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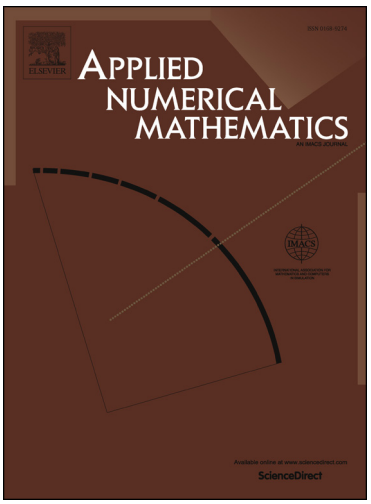

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A Lagged Diffusivity Method for reaction-convection-diffusion equations with Dirichlet boundary conditions

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Abstract

In this paper we solve a 2D nonlinear, non-steady reaction-convection-diffusion equation subject to Dirichlet boundary conditions by an iterative procedure consisting in lagging the diffusion term.

First, we analyze the procedure, which we call Lagged Diffusivity Method. In particular, we provide a proof of the uniqueness of the solution and of the convergence of the lagged iteration when some assumptions are satisfied. We also describe outer and inner solvers, with special regard to how to link the stopping criteria in an efficient way.

Numerical experiments are then introduced in order to evaluate the role of different linear solvers and of other components of the solution procedure or parameters of the discretization.

Keywords: Non-steady reaction-convection-diffusion equation, Lagged Diffusivity Method, Finite difference discretization

2010 MSC: 65H10, 65M06, 65M22

1. Introduction

Processes involving reaction, convection and diffusion are of great importance in several fields of science. On a mathematical point of view, a process of this kind in a bounded diffusion medium and with suitable boundary and initial conditions can be described by the nonlinear, non-steady reaction-convection-diffusion equation. A rich bibliography on how to solve partial differential equations of this kind exists: e.g. see [12] for an analysis on this topic, including the description of existing solution methods and applications.

Calling Ω a two-dimensional diffusion medium, $\partial\Omega$ its boundary and $\overline{\Omega} = \Omega \cup \partial\Omega$ its closure, in this paper

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