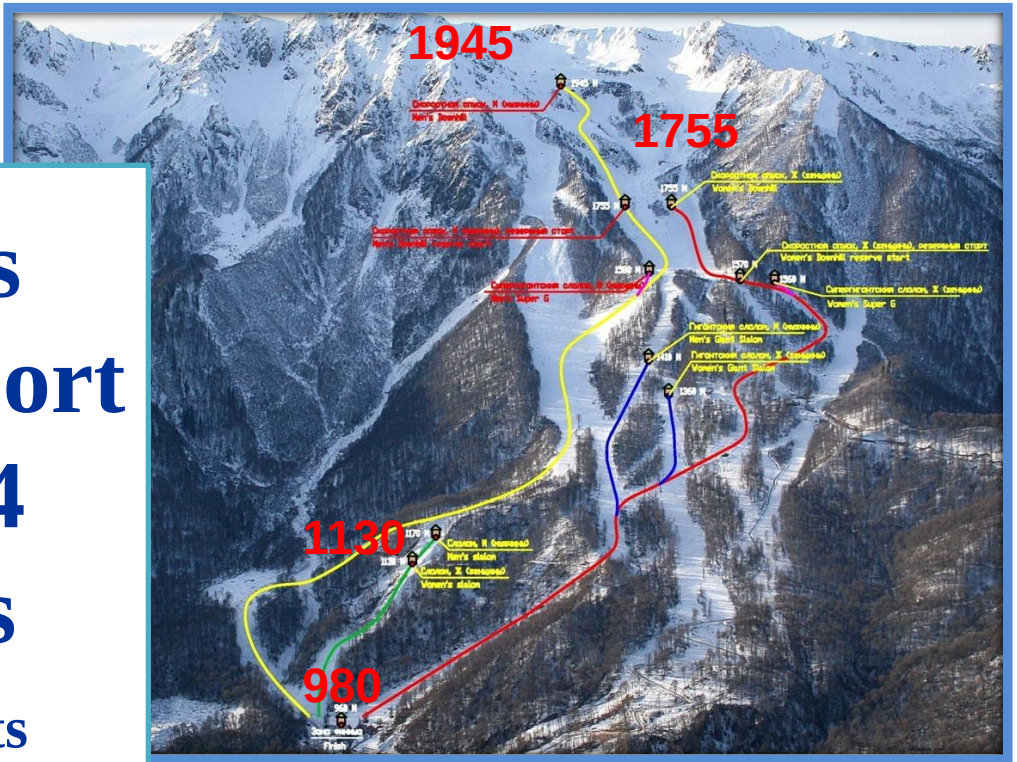
sochi.ru 2014



COSMO provides meteorological support for the Sochi-2014 Winter Olympics

and other large sport events
(Summer Universiade Kazan-2013)

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


Snow sports competitions
Krasnaya Polyana
Krasnaya Polyana
PV
45 km
Mountain Cluster
Sochi
Coastal and mountain clusters of Sochi-2014
Matsesta
45 km
Hosta
5 km
Adler
Adler
PV
PV
Coastal Cluster
Ice sports competitions

PP CORSO: METEOROLOGICAL SUPPORT FOR THE SOCHI-2014 OLYMPICS

http://cosmo-model.org/content/tasks/priorityProjects/corso/default.htm

PP CORSO:
Consolidation of Operation and Research results for the Sochi Olympic Games

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

PP CORSO is considered as a COSMO contribution to WWRP FDP/RDP FROST-2014 http://frost2014.meteoinfo.ru/

Main participants:
Russia , Germany, Italy, Switzerland, and Greece

PP CORSO CONTENT

PP leaders: G.Rivin, I.Rozinkina (Russia)

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

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

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

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

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

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

TASK 3. Development and adaptation of COSMO EPSs for the 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-Ru2-EPS 2.2 km for the Sochi region (with ICs and BCs from COSMO-S14-EPS) (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, 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

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

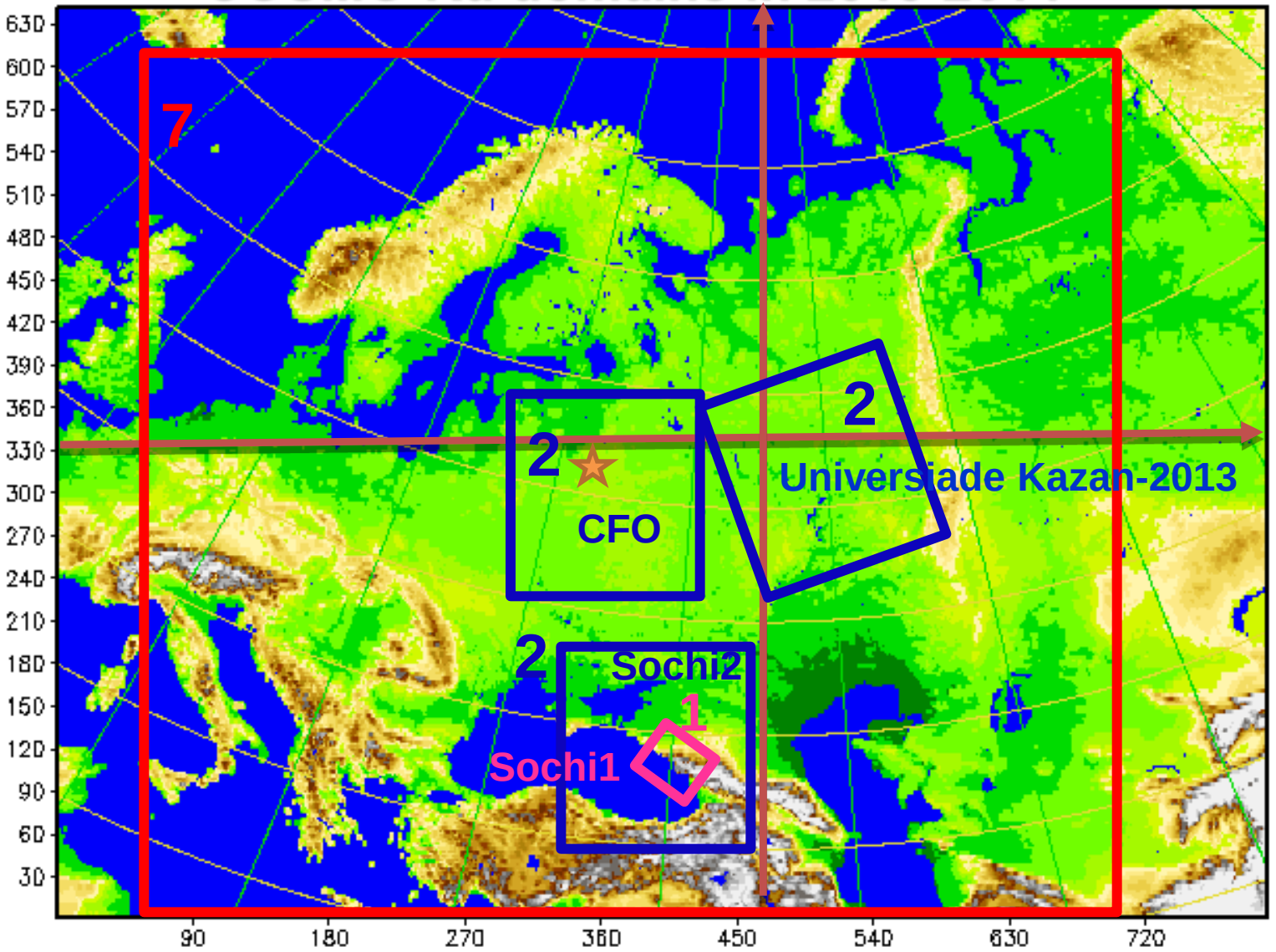
Monday 12 December 2011, MeteoSwiss Zurich

