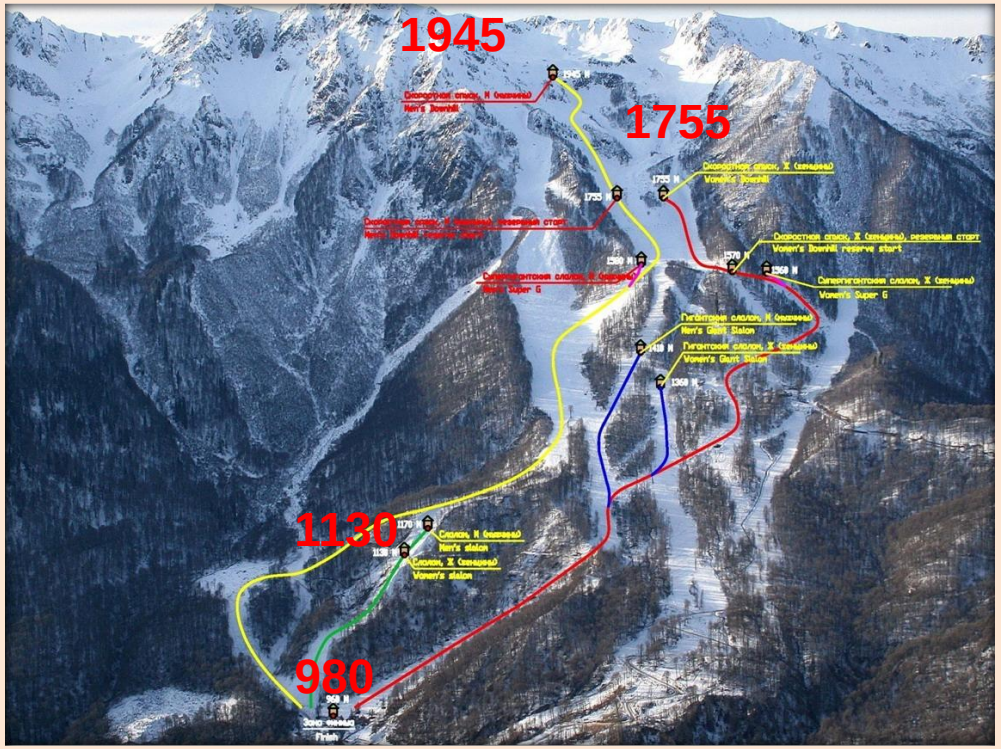
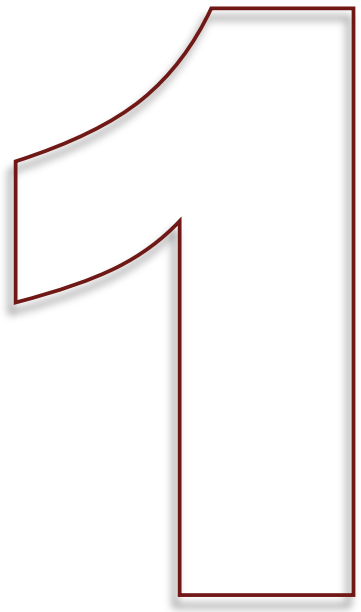
Final report of PP CORSO



Gdaly Rivin, Inna Rozinkina,
Elena Astahova, Andrea Montani
AND … colleaques from
Germany, Italy, Switzerland, Greece and Russia.

CONTENTS



CORSO

The important target of PP CORSO for COSMO:

Implementation and development of some COSMO researches permit to improve the whole complex of COSMO based technologies

COSMO - METEOROLOGICAL SUPPORT FOR OLYMPICS "SOCHI-2014"

COSMO Priority Project
CORSO:
Consolidation of
Operation and
Research results for the
Sochi
Olympic Games

The main goal:
to enhance and demonstrate the capabilities of COSMO-based systems of short-range numerical weather prediction in winter conditions for mountainous terrain and to assess the effect of practical use of this information during SOCHI-2014 Olympic Games

PP CORSO
is considered as COSMO contribution into WMO project FROST-2014 (Forecast and Research in the Olympic Sochi Testbed)
PL Dmitry Kiktev

Participants:
Germany, Italy, Switzerland, Greece and Russia.

MAIN DIFFICULTIES OF SOCHI METEOROLOGICAL SUPPORT and of PP CORSO

1. Complex geographical conditions

(high mountains near the subtropical Black Sea coast):

- Strong temperature gradients and inhomogeneity
- Powerful influence of high mountains on synoptic processes
- Sport venues were close to the snow boundary
- The local weather on the venues was strongly governed by **local orography**

Coastal cluster (Sochi)

End of Jan 2013

Mountain cluster (near Biathlon Stadium)

2. Low observational network density.

PP CORSO: TIMELINES

Phase 1	Phase 2	Phase 3
2011 / 2012	2012 / 2013	2013 / 2014
▪ Choice of strategy ▪ Proposals for development and modification of algorithms ▪ Preliminary tests	• Tests • Pre-operational runs • Feedback from forecasters	• Tuning • Operational runs • Analysis of results

The main requirement: the newly developed tools and the COSMO-Ru system modifications must be quickly implemented to the operation

PP CORSO:
EXPERT MEETINGS

Expert meetings were a very important part of PP CORSO !

ARPA-SIMC, 5-10 December 2011
Italy, Bologna
Tasks 1 and 3
Italy: T. Paccagnella, A.Montani, C.Marsigli, D.Cesari, M.-S.Tesini.
Russia: G.Rivin, E.Astakhova, A.Scherbakov.

DWD, 2-6 July 2012
Germany, Offenbach on Main
Task 1
Germany: D.Majewski, C.Schraff, J.Foerstner.
Russia: G.Rivin, D.Blinov.

DWD, 5-10 December 2013
Germany, Offenbach on Main
Task 1
Germany: D.Majewski, J. Helmert.
Russia: I.Rozinkina, M.Shatunova

MeteoSwiss: 12-16 December 2011
Switzerland, Zurich-Geneva
- Planning and optimizing PP CORSO
- Tasks 1 and 2

Switzerland: More than 15 participants, responsible: Ph. Steiner, M.Arpagaus, P. Eckert
Russia: G.Rivin, I.Rozinkina

An example of the expert meeting agenda

Monday 12 December 2011, MeteoSwiss Zurich

Time	Title	Who	Place
09:00	COSMO-1: Numerics (Prototype configuration and Code-Improvements for stability)	Guy de Morsier, Marco Arpagaus	507
11:00	COSMO-1: Physics	Marco Arpagaus, Oliver Fuhre	507
12:30	Lunch		
13:30	COSMO-1: synchronization of the developments at Roshydromet and MeteoSwiss	Marco Stein	
14 :30	Snow map derived from satellites	Nand (even Bette analy	
16 :30	CORSO project plan, mainly task 2	Marco Stein	
18:30	End		

Tuesday 13 December 2011, MeteoSwiss Zurich

Time	Title	Who	Place
09:00	CORSO project plan (2nd part)	Marco Arpagaus, Philippe Steiner	507
11:00	Postprocessing	Vanessa Stauch	Ackermannstrasse
12:00	Lunch		
13:00	Kalman Filter for COSMO (Kalman modul computing the coefficients / Fieldextra part applying them)	Vanessa Stauch	Ackermannstrasse
14:00	Use of COSMO-ART	Philippe Steiner, Pirmin Kaufmann	507
15:00	Additional questions of Roshydromet	Marco Arpagaus, Philippe Steiner, ?	507

PP CORSO

(Project Leaders: G.Rivin, I.Rozinkina (Roshydromet)

TASK 1.High resolution COSMO-modeling for mountainous regions (TL G.Rivin)

1.1. Improvement of modeling technology of deterministic forecasting of weather conditions with resolution 2.2.km for the North-Caucasian area (SOCHI-2014) (FDP)

1.2. Development of COSMO-So-1km (RDP)

TASK 2. Downscaling / postprocessing for Sochi area and applications (TL I.Rozinkina)

2.1. Adapted down-scaling techniques for winter conditions in the mountains and IOC requirements (FDP)

2.2. Determination of typical COSMO-model inaccuracies for typical synoptic situations , incl. verification (RDP)

TASK 3. Development and adaptation of COSMO EPSs for Sochi region

TLs E. Astakhova, A. Montani

3.1. Adaptation of COSMO LEPS 7 km to the Sochi region and to specific requirements of winter Olympics. Operational ensemble forecasts during the Trials and Olympics (FDP)

3.2. Development and verification of COSMO-RU-LEPS 2.2 km for the Sochi region (with ICs and BCs from SOCHMEL7) (RDP)

PP CORSO PARTICIPANTS

Task 1 High resolution COSMO-modeling for mountainous regions

Russia: G. Rivin, Yu. Alferov, D. Blinov, M. Chumakov, E. Kazakova, A. Kirsanov, M.Nikitin, V. Perov, A. Revokatova, I. Rozinkina, M. Shatunova;

Germany: D. Majewski, J. Foersner, J. Helmert;

Switzerland: G. de Morsier, M. Arpagaus, P. Steiner.

Task 2 Downscaling / postprocessing for Sochi area and applications

Russia: I. Rozinkina, D. Blinov, A. Bundel, E. Kazakova, A. Kirsanov, V.Kopeikin, A. Muravev, G. Rivin, M. Zaichenko;

Switzerland: P. Eckert, J-M. Bettems;

Greece: E. Avgoustoglou, A. Voudouri.

Task 3 Development and adaptation of COSMO EPS for Sochi region

Russia: E. Astakhova, D. Alferov, G. Rivin;

Italy: A. Montani, C. Marsigli, T. Paccagnella.

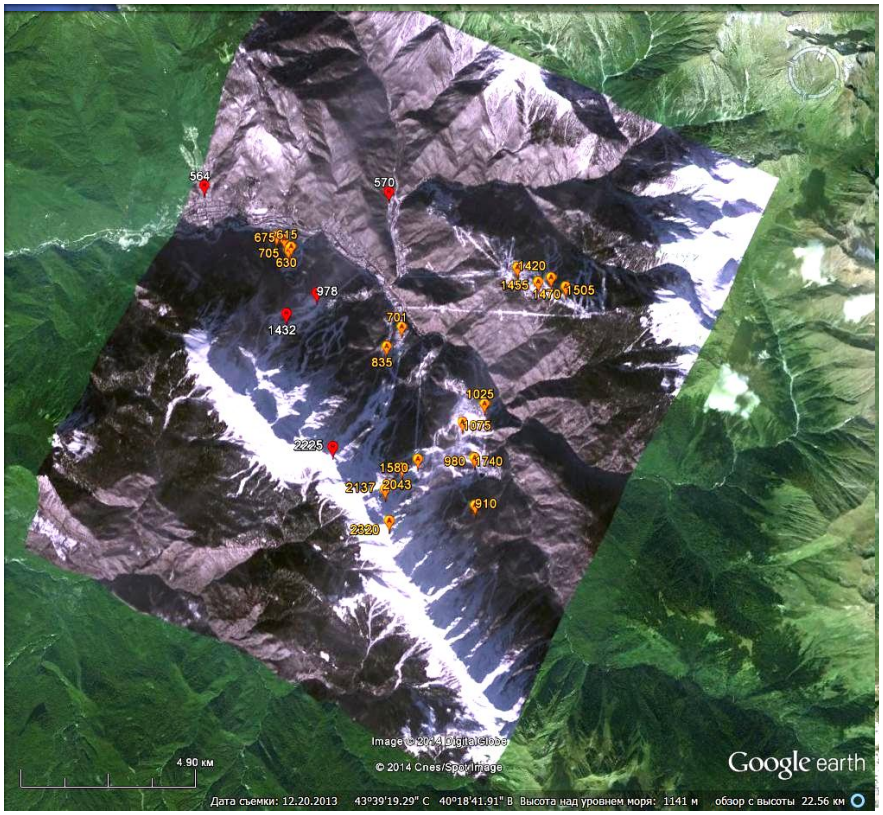
WG4: PP CORSO

T1. High resolution Modeling and DA
WG1, WG2, WG3a, WG3b, WG4, WG6 → Operational forecasts of meteorological fields

T2. Postprocessing / Forecast Interpretation
WG4, WG5 → Downscaling for venues and local specific weather conditions

T3. High resolution EPS
WG5, WG7 → Forecasts of probability of local weather events

Observation network 1/4



Meteorological stations

Total number	**33**
Roshydromet stations	13
Automatic meteo station (AMS)	20

Most of the AMS are located in the mountain cluster next to the sports facilities.

Variables

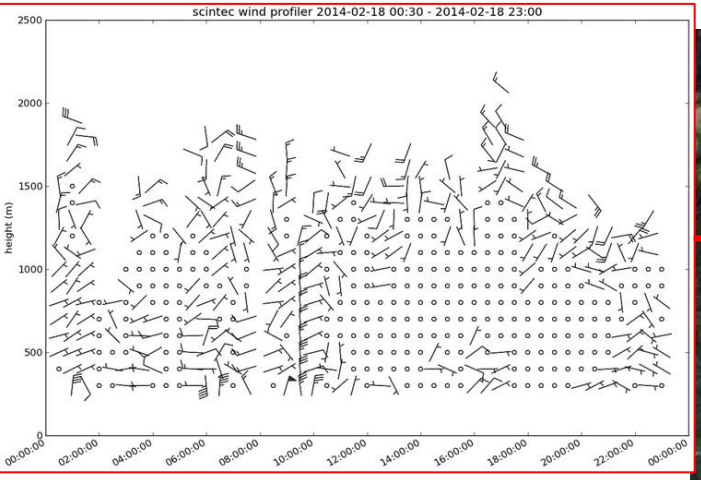
- Pressure
- Air temperature at 2 m,
- Dew point temperature at 2 m
- Relative humidity at 2 m
- Wind speed (mean, min, max) and direction (average period …)
- Wind gust
- Lowest cloud base altitude
- Precipitation rate (average period …)
- Visibility
- Snow depth
- Snow temperature

Radars	4
Profilers	3
Video cameras	3+4x2

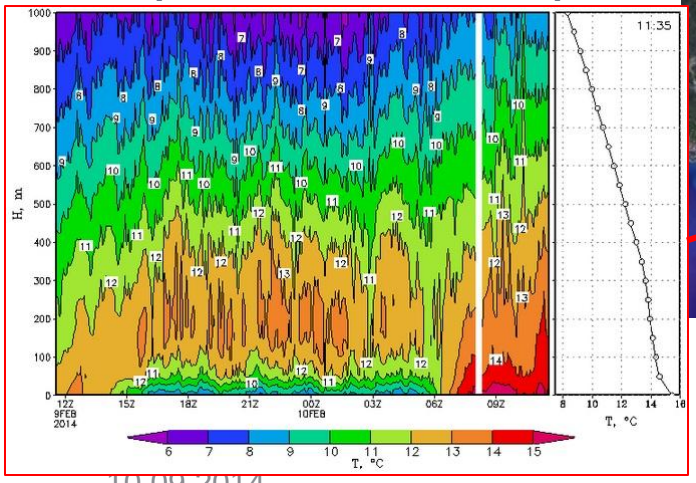
Observation network, 2/4

Profilers

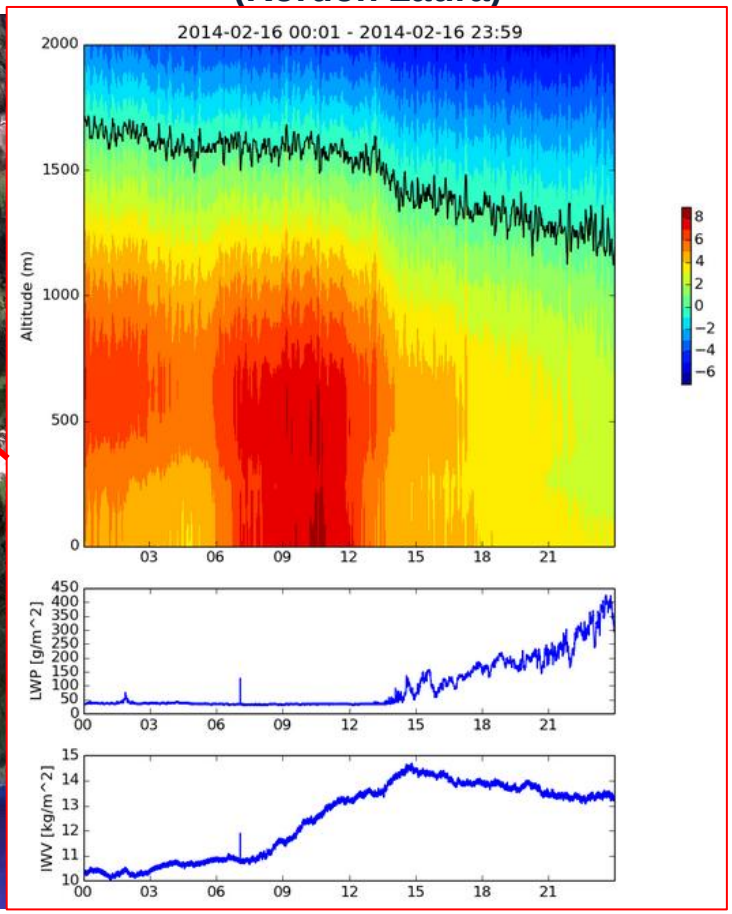
Scintec wind profiler (Kordon Laura)



MTP-5 Temperature Profiler Data (Adler, altitude 6+1.5 m)



