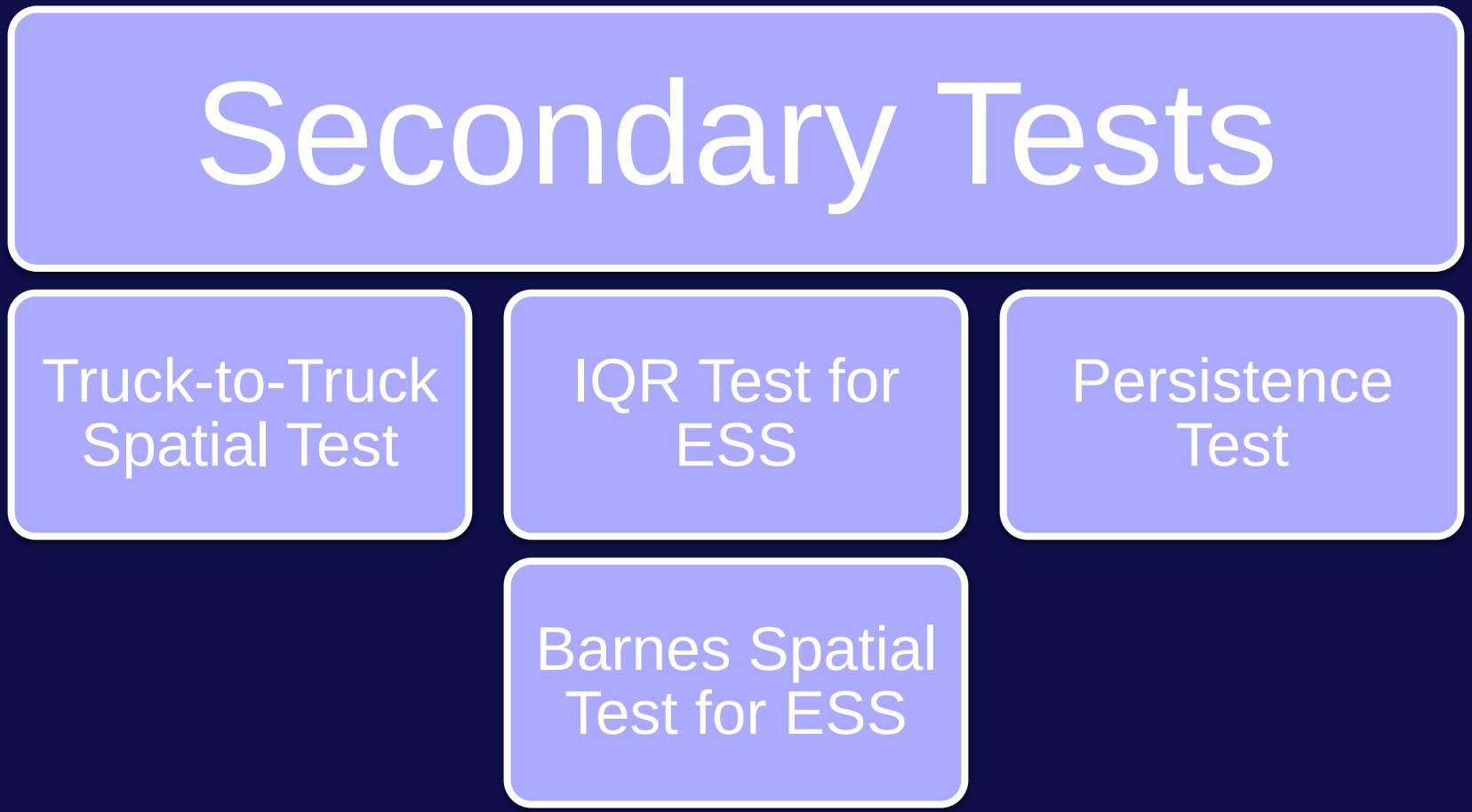


Primary Tests (Cont.)

