CORSO ensembles: main PP results and their further application

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and RHMC FROST team

CORSO PP: Task 3

Development and adaptation of COSMO EPSs for the Sochi region

Task Leaders: E. Astakhova, A. Montani

FDP: 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

Result: COSMO-S14-EPS 7 km (S14 for Sochi 2014) Operational ensemble forecasts

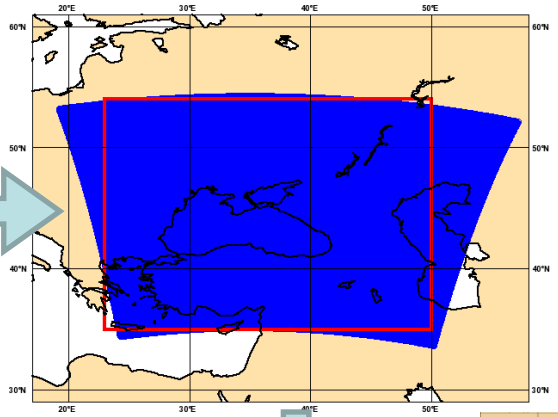
RDP: Development and verification of high-resolution EPS for the Sochi region

Result: COSMO-Ru2-EPS 2.2 km (with ICs and BCs from COSMO-S14-EPS)

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

Meteorological support for Sochi Olympics (products operationally delivered to Sochi forecasters in February-March 2014)

COSMO-S14-EPS (7km):

- Probability fields (T2m max&min,wind gusts 10m,precip,etc)
- Epsgrams (box-and-whiskers + plumes)
- Ensemble mean&spread (on Google maps)

COSMO-Ru2-EPS (2.2 km):

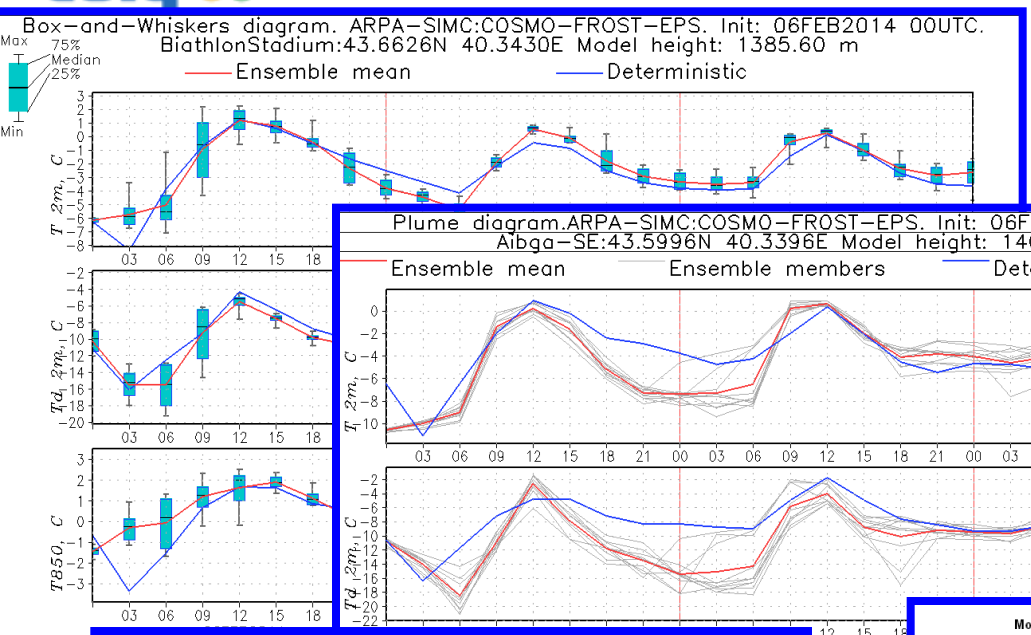
•Epsgrams (box-and-whiskers + plumes)
with T corrected using prognostic lapse rate included

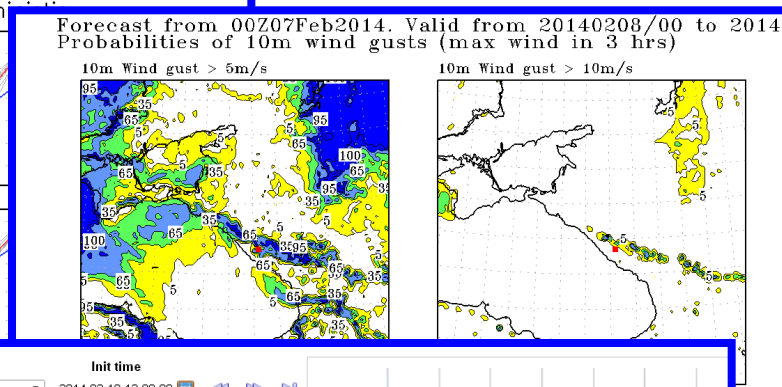
Web-site: frost2014.meteoinfo.ru + ***e-mail directly to forecasters***

