

千万核可扩展大气动力学全隐式模拟

获奖: ACM Gordon Bell Prize (“戈登•贝尔” 奖——高性能计算应用领域世界最高奖)

文献: 10M-Core Scalable Fully-Implicit Solver for Nonhydrostatic Atmospheric Dynamics, Proc. 2016 IEEE/ACM Int'l Conference for High Performance Computing, Networking, Storage and Analysis (SC'16), 2016, pp. 6:1-12.

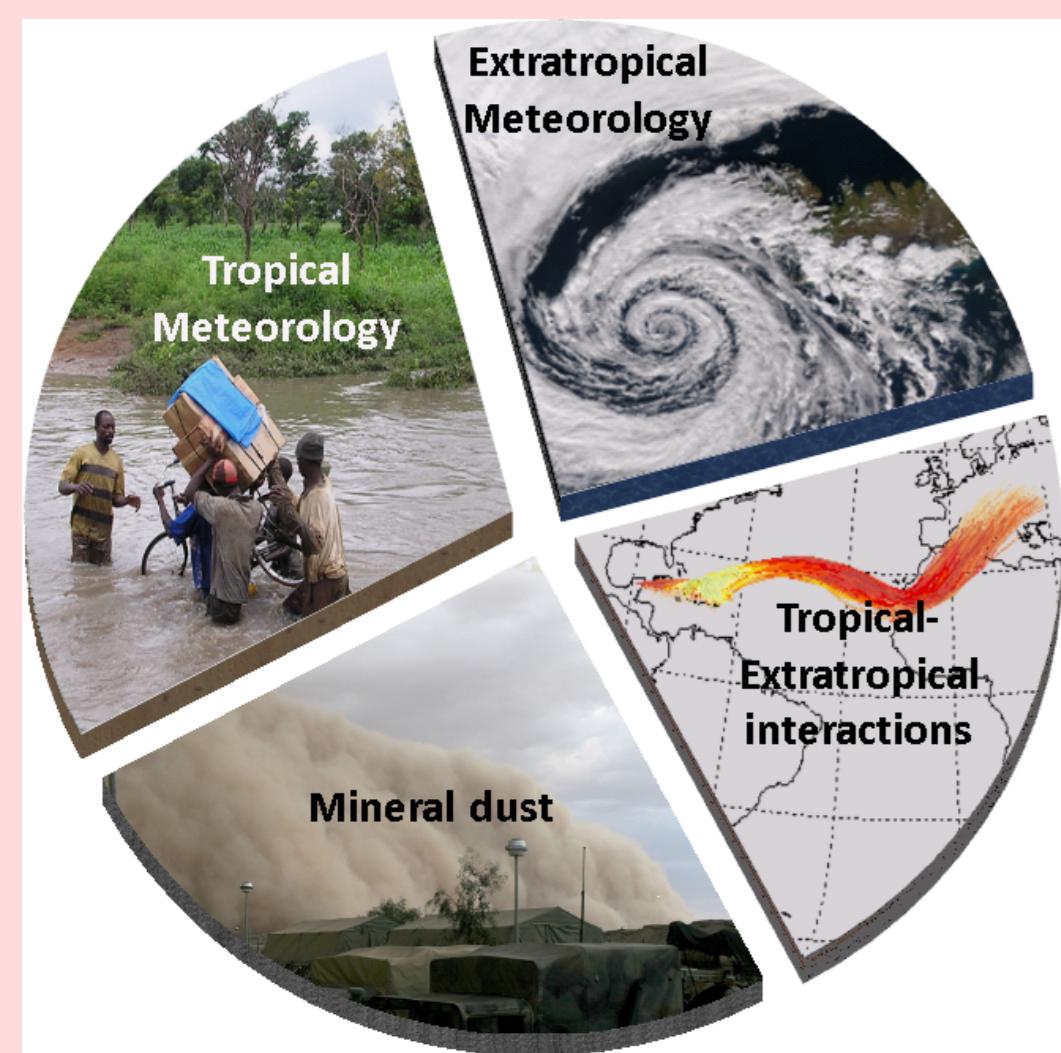
获奖者: 杨超、薛魏、付昊桓、尤洪涛、王欣亮、敖玉龙、刘芳芳、甘霖、许平、王兰宁等

