Québec 2010
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XIII INTERNATIONAL WINTER ROAD CONGRESS

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SUSTAINABLE WINTER SERVICE FOR ROAD USERS

Combining Meteorological and Geographic Information Systems to Increase the Capacity of Road Weather Forecasts

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Québec

Introduction

- Operational numerical weather forecast models have much improved over the past couple of years
- However, the distance between its gridpoints is normally still too large to be directly suitable for road weather forecasting, especially over complex terrain

-> « Downscaling » approaches are many places, trying to make the original forecast more precise.

This presentation describes downscaling approach, combining meteorological with geographic information systems, using the example of the MetGIS model

MetGIS

- What is MetGIS? A high-resolution combined **Met**eorological and **G**eographic **I**nformation **S**ystem with a specific focus on snow, mountain areas and the traffic system in alpine terrain.

Main Features:

- Efficient downscaling of meteorological forecast data, included into an operational system
- Easy international application through use of standard meteorological and geographic data formats
- Excellent Graphical User Interface that allows traffic managers an easy access to the forecasts

MetGIS Development History

Research Contributions

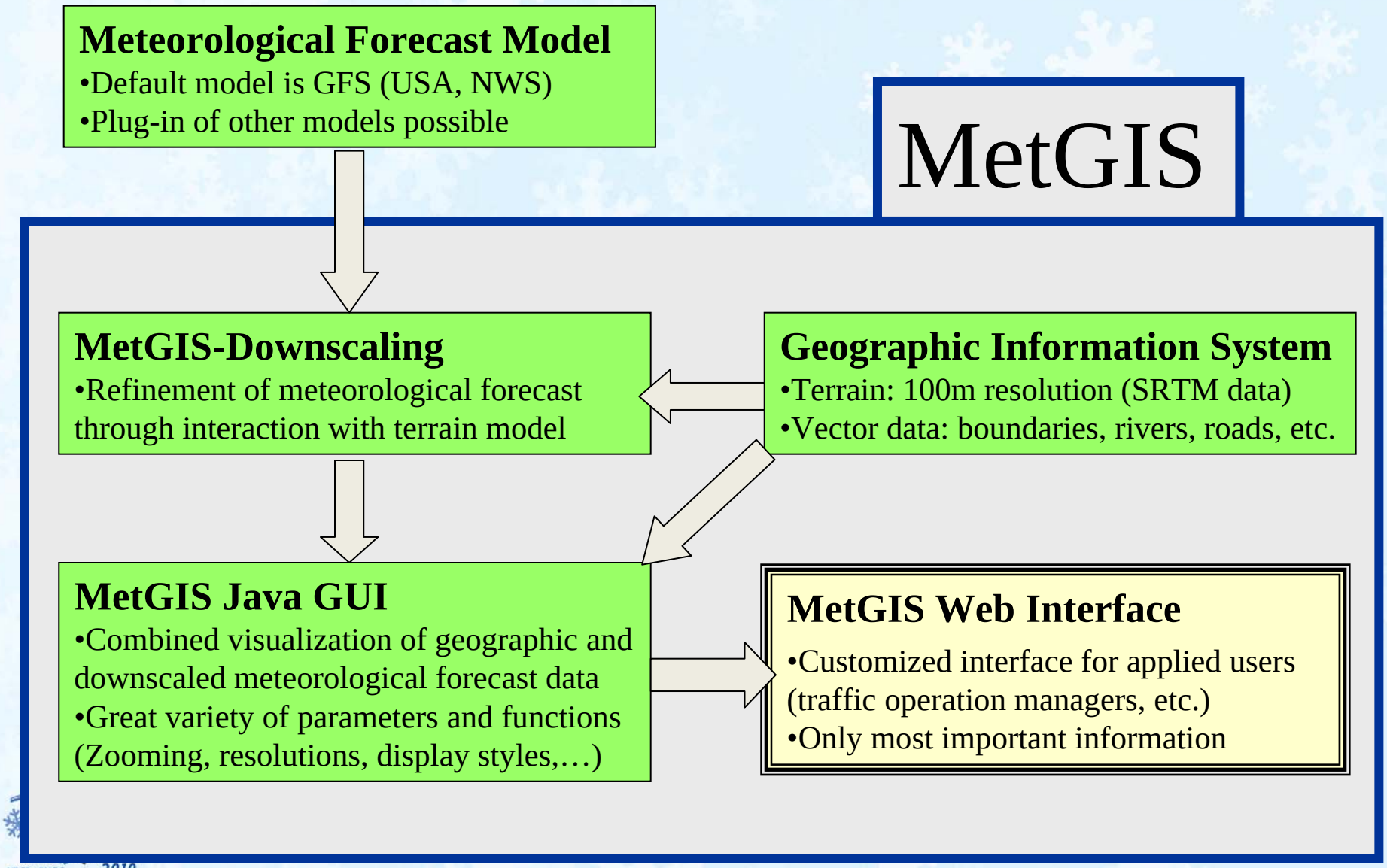
Country/City	Research Institution	Contribution/Achievement
USA (Boulder, CO)	**WELS** Research Corporation/ Alden Electronics	Basic ideas about combination between GIS and meteo forecast
Switzerland (Davos)	**SLF** (Swiss Federal Institute for Snow and Avalanche Research)	Java technology for GUIs, SNOWPACK visualization
Peru (Lima)	**SENAMHI** (Servicio Nacional de Meteorología e Hidrología)	Start programming Java-based GIS
Japan (Nagaoka)	**NIED/NISIS** (National Research Institute for Earth Science and Disaster Prevention)	Continue GIS, Start programming interface for meteorological forecast models
Argentina (Mendoza)	**IANIGLA** (Instituto Argentino de Nivelogía y Glaciología)	Integration of SRTM terrain data
Chile (Santiago)	**DGF** (Departamento de Geofísica, Universidad de Chile)	MM5 forecast integration
Austria (Vienna)	**IMG** (Institute of Meteorology and Geophysics, University of Vienna)	Display of observation data, downscaling, GFS fc. integration

