CIBSE Application Manual AM11 'Building Performance Modelling'

Chapter 7: Lighting Modelling

Contents

- Daylight / electric lighting
- Daylight basics
- Daylight factor
- Reliability / accuracy of simulation
- Daylighting strategies / glazing systems
- Climate-based daylight modelling
- Electric lighting
- Case studies

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Chapter 7: Lighting Modelling

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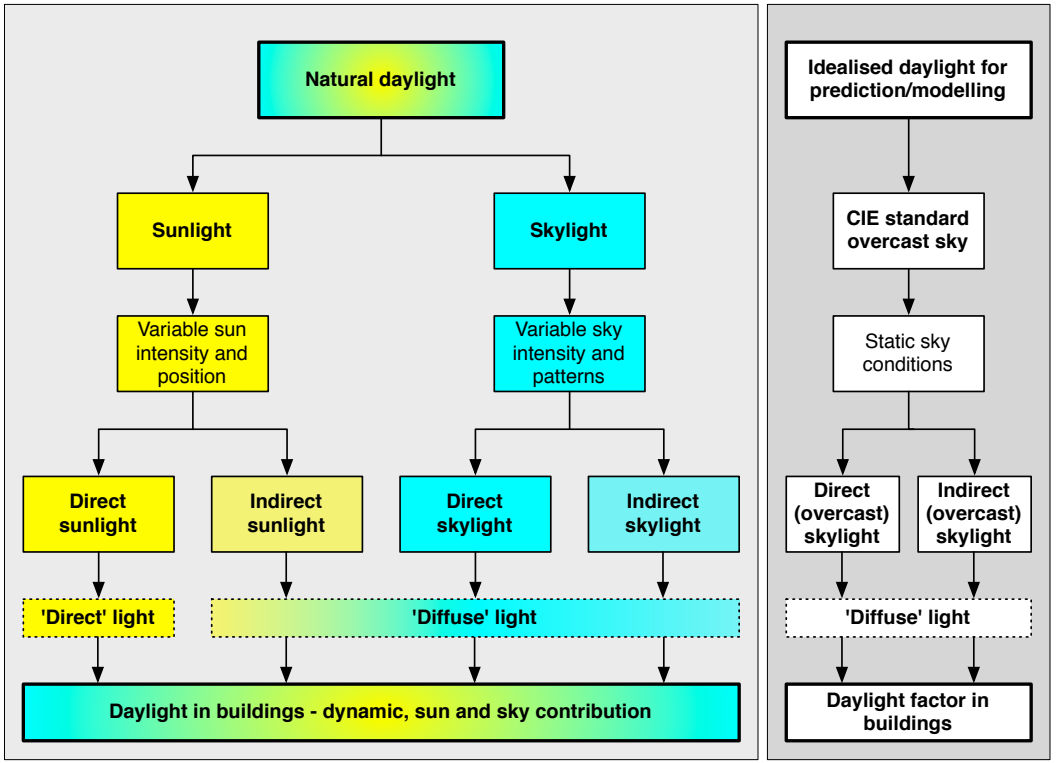
Chapter 7: Lighting Modelling

Section 7.1

Daylight Basics

- Actual and modelled daylight
- Daylight and building occupants
- Daylight and sky conditions
- Daylight factor definition
- DF and guidelines

