

Supplement of  
*High-Performance Geodynamics on GPUs Using the PETSc  
CUDA Backend (GAUZZ v1.0.0)*

Kyeong-Min Lee<sup>1</sup>, Deok-Kyu Jang<sup>3</sup>, Cedric Thieulot<sup>4</sup>, and Byung-Dal So<sup>1,2</sup>

<sup>1</sup>Interdisciplinary Program in Earth Environmental System Science & Engineering,  
Kangwon National University, Chuncheon, Republic of Korea

<sup>2</sup>Department of Geophysics, Kangwon National University, Chuncheon, Republic of  
Korea

<sup>3</sup>Research Institute for Mathematical Sciences, Kangwon National University,  
Chuncheon, Republic of Korea

<sup>4</sup>Department of Earth Sciences, Utrecht University, Princetonlaan 8A, The Netherlands

*Correspondence to:* Byung-Dal So (bdso@kangwon.ac.kr)

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**Introduction**

This document provides supplementary information to accompany the main manuscript, including benchmark velocity and pressure field plots, dimensional parameter tables, a pre-assembly memory table across 3D mesh resolutions, and a wall-time table for the 3D thermo-mechanical convection.

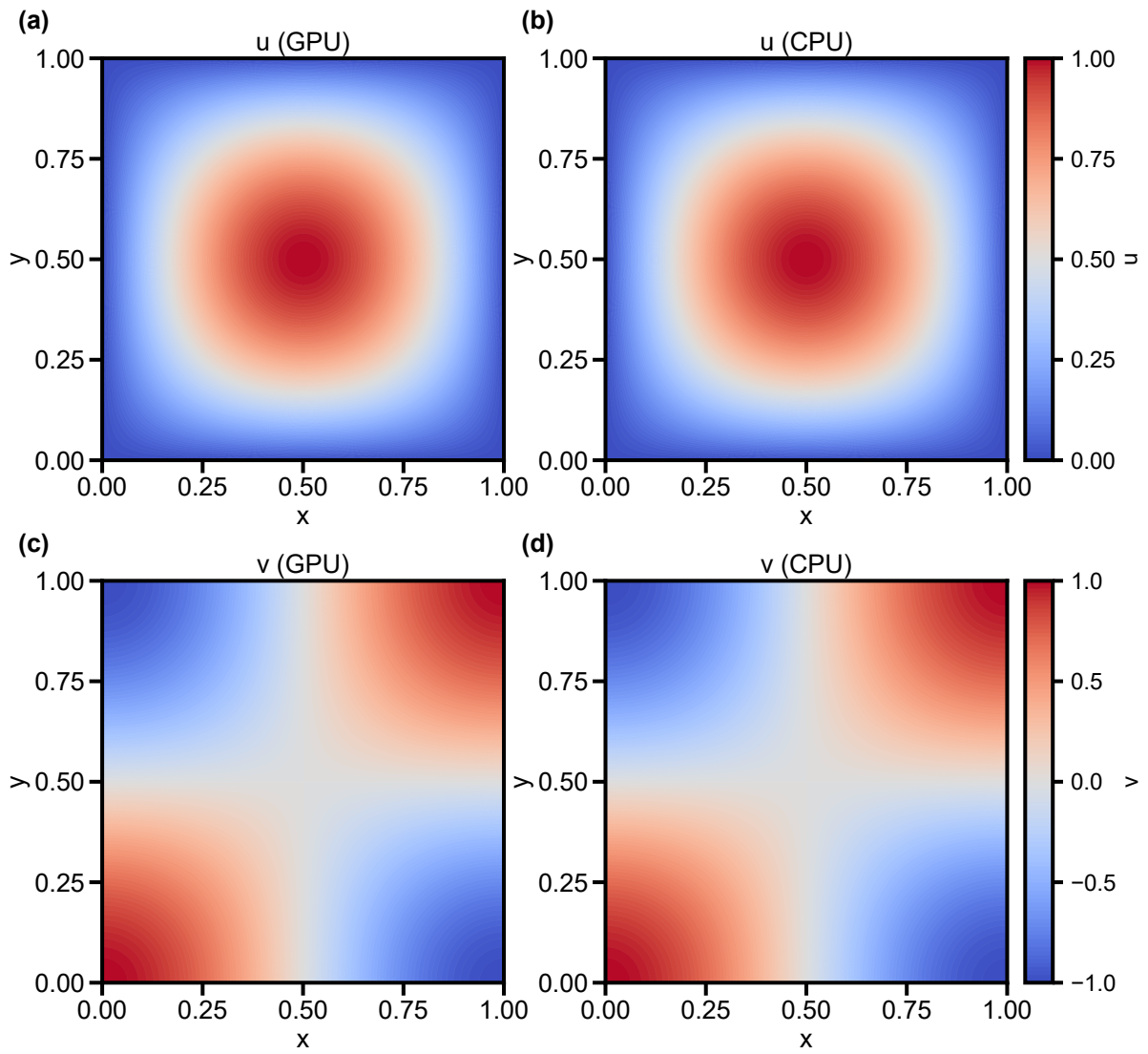


Figure S1: Velocity fields in the  $x$ -direction and  $y$ -direction from the velocity subproblem derived on the GPU (a and c) and CPU (b and d).

