Rapid Model Fitting Tool Suite Summary

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An integral component of many NASA missions involves remote sensing of the environment, both terrestrial and celestial. This is a challenging problem, since quantities of interest typically cannot be directly measured but instead must be inferred. These inferences are made by solving inverse problems, where complex forward models are inverted to estimate parameters of the model. These parameters correspond to physical properties of the environment. Because of the complexity of many forward models, inversion is usually accomplished by minimizing the difference between observations and model predictions through adjustment of model parameters. This minimization process is computationally demanding, since it requires evaluating the forward model many times and minimizing a function of many variables.

In this project, we have developed a fast general-purpose parameter fitting software tool suite for fitting model parameters to observed data using low-cost high-performance hardware accelerators. The tool suite will allow NASA scientists to use state of the art high-performance computing resources to speed their work.

In the Phase I of this project we have shown that the three key components of model fitting, namely model evaluation, gradient calculation and cost functional minimization, can be accelerated using graphical processing unit (GPU) technology. In addition, we have demonstrated the performance benefits directly for curve fitting code from the NASA Stratospheric Aerosol and Gas Experiment (SAGE) III mission.

During Phase II, we have worked to accelerate the line-by-line code provided by NASA scientists from the (SAGE) III mission. Using NVIDIA's CUDA to move portions of the code to a GPU and various other CPU optimizations to the code, we have achieved a 24x speedup on our test input data.

We have also added accelerated linear algebra and curve fitting capabilities to our commercial product for GPU acceleration of IDL, GPULib. The ability to evaluate generic expressions for curve fitting also led to more generic runtime evaluation and the exploration of OpenCL, which has increased interest and the available market for our product. We have released two versions of this product in the last year and intend to release another in the coming months.