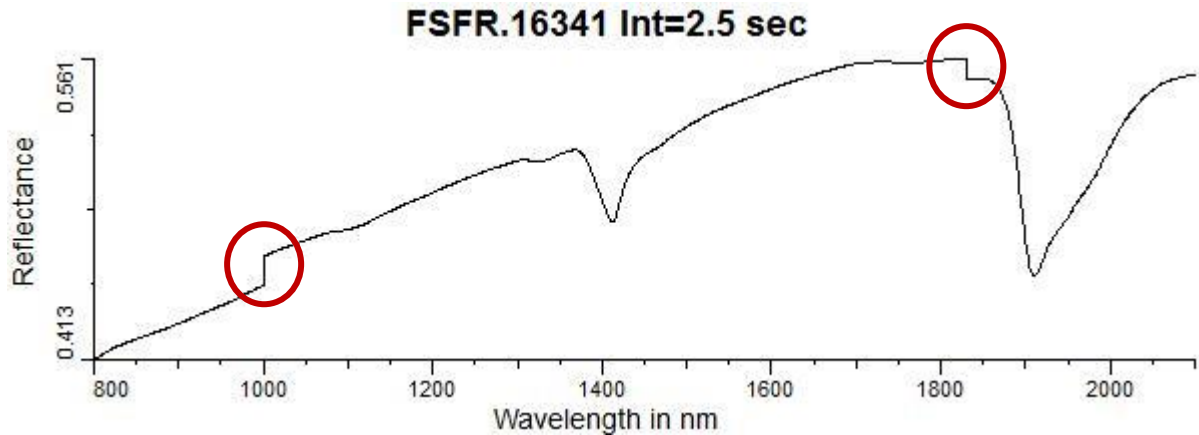


Inter-Detector Step Correction



Introduction

Do you have spectra like the one shown above, with one or two steps showing consistently at the same wavelengths? They can be quite common. If you see spectra like this then don't panic. Your spectrometer is probably not broken. Use this module to correct the steps.

The reason for steps like these is that a spectrometer commonly includes more than one detector¹. Even with best practices, such a spectrometer will produce spectra with steps at least some of the time. The *dominant* reason is that it is very hard to deliver the same field of view to each detector, even with a fibre-optic bundle. The detectors see slightly different patches of surface. There may also be secondary reasons to do with detector calibration (e.g., dark correction) and linearity.

Now depending on your spectrometer you might never actually get to *see* these steps. HyLoggers and the Spectral Evolution OreXpress take care of de-stepping themselves and produce step-free spectra. TSG's import for the ASD spectrometer family has a de-stepping correction turned on by default².

The correction

The correction itself is straightforward. The objective is to bring the two sides of the spectrum (around a step) into alignment. The correction is done by scaling.

- The step is between channel[i] and channel[i+1]. A typical channel increment is estimated for the left half leading up to channel[i], and a similar increment for the right half starting from channel[i+1]. The smaller of these estimates is used as the *target* increment from channel[i] to channel[i+1].
- One of the sides (normally the bigger side) is the "reference side" and it stays put. For the other side, a scale factor is calculated to achieve the target increment and the whole side is moved up or down by scaling.
- At this point, smoothing may be done around the corrected step. The smoothing is faded in and out to affect just a few channels around the corrected step.

¹ Not all spectrometers are like this. A spectrometer that measures a relatively small wavelength interval (e.g., PIMA SWIR, OceanOptics visible) will probably have just one detector. However a field spectrometer that measures a large interval like the common Vis-NIR-SWIR range (about [350, 2500] nm) is likely to include two or more detectors. There are sound design reasons for this.

² You can (re)do an import with this option turned off if you wish to see what steps exist in your ASD spectra.

- Finally, the whole spectrum may be rescaled if necessary so that it does not exceed the range [0,1].

Onwards

Your starting point is a TSG dataset that you would like to correct or experiment with. Ideally, this dataset should have been imported as close to full spectral resolution as possible, with no resampling or simple linear resampling if TSG insisted. (For example, an ASD Fieldspec dataset should be imported retaining the incoming 1nm channel spacing.)

