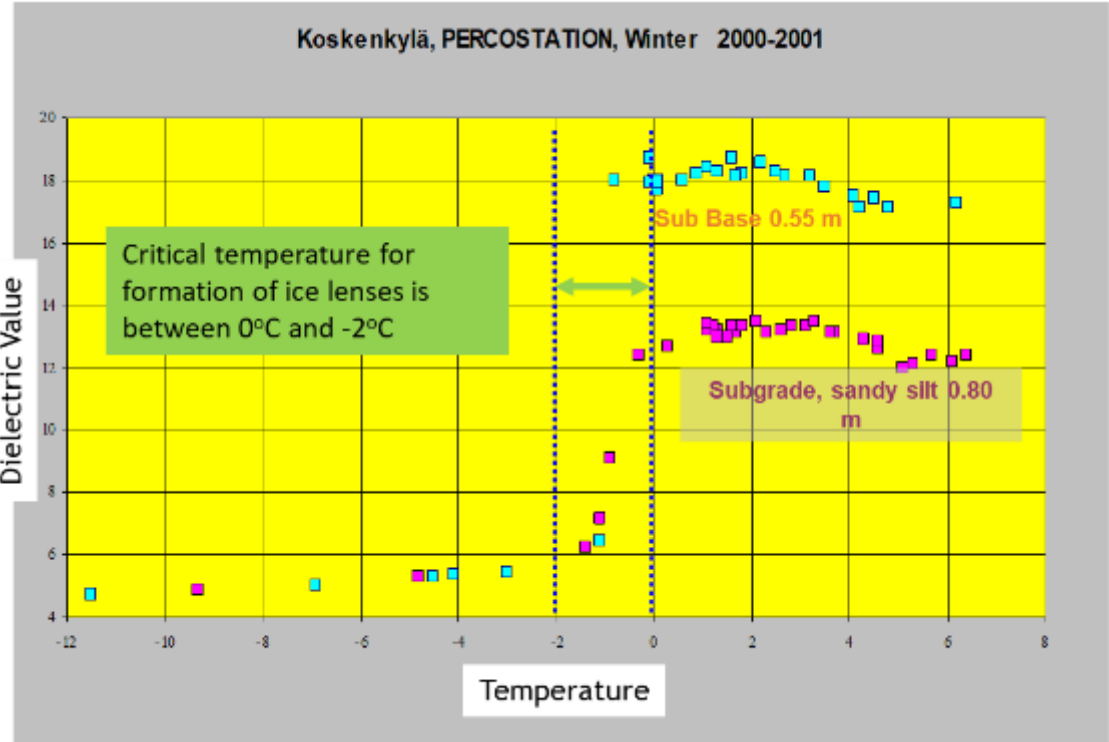


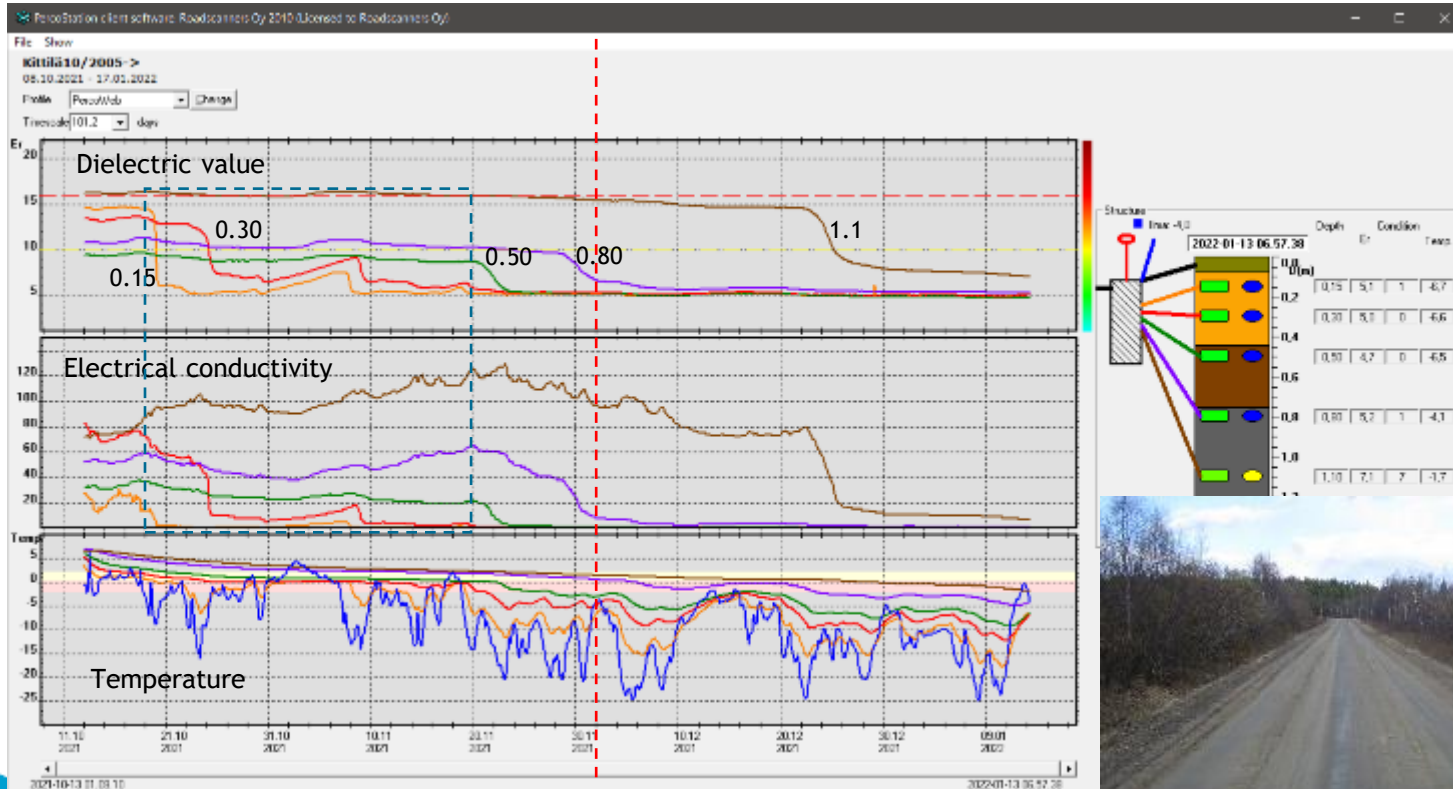
Measuring Frost and Frost Action on Roadways

