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National Training Center
Ft Irwin, CA

A Full-Year Study

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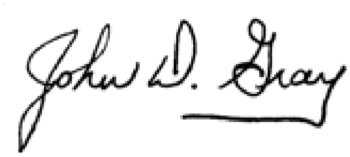

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13. Abstract: This country climatology digest is a climatological study of National Training Center (NTC), Fort Irwin, California. After describing the geography and major meteorological features of the entire region, the study discusses in detail the climatic controls of National Training Center's' weather. Each "season" is defined and discussed in considerable detail with emphasis on general weather, hazards, clouds, visibility, winds, precipitation, and temperature.

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CONVENTIONS: The spelling of place names and geographical features are those used by the National Geospatial-Intelligence Agency (NGA). All distances are in nautical miles (NM) and kilometers (km), except for visibility, which is in statute miles and meters. Elevations are in feet above mean sea level (MSL), with a metric conversion following. Temperatures are in degrees Fahrenheit (F) and Celsius (C). Wind speeds are in knots. Cloud bases are above ground level (AGL) unless otherwise stated; tops, when provided, are above mean sea level (MSL). Precipitation amounts are in inches, with a millimeter (mm) or centimeter (cm) conversion following. Precipitation values given are liquid equivalent unless stated otherwise. Any graphics provided to supplement the text will not include conversions. Standard pressure levels are expressed in millibars (mb). Time is reported either in Coordinated Universal Time (UTC) (also known as Zulu or Z), or Local (L).

TERRAIN. The National Training Center is in the heart of the Mojave Desert, 30 NM (56 km) northeast of Barstow, Calif. Bicycle Lake AAF is 2.6 NM (5 km) northeast of the main post. The field elevation is 2,350 feet (716 meters). The entire reservation encompasses more than 642,000 acres of training area with the northern boundary less than 1.7 NM (3 km) from Death Valley National Monument. The San Bernadino and San Gabriel Mountains are oriented east to west 73 NM (135 km) southwest of Bicycle Lake. The Sierra Nevada Mountains, oriented north to south, are to the west. Elevations in excess of 10,000 feet (3,050 meters) are common in these ranges.

Broad valleys surrounded by rugged mountain peaks dominate the NTC. Dry lakebeds are found in nearly every internal basin. Elevations range from more than 6,000 feet (1,830 meters) in the northeast corner (the Avawatz Mountains) to 1,300 feet (400 meters) in the southeast corner. This type of terrain is typical of most of the Mojave Desert.

Bicycle Lake is in a basin at the intersection of several mountain ranges. The basin is 16 NM (30 km) long and extends northeast to southwest. It is 3.5 NM (6 km) wide at Bicycle Lake. It slopes gradually 9 NM (17 km) southwest to Paradise Range, which is at 3,430 feet (1,046 meters). The Granite Mountains start 11 NM (20 km) north. Elevations are 3,700-4,000 feet (1,130-1,220 meters). Just 0.9 NM (2 km) east, the Tiefort Mountains rise abruptly to 5,000 feet (1,520 meters) and 4 NM (7 km) west, the foothills of Goldstone Range rise to 3,500 feet (1,070 meters). There is a narrow pass between two hills 4.3 NM (8 km) west-northwest.

The lake is dry most of the time. Almost all precipitation that falls on the mountains runs off into the basins. Bicycle Lake acts as a drainage point for the surrounding high ground. Even when it does contain water, it is very shallow. Water may remain in the lake for up to 2 weeks after the surrounding mountains receive heavy rain. Figure 1 is a terrain map of the area.

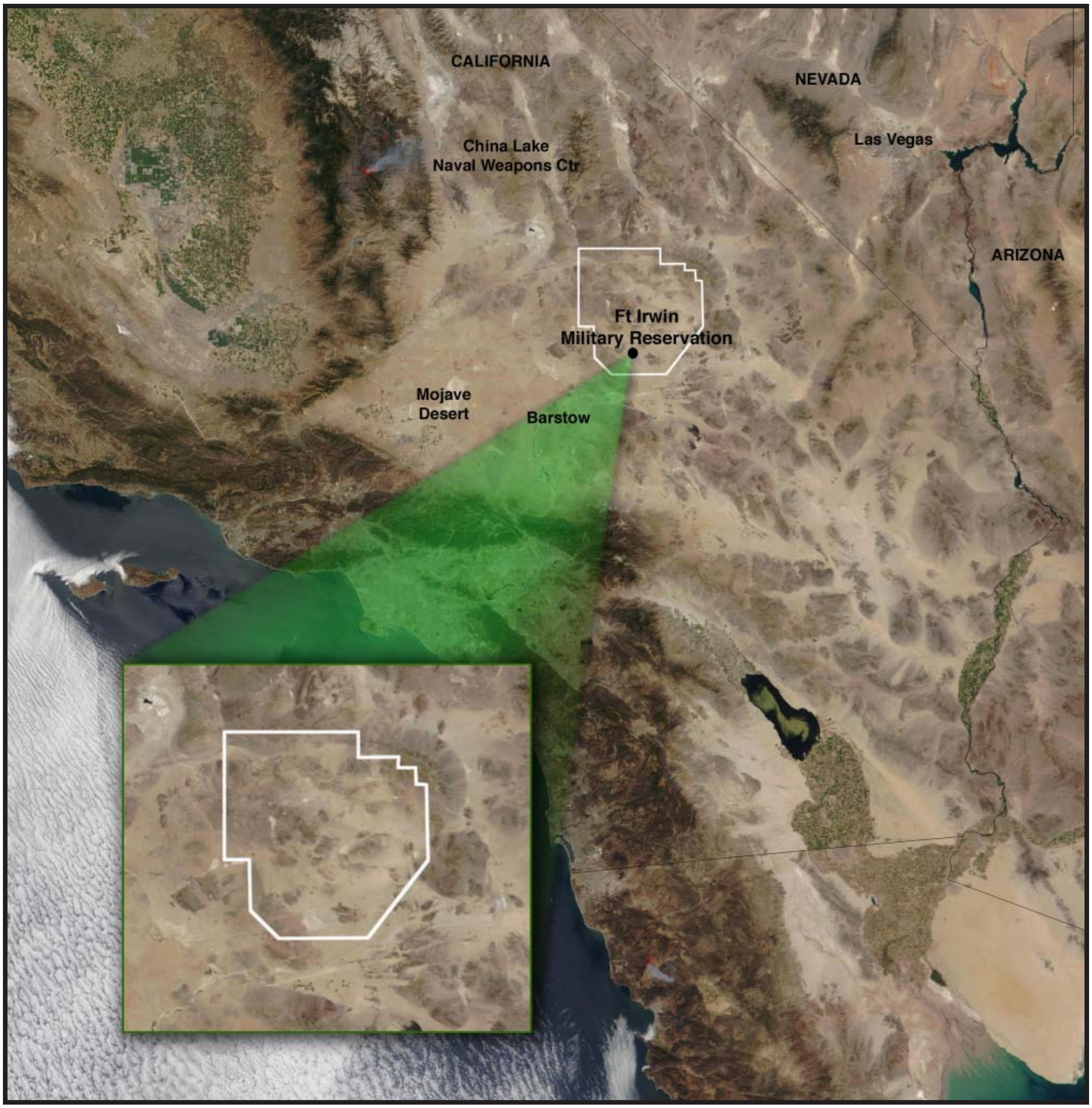


Figure 1. Terrain Map of the Area. The box includes the working area around the NTC.

ALL SEASONS

Air Pollution. Smog from the Los Angeles area occasionally spills over the San Gabriel Mountains into the Mojave Desert. This is most common in September through March. Visibility generally remains at or above 5 miles (8,000 meters). Increasing industrial activity in the desert to the south and west of the training center adds its share of pollution. The haze and smog generally stay in southern areas of the desert and usually have no impact on conditions at the training center.

WINTER (NOVEMBER-FEBRUARY)

General Weather. During winter more low-pressure systems (storms) move through the area than at any other time of year; however, rainfall is still minimal in this desert region. The North Pacific and Bermuda highs both retreat out of the area, which sets up the cycle of short wave systems that move through the long wave trough over the western US. Despite the number of storm systems that can reach the area, few produce more than brief periods of cloudiness and even fewer produce any rainfall in this sheltered desert area. Storms that develop in the Aleutian low track down the western side of the long wave trough to hit the US western coast and then continue eastward. These Gulf of Alaska lows generally stay north of the area until late December, but their associated cold fronts can reach here by late November. During El Niño years, rainfall and cloud cover are both greater in the region than in other years, but conditions still remain largely dry because of the sheltering mountains to the west.

Wave trains (series of storms) that move through the zonal (straight-line) large-scale flow occasionally set up and a cycle of cloudy and clear skies that continues until the zonal flow disappears, usually in 3-5 weeks. The mountains to the west protect this area from most of the effects of these storms, but some precipitation still occurs. Cold fronts associated with lows that sweep past to the north produce limited rainshowers or rain, but storms that move up from the southwest can bring heavier rain to the area.

Cut-off lows sometimes form off the southern California coast (San Diego vicinity). The longer these storms remain in place, the more rainfall they can bring to the area. They are almost exclusively a winter feature and bring steady light rain from the west or southwest. Cut-off lows that form between the Rockies and the eastern Pacific Ocean and those that occur far enough south can bring rainfall directly to the area from mid-level clouds that stream over the mountains or indirectly in wrap-around moisture that is advected in behind the passing low once it moves eastward.

Cold fronts that approach from the northeast are called "Back-door" cold fronts. They develop on the southern rim of a shallow cold high over the Salt Lake area and can bring strong, gusty winds to the area. The area is most vulnerable to these fronts in January and February. Mountain passes that are oriented northeast to southwest can enhance these winds because of funneling. Very high pressure over the Great Basin area is a good indicator of an approaching back door front.

The Pineapple Express is the name for a long band of moisture that stretches across the eastern Pacific from south of Hawaii to the west coast. Although this normally brings heavy rainfall to the northwestern states, the band of moisture occasionally shifts southward to cause heavy rain, unusually warm temperatures for the season, and potentially, flooding. The mountains shelter the training center from the worst effects but do not totally protect the area. Snowmelt in the mountains can also cause flooding in the lowlands.

October-March is the main period for the occurrence of Santa Ana (also seen as Santana) winds. Santa Anas are hot, extremely dry foehn-like desert winds that blow from the north or northeast across the desert. They enter southern California through mountain passes, where they are further enhanced as mountain gap winds. Santa Anas develop under strong pressure gradients between a high centered over the Great Basin (Nevada) and a low off the southern California coast. They seldom persist more than 36 hours at a time, but there are have been events that persisted for days. The winds blow, sometimes with great force (gale force), from the deserts, and they may carry a tremendous dust load. The combination of heat, aridity and strong winds increase the potential for serious fires.

Gale force winds can also occur when high pressure is off the coast and low pressure is over the Great Basin. The tight pressure gradient between the two systems causes strong winds to blow from the north or northwest over the Mojave Desert. Winds have been reported as high as 85 mph in some places. Sand an dust storms are more likely to occur in the NTC area with these winds than with Santa Anas. Visibility in the areas most intensely impacted drops to just a few feet and sandblasting can seriously damage engines, rotors and other equipment. These wind events are most likely to occur in late winter and spring, but they can occur any time the same circumstances (high off the coast and low over the Great Basin) develop. Sandblasting is most severe within 6 feet of the ground. There are several documented instances in this area in which wind-driven sand wore away telephone/power poles until they snapped.

Sky Cover. Most cloud cover in this area is in middle and high clouds. The mean cloud cover is scattered all season, but there is more in January and February than in November and December. Low clouds, mostly in stratocumulus and stratus, rarely produce ceilings except for brief periods under rainshowers. Ceilings below 25,000 feet occur 15-20 percent of the time all day in November. In December through February, they occur 25-35 percent of the time, with the peak rate at 09-17L. Ceilings below 10,000 feet occur 4-6 percent of the time all day in November and 15-20 percent of the time all day in December-February. Ceilings below 3,000 feet do not occur in November and occur 2-3 percent of the time all day in December-February. Ceilings below 1,000 feet are very rare all day in January and at 06-14L in February and are not reported the rest of the season. Ceilings below 200 feet are not reported at any time of the year.

