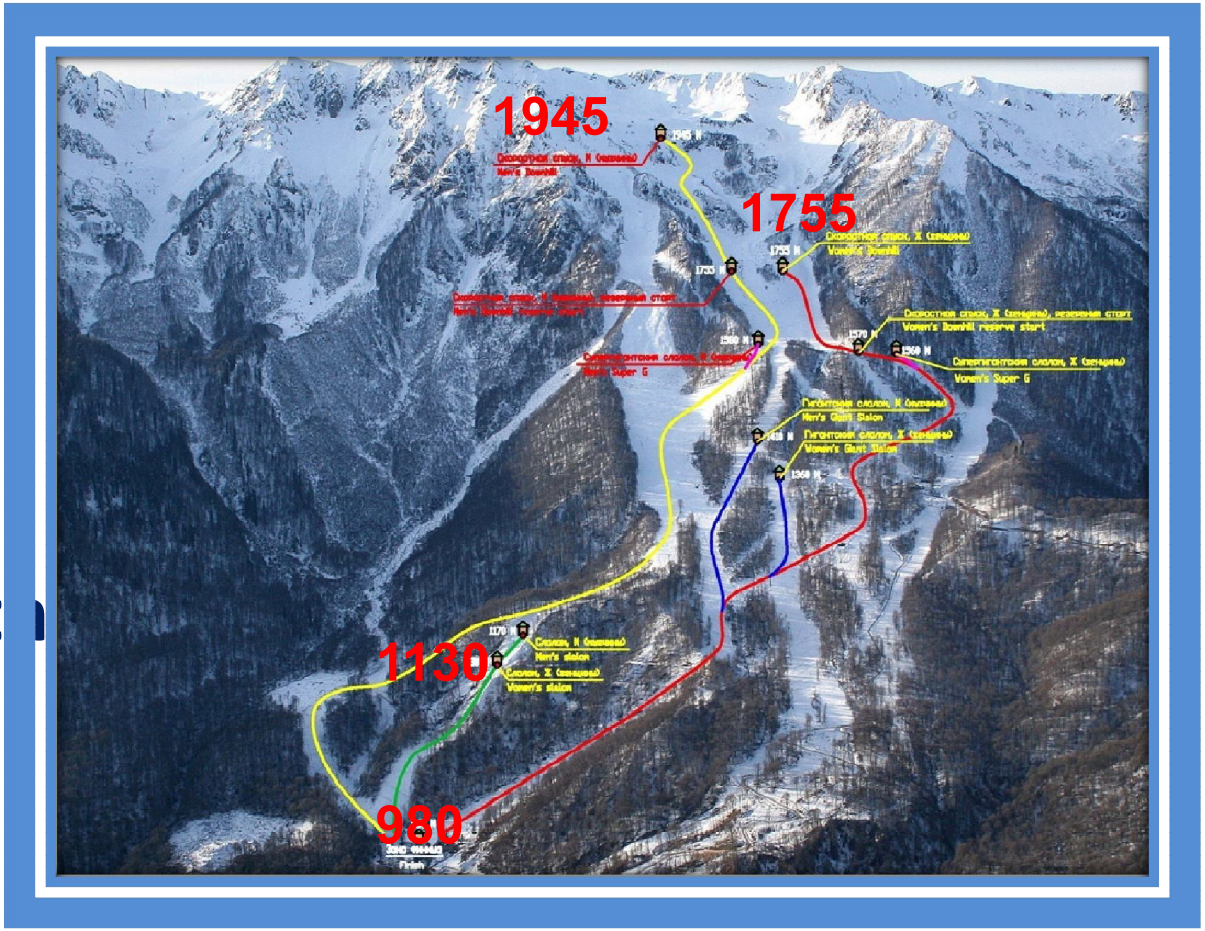
# COSMO Project

## CORSO:

**C**onsolidation of
**O**perational and
**R**esearch results for t
**S**ochi
**O**lympics -2014




*Gdaly Rivin, Inna Rozinkina*

*Hydrometeorological centre of Russia (Roshydromet)*

*and many our colleagues*

# CONTENTS

# CONTENTS

# WHY IS NECESSARY THE PRIORITY PROJECT CORSO?

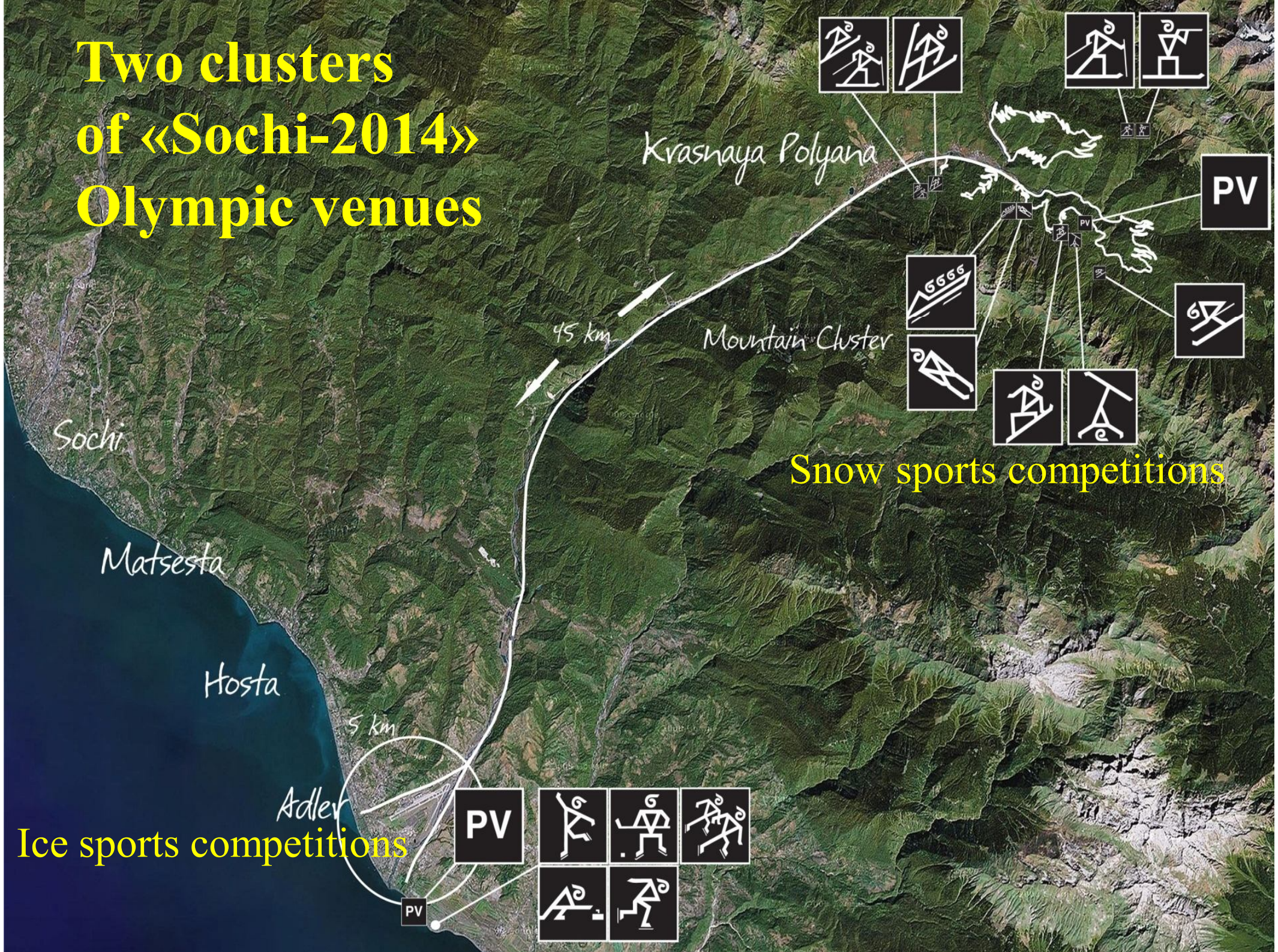
1. **Complex geographical conditions:**
   - **sea - land winter T differences**
   - **high mountains near cost**
   - **the area of venues is located near boundary snow and/or fractional cover**

2. **Insufficient density of network of measurements**

3. **The significant part of winter weather processes is due the local orography**

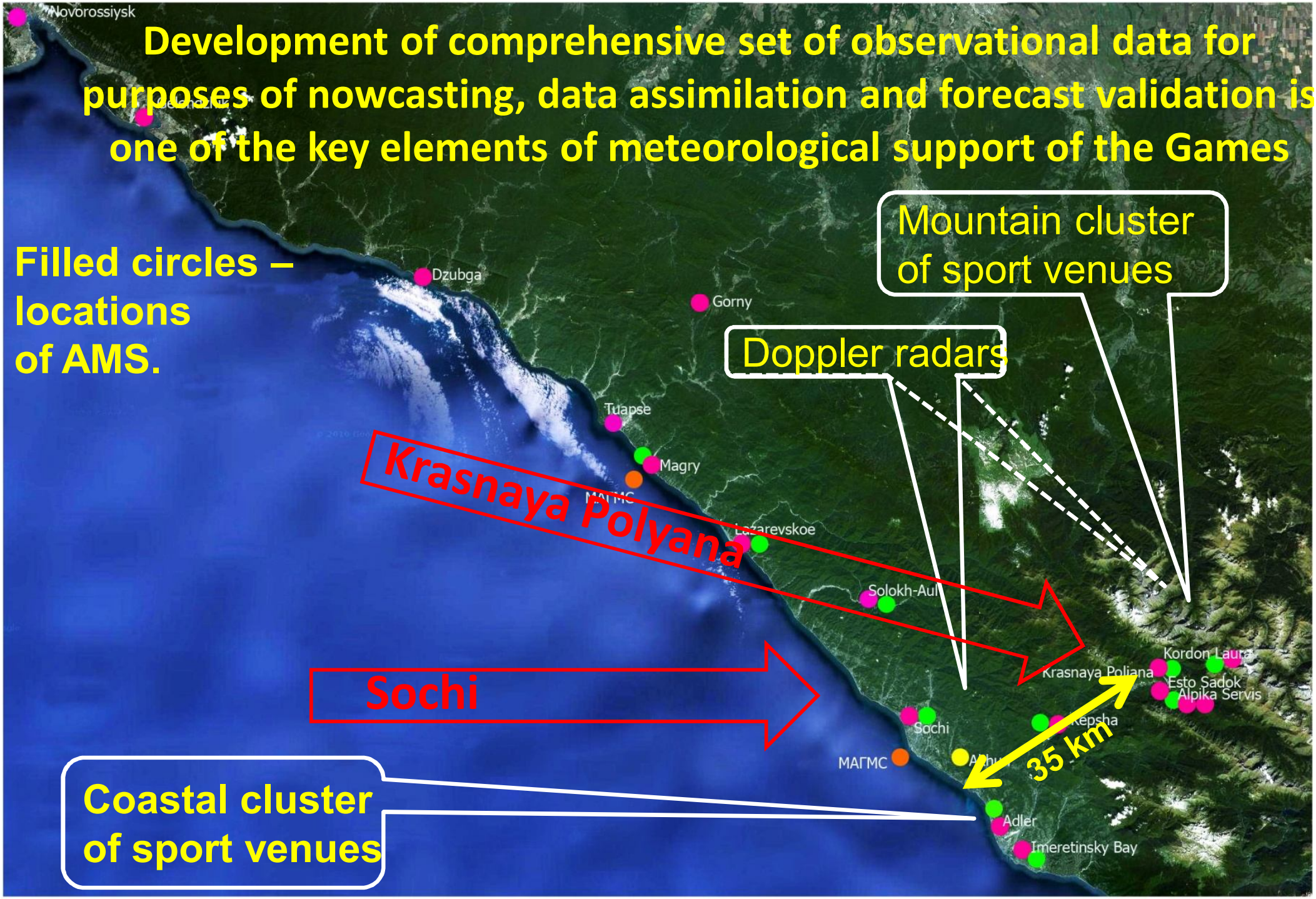
4. **The level of skill of forecasts for T2m and precipitation must be better**

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


Two clusters
of «Sochi-2014»
Olympic venues
Krasnaya Polyana
PV
45 km
Mountain Cluster
Sochi
Matsesta
Hosta
5 km
Adler
PV
Snow sports competitions
Ice sports competitions
PV

# Weather contrasts:

## two photos taken on March 2–3, 2009 at the coastal and mountain clusters


Development of comprehensive set of observational data for purposes of nowcasting, data assimilation and forecast validation is one of the key elements of meteorological support of the Games
Filled circles – locations of AMS.
Mountain cluster of sport venues
Doppler radars
Krasnaya Polyana
Sochi
Coastal cluster of sport venues
35 km
Novorossiysk
Dzubga
Gorny
Tuapse
Magry
Lazarevskoe
Solokh-Aul
Kordon Laura
Krasnaya Poliana
Esto Sadok
Alpika Servis
Sochi
МАГМС
Adler
Imeretinsky Bay

# COSMO - METEOROLOGICAL SUPPORT FOR OLYMPICS "SOCHI-2014"

**COSMO Perspective 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***

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


**Project web-site**
**http://frost2014.meteoinfo.ru**

## WWRP RDP/FDP FROST-2014 activities in 2011/2012

**(FROST: Forecast and Reseach – Olympic Sochi Testbed)**

**Dmitry Kiktev**
**Hydrometcentre of Russia / Roshydromet**

**16 April 2012, Moscow**

## *WHAT IS MOST IMPORTANT TO INCREASE THE SKILL OF COSMO-FORECASTS FOR SOCHI-REGION?*

- *To improve the near-surface (first - T2m) forecasts:*
  - *- TERRA development*
  - *- Regional DAS implementation*
  - *- Snow-cover assimilation*
- *To increase the model resolution (orographic effects)*
- *To develop the probabilistic forecasting for significant weather phenomena*
- *To develop the statistical postprocessing with small training period*

# PP CORSO

## 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 (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

**T1. High resolution Modeling and DAS**
**WG1, WG2, WG3a, WG3b, 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**

# FDP & RDP CORSO DELIVERABLES

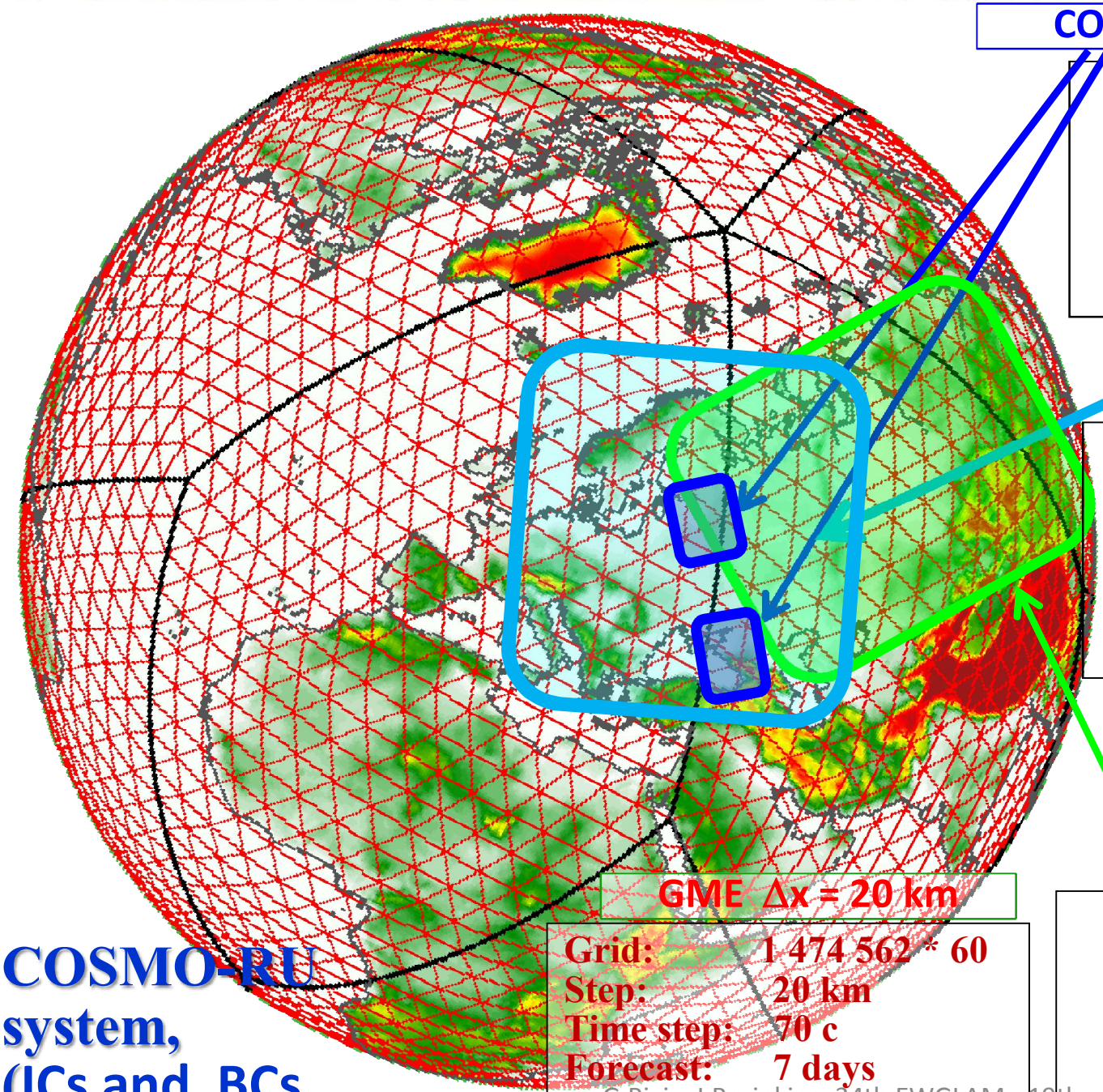
1. Increased skill of operational COSMO-RU7/So2 model for key meteorological parameters;
2. Research technology COSMO-So1 with horizontal resolution ≈ 1km;
3. Operational implementation of tools allowing the forecasting of local weather conditions in the venues, visualization support, guidelines for forecasters;
4. Adapted postprocessing techniques for winter weather conditions in sub-tropical mountain conditions and satisfying the requirements of the winter Olympics;
5. Recommendations for operational forecasters in using the high-resolution model output with special attention to possible model error spatial and temporal structures for different weather types;
6. Programming tools for object-oriented and multi-scale verification of hydrodynamic mesoscale forecasts
7. RDP: Developed weather types classification approaches, results of case studies for the Sochi2014 region;
8. *A COSMO-LEPS system with 7 km resolution adapted to the Sochi region and to specific requirements of winter Olympics (SOCHMEL7). Operational ensemble forecasts during the Olympics. Technology of presentation and interpretation of SOCHMEL7 results in operational mode;*
9. *COSMO-RU-LEPS 2.2 km for the Sochi region (with ICs and BCs from SOCHMEL7.*

# PP CORSO

| Phase 1 | Phase 2 | Phase 3 |
|---|---|---|
| 2011 / 2012 | 2012 / 2013 | 2013 / 2014 |
| ▪ Choice of strategy<br>▪ Proposals for development and modification of algorithms<br>▪ Preliminary tests | • Tests<br>• Pre-operational running<br>• Feed-back from forecasters | • Tuning implementation<br>• Operational runs<br>• Analysis of results |

***All algorithms must be implemented very fast, based the previous experience of COSMO-countries (incl. know-how for mountain forecasting)***

# CONTENTS



**COSMO-RU2 Δx =2.2 km**

| | |
|---|---|
| Domain: | 900 km * 1000 km |
| Grid: | 420*470 * 50 |
| Step: | 2.2 км |
| Time step: | 15 c |
| Forecast: | 24 h |
| Cores: | 800 |

**COSMO-RU7 Δx = 7 km**

| | |
|---|---|
| Domain: | 4900 km * 4340 km |
| Grid: | 700*620 * 40 |
| Step: | 7 km |
| Time step: | 40 c |
| Forecast: | 78 h |
| Cores: | 800 |

**GME: initial and boundary data**

**COSMO-RUsib Δx =14 km**

| | |
|---|---|
| Domain: | 5000 km * 3500 km |
| Grid: | 360*250 * 40 |
| Step: | 14 km |
| Time step: | 80 c |
| Forecast: | 78 h |
| Cores: | 48 |

**GME Δx = 20 km**

| | |
|---|---|
| Grid: | 1 474 562 * 60 |
| Step: | 20 km |
| Time step: | 70 c |
| Forecast: | 7 days |

**COSMO-RU system, (ICs and BCs from GME)**

# Forecast system COSMO-RUO7/02

## 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)

# CONTENTS

# CORSO Task 1

## "High resolution COSMO model development for mountainous regions" *(Roshydromet, DWD, MeteoSwiss, ARPA-SIMC)*

**1.1: Improvement of technology of deterministic forecasting of weather conditions with model resolution 2.2 km for the North-Caucasian area (SOCHI-2014)**

**1.2: Development of COSMO-So-1km**

**Deliverables:**

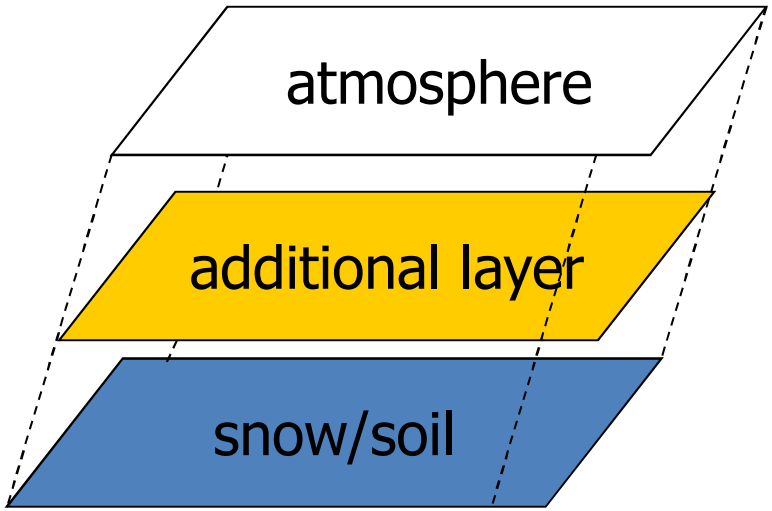
**FDP:** ***Improved operational numerical deterministic forecasts for Sochi-2014 area. Increased skill of operational COSMO-RU7/So2 model for key meteorological parameters.***

**RDP:** ***Research technology COSMO-So1 with horizontal resolution ≈ 1km. Adapted EUMETSAT software for snow-map with high resolution.***

# Snow aspects

## *A. TERRA Modification*

Motivation: The Systematic underestimation of T2m in snow conditions in area of forests or fractional snow cover.