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1) 背景介绍



超级计算机



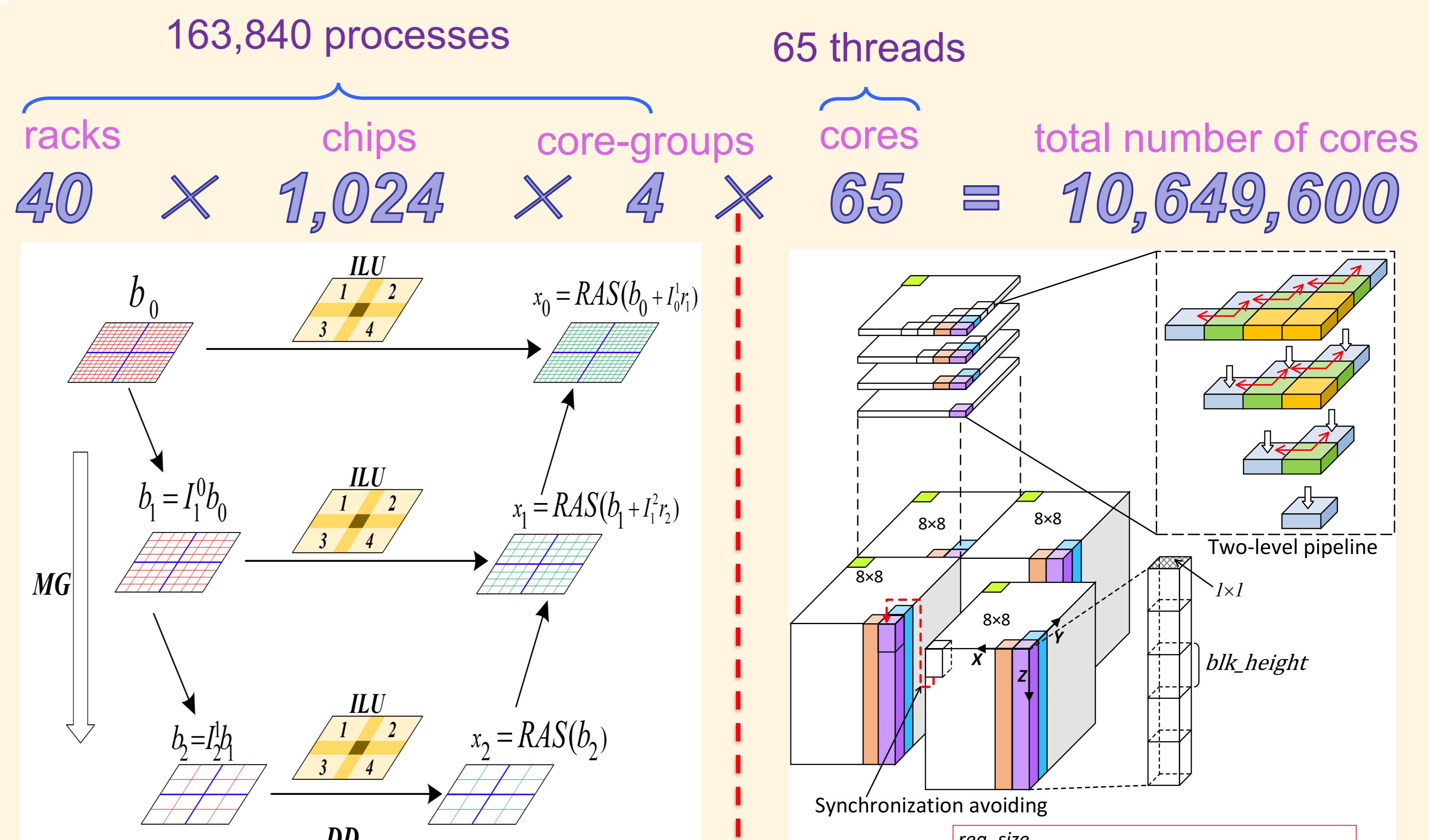
大气模拟应用

“神威•太湖之光”超级计算机，于2016年6月发布，目前排名世界第一，峰值性能125 PFLOPS，HPL性能93 PFLOPS，拥有1064万个计算核心，采用我国自主设计的申威异构众核处理器。

