PP CORSO TASK2
«Downscaling / post-processing for Sochi area and applications» Part 1

Inna Rozinkina, Ekaterina Kazakova, Mikhail Chumakov

TASK2 «Downscaling / post-processing for Sochi area and applications

- **Subtask 2.1 Adapted downscaling techniques for mountain winter conditions and IOC requirements**

- **Subtask 2.2. Determination of typical COSMO-model inaccuracies for typical climatologic /synoptic situations**, incl. verification

- **The calculations of fresh-snow depth were included in the operational technology and were available for forecasters from meteograms and form charts. The algorithm was included into FieldExtra**

- **The operational technology for down-scaling corrections of forecasts for points of venues based the forecasts of lapse rate + the KF statistics was realized**. Results of tests for the forecasts archives was received

- In meteograms were included the new columns and lines: for fresh snow depth and for corrected T2m

- During the Olympics some in-situ trainings and Guidelines-recommendations for forecasters for specifics of interpretation of mesoscale products were performed.

Fresh snow depth postprocessing

Scheme of fresh snow postprocessing at Roshydromet
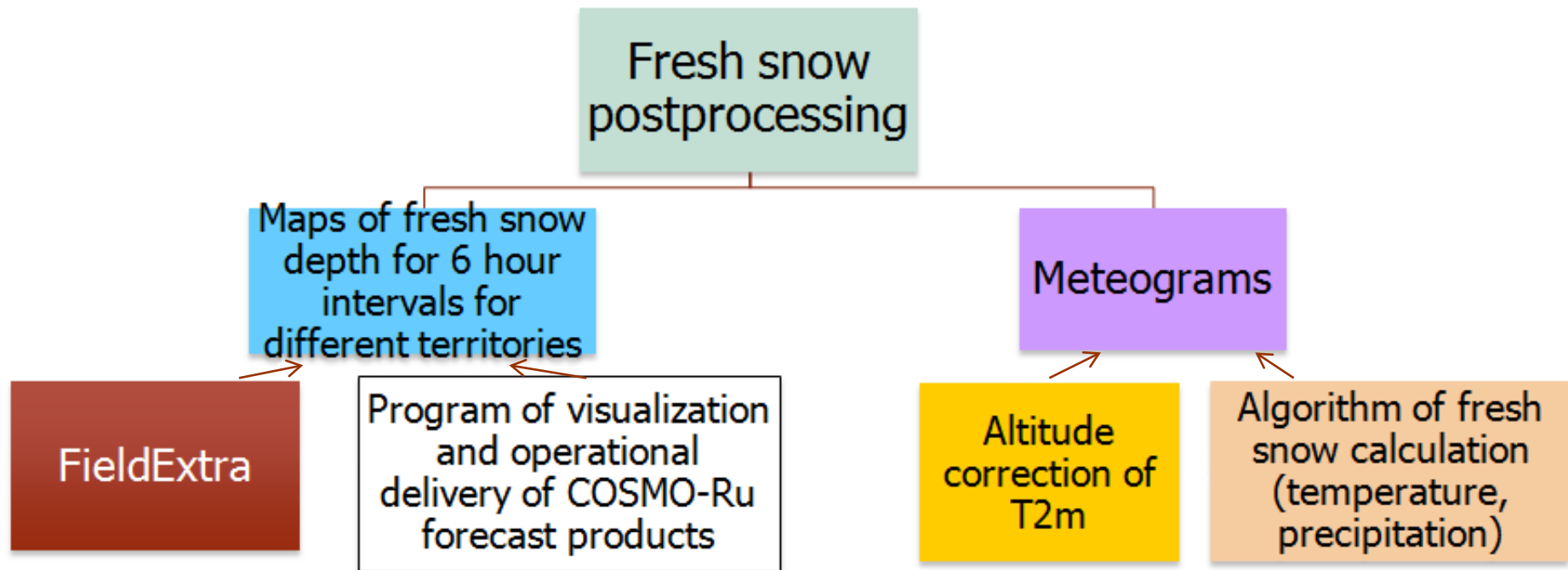
Fresh snow depth postprocessing (maps) is coupled with COSMO-Ru technology (COSMO-Ru7/2/1 (four times per day)   and produced the results (maps and meteograms) for each versions (7, 2.2 and 1.1 km).

