SNOW ANALYSIS in HYDROMETCENTER OF RUSSIA:

Challenges

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The NWP systems of Hydrometcenter of Russia use as initial data:

- *Global NWP :*

Global Snow Depth (SD) OA analysis, OI, 0.5x0.5 °- from DAS system of Hydrometcenter of Russia

Snow water equivalent (SWE)= a·SD, a= const

- *COSMO-Ru and ICON-Ru modeling systems:*

SD and SWE from Global DAS ICON (on the grid 13,2 km)

following DAS ICON system algorithms: SWE = B(t) x SD B(t) – aging function

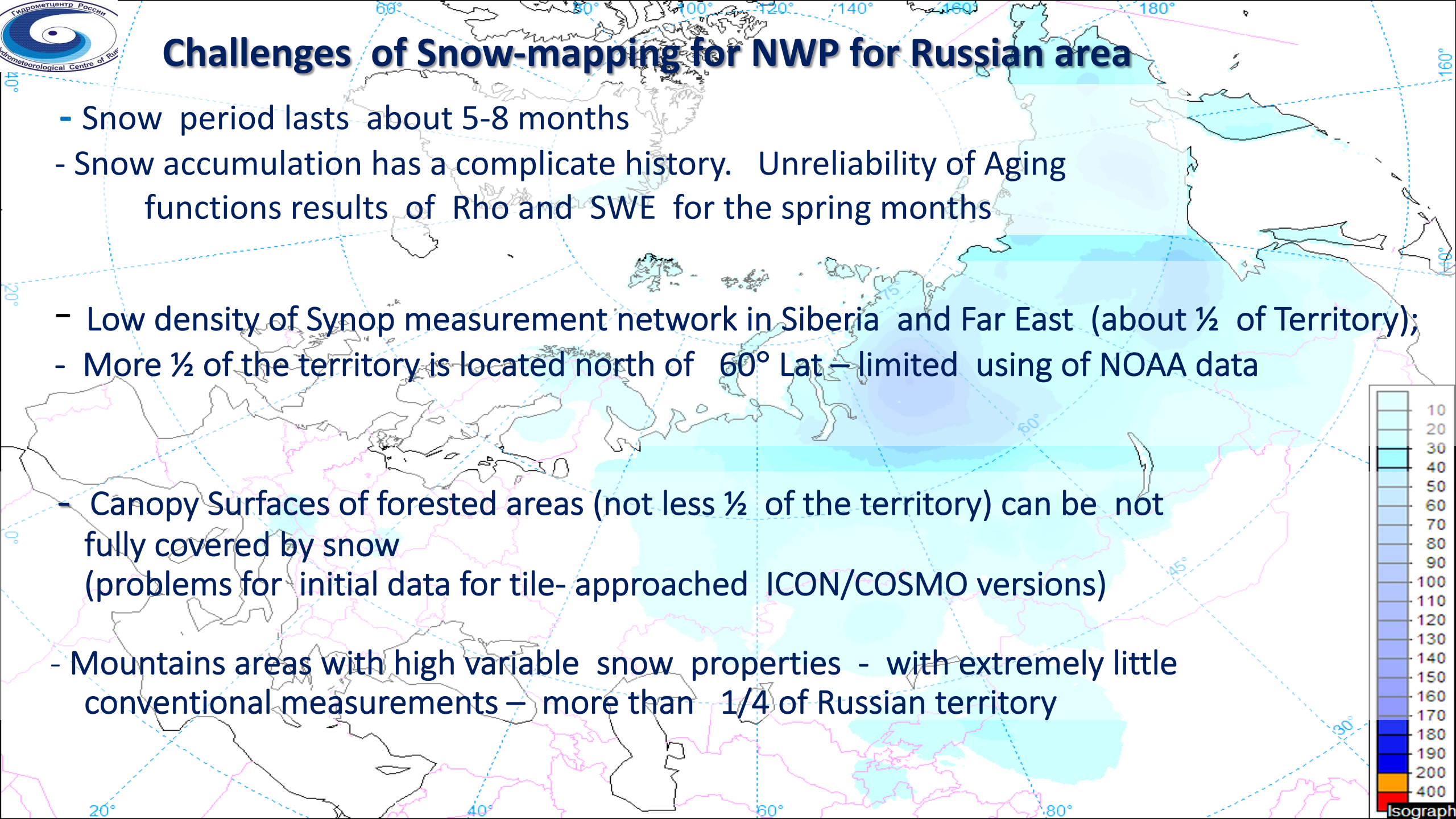
Challenges of Snow-mapping for NWP for Russian area

- Snow period lasts about 5-8 months
- Snow accumulation has a complicate history. Unreliability of Aging functions results of Rho and SWE for the spring months

- Low density of Synop measurement network in Siberia and Far East (about ½ of Territory);
- More ½ of the territory is located north of 60° Lat – limited using of NOAA data

- Canopy Surfaces of forested areas (not less ½ of the territory) can be not fully covered by snow
  (problems for initial data for tile- approached ICON/COSMO versions)

- Mountains areas with high variable snow properties - with extremely little conventional measurements – more than 1/4 of Russian territory



- Snow period of Russia lasts about 5-8 months and has a complicate snow accumulate history

→

- Accumulation of inaccuracies of aging functions to the spring
- Good area for SWE calculations algorithms testing

- Low density of Synop measurement network in Siberia and Far East (about 1/2 of the territory)

→ Significant influence of single random Snow Depth measurement errors

- Surfaces of forested areas can be not fully covered by snow (not less 2/3 of the territory)

→ Snow analysis should include additional information about snow covering of canopies (+available for tile approach) (as example:
“Free – snow – canopy – factor” - FSCF)