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

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 : 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

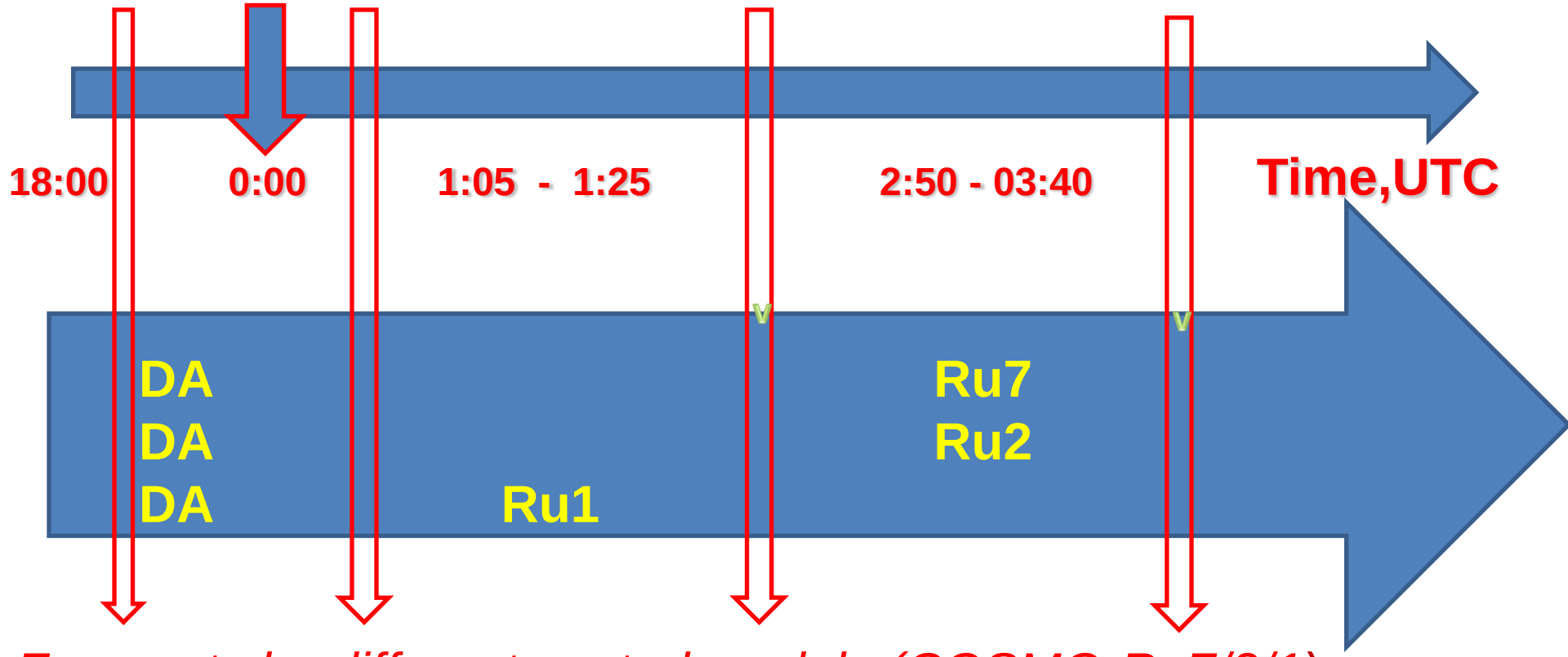
Domain: 210 km x 210 km
Grid: 190 x 190 x 50
Grid size: 1.1 km
Time step: 5 s
Forecast: 36 h

Runtime 24 min

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

COSMO-Ru system : technological line

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

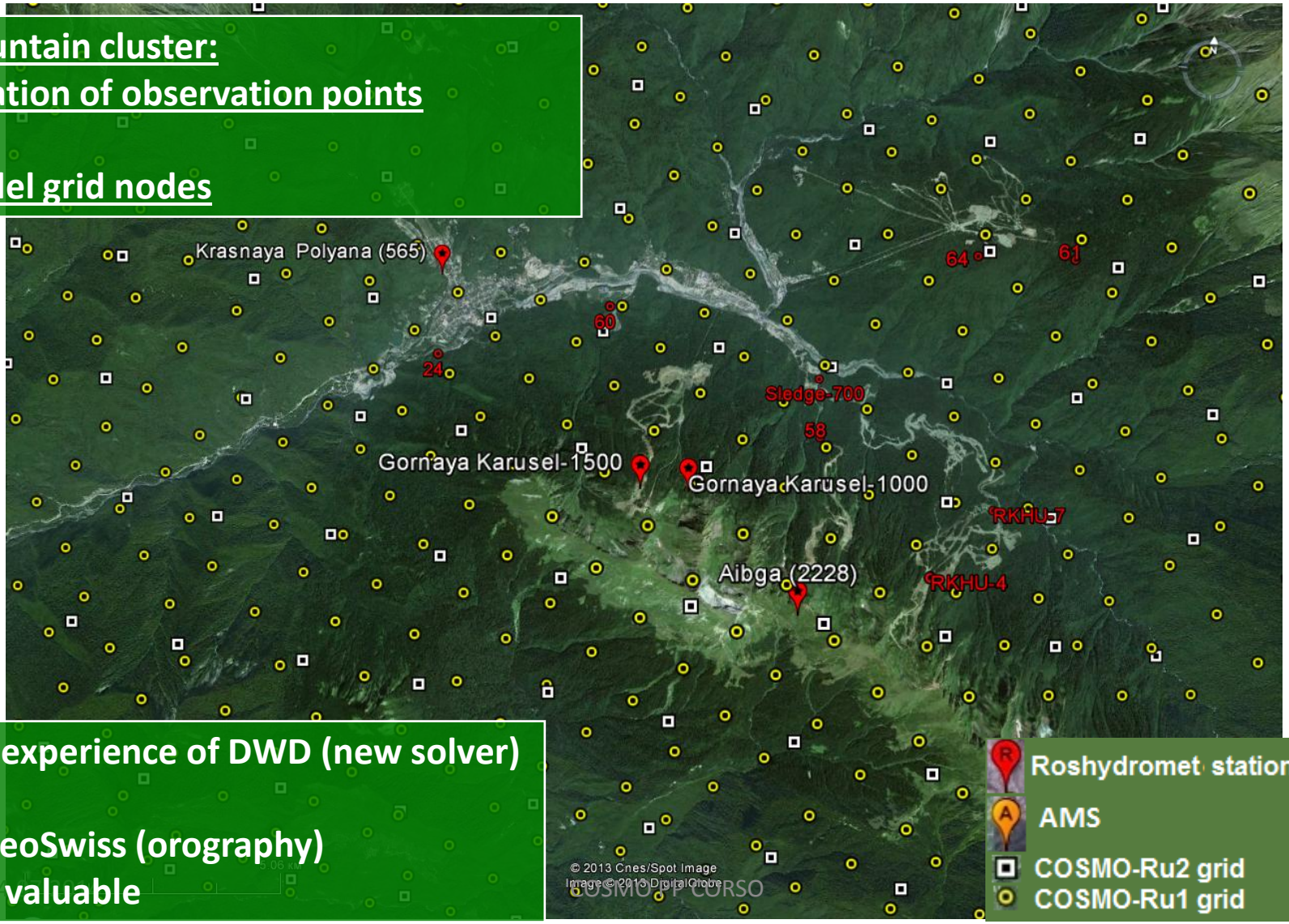


Forecasts by different nested models (COSMO-Ru7/2/1)

