Corrections in IUESIPS to the Ripple Correction Algorithm

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Recently two minor errors were discovered in the algorithm used to apply the ripple correction to high dispersion data in IUESIPS. The algorithm, implemented in IUESIPS on Aug. 27, 1982, is based on the theoretical derivation of Ake (1981) and documented in the IUE Spectral Image Processing Information Manual Version 2.0 (Turnrose and Thompson, 1984; hereafter called Version 2.0). Prior to Aug. 27, 1982, the IUESIPS ripple correction algorithm was a parameterized sinc function with a parabolic correction, of the form

$$\frac{sin^2 \pi x}{(\pi x)^2}(1 + a\pi^2 x^2)$$

where

$$x = min \left\{ \begin{matrix} m(\lambda/\lambda_c - 1) \\ 2.61/\pi \end{matrix} \right\}$$

Ahmad (1981) had suggested that the SWP ripple correction could be better represented by a sinc function with no parabolic correction. Ake's work justified the use of Ahmad's parameterization, with a slight modification in the definition of the term x. Ake found the denominator for x should be λ instead of λ_c, λ_c representing the central wavelength corresponding to the peak of the blaze. The definition of x according to Ake (1981) is

$$x = \pi m \alpha \frac{|\lambda - \lambda_c|}{\lambda}$$

where m=order number and α=constant (0.856 for SWP and 0.896 for LWR and LWP).

Inadvertently, the equation for x was coded with the denominator as λ_c rather that λ at the time that the Ake version of the algorithm was implemented. Version 2.0 reflected the error in the code by reporting the denominator as λ_c, although the text on page 7-9 of Version 2.0 states the algorithm is based on Ake. This error was rectified in IUESIPS on May 20, 1987 at GSFC and on Aug. 12, 1987 at VILSPA.

The impact of the incorrect denominator on high dispersion fluxes is not large and clearly is a function of $|\lambda - \lambda_c|$, the effect being greatest at the ends of the orders. Theoretically, the effect on the fluxes can be as large as 5% at the ends of the orders for the higher order numbers in each camera. The magnitude of the effect should be no more than 1% at the splice points between orders. In practice, the situation differs slightly. Because the blaze center is not centered on the orders, the difference in fluxes is greater at the longer wavelengths and lesser at the shorter wavelengths for the SWP camera. The opposite case, but to a much lesser degree, is true of the LWP camera. Figures 1 and 2 show the ratio of the difference of the fluxes processed with the erroneous ripple correction and the fluxes processed with the currently implemented ripple correction, to the original fluxes ((New Ripple-Corrected Fluxes-Old Ripple Corrected Fluxes)/Old Ripple Corrected Fluxes). Figure 1 represents this ratio plotted for order 99 of LWP 8873. Figure 2 represents this ratio plotted for order 73 of the same image. The shape of the ratio curves is significant. The difference is essentially zero for about the central 60% of the order. The differences increase to about 1% at the splice points of the orders. The differences then increase rapidly to the ends of the orders. Resulting fluxes are larger with the new ripple correction algorithm at shorter wavelengths than with the old ripple correction algorithm, and smaller at longer wavelengths.

Figures 3 and 4 are plots of the ratio as described above for orders 100 and 76 of SWP 28516. Note the shape of these ratio curves differs from the LWP curves in Figures 1 and 2, reflecting the offset of the blaze center. While there is little change at the short wavelength end of the order, the long wavelength end of the order shows differences of up to 5% for order 100. The differences, while qualitatively the same, are only of a magnitude of about 2% for order 76.

An additional error has been discovered in the ripple correction algorithm. As stated in Version 2.0, the net ripple-corrected fluxes are assigned a value of zero when $x \geq 2.61$. However, we find the IUESIPS code tests whether $x \geq 2.61$ *before* the α term is applied to the equation for x (i.e., the test is applied to $x = \pi m \frac{|\lambda - \lambda_c|}{\lambda}$). The result of this error is that most orders in the high dispersion spectrum are truncated prematurely at each end. The significance of the $x \geq 2.61$ limit, determined in 1978, was to provide a means of preventing correction to the net flux by more than a factor of 25. The current coding, however, prevents corrections of more than a factor of eight in the SWP images and eleven in LWP images. Due to the shift in the blaze center in the SWP camera, only the long wavelength end of each order passes the currently coded limits for the value of x and experiences premature truncation (2-3 Å). In the LWP camera, only the short wavelength end is affected, for the same reason. The error in performing the test for the limit of x will be corrected in the near future. We note that the *net* spectrum is not trucated, in contrast to the the ripple corrected spectrum. Thus, a researcher can apply an independent ripple correction to the net spectrum to retain all data points.

