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June Southwest Climate Outlook

Precipitation & Temperature: May precipitation was variable across the Southwest, ranging from average to much-above average in Arizona and below to above average in New Mexico (Fig. 1a). Similarly, May temperatures were average to above average across Arizona and ranged from below to above average in New Mexico (Fig. 1b). Taking a longer view, spring (March-May) precipitation was mostly below average in Arizona, while New Mexico ranged from below average in the southwestern region to above average in the northeast (Fig. 2a). Spring temperatures were much-above average across most of the Southwest (Fig. 2b). So far in June, temperatures have ranged from 0 to 8 degrees above normal across much of Arizona and New Mexico, with extreme heat forecast for the week of June 19. June precipitation has been sparse in most of Arizona, with infrequent storm activity mostly in southern and eastern New Mexico.

Snowpack, Streamflow & Water Supply: While snow is mostly—if not completely—now gone from the Southwest, some Colorado River Upper Basin snow water equivalent (SWE) values remain well-above average (Fig. 3). Above-average temperatures have amplified melting and runoff, leading to impressive streamflow forecasts across much of the West (see last month's outlook for details) and, in many cases, higher reservoir volumes compared to one year ago.

Drought: The transitional period between cool-season precipitation and the monsoon is one of the driest times of year for the Southwest, but prior to this dry period, seasonal temperature and precipitation patterns had been above and below average, respectively, since mid-January. This led to both short- and long-term drought designations in southern Arizona and the southwestern corner of New Mexico (Fig. 4). Monsoon precipitation can be impressive in its intensity, but these events vary considerably in both their spatial extent and their temporal frequency, therefore they typically do not provide as much drought relief as sustained regional cool-season precipitation.

Wildfire, Environmental Health, & Safety: In the late spring and early summer, warming temperatures, low relative humidity, and sustained and gusting winds all contribute to increased risk of wildfire (Fig. 5). Accordingly, the Southwest has seen higher fire activity over the last month. Many of these fires are lightning-caused, as is common when the emergent monsoon brings convective activity, often in the absence of measurable precipitation. As the monsoon settles in, heavy precipitation events and increased relative humidity help suppress existing fires and reduce seasonal wildfire risk. In fact, the midpoint of the wildfire season follows the seasonal progression of the monsoon (see Monsoon Tracker on pp. 4-5), and a late start to the monsoon can extend the fire season just as an early start can help shorten it.

El Niño Southern Oscillation: Current forecasts suggest an increased likelihood of ENSO-neutral conditions in 2017 (50-55-percent chance), with a slightly lower chance of an El Niño event (35-50 percent chance) during the same period (see ENSO Tracker on p. 3 for details).

Precipitation & Temperature Forecast: The June 15 NOAA Climate Prediction Center's outlook for July calls for equal chances of above or below average precipitation in Arizona and New Mexico, and increased chances of above average temperatures across the Southwest. The three-month outlook for July through September calls for equal chances of above or below average precipitation in Arizona and New Mexico (Fig. 6, top). Increased chances of above normal temperatures are forecast for the entire southwestern region (Fig. 6, bottom).

Tweet May SW Climate Outlook

CLICK TO TWEET

JUN2017 @CLIMAS_UA Climate Outlook, ENSO Tracker, Monsoon & Extreme Heat, Reservoir vol. http://bit.ly/2sglWL3 #SWclimate #AZWX #NMWX #SWCO

Online Resources

Figures 1-2
National Center for Environmental Information
http://www.ncdc.noaa.gov

Figure 3
Western Regional Climate Center
http://www.wrcc.dri.edu/

Figure 4
U.S. Drought Monitor
http://droughtmonitor.unl.edu/

Figure 5
National Interagency Fire Center
www.predictiveservices.nifc.gov/

Figure 6
NOAA - Climate Prediction Center
http://www.cpc.ncep.noaa.gov/

CLIMAS YouTube Channel

Visit our YouTube channel for videos of content pulled from the podcast.

www.youtube.com/user/UACLIMAS/

Podcasts

Visit our website or iTunes to subscribe to our podcast feed.

www.climas.arizona.edu/media/podcasts

June 2017 Southwest Climate Outlook

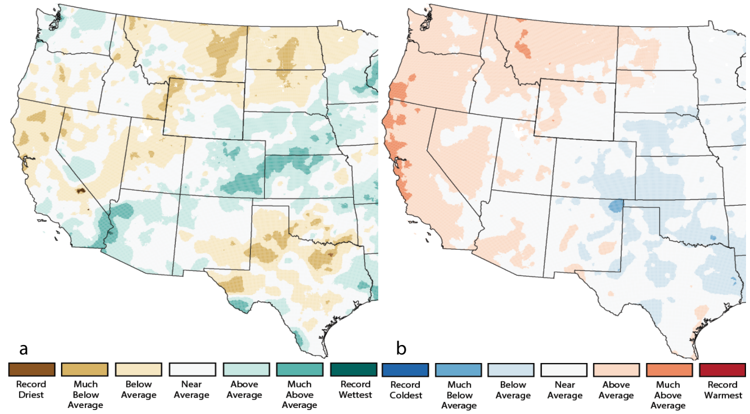


Figure 1: May 2017 Precipitation (a) & Temperature Ranks (b)

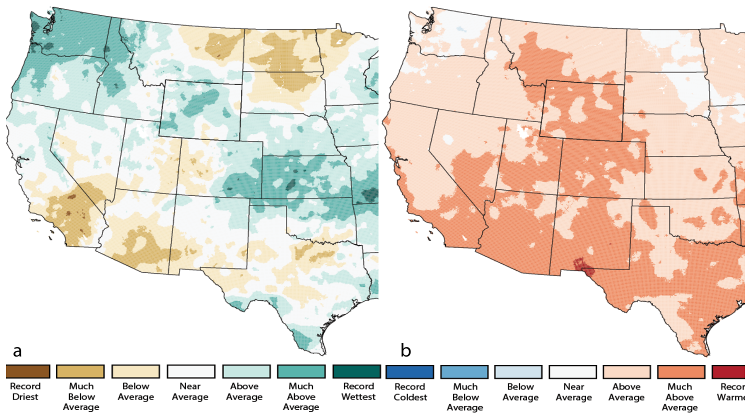


Figure 2: Mar-May 2017 Precipitation (a) & Temperature Ranks (b)