Timo Saarenketo, PhD, Adj.Prof.
CEO, Roadscanners Group

Percostation for Frost Monitoring and Spring Thaw Weakening Monitoring Since 2000



Percostation Data Kittilä Finnish Lapland Fall 2021



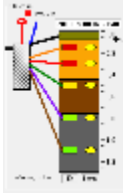
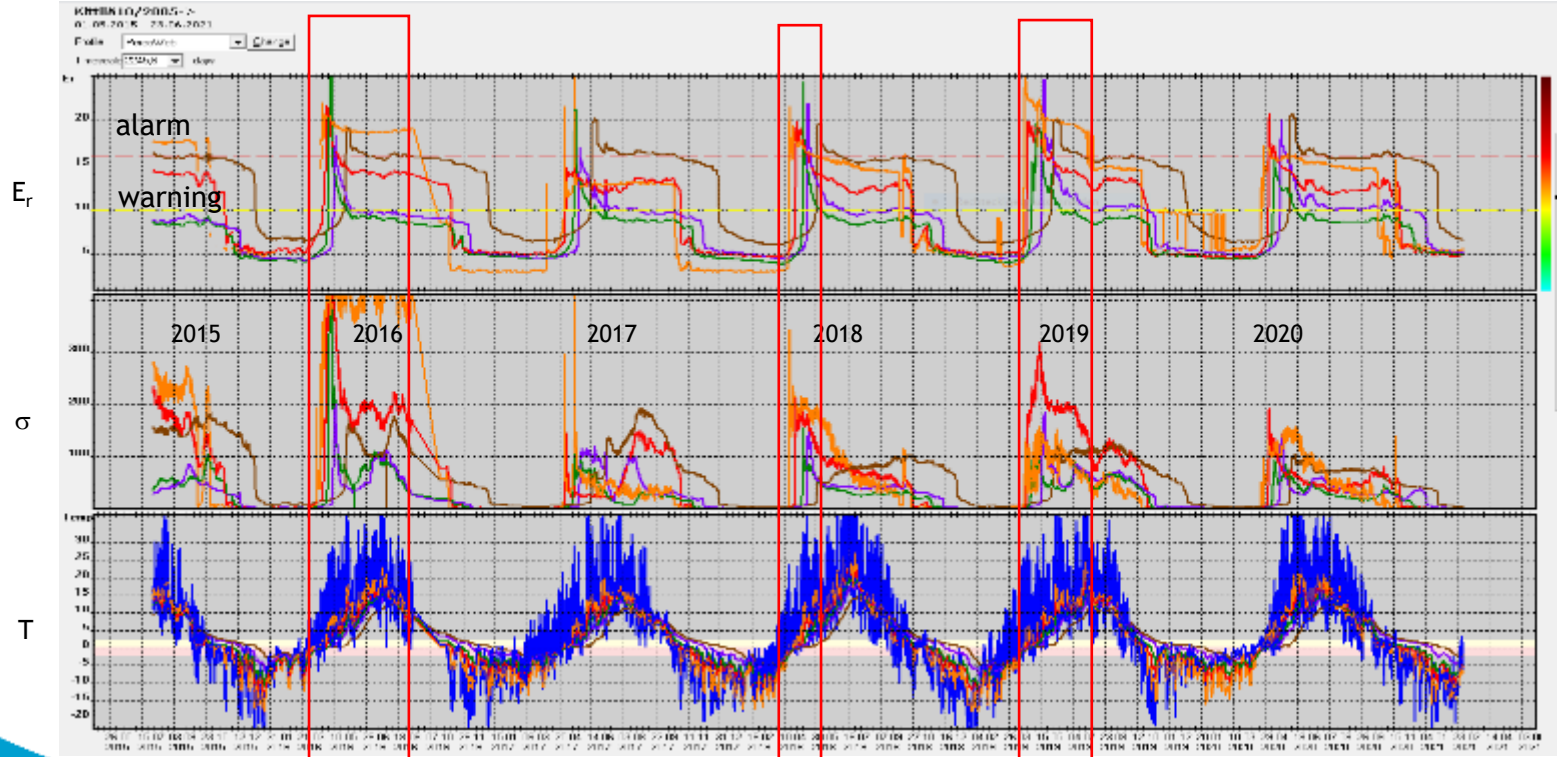
Percostation Data Kittilä Finnish Lapland Spring 2022