Visibility. Visibility is generally excellent. While fog is more likely in winter than in any other season, it is still not at all common. If it occurs, it is most likely to happen under a dome of high pressure the morning after rain has occurred. In areas downwind of dust sources, dust lifted by strong winds is more likely to cause restrictions than fog. Fog restricts visibility below 7 miles (11,000 meters) on an average of 1-2 days per month all season. January has the most days. For the area, wind blown dust restricts visibility below 11,000 meters on an average of 1 day or less per month, but man-made dust occurs whenever the range is in use. Because there is little vegetation, vehicle traffic causes dust restrictions in the area of activity; the heavier the vehicles and traffic, the worse visibility becomes. Once the surface hardpan is broken, the soil is quickly pulverized into dust. Under light winds, visibility in the area of activity can remain poor for some time as dust lingers in the air.

At the observation site, visibility below 11,000 meters occurs 1-3 percent of the time all winter except at 00-08L in January, when it occurs 4-5 percent of the time. Visibility below 3 miles (4,800 meters) is very rare at 00-05L in January and is not reported the rest of the season. Visibility below 1 mile (1,600 meters) is not reported all season.

Winds. The complex terrain at the NTC causes funneling of the winds that can increase prevailing speeds by 10-15 knots. The strongest winds occur at the ends of valleys and passes. Wind direction is steered by terrain and may be very different from place to place throughout the training area. Calm conditions occur 25 percent of the time all season but occurrence rates will vary widely with location. Sheltered sites have the highest rates of calm conditions.

Funneled winds through valleys can cause wind gusts up to 35 knots. The occasional frontal system that moves through the area can produce wind gusts of 25-35 knots. Winds that blow across ridges and peaks will cause light-to-moderate turbulence over the ridges and up to 50 NM (93 km) downwind. The air is very dry so rotor clouds will not usually form to give visual clues to this hazard. The training center is vulnerable to strong gradient winds such as Santa Anas and Great Basin winds. Figure 2 is the January wind rose for Ft Irwin/Bicycle Lake, which is representative for the season in this area.

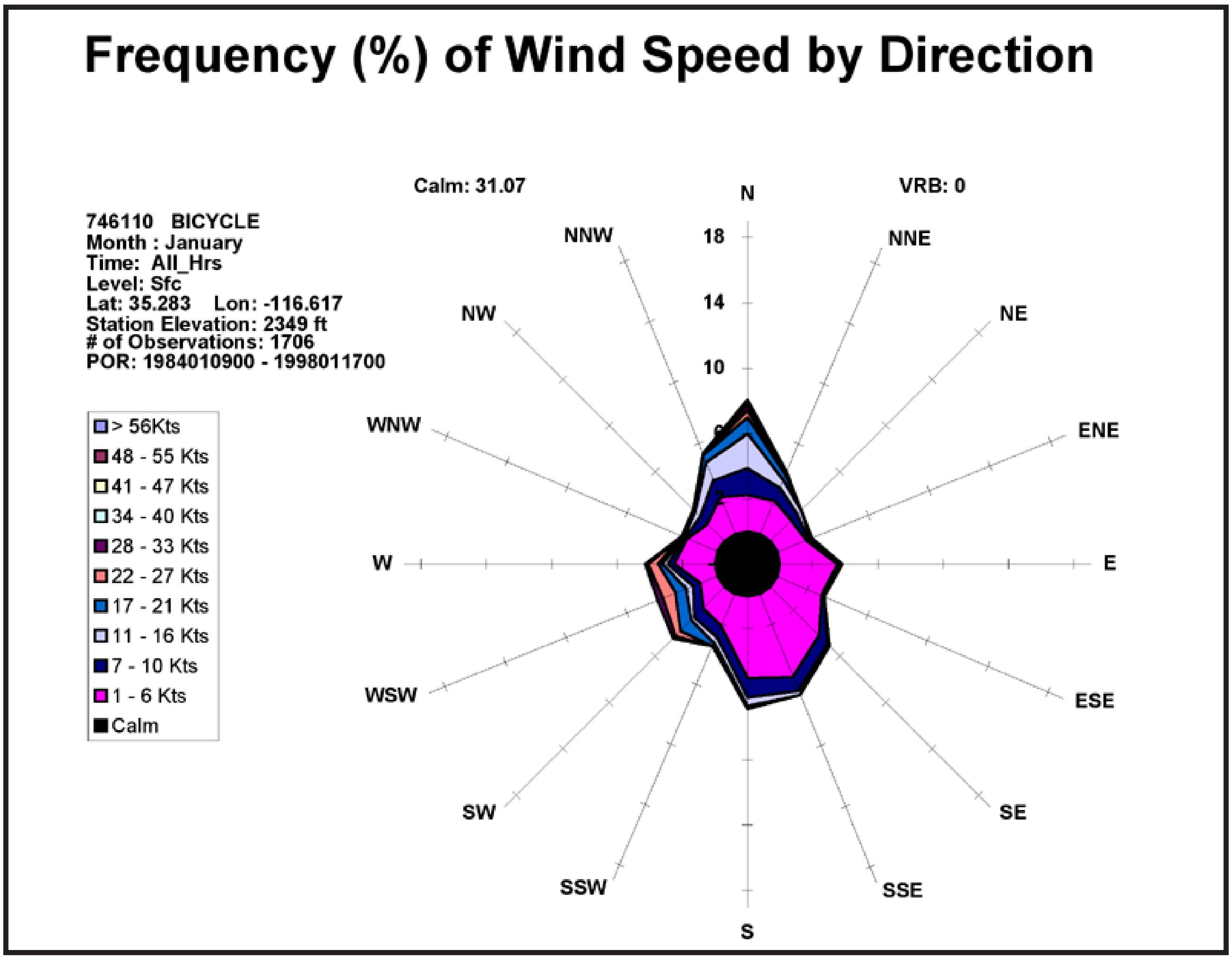
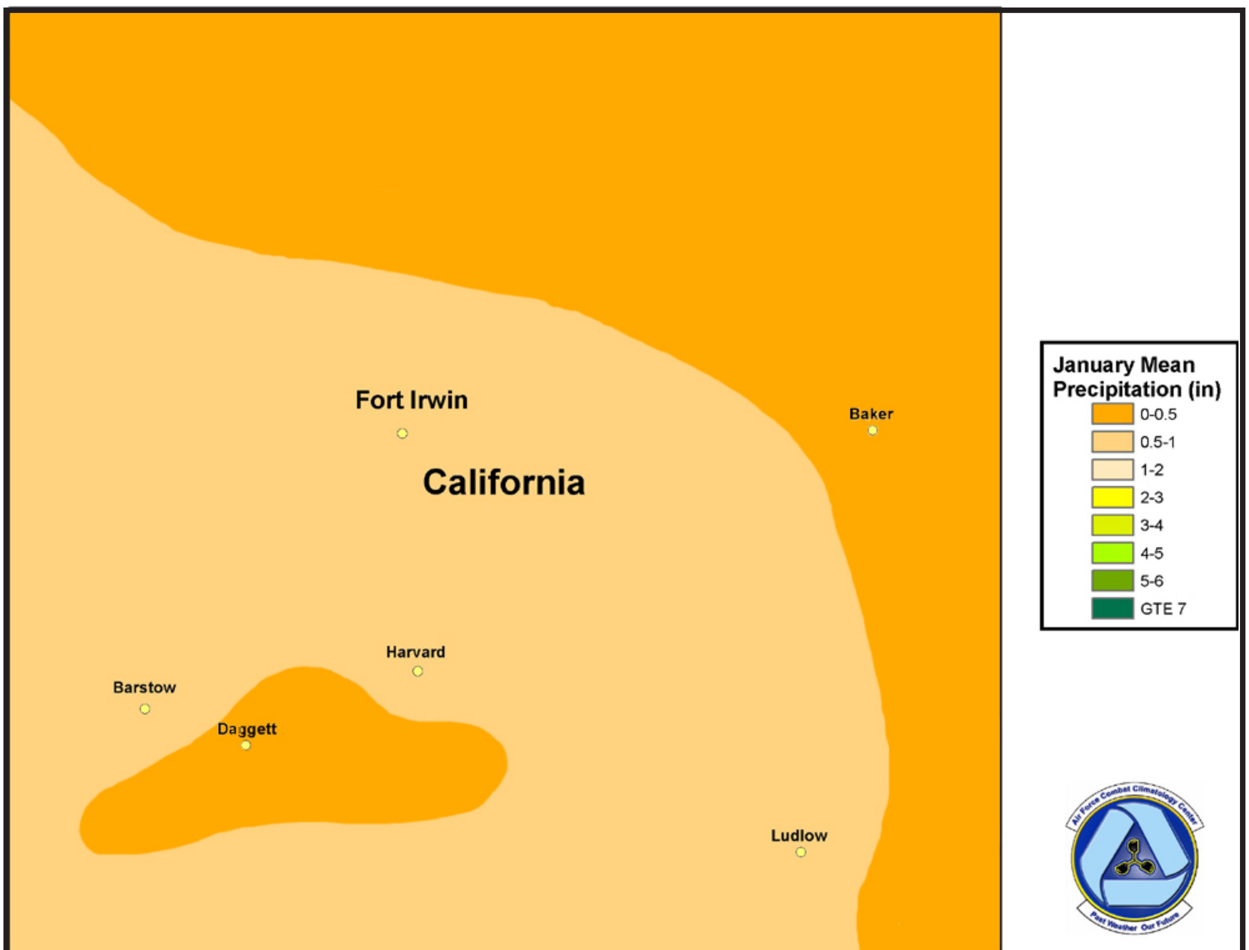


Figure 2. January Wind Rose for Ft Irwin/Bicycle Lake.

Precipitation. Although rainfall occurs in winter, it is typically light and with little accumulation. Light drizzle or rain that persists for a few hours is most common with lows from the southwest (such as cut-off lows), but rainshowers occur with cold fronts. Thunderstorms are uncommon but can occur with fast-moving cold fronts. Cold fronts and their parent storm systems move progressively farther south as the season advances and typically do not bring much rain to the area until late in December. During El Niño years, however, they bring in rain as early as mid to late October.

Snow is uncommon here. The local mountain peaks are more likely to get snow than the lowlands, but it does linger for more than a few hours below 2,500 feet (760 meters) elevation. There are exceptions. The winter of 1948-1949 brought a drastic departure from the usual weather. The entire western United States experienced very cold temperatures and unusual snowfall. George AFB at Victorville, to the southwest, recorded 17 inches (43 cm) of snow in January while other nearby locations reported up to 14 inches (36 cm) of snow. This was a very unusual event, but these conditions are always possible, if not probable. Figures 3a-b depict January precipitation statistics for the area.



Source: Air Force Combat Climatology Center Operational Climatic Data Summary

Figure 3a. January Mean Precipitation.