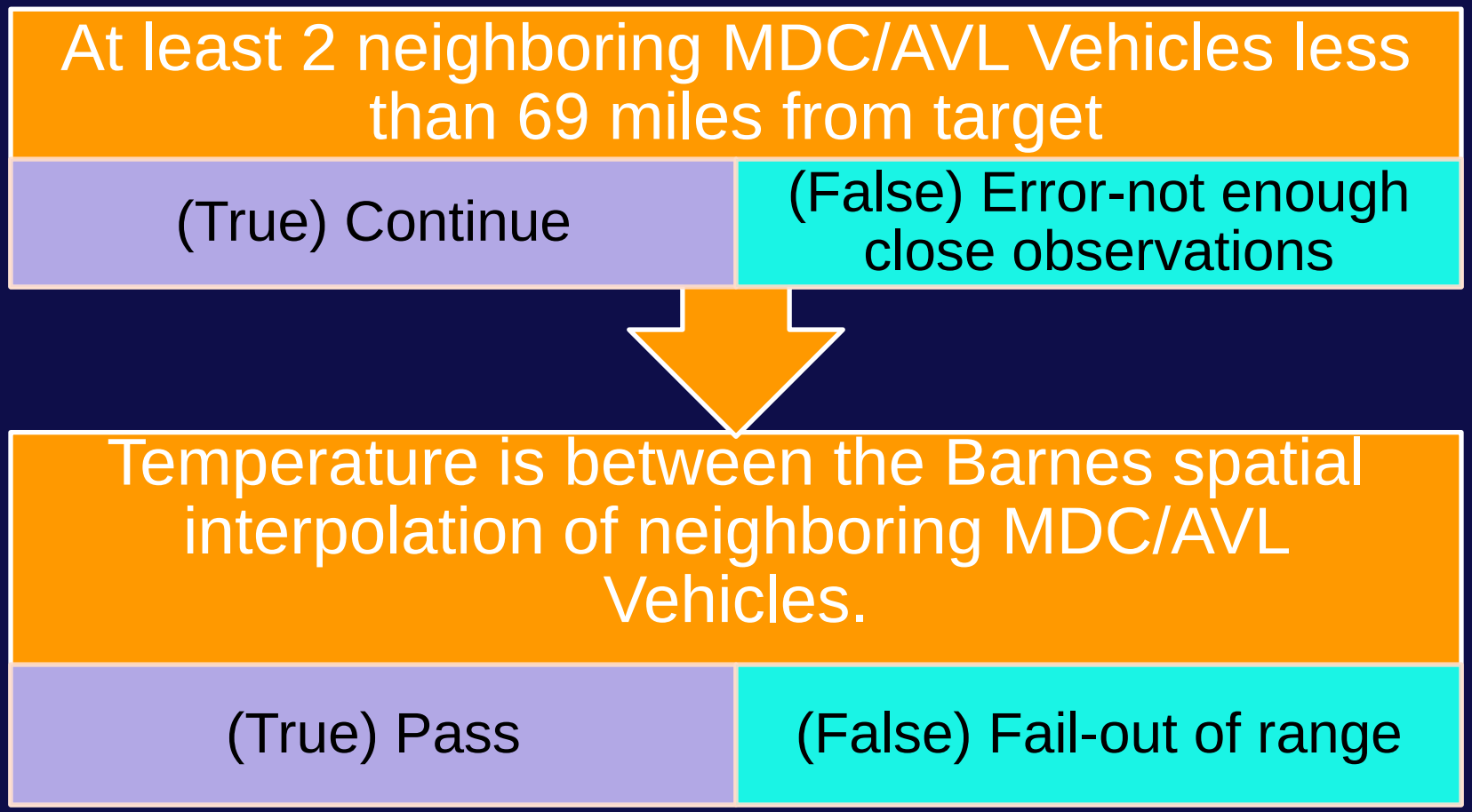
- **Gross QC Test**



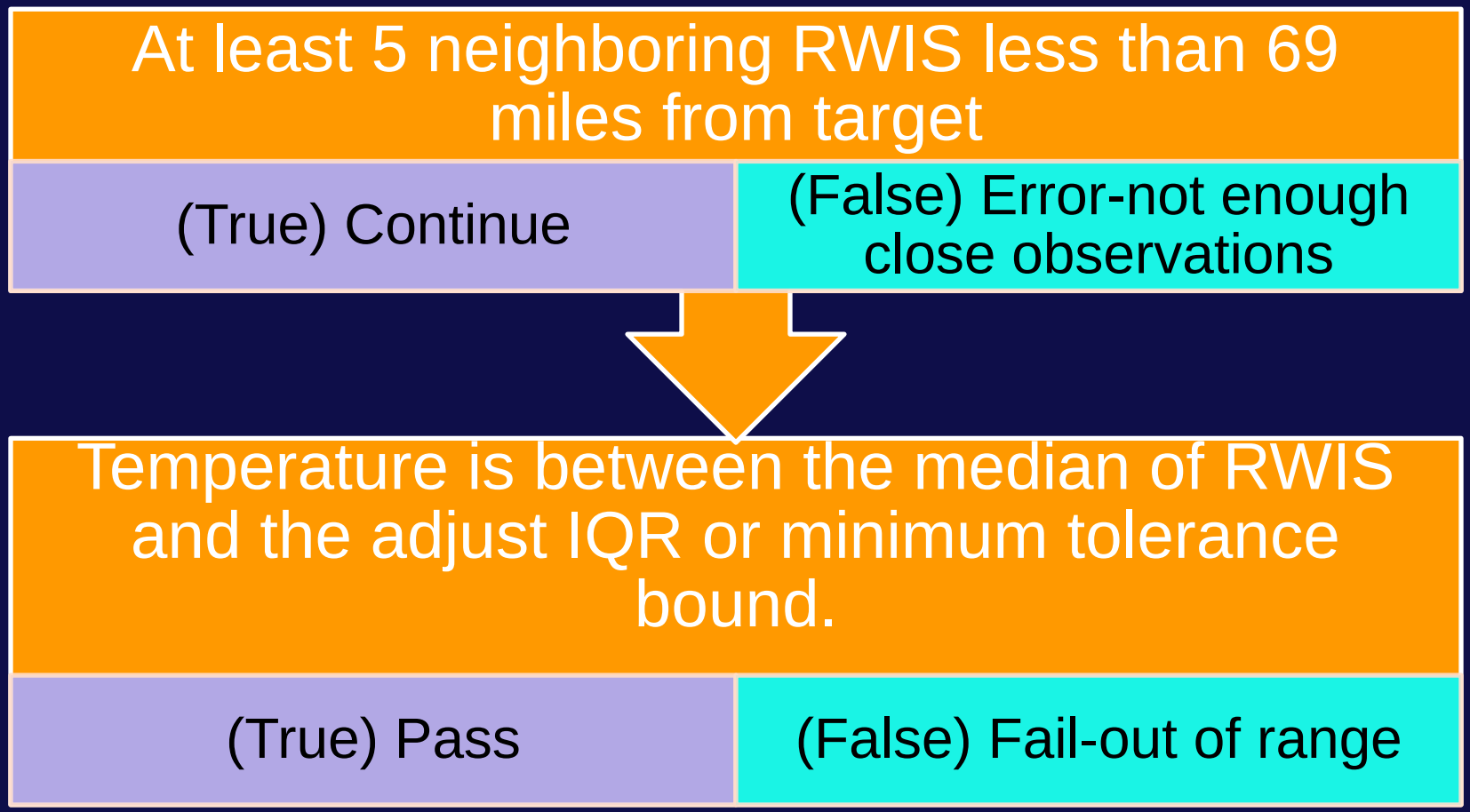
Secondary Tests



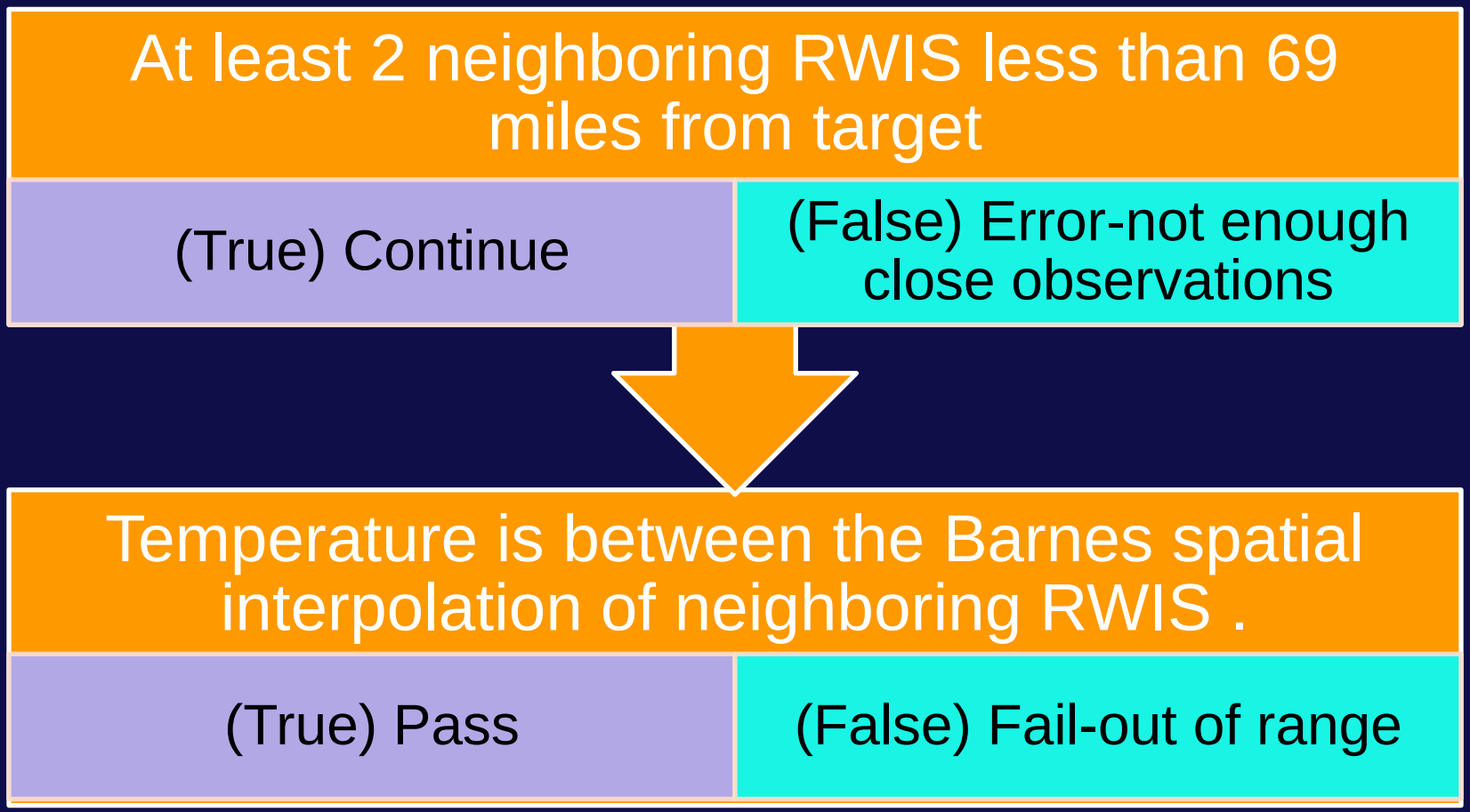
Truck-to-Truck Spatial Test



IQR Test For RWIS

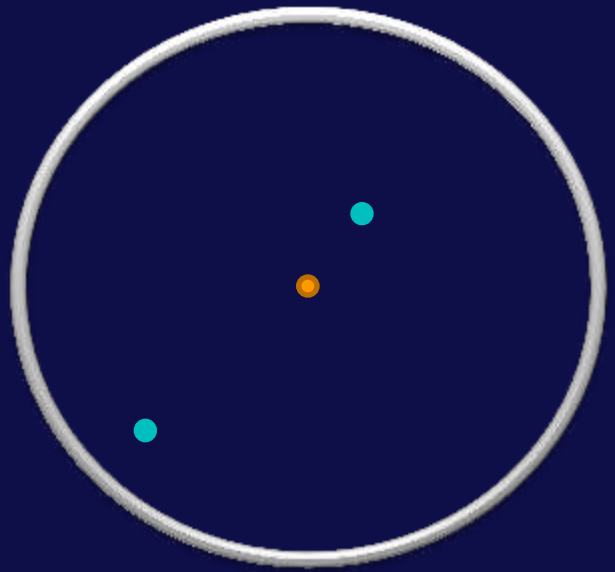


Barnes Spatial Test for RWIS



Barnes Spatial Analysis

