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Atmospheric Measurement Techniques Discussions

# *Interactive comment on* "Chlorophyll fluorescence remote sensing from space in scattering atmospheres: implications for its retrieval and interferences with atmospheric $CO_2$ retrievals" *by* C. Frankenberg et al.

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This is my last comments to the discussion paper by Frankenberg et al.

I would like to state some final conclusions from my side, and I hope the authors can take advantage of them to improve their paper.

In general, I would recommend to choose a more careful phrasing, in order to prevent misunderstandings and confusion in parts of your audience, which is wider than just the atmospheric chemistry community. For instance, labeling FLEX as almost an O2-A



band mission generated some irritation. Also, speculations about photosynthesis mapping through clouds are very premature. An ESA-funded project investigating exactly this point of the Fs-GPP relationship still has to start. At least there is general consensus that a minimum requirement is the knowledge of both Fs peaks at 685 and 740 nm, and my private opinion of the moment is that the second peak tells more about leaf chlorophyll than about photosynthetic activity. Disentangling chlorophyll concentration effects and photosynthetic activity will require information about both peaks, and probably also the reflectance signature.

Although the authors obviously have a different opinion, in general one can state that wider spectral windows provide more information and a higher robustness against ill-posedness of Fs retrieval and this can be quantified numerically by error propagation analysis. Wider windows give more spectral samples and a smaller chance of linear dependence, and both contribute to reaching a smaller retrieval error. Using only the solar Fraunhofer lines in the 755 nm window requires a very high SNR in combination with a very high spectral resolution. This concept may be useful to the atmospheric chemistry community for the correction of fluorescence contamination effects in very low spatial resolution (several km) imagery as explained well in the paper, however for FLEX this option is out of the question because of its target spatial resolution of 300m. FLEX will use the whole region from 500 to 780 nm (about 400 samples total), thereby taking advantage of the fact that at this scale the spectral shape of chlorophyll fluorescence is absolutely unique, and not any atmospheric phenomenon will be able to reproduce this spectral signature, like what may happen indeed when using only narrow spectral windows. In your discussion paper you refer back to earlier peer-reviewed papers in which you demonstrate cases of near linear dependence, but already on the scale of the 750 - 770 nm window, where both solar and telluric absorption lines are active, this linear dependence has already decreased substantially. This can be quantified easily by means of singular value decomposition (SVD) of the Jacobian matrix, as you are probably aware of.

In answer to Luis, regarding non-isotropic Fs, in the concept of using only solar Fraunhofer lines the total transmittance may decrease only slowly with AOD, the ratio of the direct and the diffuse contributions to the total transmittance does change rapidly, which means that in the case of non-isotropic Fs the measured signal would partly depend on AOD. By the way, I did not discuss yet BRDF effects, and actually these should be included in the forward model as well in order to be able to speak of a "full-physics" model, right? So, do you agree that your model is actually not a "full-physics" model if it cannot deal with BRDF effects?

I wish you all good luck with the final version of this interesting paper.

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