

RhinoCFD

Powered by **PHOENICS**

1. General

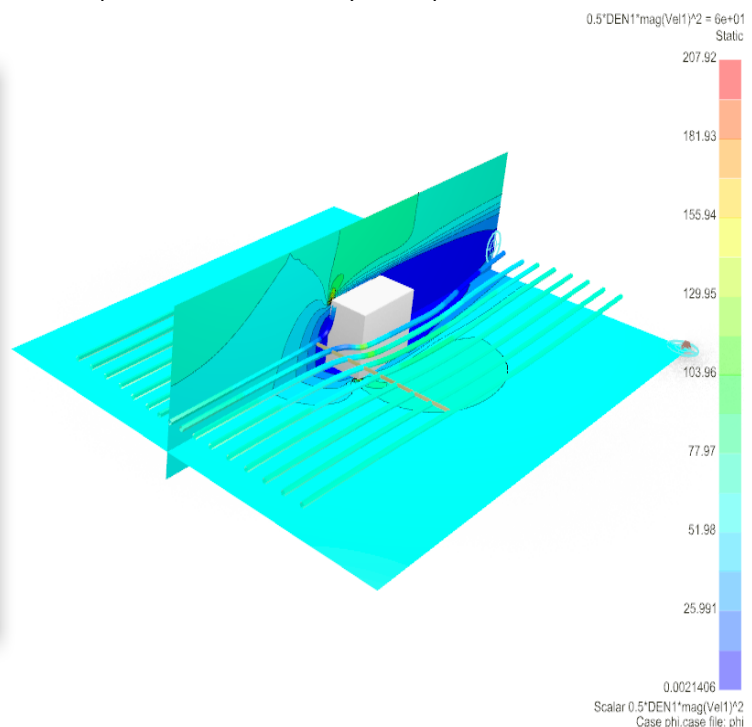
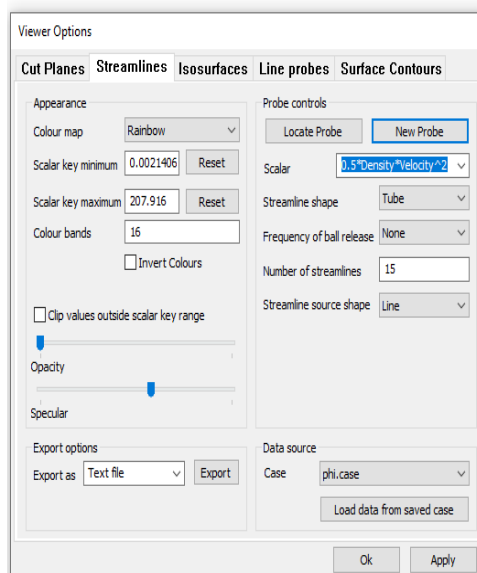
The latest version of RhinoCFD is compatible with RhinoV6 and V7.

