BACKGROUND

Bob Brown (VIMS Team Leader), Roger Clark (VIMS Team Member responsible for maintaining/improving the VIMS calibration files) and Dyer Lytle (Senior VIMS Programmer responsible for the University of Arizona VIMS pipeline) have discovered that the VIMS IR wavelengths have been gradually shifting through the mission (Fig. 1)

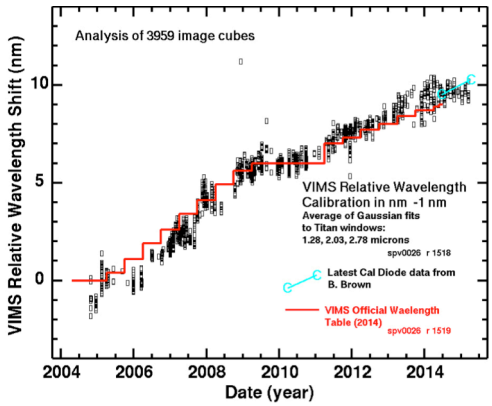

Figure 1. VIMS IR wavelength shift from Roger Clark PDF 11/03/2015.

The width of each of the 256 VIMS IR spectral bands is roughly 17nm, so the total shift over the mission is a little over half of the width of each spectral band. Because of this gradual shift, several spectral files used in the radiometric calibration process are no longer properly "lined up" with the raw VIMS IR data. **Brown, Clark, and Lytle decided to generate a full set of calibrations files for each year starting with 2004 and ending with 2017 (4 files each for each of these14 years). The modification that is required in vimscal is to first determine in what year an IR cube was acquired and to use the spectral calibration file set appropriate for that year. Discussed below is the sequence of steps executed in vimscal and to note where these year-specific files need to be used.**

Prior to the vimscal step the raw VIMS EDRs are 'ingested' into ISIS3 format using a program vims2isis. In this process the cube is converted into standard ISIS3 format and wavelengths added to the label as 256 BAND_BIN_CENTERS. Various other housekeeping data is added as well (exposure times, geometric data, etc).

VIMSCAL STEPS IN RADIOMETRIC CORRECTION OF A VIMS IR CUBE

Where year-by-year spectral files are to be used is called out in bold.

Residual Dark Current Correction:

Although the most of the dark current (DC) was subtracted on board, some residual DC remains. At the end of each line a dark value is acquired and returned as a side-plane. A down-column linear fit (to smooth out noisy values) is made to these residual DC values (one for each spectral band on the line) and the linear fit is subtracted from each raw spectrum.

Flat field Correction:

The VIMS IR Spectrometer field of view is swept across the sky with a two-axis articulation of a mirror in order to form an image. This introduces some 'shading' across the spectral image owing to the variations in the optical path for each position in the scanned image. The flat field correction data is a in 3-D file for each off-axis line and sample position and spectral band. This file is NOT year-dependent because the flat field (aka field shading file) varies smoothly with wavelength and the small wavelength shifts across the mission lifetime do not impact it.

<u>Conversion of DN to Specific Intensity or Energy Units:</u>
This is the first place where the year-by-year calibration files are to be applied in the modified vimscal. Two multiplicative corrections are applied. The first is to convert from DN/sec to photons/sec using a file called RC19(λ, YEAR) (radiometric correction version 19). The second is to convert from photons/second to specific energy (or specific intensity) and to apply corrections that are functions of the band wavelength, spectral band width, and a wavelength-dependent aperture correction. This files we call MULT(Δλ, λ, Aperture, YEAR).

<u>Conversion from Specific Energy (Intensity) to I/F:</u>
This step involve dividing the specific intensity by that of a perfectly reflecting Lambert disk sitting at Saturn's distance from the Sun and viewed and illuminated perpendicular to its surface. This requires a different solar spectrum files we call SOLAR_INTENSITY(λ, YEAR). We also noted that currently vimscal uses the distance from the Sun to the target. Some VIMS cubes have multiple targets and this introduces unnecessary complexity and it was decided that this conversion to I/F should use the Sun-Saturn distance.

<u>Update the BAND_BIN_CENTER Wavelengths:</u>
This last step needs to be added to vimscal. As noted above the BAND_BIN_CENTER wavelengths are added in the vims2isis program that is run before vimscal. In the final step the wavelengths of the BAND_BIN_CENTER table in the VIMS IR label need to be changed to the correct wavelengths for the YEAR that the cube was acquired using the file BAND_BIN_CENTER(BAND, YEAR).

<u>Generate the output file and update the labels.</u>

END