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Real-time BOD monitoring of final effluent

Dr Kieran Khamis

kieran.khamis@rshydro.co.uk

k.khamis@bham.ac.uk

UNIVERSITY OF BIRMINGHAM

rshydro

Traditional monitoring method

5 day
Biochemical
Oxygen
Demand Test
(BOD_5)

The problem…

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- Lag time for result – damage has already occurred
- Handling/storage time can influence readings
- Error in lab measurement can be as high as 15%
- Real time monitoring (with alerts) not possible
- Distinct need for a new monitoring approach to improve monitoring resolution and repeatability

The Proteus BOD: a robust solution

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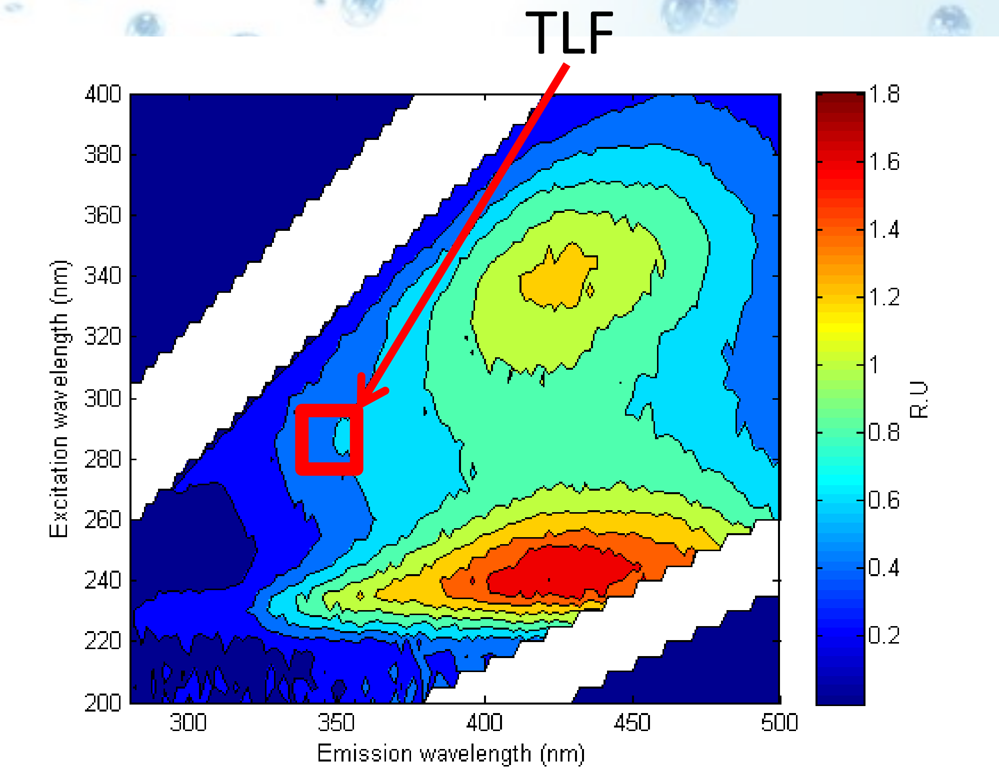

Fluorescence based sensor platform for real time BOD

TLF (Tryptophan-like fluorescence):
Optical signal associated with free amino acid/proteins and amino acids bound in microbial cells.

The Proteus BOD: a robust solution

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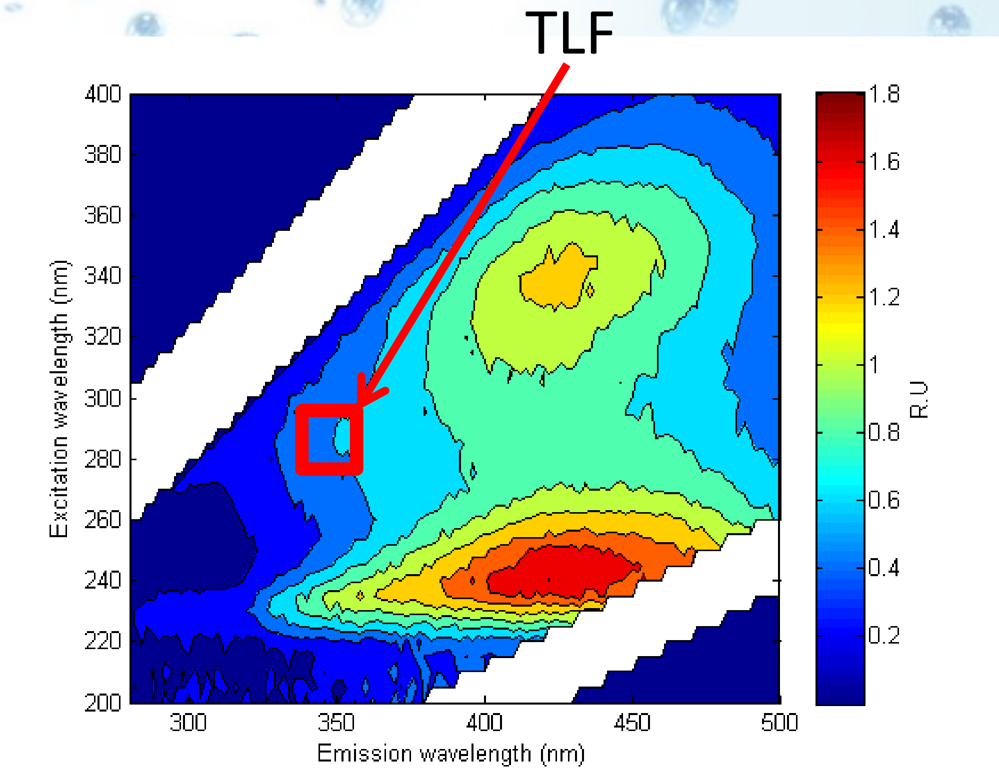

Why Tryptophan-like fluorescence?