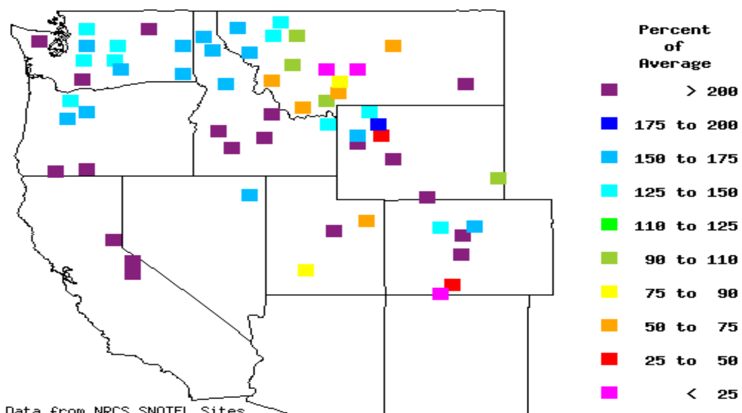


Figure 3: Basin Percent of Average Snow Water Equivalent (Jun 15, 2017)

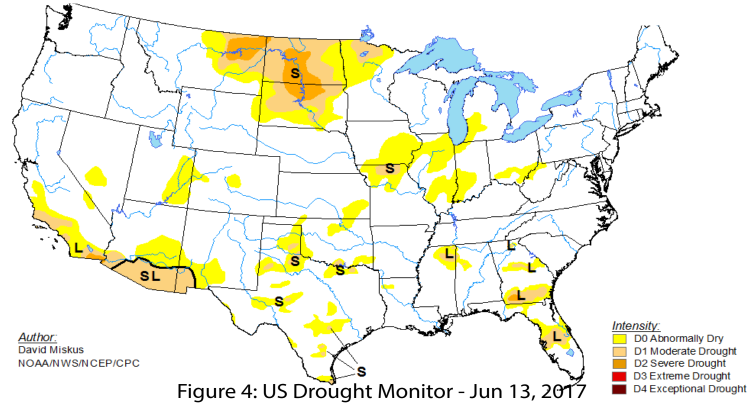


Figure 4: US Drought Monitor - Jun 13, 2017

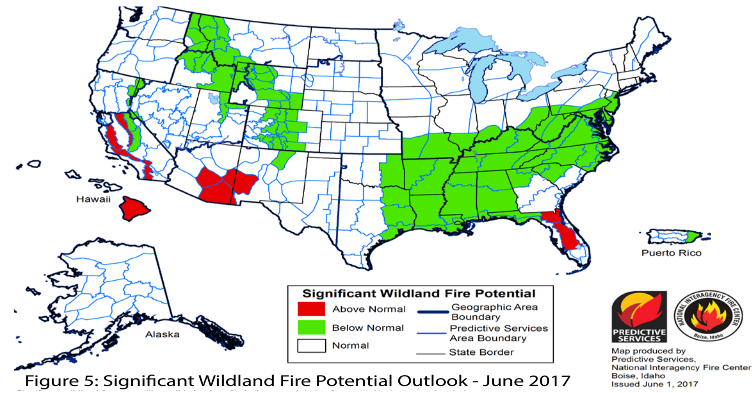


Figure 5: Significant Wildland Fire Potential Outlook - June 2017

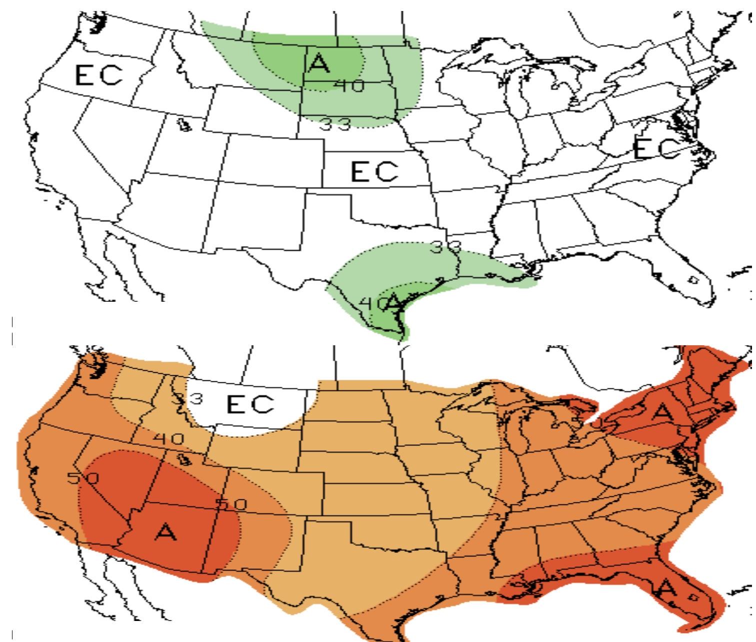


Figure 6: Three-Month Outlook - Precipitation (top) & Temperature (bottom) - Jun 15, 2017

Online Resources

Figure 1
Australian Bureau of Meteorology
http://www.bom.gov.au/climate/enso/

Figure 2
NOAA - Climate Prediction Center
http://www.cpc.ncep.noaa.gov/

Figure 3
International Research Institute for Climate and Society
http://iri.columbia.edu

Figure 4
NOAA - Climate Prediction Center
http://www.cpc.ncep.noaa.gov/

International Research Institute for Climate and Society
http://iri.columbia.edu - #IRIforecast

El Niño / La Niña

Information on this page is also found on the CLIMAS website:

www.climas.arizona.edu/sw-climate/el-niño-southern-oscillation

El Niño-Southern Oscillation (ENSO) - Tracker

Oceanic and atmospheric indicators of the El Niño-Southern Oscillation (ENSO) are still within the range of neutral (Figs. 1-2), although sea-surface temperatures more consistently hint at borderline El Niño conditions compared to atmospheric indicators. Outlooks and forecasts generally agree that ENSO-neutral conditions will persist through the summer and is the most likely scenario for the rest of 2017. A lingering possibility remains of an El Nino event developing later this fall, but forecasts since last month have shifted further from that likelihood.

