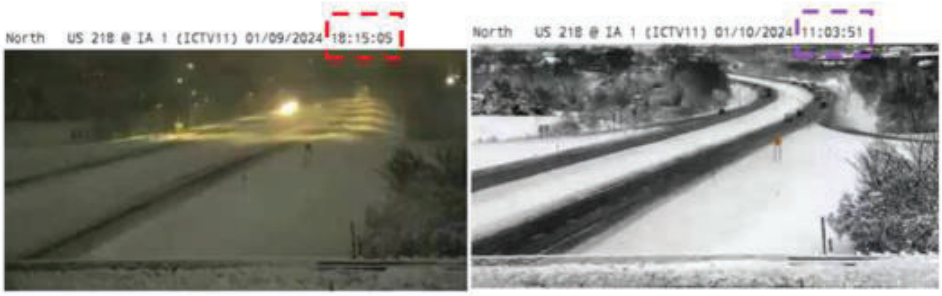
Improved Driver Experience and Safer Routing with Road Weather Data

Publik rapport



Author: Klimator and Volvo Group North America
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Proof of Concept Project within FFI, Accelerate Startup Partnership project /Program

Content

1. Summary

During the period of 2023-10-01 and 2024-03-31, the project Improved Driver Experience and Safer Routing with Road Weather Data was carried out. The project was executed in Sweden and the US, with the test area defined as Iowa. The project parties were Klimator AB, Volvo Group North America LLC, and Volvo Technology Cooperation (coordinator). The project was of the nature proof-of-value and was part of the FFI Startup Acceleration Partnership.

The purpose of the project was to determine what potential there is in utilizing the data from Klimator's Road Condition Data (RCD) technology to provide the driver with proactive information about slip risk and bad road conditions. The goal was to evaluate the possibility of utilizing the information when choosing the route, to decrease the risk of accidents.

To be able to determine what potential there is in utilizing RCD, the following success factors have been defined:

- Visualize slip risk for the defined road network in a tablet.
- Verify that the provided data is sufficiently accurate.

2. Background

Road weather conditions have a significant impact on the safety and efficiency of truck transportation which causes significant challenges for truck drivers, leading to a higher risk of accidents. The Federal Highway Administration (FHWA) reports that more than 1,300 people are killed, and more than 116,000 people are injured in the United States yearly in snow, ice, or slush-related auto accidents. Even rain can have disastrous consequences. A study published in the Bulletin of the American Meteorological Society revealed that rain and snow increase the risk of fatal car crashes by 34 percent. The FHWA reports that approximately 24 percent of all weather-related car crashes occur on slushy, icy, or snowy roads.

The Volvo Group Safety Vision "Zero" provides a distinct direction for all safety work. By adding proactive information about road conditions in the navigation system, truck drivers and fleet managers can be aware of the weather conditions they will face along their routes and plan accordingly. This type of proactive development of intelligent solutions, that not only mitigate the consequences of accidents but strive to avoid them altogether goes in line with the Volvo Group Safety Vision "Zero". In addition, other positive outcomes follow when integrating road weather information into the routing function. The information could help fleet managers optimize their operations, reducing accidents, fuel consumption, and maintenance costs.

3. Purpose, Research Questions, and Method

The purpose of the project was to determine what potential there is in utilizing the data from Klimator's Road Condition Data (RCD) technology to provide the driver with proactive information about slip risk and bad road conditions. The goal was to evaluate the possibility of utilizing the information when choosing the route, to decrease the risk of accidents.

The two project partners, Klimator AB and Volvo Group North America LLC, have both conducted separate validations of the data and have had several technical meetings to discuss results and road climatological trends and outcomes. The methods used are briefly described below.

3.1 Evaluate the data from real-world experience.

By providing Volvo Group North America LLC with a tablet (Samsung Galaxy Tab A8 4G) showing Klimator's real-time RCD forecasts, Volvo Group North America LLC was able to follow the forecasts in real-time and compare it with the driver's experience. This was done January 9-12.

3.2 Evaluate the data against measured values.

Klimator performed a quantitative validation on the entire dataset against measured values at stations and cameras. Klimator conducted three types of validations: Cross-validation of Road Surface Temperature, Slipperiness detection; Air Temperature vs Modelled Surface Temperature, and Case analysis with CCTV stations.

4. Objectives

The project goals were formatted as success factors in the project, which are listed below.

- Visualize slip risk for the defined road network in a tablet.
- Verify that the provided data is sufficiently accurate.

The project also consisted of sub-goals, which are listed below.

