CHAM

PHOENICS

2010 September

Contents

- This presentation shows some of the new features introduced in PHOENICS, and corrections made between July 2009 and September 2010
- The talk is in four parts:
  - Pre-processor (VR-Editor)
  - Post-processor (VR-Viewer)
  - Solver (Earth)
  - General improvements (common to all modules)

VR Editor Improvements

PHOENICS Today

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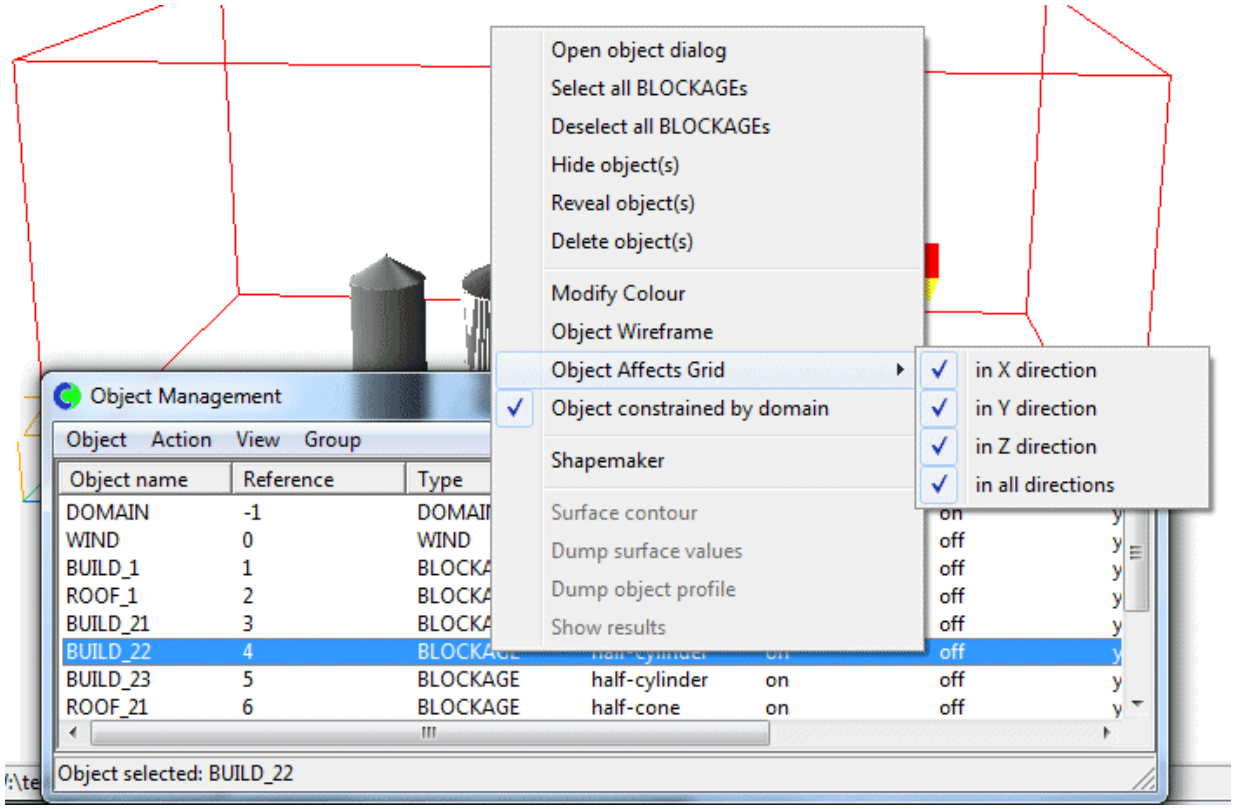
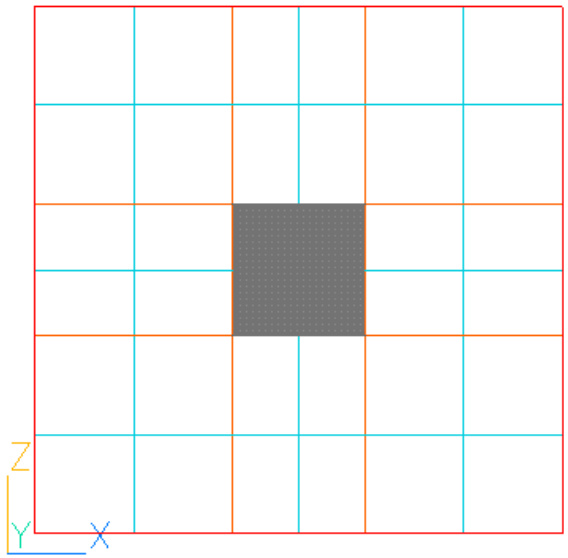
- The ‘Object affects grid’ attribute has been split into the three coordinate directions.

