PT SnoWE

(SNOw Water Equivalent pre-calculations)
09.2014 – 08.2015,
WG3b
0,5 FTE

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PT SnoWE

The goal:

To obtain the system of initialization of snow water equivalent (SWE) fields based on coupling of first guess of COSMO fields, incl. Snow depth analysis with the results of continuous calculations of SWE values for full snow period with the use of information of standard (SYNOP) meteorological measurements (based the realized new 1-D model SMFE)

Motivation-1

The COSMO forecasts of T2m during the spring has the enormous errors (till 15 C Degrees) for the snow-covered areas and near snow -boundaries because:

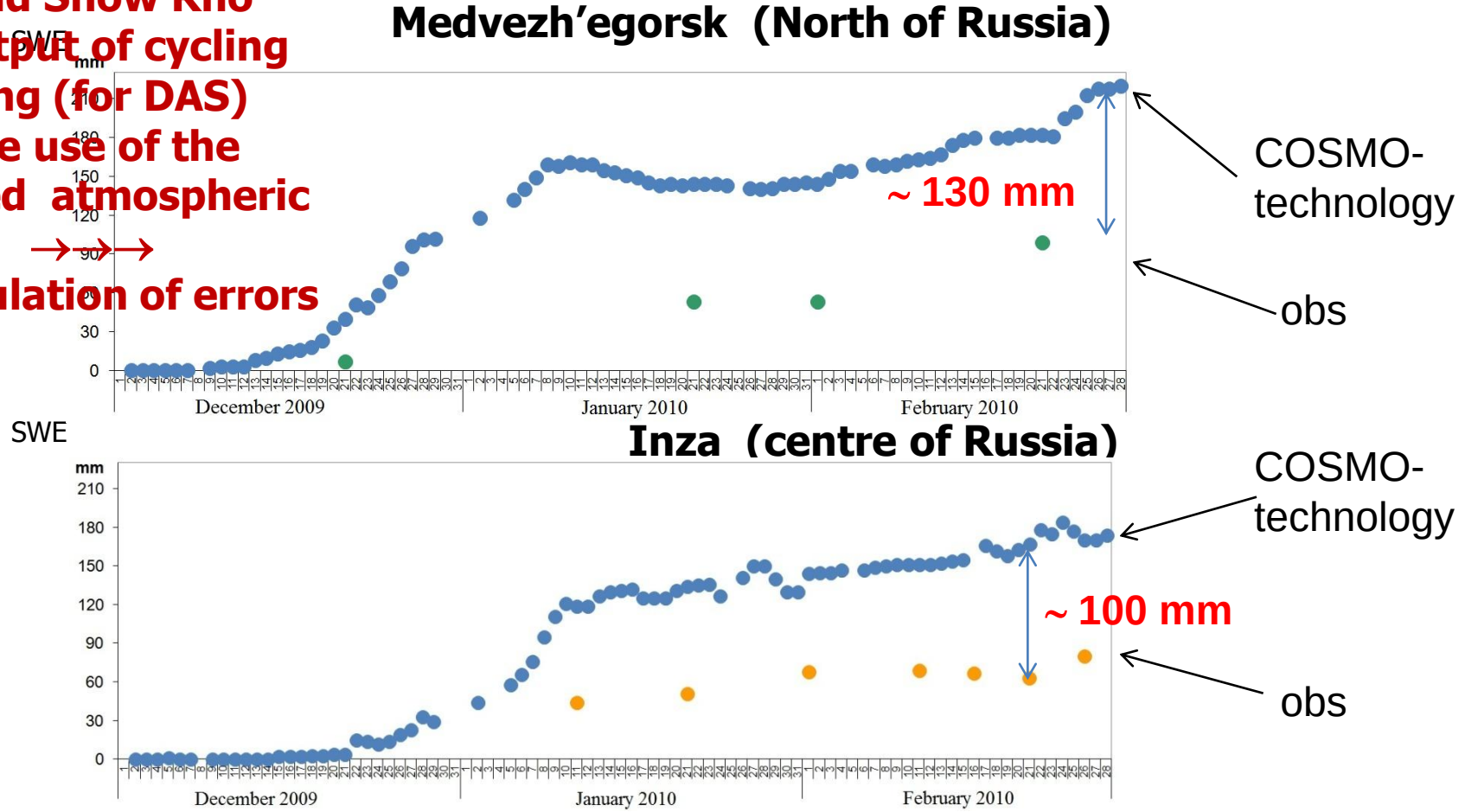
- **The errors on the initial data of T of the bottom atmospheric and top soil/snow levels (DAS need improve the assimilation of SYNOP measurements)**
- **The TERRA parameterizations need to include the description of continuous layer of vegetation and of snow-free surfaces on the cells (now the predicted T of land surface can't be positive over the snow covered cells)**
- **The errors of SWE on the end of snow period provide the errors of forecasts of speed of snow boundary till 100-200 km/3 forecast days** (The sensitivity of all components of heat budget)

