SNOWE – technology – winter 2016/17

Preoperational runs for continuous modelling and initialization of SWE values for COSMO runs

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Outline

- Motivation;
- Challenges;
- Approach;
- Multi-layer snow model SMFE;
- SNOWE technology;
- Activities;
- Stations;
- Cosmo past forecasts;
- References;

Motivation

Initial information for NWP models should include fields of current values of

Snow water equivalent (SWE)

Snow Depth (SD)

Great sensitivity of *T2m model forecasts* to the SWE accuracy near snow boundary was detected.

→ T2m error can reach more than 10°

Motivation

Serious inaccuracies of *initial fields* of *SWE* coming from global model systems to *COSMO-Ru* are detected for large regions of long snow period especially for snowy years

(*up to 100% or 1 m*)

*** The *SWE* as *COSMO product* is used in spring flood calculations for regions with rare observation network

It would be useful to have a *reliable system* for SWE which can be used in *the spring flood time*

Challenges

There are no direct operational observations of either SWE or Snow Density (SD);

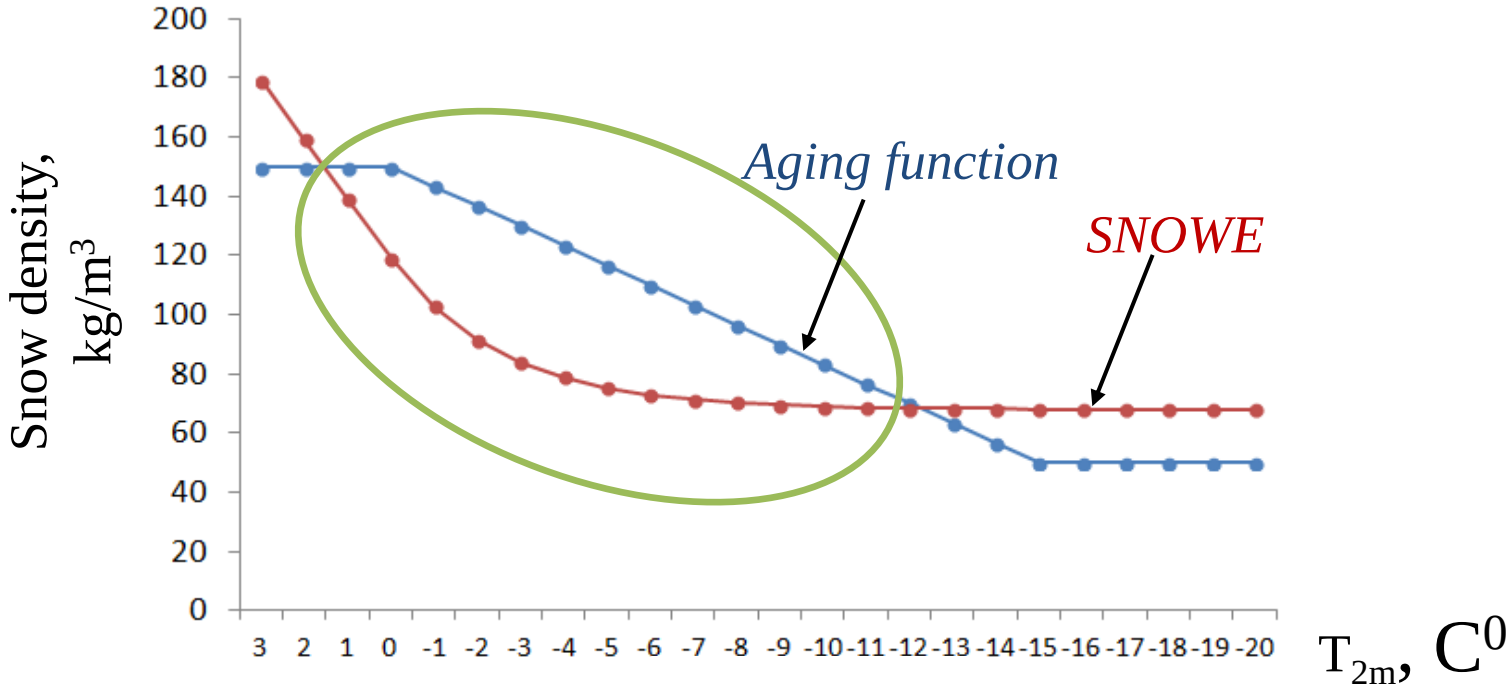
Hydrological observations: 1 measurement per 5 – 10 days

Reliable satellite technologies for determination of SWE (in particular for northern regions) are **in progress**

They are expected to provide reliable information only after a few years;

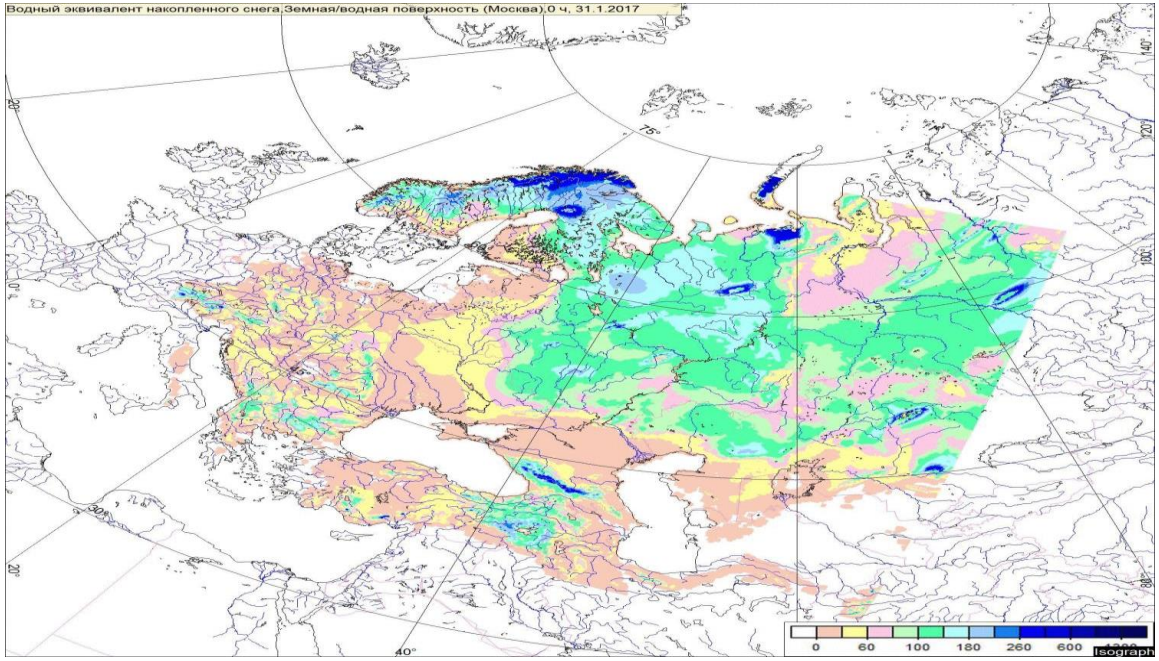
Challenges

SWE and *SD* values depend on the *whole* previous weather winter history. Moreover, the use of constants and aging functions for SD for long periods can lead to **wrong results;**



Challenges

The continuous modeling of *SWE/SD* into atmospheric models-DAS cycles leads to accumulation of **errors;**



But: The operational Snow Depth values coming from operational *Synop data* and the operational *data of Snow mask based satellites* are realistic!

Approach

The *regional system of correction* of *SWE fields* coming from global modelling & DAS should ***improve the situation***

Snow-analysis schemes in *ICON-DAS* provide the realistic values of snow depth and snow mask

SWE and SD values depend on the whole previous weather winter history

The standalone continuous modeling of *SWE* operated the ***SYNOP*** measurements is realistic way to obtain the daily SWE values

