



Can MDSS systems really work? Km by km forecasting improving winter maintenance efficiency in the Czech Republic

Ing. Tomas Pospisek

Head of Sales

CROSS Zlín, a.s.

pospisek@cross.cz

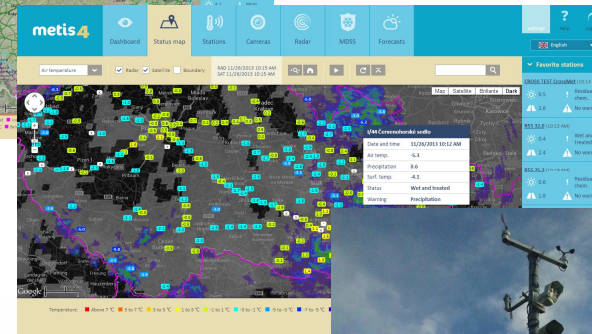
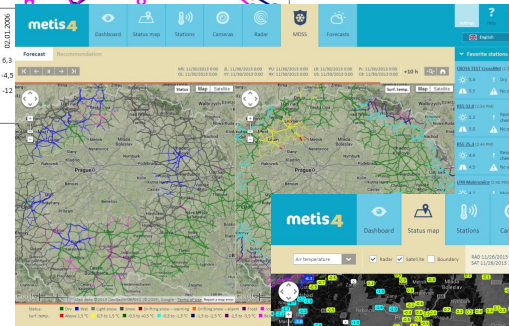
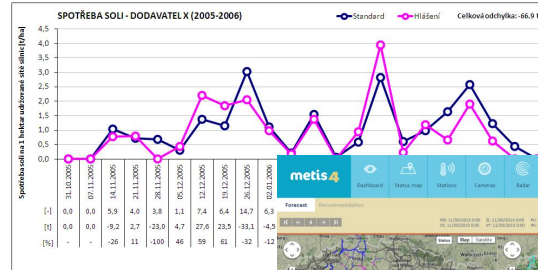
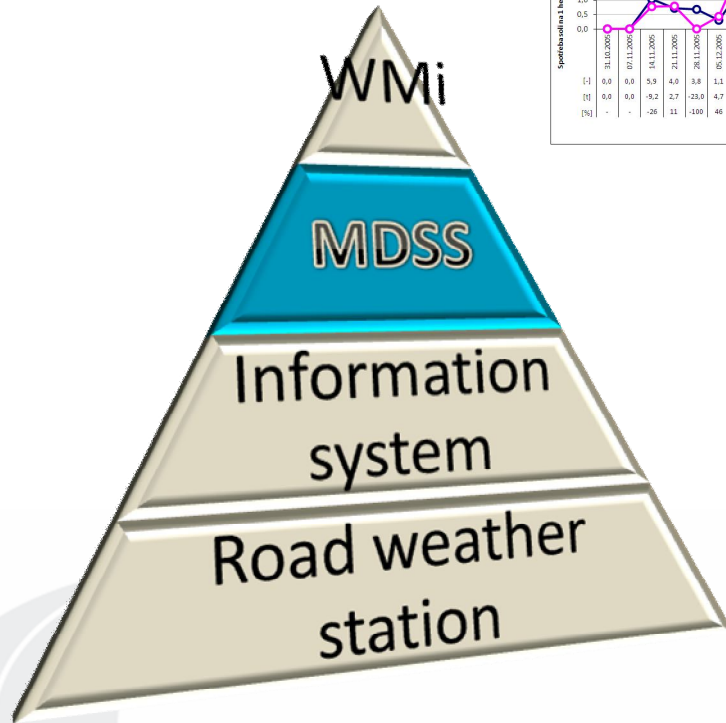
CROSS



