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Recent developments at Roshydromet

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Motivation:

1. **Improve the T2m skill in case of partial snow- cover**
2. **Initialisation of snow WE**
3. **Applications for Sochi2014 meteosupport (PP CORSO)**

Experiment was done for territories covered with snow.
Operational version of COSMO-Ru (version 4.18) was used.

1. **The modification of TERRA for more realistic T2m skill in case of partial snow- cover :**

the additional plant level was parameterized into TERRA

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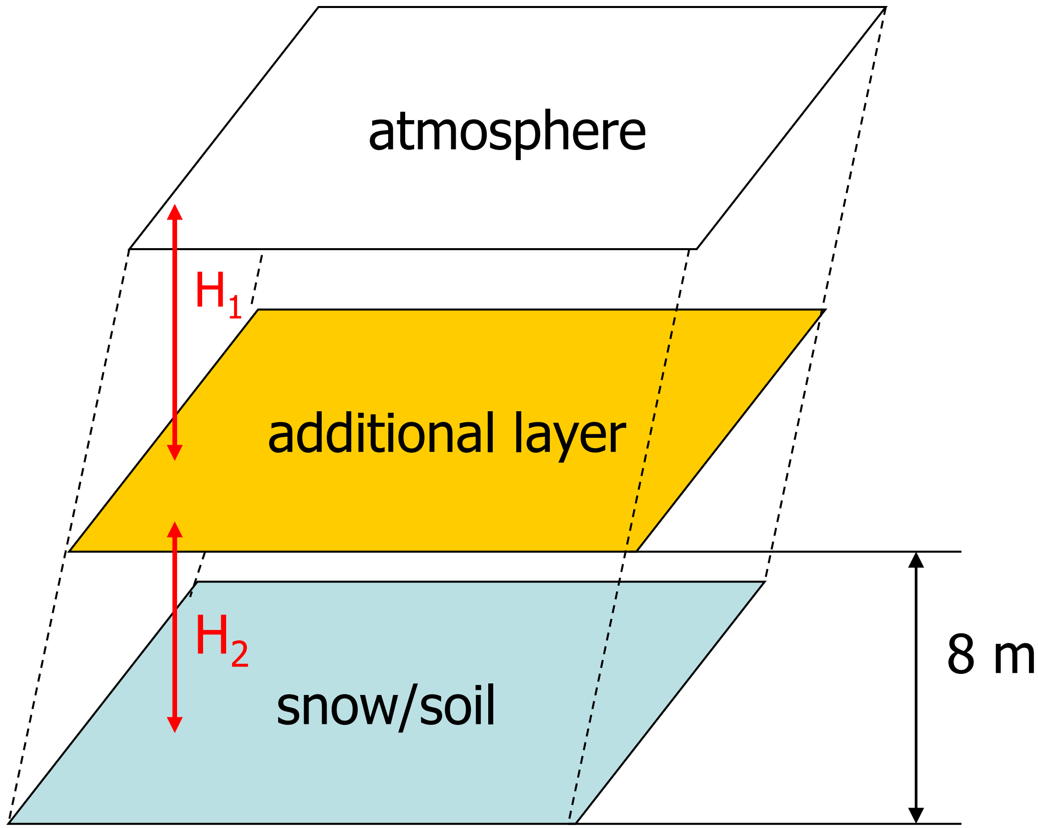
Experiments with TERRA in COSMO-Ru, version 4.18

Additional plant layer



The simplest parameterization:
The

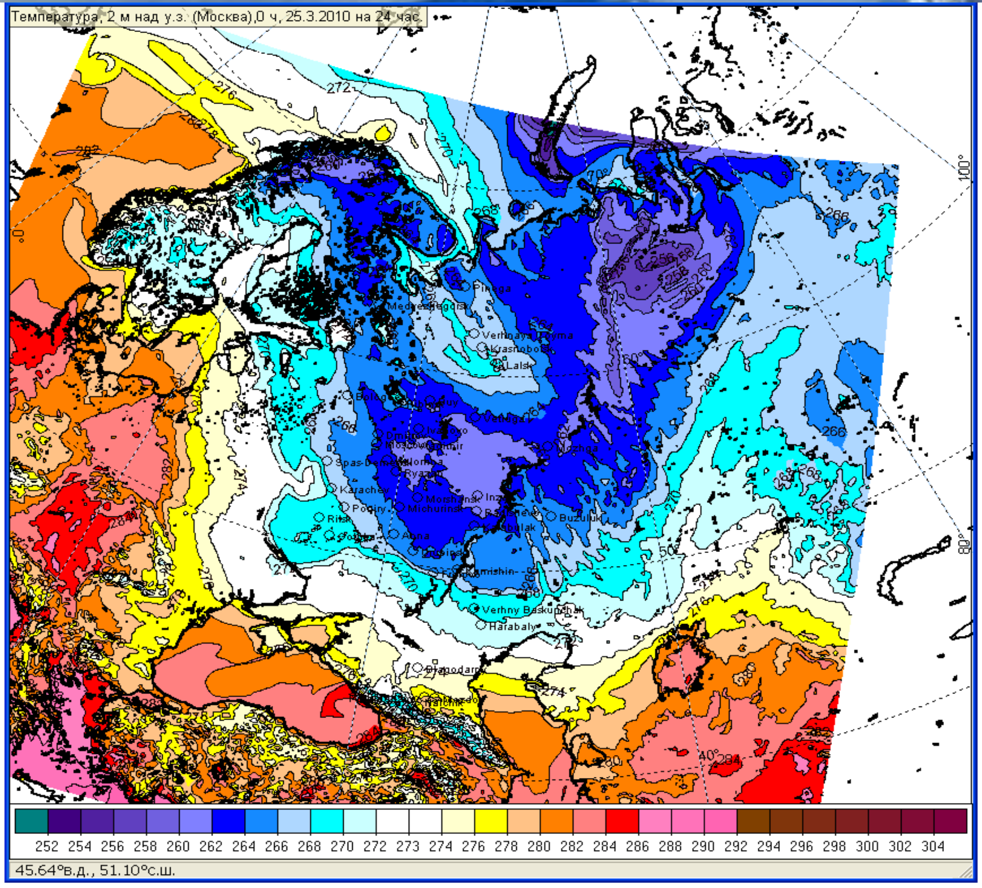
H= SW+LW

So, additional layer should get some heat to the upper atmosphere and increase T2m.

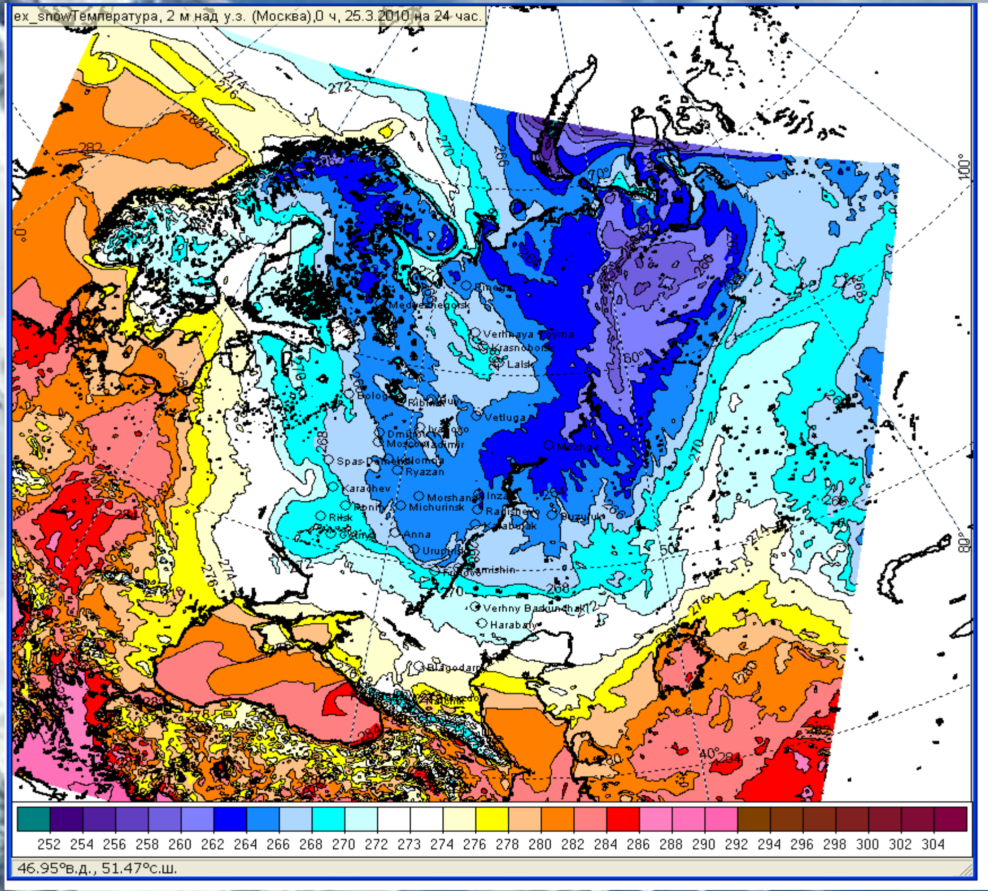
Experiment was done for territories covered with snow.
Operational version of COSMO-Ru (version 4.18) was used.

