# Weather Forecasts & Natural Hazards

## Best practice examples
## Climate change
## Natural Hazards Map
## Research activities

UBIMET GmbH
Donau-City-Str. 11
1220 Vienna / AUSTRIA

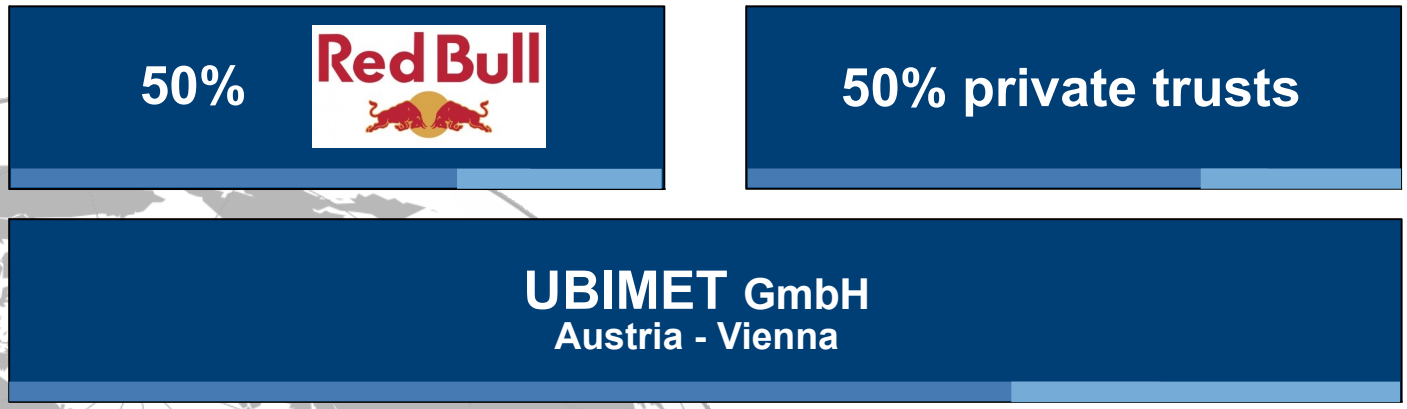
Mr. Stefan EISENBACH
☎ 0043 1 99 71 004
office@ubimet.com

Fax 0043 1 997 004 20
www.ubimet.com

# UBIMET – THE RAILWAY WEATHER SERVICE

- One of the largest meteorological institutes in Central and Eastern Europe
- **International corporation** with branches from Austria to Australia and **more than 150 employees (mostly scientists)**
- Specialized in **forecast and warning systems for railway operators** and other infrastructure businesses
- **Main supplier** of meteorological data for the **Austrian Federal Railroads (ÖBB)**

# UBIMET - Company Structure




- Founded 2004 in Vienna, Austria
- International & global meteorological services service
- Market and innovation leader regarding severe weather warnings
  - more than 1.5 mio recipients
- Specialized in forecast and warning systems for railway operators and other infrastructure businesses
- High resolution weather forecast models and very local predictions systems

# UBIMET – Head Quarters

**Vienna, Austria**

Meteorological Head Office
Weather Warning Centre
Administration

**Innsbruck, Austria**

Centre for
Alpine Meteorology

**Melbourne, Australia**

Subtropical and tropical
Forecast- & Research
Centre

# Our advantage – more detailed forecast models

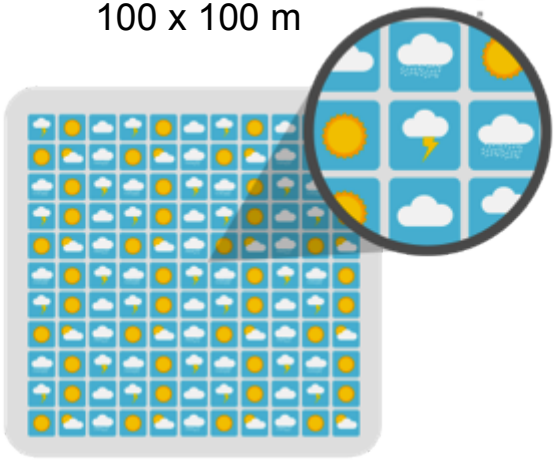
STANDARD global
50 x 50 km

1 Weather Zone

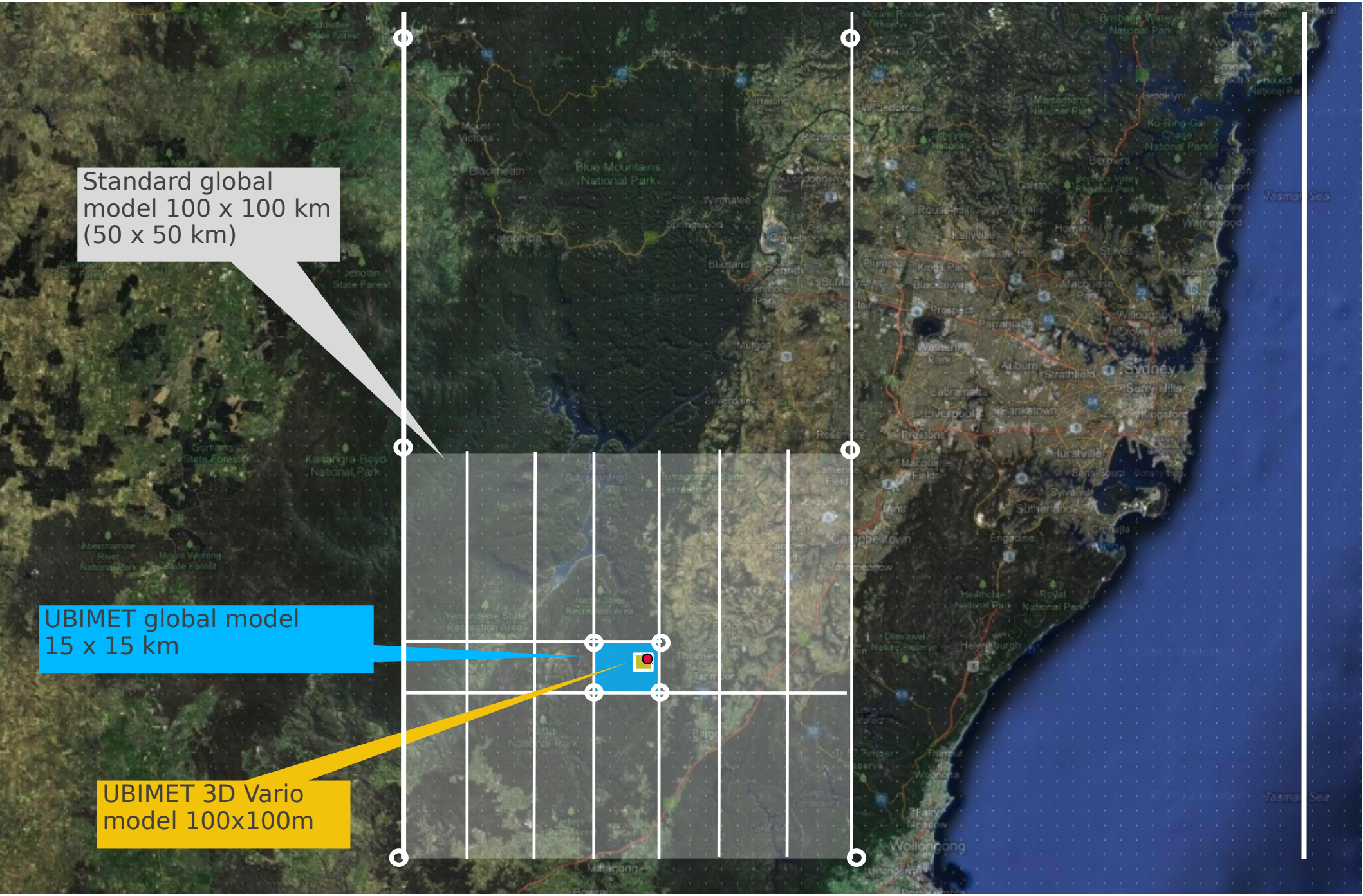
UBIMET global
15 x 15 km

9 Weather Zones

UBIMET 3D VAR
100 x 100 m



250.000 Weather Zones


Standard global model 100 x 100 km (50 x 50 km)
UBIMET global model 15 x 15 km
UBIMET 3D Vario model 100x100m
Blue Mountains National Park
Sydney
Wollongong

# Advantage in mountainous regions

**UBIMET**
Forecasts for every single location in real time

**BASE MODELS**
Forecasts fore large areas recalculated 2-4 times a day

# RAILWAYS AND CLIMATE CHANGE

# Climate change study by the Austrian Railways

## ÖBB, Umweltbundesamt, BOKU Vienna

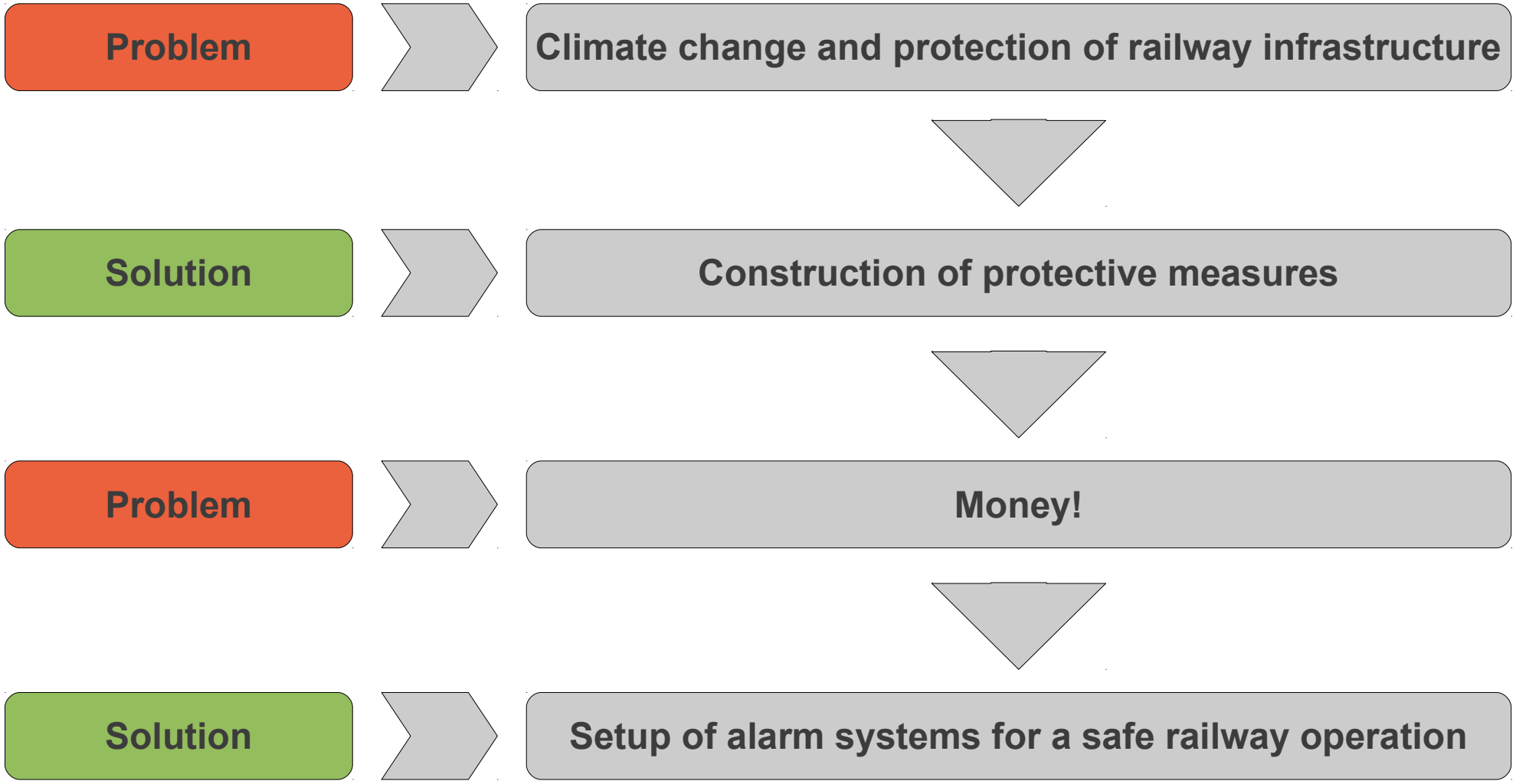
| | | |
|---|---|---|
| large scale precipitation | floodings of larger rivers | |
| local heavy precipitation | flash floods | |
| heavy snowfall (near 0°C) | wet & heavy snow e.g. on trees | |
| avalanches | snow, wind, changing temperatures | |
| local storm gusts | thunderstorms | |
| large scale gales | e.g. storms in autumn/winter | |
| blowing snow | wind & cold temperatures | |
| high temperatures | multiple day heat waves | |

