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OMI-observed HCHO in Shanghai, China, during 2010–2019 and ozone sensitivity inferred by an improved HCHO / NO_2 ratio

Danran Li et al.

Correspondence to: Shanshan Wang (shanshanwang@fudan.edu.cn)

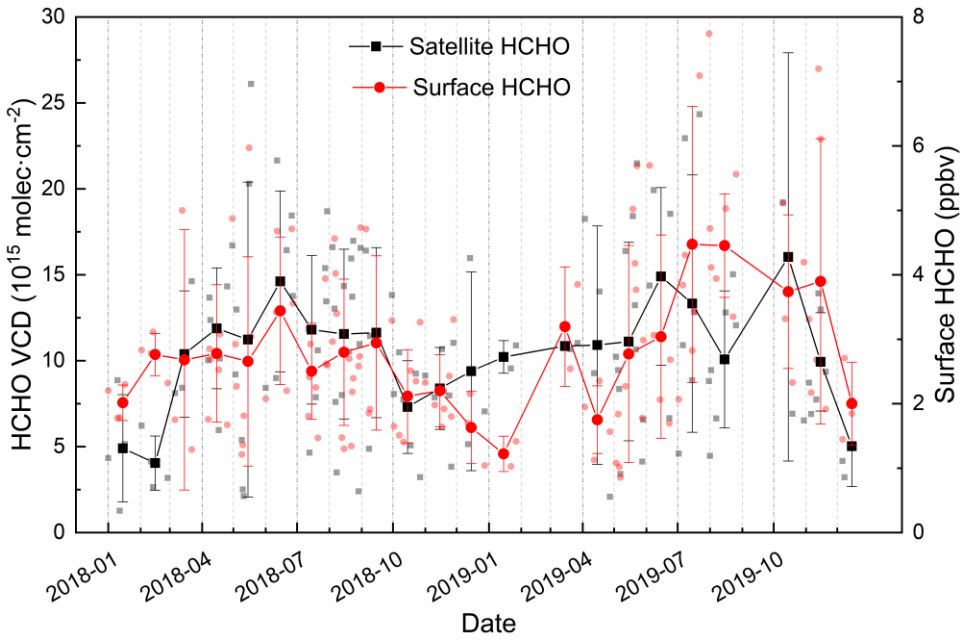

Figure S1. Comparison of HCHO observed by LP-DOAS and satellite on daily and monthly scale. The black and red points represent the daily observation of HCHO VCD and surface HCHO respectively, while the dot lines indicate the monthly averages.

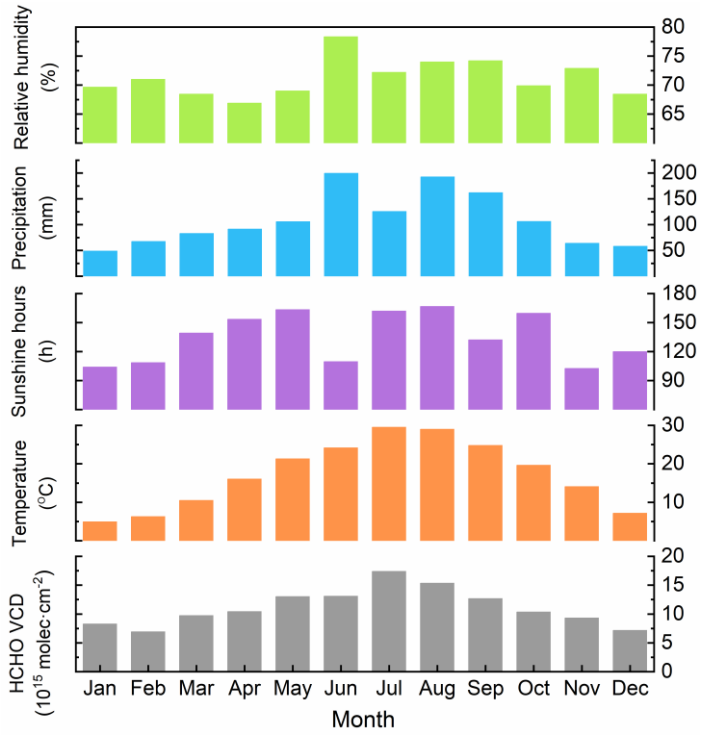

Figure S2. HCHO VCDs and meteorological factors including temperature, sunshine hours, precipitation and relative humidity in Shanghai for 2010-2018.

