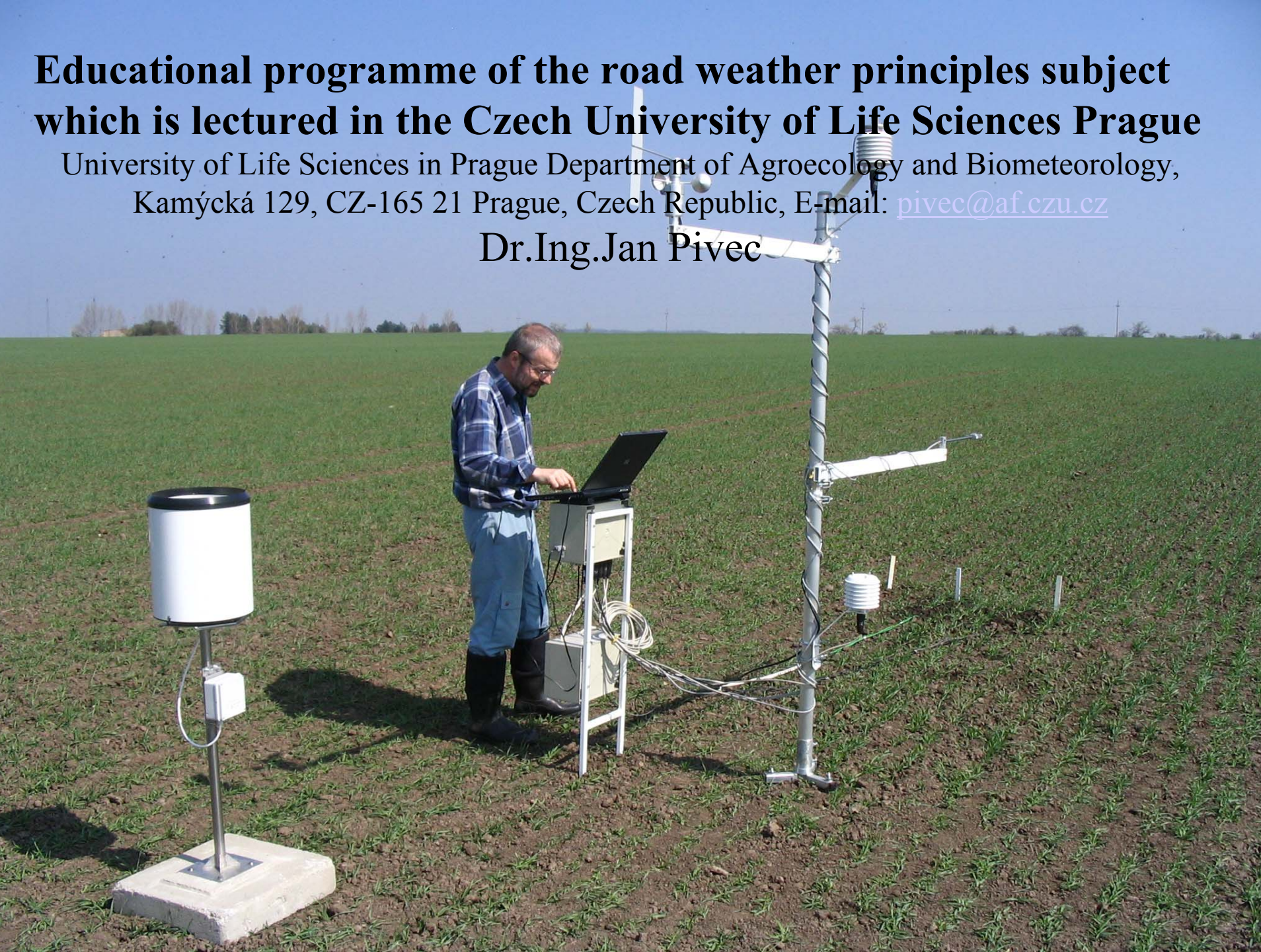
# Educational programme of the road weather principles subject which is lectured in the Czech University of Life Sciences Prague

University of Life Sciences in Prague Department of Agroecology and Biometeorology,
Kamýcká 129, CZ-165 21 Prague, Czech Republic, E-mail: pivec@af.czu.cz

Dr.Ing.Jan Pivec



The Faculty of Engineering offers its prospective students three year Bachelor degree courses and two year Master degree courses within the scope of two-stage study plans. The Master degree course graduates are offered three year postgraduate courses among others in the field of Road transportation and city traffic.

Within the subject of road transportation and city traffic we provide essential knowledge about the Earth's atmosphere and physical processes which determine its properties and behaviour; atmospheric composition and energy, water in the atmosphere and air circulation (global, synoptic and local scales). The Course continues in the description of the climate in the World. Special emphasis is put on the problems of transport meteorology, a guide to the road weather systems and SIRWEC suggestions