Algorithm of fresh snow depth calculation

Fresh snow depth calculation is based on the dependency on air temperature and precipitation sums. The basic equations:

$$\rho_{s,f} = 67,92 + 51,25 e^{\frac{T_a}{2.59}}, \ T_a \leq 0^0 C; \ \rho_{s,f} = \min(200,119,2 + 20 T_a), T_a > 0^0 C$$

$$h_{s,f} = \frac{p_s \cdot \rho_w}{\rho_{s,f}}$$

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)

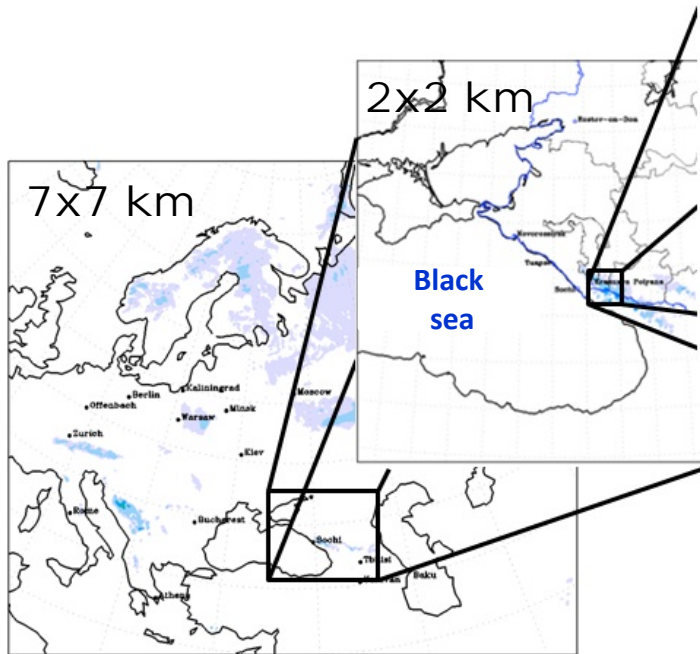$\rho_{s,f}$ - fresh snow density (kg/m³), T_a - air temperature (◦C), p_s - sum of precipitation (mm)

ρ_w =1000kg/m³ – density of water

In Dec-Jnv 2013 some tuning for cases of positive temperature was performed

Fresh snow depth forecasts form
COSMO-Ru technology.
12 UTC 5 March 2014
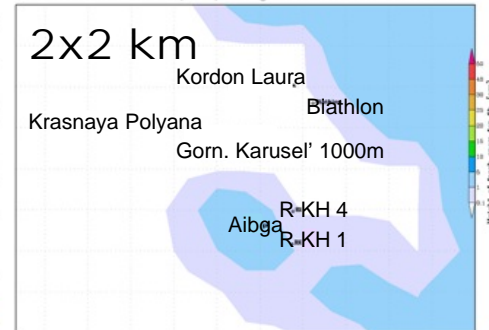
Snow depth measurements s in Sochi region

Fresh snow depth can be determined from measurements of AMS with 1-hour interval.

Standard meteorological observations made once a day and could be used for quality estimation

