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Demonstrating the Power of GPU Simulations for an Advection-Reaction-Diffusion Model

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Land surface models are important for regional-scale assessments and studies on ecosystem services. Cheng et al (this session) demonstrated that the explicit representation of small-scale ecosystem processes, i.e. vegetation pattern formation processes in land surface models can improve the realism and accuracy of these models. However, the explicit inclusion of these small-scale processes into models comes at a real cost; specifically, a large computational cost that most research groups cannot afford. We propose the utilization of advanced computational techniques and algorithms (i.e. GPU acceleration) to overcome the computational bottleneck and allow most research groups to simulate fine-scale processes for regional assessments. We demonstrate the processing power of GPU acceleration through a comparison study on the processing speed of an existing, spatially explicit, advection-reaction-diffusion model coded in a GPU framework and the same model coded in a CPU framework. This is the same code shown in the Cheng et al presentation, discussed in this session. The performance of the model is evaluated based on the total number of frames/time-steps for five different simulation grid sizes. Results also show that for all simulations the GPU framework has higher processing speed than the CPU framework by approximately two orders of magnitude for all domain sizes. Based on the speeds derived from the comparison study, we calculated the amount of time needed to complete a 50-year simulation, for a simulation grid of approximately 105 km2. The simulation took 41 min to complete on a GPU, but 110 times longer, or 76 hours using the CPU only.