Supporting Information

# Urban Ammonia and Amines in Houston, Texas

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**Table S1.** CIMS sensitivities and detection limits for ammonia and amine measurements during this study in Houston. The sensitivities (Hz $pptv^{-1}$) shown here are normalized for 1,000,000 Hz reagent ion signals. The detection limits are estimated using a 1-min integration time. In comparison, we also included those previously reported nearly 10 years earlier by You et al.[*You et al.*, 2014]

| **Compound** | **Sensitivity (Hz $pptv^{-1}$ $MHz^{-1}$)** | **Detection limit (pptv)** | **Sensitivity[*You et al.*, 2014] (Hz $pptv^{-1}$ $MHz^{-1}$)** | **Detection limit[*You et al.*, 2014] (pptv)** |
|---|---|---|---|---|
| Ammonia | 13.1 | 128.4 | 13 | 35 |
| C1 amine | 8.6 | 0.4 | 12 | 0.1 |
| C2 amine | 2.6 | 0.7 | 12 | 0.5 |
| C3 amine | 4.3 | 1.2 | 8 | 0.8 |
| C4 amine | 2.3 | 3.6 | 4 | 3.3 |
| C5 amine | 1.3 | 2.7 | 2 | 1.9 |
| C6 amine | 1.3 | 2.6 | 2 | 1.4 |

**Table S2.** Relationships of the measured amines concentrations to ammonia derived from the combined observations in Houston reported by this study and Kent, OH reported by You et al[*You et al.*, 2014].

| **Amine** | **Relationship to ammonia in pptv** |
|---|---|
| C1 | $1.1\times10^{-3}$ [$NH_3$] |
| C2 | $1.4\times10^{-3}$ [$NH_3$] |
| C3 | $8.4\times10^{-3}$ [$NH_3$] |
| C4 | No correlation |
| C5 | $1.9\times10^{-2}$ [$NH_3$] |
| C6 | $3.5\times10^{-3}$ [$NH_3$] |


**Fig. S1.** (Left) Measurement site in the greater Houston urban area. The site was SE of the city center and located NW of Tranquility Bay. (Right) Satellite view of the nearby vicinity of the measurement site. The University of Houston campus is seen in the lower-left. The highways, train yard and industrial area are seen in the lower right. The upper right shows the nearby residential zone. Map credit: © Google Earth.

