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Chinese Research Team that Employs High Performance Computing to Understand Weather Patterns Wins 2016 ACM Gordon Bell Prize

Salt Lake City, Utah, November 17, 2016 – ACM, the world's leading professional computing society (www.acm.org), has named a 12-member Chinese team the recipients of the 2016 ACM Gordon Bell Prize for their research project, "10M-Core Scalable Fully-Implicit Solver for Nonhydrostatic Atmospheric Dynamics." The winning team presented a solver (method for calculating) atmospheric dynamics. The ACM Gordon Bell Prize (awards.acm.org/bell) tracks the progress of parallel computing and rewards innovation in applying high performance computing to challenges in science, engineering, and large-scale data analytics. The award was bestowed during the International Conference for High Performance Computing, Networking, Storage and Analysis (SC16) (sc16.supercomputing.org/) in Salt Lake City, Utah.

Since the dawn of computing, scientists have used data analytics in an effort to predict and simulate the weather and related atmospheric events. In the early years of weather forecasting, scientists might have used standard central processing units (CPUs). With each passing year, the continued expansion in the capabilities of high performance computers has enabled researchers to employ increasingly sophisticated computational methods for the analysis and modeling of weather patterns. Advanced scientific computers break problems down into composite parts and perform immense amounts of mathematical calculations simultaneously. The performance of a supercomputer is measured in floating-point operations per second (FLOPS). Some of the latest supercomputers are capable of performing quadrillions of FLOPS.

In the abstract of their presentation, the winning team writes, "On the road to the seamless weather-climate prediction, a major obstacle is the difficulty of dealing with various spatial and temporal scales. The atmosphere contains time-dependent multi-scale dynamics that support a variety of wave motions."

To simulate the vast number of variables inherent in a weather system developing in the atmosphere, the winning group presents a highly scalable fully implicit solver for three-dimensional nonhydrostatic

atmospheric simulations governed by fully compressible Euler equations. Euler equations are a set of equations frequently used to understand fluid dynamics (liquids and gasses in motion).

Elaborating further, they add, "In the solver, we propose a highly efficient domain-decomposed multigrid 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."

The fully-implicit solver successfully scales to the entire system of the Sunway TaihuLight, a Chinese supercomputer with over 10.5 M heterogeneous cores, allowing for a performance of 7.95 PFLOPS in double precision. The Chinese team contends that this is the largest fully-implicit simulation to date. The Sunway TaihuLight is ranked as the fastest supercomputer in the world. It is nearly three times as fast as the Tianhe-2, the supercomputer that previously held the world record for speed.

Winning team members include Chao Yang, Chinese Academy of Sciences; Wei Xue, Tsinghua University; Haohuan Fu, Tsinghua University; Hongtao You, National Research Center of Parallel Computer Engineering and Technology; Xinliang Wang, Beijing Normal University; Yulong Ao, Chinese Academy of Sciences; Fangfang Liu, Chinese Academy of Sciences, Lin Gan, Tsinghua University; Ping Xu, Tsinghua University; Lanning Wang, Beijing Normal University; Guangwen Yang, Tsinghua University; and Weimin Zheng, Tsinghua University.

Innovations from advanced scientific computing have a far-reaching impact in many areas of science and society—from understanding the evolution of the universe and other challenges in astronomy, to complex geological phenomena, to nuclear energy research, to economic forecasting, to developing new pharmaceuticals. The annual SC conference brings together scientists, engineers and researchers from around the world for an outstanding week of technical papers, timely research posters, and tutorials.

About ACM

ACM, the Association for Computing Machinery (www.acm.org) is the world's largest educational and scientific computing society, uniting computing educators, researchers and professionals to inspire dialogue, share resources and address the field's challenges. ACM strengthens the computing profession's collective voice through strong leadership, promotion of the highest standards, and recognition of technical excellence. ACM supports the professional growth of its members by providing opportunities for life-long learning, career development, and professional networking.

About the ACM Gordon Bell Prize

The ACM Gordon Bell Prize (awards.acm.org/bell) is awarded each year to recognize outstanding achievement in high-performance computing. The purpose of this recognition is to track the progress over time of parallel computing, with particular emphasis on rewarding innovation in applying high-performance computing to

applications in science. The prize is awarded for peak performance as well as special achievements in scalability and time-to-solution on important science and engineering problems and low price/performance. Financial support for the $10,000 awards is provided by Gordon Bell, a pioneer in high-performance and parallel computing.

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