



Laboratory of Environmental Analytical Chemistry

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Università di Torino
Centro interdipartimentale
sui rischi naturali in ambiente
montano e collinare

Photochemical self-depuration processes in surface waters

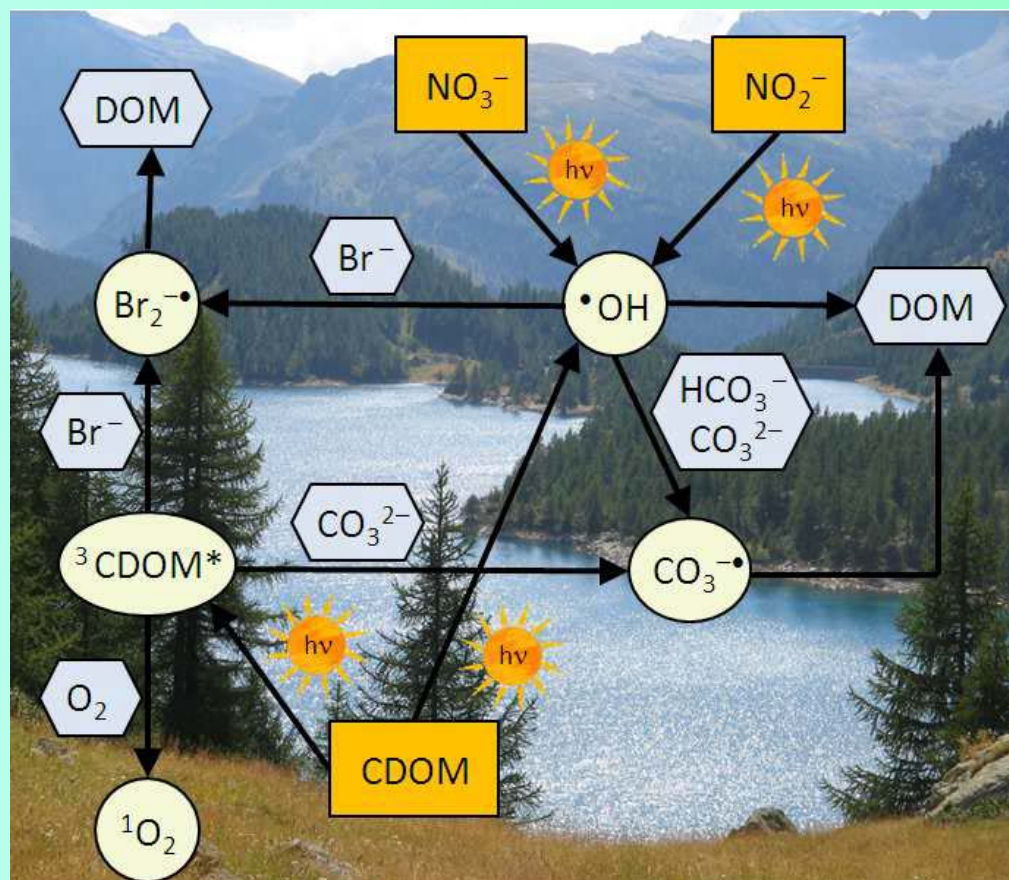
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Photochemical reactions in freshwater

- Direct photolysis.
- Indirect photochemistry:
 - Reaction with photogenerated transient species.
 - $\cdot\text{OH}$, $^1\text{O}_2$, $\text{CO}_3^{\cdot-}$, $^3\text{CDOM}^*$.
- Transformation of organic pollutants.



Photochemical reactions

R.E.A.CH.

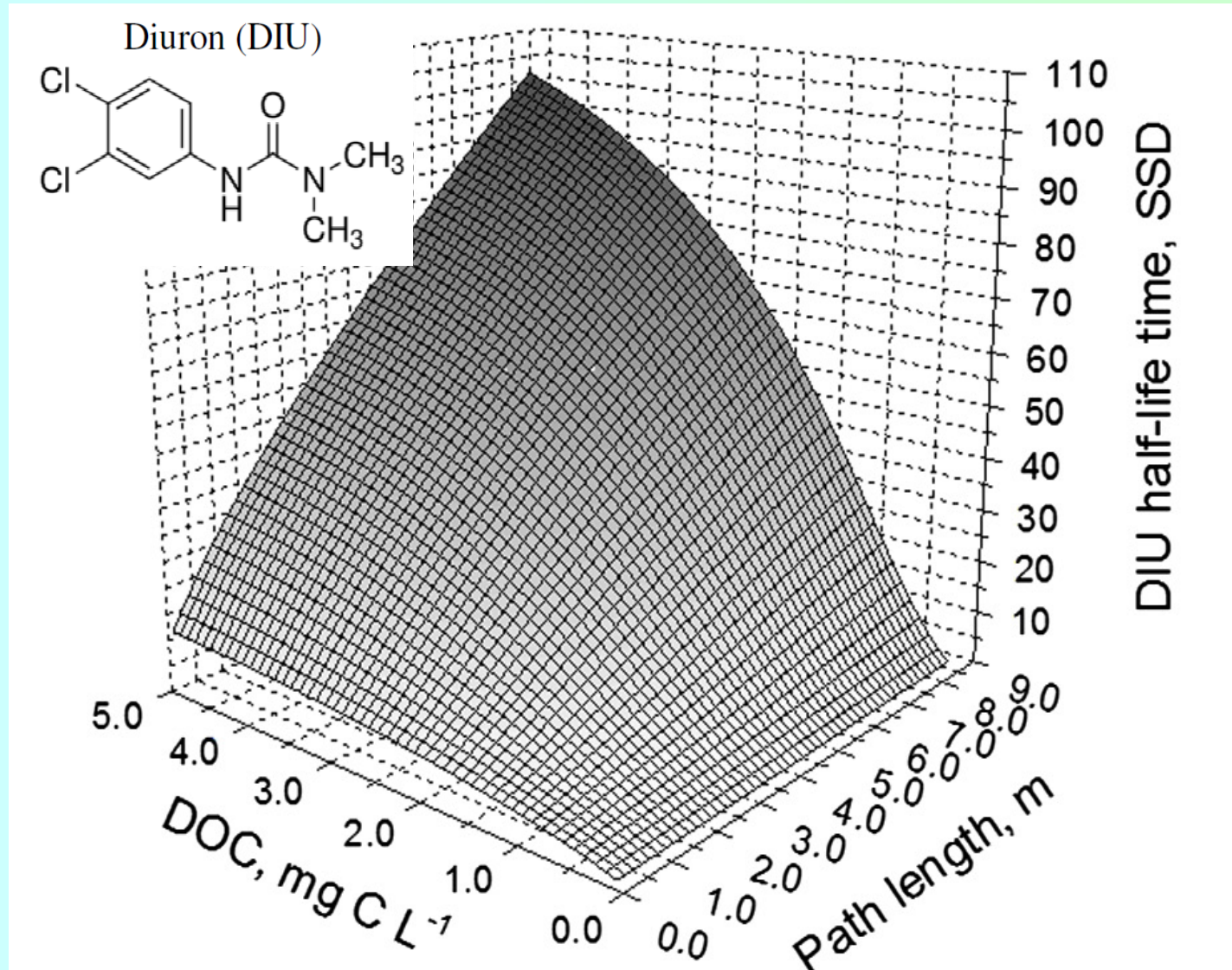


As far as photoreactivity is concerned,

Photostable \leftrightarrow Photolabile compounds

Substrate-dependent...