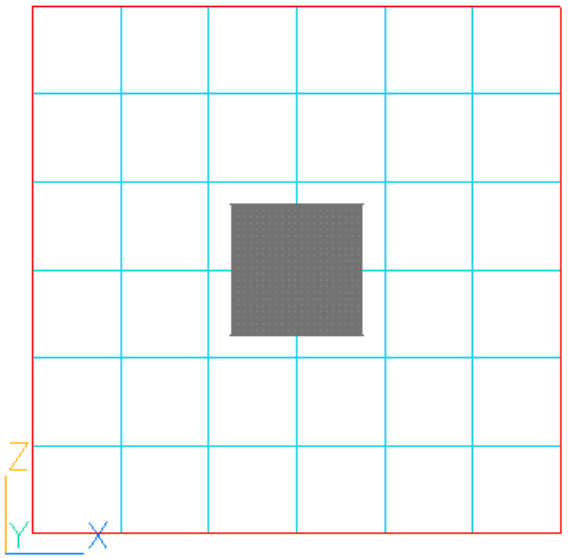


VR Editor Improvements

CHAM

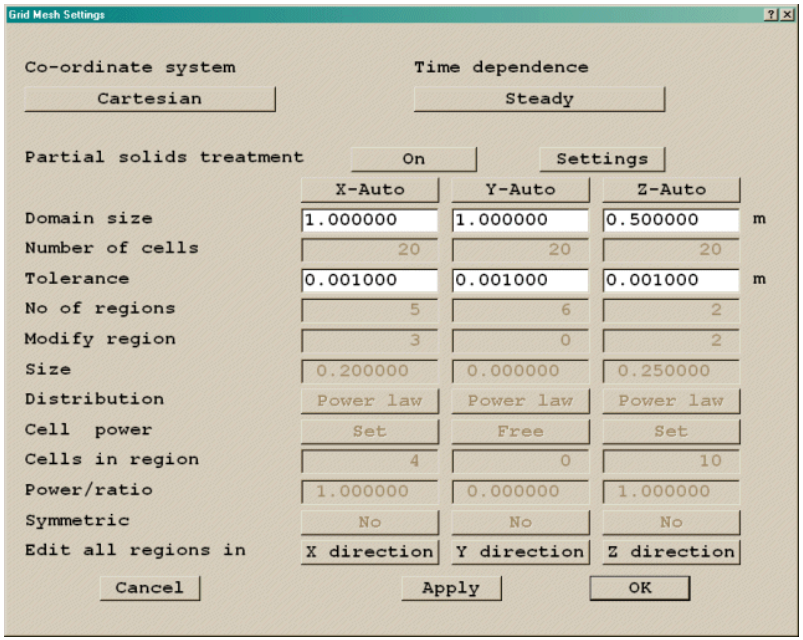
- This allows greater control over how the grid is divided into regions in each direction.
- For example, we may want a floor object to create regions in the Z direction, but not need them in X and Y.





VR Editor Improvements

- The tolerance used in matching the grid has also been divided into the three coordinate directions.

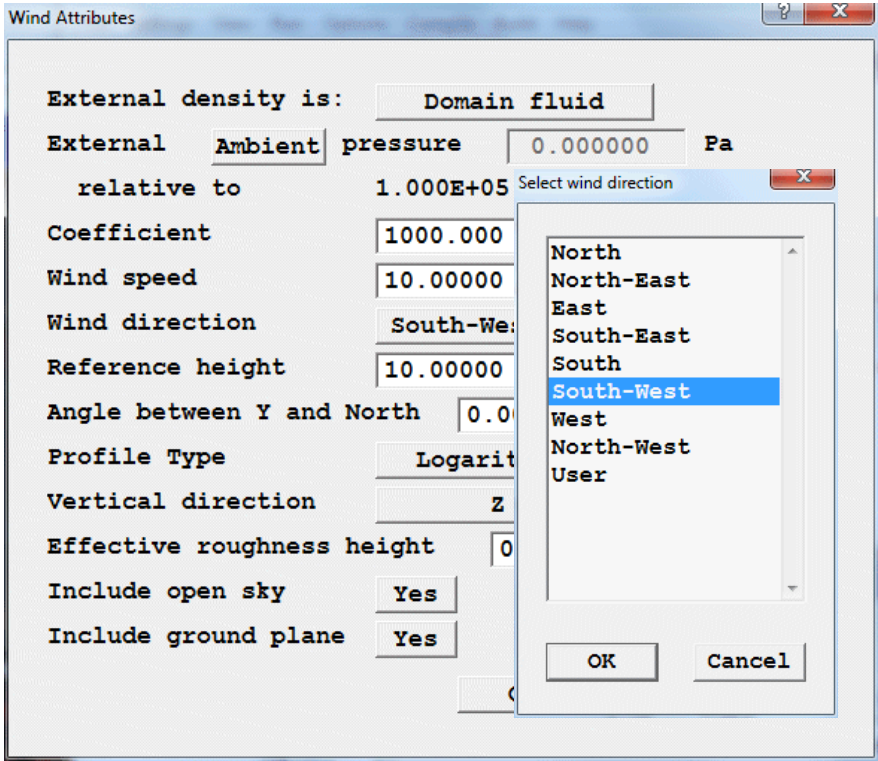


- This can be helpful when the domain dimensions are very different in one direction, say in a tunnel.