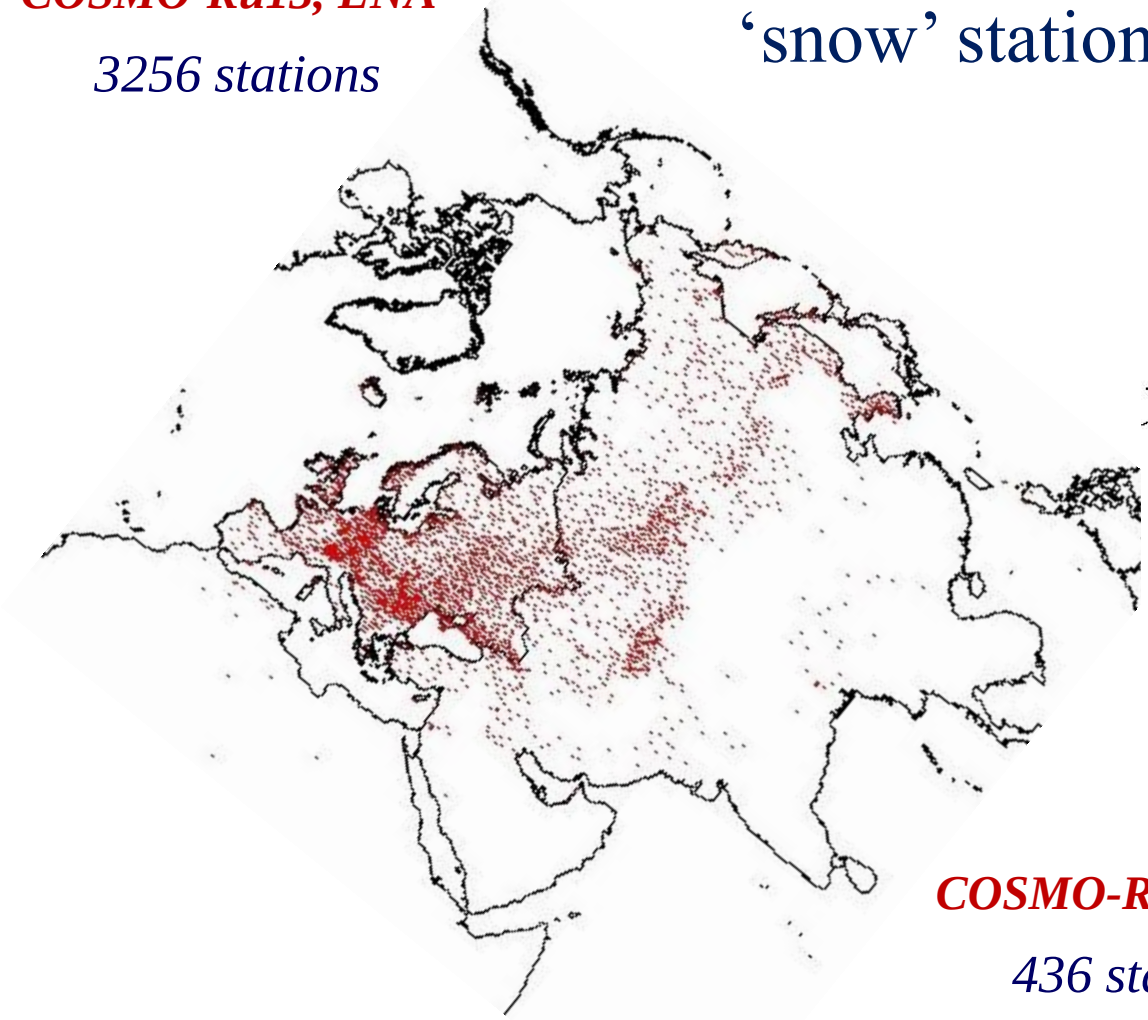
Approach

SYNOP

'snow' stations

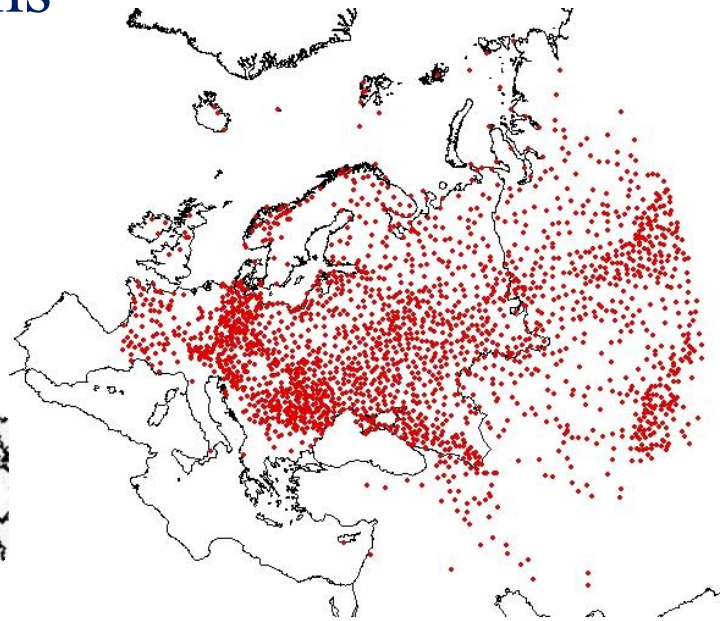
COSMO-Ru13, ENA

3256 stations



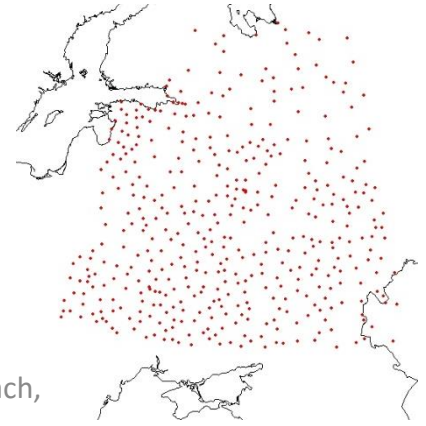
COSMO-Ru7, ETR

2163 stations

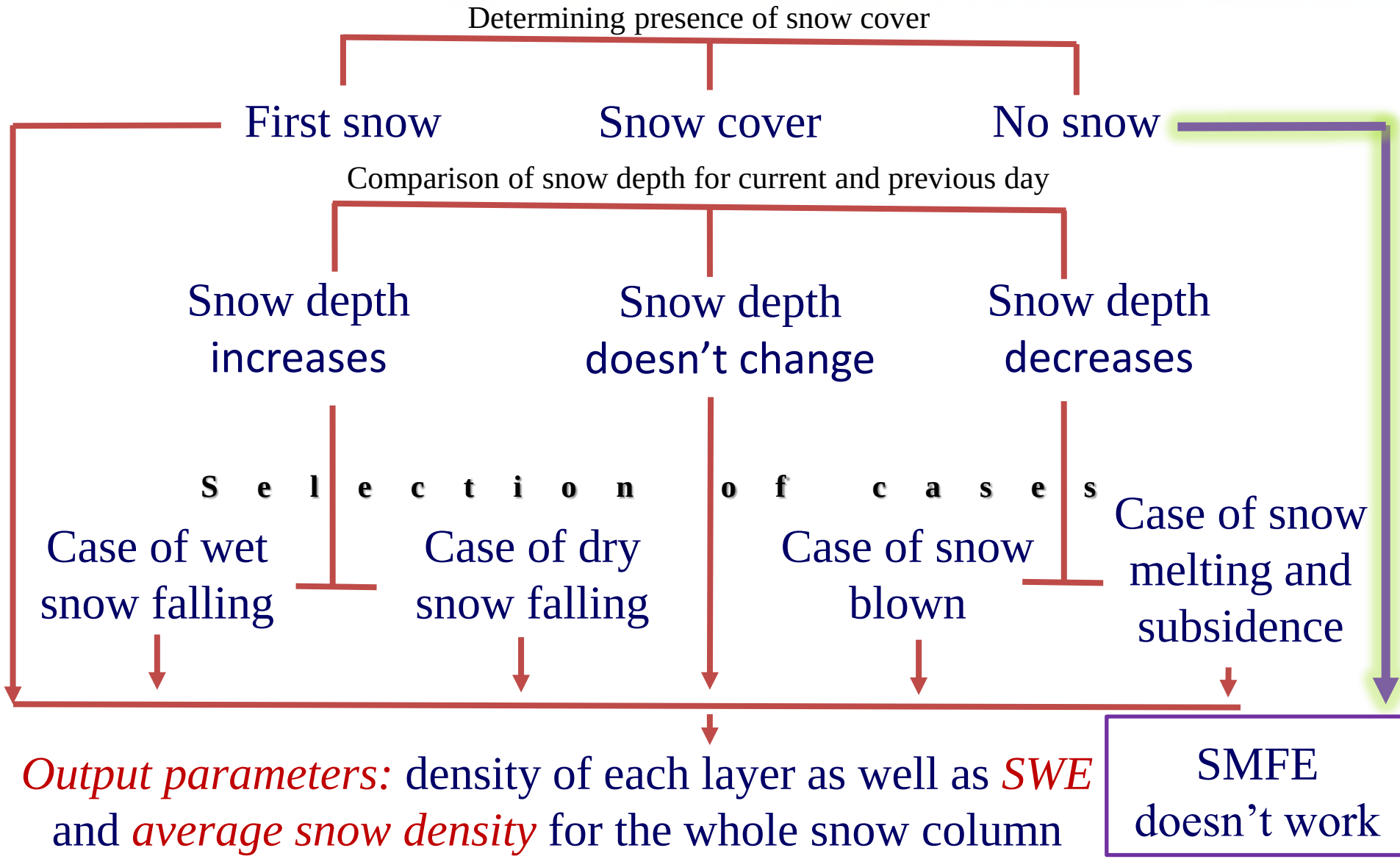


COSMO-Ru7, ETR

436 stations

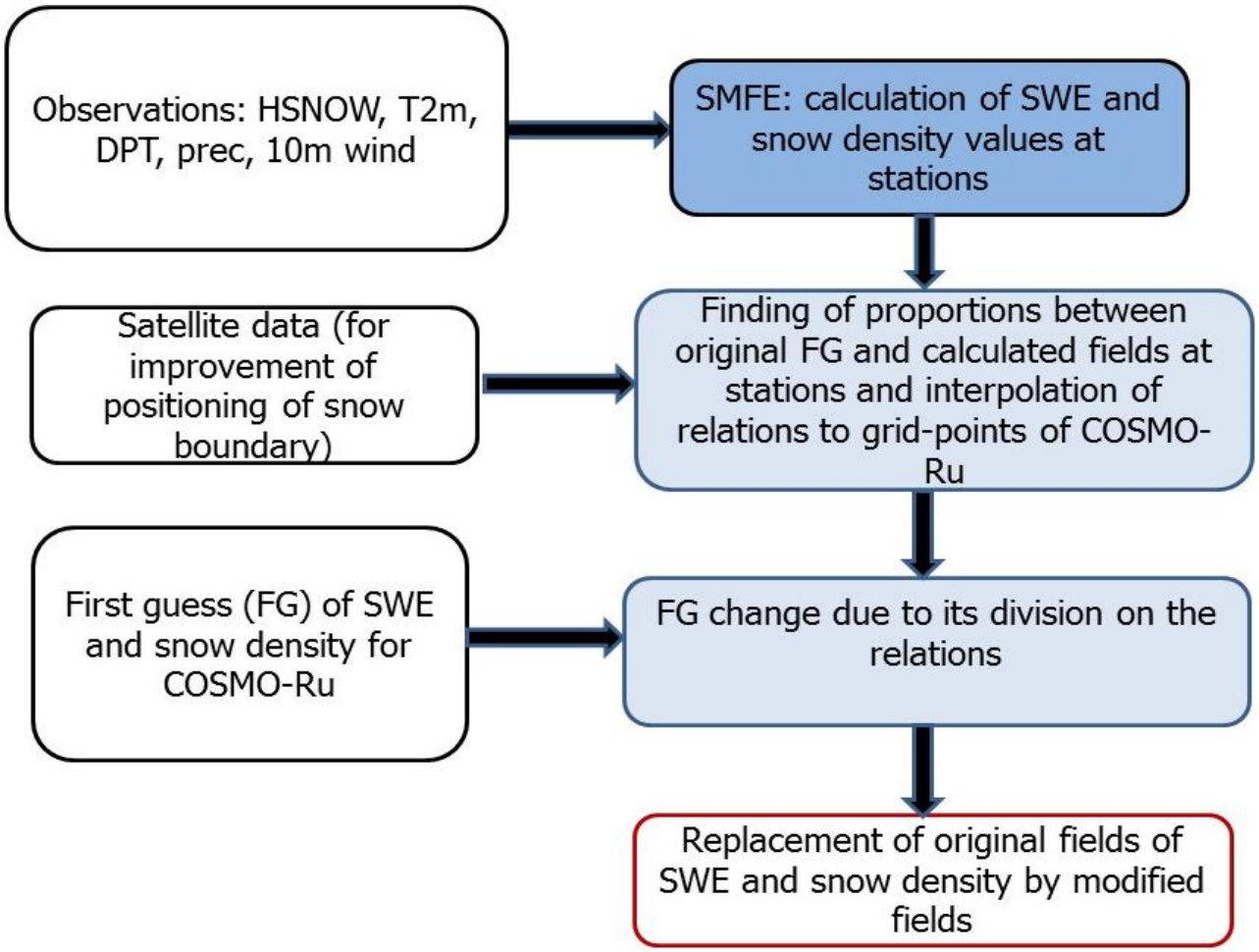


Multi-layer snow model SMFE



SNOWE technology

OA of snow cover characteristics for NWP model (exemplifying COSMO-Ru)