T2m (K). 24 forecast. Start - 25 March 2010

Operational version (control run)



Experiment



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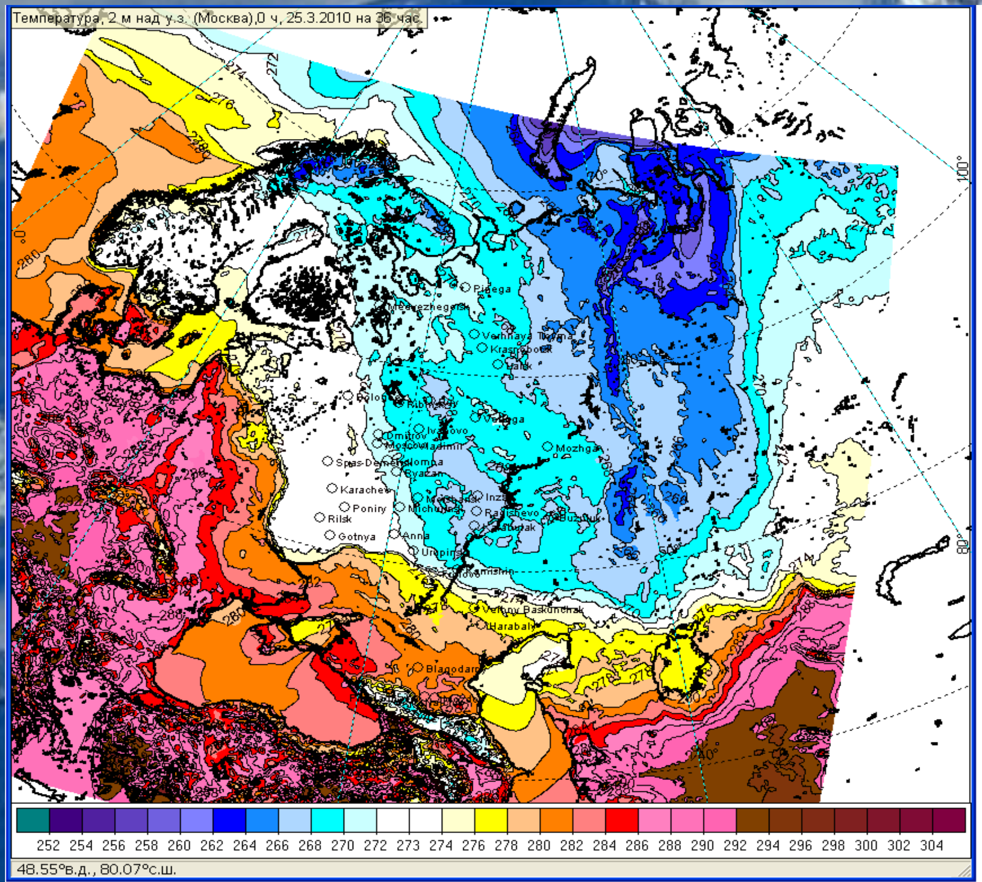
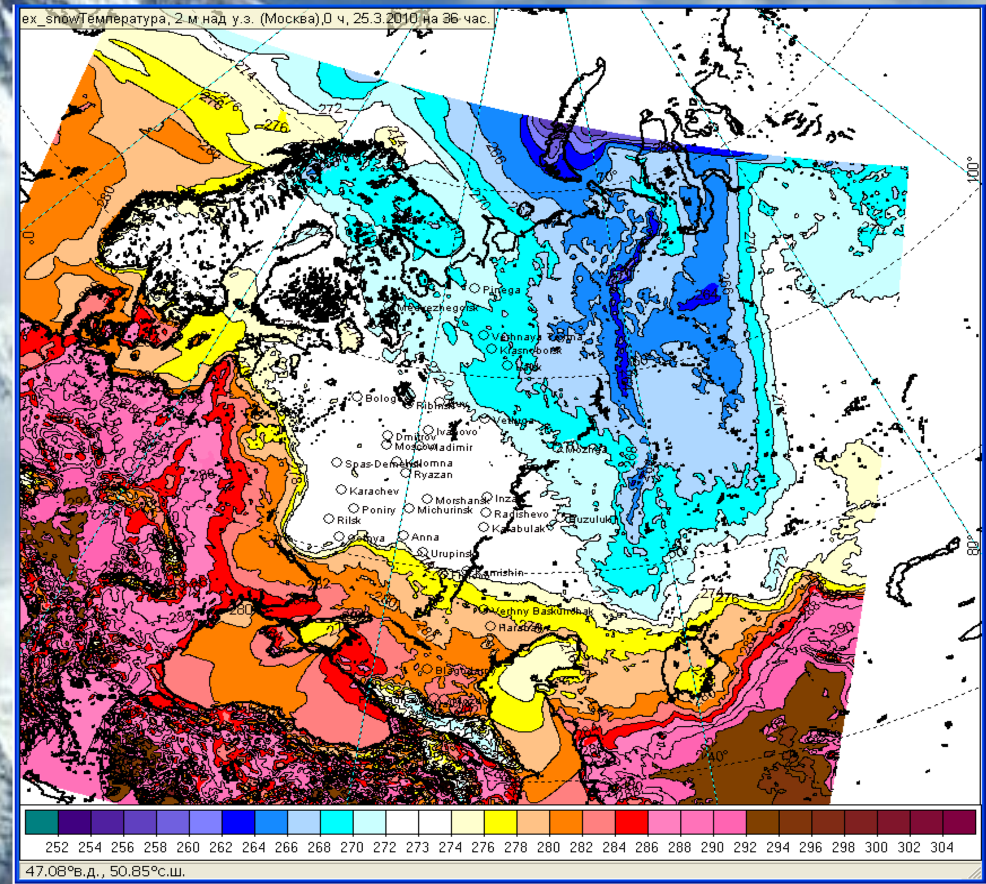
T2m (K). 36 forecast. Start - 25 March 2010

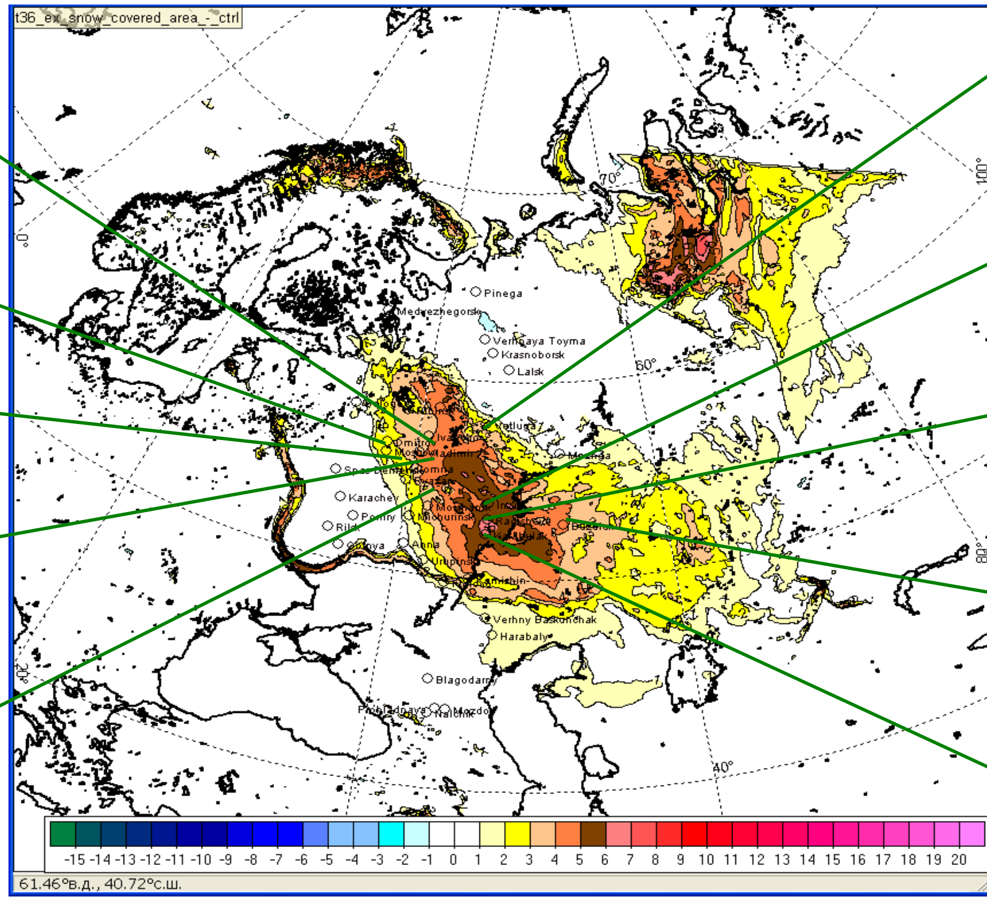
Operational version (control run)