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

Development and Implementation of COSMO-Ru1 for the mountain cluster

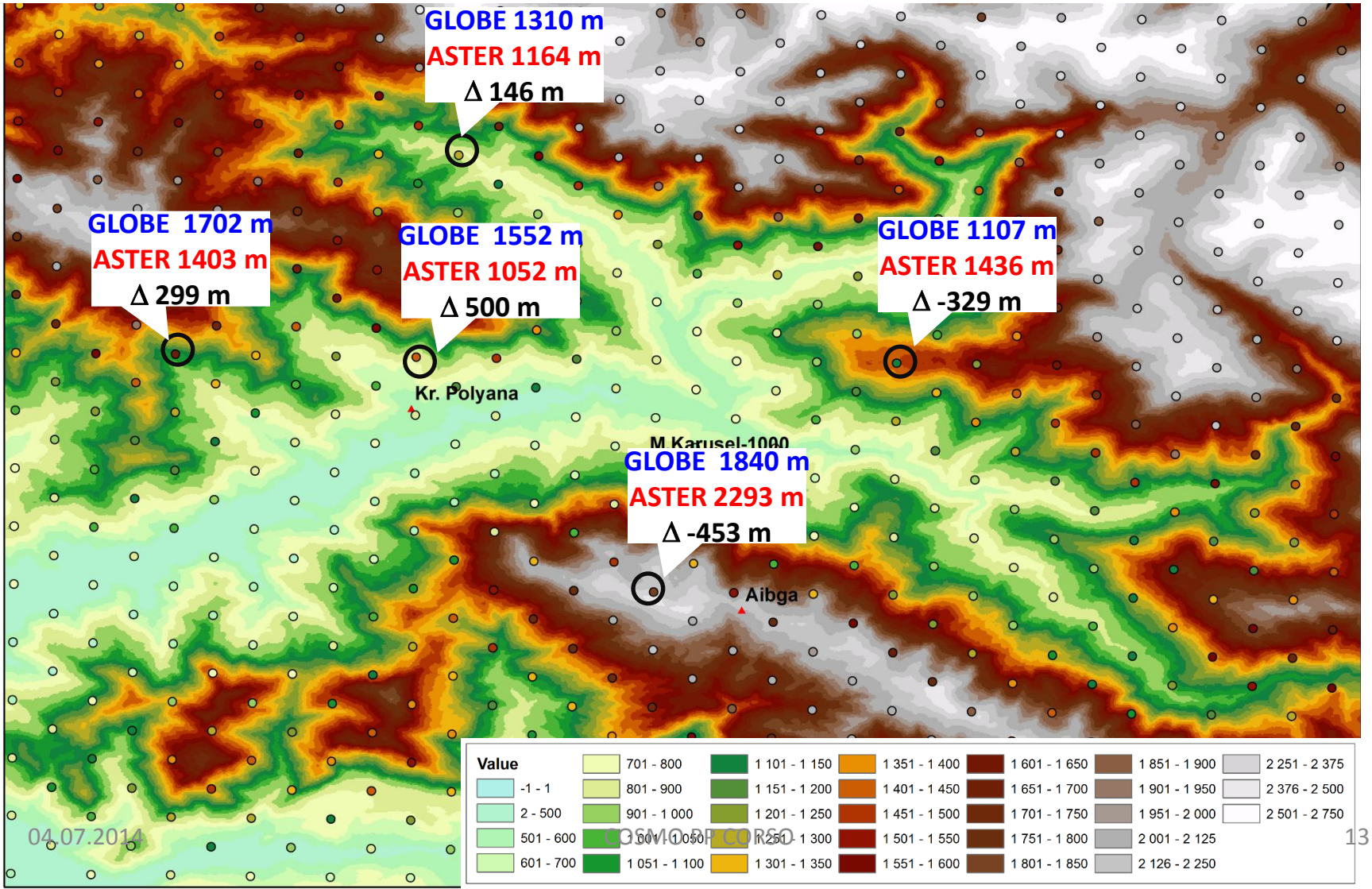
Mountain cluster:
location of observation points
and
model grid nodes



The experience of DWD (new solver)
and
MeteoSwiss (orography)
was valuable

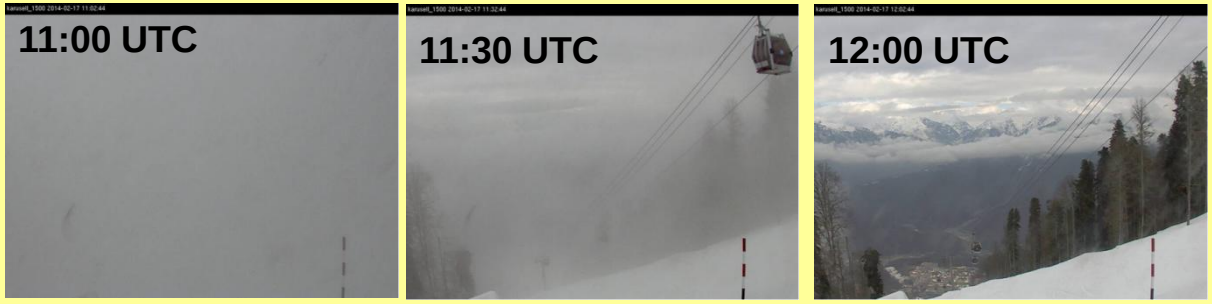
Implementation of COSMO-Ru1 for mountain cluster

The importance of using ASTER GDEM2 (Δx ≈ 30 m) instead of GLOBE (Δx ≈ 1 km) for COSMO-Ru1

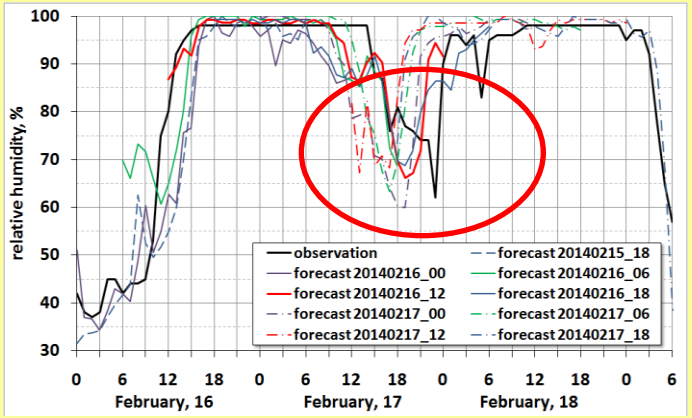


On February, 17 at 12:00-12:30 UTC (for Biathlon Stadium) visibility conditions improved. COSMO-Ru1 forecast of the wind direction and relative humidity ***allowed forecasters to predict changes in visibility and determine the time for competition***.