In quasi-operational regime since 1 December 2014 for:

COSMO-Ru7, ETR versions with 7 km resolution

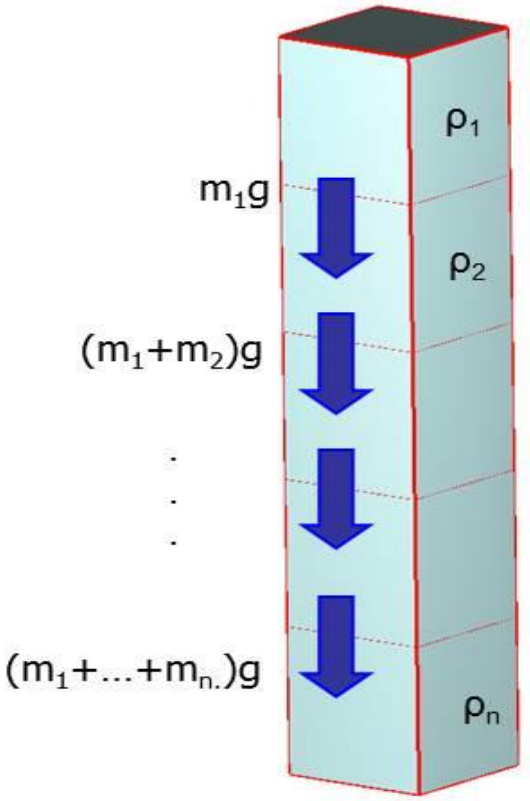
COSMO-Ru2, CFO versions with 2 km resolution

Since 1 March 2016 – for COSMO-Ru13, ENA versions with 13.2 km resolution

SNOWE technology

Snow is represented as a number of layers *(«elements»)*. The number of elements depends on snow depth. Each element has a height of h=1 cm;

Each time step (equal to 1 day) the number of new elements is determined depending on snow depth changes :



Activities

Calculation of *SWE* and *snow density* through the developed snow model SMFE can be *executed*

directly → *At SYNOP stations* ("stations", their further interpolation and using COSMO first guess)

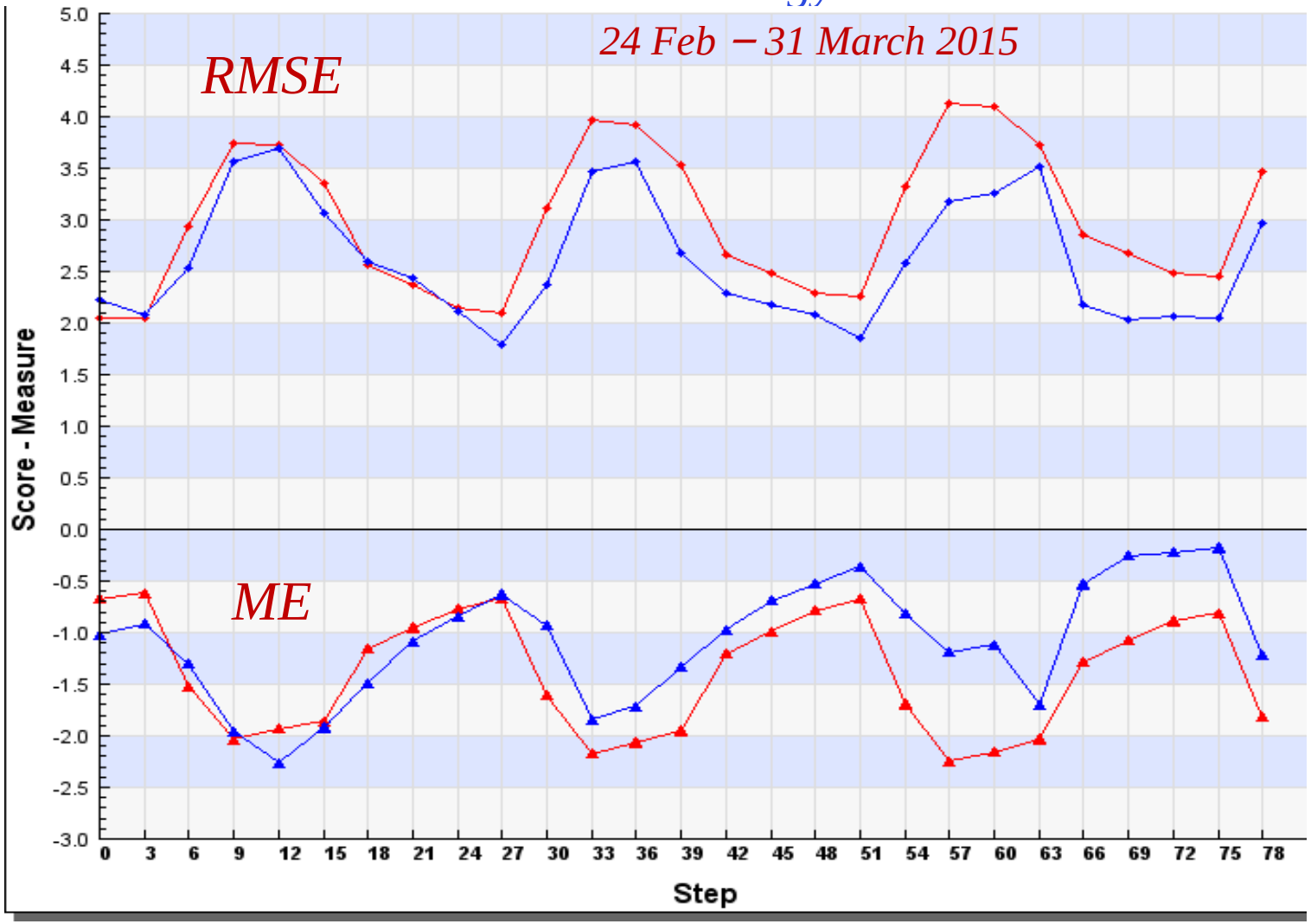
or → *At COSMO-grid points* ("COSMO past forecasts")

* For the time being, forecasts from *"COSMO past forecasts"* are calculated just to debug this part of code, with incorrect snow history

** *SNOWE* code is written in Fortran 90 and is ready for users

Activities

Conditional verification of T2m forecasts for *operational run* and *SNOWE technology* of COSMO-Ru7



Comparison of *positive* air temperatures

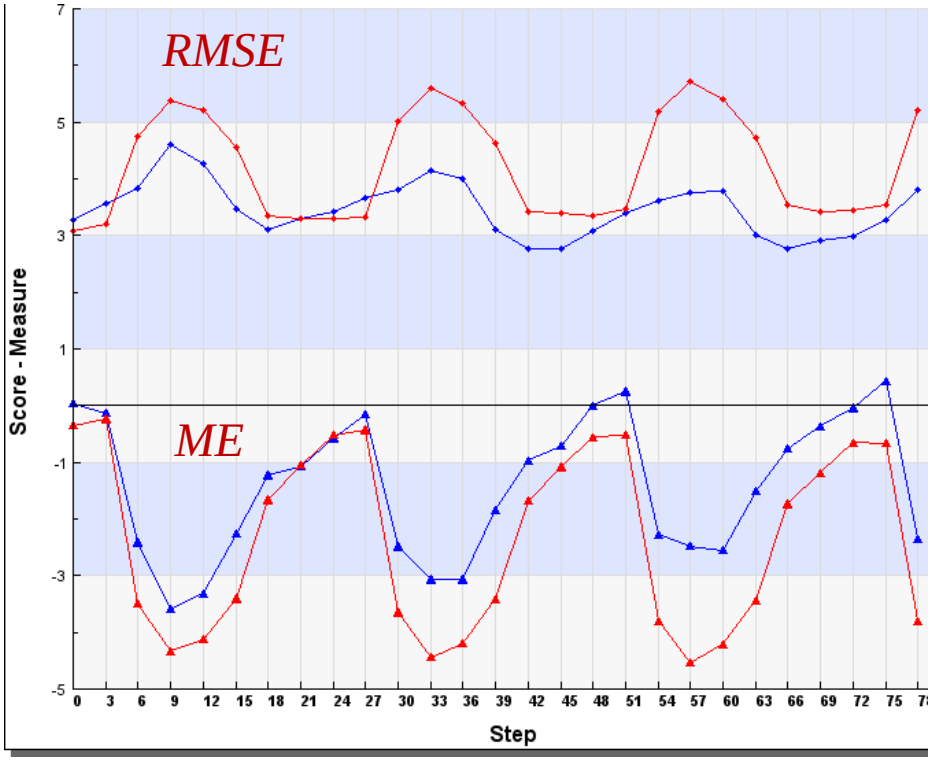
Activities

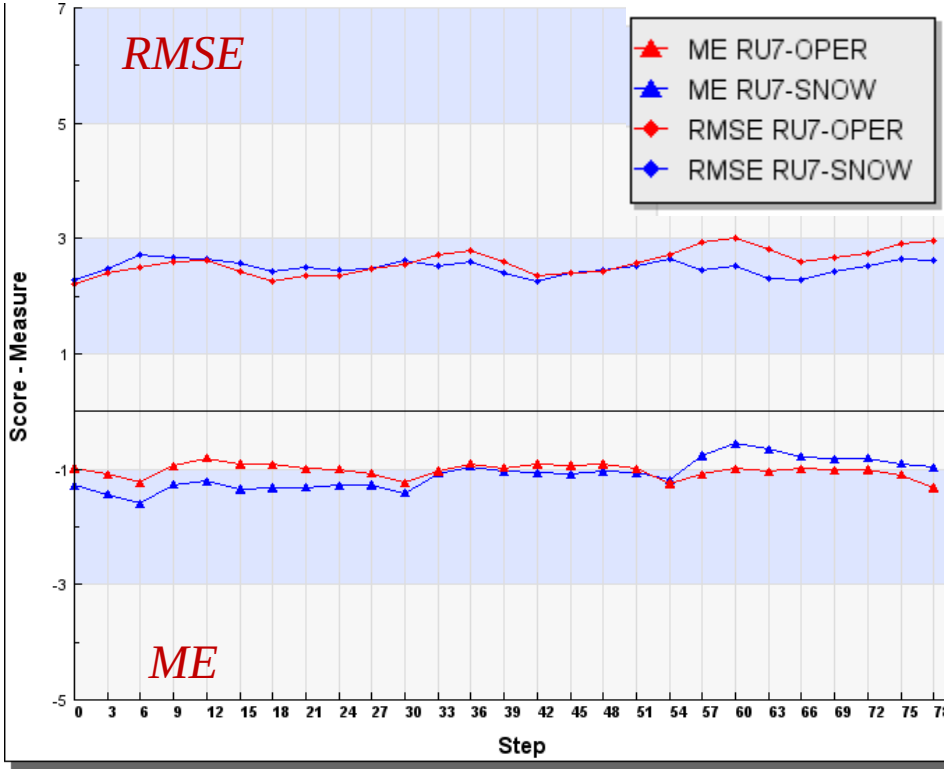
Conditional verification of T2m forecasts for *operational run* and *SNOWE technology* of COSMO-Ru7

