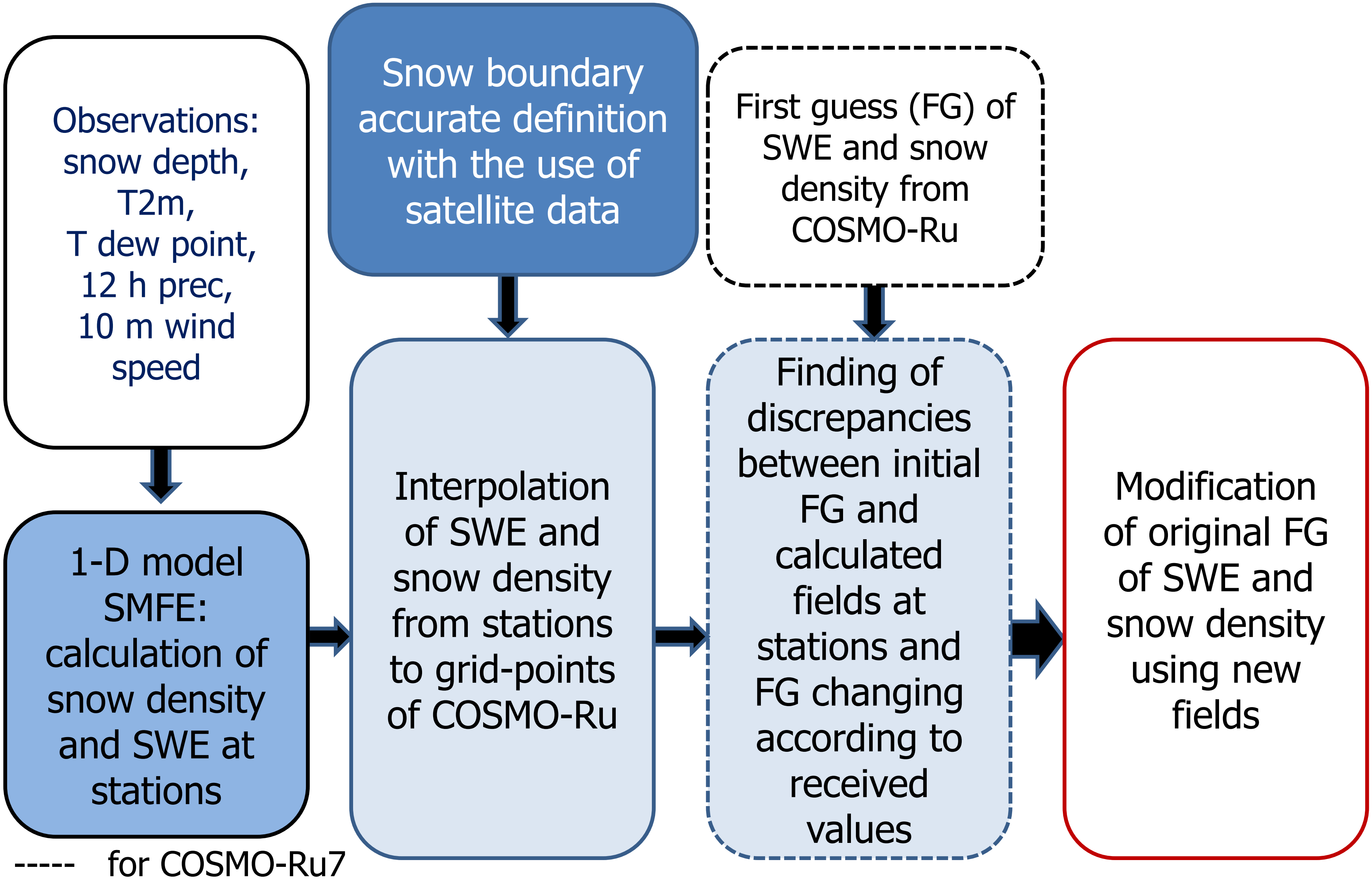
Quasi-operational technology for preparation of initial values of Snow Water Equivalent (SWE) and Snow Density for COSMO-Ru (PT SNOWE)

Ekaterina Kazakova, Inna Rozinkina, Mikhail Chumakov

Technological scheme



Quasi-operational regime

- Daily calculation of snow characteristics (SWE and snow density) at stations started since 1 September 2014

- We selected stations which have more then 4 observations per day and make snow depth measurements: 436 – for COSMO-Ru2, 2296 - for COSMO-Ru7

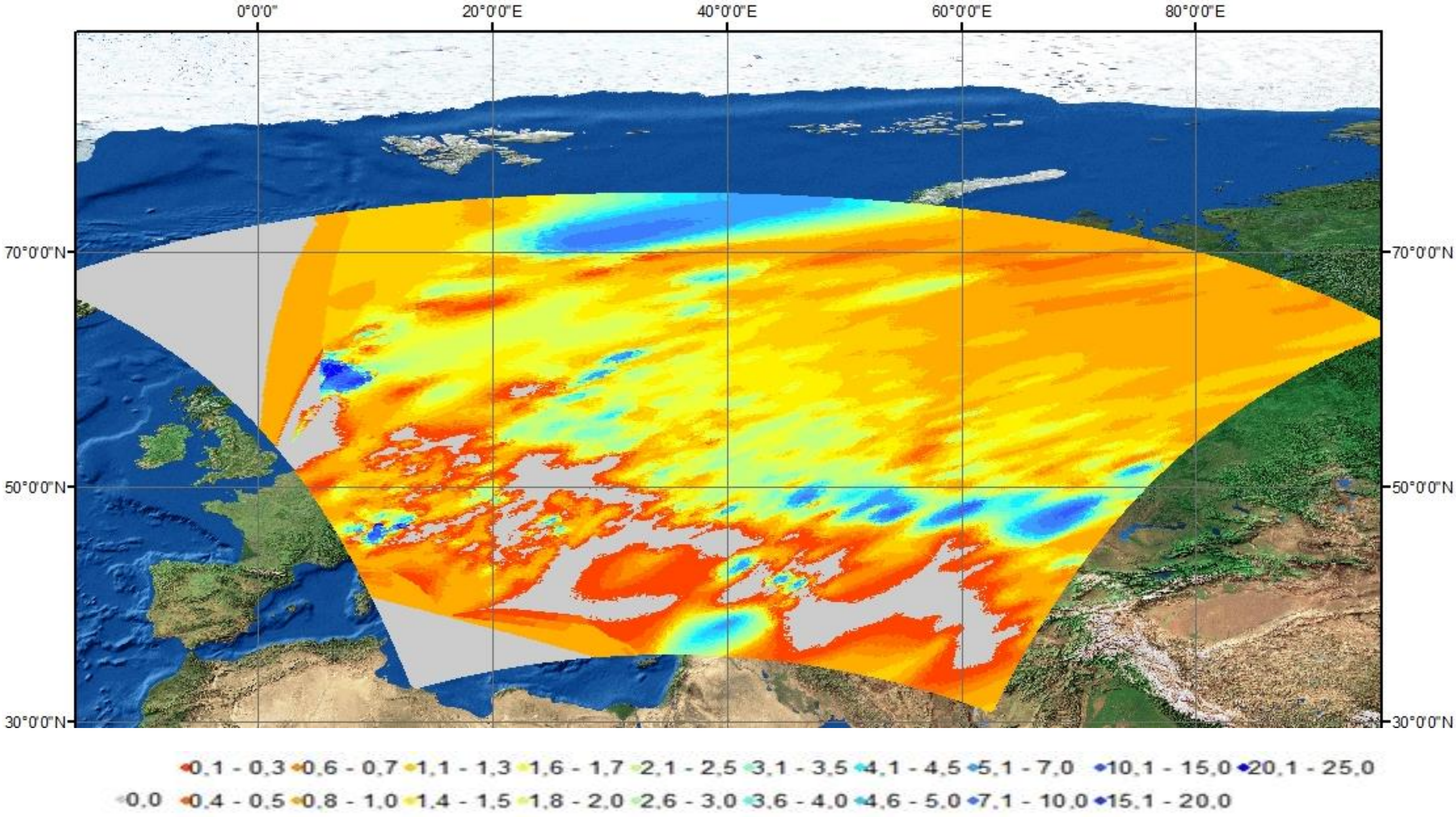
- Before calculation of snow fields primary data quality control was carried out (T2m, dew point temperature, snow depth)

- FG of snow fields were not modified for mountain regions (higher than 500 m) and water areas (fr_land<0.5) in COSMO-model

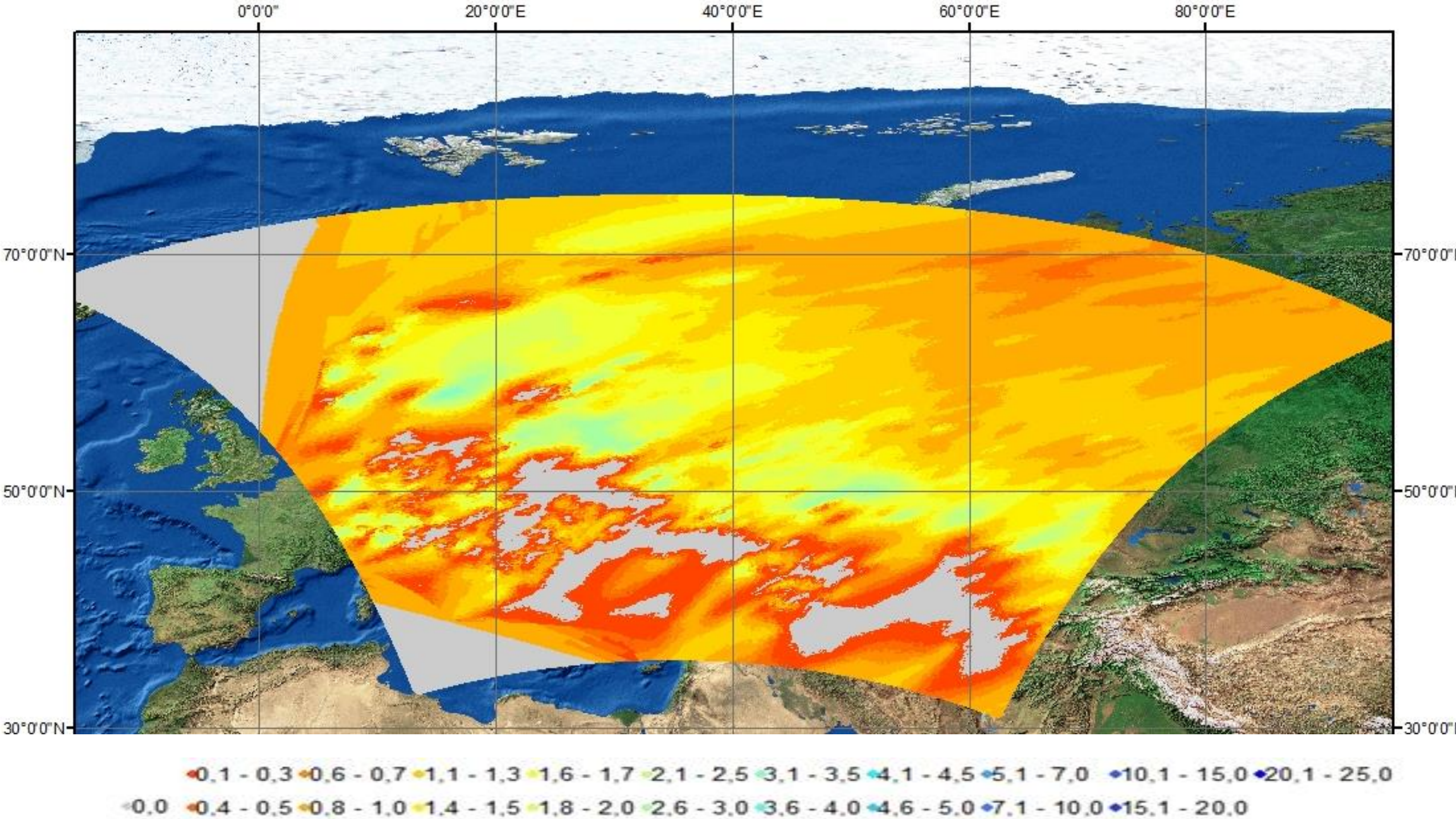
- If there are zones free of snow in COSMO-model initial field (and according to SMFE they are covered with snow), it is supposed to consider them snowless

- Technology began to work quasi-operationally in November 2014. Forecasts were collected since 1 December 2014 for 00 UTC start

Interpolated discrepancies between COSMO-Ru7 initial SWE fields and SMFE calculations. 26 January 2015

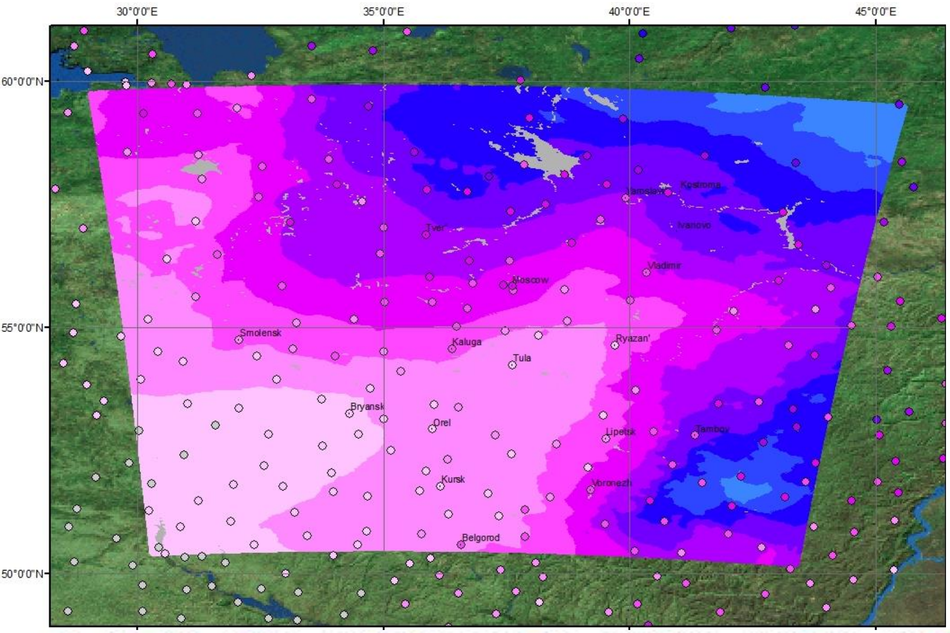


Interpolated discrepancies between COSMO-Ru7 initial RHO fields and SMFE calculations. 26 January 2015