The differences in the output data from these changes in the ripple correction are small and will have impact on only a few research investigations. Anyone desiring reprocessing of IUE data is welcome to contact the IUESIPS staff to discuss their needs.

References

Ahmad. I., 1981, NASA IUE Newsletter 14, p. 129.

Ake, T.B., 1981, NASA IUE Newsletter 15, p. 60.

Turnrose, B.E. and Thompson, R.W., 1984, "International Ultraviolet Explorer Image Processing Information Manual, Version 2.0", CSC/TM-84 /6058.

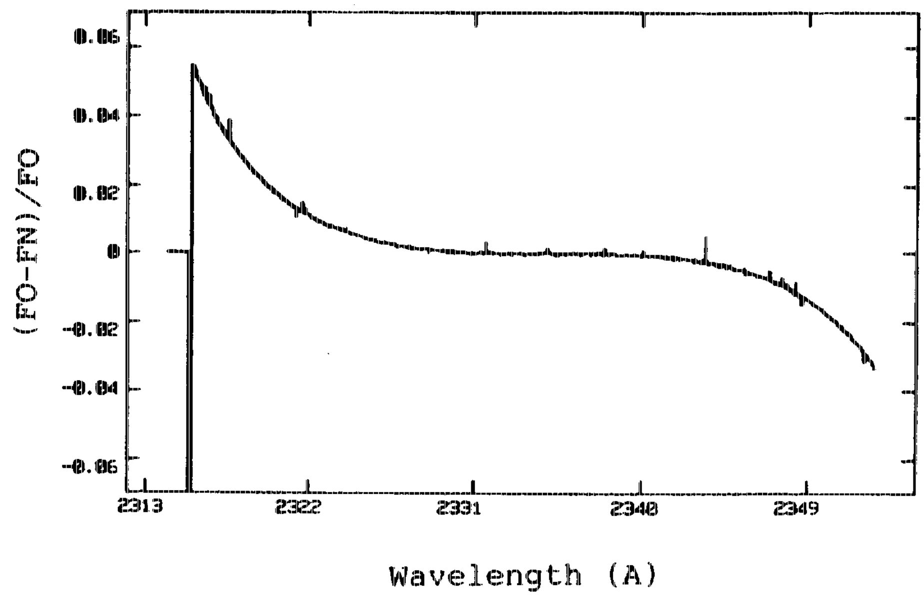

Figure 1: Order 99 of LWP 8873. For FO=Flux from original processing, and FN=Flux from processing with corrected ripple correction algorithm, the y-axis represents $\frac{(FO-FN)}{FO}$. The x-axis is wavelengths in angstroms. Zero values at the short wavelength end of the order represent points which had an assigned net flux value, but were truncated by the ripple correction algorithm.

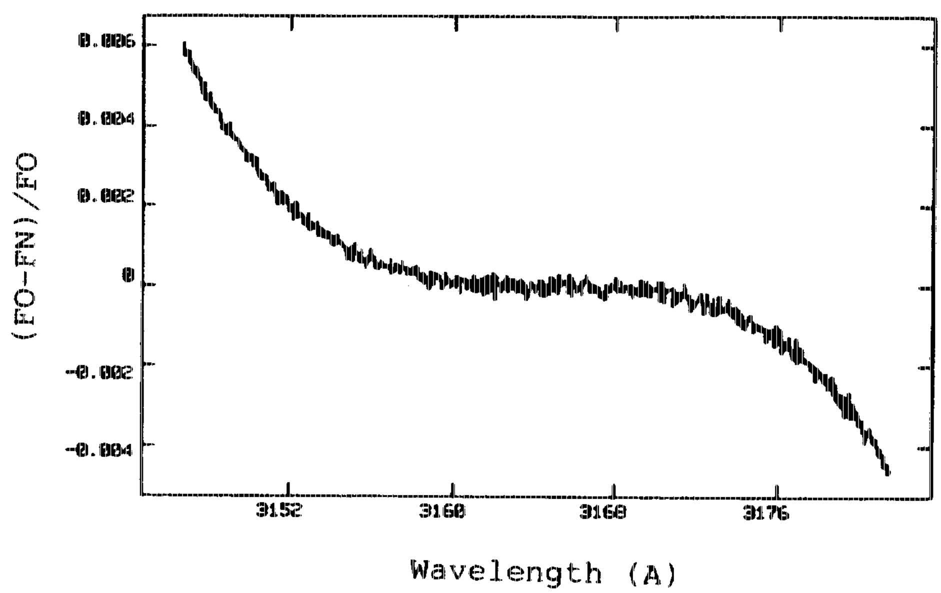

Figure 2: Order 73 of LWP 8873. For FO=Flux from original processing and FN=Flux from processing with corrected ripple correction algorithm, the y-axis represents $\frac{(FO-FN)}{FO}$. The x-axis is wavelengths in angstroms. Note the values of the tick marks on the y-axis differ from the other three plots.