Although the temperature continued to increase in June, HCHO VCDs decreased with significant increase of precipitation and relative humidity. The changes of monthly averaged relative humidity and

HCHO VCDs were regarded as two variables, as shown in Eq. (S1) and (S2).

$$\Delta RH_i = RH_i - RH_{i-1} \quad (S1)$$

$$\Delta VCD_i = VCD_i - VCD_{i-1} \quad (S2)$$

where ΔRH_i and ΔVCD_i are the changes of relative humidity and HCHO VCD for month i (Jun, Jul and Aug) between 2010 and 2018, respectively.

Then, the response of monthly HCHO VCDs variations to the changes of monthly relative humidity were examined by Fisher's exact test (Clinton et al., 2020). ΔVCD_i exceeding $\pm 1\times10^{15}$ molec·cm^{-2} (about 10% of VCD_{range}) was defined as an obvious increase or decrease of HCHO VCDs. And two conditions of 10% and 20% changes on RH_{range} were checked. The RH_{range} and VCD_{range} is the range of relative humidity and HCHO VCDs between respective maximum and minimum, which are represented by the subscripts of 'max' and 'min' respectively, as expressed in Eq. (S3) and (S4).

$$RH_{range} = RH_{max} - RH_{min} \quad (S3)$$

$$VCD_{range} = VCD_{max} - VCD_{min} \quad (S4)$$

Results of Fisher's exact test determined that when ΔRH_i exceeds 10% of RH_{range}, no significant correlation is found between these two variables ($P = 0.637$); when the change degree goes up to 20%, there is a significant correlation between them ($P < 0.05$). Therefore, it can be inferred that the variation in HCHO VCDs is related to the significant change of relative humidity in summer.

Table S1. The primary emissions and estimated secondary productions of HCHO in Shanghai from anthropogenic NMVOCs based on SAPRC07 mechanism species.

Year		Estimated HCHO production from each sector (10^9 g)				
		Industry	Power	Residential	Transportation	Total
2010	Primary[1]	9.10	0.03	0.06	1.47	10.66
	Secondary[2]	240.58	0.52	15.14	66.04	322.28
2012	Primary	7.73	0.05	0.07	1.01	8.86
	Secondary	246.67	0.57	15.67	51.91	314.82
2014	Primary	6.88	0.05	0.07	0.74	7.74
	Secondary	253.32	0.50	16.44	44.32	314.58
2016	Primary	6.29	0.05	0.06	0.61	7.01
	Secondary	286.36	0.51	16.64	43.14	346.65

[1] Primary indicates HCHO that is directly emitted by anthropogenic sources from MEIC inventory.

[2] Secondary indicates HCHO that is produced by anthropogenic NMVOCs, which is calculated based on 1-day HCHO yields under high NO_x condition (Shen et al., 2019).

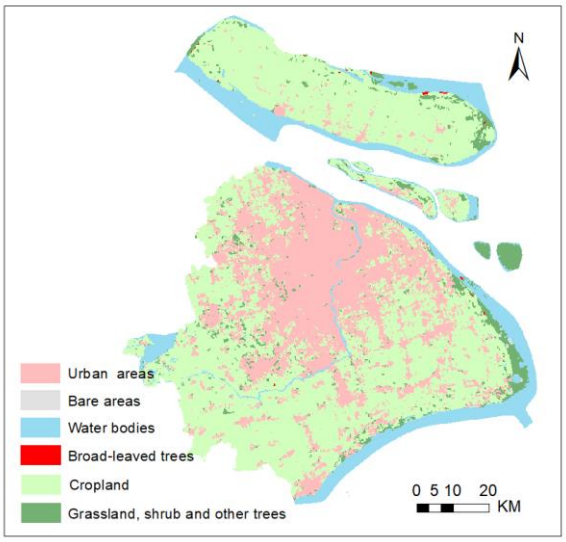

Figure S3. The spatial distribution of surface land types in Shanghai (data from ESA Land Cover Product, available at: http://maps.elie.ucl.ac.be/CCI/viewer/).

Reference:

Clinton, S., Johnson, J., Lambirth, K., Sun, S., Brouwer, C., Keen, O., Redmond, M., Fodor, A., and Gibas, C.: Sediment Microbial Diversity in Urban Piedmont North Carolina Watersheds Receiving Wastewater Input, Water-Sui, 12, 16, https://doi.org/10.3390/w12061557, 2020.

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