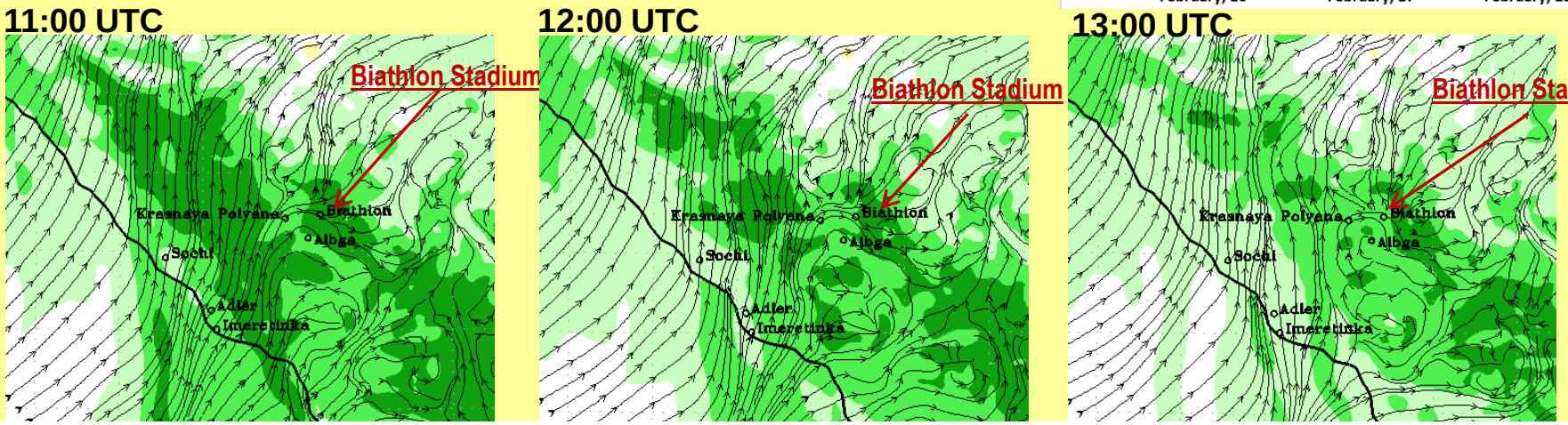
Video camera shots from Gornaya Karusel-1500 for 17.02.2014



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 high-quality NWP products

PP CORSO:
Development of postprocessing and feedback from forecasters

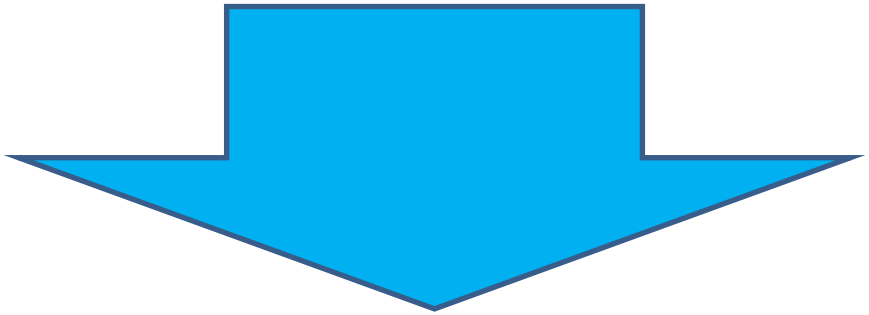
- Postprocessing for Sochi-2014:
  - Tools for correction of forecasts
  - Tools for calculation of new products (For example, fresh snow depth)
- Feedback from forecasters:
  - Trainings
  - Selection of more important forecast elements & Visualisation
  - Guidelines

The 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



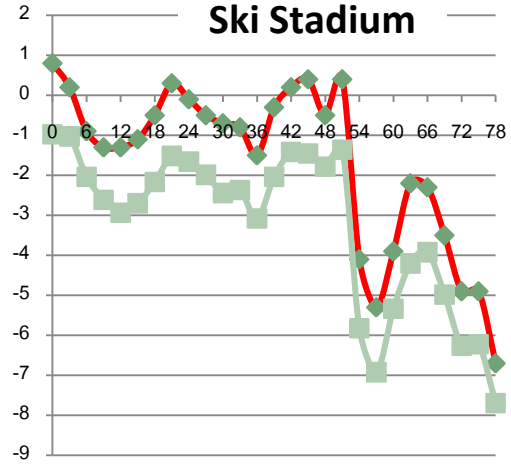
Two-step correction of forecasts for points (meteograms)

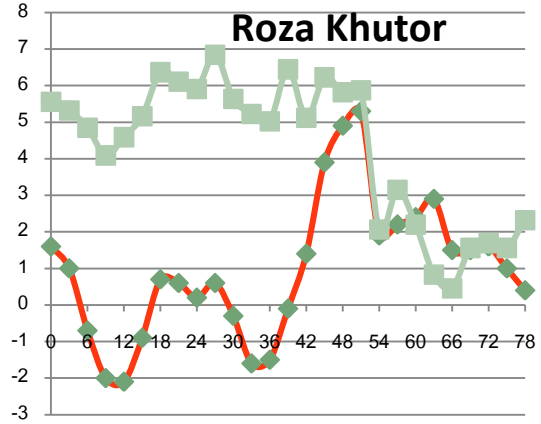
Correction based on the forecasts of vertical T gradient within the boundary layer (H-correction)

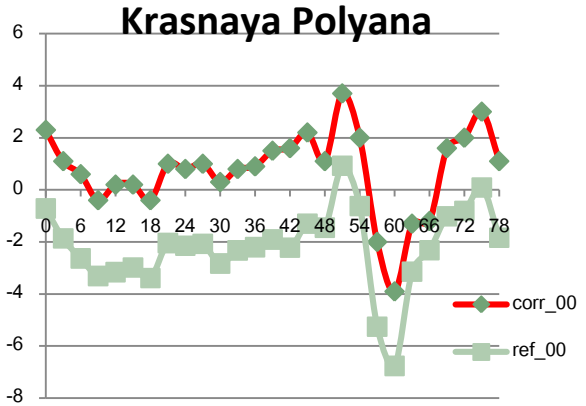
Statistical correction based on Kalman Filter (KF-correction)

The examples of H-correction

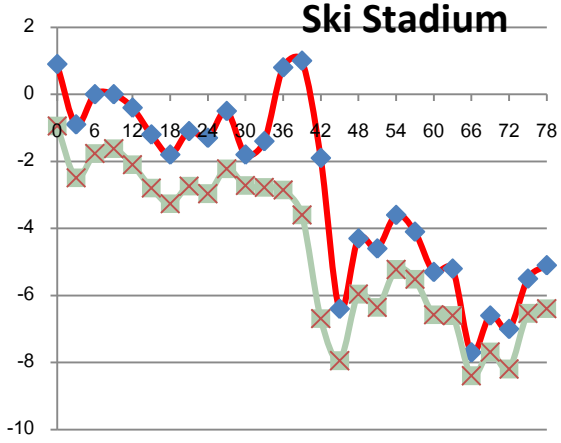
dT2m =Tref-THcorr, dT2m before correction (green), dT2m after correction (red)

