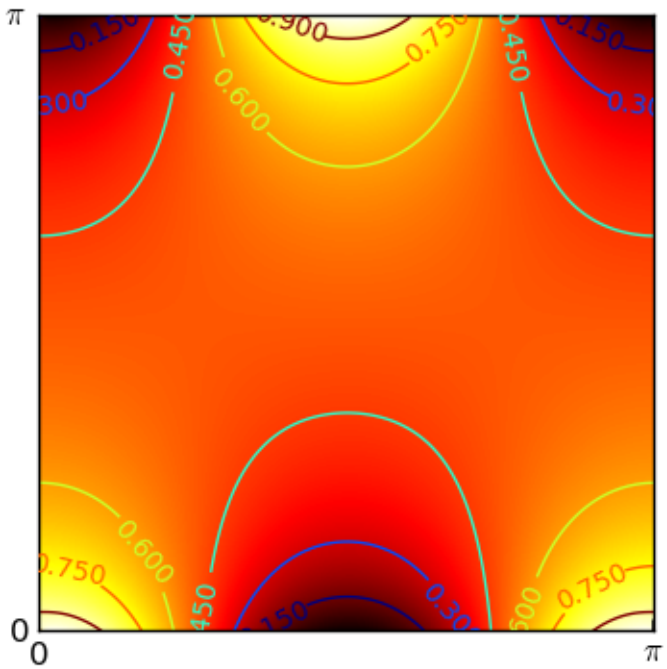
APC 524 – Homework 4

Tom Bertalan

The solution at $t = 0.5\ \pi^2 / \kappa$ had an average of about 0.49, and had the appearance of a smooth transition from the squared-cosine function along the bottom edge to the square-sine function along the top.



Contour plot of solution after final timestep.

Serial

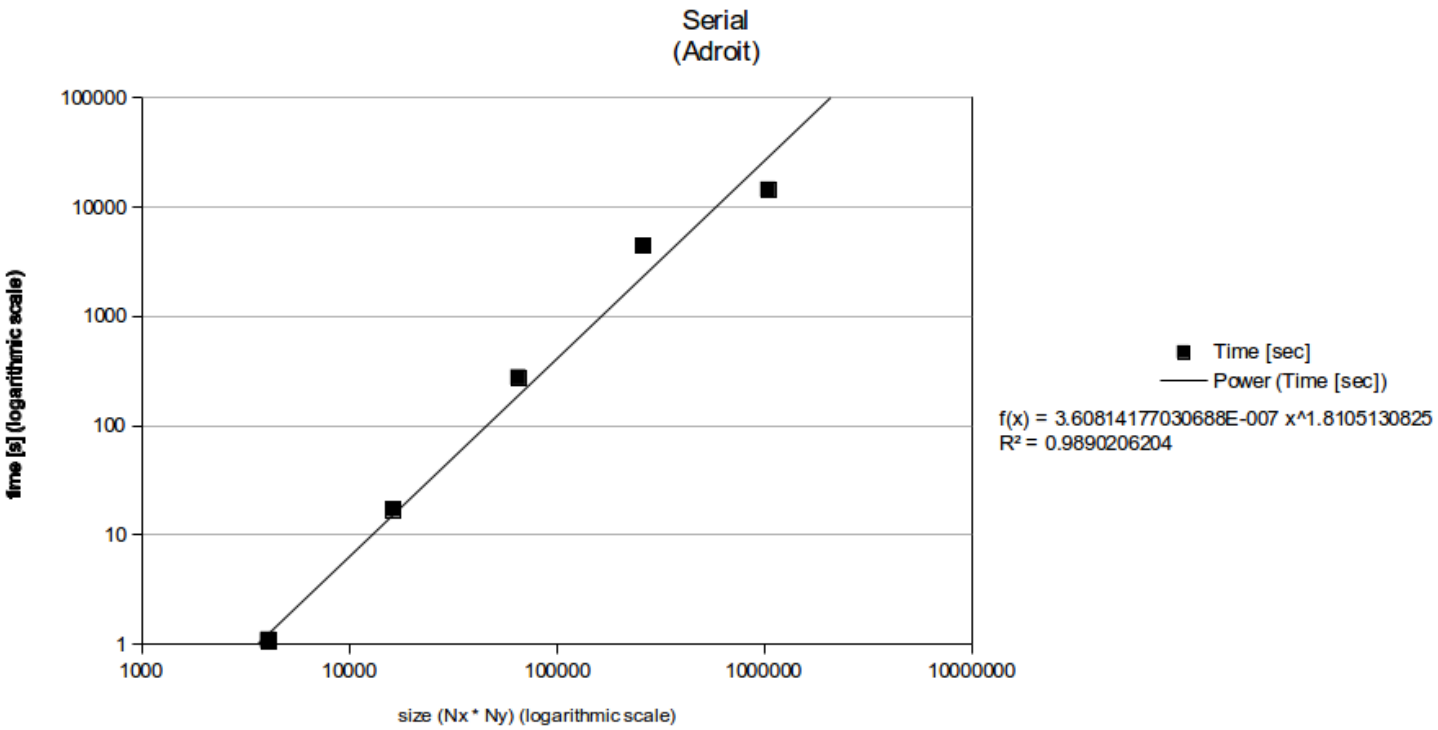
The serial program benefited dramatically from including the level-2 optimization flag in calls to the g++ compiler—there was a 6.96-times speedup for the 1024x1024 problem.