On June 6, the Australian Bureau of Meteorology maintained its El Niño Watch with a 50-percent chance of an El Niño event in 2017, but noted indicators have remained mostly unchanged for multiple weeks, "suggesting El Niño development has stalled for now." On June 8, the NOAA Climate Prediction Center (CPC) observed that oceanic and atmospheric conditions were consistent with ENSO-neutral conditions, but recent model runs led CPC forecasters to shift to a 50-55-percent chance of ENSO-neutral conditions in 2017 and a 35-50 percent chance of El Niño. On June 9, the Japanese Meteorological Agency (JMA) identified a continuation of ENSO-neutral conditions with a 70-percent chance of El Niño conditions until fall 2017, noting that oceanic and atmospheric conditions "indicate no clear signs of El Niño development." On June 15, the International Research Institute for Climate and Society (IRI) and CPC identified ENSO-neutral as the most likely outcome in 2017, with a 40-to-45-percent chance of an El Niño in 2017 (Fig. 3). The North American Multi-Model Ensemble (NMME) is borderline weak El Niño as of June 2017, and while the model spread indicates a wide range of possible outcomes for the rest of 2017 (Fig. 4), the ensemble mean indicates ENSO-neutral as the most likely outcome (but with a weak El Niño event still within the range of plausibility), which is reflected in the uncertainty in the CPC and IRI/CPC outlooks.

Summary: The lack of atmospheric indicators of El Niño and the borderline status of sea-surface temperature anomalies have strengthened the forecaster consensus that ENSO-neutral is the most likely scenario for the remainder of 2017. It is too early to entirely rule out an El Niño event later this year, but the timing and intensity of this plausible but increasingly unlikely El Niño event is still relatively uncertain. There are two key takeaways from the current outlooks and forecasts. One, there is a near-zero probability of a La Niña event in 2017. Given that the Southwest shifts toward warmer and drier winter conditions in La Niña years, this is a welcome alternative. Two, given the relatively weak correlation between cool-season precipitation and weak El Niño events, whether ENSO-neutral or weak El Niño conditions ultimately prevail, the overall seasonal outlook for the Southwest would look relatively similar.

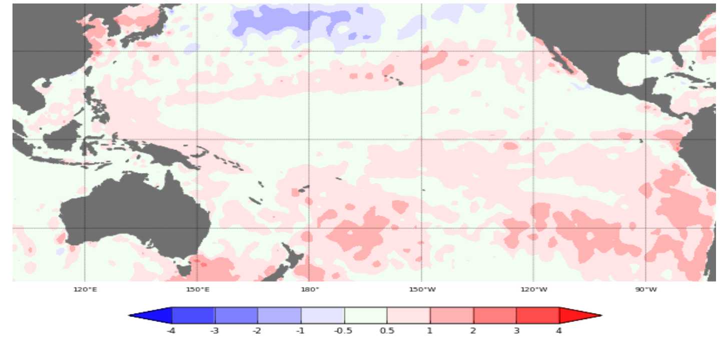


Figure 1: May 2017 Sea Surface Temperature (SST) Anomalies

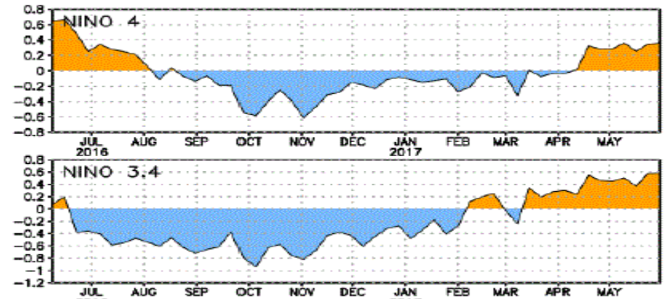


Figure 2: SST Anomalies in Niño Regions 3.4 & 4 (NCDC)

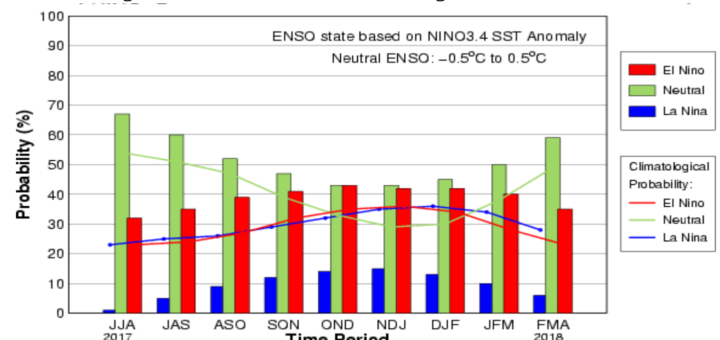


Figure 3: Mid-June IRI/CPC Model-Based Probabilistic ENSO Forecast

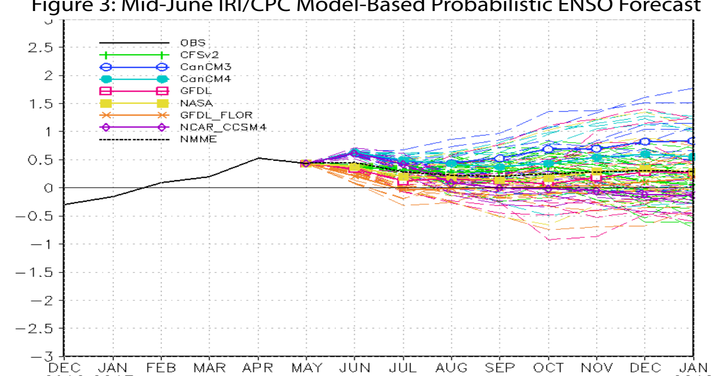


Figure 4: North American Multi-Model Ensemble Forecast for Niño 3.4

Online Resources

Figure 1
Australian Bureau of Meteorology
http://www.bom.gov.au/climate/enso/

Figure 2
CLIMAS: Climate Assessment for the Southwest
climas.arizona.edu

Figures 3a-3b
Monsoon Definition & Progression
National Weather Service - Tucson
http://www.wrh.noaa.gov/twc/monsoon/monsoon.php

NWS Tucson has an excellent extended explanation of seasonal atmospheric dynamics that drive monsoon progression.