1. Meteorology and Climatology, history, present, World Meteorological Organization.
2. The Earth's atmosphere, air composition, vertical and horizontal structure, ICAO atmosphere.
3. Atmospheric pressure. Instruments, barometric hypsometry, reduction of pressure.
4. Radiation, sunshine, illumination. Instruments, standards.
5. Air, water, soil and road surface temperature. Instruments, characteristics. Completion of the missing temperature's data.
6. Air moisture. Instruments, characteristics, computational procedure. Condensation effects.
7. Cloudiness, wind, refrigeration. Instruments, characteristics. Standards.
8. Fog. Technical and meteorological visibility. Estimation of the freezing depth of pavement.
9. RWIS system of data processing and collection. Characteristics, computational procedure.
10. Synoptic charts, information of meteorological satelites and radiolocators, meteorological films.
11. World Weather Watch. Synoptic meteorology, weather information - charts, radiolocators, satellites.
11. Classification of synoptic situation, fronts, air masses, meteorological elements and their symbols and codes.
12. Meteorology and transport. Weather forecast.
12. Climate evaluation of selected sites in Czech Republic, climatological standards, methodology.
13. Road meteorology. SIRWEC Standing International Road Weather Commission. SERWEC (European).
13. Climatogram. Griffith- Taylor, Walter-Lieth, Köppen classification.
14. Transport climatography of the World.

# Road Weather Information Systems around the World

Roads are set up by sensors, installed into the pavement or runways for theirs temperature and humidity, wind speed and direction measurements, precipitation characteristics and visibility. Measured data are transmitted by wireless technology to the processing places, than to the end-users.

| Country | Road Weather Outstations | State |
|---|---|---|
| Australia | 10 | |
| Austria | 280 | |
| Belgium | 100 | |
| Canada | 155 | 01-2002 |
| Czech Republic | 49 | |
| Denmark | 310 | 09-2003 |
| Estonia | 50 | 06-2004 |
| Finland | 326 | 09-2003 |
| France | 650 | 08-2002 |
| Germany | 780 | 05-2007 |
| Holland | 330 | 08-2002 |
| Hungary | 30 | |
| Iceland | 10 | |
| Republic of Ireland | 54 | 04-2004 |
| Iran | 5 | 08-2002 |
| Italy | 100 | |
| Japan* | 1014 | 08-2002 |
| Latvia | 22 | |
| Lithuania | 38 | 06-2004 |
| Luxembourg | 20 | |
| New Zealand | 7 | 08-2002 |
| Norway | 217 | 09-2003 |
| Poland | 70 | |
| Russia | 10 | |
| Slovenia | 22 | 09-2003 |
| Spain | 10 | |
| Sweden | 720 | 09-2005 |
| Switzerland | 610 | 09-2003 |
| United Kingdom | > 800 | 09-2003 |
| United States | 1250 | 08-2002 |
| **TOTAL** | **>7891** | |

# Links to other Road Weather Sites

**National / Regional Systems:**

www.balticroads.net
Danish Road- and Weather Info
Finnish Road Administration: Road Weather Conditions
Finnish Road Administration: Finnra Today
Iceland
Rep.of Ireland National Road Authority
Lithuanian Road Administration
Road Weather USA
Road Maintenance USA
COST 309
Winterterm Glossary COST 344
Swedish Roadinfo
Swiss Weatherinfo

http://www.ssiweather.com/

**RWIS Companies:**

AerotechTelub ITS Technology, Sweden
Boschung, Switzerland
Coastal Evironmental Systems, USA
Entice Technology Ltd
Findlay Irvine, UK
LAB-EL, Poland
Lufft, Germany
Optical Scientific, USA
ScanMatic, Norway
Surface Systems, USA
Vaisala

**Other Commercial Companies / Organizations:**

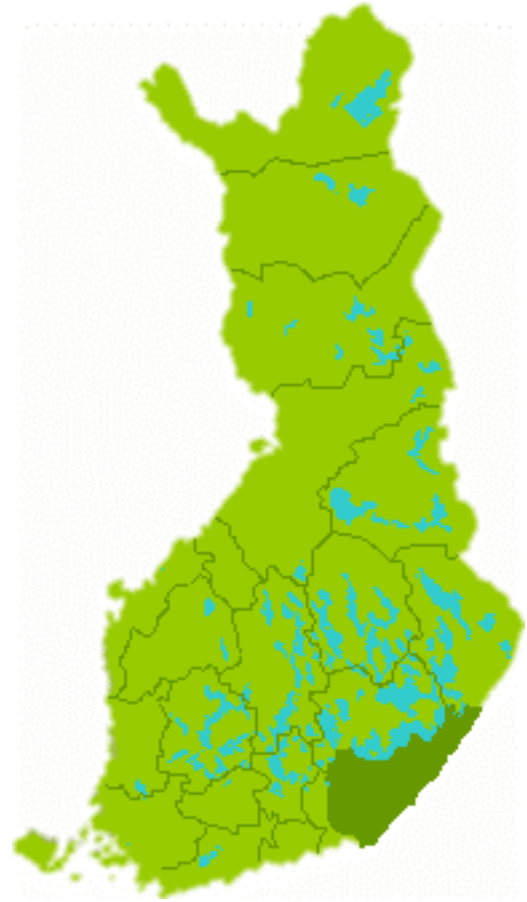
Axicon (BiTaD), Norway
Campbell Scientific
Cryotech, USA
Davis Instruments, USA
Ilkka Lilja Oy, Finland
Mark F. Pinet & Associates Limited, Canada
micKS, Germany
Odin Consultants, USA
R.M. Young Company
Salt Institute, USA
Traffic Tecnology 2000
Weather Solutions Consultants, USA