# Recommendations based on the study

- Considerations of future climate change and meteorological conditions during the **planning phase of new railway lines**
- **Creation of awareness inside your company** about climate change and severe weather phenomena
- Encouragement of **knowledge transfer** with other companies, scientific institutions, networks and railroads.

PERSPEKTIVEN FÜR UMWELT & GESELLSCHAFT umweltbundesamt
BOKU Met
ÖBB INFRA
Contact: Mr. Christian Rachoy (ÖBB)
christian.rachoy@oebb.at

# How to be prepared for climate change challenges?



# Best Practice Example: ÖBB infra:wetter

- In 2005 the Austrian Federal Railroads (ÖBB) implemented a ubiquitous Weather Information System, called **infra:wetter**, in order to be more prepared for extreme weather events!

- Goals of the System:
  - Highly precise weather forecasts along the railway lines
  - Exact snow forecasts for the planning of winter services
  - Severe Weather Warnings for the safety of railway operation

- The system includes:
  - On demand weather forecasts by special infrastructure weather models
  - Weather warning system
  - Flash flood warning system
  - Fire risk warning system
  - Weather station data
  - Flooding predictions

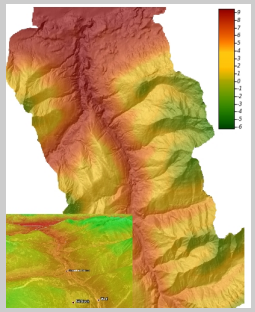
**The Weather Alert and Informations system of ÖBB is considered as an best practice example by respective EU projects**

# Weather forecast & warning systems for railways

- Detailed & accurate forecasts
- Severe weather warnings
- Naturals hazards & risk plan
- Decision support system
- Documentation & communication

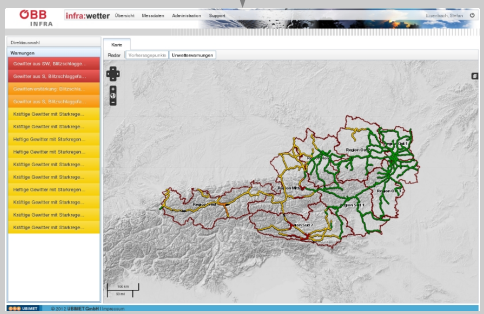
**Railway Weather Information & Alert System**

## Information process:



Weather models

Quality control / Meteorologist

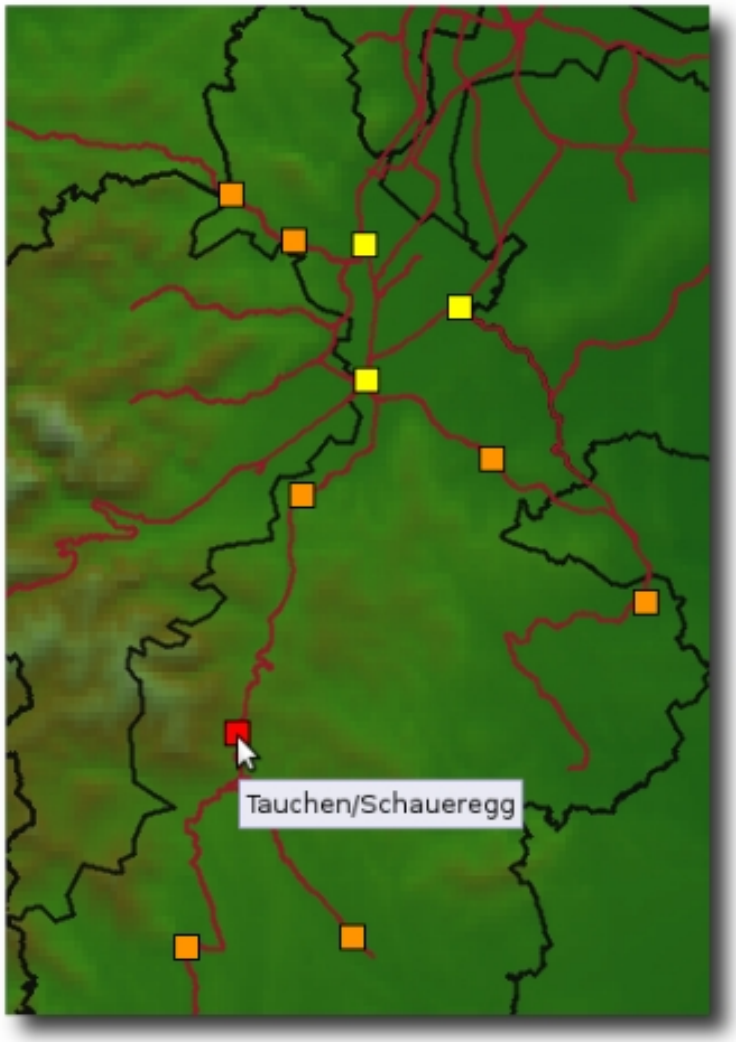



Weather Information & Warning System

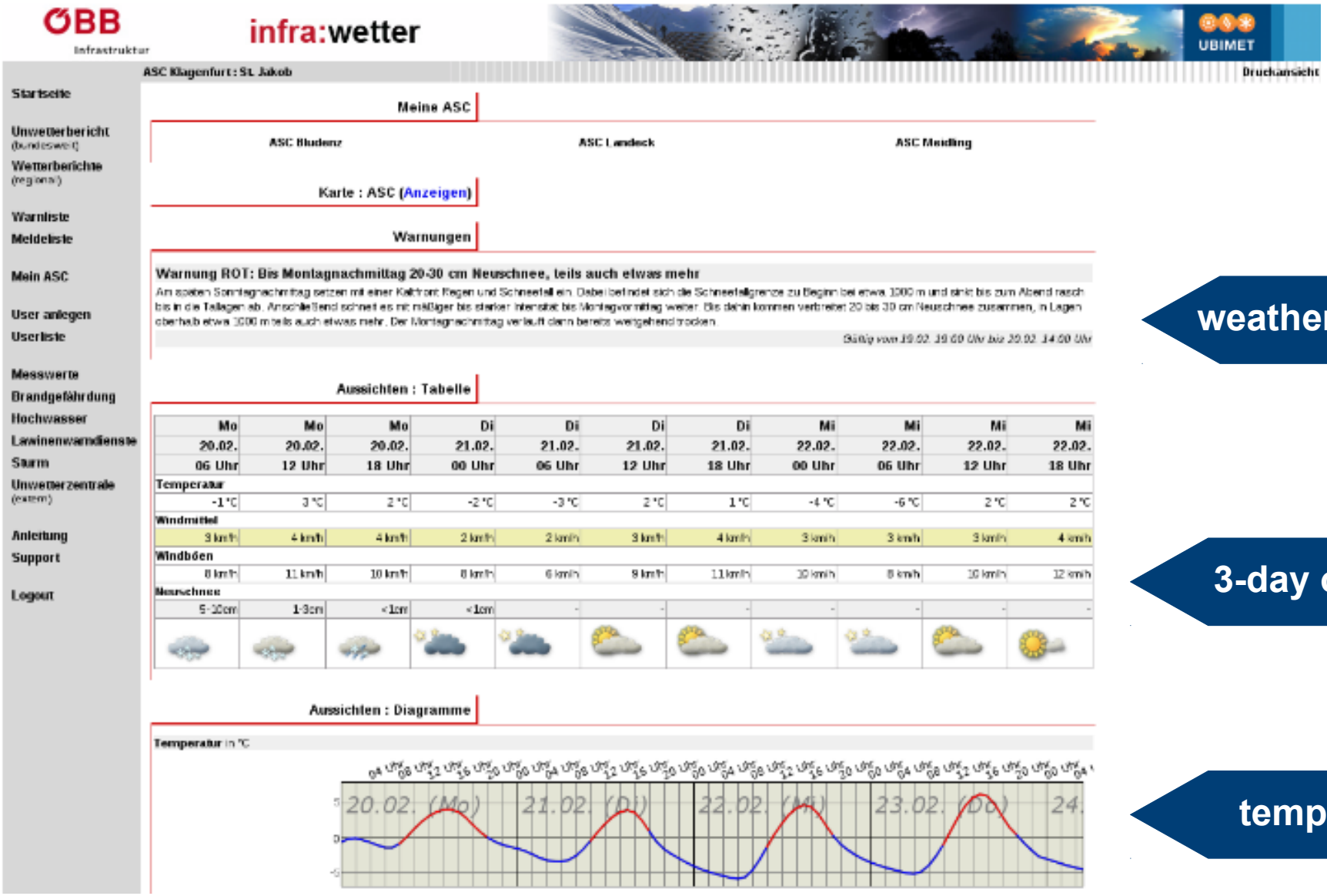
Railway Operator

# The Austrian infra.wetter

- On demand forecasts for important railway stations or critical points along the tracks
- High resolution weather model with a complete implementation of the railway network
- Exact calculation of important meteorological parameters like temperature, windspeed, precipitation, snowfall, snow line,...
- Essential for the organization of the whole railway operation (planning of human ressources, snow removal,...)
- Weather warnings for safe operation!



