



LARGE EDDY
SIMULATION
of COMPLEX
ENGINEERING
and GEOPHYSICAL
FLOWS

Edited by

Boris Galperin

Steven A. Orszag

Large Eddy Simulation of Complex Engineering and Geophysical Flows

Edited by

BORIS GALPERIN

University of South Florida

STEVEN A. ORSZAG

Princeton University



CAMBRIDGE
UNIVERSITY PRESS

Contents

<i>Contributors</i>	page ix
<i>Preface</i>	xv
<i>Plates</i>	xix
Part One: Fundamentals of Large Eddy Simulation	
1 Some Historical Remarks on the Use of Nonlinear Viscosities <i>Joseph Smagorinsky</i>	3
2 Subgrid-Scale Modeling <i>Joel H. Ferziger</i>	37
3 Some Basic Challenges for Large Eddy Simulation Research <i>Steven A. Orszag, Ilya Staroselsky, and Victor Yakhot</i>	55
4 Some Contributions of Two-Point Closure to Large Eddy Simulations <i>Jackson R. Herring and Robert M. Kerr</i>	79
5 Stochastic Backscatter Formulation for Three-Dimensional Compressible Flows <i>Cecil E. Leith</i>	105
Part Two: Large Eddy Simulation in Engineering	
6 Applications of Large Eddy Simulations in Engineering: An Overview <i>Ugo Piomelli</i>	119

Incompressible Flows

- 7 Large Eddy Simulation of Scalar Transport with the Dynamic Subgrid-Scale Model 141
William Cabot and Parviz Moin
- 8 Renormalization Group Theory Simulation of Transitional and Turbulent Flow over a Backward-Facing Step 159
George E. Karniadakis, Steven A. Orszag, and Victor Yakhot
- 9 Spectral Large Eddy Simulation of Turbulent Shear Flows 179
Marcel Lesieur, Olivier Métais, Xavier Normand, and Aristeu Silveira-Neto
- 10 Anisotropic Representation of Subgrid-Scale Reynolds Stress in Large Eddy Simulation 193
Kiyosi Horiuti
- 11 Large Eddy Simulation of Transitional Flow 209
Thomas A. Zang and Ugo Piomelli

Compressible and Reacting Flows

- 12 Direct Numerical Simulation and Large Eddy Simulation of Compressible Turbulence 231
Gordon Erlebacher and Mohammed Y. Hussaini
- 13 Large Eddy Simulation of Mixing Layers 255
Saad A. Ragab and Shaw-Ching Sheen
- 14 A Linear-Eddy Mixing Model for Large Eddy Simulation of Turbulent Combustion 287
Suresh Menon, Patrick A. McMurtry, and Alan R. Kerstein
- 15 Direct Numerical Simulation and Large Eddy Simulation of Reacting Homogeneous Turbulence 315
Cyrus K. Madnia and Peyman Givi

Part Three: Large Eddy Simulation in Geophysics

- 16 Large Eddy Simulation in Geophysical Turbulence Parameterization: An Overview 349
John C. Wyngaard and Chin-Hoh Moeng

Atmospheric Sciences

- 17 Using the Regional Atmospheric Modeling System in the Large Eddy Simulation Mode: From Inhomogeneous Surfaces to Cirrus Clouds 369
William R. Cotton, Robert L. Walko, Keeley R. Costigan, Piotr J. Flatau, and Roger A. Pielke

- 18 Large Eddy Simulation of Turbulent Convection over Flat
and Wavy Surfaces 399
Ulrich Schumann

Physical Oceanography

- 19 The Role of Oceans in Climate Change: A Challenge to
Large Eddy Simulation 425
Greg Holloway
- 20 Modeling the Oceanic Planetary Boundary Layer 441
*James C. McWilliams, Patrick C. Gallacher,
Chin-Hoh Moeng, and John C. Wyngaard*
- 21 Diapycnal Mixing in the Ocean: A Review 455
Peter Müller
- 22 Near-Surface Mixing and the Ocean's Role in Climate 489
Mark A. Cane

Environmental Flows

- 23 Conjunctive Filtering Procedures in Surface Water Flow
and Transport 513
Keith W. Bedford and Woon K. Yeo
- 24 Leonard and Cross-Term Approximations in the Aniso-
tropically Filtered Equations of Motion 539
Alvaro A. Aldama
- 25 Large Eddy Simulation as a Tool in Engineering and Geo-
physics: Panel Discussion 559
Thomas A. Zang

Part Four: Large Eddy Simulation and Massively Parallel Computing

- 26 Parallel Computing for Large Eddy Simulation 569
Cecil E. Leith
- 27 Geophysical Fluid Dynamics, Large Eddy Simulation, and
Massively Parallel Computing 577
William P. Dannevik

- Index* 597