NOAA Technical Memorandum NESDIS 6

DEPARTMENT OF COMMERCE
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THE ADVANTAGES OF SOUNDING WITH THE SMALLER DETECTORS OF THE VISSR ATMOSPHERIC SOUNDER

Washington, D.C.
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U.S. DEPARTMENT OF COMMERCE / National Oceanic and Atmospheric Administration / National Environmental Satellite, Data, and Information Service

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CONTENTS

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Abstract

Results are presented that show sounding with the small detectors on the VAS produces more temperature profile retrievals of good quality in partly cloudy conditions than was possible with the large detectors. The increased ability to find clear fields of view outweighs the disadvantage of greater detector noise.

1. Introduction

With the launch of three VISSR Atmospheric Sounders (VAS) since late 1980, the era of time continuous sounding from a geostationary platform has begun. The results of the last three years have been well documented in the literature (Smith et al., 1981; Menzel et al., 1981; Chesters et al., 1982; Smith et al., 1982, Smith, 1983; Chesters et al., 1983; Petersen et al., 1983). All of the sounding data from this time period exclusively employed the large detectors on VAS (horizontal resolution of 13.8 km at subsatellite point); this study explores the advantages of sounding with the small detectors (horizontal resolution of 6.9 km at subsatellite point). While the small detector noise is roughly double that of the large detector, the doubled horizontal resolution compensates so that soundings representing equivalent areas have the same radiometric noise (4 small samples are equivalent to one large sample). However, the small detector has a great advantage in partly cloudy areas, as it is capable of finding clear fields of view in and around the clouds and thus can provide more soundings.

2. VAS data characteristics

The VAS instruments, on board the GOES-4 (now defunct), GOES-5, and GOES-6 satellites, are radiometers with eight visible detectors and six thermal detectors that sense infrared radiation in 12 spectral bands. The spectral bands cover the range of 678.7 cm^{-1} (14.73 μm) through 2535 cm^{-1} (3.94 μm) and are presented in Table 1. A filter wheel in front of the detector package enables spectral selection. The horizontal resolution at subsatellite point is .9 kilometers in the visible and 6.9 and 13.8 kilometers in the infrared depending on which detectors are used. Figure 1 shows the VAS Detector Package Array. Although there are six VAS infrared detectors, only two are in use during any satellite spin period. The selected mode of operation will dictate which detector pair is used--the small HgCdTe channels, the large HgCdTe channels, or the InSb channels.

In the sounding mode, up to twelve spectral bands on the filter wheel can be positioned into the optical path while the scan mirror is dwelling on a single earth swath (scan line). The filter wheel can be programmed so that each spectral band is sampled on the same earth swath from 0 to 255 spacecraft spins. For seven of the spectral bands either the high resolution (6.9 km) or low resolution (13.8 km) detectors can be selected. The remaining five spectral bands are limited to the low resolution detectors (see Table 1).

Table 2 shows the single sample noise observed for the VAS channels. A single sample is the voltage accumulated on the detector every 8 μsec, which is then calibrated to a radiance value (Menzel et al., 1981; Menzel et al., 1983). The noise was estimated by taking the standard deviation of 200 successive samples from outer space. The GOES-5 and GOES-6 noise characteristics are very similar and have been averaged to produce Table 2. The noise equivalent radiance of the small detectors is roughly twice that of the large detectors for a single sample.

Temporal averaging of the VAS radiances, i.e., multiple sampling of the same earth swath in the same spectral band, is necessary to enhance the ratio of the radiance signal to detector noise. Further enhancement of radiance signal to noise can be accomplished by spatial averaging of the radiances from several adjacent satellite fields of view, but thus reducing the horizontal resolution of the sounding radiances. This trade-off between signal to noise and horizontal resolution is the primary issue of small detector sounding. Table 3 indicates a nominal spin budget, the number of satellite spins allocated to the 12 spectral bands to reduce the radiometric noise to a level suitable for temperature sounding.

Appendix A describes several scan patterns used to achieve contiguous and non-contiguous dwell sounding data. Obviously the latitude coverage accomplished with the small detectors is half that accomplished with the large detectors in the same time period using the same spin budget. Comparable extent of latitude coverage can be achieved only if the small detectors are sampled with the venetian blind scan pattern (described in the Appendix).

Temperature profile retrievals from multi-spectral infrared radiance measurements are based on the assumption that the instrument field of view is cloud free. Infrared measurements are highly susceptible to cloud attenuation, thus special efforts need to be made to avoid or correct for cloud contamination. Higher horizontal resolution increases the probability of finding clear fields of view in and around clouds. The principle question that is addressed by this report is whether the advantage of the smaller detectors, higher horizontal resolution, and thus more clear fields of view, outweighs the disadvantages, higher single sample noise and decreased latitude coverage.

3. Clear column radiance determination

Techniques for clear column radiance determination are discussed at length in the literature (Smith, 1968; McMillin, 1978; Hayden, 1984). A brief summary follows.

Clear fields of view are screened by comparing each measurement with the warmest measurement in an area of interest, accepting that the warmest measurement is indeed clear, Since this assumption is incorrect under some circumstances, it remains for the retrieval program or the post retrieval editing programs to catch the error. However, accepting that the warmest is clear, samples are collected for cloud sensitive spectral bands as shown in Table 4. In the area of interest, a minimum sample of five is required for a successful clear column radiance determination. Otherwise the adjacent field view technique is employed.

The adjacent field of view technique for correcting for broken cloud is an extrapolation method, where two measurements of cloud contaminated radiances for a given spectral band are adjusted to give a single estimate of the clear value. This extrapolation is performed for all pairs of fields of view in the area of interest. The degree of extrapolation is controlled by the value assigned to the clear window spectral band. This is a critical choice. One can use any *a priori* estimate of the surface skin temperature to assign it. In our applications, in order to be consistent with the choice of clear fields of view, we have chosen to use the warmest measurement, rather than a manipulation of the surface air temperature analysis. An analysis of surface air temperature is used as a filter, and the correction is not attempted unless the clearest 11 micron brightness temperature measurement is within 3° of the value expected from the surface temperature analysis.

4. Clear Field of View Statistics

For the small detector sounding to be feasible, one must have a sufficiently greater number of clear small detector fields of view than large detector fields of view to compensate for the increased noise of the small detectors. Using VAS data over the United States from 16 September 1982, the small detector 11 micron image at 1731 GMT was compared to the large detector 11 micron image at 1749 GMT. For different cloud types and altitudes, clear fields of view for 12 areas of 100 x 100 km were investigated. Figures 2 and 3 show the images and the areas selected. Table 5 shows the comparison. There are roughly six times more small detector clear fields of view than large detector clear fields of view; if the scene had been totally clear there would have been four times as many. Thus the signal improvement from using small detectors is (6-4)/4 or 50%. In addition clear soundings are calculable in all twelve areas with the small detectors, whereas clear soundings are calculable in only four areas with the large detectors (at least five adjacent fields of view must be clear).

For spatial averaging to overcome the greater small detector noise, four times as many fields of view must be usable. We showed six times as many are available in this case study. Clearly the small detector sounding is an attractive option. In the next section we compare small detector and large detector retrieval results.

5. Retrievals

A comparison of the VAS large and small detector generated retrievals was performed utilizing radiance data from 9 December 1983. The large detector radiance measurements (using scan pattern A.1 in the Appendix) over the eastern Pacific (EPAC) region are from adjacent ten minute dwell soundings at 1333 and 1403 GMT, while the small detector measurements (using scan pattern A.3 in the Appendix) are from 1633 and 1703 GMT. Two synoptic scale cyclones are located within the EPAC region where retrievals were generated (see Figure 4). Since there are areas of considerable cloudiness associated with these cyclones, it is possible to conduct a test of the small detector capability to produce retrievals within a partly cloud region.