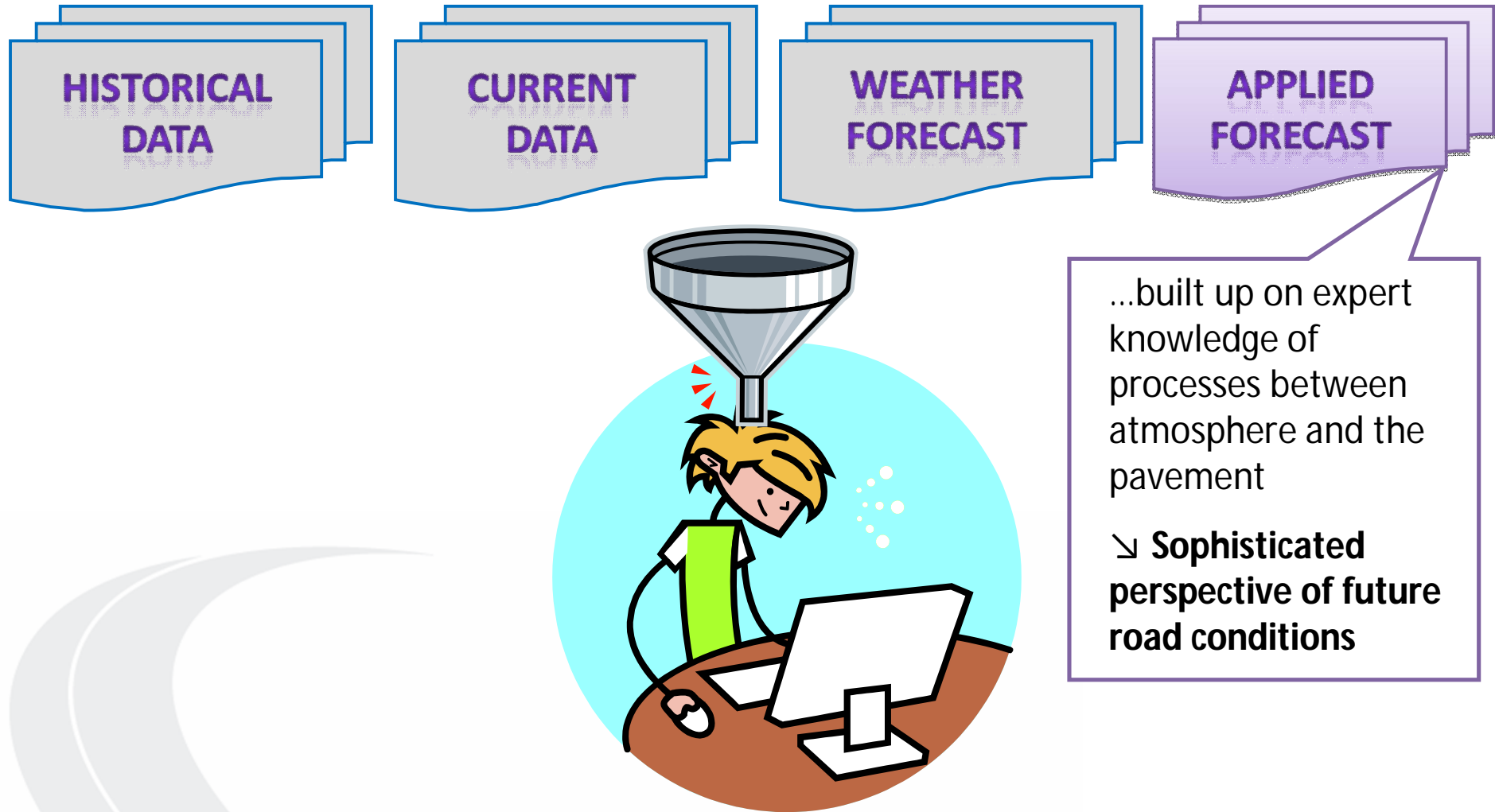
CONTENT

- 1. Introduction**
- 2. Preparation of maintenance decision support system**
- 3. Case study of MDSS weather forecast**
- 4. Methods and results of the forecast accuracy evaluation**
- 5. Conclusion**

1. INTRODUCTION



1. INTRODUCTION



1. INTRODUCTION

- Complex **road weather forecasting** system
- Precise short-term local forecast of **road slipperiness**
- Synthesized and clear graphic information so the decision-making is truly simplified



TO
SUPPORT
THE RIGHT
DECISIONS

TO
INCREASE
SAFETY ON
THE ROADS

TO
SUPPORT
MATERIAL
SAVINGS

2. PREPARATION OF MAINTENANCE DECISION SUPPORT SYSTEM

Local geodatabase

Thermal mapping

Geographical info

Expert information

Traffic flow data

Road construction

Online package

Weather prediction model

Weather stations

Maintenance data

Floating Car Data

Traffic flow data

metis4

Dashboard

Status map

Stations

Cameras

Radar

MDSS

Forecasts

Settings

Help

Logout

English

Forecast

Recommendation

Decision diagram

MS: 1/17/2014 19:00

ZL: 1/17/2014 19:00

PU: 1/17/2014 19:00

LB: 1/17/2014 19:00

PL: 1/17/2014 19:00

OL: 1/17/2014 19:00

VY: 1/17/2014 19:00

HK: 1/17/2014 19:00

US: 1/17/2014 19:00

CB: 1/17/2014 19:00

+8 h

1/17 Podhořany (12:12 PM)

☀️ 2.9 ! Wet and treated

☁️ 4.8 ! No warning

1/69 Sírákov (12:13 PM)

☀️ 4.1 ! Dry

☁️ 5.2 ! No warning

1/49 Pozděchov (12:08 PM)

☀️ 4.6 ! Dry

☁️ 5.8 ! No warning

1/49 Malenovice (12:13 PM)

☀️ 6.4 ! Dry

☁️ 7.0 ! No warning

1/358 Zhoř (12:08 PM)

☀️ 1.9 ! Dry

☁️ 3.6 ! No warning

R55 32,0 (12:08 PM)

☀️ 6.0 ! Dry

☁️ 7.9 ! No warning

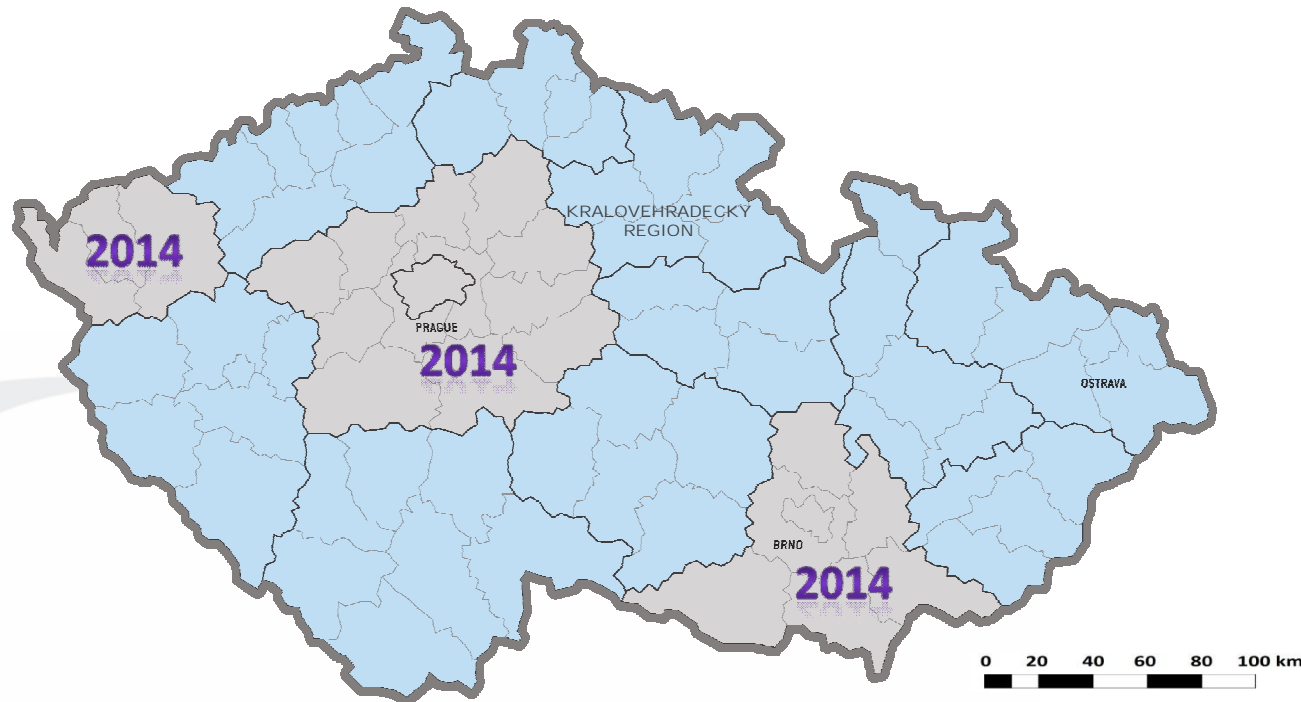
Status: ■ Dry ■ Wet ■ Light snow ■ Snow ■ Drifting snow – warning ■ Drifting snow – alarm ■ Frost ■ Ice ■ Error

