Biogeosciences Discuss., 10, C5162–C5167, 2013
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Biogeosciences
Discussions
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Interactive comment on "Using a two-layered sphere model to investigate the impact of gas vacuoles on the inherent optical properties of *M. aeruginosa*" *by* M. W. Matthews and S. Bernard

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Received and published: 19 September 2013

The authors wish to thank the referee for their constructive review. The following modifications have been made to the paper, as per the referee's recommendations:

A brief background section detailing the ecological/biogeochemical importance of the work has been added at the beginning of the introduction as suggested by the reviewer. This will demonstrate the relevance and importance of the research in an ecological/biogeochemical context and for Biogeosciences journal.

Added at Line 22 p. 10532: "Light scattering by cyanobacteria, especially those exhibiting intracellular gas vacuoles, is poorly described. Prokaryotic cyanobacteria play an

important role in the functioning of freshwater and marine ecosystems alongside eukaryotic algae, although their optical properties are less well understood than the latter. These ancient organisms represent a crucial component of earth's biogeochemical cycling and are hypothesised to have contributed towards the oxygenation of the early atmosphere (Blank2010). Therefore further knowledge of their optical properties will contribute towards an improved understanding of earth's biogeochmical cycle through their more comprehensive inclusion in ecological and biogeochemical ecosystem models."

A table defining symbols used throughout the paper has also been added in the introduction.

Reference has been made to a recently published study: Matthews, M. W., & Bernard, S. (2013). Characterizing the Absorption Properties for Remote Sensing of Three Small Optically-Diverse South African Reservoirs. Remote Sensing, 5, 4370–4404. This publication will provide additional background for the sampling area, locations, and methods, and has been referenced in appropriate places. Because of this publication, some details concerning the methods for determining tripton mass specific absorption and gelbstoff have been removed, and readers pointed to this reference which contains the detailed methodology. This has enables the methods section to be trimmed slightly, with the result that it should be easier to read. The range of concentrations of chl a, tripton and gelbstoff absorption have also been added, which add some much needed context.

Changes to methods and reference to publication containing details of methodology:

Edited at: Line 20, p. 10539: "Background information on Hartbeespoort as well as details of sampling locations and methods can be found in (Matthews2013). For the samples used in this study M. aeruginosa made up more than 90% of the population as percentage as determined by microscopy, with chl a ranging from 70 to 1503 mg m-3 with a mean value of 404 mg m-3. Given the extremely high biomass, the water might effectively be treated as a "culture", eliminating some of the complexity as far as optical modelling is concerned (Matthews 2013)." Edited at Line 1, p. 10544: "The concentration and absorption properties of tripton (TR) and gelbstoff were determined as described in Matthews (2013). TR ranged from 1.7 to 19.8 g m-3 while a_g(442) ranged between 0.17 and 2.04 m-1, with an exponential slope coefficient determined as 0.017 m-1."

All detailed comments have been adhered to and are listed below. The authors believe the changes have strengthened the paper, and it is hoped that it is now suitable for publication in BG.

Detailed changes:

Spelling corrections have been made as suggested, and checked throughout. Line 18, p. 10533 – sentence has been modified and difficult statement has been removed.

ADA, Delta n and LUT have been defined on first use.

Line 20, p. 10539. Word phytoplankton has been added to explicitly identify the population as phytoplankton only.

Line 1, p. 10542 Parentheses added to symbols.

Line 14, p. 10546 It is appropriate to assume a constant profile because the optical depth is very shallow given the extremely high biomass of the floating blooms. The addition to the text of the range of chl-a concentrations (70 – 1500 mg m-3) and the reference to Matthews & Bernard (2013) should underpin this assumption, the reason for which has now been mentioned explicitly in the text. Edited: "The vertical profile used was constant with depth, given the shallow optical depth caused by the very high cyanobacterial biomass."

Line 5, p. 10548 Colon added.

Line 4 p.10554: The correlation$> 700 nm is indeed poor, as later discussed. There-

fore, a conditional statement has been added to this sentence. Edited: "There is no apparent consistent bias with wavelength > 700 nm: there is a good spread of over and underestimates (fig 7D)."

Line 12, p. 10556 The range has been corrected to correspond with the figure.