To initialize the retrieval algorithm (see Smith, 1983), the first guess field utilized the 12 hour LFM model forecast valid at 1200 GMT 9 December 1983 for all sounding periods. Thus, any differences in retrieval quantity are due either to atmospheric variability or instrument measurement differences. Retrievals were attempted over a region bordered by 50°N,150°W in the northwest an 25°N,120°W in the southeast. The algorithm used a 5 x 5 field of view box for the large detectors (25 fields of view) and a 9 x 9 box for the small detectors (81 fields of view of which 36 have no data due to the venetian blind coverage) to determine the clear column radiance, from which the retrieval algorithm is implemented.

The 1333-1403 GMT large detector VAS radiance measurements yielded 116 retrievals over the EPAC region, while the 1633-1703 GMT small detector radiance yielded 143 retrievals as shown in Table 6. The greater number of retrievals from the small detector radiance measurements represents a 23% increase in retrievals over the large detector set. Furthermore, in the northern dwell sound locations (1333, 1633 GMT), where most of the clouds are located, the small detector produced 34% more retrievals. Visual inspection of the 500 mb retrieval temperatures (Figures 5 and 6) indicate the small detector was able to resolve sufficiently clear fields of view in the cellular convection near 40°N,150°W to produce soundings, whereas the large detector sample produced fewer retrievals in this region. Also, the small detector sample produced a number of partly cloudy (N*) retrievals in the vicinity of the frontal boundary near 35°N,140°W and off the west coast of the United States. Over the large area of mostly clear skies to the south of the cyclones the data sets produced an equal number of retrievals. It is evident that in regions of cloudiness the higher spatial resolution of the small detector instrument provides the capability of generating a significant increase in the number of retrievals.

The 500 mb temperature fields analyzed for each data set are shown in Figure 7. Examination of the fields indicates very close correspondence between large and small detector 500 mb retrieval temperatures. The gridpoint difference between the two fields is contoured in Figure 8, with an edited plot of large detector 500 mb temperatures which indicate the data coverage. All retrieval temperatures lie within the 1°C contour, indicating the close correspondence between the two 500 mb retrieval fields. It should be pointed out that the retrieval temperature differences from large and small detector radiances shown in this case are not always this close.

In summary, the small detector radiance measurement data set from 1633-1703 GMT 9 December 1983 produced 23% more retrievals than the 1333-1403 GMT large detector data set. Most of the additional retrievals were produced in areas of partial cloud cover. The higher resolution of the VAS small detector instrument is able to provide a considerable increase in the number of soundings in partly cloudy regions. A comparison of 500 mb temperatures indicates a very close correspondence in the quality of the soundings, indicating the small detector is as capable of providing the same quality retrievals as the large detector.

6. Conclusions

Based on the results reported here, and several other studies, it has become obvious that sounding with small detectors of higher horizontal resolution enables more temperature profile retrievals of good quality in partly cloudy conditions. As of January 1984 daily VAS operations have scheduled the CO_2 absorption spectral bands (3, 4, and 5) and the split window bands (7 and 8) to be sensed with the small detectors during dwell sounding (using scan pattern A.3 of the Appendix).

Acknowledgments

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References

Chesters, D., L. W. Uccellini, and A. Mostek, 1982: VISSR Atmospheric Sounder (VAS) simulation experiment for a severe storm environment. Mon. Wea. Rev., 110, 198-216.

Chesters, D., L. W. Uccellini, and W. D. Robinson, 1983: Low-level water vapor fields from the VISSR Atmospheric Sounder (VAS) split window channels. J. Clim. Applied Meteor., 22, 725-743.

Hayden, C. M., W. P. Menzel, and A. J. Schreiner, 1984: The clouds and VAS. Proceedings of the Conference on Satellite Meteorology/Remote Sensing and Applications, June 25-29, 1984, Clearwater Beach, Florida, Published by the American Meteorological Socity, Boston, Massachusetts.

McMillin, L. M., 1978: An improved technique for obtaining clear radiances from cloud contaminated radiances. Mon. Wea. Rev., 11, 1590-1597.

Menzel, W. P., W. L. Smith, and L. D. Herman, 1981: Visible infrared spin-scan radiometer atmospheric sounder radiometric calibration: an inflight evaluation from intercomparisons with HIRS and radiosonde measurements. Applied Optics, 20, 3641-3644.

Menzel, W. P., W. L. Smith, G. S. Wade, L. D. Herman, and C. M. Hayden, 1983: Atmospheric soundings from a geostationary satellite. Applied Optics, 22, 2686-2689.

Petersen, R. A., L. W. Uccellini, D. Chesters, and A. Mostek, 1983: The use of VAS satellite data in weather analysis, prediction, and diagnosis. National Weather Digest, 8, 12-23.

Smith, W. L., 1968: An improved method of calculating tropospheric temperature and moisture from satellite radiometer measurements. Mon. Wea. Rev., 96, 387-396.

Smith, W. L., 1983: The retrieval of atmospheric profiles from VAS geostationary radiance observations. J. Atmos. Sci., 40, 2025-2035.

Smith, W. L., V. E. Suomi, W. P. Menzel, H. M. Woolf, L. A. Sromovsky, H. E. Revercomb, C. M. Hayden, D. N. Erickson, and F. R. Mosher, 1981: First sounding results from VAS-D. Bull. Amer. Meteor. Soc., 62, 232-236.

Smith, W. L., V. E. Suomi, F. X. Zhou, and W. P. Menzel, 1982: Nowcasting applications of geostationary satellite atmospheric sounding data. Nowcasting, (K. A. Browning, ed.), Academic Press, New York, pp. 123-135.

TABLE 1

CHARACTERISTICS OF THE VAS SPECTRAL BANDS

VAS Channel Number	Spectral Center μm	Spectral Center cm^{-1}	Bands Width cm^{-1}	Purpose for Sounding	Main Absorbing Gas
1	14.7	678	10	temp	CO_2
2	14.5	691	16	temp	CO_2
3*	14.3	699	16	temp	CO_2
4*	14.0	713	20	temp	CO_2
5*	13.3	750	20	temp	CO_2
6	4.5	2209	45	temp+cloud	N_2O
7*	12.7	787	20	moisture	H_2O
8*	11.2	892	140	surface	-
9*	7.3	1370	40	moisture	H_2O
10*	6.8	1467	150	moisture	H_2O
11	4.4	2254	40	temp+cloud	CO_2
12	3.9	2540	140	surface	-

* Available at 6.9 km as well as 13.8 km resolution

TABLE 2

SINGLE SAMPLE RADIANCE NOISE OBSERVED IN THE VAS SPECTRAL BANDS

Band	Large Detector	Small Detector
1	2.8	n.a.
2	1.6	n.a.
3	1.2	2.5
4	1.0	2.0
5	0.8	1.6
6	0.022	n.a.
7	0.8	1.4
8	0.2	0.3
9	0.6	1.3
10	0.2	0.3
11	0.025	n.a.
12	0.008	n.a.

TABLE 3

SPIN BUDGET USED ON VAS

Band	Large Detector Only	Large Detector and Small Detectors
1	1	1
2	4	4
3	5	5 S
4	3	4 S
5	2	4 S
6	4	1
7	2	4 S
8	1	1 S
9	3	1
10	1	1
11	0	0
12	1	1

TABLE 4

"CLEAR" TOLERANCES FOR VAS SPECTRAL BANDS MEASURED AGAINST THE WARMEST SAMPLE OF THE POPULATION. ANY VALUE COLDER THAN TOLERANCE ELIMINATES ALL CHANNELS LISTED. LEVEL 2 IS TESTED ONLY IF LEVEL 1 FAILS.

Spectral Band Level 1	Level 2	Frequency cm^{-1}	Tolerance K	Bands Eliminated
6		2214	1.0	6,12
	9	1380	Band 6 T_B minus 20	9,10
8		890	2.0	5,6,7,8,12
	5	751	1.5	4,9
	4	715	1.0	3,10

TABLE 5

CLEAR FIELD OF VIEW STATISTICS

Area[a]	Cloud Altitude	Number of Small Cloud[b]	Number of Large Clouds	Ratio
1	Clear	100	25	4.0
2	Middle	15	4	3.7
3	Low	41	10	4.1
4	Middle/High	5	2	2.5
5	High	9	1	9.0
6	Middle	14	2	7.0
7	Low	14	3	4.7
8	Low/Middle	21	1	21.0
9	Low/Middle	14	1	14.0
10	Middle/High	15	4	3.7
11	High	7	0	7/0
12	Low	47	6	7.8
Total		202	34	5.9

[a] Sounding area includes 10 x 10 small detector fields of view and 5 x 5 large detector fields of view.