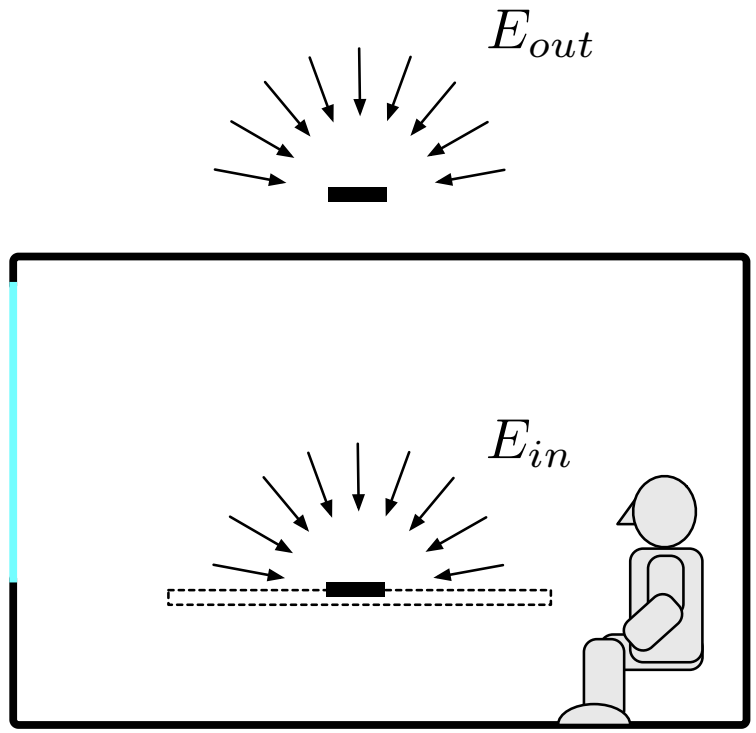


Section 7.1

Daylight factor definition

$$L_\zeta = \frac{L_z\,(1 + 2\cos\zeta)}{3}$$

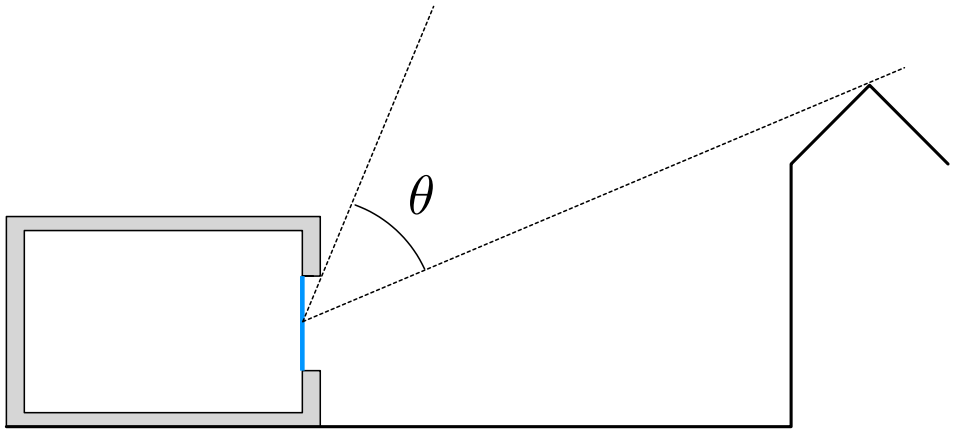
$$DF = \frac{E_{in}}{E_{out}} 100\%$$



Section 7.2

Methods to predict the daylight factor

- 'Historical'
- Rules of thumb
- Average daylight factor equation
- Computer simulation



$$\overline{DF} = \frac{TW\theta M}{A\left(1 - R^2\right)}$$

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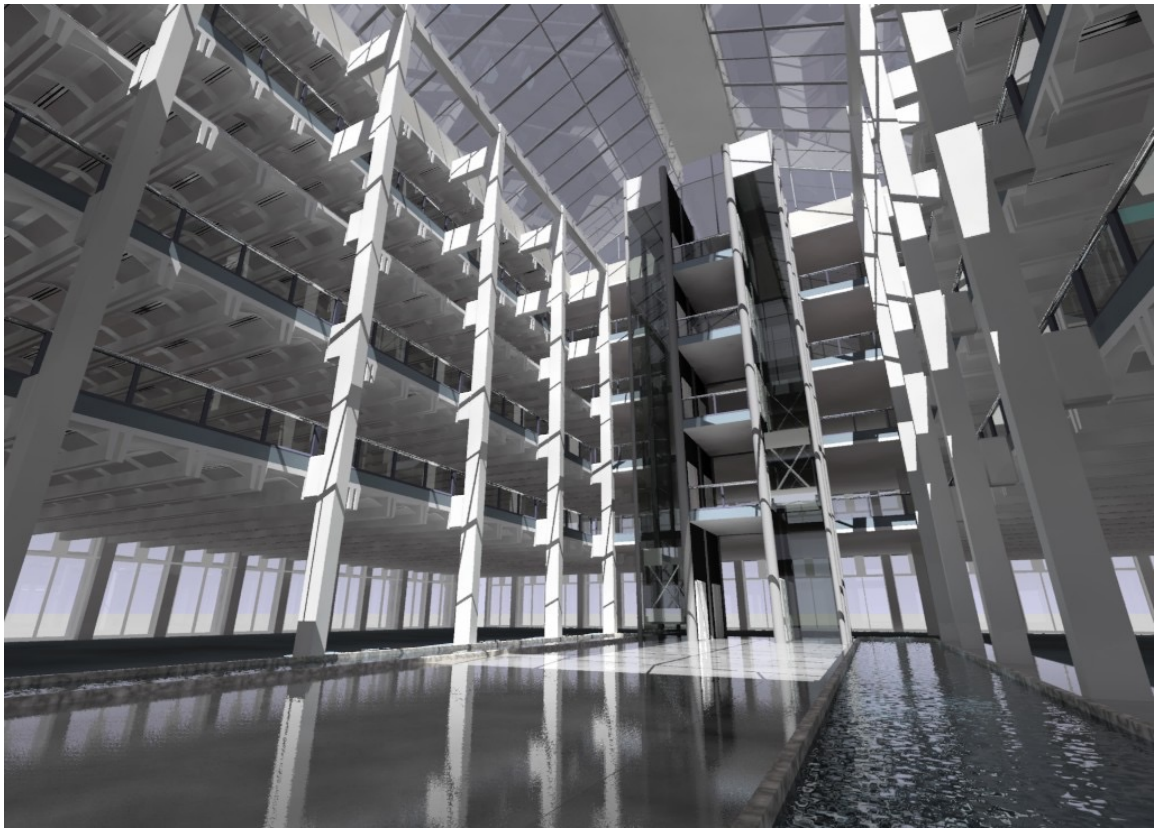
Section 7.2