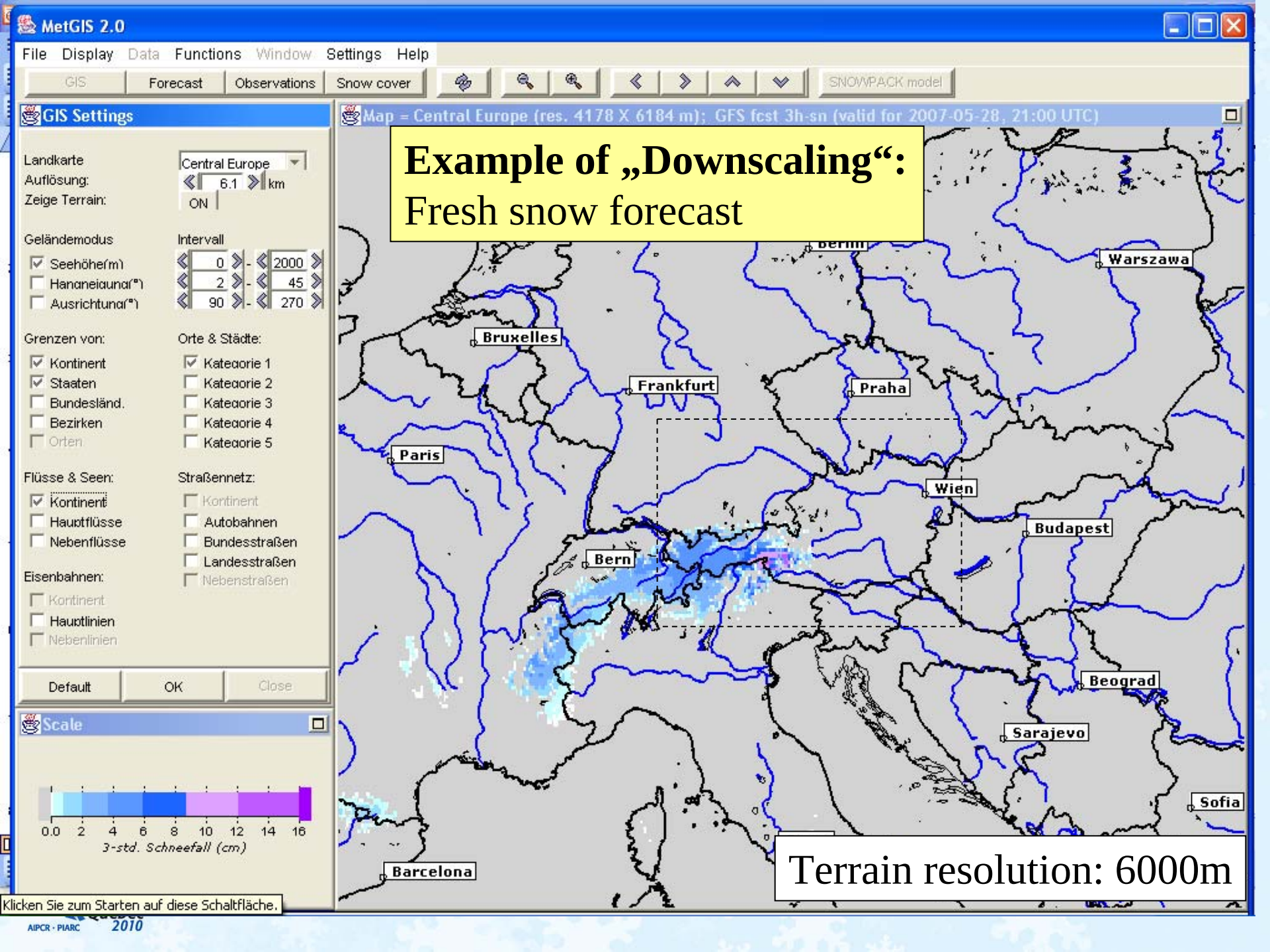
Role of Austrian Institutions in Development

- From 2005 much of development work at University of Vienna in Austria, partly sponsored by BMVIT (Federal Ministery for Traffic, Innovation and Technology)
- Very fruitful interaction with ASFINAG (Austrian Federal Highway Administration) and traffic operation centers of several Austrian states (Vienna, Upper Austria, Vorarlberg)

-> MetGIS optimized for practical application (which started in 2007)

