Operational meteorological support to the Winter Olympic Games Sochi-2014 and findings from the COSMO priority project CORSO

Gdaly Rivin, Inna Rozinkina,
Elena Astakhova, Andrea Montani,
colleaques from *Germany, Italy, Switzerland, Greece and Russia.*


Snow sports competitions
Krasnaya Polyana
Krasnaya Polyana
(Red Glade)
PV
15 km
Mountain Cluster
Coastal and mountain clusters of Sochi-2014
Matsesta
Sochi
Hosta
45 km
5 km
Adler
Adler
PV
PV
10.06.2014
COSMO-SkyMed CORSO
Coastal Cluster
Ice sports competitions

CONTENTS

1. PP CORSO

   Task1 High Resolution Modeling

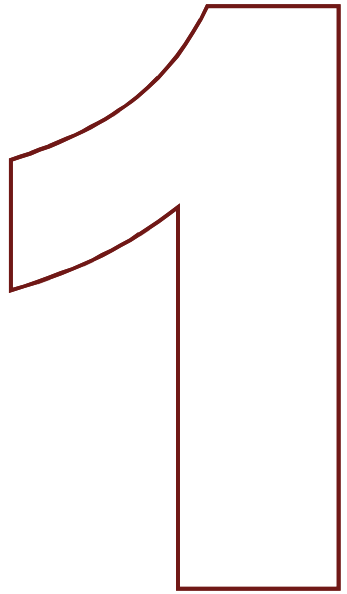
   Task2 Postprocessing

   Task3 COSMO EPSs for Sochi-2014

2. FROST-2014

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

4. Conclusions



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 FROST-2014 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

(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

PP CORSO:
EXPERT MEETINGS

Expert meetings were a very important part of PP CORSO !

ARPA-SIMC, 5-10 December 2011
Italy, Bologna **1**
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 **3**
Task 1
Germany: D.Majewski, C.Schraff, J.Foerstner.
Russia: G.Rivin, D.Blinov.

DWD, 5-10 December 2013
Germany, Offenbach on Main **4**
Task 1
Germany: D.Majewski, J. Helmert.
Russia: I.Rozinkina, M.Shatunova

MeteoSwiss: 12-16 December 2011
Switzerland, Zurich-Geneva **2**
- 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

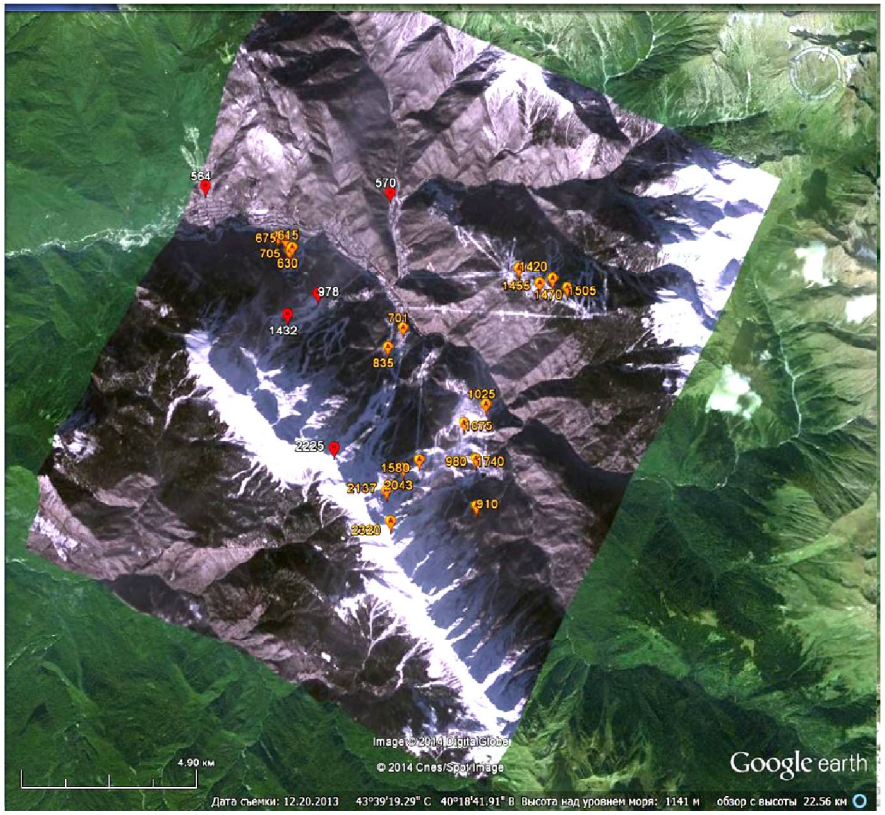
Monday 12 December 2011, MeteoSwiss Zurich

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 Fuhr	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

Observation network 1/4



Radars	4
Profilers	3
Video cameras	3+4x2

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.

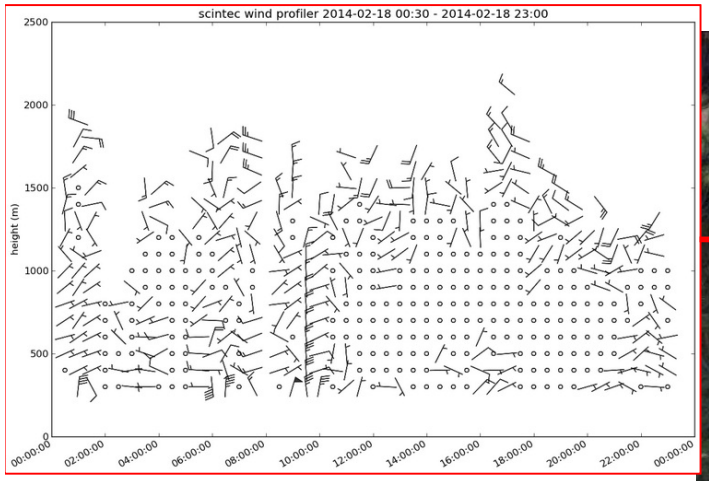
Variables

- 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

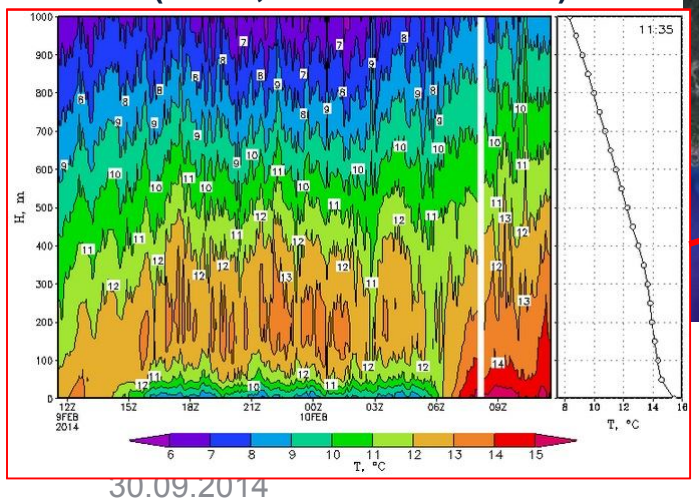
Observation network, 2/4

Profilers

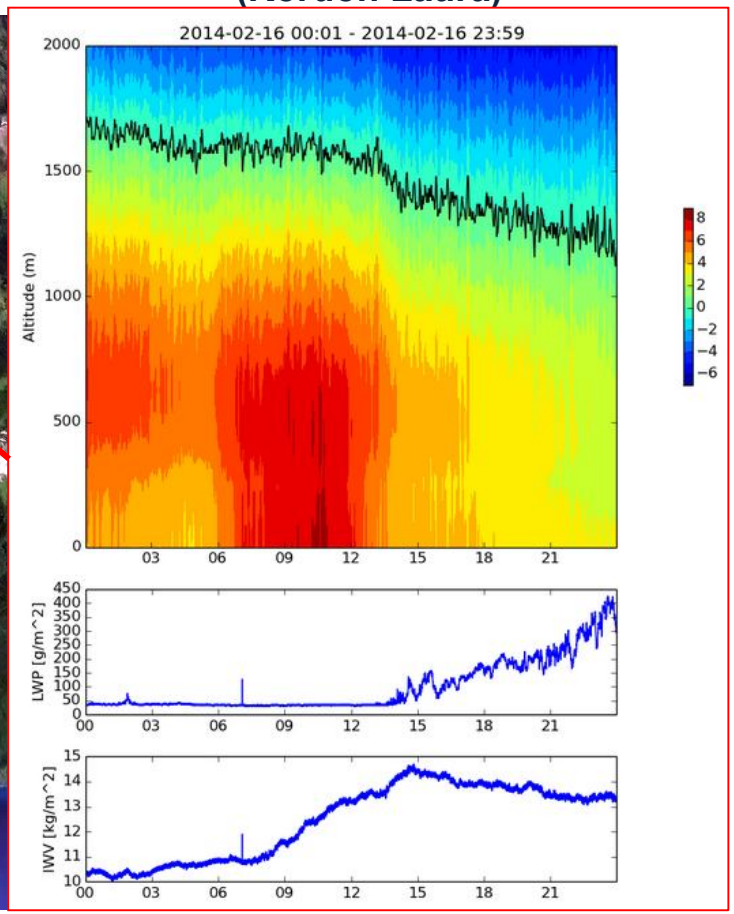
Scintec wind profiler (Kordon Laura)



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



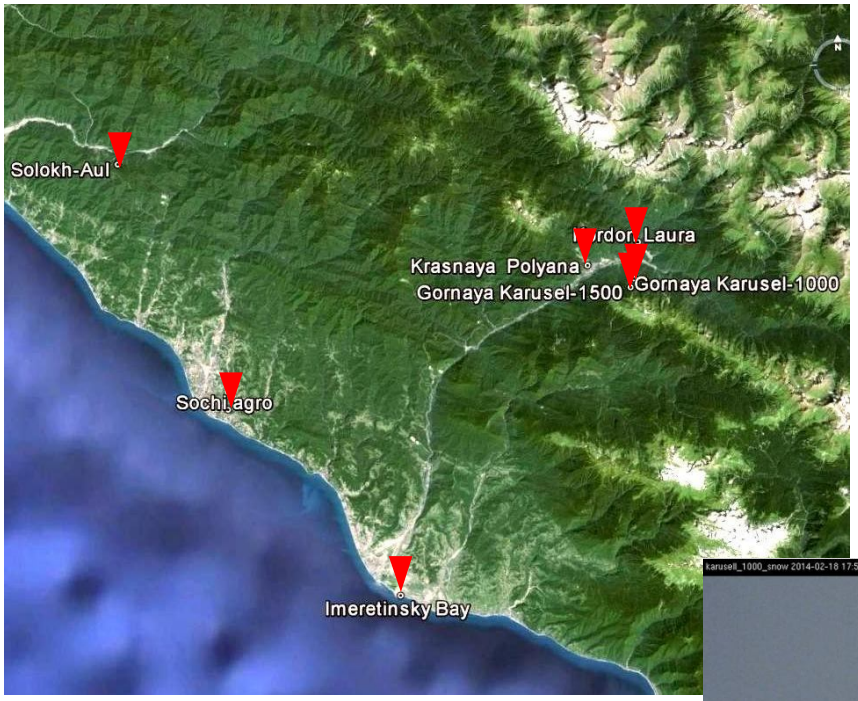
PRG Temperature/Humidity Profiler (Kordon Laura)



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

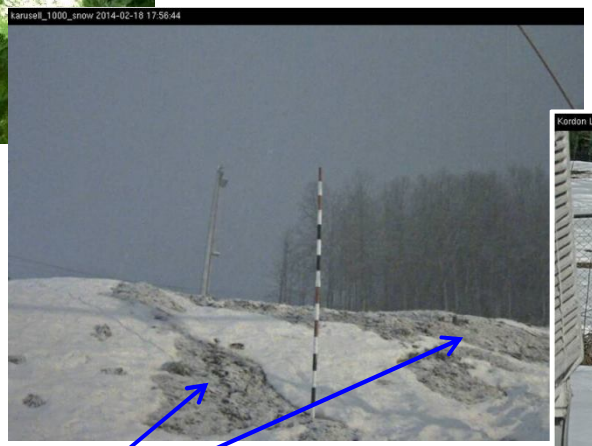
Observation network, 3/4

Video cameras



Sky conditions and development of the clouds

Surface conditions



fresh snow

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)

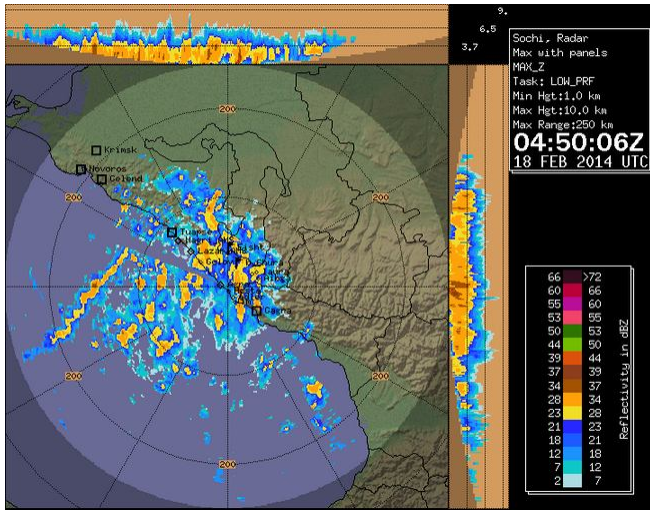
Update rate – 10 min

Observation network, 4/4

Radar

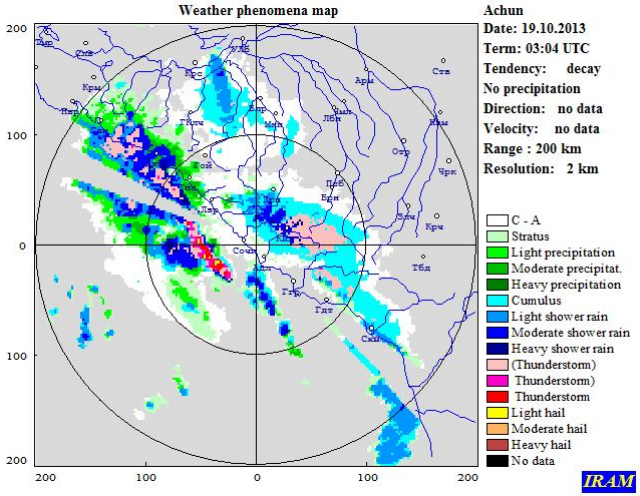
Max Reflictivity (Akhun Radar)

Product of Central Aerological Observatory



Weather phenomena map (Akhun Radar)

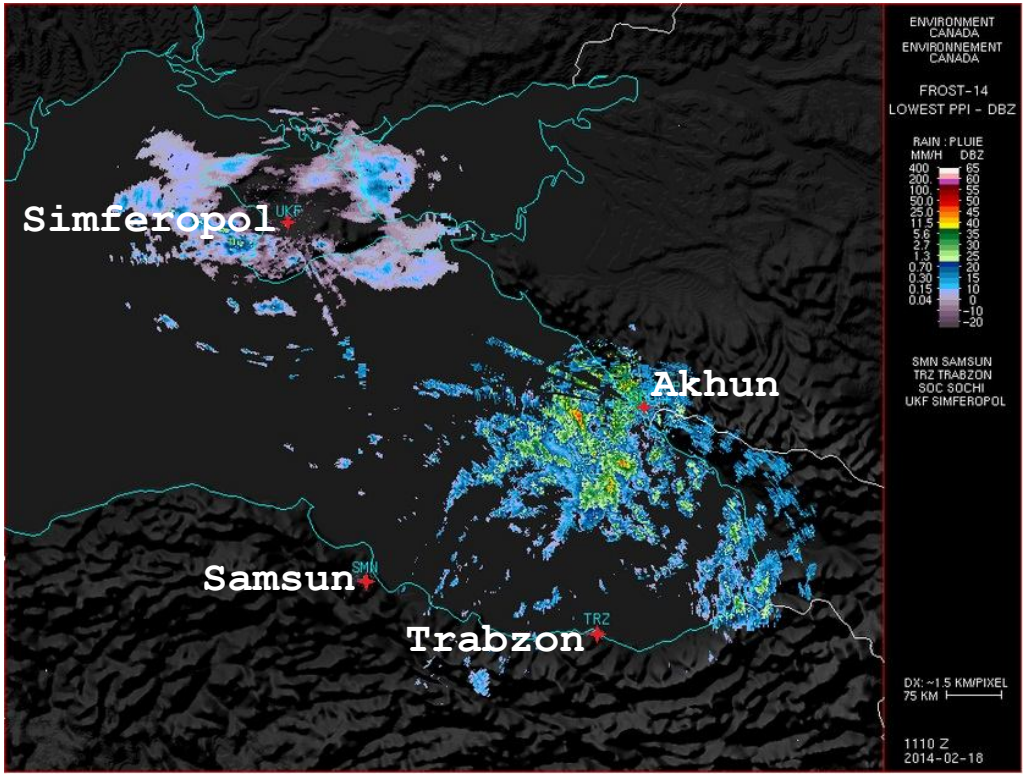
Product of IRAM



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

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

Product of Envaronment Canada



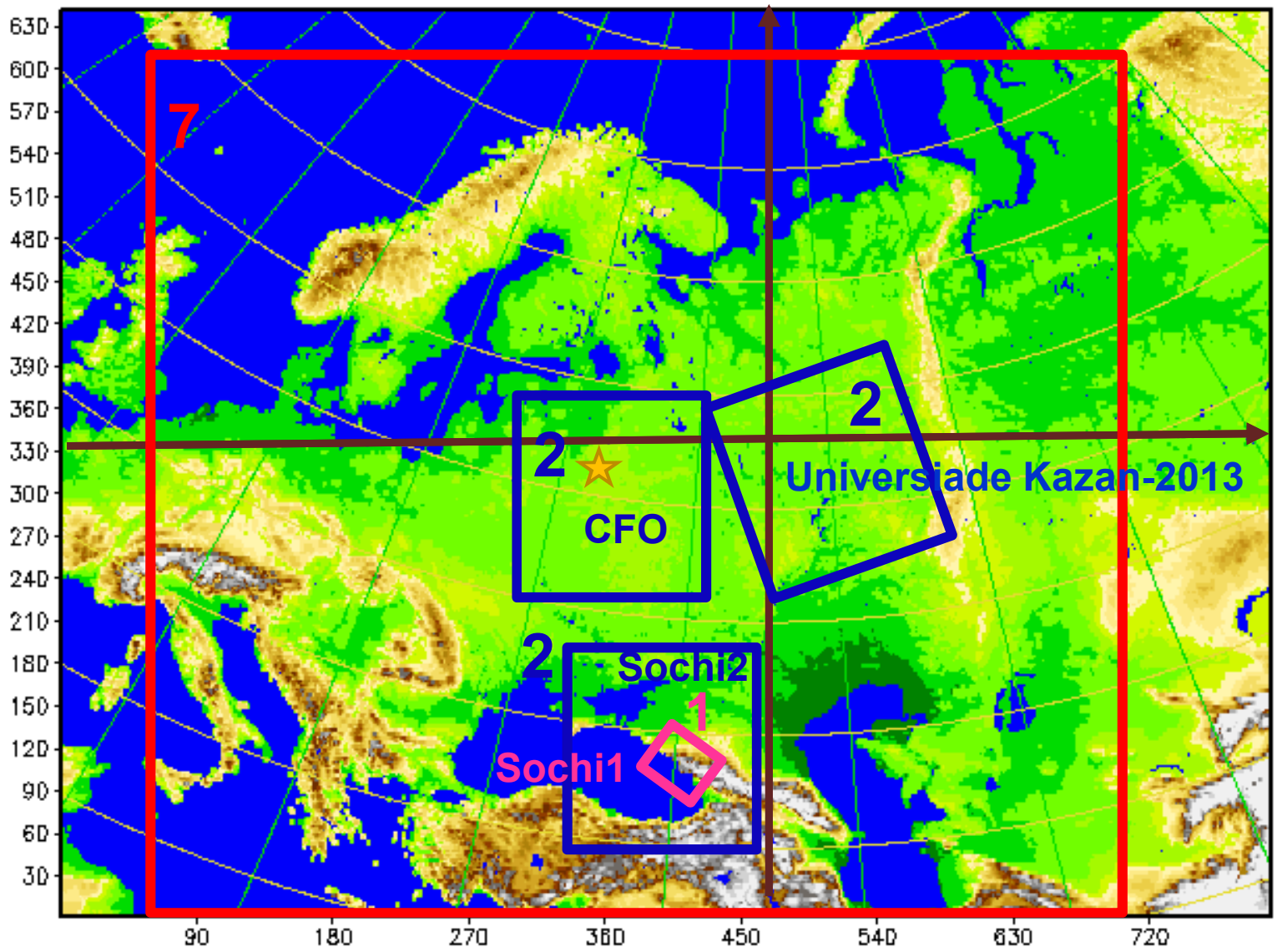
Update rate – 10 min

Task 1.
High resolution COSMO-modelling for mountains regions

Main results of TASK 1

- The new version of operational technology COSMO-Ru7/2 including the nudging-assimilation was developed for Caucasian region
- The technology of modeling of accumulated snow WE as initial fields for COSMO-Ru was proposed and tested for the different weather conditions of Russia & The TERRA codes were adapted with respect to partial snow cover. It was detected the stable improvement of forecasts of T2m in case of artificial decreasing of snow covering
- COSMO-Ru1, $\Delta x = 1.1$ km, was installed on cluster-based architecture Tornado in Roshydromet. From January, 29, 2014 COSMO-Ru1 runs in operational mode 4 times per day. COSMO-Ru1 forecast were used by forecasters along with COSMO-Ru2 during SOCHI-2014 Olympic Games.

