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Vela Event Alert 747 (U)

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VELA EVENT ALERT 747 (U)

by

Henry G. Horak

ABSTRACT (SRD)

On September 22, 1979, the two bhangmeter-photometers of Vela satellite 6911 measured a two-peaked signal that displayed the time-history and [

] The signal origin was within the hemisphere including the southern Atlantic Ocean and Antarctica. [

] The bhangmeter results were interpreted by theoretical calculations using the radiation-hydrodynamics code, RADFLO. This analysis leads to the conclusion that the bhangmeter observations are consistent with a signal produced [

]

INTRODUCTION

On September 22, 1979 at $00^h52^m43.6^s$ UT, the two bhangmeters on Vela satellite 6911 detected a two-peaked signal that displayed the irradiance-vs-time [

]

This event has been designated Alert 747. [

] The subsatellite position was $\sim 50^{\circ}$S latitude $\sim 0^{\circ}$ longitude in the Atlantic Ocean; the distance of the Vela from the earth's center was 1.064×10^5 km ($\sim$ 17 earth radii). The aspect of the earth as seen from Vela is shown in Fig. 1 with the angular diameter of the earth being $6^{\circ}.8$. The angle at the

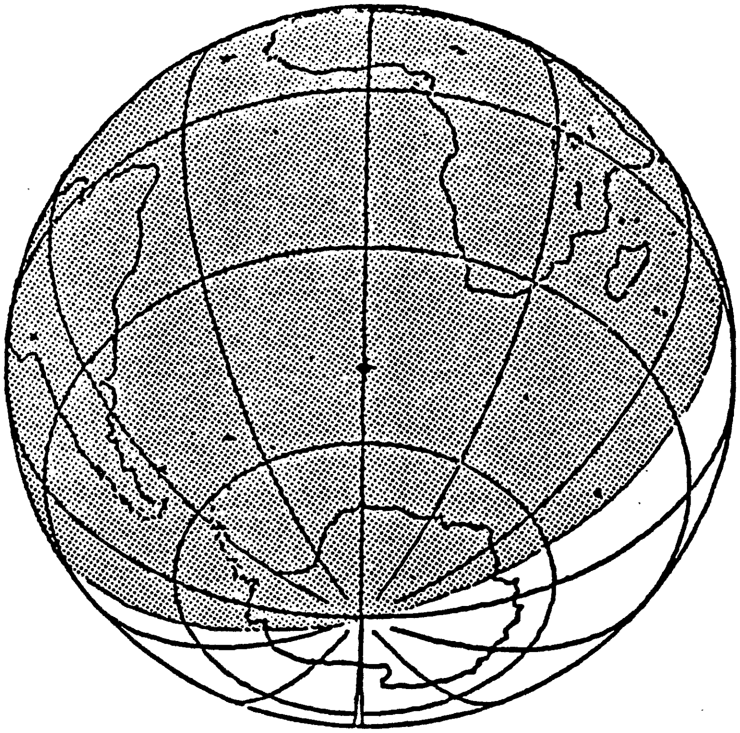

Fig. 1.
The earth as seen from Vela satellite 6911 at the time of Alert 747.

earth between the sun and Vela was ~ 130^{0}, so that the earth displayed a crescent phase with most of the hemisphere viewed from Vela in darkness.

The bhangmeter curves were not entirely consistent. The differences during the first pulse can be readily explained in terms of instrumental behavior. However, by second maximum, the more sensitive bhangmeter was recording an irradiance over twice as high as the less sensitive instrument. This was quite possibly caused by optical background changes during the much longer second pulse, though the quantitative explanation is not yet available. Calibration checks by internal triggering and external laser triggering before and after the event indicate that both bhangmeters behaved normally.

Two DSP satellites (6 and 7) were also viewing some of the area visible to Vela, but their bhangmeters did not trigger. The weather in the south Atlantic was overcast to broken with both low and high clouds, so it is necessary to conclude that either the event didn't take place within their fields of view, or the event signal was weakened by transmission through clouds and wasn't strong enough to attain the necessary threshold irradiance. It is also plausible that Vela observed the event through a break in the clouds, or through thin clouds.