MetGIS Subsystems




MetGIS 2.0
File Display Data Functions Window Settings Help
GIS Forecast Observations Snow cover
SNOWPACK model
GIS Settings
Landkarte Central Europe
Auflösung: 6.1 km
Zeige Terrain: ON
Geländemodus
Seehöhe(m) 0 - 2000
Hangneigung(°) 2 - 45
Ausrichtung(°) 90 - 270
Intervall
Grenzen von:
Kontinent
Staaten
Bundesländ.
Bezirken
Orten
Orte & Städte:
Kategorie 1
Kategorie 2
Kategorie 3
Kategorie 4
Kategorie 5
Flüsse & Seen:
Kontinent
Hauptflüsse
Nebenflüsse
Straßennetz:
Kontinent
Autobahnen
Bundesstraßen
Landesstraßen
Nebenstraßen
Eisenbahnen:
Kontinent
Hauptlinien
Nebenlinien
Default OK Close
Scale
0.0 2 4 6 8 10 12 14 16
3-std. Schneefall (cm)
Map = Central Europe (res. 4178 X 6184 m); GFS fcst 3h-sn (valid for 2007-05-28, 21:00 UTC)
Example of „Downscaling“:
Fresh snow forecast
Bruxelles
Frankfurt
Praha
Warszawa
Paris
Wien
Budapest
Bern
Beograd
Sarajevo
Sofia
Barcelona
Terrain resolution: 6000m
Klicken Sie zum Starten auf diese Schaltfläche.
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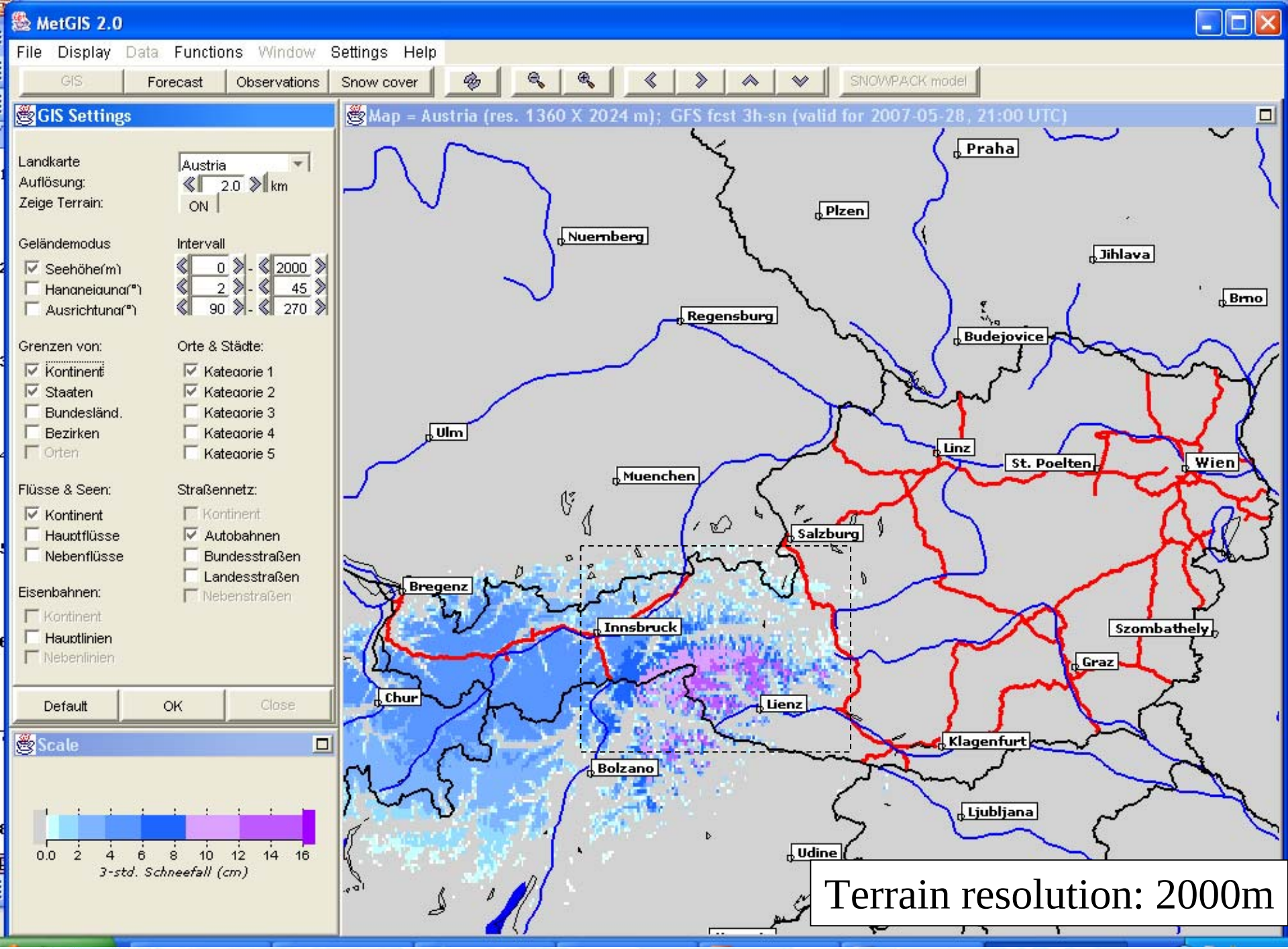
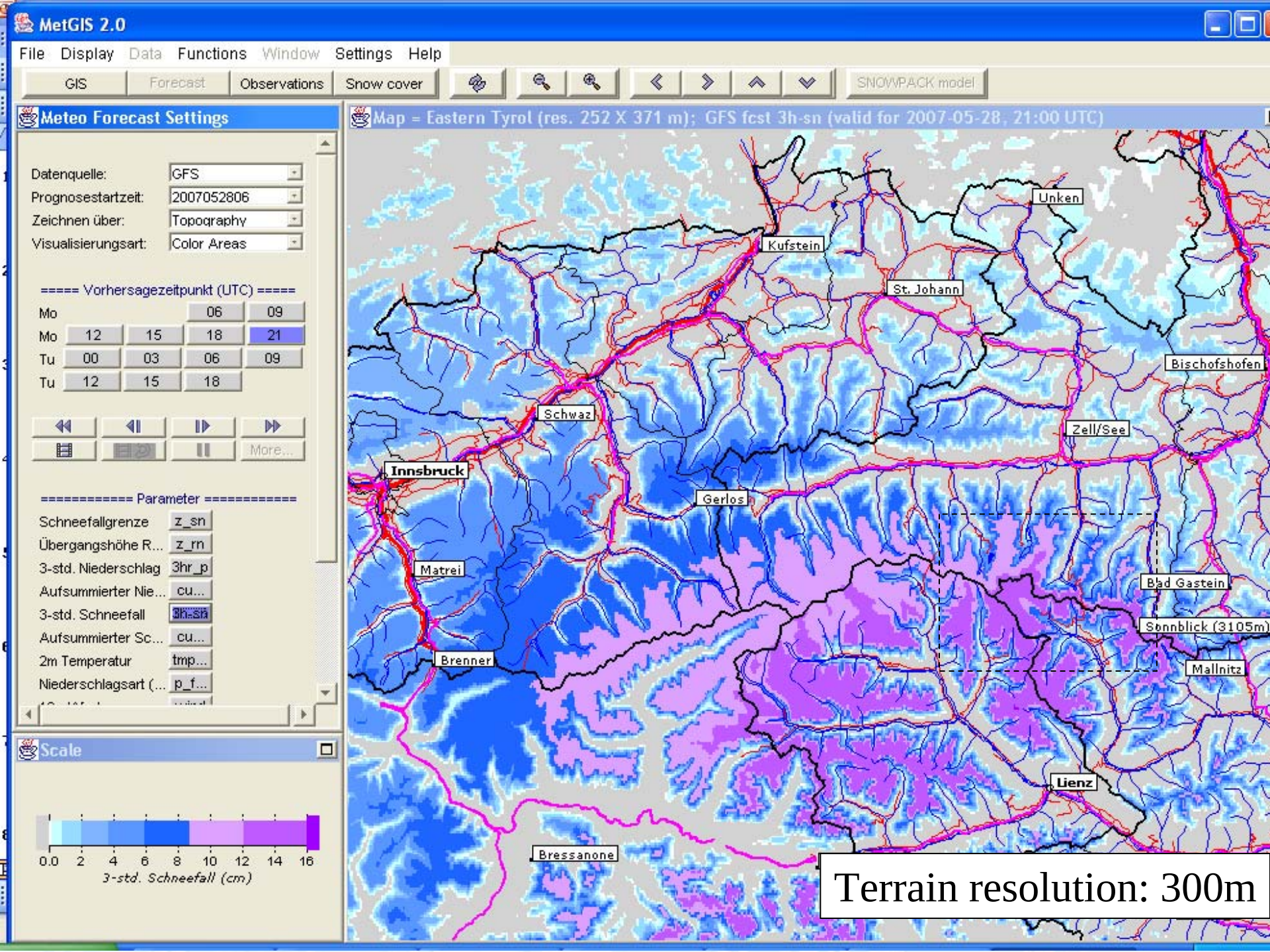
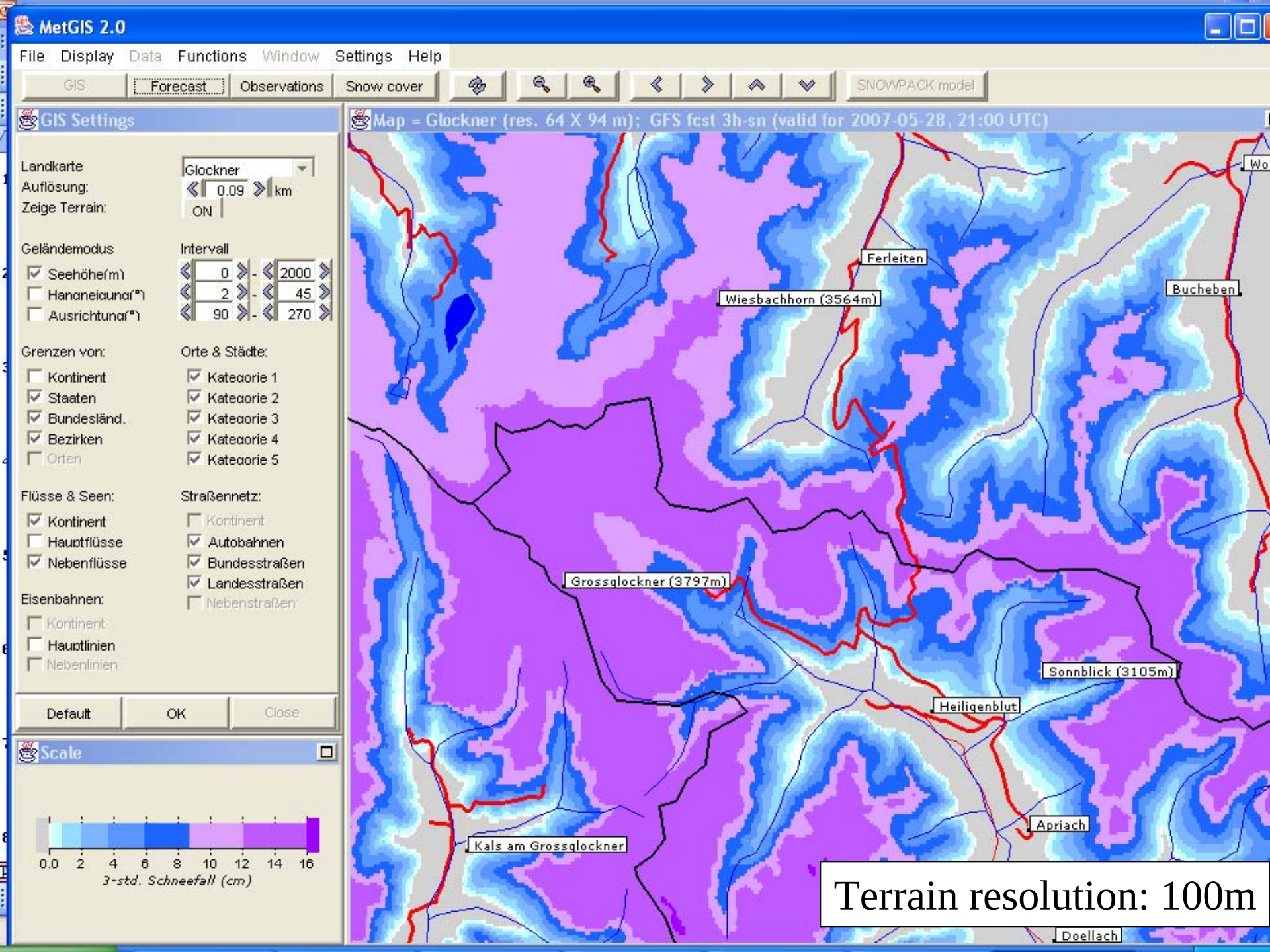