...and environment-dependent



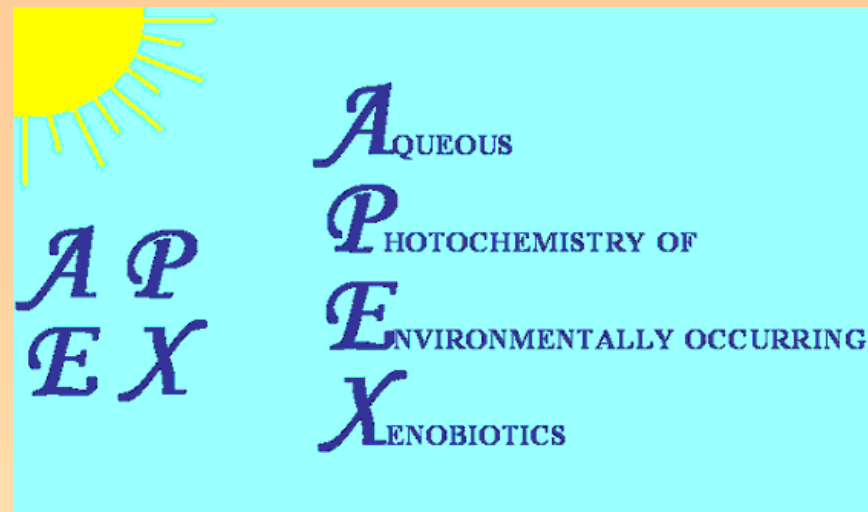
Standard quantities (sunlight irradiance and spectrum, formation quantum yields of transients)

Environmental variables
(water chemistry, depth, spectrum)

Substrate reactivity
(quantum yield, reaction rate constants, formation yields of intermediates)

Model equations

OUTPUT DATA (first-order rate constants, steady-state concentrations)



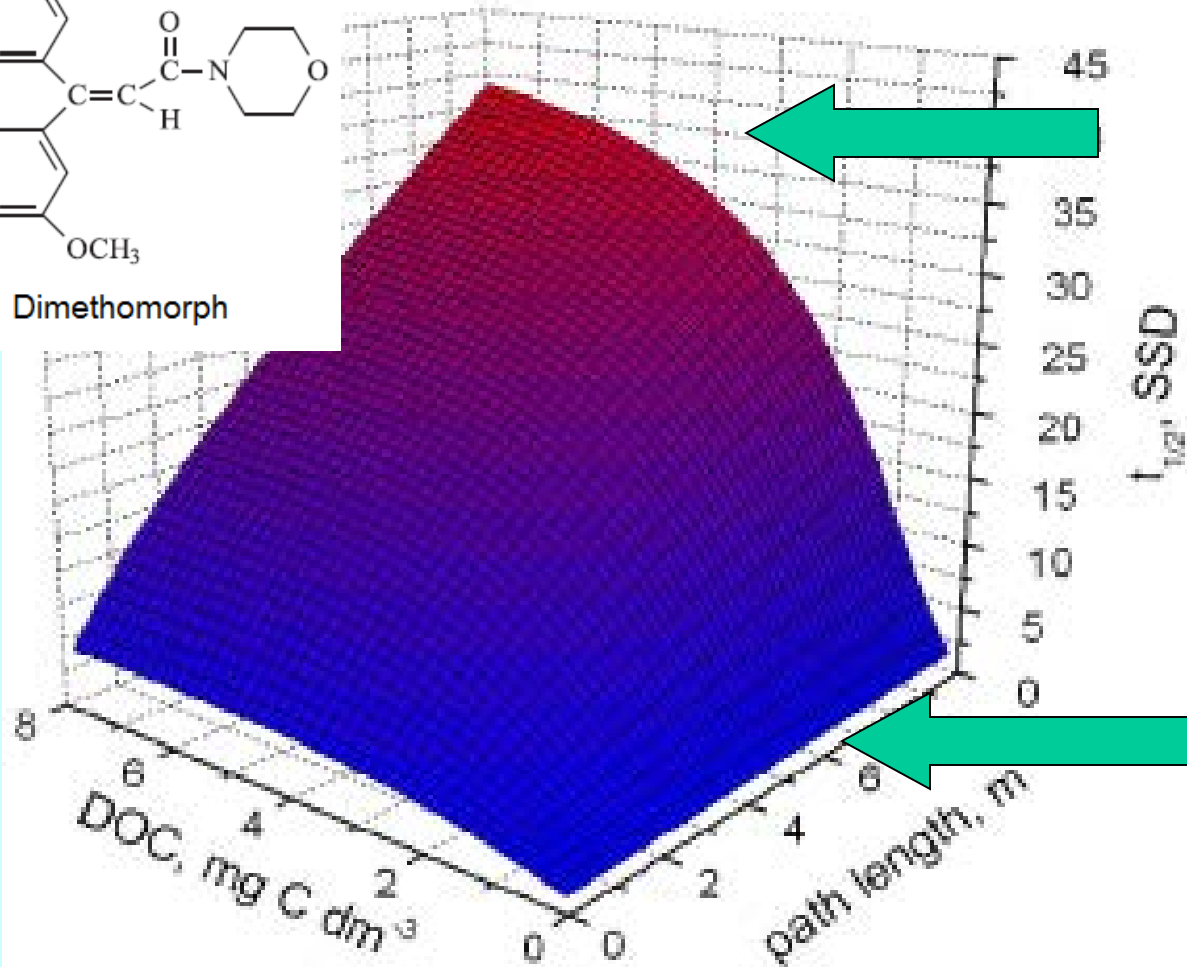
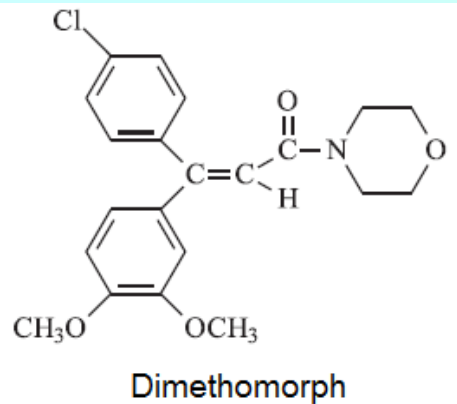
Environ. Sci.: Processes Impacts **2014**, *16*, 732-740 (free download – APEX.zip - as article ESI)

DOES IT WORK?