Experiment



T2m. 36 forecast. Start - 25 March 2010



Ivanovo

ctrl	exp	measured
-4.2	-0.4	4.0

Dmitrov

ctrl	exp	measured
-2.5	0.1	7.0

Moscow

ctrl	exp	measured
-2.3	0.1	8.3

Vladimir

ctrl	exp	measured
-4.5	-0.5	3.8

Ryazan

ctrl	exp	measured
-2.0	0.1	3.9

Vetluga

ctrl	exp	measured
-3.8	-1.0	0.4

Inza

ctrl	exp	measured
-5.3	0.0	1.0

Radishevo

ctrl	exp	measured
-6.3	-0.4	0.7

Buzuluk

ctrl	exp	measured
-5.0	-0.4	-0.6

Karabulak

ctrl	exp	measured
-6.6	-0.3	-2.4

Due to additional layer it became possible to influence T2m forecast. In all the stations, where snow was present, T2m was increased.

The next step – to parameterize this effect only for forest area to coordinate the codes with Tile-parameterization

1-d parametric model for calculation SWE and snow density according to SYNOP data (snow height, T2m,dew point, wind speed)

Motivation

- The errors in SWE and snow density (from GME) produce inaccuraties in COSMO-model - first during the m

- In framework of Sochi-2014:

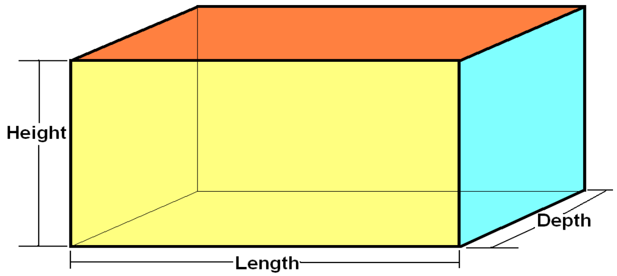
  the accurate data for snow walues for points of competitions are required .

  The measurements in SYNOP - complex are developed

- Main goal of our improvement is to obtain an initial SWE and density fields for COSMO-model with the use of current station and satellite data

Characteristics of the model

- **Snow column is represented as the set of finite elements, which are in mechanical and thermal interaction with each other. The number of finite elements depends on the height of the snow column. One finite element has a cuboid shape with height equal to 1 cm, length and depth equal to 100 cm.**



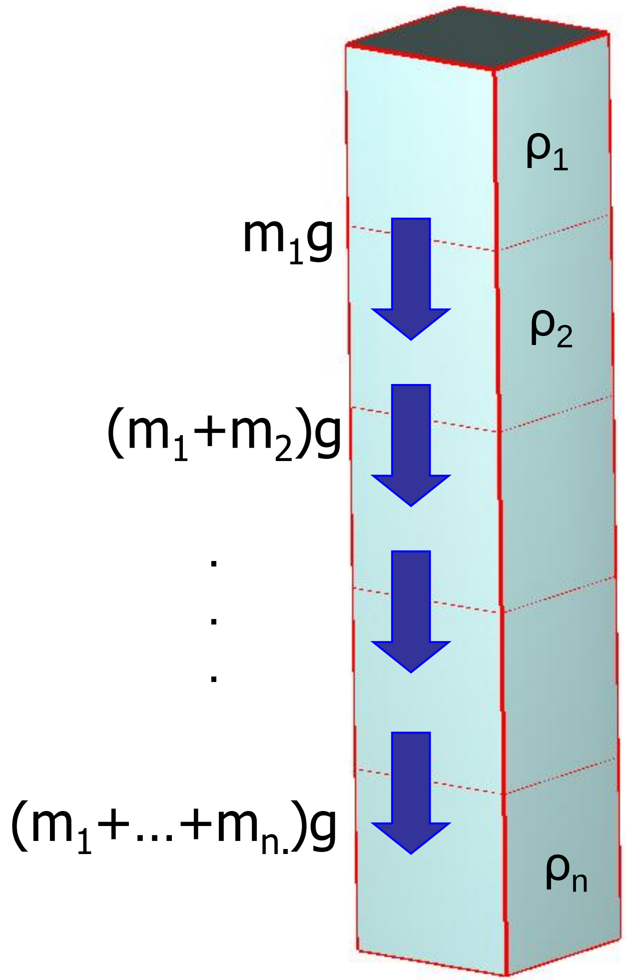
- **In paper Yosida and Huzioka is supported that Young's modulus for snow can be calculating by formula:**

$$E = (0{,}0167\rho - 1{,}86)\cdot 10^6, -3 < T_a < -1 \qquad E = (0{,}059\rho - 10{,}8)\cdot 10^6, -13 < T_a < -5$$

- **We suppose that finite elements of the snow column undergo only elastic deformation, so it can be written (example for T_a>-5°C):**

$$\rho = \frac{\left(\frac{mg}{10^6(1-\sigma_{02})} + 1{,}86\right)}{0{,}0167}, \quad m = (\rho_1 + \rho_2 + \ldots)H, H = 0{,}001m \qquad \frac{l_n}{l_0} = (1-\sigma_{02}) = 1 - 0{,}002$$

Representation of snow column in the model



Each finite element undergoes the weight of the previous overlying elements and hence its density is defined by ambient temperature and accumulative weight

Characteristics of the model

- **Fresh snow is not a constant and calculating according to formula from canadian snow scheme CLASS 3.1 (depends on air temperature)**

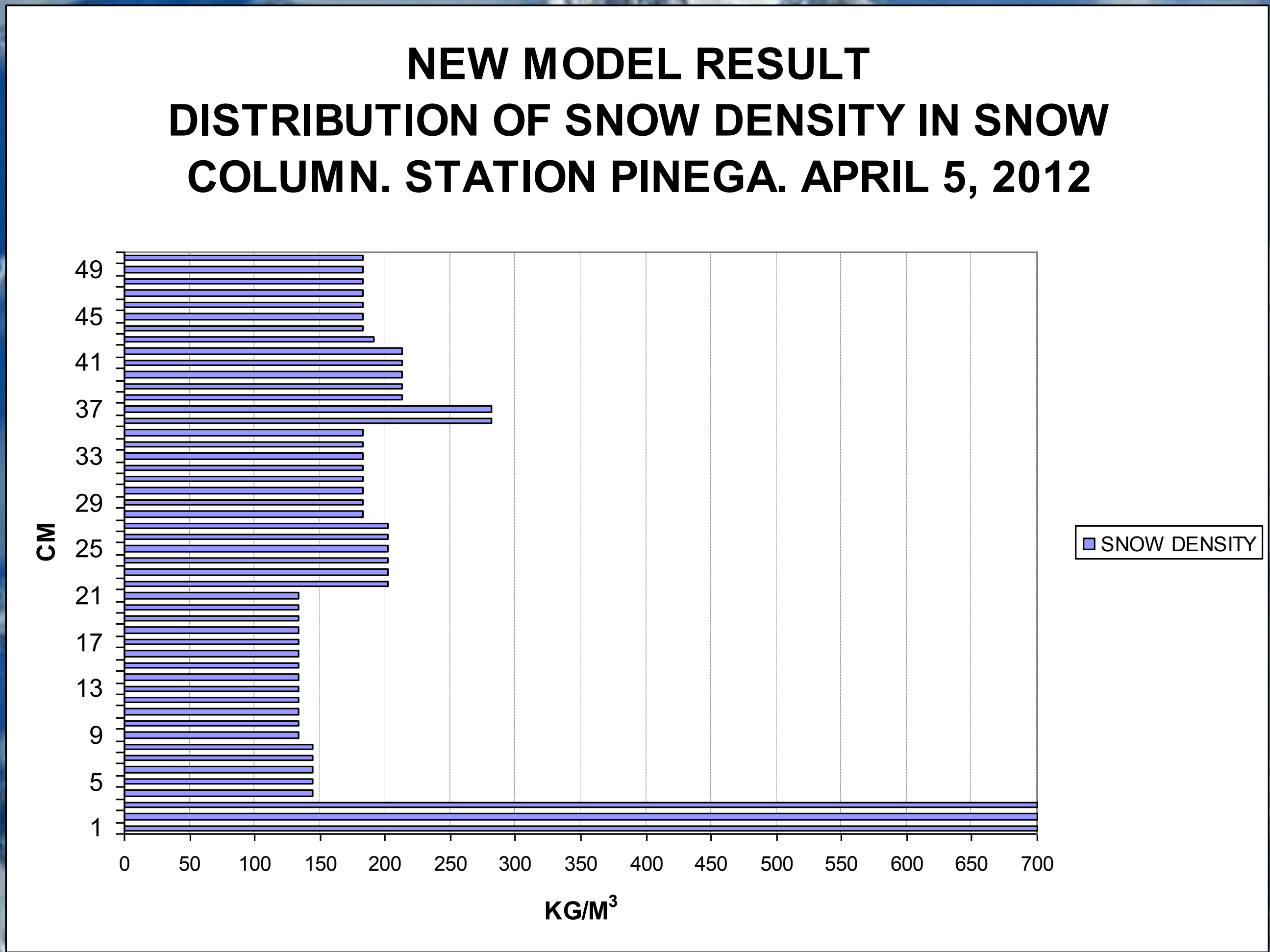
$$\rho_{s,f} = 67.92 + 51.25 e^{\frac{T_a}{2.59}}, T_a \le 0^0 C$$

