Contribution ID: **16** Type: **Oral presentation**

Challenges and Advancements in Environmental Monitoring at the Controlled Air Ventilation Environment (CAVE) Laboratory

The CAVE (Controlled Active Ventilation Environment) laboratory is a purpose-built, climate- and ventilation-controlled indoor laboratory. With a plan area of 206 m² and a height of 10 m, CAVE has been designed to support full-scale "living labs," ranging from small buildings to vehicles and double-decker buses. With a fully furnished, two-story building inside, our laboratory HVAC systems can achieve completely independent "interior" and "exterior" environments, creating complex thermal and ventilation scenarios for each. The climate capabilities range between -5℃ to 43℃ in the "exterior"environment and 10℃ to 28℃ in the "interior" , and both environments can be supplied with fresh or recirculated air or artificially generated pollutants.

Presented are the key challenges of sensor selection and management in such a complex setting. Consistently accurate monitoring of temperature, humidity, airflow, and pollutants (CO_2, particulate matter, VOCs, CO, NOx, etc.) requires rigorous sensor alignment, mapping, and calibration to ensure comparability across our +200 devices from multiple manufacturers. Demonstrated through several experiment case studies, CAVE allows us to track the alignment between reference-grade instruments and networks of low-cost sensors. Optimising placement with these sensors through partial collocation alongside these calibration instruments is crucial to accurately capturing spatial variability, airflow patterns, and pollutant distributions. Low-cost sensors, while key to achieving this high spatiotemporal resolution, require assiduous management to mitigate issues like baseline drift and false readings.

The data produced by CAVE is used to validate our in-house computational fluid dynamics (CFD) models, which simulate urban airflows, pollutant dispersion, and the indoor environment. This presentation also explores approaches to unifying diverse data streams into a real-time dashboard and leveraging kriging interpolation heat maps for visualisation. Early-stage data preparation for future machine-learning applications is also discussed. CAVE can provide full characterisation of physical and environmental parameters, which can be used to enhance computational modelling and advance research in the built environment.

Primary author: WILD, Oliver (University College London)

Co-author: Prof. MALKI-EPSHTEIN, Liora (University College London)

Presenter: WILD, Oliver (University College London)

Session Classification: POSTER SESSION