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Atmospheric Measurement Techniques Discussions

Interactive comment on "New methods for retrieval of chlorophyll red fluorescence from hyper-spectral satellite instruments: simulations and application to GOME-2 and SCIAMACHY" *by* J. Joiner et al.

Anonymous Referee #1

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Reviewers general comments:

The hyperspectral satellite data retrieval of SIF (solar-induced fluorescence) for land and ocean applications holds great scientific potential as the present article describes. This was also shown by a number of previous publications which are cited and mentioned well in the manuscript. Obviously, it is possible to extract in-filling spectral signatures of inelastic scattering processes associated with fluorescence emitted by terrestrial plants and oceanic phytoplankton from satellite measurements of SCIAMACHY and GOME-2. Joiner et al. describe the retrieval of the fluorescence signal by an in-

version scheme based on a Principle Component Analysis (PCA) technique and use three different spectral settings: 1. Solar-line-red-SIF retrieval from 682 to 686.5nm (similar to previous work like Wolanin et al.), which is applicable to terrestrial SIF. 2. Improved O2-red-SIF retrieval with combination of two fitting windows encompassing O2 Gamma- and B-bands from 622-640nm and 682-692nm, which is applicable to terrestrial SIF retrieval. 3. Ocean retrieval in the spectral region of 660-713nm. The results of the different settings are extensively analyzed, compared and well discussed.

In my opinion, the well-written article is a valuable contribution for the exploitation of hyperspectral satellite data for the retrieval of fluorescence and should be accepted with minor revisions considering the specific comments.

Reviewers specific comments:

1. You mentioned in the introduction, that the photon path in the atmosphere is modulated strongly by aerosol and clouds and this fact makes the retrieval in the O2-A and B absorption bands so complicated (s.a. Frankenberg et al. 2011). How do you correct the O2 absorption in the O2-B band retrieval for different atmospheric conditions, mainly aerosol and partly clouded pixel? The O2-Gamma retrieval is used to estimate the actual spectral structure of the O2-B band. But aerosols are affecting both bands?

2. What do you mean with "O2-Gamma band can be used as an anchor to estimate the spectral structure of the O2-B band"? Please describe more in detail.

3. I am confused with the wavelength regions you used. In Section 4 you describe the spectral fitting window for the O2-B band is 682-698nm. And in Section 4.3 and Section 6 the fitting window is 682-692nm. Further in Section 4.2 and in Fig. 2 the wavelength range for the PCs are 680-713nm. Why this extend to 713nm for the PCs and isn't that problematic?

4. I think Figure 4. is unnecessary. It is a normal behaviour for all spectrometer that SNR increase with measured intensity. The ranges can be described in the text with

one sentence.

5. Why did you not include the fit window of 682-692nm, which you finally use in the satellite data retrieval, into the sensitivity Section 5 and Table 1. Also in Figure 6 the relation of true SIF to retrieved SIF for the fit window of 682-692 would be of more interest.

6. No spectral fit results of real satellite data are shown? Can you show at least examples of the satellite measurement and the fit result?

7. I think Section 6.1, which refer to Fig.7, has to be revised carefully, because it is a crucial issue, that the fit of SIF nearly do not affect the fit residuals and do not yield to an improvement of the fit quality. The simulations show a complete different behaviour and also the residuals of the ocean fits show an improvement by including SIF in the algorithm. Please add some explanations, even if assumptions.

8. In Bismarck et al. (2013) simulations of the Radiative transfer model (RTM) MOMO, which is also used in this study, show that the fraction of the vibrational Raman scattered radiation in the water-leaving radiance reaches values of over 25% in the visible and SWIR spectral region in totally clear seawater, and still values of several percent in moderately turbid waters. Also Wolanin et al. (2015) showed by using the RTM SCIATRAN that the in-filling of Fraunhofer lines due to rotational Raman scattering is not negligible in this wavelength region and she correct her retrieval algorithm for this effect, whereas she mentioned that no correction for VRS is necessary. I recommended to clarify these inconsistencies by estimating the impact of these inelastic scattering processes to your fit windows by RTM simulations and investigate the errors in your approach due to these effects. Since the signal of the in-filling of the inelastic scattering processes are very small, it is important to estimate the deviations due to uncompensated processes.

9. Eq.(3) indicates that SIF is a dimensionless spectrum and not a single value? Please define SIF properly.

Minor issues:

- Label colorbars in global plots, what are the units of SIF etc.?

- Some equation references are not set (only ?? is seen)

- Meanwhile a new paper (Khosravi et al., Front. Environ. Sci. 2015) about retrieval of fluorescence from SCIAMACHY data in the far-red spectral region data was published and should be also cited in the introduction to complete the overview of established retrievals.

- Title: New methods for the retrieval ...

- Page 2, line 26: ... over land include the MEdium ...

- Page 8, line 62: ... , a single PCA is performed ...

- Page 15, line 71: ... SIF is fitted, ...

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