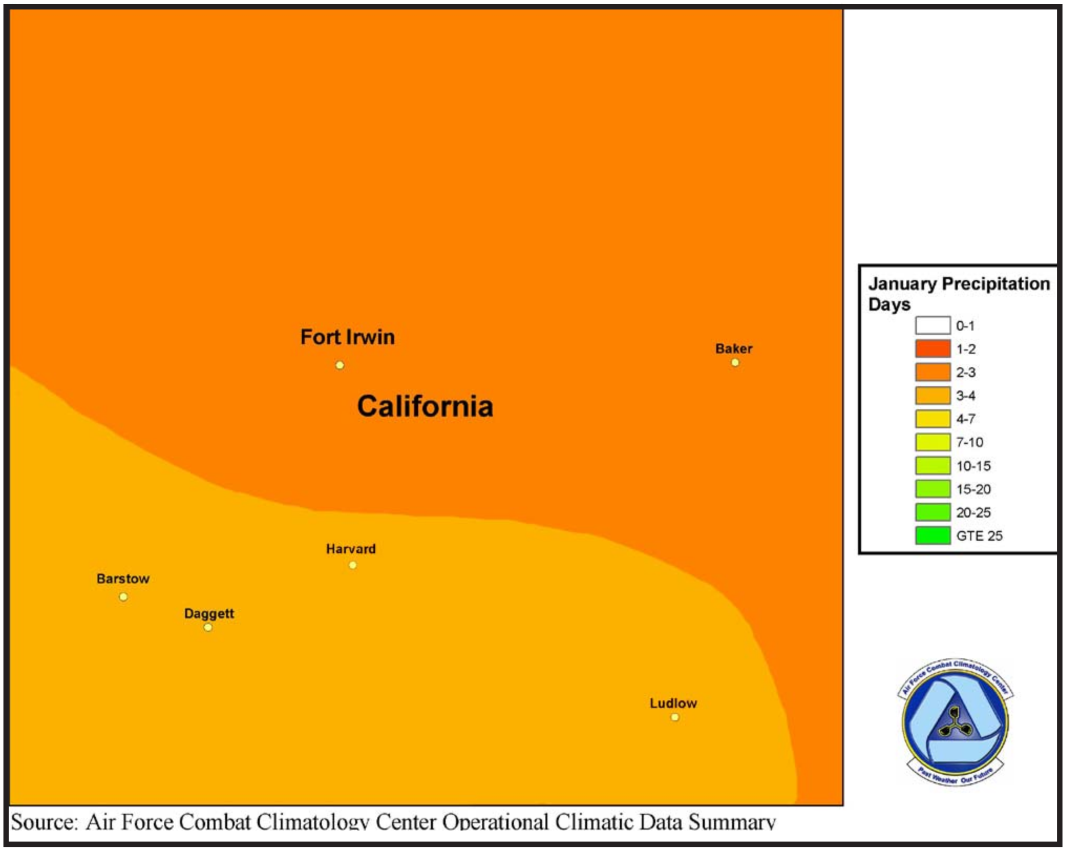


Figure 3b. January Mean Precipitation Days.

Temperatures. Winter is generally mild to cool. Cold air outbreaks behind back door cold fronts produce the lowest temperatures and southwesterly winds and clear skies produce the warmest days. Record highs reached 86F (30C) in November and February and 74F (23C) in December and January. Record lows reached 11 to 18F (-12 to –8C) all season, with the coldest records in December and January. Figures 4a-e depict January temperature statistics, which are representative for winter in this area.

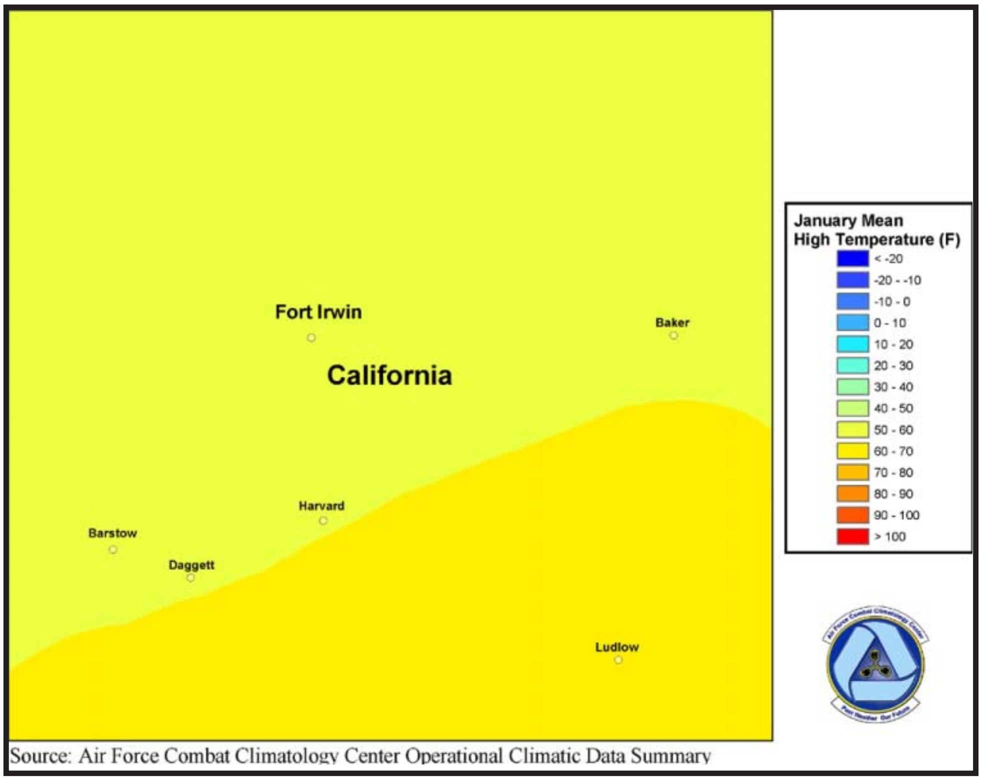


Figure 4a. January Mean High Temperature.

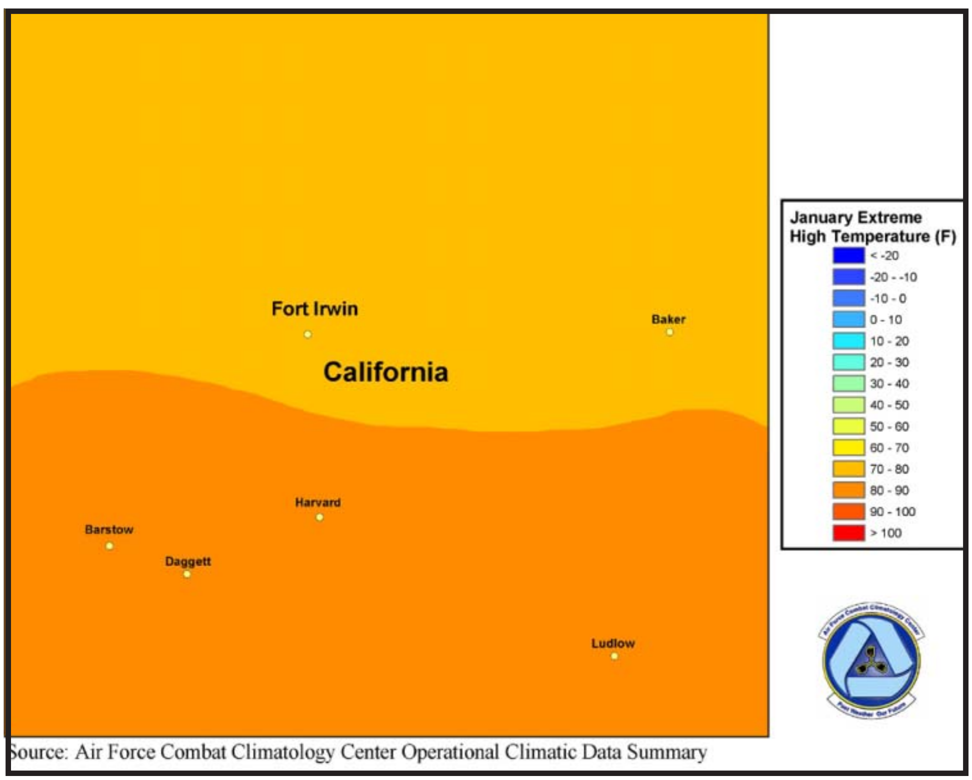


Figure 4b. January Extreme High Temperature.

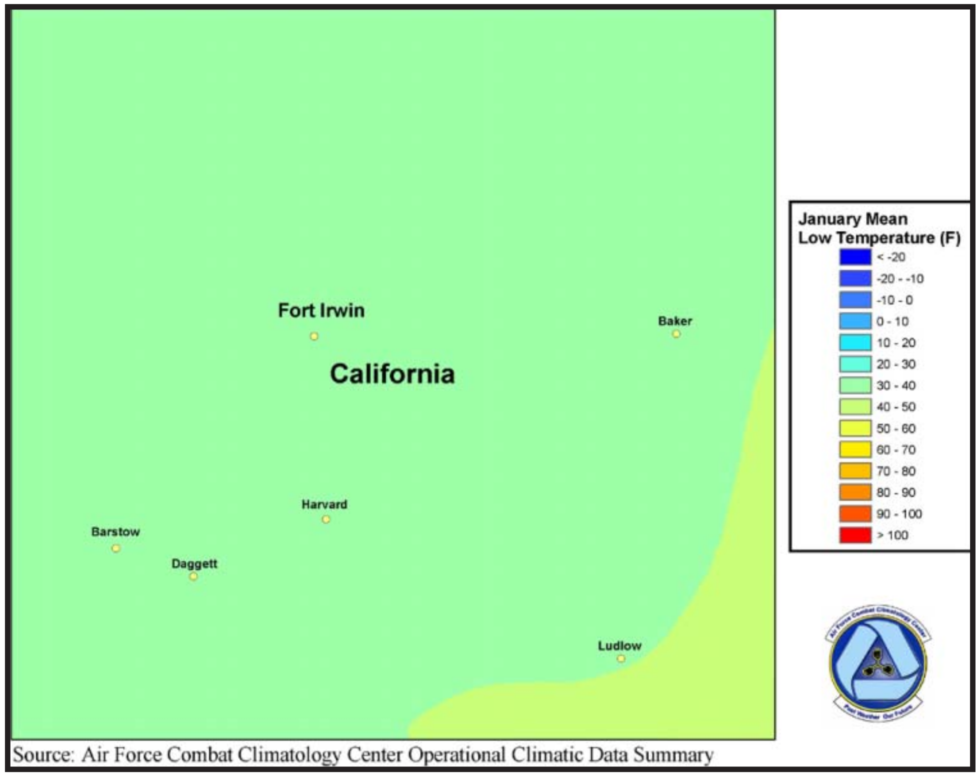


Figure 4c. January Mean Low Temperature.

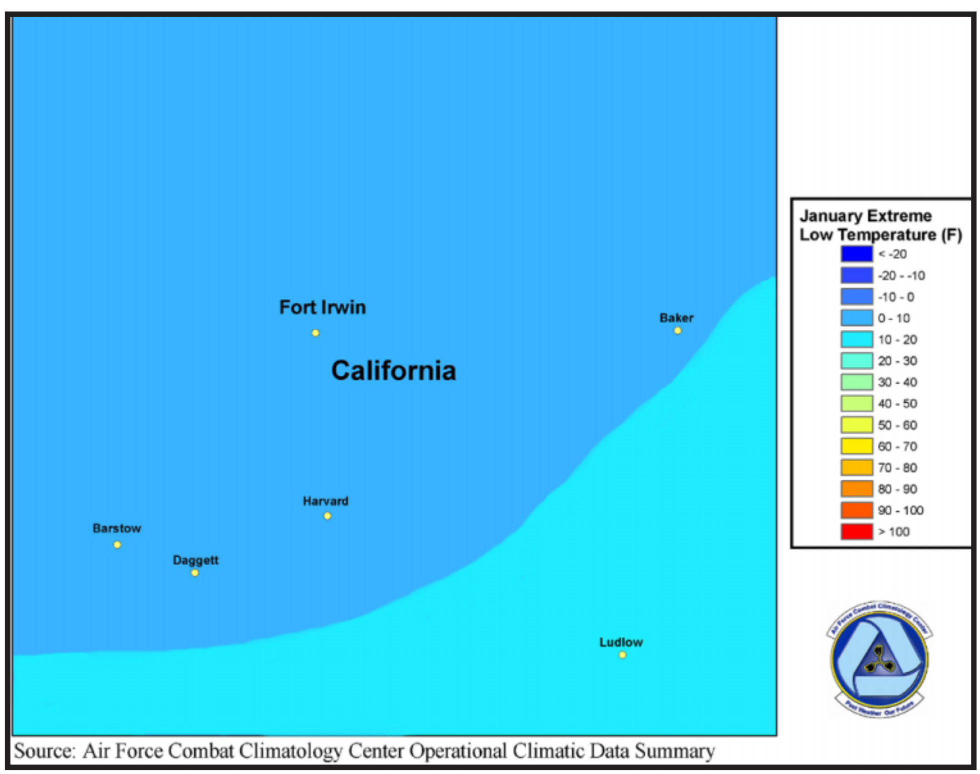


Figure 4d. January Extreme Low Temperature.