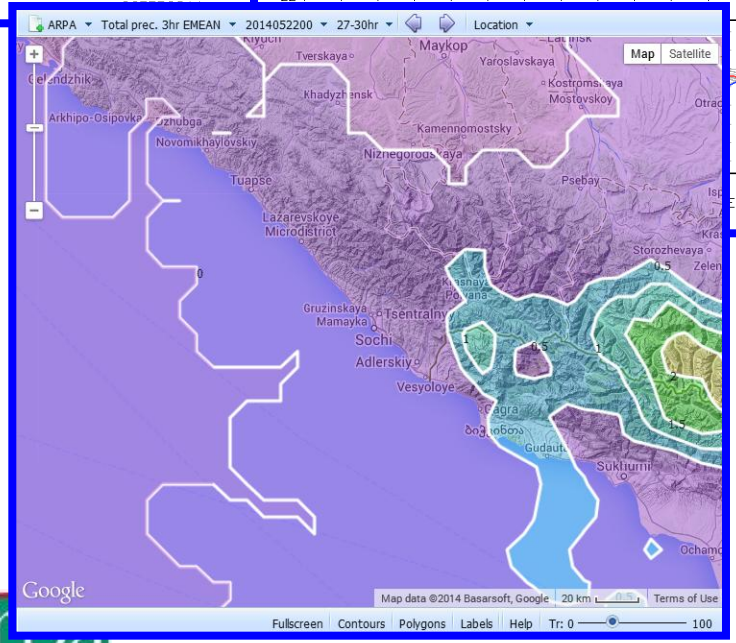
EPSs operational products

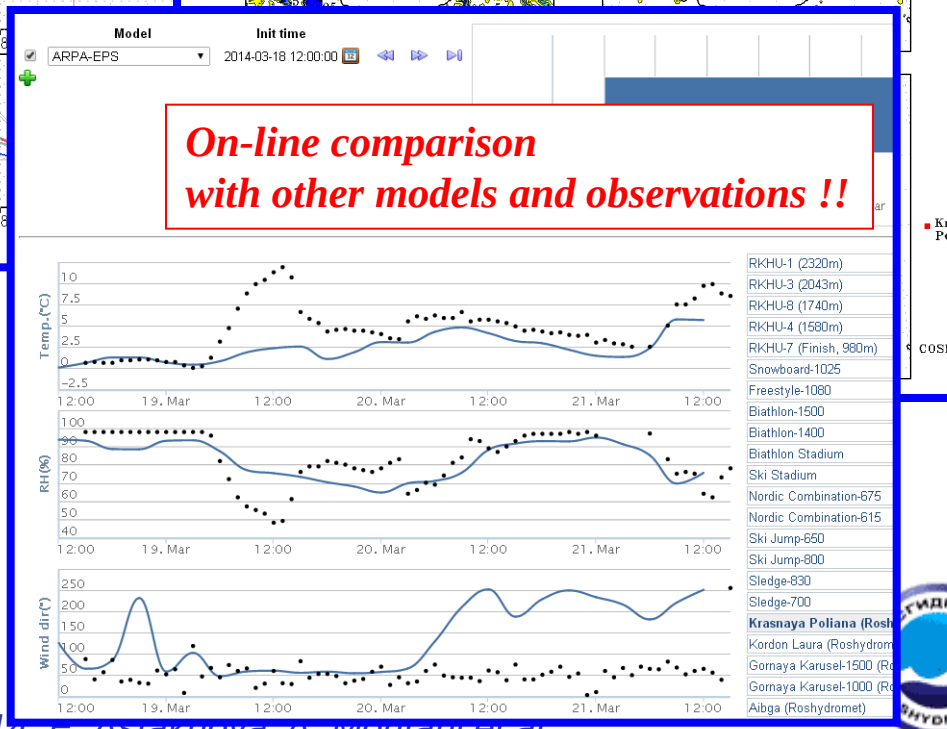
www.frost2014.meteoinfo.ru

Distributed by e-mail









Subjective Evaluation of FROST EPS technologies

0 – not useful 1 – partly useful 2 – useful 3 - excellent

Model Grid mesh size	Overall use-fulness	Forecast accuracy					Visualization (appearance)	Timelines s and reliability
		T	Prec	Wind	Gusts	Vis		
COSMO-S14-EPS 7 km	2.1	2.0	2.0	2.0	2.0		2.7	2.7
	Precip reasonable. Good tendencies. Wind poor. Was available well before the Olympics that was helpful to get used to this information							
ALADIN LAEF 11 km	2.0	1.8	1.8	2.0	2.0		2.5	2.7
	Good Wind, including Vmax. Nice plots							
GLAMEPS 11 km	1.5	1.8	1.8	1.8	2.0		2.3	2.7
	Informative tendencies. Issues with absolute values							
GLAMEPS calibr 11 km	2.0	2.0	2.0	2.0	2.0		2.2	2.7
	Interesting and helpful							
NMMB-EPS 7 km	2.1	2.0	2.0	1.3	2.0	1.7	2.2	2.7
	Nice. Informative visibility. Precip reasonable. Tmin, Tmax poor							

Subjective Evaluation of FROST EPS technologies (continued)

0 – not useful 1 – partly useful 2 – useful 3 - excellent

Model Grid mesh size	Overall use-fulness	Forecast accuracy					Visualization (appearance)	Timeliness and reliability
		T	Prec	Wind	Gusts	Vis		
COSMO-Ru2-EPS 2.2 km	1.7	1.3	1.7	1.7	2.0		2.3	2.3
	Experimental							
HarmonEPS 2.5 km	1.3	1.5	1.3	1.3	1.3		2.2	1.8
	In general good in T and Precip, but there were problems with T in anticyclones and Foehn							

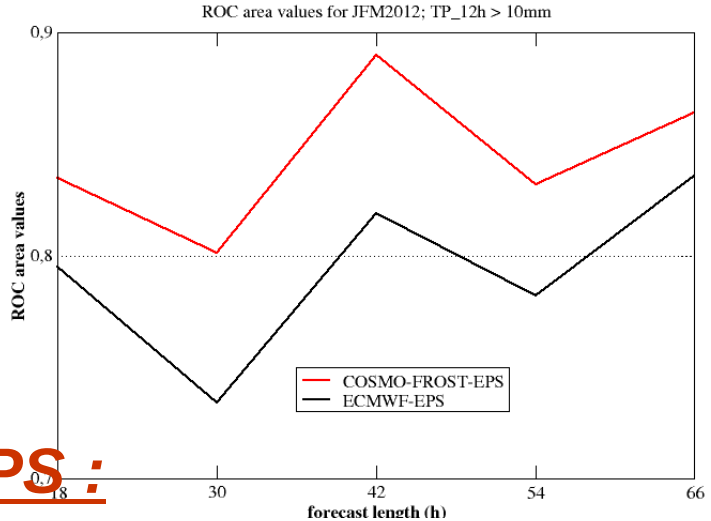
During the Sochi Olympics COSMO model was the most popular (both deterministic and ensemble forecasts) !!