Gravel Road with Spring Thaw Weakening Problems



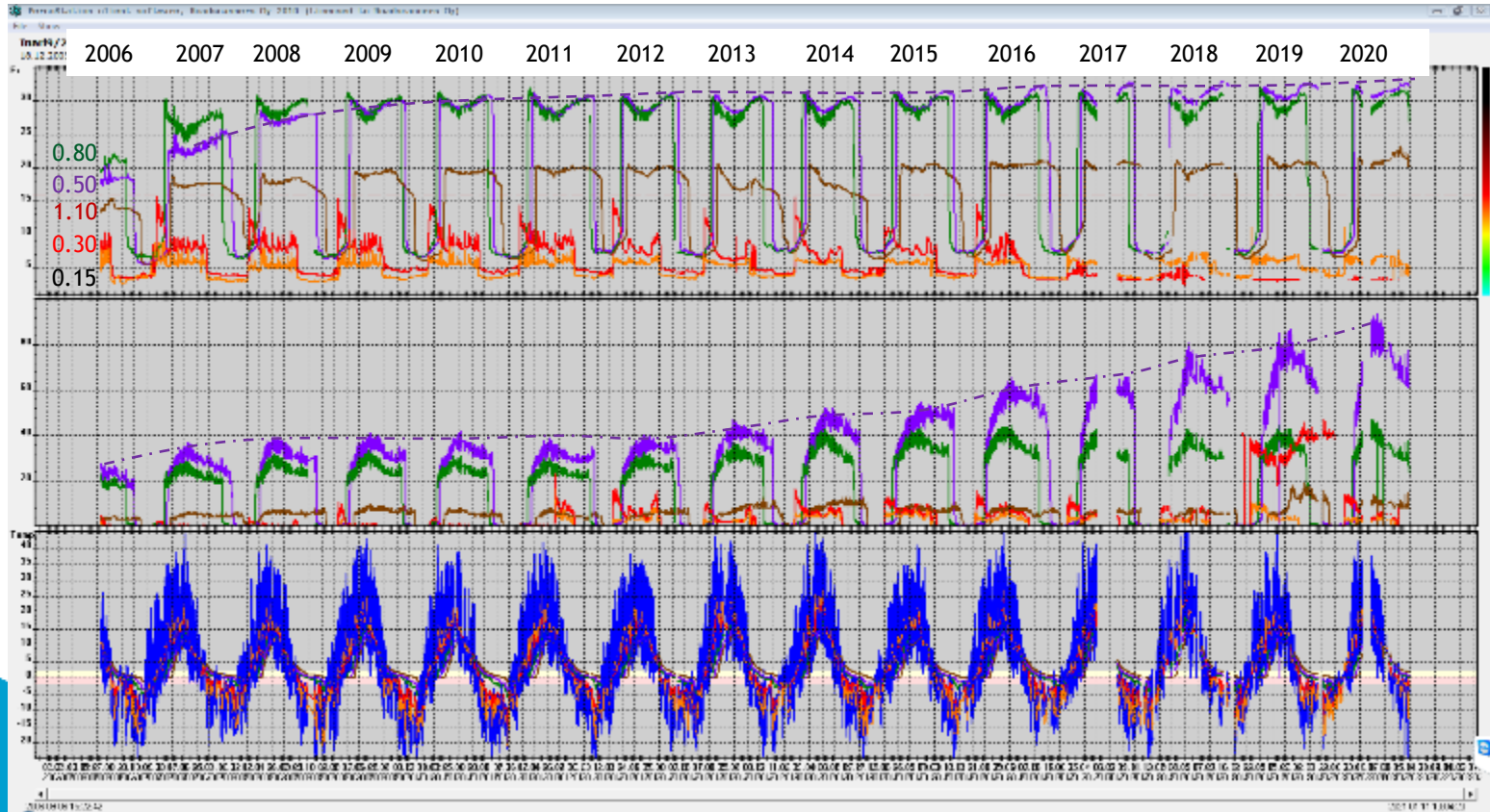
Percostation Data Kittilä Finnish Lapland 2015 - 2021

