NEGATIVE FLUXES FROM NULL AND TFLOOD IMAGES

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Abstract

An analysis of SWP null and t-flood images indicates that negative flux levels can occur as a result of previous overexposures of the camera. Evidence is presented that overexposures can temporarily decrease the sensitivity of the camera in the spectral region.

Introduction

Large or repeated overexposures of the IUE cameras can affect subsequent exposures by introducing additional phosphorescence in the spectral region (Imhoff 1987; Snijders 1983). For long exposures, this phosphorescence can result in a significant residual image. The effect of overexposures on subsequent short exposures has not been investigated in detail; therefore this preliminary study will concentrate on a study of SWP null and t-flood images. The null images in this study have been prepared in the standard way (with the normal t-flood exposures and read-erases for an "SPREP", see Sonneborn et al. 1987) and read without any further exposures. T-flood images are created by exposing the entire prepared camera to a tungsten flood lamp before reading the camera. Ideally, the net flux from null and t-flood images should average to zero over a suitably large wavelength interval.

This study is motivated by the findings of R. Dufour, who found that the null SWP images that he had taken for flat-field studies exhibited negative flux levels in the long wavelength region. An investigation into the circumstances surrounding the observations reveal that from 1986 February 7 to 1986 March 6, 44 overexposed spectra of Capella and Procyon were obtained by another guest observer. The spectra of these F stars were overexposed 5 to 20 times at longer wavelenghts to obtain optimum exposure levels for C IV at 1550 angstroms. R. Dufours's images were obtained during the latter part of this time period, from 1986 March 1 to 1986 March 7. For comparison, a number of nulls not affected by previous overexposures were obtained from the IUE archives.

All of the null and t-flood images were processed by IUESIPS as extended sources; this scheme uses a slit height of about 15" perpendicular to the dispersion to produce the merged spectrum. The null spectra are plotted in the form of flux numbers (FN) and the t-floods as FN/sec as functions of wavelength; the absolute sensitivity curve has not been applied. The null spectra were separated into three separate groups and averaged; the average of Dufour's null spectra is designated "SWPNULL2", and the averages of null spectra taken before and after Dufour's observations are designated "SWPNULL1" and "SWPNULL3" respectively. The average of the t-flood spectra from Dufour is designated "SWPTFLOOD". The average spectra were binned at 50 angstrom intervals to help in identifying large scale changes; reseaux and emission features flagged by the processing software were not included in the bins.

Results

Figures 1-4 show plots of the average spectra and binned data. For SWPNULL2 and SWPTFLOOD, it is obvious that the fluxes in the region 1700 - 1950 angstroms are negative; it is in this region that the previous overexposures occured. For SWPNULL1 and SWPNULL3, the overall flux level is slightly negative in this region, but has approximately the same amplitude as other large scale variations across the spectrum. Thus, it appears that overexposures can affect subsequent images, even if the exposure times are small. Apparent in all of the nulls is a camera artifact that appears as an emission feature at about 1970 angstroms; this area is therefore excluded from further consideration.

Figure 5 shows a plot of the net flux in the wavelength band 1850 - 1950 angstroms as a function of exposure time for the t-flood and average null spectra affected by the overexposures. It is obvious that the net flux in this wavelength region decreases linearly with increasing exposure time (or gross flux), which indicates that the camera sensitivity in this region has decreased by some constant percentage due to the previous overexposures. The net flux for the null spectra is not zero, due to the decreased sensitivity of the camera in the spectral region to the t-flood exposures during the camera preparation sequence. A linear regression fit to the data yields the following equation:

$$F(net) = -623 - 281*t(exp),$$

where F(net) is the average net flux in the wavelength region and t(exp) is the exposure time in seconds. The correlation coefficient for the fit is -0.943.

The importance of the sensitivity loss can be evaluated by considering Figure 6, which shows a 10 second t-flood exposure that resulted in a maximum DN level of about 200. The expected gross flux F (gross), is the average flux in the 1850 - 1950 region corrected for the sensitivity loss from the above equation; for the 10 sec exposure, F(gross) = 1.87 E+05. The percentage error in the gross flux due to decreased sensitivity can be calculated by dividing the above equation by F(gross):

$$\begin{aligned} E(gross) &= (-623 / F(gross)) - (281 * 10 / 1.87E+05) \\ &= (-623 / F(gross)) - 0.015. \end{aligned}$$

The percentage error in the gross flux due to loss of camera sensitivity is therefore -1.5% plus the percentage error due to the negative flux level of the pedestal placed on the camera by the preparation sequence. With a little algebra, the percentage error in the net flux can be shown to be:

$$E(net)= E(gross) / (1 - F(bkgd)/F(gross)),$$

where F(bkgd) is the background flux in FN.