The simplest parameterization for T for additional free-snow artificial transparent level (canopy, tree trunks, rocks) was added into TERRA.

T of this level can be determined from energy balance equation:

$B_{SW}+B_{LW} = H\uparrow+H\downarrow$

So, additional layer should get some heat to the upper atmosphere and increase T2m.

Experiment was done for territories covered with snow.
Operational version of COSMO-Ru (version 4.18) was used.

# The modification of TERRA: Differences between T2m forecasts with/without use the additional snow-free (canopy) level over land surface (T2м, lead time 36 h, start 25 march 2010)

**Ivanovo**

| ctrl | exp | measured |
|---|---|---|
| -4.2 | -0.4 | 4.0 |

**Dmitrov**

| ctrl | exp | measured |
|---|---|---|
| -2.5 | 0.1 | 7.0 |

**Moscow**

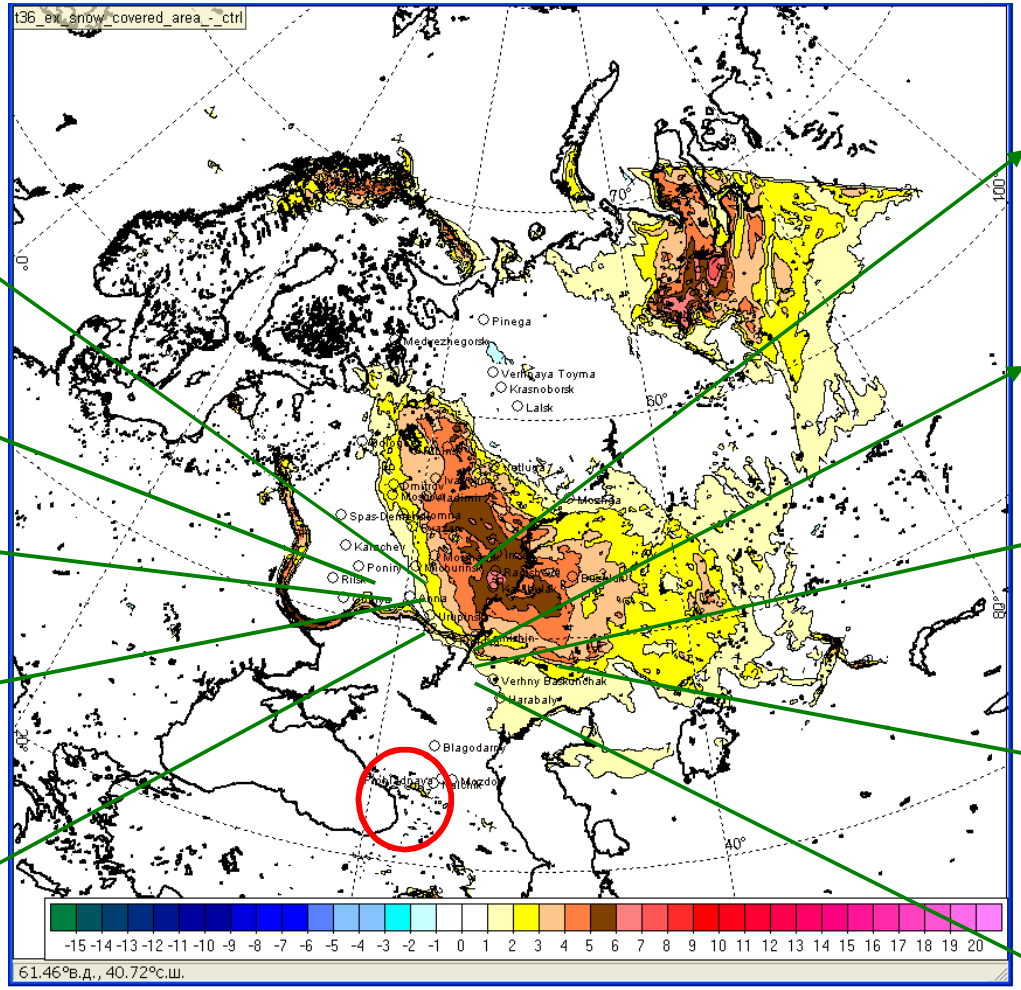
| ctrl | exp | measured |
|---|---|---|
| -2.3 | 0.1 | 8.3 |

**Vladimir**

| ctrl | exp | measured |
|---|---|---|
| -4.5 | -0.5 | 3.8 |

**Ryazan**

| ctrl | exp | measured |
|---|---|---|
| -2.0 | 0.1 | 3.9 |




**Vetluga**

| ctrl | exp | measured |
|---|---|---|
| -3.8 | -1.0 | 0.4 |

**Inza**

| ctrl | exp | measured |
|---|---|---|
| -5.3 | 0.0 | 1.0 |

**Radishevo**

| ctrl | exp | measured |
|---|---|---|
| -6.3 | -0.4 | 0.7 |

**Buzuluk**

| ctrl | exp | measured |
|---|---|---|
| -5.0 | -0.4 | -0.6 |

**Karabulak**

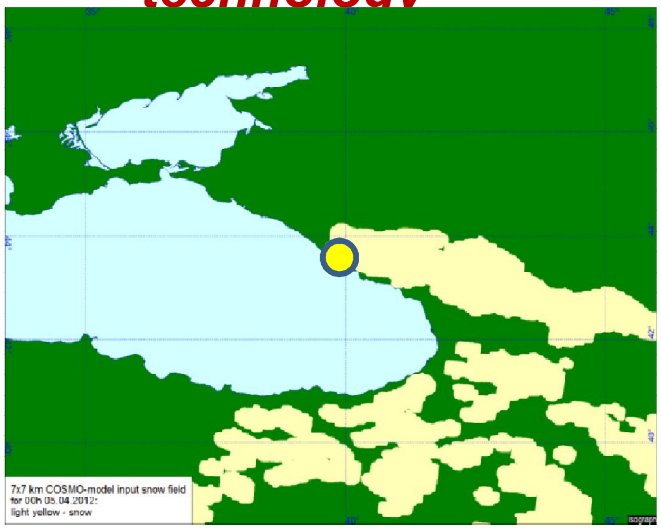
| ctrl | exp | measured |
|---|---|---|
| -6.6 | -0.3 | -2.4 |

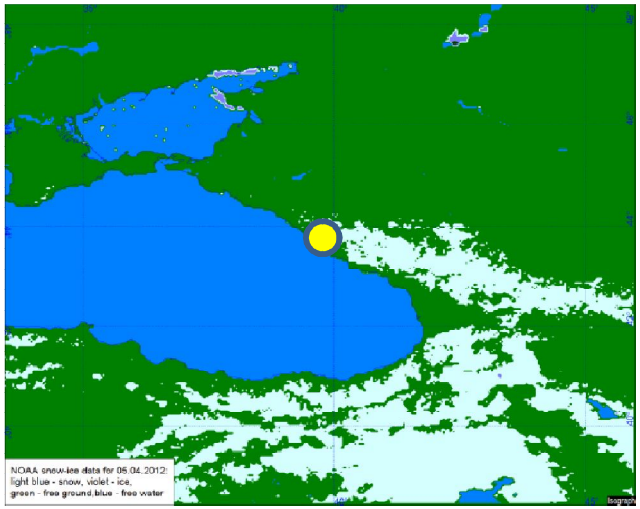
*The jobs will be completed by 2013*

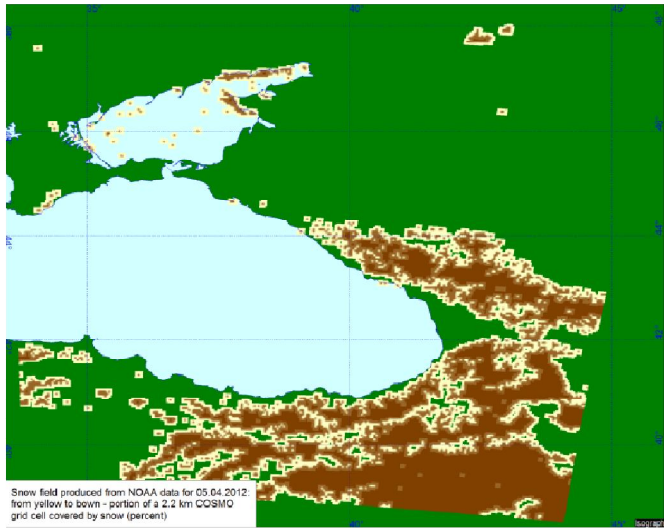
*The maximal effect was obtained for the snow-covered area for sunny days*

## B. *Pre-operational technology for Snow OA with flexible resolution based on available NOAA multisensory snow cover maps information (http://satepsanone.nesdis.noaa.gov):*

***preliminary stage before of the development of the EUMETSAT technology***



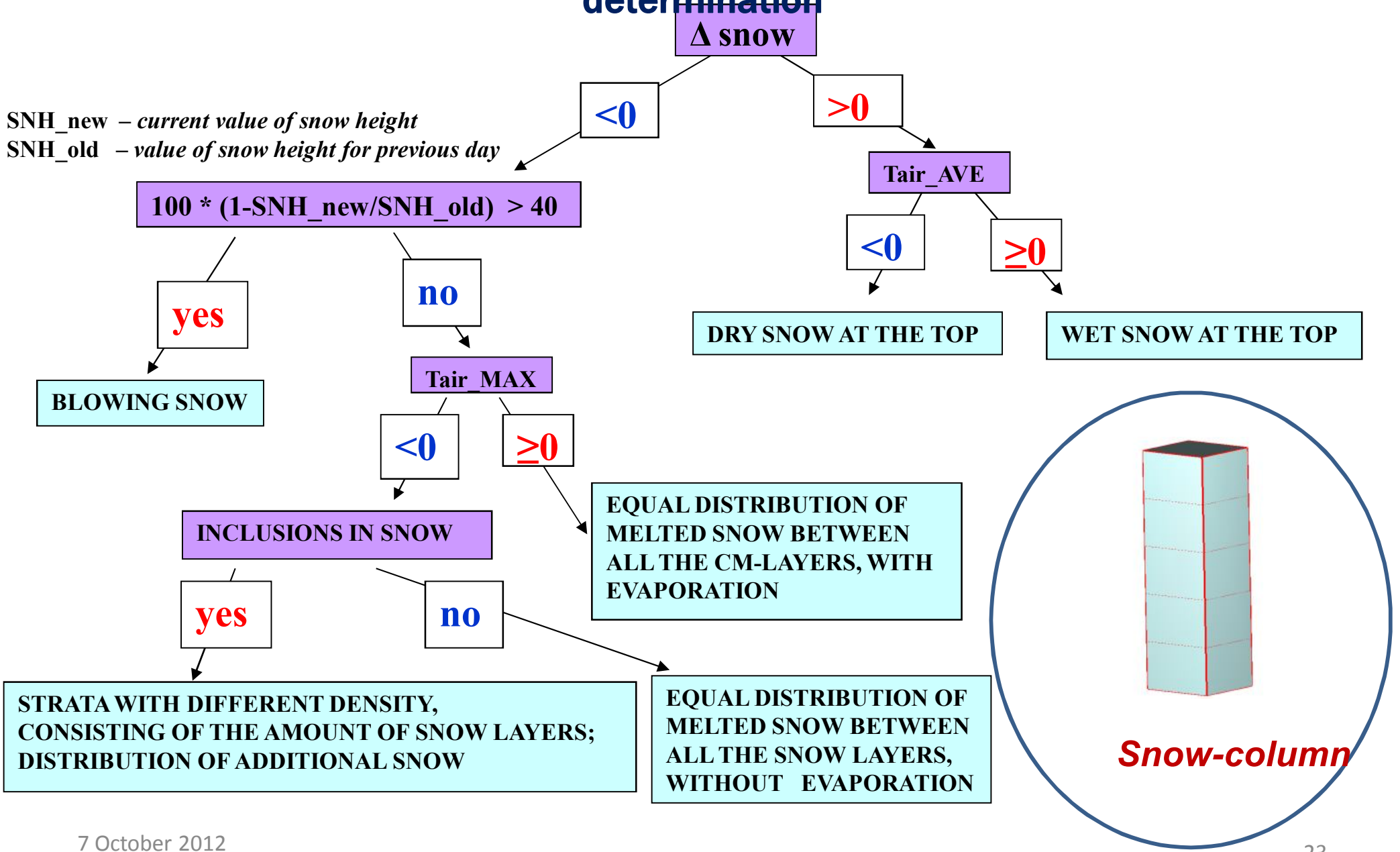

**COSMO snow field on a 20 km grid from GME for 05.04.2012 (old initial data for COSMO-Ru07/02)**

**Input NOAA multisensor snow/ice cover product on 4 km grid**

**output:**
**Snow field for COSMO model 2.2 km produced from NOAA data**
**(new initial data for COSMO-Ru07/02)**

# c. The multi-level 1-d snow model, based on the SYNOP-input – For WE determination

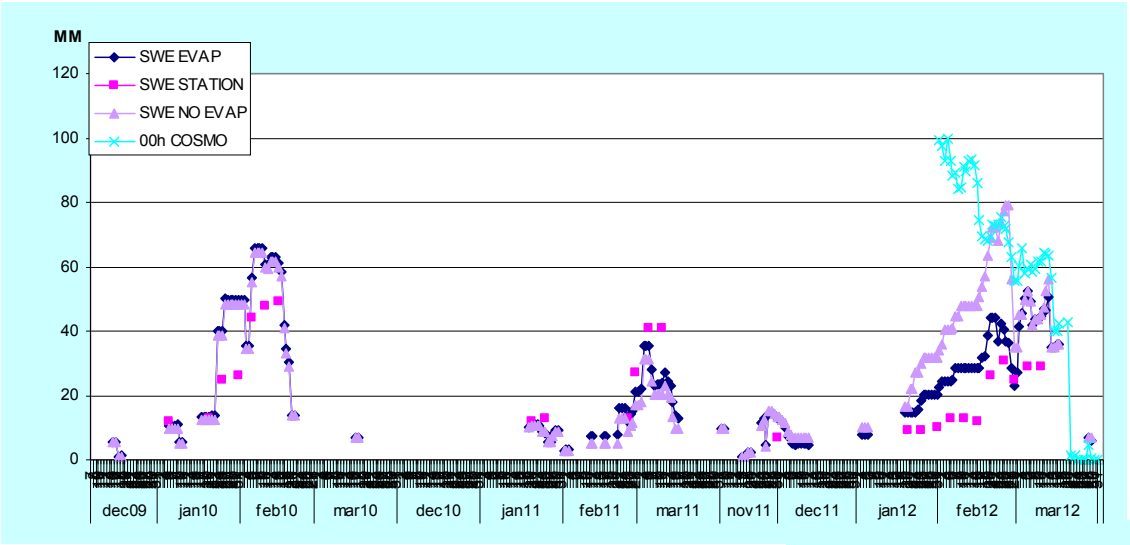
SNH_new – *current value of snow height*
SNH_old – *value of snow height for previous day*



## C. The multi-level 1-d snow model, based on the SYNOP-input (end)

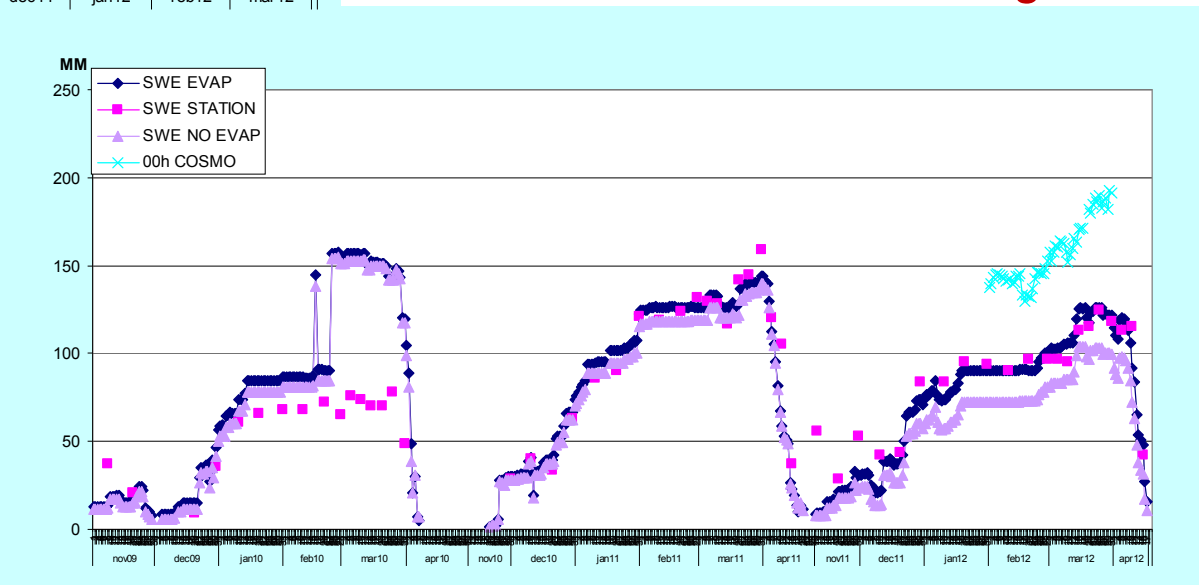
# Example of simulation of snow WE for different of stations of Russia (Nalchik, Vetluga) during the winters 2009/10, 2010/11, 2011/12

*Nalchik*

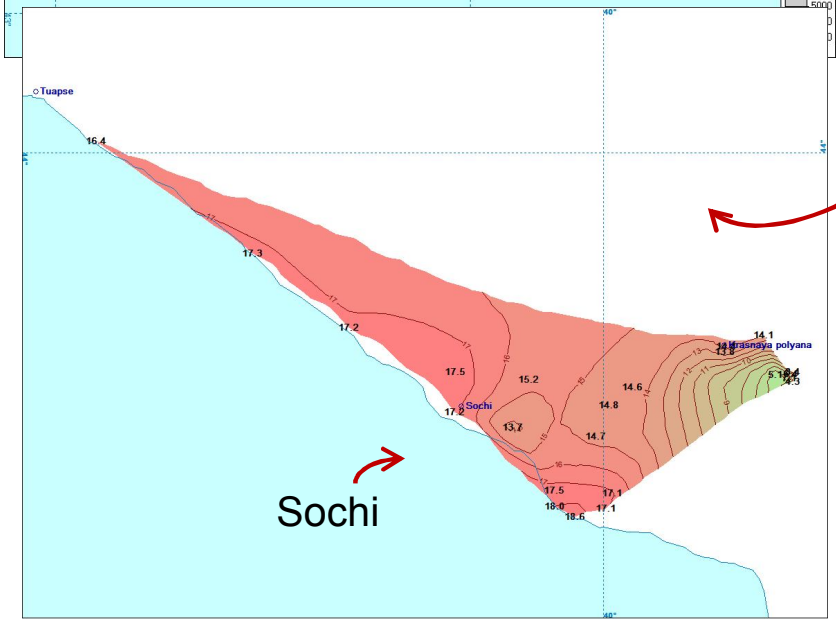



Calculations
Measurements
Data from DAS of GME

*Vetluga*



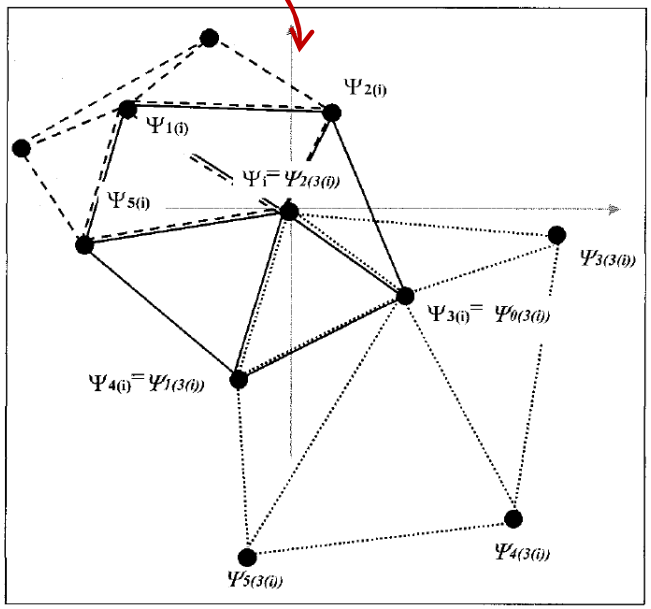
# Data quality control


We'll reproduce VERA quality control based on a method described in

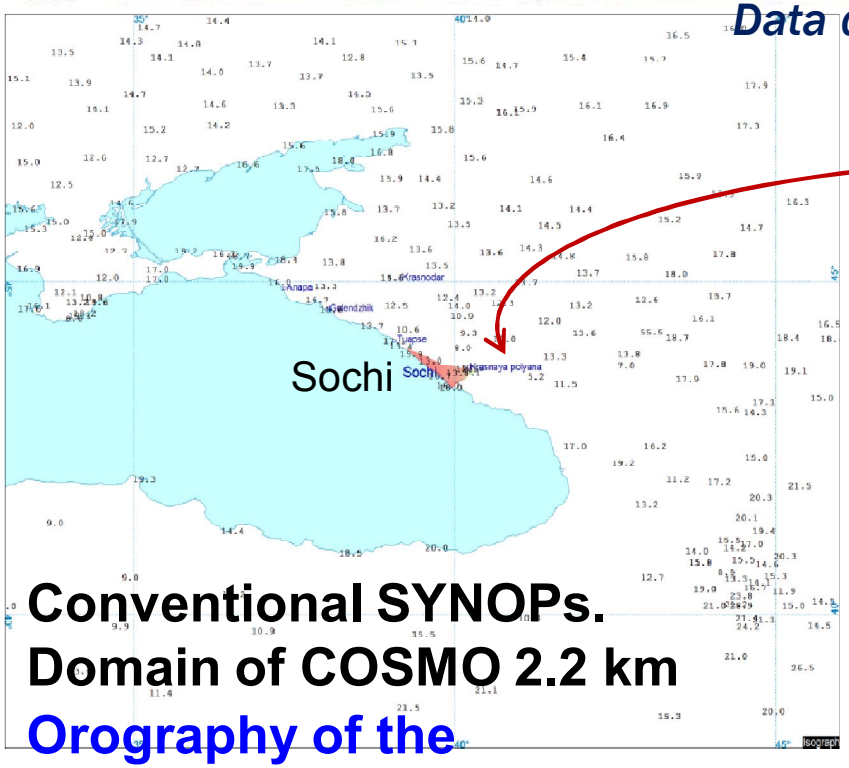
*Steinacker, R. et al., 2000: A Transparent Method for the Analysis and Quality Evaluation of Irregularly Distributed and Noisy Observational Data. MWR., 128, 2303 – 2316.*

