Pre-Operational trials of the new Met Office Global NWP Model

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In spring 2002 the Met Office is planning to update the formulation of the Unified Model which is used for both global and mesoscale NWP. The formulation changes include both a new dynamical core for the model (Cullen *et al* (1997), (see also article by Davies et al in this issue)) and a new package of parametrizations.

The current dynamics is a split-explicit scheme consisting of a forward-backward scheme for the adjustment steps and a Heun scheme for advection. This is being replaced by a semi-implicit, semi-Lagrangian formulation. The new model is also non-hydrostatic with height as the vertical coordinate and has a changed horizontal and vertical grid staggering. In the vertical a Charney-Phillips grid staggering is used i.e. potential temperature and vertical velocity are now on the same half levels whereas everything else is held on the full levels. An Awakawa C grid staggering is utilised in the horizontal.

In addition to the new dynamical core many of the physical parametrizations are either new or have been reformulated. There is a new radiation scheme (Edwards and Slingo (1996)), based on the two-stream equations in both the long-wave and short-wave spectral regions. A new boundary layer scheme has also been introduced into the model (Lock *et al* (2000)) and allows for non-local mixing in unstable regimes, and a cloud microphysical scheme with prognostic ice has been introduced (Wilson and Ballard (1999)). The convection scheme is modified to take into account the changes in the boundary layer scheme and also to include a new scheme for shallow convection. The new model takes advantage of the more accurate GLOBE orography dataset and the gravity wave drag scheme has been reformulated and includes a flow blocking scheme.

A comprehensive set of trials have been carried out to compare the performance of the new model (NM) to that of the current operational global NWP model (OP). In general the NH RMS errors against observations in the NM have been reduced versus the OP model by up to 5%. Long standing systematic biases have been reduced, such as the tropospheric cold bias.The NM shows a marked reduction in numerical noise especially within strong jets near the pole. This reduction can be attributed to the semi-implicit time-stepping.

One area of increasing focus for current NWP forecast models is their ability to forecast extreme events successfully. Two examples are presented in this report. The first is the French storm of 12UTC 27/12/1999 (Figure 1(a)). The NM forecast cyclone at T+72 is significantly deeper (8hPa) than the OP model and has a structure and position much closer to the analysis. Tropical cyclones are also consistently improved with the NM. Statistics calculated over a large number of tropical cyclones shows that the NM is better able to maintain the intensity of the cyclones over the forecast period (Fig. 1(b)) compared to the OP model. The NM also shows on average a 5% improvement in skill predicting the track of the tropical cyclones. One possible reason for this improvement in the prediction of extreme events is that the NM requires significantly less horizontal numerical diffusion than the OP model in order to maintain stability. The new modelling system includes options for idealised studies of the dynamical core and a single column version of the physical parameterizations. Versions still under development include a climate configuration (HadGEM) and a portable version.