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SCIENCE OF THE TOTAL ENVIRONMENT 391 (2008) 149–158

available at www.sciencedirect.com
ScienceDirect
www.elsevier.com/locate/scitotenv

Can fluorescence spectrometry be used as a surrogate for the Biochemical Oxygen Demand (BOD) test in water quality assessment? An example from South West England

Naomi Hudson[a], Andy Baker[a,], David Ward[b], Darren M. Reynolds[c], Chris Brunsdon[d], Cynthia Carliell-Marquet[e], Simon Browning[f]*

ELSEVIER
Water Research 38 (2004) 2934–2938
WATER RESEARCH
www.elsevier.com/locate/watres

Measurement of protein-like fluorescence in river and waste water using a handheld spectrophotometer

Andy Baker[a,*], David Ward[b], Shakti H. Lieten[c], Ryan Periera[d], Ellie C. Simpson[c], Malcolm Slater[c]

[a] *School of Geography, Earth and Environmental Sciences, University of Birmingham, Birmingham B15 2TT, UK*
[b] *Safe Training Systems Ltd., Holly House, Maidenhead Road, Wokingham, Berkshire RG40 5RR, UK*
[c] *School of Civil Engineering and Geosciences, University of Newcastle, Newcastle NE1 7RU, UK*
[d] *School of Geography, Politics and Sociology, University of Newcastle, Newcastle NE1 7RU, UK*
[e] *Centre for Land Use and Water Resources Research (CLUWRR), University of Newcastle, Newcastle NE1 7RU, UK*

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ISSN 1424-8220
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Article

Prediction of BOD, COD, and Total Nitrogen Concentrations in a Typical Urban River Using a Fluorescence Excitation-Emission Matrix with PARAFAC and UV Absorption Indices

Jin Hur * and Jinwoo Cho

Department of Environment & Energy, Sejong University, 98 Gunja-dong, Gwangjin-ku, Seoul 143-747, Korea; E-Mail: jinwoocho@sejong.ac.kr

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RAPID AND DIRECT DETERMINATION OF WASTEWATER BOD VALUES USING A FLUORESCENCE TECHNIQUE

D. M. REYNOLDS[1] and S. R. AHMAD[2*]

[1]Water Analysis Division, Hydrospheric Environmental Protection Department, National Institute for Resources and Environment, 16-3 Onogawa, Tsukuba, Ibaraki 305, Japan and [2]Laser Environmental Research Unit, Environmental and Chemical Systems Department, School of Engineering and Applied Science, Cranfield University (RMCS), Shrivenham, Swindon, Wiltshire SN6 8LA, U.K.

Proteus BOD: sensor development

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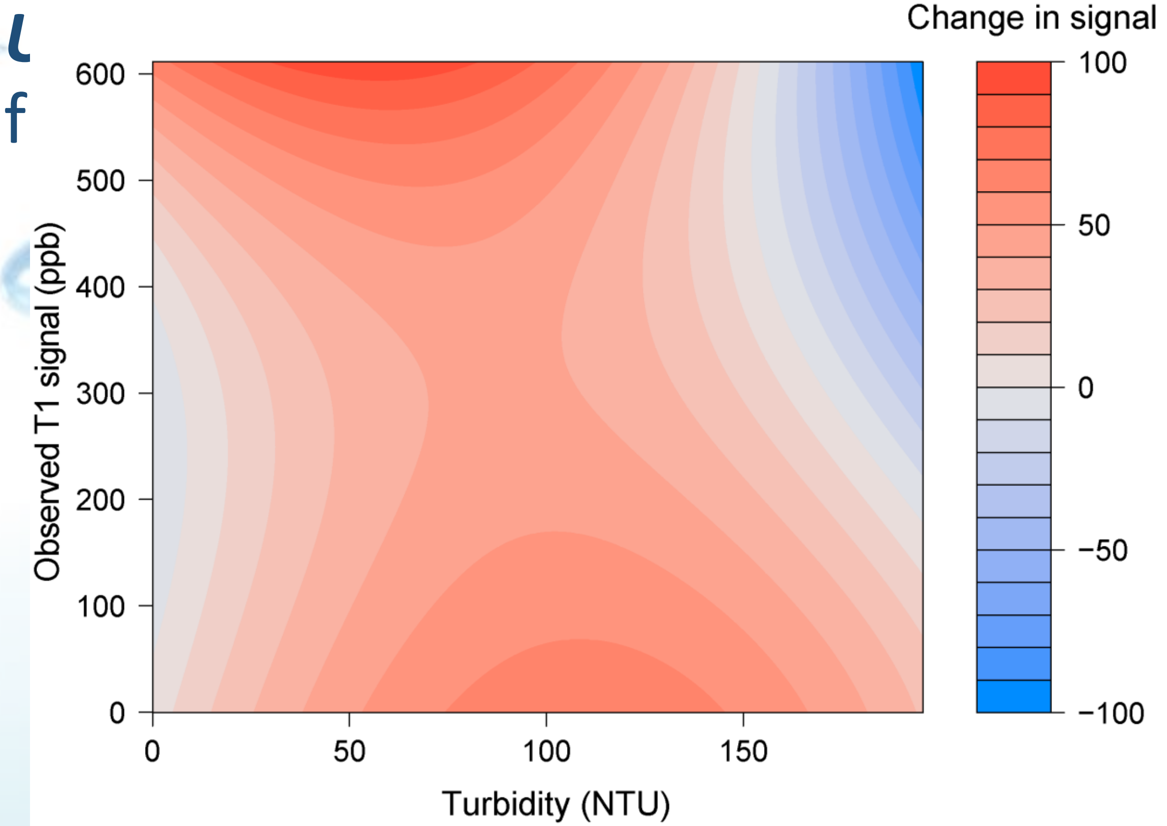

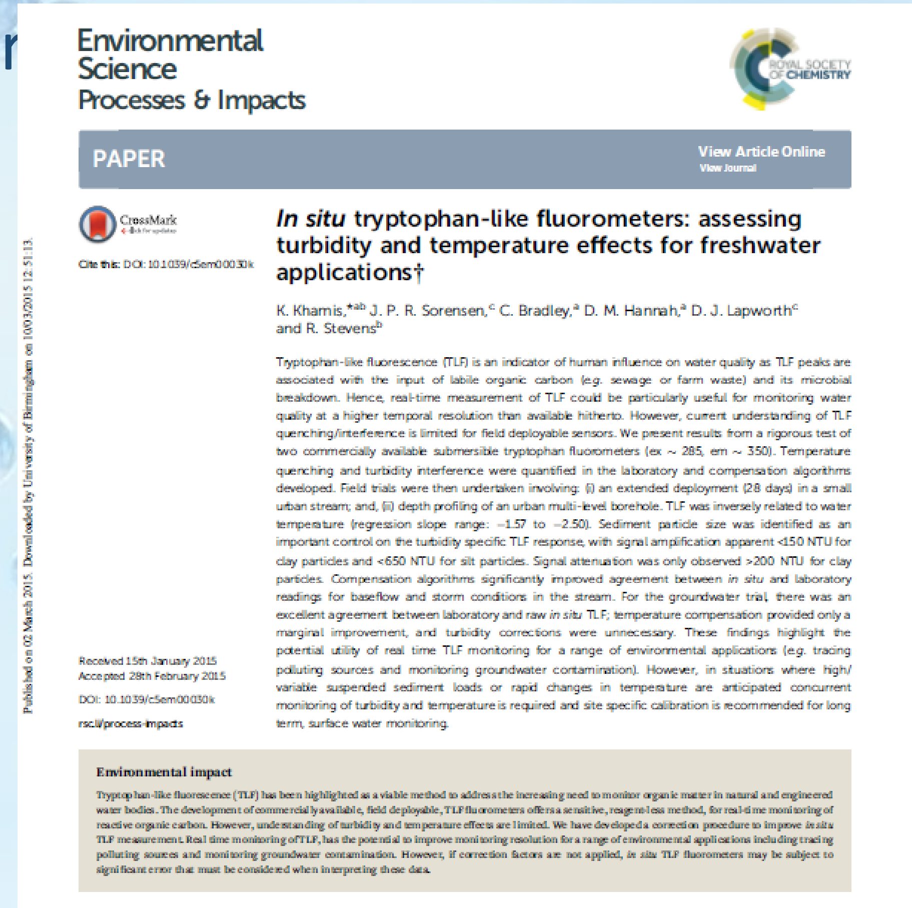

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In situ tryptophan-like fluorometers: assessing turbidity and temperature effects for freshwater applications†