- Mountains areas – more than 1/4 of territory

→ Smoothing interpolation techniques lead to not reliable results

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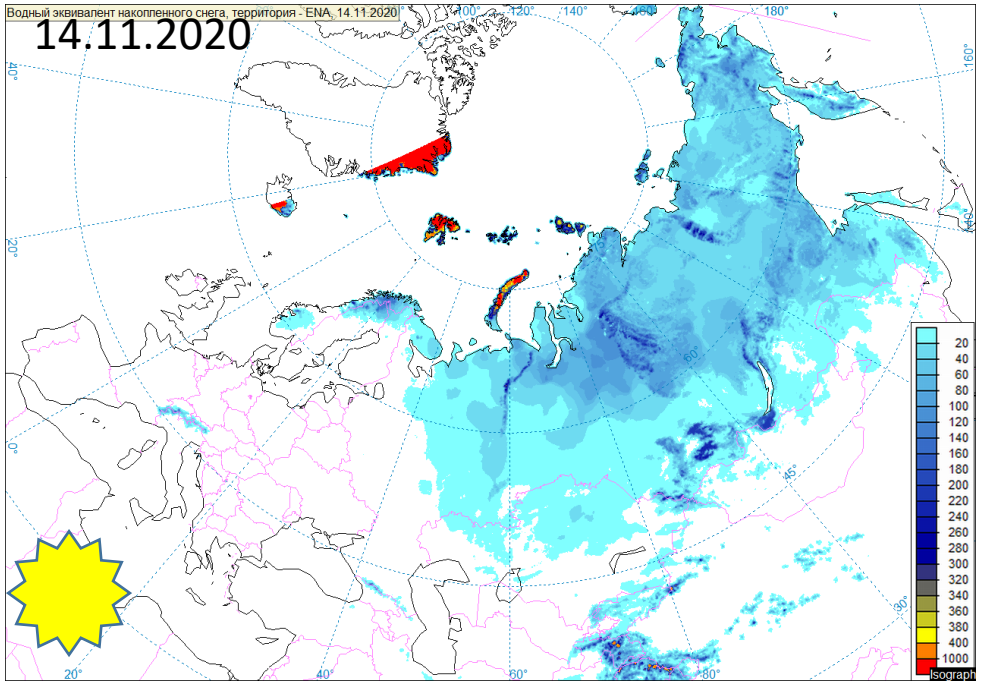
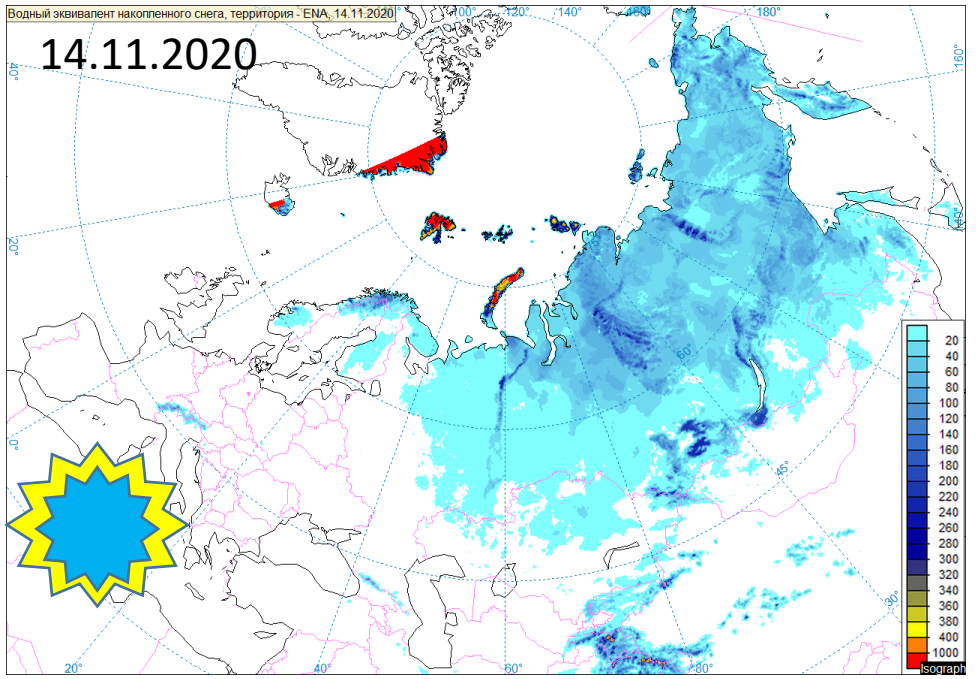
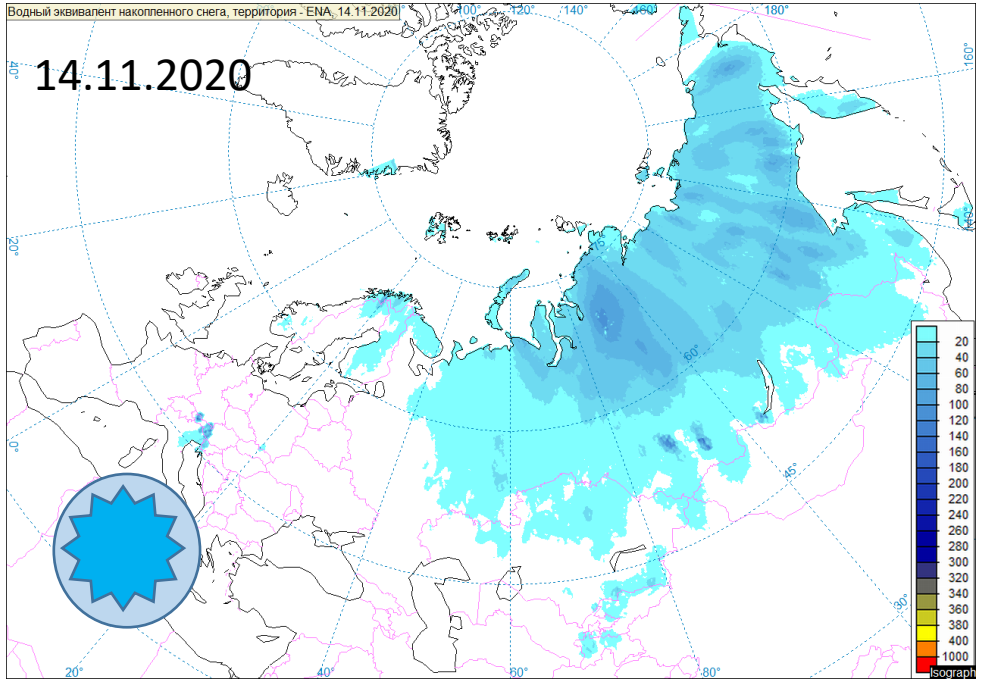
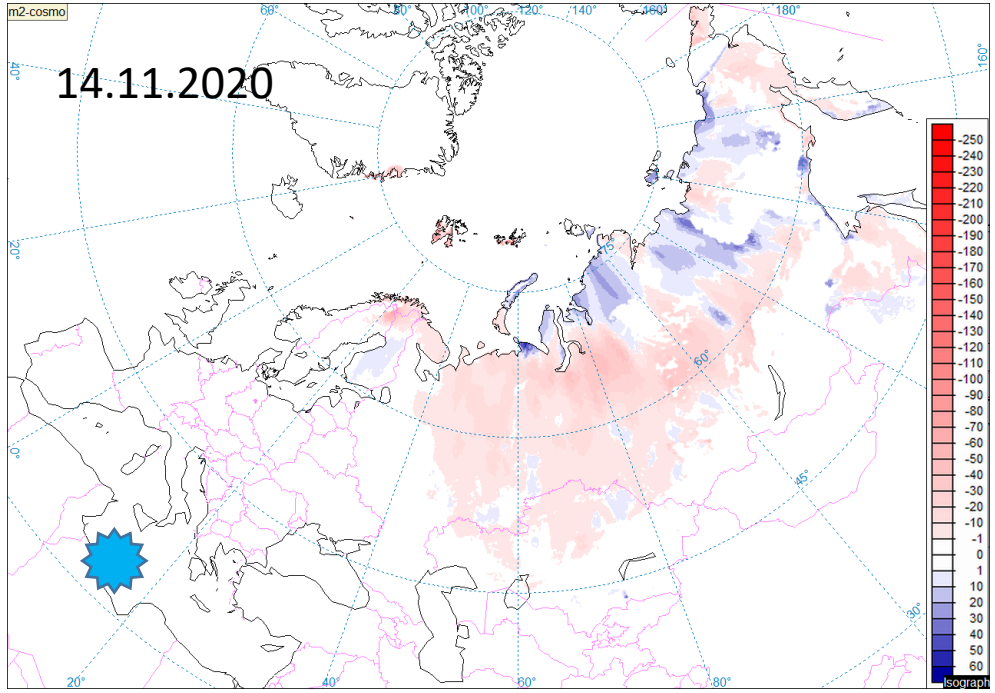




FG Field (Initial data arriving from ICON DAS)

1D SNOWE calculations for points for Synop stations +Cressman)