24 Feb – 31 March 2015

Clear sky

Overcast

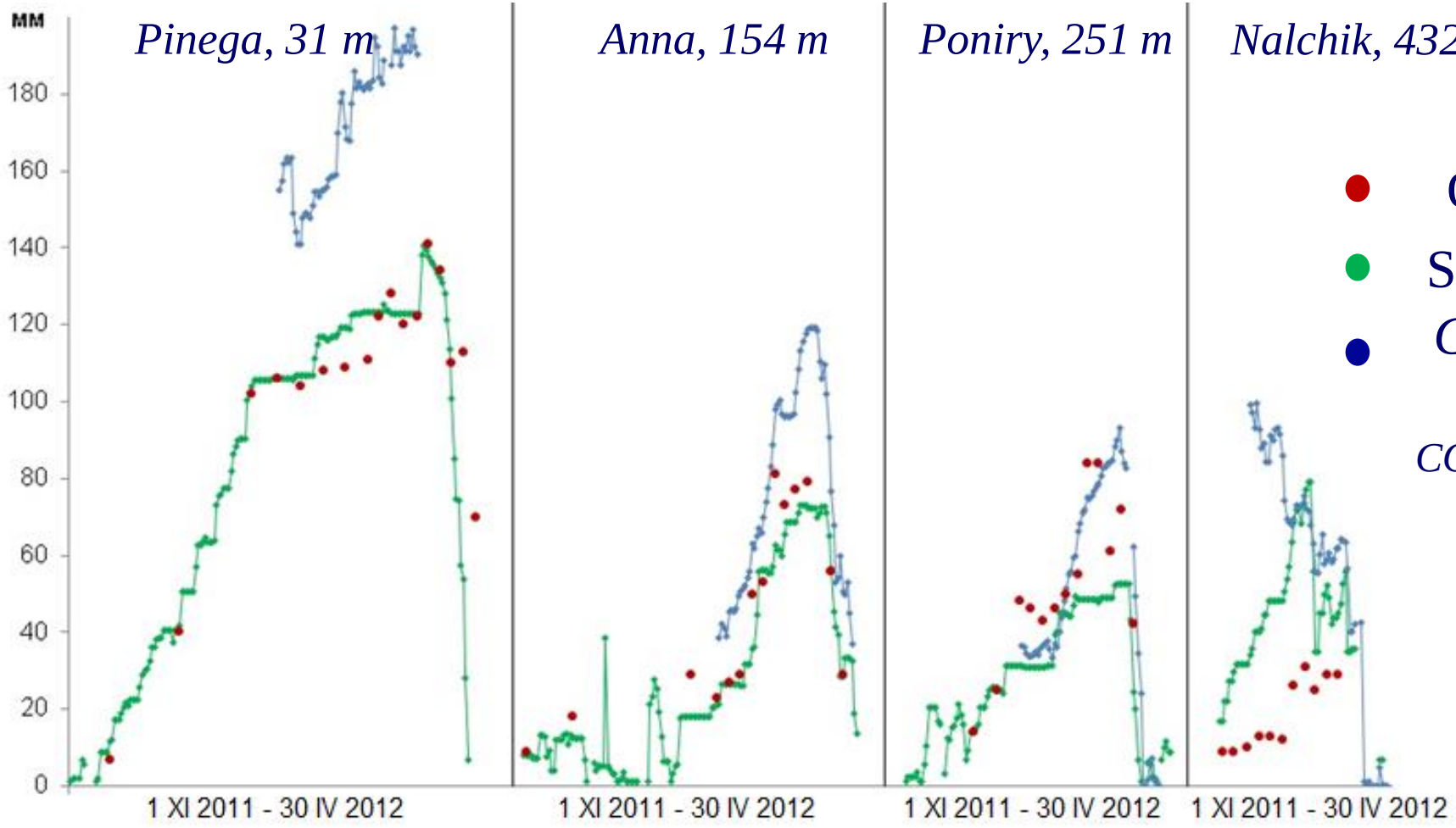




Condition: prognostic and observed total cloud cover ≤ 25%

Condition: prognostic and observed total cloud cover ≥ 75%

SWE for stations situated at the European part of Russia (snow season 2011/12)



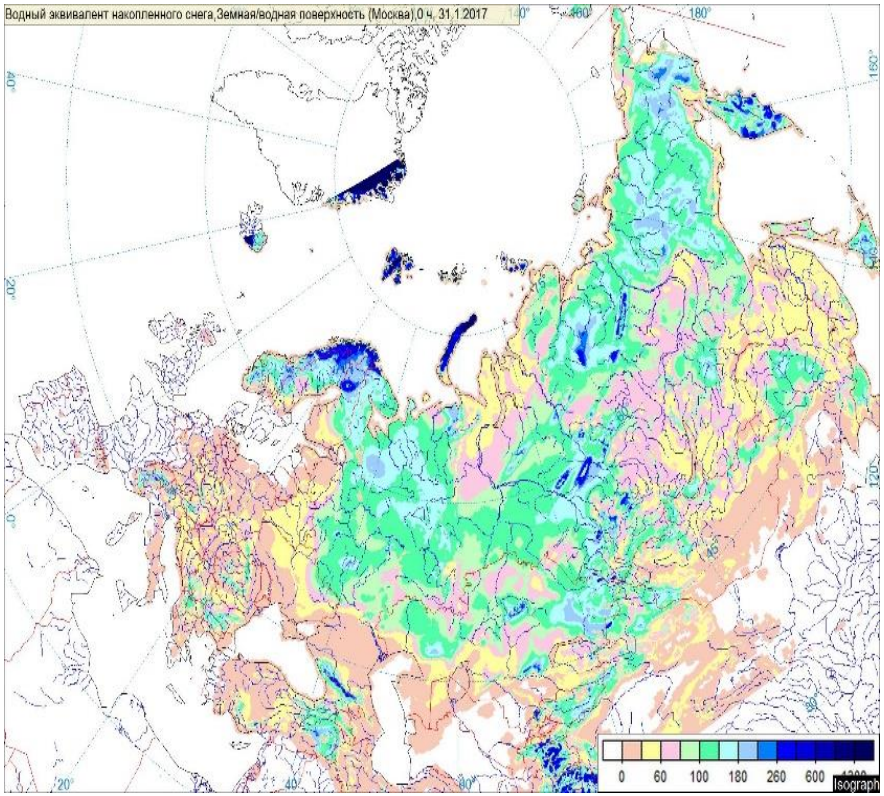
SWE fields for *"stations"* version

Stations

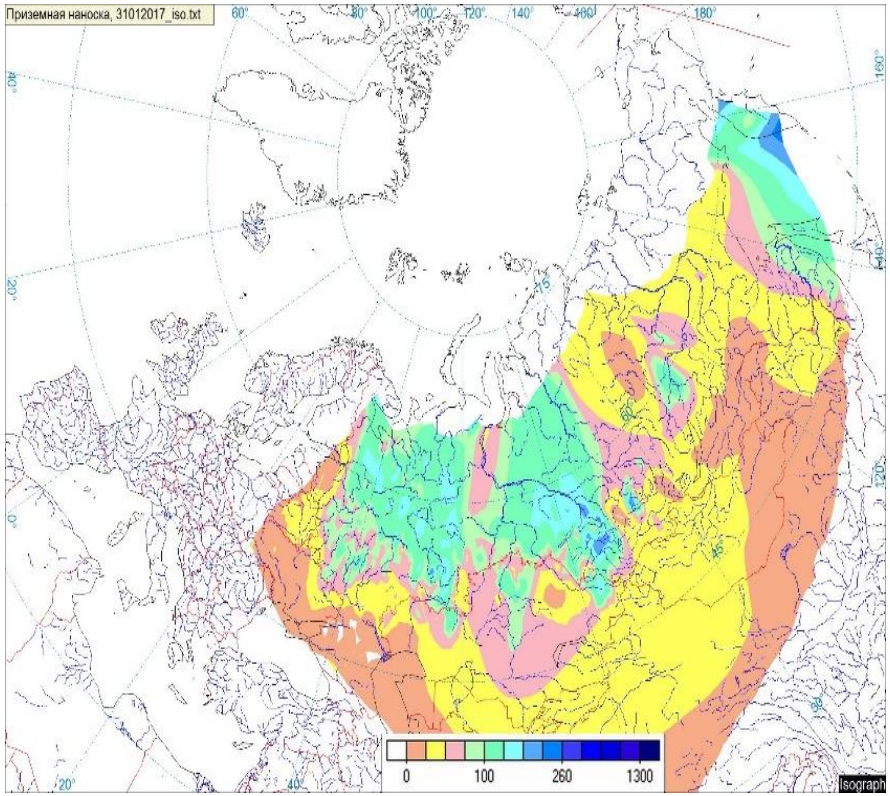
Maps of SWE (mm) – 31 January 2017

COSMO-Ru13 ENA

SMFE analysis



Hydrological obs.