K. Khamis,*[ab] J. P. R. Sorensen,[c] C. Bradley,[a] D. M. Hannah,[a] D. J. Lapworth[c] and R. Stevens[b]

Tryptophan-like fluorescence (TLF) is an indicator of human influence on water quality as TLF peaks are associated with the input of labile organic carbon (e.g. sewage or farm waste) and its microbial breakdown. Hence, real-time measurement of TLF could be particularly useful for monitoring water quality at a higher temporal resolution than available hitherto. However, current understanding of TLF quenching/interference is limited for field deployable sensors. We present results from a rigorous test of two commercially available submersible tryptophan fluorometers (ex ~ 285, em ~ 350). Temperature quenching and turbidity interference were quantified in the laboratory and compensation algorithms developed. Field trials were then undertaken involving: (i) an extended deployment (28 days) in a small urban stream; and, (ii) depth profiling of an urban multi-level borehole. TLF was inversely related to water temperature (regression slope range: −1.57 to −2.50). Sediment particle size was identified as an important control on the turbidity specific TLF response, with signal amplification apparent <150 NTU for clay particles and <650 NTU for silt particles. Signal attenuation was only observed >200 NTU for clay particles. Compensation algorithms significantly improved agreement between *in situ* and laboratory readings for baseflow and storm conditions in the stream. For the groundwater trial, there was an excellent agreement between laboratory and raw *in situ* TLF; temperature compensation provided only a marginal improvement, and turbidity corrections were unnecessary. These findings highlight the potential utility of real time TLF monitoring for a range of environmental applications (e.g. tracing polluting sources and monitoring groundwater contamination). However, in situations where high/variable suspended sediment loads or rapid changes in temperature are anticipated concurrent monitoring of turbidity and temperature is required and site specific calibration is recommended for long term, surface water monitoring.

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Environmental impact

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Urban river installation

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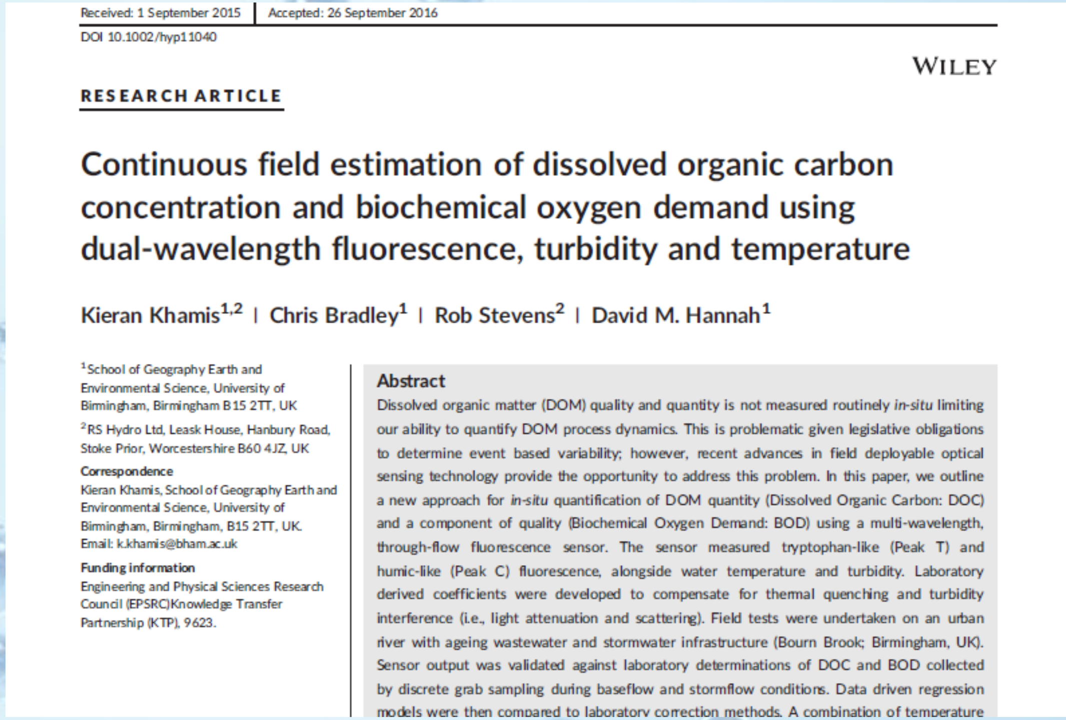
BOD – TLF relationship for an urban stream with cross-connected sewers and CSO's upstream *(results published in leading hydrology journal)*



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WILEY

RESEARCH ARTICLE

Continuous field estimation of dissolved organic carbon concentration and biochemical oxygen demand using dual-wavelength fluorescence, turbidity and temperature

Kieran Khamis[1,2] | Chris Bradley[1] | Rob Stevens[2] | David M. Hannah[1]

[1] School of Geography Earth and Environmental Science, University of Birmingham, Birmingham B15 2TT, UK

[2] RS Hydro Ltd, Leask House, Hanbury Road, Stoke Prior, Worcestershire B60 4JZ, UK

Correspondence
Kieran Khamis, School of Geography Earth and Environmental Science, University of Birmingham, Birmingham, B15 2TT, UK.
Email: k.khamis@bham.ac.uk

Funding information
Engineering and Physical Sciences Research Council (EPSRC)Knowledge Transfer Partnership (KTP), 9623.

