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Integrated high performance computational tools for simulations of transport and diffusion of contaminants in urban areas. (English) Zbl 1187.86002

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Summary: Rapid analysis of transport and diffusion of chemical and biological aerosols and contaminants in an urban environment is a critical part of any homeland security response team. High performance computing (HPC) is a valuable technique for such analysis. The time constraint needed to create fully developed complex 3D city terrain models to support such dispersion simulations requires a task of converting agency data to the format necessary on the simulation platform. Numerous data sets have been employed in the development of complex 3D city models. Such data include the use of multi-layer building morphology data, the use of geographic information system (GIS) based shapefiles and digital elevation models (DEM), and the use of remote sensing data such as Light Detection and Ranging (LIDAR). The constructed geometry models are used to generate large-scale computational domains on a platform that supports our HPC tools. These tools include fully automated unstructured mesh generation, parallel and scalable flow solvers based on stabilized finite element formulations and a remote client-server environment for large-scale flow visualization. The stabilized finite element formulations, which are based on the SUPG and PSPG techniques, are parallelized and vectorized on the Cray X1. The 3D validation problem involves transient simulation of flow past a building with a source point releasing traces. A 3D application problem is presented to demonstrate the capability of the integrated HPC tools.

MSC:

86-08 Computational methods for problems pertaining to geophysics
76M10 Finite element methods applied to problems in fluid mechanics
76R50 Diffusion

Keywords:

light detection and ranging (LIDAR); high performance computing; biological aerosol; CRAY X1; finite element method; transport and diffusion

Full Text: DOI

References:

[1] DOI: 10.1002/fld.1650211003 · Zbl 0862.76033 · doi:10.1002/fld.1650211003

[2] DOI: 10.1016/S0045-7825(00)00200-0 · Zbl 0994.76050 · doi:10.1016/S0045-7825(00)00200-0

[3] DOI: 10.1002/cnm.469 · Zbl 1001.76052 · doi:10.1002/cnm.469

[4] DOI: 10.1002/fld.459 · Zbl 1107.76344 · doi:10.1002/fld.459

[5] DOI: 10.1002/cnm.594 · Zbl 1069.76028 · doi:10.1002/cnm.594

[6] Aliabadi, S., Johnson, A., Abedi, J., Tu, S. and Tate, A., High performance simulation of contaminant dispersion on the Cray X1: verification and implementation. accepted in the J. Aerospace Eng. Comput. Inf. Comm.

[7] DOI: 10.1016/0021-9991(73)90147-2 · Zbl 0251.76004 · doi:10.1016/0021-9991(73)90147-2

[8] DOI: 10.1109/5992.988644 · Zbl 05091830 · doi:10.1109/5992.988644

[9] Brown, M.J., Burian, S.J., Linger, S., Velugubantla, S.P. and Ratti, C., An overview of building morphological characteristics derived from 3D building datasets, the Fourth Symposium on the Urban Environment 2003.

[10] Burian, S.J., Brown, M.J. and Velugubantla, S.P., Building height characteristics in three US cities, the Fourth Symposium on the Urban Environment 2003.

[11] Cybyk, B.Z., Boris, J.P., Young, T.R., Landsberg, A.M. and Lind, C.A., A complex-geometry CFD model for chemical/biological contaminant transport problem, 1999 DoD HPC Users Group Conference, Monterey, CA, June 7–10 1999.

[12] DOI: 10.1175/1520-0450-30.7.1005· doi:10.1175/1520-0450-30.7.1005

[13] DOI: 10.1016/0045-7825(91)90009-U · Zbl 0760.76070 · doi:10.1016/0045-7825(91)90009-U

[14] DOI: 10.1016/0045-7825(95)00988-4 · Zbl 0895.76046 · doi:10.1016/0045-7825(95)00988-4

[15] Kato C., Advances in Numerical Simulation of Turbulent Flows 117 pp 49– (1991)

[16] Koomullil, R. and Soni, B., Wind field simulations in urban areas, AIAA Paper 2001–2621

[17] DOI: 10.1017/S0022112072001855· doi:10.1017/S0022112072001855

[18] DOI: 10.1016/0167-6105(87)90023-7· doi:10.1016/0167-6105(87)90023-7

[19] Reisner, J., Smith, W., Bossert, J. and Winterkamp, J., Tracer modeling in an urban environment, AMS 2nd Urban Environment Symposium, Albuquerque, NM 1998.

[20] Reisner, J., Smith, S., DeCorix, D., Langley, D. and Brown, M., High fidelity urban scale modeling, Los Alamos National Laboratory Technical Report, LA-UR-01-1422, 2001.

[21] DOI: 10.1137/0907058 · Zbl 0599.65018 · doi:10.1137/0907058

[22] DOI: 10.1016/S1352-2310(01)00177-7· doi:10.1016/S1352-2310(01)00177-7

[23] Snyder W.H., Stably Stratified Flows: Flow and Dispersion over Topography pp 310– (1994)

[24] DOI: 10.1016/1352-2310(95)00326-6· doi:10.1016/1352-2310(95)00326-6