Tas Climate Based Daylight Modelling

Climate based daylight modelling originated in the **lighting simulation community**. Hourly diffuse and direct solar radiation climate data is used to produce daylight coefficients for patches of sky. Irradiance data is converted to illuminance using a luminous efficacy model. The daylight contribution to the space is then calculated hourly through the year for each sky patch.

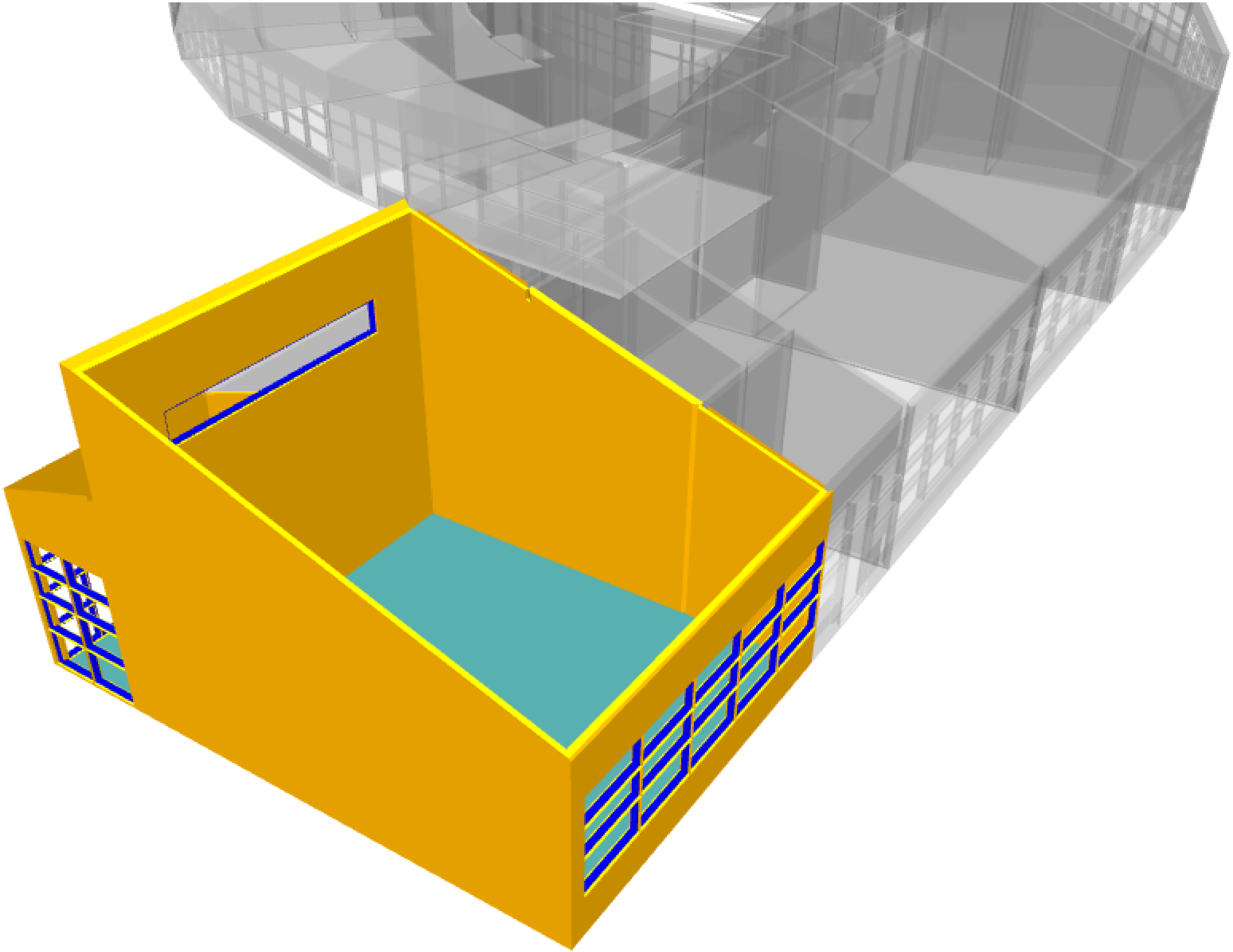
EDSL's Tas software has originated in the **thermal simulation community**. Our Tas software calculates the diffuse and direct solar distribution in spaces hourly through the year. We have developed a daylighting simulation engine, which is fully integrated with our thermal simulation engine. We are, therefore, able to calibrate the daylight contribution from the solar contribution in a space using luminous efficacy. Put simply, we convert the hourly solar income into hourly daylight income.

The following slides illustrate the functionality of the combined thermal and daylight simulation model on a classroom.

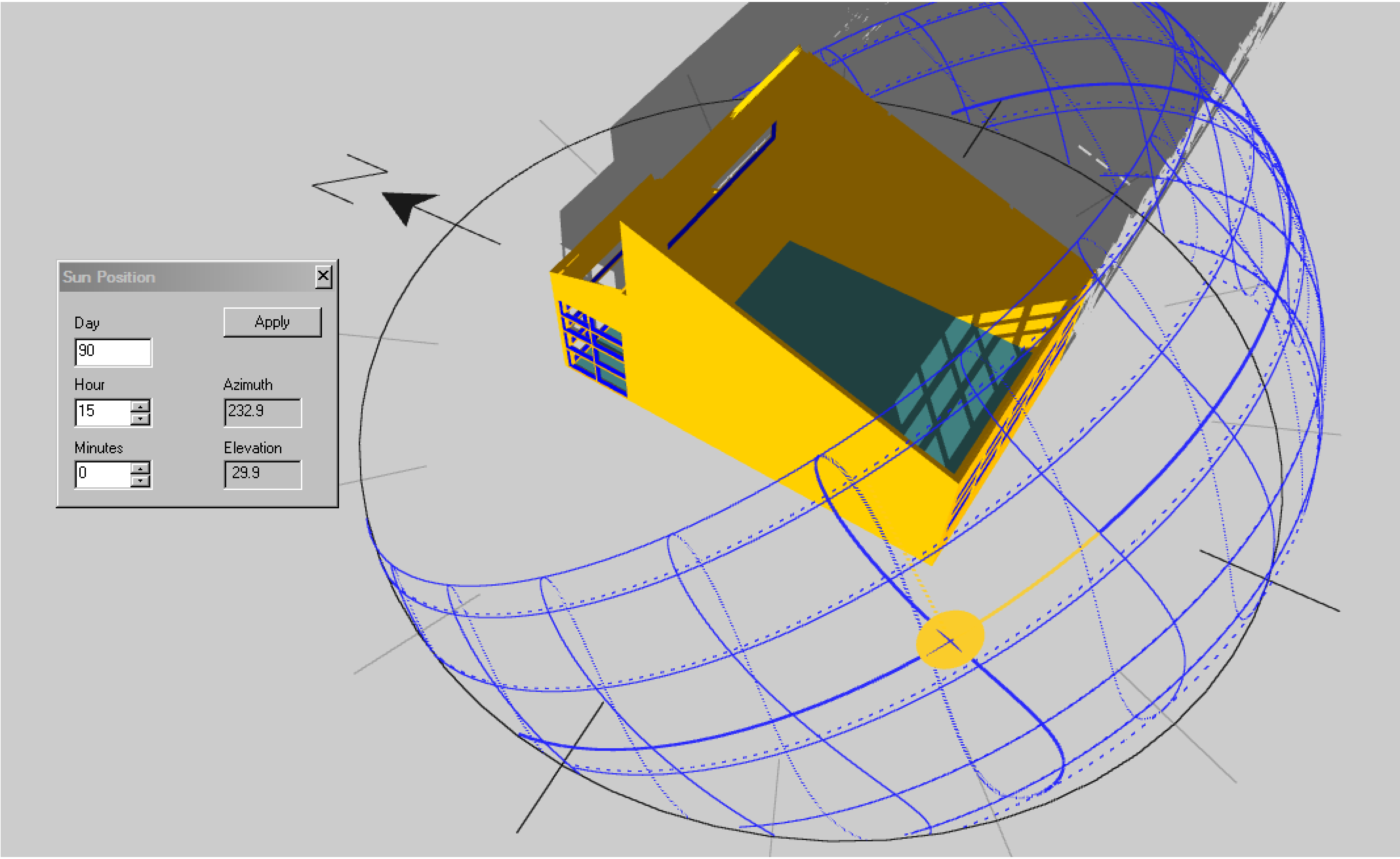
Tas allows specific spaces, from a large model, to be selected for individual analysis. A complete range of analysis may be undertaken on the selected space, or spaces, without having to simulate the whole of the building model.