Abstract

Dissolved organic matter (DOM) quality and quantity is not measured routinely *in-situ* limiting our ability to quantify DOM process dynamics. This is problematic given legislative obligations to determine event based variability; however, recent advances in field deployable optical sensing technology provide the opportunity to address this problem. In this paper, we outline a new approach for *in-situ* quantification of DOM quantity (Dissolved Organic Carbon: DOC) and a component of quality (Biochemical Oxygen Demand: BOD) using a multi-wavelength, through-flow fluorescence sensor. The sensor measured tryptophan-like (Peak T) and humic-like (Peak C) fluorescence, alongside water temperature and turbidity. Laboratory derived coefficients were developed to compensate for thermal quenching and turbidity interference (i.e., light attenuation and scattering). Field tests were undertaken on an urban river with ageing wastewater and stormwater infrastructure (Bourn Brook; Birmingham, UK). Sensor output was validated against laboratory determinations of DOC and BOD collected by discrete grab sampling during baseflow and stormflow conditions. Data driven regression models were then compared to laboratory correction methods. A combination of temperature

AST WwTW (~80,000 p.e)

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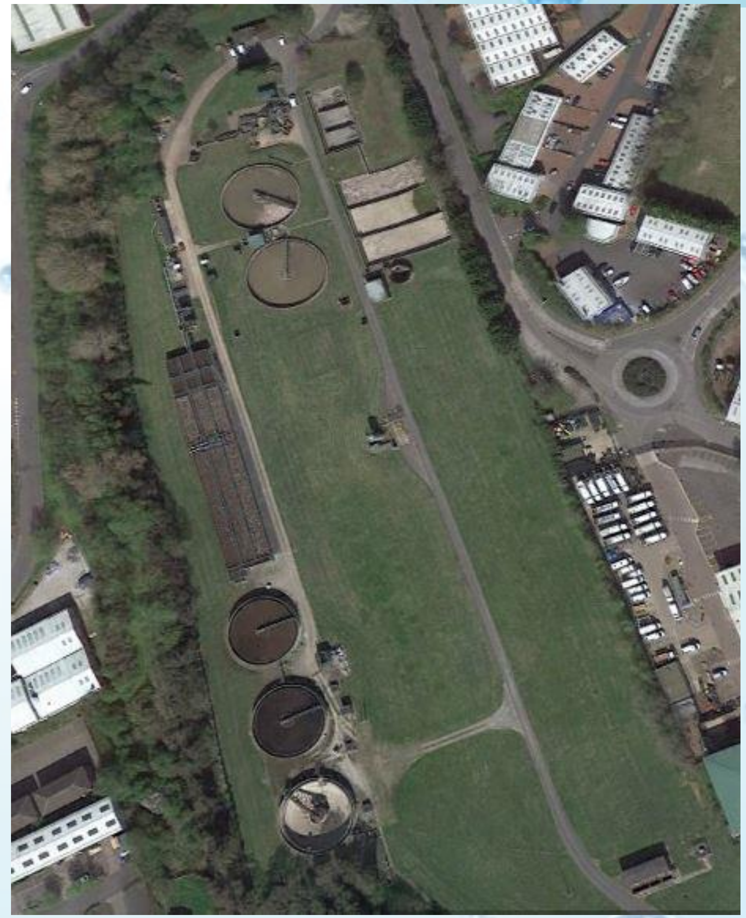

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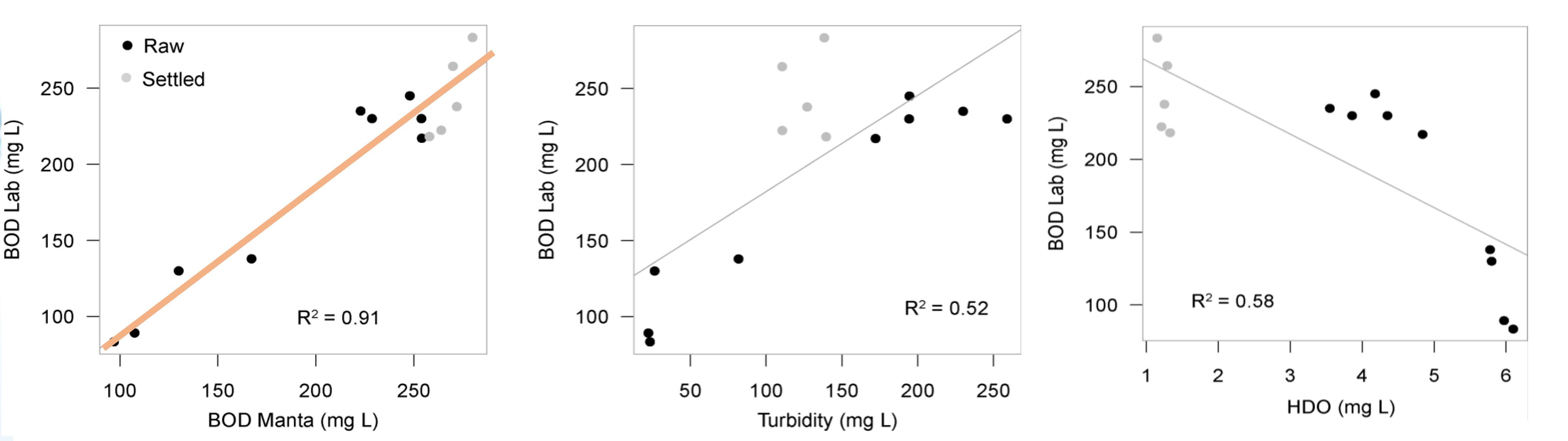
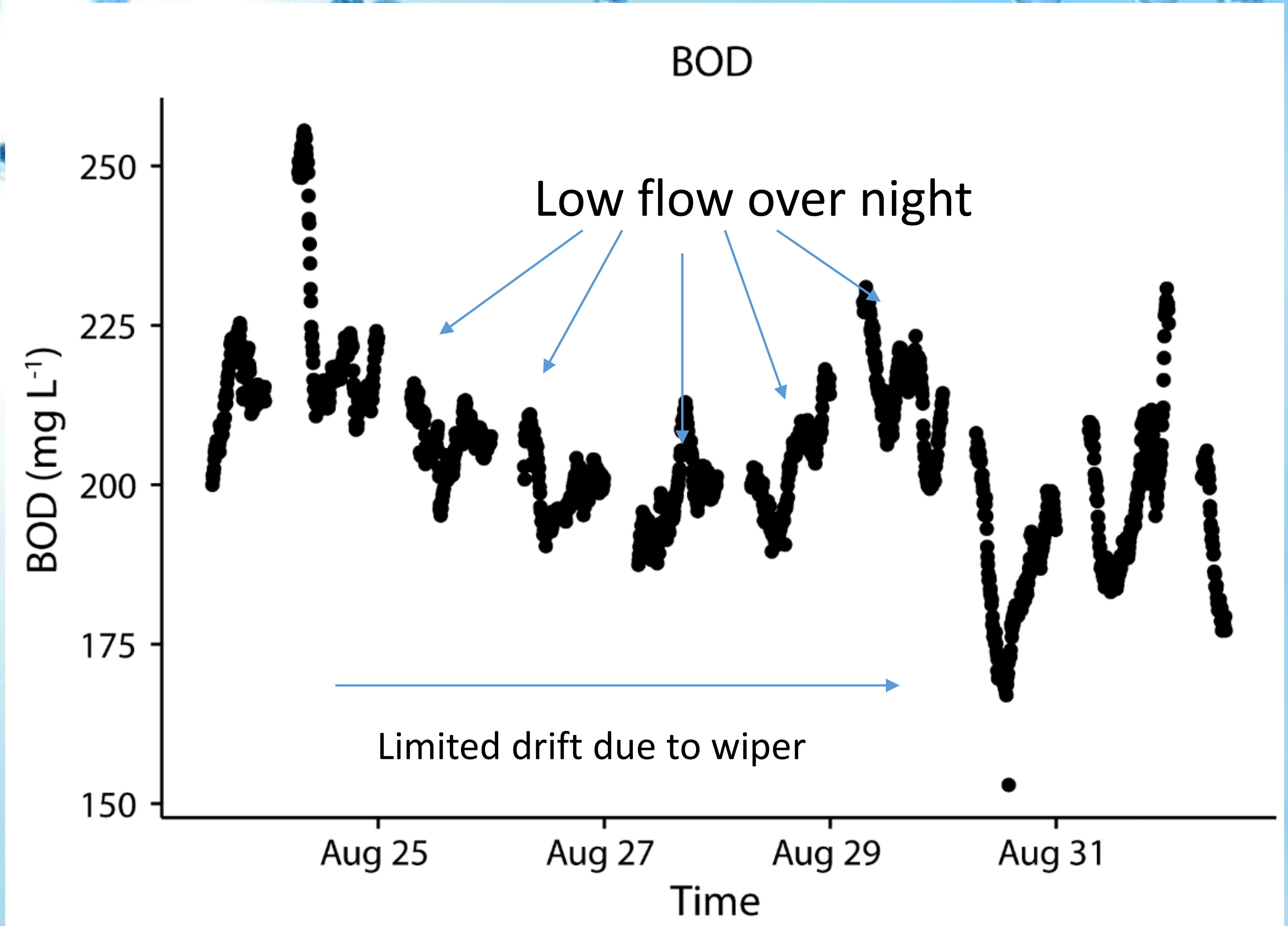


