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SMOV3B Flat Field Verification

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ABSTRACT

We compare WFPC2 Earthflats taken before and after the 2002 Servicing Mission 3B. Most of the field-of-view shows no change (<0.3%) in flat field calibration. The only changes on large scales are at very low levels (<0.1-0.2%) and are likely attributable to long-term changes in the camera geometry, rather than SM3B.

1. Introduction

As part of our post-servicing check-out of WFPC2 after SM3B, we have examined a series of Earthflats to test the flat field stability, over a wide range of narrow-band filter including F375N, F502N, F656N, and F953N. The goal of these observations is to test for any unexpected OTA obscuration or contamination in WFPC2 that may have occurred as a result of the servicing mission. The flats are also capable of revealing changes in the OTA/WFPC2 geometry, as well as any QE changes localized to one CCD camera or to a small region of the field-of-view. While internal flats can provide some of this information, the Earthflats are unique in providing an end-to-end test of the OTA+WFPC2 system. Detailed discussion of Earthflats and WFPC2 flat fields can be found elsewhere (Biretta et al. 1995; Koekemoer, Biretta & Mack 2002).

2. Observations and Analyses

Earthflats were observed as part of the routine calibration proposals 8815 and 8940 for late Cycle 9 and early Cycle 10, as well as proposal 8495 during SMOV3B. All the F502N flats are 1.2 second exposures of the bright Earth made with gain 15. Since we are interested primarily in changes to the flat field, we select subsets of these to construct a pre-SMOV and an SMOV flat.

For the pre-SMOV observations we started with a total of 124 Earthflats in F502N taken between June 2001 and February 2002 as part of proposals 8815 and 8940. We discarded images with mean counts in the PC1 below 500 DN and mean counts in the three WFC chips above 3200 DN (to avoid saturation), and furthermore selected only those that had been obtained within 7 days after a decontamination (to minimize effects from contamination). These images were then examined for streaks (produced by features on the Earth moving across the detector), after multiplying with the current F502N flat field reference file. The streaks increase the overall RMS of the image; displaying the images and examining them with IMSTAT allowed the rejection of images with prominent streaks (more than around 0.8% overall normalized RMS, and exceeding about 1% peak-to-peak amplitude). Images with prominent "worms" in WF2 were also rejected. The remaining 10 images were combined with the task STREAKFLAT to produce an averaged, destreaked pre-SMOV flat.

Similar rejection criteria were applied to the Earthflats taken after the servicing mission, as part of program 8952. Again the images were displayed and examined with IMSTAT, rejecting those with too high an RMS and large peak-to-peak streak variations. The remaining five acceptable images were also combined with STREAKFLAT, to produce the post-SMOV flat.

We then divided the SMOV flat by the pre-SMOV image, and normalized so that the central 400x400 pixels of WF3 had a mean of unity. The resulting post-SMOV/pre-SMOV ratio image is shown in Figure 1.

3. Results

Figure 1 shows that the mean ratio between the pre- and post-servicing flats is essentially unity. The most significant changes are seen at low levels, on large scales across the chips, where departures from unity reach about 0.1-0.2%. These effects are well characterized based on pre-SMOV data over the past few years (Koekemoer et al. 2002) and are most likely due to small changes in the camera vignetting, which in turn result from small changes in the geometry of WFPC2. Other evidence of such small on-going geometric changes is also seen in K-spot images and is described by Mutchler and Stiavelli (1997), and Casertano and Wiggs (2001).

The pixel-to-pixel fluctuations (over the central 400 x 400 pixels) in the ratio image are typically 0.4% RMS for the WFC CCDs, and 0.8% RMS for PC1, which is entirely consistent with photon statistical noise. After smoothing with a 10-pixel FWHM Gaussian function, the fluctuations decrease to <0.1% RMS, as would be expected for photon noise.

No change in chip-to-chip sensitivity is seen in on any levels above ~0.3% in the average ratio of post-SMOV / pre-SMOV counts over the central 400x400 pixels of each CCD. There is also no significant evidence of obscuration or other changes in the OTA.

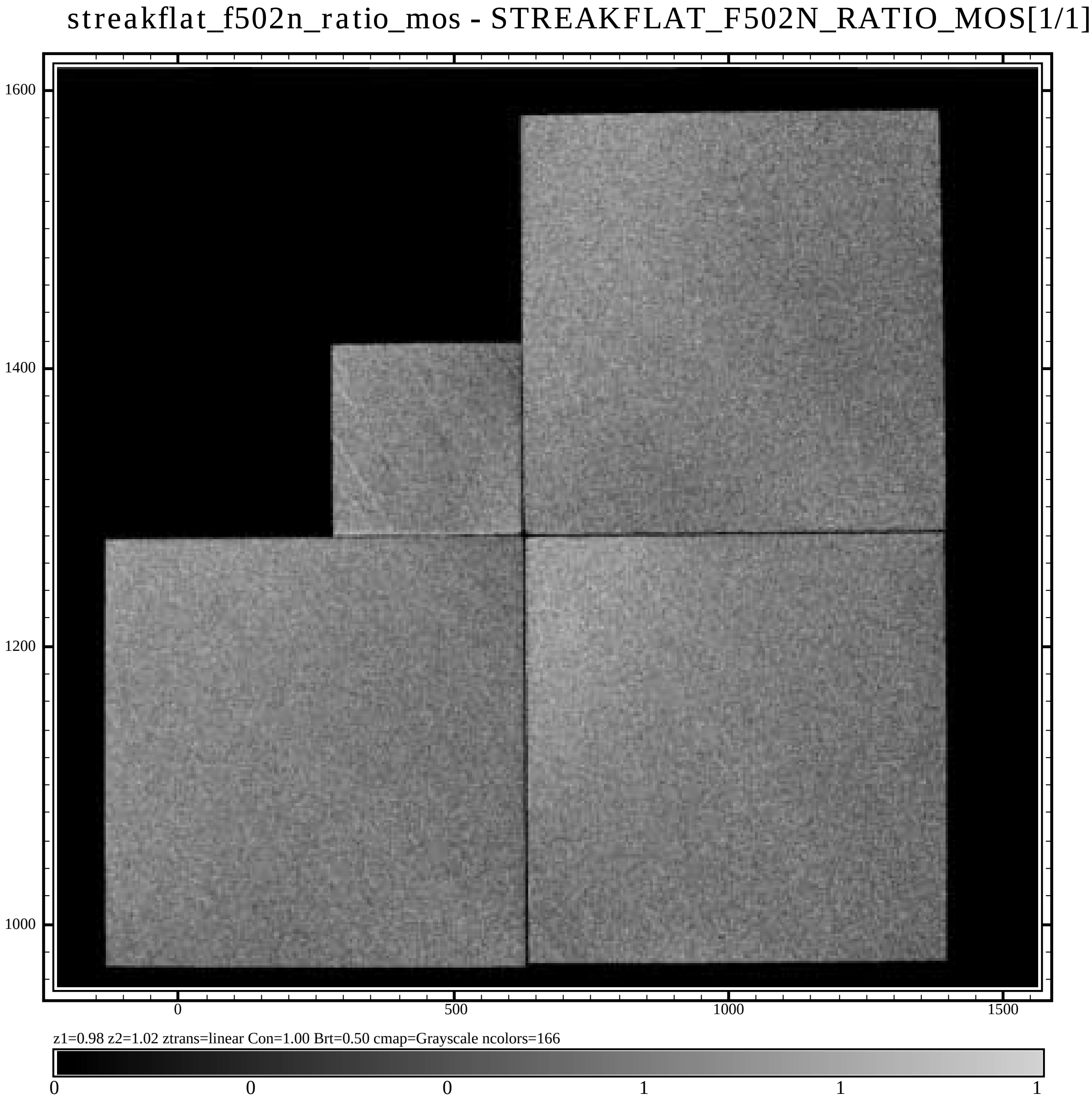

Figure 1: Ratio of SMOV / pre-SMOV flats taken in F502N. The display greyscale ranges from 0.98 (black) to 1.02 (white). The large-scale changes are of the order of 0.1-0.2%, and are entirely consistent with well-known long-term changes in the camera geometry.

4. References

Biretta, J., “WFPC2 Flat Field Calibration,” in Calibrating HST: Post Servicing Mission, eds. A. Koratkar and C. Leitherer, STScI, p. 257, 1995

Casertano, S. and Wiggs, M. 2001, “An Improved Geometric Solution for WFPC2”, Instrument Science Report WFPC2-2001-10

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Mutchler, M. and Stiavelli, M. “WFPC2 Internal Monitoring for SM97,” Technical Instrument Report WFPC2-97-07