Testing and verification

COSMO-S14-EPS vs ECMWF EPS :

Andrea Montani, C. Marsigli and T. Paccagnella, COSMO Newsletter No. 13,2013:
Verification against 60 SYNOPs, SOCHIDOM, 12-h precipitation sum, JFM2012

Conclusion: Cosmo-S14-EPS mainly performs better than the driving EPS



COSMO-S14-EPS vs COSMO-Ru2-EPS :

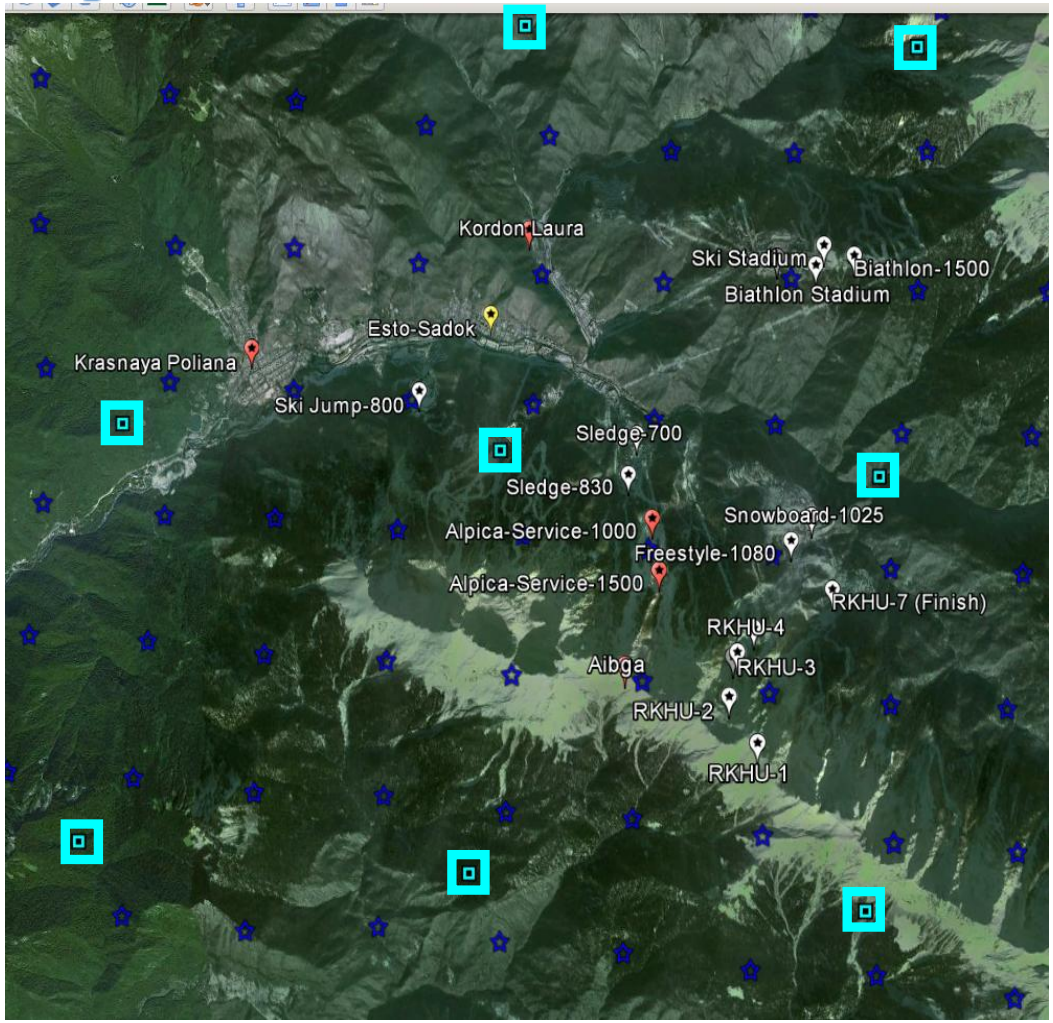
1)Verification using VERSUS
3-h prec,T2m: 15-km +nearest point,
all stations in Sochi region (AMS+SYNOPs, 69 for T), 13 mountain stations
2) Verification using HMC verification package based on R (A. Muravev)
3-h prec,T2m,wind speed
13 mountain stations (the lowest - Krasnaya Polyana, H=564 m)

All FROST EPSs:

COSMO-S14-EPS: Italy, 7 km, M10, fc+72; LAEF: Austria, 7 km, M17, fc+72;
NMMB-EPS: USA, 7 km, M7,fc+72; GLAMEPS: Norway,11 km, M54, fc+54;
COSMO-RU2-EPS: Russia, 2.2 km,M10, fc+48;
HARMON-EPS: Norway , 2.5 km, M13, fc+36

Come to Anastasia's presentation tomorrow!

Verification problems



Legend:

Light-blue squares: COSMO-S14-EPS grid-points

Dark-blue stars: COSMO-RU2-EPS grid-points

Nearest point approach:

- One model grid-point may be the nearest to several stations
- The nearest grid-point can be in different valley, at different slope, or at different height with respect to the station
- Differentiation by height decreases the sample considerably

Several-km domain:

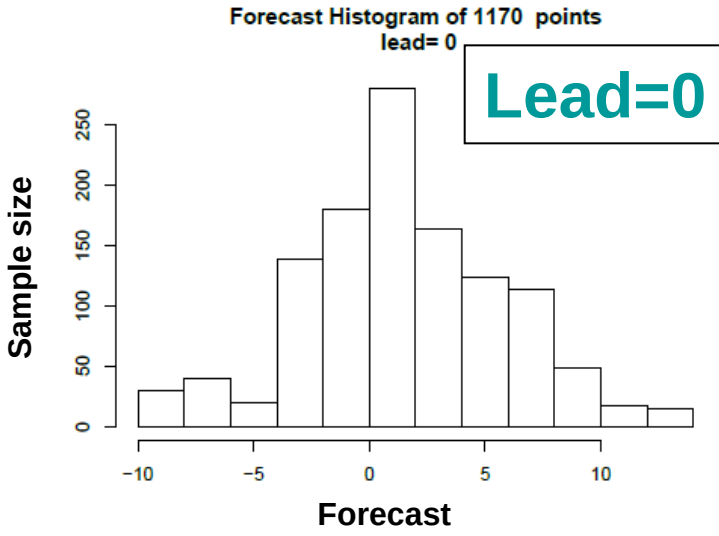
- Stations in the domain can be at different heights, slopes, etc. and can be characterized by various meteorological regimes

All approaches:

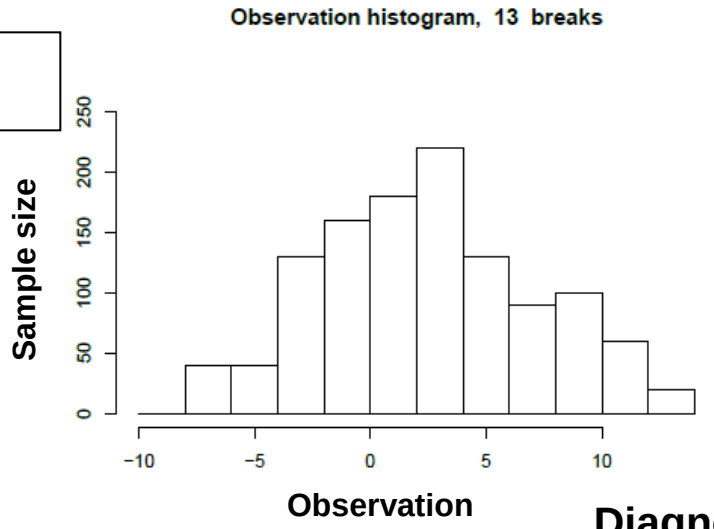
- Need for better observation data control
- Need for forecast data control (especially for hi-res!)
- The more observations the better