Computer simulation



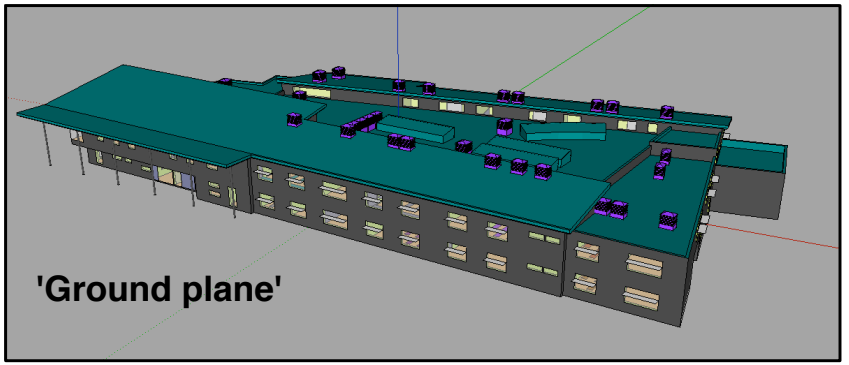
Section 7.3

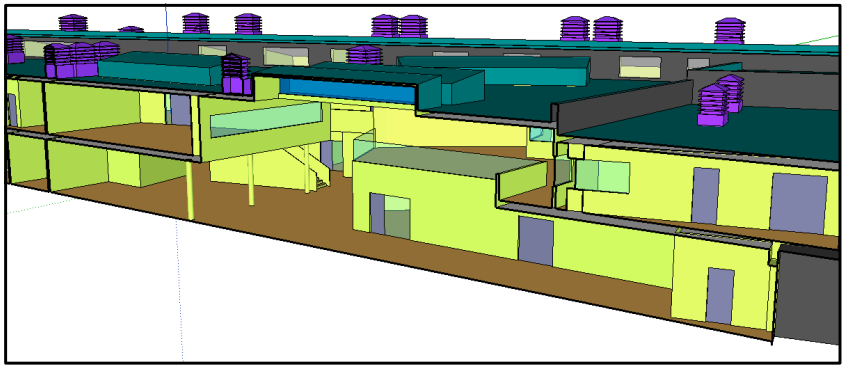
Factors affecting the accuracy and reliability of computer predictions

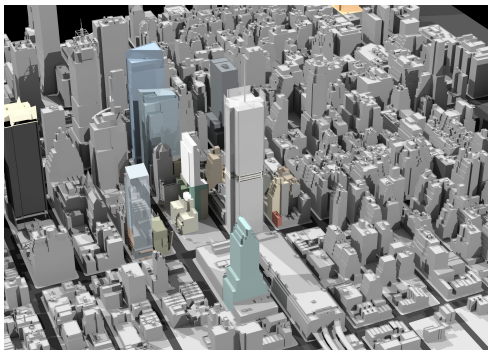
- Model geometry
- Physical properties
- Luminous environment
- Sensor grid/points
- Simulation parameters
- Data output / presentation

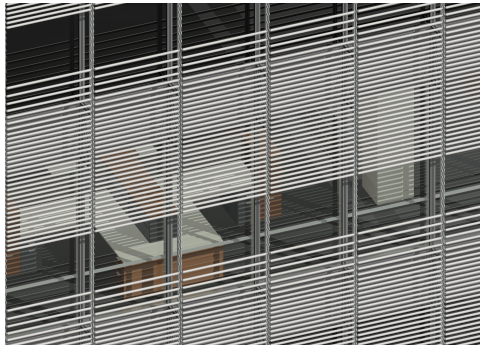
Section 7.3.1
Model geometry

- Construction
- Complexity
- Good practice
- Walls - thick!









Section 7.3.2
Physical properties

- Diffuse / specular
- Typical values
- Glazing standard
- Advanced / complex fenestration

Table 7.1 Typical reflection and transmittance values for common building surfaces

Opaque surfaces	Typical reflectance range (%)
Ceiling	70–85
Walls	40–70
Floors	5–30
Ground	5–30
External facade	20–40
Glazing	**Typical light transmittance value(s)**
Clear single glazing	0.88
Clear double glazing	0.79
Low-e double glazing	0.69
Solar control glazing	0.20–0.50

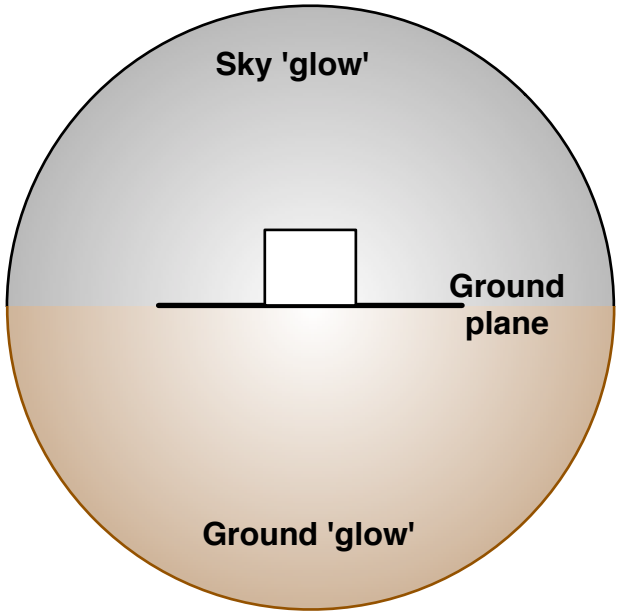
Section 7.3.3 / 7.3.4

Luminous environment

- Enclosing
- Sky models
- Ground plane
- LEED Clear sky options

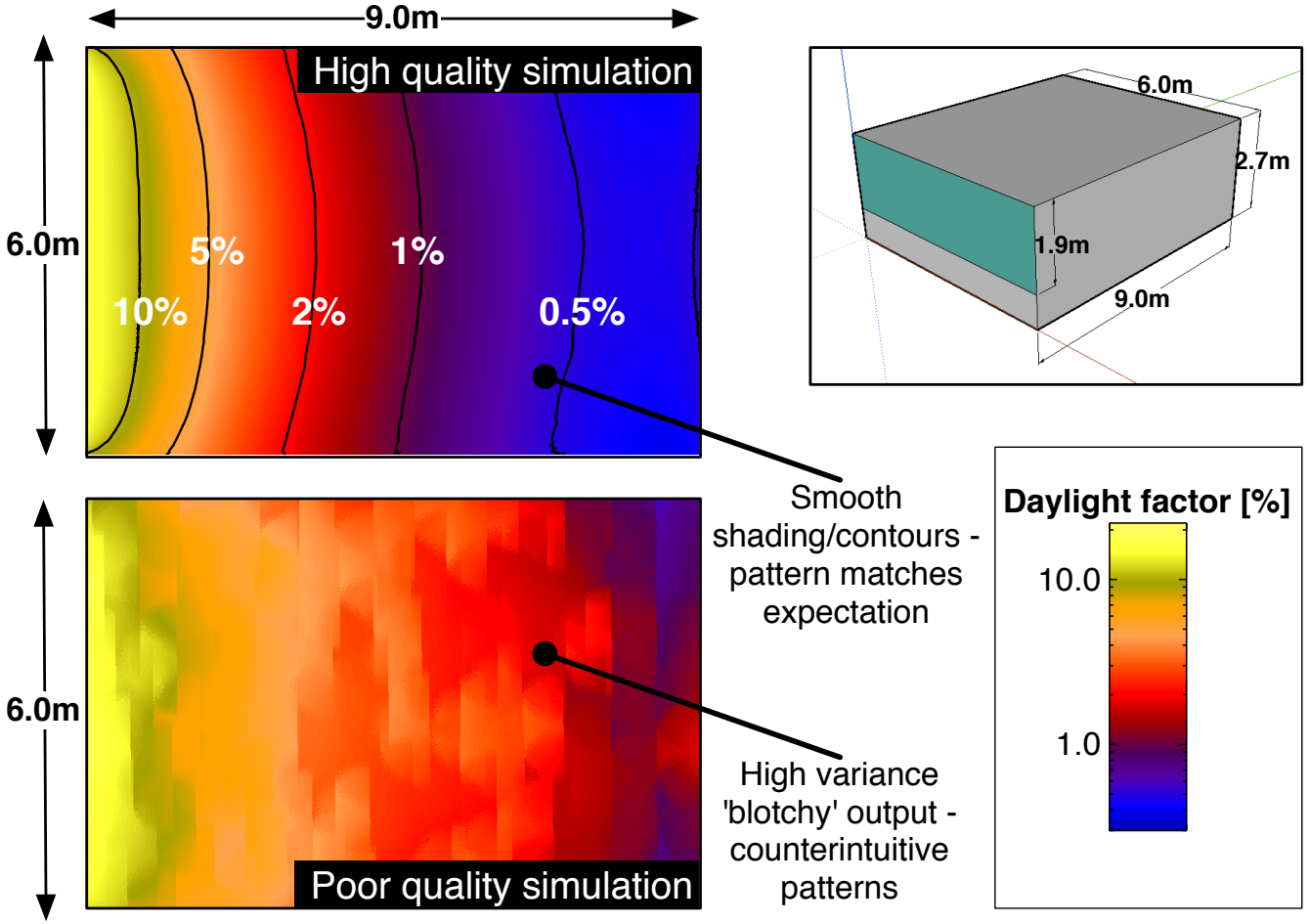
Sensor grid/points

- 0.5m perimeter



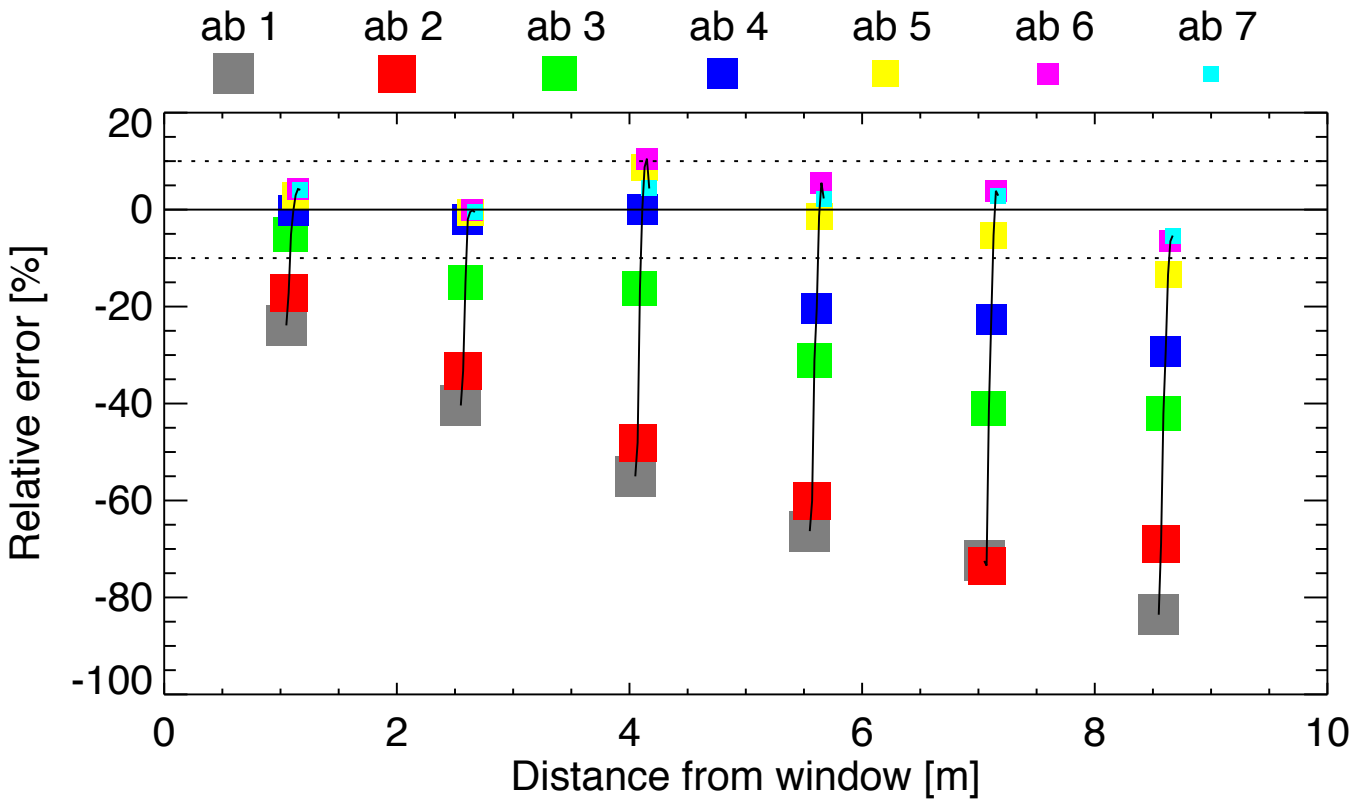
Section 7.3.5
Simulation parameters

- Quality settings