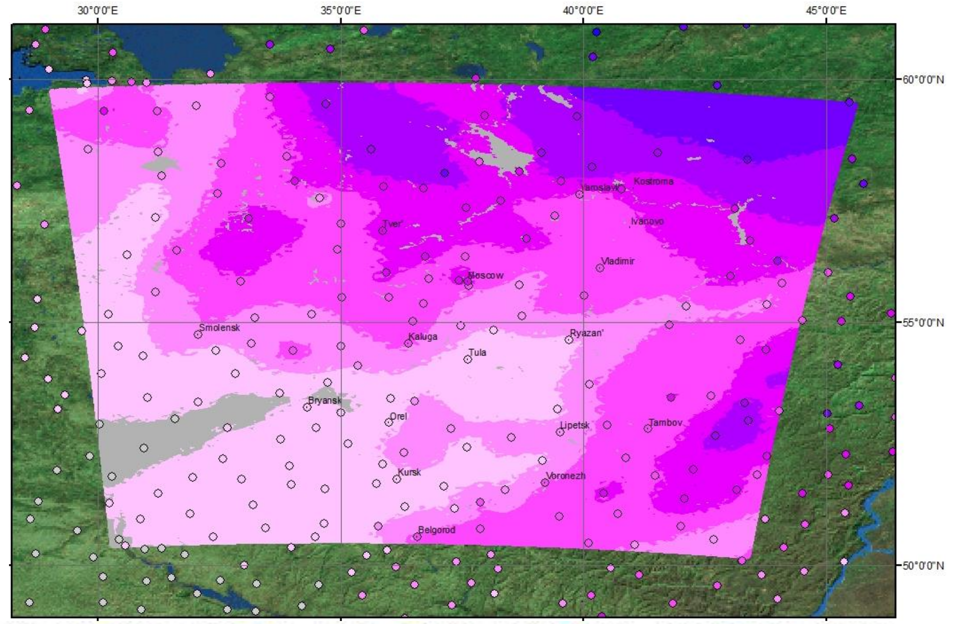


COSMO-Ru2 SWE initial fields. 26 January 2015

reference



new technology



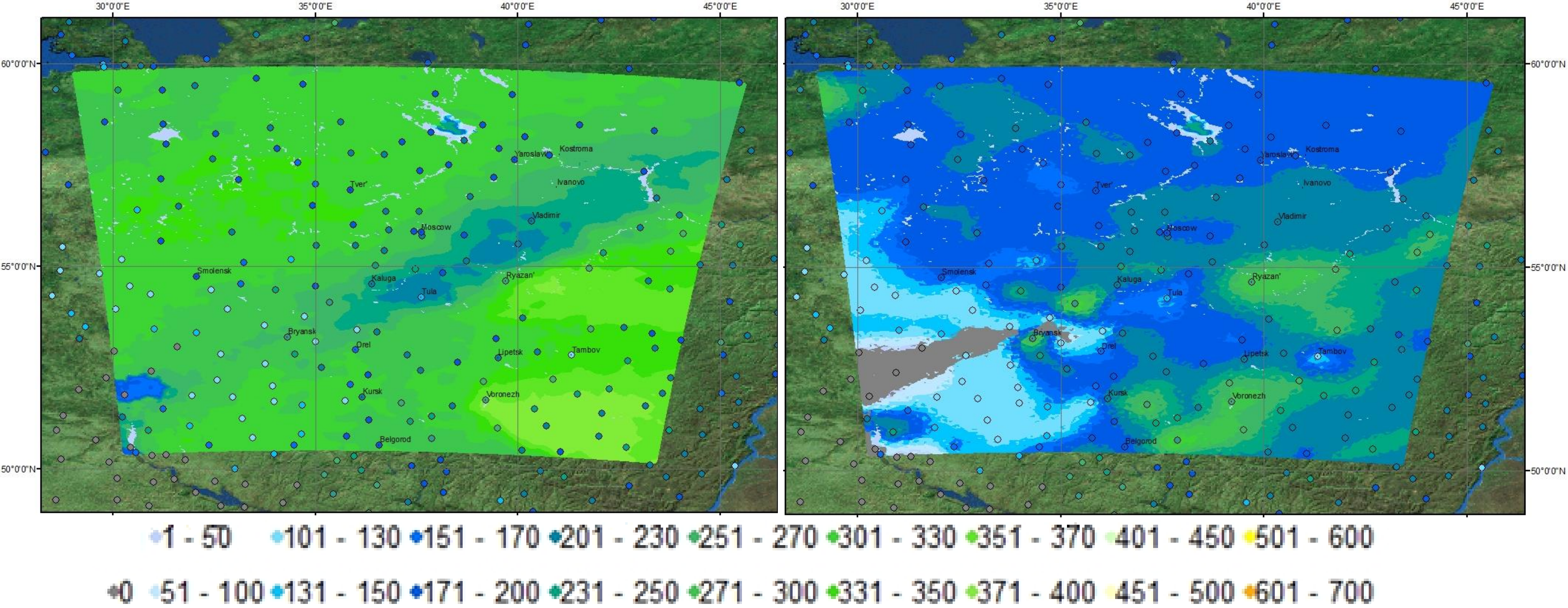
1 - 20 41 - 60 81 - 100 121 - 140 161 - 180 201 - 250 301 - 350 401 - 500 601 - 700 801 - 900 1001 - 1100 1201 - 1300 1401 - 1500

0 21 - 40 61 - 80 101 - 120 141 - 160 181 - 200 251 - 300 351 - 400 501 - 600 701 - 800 901 - 1000 1101 - 1200 1301 - 1400

Station SWE values calculated by the snow model SMFE are shown in circles

COSMO-Ru2 RHO initial fields. 26 January 2015

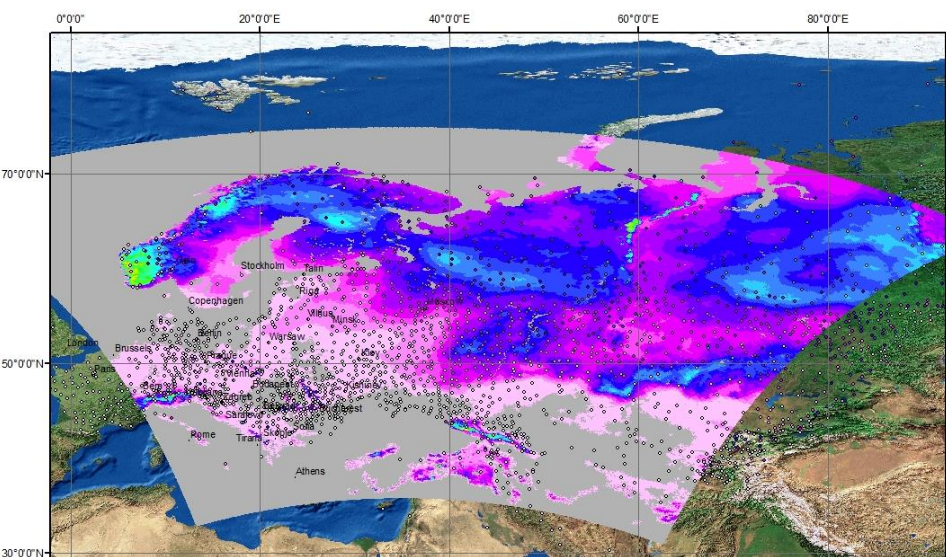
reference | new technology



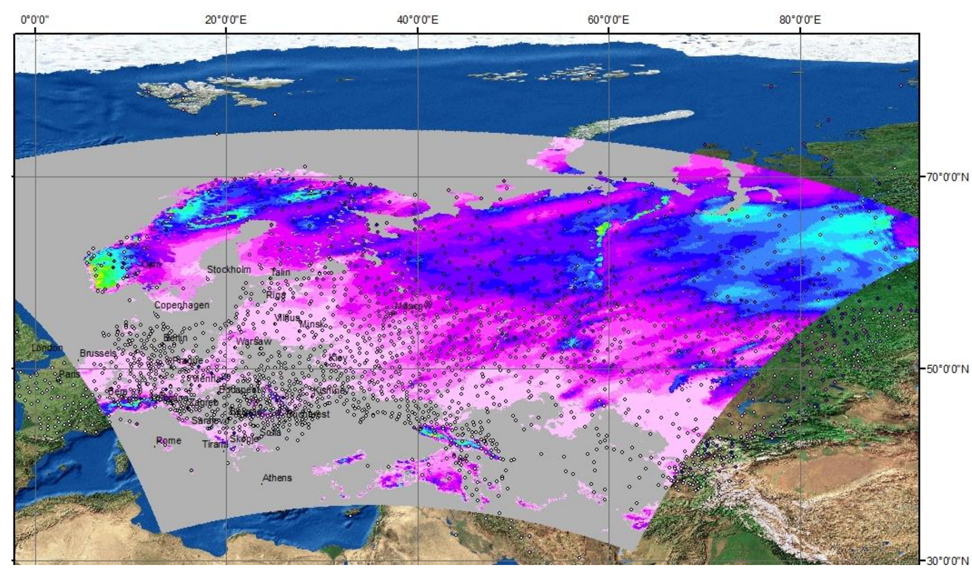
Station RHO values calculated by the snow model SMFE are shown in circles

COSMO-Ru7 SWE initial fields. 26 January 2015

reference



new technology

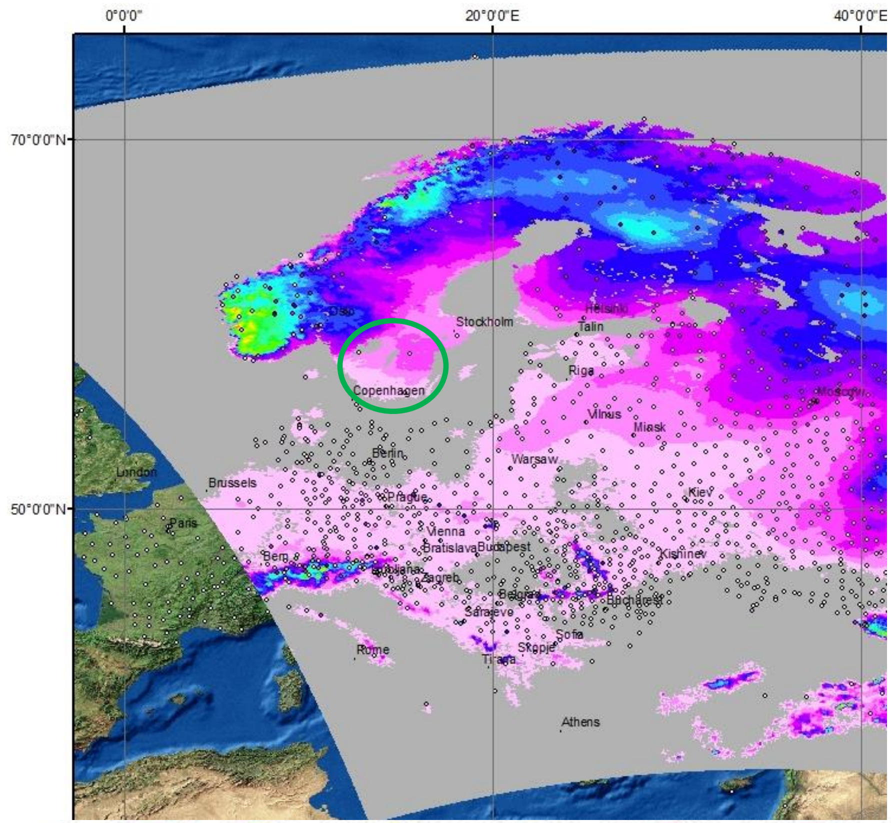


0 | 1 - 20 | 21 - 40 | 41 - 60 | 61 - 80 | 81 - 100 | 101 - 120 | 121 - 140 | 141 - 160 | 161 - 180 | 181 - 200 | 201 - 250 | 251 - 300 | 301 - 350 | 351 - 400 | 401 - 500 | 501 - 600 | 601 - 700 | 701 - 800 | 801 - 900 | 901 - 1000 | 1001 - 1100 | 1101 - 1200 | 1201 - 1300 | 1301 - 1400 | 1401 - 1500

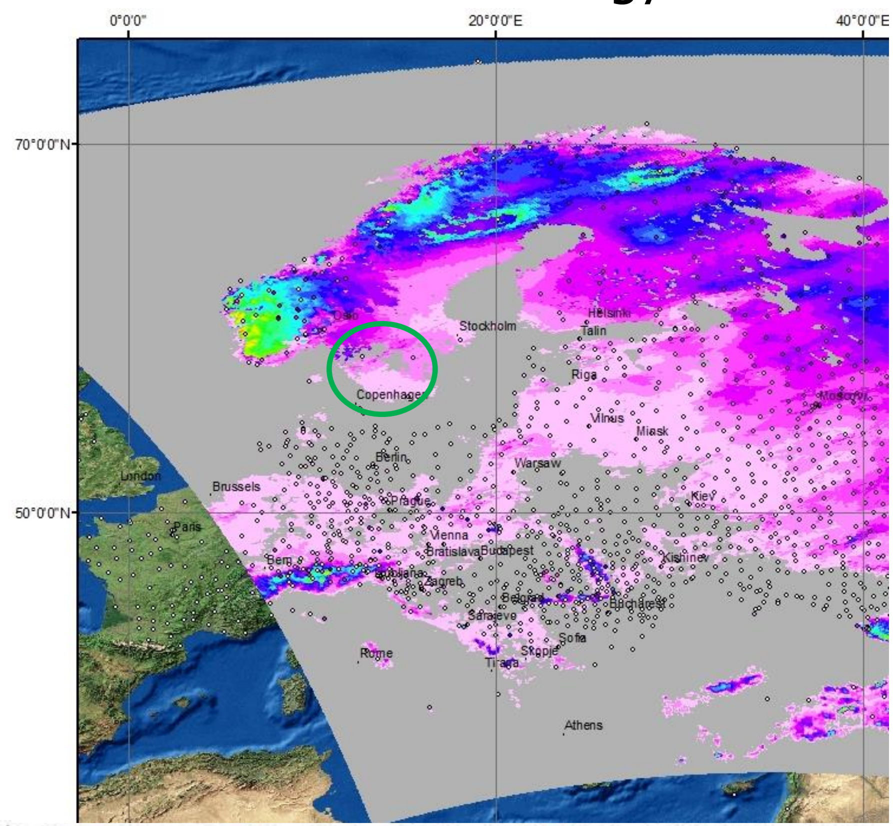
Station SWE values calculated by the snow model SMFE are shown in circles