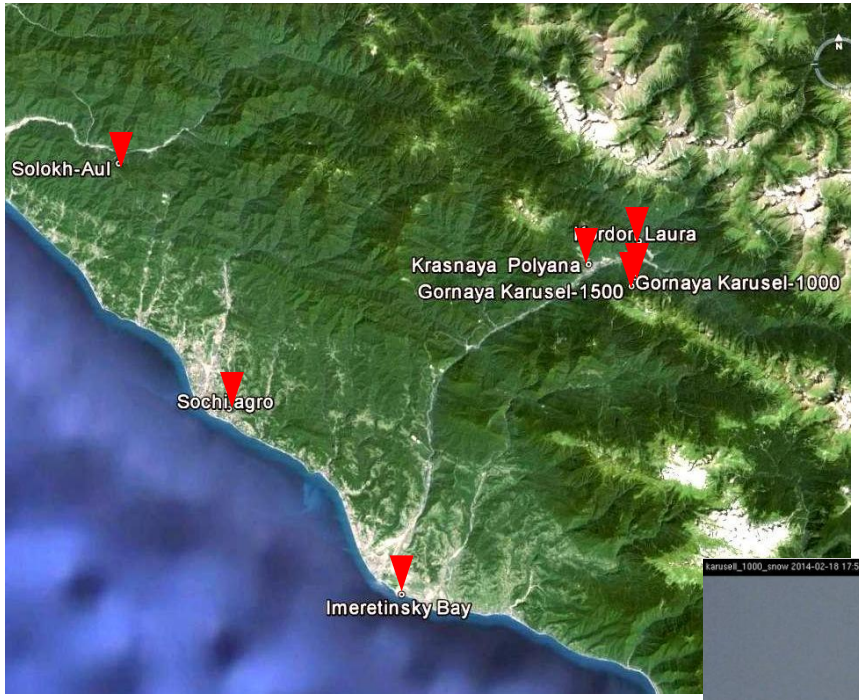
PRG Temperature/Humidity Profiler (Kordon Laura)



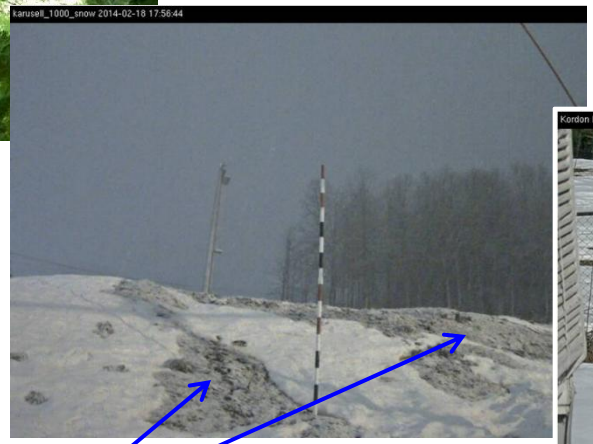
Update rate – 20 min for MTP-5 data / 15 min for Scintec

Observation network, 3/4

Video cameras



Sky conditions and development of the clouds



Surface conditions

Single cam – 3 sites
(2 at the seashore and one at 11 km from the sea)
Paired cam – 4 sites, all within the valley at different altitude (560, 570, 980, 1400 m)

fresh snow

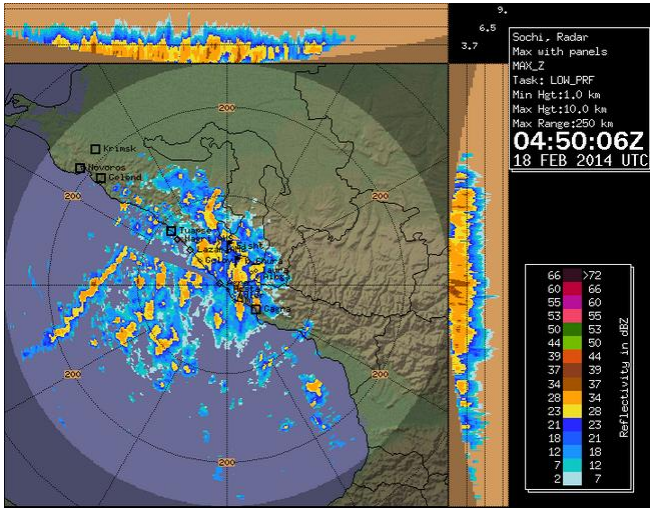
Update rate – 10 min

Observation network, 4/4

Radar

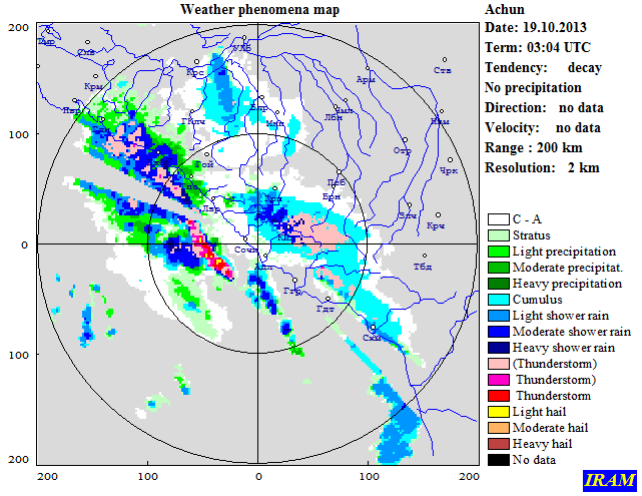
Max Reflictivity (Akhun Radar)

Product of Central Aerological Observatory



Weather phenomena map (Akhun Radar)

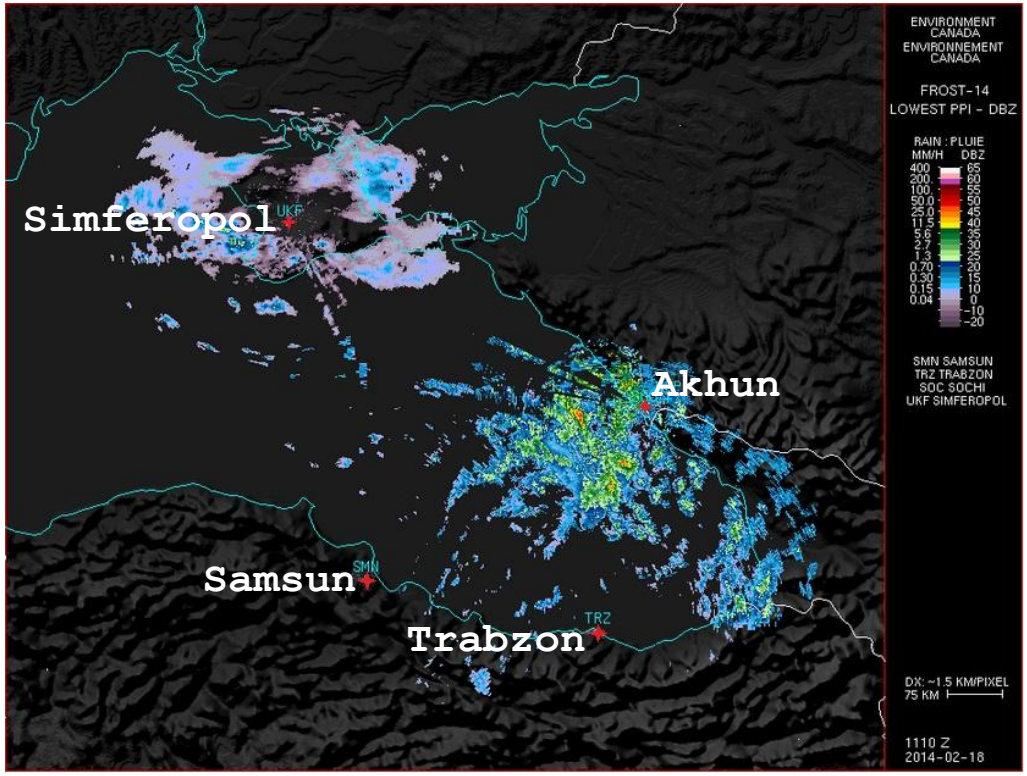
Product of IRAM



Black Sea Composite map (Akhun+Simferopol+Samsun+Trabzon)

Rain Intensity (mm/h) / Reflectivity (DBZ)

Product of Envaronment Canada



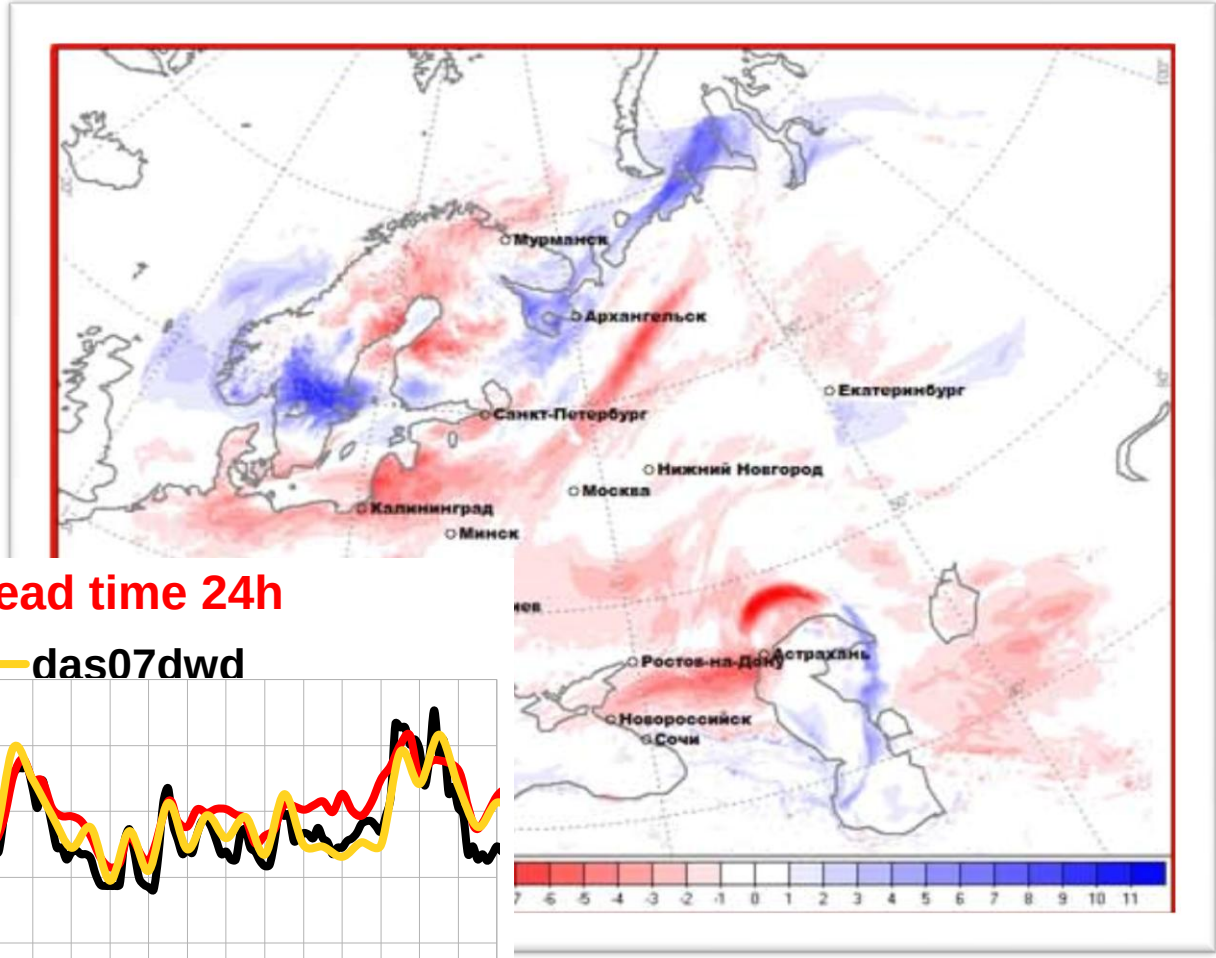
Update rate – 10 min

Task 1.
High resolution COSMO-modelling for mountains regions

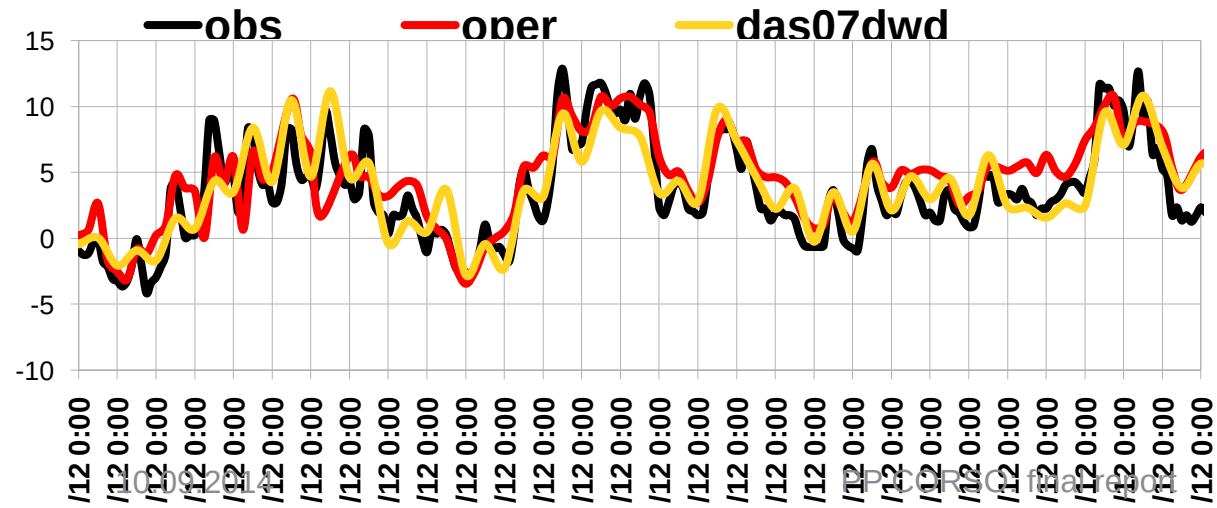
Atmospheric data assimilation: comparing COSMO-Ru7 running with (at DWD) and without (at Roshydromet)

Results of comparison of the differences for T2m: COSMO-Ru07 without DA minus COSMO-Ru07 with DA from DWD

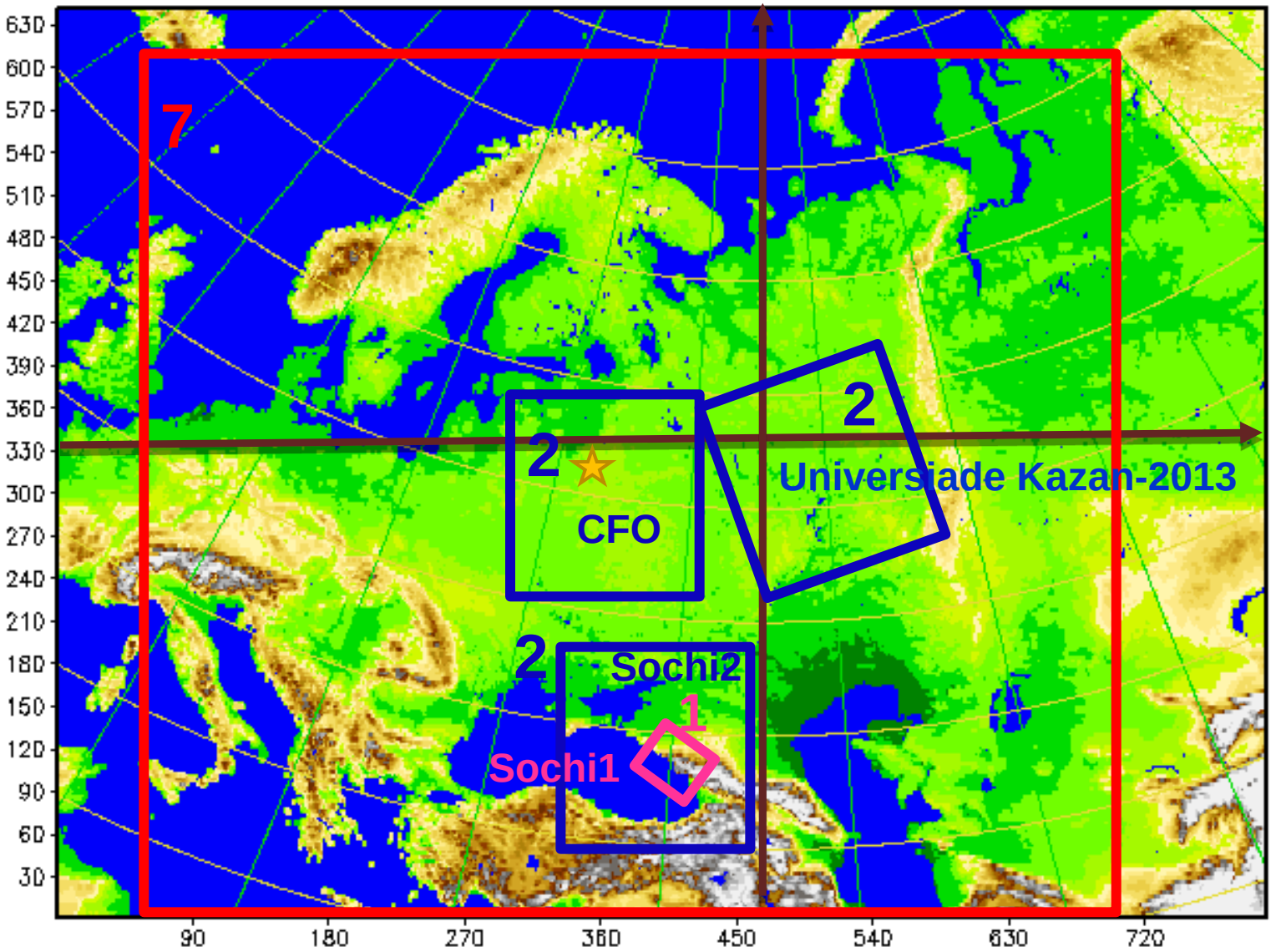
The most significant differences was obtained in the T2m fields



