Luminous Data Analysis and Quality Assurance of Climate Based Daylighting Simulation

Francesco Anselmo

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HOTEL AMISOS

Recent window design

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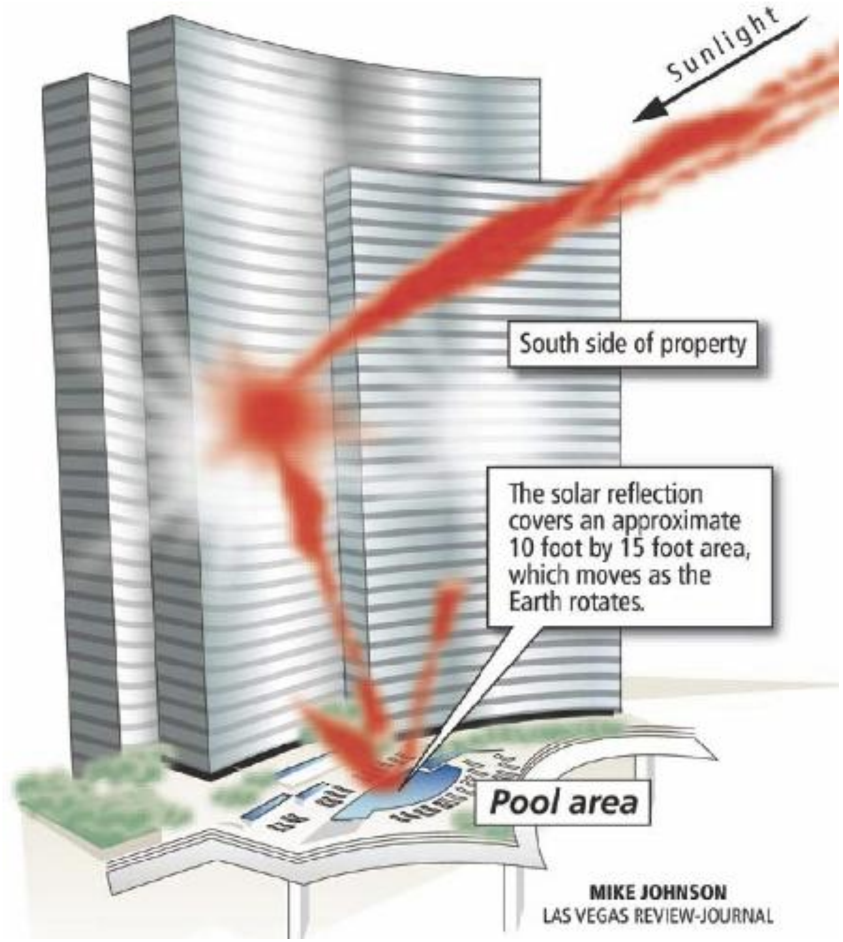
Le Corbusier

- **‘A sheet of glass and three partition walls make an ideal office: this type of construction holds good when a thousand have to be provided. So from top to bottom the façades of the new city’s office buildings form unbroken expanses of glass ... These translucent prisms that seem to float in the air without anchorage to the ground – flashing in summer sunshine, softly gleaming under the grey winter skies, magically glittering at nightfall – one huge block of offices.’**

... flashing in summer sunshine ...



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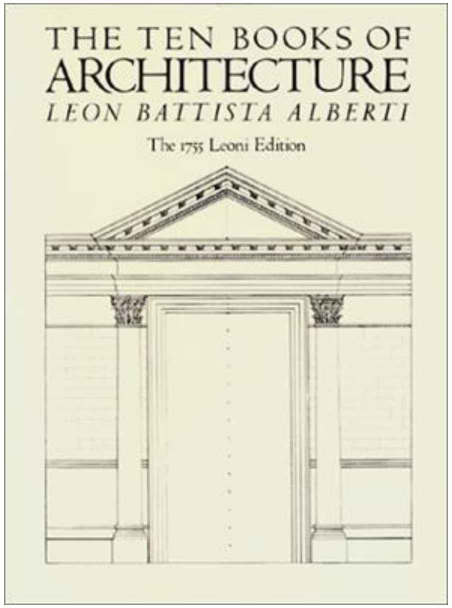
Leon Battista Alberti (Ten books on Architecture, 1485)

- **warning against reflected solar radiation from land or water (whereby a house suffers a 'double sun') in hot climates**



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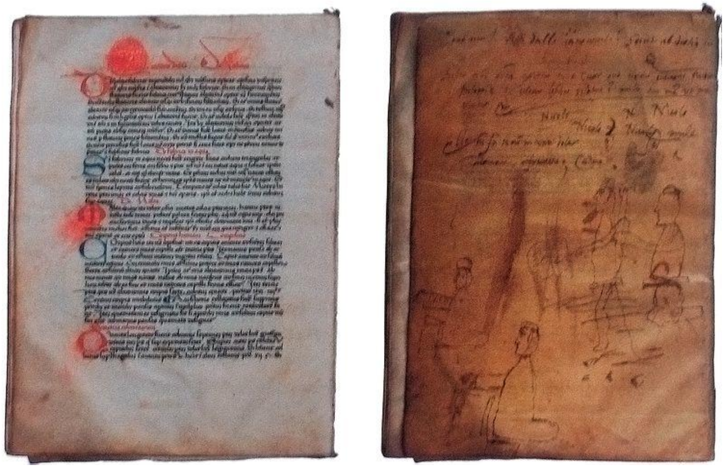
Vitruvius (De Architectura, ~ 25 BC)

- **climate as a determinant to the style of the house**
  - southerly exposure and roofed in the north (of Europe)
  - northerly exposure and more open in the south (of Europe)
- **the pitch of human voice changes with latitude:**
  - southerners with high and shrill voices
  - northerners speaking in heavier tones



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The culmination of all this knowledge

$$DF = \frac{E_i}{E_o} \cdot 100$$

$$L_\theta = L_z \cdot \frac{1 + (2 \cdot \sin\theta)}{3}$$

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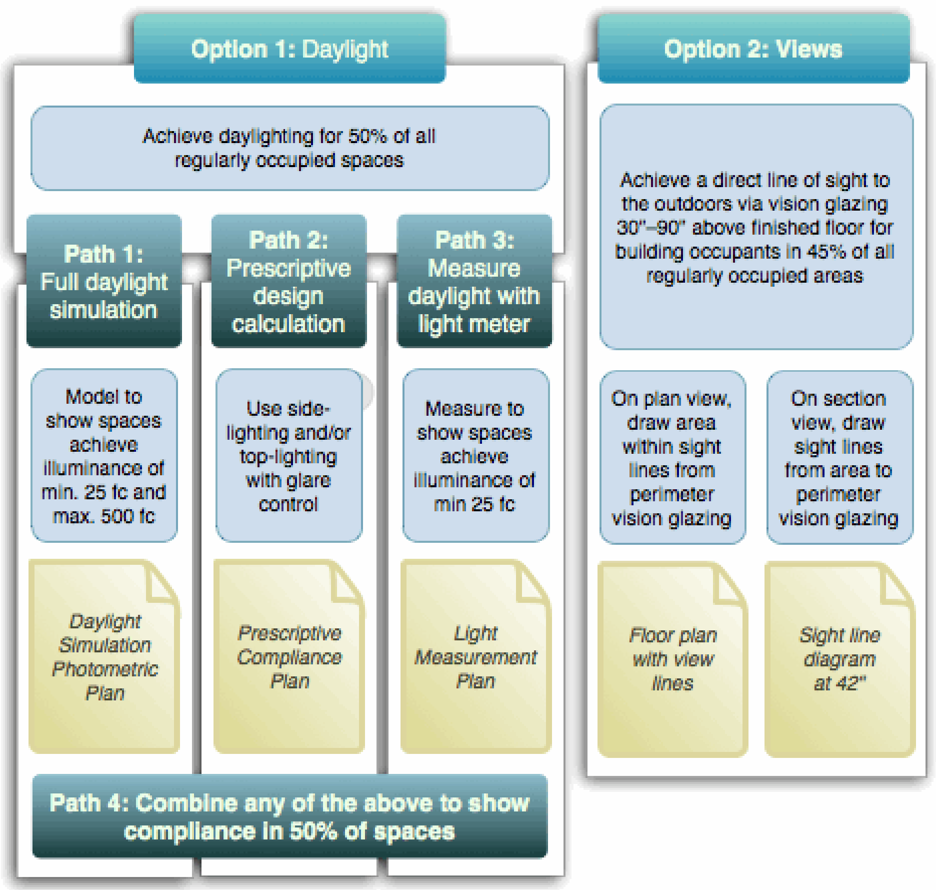
Standards, norms, regulations, points

- **Achieve a minimum of ...% DF**
- **BREEAM**
  - at least 80% of floor area in occupied spaces has an average daylight factor of 2% or more and a uniformity ratio of at least 0.4 or a minimum point daylight factor of at least 0.8%.

Standards, norms, regulations, points

- **Achieve a minimum of ...% DF**
- **LEED®**
  - "Old" target : achieve a minimum Daylight Factor of 2% (excluding all direct sunlight penetration) in 75% of all space occupied for critical visual tasks



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Standards, norms, regulations, points

- **Achieve a minimum of ...% DF**
- **Estidama**
  - In office buildings 1 credit point is achieved where 45%, 2 credit points where 60%, 3 credit points where 75% of the occupied area demonstrate an average DF of 2%. In retail developments 1 credit point is achieved where 35%, 2 credit points where 45%, 3 credit points where 55% of the occupied area demonstrate an average DF of 2%. Product may also improve internal reflectivities above average- 80% for ceilings, 70% for walls, 30% for floors
- **Green Star, HK-BEAM, CASBEE**
- **Does compliance translate to good design?**

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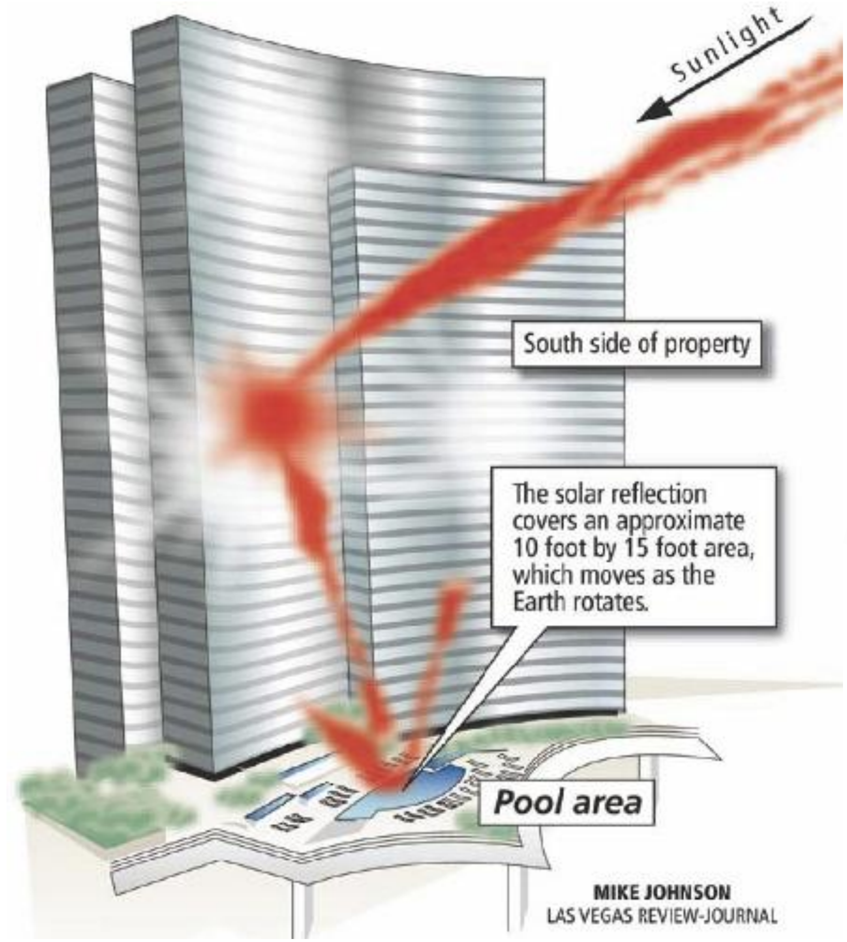
Does compliance translate to good design?



We have the power – luminous data

- **EPW (many world locations)**
  - collection of different sources of weather data, usually including exterior illuminance series
- **US National Weather Service real time-data**
- **S@tel-Light (Europe only)**
- **Mesor (many world locations)**
  - Meteonorm
  - SOLEMI
  - HelioClim3
  - etc ...
- **Data from local institutions**
  - Test reference years

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We have the power – climate based daylight modelling

- **Radiance (rtcontrib & co.)**
- **Daysim**
- **Lightsolve**
- **VELUX Daylight Visualizer (domestic applications)**

CIE 171:2006

Test cases to assess the accuracy of lighting computer programs

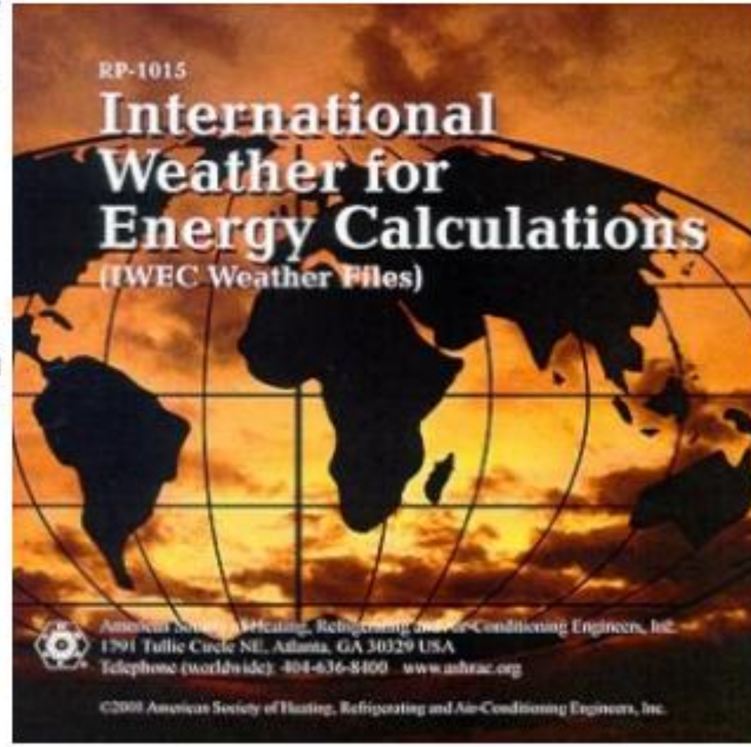
Commission Internationale de L'Eclairage / 01-Jan-2006 / 99 pages

ISBN: 9783901906473

With great power comes great responsibility

- **Look at the data**
- **Study the data**
  - Data source
  - Type (real time series? test reference year?)
  - Visualise the data
  - Understand the data
    - limitations
    - missing data
    - interpolations
    - ‘invented’ data
- **Is it correct to use it for my project locale?**
  - Localised microclimates not captured by weather series
  - Mountains, reflection from water, urban environment ...

IWEC



Contains "typical" weather data in ASCII format files, suitable for use with building energy simulation programs, for 227 locations outside the USA and Canada. The International Weather for Energy Calculation (IWEC) files are derived from up to 18 years of DATSAV3 hourly weather data originally archived at the National Climatic Data Center. The weather data is supplemented by solar radiations estimated on an hourly basis from earth-sun geometry and hourly weather elements, particularly cloud amount information.

The IWEC files contain hourly weather observations such as dry bulb temperature, dew point temperature, wind speed, and wind direction, which are derived from the DATSAV3 database of surface observations developed by the National Climatic Data Center, Asheville, NC; and hourly solar radiation and illuminance data that is calculated from earth-sun geometry and cloud cover. The development of the IWEC files followed a two step process. First, up to 18 years (1982-1999) of DATSAV3 weather data were processed. Small gaps in the data were filled, and solar radiation was computed from cloud cover and earth-sun geometry. In a second step, twelve Typical Meteorological Months were selected from the long-term time series and assembled into an IWEC file. Screen Shots

Keywords
international weather, weather data, climate data, energy calculations

Validation/Testing
N/A

Expertise Required
Student or engineer of HVAC system design or building energy analysis. Low level of computer literacy required.

Users
Worldwide distribution and use.

Audience
: International and US/Canadian engineers that provide engineering services outside North America.

Input
Select weather data file by location name or six digit WMO#.

Output
ASCII file. The IWEC files contain a header and 8760 hourly records. The size of the IWEC files is calculated as follows:

- Header: 76 characters + 2 termination characters
- Data records: 150 characters + 2 termination characters
- Total: 1,331,598 bytes.

Computer Platform
CD-ROM is ISO-9660 compliant and should be readable in any standard CD-ROM drive.

Programming Language
none

Computer Platform

CD-ROM is ISO-9660 compliant and should be readable in any standard CD-ROM drive.

Programming Language

none

Strengths

Includes 227 international locations. The IWEC files are well suited to the following uses:

- Input to building energy hourly simulation software (such as DOE-2, BLAST or EnergyPlus) to estimate the typical annual energy consumption of buildings.
- Input to simulation software for the hourly simulation of solar energy systems.

