

Simulated leaching and photodegradation of tire tread particle-derived compounds in natural water

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Tire wear particles (TWP)

- Microplastics found in stormwater and roadway runoff leads to surface water pollution



Pristine, cryomilled tire tread particles
 $32.2 \mu\text{m} \pm 25.5 \mu\text{m}$



Tires and road surface interaction

Shear force



Release of
coarser
particles
(PM₁₀)

**Evaporation of
volatile content**

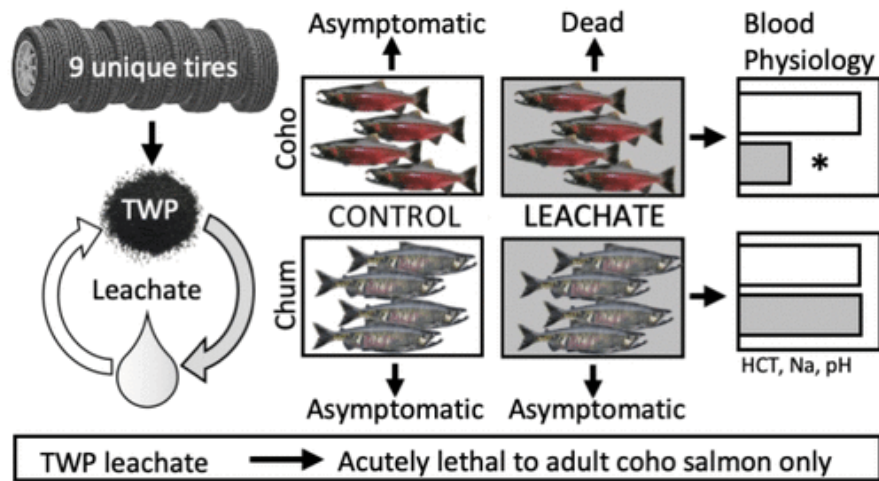


Release of
finer particles
(PM_{2.5}, PM_{0.1})

Kim & Lee, 2018; Wagner et al., 2018

TWP-derived compounds

- Leachate resulted in coho salmon death (McIntyre et al., 2021)
- **6PPD-Quinone** associated with mortality



McIntyre et al., 2021



NOAA



TWP-derived compounds

- Which chemicals leach from TWP?
- How rapidly do chemicals leach under sunlight? What is their persistence?



Oregon Department of Forestry



TWP suspended in water

Methods

❖ TOC Analysis

- Dissolved organic carbon (DOC) and total dissolved nitrogen (TDN)



TOC
Analyzer

❖ Experimental Setup

- TWP
- Lab-created freshwater (low DOC)
- Sunlight or dark conditions

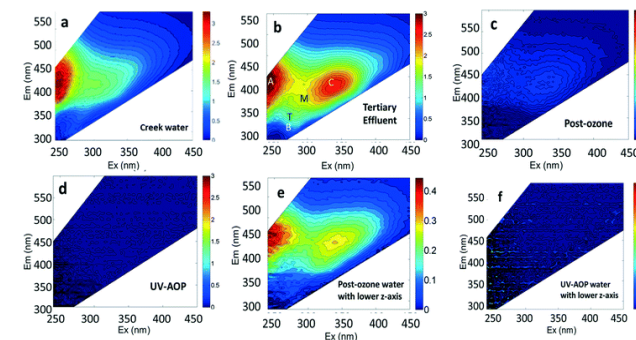


Solar
Simulator

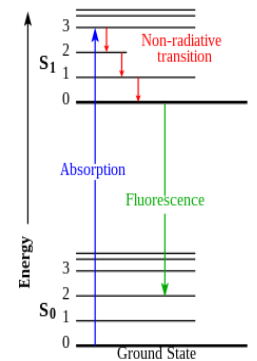


❖ Fluorescence spectroscopy

- Many trace organics are fluorescent
- Technique: 4 mL sample in cuvette; non-destructive

