THE WINTERSCHOOL ON ENVIRONMENTAL AND INDUSTRIAL CFD SIMULATIONS
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1 Introduction

It became a tradition to organise specialised summercourses and summerschools for under- and postgraduate students around the world. These courses are great opportunity for students, teachers and specialists from different countries to meet at interesting places, discuss common problems, exchange their knowledge and experience in the area they are all together interested in. These summerschools and summercourses usually profit from the long summer holidays when both, students and teachers, have enough time to organise and attend the courses.

The basic idea behind the international course week in Prague was the same as in the classical "summerschool" case. However we have decided to place the lectures into the last week of winter holidays, i.e. the last week in February. Thus it was obvious that we can not call this event "summerschool" (unless redefining the term "summer" by taking into account the snow in Prague) and that was the moment when the "Winterschool on Environmental and Industrial Computational Fluid Mechanics" was born.

2 Objectives

When preparing the Winterschool, we had several objectives in mind:

- Bring together people interested in CFD simulations of environmental and industrial problems.
- Offer to the students the latest state of the art in theoretical and applied CFD.
- Establish and reinforce the contacts between young specialists from different European countries.
- Present Prague and Czech republic as a partner in the future European Union community research and education programmes.

Among these basic objectives, we have appreciated the chance to include into the framework of the Winterschool also the "Conference on Topical Problems in Fluid Mechanics" which is every year held at this time in Prague. This connection with the conference gave us the opportunity to offer to the students to present their works before an international audience and also to see the latest developments in the fluid mechanics research in Czech Republic and abroad.

3 Programme

All the above objectives were reflected in the Winterschool programme. In the five-day Winterschool schedule, there were four lecture-days and one conference-day. Three 90 minutes lectures were scheduled for Monday, Tuesday, Thursday and two lectures for Friday. Wednesday was reserved for the attendance of the conference on "Topical Problems in Fluid Mechanics 2004".

The following lectures have been presented during the Winterschool:

(1) T. Bodnár & K. Kozel
Classical methods for CFD

(2) J. Fürst
High resolution finite-volume methods for transonic flows

(3) J. Neustupa & A. Novotný
Navier-Stokes equations

(4) J. M. Redondo
Stratified and rotating flows

(5) P. Burda
Stabilised finite-element methods for incompressible flows

(6) M. Feistauer
High resolution finite-element methods for compressible flows

(7) N. Seguin & Ph. Helluy
Source terms and well balanced schemes for conservation laws

(8) Ph. Helluy
Entropy optimisation scheme

(9) J. Fořt
Numerical solution of some industrial flow problems

(10) J. Příhoda & Z. Jaňour
Turbulence models for environmental and industrial flows

(11) Ph. Fraunié
Small scale modelling in stratified environmental flows

4 Main Topics

The scope of the Winterschool was very wide, however it is possible to recognise there at least three main topics addressed:

In the first part of lectures the mathematical background of several models describing incompressible and compressible fluid flow has been discussed. The most important qualitative properties of solution and some fundamental methods of their theoretical analysis have been presented for these models. To this more or less theoretical part we could add the lectures dealing some basic and advanced numerical techniques for solution of the above discussed mathematical models of fluid flow problems. The overview of methods has started from some classical finite-difference methods and their analysis and improvements. Further the finite-volume methods have been introduced and some of their advanced variants have been discussed. The finite-element techniques for incompressible and compressible flows have been presented including the discussion of the recent developments in discontinuous Galerkin techniques. From the lectures dealing these subjects let's mention the ***(1)***, ***(2)***, ***(3)***, ***(5)*** and ***(6)***.

In the second part of the lectures mainly the physical phenomenology of selected environmental and industrial problems has been addressed. Special attempt was made to clarify the effects of turbulence, fluid rotation and stratification. These phenomena are one of the most important features mainly in environmental applications. The aim of all lectures was not only explain how does the physics of these phenomena looks like, but also to show how it can be modelled in the CFD simulations. This has been appreciated mainly in the lectures concerning turbulence effects and their modelling in environmental as well as in industrial applications. Among the lectures dealing these subjects let's mention the ***(4)***, ***(10)*** and ***(11)***.

The last part of lectures collects the selected advanced applications of mathematical and numerical methods. Many of the methods and models discussed and developed in the previously mentioned lectures have been extended and applied for practical cases. The range of applications mentioned in this part covers among others the internal and external transonic flows, free-surface flows and atmospheric boundary layer flows. The problems appearing in formulation, numerical implementation and solution have been discussed in detail. From the lectures dealing these advanced applications let's mention ***(1)***, ***(7)***, ***(8)*** and ***(9)***.

5 Conclusions & Perspectives

The choice of topics addressed during the Winterschool seems to match exactly the actual trends of applied CFD. The importance of interconnection of environmental and industrial simulations is one of the most challenging and promising ways of future CFD applications. The increasing interest in many interdisciplinary simulations could be demonstrated by the large number of participating students (about 40) and extremely interesting discussions following each of the presented lectures.

The overall reaction of students and lecturers to the Winterschool scientific programme, organisation and also to the Prague as a suitable place for scientific meetings, enables us to judge the Winterschool EICFD2004 as extremely successful. This great success of the Winterschool together with the interest of students and enthusiasm of lecturers are promising signals for the possible future continuation of this type of courses in Prague.

Finally let's acknowledge the generous support of the organising institutions without the which it would be impossible to organise such a successful course. Special thanks belongs to the Institute of Thermomechanics of the Academy of Sciences of Czech Republic for providing all the technical background of the Winterschool. The accommodation of students and lecturers in Prague has been made possible due to the support from Czech Technical University in Prague. Finally the great number of students has profitted from the financial support from ERCOFTAC which has significantly reduced the Winterschool registration fees.

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