To use this method we must build pentagonal structures like these



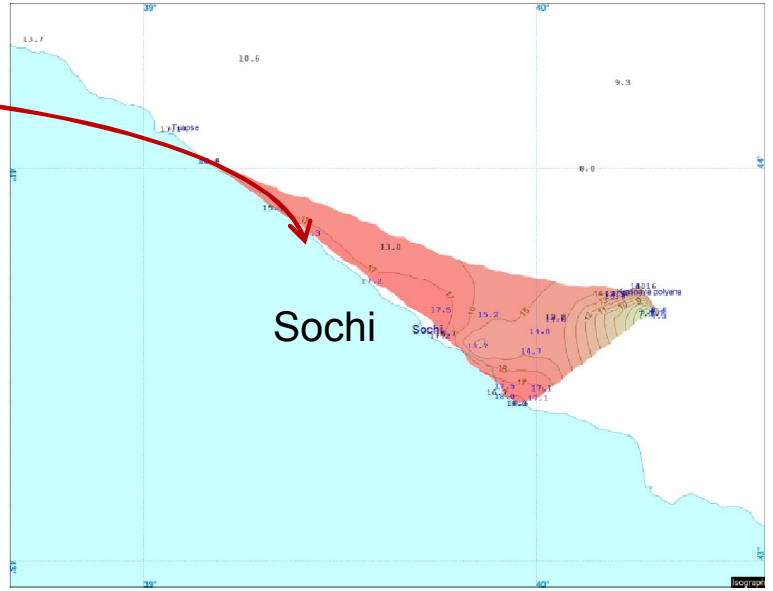

Not enough data from new stations for this process. So these data should be considered together with conventional SYNOPs from GTS

## *Data quality control (continue)*




**Conventional SYNOPs.**
**Domain of COSMO 2.2 km**
**Orography of the COSMO 2.2 km domain**


**Domain of new stations opened for Sochi-2014**




**Algorithm of a choice of influencing stations is based on Delaunay triangulation used in graphic system:**

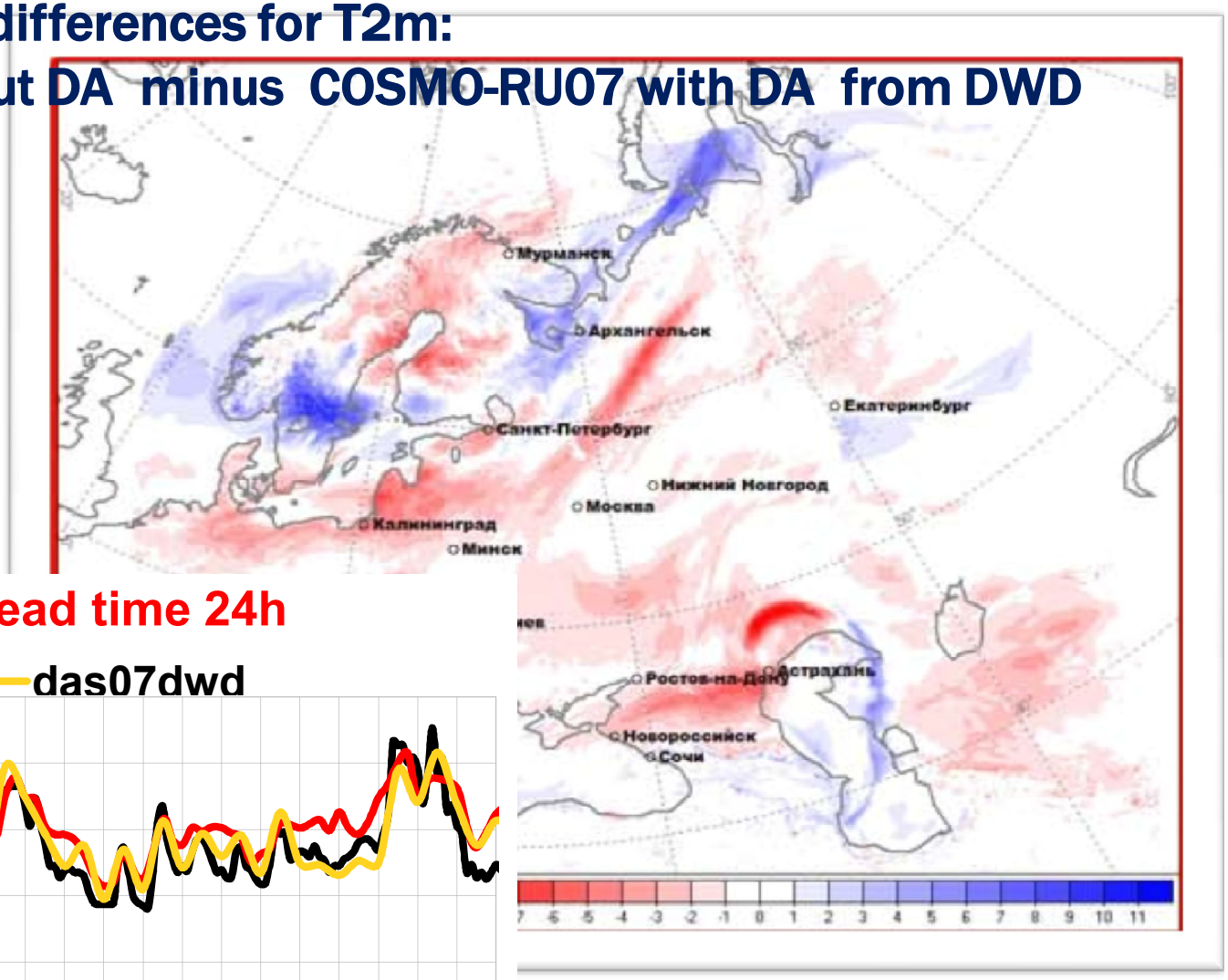
***Kopeikin, V., Yu. Alferov, 2011: Construction of isolines on an scatter points network within the graphic system Isograph framework. Proc. of Hydrometcentre of Russia, 346, 62 – 75 (in Russian).***

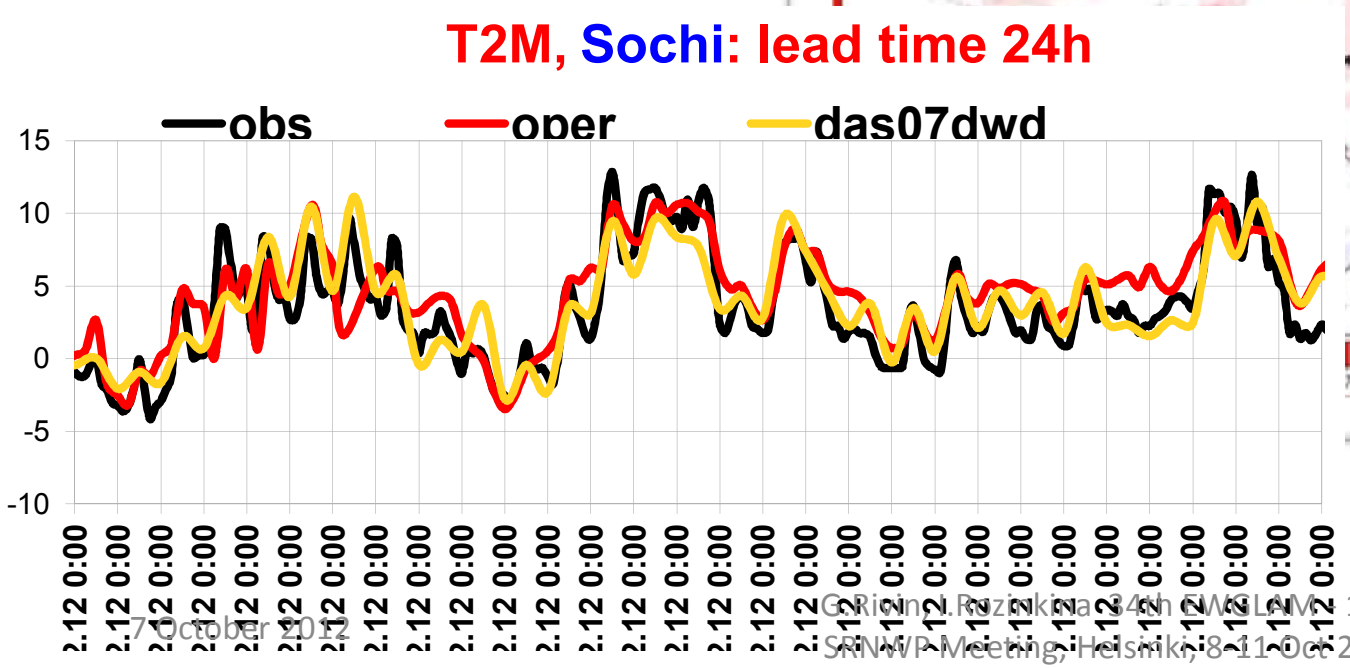
**The beginning of work on quality control - July 2012**

# DAS Nudging development:

## Results of comparison of the differences for T2m:
## COSMO-RU07 without DA minus COSMO-RU07 with DA from DWD

***The must significant differences was obtained in the T2m fields***



# Development of DA- nudging for COSMO-Ru7/So2 (as is it used in COSMO-countries) based on the available measurements (first the SYNOP and TEMP), COSMO software and methodical consultations of COSMO WG1.

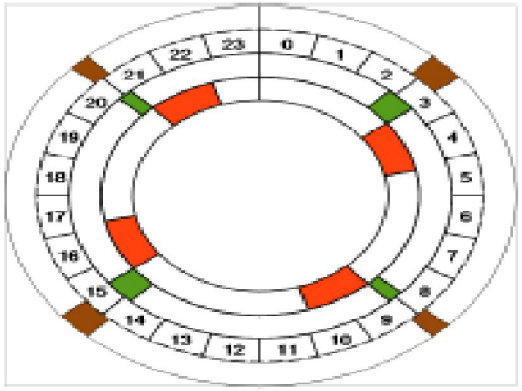
**Download GME**

| | 00UTC | 06UTC | 12UTC | 18UTC |
|---|---|---|---|---|
| Start | 02:50 | 08:50 | 14:50 | 20:50 |
| End | 03:25 | 09:10 | 15:25 | 21:10 |
| Time work | 00:35 | 00:20 | 00:35 | 00:20 |

## OLD scheme

| 00 | 06 | 12 | 18 | RU07 |
|---|---|---|---|---|
| 02:50 | 08:50 | 14:50 | 20:50 | Start (UTC) |
| 03:30 | 09:10 | 15:30 | 21:10 | End (UTC) |
| 00:40 | 00:20 | 00:40 | 00:20 | Time work |

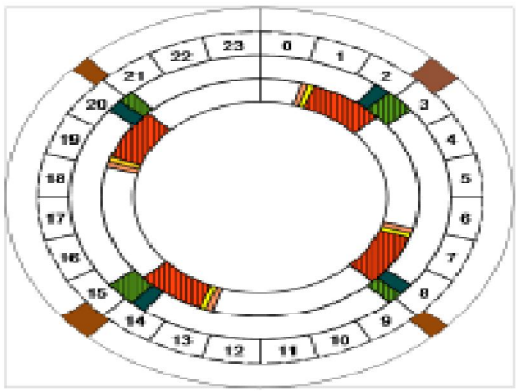
| 00 | 06 | 12 | 18 | RU02 |
|---|---|---|---|---|
| 03:30 | 09:10 | 15:30 | 21:10 | Start (UTC) |
| 05:10 | 10:50 | 17:10 | 22:50 | End (UTC) |
| 01:40 | 01:40 | 01:40 | 01:40 | Time work |



## NEW scheme with DA

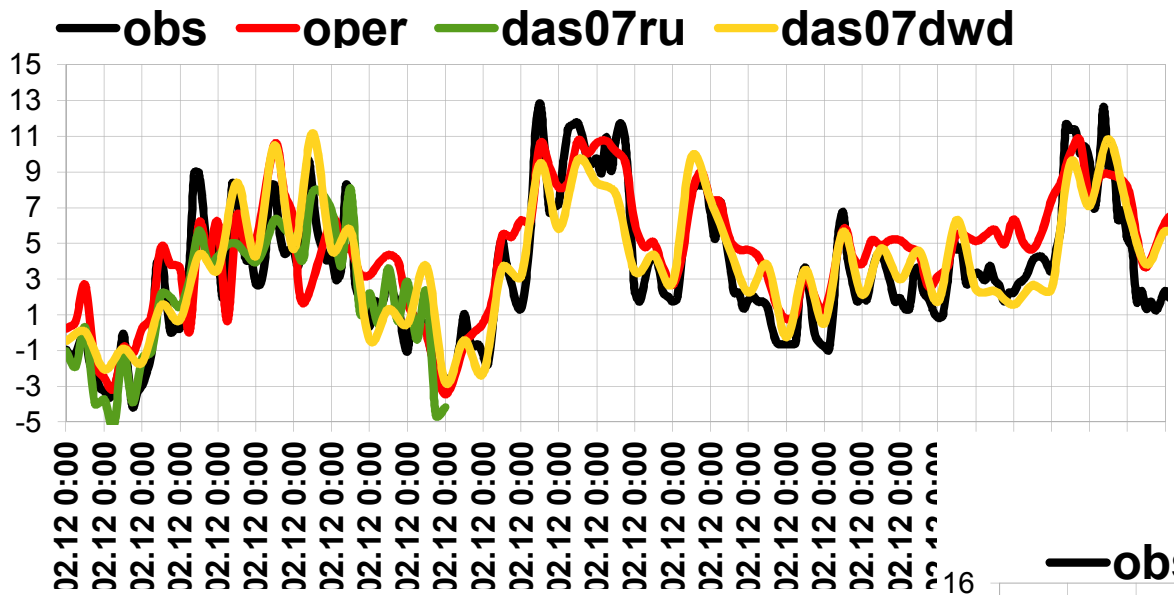
| 00 | | 06 | | 12 | | 18 | |
|---|---|---|---|---|---|---|---|
| 03:00 | 03:40 | 09:00 | 09:30 | 15:00 | 15:40 | 21:00 | 21:30 |
| 00:20 | 00:40 | 00:20 | 00:20 | 00:20 | 00:40 | 00:20 | 00:20 |

| 18 | | 00 | | | 06 | | | 12 | | | 18 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 01:00 | | 03:00 | | 07:00 | | 09:00 | | 13:00 | | | 19:00 | 21:00 |
| 00:10 | 00:10 | 01:50 | 00:10 | 00:10 | 01:40 | 00:10 | | 00:10 | 01:40 | 00:10 | 00:10 | 01:40 | |

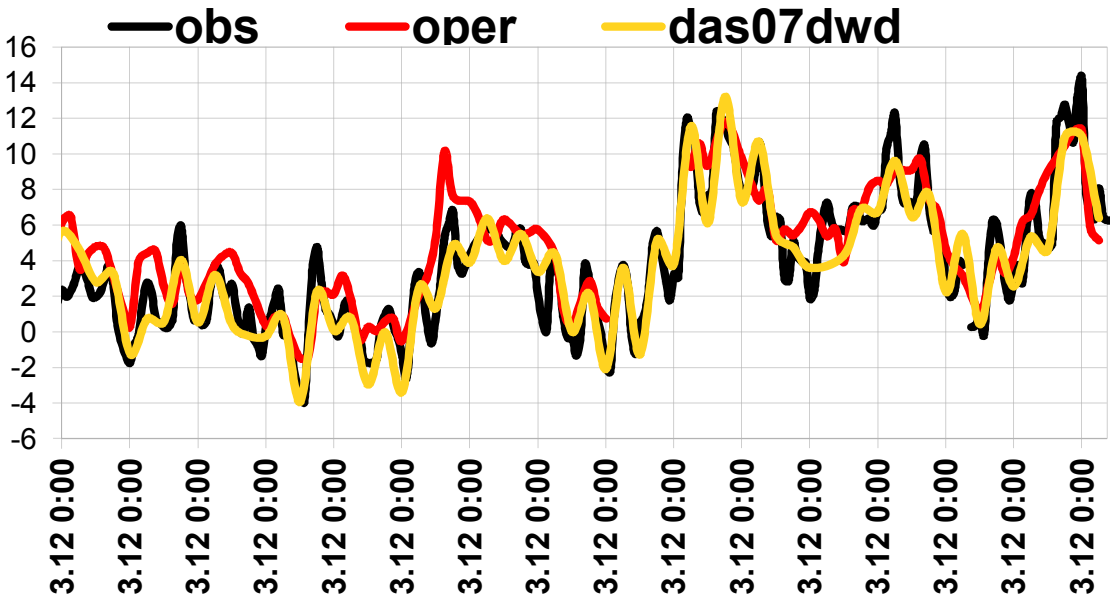


# The results of “nudgcast” in comparison with operational CSMO-Ru7 (withour regional DAS) version

## T_2M, Sochi: initial

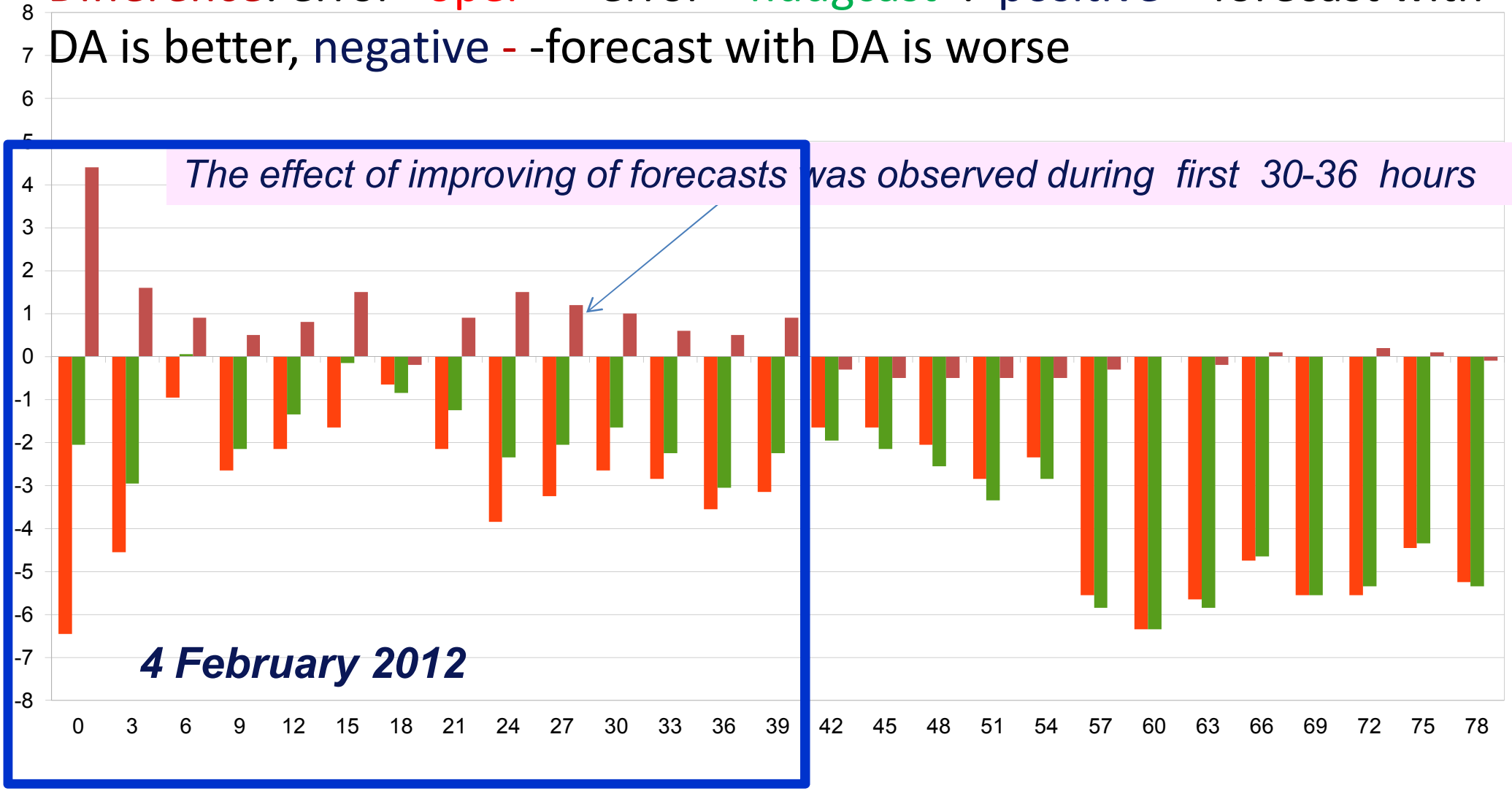



## T2M, Sochi: 24h. forecast



# Errors of "oper" and of "nudgcast" T2m forecasts for Sochi

Difference: error "oper" - error "nudgcast": positive - forecast with DA is better, negative - -forecast with DA is worse