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

snow
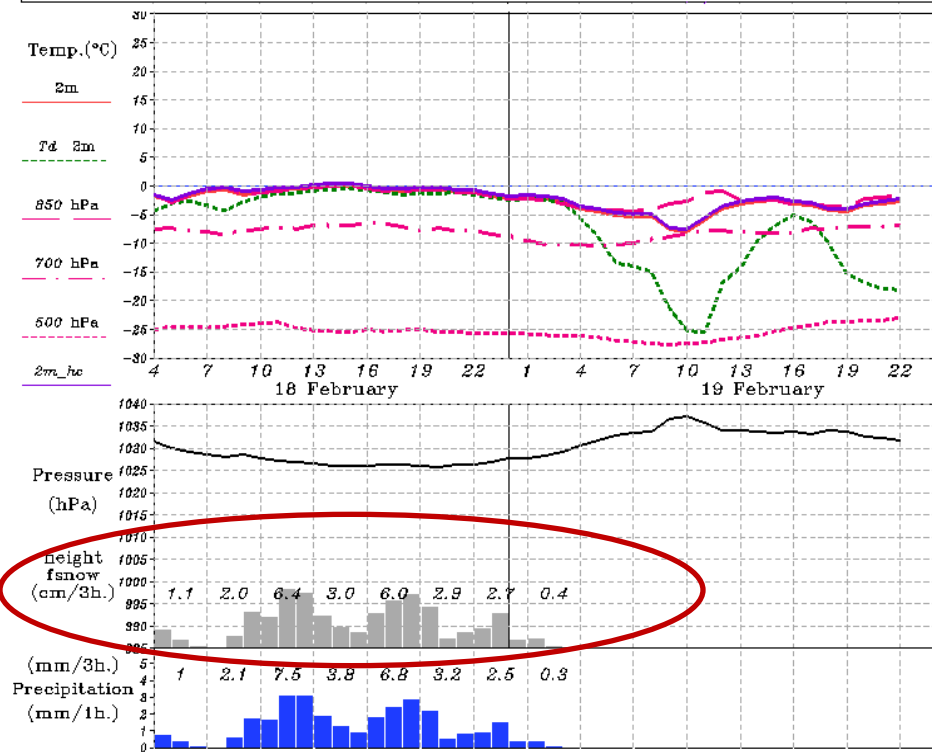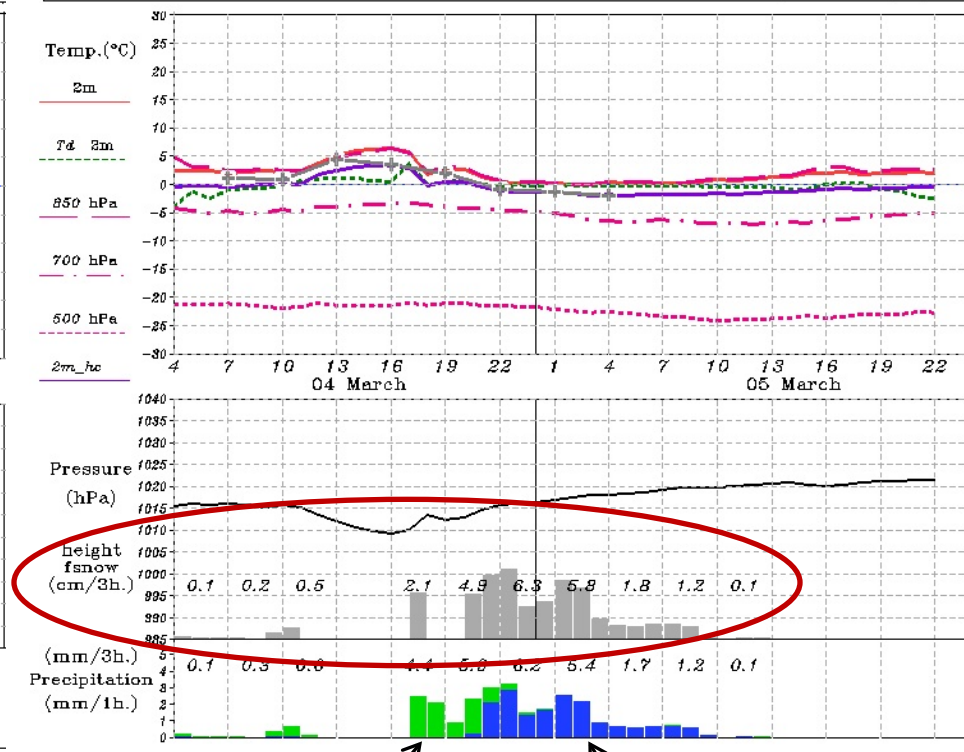
rain   snow

Fresh snow depth (cm) for 18 February 2014 (24 hours) for station Roza Khutor 4

Obs	Model start (day hour)						www.snow-forecast.com
	16 18	17 00	17 06	17 12	17 18	18 00	
28,2	COSMO-Ru 2.2 forecasts						12,0
	18,0	30,0	39,5	22,1	25,4	**21,3**	
28,2	COSMO-Ru 1.1 forecasts						12,0
	-	17,0	24,9	40,8	19,9	**16,8**	

In bold type there are prognostic sums for 18 hours

Results

- Technology of fresh snow depth postprocessing is realized at Roshydromet

- During winter Olympic Games Sochi-2014 maps, meteograms and tables were used operationally by forecasters

- Comparison between different versions of COSMO-model (7 km, 2.2 km and 1 km) was done. Accuracy for versions COSMO-Ru2 and COSMO-Ru1 is familiar and depends on accuracy in amount and prognostic time of precipitation

- Use of corrected T2m in the proposed fresh snow depth algorithm for Sochi stations (Sochi region) improves COSMO-Ru2 and COSMO-Ru1 forecasts of the amount of fresh snow and its presence (reflected in meteograms)

T2m forecasts

Main factors of T2m inaccuracies in mountain

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

Inadequate work of parameterizations schemes

Two-step correction of forecasts for points (meteograms)

