

APPENDIX 7-A: DETAILED METHODOLOGY

1. CFD METHODOLOGY

1.1. The CFD was performed using OpenFOAM.

1.2. Meshed using a hybrid mesh of hexahedral, polyhedral, tetrahedral and prismatic elements:

1.3. On site building edge length: 0.05m - 0.25m

1.4. Surrounding context edge length: 0.25m - 1m

1.5. Prismatic cells were used in the boundary layer region, with 4 layers of cells growing with an expansion ratio of 1.15 and aspect ratios between 0.1 and 0.4.

1.6. The total mesh size was between 101 million cells and 122 million cells. Mesh detail is shown in Figure 1 and Figure 2.

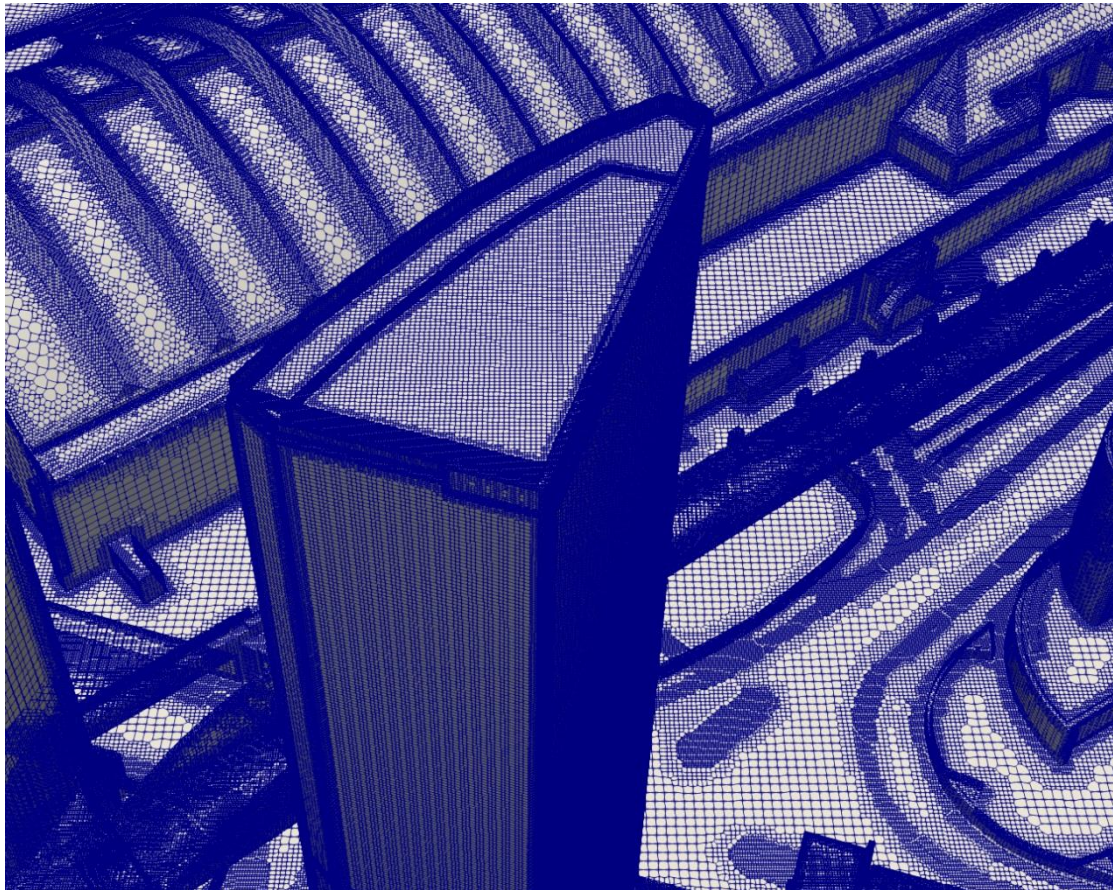


Figure 1 Mesh Detail on Site Buildings

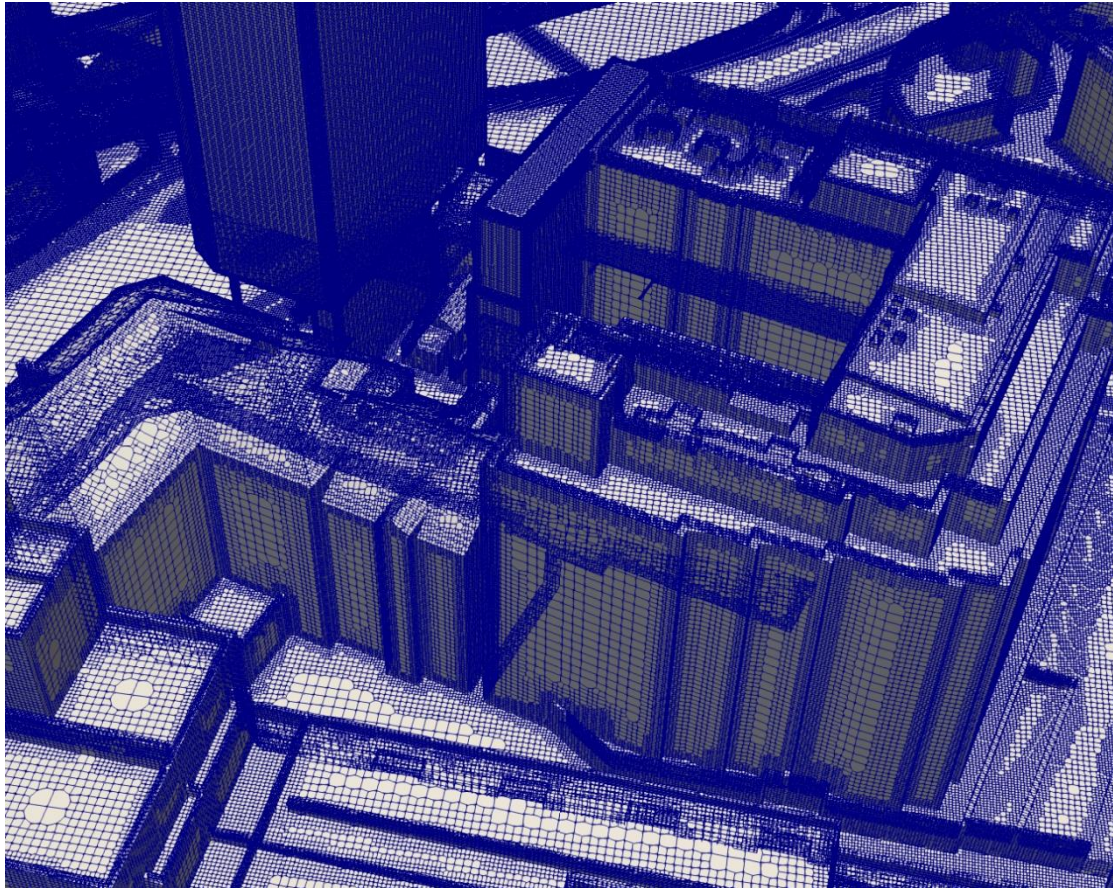


Figure 2 Mesh Detail on Surrounds

- 1.7. Buildings within 400m of the site were included.
- 1.8. The 400m radius of surrounding context was contained within an overall domain of 5000mx5000m, with a blockage ratio of 0.5%
- 1.9. The blockage ratio uses a “test section” of 600mx200m (within which detail is captured).
- 1.10. Run using the SST turbulence model with high Re wall functions to ensure mesh suitability.
- 1.11. The simulations were steady state and isothermal.
- 1.12. 2nd order discretisation schemes were used.
- 1.13. Convergence was measured as the residuals of the continuity, x-velocity, y-velocity, z-velocity, k and omega equations all falling by at least 2 orders of magnitude, and by measured static pressure on the site buildings varying by less than 1% over the final 100 iterations.
- 1.14. The wind speed is corrected into a “gust-equivalent” mean. The gust-equivalent mean is calculated using mean velocity and turbulent kinetic energy to calculate the velocity fluctuations and hence peak gust velocity, which is divided by 1.85 to be equivalent to the mean and appropriate to the comfort and safety calculations.

2. WIND CLIMATE METHODOLOGY

- 2.1. The simulations were performed from 18 wind directions, spaced such that no single direction contributed more than 10% of the annual winds.
- 2.2. The directions simulated were 0°, 30°, 60°, 90°, 120°, 150°, 170°, 180°, 190°, 200°, 210°, 220°, 240°, 260°, 270°, 280°, 300°, 330°.
- 2.3. 30 years of wind data was obtained for Manchester International Airport, seasonal wind roses for this data are shown in Figure 3.