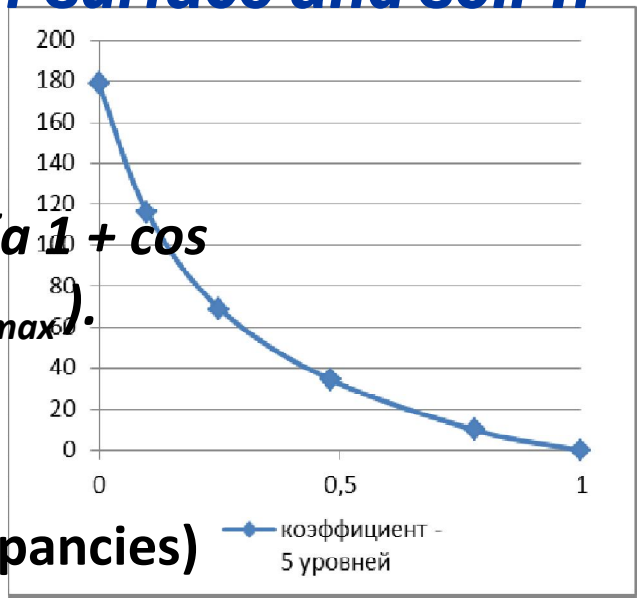


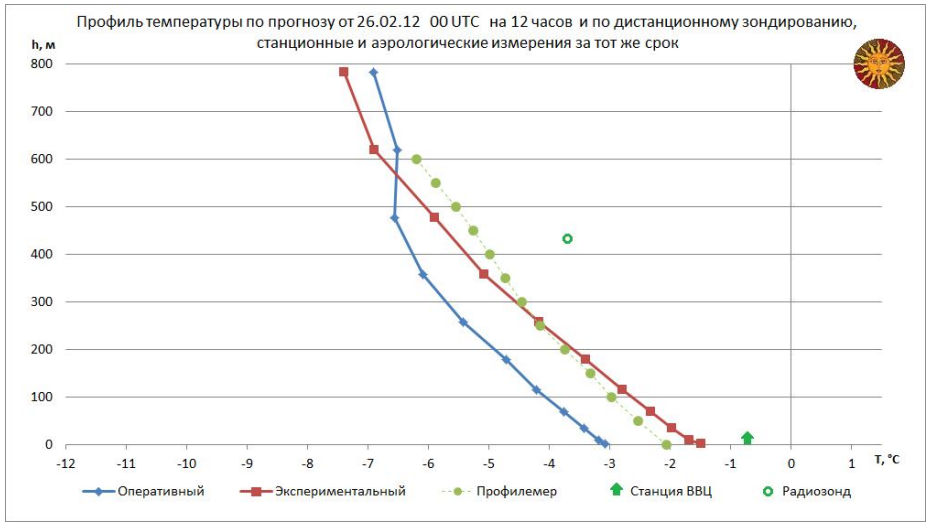
# RDP: The technology for correction of initial near-surface and soil T:

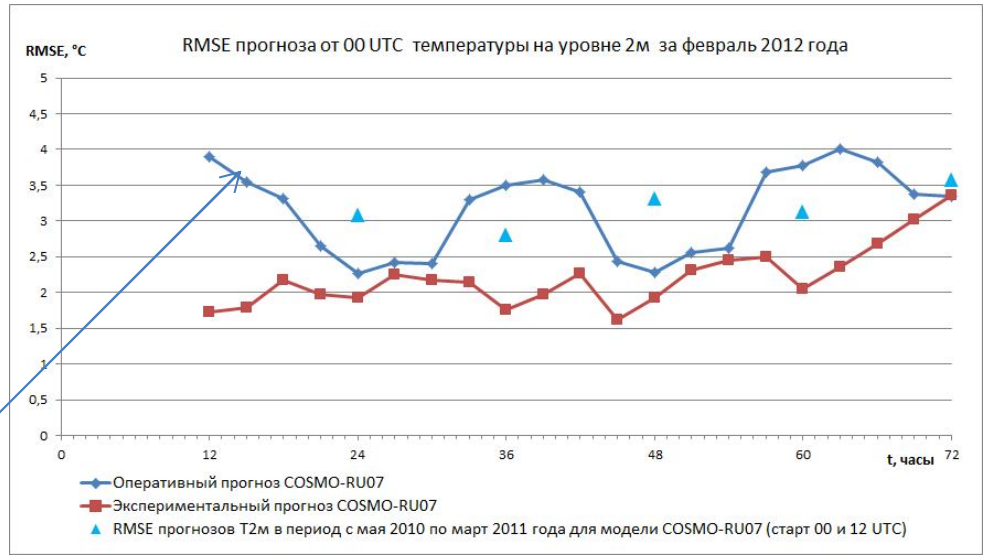
- Cressman method for OA T2m

$$w_k^m = h_k^m v_k^m, \quad h_k^m = 0.5\,[a\,1 + \cos(\pi\,\rho_h^{k,m}/R_{scan})],\ v_k^m = 0.5\,[a\,1 + \cos(\pi\,\rho_v^{k,m}/H_{max}) / (1+0.8\,\rho_v^{k,m}/H_{max})],\quad H_{max} = \max(\rho_v^{k,m}, Z_{max}).$$

- Correction (adaptation) of T for 6-8 bottom atmosphere levels (log-profiles for discrepancies)
- Correction of T for soil levels (linear functions for discrepancies)




*The effect of improving of forecasts was observed during whole lead time (since 72-78 h)*

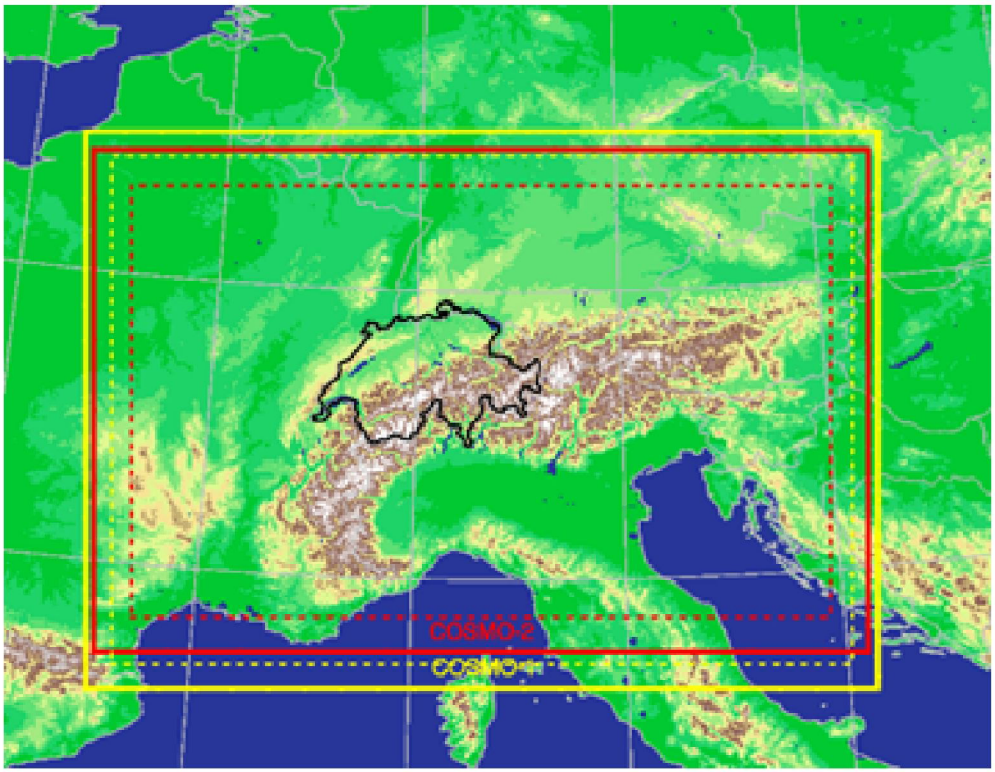
# T1.2. Guy de Morsier with contributions from Oliver Fuhrer. First experiments with COSMO-1 at MeteoSwiss

## COSMO-1 Setup (1) Domain

- dlon = dlat = 0.01, ie × je =1062 × 774

$1062 = 2^5 \times 3 \times 11 + 6$

$774 = 2^8 \times 3 + 6$




First experiments with COSMO-1, COSMO-GM, CORSO project, 11 September 2012 Guy de Morsier 3

# COSMO-1 cases with new FW code

**A. Storm** Carmen 12 November 2010
Although max. wind ~ 0.8 CFL **needs 8s time step**
**Experiments:**
1) horizontal diffusion (**HD**) instead of Smag. Diff.
2) Gal-Chen vs. SLEVE2, etc.

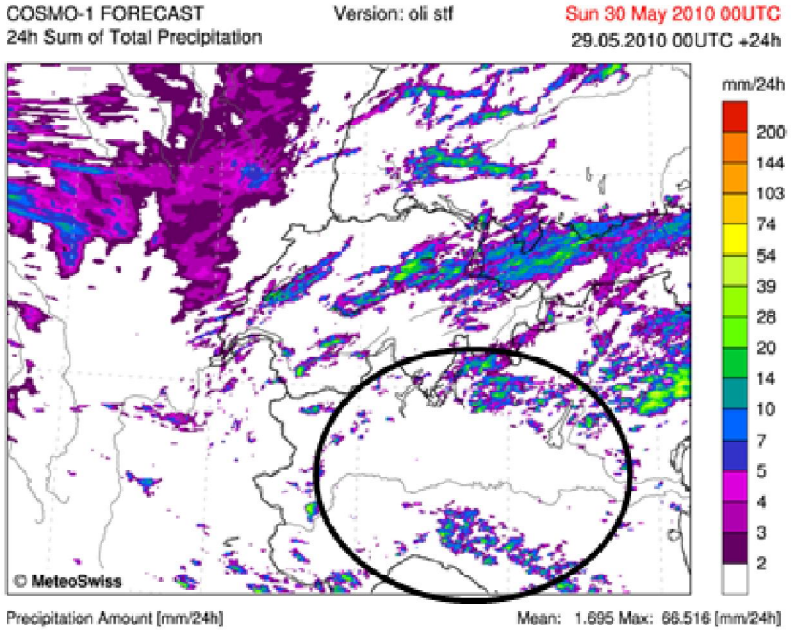
**B. Convective** case 29 May 2010 with:
1) **SL3_MF** **2) HD**
3) different bottom boundary conditions (**BBC**)
4) shallow conv. parameterization (**Iconv** ON/OFF)

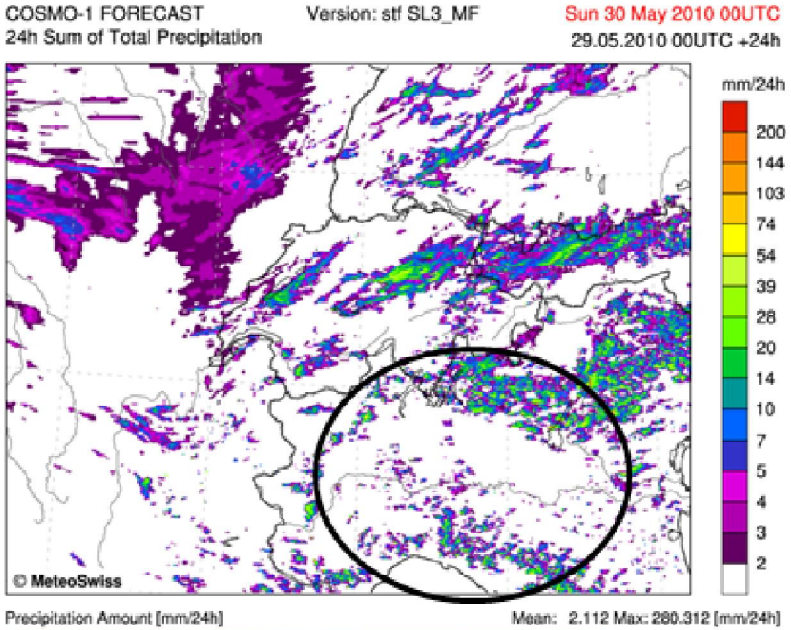
**C. Stratus** case of 27 October 2009
with the same exp. as B. (no slides)

First experiments with COSMO-1, COSMO-GM, CORSO project, 11 September 2012 Guy de Morsier 14

**New code** with **new** fast wave (FW) solver in COSMO V4.23:
**i_type_fast_w=2 + irefatm=2**

# B. Convective case with COSMO-1



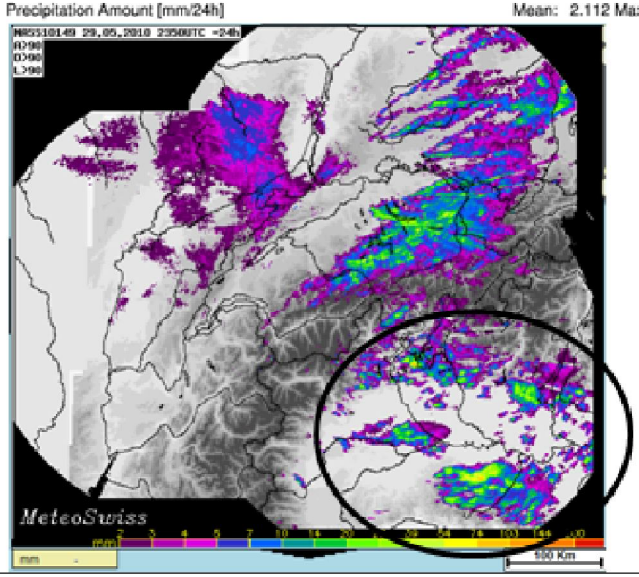

- COSMO-1 less precipitation
- Bottom Bound. Cond. for w (bbc)

and

- Hor. Diff. (HD) have

**little IMPACT but**

- qx advection with SL3_ML has



# CONTENTS

# CORSO Task 2

## "Downscalling / post-processing for Sochi-area and applications"
## *(Roshydromet, MeteoSwiss)*

**2.1: Adapted down-scaling techniques for winter conditions in the mountains and IOC requirements**

**2.2: Determination of typical COSMO-model inaccuracies for typical synoptic situations**

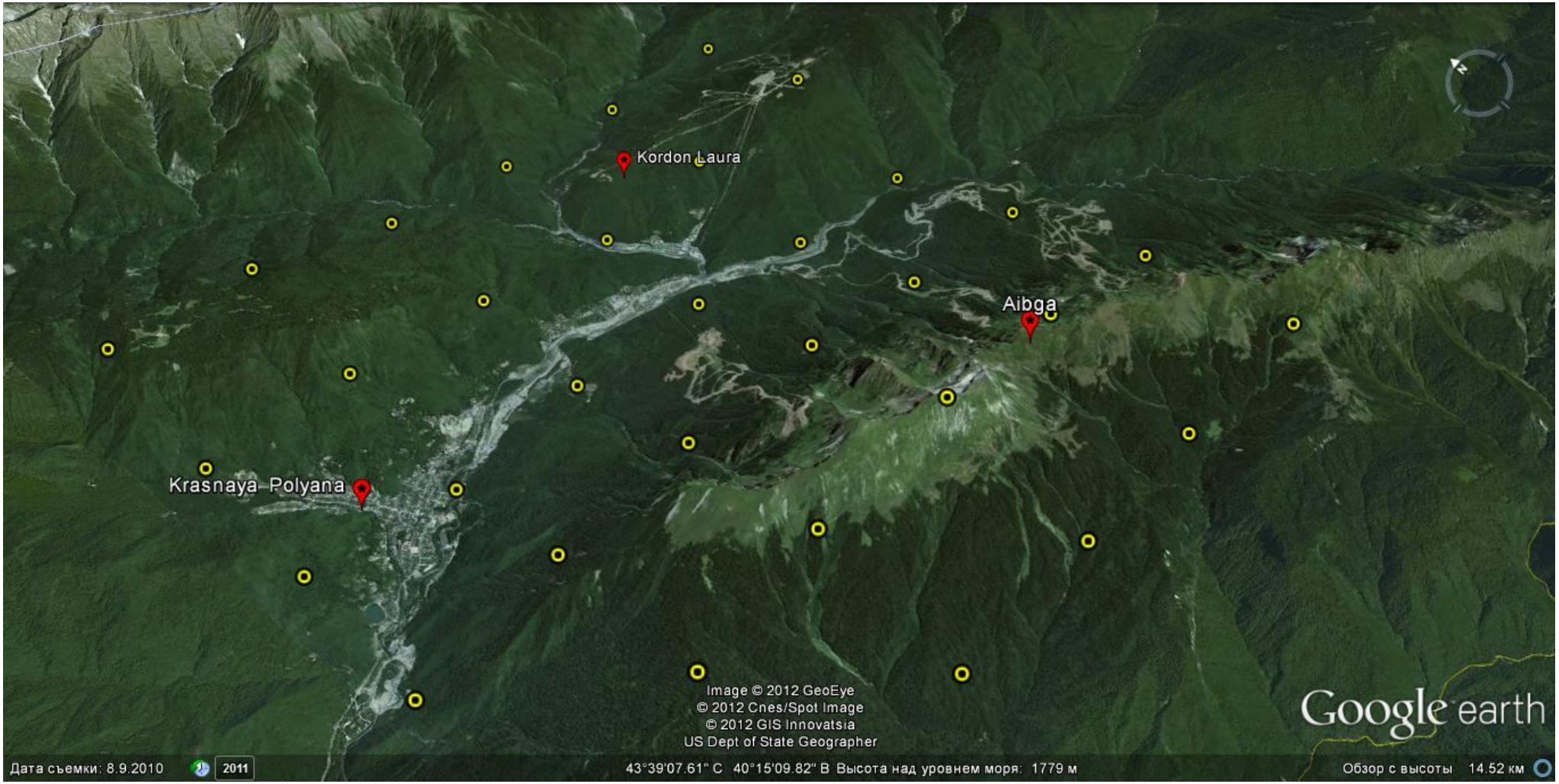
**Deliverables:**

**FDP:** ***Adapted post-processing techniques for winter weather conditions in sub-tropical mountain conditions and satisfying the requirements of the winter Olympics***