VR Editor Improvements

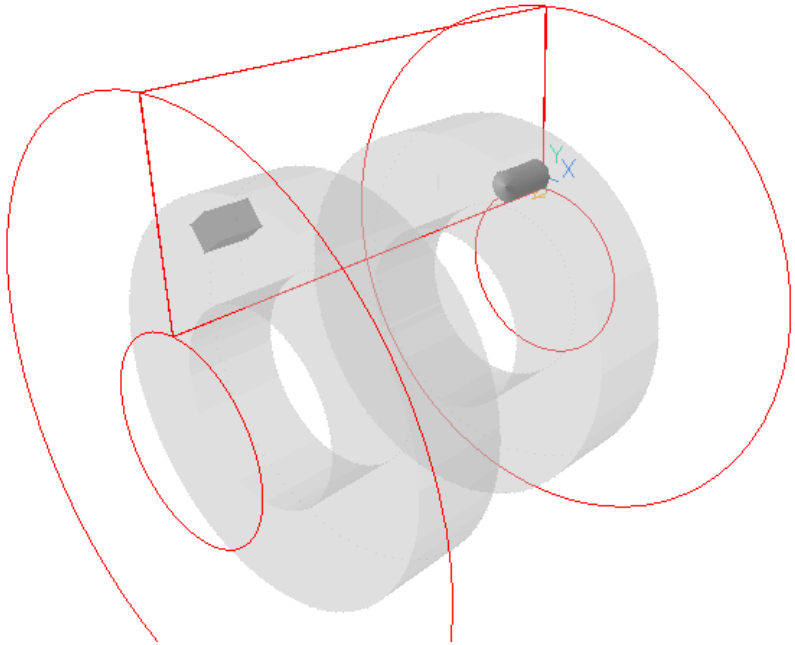
CHAM

- The WIND Object has been extended to add pre-set compass directions for the wind direction.
- In transient cases multiple WIND objects are allowed, with differing start- and end-times.
- This gives the opportunity to change wind direction and/or speed with time.



VR Editor Improvements

- The previous restriction of only one ROTOR object has been removed. There can now be as many ROTORs as needed.



VR Editor Improvements

CHAM

- At an OUTLET (OPENING), the external velocity can be set to DEDUCED.
- **Deduced** means that for cells where the internal pressure is lower than the external, the in-coming velocity will be deduced at run-time from the mass flow rate divided by the in-cell density and cell area.
- The rate of change of the deduced velocity can be relaxed to aid stability.
- If VOUT (and VOU2 for two-phase case) is STOREd, the deduced velocity is made available for plotting in the Viewer and is printed to RESULT.

VR Editor Improvements

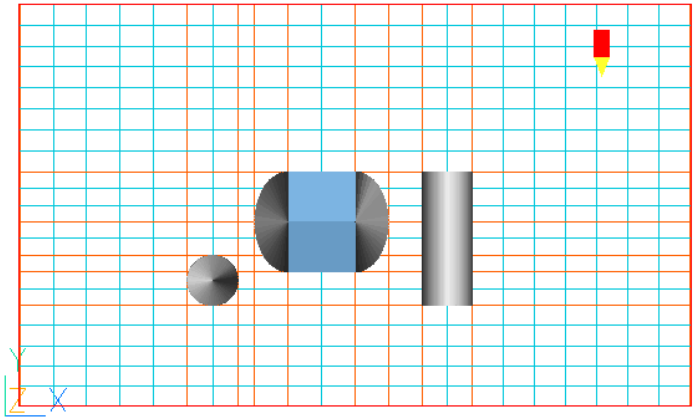
CHAM

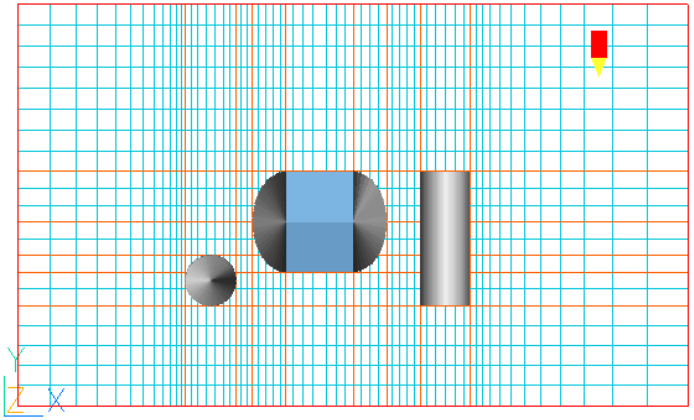
- A long-standing error in the Auto-mesher has been corrected.
- The grid refinement should stop when the ratio between the size of the last cell in one region and the first in the next region falls below a set criterion.
- On the auto-mesh dialog, this was set as a fraction of the domain size, but was then treated as an actual physical dimension when being compared to the normalised cell sizes.
- This means that for large domains, the refinement process terminated earlier than expected.