T2M, Sochi: lead time 24h



COSMO-Ru domains in 2013-2014



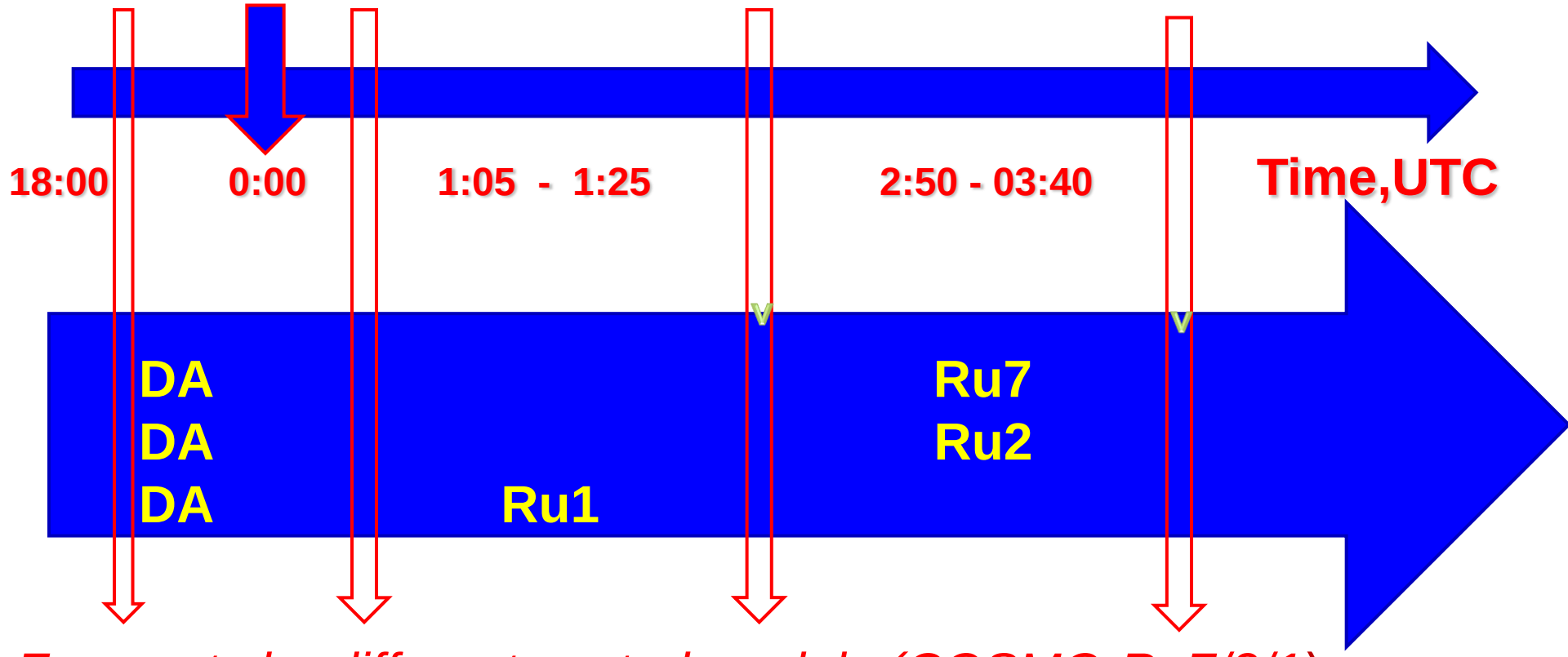
COSMO-Ru7, Δx = 7 km

COSMO-Ru1, Δx = 1.1 km

COSMO-Ru2 (CFO, Universiade, Sochi-2014), Δx =2.2 km

COSMO-Ru system for Sochi-2014: technological line

Start and end times of the nested models runs for 00 UTC analysis



Forecasts by different nested models (COSMO-Ru7/2/1)

The structure of forecast runs was so complicated because of strict time requirements

COSMO-Ru system : Initial & Boundary Conditions

GME → **IC & BC** → **COSMO-Ru7**

Domain: 4900 km x 4340 km
Grid: 700 x 620 x 40
Grid size: 7 km
Time step: 40 s
Forecast: 78 h

Runtime 50 min

IC & BC → **COSMO-Ru2**

Domain: 900 km x 1000 km
Grid: 420 x 470 x 50
Grid size: 2.2 km
Time step: 20 s
Forecast: 48 h

Runtime 50 min

IC & BC → **COSMO-Ru1**

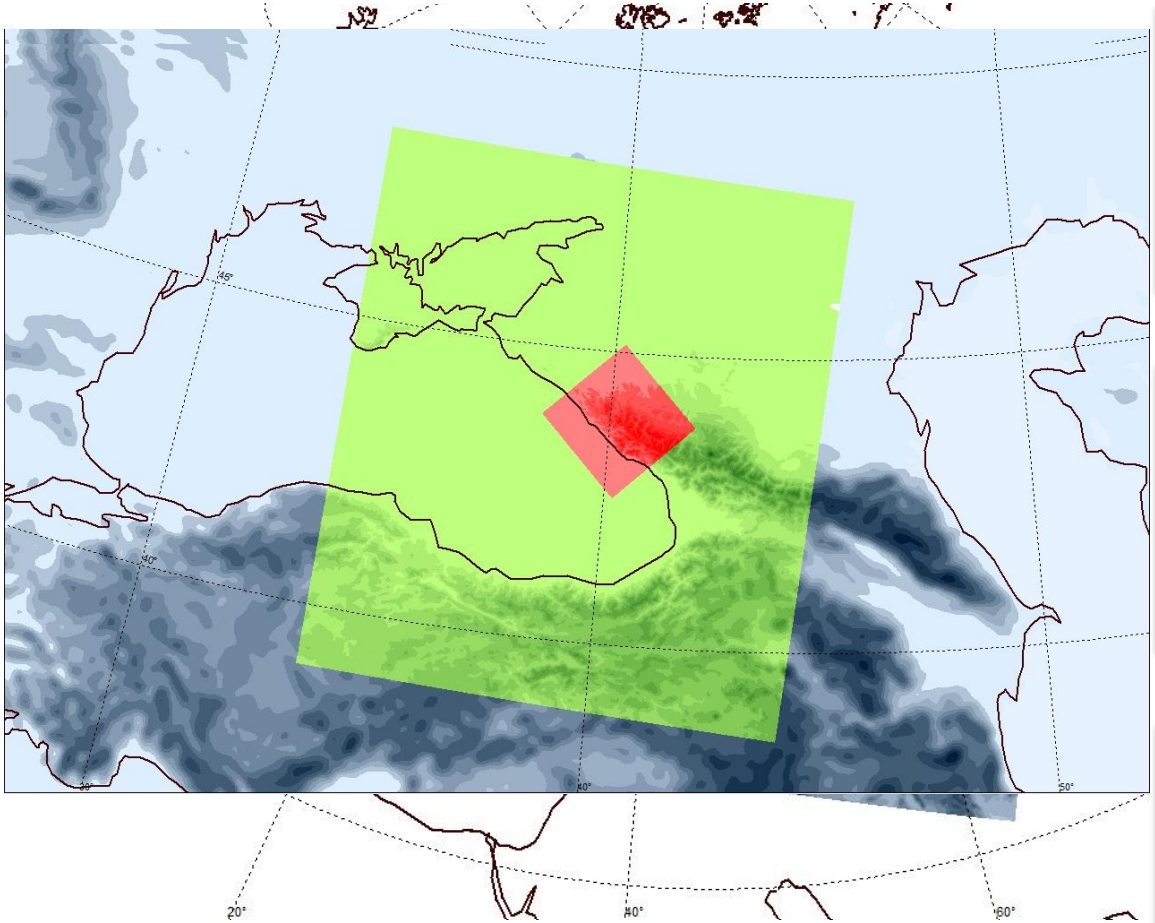
Domain: 210 km x 210 km
Grid: 190 x 190 x 50
Grid size: 1.1 km
Time step: 5 s
Forecast: 36 h

Runtime 24 min

RSK Tornado:
Cluster-based architecture,
peak performance 35 TFLOPS, 1536 PEs
COSMO-Ru uses 288 PEs

Model overview

Model domain



COSMO-Ru7
Domain: 4900 km x 4340 km
Grid: 700 x 620 x 40
Space step: 7 km
Time step: 40 s
Forecast: 78 h

IC&BC

COSMO-Ru2
Domain: 900 km x 1000 km
Grid: 420 x 470 x 50
Space step: 2.2 km
Time step: 20 s
Forecast: 48 h

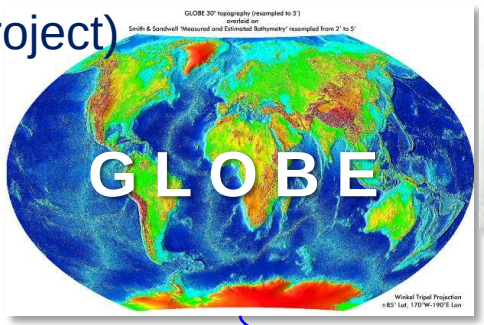
IC&BC

COSMO-Ru1
Domain: 495 km x 495 km
Grid: 450 x 450 x 50
Space step: 1.1 km
Time step: 5 s
Forecast: 36 h

Model overview

Model orography

Initially model orography was based on the **GLOBE** (The Global Land One-km Base Elevation Project) data (NOAA/NGDC).



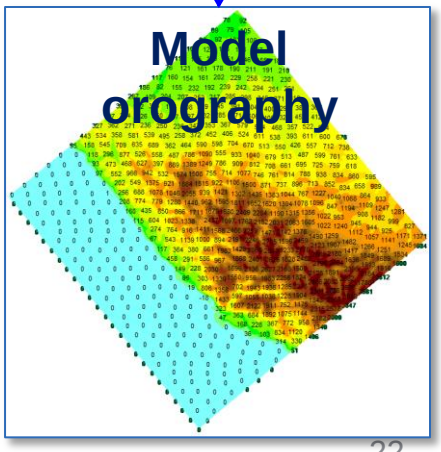
Rather large difference between model's grid height and observation points height, and **ASTER** data also, forced us to correct model orography.

New orography is based on the **ASTER** (Advanced Spaceborne Thermal Emission and Reflection Radiometer) data that has resolution 1" (~ 30 m) (METI/NASA).

EXTPAR software

With new orography:

- ***T2m and wind forecast* have been improved for the most sites;**
- **slightly improvement of the precipitation forecast was noticed;**
- **there are changes in the precipitation amount, its space and time distribution.**



Case study

❑ On February, 16-18, 2014 in mountain cluster low visibility conditions were observed. The first reason was in high humidity and formation of cloud on the mountain slopes (February, 16-17). The second reason was in heavy snowfall during cold front passing (February, 18).

❑ Another case of low visibility (March, 11) was connected with cold front.

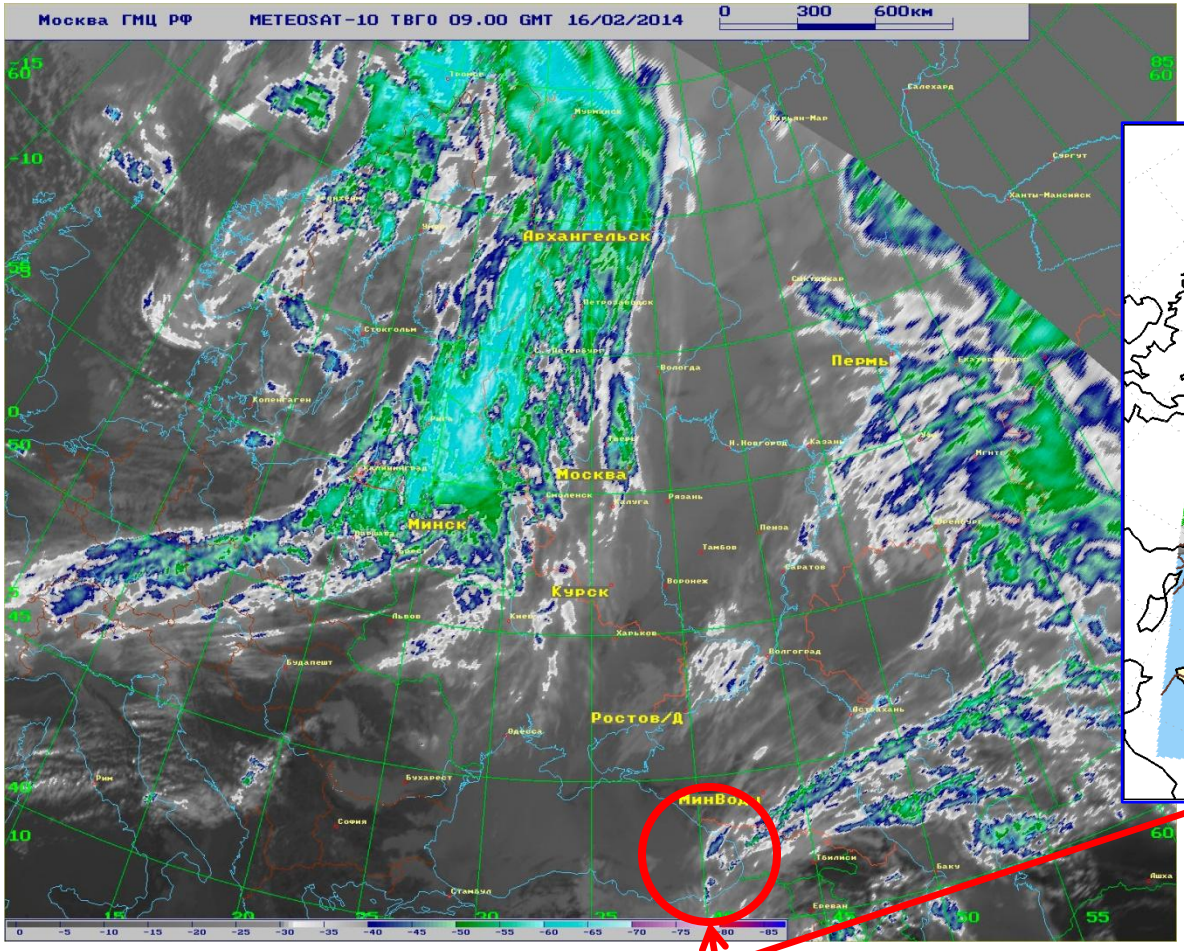
Could we make good forecast of visibility using COSMO-Ru2 or/and COSMO-Ru1 results???

Direction of the study

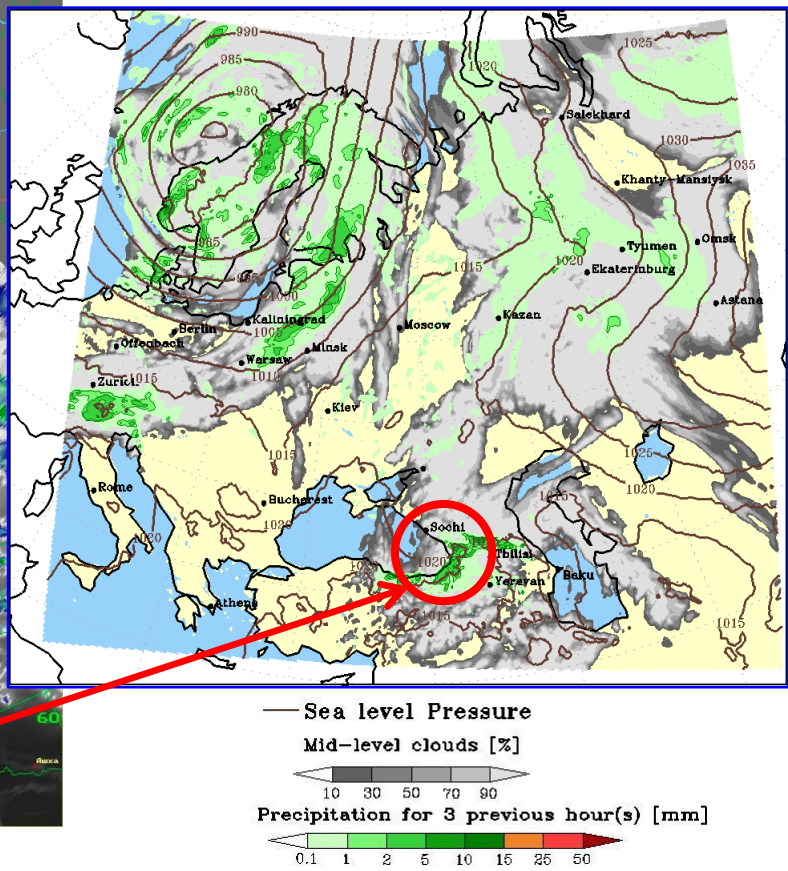
- ✓ review the synoptic situation
- ✓ browse observations
- ✓ investigate models results
- ✓ make conclusions

Low visibility on February, 16-17, 2014

METEOSAT-10. Cloud top temperature
16.02.2014, 09 UTC



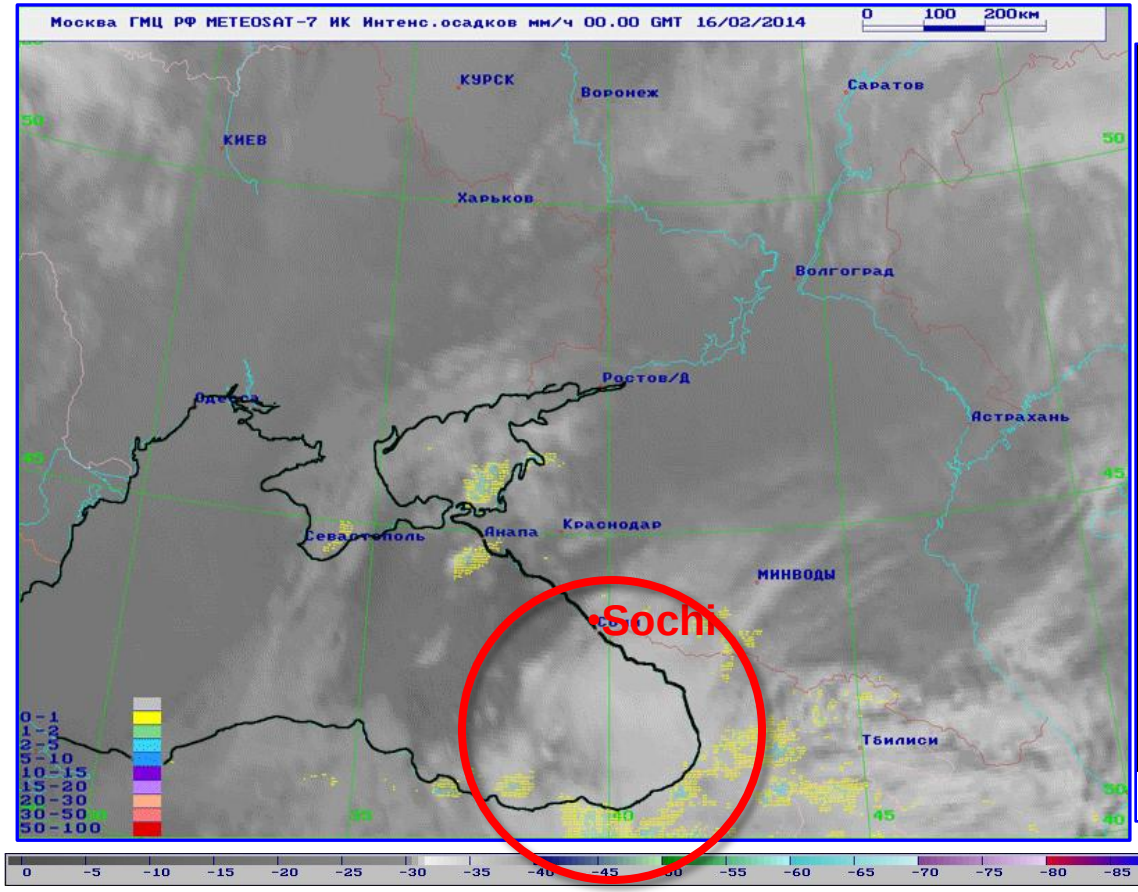
COSMO-Ru7 forecast.
PMSL, Midlevel Cloud & Precipitation
9 h forecast from 16.02.14, 00 UTC



Local cyclone existed during first half the day on February, 16.
Instability zone was observed on satellite images till 15 UTC, 16.02.