OA: FG+ SNOWE based increments

SNOWE- based increments

Red: FG overestimates

Blue:FG underestimates

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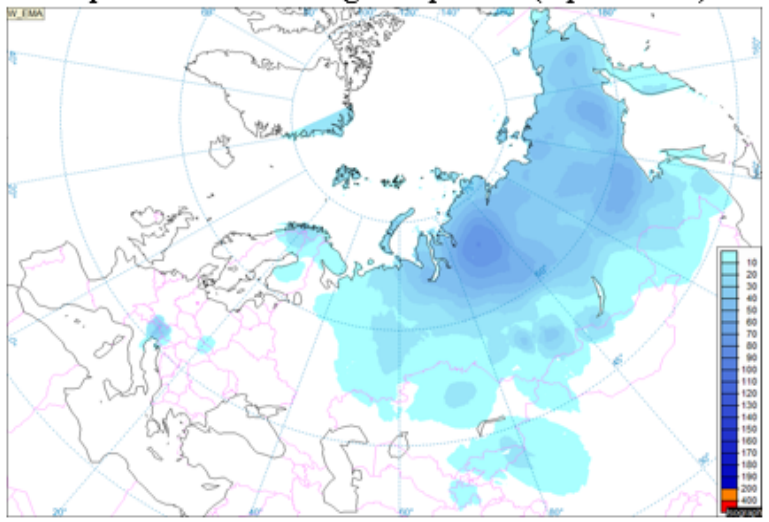
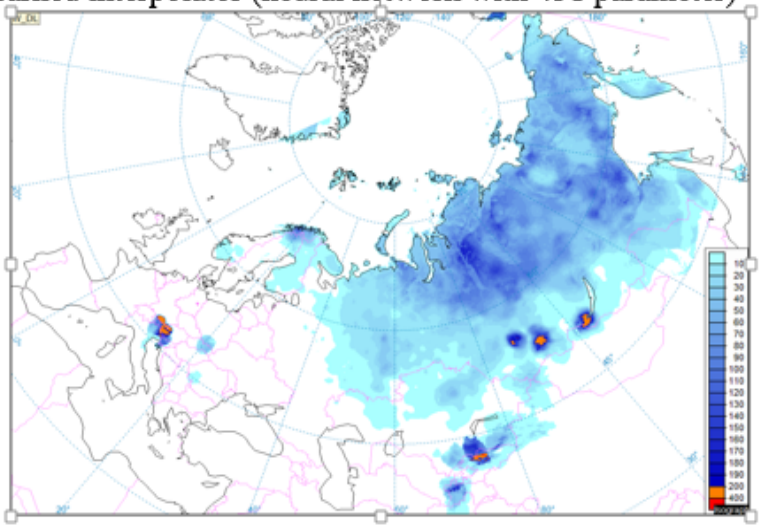
Example: 2020/11/14 snow analysis

Exponential smoothing interpolator (1 parameter)

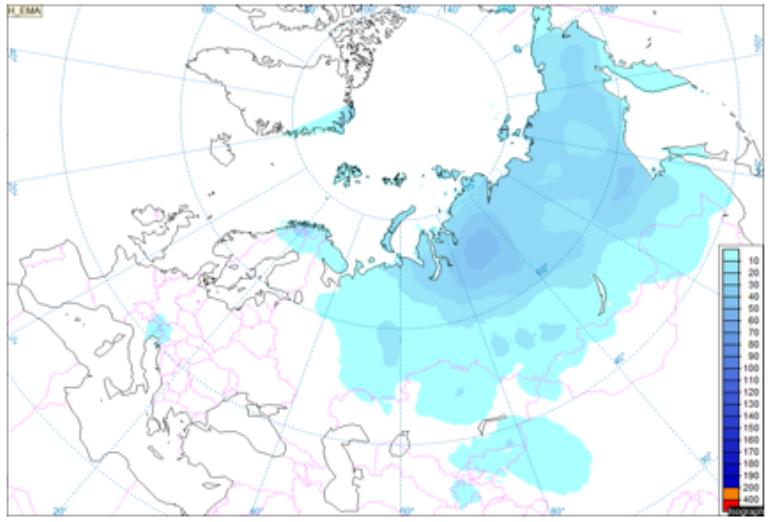
Deep learned interpolator (neural network with 451 parameter)