VR Editor Improvements

CHAM

- The image on the left shows the original auto-mesh, that on the right the new corrected version.





- There is also a new option to set the minimum and initial cell sizes as physical dimensions rather than fractions of the domain size.

VR Editor Improvements

- CAD-packages are frequently used to design engineering equipment. Most have the ability to define their output in a variety of formats. The formats supported directly by VR are:
  - STL - Stereolithography file. This is available in many popular CAD programs as an export format.
  - DXF - Drawing Exchange Format File (AutoCAD)
  - 3DS - Autodesk 3ds Max
  - WRL - Virtual Reality Modelling Language file
  - DW - Files generated by DesignWorkshop from Artifice
  - AC - Files generated by AC3D from Invis
  - IV - Files generated by Open Inventor

VR Editor Improvements

CHAM

- PHOENICS VR uses readers in the OpenSceneGraph libraries to read files in the above formats and convert them to the PHOENICS-VR geometry format.
- Once a CAD file is converted to the PHOENICS VR geometry format, its file extension is changed to '.DAT'.
- In addition, a JPEG thumbnail of the converted geometry is created. This can be used later to import another copy of the same geometry.

VR Editor Improvements

CHAM

- In Flair, the FIRE object has a new option to read the heat, mass and smoke sources from a table in a file, allowing any complex fire curve to be used.
- The tables consist of two columns of numbers in free format, with an optional first line of titles:

```
Time, Mass
0, 0
60, 0.0073
120, 0.0219
180, 0.0365
240, 0.051
300, 0.0583
360, 0.0583
420, 0.0583
480, 0.0583
540, 0.0583
600, 0.072
```

VR Editor Improvements

- The Earth solver will interpolate in the table to find the value at the current time-step.
- In the Q1 file, the settings are:

```
> OBJ,    TYPE,         FIRE
> OBJ,    TIME_LIMITS, ALWAYS_ACTIVE
> OBJ,    PRE-TEMP,     T_AMBIENT
> OBJ,    MASS-SOURCE,   From table file
> OBJ,    MASS-FILE,   1car_mass.csv
> OBJ,    HEAT-SOURCE,   From table file
> OBJ,    HEAT-FILE,   1car_heat.csv
> OBJ,    SCALAR-SOURCE, Mass Related
> OBJ,    INLET_SMOK,  1.
```

- The input files are ascii text files which can be created in any convenient manner.

VR Editor Improvements

- In Flair the JETFAN object can set a turbulence intensity.
- The k and ε values at the fan location are then deduced from the fan velocity and diameter.
- This can help improve the spreading of the jet.

VR Editor Improvements

CHAM

- Faster processing of Q1 files with many Inform commands attached to objects.
- The processing time of a data centre Q1 with 5000 objects, many of which had InForm commands attached , has reduced from well over an hour to under 2 minutes.
- The processing time of a transient Q1 with many (> 1000) time steps has been drastically reduced. The time-grid only need be set once, not regenerated for each step!
- More internal arrays have been made dynamic, allowing bigger cases and more complex InForm commands to be handled.

VR Editor Improvements

CHAM

- In PIL, the length of LABEL used together with GOTO has been increased to 68 characters.
- The PIL SORT function can be used to sort a PIL array into ascending or descending order, and remove duplicate entries. (This facility is used by our Data Centre models).
- An internal format has been changed to avoid a loss in accuracy during the sorting, and a tolerance has been added to help in identifying duplicates.

VR Viewer Improvements

CHAM

- Viewer plots contours based on values interpolated from the cell centres (for scalars) to the cell corners.
- Each time a new variable is chosen for plotting, the corner values are obtained by interpolation.
- For large grids, this causes an appreciable delay before the next contour is drawn.
- The interpolated values are now stored in memory, and when the same variable is requested again, the corner values are restored from the internal store rather than being interpolated again.
- The delay in switching variables is now no longer noticeable even for very large grids.

VR Viewer Improvements

- The file name used to save profile and time-history plots can be set to any required string.
- Profile and time-history plots can be saved to, and created from macros.
- Screen images of profile and time-history plots can be saved from macros.
- Continuous and inverse colour contours can be set from a macro.
- Macros still function after ‘Cancel’.

