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Atmospheric surface layer parameterization in a weather prediction system HIRLAM

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Recently developed spectral theory of turbulence has been implemented for parameterization of the atmospheric surface layer in a weather prediction system HIRLAM (High Resolution Limited Area Model). The spectral model is based upon the successive elimination of small-scale modes of velocity and temperature and is known as QNSE (Quasi-Normal Scale Elimination) model. Currently, HIRLAM employs a modified Louis scheme for parameterization of the surface layer; this scheme yields a significant positive Bias for 2meter temperature in cases of stable stratification. Studies of this phenomenon indicate that this Bias is due to small values of the exchange coefficients, C_d, C_h, and C_q, in expressions representing surface fluxes of momentum and sensible and latent heat in the Louis scheme. The parameterization of surface fluxes based upon the QNSE theory gives more realistic values. Along with the QNSE-based parameterization of atmospheric boundary layers, the new surface layer scheme provides a self-consistent framework for representation of turbulent processes in the entire PBL. For testing and validation of the new surface layer scheme, a 1D variant of the HIRLAM has been employed. The results of simulations of surface fluxes of momentum and sensible and latent heat were compared with the observations at the polar Finish station Sodankyla. The simulated surface fluxes and wind, temperature and humidity are in good agreement with the observational data.

For further validation and verification of the new surface layer parameterization, the 3D HIRLAM model (version 7.0) was used for +48h forecasts during January and March of 2005, for a total of 120 forecasts per month. Statistical analysis and local model-to-data comparisons demonstrate significant improvement in the forecast skills, Bias and rms of 2m temperature, 2m relative humidity, 10m wind, and mean sea level pressure