Proteus performs better than traditional BOD surrogates (Turbidity / dissolved oxygen)

AST WwTW: Post PST



AST WwTW (>100,000 p.e)

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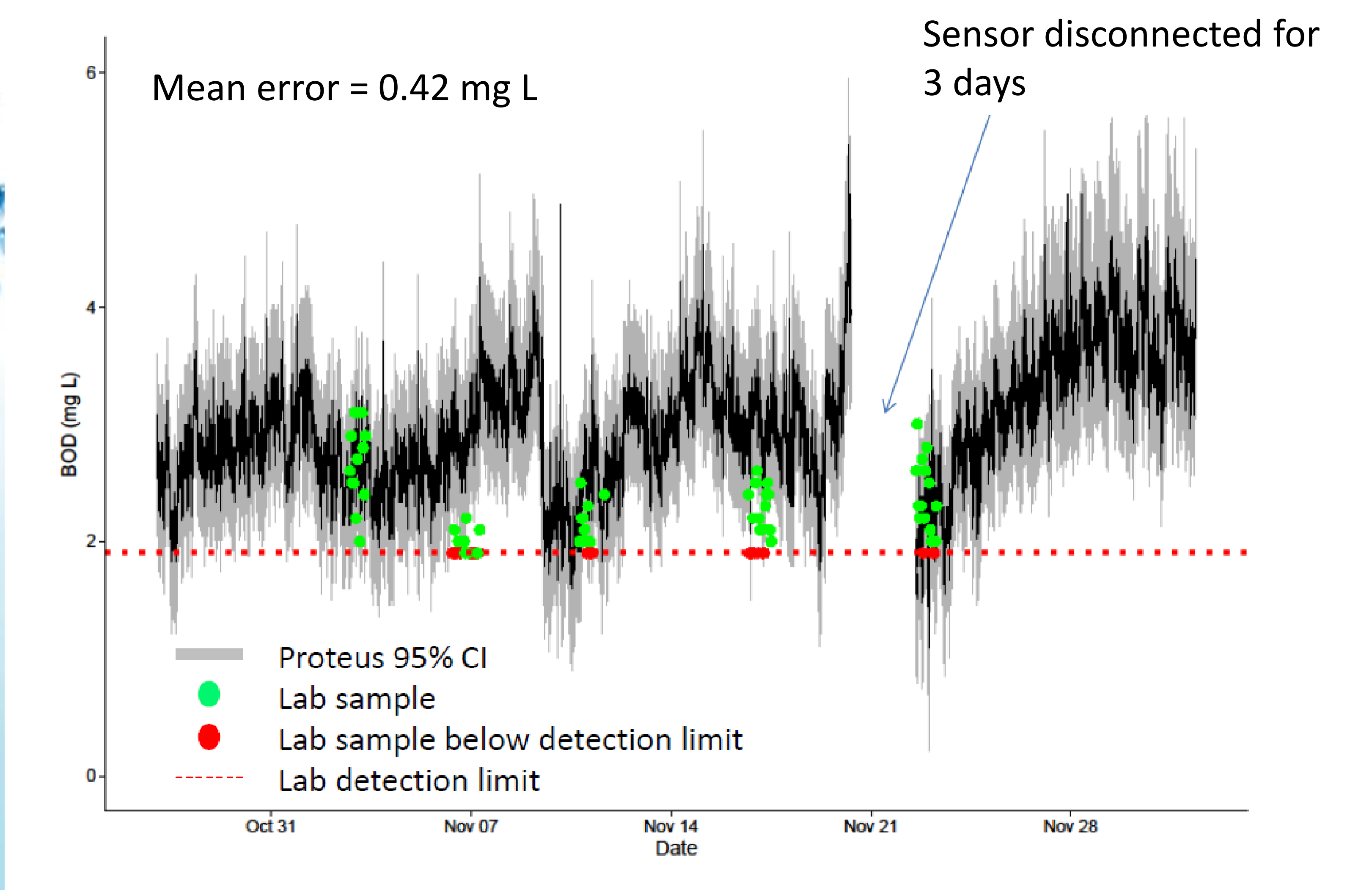