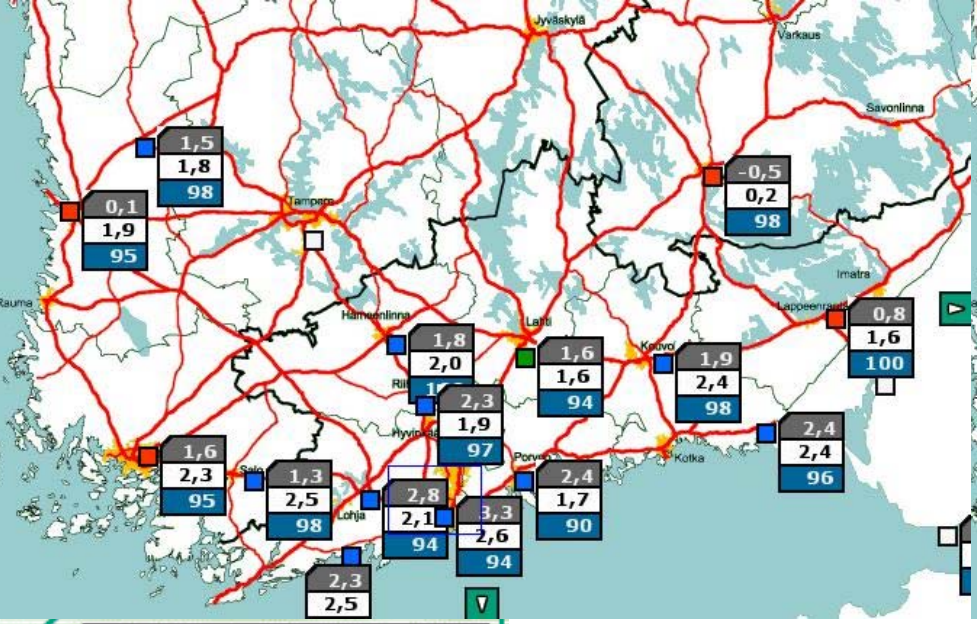
# ROAD WEATHER CONDITIONS

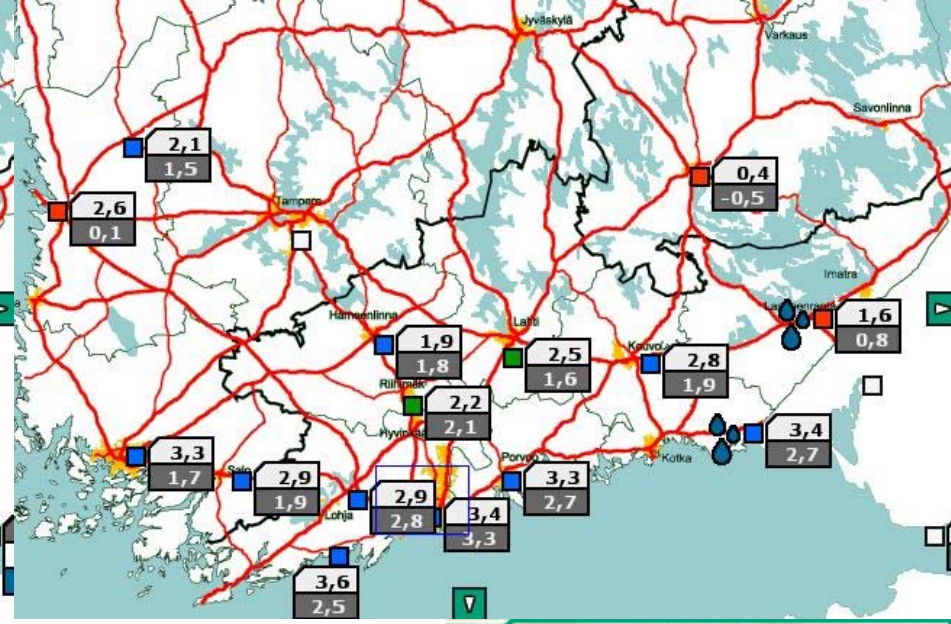
## Road Weather in South Karelia

**Updated:** 07.12.2004 21:05

| Station | Time | Air | Road surf. | Precipit. | Road cond. |
|---|---|---|---|---|---|
| Road 6; Luumäki, Taavetti | 20:49 | 2.0 | 1.1 | No rain | Wet |
| Road 6; Lappeenranta | 20:50 | 1.7 | 0.7 | No rain | Wet |
| Road 6; Imatra | 20:49 | 1.4 | 0.2 | No rain | Wet |
| Road 6; Parikkala | 20:57 | 0.3 | -0.6 | No rain | Snow on the road |
| Road 13; Savitaipale | 20:50 | 1.2 | -0.5 | No rain | Wet |
| Road 13; Suomenniemi, Kauriansal | 20:51 | 1.9 | 0.0 | No rain | Frost |
| Road 62; Puumala | 20:46 | 0.7 | -0.5 | No rain | Frost |

