Assessing the potential of fluorescence spectroscopy to track the presence of contaminants in water reuse systems

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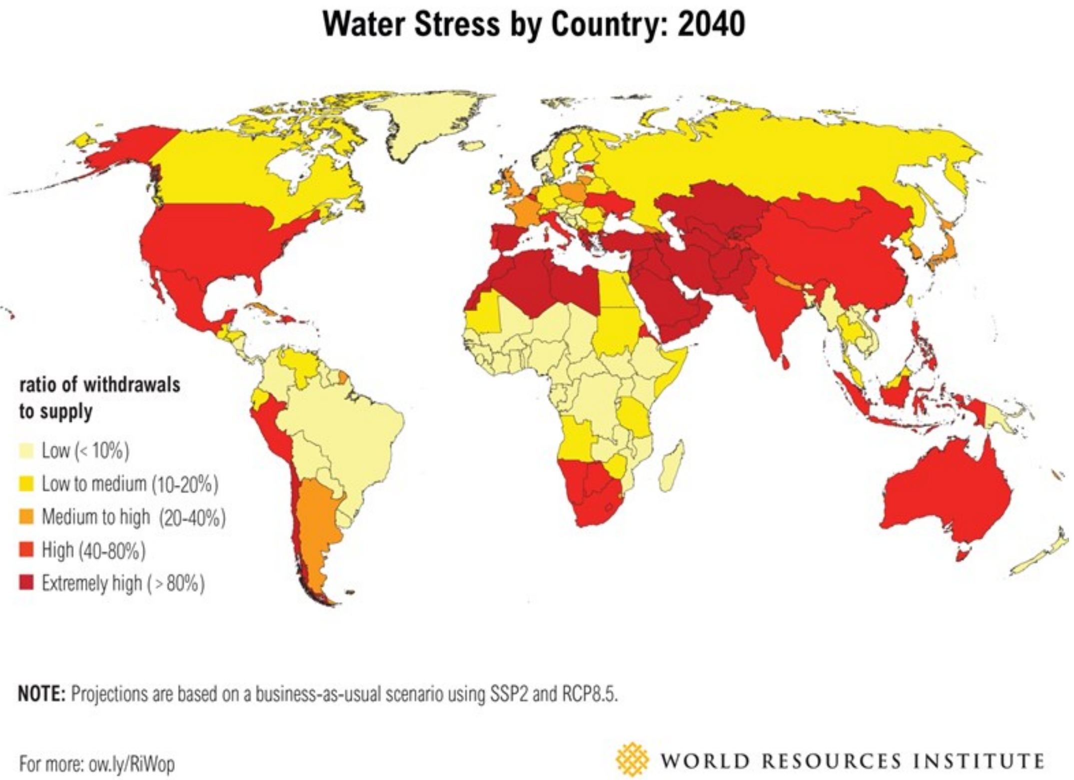
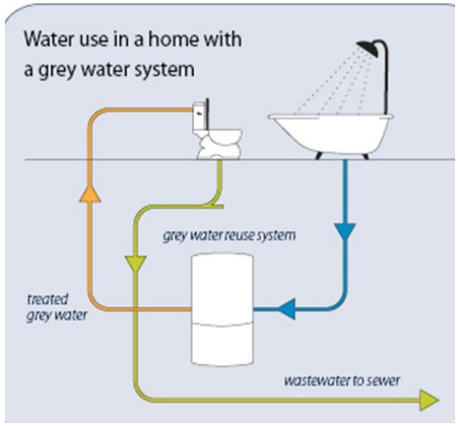
WIRL
WATER INNOVATION & REUSE LAB

MOTIVATION



- A way forward is water reuse
  - Non-potable
  - Potable
    - indirect and direct



ETC

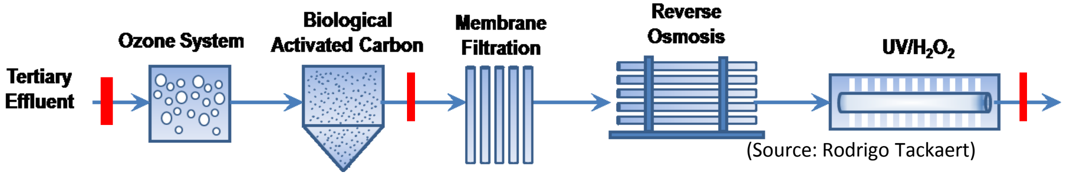
RESEARCH PROBLEM

Risk of public health

Public Perception

Water reuse has challenges

- For <u>potable water reuse</u>, water must meet stringent standards.
- There is a need for advanced monitoring of:
  - **Source waters**
  - **Performance of different barriers**



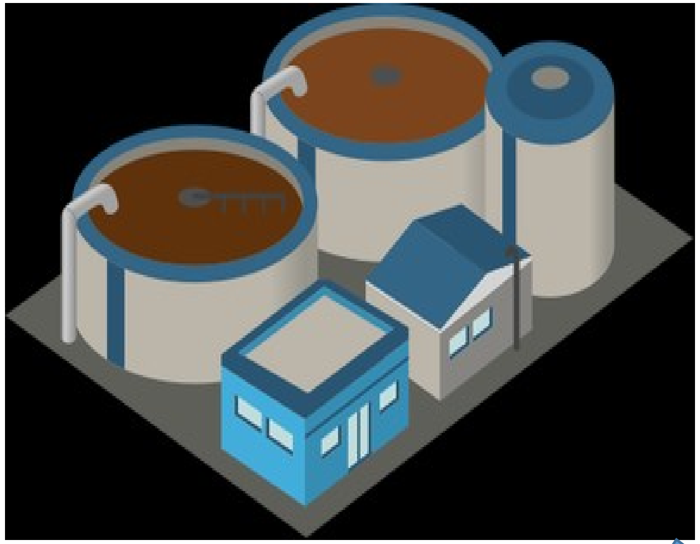
(Source: Rodrigo Tackaert)