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

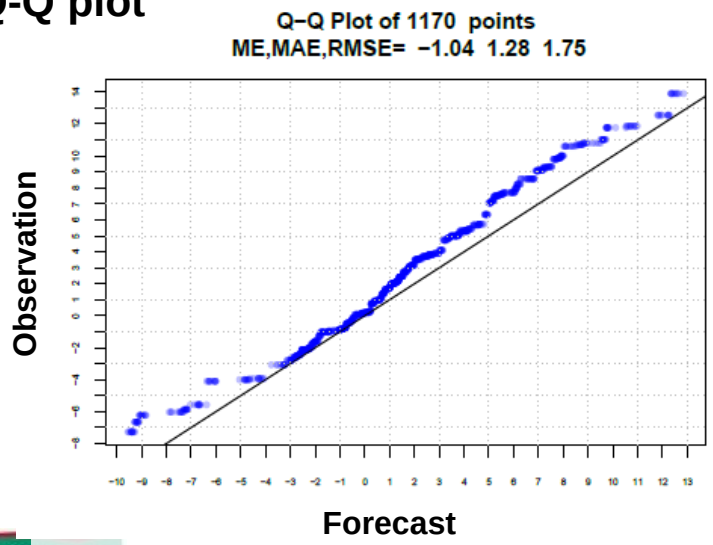


Lead=0

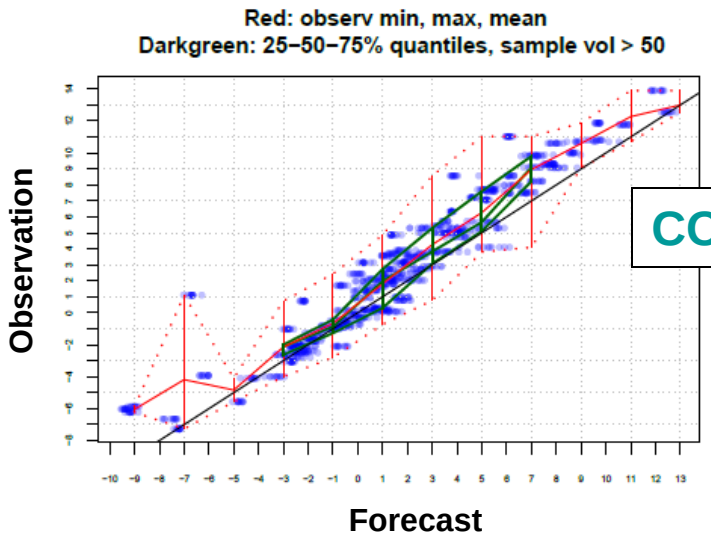


All forecasts starting from 00 UTC and 12 UTC analyses

Q-Q plot



Diagnostic diagram



Red:observations
Blue:forecasts

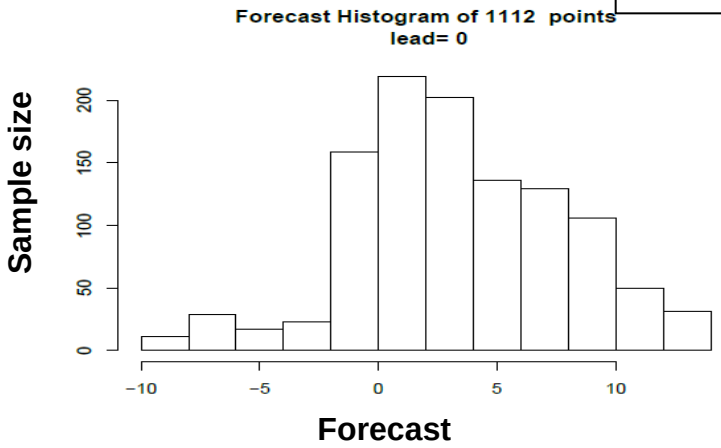
COSMO-S14-EPS

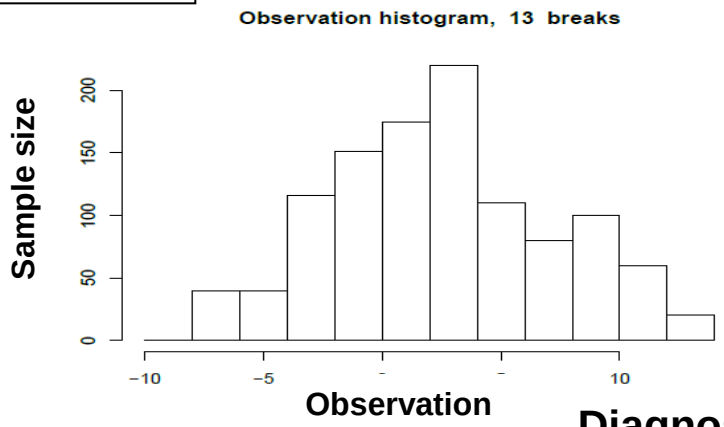
Q-Q plots test whether the samples are from the same distribution

