COSMO-Ru System: Status and Scientific Projects Including Testing of ICON-NWP

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Status of COSMO-Ru System

The **operational short-range numerical weather prediction (NWP) system COSMO-Ru** of the Hydrometeorological center of Russia currently uses various configurations of COSMO v. 5.8 model of the meteorological European consortium of the same name as an atmospheric model and SGI ICE-X (peak performance 14 Tflops), T-Platforms V6000 (800 Tflops) and Cray XC40-LC (1.3 Pflops) as computers (http://www.mcc.meteorf.ru/oborudovanie.html).

Figure 1 presents the COSMO-Ru system on SGI ICE-X as at the beginning of 2020. Integration domains for different configurations are shown in color. The list of configurations (their name, the number of grid points, the grid spacing) is given at the top of the plot in colors corresponding to those in the map. For the configuration COSMO-RuENA with the largest integration domain 120-h forecasts were issued.

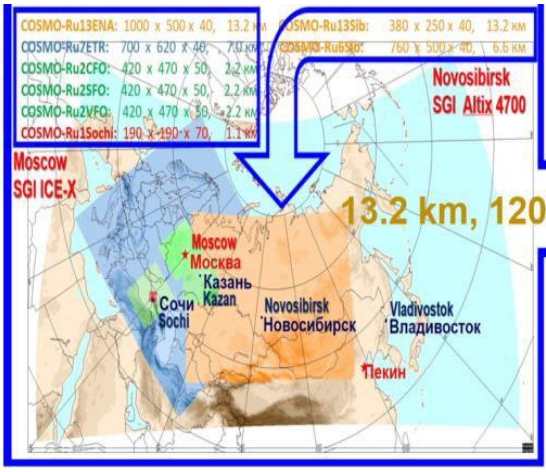

Fig. 1. System COSMO-Ru as at the beginning of 2020 on the SGI ICE-X cluster.

Note that for the Urals and Siberia region, highlighted brown in the plot, weather forecasts were issued also using the COSMO-Ru system with a grid spacing of 13.2 km but at the Novosibirsk WMO regional center. For this, a slightly modified configuration was prepared jointly with Novosibirsk colleagues.

At present, the COSMO-Ru system has been transferred to the Cray computer, with a decrease in the grid spacing for ENA (from 13.2 km to 6.6 km) and an extension of the integration area with a grid spacing of 2.2 km.

The relevant information about configurations of the COSMO model (domains, the corresponding grids, the forecast lengths) is shown in Figure 2. With the advent of the T-Platforms V6000 computer at the Main Computing Center of Roshydromet, the work has begun on implementing the COSMO-Ru system on it as a backup of its versions on SGI ICE-X and Cray XC40-LC "Roshydromet". This will guarantee sustainable issuance of numerical weather forecasts using the COSMO-Ru system.

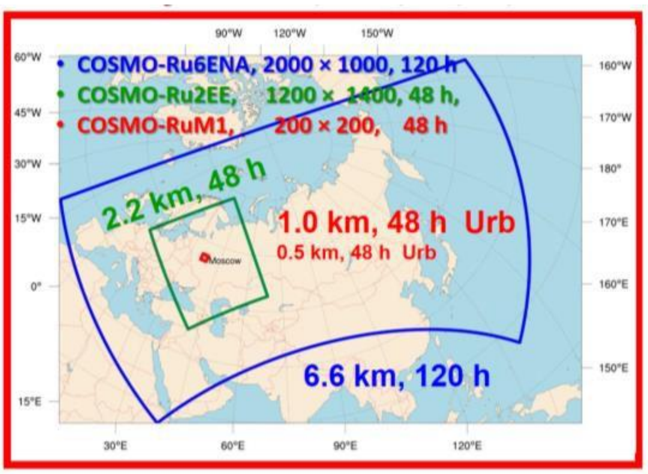

Fig. 2. System COSMO-Ru with COSMO model configurations on the Cray XC40-LC "Roshydromet".

The operational short-range NWP system COSMO-Ru runs 4 times a day and prepares more than 8000 maps, 1200 meteograms and T-skew diagrams. Additionally, 2 times per day a configuration COSMO-Ru2ART runs for the pollution forecast with a grid spacing of 2.2 km for Moscow region.

Testing of ICON-NWP

Currently, the COSMO consortium is working to replace the non-hydrostatic COSMO model for a limited area with a new ICON model [*Zängl et al, 2015*], which has greater capabilities and better forecasting skill.

In this regard, the Hydrometcenter of Russia is working on replacing the COSMO model configurations in the COSMO-Ru system with the ICON model configurations for short-term forecasting not only for a limited area, but also for the entire Earth (90 levels up to 75 km).

Figure 3 shows the domains of integration including the nested ones and the results of numerical experiments with different numbers of cores made for choosing optimal configurations. A 5-day forecast by the global ICON model with nesting (a grid step of 6.5 km to the north of 30^0N and 13 km for the rest of the region, 90 vertical levels up to 75 km) requires 42 min of processor time using 5760 cores for computations and 32 cores to organize the input / output process.

Fig. 3. System COSMO-Ru with configurations ICON-Ru (global and regional (LAM)) on the Cray XC40-LC "Roshydromet".

Scientific Projects

To develop and improve the COSMO and ICON models, research is carried out within the framework of projects of Roshydromet and the COSMO consortium, considering various atmospheric processes and components (aerosol [*Poliukhov, Blinov, 2021*], clouds and radiation [*Khlestova et al, 2020; Shatunova et al, 2020*], ensembles [*Astakhova et al, 2020*], the fires in Siberian forests [*Kirsanov et al, 2020*], polar lows [*Revokatova et al, 2021*], tornadoes [*Chernokulsky et al, 2020*], urban [*Galbero et al, 2020; Rivin et al, 2020; Varentsov et al, 2020*]), using machine learning methods in post-processing [*Bykov, 2020*], verification, etc.

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