[b] Clear threshold was chosen to be the maximum brightness temperature of the 100 small detector fields of view less 2°K.

TABLE 6

NUMBER OF RETRIEVALS
SMALL VERSUS LARGE DETECTOR

Time (GMT)	Detector	Number of boxes (100×100 km^2)	Number of Retrievals	Retrieval Piece
1333-1403	Large	101	70	N
		56	46	S
		157	116	TOTAL
1633-1703	Small	106	94	N
		52	49	S
		158	143	TOTAL

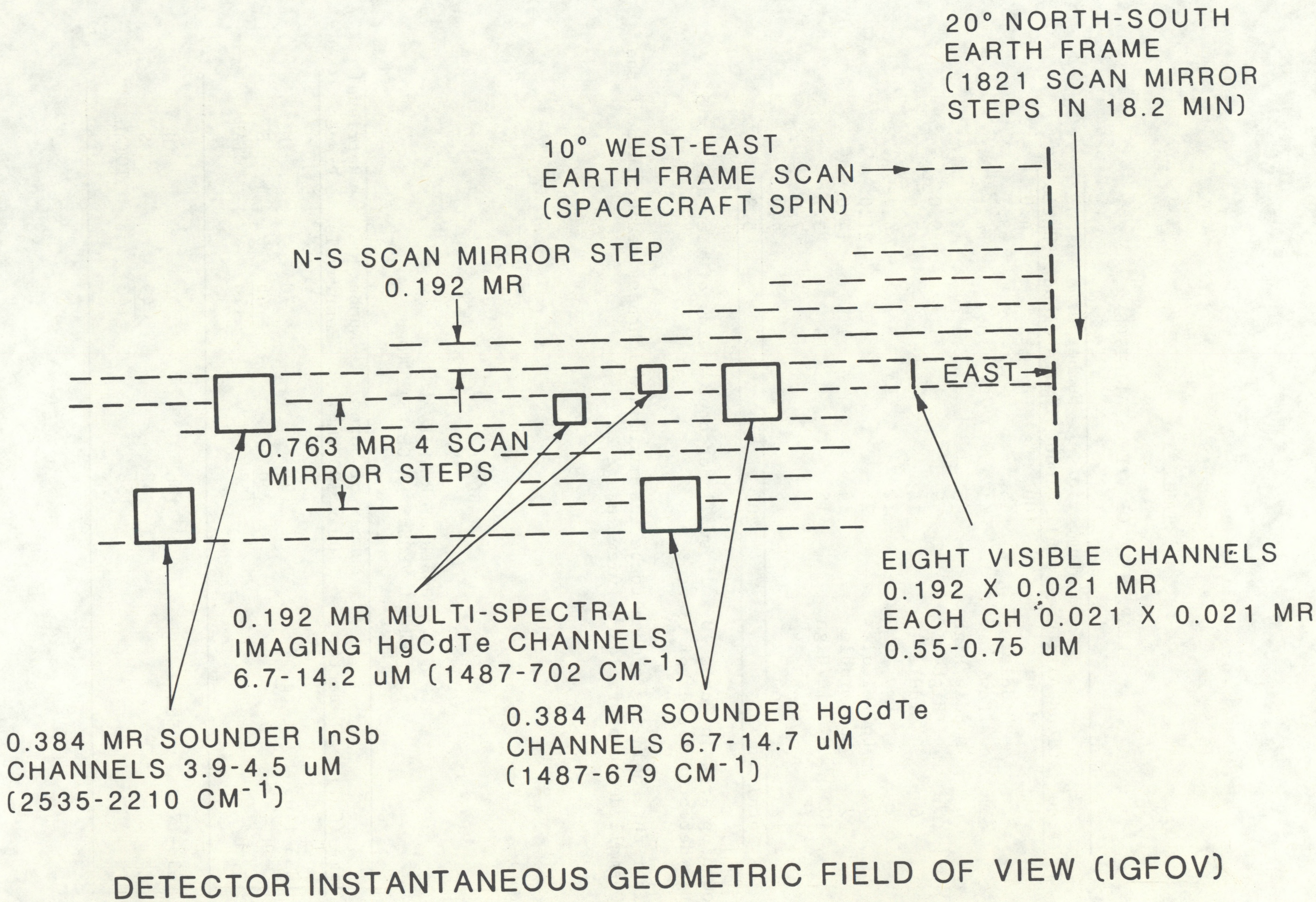

Figure 1: VAS-D detector package array.

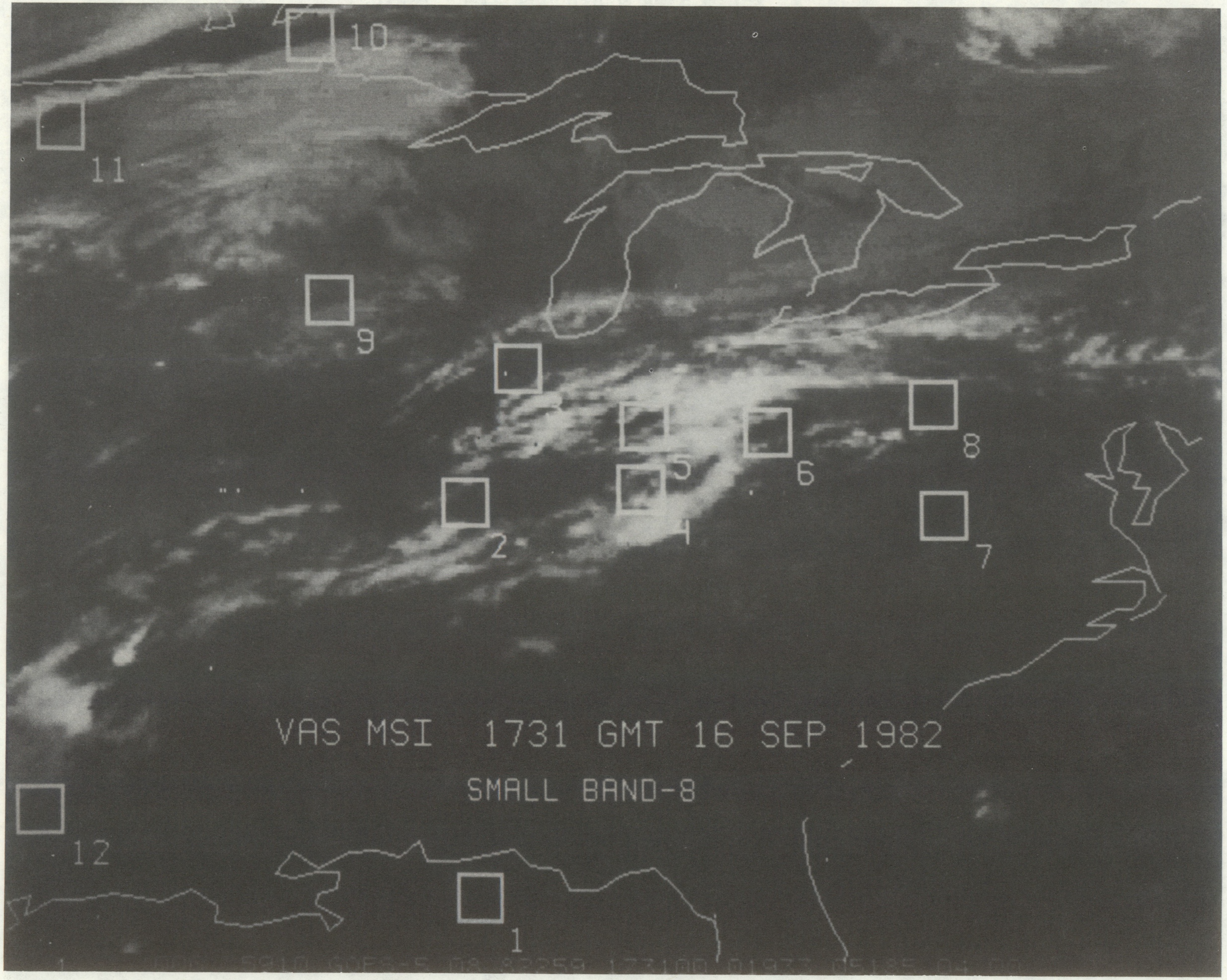

Figure 2: VAS small detector band 8 image for 1731 GMT 16 September 1982 showing areas (boxes) where soundings were made.