	$t_{1/2}$, model (days)	$t_{1/2}$, field (days)	Location	Reference
4-Nitro-2-chlorophenol	6.3±2.3	8.5±0.2	Rhône	<i>Environ. Sci. Technol.</i> 2011 , <i>45</i> , 209-214
2-Nitro-4-chlorophenol	5.5±1.5	6.4±0.1	Rhône	<i>Sci. Total Environ.</i> 2012 , <i>426</i> , 296-303
MCPA	11.5±2.1	10	Rhône	<i>Wat. Res.</i> 2010 , <i>44</i> , 6053-6062
Ibuprofen	60±10	60-110	Greifensee	<i>Wat. Res.</i> 2011 , <i>45</i> , 6725-6736
Carbamazepine	115±45	140±50	Greifensee	<i>Environ. Sci. Technol.</i> 2012 , <i>46</i> , 8164-8173
Atrazine	13-85	20-100	Chesapeake Bay	<i>Wat. Res.</i> 2013 , <i>47</i> , 6211-6222

<p><i>Macrolide antibiotics</i> <i>Water Research</i> 2009, 43, 1959-1967.</p>	<p><i>Benzophenone-3</i> <i>Sci. Total Environ.</i> 2013, 463-464, 243-251.</p>
<p><i>2,4-Dinitrophenolate</i> <i>Chemosphere</i> 2010, 80, 759-763.</p>	<p><i>Benzophenone-4</i> <i>Water Research</i> 2013, 47, 5943-5953.</p>
<p><i>MCPA</i> <i>Water Research</i> 2010, 44, 6053-6062.</p>	<p><i>Atrazine</i> <i>Water Research</i> 2013, 47, 6211-6222.</p>
<p><i>2,4-Dichloro-6-nitrophenolate</i> <i>Environ. Sci. Technol.</i> 2011, 45, 209-214.</p>	<p><i>Cycloxydim</i> <i>Chemosphere</i> 2014, 99, 272-275.</p>
<p><i>Ibuprofen</i> <i>Water Research</i> 2011, 45, 6725-6736.</p>	<p><i>Acetaminophen</i> <i>Water Research</i> 2014, 53, 235-248.</p>
<p><i>4-Chloro-2-nitrophenolate</i> <i>Sci. Total Environ.</i> 2012, 426, 296-303.</p>	<p><i>Nicotine</i> <i>Water Research</i> 2014, 53, 106-114.</p>
<p><i>Carbamazepine</i> <i>Environ. Sci. Technol.</i> 2012, 46, 8164-8173.</p>	<p><i>Dimethomorph</i> <i>Sci. Total Environ.</i> 2014, 500-501, 351-360.</p>
<p><i>Isobutylacetophenone</i> <i>Water Research</i> 2013, 47, 6109-6121.</p>	<p><i>Phenylurea herbicides</i> <i>Chemosphere</i> 2015, 119, 601-607.</p>
<p><i>Triclosan</i> <i>Water Research</i> 2015, 72, 271-280.</p>	<p><i>Cephalosporin antibiotics</i> <i>Chemosphere</i> 2015, 134, 452-458.</p>
<p><i>Ionic liquids</i> <i>Environ. Sci. Technol.</i> 2015, 49, 10951-10958</p>	<p><i>Solar filters</i> <i>Sci. Total Environ.</i> 2015, 537, 58-68.</p>