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

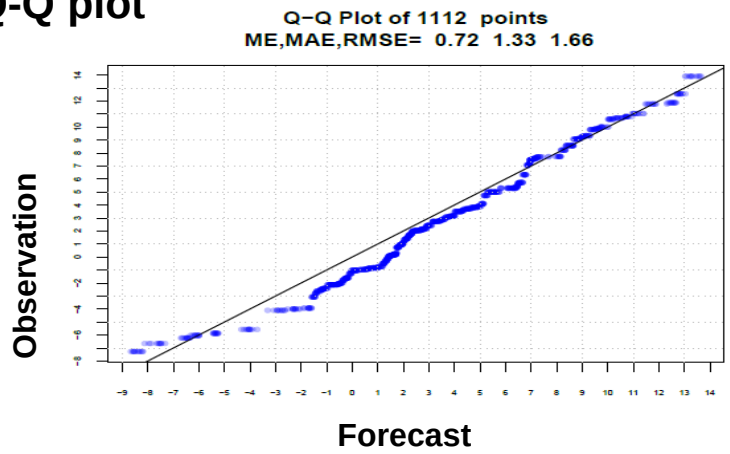


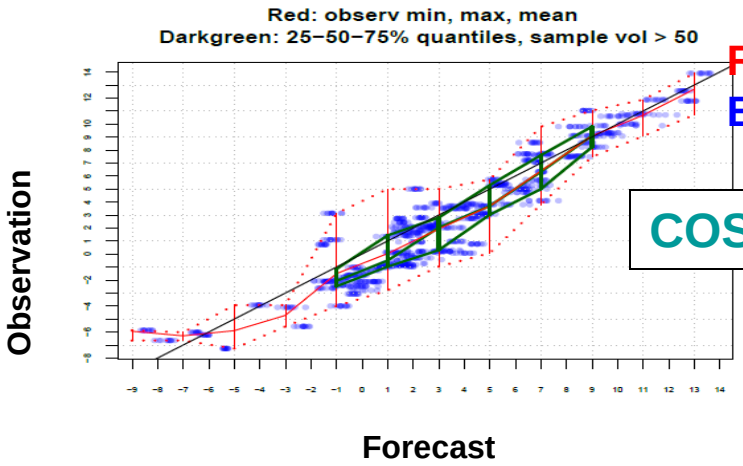


All forecasts starting from 00 UTC and 12 UTC analyses

Diagnostic diagram

Q-Q plot





Red:observations
Blue:forecasts

COSMO-Ru2-EPS

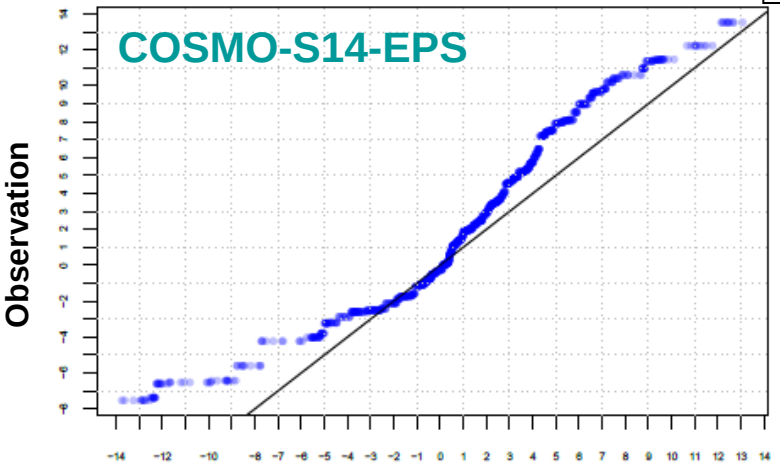
If the two datasets come from the same distribution, the points should lie roughly on a line through the origin with slope 1

Role of spatial resolution

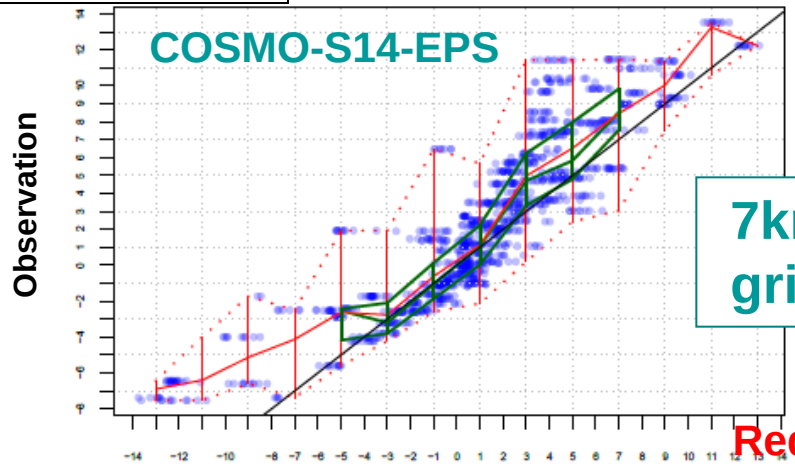
Parameter: T2m, Location: Biathlon Stadium (1455 m),
Verification Period: 15.1.2014-15.3.2014, Verification approach: Nearest point

Lead=48

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

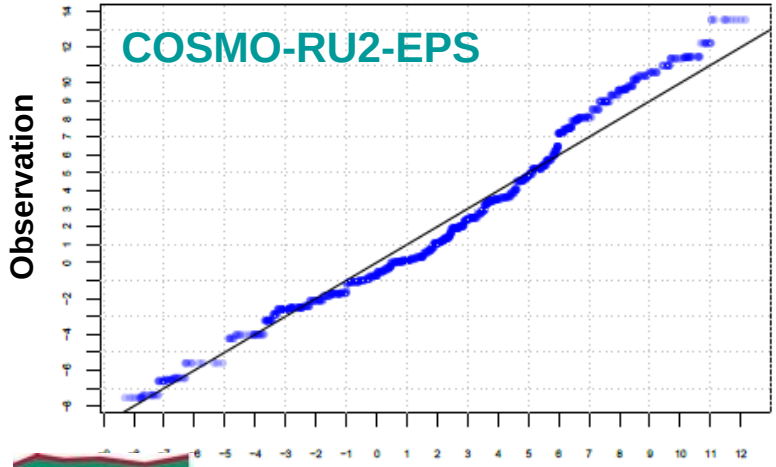


Diagnostic diagram
Red: observ min, max, mean
Darkgreen: 25–50–75% quantiles, sample vol > 50

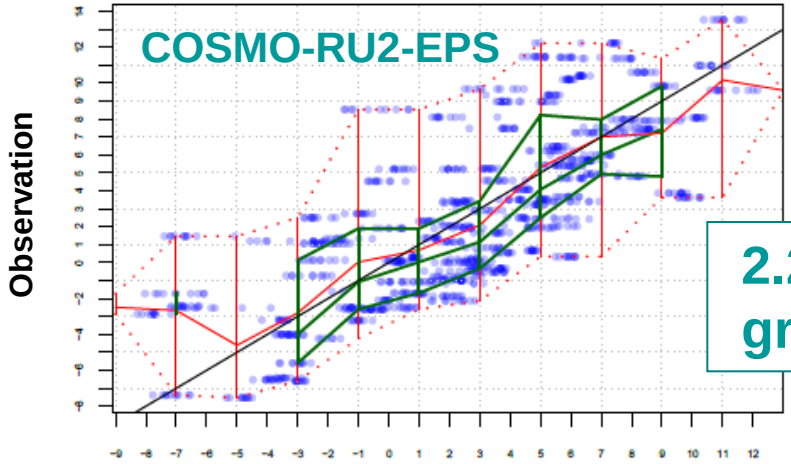


7km
grid spacing

ME=-0.02 MAE=2.61 RMSE= 3.20



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



Red:observations
Blue:forecasts

2.2 km
grid spacing

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

Role of spatial resolution for ensemble forecasts – continued

COSMO-S14-EPS (7km grid spacing) vs COSMO-RU2-EPS (2.2 km grid spacing)

