Review of Bi et al., “TanSat ACGS on-orbit spectral calibration by use of individual solar lines and entire atmospheric spectra”

In this work, the authors discuss using individual solar lines and fitting to entire atmospheric spectra of TanSat ACGS data to fit for shifts and stretches in the wavelength (dispersion) calibration of the ACGS relative to its preflight calibration.

There are a number of problems with this paper. Space-borne spectrometers require calibration in terms of radiometric, geometric (geolocation), spectral, and polarization behavior. In terms of spectral calibration, both wavelength (dispersion) calibration as well as calibrating the instrument line shape (ILS) functions. Of all these categories of calibration, fitting the dispersion is probably the easiest and best understood. It is so straightforward and robust, in fact, that few groups even bother to do this in a dedicated fashion, because it is easily fit for simultaneously with other atmospheric parameters required to derive e.g. column mean carbon dioxide concentration (XCO2) or solar-induced chlorophyll fluorescence (SIF). This is well documented in many publications (e.g., Reuter et al. 2010, Taylor et al 2011, Frankenberg 2011, O’Dell et al 2012, Crisp et al. 2017, Wu et al. 2018).

Therefore, the methods espoused are nothing new. It is confusing to me why they focus on individual solar lines, when they could just as easily fit for example a 2 or 3-parameter update to the wavelength dispersion by using all the solar lines (or all solar lines greater than a certain depth); this would be significantly more robust than using a single solar line. And also why they choose the Kurucz spectrum as their reference, where nearly all groups have found that the Toon solar reference spectrum (http://mark4sun.jpl.nasa.gov/toon/solar/solar_spectrum.html) is considered superior in terms of accuracy.

But these are minor problems. The biggest problem is that much of this work is already documented in a prior publication by many of these same authors, in the recent paper “Inflight Performance of the TanSat Atmospheric Carbon Dioxide Grating Spectrometer” (Yang et al., 2020). That publication also fits for spectral shifts using the solar spectrum, and produces time series of the results, just as in this paper. Remarkably, the Bi et al. paper under review here does not even reference, discuss, or compare to the results from Yang et al. in terms of the wavelength shifts found in both works. The single reference to the Yang et al. paper in this work is to state the size of the spatial field-of-view of TanSat; nothing about its results on spectral shifts relative to preflight.

Another serious problem with this paper is that although they say that the solar and atmospheric methods give similar results, they never actually demonstrate this. There is no figure that compares them, no method to actually discuss and compare quantitatively their respective results. I tried to do this manually, and they actually did not agree (comparing the offsets given in their table 2 results, to those in figures 4-6 for the solar method).

A minor point is that while they discuss the solar doppler shift (induced by the relative motion of the spacecraft and the sun, when they use the solar method), they never discuss the doppler shift of the telluric (earth's atmosphere) lines, induced by the relative motion of the satellite and the target point on the earth's surface. It's not clear if they take this into account.

Finally, there are many English grammar errors that require correcting. I do not bother to list them, as this is a relatively minor point considering the structural deficiencies in the paper.

Therefore, I recommend to reject this work for publication. It introduces nothing new to the field, its results are not coherent, it does not try to explain the physics of what is going on (e.g. the noticeable jump in spectral shift around DOY 150 in Figure 4). It does not explain the disparity of results across the 9 FOVs, in particular in the strong CO2 band. So it is not new, it does not explain anything to us regarding what is happening with TanSat in particular, the results are confusing and not well-presented, and the effect is easily and automatically taken into account by the TanSat XCO2 and SIF retrievals anyway (e.g., Liu et al., 2013, Du et al., 2018).

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