References

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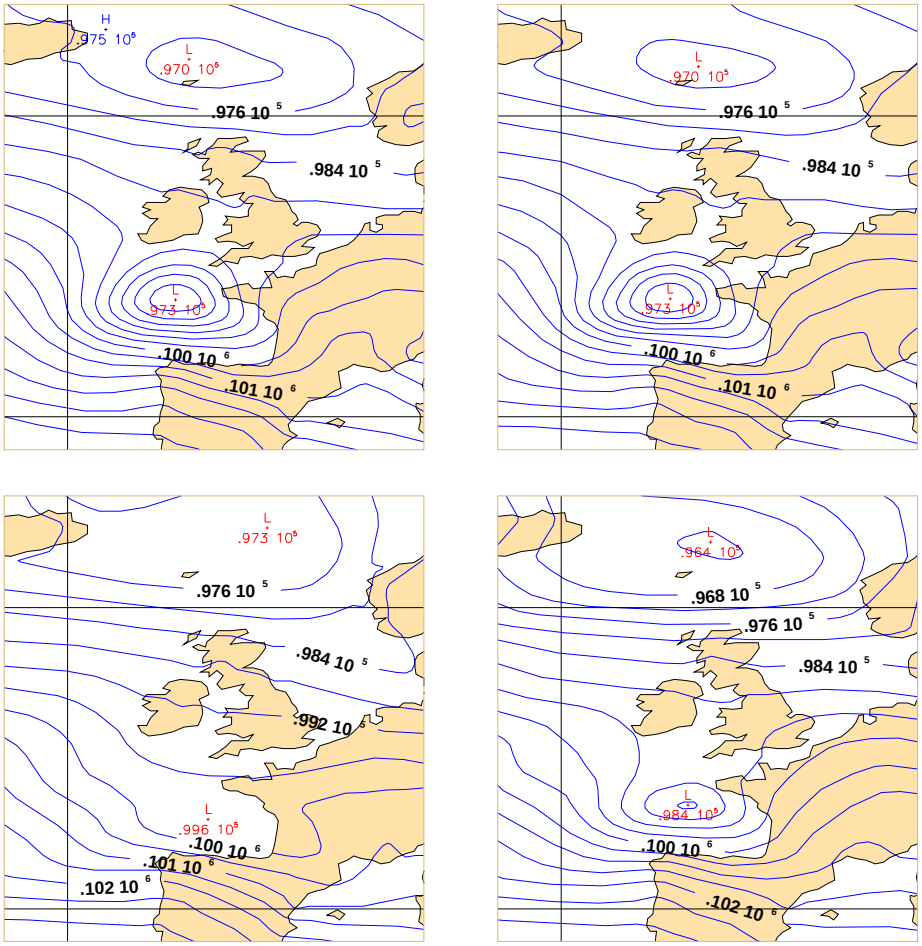
(a)



(b)

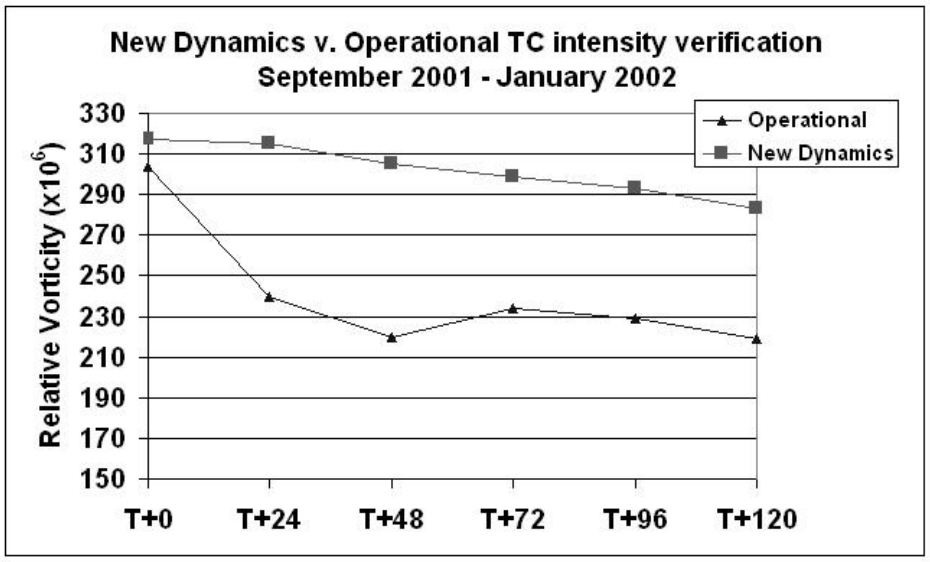


Figure 1: (a) the French storm of 12UTC 27/12/1999. Top left and top right are shown the operational (OP) and new model (NM) analysis respectively. Bottom left and bottom right are shown the OP and NM forecasts at T+72. The NM forecast is 8hPa deeper and has a superior structure. (b) Tropical cyclone verification statistics for Sep 2001 to Jan 2002. The new model (NM) maintains more intense TC throughout the forecast period. Note new dynamics in the plot is equivalent to the new model described in the text.