**Supporting Information**

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Natural fluorescence emission - an indirect measurement of applied ozone doses in polished for pharmaceuticals wastewater

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1. Wastewater treatment plants

|  |  |
| --- | --- |
| **WWTP** | **Name** |
| Källby 1 | Effluents 1 |
| Källby 2 | Effluents 2 |
| Björnstorp | Effluent 3 |
| Öresundsverket | Effluent 4 |
| Sjölunda | Effluent 5 |
| Nykvarnsverket | Effluent 6 |

1. Ozone dosages applied in each experiment

Table S1: Ozone dosages applied in each experiment [15].

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| WWTP | Ozonation  Levels | Effluent 1 | Effluent 2 | Effluent 3 | Effluent 4 | Effluent 5 | Effluent 6 |
| Applied ozone dosage  (mg O3/L) | 6 | 10.2 | 11.7 | 8.0 | 7.8 | 8.9 | 7.7 |
| 5 | 6.9 | 7.1 | 5.3 | 5.5 | 6.1 | 6.2 |
| 4 | 5.0 | 5.4 | 3.5 | 3.6 | 4.4 | 4.5 |
| 3 | 2.6 | 2.4 | 2.0 | 2.1 | 2.3 | 2.4 |
| 2 | 1.3 | 1.2 | 1.1 | 1.1 | 1.1 | 1.2 |
| 1 | 0.6 | 0.6 | 0.5 | 0.6 | 0.5 | 0.6 |

1. Fluorescence removal
   1. First order decay



Figure S1: Fluorescence removal of ozonated wastewater at EX231Em315-first order decay analysis.



Figure S2: Fluorescence removal of ozonated wastewater at EX231Em360-first order decay analysis.



Figure S3: Fluorescence removal of ozonated wastewater at EX249Em450-first order decay analysis.

Figure S4: Fluorescence removal of ozonated wastewater at EX275Em310-first order decay analysis.



Figure S5: Fluorescence removal of ozonated wastewater at EX335Em450-first order decay analysis.

Figure S6: Fluorescence removal of ozonated wastewater at EX335Em450-first order decay analysis.

* 1. Linear regression

Figure S7: Fluorescence removal of ozonated wastewater at EX231Em315-linear regression analysis.

Figure S8: Fluorescence removal of ozonated wastewater at EX231Em360-linear regression analysis.





Figure S9: Fluorescence removal of ozonated wastewater at EX249Em450-linear regression analysis.



Figure S10: Fluorescence removal of ozonated wastewater at EX275Em310-linear regression analysis.



Figure S11: Fluorescence removal of ozonated wastewater at EX275Em340-linear regression analysis.



Figure S12: Fluorescence removal of ozonated wastewater at EX335Em450-linear regression analysis.

* 1. Fluorescence sensitivity

Table S2: Slope and R2 comparison between the two humic-like wavelength transitions when applied ozone dosages (0-11 mg O3/L).

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | | Ex249Em450 | | | Ex335Em450 | |
| WWTPs | R2 | | Slope | R2 | | Slope |
| Eff 1 | 0.9455 | | -40.01 | 0.9335 | | -34.39 |
| Eff 2 | 0.9378 | | -33.44 | 0.9221 | | -27.63 |
| Eff 3 | 0.8975 | | -33.82 | 0.8717 | | -27.83 |
| Eff 4 | 0.9665 | | -51.14 | 0.9632 | | -44.62 |
| Eff 5 | 0.9818 | | -45.51 | 0.9936 | | -47.98 |
| Eff 6 | 0.9906 | | -44.75 | 0.9897 | | -39.25 |

Table S3: Slope and R2 comparison between the two humic-like wavelength transitions when applied low ozone dosages (0-3 mg O3/L).

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | | Ex249Em450 | | | Ex335Em450 | |
| WWTPs | R2 | | Slope | R2 | | Slope |
| Eff 1 | 0.6095 | | -38.71 | 0.7566 | | -45.26 |
| Eff 2 | 0.9588 | | -48.34 | 0.9603 | | -44.25 |
| Eff 3 | 0.9728 | | -63.94 | 0.9847 | | -55.86 |
| Eff 4 | 0.8680 | | -50.16 | 0.8831 | | -47.63 |
| Eff 5 | 0.8447 | | -32.14 | 0.9306 | | -41.46 |
| Eff 6 | 0.9250 | | -46.67 | 0.9589 | | -42.93 |

* 1. APIs sensitivity



Figure S13: Correlation of matrix (Effluent 2; Kalby 2) fluorescence at Ex249Em450nm with the corresponding remaining API concentration



Figure S14: Correlation of matrix (Effluent 3; Björnstorp) fluorescence at Ex249Em450nm with the corresponding remaining API concentration.



Figure S15: Correlation of matrix (Effluent 4; Öresundsverket) fluorescence at Ex249Em450nm with the corresponding remaining API concentration.