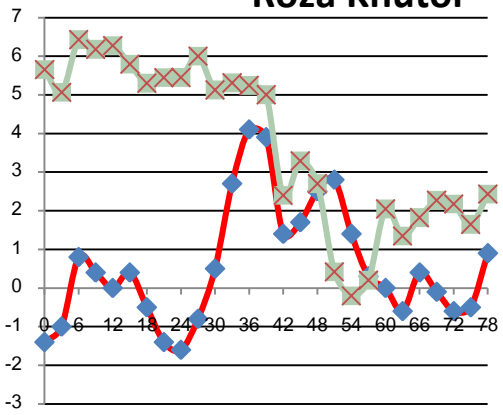


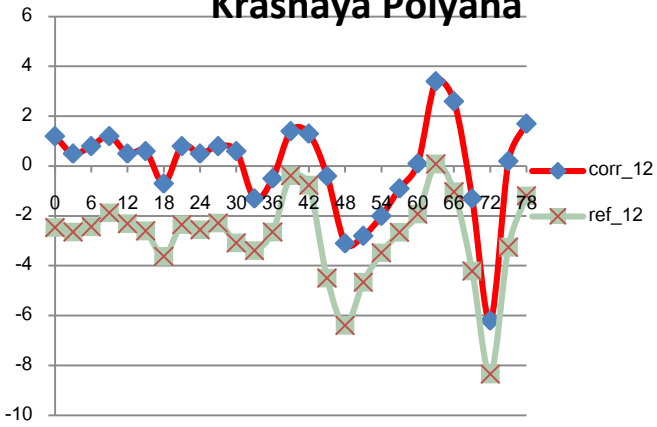




00 UTC

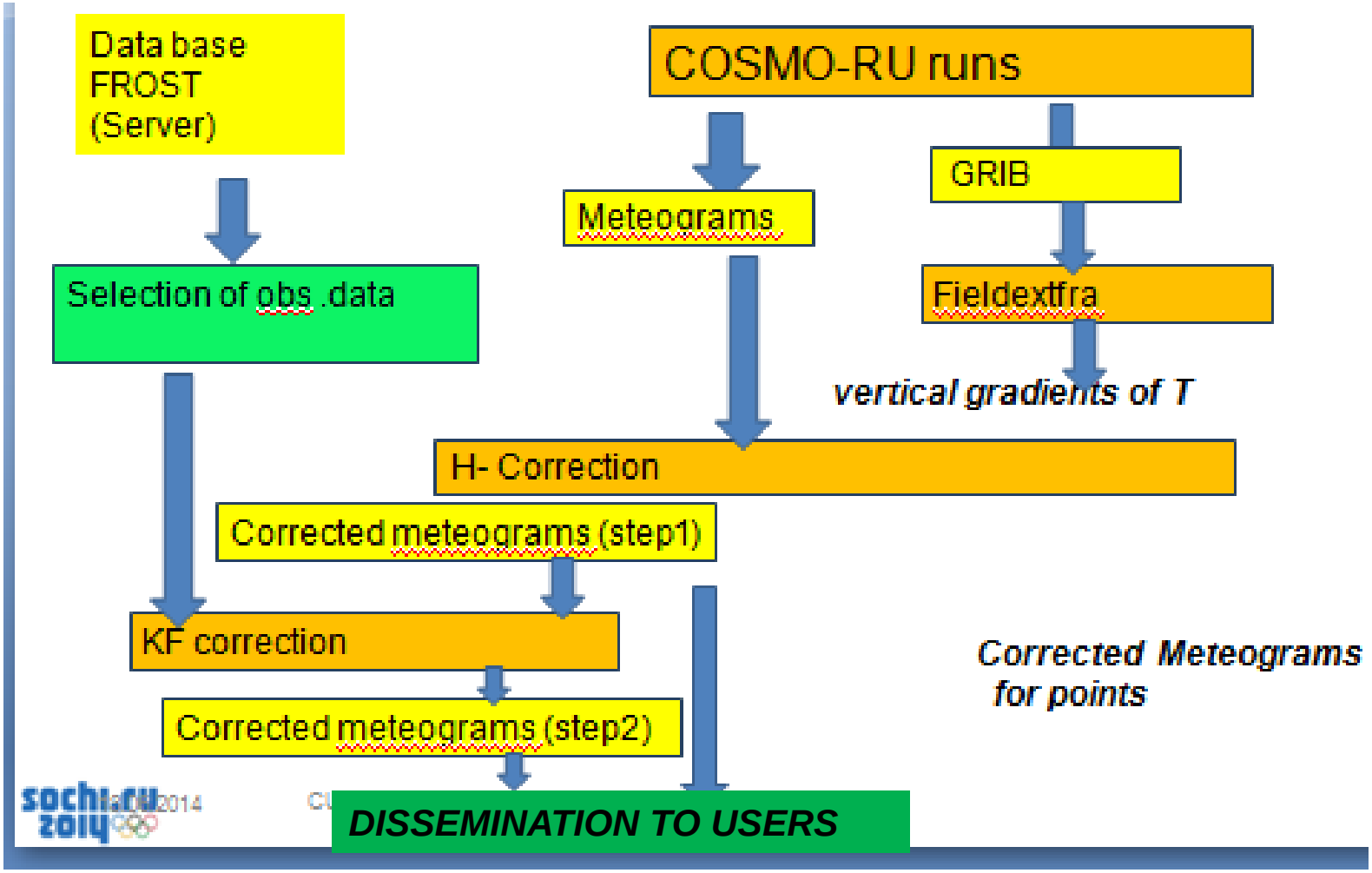






12 UTC

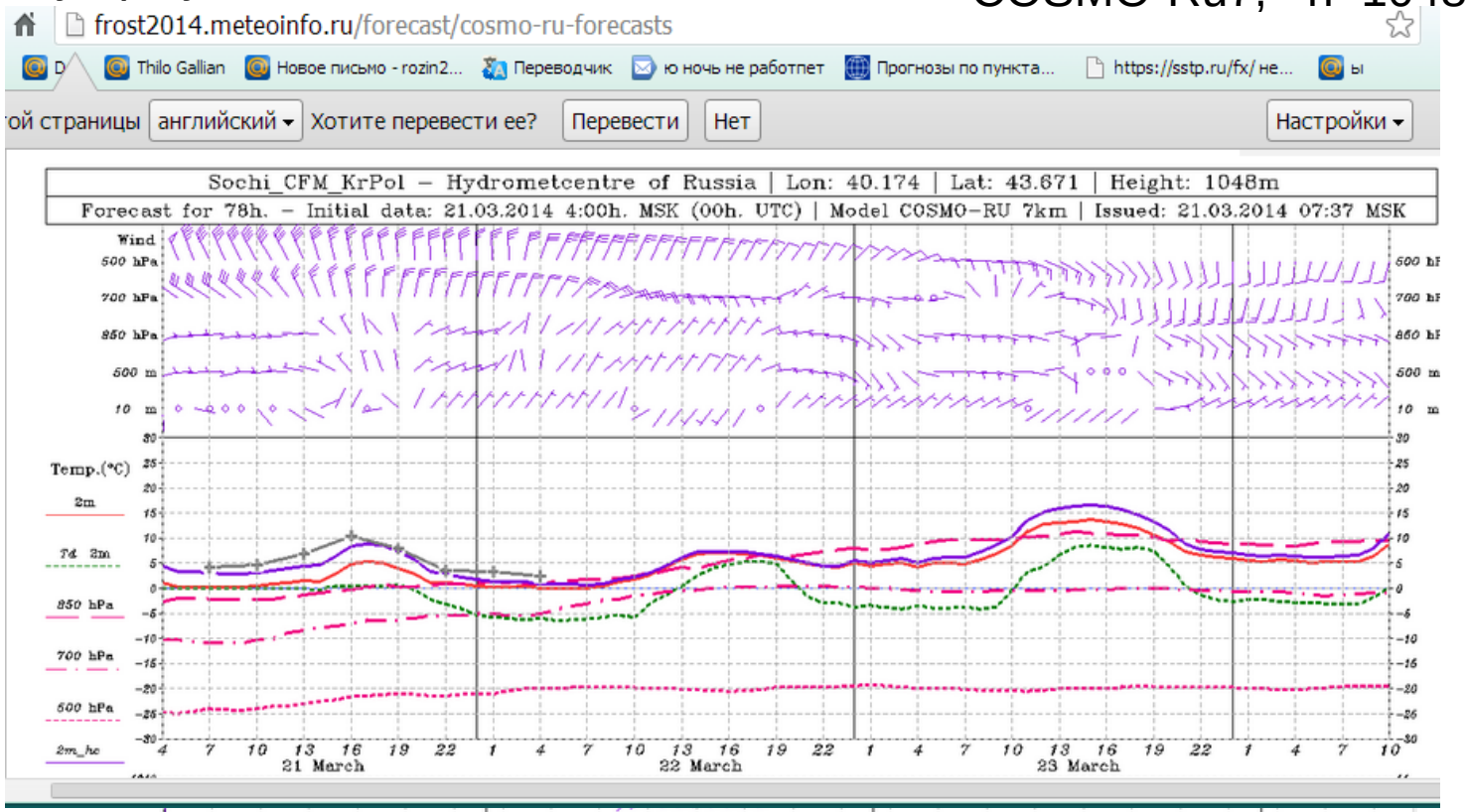
The 2-step correction : realization for the Sochi-2014 meteorological support