Section 7.3.5
Simulation parameters

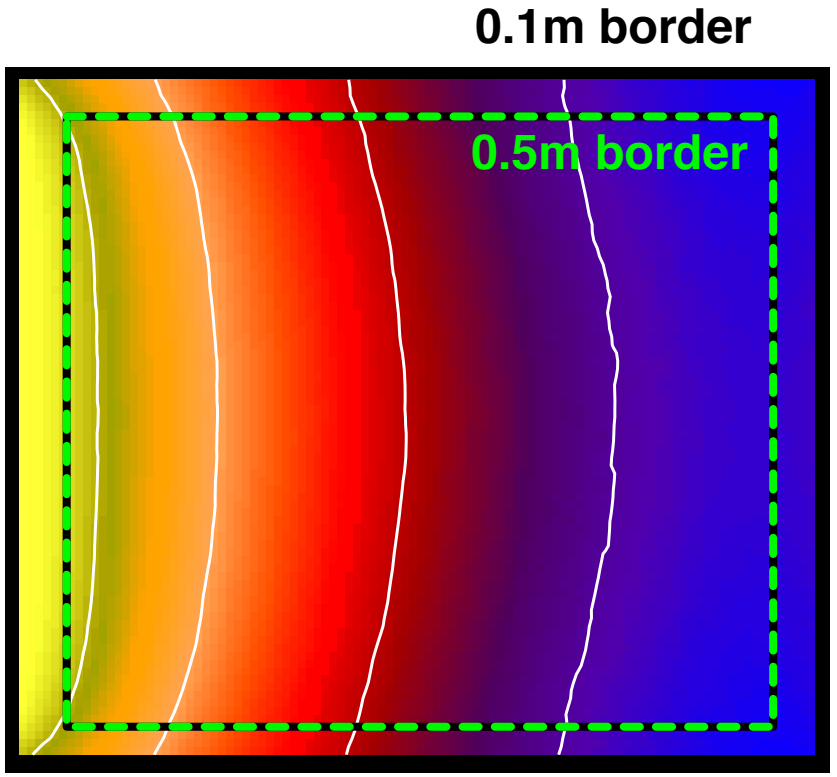
- Convergence testing



Section 7.3.6

Data output / presentation

- Perimeters
- Average vs. median



Border	Mean	Median	Uniformity
0.1m	3.4%	1.7%	0.20
0.5m	2.9%	1.7%	0.23

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Chapter 7: Lighting Modelling

