PROJECT 1 [illegible] RECORD

1. DATE - TIME GROUP 6 Oct 67 07/0300Z	2. LOCATION Vandenburg AFB, California
3. SOURCE Military	10. CONCLUSION Sighting: Other: Probable (MIRAGE) Radar: Other: (BIRDS AND ANOMOLOUS PROPAGATION)
4. NUMBER OF OBJECTS See Case	
5. LENGTH OF OBSERVATION See Case	11. BRIEF SUMMARY AND ANALYSIS On Oct 6, events began at 2000 hours with the visual sighting that continued for 3/4 hour of an object over the ocean at a bearing of 290 deg and an elevation of 10 to 15 deg. The object displayed no appreciable motion. The missile-tracking radars, were, at 2045 asked to go into search mode and look for the object sighted visually. The result was that many objects were quickly picked up and tracked. COMMENTS: See University of Colorado Report.
6. TYPE OF OBSERVATION Ground-Visual (RADAR)	
7. COURSE See Case	
8. PHOTOS ☐ Yes XX No	
9. PHYSICAL EVIDENCE ☐ Yes XX No	

FORM
FTD SEP 63 0-329 (TDE) Previous editions of this form may be used.

Vandenberg Sighting Report

LOCATION: Vandenberg Air Force Base, Lompoc, California

DATE: October 6, 1967

TIME: 8:00 pm, October 6, until approximately 2:30 am, October 7, PDT

WITNESSES: Numerous (see body of report)

INVESTIGATORS: [redacted] and others (see body of report)

Abstract

The October 6th events began at 8:00 pm with the visual sighting that continued for over 3/4 hour of an object over the ocean at a bearing of 290° and an elevation of 10 to 15°. The object displayed no appreciable motion. The missile-tracking radars were, at 2045, asked to go into a search mode and look for the object sighted visually. The result was that objects - many objects - were quickly picked up and tracked. There were no known aircraft in the area at this time. A series of remarkable events then ensued, of which the most important are the following:

1. Observations of radar targets continued for a period of over four hours.
2. The targets exhibited velocities of from 0 to 80 knots; some of the returns were very strong - up to 80 db at reduced instrument gain.
3. The objects characteristically, but not always, permitted radar lock-on.
4. Most of the observations were made over the sea, but there were some seen to the east and north - over the land.

5. There were several visual sightings in addition to the initial visual sighting at 2000.
6. Three flights of fighters were dispatched by the Air Defense Command to investigate; they found nothing.
7. The radars were closed down and the exercise terminated at approximately 2:30 am at a time when targets were still being observed but remained completely unidentified.
8. The tracking radars had produced (and the results were available to us for study) numerical data on the targets including range, azimuth, elevation, and velocity, printed out at 15-second intervals.

Detailed Description of Sightings

Information Available Before Investigation

[redacted] was visiting [redacted] at the Jet Propulsion Laboratory in Pasadena on other contract business. A telephone call from the office in Boulder advised that Blue Book had notified us of a very interesting sighting at Vandenberg involving simultaneous visual and radar observations. It was reported, in addition, that in a test three nights after the sightings, made to determine whether the radars could be made to observe bogeys similar in nature to those seen the night of October 6, ~~there~~ the radars did in fact pick up targets that looked similar. [redacted] decided to extend his trip by one day and visit Lompoc on October 18. [redacted] agreed to accompany [redacted]. A subsequent trip proved necessary on November 8. In reporting the circumstances of the sightings, information learned on the two trips will, in general, be reported as if accumulated at one time. This will contribute to clarity of the report.

Investigators

[redacted] and [redacted] made the October 13th trip. The following were present on November 8th: from Stanford Research Institute - [redacted]. [redacted] from New Mexico Institute of Mining and Technology - [redacted] from the Environmental SciencesServices Administration - Roger Lhermitte; from the UFO Project - [redacted] and [redacted]

Observers

The Vandenberg sightings are exceptional because of the extraordinarily high professional qualifications of the observers. [redacted] are officials of the Western Test Range. [redacted] has 17 years' experience as a Naval aviator, 25 years altogether in military and civil aviation. He has 10,000 hours as an air-intercept and final-approach controller. [redacted] is an ex-Naval aviator with 17 years' experience. He also has been an air-intercept controller. [redacted] served the night of October 6th as Range air-control officer. [redacted] years' experience with ground and airborne electronics systems. [redacted] are radar operators, employed by private contractors on the base, and all had extensive experience in radar operation. They displayed an impressive understanding of the sophisticated radar systems they were operating and a good comprehension of radar engineering principles. [redacted] is a member of the security force. He does not have a strong background of technical training.

Radars

The following radars were involved in the sightings:

1. FPS-16 - C-band tracking radar with a 1.2° beam.
2. TPQ-18 - C-band tracking radar with a 0.4° beam.

3. GERTS - X-band tracking and command radar usually used in beacon mode (in which the radar transmission triggers a beacon carried by the vehicle being tracked) but can, and was during the sightings, be used in skin mode (conventional radar operation in which the target is seen by reflected radiation from the transmitted pulse).
4. M33 - X-band tracking radar.
5. ARCER - L-band search radar.

Details of the Sightings

2000 to 2045 - Atherton observed visually from his house near Lompoc, for one half hour, an object at azimuth 290°. He called [redacted] also at home, three miles to the south, who confirmed the sighting at an azimuth of approximately 280° at an altitude of 10 to 15°. [redacted] observed the object through 7-50 binoculars and reported it looked to be the size of a large thumbtack, elliptical in shape - a red and green light separated by a small distance, like the wing span of an aircraft. But there was no motion. It was fuzzy, like a top spinning.

2045 - [redacted] called Ralston at Range Control Operations (located at an altitude of 900 to 1,100 ft.). [redacted] confirmed the visual observation, said it appeared to have white, red, and green or blue colors that did not vary. They "looked like the running lights on a stationary object." Bearing 290°, out several miles, at approximately 10,000 ft.altitude. It was suggested that the object looked like a helicopter.

2045 - FPS-16 locked on two strong targets, one moving around and one stationary. One of them a 50 db target. Target seen in the general direction of the visual sighting, but the optical position was not determined with sufficient accuracy that it could be stated unambiguously that it was a simultaneous optical-visual sighting. Original interpretation was a helicopter, with another one assisting.

2100 - [redacted] checked for possible air traffic in the Vandenberg area with the following activities: Point Mugu - no; operations ceased. Com Fleet Air, Alameda - no aircraft in the area. 15th Air Force at March AFB - countermeasure flights in the area? No. NORAD - no. FAA Center, Los Angeles - no.

