

REGIONAL DECISION SUPPORT SYSTEM



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MAIN COMPONENTS

MeteoTrassa system has been developed to provide the road authorities with a decision support tool for winter road maintenance.

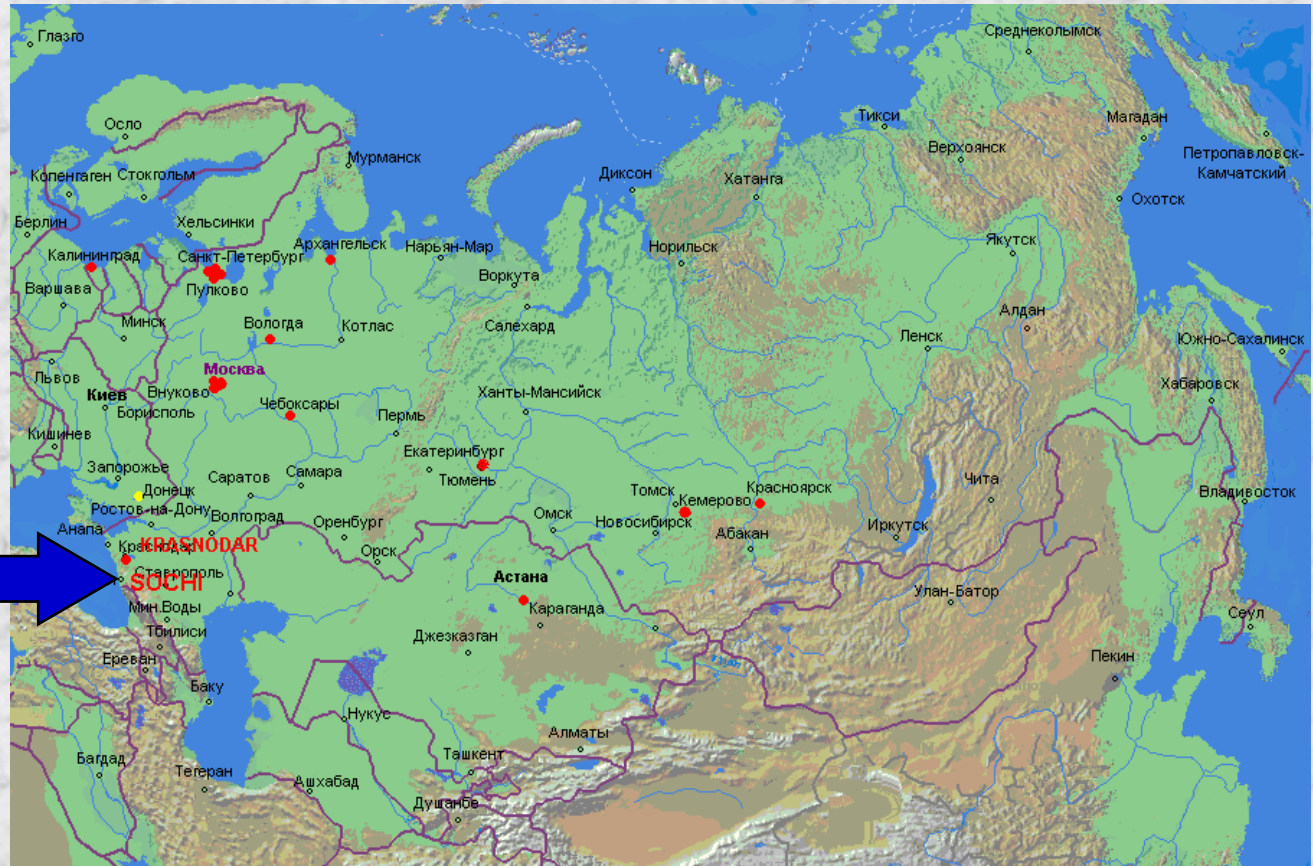
- **RWIS**

- road weather stations
- traffic weather cameras
- weather radars
- hydrological sensors
- thermal mapping
- forecasts



- **Recommendations on road treatment strategies based on standard practices for effective winter road maintenance (anti-icing, de-icing, ploughing, sanding), which are tailored to the procedures of the local agency.**

