Validation of the Imperial College Ocean Model with a wind-driven baroclinic gyre

S.C. Kramer[1], **M.D. Piggott**[1,2], **R.B. Nelson**[1], **D.A. Ham**[1,2], **C.J. Cotter**[3], **P.E. Farrell**[1], **G.J. Gorman**[1] and **C.C. Pain**[1]

[1]Applied Modelling and Computation Group
Department of Earth Science and Engineering, Imperial College London
South Kensington Campus, London, SW7 2AZ, UK
s.kramer@imperial.ac.uk

[2]Grantham Institute for Climate Change, Imperial College London
South Kensington Campus, London, SW7 2AZ, UK

[3]Department of Aeronautics, Imperial College London
South Kensington Campus, London, SW7 2AZ, UK

The Imperial College Ocean Model [Piggott *et al.* , 2008] is a fully unstructured, mesh-adaptive, non-hydrostatic ocean model. A key advantage of mesh adaptivity is that the flexibility provided by unstructured meshes to focus resolution where needed, is enhanced by enabling this focus to follow the dynamic features of the flow. The mesh adaptive technology of ICOM has already been applied succesfully to many smaller scale process studies in geophysical fluid dynamics, as well as larger scale barotropic problems. Several challenges encountered in the use of ICOM in a wider range of oceanographic applications, have been met with the development of new numerical techniques, such as the ability to conservatively interpolate between the subsequently adapted meshes [Farrell *et al.* , 2009], without violating boundedness and introducing too much diffusion, and a novel algebraic multigrid method [Kramer *et al.* , 2010] to deal with the ill-conditioning of large aspect ratio problems.

In this contribution the application of ICOM to an important large scale oceanographic problem, in the form of a wind-driven, baroclinic double gyre is studied. The results are compared with that of two other, more traditional ocean models, the widely used MITgcm and NEMO. This study will provide validation of ICOM and is a major step towards application of ICOM in larger scale ocean applications with full baroclinic dynamics. A comparison will be made based on the main statistics of the flow fields, velocity, pressure, free surface and temperature, the turbulent bifurcation behaviour, and water mass mixing statistics to investigate the models' ability to maintain stratification. Although the simplified geometry does not necessarily bring out the main advantages of unstructured and adaptive mesh technology, a comparison is also made in computational efficiency and in particular parallel scaling.

References

M.D. Piggott, G.J. Gorman, C.C. Pain, P.A. Allison, A.S. Candy, B.T. Martin and W.R. Wells, "A new computational framework for multi-scale ocean modelling based on adapting unstructured meshes", *International Journal for Numerical Methods in Fluids*, vol. 56, pp. 1003–1015, 2008

P.E. Farrell, M.D. Piggott, C.C. Pain, G.J. Gorman and C.R. Wilson "Conservative interpolation between unstructured meshes via supermesh construction" *Computer Methods in Applied Mechanics and Engineering*, vol. 198, pp. 2632–2642, 2009

S.C. Kramer, C.J. Cotter and C.C. Pain, "Solving the Poisson equation on small aspect ratio domains using unstructured meshes", submitted to *Ocean Modelling*, 2010