Schwartz-Narbonne H, Abbatt J, DeCarlo PF, Farmer DK, Mattila J, Wang C, Donaldson DJ, Siegel JA. 2021. Modelling the removal of water-soluble trace gases from indoor air via air conditioner condensate. *Environmental Science and Technology*, **55**, 10987-10993. DOI: 10.1021/acs.est.1c02053

Abstract

Water-soluble trace gas (WSTG) loss from indoor air via air conditioning (AC) units has been observed in several studies, but these results have been difficult to generalize. In the present study, we designed a box model that can be used to investigate and estimate WSTG removal due to partitioning to AC coil condensate. We compared the model output to measurements of a suite of organic acids cycling in an indoor environment and tested the model by varying the input AC parameters. These tests showed that WSTG loss via AC cycling is influenced by Henry's law constant of the compound in question, which is controlled by air and water temperatures and the condensate pH. Air conditioning unit specifications also impact WSTG loss through variations in the sensible heat ratio, the effective recirculation rate of air through the unit, and the timing of coil and fan operation. These findings have significant implications for indoor modeling. To accurately model the fate of indoor WSTGs, researchers must either measure or otherwise account for these unique environmental and operational characteristics.

Main findings

- AC units can remove WSTGs from indoor air, and this removal can be estimated using a simple box model.
- The Henry's law constant of each individual compound will influence its removal rate.
- Henry's law is controlled by air and water temperatures, and condensate pH.
- Individual AC units will have varying removal rates, depending on the effective recirculation rate of air through the unit and the sensible heat ratio.
- These findings could have significant implications for indoor atmospheric modelling and understanding AC maintenance.

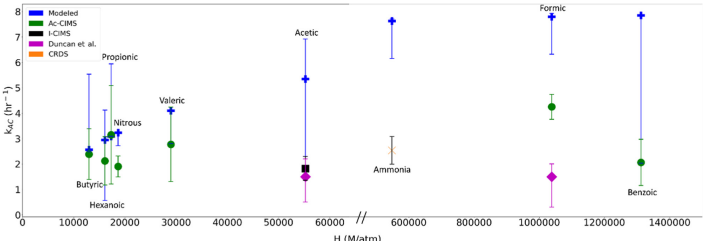

Figure 2. Comparison of modeled loss rate of WSTG (k_{AC}) values for the studied acids in blue to median fitted k_{AC} values collected by three different instruments during the HOMEChem campaign in green, black, and orange. The purple diamonds represent the k_{AC} reported by Duncan et al. for formic and acetic acids, and the error bars are their highest and lowest reported values. Error bars on the fitted points represent the median error on the fitted value. Error bars on the modeled points represent variation due to variations in the literature value of H for each compound.

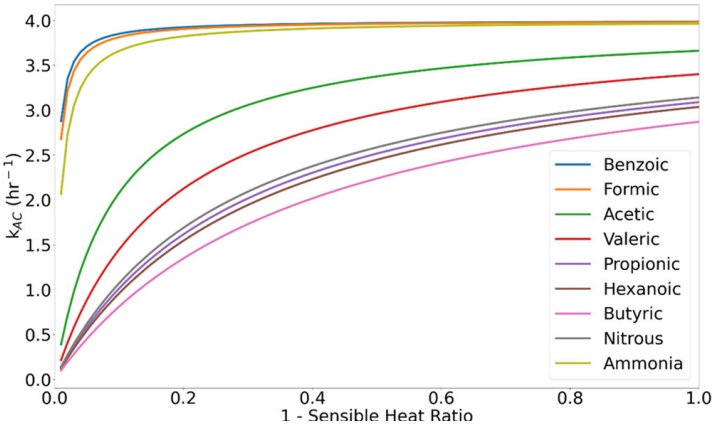

Figure 6. Impact of changes in sensible vs latent cooling (sensible heat ratio) within the AC unit on modeled k_{AC}.

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