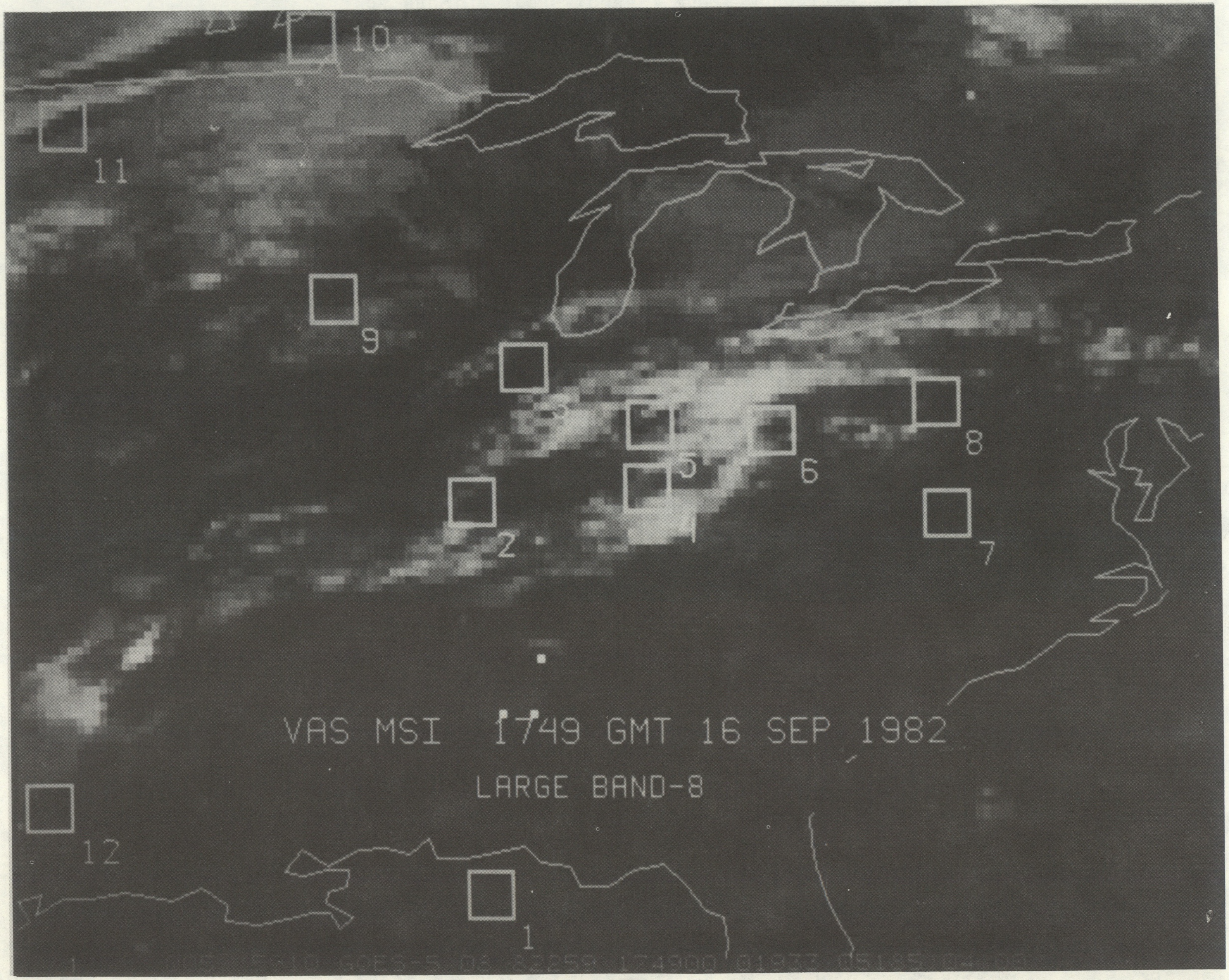

Figure 3: VAS large detector band 8 image for 1749 GMT showing areas (boxes) where soundings were made.

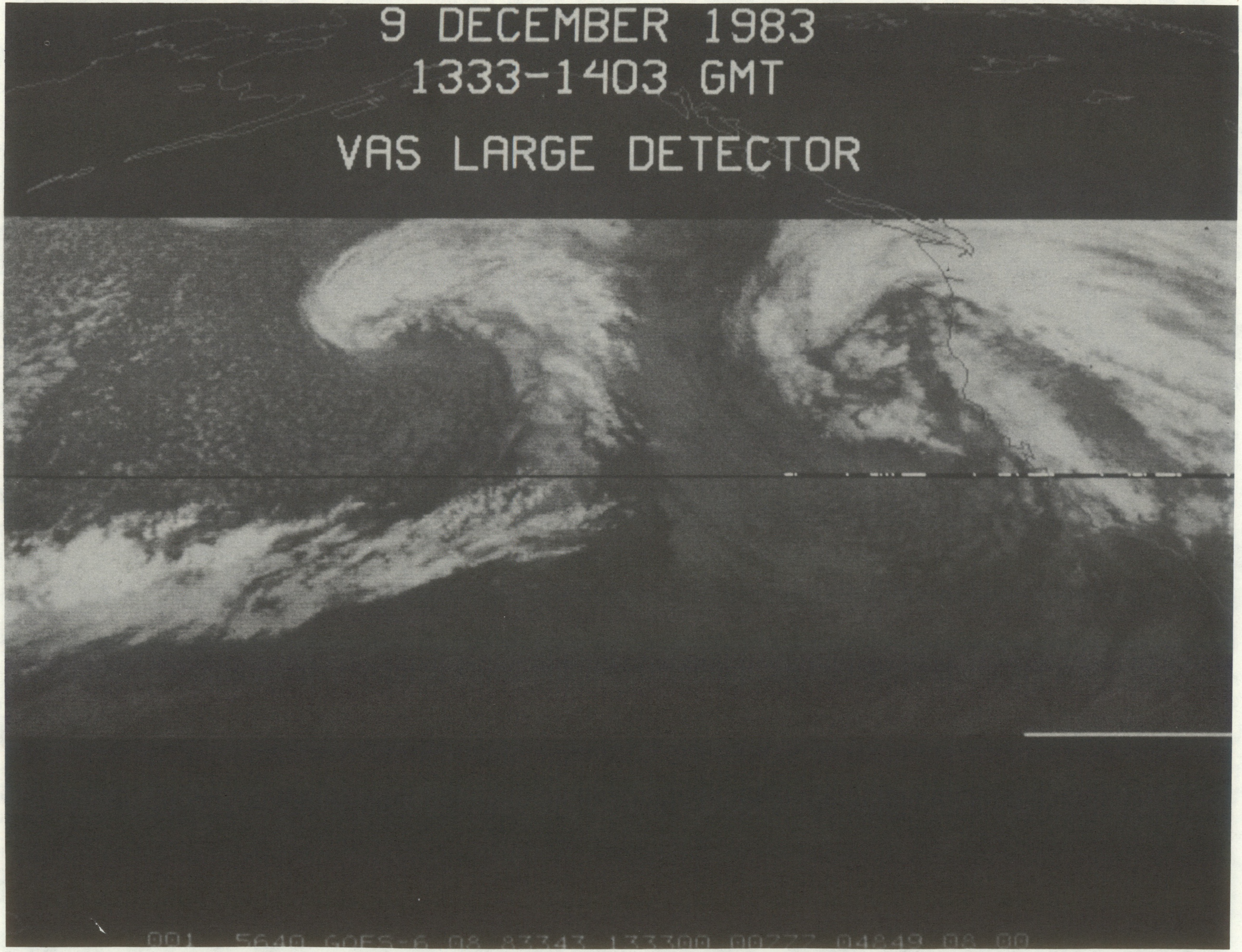

Figure 4: VAS large detector band 8 images for 1333 and 1403 GMT 9 December 1983.