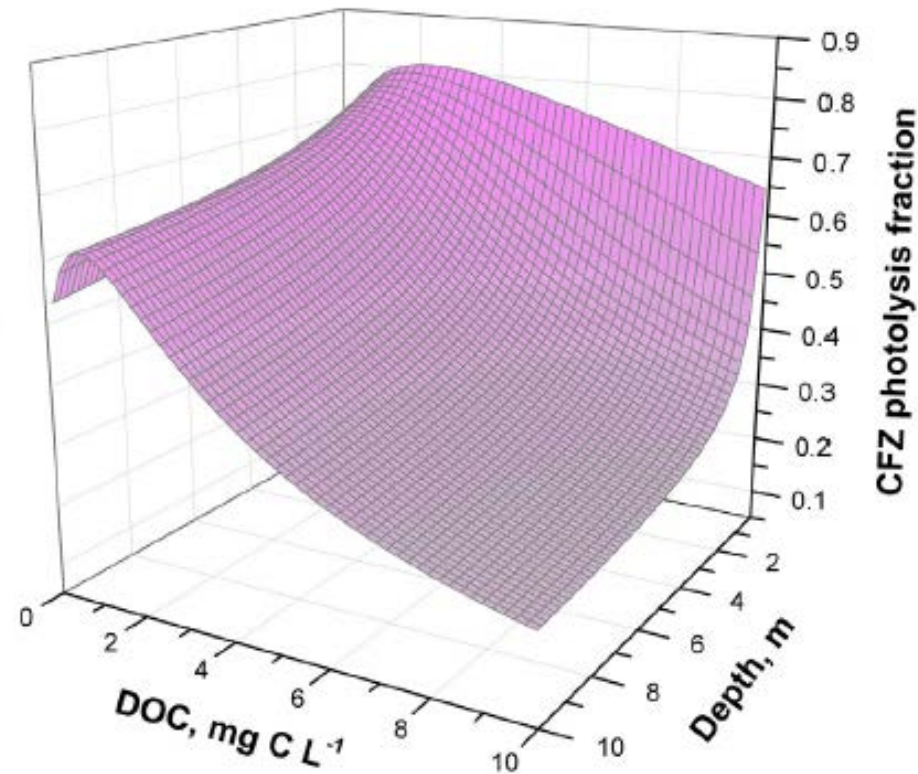
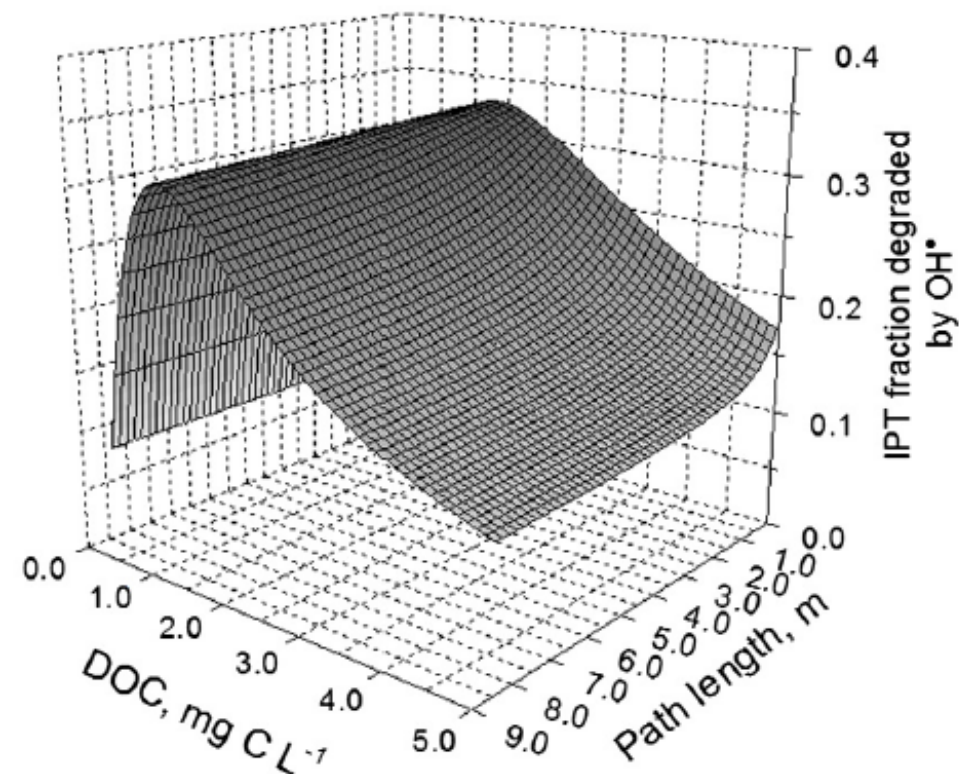
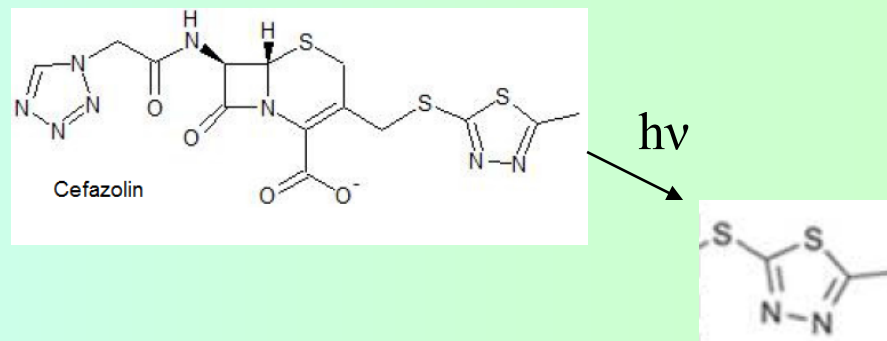
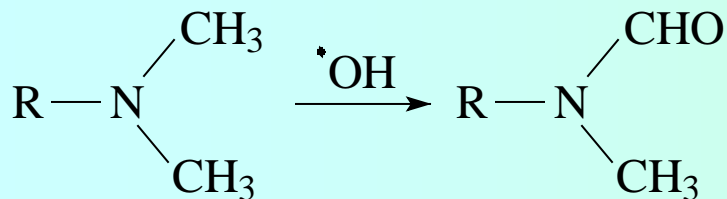
Photochemical vulnerability of water environments to pollution