Motivation-2

- The SWE is one of variables of COSMO-model and one of components of hydrological cycle
- Initial GME-fields of Snow Water Equivalent (SWE) (determined as function of OA of Snow depth and modeled Snow density) can have the discrepancies up to 100 mm
- No daily operational observations of SWE
- The correct forecasts of SWE values are in demand (hydrological forecasts of spring flood)

Initial GME-fields of Snow Water Equivalent (SWE) (as function of analyzed Snow depth and modeled Snow density) can have the discrepancies up to 100 mm

SWE and Snow Rho are output of cycling modeling (for DAS) with the use of the modeled atmospheric forcing →→→ accumulation of errors



Available measurements of snow properties:

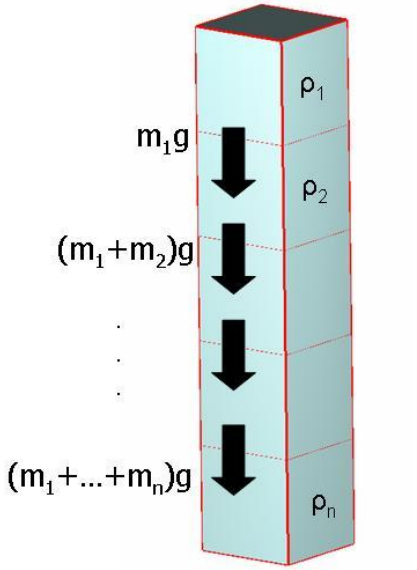
- **SYNOP: regular, daily: snow depth**

- **satellite data: regular, daily: Snow mask , SWE***

- **specialized hydrological snow surveys: in dependence from weather every 5-10 days for Russia: snow depth, SWE (can be used for testing and validations)**

1-D Multilayer snow model SMFE (E. Kazakova, M. Chumakov, Roshydromet)

- **input: - SYNOP data (Hsnow, T2m, Td2m, Wind, Prec);**
- **output: – SWE and snow density**
- **daily calculations**
- **the whole snow period**