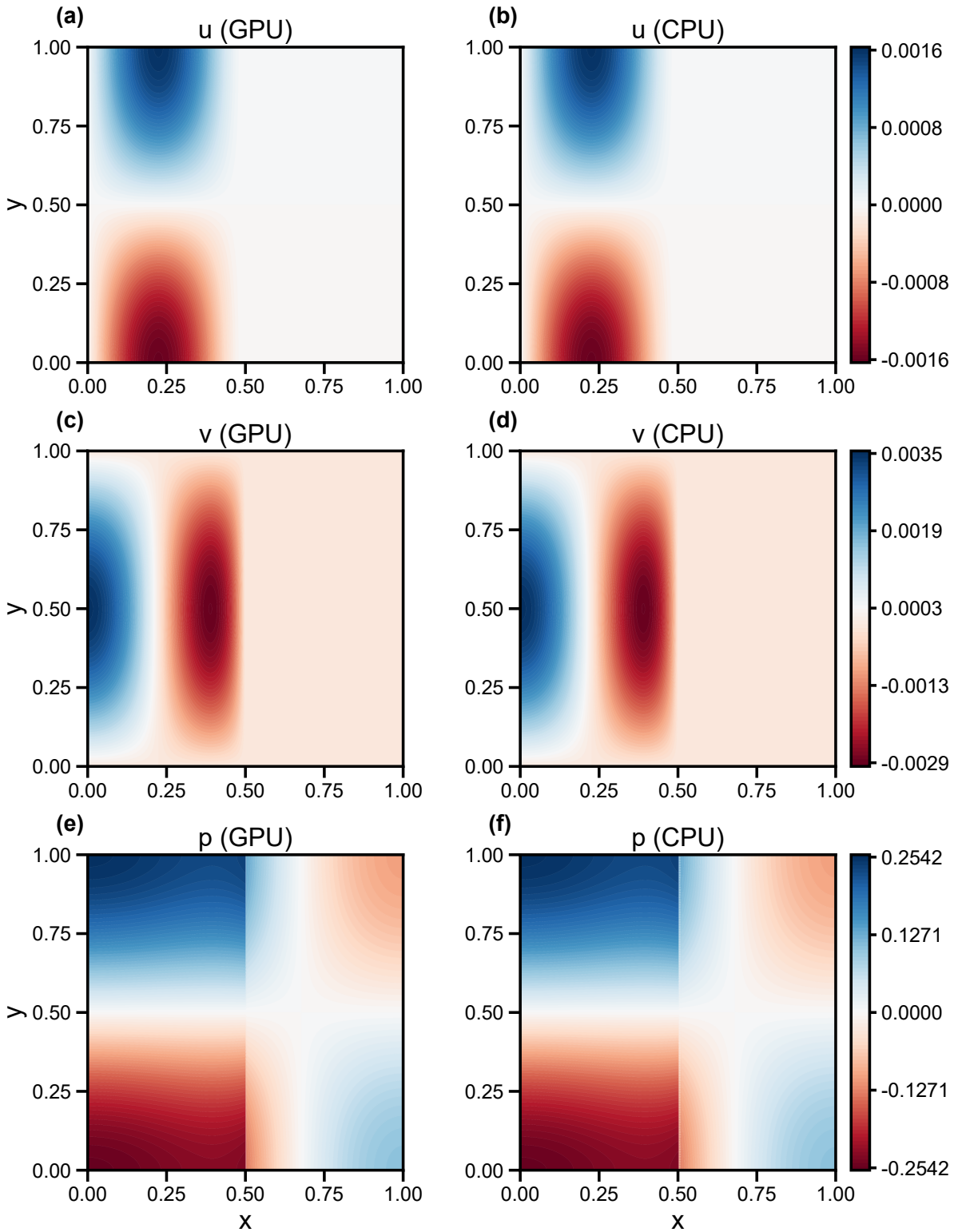


Figure S2: SolCx benchmark  $x$ - and  $y$ -velocity and pressure computed on the GPU (a, c, and e) and CPU (b, d, and f).

Table S1: Dimensional parameters for sticky-air benchmark.

Descriptions	Symbols	Values
Reference viscosity	$\eta_0$	$10^{18} \text{ Pa} \cdot \text{s}$
Reference density	$\rho_0$	$0 \text{ kg} \cdot \text{m}^{-3}$
Characteristic length	$D$	800 km
Thermal diffusivity	$\kappa$	$10^{-6} \text{ m}^2 \cdot \text{s}^{-1}$
Gravitational acceleration	$g$	$10 \text{ m} \cdot \text{s}^{-2}$

Table S2: Dimensional parameters for subduction model.

Descriptions	Symbols	Values
Reference viscosity	$\eta_0$	$3.5 \times 10^{23} \text{ Pa} \cdot \text{s}$
Reference density	$\rho_0$	$3230 \text{ kg} \cdot \text{m}^{-3}$
Characteristic length	$D$	600 km
Thermal diffusivity	$\kappa$	$10^{-6} \text{ m}^2 \cdot \text{s}^{-1}$
Gravitational acceleration	$g$	$10 \text{ m} \cdot \text{s}^{-2}$