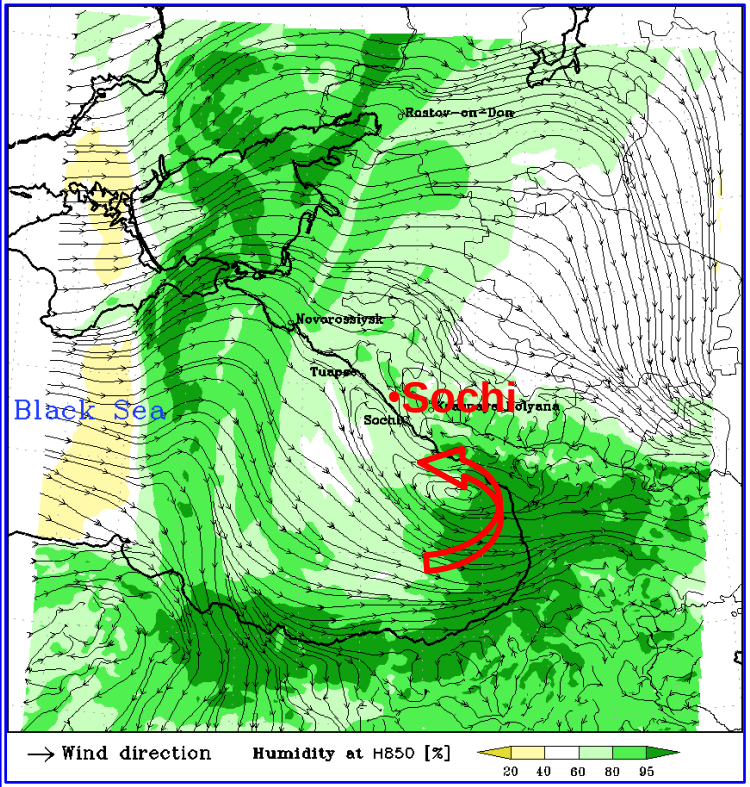
Low visibility on February, 16-17, 2014

METEOSAT-7. Cloudiness and precipitation rate 16.02.2014, 00-22 UTC



COSMO-Ru2 forecast Stream lines and relative humidity at 850 hPa

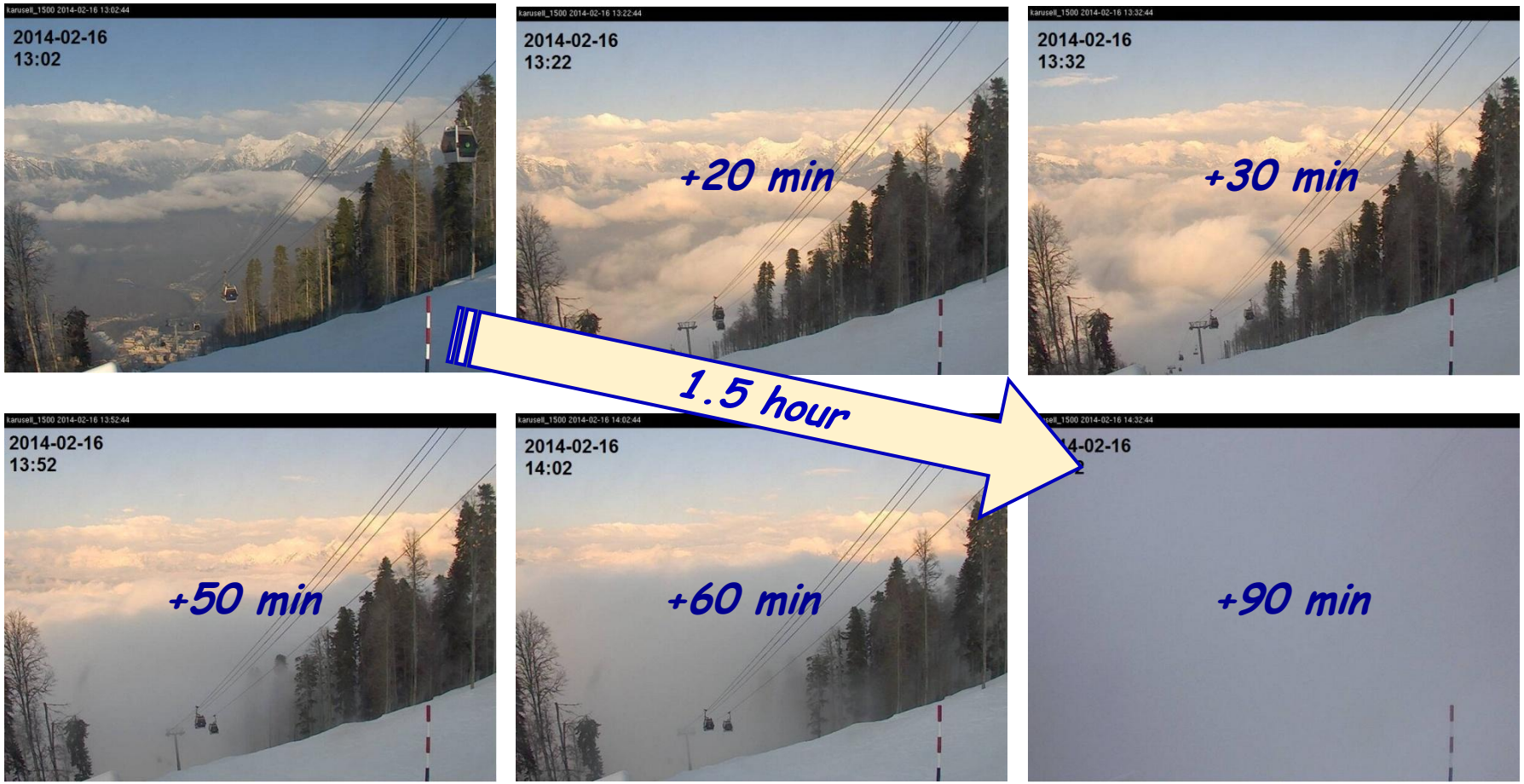
12 h forecast from 16.02.14, 00 UTC



COSMO-Ru2 forecast shows movement of humid air towards Sochi region along the coastline

Low visibility on February, 16-17, 2014

Cloudiness formation due to adiabatic cooling of the moisture air during it rise along the slope of the valley



Camera shots at Gornaya Karusel-1500

- High resolution model (the higher the better) has a **potential for visibility forecast** having most of the necessary predictors as a simulation results (e.g. temperature, humidity and wind speed at different level, precipitation intensity and phase).

  But! It is necessary to have high vertical resolution within near surface layer.

  And not forget about high precision of the prescribed model orography, especially for mountain regions!

- Meteorological support for sporting events should have high temporal resolution forecasts. It's important to know time of the beginning and ending of events, the timing of the maximum (e.g. heavy precipitation, low visibility, etc).

  Today error in determining the beginning of the event is about 1-2 hours.

COSMO-Ru1: **FUTURE PLANS**

- Subtask within the PT CORSO-A: the guidance of the optimal domain's size selection for 1.1 km resolution of nested COSMO models for the regions with complex mountain relief.

Motivation:

During the CORSO PP were obtained results shown the strong dependence of the predicted precipitation amount and spatial distribution on the model's domain size. This problem need the more attentive examination, because the runs of COSMO-Ru1 as part of nested technologies are very expensive in point of view of computing time.

- To perform case study for all cases mentioned by forecasters (see Table).

Task 2.
Downscaling / postprocessing for Sochi area and applications

PP CORSO:
Development of postprocessing and f eedback from forecasters

- Postprocessing for Sochi-2014:
  - Tools for correction of forecasts
  - Tools for calculation of new products (For example, fresh snow depth)
- Feedback from forecasters:
  - Trainings
  - Selection of more important forecast elements & Visualisation
  - Guidelines

- **The calculations of fresh-snow depth were included in the operational technology and were available for forecasters from meteograms and form charts. In Nov/ 2013 the algorithm was implemented in FieldExtra (release 11.2.0) by Jean-Marie Bettems (http://www.cosmo-model.org/content/support/software/default.htm#fieldextra)**
- **The operational technology for down-scaling corrections of forecasts for points of venues based the forecasts of lapse rate + the KF statistics was realized**. Results of tests for the forecasts archives was received
- During the Olympics some in-situ trainings and Guidelines-recommendations for forecasters for specifics of interpretation of mesoscale products were performed
- The verification of operational forecasts was performed

T2m forecasts

Main factors of T2m inaccuracies in mountain areas:

Discrepancy of model and real height of soil levels (smoothed and averaged orography).
For Sochi2014 mountain cluster the differences of heights of COSMO-Ru attempt to 1000 m

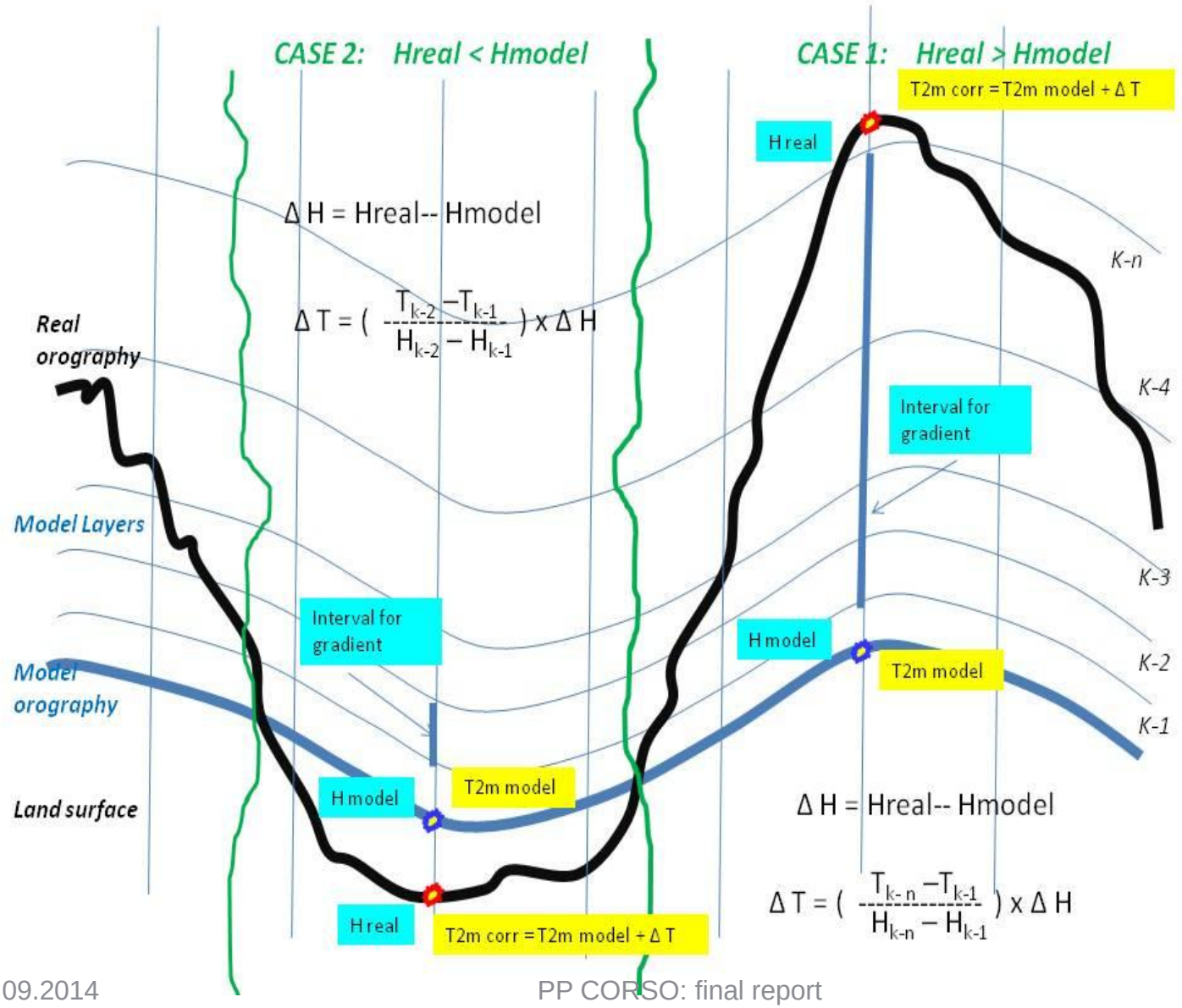
Inadequate work of parameterizations schemes

Two-step correction of forecasts for points (meteograms)

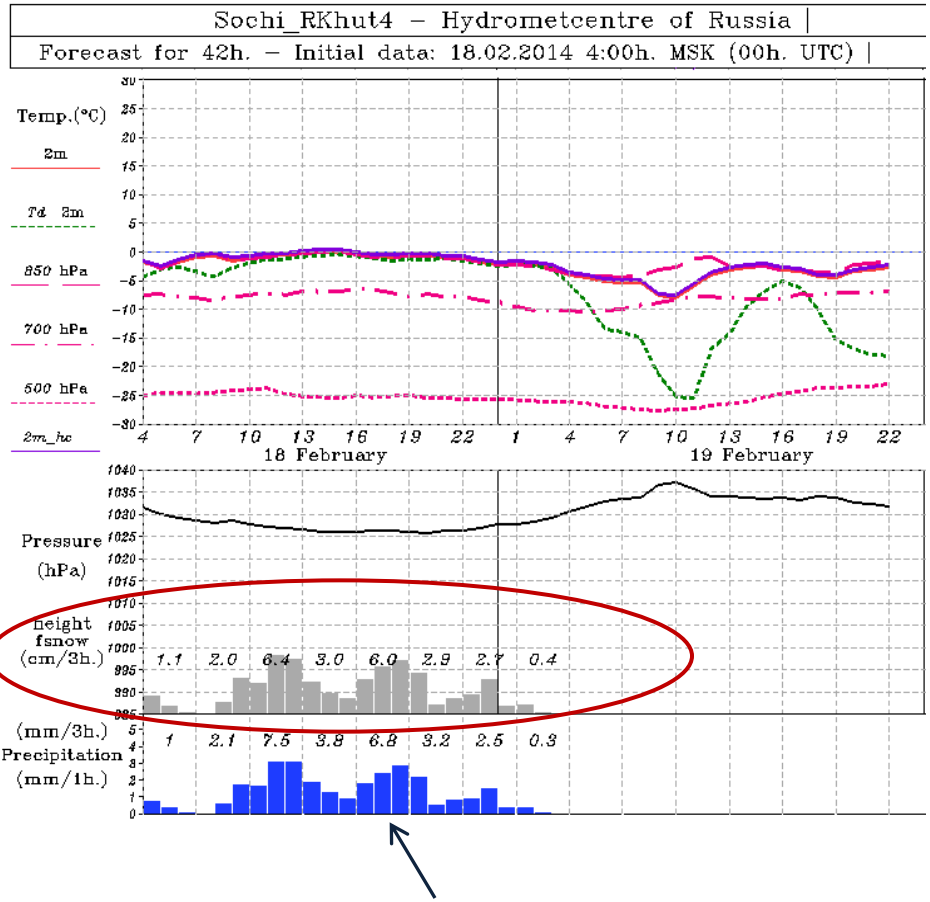
Correction based on the forecasts of vertical T gradient of bottom levels (h- correction)