COSMO-Ru domains in 2013-2014



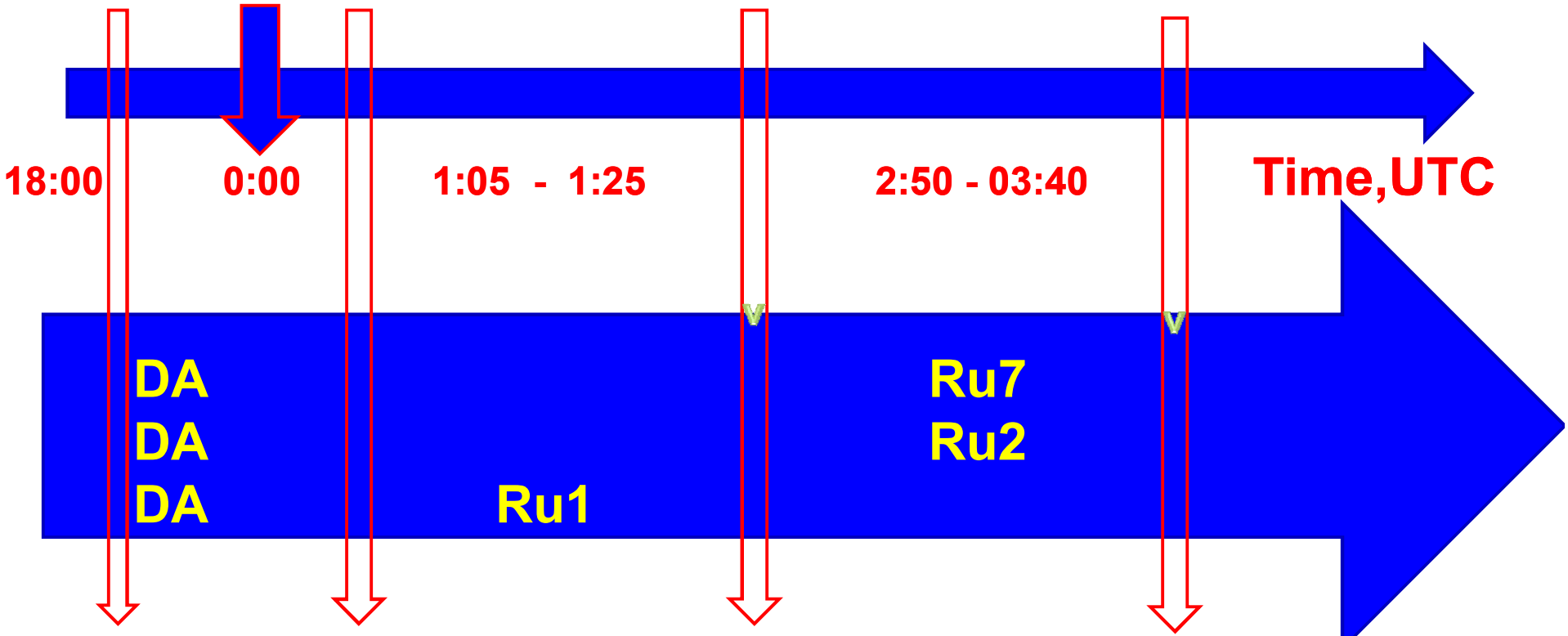
COSMO-Ru7, Δx = 7 km

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

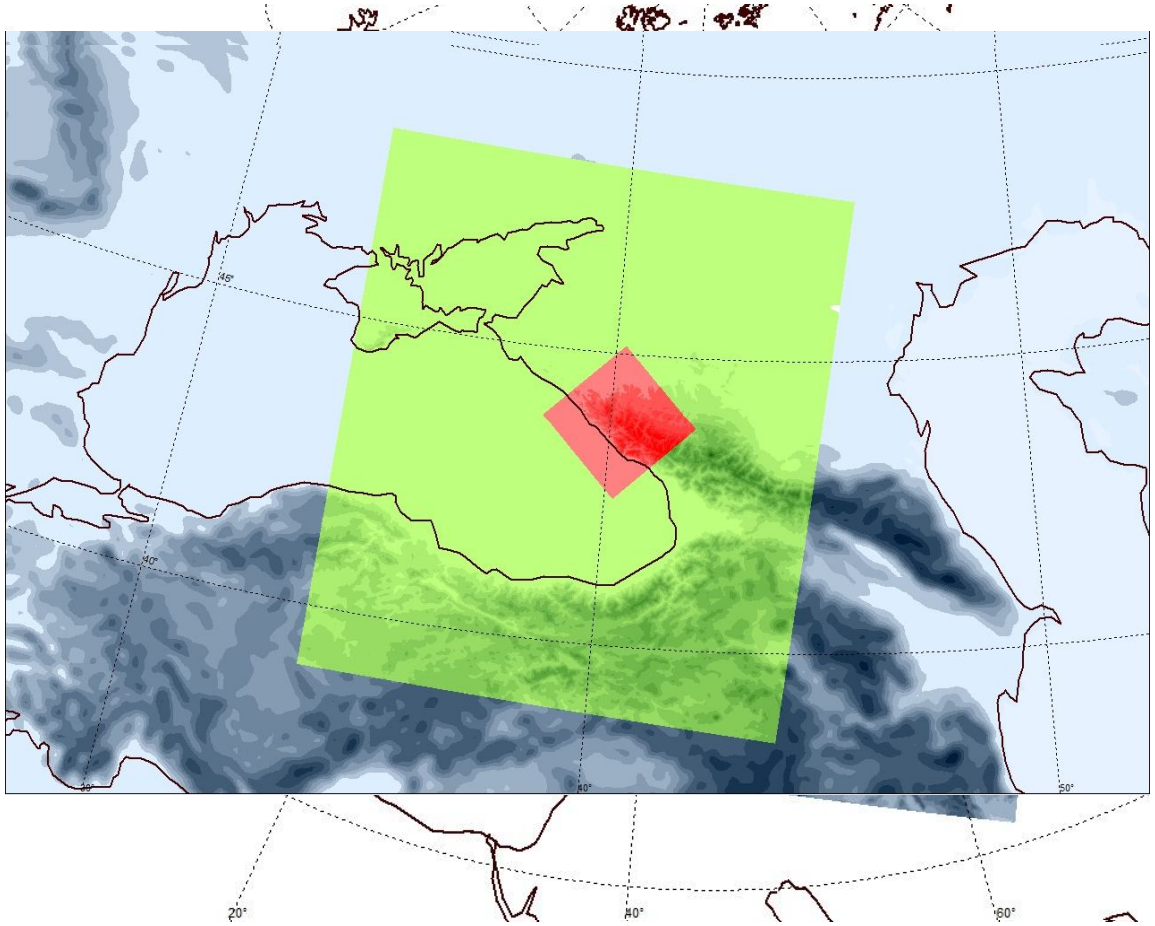
Domain: 210 km x 210 km
Grid: 190 x 190 x 50
Grid size: 1.1 km
Time step: 5 s
Forecast: 36 h

Runtime 24 min

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

COSMO-Ru1: 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

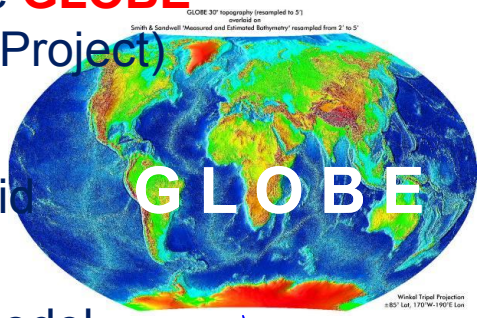
IC&BC

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

COSMO-Ru1

New: model orography (ASTER) + dynamic core (M.Baldauf)

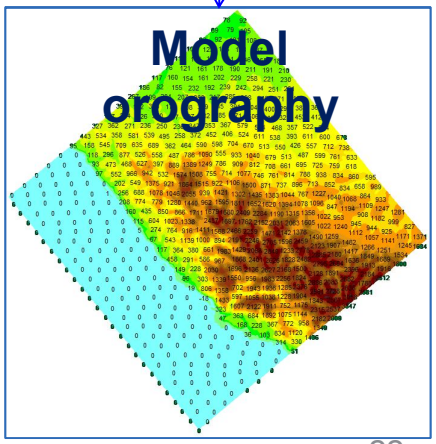
Initially model orography was based on the **GLOBE** (The Global Land One-km Base Elevation Project) data (NOAA/NGDC).



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

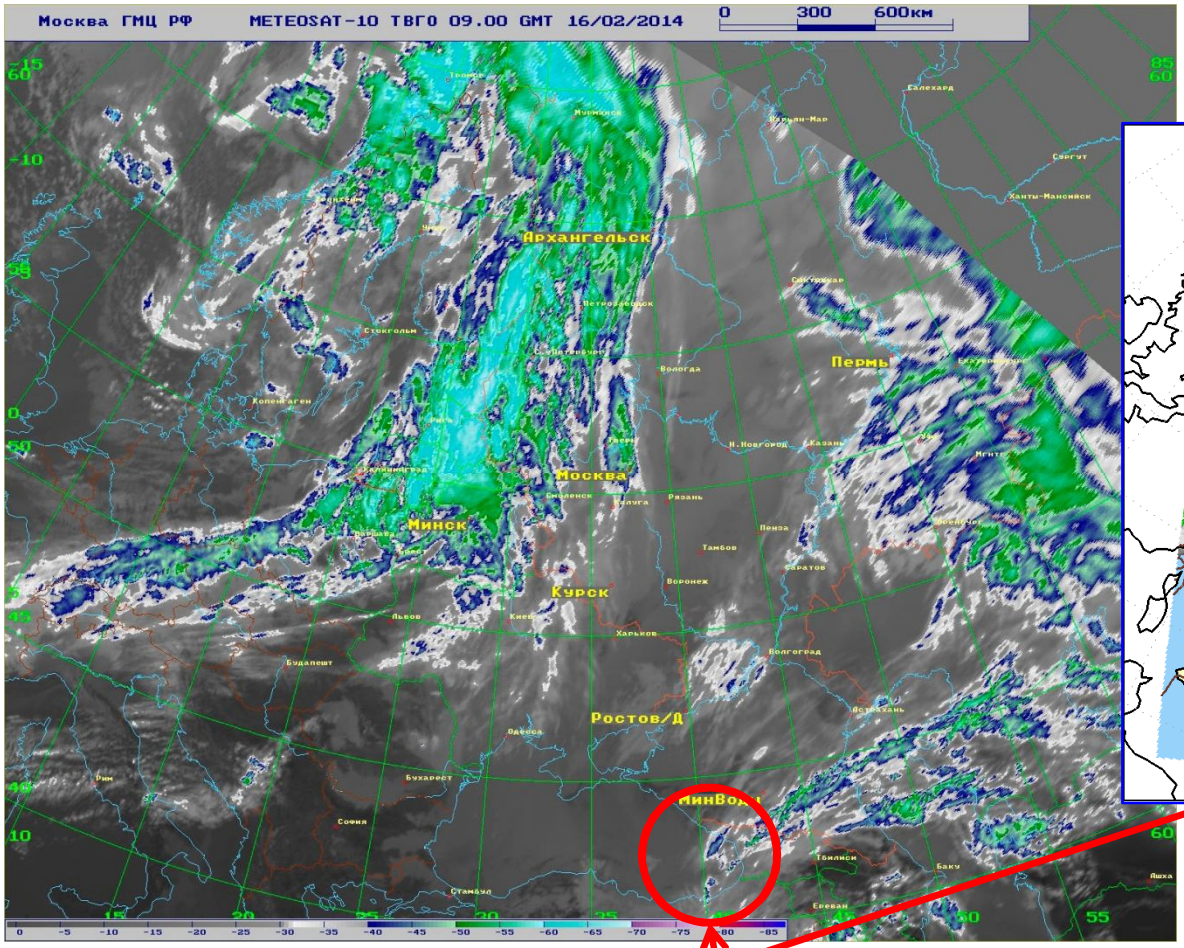
- On February, 16-18, 2014 in mountain cluster low visibility conditions were observed. The first reason was in high humidity and formation of cloud on the mountain slopes (February, 16-17). The second reason was in heavy snowfall during cold front passing (February, 18).

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

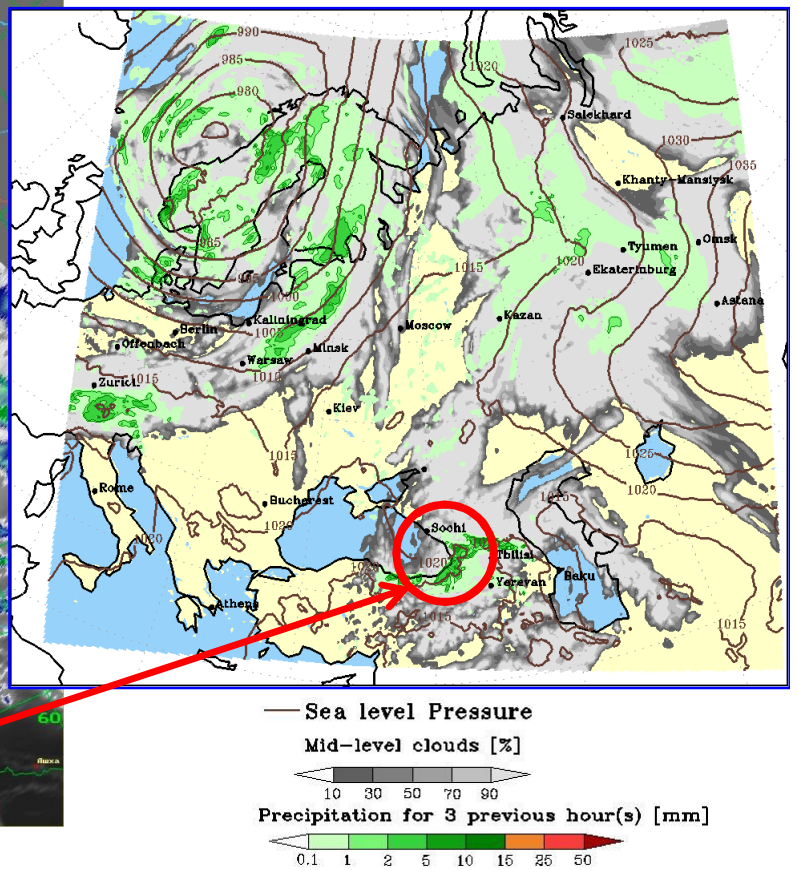
..