$$\rho_{s,f} = \min(200, 119.2 + 20 T_a), T_a > 0^0 C$$

- **Evaporation from snow according to Kuzmin's formula:**

$$F = (0.18 + 0.098 u_{10m})(e_{pot} - e_{2m}) \quad mm/day$$

The model shows realistic snow density in snow column for each station. The previous version of model contains 3 layers and don't represent snow density distribution in column.



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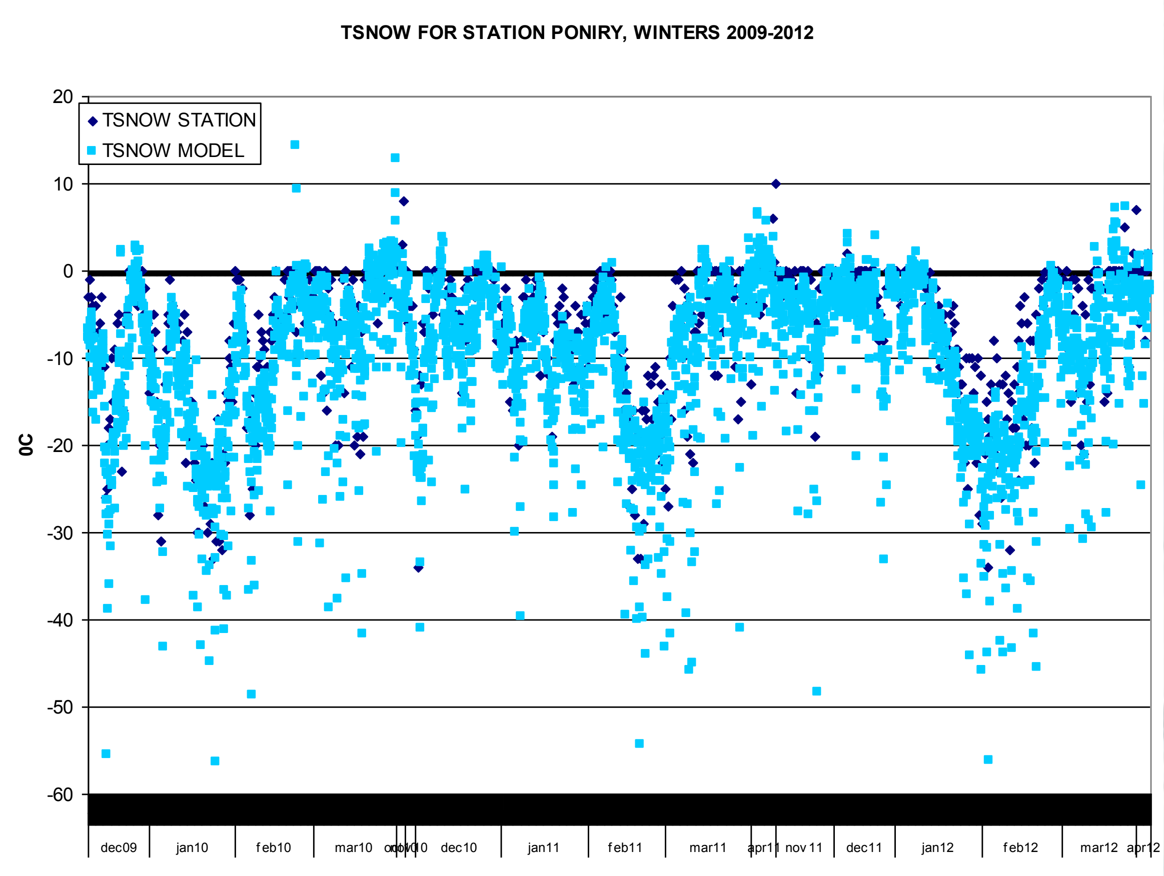
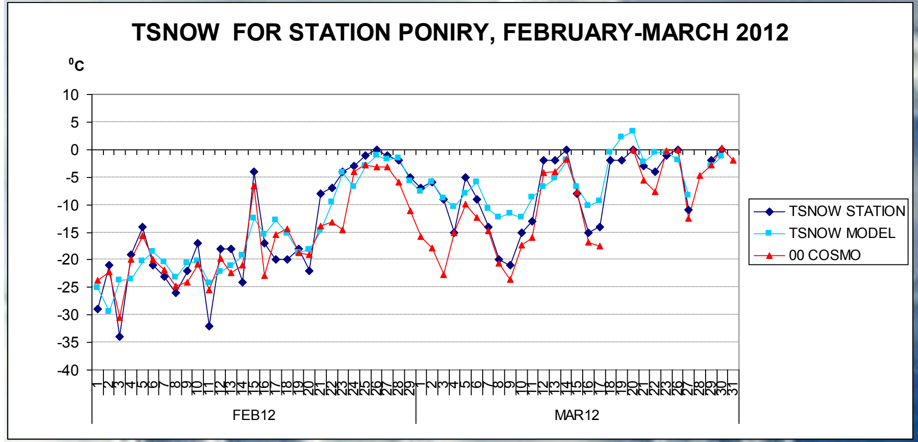
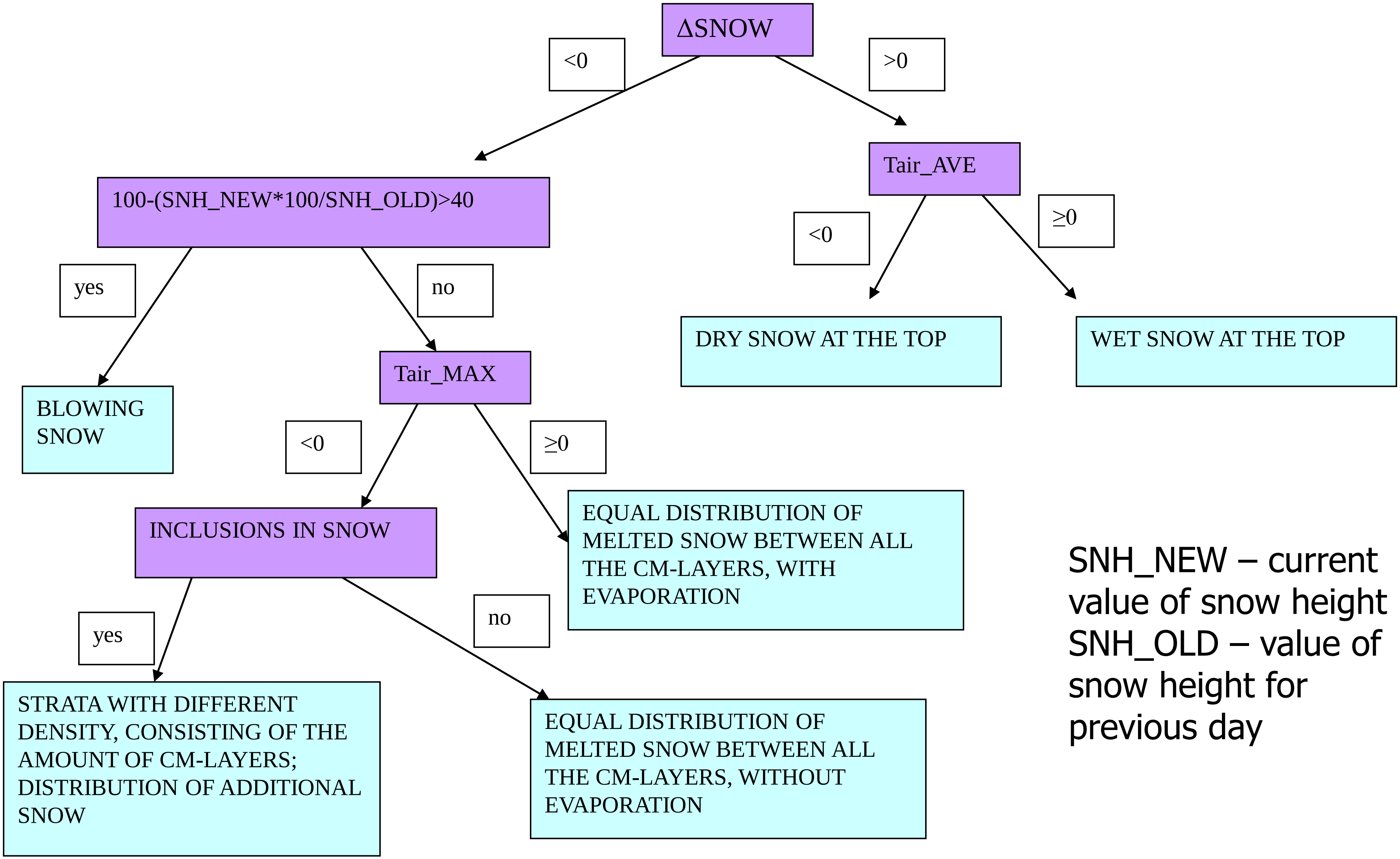
Characteristics of the model