Sections 7.4, 7.5 & 7.6

Modelling sunlight non-standard materials / structures & glare / discomfort

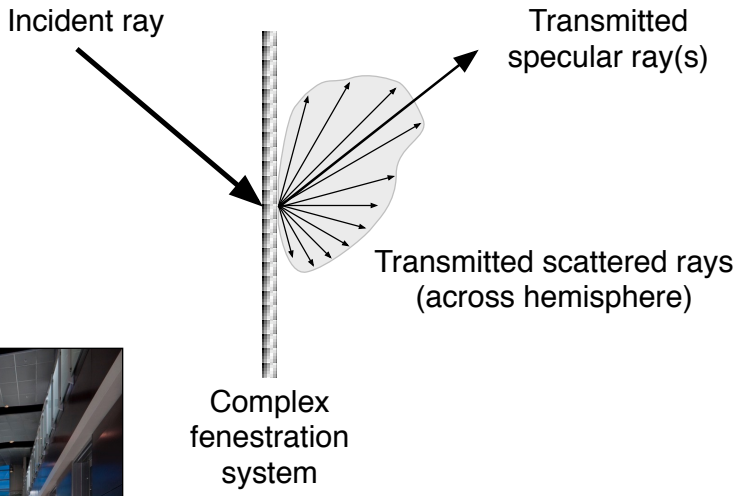
- Sunlight - largely qualitative (see CBDM)

Daylighting strategies

- Materials / structures: basic vs. advanced / complex

Visual discomfort / glare

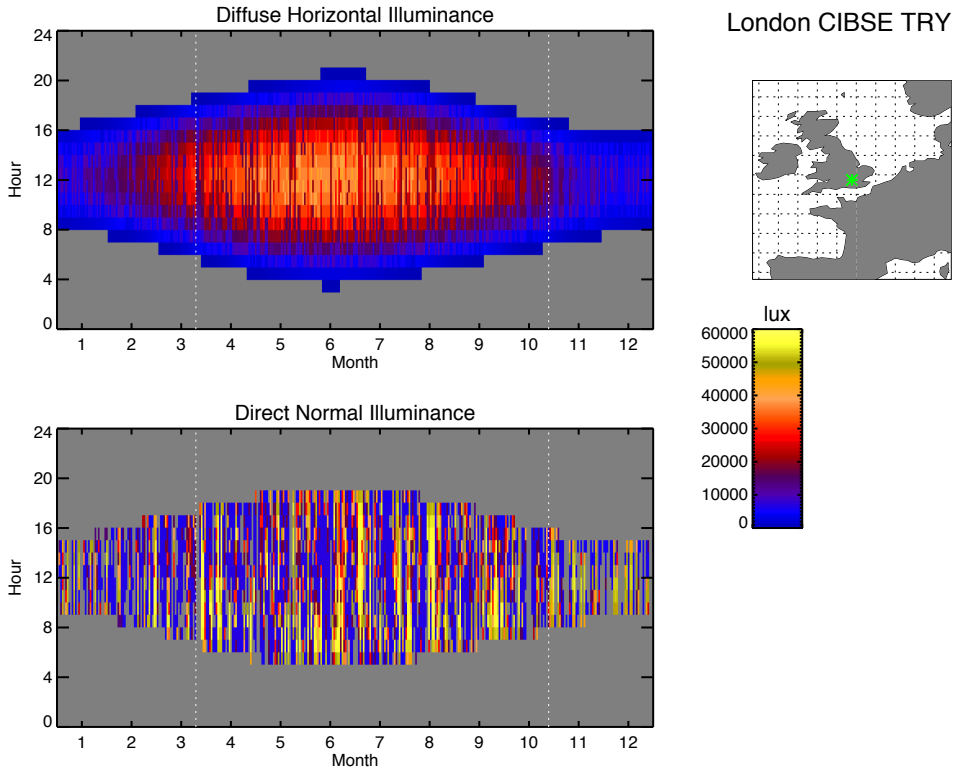
- DGI, DGP



Section 7.7

Climate-based daylight modelling (CBDM)

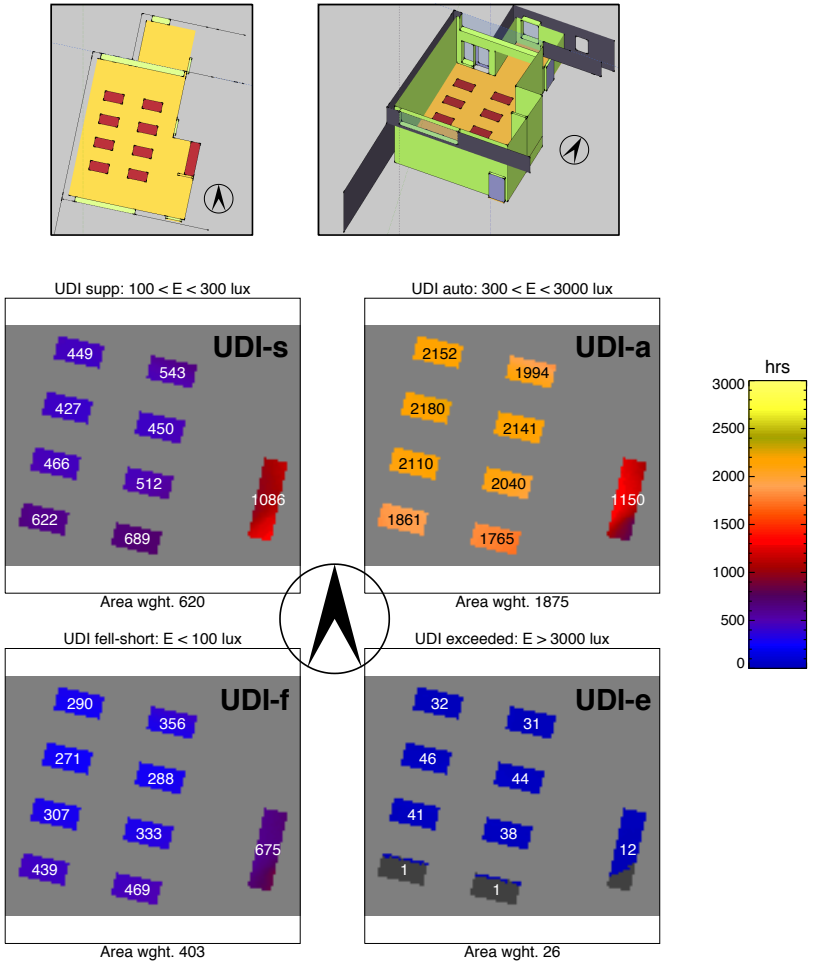
- Climate data
- CBDM metrics
- Irradiation modelling / mapping
- CBDM simulation of glare (DGP)