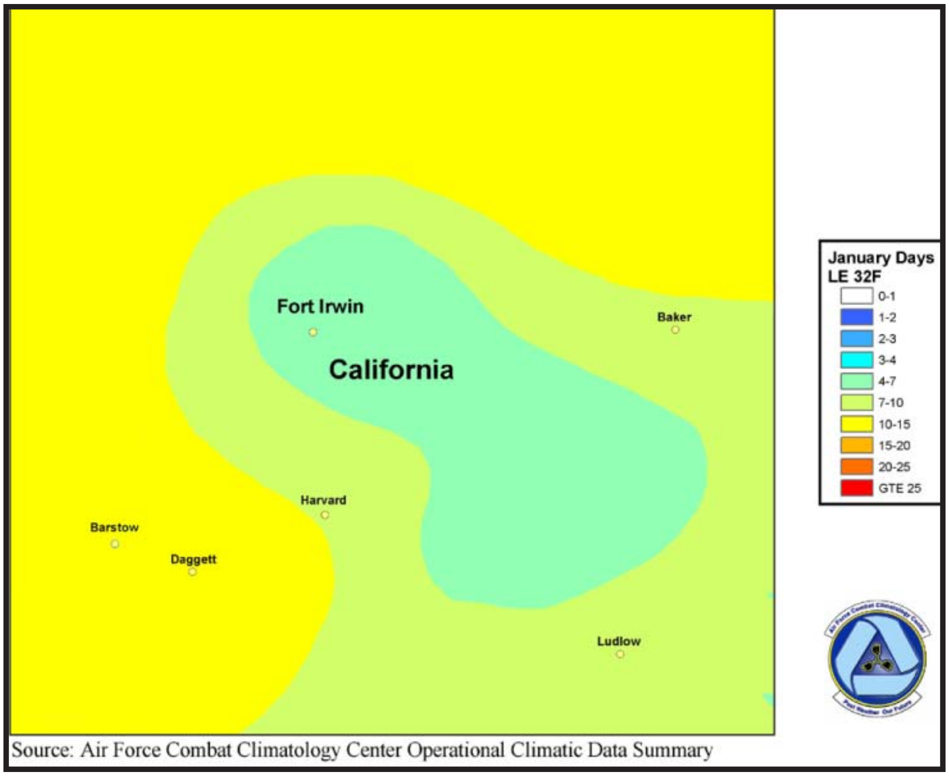


Figure 4e. January Days with Temperature Less Than or Equal to 32F.

SPRING (MARCH-MAY)

General Weather. Spring weather is a true mix of winter and summer systems. As the North Pacific and Bermuda high build back into the region, the cycle of storm systems that move down from the Gulf of Alaska slowly shifts northward. The North Pacific high is characterized by strong subsidence on the eastern side. This causes the air to become very hot and dry and contributes to the desert characteristics of the region. All the storm systems that occur in winter still occur in spring, but summer systems begin to take over by mid-April. Fronts occasionally move through but usually produce little weather. Winds increase 12 hours before the frontal passage to gust up to 25-35 knots, generally from the west. Skies will be overcast with ceilings of 4,000-5,000 feet with frontal passage, but these conditions usually last only 2-6 hours. March weather is much like that of winter and May weather is like that of summer. Rainfall remains limited in March and decreases in April and May toward the annual minimum in June. Temperatures warm quickly and diurnal temperature spreads increase as humidity decreases.

Santa Ana winds, while more prevalent In October-March have occurred all through spring in some years. These strong, hot winds are extremely dry and can carry a lot of dust into the area. Slant range visibility aloft is often more severely restricted, but ground visibility can be sharply reduced as well. Santa Anas increase the potential for serious fire hazards, can cause problems with equipment due to dust, and are dangerous to ground troops because of heat and dehydration issues.

Great Basin gale force winds blow from the north or northwest over the Mojave Desert. Winds have been reported as high as 85 mph in some places. Sand and dust storms are more likely to occur in the NTC area with these winds than with Santa Anas. Visibility in the areas most intensely impacted drops to just a few feet and sandblasting can seriously damage engines, rotors and other equipment. These wind events are most likely to occur in late winter and spring, but they can occur any time the same circumstances (high off the coast and low over the Great Basin) develop. A severe sand and dust storm event occurred in 30 April 1954.

Sky Cover. Mean cloud cover is scattered all season but there is less in May than in April or March. The sky is clear more than 50 percent of the time. The cloud types change from mostly stratiform types to mostly cumuliform clouds and high, thin cirrus. Rainshower and thunderstorm cloud bases, already high, rise as the temperatures warm and aridity increases. When thunderstorms develop over the mountains, the cirrus canopy, known as the anvil, spreads downwind of the storm.

Ceilings below 25,000 feet occur 20-30 percent of the time in March, with the highest rates at 09-17L. In April, they occur 15 percent of the time or less most of the day and 26 percent of the time at 12-20L. In May, they occur 10-15 percent of the time all day with the highest rates at 12-20L. Ceilings below 10,000 feet occur less than 10 percent of the time most of the days in March and a maximum of 15 percent of the time at 09-17L. In April and May, they occur 5 percent of the time or less all day, with little to no diurnal variation. Ceilings below 3,000 feet are very rare at all hours in March and April and are not reported at all in May. Ceilings below 1,000 feet are not reported in this season.

Visibility. Visibility is typically excellent all season. Although a light fog at sunrise is still possible along rivers in March and early April, it is not at all common and it quickly dissipates once the sun is well up. Dust is much more likely to restrict visibility, especially where human activity is greatest. Wheeled and tracked vehicles that move off road can cause dust restrictions of 3 miles (4,800 meters) or less that persist for hours in the immediate area of the activity. On windy days, they can kick up a dust haze that spreads over a larger area downwind and cause slight restrictions for as long as they continue to move. In periods of intense vehicle activity, visibility can be degraded to below 1 mile (1,600 meters) in the immediate area.

Fog that restricts visibility below 7 miles (11,000 meters) occurs on an average of less than 1 day per month in March and April and not at all in May. Blowing dust restricts visibility below 11,000 meters on an average of 1 day per month. At the observation site, visibility below 11,000 meters occurs 1-2 percent of the time at all hours in March and April and not at all in May. Visibility below 4,800 meters is not reported all season.

Winds. The complex terrain at the NTC causes funneled winds that can increase prevailing speeds by 10-15 knots. Calm conditions occur 10-15 percent of the time all season with the most occurrences at sunrise. Santa Ana and Great Basin winds are generally the strongest persistent winds but thunderstorm down rush gusts cause winds up to 55 knots. The strongest winds occur at the ends of valleys and passes where funneling occurs. Wind direction is largely governed by terrain and may be very different from place to place throughout the training area. Figure 5 is the April wind rose for Bicycle Lake, which is representative of the seasonal winds for this area.

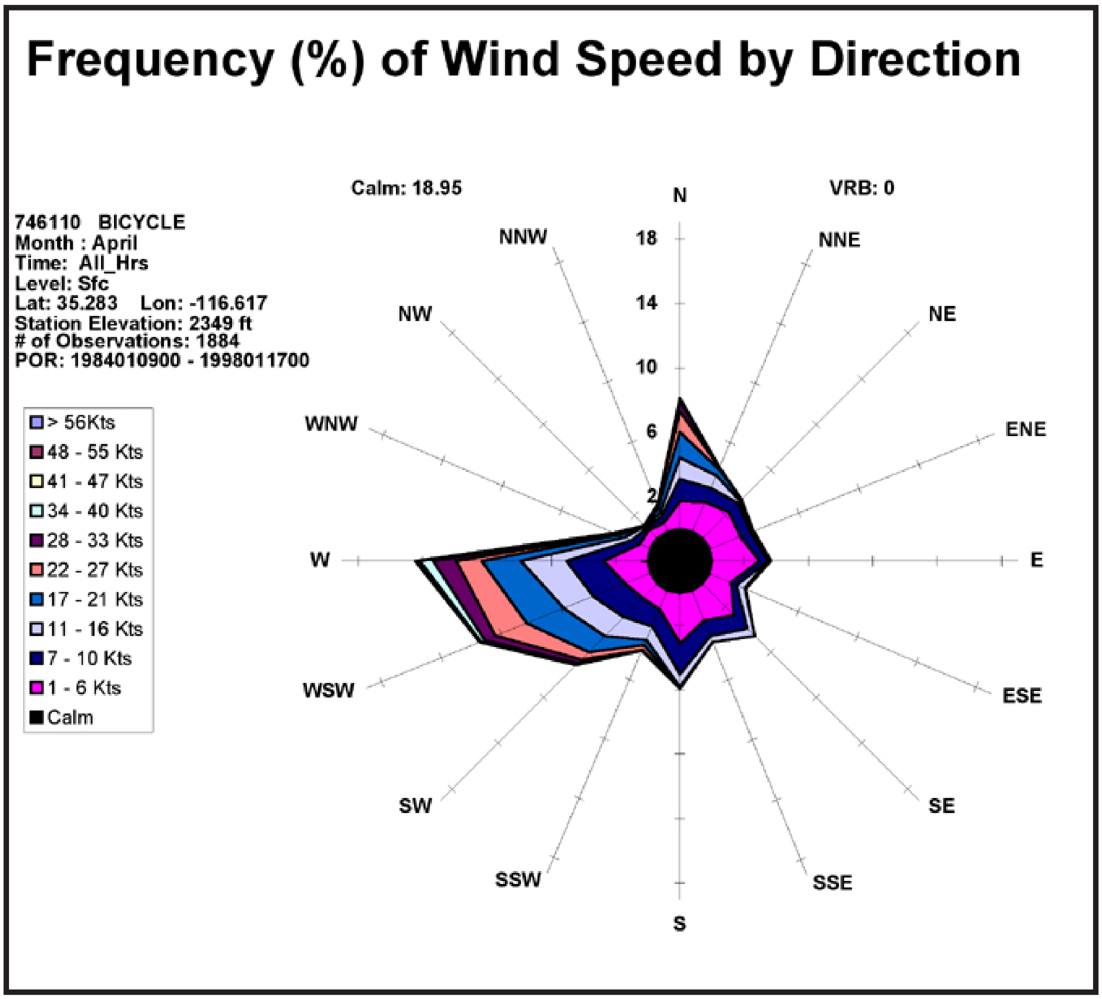


Figure 5. April Wind Rose for Ft Irwin/Bicycle Lake.

Precipitation. Rainfall decreases quickly in March as the winter storm track shifts northward out of the region. The summer monsoon is not yet in effect and there is only limited convection (rainshowers and thunderstorms) with passing late season cold fronts. Mean precipitation ranges from 0 to 0.5 inches (0 to 13 mm).

Temperatures. The days heat up quickly in this season and the average high is above 90F (32C) before mid April. The relative humidity decreases as temperatures rise, which increases the diurnal spread between the daily high and low temperatures. The progressively hotter and drier conditions begin to make ground troops vulnerable to disabling dehydration and heat-related illness. Mean high temperatures range from 70 to 80F (21 to 27C). Record highs reached 88F (31C) in March, 96F (36C) in April and 107F (42C) in May. Record lows reached 30F (-1C) in March, 34F (1C) in April and 38F (3C) in May. Figures 6a-d depict temperature statistics for April, a representative spring month.