Low visibility on February, 16-17, 2014

METEOSAT-10. Cloud top temperature
16.02.2014, 09 UTC



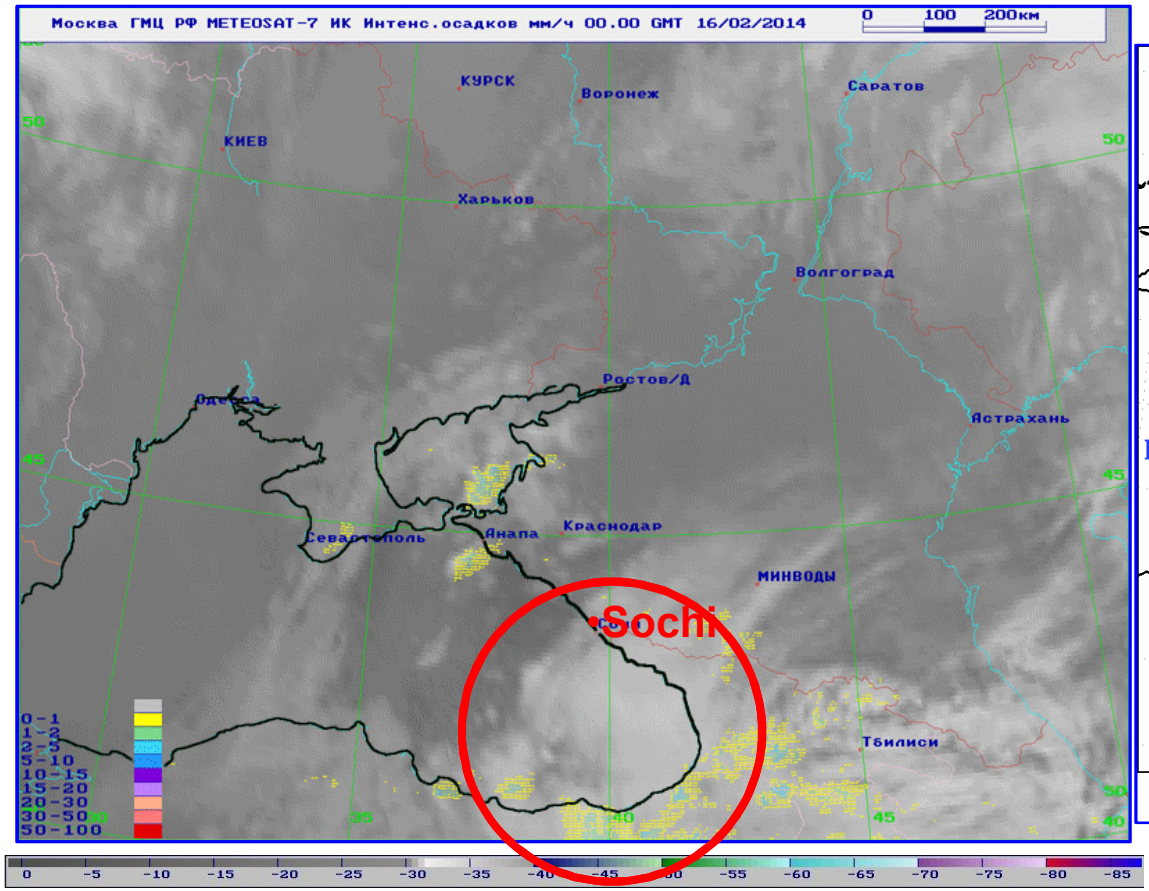
COSMO-Ru7 forecast.
PMSL, Midlevel Cloud & Precipitation
9 h forecast from 16.02.14, 00 UTC



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

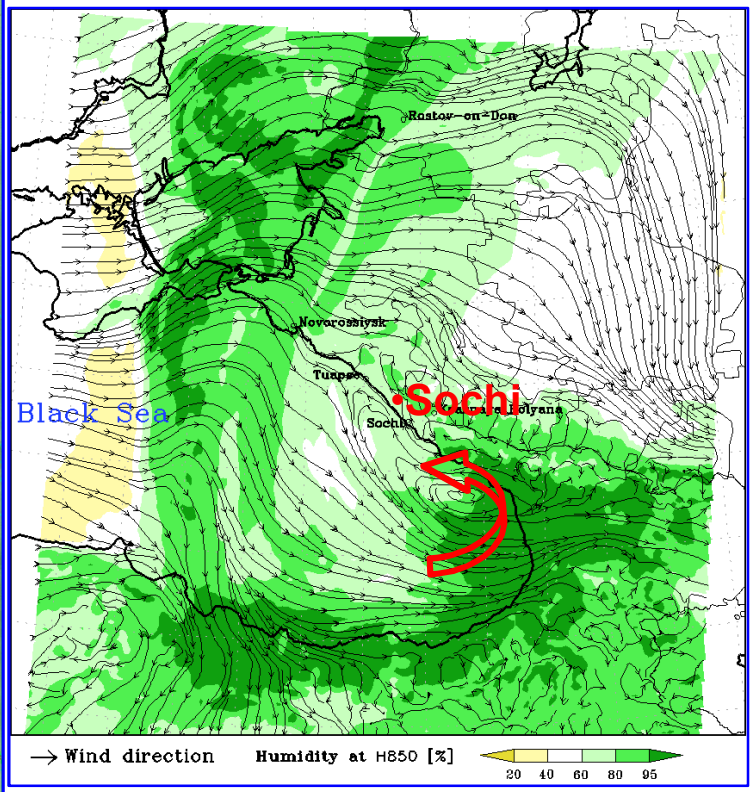
Low visibility on February, 16-17, 2014

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



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

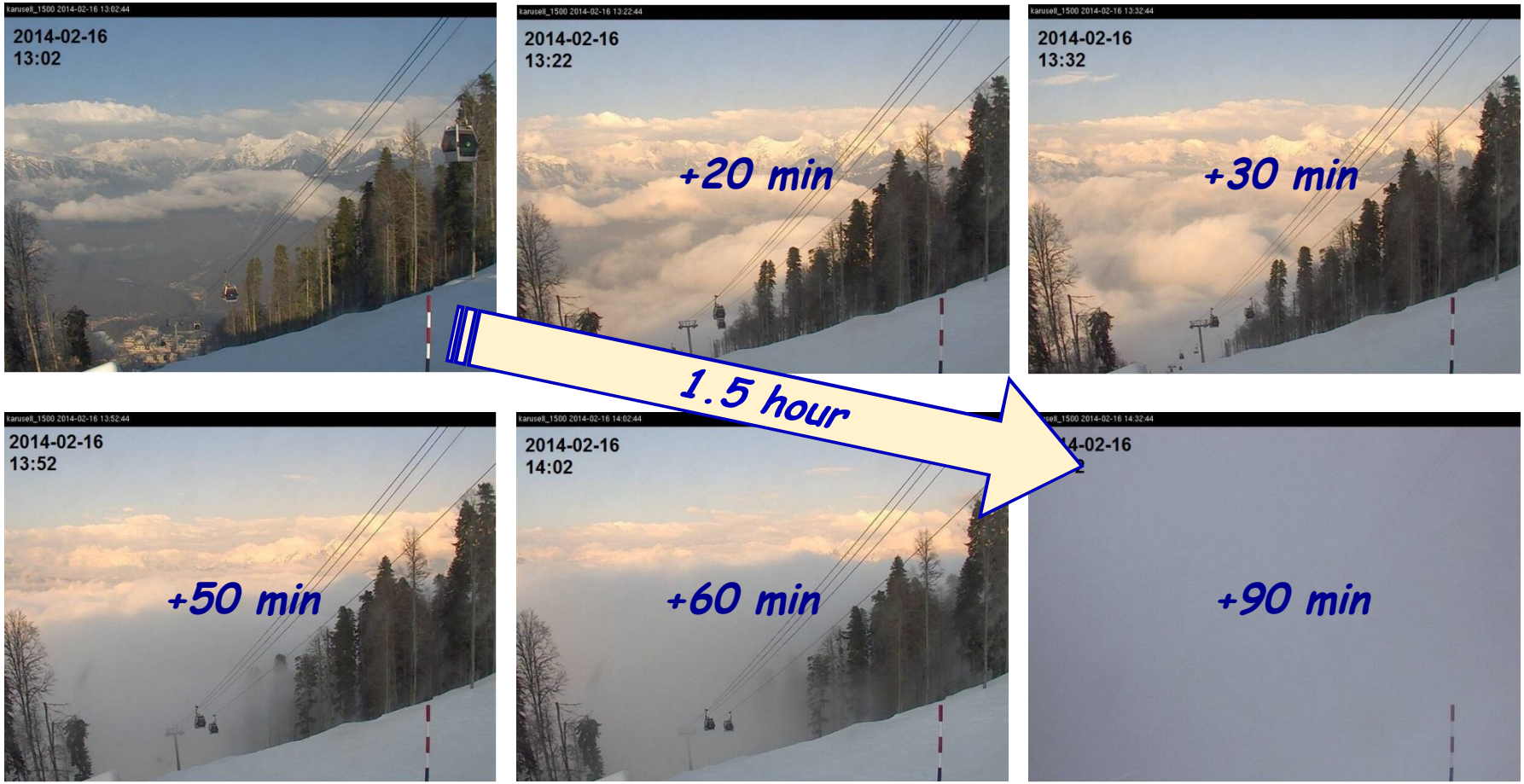
12 h forecast from 16.02.14, 00 UTC



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

Low visibility on February, 16-17, 2014

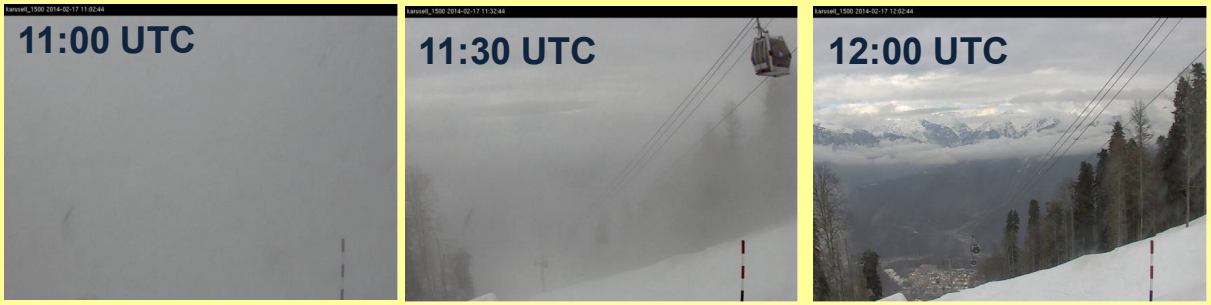
Cloudiness formation due to adiabatic cooling of the moisture air during it rise along the slope of the valley



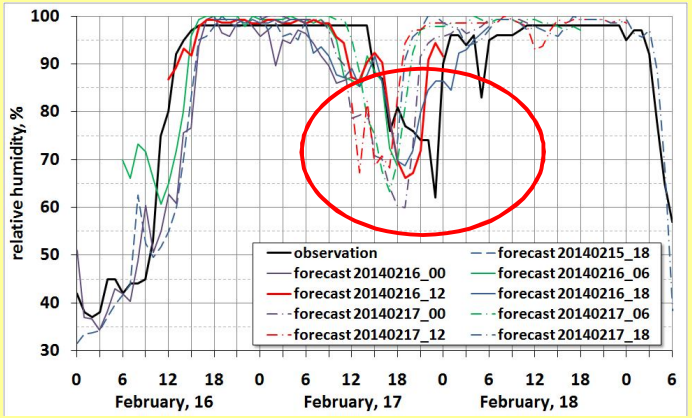
Camera shots at Gornaya Karusel-1500

On February, 17 at 12:00-12:30 UTC (for Biathlon Stadium) visibility conditions improved. COSMO-Ru1 forecast of the wind direction and relative humidity ***allowed forecasters to predict changes in visibility and determine the time for competition***.

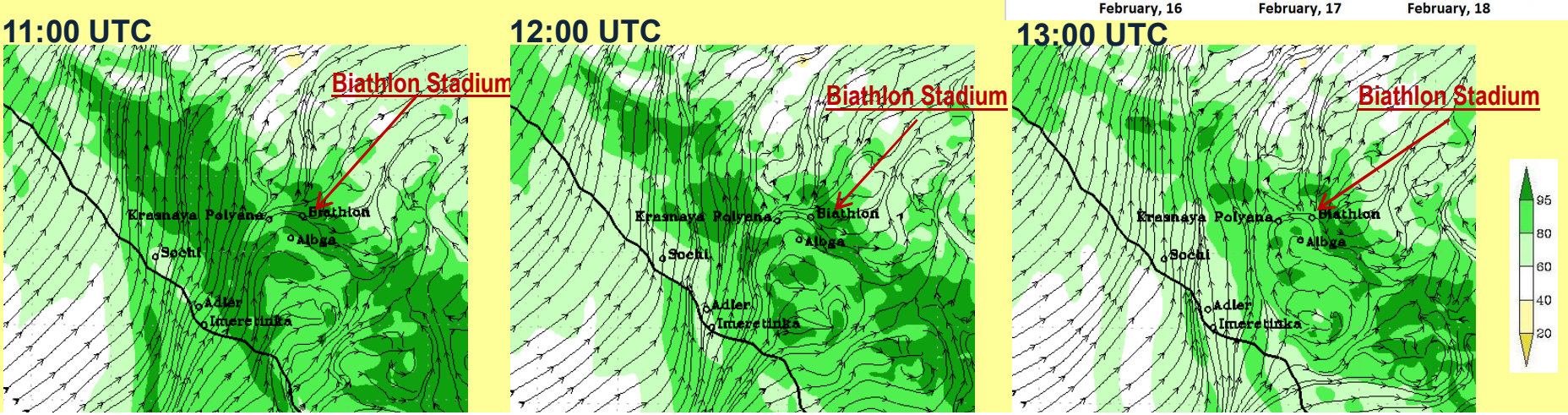
Video camera shots from Gornaya Karusel-1500 for 17.02.2014



Relative humidity at 2m forecasts and observation at Biathlon Stadium



Wind and relative humidity at 850 hPa. Forecast from 16.02, 12 UTC

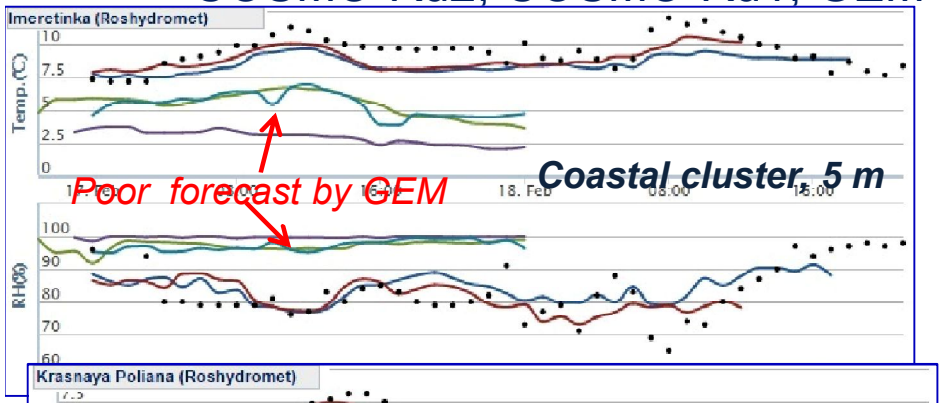


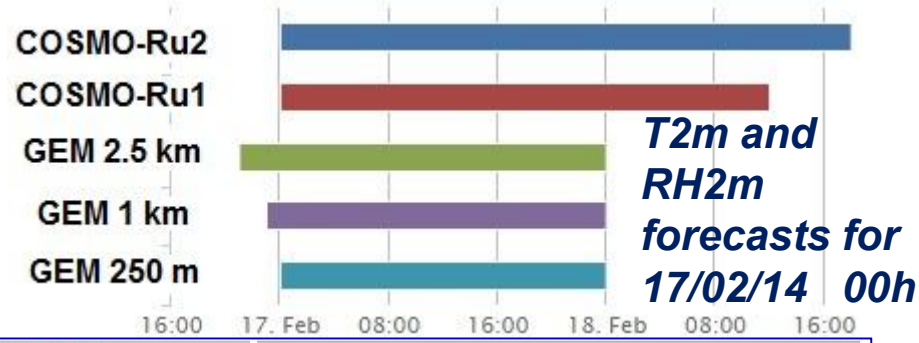
Thanks to the operational runs of COSMO-Ru1 the forecasters received the new quality NWP products

Meteosupport of Sochi-2014 Olympics and Paralympics

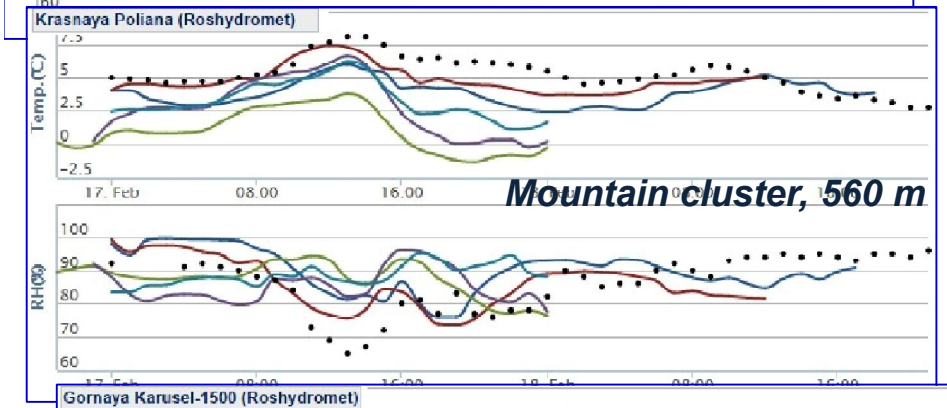
Intercomparison High-resolution models intercomparison

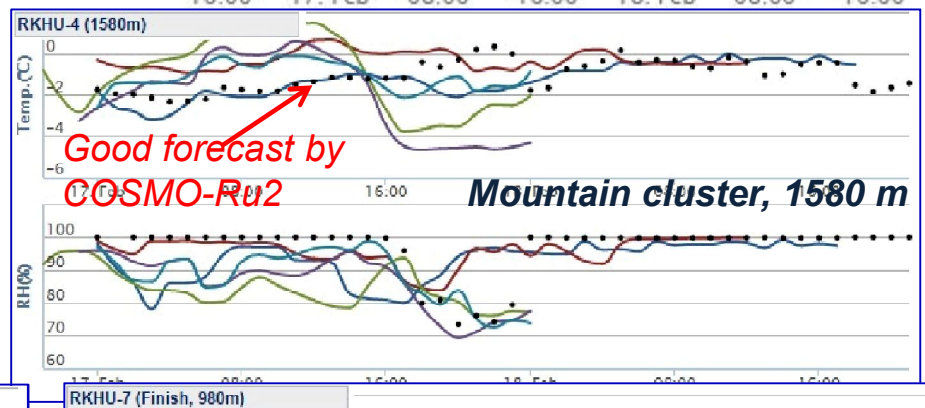
COSMO-Ru2, COSMO-Ru1, GEM (2.5 km), GEM (1.0 km), GEM (250 m)

