Border Climate Summary
Resumen del Clima de la Frontera
Issued: June 21, 2010

Training on tropical cyclones and their passage across the border

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Figure 1. Participants from the spring 2010 training course in La Paz, Baja California Sur, Mexico.

Tropical cyclones are important weather systems that develop over several regions of the globe. While they occur over relatively warm oceans, the eastern North Pacific basin is a remarkably prolific region, where more systems develop per unit area than any other region in the world. Their development has the potential to affect countries in Central and North America. In general, the approach of tropical cyclones brings changes in moisture content over relatively large areas and they become a significant source of rainfall over mountainous terrain.

On average, 15 tropical cyclones develop every season, which extends from late May until mid-November. The west coast of Mexico is especially vulnerable to these systems and, even more, to those that move close to the coastline. Landfall is defined as the passage of the system center across the coast. Tropical cyclones that make landfall are likely to be accompanied by strong winds, coastal storm surges, and heavy rainfall, with the potential for extensive property damage and flooding in coastal areas. Northwestern Mexico has the highest frequency of landfall in the entire eastern Pacific basin. This region includes the states of Nayarit, Sinaloa, Sonora, and the entire Baja California Peninsula. Most landfalls are late in the season, from August through October, and they tend to occur over Baja California, or over Sinaloa on the mainland.

Table of Contents:

Training courses

In comparison to developed countries, in Latin America there is a lack of meteorology and climatology professionals with adequate knowledge of tropical cyclones and major improvements are required to build capacity in these disciplines. As part of an international research project, funded by the Inter-American Institute for Global Change Research (IAI, http://www.iai.int), we designed a series of short courses based on the current understanding of tropical cyclones in the eastern Pacific. Our main goal is to train students from institutions of higher education in Mexico, the Caribbean, Central, and South America, where capacity building is in the early stages of development. These 4-5 day courses have been offered during the last three consecutive years in Mexico (La Paz, Baja California Sur, in 2008 and 2010 and Acapulco, Guerrero, in 2009).

Our approach includes a brief review of climatological features on formation, intensification, and dissipation of tropical

continued on page 4

Executive Summary

In General – The transition from strong El Niño to neutral conditions in the Pacific Ocean was accompanied by a transition from a wet winter in our region to a mostly dry late spring. Regional temperatures were near to below average for the spring months. Large reservoirs in Sonora's Bavispe-Yaqui river system are at 55-68% of capacity. Summer precipitation forecasts always have high uncertainty; this year's SMN forecasts indicate near-average precipitation for most of the border region.

Temperature – Spring season temperatures were mostly below-average across the region. Cool temperatures affected agriculture in California. A May heat wave in Sonora was associated with heat-related illnesses.

Precipitation – Spring precipitation was below average in most of the border region.

Precipitation Forecast – SMN summer precipitation forecasts show near-average precipitation for most northern Mexico states. NOAA precipitation outlooks show "equal chances" for the border states, indicating a lack of skill or consensus among forecast tools.

ENSO – Forecasts show a greater than 55 percent chance of neutral conditions developing during the summer months, and an approximately 40 percent chance of La Niña developing during the rest of 2010. La Niña is associated with lower than average Pacific tropical cyclone development, and below average winter precipitation.

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Climate Assessment for the Southwest

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Flash-Flood Forecasting at Ambos Nogales

By Laura M. Norman

Scientists and experts from academia and public and private agencies from the United States and Mexico are expanding a model designed to evaluate the watershed of Nogales, AZ, and Nogales, Sonora, and assess flood vulnerability.

The project, part of a larger effort to develop an Early Warning Hazard System for the region, will incorporate real-time rainfall data input and compute volumes of runoff, peak flow, and watershed discharge rate.

The cities of Nogales, Sonora, and Nogales, Arizona, are located in the Ambos Nogales Watershed, a north-south oriented area of varied topography that spans the U.S.-Mexico border. Throughout history, residents in both cities have been affected by flooding. Actions to control and regulate dangerous flows into the urban areas of Ambos Nogales are being carried out primarily upstream in Mexico.

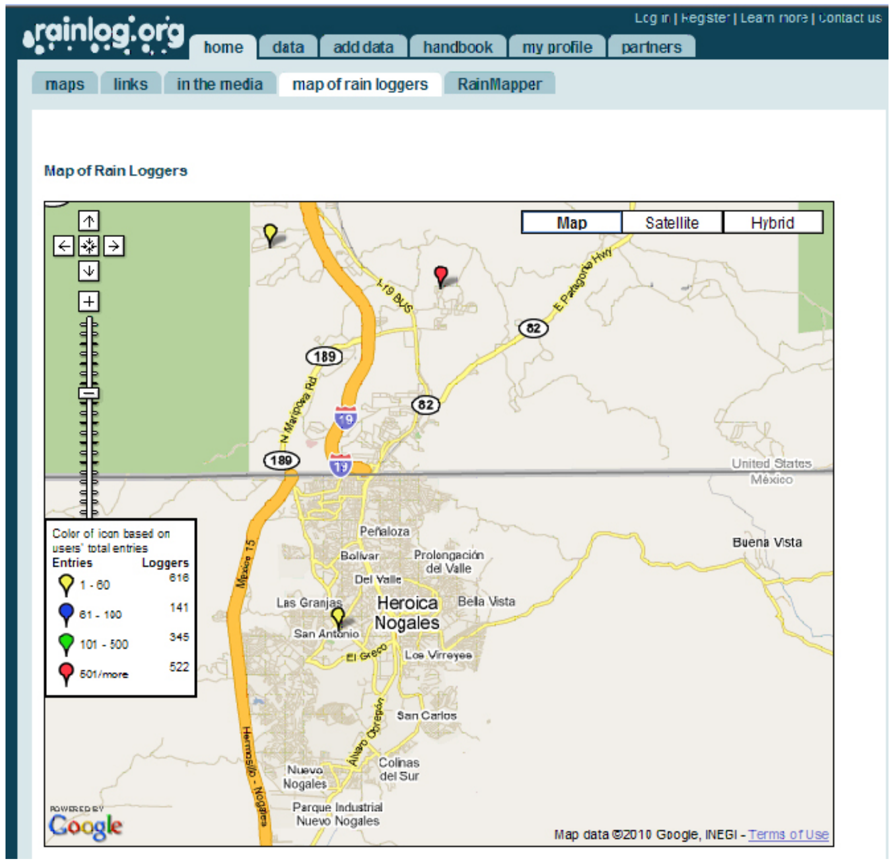


Figure 1. A map from the Rainlog Web site (http://rainlog.org) showing the location of the first precipitation gage online in Nogales, Sonora (May 4).

The model the scientists are working with, KINEROS2 (K2),uses mathematical equations to describe watershed hydrology processes, such as infiltration of water into the soil layers, erosion, streamflow hydrographs, and sediment transport.

Live data will be streamed into the K2 model to support the pilot flood warning system. The model estimates both rain gage-derived rainfall and predicts associated runoff. A runoff graph will show stage of flows and equivalent discharge rate in streams, and indicates the peak stage (discharge) and time of peak.

A rain gage network is being adapted in Nogales, Sonora, to measure precipitation and provide electronically recorded precipitation measurements straight to an online rainfall monitoring network initially developed for Nogales, Arizona (http://rainlog.org, see Figure 1).

Gages will be well-distributed throughout the upper watershed at Nogales, Sonora, to citizens of the community, drawing on collective local knowledge and support to determine the best locations. Members of the research team are recruiting residents who have Internet access and safe locations for the rain gages and electronic equipment to begin the process of receiving precipitation data and conveying it to the Rainlog web site.

Currently, one rain gage has been installed at the Nogales, Sonora Water and Wastewater Utility (Figure 2). Information from this new station has been displayed online since April 5.

The model system includes an alarm capability to alert the forecaster or other designees when the maximum predicted stage level exceeds the critical stage or stages of the Nogales Wash in Nogales, Sonora, as designated.

The K2 model also will be used to evaluate future flood hazards across the watershed using alternative land-use scenarios as inputs. For example, the primary method proposed for regulating runoff is a series of detention basins in Nogales, Sonora; the impacts of these are being modeled.

Rain gage data will be used to calibrate the K2 model for advanced flood modeling and help inform land use planning for future scenario development, such as urban growth and development. Rain gage data also will be

continued on page 5

Training on tropical cyclones, continued

cyclones. Key aspects are the stages of formation and intensification, with particular emphasis on the development off the west coast of Mexico during the last decade. More advanced topics include lectures on thermodynamic models, air-sea interactions, oceanic responses, long-term variability, climate-related predictions, and geology-related techniques to study coastal impacts during the last 100-500 years. Additionally, practical sessions are offered to analyze case studies of tropical cyclone approach and landfall over northwestern Mexico. During these sessions, students apply a historical database, issued by the United States National Hurricane Center (http://www.nhc.noaa.gov), to analyze eastern Pacific basin activity during the period 1970-2009. Case studies of cyclones that resulted in landfall over northwestern Mexico are explored in more detail by including observations from the seasons 2006 through 2009.

Course instructors are affiliated with academic and research institutions from Mexico (UNAM, IMTA, IPN, UABCS, and CICESE*), the United States (New Mexico Institute of Mining and Technology , Louisiana State University, and University of California at Los Angeles), Cuba (Institute of Meteorology), and Costa Rica (University of Costa Rica). Students have come from Mexico, the United States, Costa Rica, Colombia, Cuba, Brazil, Dominican Republic, Argentina, and Chile (Figure 1). The students are organized into groups to discuss recent publications on climate change and its impact on tropical cyclone development. During the last day of the course, there is a forum in which the students present their findings. For more information on the training courses, see the following website: http://cabernet.atmosfcu.unam.mx/IAI/3th_spc_tc.html

In addition to the course, we have convened symposia, to discuss social and

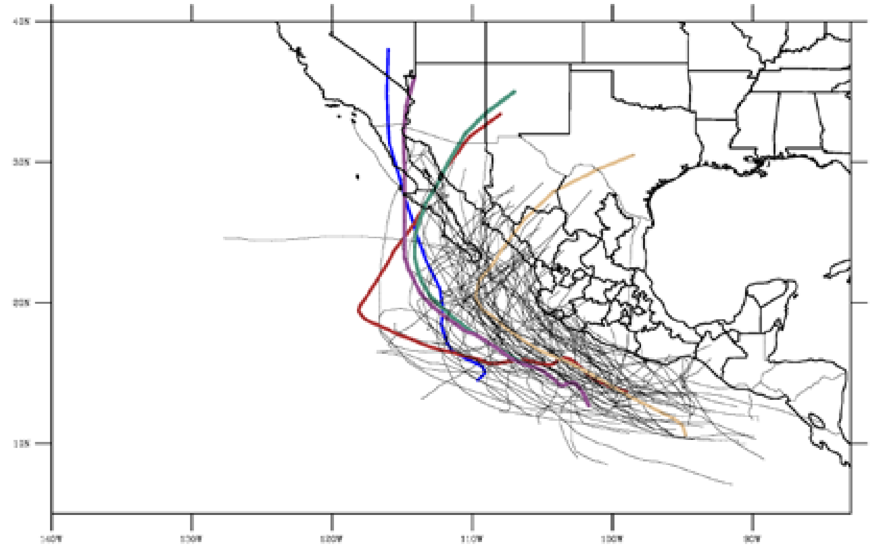


Figure 2. Tracks of the 97 tropical cyclones that made landfall over the west coast of Mexico, during the period 1970-2009. Lines in color are from storms that crossed the Mexico-United States border: Kathleen (1976, blue), Raymond (1989, red), Lester (1992, green), Lidia (1993, yellow), and Nora (1997, purple).

economic issues that are associated with the landfall of tropical cyclones. Topics include coastal impacts and flooding, the link between cyclones and water resources, flow of weather and climate information from scientists to policy-makers, the role of emergency managers, and impacts on public health. Speakers on the human dimensions of tropical cyclones represent educational institutions and public and private agencies, including emergency management agencies from regions with frequent cyclone activity during the storm season. This includes personnel from the states of Baja California Sur and Guerrero, and from the national center for disaster prevention in Mexico (CENAPRED, http://www.cenapred.unam.mx).

Tropical cyclones crossing the Mexico-United States border

From 1970 through 2009, more than 90 tropical cyclones made landfall across the Pacific coast of Mexico. Eventually, five of them moved into the United States: Kathleen (1976), Raymond (1989), Lester (1992), Lidia (1993), and Nora (1997) (Figure 2). These storms first moved over the Baja California Peninsula, Gulf of California, and Mexican mainland and, after crossing the international border, they moved across the states of California, Arizona, New Mexico, or Texas.

The description of Hurricane Nora's life cycle provides a valuable illustration. The 1997 season was considered just average to above-average, with 17 systems in the eastern Pacific basin. Four of them made landfall over southern (Olaf, Pauline, and Rick) or northern (Nora) Mexico. Hurricane Nora developed during the period 16-26 September and affected Baja California, northwestern Sonora, and the Arizona-California boundary. On September 24, 1997, Nora made landfall in north-central Baja California, as a category-one hurricane, with a well-defined area of intense cloud cover; and a large area of moist air moved into the border region (Figure 3).

During Nora's passage, strong winds (35-45 mph; 55-75 km/h) were reported at Puerto Peñasco, Sonora, and Yuma, Arizona, while maximum rainfall accumulations exceeded 5 inches (125

continued on page 5

Training on tropical cyclones, continued

mm) at several stations over western Arizona. This amount is much greater than average annual precipitation in Yuma (3 inches; 75 mm). According to post-storm surveys, this event was responsible of two deaths and 350-400 homeless in Baja California. There were reports of agricultural losses, traffic fatalities, power outages, and urban flooding in southern California. Improved integration of forecast use and dissemination, and integration of decision-makers, such as emergency managers, may have helped reduce the tragic loss of life associated with Hurricane Nora.

In summary , tropical cyclones moving across North America may be associated with intense precipitation, wind damage, and fatalities in both northwestern Mexico and the southwestern United States. Building scientific and professional capacity to monitor, predict, and prepare for changes in storm structure and motion is an important part of reducing property damage and saving lives. The efforts described above are particularly important because they build bridges across multiple disciplines and geographic areas and, as a result workshop participants and operational agencies can improve communication across the Mexico-U.S. border.

Figure 3. Image from the GOES-9 weather satellite, at 1700 (5:00 PM) MST on 24 September 1997. Hurricane Nora is located off the west coast of the Baja California peninsula, just a few hours prior to landfall.

* UNAM: Universidad Nacional Autónoma de México; IMTA: Instituto Mexicano de Tecnología del Agua; IPN: Instituto Politécnico Nacional; UABCS: Universidad Autónoma de Baja California Sur; CICESE: Centro de Investigación Científica y de Educación Superior de Ensenada

Flash-Flood Forecasting, continued

used in a demonstration project to locate the most advantageous sites for more extensive weather monitoring equipment that will provide emergency managers with the most reliable alert system.

Collaboration

This project is part of a large collaboration of agencies and people, including the Arizona Department of Environmental Protection- Office of Border Environmental Protection, Tucson, Arizona (ADEQ-OBEP; Hans Huth); Nogales, Sonora Water and Wastewater Utility (OOMAPAS-NS; Francisco Gastelum); Nogales, Sonora Instituto Municipal de Investigación y Planeación (IMIP; Claudia Zulema Gil Anaya); the U.S. Department of Agriculture, Tucson, Arizona (USDA-ARS-SWRC; David Goodrich); the University of Arizona, Tucson, Arizona (UA; Gary Woodard, D. Phillip Guertin); La Sección mexicana de la Comisión Internacional de Límites y Aguas, Nogales, Sonora (CILA; Jesús Quintanar Guadarrama); U.S. Section of the International Boundary and Water Commission, El Paso, Texas (IBWC; Jose Nunez and Donald Atwood); Mexico's National Water Commission, Hermosillo, Sonora (CONAGUA; Gilberto Oliveros); Sonora's Water Commission Hermosillo, Sonora (CEA; Roberto Molina); City of Nogales, Sonora, Mexico - Department of Emergency Response (Eduardo Canizales); and colleagues from the U.S. Geological Survey, Tucson, Arizona (USGS; Floyd Gray and James Callegary).

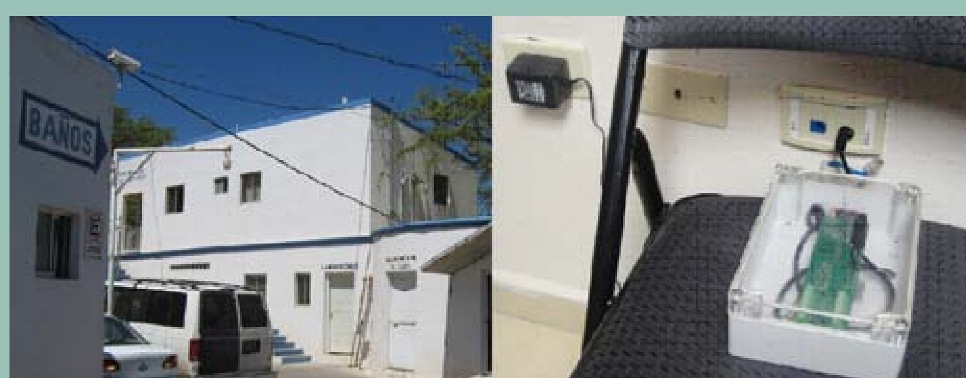


Figure 2. The Nogales, Sonora Water and Wastewater Utility building, site of the first community rain gage in the network (left). Electronic connection that conveys precipitation data from the rain gage directly to the Internet (right).

Temperature

In the late spring, mid-latitude storms are rare in our region; however, several made their way down the Pacific coast, cooling temperatures in the border region. May temperatures were substantially lower than the 1971-2000 average for much of Arizona, southern Nevada and Utah, and northwestern New Mexico (Figures 1a and c). In Mexico, temperatures were near average throughout Chihuahua, Sonora and Sinaloa, but 1-2 degrees C (2-4 degrees F) above average in Durango. Mexican health authorities announced preventive alerts throughout the country due to heat related illnesses. Health authorities sited cases of intestinal illnesses, diarrhea and vomiting, many of which were related to May heat waves. According to the Mexican National Weather Service, temperatures reached 40 degrees C (104 degrees F) in several northern Mexico states, including Sonora (*El Imparcial*, May 8, 2010). Spring season temperatures were more uniformly below average across the region (Figures 1b and d), due to a strong El Niño episode during the first half of 2010. Cooler than average spring temperatures hampered the emergence and growth of summer crop plantings, such as rice and cotton, and wet weather complicated spraying of some fruit and nut crops in California (USDA Weekly Weather and Crop Bulletin).

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 May.

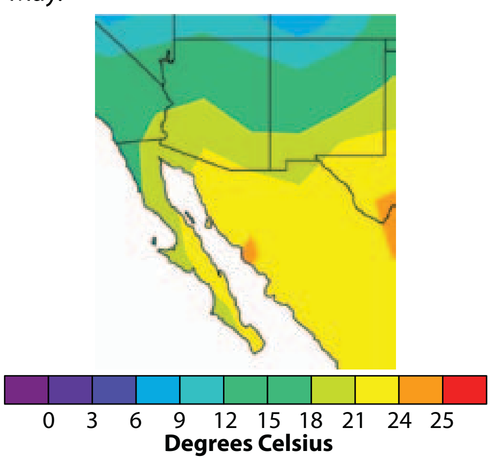


Figure 1b. Mean temperature departure from 1971-2000 average at 2-m elevation for May.

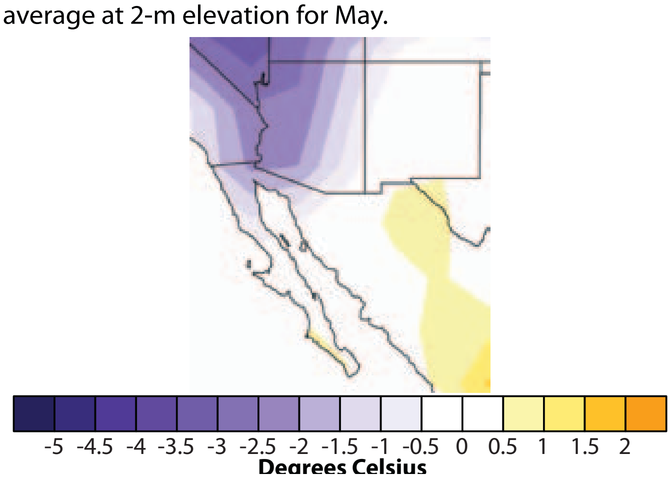


Figure 1c. Mean temperature at 2-m elevation for March–May 2010.

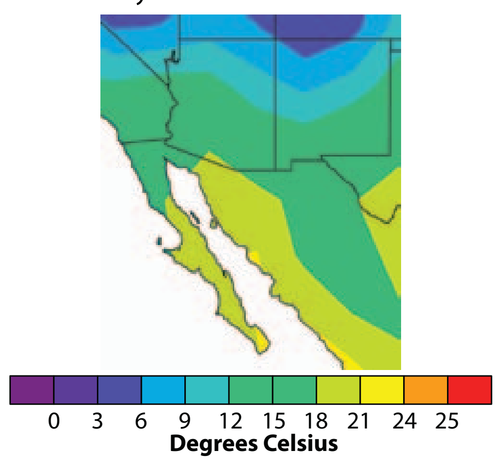
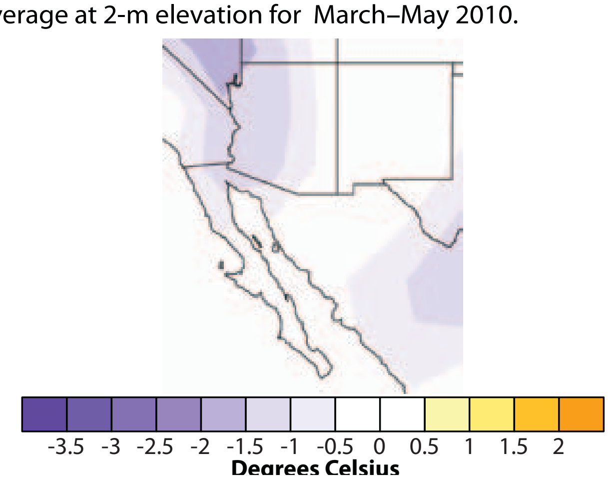


Figure 1d. Mean temperature departure from 1971-2000 average at 2-m elevation for March–May 2010.



On the Web:

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

Precipitation

The transition from strong El Niño to neutral conditions in the Pacific Ocean was accompanied by a transition from a wet winter in our region to a mostly dry late spring. Both the month of May and the spring season brought only scant precipitation across most of the Mexico-US border region (Figures 2a-b). Notable exceptions included northern Mexico, near the Rio Grande's Big Bend region on the Texas-Coahuila border, Northern Baja California, northwestern Sonora and central New Mexico, where precipitation totals were above average (Figure 2d). Extreme eastern and northeastern New Mexico received some May precipitation (Figure 2c). May precipitation totals, however, were relatively low, which is typical for this dry time of year. The president of the Regional Cattle Union of Sonora, Luis Sierra Maldonado, stated that unlike in years past, the majority of Sonoran rangelands are in good condition, and ranchers will not face severe drought-related problems. Overall, Maldonado commented that there was neither a problem with water nor pastures (*El Imparcial*, May 15, 2010). In parts of New Mexico, spring dryness has occasionally been accompanied by strong winds, which have damaged crops (USDA Weekly Weather and Crop Bulletin).

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.

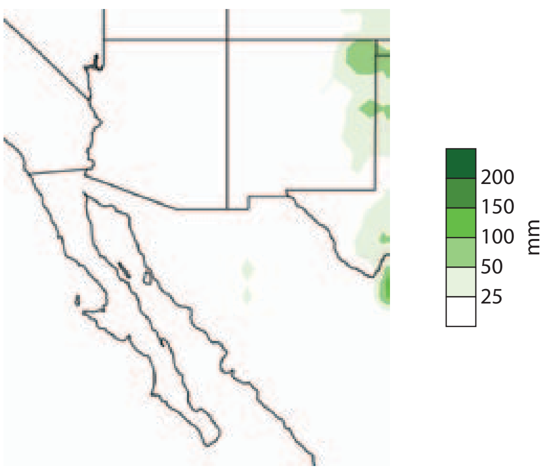


Figure 2a. United States and Mexico precipitation for May 2010.

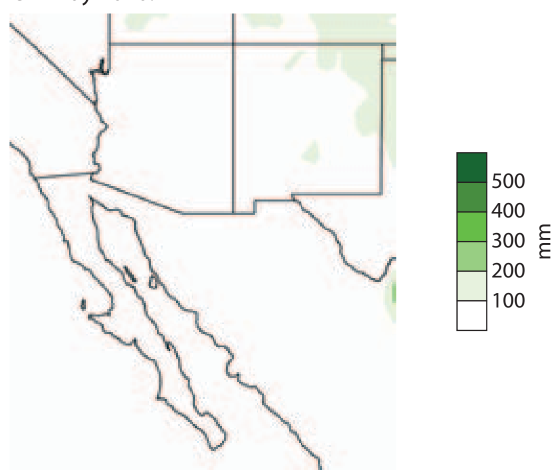


Figure 2b. United States and Mexico precipitation for March–May 2010.

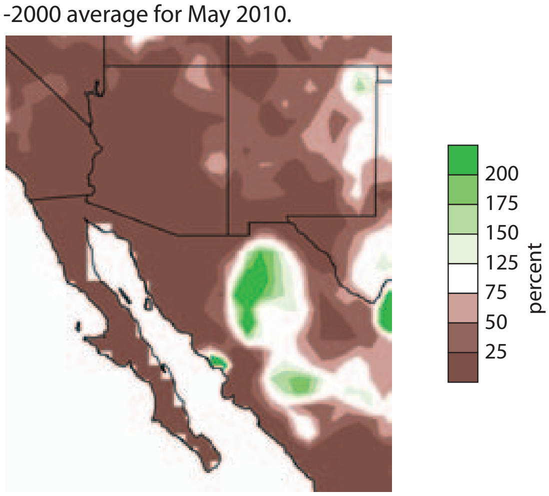


Figure 2c. United States and Mexico precipitation percent of 1971-2000 average for May 2010.

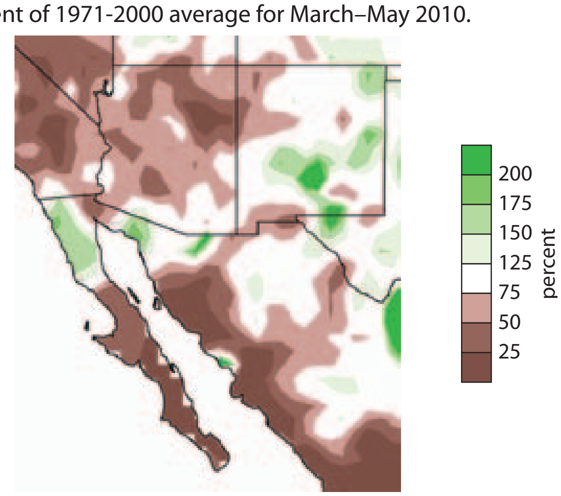


Figure 2d. United States and Mexico precipitation percent of 1971-2000 average for March–May 2010.

On the Web:

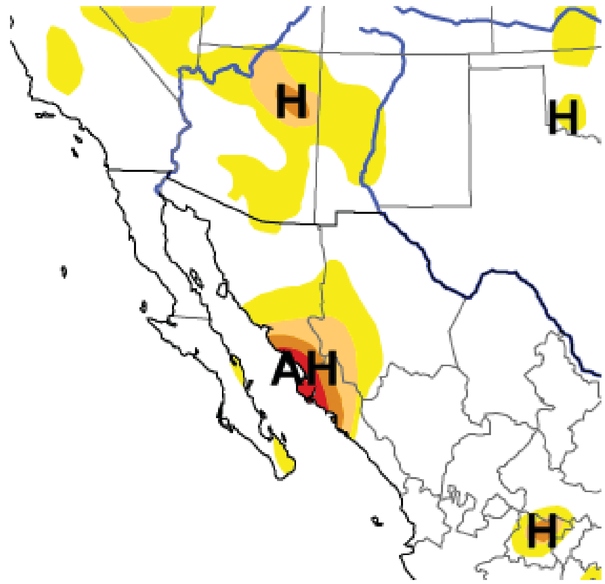
For more information:
http://www.cpc.ncep.noaa.gov/products/Drought/Atm_Circ/2m_Temp.shtml

North American Drought Monitor

Drought status is varied across southeastern Nevada and Arizona and extreme drought conditions dominate in southern Sonora and Sinaloa. The western portions of New Mexico were abnormally dry (Figure 3). The southwestern United States experienced unusually cool temperatures during the winter and spring, accompanied by above-average winter rain and snow, which benefitted dry areas and boosted storage at a number of reservoirs. However, the northward shift of storms in April and May led to below-average seasonal precipitation totals in the Southwest. Throughout the border region, drought conditions have improved since January, due to winter precipitation, but parts of northeastern Arizona remain in severe drought status.

April is usually a dry month for northern Mexico; however, April 2010 was the third wettest in 70 years according to the Mexican National Weather Service (SMN). This may have contributed to a decrease in forest fires in the last several months. According to Juan Manuel Torres Rojo, director of the National Forest Commission (CONAFOR), during 2010 only 3 major forest fires have been recorded in the state of Sonora. Rojo added that the areas affected by fires were 80 percent less than during 2009 (*El Imparcial*, May 15, 2010). Precipitation was registered mainly in the northeastern region of the country as well as along the Gulf of Mexico coast. Abnormally dry conditions dissipated in Northern Sonora, whereas southern Sonora, northern Sinaloa, and southwestern Chihuahua continued to experience drought conditions. The National Water Commission of Mexico (CONAGUA) reported that water storage in northwestern and central-northern Mexico decreased during April.

Figure 3. North American Drought Monitor (released May 21).



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/

Sonoran Reservoir Levels

Sonoran reservoir storage declined during the spring season. Total storage in the reservoirs displayed in Figure 4 declined by almost 900 cubic hectometers. The largest percent of capacity loss was in the A. Ruiz Cortines reservoir.

In reservoir related news, high storage levels are presenting new opportunities for some Sonoran agricultural producers. Aquiles Souque Brito, president of the Irrigation District of the Rio Yaqui, announced that after nearly 16 years of limited production of secondary crops in the Yaqui Valley, a projected 40,000 hectares of crops, such as soy plantations like those of the mid 1990s, will be irrigated from reservoirs this season. Brito stated that this alternative was made possible by the contributions of a Rio Yaqui reservoir system that is at 80 percent of average capacity, storing more than 5 billion cubic meters of water (*El Imparcial*, May 1, 2010).

The Southern Nevada Water Authority (SNWA) recently unveiled a $25 million custom-made tunneling machine that will be used to create a deeper water intake from Lake Mead (*Las Vegas Business Press*, May 10). The new intake provides the SNWA with insurance in case the lake level continues to drop—water levels in Lake Mead have dropped 110 feet (33.5 m) since 2000.

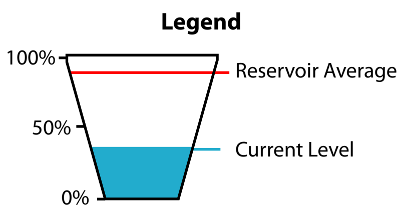
Notes:

The map gives a representation of current storage levels for reservoirs in Sonora. Reservoir locations are numbered within the blue circles on the map, corresponding to the reservoirs listed in the table. The cup next to each reservoir shows the current storage level (blue fill) as a percent of total capacity. Note that while the size of each cup varies with the size of the reservoir, these are representational and not to scale.

The table details more exactly the current capacity level (listed as a percent of maximum storage, and percent of average storage). Current and maximum storage levels are given in cubic hectometers for each reservoir. One cubic hectometer is one billion liters.

This map is based on reservoir reports updated daily in El Imparcial (http://www.elimparcial.com), using data provided by Comisión Nacional del Agua.

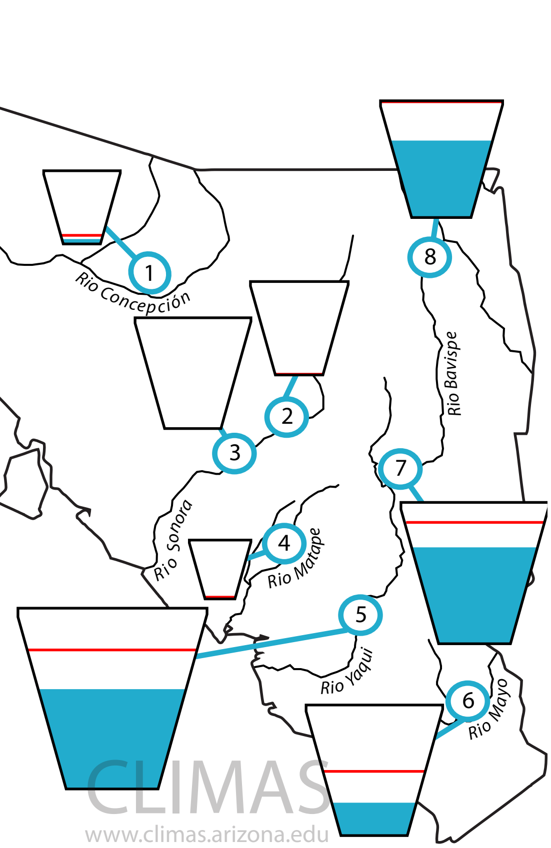
Figure 4. Sonoran reservoir levels for June 1, 2010, as a percent of capacity. The table lists current, average, and maximum storage levels.



size of cups is representational of reservoir size, but not to scale

Reservoir Name	Capacity Level	Current Storage*	Max Storage*	Average Storage*
1. Cuauhtémoc	7%	4.9	66.1	42.5
2. El Molinito	0%	1.0	233.9	130.2
3. A.L. Rodríguez	0%	0.0	284.5	219.5
4. I.R. Alatorre	2%	0.6	31.1	17.8
5. Álvaro Obregón	55%	2,309.9	4,200.0	2,989.2
6. A. Ruiz Cortines	25%	464.2	1,822.6	950.3
7. P. Elías Calles	68%	2,470.2	3,628.6	2,874.1
8. Lazaro Cárdenas	66%	733.1	1,116.5	703.4

*** cubic hectometers**



On the Web:
For more information:
http://www.elimparcial.com

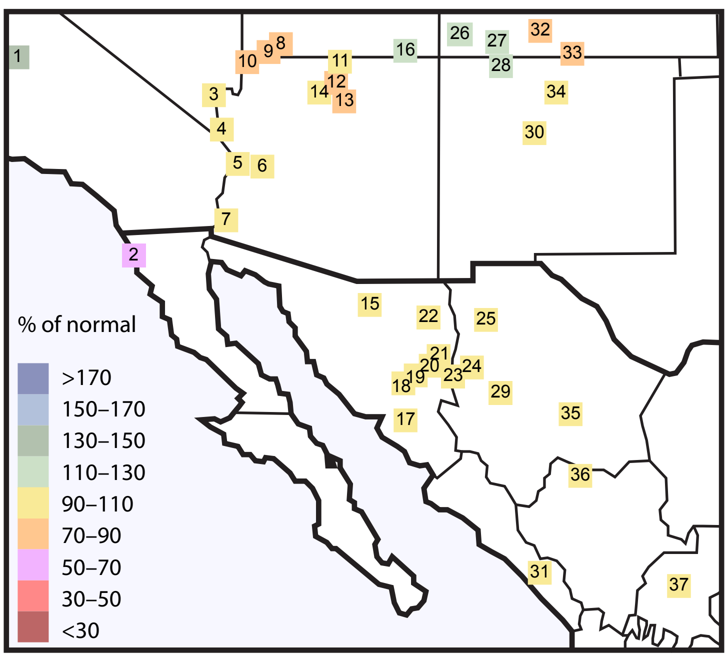
Streamflow Forecast

The six-month Ensemble Streamflow Prediction (ESP) forecast, released May 17 by the University of Washington and Princeton University, predicts near-average May-October streamflow for gages on both sides of the Mexico-U.S. border region. The average flow is based on the period from 1960 through 1999. Most of the streamflow forecasts for the region predict six-month streamflow volumes of 90 to 110 percent of average (Figure 5). However, the gages located in northern Arizona along the Virgin River (numbers 8-10 in Figure 5) and along the Colorado River (numbers 12-13) are predicted to have below-average streamflow (70-90 percent of average). Only the San Joaquin (number 1) and Boquilla Rivers (number 2) are forecast to have extreme conditions, at 147 percent of average for the San Joaquin and 50 percent of average for the Boquilla.

Notes:

The forecast information provided in Figure 5 is updated monthly by the University of Washington and Princeton University using ensemble streamflow prediction (ESP) techniques. The average of a group (ensemble) of forecasts is generated by using recent meteorology to initialize the Variable Infiltration Capacity (VIC) hydrologic model. Streamflow volume estimates are based on 40 VIC model runs, using meteorological data from the period 1960–1999. These estimates, shown in Figure 5, are expressed in terms of the percent of the 1960–1999 average streamflow at each gage.

Figure 5. United States and Mexico streamflow forecast for May–October.



1. San Joaquin
2. Boquilla
3. Hoover Dam
4. Davis Dam
5. Parker Dam
6. Alamo Dam
7. Imperial Dam
8. Virgin, UT
9. Near Hurricane, UT
10. Littlefield, AZ
11. Paria River
12. Desert View, AZ
13. Near Cameron, AZ
14. Near Grand Canyon
15. Imuris
16. Near Bluff, UT
17. Oviachic
18. La Junta
19. Novillo
20. Cubil
21. Paso Nacori
22. Angostura
23. Guadalupe
24. Huapaca
25. Casas Grandes
26. Near Mcphee, CO
27. Near Bayfield, CO
28. Navajo Reservoir
29. Abraham Gonzalez
30. Albuquerque
31. Ixpalino
32. Near Del Norte, CO
33. Near Lobatos, CO
34. Near Chamita
35. Villalba
36. Las Sardinas
37. Zacatecas

On the Web:

For more information:
http://www.hydro.washington.edu/forecast/westwide/sflow/index.6mons.shtml#seas_vol

Precipitation Forecast

The Servicio Meteorológico Nacional (SMN) forecasts, issued in April 2010, are based on years with similar patterns of precipitation, atmospheric circulation, and ocean temperatures, which affect the climate of the region. For the forecasts shown in Figures 6a–b, the years are 1958, 1969, 1980, 1983, 1988, and 1992. SMN predicts below-average precipitation for most of Mexico in June. Baja California, extreme northwestern Sonora, and southern Chihuahua are expected to be extremely dry. Dry conditions in southern Baja, northern Coahuila, and parts of northwestern Sonora are expected to give way to above-average precipitation through July. July forecasts for Northern Baja, eastern Chihuahua and western Coahuila indicate less than average precipitation. Forecasts for August show above-average precipitation for most of the Baja peninsula and northwestern Sonora.

Summer season outlooks from the NOAA Climate Prediction Center (CPC; not shown) predict continued decreasing SST anomalies. Most numerical models predict a complete transition to ENSO-neutral conditions by June (Figure 7). These conditions are expected to continue through the summer, although there is a slight chance that La Nina conditions may begin in the latter half of the summer. Forecasts of average precipitation in July are consistent with continued weakening of El Niño and progression towards neutral ocean temperatures during the summer.

Figure 6a. Precipitation forecast for April 2010.

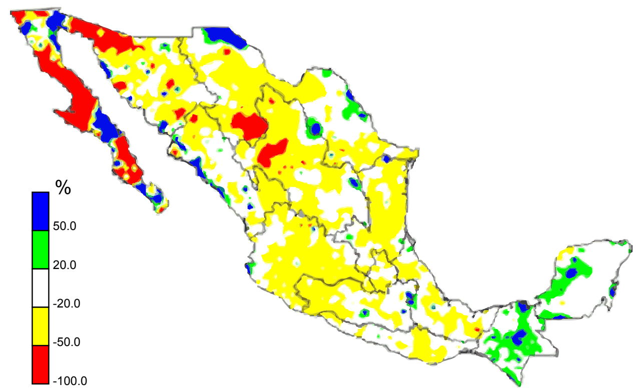


Figure 6b. Precipitation forecast for May 2010.