Weaknesses

The IWEC files are **not** suited to the following uses:

- Simulation of wind energy or other renewable energy systems. The weights used for the selection of typical months (see section 1.1) are heavily biased toward dry bulb temperature and solar radiation. There is no guarantee that wind speed or other variables are typical of the conditions experienced at the site.
- Derivation of bin data or monthly averages. These should be derived from the long-term data series (up to 18 years) from which the IWEC files were assembled, not from the IWEC files themselves. The typical month selection process guarantees that the month chosen is the 'most representative' overall, but not necessarily that monthly averages will match those calculated from longterm time series.
- Sizing of systems. The IWEC files are 'typical years' that normally stay away from extreme conditions. Sizing of HVAC systems that require the consideration of extreme conditions cannot be done with the IWEC files.

Contact

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E-mail:	orders@ashrae.org
Website:	http://xp10.ashrae.org/bookstore/bookstore.html

Availability

ASHRAE's International Weather for Energy Calculations is available for $230 ($190 for members of ASHRAE). Order on the web at www.ashrae.org/bookstore/bookstore.html. Order by phone by calling ASHRAE Customer Service at 1-800-527-4723 in the U.S. and Canada, or at (404) 636-8400 worldwide. Fax your order to (404) 321-5478. Questions about this or other ASHRAE products should be e-mailed to orders@ashrae.org.

Data Element	DOE-2	BLAST	ESP-r	E/E
Location (name, latitude, longitude, elevation, time zone)	X	X	X	X
Data source				X
Commentary			X	X
Design conditions				X
Typical/extreme periods				X
Data periods				X
Holiday/Daylight Savings		X		X
Solar Angles/Equation of Time Hours		X		
Degree Days		X		X
Year	X	X	X	X
Month	X	X	X	X
Day	X	X	X	X
Hour	X	X	X	X
Minute				X
Data source and uncertainty flags				X
Dry bulb temperature	X	X	X	X
Wet bulb temperature	X	X		X
Dew point temperature	X			X
Atmospheric station pressure	X	X		X
Humidity ratio	X	X		X
Relative humidity			X	X
Enthalpy	X			
Density	X			
Wind Speed	X	X	X	X
Wind Direction	X	X	X	X
Infrared Sky Temperature		X		X
Solar Radiation (global, normal, diffuse)	X	X	X	X
Illuminance (global, normal, diffuse)				X
Sky cover (cloud amount)	X			X
Opaque sky cover				X
Visibility				X
Ceiling height				X
Clearness (monthly)	X			
Ground temperatures (monthly)	X			X
Present weather observation and codes (rain, snow)		X		X
Precipitable water				X
Aerosol optical depth				X
Snow depth				X
Days since last snowfall				X

Data Flag	Flag Values
Dry Bulb Temperature Data Source	A-F
Dry Bulb Temperature Data Uncertainty	0-9
Dew Point Temperature Data Source	A-F
Dew Point Temperature Data Uncertainty	0-9
Relative Humidity Data Source	A-F
Relative Humidity Data Uncertainty	0-9
Atmospheric Station Pressure Data Source	A-F
Atmospheric Station Pressure Data Uncertainty	0-9
Horizontal Infrared Radiation Data Source	A-H, ?
Horizontal Infrared Radiation Data Uncertainty	0-9
Global Horizontal Radiation Data Source	A-H, ?
Global Horizontal Radiation Data Uncertainty	0-9
Direct Normal Radiation Data Source	A-H, ?
Direct Normal Radiation Data Uncertainty	0-9
Diffuse Horizontal Radiation Data Source	A-H, ?
Diffuse Horizontal Radiation Data Uncertainty	0-9
Global Horizontal Illuminance Data Source	I, ?
Global Horizontal Illuminance Data Uncertainty	0-9
Direct Normal Illuminance Data Source	I, ?
Direct Normal Illuminance Data Uncertainty	0-9
Diffuse Horizontal Illuminance Data Source	I, ?
Diffuse Horizontal Illuminance Data Uncertainty	0-9
Zenith Luminance Data Source	I, ?
Zenith Luminance Data Uncertainty	0-9
Wind Direction Data Source	A-F
Wind Direction Data Uncertainty	0-9
Wind Speed Data Source	A-F
Wind Speed Data Uncertainty	0-9
Total Sky Cover Data Source	A-F
Total Sky Cover Data Uncertainty	0-9
Opaque Sky Cover Data Source	A-F
Opaque Sky Cover Data Uncertainty	0-9
Visibility Data Source	A-F, ?
Visibility Data Uncertainty	0-9
Ceiling Height Data Source	A-F, ?
Ceiling Height Data Uncertainty	0-9
Precipitable Water Data Source	A-F
Precipitable Water Data Uncertainty	0-9
Broadband Aerosol Optical Depth Data Source	A-F
Broadband Aerosol Optical Depth Data Uncertainty	0-9
Snow Depth Data Source	A-F, ?
Snow Cover Data Uncertainty	0-9
Days Since Last Snowfall Data Source	A-F, ?
Days Since Last Snowfall Data Uncertainty	0-9

Flag Code	Definition
A	Post-1976 measured solar radiation data as received from NCDC or other sources
B	Same as "A" except the global horizontal data underwent a calibration correction
C	Pre-1976 measured global horizontal data (direct and diffuse were not measured before 1976), adjusted from solar to local time, usually with a calibration correction
D	Data derived from the other two elements of solar radiation using the relationship, global = diffuse + direct ´ cosine (zenith)
E	Modeled solar radiation data using inputs of observed sky cover (cloud amount) and aerosol optical depths derived from direct normal data collected at the same location
F	Modeled solar radiation data using interpolated sky cover and aerosol optical depths derived from direct normal data collected at the same location
G	Modeled solar radiation data using observed sky cover and aerosol optical depths estimated from geographical relationships
H	Modeled solar radiation data using interpolated sky cover and estimated aerosol optical depths
I	Modeled illuminance or luminance data derived from measured or modeled solar radiation data
?	Source does not fit any of the above categories. Used for nighttime values and missing data

Flag	Uncertainty Range (%)
1	Not used
2	2 - 4
3	4 - 6
4	6 - 9
5	9 - 13
6	13 - 18
7	18 - 25
8	25 - 35
9	35 - 50
0	Not applicable

Example – Accra, Ghana

LOCATION,ACCRA/KOTOKA_INTL,-,GHA,SWERA,654720,5.60,-0.17,0.0,69.0
DESIGN CONDITIONS,0
TYPICAL/EXTREME PERIODS,3,No Dry Season - Week Near Average Annual,Typical,12/10,12/16,No Dry Season - Week Near Annual Max
GROUND TEMPERATURES,
3,.5,,,,28.62,28.29,27.64,27.04,25.90,25.31,25.15,25.46,26.17,27.05,27.91,28.47,2,,,,28.17,28.09,27.72,27.31,26.44,25.88,25
,26.07,26.01,26.19,26.55,27.01,27.43
HOLIDAYS/DAYLIGHT SAVINGS,No,0,0,0
COMMENTS 1,Solar and Wind Energy Resource Assessment (SWERA) project funded by the United Nations Environment Program.; NRE
format for 14 developing countries for SWERA.
COMMENTS 2, -- Ground temps produced with a standard soil diffusivity of 2.3225760E-03 {m**2/day}
DATA PERIODS,1,1,Data,Sunday, 1/ 1,12/31
1991,1,1,1,60,B8B8E8B8*0H5H5H5I5I5I5I5E9B8B8E9*0*0F89F9?9?,24.0,14.2,54,100300,0,0,365,0,0,0,0,0,0,0,2.8,1,0,777.7,77777,
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1991,1,1,5,60,B8B8E8B8*0H5H5H5I5I5I5I5E9B8B8E9*0*0F89F9?9?,22.0,9.5,45,100300,0,0,350,0,0,0,0,0,0,0,3.8,0,0,777.7,77777,9
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1991,1,1,7,60,A7A7E8A7*0H5H5H5I5I5I5I5A7A7B8E9A7A7F89F9?9?,21.0,14.0,64,100400,104,1095,350,31,22,28,3400,1200,3200,690,50,
1991,1,1,8,60,A7A7E8A7*0H5H5H5I5I5I5I5A7A7B8E9A7A7F89F9?9?,22.0,16.0,69,100400,422,1414,357,197,291,110,21200,21300,14800,2
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1991,1,1,11,60,B8B8E8B8*0H5H5H5I5I5I5I5E9B8B8E9*0*0F89F9?9?,27.0,4.4,23,100400,1134,1414,368,829,711,258,87800,70300,31400,
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1991,1,1,17,60,A7A7E8A7*0H5H5H5I5I5I5I5A7A7B8E9A7A7F89F9?9?,28.0,12.0,37,100200,464,1414,399,186,174,129,20600,14500,15800,
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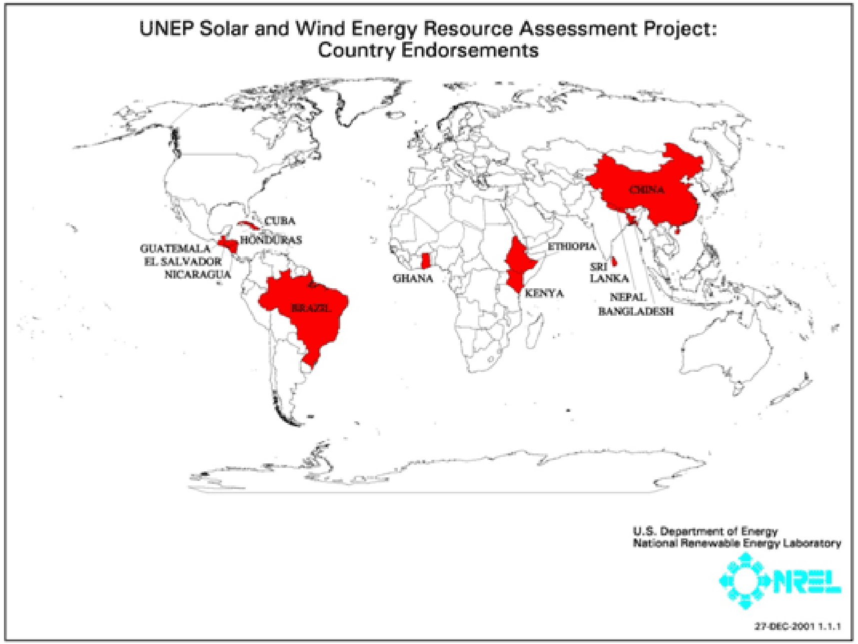
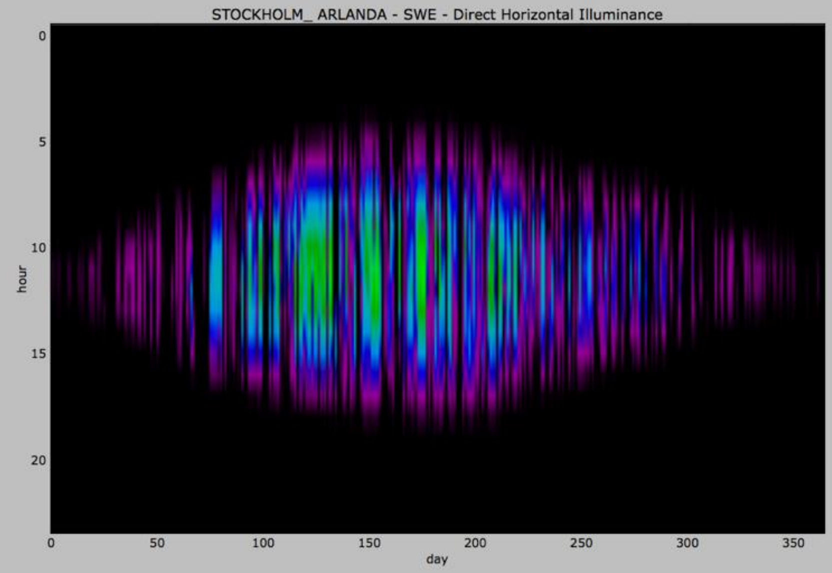
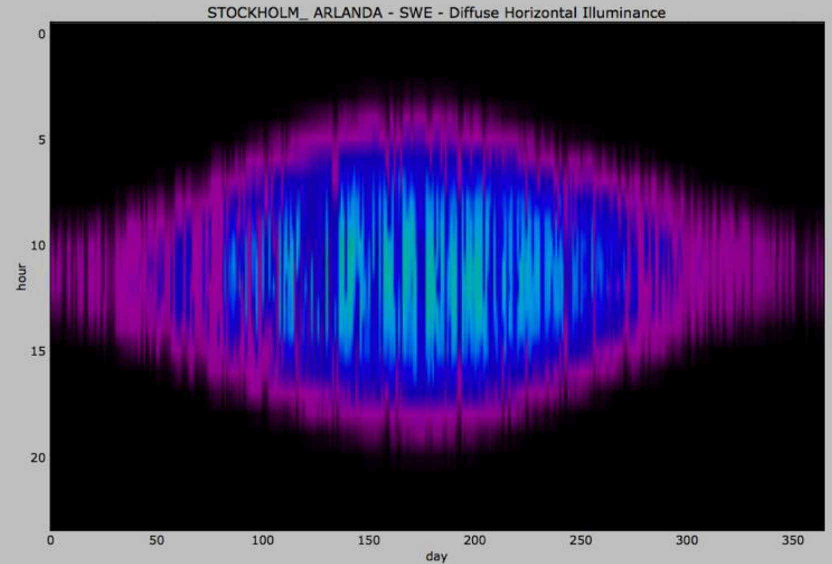
1.1 History of SWERA

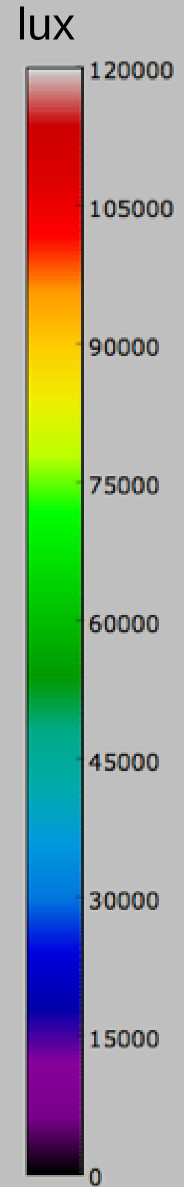
The Solar and Wind Energy Resource Assessment (SWERA) started in 2001 to advance the large-scale use of renewable energy technologies by increasing the availability and accessibility of high-quality solar and wind resource information. SWERA began as a pilot project with funding from the Global Environment Facility (GEF) and managed by the United Nations Environment Programme's (UNEP) Division of Technology, Industry and Economics (DTIE) in collaboration with more than 25 partners around the world. With the success of the project in 13 pilot countries SWERA expanded in 2006 into a full programme. Its expanded mission is to provide high quality information on renewable energy resources for countries and regions around the world, along with the tools needed to apply these data in ways that facilitate renewable energy policies and investments.