# On demand weather forecasts

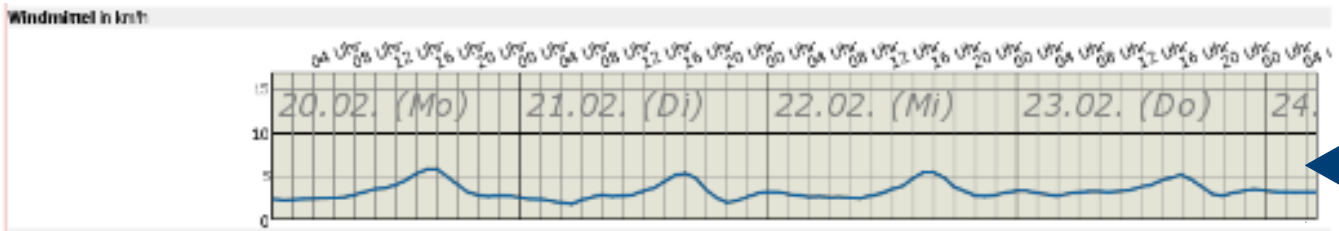



weather warnings

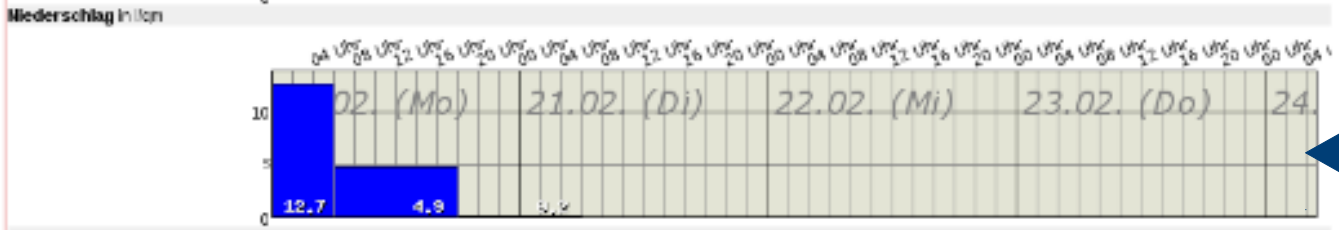
3-day overview

temperature

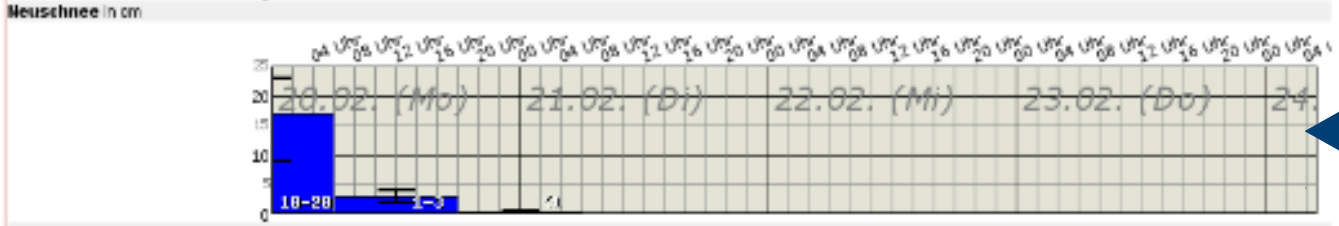
# On demand weather forecasts



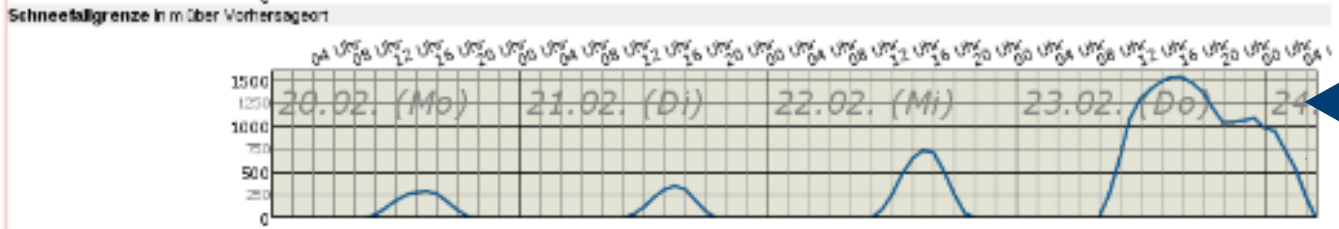

wind




precipitation




snow




Snow line

report system

ÖBB INFRA

infra:wetter Übersicht Messdaten Administration Support Eisenbach, Stefan

Direktauswahl

Warnungen

- Gewitter aus SW, Blitzschlagge...
- Gewitter aus S, Blitzschlaggefa...
- Gewitterverstärkung: Blitzschla...
- Gewitter aus S, Blitzschlaggefa...
- Kräftige Gewitter mit Starkrege...
- Kräftige Gewitter mit Starkrege...
- Heftige Gewitter mit Starkregen...
- Heftige Gewitter mit Starkregen...
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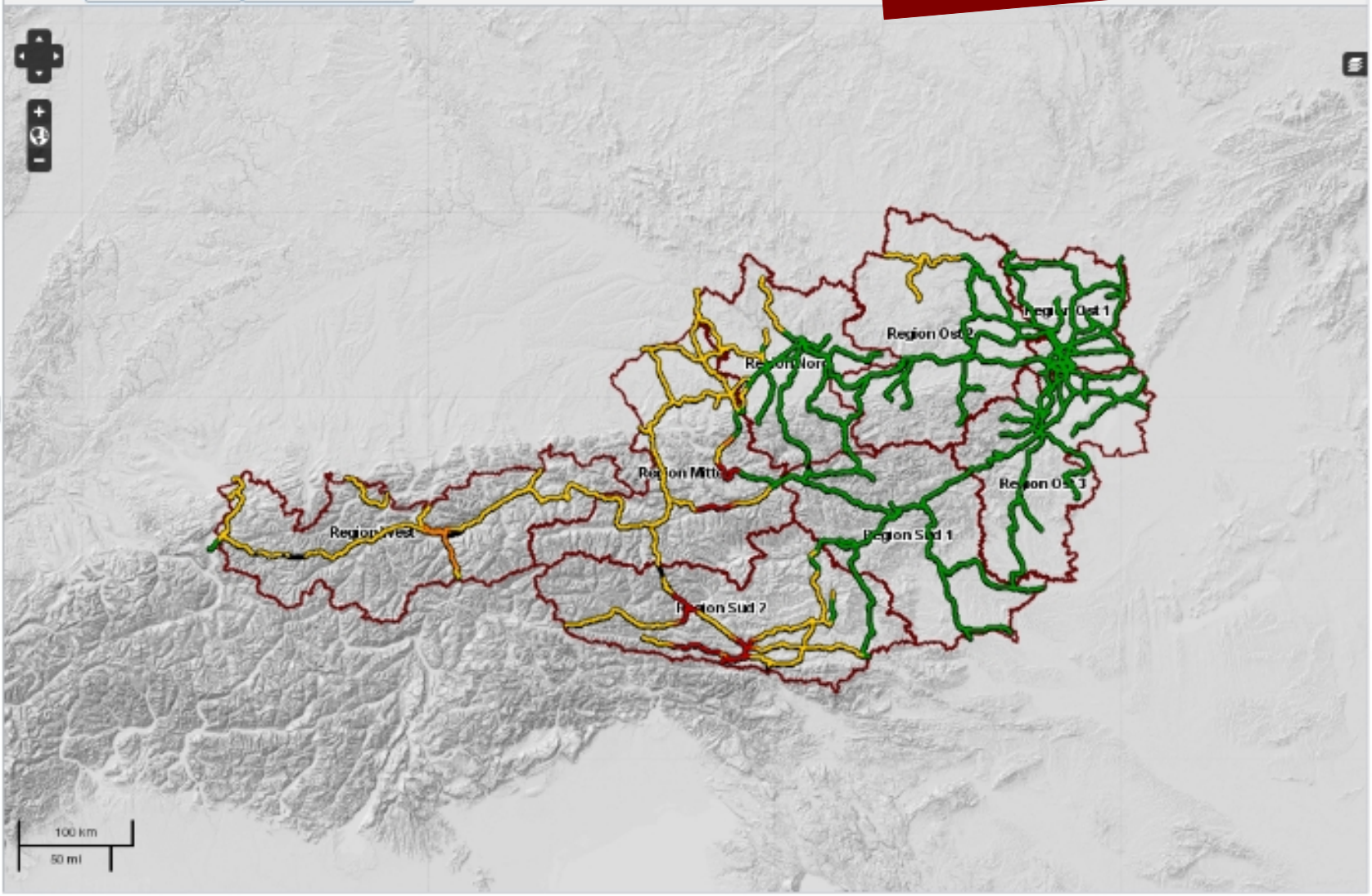
Karte

Radar | Vorhersagepunkte | Unwetterwarnungen

overview

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infra:wetter Übersicht Administration Stefan Eisenbach

regional overview

Direktauswahl

Meine Bereiche | Alle Bereiche

- ASC Bludenz
- ASC Innsbruck
  - Brennersee
  - Hall/Tirol
  - Hochzirl
  - Innsbruck Hbf.
  - Matrei
  - Schamitz
  - Schwaz
  - Seefeld
  - Steinach
- ASC Landeck

Warnungen

Karte | ASC Innsbruck

## Vorhersage für ASC Innsbruck

### Warnungen

**ORANGE-WARNUNG: Erneut Südföhn, ab dem späten Nachmittag einzelne Böen von 70 bis 80 km/h**

Am Montag lebt im Tagesverlauf erneut teils kräftiger Südföhn auf. Ab dem späten Nachmittag sind besonders in freien und exponierten Lagen einzelne Böen von 70 bis 80 km/h zu erwarten, kurzzeitig sind auch noch stärkere Böen möglich. In der Nacht auf Dienstag flaut der Wind dann wieder ab.

| | |
|---|---|
| Erstellungszeit | Montag, 30. April 2012 **13:22** |
| Beginn | Montag, 30. April 2012 **15:00** |
| Ende | Dienstag, 01. Mai 2012 **00:00** |

### Prognose für den Winterdienst

| | Fr., 25.10.2013 | | Sa., 26.10.2013 | | So., 27.10.2013 | | |
|---|---|---|---|---|---|---|---|
| | 18:00–06:00 | 06:00–18:00 | 18:00–06:00 | 06:00–18:00 | 19:00–06:00 | 06:00–18:00 | |
| **Mödling** 212m | — | — | — | — | — | — | *Neuschneehöhe* |
| | — | — | — | — | — | — | *Glatteisgefahr* |
| **Wien West** 205m | — | — | — | — | — | — | *Neuschneehöhe* |
| | — | — | — | — | — | — | *Glatteisgefahr* |

*Diese Prognose wurde von Meteorologen erstellt.*

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Direktauswahl

Warnungen

Derzeit liegen keine Warnungen...