Small WwTW: trickle bed

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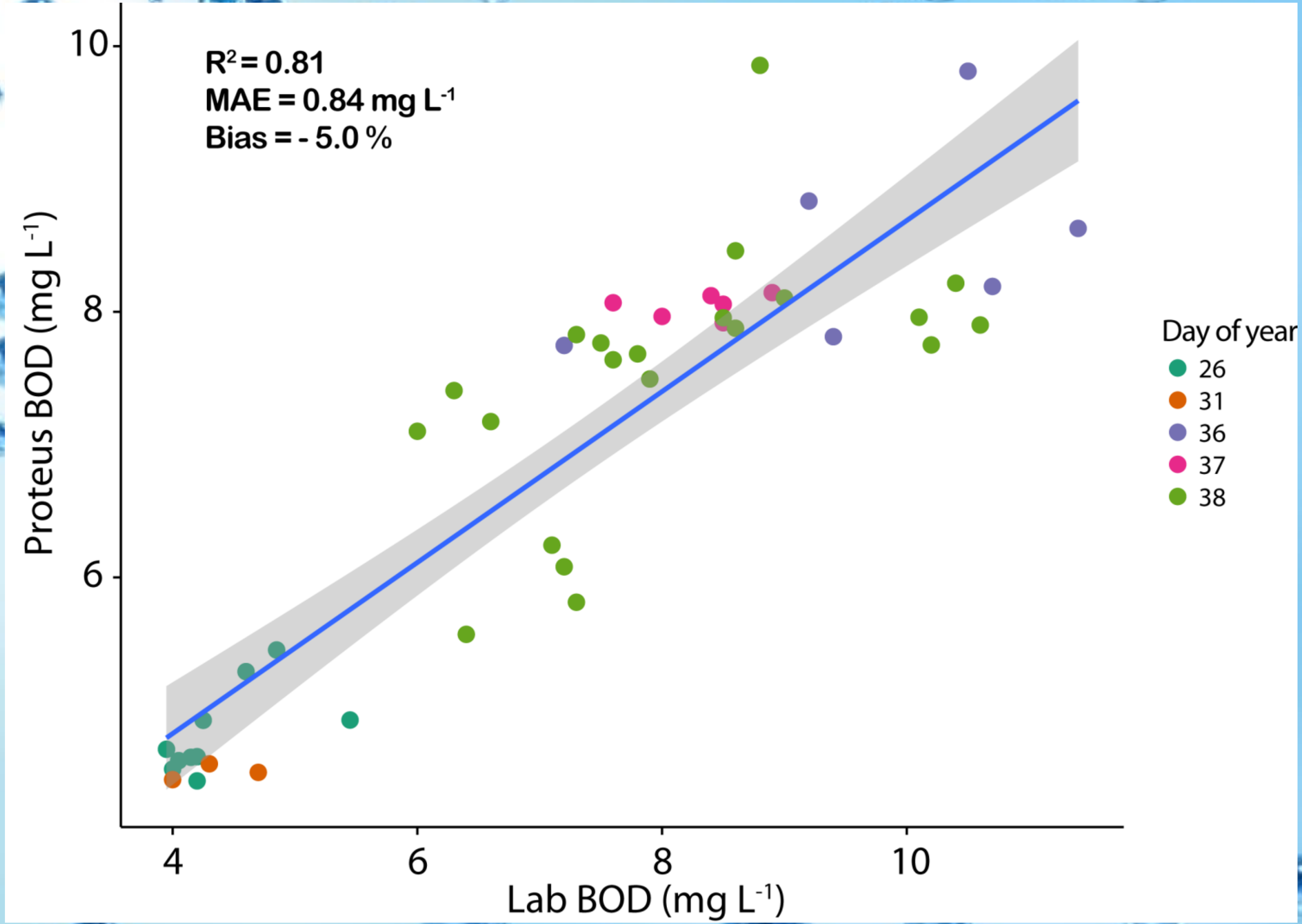

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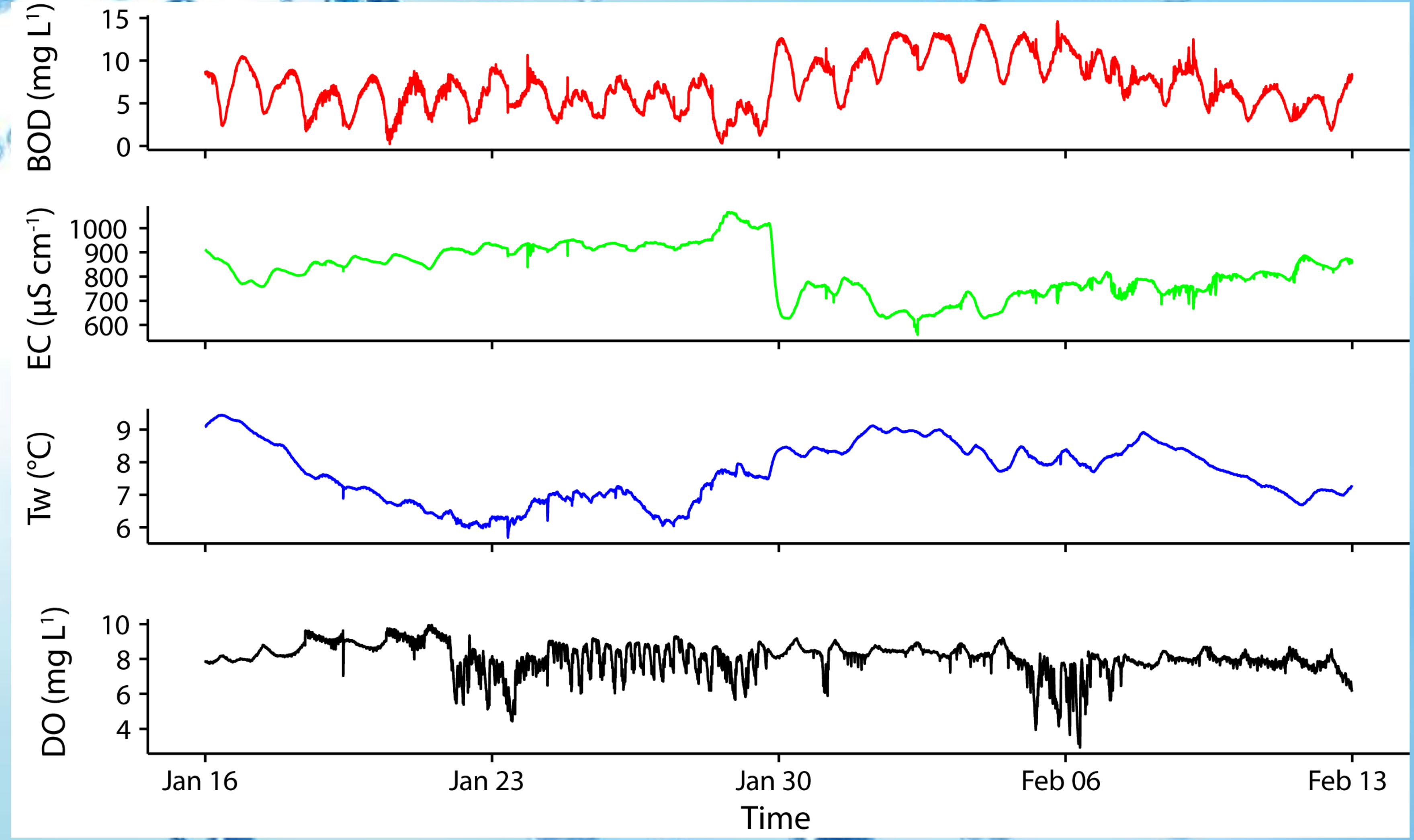

