Medium-Range Ensemble Prediction at the Hydrometcenter of Russia

E.D. Astakhova and A.Yu. Bundel

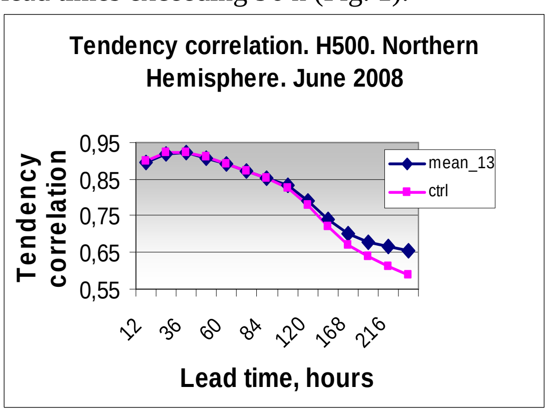
Hydrometcenter of Russia, Moscow, Russia, helen@mecom.ru

An ensemble system for medium-range global weather forecasting has been developed at the Hydrometcenter of Russia. The system is based on the spectral T85L31 model, presently used for operational deterministic medium-range forecasting (Frolov et al., 2004). The ensemble is formed of 13 members — 12 perturbed forecasts and a control (unperturbed) forecast. Only uncertainties inherent in initial conditions are taken into account. Initial state perturbations are calculated using the breeding method (Toth and Kalnay, 1997). The 12-h breeding cycle is applied. Temperature, wind, and surface pressure are perturbed at each level and at each model gridpoint. The starting perturbations are determined as a difference between an analysis and a 12-h forecast valid for the same date. The perturbations are symmetrically added to/subtracted from the analysis data forming initial conditions for a pair of perturbed forecasts. Next perturbations are determined as a half-difference between the results of the pair of 12-h perturbed forecasts. The perturbations are scaled down at each step of the breeding cycle using the global total energy norm.

The ensemble system is implemented on one node of a four-node computer based on Quad-Core Intel Xeon5345 (2.33 GHz) processors (2 per node) in Linux. Although the model used in the runs is parallelized using MPI, it is still running in a one-processor mode because only 2 PCs are attributed to the job.

The system runs in quasi-operational mode from April 2008. Because of the limited computer resources, 10-day ensemble forecasts are issued only once a day for 12 UTC. The forecasts starting from 00 UTC are run for 12 h. The ensemble forecasts of 850-hPa temperature, mean sea level pressure, 500-hPa geopotential height, and convective, large-scale, and total precipitation are accumulated in a 40-day database.

The analysis of the EPS results shows that the ensemble mean is obviously better than the control run for lead times exceeding 96 h (Fig. 1).



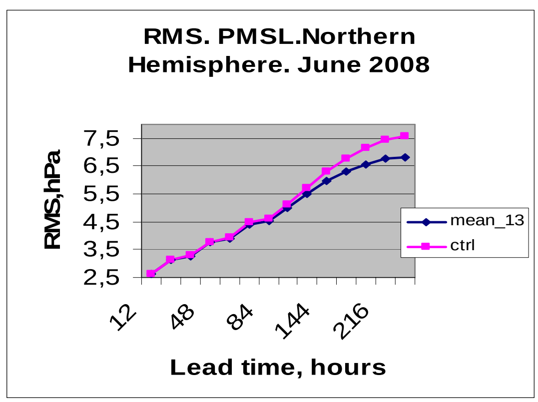


Figure 1: A comparison of verification scores for the ensemble mean and control forecasts

Varying the ensemble size from 9 to 13 members only slightly affected the skill of the ensemble mean. However, spaghetti maps clearly show that the ensemble range is insufficient and often does not embrace the analysis thus indicating the necessity of a larger ensemble.

A special study was made for 6-h precipitation totals. The verification period was from April 2 to September 29, 2008, 171 days in total. The station observations averaged over the model grid cells were used for comparison. The deterministic scores included a set of measures based on the contingency table (in particular, the Peirce skill score), the RMSE, and some others. Figure 2 shows that the ensemble mean outperforms individual ensemble members and that the precipitation quality is better in the day time.

