A technology to prepare initial fields of snow water equivalent and snow density for atmospheric models

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Snow analysis done at different meteorological centers is usually based on SYNOP snow depth measurements and satellite data about snow fractional cover. Other measurements of snow cover characteristics are carried out (aircraft measurements, snow surveys, measurements at automatic meteorological stations, etc.), but because of their temporal and spatial resolution these data can be used only for some special tasks and are not suitable for operational forecasting technologies. The problem is that NWP models need snow water equivalent (SWE) and snow density data as input. SWE can be restored from the snow depth based on the snow density usually calculated by simple formulas or assumed constant. All this leads to discrepancies in the initial SWE and snow density fields. As it was demonstrated in our study, these discrepancies can be very large - the SWE fields routinely used in COSMO model differed by a factor of up to 2 from snow surveys' data in Russia [1].

In order to calculate SWE and snow density a new multi-layer snow model was created at the Hydrometcenter of Russia [2]. It is sketched in Fig.1. The model uses only standard SYNOP station data for input thus enabling daily calculations during the whole snow period. SWE values calculated by the snow model were in good correspondence with snow surveys' measurements done in the European part of Russia [2].

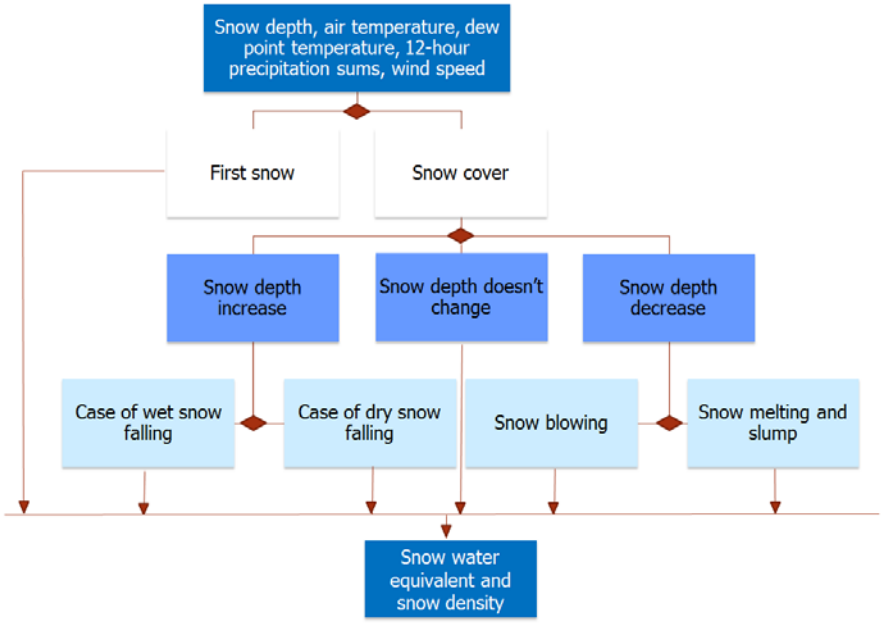

Fig.1. Scheme of the multi-layer snow model

Based on the snow model, a technology for preparation of initial fields of SWE and snow density was proposed. It has been implemented in experimental mode since the end of 2014 (Fig.2). 78-h forecasts using new SWE and snow density are issued daily for 00 UTC for the two domains of COSMO model in Russia - Europe (COSMO-Ru7 with a resolution of 7 km) and Central Russia (COSMO-Ru2 with a resolution of 2,2 km).

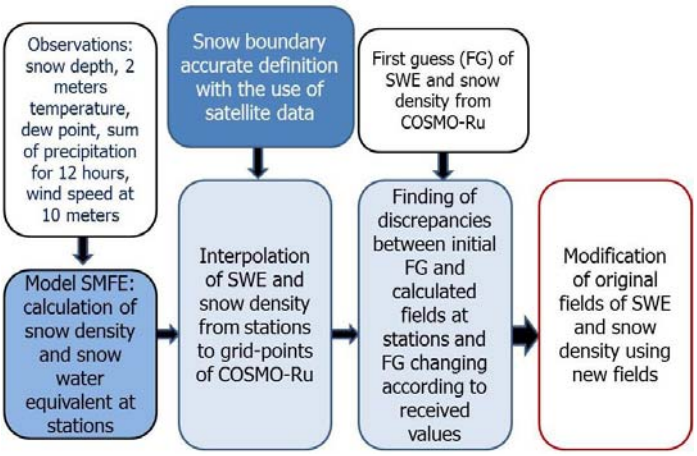

Fig.2. Scheme of the technology for preparation of initial fields of SWE and snow density at the Hydrometcenter of Russia

The introduction of the new technology led to maximum changes in meteorological elements in a zone close to the snow boundary during the snow period. The effect was most prominent during snow melting and for air temperature.

Figure 3 demonstrates an improvement of the forecast skill due to implementation of the new technology (for cases when positive temperatures are observed at stations). The air temperature ME and RMSE clearly decreased over Europe, especially for the third forecast day.

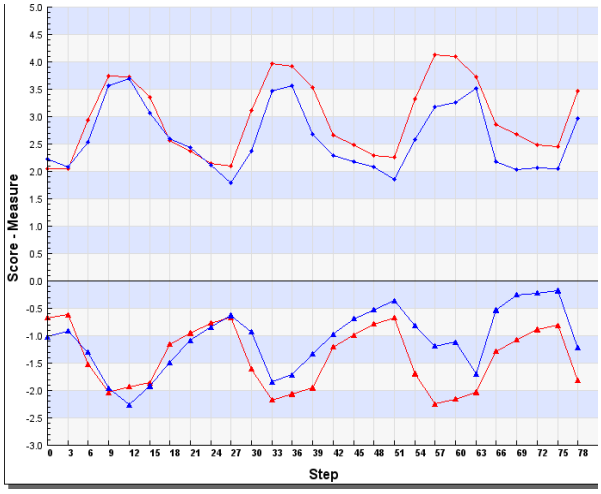

Fig.3. The air temperature ME (bottom panel) and RMSE (upper panel) over Europe for COSMO-Ru7 operational forecasts (red) and for the forecasts made using the new technology (blue). 24 Feb – 31 March 2015

Changes in COSMO-model forecasts of 10-meter wind speed, surface albedo and cloudiness are also found.

References

1. Kazakova E., Rozinkina I. Testing of Snow Parameterization Schemes in COSMO-Ru: Analysis and Results // COSMO Newsletter No.11, 2011, pp.41-51
2. 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