2100 - Point Mugu fired up FPS-16 and reported that they saw strong targets headed toward Vandenberg AFB (VAFB). The targets must be behind one another in a line, because of the narrow beam of the radar. Lock-on, automatic track mode.

2100 - TPQ-18 at VAFB brought up, and it sees many targets. One, at 8 nautical miles' range, 4,000 ft. altitude, 290° azimuth, proceeded south at slow speed. At one time the TPQ-18 saw 4 targets but usually 2. Point Mugu saw as many as 8. VAFB and Point Mugu did not correlate their targets - that is, they did not establish that they were looking at the same targets. The TPQ-18 began to get different targets. At one time a strong target approached and went right overhead.

2100-0200 - (Times uncertain because of the confusion, although this could, very laboriously, be checked by examining the computer printouts from the radars and by listening to the tape of Ralston's conversations with the radar operators and with the other military bases, these materials being available at VAFB but not in the Colorado Project files).

Radar observations:

a. Up to 14 targets were seen.

b. Velocities ranged from 0 to 80 knots, with rapid changes in altitudes.

c. The radars would lose their locks and then reengage.

d. NORAD surveillance radar on the base did not see anything, but the operator did talk about having a good deal of clutter or, perhaps, jamming. (The surveillance radar operates at a frequency quite different from the tracking radars.)

e. Point Mugu reported a target "bigger than any flat-top at three miles."

f. As the radar activity increased, the number of visual observations decreased. The radars attracted all the attention.

g. The target that went directly overhead is the one that produced an 80 db signal. Three persons went outside the radar shack but were unable to see it.

h. One of the strongest target of all really "moved out in azimuth." A total of eight objects appeared on the radar to emerge from this one. After the separation

occurred, it was necessary to go to manual gain control to separate the signal from the clutter (TPQ-18).

Visual sightings:

a. There were many visuals, but they declined in number as the radar activity increased.

b. One visual moved toward the observers so alarmingly that one of them finally yelled, "Duck."

c. One object, dull in color but showing red, white, and green, moved generally south and finally out of visual range.

d. Another, with the color of a bright fireball, moved on a zig-zag course from north to south.

e. Richard Hamilton and another radar operator, Carl Bailey, reported that, "The radar didn't get locked onto what we saw. By the time the radar slaved to us, the object was gone visually, and the radar didn't see anything." "It looked like a fireball coming down through there. Like a helicopter coming down the coast, at low elevation. We got the telescope on it." Then it grew smaller and smaller until it disappeared. Duration: 1-1/2 to 2 minutes. Moved only in azimuth. Observed it through 13-power telescope. Brighter than a bright star. Like aircraft landing lights except yellower. The time of this sighting was after midnight, between 0100 and 0200. There was a balloon release about this time, and the winds were right. But the weather officer, Lt. Col. Davis, thought it could not be a balloon because the report did

not indicate that the object rose, and a balloon would rise at approximately 1,000 feet per minute.

f. Yokobosky and Yeteryan reported seeing an object that covered 45° in a few seconds, making four zigs and four zags, and then, after reappearing for one second, disappeared to the north.

g. This covers only the most interesting of the visual sightings.

2310 - Air Defense Command scrambled the first of three flights of fighters to investigate the situation. The first and third flights came from Ontario, California, and the second from Oxnard. At this time the tape of the conversations with the radar sites and other bases gave evidence of a good deal of confusion but not alarm or panic. The fighters were handed off to VAFB (Ralston) by the FAA at LA and controlled locally. Ralston attempted to vector the fighters in on the bogeys although, according to Ralston, it was not possible to do a very systematic job of this. By the time the second flight came in, the controllers, because they were so busy with the aircraft, no longer observed any targets. They did observe a good deal of clutter in the west and southwest quadrant. Not bad, they said, about like you get when there is a choppy sea, but the winds that night were only 5 to 10 knots. None of the aircraft, saw anything. One pilot observed something on his IR detector, and, although he reported he could see it repeatedly, he could see it only at distance. As soon as he closed in, the object would disappear. Another aircraft did lock-on to a target, but, after

Weather

Lt. Col. Davis reported that there was an inversion layer at 1,800 to 2,200 ft. But it was generally reported that the objects were above the inversion. All observers indicated that the night was exceedingly clear. Loren W. Crow, consulting meteorologist, has prepared a detailed weather report, which is included as a part of this sighting wright-up.

Evaluation and Conclusions

Radar Tests October 9th and November 8th

On October 9th, under weather conditions similar to October 6th but with more wind, more clouds, and cooler temperatures, the FPS-16 was fired up to determine if the same targets could be seen again. In fact, targets having the same general characteristics were acquired, but they were reported to be not as strong. Two other operators, working on an unofficial basis with a different radar, indicated that they observed "some of the same sort of stuff" on the evenings of the 9th and the 10th.

On November 8th, the night of our second visit, the same or similar targets were acquired on the FPS-16 and TPQ-18. The radar experts among those present (Blackmer, Brook, Collis, Herold, Lhermitte) immediately requested that printouts be obtained giving information on signal strength. This information was not available, because the operators didn't take steps to print it out, for the observations of October 6th and 9th.

Birds?

The behavior and characteristics of the targets appeared to be consistent with the hypothesis that was developed during the discussions

earlier on November 8th, namely, that most of the radar targets were in fact birds. Individual birds, having a cross section approximately equivalent to that of one quart of water, would produce signal strengths consistent with those observed. (The targets observed the night of November 8th, according to calculations made by Dr. Lhermitte, yielded a radar cross section of approximately 10 cm^2.) The velocities and coherent tracks of the targets also suggested consistency with the bird hypothesis. What had apparently been overlooked initially (and for a while it fooled the experts) was that, with the fourth-power law operating, the signal strength produced by a bird close in, with radars of the great power of the FPS-16 and especially the TPQ-18, would be very large, but it would drop off extremely rapidly with increasing distance. It became apparent, from examination of the data available from the tape and the printouts, that the high signal strengths were associated with targets at close range. No attempt was made at the time of the sightings to associate ranges and signal strengths. Had someone asked, "When you get an 80 db signal, what range do you read?" the evening would probably have had a different conclusion. Operating procedures might, in the future, very well provide, when unidentified targets are causing concern, that ranges and signal strengths be related to one another.