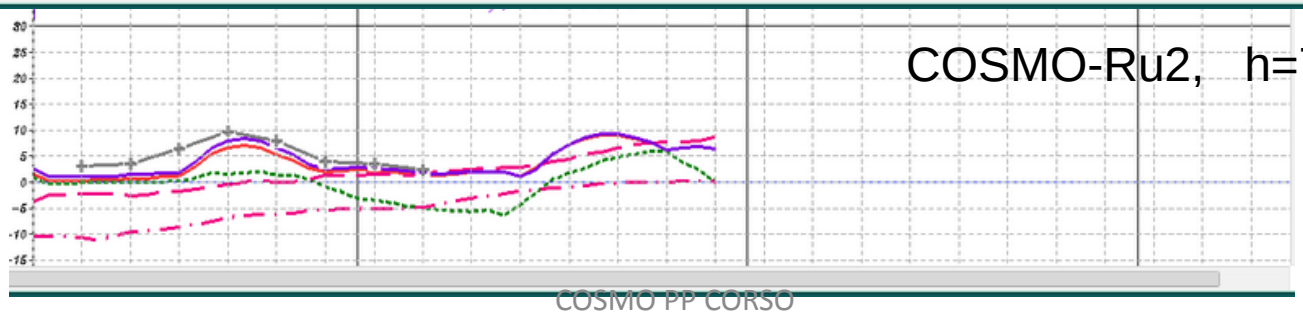
An example of meteograms with corrected T (violet)

