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Implementation of the quasi-normal scale elimination theory of turbulence in a regional weather prediction model HIRLAM

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A recently developed quasi-normal spectral theory of turbulence based upon the successive small-scale modes elimination is implemented in the numerical weather prediction model HIRLAM (High Resolution Limited Area Model). Currently, for parameterization of turbulent mixing, HIRLAM employs a $K - l$ model which requires a prognostic equation for the turbulence kinetic energy, K, and a diagnostic equation for mixing length, l. The original stability functions used in HIRLAM were replaced by those derived within the QNSE theory; these functions are used for calculation of the vertical turbulent mixing coefficients, K_M and K_H. For preliminary testing and validation of the $K - l$ model with new stability functions, a 1-D variant of the HIRLAM has been employed. The results of simulations with 1-D HIRLAM were compared with the observational datasets from CASES-99 and Sodankyla station (polar Finland). The simulated profiles of wind, temperature and turbulence dissipation (when available) are in good agreement with the observational data.

For further validation and verification of the new $K - l$ model, the 3-D HIRLAM model (variant 6.4.1) was used for +48h forecasts during January 2005, total 120 forecasts. These datasets are used for statistical analysis and calculation of the skills of the forecasts. The results show an improvement in bias and rms of 2m temperature and 2m relative humidity and significant improvement in bias of mean sea level pressure, P_{msl}.