



ILMATIETEEN LAITOS
METEOROLOGISKA INSTITUTET
FINNISH METEOROLOGICAL INSTITUTE

A statistical forecast model for road surface friction

Marjo Hippi marjo.hippi@fmi.fi

Ilkka Juga

Pertti Nurmi

Finnish Meteorological Institute

ROADIDEA

-S-I-R-W-E-C-



Winter in Finland

- **Snow and ice may exist on roads almost 6 months per year in Finland**
- **In north roads are covered by snow and ice most of the winter whereas in south roads are tried to keep clear of ice and snow always when possible**
- **Ice and snow reduce friction**
- **In case of low friction values risk of traffic incidents rise**



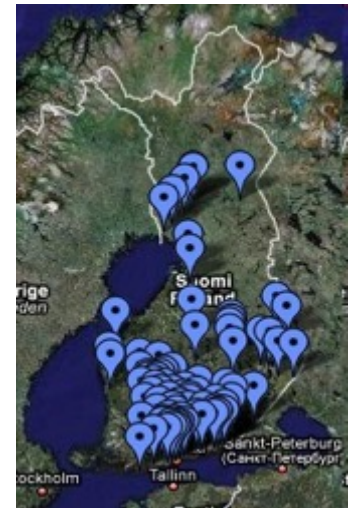


Friction model :: Background

- Friction means the grip between tires and road surface
- The amount of water/ice/snow on the surface as well as an estimation of friction can be measured by **Vaisala DSC111** sensor
- FMI has developed a **statistical friction model** based on observations made by DSC111 sensor
- The model is running for points installed with DSC111 sensor
- The friction model was developed to help road maintenance personnel and meteorologists
- Also, product for drivers in ROADIDEA pilot



Vaisala DSC111 sensor



Vaisala DSC111 sensors in Finland



Road weather classification

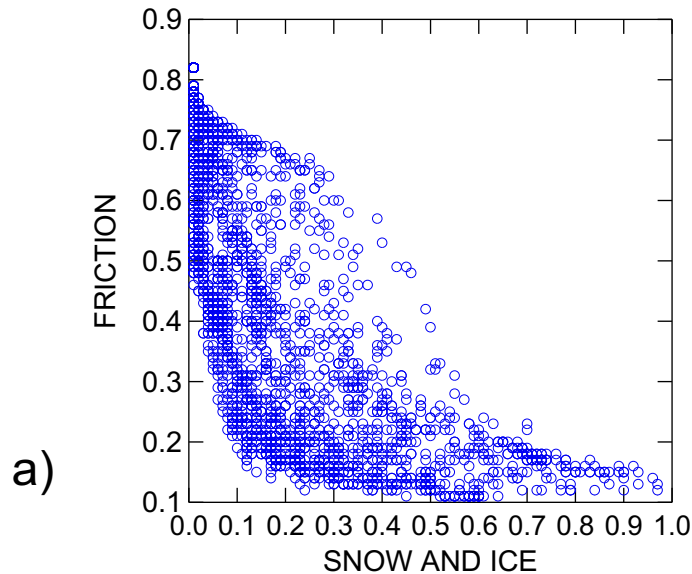
Friction	0,00 – 0,14	0,15 – 0,19	0,20 – 0,24	0,25 – 0,29	0,30 – 0,44	0,45 – 1,00
Description of the road surface	Wet ice	Icy	Packed snow	Rough ice/ packed snow	Clear and wet	Clear and dry
Slipperiness classification	Very slippery	Slippery	Fair winter condition	Good winter condition	Good road condition	Good road condition
Road weather index	Very bad road weather	Bad road weather			Normal road weather	