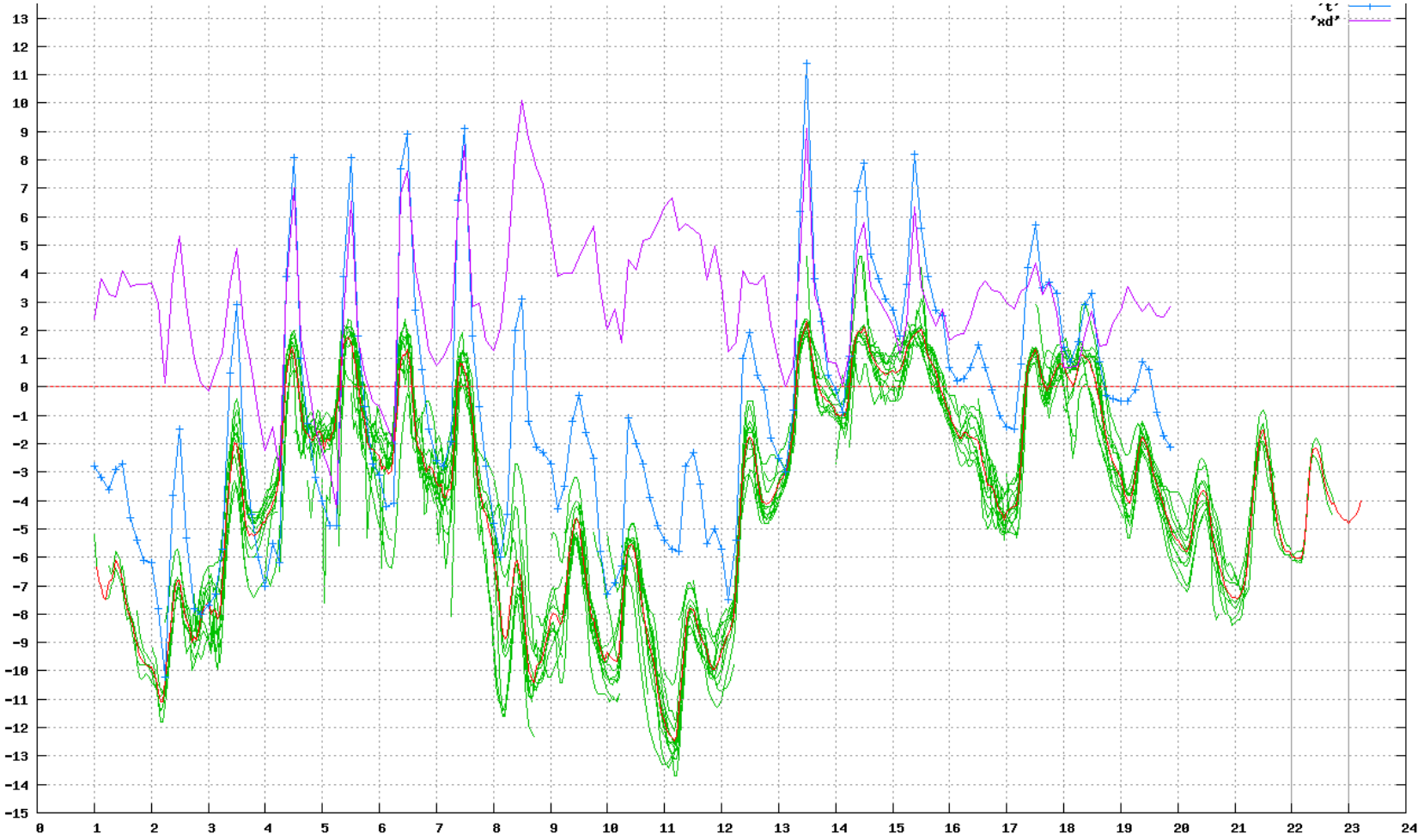
**RDP:** ***developed weather types classification approaches, results of case studies for the Sochi-2014 region***

# Location of the meteorological stations and COSMO-RU2 (Sochi) model's grid-points (mountain sector)

*(view from SW)*



# The 2m temperatures observed at Krasnaya Polyana station in February, 2012 and the COSMO-RU07 model forecasts at the nearest grid point over the same period




***The temperatures observed at the station are shown in blue;***
***the temperature forecasts - in green;***
***the averaged forecast - in red;***
***the difference between the observed temperature and the averaged forecast is depicted in violet,***

# Corrected 2m temperature for Tp=7 days, Td=1 day, and various Np and Nd

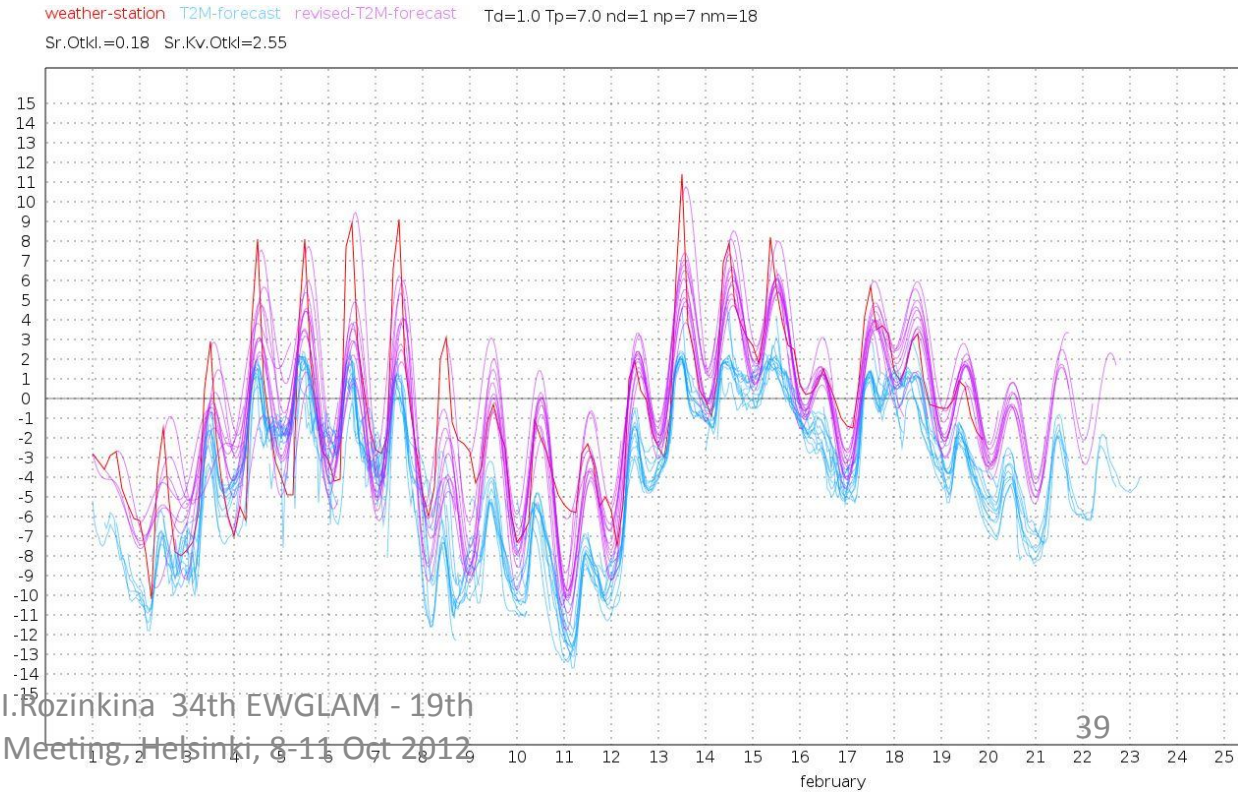
**The 2m temperature forecast at Krasnaya Polyana station was corrected over February, 2012 by applying the described method,**
**The errors in the initial forecasts:**

**average deviation: 2,86 K**
**root-mean-square deviation: 3,89 K**

**For Np=7 and Nd=1, the errors of the corrected forecasts:**
**average deviation: 0,18 K**
**root-mean-square deviation: 2,55 K**

## Kalman Filter

- *observed data*
- *T2 forecasts*
- *revised T2 forecast*



# Corrected 2m temperature for Tp=7 days, Td=1 day, and various Np and Nd

**The 2m temperature forecast at Krasnaya Polyana station was corrected over February, 2012 by applying the described method,**

**The errors in the initial forecasts:**

**average deviation: 2,86 K**

**root-mean-square deviation: 3,89 K**

**For Np=7 and Nd=1, the errors of the corrected forecasts:**

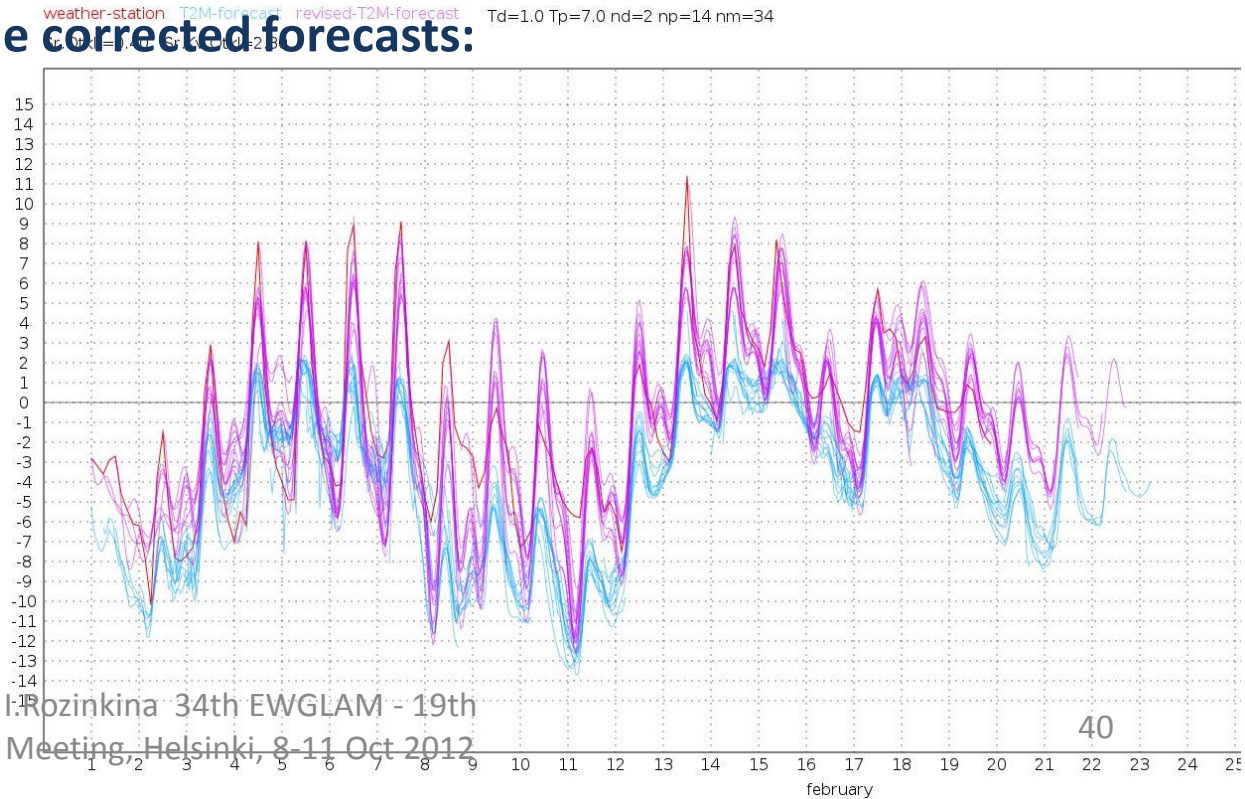
**average deviation: 0,18 K**

**root-mean-square deviation: 2,55 K**

**For Np=14 and Nd=2, the errors of the corrected forecasts:**

**average deviation: 0,40 K**

**root-mean-square deviation: 2,3 K**




- *observed data*
- *T2forecasts*
- *revised T2 forecast*

# Corrected 2m temperature for Tp=7 days, Td=1 day, and various Np and Nd

The 2m temperature forecast at Krasnaya Polyana station was corrected over February, 2012 by applying the described method,

The errors in the initial forecasts:

average deviation: 2,86 K

root-mean-square deviation: 3,89 K

For Np=7 and Nd=1, the errors of the corrected forecasts:

average deviation: 0,18 K

root-mean-square deviation: 2,55 K

For Np=14 and Nd=2, the errors of the corrected forecasts:

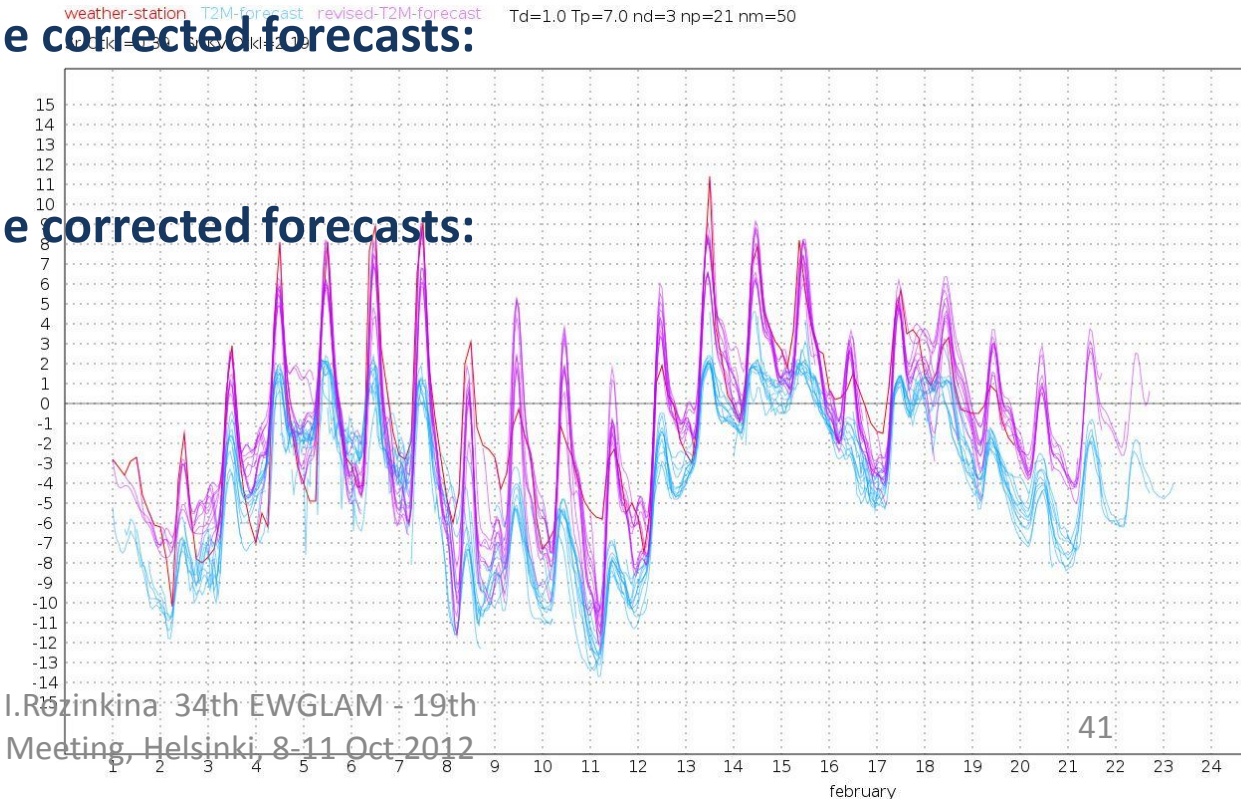
average deviation: 0,40 K

root-mean-square deviation: 2,3 K

For Np=21 and Nd=3, the errors of the corrected forecasts:

average deviation: 0,39 K

root-mean-square deviation: 2,19 K




- *observed data*
- *T2forecasts*
- *revised T2 forecast*

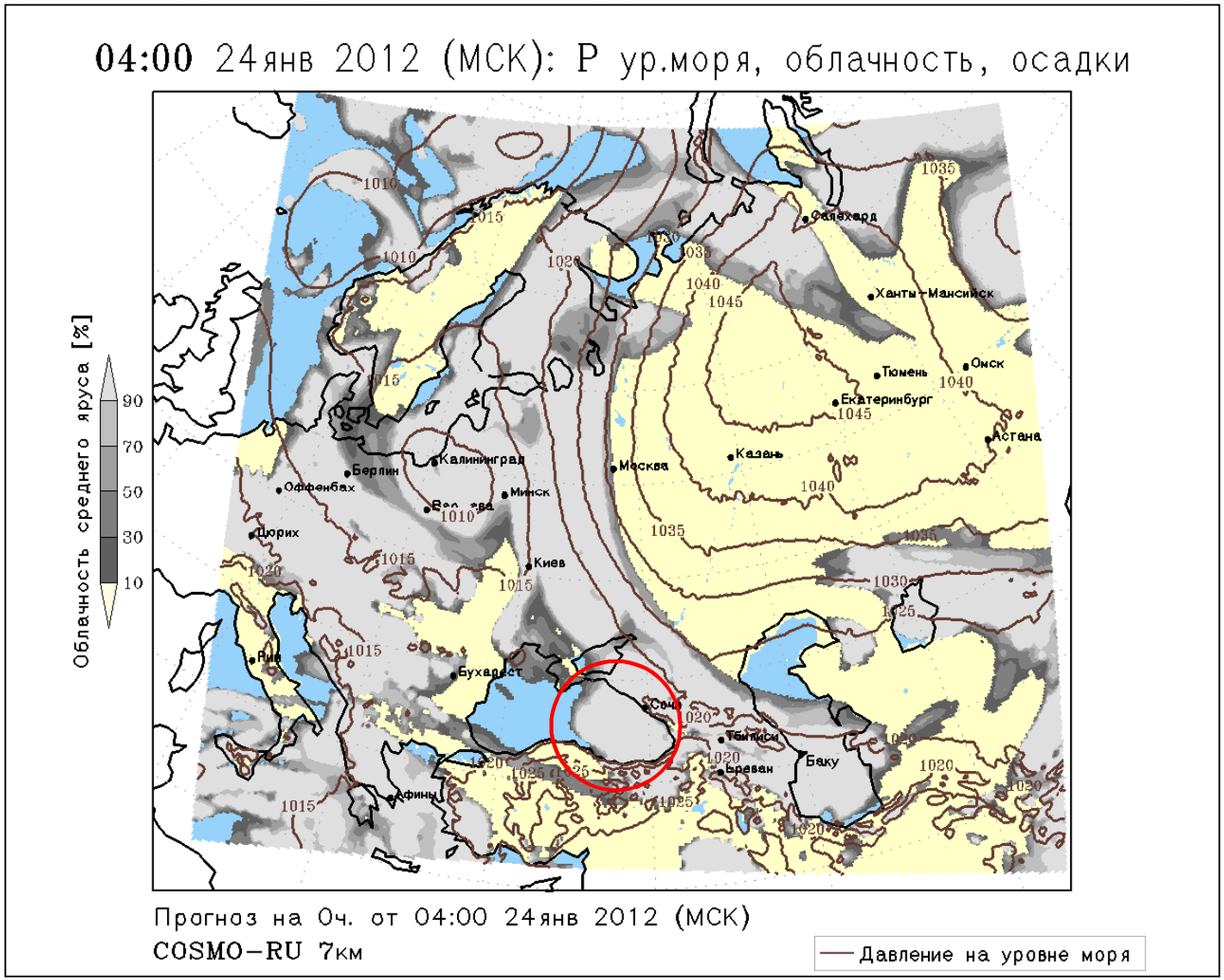
## KF : Errors of the forecasts from the observations before and after the correction for various filter parameters, Feb2012

(mean deviation (upper), and root-mean-square deviation (lower))

| Weather station | Initial forecast | $T_p$=7; $T_d$=1 $n_p$=7; $n_d$=1 | $T_p$=7; $T_d$=1 $n_p$=14; $n_d$=2 | $T_p$=7; $T_d$=1 $n_p$=21; $n_d$=3 |
|---|---|---|---|---|
| Krasnaya Polyana | 2,86<br>3,89 | 0,18<br>2,55 | 0,4<br>2,3 | 0,39<br>2,19 |
| Aibga | -1,86<br>3,48 | 0,38<br>2,59 | 0,26<br>2,72 | 0,2<br>2,78 |
| Kordon Laura | 5,3<br>6,17 | 0,41<br>3,14 | 0,46<br>2,95 | 0,47<br>2,91 |

**The local cyclones didn't indicate into PMSL fields and forecasters often can't see it**

**But more dangerous phenomena is due to this local cyclones**




**The calculations of dangerous weather showed the necessity to adapt the software of automatic weather classification (COST733) for the region including the west of Asian part.**

**This jobs are developed since 05.2012**

# CONTENTS

# CORSO Task 3

## "Development and adaptation of COSMO EPSs for the Sochi-region"

*(Roshydromet, ARPA-SIMC)*

**3.1: Adaptation of COSMO LEPS 7 km to the Sochi-region and to specific requirements of winter Olympics. Operational ensemble forecasts during Olympics**

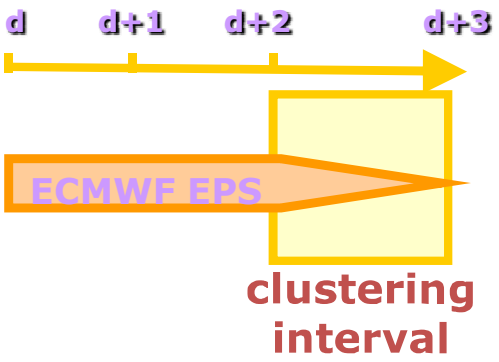
**3.2: Development and verification of COSMO-RU-LEPS 2.2 km for the Sochi-region (with ICs and BCs from SOCHMEL7)**

**Deliverables:**

**FDP:** ***COSMO-FROST-LEPS system with 7 km resolution adapted to the Sochi-region and to specific requirements of winter Olympics. Operational ensemble forecasts during the Olympics. Technology of presentation and interpretation of COSMO-FROST-LEPS results in operational mode***

**RDP:** ***COSMO-RU-LEPS 2.2 km for the Sochi-region (with ICs and BCs from COSMO-FROST-LEPS ).***

# COSMO-FROST-EPS @ ECMWF: present status




4 variables
Z U V Q

3 levels
500 700 850 hPa

Cluster Analysis and RM identification

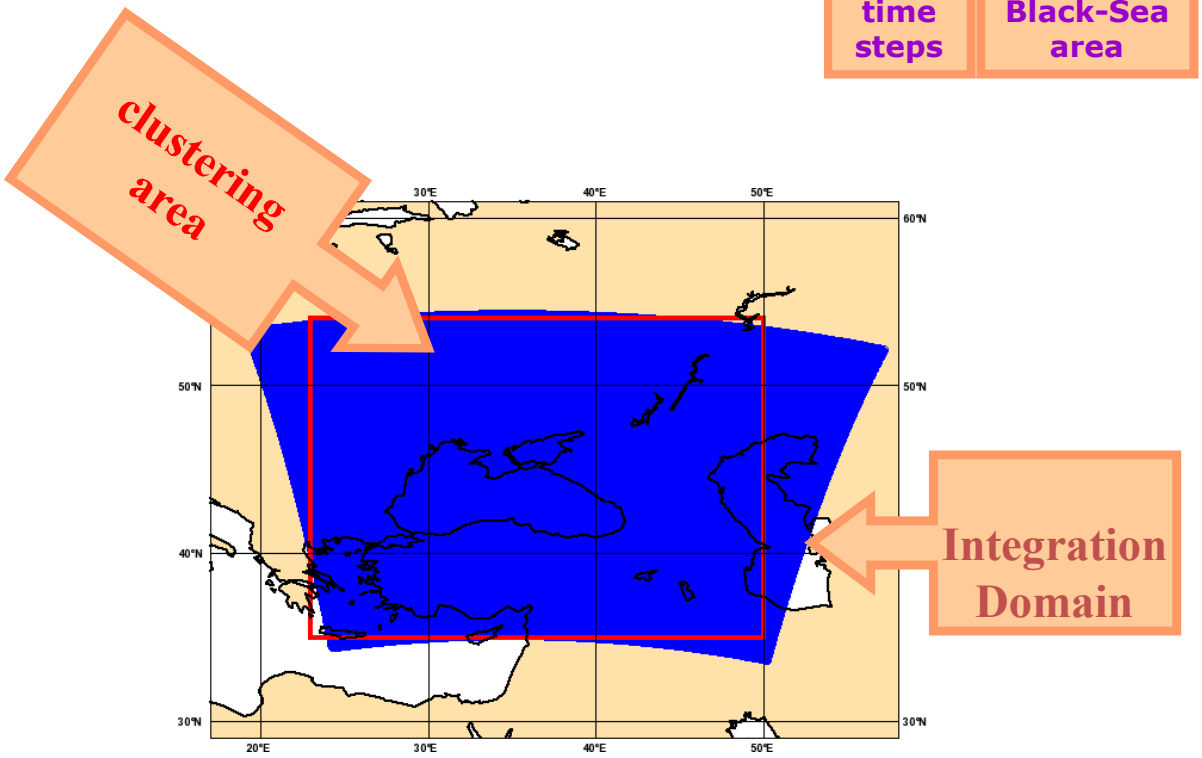
2 time steps

Black-Sea area

Complete Linkage

**10 Representative Members driving the 10 COSMO-model integrations (weighted according to the cluster populations)**

**employing either Tiedtke or Kain-Fristch convection scheme (randomly choosen) + perturbations in turbulence scheme and in physical parameterisations**




- Δx ~ 7 km; 40 ML;
  fc+72h; initial time: 00/12 UTC;
- At the moment, computer time (~ 2 million BUs for 2012) is provided by an ECMWF Special Project;
- suite managed by ARPA-SIMC;
- contributions from ECMWF member states could be needed in the future.