CLIMAS Monsoon Hub

Information on this page is also found on the CLIMAS website:

www.climas.arizona.edu/sw-climate/monsoon

In the coming months, CLIMAS will include a variety of monsoon tracking tools to assess the current monsoon in comparison to past years and climatological averages, as well as link to outside experts and tools that provide further context and information about the monsoon.

Southwestern Monsoon Outlook

In 2008, the National Weather Service changed the definition of the start of the Southwest monsoon from a variable date based on locally measured conditions to a fixed date of June 15. Prior to 2008, the start date reflected the seasonal progression of the monsoon (Fig. 1). This is based on larger seasonal atmospheric patterns and the establishment of the 'monsoon ridge' in the Southwest (Figs. 3a-b, also see sidebar for link to NWS pages).

In Southern Arizona, the start date was based on the average daily dewpoint temperature. Phoenix and Tucson NWS offices used the criteria of three consecutive days of daily average dewpoint temperature above a threshold (55 degrees in Phoenix, 54 degrees in Tucson) to define the start date of the monsoon. As shown in Figure 2, the dewpoint temperature criterion produced start dates ranging from mid-June to late July over the period of record (1949-2016).

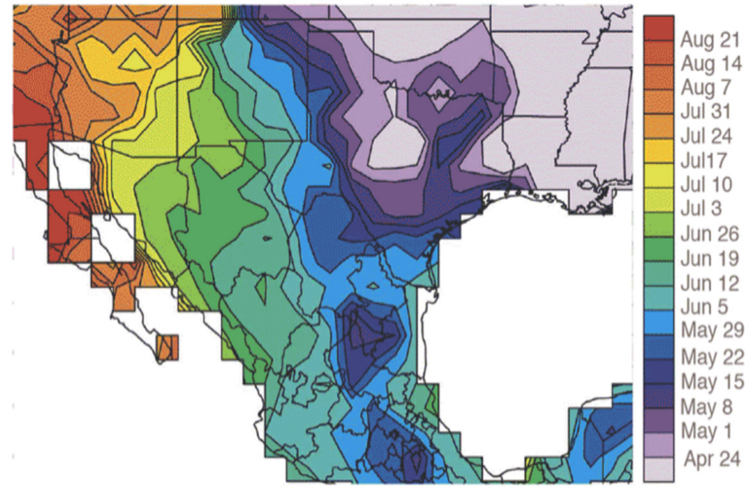


Figure 1: Historical Monsoon Onset Date

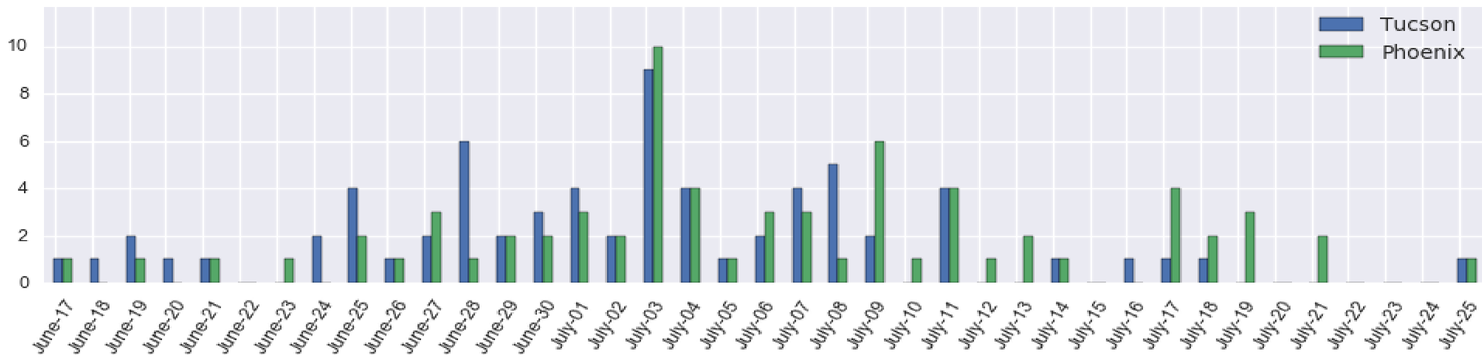


Figure 2: Monsoon Onset (as defined by dewpoint thresholds) in Tucson and Phoenix, Frequency by Date (1949-2016)

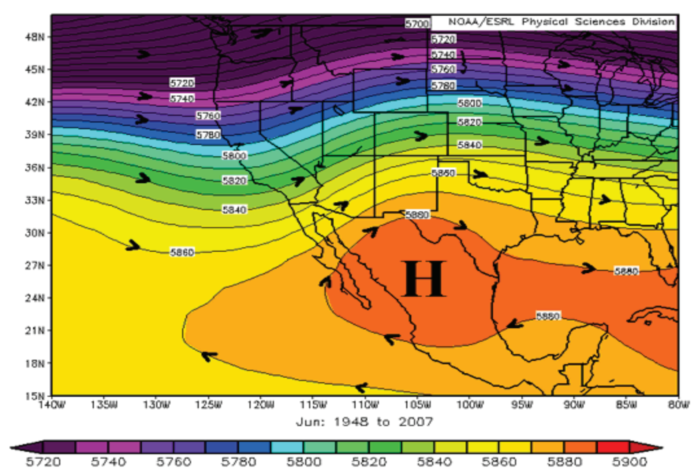


Figure 3a: NCEP/NCAR Mean 500mb Geopotential Height - Jul (1948-2007)