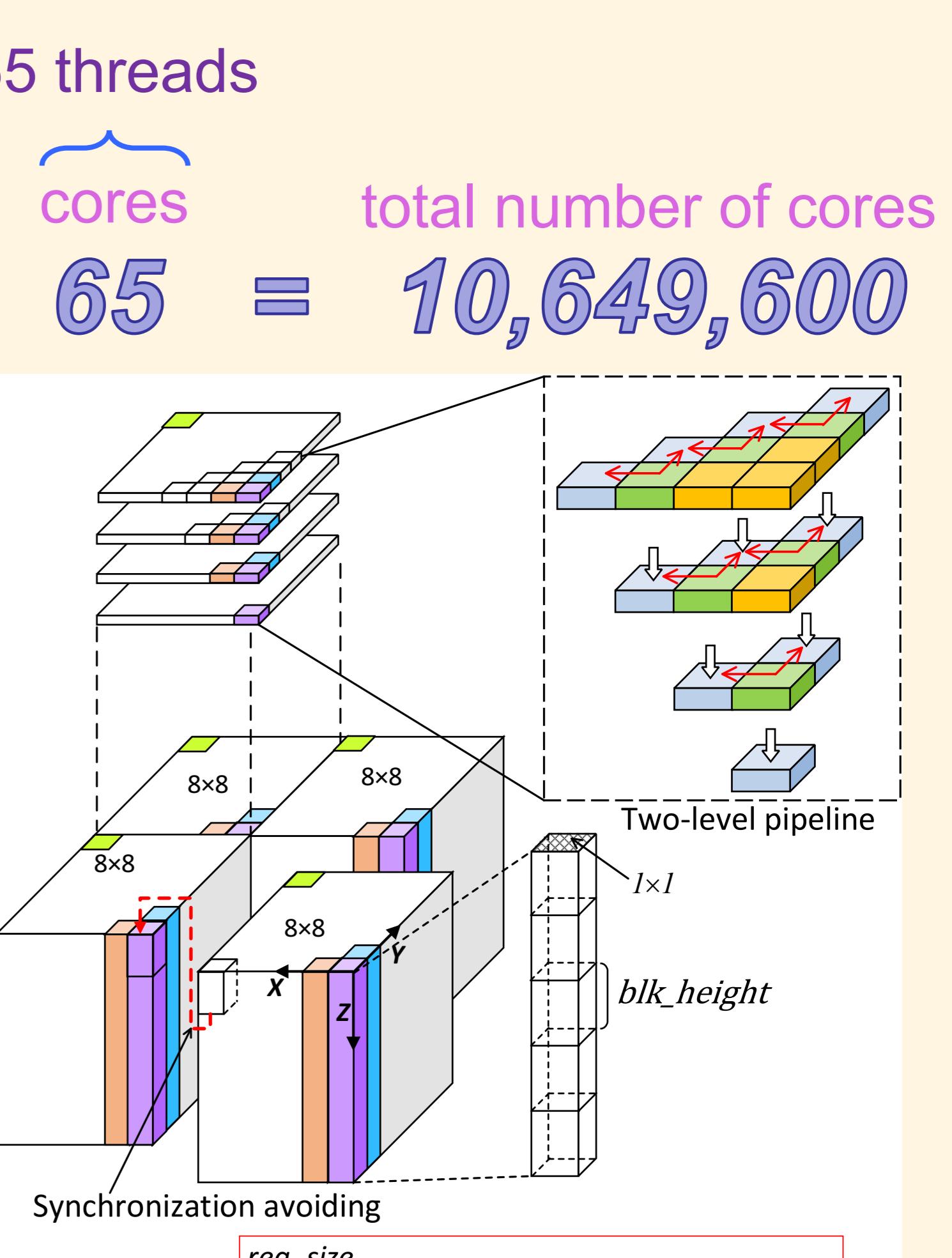


$$\begin{aligned} \frac{\partial \rho'}{\partial t} + \nabla \cdot (\rho \mathbf{v}) &= 0, & \text{Continuity equation} \\ \frac{\partial \rho \mathbf{v}}{\partial t} + \nabla \cdot (\rho \mathbf{v} \otimes \mathbf{v}) + \nabla \cdot \bar{p} + \nabla p' + \rho' g \mathbf{z} + 2\rho \Omega \times \mathbf{v} &= 