Here a classroom has been selected to produce CBDM metrics and adaptive comfort analysis.

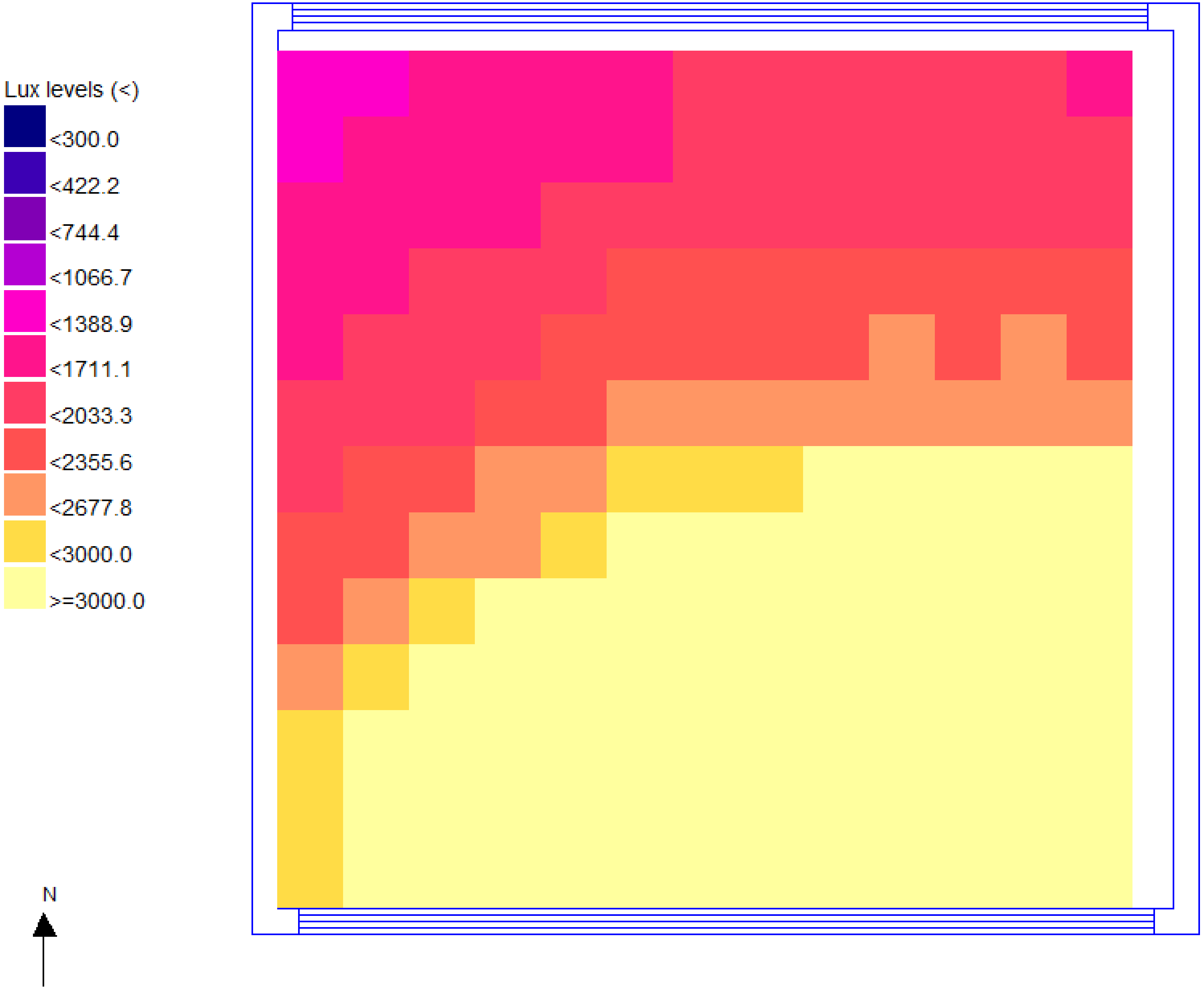
The roof has been made transparent in the display to show internal layout.

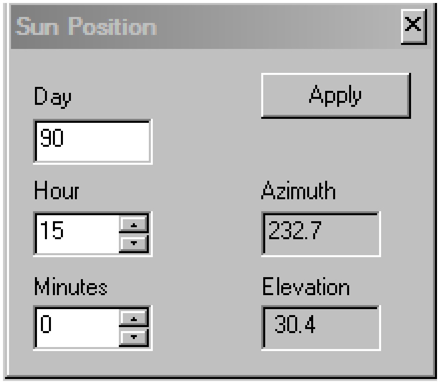


This image shows the direct sunlight patches through the windows for 15.00 hours, around the end of March