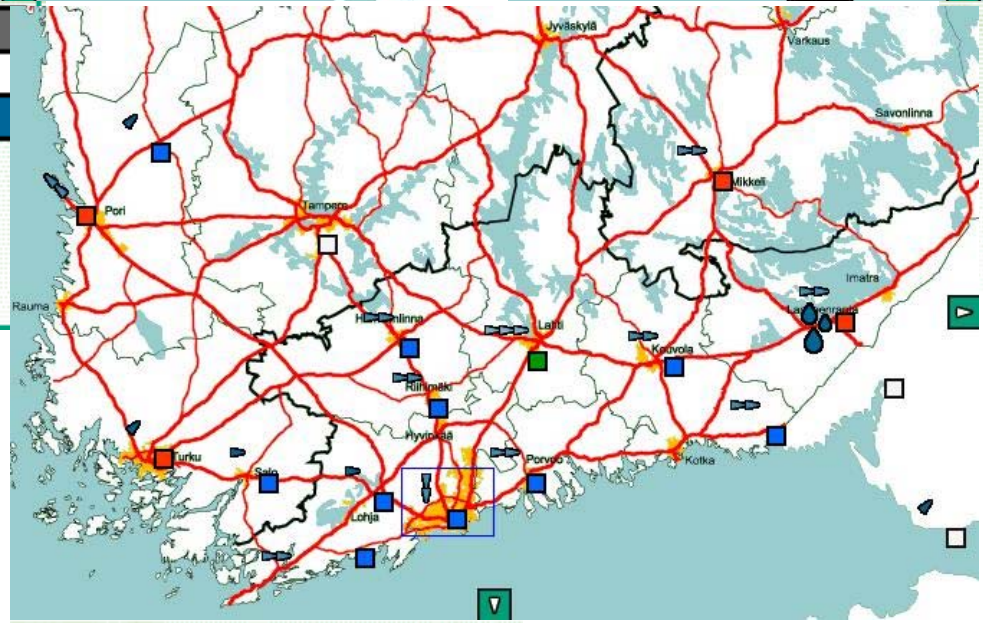





**Road temperature**
**Dew point**
**Relative humidity %**

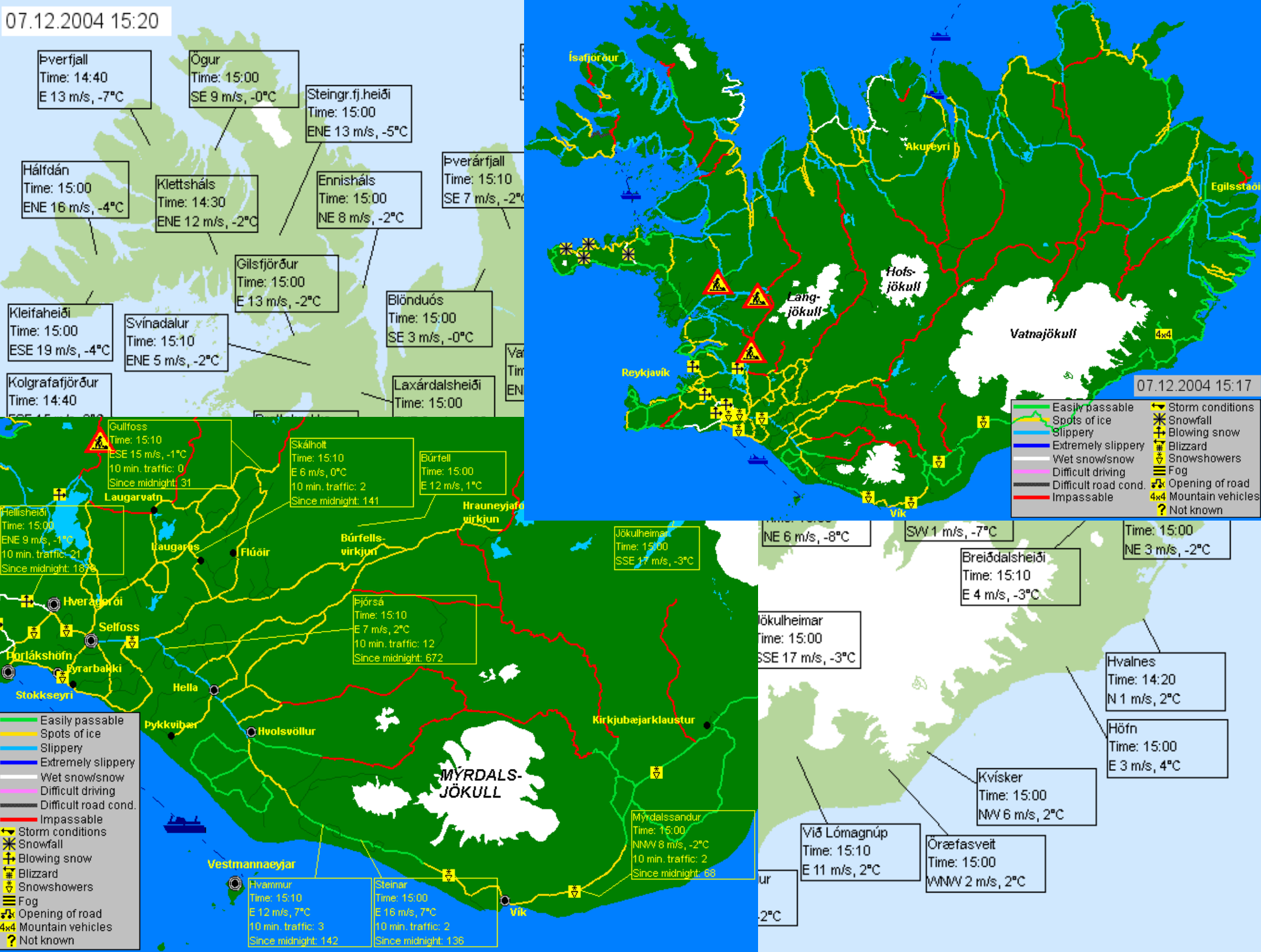
- Not available
- Dry
- Wet
- Possibly slippery




