

Freezing of Anti-Icing Solutions on Road Surfaces

AASHTO/TRB SCOM 2015, Des Moines, Iowa

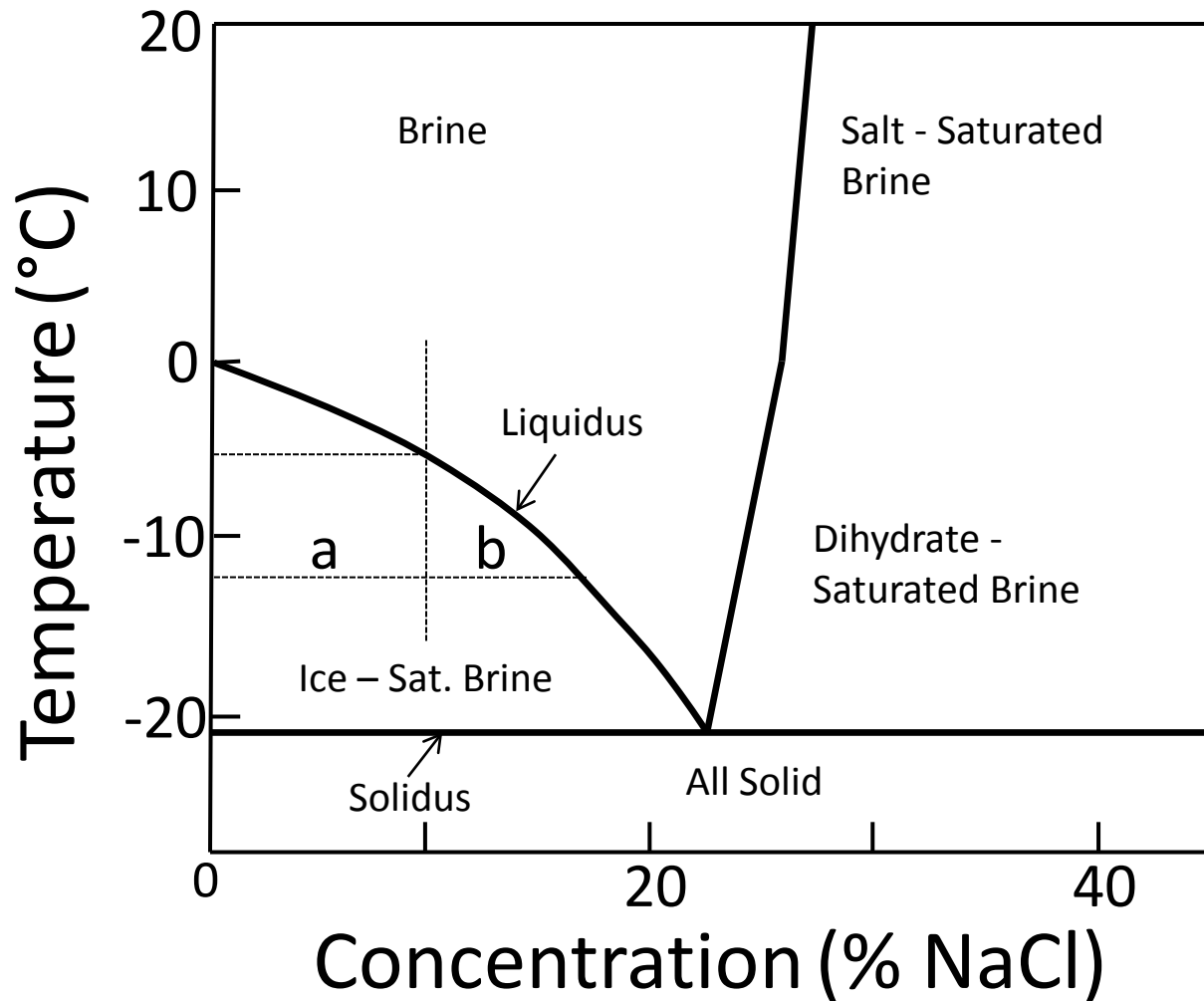
Taisto Haavasoja

name.surname@teconer.fi

Contents

- Freezing process
- Composite ice-brine mixture
- Consequences to winter maintenance
- Mobile measurements

Phase Diagram of NaCl



$$\text{Ice Fraction} = \frac{b}{a+b}$$

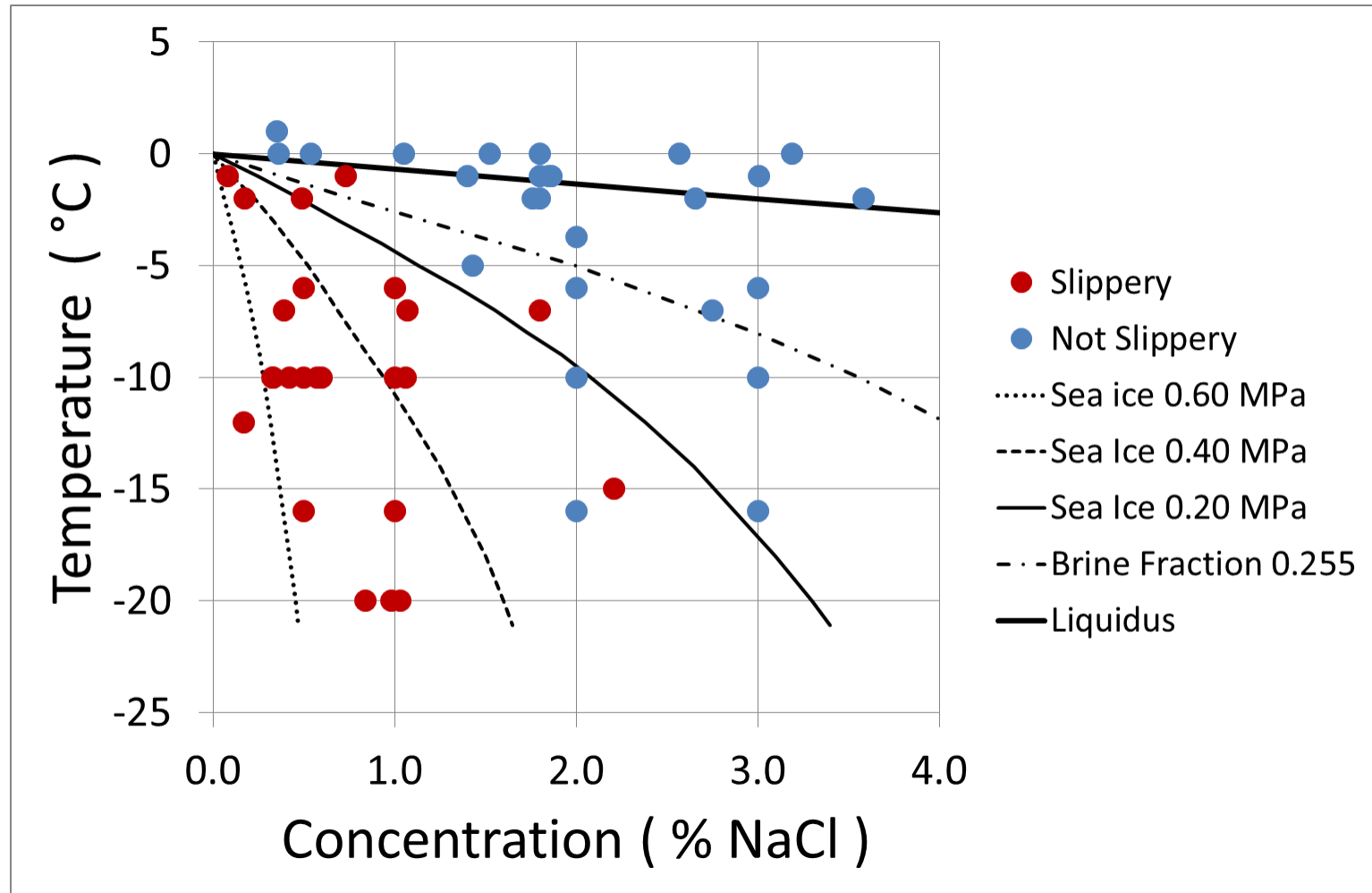
$$\text{Brine Fraction} = \frac{a}{a+b}$$