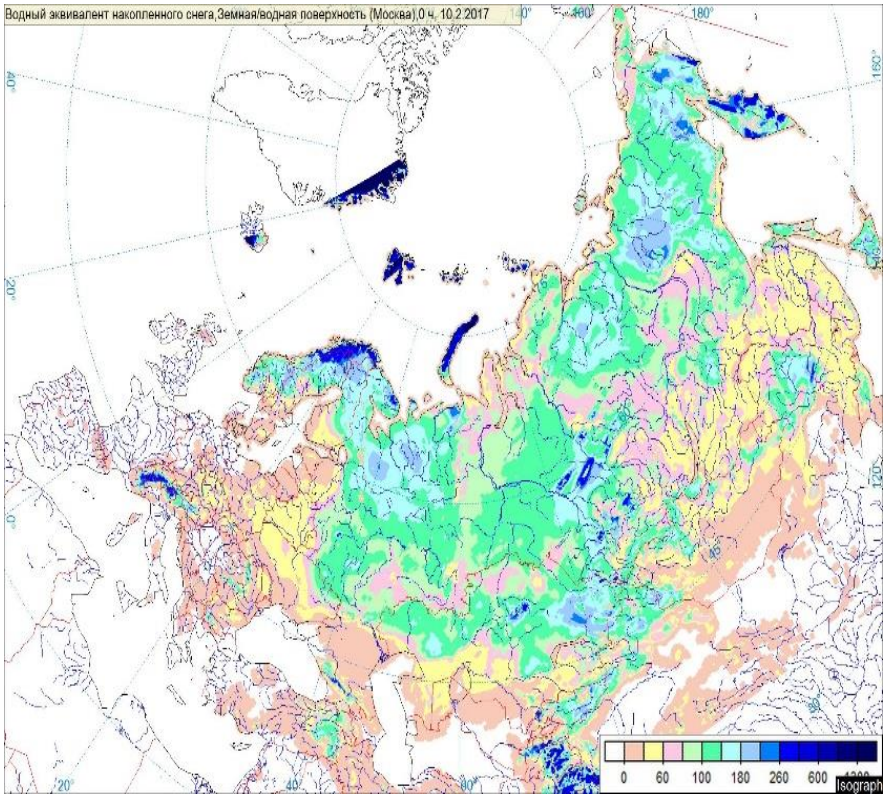


Stations

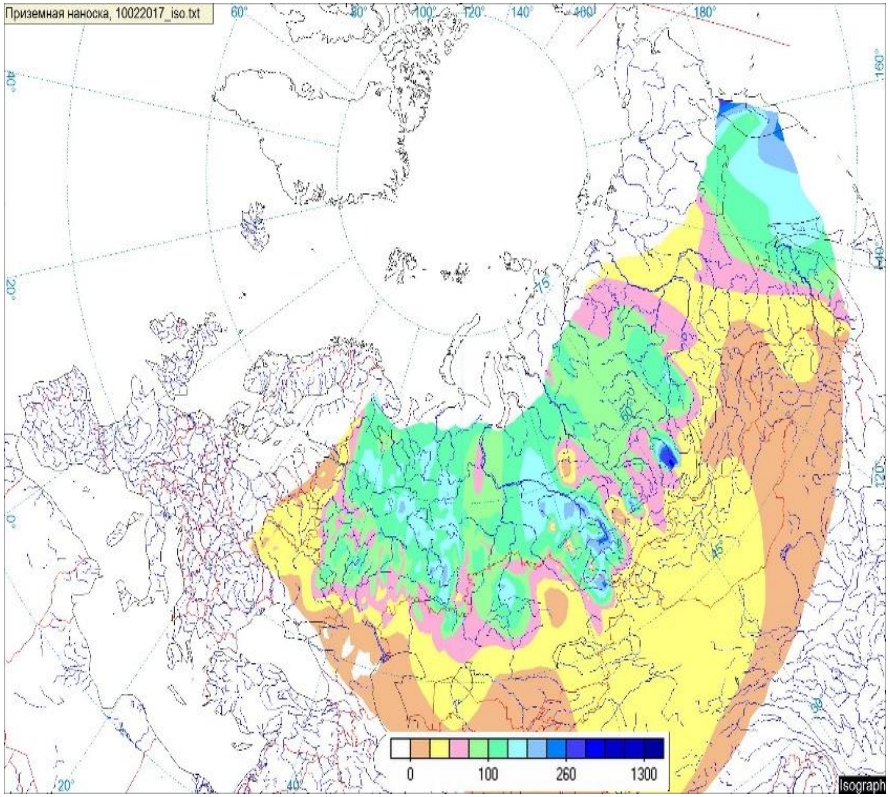
Maps of SWE (mm) – 10 February 2017

COSMO-Ru13 ENA

SMFE analysis



Hydrological obs.

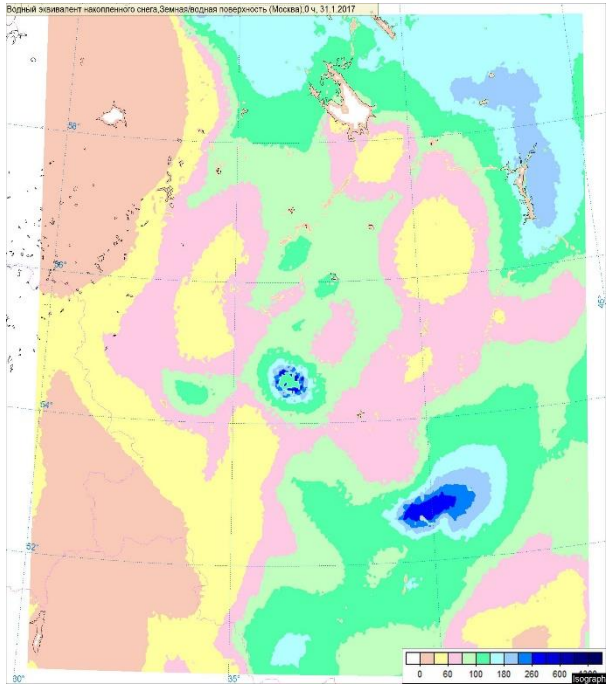


Stations

Maps of SWE (mm) – 31 January 2017

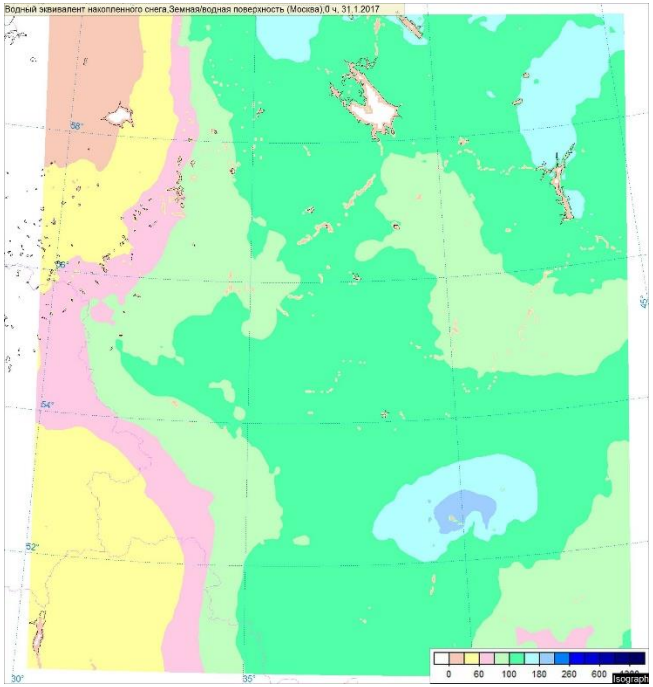
COSMO-Ru2 CFO

SMFE analysis



Hydrological obs.

Initial field from GME to COSMO-Ru7

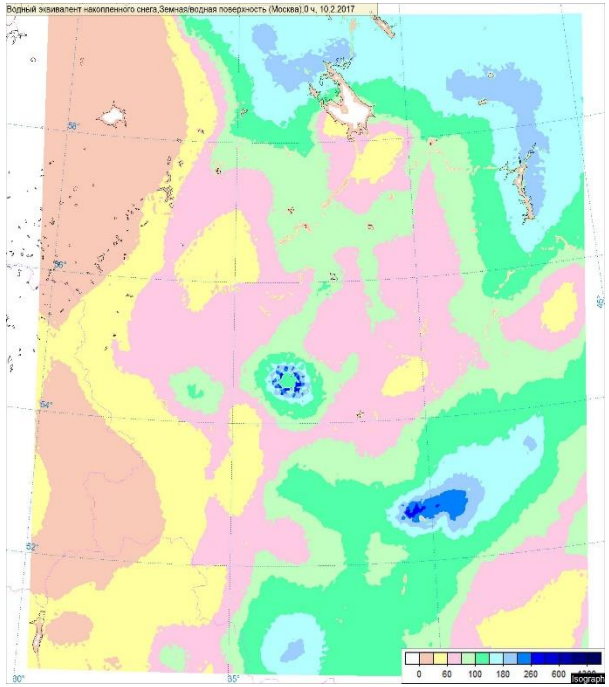


Stations

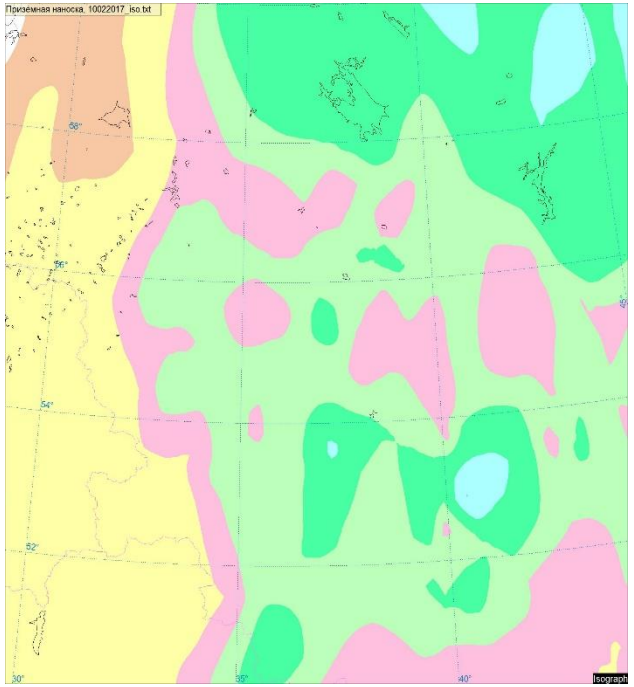
Maps of SWE (mm) – 10 February 2017

COSMO-Ru2 CFO

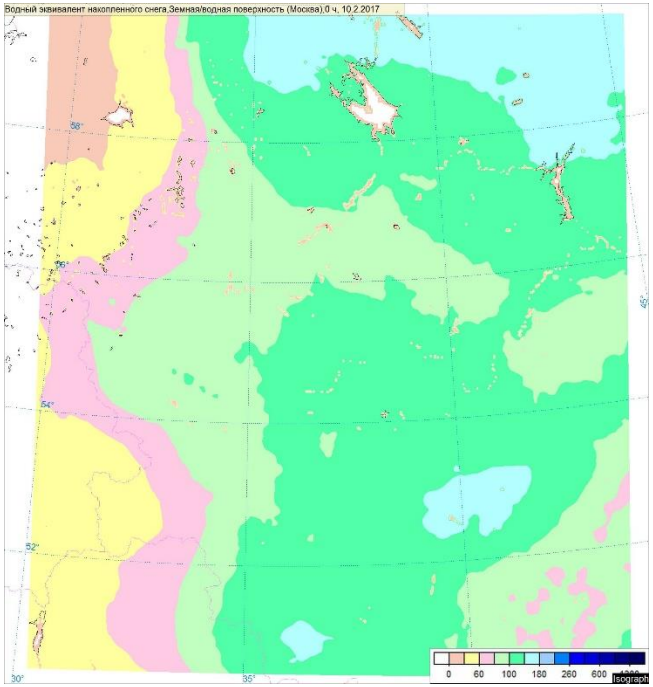
SMFE analysis



Hydrological obs.