2. New Features

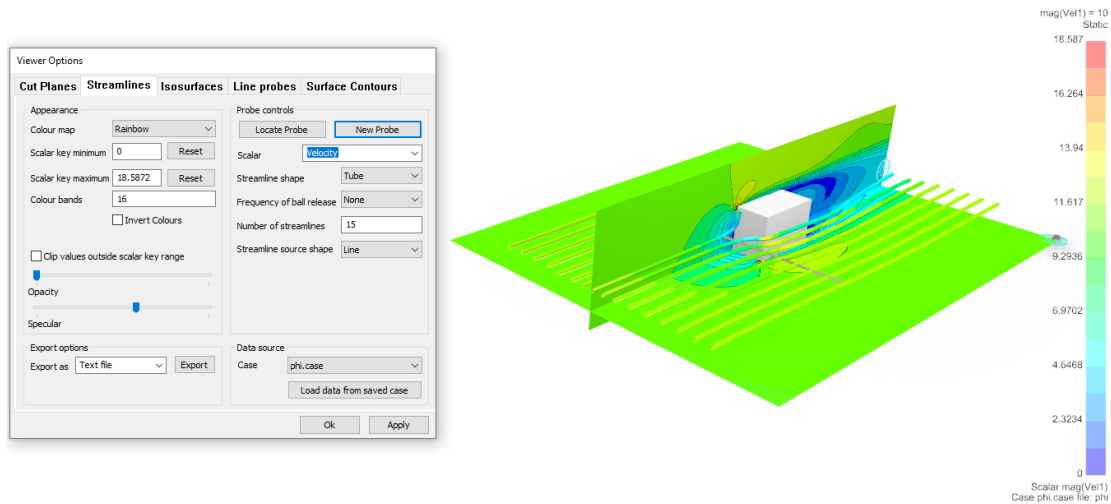
1.1 New Post-Processing Panel

We've tried to expand capabilities and make things clearer for users when post-processing results of a simulation. Changes include:

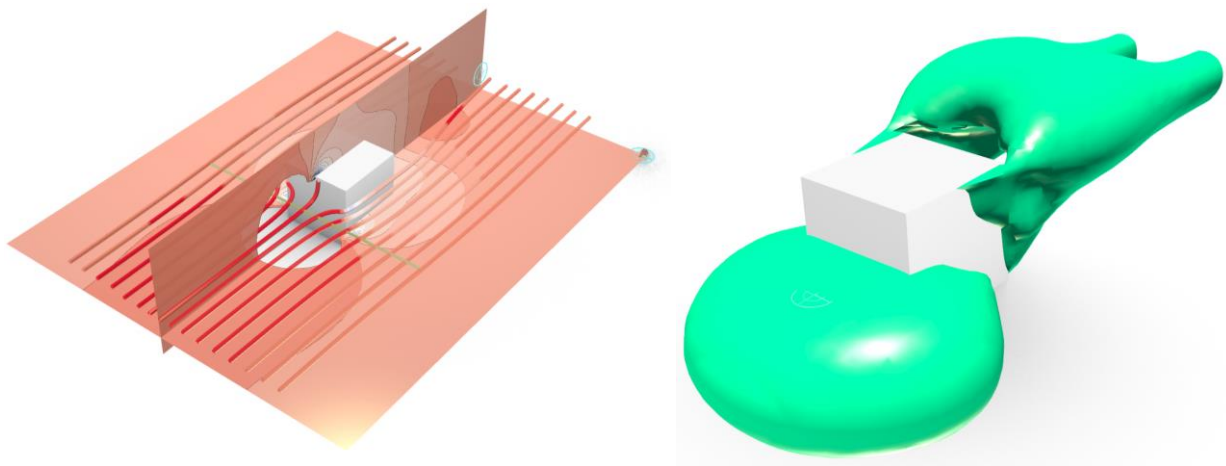
1. Redesign of the post-processing Viewer menu window incorporating new features.
2. Variables (temperature, velocity, cell material, etc.) are displayed with full names in post-processing,
3. Mathematical operations in post-processing can be performed on the data – e.g.: typing $0.5 * \text{Density} * \text{Velocity} * \text{Velocity}$ in the Scalar input box will calculate dynamic pressure in the flow.



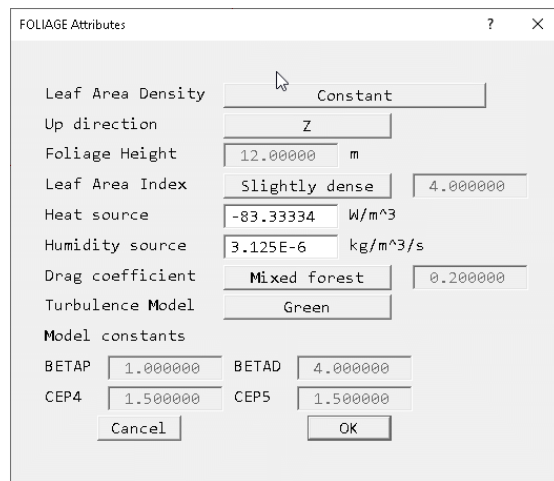
4. Standard notation added to scale; added feature to invert colours in post-processing; a grey-scale and other colour map options.



