Electronic Supplementary Material (ESI) for Environmental Science: Processes & Impacts.

Supporting information for

Reactive uptake of ozone to azo dyes in a coated-wall flow tube

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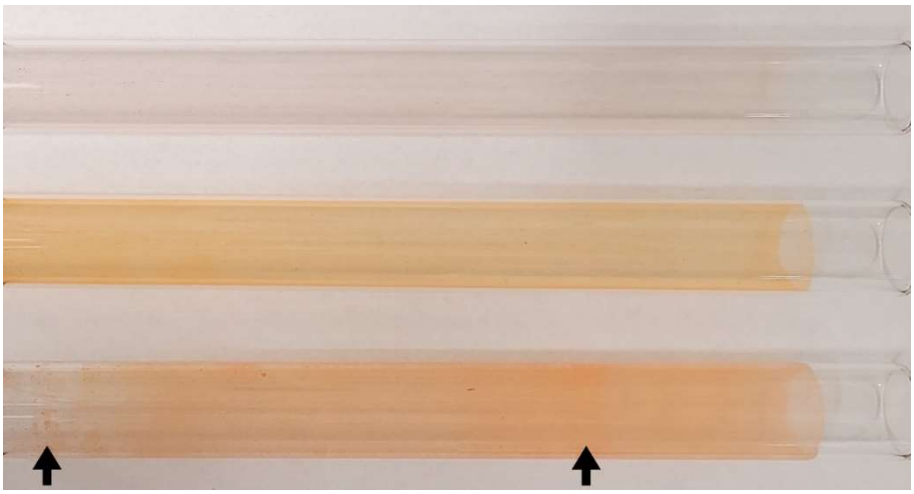

Fig. S1. Representative substrate tubes with thin films of sunset yellow, showing a sample prepared by rolling with dye solution, exhibiting bands and patches indicated with arrow (bottom); a sample prepared by atomizing and depositing particles, before (middle) and after (top) deliquescence and removal of water. Before deliquescence, the sample is uniform but coarse and opaque; afterwards, it is uniform, smooth, and translucent.

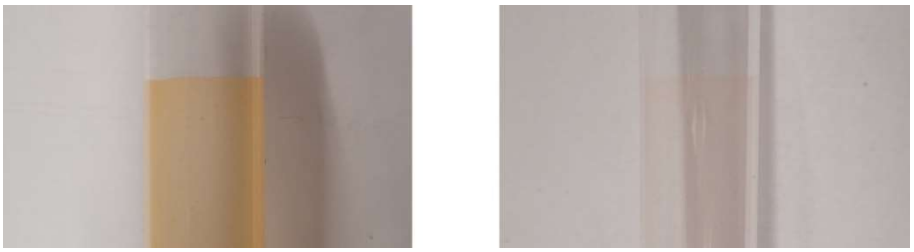

Fig. S2. Representative substrate tubes with thin films of sunset yellow, after deliquescence (left) and after drying (right). Upon deliquescence, the sample increases in opacity significantly; after drying, it decreases in opacity, to be much more translucent than the initial tubes before deliquescence.

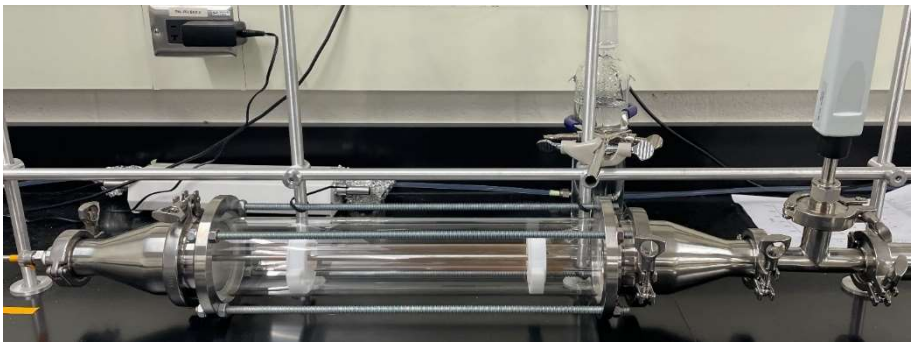

Fig. S3. The coated-wall flow tube apparatus. Ozone enters from the left through the moveable injector. The substrate tube is supported and centered by Teflon spacers. The temperature and relative humidity probe is shown on the far right.