T2m ensemble mean

Verification Period: 15.1.2014-15.3.2014

Station	BIAS (for 6/12/18hr lead time)		Mean Absolute Error (for 6/12/18hr lead time)	
	COSMO-S14-EPS	COSMO-RU2-EPS	COSMO-S14-EPS	COSMO-RU2-EPS
Sledge (~700m)	-1.3 / -2.0/ -1.4	0.2 / -1.9 / -0.1	1.6 / 2.2 / 1.6	1.4 / 3.5 / 1.7
Freestyle (~1000m)	-2.0 / -1.8 / -1.9	0.3 / -0.7 / 0.0	2.1 / 2.0 / 2.1	1.6 / 2.4 / 1.7
Biathlon Stadium (~1500m)	-1.4 / -1.3 / -1.4	0.9 / 0.0 / 0.5	2.0 / 1.8 / 2.1	2.1 / 2.6 / 2.3
Mountain Skiing(start) (~2000m)	1.6 / 2.2 / 1.6	0.6 / 0.2 / 0.1	2.8 / 3.1 / 2.8	2.1 / 2.2 / 2.6

Green – better for all lead times

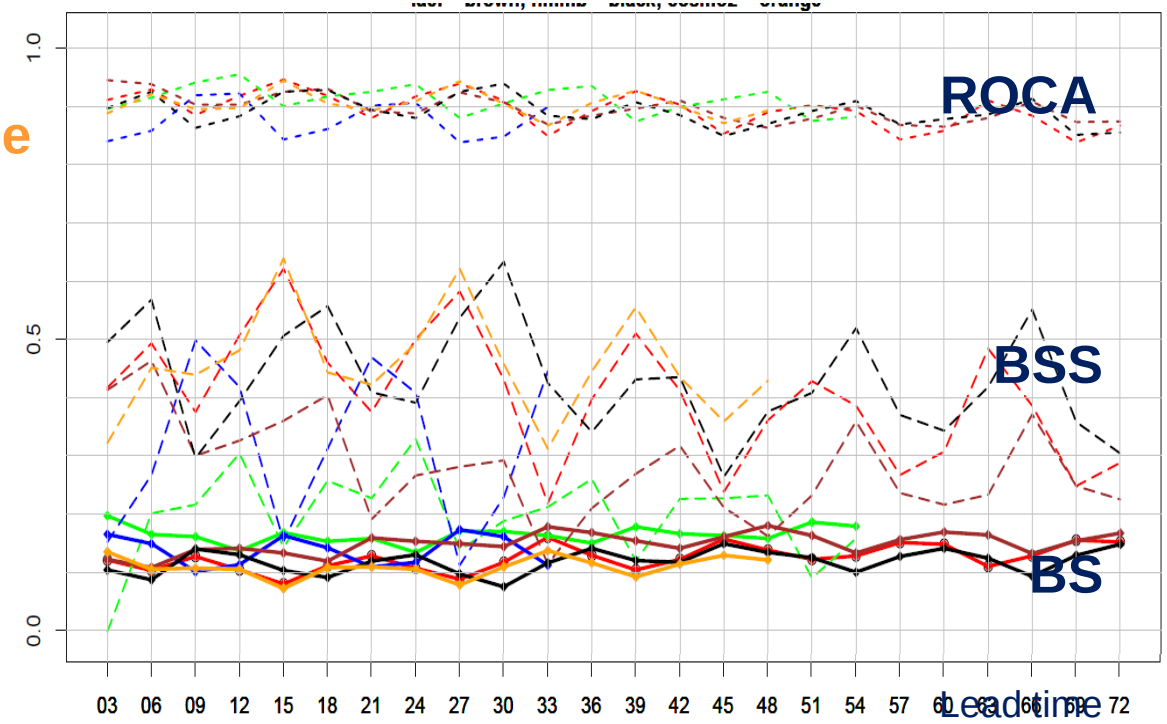
- **T2m: Some positive effect of downscaling from 7 to 2 km resolution**
- **Wind Speed: No positive effect of dynamical downscaling was found**

Comparison with other FROST2014 ensembles
Precip > 0.01 mm/3h

Verification Period: 15.1.2014-15.3.2014

COSMO-S14-EPS – red
COSMO-RU2-EPS – orange
LAEF – brown
NMMB-EPS – black
HARMON-EPS – blue
GLAMEPS – green

Verification approach: 13 mountain stations in the area of Krasnaya Polyana were clustered for matching to forecasts

