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Preface

Special Issue: The third international workshop on unstructured mesh numerical modelling of coastal, shelf and ocean flows Toulouse, France, September 20–September 22, 2004

The last few years have witnessed the increasing recognition of the importance of the new generation of unstructured mesh models. The inherent geometric flexibility of unstructured mesh numerical models offers distinct advantages for oceanic simulations at various spatial and temporal scales. Chief among these are a faithful and efficient representation of the complex coastlines and topography, and a variable resolution grid that can be adapted to capture evolving critical dynamical features. Building on the recent progress in finite element and finite volume flow solvers, a number of research groups have embarked on a journey to develop unstructured mesh ocean models aimed at simulating basin, coastal and estuarine flows. A series of now annual workshops has served as a forum for developers and users to discuss common issues, share ideas and collaborate on model development and applications. These workshops are unique in that, oceanographic and engineering groups, with complementary expertise exchange ideas and experience openly, and in the same spirit as the 2002 founding workshop. The success of the series of workshops held in Louvain la Neuve, Delft, Toulouse and Bremerhaven is evident and many more participants are expected at the upcoming workshop to be held in Miami in November 2006.

This volume publishes eight papers from the workshop held in Toulouse 20, 21 and 22 September, 2004. The diversity of papers totalling 31 talks and discussion groups, was aided by the beautiful surroundings and lengthy lunch breaks which provided ample opportunity for discussions. The increasing recognition of the advantages of the unstructured mesh approach, not only for coastal and shelf but also for open ocean dynamics, is evident; the European efforts around ICOM; SLIM, UnTrim, FEOM, Delfin, Finlab, HUGO-m, the American efforts around SEOM, ADCIRC, ELCIRC/SELFE, SUNTANS as well as many other international efforts such as RiCOM. The growing list of coastal systems based on these models, attests to the growing importance and maturing of this new generation of unstructured mesh models. For example the new German-Indonesian tsunami warning system; the Gulf of Mexico flooding system; new Dutch coastal flooding systems, New Zealand tsunami models, the French Amazonian shelf and estuary dynamics project and new Canadian Artic Archipelago applications all demonstrate the advantages of mesh flexibility and the importance of resolving coastlines and islands at high resolution.

The unstructured mesh approach can easily accommodate a vast variety of numerical schemes, such as the finite elements with Continuous Galerkin or Discontinuous Galerkin schemes, finite volumes schemes, as well as an unlimited range of higher order schemes. Moreover, it allows the flexibility of mixing different numerical schemes and their order in the same model. The geometric and numerical flexibility of the unstructured mesh approach is illustrated by the present developments, such as the mesh adaptivity and the temporal sub-cycling. A wide range of new techniques are being assessed and used, both with respect to hydrodynamic modeling as well as for data assimilation. At the price of a preliminary higher complexity, the unstructured mesh approach

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offers to the modellers a nearly unlimited choice for their model design and the ability to select numerical solutions appropriate for different classes of problems.

The papers presented here cover some of the topics presented at the workshop (see http://www.legos.obs-mip.fr/evenements/colloques/fe_fv). Several authors discuss the advantages and challenges of mesh adaptivity: Powers et al., Adjoint goal-based error norms for adaptive mesh ocean modeling; Fang et al., An adaptive mesh adjoint data assimilation method and a novel implementation of the Mellor-Yamada level 2.5 turbulence closure scheme by Hanet et al. who present an adaptive FE water column model. The advantages of continuous and discontinuous finite element are explored in Levin et al. To Continue or Discontinue: Comparisons of Continuous and Discontinuous Galerkin Formulations in a Spectral Element Ocean Model. While Kubatko et al. demonstrate the advantages of the discontinuous Galerkin method in an unstructured grid morphodynamic model with bed evolution. The potential for unstructured grid tsunami warning systems for New Zealand is demonstrated by Walters in his paper on Design Considerations for a FE coastal ocean model. Test cases and a discussion of FE methods are presented in: Laurent White A one dimensional benchmark for the propagation of Poincare waves. Finally Kliem et al. (Evaluation of a shallow water unstructured mesh model for the North Sea–Baltic Sea) validate their finite element model against tidal observations.

We would like to thank Ocean Modeling for the continued interest in and support of our activities. We would also like to thank the reviewers for their excellent work and their time. We hope that the special issue will continue to excite the interest of other groups.

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