First of all, make a copy of the dataset's files in case something goes wrong. Now open the dataset in TSG. Browse through some spectra in TSG's Spectrum screen, noting the wavelengths where you see the step(s). The Stack screen (with its moving-average functionality enabled) can also be useful for this. Once you're ready, launch the correction module **from the menu**:

File -> Special -> General inter-detector step correction

The module takes a quick look through your dataset's spectra and then puts up its **control panel** (see opposite).

The first thing to note is that the dialog has two main parts (top and bottom). It can correct two steps in one run. This is done because it is common for a Vis-NIR-SWIR spectrometer to have three detectors, hence two steps. The bottom set of controls is enabled by turning on the **Also correct a second transition** checkbox in the middle.

Now let's look at a set of controls.

Location

The label shows the wavelengths of the channels before and after the step. (The step between detectors is commonly called a "splice point" by spectrometer manufacturers.) The default selection is made by TSG according to its examination of the spectra. You should check this selection against what you found yourself in your earlier browsing.

The **Pick** button brings up a dialog that allows you to select the step location, should you disagree with the default selection. Each row in this dialog has before & after wavelengths, along with a mean |channel difference| found by TSG. The rows are coloured according to their mean |channel difference|, with small differences being blue and large ones red. Channels in very active or noisy spectral regions will tend to have large differences but one would normally see a **region** of such channels. *A genuine inter-detector step will normally stand out on its own*, like in the screen-grab opposite.

995 : 996 nm, step=0.0173
996 : 997 nm, step=0.018
997 : 998 nm, step=0.0139
998 : 999 nm, step=0.0172
999 : 1000 nm, step=0.0209
1000 : 1001 nm, step=0.532
1001 : 1002 nm, step=0.0133
1002 : 1003 nm, step=0.0132
1003 : 1004 nm, step=0.0133
1004 : 1005 nm, step=0.0142
1005 : 1006 nm, step=0.0133
1006 : 1007 nm, step=0.0132
1007 : 1008 nm, step=0.0128

Reference side

The step point divides the spectrum into two “sides”. The correction works by moving one side so that it lines up with the other at the step. This moving is done by applying a scale factor. The side that is not moved is called the “reference side” here. By default TSG picks the larger of the two sides to be the reference side but you can override this choice with the **Left** and **Right** radio buttons.

Smooth the transition

Turn on this checkbox to have TSG apply some smoothing to a small interval around the step, after the step has been corrected.

The “splice point” between two detectors is normally at a wavelength where the overall throughput for *both* detectors is fading off. The spectrum can be noisy there (on both sides) and smoothing can be beneficial.

Force [0,1] range

As noted earlier, the correction works by scaling one side of the spectrum, effectively moving it up or down. In rare cases this can cause a strong spectrum to be moved up so that it peaks at more than 1.0 (more than 100% reflectance). Turn this checkbox on to force such a spectrum to be rescaled so that it peaks at 1.0.

This option only makes sense if your reflectance spectra range [0,1]. However this is what you should *always* have in TSG. You should never have reflectance spectra ranging [0,100] in TSG.

Recalculate all scalars

If you feel that the step correction might change things enough to warrant a general dataset recalculation then you can have TSG do this after correcting the spectra. Turn on the **Recalculate all scalars** checkbox.

Proceed

Click **Proceed** once you’re ready to run the correction. TSG will ask you to confirm as it is about to change the dataset fundamentally.

If all goes well, the dataset’s reflectance spectra are corrected *in place* and the dialog is closed.

If you asked for the dataset’s scalars to be recalculated then this is done next.

If something goes wrong, TSG beeps and the dialog stays up.

Feedback

This tool has only recently been made available for general use in TSG. If it does not work for you for some reason (once you’ve seriously explored its options) or you have an instrument with unusual step characteristics then please contact peter.mason@csiro.au so that it can be improved.