Surf. temp.: ■ Above 1,5 °C ■ 0,5 to 1,5 °C ■ -0,5 to +0,5 °C ■ -0,5 to -1,5 °C ■ -1,5 to -2,5 °C ■ -2,5 to -3,5 °C ■ Below -3,5 °C ■ Error

Copyright © 2013 CROSS Zlin, a.s. | Technical support: support@cross.cz, +420 725 452 255 | Online: 80

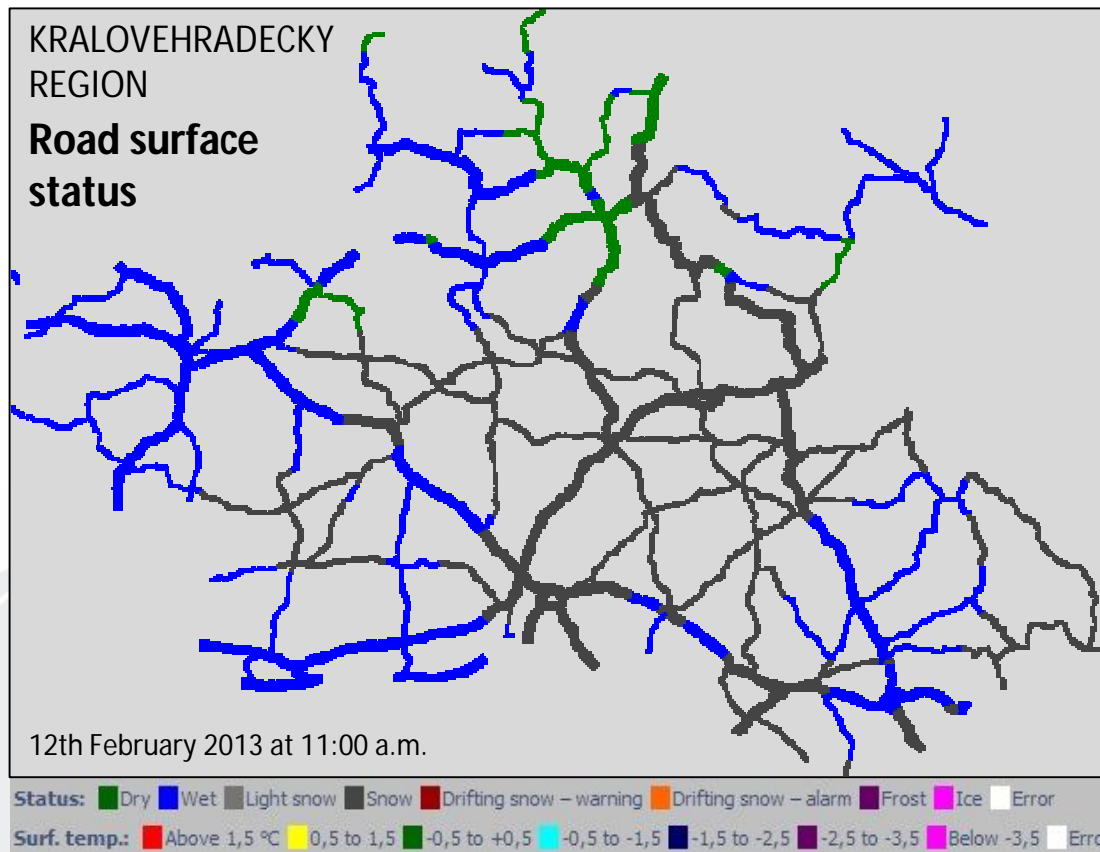
3. CASE STUDY OF MDSS WEATHER FORECAST

- **10 regions** use MDSS since **2007–2013**
- **15 300 km roads = 15 300 segments** of motorways, expressways, Ist class and IInd class roads



