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Atmospheric Measurement Techniques
Discussions

Interactive comment on "Potential of the TROPOspheric Monitoring Instrument (TROPOMI) onboard the Sentinel-5 Precursor for the monitoring of terrestrial chlorophyll fluorescence" *by* L. Guanter et al.

L. Guanter et al.

luis.guanter@wew.fu-berlin.de

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We would like to thank the reviewer for the thoughtful comments and the positive evaluation of our manuscript. Please, see our responses to your comments below (in bold).

The paper by Guanter et al. reports on the prospective performance of the Sentinel-5 Precursor (S5P) in retrieving plant fluorescence. An ensemble of simulated soundings is subject to an approximate retrieval method similar to the one in operation for real

data e.g. from GOME-2. As such, the assessed error budget includes contributions from simulated noise errors and from the approximate nature of the retrieval e.g. with respect to the treatment of aerosols and clouds. The paper aims at estimating what errors to expect from S5P on the global scale in comparison to the existing GOME-2 records

The paper is very well written. It is a relevant contribution to the atmospheric sciences. So, I recommend publication in AMT.

In my opinion, the paper could put more emphasis on S5P specific challenges. The employed retrieval method works well for other satellites for very similar spectral ranges; S5P's instrument properties are improved compared to previous satellites; so, what else to expect than a better fluorescence retrieval? Then, the simulated noise is pessimistic (p12556,l26) i.e. the estimated performance does tell that S5P will be better than GOME-2 but, does not tell by how much really. In particular, it would be interesting to assess how much spatiotemporal averaging will actually be necessary to make S5P's fluorescence a useful product. Further, S5P's wide swath implies large viewing zenith angles. How accurate is the assumption that fluorescence is isotropic and that there are no angle dependent instrument effects? Will averaging inner and outer swath pixels work through via statistical error reduction? Could there be seasonal and regional biases e.g. due to changing canopy structure? As far as I understand the paper shortly touches on that aspect but does not go into depth (p12567,l3).

Thanks for this comments. We agree that it would be very interesting to address more in detail some of the specific challenges that we will have to overcome with real TROPOMI retrievals. Unfortunately we still lack some key details of the instrument performance that would be needed for such analysis. In particular, a critical issue at the moment is the lack of an instrument noise model including multiplicative and additive noise contributions, or at least of consolidated SNR-radiance curves, which will become available at a later stage. This limitation for the simulations makes it difficult to obtain more quantitave estimates of abso-

lute error figures for either single retrievals or spatio-temporal composites. For this reason, we decided to base the analysis on the comparison with GOME-2 (the most similar instrument currently flying) in order to present to the potential user community the substantial improvements (in a relative sense) that we can expect from TROPOMI. We will indeed address those aspects in the future when hopefully dealing with retrievals from real data.

We have added some statements acknowledging the limitations of our analysis (e.g. no systematic errors included, no directional effects considered in the averaging, no separation between multiplicative and additive noise contributions, conservative SNR-radiance curve for TROPOMI) throughout the text.

Specific comments

section 2.2: It is unclear to me where the convolution of the monochromatic radiance-at-sensor by the instrument function enters the forward model?

Because of the followed data-driven approach, the variables in the forward model are by definition convolved by the instrument spectral response function after principal component analysis of the training set. One spectral convolution is however applied to the solar constant for the derivation of $\vec{T}_{\uparrow}^{e}$ in a pre-processing step. This clarification has been added to the text.

p12554,l21: The whole paragraph reads confusing. Signal-to-noise is defined at the continuum radiance level and scales with the square root of radiance. Thus, for bright surfaces, radiance at the continuum is large and the fluorescence contribution is relatively small implying that while signal-to-noise at the continuum increases the fluorescence retrieval error might actually increase. Is that the main point discussed here?

We meant that the 1σ error of our retrieval scales linearly with measurement noise, so precision decreases with at-sensor radiance for photon-noise driven instruments (more radiance leads to more noise and hence to a higher random

error). We have rephrased this part of the text, and Fig. 7 has been modified by the inclusion of real GOME-2 data illustrating this finding.

p12556,equ 5: The noise model depends on the square root of radiance alone. Typically, there is radiance independent contributions e.g. from dark current noise, read-out noise. In that sense, the noise model is optimistic for dark surfaces. The denominator lacks radiance units.

True, thanks. We acknowledge that this simplification may affect our simulations at 690 nm (now stated in the text). However, we believe this is not an issue for far-red retrievals, as vegetation reflectance is relatively high in the near-infrared.

p12564, Discussion: The discussion is quite speculative on what S5P can deliver beyond SIF, but does not cover a critical assessment of the shortcomings of the presented SIF assessment. A few aspects that come to mind: pessimistic and simplistic noise model, fluorescence assumed isotropic, S5P instrument issues such as angle-dependent spectral features of a mirror.

Thanks for the comment. We have stated in the Conclusions section that more accurate assessments of absolute error figures will be performed when more information on the instrument radiometric and spectral performance becomes available.

Interactive comment on Atmos. Meas. Tech. Discuss., 7, 12545, 2014.