3. Margarida BELO PEREIRA : "Improving the assimilation of water in a NWP model"

Introduction

It is known that the forecasts from NWP models are very sensitive to small errors in the initial state. The aim of the meteorological data assimilation is to determine this initial state, trying to make it as close as possible to the true state of the atmosphere. However, the observations are insufficient to describe the atmospheric state. Therefore, a short range (6 hours) forecast (known as background) is used as a first guess of the initial state. So, the analysis field is a combination of background and observations. The weights given in the analysis to observations and to background are determined by the magnitudes of errors at each location (variances) and the correlations between errors at different locations (covariances). The matrix which contains these statistics for the background is known as the B matrix. In order to determine the B matrix, the NMC method was tried at NCEP (Parrish and Derber, 1992). Afterwards, the Analysis Ensemble method was tried in Canada (Houtekamer et al., 1996) and at ECMWF (Fisher, 1999). Presently, the Ensemble method is under study in ARPEGE (Belo Pereira, 2002).

NMC method versus Ensemble Method

In the present work, the differences between 12 h and 36 h forecasts valid at the same time are used in the NMC method. The description of the experiments made for using the Ensemble method is given in the previous ALATNET Newsletter (Belo Pereira, 2002).

In order to study the differences between the two methods some global statistics of the background errors were analysed. The largest differences between the two methods are found for vorticity and temperature. Figure 1 shows the standard deviation of vorticity background errors, as estimated by the two methods. The largest errors are found near the tropopause, for wavenumbers between 18 and 40, with both methods, but the magnitude of errors is significantly larger for the NMC method. Moreover it is interesting to mention that the NMC method produces a second error maximum near the top of the Planetary Boundary Layer, which doesn't appear when the Ensemble method is used. For temperature, the largest contribution for errors comes from the top levels and from planetary scales, for both methods. Nevertheless, when using the NMC method, the standard deviation of temperature background errors shows a second maximum above the tropopause level, which comes from synoptic scales. The Ensemble method doesn't produce this second maximum.

For surface pressure, the standard deviation of background errors has much larger values when computed using the NMC method than with the Ensemble method. The biggest differences occur for synoptic scales, i.e. for wavenumbers between 3 and 20.

The auto-correlation spectra were also examined for different variables. The results show that the variance of vorticity and divergence errors in the troposphere have a bigger contribution from mesoscale phenomena, when estimated by the Ensemble method than by the NMC method. This difference is stronger for the vorticity field.

The auto-correlation spectra for specific humidity show that the variance maximum is shifted towards the smaller scales in the NMC method.

In the bottom levels, for temperature, the maximum difference between the two methods occurs for synoptic scales, which are the scales that contribute most for the uncertainties in the temperature field. In the middle troposphere, the Ensemble method produces a broader spectra for temperature errors than NMC method. This means that, with the NMC method, the error variance is increased in the synoptic scales, but decreased in meso and in planetary scales. In the tropopause and in stratospheric levels, the maximum variance of temperature error is shifted towards smaller scales when the NMC method is used.

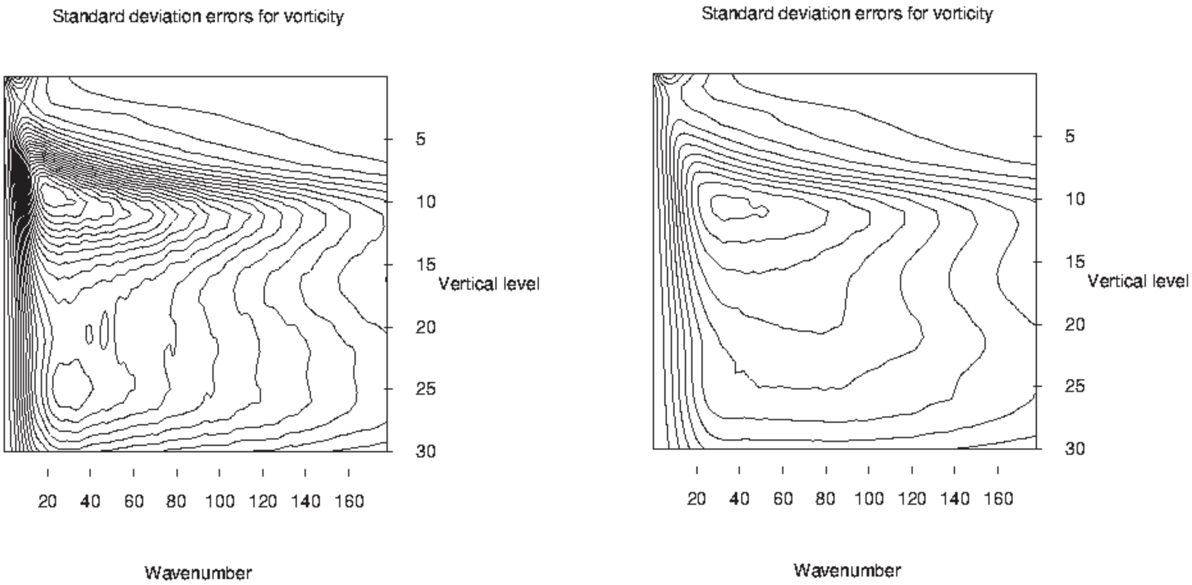

Figure 1. Standard deviation of vorticity background error as a function of model level and horizontal wavenumber, using the NMC method (left side) and the Ensemble method (right side). Isoline spacing is 0.15, starting at 0.15.

The mean vertical correlations, as functions of the horizontal wavenumber, were also analysed. The results show that the Ensemble method produces much sharper vertical correlations for the largest scales (for wavenumbers smaller than 30) than the NMC method. This result is in accordance with those obtained at ECMWF (Fisher, 1999).

Figure 2 shows the mean horizontal correlations for specific humidity at level 20 (700 hPa). When the Ensemble method is used the correlations are sharper than with the NMC method. This result is valid also for surface pressure.

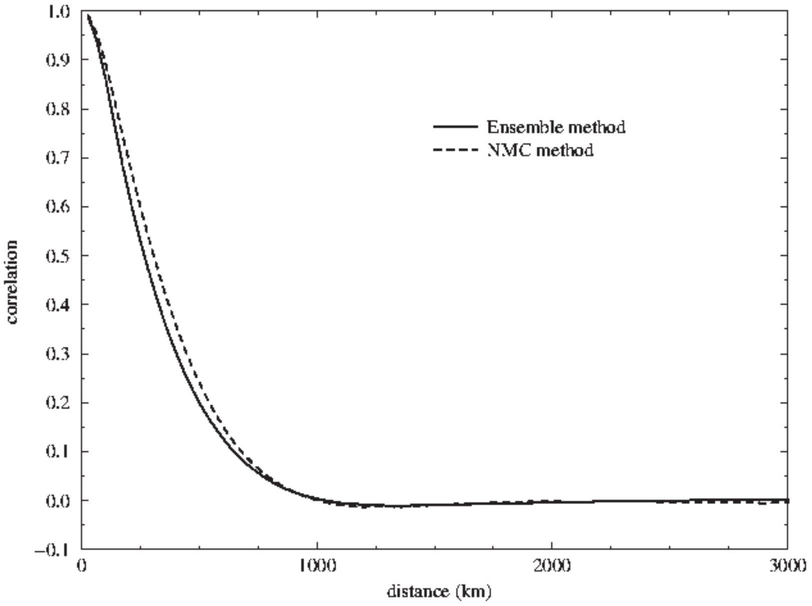

Figure 2. Horizontal correlation for specific humidity at level 20 (700 hPa).

References

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