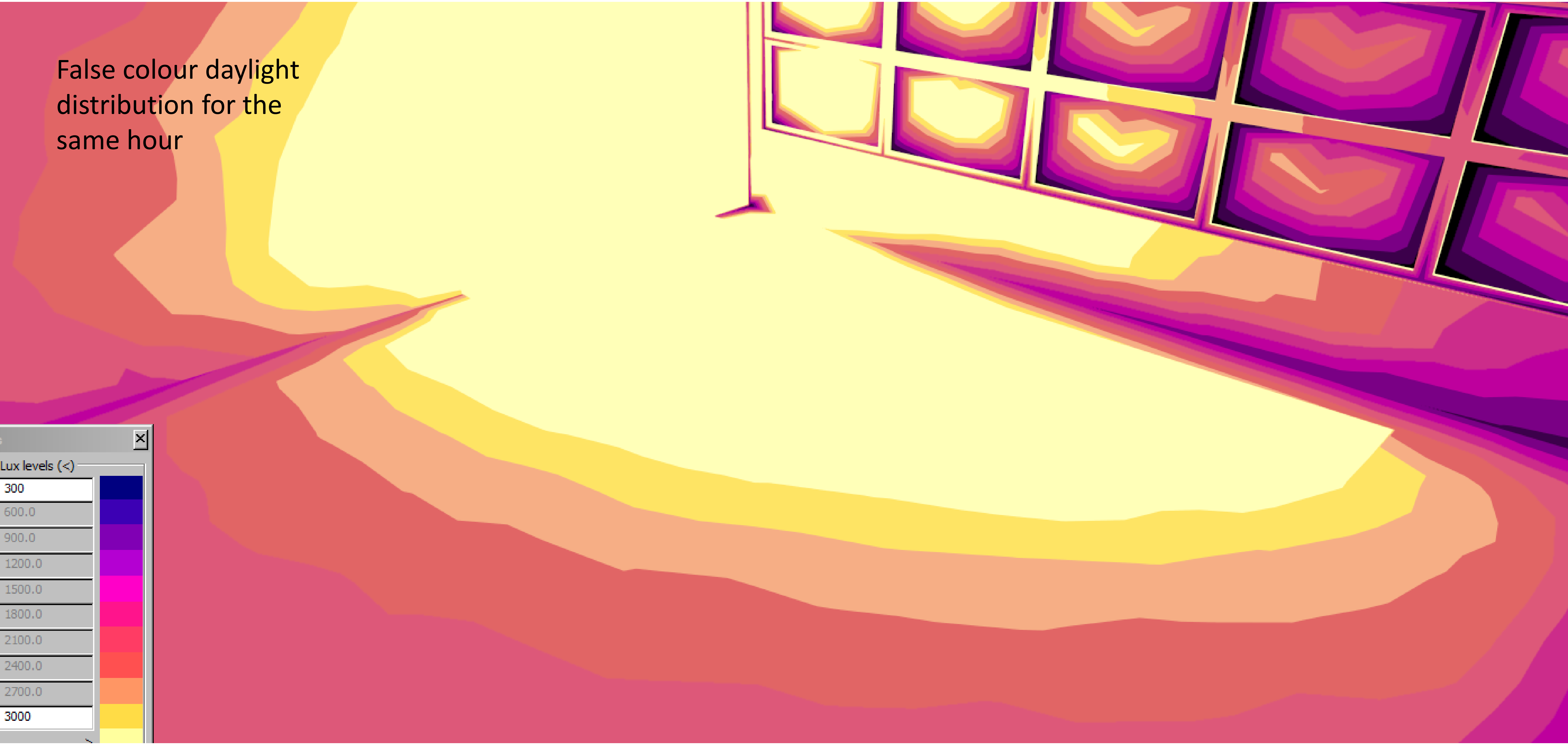


For the same hour a clear sky daylight simulation shows the daylight lux level distribution





False colour daylight distribution for the same hour



A summary of the CBDM metrics

Climate Based Daylight Modelling aims to assess the distribution of light within a space and the intensity of the light.

UDIs - 'Supplementary' - Annual occurrence of illuminances less than 'UDIa Limit' lux.
UDIa - 'Autonomous/Acceptable' - Annual occurrence of illuminances between 'UDIa Limit' to 'UDIe Limit' lux.
UDIt - 'Target' - Annual occurrence of illuminances and is usually between 'UDIt Limit' to 'UDIe Limit' lux.
UDIe - 'Exceedance/Excessive'- Annual occurrence of illuminances greater than 'UDIe Limit' lux.
DA - 'Daylight Autonomy' - Amount of time a space reaches minimum acceptable illuminance.

In the UDIs range, electric lighting is required. In the acceptable range, electric lighting is not required. In the excessive range, spaces may be subject to glare and be too bright for the occupants.

Grid Size: **0.25m** Accuracy **Factors** Area Margin: **0.5m** Plane Height: **0.7m**

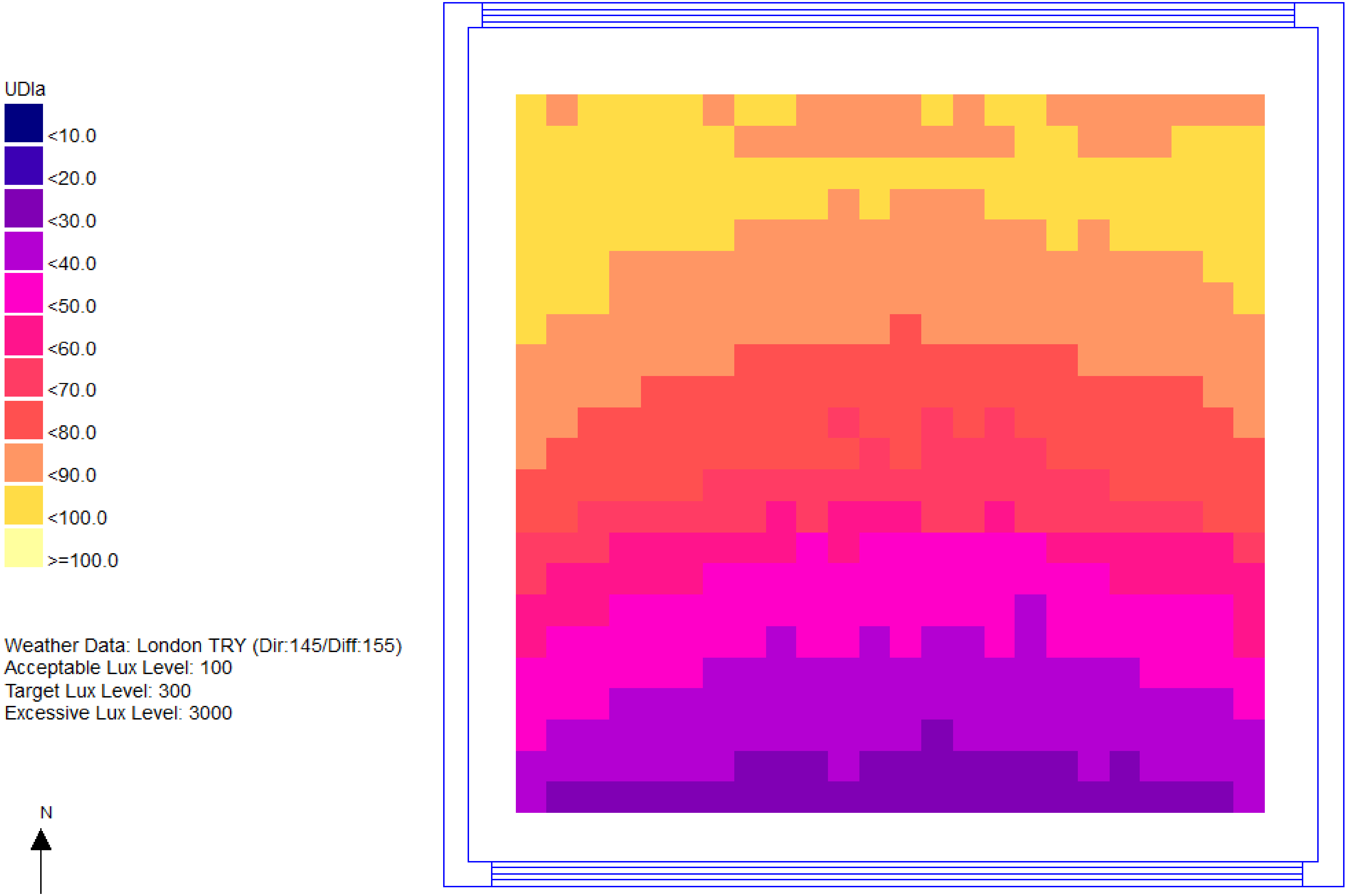
London TRY (Dir:145/Diff:155) **London TRY (Dir:145/Diff:155)**

UDIs:	**2 %**	<=100 lux
UDIa:	**66 %**	100<x<3000 lux
UDIt:	**59 %**	300<x<3000 lux
UDIe:	**32 %**	x>3000 lux
DA(300/50%):	**100%**	
UDIa Min	**26 %**	
Run Name:	**full glazing**	
Description::	**(Start Hour: 9, End Hour:16)**	

CBDM metrics show that the UDIa at 66% is below the acceptable level.