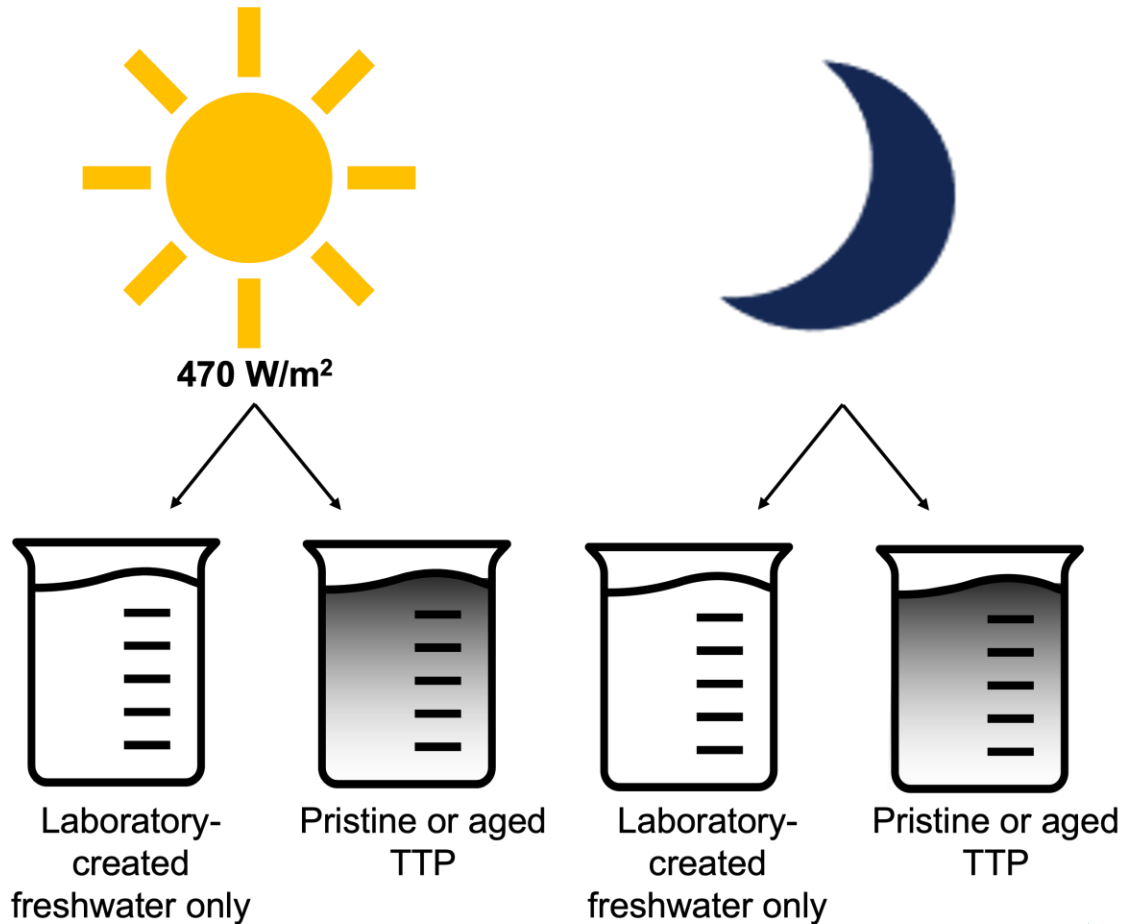


Three-dimensional excitation emission matrices (3D EEMs) of different water types (Wasswa et al., 2019)



Jablonski
diagram

Leaching TWP under photoirradiation

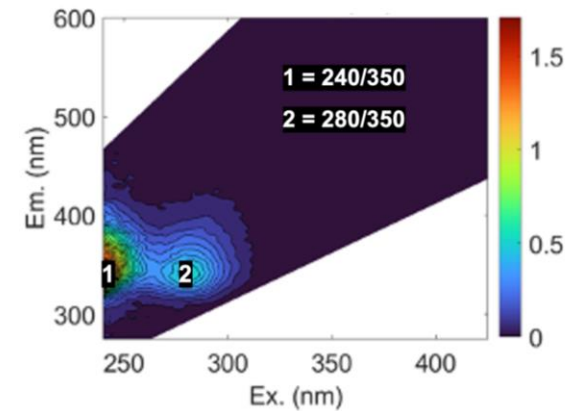


Samples (10 g/L) and controls inside the Solar Simulator

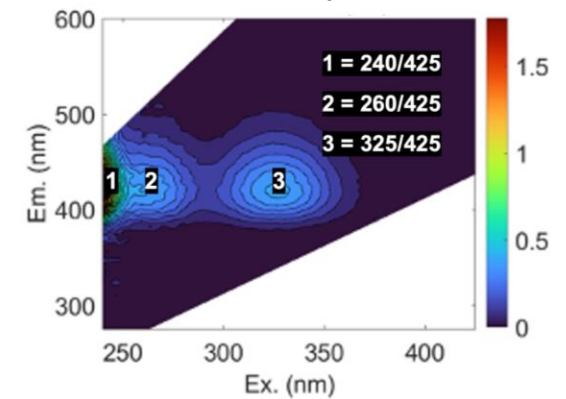
TWP-specific compounds

- **Cyclohexanamines** = used in rubber manufacturing
- **Quinolines** = nitrogenous heterocyclic aromatic compounds