**Air temperature**
**Road temperature**

- Not available
- Dry
- Wet
- Possibly slippery

0-5 m/s ►
5-10 m/s ►►
10-15 m/s ►►►
15-20 m/s ►►►►
20-40 m/s ►►►►►


07.12.2004 15:20
Þverfjall
Time: 14:40
E 13 m/s, -7°C
Ögur
Time: 15:00
SE 9 m/s, -0°C
Steingr.fj.heiði
Time: 15:00
ENE 13 m/s, -5°C
Hálfdán
Time: 15:00
ENE 16 m/s, -4°C
Klettsháls
Time: 14:30
ENE 12 m/s, -2°C
Ennisháls
Time: 15:00
NE 8 m/s, -2°C
Þverárfjall
Time: 15:10
SE 7 m/s, -2°C
Gilsfjörður
Time: 15:00
E 13 m/s, -2°C
Blönduós
Time: 15:00
SE 3 m/s, -0°C
Kleifaheiði
Time: 15:00
ESE 19 m/s, -4°C
Svínadalur
Time: 15:10
ENE 5 m/s, -2°C
Kolgrafafjörður
Time: 14:40
Laxárdalsheiði
Time: 15:00
Ísafjörður
Akureyri
Egilsstaðir
Hofs-
jökull
Lang-
jökull
Vatnajökull
4x4
Reykjavík
Vík
07.12.2004 15:17
Easily passable
Spots of ice
Slippery
Extremely slippery
Wet snow/snow
Difficult driving
Difficult road cond.
Impassable
Storm conditions
Snowfall
Blowing snow
Blizzard
Snowshowers
Fog
Opening of road
4x4 Mountain vehicles
Not known
Gullfoss
Time: 15:10
ESE 15 m/s, -1°C
10 min. traffic: 0
Since midnight: 31
Skálholt
Time: 15:10
E 6 m/s, 0°C
10 min. traffic: 2
Since midnight: 141
Búrfell
Time: 15:00
E 12 m/s, 1°C
Laugarvatn
Hellisheiði
Time: 15:00
ENE 9 m/s, -1°C
10 min. traffic: 21
Since midnight: 187
Laugarás
Flúðir
Hraunneyjafoss-
virkjun
Búrfells-
virkjun
Jökulheimar
Time: 15:00
SSE 17 m/s, -3°C
Hveragerði
Selfoss
Þjórsá
Time: 15:10
E 7 m/s, 2°C
10 min. traffic: 12
Since midnight: 672
Þorlákshöfn
Eyrarbakki
Stokkseyri
Hella
Pykkvibær
Hvolsvöllur
MÝRDALS-
JÖKULL
Kirkjubæjarklaustur
Mýrdalssandur
Time: 15:00
NNW 8 m/s, -2°C
10 min. traffic: 2
Since midnight: 68
Vestmannaeyjar
Hvammur
Time: 15:10
E 12 m/s, 7°C
10 min. traffic: 3
Since midnight: 142
Steinar
Time: 15:00
E 16 m/s, 7°C
10 min. traffic: 2
Since midnight: 136
Vík
NE 6 m/s, -8°C
SW 1 m/s, -7°C
Time: 15:00
NE 3 m/s, -2°C
Breiðdalsheiði
Time: 15:10
E 4 m/s, -3°C
Jökulheimar
Time: 15:00
SSE 17 m/s, -3°C
Hvalnes
Time: 14:20
N 1 m/s, 2°C
Höfn
Time: 15:00
E 3 m/s, 4°C
Kvísker
Time: 15:00
NW 6 m/s, 2°C
Við Lómagnúp
Time: 15:10
E 11 m/s, 2°C
Öræfasveit
Time: 15:00
WNW 2 m/s, 2°C
Easily passable
Spots of ice
Slippery
Extremely slippery
Wet snow/snow
Difficult driving
Difficult road cond.
Impassable
Storm conditions
Snowfall
Blowing snow
Blizzard
Snowshowers
Fog
Opening of road
4x4 Mountain vehicles
Not known