Gravel Road with Spring Thaw Weakening Problems



Percostation Data Inari Finnish Lapland 2006 - 2020

Paved Road on Weak Subgrade with Spring Thaw Weakening Problems

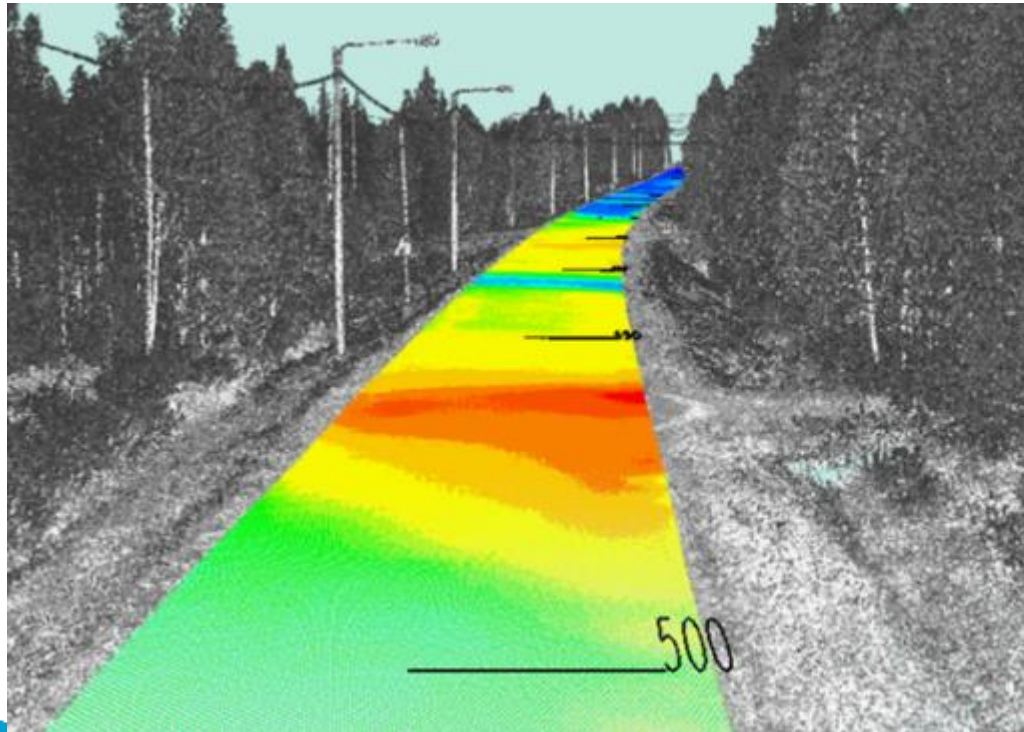


LASER SCANNER (LIDAR) TECHNIQUES IN DIFFERENTIAL FROST HEAVE SURVEYS

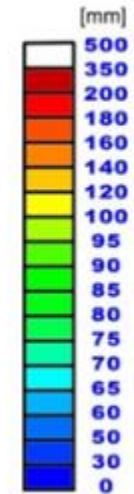


3d Mobile Mapper Based Frost Heave Diagnostics

Private Access Road Junction

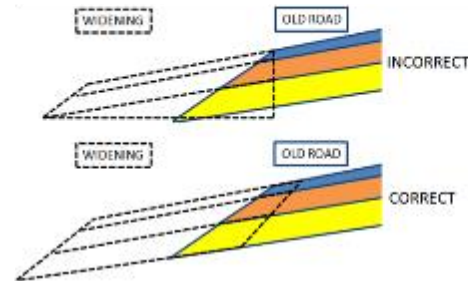
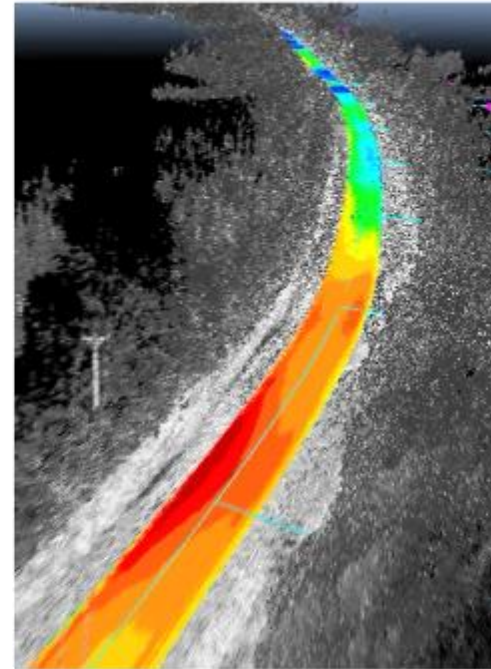
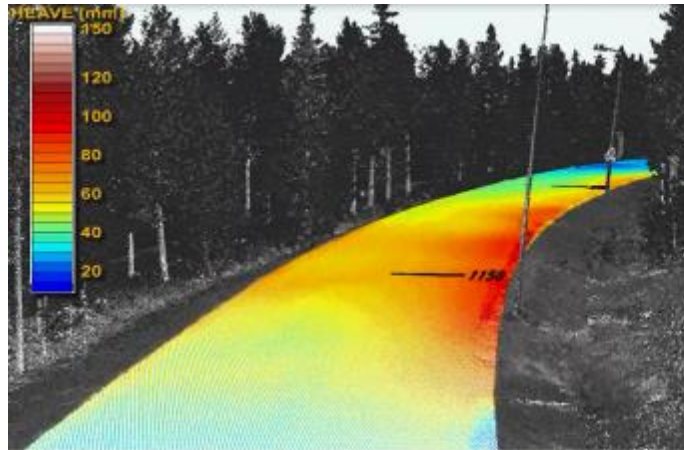


FROST HEAVE COLOR SCALE



3d Mobile Mapper Based Frost Heave Diagnostics

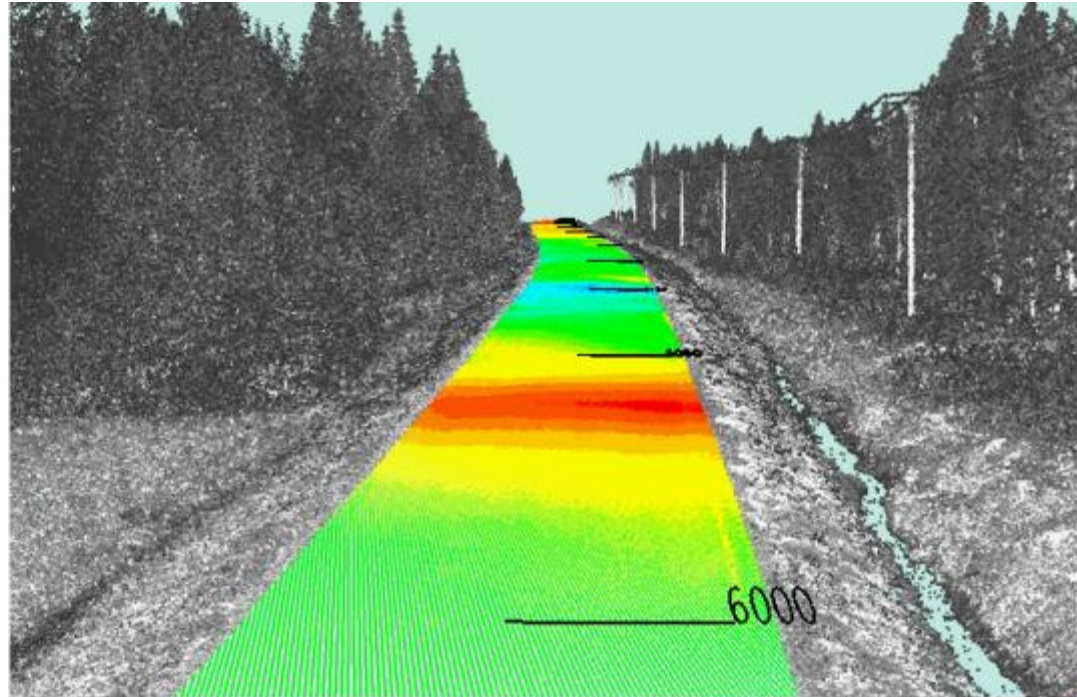
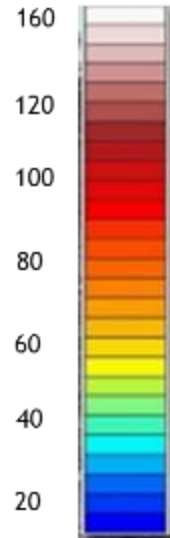
Frost Heave in Inner Curve



