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Mesoscale atmospheric modelling technology as a tool for the long-term meteorological dataset development

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The detailed hydrodynamic modelling of meteorological parameters during the last 30 years (1985 – 2014) was performed for the Okhotsk Sea and the Sakhalin island regions. The regional non-hydrostatic atmospheric model COSMO-CLM used for this long-term simulation with ∼13.2, ∼6.6 and ∼2.2 km horizontal resolutions. The main objective of creation this dataset was the outlook of the investigation of statistical characteristics and the physical mechanisms of extreme weather events (primarily, wind speed extremes) on the small spatio-temporal scales.
COSMO-CLM is the climate version of the well-known mesoscale COSMO model, including some modifications and extensions adapting to the long-term numerical experiments. The downscaling technique was realized and developed for the long-term simulations with three consequent nesting domains. ERA-Interim reanalysis (∼0.75 degrees resolution) used as global forcing data for the starting domain (∼13.2 km horizontal resolution), then these simulation data used as initial and boundary conditions for the next model runs over the domain with ∼6.6 km resolution, and similarly, for the next step to ∼2.2 km domain. Besides, the COSMO-CLM model configuration for ∼13.2 km run included the spectral nudging technique, i.e. an additional assimilation of reanalysis data not only at boundaries, but also inside the whole domain. Practically, this computational scheme realized on the SGI Altix 4700 supercomputer system in the Main Computer Center of Roshydromet and used ∼2,400 hours of CPU time total.
According to modelling results, the verification of the obtained dataset was performed on the observation data. Estimations showed the mean error -0.5 0C, up to 2 – 3 0C RMSE in temperature, and overestimation in wind speed (RMSE is up to 2 m/s). Overall, analysis showed that the used downscaling technique with applying the COSMO-CLM model reproduced the meteorological conditions, spatial distribution, seasonal and synoptic variability of temperature and wind speed for the study area adequately. The dependences between reproduction quality of mesoscale atmospheric circulation features and the horizontal resolution of the model were revealed. In particular, it is shown that the use of ∼6 km resolution does not give any significant improvement comparing to ∼13 km resolution, whereas ∼2.2 km resolution provides an appreciable quality enhancement.
Detailed synoptic analysis of extreme wind speed situations identified the main types of favorable to their genesis, associated with developing of cyclones over the Japan Islands or the Primorsky Kray of Russia, and penetration of intensified cyclones from Pacific Ocean through the Kamchatka peninsula, Kuril or Japan Islands.
The obtained dataset will continue to be used for a full and comprehensive analysis of the reproduction quality of hydrometeorological fields, their statistical estimates, climatological trends and many other objectives.