Research on Freezing Solutions

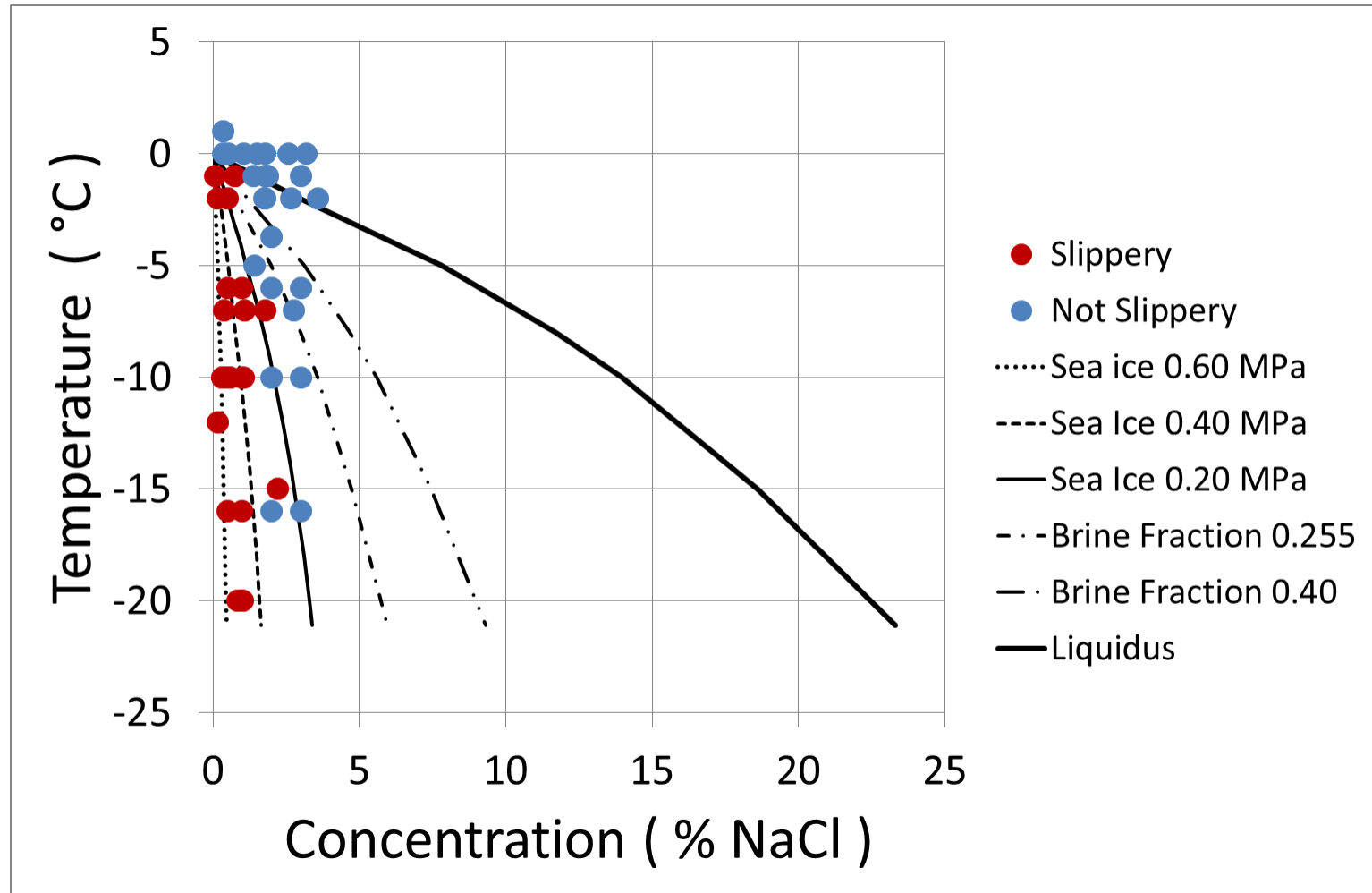
- T. Haavasoja, J. Nylander and P. Nylander, *Relation of Road Surface Friction and Salt Concentration*, SIRWEC 2012, Helsinki
 - adequate friction even with low brine fraction
 - pressure dependence of safe brine fraction

- A. Klein-Paste, J. Wåhlin, “*Wet pavement anti-icing — A physical mechanism*”, Cold Regions Science and Technology 96 (2013), pages 1–7
 - safe brine fraction is independent of salt type

