



# RhinoCFD

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## RhinoCFD 2.1 Release Notes

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This document is a summary of the changes that have been made to RhinoCFD from 2.0 to 2.1. We would like to give a special thanks to all of our users who have provided feedback and bug reports throughout the lifecycle of RhinoCFD 2.0.

## 1 Summary of Upgrades

To give you a roundup of what's new in RhinoCFD 2.1, here is a short summary:

- [New Post processing panel to simplify creating plots and produce higher quality results processing](#)
- [Temperature effects on foliage model](#)
- [Auto calculation of time step in transients](#)
- [Forces output on single objects or all of them](#)
- [Can now add heat to objects without assigning a material](#)
- [Improvements to the VOF free surface model](#)
- [Options to plot vorticity and Q-criterion easily](#)

We also have some improvements that are specific to FLAIR, our built environment module:

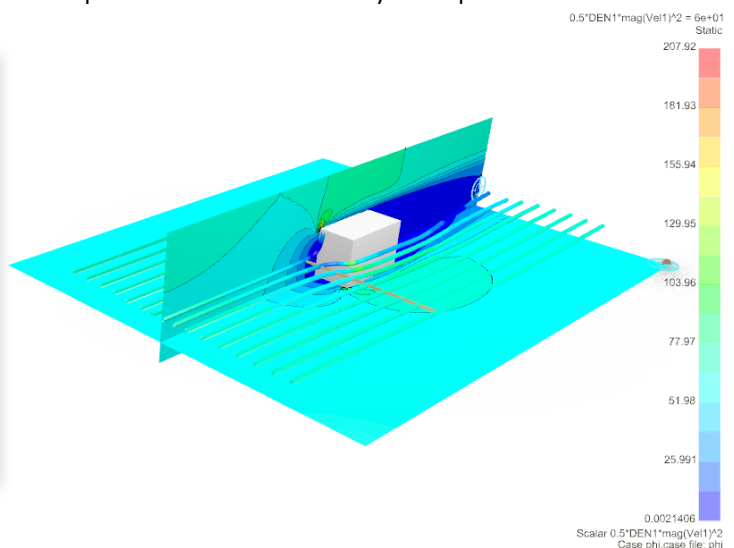
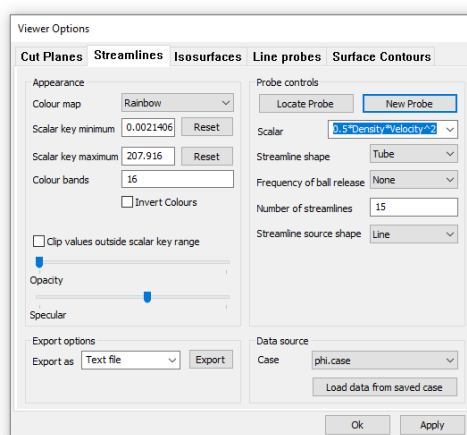
- [Wind conditions can now be specified via Weibull coefficients](#)
- [The Dutch and Belgian Fire standards are now selectable](#)
- [A new comfort index is available: Universal Thermal Climate Index](#)
- [A new aerosol deposition model is available](#)