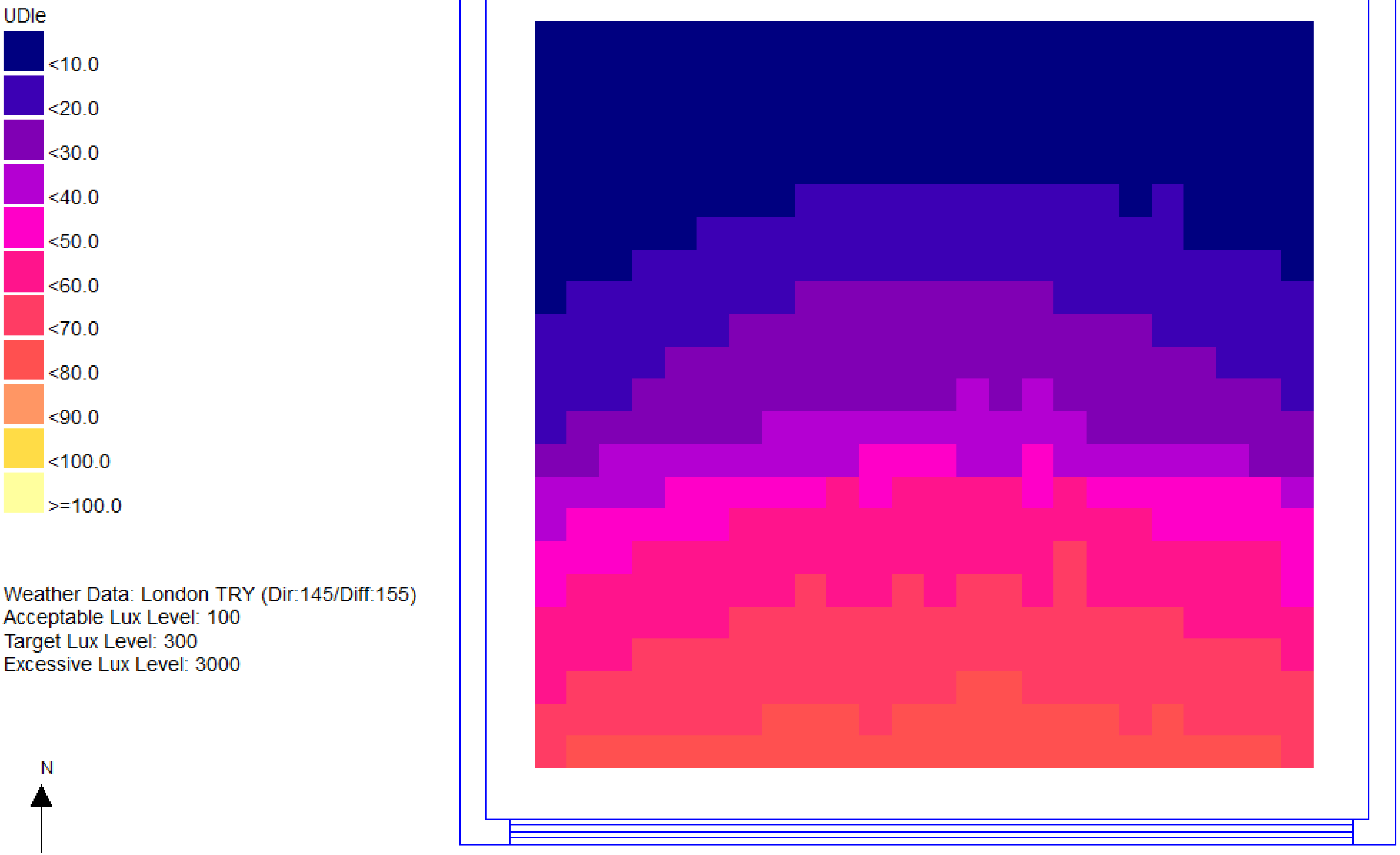
The UDIe at 32% indicates that there could well be excessive glare for about a third of occupied hours.

The UDIa distribution over the working plane shows poor performance in the front third of the space.



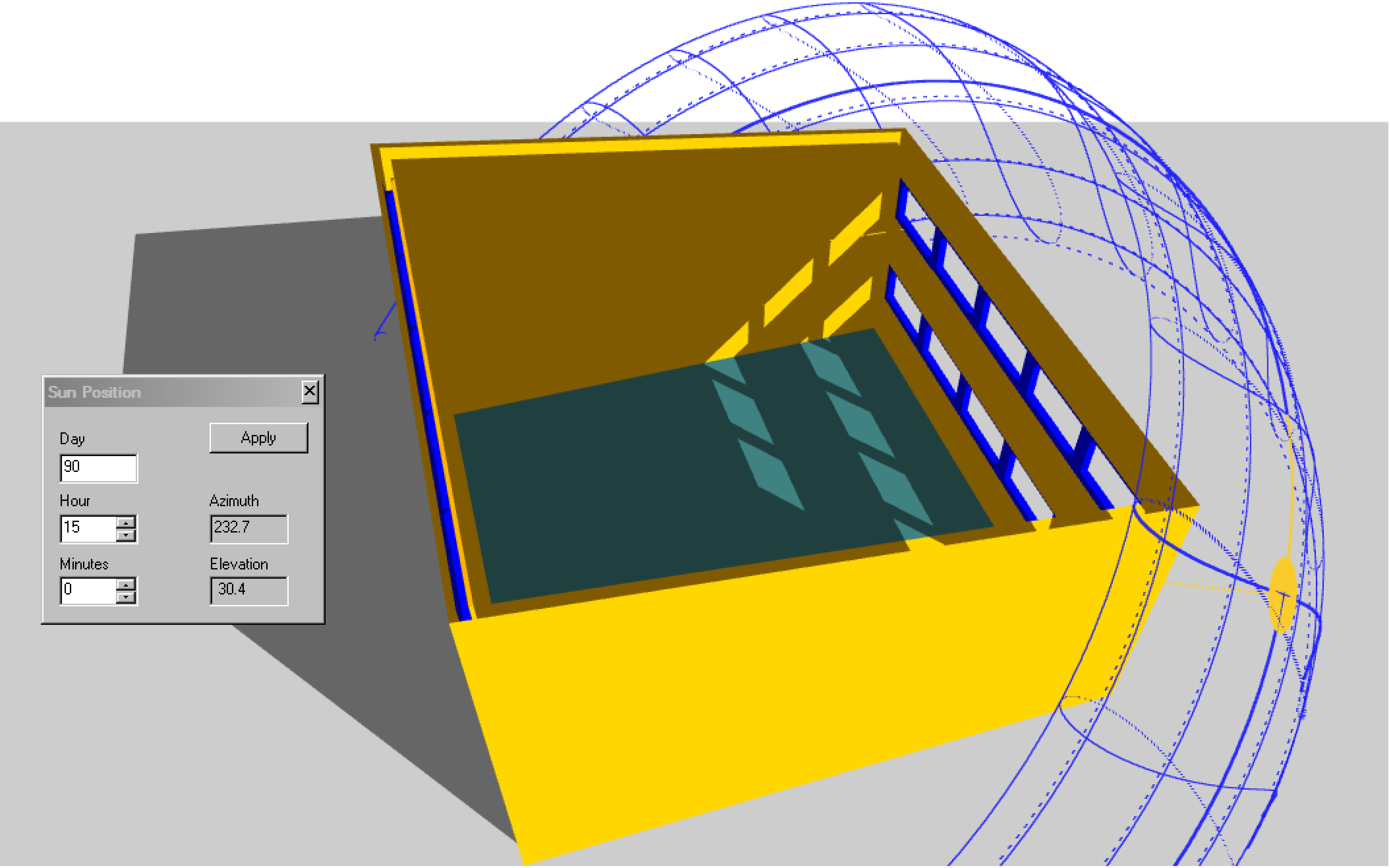
Again, the UDIe levels are excessive at the glazed end of the classroom

The glazing configuration is meant to throw daylight to the back of the classroom, which is achieved, but at the expense of performance closer to the windows.