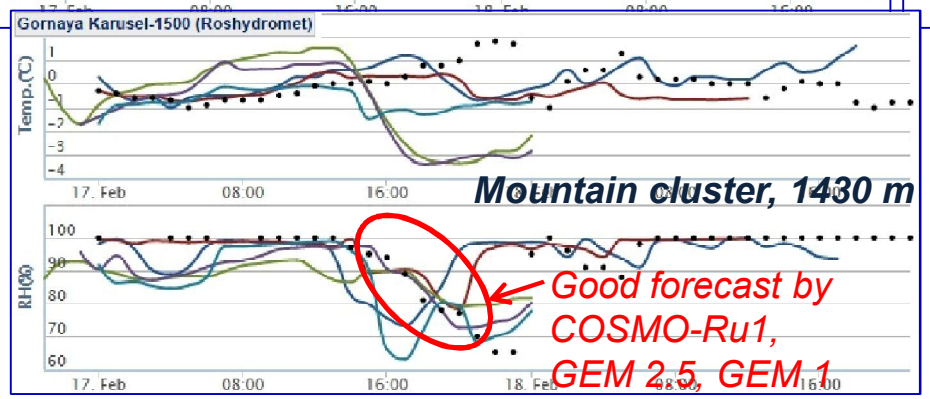


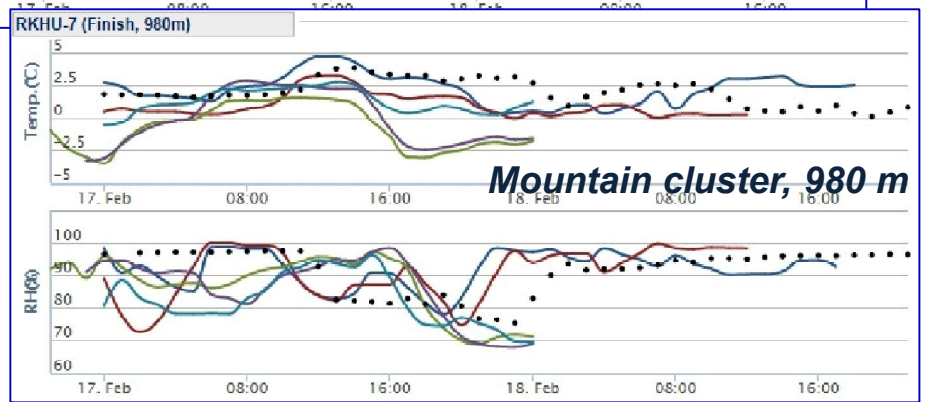


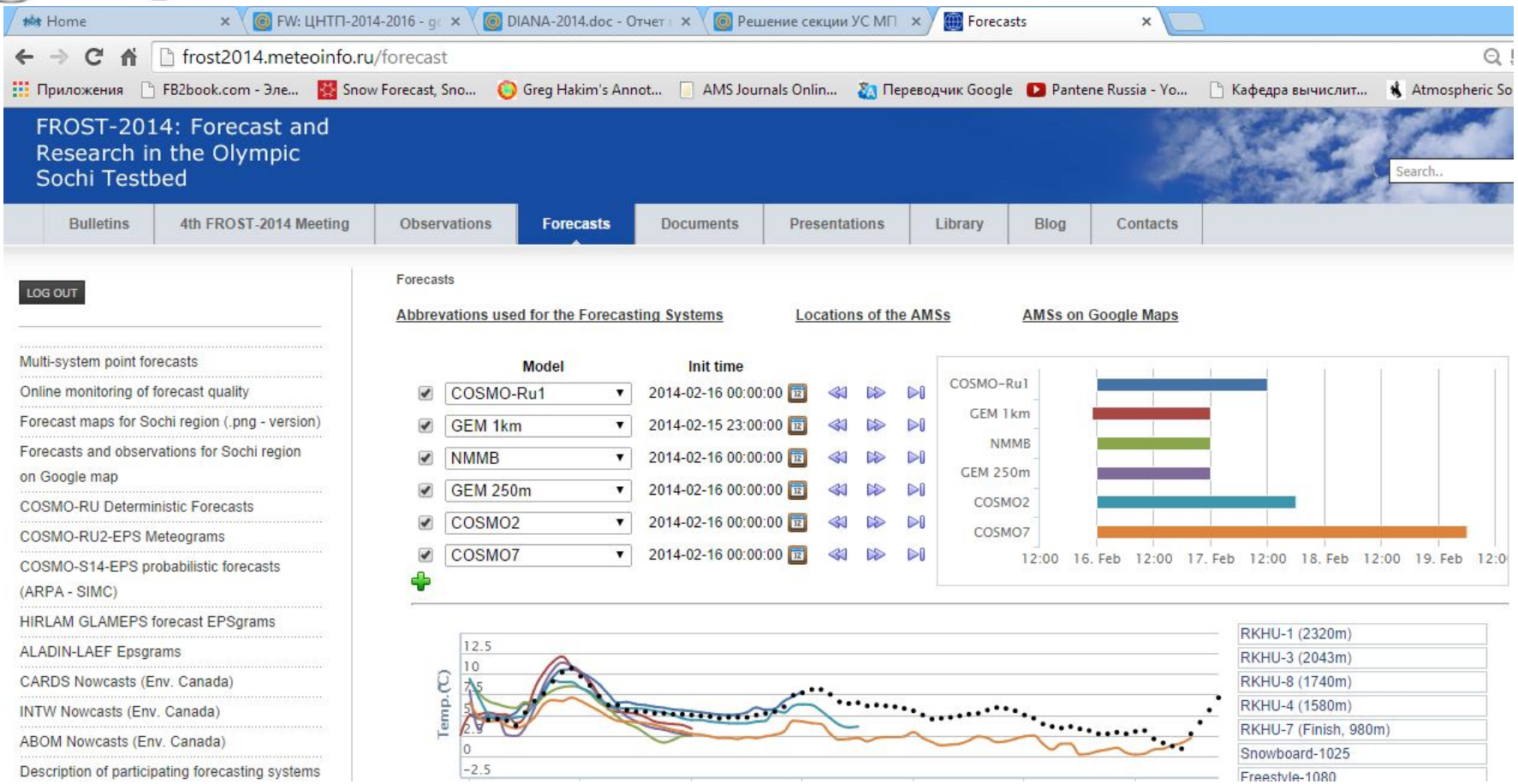
T2m and RH2m forecasts for 17/02/14 00h

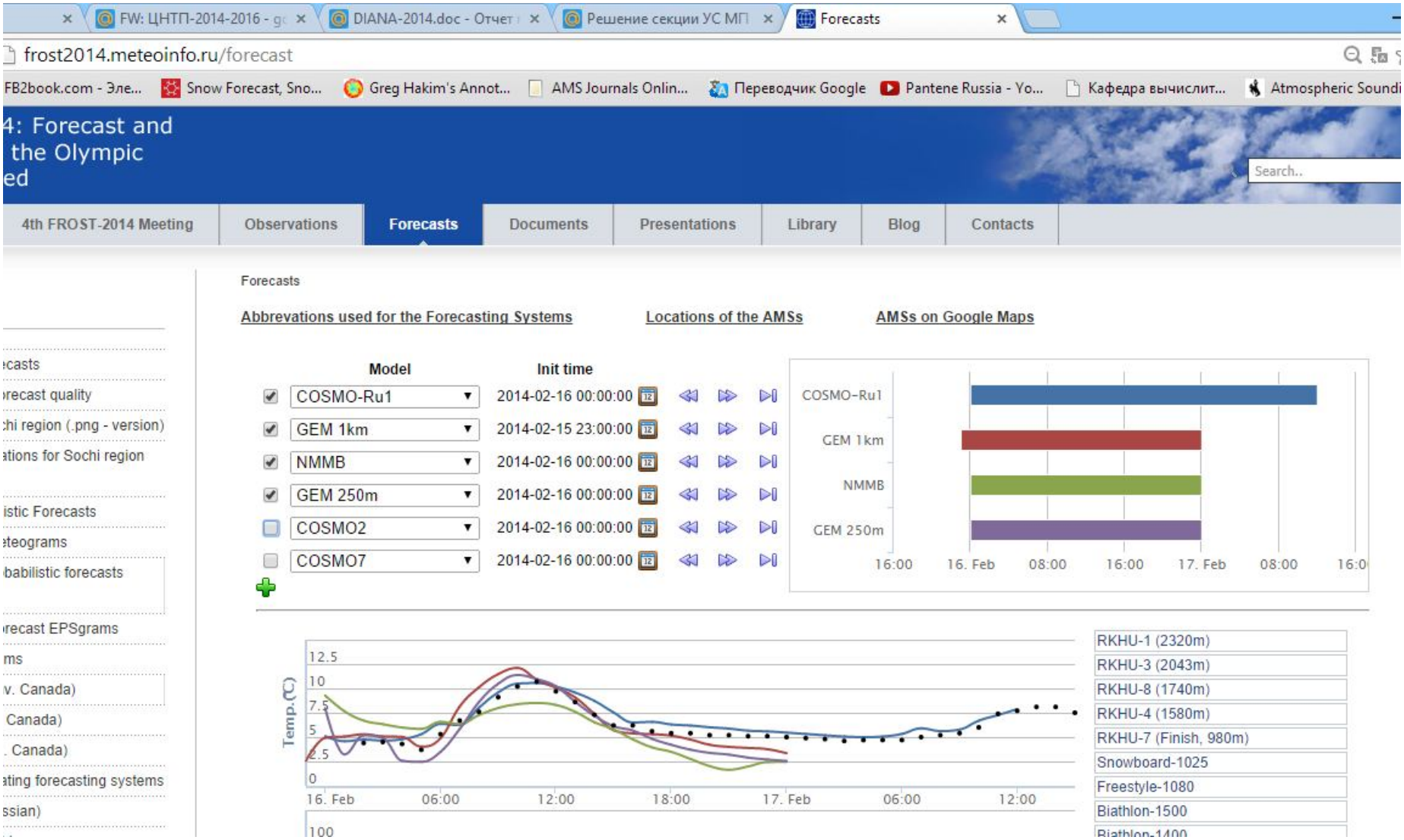









Home
FW: ЦНТП-2014-2016 - g
DIANA-2014.doc - Отчет
Решение секции УС МП
Forecasts
frost2014.meteoinfo.ru/forecast
Приложения
FB2book.com - Эле...
Snow Forecast, Sno...
Greg Hakim's Annot...
AMS Journals Onlin...
Переводчик Google
Pantene Russia - Yo...
Кафедра вычислит...
Atmospheric So
FROST-2014: Forecast and Research in the Olympic Sochi Testbed
Search..
Bulletins
4th FROST-2014 Meeting
Observations
Forecasts
Documents
Presentations
Library
Blog
Contacts
LOG OUT
Multi-system point forecasts
Online monitoring of forecast quality
Forecast maps for Sochi region (.png - version)
Forecasts and observations for Sochi region on Google map
COSMO-RU Deterministic Forecasts
COSMO-RU2-EPS Meteograms
COSMO-S14-EPS probabilistic forecasts (ARPA - SIMC)
HIRLAM GLAMEPS forecast EPSgrams
ALADIN-LAEF Epsgrams
CARDS Nowcasts (Env. Canada)
INTW Nowcasts (Env. Canada)
ABOM Nowcasts (Env. Canada)
Description of participating forecasting systems
Forecasts
Abbrevations used for the Forecasting Systems
Locations of the AMSs
AMSs on Google Maps
Model
Init time
COSMO-Ru1
2014-02-16 00:00:00
GEM 1km
2014-02-15 23:00:00
NMMB
2014-02-16 00:00:00
GEM 250m
2014-02-16 00:00:00
COSMO2
2014-02-16 00:00:00
COSMO7
2014-02-16 00:00:00
COSMO-Ru1
GEM 1km
NMMB
GEM 250m
COSMO2
COSMO7
12:00
16. Feb
12:00
17. Feb
12:00
18. Feb
12:00
19. Feb
12:0
Temp.(C)
12.5
10
0
-2.5
RKHU-1 (2320m)
RKHU-3 (2043m)
RKHU-8 (1740m)
RKHU-4 (1580m)
RKHU-7 (Finish, 980m)
Snowboard-1025
Freestyle-1080


FW: ЦНТП-2014-2016 - g
DIANA-2014.doc - Отчет
Решение секции УС МП
Forecasts
frost2014.meteoinfo.ru/forecast
FB2book.com - Эле...
Snow Forecast, Sno...
Greg Hakim's Annot...
AMS Journals Onlin...
Переводчик Google
Pantene Russia - Yo...
Кафедра вычислит...
Atmospheric Soundi
4: Forecast and
the Olympic
ed
Search..
4th FROST-2014 Meeting
Observations
Forecasts
Documents
Presentations
Library
Blog
Contacts
Forecasts
Abbrevations used for the Forecasting Systems
Locations of the AMSs
AMSs on Google Maps
Model
Init time
COSMO-Ru1
2014-02-16 00:00:00
GEM 1km
2014-02-15 23:00:00
NMMB
2014-02-16 00:00:00
GEM 250m
2014-02-16 00:00:00
COSMO2
2014-02-16 00:00:00
COSMO7
2014-02-16 00:00:00
COSMO-Ru1
GEM 1km
NMMB
GEM 250m
16:00
16. Feb
08:00
16:00
17. Feb
08:00
Temp.(C)
12.5
10
7.5
5
0
16. Feb
06:00
12:00
18:00
17. Feb
06:00
12:00
100
RKHU-1 (2320m)
RKHU-3 (2043m)
RKHU-8 (1740m)
RKHU-4 (1580m)
RKHU-7 (Finish, 980m)
Snowboard-1025
Freestyle-1080
Biathlon-1500

- High resolution model Δx~ 1 km produces a potential for visibility forecast for mountain area having most of the necessary predictors (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!*

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

Task 2.
Downscaling / postprocessing for Sochi area and applications

TASK2:

- **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**

Main results of TASK 2

- 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 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 Sochi-2014 mountain cluster the differences of heights of COSMO-Ru attempt to 1000 m

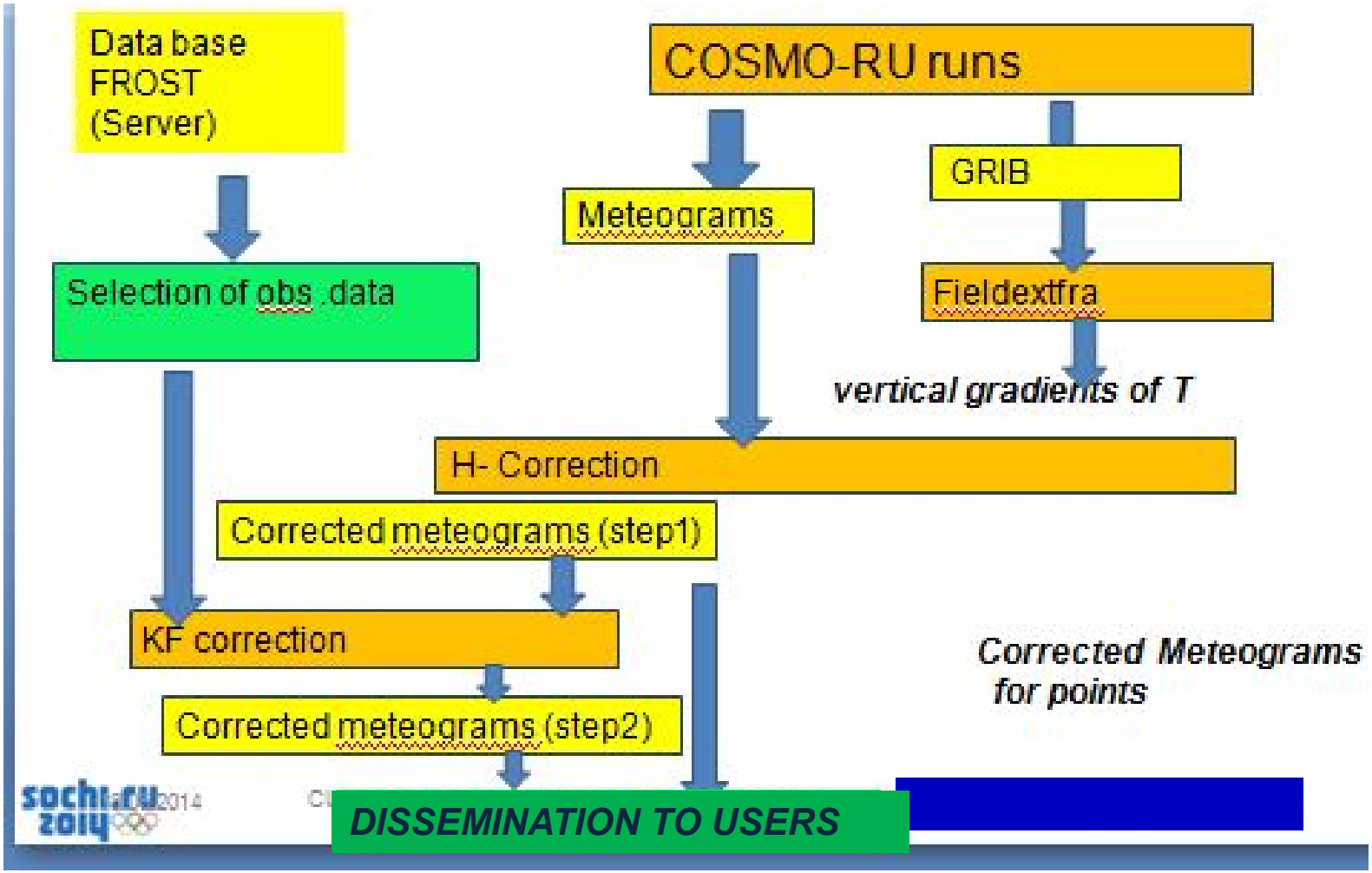
Inadequate work of parameterizations schemes

Two-step correction of forecasts for points (meteograms)

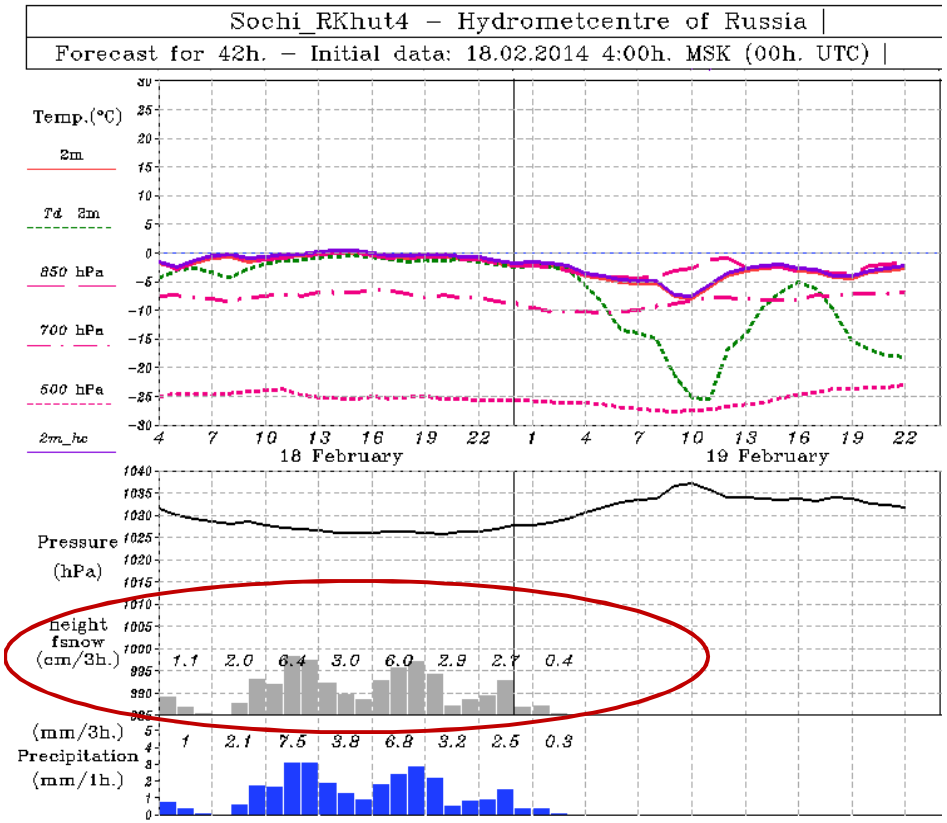
Correction based on the forecasts of vertical T gradient of bottom levels (h- correction)

