Extended configuration of the Met Office Unified Model.

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The Met Office Unified Model (UM) (Cullen 1993) is used for atmospheric modelling on timescales ranging from hours for weather forecasting to centuries for climate prediction. We describe developments of a vertically extended version of this model.

New dynamical core.

The new dynamical core (Staniforth et al 2001) improves on the continuous equations used in the previous model (White and Bromley 1995) by including acceleration (Dw/Dt) in the vertical momentum equation. Solutions are obtained using a semi-implicit 2 time-level approach and advection is carried out by a 3D Semi-Lagrangian scheme. This new version of the UM runs on an Arakawa C grid in the horizontal and a Charney-Phillips grid on a height-based coordinate in the vertical (Cullen et al. 1997). See Davies et al (this report) for further details. The choice of levels for an extended model was constrained by computing costs incurred by including extra levels to span the stratosphere and a requirement that lower levels coincide with levels in the tropospheric model to allow clear intercomparisons and use of the same parametrizations. A 50-level model that meets these requirements is being tested. Consecutive levels in the lower stratosphere are just over 1km apart. This increases with height to around 5km near the model top at 63km, in the lower mesosphere.

The upper panels in Fig.1 show winds from the 50-level model with the same parametrizations as used for tropospheric modelling. The basic stratospheric annual cycle is reproduced but stratospheric winds are overestimated and do not show the observed upper stratospheric maxima. The tropical winds are in more serious error. Fig.2 (upper) shows evidence of a semi-annual oscillation (SAO) but with a strong easterly bias and the quasi-biennial oscillation (QBO) is absent from this integration.

Updated physical parametrizations.

Including a version of the Ultra Simple Spectral Parameterization for gravity waves (Warner and McIntyre 2001) was previously shown to improve the middle atmosphere version of this model (Scaife et al 2000, 2002). Fig.1 shows that a similar experiment for the 50-level model alleviates biases in upper level winds. Resulting winds have reasonable strength, especially if all remaining momentum flux from the spectral gravity wave parametrization is dissipated in the top model layer (as might be expected given the downward control theory of Haynes et al (1991)). The tropical stratosphere in the model is greatly improved (Fig.2) with a realistic looking QBO and improvement in the SAO (c.f. Scaife et al 2002). Nevertheless, upper level easterly biases remain in the tropics and winter jets do not tilt far enough towards the equator.

Other horizontal resolutions are being investigated and the 50-level model will be tested for possible use in operational forecasting and climate prediction work.

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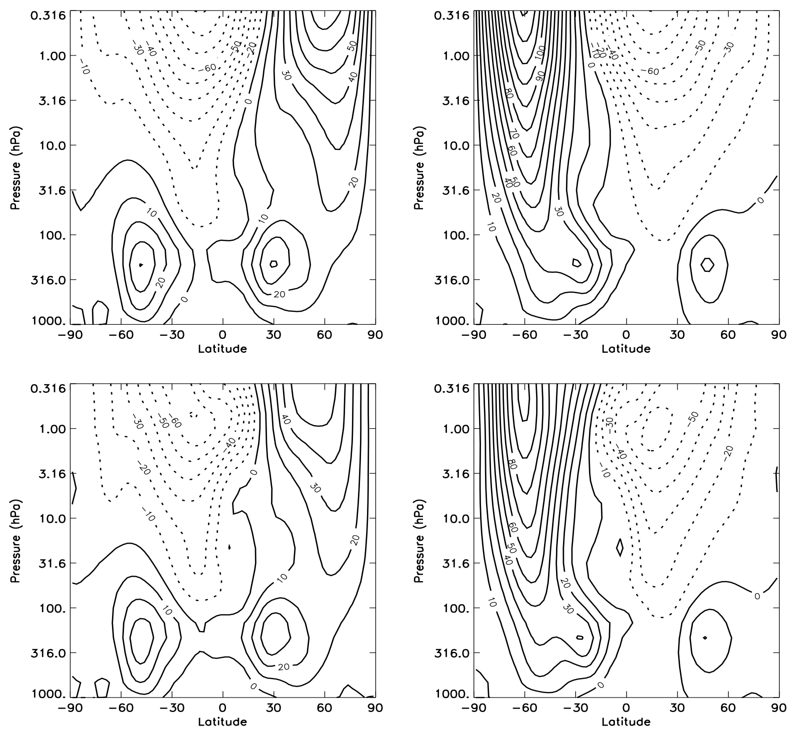

Figure 1: Zonal wind for January (left) and July (right) for the N48L50 model with the new dynamical core (upper) and new dynamical core plus improved parametrizations (lower). (N48=>96x73 lat-lon grid)

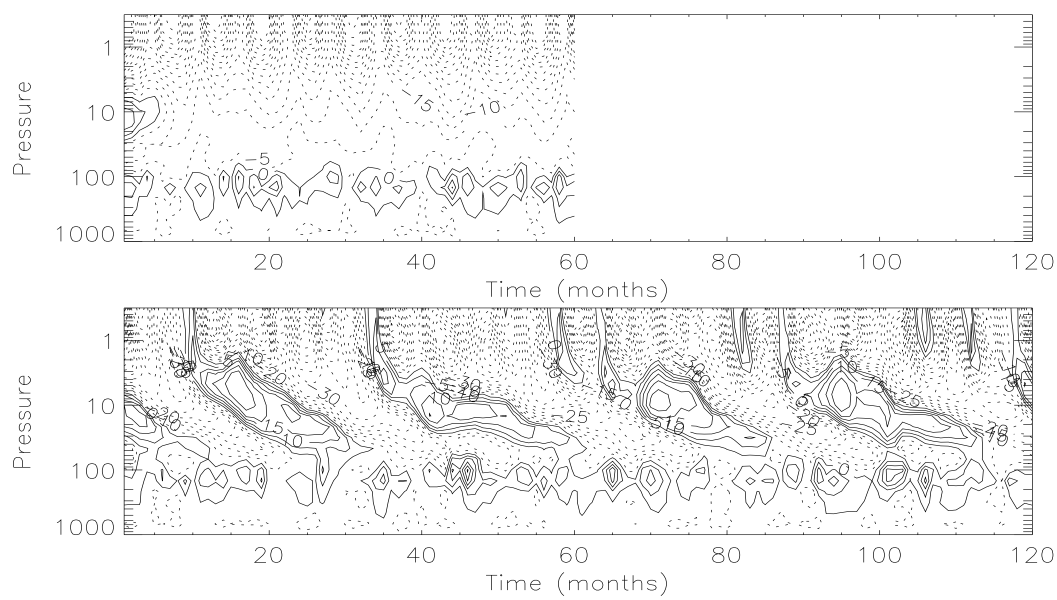

Figure 2: Zonal wind over the equator for the N48L50 model with the new dynamical core (upper) and new dynamical core plus improved parametrizations (lower).