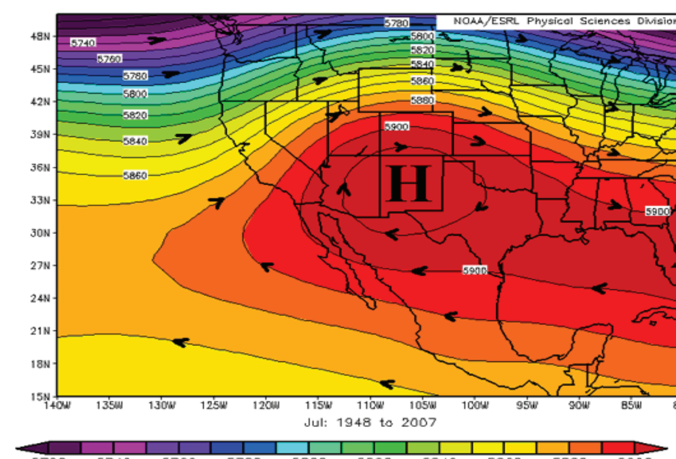


Figure 3b: NCEP/NCAR Mean 500mb Geopotential Height - Jul (1948-2007)

Southwestern Monsoon Outlook (cont.)

The average daily dewpoint temperature is still a useful tool to track the onset and progression of conditions that favor monsoon events, and the National Weather Service includes a dewpoint tracker in their suite of monsoon tools (see sidebar).

Thirty-year averages for daily dewpoint and precipitation demonstrate the gradual increase in dewpoint temperatures during the monsoon season, as well as the variability of precipitation observed over the same window (Fig. 4).

The updated definition of the monsoon identifies a season that lasts for 108 days with defined start and end dates of June 15 and Sept 30. In the Southwest, however, the majority of monsoon storm activity occurs in July and August (Fig. 5), with some lingering activity into September (occasionally augmented by eastern Pacific tropical storms). Dewpoint and precipitation may provide a more granular assessment of monsoon activity, but the seasonal designation allows for easier comparisons between years, and focuses planning activities on a discrete monsoon season (see sidebar for link to NWS video about Monsoon Awareness Week).

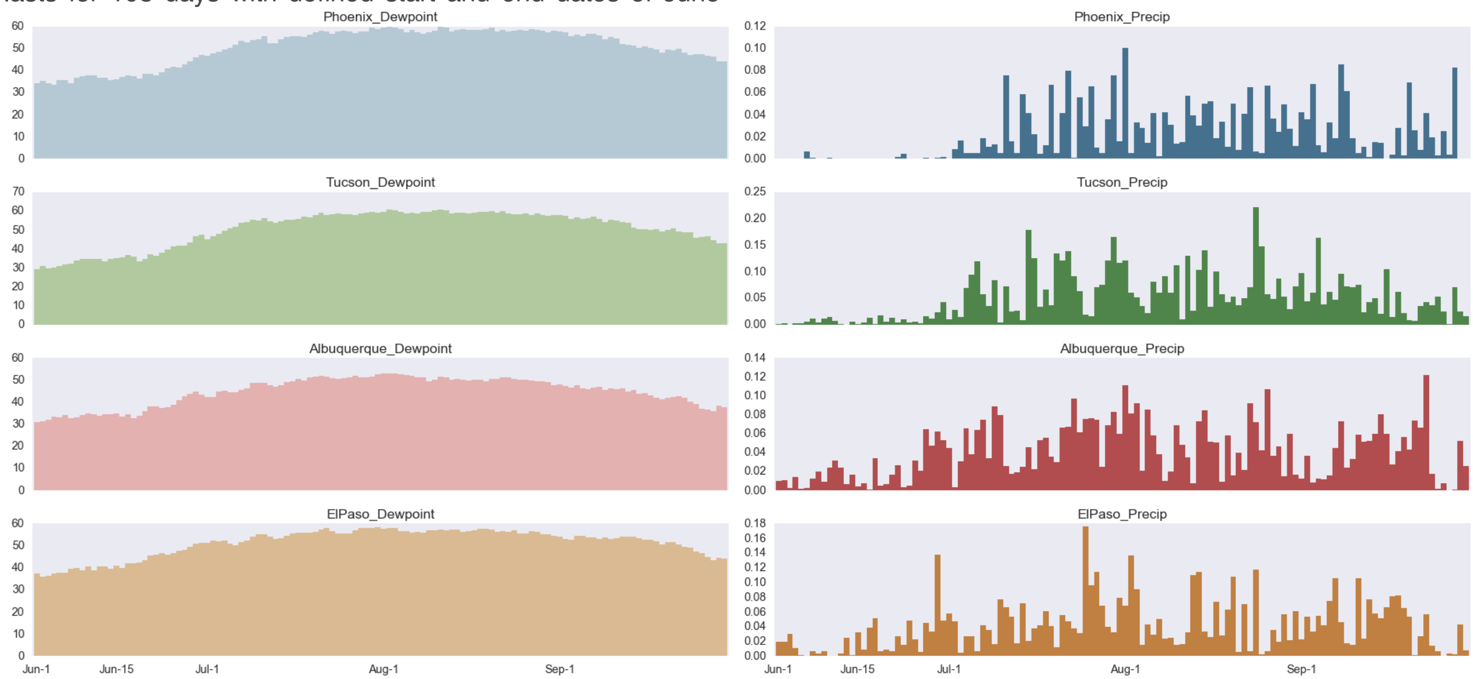


Figure 4: Average Daily Dewpoint Temperature (Left) and Average Daily Precipitation (Right) - Phoenix, AZ - Tucson, AZ - Albuquerque, NM - El Paso, TX