Section 7.7.1

CBDM metrics

- Daylight autonomy (DA)
- Useful daylight illuminance
- Spatial DA IES-LM-83
- EFA PSBP



Sections 7.7.2, 7.7.3 & 7.7.4

Irradiation / illumination modelling / mapping

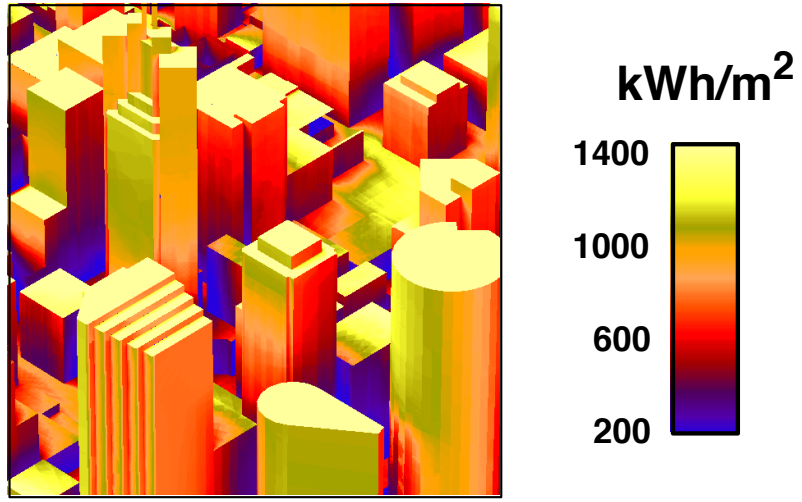
- Urban
- Inside buildings (case study 7.10.2)

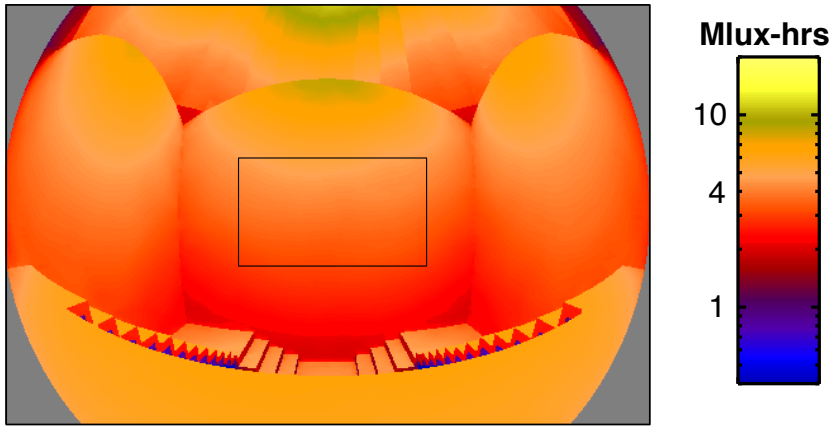
Simulation of daylight glare probability