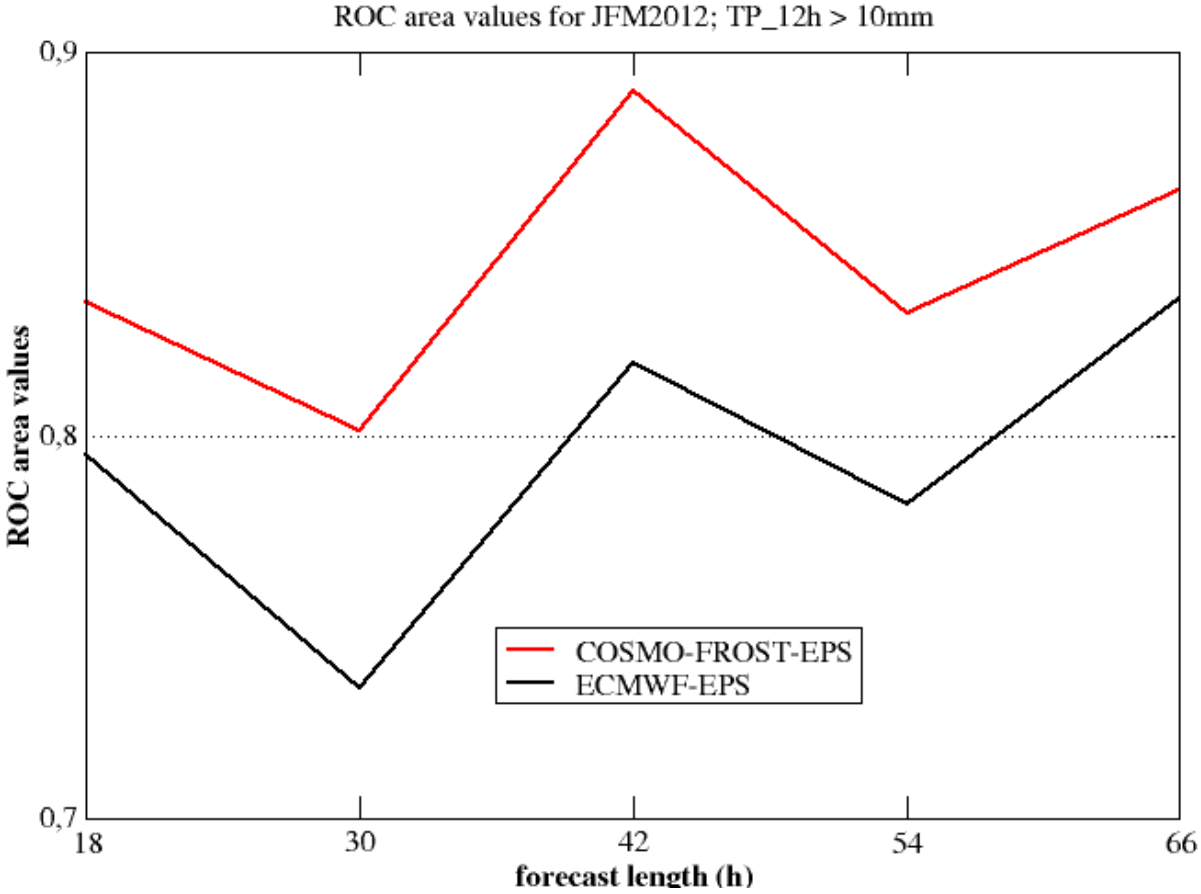
*A.Montani; The COSMO-LEPS system.*

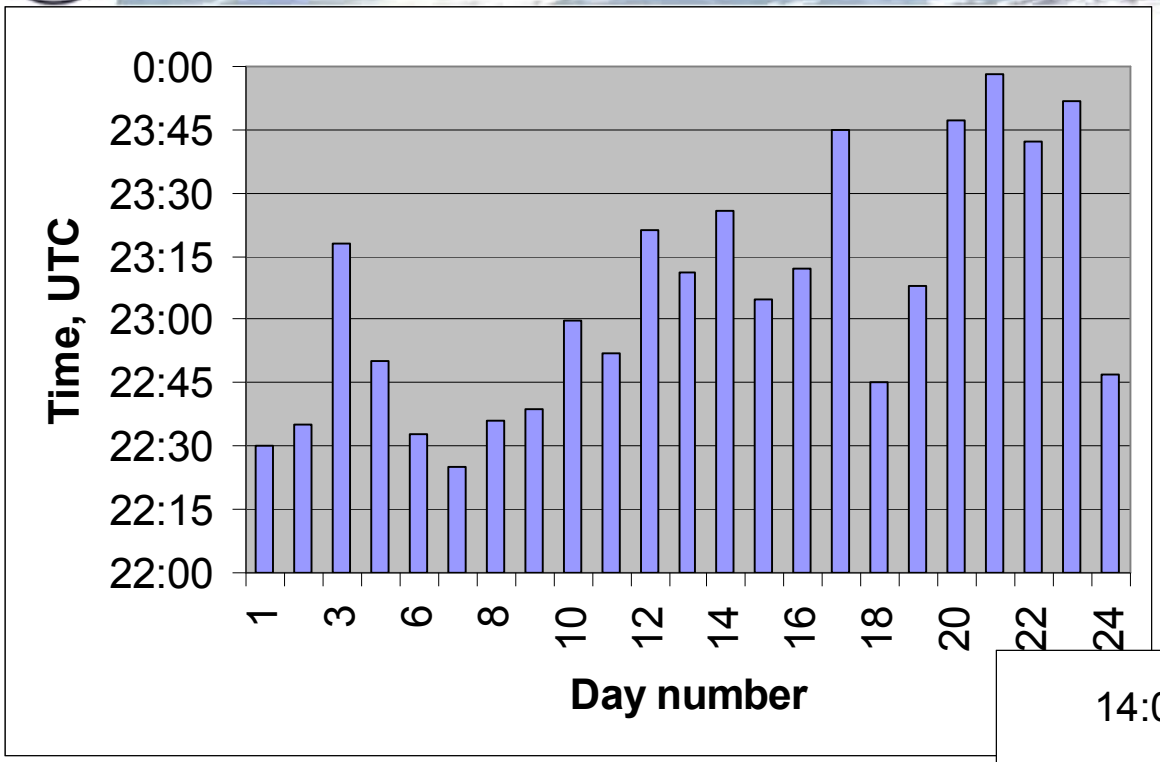
# ROC area

- Area under the curve in the HIT rate vs FAR diagram; the higher, the better …
- Valuable forecast systems have ROC area values > 0.6.
- Consider the event: 12-hour precipitation exceeding 10 mm

- COSMO-FROST-EPS outperforms ECMWF-EPS for all forecast ranges.
- 12-hour cycle of the score for both systems, which better predict precipitation occurring during daytime (6-18Z).
- ROC area values show little dependence on the threshold (not shown).

These results need to be confirmed over higher-resolution observational networks.

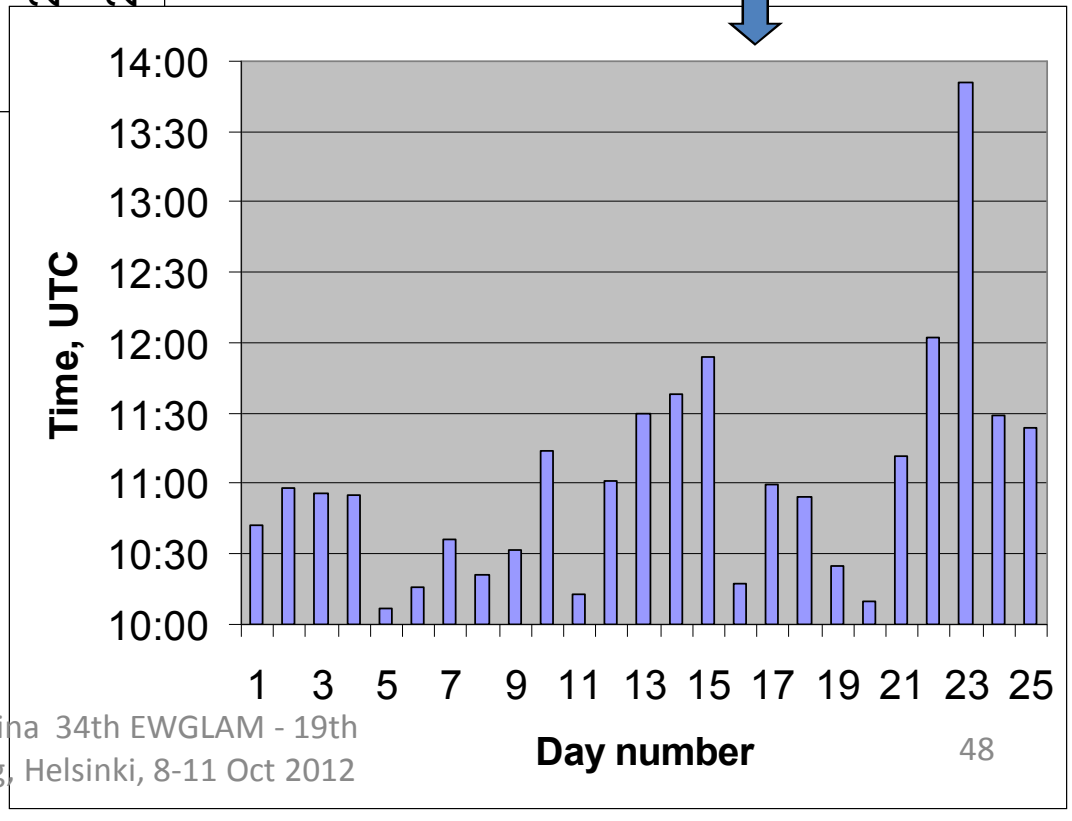





1-25 July 2012

12 UTC
Δt~1,5 h
The earliest: 22:25 UTC (2:25 MSK)

00 UTC
Δt~ 4 h
The earliest: 10:07 UTC (14:07 MSK)




Plus time for plotting & transferring to the forecasters ~15-20 min

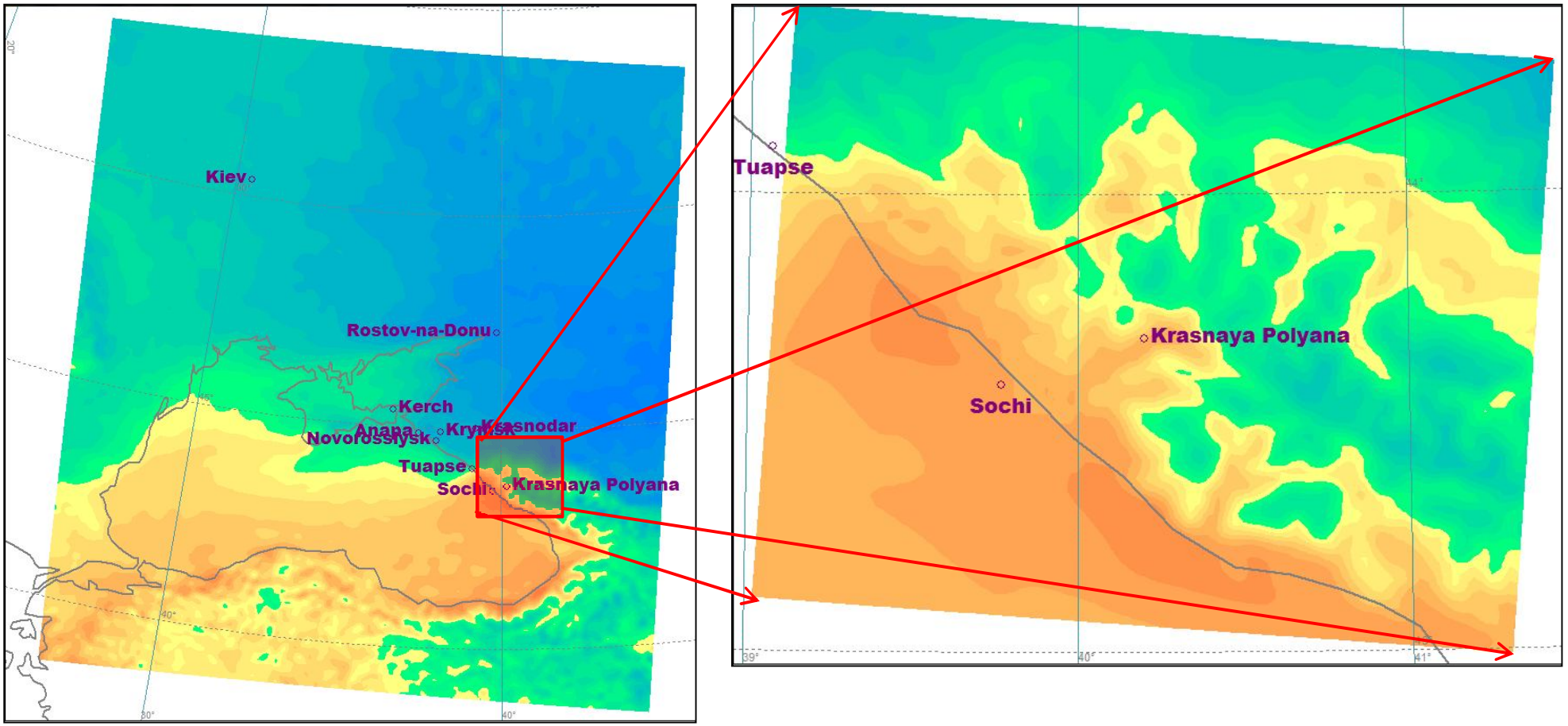
**Forecasters' schedule:**
**3 UTC (7 MSK)**
**10 UTC (14 MSK)**

**Information flow:**

**The time of forecast arrival at RHMC**

# COSMO-RU-LEPS- 2.2 km

- 10 members; BCs & ICs from COSMO-FROST-EPS
- No physical parameters perturbed or modified
- ~ 2h (min ~ 70 minutes) on 120PE (10*12)
- Forecast length 48 h; output time step 1h



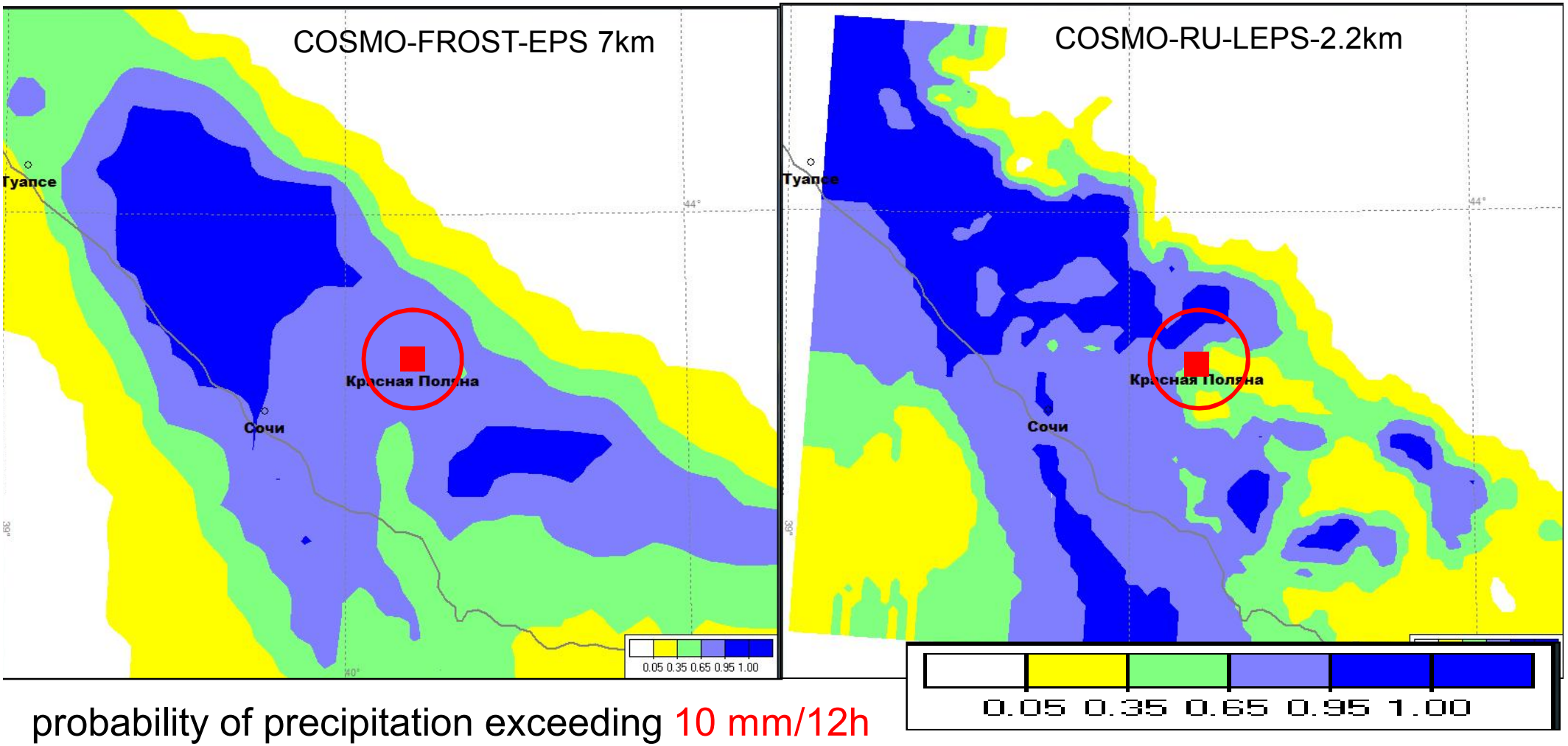

COSMO-FROST-EPS

**Domain:** 1575 km * 1680 km
**Grid:** 226*241, 40 lev
**Step:** 7 km

COSMO-RU-LEPS- 2.2 km

**Domain:** 187 km * 143 km
**Grid:** 86*66, 50 lev
**Step:** 2.2 km

# COSMO-FROST-EPS 7km vs. COSMO-RU-LEPS-2.2km




probability of precipitation exceeding 10 mm/12h

Krasnaya Polyana

Initial time: 12 UTC 14.02.2012

Valid: 15 UTC 15.02.2012 – 03 UTC 16.02.2012

Lead time 39h

# Case studies: conclusions

- COSMO-EPS-FROST 7 km gives valuable information for forecasters but failed to predict heavy enough precipitation on July 6-7 2012 (the flood in Kuban)

- COSMO-RU-LEPS 2.2 km gives reasonable results describing precipitation fields in more detail than COSMO-EPS-FROST 7 km does

