

Interactive comment on “Using empirical orthogonal functions derived from remote sensing reflectance for the prediction of concentrations of phytoplankton pigments” by A. Bracher et al.

Anonymous Referee #1

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General comment This study reports the development of an algorithm based on empirical orthogonal functions (EOFs) for detecting phytoplankton pigments using field- and satellite-measured spectra of remote sensing reflectance. This is a methodological paper and it is appropriate for Ocean Science. Developing new methods for deriving phytoplankton pigments from space is very interesting for remote sensing community. Detection of individual pigments or pigments groups is not useful only for the retrieval of phytoplankton functional types, which is still a debate, but also for examining the physiology of phytoplankton over a wide scale. I appreciated the use of EOF analysis which is a robust method of investigation, as well its use in oceanic waters, for which this kind of applications are always problematic. The models are well developed and

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internally validated. However, the model validation made by using a totally independent data set of pigment data is missing. Validation is an important step to understand if the method can really be applied. However, a comparison with other approaches and an application over a wide area using satellite data are present and they are useful to reinforce somehow model results. I think the paper is worth to be published but there are several aspects that need further clarification before publication (see list below). In addition, I found the manuscript difficult to follow and sometimes confusing. I suggest revision of the english.

Specific comments:

Title: I suggest “. . .for the prediction of phytoplankton pigment concentrations”.

Page 2076, lines 15-20: PSC are also involved in light harvesting like accessory chlorophylls.

Page 2076, line 20: a reference which summarizes the distribution of taxonomic pigment among the algal classes could be useful. I don't think Mackey et al. (1996) is appropriate here.

Page 2076, line 26: what do you mean for “overall biomass”? Generally Tchl a is considered a proxy of phytoplankton biomass. Please, reformulate the sentence.

Page 2077, lines 4-7: it is not clear if these studies are referring just to the surface layer or to the water column.

Page 2077, lines 15-18: I think it is not only a problem of atmospheric correction but also of appropriate inversion models. If AOPs-inversion models are accurately validated, also inherent optical properties could be used to derive pigment composition.

Page 2078, lines 12-20: I suggest to make the aim of the study clearer.

Section 2.2: I suggest to insert any source of pigment data you used or to add this information in Table S1. In addition, why did you use also 3X3 and 5X5 matchups?

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Along the text, you sparingly speak about them. Some results are just shown in table 4.

Page 2082, line 9: "different combinations. . .", please be more clear.

Various pages in the methods section: A flowchart describing the various steps of your algorithm would be very useful to the reader.

Section 2.3.1: How many models did you develop? Because of the two spectral ranges for hyperspectral Rrs (350-700 nm and 380-700 nm), are two different models produced? It is not clear. Please, explain also why you normalized the spectra. I expect that pigment concentrations are more related to the magnitude.

Page 2085, eq 4: It is not necessary r-squared formula. Page 2085, eq 5-8: As you calculated other statistics using log-transformed quantities, why are RMSE, MPD, PB and MDPD calculated for no-log quantities? I suggest to use same quantities.

Section 2.3.4: it is not necessary or I suggest to move it in another section.

Section 2.4: could be included in section 2.2.

Page 2088, lines 15-20: They are not results and could be included into the methods.

Page 2089, lines 3-16: This paragraph is confused and contradictory. You say that range of pigments is similar between the two datasets and then that the maxima and minima of one dataset are higher than those of the other. The paragraph has to be reformulated.

Page 2089, line 27 to the end of the sentence: "Still one has to bear in mind. . ." You did not explain it in the method section.

Page 2090, line 25: "more or less" is not appropriate.

Page 2091, lines 1-4: "This indicates that. . .", I think this is a conclusion that you can draw after description of also EOF-4 which is related to the different pigment composi-

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tion.

Page 2091, lines 6-8: you say that Rrs amplitude is affected only by pigment absorption. What about backscattering influence?

Page 2091, lines 11-13: I don't agree with this statement. In EOF-2 the peak at 683 nm is negative, as in Craig et al. 2012, so as they suggested it is not related to chlorophyll. Only in EOF-1 you don't see the peak, because of the low chlorophyll concentrations as you said.

Page 2091, lines 14-20: What about CDOM influence?

Page 2092, line 3: "apparent" is not appropriate. You can replace with "detected", for example.

Section 3.3.1: You could discuss more the regressions shown in Figure 4. The replacement of concentration of 0 mg m⁻³ with a small value generates only confusion.

Page 2092, lines 15-17. I am not sure that bad predictions are related to the occurrence of some samples with concentrations of 0. I think that when a pigment concentration is generally low is difficult to outline its spectral shape and therefore to predict its concentration.

Section 3.3.2: You could discuss more the regressions shown in Figure 5.

Page 2095, line 26: "Exemplarily"?

Section 3.6: Prediction of pigment concentration over a wide area is an interesting application. However, as you do not have in situ pigment concentrations for validation, I suggest you to compare your pigment distribution with results from literature even if sampled in other periods.

Table 1: Add a column showing the cumulative proportion of explained variance.

Table 2: I will find useful, also for future studies and applications, if you show statistics

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also for bad predicted pigments.

Figure 1: A legend on the panel will be also useful.

Figure 3: I suggest you to make a panel for each EOF. Please, add y-axes name.

Figures 4 and 5: units for pigment concentrations are missing in the plot. Could you add also MPD, PB and MDPD and discuss them in the text?

Table S2: It would be useful also information on the mean +- standard deviation for each pigment.

Typesetting errors:

Along the text: I think it is better if you use Rrs instead of RRS.

Page 2084, line 19: please verify if the occurrence of the term “e” is appropriate.

Page 2084, line 28: the intercept sometimes is called “l” and sometimes “a”.

Page 2105, line 24: It is “Antoine” instead of “Antoinem”.

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