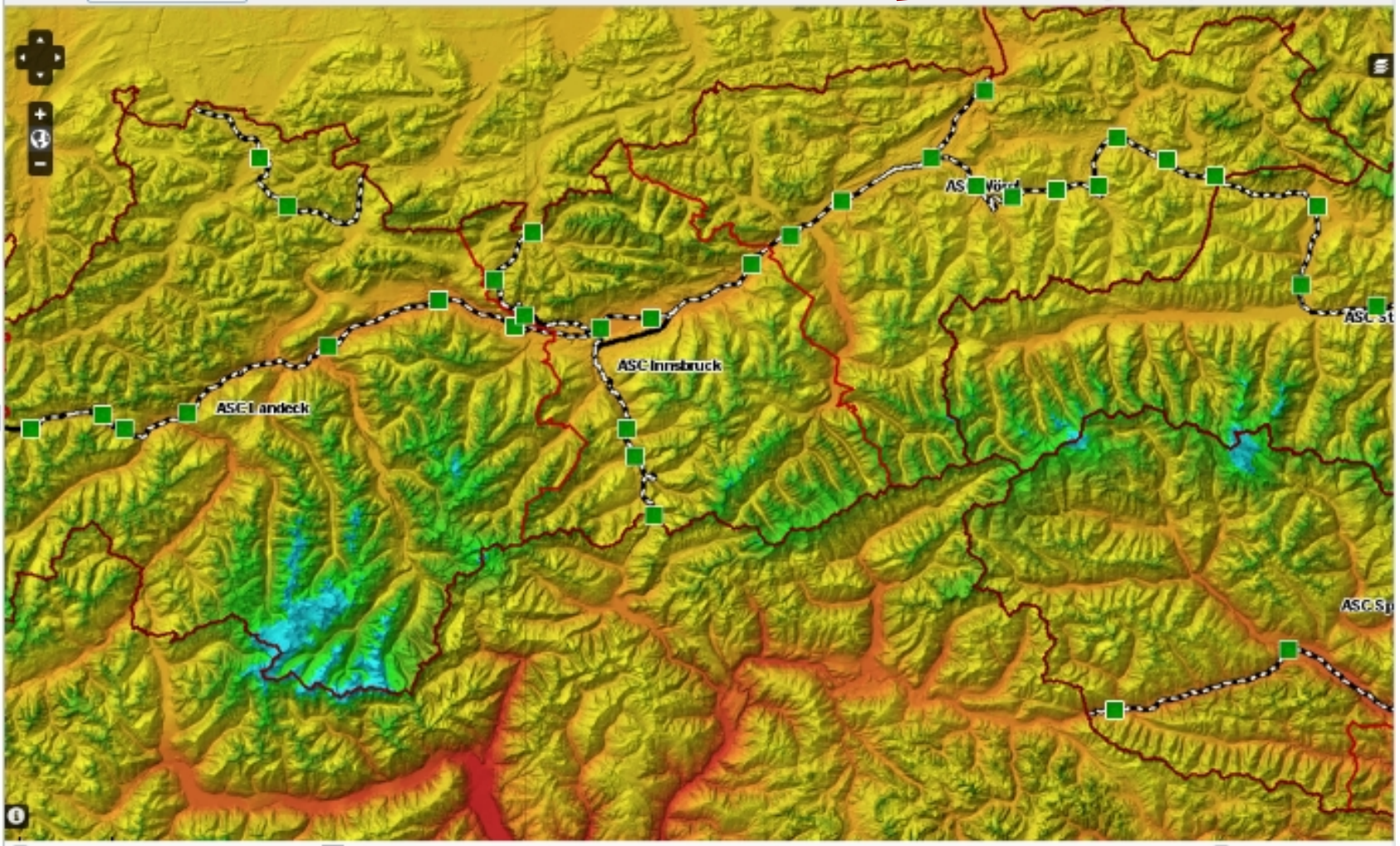
Warnstufen

Karte | Wetterberichte | ASC Meidling | Ebenfurth | Heiligenstadt

Radar | Vorhersagepunkte | Unwetterwarnungen

Donnerstag, 06. September 2012 **18:00**

**temperature**




06.09. 06:00 12:00 18:00 07.09. 06:00 12:00 18:00 08.09. 06:00 12:00 18:00 09.09.

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Direktauswahl

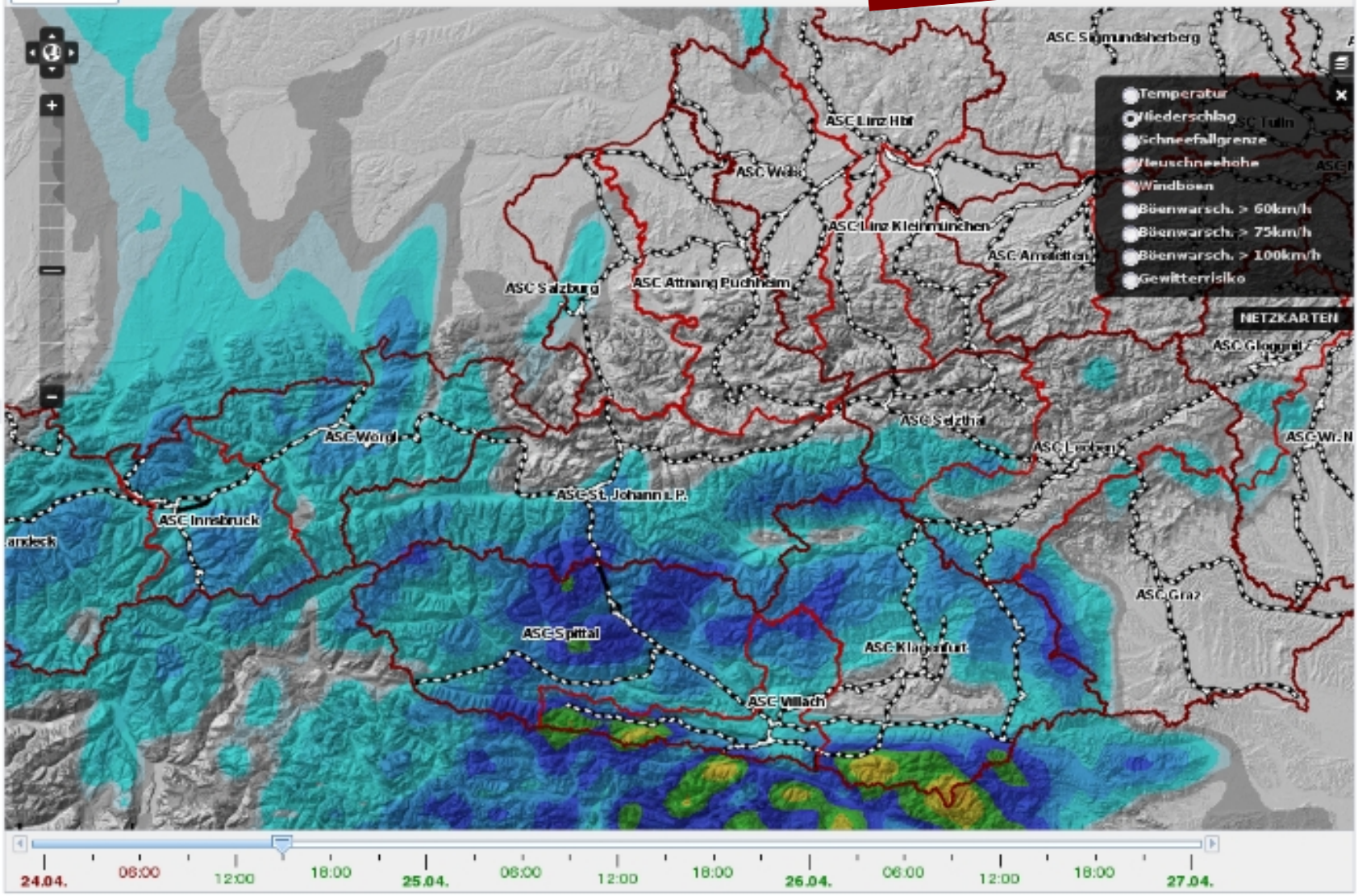
Warnungen

Derzeit liegen keine Warnungen vor.

Karte

Warnpunkte

**precipitation**

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Direktauswahl

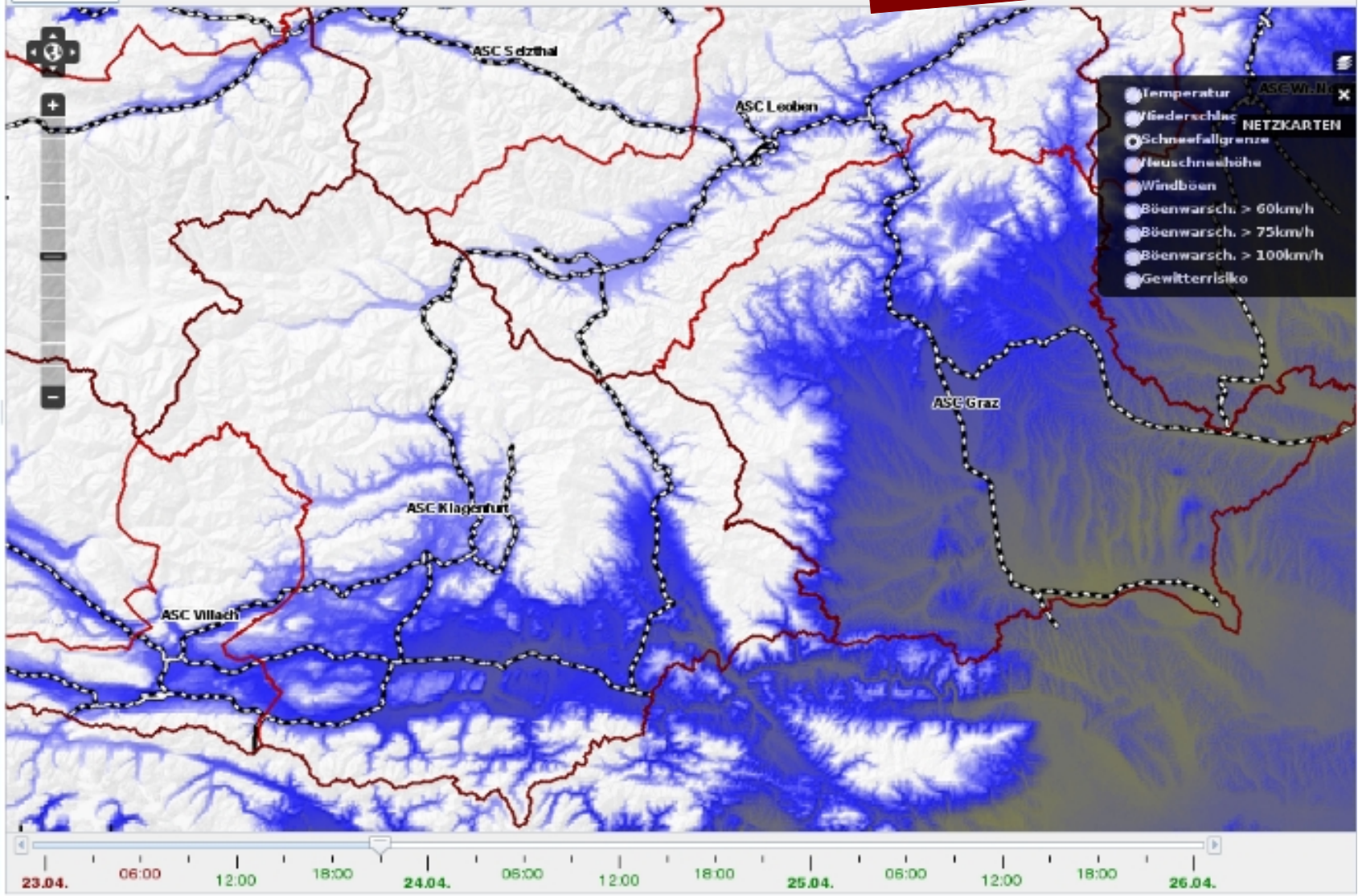
Warnungen

Derzeit liegen keine Warnungen vor.