INSTALLATIONS



**2014 Winter
Olympic
Games**

17 systems have been installed since year 2000

FUNCTIONALITY

The system capitalizes on existing data sources. It collects

- Data from RWSs**
- Images from cameras**
- Forecasts from HMC**
- Weather radar data**
- Hydrological data**

Processes, stores and fuses data

- To visualize current weather and road conditions**
- To make specialized forecasts and warnings**
- To generate treatment recommendations**

Transfers to workstations

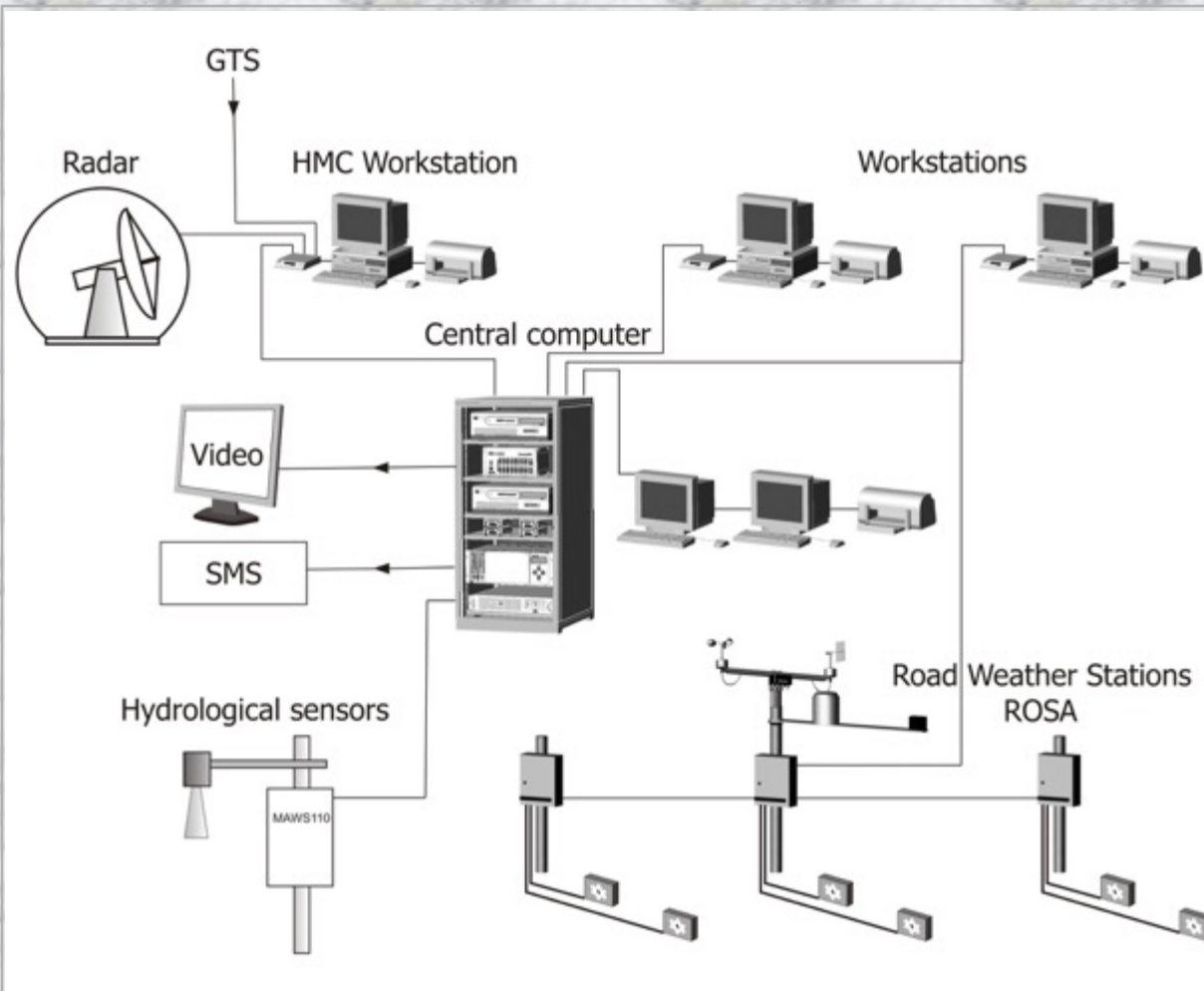
- Data from RWSs**
- Images from cameras**
- Forecasts & Warnings**
- Treatment recommendations**

Transfers to cell phones
Warnings



Traffic control centre in Krasnodar

CONFIGURATION



The system in Krasnodar (Sochi region) includes

- Central computer
- User's workstations -45
- Workstation at HMC
- RWSs - 28
- Cameras – 41
- Hydrological sensors - 5

MeteoTrassa software is responsible for collection, processing, analysis, storing, presentation and distribution of the data, forecasting and generation of recommendation on road treatment.