COSMO-Ru7 SWE initial fields. 26 January 2015

reference



new technology



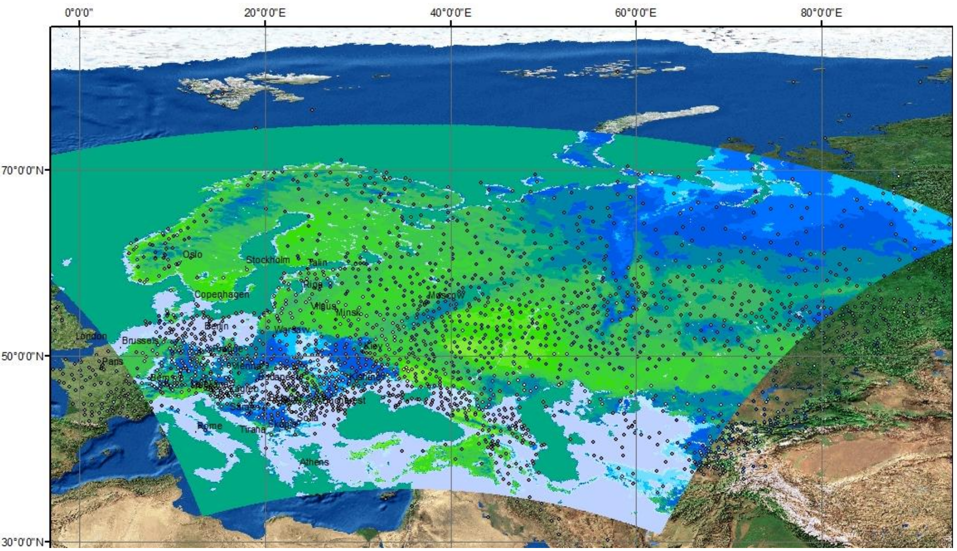
1 - 20 41 - 60 81 - 100 121 - 140 161 - 180 201 - 250 301 - 350 401 - 500 601 - 700 801 - 900 1001 - 1100 1201 - 1300 1401 - 1500

0 21 - 40 61 - 80 101 - 120 141 - 160 181 - 200 251 - 300 351 - 400 501 - 600 701 - 800 901 - 1000 1101 - 1200 1301 - 1400

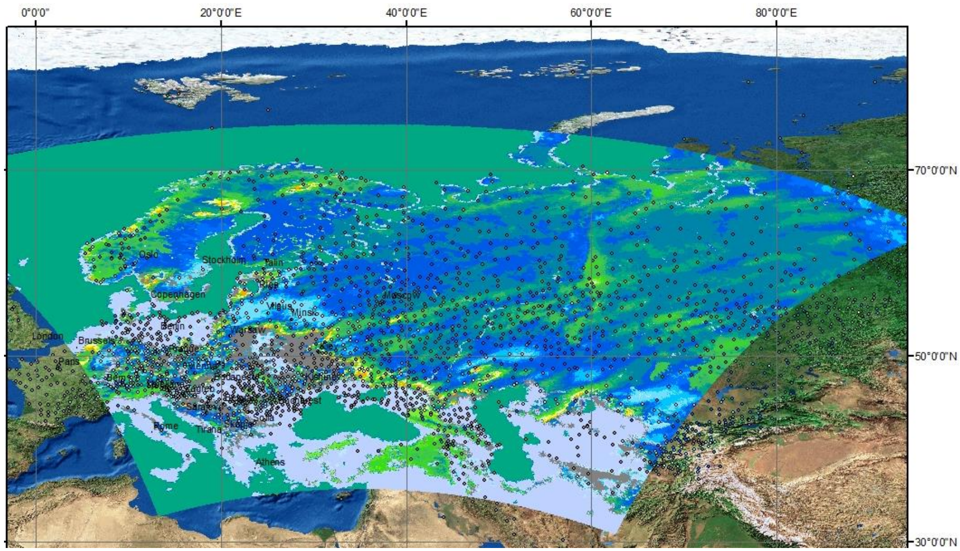
Station SWE values calculated by the snow model SMFE are shown in circles

COSMO-Ru7 RHO initial fields. 26 January 2015

reference



new technology



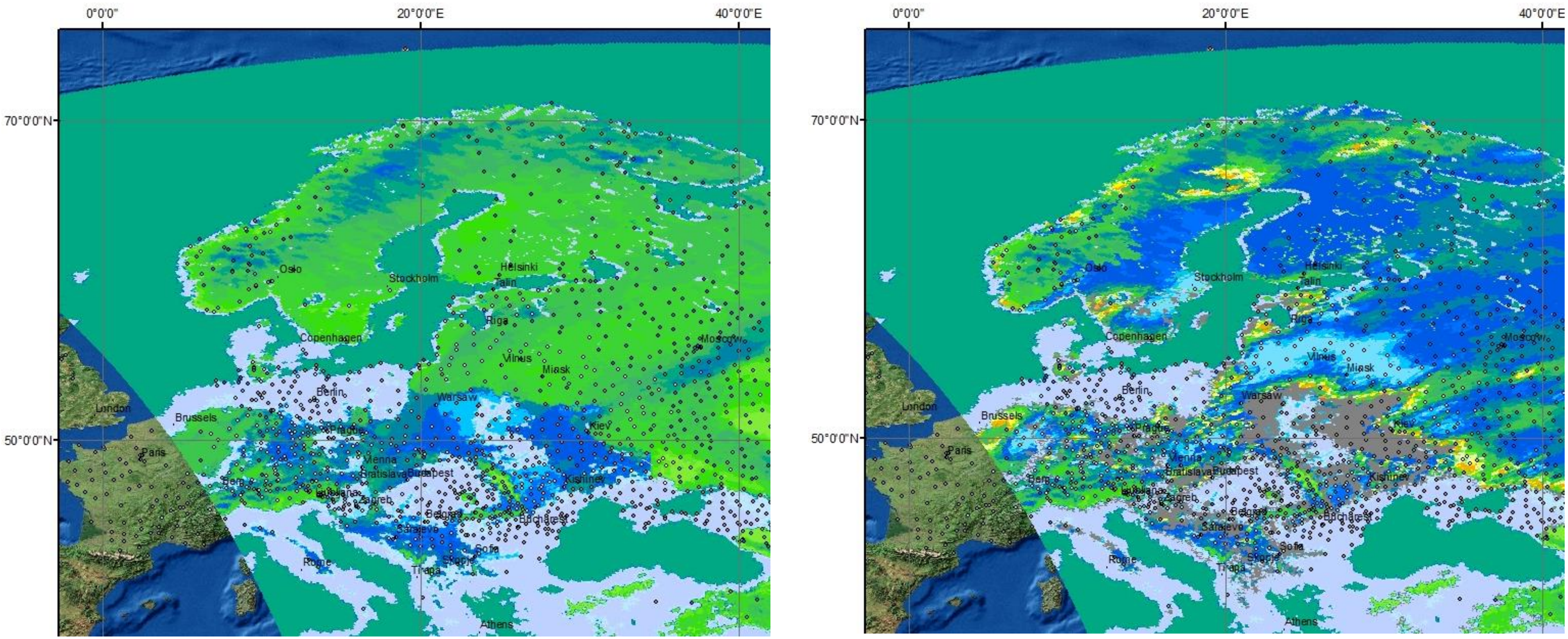
1 - 50 · 101 - 130 · 151 - 170 · 201 - 230 · 251 - 270 · 301 - 330 · 351 - 370 · 401 - 450 · 501 - 600

0 · 51 - 100 · 131 - 150 · 171 - 200 · 231 - 250 · 271 - 300 · 331 - 350 · 371 - 400 · 451 - 500 · 601 - 700

Station RHO values calculated by the snow model SMFE are shown in circles

COSMO-Ru7 RHO initial fields. 26 January 2015

reference | new technology



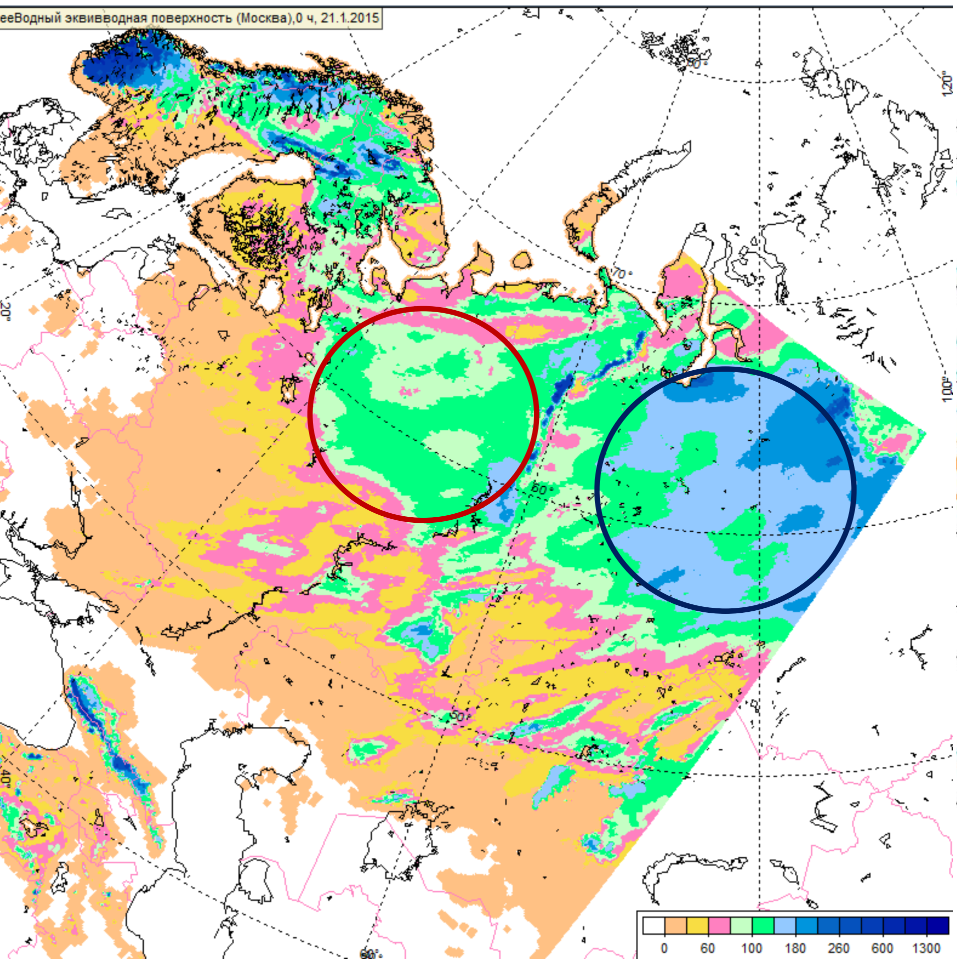
• 1 - 50 • 101 - 130 • 151 - 170 • 201 - 230 • 251 - 270 • 301 - 330 • 351 - 370 • 401 - 450 • 501 - 600

• 0 • 51 - 100 • 131 - 150 • 171 - 200 • 231 - 250 • 271 - 300 • 331 - 350 • 371 - 400 • 451 - 500 • 601 - 700

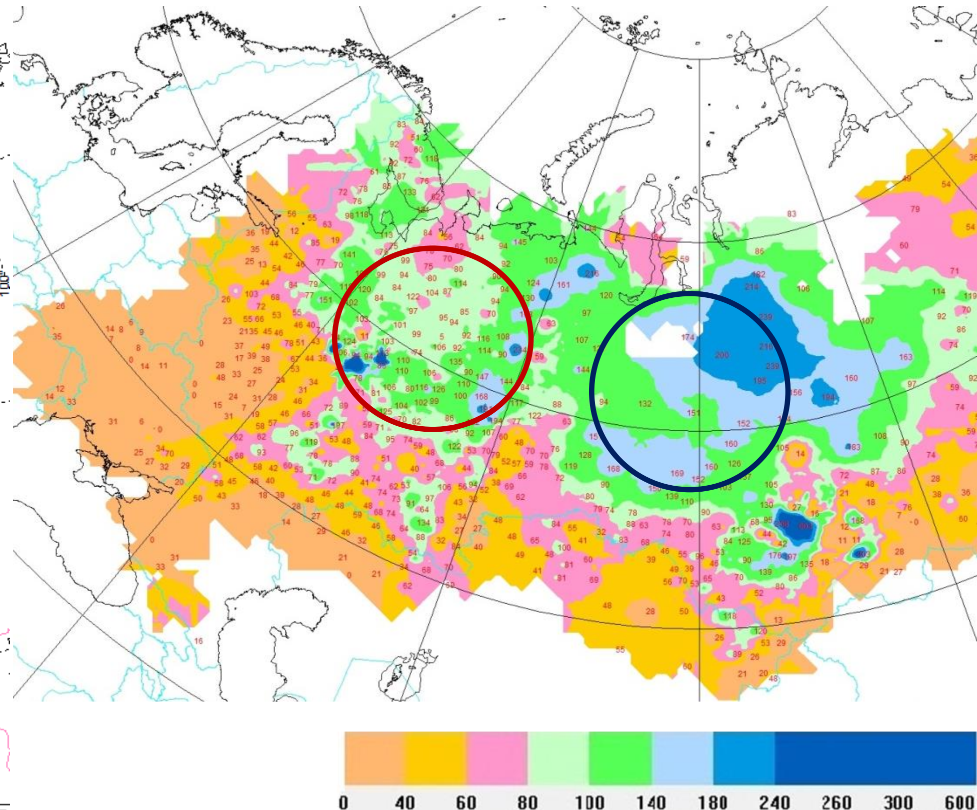
Station RHO values calculated by the snow model SMFE are shown in circles

