8th. World Congress on Computational Mechanics (WCCM8)
5th. European Congress on Computational Methods in Applied Sciences and Engineering (ECCOMAS 2008)
June 30 – July 5, 2008
Venice, Italy

Large scale simulations of air/water free interface

F.Xiao[1,2] , S.Yamashita[2] , C.G.Chen[2*], K.Takahashi[3]

[1]Institute of Mechanics, Chinese Academy of Sciences No. 15 Beisuhuanxi road, 100080, Beijing, China (E-mail: xiao@imech.ac.cn)
[2]Department of energy sciences, Tokyo Institute of Technology, 4259 Nagatsuta, Midori-ku, Yokohama, 226-8502, Japan
[3]The Earth Simulator Center, 3173-25 Showamachi, Kanazawa-ku, Yokohama, Japan

Key Words: *Free interface, large scale simulation, parallel computing, multi-phase flow, air-sea interaction.*

ABSTRACT

We have recently constructed a numerical model for large scale direct simulations of the interactions between air and water across free interfaces which may be largely deformed and experience topologically changes, such as breaking and merging. The numerical model is designed so as to make full use of the capacity of the hardwares of two top-ranked supercomputer systems with distributed memory architecture.

Computational efficiency has been emphasized. An algebraic front capturing scheme is employed to compute the moving interface between different fluids, and the dynamics of different fluids is formulated by using a unified framework for incompressible flow. A multi-moment finite volume method for spatial discretization is incorporated into a projection procedure to solve incompressible flows of variable density and viscosity, which results in a pressure Poisson equation having large discontinuities and singularities in the coefficients and the source term. An algebraic multigrid (AMG) method is used as the preconditioner of a conjugate gradient method to solve the Poisson equation that shows a satisfactory scalability in terms of both the parallel speedup rate and the size of the problem. Some other efforts have been also made to achieve high computational performance on the Earth Simulator at Earth simulator research center and the TSUBAME supercomputer system at Tokyo Institute of Technology.