0, & \text{Momentum equation} \\ \frac{\partial (\rho e_T)}{\partial t} + \nabla \cdot ((\rho e_T) \mathbf{v}) &= 0, & \text{Energy equation} \\ \frac{\partial (\rho q)}{\partial t} + \nabla \cdot (\rho q \mathbf{v}) &= 0, & \text{Moisture equation} \end{aligned}$$

2) 千万可扩展全隐式并行算法

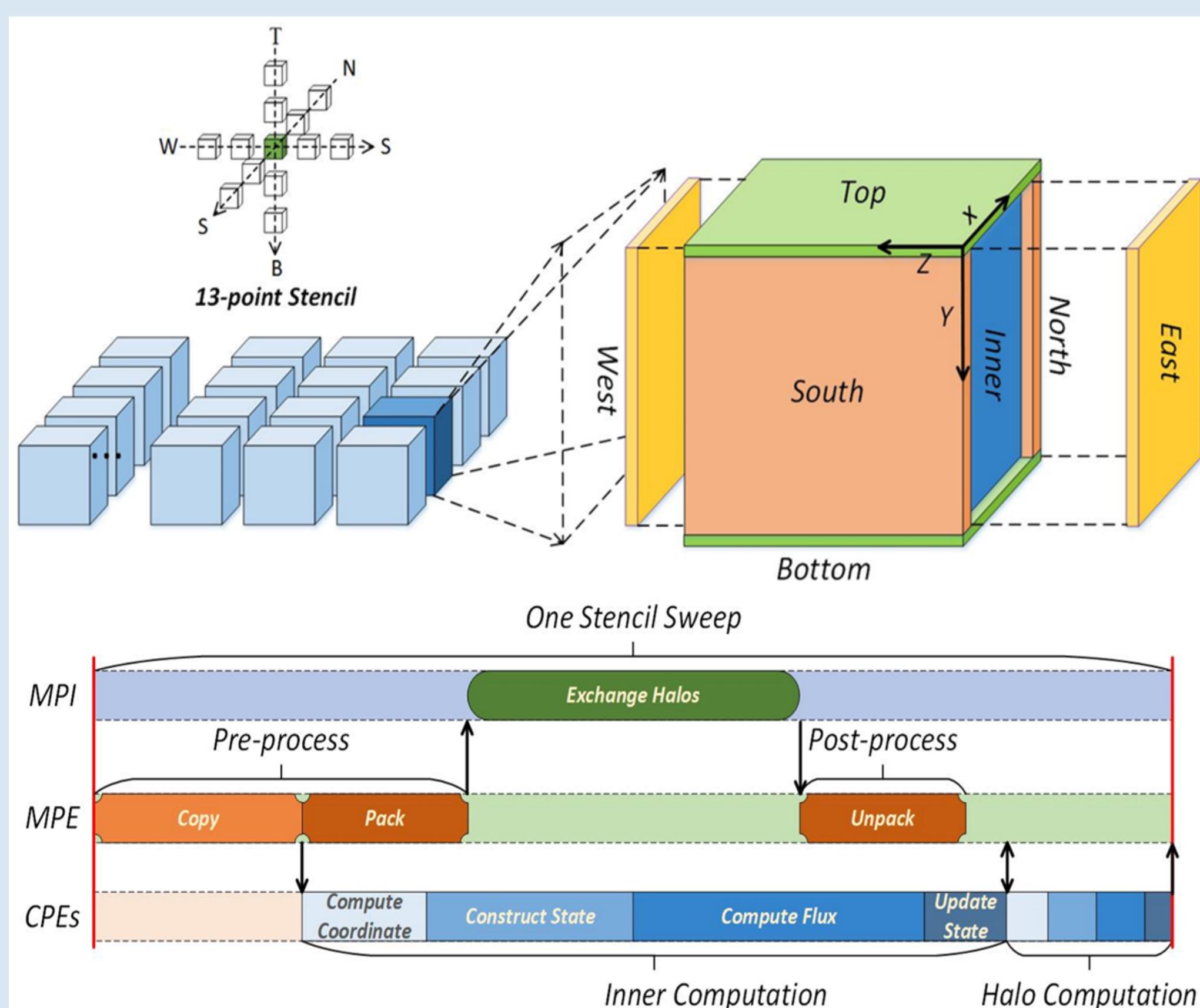
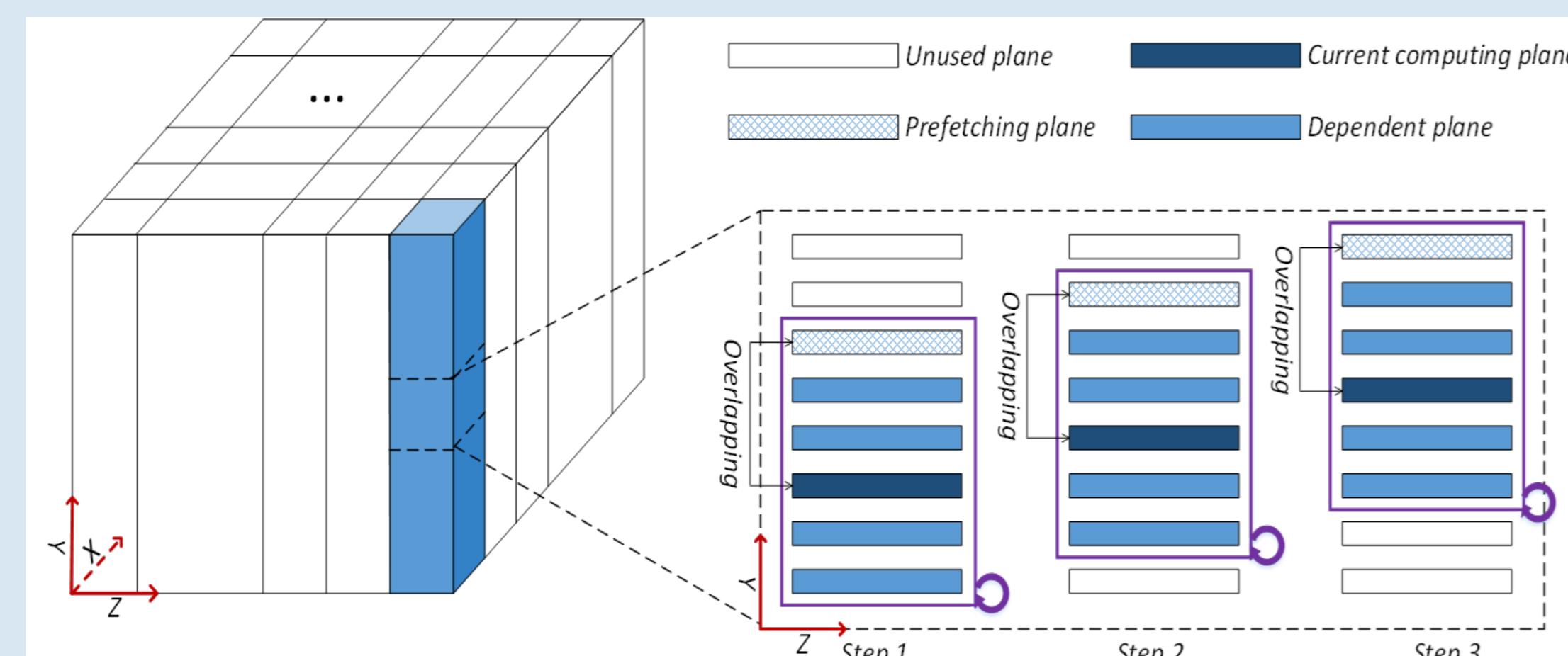


