

# **21st AIAA Computational Fluid Dynamics Conference 2013**

**San Diego, California, USA  
24-27 June 2013**

**Volume 1 of 4**

**ISBN: 978-1-62748-892-1**

**Printed from e-media with permission by:**

Curran Associates, Inc.  
57 Morehouse Lane  
Red Hook, NY 12571



**Some format issues inherent in the e-media version may also appear in this print version.**

The contents of this work are copyrighted and additional reproduction in whole or in part are expressly prohibited without the prior written permission of the Publisher or copyright holder. The resale of the entire proceeding as received from CURRAN is permitted.

For reprint permission, please contact AIAA's Business Manager, Technical Papers. Contact by phone at 703-264-7500; fax at 703-264-7551 or by mail at 1801 Alexander Bell Drive, Reston, VA 20191, USA.

# TABLE OF CONTENTS

## VOLUME 1

<b>Coupled/Decoupled Solutions of RANS Equations using a Jacobian-free Newton-Krylov Method</b> .....	1
<i>Cedric Content, Pierre-Yves Outtier, Paola Cinnella</i>	
<b>Advanced Numerical Simulation of Mixing Hot Core and Cold Bypass Flow in Modern Propulsion Systems with Internal Lobed Forced Mixer</b> .....	13
<i>Sebastian F. Saegeler, Christian Mundt</i>	
<b>Bypass Transition and Tripping in Reynolds-stress Model Computations</b> .....	29
<i>G. A. Gerolymos, Isabelle Vallet</i>	
<b>Adverse Pressure Gradient Modification to Turbulence Models for Wall-bounded Flows</b> .....	46
<i>Shivaji Medida, James Baeder</i>	
<b>An Investigation into the Failure of a Non-Linear Eddy-Viscosity Model in Capturing the Laminarisation Phenomenon</b> .....	56
<i>Amir Keshmiri, Rasool Erfani, Hamidreza Gohari Darabkhani</i>	
<b>Hole Cutting of Curved Discontinuous Galerkin Chimera Overset Meshes using a Direct Cut Method</b> .....	69
<i>Marshall C. Galbraith, Paul D. Orkwis, John Benek</i>	
<b>Aerodynamic and Acoustic Analysis of an Extruded Airfoil with a Trailing Edge Device Using Detached Eddy Simulation with a Discontinuous Galerkin Method</b> .....	94
<i>Michael Wurst, Manuel Kessler, Ewald Kraemer</i>	
<b>High Order Schemes for Cylindrical/spherical Coordinates with Radial Symmetry</b> .....	103
<i>Sheng Wang, Eric Johnsen</i>	
<b>Fully Compressible Flow Model and High-order Simulation of Convection and Differential Rotation of Solar Convection Zone</b> .....	113
<i>Junfeng Wang, Chunlei Liang, Mark Miesch</i>	
<b>High-Order Space-Time Methods for Conservation Laws</b> .....	124
<i>Hi Huynh</i>	
<b>Parallel Implicit Adaptive Mesh Refinement for Unsteady Fully-Compressible Reactive Flows</b> .....	160
<i>Scott Northrup, Clinton P. Groth</i>	
<b>Numerical Simulation of the Non-Reactive and Reactive Flow in a Swirled Model Gas Turbine Combustor</b> .....	180
<i>Gilles Reichling, Berthold Noll, Manfred Aigner</i>	
<b>1D and 2D Simulations Related to the NASA Electric Arc Shock Tube Experiments</b> .....	221
<i>Dmitry V. Kotov, Helen Yee, Marco Panesi, Dinesh K. Prabhu, Alan A. Wray</i>	
<b>Carbuncles in Higher-order Resolution Eulerian-lagrangian Computation of High-speed, Particle-laden Flow</b> .....	243
<i>Sean Davis, Gustaaf B. Jacobs, Wai Sun Don</i>	
<b>Three-Dimensional Integral Boundary Layer Formulation for General Configurations</b> .....	253
<i>Mark Drela</i>	
<b>Effects of Turbulence Modeling for a Dual Mesh CFD Solver</b> .....	277
<i>Nicholas Burgess, Andrew M. Wissink</i>	
<b>The High-order Dynamic Computational Laboratory for CFD Research and Applications</b> .....	293
<i>Pierre-Yves Outtier, Cedric Content, Paola Cinnella, Bertrand Michel</i>	
<b>Development of Numerical Schemes for Hybrid Turbulence Modelling in an Industrial CFD Solver</b> .....	306
<i>Grégoire Pont, Jean-Christophe Robinet, Paola Cinnella, Pierre Brenner</i>	
<b>An ALE-Eulerian Formulation of Embedded Boundary Methods for Turbulent Fluid-Structure Interaction Problems</b> .....	325
<i>Vinod K. Lakshminarayan, Charbel Farhat</i>	
<b>Parallel Anisotropic Block-Based Adaptive Mesh Refinement Algorithm For Three-Dimensional Flows</b> .....	342
<i>Michael Williamschen, Clinton P. Groth</i>	
<b>An Adaptive Simplex Cut-cell Method for High-order Discontinuous Galerkin Discretizations of Multi-material and Multi-physics Problems</b> .....	364
<i>Huafei Sun, David L. Darmofal</i>	
<b>Structured Mesh r-Refinement using Truncation Error Equidistribution for 1D and 2D Euler Problems</b> .....	382
<i>Aniruddha Choudhary, Christopher J. Roy</i>	
<b>Boundary Layer Adaptivity for Transonic Turbulent Flows</b> .....	398
<i>Kedar Chitale, Onkar Sahni, Saurabh Tendulkar, Rocco Nastasia, Mark Shephard, Kenneth Jansen</i>	
<b>Implementation of Adaptive Mesh Refinement in an Implicit Unstructured Finite-Volume Flow Solver</b> .....	413
<i>Alan Schwing, Ioannis Nompelis, Graham V. Candler</i>	
<b>On the Accuracy and Convergence of Minimum-Residual-Based Nonlinear Reduced-Order Models in CFD</b> .....	433
<i>David Amsellem, Matthew J. Zahr, Charbel Farhat</i>	
<b>Verification and Validation Studies for the LAVA CFD Solver</b> .....	451
<i>Shayan Moini-Yekta, Michael F. Barad, Jeffrey A. Housman, Cetin Kiris, Emre Sozer, Christoph Brehm</i>	
<b>Numerical Solution of Ionized Gas Compressible Flows Under the Influence of Electromagnetic Fields</b> .....	481
<i>Konstantinos Panourgias, John A. Ekaterinaris</i>	
<b>SENSEI Computational Fluid Dynamics Code: A Case Study in Modern Fortran Software Development</b> .....	507
<i>Joseph M. Derlaga, Tyrone Phillips, Christopher J. Roy</i>	
<b>Immersed Boundary Method for Compressible Turbulent Flow Computations in Building-Cube Method</b> .....	520
<i>Takashi Ishida, Kazuhiro Nakahashi</i>	