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

Statistical correction based KF

Scheme of h-correction of T2m

CASE 2: Hreal < Hmodel   CASE 1: Hreal > Hmodel

T2m corr = T2m model + Δ T

H real

Δ H = Hreal-- Hmodel

$$\Delta T = \left(\frac{T_{k-2} - T_{k-1}}{H_{k-2} - H_{k-1}} \right) \times \Delta H$$

Real orography

Interval for gradient

K-n

K-4

Model Layers

K-3

Interval for gradient

H model

K-2

Model orography

T2m model

K-1

Land surface

H model

T2m model

H real

T2m corr = T2m model + Δ T

Δ H = Hreal-- Hmodel

$$\Delta T = \left(\frac{T_{k-n} - T_{k-1}}{H_{k-n} - H_{k-1}} \right) \times \Delta H$$
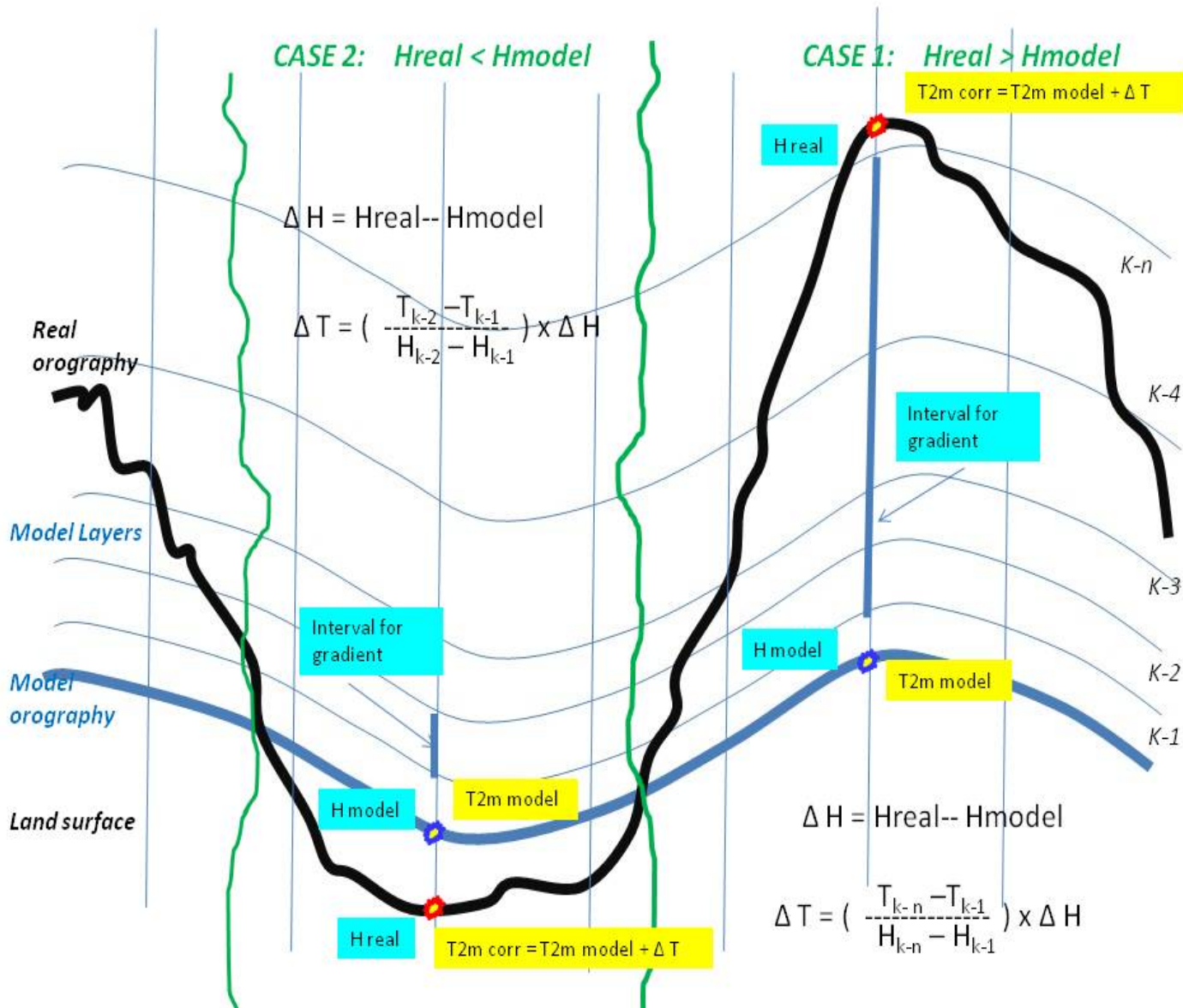
Kalman filter correction for Sochi region

