Supporting Information for:

Near-Source Hypochlorous Acid Emissions from Indoor Bleach Cleaning

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No. of pages: 6

No. of figures: 3

No. of tables: 2

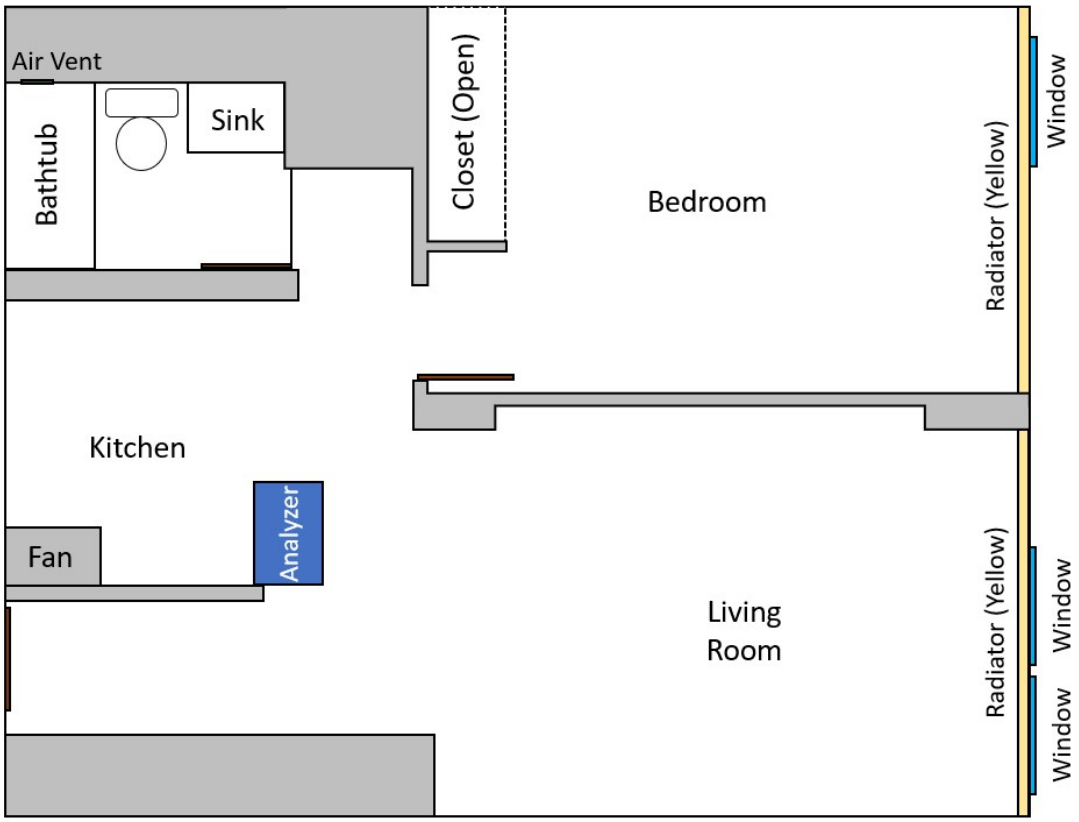

Figure S1. Layout of the residential apartment (53 m^2; approximately to scale).