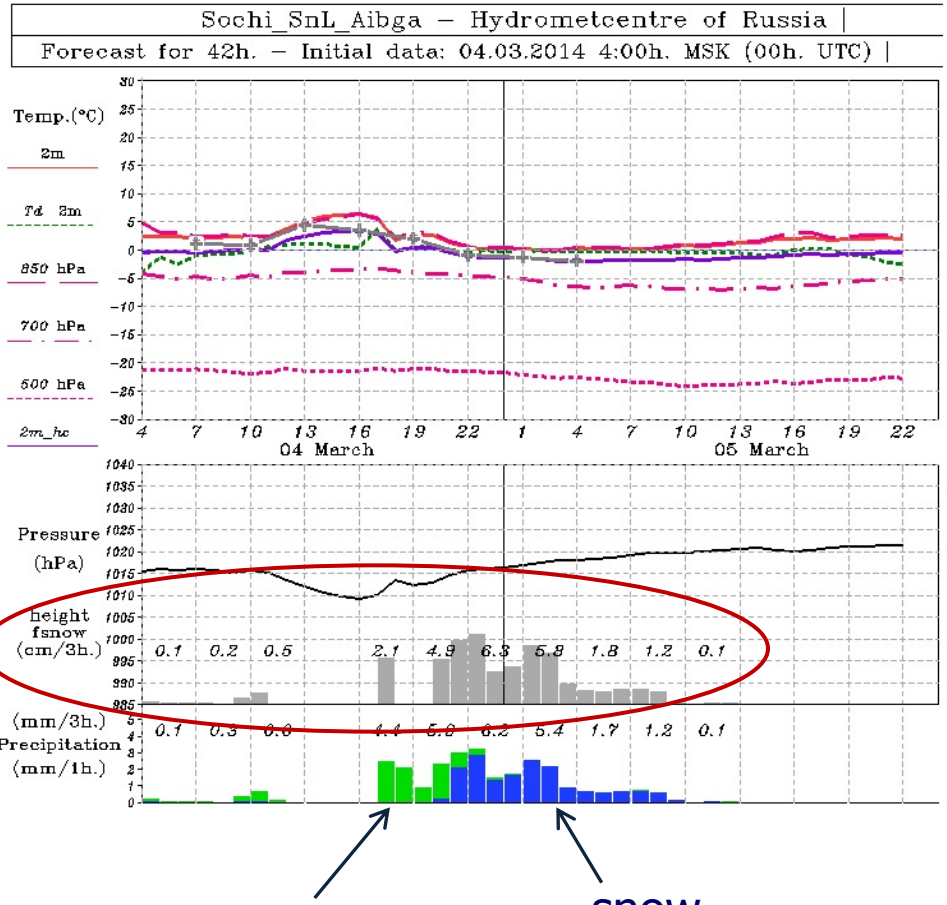
Statistical correction based KF

Scheme of h-correction of T2m



Meteograms for stations Roza Khutor 4 and Aibga by COSMO-Ru 2.2 km



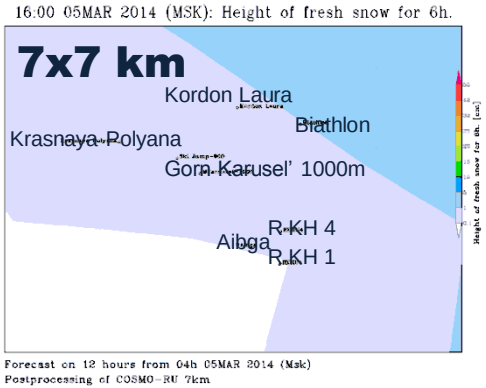


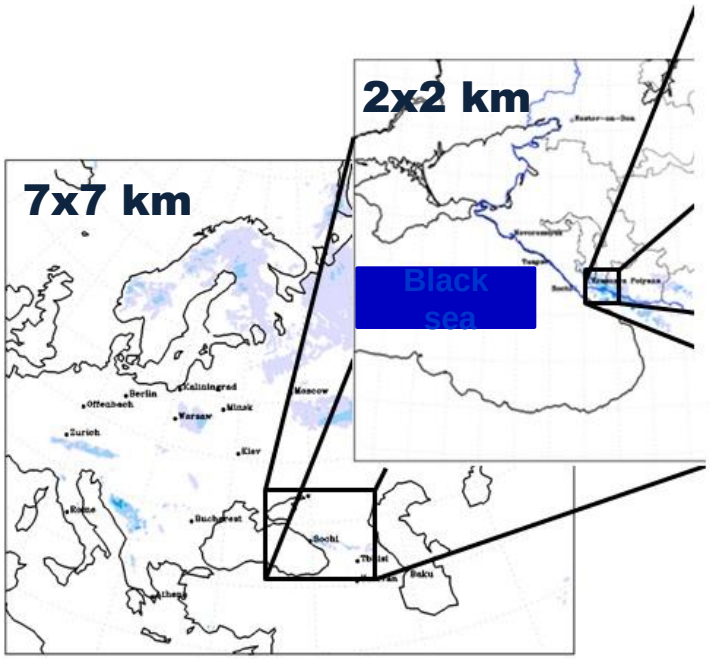
snow

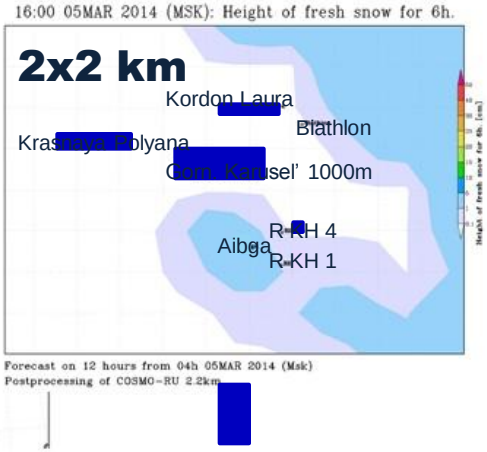
rain

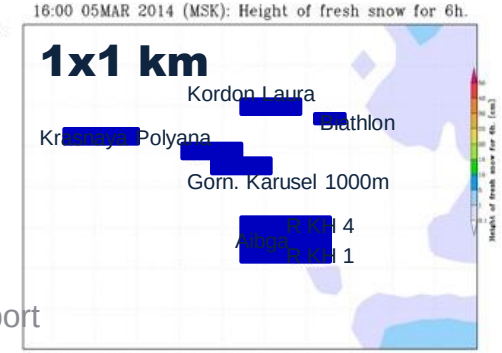
snow

Example
of fresh snow depth forecasts
12 UTC 5 March 2014









Results of verification activities

- Traditional scores aggregated over the Sochi region show overall prevalence of COSMO-RU2 wrt COSMO-RU7 and COSMO-RU1
- However, some cases of intense precipitation and visibility are better predicted by COSMO-RU1
- Wind is also better in COSMO-RU1
- Precipitation is best forecasted in the late afternoon

Proposals for CORSO-A

- Is planned to realize the **of the T2m correction**

based the forecasts of T **lapse rate** in bottom levels into FieldExtra

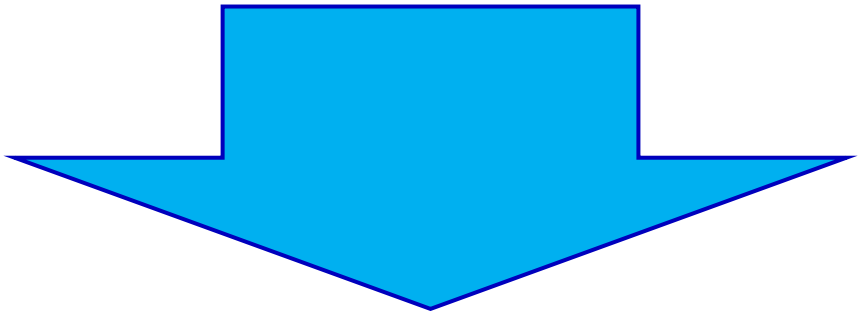
(J-M Bettems, E.Kazakova, I.Rozinkina)

The main problem were T2m forecasts

Main factors of T2m inaccuracies in mountain areas:

Discrepancy between model and real surface height
(the height differences for COSMO-Ru were up to 1000 m at some points of the Sochi2014 mountain cluster)

Inadequate work of parameterization schemes



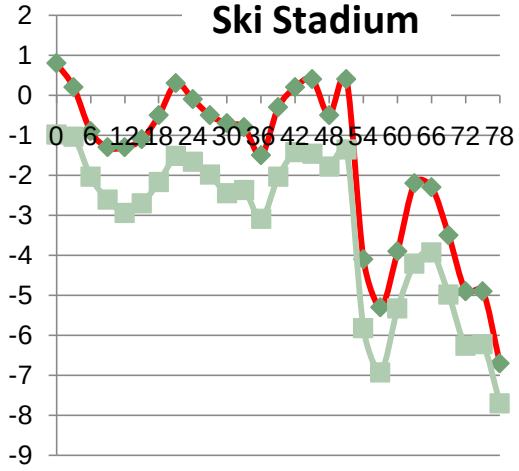
Two-step correction of forecasts for points (meteograms)

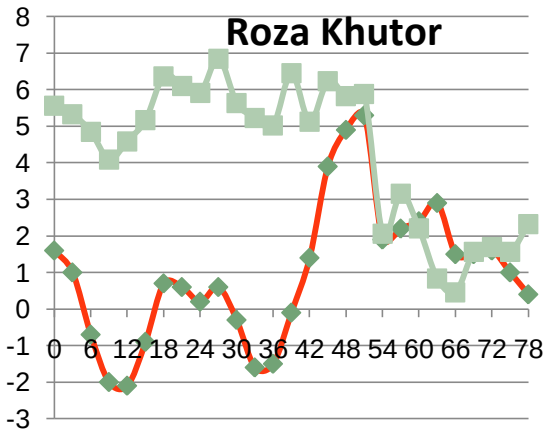
Correction based on the forecasts of vertical T gradient within the boundary layer (H-correction)

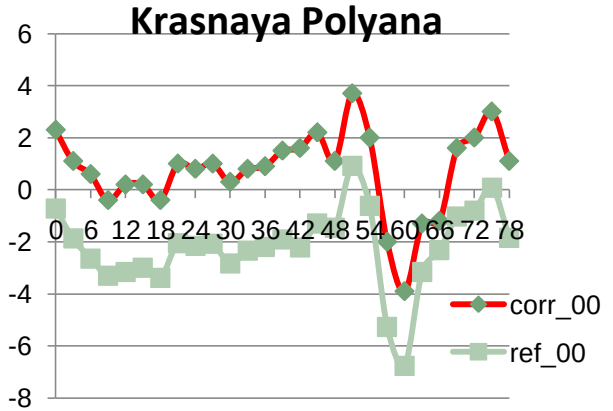
Statistical correction based on Kalman Filter (KF-correction)

The examples of H-correction

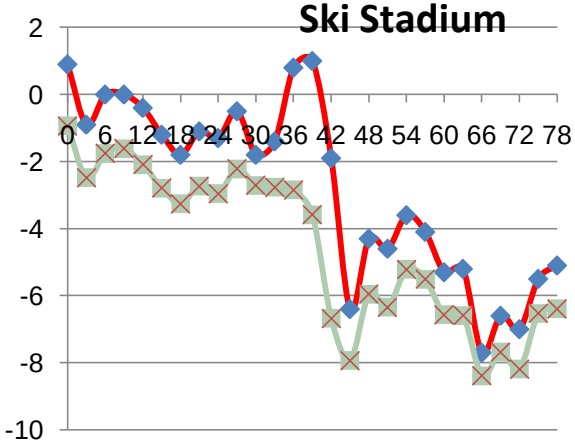
dT2m =Tref-THcorr, *dT2m before correction (green),* *dT2m after correction (red)*

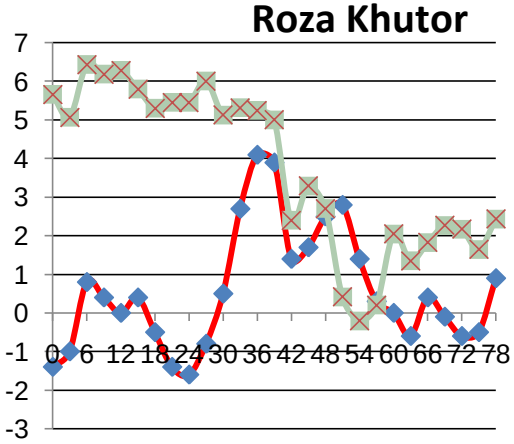


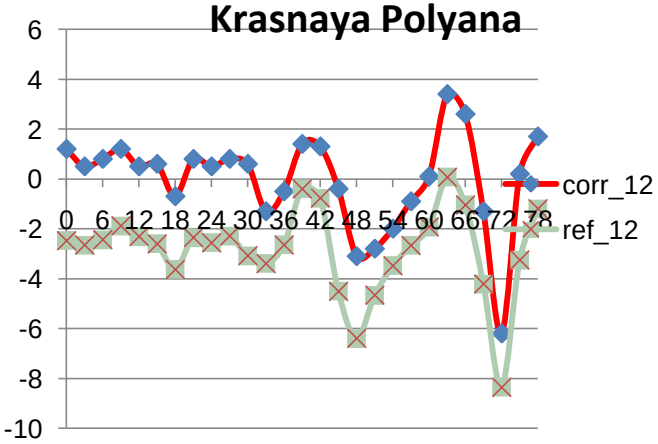




00 UTC

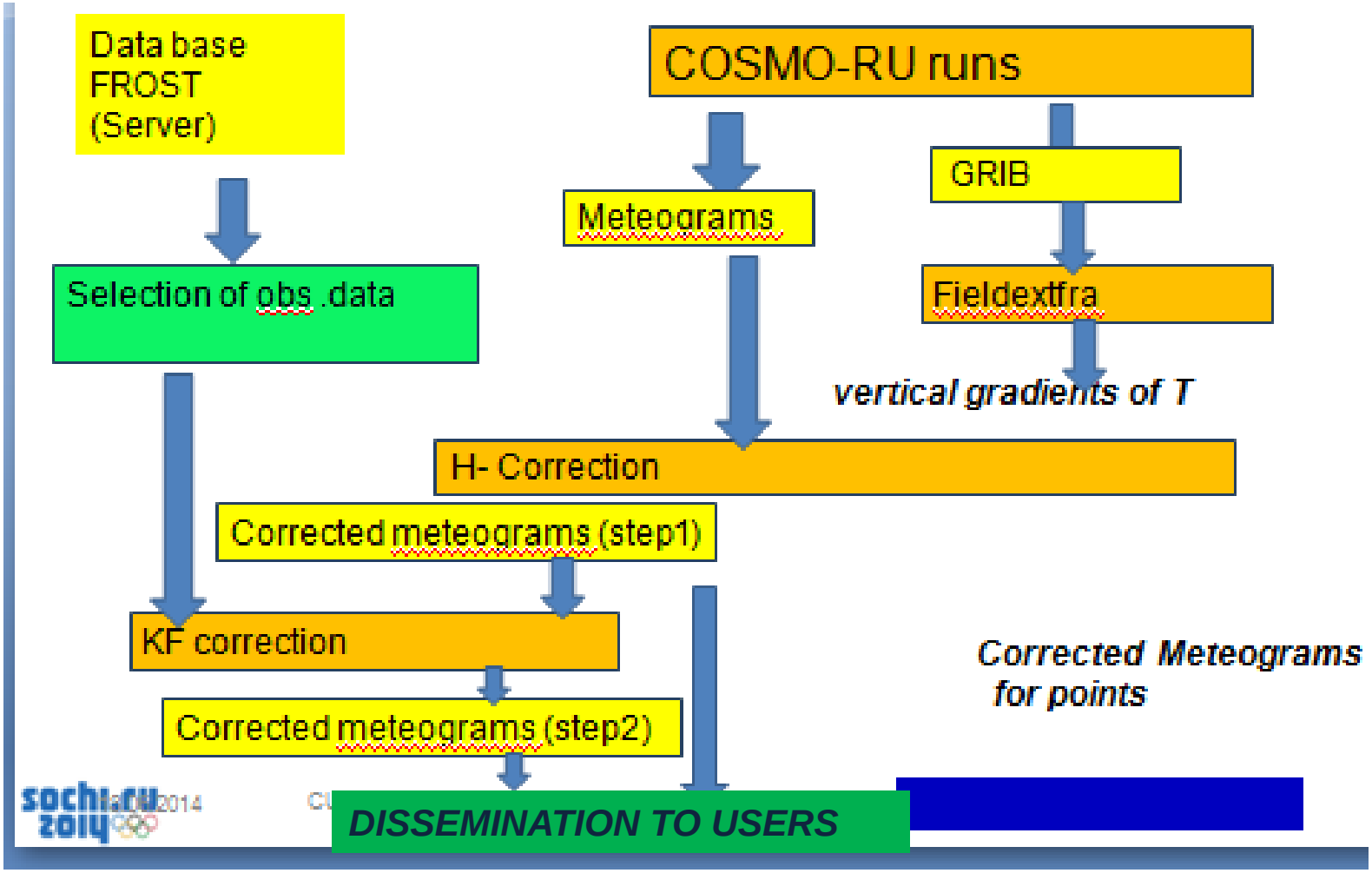






12 UTC

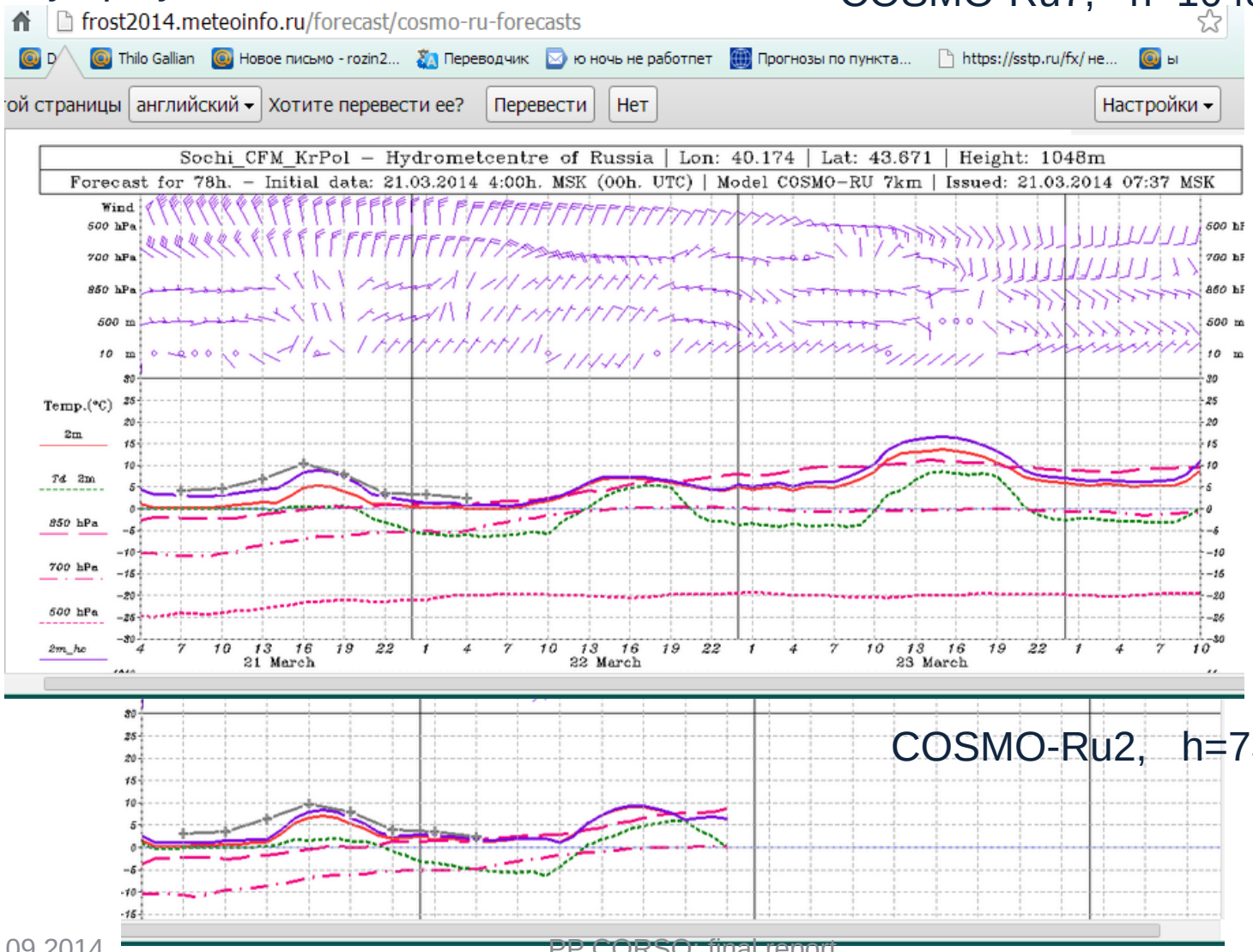
The 2-step correction : realization for the Sochi-2014 meteorological support