3d Mobile Mapper Based Frost Heave Diagnostics

Missing Transition Wedge Structure

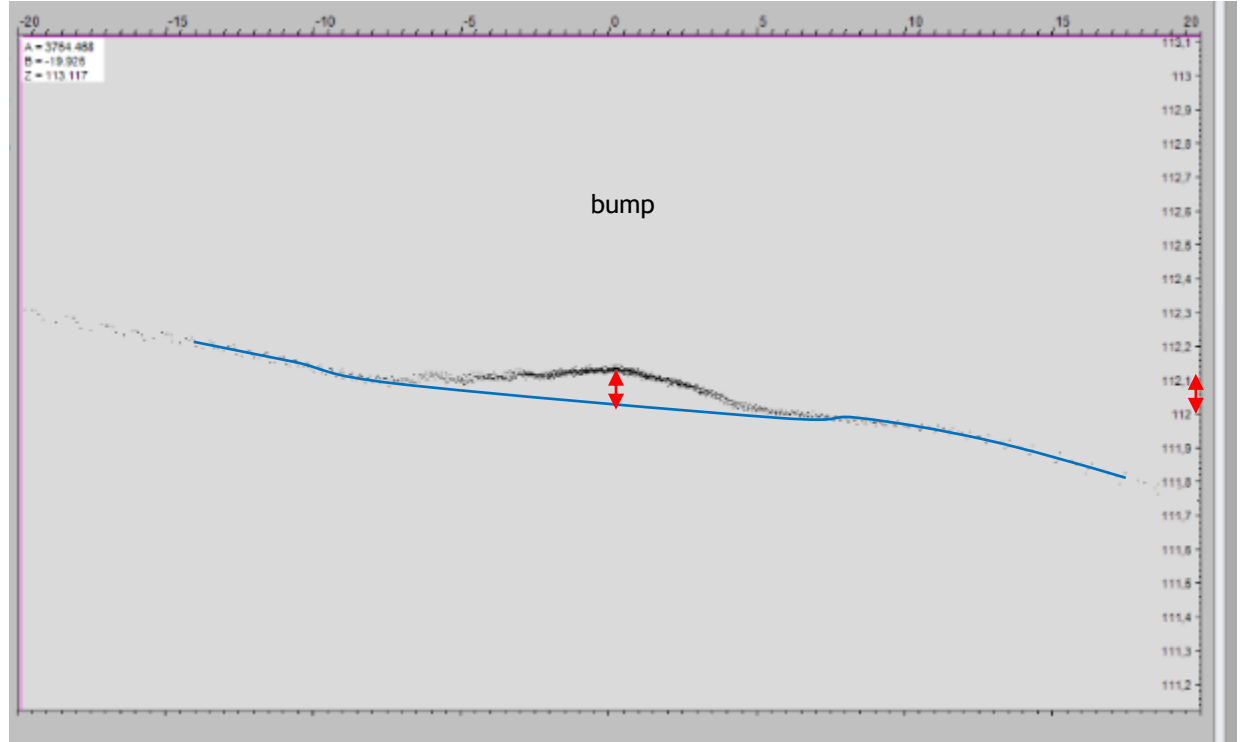
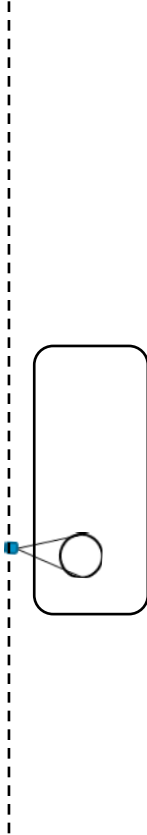
Frost heave
(mm)



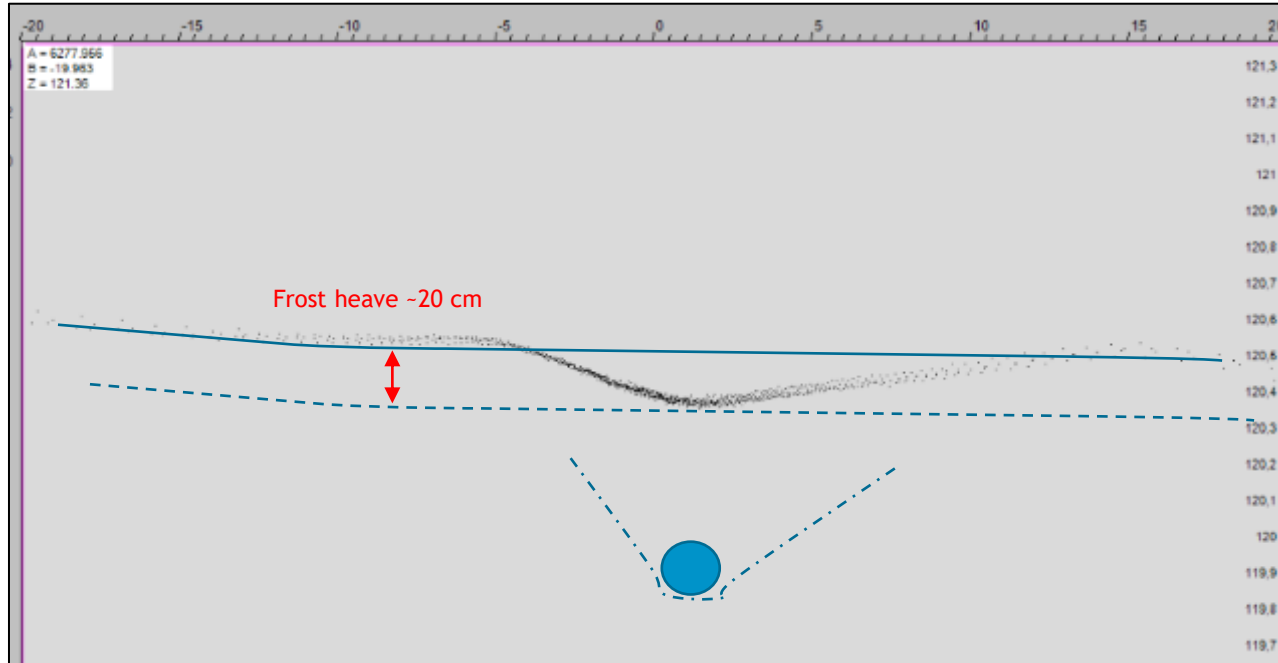
Monitoring Differential Frost Heave with RDSV Lidar



