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Efficient modelling of overflows using dynamically-adaptive meshing

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Overflow processes play an important role in the evolution of the global thermohaline circulation, supplying much of the source waters for the deep and intermediate water masses in the ocean. When water from marginal seas enters the open ocean, it flows down and along the continental slope due to differences in buoyancy and the effects of rotation. Turbulent eddies form in the wake of the head due to both Kelvin-Helmholtz and barolinic instabilities, though the resultant rates of diapycnal mixing with the ambient fluid remain poorly understood.

Many of the critical mixing and entrainment processes take place at small scales and thus, in order to properly represent overflows, numerical models need the ability to resolve both on the small scale (in the order of 1km or less) as well as on the basin scale. In reality this level of resolution needed is almost impossible to achieve with conventional techniques, and so previously parameterisations of sub-grid scale processes have been employed.

In this paper, preliminary results will be presented from simulations of an idealised overflow using a new finite-element ocean model with an unstructured, dynamically-adaptive mesh. This model not only focuses resolution in locations of particular dynamical interest (such as regions of intense mixing), but also adapts the mesh in response to evolving flow structures as the simulation proceeds. Our preliminary results compare favourably with those obtained using more conventional methods, though at a fraction of the computational overhead.