No radioactivity was ever detected that could be correlated with the event. Though there are other pieces of possibly corroborative evidence, e.g., the traveling ionospheric disturbance (TID) observed by the Arecibo Radio Observatory in Puerto Rico, we are not prepared to comment on their value at this time; it is our impression that they are not definitive.

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Radiation-hydrodynamic calculations were carried out with the one-dimensional code RADFLO[1] and show that the observed bhangmeter curves can be explained, [

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THE VELA BHANGMETERS

The two bhangmeters on Vela 6911 are mounted near each other with their lines of sight parallel and pointing towards the earth. The satellite maintains a slow rotation (period of ~ 64 s) about an axis closely parallel to these lines of sight. [

] the earth's hemisphere directed towards Vela is always fully contained in each detector's field of view.

The two bhangmeters differ somewhat in design, though each sensing element is a one-inch diameter silicon photodiode with quartz cover glass. The sensitivity curve for the silicon detector is shown in Fig. 2. [

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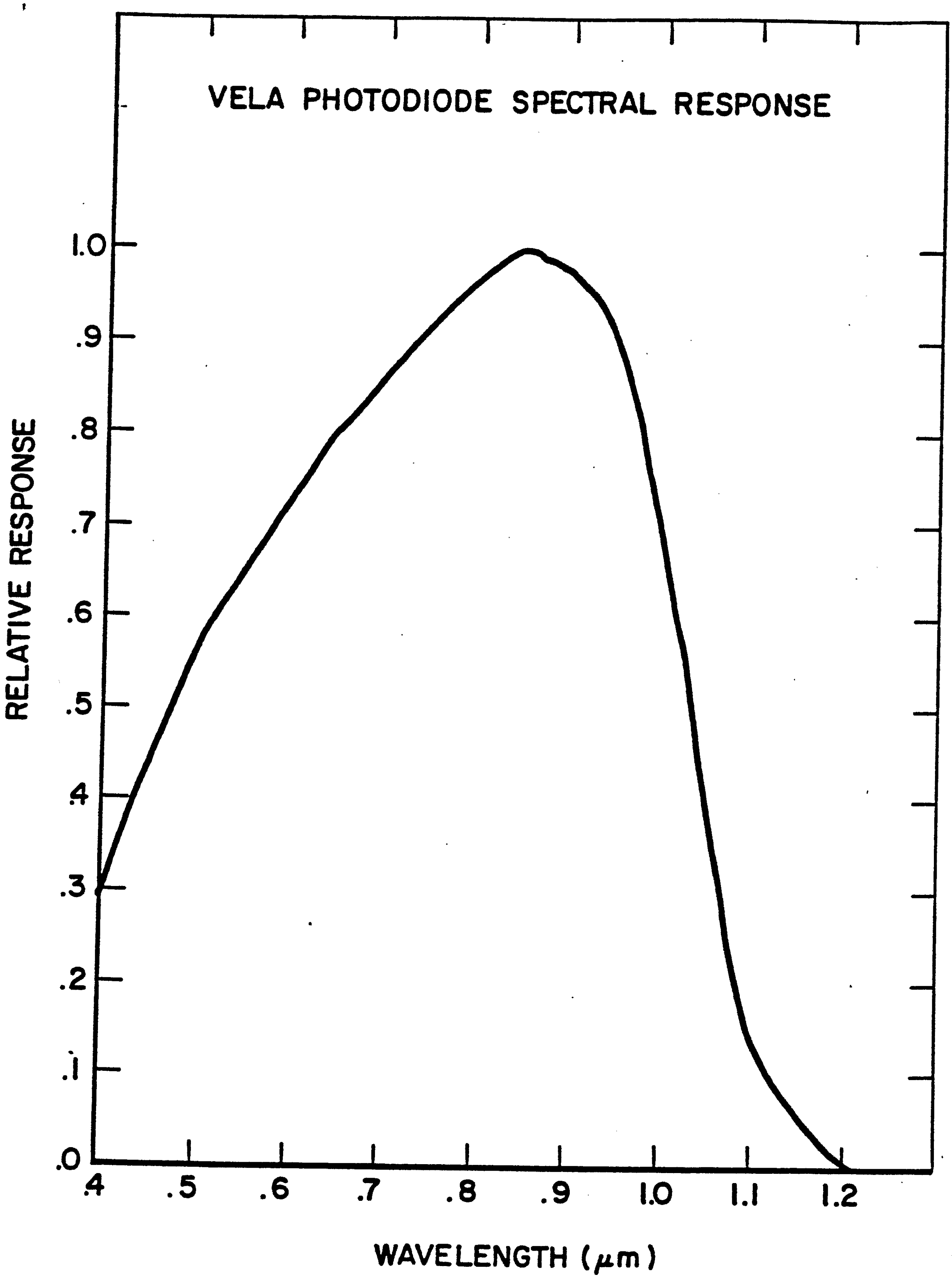