- The Barnes spatial test uses neighboring observations and weights them based on their distance from the target sensor.
- The weights from the neighboring observations drop exponentially as the distance from the target increases.
- Observations outside of the radius of influence receive a weight of zero.



Target
Surrounding
Observations

Persistence Test

Observation occurred in last 30 minutes

(True) Check if value changed from last 15 observations

- (True) Pass value changed
- (False) Fail-value didn't change

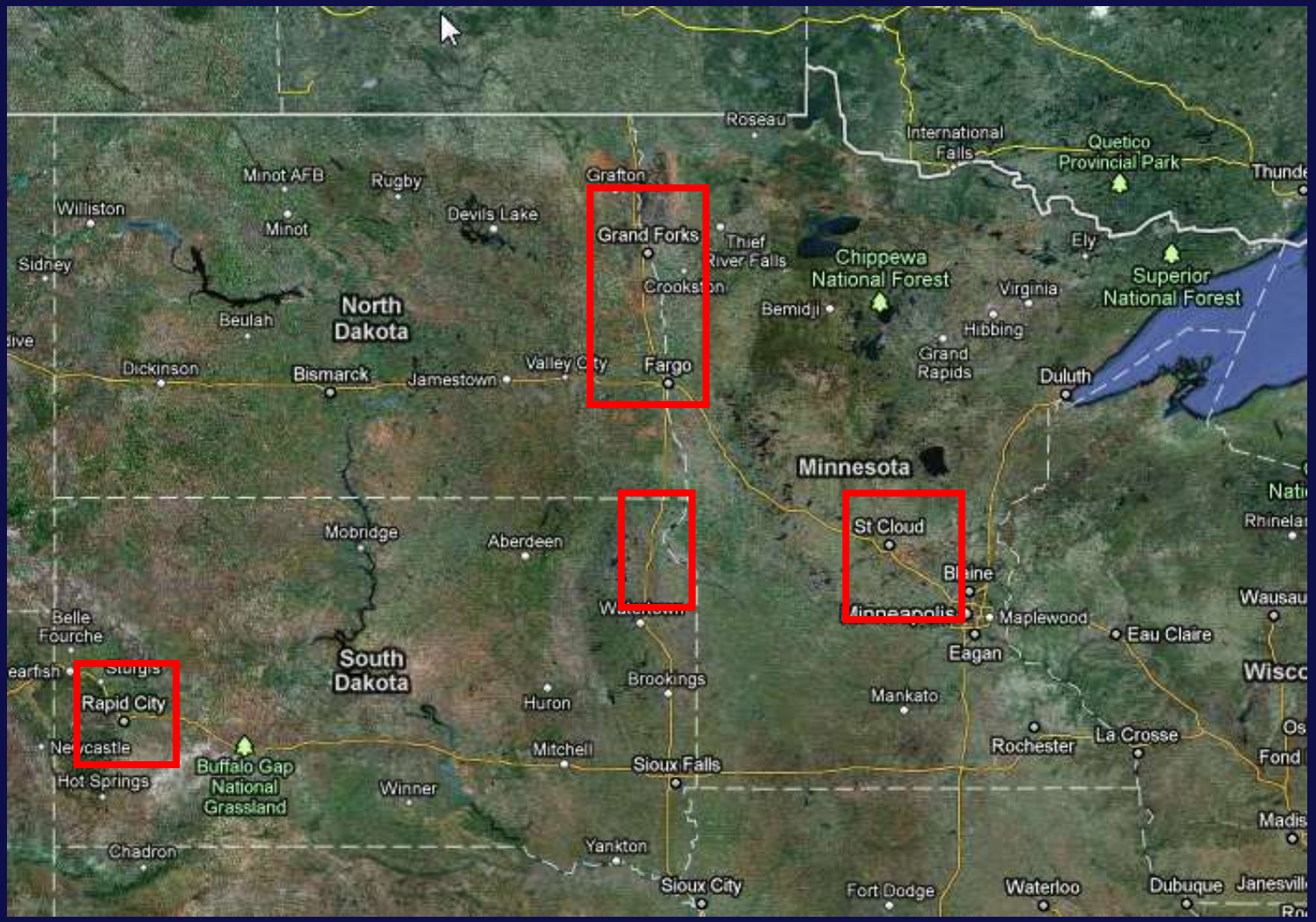
(False) Check if the observation is same as last reported value