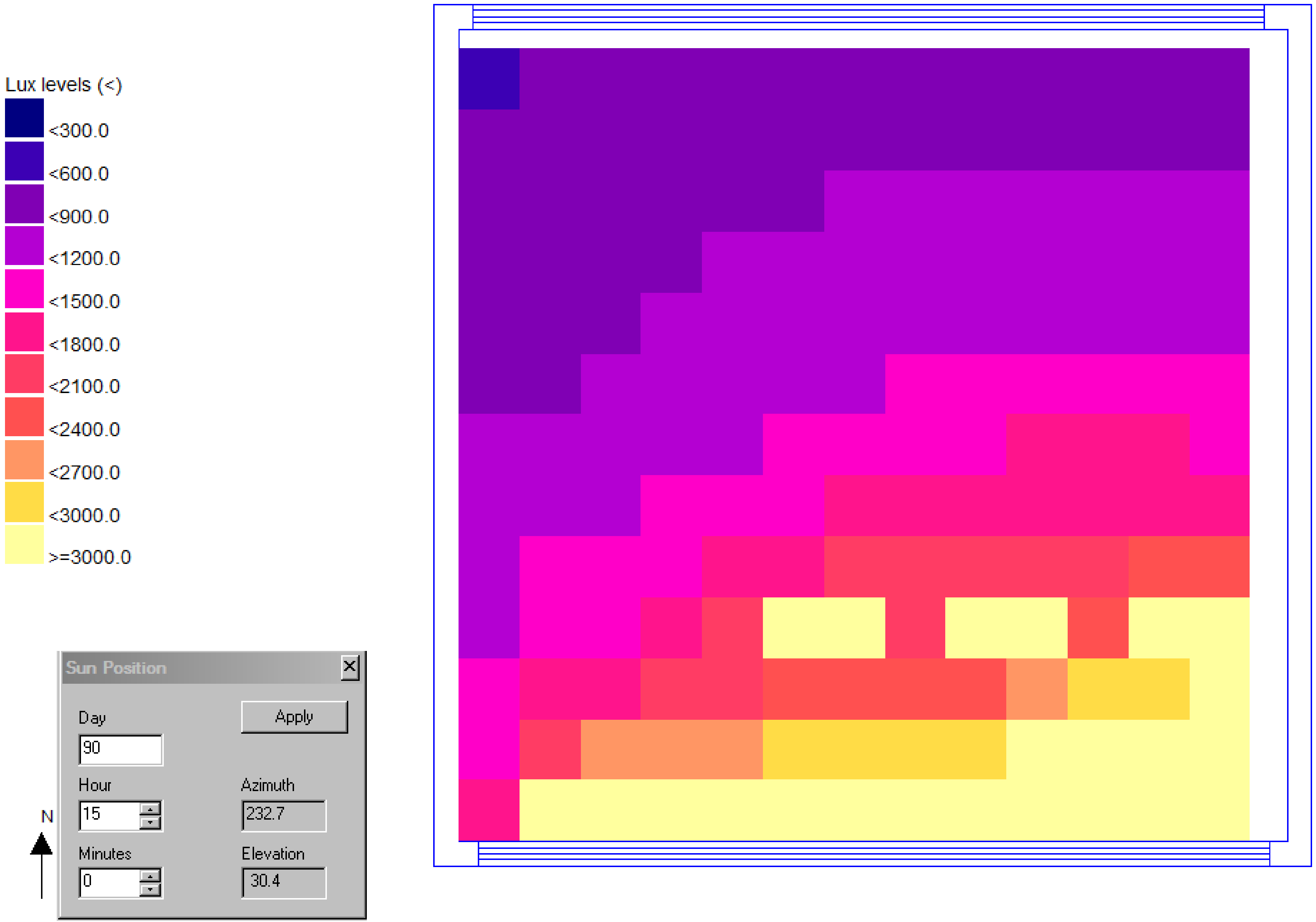


This new configuration of windows has the middle row removed.

The high level windows still throw light to the back of the space and the view is maintained by the lower row of windows.



A daylight analysis for 15:00 hours at the end of March shows that a useful amount of daylight is reaching the back of the room via the high level windows. Also the amount of direct sunlight next to the windows is reduced.



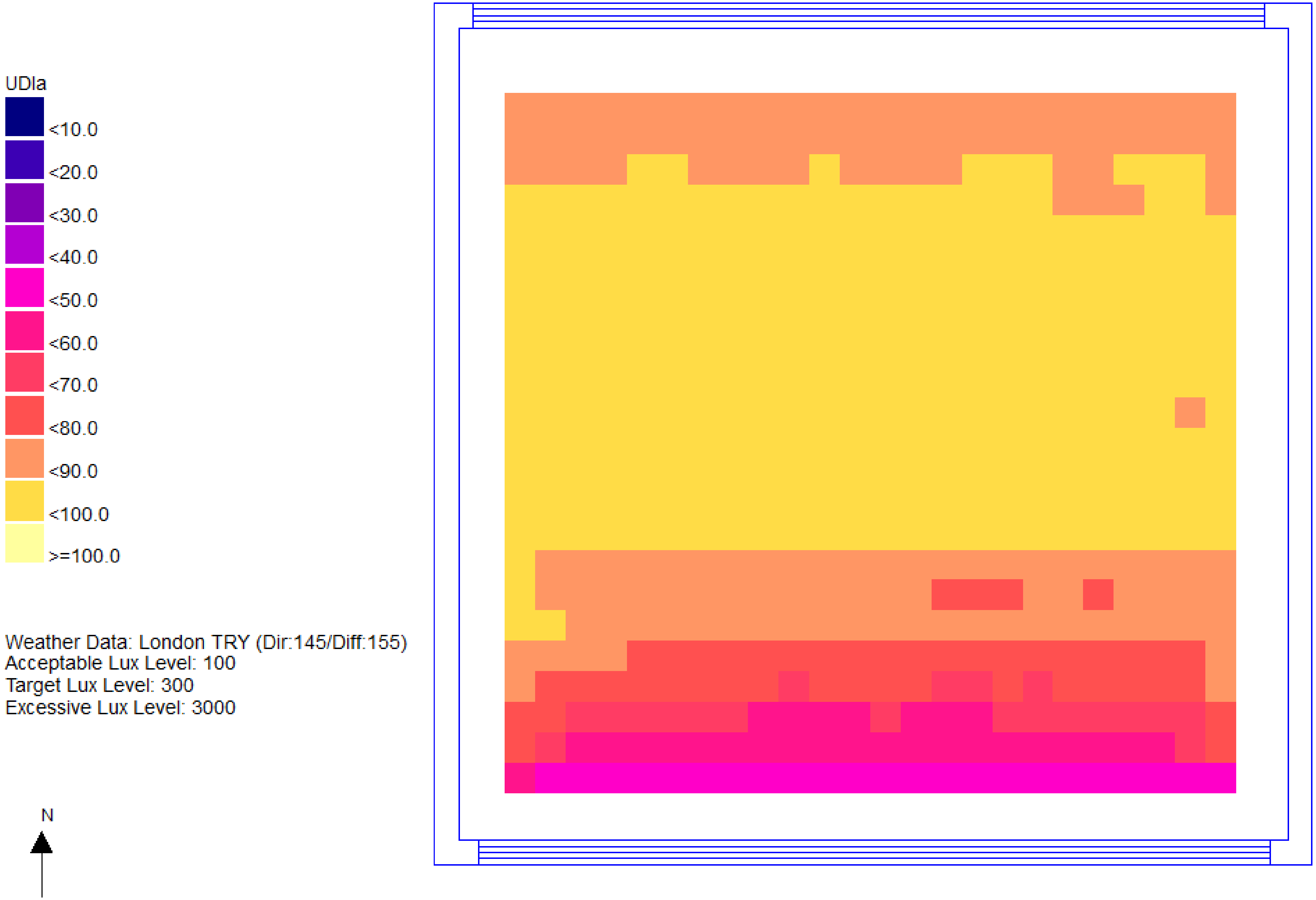
Grid Size:	0.25m	Accuracy	Factors	Area Margin:	0.5m	Plane Height:	0.7m

London TRY (Dir:145/Diff:155)	London TRY (Dir:145/Diff:155)	
UDIs:	4 %	<=100 lux
UDIa:	85 %	100<x<3000 lux
UDIt:	73 %	300<x<3000 lux
UDIe:	11 %	x>3000 lux
DA(300/50%):	100%	
UDIa Min	41 %	
Run Name:	centre row of glazing removed	
Description::	(Start Hour: 9, End Hour:16)	