Initial field from GME to COSMO-Ru7



SWE fields for *"COSMO past forecasts"* (grid) version

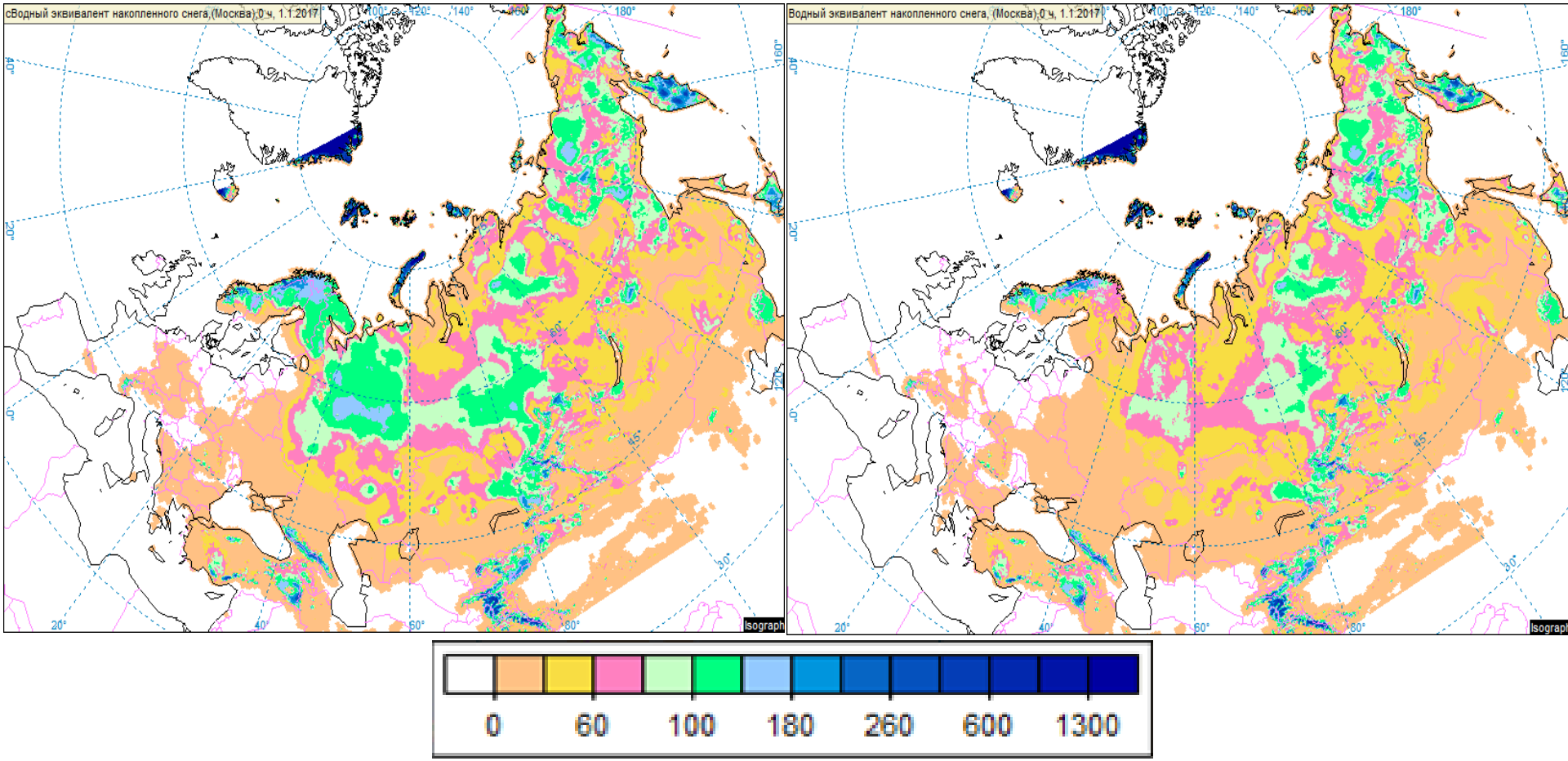
COSMO past forecasts

SWE for 00 UTC - 1 January 2017

COSMO-Ru13, ENA

Operational run

SNOWE technology



Conclusions

The approach based on SYNOP data *(SNOWE technology)* has been offered and implemented;

Values of SWE which have been calculated are *reliable* and can be useful for hydrological forecasting;

The data of *SNOWE technology* (*fields of SWE values*) have been applied in the spring flood time in 2015/2016 for northeast part of Russian Federation, where the observing network is rare;

Conclusions

SNOWE technology as corrector of initial fields of COSMO-Ru have reduced *RMSE* of T_{2m} forecasts near snow boundary in the spring time on 0.5 – 1.5 ℃, in some places up to 7 ℃;

The pre-operational starts of SNOWE in COSMO-Ru technology have demonstrated more realistic values of SWE than obtained from DAS system (in comparison with direct hydrological snow measurements) for winters 2014/2015 and 2015/2016 years.

References

- Kazakova E., Rozinkina I., (2016). Snow water equivalent analysis based on modeling as Synop observation operator – experience of COSMO-Ru technology (presentation). 38-th EWGLAM and 23-th SRNWP Meeting;

- Kazakova E., Rozinkina I., Chumakov M., (2016). Snow water equivalent analysis based on modeling with usage of SYNOP measurements as observational data operator: experience of COSMO technology in Roshydromet. 38-th EWGLAM and 23-th SRNWP Meeting;

- Kazakova E., Rozinkina I., Chumakov M., (2013). Realization of the parametric snow cover model SMFE for snow characteristics calculation according to standard net meteorological observations. COSMO newsletter, No.13: April 2013

- Kazakova E., Rozinkina I., (2011). Testing of snow parametrization schemes in COSMO-Ru: Analysis and Results. COSMO newsletter, No.13: February 2011