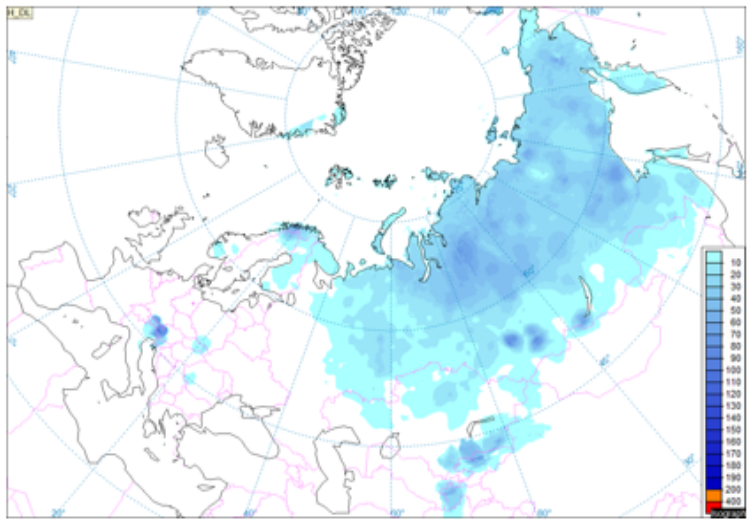
snow water content





snow depth



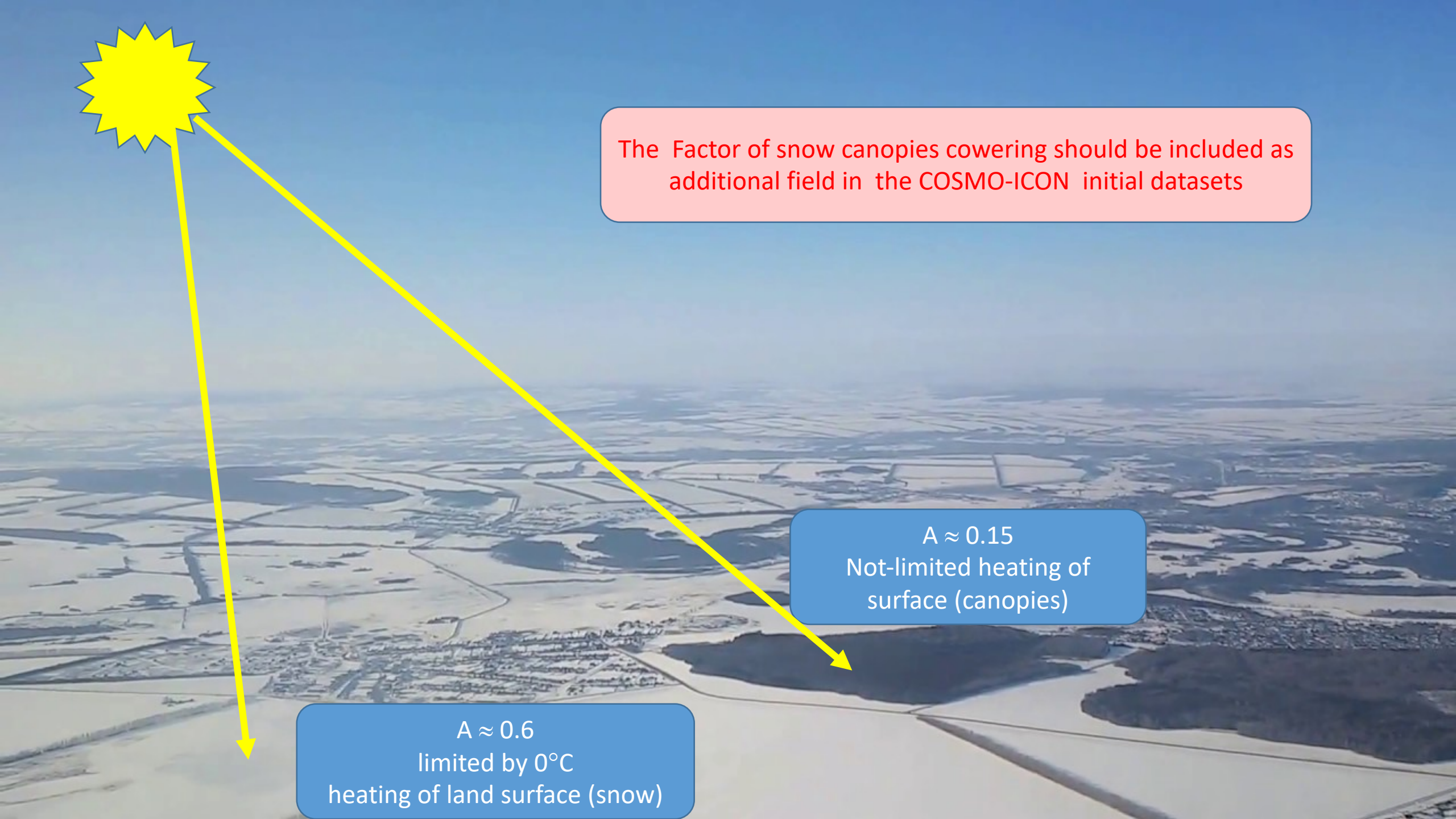


First results of experiments of Snow analysis based on neural network

neural network can be useful - In progress

Conclusions – Part 1

- 1D- SnoWE modelling for locations of Synop stations based on its observations produces daily values of Rho Snow (mean and vertical distribution) and SWE.
- 1D SnoWE calculations allow to specify the fields of SWE and Pho from DAS ICON (to use ones as FG) for OA for initial data fields for COSMO/ ICON-LAM runs.
- The increments based on the SnoWE modelling increase during whole snow season to the spring.
- A monitoring system of comparison of SWE modeling results is developed based on SWE not- operational measurements of hydrological Roshydromet departments
- The maps of SWE as initial fields for COSMO-Ru runs are calculated daily in Hydrometcenter of Russia. The main significant uncertainties are associated with mountainous areas
- The potential increasing of reliability of SWE mapping for mountainous areas can be obtained based on use and developing of Neural Network techniques


The Factor of snow canopies cowering should be included as additional field in the COSMO-ICON initial datasets
A ≈ 0.15
Not-limited heating of surface (canopies)
A ≈ 0.6
limited by 0°C
heating of land surface (snow)

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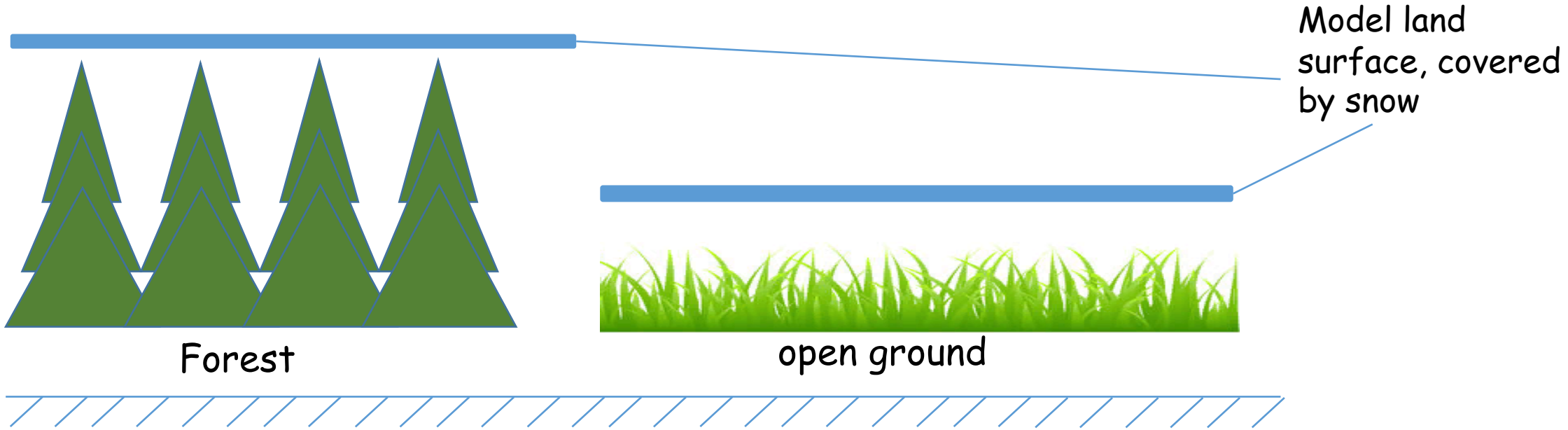
The model snow layers envelop all types of land-surface

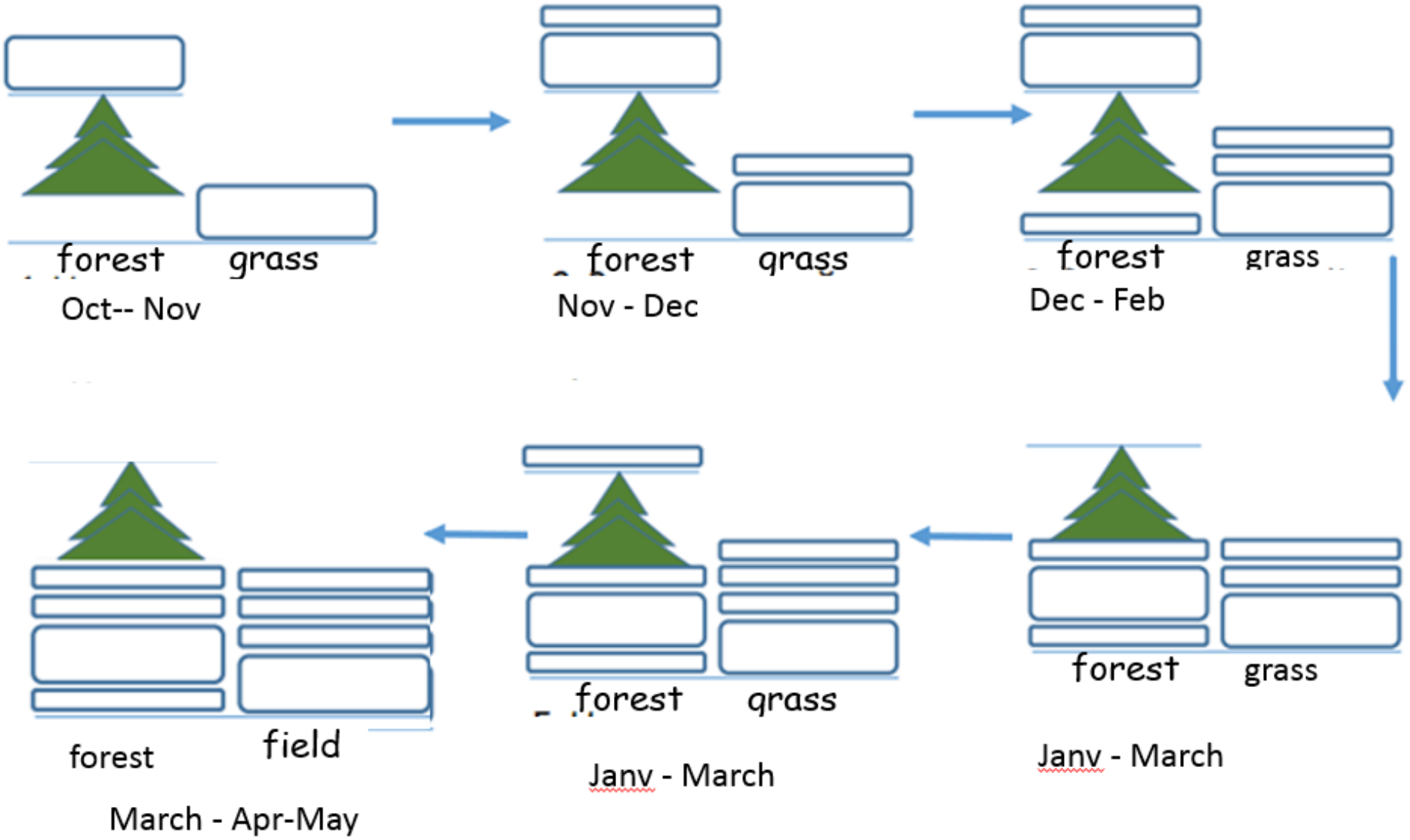


Main features of snow cover as a type of land surface :