RESEARCH QUESTION

Water Reuse Facility

Online water quality sensor to monitor any presence of contaminants or spill

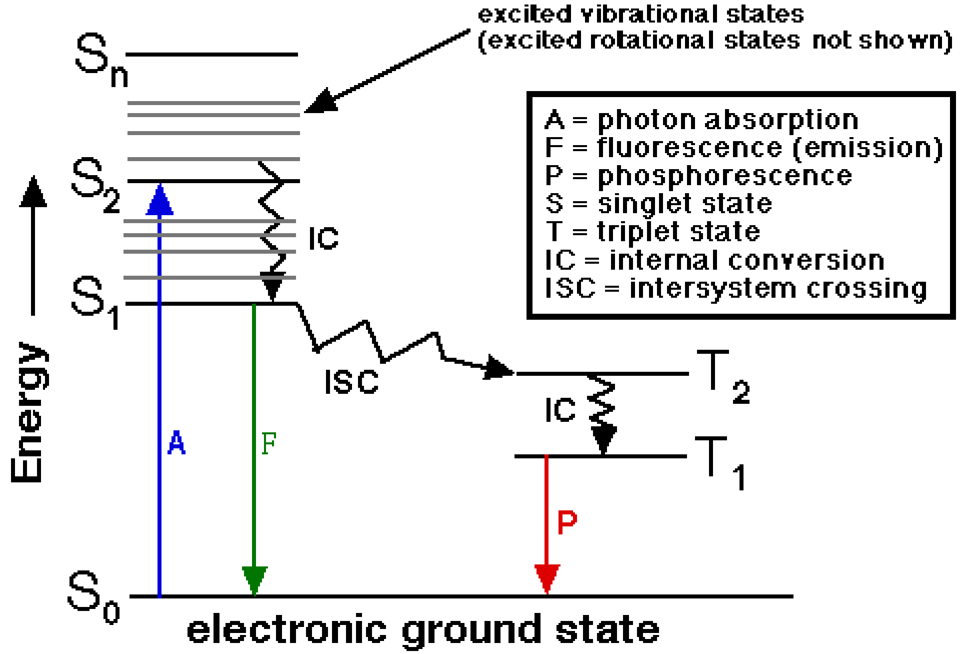
RECYLCLED WATER CONSUMERS

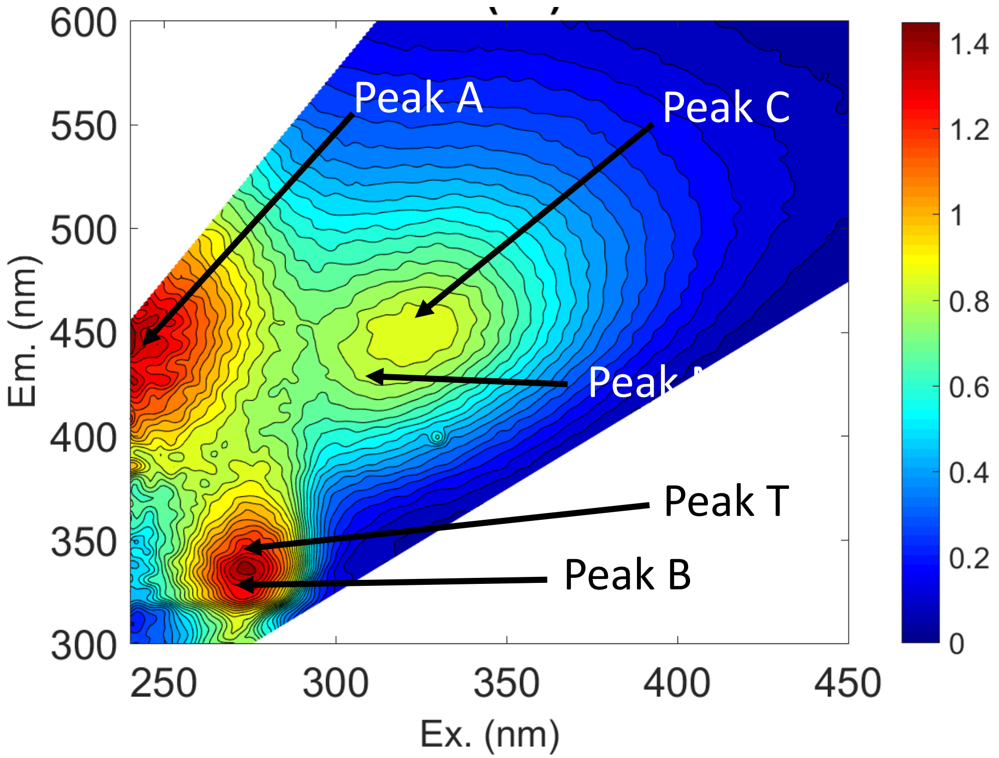


~~Waste Water treatment Plant~~

How well do in-situ *fluorescence sensors* *track contaminants of concern?????*

Fluorescence spectroscopy (FS) and the excitation emission matrices (EEMs)