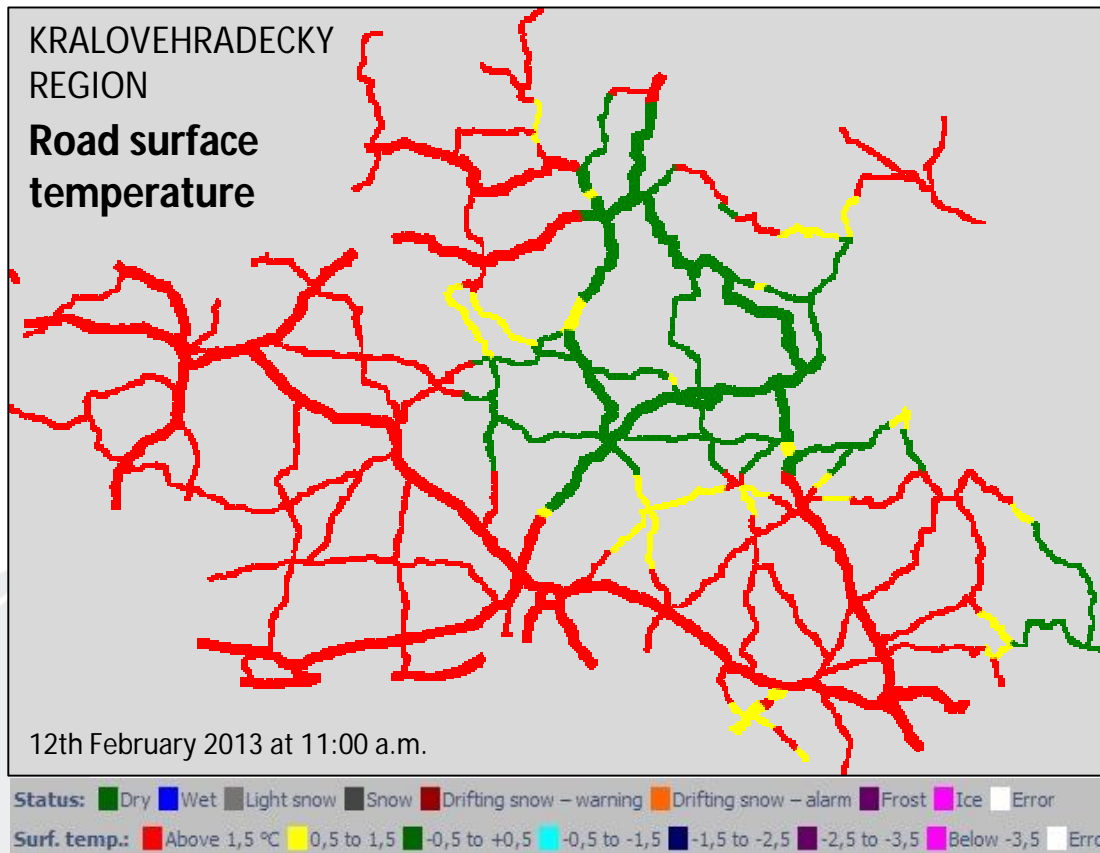
3. CASE STUDY OF MDSS WEATHER FORECAST

Forecast issued on 12th February 2013 at 01:00 a.m. +10 hours, i.e. on 12th February 2013 at 11:00 a.m.



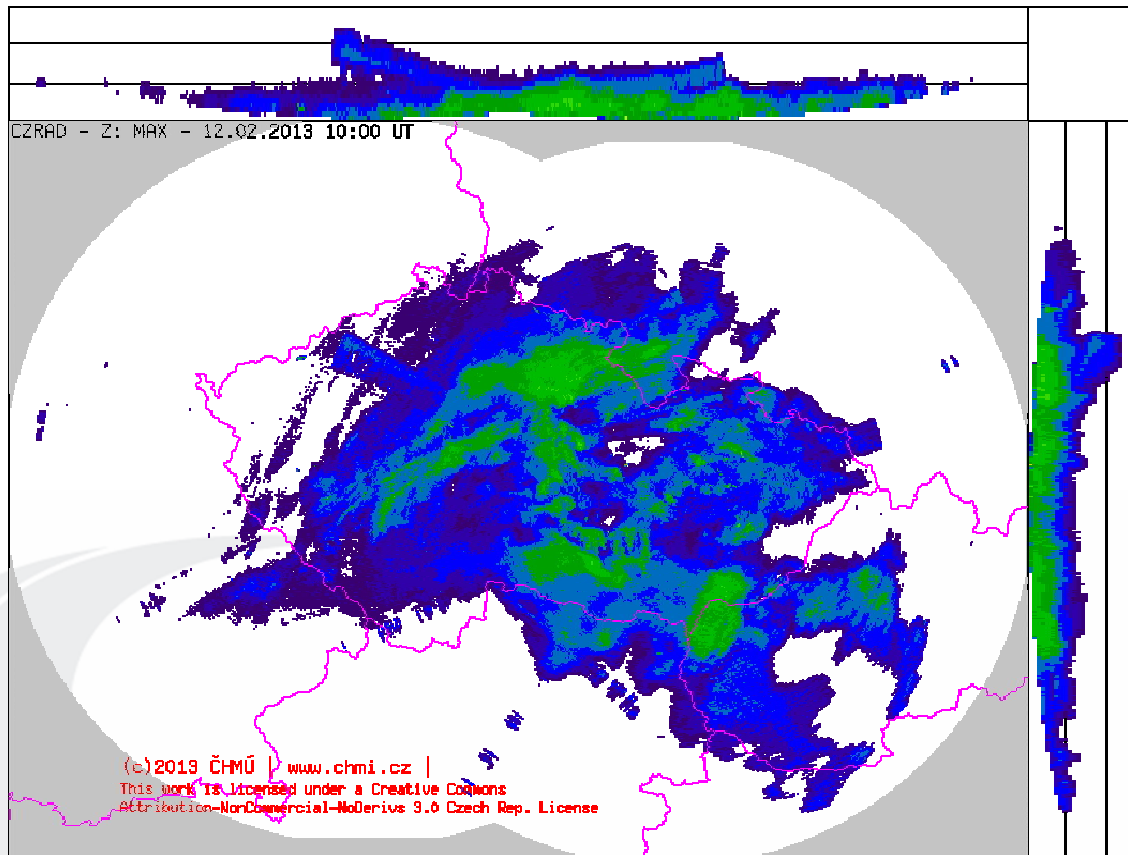
3. CASE STUDY OF MDSS WEATHER FORECAST

Forecast issued on 12th February 2013 at 01:00 a.m. +10 hours, i.e. on 12th February 2013 at 11:00 a.m.