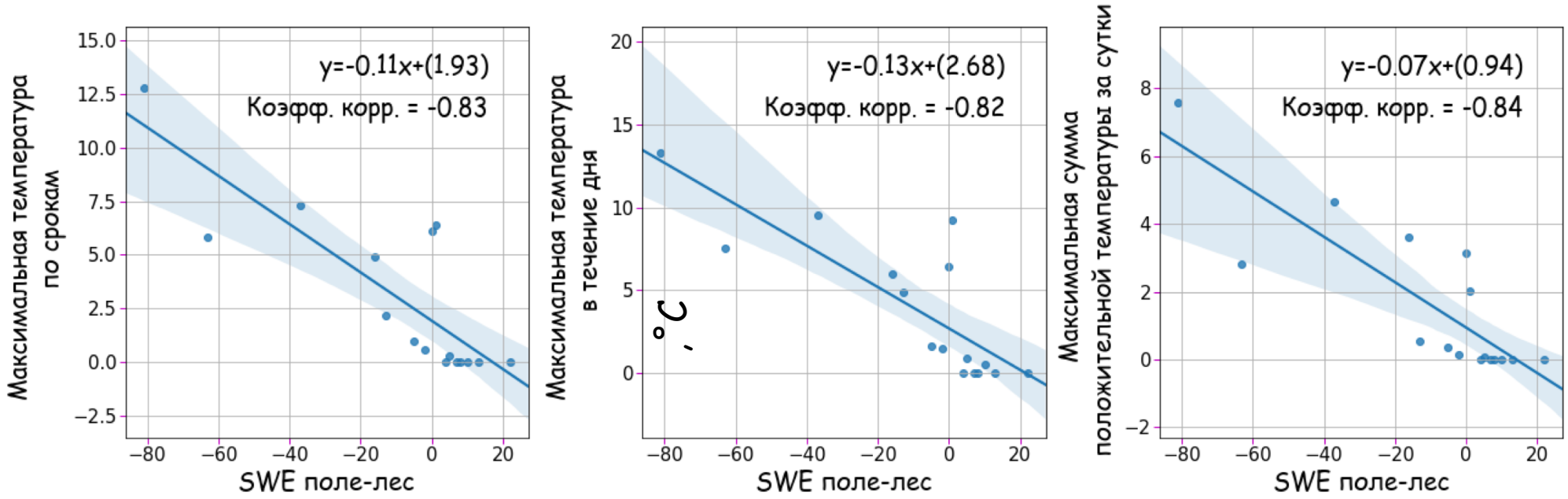
- *high albedo 0,6-0,7*
- *when temperature is above 0°C, the heat is spent on the snow melting*

Cold-seasonal dynamic of snow cowering in the Forests and on the fields

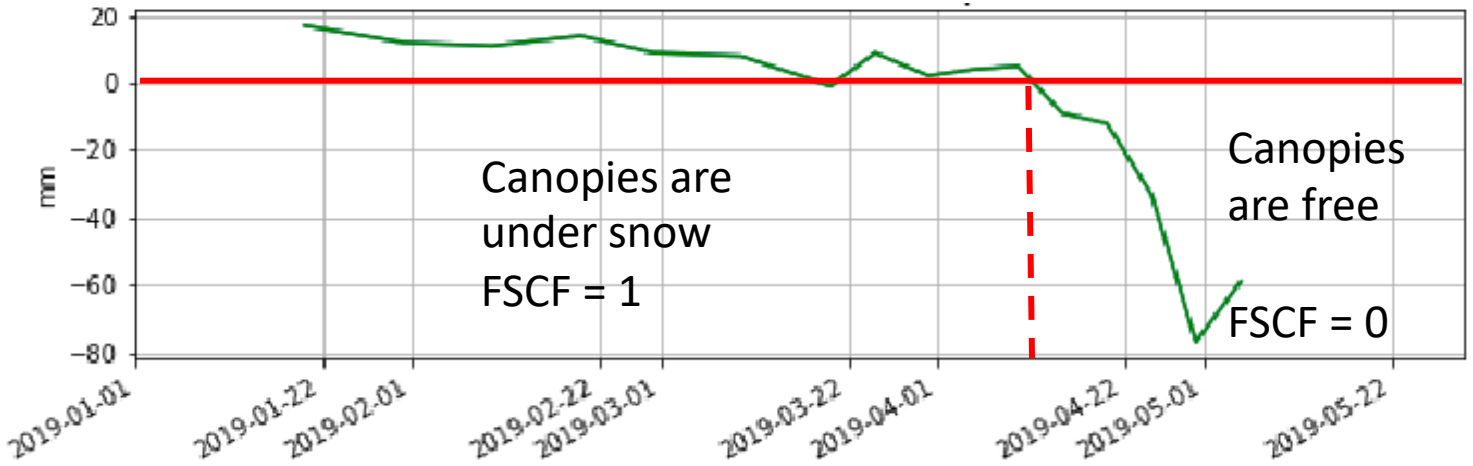
Typically, at the end of snow period, the most of canopies are snow-free and produce completely different heat balance structure in comparison with grasslands



T2m: accumulative positive values in neighboring days, maximal values, …..

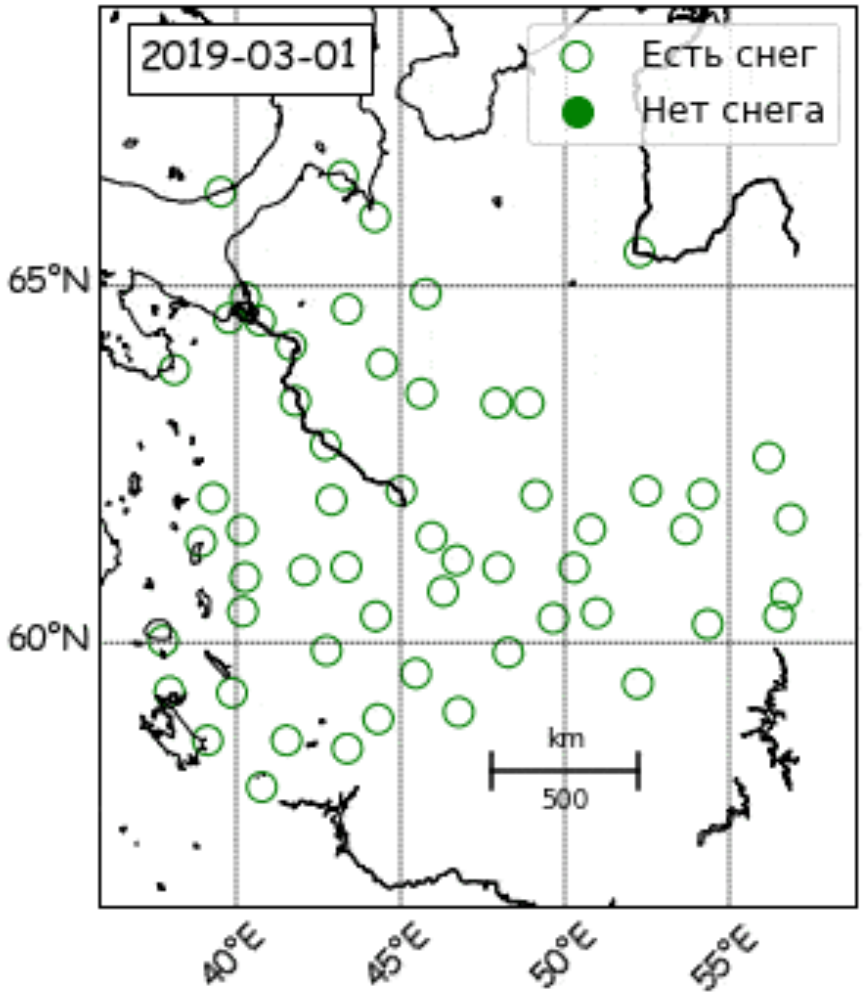


Difference SWE Grass – Forest (coupled SWE measurements of for 22213 Apatites)