Figure S16: Correlation of matrix (Effluent 5; Sjölunda) fluorescence at Ex249Em450nm with the corresponding remaining API concentration.

Figure S17: Correlation of matrix (Effluent 6; Nykvansverket) fluorescence at Ex249Em450nm with the corresponding remaining API concentration.

Table S4: Slope and R2 of APIs from Eff1 (Kalby1) when applied ozone dosages (0-11 mg O3/L).

|  |  |  |
| --- | --- | --- |
|  | Ex249Em450 |  |
| Eff1 | R2 | Slope |
| Repaglinide | 0.7607 | 1.055 |
| Codeine | 0.7979 | 0.9957 |
| Naproxen | 0.8268 | 1.115 |
| Amitryptiline | 0.9001 | 1.067 |
| Bisoprolol | 0.9468 | 1.223 |
| Metoprolol | 0.9540 | 1.195 |
| Memantine | 0.8561 | 0.8665 |
| Flutamide | 0.4375 | 0.6744 |
| Beclomethazone | 0.4767 | 0.5520 |

Table S5: Slope and R2 of APIs from Eff2 (Kalby2) when applied ozone dosages (0-11 mg O3/L).

|  |  |  |
| --- | --- | --- |
|  | Ex249Em450 |  |
| Eff1 | R2 | Slope |
| Repaglinide | 0.7809 | 1.111 |
| Codeine | 0.8278 | 1.197 |
| Naproxen | 0.8944 | 1.208 |
| Amitryptiline | 0.9708 | 1.226 |
| Bisoprolol | 0.9569 | 1.270 |
| Metoprolol | 0.9556 | 1.219 |
| Memantine | 0.8918 | 1.039 |
| Flutamide | 0.8085 | 0.7443 |
| Beclomethazone | 0.5130 | 0.8047 |

Table S6: Slope and R2 of APIs from Eff3 when applied ozone dosages (0-11 mg O3/L).

|  |  |  |
| --- | --- | --- |
|  | Ex249Em450 |  |
| Eff1 | R2 | Slope |
| Repaglinide | 0.7469 | 1.103 |
| Codeine | 0.7907 | 1.276 |
| Naproxen | 0.7835 | 1.074 |
| Amitryptiline | 0.8801 | 1.176 |
| Bisoprolol | 0.9399 | 1.361 |
| Metoprolol | 0.9268 | 1.326 |
| Memantine | 0.7347 | 0.9027 |
| Flutamide | 0.7590 | 0.9789 |
| Beclomethazone | 0.8361 | 1.216 |

Table S7: Slope and R2 of APIs from Eff4 when applied ozone dosages (0-11 mg O3/L).

|  |  |  |
| --- | --- | --- |
|  | Ex249Em450 |  |
| Eff1 | R2 | Slope |
| Repaglinide | 0.8822 | 1.266 |
| Codeine | 0.9094 | 1.333 |
| Naproxen | 0.8148 | 1.002 |
| Amitryptiline | 0.9455 | 1.119 |
| Bisoprolol | 0.9608 | 1.276 |
| Metoprolol | 0.9488 | 1.306 |
| Memantine | 0.8945 | 0.8512 |
| Flutamide | 0.8520 | 0.6855 |
| Beclomethazone | 0.7958 | 0.8688 |

Table S8: Slope and R2 of APIs from Eff5 when applied ozone dosages (0-11 mg O3/L).

|  |  |  |
| --- | --- | --- |
|  | Ex249Em450 |  |
| Eff1 | R2 | Slope |
| Repaglinide | 0.9267 | 1.656 |
| Codeine | 0.9235 | 1.585 |
| Naproxen | 0.9383 | 1.598 |
| Amitryptiline | 0.8726 | 1.020 |
| Bisoprolol | 0.9277 | 1.146 |
| Metoprolol | 0.8808 | 1.114 |
| Memantine | 0.7072 | 0.5957 |
| Flutamide | 0.2642 | 0.3361 |
| Beclomethazone | 0.1387 | -0.2782 |

Table S9: Slope and R2 of APIs from Eff6 when applied ozone dosages (0-11 mg O3/L).

|  |  |  |
| --- | --- | --- |
|  | Ex249Em450 |  |
| Eff1 | R2 | Slope |
| Repaglinide | 0.4156 | 0.7053 |
| Codeine | 0.7872 | 1.166 |
| Naproxen | 0.6969 | 0.9740 |
| Amitryptiline | 0.8916 | 1.339 |
| Bisoprolol | 0.9411 | 1.408 |
| Metoprolol | 0.9501 | 1.088 |
| Memantine | 0.8435 | 0.8959 |
| Flutamide | 0.6005 | 0.7235 |
| Beclomethazone | 0.7511 | 1.1174 |



Figure S18: Correlation between fluorescence and absorbance at 254 nm and DOC in the six non-ozonated wastewater effluents.