THE CHARACTERIZATION OF SURFACE BOUNDARY CONDITIONS WHEN MODELLING DISPERSION OVER A COMPLEX SITE

Keith D. Harsham\textsuperscript{1} and Michael Bennett\textsuperscript{2}

\textsuperscript{1}BP International Ltd., Sunbury-on-Thames, UK

\textsuperscript{2}UMIST, Manchester, UK
Wind Vane
Anemometer
Relative Humidity and temperature
VLF Monitor Antenna
Pyranometer
UHF Telemetry Antenna
Power generator
Marvin Signal acquisition and processing unit
Estate car
NB. Met post not fully extended to 10m
Lidar at Hythe
**Lidar Scanning Modes**

**Longitudinal-vertical**
Lateral-vertical (azimuths 1 & 2)
Lateral-horizontal (3 and 4)
Lidar

Range 1
Range 2
Range 3
Range 4

plume

stack

Longitudinal-vertical
Typical Lidar scan
Interpolators

- **Inverse Distance** - Smoothing possible. Fast.

- **Kriging** - Smoothing possible. Flexible.

- **Nearest Neighbour** - Useful for regularly spaced grids.

- **Polynomial regression** - Smoothing possible.

- **Radial Basis Functions** - Smoothing possible. Flexible.

- **Shepard’s Method** - Smoothing possible. Similar to inverse distance.

- **Triangulation with Linear Interpolation** - Fast.
Examples of different interpolations on the same Enicem grid file

- Radial Basis Function
- Shepard's method
- Triangulation method
Contour plots of site as OS only and OS with obstacles (m)
Surface plots of OS and OS with obstacle data

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NB. If only hard copy of site plans are available and digitised OS maps, then the OS maps need to be printed out to make a hard copy.

1. Are site plans digitised?
   - Yes: Are digitised OS maps available?
     - Yes: Commission site/location survey using theodolite
     - No: Alternative: Establish displacement height for site using Macdonald's method
   - No: Are hand drawn plans available?
     - Yes: Commission site/location survey using theodolite
     - No: Are paper OS maps available?
       - Yes: Option 2: Construct grids on plans and OS maps and produce node point matrix. Use Kriging to generate contour and 3D plots
       - No: Option 1: Combine digitally and generate contour and 3D plots
Wind direction sectors imposed upon site contour map

Notional directions in bubbles represent direction wind is blowing towards from stack. They match up with Table 11.
Sections through site matching nominal wind directions

Direction S

Direction SSW

Direction SW

Direction N
Briggs’ Model of Plume Rise

Buoyant rise, $z$, of plume above the streamline into which it is emitted:

$$
C_B \left( \frac{F_b}{\pi} \right)^{1/2} x^{2/3} \frac{1+\frac{u\tau}{x}}{u}^{1/3} = C_B Br (F_b, x, u),
$$

where,

$C_B \approx 1.6$ is a numerical parameter,

$F_b \approx 86 \text{ m}^4 \text{s}^{-3}$ is the buoyancy flux,

$u$ the wind speed at plume height,

$x$ the distance downwind, and

$\tau \approx 1.4 \text{ s}$ the cross-over time from a momentum-dominated jet to a buoyancy-dominated plume.
Plots of plume rise vs. Briggs' variable for Flat, OS, and OS with building correction

Ht less 61m

OS ground corrected

Obstacle unsmoothed

Obstacle smoothed

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Regression of measured plume rise, $\Delta h$, against $Br$.  

<table>
<thead>
<tr>
<th>Streamline correction</th>
<th>Slope, $C_B$</th>
<th>Correlation coefficient, $r$</th>
<th>$n = 92$</th>
</tr>
</thead>
<tbody>
<tr>
<td>None</td>
<td>1.26</td>
<td>0.61</td>
<td></td>
</tr>
<tr>
<td>Ground surface</td>
<td>1.12</td>
<td>0.56</td>
<td></td>
</tr>
<tr>
<td>+ buildings</td>
<td>0.83</td>
<td>0.62</td>
<td></td>
</tr>
<tr>
<td>+ smoothed buildings</td>
<td>0.84</td>
<td>0.54</td>
<td></td>
</tr>
</tbody>
</table>
AERODYNAMIC SURFACE ROUGHNESS

- **Stull**
  Qualitative table.

- **Kondo and Yamazoura**

\[
\frac{z_o}{S_T} = \frac{0.25}{N} \sum_{i=1}^{N} h_i S_i = \frac{0.25}{L_T} \sum_{i=1}^{N} h_i w_i ,
\]

- **Macdonald et al**

\[
\frac{z_o}{H_o} = \left( 1 - \frac{d}{H_o} \right) \exp \left( -0.5 \beta \frac{C_D}{k^2} \left( 1 - \frac{d}{H_o} \right) \lambda_f \right)^{0.5}
\]

- **Wieringa**
  Gustiness
A summary of the aerodynamic roughness lengths \( z_o \) derived for the site. EMcK = Elaine McKinney, KDH = Keith Harsham.

<table>
<thead>
<tr>
<th>Method</th>
<th>( z_o ) (m)</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Localised, site only, from 1:10000 OS (Ordnance Survey) map. <em>(e.g. Stull)</em></td>
<td>0.25 – 0.8</td>
<td>EMcK</td>
</tr>
<tr>
<td>2. Kondo and Yamazoura’s method from 1:10000 OS map with 1.5 km radius.</td>
<td>0.08 – 0.2</td>
<td>EMcK</td>
</tr>
<tr>
<td>3. Wieringa’s method</td>
<td>0.3 – 2.1</td>
<td>Dependent upon wind direction.</td>
</tr>
</tbody>
</table>