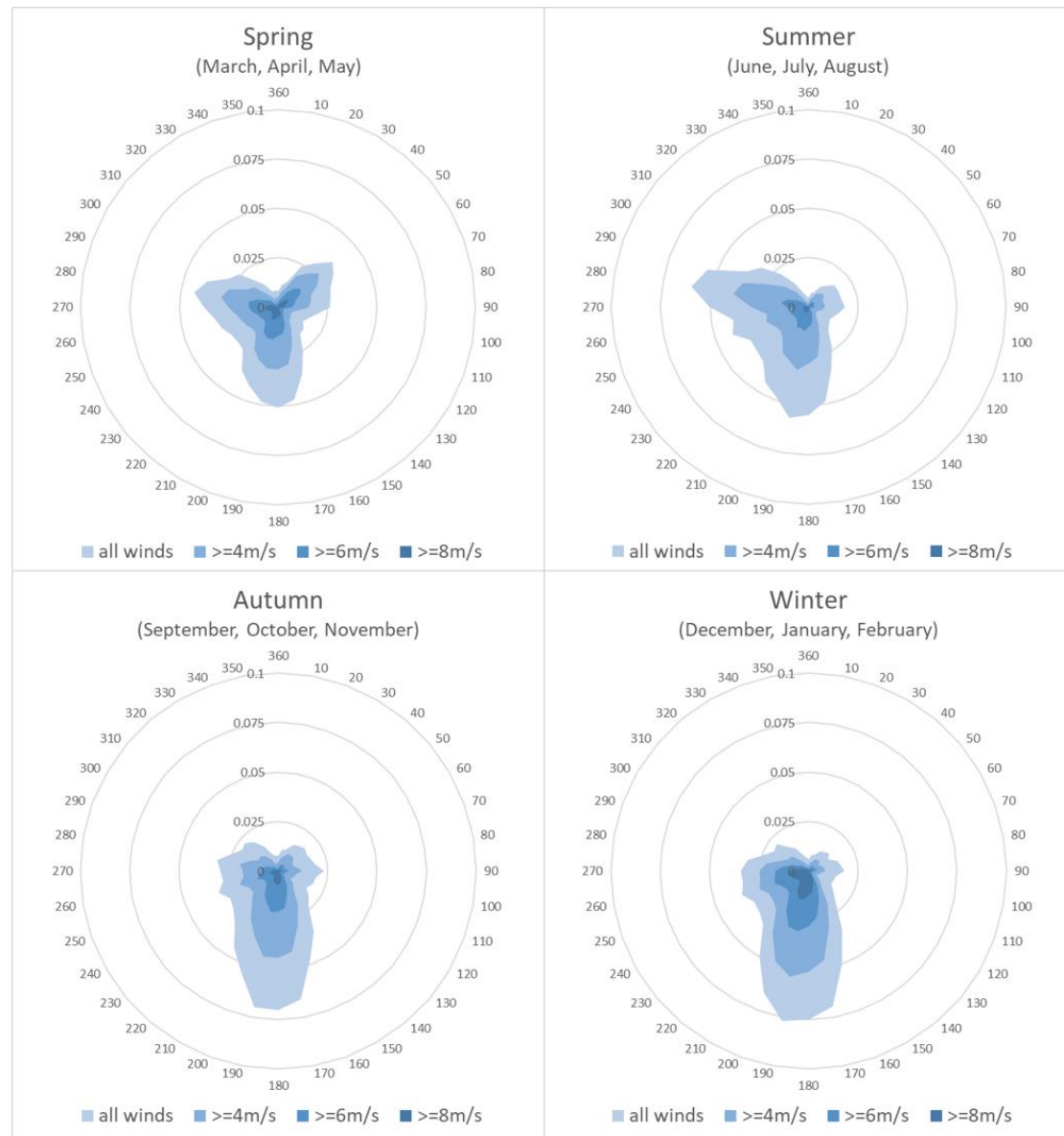


Figure 3 Seasonal Wind Roses for Manchester International Airport (1990-2021)

2.4. Target wind profiles for the site, from each wind direction, were generated using sectoral analysis of the terrain surrounding the site and the local weather stations with ESDU 2010 Item 01008 'Computer program for wind speeds and turbulent properties: flat or hilly sites in terrain with roughness changes'. The target wind profiles, compared to the wind speeds measured from the CFD model are shown in Figure 4.