Krasnaya polyana, h=650 m

COSMO-Ru7, h=1048 m

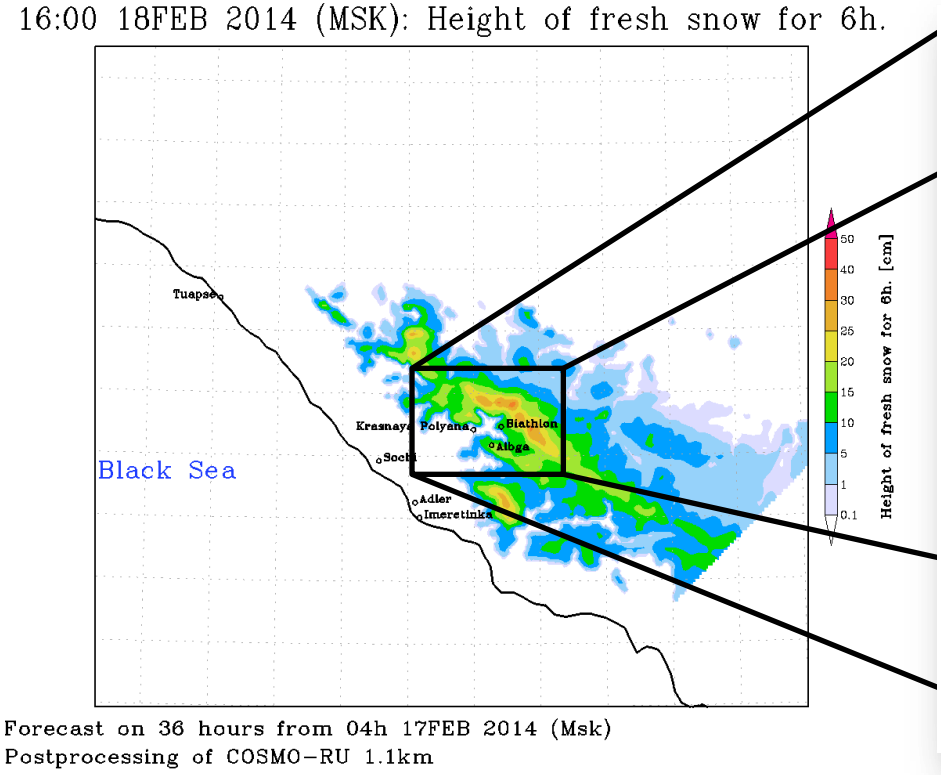


COSMO-Ru2, h=734 m

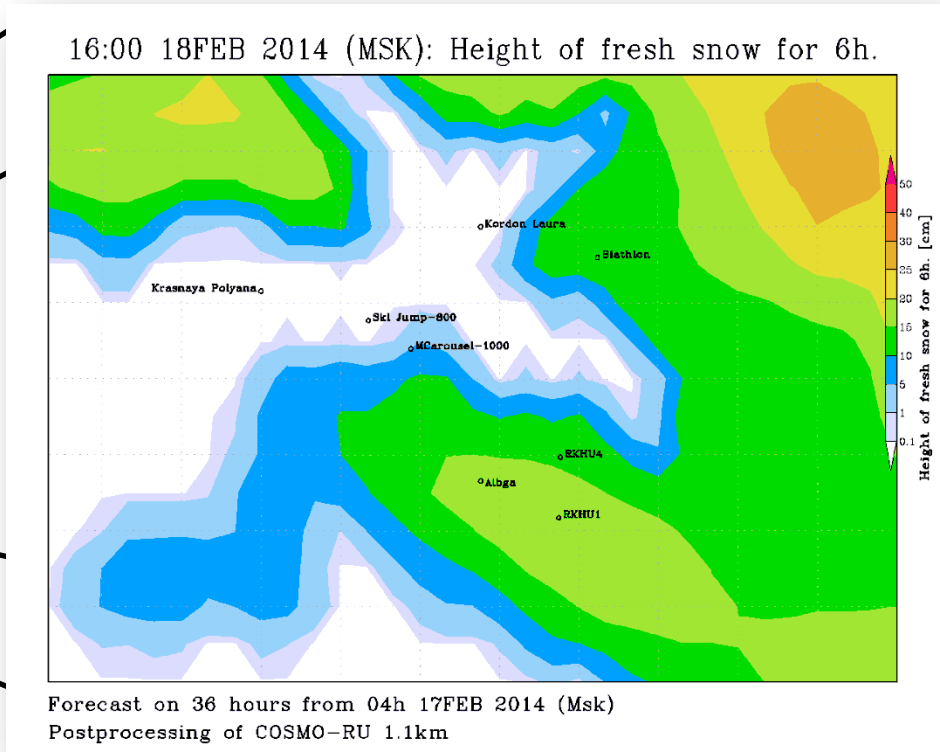


PP CORSO: Development of postprocessing: new products

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



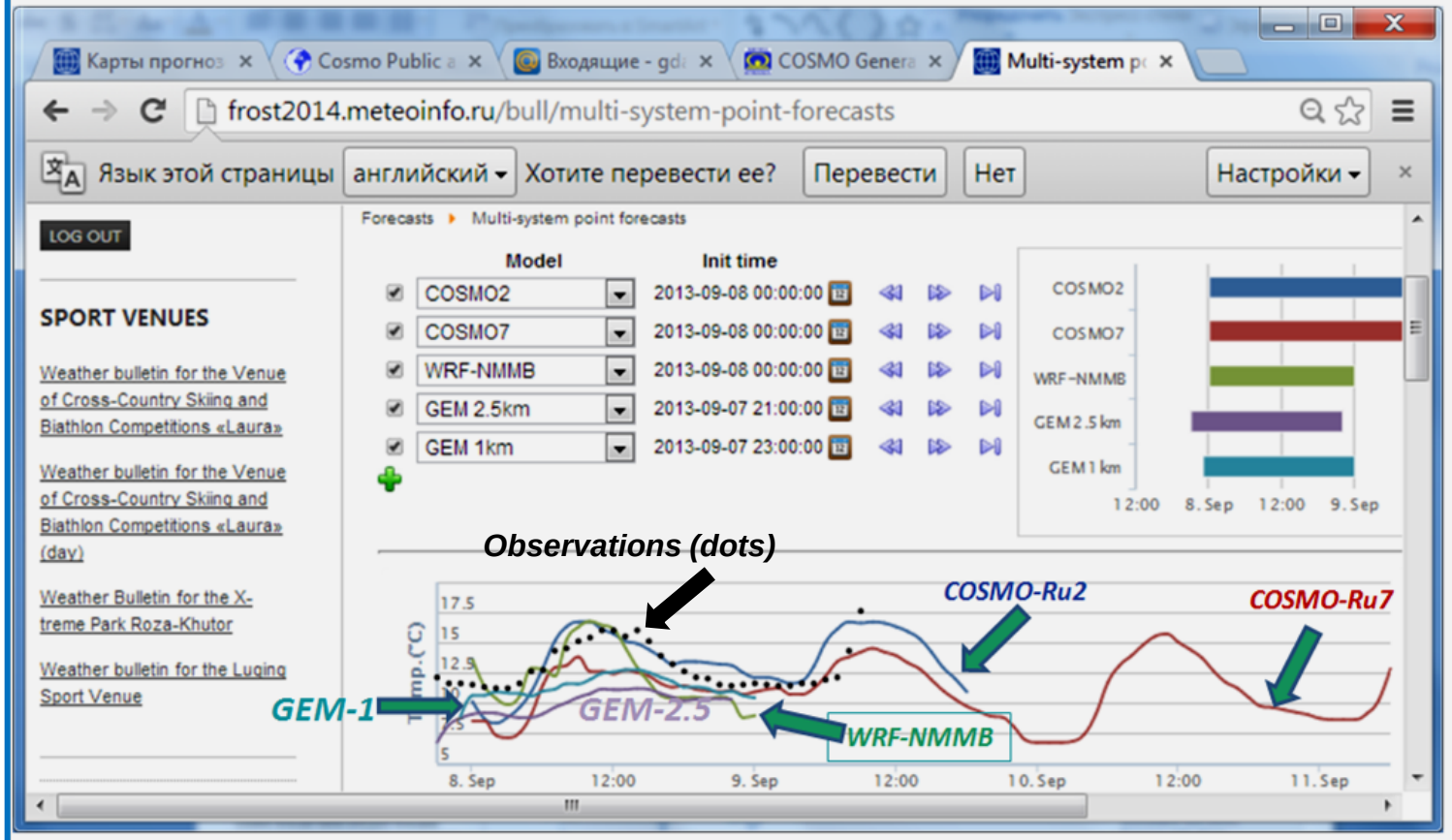
Forecast on 36 hours from 04h 17FEB 2014 (Msk)
Postprocessing of COSMO-RU 1.1km

COSMO as a participant of WWRP FDP/RDP FROST-2014:

comparing COSMO-Ru7 /2 with observations and others forecasting systems

Synop - Krasnaya Polyana (Sochi-2014, Height – 565 m), 2013-09-06-00

COSMO-Ru2, COSMO-Ru7, USA: WRF-NMMB, Canada: GEM-2.5, GEM-1



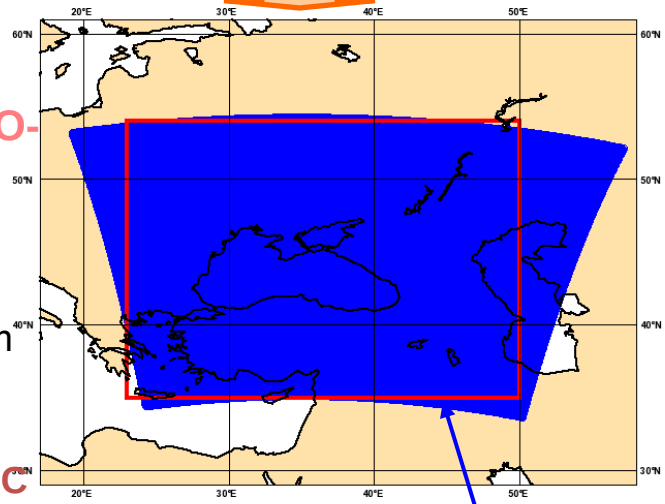
From site WMO project FROST (PL – Dmitry Kiktev):

http://frost2014.meteoinfo.ru

Task3 PP CORSO: Ensemble prediction-2 EPSs for Sochi2014

ECMWF EPS forecasts

Clustering+ COSMO-LEPS for Sochi 2014



FDP

COSMO-S14-EPS

Δx~7 km
40 ML
fc+72h

ARPA-SIMC

All 10 forecasts for Sochi-mini Probability fields for the entire domain

RHMC

Preparation of epsgrams
Visualization
Operational dissemination
Forecasters' feedback