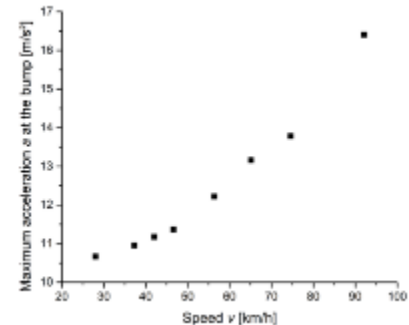
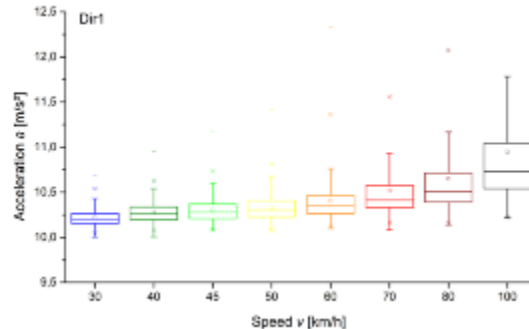
20 m



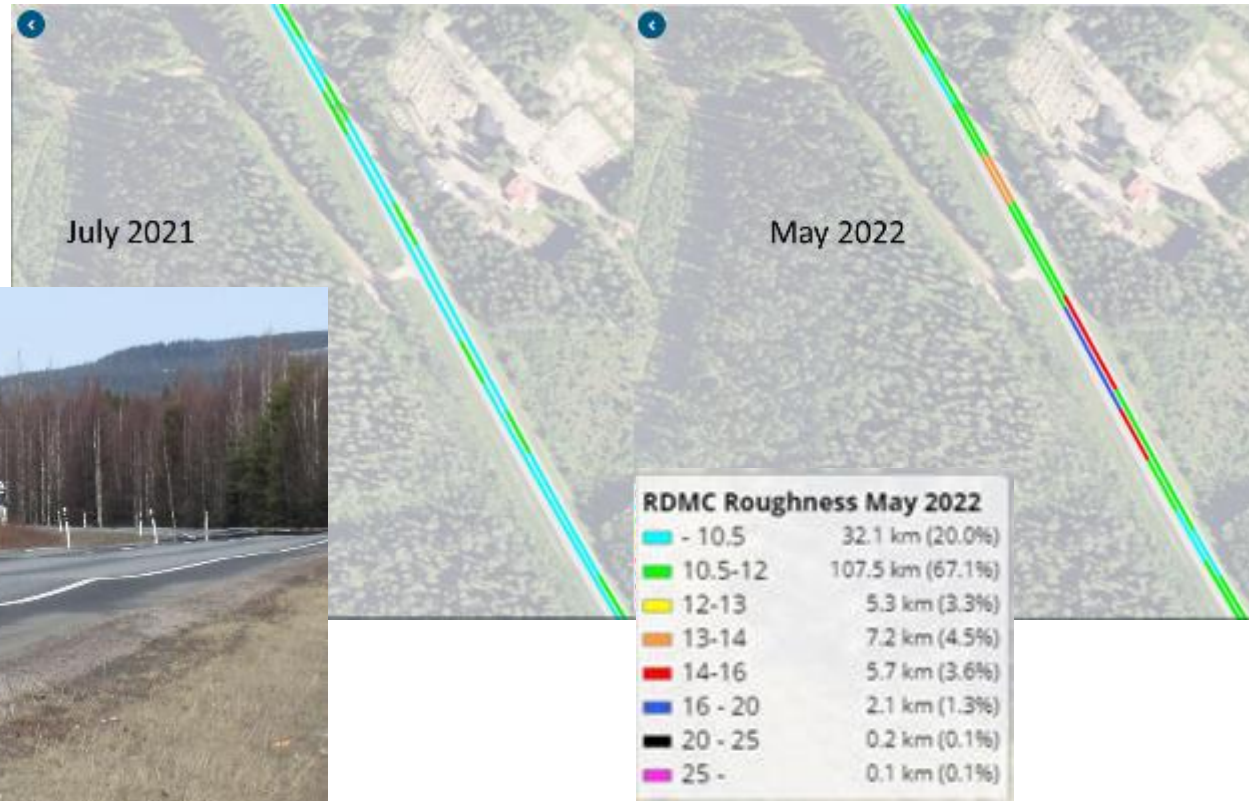
Monitoring Frost Heave with RDSV Lidar



RDMC TECHNIQUE IN REAL TIME MONITORING OF ROAD ROUGHNESS AND RUTTING



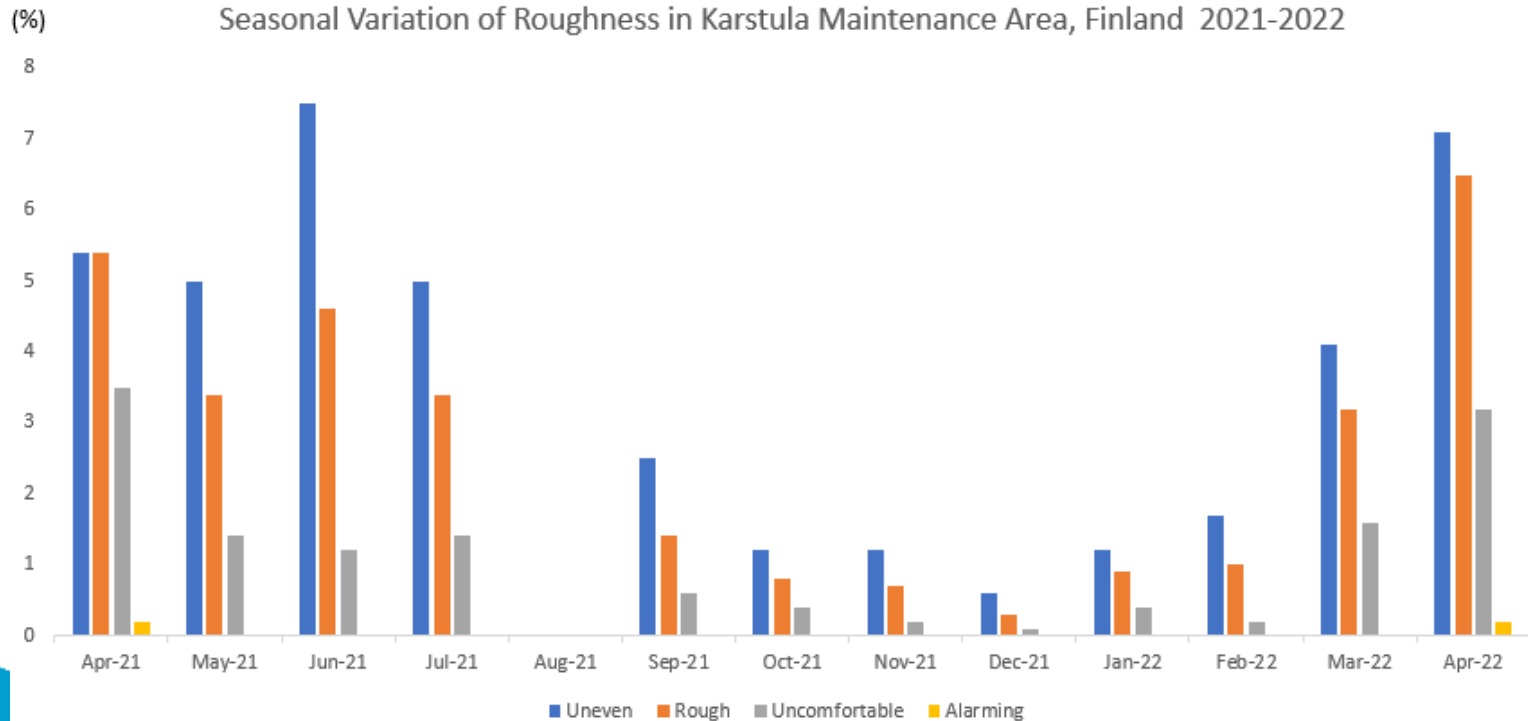