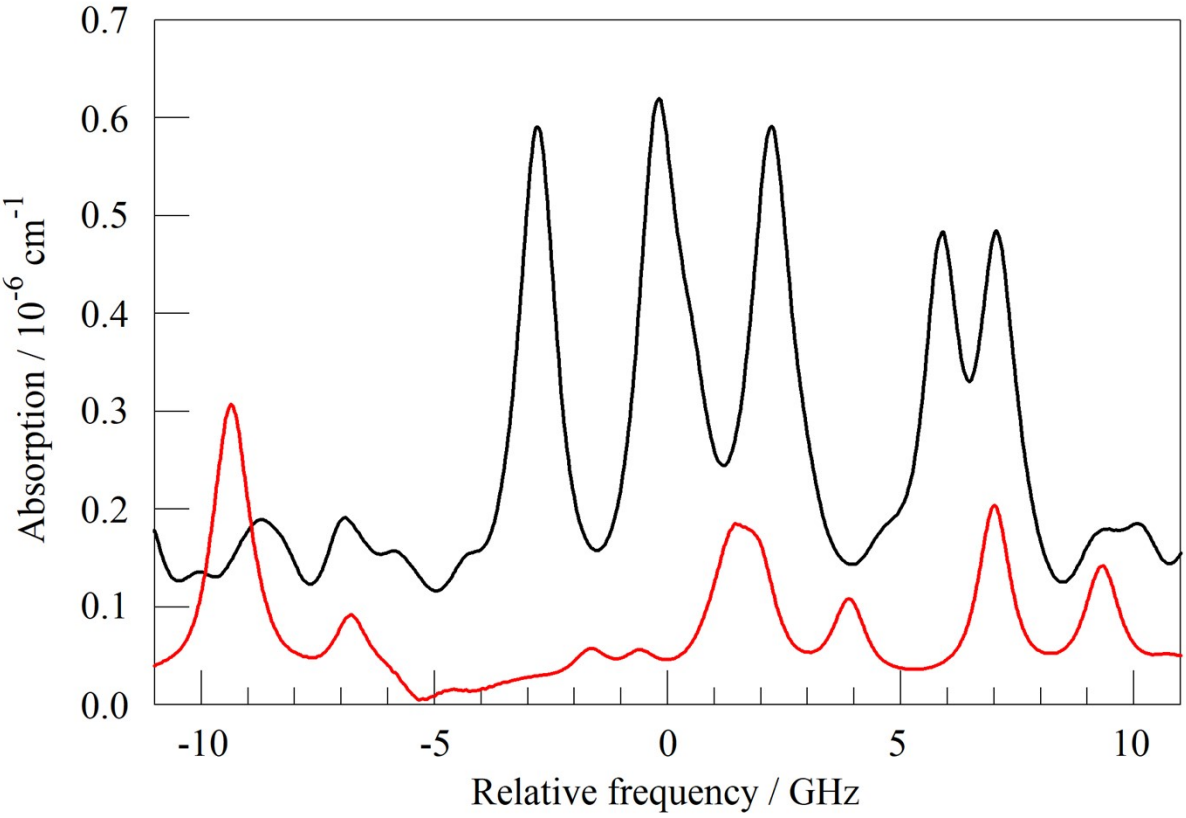

Figure S2. Spectra acquired by CRDS, after correcting for empty-cavity baseline and water absorption. Sample temperature was 45 °C and pressure was 13332 Pa (100 Torr); carrier gas was synthetic air. Red: 8.3 ppm HOCl; black: 9.3 ppm H_2O_2. The concentration assignment for the HOCl spectrum is from the calibration procedure described in the text. The calibration of the H_2O_2 analyzer is described in a white paper available from Picarro.[1]

Hypochlorous acid quantitation

Hypochlorous acid (HOCl) was generated by bubbling zero air at a known flow rate through a sodium hypochlorite (NaOCl) solution (available chlorine content 13% by mass, Sigma-Aldrich), buffered using sodium phosphate monobasic monohydrate solution (≥ 98%, $NaH_2PO_4 \cdot H_2O$, Caledon Laboratories).[2] The concentration of NaOCl in the resulting buffer solution is 0.37 M with a pH of ~6.3. The mixing ratios of gas-phase HOCl from the headspace of the bubbler were quantified at different flow rates (between 50 and 670 sccm) with UV–vis spectroscopy (PerkinElmer Lambda 1050), using a 240 nm absorption cross section of 2.06×10^{-19} cm^2 $molec^{-1}$.[3] The measured mixing ratio of HOCl from the bubbler was 200 ± 115 parts per million by volume (ppmv) for the tested flow rates. A flow rate of 50 sccm, with a mixing ratio of 178 ± 26 ppmv exiting the bubbler, was chosen for the calibration to minimize the perturbation of equilibrium from the air-water partitioning system. The uncertainties of the reported HOCl mixing ratios are estimated to be 20%. The continuous UV–vis measurement for the flow of the same NaOCl solution at one specific flow rate indicates that this method generates relatively stable HOCl mixing ratios over a 1

hour period with less than ± 10 % variation. Calibration of the Picarro instrument was conducted by directly bubbling zero air into the NaOCl buffer solution at 50 sccm and then mixed with a dry zero air dilution flow prior to Picarro detection, resulting in a mixing ratio of HOCl ranging from 0 to 3.7 ppmv. Mixing ratios used for calibration were acquired in random order to avoid potential time-dependent artifacts.

The HOCl signal was converted to mixing ratios using a calibration curve where the trendline was forced through zero (Fig. S3). The HOCl mixing ratios in ppmv were determined by multiplying the signal by the slope. We note that the calibration curve does not encompass all HOCl levels observed in this study. Given that we are using a spectroscopic technique, we expect signal to depend linearly on concentration. Potential deviations from the Beer-Lambert law at low HOCl concentrations are accounted for in our LOD determination, which is based on the signal-to-noise of the blank analyses. Deviations due to high absorbance are not expected, as HOCl absorbance was below 1 for all measurements.