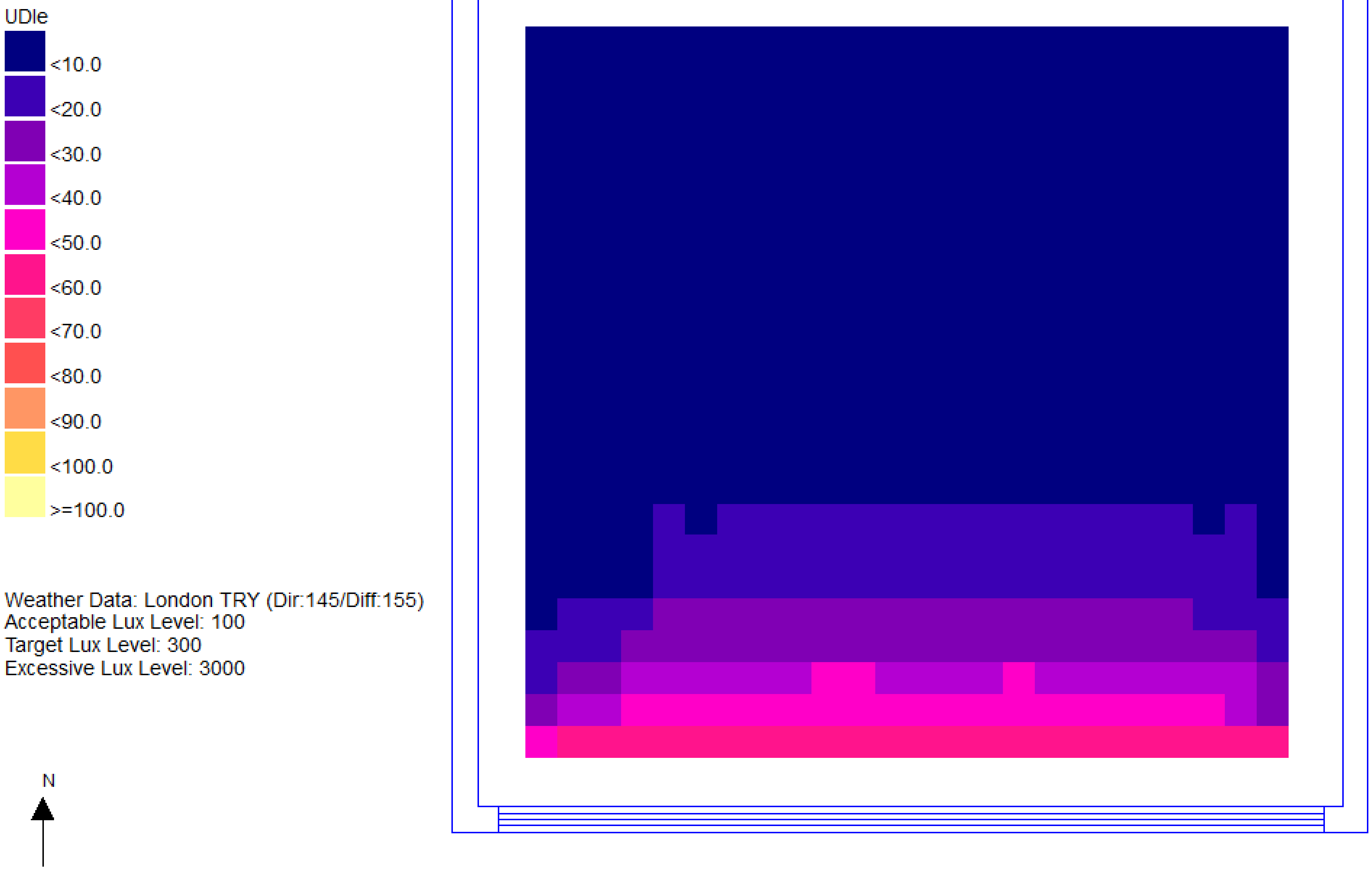
This time the UDIa is at 85% giving a very good performance. UDIe is at an acceptable level.

High level windows have given a good general distribution of daylight and the low level view windows do not produce excessive glare.

The UDIa distribution is quite flat, which is ideal.



UDIe is confined to close to the view windows.



The high level windows at the front and back of the room are good for daylight distribution, but are also very useful for natural ventilation combined with some limited view window opening.

The reduction in lighting gains has also helped to achieve a pass on BB101 with the London TRY weather set, and on TM52 when using the same weather set.

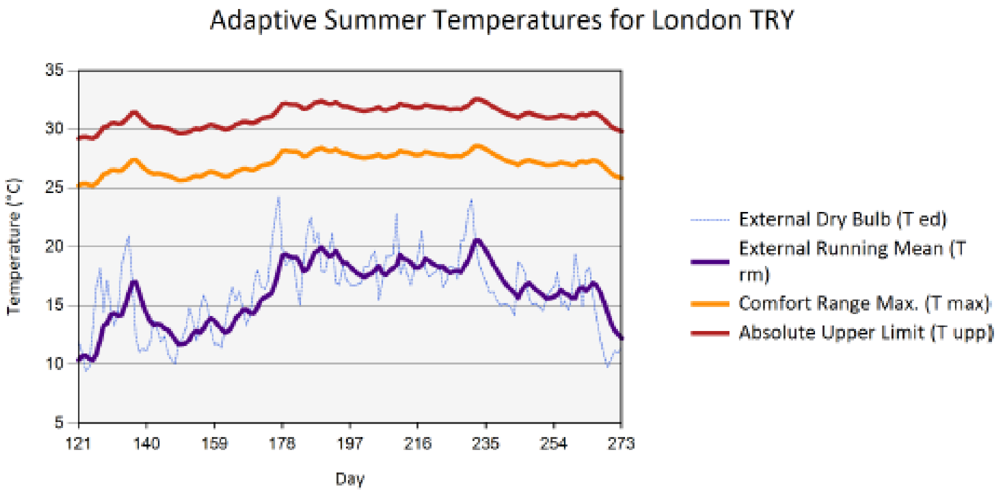
Performance metrics can be output to Excel or pdf as shown.

no shade south middle row of windows removed.tsd

BB101 Report

Zone Name	Avg Diff	Peak	Day	Hour	>28°C	Result
classroom	5.61	31.59	177	15	52.5	Pass

Adaptive Overheating Report (CIBSE TM52)



The adaptive overheating assessment tests rooms against three criteria. If a room fails any two of the three criteria then it is said to overheat.

1. The first criterion sets a limit for the number of hours that the operative temperature exceeds the comfort temperature by 1°C or more during the occupied hours over the summer period (1st May to 30th September).
2. The second criterion deals with the severity of the overheating within any one day. This sets a daily limit for acceptability.
3. The third criterion sets an absolute maximum daily temperature for the room.