Karte

Warnpunkte

snow line

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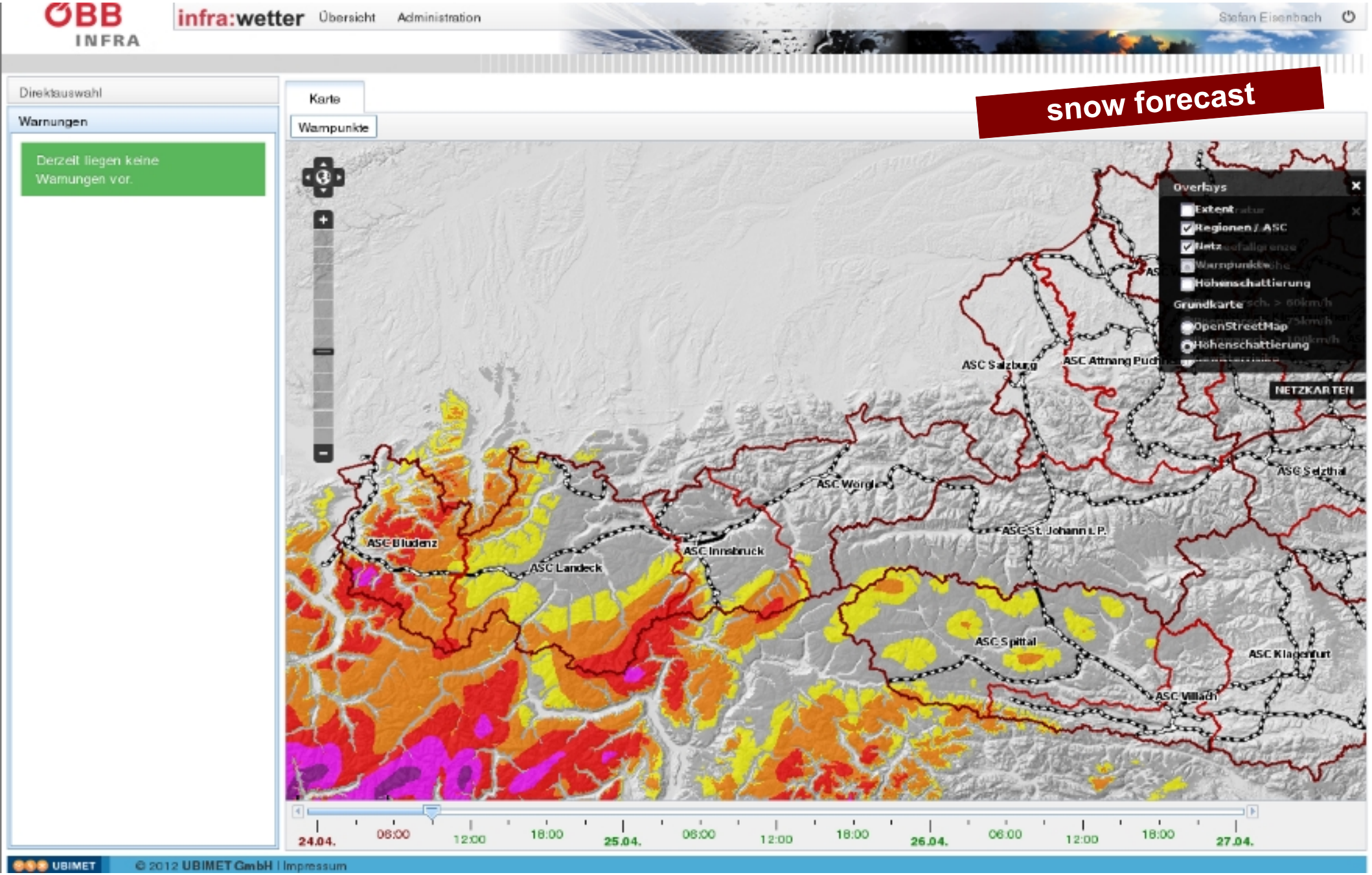
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infra:wetter
Übersicht
Administration
Stefan Eisenbach
Direktauswahl
Warnungen
Derzeit liegen keine Warnungen vor.
Karte
Warnpunkte
snow forecast
Overlays
Extent
Regionen / ASC
Netz
Warnpunkte
Höhenschattierung
Grundkarte
OpenStreetMap
Höhenschattierung
NETZKARTEN
ASC Salzburg
ASC Attnang Puch
ASC Selzthal
ASC Wörgl
ASC St. Johann i.P.
ASC Bludenz
ASC Innsbruck
ASC Landeck
ASC Spittal
ASC Klagenfurt
ASC Villach
24.04.
06:00
12:00
18:00
25.04.
06:00
12:00
18:00
26.04.
06:00
12:00
18:00
27.04.
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Direktauswahl

Warnungen

Derzeit liegen keine Warnungen vor.

Karte

Warnpunkte

zoom in

Temperatur
Niederschlag
Schneefallgrenze
Neuschneehöhe
Windboen
Böenwarsch. > 60km/h
Böenwarsch. > 75km/h
Böenwarsch. > 100km/h
Gewitterrisiko

NETZKARTEN

ASG Innsbruck

24.04. 06:00 12:00 18:00 25.04. 06:00 12:00 18:00 26.04. 06:00 12:00 18:00 27.04.

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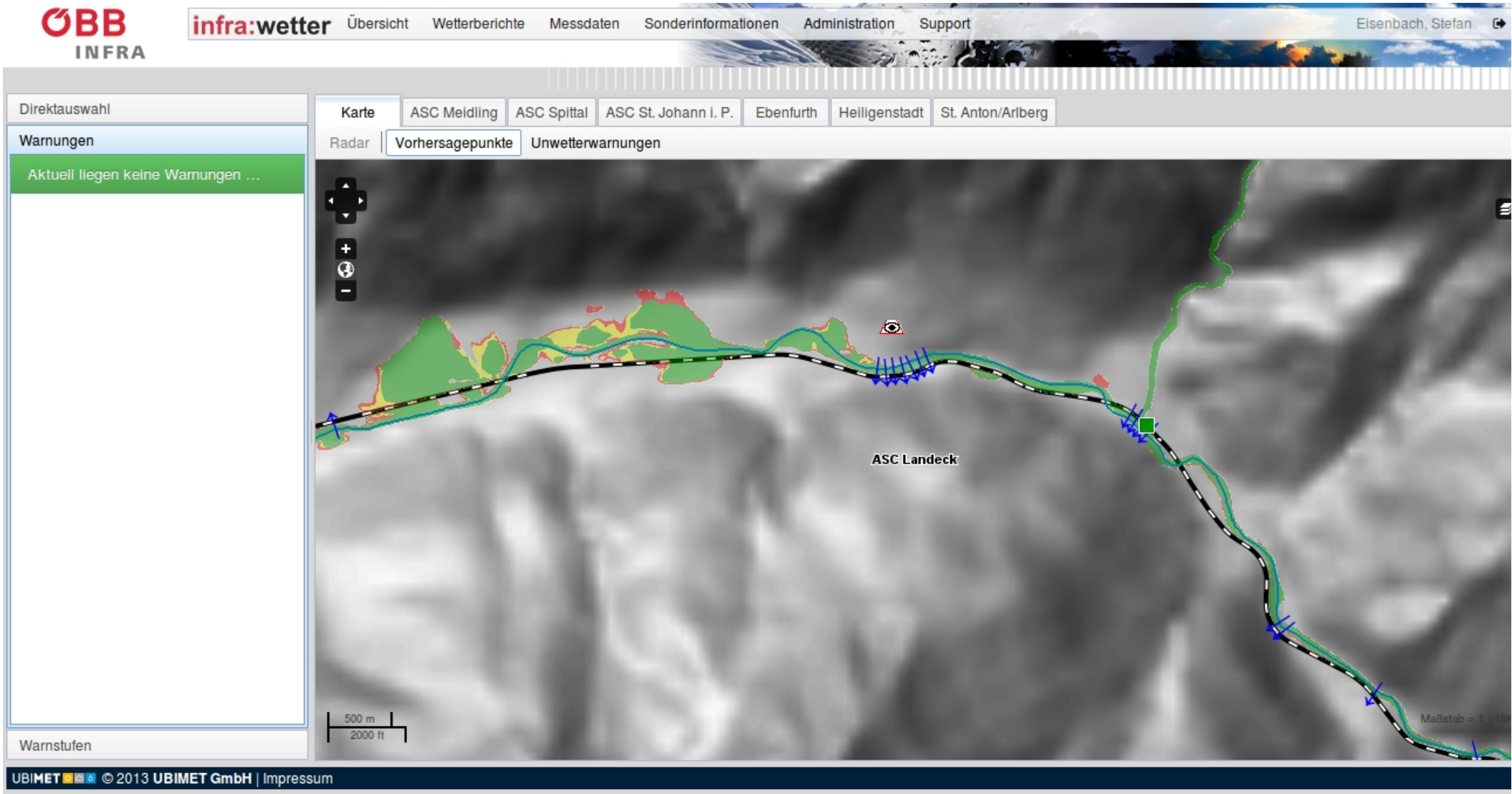
# Implementation of natural hazards information into the rail weather system



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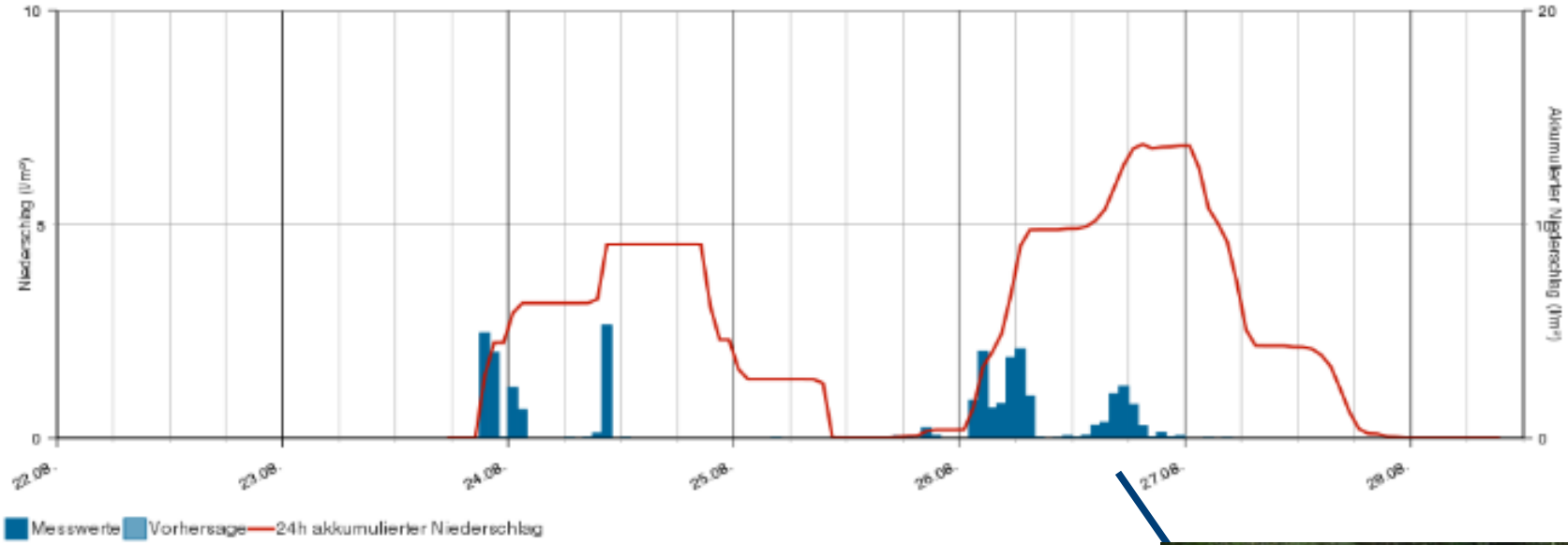
Kathalbach | Masonbach | Poellinger Graben | Schmiedgraben | Trattenbach