The author is not aware of the existence of any procedure to be followed that would lead toward the prompt explanation of unidentified radar targets of an unusual nature e.g. insects, side-lobe echoes, anomalous echoes from objects on the ground, etc. In the absence of such a procedure, the operators involved in this case handled the situation reasonably, and their performance is not to be criticized.

They were all extremely helpful to Colorado Project members in tracing the causes of the evening's events.

General Conclusions

This is a remarkable series of sightings, for two reasons, first, because of the extraordinarily high qualifications of the observers, and, second, because of the availability of the hard data. There is no other UFO case in the records of the Colorado Project that contains as many numbers, representing quantities like range, azimuth, elevation, and velocity. Information, from which signal strength could have been computed, would also have been available had the operators thought to print it out, but they did not. It was necessary, to relate signal strengths and ranges for these events, to go back to the tape of the conversations and dig out the reports of signal strengths, which, when assigned precise times (fortunately, the tape contained good timing references), could be compared with the printouts of range, which also included timing references. Information on the visual sightings was, except for the high credibility of the observers, the same as in other reports of UFO sightings in the Colorado files. That is to say, there were no reliably measured quantitative values available from such sightings.

The detailed weather study, by Loren Crow, was not available at the time of the November trip to Vandenberg, and it was not known at that time that the weather conditions were in fact so unusual. The reader's attention is invited to Figure 4 in Crow's report, in which it is indicated that at VAFB, although return flow (that is, an on-shore breeze) at the surface was well established by the late afternoon of October 6th, the flow at 2,000 ft. was still from the northeast, so that there existed a narrow tongue of warm, dry air overlying the cool, moist air. This

tongue of air extended southward almost to San Nicolas Island but stopped there. At San Nicolas, there was return flow on the surface and up to 3,000 ft., but easterly flow persisted above 3,000 ft. all the way to 10,000 ft. As the chart shows, there were strong gradients of moisture and temperature at both stations. Crow has pointed out that the temperature and moisture contrasts are probably even greater than those shown, because the surface measurements were not made at the surface, but at some distance above the surface. One concludes, from study of the weather report that conditions were very favorable indeed for optical mirage and scintillation and for anomolous radar propagation.

It should be noted that the event that set off the entire sequence of events was an optical sighting at 8:00 pm. There is a strong possibility that the stimulus for this sighting was due to the running lights of a ship below the horizon, seen as a result of mirage. The conditions for such a mirage were present, but it must be pointed out that Payer and Atherton were most emphatic that the object appeared at an elevation angle of about 10°. That is too high for mirage observation of a ship's lights below the horizon. Hence, either their reports of the elevation angle are incorrect, or some other explanation must be found.

A further fact is of interest, and that is that, in the Operations Control Center on November 8th, one of the operators of a search radar indicated that he never saw any ships, that the shipping lanes were too far off the coast for ships to be seen by radar from that location, although the antenna was at an altitude of approximately 1,000 ft. He thereupon switched to his most distant range (80 miles), and immediately a sprinkling of blips appeared at extreme range. They turned out to be ships, their identity confirmed by their slow speed. Since there is no

reason to suppose, from a quick study of weather conditions on the night of November 8th, that anomolous propagation had anything to do with this observation of ships, it must be concluded that they could be seen any time. The only reasonable explanation, therefore, of the operator's statement that he never saw ships on the scope is that he never looked for them before. Payer and Atherton indicated that large ships were never seen visually from the coast off Lompoc, and that is undoubtedly correct, because they would be below the horizon. Computations show, however, that, with mirage conditions, the running lights of ships would be visible at the 80-mile range indicated by the radars.

If one is satisfied to overlook the inconsistent report of the elevation angle of the initial visual sighting (lo to 15°) and assign its cause to optical mirage, then one can say that that is what set off the ensuing chain of events. The operators of the missile tracking radars insisted that they had never, except on one or two occasions when they were also looking for UFOs, used their radars in a search mode. On those other occasions, they had seen nothing. This time, however, and subsequently on October 9th and 10th and November 8th, they saw targets. At no time did the surveillance radars pick up unidentified targets. Because of the enormous power and concentrated beam of the tracking radars, the hypothesis that some of the objects seen were birds appears consistent with all the facts that are known. Now that the weather report is available, it also would seem highly probable that <u>some</u> of the radar targets seen were due to anomolous propagation. There existed strong enough gradients to produce echoes from atmospheric discontinuities, and, together with the unusual circumstances for visual observation, the conditions were present to produce what happened - a wild evening in which literally hundreds of UFOs were observed.

As Mr. [redacted] wrote in a letter dated November 13, 1967:

> It would seem that most of the inexplicability of the events in this case (and possibly in many others) arises not from the facts themselves, (i.e., the specific sightings, etc., at any given instant) but in the interpretation made and significance attached to them when they were considered in inappropriate juxtapositions. The way in which this was done at the time under operational pressures and even subsequently provides, in my opinion, a most important object lesson.

It does indeed! The lesson is that the flap could have been avoided; the aircraft need not have been scrambled. It is unlikely they will be again at Vandenberg under those circumstances, but it could happen someplace else - unless the Vandenberg experience is communicated, through the adoption of appropriate operating procedures or in some other manner, to other operators of powerful tracking radars.

Thanks

Special appreciation is extended to John Payer for his assistance in arranging the meetings, discussions, and subsequent radar experiments that led to the probable solution of this case. He went out of his way to help.

THIS MSG SENT TO Colo Univ 17 OCT 67 — G!

Walter Meyers?

6 Oct 67

Radar-visual

183/RR

OCT 21 49z

Tentatively Birds

note: get complete weather data on VAFB on that date.
26,000 ft 6 Oct
— 23,000 ft 7 Oct

PRIORITY

Maj VAVAR

WPB187 Lt. Col. Sinsabaugh 878-1450 ex 63791

PTTEZYUW RUWJSLA9312 2862015-EEEE--RUEDFIF.

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P 132014Z OCT 67

FM HQ AFWTR VAFB CALIF

TO RUWMFVA/ADC ENT AFB COLO

RUWMDSA/27 AIRDIV ADC LUKE AFB ARIZ

RUEDFIF/FTD WPAFB OHIO

RUEFHQA/CSAF

RUEFHQA/OSAF WASHDC

18 Jan 68 Talked to Maj Vavar. He said that they didn't have all the data yet (particularly weather) when they get all the data they will send to us.

