Dear Dr. C. Frankenberg:

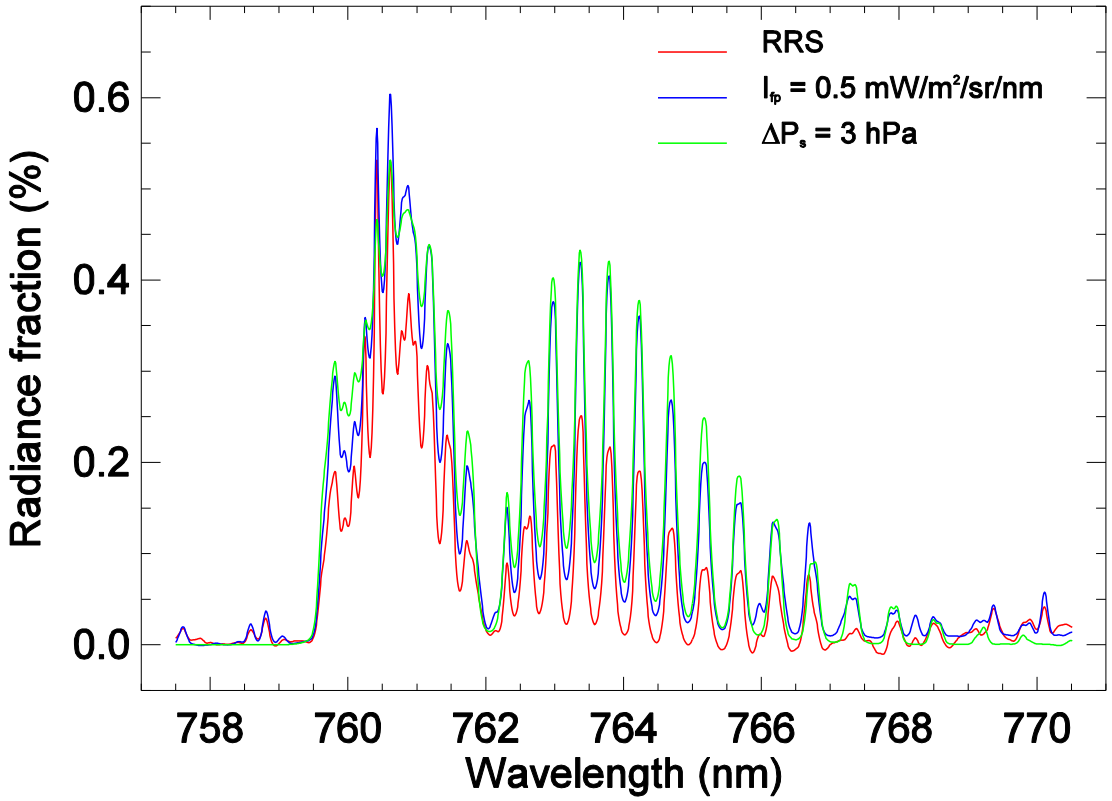
Thank you very much for your comments that have helped us to improve our paper. Below are our responses to your comments shown for convenience in bold face.

"the title is misleading as the paper shows only the impact on observed radiances but not how these actually propagate into errors in retrievals"

We agree that the title of the paper may not be appropriate. We changed the title by removing "Implications for retrieval of trace-gas concentrations and terrestrial chlorophyll fluorescence".

"At the very least, the impact of RRS should be discussed in a qualitative way (e.g. by judjing from the impact of fluorescence onxCO2 as in the Frankenberg 2012 AMT paper)."

To illustrate how RRS might affect a retrieval related to photon path length in the O2-A band, we changed the old Fig. 10 comparing the RRS spectral response with that of fluorescence. We removed one the upper fluorescence curve and replaced it with one showing the spectral response due to a 3 hPa change in surface pressure. This surface pressure change produces a similar magnitude and spectral response as RRS, although there are subtle differences (see Figure below).



