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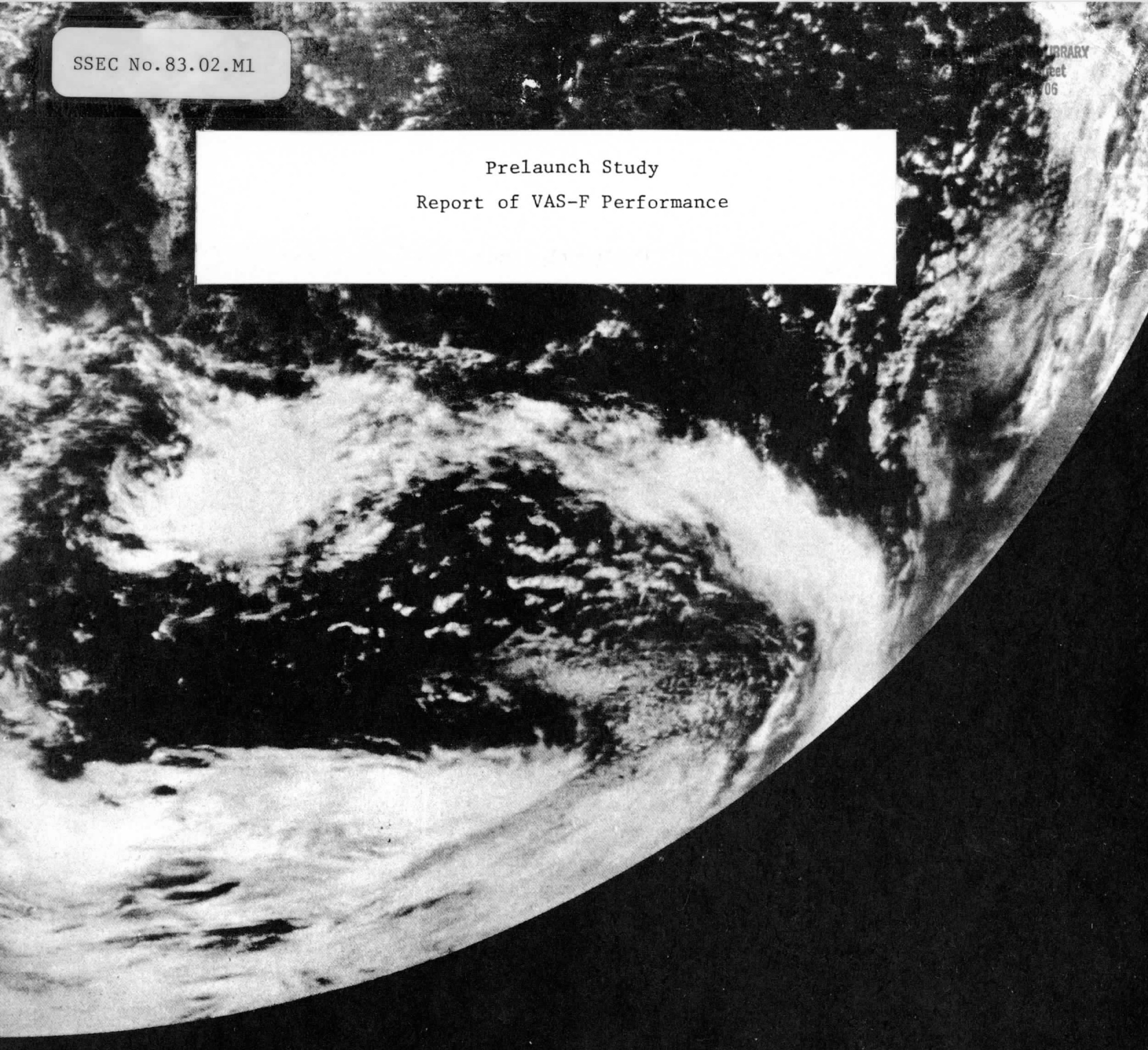
Prelaunch Study
Report of VAS-F Performance



A REPORT

from the space science and engineering center
the university of wisconsin-madison
madison, wisconsin

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by

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INTRODUCTION

GOES-F is the third in a series of three VAS instruments to be launched into geostationary orbit. It is scheduled for launch in April 1983. The VAS instrument has been designed to enable timely imaging and sounding in and around short lived weather phenomena. During the VAS Demonstration with GOES-4 and GOES-5, the accuracy and utility of the VAS data in depicting small but significant temporal variations in atmospheric temperature and moisture were successfully demonstrated. The VAS performance in the areas of radiometric calibration, noise reduction, and registration of different spectral bands was found to be within the guidelines set out in the Prelaunch Study Report of VAS-D Performance of September 1980.

This study is a sequel to that study; the VAS-D report should be read first so that the VAS-F results make sense. No attempt will be made here to reiterate the theoretical basis for the many calculations; only results where VAS-F differs from VAS-D will be presented.

