XVII Workshop de Computação Aplicada
WORCAP 2017

Parallelization techniques applied to the MGB hydrological model

Henrique Rennó de Azeredo Freitas; Celso Luiz Mendes

henrique.renno@inpe.br

Hydrological modeling is mainly concerned with the flow of water on rivers and watersheds, which is fundamental to study and to analyze floods and droughts, forecast of discharge, quality of water, and many other applications. The main equations associated to the process of propagation of water flows on rivers are the Saint-Venant equations, including their simplifications, that form a set of partial differential equations to be numerically solved in a computer. Moreover, depending on the numerical method, the solution may require more computational effort to produce the results at each time step. For this reason, parallel computing can be employed to reduce the time needed to find the solution by using a computer system manufactured with multiple processors (CPUs) that support parallel programming, known as shared memory environments, and also systems with graphics processing units (GPUs). This work focuses on the application of parallelization techniques to the MGB hydrological model that is coded in Fortran 90 and includes numerical methods for representing hydrological processes in large-scale watersheds. The interfaces used for parallel programming are OpenMP for CPUs and OpenACC for GPUs, where both interfaces include a set of directives that instruct the compiler how to parallelize parts of the code. Results indicate that parallelization of the most time-consuming parts with either CPUs (threads in an appropriate load balancing scheme) or GPUs can improve model performance, although a hybrid approach that uses both CPUs and GPUs is also being considered with the aim of achieving better performance. For the parallel simulations of the model, this work employed computing resources of the Laquibrido cluster, maintained by LAC/INPE.

Hydrological modeling. numerical methods. parallel programming