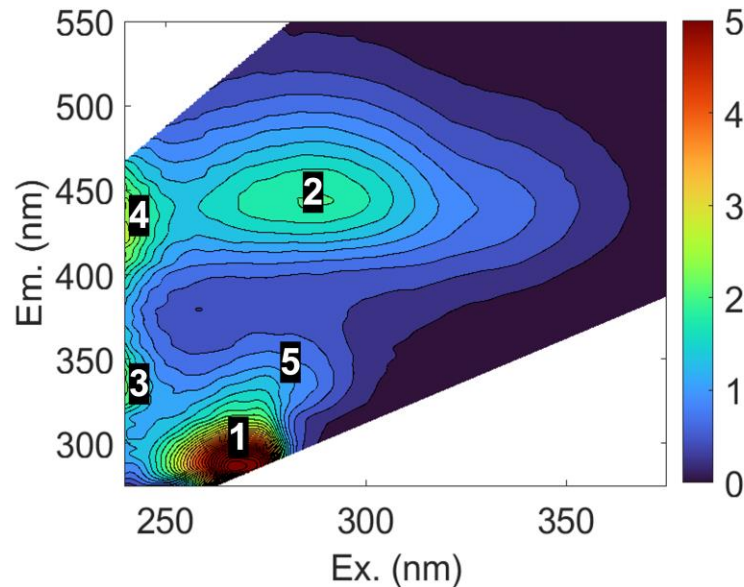
Cyclohexanamine,
N-cyclohexyl-



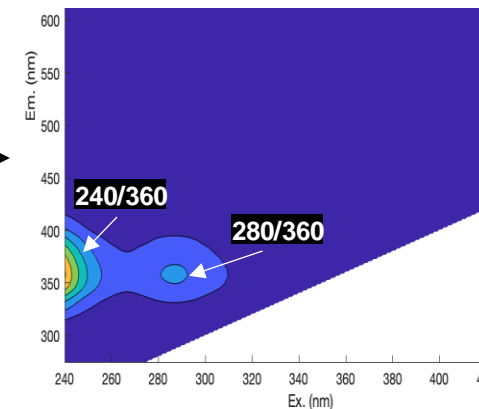
Quinoline, 1,2-dihydro-2,2,4-trimethyl-



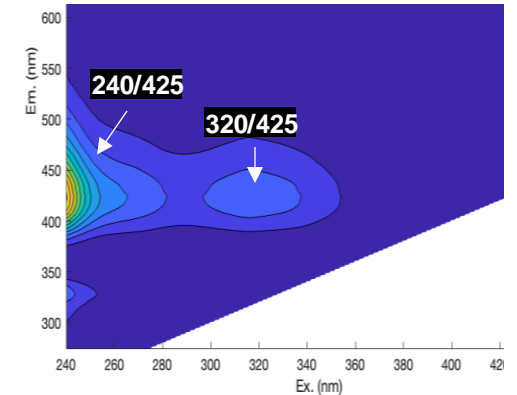
TWP
Leachate