I. VAS-F RADIOMETRIC CALIBRATION

The data from the VAS-F Calibration and Acceptance Test of January 1981 were analyzed in the manner described in the Prelaunch Study Report of VAS-D Performance. The ray trace determination of the calibration coefficients (see Table I.1) were adjusted after performing an analysis of covariance on the vacuum test data. Table I.2 shows those results.

With the coefficients determined from ray tracing, the absolute and relative errors for the 28 test gradients for some of the spectral bands were not within the specified ±1.5°C ±.5°C. Therefore improved results were sought and obtained by changing C_{BF} and C_{SMS} using an analysis of covariance; the new absolute and relative errors shown on Table I.2 all are within specifications. The detector nonlinearity of VAS-F is minimal; incorporating it explicitly in the analysis of covariance did not change the results.

The uncertainty of the effective external blackbody radiance determination was found to be .15 ergs/etc., .10 ergs/etc., and .05 ergs/etc. for summer, winter, and equinox respectively.

Comparing the VAS-F calibration to the VAS-E calibration, one finds that the VAS-F relative errors are somewhat lower for all bands but the VAS-F absolute errors are larger for all bands.

Table I.1 VAS-F Radiometric Calibration Algorithm Coefficients determined from Ray Tracing

1	SM	Secondary Mirror	.041 ± .014
2	PM	Primary Mirror	.032 ± .011
3	ΘM	Scan Mirror	.031 ± .010
4	BF	Baffle Forward	.176 ± .015
5	SC	Shutter Cavity	-.031 ± .016
6	PMM	Primary Mirror Mask	.060 ± .016
7	SMS	Secondary Mirror Shield	.213 ± .017
8	BA	Baffle Aft	.095 ± .008

Table I.2 VAS-F Calibration Coefficients Determined from Test Data

Band	C_{BF}	C_{SMS}	Absolute Error (in ergs/etc.)	Relative Error
1	.148 ± .051	.192 ± .021	.02	.65
2	.066	.209	-.89	.38
3	.162	.170	-.65	.45
4	.165	.160	-1.04	.53
5	.130	.202	-1.10	.27
6	.137	.149	-.072	.016
7	.153	.213	-.95	.35
8	.134	.231	-1.68	.27
9	.171	.245	-.34	.13
10	.164	.238	-.39	.12
11	.132	.217	-.062	.015
12	.188	.219	-.024	.005

II. VAS-F DETECTOR NOISE REDUCTION ANALYSIS

Raw data from the test of January 1981 was analyzed to estimate the spin budget. The results are shown in Table II.1.

The lower large HgCdTe detector is noticeably noisier than its upper counterpart. After some additional tests at SBRC, it was concluded that the performance of the lower large HgCdTe detector was stable (it had not deteriorated in the two years between tests) and that the additional noise is probably inherent in the detector surface (where the electrical leads are connected). Therefore the VAS-F spin budget must be 68 (to assure good signal to noise in all detectors) and sounding rate at the subsatellite point is roughly 38.3 km/min without visible data and 36.3 km/min with visible data.

Table II.1 VAS-F Large Detector Spin Budget

Band	σ	I	σ_M	σ_{Req}	SB
1U†	3.04	12.89*	.24	.25	1
1L	4.48	12.92	.35	.25	2
2U	1.78	2.38	.75	.25	9
2L	2.60	2.70	.96	.25	15
3U	1.51	2.44	.62	.25	6
3L	2.27	2.68	.85	.25	12
4U	1.24	2.39	.52	.25	4
4L	1.78	2.59	.69	.25	8
5U	.87	2.42	.36	.25	2
5L	1.47	2.92	.50	.25	4
6U	.021	2.39	.009	.004	5
6L	.021	2.39	.009	.004	5
7U	.84	2.46	.34	.25	2
7L	1.27	2.73	.46	.25	4
8U	.09	2.38	.04	.25	1
8L	.17	2.76	.06	.25	1
9U	.71	2.42	.29	.15	4
9L	1.16	2.81	.41	.15	8
10U	.17	2.39	.07	.10	1
10L	.24	2.66	.09	.10	1
11U	.023	2.40	.010	.004	6
11L	.025	2.37	.011	.004	7
12U	.009	2.42	.004	.004	1
12L	.009	2.37	.004	.004	1
Total U					42
Total L					68

*Improvement factor for band 1 is evaluated for samples from 150 x 150 km^2; for all other bands it is evaluated for samples from 30 x 30 km^2.

†U indicates upper, L indicates lower.

III. MISREGISTRATION EFFECTS

The analysis for VAS-D also holds true for VAS-F. Peak registration errors of 7% of a large detector field of view are expected which allow clear column radiance retrievals for resolutions as small as 60 x 60 km^2.