- **There is a subroutine for snow temperature calculation, if needed**

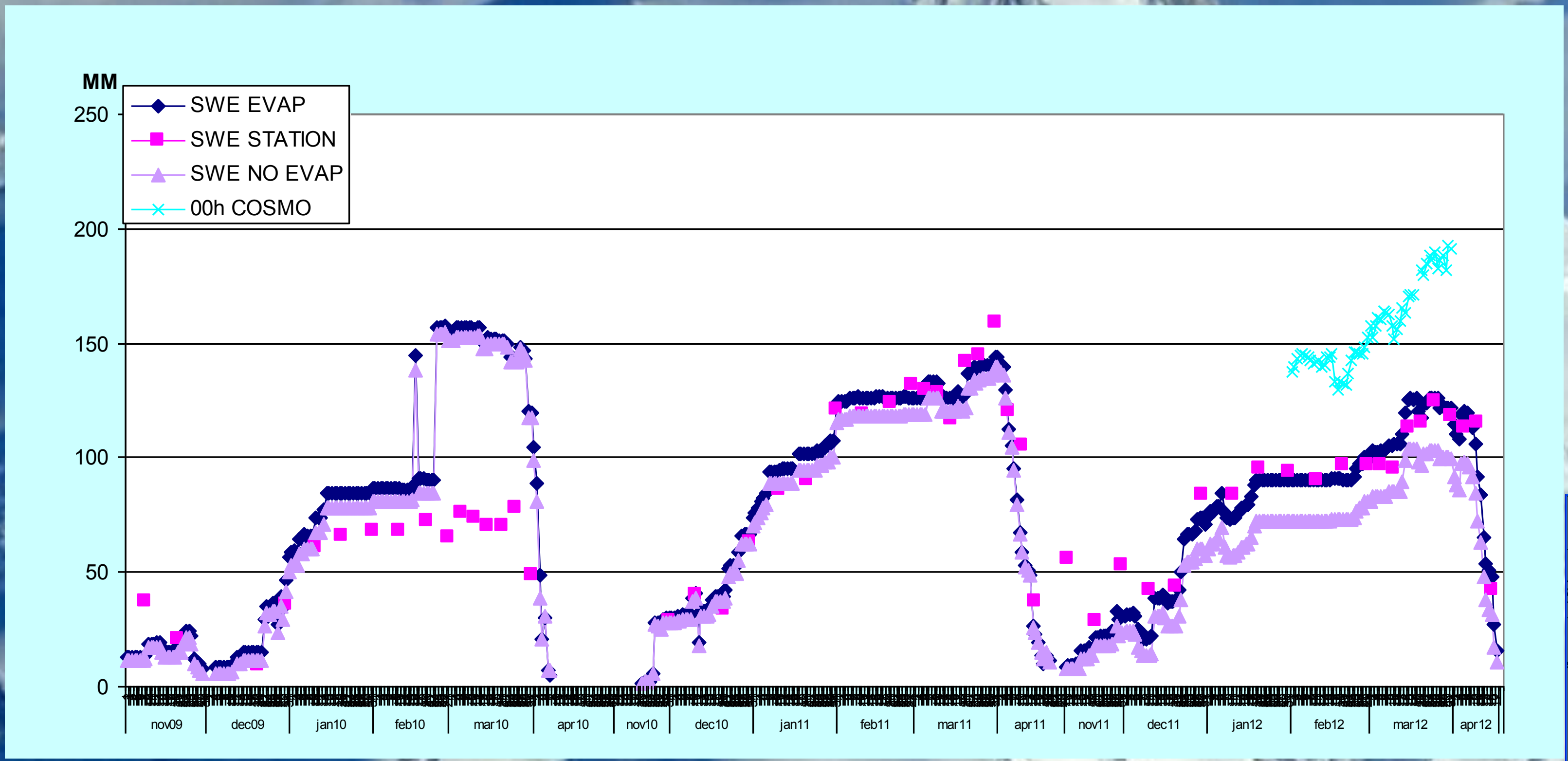






SNH_NEW – current value of snow height
SNH_OLD – value of snow height for previous day

SWE for station VETLUGA, winters 2009-2012



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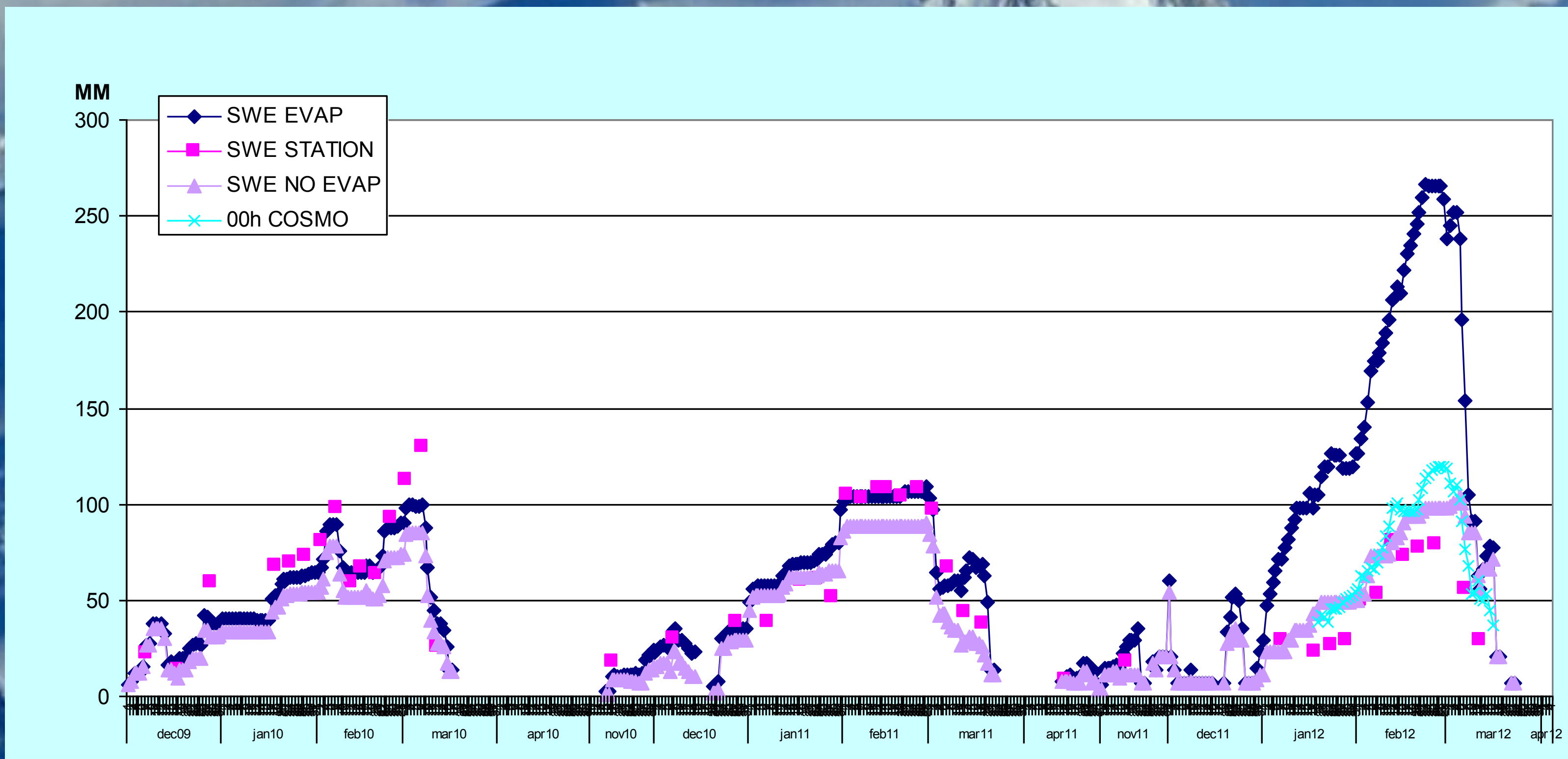
SWE for station ANNA, winters 2009-2012