Road Weather Station ROSA (Vaisala)



With the data received from its sensors the ROSA is capable of making the following analysis:

- **air** temperature (T_s), dew point (T_{dew}), relative humidity, rain intensity, wind speed and direction, gust speed and direction, freezing point temperature,
- **surface** temperature (T_s), surface condition (dry, moist, wet, moist and treated, wet and treated, frost, ice, and snow) and presence and concentration of deicing chemicals
- **Grip** (slipperiness on road surface) in case of non-invasive remote sensors

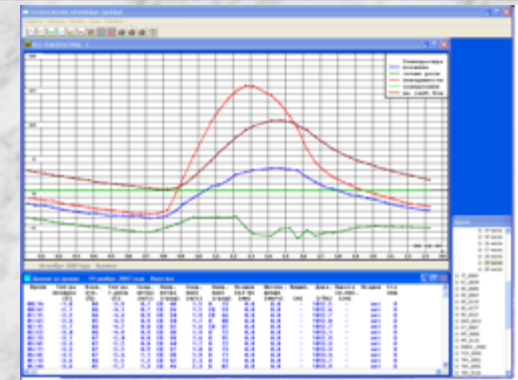
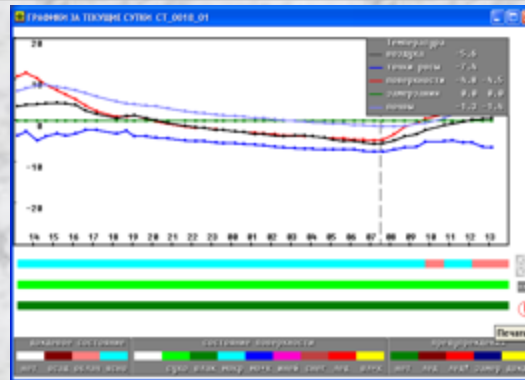
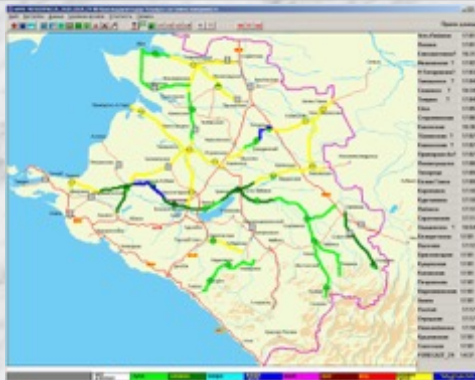
RWS ROSA (Vaisala)

ROSA provides information about the following states and warnings:

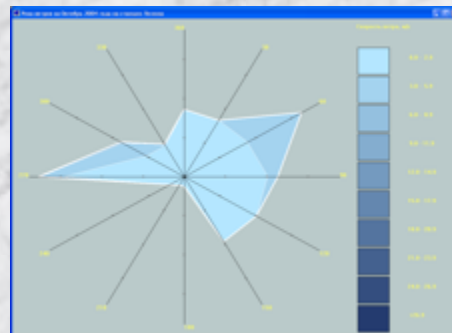
- **Clear** – no warnings or alarms
 - **Rain warning** – rain or snow detected recently and there may be subsequent freezing, as the T_s is close to or below T_{fr}
 - **Ice warning** – T_s is negative and within a given limit of the dew point. Hence hoar frost, or ice, is either present or expected very soon.
 - **Ice alarm** – close to freezing point; either there is ice already or there will be very soon.
- non - invasive remote sensor:*
- **Grip warning** – surface slightly slippery
 - **Grip alarm** – surface slippery



