

Interactive comment on “Chlorophyll fluorescence remote sensing from space in scattering atmospheres: implications for its retrieval and interferences with atmospheric CO₂ retrievals” by C. Frankenberg et al.

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We wish to thank this anonymous reviewer for his/her supportive remarks. In the meantime, we addressed almost all of the other comments and will also add a more detailed discussion on the usability of the Fs signal derived at 755nm. We also removed most references to the FLEX missions (but those which might have been seen to critical). Time will tell in the long run what concepts are feasible and how fluorescence can best be retrieved from space. In the absence of more detailed studies encompassing the

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entire FLEX spectral range, we thus refrain from too direct statements even though we stick to our opinion that Fraunhofer lines (though more demanding for the instrument) would provide the most robust (and fast!) retrieval method.

In the following, we will respond to the reviewers comments, which needed text changes:

Full physics retrievals:

→ We added an introduction: The term *full-physics* algorithm is commonly used in the atmospheric remote sensing community for retrievals based on the full modeling of the radiative transfer instead of parameterizations or a decoupling of the retrieval of trace gas slant column densities and radiative transfer modeling.

Modeling of fluorescence in the simulation:

→ Yes, in the modeling, Fs is fully implemented in the radiative transfer scheme. We added the following sentence at the end of the section: "To conclude, we implemented the chlorophyll fluorescence emission into an orbit simulator, fully modeling the propagation of the signal through a scattering atmosphere, also including multiple scattering effects. "

→ put s in italics

aerosol height

→ We added " (note: in our setup, aerosol height is defined as the peak height of a Gaussian aerosol profile). "

Figure 11

→ removed "true"

TOA vs. surface discussion

→ If we ignore scattering, we in fact retrieve TOA Fs, not surface Fs. We added the fol-

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lowing statement: "In the retrieval as outlined before and also in the Fraunhofer line focussed retrieval, we ignore atmospheric scattering. Hence, the retrieved fluorescence signal accurately represents the true signal at TOA (see Fig. ??) but not necessarily the surface emission."

Related to this: My understanding is that the "true fluorescence signal at TOA" is given by Eq. (2) and is computed using the true surface (TOC) fluorescence. Is this correct ?

→ Yes, this is correct

My understanding is that the retrieved fluorescence is the one at the surface (or TOC). Please explain "retrieved fluorescence signal at TOA" ? Is it computed using Eq. (4) with F_{surf} on the right hand side being the retrieved (surface) fluorescence ?

→ The way we set up the fluorescence retrievals was not by using Eq. 2 but the simplified method outlined in eq. 4. Outside of the O2 lines, F_s at TOA and at the surface are thus identical. Within a line, these values differ largely. The reviewer is right that the state vector element is F_{surf} (at 755nm + its slope) but that the simple setup in the retrieval is in principle more indicative of *F_{TOA} as scattering is ignored, esp because we defined the retrieved parameter at 755nm.*

Section 5.1, page 2502, and Fig. 12: Similar as previous item related to TOA and TOC fluorescence: Please explain how the discussed quantity used for the y-axis of Fig. 12 has been obtained.

→ This has been derived from the simulations, where scattering and aerosol extinction is included. We added the following in brackets: "(calculated from the simulated fluorescence signal at TOA propagated through the scattering atmosphere)"

Please also explain the difference between the red and light red points.

→ Are you referring to Fig 11? All red points have the same color (though there is transparency, so it may look differently if they overlap).

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Section 5.1, page 2503, and Figs. 13: Please explain how the TOA chlorophyll fluorescence has been obtained (see also previous items) ? Is it the TOC fluorescence multiplied with transmission obtained using AERONET AOD ? Or the other way around ? Apparently the latter as the figure caption suggests that the TOC fluorescence is obtained from the TOA fluorescence. This appears to be in contraction to the previous descriptions stating that the retrieved fluorescence is the one at TOC, not at TOA. Please clarify

→ TOA F_s was also derived using full radiative transfer simulations given a surface F_s . The main message here is that TOA and surface F_s are almost identical, even at high AODs (unlike EVI or LAI would respond). Hence, measured F_s at TOA (what we do with the Fraunhofer lines) is a very good measure of F_s at TOC. We added (scattering + absorption) in the caption to clarify that we fully modeled the F_s propagation to the sensor.

Interactive comment on Atmos. Meas. Tech. Discuss., 5, 2487, 2012.

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