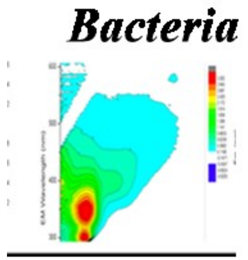




Advantages of FS

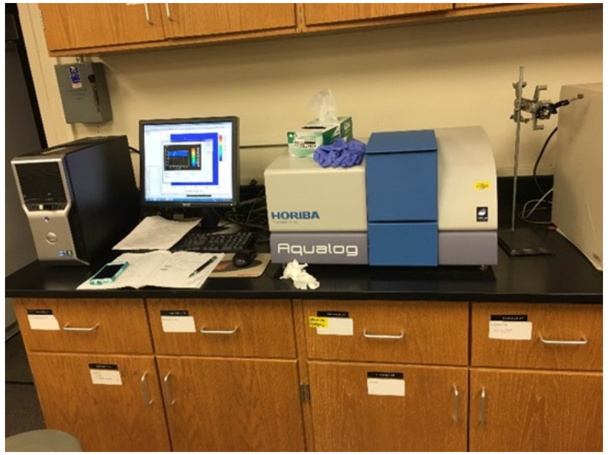
- Sensitive and selective
- No sample preparation needed

Peak T has been used to track bacteria and wastewater influence



MONITORING EQUIPMENT

3D Benchtop fluorometer

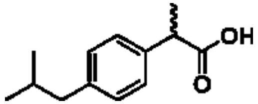


	(ex260, max em (380:460))
	(ex350,maxem(420:480))
	(ex275,em310)
	(ex275,em340)
	(ex312,maxem(380:420))

Insitu C3 fluorometer

	Ex 325±120, em470±60
	Ex285+120, em350±55

- Spike contaminants into several water sources
  - *VOCs (Diesel and Gasoline)*
  - *PPCPs (Ibuprofen, Caffeine and Lopinavir)*
  - *Pesticides (Isoxathion)*



- Monitor the changes in DOM fluorescence intensities and characteristics

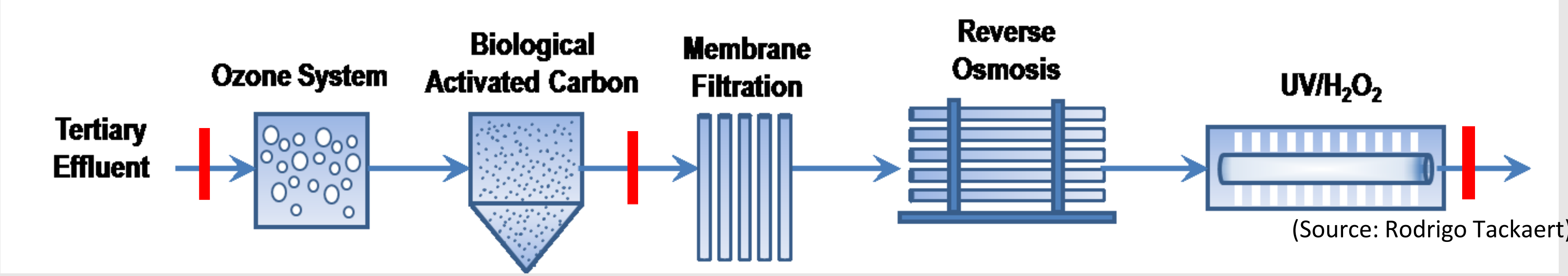
WATER SOURCES USED

Advanced Water Purification Facility, San Diego, CA

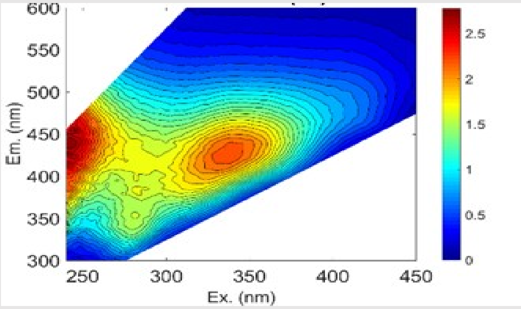
Photo by City of SD Public Utilities Department

Collection points:

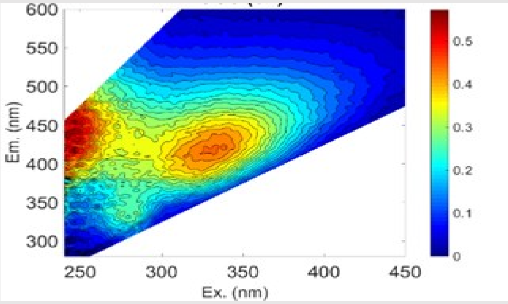
- Before ozonation (Pre-ozone)
- After ozonation (Post-ozone)
- After UV (UV-AOP)