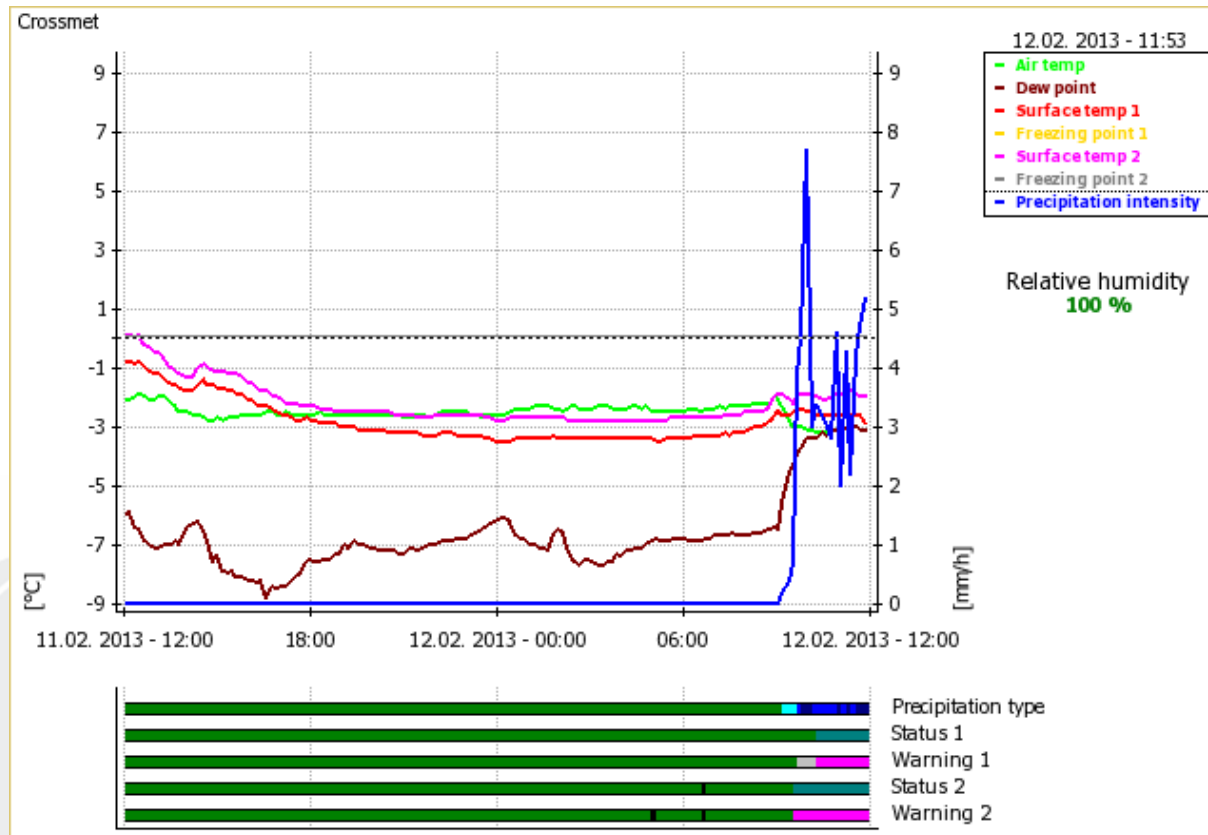
3. CASE STUDY OF MDSS WEATHER FORECAST

Radar picture of the Czech Republic in time 10:00 a.m. UTC



3. CASE STUDY OF MDSS WEATHER FORECAST

Line graph of the I/16 Vestrev road weather station



3. CASE STUDY OF MDSS WEATHER FORECAST

Overview camera pictures



4. METHODS AND RESULTS OF THE FORECAST ACCURACY EVALUATION

- Analysis of the forecast accuracy of road surface status
 - Comparing the **predicted** and **later measured** road surface status, respectively station warning >>>

the error index

Status	DR	TR	MO	WE	WT	SN	PF	FR	IC	ER
Dry	2347	0	1743	29	0	0	56	0	0	3510
Wet	145	0	1682	119	0	0	41	0	0	828
DriftLow	0	0	0	0	0	0	0	0	0	0
DriftHigh	0	0	0	0	0	0	0	0	0	0
Snow	0	0	20	2	0	0	23	0	0	232
Slipp	25	0	63	3	0	0	30	0	0	349
Hazard	87	0	82	0	0	0	12	0	0	224
ER	0	0	0	0	0	0	0	0	0	36