Latitude: 59.65º North







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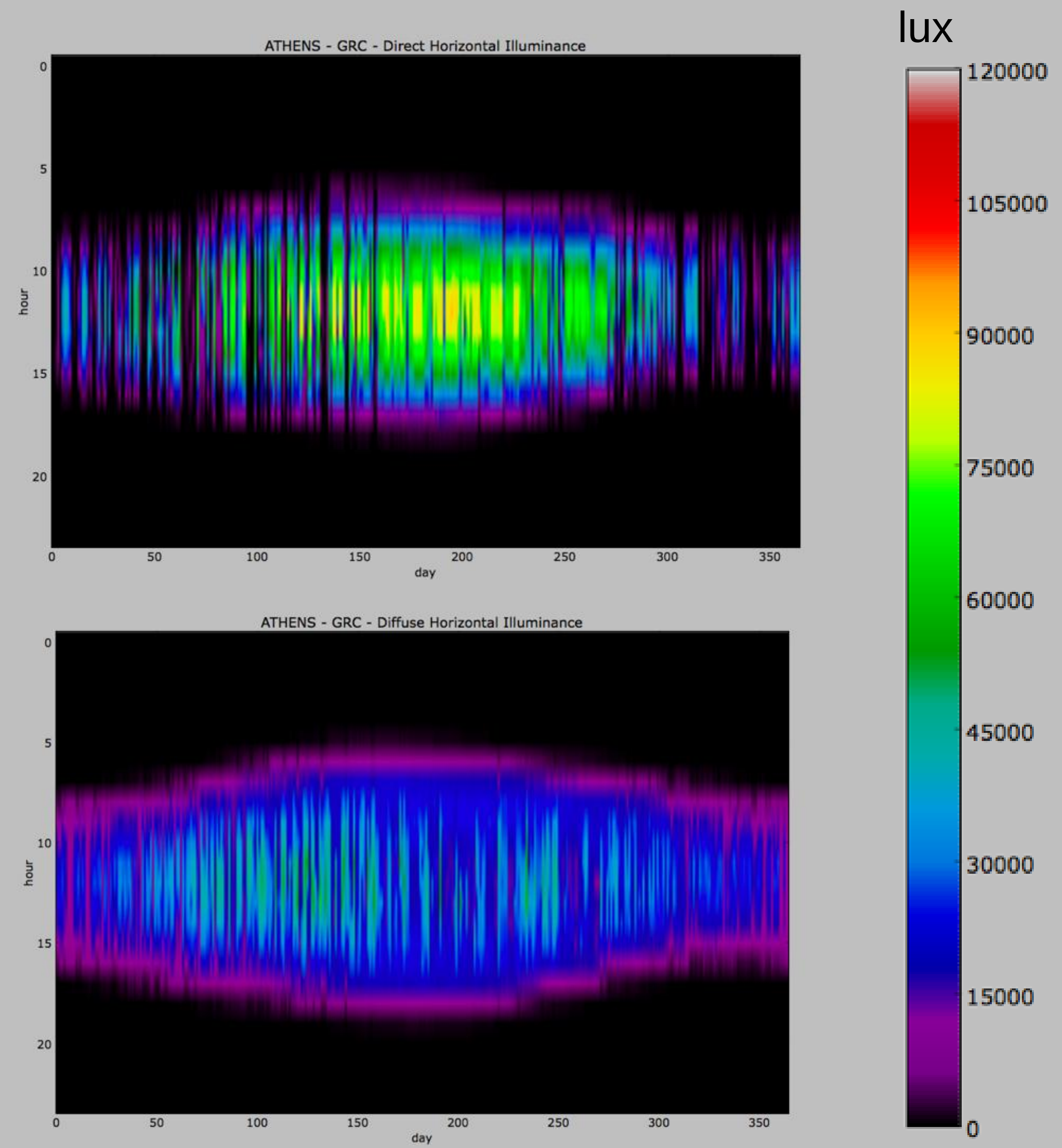
Latitude: 37.90º North



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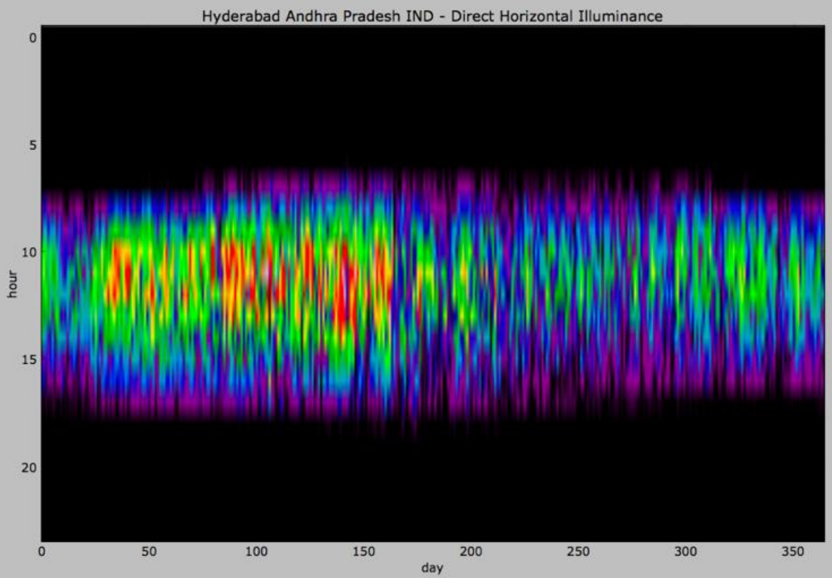
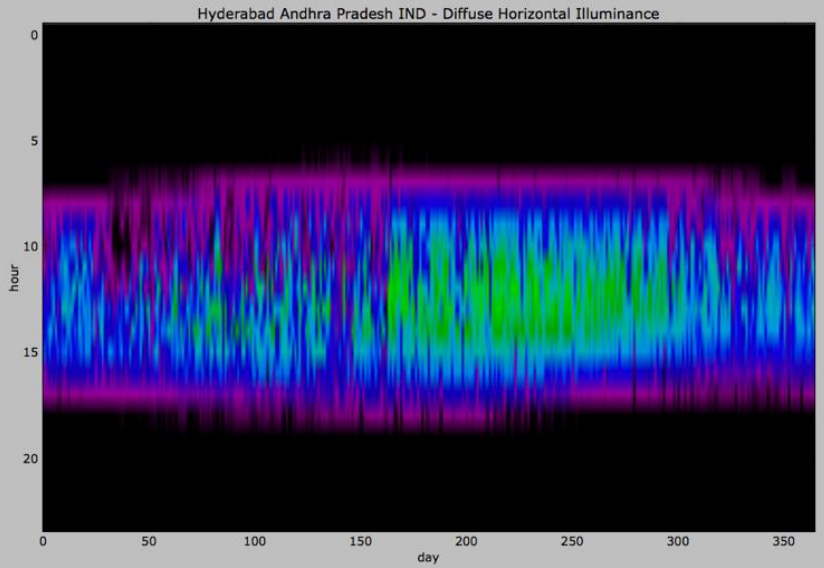
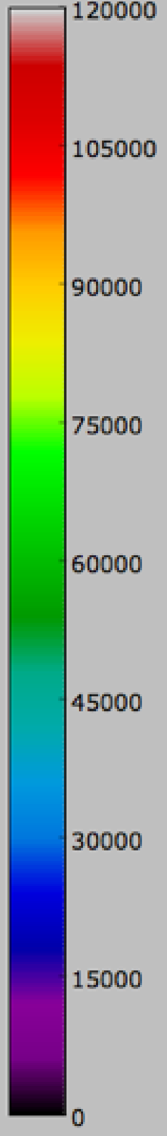
Latitude: 17.45º North







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Sky models

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Know your software

- **Check if it has been validated**
- **Look inside the code (no black boxes please!)**
- **How is climate data translated into luminance/radiance sky distributions**
- **Check your assumptions**
- **Sensitivity study**
- **Use different methods to calculate the same metric**

Example - gensky

gensky at the moment behaves this way (I hope not to make any error ...):

1. it can model uniform skies

2. it can model CIE standard clear skies (as described in CIE 110-1994)

3. it can model CIE standard overcast skies (as described in CIE 110-1994 and previous standards)

4. it can model non standard intermediate skies, whose definition is contained inside src/gen/gensky.c and /src/gen/skybright.cal (I don't have a reference about where the intermediate sky definition was taken from)

If it is given zenith radiance (-b) and solar radiance (-r), gensky uses directly the CIE formulas or the intermediate sky formula, since all the sky distribution parameters are already defined, but it is not very usual to have measured sequences of such weather data.

DIRECT CONTRIBUTION from the sun

If we provide gensky with horizontal direct irradiance (ees), solar radiance (solarbr) is computed with the following formula:

solarbr = ees/(6e-5*sin(sunaltitude))

If we only specify location and time, gensky uses the following formula:

solarbr = 1.5e9/SUNEFFICACY*sin(sunaltitude) if (1.147 - .147/sin(sunaltitude) > .16), otherwise 1.5e9/SUNEFFICACY*.16

where SUNEFFICACY = 208 /* illuminant B (solar dir.) */

Additionally, if the sky is intermediate, the previous value is multiplied by 0.15 (i.e the so called /* fudge factor! */)

DIFFUSE CONTRIBUTION from the sky

Example - gensky

DIFFUSE CONTRIBUTION from the sky

If neither zenith radiance (zenithbr) nor horizontal diffuse irradiance (eed) are given, the Krochmann equation is used for the CIE OVERCAST SKY:

zenithbr = 8.6*sin(sunaltitude) + .123 [kcd/m^2] (Krochmann)

CIE 110-1994 also reports equations by Kittler and Nakamura, Oki et al. for this purpose.

For the CIE CLEAR SKY the LBL equation (Karayel, Navvab, Ne'eman, Selkowitz) is used (here the Linke Turbidity appears for the first time):

zenithbr = (1.376*turbidity-1.81)*tan(sunaltitude)+0.38 [kcd/m^2] (Karayel, Navvab, Ne'eman, Selkowitz)

CIE 110-1994 also reports a lot of equations that should be chosen according to the climate condition in the location of interest (Kittler, Dogniaux, Krochmann, Liebelt, Gusev, Nagata, Nakamura Oki et al.), but gensky only uses the LBL one.

For the INTERMEDIATE SKY, gensky computes the average of the overcast and CIE clear zenith radiances.

At the end, the computed resulting value is divided by SKYEFFICACY

D65EFFICACY = 203 /* standard illuminant D65 */ SKYEFFICACY = D65EFFICACY /* skylight */

If the horizontal diffuse irradiance (eed) is provided, then gensky computes the zenith radiance by using the following formula:

zenithbr = eed/(normfactor*PI)

normfactor = 7/9 for CIE OVERCAST SKY

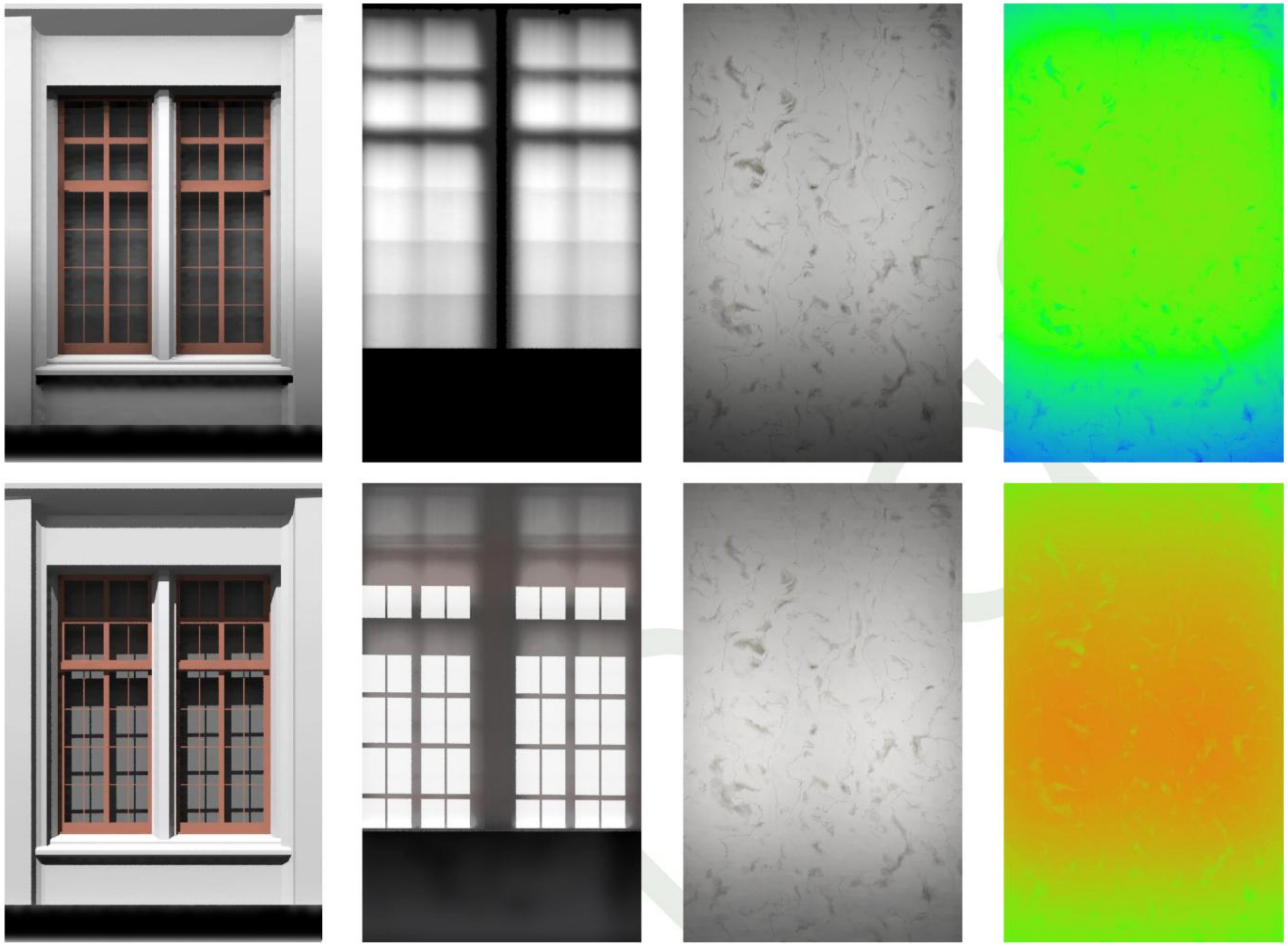
while for CIE CLEAR SKY and the INTERMEDIATE SKY, normfactor is computed by using two different polynomial approximations.

For the CIE CLEAR SKY, CIE 110-1994 suggests two different polynomial approximations by Kittler (as said, „for practical purposes") and by Gusev (for polluted atmosphere): both of them are not used by gensky.

Do we need compliance?

- **We need new design metrics to understand dynamic lighting and take appropriate decisions**
  - statistical analysis
  - identify problems
  - give feedback about appropriate decisions
  - include the possibility to assess performance of advanced daylight devices
- **We need to test the quality of our assumptions, design data and simulation procedures**
- **The final evaluation metrics are occupants' happiness/satisfaction and energy use**

Simulation enables to explore the visual field



Sample #	Material name	Tvis (%)	Width (mm)
1	Alabaster	48.4	10
2	Fiber stone	46.2	6 glass / 1 glue / 5 stone
3	Mexican Onyx	53.3	10 glass / 4 stone
4	White Onyx + Polished Ïnish	54.6	6 glass / 6 stone
5	White Onyx + Polished ‡clear· glass	50.7	5 glass / 7 stone

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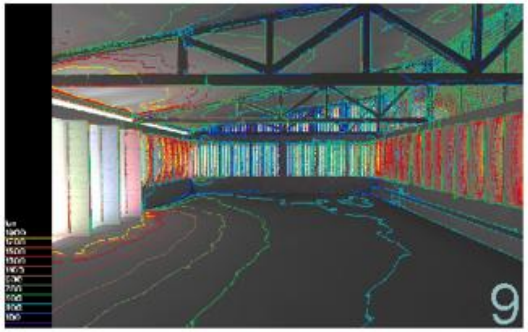
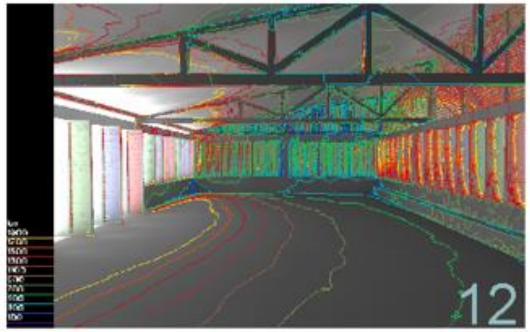
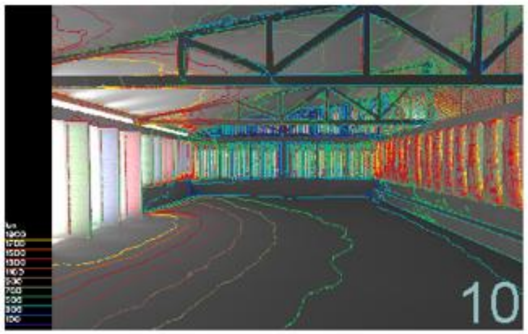
3. Time of day sequences

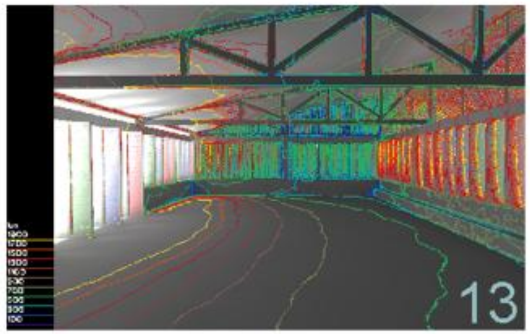
The simulation results on this and on the next pages show time of day sequences for the western classroom, between the hours 9AM and 4PM, in order to visualise both qualitatively and quantitatively the daylighting performance on a typical day in June and December.

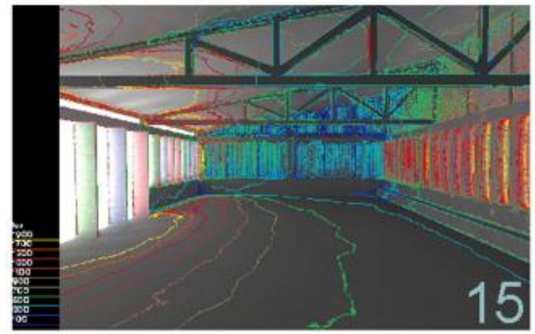
3.1 June 21st

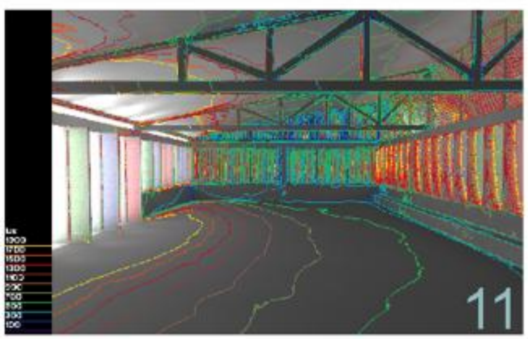


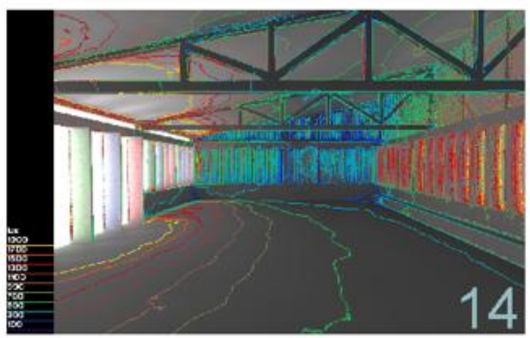


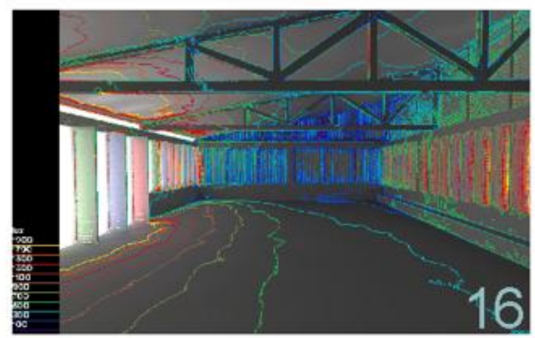












Le Corbusier

- **‘The materials of town planning are: the sun, the space, the vegetation, steel and concrete, in that precise order and hierarchy.’**

Thank you!

