SUPPLEMENTARY MATERIALS: REDUCING PARALLEL COMMUNICATION IN ALGEBRAIC MULTIGRID THROUGH SPARSIFICATION*

AMANDA BIENZ†, ROBERT D. FALGOUT‡, WILLIAM GROPP§, LUKE N. OLSON¶, AND JACOB B. SCHRODER‖

The drop tolerances used for the various runs are listed below in the format $[\gamma_1, \gamma_2, \dots]$ where γ_1 is the drop tolerance used on the first coarse level, γ_2 on the second coarse level, and so on. The last drop tolerance in the list is used on all remaining levels. For example:

$[0.1]$	0.1 on all levels
$[0.0, 0.1]$	0.0 on first coarse level, 0.1 on all other levels
$[0.0, 0.1, 1.0]$	0.0 on first coarse level, 0.1 on second coarse level, 1.0 on all remaining levels

*This work is partially supported by the National Science Foundation Graduate Research Fellowship award DGE-1144245 and the Air Force Office of Scientific Research under grant FA9550-12-1-0478. This research is also part of the Blue Waters sustained-petascale computing project, which is supported by the National Science Foundation (awards OCI-0725070 and ACI-1238993) and the state of Illinois. Blue Waters is a joint effort of the University of Illinois at Urbana-Champaign and its National Center for Supercomputing Applications. This work was performed under the auspices of the U.S. Department of Energy by Lawrence Livermore National Laboratory under Contract DE-AC52-07NA27344 (LLNL-JRNL-673388).

†Department of Computer Science, University of Illinois at Urbana-Champaign, Urbana, IL 61801, bienz2@illinois.edu, http://web.engr.illinois.edu/~bienz2

‡Center for Applied Scientific Computing, Lawrence Livermore National Laboratory, Livermore, CA 94550, rfalgout@llnl.gov, http://people.llnl.gov/falgout2

§Department of Computer Science, University of Illinois at Urbana-Champaign, Urbana, IL 61801, wgropp@illinois.edu, http://wgropp.cs.illinois.edu

¶Department of Computer Science, University of Illinois at Urbana-Champaign, Urbana, IL 61801, lukeo@illinois.edu, http://lukeo.cs.illinois.edu

‖Center for Applied Scientific Computing, Lawrence Livermore National Laboratory, Livermore, CA 94550, schroder2@llnl.gov, http://people.llnl.gov/schroder2

processors	method	γ list
128	NonGalerkin	[1.0]
	Sparse (Full)	[1.0]
	Hybrid (Full)	[1.0]
	Sparse (Diag)	[0.0, 0.1]
	Hybrid (Diag)	[0.0, 0.1]
1024	NonGalerkin	[1.0]
	Sparse (Full)	[1.0]
	Hybrid (Full)	[1.0]
	Sparse (Diag)	[0.0, 0.1]
	Hybrid (Diag)	[0.0, 0.1]
4096	NonGalerkin	[1.0]
	Sparse (Full)	[1.0]
	Hybrid (Full)	[0.0, 1.0]
	Sparse (Diag)	[0.0, 0.1]
	Hybrid (Diag)	[0.0, 0.1]
8192	NonGalerkin	[0.0, 0.01, 0.1, 1.0]
	Sparse (Full)	[1.0]
	Hybrid (Full)	[1.0]
	Sparse (Diag)	[0.0, 0.1]
	Hybrid (Diag)	[0.0, 0.1]
16384	NonGalerkin	[0.0, 0.01, 0.1, 1.0]
	Sparse (Full)	[1.0]
	Hybrid (Full)	[1.0]
	Sparse (Diag)	[0.0, 0.1]
	Hybrid (Diag)	[0.0, 0.1]
32768	NonGalerkin	[0.0, 0.01, 0.1, 1.0]
	Sparse (Full)	[1.0]
	Hybrid (Full)	[1.0]
	Sparse (Diag)	[0.0, 0.1]
	Hybrid (Diag)	[0.0, 0.1]
100000	NonGalerkin	[0.0, 0.01, 0.1, 1.0]
	Sparse (Full)	[1.0]
	Hybrid (Full)	[1.0]
	Sparse (Diag)	[0.0, 0.1]
	Hybrid (Diag)	[0.0, 0.1]