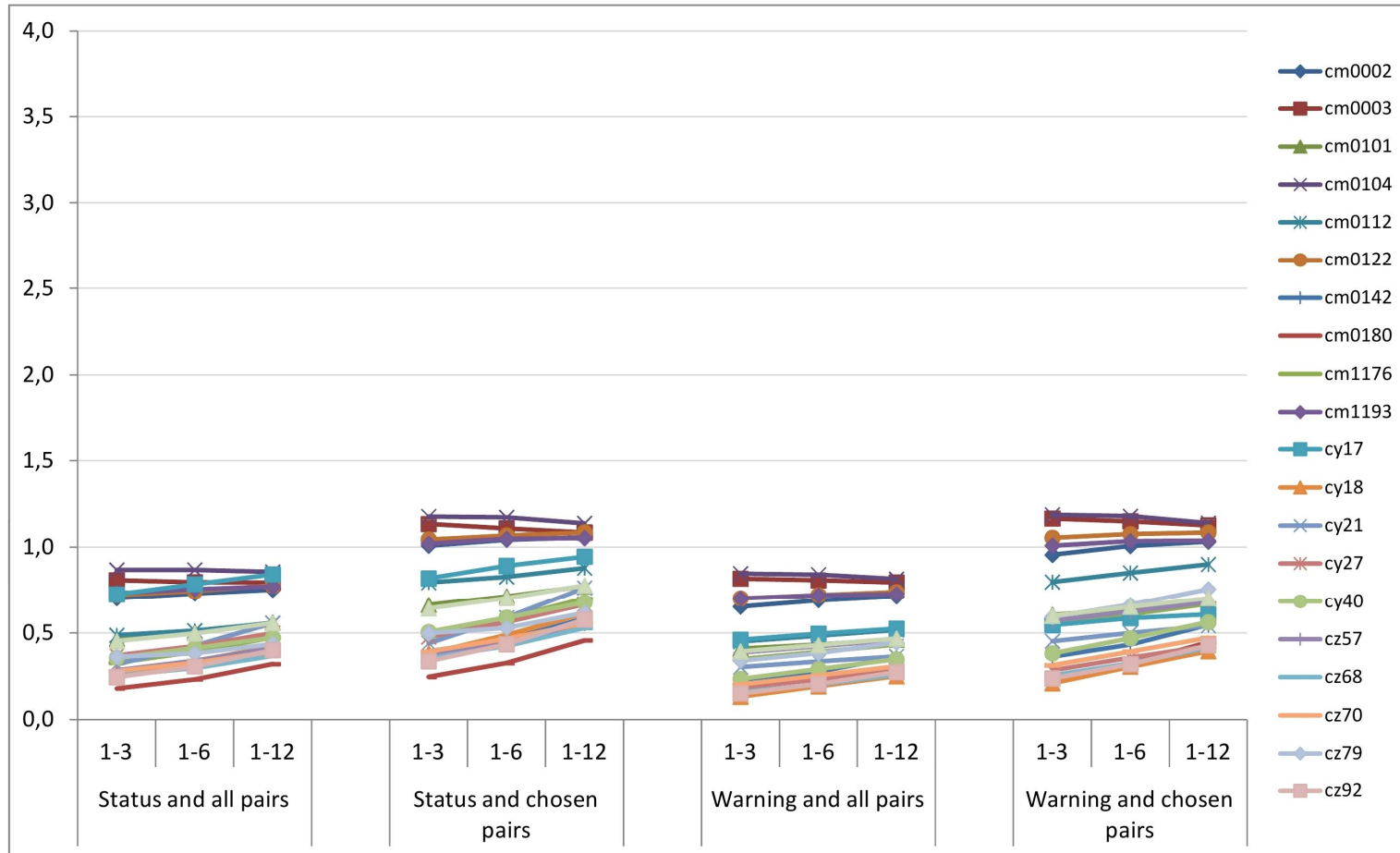
Error matrix – pattern

Status	DR	TR	MO	WE	WT	SN	PF	FR	IC
Dry	0	0	0	1	1	2	3	3	4
Wet	1	1	0	0	0	1	2	2	3
DriftLow	2	2	1	1	1	0	1	1	2
DriftHigh	2	2	1	1	1	0	1	1	2
Snow	2	2	1	1	1	0	1	1	2
Slipp	3	3	2	2	1	1	0	0	1
Hazard	4	4	3	3	1	1	1	1	0

Scale matrix

Forecast: **Dry**, **Wet**, **DriftLow** – Snow drifts warning, **DriftHigh** – Snow drifts alarm, **Snow**, **Slipp** – Frost, **Hazard** – Ice, Error.
Status measurement: **DR** – Dry, **TR** – Residual chemicals, **MO** – Moist, **WE** – Wet, **WT** – Wet and treated, **SN** – Snow, **PF** – Possible frost, **FR** – Frost, **IC** – Ice, **ER** – Error.
Warning measurement: **noW** – No warning, **R** – Precipitation, **S** – Snow, **F** – Frost, **W** – Ice warning, **A** – Ice alarm, **ER** – Error.

4. METHODS AND RESULTS OF THE FORECAST ACCURACY EVALUATION



4. METHODS AND RESULTS OF THE FORECAST ACCURACY EVALUATION

- Analysis of the forecast accuracy of road surface temperature
 - Comparing the **predicted** and **later measured** road surface temperature (predicted minus measured).
 - The result is a **derivation of the average error** alias **average absolute error** in determining the temperature.
 - Evaluation splits into two sub-analyzes:
 - Analysis of all pairs of measurement–forecast
 - Analysis of chosen pairs of measurement–forecast when it was measured RST below +3 °C

4. METHODS AND RESULTS OF THE FORECAST ACCURACY EVALUATION

T u3	Total	cm0002	cm0003	cm0101	cm0104	cm0112	cm0122	cm0142	cm0180	cm1176	cm1193	cy17	cy18	cy21	cy27	cy40	cz57	cz68	cz70	cz79	cz92
Forecast+1	0,04	-0,07	0,11	0,06	0,12	0,68	0,00	0,04	-0,02	-0,41	-0,29	0,25	0,01	0,10	0,05	-0,44	0,64	-0,02	0,02	0,00	-0,02
Forecast+2	0,00	-0,26	0,11	0,04	0,15	0,60	-0,08	-0,02	-0,12	-0,41	-0,32	0,41	-0,06	0,05	-0,03	-0,47	0,60	-0,10	-0,06	-0,11	-0,09
Forecast+3	-0,09	-0,49	0,08	-0,03	0,15	0,46	-0,23	-0,14	-0,27	-0,48	-0,43	0,53	-0,17	-0,05	-0,14	-0,55	0,52	-0,23	-0,18	-0,28	-0,21
Forecast+4	-0,22	-0,73	0,00	-0,15	0,10	0,31	-0,41	-0,30	-0,45	-0,59	-0,56	0,58	-0,31	-0,16	-0,28	-0,67	0,39	-0,38	-0,32	-0,48	-0,35
Forecast+5	-0,35	-0,95	-0,07	-0,26	0,05	0,15	-0,59	-0,45	-0,63	-0,71	-0,70	0,58	-0,44	-0,29	-0,42	-0,79	0,29	-0,51	-0,46	-0,67	-0,48
Forecast+6	-0,46	-1,13	-0,16	-0,36	0,01	0,01	-0,74	-0,59	-0,79	-0,81	-0,83	0,54	-0,56	-0,39	-0,55	-0,89	0,19	-0,63	-0,58	-0,83	-0,59
Forecast+7	-0,56	-1,28	-0,23	-0,43	-0,04	-0,11	-0,88	-0,70	-0,92	-0,91	-0,93	0,50	-0,65	-0,48	-0,66	-0,97	0,11	-0,74	-0,68	-0,95	-0,69
Forecast+8	-0,63	-1,41	-0,29	-0,51	-0,08	-0,22	-1,00	-0,80	-1,04	-0,97	-1,02	0,47	-0,72	-0,54	-0,73	-1,04	0,04	-0,82	-0,75	-1,04	-0,76
Forecast+9	-0,69	-1,52	-0,34	-0,57	-0,11	-0,30	-1,09	-0,89	-1,12	-1,03	-1,09	0,45	-0,77	-0,59	-0,78	-1,08	0,00	-0,88	-0,81	-1,10	-0,81
Forecast+10	-0,75	-1,61	-0,38	-0,63	-0,14	-0,38	-1,17	-0,96	-1,20	-1,07	-1,14	0,44	-0,82	-0,64	-0,83	-1,11	-0,05	-0,94	-0,87	-1,16	-0,86
Forecast+11	-0,79	-1,69	-0,42	-0,68	-0,15	-0,44	-1,23	-1,03	-1,26	-1,11	-1,19	0,42	-0,86	-0,69	-0,86	-1,14	-0,09	-0,99	-0,91	-1,20	-0,91
Forecast+12	-0,83	-1,76	-0,45	-0,72	-0,17	-0,50	-1,28	-1,07	-1,32	-1,14	-1,24	0,42	-0,90	-0,73	-0,90	-1,18	-0,12	-1,03	-0,95	-1,25	-0,95