<b>A Hybrid Adjoint Approach Applied to Turbulent Flow Simulations</b> .....	531
<i>Thomas W. Taylor, Francisco Palacios, Karthikeyan Duraisamy, Juan J. Alonso</i>	
<b>Parametric Analysis of Icing Control Using Synthetic Jet Actuators</b> .....	557
<i>Nikisha Nagappan, Vladimir V. Golubev, Wagdi Habashi</i>	
<b>CFD Based Optimization of A Flexible Flapping Wing</b> .....	576
<i>Clayton Carson, Haoxiang Luo, Bo Yin</i>	
<b>Massively Parallel 3D Spectral Difference Solver for Simulating Vortex-Induced Vibrations of Circular Cylinders</b> .....	586
<i>Andrew Dejong, Chunlei Liang</i>	
<b>Lift and Drag Control Using Dielectric Barrier Discharge Plasma Actuators Installed on the Wingtips</b> .....	599
<i>Takuji Mizokami, Daigo Noguchi, Koji Fukagata</i>	
<b>Discontinuous Galerkin Discretization Coupled with Sharp Interface Method for Ablative Materials</b> .....	605
<i>Pierre Schrooyen, Koen Hillewaert, Thierry E. Magin, Philippe Chatelain</i>	
<b>Fluid-Solid Interaction Modeling of Compressible Droplet Impact onto Elastic Substrates</b> .....	619
<i>Seyedmohsen Najafi Marzbali, Ali Dolatabadi, Pawel Jedrzejowski</i>	
<b>Hypersonic Stability and Transition Prediction</b> .....	627
<i>Helen L. Reed, Eduardo Perez, Joseph Kuehl, Travis Kocian, Nicholas Oliviero</i>	
<b>Computation of Hypersonic Flows Using the Direct Simulation Monte Carlo Method</b> .....	642
<i>Iain D. Boyd</i>	
<b>Functional Equivalence Acceptance Testing of FUN3D for Entry, Descent, and Landing Applications</b> .....	675
<i>Peter A. Gnoffo, William A. Wood, Bill Kleb, Stephen J. Alter, Jose Padilla, Jeffery A. White, Chris Glass, Dana Hammond</i>	
<b>Recent Advancements in Fully Implicit Numerical Methods for Hypersonic Reacting Flows</b> .....	696
<i>Benjamin Kirk, Roy Stogner, Todd A. Oliver, Paul T. Bauman</i>	
<b>Numerical Rebuilding of Unsteady Loads on ARIANE5 by (U)RANS, and Large Eddy Simulation and Validation against Time Accurate Particle Image Velocimetry Measurements</b> .....	726
<i>Richard Schwane</i>	
<b>CFD Analysis of Radiative Heat Loading on Hypervelocity Re-entry Vehicles</b> .....	739
<i>Sebastian Karl, Daniel F. Potter, Markus Lambert, Klaus Hannemann</i>	
<b>High Order Preserving Residual Distribution Schemes for the Laminar and Turbulent Navier Stokes on Arbitrary Grids</b> .....	758
<i>Remi Abgrall, D. De Santis</i>	
<b>A Review of 44 Years of Von Karman Institute Computational Fluid Dynamics Lecture Series</b> .....	786
<i>Herman Deconinck</i>	
<b>High-Order Methods for Computational Fluid Dynamics: A Brief Review of Compact Differential Formulation on Unstructured Grids</b> .....	787
<i>Ht Huynh, Zhi J. Wang, Peter Vincent</i>	
<b>Higher-Order Finite Volume Solution Reconstruction on Highly Anisotropic Meshes</b> .....	812
<i>Alireza Jalali, Carl F. Ollivier Gooch</i>	
<b>High-Order Flux Correction for Viscous Flows on Arbitrary Unstructured Grids</b> .....	832
<i>Brian B. Pincock, Aaron J. Katz</i>	
<b>A High-Order Central ENO Finite-Volume Scheme for Three-Dimensional Turbulent Reactive Flows on Unstructured Mesh</b> .....	852
<i>Marc R. Charest, Clinton P. Groth</i>	
<b>First, Second, and Third Order Finite-Volume Schemes for Advection-Diffusion</b> .....	873
<i>Hiroaki Nishikawa</i>	
<b>A New Technique for Finite Difference WENO with Geometric Conservation Law</b> .....	890
<i>Taku Nonomura, Yoshiaki Abe, Kozo Fujii, Daiki Terakado</i>	
<b>High-Order Compact-Stencil Summation-By-Parts Operators for the Compressible Navier-Stokes Equations</b> .....	906
<i>David C. Del Rey Fernández, David W. Zingg</i>	