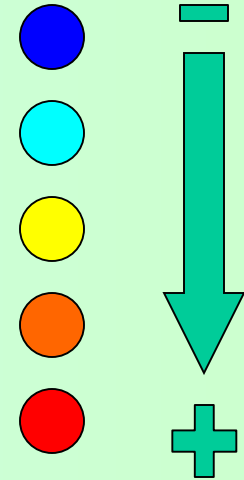
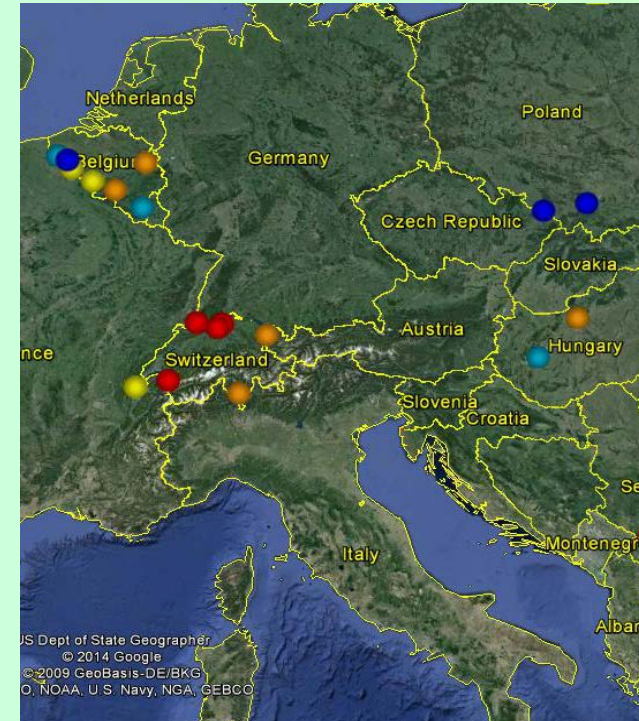
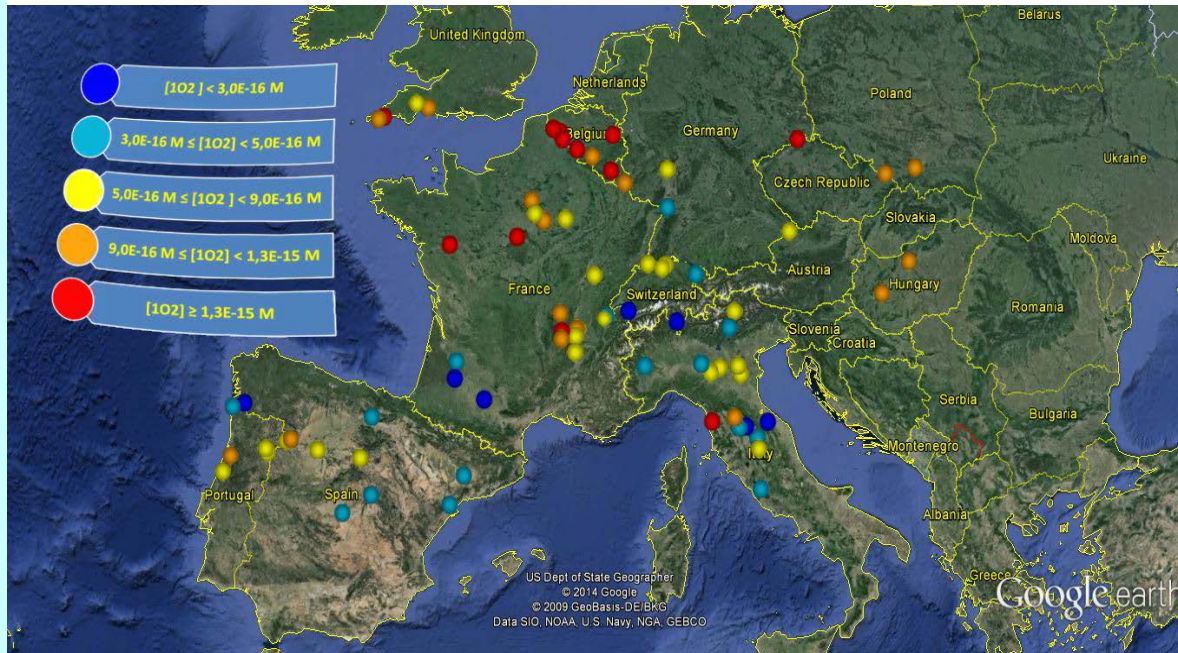
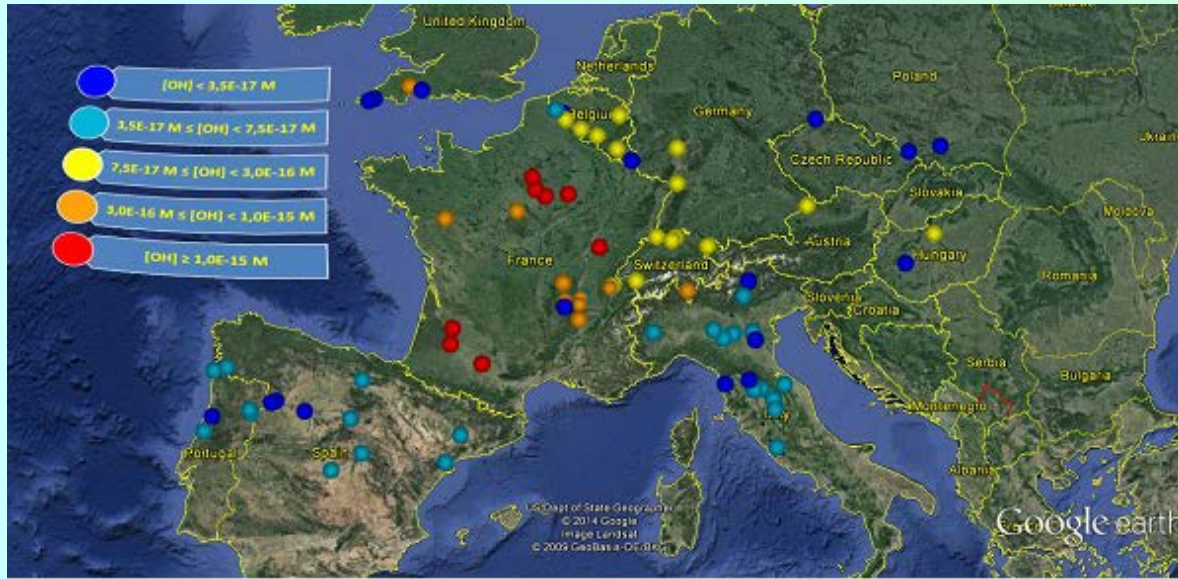
HIGH
PERSISTENCE:
more time to give
harmful effects