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Small WwTW: trickle bed

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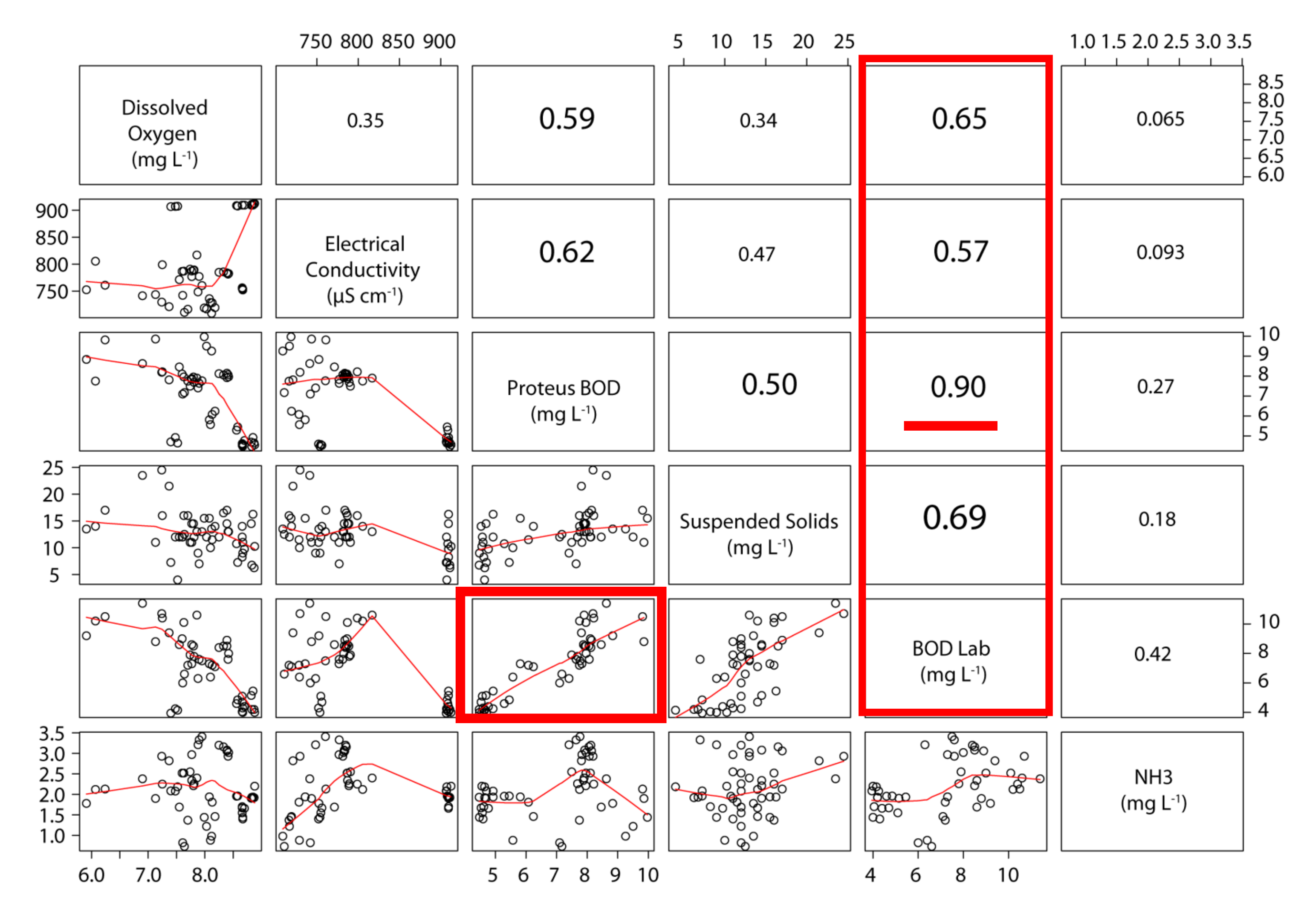

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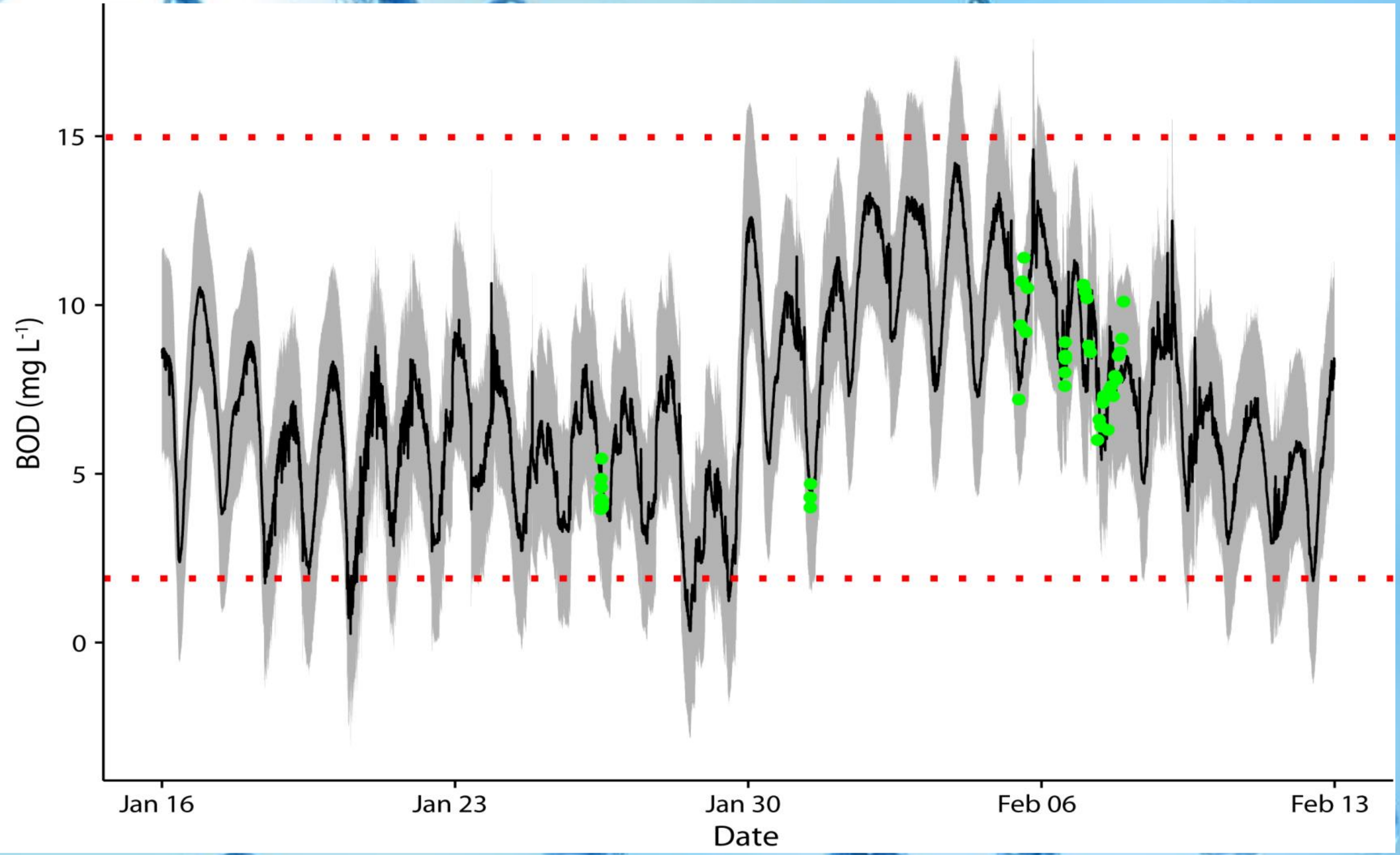

