Statistical downscaling of results of the forecasting system MM5-Ukraine using neural net technology

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Abstract

Since 2001 MM5 model is customized in IMMSP for the operational weather forecasts for the Ukrainian territory. The simulated results are used for the flood forecasting, assessment of the potential accidental releases from the Nuclear Power Plants and there are presented for the public at the web portal http://meteoprog.ua. Configuration of the system: grid 27 km x 27 km (covers Ukraine) nested in grid 81 km x 81 km, nested areas 9*9 km and 3*3 km for the Carpathian mountains and regions of NPPs. Data from Global meteorological model provided by National Center for Environmental Predictions of USA is used for initial and boundary conditions of the model. Geospatial data is taken from Geological service of USA (USGS), spatial resolution is 5'. Parameterizations: Explicit Moisture Schemes (simple ice scheme), PBL Schemes (MRF scheme), Cumulus Parameterizations (Grell, see Grell et al. (1994).), Radiation Schemes (Rapid Radiative Transfer Model long-wave scheme). Post processing procedure: linear interpolation.

Comparison of temperature forecasts at higher and lower layers of atmosphere showed that improvement of mesoscale model and post processing procedure is required. Dependency of forecast quality from horizontal mesh step showed better results for smaller steps, but it is impossible to use small steps for the whole domain. The statistical downscaling based on the Artificial Neural Network (ANN) was developed and tested for MM5-Ukraie. Predictors: temperature at 2m height, soil temperature, dew point temperature, relative humidity, accumulated precipitations, wind speed, day time, month, day of month at 4 closest nodes of the calculation mesh. Forecast time up to 48 hours. Number of predictors is 32. Predicted quantities: 2m height temperature at desired point, accumulated precipitations during last 6 hours. Training interval: January 2007 - March 2008 (~7000 training examples for temperature, ~1000 for precipitations). Type of the neural net: static feed-forward, training function: 'trainlm' (which utilizes Levenberg-Marquard algorithm for error minimization), number of layers: 2, number of neurons: 16, activation functions 'tansig' for the first layer and linear for the second. The ANN modules of "MATLAB 7.0" were used in the study.

The ANN downscaling procedure allows to diminish the error of the forecast of near surface temperature for the stations with rms > 2C. For some 48 h periods the error decreases at 5 C. Especially this concerns mountain and coastal stations. The diminishing of the error is not so significant for precipitations. It is caused by lack of predictors (vertical wind speed is not presented in the archive data) and smaller size of training set. Required size of training set is O(N/e), where N is a number of parameters, e – desired error. There were needed at 5000 training examples to train the net with the error less than 10%.