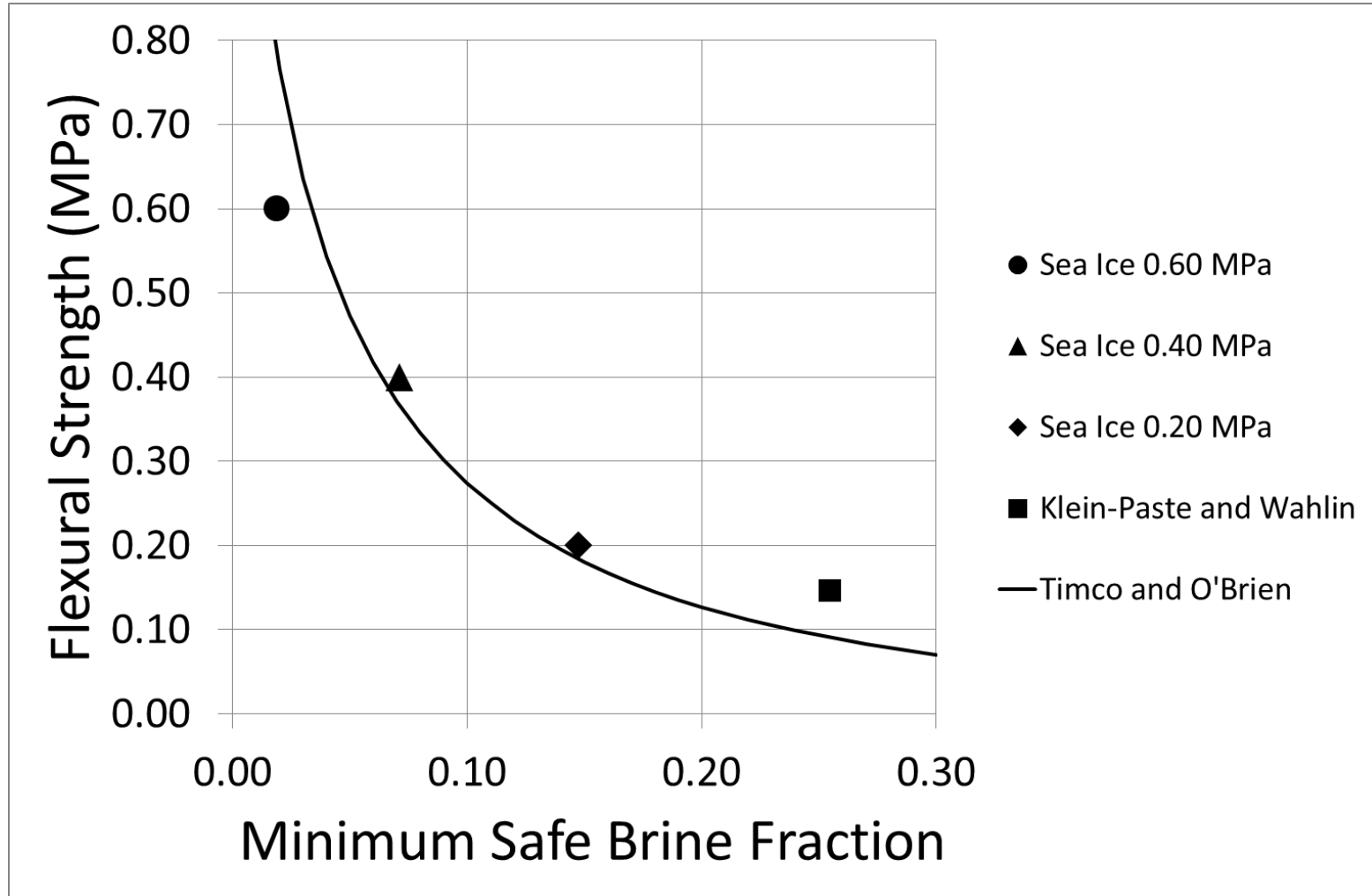
Salt Concentration and Slipperiness



Salt Concentration and Slipperiness



Minimum Safe Brine Fraction



Consequences to Winter Maintenance

1. Fairly low salt concentrations keep friction at tolerable levels, even at low temperatures

$$0.25 \text{ mm} * 1 \% = 2.5 \text{ g/m}^2 \text{ NaCl}$$

or

$$0.01'' * 1 \% = 30 \text{ lbs per lane mile}$$

Consequences to Winter Maintenance

2. Let surface partially freeze

- reduce liquid spray at low temperatures
- safety factor, clear windshield

Consequences to Winter Maintenance

3. Liquid anti-icers work well

- low brine fraction required – small amount of added water
- sticks well to the road surface, lasts longer, easy to spray evenly

Consequences to Winter Maintenance

4. Potential for **saving salt** and anti-icers

– measure

- friction
- water layer
- add weather forecast



- calculate required salt amount

– Mobile Winter Road Condition Monitoring

Road Condition Monitor

- road **surface condition**
 - dry,
 - moist,
 - wet,
 - icy,
 - snowy,
 - slushy
- water layer **thickness**
- modeled **friction**
- **surface temperature**