## 2 New Features

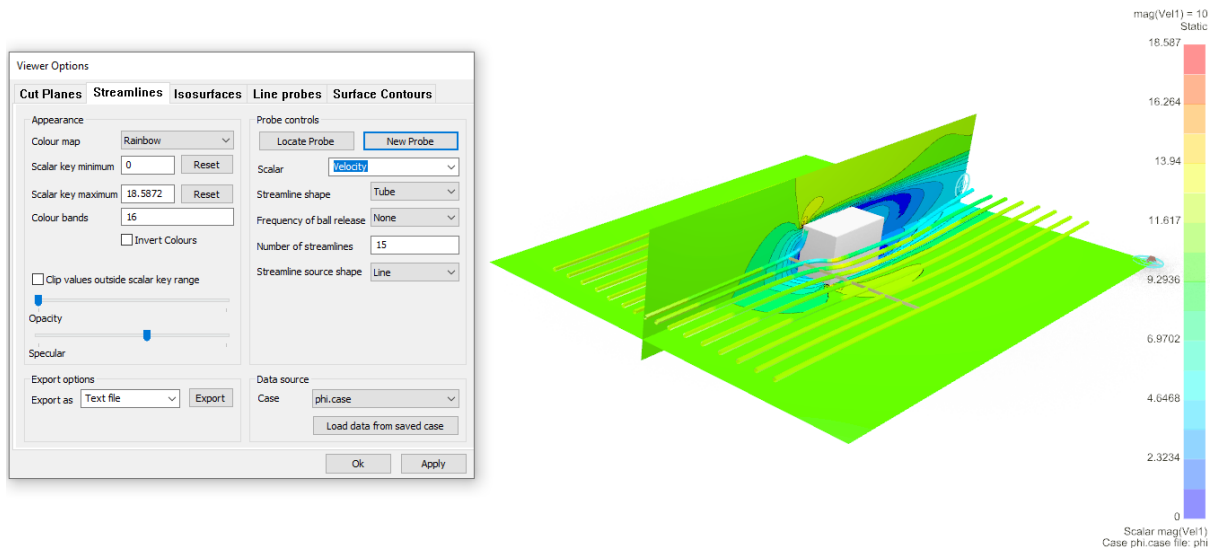
### 2.1 New Post-Processing Panel

We've tried to both expand the capabilities and make things a lot clearer for users when post-processing results of a simulation. Some of the new changes are:

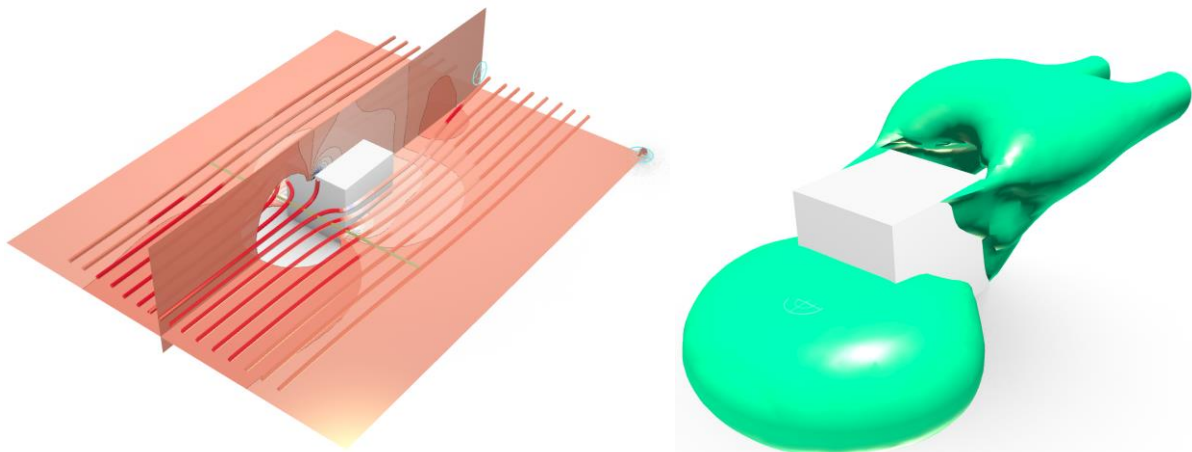
1. Complete redesign of the post-processing Viewer menu window – packed with new features and better organised.
2. In post-processing, variables (temperature, velocity, cell material, etc.) are displayed with full names instead of shorthand names.
3. In post-processing mathematical operations can now be performed on the data – e.g.: typing “ $0.5 * \text{Density} * \text{Velocity} * \text{Velocity}$ ” in the Scalar input box will calculate the dynamic pressure in the flow



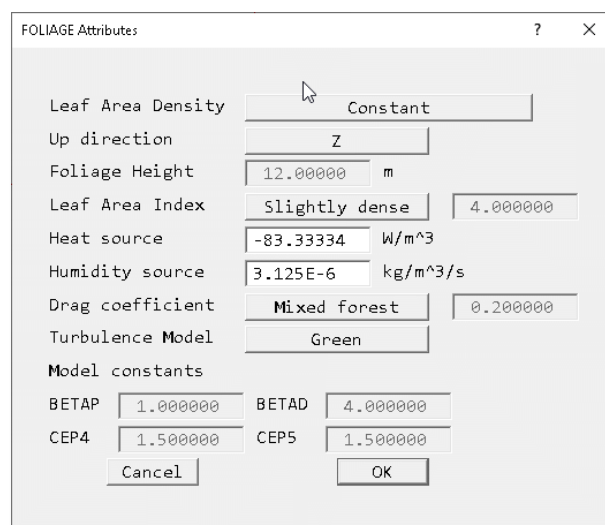
4. Standard notation added to scale, added feature to invert colours in post-processing and a grey-scale and other colour map options.