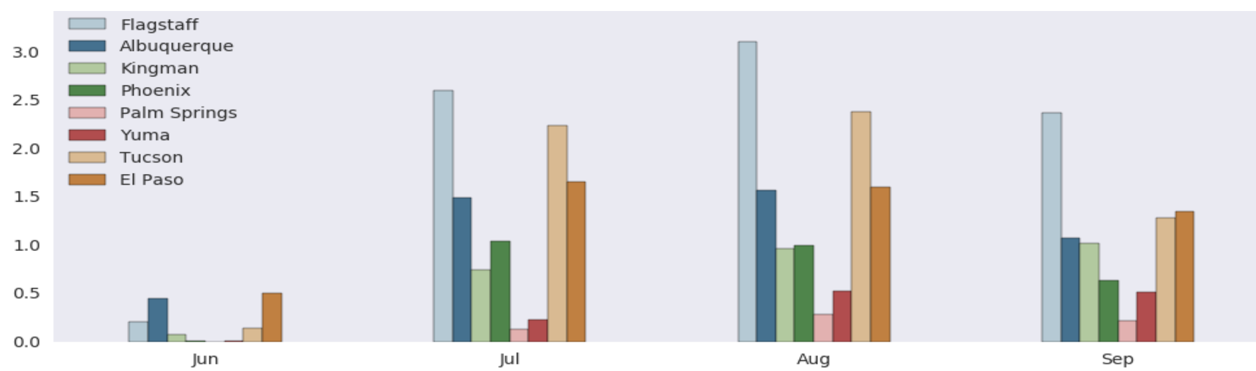


Figure 5: Average Monthly Monsoon Precipitation in the Southwest

Online Resources

Figures 4-5
CLIMAS: Climate Assessment for the Southwest
climas.arizona.edu

National Weather Service Monsoon Awareness Week
https://www.youtube.com/watch?v=d_sn2DLS6pA

National Weather Service Monsoon Dewpoint Tracker
(http://www.wrh.noaa.gov/twc/monsoon/dewpoint_tracker.php)

CLIMAS Monsoon Hub

Information on this page is also found on the CLIMAS website:

www.climas.arizona.edu/sw-climate/monsoon

In the coming months, CLIMAS will include a variety of monsoon tracking tools to assess the current monsoon in comparison to past years and climatological averages, as well as link to outside experts and tools that provide further context and information about the monsoon.

Online Resources

Figures 1a-b
National Weather Service Experimental Potential Heat Risks
https://www.wrh.noaa.gov/wrh/heatrisk/

National Integrated Heat Health Information System (NIHHIS)
https://toolkit.climate.gov/nihhis/

Arizona Department of Health Services
http://www.azdhs.gov/preparedness/epidemiology-disease-control/extreme-weather/index.php#heat-home

Maricopa County Dept of Public Health
http://www.maricopa.gov/1871/Extreme-Heat

Pima County Dept of Health
pima.gov/heat

Category	Level	Meaning
Green	0	No Elevated Risk
Yellow	1	Low Risk for those extremely sensitive to heat, especially those without effective cooling and/or adequate hydration
Orange	2	Moderate Risk for those who are sensitive to heat, especially those without effective cooling and/or adequate hydration
Red	3	High Risk for much of the population, especially those who are heat sensitive and those without effective cooling and/or adequate hydration
Magenta	4	Very High Risk for entire population due to long duration heat, with little to no relief overnight

Extreme Heat in the Southwest

At the time of publication (Jun 15, 2017), an extreme heatwave is forecast to hit the Southwest beginning later this week and extending into next week the week of June 19, peaking on/around June 19-20, 2017. Tucson is currently forecast to reach 114, while Phoenix may see temperatures reach 120 – both of which are approaching the record high temperatures for Tucson and Phoenix, respectively. Southwestern summers have a well-earned reputation for extreme temperatures, and compared to most of the country, even a 'normal' summer day is often much warmer than record high temperatures in more temperate locales.

It is important to note that the current forecast represent temperature extremes that can be dangerous or even deadly, as a result of direct exposure, or associated with the accumulated effects of heat stress, particularly when nighttime temperatures remain elevated and it is harder to cool off at night.

The Phoenix NWS office is piloting an experimental heat extremes tracker/map that highlights the risk potential associated with direct exposure and more sustained heat events. (Figs. 1a-ab).