5. Improved performance of cutplane manipulation, including new faster vector drawing and improved shaders for colouring results.
6. Added feature specular reflection to results objects (cutplanes, iso-surfaces, streamlines, etc.)



2.2 Improved foliage model – evaporation & mass transfer

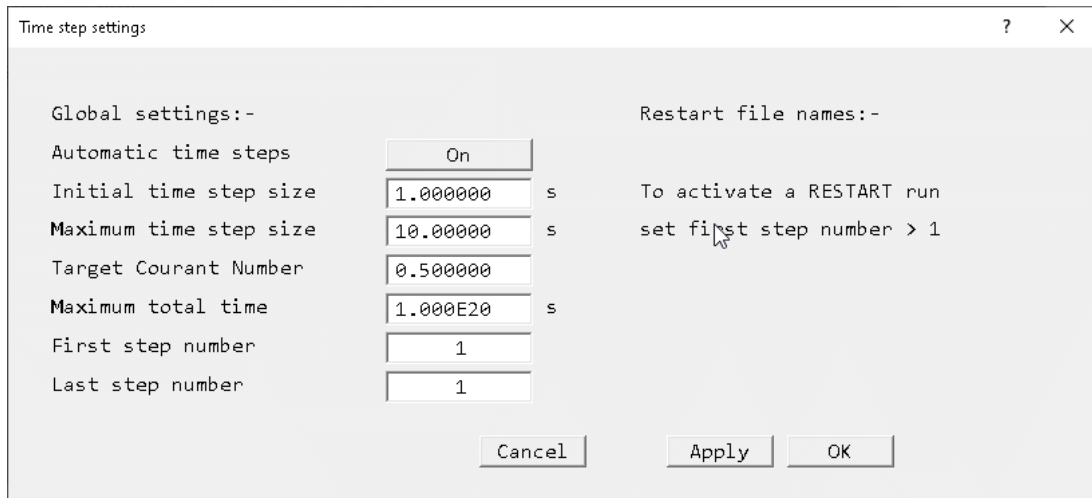


The foliage object represents a group of trees or other vegetation. As trees and plants absorb heat and release water vapour, a pair of input boxes has been added to the Foliage object to allow entering the cooling rate in W/m^3 and water-vapour release rate in $kg/m^3/s$.

The '**Heat source**' box should be set to the cooling power of the foliage (typically $250 W/m^2$) multiplied by the Leaf Area Density. The '**Humidity source**' box (only available in Flair) should be set to the moisture source in $kg/m^2/s$ (of the order $810 g/m^2/d$), also multiplied by the Leaf Area Density.

2.3 Automatic Time Step Calculation

An option in the 'Time step settings' dialog allows Earth to calculate time – step size.



Dialog sets the size of time step 1. At the end of each time step the flow field is scanned for the largest Courant Number. Step size for the next step is adjusted to maintain 'Target Courant Number' within user-set limits. The run will stop when 'Last step number' steps have been performed, or time exceeds 'Maximum total time'.

Current sweep number, time step number and time are written to any dumped solution files which enables restart runs to continue smoothly. This will benefit many transient cases where the timescale of the process changes during the calculation. This includes many VOF cases.