Project Details

Building Designer File (.tbd): no shade south middle row of windows removed.tbd
Simulation Results File (.tsd): CBDM daylight saving controls.tsd
Date: 30 August 2017
Building Category: Category II
Report Criteria: TM52

Results

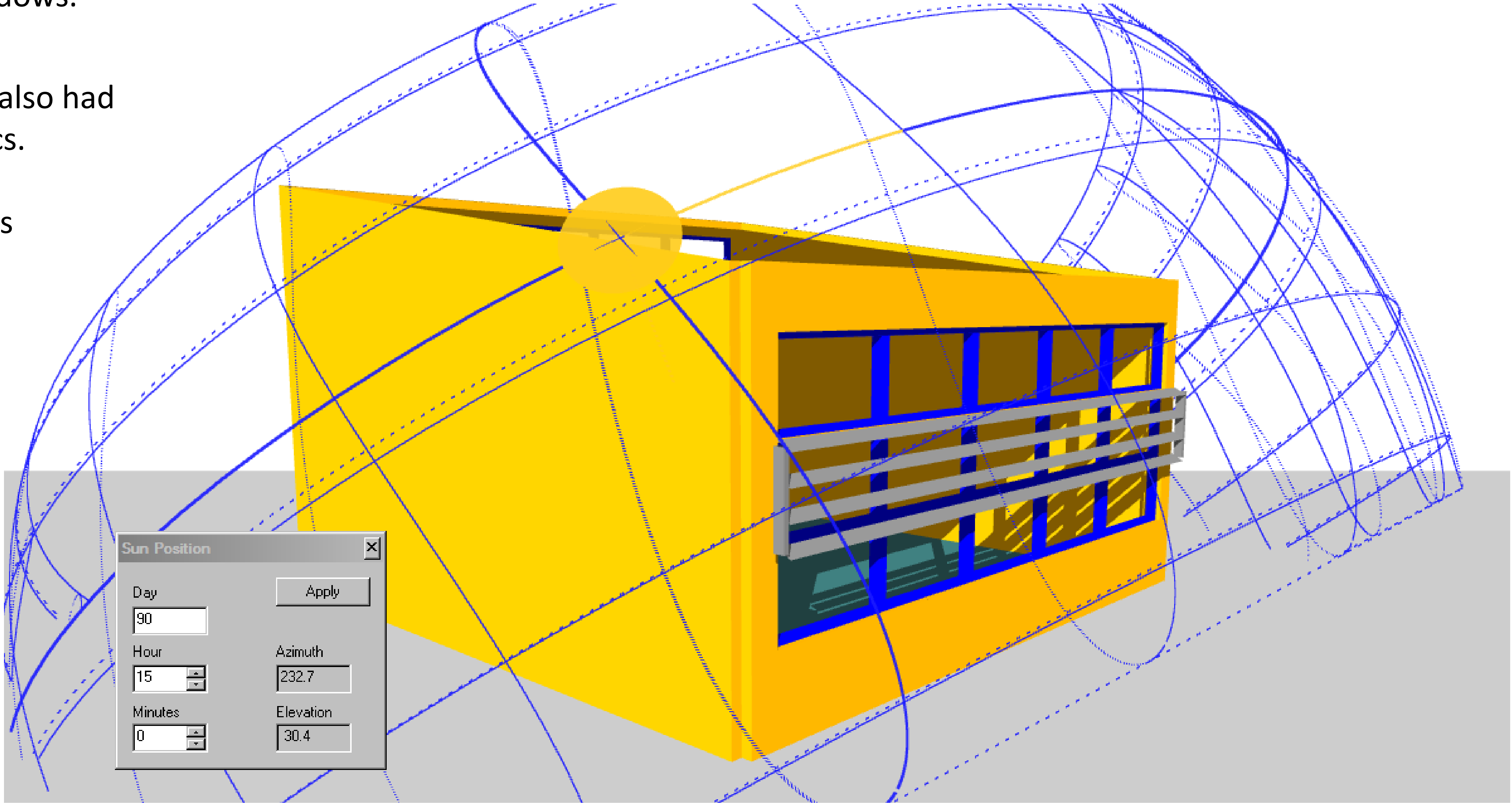
Zone Name	Occupied Summer Hours	Max. Exceedable Hours	Criterion 1: #Hours Exceeding Comfort Range	Criterion 2: Peak Daily Weighted Exceedance	Criterion 3: #Hours Exceeding Absolute Limit	Result
classroom	814	24	8	11.0	0	Pass

An alternative to removing the middle row of windows would be to provide some solar shading to reduce the direct sunlight through these windows.

This configuration also had good CBDM metrics.

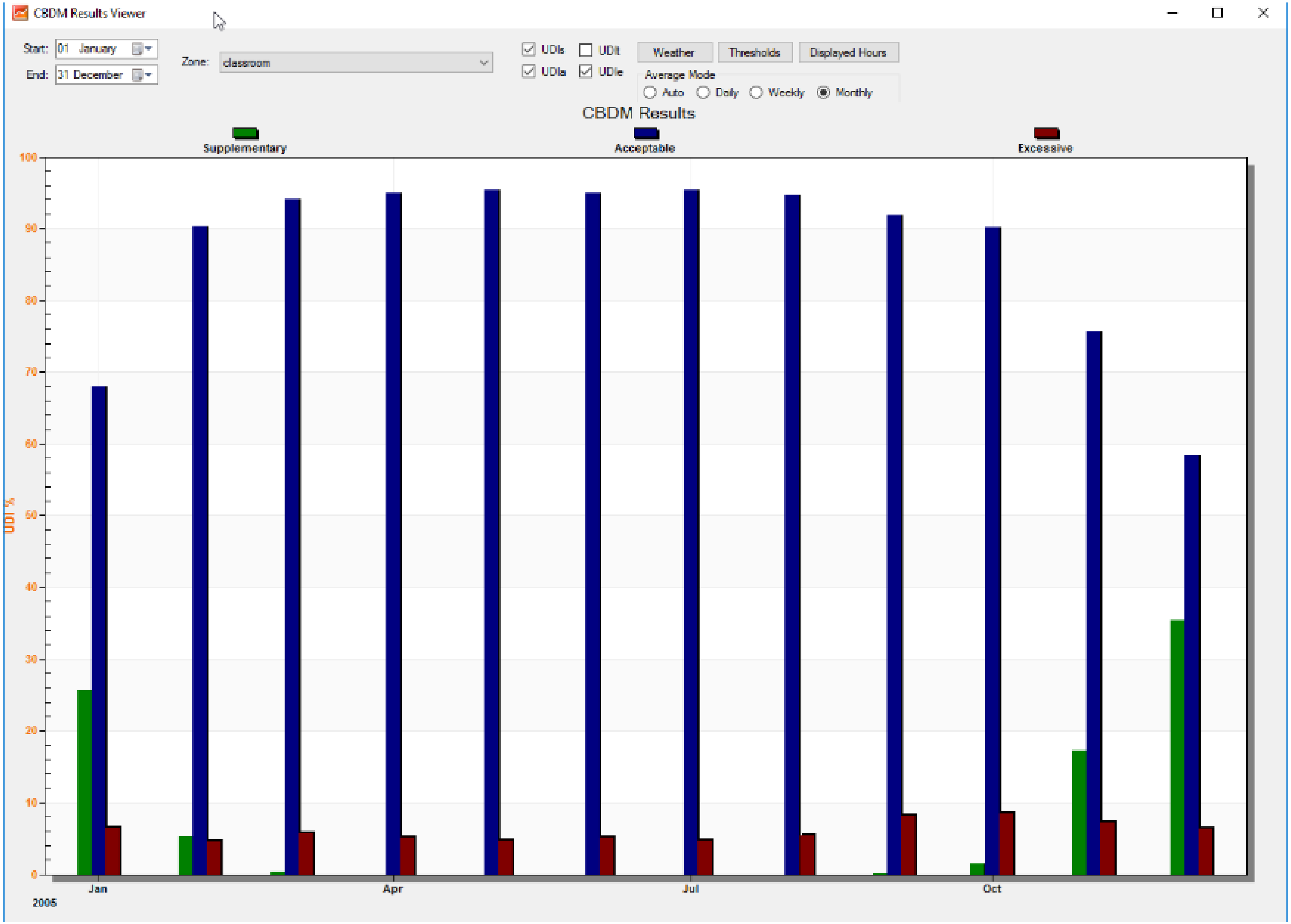
Both configurations worked well on all orientations.