As an example, the percentage error due to sensitivity loss can be calculated for different exposure levels (given in DN):

F(gross)	F(bkgd)	E(gross)	E(net)	Comments
200 DN	20 DN	1.8%	2.0%	opt. exp., no extra bkgd.
200 DN	100 DN	2.2%	4.4%	opt. exp., high bkgd.
200 DN	180 DN	4.8%	48.0%	opt. exp., very high bkgd.
40 DN	20 DN	4.8%	9.6%	weak exp., no extra bkgd.

Thus for short optimum exposures with no extra background due to particle radiation or camera phophorescence, the effect of previous overexposures is relatively small. For high backgrounds and/or weak signals however, the percentage error in the net flux can be quite large. This example does not include the effects of excess camera phophorescence in the spectral region, which can be important for long exposures.

The magnitude of the decrease in sensitivity for the SWP will certainly depend on the number and degree of previous overexposures, as well as the amount of time elapsed between exposures. Therefore the errors given are only relevant to the data presented here. To fully estimate the effects of overexposures on a subsequent long exposure, an observer would need to obtain a serious of t-flood and null images to determine the loss in camera sensitivity, as well as long sky background exposures to measure the effects of camera phosphorescence.

References

Imhoff, C.L. 1987, NASA IUE Newsletter No. 33, p. 25.

Snijders, M.A.J. 1983, NASA IUE Newsletter No. 23, p. 56 (also ESA IUE Newsletter No. 16, p. 10).

Sonneborn, G., Oliversen, N.A., Imhoff, C.L., Pitts, R.E., and Holm, A.V. 1987, NASA IUE Newsletter No. 32, p. 1.