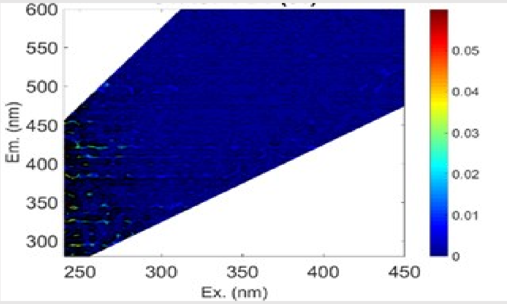
(Source: Rodrigo Tackaert)



Pre-ozone water

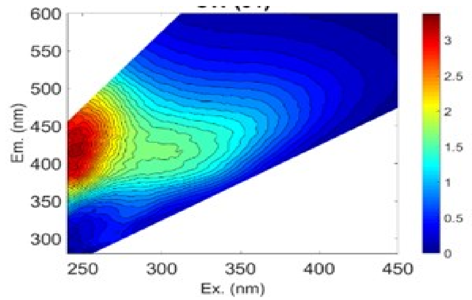


Post-ozone water

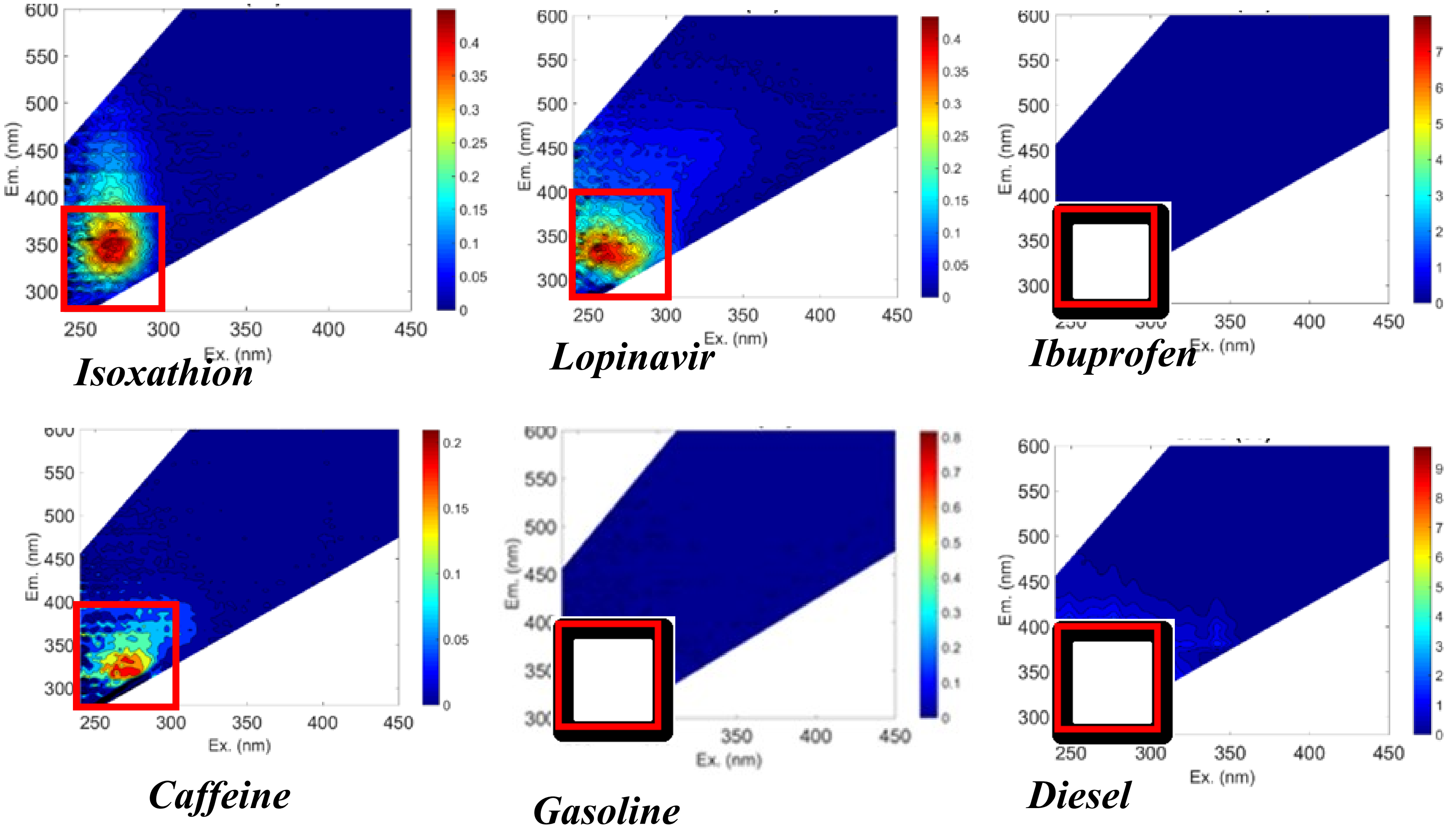


UV-AOP water

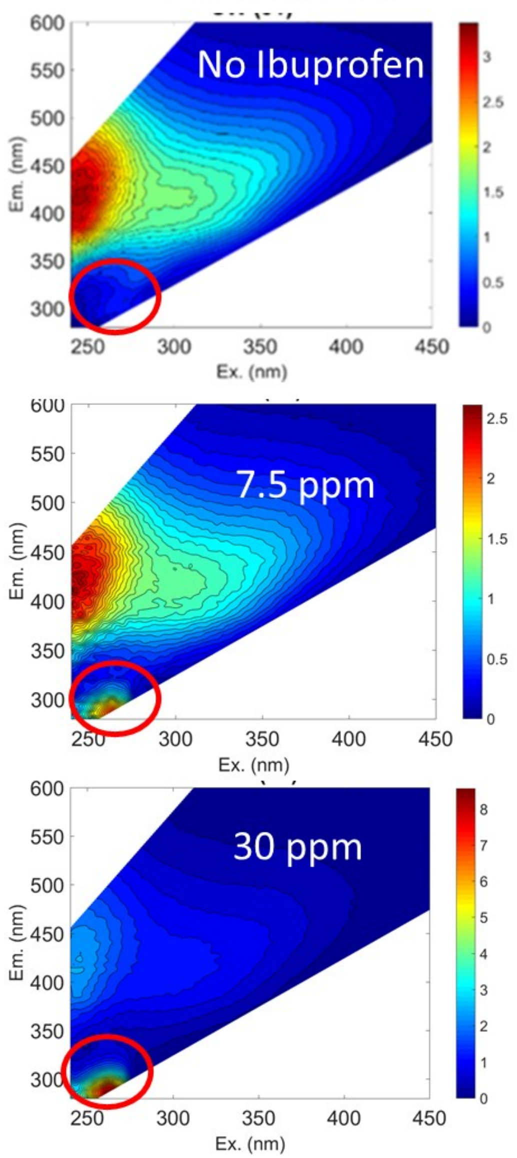
Alvarado Creek, San Diego, CA



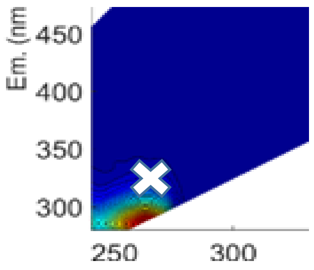
Creek water



CREEK WATER