Meteorological stations in Sochi region

RMSE for T2m COSMO-Ru 2.2 km forecasts. Start 00UTC 1 March -30 June 2014

Sochi Adler (0 m)

forecast, hour	RMSE		
	oper	cor	FK
3	1,8	1,9	1,5
6	1,8	1,8	1,5
9	2,0	2,0	2,1
12	1,9	1,9	1,9
15	1,6	1,6	1,7
18	1,5	1,5	1,8
21	2,0	2,0	2,2
24	1,4	1,5	1,9

Imeretinka (6 m)

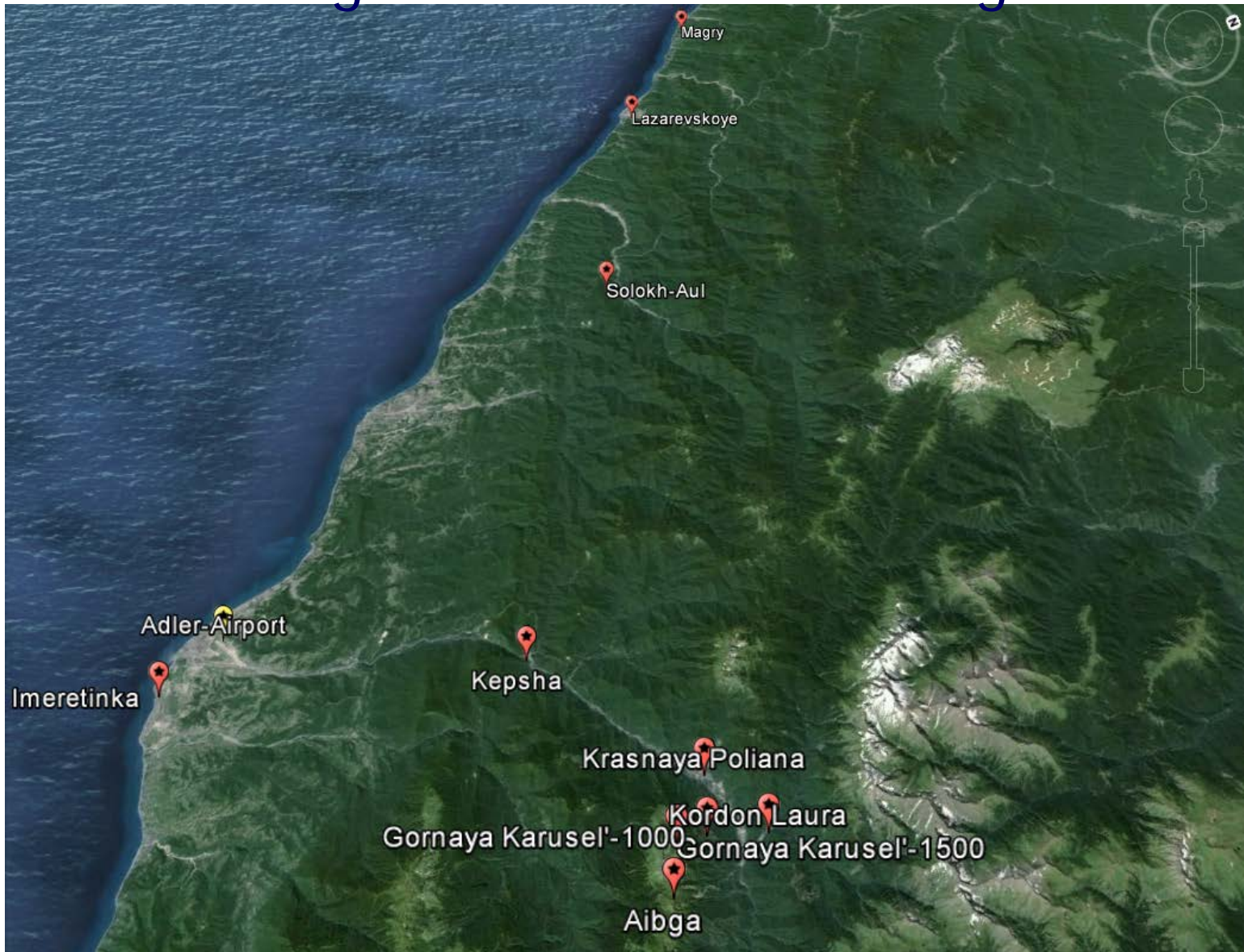| forecast, hour	RMSE		
	oper	cor	FK
3	3,0	3,1	2,8
6	3,1	3,1	3,0
9	3,8	3,8	3,9
12	3,7	3,7	3,6
15	1,7	1,6	1,6
18	2,0	2,1	2,3
21	2,0	2,0	2,3
24	2,3	2,3	2,6