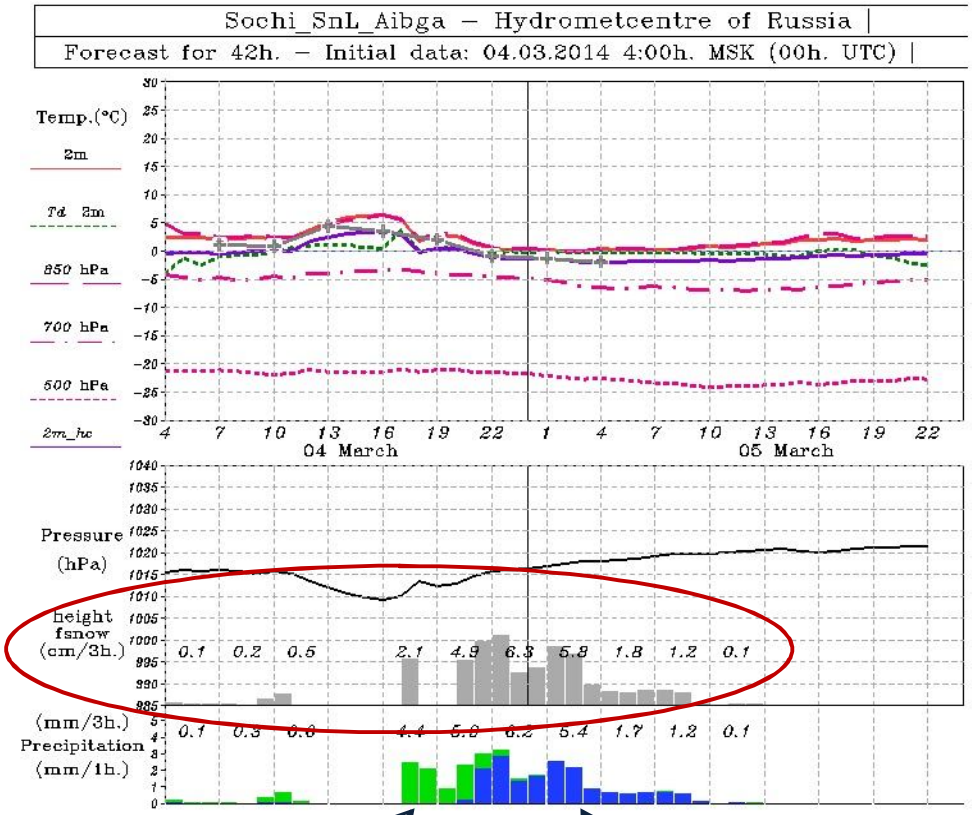
Statistical correction based KF

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



Meteograms for stations
Roza Khutor 4 and Aibga by COSMO-Ru2 (2.2 km)

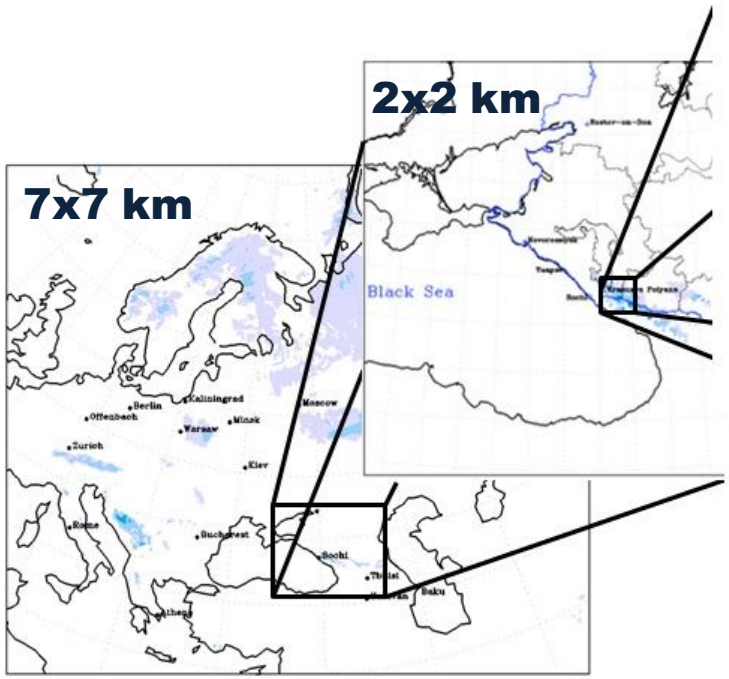


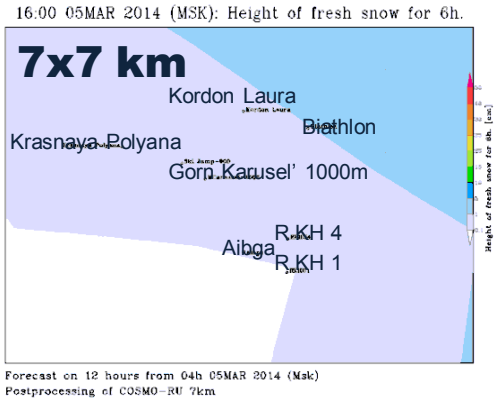


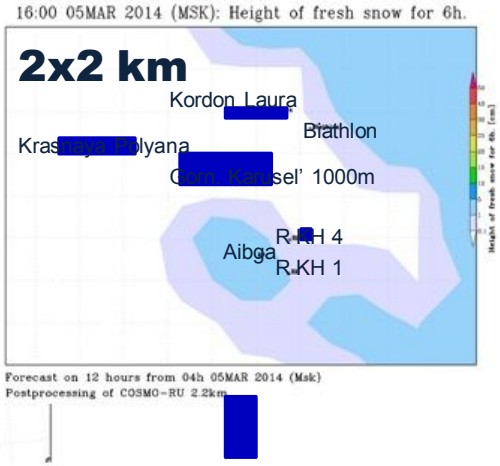
snow rain snow

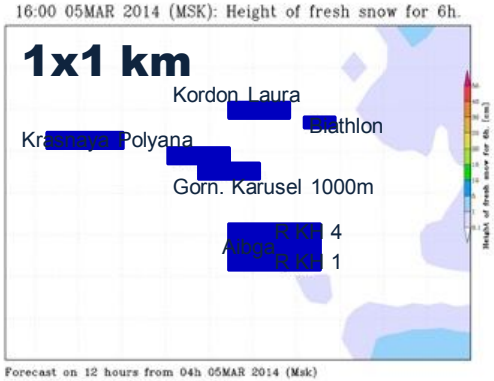
Example of new COSMO products:

fresh snow depth 24h- forecast for 6 March 2014







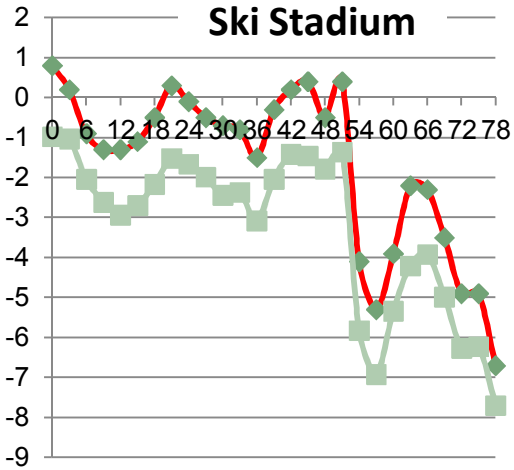


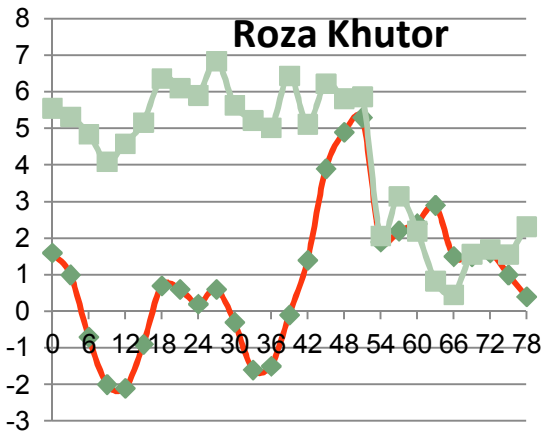
Verification activities

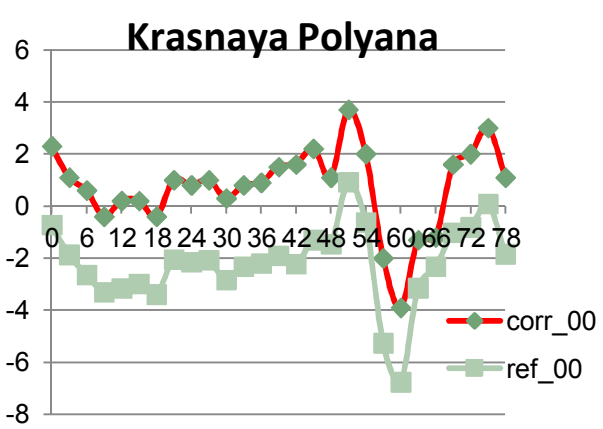
- Traditional scores aggregated over the Sochi region show overall prevalence of COSMO-Ru2 wrt COSMO-Ru7 and COSMO-Ru1
- However, some cases of intense precipitation and visibility are better predicted by COSMO-Ru1
- Wind is also better in COSMO-Ru1
- Precipitation is best forecasted in the late afternoon

The examples of H-correction

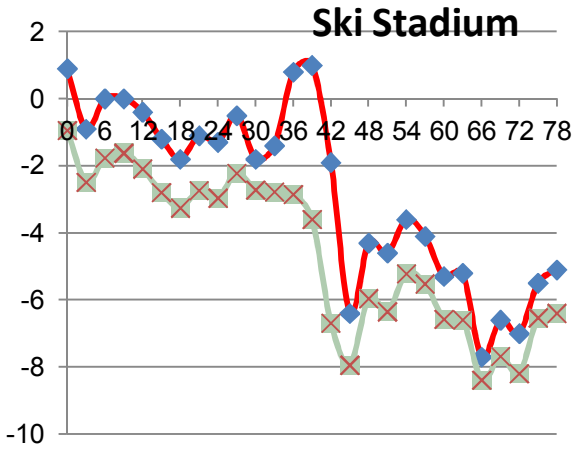
dT2m =Tref-THcorr, dT2m before correction (green), dT2m after correction (red)