- All contaminants fluorescein the tryptophan-like peak region.
- But can we distinguish them against the background?

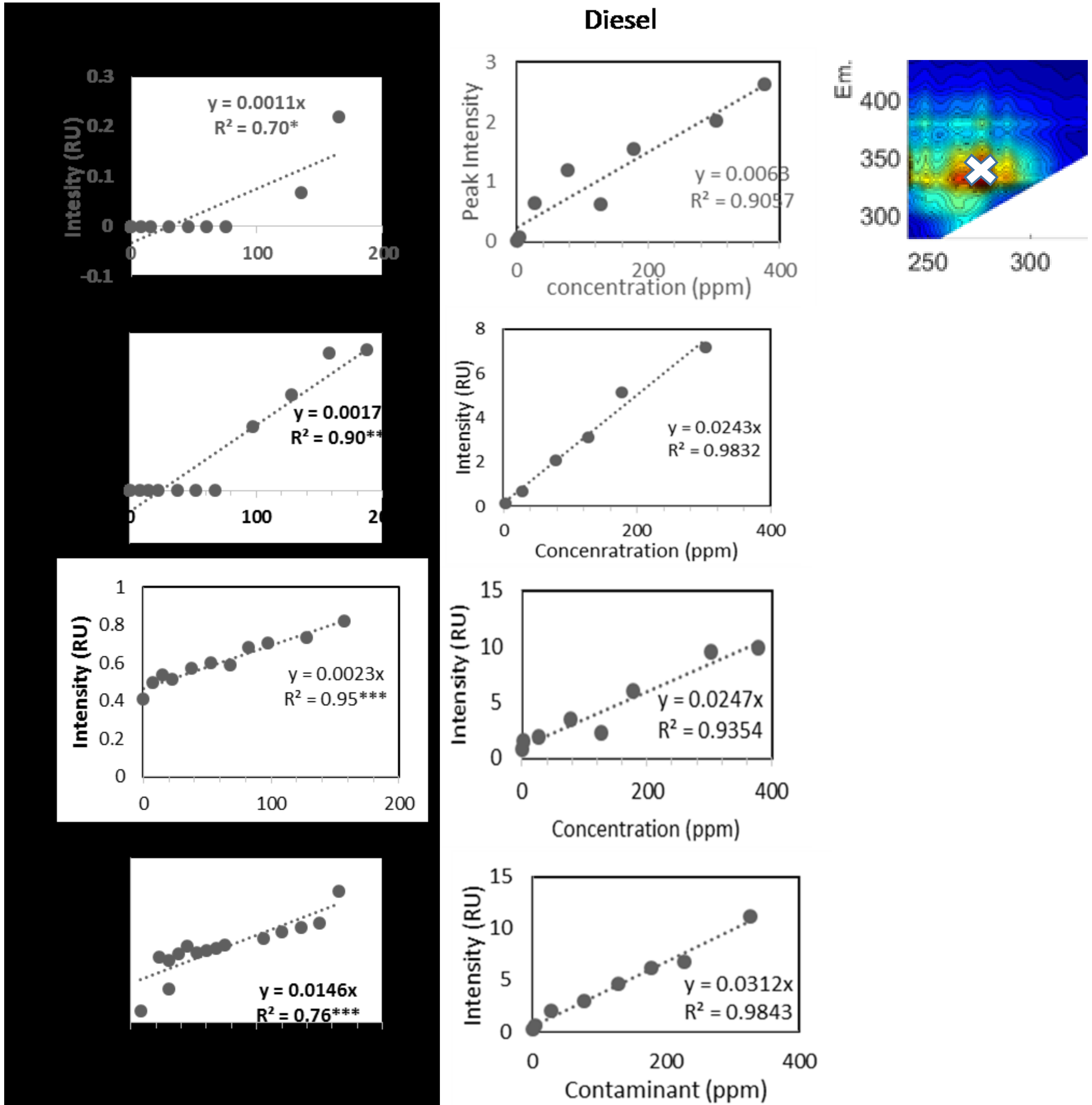


3D benchtop fluorometer

Results of titration with contaminants

- Strong linear and significant relationship relationship between peak B intensities and contaminant concentration

