RECENT SOLAR MEASUREMENTS RESULTS AT THE PARABOLIC DISH TEST SITE*

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ABSTRACT

After the Mexican volcanic eruptions of March 28, April 3 and 4, 1982, the question of its effect on insolation levels at the Parabolic Dish Test Site (PDTS) naturally arose. It was decided to look at this question in three steps: First to determine the impact, if any, on total direct normal energy (by month) at the PDTS for the summer of 1982 as compared to the summer of 1981 (after and before the explosion respectively). Secondly, we would look at the effect on peak insolation levels for the same period of time. The results of the first step were the following: A drop of 20%, 9% and 18% in total direct normal energy for the months of June, July and August 1982 respectively, as compared to the same months in 1981 was experienced. For the second step we found a decrease of 4.0%, 5.8% and 7.7% in peak direct normal insolation levels for the months of June, July and August 1982 respectively, as compared to the same months in 1981 (where the peak levels for each month were determined by averaging the top 3 days for each month). The most striking difference noted between the summer of 1981 and 1982 was the following: There were 29 days in June, July and August of 1981 where the insolation level exceeded 1,000 W/m^2. For the same period in 1982 there were no days that were in excess of 1,000 W/m^2. The third and final step was to compare the results of the summer of 1983 (a year after the explosion) with the summer of 1982. The results show only one day in excess of 1,000 W/m^2 during the summer of 1983 (this was in July 1983, a hiatus of thirteen months since the last one). Clearly, the answer to the original question is that the Mexican volcanic explosion had a significant impact on insolation levels at the PDTS and, furthermore, it has been quite long lasting. The data would seem to suggest that the volcanic explosion had little effect on PDTS insolation until the first of June 1982.

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INTRODUCTION

The Parabolic Dish Test Site (PDTS) was established in 1978 for the Department of Energy by the Jet Propulsion Laboratory (JPL), an operating Division of Caltech. It was established for the purpose of testing and evaluating parabolic dishes at the component, subsystem and system (or module) level. The PDTS is located on Edwards Test Station (A JPL facility), which in turn is located on Edwards Air Force Base. The test site is situated approximately a hundred miles north of Los Angeles. Figure 1 shows two identical Test Bed concentrators, 11 meters in diameter (on the right) and a single 12 meter diameter concentrator (on the left) designated Parabolic Dish concentrator Number One.

Since the El Chichon volanic eruption in Mexico on March 28, April 3, and 4, 1982, there have been reports from various solar sites in the United States of its effect. It was decided to determine the effect (if any) of these eruptions on insolation levels at the PDTS. Having this data would then enable a comparison to be made of volcanic effects at solar sites throughout the United States.

The approach employed to make this comparison was to compare the direct normal energy at the PDTS for the summers of 1981, 1982 and 1983, or in other words compare data for a year before the explosion, the summer shortly after the explosion and a year after the explosion. Secondly, determine the effect on peak insolation levels for the same period of time.