Classification by Finnish Road Administration

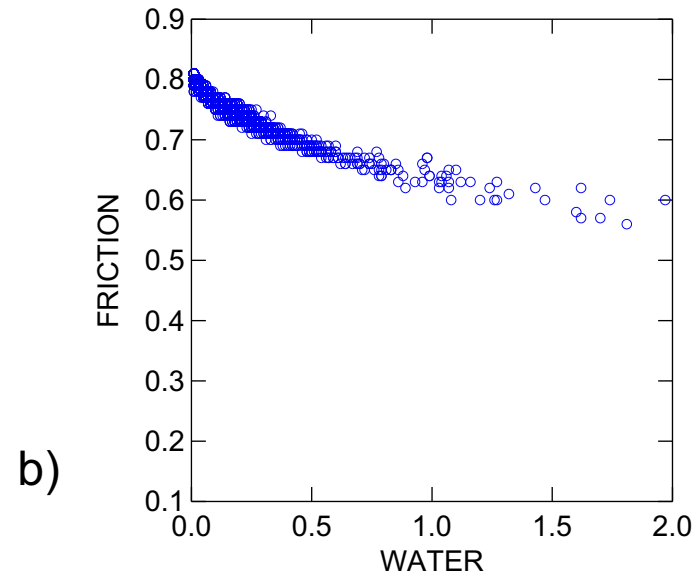


Observed friction vs. snow+ice and water on the surface

Anjala's observations winter 2007-2008



Observed friction with ice and/or snow on the surface (water content in mm)



Observed friction with water on the surface.



Developed friction model

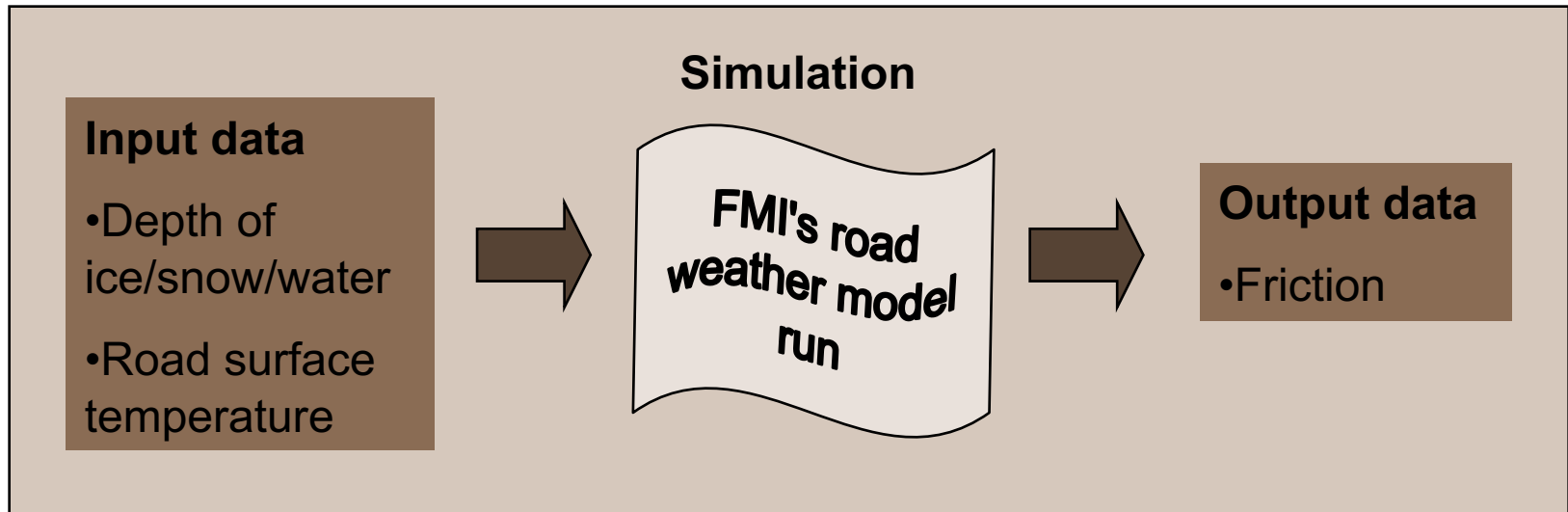
$$\text{Friction} = \begin{cases} A \times f(\text{Snow_mm} + \text{Ice_mm}) + B \times T_{\text{road}} + C & \Leftrightarrow \text{Snow_mm} + \text{Ice_mm} > 0 \\ D \times f \text{Water_mm} + E & \Leftrightarrow \text{Snow_mm} + \text{Ice_mm} = 0, \text{Water_mm} > 0 \\ 0.82 & \Leftrightarrow \text{Snow_mm} + \text{Ice_mm} = 0, \text{Water_mm} = 0 \end{cases}$$

- Own formulas for snowy/icy, wet/damp and dry situations
- Friction is a function of depth of snow/ice/water on the surface
- Small temperature dependency in case of snow/ice on the surface
- A - E are coefficients
- Minimum value for friction **0.10** and maximum **0.82**
- Used formulas were developed using Utti's data observed in winter 2007-2008
- Same formulas in use for all computation points



How does the friction model work?