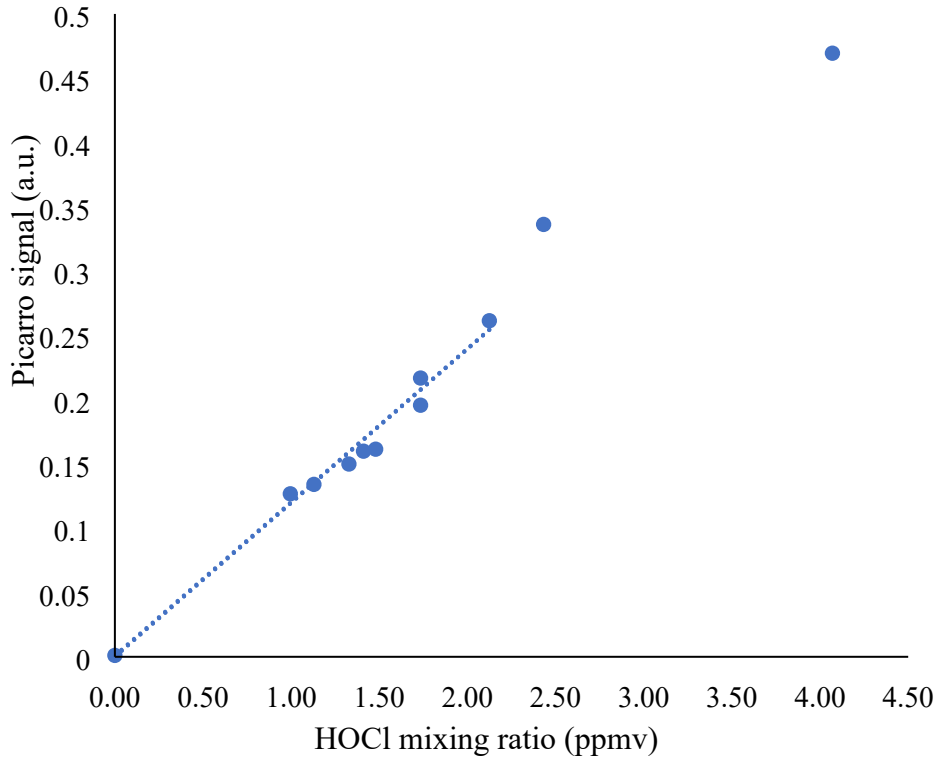

Figure S3. Linear least-squares regression plot of HOCl mixing ratios as a function of signal with a slope of 0.1199 ± 0.0061 at the 95% confidence interval. The mixing ratio (x-axis) was determined by UV-Vis spectroscopy as described above.

Table S1. Summary of all cleaning experiments after bleach product was sprayed on the bathtub surface. "np" represents the number of data points averaged. "n/a" means HOCl was not measured.

Type of experiment/ Sampling location	Lysol sprays	Peak HOCl[a] (ppmv)	Mean steady-state HOCl (ppmv)
Mobile experiments	169[b]	2.14 ± 1.12	n/a
	162[b]	3.13 ± 1.55	n/a
	117	1.43 ± 0.31	n/a
	79	3.60 ± 0.58	300 ± 160 (np = 26)
Near-ceiling	118	0.15 ± 0.03	0.0192 ± 0.0091 (np = 346)
	87	1.48 ± 0.35	0.159 ± 0.043 (np = 342)
	88	1.11 ± 0.29	0.131 ± 0.068 (np = 221)
Mid-room	113	0.23 ± 0.17	0.131 ± 0.040 (np = 915)
	94	0.22 ± 0.10	0.162 ± 0.040 (np = 703)
	91	0.21 ± 0.16	0.142 ± 0.048 (np = 617)
Near-tub	85	27.71 ± 6.77	23.92 ± 8.27 (np = 748)
	89	17.45 ± 6.33	18.46 ± 4.12 (np = 544)

[a]6 points surrounding the peak were averaged

[b]Living room windows were open during the cleaning experiment

Table S2. Hypochlorous acid measurements during cleaning of sink surface. "Mobile" refers to cleaning events when the inlet was at the researcher's face. "Near-ceiling" refers to cleaning events where the inlet was in the near-ceiling position (see Table 1). "< LOD" means that HOCl concentrations were below the limit of detection. "np" represents the number of data points averaged.

Type of experiment/Sampling location	Spraying HOCl (ppbv)	Peak HOCl (ppbv) (np = 6)
Mobile	< LOD (np = 21)	370 ± 210
	30 ± 101 (np = 20)	700 ± 470
	19 ± 33 (np = 35)	45 ± 54
Near-ceiling	< LOD (np = 37)	< LOD

References

(1) Hoffnagle, J.; Lee, J.; Winkler, R.; Rella, C. PI2114: Traceable Calibration of Hydrogen Peroxide (H2O2) White Paper. Picarro, Inc.: Santa Clara, CA 2018.

(2) Wang, C.; Collins, D. B.; Abbatt, J. P. D. Indoor Illumination of Terpenes and Bleach Emissions Leads to Particle Formation and Growth. *Environ. Sci. Technol.* **2019**, *53* (20), 11792–11800.

(3) Burkholder, J. B.; Sander, S. P.; Abbatt, J. P. D.; Barker, J. R.; Huie, R. E.; Kolb, C. E.; Kurylo, M. J.; Orkin, V. L.; Wilmouth, D. M.; Wine, P. H. Chemical Kinetics and Photochemical Data for Use in Atmospheric Studies: Evaluation Number 18. V1 ed. Root. https://doi.org/hdl:2014/45510.