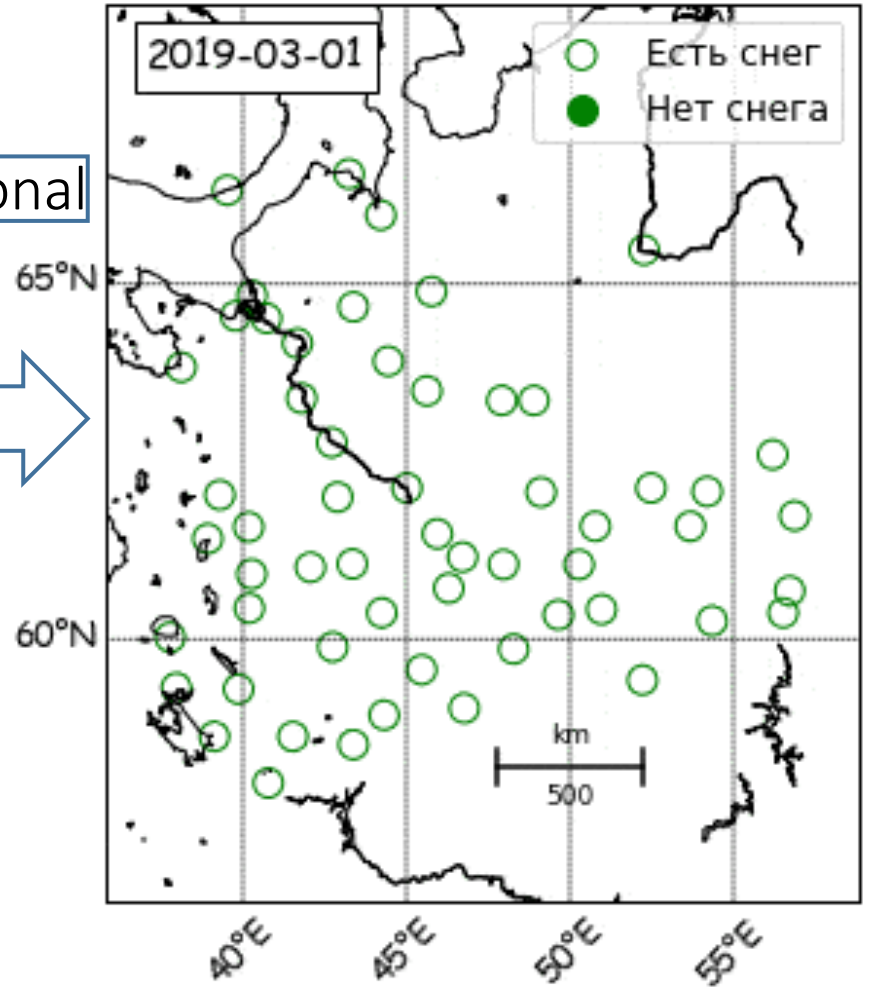
22213 Apatites
1 Oct 2018 – 31 May 2019

Initial snow mask data for the forest-covered area



Following operational DAS data

With FSFF



Green: FSCF=0
White: FSCF = 1

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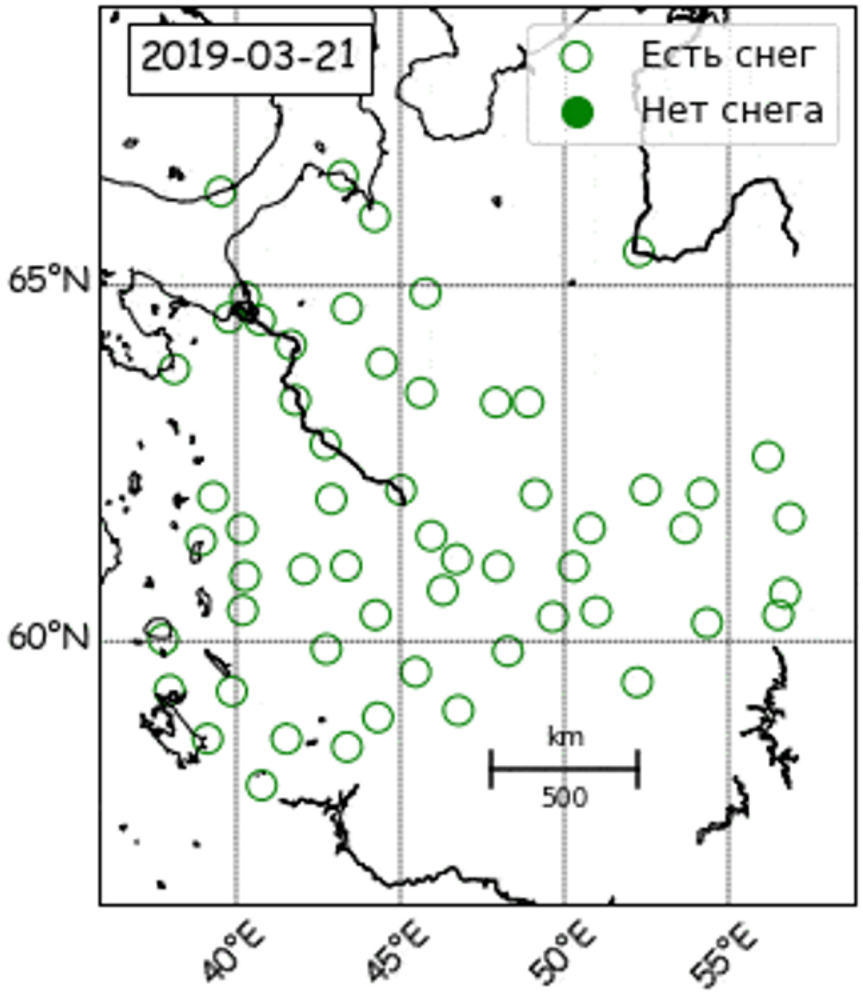

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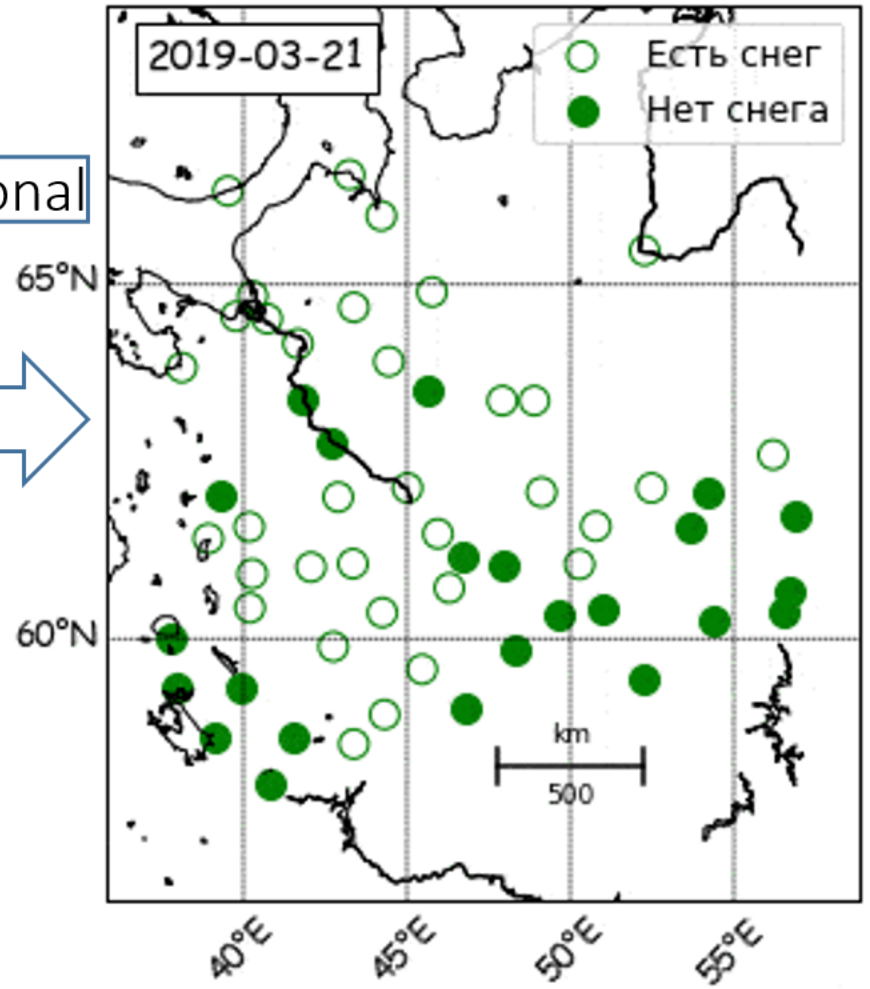