- (True) Fail-same as previous trip
- (False) Pass Value changed

Test Cases

- **Eastern ND Cases:**
  - November 29-30, 2010
  - Dec 30, 2010 - Jan 1, 2011
  - March 11-12, 2011
  - March 22-23, 2011
  - April 15-16, 2011
- **St. Cloud, MN Cases**
  - November 22, 2010
  - December 11, 2010
  - February 20-22, 2011
  - March 22-23, 2011
  - April 20, 2011
- **Black Hills, SD Cases**
  - Dec 30, 2010 - Jan 1, 2011
  - January 15, 2011
  - February 24, 2011
  - March 8, 2011
  - March 26, 2011
- **Sisseton Moraine, SD**
  - Dec 30, 2010 - Jan 2, 2011
  - February 2-3, 2011
  - February 8-9, 2011
  - February 13-14, 2011
  - February 17-18, 2011

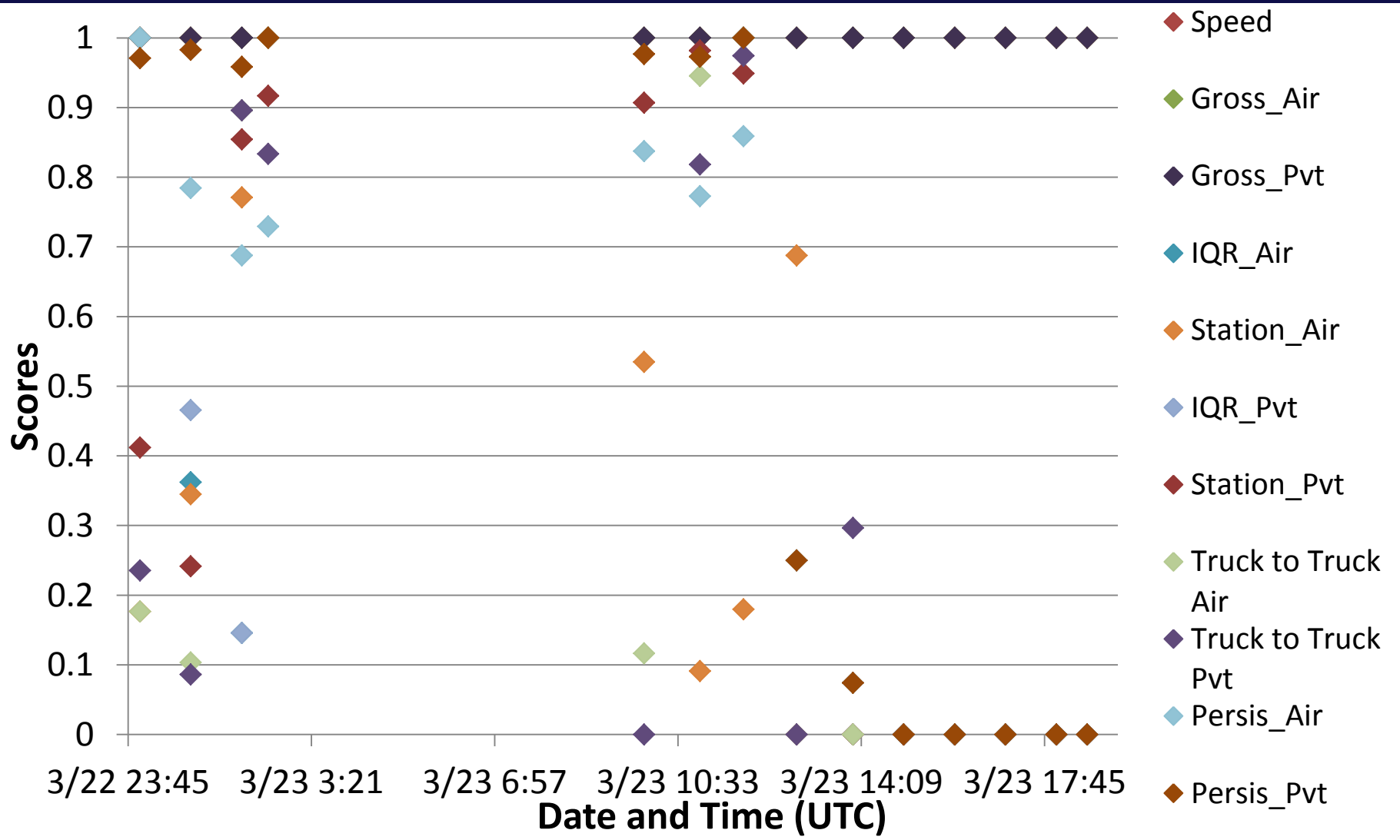
Cases Location



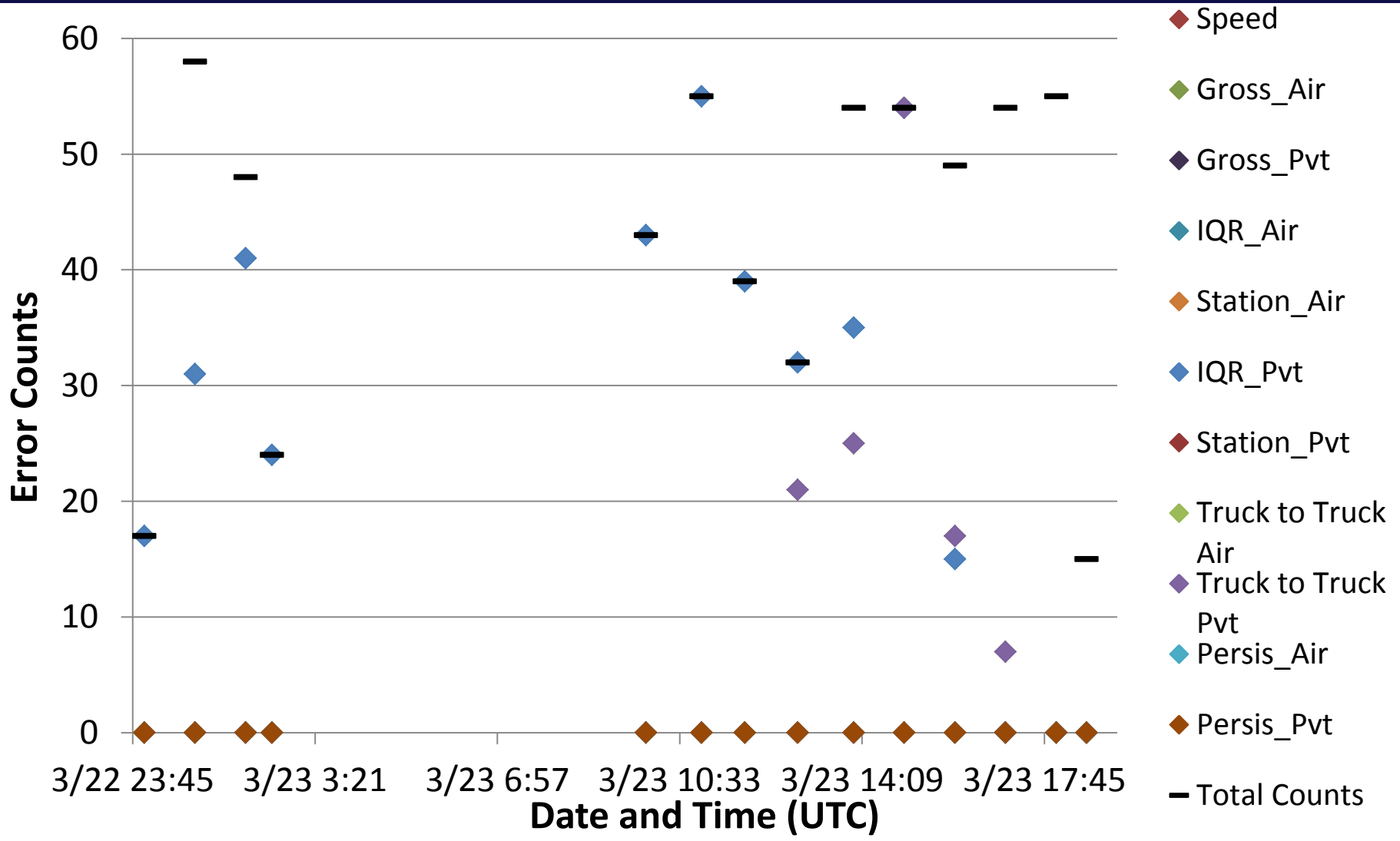
Case March 22-23, 2011

- **Focuses on Eastern ND and St. Cloud, MN area**
- **Trucks that were processed include:**
  - MN-AT-205569, MN-AT-206572, MN-AT-208503, MN-AT-208562, MN-AT-208563, MN-AT-209507
  - ND-9303, ND-9311, ND-9372, ND-9519, ND-9644, ND-9757, ND-9784
- **Trucks ND-9372 and MN-AT-208562 show a sample of some results.**

