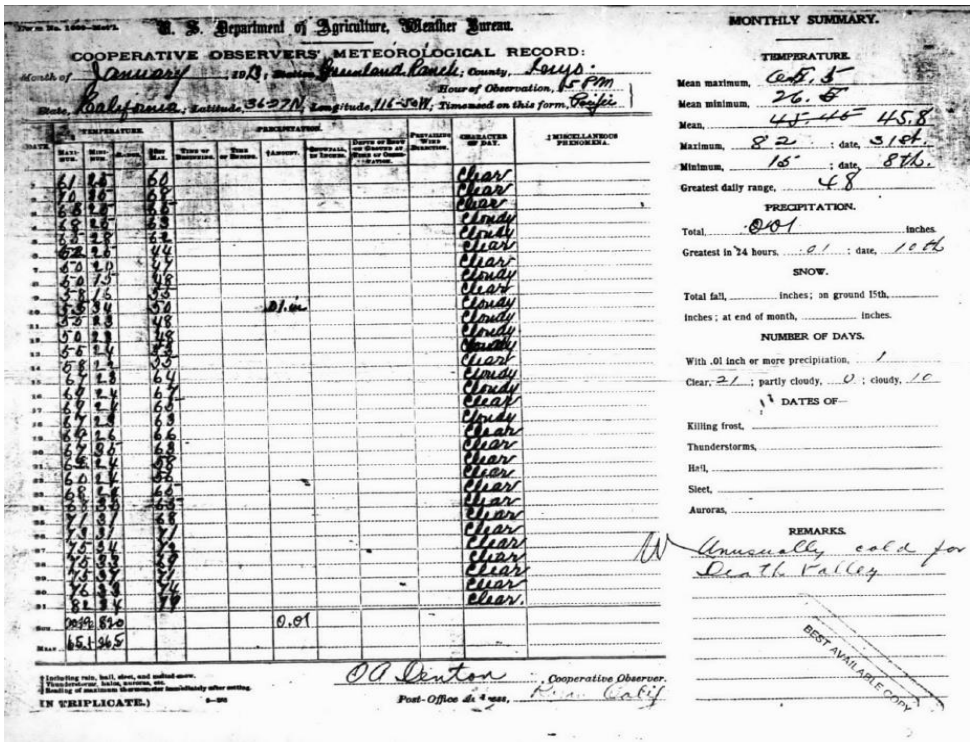
# Twelve Significant Weather Events

Below is a list of events in chronological order of significant weather events in Death Valley, California. This list is intended to capture extreme events in terms of their place in meteorology and impact on society in Death Valley. It is not intended to be all-inclusive and should be considered objective in nature.

## Arctic Outbreak of January 1913

Although only the seventh coldest month ever recorded in Death Valley based on average temperature, January 1913 still holds the record for the coldest low temperature ever recorded here. A total of 18 days saw a low temperature of 25 degrees or lower which is an all-time record for any month. The average low of 26.6 degrees in January 1913 is 1.5 degrees colder than the next coldest average low temperature for January which was in 1919. Only 7 days in January 1913 did not see the temperature fall to freezing or below. While the high temperatures in January 1913 were cool by Death Valley standards, the coldest high of the month was 50 degrees recorded on both January 7$^{th}$ and January 8$^{th}$.

The lowest reading of January 1913 came on the morning of January 8$^{th}$ when the temperature dropped to 15 degrees. This set the record for the coldest low temperature ever at Death Valley. Surface weather maps show a 1030 mb high centered near the Four Corners region that morning. The character of the day was described as cloudy by the observer, which is interesting given that extremely cold readings are usually obtained under clear conditions at Death Valley or any location. Even though official weather observations had only been recorded for roughly a year and a half, the observer made a remark on that month's observations that the weather during January 1913 was "unusually cold" for this area.



U. S. Department of Agriculture, Weather Bureau.

COOPERATIVE OBSERVERS' METEOROLOGICAL RECORD:

Month of January; 1913; State, California; County, Inyo; Station, Furnace Creek; Hour of Observation, 5 PM; Latitude, 36.27 N; Longitude, 116.52 W; Timezone on this form, Pacific

MONTHLY SUMMARY.

TEMPERATURE.
Mean maximum, 66.5
Mean minimum, 26.6
Mean, 45.46 45.8
Maximum, 82 ; date, 31st.
Minimum, 18 ; date, 8th.
Greatest daily range, 48

PRECIPITATION.
Total, .001 inches.
Greatest in 24 hours, .01 ; date, 10th

SNOW.
Total fall, inches; on ground 15th, inches; at end of month, inches.

NUMBER OF DAYS.
With .01 inch or more precipitation, 1
Clear, 21 ; partly cloudy, 0 ; cloudy, 10

DATES OF—
Killing frost,
Thunderstorms,
Hail,
Sleet,
Auroras,

REMARKS.
Unusually cold for Death Valley

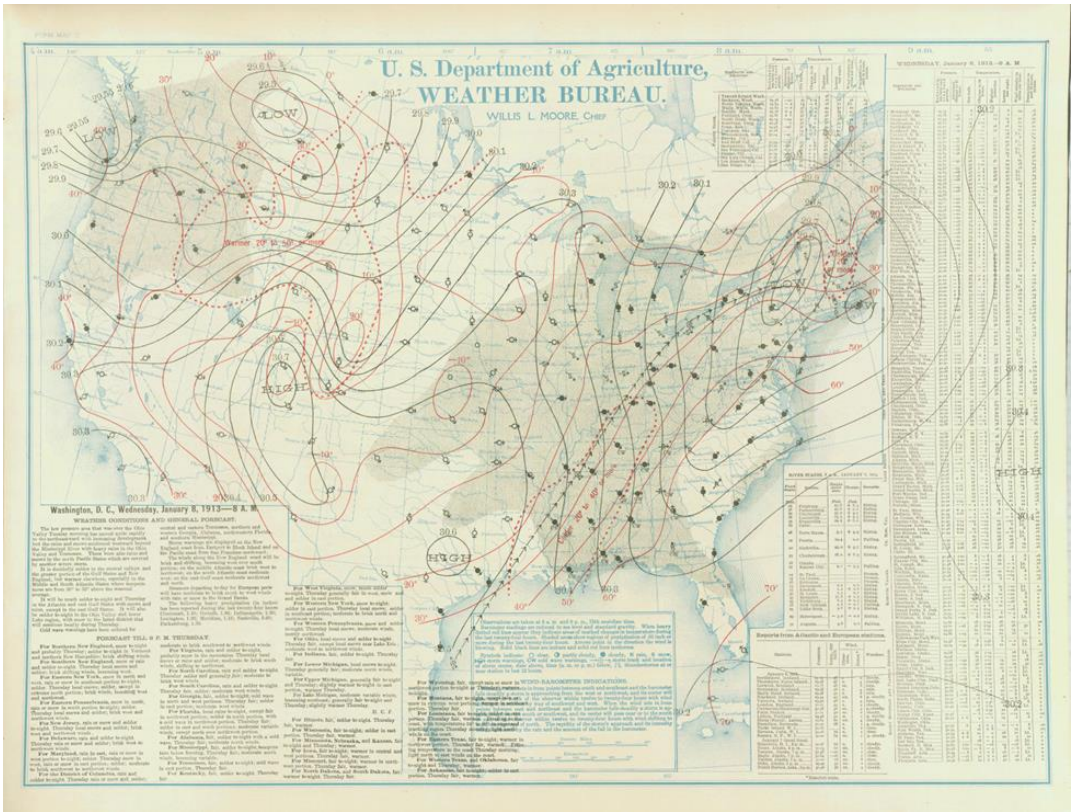
| DATE | TEMPERATURE 7 A.M. | TEMPERATURE 5 P.M. | TEMPERATURE Max. | PRECIPITATION Amount | CHARACTER OF DAY |
|---|---|---|---|---|---|
| 1 | 61 | 28 | 60 | | Clear |
| 2 | 70 | 36 | 69 | | Clear |
| 3 | 68 | 29 | 66 | | Clear |
| 4 | 69 | 26 | 69 | | Cloudy |
| 5 | 53 | 28 | 62 | | Cloudy |
| 6 | 62 | 26 | 44 | | Clear |
| 7 | 60 | 20 | 67 | | Clear |
| 8 | 60 | 35 | 48 | | Cloudy |
| 9 | 58 | 26 | 55 | | Clear |
| 10 | 53 | 34 | 50 | .01 | Cloudy |
| 11 | 52 | 33 | 48 | | Cloudy |
| 12 | 50 | 29 | 48 | | Cloudy |
| 13 | 56 | 24 | 53 | | Cloudy |
| 14 | 58 | 24 | 55 | | Clear |
| 15 | 67 | 28 | 64 | | Cloudy |
| 16 | 69 | 24 | 67 | | Cloudy |
| 17 | 69 | 24 | 66 | | Clear |
| 18 | 67 | 28 | 69 | | Cloudy |
| 19 | 66 | 26 | 66 | | Clear |
| 20 | 67 | 30 | 68 | | Clear |
| 21 | 65 | 24 | 68 | | Clear |
| 22 | 60 | 24 | 58 | | Clear |
| 23 | 68 | 26 | 66 | | Clear |
| 24 | 63 | 30 | 65 | | Clear |
| 25 | 47 | 37 | 48 | | Clear |
| 26 | 49 | 37 | 47 | | Clear |
| 27 | 45 | 34 | 44 | | Clear |
| 28 | 46 | 33 | 47 | | Clear |
| 29 | 46 | 37 | 47 | | Clear |
| 30 | 46 | 33 | 44 | | Clear |
| 31 | 42 | 34 | 44 | | Clear |
| Sum | 1849 | 890 | | 0.01 | |
| Mean | 65.1 | 28.5 | | | |

O O Denton, Cooperative Observer.
Post-Office Furnace Creek, Calif.

IN TRIPLICATE.)

BEST AVAILABLE COPY

Observer's record of weather observations from Death Valley in January 1913 showing the coldest temperature ever recorded here.




U.S. Daily Weather Map for January 8, 1913 showing an area of surface high pressure near the Four Corners Region which helped bring extremely cold air to the southwest United States.