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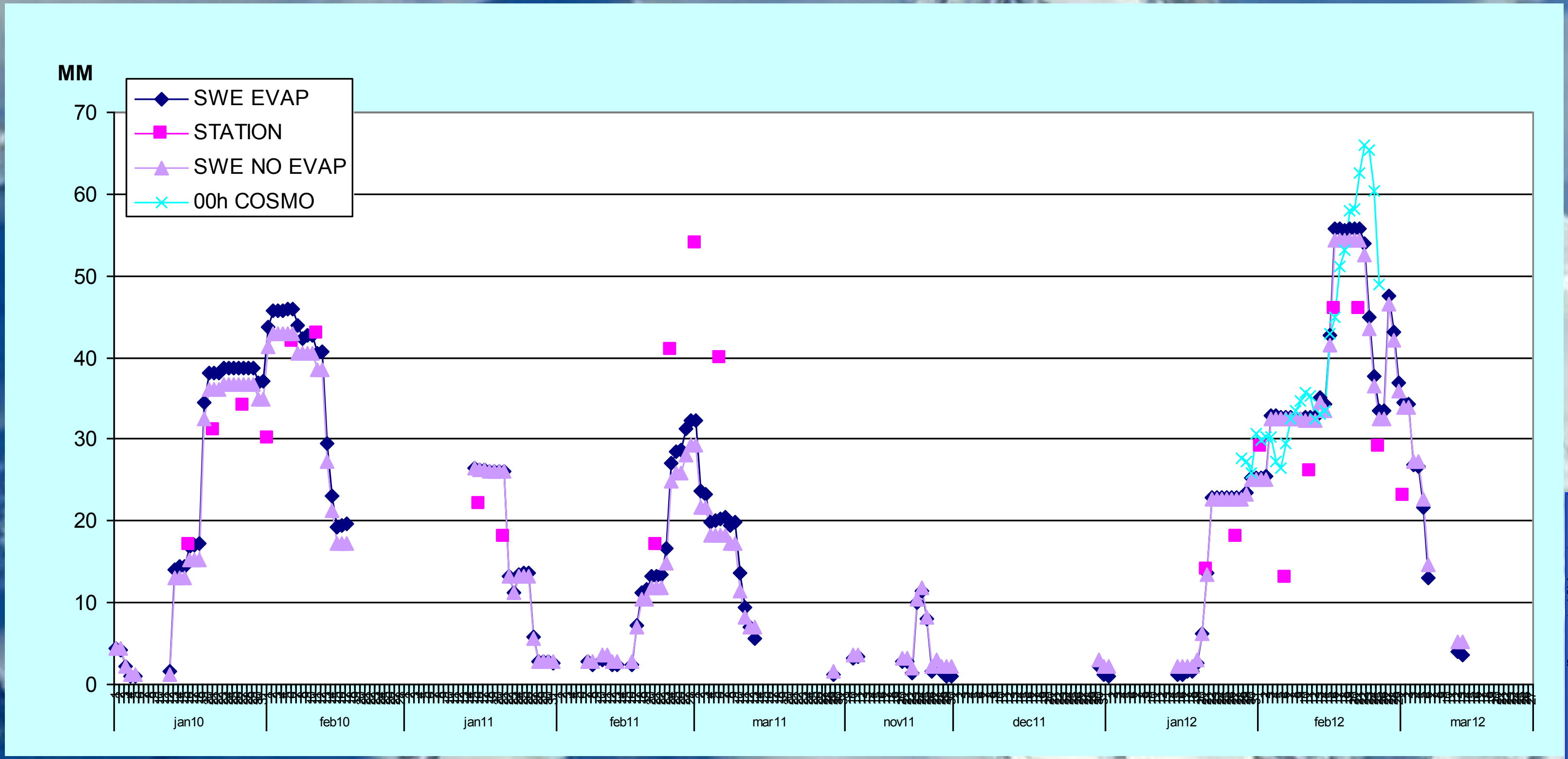
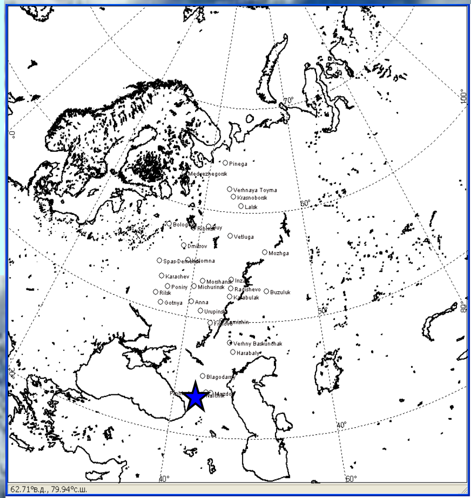
SWE for station PROHLADNAYA, winters 2009-2012





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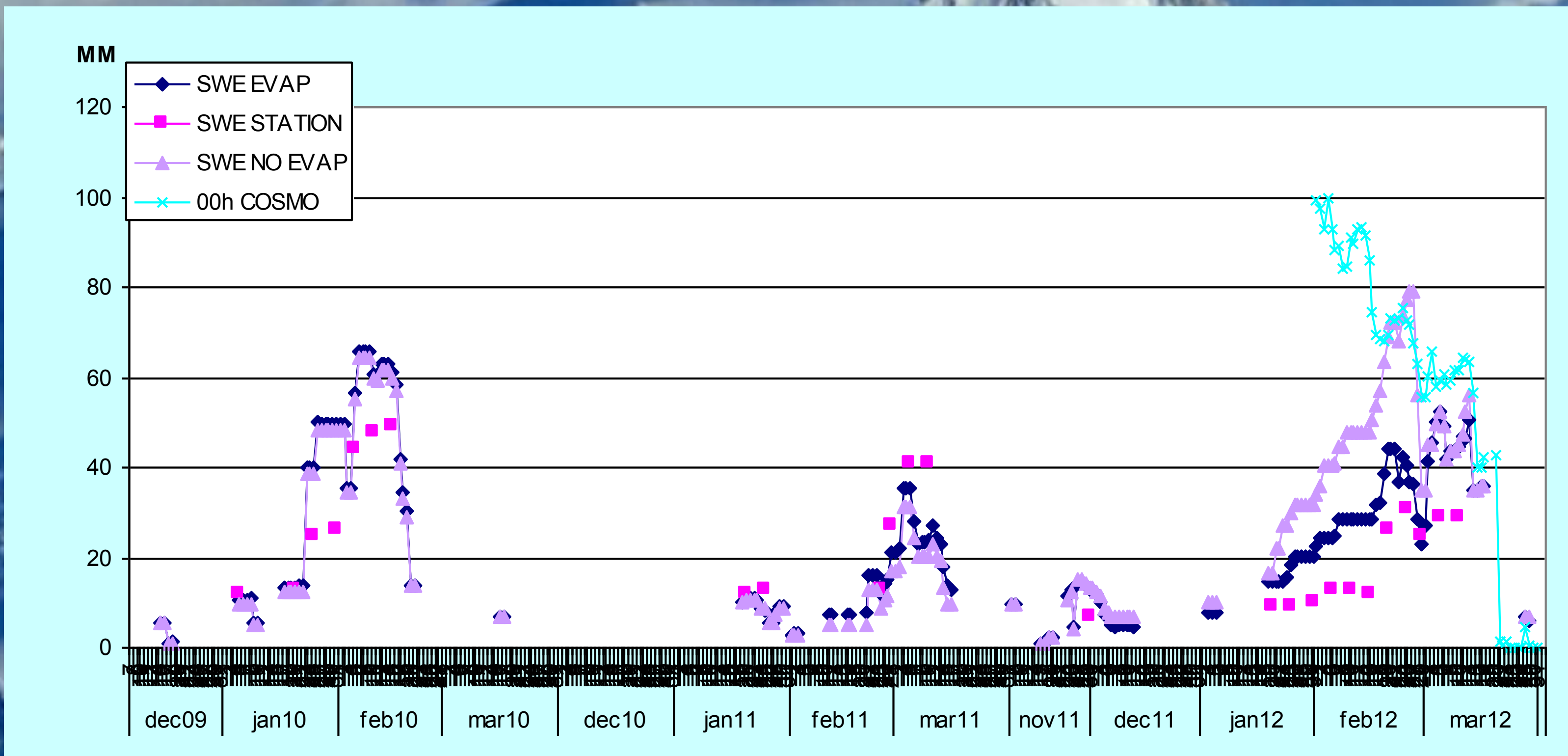
SWE for station NALCHIK, winters 2009-2012



