



## CHAM Product Update

PHOENICS – Your Gateway to CFD Success

# PHOENICS Direct 2015

## Urban-VWT Simscene (Mk1.0)

### Cityscape Simulation – Urban Virtual Wind Tunnel

#### Introduction

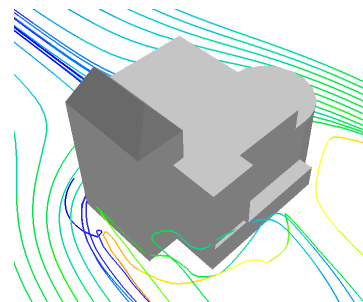
PHOENICS-Direct is a low-cost, simplified user environment for CHAM’s PHOENICS CFD software package. Using intuitive parameters, its purpose is to make available only those functions needed to fulfil the particular tasks for which the interface has been designed, without the need for its users to have extensive CFD knowledge. Urban-VWT (Urban Virtual Wind Tunnel) is an application-specific SimScene that uses PHOENICS-Direct as its user interface. It is a tool to assess the effect of wind around buildings and other structures and its impact upon pedestrians and the surrounding cityscape.

Designed with pre-defined graphical displays, Urban-VWT employs intelligent default settings and generates results in a form needed to meet international standards and modelling regulations.

#### Why simulate Cityscapes?

CFD simulation is used to assess the effects of the wind around new building designs and also the impact of building construction upon the immediate environs. Using Urban VWT, architects, building engineers, urban planners and local authorities can obtain performance data relating to:

- Forces on roofs and walls.
- Pedestrian comfort.

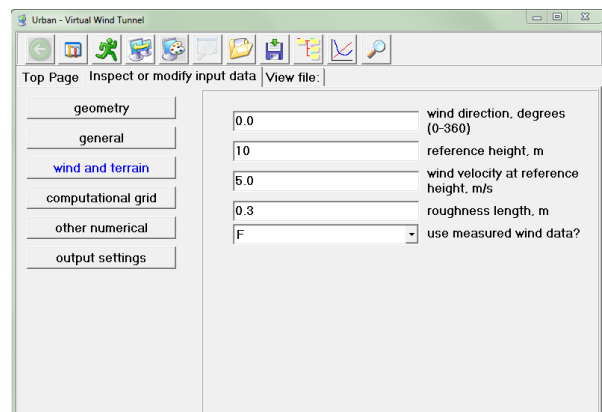


Building loaded in Urban-VWT

#### Features

Urban VWT offers:

- Accurate CFD results for any architectural structure, wind direction and wind speed.
- Easy loading of the buildings and cityscape geometry from a wide variety of CAD formats.
- Execution as a CFD plug-in to a commercial CAD package.
- Incorporation of measured wind statistics to the simulation results.
- Automatic grid generation with refinement at interest areas.
- Grid aligned with the prevailing wind direction to avoid numerical-diffusion inaccuracies.



Urban VWT user interface. Wind and terrain panel



### Example

In the example described below, Urban-VWT is used to simulate the air flow through a group of buildings. The focus is on the wind at pedestrian level, especially around the building circled in Fig1 for North (N) and East-South-East (E-S-E) wind directions.

### Simulation requirements

The particular region of interest is around the central building up to 10m above ground. The circle marks the building and the arrows show the two wind directions simulated. In this example, the wind speed is 5m/s at a height of 10m and the surrounding surface roughness height is 0.03m, (representative of low obstacles and vegetation.)

Fig 2 shows a histogram of the measured frequency of each wind speed for the two wind directions modelled. Each velocity value shown is the upper limit of its interval.

### Simulation setup

The Urban-VW's menus contain all the relevant parameters needed to configure the simulation.

The setup displayed takes ~10 minutes to create.

Urban-VWT's user interface presents 7 parameter groups as buttons on the left hand side. Fig 3 shows the *wind and terrain* group. It contains the characteristics of the incoming wind (i.e 0° *wind direction, degrees (0-360°)*, so *N wind*) and the roughness of the terrain.