ANALYSIS AND VISUALIZATION OF RWS DATA



Название	Пром.	Темп.	Влаж.	Трис.	Темп.	Темп.	Сост.	Прог.	Хим.	Сил.	Скор.	Напр.	Сум.
Вост.-Валиевск	32.00	-2.1	95	-2.8							0.3	100	0.8
Вост.-Валиевск	32.00			-2.5	0.8	0.8	0.8	0	0	0	0	0	0
Вост.-Валиевск	32.00			-2.5	0.8	0.8	0.8	0	0	0	0	0	0
Ревма	32.00	-1.5	96	-2.3							1.2	100	0.8
Ревма	32.00			-1.9	0.8	0.8	0.8	0	0	0	0	0	0
Ревма	32.00			-2.5	0.8	0.8	0.8	0	0	0	0	0	0
С.жизавитевск	32.00	2.4	99	-2.8							0.1	100	2.1
С.жизавитевск	32.00			-2.7	0.8	0.8	0.8	0	0	0	0	0	0
С.жизавитевск	32.00			-2.1	0.8	0.8	0.8	0	0	0	0	0	0
Новоселовск	32.00	-1.3	100	-1.9							2.8	100	0.8
Новоселовск	32.00			-2.1	0.8	0.8	0.8	0	0	0	0	0	0
Новоселовск	32.00			-0.6	0.8	0.8	0.8	0	0	0	0	0	0
Н-Татаровск	32.00	-1.3									0.4	100	0.8
Н-Татаровск	32.00			-1.1	0.8	0.8	0.8	0	0	0	0	0	0
Н-Татаровск	32.00			-1.2	0.8	0.8	0.8	0	0	0	0	0	0



СИСТЕМА ПРЕДУПРЕЖДЕНИЯ И ПРОГНОЗА ГОЛОЛЕДА М10_0040 13.02.2001

ДАННЫЕ МЕТЕОРОЛОГИЧЕСКИХ ИЗМЕРЕНИЙ

Время	Темп. (С)	Влаж. (%)	Тр. (С)	Скор. (м/с)	Напр. (град)	Осад. (мм)	Инт. док. (мм)	Видн. (м)	Давл. (гПа)	Выс. сл. (сп)	Дождь (сп)
10:00	-1.6	95	-2.7	18.1	252	0.0	0.0	0	0	0	нет

ДАННЫЕ ИЗМЕРЕНИЙ ПОВЕРХНОСТИ

Время	Темп. (С)	Темп. Тр. (С)	Темп. Тр. (С)	Химикаты (град)	Вода (мм)	Сост. пов. (мм)	Осадки (мм)	Датчик
10:00	-1.5	-0.7	-0.8	-0.3	0	0	28	облачно 1
10:00	-1.6	-0.9	-2.1	-2.0	3	0	28	облачно 2

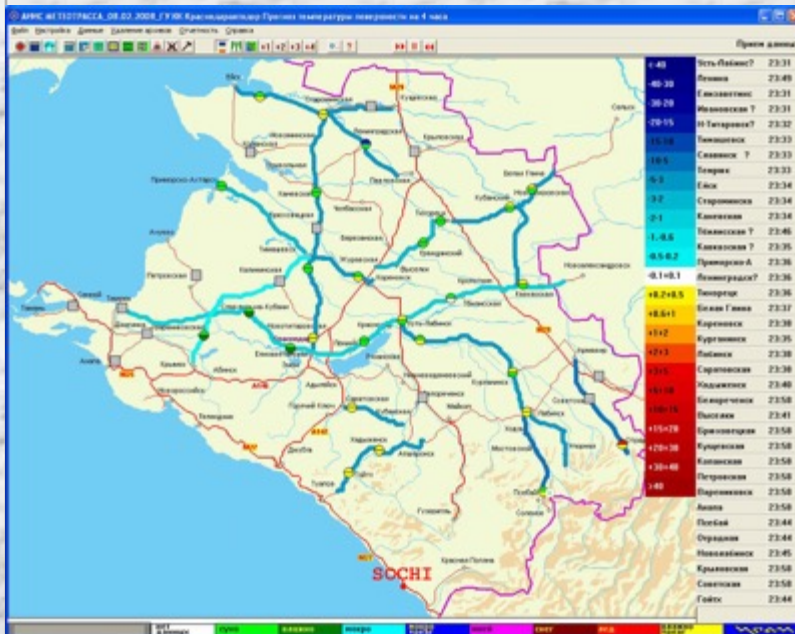
ВЛАЖНО С ХИМИКАТАМИ

ПРЕДУПРЕЖДЕНИЙ НЕТ

АКТИВНО ПРОГНОЗ

MeteoTrassa manages and presents information about weather conditions on roads. Chart, graphs and tables are available. The data is updated at certain intervals (15-30 min, usually) as determined automatically or by a user. The observational data is checked for critical alarm states as it arrives.