- Ibuprofen peak not tracked well with Peak T or B fluorescence



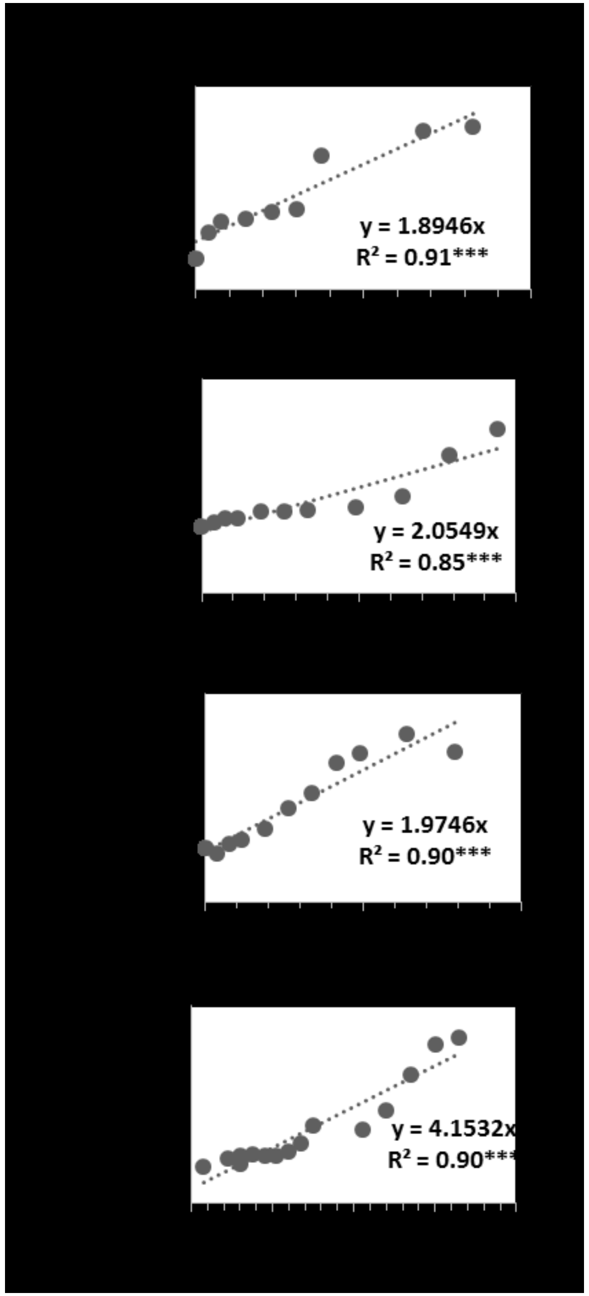
C3 submersible fluorometer

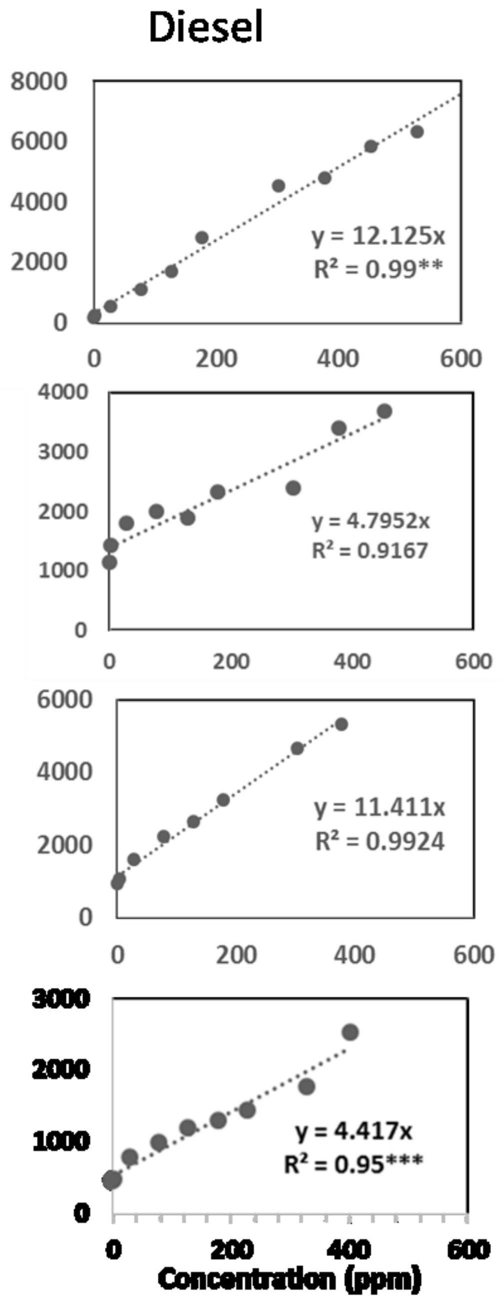
Results of titration with contaminants

- Strong linear and significant relationship relationship between tryptophan intensities and contaminant concentrations