Table SM1: 27-Point Laplacian, Weak Scaling Studies, and the "8192 Processes" cases correspond to Figure 8

processors	method	γ list
128	NonGalerkin	[1.0]
	Sparse (Full)	[1.0]
	Hybrid (Full)	[1.0]
	Sparse (Diag)	[0.0, 0.1]
	Hybrid (Diag)	[0.0, 0.1]
1024	NonGalerkin	[1.0]
	Sparse (Full)	[1.0]
	Hybrid (Full)	[1.0]
	Sparse (Diag)	[0.0, 0.1]
	Hybrid (Diag)	[0.0, 0.1]
4096	NonGalerkin	[1.0]
	Sparse (Full)	[1.0]
	Hybrid (Full)	[1.0]
	Sparse (Diag)	[0.0, 0.1]
	Hybrid (Diag)	[0.0, 0.1]
8192	NonGalerkin	[1.0]
	Sparse (Full)	[1.0]
	Hybrid (Full)	[1.0]
	Sparse (Diag)	[0.0, 0.1]
	Hybrid (Diag)	[0.0, 0.1]
16384	NonGalerkin	[1.0]
	Sparse (Full)	[1.0]
	Hybrid (Full)	[1.0]
	Sparse (Diag)	[0.0, 0.1]
	Hybrid (Diag)	[0.0, 0.1]
32768	NonGalerkin	[1.0]
	Sparse (Full)	[1.0]
	Hybrid (Full)	[1.0]
	Sparse (Diag)	[0.0, 0.1]
	Hybrid (Diag)	[0.0, 0.1]
100000	NonGalerkin	[1.0]
	Sparse (Full)	[1.0]
	Hybrid (Full)	[1.0]
	Sparse (Diag)	[0.0, 0.1]
	Hybrid (Diag)	[0.0, 0.1]

Table SM2: 27-Point Laplacian, Strong Scaling Studies

processors	method	γ list
128	NonGalerkin	[0.0, 0.0, 0.0, 0.01, 0.1, 1.0]
	Sparse (Full)	[0.0, 0.1]
	Hybrid (Full)	[0.0, 0.0, 0.0, 0.01, 0.1, 1.0]
	Sparse (Diag)	[0.0, 0.0, 0.0, 0.1]
	Hybrid (Diag)	[0.0, 0.0, 0.0, 0.1]
1024	NonGalerkin	[0.0, 0.0, 0.0, 0.01, 0.1, 1.0]
	Sparse (Full)	[0.0, 0.0, 0.0, 0.1]
	Hybrid (Full)	[0.0, 0.0, 0.1]
	Sparse (Diag)	[0.0, 0.0, 0.0, 0.1]
	Hybrid (Diag)	[0.0, 0.0, 0.0, 0.1]
4096	NonGalerkin	[0.0, 0.0, 0.0, 0.01, 0.1, 1.0]
	Sparse (Full)	[0.0, 0.0, 0.0, 0.1]
	Hybrid (Full)	[0.0, 0.0, 0.0, 0.01, 0.1, 1.0]
	Sparse (Diag)	[0.0, 0.0, 0.0, 0.1]
	Hybrid (Diag)	[0.0, 0.0, 0.0, 0.1]
8192	NonGalerkin	[0.0, 0.0, 0.0, 0.01, 0.1, 1.0]
	Sparse (Full)	[0.0, 0.0, 0.0, 0.01, 0.1, 1.0]
	Hybrid (Full)	[0.0, 0.0, 0.0, 0.01, 0.1, 1.0]
	Sparse (Diag)	[0.0, 0.0, 0.0, 0.1]
	Hybrid (Diag)	[0.0, 0.0, 0.0, 0.1]
16384	NonGalerkin	[0.0, 0.0, 0.0, 0.01, 0.1, 1.0]
	Sparse (Full)	[0.0, 0.0, 0.0, 0.01, 0.1, 1.0]
	Hybrid (Full)	[0.0, 0.0, 0.0, 0.01, 0.1, 1.0]
	Sparse (Diag)	[0.0, 0.0, 0.0, 0.1]
	Hybrid (Diag)	[0.0, 0.0, 0.0, 0.1]
32768	NonGalerkin	[0.0, 0.0, 0.0, 0.01, 0.1, 1.0]
	Sparse (Full)	[0.0, 0.0, 0.0, 0.01, 0.1, 1.0]
	Hybrid (Full)	[0.0, 0.0, 0.0, 0.01, 0.1, 1.0]
	Sparse (Diag)	[0.0, 0.0, 0.0, 0.1]
	Hybrid (Diag)	[0.0, 0.0, 0.0, 0.1]
100000	NonGalerkin	[0.0, 0.0, 0.0, 0.01, 0.1, 1.0]
	Sparse (Full)	[0.0, 0.0, 0.0, 0.01, 0.1, 1.0]
	Hybrid (Full)	[0.0, 0.0, 0.0, 0.01, 0.1, 1.0]
	Sparse (Diag)	[0.0, 0.0, 0.0, 0.1]
	Hybrid (Diag)	[0.0, 0.0, 0.0, 0.1]