Table S3: Comparison of DOFs and pre-assembly memory requirements for different mesh resolutions.

Mesh resolution	DOFs	Memory for pre-assembly (MB)
$100 \times 15 \times 100$	3,352,864	510.0
$100 \times 20 \times 100$	4,456,884	680.0
$100 \times 25 \times 100$	5,560,904	850.0
$100 \times 30 \times 100$	6,664,924	1014.0
$100 \times 35 \times 100$	7,768,944	1176.0
$100 \times 40 \times 100$	8,872,964	1336.0

Table S4: Comparison of computational wall times for 3D thermo-mechanical convection simulations across different hardware configurations (GPU, CPU) and ASPECT.

3D thermo-mechanical convection	GPU (two-GPU, 16-core)	GPU (single-GPU, 16-core)	CPU (32-core)	ASPECT (32-core)
Total wall time	169.87 s	239.99 s	2855.62 s	2438.6 s
Assemble Stokes	0.04 s	0.15 s	0.18 s	616 s
Mesh generation	0.85 s	0.74 s	2.73 s	0.15 s
Set up initial conditions	0.00 s	0.00 s	0.04 s	0.12 s
Solve Stokes	139.32 s	200.76 s	2782.39 s	1473 s
Assemble temperature	6.60 s	6.57 s	5.11 s	166 s
Solve temperature	19.35 s	28.18 s	65.56 s	66 s