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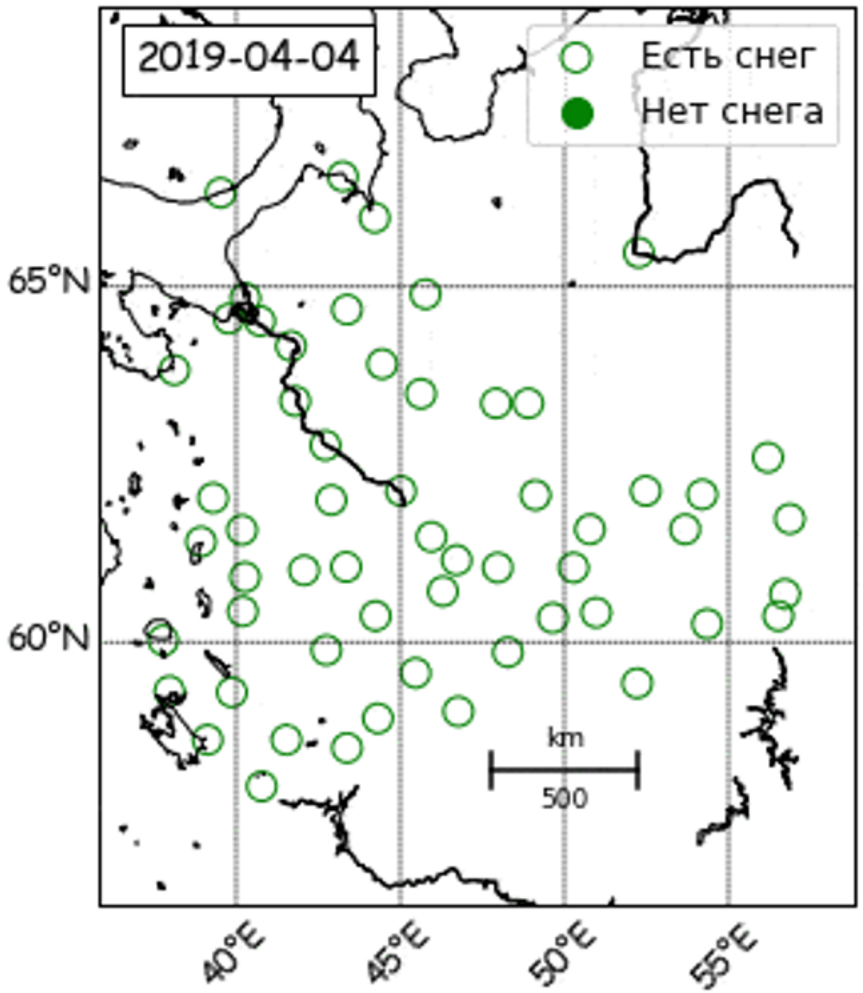

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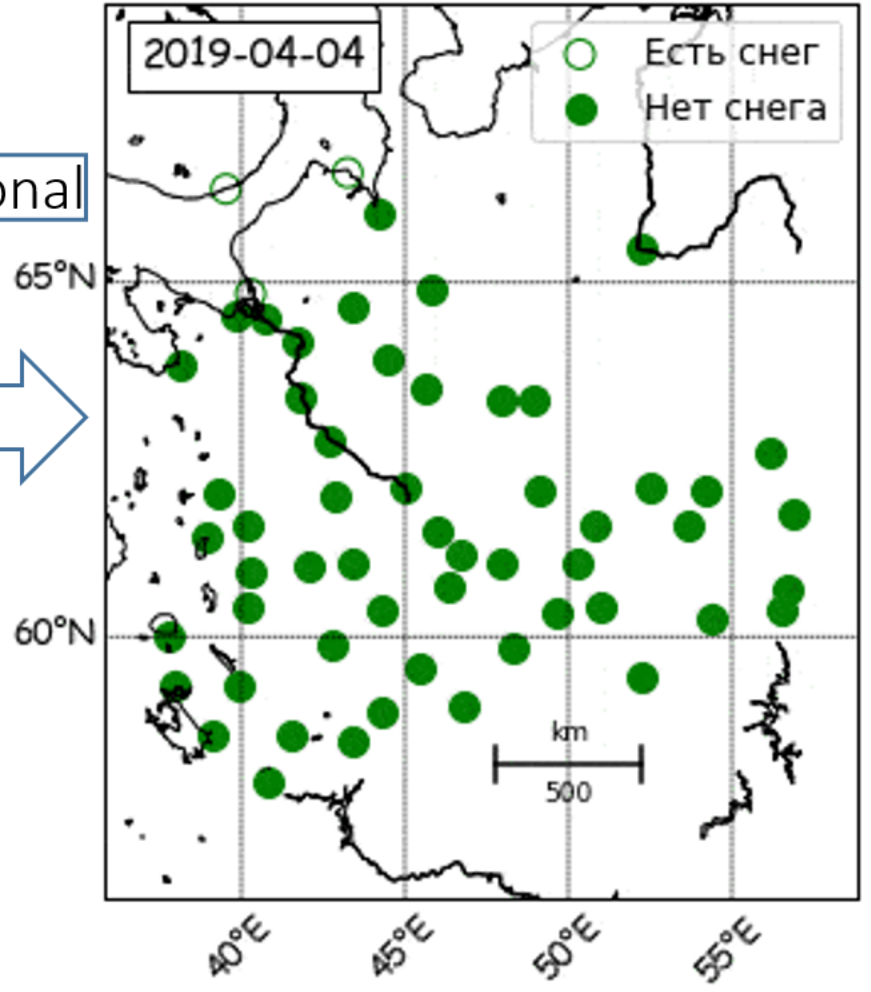