Table SM3: Rotated Anisotropic Diffusion, Weak Scaling Studies, and the "8192 Processes" cases correspond to Figure 8

processors	method	γ list
128	NonGalerkin	[0.0, 0.0, 0.0, 0.01, 0.1, 1.0]
	Sparse (Full)	[0.0, 0.01, 0.1, 1.0]
	Hybrid (Full)	[0.0, 0.1]
	Sparse (Diag)	[0.0, 0.0, 0.0, 0.1]
	Hybrid (Diag)	[0.0, 0.0, 0.0, 0.1]
1024	NonGalerkin	[0.0, 0.0, 0.0, 0.01, 0.1, 1.0]
	Sparse (Full)	[0.0, 0.0, 0.0, 0.1]
	Hybrid (Full)	[0.0, 0.0, 0.1]
	Sparse (Diag)	[0.0, 0.0, 0.0, 0.1]
	Hybrid (Diag)	[0.0, 0.0, 0.0, 0.1]
4096	NonGalerkin	[0.0, 0.0, 0.0, 0.01, 0.1, 1.0]
	Sparse (Full)	[0.0, 0.1]
	Hybrid (Full)	[0.0, 0.01, 0.1]
	Sparse (Diag)	[0.0, 0.0, 0.0, 0.1]
	Hybrid (Diag)	[0.0, 0.0, 0.0, 0.1]
8192	NonGalerkin	[0.0, 0.0, 0.0, 0.01, 0.1, 1.0]
	Sparse (Full)	[0.0, 0.0, 0.0, 0.01, 0.1, 1.0]
	Hybrid (Full)	[0.0, 0.0, 0.0, 0.01, 0.1, 1.0]
	Sparse (Diag)	[0.0, 0.0, 0.0, 0.1]
	Hybrid (Diag)	[0.0, 0.0, 0.0, 0.1]
16384	NonGalerkin	[0.0, 0.0, 0.0, 0.01, 0.1, 1.0]
	Sparse (Full)	[0.0, 0.0, 0.0, 0.01, 0.1, 1.0]
	Hybrid (Full)	[0.0, 0.0, 0.0, 0.01, 0.1, 1.0]
	Sparse (Diag)	[0.0, 0.0, 0.0, 0.1]
	Hybrid (Diag)	[0.0, 0.0, 0.0, 0.1]
32768	NonGalerkin	[0.0, 0.0, 0.0, 0.01, 0.1, 1.0]
	Sparse (Full)	[0.0, 0.0, 0.0, 0.01, 0.1, 1.0]
	Hybrid (Full)	[0.0, 0.0, 0.0, 0.01, 0.1, 1.0]
	Sparse (Diag)	[0.0, 0.0, 0.0, 0.1]
	Hybrid (Diag)	[0.0, 0.0, 0.0, 0.1]
100000	NonGalerkin	[0.0, 0.0, 0.0, 0.01, 0.1, 1.0]
	Sparse (Full)	[0.0, 0.0, 0.0, 0.01, 0.1, 1.0]
	Hybrid (Full)	[0.0, 0.0, 0.0, 0.01, 0.1, 1.0]
	Sparse (Diag)	[0.0, 0.0, 0.0, 0.1]
	Hybrid (Diag)	[0.0, 0.0, 0.0, 0.1]