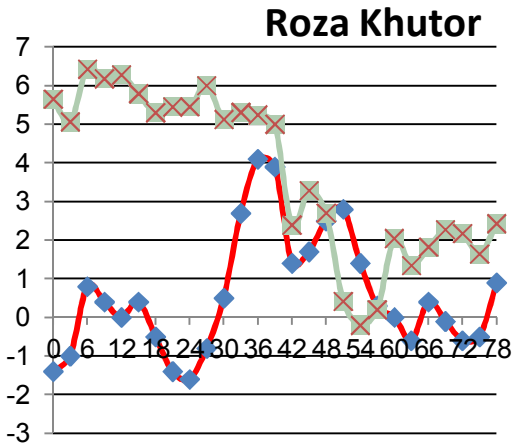


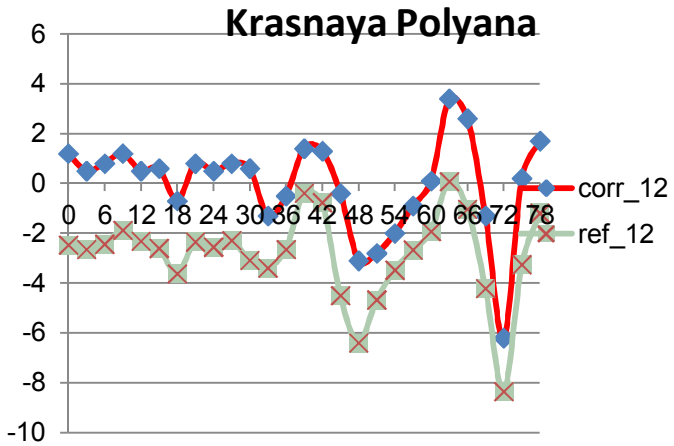




00 UTC





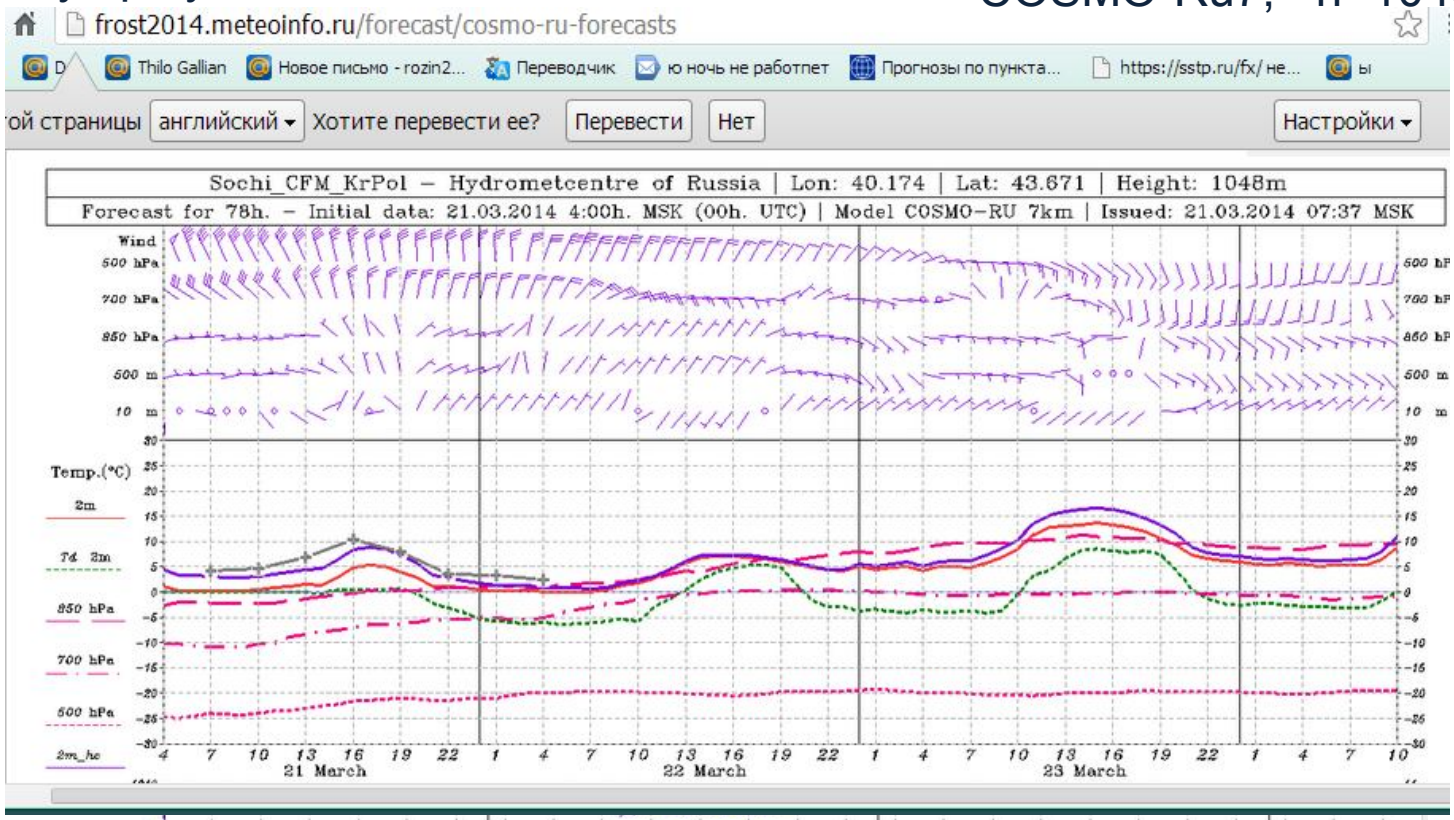


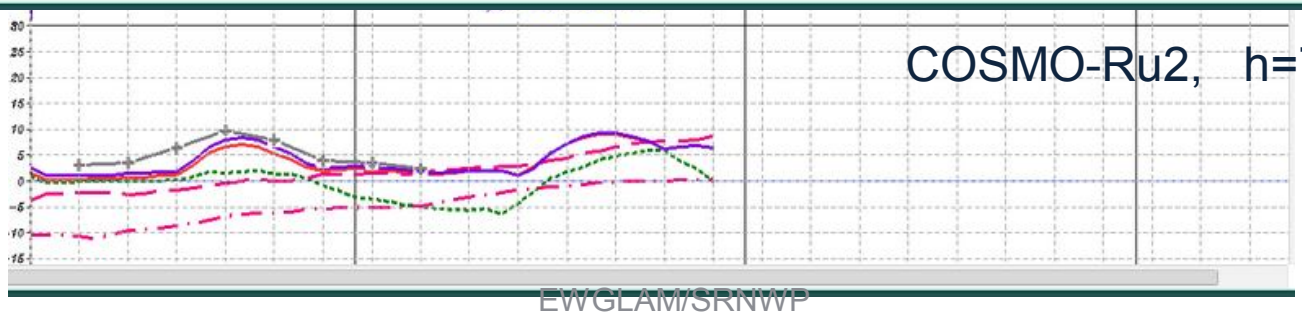
12 UTC

Example of meteograms with corrected T (viole

Krasnaya polyana, h=650 m

COSMO-Ru7, h=1048 m

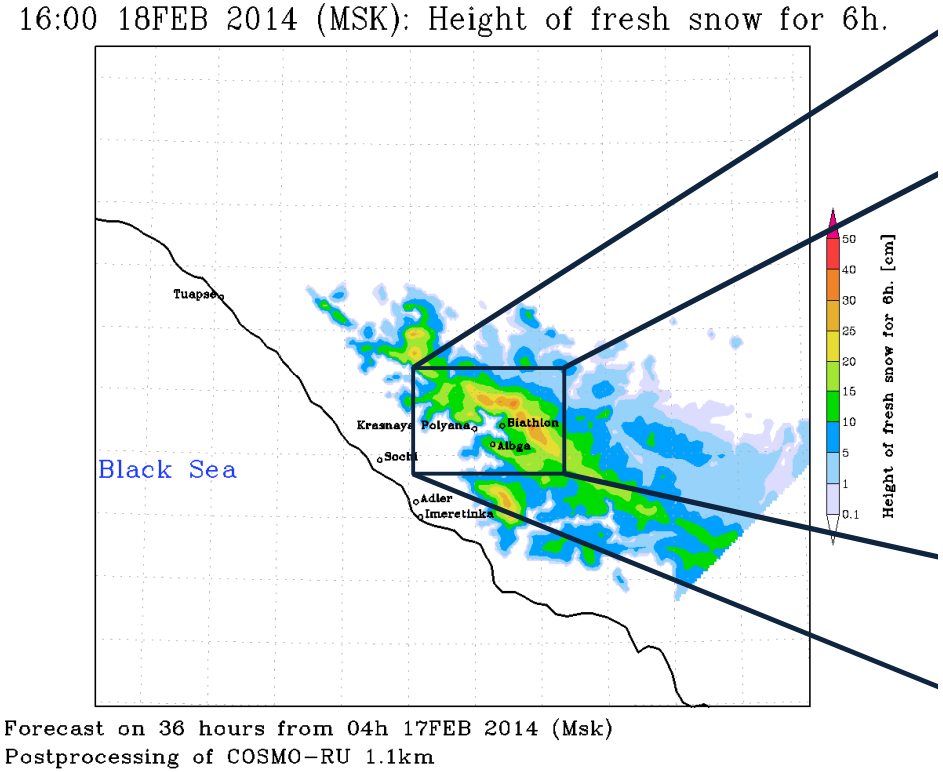




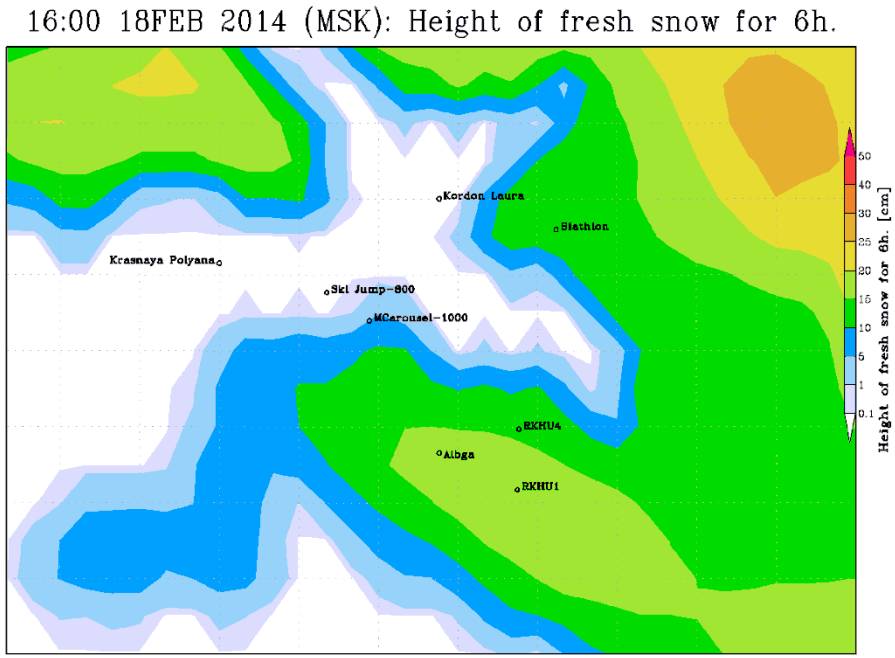
COSMO-Ru2, h=734 m

Development of postprocessing: new products

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



Forecast on 36 hours from 04h 17FEB 2014 (Msk)
Postprocessing of COSMO-RU 1.1km



Forecast on 36 hours from 04h 17FEB 2014 (Msk)
Postprocessing of COSMO-RU 1.1km

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

Main results of TASK 1

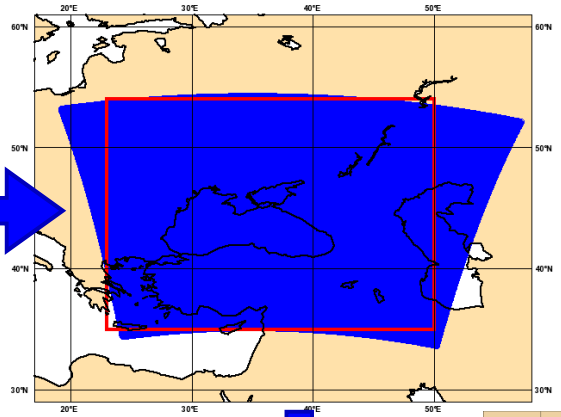
- **During the Olympics, COSMO-S14-EPS forecasts were issued in operational mode twice a day (00UTC, 12UTC). The standard probabilistic products were prepared, visualized and presented to the Olympic forecasters' team via e-mail and on the FROST-2014 web-site.**

- **During the Olympics, COSMO-Ru2-EPS nested into COSMO-S14-EPS issued forecasts in operational mode twice a day (00UTC, 12UTC). The standard probabilistic products were prepared** using Fieldextra, visualized using Grads**, and presented on the FROST-2014 web-site.**

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

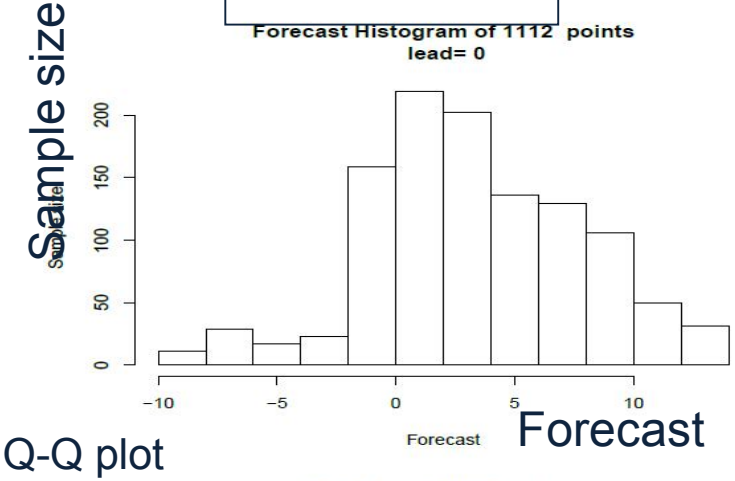
COSMO-Ru2-EPS
Sochi region
Δx~2.2 km, L51
M10, fc+48h
RHMC computer

DISTRIBUTION ANALYSIS: HISTOGRAMS AND QUANTILE-QUANTILE PLOTS

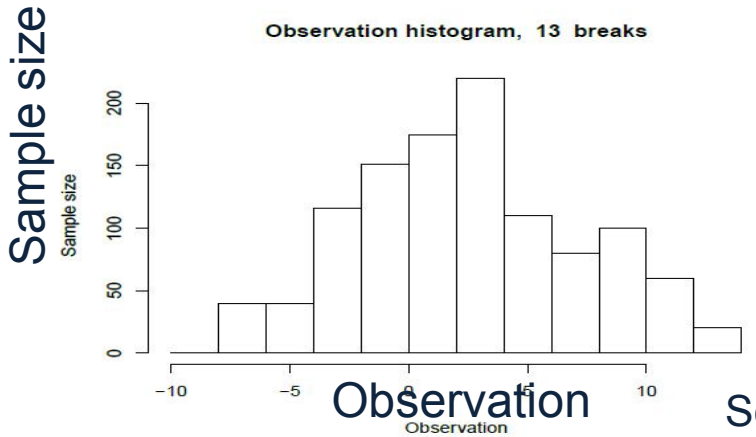
Parameter: T2m, Location: Biathlon Stadium (1455 m),
Verification Period: 15.1.2014-15.3.2014,
Verification approach: Nearest point

Lead=0

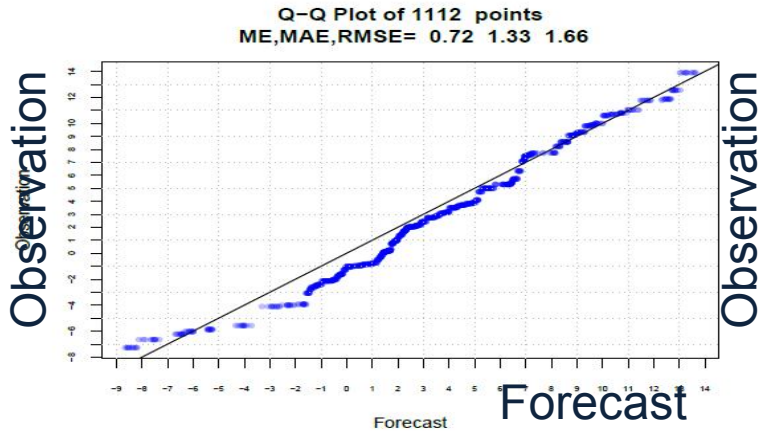
All forecasts starting from 00 UTC and 12 UTC analyses

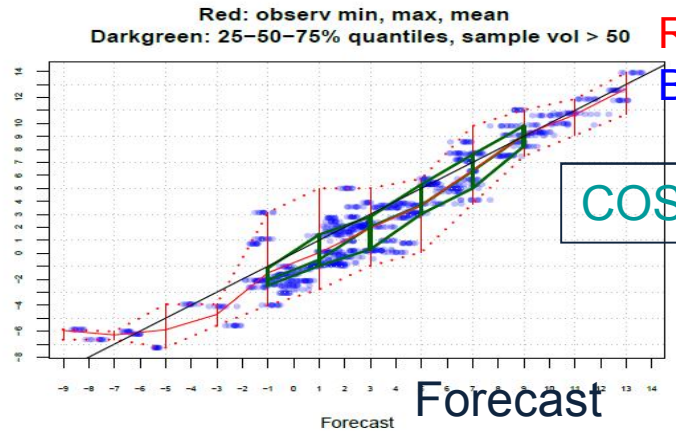


Q-Q plot



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.

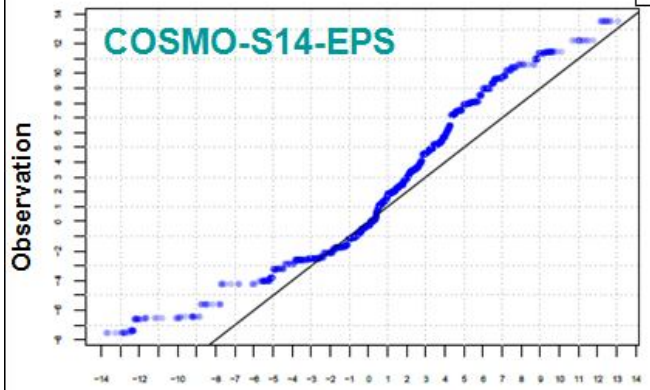
Role of spatial resolution

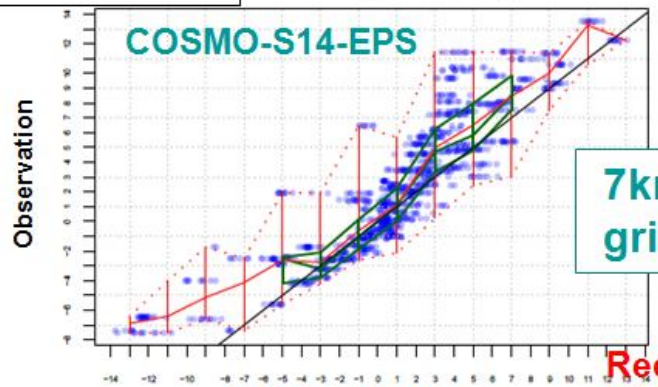
Parameter: T2m, Location: Biathlon Stadium (1455 m),
Verification Period: 15.1.2014-15.3.2014, Verification approach: Nearest point

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



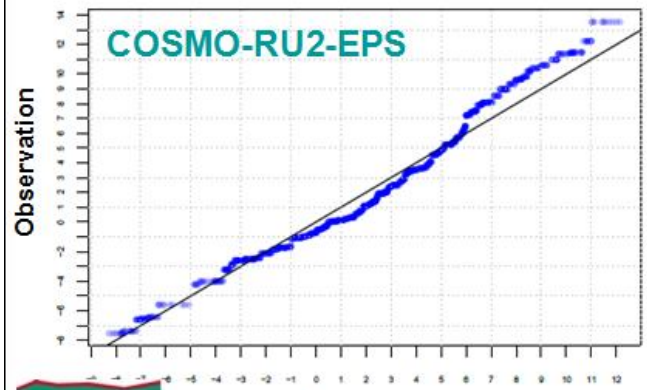


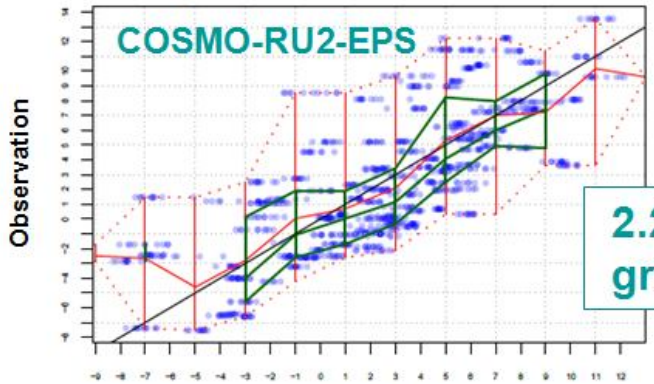
7km
grid spacing

Red:observations
Blue:forecasts

ME=-0.02 MAE=2.61 RMSE= 3.20

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





2.2 km
grid spacing

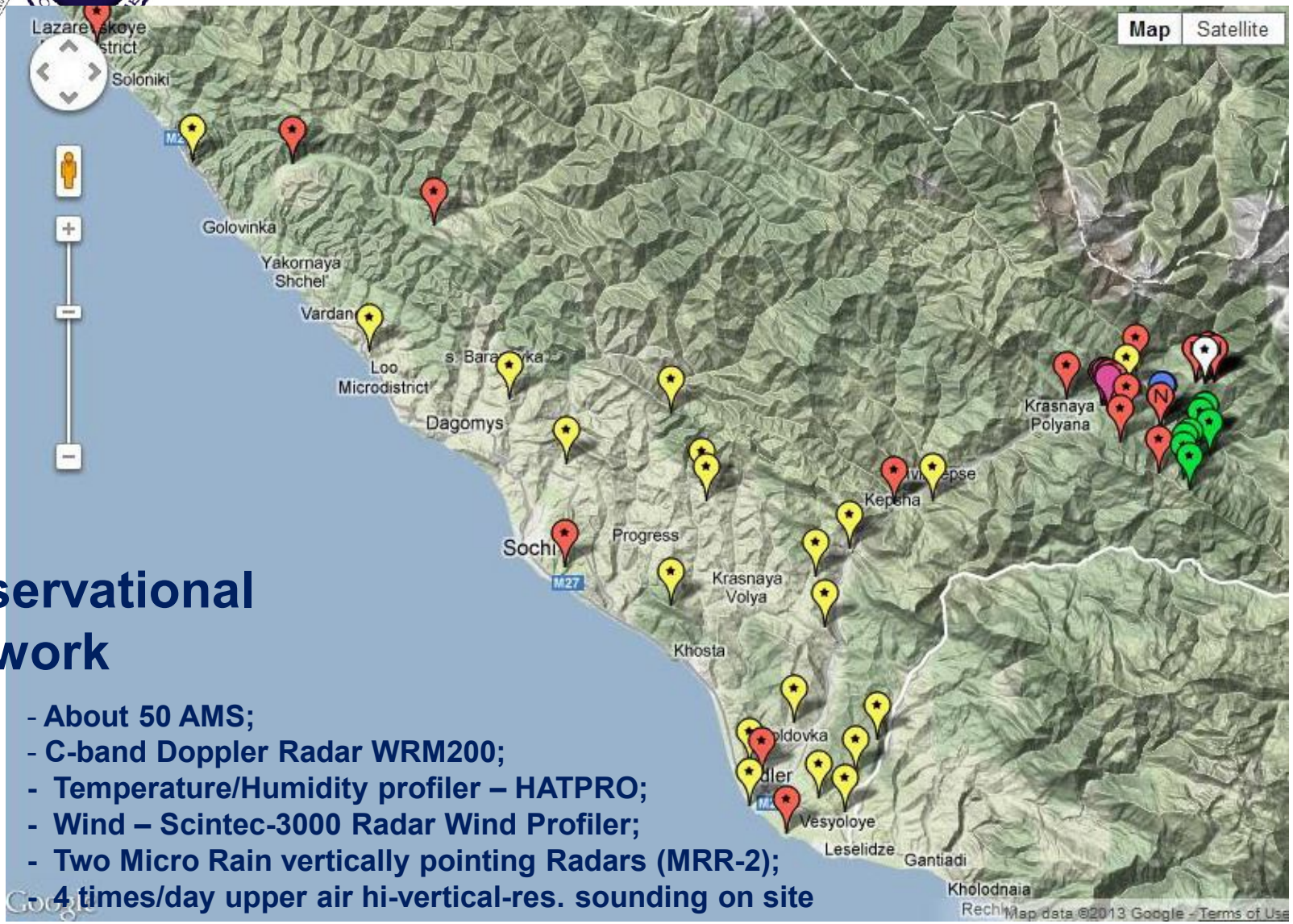
Hi-res ensemble forecasts: better pdfs, higher variability but poorer ensemble mean scores

2

FROST-2014

FROST –

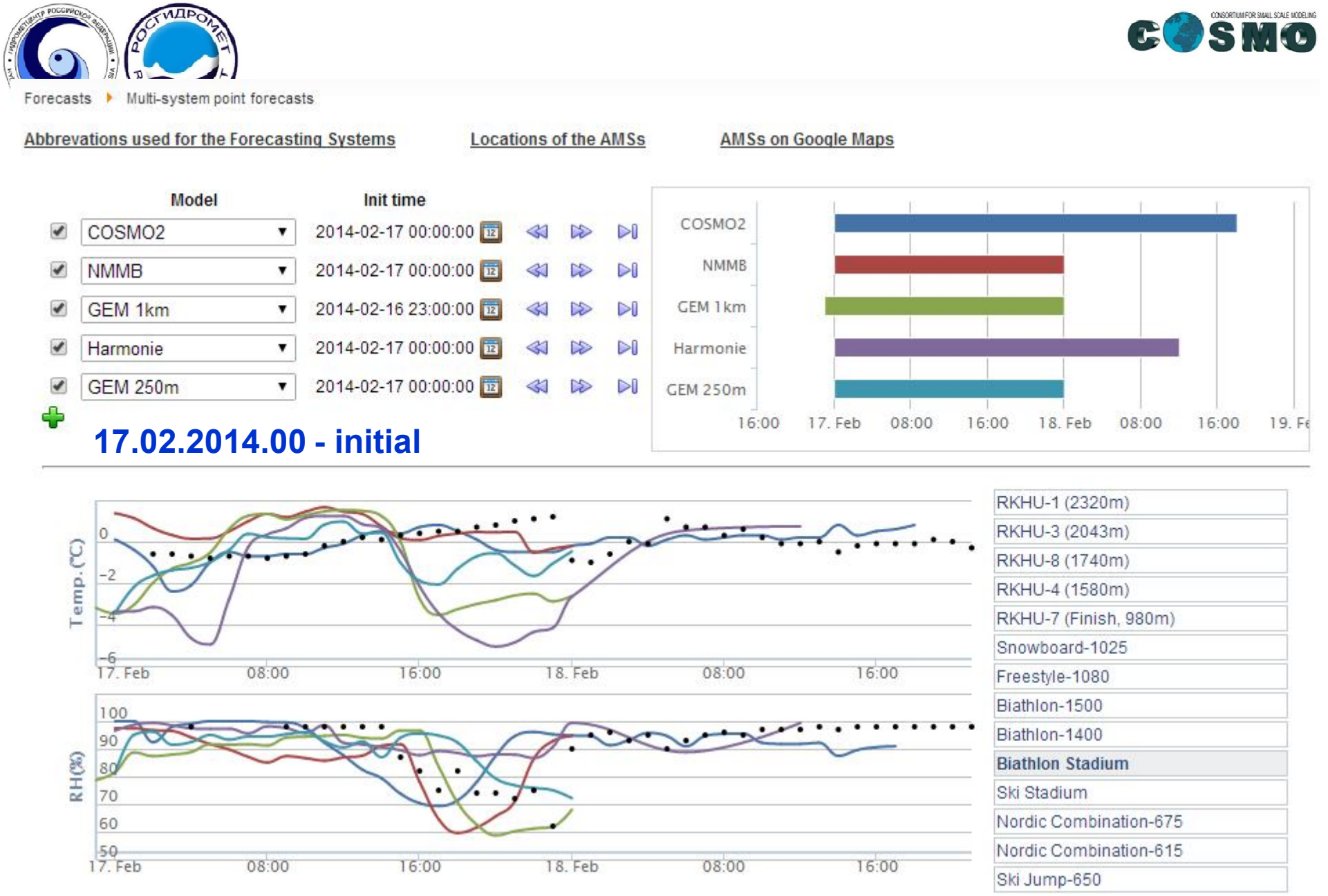
Forecast and Research in the Olympic Sochi Testbed



