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Forecasting the weather
- ensemble techniques
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Aspects of physics-dynamics coupling in the UK Met Office's Unified Model (MetUM)

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Abstract

In numerical weather prediction and climate simulation models there has traditionally been a split between the resolved fluid-dynamical processes (referred to as the "dynamics") and the unresolved fluid-dynamical processes and non-fluid dynamical aspects (collectively referred to as the "physics"). Whilst each of these parts of the flow have received considerable attention the coupling between them has received only minor attention. However, the methods used for the coupling can determine the overall accuracy of the model. This becomes especially important with the large time steps permitted in a semi-implicit semi-Lagrangian model. For this reason, and in contrast to most other operational models, both the Met Office and ECMWF use a sophisticated coupling between the dynamics and the physics. This is achieved by first associating different time scales to each physical process (typically categorizing them as either "slow" or "fast" physics) and then coupling them in different ways (either in parallel or sequentially). Both practical results and analysis have shown the benefits of this form of coupling, e.g. good maintenance of balance and reduction of the splitting error.

At the Met Office we have been developing and experimenting with the next version of the MetUM's dynamical core (ENDGame: Even Newer Dynamics for General Atmospheric Modelling of the Environment). An important aspect of this dynamical core, distinct from the current New Dynamics dynamical core, is that it uses an iterative approach to solving the SISL equations. This then raises the question as to how the tight coupling applied in the current version of the model should be extended to the new version and whether any additional benefit can be achieved from the iterative nature of the solution over and above that obtained for the dynamics.

The basic ENDGame formulation will be presented and then aspects of the physics-dynamics coupling will be discussed. In particular, analysis of an idealised coupled equation set will be presented alongside numerical experimentation.