Table SM4: Rotated Anisotropic Diffusion, Strong Scaling Studies

processors	method	γ list
32	NonGalerkin	[0.0, 0.0, 0.0, 0.1]
	Sparse (Diag)	[0.0, 0.1]
	Hybrid (Diag)	[0.0, 0.0, 0.1]
64	NonGalerkin	[0.01]
	Sparse (Diag)	[0.0, 0.1]
	Hybrid (Diag)	[0.0, 0.1]
128	NonGalerkin	[0.0, 0.0, 0.0, 0.1]
	Sparse (Diag)	[0.0, 0.0, 0.1]
	Hybrid (Diag)	[0.0, 0.0, 0.1]
256	NonGalerkin	[0.0, 1.0]
	Sparse (Diag)	[0.0, 0.1]
	Hybrid (Diag)	[0.0, 0.1]

Table SM5: Florida Sparse Matrix Collection: `2cubes_sphere.mtx`

processors	method	γ list
32	NonGalerkin	[0.0, 1.0]
	Sparse (Diag)	[0.0, 0.01, 0.1]
	Hybrid (Diag)	[0.0, 0.01, 0.1]
64	NonGalerkin	[0.0, 0.01, 0.1, 1.0]
	Sparse (Diag)	[0.0, 0.01, 0.1, 1.0]
	Hybrid (Diag)	[0.0, 0.01, 0.1, 1.0]
128	NonGalerkin	[0.0, 0.1]
	Sparse (Diag)	[0.0, 0.1]
	Hybrid (Diag)	[0.0, 0.01, 0.1, 1.0]
256	NonGalerkin	[0.0, 0.01, 0.1]
	Sparse (Diag)	[0.0, 0.1]
	Hybrid (Diag)	[0.0, 0.01, 0.1, 1.0]

Table SM6: Florida Sparse Matrix Collection: `G2_circuit.mtx`

processors	method	γ list
32	NonGalerkin	[0.0, 1.0]
	Sparse (Diag)	[0.0, 0.01, 0.1, 1.0]
	Hybrid (Diag)	[0.0, 0.01, 0.1, 1.0]
64	NonGalerkin	[0.0, 0.1]
	Sparse (Diag)	[0.0, 0.0, 0.1]
	Hybrid (Diag)	[0.0, 0.0, 0.1]
128	NonGalerkin	[0.0, 0.0, 0.1]
	Sparse (Diag)	[0.0, 0.0, 0.1]
	Hybrid (Diag)	[0.0, 0.0, 0.1]
256	NonGalerkin	[0.0, 1.0]
	Sparse (Diag)	[0.0, 0.01, 0.1, 1.0]
	Hybrid (Diag)	[0.0, 0.01, 0.1]