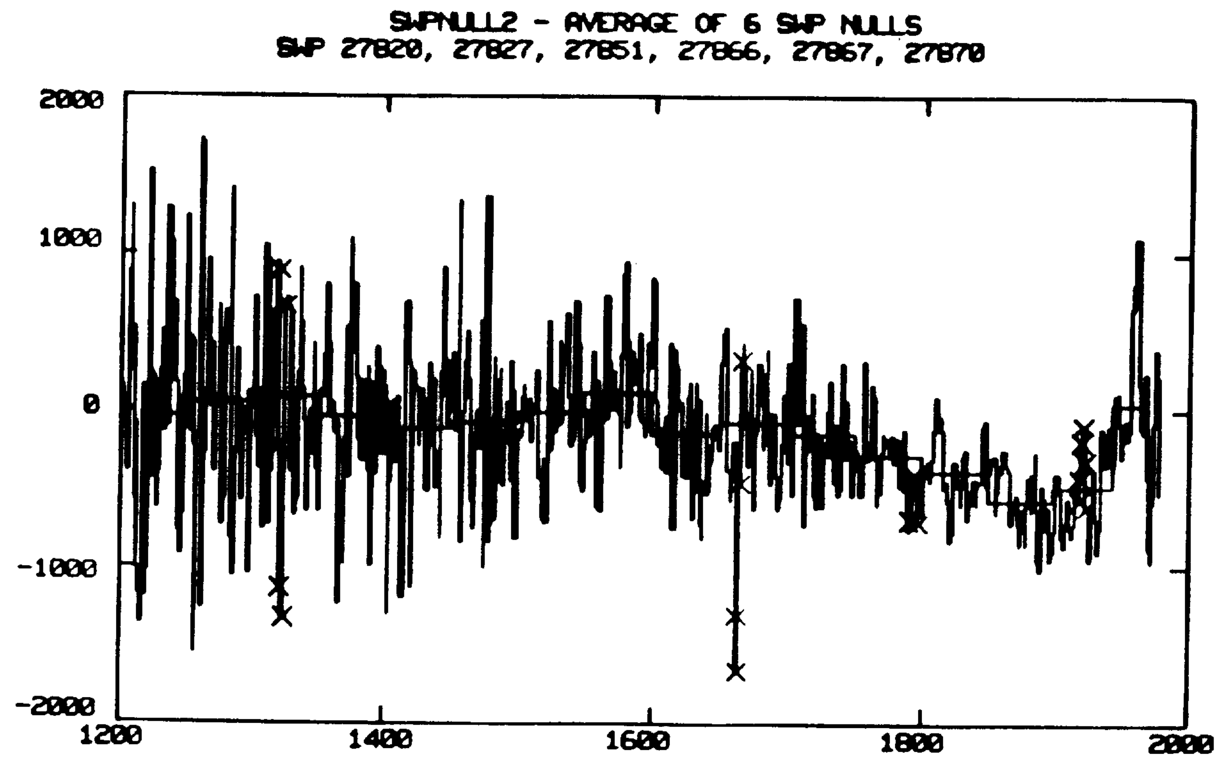

Figure 1. Average of 6 SWP null spectra obtained by Dufour given in flux numbers (FN) as a function of wavelength (angstroms). The flux in 50 angstrom bins is also plotted. The reseaux and an emission spike are indicated with an " X ", and were not used in computing the average flux in each 50 angstrom bin.

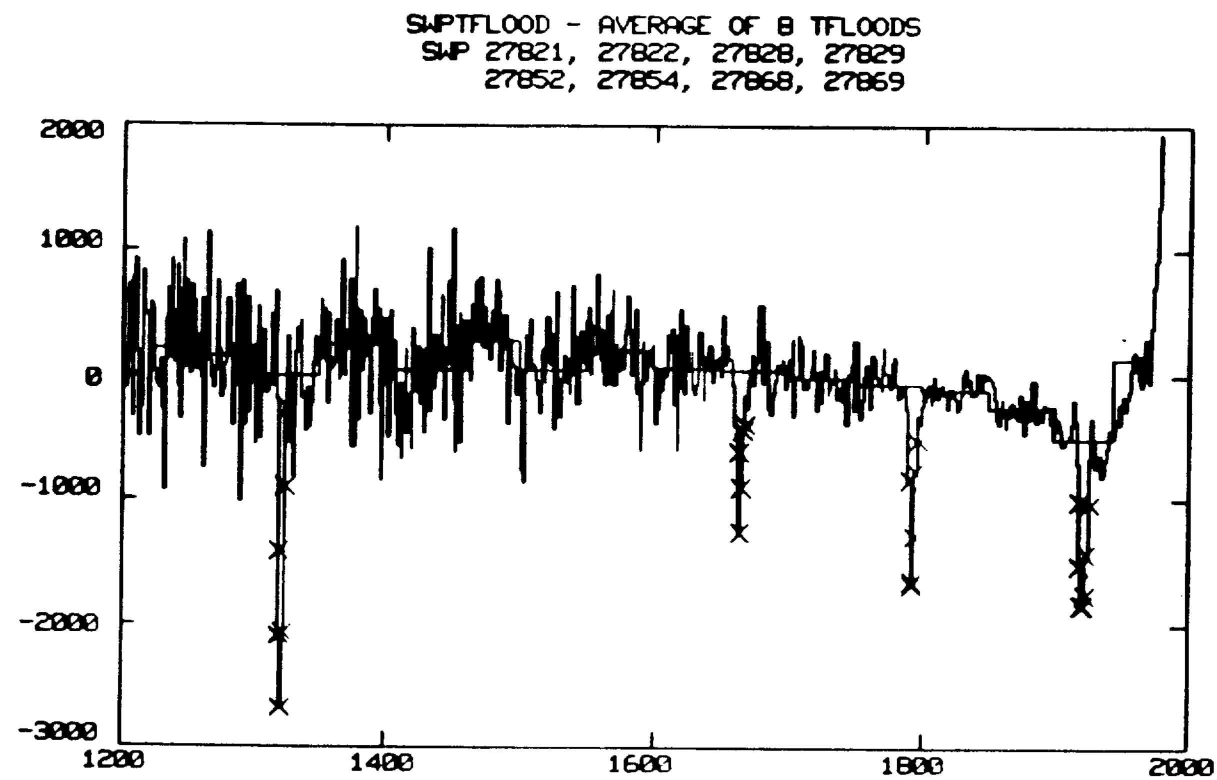

Figure 2. Average of 8 t-floods obtained by Dufour given in flux numbers per second. The spectrum is plotted as in Figure 1.