## Hottest Temperature Ever – July 10, 1913

Death Valley holds the distinction of having both the lowest and hottest temperature ever recorded here being set in the same year. Unlike the record cold of January 1913 which set records throughout California – the July 1913 event was not noted for being a large scale regional heat spell. This reading at the time was the highest known air temperature ever recorded in a properly sighted and maintained instrument shelter. On September 13, 1922 a temperature of 136 degrees was recorded at El Azizia, Libya. This was eventually certified by the World Meteorological Organization as the hottest air temperature ever recorded on Earth. However, evidence about the 136 degree reading suggested that it was invalid. On September 12, 2012 the World Meteorological Organization officially re-certified the 134 degrees reading at the Greenland Ranch as the all-time highest air temperature recorded on the planet (http://www.wmo.int/pages/mediacentre/press_releases/pr_956_en.html).

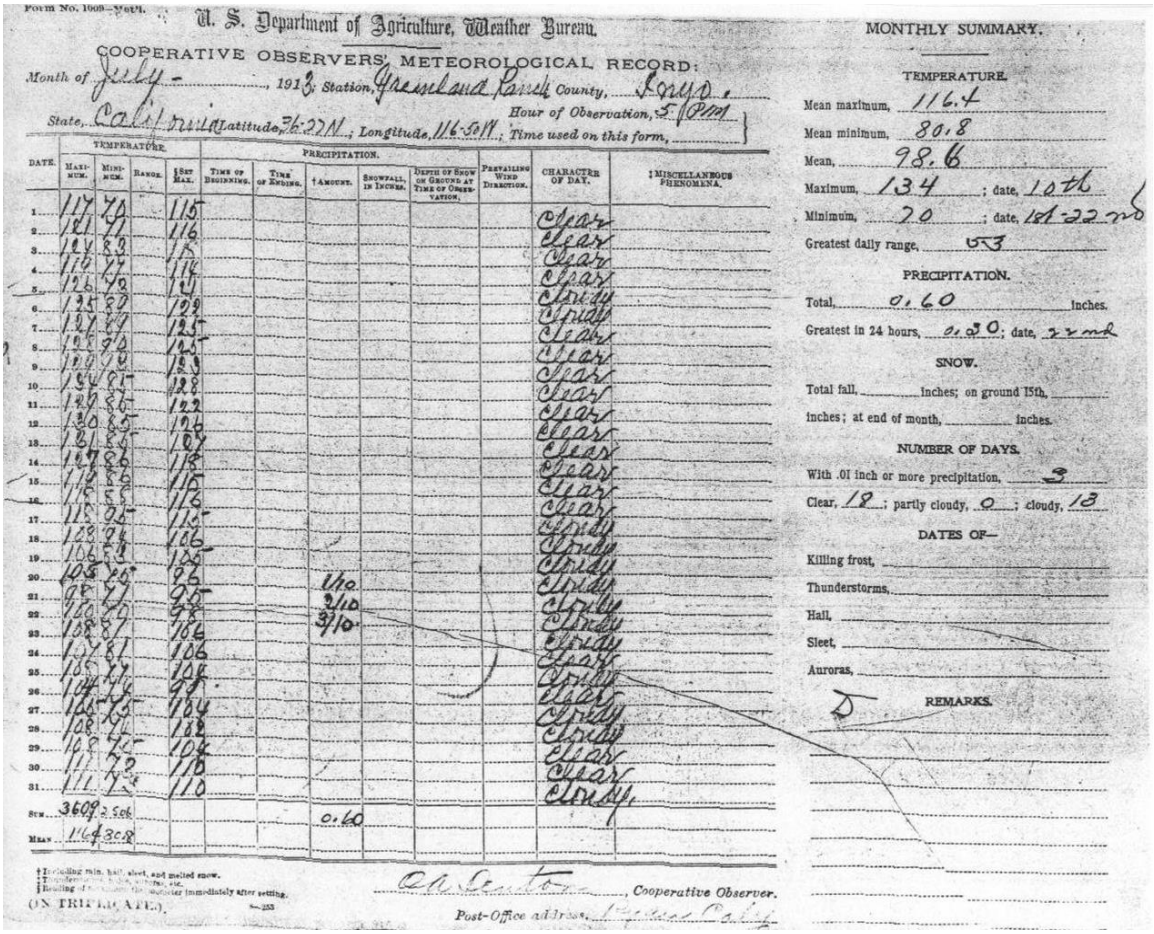
The morning surface weather map shows high pressure centered over western Oregon as well as in the Four Corners region with a thermal trough set up near the California coast. Remarks from the observer at Greenland Ranch gave the character of the day as clear.

Unlike most intense heat waves in Death Valley, a large diurnal range in temperatures occurred during this event. The low of 85 degrees that morning represents a 49 degree diurnal temperature spread. This is incredibly large for Death Valley, even in earlier times. More intense heat waves in modern times have usually seen lows of 95 degrees or hotter recorded on the day the hottest high temperature occurred. The low of 85 degrees would tie for the 30$^{th}$ coldest low temperature ever recorded on July 10$^{th}$ in the period of record from 1911 through 2011.

Why it got so hot in Death Valley on July 10, 1913 is somewhat difficult to determine because the observation was recorded well before the era of upper air observations as well as satellite data that can better gauge the pattern in the atmosphere. In addition, the observation network in those days was very sparse which would makes determining any mesoscale impacts difficult to determine. Although no remark of the weather was made on the observer's form from July 1913, details provided in a letter from F.W. Corkill on July 6, 1915 who was the mill superintendent then for the Pacific Borax Company give some additional details on the weather that day remarking about strong winds. One theory proposed in 1949 by Arnold Court was that the extreme heat experienced in Death Valley that day was generated by superheated sand picked that was up by the wind and blown inside the instrument shelter causing the temperature to spike (Court 1949). Increasing winds in the afternoon associated with the increased heating of the day and the typical flow of air towards the lower pressure associated with the thermal low over the deserts of southern California are common in the summer months. Typically these winds do not exceed 25 mph

at lower elevations away from terrain funneling. Personal experience forecasting in the Mojave Desert has shown that winds of 35 to 40 mph or greater are usually needed to loft large quantities of dust and sand which likely could have been caused by some sort of small scale weather feature, such as a favorable pressure gradient, on this date in Death Valley.

Further documentation also shows no issues noted during this time with the equipment at the station. However, when the observer did mail his form into the Weather Bureau a note was attached whether the 134 degree reading was high enough as the thermometer only could read to 135 degrees and other thermometers that day at the Greenland Ranch read much higher (Willson 1915). While the monthly climatological report for July 1913 for California initially did not include the monthly report from Greenland Ranch, the annual report for 1913 later published did include this value along with a remark that the 134 degree high was “believed to be the highest temperature ever recorded in the United States”.



Form No. 1008—Wea'l.

U. S. Department of Agriculture, Weather Bureau.

COOPERATIVE OBSERVERS' METEOROLOGICAL RECORD.

Month of July, 1913; Station, Greenland Ranch; County, Inyo; State, California; Latitude, 36.22 N.; Longitude, 116.50 W.; Hour of Observation, 5 PM; Time used on this form,

| DATE. | TEMPERATURE. MAXIMUM. | TEMPERATURE. MINIMUM. | TEMPERATURE. RANGE. | TEMPERATURE. †SET MAX. | PRECIPITATION. TIME OF BEGINNING. | PRECIPITATION. TIME OF ENDING. | PRECIPITATION. †AMOUNT. | PRECIPITATION. SNOWFALL IN INCHES. | PRECIPITATION. DEPTH OF SNOW ON GROUND AT TIME OF OBSERVATION. | PREVAILING WIND DIRECTION. | CHARACTER OF DAY. | ‡MISCELLANEOUS PHENOMENA. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 117 | 79 | | 115 | | | | | | | Clear | |
| 2 | 121 | 71 | | 116 | | | | | | | Clear | |
| 3 | 124 | 83 | | 118 | | | | | | | Clear | |
| 4 | 116 | 77 | | 114 | | | | | | | Clear | |
| 5 | 126 | 78 | | 124 | | | | | | | Cloudy | |
| 6 | 125 | 80 | | 122 | | | | | | | Cloudy | |
| 7 | 124 | 80 | | 123 | | | | | | | Clear | |
| 8 | 122 | 76 | | 125 | | | | | | | Clear | |
| 9 | 120 | 76 | | 120 | | | | | | | Clear | |
| 10 | 124 | 81 | | 122 | | | | | | | Clear | |
| 11 | 122 | 80 | | 122 | | | | | | | Clear | |
| 12 | 120 | 85 | | 126 | | | | | | | Clear | |
| 13 | 121 | 84 | | 124 | | | | | | | Clear | |
| 14 | 124 | 86 | | 118 | | | | | | | Clear | |
| 15 | 118 | 86 | | 116 | | | | | | | Clear | |
| 16 | 116 | 55 | | 120 | | | | | | | Clear | |
| 17 | 115 | 84 | | 115 | | | | | | | Cloudy | |
| 18 | 128 | 96 | | 106 | | | | | | | Cloudy | |
| 19 | 106 | 83 | | 124 | | | | | | | Cloudy | |
| 20 | 108 | 80 | | 96 | | | 1/10 | | | | Cloudy | |
| 21 | 98 | 77 | | 95 | | | 2/10 | | | | Cloudy | |
| 22 | 100 | 80 | | 98 | | | 3/10 | | | | Cloudy | |
| 23 | 108 | 81 | | 106 | | | | | | | Cloudy | |
| 24 | 107 | 81 | | 106 | | | | | | | Clear | |
| 25 | 105 | 77 | | 104 | | | | | | | Cloudy | |
| 26 | 104 | 76 | | 98 | | | | | | | Clear | |
| 27 | 126 | 75 | | 104 | | | | | | | Cloudy | |
| 28 | 108 | 76 | | 102 | | | | | | | Cloudy | |
| 29 | 109 | 76 | | 104 | | | | | | | Clear | |
| 30 | 111 | 79 | | 110 | | | | | | | Clear | |
| 31 | 111 | 78 | | 110 | | | | | | | Cloudy | |
| Sum. | 3609 | 2506 | | | | | 0.60 | | | | | |
| Mean | 116.4 | 80.8 | | | | | | | | | | |

†Including rain, hail, sleet, and melted snow.
‡Reading of thermometer immediately after setting.

(ON TRIPLICATE.) No. 253

A. Lentow, Cooperative Observer.

Post-Office address, Keeler, Cal.

MONTHLY SUMMARY.

TEMPERATURE.

Mean maximum, 116.4

Mean minimum, 80.8

Mean, 98.6

Maximum, 134; date, 10th

Minimum, 70; date, 1st-22nd

Greatest daily range, 53

PRECIPITATION.

Total, 0.60 inches.

Greatest in 24 hours, 0.30; date, 22nd

SNOW.