Table SM7: Florida Sparse Matrix Collection: `G3_circuit.mtx`

processors	method	γ list
32	NonGalerkin	[0.0, 0.1]
	Sparse (Diag)	[0.0, 0.0, 0.0, 0.01, 0.1, 1.0]
	Hybrid (Diag)	[0.0, 0.0, 0.0, 0.01, 0.1, 1.0]
64	NonGalerkin	[0.0, 0.01, 0.1]
	Sparse (Diag)	[0.0, 0.0, 0.0, 0.01, 0.1, 1.0]
	Hybrid (Diag)	[0.0, 0.0, 0.0, 0.01, 0.1, 1.0]
128	NonGalerkin	[0.0, 0.0, 0.1]
	Sparse (Diag)	[0.0, 0.0, 0.0, 0.1]
	Hybrid (Diag)	[0.0, 0.0, 0.0, 0.1]
256	NonGalerkin	[0.0, 0.1]
	Sparse (Diag)	[0.0, 0.0, 0.1]
	Hybrid (Diag)	[0.0, 0.01, 0.1, 1.0]

Table SM8: Florida Sparse Matrix Collection: `af_0_k101.mtx`

processors	method	γ list
32	NonGalerkin	[0.0, 0.1]
	Sparse (Diag)	[0.0, 0.0, 0.0, 0.01, 0.1, 1.0]
	Hybrid (Diag)	[0.0, 0.0, 0.0, 0.01, 0.1, 1.0]
64	NonGalerkin	[0.0, 1.0]
	Sparse (Diag)	[0.0, 0.0, 0.0, 0.01, 0.1, 1.0]
	Hybrid (Diag)	[0.0, 0.0, 0.0, 0.01, 0.1, 1.0]
128	NonGalerkin	[0.0, 0.01, 0.1, 1.0]
	Sparse (Diag)	[0.0, 0.0, 0.0, 0.01, 0.1, 1.0]
	Hybrid (Diag)	[0.0, 0.0, 0.1]
256	NonGalerkin	[0.0, 1.0]
	Sparse (Diag)	[0.0, 0.1]
	Hybrid (Diag)	[0.0, 0.01, 0.1, 1.0]

Table SM9: Florida Sparse Matrix Collection: `af_1_k101.mtx`

processors	method	γ list
32	NonGalerkin	[0.01]
	Sparse (Diag)	[0.0, 0.0, 0.1]
	Hybrid (Diag)	[0.0, 0.0, 0.0, 0.01, 0.1, 1.0]
64	NonGalerkin	[0.0, 0.0, 0.0, 0.1]
	Sparse (Diag)	[0.0, 0.0, 0.1]
	Hybrid (Diag)	[0.0, 0.0, 0.1]
128	NonGalerkin	[0.0, 0.0, 0.1]
	Sparse (Diag)	[0.0, 0.0, 0.1]
	Hybrid (Diag)	[0.0, 0.0, 0.1]
256	NonGalerkin	[0.0, 1.0]
	Sparse (Diag)	[0.0, 0.1]
	Hybrid (Diag)	[0.0, 0.01, 0.1, 1.0]

Table SM10: Florida Sparse Matrix Collection: `af_2_k101.mtx`

processors	method	γ list
32	NonGalerkin	[0.0, 0.1]
	Sparse (Diag)	[0.0, 0.0, 0.0, 0.01, 0.1, 1.0]
	Hybrid (Diag)	[0.0, 0.0, 0.0, 0.1]
64	NonGalerkin	[0.0, 0.0, 0.0, 0.01, 0.1, 1.0]
	Sparse (Diag)	[0.0, 0.0, 0.1]
	Hybrid (Diag)	[0.0, 0.0, 0.1]
128	NonGalerkin	[0.0, 1.0]
	Sparse (Diag)	[0.0, 0.0, 0.1]
	Hybrid (Diag)	[0.0, 0.01, 0.1, 1.0]
256	NonGalerkin	[0.0, 1.0]
	Sparse (Diag)	[0.0, 0.01, 0.1, 1.0]
	Hybrid (Diag)	[0.0, 0.01, 0.1, 1.0]