BT

UNCLAS E F T O BLUE SURF WTOOP-4 23340 OCT 1967

FOR FTD (TDETR) WPAFB: CSAF AFRDC): OSAF (SAF-OI)

SUBJECT: UFO REPORT

UFO. ON THE EVENING OF 6 OCT 1967, SEVERAL UFO SIGHTINGS WERE REPORTED BY CIVILIANS IN THE LOMPOC/VANDENBERG AREA. SUBJECT REEPORTS WERE TELEPHONED TO THE AIR FORCE WESTERN TEST RANGE (AFWTR) RANGE OPERATIONS CONTROL CENTER (ROCC). THE ROCC DUTY OFFICER CONFIRMED VISUAL SIGHTINGS ? OF UFO AND DIRECTED RANGE METRIC TRACKING RADAR SYSTEMS TO ATTEMPT ACQUISITION. FPS-16, TPQ-18 AND GERTS SYSTEMS (C BAND, K-BAND AND X-BAND RESPECTIVELY) ACQUIRED MULTIPLE SOLID TARGETS AT VARIOUS AZIMUTHS AND ELEVATIONS.

RAPID CHANGE IN BOTH ELEVATION AND AZIMUTH. IT WAS DETERMINED THAT NO KNOWN AIRCRAFT FROM ANY OF THE WEST COAST MILITARY COMMANDS WERE OPERATING IN OR ABOUT THE VANDENBERG AFB AREA. THE PACIFIC MISSILE RANGE (PMR) WAS ASKED TO BRING ANY AVAILABLE METRIC TRACKING RADAR TO BEAR IN THE VAFB AREA TO CONFIRM AFWTR RADAR CONTACTS. PMR CONFIRMED

THE PRESENCE OF MULTIPLE TARGETS IN THE VAFB AREA. THIS WAS REPORTED T
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THE 1STRAD COMMAND POST. THE 27TH AIR DIVISION OF ADC WAS ADVISED OF
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SIGHTINGS. THE ADC SCRAMBLED A TOTAL OF 3 FLIGHTS OF 2 AIRCRAFT EACH TO

AFWTR CONTROL FOR INVESTIGATION OF CONTACTS. A COMBINATION OF METRIC TRACKING AND SURVEILLANCE RADARS WERE USED FOR AIRCRAFT VECTORING TO INTERCEPT. EACH FLIGHT WAS VECTORED TO NUMEROUS STRONG RADAR TARGETS. RADAR CONTACT WAS REPORTED SEVERAL TIMES BY THE AIRCRAFT, HOWEVER TARGETS DISAPPEARED FROM THE SCOPE WHEN APPROACHING AT CLOSE RANGE. ON
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VISUAL REPORT WAS CALLED FROM THE AIRCRAFT OF FLIGHT NUMBER 2, BUT WAS

LOSTON CLOSING. SUBSEQUENT ATTEMPTS TO REACQUIRE WERE NEGATIVE.
UFO INVESTIGATION WAS TERMINATED AT 0900Z 7 OCT.
THE WEATHER WAS CLEAR AND VISIBILITY AT LEAST 12 MILES FROM THE BEGINNING TO THE TERMINATION OF THE PERIOD IN QUESTION. INVERSION CONDITIONS EXISTED THROUGHOUT THE PERIOD. ONE METRIC RADAR (TPQ-18) RECORDED LONG AND SHORT PERIODS OF TRACK OVER A 3 HOUR PERIOD.

REDUCED METRIC DATA CONFIRMED TARGETS BETWEEN 3000/7000 FEET IN ALTITUDE. ALL TARGETS WERE PREDOMINATELY IN THE WEST TO SOUTH WEST AREA (SEAWARD) WELL ABOE THE RECORDED INVERSIION CONDITIONS WITH RANGES VARYING FROM OVERHEAD THE TPQ-18 RADAR TO 65,000 FEET IN HORIZONTAL RANGE. TARGET VELOCITIES VARIED FROM 20/60 FEET/SEC. VISUAL SIGHTINGS COULD NOT BE CORRELATED WIITH RADAR TARGETS. WITH SIMILAR WEATHER CONDITIONS EXISTING ON 9 OCT, AN ATTEMPT WAS MADE TO DUPLICATE RADAR TARGET ACQUISITION EXISTING THE NIGHT OF 6 or 9? OCT 1957. THE SAME METRIC RADARS DID LOCK ON TO MULTIPLE TARGETS OF STRONG SIGNAL STRENGTH IN VARIOUS WEST QUADRANT AZIMUTHS AND ELEVATION ANGLES. NO VISUAL SIGHTINGS WERE ATTEMPTED OR REPORTED 9 OCT. PRELIMINARY ANALYSIS INDICATED METRIC TRACKING RADAR DID TRACK EXCEEDINGLY STRONG TARGETS, WHICH TARGETS ARE TENTATIVELY IDENTIFIED AS POSSIBLY BEING CAUSED BY SOME KNOWN REFRACTIVE CONDITIONS. THE VISUAL SIGHTING MAY BE RELATED TO A MIRAGE EFFECT. FURTHER RADAR TESTS, IF ANY, AND A FOLLOW-ON REPORT, INCLUDING STATEMENTS OF VISUAL SIGHTINGS WILL BE FORWARDED UNDER SEPARATE COVER.

BT

NNNN

SUMMARY OF WEATHER RELATED TO UFO SIGHTING NEAR VANDENBERG AIR FORCE BASE, CALIFORNIA

October 6, 1967

PREPARED FOR

UFO INVESTIGATION
UNIVERSITY OF COLORADO

By

LOREN W. CROW
Certified Consulting Meteorologist

April 24, 1968

Report # 64

April 24, 1968

Mr. Robert J. Low
Project Coordinator
U.F.O. Investigation
202 Woodbury Hall
University of Colorado
Boulder, Colorado 80302

Dear Bob:

The following is a summary of weather conditions surrounding UFO visual and radar sightings near Vandenberg Air Force Base between 7:30 P.M. and midnight on October 6, 1967.

SOURCES OF DATA

Radiosonde and wind data from -

Vandenberg Air Force Base, San Nicholas Island, San Diego

Surface weather observations surrounding the times of sightings from -

Santa Maria, Vandenberg AFB, Oxnard AFB, Pt. Mugu, Santa Barbara, Long Beach, Bakersfield, March AFB

GENERAL WEATHER SITUATION

In a weather sequence which moved a troughline and a low pressure center southeastward from northwestern Utah to northwest Texas between October 5 and 6, a dome of high pressure formed over the Great Basin and a surge of warm air moved from northeast to southwest across Nevada and the southern end of the San Joaquin Valley. Most of the surge of warm air moved southwestward from the southern part of the San Joaquin Valley between midnight of October 5 and 3:00 P.M. of October 6. Weather stations near the coast from Santa Maria to Long Beach all showed abnormally warm temperatures at a time of day when ordinarily a sea breeze would have created a cooling influence.