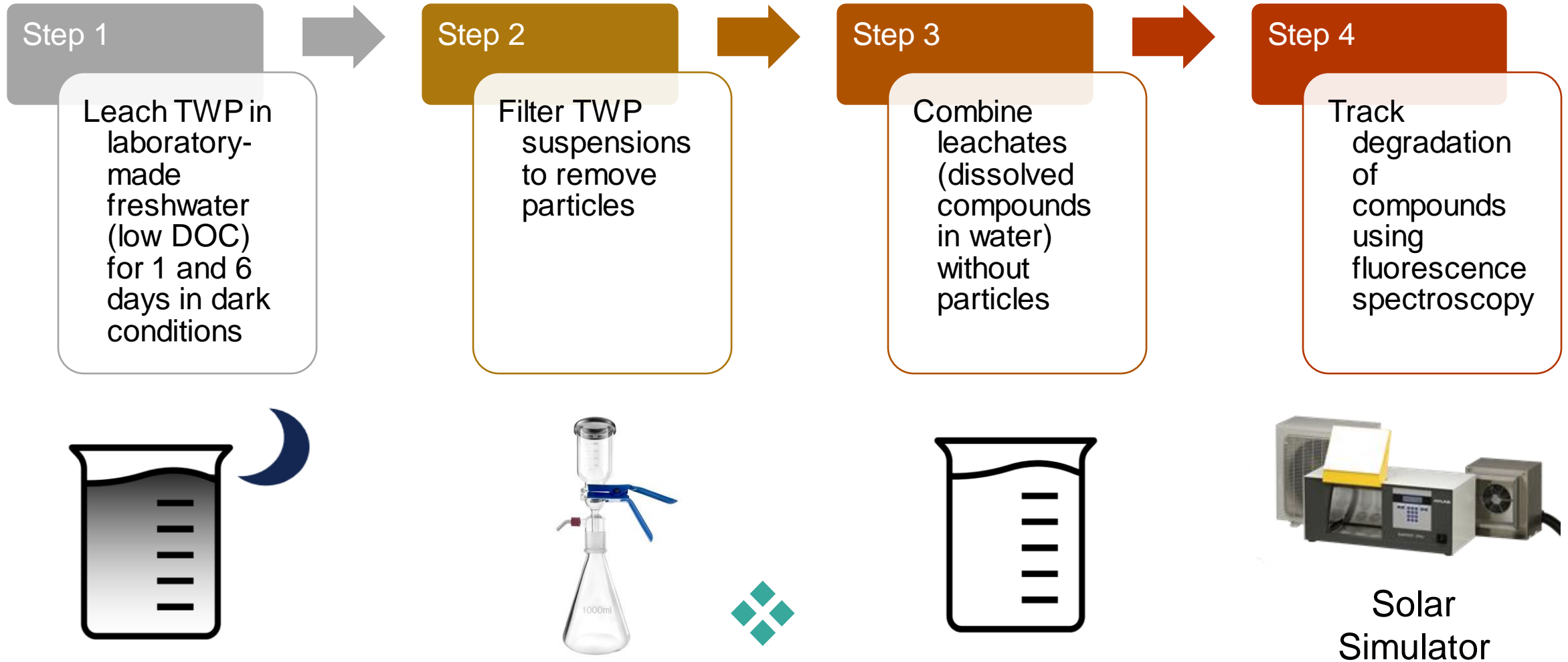
Peaks 3 and 5



Peak 4



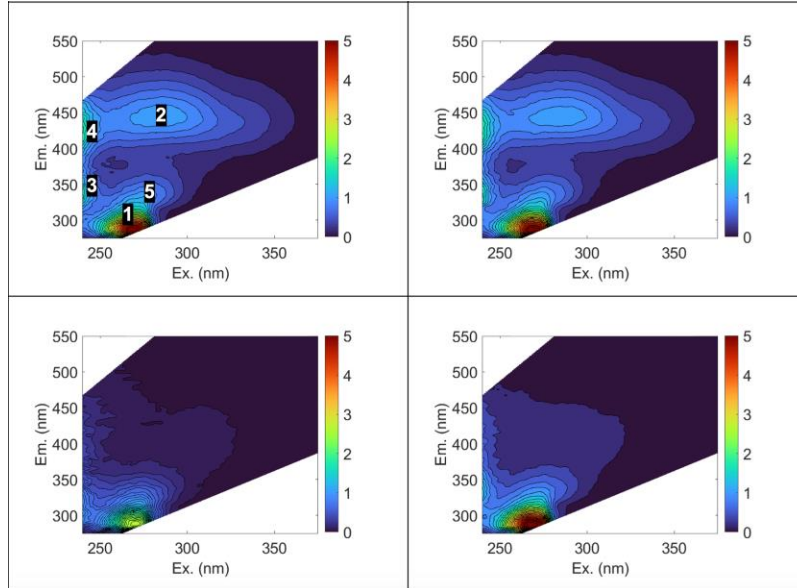
TWP leachate photodegradation



TWP leachate photodegradation



0 hours



3 days

Fastest