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**



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**

frost2014.meteoinfo.ru/forecast/cosmo-ru-forecasts/cosmo-ru1-meteograms

Приложения | FB2book.com - Эле... | Snow Forecast, Sno... | Greg Hakim's Annot... | AMS Journals Onlin... | Переводчик Google | Pantene Ru

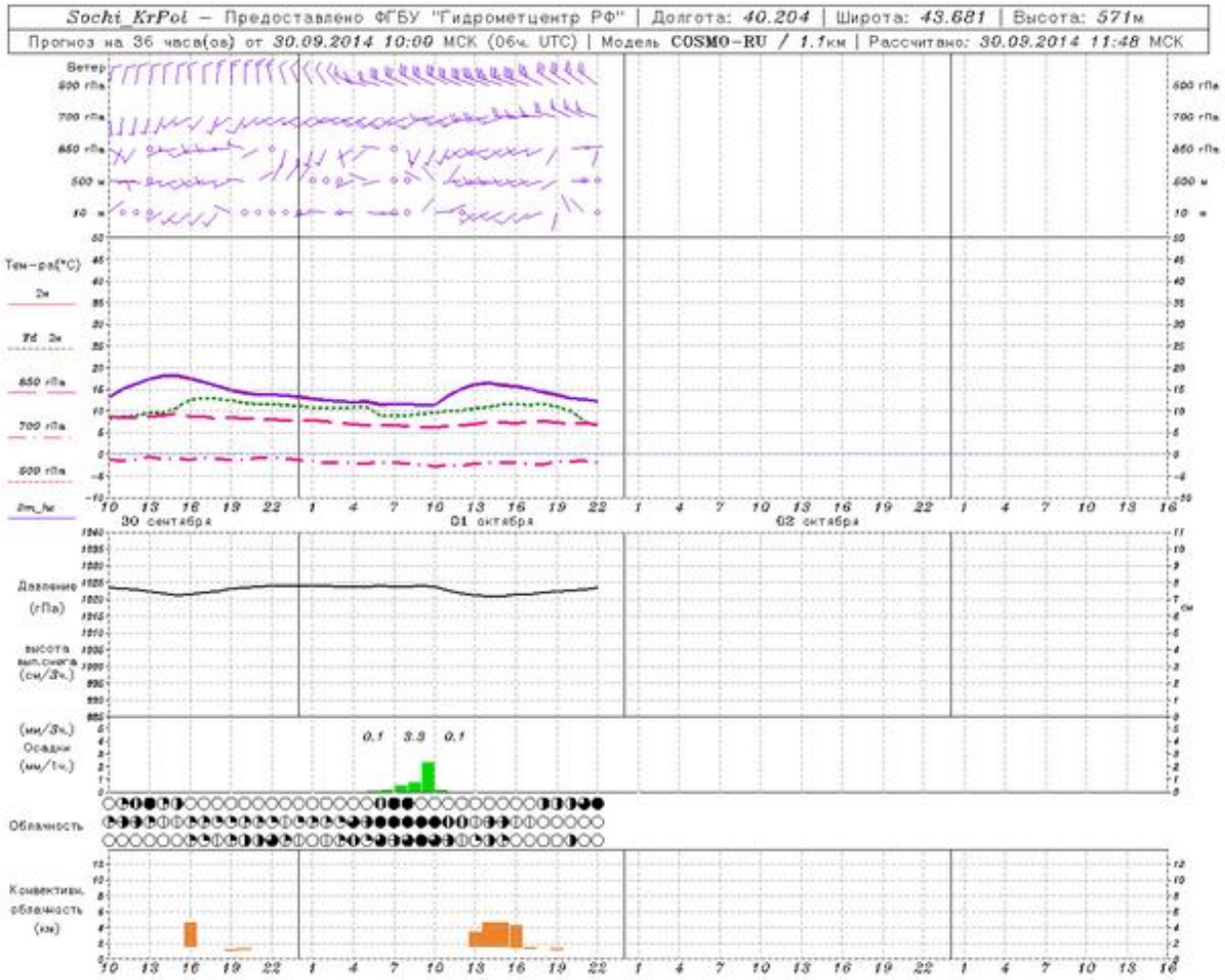
LOG OUT

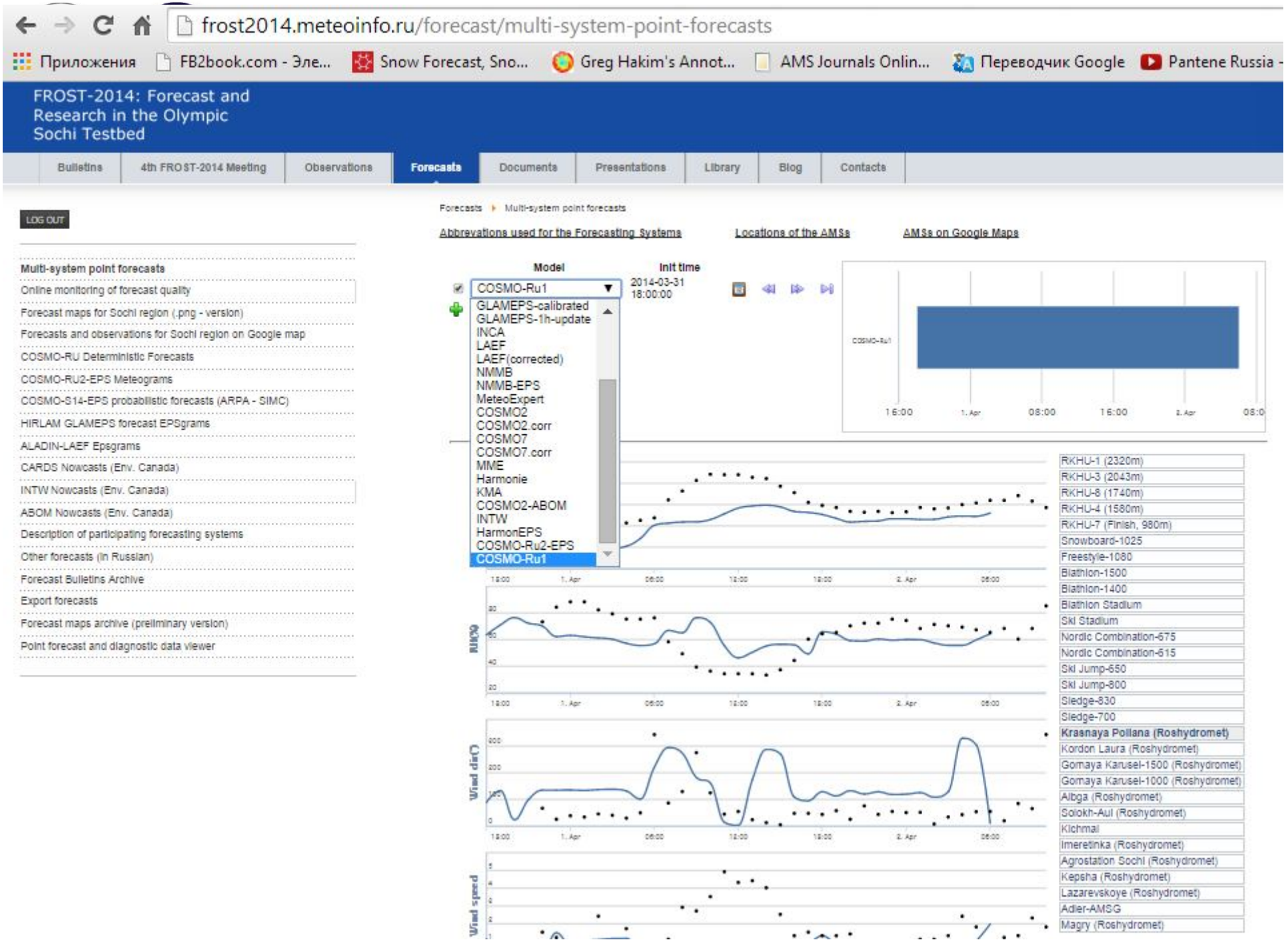
- Multi-system point forecasts
- Online monitoring of forecast quality
- Forecast maps for Sochi region (.png - version)
- Forecasts and observations for Sochi region on Google map
- **COSMO-RU Deterministic Forecasts**
  - **COSMO-RU7 Meteograms**
  - **COSMO-RU7 Maps**
  - **COSMO-RU2 Meteograms**
  - **COSMO-RU2 Maps**
  - **COSMO-RU1 Meteograms**
  - **COSMO-RU1 Maps**
  - **COSMO forecast tables and point forecasts**
- COSMO-RU2-EPS Meteograms
- COSMO-S14-EPS probabilistic forecasts (ARPA - SIMC)
- HIRLAM GLAMEPS forecast EPSgrams
- ALADIN-LAEF Epsgrams
- CARDS Nowcasts (Env. Canada)
- INTW Nowcasts (Env. Canada)
- ABOM Nowcasts (Env. Canada)
- Description of participating forecasting systems
- Other forecasts (in Russian)
- Forecast Bulletins Archive
- Export forecasts
- Forecast maps archive (preliminary version)
- Point forecast and diagnostic data viewer

Forecasts ▸ COSMO-RU Deterministic Forecasts ▸ COSMO-RU1 Meteograms

COSMO-RU1 Forecast Meteograms. Grid spacing - 1.1 km

Initial Time (UTC) and Location: 06 ▼ Krasnaya Polyana ▼




frost2014.meteoinfo.ru/forecast/multi-system-point-forecasts
Приложения
FB2book.com - Эле...
Snow Forecast, Sno...
Greg Hakim's Annot...
AMS Journals Onlin...
Переводчик Google
Pantene Russia -
FROST-2014: Forecast and Research in the Olympic Sochi Testbed
Bulletins
4th FROST-2014 Meeting
Observations
Forecasts
Documents
Presentations
Library
Blog
Contacts
LOG OUT
Multi-system point forecasts
Online monitoring of forecast quality
Forecast maps for Sochi region (.png - version)
Forecasts and observations for Sochi region on Google map
COSMO-RU Deterministic Forecasts
COSMO-RU2-EPS Meteograms
COSMO-S14-EPS probabilistic forecasts (ARPA - SIMC)
HIRLAM GLAMEPS forecast EPSgrams
ALADIN-LAEF Epsgrams
CARDS Nowcasts (Env. Canada)
INTW Nowcasts (Env. Canada)
ABOM Nowcasts (Env. Canada)
Description of participating forecasting systems
Other forecasts (in Russian)
Forecast Bulletins Archive
Export forecasts
Forecast maps archive (preliminary version)
Point forecast and diagnostic data viewer
Forecasts ▸ Multi-system point forecasts
Abbrevations used for the Forecasting Systems
Locations of the AMSs
AMSs on Google Maps
Model
Init time
COSMO-Ru1
2014-03-31 18:00:00
GLAMEPS-calibrated
GLAMEPS-1h-update
INCA
LAEF
LAEF(corrected)
NMMB
NMMB-EPS
MeteoExpert
COSMO2
COSMO2.corr
COSMO7
COSMO7.corr
MME
Harmonie
KMA
COSMO2-ABOM
INTW
HarmonEPS
COSMO-Ru2-EPS
COSMO-Ru1
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
Ski Jump-800
Sledge-830
Sledge-700
Krasnaya Poliana (Roshydromet)
Kordon Laura (Roshydromet)
Gornaya Karusel-1500 (Roshydromet)
Gornaya Karusel-1000 (Roshydromet)
Alpga (Roshydromet)
Solokh-Aul (Roshydromet)
Kichmai
Imeretinka (Roshydromet)
Agrostation Sochi (Roshydromet)
Kepsha (Roshydromet)
Lazarevskoye (Roshydromet)
Adler-AMSG
Magry (Roshydromet)

COSMO-Ru, Sept 2014

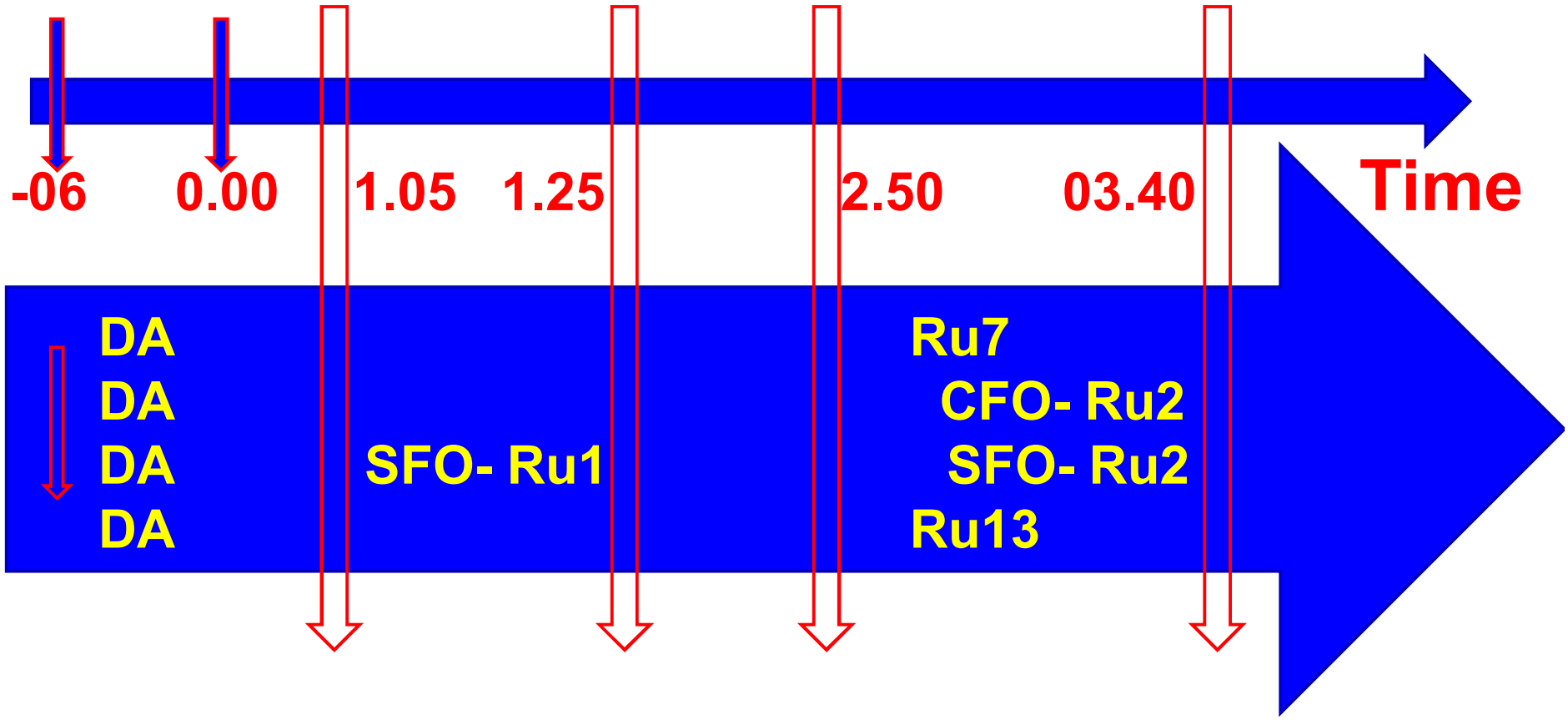
COSMO-Ru:
Ru1, Ru2, Ru7, Ru7-ART, Ru14, Ru13,
Universiade Kazan-2013

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

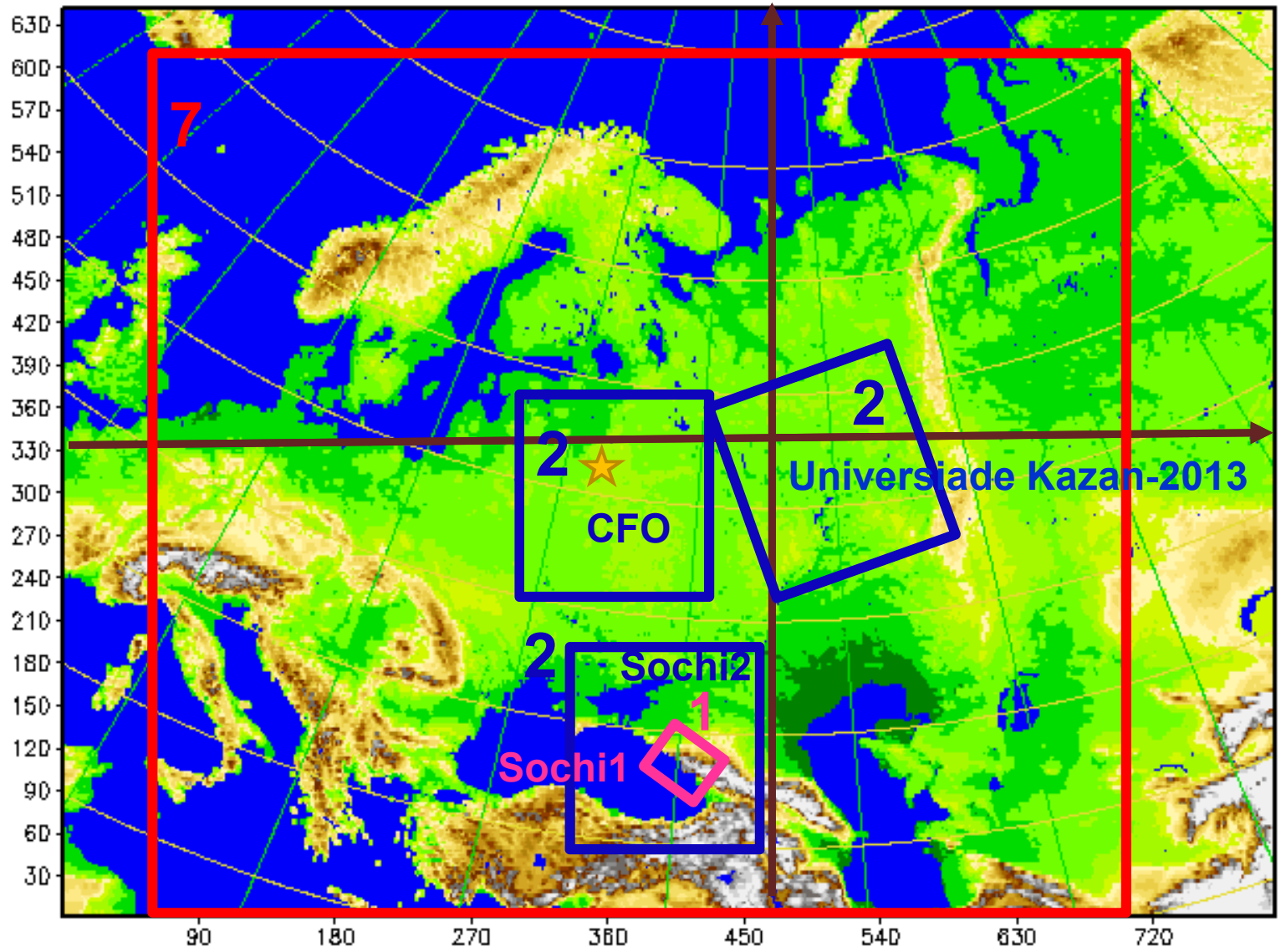
Daily 4 times (00, 06, 12, 18 h UTC):