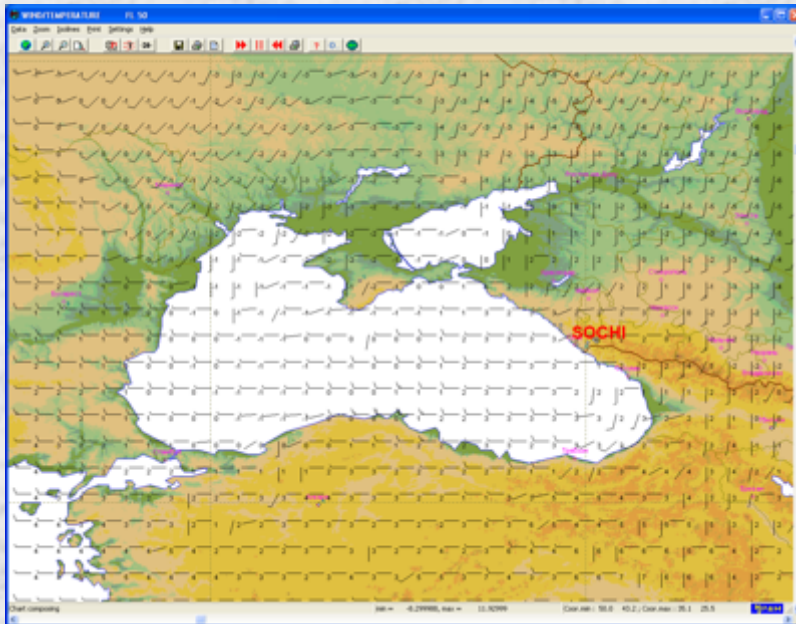
FORECAST OF THE ROAD WEATHER AND SURFACE CONDITION. 1- Numerical model



Prognostic map of Ts and road conditions (for 4 hours)

- **Numerical model** of atmospheric boundary layer provides forecasts of Ts and road condition for a period up to 4 hours. The forecasts are updated every 30min.
- **The prediction of road surface condition** is based on consideration of Ts, Tdew, and precipitation status.
- **The model uses the following input data:**
 - Data from the road weather stations
 - GRIB-encoded prognostic data
 - Weather radar data

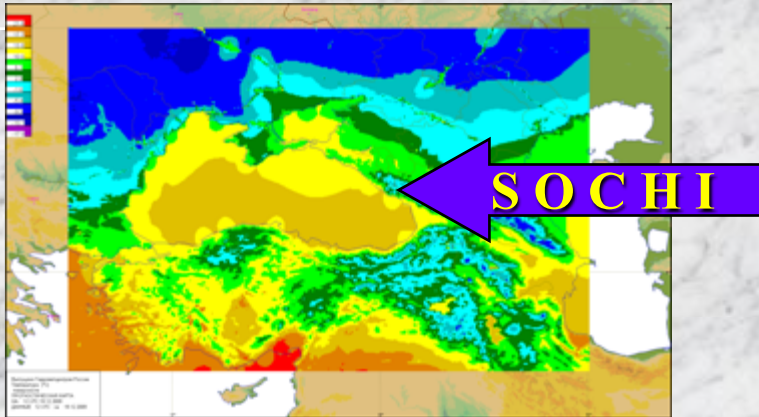
FORECAST OF THE ROAD WEATHER AND SURFACE CONDITION. 2- Prognostic data