- C3 allows a wider range of fluorescence to be captured hence better R2 values

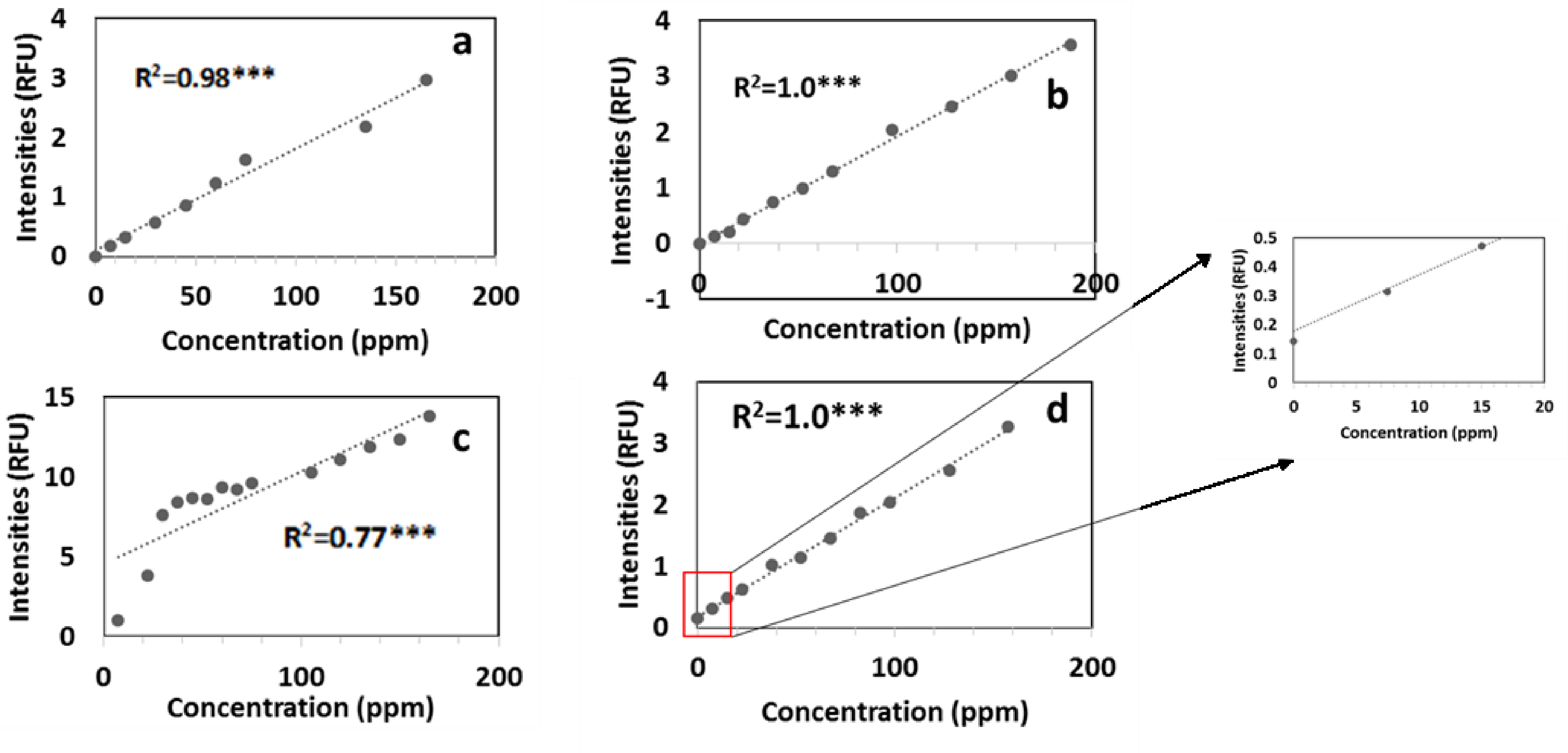
	Ex 325±120, em470±60
	Ex285+120, em350±55





- Adjusting the algorithm to track a specific Ibuprofen peak

Peak I (Ex/Em 260/(290-300 nm)