For the E-S-E wind direction simulation the user merely has to change the *wind direction degrees* parameter to 112.5°. The new configuration will then be applied and the computational grid for the E-S-E wind will be re-generated and aligned with the wind direction automatically.

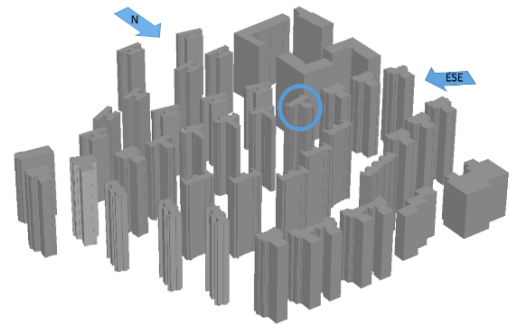


Fig 1 Geometry of the simulation

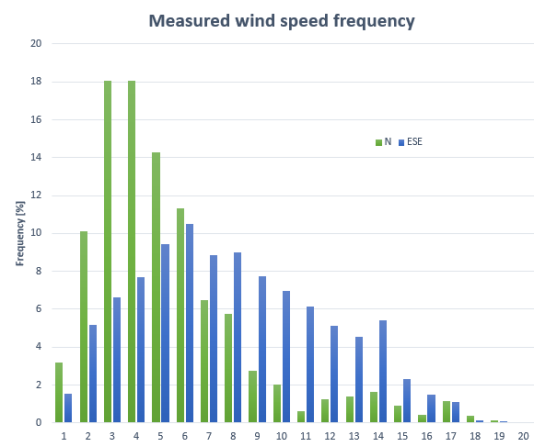


Fig 2 Probability of wind speed for N & ESE winds

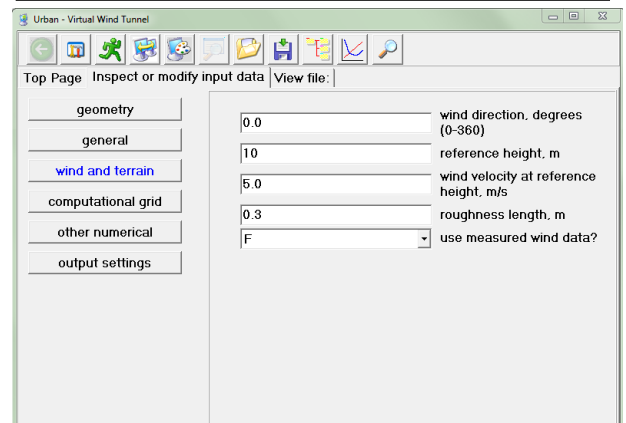


Fig 3 Wind and terrain parameters

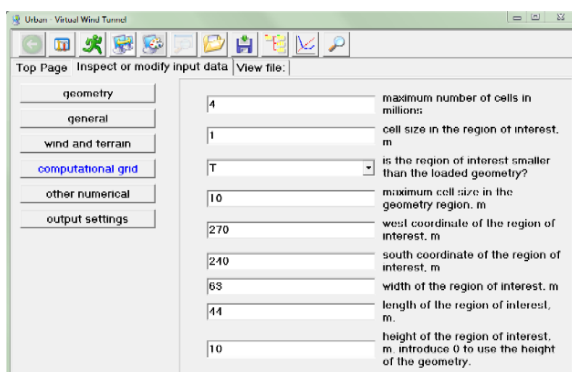


Fig 4 Computational grid parameter group and (left) graphical representation of its parameters (right)