SWE fields. 20 January 2015

COSMO-Ru7 SWE initial field (new technology)

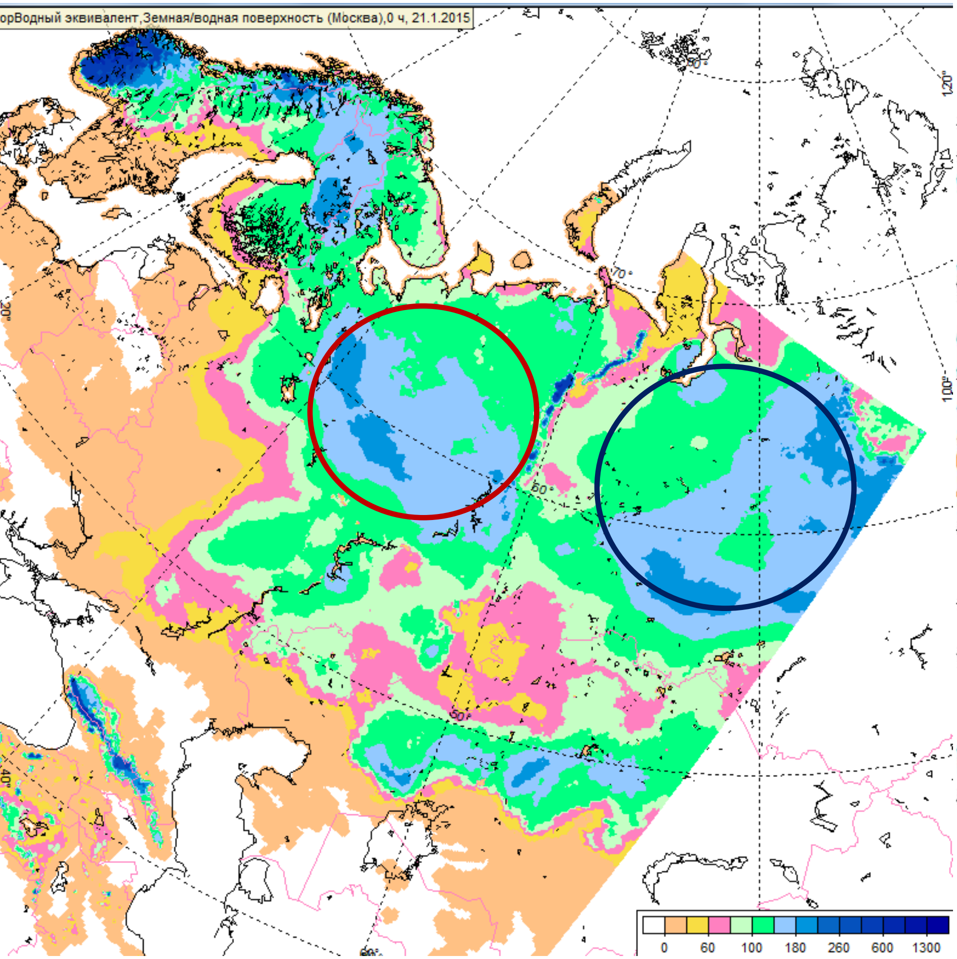


SWE measurements

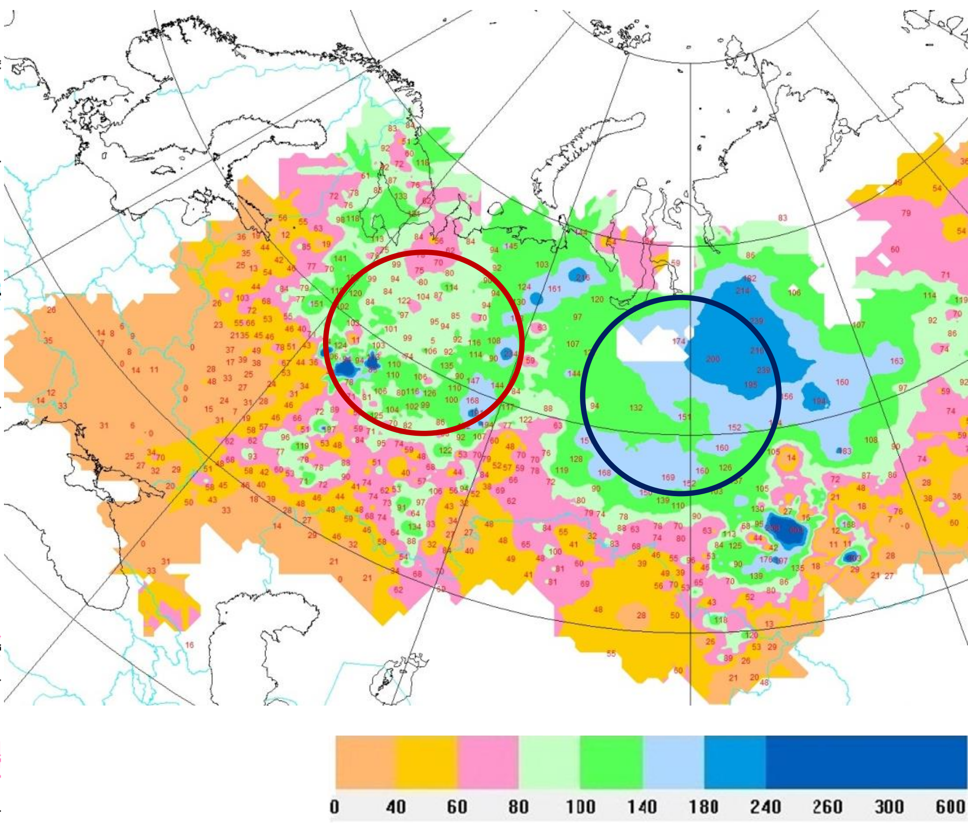


SWE fields. 20 January 2015

COSMO-Ru7 SWE initial field (reference)

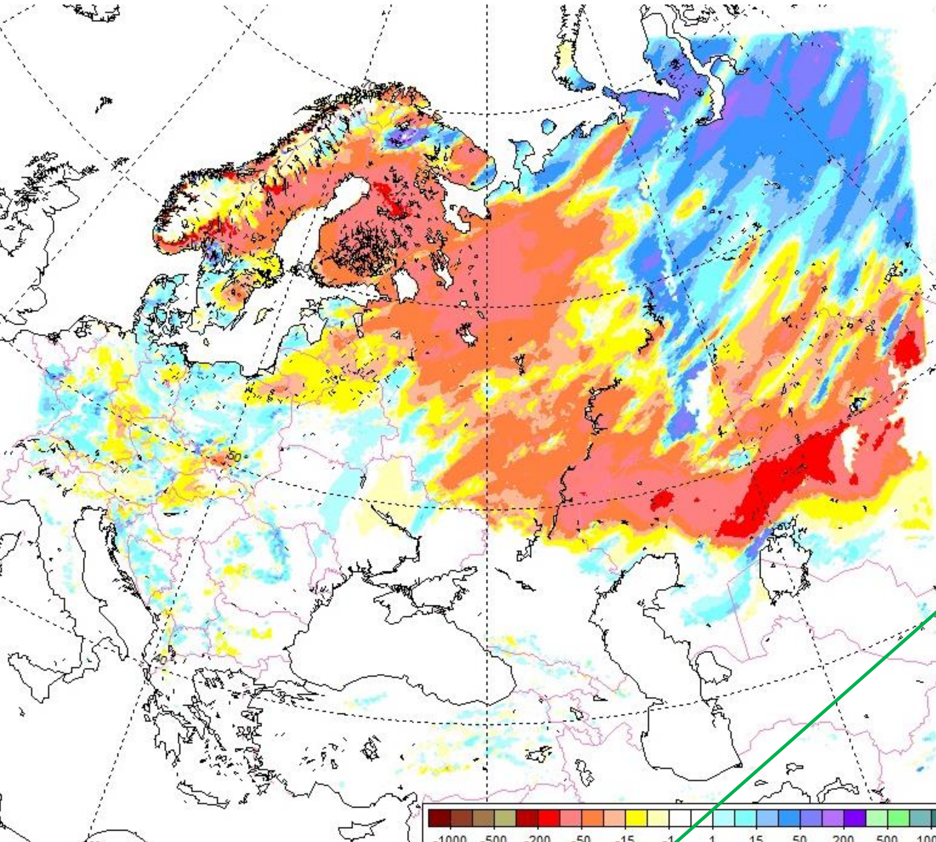


SWE measurements

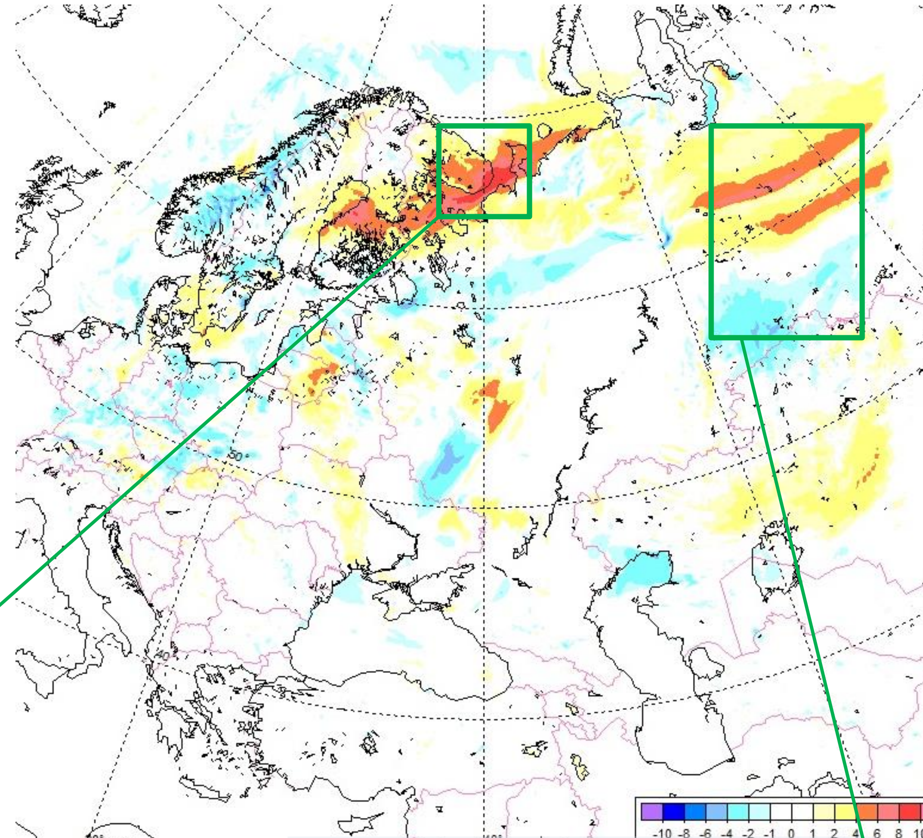


COSMO-Ru7 78h forecasts. 1 February 2015

ΔSWE (new technology-reference)



ΔT2m (new technology-reference)

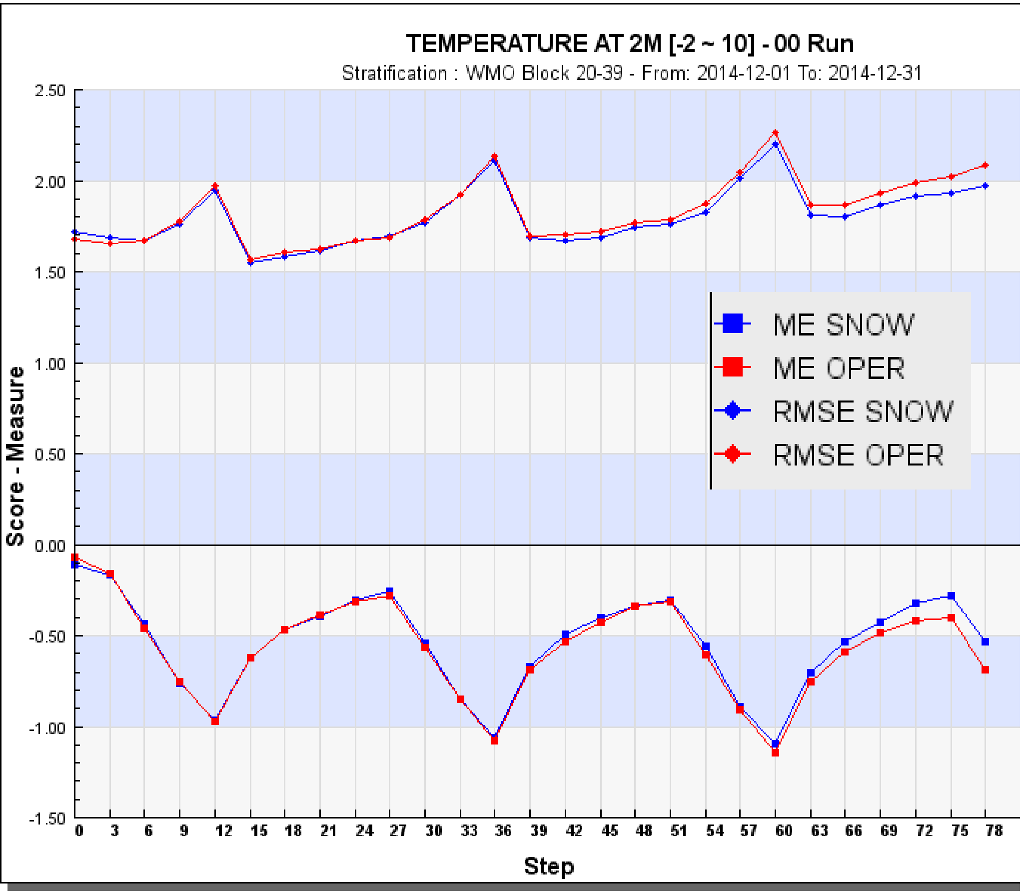


Station	obs	ex	reference
Pyalitza:	-19,5	-15,6	-25,1
Svyatoy Nos:	-16,6	-14,9	-16,7
Lovozero:	-23,4	-21,7	-25,5
Krasnoshel'e:	-23,7	-23,1	-27,4