新型多重区域分解算法

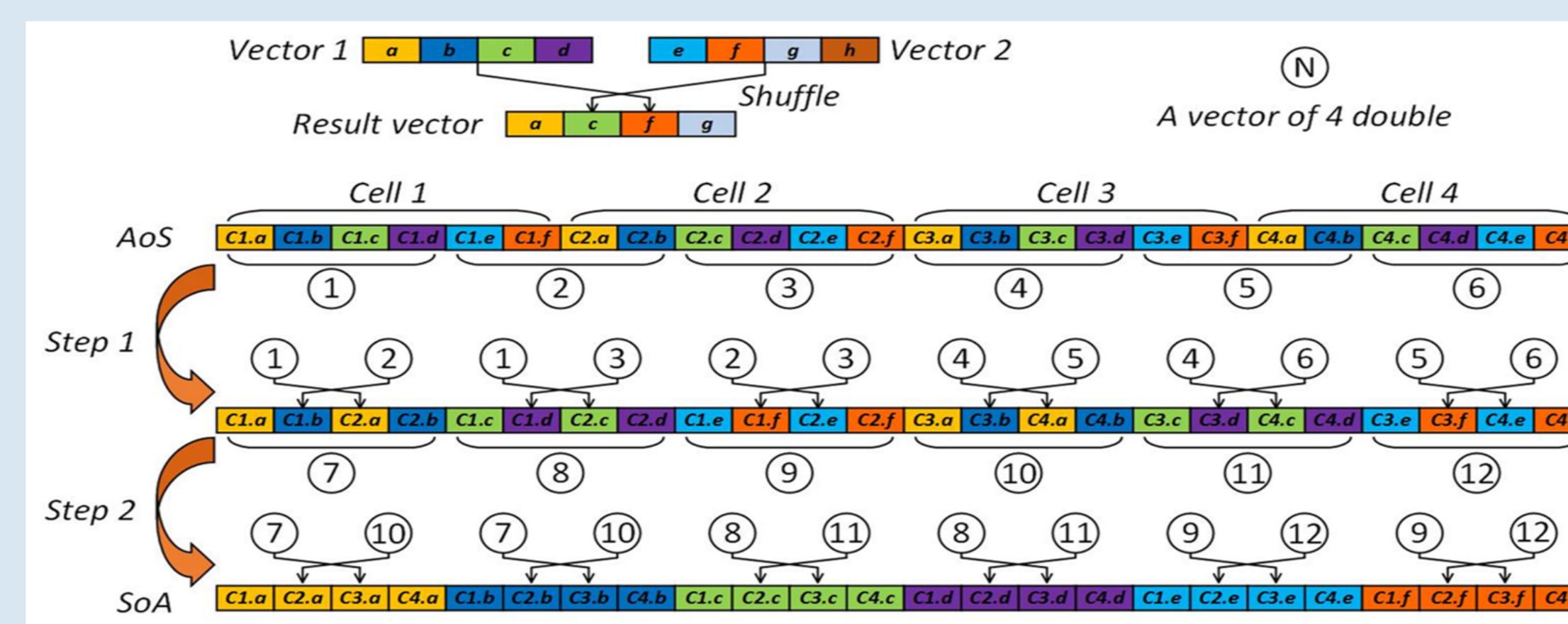


新型不完全矩阵分解算法

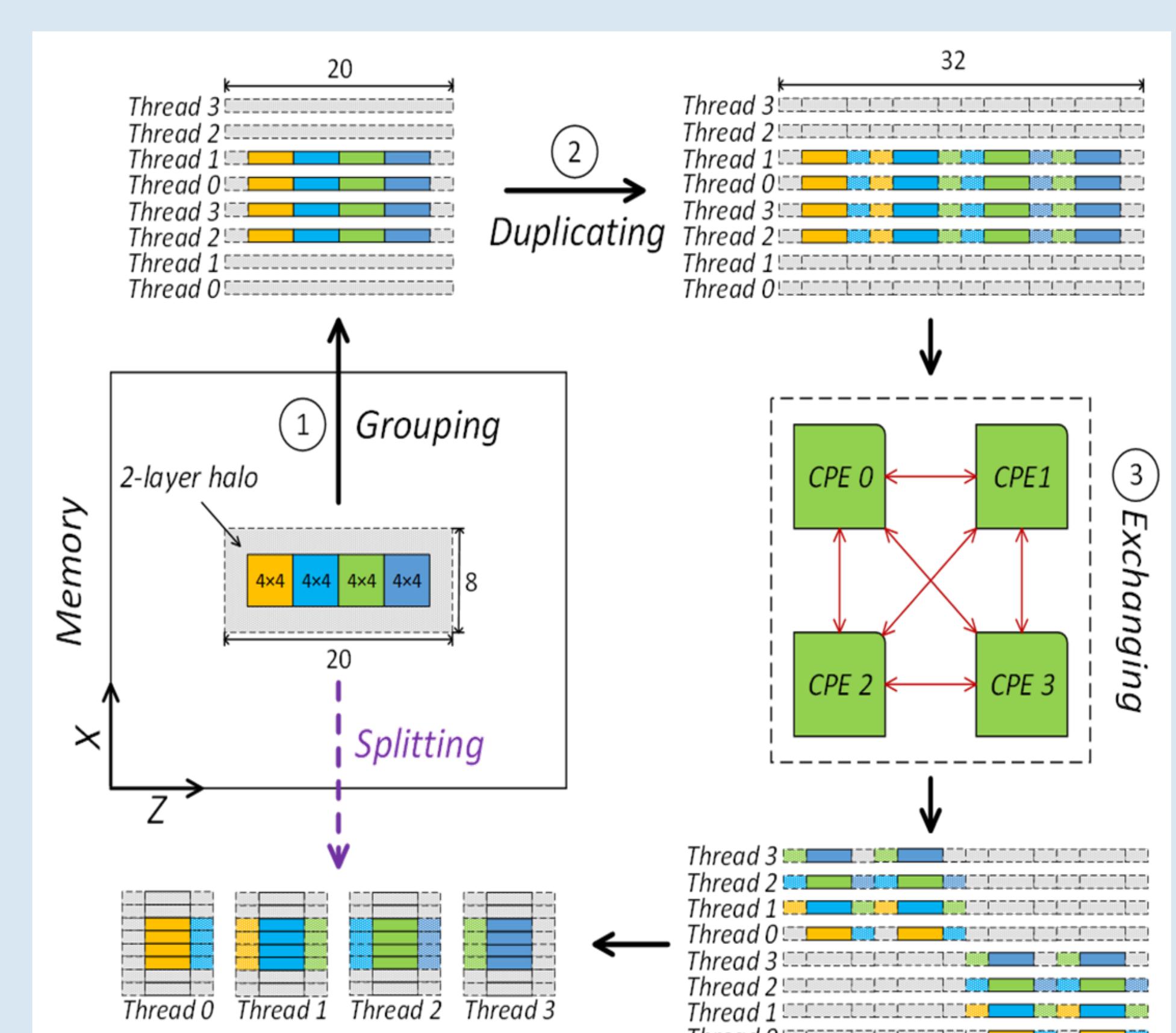