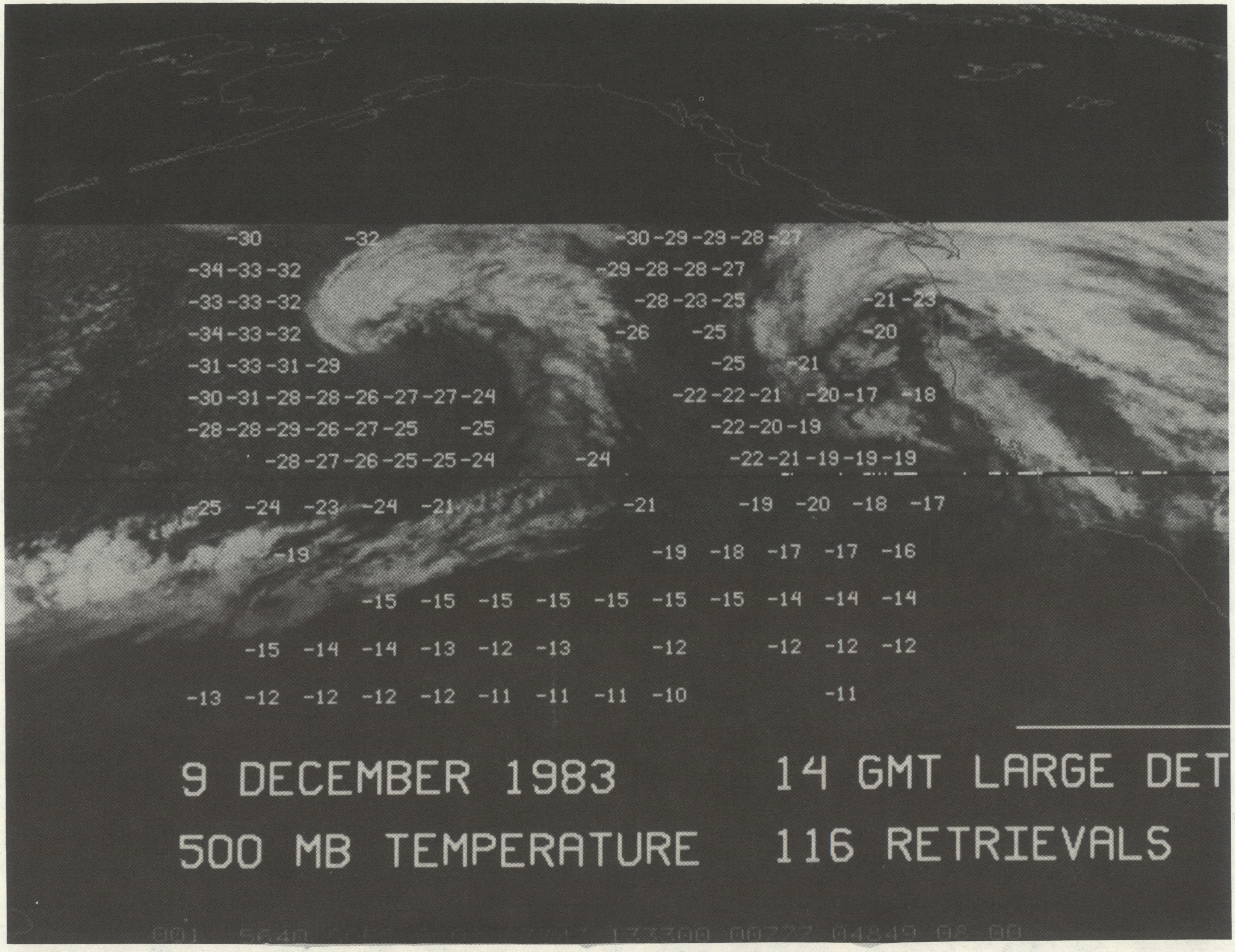

Figure 5: VAS large detector 500 mb temperatures (°C) for 1333-1403 GMT 9 December 1983.

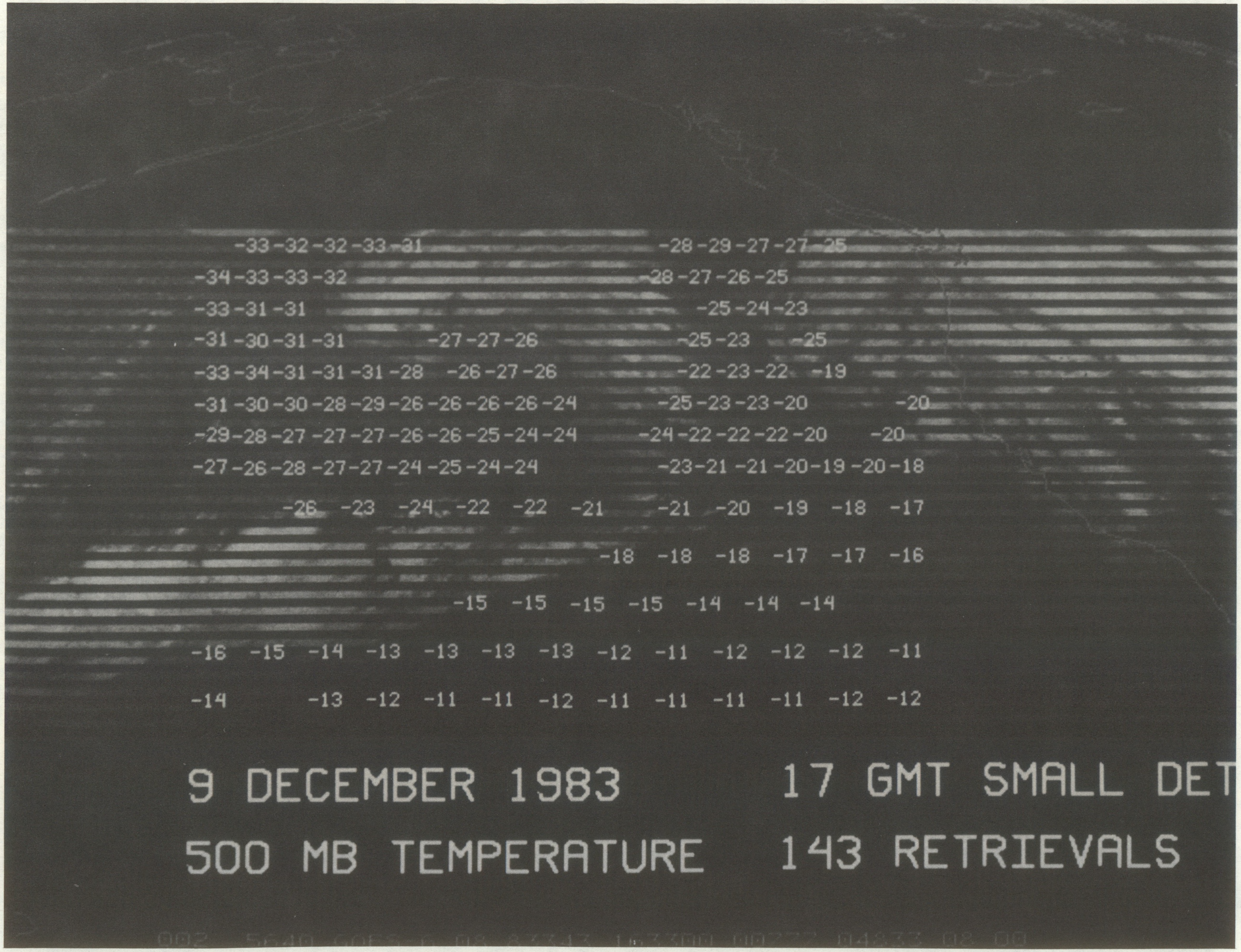

Figure 6: VAS small detector 500 mb temperatures (°C) for 1633-1703 GMT 9 December 1983.