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Valdai observatory: data exchange

Valdai observatory

- The description of the observatory is sent.
- Data for period 1 Jan – 31 May 2012 is sent for the following parameters:

ARTM –air temperature, °C;
EGPA –water vapor pressure, hPa;
EREL –relative humidity, %;
DEF –air moisture deficit, hPa;
PRESS –air pressure, hPa;
LOSD –visibility range;
NCOM –total cloudiness 0-10;
NLOW –low cloudiness 0-10;
WINDR –wind direction;
WINSP –wind speed, m/s ;
PREC –precipitation 1, mm;
DEWPT –dew-point temperature, °C;
TSOSN –soil/snow surface temperature, °C .

- It is planned to prepare data for lakes for period of some months of year 2010.

Valdai observatory

- It is planned to prepare data for lakes for period of some months of year 2010.

System of Lakes Valdai and Uzhin

The water level and ice regime have been recorded since 1936. The vertical distributions of water temperature have been measured since 1952.

The water temperature, dissolved oxygen, a-type chlorophyll, total phosphorus, and transparency have been measured since 1987 once a week (in ice-free periods) and once a month (during ice-cover periods).

Thank you for your attention!

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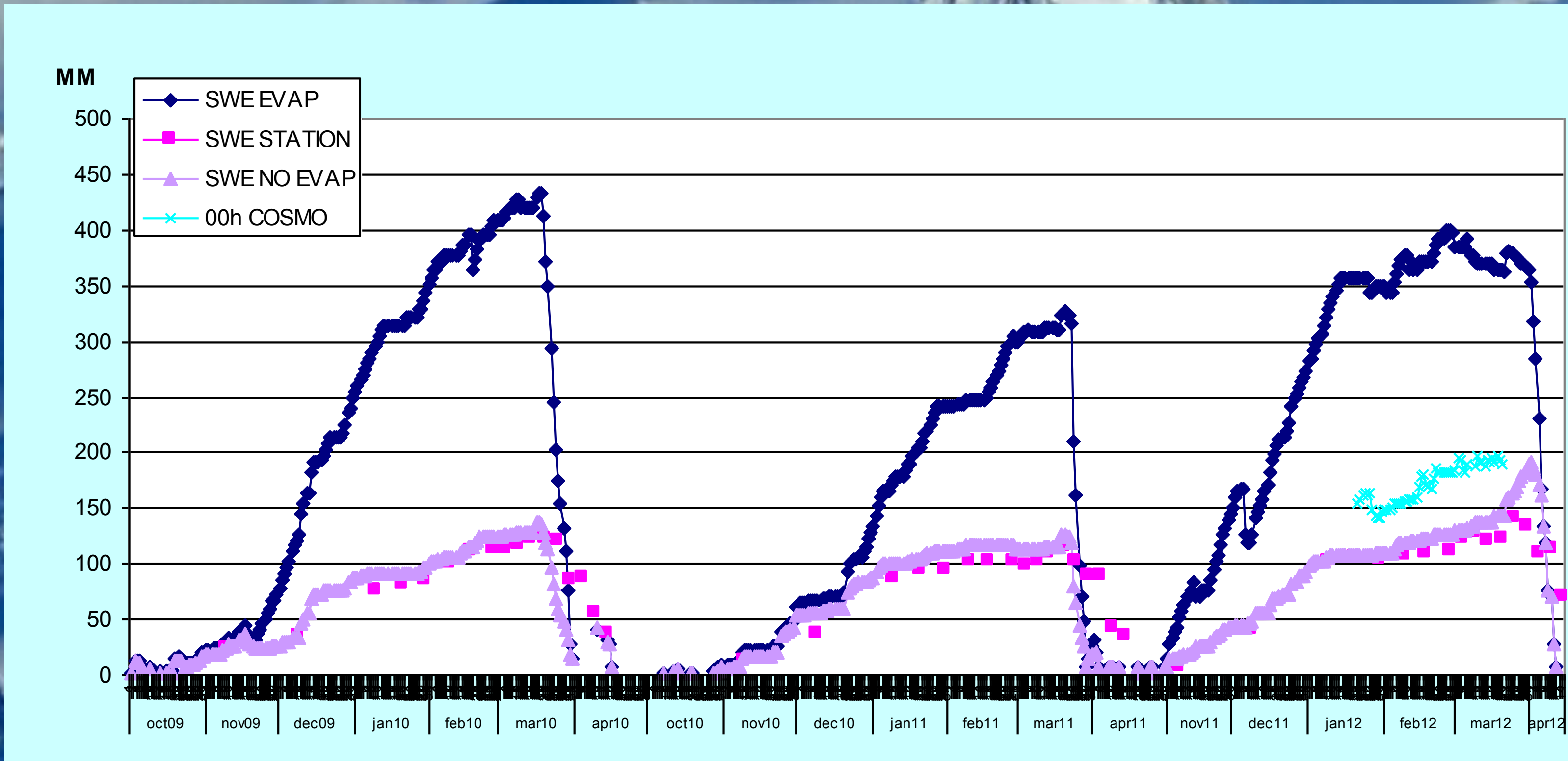
SWE for station PINEGA, winters 2009-2012



