Meteorological data for Climate-Based Daylight Modelling

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Climate-Based Daylight Modelling:
The assessment of the luminous conditions within the built environment that makes use of representative climate data to recreate realistic sky luminance distributions, at hourly or sub-hourly consecutive steps, by means of physically accurate lighting simulation tools.

e.g. Radiance
representative climate data
For Building Performance Simulation applications:
EPW (EnergyPlus Weather) format

- Global horizontal irradiance [W/m²]
- Direct normal irradiance [W/m²]
- Diffuse horizontal irradiance [W/m²]
- Global horizontal illuminance [klux]
- Direct normal illuminance [klux]
- Diffuse horizontal illuminance [klux]
CRM (Cloud Radiation Model)  
(Kasten-Czeplak 1980)

Baseline Surface Radiation Network  
(BSRN)
- 1-min time step
- Global horizontal and direct normal irradiance [W/m²]
- 2 UK locations: Camborne and Lerwick
- 2001-present

MIDAS  
(Met Office from CEDA)
- Hourly time step
- Cloud Cover [0-9]
### Lerwick 2016

<table>
<thead>
<tr>
<th></th>
<th>GHI</th>
<th>DNI</th>
<th>DHI</th>
</tr>
</thead>
<tbody>
<tr>
<td>MBE</td>
<td>-15 W/m²</td>
<td>-8 W/m²</td>
<td>-6 W/m²</td>
</tr>
<tr>
<td>[rMBE]</td>
<td>[12%]</td>
<td>[4160%]</td>
<td>[19%]</td>
</tr>
<tr>
<td>RMSE</td>
<td>62 W/m²</td>
<td>91 W/m²</td>
<td>42 W/m²</td>
</tr>
<tr>
<td>[rRMSE]</td>
<td>[138%]</td>
<td>[29491%]</td>
<td>[132%]</td>
</tr>
</tbody>
</table>

**Equations and Coefficients:**

- **GHI:**
  
  \[ y = 0.8x + 8.5 \]
  
  \[ r^2 = 0.90 \]

- **DNI:**
  
  \[ y = 0.7x + 11.4 \]
  
  \[ r^2 = 0.66 \]

- **DHI:**
  
  \[ y = 0.7x + 9.5 \]
  
  \[ r^2 = 0.84 \]

### Camborne 2016

<table>
<thead>
<tr>
<th></th>
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<th>DNI</th>
<th>DHI</th>
</tr>
</thead>
<tbody>
<tr>
<td>MBE</td>
<td>-17 W/m²</td>
<td>-25 W/m²</td>
<td>-2 W/m²</td>
</tr>
<tr>
<td>[rMBE]</td>
<td>[1.27%]</td>
<td>[2441%]</td>
<td>[7%]</td>
</tr>
<tr>
<td>RMSE</td>
<td>69 W/m²</td>
<td>124 W/m²</td>
<td>23 W/m²</td>
</tr>
<tr>
<td>[rRMSE]</td>
<td>[81.43%]</td>
<td>[21000%]</td>
<td>[92%]</td>
</tr>
</tbody>
</table>

**Equations and Coefficients:**

- **GHI:**
  
  \[ y = 0.8x + 10.4 \]
  
  \[ r^2 = 0.91 \]

- **DNI:**
  
  \[ y = 0.6x + 16.7 \]
  
  \[ r^2 = 0.71 \]

- **DHI:**
  
  \[ y = 0.8x + 4.0 \]
  
  \[ r^2 = 0.88 \]
Luminous Efficacy Model
(Perez 1990)

Public Health England
(PHE)
- 5-min time step
- Global horizontal illuminance [klux] and UV index
- 9 UK locations
- 2013-present

MIDAS
(Met Office from CEDA)
- Hourly time step
- Cloud Cover [0-9]
Camborne 2016

MBE = -2127.89 lx
rMBE = 0.48%
RMSE = 7732.98 lx
rRMSE = 72.98%

Lerwick 2016

MBE = -1826.01 lx
rMBE = 7.05%
RMSE = 6900.16 lx
rRMSE = 88.47%
Loughborough University Delta-T measurements

- 1-min time step
- Global and diffuse horizontal illuminance [klux] and irradiance* [W/m²]
- 2 UK locations: Loughborough and Ickworth
- 2015-present

* Loughborough only
MIDAS
(Met Office from CEDA)

- Hourly time step
- Global horizontal irradiance [W/m²]
- 95 UK locations
- ~1980s - today

Diffuse horizontal irradiance / Direct normal irradiance
Erbs model (in gendaylit already)
Reindl model (Jones and Reinhart, 2017)
CBDM within Building Performance Simulation

- Typical climate
- Extreme climate conditions
- Future climate projections
- Expected design performance
- Resilience / Worst case scenarios
- Climate change adaptation
Thank you!

Any question?