MetGIS 2.0
File Display Data Functions Window Settings Help
GIS Forecast Observations Snow cover SNOWPACK model
GIS Settings
Landkarte Austria
Auflösung: 2.0 km
Zeige Terrain: ON
Geländemodus Intervall
Seehöhe(m) 0 - 2000
Hangneigung(°) 2 - 45
Ausrichtung(°) 90 - 270
Grenzen von:
Kontinent
Staaten
Bundesländ.
Bezirken
Orten
Orte & Städte:
Kategorie 1
Kategorie 2
Kategorie 3
Kategorie 4
Kategorie 5
Flüsse & Seen:
Kontinent
Hauptflüsse
Nebenflüsse
Straßennetz:
Kontinent
Autobahnen
Bundesstraßen
Landesstraßen
Nebenstraßen
Eisenbahnen:
Kontinent
Hauptlinien
Nebenlinien
Default OK Close
Scale
0.0 2 4 6 8 10 12 14 16
3-std. Schneefall (cm)
Map = Austria (res. 1360 X 2024 m); GFS fcst 3h-sn (valid for 2007-05-28, 21:00 UTC)
Praha
Plzen
Nuernberg
Jihlava
Brno
Regensburg
Budejovice
Ulm
Linz
St. Poelten
Wien
Muenchen
Salzburg
Bregenz
Innsbruck
Szombathely
Graz
Chur
Lienz
Klagenfurt
Bolzano
Ljubljana
Udine
Terrain resolution: 2000m