Lazarevskoe (9 m)
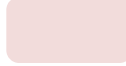
forecast, hour	RMSE		
	oper	cor	FK
3	2,0	2,1	1,8
6	2,0	2,0	2,1
9	3,0	3,0	2,6
12	3,1	3,1	2,5
15	2,4	3,3	2,4
18	1,6	1,6	2,0
21	1,6	1,6	1,5
24	2,0	1,9	1,7

Magri (50 m)

forecast, hour	RMSE		
	oper	cor	FK
3	4,0	3,9	3,4
6	1,9	1,9	2,1
9	2,9	3,0	2,7
12	2,9	2,9	2,5
15	1,9	1,9	1,9
18	3,3	3,2	2,5
21	4,2	4,1	3,2
24	4,1	3,9	3,2

Kepsha (180 m)

forecast, hour	RMSE		
	oper	cor	FK
3	2,8	3,1	2,8
6	2,8	3,4	2,8
9	4,2	4,2	4,0
12	5,0	4,7	4,4
15	3,4	3,5	3,6
18	1,5	2,1	1,6
21	1,4	1,6	1,7
24	1,6	1,6	1,9

Kalman filter is better/equal than operational version and correction mode

Kalman filter is better than operational version

T2m correction algorithm is better than operational version

RMSE for T2m COSMO-Ru 2.2 km forecasts. Start 00UTC 1 March -30 June 2014

Solokh Aul (443 m)

forecast, hour	RMSE		
	oper	cor	FK
3	1,8	1,6	1,3
6	1,8	1,7	1,8
9	2,6	2,5	2,5
12	2,9	2,8	2,7
15	2,7	2,6	2,7
18	1,6	1,3	1,3
21	1,7	1,4	1,3
24	2,6	2,5	2,5

Krasnaya Polyana (564 m)

forecast, hour	RMSE		
	oper	cor	FK
3	1,7	1,5	1,3
6	1,9	2,0	1,7
9	2,7	2,3	2,3
12	3,3	2,7	2,3
15	2,5	2,0	2,0
18	2,0	1,8	2,1
21	1,7	1,5	1,8
24	1,6	1,5	1,6

Kordon Laura (570 m)

forecast, hour	RMSE		
	oper	cor	FK
3	2,9	3,1	2,4
6	3,2	3,4	3,3
9	3,1	3,0	3,0
12	3,7	4,0	3,7
15	2,0	2,8	1,7
18	2,8	3,1	2,4
21	2,1	2,4	1,8
24	2,6	2,9	2,1

Gornaya Karusel (977 m)

forecast, hour	RMSE		
	oper	cor	FK
3	2,3	2,3	2,1
6	2,9	2,7	2,7
9	2,3	2,0	2,0
12	3,0	2,6	2,7
15	3,1	2,9	3,1
18	1,7	1,5	1,6
21	1,6	1,5	1,5
24	1,4	1,3	1,6

Gornaya Karusel (1434 m)

forecast, hour	RMSE		
	oper	cor	FK
3	2,0	2,1	2,2
6	2,2	2,2	2,2
9	2,4	2,4	2,4
12	3,0	3,0	3,1
15	1,6	1,6	1,8
18	1,3	1,3	1,8
21	1,4	1,4	1,7
24	1,3	1,3	1,6

Aibga (2225 m)

forecast, hour	RMSE		
	oper	cor	FK
3	2,5	1,3	1,4
6	3,0	1,3	1,4
9	3,5	1,7	1,7
12	4,1	2,5	2,3
15	3,0	1,4	1,3
18	3,2	1,4	1,9
21	2,8	1,1	1,1
24	7,4	1,5	2,3