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Appendix (if we have more time)

- **Example: Kindergarten in Dwabor, Ghana**
  - Design “without” compliance = design freedom
  - Ultimate passive design: no electricity, only natural ventilation, natural light, use of local materials

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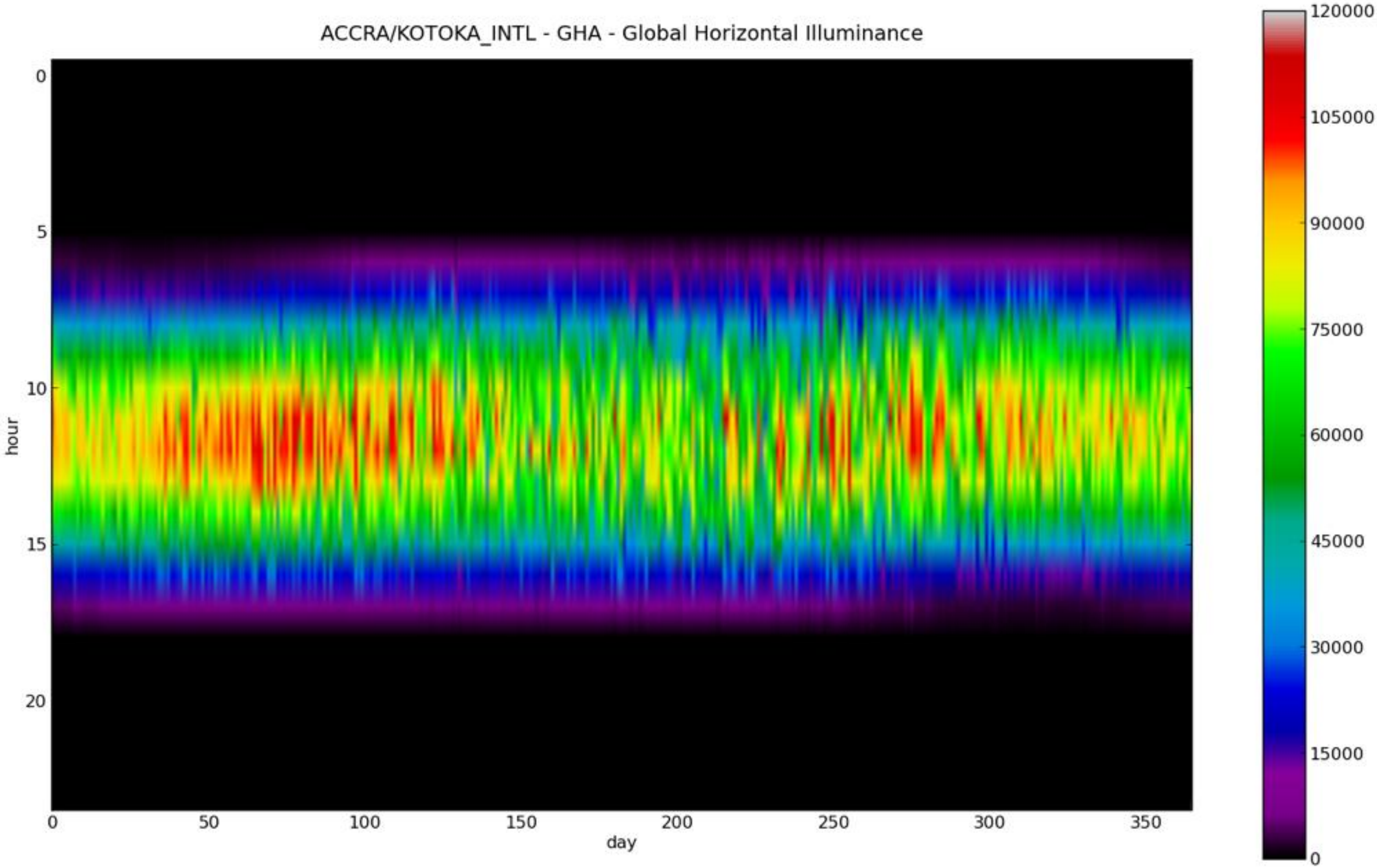
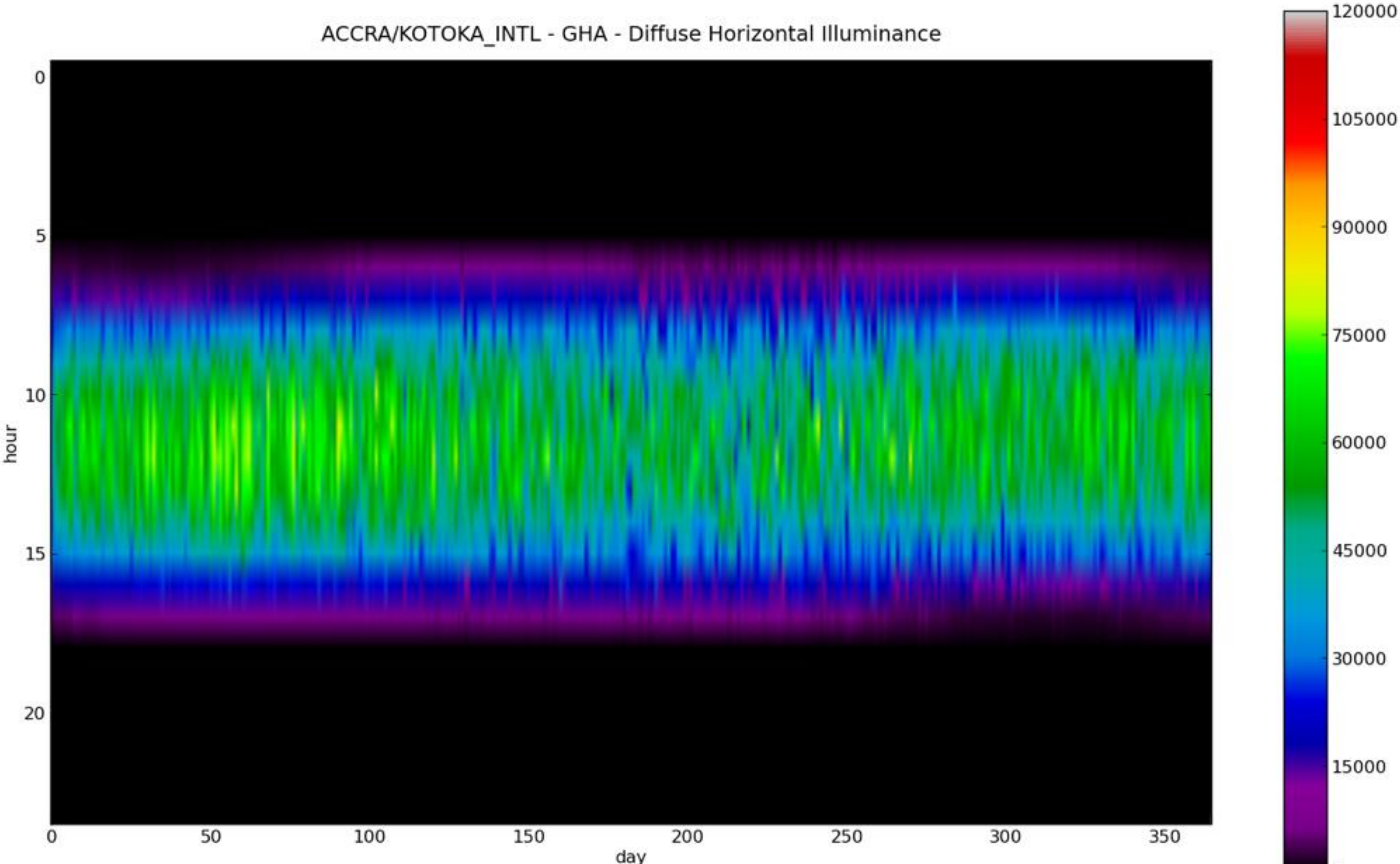
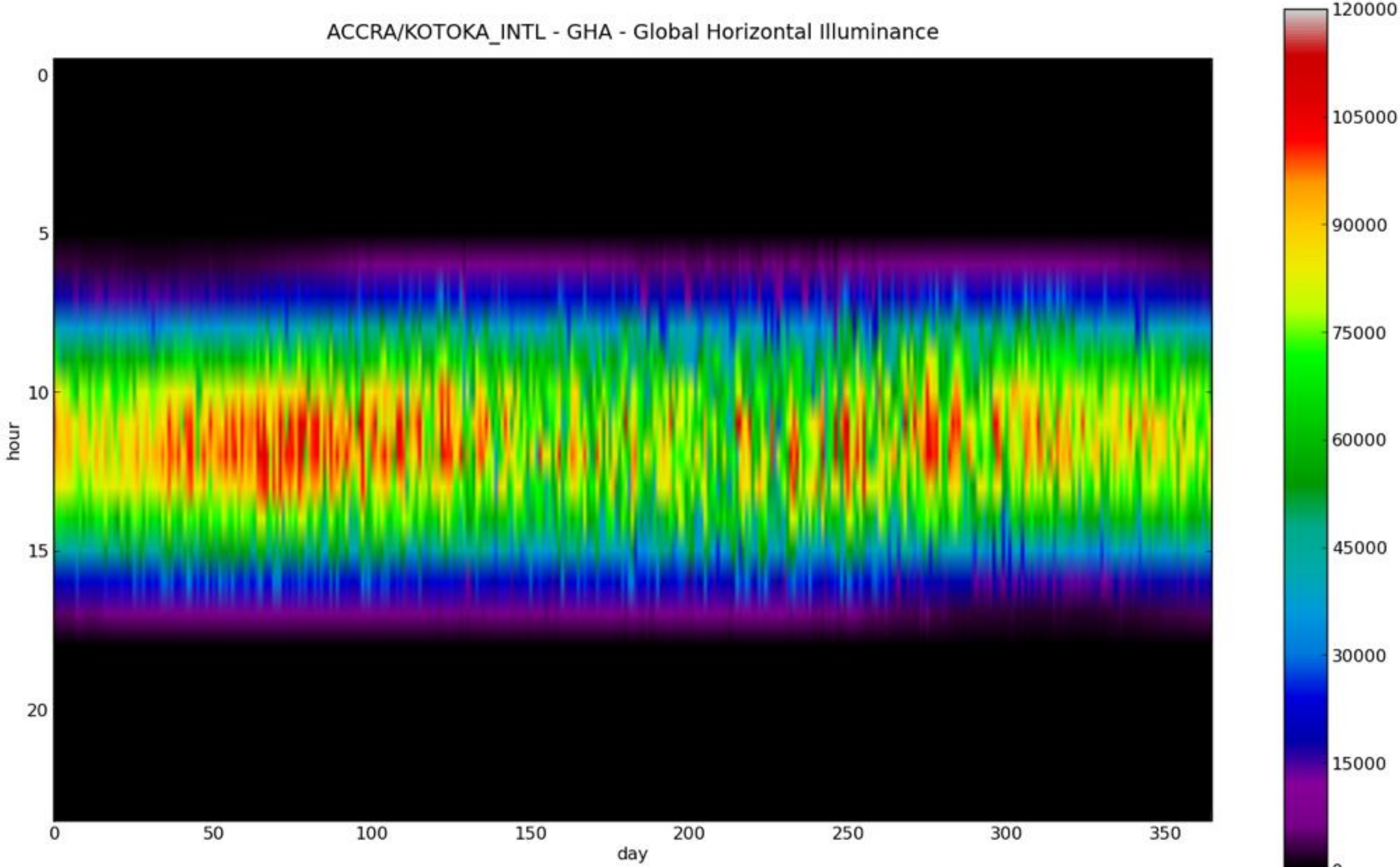
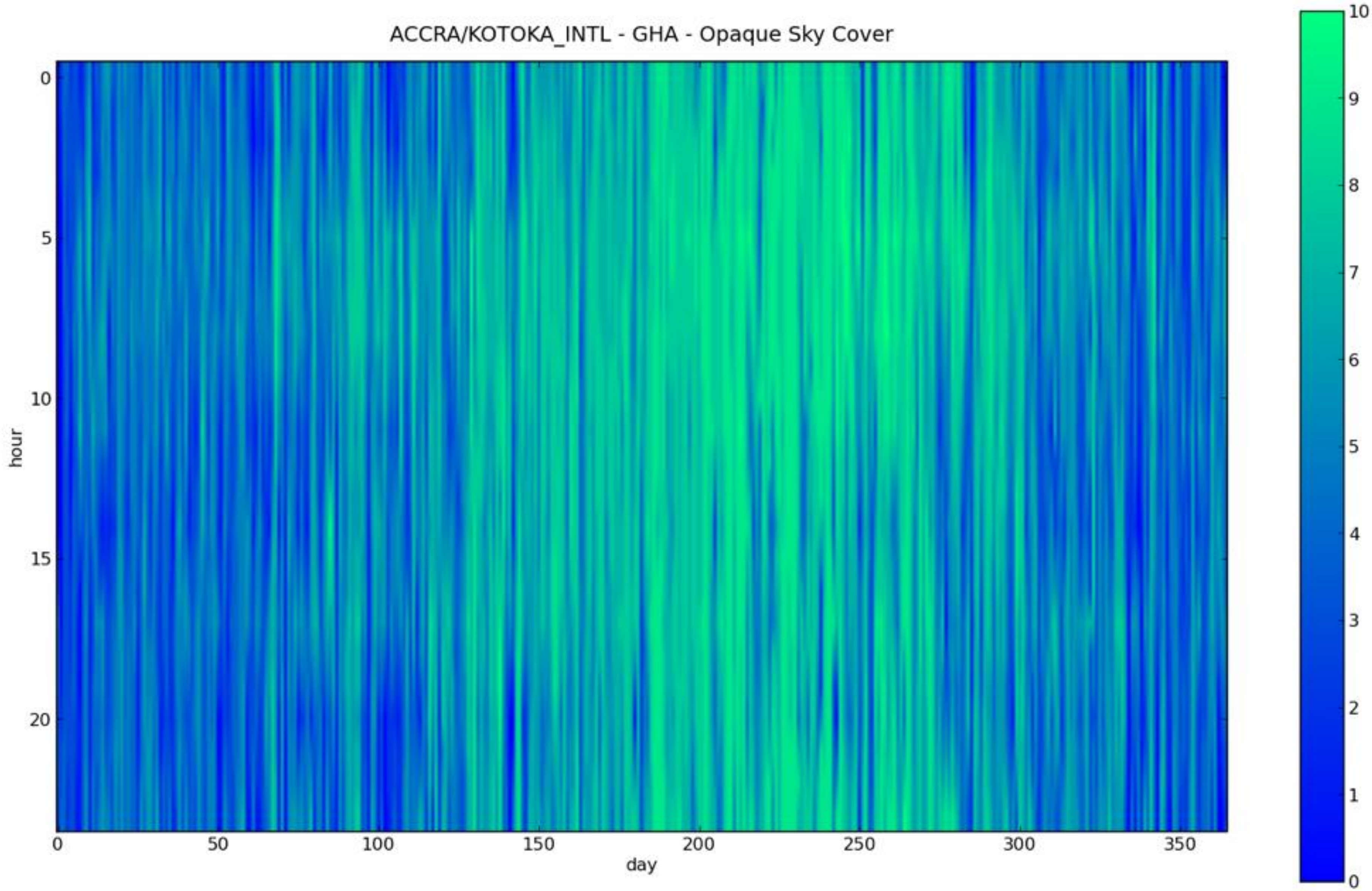
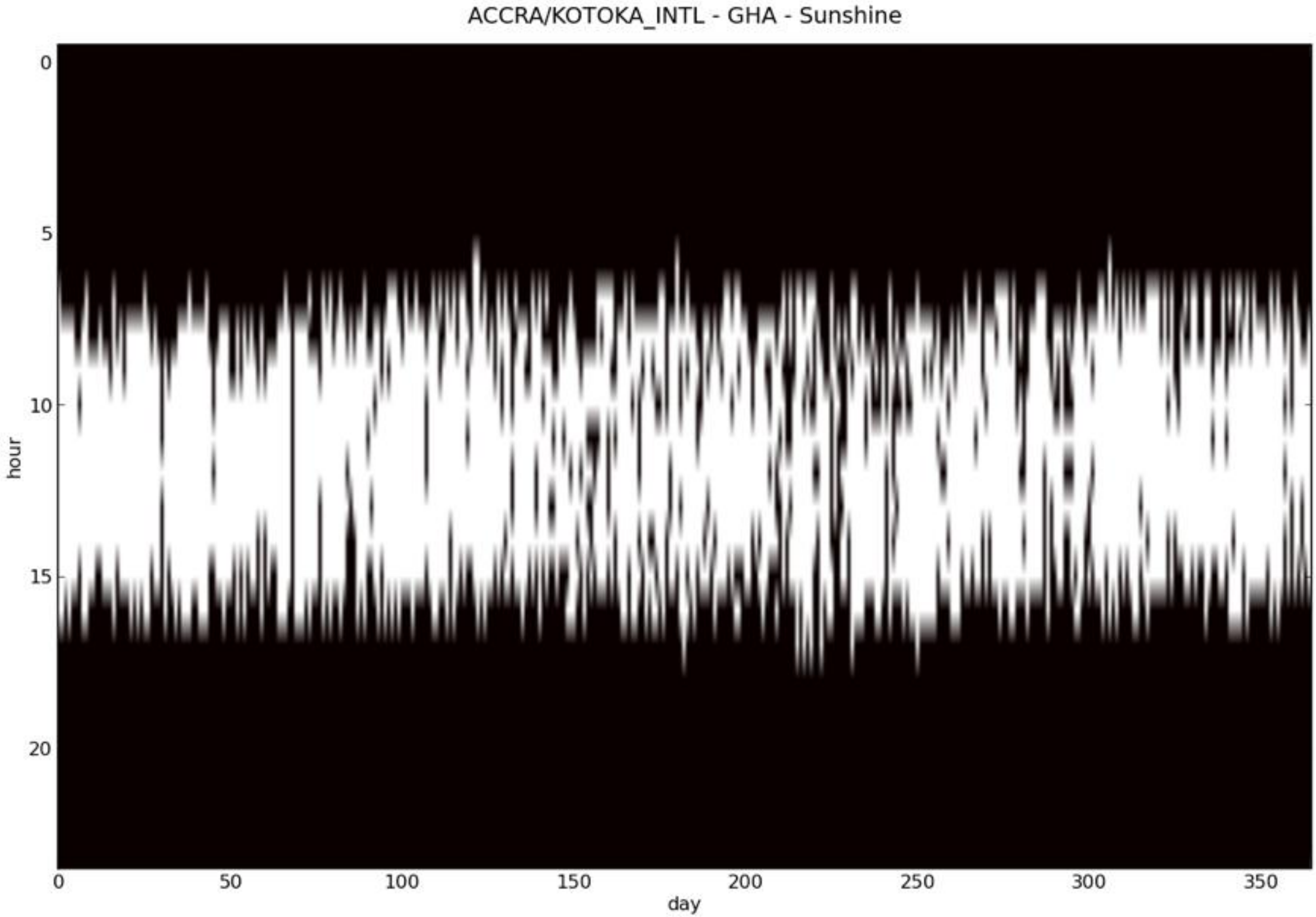

