VARIATIONAL DATA ASSIMILATION AT THE ITALIAN AIR FORCE WEATHER SERVICE: A PROGRESS REPORT

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Development and Implementation of CNMCA 3D-PSAS Assimilation System

A new data assimilation system (Bonavita and Torrisi, 2003) has been designed and implemented at the National Center for Aeronautic Meteorology and Climatology of the Italian Air Force (CNMCA) in order to improve its operational numerical weather prediction capabilities and provide more accurate guidance to operational forecasters. The system is based on an "observation space" version of the 3D-Var method for the objective analysis component (Cohn et al., 1998), and on the High Resolution Regional Model (HRM) of the Deutscher Wetterdienst (DWD) for the prognostic component (Majewski, 2001). Notable features of the system include a completely parallel (MPI+OMP) implementation of the solution of analysis equations by a preconditioned conjugate gradient descent method; functional representation of background error correlations in spherical geometry with thermal wind constraint between mass and wind field; derivation of the objective analysis parameters from a statistical analysis of the innovation increments.

The analysis and forecast fields derived from the assimilation system are objectively evaluated through comparisons with parallel runs based on the previous Optimum Interpolation based operational analysis and on the European Centre for Medium Range Weather Forecast (ECMWF) analyzed fields. Objective comparisons with RAOB and conventional surface observations are also presented in Bonavita and Torrisi, 2003. The main result of these studies is that, despite its relative simplicity, the new system is capable of adequately capturing the information content of the available observations, while the efficient parallel implementation of the objective analysis algorithm makes it suitable for operational use even in small operational environments.

Current Development Activities

Current activities focus on the continued development and extension of the data assimilation system:

1. Increase the forecast model horizontal resolution from the current 0.5° to 0.25° on the integration domain shown in fig.1. This is expected to improve the realism of the model forecasts especially in the lower troposphere, thus allowing for a larger number of surface and low level observations to be successfully ingested;

2. Observing system experiments (OSEs) to evaluate the impact of asynoptic observations on the analysis and forecast fields. Although it may be argued that the Euro-Atlantic integration domain is an area relatively well covered by the conventional observing network, encouraging results have been recorded so far from the inclusion of satellite-derived wind vectors. In fig.2 the impact of Quickscat derived winds on the Mean Sea Level Pressure forecast fields is shown. A small but persistent positive impact can be seen from the +18h forecast onwards. More impressive results are being obtained from the ingestion of METEOSAT Atmospheric Motion Vectors (AMV). Fig. 3 shows the importance of this type of observations in improving the wind field forecasts for almost all tropospheric levels, while the multivariate character of the objective analysis projects the geostrophic component of the information on the temperature field (fig. 4)

3. Another active field of activity is the implementation of interactive 1DVAR retrievals of temperature and humidity profiles from ATOVS radiances, for their subsequent ingestion in the objective analysis. This is considered an intermediate but necessary step towards the direct assimilation of ATOVS radiances. Work is now focusing on bias removal, cloud clearing algorithms and quality control of the observations.

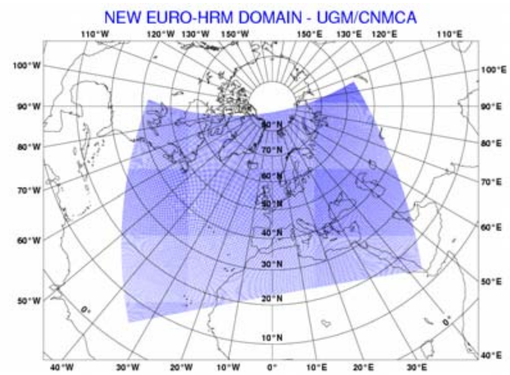

Figure 1. CNMCA Regional Model (EURO-HRM) domain of integration.

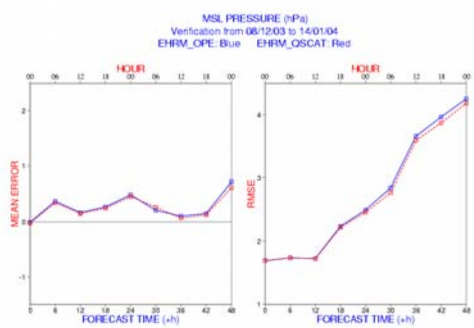

Figure 2. Mean and RMS error of EURO-HRM Mean Sea Level Pressure forecasts from CNMCA 3dVar analysis with (red) and without (blue) the ingestion of Quikscat winds verified against surface observations covering the entire integration domain.

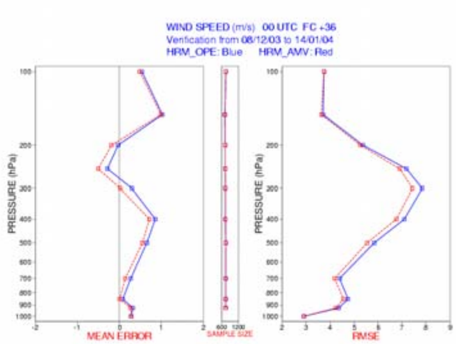

Figure 3. Mean and RMS error of EURO-HRM +36h wind speed forecasts from CNMCA 3dVar analysis with (red) and without (blue) the ingestion of AMV winds verified against RAOB observations covering the entire integration domain.

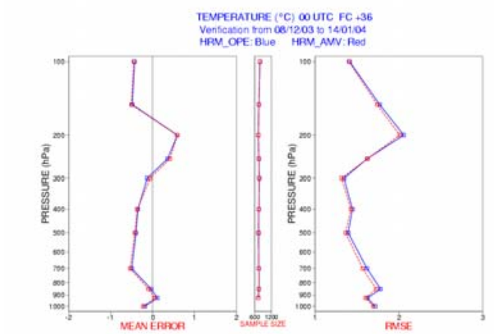

Figure 4. Mean and RMS error of EURO-HRM +36h Temperature forecasts from CNMCA 3dVar analysis with (red) and without (blue) the ingestion of AMV winds verified against RAOB observations covering the entire integration domain

REFERENCES

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