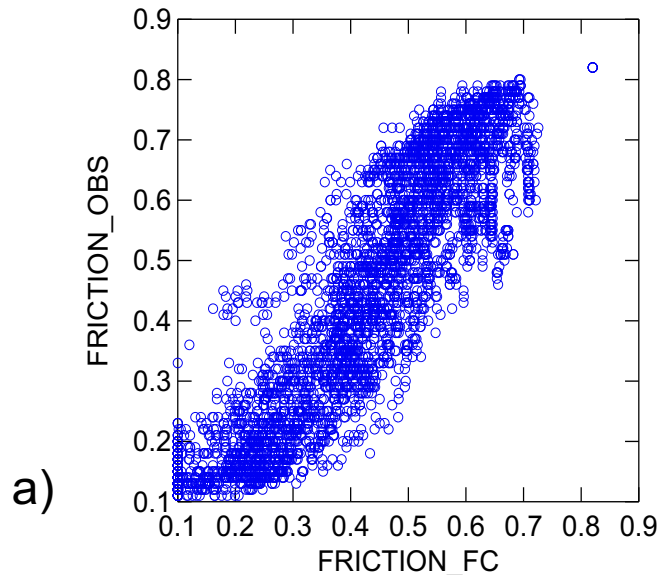
- All input data available on FMI's road weather model → Friction formulas included into FMI's road weather model
- Model takes into account weather parameters, precipitation, melting/freezing, evaporation/condensation, traffic wear, traffic heat, turbulence, ...
- Initialization is done by running the model with observations (48 hours)
- Forecasted values up to 48 hours



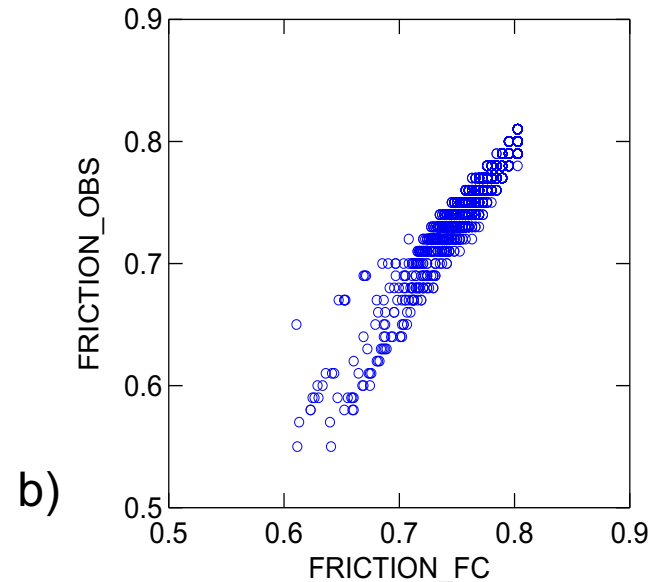


Simulated results :: modeled vs. observed

Simulations for Anjala's point using independent data 2008-2009



Observed (OBS) and modeled friction (FC) in case of icy and/or snowy roads. Correlation 0.89.

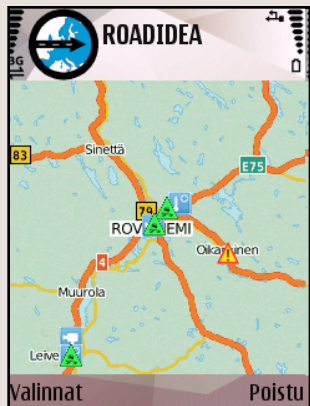
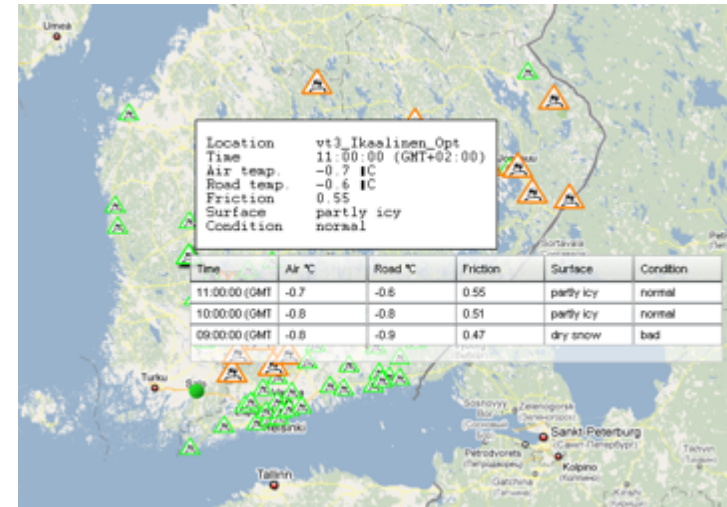