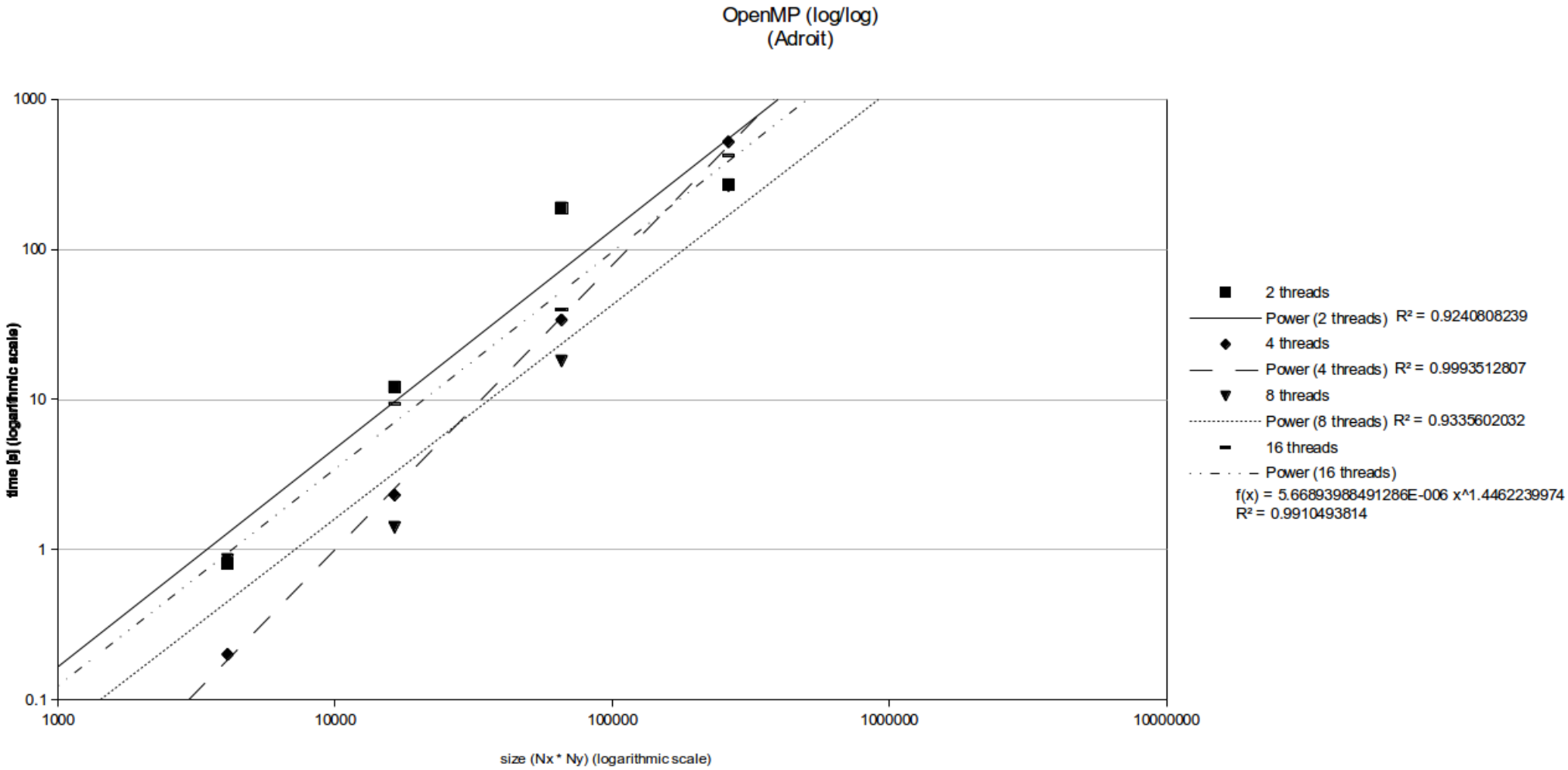
OpenMP

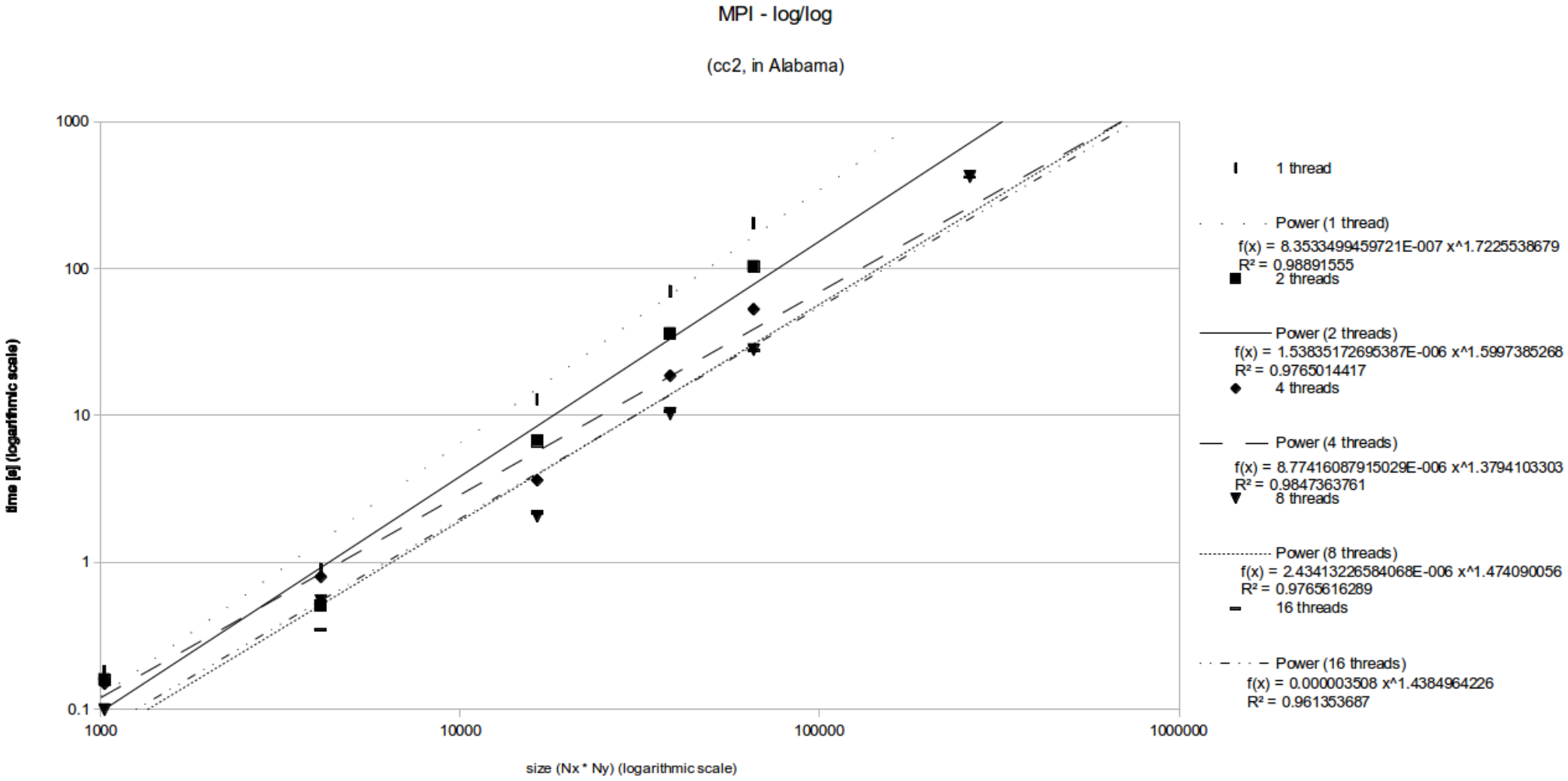
The OpenMP version was recommended by its ease of implementation—a single #pragma preprocessor directive and an extra flag in the makefile were all that was really required to transform the serial program into a parallelized OpenMP program, although code was also added to handle the new number-of-threads command-line argument.