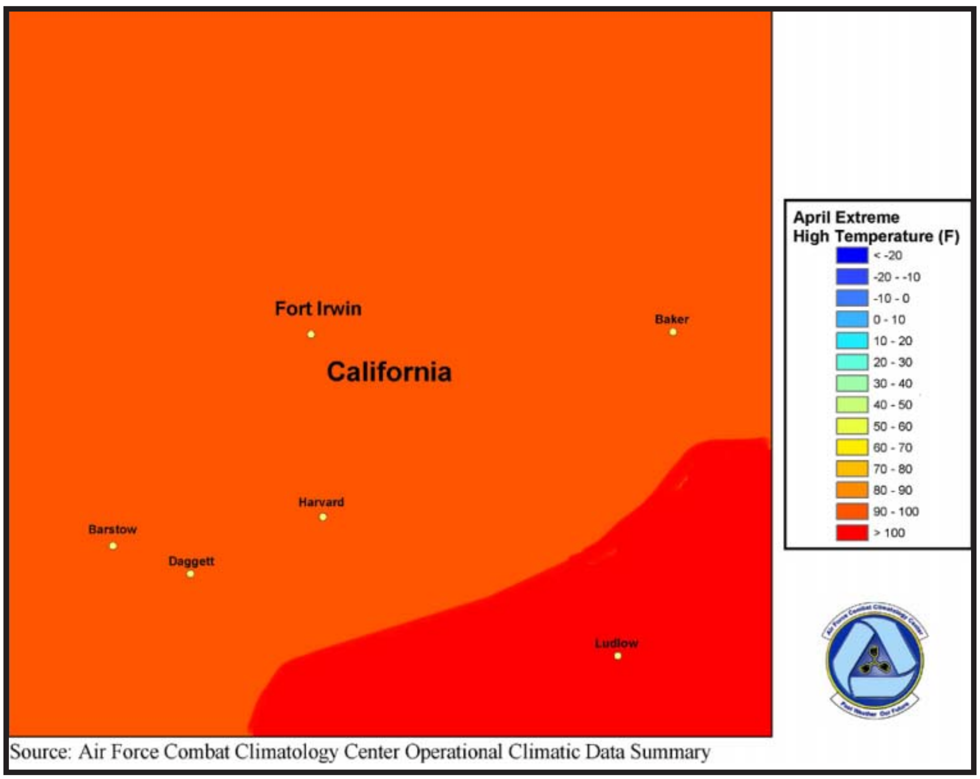


Figure 6a. April Extreme High Temperatures.

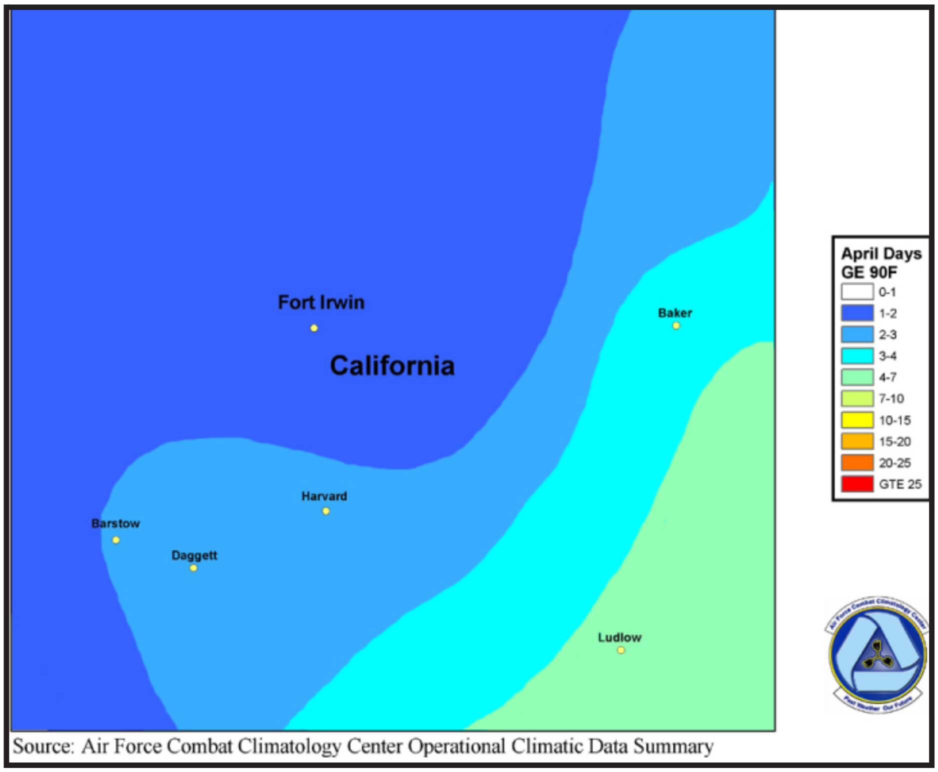


Figure 6b. April Days with Temperatures Equal to or Greater Than 90F.

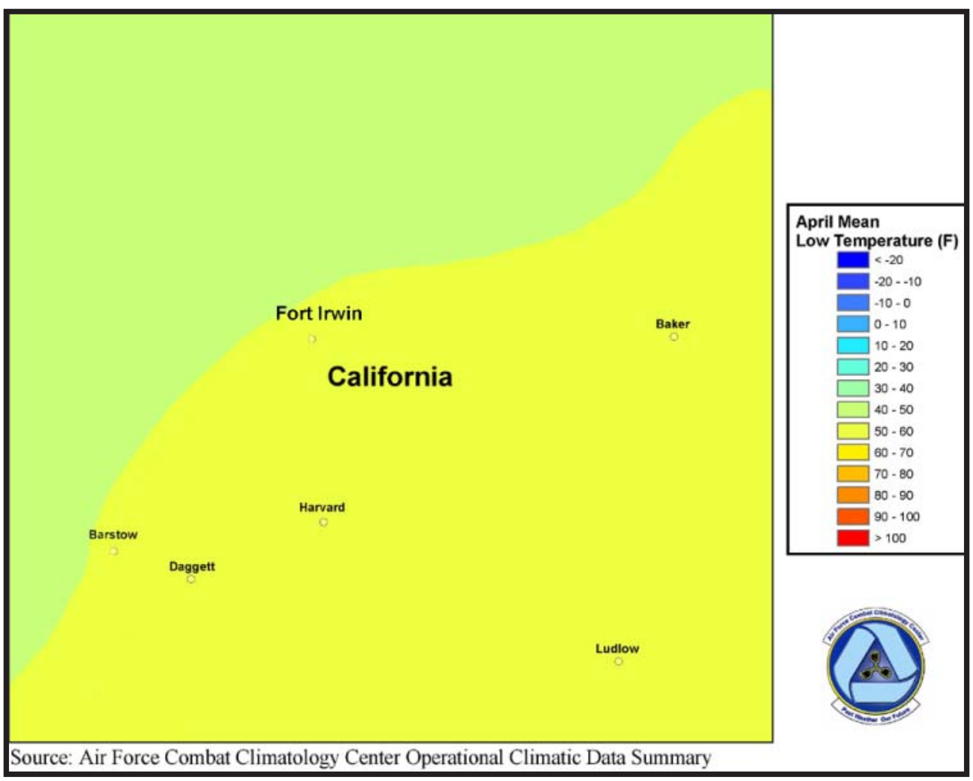


Figure 6c. April Mean Low Temperatures.

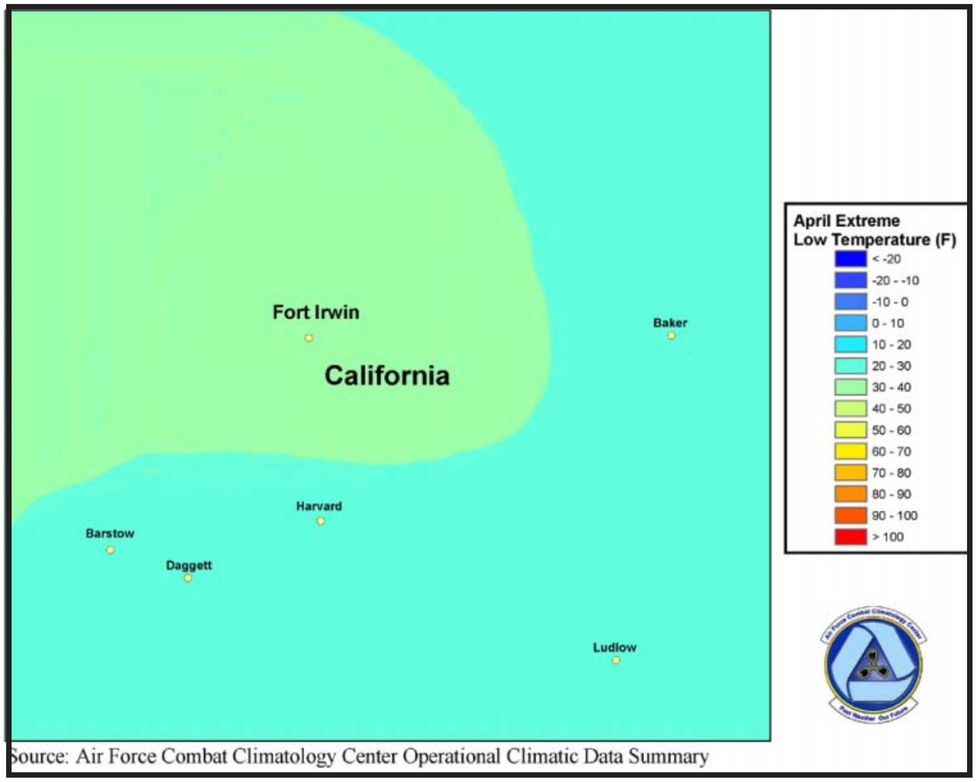


Figure 6d. April Extreme Low Temperatures.

SUMMER MONSOON (JUNE-SEPTEMBER)

General Weather. The North Pacific and Bermuda highs expand over the region and bring frequent clear skies and high temperatures. Summer is hot and dry in the Desert Southwest even though the summer monsoon brings rainfall to the region in the form of rainshowers and thunderstorms. The mountains in the area get the most rain, as this is where convective activity typically develops and expends most of its energy. Thunderstorms are high-based and often produce little more than virga (rain that evaporates before it hits the ground) over the lowlands because the air is so dry. Spectacular lightning displays frequently light the night horizon in late June through early September. The lightning from these dry thunderstorms can spark fires.

The monsoon is a period of thunderstorm and rainshower activity that results from the prevalent southeasterly flow in the region in July through early September. The flow comes from the Bermuda high, which reaches its maximum extent and intensity in this period. It carries tremendous moisture westward from the Gulf of Mexico at 8,000-12,000 feet. Combined with the valley breezes that flow up mountains and hills, and rising convective currents in blistering daytime heating, this moist flow fuels high-based convection that typically starts on mountain tops. It rapidly expands as outflow boundaries from these first storms converge and fire off more. The thermal trough that is over the Mexican and American deserts and separates the Bermuda and North Pacific highs contributes to the instability of the regime. Early markers for the onset of the monsoon are rising humidity and afternoon "popcorn" cumulus that begins to develop on the mountains. As the season gets closer, the cumulus gets larger and larger and eventually develops into thunderstorms. Another indicator is the steady westward spread of thunderstorm activity across Texas and then New Mexico, Arizona and, finally, California. Despite this, rainfall is still only comparatively heavy, relative to normally bone-dry conditions, in the valleys and basins. The moisture seldom reaches the desert floor, but helps produce thunderstorms over the San Gabriel Mountains to the south. Rain from these storms may cause flash floods in the training area. Figure 7 depicts the generalized large-scale flow during the monsoon season.

