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Convergence acceleration for difference equations with flat grids: Application to incompressible atmospheric flow

Melitta Fiebig-Wittmaack (1), Wolfgang Boersch-Supan (2), Ingeborg Bischoff-Gauss (3), and Orlando Astudillo (4)

(1) Mathematical Department, University of La Serena, Chile (melitta.fiebig@userena.cl), (2) Mathematical Department, Johannes-Gutenberg University, Germany (wolfgang.boerschsupan@gmail.com), (3) Steinbuch Centre for Computing, Karlsruhe Institute of Technology, Germany (ingeborg.bischoff-gauss@kit.edu), (4) Centre for Advanced Studies in Arid Zones, Chile (orlando.astudillo@ceaza.cl)

In geophysical fluid dynamics modeling, the convergence of many iterative procedures, in particular of the conjugate gradient method, strongly depends on the condition number of the linear system to be solved. In cases with a large condition number, therefore, preconditioning is often used to transform the system to an equivalent one, with smaller condition number and therefore faster convergence. For Poisson-like difference equations with flat grids, the vertical part of the difference operator is dominant and tridiagonal and can be used for preconditioning.
In the present study such a procedure has been applied on incompressible atmospheric flows in order to maintain incompressibility, where a system of Poisson-like difference equations is to be solved for the dynamic pressure part. For an example in mesoscale atmospheric modeling, it is shown that convergence has been speeded up considerably, improving the efficacy of the numerical procedures involved, even though the system matrix is not symmetric and, hence, the biconjugate gradient method must be used.