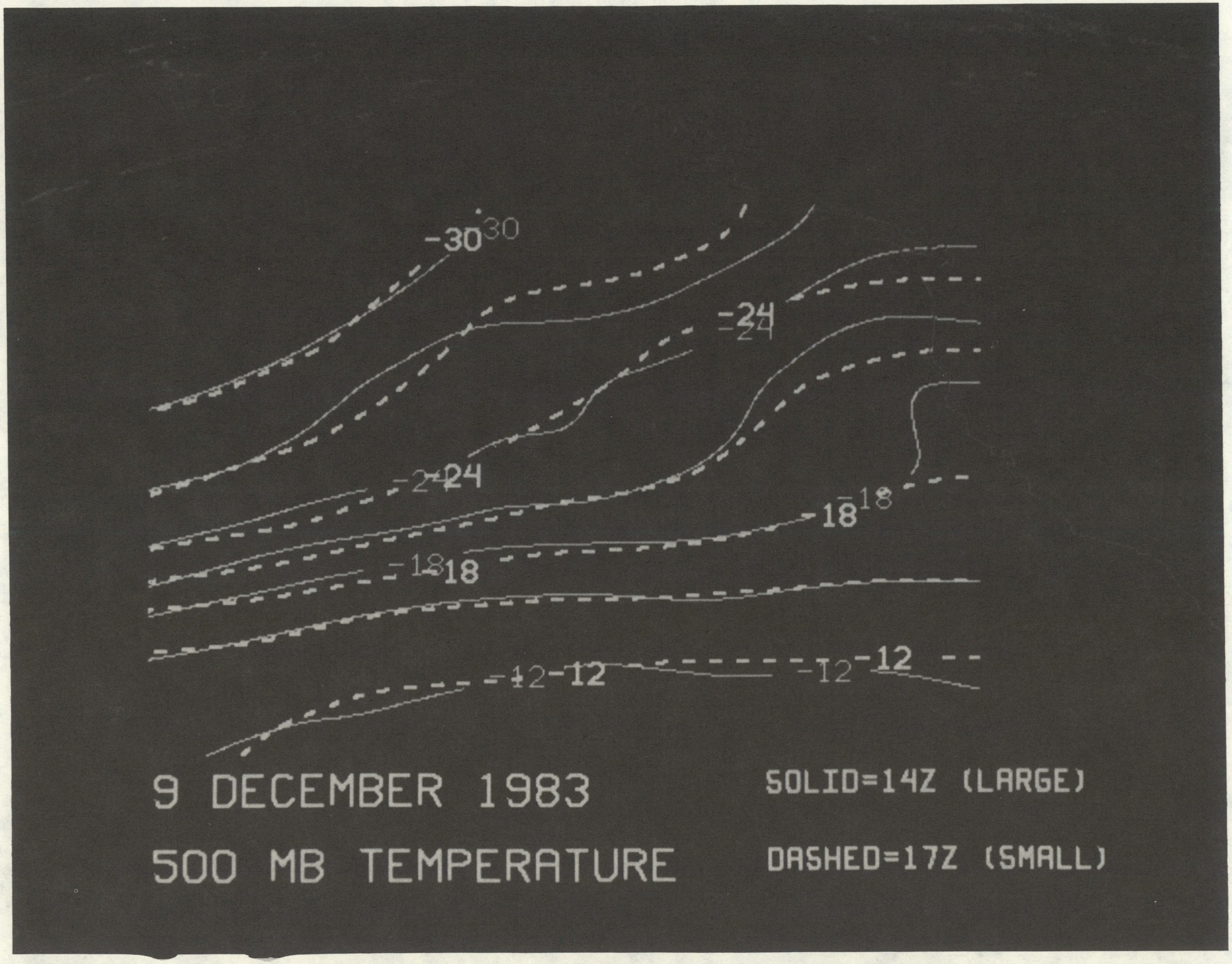

Figure 7: VAS 500 mb temperature contours (°C) for large detector (solid) and small detector (dashed).

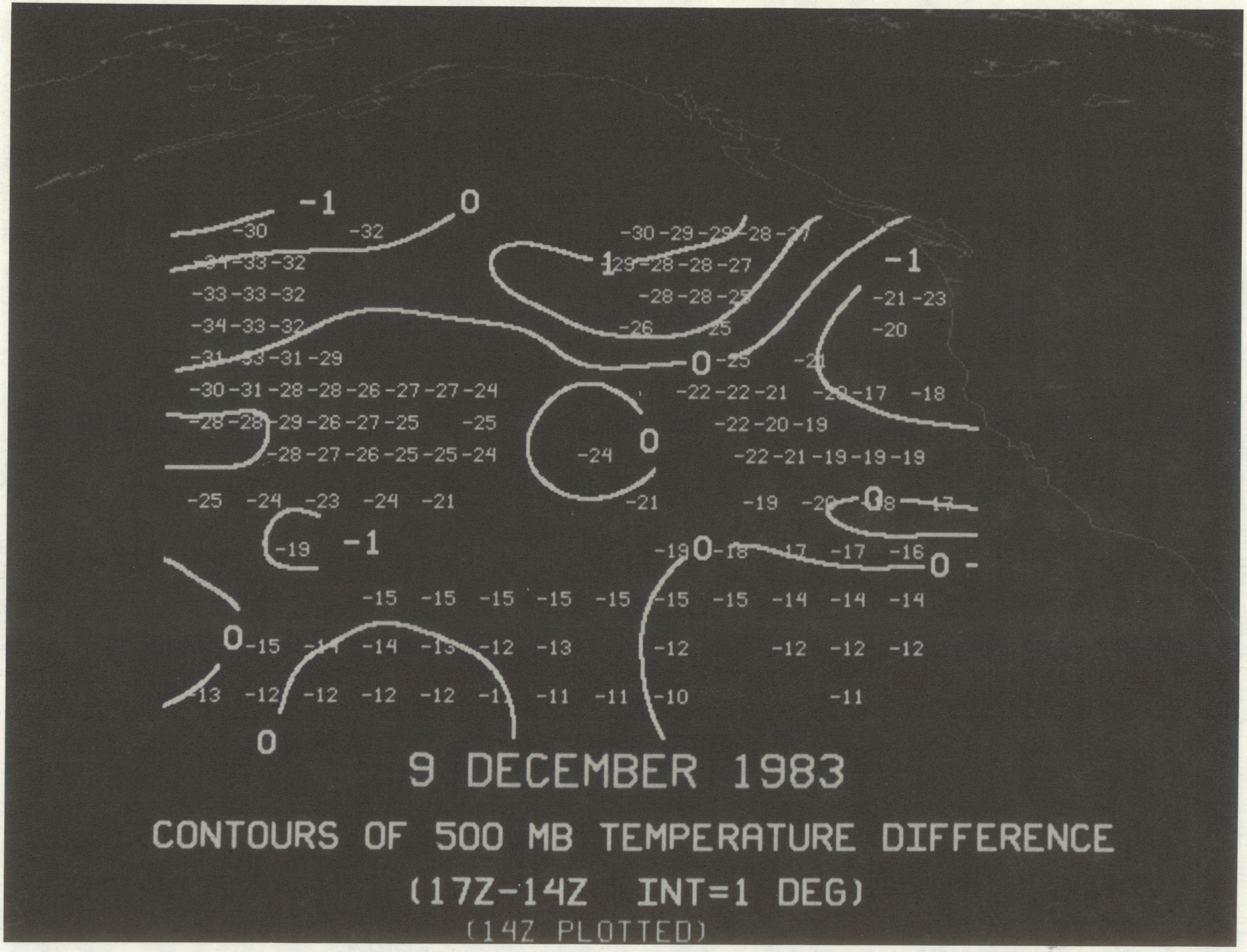

Figure 8: Contours of VAS 500 mb temperature difference (°C) (small detector-large detector) with plot of large detector 500 mb temperatures.

Appendix A

The dwell sounding mode has three submodes. The are submode 1, submode 2, and submode 3. They occur in the cyclic order 1, 2, 3, 2, 1, 2, 3, 2, etc., throughout the frame. A brief explanation of the submodes follows.