Observed (OBS) and modeled friction (FC) in case of water on the road. Correlation 0.97.



Implementation

- **Google.maps application presents 3 hour forecast of expected road weather**
 - Temperature
 - Friction
 - Road condition
- **Produced in collaboration with FMI, Destia and Demis**
- **<http://pilot.roadidea.eu/friction/>**

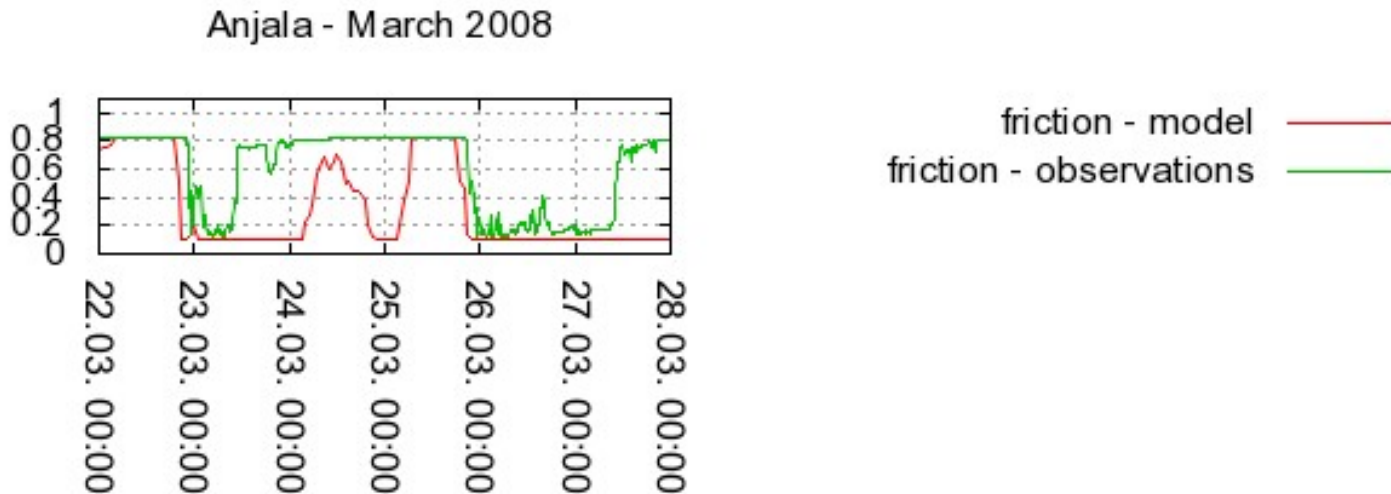


- **Also, a mobile phone application available**
- **Information of road weather (including friction), road weather pictures, warnings given by other users**
- **Produced in collaboration with FMI, Destia and Logica**



Results

- **Model simulates cases of poor friction very well, but...**
- **Friction model produces often too low values for friction too long time**
 - FMI's road weather model has too big storages for ice
 - The lack of road maintenance action
- **More discussion on validation in next presentation by P. Nurmi / FMI**





Problems

- **Finnish road weather model has usually too much ice (and frost) on the surface → too low values for friction**
 - Need to develop the wearing of ice in the model
 - Need to improve influence of traffic
- **Common problem in road weather forecasts: no information about road maintenance actions available**
 - Modeling presents situation if no maintenance actions have been done



Conclusions and future

- **Friction model is a new and innovative product**
- **Results are not as good as expected, but the problems are known**
- **Testing, evaluating and developing is an ongoing process**

- **Define station specific correlations at all computation points**