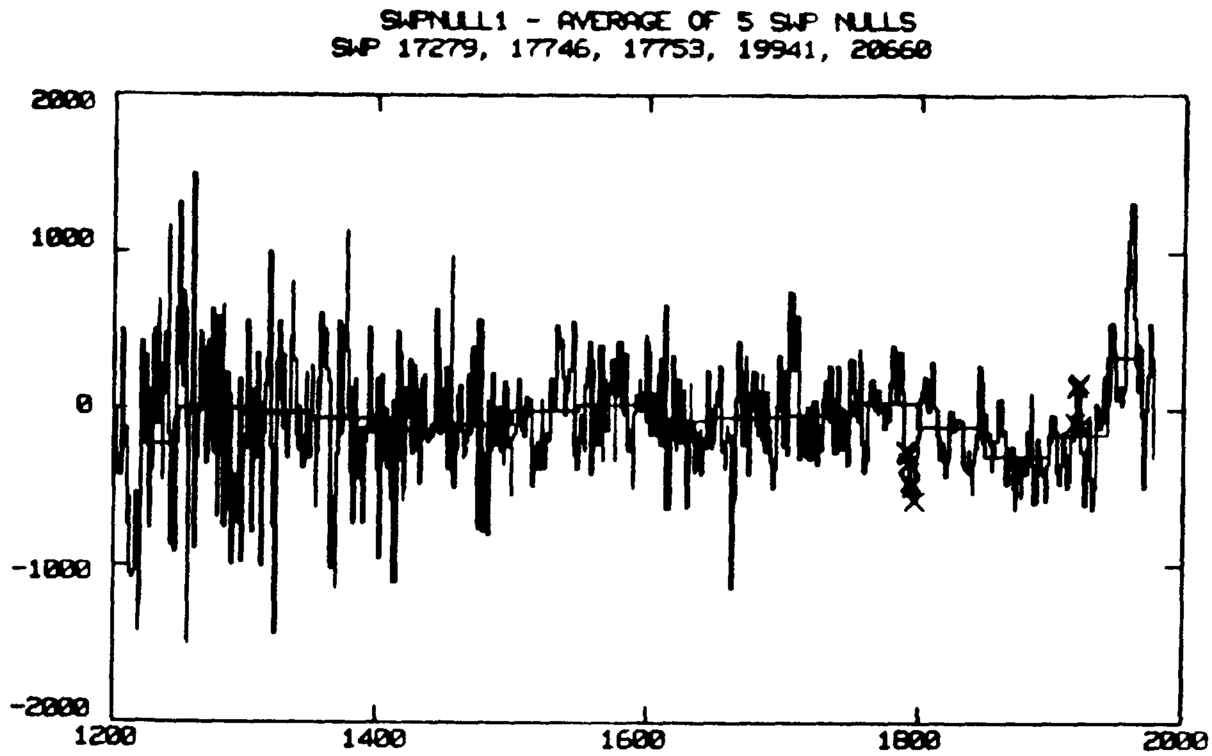

Figure 3. Average of 5 SWP null spectra obtained prior to those in Figure 1. The spectrum is plotted as in Figure 1.