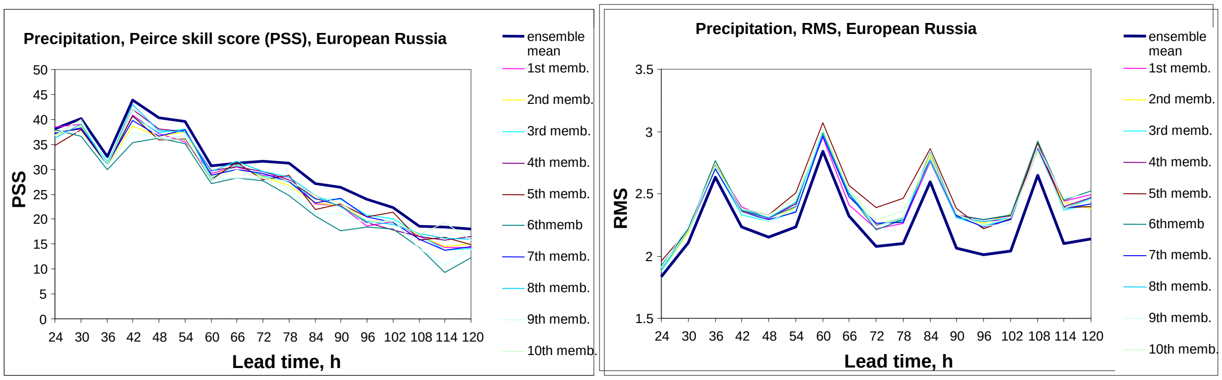


Figure 2: Deterministic scores for 6-h precipitation forecasts for ensemble mean and different ensemble members.

The probabilistic measures included the ROC curves and the area under the ROC curve, the Brier score, reliability diagrams, and frequency histograms. The binary events were precipitation exceeding 0.1; 1; 2.5; and 5 mm/6h. Figure 3 shows that the precipitation forecast in European Russia is better than in Western Siberia and that the intense precipitation is more difficult to predict. Overall, the probabilistic forecast is good up to three days. The reliability diagrams showed that the system is overconfident in predicting precipitation events or their absence.

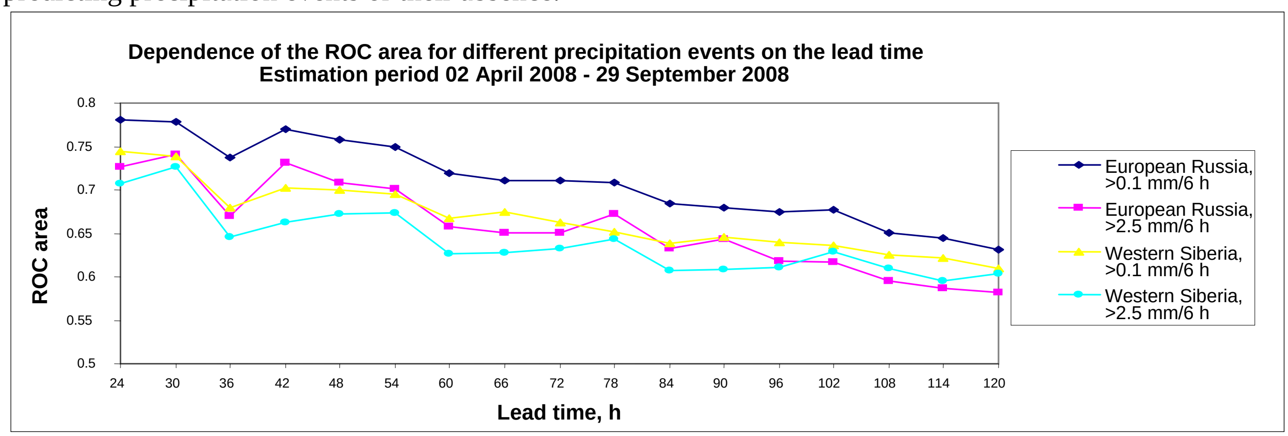


Figure 3: ROC areas for different precipitation thresholds and regions

An increase in the ensemble size and an improvement of the model resolution will be possible this year after the ensemble system is implemented on a new powerful computer recently installed at the Hydrometcenter of Russia. Introduction of another model, namely, the semi-Lagrangian model (Tolstykh, 2001), to the ensemble is planned as well.

Acknowledgements

The study was supported by the Russian Foundation for Basic Research (project no. 07-05-13607-ofi_ts).

References

1. Frolov, A.V., Astakhova, E.D., Rozinkina, I.A., et al., *Russian Meteorology and Hydrology*, 2004, 5, 5-20.
2. Toth, Z. and Kalnay, *Mon. Wea. Rev.*, 1997, 125, 3297—3319.
3. Tolstykh, M.A. Semi-Lagrangian high-resolution atmospheric model for numerical weather prediction. *Russian Meteorology and Hydrology*, 2001, 4, 1- 9.