3) 关键优化技术

基于异构子区域切分的
计算/通信重叠技术

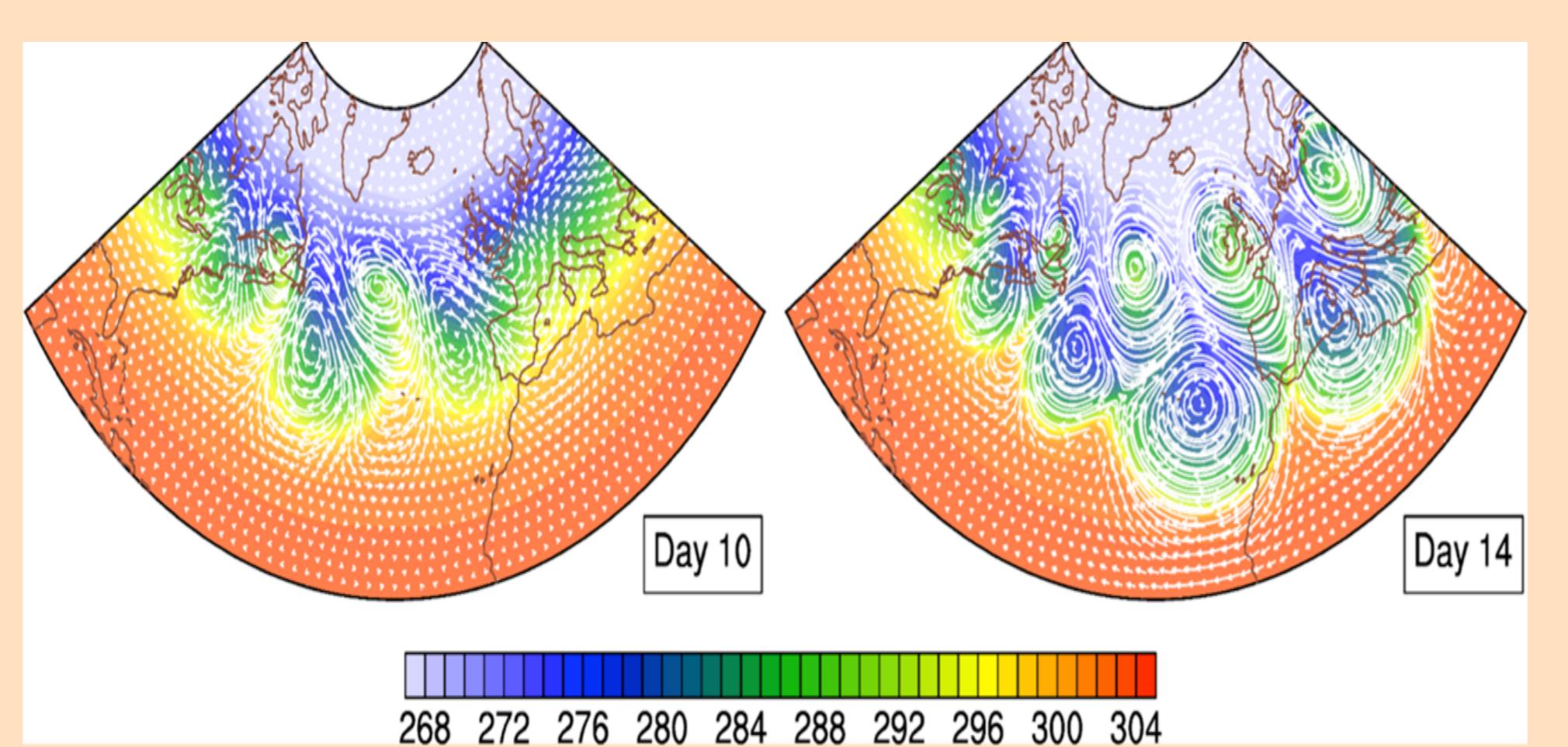
局部性感知的分块技术



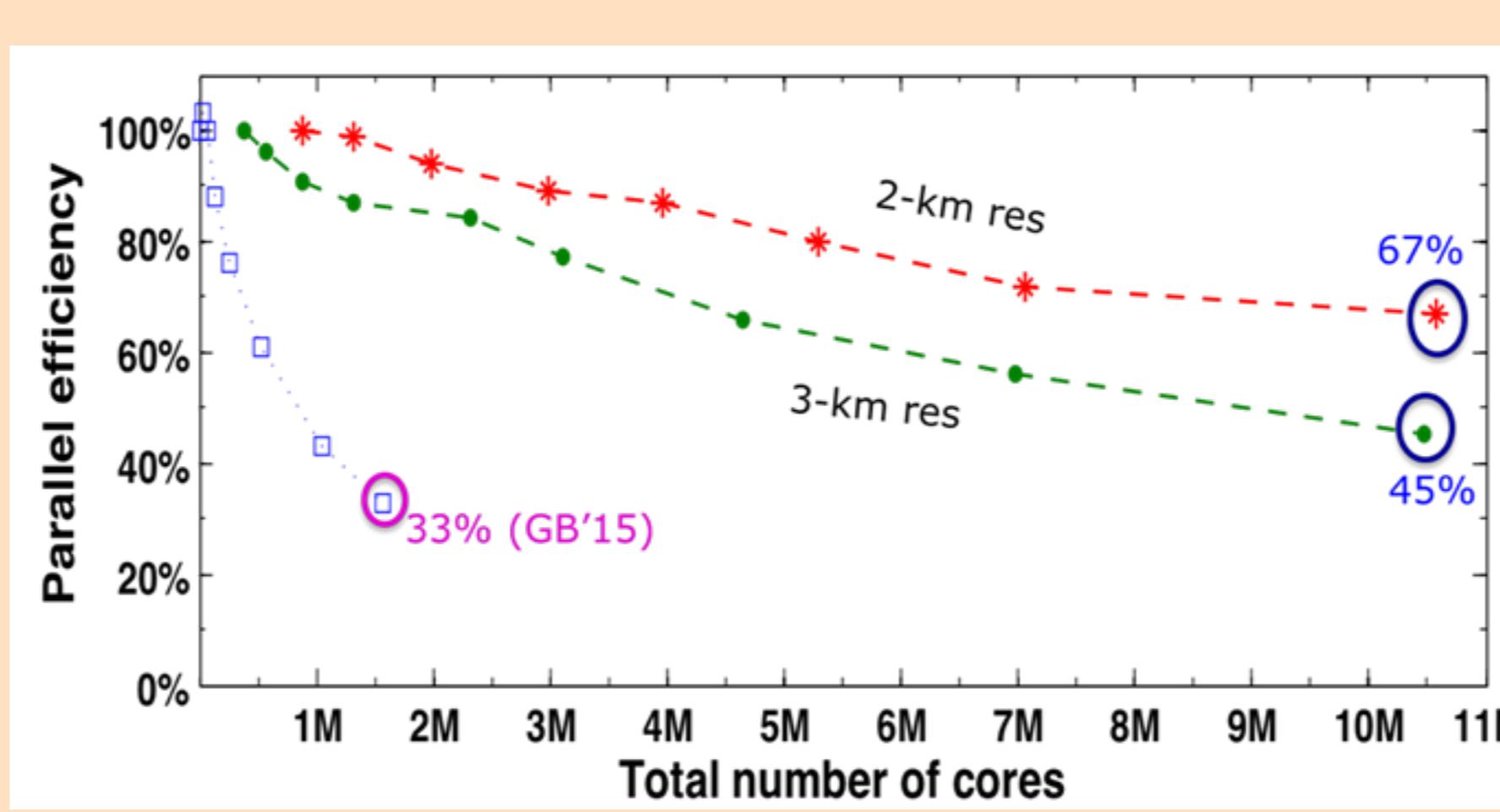