- Adaptive zone

User operation of blinds / shades

- Models
- Confounding factors

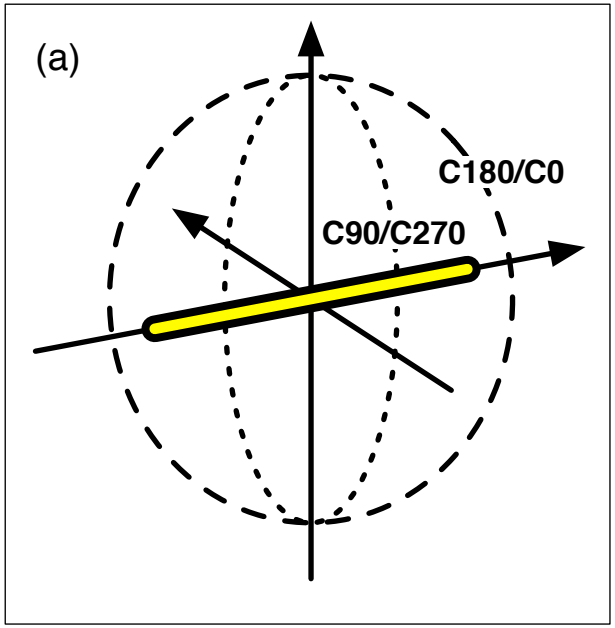


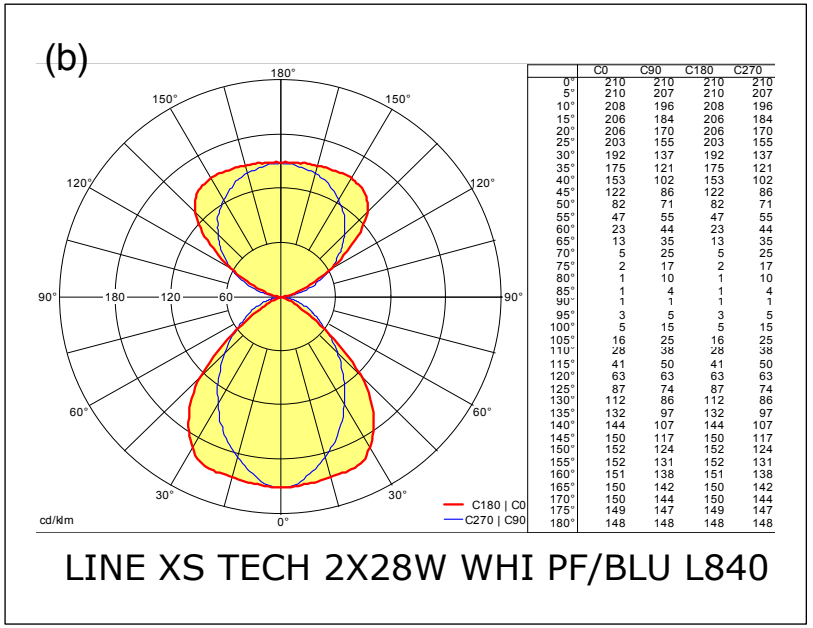


Section 7.8

Modelling artificial lighting

- Luminaire data
- Choosing a software package
- Creating the model





	C0	C90	C180	C270
0°	210	210	210	210
5°	210	207	210	207
10°	208	196	208	196
15°	206	184	206	184
20°	206	170	206	170
25°	203	155	203	155
30°	192	137	192	137
35°	175	121	175	121
40°	153	102	153	102
45°	122	86	122	86
50°	82	71	82	71
55°	47	55	47	55
60°	23	44	23	44
65°	13	35	13	35
70°	5	25	5	25
75°	2	17	2	17
80°	1	10	1	10
85°	1	4	1	4
90°	1	1	1	1
95°	3	5	3	5
100°	5	15	5	15
105°	16	25	16	25
110°	28	38	28	38
115°	41	50	41	50
120°	63	63	63	63
125°	87	74	87	74
130°	112	86	112	86
135°	132	97	132	97
140°	144	107	144	107
145°	150	117	150	117
150°	152	124	152	124
155°	152	131	152	131
160°	151	138	151	138
165°	150	142	150	142
170°	150	144	150	144
175°	149	147	149	147
180°	148	148	148	148

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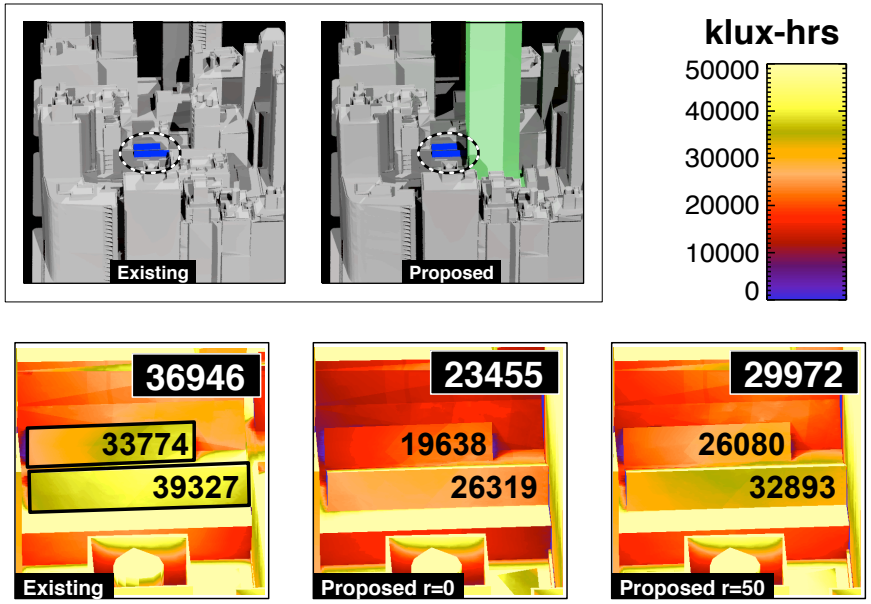
Section 7.9

Lighting environmental and energy modelling

- Lighting control system modelling
- Lighting energy compliance modelling
- Lighting energy numeric indicator (LENI)

Section 7.10
Case studies

- Evaluation of a classroom using UDI
- Daylight exposure study for conservation
- Urban daylight injury study



Summary and conclusions

- Major revision compared to 1998 AM11
- CBDM still evolving - new tools
- Compliance driven