Line 22, p. 10557 The text has been corrected to correspond to the figure.

Figure 1: Line legends have been included in the figure, and caption changed correspondingly. F(d) has been defined in the caption.

Figure 4: Caption has been corrected.

Figure 7: The colours in the figure represent the different samples. This has been mentioned in the caption.

Figure 8: The detail regarding the depth profile measurements has been clarified with some edits being made to the methods section to improve readability.

Interactive comment on Biogeosciences Discuss., 10, 10531, 2013.

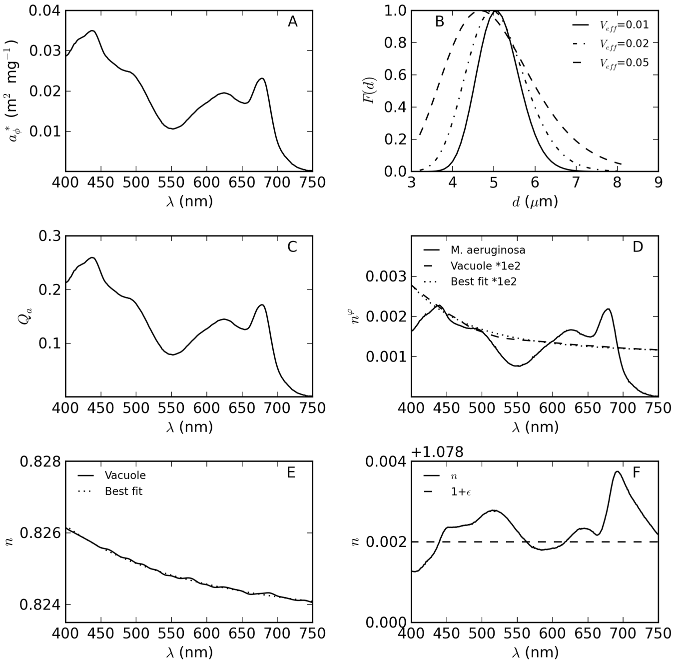

Fig. 1.

Symbol	Definition	Unit
m	Complex refractive index	
n	Real refractive index	
n'	Imaginary refractive index	
n_w	Real refractive index for water	
n_m	Homogeneous real refractive index	
$1+\epsilon$	The central value of n	
Δn	The variation of n around $1+\epsilon$	
d	Diameter	μm
r_{eff}	Effective radius	μm
V_{eff}	Effective variance	
$F(d)$	Size distribution function	
V_g	Gas vacuole volume	
V_c	Core layer volume	
V_s	Shell layer volume	
c_i	Intracellular chl a concentration	kg m^{-3}
a	Absorption coefficient	m^{-1}
b	Scattering coefficient	m^{-1}
c	Attenuation coefficient	m^{-1}
b_b	Backscattering coefficient	m^{-1}
a_ϕ^*	Chl a specific absorption coefficient	m^2 mg^{-1}
b_{ϕ}^*	Chl a specific scattering coefficient	m^2 mg^{-1}
$b_{b\phi}^*$	Chl a specific backscattering coefficient	m^2 mg^{-1}
$a_{tr} ^*$	Tripton mass specific absorption coefficient	m^2 g^{-1}
b_{tr}^*	Tripton mass specific scattering coefficient	m^2 g^{-1}
b_{btr}^*	Tripton mass specific backscattering coefficient	m^2 g^{-1}
a_g	Gelbstoff absorption coefficient	m^{-1}
a_w	Water absorption coefficient	m^{-1}
b_{bp}	Particulate backscattering coefficient	m^{-1}
b_{bp}^*	Chl a specific particulate backscattering coefficient	m^2 mg^{-1}
$\tilde{b_b}$	Backscattering ratio	
$\tilde{b_f}$	Forward scattering ratio	
Qa	Optical efficiency factor for absorption	
Qb	Optical efficiency factor for scattering	
Qc	Optical efficiency factor for attenuation	
$\bar{Qa}$	The experimental mean absorption efficiency factor	
Q_c^{NAE}	The non-absorbing efficiency factor for attenuation	
R_{rs}	Remote sensing reflectance	sr^{-1}
β	Phase function	m^{-1} sr^{-1}

Fig. 2.