

Premier implementation of GRAPES-GLB on Sunway Taihu Light

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GRAPES (Global/Regional Assimilation and Prediction System)-GLB is the operational weather prediction global model of China Meteorological Administration (CMA). Sunway Taihu Light is a heterogeneous many-core supercomputer system made in China. The parallel processing of GRAPES-GLB bases on MPI and OpenMP, Sunway Taihu Light supports MPI, OpenACC and A-thread but not OpenMP. To keep the code readable and portable, openACC was adopted as programming model in most cases. This paper mainly presents the efforts exploring the performance of GRAPES-GLB on Sunway Taihu Light and some hot spots of dynamic core, including Piecewise Rational Method for water vapor advection and semi Lagrange advection computations will be described in detail, and premier test results will be presented.

An ultra-scalable implicit solver is developed for GRAPES-GLB. In the solver, we propose a highly efficient hybrid domain-decomposed preconditioner that can greatly accelerate the convergence rate at the extreme scale. For solving the overlapped subdomain problems, a geometry-based pipelined incomplete LU factorization method is designed to further exploit the on-chip fine-grained concurrency. We perform systematic optimizations on different hardware levels to achieve best utilization of the heterogeneous computing units and substantial reduction of data movement cost. The implicit solver successfully scales to half system of the Sunway Taihu Light supercomputer with over 6M heterogeneous cores, and enables fast atmospheric dynamic simulations at the 10km horizontal resolution.

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