LOW
PERSISTENCE:
limited time to
produce harmful
effects

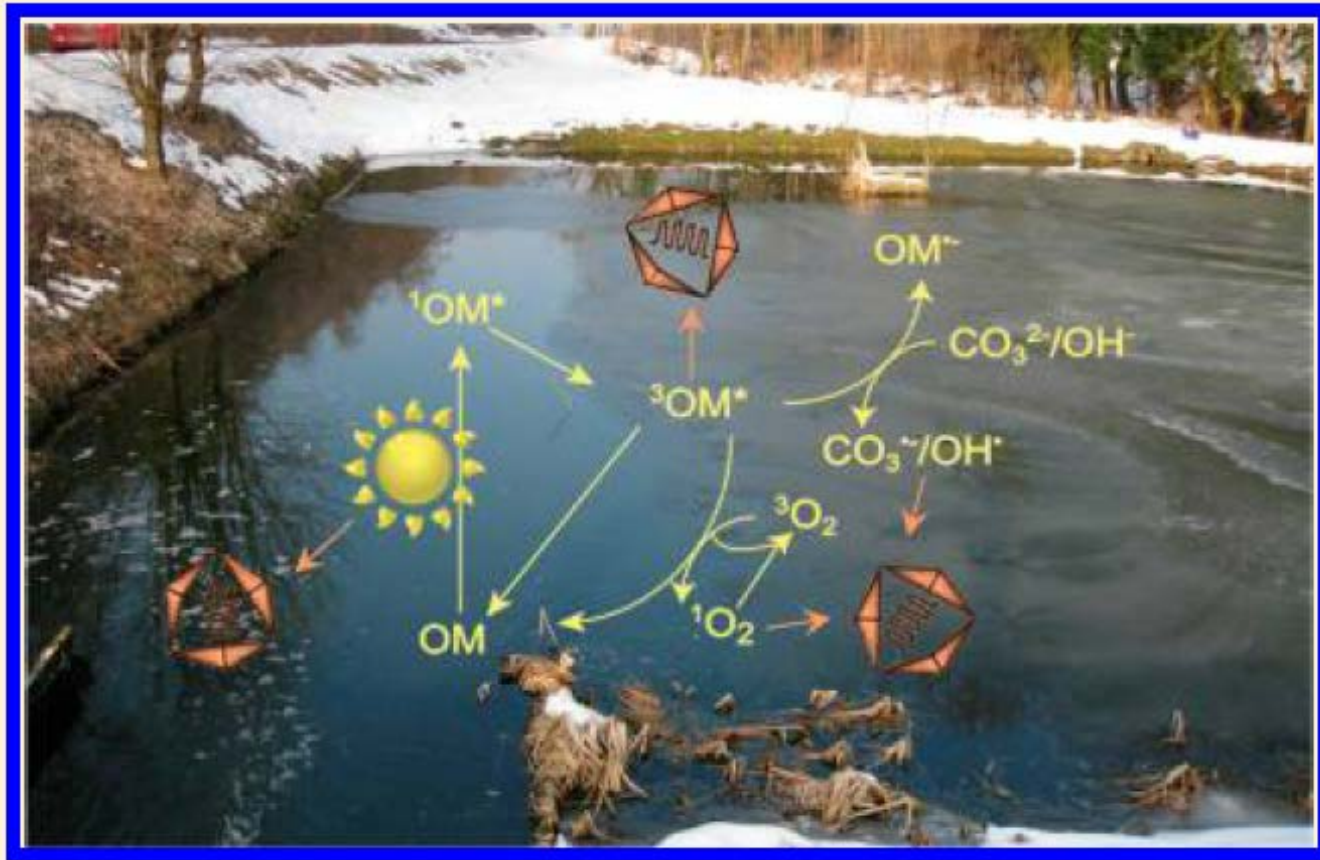
Formation of harmful intermediates

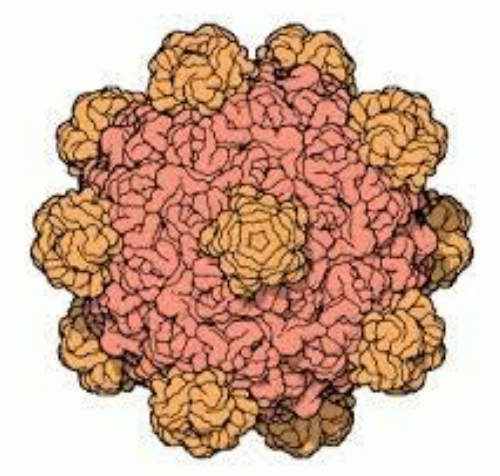
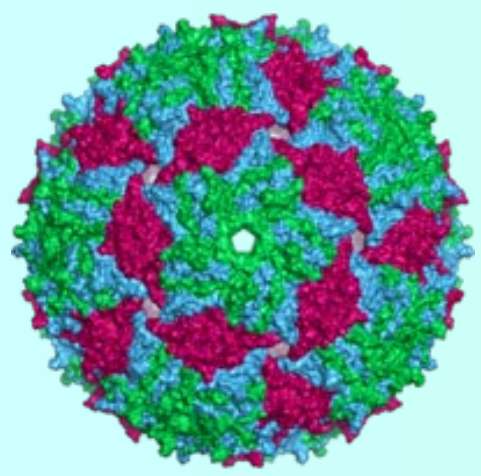
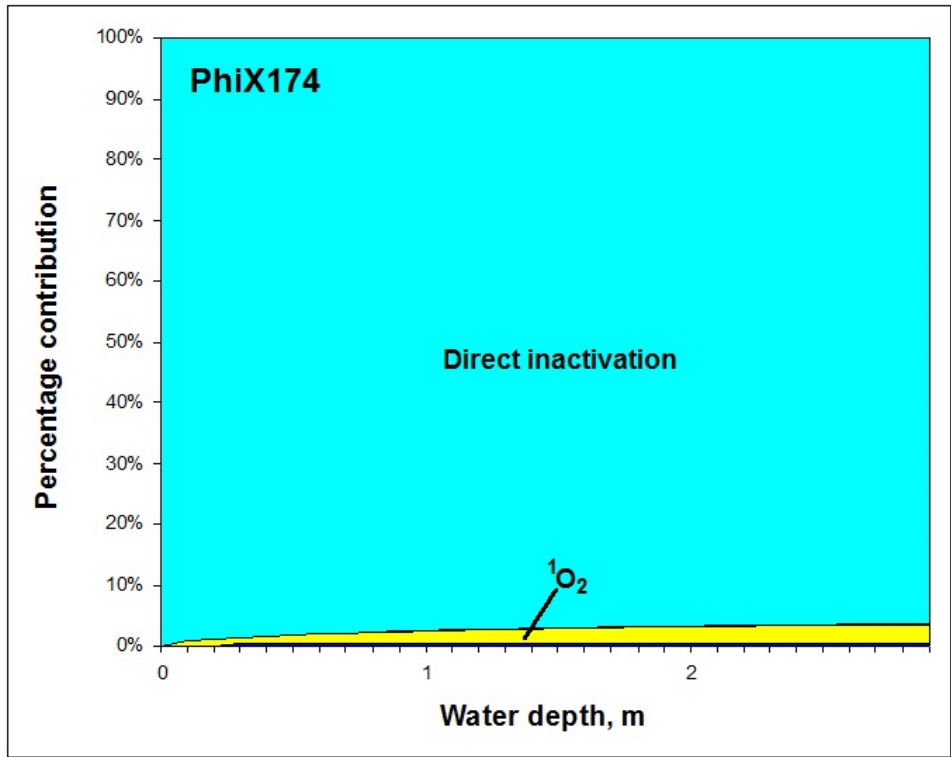
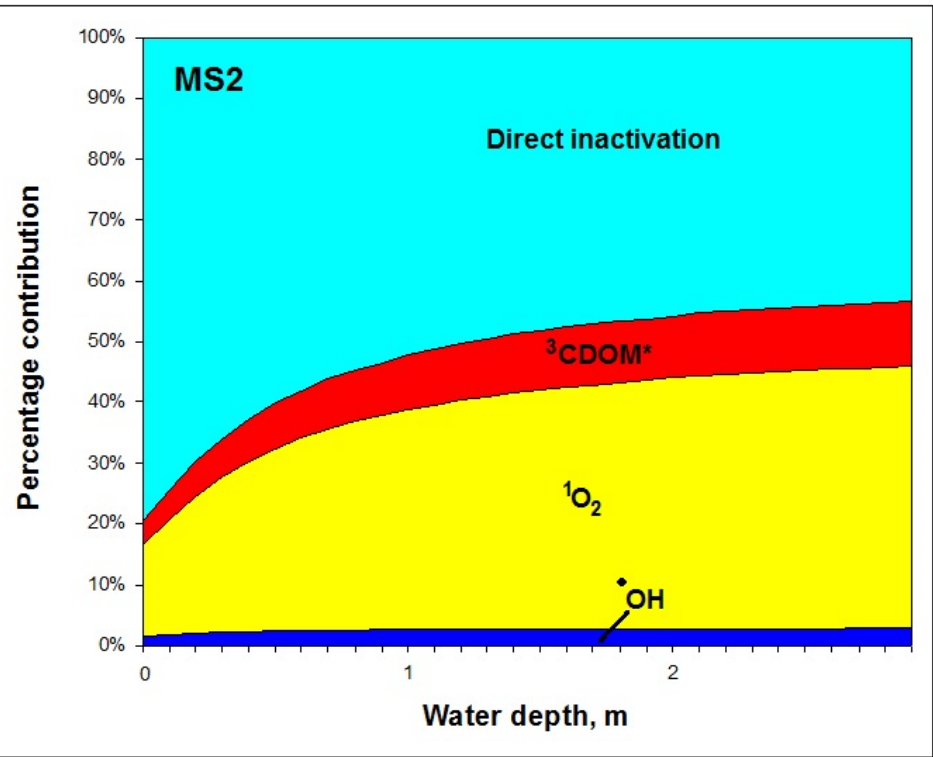