## Trattenbach

**flash flood warning**



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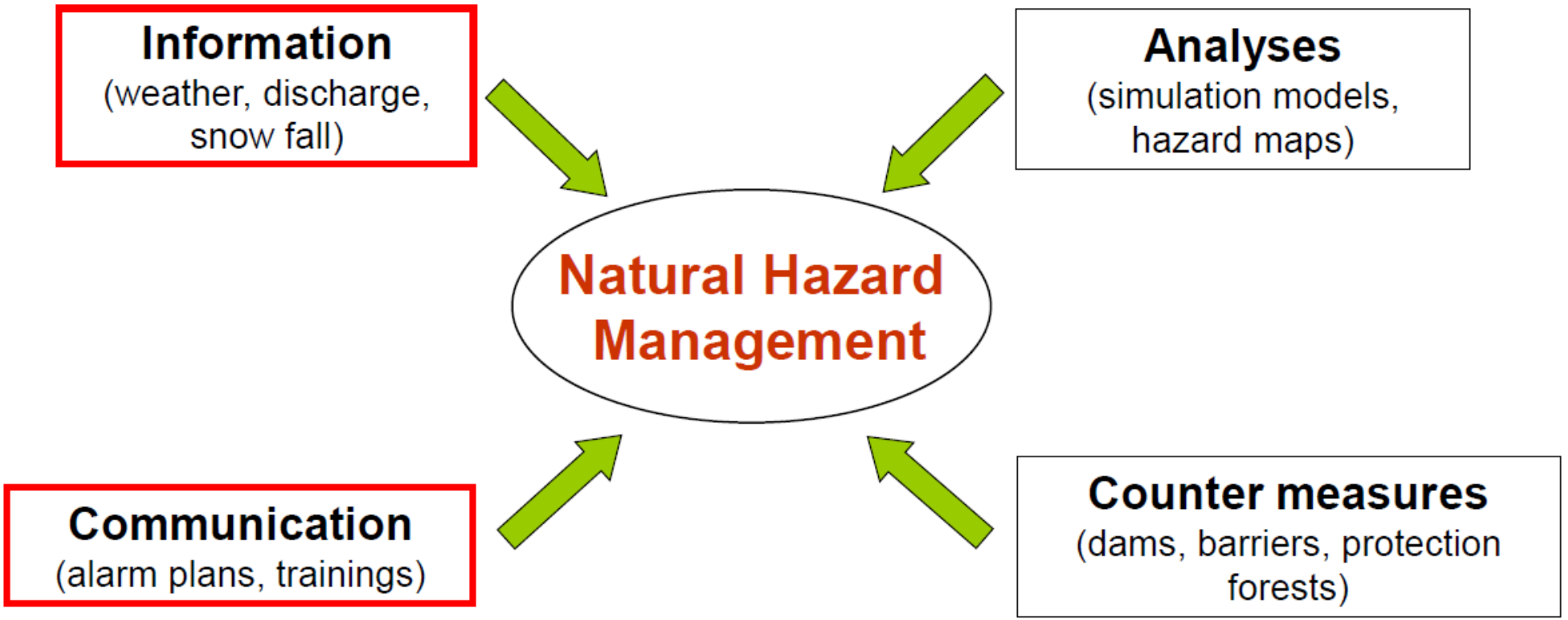
# Further best practice examples

- **SNCF** (France)
  - Special emergency time tables at severe weather events
  - Passenger and customer information when these time tables are in place
  - Information videos for passengers
  - Passengers know what delays are expected and which trains will be cancelled

- **ÖBB** (Austria)
  - Handbuch Winterdienst (handbook winter service)
  - Checklists and decisions support for the whole winter operation, based on forecasts

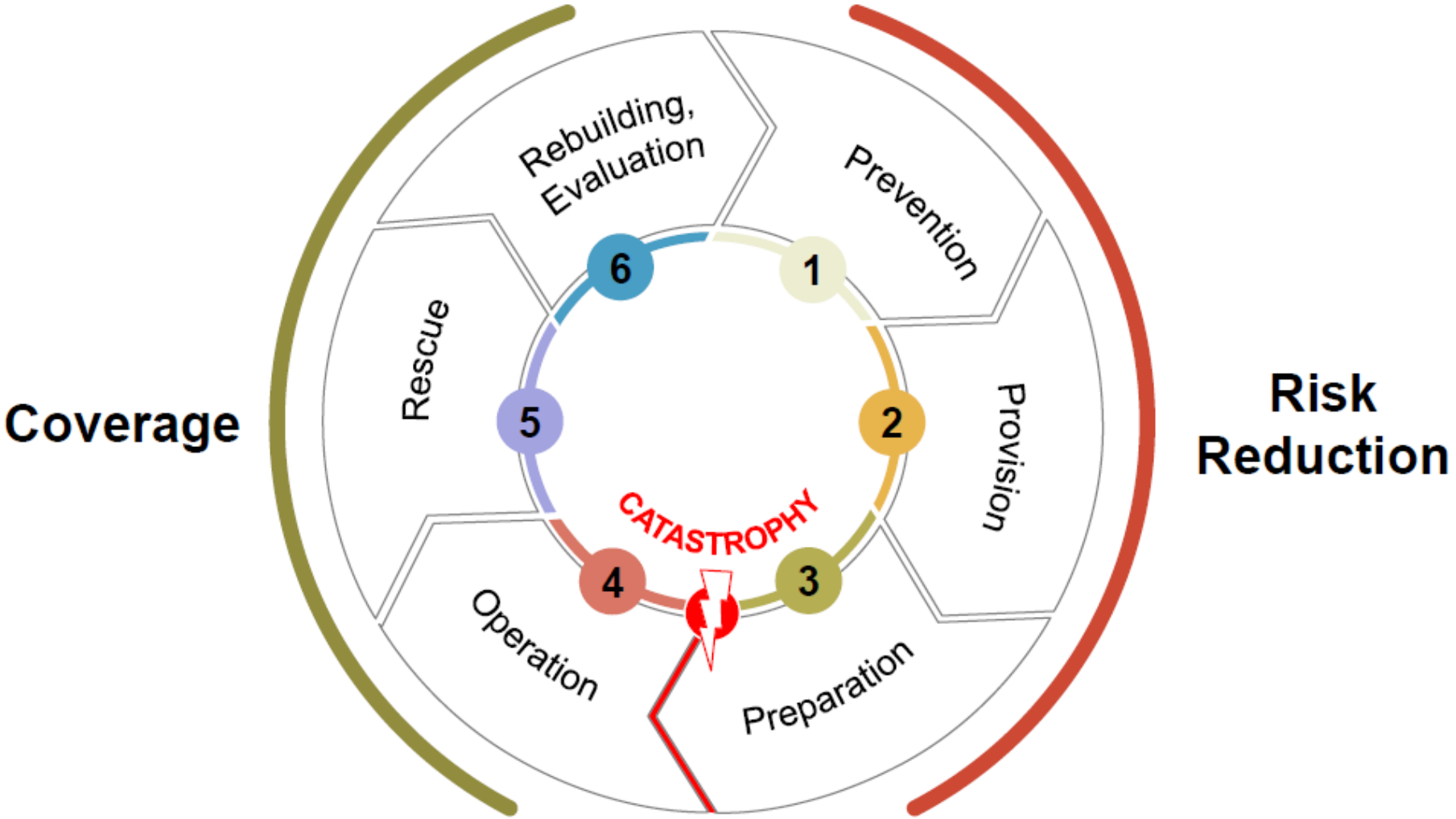
- **ÖBB** (Austria) and **SBB** (Switzerland)
  - Natural Hazards Departments
  - Own departments for risk analysis and risk prevention
  - Special trained core staff for natural hazards

# ÖBB Natural Hazards Management System

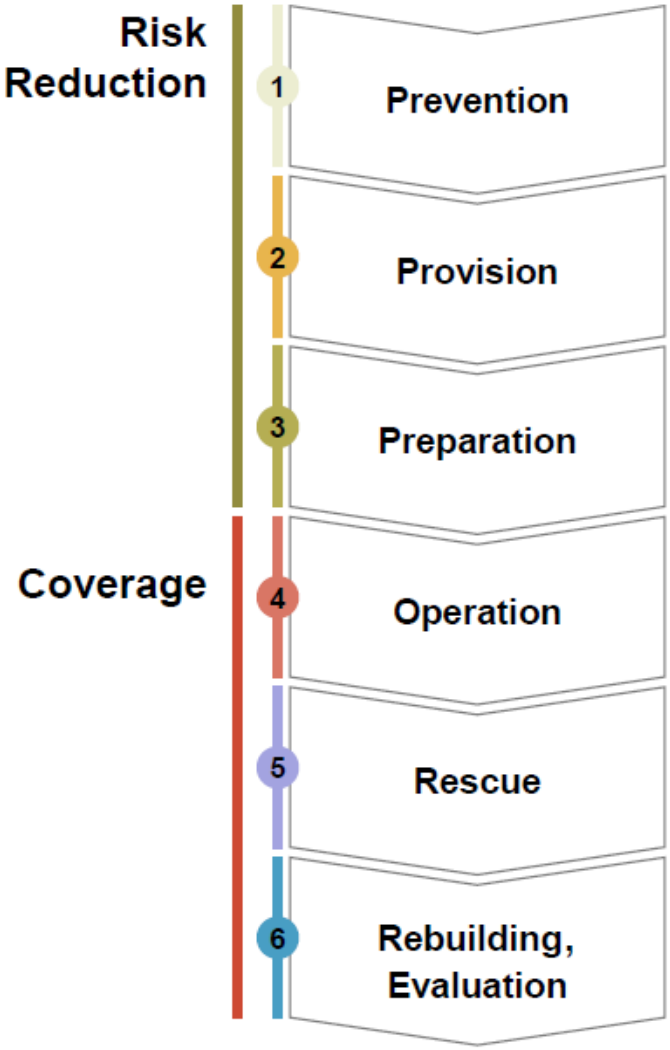



**Prevention instead of reaction!**

# ÖBB Natural Hazards Management System



# ÖBB Natural Hazards Management System




- Natural Hazard Map
- Protection Forest Management
- Technical Facility Management