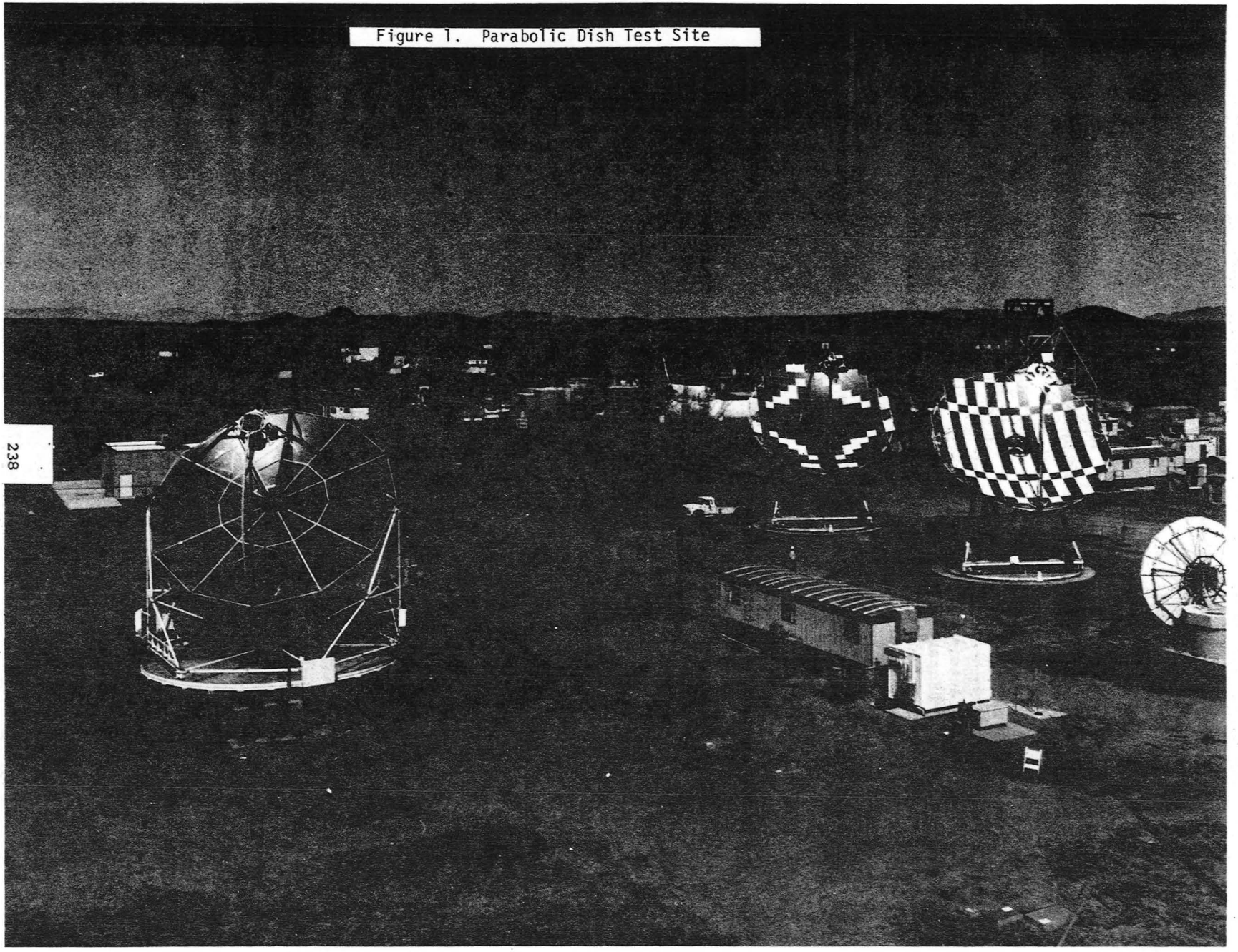

Figure 1. Parabolic Dish Test Site

Direct Normal Energy

The direct normal energy levels for the summers of 1981, 1982 and 1983 were compiled and are as shown in Table 1 below:

TABLE 1

COMPARISON OF DIRECT NORMAL ENERGY AT
ETS FOR THE SUMMERS OF 1981, 1982 and 1983

	1981 kW-HR/SQ-METER/DAY	1982 kW-HR/SQ-METER/DAY	1983 kW-HR/SQ-METER/DAY
June	10.93	8.78	9.62
July	10.09	9.21	10.05
August	9.44	7.71	7.68

This data was obtained with the use of a Kendall Pyrheliometer (Absolute cavity Radiometer) that was mounted at the PDTS. This instrument is part of the weather station that was set up at the PDTS in support of the solar program. Insolation measurements have been taken since October 1978. Other instrumentation has been added over the years, such as: wind speed and direction, ambient temperature, barometric pressure and dew point.

Note that there was a significant drop during the summer of 1982 as compared to 1981 (19.7%, 8.7% and 18.3% for June, July and August respectively). For the summer of 1983 vs. 1981, the comparable numbers are: 12.0%, 0.4% and 18.6%. This indicates a significant increase in energy available in June 1983 (as compared to June 1982) and a return during July 1983, to the energy levels available prior to the volcanic explosion . Although not shown in Table 1, there was a large increase in energy level in May 1983 over May 1982 and in fact larger than May 1981. This can be seen in Table 3 in the Appendix. August of 1983, however, again shows a significant decrease from August of 1981 and virtually comparable to August of 1982. August of 1983 was, however, quite a stormy month and this undoubtedly had a significant impact on the energy available. Subsequent months will determine whether the energy levels are back to normal or not. Unfortunately, it will not be possible to make this assessment at the PDTS, since the weather station was shut down permanently early in September 1983.

Peak Direct Normal Insolation

The peak direct normal insolation levels for the summers of 1981, 1982 and 1983 are as shown in Table 2 below:

TABLE 2

COMPARISON OF PEAK DIRECT NORMAL INSOLATION LEVELS AT ETS FOR THE SUMMERS OF 1981, 1982, 1983

	1981 AVG. FOR TOP 3-DAYS W/SQ-METER	1982 AVG. FOR TOP 3-DAYS W/SQ-METER	1983 AVG. FOR TOP 3-DAYS W/SQ-METER
June	1025	984	956
July	1026	967	995
August	1040	960	967

This data was measured with the same Kendall Pyrheliometer that was used to acquire the energy data in Table 1.