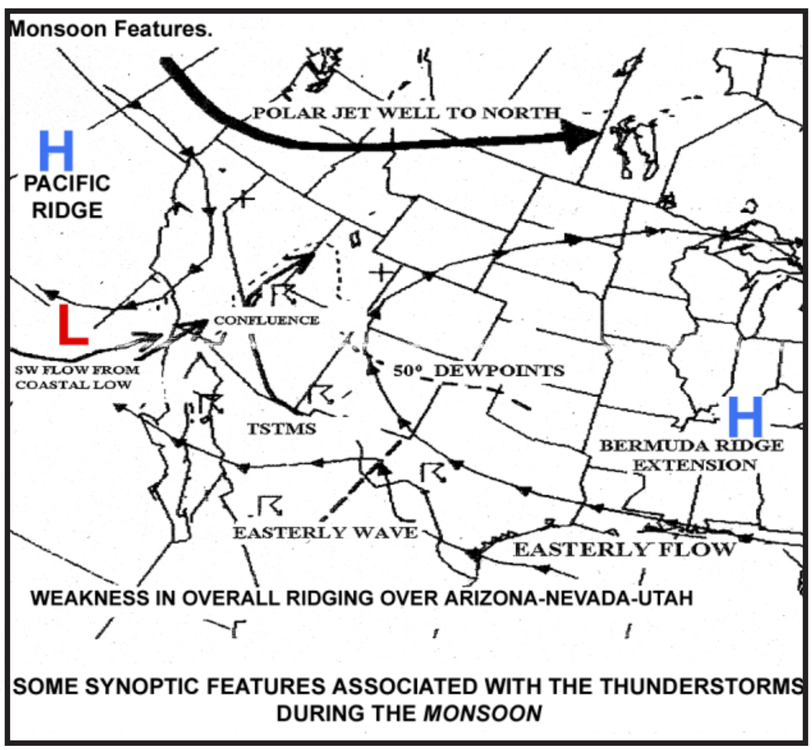


Figure 7. Typical Monsoon Set Up for the Region.

Thunderstorms can slide down the mountains into the valleys below after sunset but just as often, remain in the mountains where lightning fills the night sky for hours. The thunderstorms present a potential ground hazard apart from lightning, strong down rush gusts and occasional hail. Even if they never move down from the mountains, they still fill gullies, river and streams that are normally dry. This can happen very quickly and flash floods can occur in a valley or basin because of storms too far away to see or hear. It is not safe to camp or travel in dry riverbeds at any time of year, but it is particularly dangerous in the monsoon season. This is where the term "gullywasher," a term for flash flood-causing heavy rains, was born. Monsoon thunderstorms have dropped as much as 3-4 inches of rain within 24 hours, most typically within 6 hours, in this region.

On rare occasions, easterly waves that travel westward along the base of the Bermuda high have tracked into the area and produced heavy, even severe convective activity during the monsoon season. These rare storms tend to be the ones that produce the heaviest rainfall events. They are generally seen as lines of convection that are oriented north to south and travel rapidly westward.

Tropical cyclones that track northward from the south or southwest bring widespread precipitation and thunderstorm activity to the area. The storm tracks are those that move storms directly up the Gulf of California or up the Pacific coast toward southern California. Those storms that track directly up the Gulf of California produce the most rainfall and flooding in the desert southwest. These storm tracks are not the usual ones, however, there is a clear link between these tracks and strong El Niño events. During strong El Niños, the cold upwelling current is displaced northward and allows the storms that track up the coast to remain over warm water longer and, thus, be more intense and survive intact longer. Once there, they can be swept eastward by a passing long wave trough, which advects the storm moisture into the Southwest. Once again, the mountains absorb most of the moisture from these storms on their windward slopes but some rain does make it into the area.

Santa Anas or Great Basin winds, while not typical of summer, can occur in this season under the right conditions (see winter general weather description). These winds can rapidly spread fires started by dry thunderstorms. Winds can be very strong and funneling through northwest or north facing mountain passes contributes to the problem because it can increase winds by 15 knots or more. Sand and dust storms created by these winds can reduce visibility to near zero in the most intensely impacted areas, and cause serious mechanical problems with equipment.

Sky Cover. Mean sky cover is clear to scattered, with most cloud cover in thunderheads over the mountains or high cirrus. Low clouds are unknown outside of the occasional monsoon rainshowers or thunderstorms that reach peak activity in July and August. Middle clouds tend to occur only with rainshowers and thunderstorms. Ceilings below 25,000 feet occur 5-15 percent of the time all season. The highest rates occur at 15-20L and the lowest occur at 21-05L. Ceilings below 10,000 feet occur 5 percent of the time or less all season with lower rates overnight than during the day. Ceilings below 3,000 feet are not reported all season.

Visibility. Visibility is generally good to excellent. Although dust is the main cause of restrictions to visibility, it does not naturally limit it much below 5 miles (8,000 meters) on windy days or at all on calm or light wind days. Dust is much more likely to restrict visibility where human activity is greatest. Wheeled and tracked vehicles that move off road over the desert can cause dust restrictions of 3 miles (4,800 meters) or less that persist for hours in the immediate area of the activity. On windy days, they can kick up a dust haze that spreads over a larger area downwind and cause slight restrictions for as long as they continue to move. In periods of intense vehicle activity, visibility can be degraded to below 1 mile (1,600 meters) in the immediate area. At the observation site, visibility below 11,000 meters is very rare or is not reported all season. Visibility below 3 miles (4,800 meters) is not reported all season.

Winds. The prevailing winds in summer come from the south or south-southeast at 7-8 knots all season. Winds from these directions occur 30-40 percent of the time and reflect the summer monsoon winds that flow around the base of the Bermuda high. Calm conditions occur 10-15 percent of the time in June-August and 20 percent of the time in September. Calms are most likely at sunrise. Peak gusts reached 55-60 knots. The strongest winds of summer typically occur in down rush gusts under convection (rainshowers and thunderstorms). High-based or distant thunderstorms are still capable of producing surprisingly strong surface winds in the region.

The complex terrain at the NTC causes funneling of the winds that can increase prevailing speeds by 10-15 knots. The strongest winds occur at the ends of valleys and passes. Wind direction is largely governed by terrain and may be very different from place to place throughout the training area. Strong surface heating and funneling of winds through valleys can cause wind gusts up to 35 knots. Although they are uncommon in this season, Santa Anas or Great Basin winds cause strong winds that can persist for days at a time. They weaken somewhat at night and reach peak strength in the afternoons. Figure 8 is the August wind rose for Ft Irwin/Bicycle Lake. It is representative of the winds for the summer season.

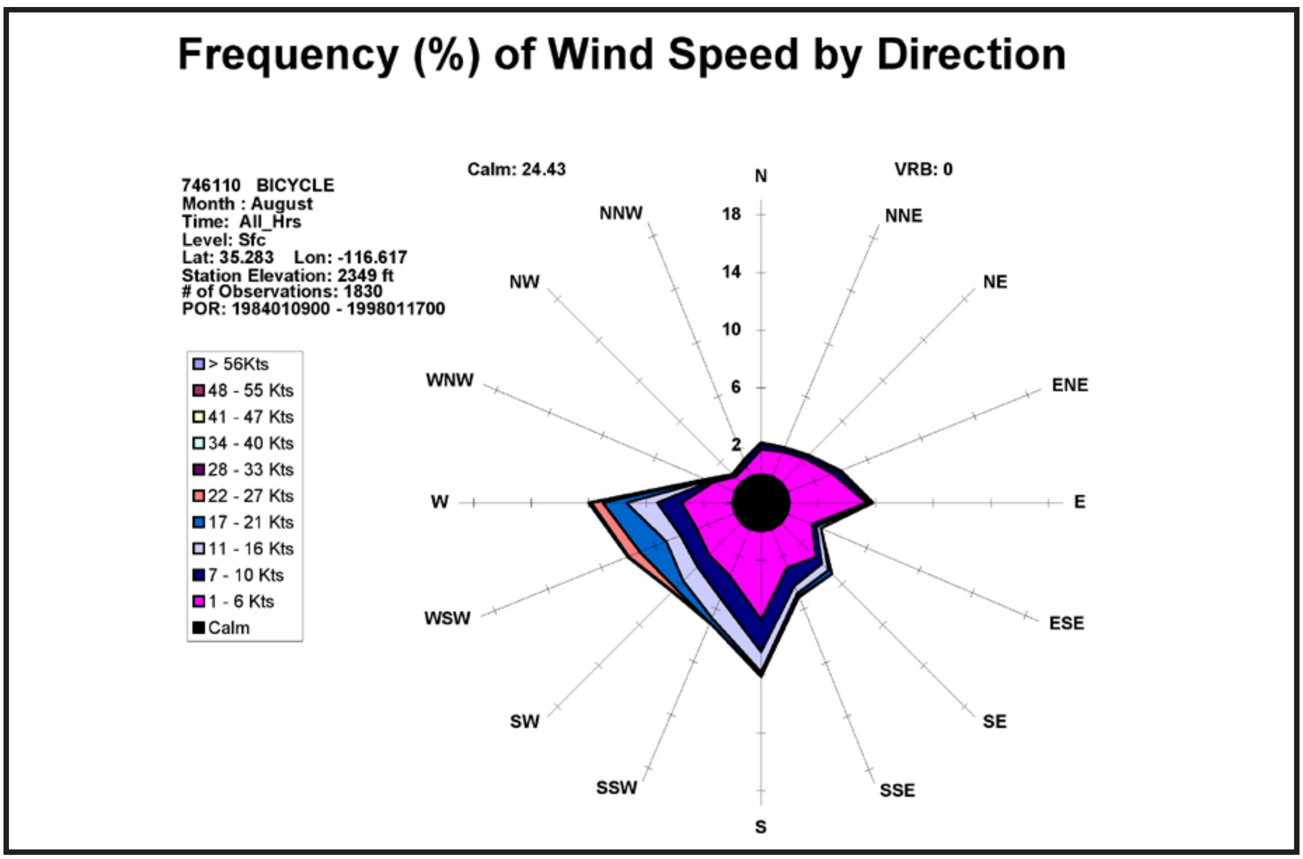


Figure 8. August Wind Rose for Ft Irwin/Bicycle Lake.

Precipitation. The area is typically pretty dry. Nearly all the rainfall occurs in rainshowers and thunderstorms over the mountains. Should a thunderstorm or heavy rainshower occur overhead, it is possible to get as much rain in an hour as is normal for the whole year. The ground is hard and resists absorbing water, so large puddles can develop quickly and only gradually disappear by evaporation under the hot sun. Distant storms or storms over the mountains may not produce rainfall on a particular site but can still produce flooding, particularly flash flooding there. Riverbeds, gullies and arroyos that are normally dry can fill to raging torrents with little to no warning and must be regarded as hazardous at all time. Mean precipitation ranges from 0 to 0.5 inches (0 to 13 mm) during August, which is a representative month for the summer.

Temperatures. Conditions are hot and dry all season and the occasional rainshowers and thunderstorms do little to nothing to break the heat. The higher relative humidity the rainfall brings makes it more uncomfortable but is not a long-term problem in this arid area. The diurnal temperature spread is typically 30 Fahrenheit (11 Celsius) degrees or more between the daily high and low temperatures. Since daytime temperatures are so high and the air is so dry, heat-related illnesses and dehydration are serious threats to ground troops. During the day, it is important to remember that the soil surface may be as much as 30 Fahrenheit (11 Celsius) degrees hotter than the air just above it. Area temperatures are above 100F (38C) every day. Record highs reached 107 to 113F (42 to 45C) all season. Record lows reached 45 to 46F (7 to 8C) in June and September and 56F (13C) in July and August. Figures 9a-d depict August temperature statistics, which represent summer conditions.