T u3 abs	Total	cm0002	cm0003	cm0101	cm0104	cm0112	cm0122	cm0142	cm0180	cm1176	cm1193	cy17	cy18	cy21	cy27	cy40	cz57	cz68	cz70	cz79	cz92
Forecast+1	0,91	0,96	0,88	0,97	0,92	1,00	0,90	0,85	0,81	1,01	1,08	1,03	0,78	0,82	0,88	1,11	1,00	0,78	0,77	0,85	0,77
Forecast+2	1,36	1,52	1,37	1,57	1,47	1,24	1,43	1,35	1,26	1,38	1,56	1,64	1,17	1,24	1,33	1,46	1,24	1,15	1,15	1,28	1,17
Forecast+3	1,68	1,96	1,70	1,98	1,84	1,44	1,83	1,72	1,59	1,67	1,89	2,09	1,47	1,48	1,67	1,72	1,45	1,43	1,41	1,59	1,45
Forecast+4	1,91	2,26	1,93	2,25	2,07	1,62	2,11	1,98	1,85	1,90	2,11	2,38	1,68	1,65	1,90	1,91	1,60	1,63	1,60	1,83	1,66
Forecast+5	2,08	2,48	2,08	2,45	2,25	1,77	2,32	2,16	2,04	2,05	2,27	2,58	1,83	1,77	2,06	2,05	1,73	1,78	1,73	2,00	1,80
Forecast+6	2,19	2,63	2,18	2,58	2,36	1,87	2,47	2,29	2,17	2,16	2,37	2,71	1,94	1,86	2,17	2,14	1,80	1,89	1,83	2,12	1,89
Forecast+7	2,26	2,73	2,25	2,67	2,43	1,93	2,57	2,38	2,26	2,22	2,44	2,78	2,01	1,92	2,24	2,20	1,85	1,96	1,89	2,19	1,95
Forecast+8	2,31	2,80	2,29	2,71	2,48	1,96	2,64	2,43	2,33	2,26	2,49	2,83	2,07	1,95	2,29	2,24	1,87	2,02	1,94	2,26	1,99
Forecast+9	2,34	2,85	2,32	2,72	2,50	1,98	2,69	2,45	2,37	2,30	2,52	2,85	2,10	1,98	2,33	2,27	1,89	2,05	1,99	2,31	2,03
Forecast+10	2,37	2,89	2,33	2,73	2,51	2,00	2,73	2,48	2,41	2,32	2,55	2,87	2,13	1,99	2,36	2,30	1,90	2,08	2,02	2,35	2,05
Forecast+11	2,39	2,93	2,34	2,74	2,51	2,01	2,76	2,49	2,44	2,35	2,57	2,87	2,15	2,01	2,39	2,32	1,92	2,09	2,03	2,40	2,07
Forecast+12	2,40	2,96	2,35	2,75	2,51	2,01	2,77	2,51	2,46	2,36	2,58	2,88	2,17	2,01	2,41	2,33	1,94	2,11	2,05	2,42	2,09

Often pessimistic forecast
Less forecasted than measured

Often optimistic forecast
More forecasted than measured

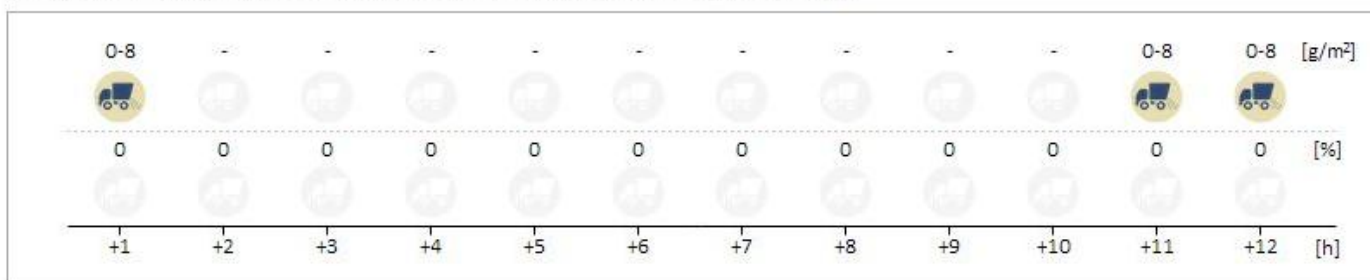
5. CONCLUSION

- Simplified planning of winter maintenance
- Remote supervision over the critical roads
- Winter maintenance efficiency
- Small direct cost saving as a planning of night and weekend readiness
- Winter season 2013/2014
 - SSWM full completion in the Czech Republic
 - Recommended treatment forecast