An example of meteograms with corrected T (violet)

Krasnaya polyana, h=650 m

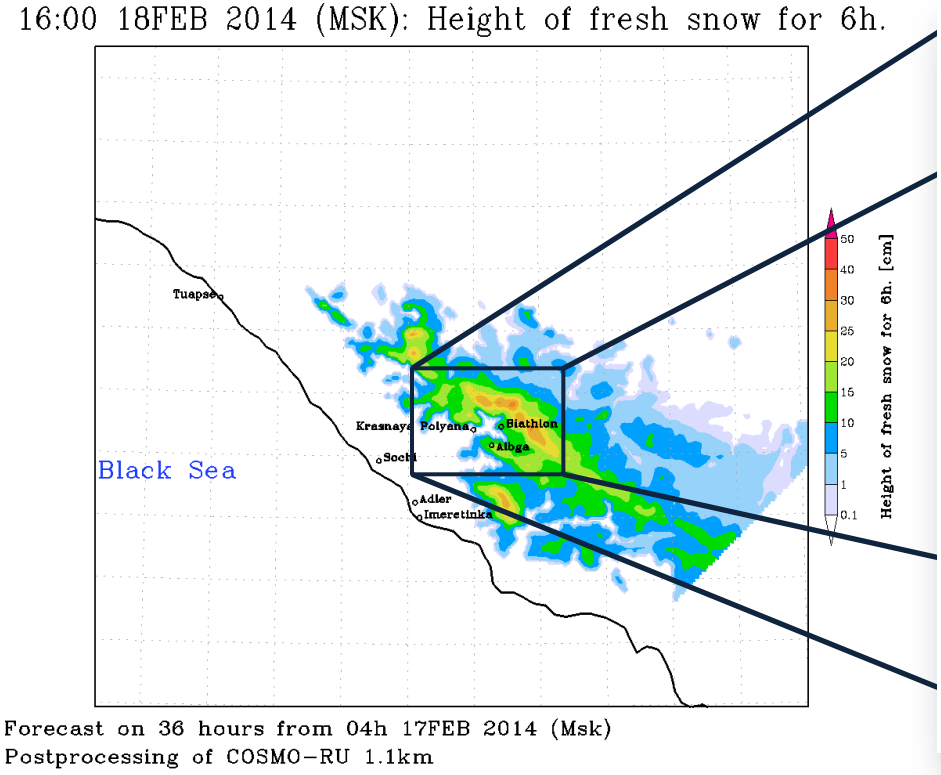
COSMO-Ru7, h=1048 m

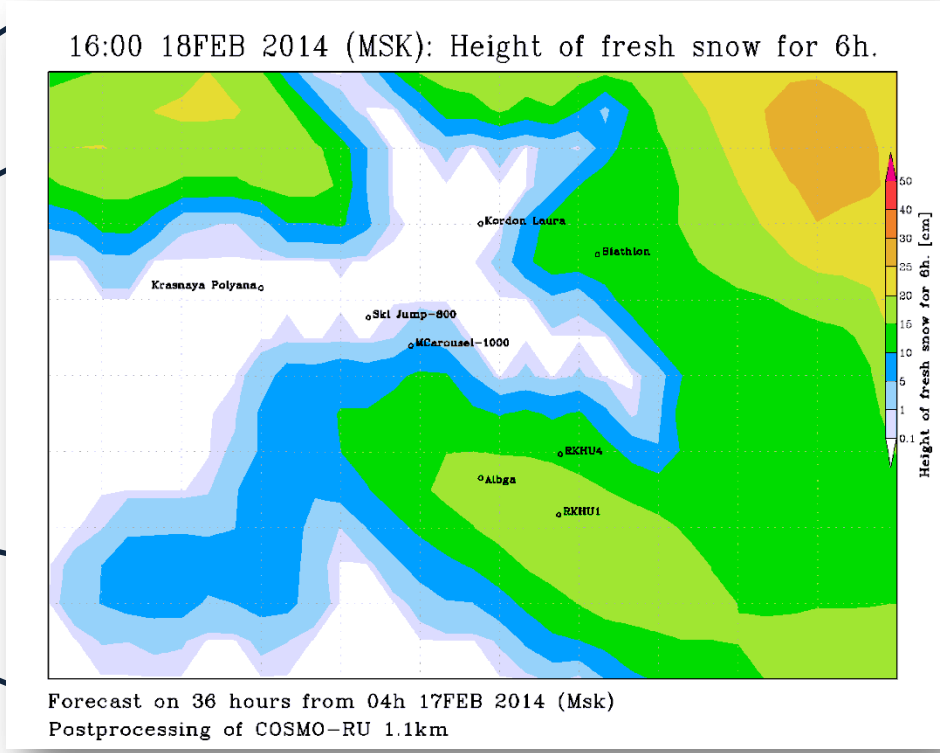


COSMO-Ru2, h=734 m

Development of postprocessing: new products

Map of fresh snow depth (cm). COSMO-Ru 1.1 36-hour forecast from 00 UTC 17 February 2014.



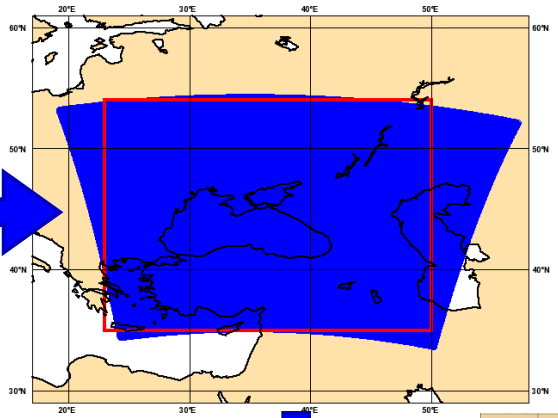


Task 3.
Development and adaptation of COSMO EPSs for Sochi region

Ensemble organization

ECMWF-EPS
Globe
T779L61 (Δx~30 km)
M51, fc+14d
ECMWF computer

Clustering
Nesting



COSMO-S14-EPS
SOCHI DOMain
Δx~7km, L40
M10, fc+72h
ECMWF computer

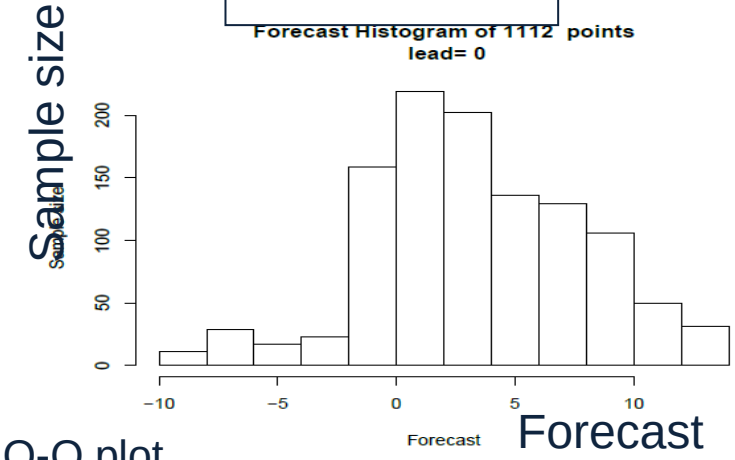
Nesting

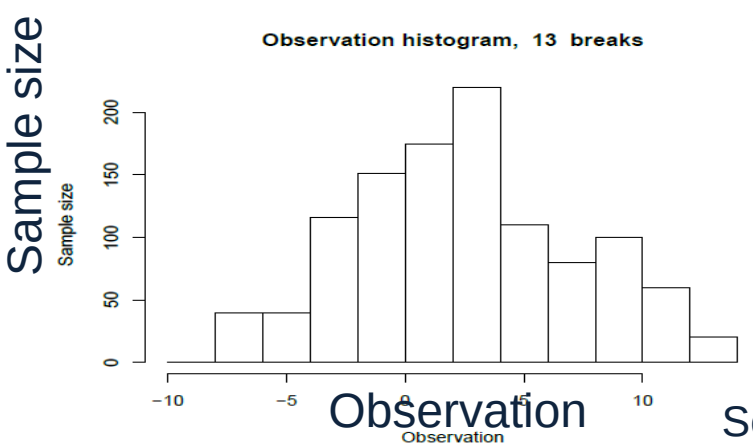
COSMO-Ru2-EPS
Sochi region
Δx~2.2 km, L51
M10, fc+48h
RHMC computer

DISTRIBUTION ANALYSIS: HISTOGRAMS AND QUANTILE-QUANTILE PLOTS

Parameter: T2m, Location: Biathlon Stadium (1455 m),
Verification Period: 15.1.2014-15.3.2014,
Verification approach: Nearest point

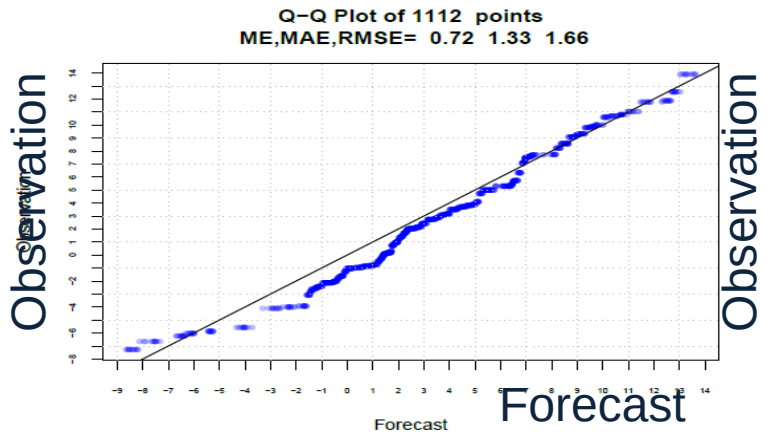
Lead=0



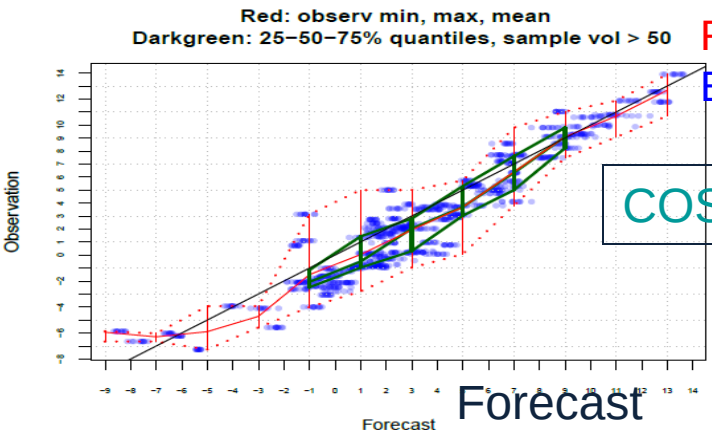


All forecasts starting from 00 UTC and 12 UTC analyses

Q-Q plot



Scatter plot



Red:observations
Blue:forecasts

COSMO-Ru2-EPS

If the two datasets come from the same distribution, the points should lie roughly on a line through the origin with slope 1

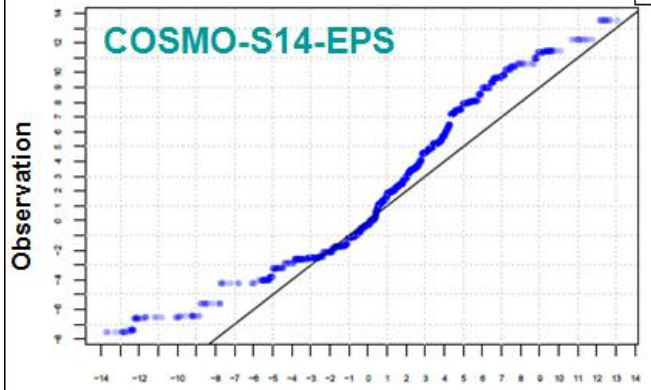
COSMO GM2014. E. Astakhova, A. Montani et al.

Role of spatial resolution

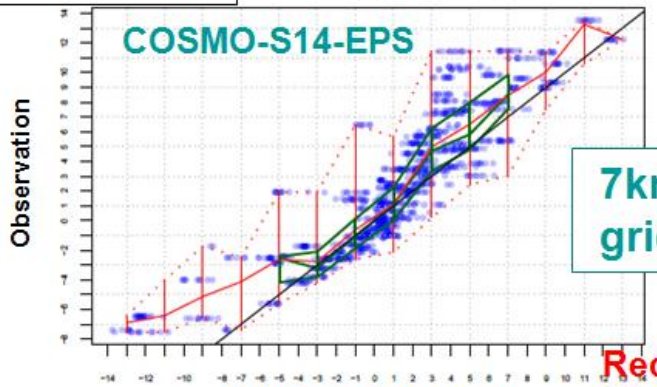
Parameter: T2m, Location: Biathlon Stadium (1455 m),
Verification Period: 15.1.2014-15.3.2014, Verification approach: Nearest point

Lead=48

Q-Q plot
ME=-1.26 MAE=1,83 RMSE= 2.52

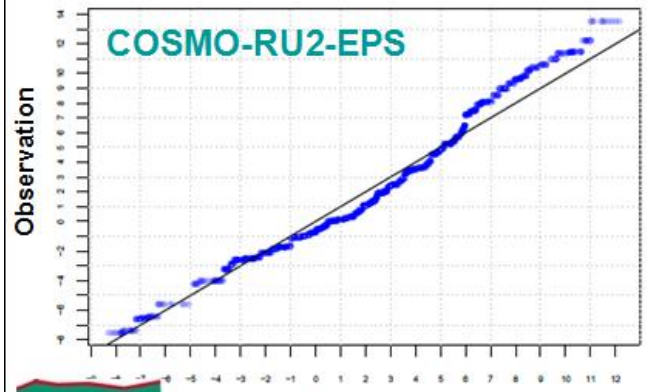


Scatter plot
Red: observ min, max, mean
Darkgreen: 25–50–75% quantiles, sample vol > 50

