

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

Anonymous Referee #1

Received and published: 30 July 2013

Part 1. General Comments

The overall goal of this manuscript is to develop a model for investigating the impact of gas vacuoles on the optical properties of the cyanophyte *Microcystis aeruginosa*. The research topic is pertinent to the field of environmental optics and fills a gap in understanding the role internal cell structures, in this case gas vacuoles, play in determining IOPs for *M. aeruginosa*. The methods applied in this manuscript appear to be sound and incorporate a breadth of approaches, including use of a two-layered sphere model, field and historical measurements, and Ecolight modeling. This work is also novel as no detailed modeling study has previously been performed to explore the effect vacuoles have on the IOPs for cyanobacteria. Thus, following the below-mentioned revisions,
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I believe this manuscript is warranted for publication in Biogeosciences. Most of my suggested revisions are minor to medium in scope related to clarifications in the text, better defining various terms used in the paper, and providing more ecological context for the importance of this work.

Part 2. Detailed Comments

Section 1 – A background paragraph is needed to set the stage for the reader regarding the ecological and/or biogeochemical significance of this work. I might have expected this article to be more appropriate for a journal like *Applied Optics*, but given that it's been submitted to this journal, a paragraph (at least) is needed on why this research is more generally important.

Section 1 – Be sure to double-check spelling, punctuation, etc. throughout manuscript, as there were numerous errors. For example, on line 24 (p. 10532) “know” should be “known”, and on line 22 (p. 10534) “order or magnitude” should be “order of magnitude”.

Section 1 – Line 18, p. 10533 – What does “initial decrease followed by an increase” mean?

Section 1 – Starting in Section 1, many symbols are used throughout this paper (Vg, Vc, nm, n', Qa, ci, a*, etc.). I recommend including a first table in the paper which defines all of these different symbols to improve readability.

Section 2 – Line 7, p. 10539 – Define ADA as “anomalous diffraction approximation” here at its first use.

Section 2 – Line 19, p. 10539 – Not all readers are familiar with Hartbeespoort Lake, so provide more detail on this sampling location, including that it's in S. Africa.

Section 2 – Line 19, p. 10539 – How many samples were collected, and how were sampling locations chosen?

Section 2 – Line 20, p. 10539 – When you refer to “the population” here are you referring to the population of total particles or just phytoplankton cells?

Section 2 – Line 27, p. 10540 – Define delta n symbol upon first use.

Section 2 – Line 1, p. 10542 – Both Q_c and Q_b should appear in the parantheses.

Section 2 – Line 21, p. 10543 – Define LUT as look-up table.

Section 2 – Line 14, p. 10546 – Why is it alright to assume that the vertical profile used was constant with depth, especially when the cyanobacteria are more concentrated at the surface?

Section 3 – Line 5, p. 10548 – Put a colon after “by the gas vacuole is”, to indicate that you are then providing a long list of numbers.

Section 3 – Line 4, p. 10554 – It says “There is no apparent consistent bias with wavelength”. However, based on Fig. 7C, it appears there is significantly more difference between modeled and measured R_{rs} above 700 nm.

Section 4 – Line 12, p. 10556 – According to Fig. 9, the range in chl-a is between 1 and 1000 mg m⁻³, in contrast to the 20 to 1000 mg m⁻³ stated in the text.

Section 4 – Line 22, p. 10557 – According to Fig. 10, $R_2 = 1.0$ versus the 0.99 stated in the text.

Figure 1 – Legend should be included directly in the figure, as opposed to stated in the text, for readability. Define $F(d)$ on the y-axis in panel B.

Figure 4 – Should say “. . . on the imaginary and real refractive index of the shell layer”.

Figure 7 – What are the different colors in the figure?

Figure 8 – I don’t recall these depth profiles being very well described in the Methods. Provide more information there on these measurements.

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

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