5. Improved the 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

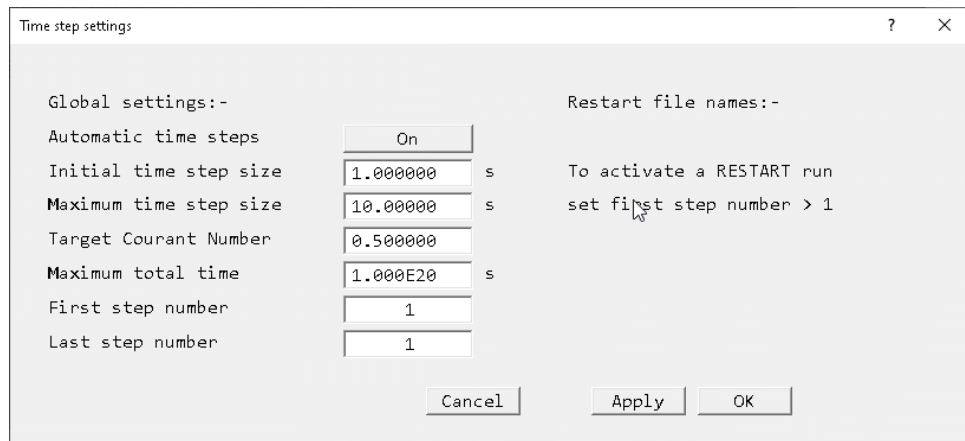


The foliage object represents a group of trees or other vegetation. As has been pointed out by users, trees and plants absorb heat and release water vapour. A pair of input boxes has been added to the Foliage object to allow the entry of the cooling rate in W/m<sup>3</sup> and water vapour release rate in kg/m<sup>3</sup>/s.

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

### 2.3 Automatic Calculation of Time Step

An option has been added to the 'Time step settings' dialog to allow Earth to calculate the size of the time steps itself.



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

The current sweep number, time step number and time are written to any dumped solution files. This 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 now output for each object participating in the force summation.

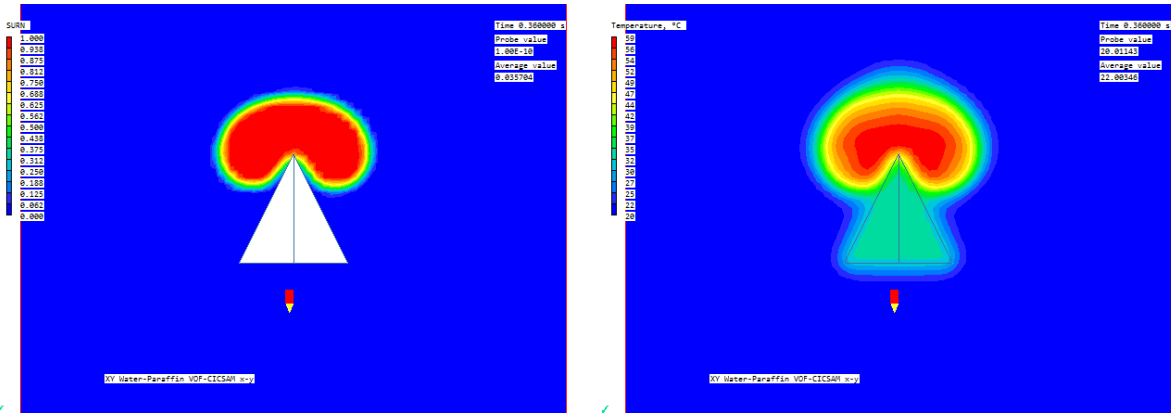
### 2.5 New Thermal Boundary Condition on objects

The dialogs for setting boundary conditions on non-participating blockages (material 198) have been updated to 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

The dialogs dealing with VOF have been updated to enable the selection of the extra THINC method, and to set the parameters required for temperature-dependent surface tension.