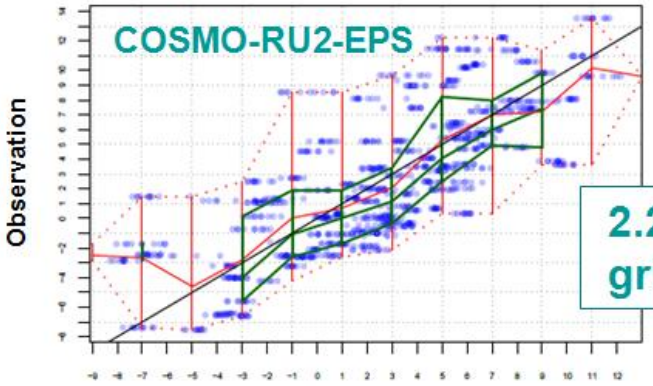


7km grid spacing

ME=-0.02 MAE=2.61 RMSE= 3.20



Red: observ min, max, mean
Darkgreen: 25–50–75% quantiles, sample vol > 50



Red:observations
Blue:forecasts

2.2 km grid spacing

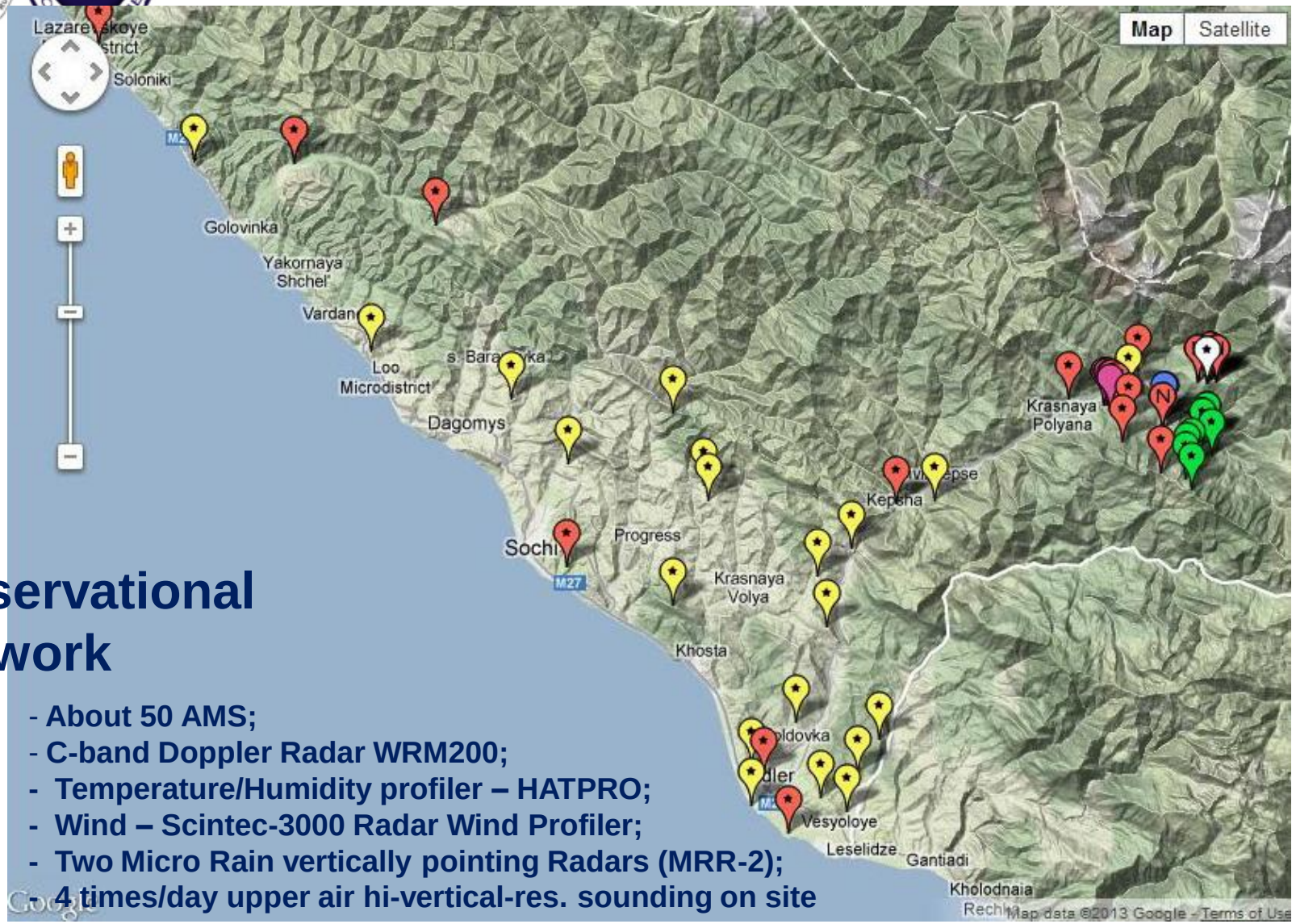
Hi-res ensemble forecasts: better pdfs, higher variability but poorer ensemble mean scores

2

FROST-2014

FROST –

Forecast and Research in the Olympic Sochi Testbed



Observational network

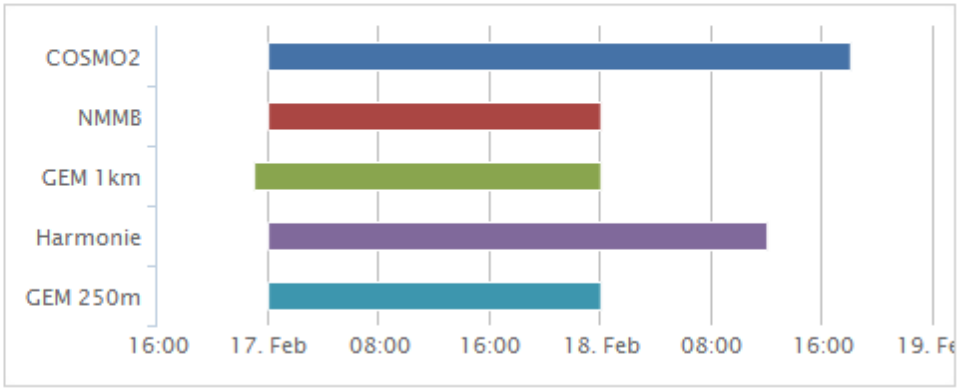
- About 50 AMS;
- C-band Doppler Radar WRM200;
- Temperature/Humidity profiler – HATPRO;
- Wind – Scintec-3000 Radar Wind Profiler;
- Two Micro Rain vertically pointing Radars (MRR-2);
- 4 times/day upper air hi-vertical-res. sounding on site

D.Kiktev, E.Astakhova, A.Muravyev, M.Tsyrulnikov. Perfomance of the WWRP project FROST-2014 forecasting systems: Preliminary assessments. **WWOSC-2014, 16-21 August 2014**

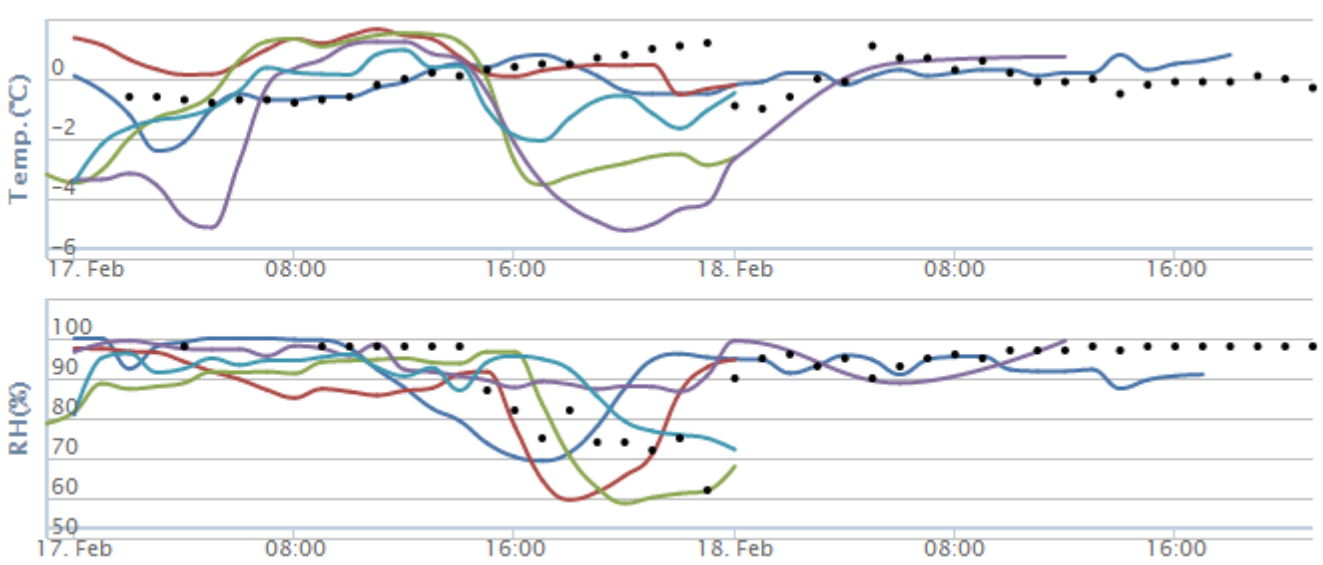
Forecasts ▸ Multi-system point forecasts

Abbrevations used for the Forecasting Systems Locations of the AMSs AMSs on Google Maps

	Model	Init time
☑	COSMO2	2014-02-17 00:00:00
☑	NMMB	2014-02-17 00:00:00
☑	GEM 1km	2014-02-16 23:00:00
☑	Harmonie	2014-02-17 00:00:00
☑	GEM 250m	2014-02-17 00:00:00



17.02.2014.00 - initial



- RKHU-1 (2320m)
- RKHU-3 (2043m)
- RKHU-8 (1740m)
- RKHU-4 (1580m)
- RKHU-7 (Finish, 980m)
- Snowboard-1025
- Freestyle-1080
- Biathlon-1500
- Biathlon-1400
- **Biathlon Stadium**
- Ski Stadium
- Nordic Combination-675
- Nordic Combination-615
- Ski Jump-650

D.Kiktev, E.Astakhova, A.Muravyev, M.Tsyrulnikov. Perfomance of the WWRP project FROST-2014 forecasting systems: Preliminary assessments. **WWOSC-2014, 16-21 August 2014**

COSMO-Ru, Aug 2014

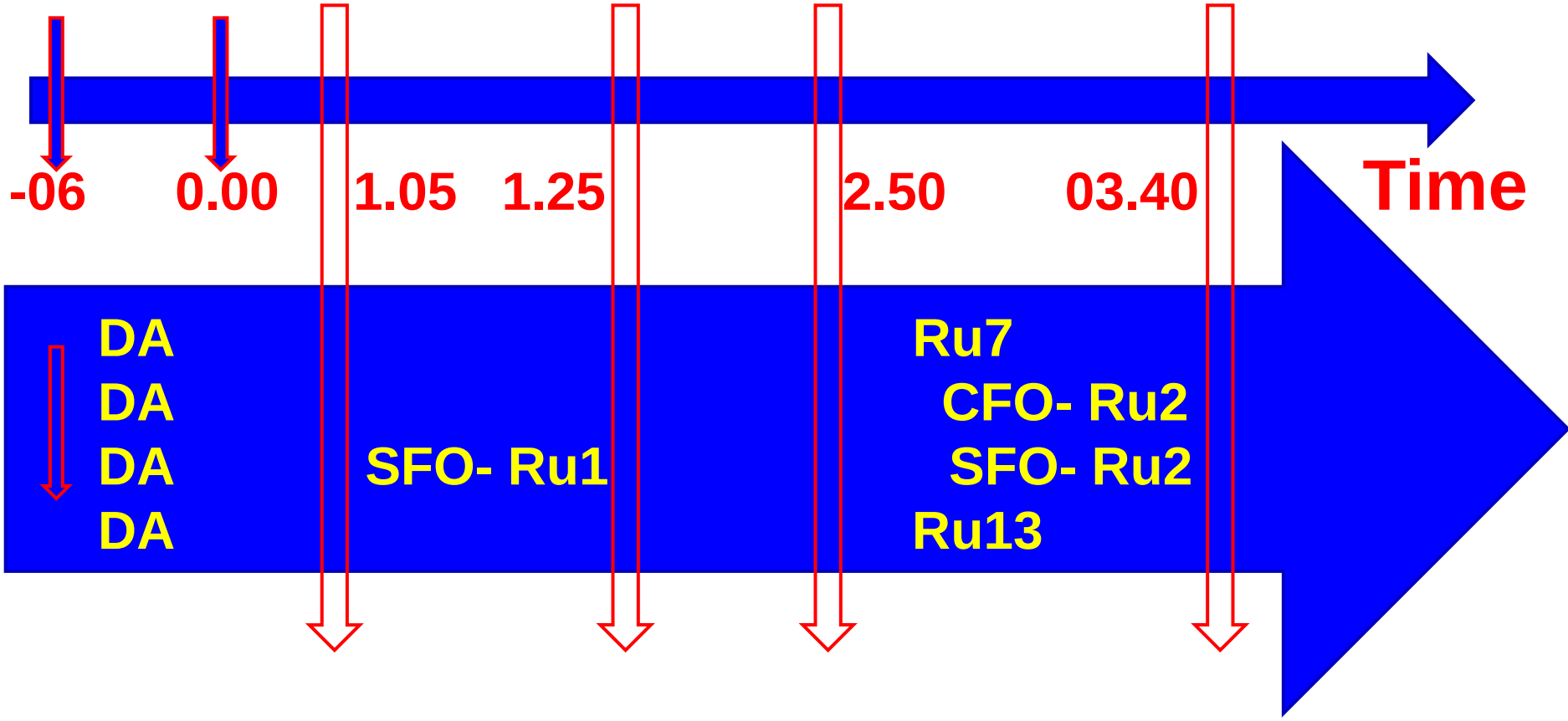
COSMO-Ru:
Ru1, Ru2, Ru7, Ru7-ART, Ru14, Ru13,
Universiade Kazan-2013

Forecast system COSMO-Ru7/2/1/14/13

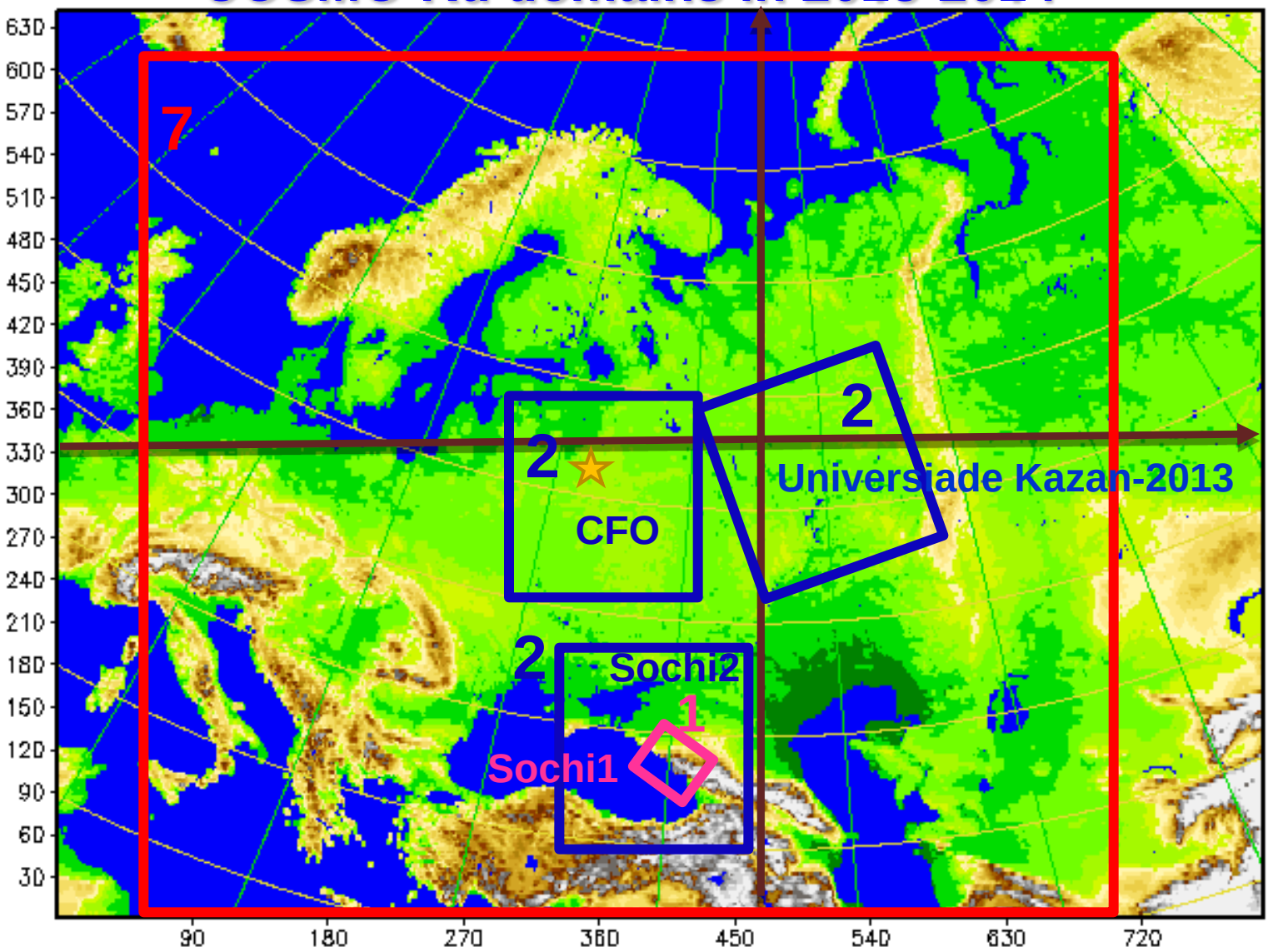
Daily 4 times (00, 06, 12, 18 h UTC):

- prepares more than 8000 (total for 1 day) weather forecast maps and about 1000 (total for 1 day) meteograms (images)
- sends these maps and meteograms to the weather forecasting offices of Roshydromet
- spreads on a FTP-servers the GRIB and graphical files (about 70 Gb)