Photochemical mapping



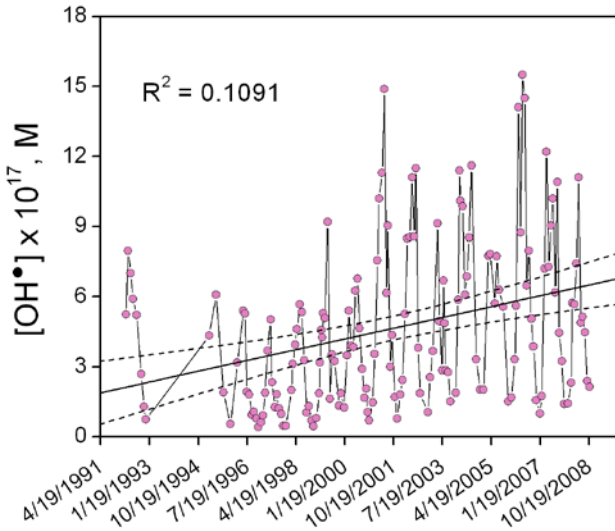
Photoinactivation of viruses





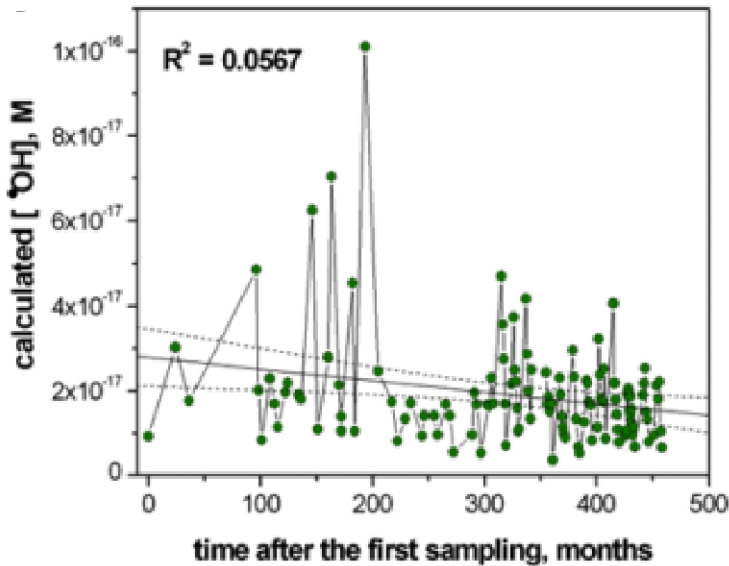
Lago Maggiore

Lake Peipsi



Sci. Total Environ.
2011, 409, 3463-3471.

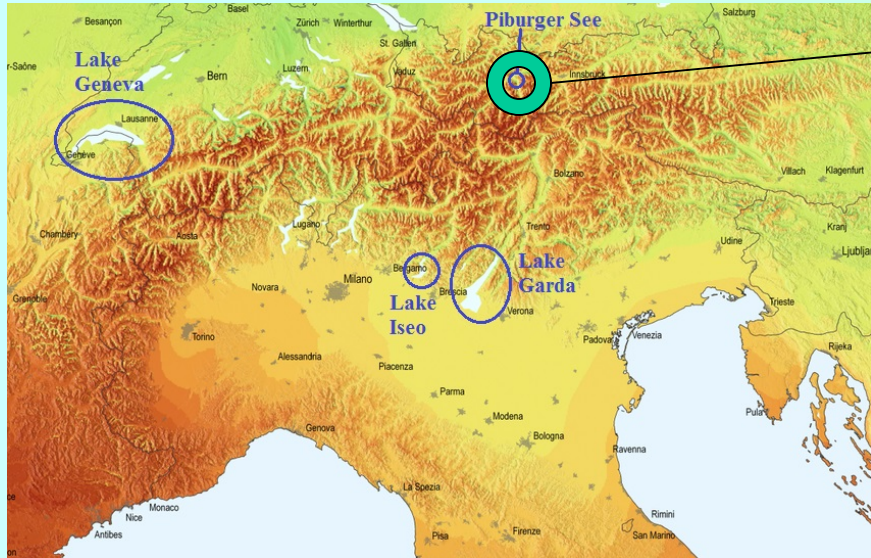
Chemosphere
2013, 90, 2589-2596.



