Report on parallel code on solving darcy equation

- The first tests were performed for a square grid with different sizes in a single process to check a rough scaling in solver times with the grid size.

Grid size	Solver times (sec)
128x128	0.06
512x512	0.92
1024x1024	3.55
2048x2048	14.68

- These results are for a grid size 8192x4096 which is the maximum possible grid size that can run on a single core of a node with the available memery resources. The number of precesses is increased and it can be seen that the time scales proportional to 1/num_procs.

Num_procs	Setup times (sec)	Solver times (sec)
1	18.21	116.77
2	8.64	57.68
4	4.32	29.91
8	2.23	15.75
16	1.28	10.06
32	0.68	4.70

- The following table is for a fixed grid size 4096x4096 and the initial condition is varied by changing the roughness in lognorm distribution to check the stability of HYPRE and the sparse matrix solver. It is found that the process times are consistent with high roughness of 0.1 to very smooth fractures of roughness 0.00001. This is a very encouraging result.

Roughness	Setup times (sec)	Solver times (sec)
0.1	0.68	4.47
0.01	0.66	4.47
0.001	0.64	4.48
0.0001	0.69	4.47
0.00001	0.66	4.47

- The following table is to check the time scaling of the code when the grid size is increased but the local domain size for each process remains the same. In this table each grid size has a local domain size of 1024x1024. It can be seen that there is some efficiency lost as the number of processes per node increases.

Num_procs	Grid size	Setup times (sec)	Solver times (sec)
1	1024x1024	0.47	3.54
2	2048x1024	0.49	3.66
4	2048x2048	0.50	3.75
8	4096x2048	0.62	3.85
16	4096x4096	0.58	4.39
32	8192x4096	0.68	4.68