All the VOF methods can now 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:

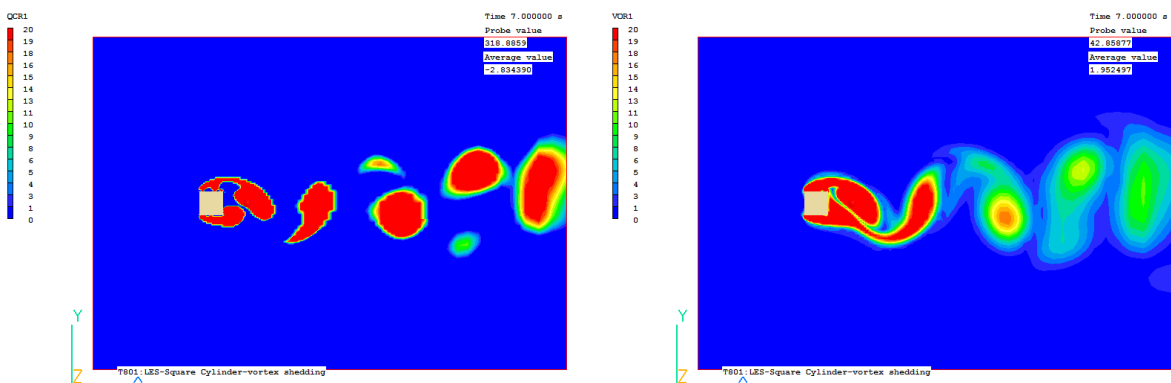


Options have been added to make the surface tension a linear function of temperature, or to use the Langmuir equation of state which includes a scalar as well as the temperature.

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 has been updated to allow the activation of the calculation and storage of the Q-criterion and the Vorticity. The following images show Q-criterion and Vorticity contours during vortex shedding from a square block:



## 2.8 Allow use of Weibull wind coefficients for averaged wind field (FLAIR)

Flair has an option to calculate the wind field and comfort index for a range of wind directions, and then produce an averaged result. The wind speed data was restricted to using tables of wind speed and probability (WASP tab format). This has been extended to allow the use of Weibull coefficients to set the wind data. These can be read from a Generalised Wind Climate file (WASP lib format).

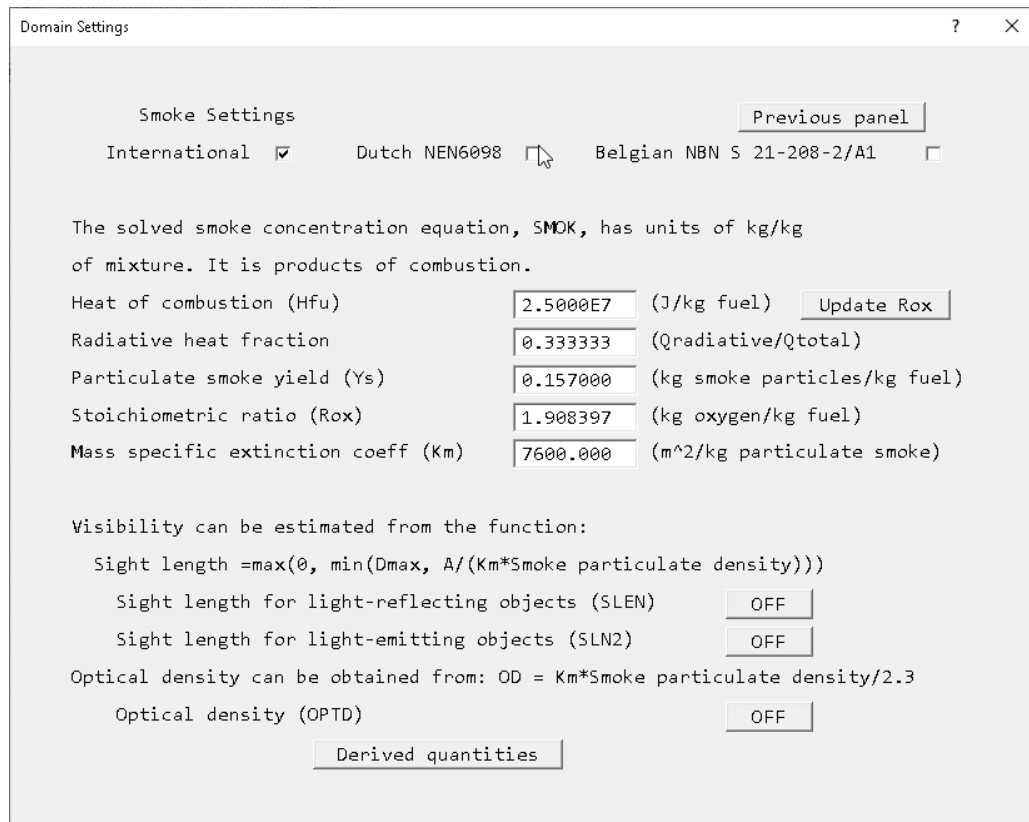
Wind data format	WEIBULL
Wind data file	gwa3_gwc_78pqdqcq.lib
Roughness class	0.030000 m
Height above ground level	10.00000 m