VR Viewer Improvements

CHAM

- Often streamline animations require several hundred if not thousand steps or frames to produce acceptably smooth motion.
- If the whole animation were saved, at say 1/10th sec per frame, the resulting movie would last several minutes and be enormous.
- We can now specify the start and end frame numbers, allowing much shorter and hence smaller movies to be saved.

VR Editor / Viewer Improvements

CHAM

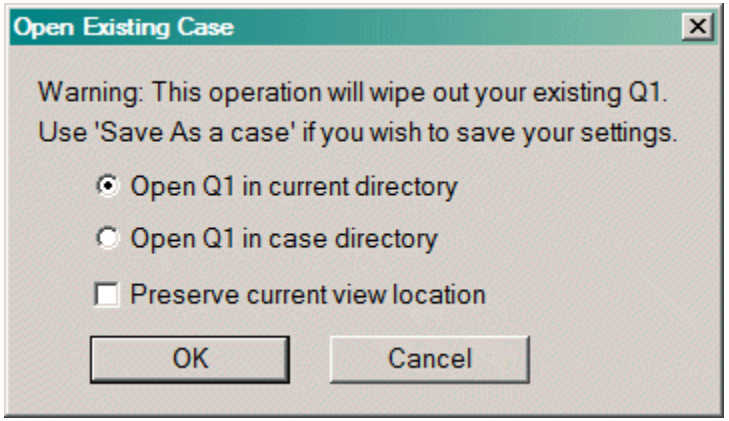
- Better checking of license file location in registry. This prevents the search patch for the license from becoming so long that either the license file cannot be found, or the search introduces an appreciable delay in the run.
- Display 32 or 64 bit in the window title and result file, to make it plain what version is in use.
- Display current working directory in status bar.
- Editor/viewer screen proportions fixed regardless of screen aspect ratio.
- Default image type (gif, pcx, bmp or jpg) for saved images can be set in cham.ini

VR Editor / Viewer Improvements

CHAM

- When opening an existing case, there is now an option to:
  - Copy the case files to the current working directory, or;
  - Switch the working directory to the folder containing the case files.

- This will allow any geometry files specific to the case stored together with the case files to be picked up.
- The current working directory is shown in the status bar.



Earth Improvements

- From 2009 the RESULT file ‘Nett source' echo showed the transient contribution for to the mass source.
- For 2010 this is extended to Energy and scalars.
- This makes it easier to judge the convergence of transient cases.
- For compressible flows, the pressure-work term for the Energy Equation is also printed.
- The ‘Nett source’ echo for parallel cases now has the same format as sequential, showing the in- and out-flow splits and transient contributions.

Earth Improvements

- Often there is a need to link the flow rate and temperature at one boundary condition to the flow and temperature at another.
- Typical examples are
  - Ducting that is not explicitly modelled that joins one part of the domain to another
  - The intake and exhaust from an Induction Fan
  - Active chilled beams
- This can now be achieved by a pair of linked ANGLED-IN objects.

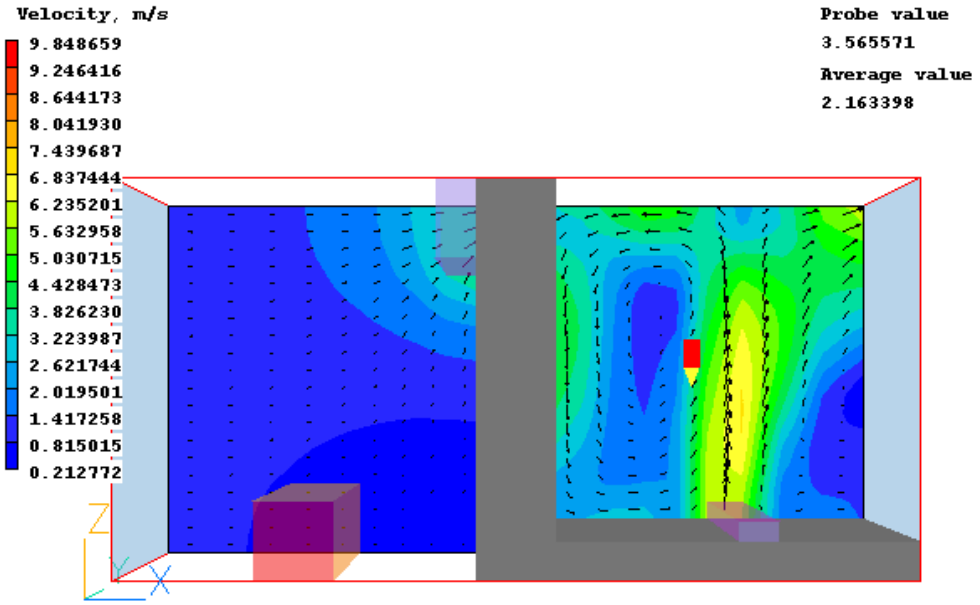
Earth Improvements

- One ANGLED-IN, set to extract flow, acts as a ‘donor’.
- The immediately-preceeding or immediately-following ANGLED-IN takes the flow rate from the ‘donor' and uses it as the inflow:
  - The temperature, smoke and other scalars are taken as the mass-averaged average values at the ‘donor' object.
  - The density is evaluated at the average temperature and ambient pressure.
  - The velocity is deduced from the mass flow rate (taken from the ‘donor’), the flow area and the deduced density.
  - The turbulence values are computed from the turbulence intensity, velocity and hydraulic diameter.
- The linking happens in pairs, so that a linked pair can be copied or arrayed. The correct objects will stay linked.