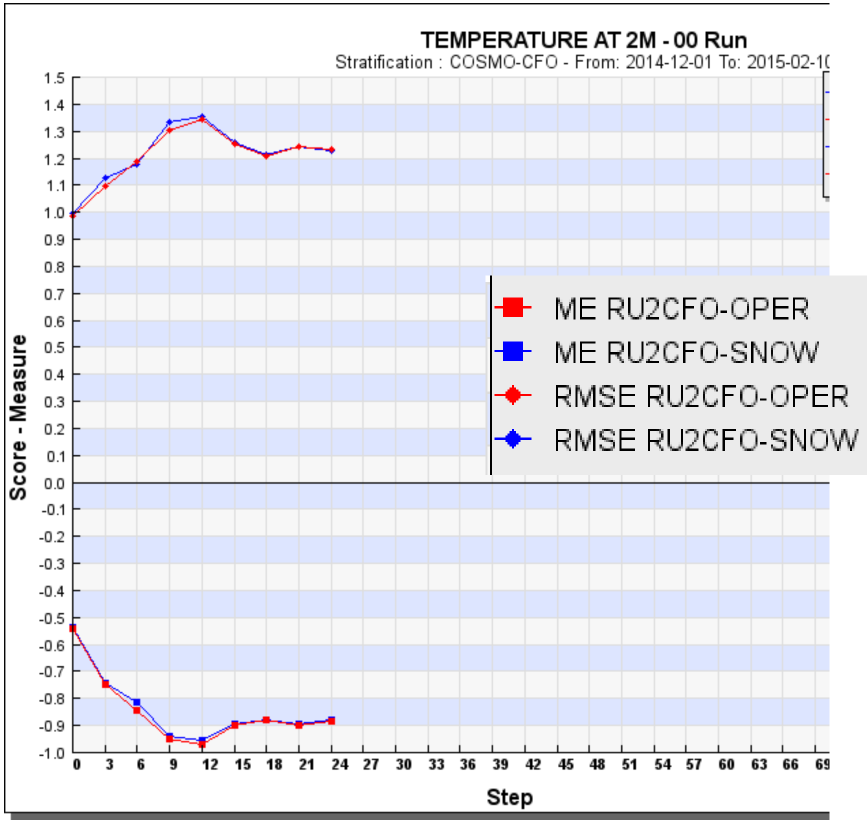
Station	obs	ex	reference
Berezovka:	-9,0	-10,8	-14,7
Kargasok:	-8,5	-9,0	-14,5
Napas:	-7,0	-11,6	-13,8
Golyshmanovo:	-13,1	-10,5	-8,1
Kogalym:	-23,5	-16,2	-21,1

COSMO-Ru T2m verification

COSMO-Ru7. 1-31 Dec. 2014



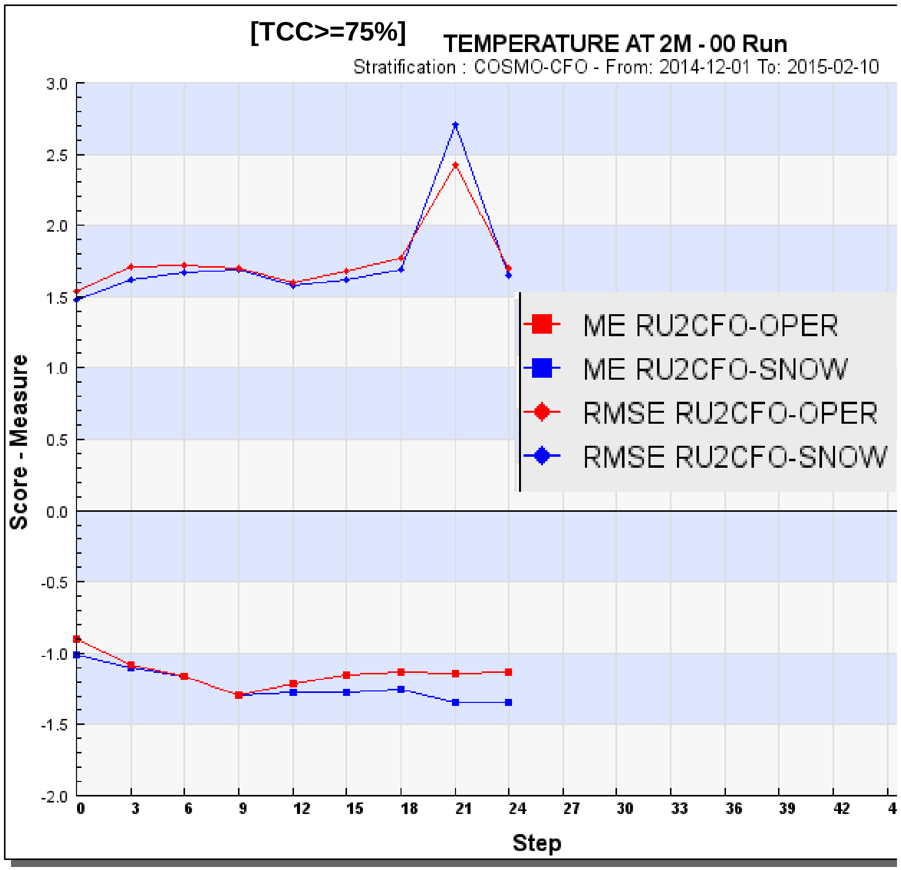
COSMO-Ru2. 1 Dec. 2014 – 10 Feb. 2015



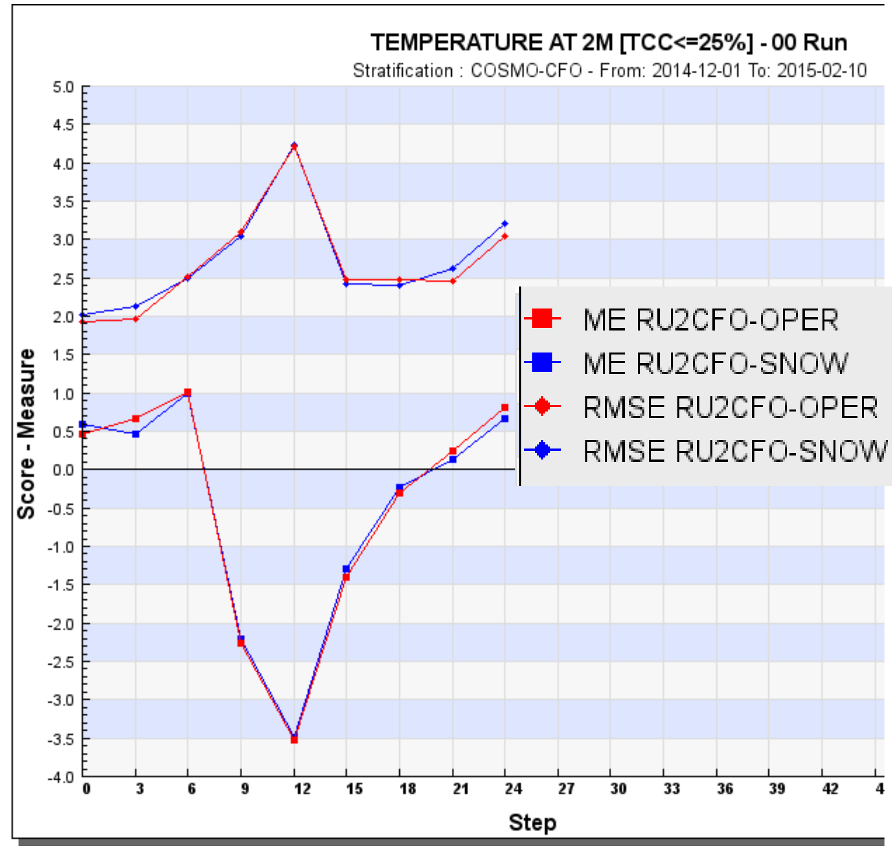
Differences in T2m forecasts are observed not only during snow melt period, but also in winter. The most significant effect is for 3rd day.

COSMO-Ru T2m verification

COSMO-Ru2. 1 Dec. 2014 – 10 Feb. 2015



COSMO-Ru2. 1 Dec. 2014 – 10 Feb. 2015



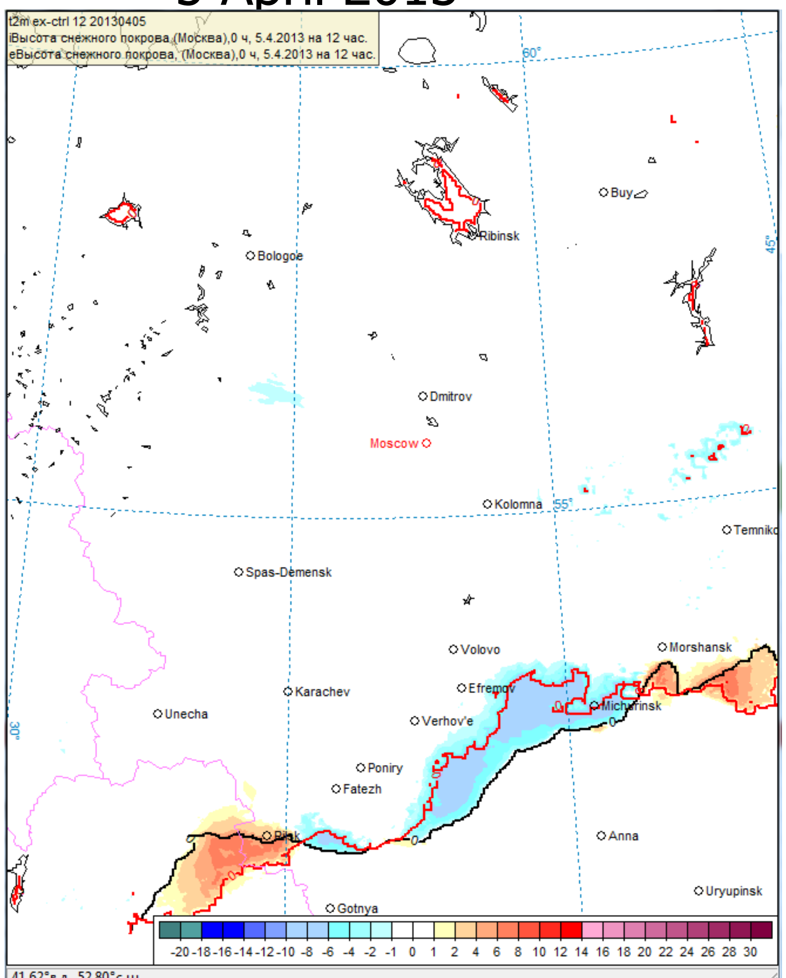
Differences in T2m forecasts are observed not only during snow melt period, but also in winter. The most significant effect is for 3rd day.

Impact on T2m during snow melt period

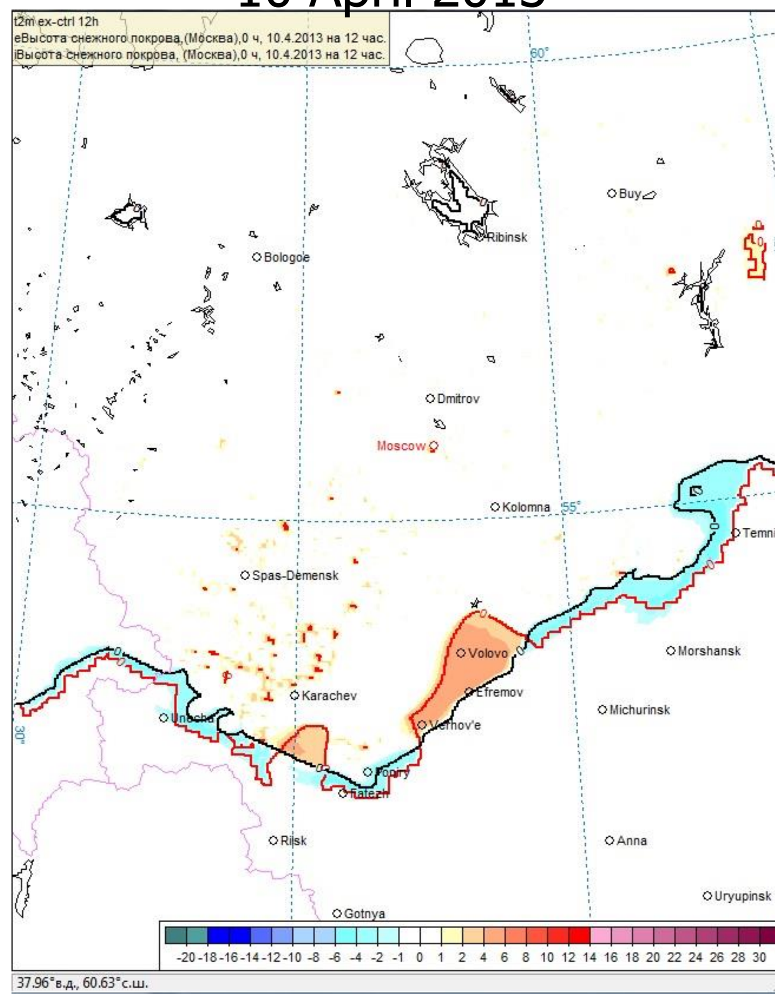
ΔT2m (ex – oper) forecast at 12 UTC. Start – 00 UTC

Lines – snow boundary forecast at 12 UTC: black– operational version, red– experiment