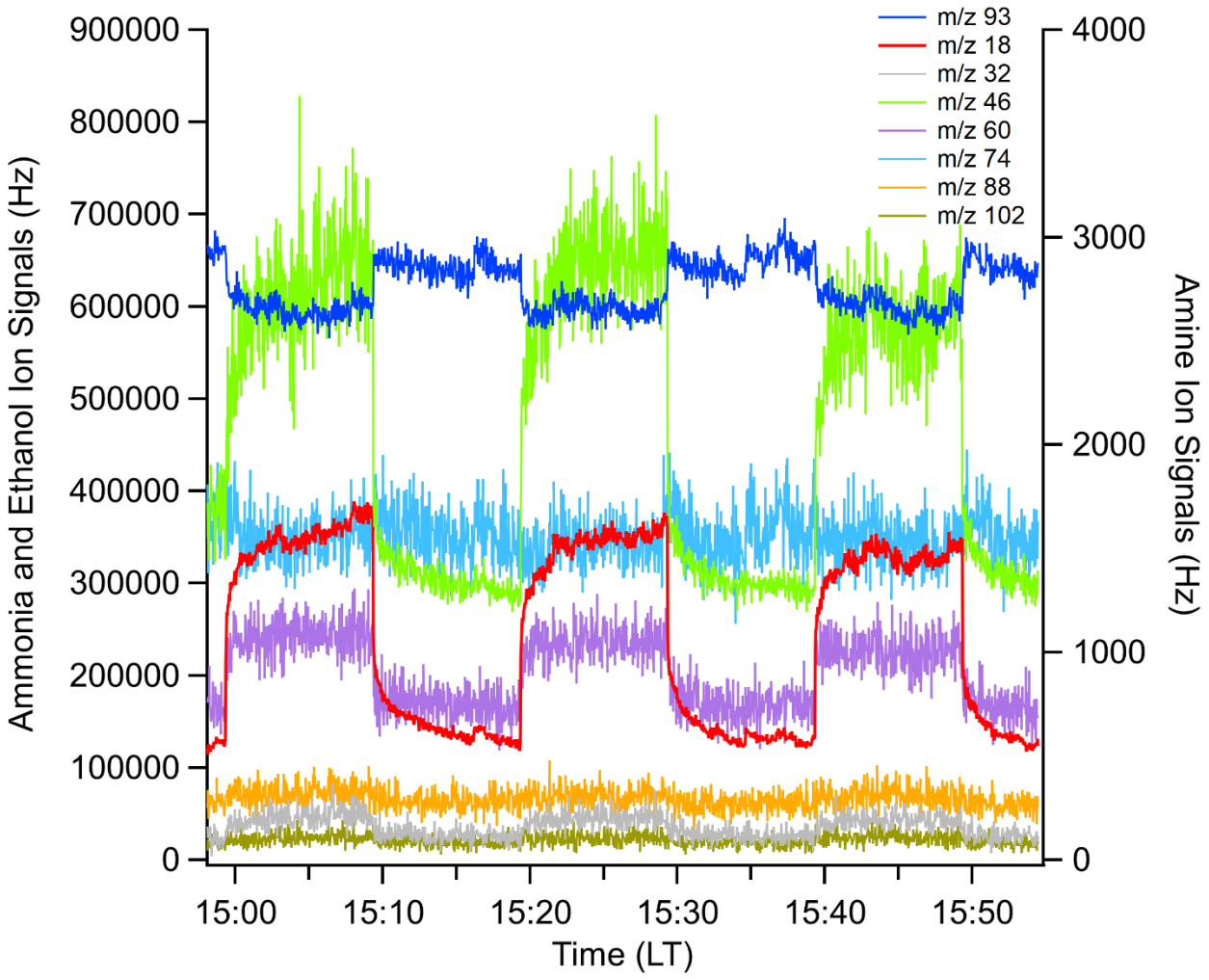


**Fig. S2.** A time series of the measurement/background cycle of the CIMS. This shows three switches of the inlet flow between ambient measurement and the phosphate scrubber. At 15:49, the flow was switched to background mode and the response of the $NH_4^+$ signal (m/z 18) immediately drops. The $NH_4^+$ signal continues to decrease after the drop, and the signal reaches an e-folded concentration within 28 seconds.

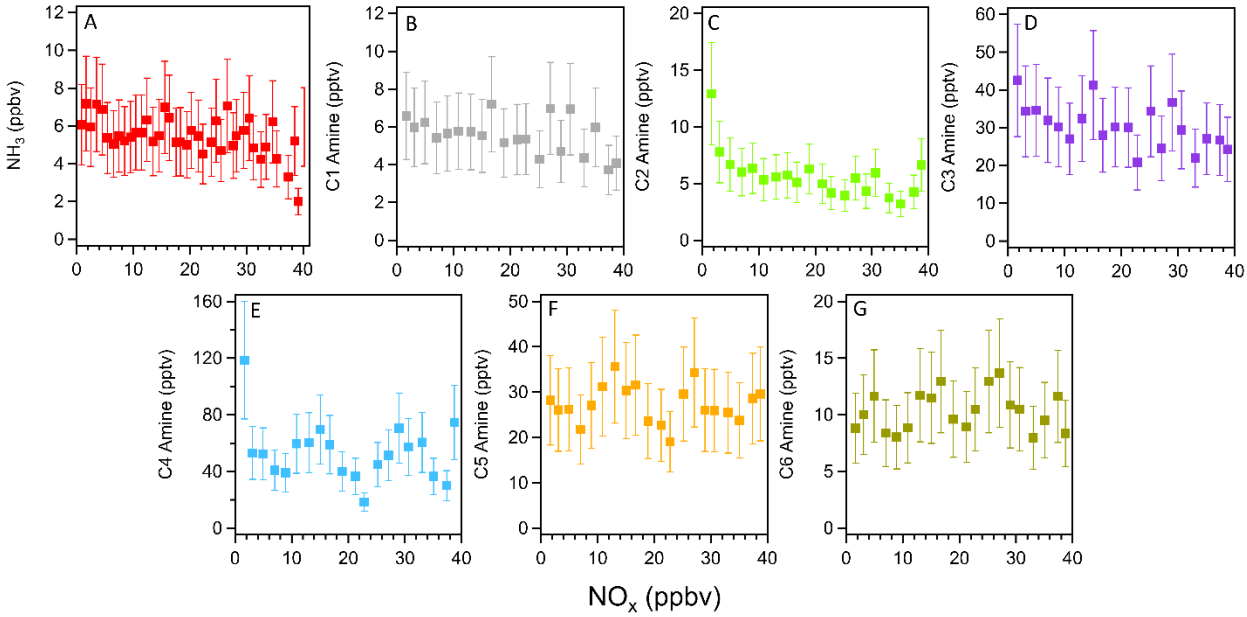


**Fig. S3.** Correlation between (a) ammonia and (b-g) C1-C6 amines with the collocated $NO_x$ concentrations during the measurement campaign. Vertical bars indicate one standard deviation from mean values of observation data.