Earth Improvements

CHAM

- Here a pair of linked ANGLED-Ins are used to represent a duct joining the left and right-hand sides of the domain.

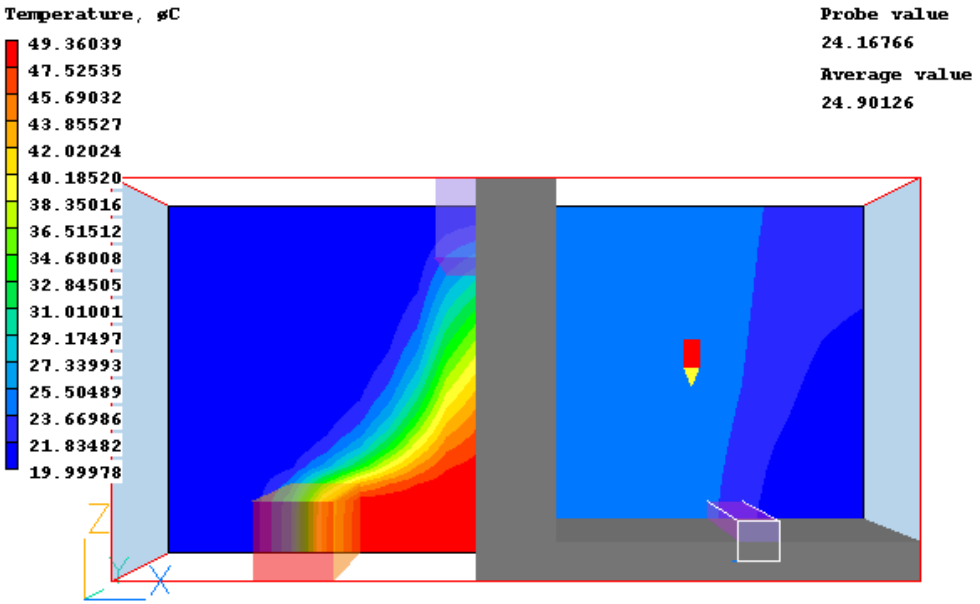


Linked Angled-in objects

Earth Improvements

CHAM

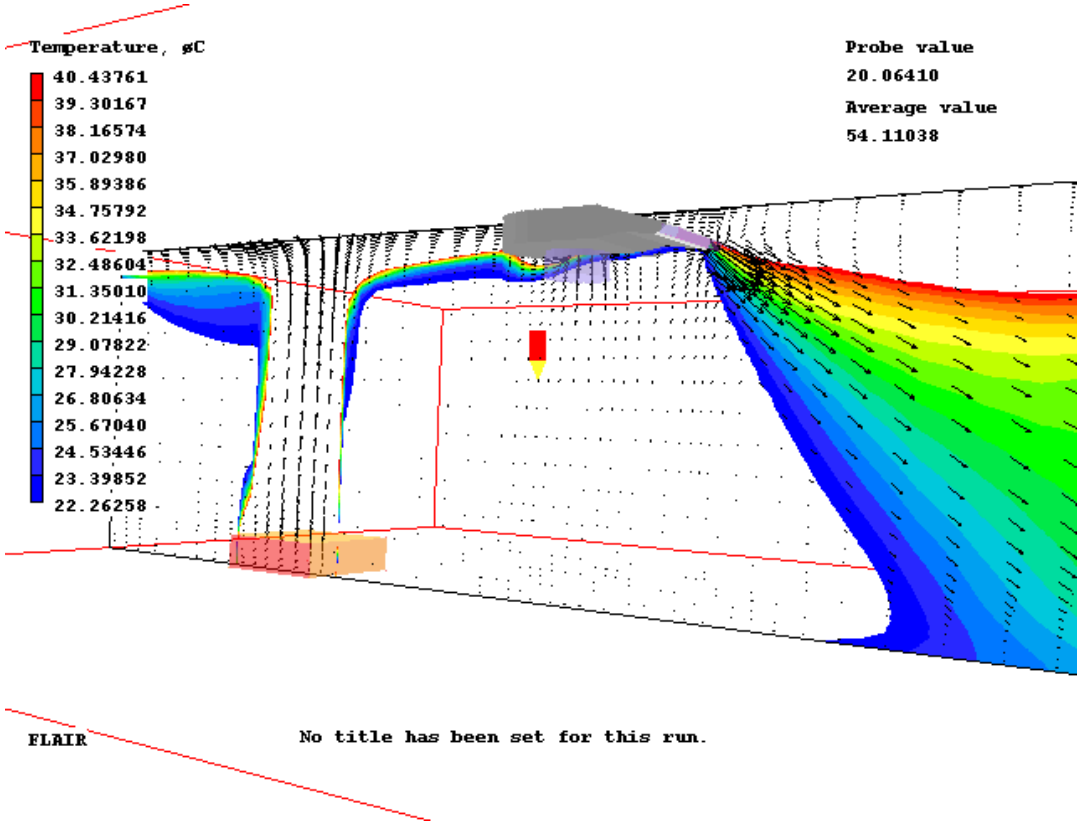
- Here a pair of linked ANGLED-Ins are used to represent a duct joining the left and right-hand sides of the domain.