Gradual recovery from eutrophication, decrease of DOC over time

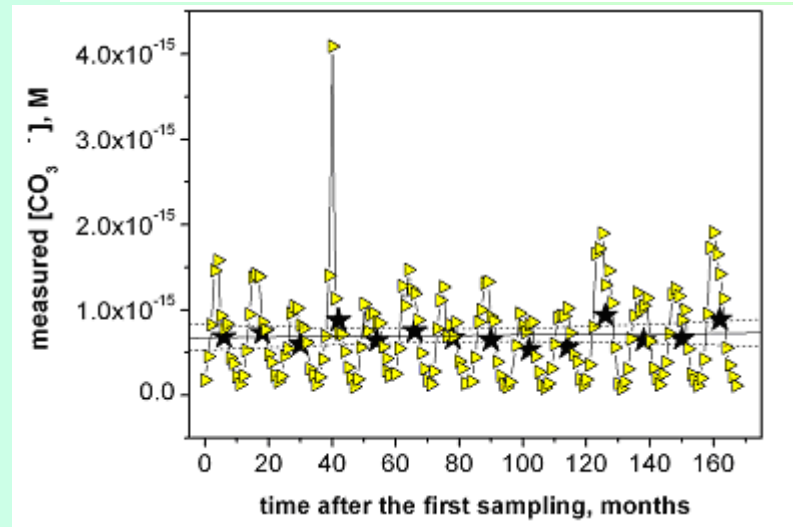
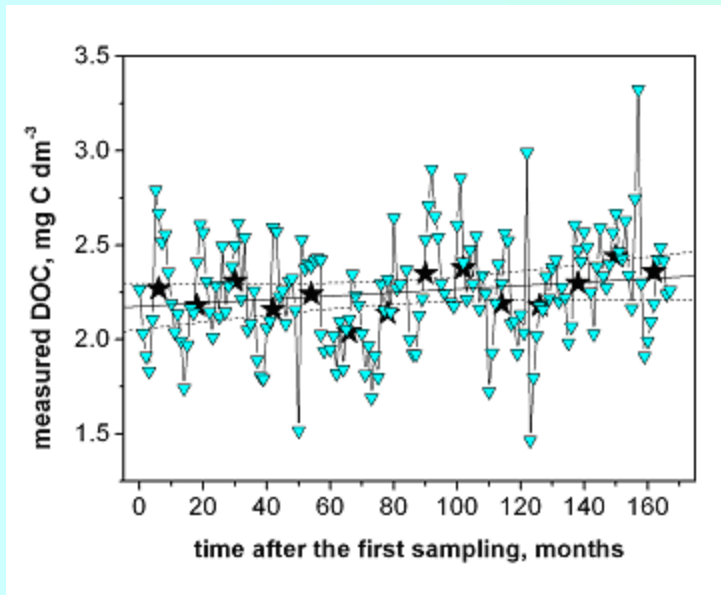
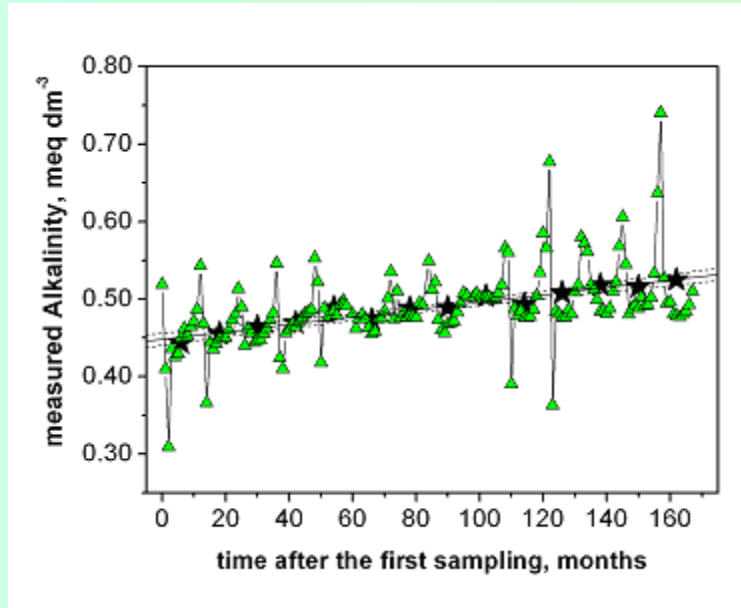
Ongoing lake eutrophication, increase of DOC over time



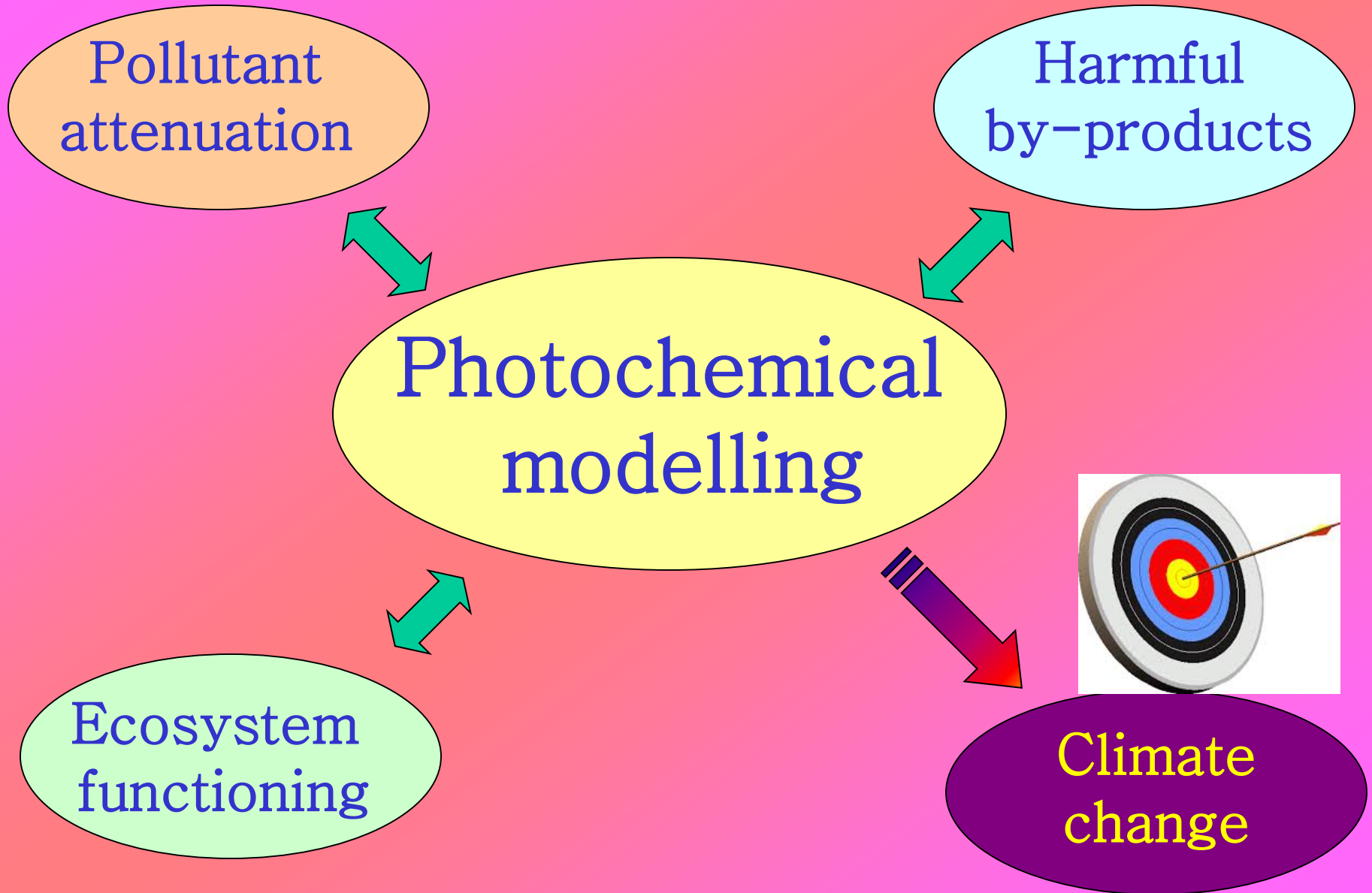


Piburgersee

Sci. Total Environ.
2016, 541, 247-256.



Conclusions



Thank you for

your kind

attention