# *ISmet* – Road Weather Information of The Road and Motorway Directorate of the Czech Republic

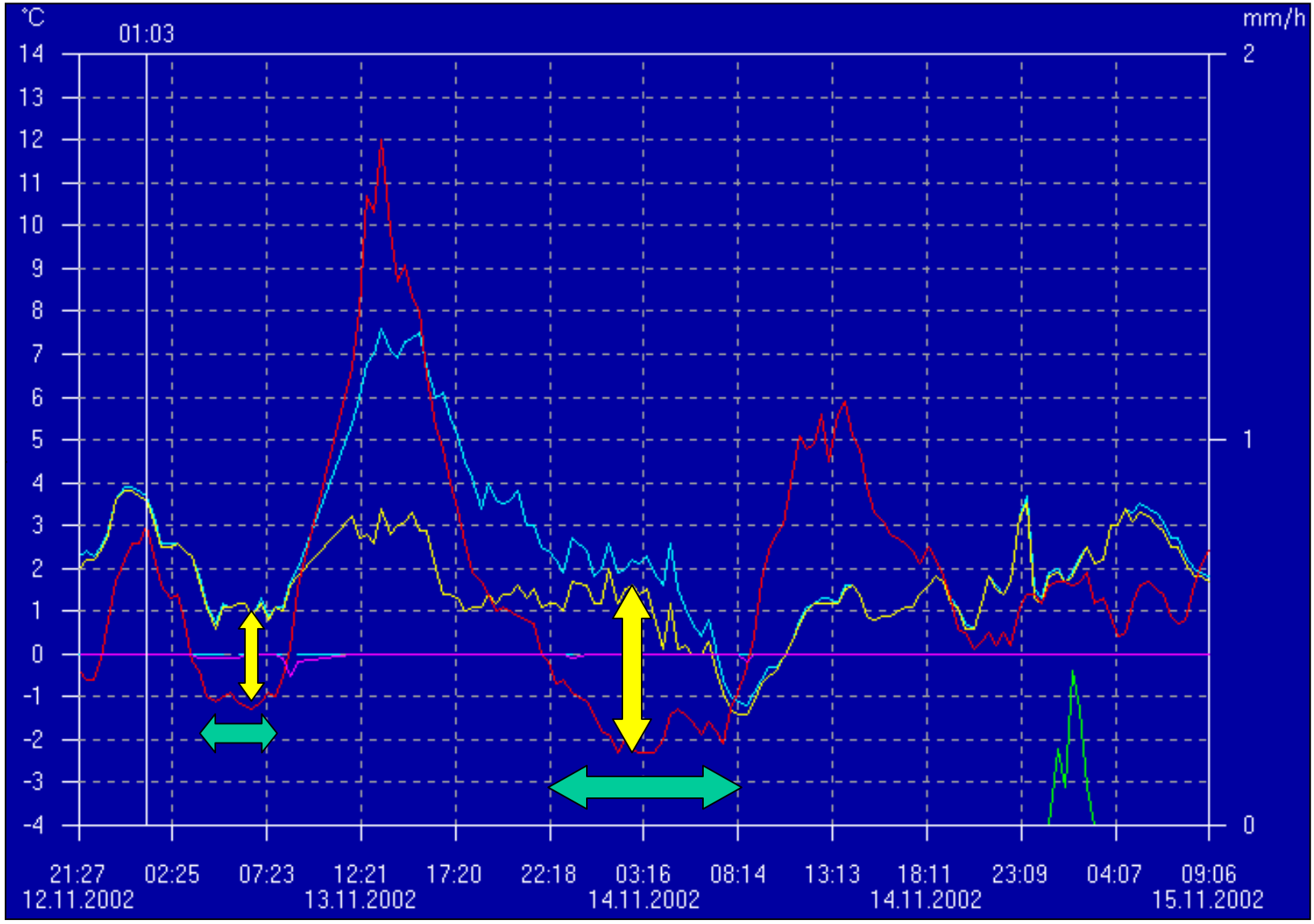
Actual meteorological information includes actual weather situation in the individual sites of meteo-stations within the RWIS in the highway and high speed roads.


| Stanice | Stav voz. | T voz. | Srážky | T vzd. | Čas |
|---|---|---|---|---|---|
| D1 2.8 km | sucho | 38.1 | žádné | 22.5 | 13:55 |
| D1 8.8 km | sucho | 40.8 | žádné | 20.7 | 13:55 |
| D1 15.4 km | sucho | 40.9 | žádné | 21.4 | 13:55 |
| D1 16.6 km | | | žádné | 20.3 | 13:48 |
| D1 27.8 km | mokro | 39.5 | žádné | 22.0 | 13:55 |
| D1 32.9 km | sucho | 39.5 | žádné | 20.4 | 13:49 |
| D1 Mirošovice 40,6 km | sucho | 39.5 | žádné | 19.4 | 13:55 |
| D1 44.3 km | sucho | 39.8 | žádné | 21.1 | 13:48 |
| D1 50.3 km | | | žádné | 19.8 | 13:51 |
| D1 68.6 km | sucho | 35.1 | žádné | 20.4 | 13:48 |
| D1 76.7 km | sucho | 41.3 | žádné | 21.3 | 13:51 |
| D1 85.7 km | sucho | 40.4 | žádné | 19.8 | 13:51 |
| D1 95.8 km | sucho | 37.6 | žádné | 18.3 | 13:51 |
| D1 103.7 km | sucho | 32.9 | žádné | 17.2 | 13:50 |
| D1 107.4 km | sucho | 34.5 | žádné | 18.2 | 13:51 |
| D1 126.0 km | sucho | 28.4 | žádné | 18.2 | 13:51 |
| D1 Beranov 136,8 km | sucho | 40.0 | lehké | 20.6 | 13:55 |
| D1 Domašov 144,0 km | sucho | 43.7 | žádné | 18.8 | 13:55 |
| D1 154.1 km | sucho | 37.0 | žádné | 19.0 | 13:53 |
| D1 164.9 km | sucho | 31.3 | žádné | 18.3 | 13:50 |
| D1 Bernartice 91.3 | sucho | 33.1 | žádné | 20.9 | 13:55 |
| D1 171.0 km | sucho | 31.4 | žádné | 17.7 | 13:49 |
| D1 179.9 km | sucho | 36.2 | žádné | 19.2 | 13:52 |
| D1 186.7 km | sucho | 31.0 | žádné | 18.7 | 13:52 |
| D1 190.9 km | sucho | 32.8 | žádné | 20.6 | 13:51 |
| D1 203.9 km | sucho | 28.6 | žádné | 18.4 | 13:48 |
| D1 214.4 km | sucho | 37.4 | žádné | 19.7 | 13:49 |
| D1 223.5 km | sucho | 40.1 | žádné | -100 | 13:50 |
| D1 228.6 km | sucho | 39.9 | žádné | -100 | 13:49 |
| D1 Ivanovice 231.8 | sucho | 39.0 | žádné | -26.0 | 13:48 |
| D1 Ivanovice 234.2 | sucho | 37.3 | žádné | -26.0 | 13:48 |
| D1 Ivanovice 241.5 | sucho | 37.8 | žádné | -26.0 | 13:48 |