degradation



Pristine TWP
leachates

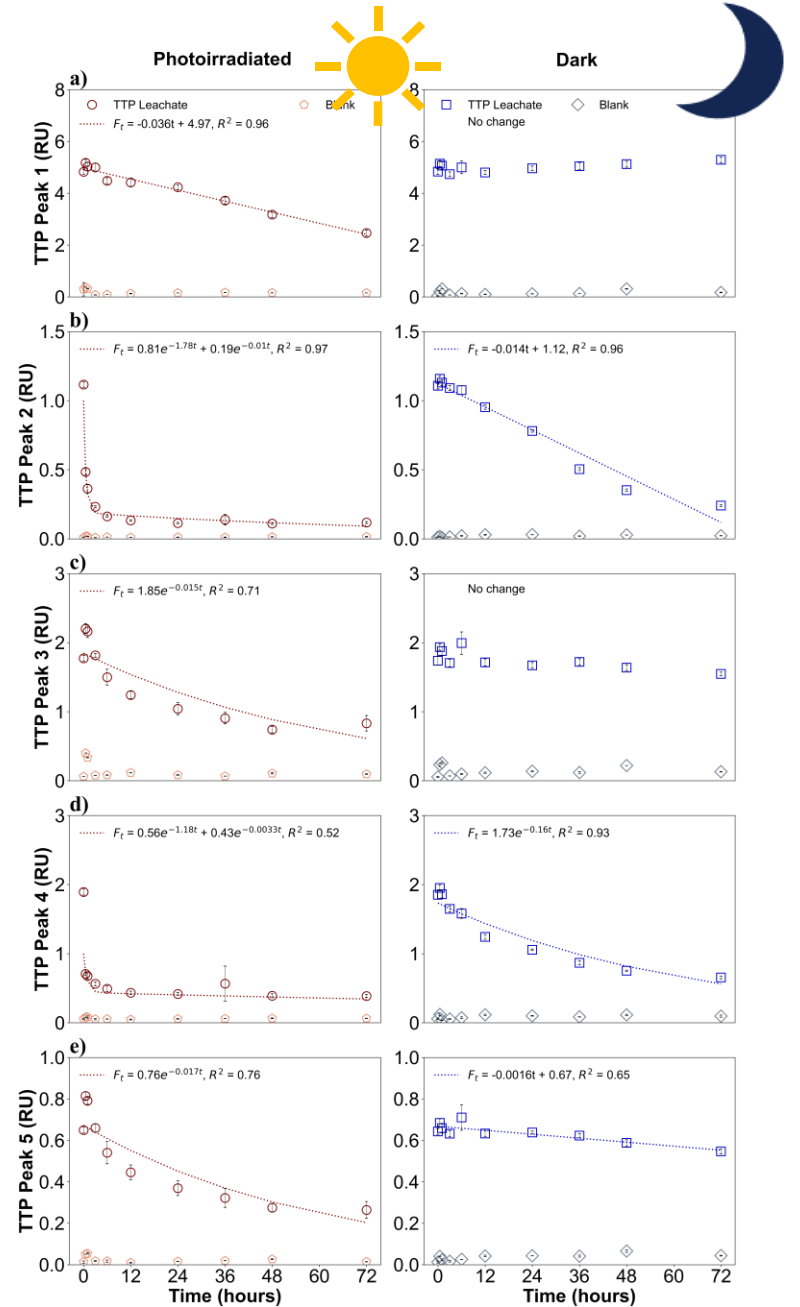
1

2

3

4

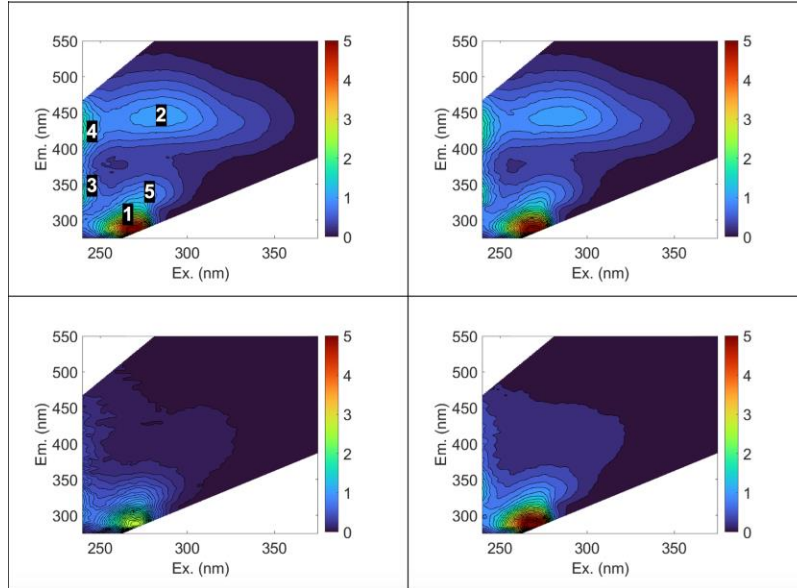
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TWP leachate photodegradation



