GPU-based Approaches for Speeding up the Spherical Harmonic Transform on Reduced Gaussian Grid in CWAGEPS Model

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Abstract

The discrete spherical harmonic transformation, involving the Fourier and Legendre transforms, is vital for efficiently solving partial differential equations defined on the spherical coordinate system. Owing to the multi-core architecture of graphic processing units (GPUs), which allows parallelly executing the same algorithm on multiple data sets, many classical algorithms have been modified and imported to accelerate computations on GPUs. For example, the discrete spherical harmonic transformation for variables collocated on a regular Gaussian grid mesh can be accelerated by utilizing all the GPU cores based on the same fast Fourier transform plan because the numbers of Fourier grid points on all latitude lines are the same. However, the situation is different for variables collocated on the reduced Gaussian grid mesh. The numbers of Fourier grid points on different latitude lines are not the same, and uniformity breaks down. Hence, speeding the spherical harmonic transform depends on whether it can utilize as many GPU cores as possible when executing multiple fast Fourier transform plans. In this talk, we will discuss relevant issues and present some GPU-based approaches for accelerating the spherical harmonic transformation used in the dynamic core of the CWAGEPS model developed by the Central Weather Administration Taiwan.

Keywords: spherical harmonic transformation, fast Fourier transform, reduced Gaussian grid, GPU