Table SM11: Florida Sparse Matrix Collection: `af_3_k101.mtx`

processors	method	γ list
32	NonGalerkin	[0.0, 0.1]
	Sparse (Diag)	[0.0, 0.0, 0.0, 0.01, 0.1, 1.0]
	Hybrid (Diag)	[0.0, 0.0, 0.1]
64	NonGalerkin	[0.0, 0.01, 0.1, 1.0]
	Sparse (Diag)	[0.0, 0.0, 0.1]
	Hybrid (Diag)	[0.0, 0.0, 0.1]
128	NonGalerkin	[0.0, 0.01, 0.1]
	Sparse (Diag)	[0.0, 0.0, 0.0, 0.01, 0.1, 1.0]
	Hybrid (Diag)	[0.0, 0.0, 0.0, 0.01, 0.1, 1.0]
256	NonGalerkin	[0.0, 1.0]
	Sparse (Diag)	[0.0, 0.0, 0.1]
	Hybrid (Diag)	[0.0, 0.01, 0.1, 1.0]

Table SM12: Florida Sparse Matrix Collection: `af_4_k101.mtx`

processors	method	γ list
32	NonGalerkin	[0.0, 0.01, 0.1]
	Sparse (Diag)	[0.0, 0.0, 0.0, 0.01, 0.1, 1.0]
	Hybrid (Diag)	[0.0, 0.0, 0.0, 0.01, 0.1, 1.0]
64	NonGalerkin	[0.0, 0.01, 0.1, 1.0]
	Sparse (Diag)	[0.0, 0.0, 0.1]
	Hybrid (Diag)	[0.0, 0.0, 0.0, 0.1]
128	NonGalerkin	[0.01]
	Sparse (Diag)	[0.0, 0.1]
	Hybrid (Diag)	[0.0, 0.1]
256	NonGalerkin	[0.0, 0.1]
	Sparse (Diag)	[0.0, 0.01, 0.1, 1.0]
	Hybrid (Diag)	[0.0, 0.01, 0.1]

Table SM13: Florida Sparse Matrix Collection: `af_5_k101.mtx`

processors	method	γ list
32	NonGalerkin	[0.01]
	Sparse (Diag)	[0.0, 0.0, 0.0, 0.1]
	Hybrid (Diag)	[0.0, 0.0, 0.0, 0.1]
64	NonGalerkin	[1.0]
	Sparse (Diag)	[0.0, 0.0, 0.0, 0.1]
	Hybrid (Diag)	[0.0, 0.0, 0.0, 0.1]
128	NonGalerkin	[0.0, 1.0]
	Sparse (Diag)	[0.0, 0.0, 0.0, 0.01, 0.1, 1.0]
	Hybrid (Diag)	[0.0, 0.0, 0.0, 0.01, 0.1, 1.0]
256	NonGalerkin	[0.0, 1.0]
	Sparse (Diag)	[0.0, 0.0, 0.0, 0.1]
	Hybrid (Diag)	[0.0, 0.0, 0.1]

Table SM14: Florida Sparse Matrix Collection: `af_shell3.mtx`

processors	method	γ list
32	NonGalerkin	[0.01]
	Sparse (Diag)	[0.0, 0.0, 0.0, 0.01, 0.1, 1.0]
	Hybrid (Diag)	[0.0, 0.0, 0.0, 0.01, 0.1, 1.0]
64	NonGalerkin	[1.0]
	Sparse (Diag)	[0.0, 0.0, 0.0, 0.1]
	Hybrid (Diag)	[0.0, 0.0, 0.0, 0.1]
128	NonGalerkin	[0.0, 0.1]
	Sparse (Diag)	[0.0, 0.0, 0.0, 0.01, 0.1, 1.0]
	Hybrid (Diag)	[0.0, 0.0, 0.1]
256	NonGalerkin	[0.0, 0.1]
	Sparse (Diag)	[0.0, 0.0, 0.1]
	Hybrid (Diag)	[0.0, 0.0, 0.1]

