**DART get\_close\_obs() Sequential Version**

Host Platform: Yellowstone Caldera 8-core Intel® Xeon® CPU E5-2670 0@ 2.60GHz

Execution Time is collected as the average of 100 runs.

**CPU Sequential Version 1:** **Intel compiler 15.0.1**

The CPU sequential version was run on Yellowstone supercomputers with **Intel Fortran** Compiler, with compiler options: -O2 -xHost -inline-level=2.

**Table 1.1: CPU Sequential Version with Intel Compiler**

|  |  |  |  |
| --- | --- | --- | --- |
| Number of Observation Locations | Average Execution Time (msecs) | Standard Deviation (msecs) | GFLOPS |
| 256x1024 | 10.8034 | 0.1264 | 0.3154 |
| 512x1024 | 23.1817 | 0.1783 | 0.2941 |
| 1024x1024 | 45.6704 | 0.3598 | 0.2985 |
| 2x1024x1024 | 88.2981 | 0.6404 | 0.3087 |

The CPU sequential version was run on Yellowstone supercomputers with **Intel Fortran** Compiler, with compiler options: -O2 -xHost.

**Table 1.2: CPU Sequential Version with Intel Compiler**

|  |  |  |  |
| --- | --- | --- | --- |
| Number of Observation Locations | Average Execution Time (msecs) | Standard Deviation (msecs) | GFLOPS |
| 256x1024 | 10.9250 | 0.1902 | 0.3119 |
| 512x1024 | 23.9490 | 0.2089 | 0.2847 |
| 1024x1024 | 43.7126 | 0.3097 | 0.3119 |
| 2x1024x1024 | 87.5588 | 0.6321 | 0.3113 |

The CPU sequential version was run on Yellowstone supercomputers with **Intel Fortran** Compiler, with compiler options: -O3 -xHost -inline-level=2.

**Table 1.3: CPU Sequential Version with Intel Compiler**

|  |  |  |  |
| --- | --- | --- | --- |
| Number of Observation Locations | Average Execution Time (msecs) | Standard Deviation (msecs) | GFLOPS |
| 256x1024 | 10.6796 | 0.1635 | 0.3191 |
| 512x1024 | 21.5801 | 0.1853 | 0.3159 |
| 1024x1024 | 43.1317 | 0.3108 | 0.3161 |
| 2x1024x1024 | 86.7465 | 0.6182 | 0.3143 |

The CPU sequential version was run on Yellowstone supercomputers with **Intel Fortran** Compiler, with compiler options: -O3 -xHost.

**Table 1.4: CPU Sequential Version with Intel Compiler**

|  |  |  |  |
| --- | --- | --- | --- |
| Number of Observation Locations | Average Execution Time (msecs) | Standard Deviation (msecs) | GFLOPS |
| 256x1024 | 10.5448 | 0.1888 | 0.3232 |
| 512x1024 | 21.5035 | 0.1959 | 0.3171 |
| 1024x1024 | 44.0840 | 0.3405 | 0.3092 |
| 2x1024x1024 | 88.2941 | 0.5725 | 0.3088 |

Intel Fortran Compiler Options Descriptions:

O2: Enables optimizations for speed. This is the generally recommended optimization level.

This opton also enables:

* Inlining of intrinsics
* Intra-file interprocedural optimizations, which includes:
* Inlining
* Constant propagation
* Forward substitution
* Routine attribute propagation
* Variable address-taken analysis
* Dead static function elimination
* Removal of unreferenced variables
* The following capabilities for performance gain:
* Constant propagation
* Copy propagation
* Dead-code elimination
* Global register allocation
* Global instruction scheduling and control speculation
* Loop unrolling
* Optimized code selection
* Partial redundancy elimination
* Strength reduction/induction variable simplification
* Variable renaming
* Exception handling optimizations
* Tail recursions
* Peephole optimizations
* Structure assignment lowering and optimizations
* Dead store elimination

O3: Enables O2 optimizations plus more aggressive optimizations, such as prefetching, scalar replacement, and loop and memory access transformations. Enables optimizations for maximum speed, such as:

* Loop unrolling, including instruction scheduling
* Code replication to eliminate braches
* Padding the size of certain power-of-two arrays to allow more efficient cache use.

The O3 optimizations may not cause higher performance unless loop and memory access transformations take place. The optimizations may slow down code in some cases compared to O2 optimizations.

The O3 option is recommended for applications that have loops that heavily use floating-point calculations and process large data sets.

Function inlining has already been performed by enabling O2, therefore, -inline-level=2 has no effect on performance.

**CPU Sequential Version 2: PGI compiler 15.1**

The CPU sequential version was run on Yellowstone supercomputers with **PGI Compiler**, with compiler option: -O2.

**Table 2.1: CPU Sequential Version with PGI Compiler**

|  |  |  |  |
| --- | --- | --- | --- |
| Number of Observation Locations | Average Execution Time (msecs) | Standard Deviation (msecs) | GFLOPS |
| 256x1024 | 24.3506 | 0.1126 | 0.1399 |
| 512x1024 | 50.7046 | 0.1817 | 0.1345 |
| 1024x1024 | 98.1269 | 0.2809 | 0.1389 |
| 2x1024x1024 | 196.0875 | 0.4029 | 0.1390 |

The CPU sequential version was run on Yellowstone supercomputers with **PGI Compiler**, with compiler option: -O3.

**Table 2.2: CPU Sequential Version with PGI Compiler**

|  |  |  |  |
| --- | --- | --- | --- |
| Number of Observation Locations | Average Execution Time (msecs) | Standard Deviation (msecs) | GFLOPS |
| 256x1024 | 24.4681 | 0.1178 | 0.1393 |
| 512x1024 | 48.9802 | 0.1876 | 0.1392 |
| 1024x1024 | 98.0082 | 0.2431 | 0.1391 |
| 2x1024x1024 | 196.1205 | 0.4146 | 0.1390 |

The CPU sequential version was run on Yellowstone supercomputers with **PGI Compiler**, with compiler option: -fast.

**Table 2.3: CPU Sequential Version with PGI Compiler**

|  |  |  |  |
| --- | --- | --- | --- |
| Number of Observation Locations | Average Execution Time (msecs) | Standard Deviation (msecs) | GFLOPS |
| 256x1024 | 24.4643 | 0.5717 | 0.1393 |
| 512x1024 | 48.9827 | 0.2812 | 0.1392 |
| 1024x1024 | 98.1438 | 0.3820 | 0.1389 |
| 2x1024x1024 | 196.7544 | 0.9840 | 0.1386 |

PGI Compiler Options Descriptions:

fast: Enables vectorizations with SSE instructions, cache alignment, and flushz for 64-bit targets.

O2: Level tow specifies global optimization. This level performs all level-one optimization (scheduling of basic blocks, register allocations) as well as level-two global optimization (traditional scalar optimizations, induction recognition, and loop invariant motion). In addition, this level enables more advanced optimizations such as SIMD code generation, cache alignment, and partial redundancy elimination.

O3: Level three specifies aggressive global optimization. This level performs all level-one and level-two optimizations and enables more aggressive hoisting and scalar replacement optimizations that many or may not be profitable.