在线数据格式转换技术

基于寄存器通信的核间
协作式数据访问技术

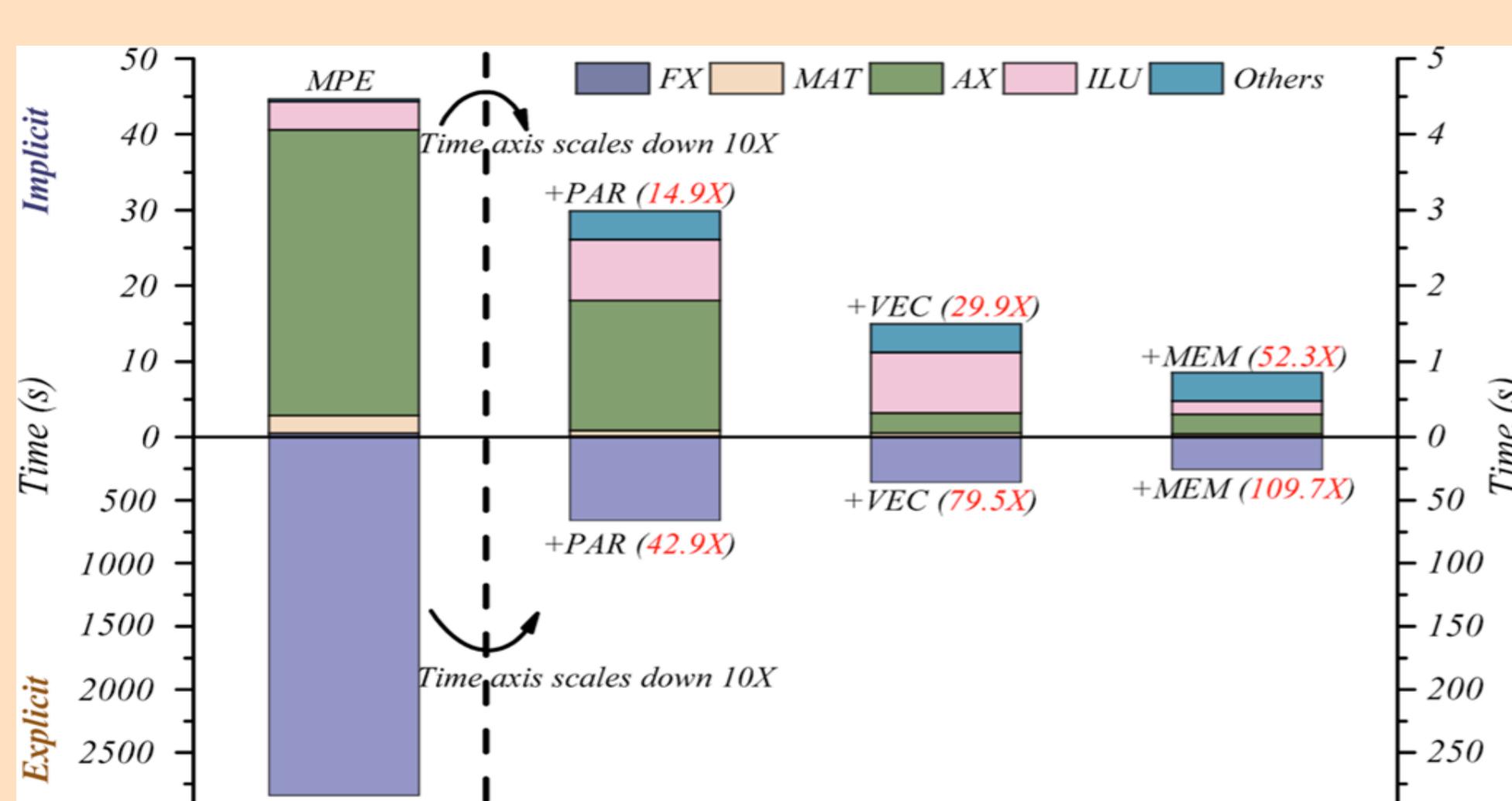
4) 实验结果