US WwTW (>150,000 p.e)

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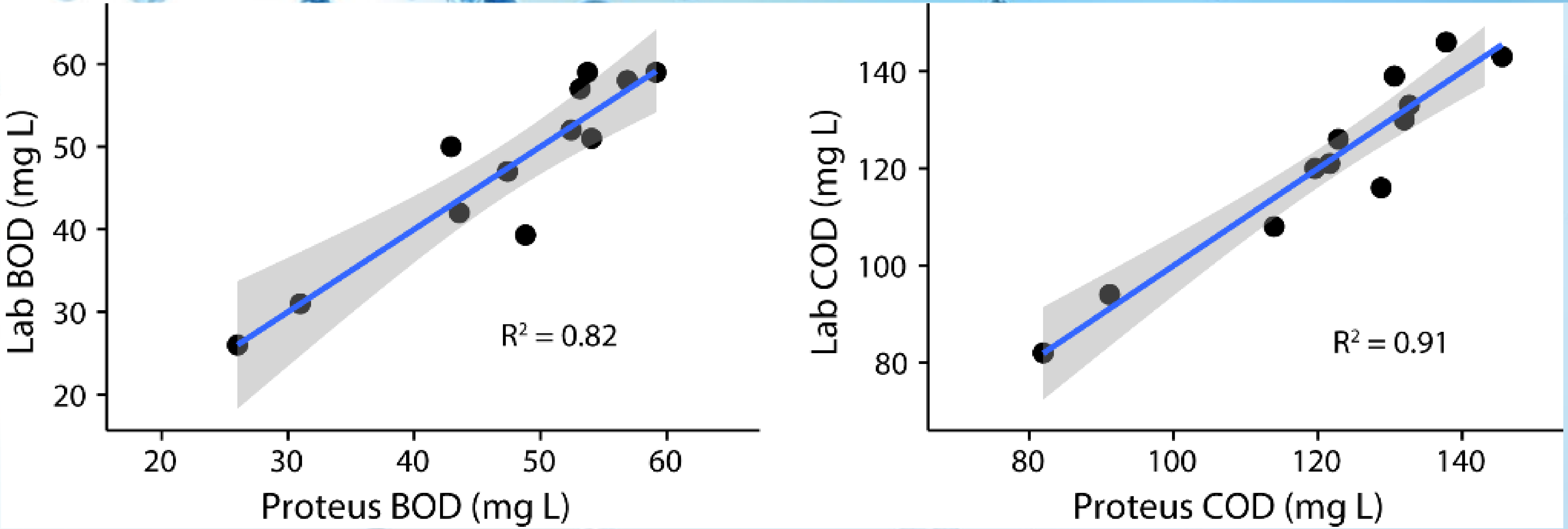

Strong relationship for BOD and COD observed during trial in USA

Water industry applications

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- Monitoring of final effluents to ensure compliance
- Optimization of waste water treatment processes (aeration lanes – energy saving)
- Development of process control algorithms
- Identification of cross-connections in the sewerage network
- Combined sewage overflow monitoring

Conclusions

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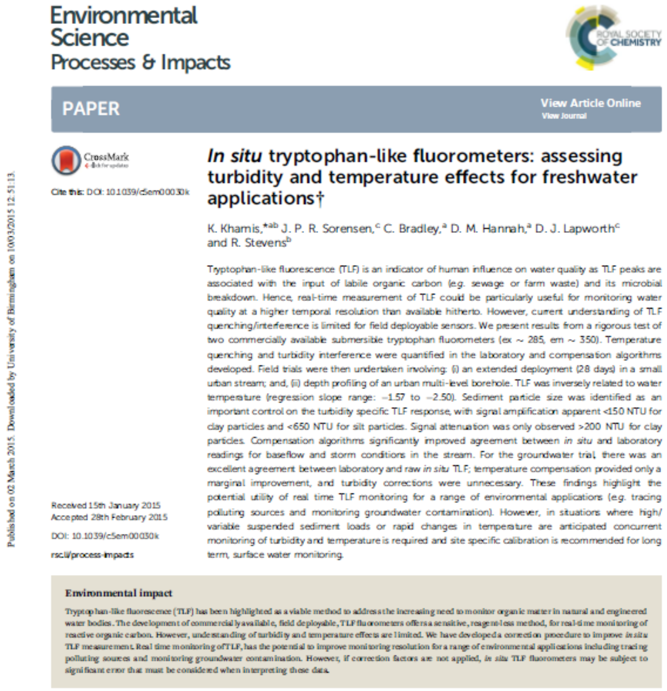
- The *Proteus BOD displayed s*trong relationships with lab data for both high range applications (post PST) and low range (final effluent)
- Automated wiper and antifouling kit are essential to ensure high quality data for demanding applications
- Strong diurnal variability in BOD load identified for all trial works – potential for aeration control and energy savings
- Sensitive at low concentration < 5 mg L^{-1} so possible to monitor effluents with stringent discharge permits



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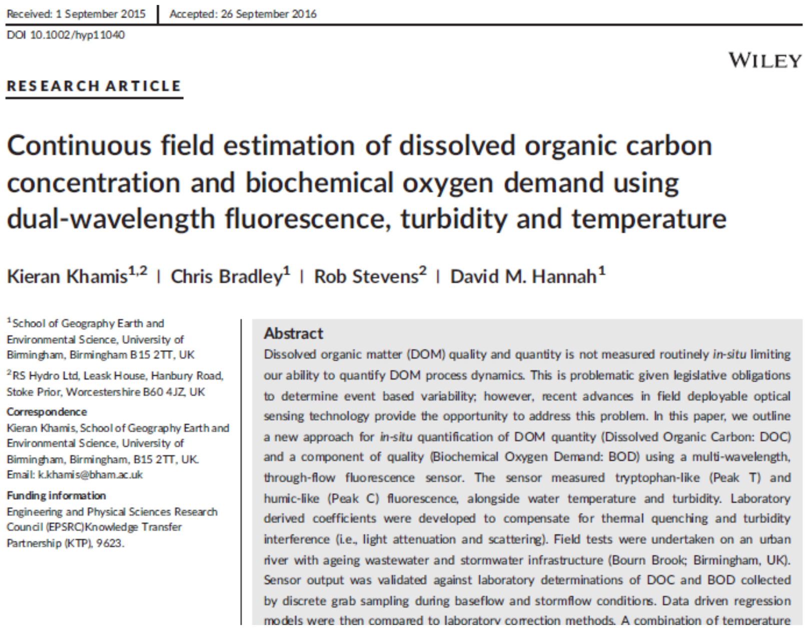

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