Submode 1

One satellite spin occurs per scan mirror step. After each mirror step, data is transmitted from the two small (6.9 km) band 8 (11 micron) channels. This mode is programmable to have one to eight scan mirror steps.

Submode 2

This is the dwell mode. The scan mirror does not step during this mode. During this mode each of the 12 spectral filters may be put into the optical train and held there for from 0 to 255 satellite spins. The number of spins for each spectral band is programmable.

Submode 3

This is the same as submode 1, except the number of scan mirror steps may be different than submode 1.

If $S_1(S_3)$ is the number of scan mirror steps in submode 1 (3) and S_2 is the number of dwell spins in submode 2, then the time required for each (1, 2, 3, 2) sounding cycle is

$$T = (S_1 + 2S_2 + S_3)t \qquad \text{(A.1)}$$

where t is the nominal spin period of the satellite (.01 minutes). The north-south spatial coverage of each scan mirror step at the subsatellite point is 6.9 km, so the north-south extent of a latitude swath covered during one sounding cycle is

$$X_{NS} = (S_1 + S_3)\ 6.9 \text{ km} . \qquad \text{(A.2)}$$

The sounding rate is the ratio

$$S = 6.9(S_1 + S_3)/(S_1 + 2S_2 + S_3)/t \text{ km/min} . \qquad \text{(A.3)}$$

Figures A.1 through A.3 illustrate three scan patterns that enable dwell sounding using the spin budget presented in section 2. Scan pattern A.1 provides contiguous dwell sounding coverage from the large detectors; the sounding rate is 89 km/min. Scan pattern A.2 provides contiguous dwell sounding coverage from the small detectors; the sounding rate is 47 km/min.

Scan pattern A.3 provides venetian blind dwell sounding coverage from the small detectors; the sounding rate is 44 km/min covering the latitude extent at 89 km/min (half the latitude extent is not covered in a sounding mode).

LARGE DETECTOR DWELL SOUNDING SCAN PATTERN
MIRROR STEPPING-FILTER SELECTION SUBROUTINE SET AT
(6-DWELL-2-DWELL)

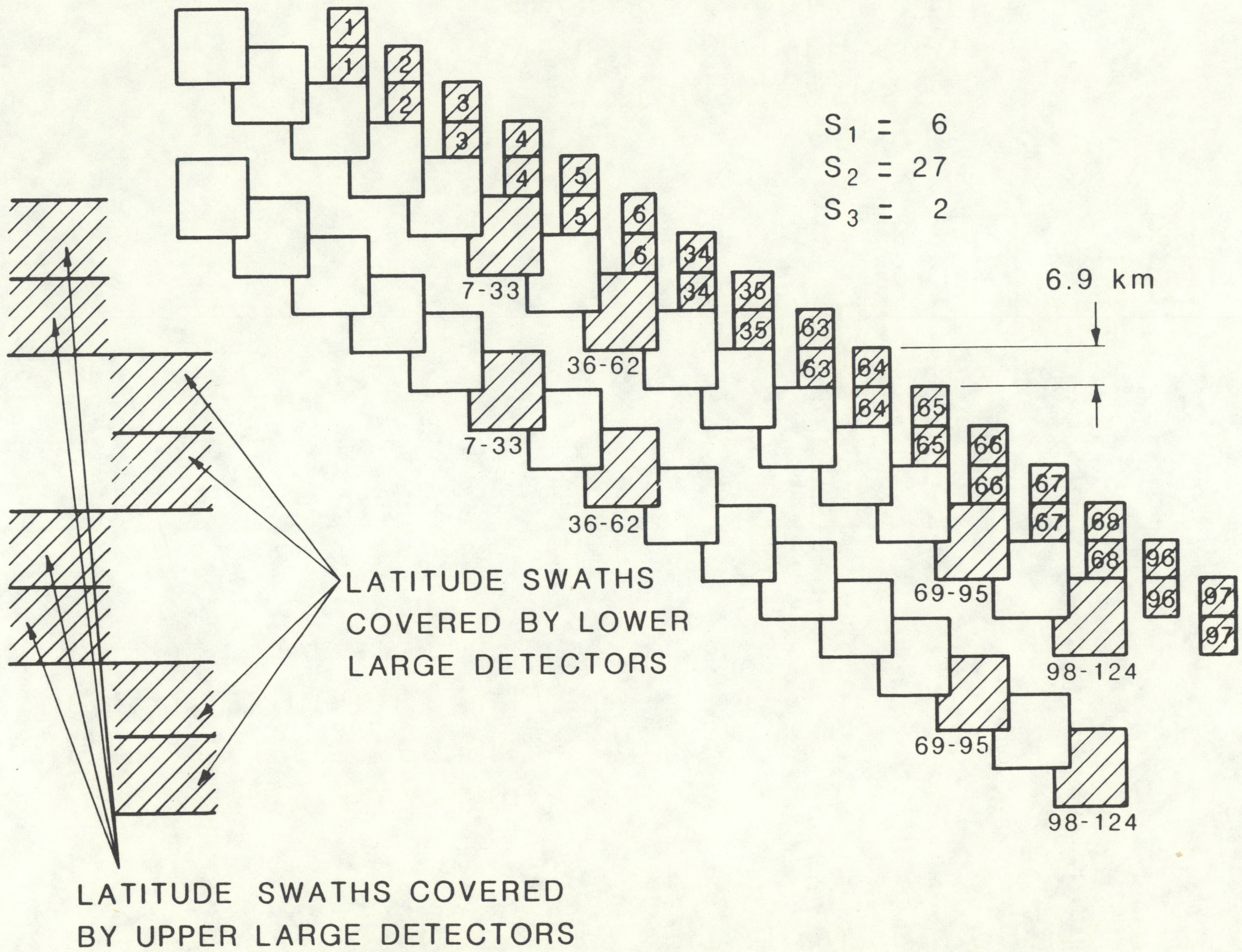

Figure A-1: Scan pattern for contiguous sounding with the large detectors.