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- Weather Information System infra:wetter
- Technical Warning Systems
- Emergency Trainings

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- ÖBB-Avalanche Warning Service & Commissions
- Flood Warning Service
- Alarm Plans

---

- Observation
- Hazard Assessment
- (Avalanche) Victim Search

---

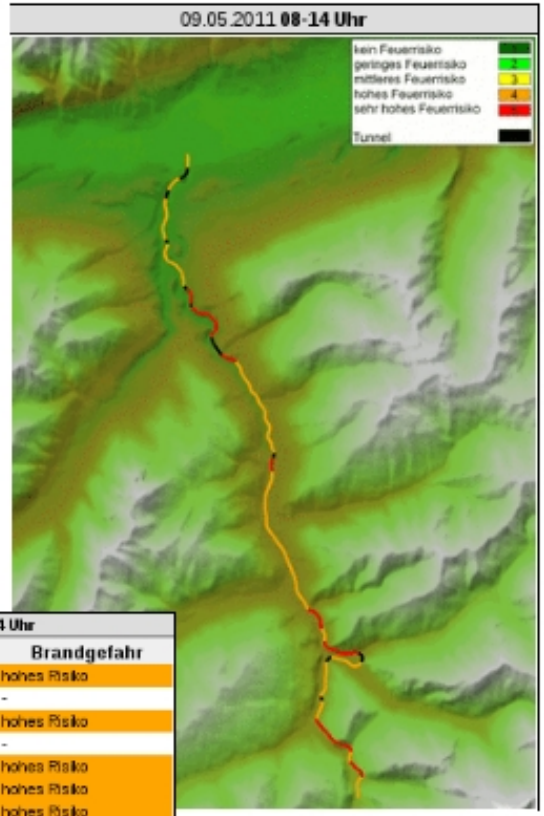
- Provisional Arrangements
- Removal
- Emergency Treatment

---

- Event Documentation
- Clear Passage
- Damage Control

# Latest ÖBB Project: Security Deficit

- Analysis of potential Natural Hazards for all railway lines in Austria!
- Evaluation of security issues on track sections, bridges, mountain tracks,...
- Implementation of a “Security Deficit” map for the railway lines
- Definition of measures e.g.
  - **Security Deficit 1** = OK
  - **Security Deficit 3** = Weather Alert System
  - **Security Deficit 5** = Very urgent construction works

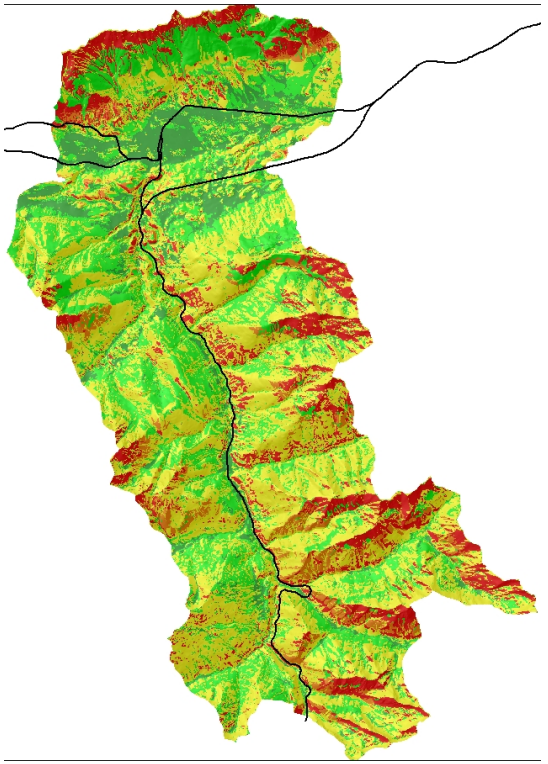



09.05.2011 08-14 Uhr

| Abschnitt | Brandgefahr |
|---|---|
| km 76,1 - 76,7 | hohes Risiko |
| km 76,7 - 77,4 (Tunnel) | - |
| km 77,4 - 78,3 | hohes Risiko |
| km 78,3 - 78,7 (Tunnel) | - |
| km 78,7 - 79,6 | hohes Risiko |
| km 79,6 - 80,3 | hohes Risiko |
| km 80,3 - 80,5 | hohes Risiko |
| km 80,5 - 80,7 (Tunnel) | - |
| km 80,7 - 80,9 | hohes Risiko |
| km 80,9 - 81,2 | hohes Risiko |
| km 81,2 - 81,3 | hohes Risiko |
| km 81,3 - 82,2 | hohes Risiko |
| km 82,2 - 82,8 | hohes Risiko |
| km 82,8 - 83 (Tunnel) | - |
| km 83 - 83,2 | sehr hohes Risiko |
| km 83,2 - 83,7 | sehr hohes Risiko |

# Project Idea
# Natural Hazard Risk Map for Eurasian Corridors

# Natural Hazard Risk Map



- Evaluation of possible (natural) dangers for rail corridors
  - Heavy rain & flash floods
  - Large scale flooding
  - Heat waves & fire risk
  - Heavy snowfall & snow drifts
  - Sand storms
  - etc.
- Analysis of typical meteorological pattern within the last years and anomalies
- Connection of GIS Analysis (Mountain Slopes, Rivers, Vegetation) and meteorological data
- Consideration of future developments, based on the IPCC reports

**GOAL:** MAP WITH ALL POTENTIAL (NATURAL) RISKS FOR RAILWAY LINES

# UBIMET

UBIMET GmbH
Ares Tower
Donau-City-Str. 11
1220 Vienna
Austria

Phone: 0043 / 1 / 99 71 004
office@ubimet.com

Your Contact:

**Stefan Eisenbach**
General Project Manager
Infrastructure, Traffic & Logistics

seisenbach@ubimet.com
Tel.: 0043 / 1 / 99 71 004 - 22

**www.ubimet.com**

# Current & plannes research projects

| | |
|---|---|
| **Switch Points** | Energy consumption forecasts & active steering |
| **Blowing Snow** | Implementation of blowing snow forecasts into the system |
| **Ice on overhead lines** | Development of ice forecasts on overhead contact lines |
| **Ice detection sensor** | Adoption of ice detection sensors to the railway environment |

# Forecasts for switch points

- Short term weather forecasts for switch point heatings
  - Preheating of switches 1 hour before snow fall is expected

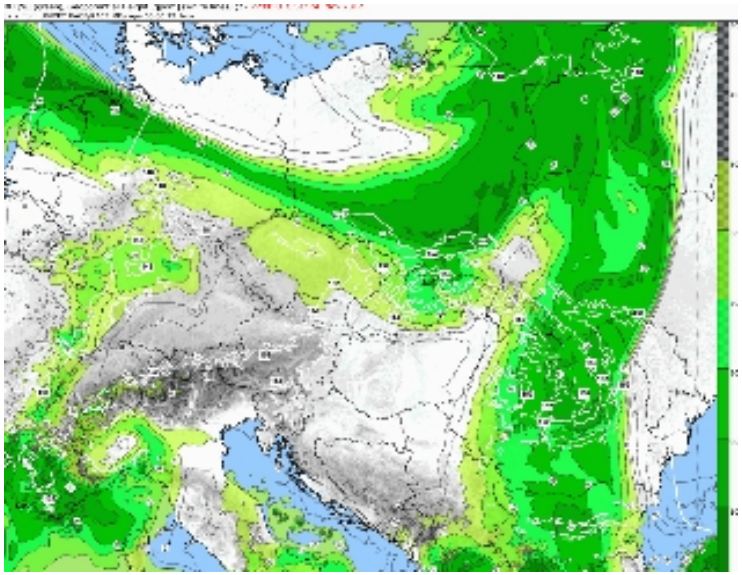
    ➡ **less failures**
  - Reduced heating at not severe snowfall events

    ➡ **less energy consumption**
  - Forecast parameters:
    - Temperature
    - Fresh Snow
    - Drifting snow by wind and trains
- Remote weather data for switches
  - Improvement of switch point weather sensors, incl. communication unit
- Energy consumption calculation for the next 3 days
  - Estimated energy need for switch point heatings across your network

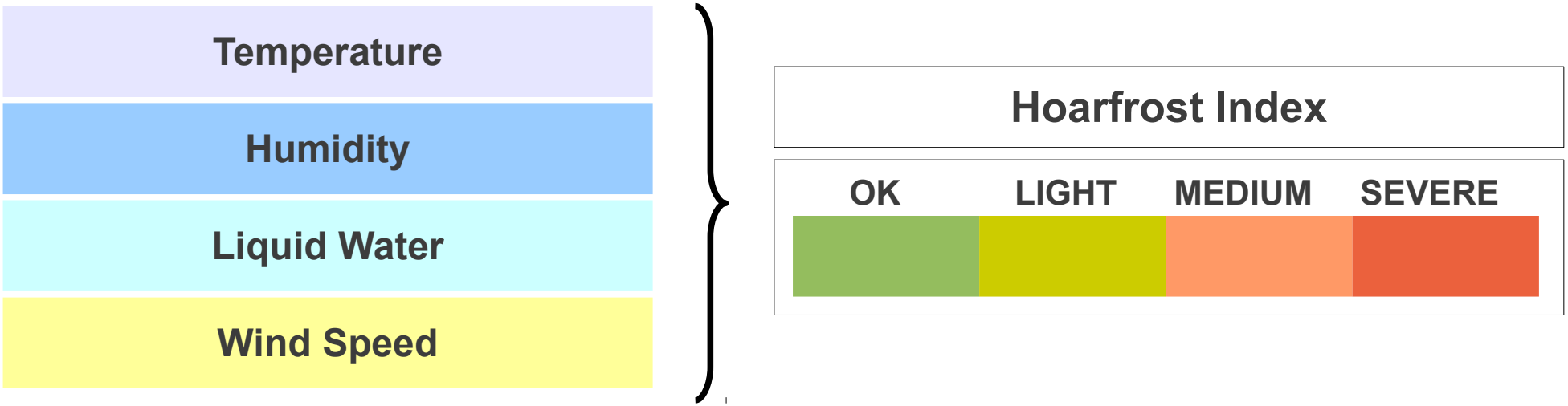
# Blowing Snow

- Drifting snow is affecting the railway operation to a very high degree
  - Snowdrifts
  - problems with switches
  - ...
- UBIMET developed 2012 a blowing snow index, the tests last winter where very promising
- The implementation into the railweather systems is planned for winter 2013/14