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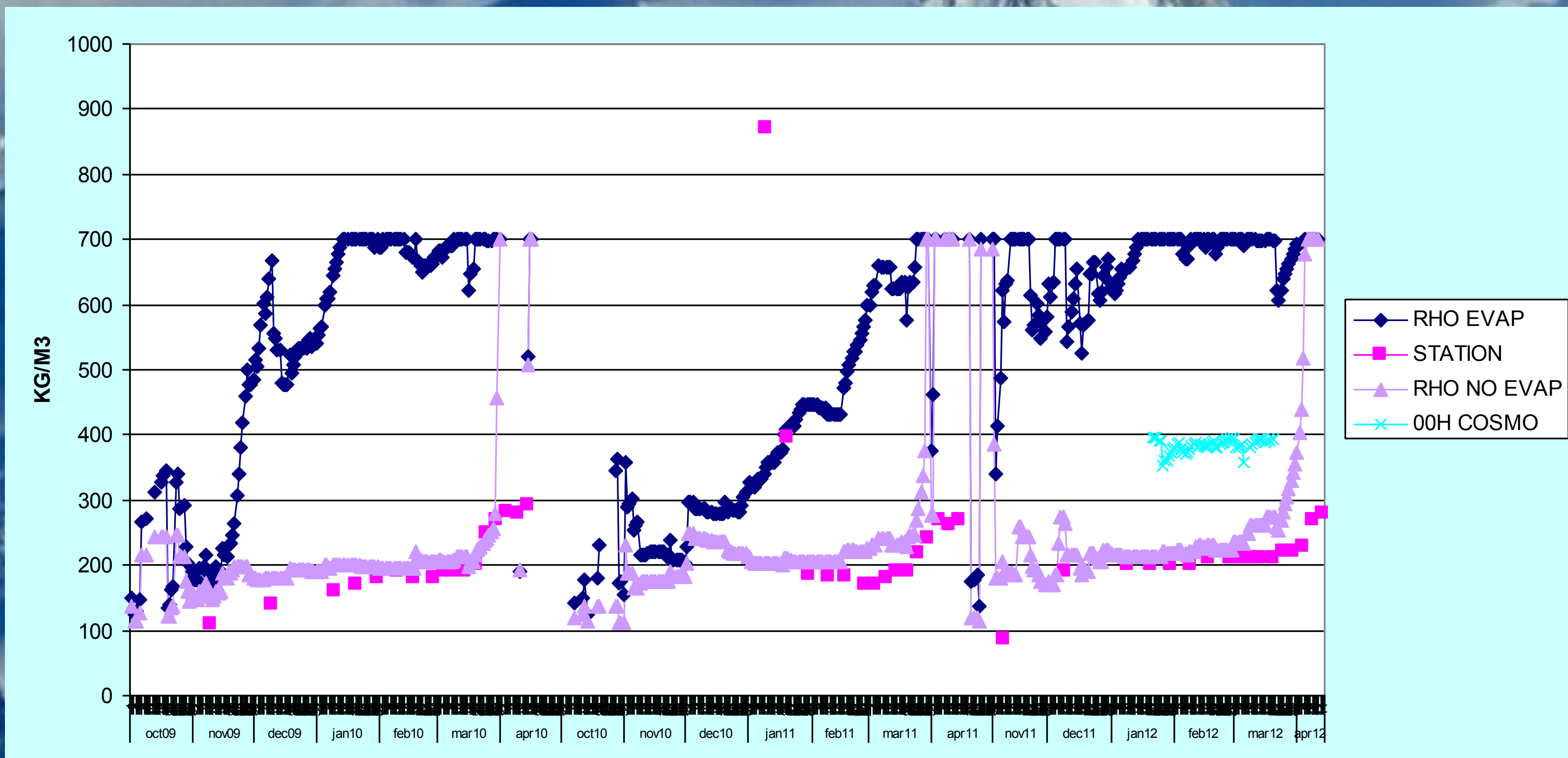
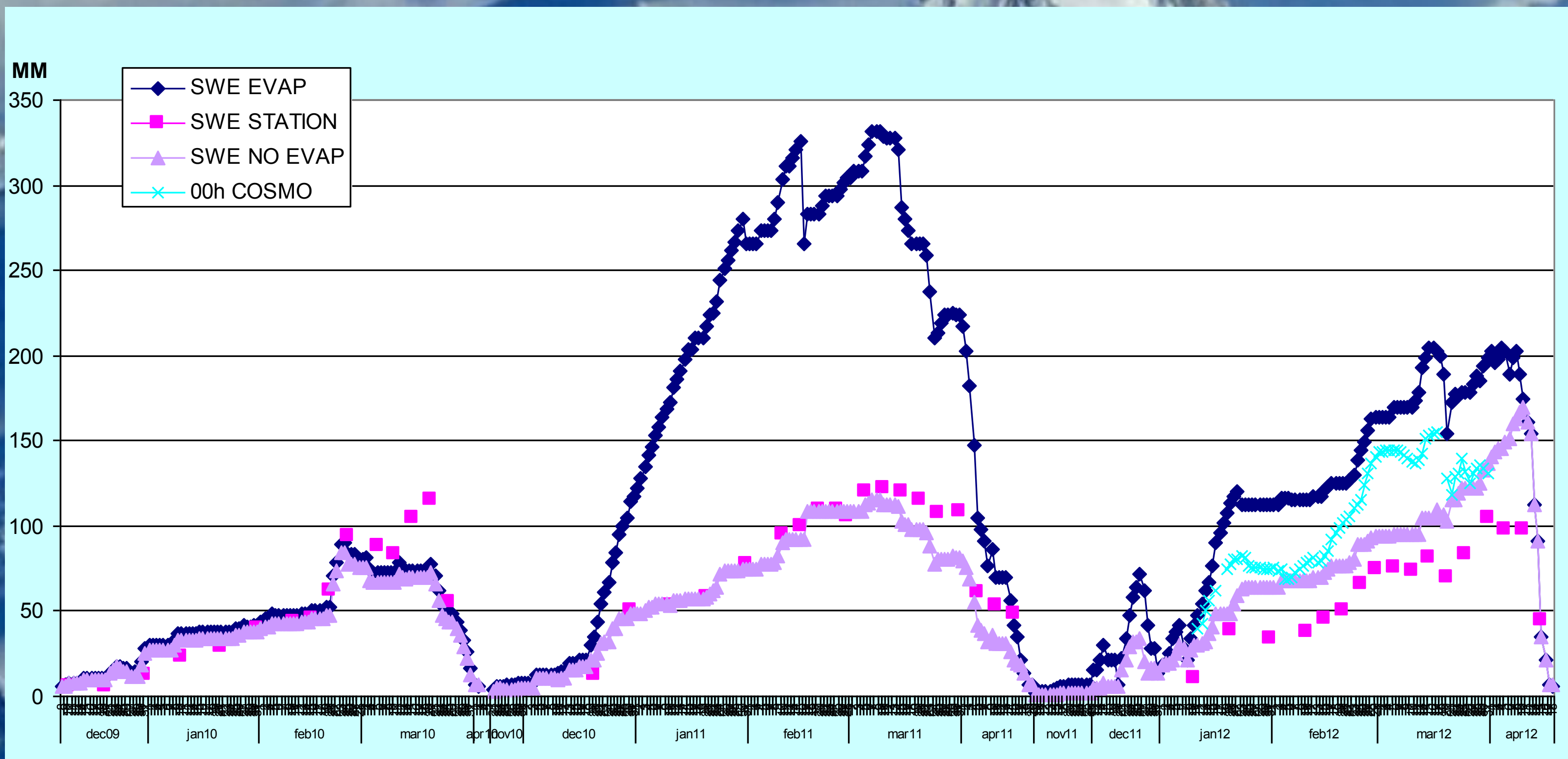
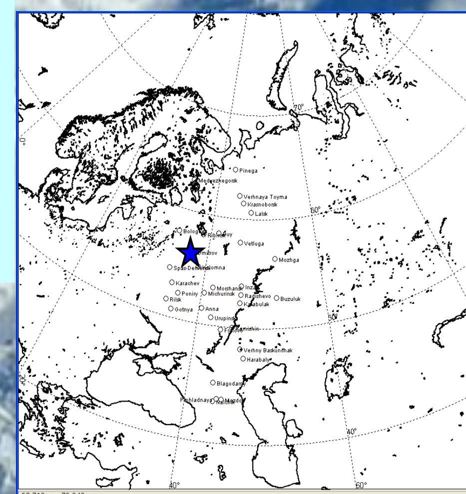
Snow density for station PINEGA, winters 2009-2012



SWE for station DMITROV, winters 2009-2012





$$R + H = 0$$

$$R = (R_{dir} + R_{dif})(1-\alpha) - E_s + E_a$$

$$E_s = \sigma T_{layer}^4$$

$$H_1 = -\rho c_p k_1 |\overline{v}_1| \frac{T_{layer} - T_a}{\Delta z}$$

$$H_2 = \rho c_p k_2 |\overline{v}_2| \frac{T_s - T_{layer}}{\Delta z}$$

$$(R_{dir} + R_{dif})(1-\alpha) + E_a - \sigma T_{layer}^4 - \rho c_p k_2 |\overline{v}_2| \frac{T_s - T_{layer}}{\Delta z} + \rho c_p k_1 |\overline{v}_1| \frac{T_{layer} - T_a}{\Delta z} = 0$$

$$\sigma T_{layer}^4 \approx \sigma T_{layer} \cdot T_a^3$$

$$\sigma T_{layer} \cdot T_a^3 + \rho c_p k_1 |\overline{v}_1| \frac{T_{layer}}{\Delta z} - \rho c_p k_1 |\overline{v}_1| \frac{T_a}{\Delta z} - \rho c_p k_2 |\overline{v}_2| \frac{T_s}{\Delta z} + \rho c_p k_2 |\overline{v}_2| \frac{T_{layer}}{\Delta z} = (R_{dir} + R_{dif})(1-\alpha) + E_a$$

$$T_{layer}(\sigma T_a^3 + \rho c_p k_1 |\overline{v}_1| \frac{1}{\Delta z} + \rho c_p k_2 |\overline{v}_2| \frac{1}{\Delta z}) = (R_{dir} + R_{dif})(1-\alpha) + E_a + \rho c_p k_1 |\overline{v}_1| \frac{T_a}{\Delta z} + \rho c_p k_2 |\overline{v}_2| \frac{T_s}{\Delta z}$$

$$T_{layer} = \frac{(R_{dir} + R_{dif})(1-\alpha) + E_a + \rho c_p k_1 |\overline{v}_1| \frac{T_a}{\Delta z} + \rho c_p k_2 |\overline{v}_2| \frac{T_s}{\Delta z}}{\sigma T_a^3 + \rho c_p k_1 |\overline{v}_1| \frac{1}{\Delta z} + \rho c_p k_2 |\overline{v}_2| \frac{1}{\Delta z}}$$

$\alpha = 0.25,\ k_2 = 10^{-3},\ v_2 \approx 0.1 v_1,\ \Delta z = 8$ - parameters we used for calculations (all the others are in COSMO)