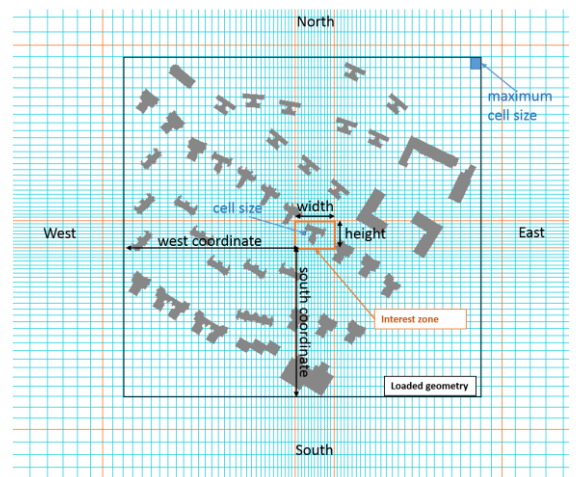




Fig 4 displays the *computational grid* group. It controls the resolution of the grid and the maximum number of computational cells. For the present model the maximum number of cells is set to 15 million. The smallest cell size is 0.5m in each direction. This resolution is uniformly applied in an area surrounding the building of interest (Fig 1) up to 10m above ground level. The cell size expands to 8m for the remainder of the built up area, with further expansion towards the domain boundaries. All these values can be changed using the menu and their effect on the grid viewed.

Figures 5 and 6 below display the grids generated for N and E-S-E wind directions.

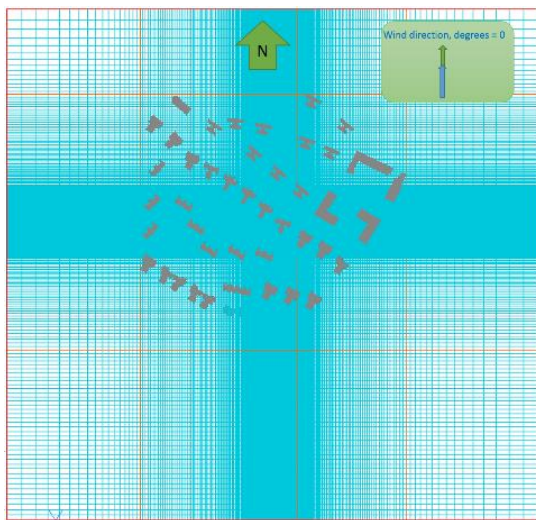


Fig 5 Domain, geometry and grid – N wind

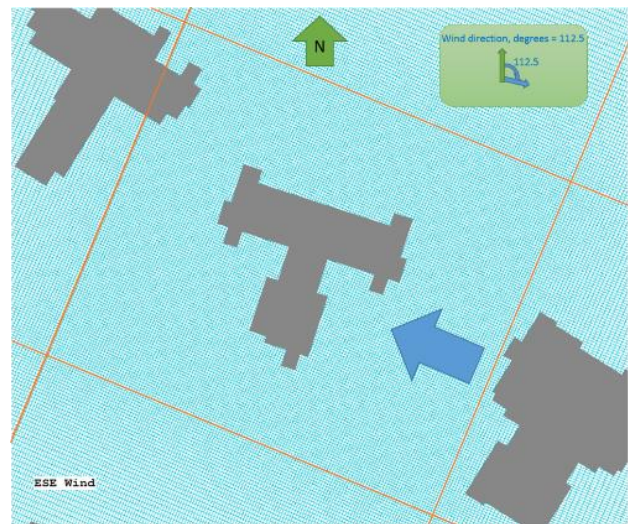


Fig 6 Close up of the region of interest for E-S-E wind.

The remaining groups listed in Fig 3 and Fig 4 above are:

- *geometry*, which imports the file with the geometry and configures it;
- *general*, which sets the title of the simulation and the size of its domain;
- *other numerical* which contains the number of sweeps and processors and;
- *output settings* which controls the automatic post-processing of the results.

Clicking 'Run the simulation' will launch the solver and begin the simulation. Once finished, clicking on 'Display results graphically' will generate the 2D and 3D plots previously configured in *output settings*.



## Results

Figures 7, 8, 9 and 10 show the results for the E-S-E wind generated by the post-processing feature. In this case, the *output settings* parameter group has been set to generate plots of:

1. Fig 7 - 8: Wind Amplification Factor (WAF) @ 2m above ground. Where WAF is the ratio between the wind speed with and without the buildings.
2. Fig 9: Probability of the wind speed (PRO) to exceed 6m/s @ 2m above ground. Plot generated in conjunction with the E-S-E wind data.
3. Fig 10: Streamlines started @ 2m above ground.

The images generated are oriented the same way regardless of the wind direction. Moreover, custom plots can be generated using the standard VR-viewer.