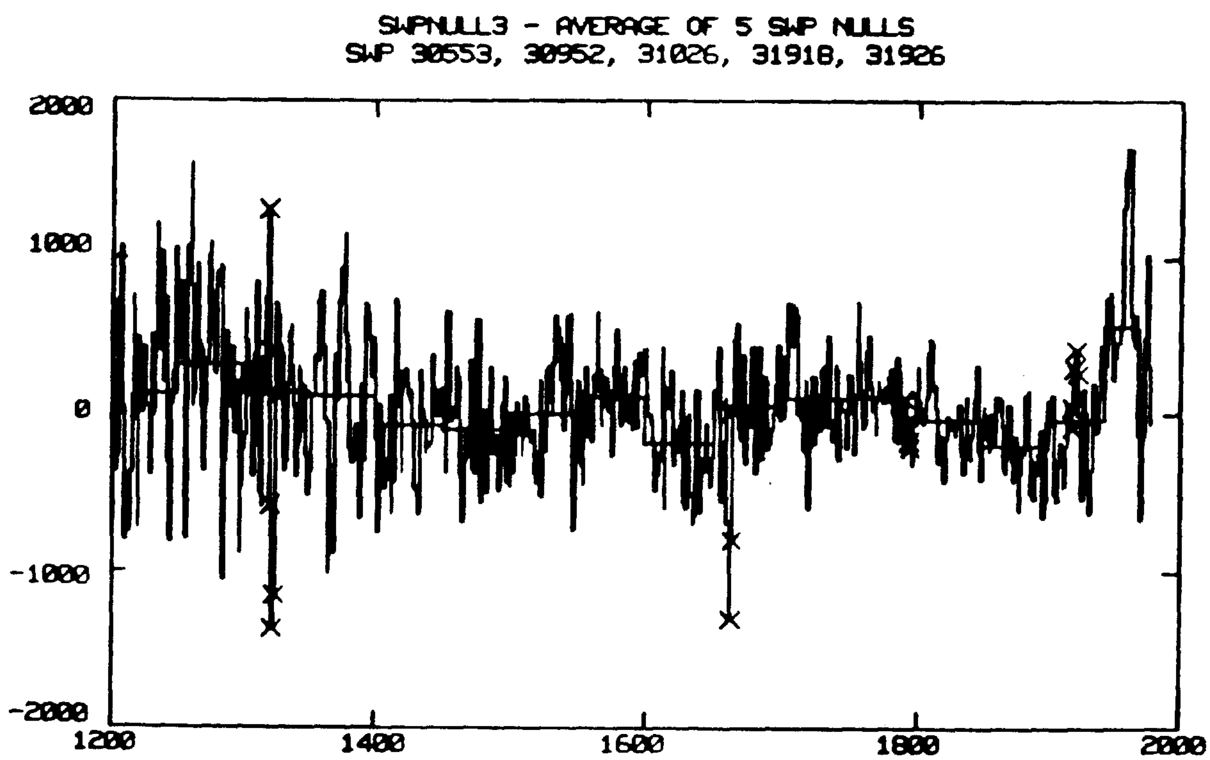

Figure 4. Average of 5 SWP null spectra obtained after those in Figure 1. The spectrum is plotted as in Figure 1.