ACCRA/KOTOKA_INTL - GHA - Global Horizontal Illuminance
hour
0
5
10
15
20
day
0
50
100
150
200
250
300
350
120000
105000
90000
75000
60000
45000
30000
15000
0

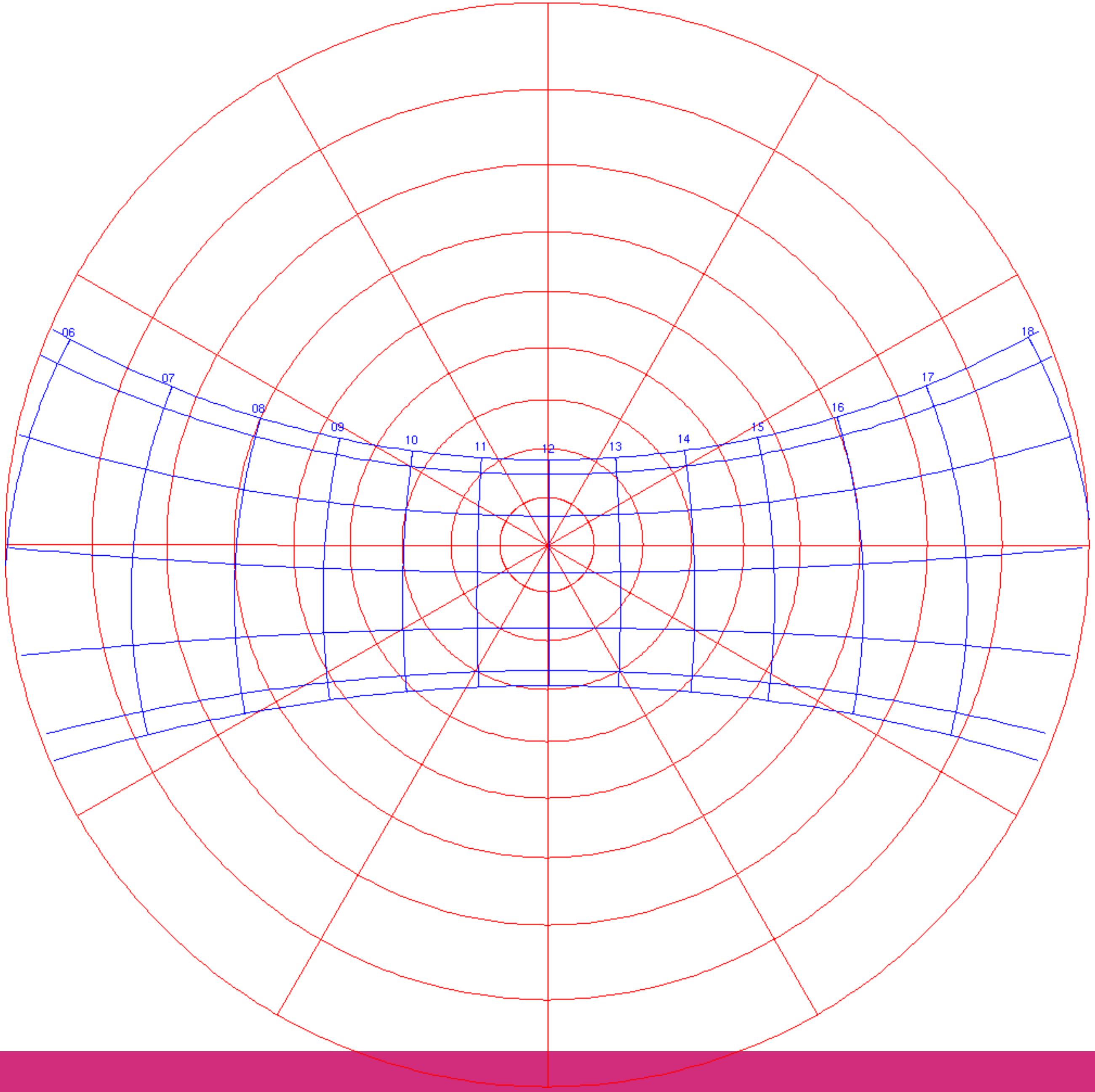

ACCRA/KOTOKA_INTL - GHA - Diffuse Horizontal Illuminance
hour
0
5
10
15
20
day
0
50
100
150
200
250
300
350
120000
105000
90000
75000
60000
45000
30000
15000
0


ACCRA/KOTOKA_INTL - GHA - Global Horizontal Illuminance
hour
0
5
10
15
20
day
0
50
100
150
200
250
300
350
120000
105000
90000
75000
60000
45000
30000
15000
0



ACCRA/KOTOKA_INTL - GHA - Opaque Sky Cover
hour
0
5
10
15
20
day
0
50
100
150
200
250
300
350
10
9
8
7
6
5
4
3
2
1
0


ACCRA/KOTOKA_INTL - GHA - Sunshine
hour
0
5
10
15
20
day
0
50
100
150
200
250
300
350



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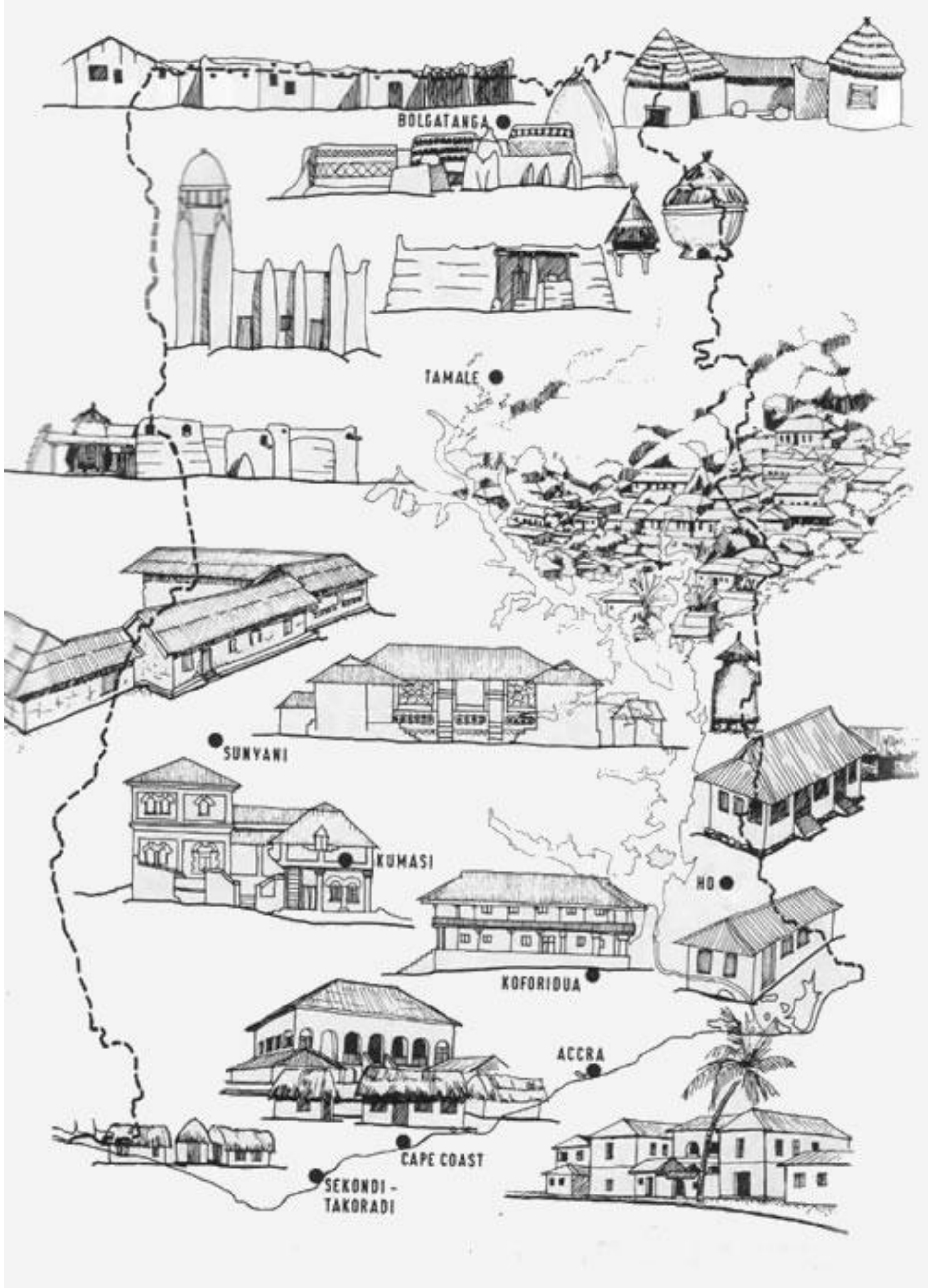
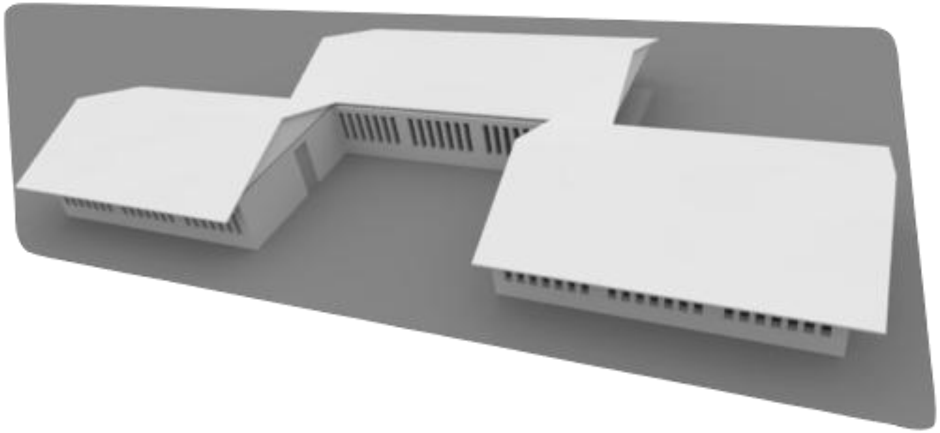
COMPAGNIE FRANCAISE DE L'AFRIQUE OCCIDENTALE