Linked Angled-in objects

Earth Improvements

- Here a pair of linked ANGLED-Ins are used to represent an induction fan.



Earth Improvements

- In parallel cases, ANGLED-IN objects can straddle processor boundaries and still produce the correct source.
- Linked ANGLED-IN objects need not be on the same processor.
- ANGLED-IN and OUT objects can act as GENTRA outlets.

Earth Improvements

CHAM

- In Flair the ‘Calculate link temperature’ and ‘Activation temperature’ settings for a SPRAY_HEAD object really activate the spray when the activation temperature is reached.
- In previous versions, a message was written to RESULT when the criterion was met, but the spray was not automatically activated.
- A table file containing the calculated link temperatures at the end of each step is also produced.

Earth Improvements

- In Flair, tables of heat and smoke sources from FIRE objects are generated, allowing for easy checking.
- A convergence table is produced showing the errors normalised by the inflow fluxes.
- This can often give a better impression of the convergence behaviour than the auto-normalised residuals on the monitor plot.
- The normalising quantities are printed to RESULT.

Earth Improvements

- The PARSOL solids detection algorithm has been given a complete overhaul to the extent of being rewritten.
- One aim was to provide more robust detection.
- The other was to provide a better start-point for the long-awaited multi-cut cell.
- It has also resulted in a reduction of memory usage of around 8%.

Earth Improvements

PHOENICS Today

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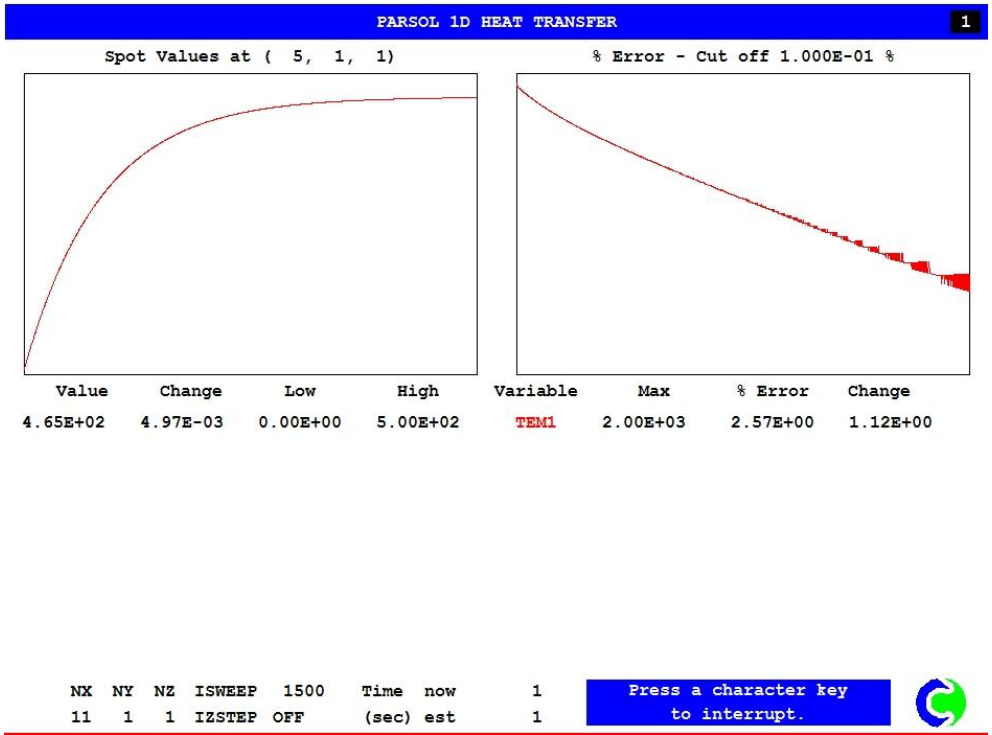
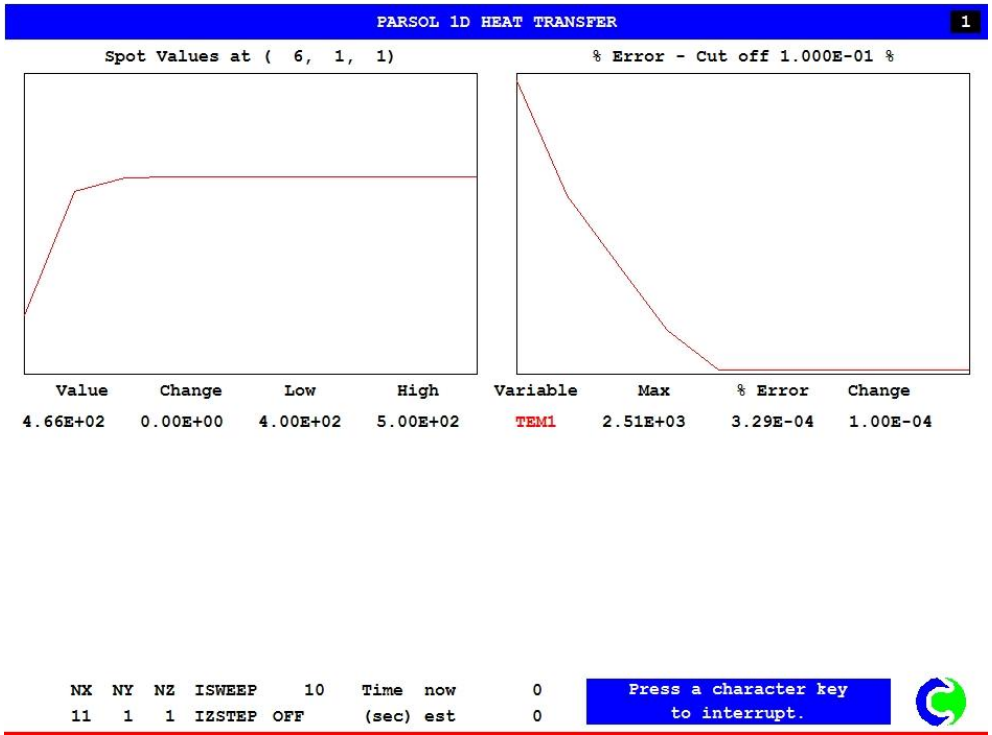
- The performance of the conjugate heat transfer solver has also been improved.
- For a 1-D case, the 2009 solver with LITER(TEM1)= 200 gave this convergence plot:



Earth Improvements

- The 2010 solver gives this convergence with LITER(TEM1)= 20:



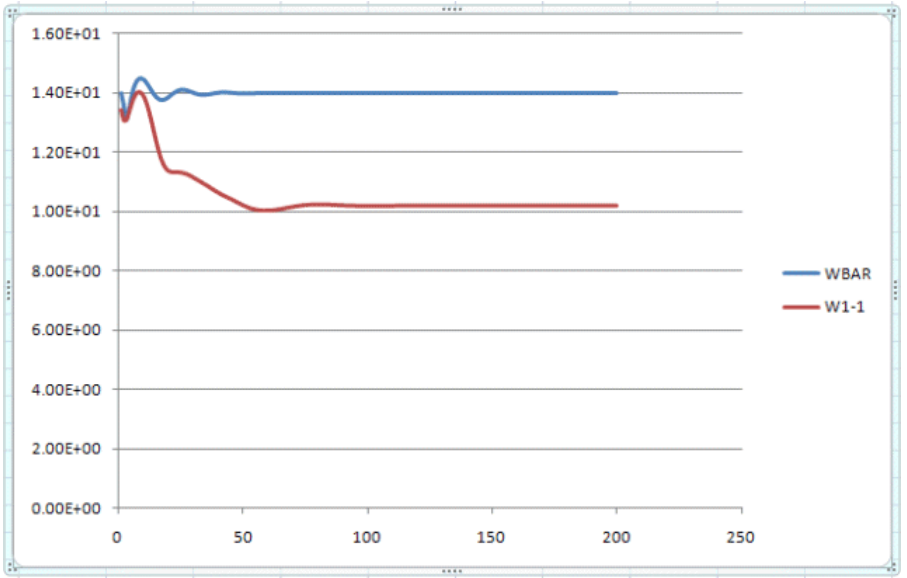
Earth Improvements

- InForm can use (much) longer and more complex formulae – up to 100 operands.
- InForm can be used to modify porosities.
- InForm recognises BFC geometrical quantities.
- InForm OLD() function corrected.
- InForm SUM function corrected for parallel.

Earth Improvements

CHAM

- A TABLE function has been added, which allows tables with any number of columns to be written once per sweep or once per time step.
- These files are compatible with Excel, and can be used to create additional monitoring points and values, as shown in the image from InForm Tutorial 4.



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