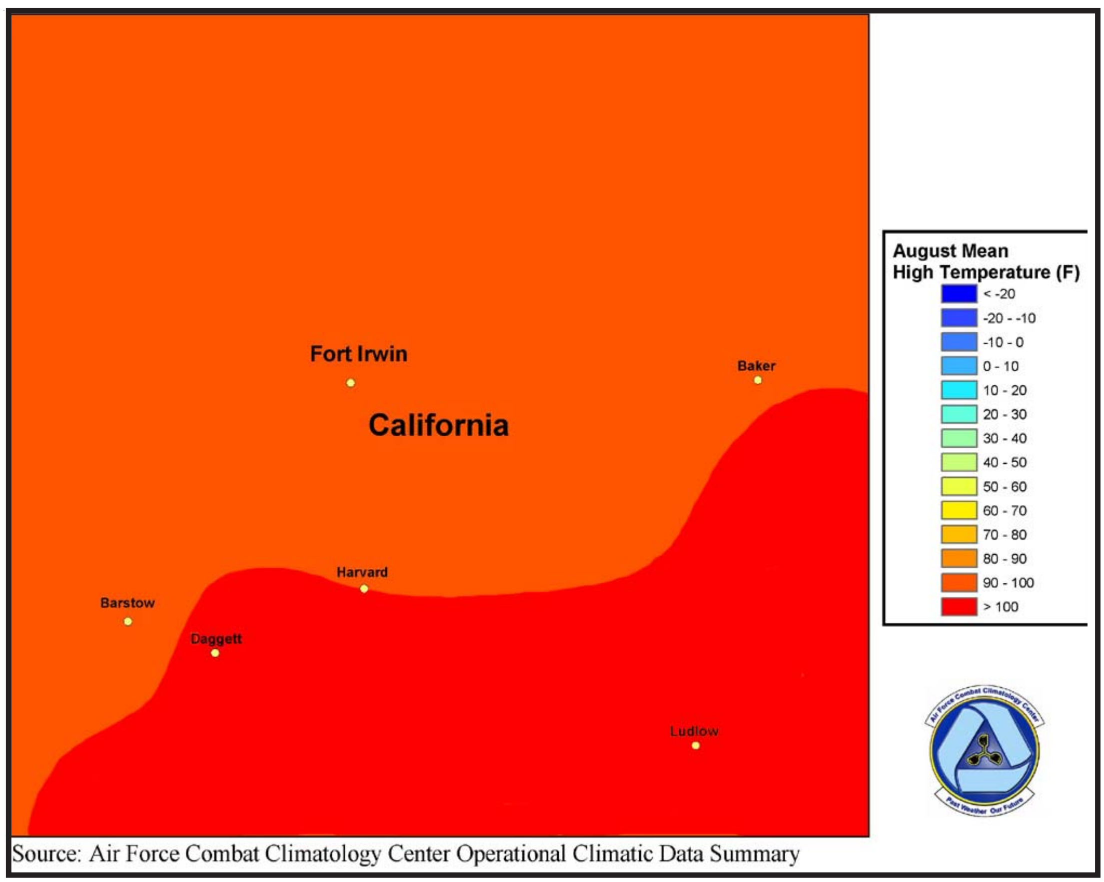


Figure 9a. August Mean High Temperature.

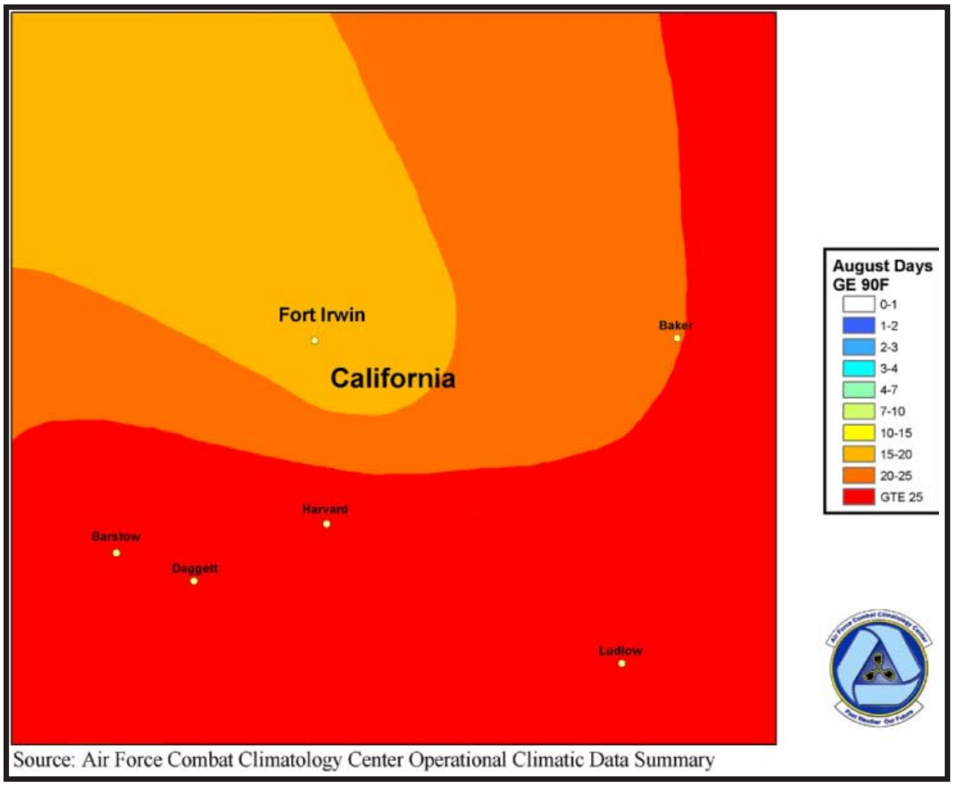


Figure 9b. August Days with Temperature Greater Than or Equal to 90F.

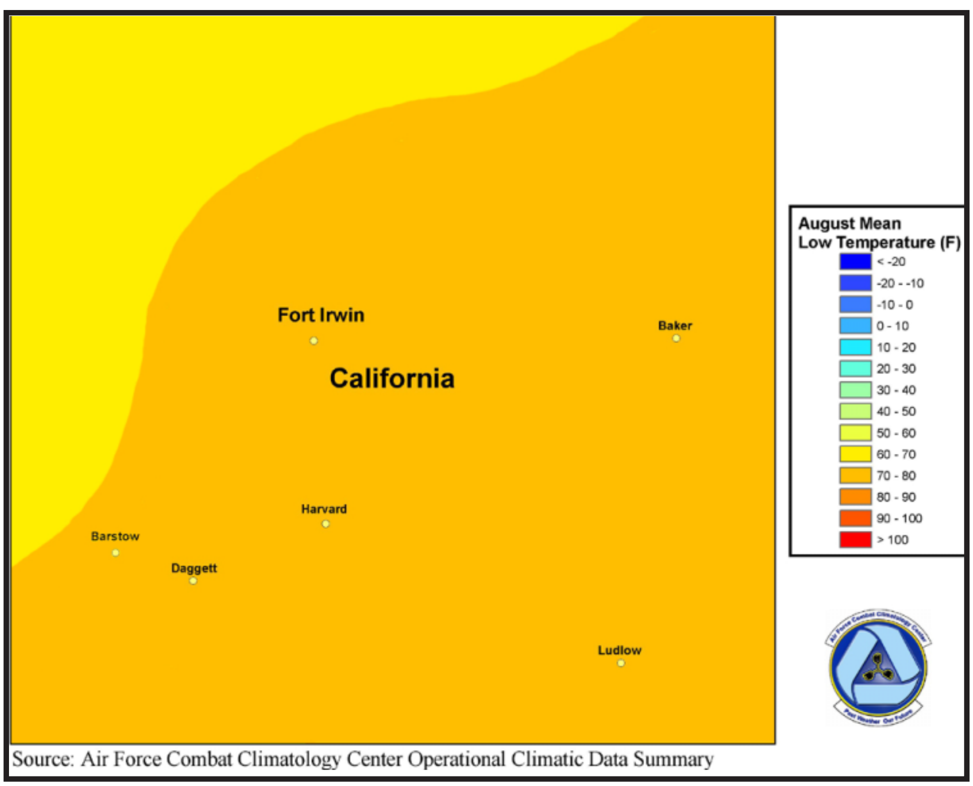


Figure 9c. August Mean Low Temperature.

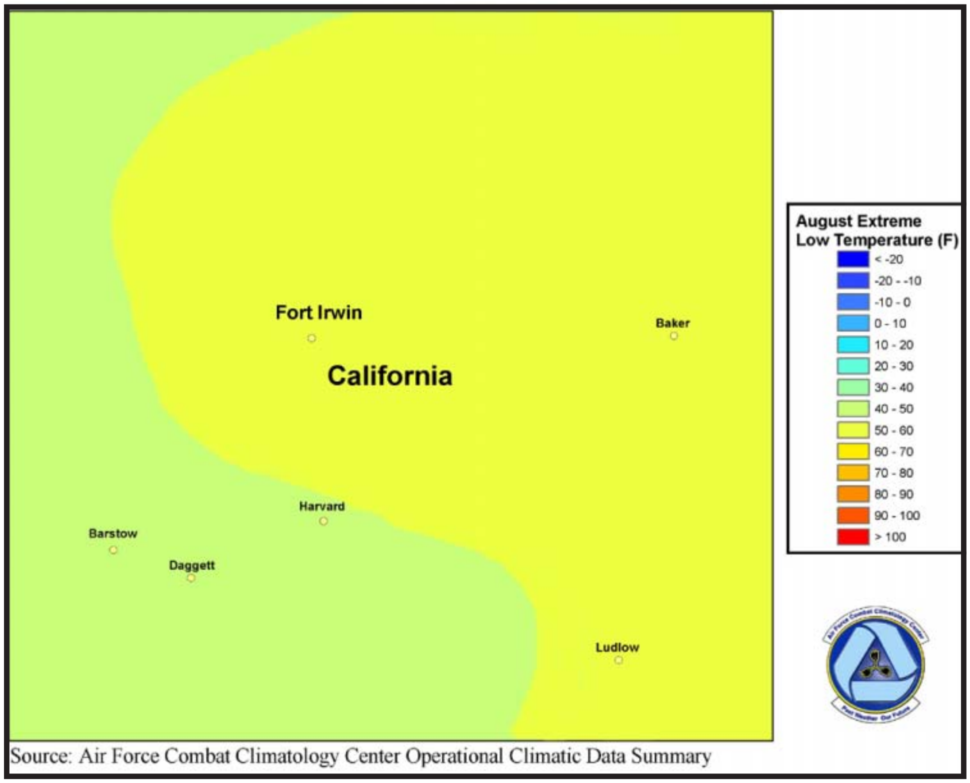


Figure 9d. August Extreme Low Temperature.

FALL TRANSITION (OCTOBER)

General Weather. Summer heat lasts nearly through this whole month yet the first signs of the coming winter season begin to be seen. Thunderstorm activity decreases to practically nothing as the monsoon flow disappears by early in the month. The retreat of the moist easterly flow from around the base of the Bermuda high can be followed with by the easterly retreat of the thunderstorm activity. The North Pacific and Bermuda highs weaken and retreat away from the area. This opens the door for deep troughs to begin to push farther and farther south as the Aleutian low deepens and expands. The first of the winter cold fronts sweep through north of Ft Irwin but get progressively closer as the month goes on. Cut-off lows and wave trains start to develop rainfall on the west coast and gradually shift farther and farther south in October.

The first of the cold season Santa Anas occur in October and these hot, dry winds can be very strong even now. They develop when a high over the Great Basin and a low off the southern California coast occur at the same time. The pressure gradient between the two systems sends powerful north or northeast winds across the deserts and through mountain passes into southern California. The passes augment the winds because of funneling and gale-force winds can persist for days or weeks at a time. The winds weaken at night and reach peak speed in the afternoons. Santa Anas sometimes carry a lot of dust and can restrict visibility both on the ground and in the air.

Great Basin winds can cause strong winds to blow from the north or northwest over the Mojave Desert. Sand/dust storms are more likely to occur in the NTC area with these winds than with Santa Anas. Visibility in the areas most intensely impacted drops to just a few feet and sandblasting by sand can seriously damage engines, rotors and other equipment. Although this is more likely to occur in winter than in other seasons, they can occur any time the same circumstances (high off the coast and low over the Great Basin) develop.

Sky Cover. The mean cloud cover is scattered through October, but there is a slight increase in high and middle cloud by the end of the month. The cloud types change from cumuliform to mostly stratiform types by the end of the month as well. Ceilings below 25,000 feet occur less than 10 percent of the time at 18-05L and 15 percent of the time or less the rest of the day. Ceilings below 10,000 feet occur 5 percent of the time all day. Ceilings below 3,000 feet are not reported in this month.

Visibility. Visibility is generally good to excellent all season. The main cause of visibility restrictions continues to be dust. Wind blown dust is far less of a problem than dust raised by tracked and wheeled vehicles over the arid terrain. Depending on the amount of vehicle traffic and the strength of the wind, visibility can be reduced to a mile (1,600 meters) or less in the immediate area of activity and to less than 3 miles (4,800 meters) within 1-3 miles (1/2-5 km) of the area. Dust lifted by wind alone rarely decreases visibility below 5 miles (8,000 meters). Although morning fog is possible, it is quite uncommon even around the seasonal rivers. It is light, and dissipates quickly soon after sunrise. Fog restricts visibility below 7 miles (11,000 meters) on an average of less than 1 day in October. Blowing dust restricts visibility below 11,000 meters) on an average of less than 1 day all month as well. At the observation site, visibility below 11,000 meters is rare all day and visibility below 3 miles (4,800 meters) is not reported.