# Concept of Ice/Frost Analysis & Forecasts

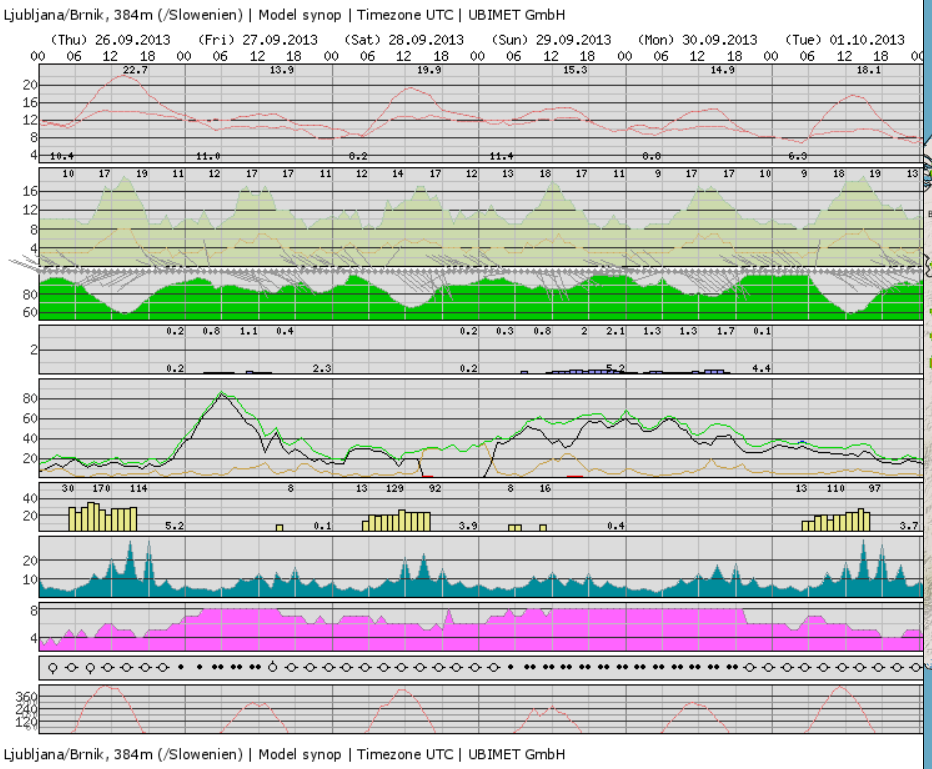


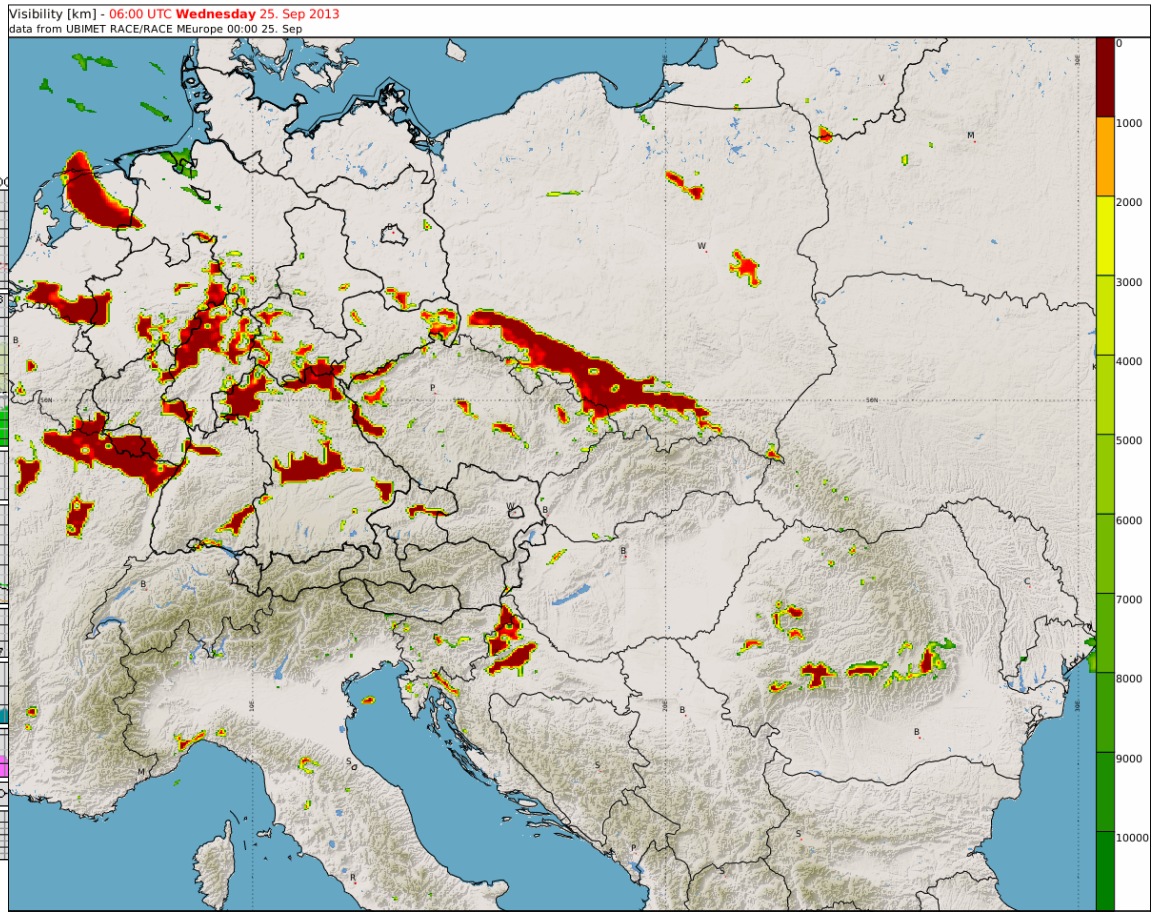
- Hourly or nocturnal frost forecasts & analysis for overhead contact lines
- Estimation of severity of hoar frost along every railway line at a resolution of 250m
- Alert system with 4 levels
  (no hoar frost to severe hoarfrost)



# Necessary improvements for the icing model

- Better simulation of humidity and liquid water content of the air in valleys
- Adaptation of the downscaling algorithm for alpine valleys and basins
- Improvement of fog forecasts



# Ice detection sensor tests

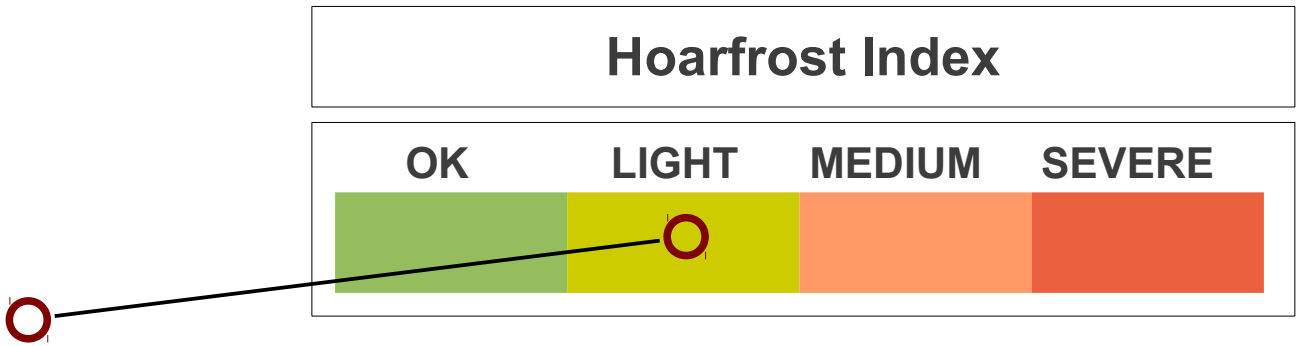
- Based on Electrical Capacitance Tomography (ECT)
- Output signal interpretation by an algorithm developed by the Technical University of Graz (Austria)
- Field tests and laboratory tests showed an excellent repeatability of the measurements

# Ice detection sensor prototype

- High sensitivity for thin layers of ice
- Water (melting ice, rain,...) clearly distinguishable from solid ice
- Multichannel Measurements to determine the thickness of the ice layer
- Information about the structure and density of the ice

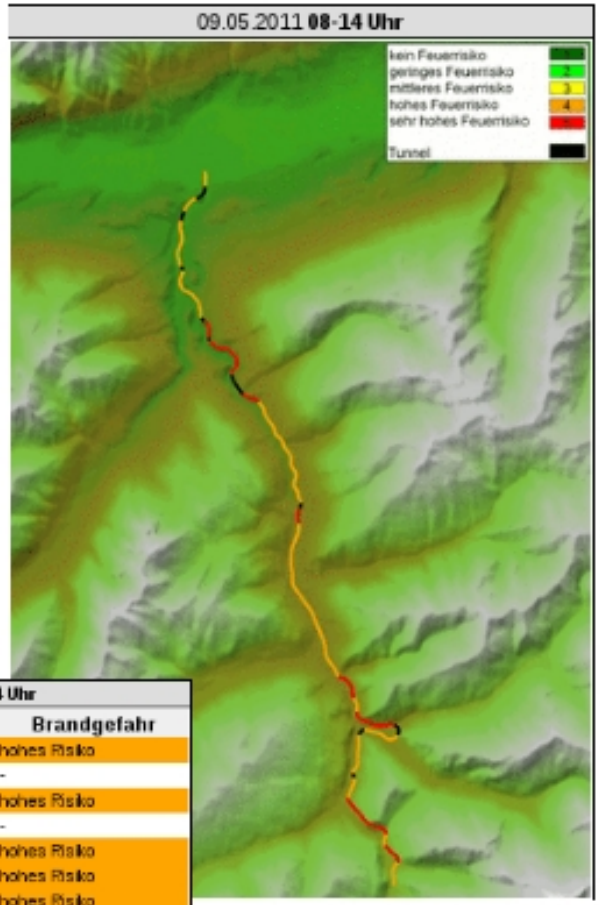
# Goals of the project

- Validation of numerical icing forecasts and analysis models
- Adaptation of the models based on the feedback of local railway employees, as well of weather station data and/or ice measurements sensors
- Test of the ice detection sensor in a railway environment
- OUTPUT = Icing alert index for railway operators (forecast & real time data)



# Implementation of the icing information system

- Implementation of the icing information into the weather information systems of the respective railway
- Real time data from sensors:
  - Special weather station
  - Ice detection sensor
- Regional analysis of the icing risk based on the railway track data
- Detailed forecasts of the icing risk for every railway line with a resolution of 250m




09.05.2011 **08-14 Uhr**

| Abschnitt | Brandgefahr |
|---|---|
| km 76,1 - 76,7 | hohes Risiko |
| km 76,7 - 77,4 (Tunnel) | - |
| km 77,4 - 78,3 | hohes Risiko |
| km 78,3 - 78,7 (Tunnel) | - |
| km 78,7 - 79,6 | hohes Risiko |
| km 79,6 - 80,3 | hohes Risiko |
| km 80,3 - 80,5 | hohes Risiko |
| km 80,5 - 80,7 (Tunnel) | - |
| km 80,7 - 80,9 | hohes Risiko |
| km 80,9 - 81,2 | hohes Risiko |
| km 81,2 - 81,3 | hohes Risiko |
| km 81,3 - 82,2 | hohes Risiko |
| km 82,2 - 82,8 | hohes Risiko |
| km 82,8 - 83 (Tunnel) | - |
| km 83 - 83,2 | sehr hohes Risiko |
| km 83,2 - 83,7 | sehr hohes Risiko |