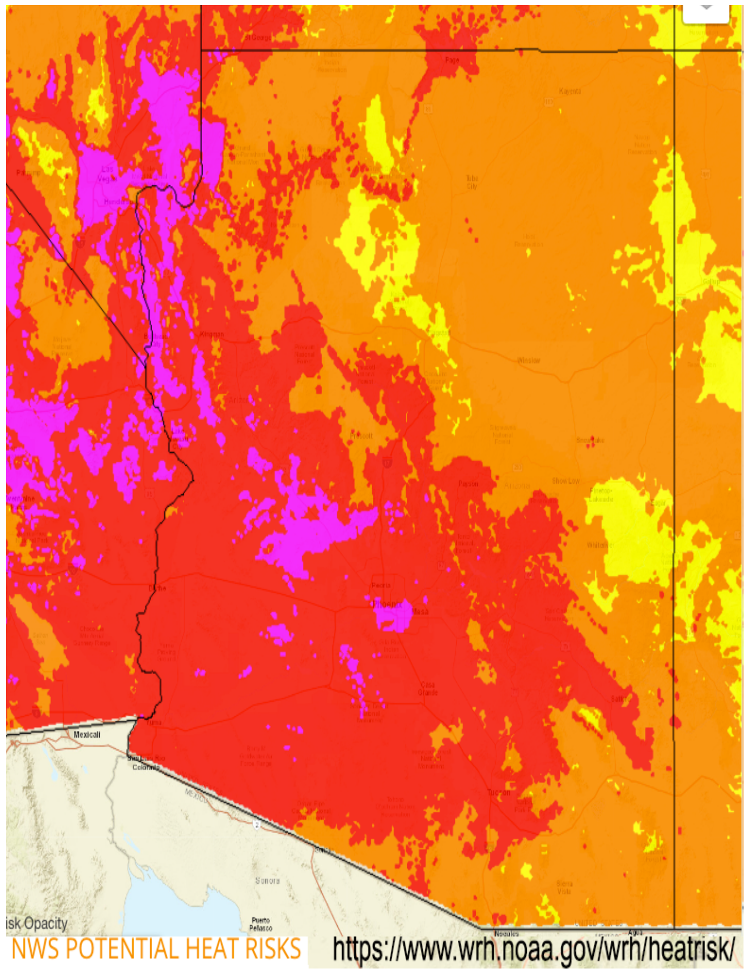


Figure 1a: NWS Potential Heat Risks - June 19, 2017

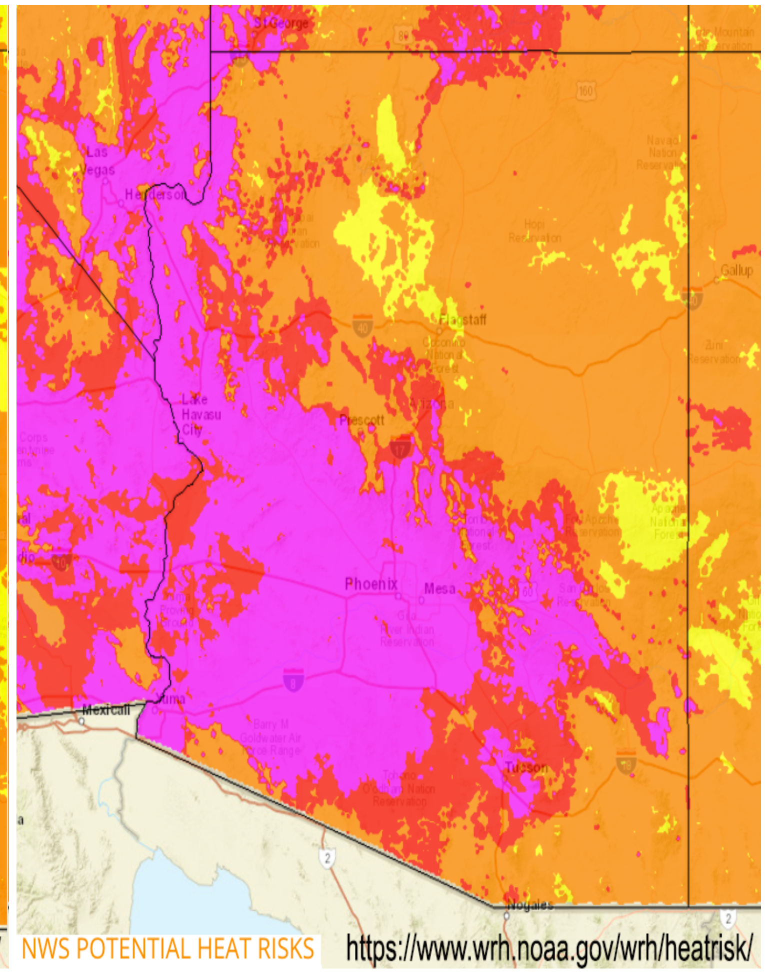


Figure 1b: NWS Potential Heat Risks - June 21, 2017

Online Resources

Portions of the information provided in this figure can be accessed at the Natural Resources Conservation Service

Arizona: http://1.usa.gov/19e2BdJ

New Mexico: http://www.wcc.nrcs.usda.gov/cgibin/resv_rpt.pl?state=new_mexico

Contact Ben McMahan with any questions or comments about these or any other suggested revisions.

Notes

The map gives a representation of current storage for reservoirs in Arizona and New Mexico. 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 (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. Each cup also represents last year's storage (dotted line) and the 1981–2010 reservoir average (red line).

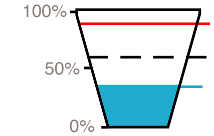
The table details more exactly the current capacity (listed as a percent of maximum storage). Current and maximum storage are given in thousands of acre-feet for each reservoir. One acre-foot is the volume of water sufficient to cover an acre of land to a depth of 1 foot (approximately 325,851 gallons). On average, 1 acre-foot of water is enough to meet the demands of four people for a year. The last column of the table lists an increase or decrease in storage since last month. A line indicates no change.

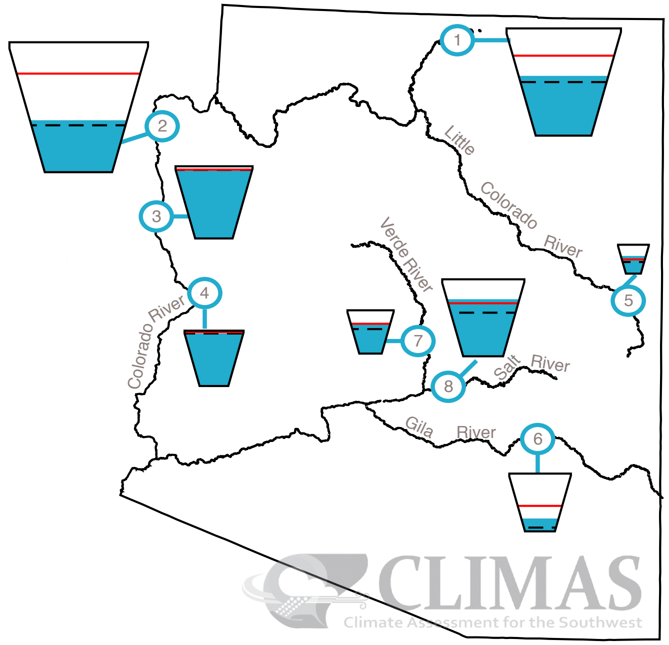
These data are based on reservoir reports updated monthly by the National Water and Climate Center of the U.S. Department of Agriculture's Natural Resources Conservation Service (NRCS).