Table SM15: Florida Sparse Matrix Collection: `af_shell4.mtx`

processors	method	γ list
32	NonGalerkin	[0.01]
	Sparse (Diag)	[0.0, 0.0, 0.0, 0.1]
	Hybrid (Diag)	[0.0, 0.0, 0.0, 0.1]
64	NonGalerkin	[1.0]
	Sparse (Diag)	[0.0, 0.0, 0.0, 0.1]
	Hybrid (Diag)	[0.0, 0.0, 0.0, 0.01, 0.1, 1.0]
128	NonGalerkin	[0.0, 0.1]
	Sparse (Diag)	[0.0, 0.0, 0.1]
	Hybrid (Diag)	[0.0, 0.0, 0.1]
256	NonGalerkin	[0.0, 0.1]
	Sparse (Diag)	[0.0, 0.0, 0.1]
	Hybrid (Diag)	[0.0, 0.0, 0.1]

Table SM16: Florida Sparse Matrix Collection: `af_shell7.mtx`

processors	method	γ list
32	NonGalerkin	[0.01]
	Sparse (Diag)	[0.0, 0.0, 0.0, 0.1]
	Hybrid (Diag)	[0.0, 0.0, 0.0, 0.1]
64	NonGalerkin	[1.0]
	Sparse (Diag)	[0.0, 0.0, 0.0, 0.1]
	Hybrid (Diag)	[0.0, 0.0, 0.0, 0.1]
128	NonGalerkin	[0.0, 0.01, 0.1]
	Sparse (Diag)	[0.0, 0.0, 0.0, 0.1]
	Hybrid (Diag)	[0.0, 0.0, 0.1]
256	NonGalerkin	[0.0, 0.01, 0.1, 1.0]
	Sparse (Diag)	[0.0, 0.0, 0.0, 0.01, 0.1, 1.0]
	Hybrid (Diag)	[0.0, 0.0, 0.0, 0.1]

Table SM17: Florida Sparse Matrix Collection: `af_shell8.mtx`

processors	method	γ list
32	NonGalerkin	[0.0, 0.01, 0.1]
	Sparse (Diag)	[0.0, 0.0, 0.1]
	Hybrid (Diag)	[0.0, 0.0, 0.1]
64	NonGalerkin	[0.0, 0.01, 0.1, 1.0]
	Sparse (Diag)	[0.0, 0.0, 0.0, 0.01, 0.1, 1.0]
	Hybrid (Diag)	[0.0, 0.0, 0.0, 0.01, 0.1, 1.0]
128	NonGalerkin	[0.0, 1.0]
	Sparse (Diag)	[0.0, 0.0, 0.1]
	Hybrid (Diag)	[0.0, 0.0, 0.1]
256	NonGalerkin	[0.0, 1.0]
	Sparse (Diag)	[0.0, 0.0, 0.1]
	Hybrid (Diag)	[0.0, 0.0, 0.1]

Table SM18: Florida Sparse Matrix Collection: `apache2.mtx`

processors	method	γ list
32	NonGalerkin	[0.0, 0.1]
	Sparse (Diag)	[0.0, 0.0, 0.1]
	Hybrid (Diag)	[0.0, 0.0, 0.0, 0.1]
64	NonGalerkin	[0.0, 0.01, 0.1, 1.0]
	Sparse (Diag)	[0.0, 0.0, 0.0, 0.01, 0.1, 1.0]
	Hybrid (Diag)	[0.0, 0.0, 0.0, 0.01, 0.1, 1.0]
128	NonGalerkin	[0.0, 1.0]
	Sparse (Diag)	[0.0, 0.0, 0.1]
	Hybrid (Diag)	[0.0, 0.01, 0.1, 1.0]
256	NonGalerkin	[0.0, 0.01, 0.1, 1.0]
	Sparse (Diag)	[0.0, 0.0, 0.1]
	Hybrid (Diag)	[0.0, 0.0, 0.1]