0 hours



3 days

Slowest degradation

Pristine TWP leachates



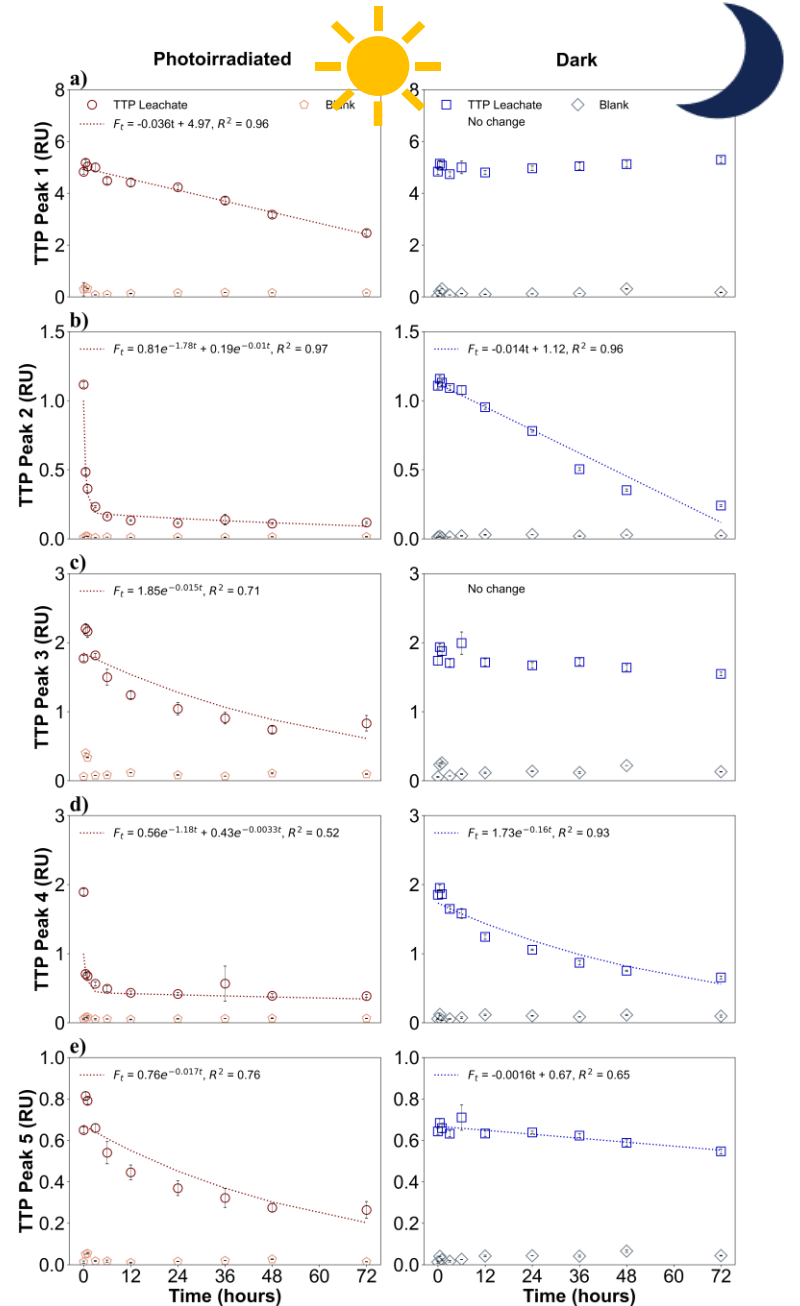
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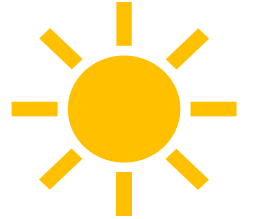
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Conclusions

- In under 24 hours, most compounds leach from TWP in water
- Compounds can be photo-labile, persistent, or volatile
- TWP-specific compounds can be tracked with fluorescence
- *Next steps*: identify additional compounds that were rapidly degraded or persisted under sunlight



Thank You



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