Total fall, inches; on ground 15th, inches; at end of month, inches.

NUMBER OF DAYS.

With .01 inch or more precipitation, 3

Clear, 18; partly cloudy, 0; cloudy, 13

DATES OF—

Killing frost,

Thunderstorms,

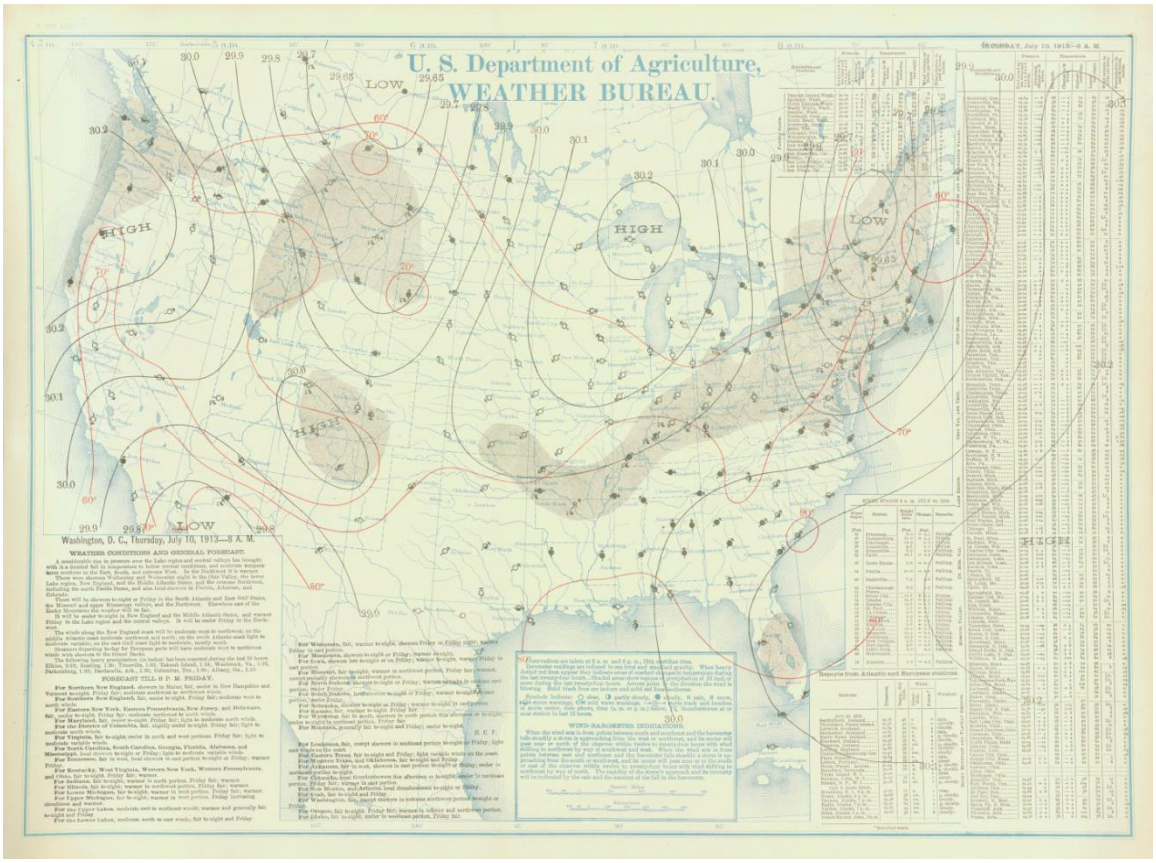
Hail,

Sleet,

Auroras,

REMARKS.

Cooperative observer weather record from July 1913 for Death Valley showing the hottest temperature ever recorded here of 134 degrees.




U.S. Daily Weather Map for July 10, 1913 on the date Death Valley set an all-time record high temperature. Two areas of high pressure at the surface are shown on this map – one in western Oregon and another near the Four Corners region.

July 6, 1915.

Mr. C. R. Dudley,
Pacific Coast Borax Co.,
Oakland, Calif.

Dear Sir:-

Replying to your favor of recent date relative to the hygrograph and thermometers at Greenland Ranch, will advise that the hygrograph at the present writing is recording a little high. I check this machine whenever I go to the Valley but since the mill was started at this point I have been unable to go out there very often. I have tried to show Mr. Denton how to check the machine with a sling psychrometer but it is a little out of his line, and after taking the wet and dry bulb readings he cannot figure from the tables the correct readings, and consequently we cannot keep the machine recording as accurately as it should be; in other words, it is not checked often enough. The thermometers seldom get out of order so the Weather Reports could be considered accurate.

Regarding the temperature of 134 deg. which was recorded July 10, 1913, will state that this record should be considered correct, for I remember the day very distinctly as a man by the name of Busch perished in the Valley that day, north of the Ranch, on account of the heat. We have no weather vane at the Ranch so I do not know in which direction the wind was blowing on that day, but it was blowing very hard in either a northerly or southerly direction. The chauffeur who was with Mr. Busch at the time he perished very nearly lost his life also. I saw him a few days later and he said that a terrific wind prevailed in the Valley on that day. The humidity records are undoubtedly on file in the Oakland office for they were always sent to Mr. Lockeas soon as they were received by me. The July charts probably would give Mr. Willson some information in case he wanted to refer back to that date.

I was out to Greenland Ranch on the 11th of July and the temperature then was 129, and I did not doubt for a minute that it was up to 134 the previous day.

I have not been out to the Ranch for three months and consequently the hygrograph has not been checked for that length of time. I have not sent the records to Oakland for the reason that they were not correct. However if you would



care to have them anyhow I will be pleased to forward them to you.

If possible I am going to make a trip to the Ranch within the next week or so and will endeavor to get the machine working accurately again.

I am under the impression that this machine should be sent in for a general overhauling as it has not been cleaned since it was taken out to the Ranch, or for about three years; and at least the clock should be cleaned and oiled by someone who understands the machine.

I am sending a copy of this letter to Mr. Willson and should he desire any other information about the instruments or weather conditions we will only be too glad to tell him all we know about them or to assist him in any other way that we can.

Yours very truly,

PACIFIC COAST BORAX CO.,

By F. W. Corkill
Mill Supt.

FWC/p
cc/ Mr. Willson,
cc/ Mr. Ryan.

Original letter from F.W. Corkill stating his recollection of the weather on July 10, 1913 when Death Valley set an all-time record high (National Weather Service Las Vegas archives).

3312 Greenland Ranch
July 30 '15

July 30,1915

Mr.C.R.Dudley,
Pacific Borax Co.,
Oakland,Cal.

Dear Sir:

I beg to acknowledge the receipt of the copy of a letter you received from Mr.F.W.Corkill dated July 6,1915,relative to the high temperatures at Greenland Ranch in July 1913 and the condition of your hygrograph. The delay in acknowledging the receipt of this letter was due to my departure on leave of absence when it reached this office.

The information furnished by Mr.Corkill is highly appreciated,as is also your kind efforts in securing it.

There is no question about your hygrograph being greatly in error. If you have this instrument returned to you at any time and desire it,we will be glad to test and adjust it,and give you any other assistance possible along these lines.

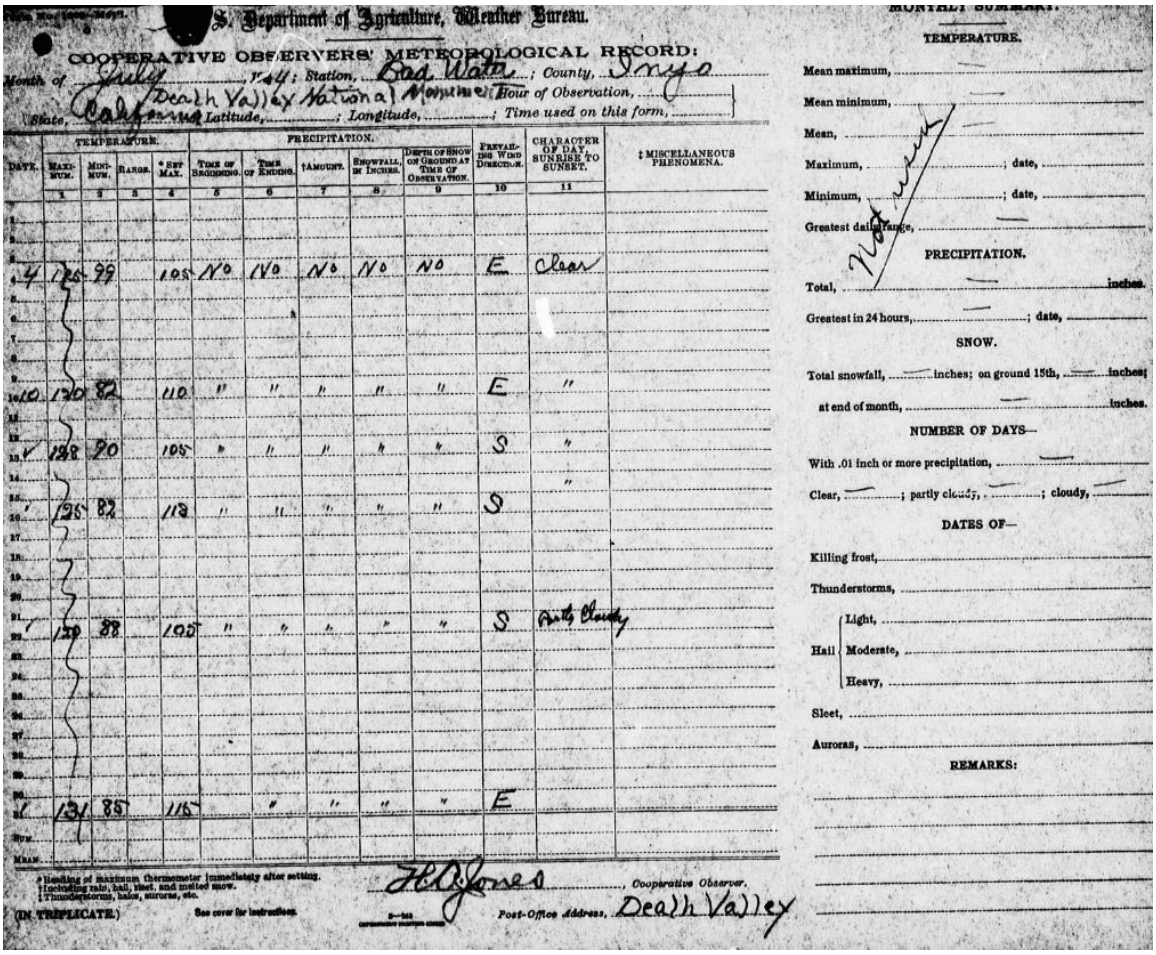
I do not think there is the slightest doubt but we have established a worlds record for high temperature at Greenland Ranch.