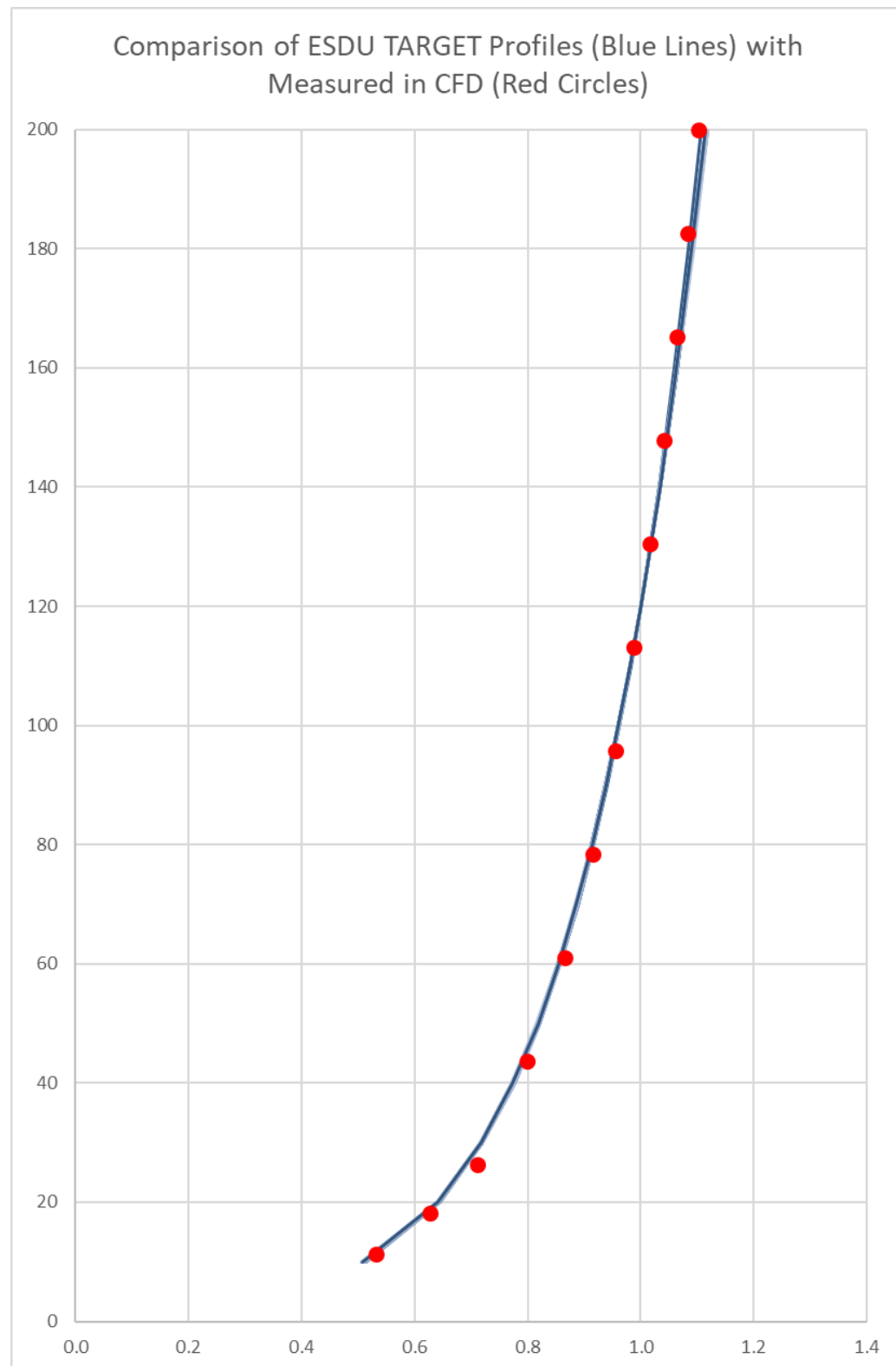


Figure 4 Wind Profile for Apex Tower