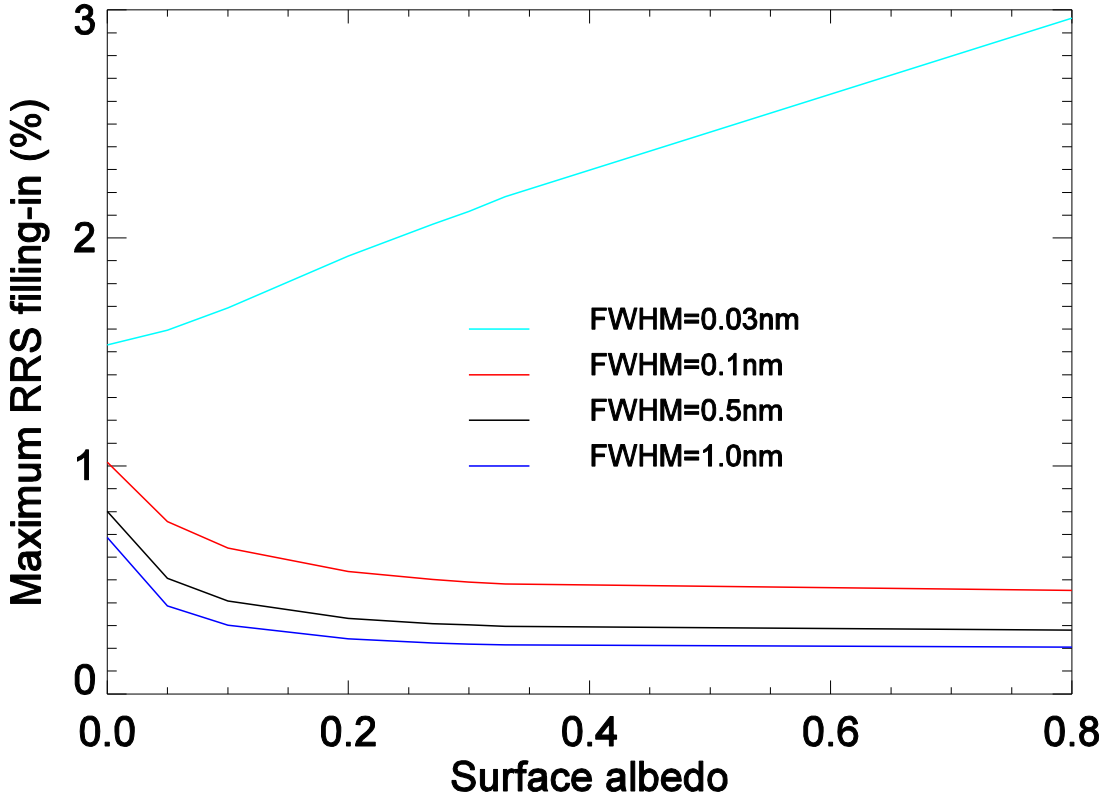
We clarified some discussion in the conclusions relating to impact on xCO2 and fluorescence retrievals to make it more quantitative. It now reads "The calculations of Frankenberg et al. (2012) showed that an additive signal from fluorescence of 1% of the continuum could lead to about 1 ppm errors in retrieved xCO2. Assuming linearity, the neglect of RRS filling-in within the O2 A-band may then lead to biases in satellite retrieved xCO2 of approximately 0.3 ppm." We also rearranged the conclusions a bit and changed "Our calculations show that RRS filling-in of telluric lines is comparable with small to moderate amounts of filling-in due to terrestrial chlorophyll fluorescence" to "Our calculations show that RRS filling-in of telluric lines is spectrally comparable with small to moderate amounts of filling-in due to terrestrial chlorophyll fluorescence (of the order of 0.5mWm2 sr−1 nm−1)."

"Also, it would be worthwhile to discuss the spatial coherence of potential biases. If the biases induced by RRS are smoothly variable as a function of viewing angle (as is shown), then even a bias would not be that problematic in retrievals as SZA dependent biases are anyhow potential biasing factors (e.g. due to spectroscopy) and will ideally be calibrated out. As such, the dependence on surface albedo might be of higher interest as this quantity has more spatial variations and co-vary with "greenness".

It is a very good point about surface albedo dependence. We carried out radiative transfer simulations in the A-band for values of the surface albedo between 0 and 0.8. Figure below shows that for moderate and low resolution instruments, the RRS filling-in dependence on surface albedo in the A-band is similar to that shown for filling-in of solar Fraunhofer lines in (Joiner et al., JGR, 2004): at low surface albedos (between approximately 0 and 0.2), the filling-in decreases with increasing surface albedo. For high resolution instruments, the telluric RRS filling-in increases with increasing surface albedo. The absorption line depth increases with increasing surface albedo. When individual absorption lines are spectrally resolved, the filling-in (defined as the ratio of inelastic radiance to the TOA radiance) then increases with surface albedo.

Figure below shows that the RRS filling-in dependence on surface albedo is very small in the albedo range of 0.2-0.8 (typical of vegetated and snow-covered land for wavelengths in the region of the A-band) for moderate to low resolution instruments. Variations for high spectral resolution instrument are larger and similar in magnitude to changes across a wide satellite swath as shown in Fig. 5. In addition, for low resolution instruments, the surface albedo dependence on RRS filling-in could be important for the B-band where surface albedos are typically lower over land. We note that the surface albedo dependence may produce some spatial structure in the observed filling-in from space-based instruments.

We added an Appendix to the paper where we describe the RRS filling-in dependence on surface albedo.


Maximum RRS filling-in (%)
Surface albedo
0
1
2
3
0.0
0.2
0.4
0.6
0.8
FWHM=0.03nm
FWHM=0.1nm
FWHM=0.5nm
FWHM=1.0nm