Winds. The end of the summer monsoon is marked by the change of southerly winds to northerly. This occurs in late September or early October. The prevailing winds in October are light and calms occur often, roughly 25-30 percent of the time. This rate depends on location. The more sheltered a site is, the higher the rate of calm conditions. The peak gusts reached 42 knots. The strongest wind gusts still occur in down rush flow under high-base thunderstorms, but winds behind cold fronts begin to increase by late in the month. Santa Anas or Great Basin winds have the highest persistent winds. Funneled winds can exceed prevailing speeds by 10-15 knots. The strongest winds occur at the ends of valleys and passes. Wind direction is largely governed by terrain and may be very different from place to place throughout the training area. Varying winds can be a hazard to low-level air operations. Funneling of winds through valleys can cause wind gusts up to 35 knots. Figure 10 is the October wind rose for Ft Irwin/Bicycle Lake, which is representative of winds in the area.

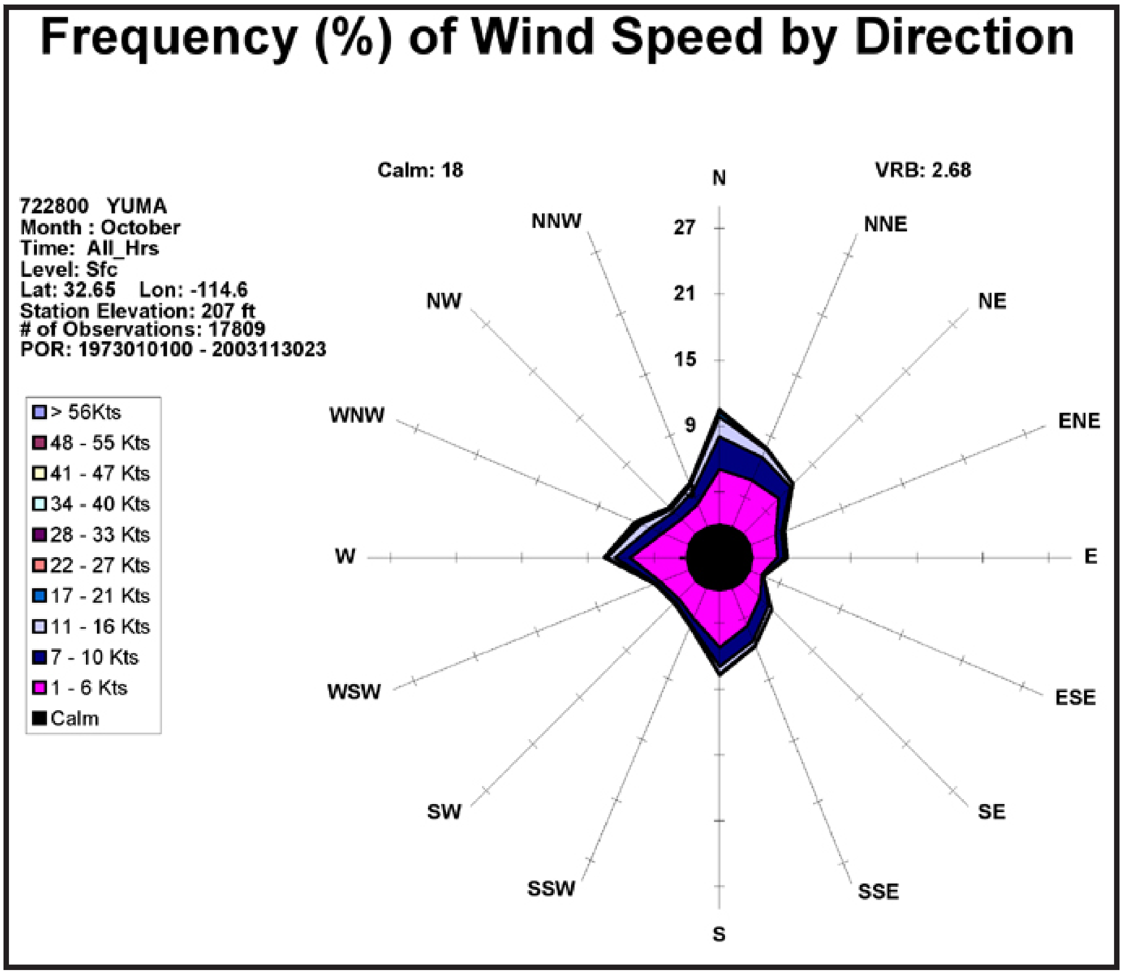


Figure 10. October Wind Rose for Ft Irwin/Bicycle Lake.

Precipitation. Summer monsoon thunderstorms disappear in October as southerly winds retreat eastward. It is still possible for a thunderstorm or rainshower to produce a brief period of heavy rainfall over a small area, which would cause localized flooding. The retreat of the monsoon rains can be tracked eastward across Arizona into New Mexico and then Texas. By the middle of the month, the monsoon convection is gone and the first of the early winter storm systems begin to sweep cold fronts north of the area. These rarely make it far enough south to reach this area with rainfall, but precipitation has occurred on occasion. El Niño years are when cold fronts are most likely to reach this far south in October. Mean precipitation ranges from 0 to 0.5 inches (0 to 13 mm).

Temperatures. It is still hot in October, but the worst is generally over by mid month. As the monsoon southerly winds disappear, the relative humidity drops and the comfort level rises a bit. The diurnal temperature spread is still quite large, an average of 30 Fahrenheit (11 Celsius) degrees between the daily highs and lows. Although temperatures are beginning to cool down, the threat of dehydration and heat-related illness still exists for ground troops. The record high at Ft Irwin reached 100F (38C) and the record low reached 31F (-1C). Extreme highs in the area range from 107 to 115F (42 to 46C) at most places. Mean low temperatures range from 40 to 50F (4 to 10C). Figures 11a-b depict October temperature statistics.

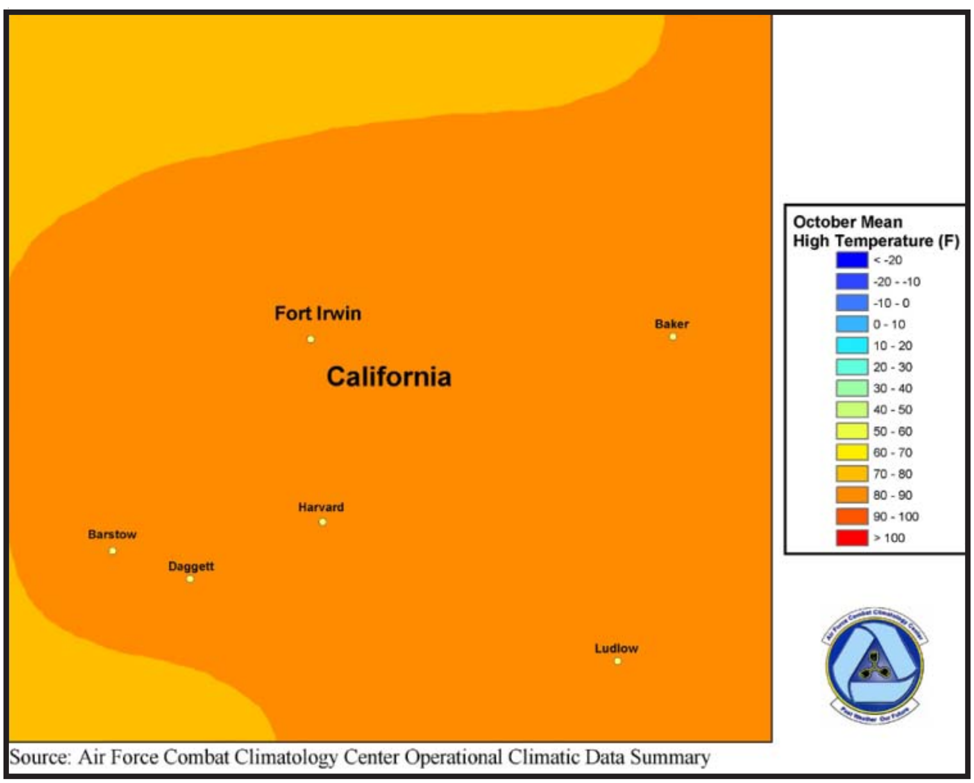


Figure 11a. October High Temperatures.

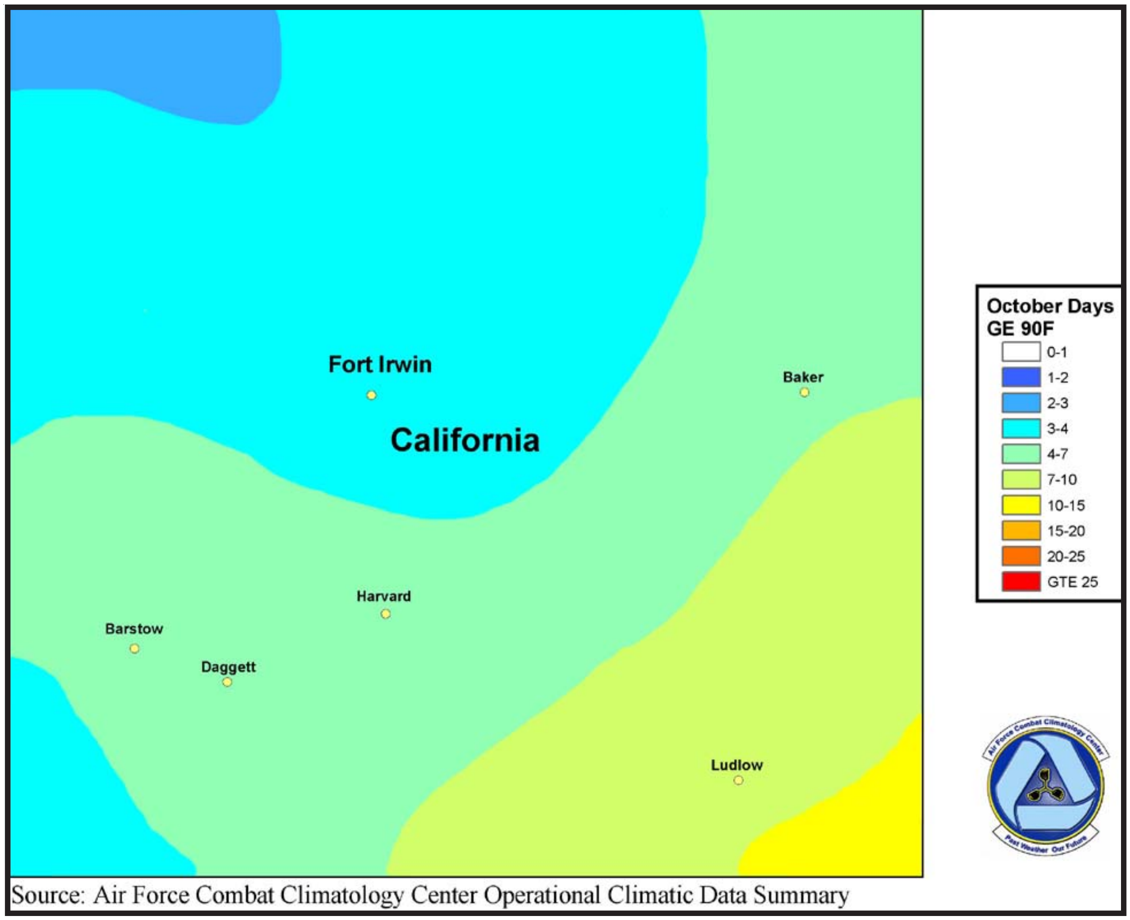


Figure 11b. October Days with Temperatures Greater Than or Equal to 90F.

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