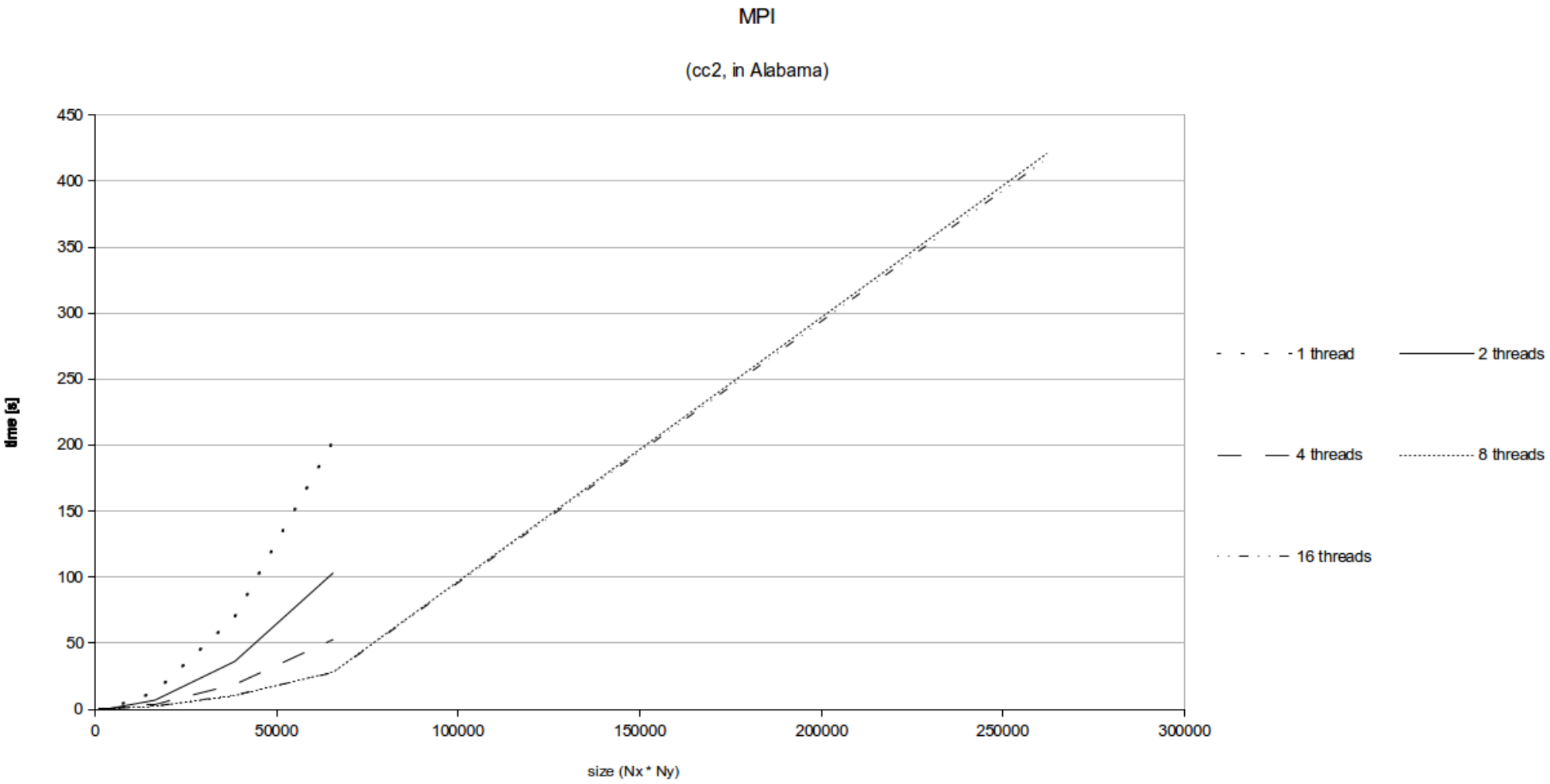
MPI

The MPI (OpenMPI) version had more predictable speed-up with increasing number-of-threads, but was hindered by the complexity of its implementation and therefore its reduced readability.




OpenMP (log/log)
(Adroit)
time [s] (logarithmic scale)
1000
100
10
1
0.1
1000
10000
100000
1000000
10000000
size (Nx * Ny) (logarithmic scale)
2 threads
Power (2 threads) R² = 0.9240808239
4 threads
Power (4 threads) R² = 0.9993512807
8 threads
Power (8 threads) R² = 0.9335602032
16 threads
Power (16 threads)
f(x) = 5.66893988491286E-006 x^1.4462239974
R² = 0.9910493814


MPI - log/log
(cc2, in Alabama)
time [s] (logarithmic scale)
1000
100
10
1
0.1
1000
10000
100000
1000000
size (Nx * Ny) (logarithmic scale)
1 thread
Power (1 thread)
f(x) = 8.3533499459721E-007 x^1.7225538679
R² = 0.98891555
2 threads
Power (2 threads)
f(x) = 1.53835172695387E-006 x^1.5997385268
R² = 0.9765014417
4 threads
Power (4 threads)
f(x) = 8.77416087915029E-006 x^1.3794103303
R² = 0.9847363761
8 threads
Power (8 threads)
f(x) = 2.43413226584068E-006 x^1.474090056
R² = 0.9765616289
16 threads
Power (16 threads)
f(x) = 0.000003508 x^1.4384964226
R² = 0.961353687


MPI
(cc2, in Alabama)
time [s]
450
400
350
300
250
200
150
100
50
0
0
50000
100000
150000
200000
250000
300000
size (Nx * Ny)
1 thread
2 threads
4 threads
8 threads
16 threads