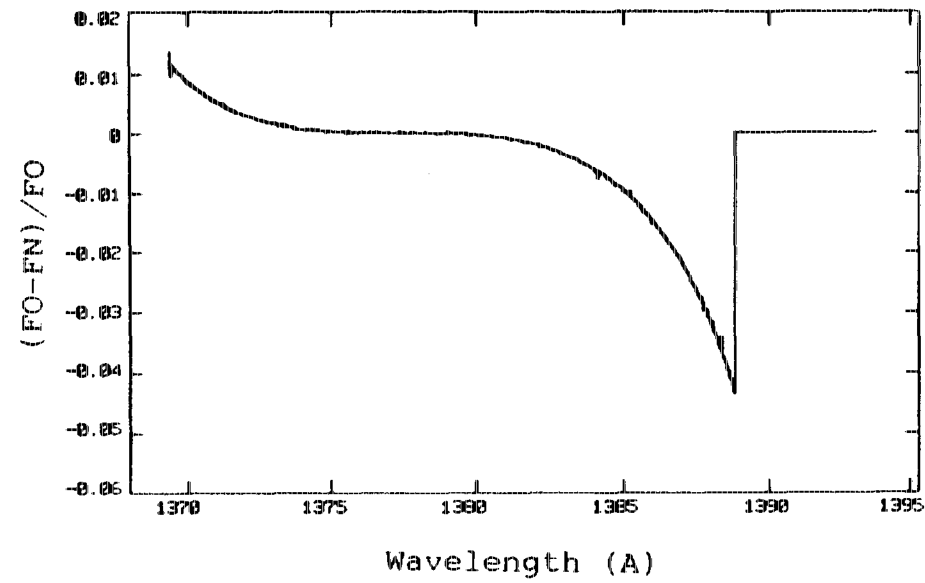

Figure 3: Order 100 of SWP 28516. For FO=Flux from original processing and FN=Flux from processing with corrected ripple correction algorithm, the y-axis represents $\frac{(FO-FN)}{FO}$. The x-axis is wavelengths in angstroms. Zero values at the long wavelength end of the order represent points which had an assigned net flux value, but were truncated by the ripple correction algorithm.

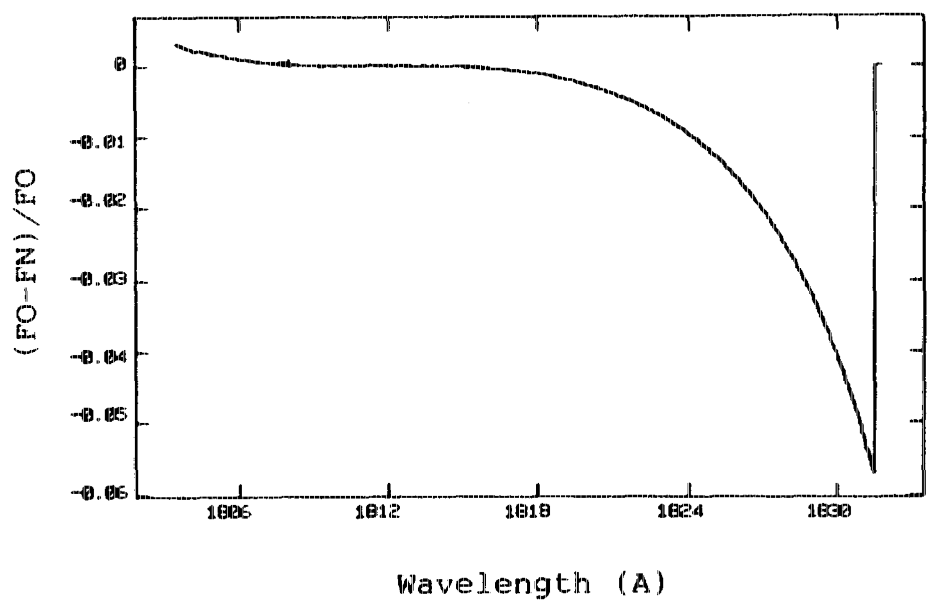

Figure 4: Order 76 of SWP 28516. For FO=Flux from original processing and FN=Flux from processing with corrected ripple correction algorithm, the y-axis represents $\frac{(FO-FN)}{FO}$. The x-axis is wavelengths in angstroms. Zero values at the long wavelength end of the order represent points which had an assigned net flux value, but were truncated by the ripple correction algorithm.