Very truly yours,

District Forecaster.

Copy of the letter sent to the Pacific Borax Company in July 1915 from the U.S. Weather Bureau District Forecaster acknowledging receipt of the letter describing in detail the weather in Death Valley on July 10, 1913 (National Weather Service Las Vegas archives).

In 1934, the United States Weather Bureau attempted to establish a weather station at Badwater Basin which is the lowest elevation in Death Valley. Although rangers from the National Park Service were not stationed in the immediate area, they agreed to travel to the site when possible to take weather readings. Observations were collected between May and September of that year before this station was closed due to the difficulty in collecting observations. These observations were never published by the Weather Bureau at the time. However, an inspection of these forms shows a high temperature of 131 degrees listed on the observation collected on July 31st which lasted for a 9 day period. During this time, the highest temperature recorded at Greenland Ranch was 125 degrees on the 27th. This is the only other known instance of a temperature reaching 130 degrees or higher somewhere in Death Valley at an official weather station.



U. S. Department of Agriculture, Weather Bureau.

COOPERATIVE OBSERVERS' METEOROLOGICAL RECORD:

Month of July 1934; Station, Bad Water; County, Inyo

State, California Latitude, ; Longitude, ; Time used on this form, Death Valley National Monument Hour of Observation,

| DATE. | TEMPERATURE. Maximum. | Minimum. | Range. | * Set Max. | PRECIPITATION. Time of Beginning. | Time of Ending. | †Amount. | Snowfall, in Inches. | Depth of Snow on Ground at Time of Observation. | Prevailing Wind Direction. | Character of Day, Sunrise to Sunset. | ‡ Miscellaneous Phenomena. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | | | | | | | | | | | | |
| 2 | | | | | | | | | | | | |
| 3 | | | | | | | | | | | | |
| 4 | 125 | 79 | | 105 | N0 | N0 | N0 | N0 | N0 | E | Clear | |
| 5 | | | | | | | | | | | | |
| 6 | | | | | | | | | | | | |
| 7 | | | | | | | | | | | | |
| 8 | | | | | | | | | | | | |
| 9 | | | | | | | | | | | | |
| 10 | 130 | 82 | | 110 | " | " | " | " | " | E | " | |
| 11 | | | | | | | | | | | | |
| 12 | | | | | | | | | | | | |
| 13 | 128 | 80 | | 105 | " | " | " | " | " | S | " | |
| 14 | | | | | | | | | | | " | |
| 15 | | | | | | | | | | | | |
| 16 | 125 | 82 | | 113 | " | " | " | " | " | S | | |
| 17 | | | | | | | | | | | | |
| 18 | | | | | | | | | | | | |
| 19 | | | | | | | | | | | | |
| 20 | | | | | | | | | | | | |
| 21 | | | | | | | | | | | | |
| 22 | 129 | 88 | | 105 | " | " | " | " | " | S | Partly Cloudy | |
| 23 | | | | | | | | | | | | |
| 24 | | | | | | | | | | | | |
| 25 | | | | | | | | | | | | |
| 26 | | | | | | | | | | | | |
| 27 | | | | | | | | | | | | |
| 28 | | | | | | | | | | | | |
| 29 | | | | | | | | | | | | |
| 30 | | | | | | | | | | | | |
| 31 | 131 | 85 | | 116 | " | " | " | " | " | E | | |
| SUM. | | | | | | | | | | | | |
| MEAN. | | | | | | | | | | | | |

MONTHLY SUMMARY.

TEMPERATURE.

Mean maximum,

Mean minimum,

Mean,

Maximum, ; date,

Minimum, ; date,

Greatest daily range,

PRECIPITATION.

Total, inches.

Greatest in 24 hours, ; date,

SNOW.

Total snowfall, inches; on ground 15th, inches; at end of month, inches.

NUMBER OF DAYS—

With .01 inch or more precipitation,

Clear, ; partly cloudy, ; cloudy,

DATES OF—

Killing frost,

Thunderstorms,

Hail { Light, Moderate, Heavy,

Sleet,

Auroras,

REMARKS:

Not much

* Reading of maximum thermometer immediately after setting.
† Including rain, hail, sleet, and melted snow.
‡ Thunderstorms, halos, auroras, etc.

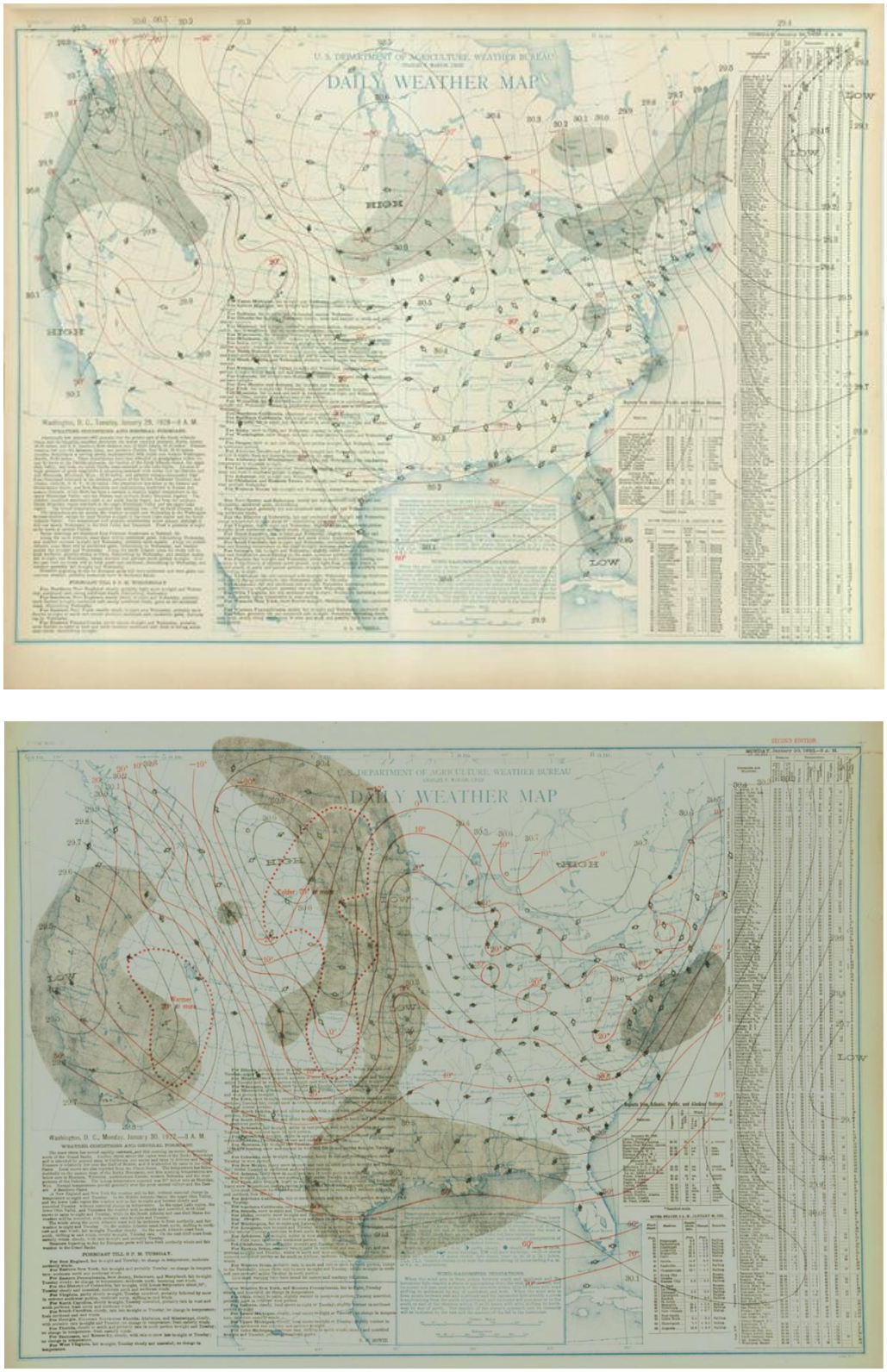
(IN TRIPLICATE.) See cover for instructions.

H. D. Jones, Cooperative Observer.

Post-Office address, Death Valley

The only other known documented instance of an air temperature on official weather equipment reaching above 130 degrees in Death Valley was recorded at Badwater in July 1934.

## Only Measurable Snow – January 29, 1922




Daily weather maps from January 29, 1922 (top) and January 30, 1922 (bottom) showing a storm system moving into the Western United States.

Although there are six dates where snow has been observed in Death Valley at the official weather stations at Greenland Ranch and Furnace Creek, measurable snow has occurred on only one of these. This was on January 29, 1922 when a half an inch of snow was measured at Greenland Ranch. The observation form gives no information as to what time the snow fell at. Daily weather maps produced by the Weather Bureau from the continental United States show an area of low pressure had moved ashore in northern California by the morning of January 30th. In nearby Goldfield, Nevada a remark from the cooperative observer there states that snow began falling at 12:30 AM on January 29th. Oddly enough, temperatures during this time period in Death Valley were shown to be above freezing. The morning low on the 29th was reported to be 36 degrees and the afternoon high was 65 degrees. Therefore snow most likely fell on the 29th in the early morning hours. Even though temperatures were above freezing, dry low levels in the atmosphere could have likely contributed to some sort of evaporative cooling process which would have allowed the precipitation to fall as snow. Evaporative cooling aiding in precipitation falling as snow has been fairly well documented in snow events in nearby Las Vegas, Nevada especially in December 2003 (Czyzyk 2004) and December 2008 (Stachelski 2008).

The January 29-30, 1922 storm did produce snow at low elevations across a large portion of the Mojave Desert and southern Great Basin which fully supports the observation of accumulating snow at Death Valley. Totals from cooperative weather observers nearby during this event included in 2.5 inches at Trona, California: 2.5 inches and in Nevada: 6 inches at Beatty, 5 inches at Alamo, 4 inches at Goldfield, 1.2 inches on Fremont Street in Las Vegas, 0.5 inch at Logandale and a trace at Searchlight. Snow was also reported in Pahrump, Nevada but no measurement was given.