Again, it is to be noted that there was a significant drop in peak insolation levels during the summer of 1982 as compared to the summer of 1981 (4.0%, 5.8% and 7.7% for June, July and August respectively). Comparing the summer of 1983 with 1981, the corresponding numbers are: 6.7%, 3.0% and 7.0%. This data indicates a significant increase in peak insolation levels during July 1983 (as compared to July 1982), but still 3% below the peaks of 1981 for the same month. As was the case with the energy levels (indicated in Table 1), however, there was again a drop in insolation levels in August 1983 to a level comparable with August 1982 and 7.0% below August 1981. Since August of 1983 was quite a stormy month, this almost certainly contributed to lower insolation levels.

The most striking difference observed between the summer of 1982 and 1981 is the decrease in the number of days in 1982 and 1981 where the peak insolation was 1,000 W/m^2 or greater. During the summer of 1981 (June, July and August), there were 29 days greater than or equal to 1,000 W/m^2, while in 1982 for the same months there were no days of 1,000 W/m^2 or greater. For the same months in 1983, there was 1 day of 1,000 W/m^2 or greater. Further, there was a hiatus of 13 months

(from June 1982 through June 1983) during which the insolation level did not equal or exceed 1,000 W/m^2. For a tabulation of this data for all of 1981 and 1982 and 8 months in 1983, see Table 4 in the appendix.

Conclusions

Clearly, the answer to the original question is that the Mexican volcanic explosion had a significant impact on energy and insolation levels at the PDTS and, furthermore, it has been quite long lasting. The first really significant decrease in energy and insolation levels occurred in June 1982 when the energy level decreased by 19.7% while the peak insolation levels went down by 4.0%. June of 1982 was also the first month (of 13 consecutive months) when peak insolation levels did not equal or exceed 1,000 W/m^2.

Signs of a recovery from the effects of the volcanic explosion began to appear in May of 1983, when the energy level exceeded that of May 1981 as well as May 1982. A return to almost normal levels (pre-volcanic explosion levels) occurred in July 1983 followed by a fairly large decrease occurring in August of 1983 because of stormy weather. Peak insolation levels did not show signs of recovery until July of 1983 when the first day above 1,000 W/m^2 occurred. July was also the first month in 1983 that registered an increase in average insolation levels over 1982. The average level in July 1983 did not, however, reach equal levels or an increase over 1981. While average insolation levels did decline in August 1983, the average was still slightly above August 1982.

In summary, it would appear that energy and insolation levels are improving at the PDTS, but have not quite reached normal or pre-volcanic levels. At this time the data would seem to suggest a return to normal energy and insolation levels will occur in the very near future.

TABLE 3

COMPARISON OF TOTAL DIRECT NORMAL ENERGY AT THE PDTS FOR 1981, 1982, AND 1983

	1981 kW-HR/SQ. METER/DAY	1982 kW-HR/SQ. METER/DAY	1983 kW-HR/SQ. METER/DAY
JANUARY	4.87	6.14	4.73
FEBRUARY	6.43	5.15	3.98
MARCH	7.12	5.69	6.01
APRIL	8.90	8.17	6.50
MAY	8.68	8.42	9.29
JUNE	10.93	8.78	9.62
JULY	10.09	9.21	10.05
AUGUST	9.44	7.71	7.68
SEPTEMBER	8.80	6.70	
OCTOBER	7.65	6.44	
NOVEMBER	6.00	4.88	
DECEMBER	5.40	3.99	
	94.31	81.28	

$\frac{94.31}{12} = 7.86$ $\frac{81.28}{12} = 6.77$

TABLE 4

COMPARISON OF PEAK DIRECT NORMAL INSOLATION LEVELS

FOR 1981, 1982 AND 1983

	1981		1982		1983	
	AVG. FOR TOP 3-DAYS W/M^2	# OF DAYS AT OR ABOVE 1,000 W/M^2	AVG. FOR TOP 3-DAYS W/M^2	# OF DAYS AT OR ABOVE 1,000 W/M^2	AVG. FOR TOP 3-DAYS W/M^2	# OF DAYS AT OR ABOVE 1,000 W/M^2
JANUARY	1053	11	1045	9	932	0
FEBRUARY	1073	17	1019	4	958	0
MARCH	1065	15	1051	13	964	0
APRIL	1021	8	1034	5	966	0
MAY	1013	5	1002	2	951	0
JUNE	1025	8	984	0	956	0
JULY	1026	11	967	0	995	1
AUGUST	1040	10	960	0	967	0
SEPTEMBER	1026	7	966	0		
OCTOBER	1018	5	977	0		
NOVEMBER	1004	2	948	0		
DECEMBER	1001	3	889	0		