Operational runs Dec 2011 – April 2014

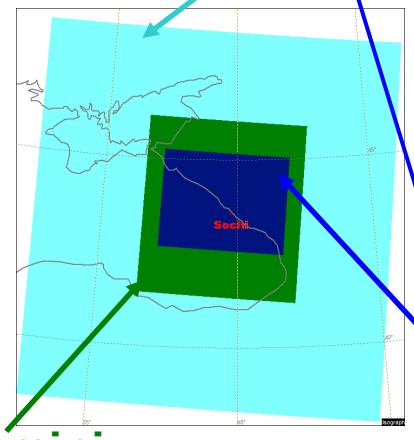
ICs&BCs

RDP

COSMO-RU2-EPS

Δx~2.2 km
50 ML
fc+48h

RHMC



RHMC

Visualization
Case studies

Operational runs Nov2013-April 2014

COSMO-RU2- EPS provided operational forecasts during the Olympics

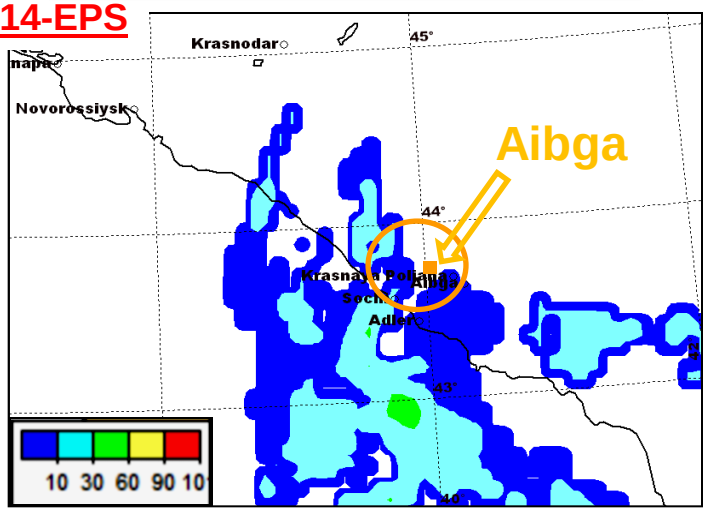
Integration domains

Sochi-mini

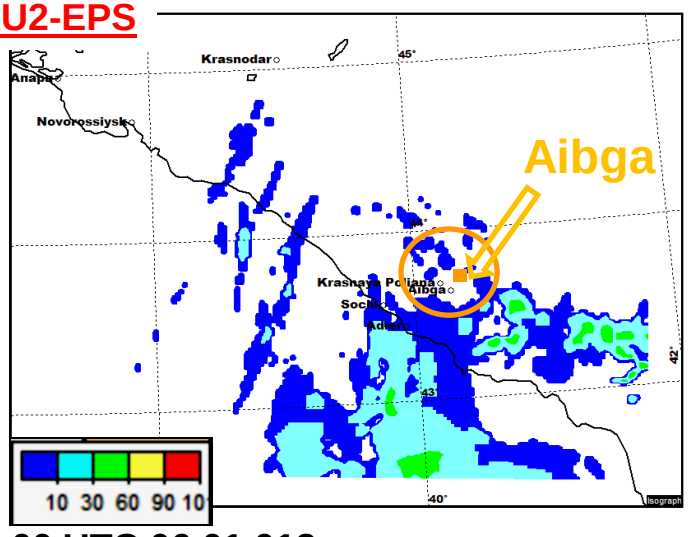
Higher-resolution EPS adds value:

Probability of total recipitation exceeding 10 mm / 12 h

COSMO-S14-EPS

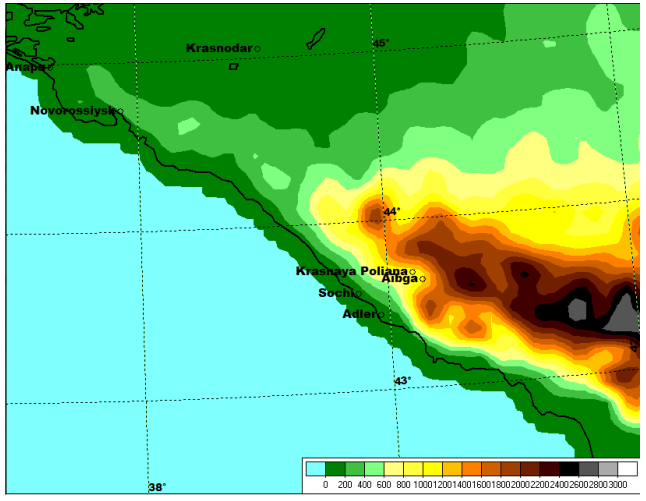


COSMO-RU2-EPS

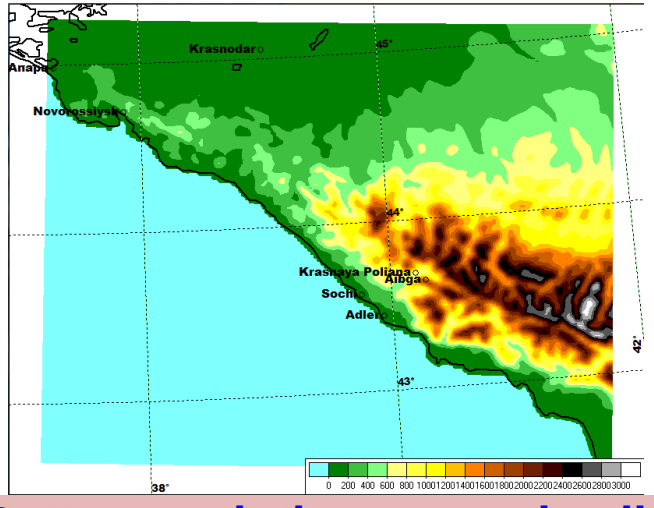


Model orography

7 km



2.2 km



Initial time: 00 UTC 06.01.013

Forecast period: 00 UTC 07.01.2013 - 12 UTC 07.01.2013

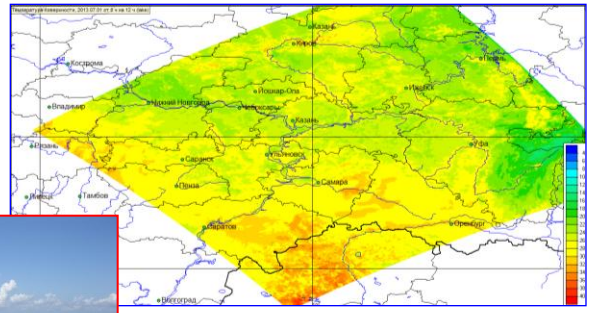
Better resolution, more details
Is most evident for small probabilities

Successful application of CORSO technologies for the meteorological support of Kazan Universiade, 5-17 July 2013

UNIVERSIADE KAZAN 2013 RUSSIA

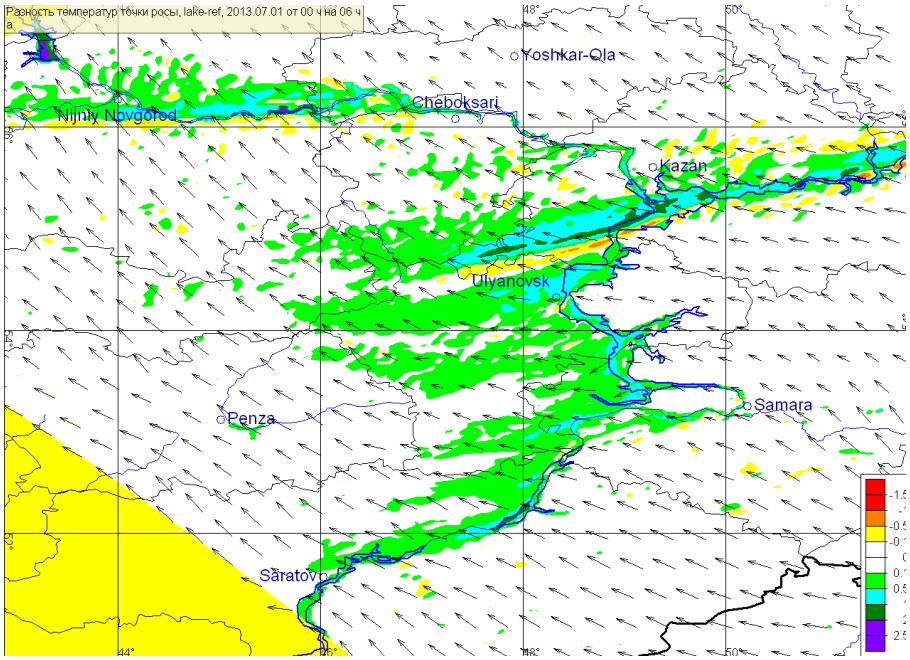
COSMO-Ru2 technology was implemented for the Kazan region and the Universiade forecasters got high–resolution numeric weather forecasts

COSMO-Ru2 (420x470) domain for Universiade Kazan-2013



*Kuibyshev reservoir is the **third largest artificial reservoir in the world**.*

To take into account the effect of numerous water reservoirs in the Volga area, the lake parameterization (Flake) was introduced to COSMO-Ru



Dew point temperature difference between Flake and reference experiments, f+06, init: 2013.07.01, 00 UTC

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 CONCLUSION

- 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