A link to the Global Wind Atlas website has been provided. From there, wind data for large parts of the world can be quickly downloaded in the form of a Generalised Wind Climate (GWC) file.

## 2.9 Dutch and Belgian Fire Standards (FLAIR)

The Flair FIRE object and Smoke solution panels have been extended to include the Dutch NEN 6098 and Belgian NBN S 21-208-2/A1 Fire Standards.

The 'International' model is the fire and smoke model used in Flair for many years. It can be used for most cases where rates of production of heat and mass can be prescribed. The Dutch and Belgian models are designed for simulating car fires in parking garages and hence are more prescriptive in the values used for heat of combustion and heat release rate.



Selecting the Dutch or Belgian model automatically sets all the parameters according to the chosen standard, and displays them in the form used.

## 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, which is coupled with a state-of-the-art clothing model. The operational procedure, which is available as software from the UTCI website ([www.utci.org](http://www.utci.org)), shows plausible responses to the influence of humidity and heat radiation in the heat, as well as to wind speed in the cold and is in good agreement with the assessment of ergonomics 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 the dispersion and deposition of aerosol particles in indoor environments has been implemented as a standard option. Typical 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 artworks, electronic equipment, etc.

The aerosol model assumes a very dilute particle phase (one-way coupling) with no collisions or coalescence, and drift-flux modelling is used to represent slippage between the particle and gas phases due to gravitational effects. In practice, aerosols can be deposited on surfaces by various mechanisms, including particle inertia,

gravitational settling, Brownian diffusion (where particles are transported towards the surface as a result of their collisions with fluid molecules), turbulent diffusion (where particles are transported towards the surface by turbulent flow eddies), turbophoresis (where particles migrate down decreasing turbulence levels as a result of interactions between particle inertia and inhomogeneities in the turbulence field) and thermophoresis (where temperature gradients drive particles towards or away from surfaces).

### 3 Bug Fixes

- Domain faces are rendered correctly and inlets with zero inflow do not show an arrow.
- Fixed a bug that caused the wind object to be sometimes shown as a pink box over the domain affecting visuals.
- Compass would sometimes be placed incorrectly – it is now locked to bottom corner of domain.
- Fixed a bug that occasionally caused objects to stay locked after exiting post-processing.
- Fixed a bug where new installations caused the toolbar to disappear.
- Accidentally deleting the probe object won't crash Rhino.
- The Domain edges are now part of the domain box and can be resized in one go.
- Fixed some of the seemingly random crashes when in post-processing.
- Fixed a bug in Marine where small units would cause an erroneously-sized domain to be created.
- Fixed a bug where inlets in a polar domain would not be set properly.
- Fixed a bug where unloading RhinoCFD would not remove all the CFD information.
- Objects now unlock properly when going from Post-processing to Pre-processing.

### 4 Back-end changes

- Opacity and specular reflection of all data visualizations are now in-sync, are set to correct initial values and can be dynamically changed.
- Changes to how console debug statements are reported making troubleshooting easier.
- Fixed a bug where the software would not install properly
- Setting the number of colour bands now affects all visualizations.
- Time step in transient cases now shown properly on the scale.
- Changed how things are drawn in RhinoCFD – now using shaders.