5 April 2013

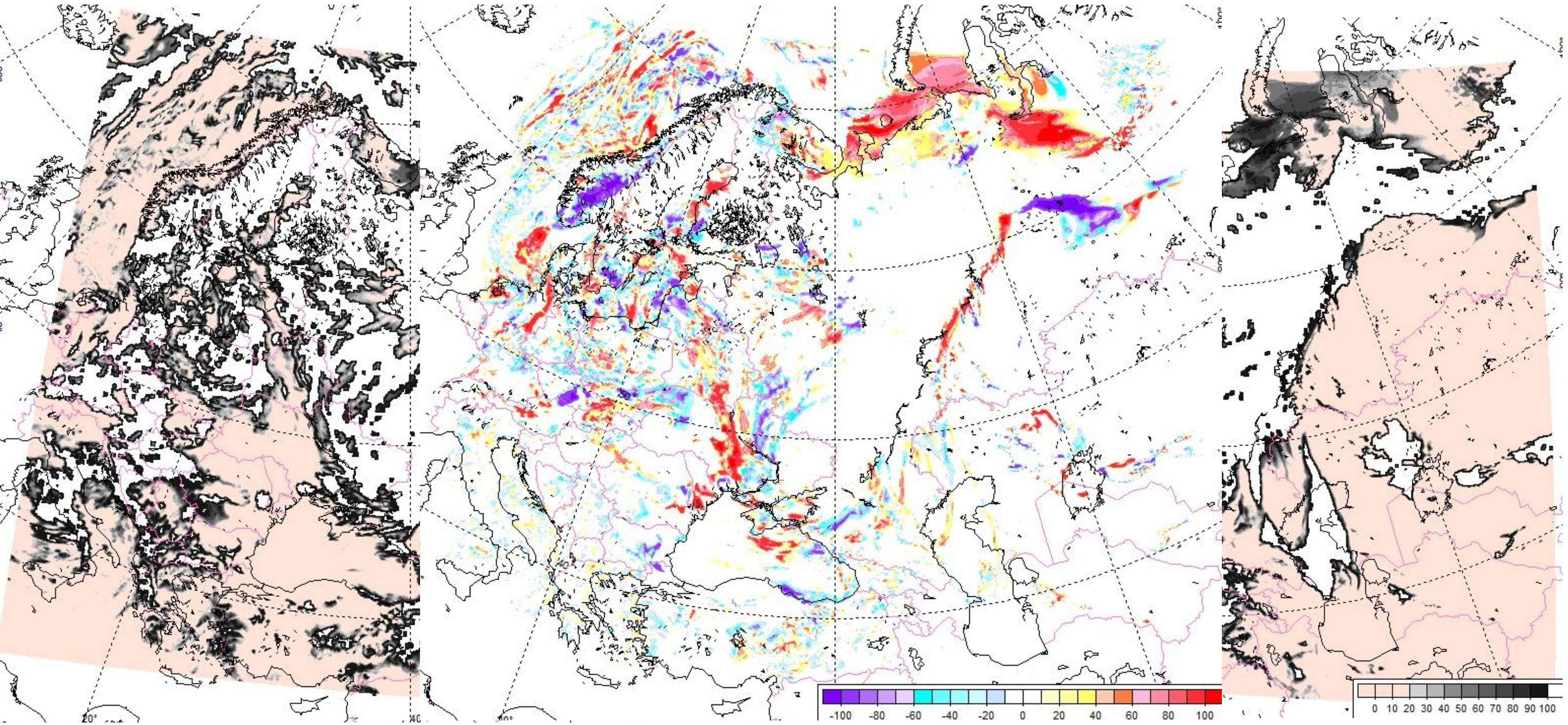


10 April 2013



COSMO-Ru7 78h low cloudiness forecasts. 1 February 2015

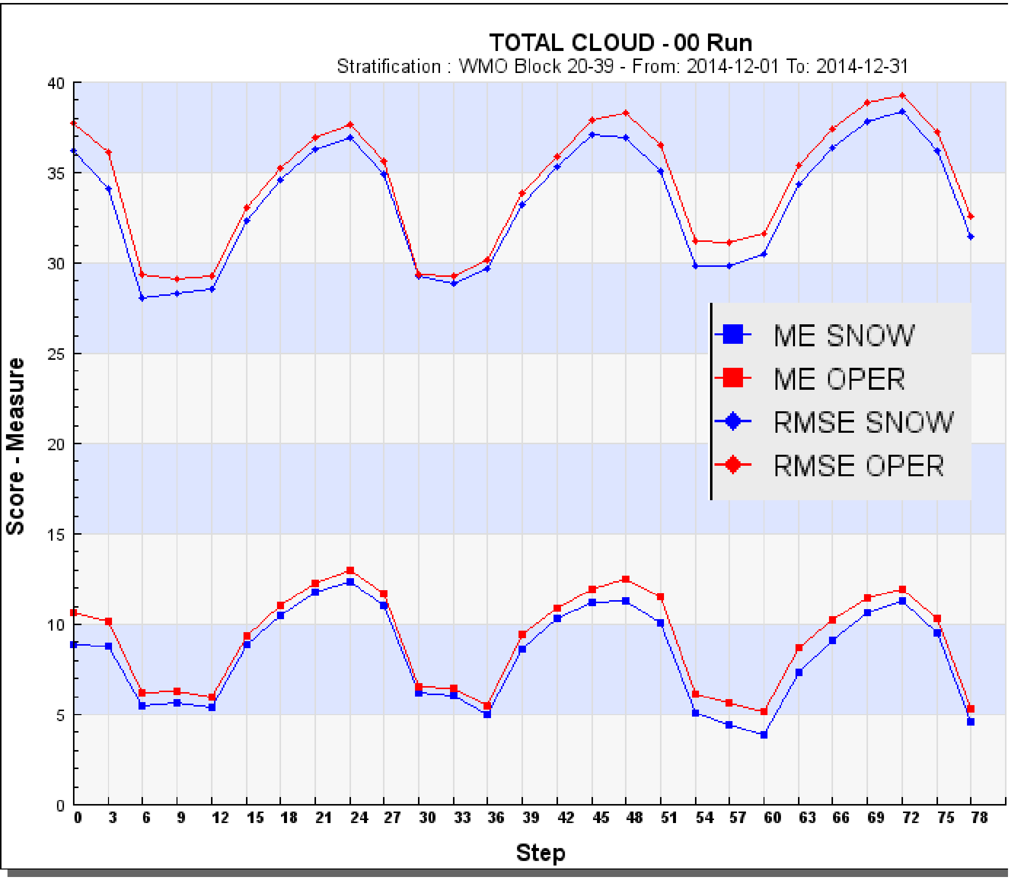
reference | new technology



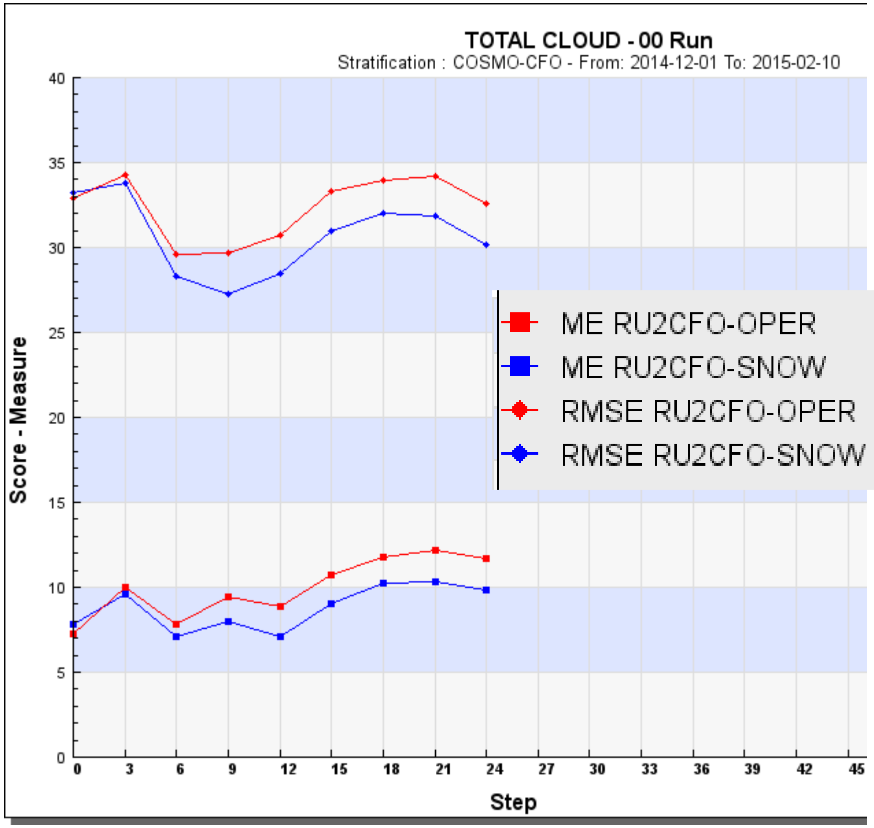
The main differences are observed on cloud edges. This feature can also be observed in fields of total cloud and middle cloudiness.

COSMO-Ru total cloud verification

COSMO-Ru7. 1-31 Dec. 2014



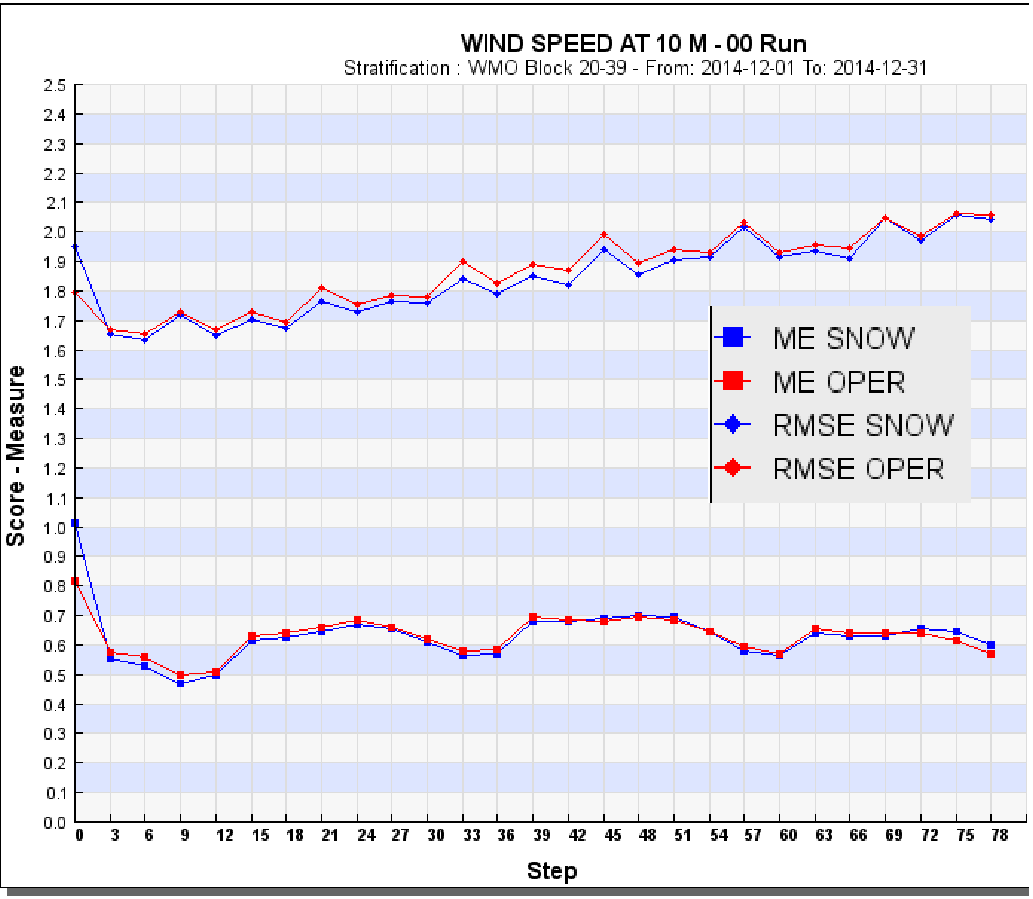
COSMO-Ru2. 1 Dec. 2014 – 10 Feb. 2015



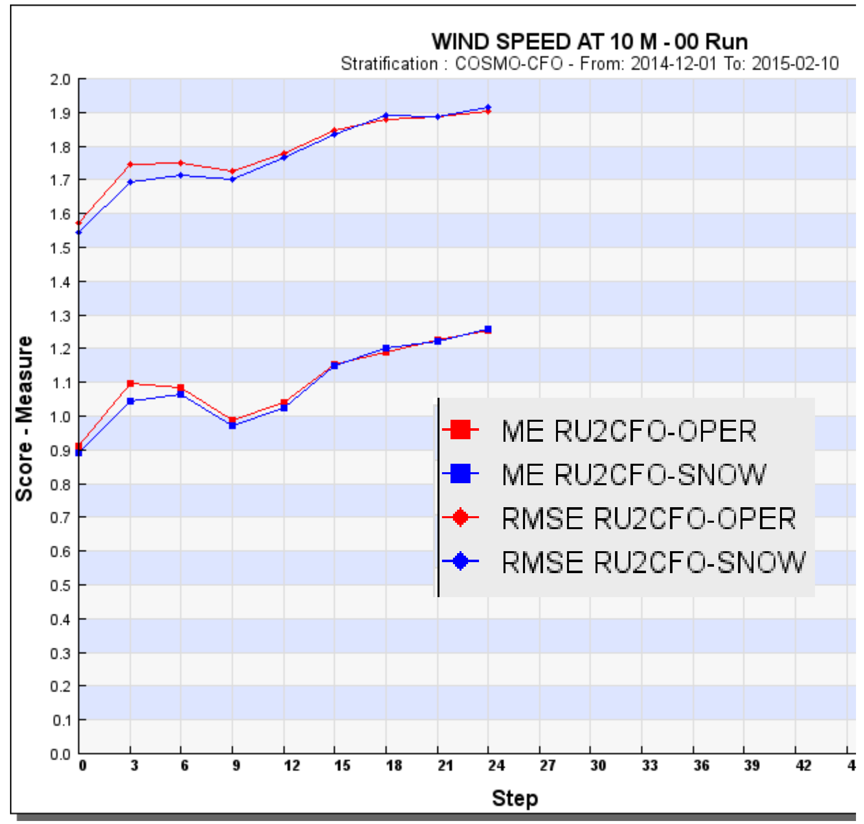
ME and RMSE are a little bit less in case of new technology using.