Fig. 2.
The sensitivity curve for the Vela silicon photodiode.

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At event time, both instruments were receiving background light from the crescent earth and from the sunlight reflected onto the sensors by those interior surfaces directly illuminated by the sun. The background irradiance was a few decades larger than the signal's maximum irradiance; however, the equipment operates far from saturation, even for a gibbous or full earth.

Both bhangmeters have internal light sources for performing calibration checks. Comparison of such checks before and after Alert 747 show that both bhangmeters were, and are now, operating normally.

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INTERPRETATION OF THE BHANGMETER DATA

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] The event character is more obvious and displays the very sharp, fast first pulse followed by the slower but more energetic second pulse. This type of time variation coupled with the observation that the irradiances are of the proper magnitude is strong evidence that a nuclear explosion actually produced the Vela Alert 747. The remainder of this report is devoted to an analysis of the Vela bhangmeter records, assuming that the event was indeed of nuclear origin.

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It is possible to convert a measured irradiance to power at the source, assuming the event occurred directly below the satellite and that the atmospheric transmission factor is known approximately. The source power, P(T), in the silicon band radiated into all directions is given by the expression $P(T) = 4\pi d^2 D(T)/\overline{T}$, where T is time, d the distance between satellite and event, D(T) the observed irradiance, and $\overline{T}$ the appropriate transmission factor (including the effects of multiple scattering) averaged over the silicon wavelengths.

[

] The question of the proper transmission factor, particularly due to the presence of clouds, is discussed in Appendix A. However, the precise value chosen for $\overline{T}$ is not crucial to our present argument; indeed, assuming the signal was nuclear and of known yield, consistency between source power and bhangmeter irradiance sets the value of $\overline{T}$.

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In order to produce a reasonable theoretical model for Alert 747, it was necessary to carry out an extensive series of one-dimensional radiation-hydrodynamic calculations using the program RADFLO.[1] [

[

In the RADFLO calculations for Alert 747, [

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SUMMARY AND CONCLUSIONS

The Vela Alert 747 shows all the characteristics of [

] the short first pulse, the extended second pulse, and the proper power levels. [

] The two Vela bhangmeters have been checked since the event, both with an internal light source and by laser-induced triggering. Such studies lead to the belief that the bhangmeters are in reasonably good order, and that they behaved as usual during the event. However, the difference in their measurements during the second pulse indicates a change in background causing the more sensitive YC bhangmeter to record abnormally [

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[

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APPENDIX A

ATMOSPHERIC TRANSMISSION AND COUPLING COEFFICIENTS

The spectral transmission factor between a point source on the ground and a satellite at zenith angle Z is the factor by which the radiance of the source is reduced due to out-scattering and pure absorption along the line of sight. In-scattering is not included. To allow for the latter, the spectral coupling coefficient is introduced which is the probability that a photon leaving the source will arrive at the receiver by any path.

The spectral transmission factors for a zenith angle of zero at various sea-level visual ranges are given in Table A-I. These data assume a cloud-free line of sight, and are based on optical measurements made from a ship in the Pacific Ocean.

Values of the spectral coupling coefficients between a point source on the ground and a satellite at zenith angle Z have been derived using observed data and some Monte Carlo calculations, and are given in Table A-II. These results also assume cloud-free conditions.