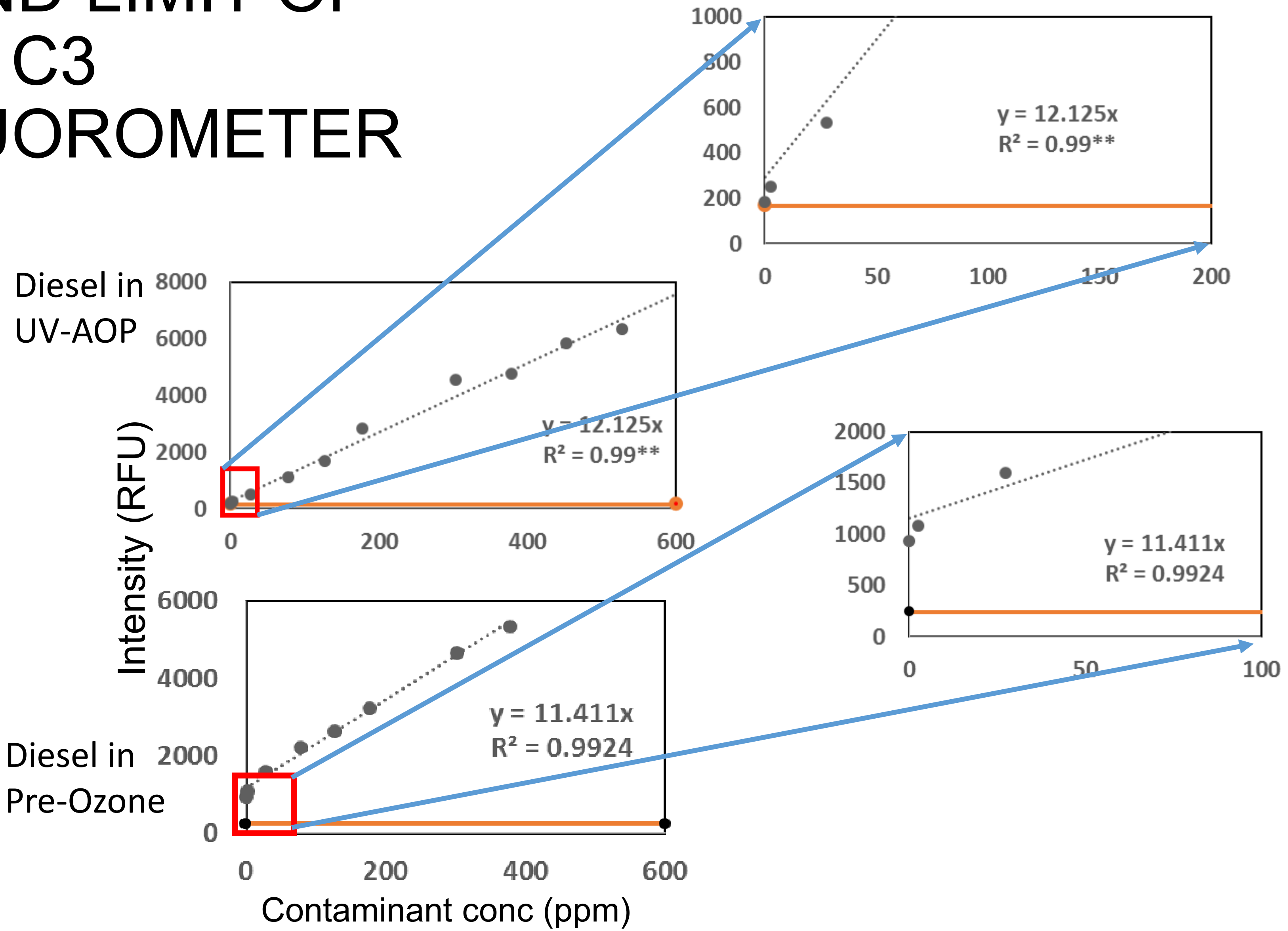
(a) UV-AOP water, (b) post-ozone water, (c) Creek water and (d) Pre-ozone water

LIMIT OF BLANK AND LIMIT OF DETECTION FOR A C3 SUBMERSIBLE FLUOROMETER

Tryptophan

The limit of Blank (LOB) and the Limit of detection (LOD) were calculated based on 10 replicates following Armbruster and Pry (2008)

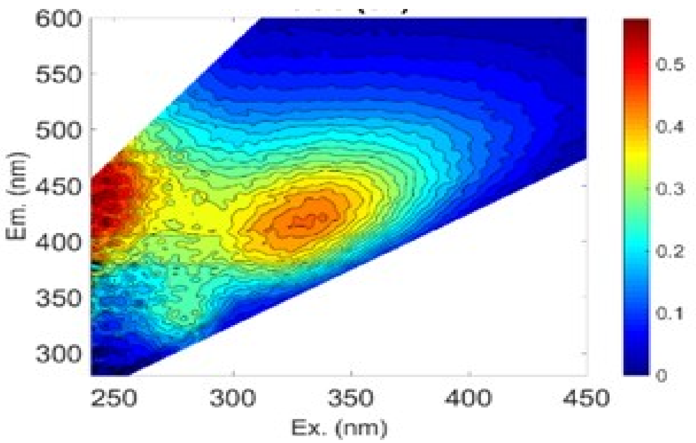
Water source	LOD (RFU)
UV-AOP	163
Post-Ozone	148
Pre-Ozone	242
Creek Water	224



- Tryptophan-like peak is the best choice for contaminant monitoring
- Applications:
  - Source water monitoring (contaminant spills, industrial discharges…)
  - Monitoring performance of treatment steps (barriers) in water reuse systems

- Advantage of in-situ instrument:
  - Optical filters on C3 cover a "range" of excitation and emission wavelengths
  - Capture multiple contaminants (VOCs, pesticides, PPCPs,…)
  - Ratio of TRP peak to CDOM peak could discriminate contaminant from background

- Benchtop instrument could provide superior monitoring if peak corresponding to every chemical is tracked
  - 3D EEM visualization
  - Algorithm to track peaks



Post-ozone water

Acknowledgements

- SDSU President's Leadership Fund
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- Bill Pearce and colleagues at Pure Water
- My lab mates at the Water Innovation and Reuse Lab, SDSU

Thanks for listening!
Any questions?