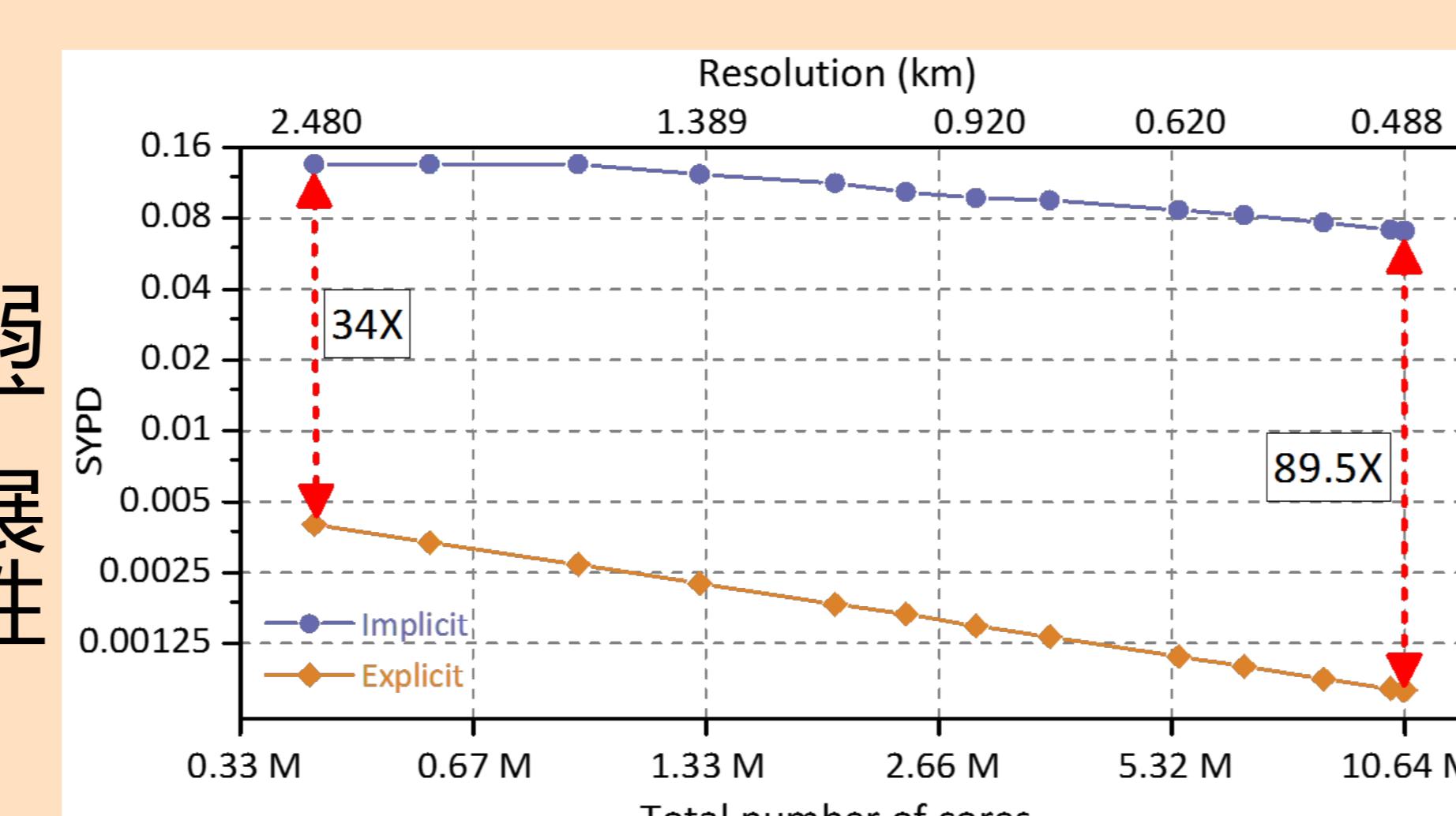
强扩展性



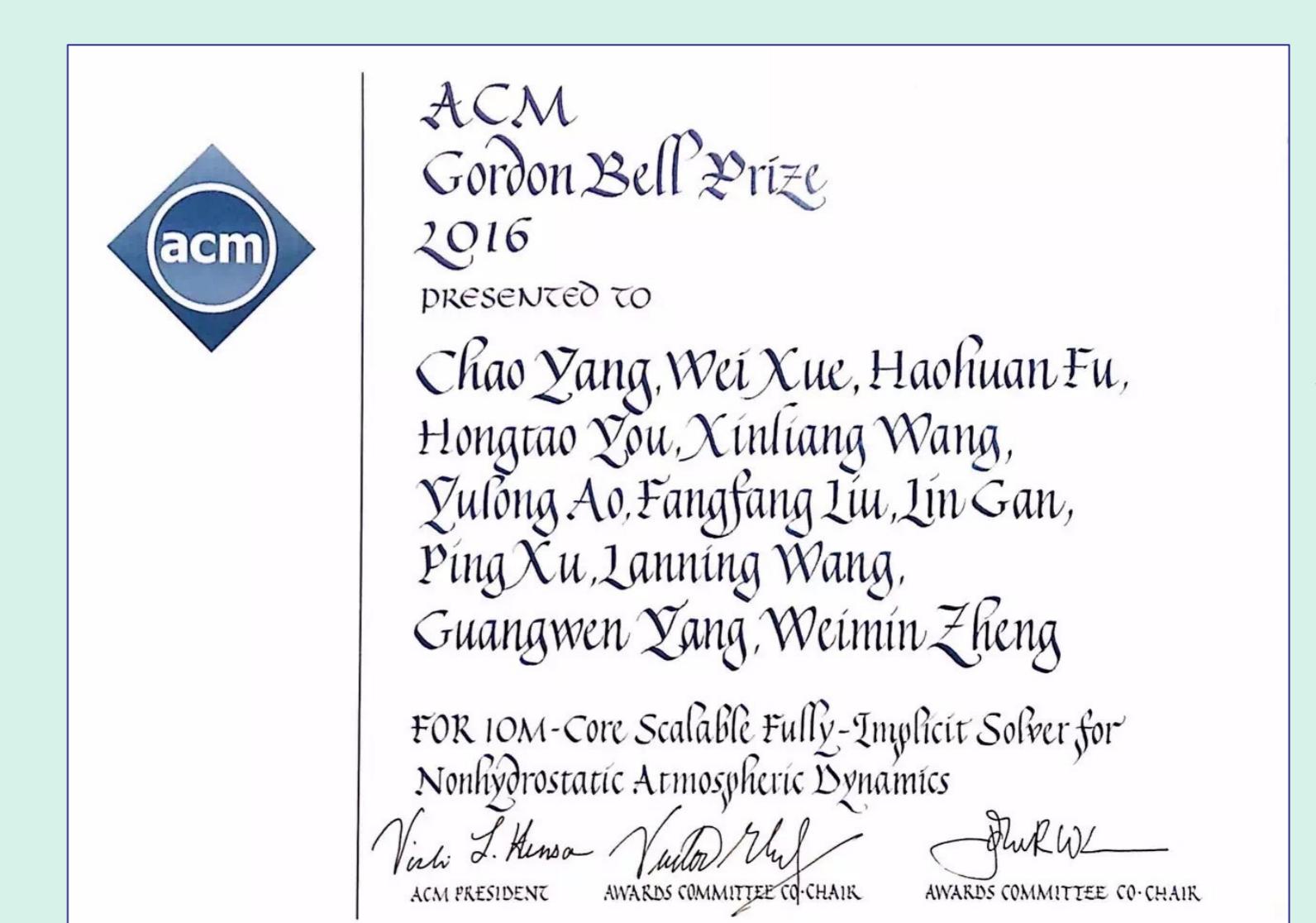
弱扩展性



众核加速效果



5) 颁奖现场和获奖证书



获奖证书