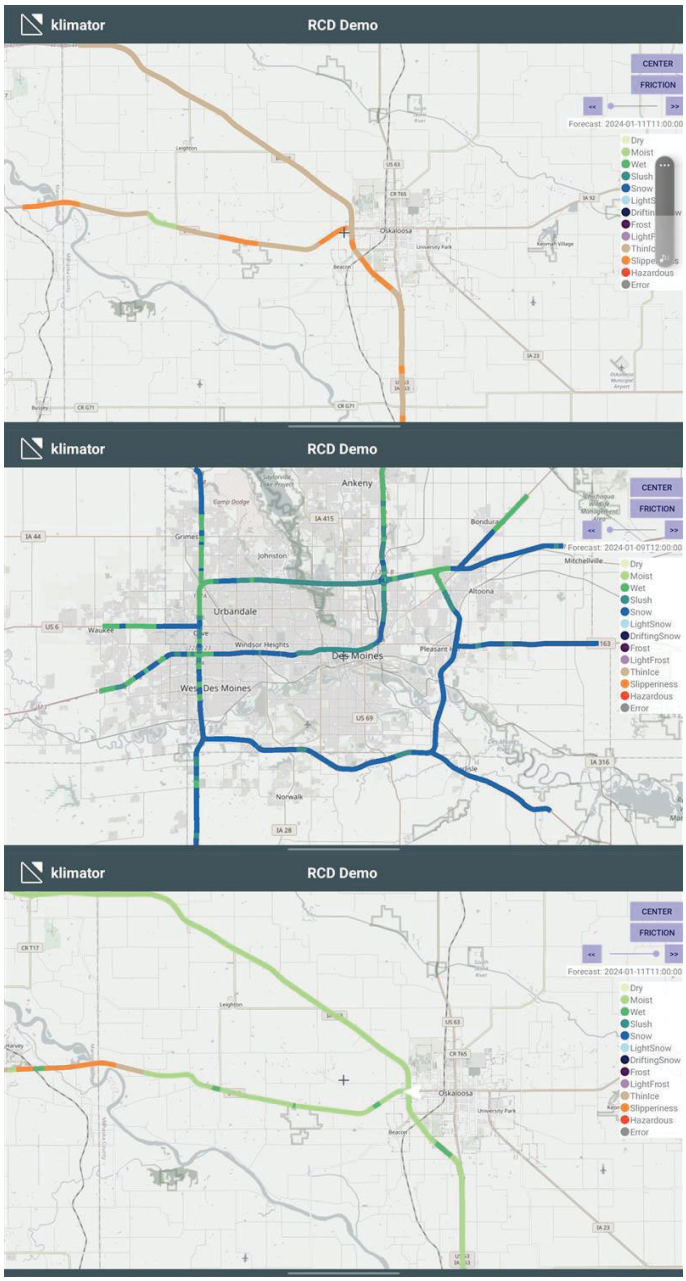
- Delivery of tablet to Volvo Group North America
- Real-time forecasts on the tablet
- Data set over the project period
- Internal final reports and discussions on their results

5. Result and Goal Achievement

In this section, the project goals are presented based on the defined success factors and their outcomes.

5.1 Visualize slip risk for the defined road network in a tablet.

Below, the interfaces with the defined road network on the tablet are illustrated. It was highly appreciated that even though one was not in Iowa, it was possible to track the road conditions and their changes over time.

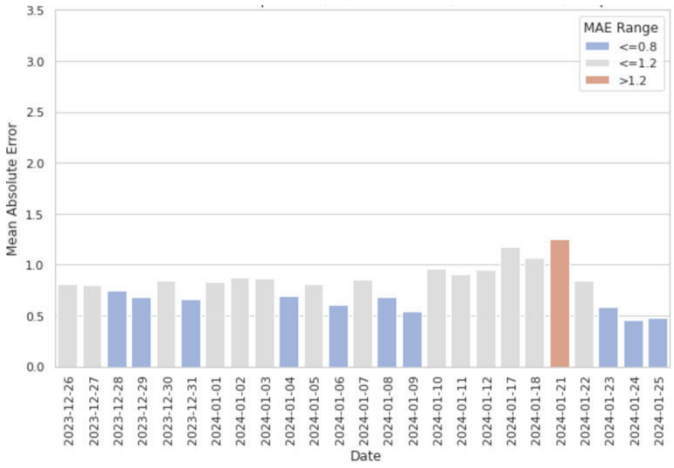


5.2 Verify that the provided data is sufficiently accurate.

Data was collected from Road Weather Stations, RWIS, between December 25th to January 25th and for the same period, Klimator's RCD model was running live. The RWIS are measuring every 10 minutes throughout the entire test period, resulting in a total of 206,800 data points. RWIS are widely accepted standards for measuring weather-related parameters along the road, such as the road surface temperature.