T2m 12h forecasts by COSMO-Ru 2.2 km. Start 00 UTC 1 March -30 June 2014. Station Krasnaya Polyana
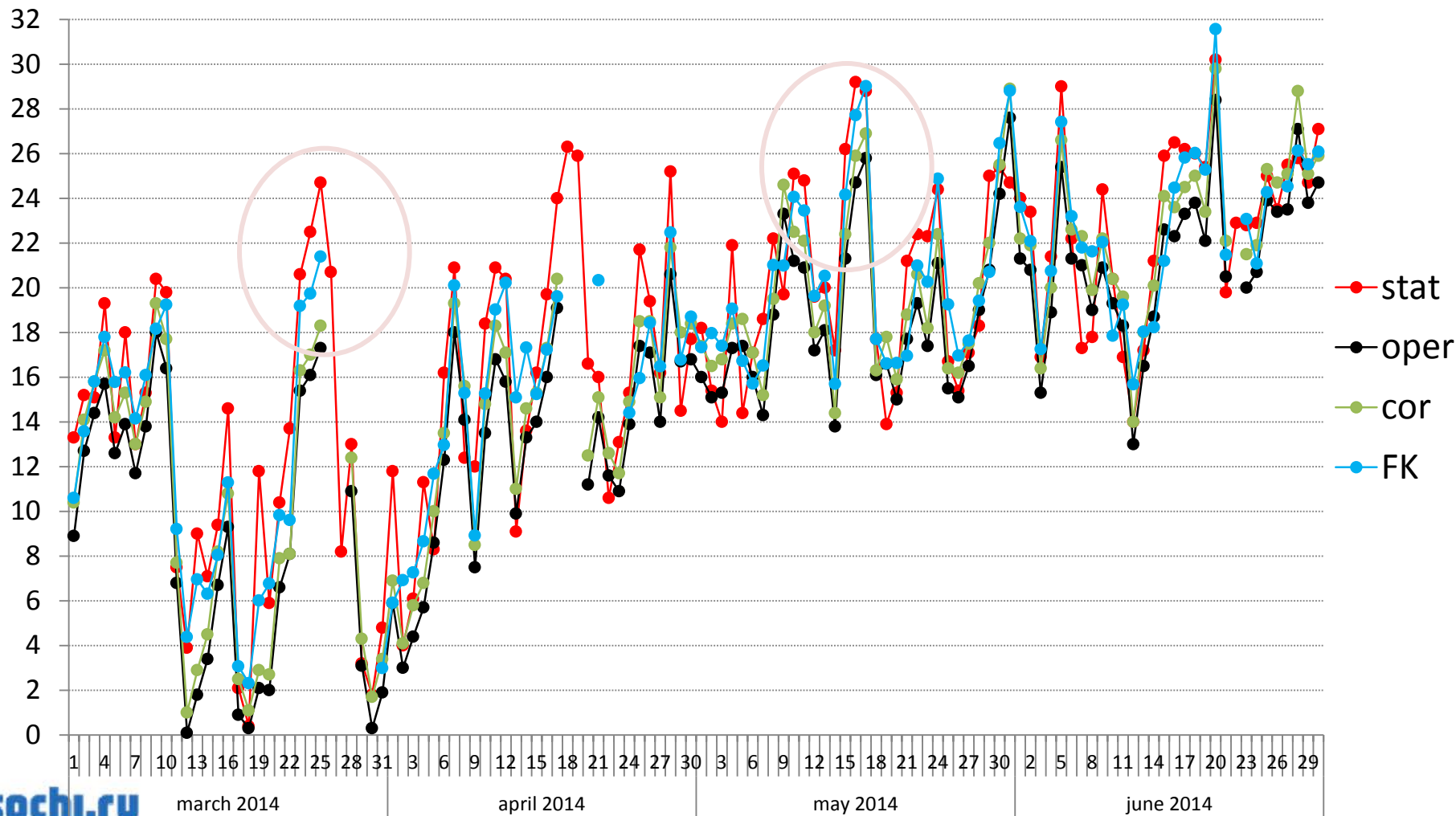
RMSE for T2m COSMO-Ru 2.2 km forecasts. Start 18UTC 1 March -30 June 2014

Sochi Adler (0 m)

forecast, hour	RMSE		
	oper	cor	FK
3	2,0	2,0	1,9
6	1,6	1,6	1,5
9	1,5	1,5	1,5
12	1,9	1,9	1,7
15	2,2	2,2	2,3
18	2,0	2,0	2,4
21	1,7	1,7	1,8
24	1,4	1,4	1,7

Imeretinka (6 m)

forecast, hour	RMSE		
	oper	cor	FK
3	2,0	2,1	2,0
6	2,4	2,4	2,3
9	2,8	2,9	2,7
12	3,2	3,2	3,0
15	3,0	3,0	3,1
18	3,5	3,5	3,8
21	1,7	1,6	1,7
24	2,2	2,3	2,5

