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Methodology of detailed regional atmospheric modelling on the multi-year timescales

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The regional non-hydrostatic atmospheric model COSMO-CLM used for the long-term (30 years, 1985-2014) simulation with ∼13.2, ∼6.6 and ∼2.2 km horizontal resolutions. The main objective of creation this dataset was the outlook of investigation of statistical characteristics and physical mechanisms of extreme weather events (primarily, wind speed extremes) on the small spatial scales.
The COSMO-CLM model 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 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 on ∼2.2 km domain. The spectral nudging technique was applied additionally in order to control the model behavior and limit the possible model retreat from the real conditions. It is based on the two-dimensional Fourier decomposition of reanalysis and regional model fields, and the succeeding adjustment of simulation results. Temperature, wind speed, geopotential and pressure were assimilated using this spectral nudging technique in this case on the spatial scale over 500 km and above 850-hPa pressure level. This computational scheme executed for many months (up to 1 year) continuous runs.
According to modelling results, the verification of the obtained dataset was performed on the observation data. Model grids were defined for comparison for each of verified meteorological stations. It was the one among the nearest model grids (of nine surroundings), that had the smallest RMSE of the model run relative to the observational data.
Verification showed the mean error -0.5 C, up to 2–3 C RMSE in temperature, and overestimation in wind speed (RMSE is up to 2 m/s). Overall, 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. Moreover, the use of ∼6.6 km resolution does not give any significant improvement comparing to ∼13.2 km resolution, whereas ∼2.2 km resolution provides an appreciable quality enhancement according to the extreme wind speeds.
The obtained dataset will be used furtherly for a full and comprehensive analysis of the reproduction quality of hydrometeorological fields, their statistical estimates, climatological trends and many other objectives.