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The coming role of GPU in computational geosciences

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For the last couple of years GPU has been catching the attention of many interested parties in computational world, because of its alluring speed and inherent potential growth over CPU. With the arrival of CUDA in 2007, which has really facilitated the GPU programming of scientific software, GPU has really expanded into diverse scientific areas, ranging from chemistry to astrophysics. Geosciences proved to be no exception to this trend and we are seeing already some incursions by GPU into seismic wave propagation, flow in fractured porous media and tsunami wave studies. Today we will discuss our experience with GPU in thermal convection. We will review our venture into using a translator of MATLAB codes into CUDA via JACKETS, which is a product of Accelereyes. This effort has allowed us to study 3D thermal convection at the Infinite Prandtl limit at a resolution of 400x400x200 finite-difference points with a second-order accurate in space and third-order in time. We have also implemented a CUDA code from scratch of a 2-D thermal convection code with the same spatial-temporal accuracy as the 3D code. This code can attain a speed on a single Tesla C-1060 GPU on the order of O(0.1) microsec/ time step grid point at the limit of asymptotically large number of grid points. We will present results at large Rayleigh numbers, in excess of a hundred million and compare them with CPU results.