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Radon as a tool for characterising atmospheric stability effects on air pollution concentrations in model evaluation studies

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A clearer understanding of the variability in near-surface concentrations of pollutants in urban regions is essential for improving the predictive abilities of chemical transport models as well as identifying the need for (and assessing the efficacy of) emission mitigation strategies. Pollutant concentrations in the atmospheric boundary layer (ABL) are a complex function of many factors, including: source strengths and distribution, local meteorology and air chemistry. On short (sub-diurnal) timescales, the extent of the vertical column within which emissions mix usually has the largest influence on measured concentrations, and the depth of this mixing volume is in turn closely related to wind speed and the thermal stability of the ABL. Continuous hourly observations of the ubiquitous, surface-emitted, passive tracer radon-222 provide a powerful alternative to contemporary meteorological techniques for assessing stability effects on urban pollutants, because radon's concentration is closely matched with pollution transport processes at the surface. Here we outline a technique by which single-height, near-surface (<20m) radon observations can be conditioned to derive a multi-category stability classification scheme for urban pollution monitoring to provide benchmarking tools for local- to regional- chemical transport model evaluations. Efficacy of the radon-based classification scheme is compared to that based on conventional Pasquil-Gifford "turbulence" and "radiation" schemes. Lastly, we apply the radon-based classification scheme to nocturnal mixing height estimates calculated from the diurnal radon accumulation time series, and provide insight to the range of nocturnal mixing depths expected for each of the stability classes.