

ISIS: a computer code for fire simulation

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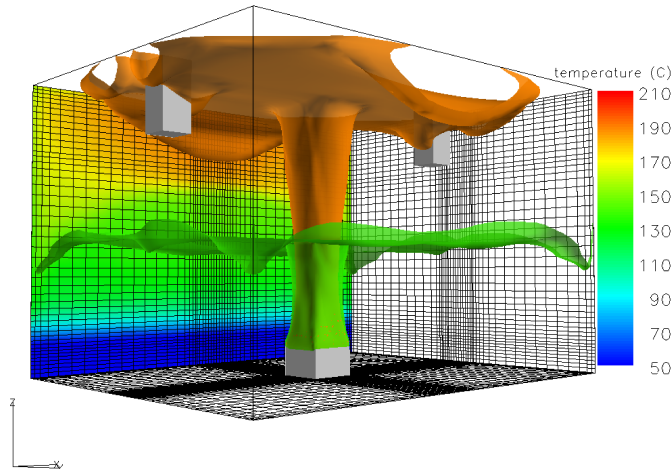
<https://gforge.irsn.fr/gf/project/isis>, email: isis@irsn.fr

ISIS is a Computational Fluid Dynamics software which copes with a wide range of applications, including laminar and turbulent flows, possibly reactive, governed by incompressible or low Mach number Navier Stokes equations. It is intensively used for the simulation of fires.

To this purpose, ISIS solves a system of partial differential equations, composed of the Navier-Stokes equations (*i.e.* the momentum and mass balance equations for a variable density flow) and additional balance relations: the energy balance, the mass conservation of chemical species and the equations governing the variables characterizing turbulence [1] or radiative transfer [4].

The ISIS software handles structured as well as unstructured grids. Low-order *inf-sup* stable finite elements are used to discretize the Navier-Stokes equations, and finite volumes are used for the other relations. For the time discretization, a fractional step scheme, falling in the class of pressure correction methods, is implemented. To ensure the code reliability, a special attention has been paid to obtain at the discrete level stability features of the continuous case: a specific convection operator has been built for the discretization of the Navier-Stokes equations to conserve the kinetic energy [2, 3]; the finite volume discretization of other conservation equations is such that the discrete solution inherits the L^∞ bounds of the continuous problem (for instance, the species concentrations are kept in the $[0, 1]$ interval).

ISIS is developed in C++, using object-oriented techniques, and is based on the component library PELICANS, itself also developed at IRSN [5]. It is the property of IRSN and is distributed under the CeCILL license agreement (see <http://www.cecill.info>).



Temperature isosurfaces in the plume generated by a fire in a ventilated room.

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- [2] G. Ansanay-Alex, F. Babik, L. Gastaldo, A. Larcher, C. Lapuerta, J.-C. Latché, and D. Vola. A finite volume stability result for the convection operator in compressible flows ... and some finite element applications. In *Finite Volumes for Complex Applications V - Problems and Perspectives - Aussois, France*, pages 185–192, 2008.
- [3] G. Ansanay-Alex, F. Babik, J.-C. Latché, and D. Vola. An L2-stable approximation of the Navier-Stokes convection operator for low-order non-conforming finite elements. *submitted*, 2009.
- [4] T. Gallouët, R. Herbin, A. Larcher, and J.-C. Latché. Analysis of a finite volume scheme for the P1 radiative transfer model. *Submitted*, 2009.
- [5] PELICANS. Collaborative development environment. <https://gforge.irsn.fr/gf/project/pelicans>.