## Year of No Precipitation – 1929

The driest year ever in Death Valley took place in 1929 when no precipitation fell at all for the entire year. A tenth of an inch of precipitation was reported in the afternoon observation of December 3, 1928 and precipitation was not observed in Death Valley again until January 7, 1930 when a trace was reported. On January 9, 1930 a total of 0.40 inch of precipitation was reported. The 401 days from December 4, 1928 through January 8, 1930 without any precipitation – not even a trace - is the longest dry stretch on record here.

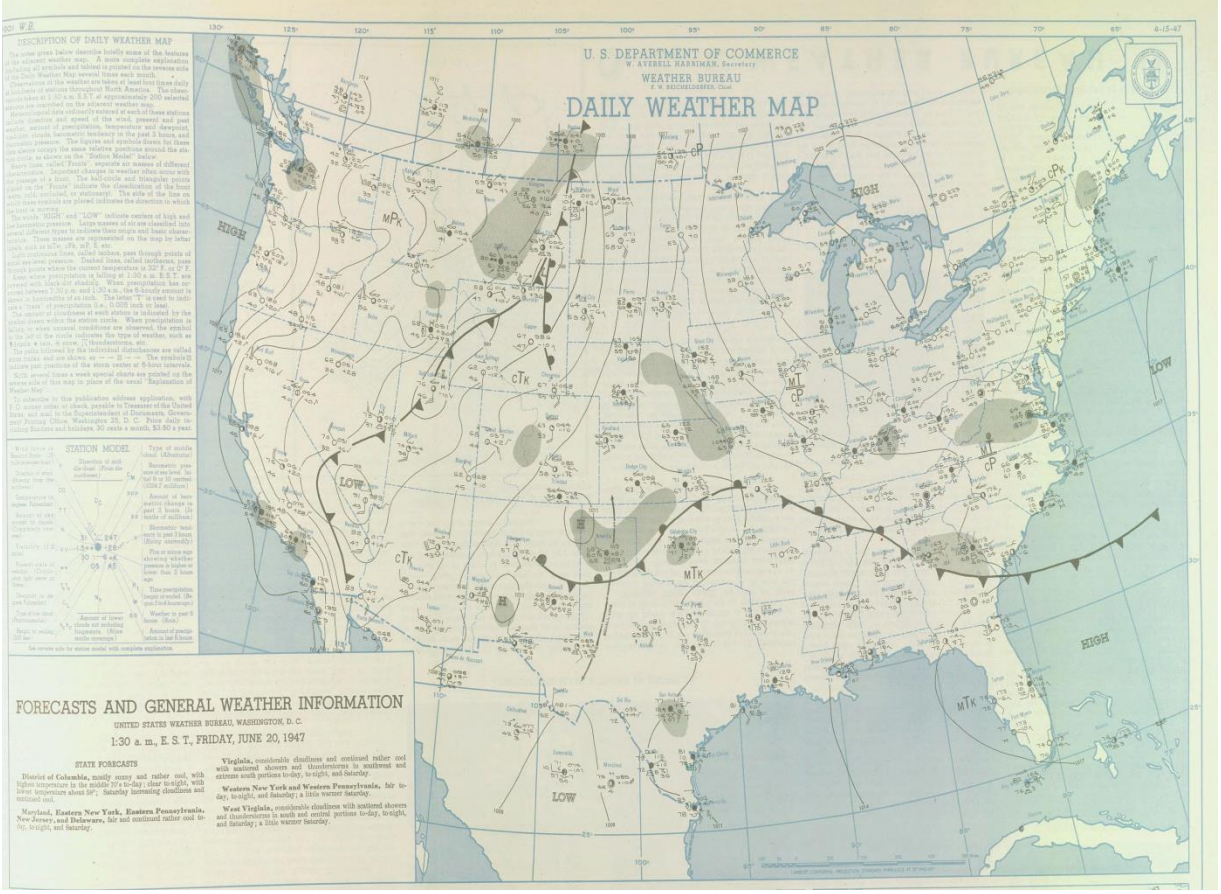
The second driest year on record in Death Valley was in 1989 when a trace was reported on only one day – January 4th. Although the total for 1953 was also a trace there were five instances of a trace reported throughout the year. Traces of precipitation (all rain) were reported in the observations on July 12th, July 13th, July 16th, October 19th and November 16th during 1953.

## Death Valley Windstorm of June 20, 1947

Strong winds are not uncommon in the Mojave Desert including Death Valley. Winds are typically greatest during intense thunderstorms and in association with the passage of cold fronts through the area. Although cold fronts are most prevalent between October and May in the Mojave Desert, they do pass through sometime during the warmer season months. On June 20, 1947 a late season cold front was moving southwest across Nevada and California. Temperatures dropped considerable behind the front with highs on the 21st roughly 12 degrees cooler across the area.

According to a detail account of this event from the National Park Service, gusty south winds had been present during the day on June 20th when "suddenly a dust storm of bleak intensity appeared to the north of the valley" around 5:10 PM. So much dust was lofted that is virtually impossible to even see any highways. The wind which was estimated at 60 to 80 mph by the Park Service damaged cabins at Stovepipe Wells and warped buildings at Cow Creek. One section of roof of the Chief Ranger's quarters was blown off and carried over the top of the house and landed on top of one of the large palm trees located about 75 feet away. Several panes of glass were blown out of the window frames in homes. A total of 17 power poles were blown down between Death Valley Junction and the Furnace Creek Ranch. At the Furnace Creek Ranch, several trees and the official United States Weather Bureau instrument shelter were blown down. Observations of temperatures were thus unavailable for a 7 day period since the equipment was damaged. Although no wind vane was in the area, the Park Service noted the wind was greatest from the north when the storm struck with the entire event lasting about four hours.

A windstorm of this intensity is quite unusual for Death Valley in the late fall, winter or spring months when cold fronts are much more common. The fact that this event occurred so late in the season and with the intensity that it did certainly ranks it among the more impressive wind events ever documented in Death Valley – if not the most impressive. This same front did not just produce high winds in Death Valley as numerous trees fell down in nearby Beatty, Nevada and power was knocked out. High winds were also reported in the Antelope Valley of California and as far south as Mount Laguna in San Diego County where at 6,202 feet a 128 mph wind gust was recorded.

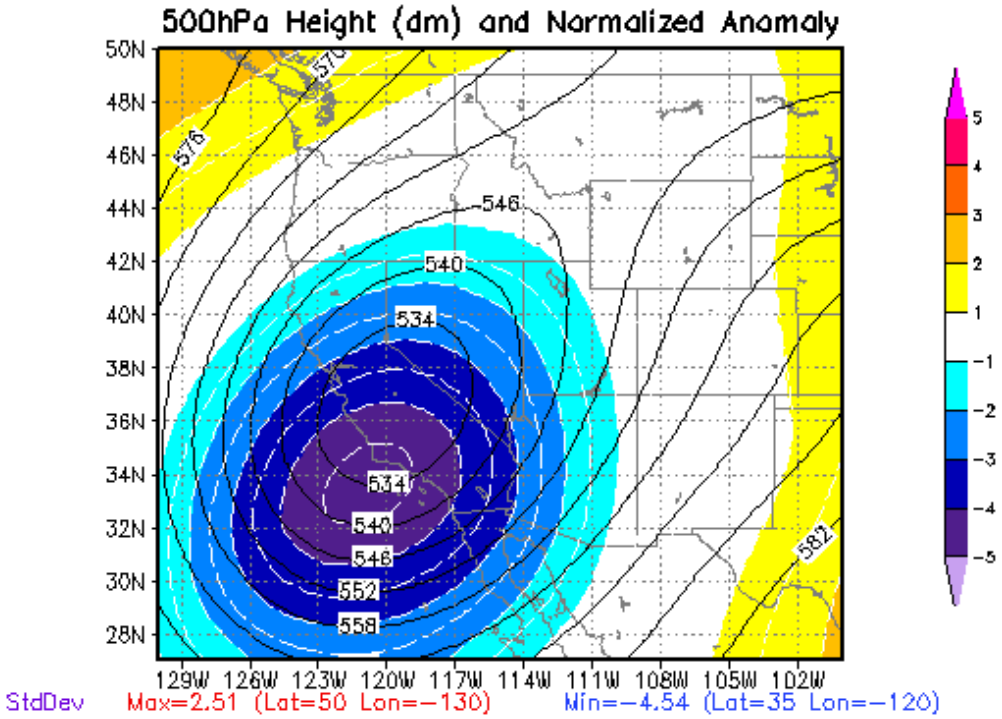


United States Daily Weather Map from June 20, 1947 showing a surface cold front moving through Nevada and California.

## Snow of January 1949

January 1949 was notorious for the widespread cold and snow that took place during this month throughout the southwestern United States. A cold area of low pressure aloft over the Great Basin dropped south towards the coast of southern California between January 9th and 11th then moved very little afterwards. In Death Valley, precipitation was generally light for this entire event with a total of 0.30 inch measured in the period between January 8th and 13th. In Death Valley snow was reported during this event twice at the Furnace Creek Ranch – on the 9th and again on the 11th with total amount both times reported as a trace. On the 11th, snow was reported by the observer to have fallen from 1:45 PM until 2:15 PM. Although the liquid equivalent was also a trace in both instances when snow fell, the observer did remark that snow did cover the ground at the ranch but did not indicate a day. In addition, it was remarked the snow melted fast and did not appear to damage any date trees. At Cow Creek, the Park Service recorded a total of 0.88 inch of precipitation during this event with precipitation falling from the 10th through the 13th. Precipitation at Cow Creek began on the 10th at 2 PM and continued until 9 AM on the 11th. However, Cow Creek reported a total of 4 inches of snow- significantly more snow than what fell at the Furnace Creek Ranch in the time frame between the afternoon of the 10th and the morning of the

11th. The 4 inches at Cow Creek is the greatest known snowfall documented below sea level in Death Valley.




Reanalysis of the 500 mb heights (black lines) and normalized anomalies (shaded colors) for 00Z on January 11, 1949 showing a cold area of low pressure near the southern California Coast. This low produced snow at Death Valley. Image Credit: Penn State University.

## February 1976 Rain Event and Golden Canyon Flash Flood

One of Death Valley's wettest periods ever on record took place in February 1976 when a total of 2.37 inches fell. This was reported from the observation days of the 6th through the 10th when a mid and upper level trough moved across California. The wettest 24 hour period was from the 8th through the 9th when 0.82 inch fell. The combination of days of heavy rain and persistent runoff along with rugged terrain in Death Valley resulted in a significant flash flood in Golden Canyon, located south of Furnace Creek and north of Badwater. At this time a paved road ran through Golden Canyon. However, it was no match for the surge of water, rock and mud that was forced through the narrow canyon by heavy rain on February 9th. The paved road that wandered through Golden Canyon was wiped out completely. Left behind was a crumbled mess of macadam that was no longer drivable. Today access into Golden Canyon by foot allows one to see the ruins of the paved road that once wandered through here.