COSMO-Ru 10m wind speed verification

COSMO-Ru7. 1-31 Dec. 2014



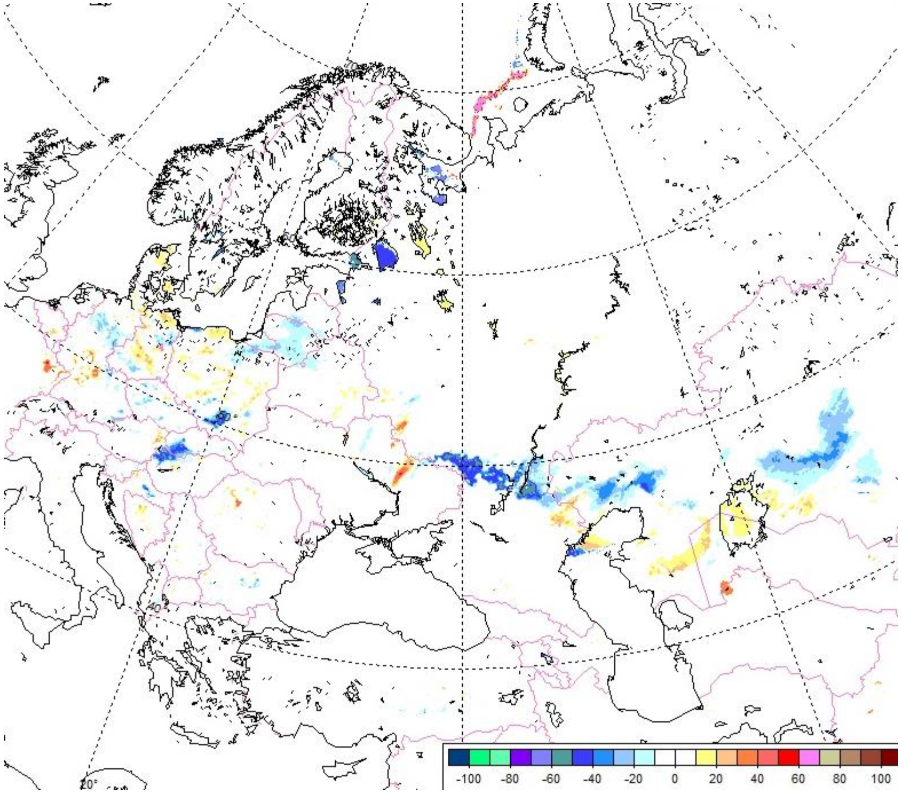
COSMO-Ru2. 1 Dec. 2014 – 10 Feb. 2015



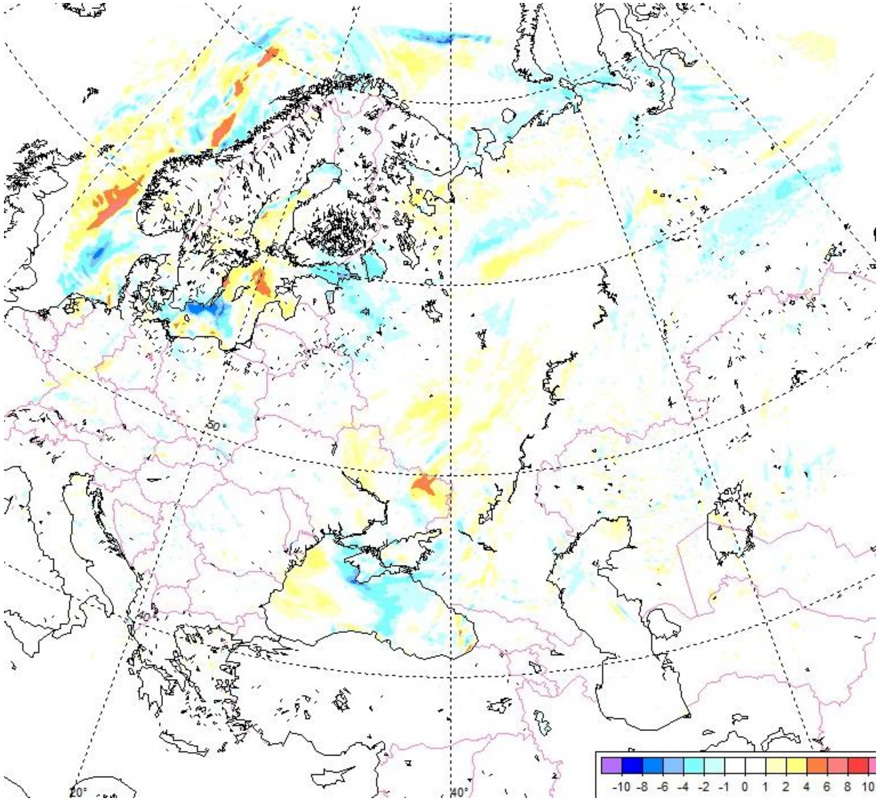
Values of ME and RMSE are close in both cases. The biggest differences are observed in the very start of the model (00h).

COSMO-Ru7 78h forecasts. 1 February 2015

Δalbedo (new technology-reference)



Δ10m wind speed (new technology-reference)



Additional activities connected with the technology

• Data quality control must be done.

But the question is – how to distinguish extreme snow accumulation due to snowfalls and measurement errors?
Now the limits are:
100 cm – for first snow in the winter season
70 cm – maximum difference in snow depth for 24 hours

• If there is no measurement for needed day, but snow was present yesterday, then the previous value of snow depth is used (snow depth is >=5 cm).

What to do, if station doesn’t send measurements several days or at least stops to do this

Conclusions

• The block for preparation of snow initial conditions (SWE and RHO) as a part of system for COSMO-Ru is implemented in the technological chain

• COSMO-Ru forecasts are calculated once a day in quasi-operational regime for two domains (7 km and 2 km)

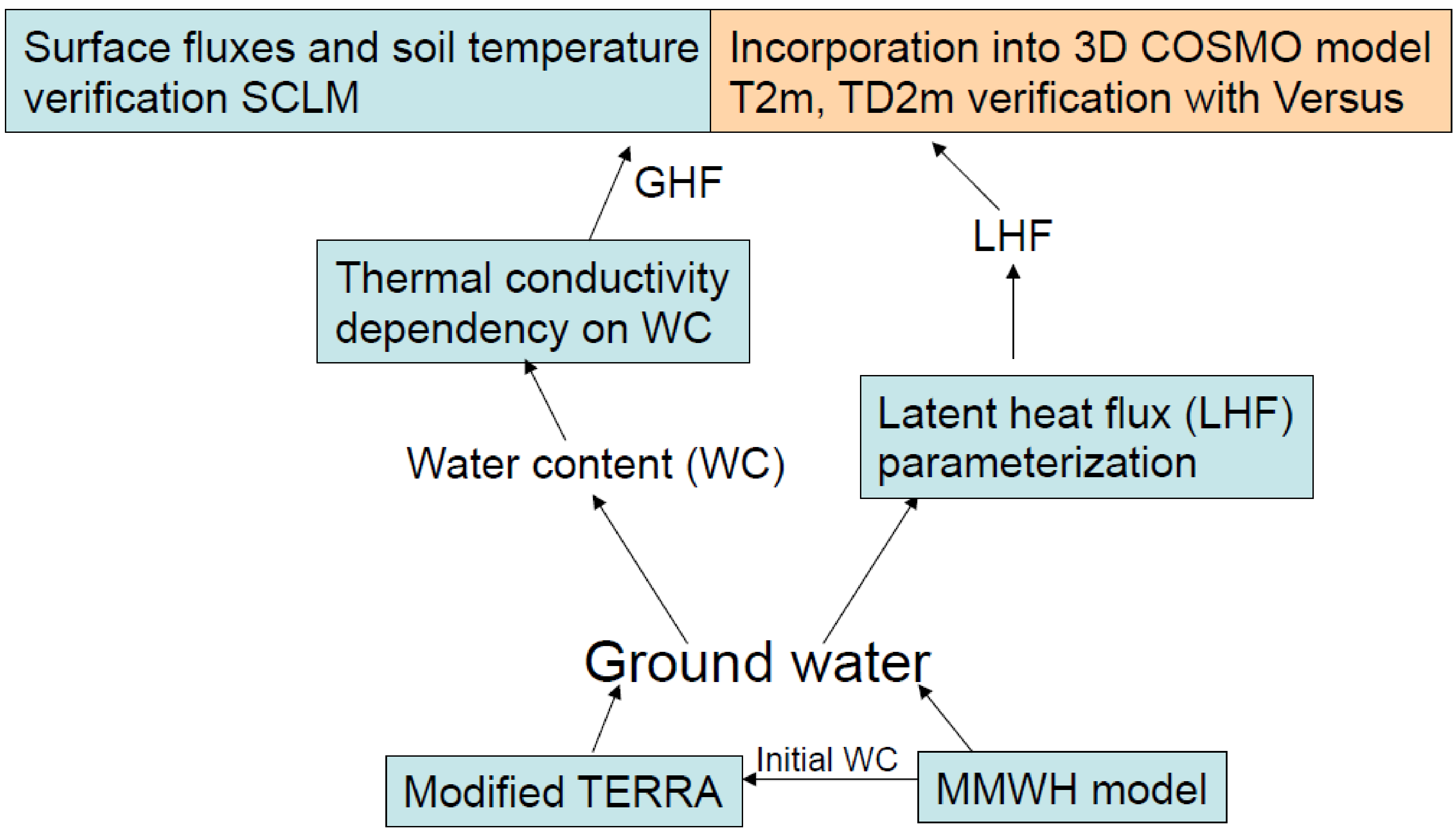
• Preliminary evaluation showed that feedback in forecasts of T2m and cloudiness is observed. There are changes in prognostic fields of surface albedo too. Differences in heat fluxes and 10m wind speed need more analysis.

Codes are written in Fotran 90 according to Software Standards: "European Standards for Writing and Documenting Exchangeable Fortran 90 Code".

PT Mire parameterization

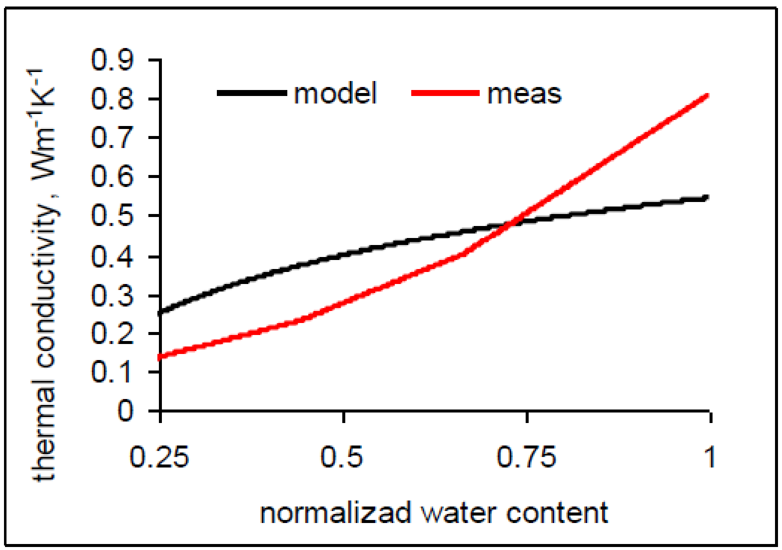
Alla Yurova

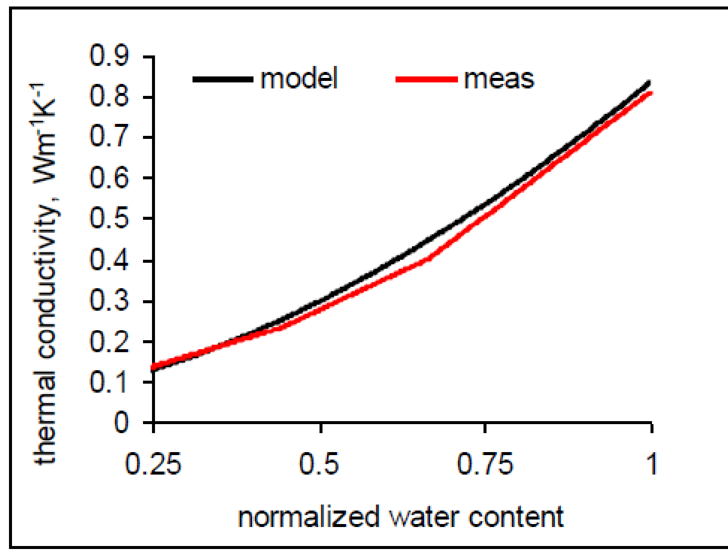
Priority task: mire parameterization



Peat thermal conductivity

Johansen equation from TERRA used. Peat-specific parameters from Lawrence and Slater(2007), reverse problem solved to obtain Kersten number as a function of water content



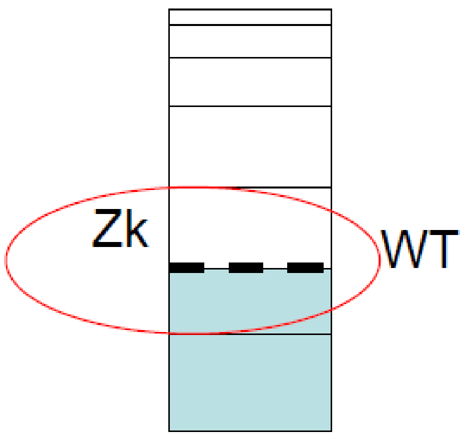


Peat thermal conductivity as a function of normalized water content:

a) as in original TERRA parameterization,

b) according to new parameterization and observed.