Contacts

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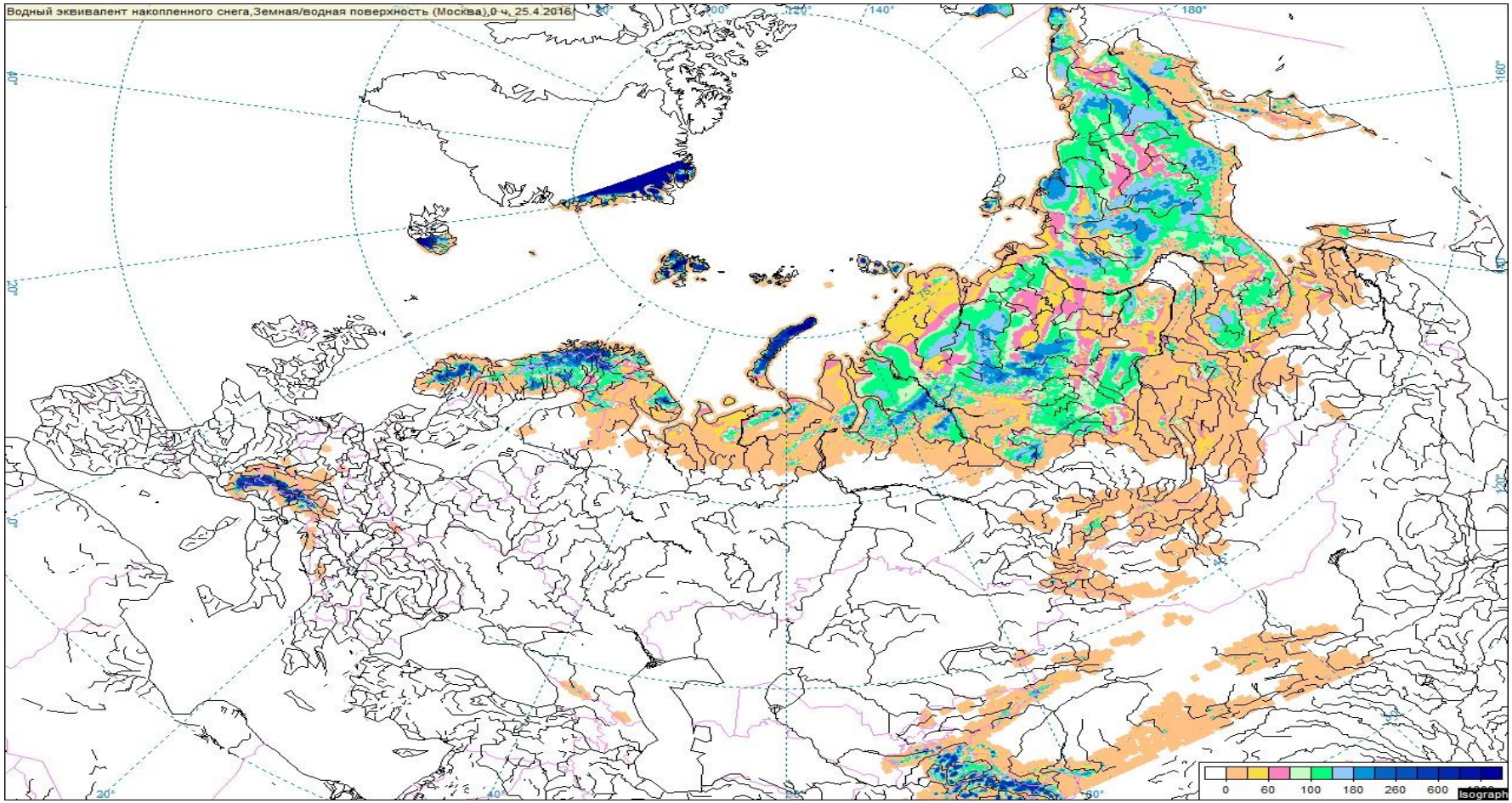
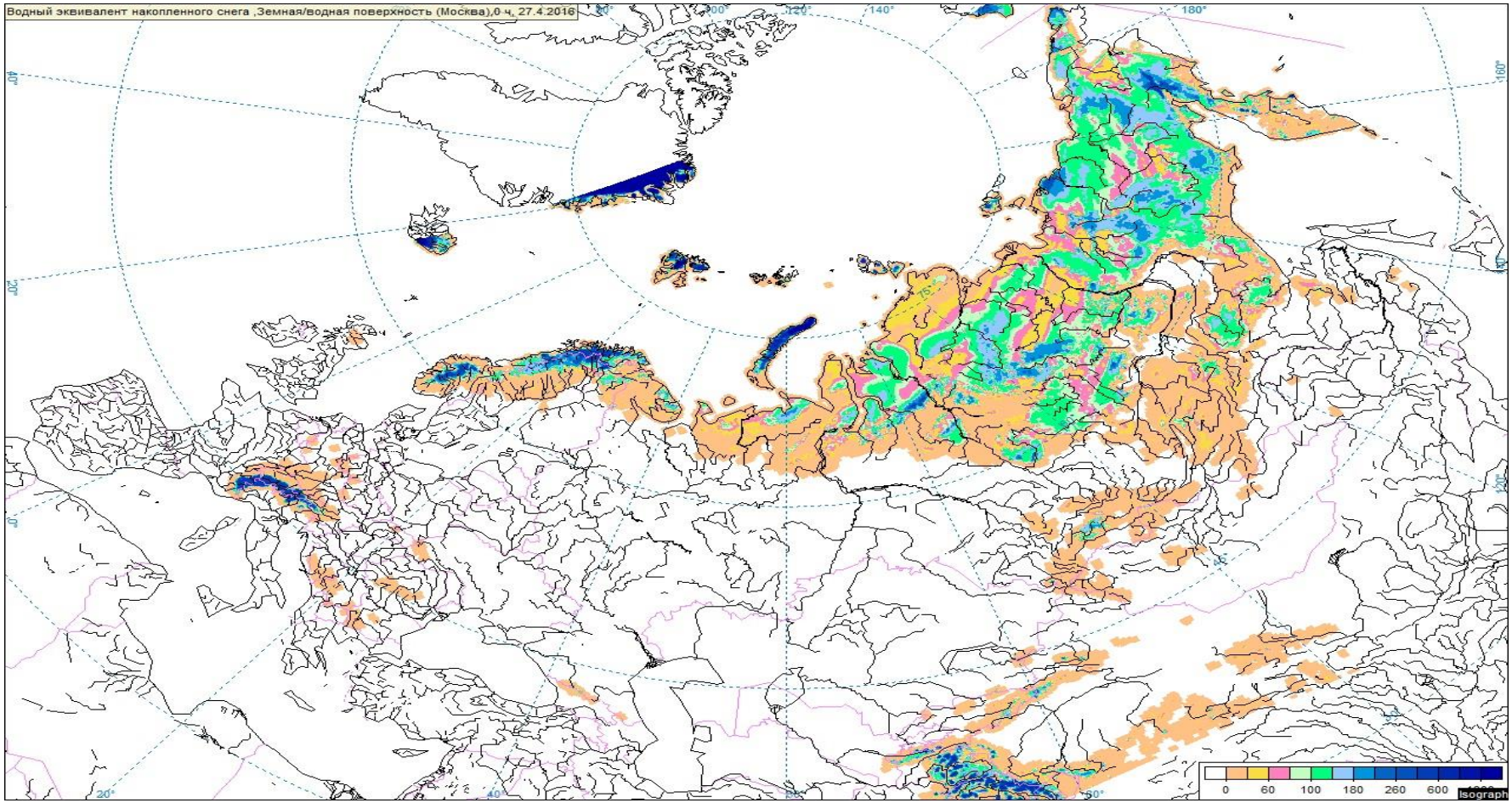
Maps of SWE (mm) – 25 April 2016