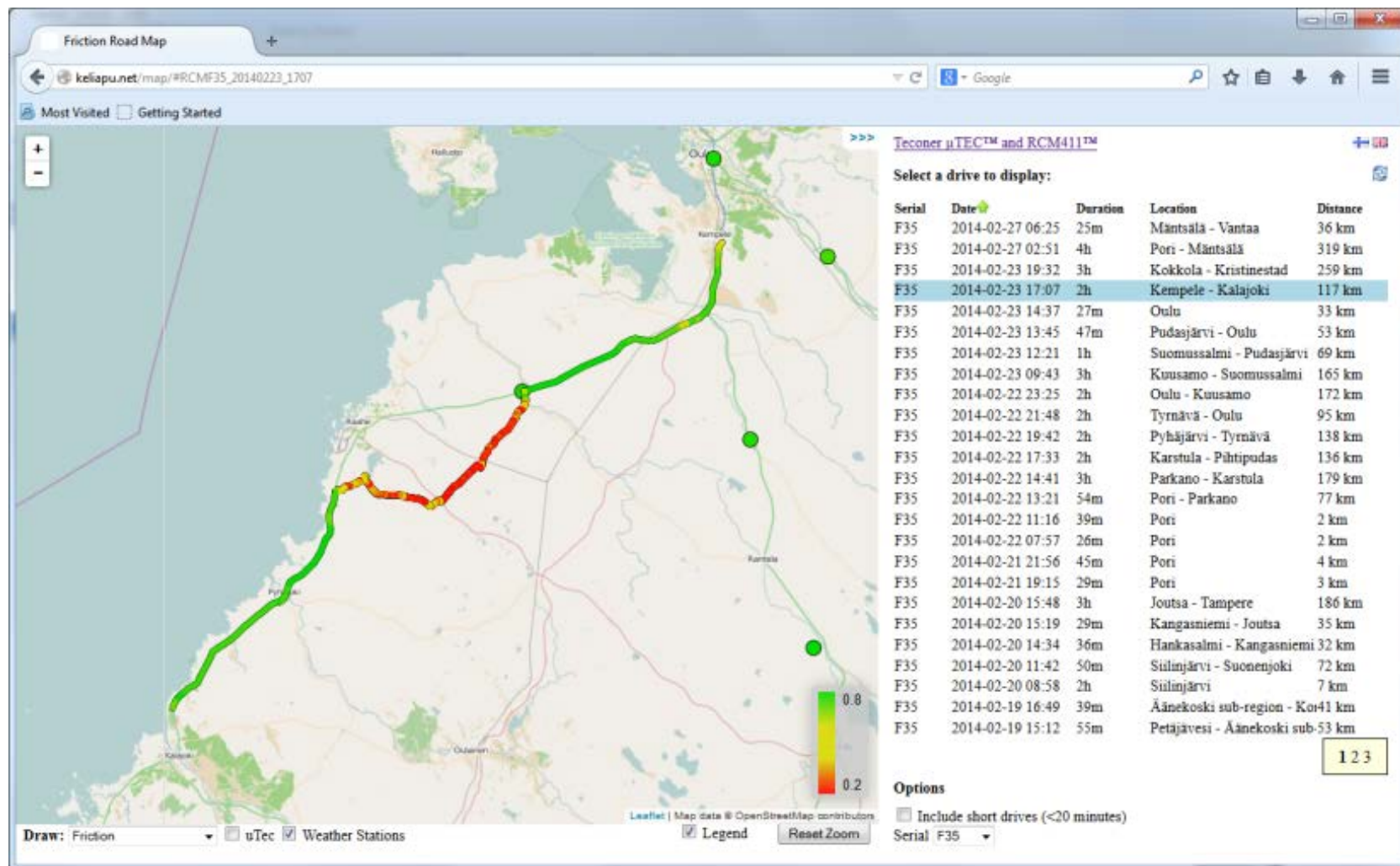


Road Condition Monitor

- user interfaces
 - cell phone application in the vehicle
 - [Mobile Road Condition Map](#) in the internet (AVL)



Map Interface for Friction ...



Summary ...

- Low brine fractions increase friction
 - partly frozen surfaces can be safe
 - save salt
- Mobile Road Condition Monitoring
 - measure friction, obtain brine fraction
 - optimize salt usage