DETECTING DIFFERENTIAL FROST HEAVE SECTIONS WITH RDMC



Roughness Diagnostics – Presenting RDMC Data on Aerial Photos



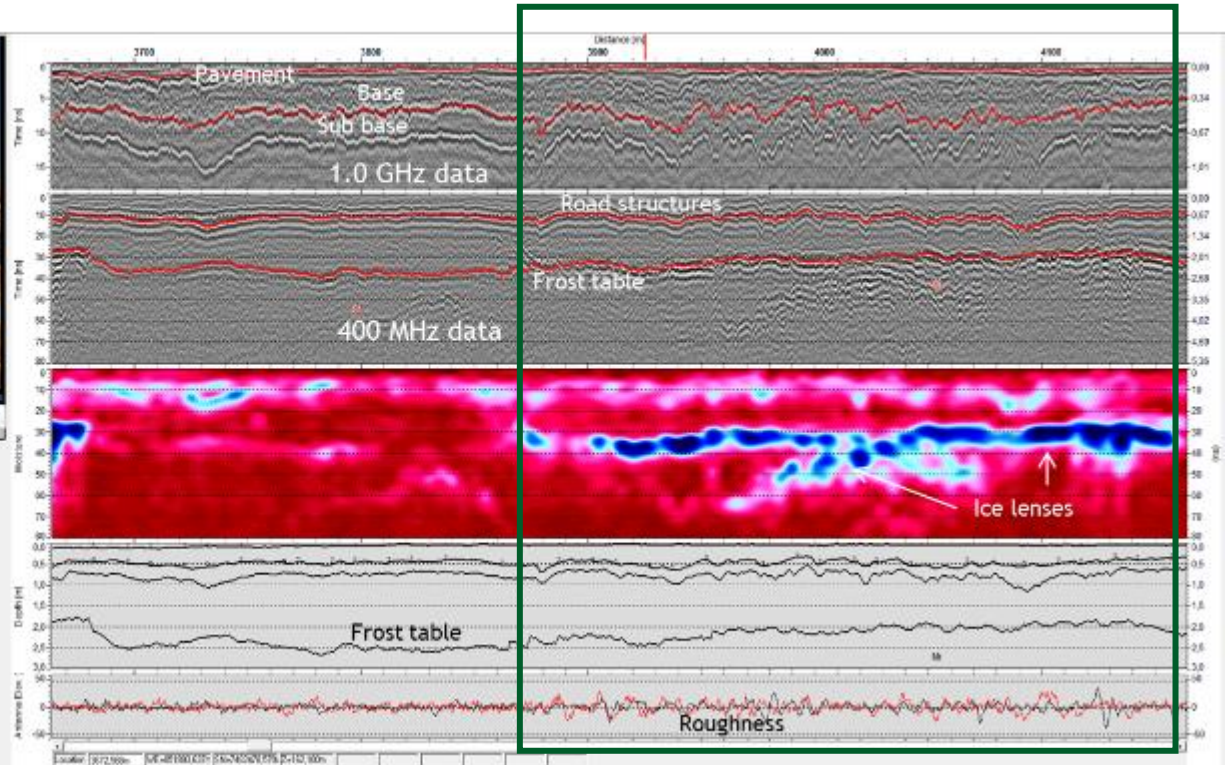
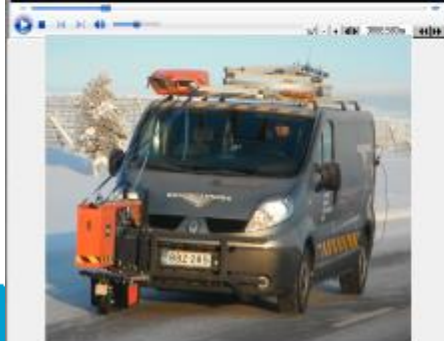
RDMC TECHNIQUE IN MONITORING SEASONAL VARIATIONS OF ROUGHNESS - KARSTULA MAINTENANCE AREA PAVED AND GRAVEL ROADS, FINLAND