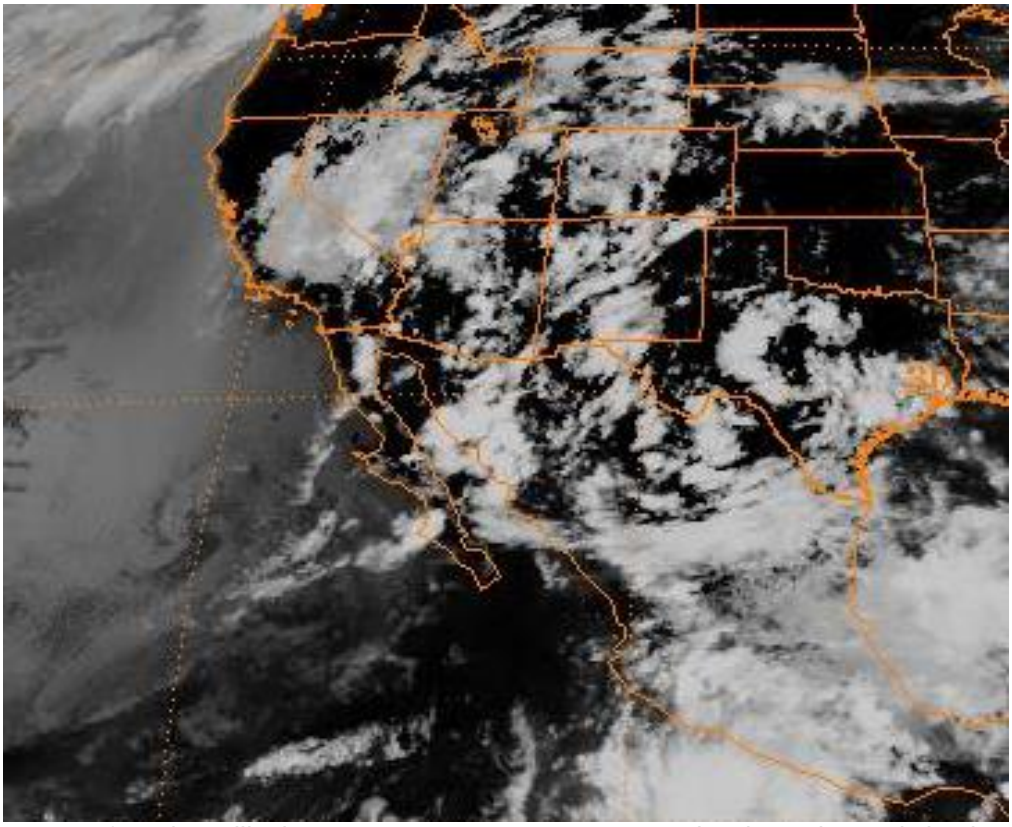
Flash flooding in Death Valley during February 1976. Photo Courtesy: Furnace Creek Inn.

Golden Canyon in Death Valley National Park in June 2008. Portions of the old paved road can be seen in the distance. Photo Credit: Chris Stachelski.

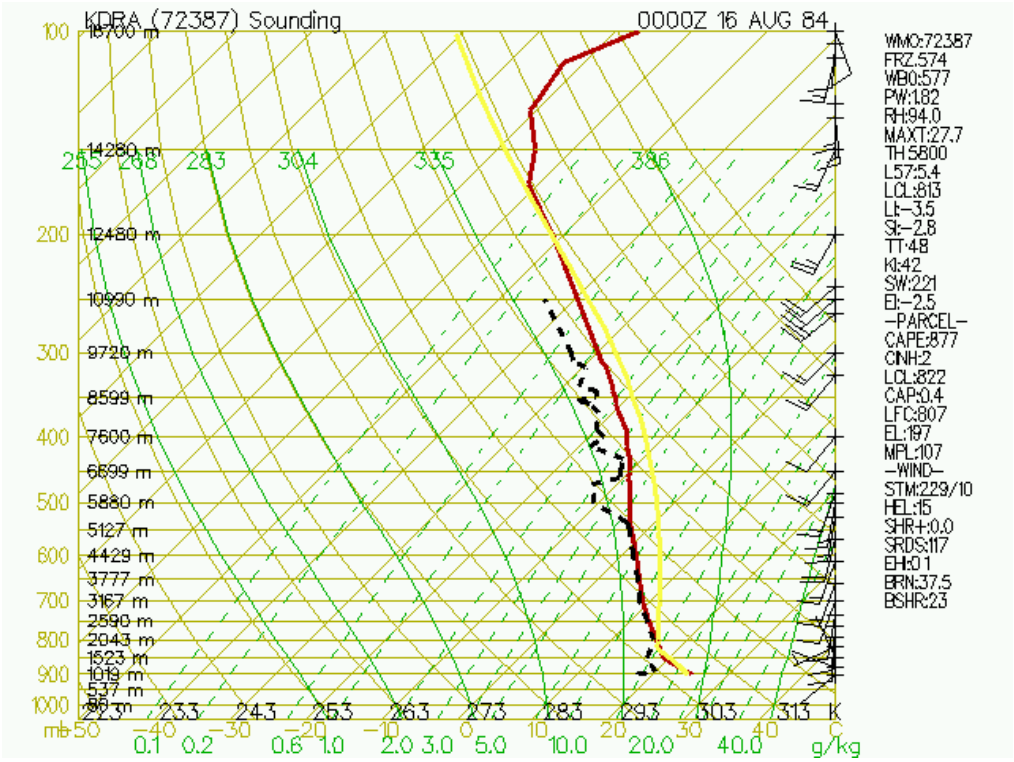
## Flash Flood of August 15-16, 1984

The monsoon season of 1984 was one of the most active on record in the Mojave Desert. Reanalysis data obtained from Penn State University of 500 mb heights shows that an area of high pressure became centered near the Four Corners region by August 10th and an inverted trough moved north on the back side of this high across Arizona initiating a push of moisture into the Mojave Desert. This 500 mb high remained in place near the Four Corners through August 15th with a broad southerly flow noted across the Mojave Desert. Sounding data from Desert Rock, Nevada showed a rise in precipitable water in this time frame. On the morning of August 15, 1984 the 12Z radiosonde had a precipitable water value of 1.62 inches with a lifted index of -1.6 degree. By the afternoon that day, the 00Z August 16 radiosonde showed a drop in the lifted index with a value of -3.5 degrees observed. Precipitable water increased to 1.82 inches, which based on a climatology complied by WFO Rapid City (http://www.crh.noaa.gov/images/unr/soo/pw/pw_Top50.pdf) ranks as the second highest on record for southern Nevada. These values indicate the atmosphere over southeast California was incredibly moist and unstable.

At Furnace Creek, observations show rain began falling around 4:00 AM on August 15th and continued through 5:00 PM on August 16th. A total of 1.17 inches was measured. The intense rains over the valley, likely combined with runoff from nearby mountains, resulted in tremendous flash flooding throughout what was then Death Valley National Monument. All roads in the monument except for the Beatty cutoff were closed due to flooding. The chief ranger for Death Valley at the time stated that floods caused cracks up to 5 feet deep on Highway 190. Other roads in the monument had rocks, mud and gravel up to two and a half feet deep. At least 37 cars were stranded within Death Valley due to the flooding. In the Panamint Range to the west, 6.09 inches of rain was measured by the Park Service at the Wildrose Ranger Station for the 15th and 16th of August combined. The heavy rain washed out the water supply system for the station and a nearby campground.



GOES-6 Infrared satellite image at 21Z on August 15, 1984 showing enhanced cloud tops asoociated with thunderstorms in Death Valley. Image Credit: NCDC.




Sounding from KDRA from 00Z on August 16, 1984. Image Credit: Plymouth State University.

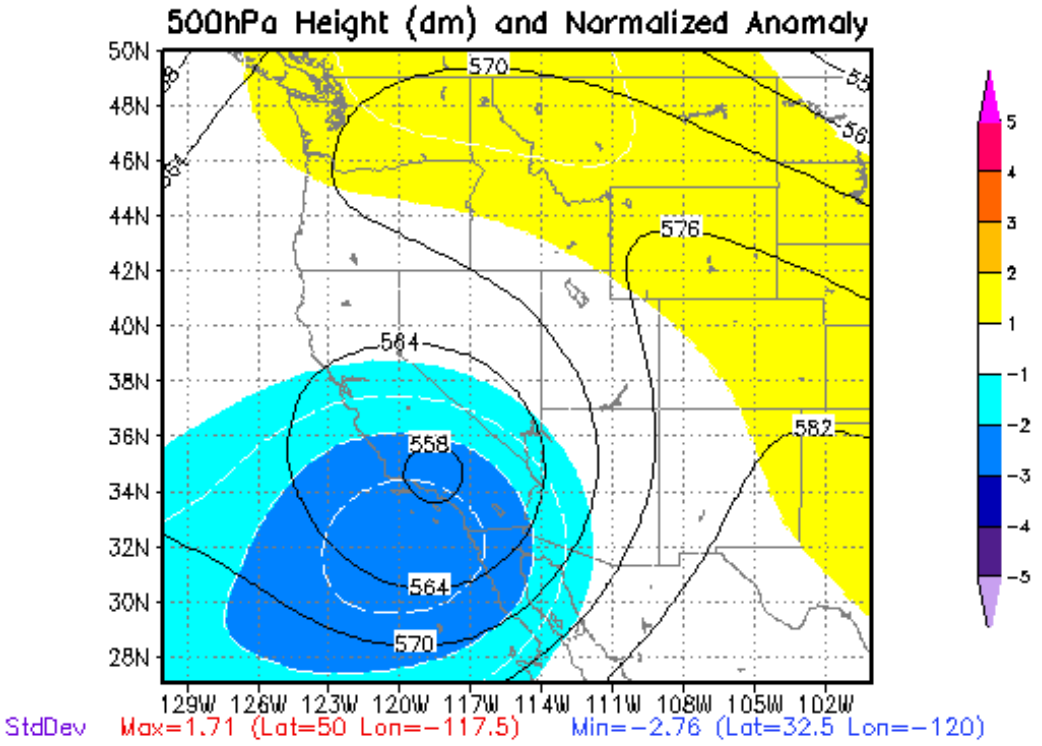
Flash flooding on the Furnace Creek Wash in August 1984 damaged roads. Photo Courtesy: Furnace Creek Inn.