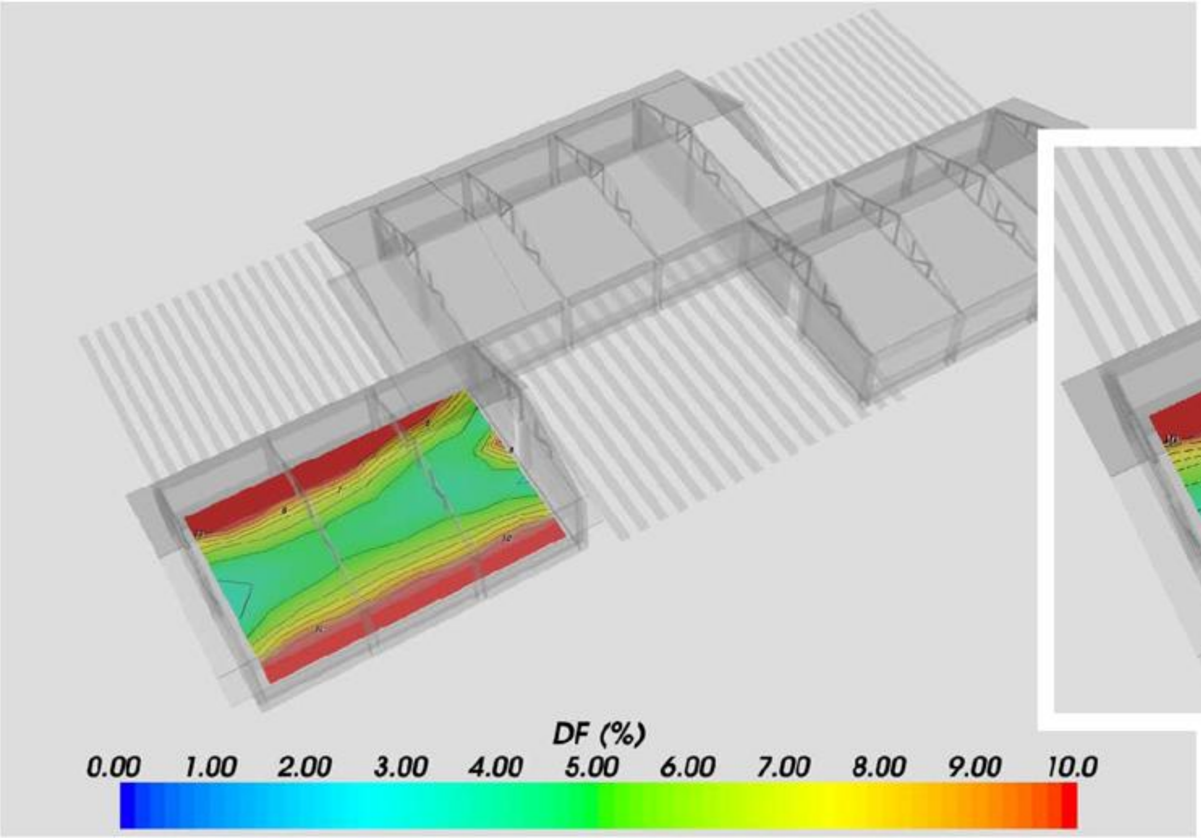

BOLGATANGA
TAMALE
SUNYANI
KUMASI
HO
KOFORIDUA
ACCRA
CAPE COAST
SEKONDI - TAKORADI

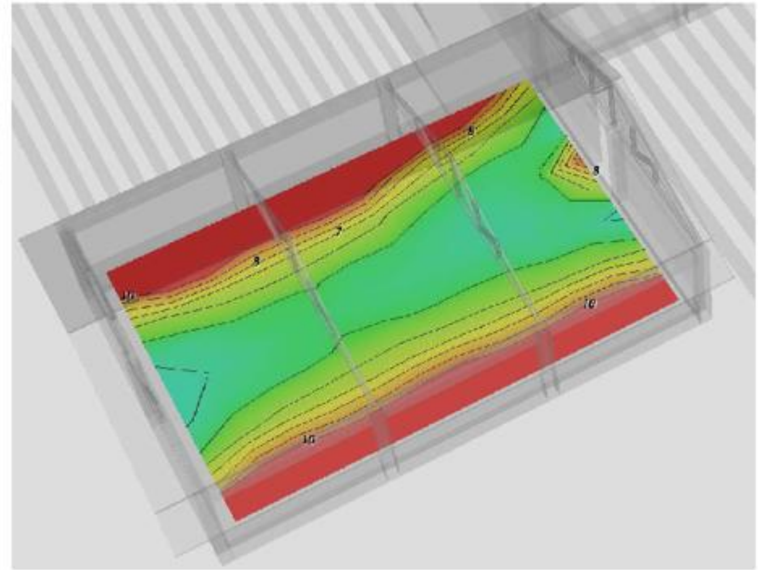
ARUP



1. Baseline - Interior visualisations

1. Baseline - Daylight Factor





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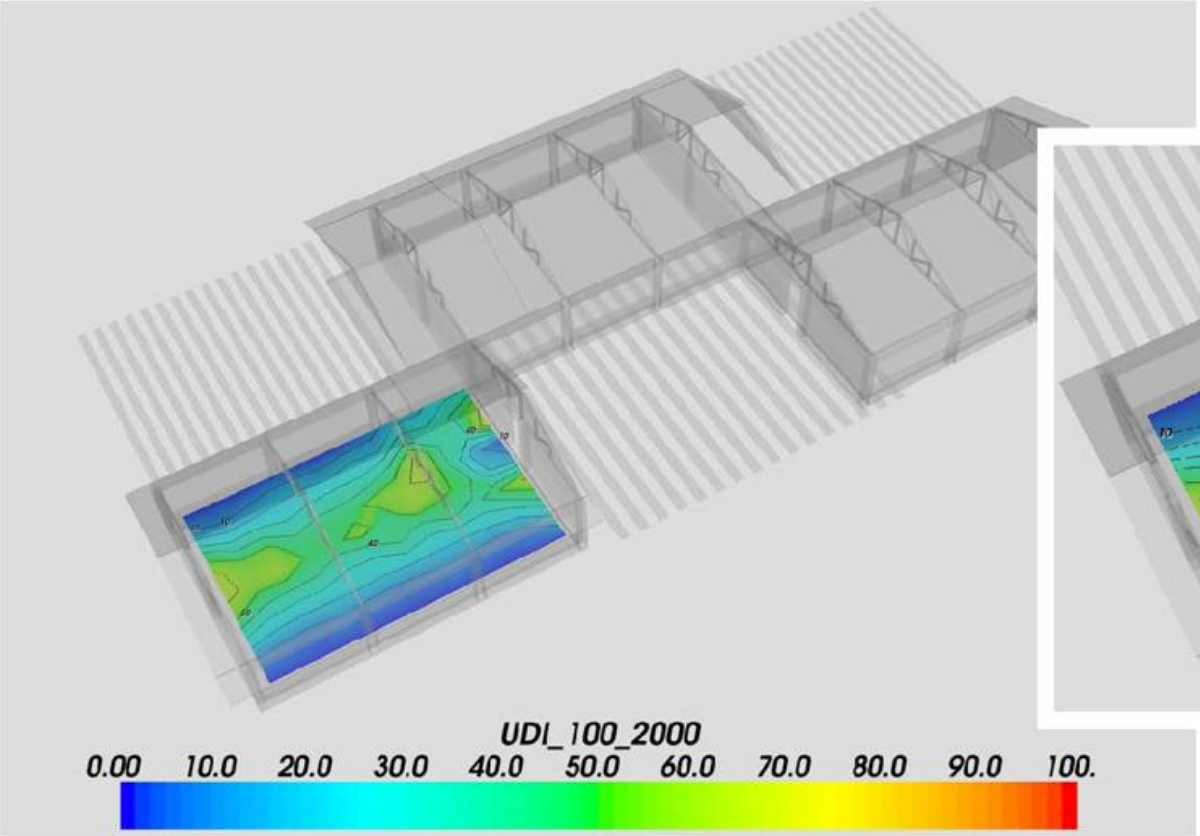
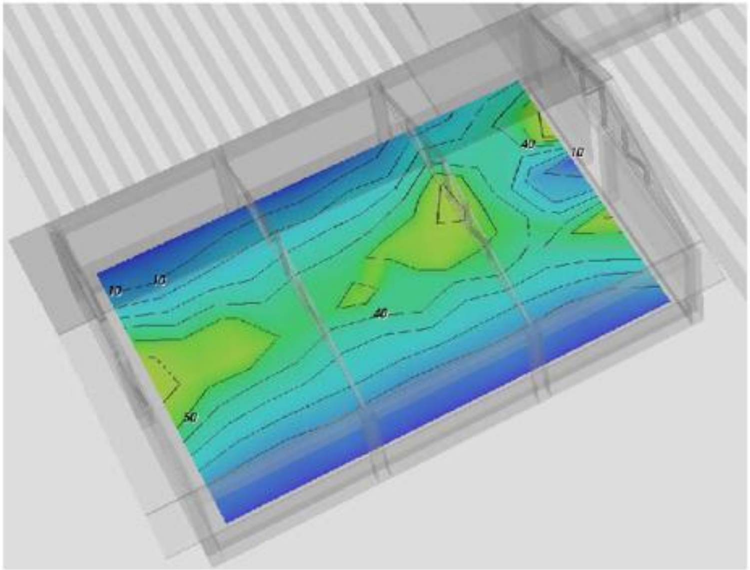
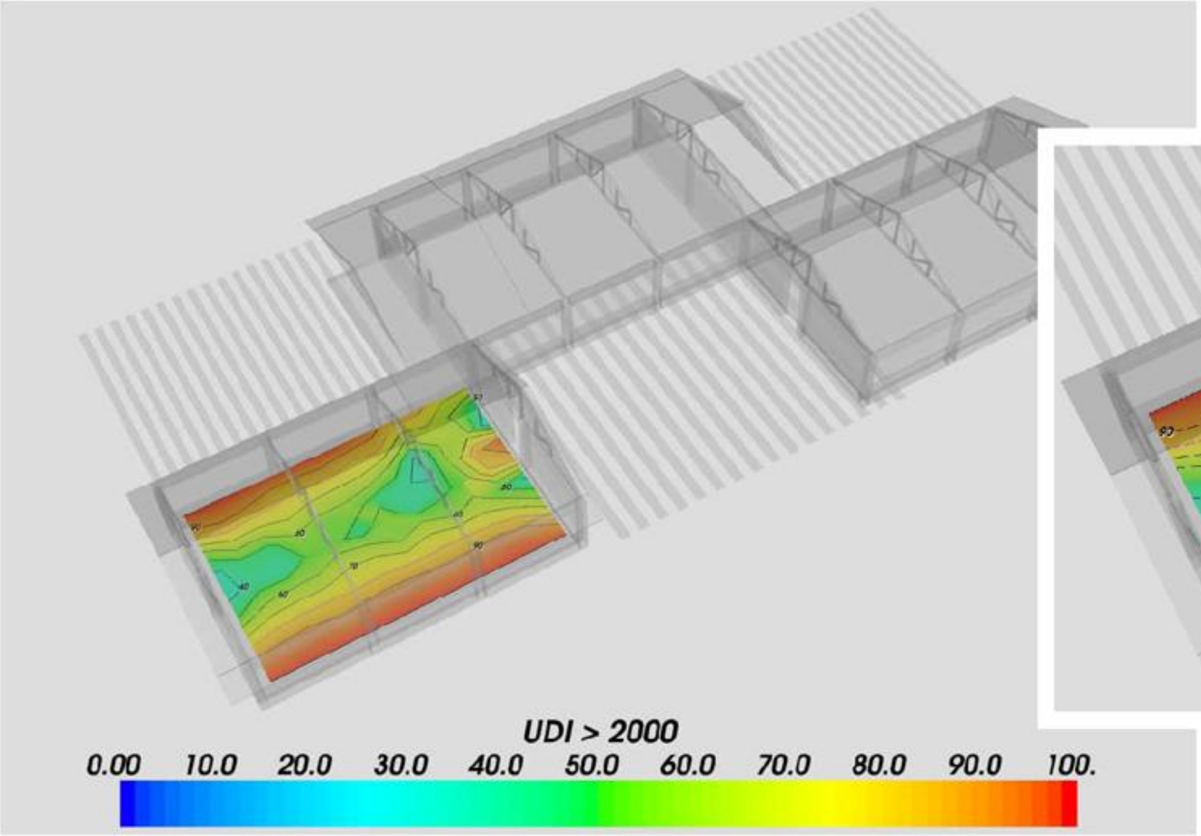
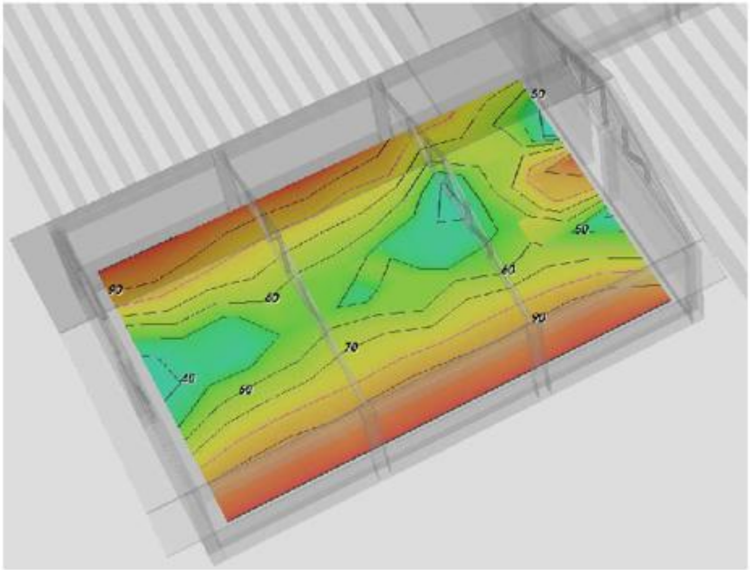


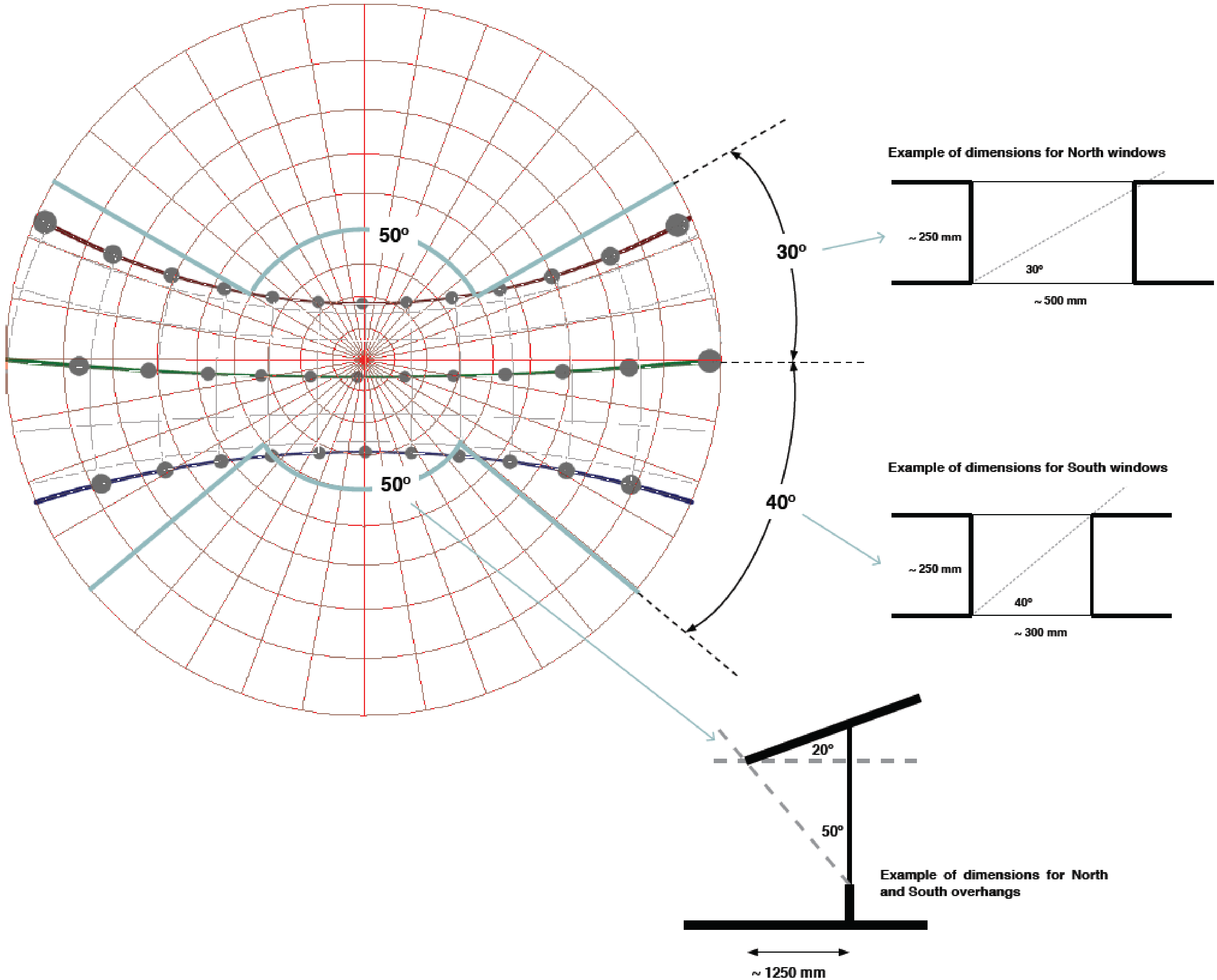


3. Baseline -
Useful Daylight Illuminance
(100-2000 lux)



4. Baseline -
   Useful Daylight Illuminance
   (> 2000 lux)




50º
50º
30º
40º
Example of dimensions for North windows
~ 250 mm
30º
~ 500 mm
Example of dimensions for South windows
~ 250 mm
40º
~ 300 mm
20º
50º
Example of dimensions for North and South overhangs
~ 1250 mm

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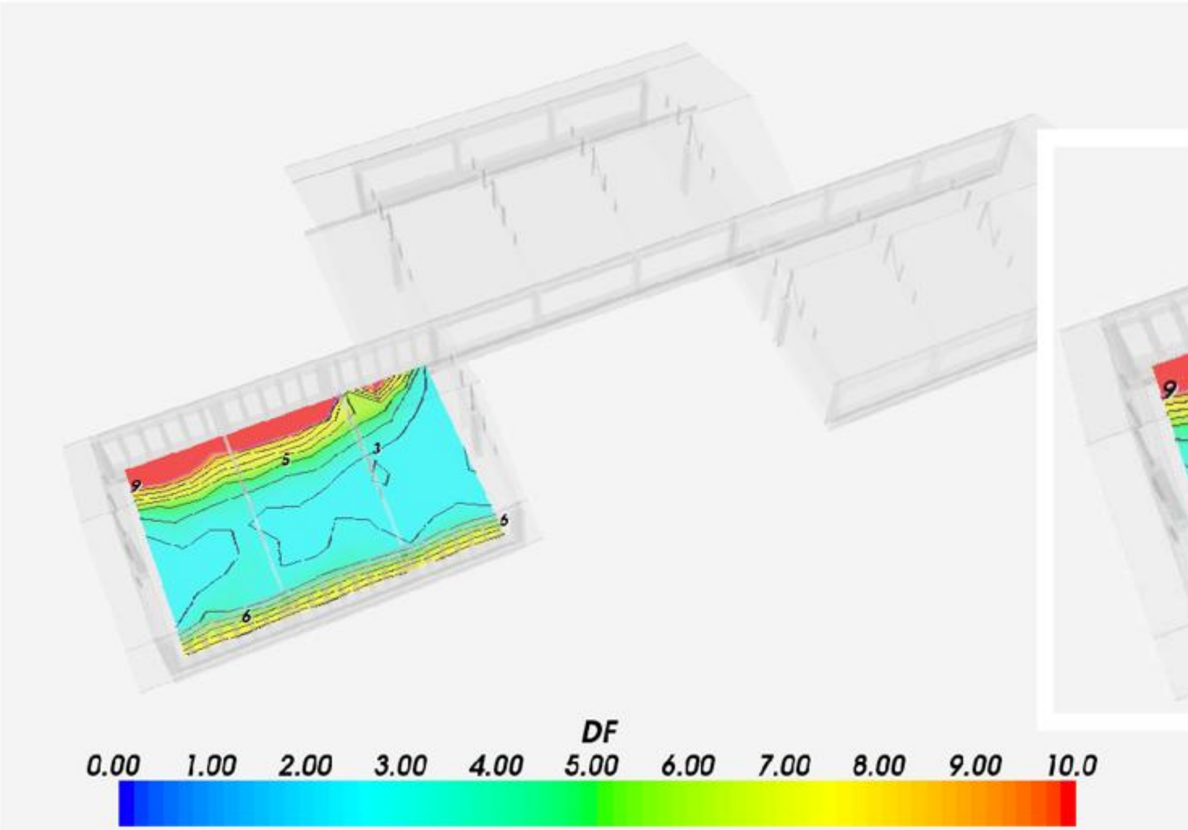
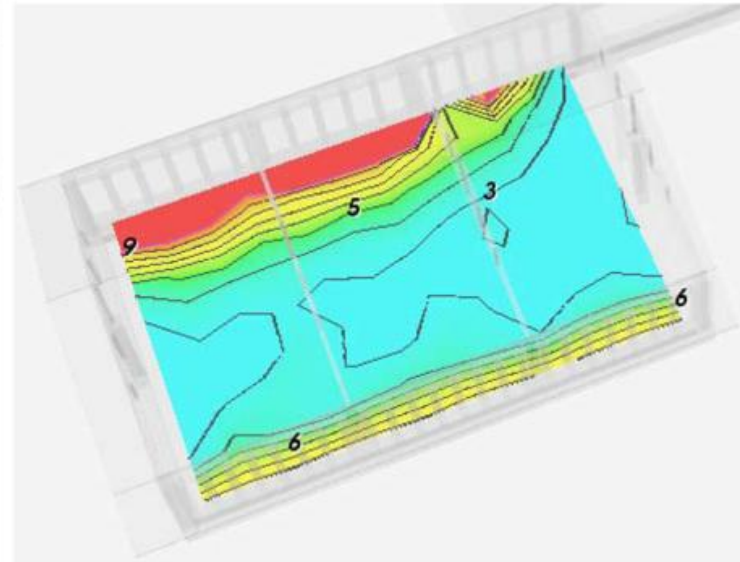
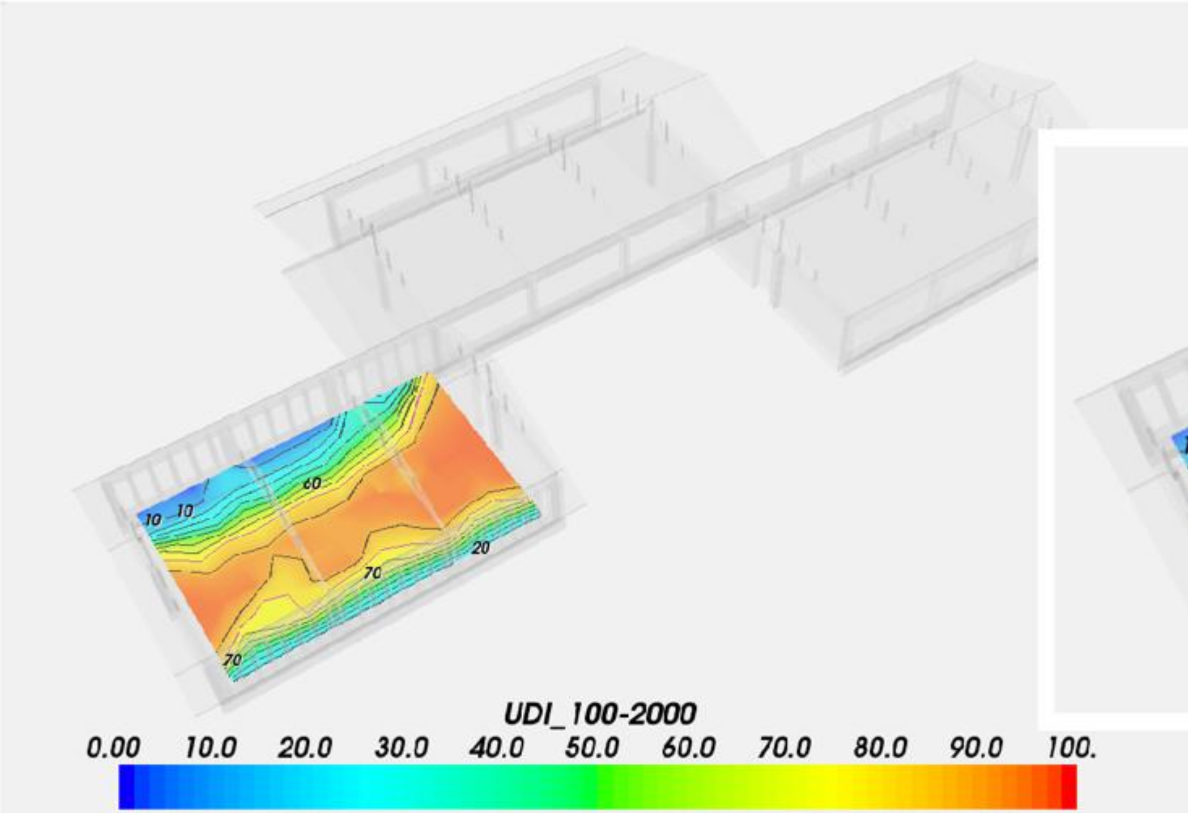
6. Proposed - Interior visualisations