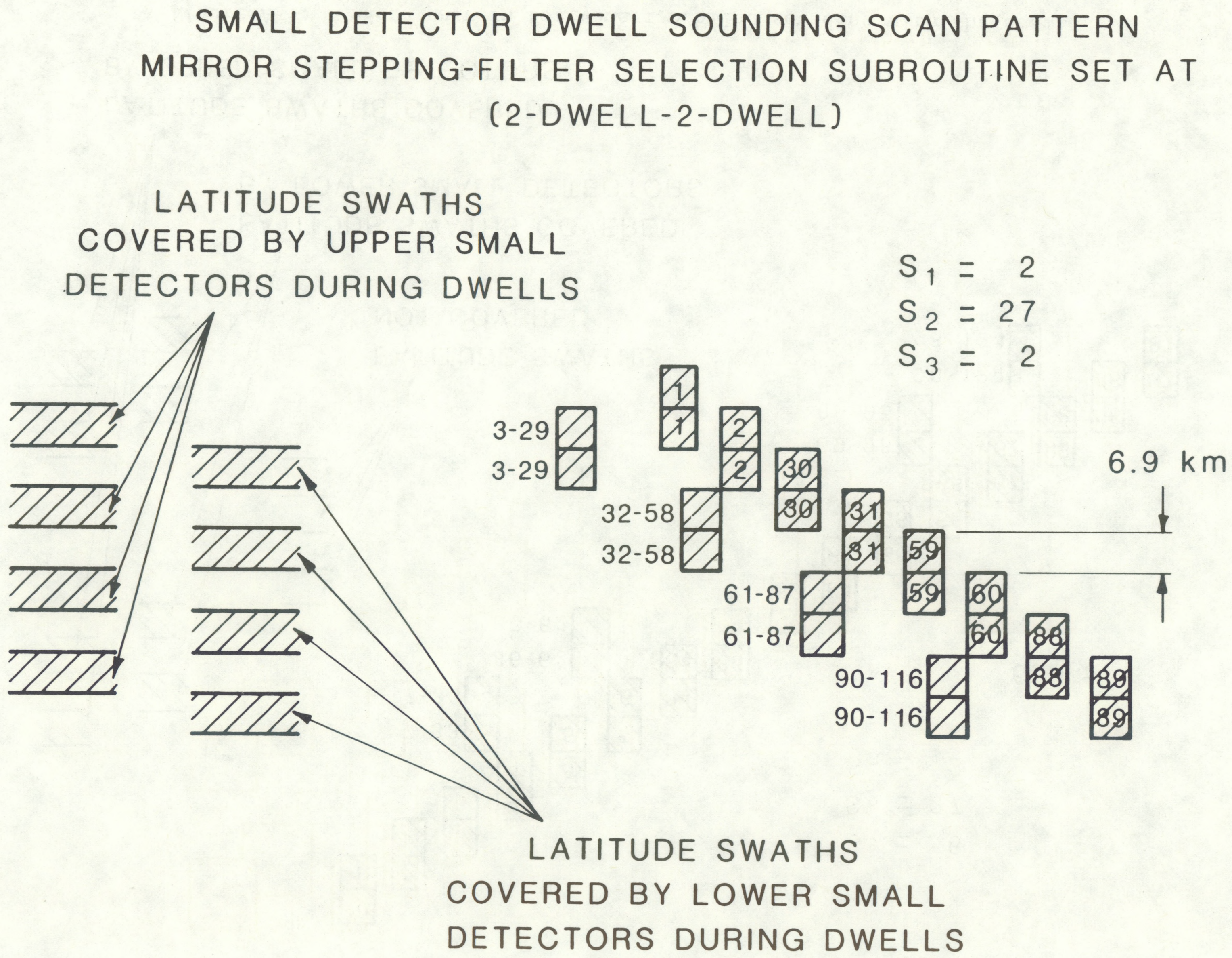

Figure A-2: Scan pattern for contiguous sounding with the small detectors.

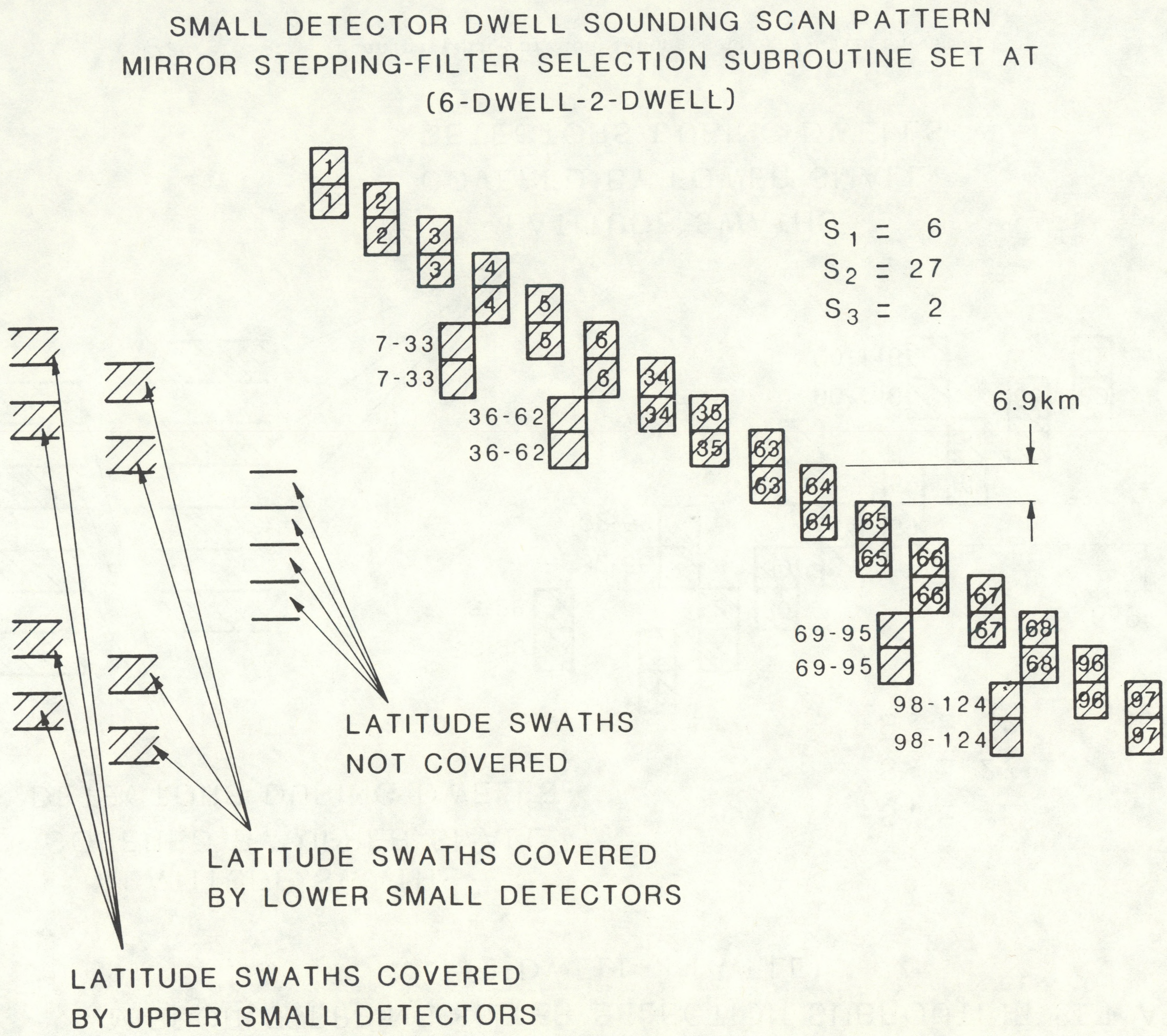

Figure A-3: Scan pattern for venetian blind sounding with the small detectors.

NOAA TECHNICAL MEMORANDUMS

National Environmental Satellite, Data, and Information Service

The National Environmental Satellites, Data, and Information service (NESDIS) manages the Nation's civil operational Earth-observing satellite systems, as well as global national data bases for meteorology, oceanography, geophysics, and solar-terrestrial sciences. From these sources, it develops and disseminates environmental data and information products critical to the protection of life and property, national defense, the national economy, energy development and distribution, global food supplies, and the development of natrual resources.

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NESS 113 Satellite Identification of Surface Radiant Temperature Fields of Subpixel Resolution. Jeff Dozier, December 1980. (PB81 184038)

NESS 114 An Attitude Predictor/Target Selector. Bruce M. Sharts, February 1981, 21 pp. (PB81 200479)

NESS 115 Publications and Final Reports on Contracts and Grants, 1980. Nancy Everson (Compiler), June 1981. (PB82 103219)

NESS 116 Modified Version of the TIROS N/NOAA A-G Satellite Series (NOAA E-J) - Advanced TIROS-N (ATN). Arthur Schwalb, February 1982, 29 pp. (PB82 194044)

NESS 117 Publications and Final Reports on Contracts and Grants, 1981. Nancy Everson (Compiler), April 1982. (PB82 229204)

NESS 118 Satellite Observation of Great Lakes Ice - Winter 1979-80. Sharolyn Reed Young, July 1983, 47 pp. (PB84 101054)

NESS 119 Satellite Observations of Great Lakes Ice: 1980-81. A.L. Bell, December 1982, 36 pp. (PB83 156877)

NESDIS 1 Publications and Final Reports on Contracts and Grants, 1982. N. Everson, March 1983. (PB83 252528)

NESDIS 2 The Geostationary Operational Environmental Satellite Data Collection System. D.H. MacCallum and M.J. Nestlebush, June 1983. (PB83 257634)

NESDIS 3 Nimbus-7 ERB Sub-Target Radiance Tape (STRT) Data Base. L.L. Stowe and M.D. Fromm, November 1983.

NESDIS 4 Publications and Final Reports on Contracts and Grants, 1983. Nancy Everson (Compiler), April 1984. (PB84 192301)

NESDIS 5 A Tropical Cyclone Precipitation Estimation Technique Using Geostationary Satellite Data. (in press)

NOAA SCIENTIFIC AND TECHNICAL PUBLICATIONS

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