Development of a variable-resolution global data assimilation system

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The data assimilation system is based on sequential "analysis-forecast" approach. At forecast step, the global finite-difference semi-Lagrangian NWP model [3] is used. It is designed in spherical geometry with a pole rotated to the region of interest. It is supposed to supplement the model in future with the variable resolution in (pseudo) latitude. The model includes the parameterizations of subgrid-scale processes developed in Météo-France for French operational model ARPEGE/IFS.

At analysis step, a 3-D multivariate Optimum Interpolation scheme is currently implemented. The analysis scheme is based on the sequential approach. That is, at each analysis cycle, the observations are divided into several batches with each batch being assimilated sequentially so that the "first-guess" at step $k+1$ is the analysis at step k. For this scheme to be optimal, the "first-guess" statistics should be recalculated at each step. Following the approach proposed in [4], in each batch but the last one, we include observation types with quasi-uniform and relatively dense coverage. As a consequence, we are allowed to approximately recalculate the "first-guess" statistics off-line [4]. Actually, we use the three batches: first, all SYNOP observations, second, the polar-orbiting temperature and humidity profiles (SATEM retrievals are used currently), and third, all other observations (radiosondes, aircraft winds, and satellite cloud-track winds).

The upper-air observations are assimilated by means of the incremental approach (e.g., [1]). In addition, sea-surface temperature is analyzed (using SHIP observations) following [2]. Soil temperature and soil moisture forecasts are corrected using the respective lowest-model-level analysis increments. The snow cover forecast is corrected using the "optimally" interpolated snow depth observations from SYNOP reports.

Although our data assimilation system is at the early stage of development, the first results are encouraging. The assimilation experiments are performed without pole rotation and variable resolution. The horizontal resolution is 1.5°, 28 vertical levels, the forecast-model time step is 36 min. We performed assimilation during the test period in February, 2000. Thirty consecutive forecasts started every 12 hours from the assimilated analyses are examined. The RMS errors of the 72 hours forecasts are shown in Figs. 1-2. Verification is against assimilated analyses, the area is Northern Hemisphere north of 20°. The similar results are obtained for verification against radiosondes (not shown). From Figs. 1-2, we see that the problems in our data assimilation system are primarily concentrated in the lower troposphere whereas in the upper troposphere and lower stratosphere, the results are more satisfactory.

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References

[1] Courtier P., Andersson E., Heckley W., Pailleux J., Vasiljević D., Hamrud M., Hollingsworth A., Rabier F. and Fisher M. The ECMWF implementation of three-dimensional variational assimilation (3D-Var). I: Formulation. *Quart. J. Roy. Met. Soc.* **124** (1998), 1783-1807.

[2] Reynolds R.W., and Smith T.M. A high resolution global sea surface temperature climatology. *J. Climate* **8** (1995), 1571-1583.

[3] Tolstykh M.A. Semi-Lagrangian high resolution model of the atmosphere for numerical weather prediction, *Russian Meteorology and Hydrology* 2001, N4, 1-9.

[4] Tsyroulnikov M.D. Three-dimensional assimilation of observations with uniform coverage using optimal spatial filtering. *Res. Activities in Atm. and Oceanic Mod.*, WMO, 1999, Rep. N 27, 1.40-1.41.

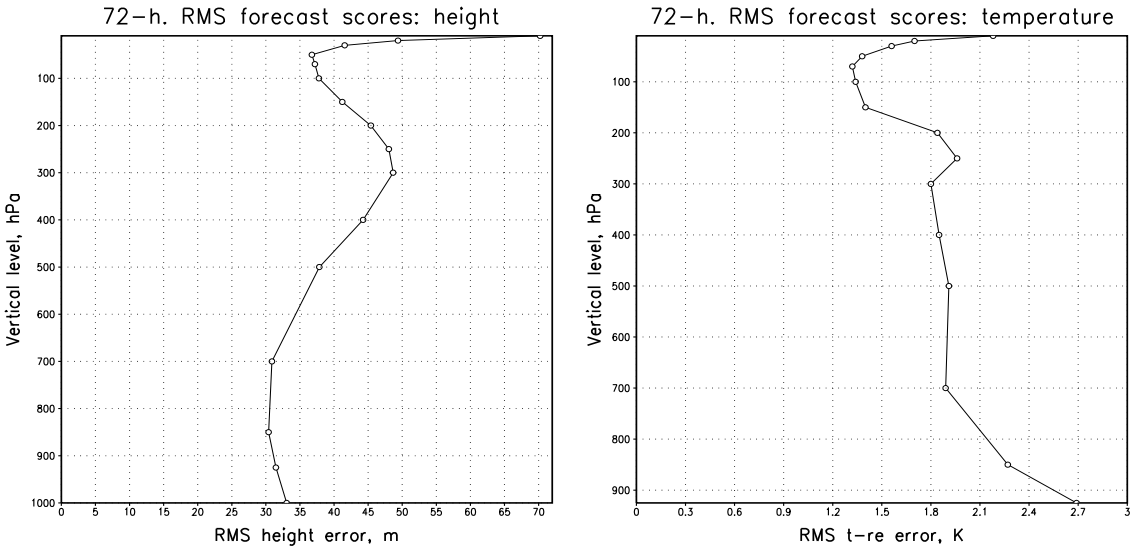

Figure 1:

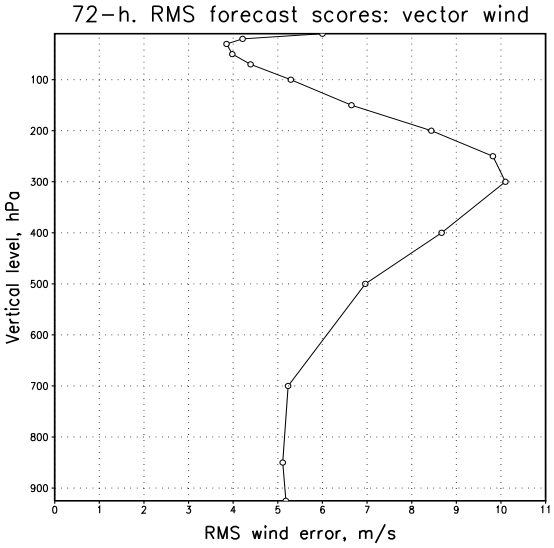

Figure 2: