

Border Climate Summary

Resumen del Clima de la Frontera

Issued: April 30, 2009

Assessing the impact of global climate change on the borderlands: the case of valley fever

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A new project is under development to assess the impact of climate changes on the distribution and epidemiology of *Coccidioidomycosis*, also known as San Joaquin Valley fever, a disease that is common in northwestern Mexico and the southwestern United States.

Coccidioidomycosis is primarily an endemic disease of the lungs caused by fungi of the genus *Coccidioides* (Baptista-Rosas and Riquelme 2007). Within the U.S., approximately 200,000 new valley fever infections occur each year; about 1 percent of these infections results in death

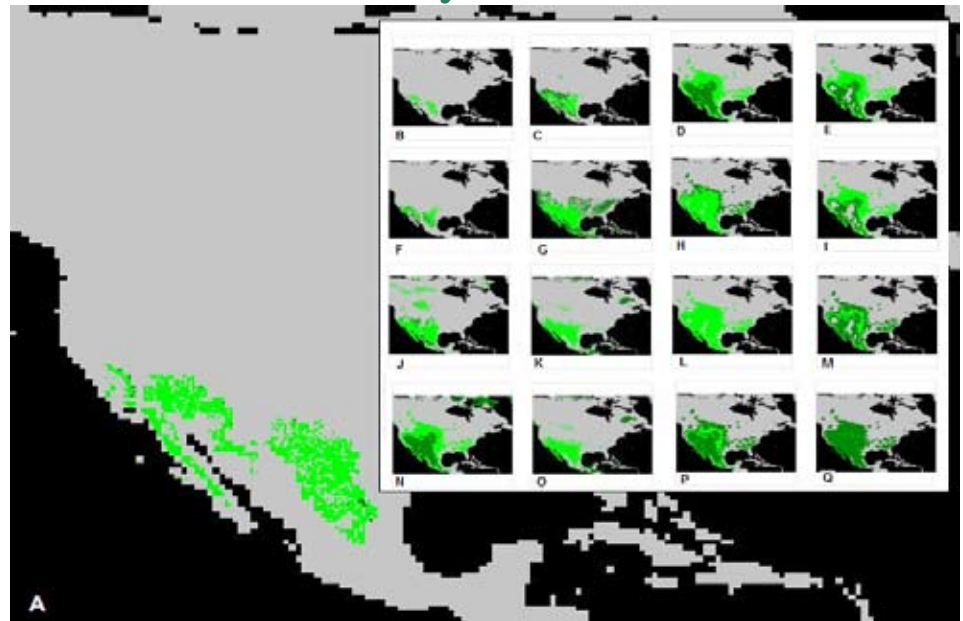


Figure 1. Map A shows the location of valley fever (*Coccidioides spp.*) in North America. The map is generated using a method called ecological niche modeling, which uses climate data and topography as input variables. Fifty spatially-referenced registries of fungi, isolated in soil samples, were used to establish initial geographic locations of valley fever. Inserts B-Q show the potential distribution of valley fever using different algorithms, climatic variables, and climate scenarios; dark green indicates higher chances of valley fever incidence. For more details about ecological niche modeling methodology, see Baptista-Rosas et al. 2007.

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(Buckley 2008). Humans, dogs, coyotes, cattle, snakes, and a number of other animals can become infected if they inhale an airborne spore from the microscopic, soil-dwelling fungus.

Climate is one of the most important factors related to changes in the distribution and incidence of the disease. Increases in the prevalence and incidence rates have been reported for more than 15 years in the U.S. and correlated to rainfall in regions that are typically dry (Kolivras and Comrie 2003, Park et al. 2005; Zender and Talamantes 2006). The available evidence shows that disease outbreaks occur a year or two after a period of above-average rainfall following a prolonged drought (Comrie

2005). The current epidemiological status of the disease and its relation to climate in arid northern Mexico, however, has not been extensively studied.

The southwestern U.S. and northwestern Mexico, including the peninsula of Baja California, are extremely vulnerable to global climate change impacts. Regional climate models indicate an increase in the frequency of extreme weather events, such as high temperatures, prolonged droughts, and extreme rainfall (Differbaugh et al. 2008).

The changes in rain patterns and increase in drought frequency have been correlated with the epidemiology of

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Executive Summary

In General – A weak La Niña episode in the tropical Pacific Ocean generated dry winter conditions in most of the Mexico-United States border region. February was an exceptionally dry month. Southern California and northern Baja California received above-average precipitation during the winter months. Servicio Meteorológico Nacional (SMN) predicts below-average border region precipitation for the spring and above-average border region precipitation for the summer.

Temperature – December–February seasonal temperatures were near average for the border region, with the exception of the area centered on northern Chihuahua, Southern New Mexico, and West Texas.

Precipitation – Winter precipitation was mostly below average across the border region. A late February storm brought significant precipitation to the California-Baja California del Norte border region.

Precipitation Forecast – SMN forecasts predict below-average border region precipitation for the duration of the spring, with the exception of the California-Baja California del Norte border region. Forecasts predict average to above-average precipitation across most of the region as the monsoon kicks in.

ENSO – La Niña conditions appear to be diminishing, and forecasts call for a transition to more neutral tropical Pacific Ocean temperatures, which generally makes forecasting more difficult.

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Funding for the Border Climate Summary/Resumen del Clima de la Frontera was provided by Inter American Institute for Global Change Research (IAI) and the NOAA Sector Applications Research Program.

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Valley Fever, continued

Coccidioidomycosis in previous studies (Comrie 2005; Park et al. 2007; Zender et al. 2006). This relationship indicates the potential for future changes in the incidence and spatial redistribution of *Coccidioidomycosis* in endemic areas.

The project, Impact of Global Climate Change on the Incidence and Prevalence of *Coccidioidomycosis* in Baja California, Mexico, is currently being developed by the Department of Microbiology at the Center for Scientific Research and Higher Education of Ensenada (CICESE) with funding from Mexican agencies, including the Secretary of Environment and Natural Resources (SEMARNAT) and the National Council for Science and Technology (CONACyT). The project will assess potential scenarios for changes in the distribution and incidence of *Coccidioidomycosis* (Figure 1). The scenarios are based on projections of regional climate changes that are being generated by the State Climate Action Plan for Baja California (PEAC-BC). Research centers and academic institutions, such as CICESE, the Autonomous University of Baja California (UABC), and the Colegio de la Frontera Norte (COLEF), among others, are participating in the project. They are also working to promote the implementation of concrete measures and strategies to address regional vulnerability to climate changes and emerging diseases of importance to the border region between Mexico and the U.S.

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Arizona Wells

By KATE SAMMLER, DEPARTMENT OF ATMOSPHERIC SCIENCES, UNIVERSITY OF ARIZONA

Groundwater is an important and valuable source of water, especially in the deserts of the southwestern United States. Many private and municipal entities tap into this vital public resource by drilling wells. Concern about chemical contamination and sustainability of water resources motivate data collection by groups and agencies. Well water monitoring can tell developers or farmers about the depth to which they may need to drill a well, and can inform policy makers and others about how drought or municipal water use is affecting groundwater supplies. The Arizona Wells website collects information from the Arizona Department of Water Resources (ADWR, <http://www.azwater.gov/dwr/>) and the U.S. Geological Survey (USGS, <http://www.usgs.gov/>) and makes it available in an easy-to-use interface on the Internet (Figure2).

The Arizona Wells project is a collaborative effort between ADWR, USGS, and The University of Arizona-affiliated Sustainability of semi-Arid Hydrology and Riparian Areas (SAHRA, <http://www.sahra.arizona.edu/>). The project aims to get information about wells to homeowners, water professionals, and state agencies in Arizona. Well data are compiled from field measurements made by ADWR and USGS and mandatory well registrations collected in the ADWR Wells 55 database.

An interactive website developed by SAHRA allows users to determine the location, ownership, water levels,

continued on page 4



Arizona Wells, continued

and water quality of wells throughout Arizona. A Google map display helps users easily navigate the state's wells. Many search criteria are available to narrow down wells by geographical location, data provider, or keyword. To find a well by location, users can enter a city, address, zip code, or latitude and longitude coordinates, or simply select sections of the map. Wells also can be

searched by owner, well ID number, or by one of several measured variables, such as water quality, depth to water, and pumpage.

Once a well is selected, a wealth of information is available, depending on the well and agency or individual providing the information. This can include a time series of well depths, water quality and

depth, annual reported well pumpage, and pump type. Several types of water quality information are presented such as biological, organic, inorganic, and radiochemical content. No data is available for wells outside of Arizona on this Web site. To contact the Arizona Wells project, email comments or questions to email@arizonawater.org, or call 520-626-0592.

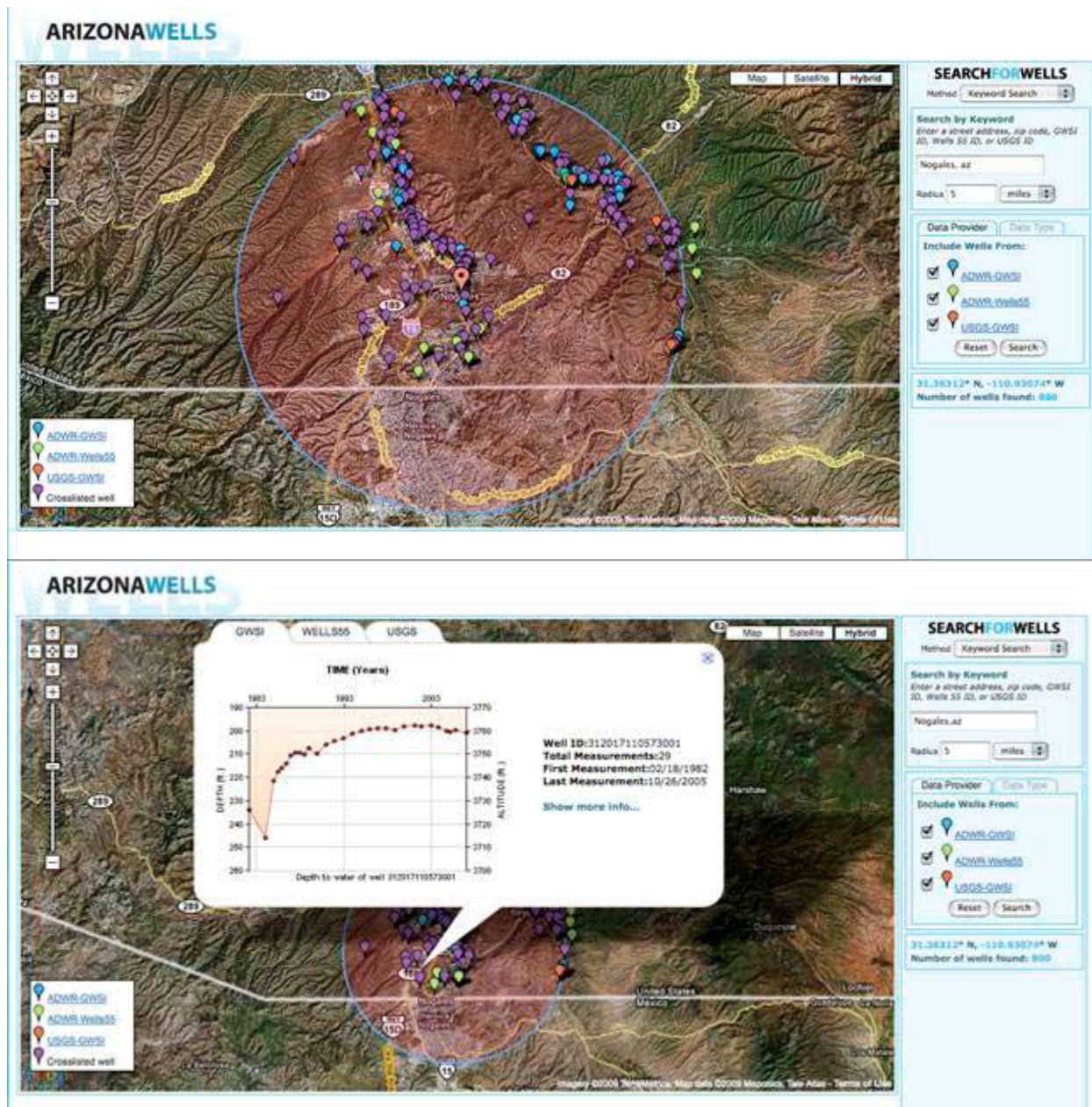


Figure 2. (Top) A selected radius of wells around Nogales, AZ, from the Arizona Wells interactive website. The search menu on the right allows the user to choose from many search criteria. Zoom options on the left can be used to manually choose a region. The red circle in the top figure indicates the well for which a graph of depth to groundwater (bottom figure) was produced by the Arizona Wells website (<http://www.sahra.arizona.edu/wells/> accessed 2/23/09).



Temperature

In much of the border region, February temperatures were 0–2 degrees Celsius above average (Figures 1a–b), whereas seasonal temperatures for December through February were near average, except near the Chihuahua-Texas border and throughout New Mexico where they were 1–2 degrees Celsius above average (Figures 1c–d). December was a chilly month along the west coast of the border region, with temperatures several degrees below average in San Diego. January temperatures were particularly warm in eastern Arizona, across New Mexico, and into southern Texas, where average monthly temperatures were among the highest on record. Tucson, Arizona, set a new daily minimum temperature record in January. February was also warmer than average in the same area, though a storm during the second week of February temporarily dropped temperatures. Persistent high

pressure off the west coast of North America was responsible for the higher- than-average temperatures. This was a typical response to the La Niña episode occurring in the tropical Pacific Ocean, particularly for the Chihuahua-West Texas-southeastern New Mexico region.

Notes:

Maps of recent temperature conditions were produced by the National Oceanic and Atmospheric Administration's Climate Prediction Center (NOAA-CPC). Temperature anomalies refer to departures from the 1971–2000 arithmetic average of data for that period.

Figure 1a. Mean temperature at 2-m elevation for February 2009.

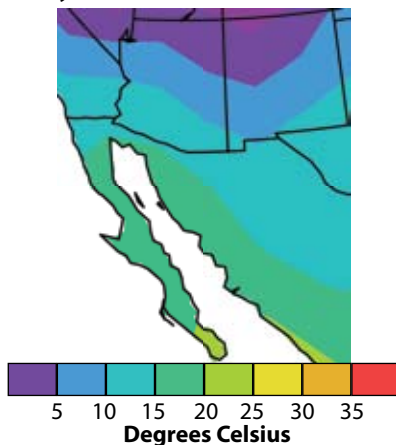


Figure 1c. Mean temperature at 2-m elevation for December 2008–February 2009.

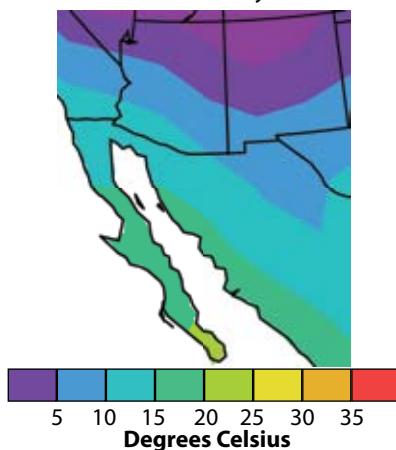


Figure 1b. Mean temperature departure from 1971-2000 average at 2-m elevation for February 2009.

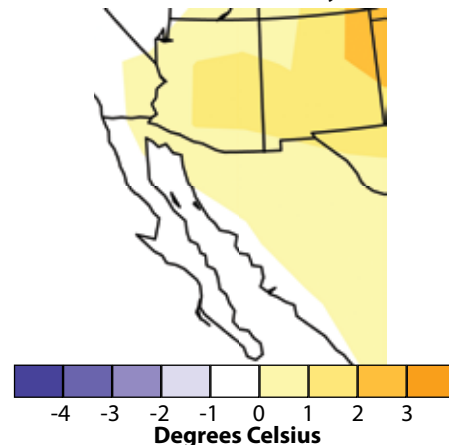
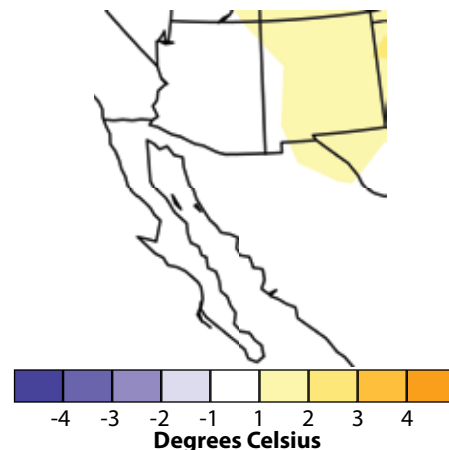


Figure 1d. Mean temperature departure from 1971-2000 average at 2-m elevation for December 2008–February 2009.



On the Web:

For more information:

http://www.cpc.ncep.noaa.gov/products/Drought/Atm_Circ/2m_Temp.shtml



Precipitation

If the recent precipitation maps (Figures 2a–2d) resemble each other, it is because the precipitation during this period came primarily in two bursts—in mid- to late-December and in early February—and affected the western portion of the border region. A frontal storm that lingered from February 5 to 9 generated precipitation primarily in the coastal areas of Southern California and northern Baja California Norte (Figures 2a–c), but did not affect the more eastern portions of the border region. Winter seasonal precipitation was far below average for most of northern Mexico, with the exception of Baja California Norte (Figures 2b and 2d). For most of the region, this pattern of exceedingly dry conditions and below-average precipitation is consistent with La Niña and matches the forecast made by Servicio Meteorológico Nacio-

nal in December. The state of California remains in a severe multi-year drought, which was first declared by Governor Arnold Schwarznegger in June.

Notes:

Maps of recent precipitation conditions were produced using data from the National Oceanic and Atmospheric Administration's Climate Prediction Center (CPC). Precipitation anomalies refer to departures from the 1971–2000 arithmetic average of data for that period. Percentage of normal is masked out where normal precipitation is less than 0.1 mm per day.

Figure 2a. United States and Mexico precipitation for February 2009.

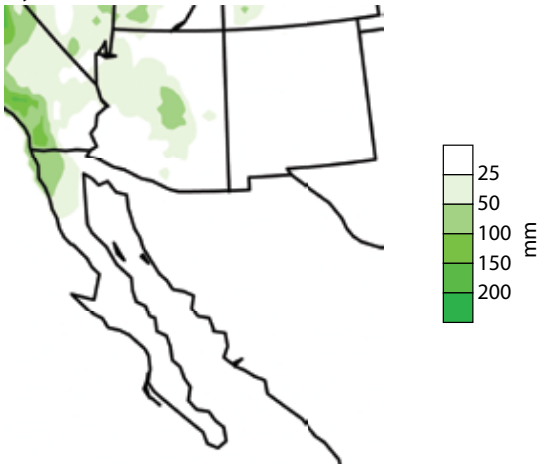


Figure 2b. United States and Mexico precipitation for December 2008–February 2009.

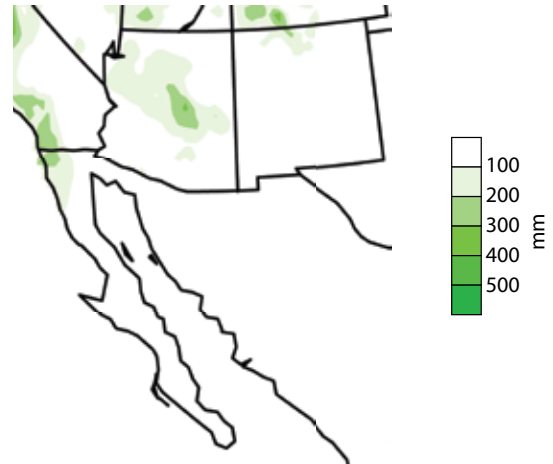


Figure 2c. United States and Mexico precipitation percent of 1971–2000 average for February 2009.

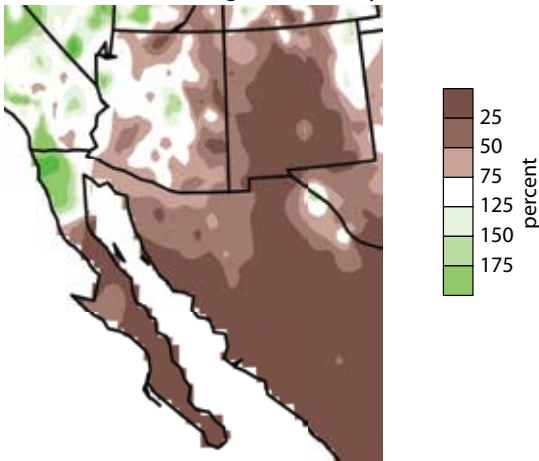
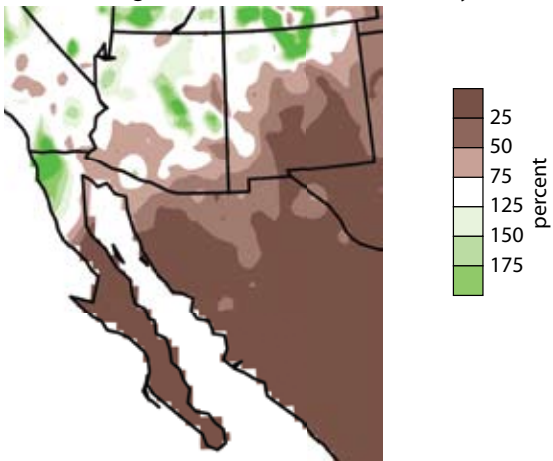


Figure 2d. United States and Mexico precipitation percent of 1971–2000 average for December 2008–February 2009.



On the Web:

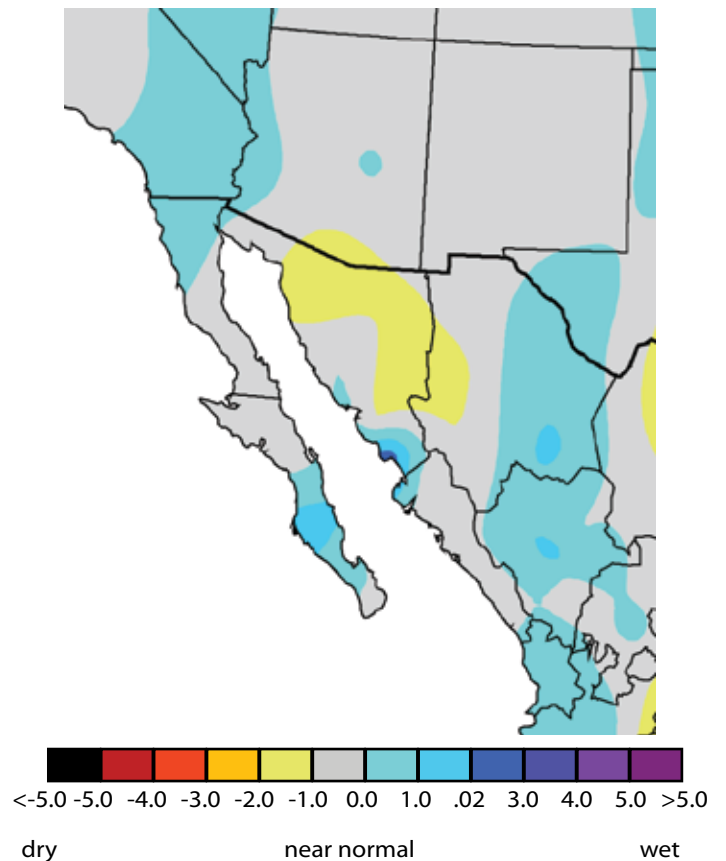
For more information:
http://www.cpc.ncep.noaa.gov/products/Drought/Atm_Circ/2m_Temp.shtml



Standardized Precipitation Index

The September 2008–February 2009 Standard Precipitation Index (SPI; Figure 3) indicates Southern California, most of Arizona, southern Sonora, and western Texas have received near-average precipitation for this six-month period. Much of northern Mexico and New Mexico, however, have received less-than-average precipitation during the last six months. Near-average SPI values for southern Sonora reflect a combination of extraordinarily wet conditions generated by tropical storms last fall and exceedingly dry conditions generated by this winter's La Niña. The SPI map is in sharp contrast with the map shown in the January Border Climate Summary, which covered June–November 2008, indicating substantial intensification of drought since the end of December. Official U.S. National Weather Service weather stations in places like Roswell, New Mexico; El Paso, Texas; and Del Rio, Texas, received less than 60 mm (0.25 in.) of precipitation between December 1 and February 28.

Figure 3. Standard Precipitation Index for September 2008– February 2009.



Notes:

Source: NOAA National Climatic Data Center and Servicio Meteorológico Nacional.

The Standardized Precipitation Index (SPI) expresses precipitation in units that correspond to a normal or “bell-curve” statistical distribution. The values are standardized so that an index of zero indicates the average precipitation. The index values correspond to standard deviation units. This gives the user an immediate sense of how recent precipitation compares with the historical record. The index is negative for drought, and positive for wet conditions. As the dry or wet conditions become more severe, the index becomes more negative or positive. The use of a common statistical distribution allows users of the SPI to compare drought severity across regions with markedly different climates.

The National Oceanic and Atmospheric Administration (NOAA) and Servicio Meteorológico Nacional (SMN) have provided the individual station data that are used to calculate SPI on this map. The continuous color map is derived by taking measurements at individual meteorological stations and mathematically interpolating (estimating) values between known data points. Interpolation procedures can cause peculiar values in data-sparse regions.

On the Web:

For more information:
<http://www.ncdc.noaa.gov/oa/climate/monitoring/drought/nadm/indices.php>

For a primer on SPI, visit http://www.climas.arizona.edu/forecasts/archive/oct2002/oct2002figs/16_The_SPI.html.

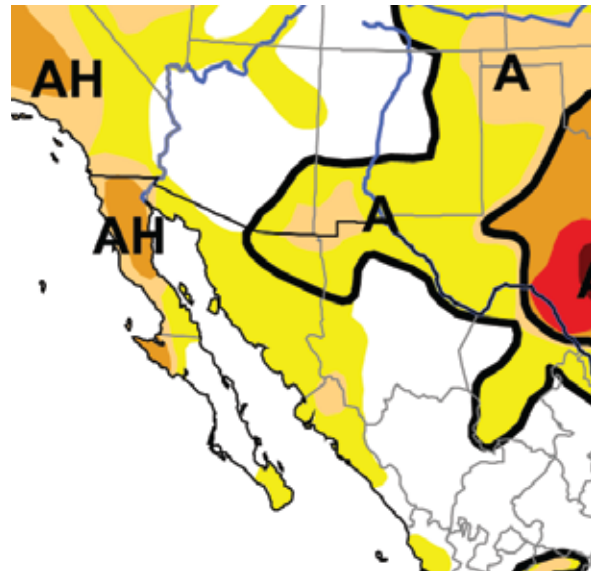


North American Drought Monitor






The February 2009 North American Drought Monitor (NADM) shows dry conditions across most of the border region; the one exception is western Arizona. Compared with the December NADM map, drought severity has decreased in Southern California but increased in Sonora, Sinaloa, southeastern Arizona, New Mexico, Chihuahua, Coahuila, and West Texas (Figure 4). Dry conditions across the border region are due to high pressure that has settled over the region this winter and is connected with La Niña conditions in the Pacific Ocean. The cool tropical eastern Pacific Ocean sea surface temperatures and strong easterly (east to west) tropical winds associated with La Niña set up a situation in the central and western Pacific Ocean that favors more storm activity in northern North America but leaves the border region mostly dry during the winter.

In February, the governing board of the Los Angeles Department of Water and Power, the largest public utility in the United States, voted to impose water rationing in Los Angeles. The last time that happened in the state was nearly two decades ago. The drought conditions in California have caused large economic and business losses, including more than \$300 million in agricultural revenue losses (*Environment News Service*, February 27). In New Mexico, the southern Pecos River Valley has hardly received any winter precipitation. Reservoir storage is low along the Pecos River, and farmers in the valley will receive less than their normal irrigation allocation.

Figure 4. North American Drought Monitor released February 28, 2009.



Drought Intensity

	D0 Abnormally Dry
	D1 Moderate Drought
	D2 Severe Drought
	D3 Extreme Drought
	D4 Exceptional

Drought Impact Types

/ Delineates Dominant Impacts

A = Agricultural (crops, pastures, grasslands)

H = Hydrological (water)

AH = Agricultural and Hydrological

Notes:

The North American Drought Monitor maps are based on expert assessment of variables including (but not limited to) the Standardized Precipitation Index, soil moisture, streamflow, precipitation, and measures of vegetation stress, as well as reports of drought impacts. It is a joint effort of several agencies, including NOAA's National Climatic Data Center, NOAA's Climate Prediction Center, the U.S. Department of Agriculture, the U.S. National Drought Mitigation Center, Agriculture and Agrifood Canada, the Meteorological Service of Canada, and the National Meteorological Service of México (SMN - Servicio Meteorológico Nacional).

On the Web:

For more information:

<http://www.ncdc.noaa.gov/oa/climate/monitoring/drought/nadm/>



Precipitation Forecast

The Servicio Meteorológico Nacional (SMN) predicts much of northern Mexico will receive below-average precipitation during May (Figure 5b). The northwestern states of Baja California Sur, Sonora, Sinaloa, Chihuahua, and Durango are predicted to receive less than 50 percent of average rainfall. Areas very close to the border are predicted to receive near-average to above-average precipitation during May. Forecasts for June and July predict average to above-average precipitation for most of the border region (Figure 5c). Northern Baja California Norte is predicted to receive lower-than-average precipitation. The SMN forecasts are based on years with oceanic and atmospheric conditions similar to this year; the years selected for the SMN forecast are 1951, 1954, 1956, 1976, and 1999.

The seasonal prediction for May–July from the International Research Institute for Climate and Society (not shown) forecasts slightly increased chances of above-average precipitation along the Arizona-Sonora and New Mexico–Chihuahua sections of the border (http://iri.columbia.edu/climate/forecast/NAME/forecast/MAM09_NAME_pcp.html). These forecasts are consistent with a historical tendency for summer monsoon precipitation to be greater than average following a La Niña winter.

Notes:

This forecast was prepared by the Servicio Meteorológico Nacional (SMN). The forecast methodology was developed by Dr. Arthur Douglas (Creighton University, retired) in collaboration with SMN scientists.

The forecasts are based on the average of precipitation values from analogous years in the historical record. Selection of analogous years is based on statistical analysis of factors in oceanic and atmospheric circulation known to influence precipitation in Mexico. Unique combinations of climate indices are used in the forecasts each month. A statistical method known as cluster analysis is used to identify evolving climate patterns observed in the historic record and place each year in historical context; the years with the evolving climate patterns most similar to the current year are selected. Average atmospheric flow patterns and surface precipitation anomalies are constructed with the historic data and compared with the climatological average.

Examples of atmospheric and oceanic factors used in identifying analogue years, include: Pacific and Atlantic Ocean temperatures, tropical upper atmosphere oscillations, the position and strength of persistent high and low atmospheric pressure centers, and other factors.

The maps show predicted percent of monthly average precipitation. The legend shows the ranges of predicted percent of average precipitation associated with each color. Blues and greens indicate above-average precipitation; yellows and reds indicate below-average precipitation. White indicates precipitation within 20% of the climatological average (based on data from 1941-2002).

On the Web:

For more information:

<http://smn.cna.gob.mx/productos/map-lluv/p-clim02.gif>

Figure 5a. Precipitation forecast for April 2009 released March 1, 2009.

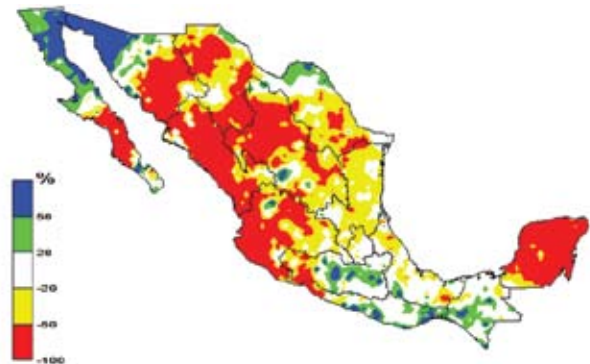


Figure 5b. Precipitation forecast for May 2009 released March 1, 2009.

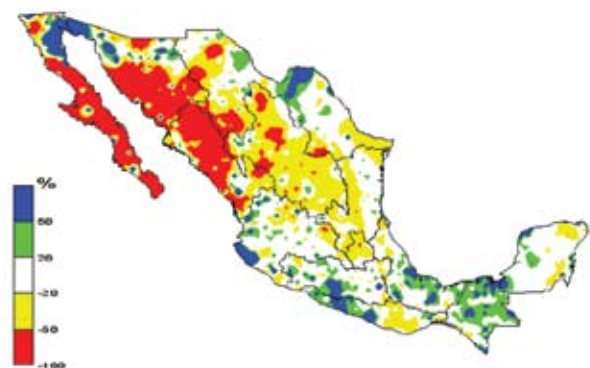


Figure 5c. Precipitation forecast for June 2009 released March 1, 2009.



ENSO (El Niño – Southern Oscillation)

The weak La Niña event that developed in December appears to be winding down. Sea surface temperatures were still below-average in the middle and eastern regions of the equatorial Pacific, but warmed slightly since last month. The NOAA-Climate Prediction Center (NOAA-CPC) reported that other sub-surface temperature measurements showed signs of warming and weakening La Niña conditions. The atmosphere is still reflecting La Niña conditions with another positive Southern Oscillation Index (SOI) value this past month and observations of above-average easterly winds continuing along the equator across the Pacific basin (Figure 6a). The NOAA-CPC notes that these observations are consistent with a weakening La Niña event.

The International Research Institute for Climate and Society (IRI) also supports the notion that the current La Niña event is waning. IRI forecasts a nearly 50 percent chance of neutral or La Niña conditions returning during the March–May period; there is virtually no chance of an El Niño conditions developing (Figure 6b). The odds tilt dramatically toward neutral conditions by the April–June forecast period, with the chance of a transition to neutral conditions at 64 percent, La Niña conditions persisting at 32 percent, and the chance of an El Niño event forming at 4 percent. This is above the historical probability (50 percent) of neutral conditions for this time year, indicating relatively high confidence in this forecast.

Notes:

Figure 6a shows the standardized three month running average values of the Southern Oscillation Index (SOI) from January 1980 through November 2008. The SOI measures the atmospheric response to sea surface temperature (SST) changes across the tropical Pacific Ocean. The SOI is strongly associated with climate effects in parts of Mexico and the United States. Values greater than 0.5 represent La Niña conditions, which are frequently associated with dry winters and sometimes with wet summers in the southwestern U.S. and northwestern Mexico. Values less than -0.5 represent El Niño conditions, which are often associated with wet winters in those regions.

Figure 6b shows the IRI probabilistic El Niño–Southern Oscillation (ENSO) forecast for overlapping three month seasons. The forecast expresses the probabilities (chances) of the occurrence of three ocean conditions in the ENSO-sensitive Niño 3.4 region, as follows: El Niño is defined as the warmest 25 percent of Niño 3.4 SSTs during the three month period in question, La Niña is defined as the coolest 25 percent of Niño 3.4 SSTs, and neutral conditions are defined as SSTs falling within the remaining 50 percent of observations. The IRI probabilistic ENSO forecast is a subjective assessment of monthly model forecasts of Niño 3.4 SSTs. The forecast takes into account the indications of the individual forecast models (including expert knowledge of model skill), an average of the models, and other factors.

Figure 6a. The standardized values of the Southern Oscillation Index from January 1980–February 2009. La Niña/El Niño occurs when values are greater than 0.5 (blue) or less than -0.5 (red) respectively. Values between these thresholds are relatively neutral (green).

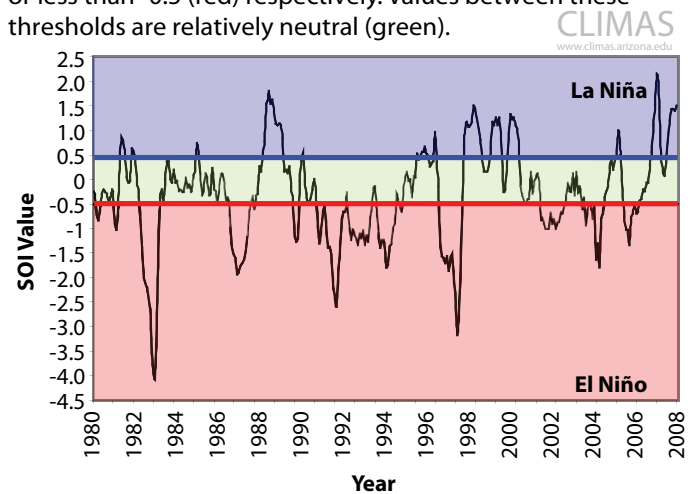
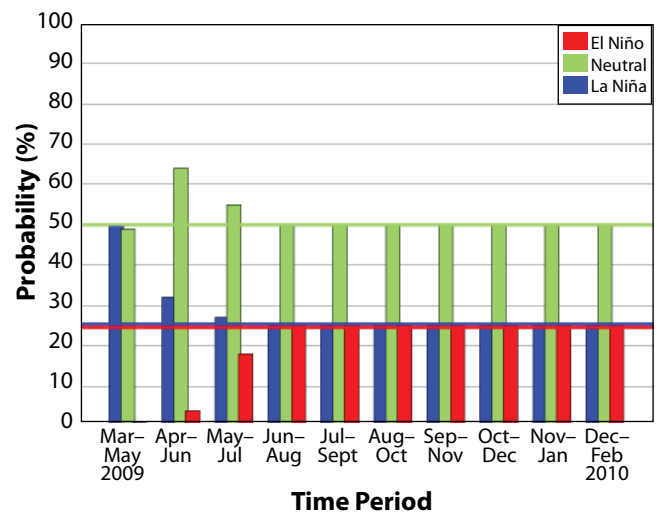


Figure 6b. IRI probabilistic ENSO forecast for El Niño 3.4 monitoring region (released March 19, 2009). Colored lines represent average historical probability of El Niño, La Niña, and neutral.



On the Web:

For more information:
<http://iri.columbia.edu/climate/ENSO/currentinfo/update.html>