MetGIS 2.0
File Display Data Functions Window Settings Help
GIS Forecast Observations Snow cover
SNOWPACK model
Meteo Forecast Settings
Datenquelle: GFS
Prognosestartzeit: 2007052806
Zeichnen über: Topography
Visualisierungsart: Color Areas
===== Vorhersagezeitpunkt (UTC) =====
Mo 06 09
Mo 12 15 18 21
Tu 00 03 06 09
Tu 12 15 18
More...
========== Parameter ==========
Schneefallgrenze z_sn
Übergangshöhe R... z_rn
3-std. Niederschlag 3hr_p
Aufsummierter Nie... cu...
3-std. Schneefall 3h-sn
Aufsummierter Sc... cu...
2m Temperatur tmp...
Niederschlagsart (... p_f...
Scale
0.0 2 4 6 8 10 12 14 16
3-std. Schneefall (cm)
Map = Eastern Tyrol (res. 252 X 371 m); GFS fcst 3h-sn (valid for 2007-05-28, 21:00 UTC)
Unken
Kufstein
St. Johann
Bischofshofen
Schwaz
Zell/See
Innsbruck
Gerlos
Matrei
Bad Gastein
Sonnblick (3105m)
Brenner
Mallnitz
Lienz
Bressanone
Terrain resolution: 300m


MetGIS 2.0
File Display Data Functions Window Settings Help
GIS Forecast Observations Snow cover
SNOWPACK model
GIS Settings
Landkarte
Glockner
Auflösung:
0.09
km
Zeige Terrain:
ON
Geländemodus
Intervall
Seehöhe(m)
0
2000
Hangneigung(°)
2
45
Ausrichtung(°)
90
270
Grenzen von:
Kontinent
Staaten
Bundesländ.
Bezirken
Orten
Orte & Städte:
Kategorie 1
Kategorie 2
Kategorie 3
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Kategorie 5
Flüsse & Seen:
Kontinent
Hauptflüsse
Nebenflüsse
Straßennetz:
Kontinent
Autobahnen
Bundesstraßen
Landesstraßen
Nebenstraßen
Eisenbahnen:
Kontinent
Hauptlinien
Nebenlinien
Default
OK
Close
Scale
0.0 2 4 6 8 10 12 14 16
3-std. Schneefall (cm)
Map = Glockner (res. 64 X 94 m); GFS fcst 3h-sn (valid for 2007-05-28, 21:00 UTC)
Ferleiten
Wiesbachhorn (3564m)
Bucheben
Grossglockner (3797m)
Sonnblick (3105m)
Heiligenblut
Apriach
Kals am Grossglockner
Doellach
Terrain resolution: 100m