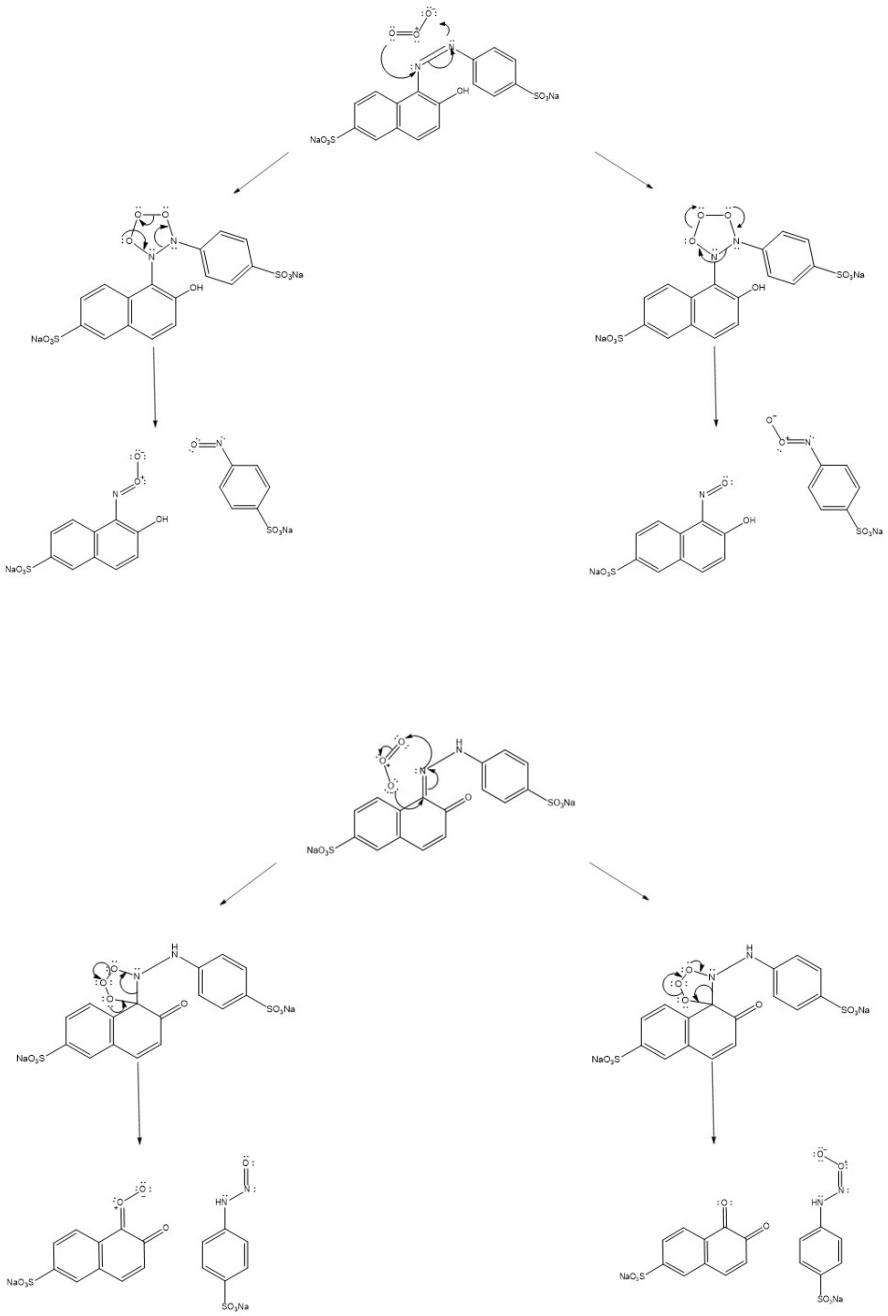

Fig. S4. Potential first step in the ozonolysis of the azo (top) and hydrazo (bottom) tautomers of sunset yellow.