Damage caused by flash flooding along the Furnace Creek Wash in August 1984. Photo Courtesy: Furnace Creek Inn.

## Heavy Rain Strands Thousands – November 1987

Perhaps the greatest number of people impacted by the weather at any one time in Death Valley took place in November 1987 when a cold upper level low moved ashore in southern California on the evening of November 5th and then moved inland towards southern Nevada by November 6th. This low produced 0.71 inch of rain at Furnace Creek. Rain fell much of the day on November 5th but became heavier as the day progressed. Between 5,000 and 8,000 people were in Death Valley National Monument for a recreational encampment that was held the first weekend in November. The heavy rain triggered extensive flooding that resulted in thousands being stranded in the monument.

The National Park Service reported that State Route 190 was covered with water, rocks and mud for a five mile stretch between Furnace Creek and Death Valley Junction resulting in the road being closed from 4:00 PM on November 5th through 1100 AM on November 6th. An eight mile stretch of State Route 190 was closed between Stovepipe Wells and Furnace Creek was also closed due to flooding with 30 vehicles stranded on it and was reopened by 1 PM on November 6th. High water and debris also closed Badwater Road from November 5th into November 7th. Lastly, flooding closed the connection road between State Route 190 and Scotty's Castle from November 5th through November 7th. The Park Service reported 1.20 inches of rain at Scotty's Castle.

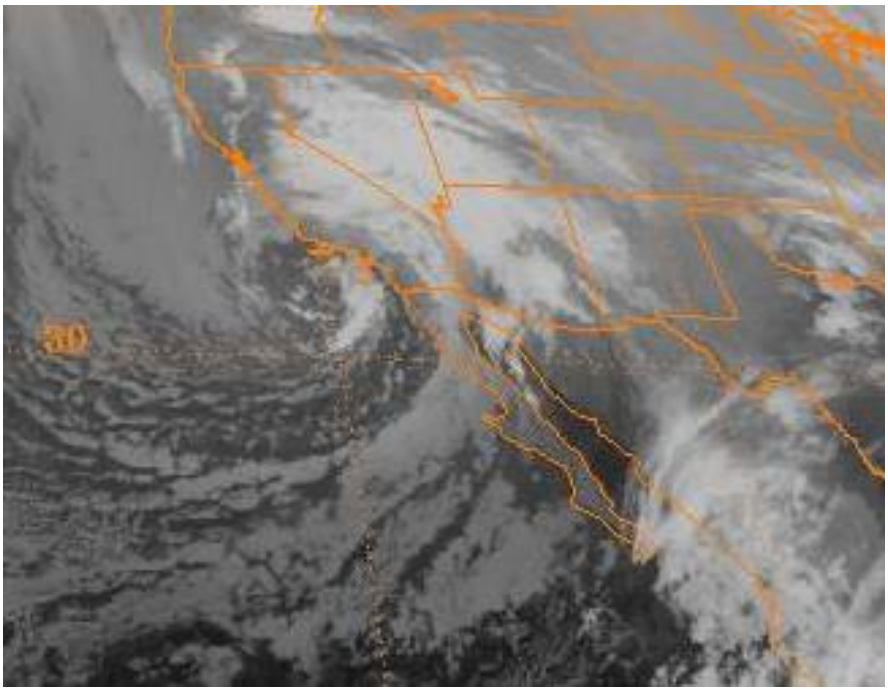



Reanalysis of the 500 mb heights (black lines) and normalized anomalies (shaded colors) for 00Z on November 6, 1987 showing a cold area of low pressure near the southern California Coast. Image Credit: Penn State University.

## Wettest Observational Day Ever – April 1988

Death Valley's wettest observational day precipitation total of 1.47 inches fell from April 14th into April 15th of 1988. This is more than double the second greatest observational day total ever recorded in April of 0.63 inches from April 14th to April 15th in 2003. The heavy rain that fell from April 14th to April 15th in 1988 was brought by an upper level low that approached the coast of southern California and spread moisture northward into the Mojave Desert. Precipitable water values were high for April with a value of 0.82 inch recorded on the 00Z April 15, 1988 sounding.

An additional 0.20 inch fell from April 15th into the morning of April 16th, bringing the total for this event to 1.67 inches. This ranks as the second greatest two observational day precipitation total on record at Death Valley, exceeded by only the 1.70 inches from November 8th through November 10th in 1923.



GOES-6 Infrared satellite image at 12Z on April 15, 1988 showing an upper level low off the coast of southern California. Image Credit: NCDC.

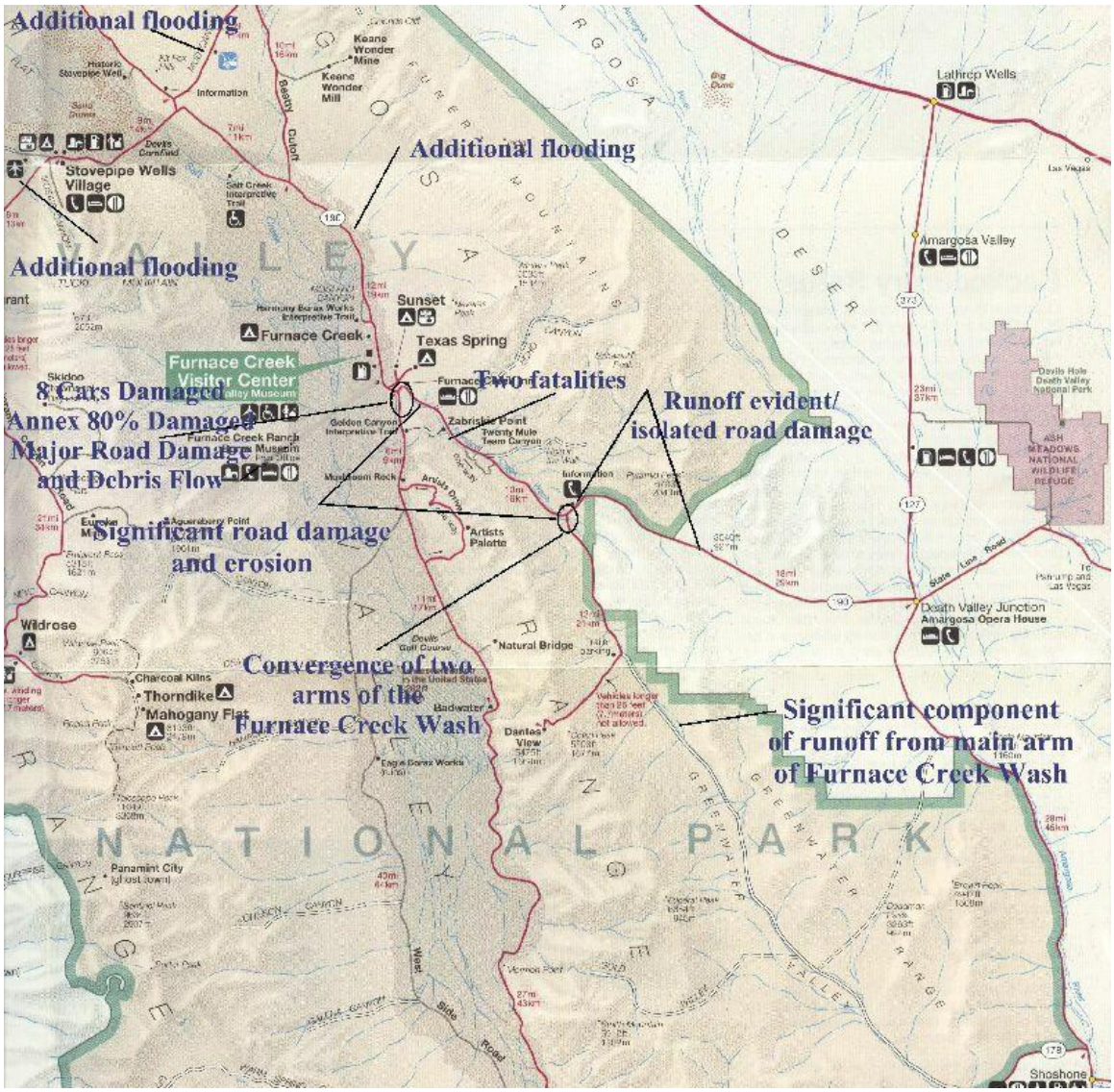
## Flash Flood of August 15, 2004

The flash flood of August 15, 2004 ranks as the costliest weather event ever in Death Valley history with respect to monetary damages. Estimates by the NWS place the total damages from this event at twenty million dollars (in 2004 dollars).

High pressure in the mid and upper levels was centered over Utah while a mid and upper level trough was located off the West Coast of the United States. This set up a southerly flow across the Mojave Desert and allowed moisture to push north into the area. Radiosonde data from Desert Rock, Nevada showed precipitable water values reached well over an inch, with the 00Z release from August 15$^{th}$ recording a value of 1.31 inches. Water vapor imagery shows thunderstorms developed that afternoon and evening along the boundary between drier and more stable air over southern California and moist and unstable air that was in place along the border of southern California and southern Nevada. Local Analysis and Prediction System (or LAPS) data archived at the time show lifted indices reached as high as -9 degrees over Death Valley by the early evening hours, indicative of extremely unstable air.

An analysis of radar by the Las Vegas NWS office showed five separate cells tracked over the southern half of Death Valley National Park that evening in about a 90 minute period. Radar and estimates from park rangers indicate rain began around 7:00 PM with flooding starting to occur at 7:55 PM. Major flooding took place starting near 8:30 PM. The heaviest rain producer as estimated by the Las Vegas WSR-88D radar occurred in the area near Dante's View. One hour

estimates in this area were over two inches in an hour (although amounts were likely lower in reality as the WSR-88D radar has historically overestimated precipitation in the Mojave Desert). The total rainfall from this event was 0.33 inch at Furnace Creek while an automated station in the Panamint Mountains recorded 0.88 inch.