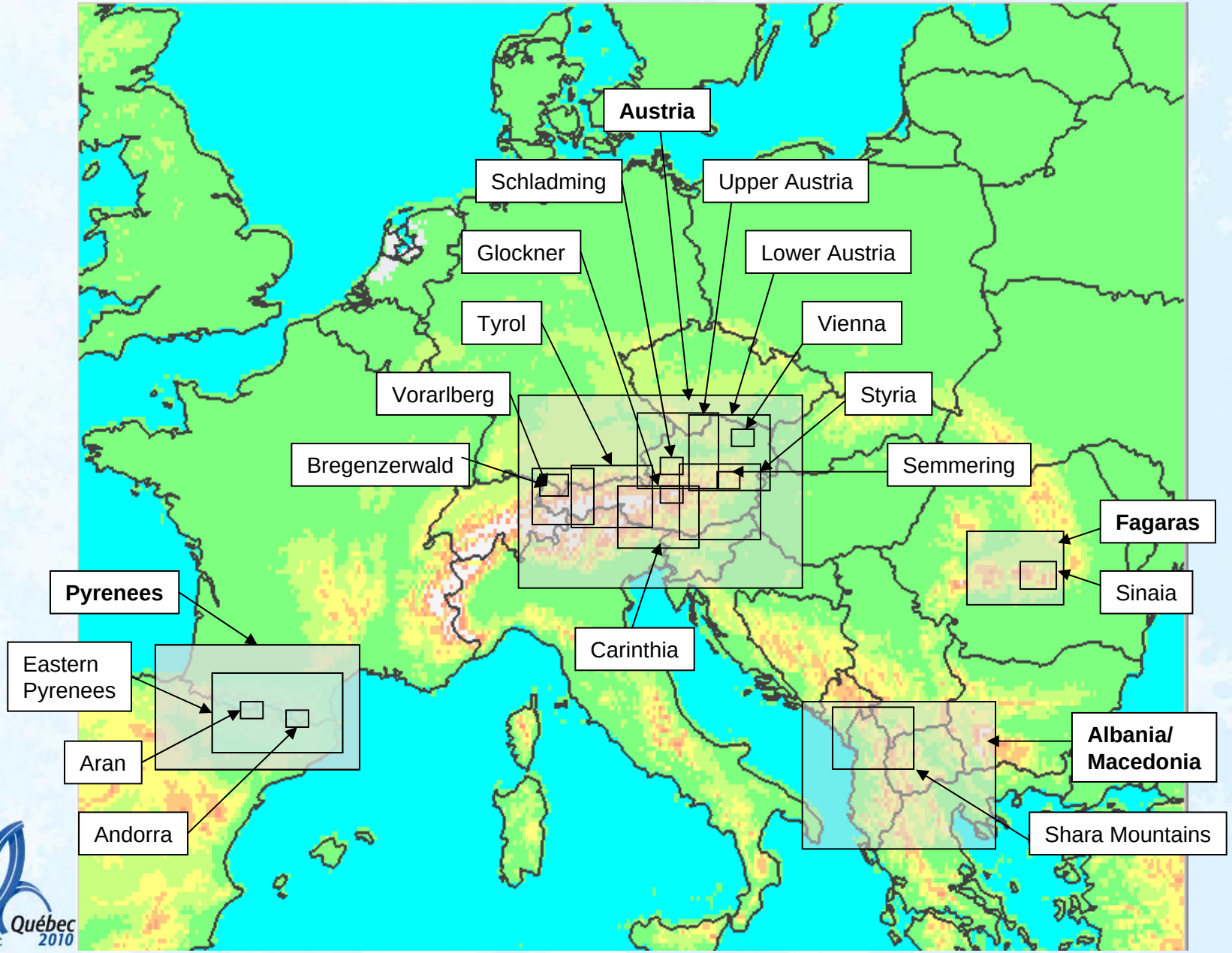
MetGIS Web Interface

- **Easy-to-use interface** designed for applied users (traffic operation centers, avalanche control centers, ...)
- **Operational 48-hour forecasts** (password-protected)
- **Forecast parameters**: temperature, precipitation amount and type, fresh snow depth, snow limit, wind
- **Languages**: English, German, Spanish, Russian
- Rapidly **growing number of users**
- Currently around **35 operational forecast areas**, mainly over Europe and South America