Lazarevskoe (9 m)
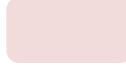
forecast, hour	RMSE		
	oper	cor	FK
3	1,5	1,5	1,4
6	1,8	1,9	1,6
9	2,2	2,2	1,8
12	2,3	2,2	2,3
15	3,3	3,2	2,7
18	3,4	3,3	2,8
21	2,4	2,4	2,5
24	1,7	1,7	2,1

Magri (50 m)

forecast, hour	RMSE		
	oper	cor	FK
3	4,3	4,2	3,6
6	4,0	3,9	3,2
9	4,2	4,0	3,3
12	2,1	2,2	2,3
15	3,1	3,2	2,7
18	3,2	3,3	2,9
21	3,6	3,6	3,6
24	3,3	3,2	2,7

Kepsha (180 m)

forecast, hour	RMSE		
	oper	cor	FK
3	1,8	1,9	1,5
6	2,1	1,9	1,8
9	2,7	2,8	2,8
12	2,8	3,3	2,7
15	4,2	4,3	3,9
18	4,7	4,5	4,6
21	2,2	2,4	2,4
24	1,5	1,9	1,6

Kalman filter is better/equal than operational version and correction mode

Kalman filter is better than operational version

T2m correction algorithm is better than operational version

RMSE for T2m COSMO-Ru 2.2 km forecasts. Start 18UTC 1 March -30 June 2014

Solokh Aul (443 m)

forecast, hour	RMSE		
	oper	cor	FK
3	1,4	1,2	1,2
6	2,6	2,5	2,3
9	2,8	2,6	2,4
12	3,0	2,8	3,0
15	3,6	3,5	3,6
18	3,8	3,7	4,0
21	1,7	1,6	1,7
24	1,6	1,4	1,5

Krasnaya Polyana (564 m)

forecast, hour	RMSE		
	oper	cor	FK
3	2,1	1,8	1,6
6	1,9	1,7	1,5
9	1,7	1,5	1,3
12	1,9	2,0	1,7
15	2,7	2,5	2,7
18	3,2	2,7	2,7
21	2,5	2,1	2,0
24	2,1	1,9	2,2

Kordon Laura (570 m)

forecast, hour	RMSE		
	oper	cor	FK
3	2,4	2,6	1,9
6	2,8	3,0	2,1
9	2,7	2,9	2,2
12	2,3	2,4	2,2
15	3,3	3,3	3,2
18	2,5	2,9	2,8
21	2,2	5,1	4,1
24	2,8	3,4	2,3

Gornaya Karusel (977 m)

forecast, hour	RMSE		
	oper	cor	FK
3	1,8	2,0	1,6
6	1,8	1,9	1,4
9	1,9	2,0	1,5
12	2,3	2,1	2,1
15	2,5	2,1	2,0
18	3,0	2,6	2,9
21	2,3	2,1	2,2
24	1,8	1,6	1,8

Gornaya Karusel (1434 m)

forecast, hour	RMSE		
	oper	cor	FK
3	1,5	1,5	1,4
6	1,5	1,5	1,3
9	2,1	2,1	2,2
12	2,1	2,1	2,3
15	2,5	2,5	2,4
18	3,0	2,9	3,4
21	1,7	1,7	1,8
24	1,4	1,4	1,8

Aibga (2225 m)

forecast, hour	RMSE		
	oper	cor	FK
3	2,3	1,0	1,0
6	2,5	1,1	1,2
9	2,4	1,2	1,3
12	3,2	1,4	1,4
15	3,8	1,8	1,7
18	4,2	2,4	2,5
21	3,1	1,5	1,3
24	3,3	1,6	2,0

Results

- Kalman filter and T2m correction algorithm (through vertical gradient) are implemented in COSMO-Ru2 (Sochi region). The technology is operational

- Kalman filter is based on the corrected T2m COSMO-Ru2 forecasts and observations at meteorological stations. It could work for other COSMO-Ru domains and with the use of standard T2m COSMO-Ru forecasts

- It is shown that KF (based on corrected COSMO-Ru2 T2m forecasts) provides more accurate T2m forecast in mountain region rather than operational version of COSMO-Ru2 (improvement up to 2°C in RMSE) and in most cases – better than using only correction algorithm for T2m

- Comparison between different forecasts was done for them with start time 00 and 18 UTC. The accuracy of FK and T2m corrected algorithm is comparable

CORSO-A

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

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

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

Thank you for your attention!