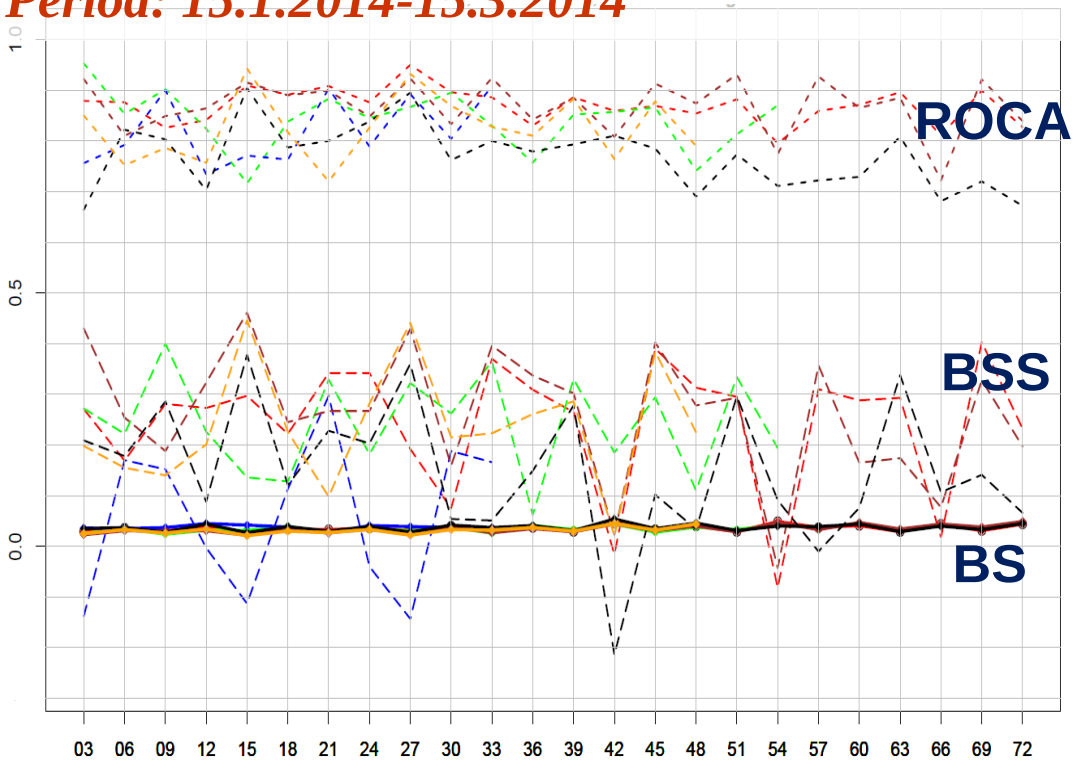


COSMO-S14-EPS, NMMB-EPS and COSMO-RU2-EPS look most informative

Comparison with other FROST2014 ensembles
Precip > 5 mm/3h

Verification Period: 15.1.2014-15.3.2014

COSMO-S14-EPS – red
COSMO-RU2-EPS – orange
LAEF-EPS – brown
NMMB-EPS – black
HARMON-EPS – blue
GLAMEPS – green



For higher Precip threshold (w.r.t. the lower threshold):
= COSMO-S14-EPS, COSMO-Ru2-EPS, NMMB-EPS, and HARMON-EPS become worse.
= In contrast, LAEF and GLAMEPS become better.

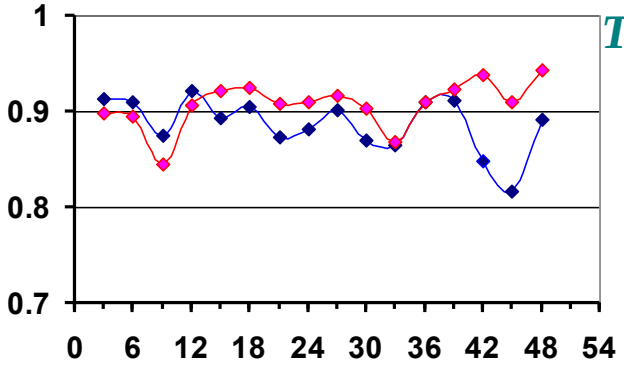
EPS verification using VERSUS

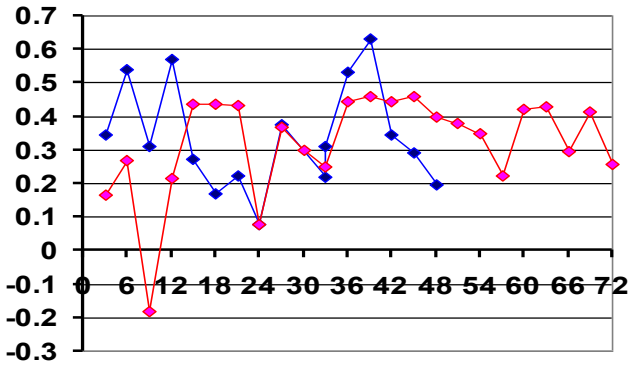
3-h precipitation. February 2014. Run 0.

ROCA | **BSS**

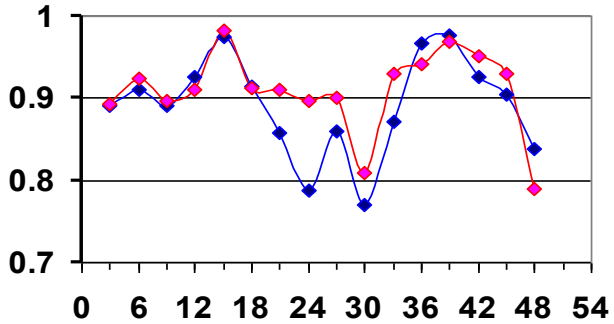
The higher the better!

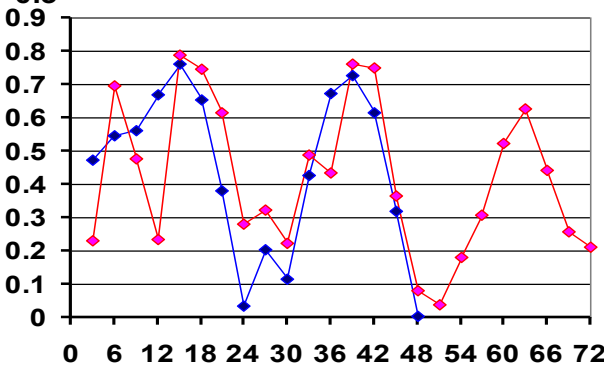
Pr>0.01 mm/3h



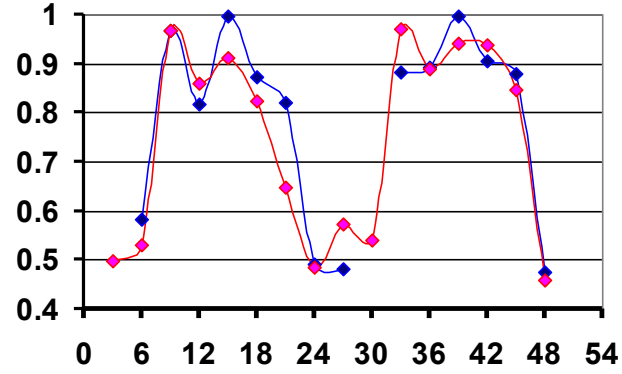


Pr>0.5 mm/3h





Pr>2.5 mm/3h



COSMO-Ru2-EPS

COSMO-S14-EPS

Lead time, h

Small differences!

The same was earlier demonstrated for T2m.

Using the nearest point and the average in 15-km radius around the station gave close results !?