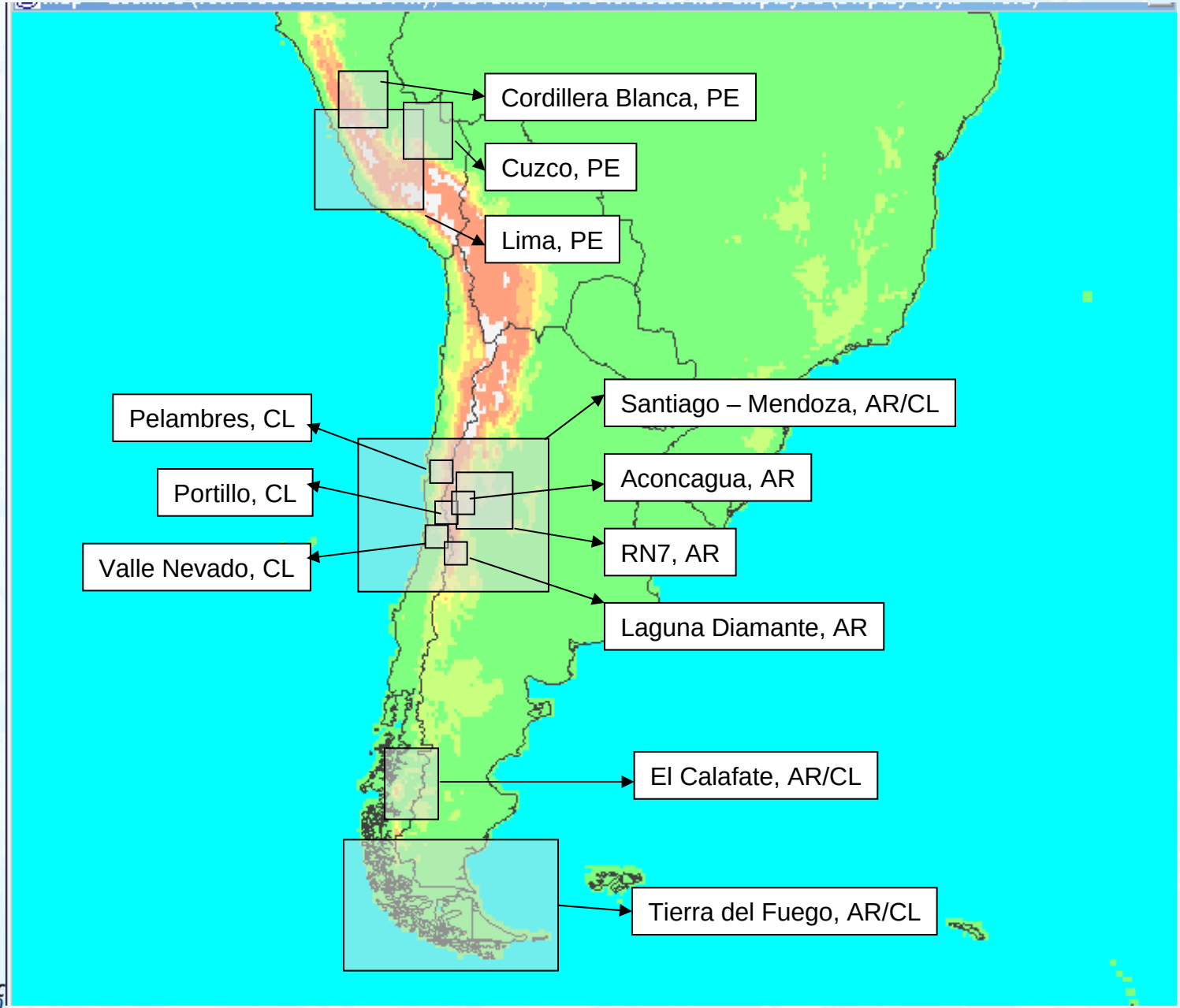
MetGIS Web Interface

Start Demo

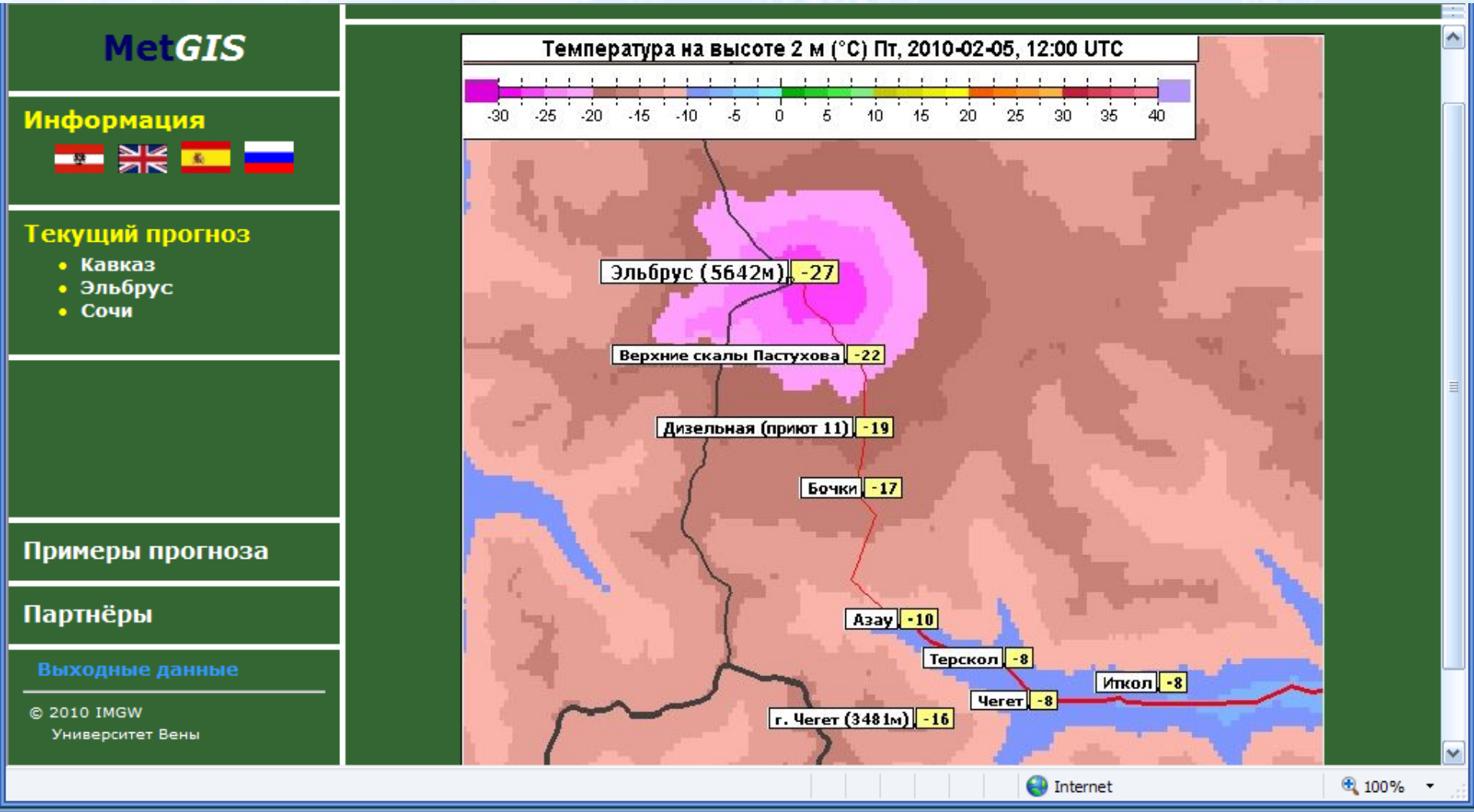
MetGIS Operational Forecast Areas in Europe



