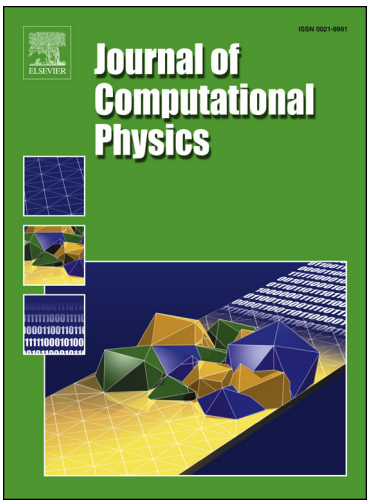
Accepted Manuscript



The standard upwind compact difference schemes for incompressible flow simulations

Ping Fan

PII: S0021-9991(16)30255-8
DOI: http://dx.doi.org/10.1016/j.jcp.2016.06.030
Reference: YJCPH 6691

To appear in: *Journal of Computational Physics*

Received date: 20 November 2015
Revised date: 5 May 2016
Accepted date: 16 June 2016

Please cite this article in press as: P. Fan, The standard upwind compact difference schemes for incompressible flow simulations, *J. Comput. Phys.* (2016), http://dx.doi.org/10.1016/j.jcp.2016.06.030

This is a PDF file of an unedited manuscript that has been accepted for publication. As a service to our customers we are providing this early version of the manuscript. The manuscript will undergo copyediting, typesetting, and review of the resulting proof before it is published in its final form. Please note that during the production process errors may be discovered which could affect the content, and all legal disclaimers that apply to the journal pertain.

ACCEPTED MANUSCRIPT

The standard upwind compact difference schemes for incompressible flow simulations

Ping Fan*

Institute of Process Engineering, Chinese Academy of Sciences, Beijing 100190, China

Abstract

Compact difference schemes have been used extensively for solving the incompressible Navier-Stokes equations. However, the earlier formulations of the schemes are of central type (called central compact schemes, CCS), which are dispersive and susceptible to numerical instability. To enhance stability of CCS, the optimal upwind compact schemes (OUCS) are developed recently by adding high order dissipative terms to CCS. In this paper, it is found that OUCS are essentially not of the upwind type because they do not use upwind-biased but central type of stencils. Furthermore, OUCS are not the most optimal since orders of accuracy of OUCS are at least one order lower than the maximum achievable orders. New upwind compact schemes (called standard upwind compact schemes, SUCS) are developed in this paper. In contrast to OUCS, SUCS are constructed based completely on upwind-biased stencils and can hence gain adequate numerical dissipation with no need for introducing optimization calculations. Furthermore, SUCS can achieve the maximum achievable orders of accuracy and hence be more compact than OUCS. More importantly, SUCS have prominent advantages on combining the stable and high resolution properties which are demonstrated from the global spectral analyses and typical numerical experiments.

Keywords: compact difference scheme; upwind scheme; upwind compact scheme; incompressible flows; lid-driven cavity

1. Introduction

Compact difference schemes have been widely used to compute problems involving compressible and incompressible flows and several other practical applications [Fu & Ma 1997, Sun & Li 2014, Zhou et al. 2015, Xie et al. 2009, Mohebbi et al. 2013]. Compared to the explicit type schemes of the same order of accuracy, high order compact difference schemes have the advantage of not only avoiding cumbersomely large size stencils but also providing spectral-like resolution characteristics. Compact

* *E-mail address*: pfan@ipe.ac.cn (P. Fan), fanping@imech.ac.cn (P. Fan)

Download English Version:

https://daneshyari.com/en/article/6929536

Download Persian Version:

https://daneshyari.com/article/6929536

Daneshyari.com