COSMO-Ru13 ENA



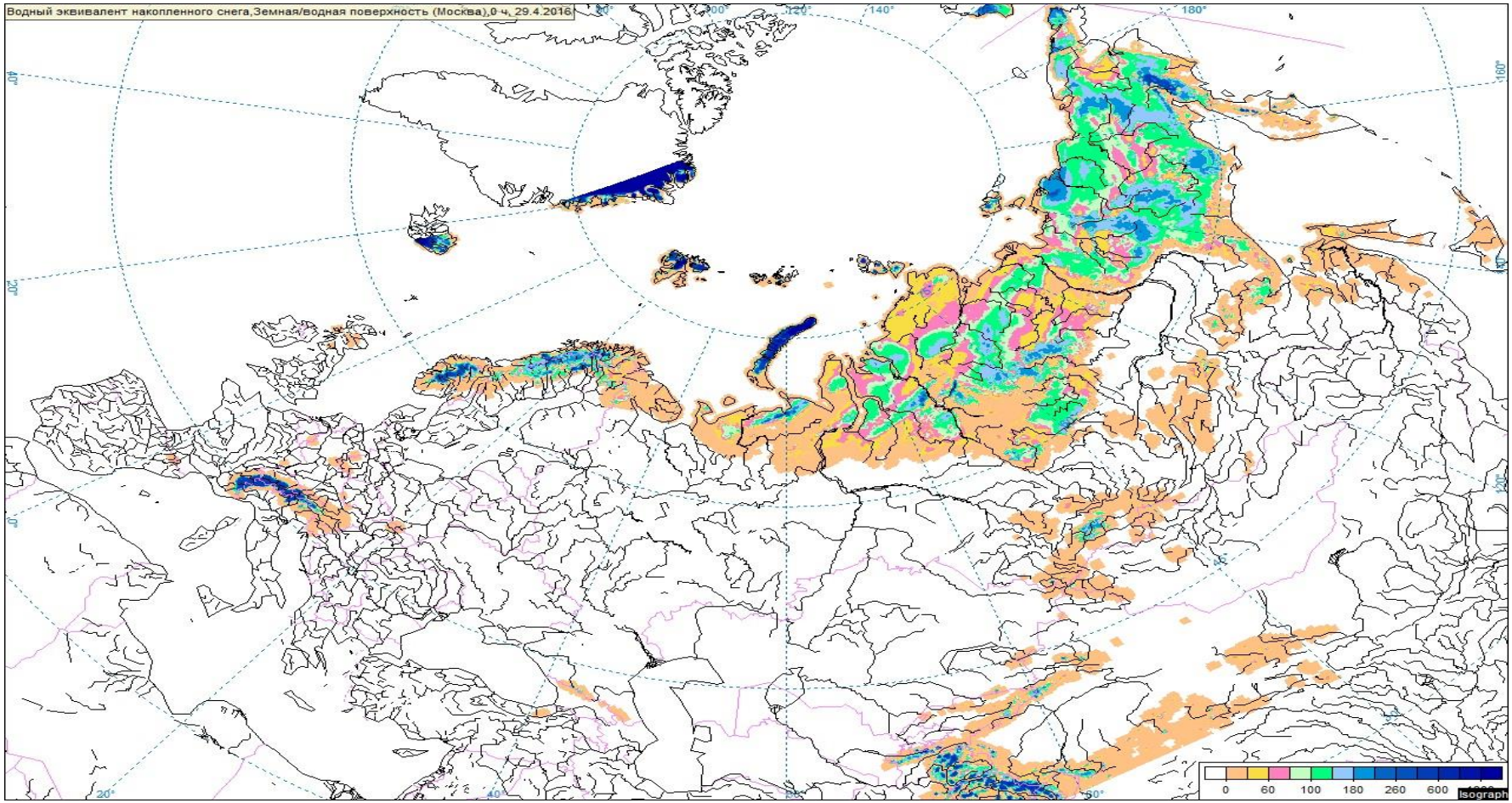
Maps of SWE (mm) – 27 April 2016

COSMO-Ru13 ENA

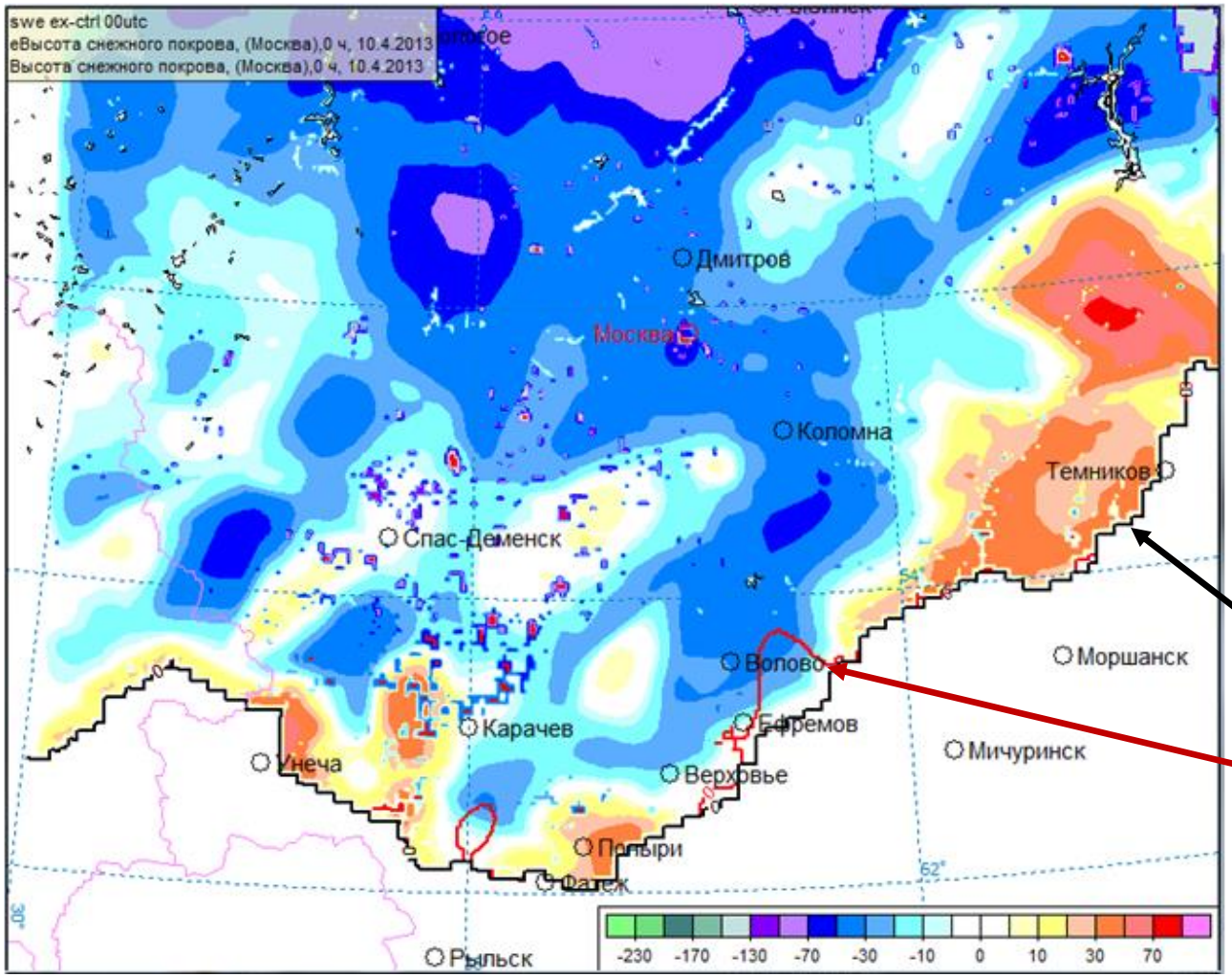


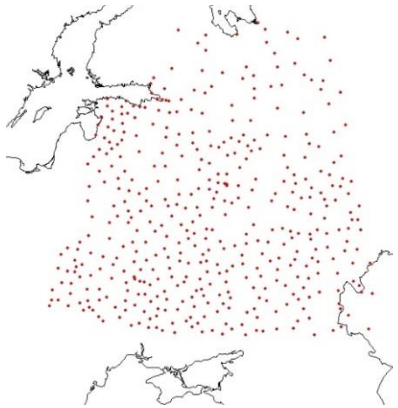
Maps of SWE (mm) – 29 April 2016

COSMO-Ru13 ENA



Differences in initial fields of SWE (mm, SNOWE technology-operational run) for COSMO-Ru2. Start – 00 UTC 10 April 2013



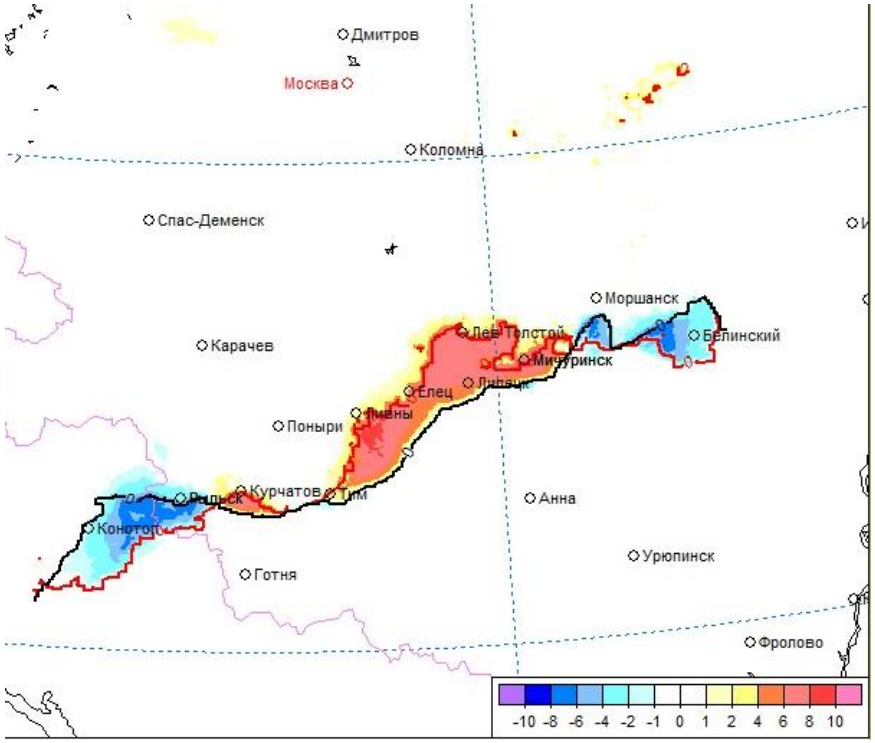


Lines – initial snow boundary disposition (**red** – SNOWE technology, **black** – operational run)

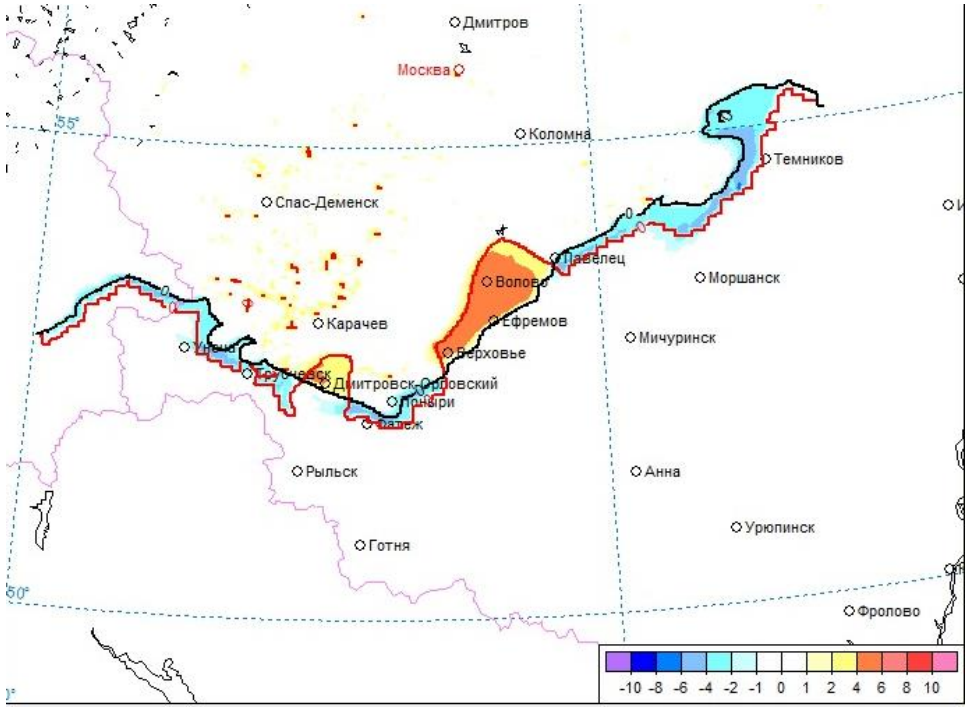
Difference in T2m forecasts (°C, SNOWE technology-operational run) of COSMO-Ru2. Start – 00 UTC 5 and 10 April 2013

Lines – forecasts of snow boundary disposition for 12 h:
black– operational run, **red** – SNOWE technology

5 April 2013



10 April 2013



Statistical characteristics for SWE (mm) for four seasons (2009/10, 2010/11, 2011/12, 2012/13)

Centre

name	RMSE(мм)	MRE(%)
Anna	1,4	23,5
Bologoe	1,5	14,9
Buzuluk	1,9	24,7
Buy	2,0	14,4
Vetluga	2,5	26,0
Gotnya	1,3	21,3
Dmitrov	1,9	16,4
Inza	4,7	46,3
Karachev	4,6	36,1
Kolomna	1,3	12,0
Michurinsk	2,4	26,8
Mozhga	3,6	19,0
Morshansk	1,6	17,6
Poniry	2,6	21,4
Radischevo	3,7	19,6
Rybinsk	5,3	26,1
Rilsk	1,6	24,2
Spas-Demensk	1,9	17,7

mean: 2,7mm; 20,4%

North

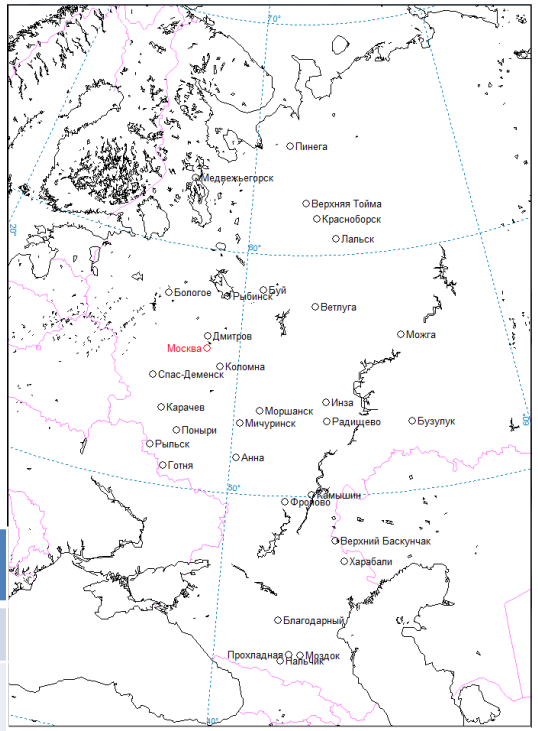
name	RMSE(мм)	MRE(%)
Verhnaya Toyma	2,6	14,2
Krasnoborsk	2,1	17,6
Lal'sk	3,4	26,6
Pinega	3,5	23,0

mean: 2,9mm; 20,4%

South

name	RMSE(мм)	MRE(%)
Blagodarniy	2,1	70,7
Verhny Baskunchak	2,1	48,3
Kamishin	4,4	45,4
Karabulak	3,6	23,3
Mozdok	3,0	28,8
Nal'chik	1,8	43,6
Prohladnaya	2,2	30,7
Frolovo	1,6	41,3
Harabaly	1,8	22,5

mean: 2,3 mm; 39,4%



31 station

124 cases