Title:

Solving Helmholtz’s equation in NWP models with a stabilized bi-conjugate gradient iterative solver.

Abstract:

The China Meteorological Administration (CMA) GRAPES Global and Regional weather models were optimized and benchmarked on a parallel supercomputer system. Both models were configured for optimal execution, in order to meet certain performance and accuracy requirements. The codes were profiled on the system and it was determined that a large part of their execution time was due to the solution of Helmholtz’s equation via a Generalized Conjugate Residual (GCR) algorithm. It was found that the introduction of the Bi-conjugate Gradient Stabilized algorithm (BiCGSTAB) improved overall performance in the GRAPES models when used as pre-cursor to the application of the GCR. Thus, the amount of iterations required for the convergence of the GCR algorithm decreased significantly, allowing both GRAPES models to execute faster, while offering the same and even better computational accuracy than the original GCR algorithm. Since additional optimizations were performed, the effect of each optimization step on the accuracy of the computations of the 10-day forecast with the GRAPES global model is examined. Comparisons were conducted for each of the 10 simulated days, by visual inspection of the generated 500mb Geopotential heights and non-convective precipitation fields against those obtained in base runs. In addition, correlation coefficients and area averaged errors for the 500mb Geopotential heights were computed as a function of the forecast days. It was found that the introduced optimizations did not alter significantly the accuracy of the obtained results for less than six forecast days. The forecasts however, show increased deterioration if extended to more than 8 days.