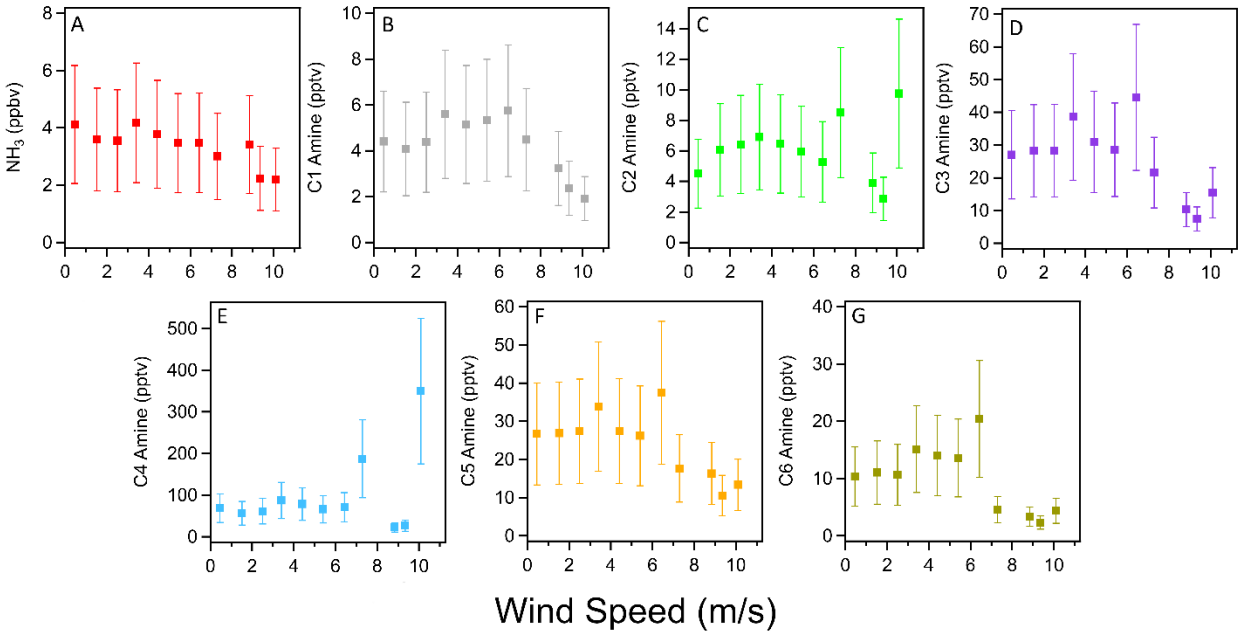


**Fig. S4.** Correlation of (a) ammonia and (b) C1-C6 amines with wind speed throughout the observation period.

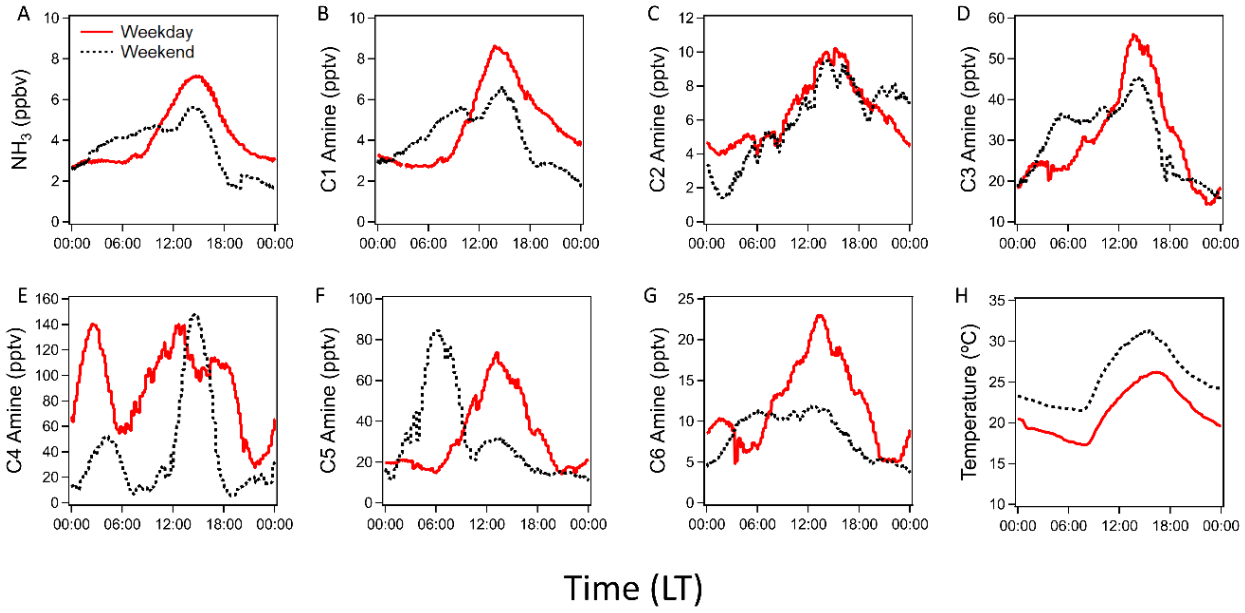


**Fig. S5.** Diurnal cycles of (a) ammonia, (b-g) amines, and (h) temperature on weekdays (solid red) vs weekdays (dashed black).

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59 **References**
60 You, Y., et al. (2014), Atmospheric amines and ammonia measured with a Chemical Ionization
61 Mass Spectrometer (CIMS), *Atmos. Chem. Phys.* , *14*, 12181-12194, doi:Doi: 10.5194/acpd-14-
62 16411-2014.
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