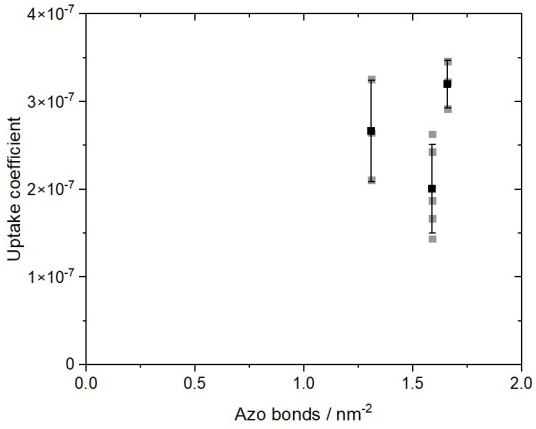

Fig. S5. Corrected steady-state uptake coefficients for thin films of sunset yellow, amaranth, and tartrazine at 80 % RH and an initial ozone mixing ratio of about 100 ppb, plotted against the concentration of azo bonds at the surface of the thin film. Grey data points indicate the individual replicate experiments (five, three, and three for sunset yellow, amaranth, and tartrazine, respectively), black data points indicate their averages, and error bars indicate one standard deviation of the replicates.

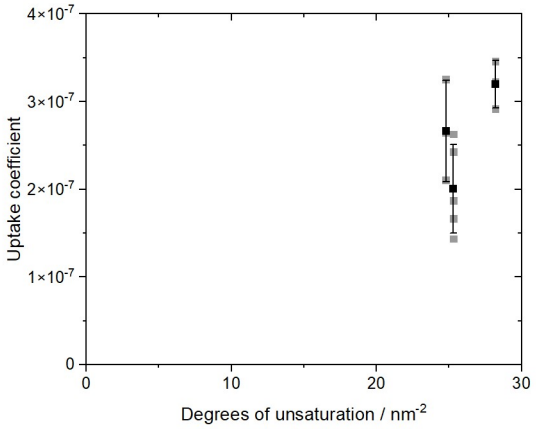

Fig. S6. Corrected steady-state uptake coefficients for thin films of amaranth, sunset yellow, and tartrazine at 80 % RH and an initial ozone mixing ratio of about 100 ppb, plotted against the degrees of unsaturation at the surface of the thin film. Grey data points indicate the individual replicate experiments (five, three, and three for sunset yellow, amaranth, and tartrazine, respectively), black data points indicate their averages, and error bars indicate one standard deviation of the replicates.

Table 1. Structural and experimental parameters for the coated-wall flow tube.

Parameter (Symbol)	**Value**	**Formula**	**Units**
Temperature (T)	296.5		K
Pressure (P)	1		atm
Flow tube diameter (D_{tube})	2.45		cm
Flow reactor cross-sectional aera (A)	4.714352476	$A=\pi r^2$	cm^2
Volumetric Flow (F)	0.25		L/min
Linear Velocity (v)	0.883825868	v=F/A	cm/s
Length of coated tube (L)	19.6		cm
Residence time (t)	22.17631405	t=L/v	s
Reynolds number (Re)	14.4358225	$Re=(\rho*D_{tube}*v)/\eta$	
Length to laminar flow (l)	1.23787178	$l= 0.035*Re*D_{tube}$	cm
Mean molecular velocity (ω)	361.6319535	$\omega=sqrt(8RT/(\pi M))$	m/s
Ozone diffusion coefficent (D)	0.13		cm^2/s^2
Mean free path (λ)	1.07844E-05	$\lambda=3D/\omega$	cm
Density (ρ)	1.2		Kg/m^3
Viscosity of air (η)	1.80E-05		Pa*s
Knudsen number (Kn)	8.80363E-06	$Kn=2\lambda/D_{tube}$	
Dimensionless axial distance (z*)	0.96057337	$z^*=z(\pi D/2F)$	
N_{effshw}	3.757007652	3.6568 + A/(z*+B)	