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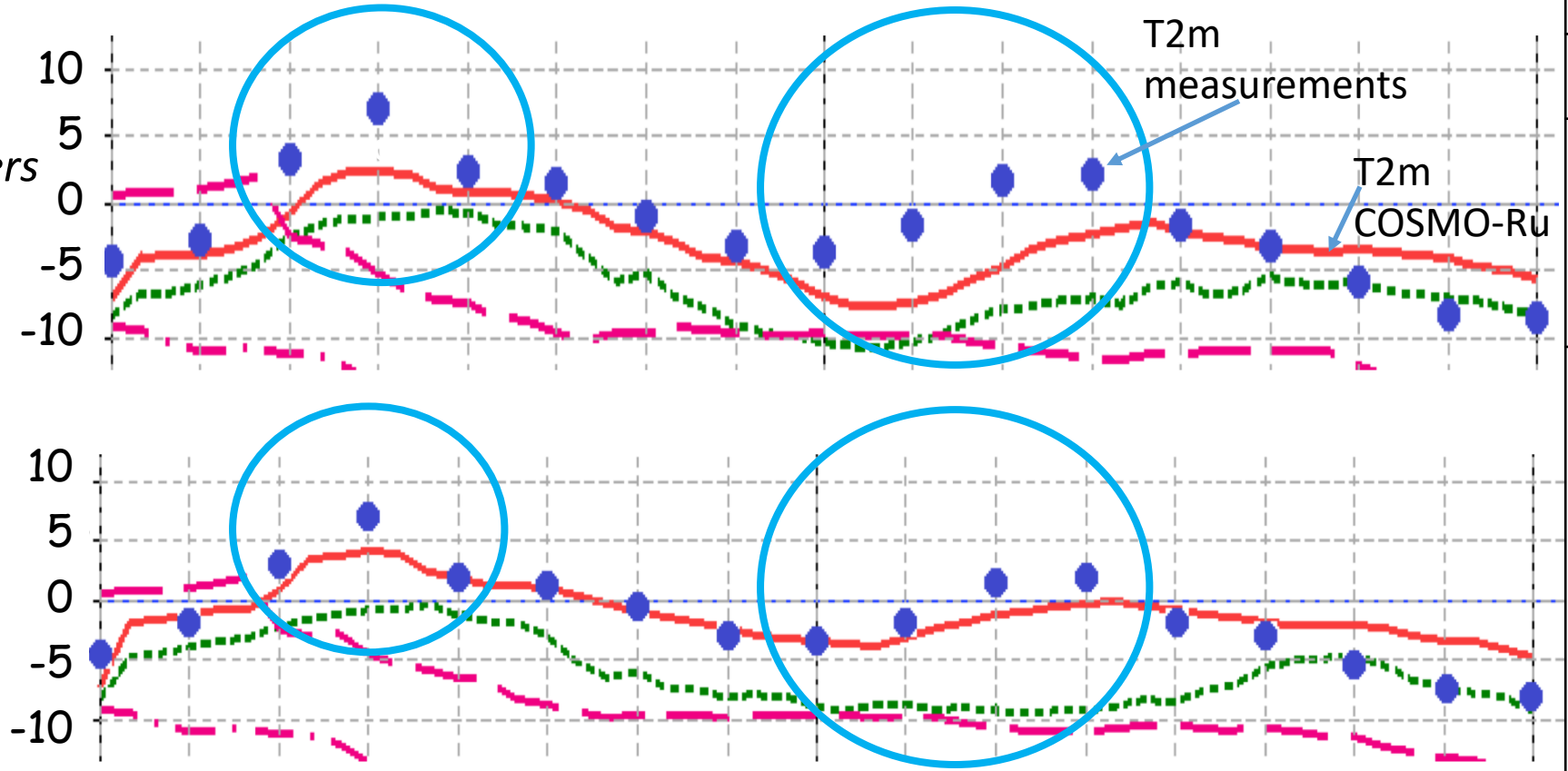
Example of COSMO-Ru T2m forecast and actual T2m at the Roev Ruchey station (Krasnoyarsk Territory) for March 5-6, 2019

Control run (initial snow covers all areas)

Run with modified initial data: FSCF = 0 (no snow on the land surface)



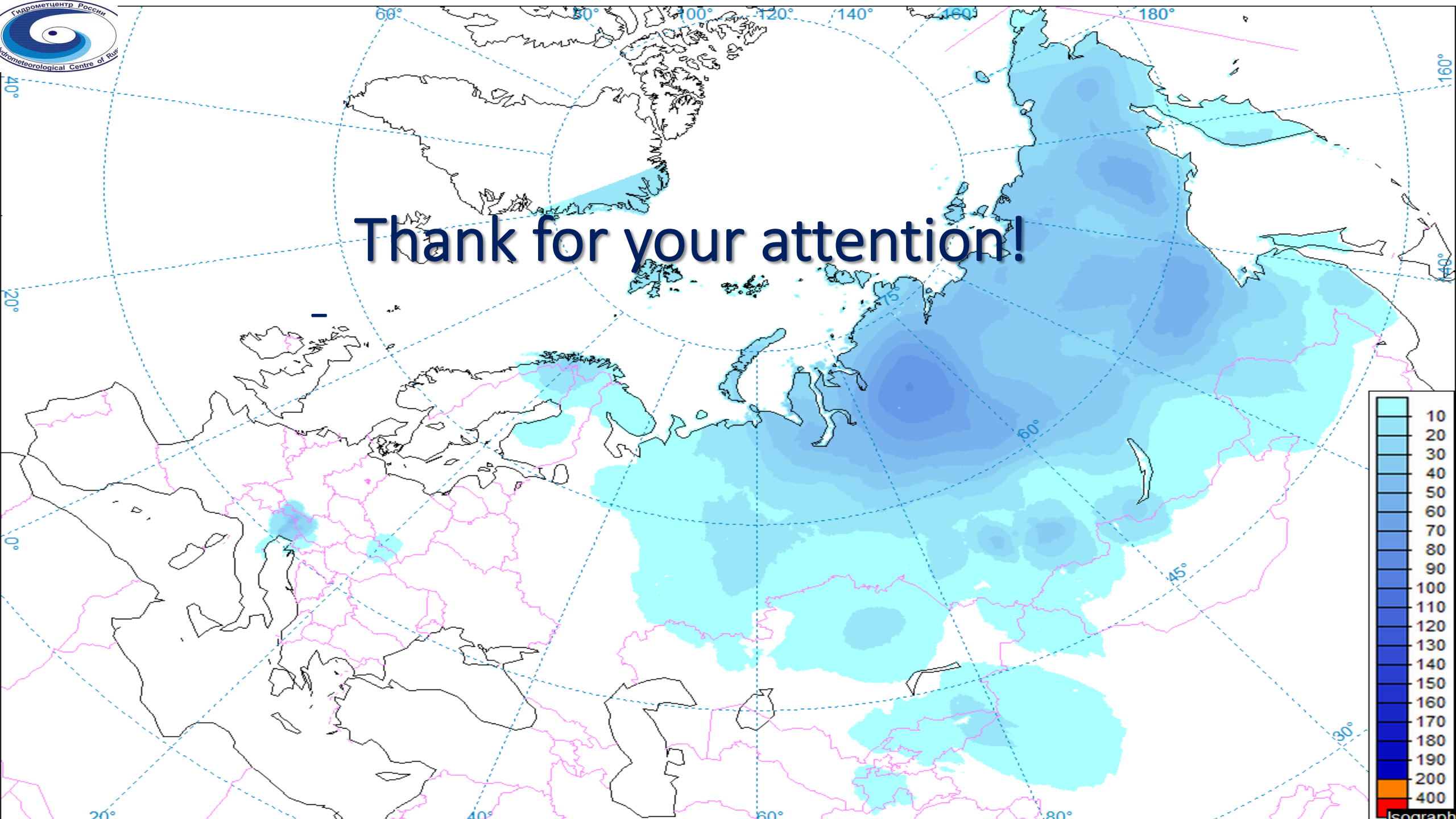
Red line – predicted T2m (COSMO-Ru model, 2.2 km grid)
Blue dots – T2m measurements data

forecast error, °C	
6-12 h	24-36 h
2-5	4-7
0-3	1-3

Conclusions – Part 2

- The values of “Free – snow –canopies– factor” - FSCF (in simplest submission 0 vs 1) should be included as additional information about canopies snow covering in output of Snow Analysis system

- The simple corresponding modifications of COSMO/ ICON codes with using of FSCF can significantly improve the accuracy of bottom-level forecasts for forested areas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Hydrometeorological Centre of Russia
Thank for your attention!
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