2.4 Option for outputting forces & moments per object as well as total

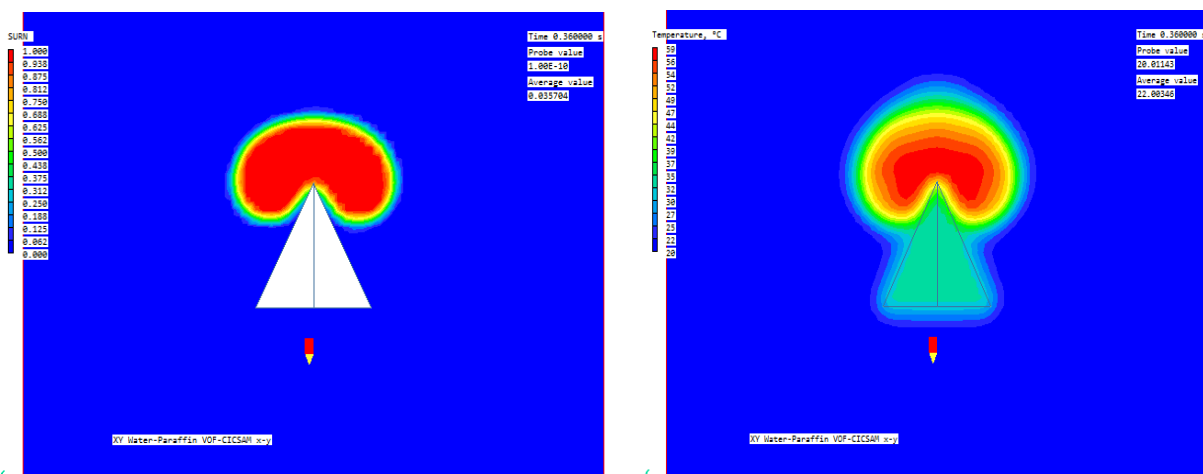
In addition to the pre-existing file containing the evolution of total force on all objects with time (or sweep), an additional file is output for each object participating in the force summation.

2.5 New Thermal Boundary Condition on objects

Dialogs for setting boundary conditions on non-participating blockages (material 198) allow the setting of thermal and scalar sources on the outer surfaces of such objects.

2.6 Extensions to the Volume-Of-Fluid (VOF) method

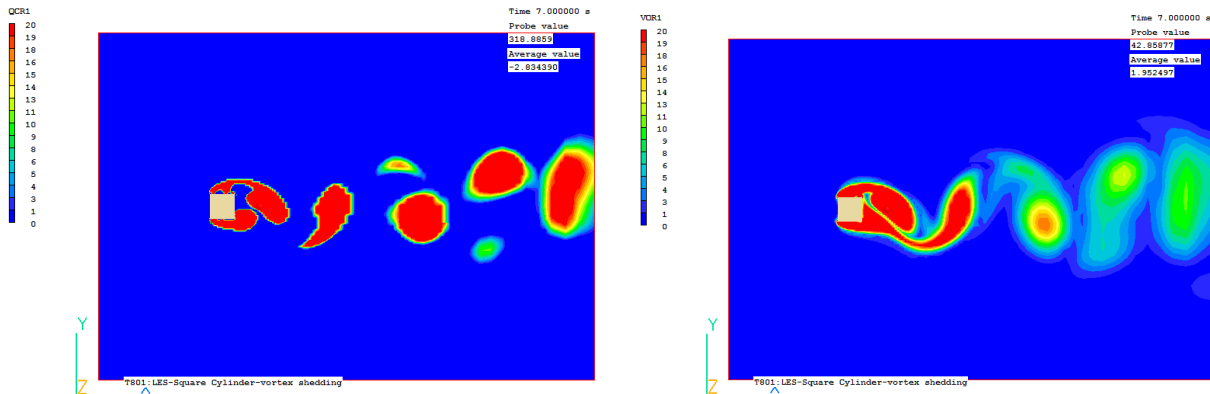
VOF dialogues enable use of THINC, and setting of parameters required for temperature-dependent surface tension. All VOF methods can solve temperature-dependent cases, with proper treatment of the temperature in each phase and in any immersed solids. The following images show a drop of hot fluid falling over a solid obstacle:



Surface tension can be a linear function of temperature; the Langmuir equation of state can be used which includes a scalar as well as temperature. A constant static contact angle can be specified to model wall adhesion effects.

