Research Proposal for the Degree of Master of Science in Applied Mathematics

Parallel Preconditioners for MODFLOW

Together with Deltares, the United States Geological Survey (USGS) is evaluating parallel solution strategies for MODFLOW. MODFLOW is the USGS finite-volume code that solves the groundwater flow equation and is used by many hydrologists to simulate flow of groundwater through aquifers. MODFLOW is written primarily in FORTRAN and is distributed as public domain software. The linear system of equations is solved by means of conjugate gradients (CG). Picard and Newton outer iterations are used to incorporate nonlinearity, which requires that the linear system be solved repeatedly for each time step. To improve performance and flexibility, the solver will be parallelized for both shared-memory computers (OpenMP) and for distributed memory computers (MPI). For the MPI-version, an overlapping, Restricted Additive Schwarz (RAS) domain decomposition method is implemented, that is accelerated by CG. The subdomain solution is obtained by preconditioning only, using incomplete LU factorization. However, there is not much experience yet with the implemented RAS-preconditioner, regarding both parallel scalability and convergence behavior. The goal of the Master's project is to get this experience and to improve the parallel preconditioner where possible.