Technological line of COSMO-Ru in Moscow



COSMO-Ru domains in 2013-2014

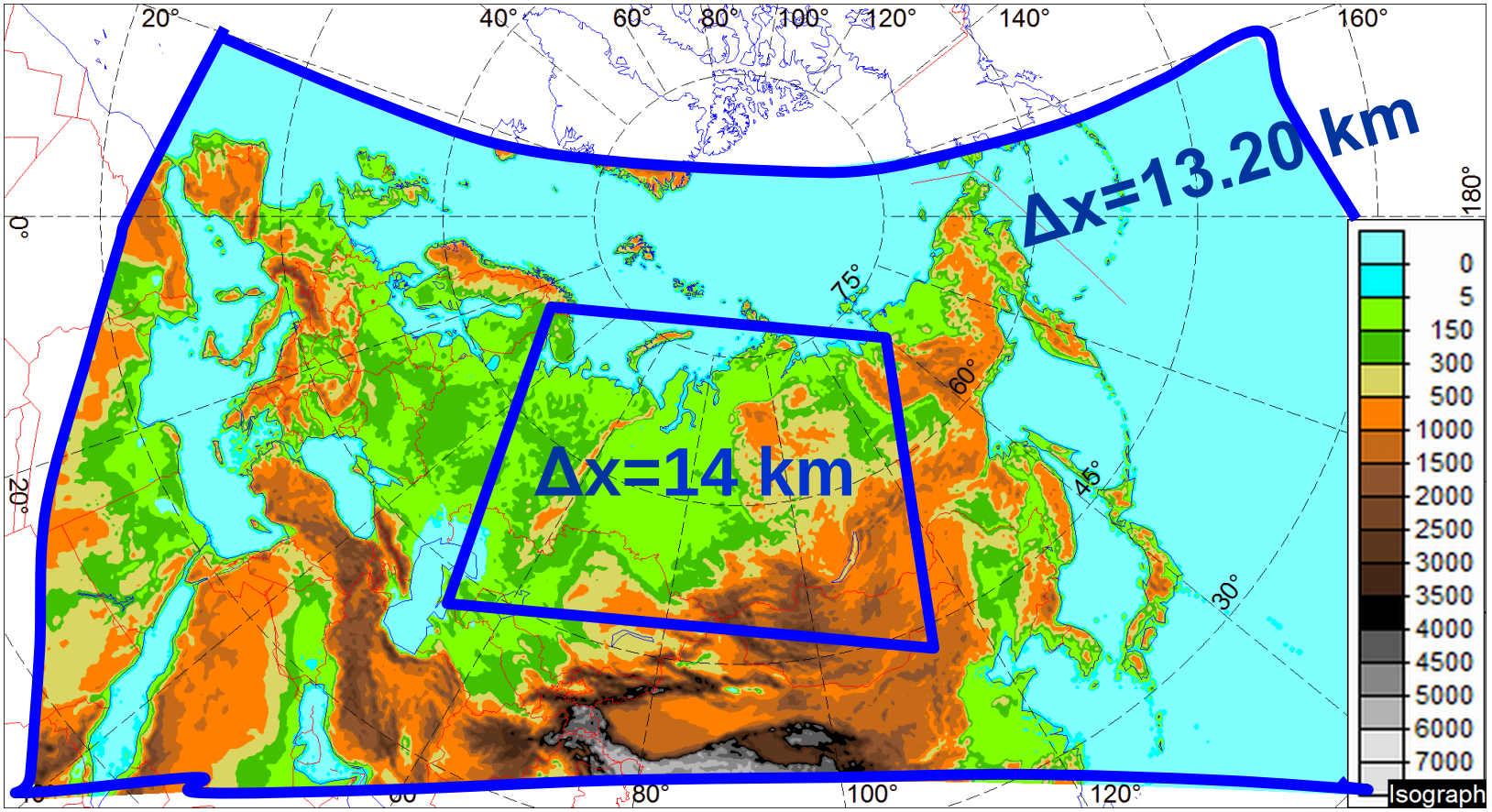


COSMO-Ru7, Δx = 7 km

COSMO-Ru1, Δx = 1.1 km

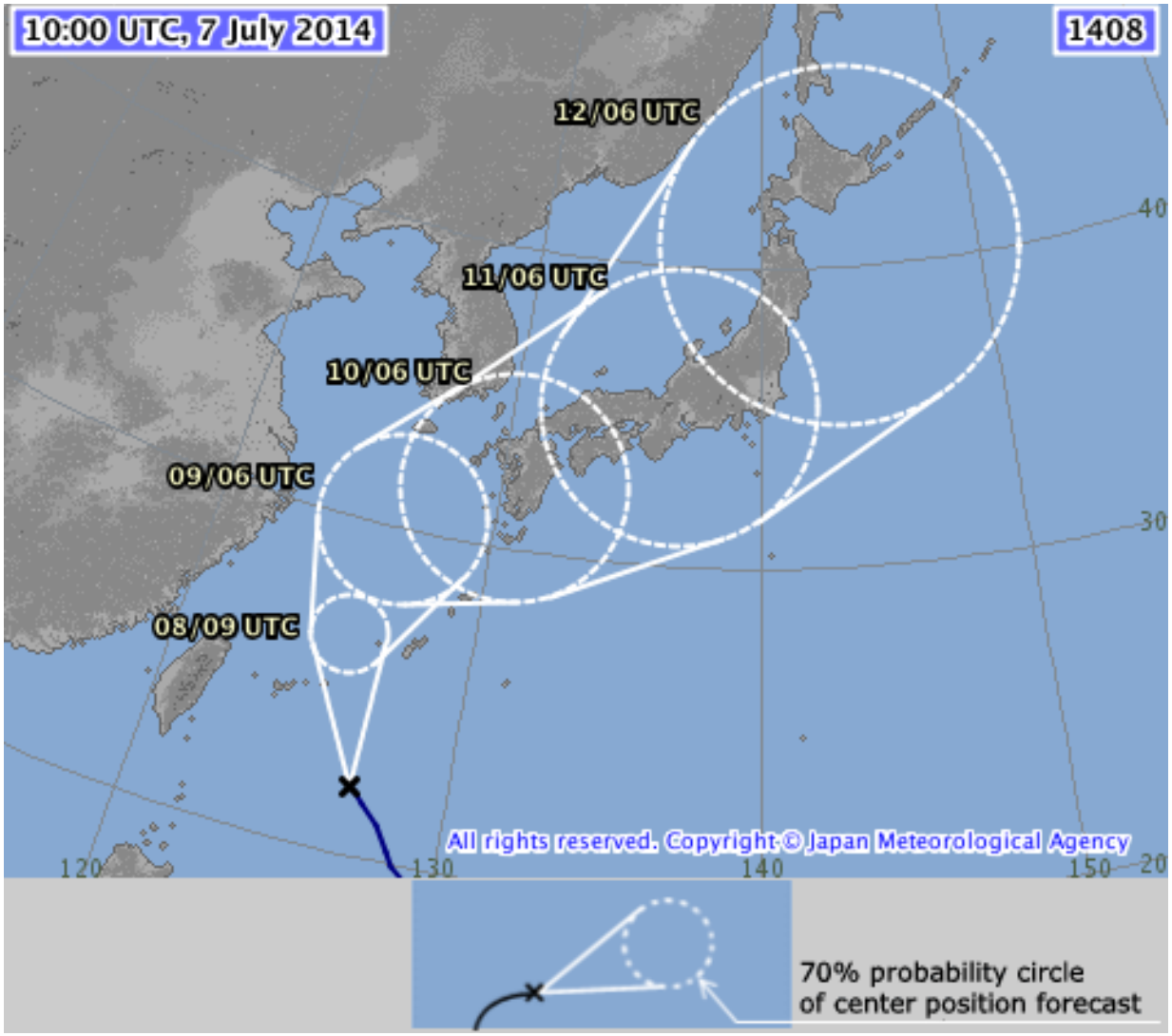
COSMO-Ru2 (CFO, Universiade, "Sochi-2014"), Δx =2.2 km

COSMO-Ru14 for Siberia: 14 km - 360 x 250
COSMO-Ru13/6 для ENA (Europe & North Asia)
Now: 13.2 км – 1000 x 500. Later: 6.6 km - 2000 x 1000.



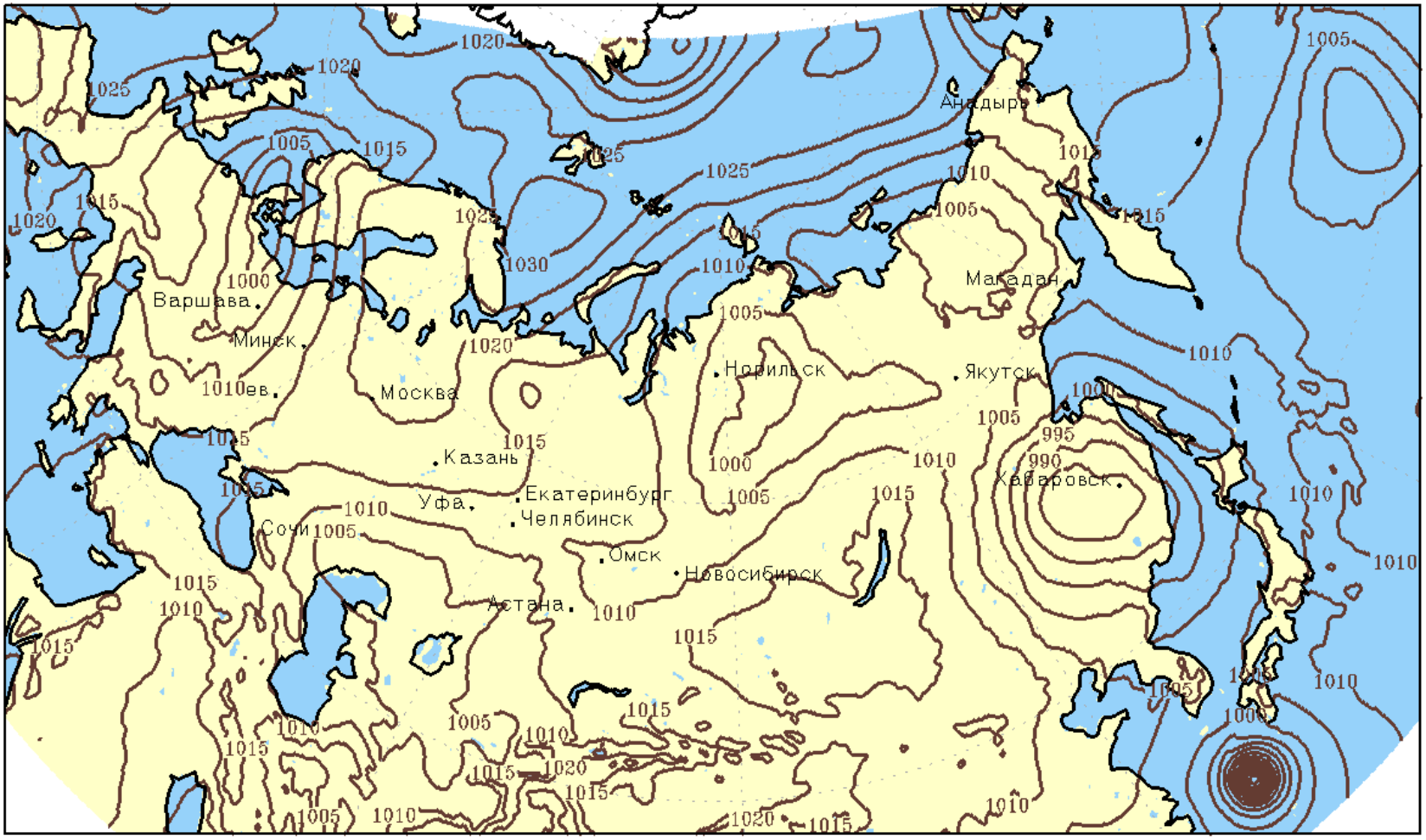
Typhoon "Neoguri”,

7 July 2014, 10.00 UTC



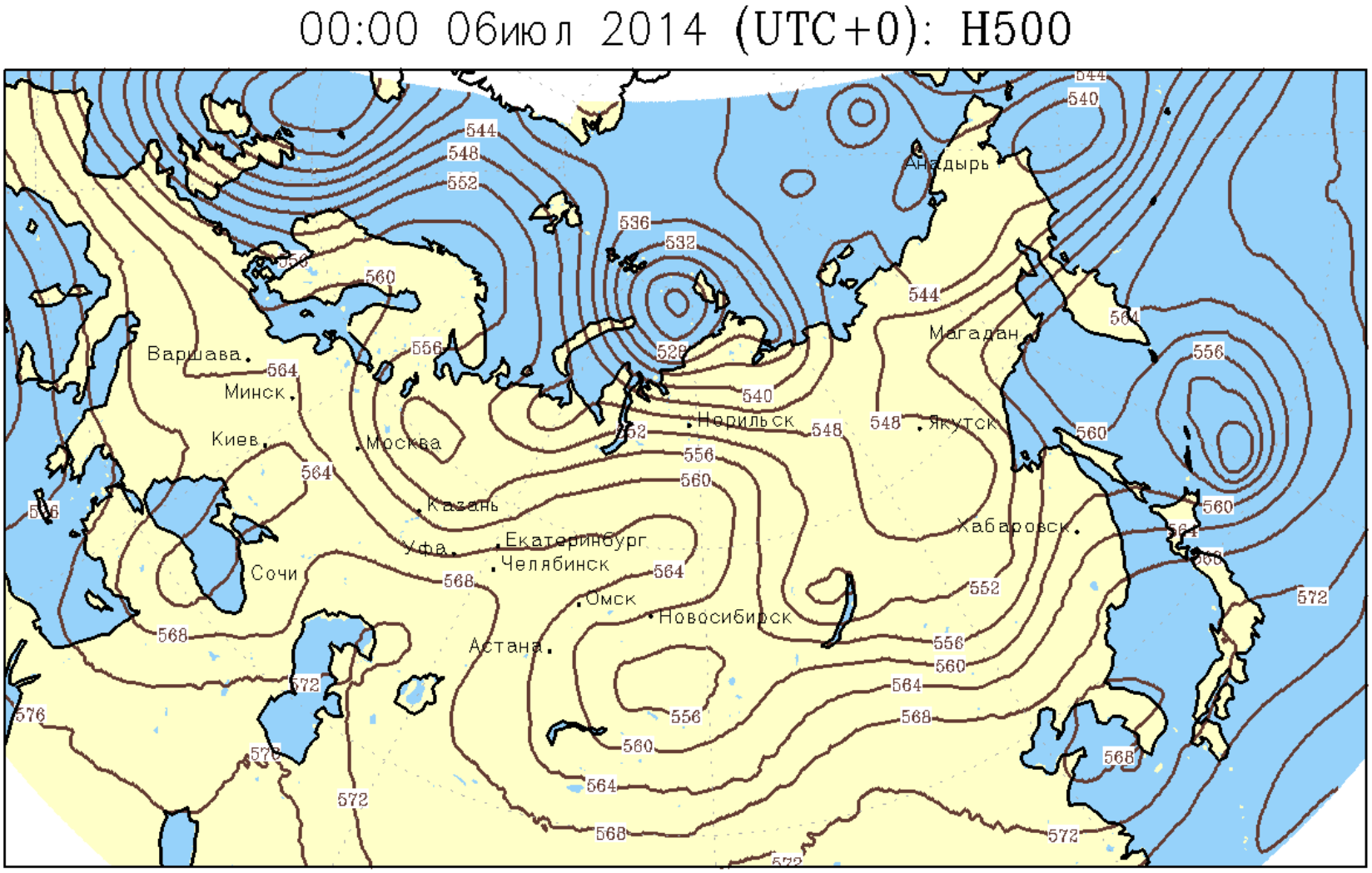
См. сайт http://www.meteoinfo.ru/news/1-2009-10-01-09-03-06/9417-07072014-qq-

9 July, 2014



Typhoon "Neoguri"

COSMO-Ru13 for Europe and North Asia (ENA13)).
Forecast from 2014070600 until 2014071003



Typhoon "Neoguri"

4

COCLUSIONS

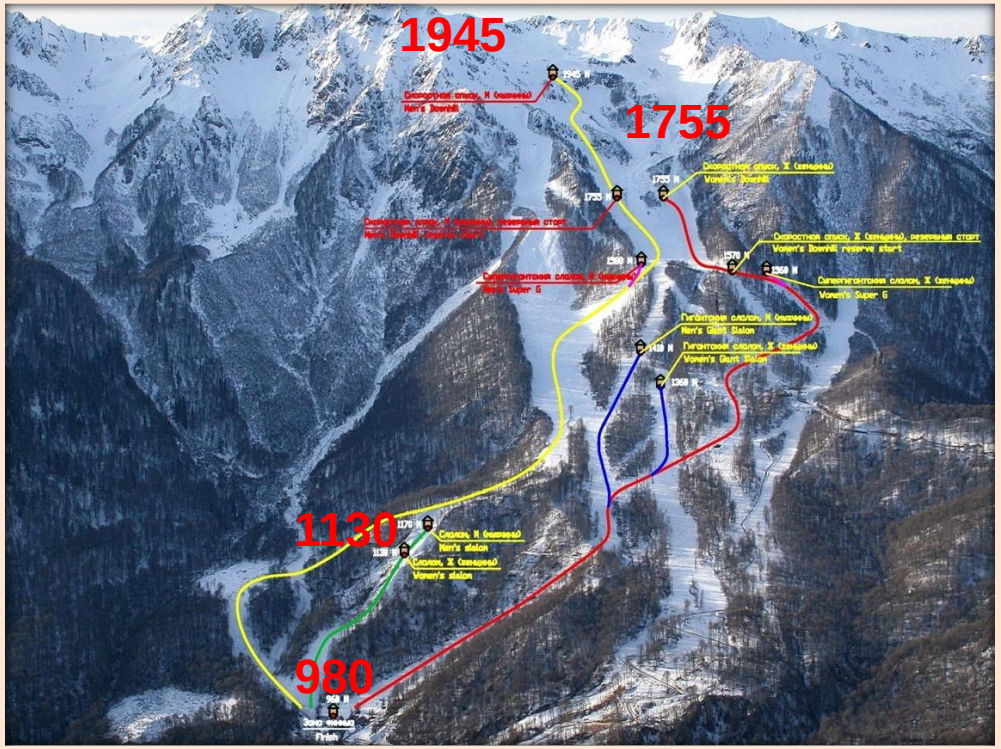
HIGHLIGHTS

- COSMO-based technologies succeeded in meteorological support for the Sochi-2014 Winter Olympics and other important sport events in Russia in 2013-2014 (for example, Universiade Kazan-2013).
- Sochi and Kazan forecasters considered COSMO-based products to be the primary material for preparing detailed weather forecasts
- High-resolution deterministic COSMO-Ru systems (7km/2.2km/1.1km) and COSMO-EPS systems (7km/2.2km) were developed and tested for the region of sport events. Higher-resolution systems added value.
- Usage of very high-resolution orography and assimilation of additional data improved the forecasts considerably.
- Development and implementation of temperature h-correction in postprocessing and fresh-snow parameterization schemes improved forecasts in the high-mountains region.
- Introduction of Flake model was useful for the Volga region.

GENERAL CONCLUSIONS

- **The PP CORSO is a successful example of international fruitful scientific and technologic cooperation within the COSMO consortium**
- **The project leaders and Olympic forecasters are grateful to all scientists from COSMO countries who participated in the project**
- **The main results of the project, including down-scaling postprocessing algorithms, the new fresh snow parameterization scheme, experience in very high resolution and ensemble prediction, nudging-assimilation, the data archives, could be useful for further research and operation in COSMO countries**

Final report of PP CORSO



THANKS!

QUISTIONS?

Gdaly Rivin, Inna Rozinkina,
Elena Astahova, Andrea Montani
AND … colleaques from
Germany, Italy, Switzerland, Greece and Russia.