- In some cases COSMO-RU-LEPS 2.2 km adds value, but not in all cases

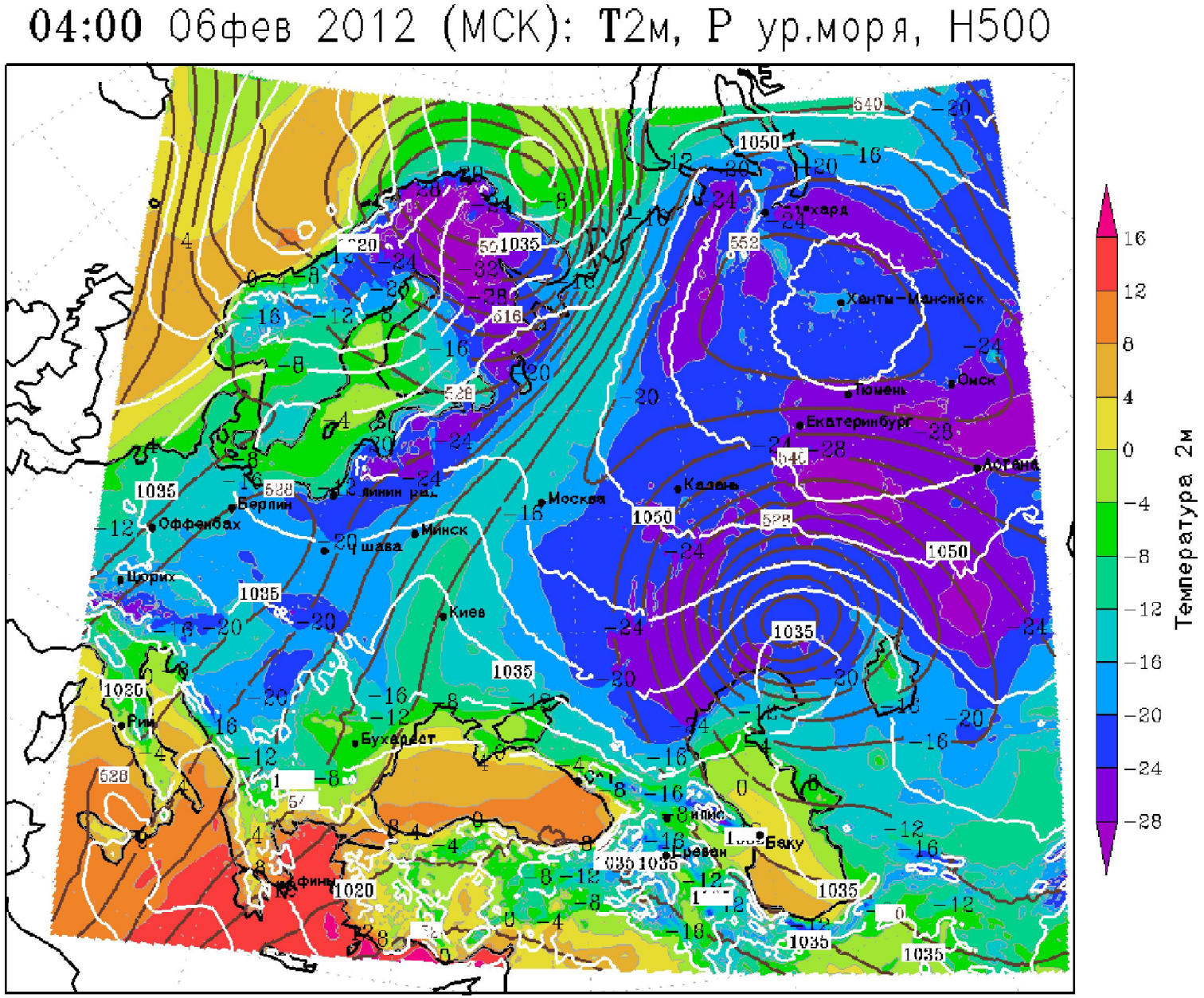
- Further studies with COSMO-RU-LEPS 2.2 km are necessary to assess the forecast skill (e.g., verification for periods)

# CONTENTS

**The bora is a downslope gusty windstorm occurring on the leeward side of the Caucasus Mountains in the town Novorossiysk and its surroundings and brings a cold snap. Of the 7 cases of bora from November 2011 to March 2012 the most powerful (extreme) bora was 6-9 February 2012, when wind gusts reach high-risk units (more than 28 m/s), hurricane force (over 33 m/s) and extremely rare and dangerous forces (more than 40 m/s), causing extensive damage and casualties.**

**Forecast of all cases of bora with wind gusts of 19 m /s to 44 m /s was successful for a forecast's period of 10-20 hours, using the model COSMO-RU with horizontal resolution of 2.2 km.**

# Synoptic situation



**WIND**
**500 гПа**
**700 гПа**
**850 гПа**
**500 м**
**10 м**

**T2м**
**Td2м**
**T850**
**T700**
**T500**

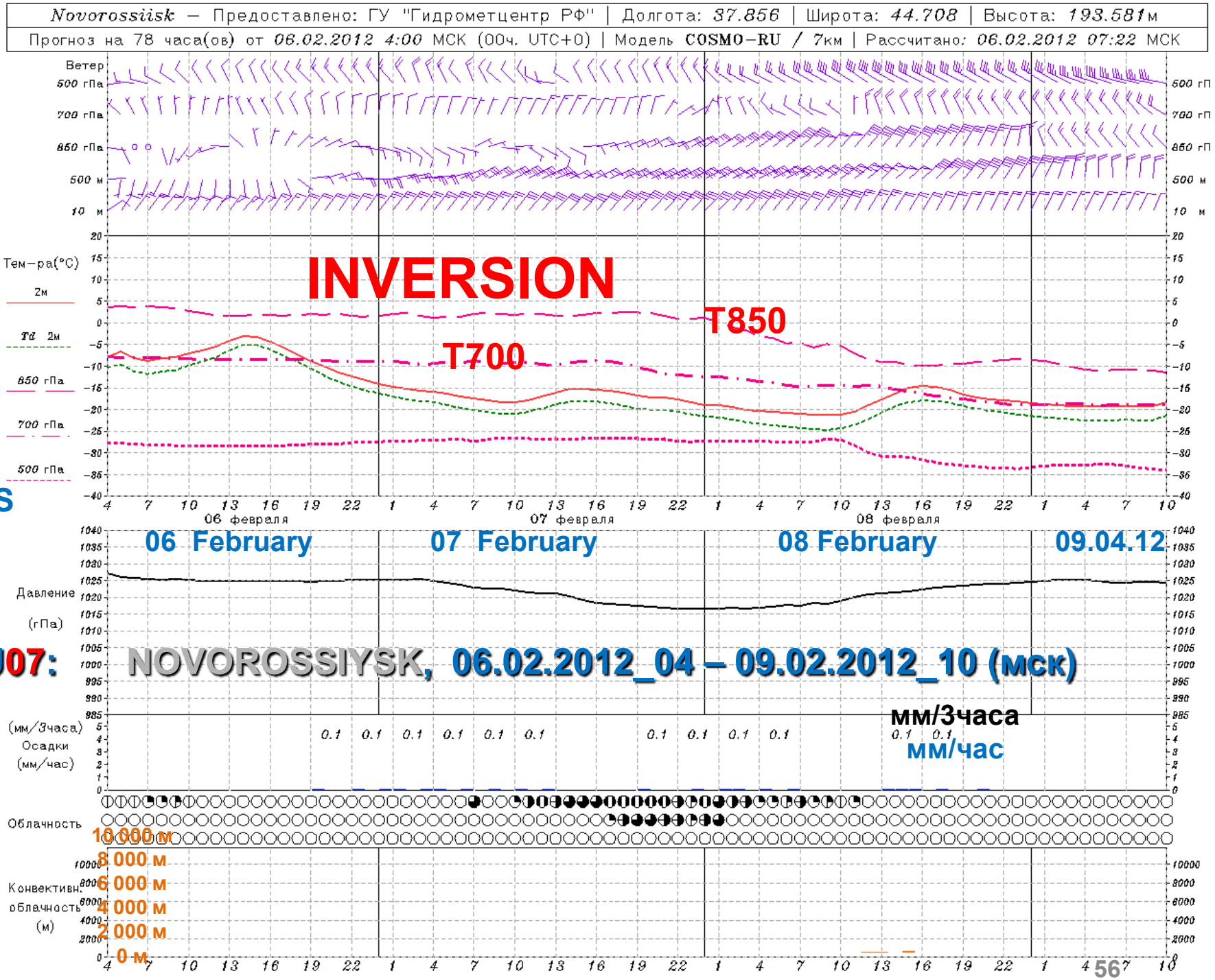
**DATE & HOURS**

**Psea**

**PRESIPITATION**

**CLOUDS,**
**3 levels**

**CONVECTIVE CLOUDS**




**COSMO-RU07:**

**COSMO-RU02**
**NOVOROSSIYSK**

**06.02.2012_0**
**V=4 m/s,**
**T2m=-8.3**

**06.02.2012_12**
**V = 11 m/s**
**T2m=-1.0⁰**

**07.02.2012_00**
**V = 22 m/s,**
**T2m=-12.2⁰**

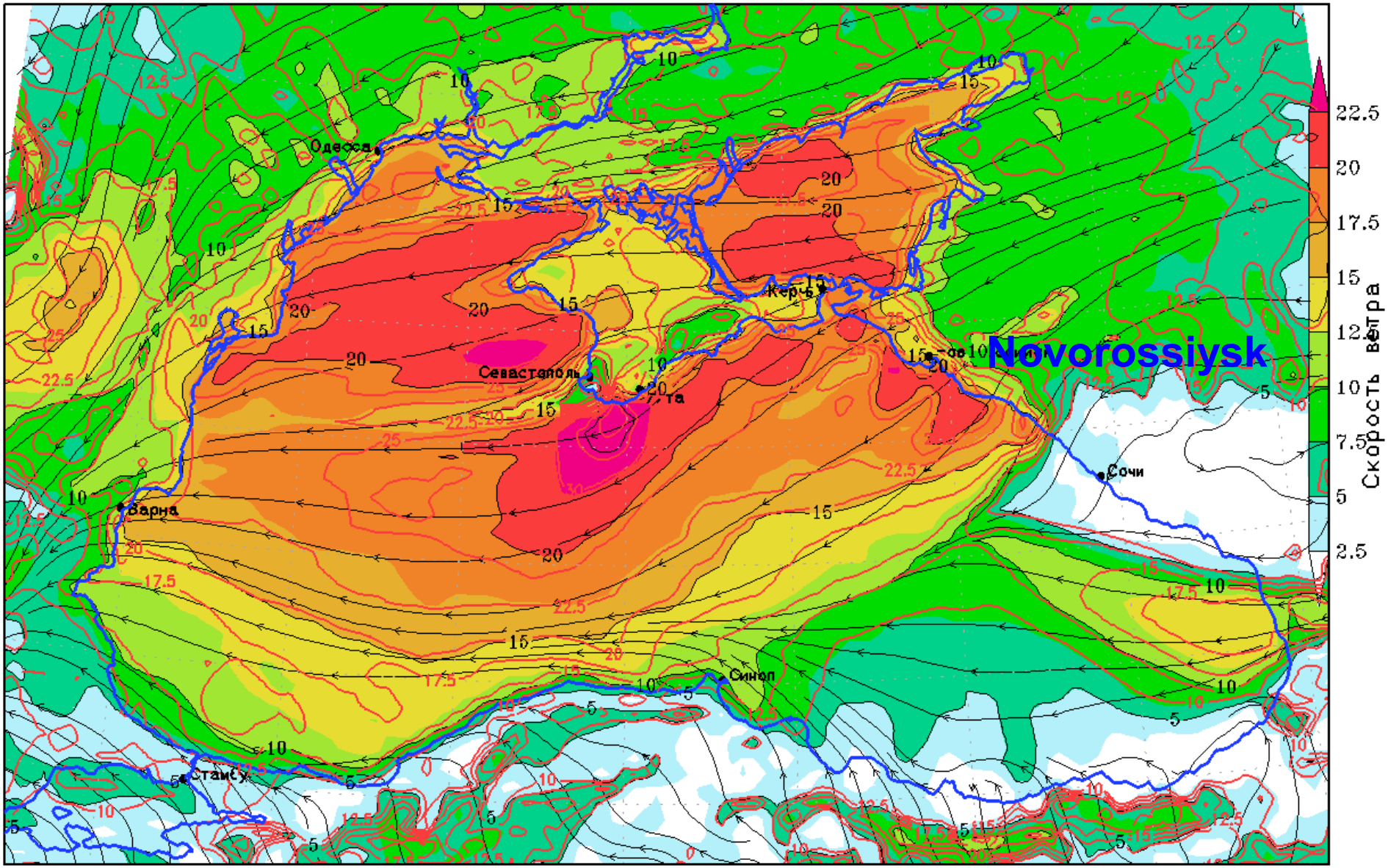
**07.02.2012_12**
**V=24,**
**T2m=-14.6**

LON (dgr): 37.853
SOIL TYPE : loam 5

| HH | PMSL | DF10M | DF500M | DF850 | DF700 | DF500 | TG | T2M | TD2M | T30M | T850 | T700 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| h | hpa | dgr m/s | dgr m/s | dgr m/s | dgr m/s | dgr m/s | degree centrigrade | | | | | |
| 0.0 | 1027.47 | 56/ 4 | 86/ 2 | 112/ 1 | 304/ 2 | 260/ 3 | -9.0 | -8.3 | -10.9 | -8.2 | 3.5 | -7.8 |
| 1.0 | 1024.66 | 62/ 10 | 154/ 1 | 134/ 1 | 314/ 3 | 266/ 3 | -3.3 | -0.7 | -6.5 | -0.1 | 3.7 | -7.9 |
| 2.0 | 1024.39 | 65/ 10 | 188/ 2 | 127/ 0 | 333/ 3 | 277/ 4 | -3.9 | -1.6 | -7.5 | -1.1 | 3.6 | -8.0 |
| 3.0 | 1024.11 | 65/ 9 | 199/ 2 | 125/ 1 | 339/ 3 | 284/ 5 | -4.2 | -2.0 | -7.9 | -1.6 | 3.7 | -7.9 |
| 4.0 | 1023.89 | 66/ 8 | 204/ 3 | 147/ 1 | 348/ 3 | 294/ 5 | -3.6 | -1.1 | -6.9 | -0.6 | 3.6 | -8.0 |
| 5.0 | 1023.93 | 65/ 8 | 204/ 3 | 196/ 1 | 358/ 3 | 305/ 5 | -3.2 | -1.0 | -6.3 | -0.5 | 3.1 | -8.2 |
| 6.0 | 1023.68 | 66/ 7 | 203/ 4 | 224/ 1 | 6/ 3 | 316/ 5 | -2.4 | -0.3 | -5.3 | 0.2 | 2.7 | -8.3 |
| 7.0 | 1023.34 | 64/ 8 | 202/ 3 | 257/ 1 | 10/ 3 | 322/ 5 | -1.4 | 0.0 | -4.2 | 0.3 | 2.4 | -8.3 |
| 8.0 | 1023.29 | 63/ 8 | 205/ 3 | 277/ 1 | 8/ 2 | 327/ 5 | -0.8 | 0.1 | -4.0 | 0.3 | 2.1 | -8.3 |
| 9.0 | 1023.17 | 64/ 8 | 204/ 2 | 309/ 1 | 352/ 2 | 333/ 5 | -0.4 | 0.5 | -3.6 | 0.7 | 2.1 | -8.4 |
| 10.0 | 1023.17 | 64/ 8 | 208/ 1 | 334/ 2 | 340/ 2 | 335/ 5 | -0.2 | 0.8 | -3.5 | 1.0 | 2.2 | -8.4 |
| 11.0 | 1023.04 | 63/ 9 | 228/ 1 | 354/ 2 | 332/ 3 | 333/ 5 | -0.2 | 0.4 | -4.0 | 0.4 | 2.4 | -8.4 |
| 12.0 | 1022.96 | 62/ 11 | 291/ 1 | 12/ 3 | 332/ 3 | 326/ 5 | -1.2 | -1.0 | -5.7 | -1.0 | 2.5 | -8.4 |
| 13.0 | 1022.88 | 62/ 13 | 341/ 0 | 30/ 3 | 334/ 4 | 322/ 6 | -2.9 | -2.8 | -7.3 | -2.8 | 2.7 | -8.4 |
| 14.0 | 1022.63 | 61/ 15 | 112/ 2 | 49/ 3 | 337/ 5 | 318/ 6 | -4.9 | -4.6 | -8.7 | -4.6 | 2.9 | -8.4 |
| 15.0 | 1022.45 | 61/ 16 | 114/ 3 | 59/ 4 | 341/ 5 | 317/ 6 | -6.6 | -6.3 | -10.4 | -6.3 | 2.7 | -8.5 |
| 16.0 | 1022.41 | 61/ 17 | 98/ 6 | 78/ 4 | 346/ 5 | 317/ 7 | -7.6 | -7.3 | -11.2 | -7.3 | 2.4 | -8.5 |
| 17.0 | 1022.36 | 62/ 18 | 94/ 8 | 115/ 4 | 354/ 6 | 317/ 7 | -8.1 | -7.7 | -11.9 | -7.7 | 2.5 | -8.4 |
| 18.0 | 1022.29 | 62/ 19 | 84/ 9 | 120/ 3 | 4/ 7 | 318/ 7 | -8.8 | -8.4 | -13.0 | -8.4 | 3.0 | -8.6 |
| 19.0 | 1022.41 | 62/ 20 | 81/ 11 | 124/ 3 | 14/ 7 | 321/ 8 | -9.5 | -9.1 | -14.0 | -9.1 | 3.1 | -9.0 |
| 20.0 | 1022.33 | 62/ 21 | 76/ 13 | 126/ 3 | 13/ 7 | 323/ 8 | -10.2 | -9.9 | -14.9 | -9.9 | 3.2 | -8.9 |
| 21.0 | 1022.31 | 63/ 22 | 73/ 14 | 126/ 2 | 14/ 7 | 321/ 8 | -10.9 | -10.6 | -15.5 | -10.5 | 3.4 | -9.0 |
| 22.0 | 1022.25 | 62/ 22 | 71/ 14 | 141/ 2 | 17/ 7 | 331/ 9 | -11.7 | -11.4 | -16.2 | -11.4 | 3.4 | -9.2 |
| 23.0 | 1022.28 | 62/ 22 | 75/ 13 | 159/ 3 | 22/ 7 | 345/ 9 | -12.0 | -11.7 | -16.5 | -11.7 | 2.7 | -9.7 |
| 0.0 | 1022.11 | 62/ 22 | 77/ 12 | 174/ 2 | 20/ 7 | 345/ 9 | -12.5 | -12.2 | -17.0 | -12.3 | 2.2 | -9.8 |
| 1.0 | 1021.70 | 61/ 22 | 73/ 12 | 150/ 1 | 16/ 7 | 341/ 7 | -13.3 | -13.1 | -17.7 | -13.1 | 1.9 | -9.4 |
| 2.0 | 1020.90 | 60/ 23 | 71/ 13 | 116/ 2 | 23/ 7 | 332/ 7 | -13.9 | -13.8 | -18.3 | -13.8 | 2.2 | -9.2 |
| 3.0 | 1020.00 | 60/ 23 | 66/ 16 | 90/ 2 | 31/ 6 | 339/ 7 | -14.3 | -14.2 | -18.8 | -14.3 | 3.0 | -8.5 |
| 4.0 | 1019.39 | 61/ 24 | 65/ 17 | 124/ 2 | 32/ 6 | 337/ 7 | -14.9 | -14.8 | -19.4 | -14.9 | 3.4 | -8.8 |
| 5.0 | 1019.34 | 62/ 24 | 66/ 19 | 137/ 2 | 28/ 7 | 324/ 6 | -15.4 | -15.3 | -19.9 | -15.3 | 2.8 | -9.3 |
| 6.0 | 1018.52 | 61/ 25 | 64/ 22 | 96/ 2 | 27/ 6 | 354/ 6 | -15.6 | -15.7 | -20.2 | -15.8 | 3.6 | -8.5 |
| 7.0 | 1018.24 | 59/ 25 | 65/ 23 | 108/ 3 | 28/ 7 | 314/ 5 | -15.6 | -16.0 | -20.3 | -16.2 | 3.5 | -9.3 |
| 8.0 | 1018.31 | 59/ 24 | 66/ 25 | 107/ 3 | 31/ 7 | 281/ 5 | -15.2 | -15.9 | -19.8 | -16.1 | 3.0 | -10.1 |
| 9.0 | 1017.97 | 57/ 24 | 68/ 26 | 123/ 4 | 39/ 7 | 292/ 6 | -14.5 | -15.3 | -19.3 | -15.6 | 2.9 | -10.4 |
| 10.0 | 1016.83 | 54/ 24 | 66/ 29 | 103/ 3 | 29/ 7 | 348/ 5 | -14.0 | -14.9 | -18.8 | -15.1 | 3.8 | -9.0 |
| 11.0 | 1016.18 | 54/ 24 | 67/ 31 | 97/ 4 | 34/ 6 | 344/ 5 | -14.0 | -14.7 | -18.8 | -14.9 | 3.7 | -9.0 |
| 12.0 | 1015.20 | 55/ 24 | 67/ 34 | 73/ 3 | 25/ 6 | 328/ 4 | -14.1 | -14.6 | -18.9 | -14.8 | 4.1 | -8.4 |
| 13.0 | 1014.73 | 54/ 25 | 66/ 33 | 93/ 2 | 28/ 5 | 341/ 6 | -15.0 | -15.3 | -19.2 | -15.5 | 4.1 | -8.5 |
| 14.0 | 1014.33 | 54/ 25 | 66/ 35 | 64/ 6 | 29/ 6 | 321/ 4 | -15.7 | -15.8 | -19.9 | -15.9 | 4.1 | -8.9 |