THE OVER OCEAN FLOW OF WARM DRY AIR

Using surface wind data from various coastal stations it is possible to reconstruct an approximate pattern of the forward edge of the warm, dry

air which moved out over the ocean from a general northeasterly direction. [illegible] fairly strong northeasterly winds were maintained through 11:00 A.M. (see Fig. 1) with northeast winds continuing until 3:00 P.M. at the surface at Oxnard Air Force Base.

The upper wind flow from 2000' to 7000' was still from an easterly component at San Nicholas Island shortly after 3:00 P.M. By 4:00 P.M. air was still moving from an easterly component between 3000' and 10,000' over Vandenberg AFB. Near the surface westerly winds were beginning to move the warm air back toward the east and southeast. This air had been cooled and some moisture had been added during its stay over the ocean.

Figure 2 shows the path of air motion during most of the afternoon hours as the modified air moved from the ocean back over the coastal area. Some of the strongest evidence of the bulge of warm air over the ocean is indicated by the warm, dry air that moved over Long Beach between the hours of noon and 5:00 P.M. With surface wind directions from 240° through 300°, temperatures held above 80° with maximums of 90°. A portion of the heating of this air would have been caused by dynamic heating as it moved downslope from the San Gabriel Mountains.

The abnormality of the warm air is indicated in Figure 3 by the approximate difference in air temperatures between 6:00 A.M. and 3:00 P.M. The blue profile of normal October 6 temperature was made up from long term average maximum and minimum temperatures and an assumed sea breeze influence. The red shaded area indicates the approximate abnormality of warm temperatures on this day as warm, dry air moved from land toward the ocean as compared with typical weather for October 6. The hatched area shows the abnormality remaining after the air had been modified by its path over water.

REFRACTION RESPONSE TO WARM, DRY AIR

When warm, dry air is forced to move from a land mass out over cooler water it creates a narrow boundary of mixing as moisture is picked up from the ocean developing small turbulent eddies of cooler, more moist air near the ocean surface. This is accompanied by very rapid fluctuations of refractive index. At the upper edge of the bulge of warm, dry air there would be another more diffuse boundary where somewhat less sharp differences in both temperature and moisture would be present. However, there would be corresponding fluctuations in refractive index.

The Glossary of Meteorology defines a mirage as "a refraction phenomenon wherein an image of some object is made to appear displaced from its true position. . . . . The abnormal refraction response for mirages is invariably associated with abnormal temperature distribution that yield abnormal spatial variations in the refractive index. Complex temperature distributions produce correspondingly complex mirages".

The layer of warm, dry air above cooler water from the ocean would have been particularly conducive to anomalous propagation of any radar unit scanning the atmosphere at low angles. A somewhat less important segment

of the air mass capable of producing anomalous propagation on the radar would have been the upper boundary of the bulge of warm, dry air. The following is quoted from Battan's book on RADAR METEOROLOGY under the heading of Meteorological Conditions Associated with Non-standard Refraction. "There are various ways that the index of refraction can be modified to give rise to anomalous propagation . . . . . When warm, dry air moves over cooler bodies of water, the air is cooled in the lowest layers, while at the same time moisture is added. In this way strong ducts are produced. These conditions are frequently found over the Mediterranean Sea as air blows off the African continent. Extreme anomalous propagation has been experienced in this region. For example, there have been days when centimeter radar sets have 'seen' ground targets at ranges of 400-500 miles, even though the horizon was at perhaps 20 miles. In conformance with meteorological terminology, superrefraction brought about by the movement of warm, dry air over a cool, moist surface may be called 'invective superrafraction'. By the nature of the processes involved, it can be seen that such conditions can occur during either the day or the night and last for long periods of time. The duration would depend on the persistency of the flow patterns producing the advection".

Figure 4 contains the wind and temperature profiles for San Nicholas Island and Vandenberg AFB beginning with release times of 3:15 P.M. and 4:08 P.M. PST respectively on October 6, 1967. At Vandenberg AFB (shown by the solid lines of temperature, dew point, wind direction and velocity) dry air prevailed for all levles above the surface at 4:00 P.M. (For the lowest point on the profile, surface temperatures reported at 7:30 P.M. have been substituted.) The vertical sounding of temperature, dew point, wind velocity and direction for San Nicolas Island are indicated by the dashed lines in Figure 4. Temperatures even warmer than over Vandenberg AFB were reported in the ascent above San Nicholas Island. For emphasis, the area shaded in red indicates how much warmer the temperatures were over San Nicholas Island than at Vandenberg AFB during the mid-afternoon hours. Ocean water temperatures between 58° and 59° were being reported, which is considerably cooler than the warm, dry air having temperature in the 80's as it moved from over land to over the water.

CONCLUSION

It is the author's opinion that the surge of very warm, dry air may have caused a mirage and visual observations could have been correspondingly distorted in the vicinity of Vandenberg AFB between 7:30 P.M. and 8:30 P.M. It is more certain that the air mass conditions prevailing over the water continuing through at least midnight in an arc from south of Vandenberg AFB changing eastward to the coastline could have produced anomalous propagation echoes on radar. Visibility observations were generally 12 miles or greater at all stations and no clouds were reported by the observer at Vandenberg AFB between 7:00 P.M. and midnight. Pt. Mugu reported a few stratus clouds offshore in the Remarks Column beginning at 7:00 P.M. continuing through 11:00 P.M.

The detailed observations are being retained in my files. Should they be of further use to you please let me know.