- 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

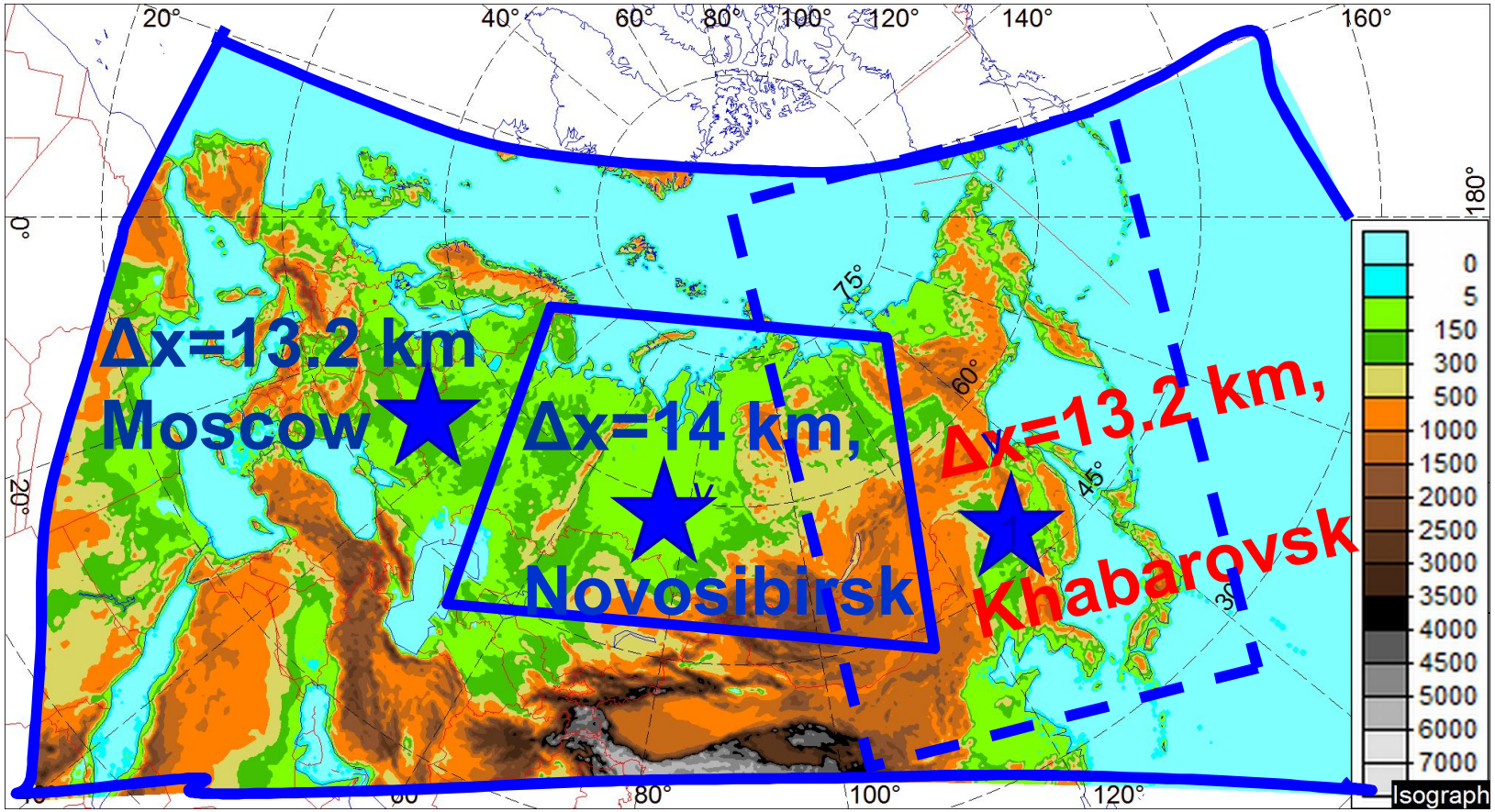


COSMO-Ru7, Δx = 7 km

COSMO-Ru1, Δx = 1.1 km

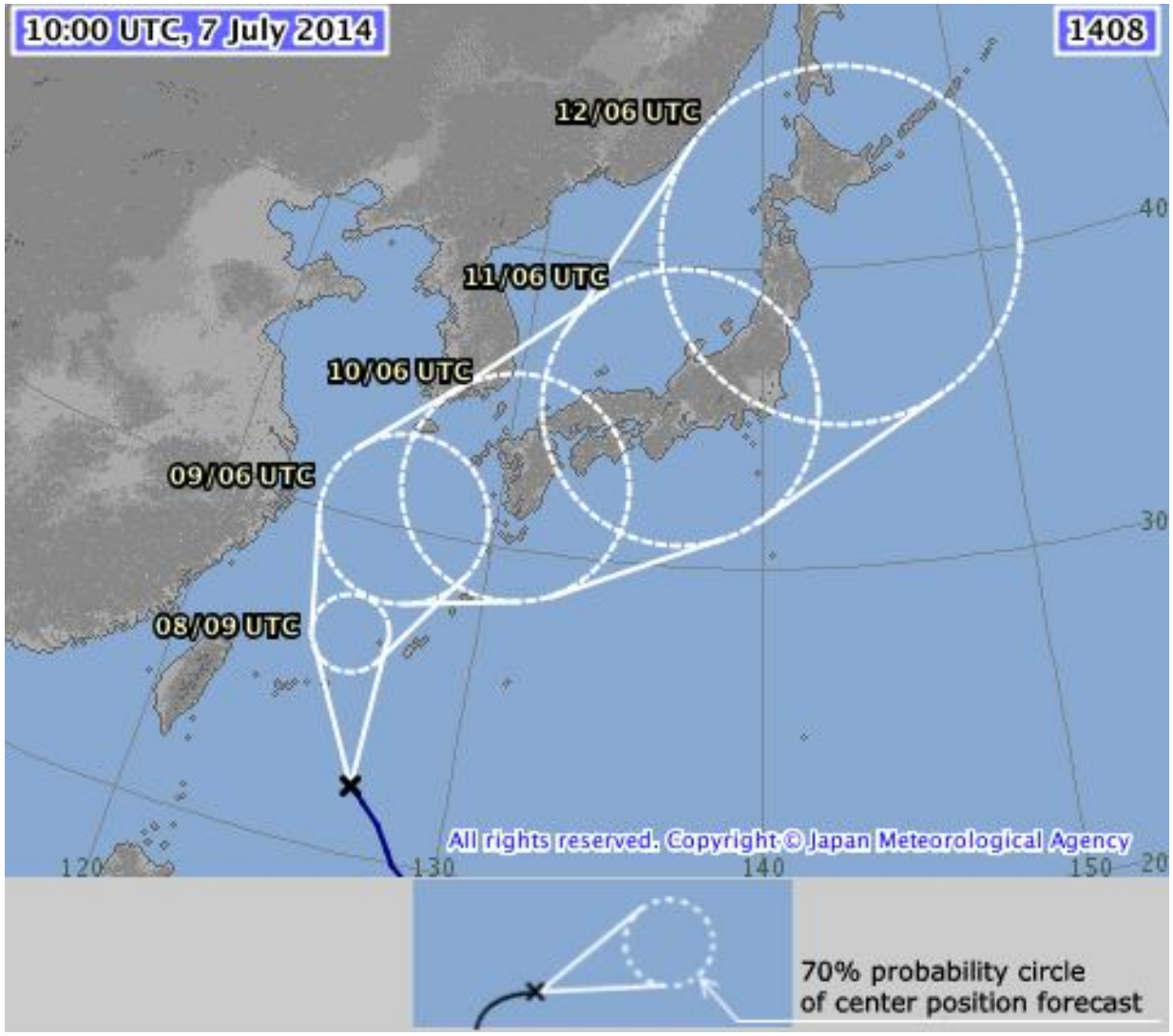
COSMO-Ru2 (CFO, Universiade, "Sochi-2014"), Δx =2.2 km

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”,

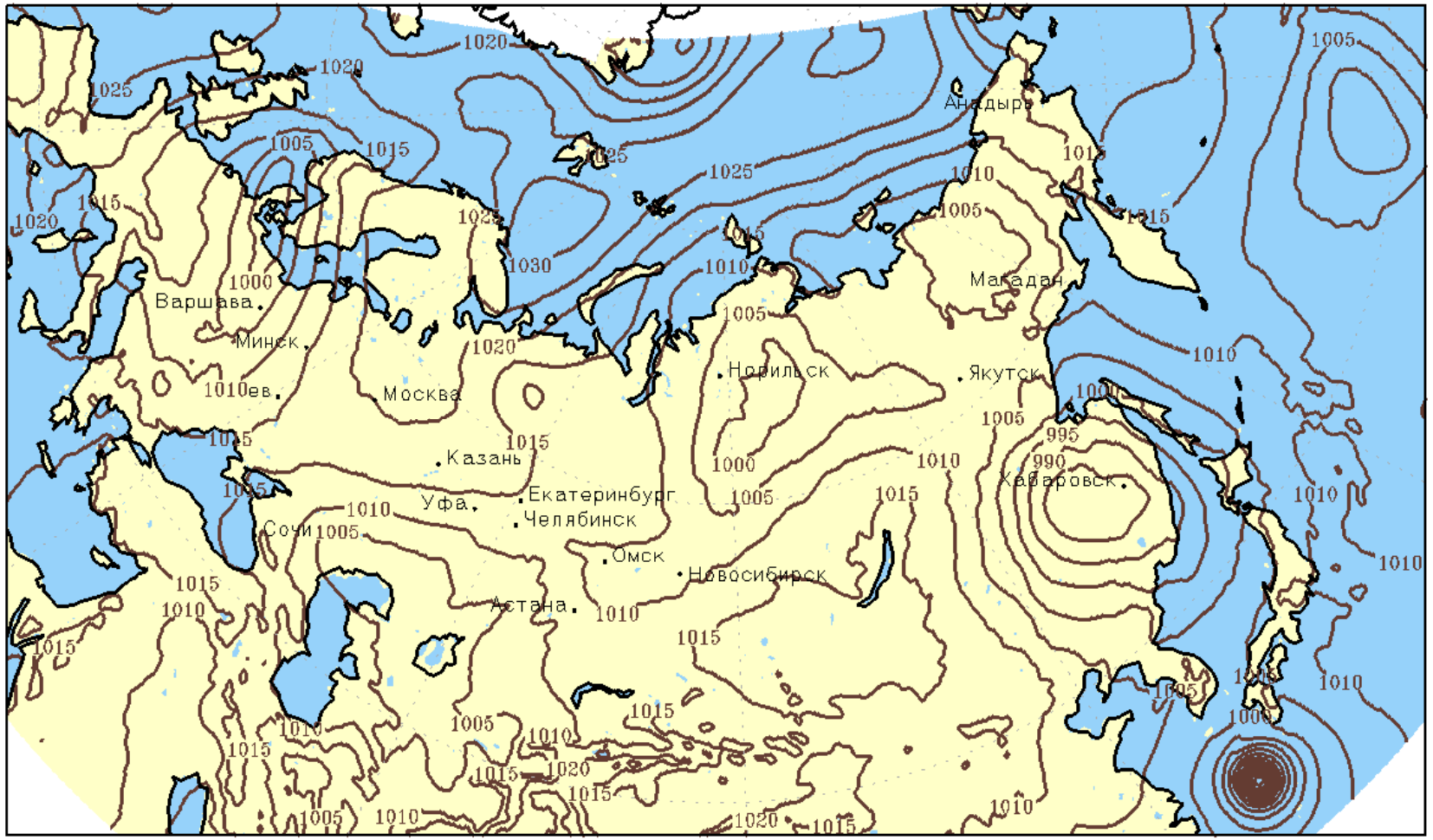
7 July 2014, 10.00 UTC



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

9 July, 2014

00:00 09июл 2014 (UTC+0): PMSL



Прогноз на 72ч. от 00:00 06июл 2014 (UTC+0)

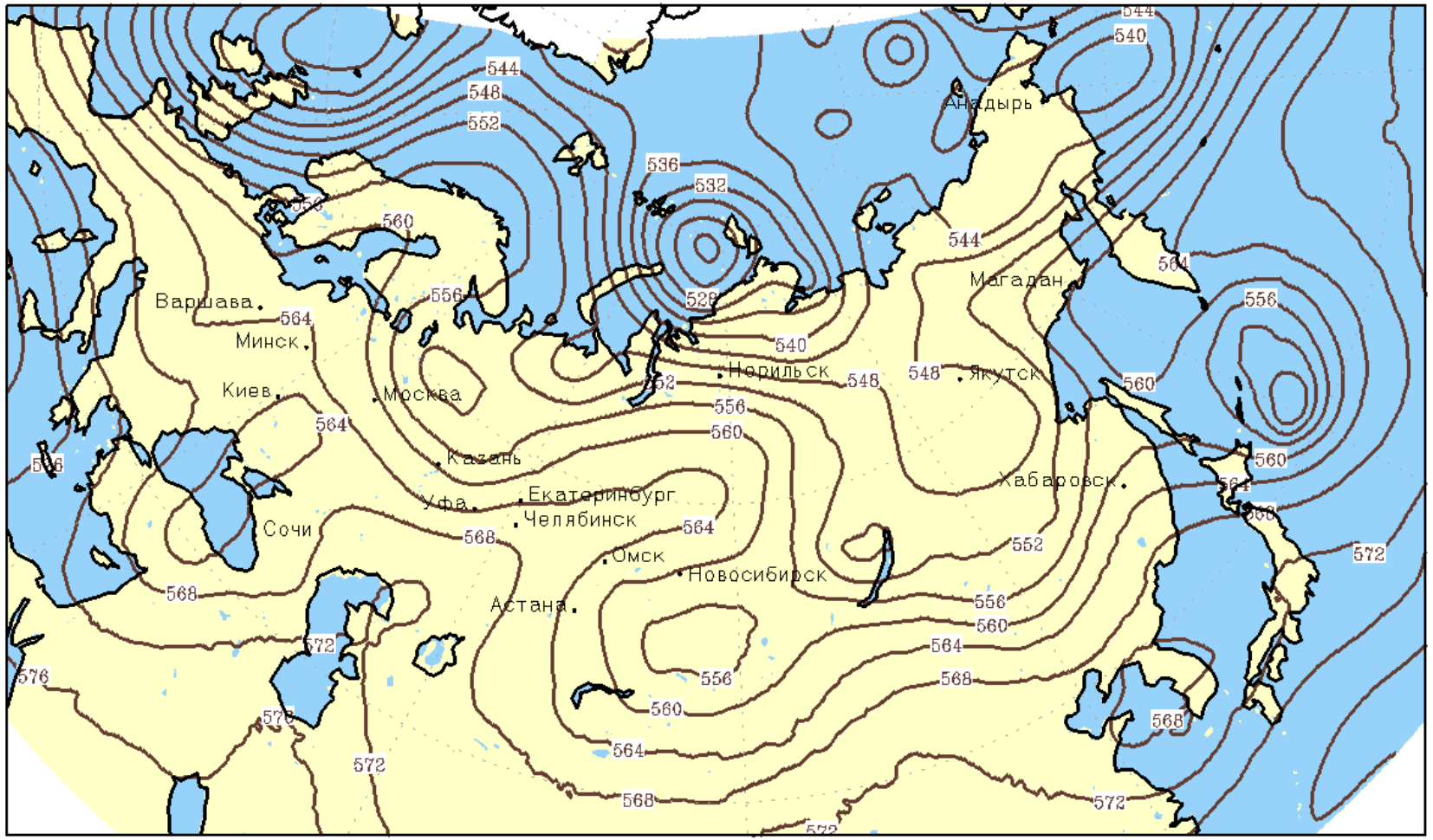
COSMO-RU 13км

Typhoon "Neoguri"

PMSL

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

00:00 06июл 2014 (UTC+0): H500



Прогноз на 0ч. от 00:00 06июл 2014 (UTC+0)

—— H500

COSMO-RU 13км

Typhoon "Neoguri"

4

CONCLUSIONS

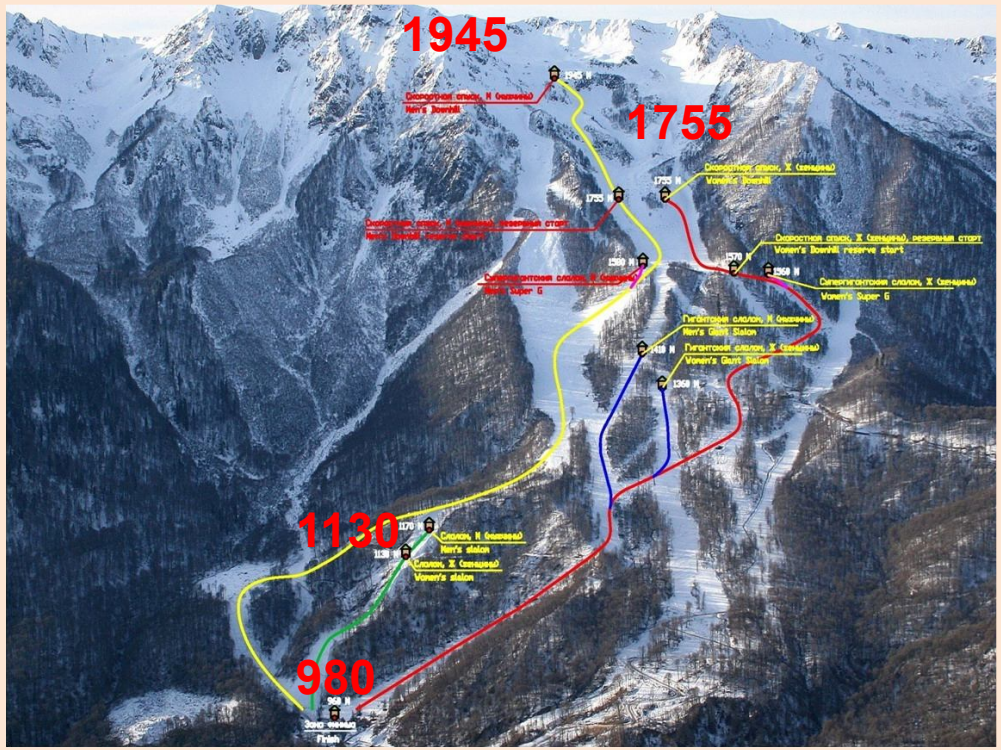
HIGHLIGHTS

- 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

Operational meteorological support to the Winter Olympic Games Sochi-2014 and findings from the COSMO priority project CORSO



THANKS!

QUISTIONS?

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