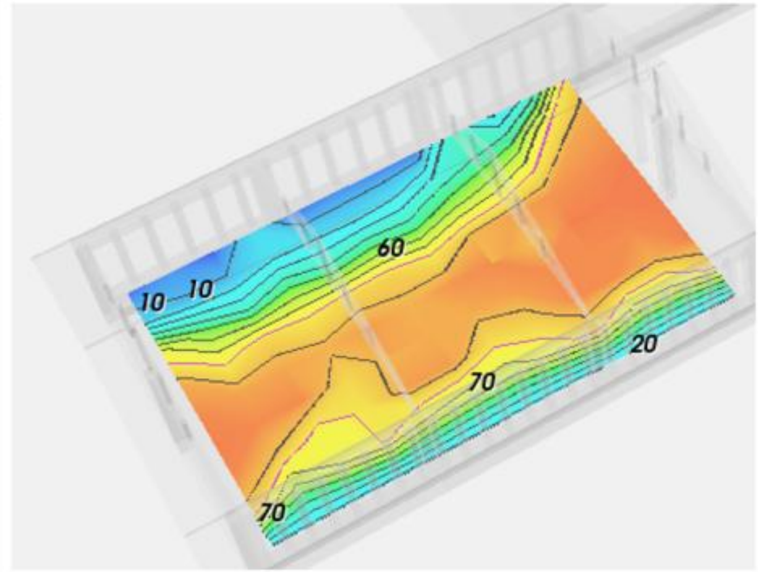
7. Proposed - Daylight Factor



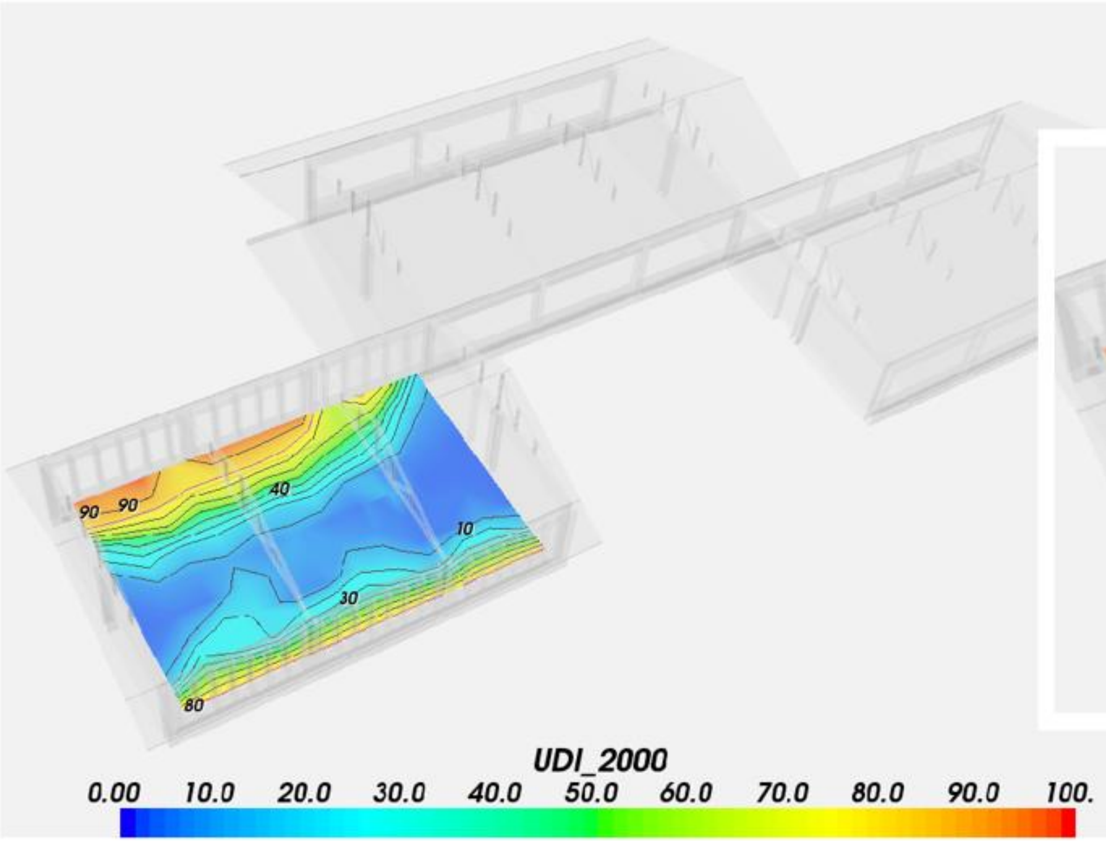


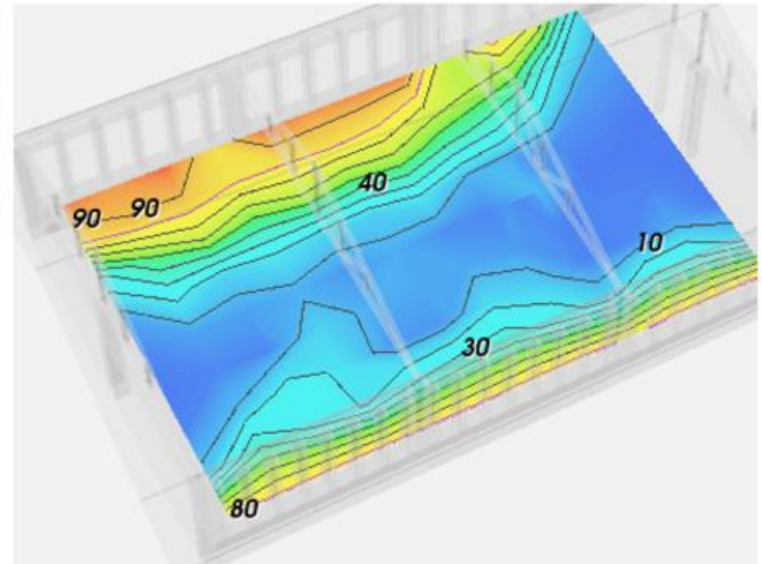


8. Proposed -
Useful Daylight Illuminance
(100-2000 lux)



9. Proposed -
Useful Daylight Illuminance
(> 2000 lux)





OAP1

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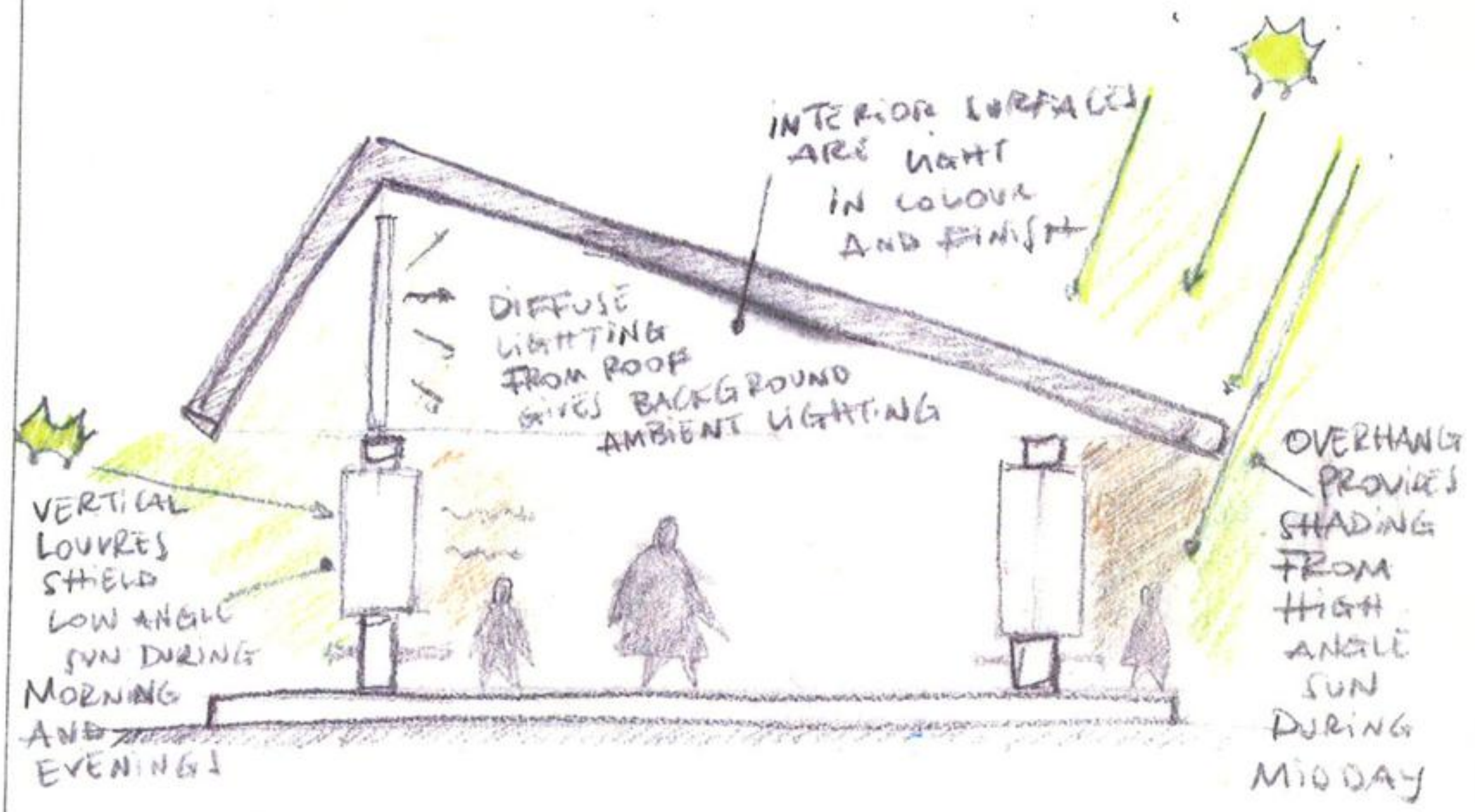
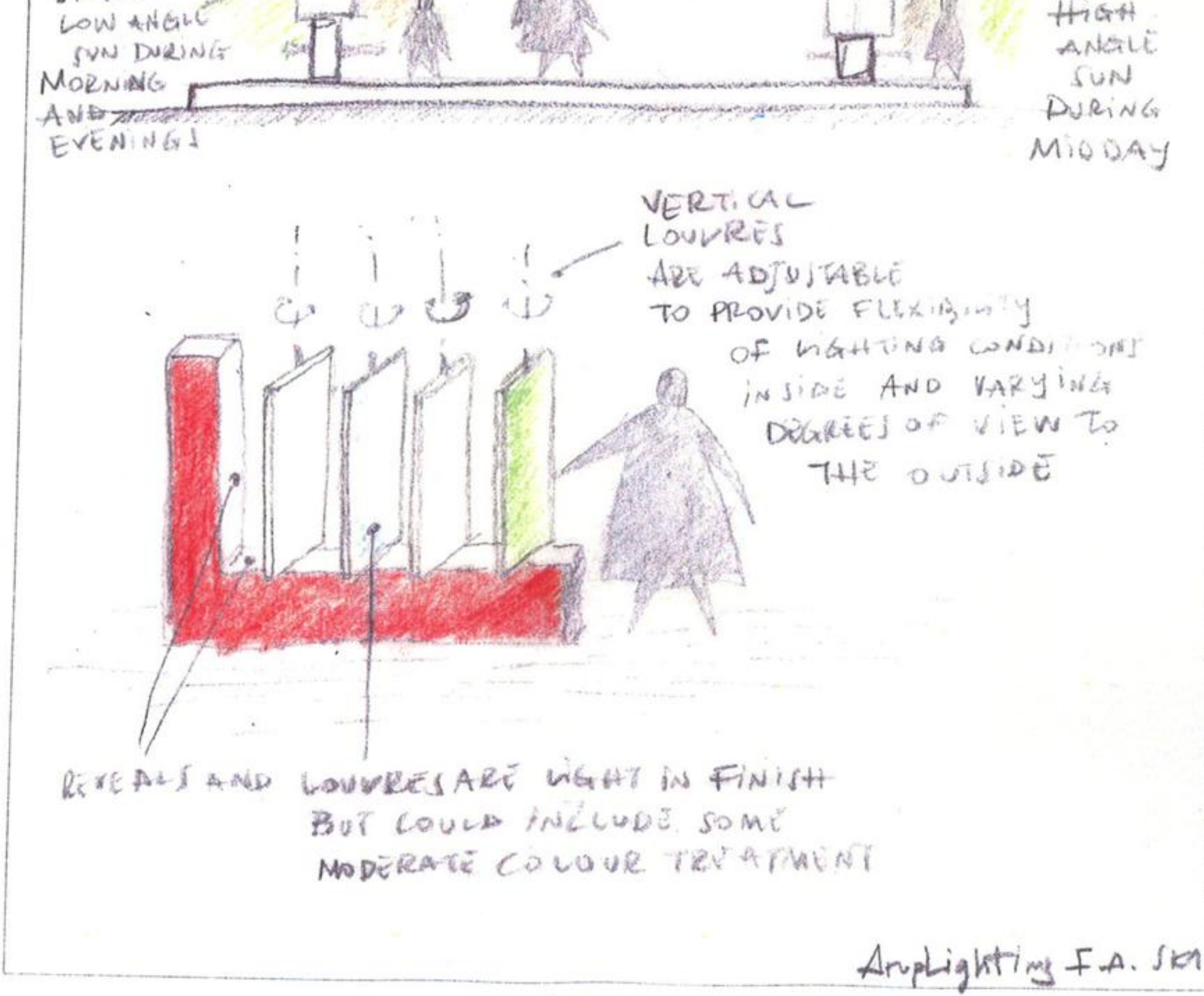
Job No.	Drawing No.	Rev.