Sincerely yours,

Loren W. Crow

Loren W. Crow CCM

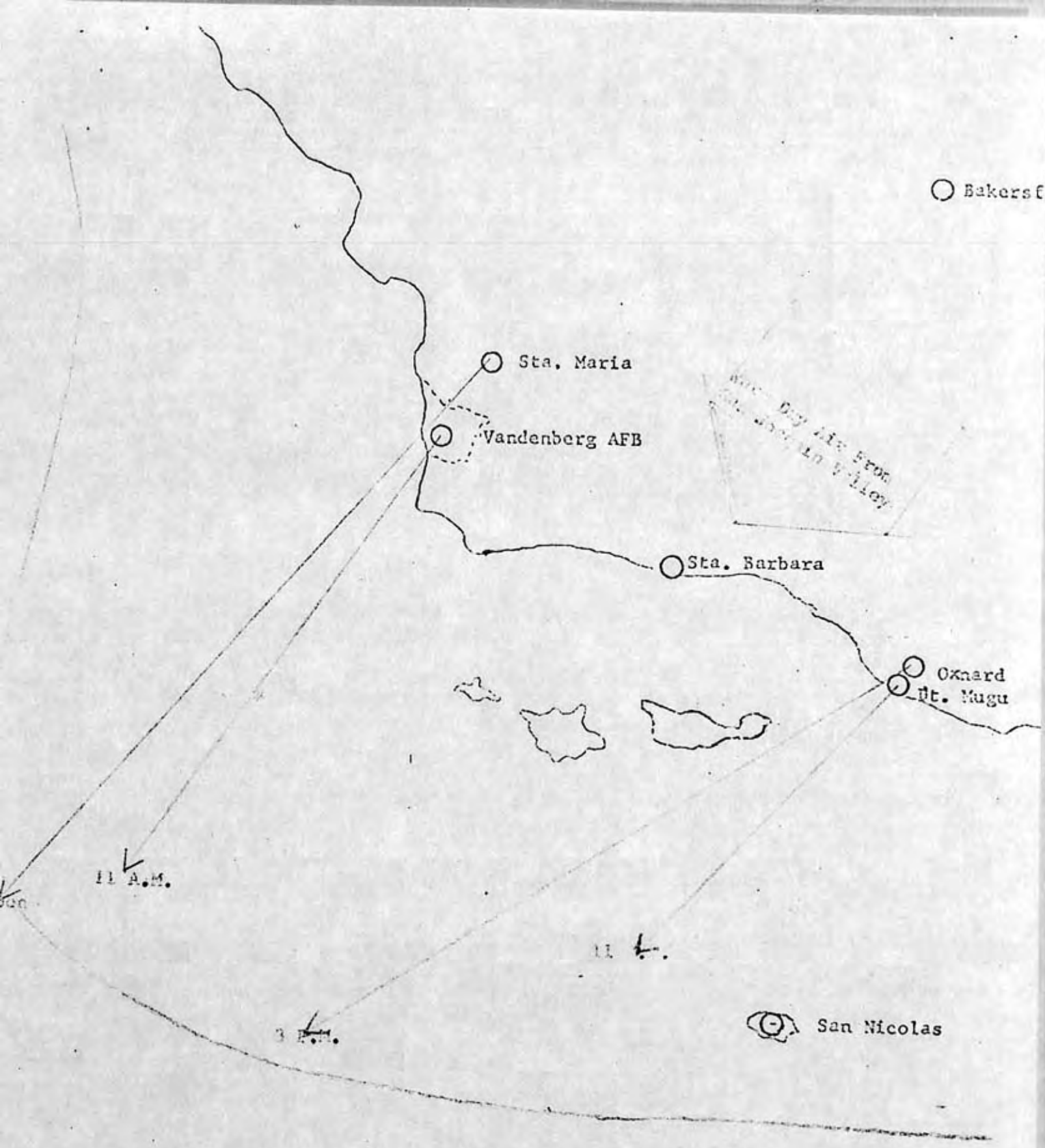


Fig. 1. Forward Edge of Warm, Dry Air Moved from Land Out Over the Ocean as Indicated by Vectors of Cumulative Hourly Wind Velocities and Direction until the End of Northeast Flow at Four Different Stations.