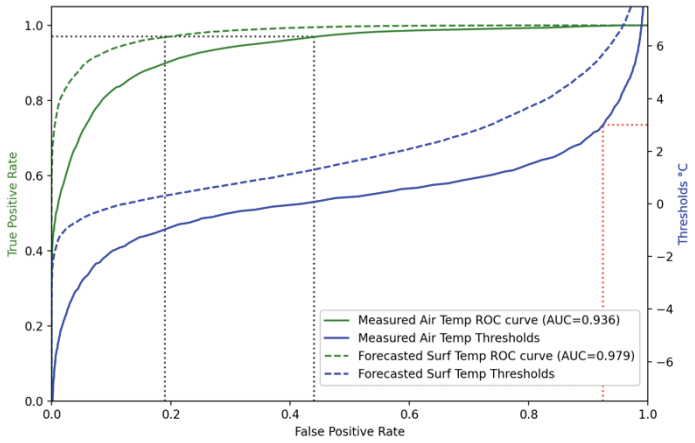
5.2.1 Cross-validation of Road Surface Temperature

Even though the model has not previously been trained in this area, a very high accuracy of the road surface temperature was achieved with a mean absolute error of 0.79°C. This can be compared to the error margins between different road weather sensor's of up to +/- 0.5°C. The figure below illustratets the mean absolute error for surface temperature (ST) from the RCD-model [-5°C < ST < 5°C] for the period.



5.2.2 Cross-validation of Road Surface Temperature

Today's slippery warning standards in vehicles warns at an air temperature below 3°C. For this project, such functionality would have generated a False positive rate of 93%, i.e. false warnings on occasions where there is no risk of slipperiness. This result makes the only-air-temperature-based model a more or less useless functionality. A Klimator model considering the road surface temperature, would with a True positive rate of 97%, only have a False positive rate of 18%. Since the model also estimates water, snow, and ice on the road, which also contributes to the risk of slipperiness, the difference to an only air temperature model is even larger.



5.2.3 CCTV cameras

Images from surveillance cameras have been used to analyze several specific events pointed out by Volvo Group North America's project representative, from the tests conducted in real-world environments. The specified locations are matched with the nearest available CCTV camera, and then model data from the road segment closest to that camera is used. CCTV images along with road condition diagrams can be seen in the illustration below and can be described as follows. The model indicates snowfall during the evening and night of January 9th, which is also confirmed by the images, leading to slippery roads later in the night and early morning. After 10 hours of slippery roads, the likelihood of salting being performed increases, and together with low humidity and strong winds, the roads begin to dry in the morning. At 11 am, the most likely road condition is dry. However, there is uncertainty about the treatment measures and a risk of thin ice, which generates a medium-high risk of slipperiness.

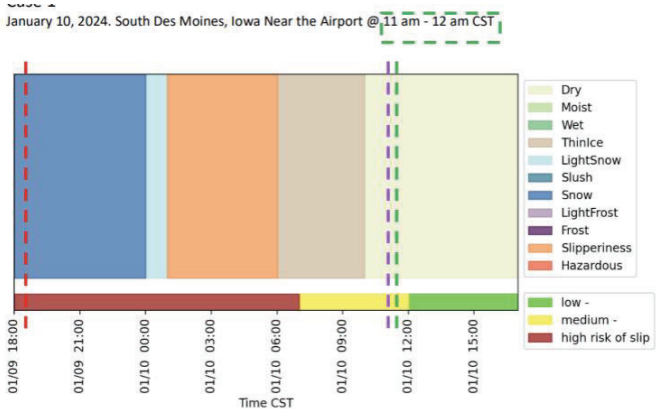
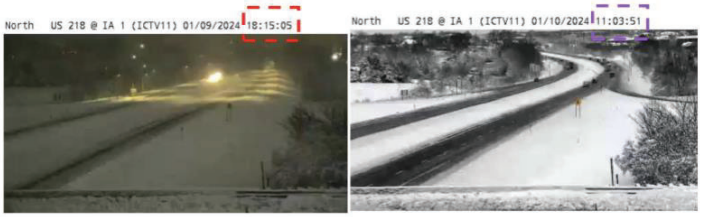


Figure 6: Road condition and estimated risk of slipperiness for the road segment closest to the CCTV camera.



6. Dissemination and Publication

6.1 Knowledge and Result dissemination

How is/planned the project result to be used and disseminated?	Mark with X	Comment
Increase knowledge within the area	x	The project has led to a better understanding and knowledge of the complexity of road condition data and how this can be interpreted for applications in the automotive industry.
Carry forward to other advanced technical development projects	x	Discussions are ongoing
Carry forward to product development projects	x	Discussions are ongoing
Introduced to the market		
Used in investigations/regulations/permit cases/political decisions		

6.2 Publications

No publications available

7. Conclusions and Further Research

7.1 Conclusion

- It was a great advantage to be able to visualize information on a tablet during the project.

- Vehicle data alone is not sufficient for this type of application.
- The information ultimately presented to the driver should be simplified to slip risk instead of highly complex road conditions.

It can be concluded that the project goals were fulfilled.

7.2 Further work/research

- Elaborate on which classifications are relevant for the driver and how to define these from a road climatological and risk of slip perspective.
- Explore and investigate how integration into Volvo's software (map system) will be implemented.
- Continue to evaluate and develop the models

8. Participating Parties

Klimator AB

Volvo Group North America LLC

CampX North America

Volvo Technology Cooperation / CampX Sweden (coordinator).