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A novel sodar design for improved wind profile measurement in urban areas

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Characterising wind climates in urban areas is necessary for many applications: wind engineering, pollution dispersion, hazardous gas release, insurance claims in the case of storm damage, weather forecasting. Urban areas are spatially heterogeneous and aerodynamically rough surfaces such that the wind field is highly spatially dependent. Point measurements made near ground level lack representativity and are hard to interpret, unless they are related to the driving flow above the urban canopy (c. 10-100m), or even blending height (c.100-200m). In addition, current NWP surface roughness representations often omit the urban canopy (e.g. by using an effective roughness) and thus urban wind-speed predictions can be poor. To establish climatologies of wind profiles across cities and enable development of new parameterisations, there is demand for an instrument that can measure vertical wind profiles which has sufficient accuracy and vertical resolution within 10-100m of the urban canopy, sufficient range to extend above the blending height, is easily deployable within a cityscape and is relatively low cost to enable multiple sites across a city. In this study, a novel design of "urban sodar" has been developed and tested. Its key design principles are to use a single vertically transmitted beam of moderate width combined with a "turbulence camera" – a ring of small, highly directional microphones that sample acoustic backscatter across the transmitted beam. The relatively low Doppler shift is compensated by having multiple samples from the same volume. The narrow beam and potential for increasing gain from multiple sensors make the instrument less noisy and less likely to suffer from spurious backscatter from nearby buildings. The design and initial test results will be presented. Field trials will be presented, including comparison with mast-based instrumentation and a Doppler lidar.