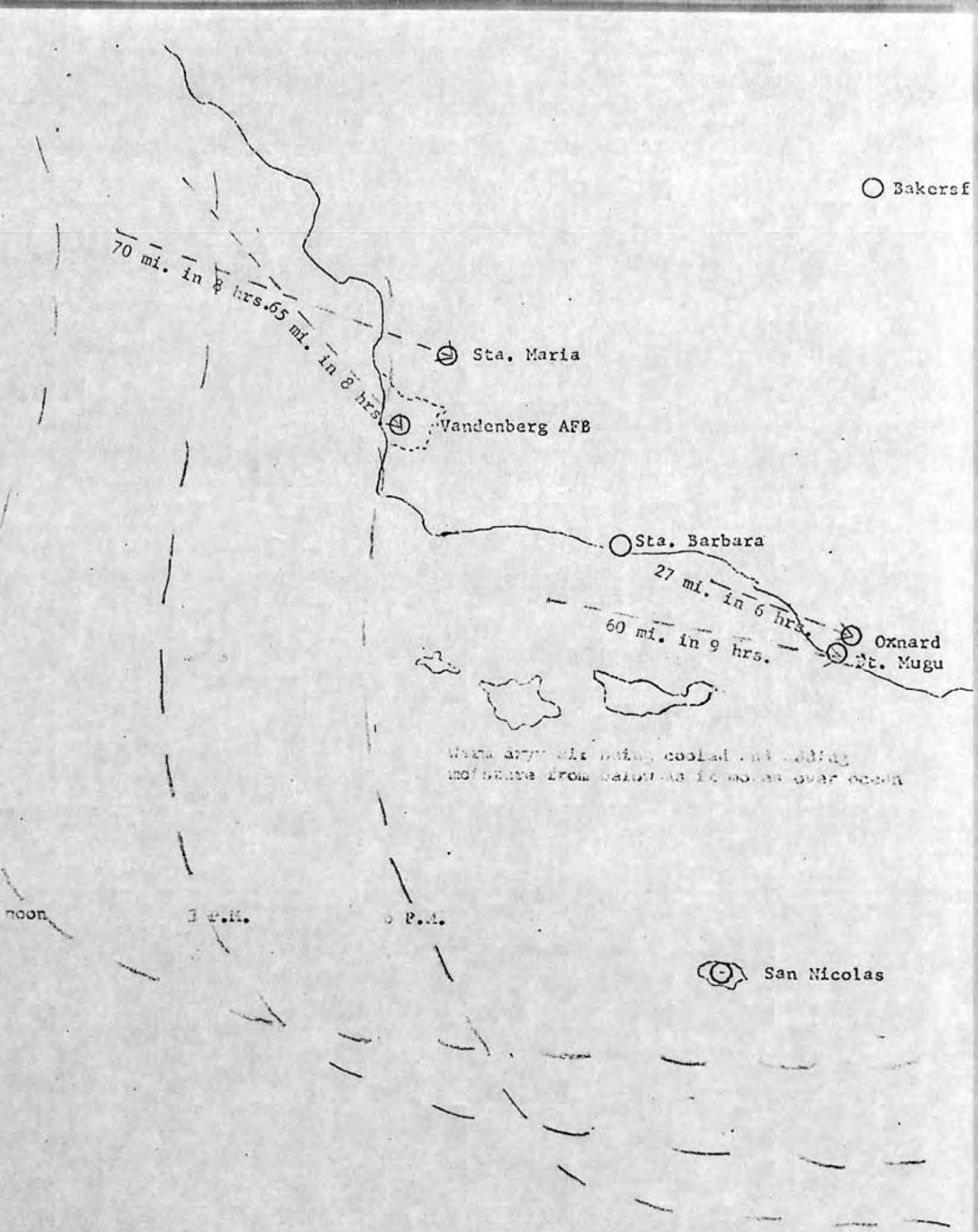
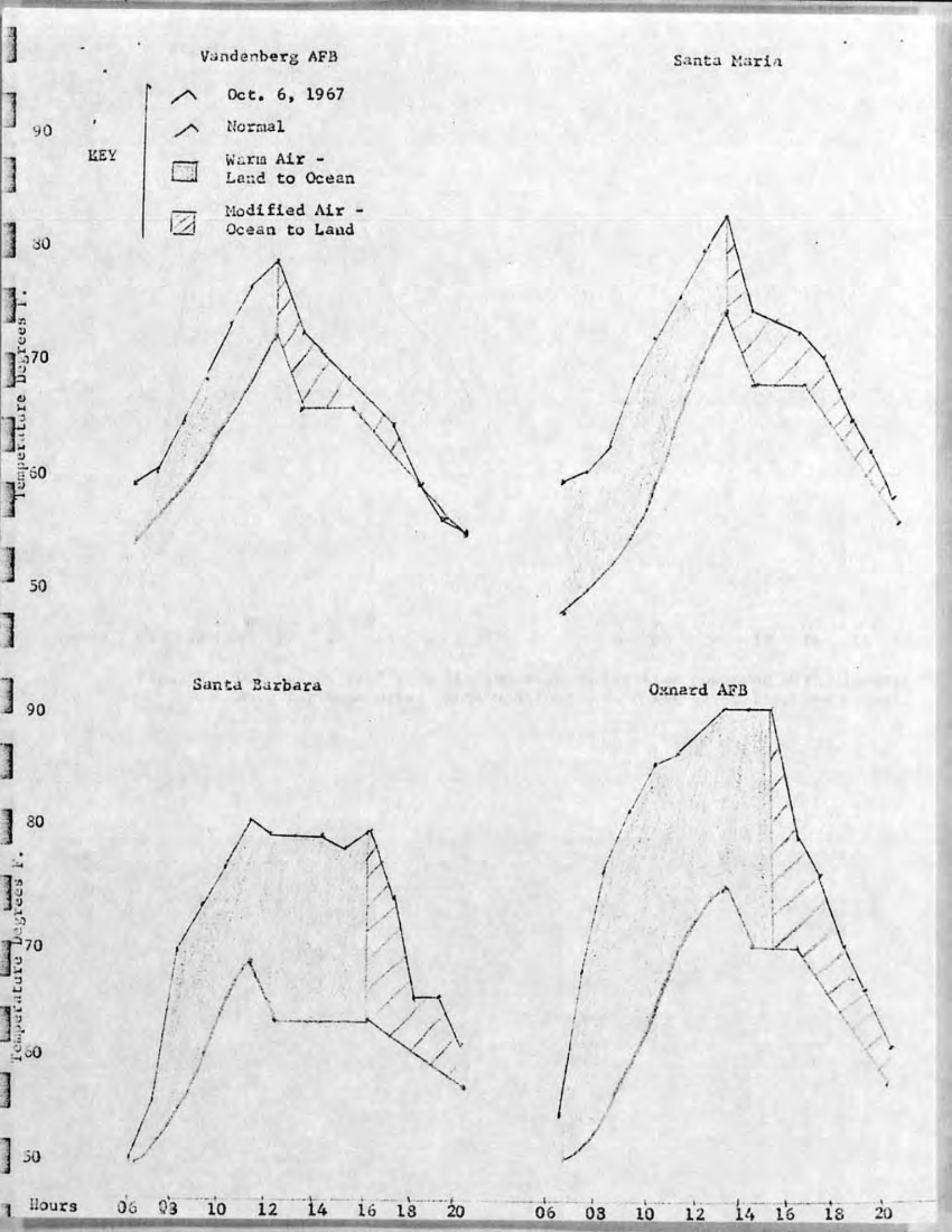


Fig. 2. Return Flow of Modified Air Arriving Over the Station From a Vector Path Between Noon And 6:00 P.M.


Vandenberg AFB
Santa Maria
Oct. 6, 1967
Normal
KEY
Warm Air - Land to Ocean
Modified Air - Ocean to Land
Temperature Degrees F.
90
80
70
60
50
Santa Barbara
Oxnard AFB
Hours
06
08
10
12
14
16
18
20