EPS verification conclusions

- Both systems demonstrate good skill for T2m, prec and wind
- Hi-res system is slightly more skilful for T2m, but worse for wind
- Observations at high temporal and spatial resolution are needed
- Further research to develop and apply new and specific methods for verification of hi-res EPS in mountain regions are necessary:
  --- Non-automatic matching of stations and grid-points
  ---Application of additional observation data (radars, satellites, etc.)
  ---Extreme dependence index (EDI) should be considered
- Case studies should be widely used

- A definite conclusion on EPSs skill in the mountains
- Precise and unambiguous methods for hi-res EPS verification

……..

There is still a lot of work to do …….

CONCLUSIONS

- The EPS systems developed for Sochi Olympics (COSMO-S14-EPS and COSMO-Ru2-EPS) demonstrated high skill

- They provided a good support to Sochi forecasters and were highly appreciated

- The hi-res system added value

- Verification activity should be continued, including application of new approaches and observations, comparison with other FROST2014 ensembles

- The archived information on forecasts, IC&BCs, and observations are valuable and new experiments can be performed within the Sochi testbed

Introduction of SPPT to COSMO-Ru2-EPS: Preliminary results

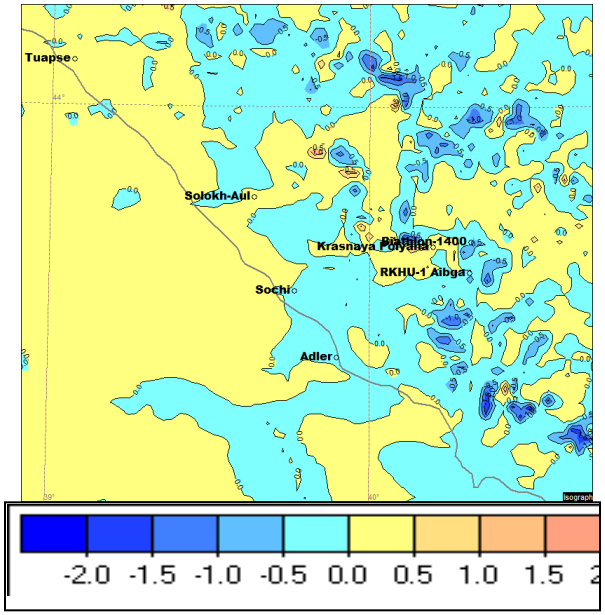
Thanks to Lucio and Christoph for the code

- COSMO model ver. 5.0
- SPPT settings

lgauss_rn=.true., hinc_rn=6., dlat_rn=5., dlon_rn=5., stdv_rn=0.4, range_rn=0.8, lhorint_rn=.false., ltimeint_rn=.false., ltype_qxlim_rn=0, ltype_qxpert_rn=0, npattern_rn=1

- Sochi data (February 2014)

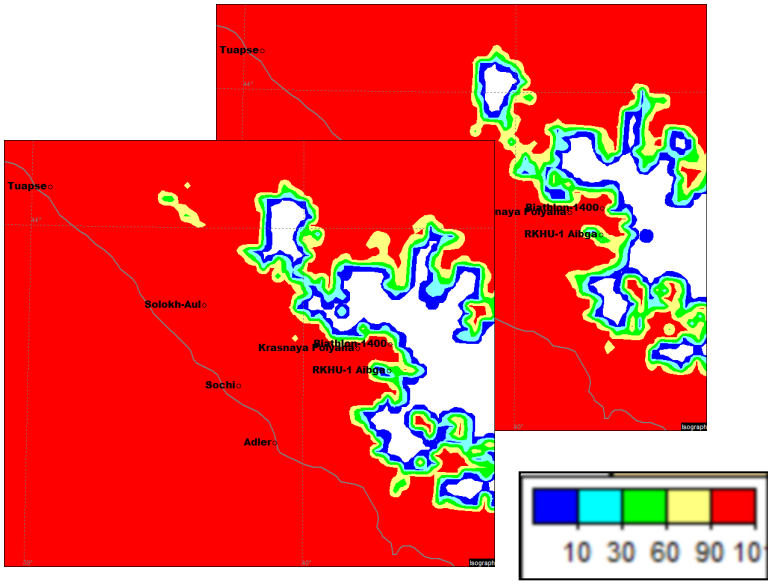
Spread changes (SPPT- oper)



00 UTC 06 Feb 2014 FC+48h

No stability problems!

Changes in probability maps



00 UTC 06 Feb 2014 FC+12h
Probability of T2m>0

Further analysis needed

CORSO-A (CORSO After)
Task 3. Motivation

- Sochi region is a very specific area, where mountains with very steep slopes are in close vicinity to the sea and where high-resolution forecasting of high-impact events is a real challenge

- As a result of CORSO and FROST-2014 projects we have

- COSMO-S14-EPS forecasts (Dec19, 2011 to April 2014)
- COSMO-Ru2-EPS forecasts (….. to April 2014)
- IC&BCs for COSMO-based EPS for Sochi region (2013 …. – April 2014)
- FROST-2014 observation data (SYNOPS+AMS) for 2011-2014
- GLAMEPS, ALADIN-LAEF,HARMON-EPS,NMMB-EPS forecasts at least for Febr-March 2014
- A preliminary list of interesting cases during the Olympics

CORSO-A (CORSO After)
Task 3. What is not done yet

- There are some gaps in the data
- COSMO-Ru2-EPS forecasts are stored on different computers to which there is no external access
- The entire model outputs are stored for COSMO-Ru2-EPS (problems with processing!)
- There is no manual
- The data should be completed by a list of severe events and periods that are worth to examine
- The entire archive should be re-organized according to TIGGE-LAM rules and be a part of FROST-2014 archive

CORSO-A (CORSO After)
Task 3. Goal.

To prepare an archive of COSMO ensemble forecasts (with 7 and 2.2 km resolutions) for the Sochi area for December 2013-April 2014 accompanied by initial and boundary conditions for high-resolution ensembles and by a list of important weather events during the period considered.

The archive must be easily accessible and have a clear manual to provide COSMO-community a possibility of experiments over a mountainous area

1-year project, 0.25 FTE for Task 3

CORSO-A (CORSO After) Task 3.

Questions

Should we include probability fields into the archive?
Should it be password protected?
Should the data for winter 2012-2013 be added to the archive?
Any additional recommendations?

Possible and current applications

Russia is using Sochi data for experiments with COSMO-Ru2-EPS version with SPPT for COTEKINO (IC&BCs + reference forecast)

……


Thank you!