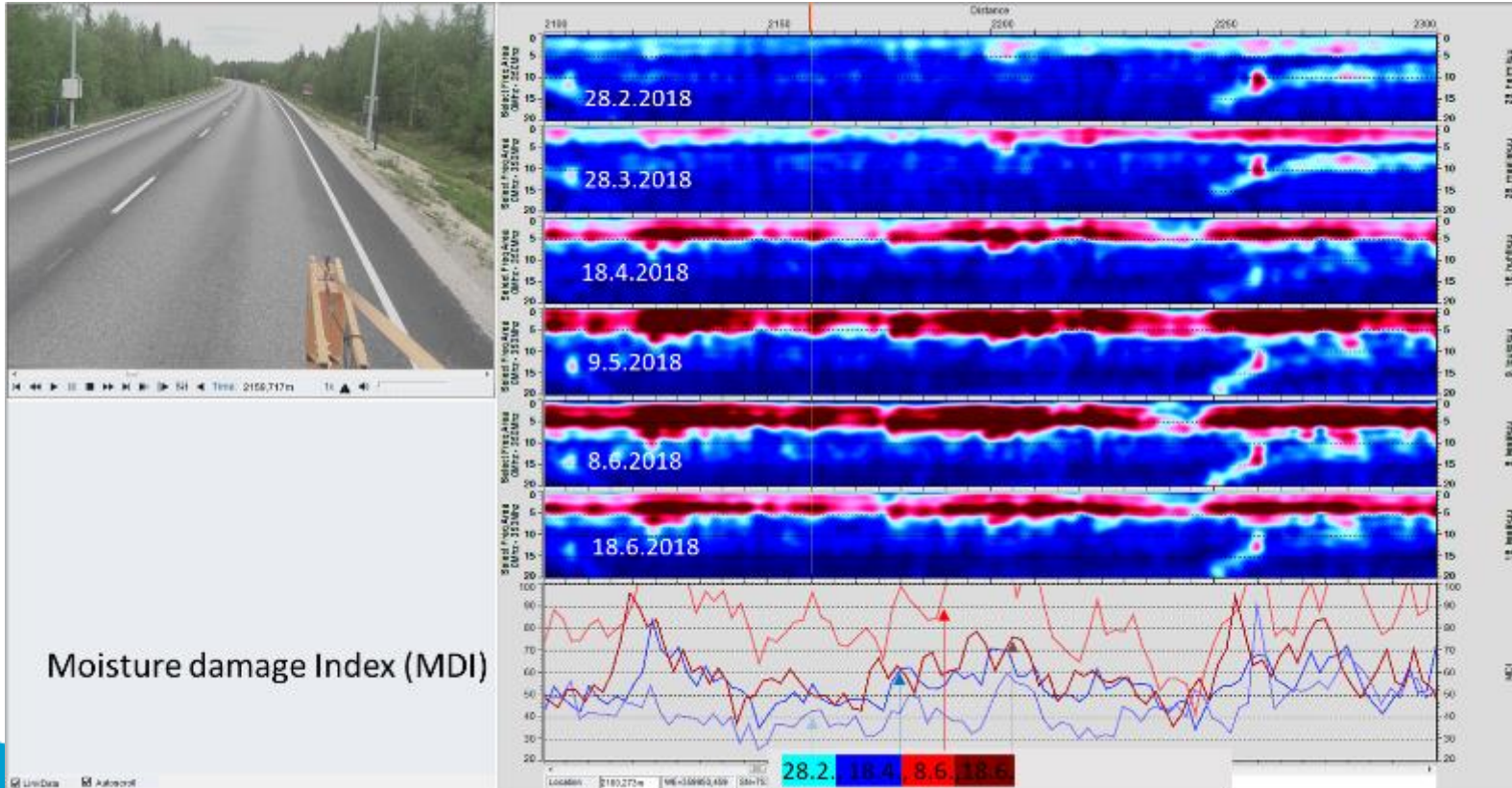
GPR Based Frost Diagnostic - Pajala Svappavaara Mine Road, Sweden



Detection of unfrozen water (ice lenses) in frozen ground



Moisture Damage Index Calculated from 400MHz GPR Data in Spring 2018 - Aurora test site, Finland



THANK YOU



BEYOND
THE
SURFACE