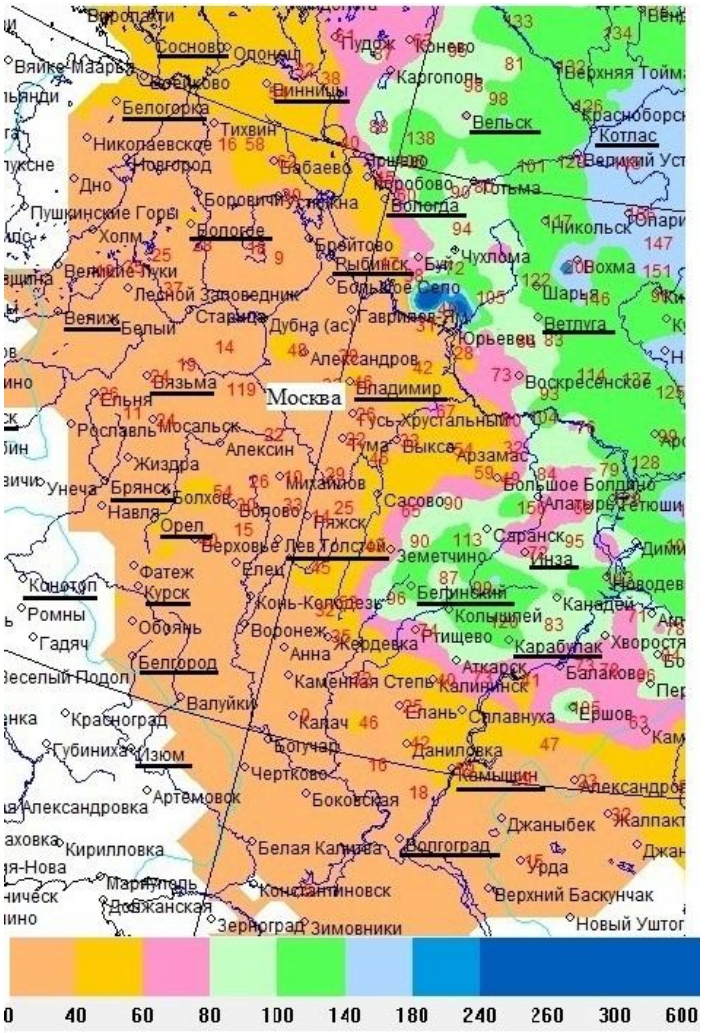
Algorithm and results for stations of the European part of Russia was discuss at WG3b during 2013-2014, showed the correspondance with SWE measurements

Kazakova E., Chumakov M., Rozinkina I. Initial fields of snow cover characteristics preparation for COSMO-Ru // COSMO Newsletter No.14, 2014, pp.37-42

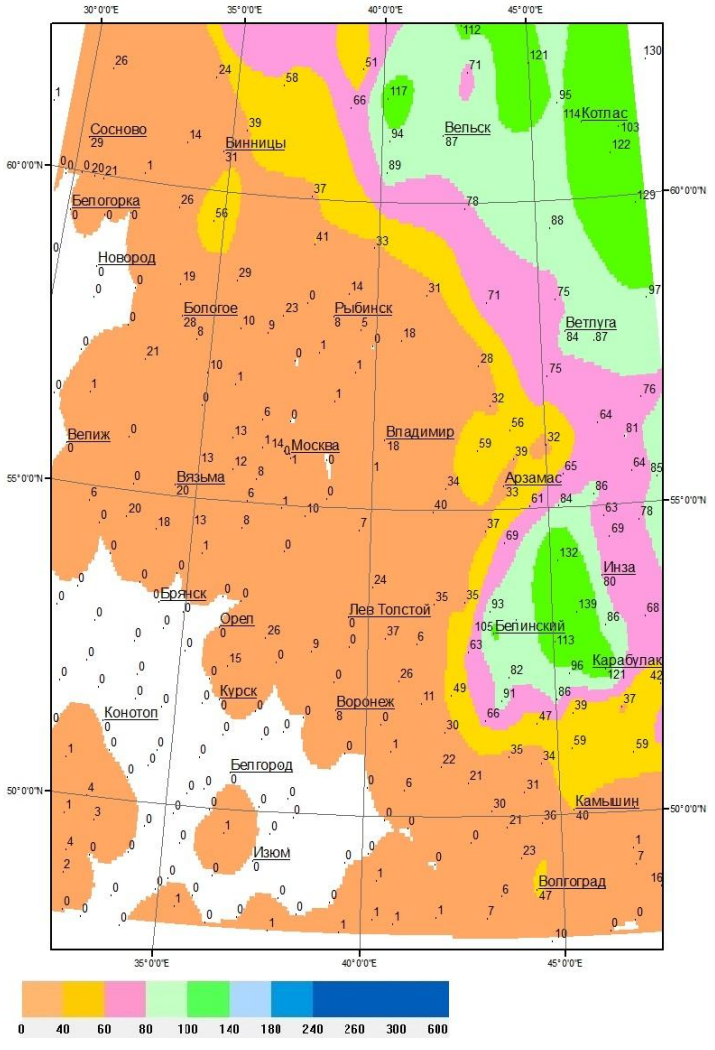
Kazakova E., Chumakov M., Rozinkina I. Realization of the parametric snow cover model SMFE for snow characteristics calculation according to standard net meteorological observations // COSMO Newsletter No.13, 2013, pp.39-49