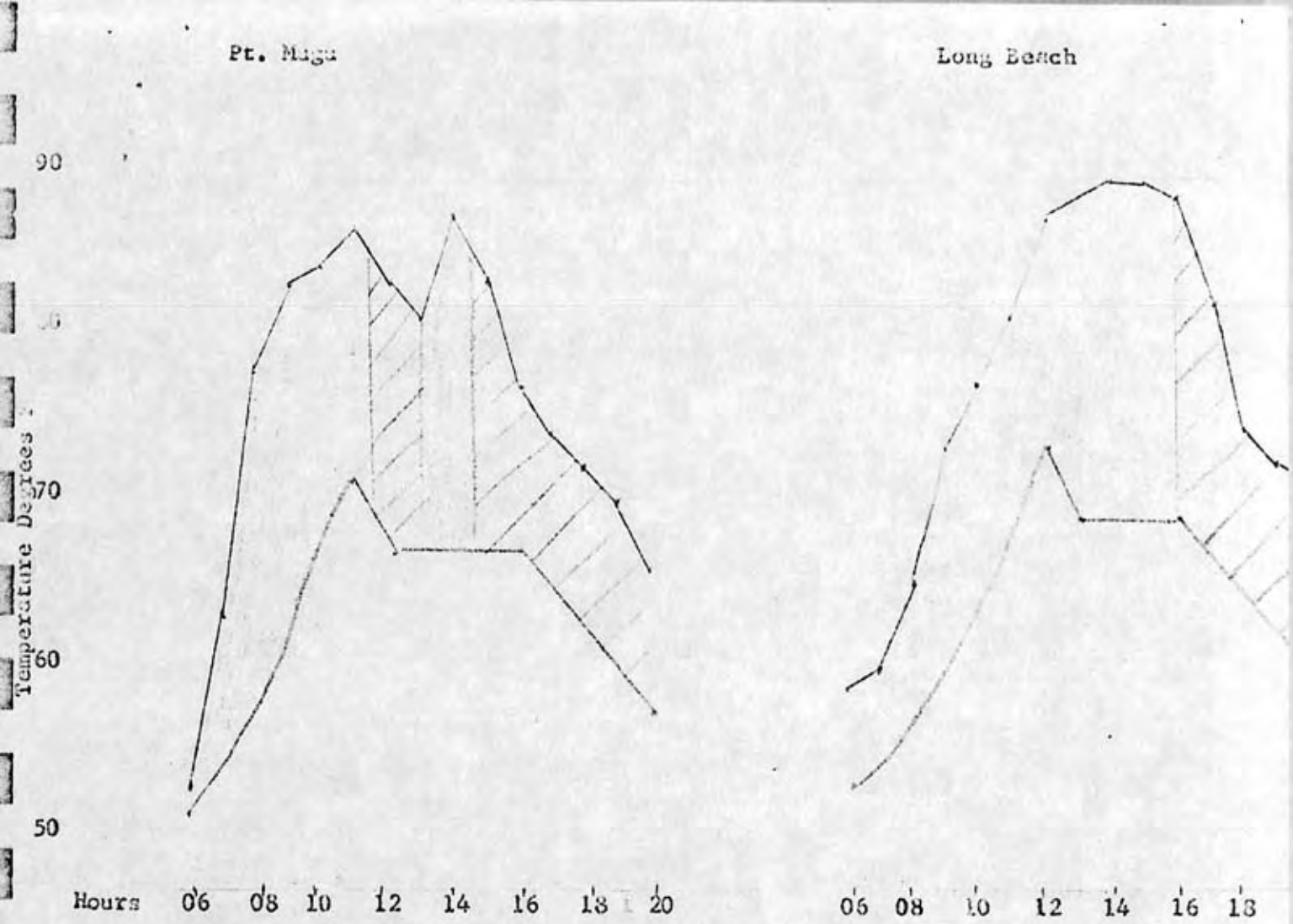


Fig. 3b. October 6, 1967 Warm Air Temperature Profiles Compared with Climatic Data for Same Date. Note Modified Return Air is Still Above Normal.

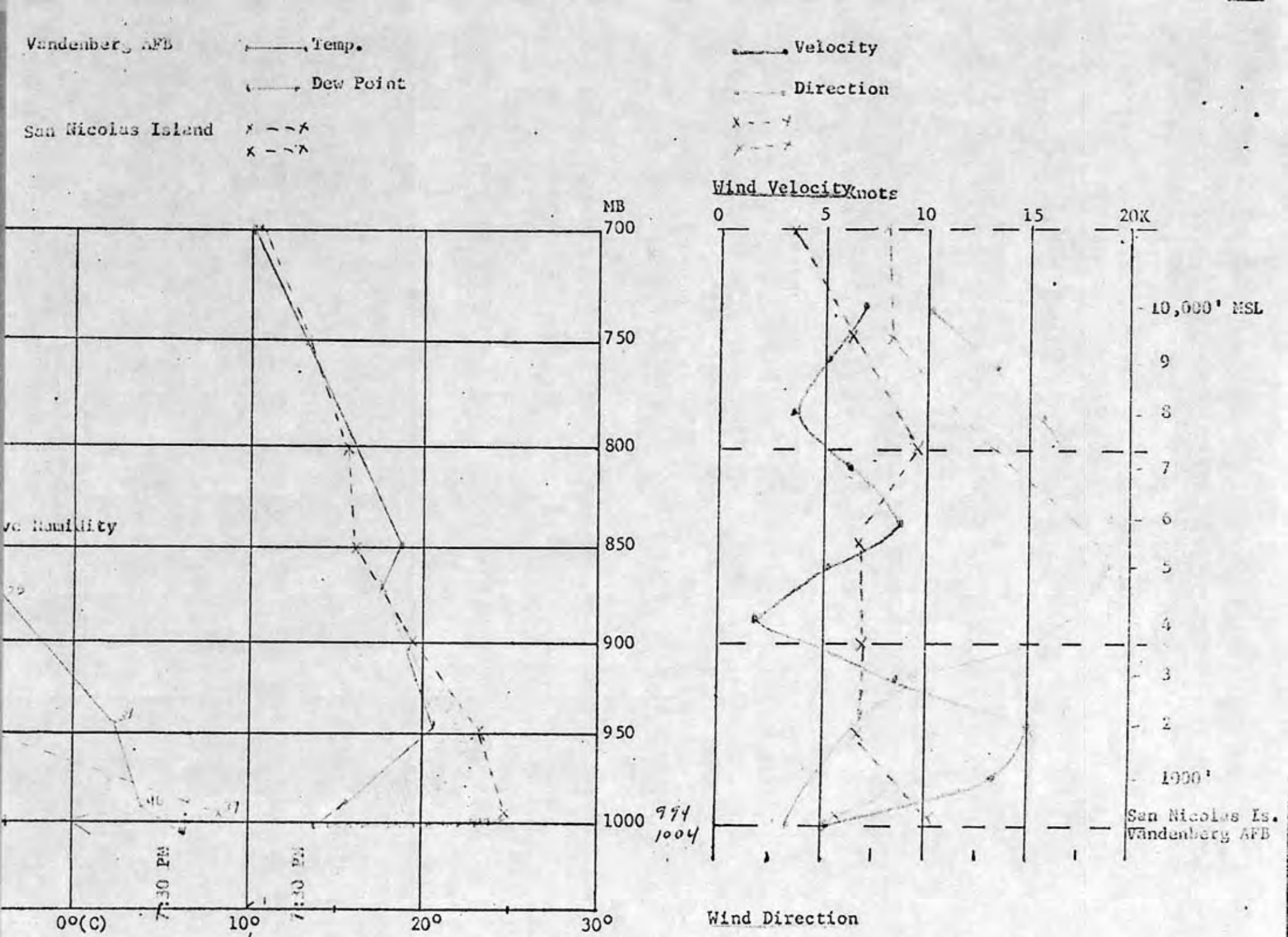


Fig. 4. Profiles of Temperature, Dew Point, Relative Humidity, Wind Direction and Velocity at Vandenberg AFB and San Nicolas Island during late Afternoon October 6, 1967.