This façade solution is but one of many that would comply with the CBDM criteria

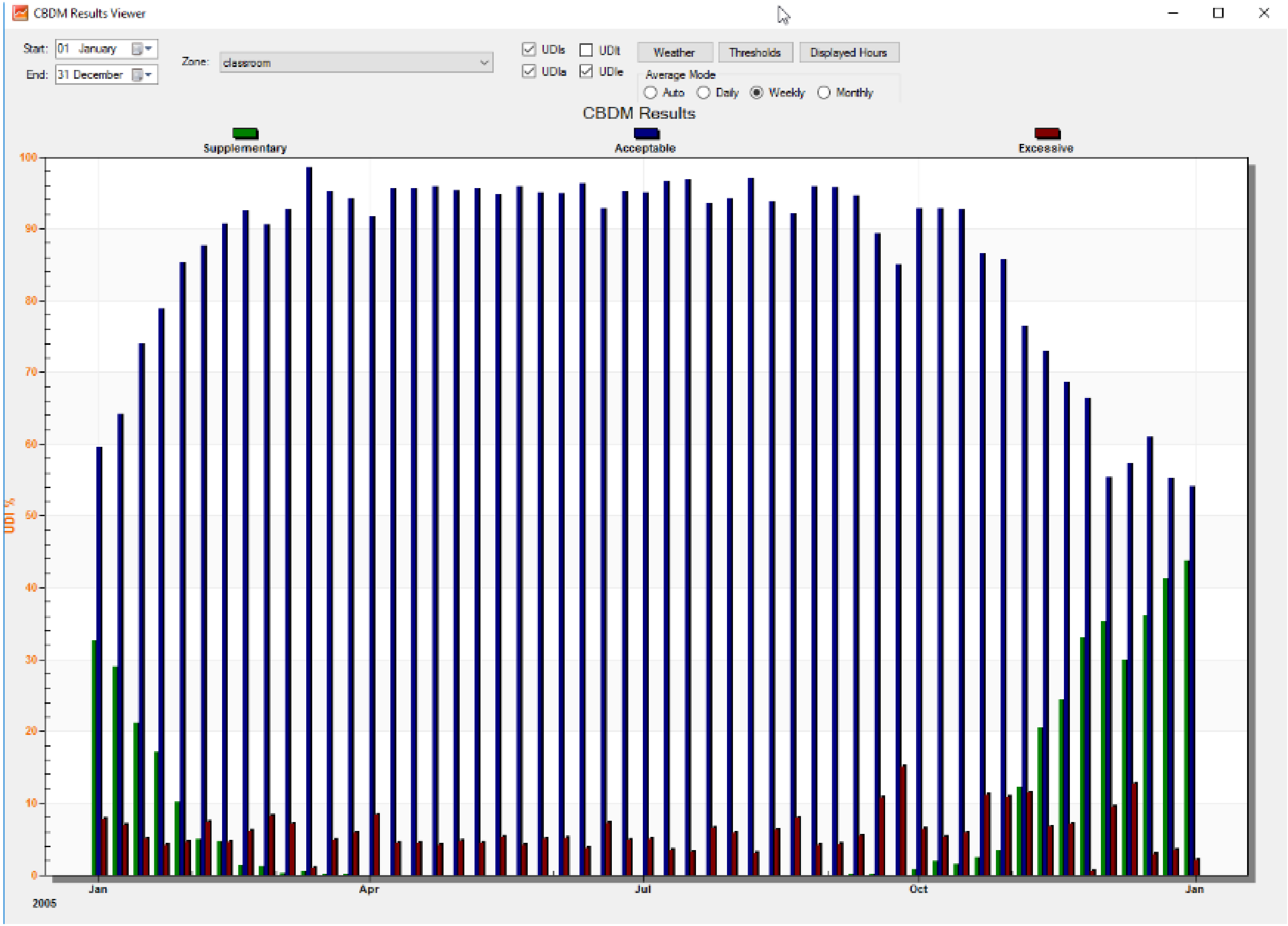


To provide an insight into the single number metrics for the whole year, they are available on a monthly, weekly and hourly basis.

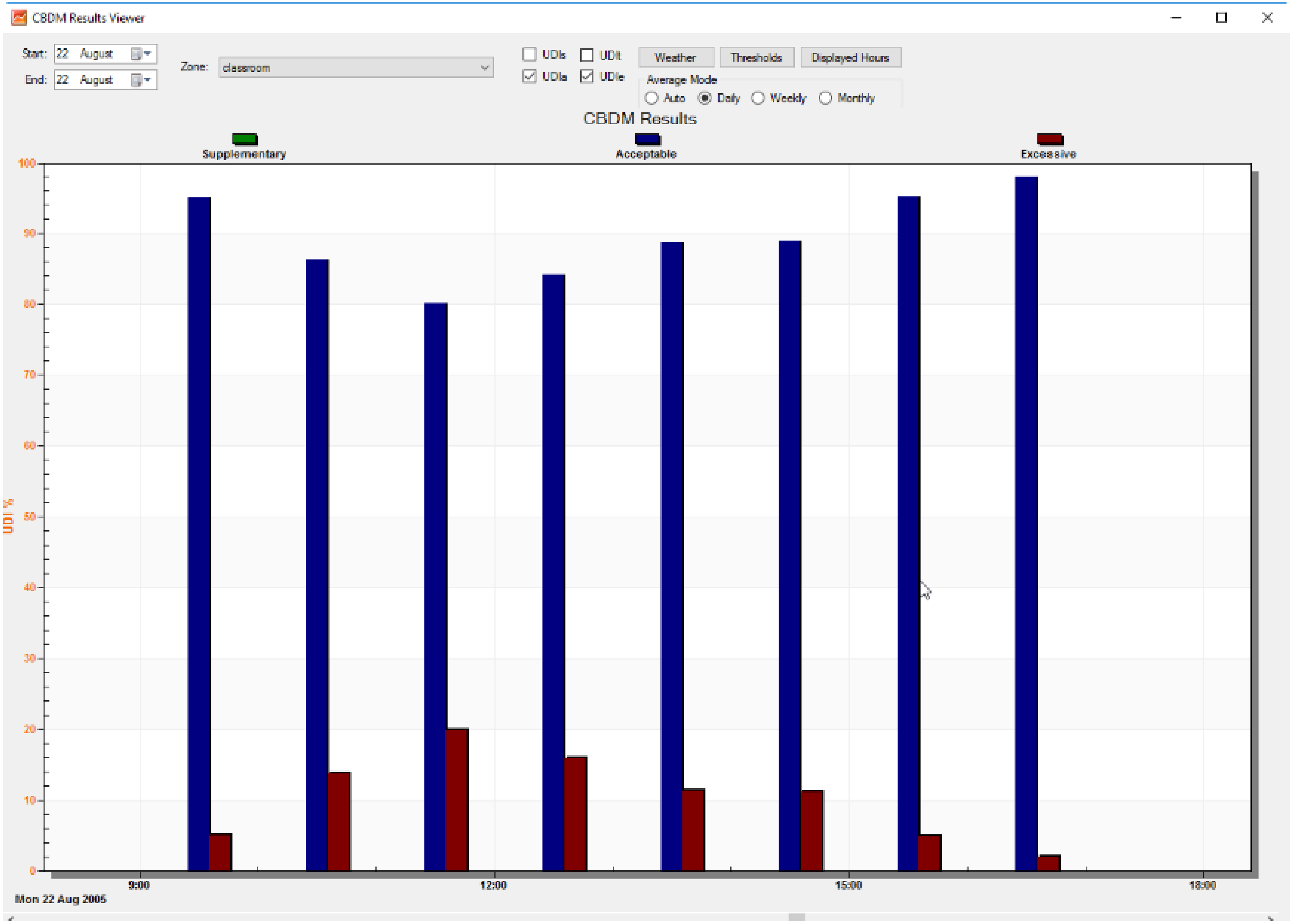
The secret to a successful solution is to have the ‘Excessive’ level consistently low over the year.



Weekly distribution



Hourly distribution



The Tas daylight engine is able to provide analysis for BREEAM and LEED daylight credits. It is also able to undertake all Right to Light calculations, including the import of 3D DWG cityscape models.