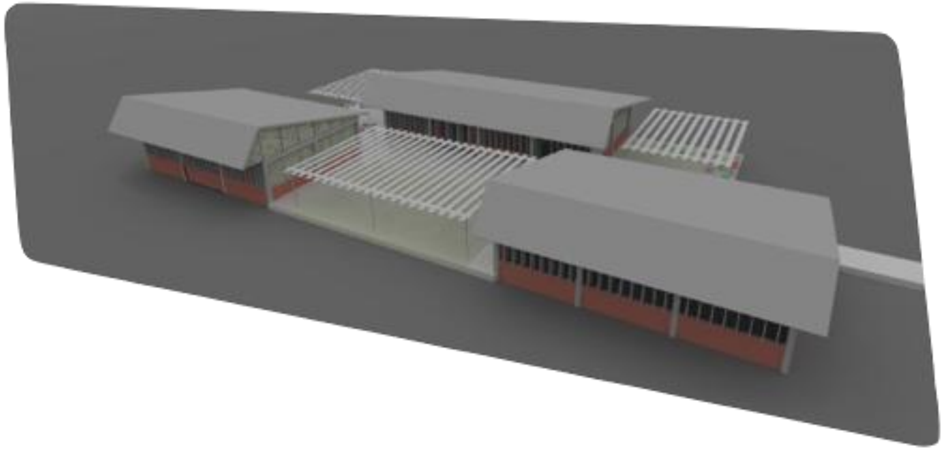
Scales N.T.S.

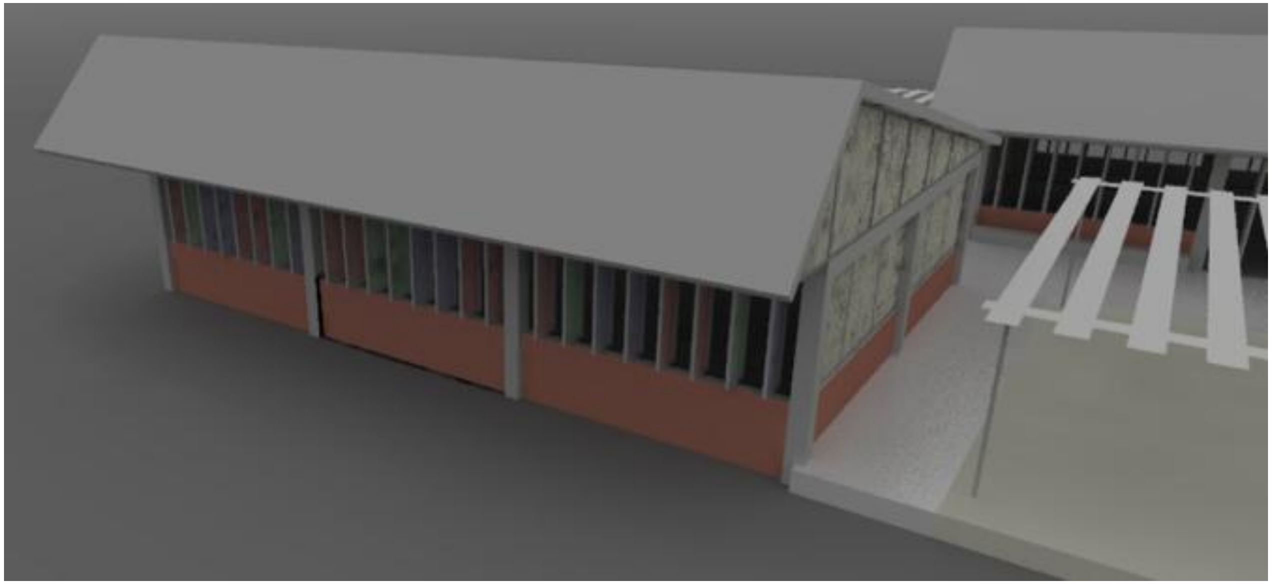
Job Title DAYLIGHTING

Drn.	Date	Chd.	Passed
F.A	2009.05.05		




LOW ANGLE SUN DURING MORNING AND EVENINGS
HIGH ANGLE SUN DURING MIDDAY
VERTICAL LOUVRES ARE ADJUSTABLE TO PROVIDE FLEXIBILITY OF LIGHTING CONDITIONS INSIDE AND VARYING DEGREES OF VIEW TO THE OUTSIDE
REVEALS AND LOUVRES ARE LIGHT IN FINISH BUT COULD INCLUDE SOME MODERATE COLOUR TREATMENT
ArupLighting F.A. SKM





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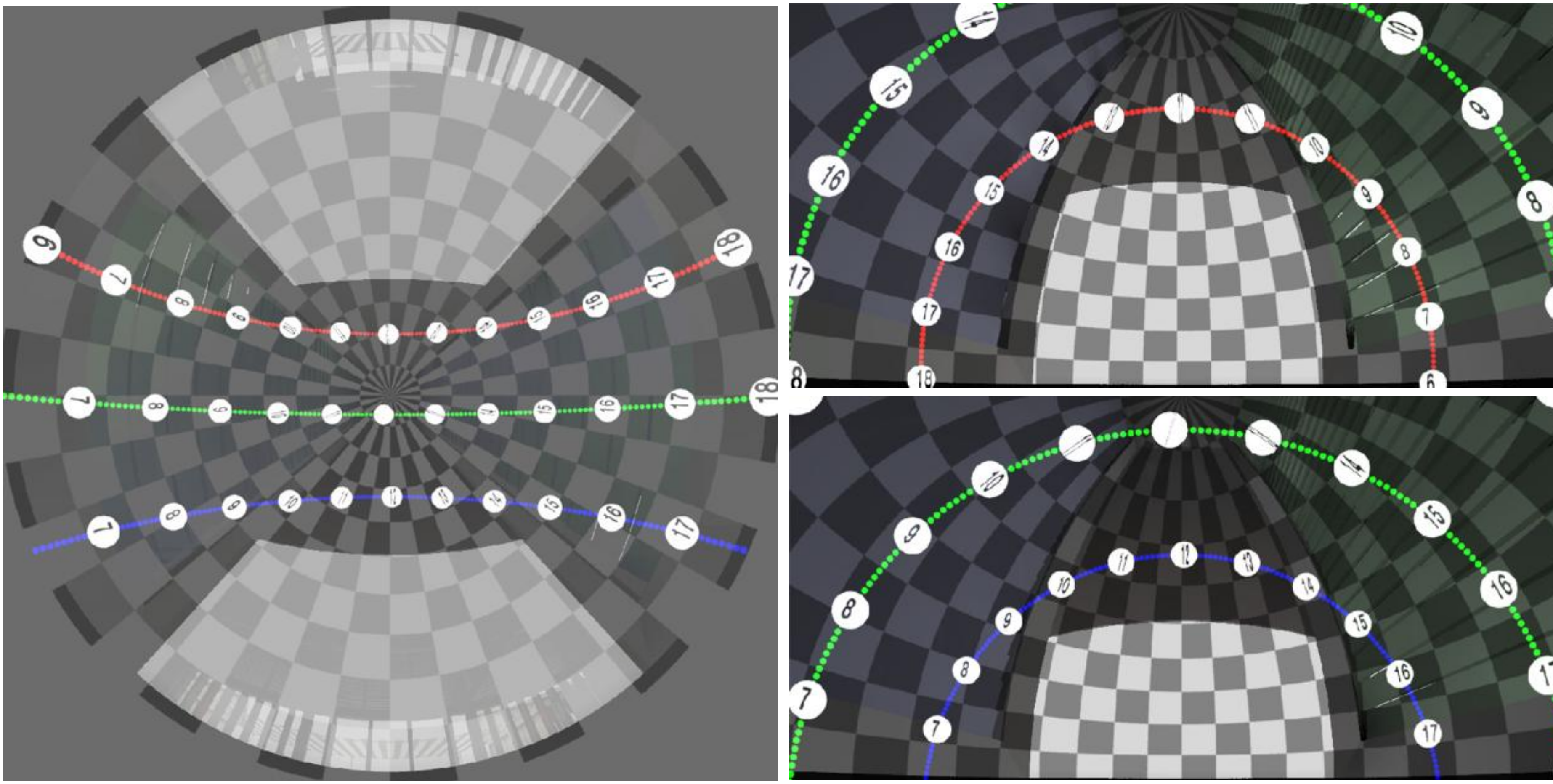
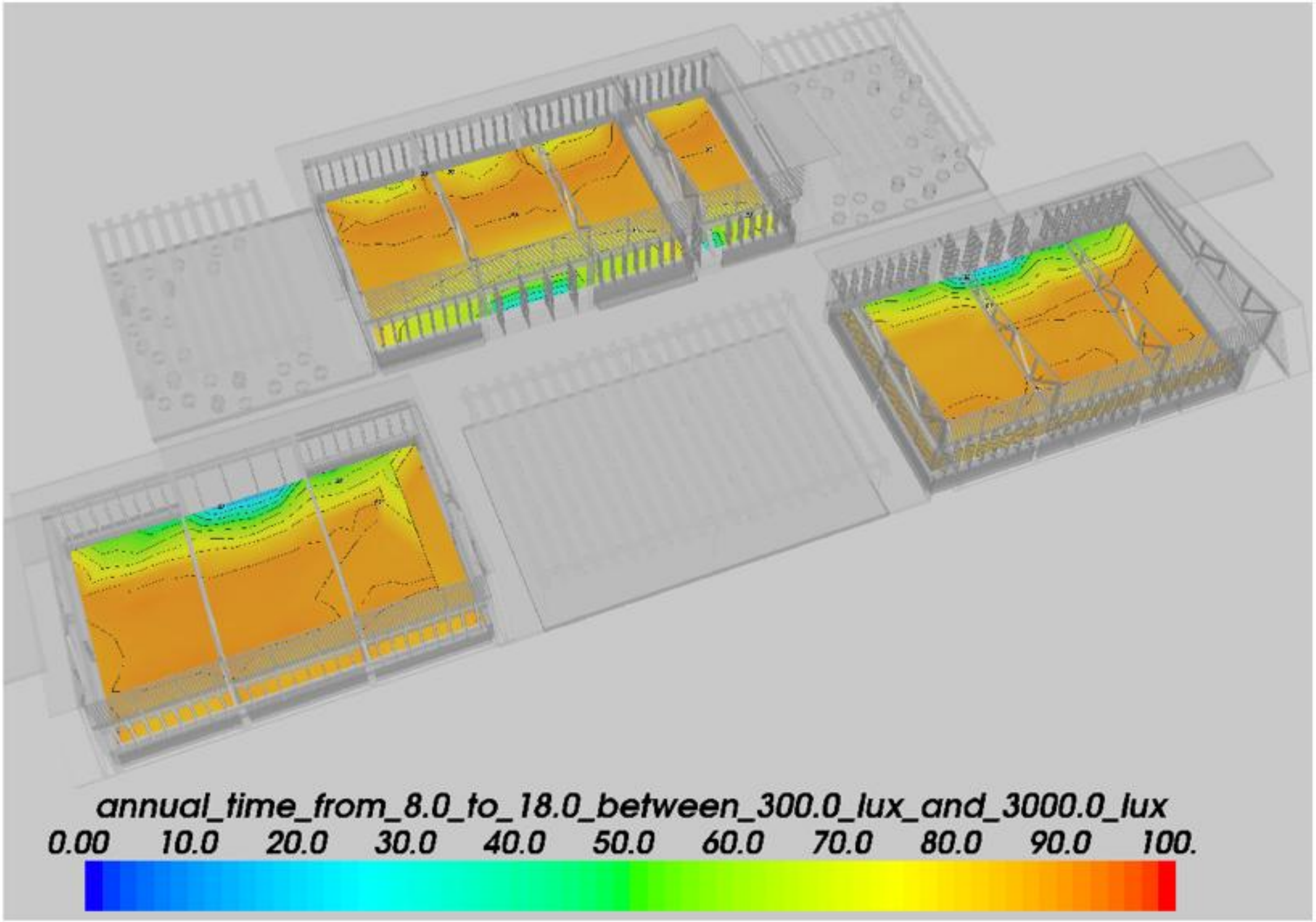
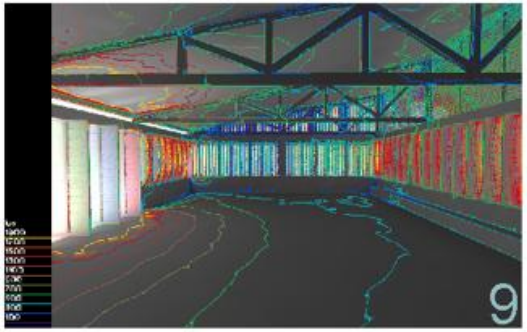


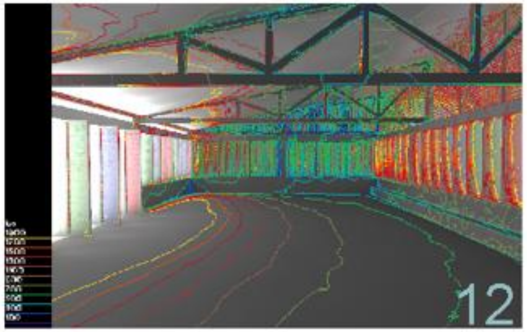


4. Useful Daylight Illuminance (UDI)

The UDI plots show the percentage of annual time between the hours 8AM and 6PM when daylight illuminance is between 300 lux and 3000 lux, i.e. when the space has enough daylight to perform educational tasks, and not too much to cause glary conditions.

Optimal visual conditions are maintained for more than 80% of the annual time in all the classrooms if the louvres are kept in the open configuration at all times.

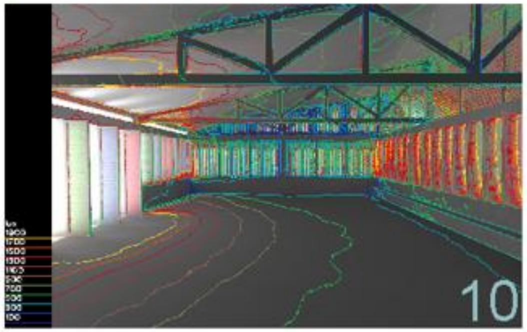


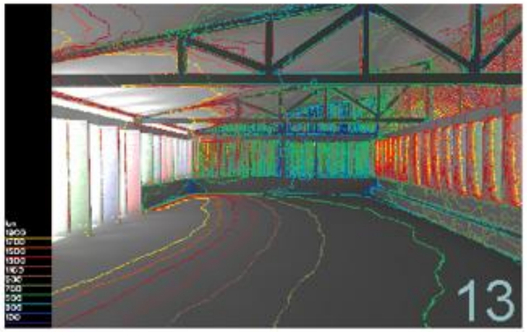


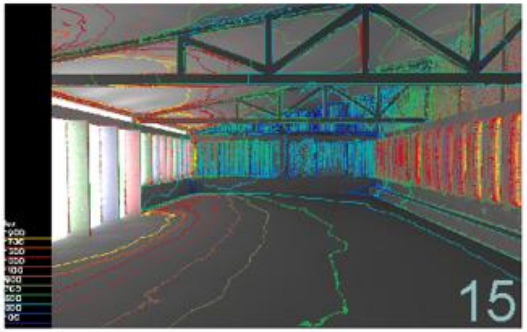
3. Time of day sequences

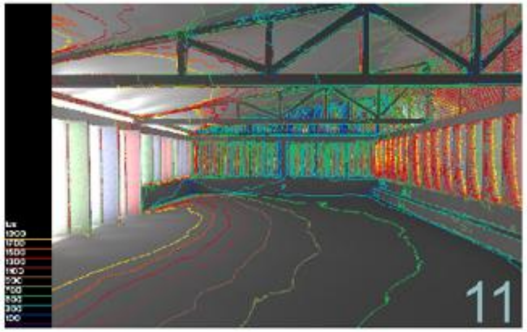
The simulation results on this and on the next pages show time of day sequences for the western classroom, between the hours 9AM and 4PM, in order to visualise both qualitatively and quantitatively the daylighting performance on a typical day in June and December.

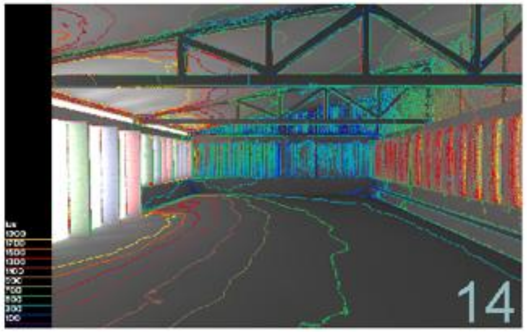
3.1 June 21st

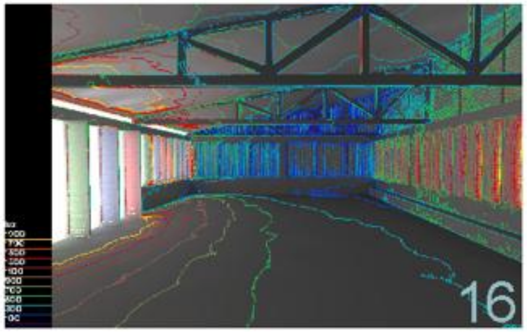












3.2 December 21st