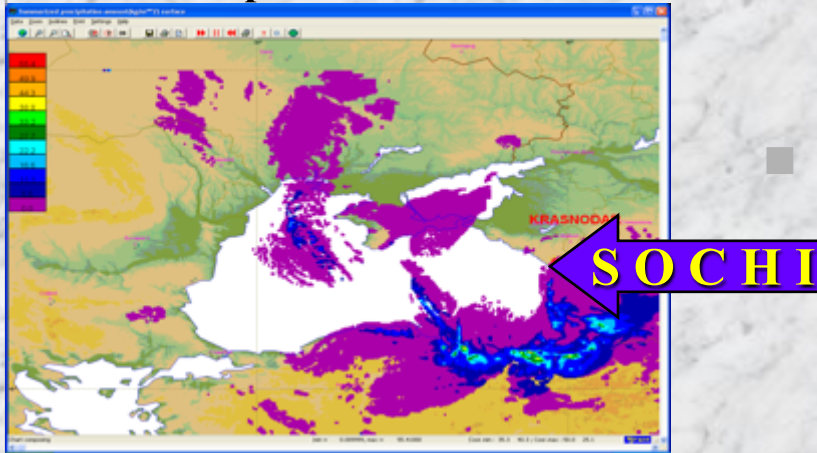
Temperature + Wind
WRF-ARW

- The high-resolution model WRF-ARW runs at the HMC of Russia. The **fine scale model** has a grid spacing of **3 km** and time resolution of **1 hour**. Its outputs in GRIB format are available at the HMC server via FTP-connection.
- GRIB-encoded prognostic data sourced from World Area Forecast Centers via GTS is another alternative, however with worse space and time resolution
(The Met Office plans to upgrade its Global NWP to **25 km** in 2010)

FORECAST OF THE ROAD WEATHER AND SURFACE CONDITION. 3- Inputs



Surface temperature.



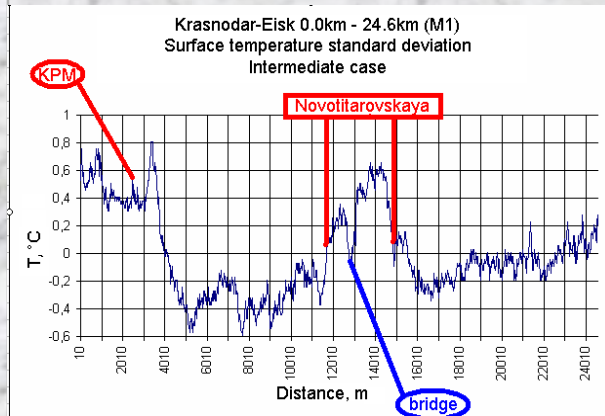
Precipitation amount.

- Observations from RWSs, forecasts from the NWP models, and weather radar data are forwarded to the road weather and surface condition forecast module
- The availability of input data with a high resolution in time and space has increased the possibility to improve short term forecasting.
- Site specific weather forecasts are provided for locations where road sensors exist and extrapolated to the road network if thermal mapping data is available.

THERMAL MAPPING



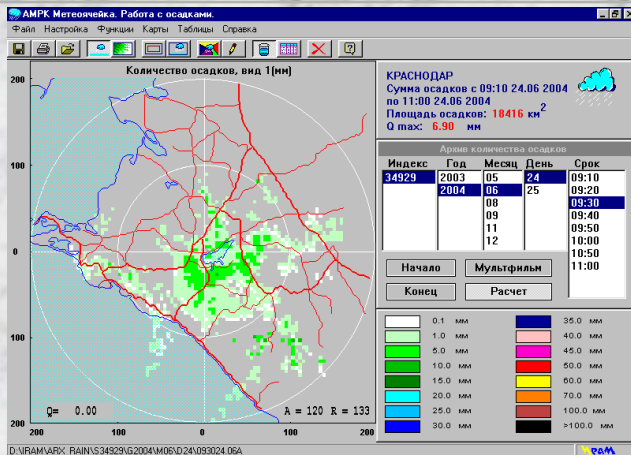
- Information on **spatial variation of T_s** in a road network is needed to make a forecast for a whole network rather than for a set of sites.
- Topography, local heat sources, basins are important **systematic factors** controlling the variation of T_s . The process to record and quantify these patterns of T_s is called **thermal mapping**.
- It is a **reliable and effective method** to explore spatial variation of T_s based on the proved fact that the pattern of T_s is reproduced from one night to the next one under the similar weather conditions.