ND-9372 Results



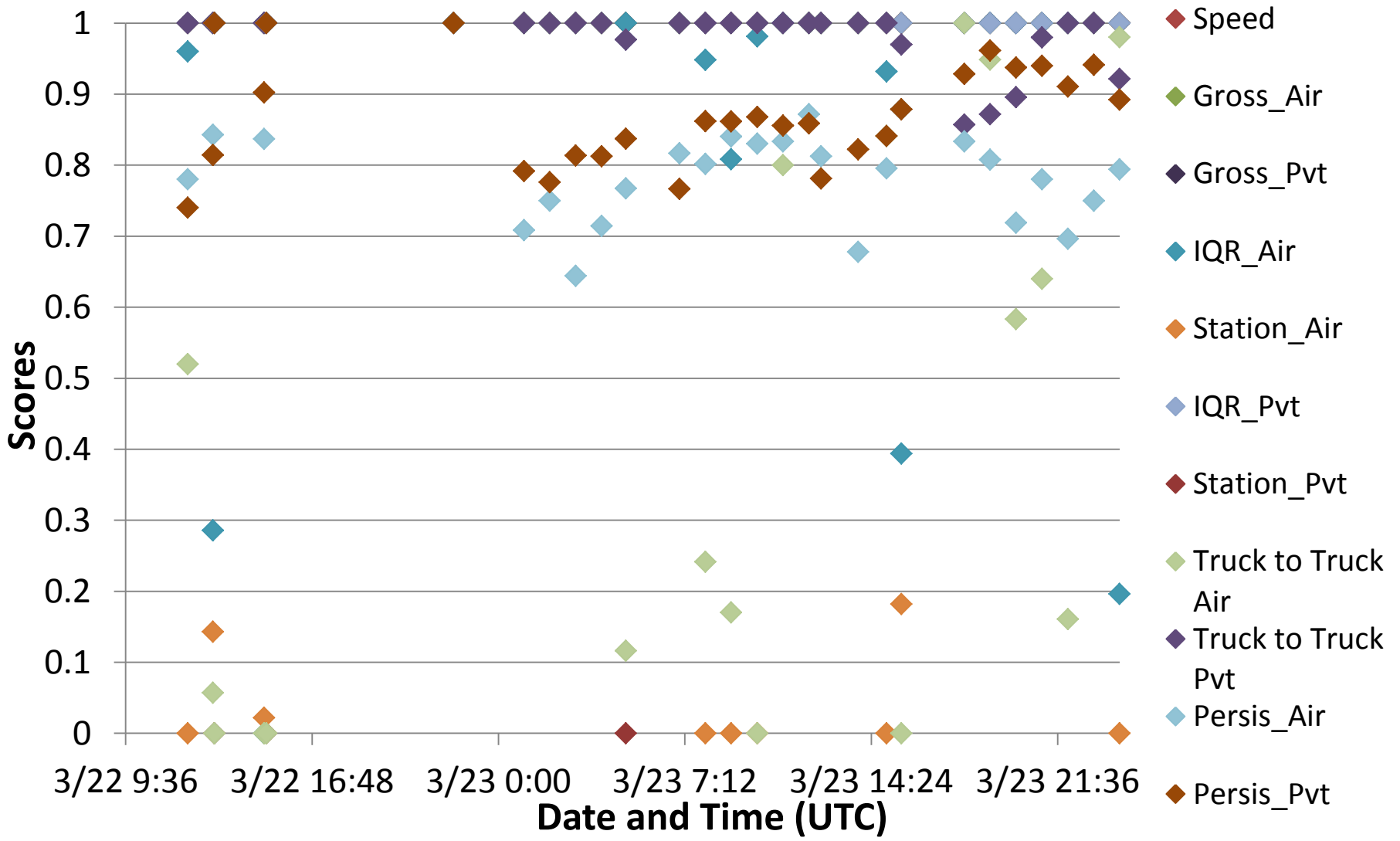
ND-9372 Error Counts



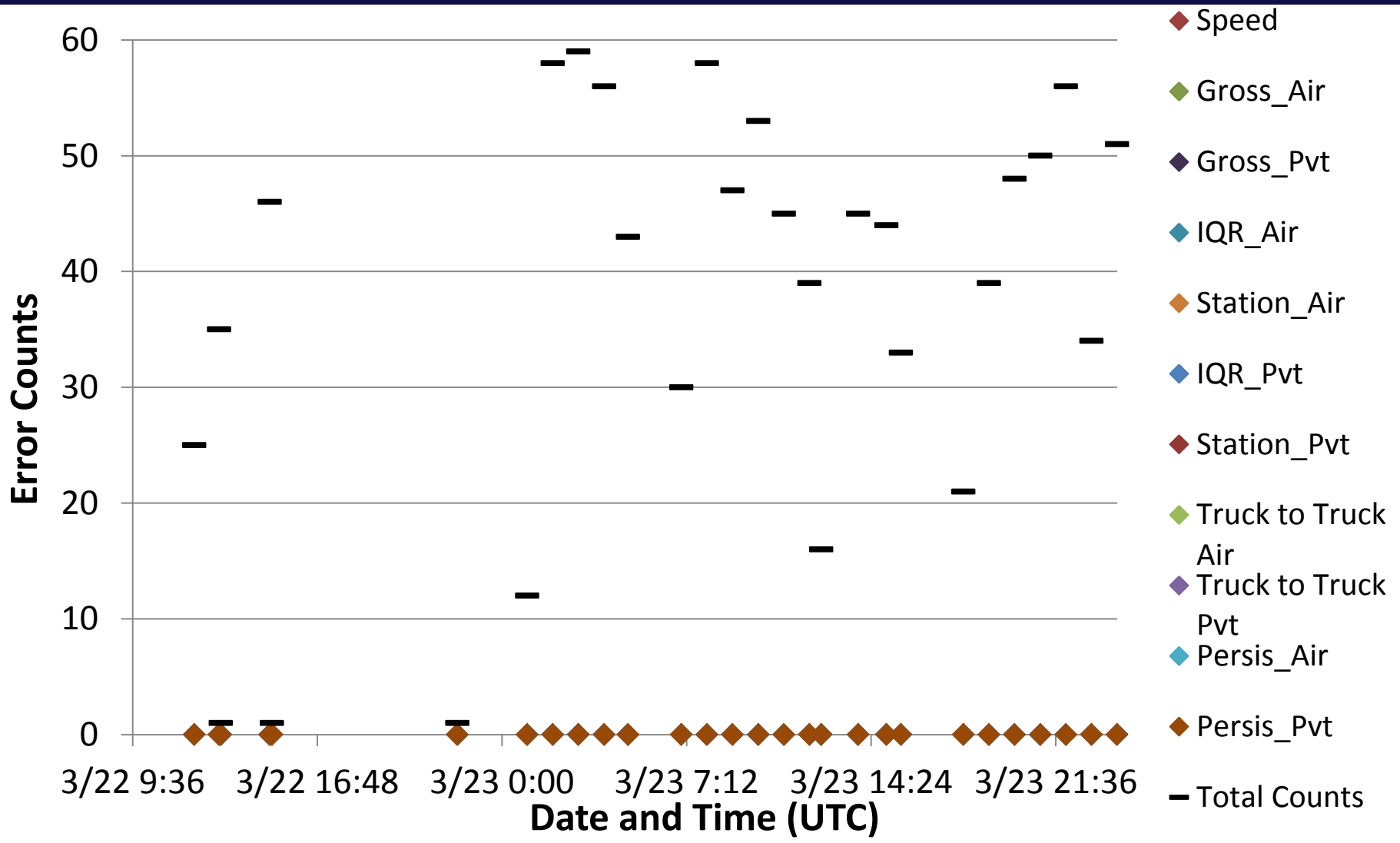
Notes for ND-9372

- ND-9372 experienced an issued during the snow event.
- At 12:20UTC (6:20 am CST)on March 23 the sensors “got stuck” at a 32.2 F for Air temperature and 52.8 F for Pavement Temperature for 40 minutes.
- At 13 UTC (7am CST) on March 23 those values switched over to 0 F for both of the sensors until the end of the run at 19UTC (1pm CST).

MN-AT-208562 Results



MN-AT-208562 Error Counts



Notes for MN-AT-208562

- **MN-AT-208562 shows that the tests were able to complete without any errors.**
- **The pavement sensor compared well against surrounding stations and trucks.**
- **The air temperature senor on board did not fair as well.**
  - Reported temperatures were typically 5-20 F degrees warmer than surrounding observations.

Summary

- **Amount of included data**
  - Frequency of GPS Data VS. Observation data
- **Timing of data**
  - Data collection from third party data is delayed
- **Data "Getting Stuck" at 0ºF**
- **Significant figures in data (xxx.xxx F or xxx F)**
- **Missing observations for comparison and/or differentiation between surface observation types**
  - No pavement/surface temperature sensors installed
  - Missing "reference locations" i.e. bridge or roadway
- **Limitations**
  - Post or Real time analysis.

Next Steps

- Study the quality check algorithm against other trucks and other wintertime events.
- Determine alternative way to run the quality checks to improve algorithm performance for high volumes of mobile observations.

Acknowledgments

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Questions?

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