## VOLUME 2

<b>High-Order Finite-Element Method for Three-Dimensional Turbulent Navier-Stokes</b> .....	924
<i>Jon T. Erwin, Li Wang, W Kyle Anderson, Sagar Kapadia</i>	
<b>A Hybrid Finite Difference-Finite Volume Approach and Its Applications to Inviscid Compressible Flows</b> .....	942
<i>Xianyi Zeng</i>	
<b>An Extension of the Lattice Boltzmann Method for Simulating Turbulent Flows Around Rotating Geometries of Arbitrary Shape</b> .....	956
<i>Patrick Nathen, Daniel Gaudlitz, Mathias Krause, Jonas Kratzke</i>	
<b>Vorticity Confinement Applied to Turbulent Wing Tip Vortices for Wake-integral Drag Prediction</b> .....	972
<i>Kristopher Pierson, Alexander Povitsky</i>	
<b>Selection of Implicit CFD Techniques for Unstructured Grids and Turbomachinery Applications</b> .....	989
<i>Jesus Pueblas, Roque Corral, Fernando Gisbert</i>	
<b>A Three-Dimensional Unstructured Finite Volume Method for Droplet Impingement in Aircraft Icing</b> .....	1008
<i>Ki Young Jung, Sung Ki Jung, Rho Shin Myong, Ji Hong Kim</i>	
<b>Viscous Flow Analysis and Design Optimization in Rocket Motors</b> .....	1019
<i>Mine Yumusak</i>	
<b>Multigrid Technique and Optimized Schwarz Method on Block-structured Grids with Discontinuous Interfaces</b> .....	1040
<i>Dmitry Kolmogorov, Niels Sørensen, Wen Shen, Jens Sørensen</i>	

<b>Energy Stable High Order Finite Difference Methods for Hyperbolic Equations in Moving Coordinate Systems</b> .....	1055
<i>Samira Nikkar, Jan Nordstrom</i>	
<b>A Viscous Continuous Adjoint Approach for the Design of Rotating Engineering Applications</b> .....	1069
<i>Thomas D. Economou, Francisco Palacios, Juan J. Alonso</i>	
<b>Automatic Differentiation Adjoint of the Reynolds-Averaged Navier-Stokes Equations with a Turbulence Model</b> .....	1088
<i>Zhoujie Lyu, Gaetan K. Kenway, Cody Paige, Joaquim Martins</i>	
<b>Aerodynamic Aircraft Design for Mission Performance by Multipoint Optimization</b> .....	1112
<i>François Gallard, Matthieu Meaux, Marc Montagnac, Bijan Mohammadi</i>	
<b>Toward High-Fidelity Aerodynamic Shape Optimization for Natural Laminar Flow</b> .....	1129
<i>Ramy Rashad, David W. Zingg</i>	
<b>Application of an Efficient Newton-krylov Algorithm for Aerodynamic Shape Optimization Based on the Reynolds-averaged Navier-stokes Equations</b> .....	1145
<i>Lana M. Osusky, David W. Zingg</i>	
<b>Discrete Adjoint based Sensitivity Analysis for Optimal Flow Control of a 3D High-Lift Configuration</b> .....	1162
<i>Anil Nemili, Özkan Emre, Nicolas R. Gauger, Felix W. Kramer, Angelo Carnarius, Frank Thiele</i>	
<b>RANS-based Aerodynamic Shape Optimization of a Blended-Wing-Body Aircraft</b> .....	1176
<i>Zhoujie Lyu, Joaquim Martins</i>	
<b>An Efficient Computational Approach to Hypersonic Nonequilibrium Radiation Utilizing Gaussian Quadrature and Space Partition</b> .....	1196
<i>Joseph J. Shang, Daniil Andrienko, Sergey Surzhikov, George Huang</i>	
<b>Model Predictive Control under Coupled Fluid-Structure Constraints Using a Database of Reduced-Order Models on a Tablet</b> .....	1217
<i>David Amsellem, Sunil Deolalikar, Fazel Gurrola, Charbel Farhat</i>	
<b>COOLFluid: An Open Computational Platform for Multi-physics Simulation and Research</b> .....	1229
<i>Andrea Lani, Nadege Villedie, Khalil Bensassi, Lilla Koloszar, Martin Vymazal, Sarp M. Yalim, Marco Panesi</i>	
<b>Flow Around an Elastically Mounted Slender Body at High Incidence</b> .....	1254
<i>Sergey Gendel, Oded Gottlieb, David Degani</i>	
<b>Toward a CFD/6 DOF Coupled Model Enhancing Projectile Trajectory Prediction</b> .....	1274
<i>Van Thuan Luu, Christophe Grignon, Frédéric Plourde</i>	
<b>Multiphase Modeling of Water Injection on Flame Deflector</b> .....	1288
<i>Bruce T. Vu, Nili Bachchan, Oshin Peromian, Vedat Akdag</i>	
<b>Computation of Gas and Multiphase Supersonic Jets with Non-Equilibrium Processes</b> .....	1301
<i>Felix Zavelevich, Alexander M. Molchanov, Nikolay Ushakov</i>	
<b>Efficient and Accurate Computations of Cryogenic Cavitating Flows around Turbopump Inducer</b> .....	1314
<i>Hyeongjun Kim, Daeho Min, Chongam Kim</i>	
<b>Discontinuous Galerkin Method for Multifluid Euler Equations</b> .....	1332
<i>Marc Henry De Frahan, Eric Johnsen</i>	
<b>Multiscale Eulerian-Lagrangian Method for Parallel Simulation of Atomization Induced by Air-blast Planar Injectors</b> .....	1344
<i>Arthur Sarthou, Davide Zucio, Jean-Luc Estivaleres</i>	
<b>On the Modelling of Spray/Wall Impingement Under Crossflow Conditions</b> .....	1363
<i>Christian M. Rodrigues, Jorge M. Barata, Andre R. Silva</i>	
<b>Performance Tuning of Newton-GMRES Methods for Discontinuous Galerkin Discretizations of the Navier-stokes Equations</b> .....	1374
<i>Matthew J. Zahr, Per-Olof Persson</i>	
<b>Pseudo-transient Continuation, Solution Update Methods, and CFL Strategies for DG Discretizations of the RANS-SA Equations</b> .....	1389
<i>Marco Ceze, Krzysztof Fidkowski</i>	
<b>Adaptive IMEX Time-Stepping for the Correction Procedure via Reconstruction Scheme</b> .....	1412
<i>Brian C. Vermeire, Siva Nadarajah</i>	
<b>An Evaluation of Implicit Time Integration Schemes for Discontinuous High Order Methods</b> .....	1430
<i>Cheng Zhou, Zhi J. Wang</i>	
<b>Evaluation of Optimized CPR Schemes for Computational Aeroacoustics Benchmark Problems</b> .....	1440
<i>Yanan Li, Zhi J. Wang</i>	
<b>A High-Order Implicit-Explicit Fluid-Structure Interaction Method for Flapping Flight</b> .....	1453
<i>Bradley M. Froehle, Per-Olof Persson</i>	
<b>Optimal Accuracy of Discontinuous Galerkin for Diffusion</b> .....	1465
<i>Loc H. Khieu, Bram Van Leer, Marcus Lo</i>	
<b>The Efficient Implementation of Correction Procedure Via Reconstruction with GPU Computing</b> .....	1476
<i>Ben J. Zimmerman, Zhi J. Wang</i>	
<b>Aerothermodynamic Shape Optimization of Hypersonic Blunt Bodies</b> .....	1496
<i>Mine Yumusak, Sinan Eyi</i>	
<b>Numerical Exploration of Transient Flow Phenomena in Hypersonic Gun Tunnel</b> .....	1518
<i>Khalil Bensassi, Andrea Lani, Herman Deconinck, Olivier Chazot, Patrick Rambaud</i>	
<b>Multiphase and Chemically Reactive Flows in LS-DYNA</b> .....	1532
<i>Grant Cook, Kyoungsu Im, Zengchan Zhang</i>	
<b>On the Improvement of the All-speed Flux Scheme for Very Low Mach Number Flows</b> .....	1541
<i>Eiji Shima</i>	
<b>Why is the Overheating Problem Difficult: the Role of Entropy</b> .....	1553
<i>Meng-Sing Liou</i>	

<b>A Further Survey of Shock Capturing Methods on Hypersonic Heating Issues</b> .....	1567
<i>Keiichi Kitamura</i>	
<b>A Second-Order Finite Volume Method that Reduces Numerical Shockwave Anomalies in One Dimension</b> .....	1588
<i>Daniel W. Zaide, Philip L. Roe</i>	
<b>Numerical Simulation of Compressible Viscous Flow Using a Velocity-Pressure-Vorticity Variational Formulation and Direct Solver</b> .....	1603
<i>Ben Chacon, Mohamed M. Hafez</i>	
<b>Convergence Acceleration Based on Convergence Error Estimation</b> .....	1618
<i>Sinan Eyi, Mine Yumusak</i>	
<b>Dynamical Optimization of the Trailing-edge Shape of a Bluff Body by Means of Extremum-seeking</b> .....	1638
<i>Kazutaka Nakayama, Hiroshi Naito, Koji Fukagata</i>	
<b>Stall Prediction of Very Light Aircraft using High fidelity Analysis</b> .....	1645
<i>Daeyeon Lee, Sangho Kim, Jaewoo Lee</i>	
<b>Design Optimization of Subsonic Airfoil and Slotted Flap Shape Using Multi-Fidelity Aerodynamic Analysis</b> .....	1661
<i>Maxim Tyan, Jin-Hwan Park, Sangho Kim, Jaewoo Lee</i>	
<b>Aerofoil Design Variable Extraction for Aerodynamic Optimization</b> .....	1674
<i>Daniel J. Poole, Christian B. Allen, T. Rendall</i>	
<b>Flap Design Optimization for Very Light Aircraft in compliance with Airworthiness Certification</b> .....	1691
<i>Jin-Hwan Park, Sangho Kim, Nhu Van Nguyen, Maxim Tyan, Jaewoo Lee</i>	
<b>Delaunay-based Derivative-free Optimization via Global Surrogate, Part 1: Theory</b> .....	1701
<i>Pooriya Beyhaghi, Daniele Cavaglieri, Thomas Bewley</i>	
<b>Introducing New Compact Parameterization Method for an Automated Blade Shape Optimization</b> .....	1713
<i>Seyyed Mohammad Iman Gohari, Alireza Ghasemi</i>	
<b>Numerical Investigations on Geometric Parameters Affecting the Oscillation Properties of a Fluidic Oscillator</b> .....	1721
<i>Bernhard C. Bobusch, Rene Woszidlo, Oliver Krüger, Christian O. Paschereit</i>	
<b>Unstructured Mesh Generation Using Advancing Layers and Metric-Based Transition</b> .....	1736
<i>David L. Marcum, Frederic Alauzet</i>	
<b>Efficient and Accurate Evaluation of Aircraft in Different Configurations with Automatic Local Remeshing</b> .....	1755
<i>Yasushi Ito, Mitsuhiro Murayama, Kazuomi Yamamoto</i>	
<b>Effects of Mesh Deformation on the Quality of Large Eddy Simulations</b> .....	1766
<i>Jukka-Pekka Keskinen, Ville Vuorinen, Ossi Kaario, Martti Larmi</i>	
<b>Use of the Immersed Boundary Method within the Building Cube Method and its Application to Real Vehicle CAD Data</b> .....	1787
<i>Keiji Onishi, Shigeru Obayashi, Kazuhiro Nakahashi, Makoto Tsubokura</i>	
<b>Application of Immersed Boundary Technique in SRM Simulations: Toward New Insights</b> .....	1799
<i>Tran Ho Phu, Frédéric Plourde</i>	
<b>Coupling a Wall Diffusion-Model with an Immersed Boundary Technique</b> .....	1809
<i>Francesco Capizzano</i>	
<b>A Robust Cut-cell Method for Fluid-structure Interaction on Adaptive Meshes</b> .....	1820
<i>Lennart Schneiders, Matthias Meinke, Wolfgang Schröder</i>	
<b>A Hybridized Least-Squares Ghost Fluid Method with Reduced Numerical Oscillations in Moving Boundary Problems</b> .....	1832
<i>John Mousel, Uday Kumar</i>	

### VOLUME 3

<b>Towards Bridging the Gaps in Holistic Transition Prediction via Numerical Simulations</b> .....	1849
<i>M. M. Choudhari, F. Li, L. Duan, C. L. Change, M. H. Carpenter, C. L. Streett</i>	
<b>Towards a Two-Equation Algebraic Structure-Based Model with Applications to Turbulent Separated Flows</b> .....	1867
<i>Alejandro Campos, Karthikeyan Duraisamy, Gianluca Iaccarino</i>	
<b>Prediction of Large Separation with Reynolds Stress</b> .....	1884
<i>Michael E. Olsen, Randolph P. Lillard, Scott M. Murman</i>	
<b>Modeling of Turbulent Free Shear Flows</b> .....	1906
<i>Dennis A. Yoder, James R. Debonis, Nicholas J. Georgiadis</i>	
<b>A New Formulation for Hybrid LES-RANS Computations</b> .....	1936
<i>Stephen Woodruff</i>	
<b>DNS, Enstrophy Balance, and the Dissipation Rate Equation in a Separated Turbulent Channel Flow</b> .....	1955
<i>Ponnampalam Balakumar, Robert Rubinstein, Christopher L. Rumsey</i>	
<b>Large Eddy Simulation of High-lift Devices</b> .....	1975
<i>Julien Bodart, Johan Larsson, Parviz Moin</i>	
<b>Advanced and High-order Numerical Discretization Methods for Large-eddy Simulation That Maximize Subgrid-scale Model Resolution</b> .....	1985
<i>Jaeseung Byun, Carlos Pantano</i>	
<b>Nodal Points and the Nonlinear Stability of High-Order Methods for Unsteady Flow Problems on Tetrahedral Meshes</b> .....	1995
<i>David M. Williams, Antony Jameson</i>	
<b>High-Order Implicit Temporal Integration for Unsteady Compressible Fluid Flow Simulation</b> .....	2016
<i>Pieter D. Boom, David W. Zingg</i>	

<b>High-Order Solution of Viscoelastic Fluid Flows Using Unstructured Discontinuous Galerkin Method</b> .....	2028
<i>Amir Nejat</i>	
<b>A Discontinuous Galerkin Method for the Navier-Stokes Equations on Deforming Domains using Unstructured Moving Space-Time Meshes</b> .....	2039
<i>Luming Wang, Per-Olof Persson</i>	
<b>The SBP-SAT Technique for Time-Discretization</b> .....	2053
<i>Tomas Lundquist, Jan Nordstrom</i>	
<b>Parallel Compressible Solver for Unsteady Turbulent Combustion in Rocket Injectors Using Flamelet Models</b> .....	2061
<i>Siddharth S. Thakur, Jeffrey Wright, Matthias Ihme</i>	
<b>Measurements in Regions of Shock Wave/Turbulent Boundary Layer Interaction from Mach 4 to 10 for Open and “Blind” Code Evaluation/Validation</b> .....	2076
<i>Michael S. Holden, Tim P. Wadhams, Matthew G. Maclean</i>	
<b>Measurements of Real Gas Effects on Regions of Laminar Shock Wave/Boundary Layer Interaction in Hypervelocity Flows for “Blind” Code Validation Studies</b> .....	2101
<i>Michael S. Holden, Tim P. Wadhams, Matthew G. Maclean, Aaron T. Dufrene</i>	
<b>Flow Distortion: Computational Investigation of a Shocked Cavity Flameholder</b> .....	2114
<i>Ryan T. Milligan, John A. Boles, Mark A. Hagenmaier, Jeffrey M. Donbar, Campbell D. Carter, Kuangyu Hsu</i>	
<b>Characterization of the Cavity Shear Layer of the Stratospheric Observatory For Infrared Astronomy by Means of Pressure Sensor Data and a Hybrid RANS-LES Study</b> .....	2132
<i>Christian Engfer, Thorsten Lutz, Ewald Kraemer</i>	
<b>A Simple Alternative to Unsteady Stress-Flux RANS/LES Models</b> .....	2143
<i>Chad M. Winkler, Andrew J. Dorgan, Mortaza Mani</i>	
<b>Lessons Learned from Hybrid RANS-LES Computations of a Three-Element Airfoil Flow</b> .....	2157
<i>Shia-Hui Peng, Bastian Nebenfuhr, Lars Davidson</i>	
<b>Simulation of Swept-Wing Receptivity to Distributed Roughness</b> .....	2174
<i>Vinay Mistry, Gary Page, James J. McGuirk</i>	
<b>LES of High Speed Jet Flow From Convergent-Divergent Rectangular S-bend Ducts Using Synthetic Inlet Conditions</b> .....	2196
<i>Tim Coates, Gary Page</i>	
<b>Characterization of Sharp-Edged Airfoils Using Large Eddy Simulations (LES)</b> .....	2213
<i>Kelsey Shaler</i>	
<b>Construction of Parametrically-Robust CFD-Based Reduced-Order Models for PDE-Constrained Optimization</b> .....	2240
<i>Matthew J. Zahr, David Amsallem, Charbel Farhat</i>	
<b>Impact of Turbulence Closures and Numerical Errors for the Optimization of Flow Control Devices</b> .....	2251
<i>Jérémie Labroquère, Régis Duvigneau, Emmanuel Guilmineau</i>	
<b>Efficient CAD-based Aerodynamic Design Optimization with Adjoint CFD Data</b> .....	2272
<i>Peter M. Thompson, Trevor T. Robinson, C. Armstrong</i>	
<b>Adjoint-Based Optimization of Flapping Kinematics in Viscous Flows</b> .....	2283
<i>Marnix Van Schrojenstein Lantman, Krzysztof Fidkowski</i>	
<b>Unsteady Aero-Structure Coupled Adjoint Method for Flutter Suppression</b> .....	2298
<i>Zhichao Zhang, Ping-Chih Chen, Shuchi Yang, Zhicun Wang, Qiqi Wang</i>	
<b>Geometry Generation of Complex Unconventional Aircraft with Application to High-Fidelity Aerodynamic Shape Optimization</b> .....	2311
<i>Hugo Gagnon, David W. Zingg</i>	
<b>Aerodynamic Design Optimization of Three Dimensional Rocket Nozzles Using Adjoint Method</b> .....	2328
<i>Sinan Eyi, Mine Yumusak</i>	
<b>On the Achievable Speeds of Finite Difference Solvers on CPUs and GPUs</b> .....	2348
<i>Rainald Lohner, Andrew T. Corrigan, Karl-Robert Wichmann, Wolfgang Wall</i>	
<b>Modeling the Two-phase Flowfield Beneath a Hovering Rotor on Graphics Processing Units Using a FVM-RANS Hybrid Methodology</b> .....	2362
<i>Sebastian Thomas, James Baeder, Mathieu</i>	
<b>Parallel Semi-Meshless Stencil Selection for Moving Geometry Simulations</b> .....	2392
<i>Juan Angulo, David J. Kennett, S. Timme, Kenneth J. Badcock</i>	
<b>A Hybrid Multi-GPU/CPU Computational Framework for Rotorcraft Flows on Unstructured Overset Grids</b> .....	2408
<i>Dominic D. Chandar, Jayanarayanan Sitaraman, Dimitri J. Mavriplis</i>	
<b>Load Balancing for Multiphysics</b> .....	2422
<i>Rainald Lohner, Joseph D. Baum</i>	
<b>Unsteady Flow Simulation around Cylinder under Airfoil using Cartesian-based Flow Solver</b> .....	2429
<i>Taro Imamura, Yuichi Takahashi</i>	
<b>The Shock Tube Problem from a Combined Experimental and Computational Perspective</b> .....	2442
<i>David Huynh</i>	
<b>A Time-Spectral Hybridizable Discontinuous Galerkin Method for Periodic Flow Problems</b> .....	2459
<i>Hemant K. Chaurasia, Cuong Nguyen, Jaime Peraire</i>	
<b>Practical Large-Eddy Simulation for Complex Turbulent Flowfield with Adaptive Cartesian Mesh and Data Compression Technique</b> .....	2471
<i>Ryotaro Sakai, Shigeru Obayashi, Yuichi Matsuo, Kazuhiro Nakahashi</i>	
<b>GPU Accelerated Kinetic Solvers for Rarefied Gas Dynamics</b> .....	2483
<i>Vladimir I. Kolobov, Sergey Zabelok, Robert R. Arslanbekov</i>	

<b>Computation of Turbomachinery Flows with a Parallel Unstructured Mesh Navier-Stokes equations Solver on GPUs</b> .....	2493
<i>Fernando Gisbert, Roque Corral, Jesus Puelblas</i>	
<b>Adjoint and Truncation Error Based Adaptation for 1D Finite Volume Schemes</b> .....	2511
<i>Joseph M. Derlaga, Christopher J. Roy, Jeff Borggaard</i>	
<b>Ventus: An Overset Adaptive Cartesian Simulation Framework for Moving Boundary Problems</b> .....	2522
<i>Robert E. Harris, Brandon Williams</i>	
<b>Adaptive Shape Parameter (ASP) Technique for Local Radial Basis Functions (RBFs) and Their Application for Solution of Navier-Stokes Equations</b> .....	N/A
<i>Ali Javed, Kamal Djidjeli</i>	
<b>High-Order Entropy Stable Formulations for Computational Fluid Dynamics</b> .....	2542
<i>Mark H. Carpenter, Travis C. Fisher</i>	
<b>Adjoint Based Anisotropic Mesh Adaptation for the CPR Method</b> .....	2569
<i>Lei Shi, Zhi J. Wang</i>	
<b>Design of a Variational Multiscale Method for High Reynolds Number Compressible Flows</b> .....	2587
<i>Laslo T. Diosady, Scott M. Murman</i>	
<b>Progress Towards a Higher-order Adaptive Solver for Aerodynamics</b> .....	2605
<i>David L. Darmofal, Steven Allmaras, Masayuki Yano, Jun Kudo</i>	
<b>High-order Provably Stable Overset Grid Methods for Block-structured Adaptive Mesh Refinement</b> .....	2628
<i>Nek Sharan, Daniel J. Bodony</i>	
<b>Adjoint-Based Hp-Adaptation for a Class of High-Order Hybridized Finite Element Schemes for Compressible Flows</b> .....	2647
<i>Aravind Balan, Michael Woopen, Georg May</i>	
<b>Scalable Parallelization of the Hybridized Discontinuous Galerkin Method for Compressible Flow</b> .....	2661
<i>Xevi Roca, Cuong Nguyen, Jaime Peraire</i>	
<b>Multidimensional Active Flux Schemes</b> .....	2674
<i>Timothy A. Eymann, Philip L. Roe</i>	
<b>High-Order Spectral Difference: Verification and Acceleration using GPU Computing</b> .....	2698
<i>Ben J. Zimmerman, Zhi J. Wang, Miguel R. Visbal</i>	
<b>Adjoint-Based Error Estimation and Mesh Adaptation for the Active Flux Method</b> .....	2715
<i>Kaihua Ding, Krzysztof Fidkowski, Philip L. Roe</i>	
<b>Advances in the Development of a High Order, Viscous-Inviscid Interaction Solver</b> .....	2740
<i>David Moro, Cuong Nguyen, Jaime Peraire, Mark Drela</i>	
<b>Advances in Homotopy Continuation Methods in Computational Fluid Dynamics</b> .....	2757
<i>David A. Brown, David W. Zingg</i>	
<b>Development of a Low-Dissipation Algorithm in a Rule-Based Framework for Unsteady Flows in Complex Geometries</b> .....	2776
<i>Manoj Parmar, Siddharth S. Thakur</i>	

#### VOLUME 4

<b>Progress Towards an Arbitrarily High-Order, Unstructured, Free-Wake Panel Solver</b> .....	2794
<i>John P. Moore, Jaime Peraire, Mark Drela</i>	
<b>Local Finite Volume Method for Calculation of Compressible Flow on Arbitrary Scattered Nodes</b> .....	2813
<i>Takeshi Takatani, Kojiro Suzuki</i>	
<b>Very Large Eddy Simulations of a Spray Reacting Flow in a Single Element LDI Injector with and Without Invoking the Eulerian Scalar DWDFD Method</b> .....	2829
<i>Tsan-Hsing Shih, Nansuey Liu</i>	
<b>Simulation of Attached and Separated Flows using Realizable Linear and Non-Linear Hybrid RANS-LES Models</b> .....	2862
<i>Harish Gopalan, Jayanarayanan Sivaraman</i>	
<b>Large-Eddy Simulation of Turbulent Trans- and Supercritical Mixing</b> .....	2874
<i>Christoph A. Niedermeier, Maria M. Jarczyk, Stefan Hickel, Nikolaus Adams, Michael Pfitzner, Hagen Muller</i>	
<b>Wind Turbine Dynamic Stall Analysis Using Harmonic Balance and Correlation-based Transition Models</b> .....	2884
<i>Jason C. Howison, Kivanc Ekici</i>	
<b>Numerical Investigation of Shock Oscillation over Airfoils at Transonic Speeds Influenced by Trailing Edge Jet</b> .....	2909
<i>Zhengke Zhang, Wei Zhou, Ke Qu, H. S. Tang</i>	
<b>Numerical Investigations and Modal Analysis of the Coherent Structures in a Generic Swirl Burner</b> .....	2916
<i>Oliver Krüger, C. Duwig, Steffen Terhaar, Christian O. Paschereit</i>	
<b>Parametric Study of Low Reynolds Number Flapping Wing Aerodynamics</b> .....	2932
<i>Sebastian Leguizamon, Omar D. Lopez</i>	
<b>Clocking Effects on Surface-Pressure Fluctuations for Variable Axial-Gaps</b> .....	2944
<i>Marc H. Biester, Yavuz Guendogdu, Jorg Seume</i>	
<b>The Influence of Viscous Operator and Wall Boundary Conditions on the Accuracy of the Navier-Stokes Equations</b> .....	2954
<i>Peter Eliasson, Jan Nordstrom</i>	
<b>Increasing the Convergence Rate to Steady-state by Using Multiple Penalty Terms Applied in a Domain</b> .....	2969
<i>Hannes J. Frenander, Jan Nordstrom</i>	
<b>Effect of Interface Thickness on Smoothed Profile Modeling of Flow Over a Stationary Sphere in <math>Re &lt; 300</math></b> .....	2978
<i>Fazlolah Mohaghegh, John A. Mousel, Uday Kumar</i>	



<b>Duality Based Boundary Treatment for the Euler and Navier-stokes Equations</b> .....	2988
<i>Jens Berg, Jan Nordstrom</i>	
<b>Well-posedness and Stability of Exact Non-reflecting Boundary Conditions</b> .....	3007
<i>Sofia Eriksson, Jan Nordstrom</i>	
<b>Frictionless Contact Algorithm for Eulerian High Speed Multimaterial Dynamic Simulations</b> .....	3025
<i>Nirmal Rai, Anil Kapahi, Uday Kumar</i>	
<b>Continuity Convergence Acceleration of a Density-Based Coupled Algorithm</b> .....	3040
<i>Doru A. Caraeni, Jonathan Weiss, Wayne Smith, Deryl O. Snyder, Nolan Halliday, James Clement</i>	
<b>Numerical Simulations of Turbulent Flow over Porous Media</b> .....	3053
<i>Michael Moessner, Rolf Radespiel</i>	
<b>A Multivariate Interpolation and Regression Enhanced Kriging Surrogate Model</b> .....	3065
<i>Komahan Boopathy, Markus P. Rumpfkeil</i>	
<b>Non-unique Numerical Solutions and Their Stability of the Euler Equations for Transonic Flow over Airfoils</b> .....	3083
<i>Ya Liu, Juntao Xiong, Feng Liu, Shijun Luo</i>	
<b>Computational Analysis of a Diffuser Using USM3D for Diffuser Augmented Wind Turbines</b> .....	3097
<i>Devon Jedamski, Kenneth D. Visser</i>	
<b>Shock Capturing for High-Order Discontinuous Galerkin Simulation of Transient Flow Problems</b> .....	3108
<i>Per-Olof Persson</i>	
<b>A Parallel, Implicit Reconstructed Discontinuous Galerkin Method for the Compressible Flows on 3D Arbitrary Grids</b> .....	3117
<i>Yidong Xia, Hong Luo, Seth C. Spiegel, Megan Frisbey, Robert Nourgaliev</i>	
<b>A Reconstructed Discontinuous Galerkin Method Based on a Hierarchical WENO Reconstruction for Computing Shock Waves on Hybrid Grids</b> .....	3159
<i>Hong Luo, Yidong Xia, Megan Frisbey</i>	
<b>3D Mixed Element Discontinuous Galerkin with Shock Capturing</b> .....	3176
<i>Michael J. Brazell, Dimitri J. Mavriplis</i>	
<b>Toward Accurate Simulation of Shockwave-Turbulence Interaction on Unstructured Meshes: A Coupling of High-Order FR and LAD Schemes</b> .....	3190
<i>Takanori Haga, Soshi Kawai</i>	
<b>Recovery Discontinuous Galerkin Method for Compressible Turbulence</b> .....	3216
<i>Eric Johnsen, Aditya Nair, Sreenivas Varadan</i>	
<b>Discontinuous Galerkin Method for Compressible Viscous Reacting Flow</b> .....	3228
<i>Yu Lv, Matthias Ihme</i>	
<b>Recent CESE Developments for the Solution of the Navier-Stokes Equations Using Unstructured Triangular or Tetrahedral Meshes With High Aspect Ratio</b> .....	3246
<i>Sin-Chung Chang, Chau-Lyan Chang, Chih Chieh J. Yen</i>	
<b>Time-Accurate Local Time Stepping and High-Order Space Time CESE Methods for Multi-Dimensional Flows Using Unstructured Meshes</b> .....	3286
<i>Chau-Lyan Chang, Balaji Shankar Venkatachari, Gary Cheng</i>	
<b>Applications of the CESE method in LS-DYNA</b> .....	3310
<i>Grant Cook, Zeng-Chan Zhang, Kyoung-Su Im</i>	
<b>A 3D Unstructured-Mesh Euler Solver Based on the Fourth-Order CESE Method</b> .....	3320
<i>David Bilyeu, Sheng-Tao J. Yu, Jean-Luc Cambier</i>	
<b>Simulation of a Stationary Plasma Thruster using the Space-Time Conservation Method</b> .....	3336
<i>Jeffrey J. Murphy</i>	
<b>The Engineering Sketch Pad: A Solid-Modeling, Feature-Based, Web-Enabled System for Building Parametric Geometry</b> .....	3351
<i>Robert Haines, John Dannenhoffer</i>	
<b>Efficient Creation of Overset Grid Hole Boundaries and Effects of Their Locations on Aerodynamic Loads</b> .....	3372
<i>William M. Chan, Shishir Pandya, Stuart E. Rogers</i>	
<b>Progress in Automatic Viscous Meshing from CAD Using Strand/Cartesian Meshes</b> .....	3392
<i>Andrew M. Wissink, Aaron J. Katz, Jayanarayanan Sitaraman, Robert Haines, Nicholas K. Burgess</i>	
<b>An Improved Point Selection Method for Hybrid-Unstructured Mesh Deformation Using Radial Basis Functions</b> .....	3414
<i>Gang Wang, Haris Hameed, Zhengyin Ye, Jender Lee</i>	
<b>Creating Exact Bezier Representations of CST Shapes</b> .....	3424
<i>David D. Marshall</i>	
<b>Computational Ship Airwake Determination to Support Helicopter-ship Dynamic Interface Assessment</b> .....	3430
<i>Jacob Van Muijden, Okko Boelens, Jasper Van Der Vorst, Joop Gooden</i>	
<b>Refinement of a Two-Equation Hybrid RANS/LES Model in BCFD</b> .....	3446
<i>Chad M. Winkler, Andrew J. Dorgan, Mortaza Mani</i>	
<b>Large Eddy Simulation of Lean Blow Off</b> .....	3466
<i>Erdzan Hodzic, Christophe Duwig, Robert Szasz, Oliver Krüger, Laszlo J. Fuchs, E. Alenius</i>	
<b>A New Crossflow Transition Onset Criterion for RANS Turbulence Models</b> .....	3479
<i>Shivaji Medida, James Baeder</i>	
<b>A Robust Simplex Cut-cell Method for High-order Discontinuous Galerkin Discretizations of Three-dimensional Aerodynamic Problems</b> .....	3490
<i>Huafei Sun, David L. Darmofal, Robert Haines</i>	
<b>Anisotropic Output-Based Mesh Optimization for Unsteady Flows</b> .....	3511
<i>Joshua A. Krakos, David L. Darmofal</i>	

<b>GMRES applied to the Time Spectral and Quasi-periodic Time Spectral Methods .....</b>	<b>3540</b>
<i>Nathan L. Mundis, Dimitri J. Mavriplis</i>	
<b>Runge-Kutta Methods for the Incompressible Navier-stokes Equations.....</b>	<b>3560</b>
<i>Benjamin Sanderse, Barry Koren</i>	
<b>Efficient Computation of the Finite-time Lyapunov Exponent.....</b>	<b>3576</b>
<i>Philippe Miron, Jérôme Vétel, Andre Garon</i>	
<b>Numerical Modeling and Validation of the Flow in a Fluidic Oscillator .....</b>	<b>3587</b>
<i>Oliver Krüger, Bernhard C. Bobusch, Rene Woszidlo, Christian O. Paschereit</i>	
<b>Code Verification of an Unsteady RANS Finite-element Solver .....</b>	<b>3600</b>
<i>Alexander Hay, Stephane Etienne, Dominique Pelletier, Andre Garon</i>	
<b>Eigenanalysis of Truncation and Discretization Error on Unstructured Meshes .....</b>	<b>3612</b>
<i>Mahkame Sharbatdar, Carl F. Ollivier Gooch</i>	
<b>Finite Volume Solution Reconstruction Methods For Truncation Error Estimation .....</b>	<b>3637</b>
<i>Tyrone Phillips, Joseph M. Derlaga, Christopher J. Roy, Jeffrey Borggaard</i>	
<b>Optimal Sensor Location for Model Parameter Estimation in CFD.....</b>	<b>3653</b>
<i>Dimitrios I. Papadimitriou, Costas Papadimitriou</i>	
<b>Modeling Flow Through a Perforated Plate for a New Combustion Rig.....</b>	<b>3663</b>
<i>Christopher J. Ruscher, John Dannenhoffer, Mark N. Glauser, Balu Sekar, Vincent Belovich</i>	
<b>Numerical Study of Fixed Artificial Transition and the Minimum Height of Roughness Strip for It .....</b>	<b>3672</b>
<i>Zhengke Zhang, Tingting Cheng, Ke Qu, H. S. Tang</i>	
<b>Low-storage IMEX Runge-Kutta Schemes for the Simulation of Navier-Stokes Systems .....</b>	<b>3694</b>
<i>Daniele Cavaglieri, Pooriya Beyhaghi, Thomas Bewley</i>	
<b>Author Index</b>	