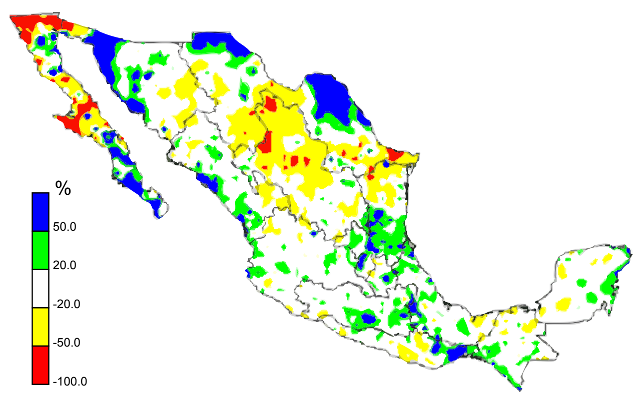
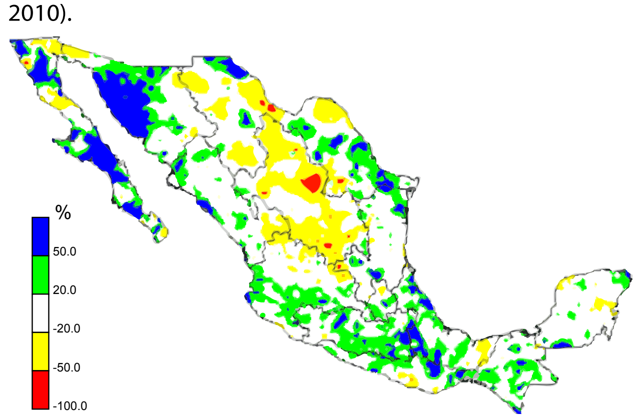


Figure 6c. Precipitation forecast for May 2010 (released May 2010).



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

ENSO
(El Niño – Southern Oscillation)

El Niño conditions continued to wind down through April, and sea surface temperatures (SSTs) across much of the equatorial Pacific Ocean are back to average values for this time of the year. The International Research Institute for Climate and Society (IRI) reported that SSTs in the mid-Pacific were near average (approximately -0.2 F), indicating that ENSO-neutral conditions have returned (Figure 7b). Many of the strong connections between the ocean and atmosphere have quickly dissipated in the past several weeks, including thunderstorm activity in the central Pacific Ocean that was evident most of the winter. The Southern Oscillation Index (SOI) also shifted from a negative to a positive value in recent weeks, further indicating a shift to ENSO-neutral conditions (Figure 7a). Additionally, there is some indication that a La Niña event is on the horizon. The IRI states that there is a significant amount of unusually cool water just below the surface that has accumulating in the western Pacific Ocean and has been moving eastward. Often cool water temperatures below the surface precede cooling of surface water. This suggests that the development of a La Niña event is not too far in the future.

The IRI ENSO forecast indicates that there is an 80 percent chance that the recent shift to neutral conditions will continue through the May–July period. By the middle to late summer (August–October), the chance that neutral conditions will persist falls to 55 percent, while the probability that La Niña conditions will develop increases to 42 percent. Chances remain around 42 percent through the fall that a La Niña event will develop. Seasonal forecasts produced by the NOAA Climate Prediction Center (CPC) reflect higher chances for a La Niña event. CPC assigns increased chances for below-average precipitation for the late fall and winter for the Southwest, which is typical during La Niña events.

Figure 7a. The standardized values of the Southern Oscillation Index from January 1980–May 2010. 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).

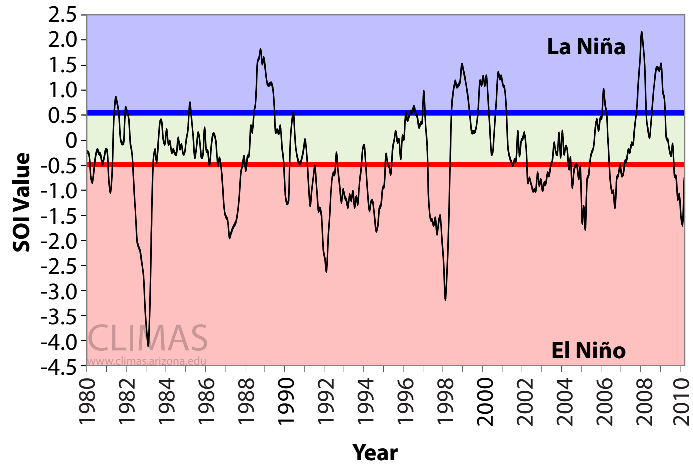
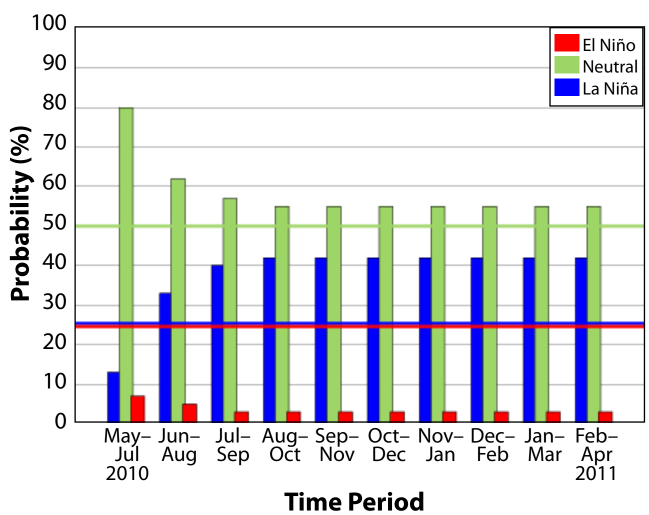


Figure 7b. IRI probabilistic ENSO forecast for El Niño 3.4 monitoring region (released May 20). Colored lines represent average historical probability of El Niño, La Niña, and neutral.



Notes:

Figure 7a shows the standardized three-month running average values of the Southern Oscillation Index (SOI) from January 1980 through May 2009. 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 7b 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.

On the Web:

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