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Alavy M, Li T, Siegel JA. Exploration of a long-term measurement approach for air change rate. *Building and Environment*, **144**, 474-481. DOI: 10.1016/j.buildenv.2018.08.051.

Abstract

Ventilation using outdoor air can have both favorable and unfavorable impacts on indoor air pollution. It also can be an important contributor to energy use in buildings. Outdoor ventilation air change rate (ACR), the rate at which outdoor air enters a building divided by its volume, is a temporally dynamic metric that can be used to characterize ventilation performance of buildings.Conventional measurement techniques for ACR have either complex or invasive experimental procedures, or present a temporal snapshot of ACR. In this study, we further developed and explored a novel signal processing approach to measure yearlong time-resolved ACR in a residence using the variations in indoor and outdoor CO_2 concentrations. Results showed that ACR varied considerably over the year [geometric mean (GM) = 0.47/h, geometric standard deviation (GSD) = 3.44] and that the air change rates calculated from the signal processing approach were in good agreement (on average, within 13%) with those measured simultaneously from 15 hour-long decay periods.In addition, estimates of ACR were largely insensitive to the occupancy status of the building. This behavior may be because the indoor CO_2 concentration variations introduced by changes in occupancy status were not large enough to impact long-term ACR values, but they may be sufficient to impact short-term ACR values. Moreover, we anticipate that cut-off frequency and filter order, two parameters needed for the signal processing approach, may be building-specific and can influence calculations of air change rates in a given building. The results suggest that this approach has promise for assessing time-varying ACR in buildings with time-resolved indoor and outdoor concentration measurements.

Main findings

1. Ventilation measured with a signal processing approach reveals temporal dynamics in air exchange rate (AER).
2. The approach requires measurement of indoor and outdoor CO_2 concentrations but no release of a tracer gas.
3. Over a year the geometric mean (geometric standard deviation) AER in a residence was 0.47/h (3.44).
4. The application of the signal processing approach is sensitive to the selection of the concentration filtering parameters.
5. The results suggest a valuable way to assess time-resolved ventilation rates in buildings

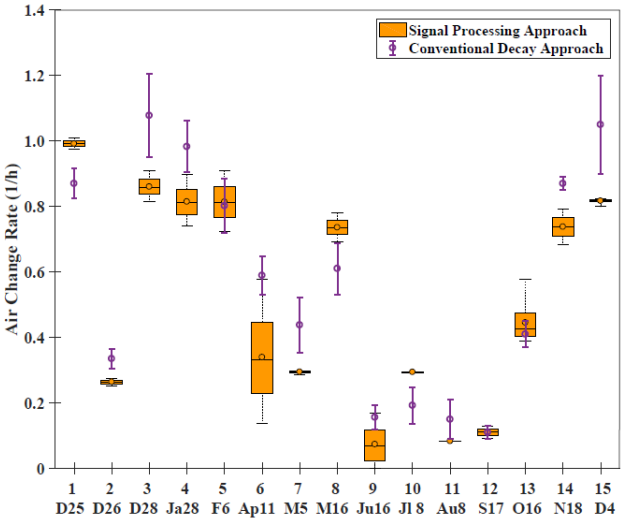

Figure 1: Comparison between the calculated air change rates from the signal processing approach and the conventional decay approach over 15 hourly decay periods from December 2016 to December 2017.

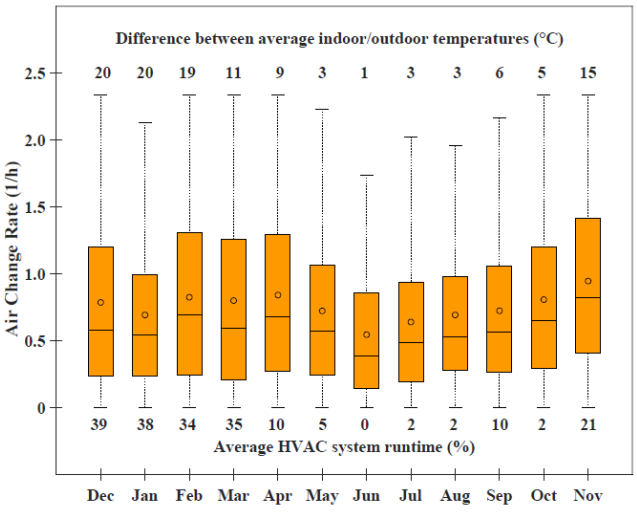

Figure 2: Monthly variation of ACR in the residence. December data (last 20 days of the month) shown are from 2016, while other months represent the data collected in 2017. On each boxplot, the central line indicates the median, the open circle indicates the mean, and the bottom and top edges of the box indicate the 25th and 75th percentiles, respectively. The whiskers extend to the most extreme data points not considered outliers.

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