2.7 Activation of Q-Criterion and Vorticity

The Main Menu – Output – Derived Variables panel allows activation of calculation and storage of the Q-criterion and Vorticity. The images show Q-criterion and Vorticity contours during vortex shedding from a square block:



2.8 Use of Weibull wind coefficients for averaged wind field (FLAIR)

FLAIR can calculate wind field and comfort index for a range of wind directions, and produce an averaged result. Both WASP tab format and Weibull coefficients can be used and can be read from a Generalised Wind Climate file.

A link to the Global Wind Atlas website allows wind data for large parts of the world to be downloaded quickly in the form of a Generalised Wind Climate (GWC) file.

Wind data format	WEIBULL
	Get Generalised Wind Climate File
Wind data file	gwa3_gwc_78pqdqcc.lib
Roughness class	0.030000 m
Height above ground level	10.00000 m

2.9 Dutch and Belgian Fire Standards (FLAIR)

FLAIR FIRE object and Smoke solution panels include Dutch NEN 6098 and Belgian NBN S 21-208-2/A1 Fire Standards. The 'International' fire and smoke model, used in FLAIR for many years, is relevant for most cases where production rates of heat and mass can be prescribed. The Dutch and Belgian models are designed to simulate car fires in parking garages and thus are more prescriptive in values used for heat of combustion and heat release rate. Selecting the Dutch or Belgian model automatically sets all parameters according to the chosen standard, and displays them in the form used.

Domain Settings

Smoke Settings

International Dutch NEN6098 Belgian NBN S 21-208-2/A1

The solved smoke concentration equation, $SMOK$, has units of kg/kg of mixture. It is products of combustion.

Heat of combustion (Hfu) (J/kg fuel)

Radiative heat fraction ($Q_{radiative}/Q_{total}$)

Particulate smoke yield (Y_s) (kg smoke particles/kg fuel)

Stoichiometric ratio (Rox) (kg oxygen/kg fuel)

Mass specific extinction coeff (Km) (m^2/kg particulate smoke)

Visibility can be estimated from the function:
 $Sight\ length = \max(0, \min(D_{max}, A/(Km * Smoke\ particulate\ density)))$

Sight length for light-reflecting objects (SLEN)

Sight length for light-emitting objects (SLN2)

Optical density can be obtained from: $OD = Km * Smoke\ particulate\ density / 2.3$

Optical density (OPTD)

2.10 Universal Thermal Climate Index (FLAIR)

The Universal Thermal Climate Index UTCI provides an assessment of the outdoor thermal environment in biometeorological applications based on the equivalence of the dynamic physiological response predicted by a model of human thermoregulation, coupled with a state-of-the-art clothing model. The operational procedure, available as software from the UTCI website (www.utci.org), shows plausible responses to the influence of humidity and heat radiation in heat, as well as to wind speed in cold, and is in good agreement with the assessment of ergonomic standards concerned with the thermal environment. The published subroutine returns the UTCI as a function of air temperature, water vapour pressure, mean radiant temperature and wind speed 10m above ground level.

2.11 Drift Flux Model for Aerosol Deposition (FLAIR)

An Eulerian-based multi-phase model for simulating dispersion and deposition of aerosol particles in indoor environments is standard. Applications include human exposure to biological or radiological aerosols in healthcare or laboratory environments; health hazards from industrial aerosols; protective environments and isolated clean rooms; and surface contamination of works, electronic equipment, etc.

The aerosol model assumes a very dilute particle phase (one-way coupling) with no collisions or coalescence; drift-flux modelling is used to represent slippage between particle and gas phases due to gravitational effects. In practice, aerosols can be deposited on surfaces by mechanisms including particle inertia, gravitational settling, Brownian diffusion (particles are transported towards the surface as a result of colliding with fluid molecules), turbulent diffusion (particles are transported towards the surface by turbulent flow eddies), turbophoresis (particles migrate down decreasing turbulence levels because of interactions between particle inertia and inhomogeneities in the turbulence field) and thermophoresis (temperature gradients drive particles towards or away from surfaces).