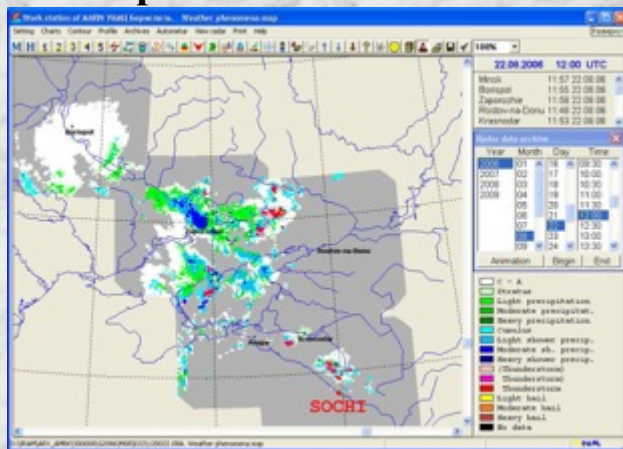
T_s profile. (Standard deviation of T_s)

Thermal Mapping fingerprint category: intermediate.

WEATHER RADAR INFORMATION



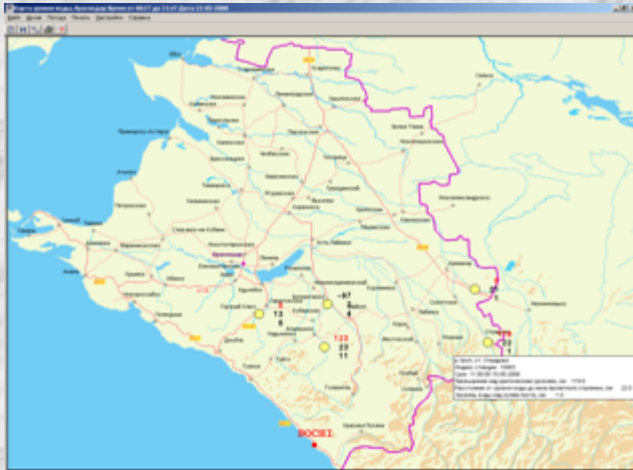
Precipitation amount



Weather radar composite

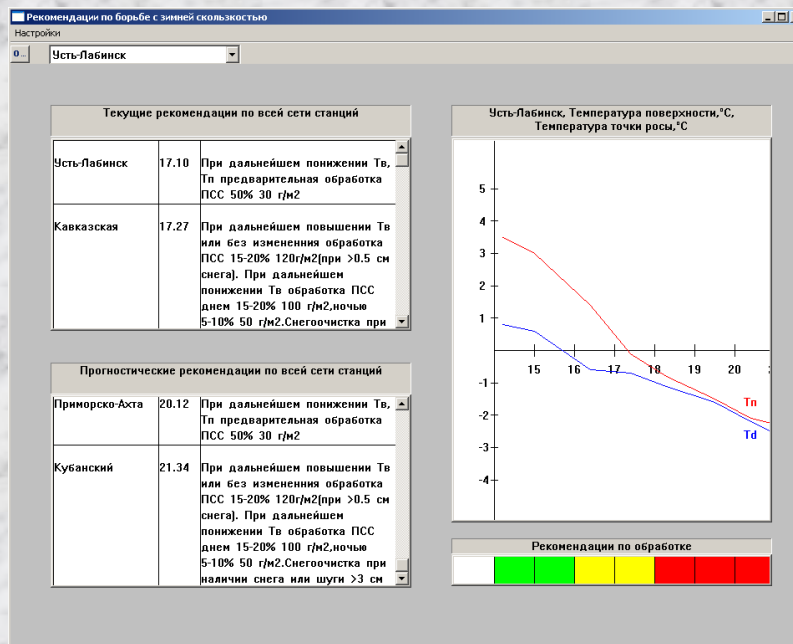
- The following weather radar products are of most interest for the road maintenance:
 - **onset and cessation of snowfall** and its intensity,
 - **amount of snowfall** for separate sections of roads,
 - **phenomena** map (thunderstorm, hail, severe winds)
- Information about **precipitation and clouds** retrieved from the radar data is used in forecasting.
- The radar images are updated **every 10 minutes** at the workstation MARS covering 1000 km x 1000 km area with resolution of 4 km x 4 km.
- Assessment of **weather system movement** for up to 2 hours based on radar data and wind forecast is performed.

HYDROLOGICAL INFORMATION



- A set of hydrological sensors gives useful information for monitoring of **water level and floods**.
- Software is responsible for collection, processing, analysis, storing and presentation of the data.
- Hydrological information in chart, graphic and tabular forms is available. It includes **indication of excess over the critical water level** and provides support to make right decision for road maintenance.