Formulation for the shallow WT



Weighted average between saturated and unsaturated water content in the layer Zk goes To Richards' equation

$$\Delta W = Fleff - q,$$
$$\Delta GW = -\Delta W(\Theta sat - \Theta)$$
$$q = lq \cdot i \cdot K\_h(zcat - zwt),$$

W, Θ -water content, *Fleff- gravitational water flux from the layer above minus capillary rise*, *q*-runoff, Θ sat-porosity, *i*-slope of the water table, $\cdot$*K_h*-transmissivity coefficient, *lq*-lumped parameter

Evapotranspiration parameterization

1

$$ET = 0.427 \cdot PET, \quad if \quad z_{wt} \geq 65$$

$$ET = 0.53 \cdot PET, \quad if \quad 25 \leq z_{wt} < 65$$

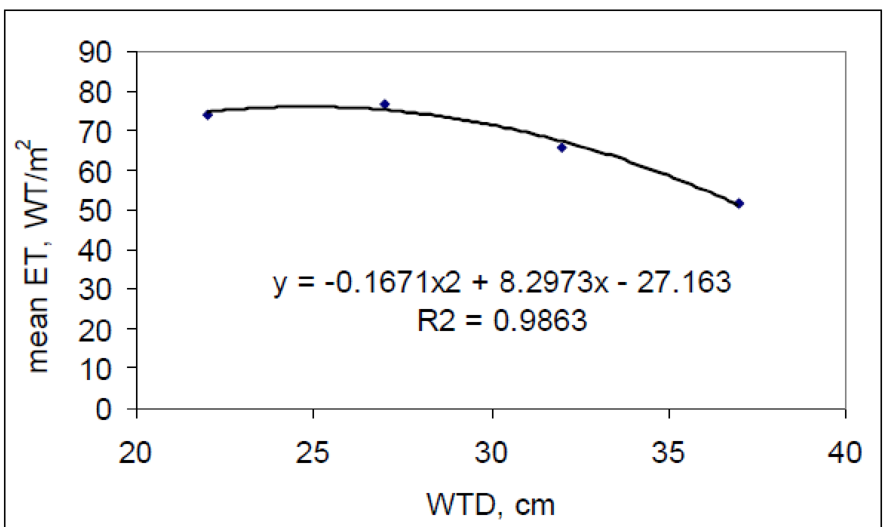
$$ET = 0.617 \cdot PET, \quad if \quad z_{wt} < 25$$

ET-evapotranspiration
PET-potential ET

2

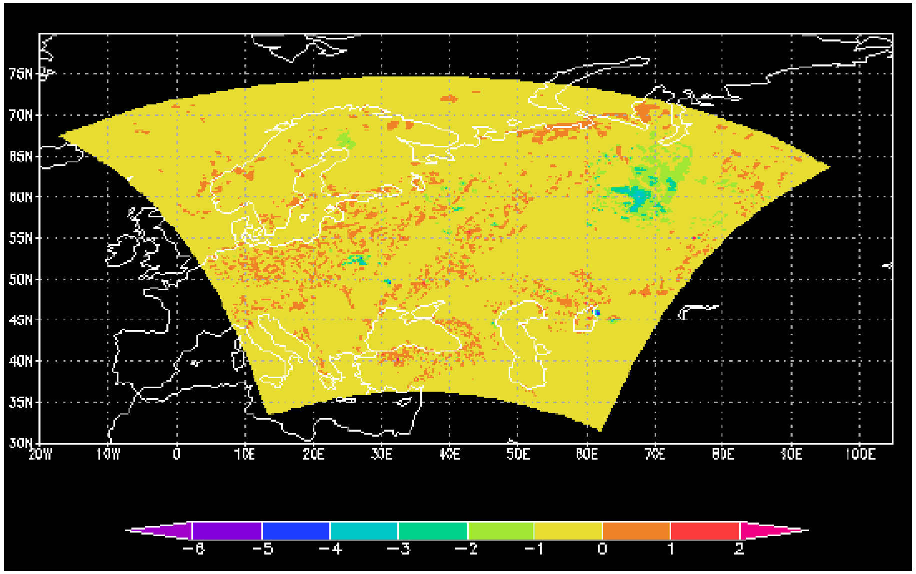
$$ET = PET \cdot m, \qquad m = s_0 + s_1(z_{wt} - z_L) + s_2(z_{wt} - z_L)^2 + s_3(z_{wt} - z_L)^3, if \ z_{wt} > z_L$$

$$1, \quad if \quad z_{wt} \leq z_L,$$

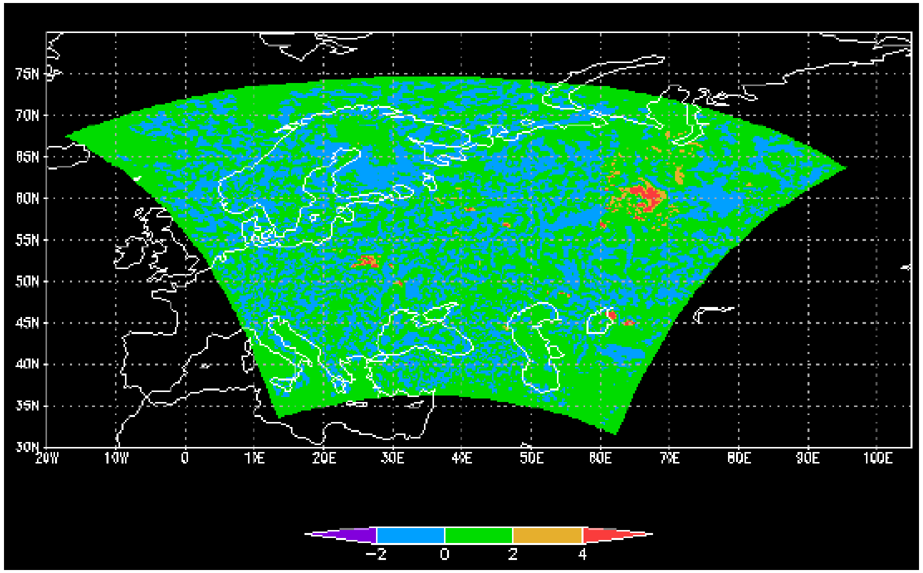


Measurements at Degero Stormyr mire, summer 2008

Results of the tests with the mire parameterization in the 3D COSMO-RU model. 08.08.12. Daytime

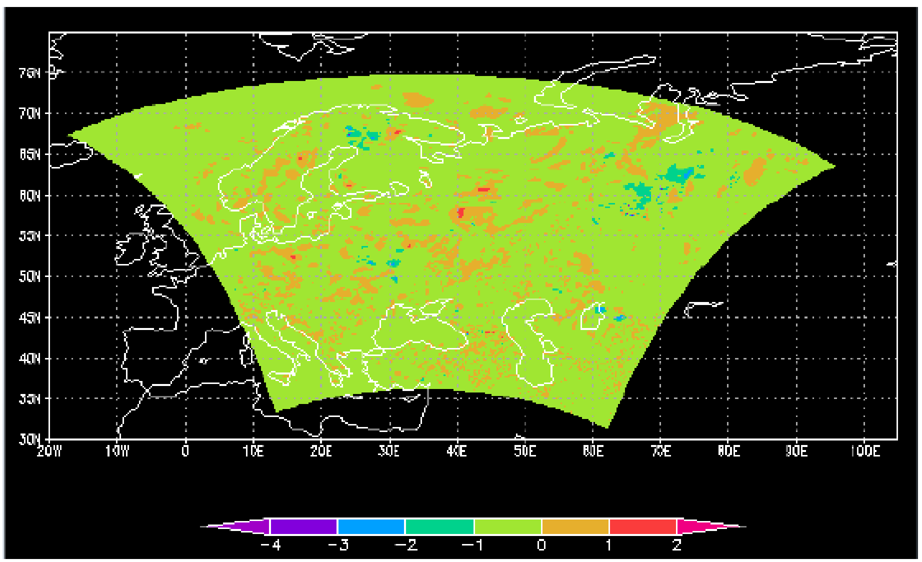


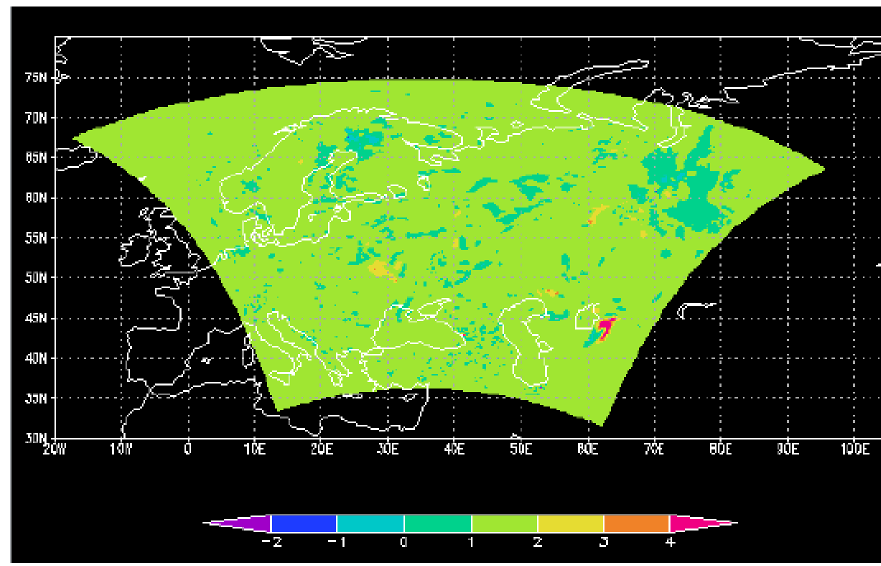
Δ T_2m 12:00 (12h)



Δ TD_2m 12:00 (12h)

Results of the tests with the mire parameterization in the 3D COSMO-RU model. 08.08.12. Nighttime

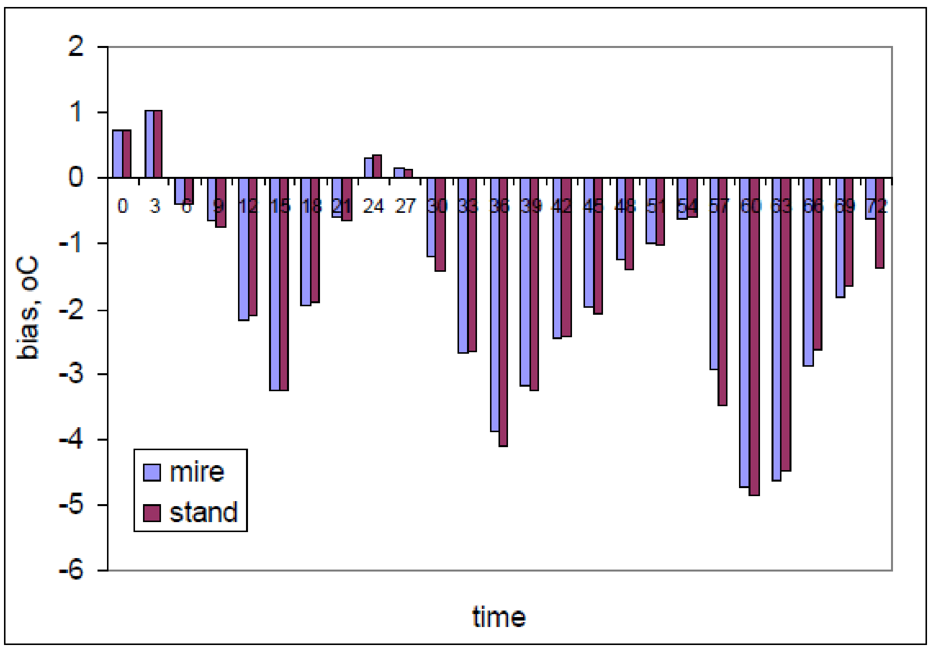


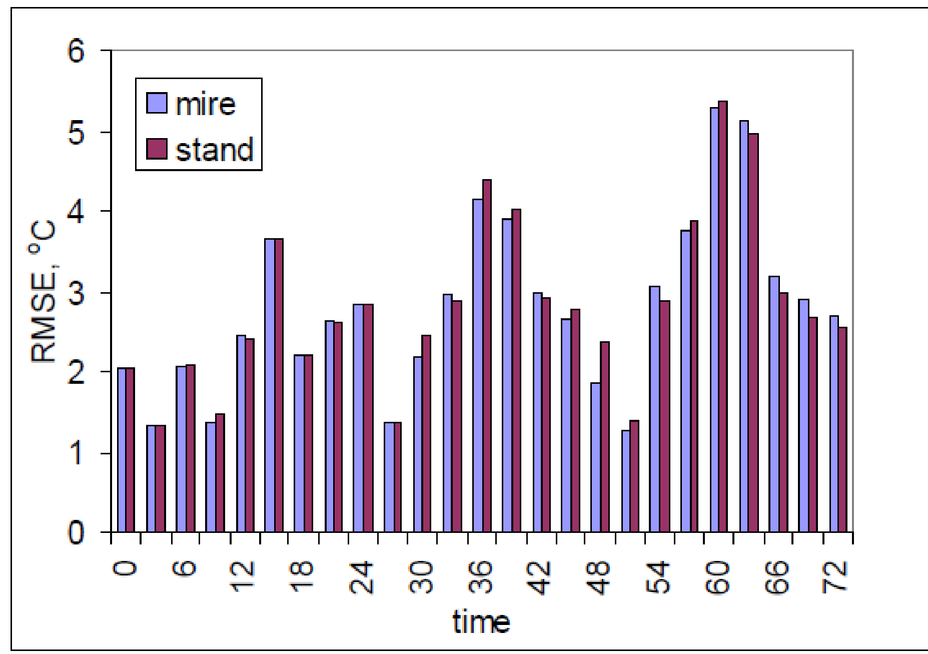


Δ T_2m 0:00 (24h)

Δ TD_2m 0:00 (24h)

Verifying 2m temperature for the West Siberian lowlands. August 2012





a) Model bias

b) RMSE

Thank you for your attention!

Thanks to A. Kirsanov for the help with verifications done in VERSUS

Peculiarities of the technology for COSMO-Ru7

- Initial COSMO-Ru7 values of snow characteristics are interpolated at stations (the nearest node of the COSMO-grid within a radius of 10 km; for several stations situated at coastal zone it was extended to 25 km). “Land” stations (fr_land>=0.5) were used

- Discrepancies k between SMFE calculated snow characteristics and COSMO one were defined (by dividing COSMO-values on SMFE-values), if SWE-values for both methods were >=5 mm. If both were not equal to 0 and less than 5 mm, then k=1

- For stations which are situated outside COSMO-grid but needed to build interpolation, values k=1 were used

- If SMFE-values were equal to 0, then k=0 (here the result SWE and snow density values are equal to 0). If SMFE-values were not equal to 0 and COSMO-values=0, then k=1

Peculiarities of the technology for COSMO-Ru7

• k-values are interpolated from stations to COSMO-grid according to program using Delaunay triangulation with the 30-km resolution (V. Kopeykin, Hydrometcenter of Russia). The resolution could be more accurate, but then calculation time increases (for COSMO-Ru2 it was 20 km). If there are points outside COSMO-grid then k=0 (northern/south sea regions)

• Finally, COSMO initial fields are divided on k-values. In order not to have huge SWE-values in case of dividing initial COSMO small values on small k values, after tuning it was accepted that COSMO initial SWE and snow density fields were modified from the value k>=0.3; otherwise snow characteristics remained as they were in COSMO-model