The direct modelling of subgrid-scale stresses and its relevance for medium range weather prediction.

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Numerical noise arising in particular from the pressure gradient term in the momentum equation has been systematically eliminated in ECMWF's integrated forecasting system (IFS) by a new de-aliasing filter. The filter effectively controls the accumulation of energy/enstrophy at the smallest resolved scales. It has been found that the strong linear horizontal diffusion (on both vorticity and divergence) previously applied to counter the aliasing may now be relaxed and potentially replaced by a more physically based subgrid-scale (SGS) model. The latter is motivated by the experience in turbulence simulation and theory, that the SGS stress tensor does not exist purely to model the non-represented effects of the subgrid scales, but rather exists as a result of the formal filtering of the equations with contributions of both resolved and unresolved scales. So far, the latter has been neglected in global numerical weather prediction (NWP) other than in the vertical direction via phenomenological parametrizations. The justification for this neglect is reassessed with horizontal resolutions O(10km). A mixed model is applied with a dynamic procedure to establish the appropriate similarity coefficients. The effect of non-linear interactions not represented on the grid are modelled in EULAG by the virtues of the monotonically integrated large-eddy simulation (MILES). In spectral models (such as IFS), a spectral viscosity regularisation may be conveniently applied instead. The effect of the spectral SGS model is compared with MPDATA based ILES for an idealised dry convective boundary layer. Finally, the magnitudes of the contributions from the inclusion of a dynamic similarity model are compared to the corresponding increments from physical parameterisations, and its potential for contemporary NWP and climate simulations, as well as for stochastic-dynamic modelling of ensemble prediction systems is tested.