RECOMMENDATIONS ON ROAD TREATMENT STRATEGIES



- Treatment recommendation module fuses the current data, forecasts and weather radar data to generate guidance for treatment procedure
- 4 different methods on road treatment are loaded into the system. The user chose the **most suitable** among them.
- The system enables instant assessment of road conditions and gives the maintenance personnel **lead time to take appropriate actions** before the conditions deteriorate.

TREATMENT RECOMMENDATIONS

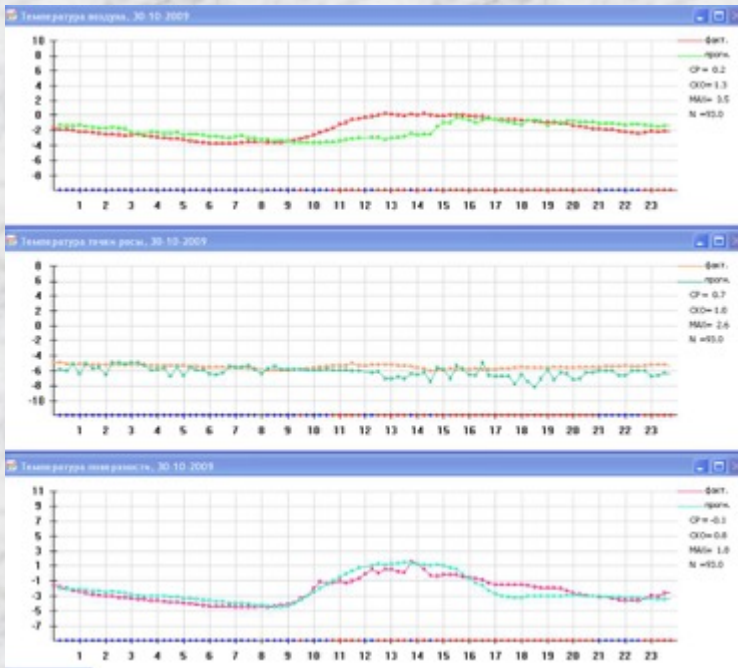
Название	Время	Осад...	Скоро...	Напр...	Тгрун...	Рекомендация
Усть-Лабинск	29:01	нет	5.4	В	69	Обработка увлажненной солью 25-30 г/м2
Усть-Лабинск	29:01				-0.4	
Усть-Лабинск	29:01				-0.4	
Ленина	29:02	нет	3.3	В	88	Обработка увлажненной солью 25-30 г/м2
Ленина	29:02				0.5	
Ленина	29:02				-0.3	
Елизаветинск	29:04	нет	0.3	СВ	25	
Елизаветинск	29:04				-0.5	
Елизаветинск	29:04				-0.4	
Ивановская	29:05	нет	4.9	СВ	58	
Ивановская	29:05				0.1	
Ивановская	29:05				0.4	
Н-Титаровска	29:06	нет	0.3	В	100	ДПС; обработка увлажненной солью 25-30 г/м2 на опасных участках
Н-Титаровска	29:06				-0.3	
Н-Титаровска	29:06				-0.7	

Treatment recommendations.

Treatment recommendations include:

- Recommended **treatment procedure** (chemical use, abrasives, combination chemical + abrasives, plough),
- Recommended **chemical amounts, chemical concentration and dilution rates**
- **Timing** of initial treatment and necessity of subsequent treatment
- Recommended **pretreatment**.

VERIFICATION



Prognostic against measured data
(Tair, Tdew and Ts)

- **Forecasts of Tair, Tdew, Ts and road condition** has been verified during winter periods of 2007 – 2008 and 2008 – 2009. Total number of cases is 135624. The model was verified against observations from 56 road weather sensors.
- The results averaged over all sites show that **RMS error of 4 h forecasts for temperatures is 2.1 °C**. The model has a **near-zero bias** for temperature forecasts.
- **Accuracy of ice predictions for 4 h forecast period varies from 83 to 93%.**

OUTLOOK

- Future development of the system is connected to the **2014 Winter Olympic Games in Sochi**. New weather road stations in that region are planned to be installed. Models are to be improved for most adequate forecasting in complex terrain.



THANK YOU FOR ATTENTION



road@iram.ru

ИРАМ