# Weather impacts on roads, traffic and operational decisions by FHWA Road Weather Management Program, U.S. Department of transportation

| Road Weather Variables | Roadway Impacts | Traffic Flow Impacts | Operational Impacts |
|---|---|---|---|
| Air temperature and humidity | N/A | N/A | •Road treatment strategy (e.g., snow and ice control) |
| Wind speed | •Visibility distance (due to blowing snow, dust)<br>•Lane obstruction (due to wind-blown snow, debris) | •Traffic speed<br>•Travel time delay<br>•Accident risk | •Vehicle performance (e.g., stability)<br>•Access control (e.g., restrict vehicle type, close road)<br>•Evacuation decision support |
| Precipitation (type, rate, start/end times) | •Visibility distance<br>•Pavement friction<br>•Lane obstruction | •Roadway capacity<br>•Traffic speed<br>•Travel time delay<br>•Accident risk | •Vehicle performance (e.g., traction)<br>•Driver capabilities/behaviour<br>•Road treatment strategy<br>•Traffic signal timing<br>•Speed limit control<br>•Evacuation decision support<br>•Institutional coordination |
| Fog | •Visibility distance | •Traffic speed<br>•Speed variance<br>•Travel time delay<br>•Accident risk | •Driver capabilities/behavior<br>•Road treatment strategy<br>•Access control<br>•Speed limit control |
| Pavement temperature | •Infrastructure damage | N/A | •Road treatment strategy |
| Pavement condition | •Pavement friction<br>•Infrastructure damage | •Roadway capacity<br>•Traffic speed<br>•Travel time delay<br>•Accident risk | •Vehicle performance<br>•Driver capabilities/behavior (e.g., route choice)<br>•Road treatment strategy<br>•Traffic signal timing<br>•Speed limit control |
| Water level | •Lane submersion | •Traffic speed<br>•Travel time delay<br>•Accident risk | •Access control<br>•Evacuation decision support<br>•Institutional coordination |

Ice formation in the pavement surface: Tp < Tdew & Tp < 0° C



COST – European Cooperation in the field of Scientific and Technical Research – is one of the longest-running European instruments supporting cooperation among scientists and researchers across Europe.

**COST-Transport**

**COST Transport** is one of 17 domains existing in COST at the present time.

## COST 309
## Road Weather Conditions

The main research areas of COST 309 were defined as: road weather detection, forecasting, statistics and service strategies. The specific topics explored were:

- Sensors and measuring systems
- Overall systems, thermal mapping, data transmission
- Fog detection and prediction
- Weather radar
- Short term and immediate prediction of road conditions
- Weather index
- Weather and accidents
- Cost-benefit analysis of road weather services
- Communication between meteorologists and road maintenance authorities
- Dissemination of information between meteorological stations/to road users
- Effects of de-icing agents

# Intelligent Traffic Systems:

## Aerotech - Sweden

## FRENSOR®

**Freezing Point Detection**

A unique, patented monitoring device which is by far more accurate and reliable than traditional 'Bridge Freeze First' warnings.

The Frensor is used at airports and for detecting road conditions status. The Frensor can also be installed as a mobile unit **collecting road surface freezing temperatures** in real time along the road. The Frensor can be conneted to any host system via a serial port.

## Optic Eye™

**Precipitation Sensor**

This extremely compact ITS Technology device doesn't only **measure precipitation intensity in general, it also classifies rain, snow, sleet and drifting snow**.

Infrared beams forming a horizontal cross alter in intensity when being exposed to various kinds and quantities of precipitation. The Optic Eye registers and analyses the precipitation situation continously and can be connected to any host system via a serial port.

The Optic Eye can also form the basis for a low cost aqua planning warning system.

## ADVICY

**Ice Warning Systen**

The ADVICY System, developed by ITS Technology, doesn't only prevent fatal runway accidents, it also minimizes use of expensive and polluting chemicals. As does it reduce time and costs for anti icing operations and minimize holding times for scheduled departures.

## RWIS

**Road Weather Information System**

The RWIS, originally tailormade by ITS Technology in close cooperation with, the Swedish National Road Administration (SNRA) is one of the world's most comprehensive networks of its kind.

The RWIS integrates some 700 field stations in a national roadside datagathering system which saves lives and cuts costs in a Nordic Climate that is extremely hazardous.

The RWIS is, in fact, road traffic intelligence on a national scale in general and on a local and human-related scale in particular.

This gigantic ITS solution, since long positively evaluated, can be individually adopted to specific road, traffic and climatological conditions anywhere in the world.

# Surface Condition Management by boschung

Boschung - Switzerland

# Surface Condition Management

by boschung

***Atmospheric & Weather Sensors:***
Our weather instruments are very successful in areas ranging from road weather information, research, aviation, to synoptic observation.