6. TREATMENT RECOMMENDATION – NEW 2014

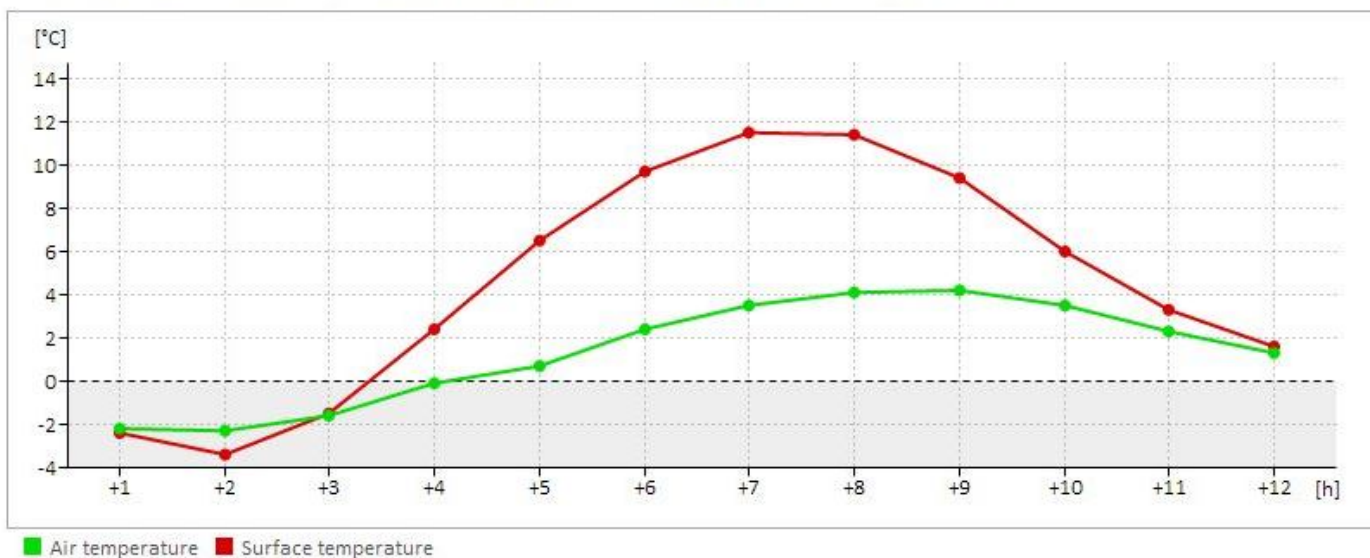
Recommended scenario for road maintenance

Graph contains probable need of chemical treatment and plough in a given hour. Percentage shows amount of roads in area covered by recommendation. For chemical treatment is also recommended weight range of spreading.



Meteorological forecas

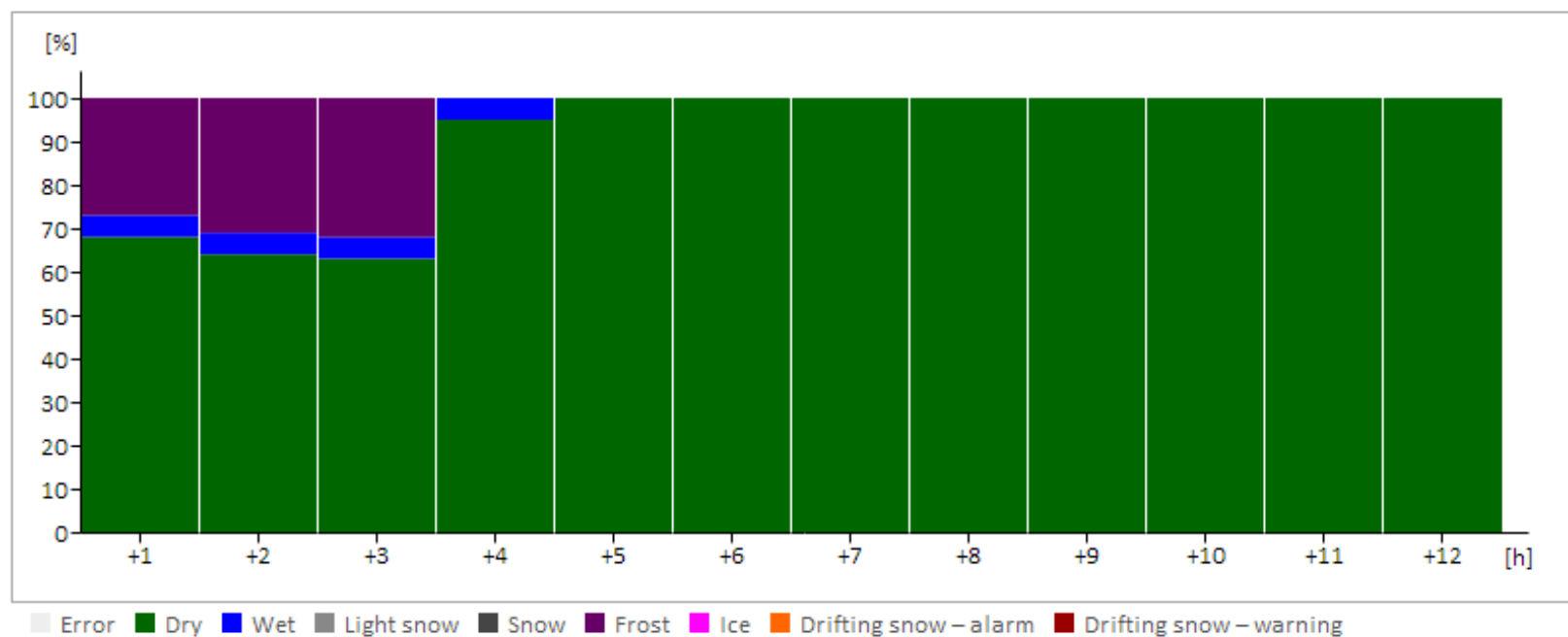
The graph contains mean temperature of air and road surface, which is counted from all roads in the area.



6. TREATMENT RECOMMENDATION – NEW 2014

Forecast of surface status

The graph shows percentage of roads in the area, which are classified into categories by probable state of road surface.



I am here for your questions

Tomas Pospisek
pospisek@cross.cz