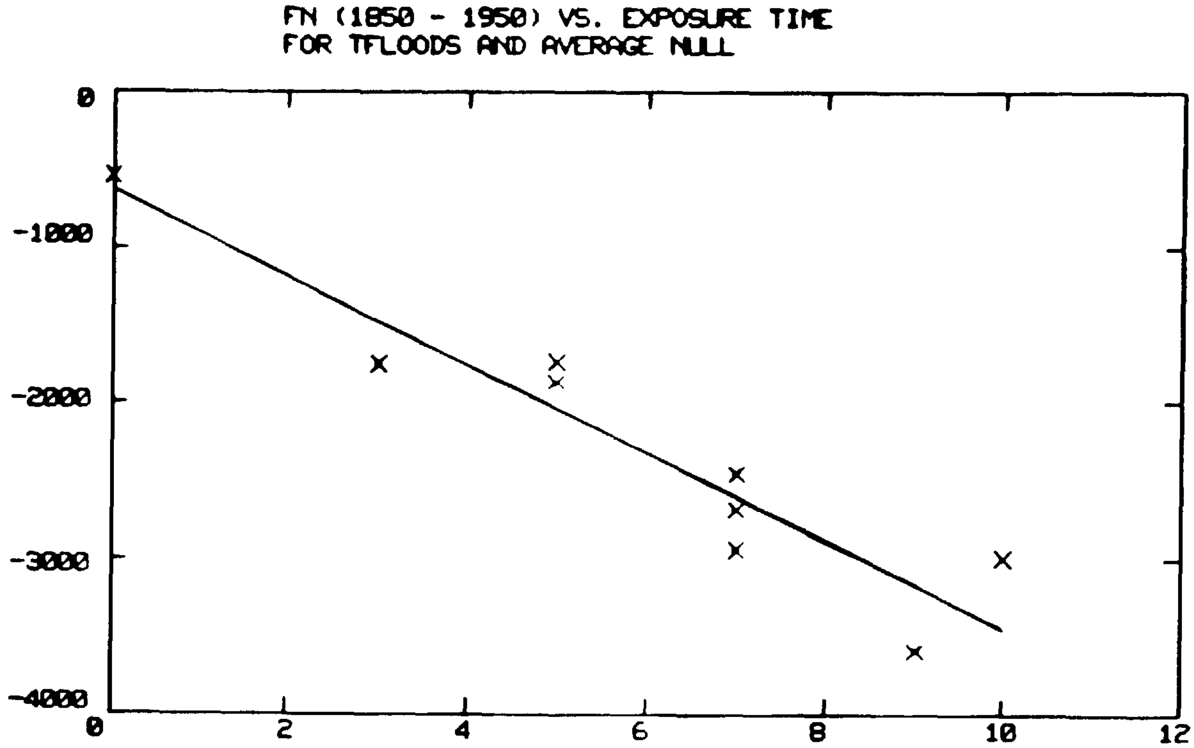

Figure 5. Plot of average flux number in the wavelength bin 1850 - 1950 angstroms as a function of exposure time in seconds for the t-floods and average null spectrum obtained by Dufour.

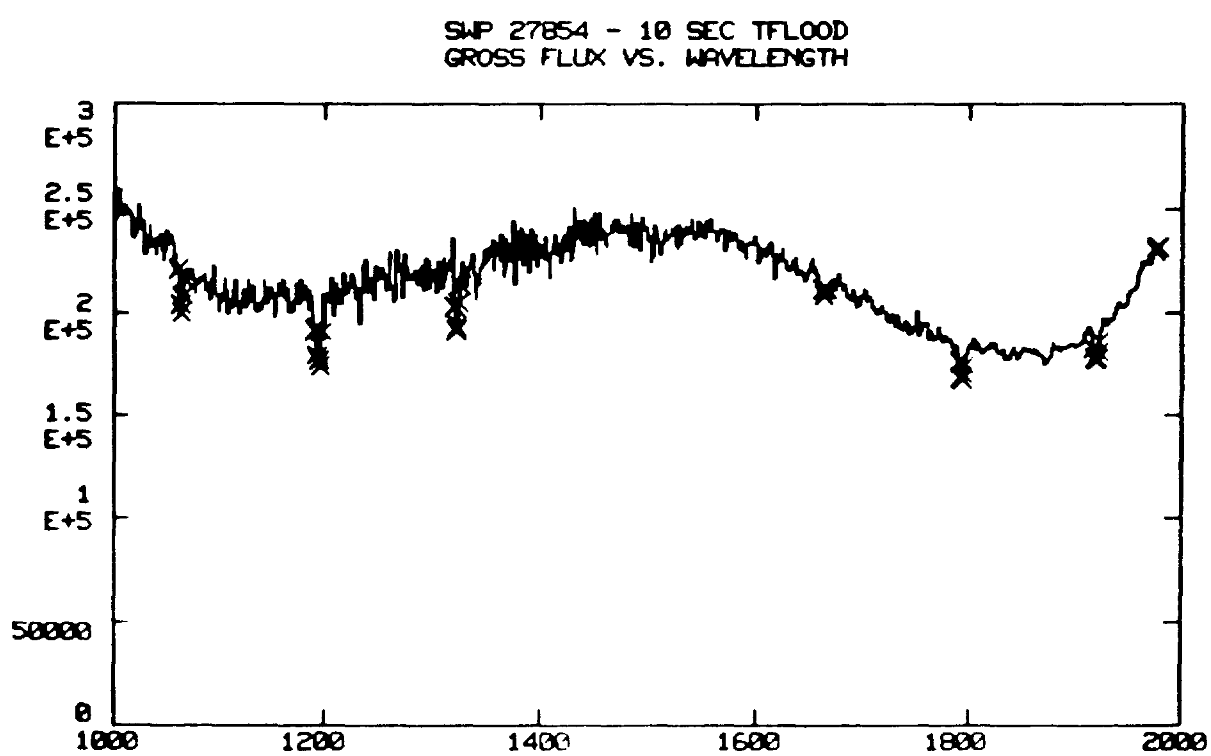

Figure 6. Flux number vs. wavelength for a 10 second t-flood exposure. In this plot the background has not been subtracted.