# COSMO-RU07 : STREAM FUNCTION

13:00 07фев 2012 (МСК): Ветер на 10м



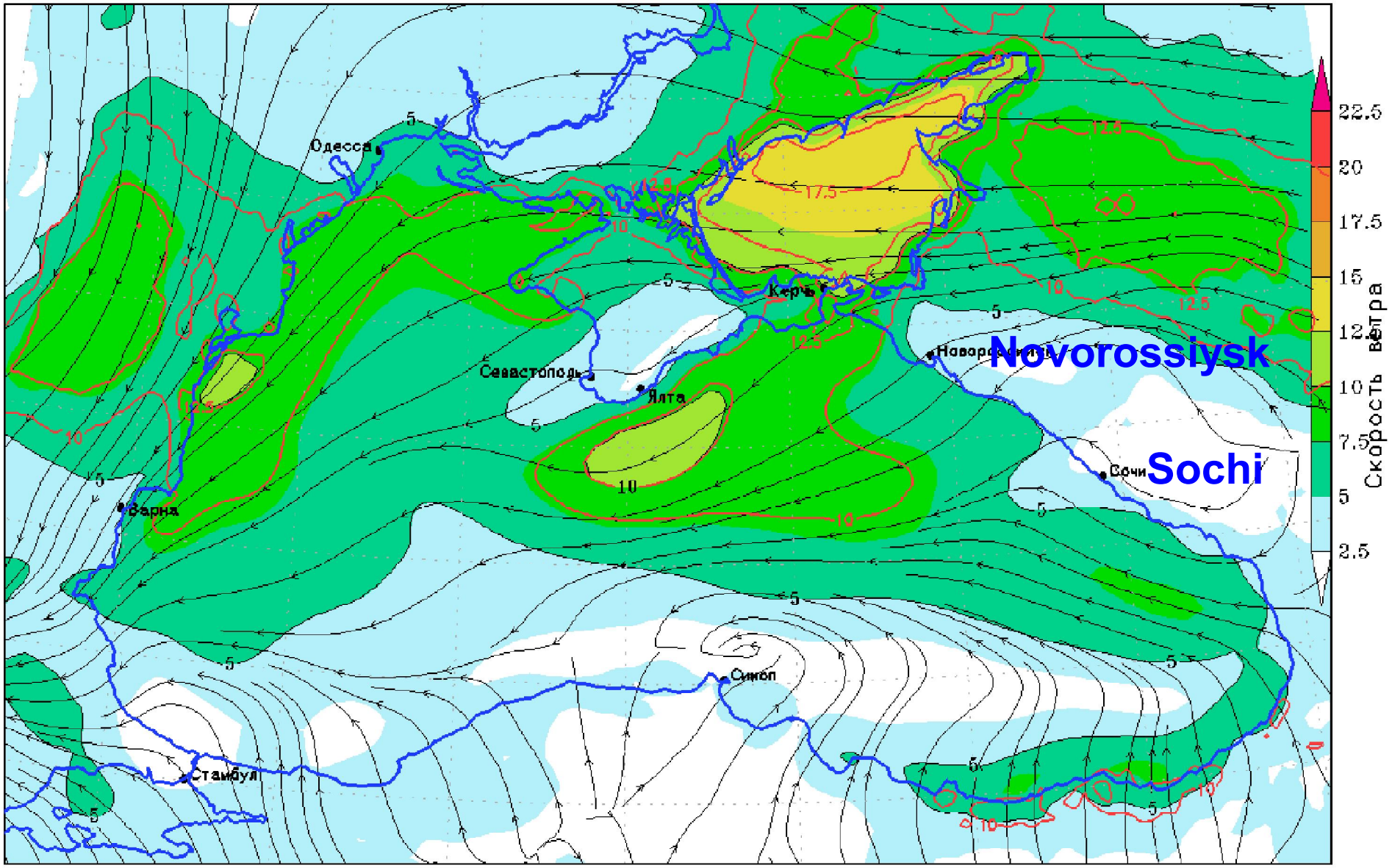

Прогноз на 33ч. от 04:00 06фев 2012 (МСК)

COSMO-RU 7км

Порывы (от 10м/с, через 2,5 м/с)

Направление ветра

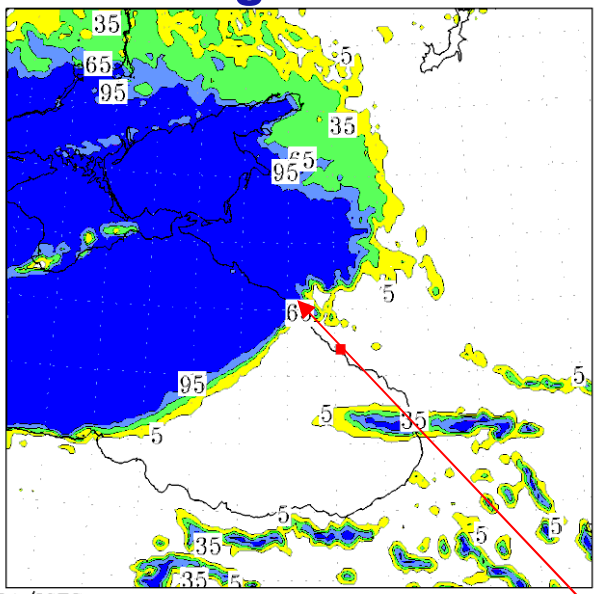
# COSMO-RU07 : STREAM FUNCTION



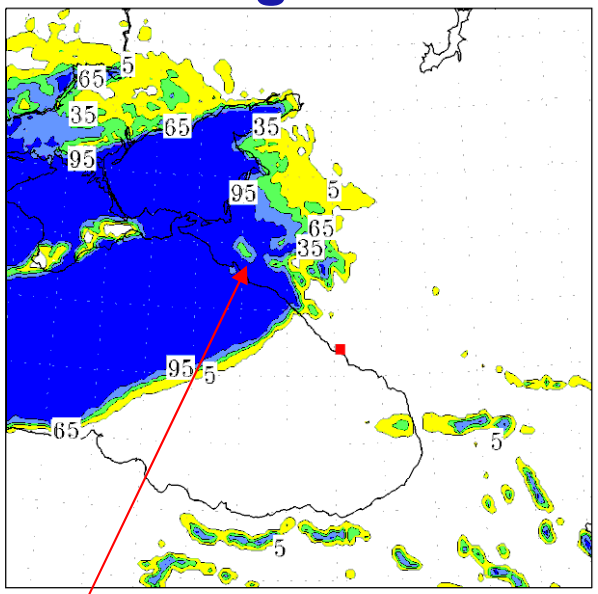
# Strong wind and low temperatures during Novorossiysk bora in February 2012 - probabilities by SOCHMEL7

**Initial 6 Feb 2012 00 GMT  Forecast 7 Feb 2012 from 09 to 12 GMT**

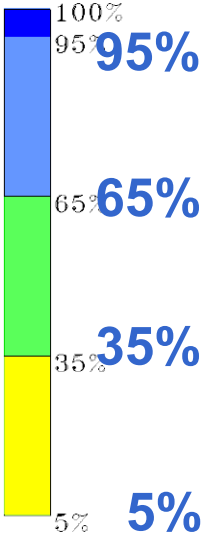
## 10 m wind gust >14m/s



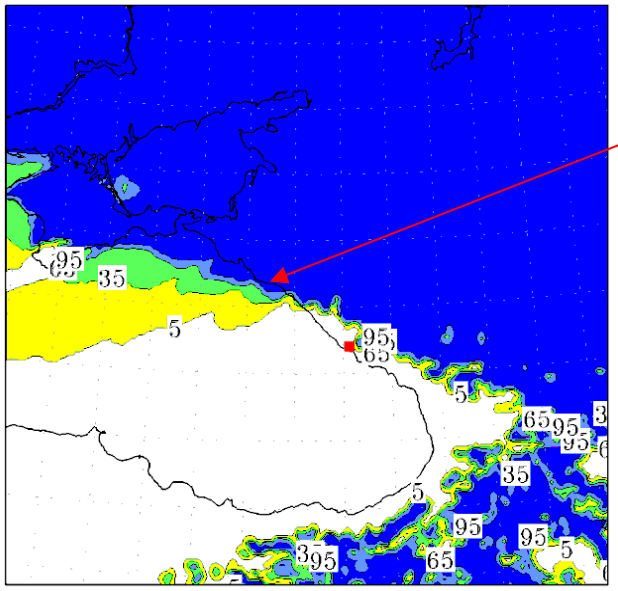

## 10 m wind gust >17m/s




**Blue->Prob >95%**




## Tmin <-5C




**Novorossiysk**
**Wind 30 m/s**
**Temperature -15C**

# CORSO – Task 3.

# CONTENTS

# Plans for 2013 (CORSO PHASE2)

- Tests
- Pre-operational running
- Feed-back from forecasters :

1. Data assimilation based on the nudging: tests and pre-operational runs
2. Development COSMO model version with h = 1 km
3. Modification of TERRA - to finalize and implement
4. Snow high- resolution OA:–WE Modelling + SAT mask information – to finalize and pre-operational tests
5. EPS: Improve the output, Feed-back from forecasters, coupling with elements of statistical postprocessing, COSMO-RU - LEPS-SO-2 km development
6. Postprocessing and applications: tests, improving, Feed-back from forecasters, adapt the software of automatic weather classification (COST733) for the region including the west of Asian part.

# COSMO Project

## CORSO:

**C**onsolidation of
**O**perational and
**R**esearch results for t
**S**ochi
**O**lympics -2014

*Gdaly Rivin, Inna Rozinkina*

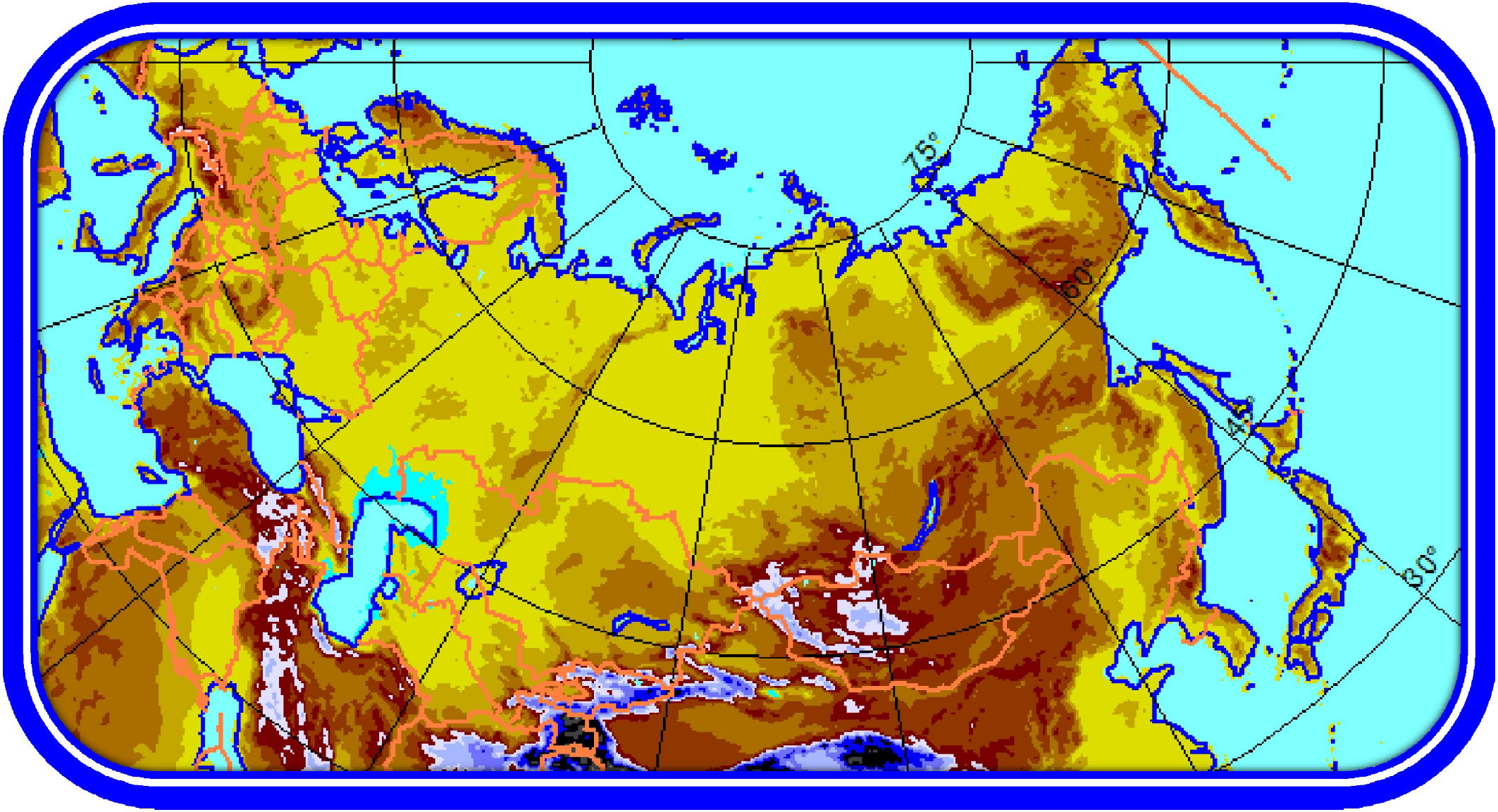
*Hydrometeorological centre of Russia (Roshydromet)*

*and many our colleagues*

sochi.ru 2014

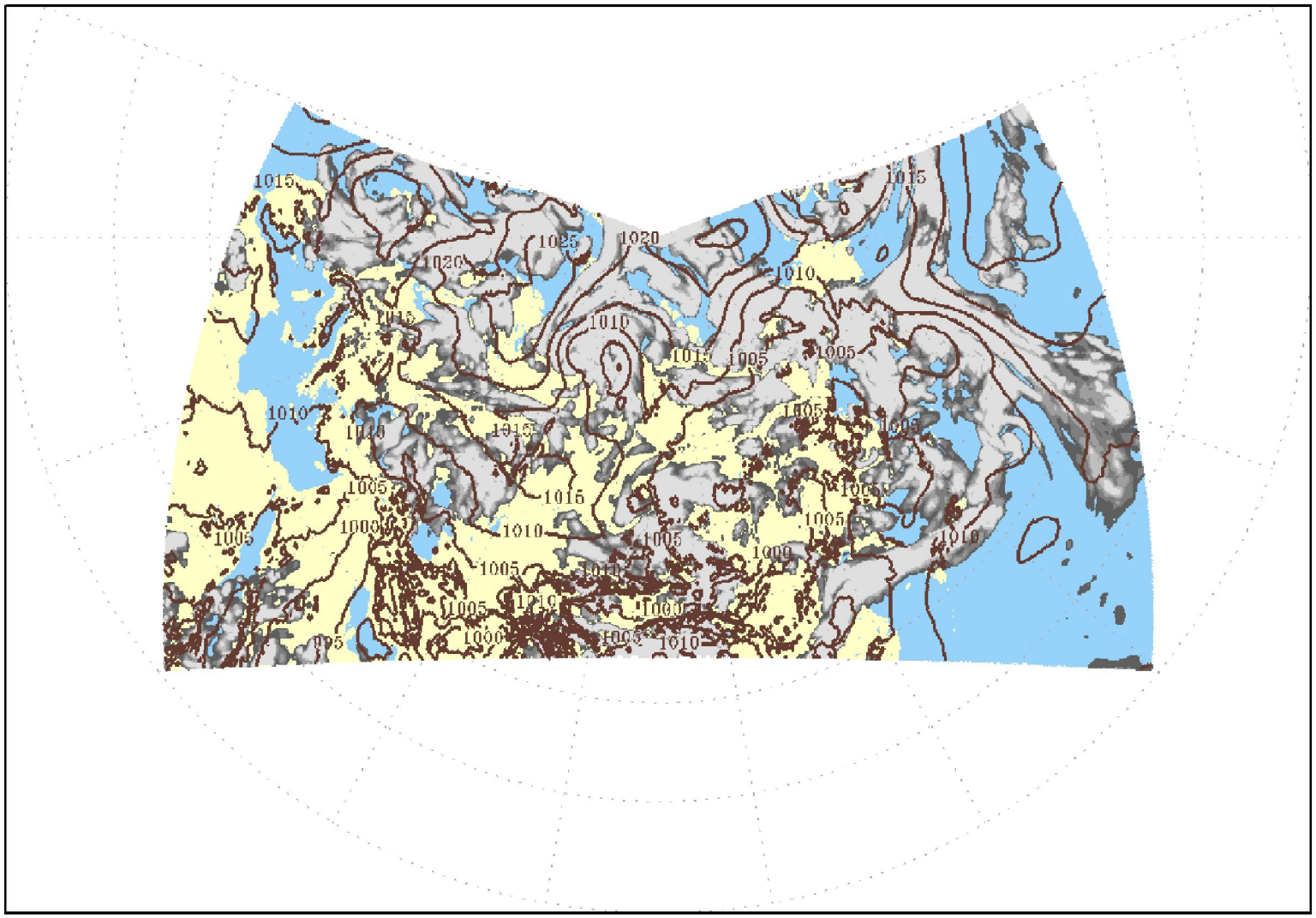
Thank you for your attension !

# 2013 PLAN: COSMO-RU06, GRID 2000 * 1000 * 60, h= 6.6 km

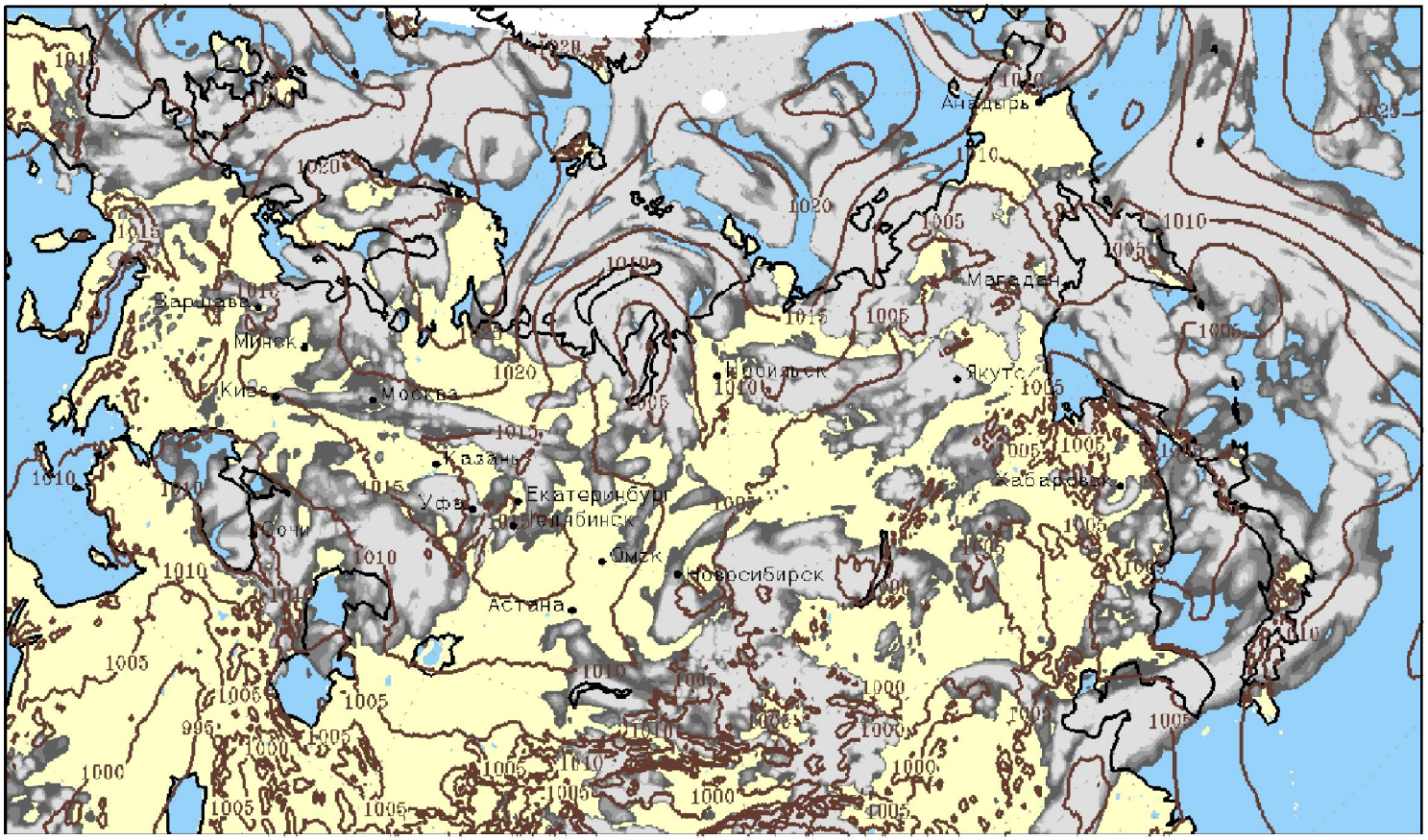



# OROGRAPHY of NEW DOMAIN

04:00 05июл 2012 (МСК): P ур.моря, облачность, осадки



**04:00** 05июл 2012 (МСК): P ур.моря, облачность, осадки




Прогноз на 0ч. от 04:00 05июл 2012 (МСК)

COSMO–RU 13км

Облачность среднего яруса [%]

10 30 50 70 90

Давление на уровне моря