Table SM19: Florida Sparse Matrix Collection: `ecology2.mtx`

processors	method	γ list
32	NonGalerkin	[0.0, 1.0]
	Sparse (Diag)	[0.0, 0.1]
	Hybrid (Diag)	[0.0, 0.1]
64	NonGalerkin	[0.0, 1.0]
	Sparse (Diag)	[0.0, 0.0, 0.1]
	Hybrid (Diag)	[0.0, 0.0, 0.1]
128	NonGalerkin	[0.0, 1.0]
	Sparse (Diag)	[0.0, 0.0, 0.1]
	Hybrid (Diag)	[0.0, 0.0, 0.1]
256	NonGalerkin	[0.0, 1.0]
	Sparse (Diag)	[0.0, 0.0, 0.1]
	Hybrid (Diag)	[0.0, 0.1]

Table SM20: Florida Sparse Matrix Collection: `parabolic_fem.mtx`

processors	method	γ list
32	NonGalerkin	[0.0, 1.0]
	Sparse (Diag)	[0.0, 0.0, 0.0, 0.01, 0.1, 1.0]
	Hybrid (Diag)	[0.0, 0.0, 0.0, 0.1]
64	NonGalerkin	[0.0, 0.0, 0.0, 0.1]
	Sparse (Diag)	[0.0, 0.0, 0.0, 0.1]
	Hybrid (Diag)	[0.0, 0.0, 0.0, 0.1]
128	NonGalerkin	[0.0, 1.0]
	Sparse (Diag)	[0.0, 0.0, 0.0, 0.1]
	Hybrid (Diag)	[0.0, 0.0, 0.0, 0.1]
256	NonGalerkin	[0.0, 1.0]
	Sparse (Diag)	[0.0, 0.0, 0.0, 0.1]
	Hybrid (Diag)	[0.0, 0.0, 0.1]

Table SM21: Florida Sparse Matrix Collection: `thermal2.mtx`

processors	method	γ list
32	NonGalerkin	[0.0, 0.1]
	Sparse (Diag)	[0.0, 0.0, 0.0, 0.01, 0.1, 1.0]
	Hybrid (Diag)	[0.0, 0.0, 0.0, 0.01, 0.1, 1.0]
64	NonGalerkin	[0.0, 1.0]
	Sparse (Diag)	[0.0, 0.0, 0.1]
	Hybrid (Diag)	[0.0, 0.01, 0.1, 1.0]
128	NonGalerkin	[0.0, 1.0]
	Sparse (Diag)	[0.0, 0.01, 0.1, 1.0]
	Hybrid (Diag)	[0.0, 0.1]
256	NonGalerkin	[0.0, 1.0]
	Sparse (Diag)	[0.0, 0.1]
	Hybrid (Diag)	[0.0, 0.01, 0.1, 1.0]

Table SM22: Florida Sparse Matrix Collection: `thermomech_TK.mtx`

processors	method	γ list
32	NonGalerkin	[0.0, 0.01, 0.1, 1.0]
	Sparse (Diag)	[0.0, 0.0, 0.0, 0.01, 0.1, 1.0]
	Hybrid (Diag)	[0.0, 0.0, 0.0, 0.01, 0.1, 1.0]
64	NonGalerkin	[0.0, 0.0, 0.1]
	Sparse (Diag)	[0.0, 0.0, 0.0, 0.1]
	Hybrid (Diag)	[0.0, 0.0, 0.1]
128	NonGalerkin	[0.0, 0.0, 0.1]
	Sparse (Diag)	[0.0, 0.0, 0.1]
	Hybrid (Diag)	[0.0, 0.0, 0.1]
256	NonGalerkin	[0.0, 0.01, 0.1]
	Sparse (Diag)	[0.0, 0.0, 0.1]
	Hybrid (Diag)	[0.0, 0.0, 0.1]

Table SM23: Florida Sparse Matrix Collection: `tmt_sym.mtx`