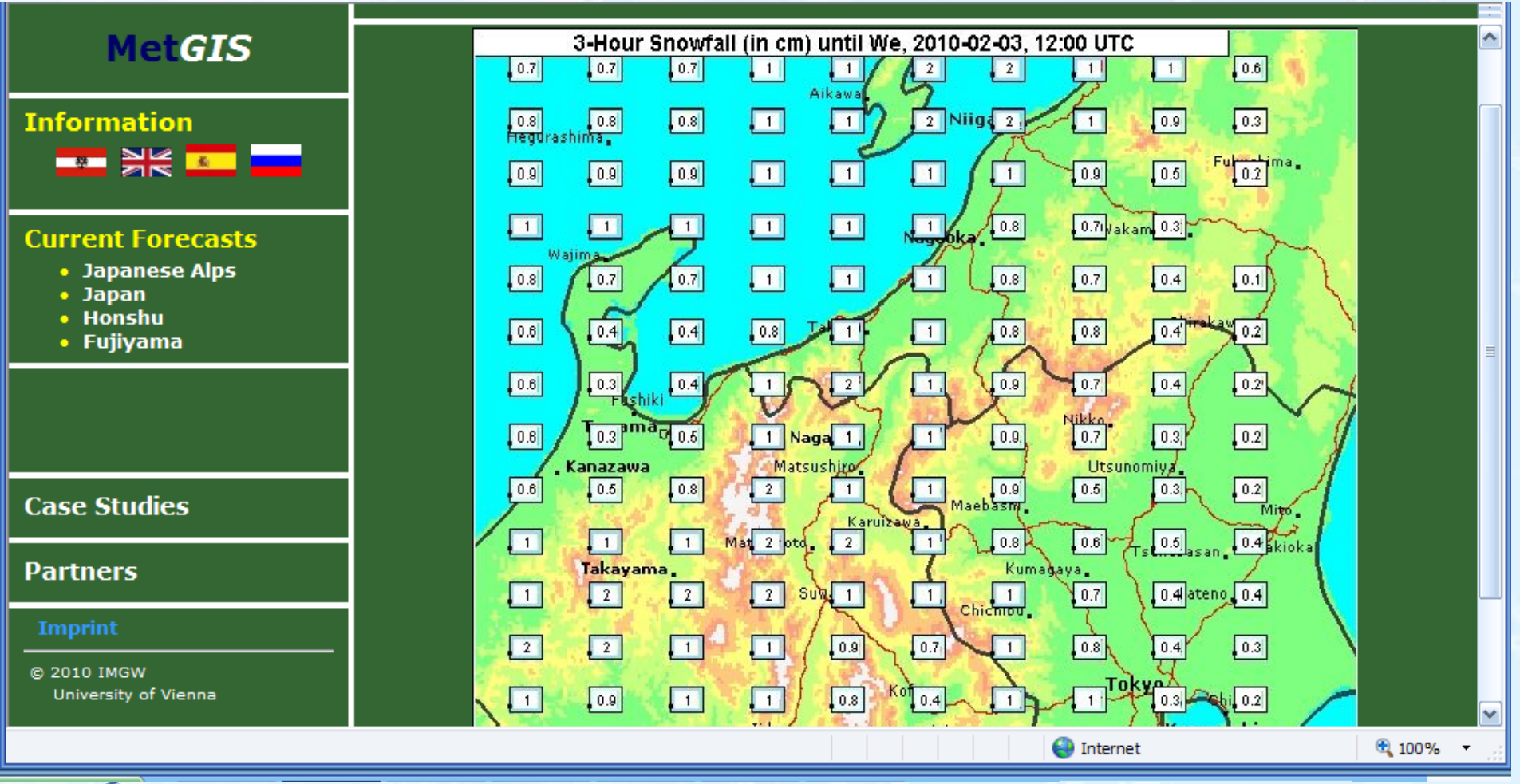
MetGIS Operational Forecast Areas in South America



MetGIS Forecast Example: Mount Elbrus (Caucasus)



MetGIS Forecast Example: Japanese Alps, Honshu Island



MetGIS Forecast Quality

- MetGIS **forecast quality** constantly monitored
- **Recently verification studies for Alps, Pyrenees and Andes** have been processed,
- using around 20 stations from various networks
- **Parameters** studied: temperature, precipitation, fresh snow

-> Results quite encouraging

Temperature Forecast Verification

Station: Rax (Austria)
Period: Jan. - Oct. 2008

Forecast range	+6h	+12h	+18h	+24h	+36h
Checked forecasts	1207	1208	1209	1209	1212
% within 1 deg	44.36	42.80	41.27	40.61	42.24
% within 2 deg	76.39	76.16	74.11	73.04	73.76
% within 3 deg	92.38	91.81	91.07	90.98	89.11
bias [deg]	-0.62	-0.58	-0.52	-0.50	-0.46
Mean abs. Err. [deg]	1.37	1.40	1.42	1.43	1.45
Correl. Coefficient	0.975	0.973	0.972	0.971	0.970

Precipitation Forecast Verification

Station: Rax (Austria) *Verification Period: Jan.- Oct. 2008*		Observed 24-hour Precipitation (in mm)				
		< 0.1	**0.1 - 1**	**1 - 10**	**> 10**	**Total**
Forecast 24-hour Precip.	**< 0.1**	**319**	23	10	0	352
	0.1 - 1	147	**60**	41	4	252
	1 – 10	119	70	**220**	58	467
	> 10	1	3	46	**70**	120
	Total	586	156	317	132	1191

Observed and forecast precipitation in same class: 56.2%

Obs. and forecast precipitation in same or neighbor class: 88.5%

Access to MetGIS Forecasts

- New forecast areas can easily be included in MetGIS (possible through international system design)
- May be used as supplement to other road weather software

Forecast access possibilities:

1. Via **MetGIS web interface** (this presentation)
2. Integration of MetGIS model output in **external software**; automated regional forecast data transfer via JPG or ASCII interface

MetGIS Outlook

- Output of ongoing research projects will further improve forecast quality
  - Snow limit (use of valley geometry)
  - Precipitation amounts (use of climatological information)
  - Wind, snow drift
- Extension of **forecast period**
- Enhanced usage of **observation data** (e.g. from road weather stations) to further improve the forecasts
- **Route forecasts** (along highways)

Thank you for your attention!

- **Contact:** Dr. G. Spreitzhofer, gerald.spreitzhofer@univie.ac.at
- **MetGIS:** http://univie.ac.at/amk/metgis