Optical Scientific Inc.
[formerly Scientific Technology, Inc.]

## Optical Scientific - USA

The LEDWI® (Light Emitting Diode Weather Identifier) applies OSi's patented light scintillation theory and uses opto-electronic technology for the identification of **precipitation type**. It can also provide an accurate measurement of **precipitant quantity**.

WIVIS® (Weather Identifier & Visibility Sensor), our premier present weather sensor, is an automated instrument providing accurate **visibility and precipitation** measurements. The sensor **detects rain, snow, and mixed precipitation** conditions.

The VIS (Visibility Sensor) uses the same reliable optical technology employed in the high-end present weather sensor, the WIVIS®, to measure **visibility**. Whether its fog detection on a highway or at an airport, the VIS can operate in a broad range of applications.

The LOA (Long Baseline Optical Anemometer and Turbulence Sensor is a very powerful instrument. It measures path integrated **crosswinds and turbulence** intensity.

The ORG® is OSi's automated **rain gauge**. The instrument provides accurate measurement of rain rate. This ability makes the instrument more reliable than traditional tipping buckets or collection gauges which have problems with very light and heavy events.

VAISALA

Vaisala - Finland

## Vaisala ROSA Weather Station - continued

Using the measurement data produced by the sensors, the ROSA Ice Warning Station determines the anti-icing chemical concentration, freezing point temperature and surface state. The surface state classifications are:

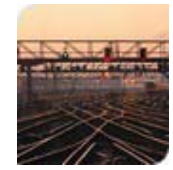
- Dry
- Moist (& chemical)
- Wet (& chemical)
- Frosty
- Snowy
- Icy

The following alarms can be generated:

- Rain warning
- Frost warning
- Ice warning
- Ice alarm

## Vaisala Rail Weather Stations

Railways and metro systems are special environments with unique requirements and regulations. Vaisala can supply rail, light rail and metro system authorities with modular, automatic weather stations that are specially adapted to the railway environment from the widely used ROSA Ice Warning stations.



## Vaisala Thermal Mapping

Some sections of a highway or runway will always be warmer or colder than others. This pattern of temperature variation is determined by local environmental factors and prevailing weather conditions. On a winter's night minimum pavement surface temperatures may vary by up to 7.0°C, creating problems for winter maintenance engineers dealing with snow and ice hazards. Thermal Mapping is a vehicle-based survey technique, scientifically proven to identify and quantify the distribution of temperature differences across a network.

## Key benefits of Thermal Mapping:

- Identification of danger areas that may not be apparent from only using weather stations.
- Identifies the optimum location and number of weather stations.
- Enables the provision of Forecast Thermal Maps in an IceCast system.
- Enables selective anti-icing strategies that only target those areas in need of treatment.
- Key input data for Route Optimisation.
- Provides quantitative reference data.

## Bridge Weather Applications

The hazards of ice, wind and low visibility are compounded on bridges. For this reason, Vaisala delivers a package of products and services to help road authorities to manage the special hazards of bad weather on bridges. These include a specially designed bridge-deck sensor that measures bridge surface state, temperature and depression of freezing point. We also provide wind measurement systems that process standard parameters (average, gust, direction, speed) and trigger alarms when they are exceeded.

## Vaisala Ultrasonic Wind Sensor WS425

With its continuous data availability, the WS425 is ideal for a variety of wind measurement applications such as meteorology, aviation, road and railway safety and energy production.

## Vaisala Wind Sensor WM30

The WM30 wind sensor is a compact, economical wind speed and direction sensor. The rotating cup anemometer at the top of the unit provides a linear response to wind speed. The vane, which is attached to the body of the unit, provides a fast response to wind direction.

## Vaisala MIDAS IV LLWAS Low-Level Windshear Alert System

The Vaisala MIDAS IV LLWAS is a ground-based system that detects low-level windshear in runway corridors. At airports that are known to experience low-level horizontal windshear, the MIDAS IV LLWAS can be fundamental to improving safety and operating efficiency. The system gives visual and audio alerts to air traffic controllers and other airport personnel in clear and concise numerical and/or graphical form.

## Vaisala AW11 Aviation Weather Reporter

The fully automatic AW11 is a stand-alone weather observation and reporting system designed for small airports, heliports and unmanned airstrips. The AW11 measures all standard aviation weather parameters and generates accurate real-time weather reports. Standard measurements include sky condition (cloud layer height and coverage), visibility, air pressure, temperature, dew point, and wind speed and direction. Precipitation occurrence and intensity measurements are also available.

# R. M. YOUNG COMPANY

## Meteorological Instruments

R.M.Young - USA

**Transportation**
Wind and temperature monitoring system for bridge traffic safety and local weather reporting on the Mackinac Bridge connecting Michigan's upper and lower peninsula.

**Weather Observing & Forecasting**
International Balloon Championship, Battle Creek, Michigan. Local weather forecasting for launch determination and safety. Photo courtesy of Dr. Ronald Portman, Department of Atmospheric and Oceanic Science, The University of Michigan.

**Harbors, Ships, and Workboats**
Harbor surge forecast experiment for NOAA-NOS (National Ocean Survey) at Brandywine Shoal Light, Delaware Bay. Photo courtesy of James H. Meyer, Applied Physics Laboratory, Johns Hopkins University.

Lectures given by the external experts: