FDS 6 and Beyond

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International Forum of Fire Research Directors
June 27, 2011

Outline

FDS-Smokeview Development Team

Kevin McGrattan (NIST): Modeler in Chief
Glenn Forney (NIST): visualization, computer scientist extraordinaire
Jason Floyd (Hughes Associates, Inc.): thermodynamics, species and combustion
Simo Hostikka (VTT): radiation, particles, solid phase
Randy McDermott (NIST): hydrodynamics, turbulence, numerical methods

Committers: Christian Rogsch (U. Wuppertal, OpenMP), Susan Kilian (hhpBerlin, pressure solver), Elizabeth Blanchard (CSTB, water mist), Timo Korhonen (VTT, Evac), Anna Matala (VTT, solid phase), Topi Sikanen (VTT, sprays), Jukka Vaari (VTT extinction), Ruddy Mell (U.S. Forest Service, WFDS), Taylor Myers (U. Maryland, validation), Rick Peacock (NIST, CFAST)

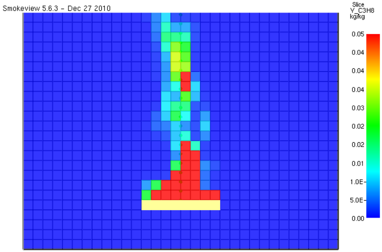
Emeritus: Howard Baum (NIST), Ron Rehm (NIST)

Mission

Our goal is to develop and maintain a robust, validated fire model—and the accompanying visualization and analysis tools—for performance-based design, fire reconstruction, and fire research applications in the built and natural environments.

Model Formulation

$$\frac{\partial \bar{\rho}\tilde{Y}_\alpha}{\partial t} + \frac{\partial(\bar{\rho}\tilde{Y}_\alpha \tilde{u}_i)}{\partial x_i} = \frac{\partial}{\partial x_i}\left(\left[\bar{\rho}D_\alpha + \frac{\mu_t}{\mathrm{Sc}_t}\right]\frac{\partial \tilde{Y}_\alpha}{\partial x_i}\right) + \overline{\dot{m}_\alpha'''}$$



pan burner, propane mass fraction

- low-Mach, LES
- generalized lumped species
- conservative, finite volume, second-order
- TVD scalar transport (CHARM, Superbee)
- dynamic Smagorinsky turbulence
- eddy dissipation model (fast kinetics)
- Arrhenius chemistry (slow kinetics)
- radiation absorption—diffuse gray gas
- radiation emission—constant radiant fraction
- JANAF thermodynamic properties

Verification Example

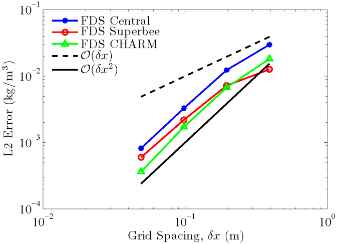
continuity equation

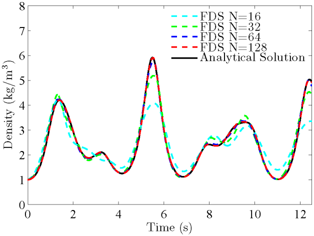
$$\frac{\partial \ln \rho}{\partial t} + \mathbf{u} \cdot \nabla \ln \rho + \nabla \cdot \mathbf{u} = 0$$

$$u(x) = c_1 + \sin(x)$$

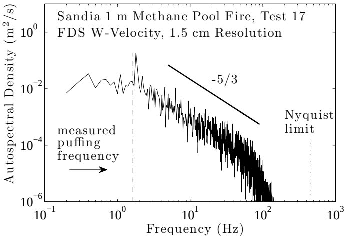
$$v(y) = c_2 + \sin(y)$$

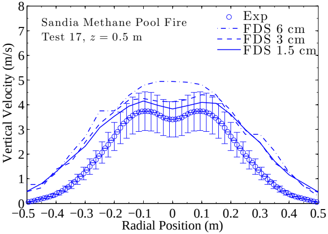
method of characteristics solution





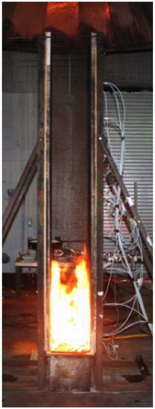
Validation Example: Sandia 1 m Methane Pool Fire

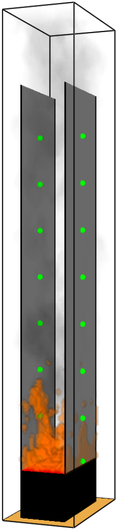


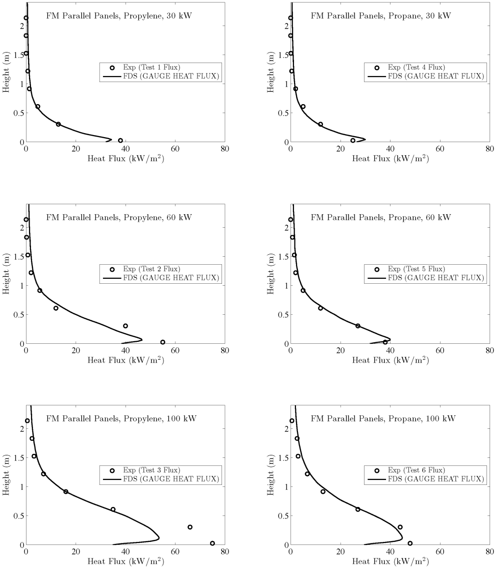


8 mm resolution, 128 cores, 24 hours

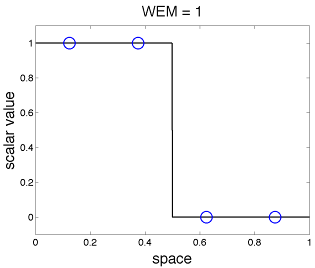
Validation Example: FM Parallel Panel Test

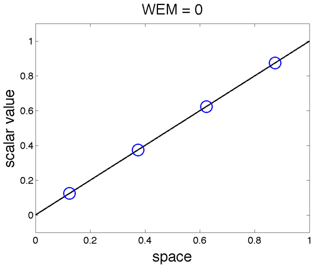






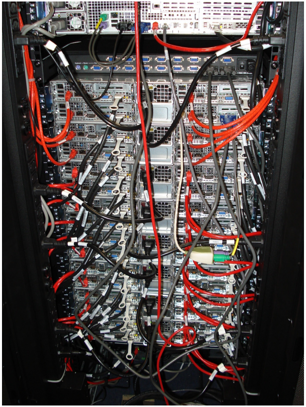
Quality Assessment





Wavelet Error Measure of fuel mass fraction
Sandia 1 m methane pool fire, 8 mm resolution

blaze.nist.gov



8 blades, each with 8 quad-core processors = 256 cores

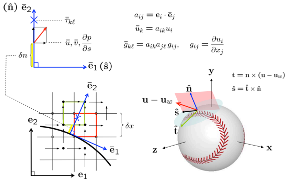
Future Development

- Species and Combustion
  - New generalized lumped species formulation
  - New post-doc, Craig Weinschenk, starting Aug. 1st, under-ventilated fires
- Adaptive Mesh Refinement
  - Wildland-Urban Interface fires
  - flame spread
  - simplify models for large spaces
- Immersed Boundary Methods
  - support unstructured and moving geometries
  - inferface with solid mechanics codes (Abaqus)
  - Global Engineering and Materials (Princeton, NJ), Navy SBIR Phase II

Embedded Mesh Method

Sandia 1 m helium plume

Immersed Boundary Method



90 mph fastball