Calculated (right) and measured (left) values of SWE, 28 Feb. 2014

Map based on hydrological observations



values from SMFE

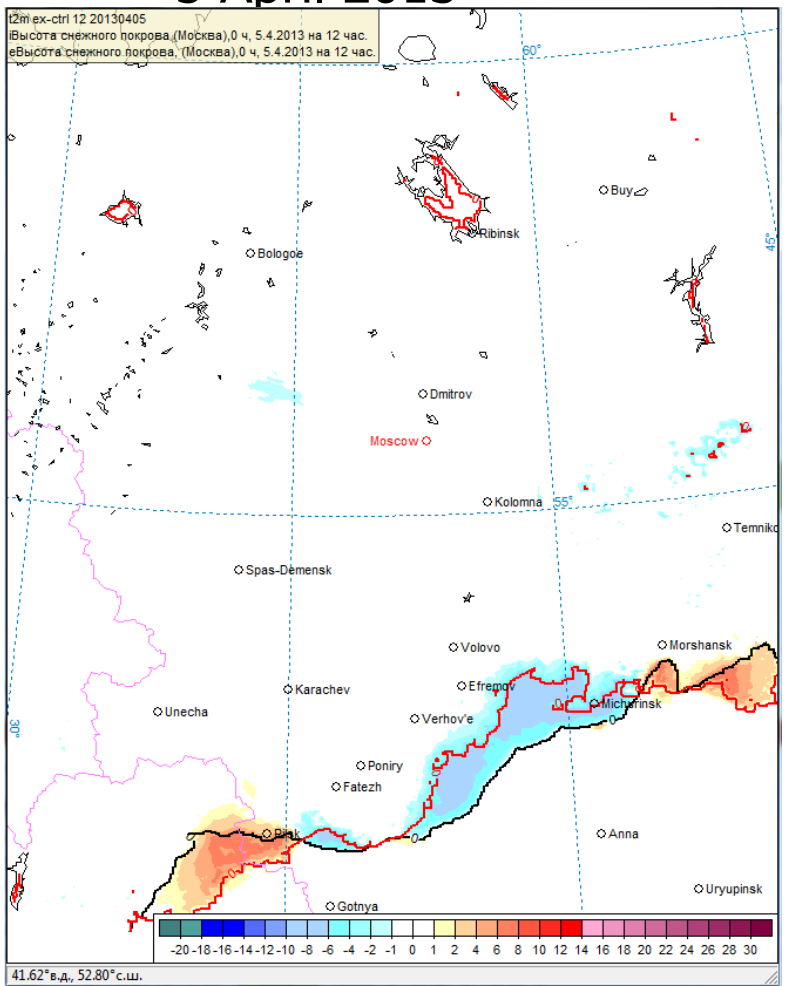


Impact of snow initial fields replacement

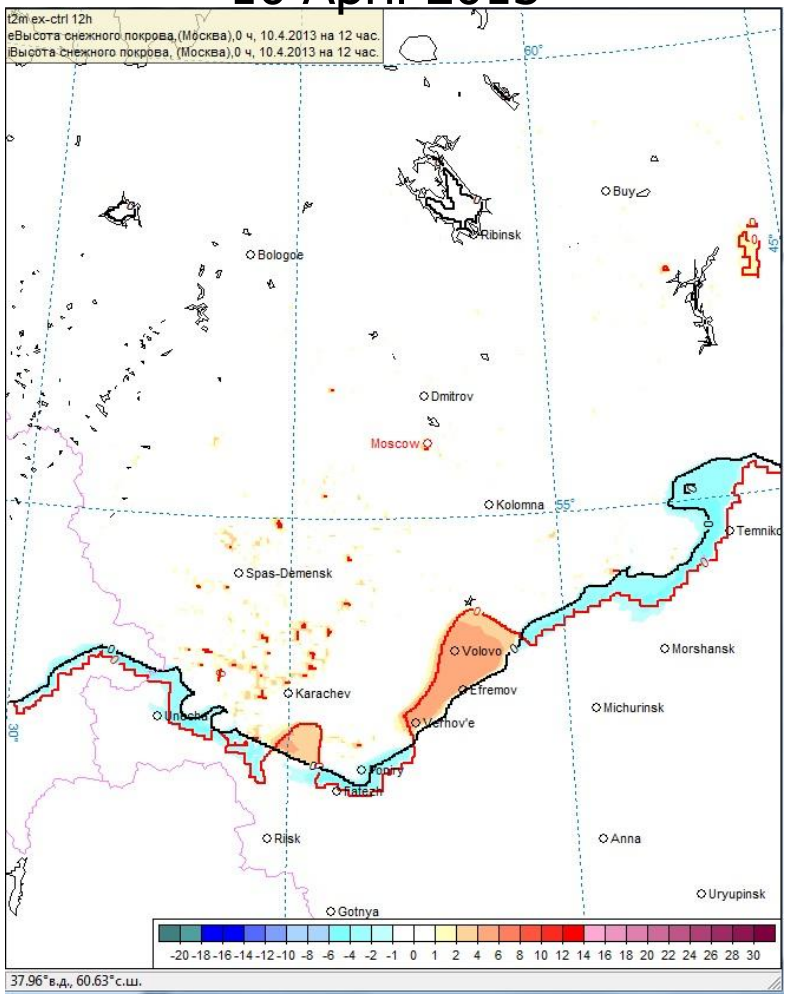
ΔT2m (ex – oper) forecast at 12 UTC. Start – 00 UTC

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

5 April 2013



10 April 2013



Impact for forecasts of replacement of snow initial fields

Station	10 April 2013, 12 UTC			11 April 2013, 00 UTC		
	Obs, t◦C	Oper, t◦C/ Abs. error, ◦C/accuracy, %	Ex, t◦C/ Abs. error, ◦C/accuracy,%	Obs, t◦C	Oper, t◦C/ Abs. error, ◦C/accuracy, %	Ex, t◦C/ Abs. error, ◦C/accuracy, %
Efremov	8,0	**4,3/3,7/0**	6,6/1,4/100	-0,4	-0,5/0,1/100	-0,6/0,2/100
Volovo	6,9	0,6/6,3/100	5,8/1,1/100	-1,1	-3,6/2,5/100	-1,7/0,6/100
Verhov'e	7,0	**1,2/5,8/0**	6,0/1,0/100	0,8	-1,2/2,0/100	-0,2/1,0/100
Temnikov	7,2	6,2/1,0/100	5,6/1,6/100	0,2	0,7/0,5/100	-3,0/2,8/100
Unecha	7,1	6,6/0,5/100	5,4/1,7/100	1,0	0,4/0,6/100	0,7/0,3/100
Fatezh	8,1	5,6/2,5/100	6,7/1,4/100	-1,5	-3,0/1,5/100	0,3/1,8/100
	Mean abs. error, ◦C/Mean accuracy, %	**3,3◦/67%**	**1,37◦/100%**		1,2◦/100%	1,11◦/100%

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Planned activities:

- Tests of SMFE for different climatic and landscape conditions for periods of snow melting and accumulation. Tuning of 1-D, Software of 1-D SMFE (SO: 0,05 FTE)
- Technology for coupling of SWE calculation with COSMO operational technology (1-D → 2-D) (ND:0,15 FTE)
- Runs of COSMO-model with corrected SWE fields for 2014/2015 winter, analyses of the sensitivity of model, tuning (JFMA: 0,2 FTE)
- Preparing of new software for coupling with COSMO-technologies and for convergence with new snow depth OA, description (MJJA:0,1 FTE)

Thank you for your attention!

Snow has impact on the calculation of surface heat budget and hence different meteorological elements (first of all, air and surface temperature, then wind speed, cloudiness…)

The most significant changes are observed in many meteorological elements during snowmelt period: the zone of partial snow coverage could extend for some hundreds km. Temperature differences between T2m model values and observations could be up to 10-12ºC here.

$$zrss = \max\left(0.01, \min\left(1.0, \frac{SWE}{0.015}\right)\right)$$

zrss – part of the model cell covered with snow