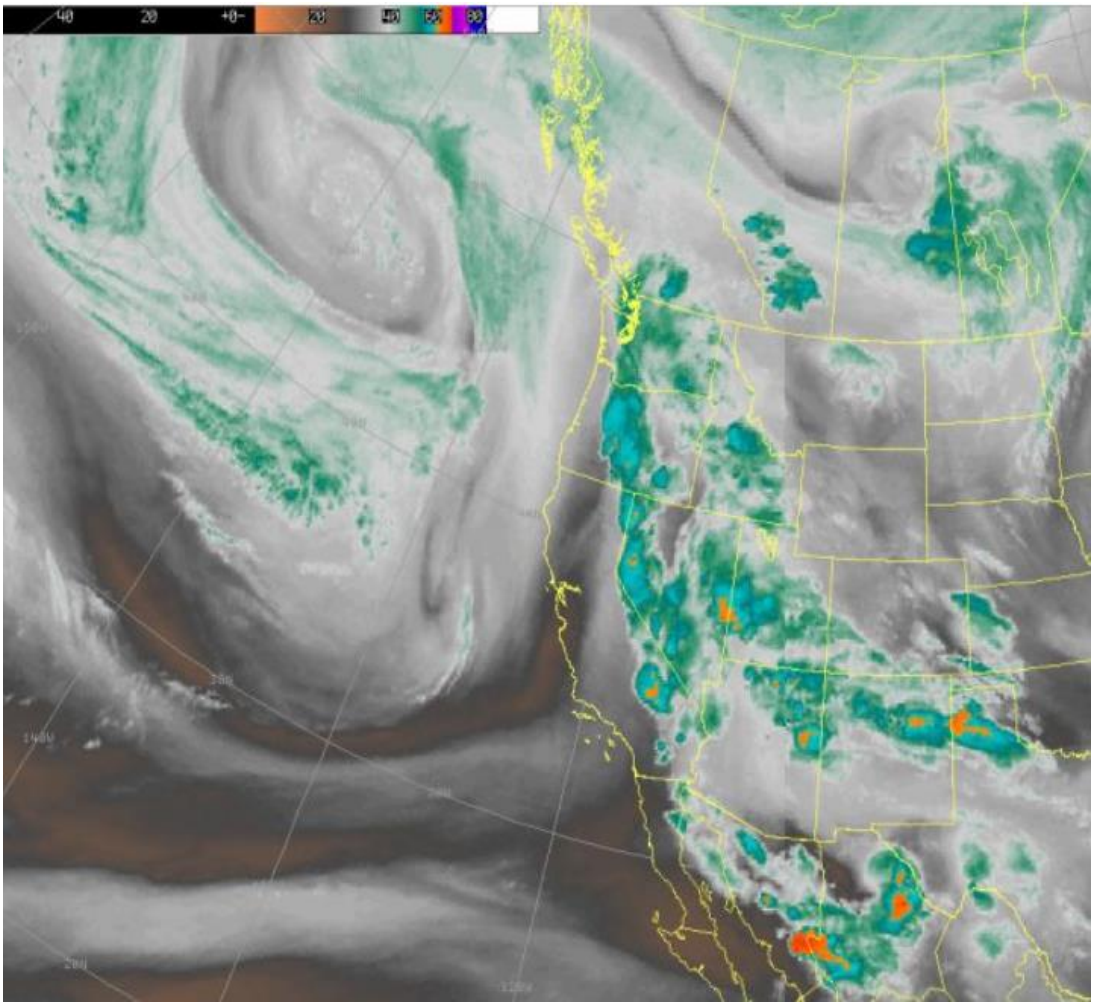


Map showing damage in Death Valley National Park from the flash flood of August 15, 2004. Map Credit: Stan Czyzyk/NWS Las Vegas.

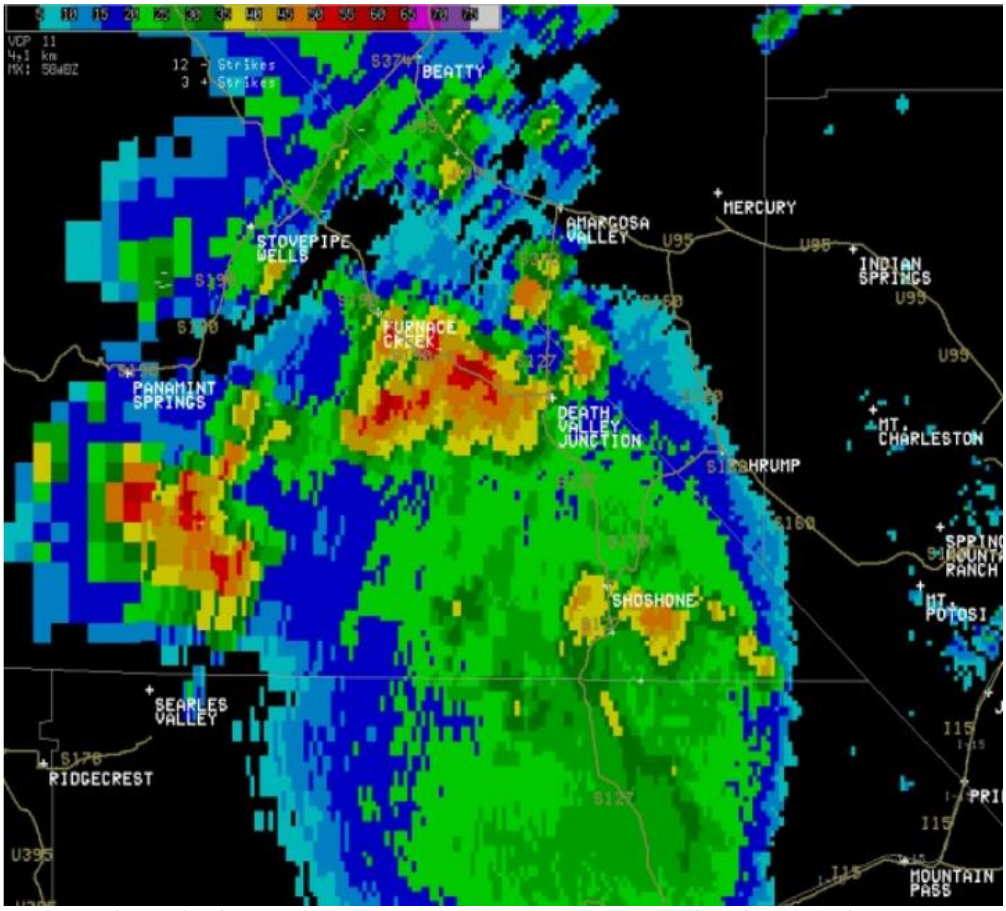
Flooding throughout the park, especially the southern portion was extensive and resulted in the parks closure for a few days. Visitors at the Furnace Creek Ranch and a nearby campground were escorted out of the park the following day because of safety concerns. Power in the park was knocked out but restored by 5:30 PM the following day. A damage survey conducted by the National Weather Service Office in Las Vegas after the event found most of the damage was along State Route 190 which borders the Furnace Creek Wash. Dante's View Road

was flooded and one vehicle was found flipped over north of the where the two arms of the Furnace Creek Wash meet. Two people died in a car along Highway 190 between the entrance of 20 Mule Team Canyon Road and Zabriskie Point that was found encased in mud and rocks. Besides complete destruction of portions of the paved road along Highway 190, damage included telephone poles knocked down and water supply pipes that were torn apart. The restrooms at Zabriskie Point had mud and debris nearly to their rooftops.

Additional damage took place near the Furnace Creek Inn. An annex that housed some of the National Park Service staff had water about eight to ten feet deep on it and eight cars were washed away and damaged severely. Several other vehicles were also damaged on back roads in the park. Flooding was also reported on Mud Canyon Road and on State Route 178 near Badwater.



Water vapor image from 0130Z on August 16, 2004.



KESX composite radar image from 0243Z on August 16, 2004 showing thunderstorms over the southern end of Death Valley National Park. This was when the most intense activity was moving through the Furnace Creek area.


Damaged vehicles at the Furnace Creek Inn. Photo Credit: Stan Czyzyk/NWS Las Vegas.

Damage at the intersection of State Routes 178 and 190. Note the extensive damage to roads and the vehicle washed away by the floodwaters. Photo Credit: Stan Czyzyk/NWS Las Vegas.

## Wettest Water Year Ever – 2004 through 2005

The water year in California is the period from July 1st through June 30th. From 2004 through 2005, the total precipitation during this period at Death Valley in Furnace Creek was 6.44 inches, more than any other eater year on record. A total of 5.44 inches of this fell between November 1st and April 30th during the cold season when storm systems typically arrive from west or north. The 2004-2005 cold season produced record or near record precipitation throughout much of the southwest United States. The 5.44 inches between November 1st and April 30th was the wettest such period on record in Death Valley.

The remarkable water year total in 2004-2005 was due to a high frequency of storm systems during the cold season including several that were efficient precipitation producers. The wettest events of that season were from November 7th through 9th when 0.76 inch fell, from December 27th and 30th when 1.31 inches fell, from January 3rd through 8th when 1.34 inches fell and from February 20th and 24th when 0.77 inch fell.

The event from December 27th through the 30th produced the most significant flooding when on the 29th most roads leading into Death Valley National Park were closed. Moderate flooding was reported by the National Park Service on January 3rd on Badwater Road. Highway 190 was closed on the same date in the park due to flooding.

The excessive precipitation in Death Valley resulted in some unique sights in the park. By late January 2005, enough water had collected in Badwater Basin to allow for people to kayak in the small lake that had formed. Some nicknamed the

water a “mini Lake Manly” after the lake that had once filled Death Valley some 10,000 years ago. Mini Lake Manly was described in internet reports at the time to be up to 5 miles wide, 20 miles long and 2 feet deep (http://www.canoekayak.com/canoe/deathvalley/) . Most of the water in Badwater receded by May of that year.

Kayakers roam the lake that formed at Badwater Basin in winter 2005.
Photo Credit: Alan Van Valkenburg/National Park Service.


Landsat 5 Satellite image of the lake that formed at Badwater Basin in the winter of 2005. The image above was take in February 2005. Image Credit: NASA.

Wildflowers typically bloom in the late winter and early spring in Death Valley following winters, especially those with above normal precipitation. However, the hefty precipitation totals from the winter of 2004-2005 led the flowers that spring to be billed as a “once-in-a-lifetime bloom”. Flowers started to bloom in the south end of the park as early as mid-January 2005 and peaked in mid-March 2005 after temperatures spiked into the low 90s for 5 days. The National Park Service reported over 50 varieties of wildflowers bloomed that spring. The wildflower display brought in large crowds of tourists including then-First Lady Laura Bush.

Wildflowers at Jubilee Pass from the “once in a lifetime bloom” in late winter 2005.
Photo Credit: Alan Van Valkenburg/National Park Service.