The source of Alert 747 was located in an area covered with persistent low and/or high clouds. In order to derive coupling coefficients for this situation, it is necessary to know cloud thickness, the droplet size distribution, etc., which are clearly unavailable. However, since the yield of the source is derived from the shape of the bhangmeter curve, the absolute power (Si band) vs time curve can be calculated, or obtained empirically from previous test data.

TABLE A-I
SPECTRAL ATMOSPHERIC TRANSMISSION AS A FUNCTION OF WAVELENGTH AND SEA-LEVEL VISUAL RANGE. THESE DATA ARE FOR ZENITH ANGLE EQUAL TO ZERO.

Visual Range, km	Wavelength, μm								
	.35	.45	.55	.65	.75	.85	.95	1.05	1.15
50	0.37	0.67	0.80	0.85	0.86	0.58	0.87	0.87	0.88
25	0.34	0.61	0.73	0.77	0.78	0.52	0.79	0.80	0.80
10	0.25	0.46	0.55	0.58	0.59	0.40	0.60	0.60	0.61
5	0.16	0.28	0.35	0.36	0.37	0.24	0.38	0.38	0.38
2	0.04	0.07	0.08	0.09	0.09	0.06	0.09	0.09	0.10

TABLE A-II
SPECTRAL COUPLING COEFFICIENTS AS FUNCTION OF WAVELENGTH FOR SAME CONDITIONS AS TABLE A-I

Visual Range, km	Wavelength, µm .35	.45	.55	.64	.75	.85	.95	1.05	1.15
50	.68	.83	.90	.92	.93	.78	.93	.94	.94
25	.66	.80	.86	.88	.89	.76	.89	.90	.90
10	.62	.73	.78	.79	.79	.69	.80	.80	.80
5	.58	.64	.67	.68	.68	.62	.68	.68	.69
2	.52	.54	.54	.55	.55	.53	.55	.55	.55

Consistency with the bhangmeter irradiance-vs-time curve enables a silicon-band coupling coefficient to be inferred. A value of ~ .76 is obtained, which is sufficiently high that there could not have been much cloud intervening directly in the line of sight. Indeed, if a cloud layer is not too thick the extinction of direct light is compensated to some extent by the multiple scattering.

APPENDIX B
THE DEPENDENCE OF SILICON RESPONSE ON THE SPECTRUM OF THE INCIDENT LIGHT

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The normalized spectral response of a Si detector has been calculated as a function of wavelength. Coupling coefficients for Z = 60° and VR = 25 km (no clouds) were used. ^{3}

] The normalization is such that the area under a curve of spectral response vs wavelength is unity.

Values of the coupling coefficient have also been calculated for a range of receiver zenith angles [

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ACKNOWLEDGEMENTS

This report is an effort to summarize all the information we have to date regarding the Vela Alert 747. Many people from several installations have contributed their time and efforts to collecting and analyzing the data.

H. Hoerlin of LASL first worked out a review and evaluation of the Vela optical data for Alert 747, and transmitted his findings to the DoE on December 14, 1979. A LASL investigating committee was formed with J. Walker (P-4) coordinating its activities. This committee consisted of G. Barasch, R. Beckman, W. D. Evans, H. Hoerlin, H. Horak, R. Jeffries, M. Johnson, E. Jones, J. Kodis, W. Lorber, M. Sandford, G. Wecksung, R. Whitaker, J. Wolcott, and J. Zinn. Maj. Meneely and J. Marshall, AFTAC, were very cooperative in transmitting the Alert 747 data to the committee. In addition, one entire session of the Satellite Working Group Meeting, Patrick AFB, Florida, 18-20 March 1980, was devoted to this event. G. Mauth, Sandia, presented a very important lecture at LASL, including a lively discussion with the committee, about the construction and capabilities of the Vela bhangmeters.

E. Jones, R. Whitaker, and J. Kodis carried out many RADFLO calculations to compare with the Vela bhangmeter curves. H. Hoerlin and H. Horak spent much time examining the data from past nuclear events. M. Wells, RRA, communicated to us the results of time-dependent Monte Carlo calculations that simulate the multiple scattering of light through clouds.

H. Stewart and D. Hanson, HSS, prepared most of the material that appears in Appendices A and B.

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