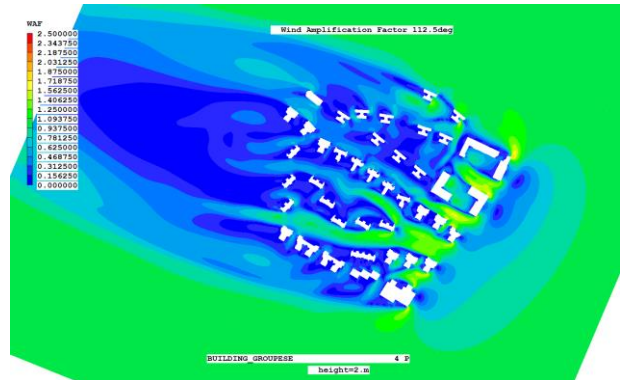


Fig 7 Wind Amplification Factor contours @ 2m above ground for E-S-E wind.

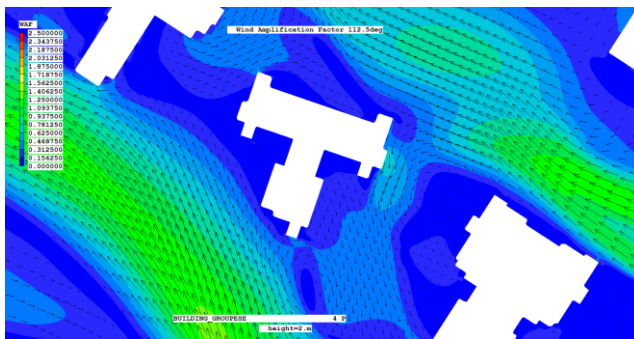


Fig 8 Zoom image - Wind Amplification Factor contours with wind velocity vectors @ 2m above ground for E-S-E wind.

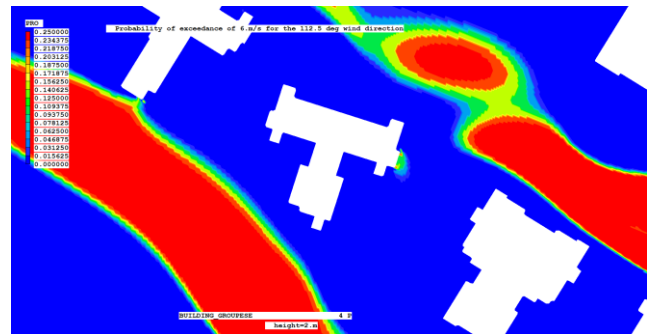


Fig 9 Contours of the probability of the wind speed to exceed 6m/s @ 2m above ground for E-S-E. The red colour denotes values of 0.25 (i.e. 25%) or higher.

## Summary

The Urban-VWT SimScene is designed to model air flow around structures and buildings. The results display meaningful variables commonly used in pedestrian wind comfort studies, allowing the user to extract valuable information without the need for specialist CFD programming knowledge.

Urban VWT operates on standard PC equipment. For further information about Urban VWT, licence arrangements, consultancy, seminars and courses, and more specifically what it can do for you, contact [Sales@cham.co.uk](mailto:Sales@cham.co.uk).

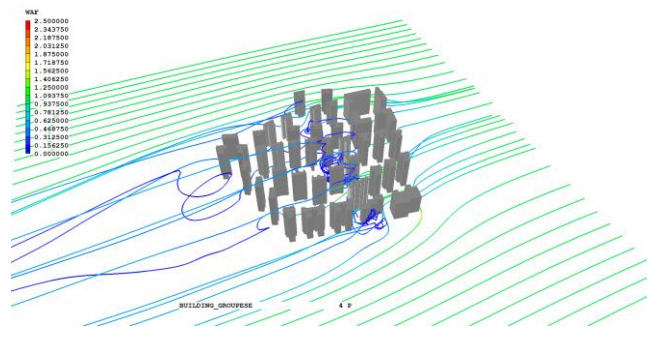


Fig 10 Streamlines started at @ 2m above ground coloured by Wind Amplification Factor for E-S-E wind.