

Chapter 1

A Review of Progress on Direct and Large-Eddy Simulation

N.D. Sandham

**Department of Aeronautics and Astronautics, University of
Southampton, Southampton SO17 1BJ, UK**

Abstract A review is given of direct and large-eddy simulation which is intended to summarize state-of-the-art research presented during the 1999 Isaac Newton Institute Programme on Turbulence. Introductions to the techniques are given, along with examples of applications across a range of turbulent and transitional flow problems. Recent developments in techniques for large-eddy simulation are highlighted. The discussion includes a summary of the guidelines proposed during the programme for practical large-eddy simulations and comments on problem areas that require further research.

1.1 Background

A 6-month Programme on Turbulence took place at the Isaac Newton Institute in Cambridge during the first 6 months of 1999. The programme gathered together researchers from around the world and stimulated the use of their complementary expertise to study aspects of turbulence in fluid flow. At any one time up to 20 academics occupied office space in the Institute building and this number was supplemented by numerous short stay participants. The programme involved participation from a core of industry sponsors (British Aerospace, Rolls-Royce, British Energy, DERA, BG Technology and the Meteorological Office), coordinated by the Royal Academy of Engineering. During the 6-month programme a number of small Workshops and larger Symposia were organized to treat specialized areas of turbulence research.

One significant area of activity during the programme concerned numerical simulation of time-dependent turbulent flow, either by direct numerical simulation (DNS) or large-eddy simulation (LES). Introductions to these areas were given during the Instructional Conference (April 6-16th), lecture notes from which will appear in [1]. More detailed discussions on LES followed during the Mathematics of Closure Workshop (April 19-30th) and there was a large 3-day Symposium on DNS and LES, organized in collaboration with ERCOFTAC with close to 100 participants (May 12-14th), proceedings from which will appear in [2]. The Symposium consisted of 6 invited talks, 30 contributed papers and 15 poster presentations. Resident participants with interests in DNS and LES included Jim Brasseur (Penn State,