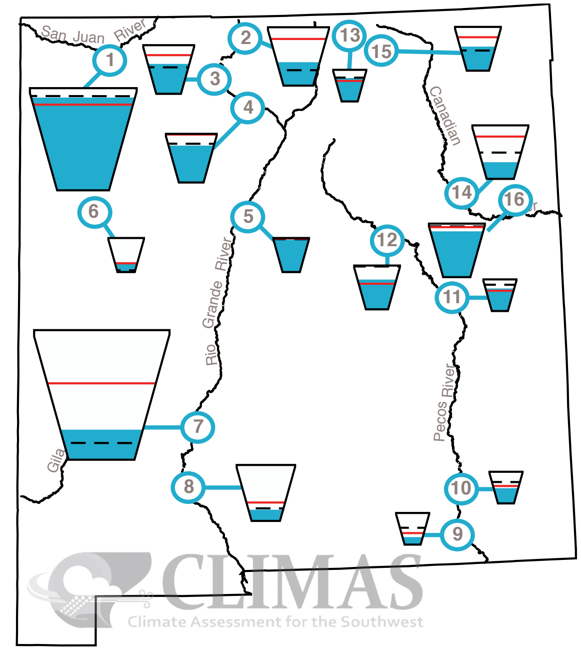
Reservoir Volumes

DATA THROUGH MAY 31, 2017

Data Source: National Water and Climate Center, Natural Resources Conservation Service







Reservoir	Capacity	Current Storage*	Max Storage*	One-Month Change in Storage*
1. Lake Powell	56%	12,667.1	24,322.0	1517.6
2. Lake Mead	39%	10,141.0	26,159.0	-263.0
3. Lake Mohave	95%	1,718.0	1,810.0	35.0
4. Lake Havasu	95%	588.9	619.0	-7.3
5. Lyman	61%	18.2	30.0	-0.7
6. San Carlos	22%	193.0	875.0	-30.0
7. Verde River System	70%	201.6	287.4	-25.0
8. Salt River System	73%	1,479.7	2,025.8	-25.3

*KAF: thousands of acre-feet

* in KAF = thousands of acre-feet
**Reservoirs with updated "Max Storage"
***Costilla reservoir data logging back online Jun 2017

Reservoir	Capacity	Current Storage*	Max Storage*	One-Month Change in Storage*
1. Navajo	91%	1,536.0	1,696.0	-61.7
2. Heron	40%	159.0	400.0	44.3
3. El Vado	61%	116.1	190.3	46.7
4. Abiquiu	76%	142.0	186.8**	9.7
5. Cochiti	94%	47.1	50.0**	-0.2
6. Bluewater	28%	10.6	38.5	-0.8
7. Elephant Butte	23%	501.1	2,195.0	105.5
8. Caballo	20%	67.1	332.0	-4.9
9. Lake Avalon	24%	1.1	4.5**	-0.6
10. Brantley	48%	20.4	42.2**	-7.4
11. Sumner	71%	25.6	102.0**	-1.6
12. Santa Rosa	68%	72.3	105.9**	11.7
13. Costilla	73%	11.7	16.0	11.7***
14. Conchas	31%	79.2	254.2	10.7
15. Eagle Nest	55%	43.2	79.0	5.4
16. Ute Reservoir	86%	172	200	1.0

Online Resources

Figure 1
Climate Program Office
http://cpo.noaa.gov/

RISA Program Homepage

http://cpo.noaa.gov/ClimateDivisions/ClimateandSocietalInteractions/RISAProgram.aspx

UA Institute of the Environment

http://www.environment.arizona.edu/

New Mexico Climate Center

http://weather.nmsu.edu/

CLIMAS Research & Activities

CLIMAS Research

www.climas.arizona.edu/research/

CLIMAS Outreach

www.climas.arizona.edu/outreach

Climate Services

www.climas.arizona.edu/climate-services

CLIMAS
Climate Assessment for the Southwest
A NOAA RISA TEAM

Dear colleagues,

We are reaching out to ask you share your CLIMAS story with us, and tell us about the kind of work you would like to see us do in the coming years.

In 1998, the Climate Assessment for the Southwest (or CLIMAS) was founded with a mission to improve the ability of people across the Southwest to respond sufficiently and appropriately to climate events, variability, and changes. Over those 19 years, we have worked directly with many of you to try to fulfill that mission. We are now looking ahead to the next 5 years and we would like to hear from you.

If you interact with CLIMAS–whether you read the Southwest Climate Outlook, listen to our podcast, or have partnered with us on projects–we would love to hear your story:

Please visit **www.climas.arizona.edu/climas-stories** to tell us what you think.

If your story or feedback is brief, you can also tweet it to us at @CLIMAS_UA

Thanks,

Dan

Daniel Ferguson, Ph.D.

Associate Research Scientist, Institute of the Environment

Director, Climate Assessment for the Southwest (CLIMAS)

Assistant Research Professor, School of Natural Resources and the Environment

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Email: dferg@email.arizona.edu

Online Resources

Figure 1
Climate Program Office
http://cpo.noaa.gov/

RISA Program Homepage

http://cpo.noaa.gov/ClimateDivisions/ClimateandSocietalInteractions/RISAProgram.aspx

UA Institute of the Environment

http://www.environment.arizona.edu/

New Mexico Climate Center

http://weather.nmsu.edu/

CLIMAS Research & Activities

CLIMAS Research

www.climas.arizona.edu/research/

CLIMAS Outreach

www.climas.arizona.edu/outreach

Climate Services

www.climas.arizona.edu/climate-services

CLIMAS
Climate Assessment for the Southwest
A NOAA RISA TEAM

What is CLIMAS?

The Climate Assessment for the Southwest (CLIMAS) program was established in 1998 as part of the National Oceanic and Atmospheric Administration's Regional Integrated Sciences and Assessments program. CLIMAS —housed at the University of Arizona's (UA) Institute of the Environment—is a collaboration between UA and New Mexico State University.

The CLIMAS team is made up of experts from a variety of social, physical, and natural sciences who all work with partners across the Southwest to develop sustainable answers to regional climate challenges.

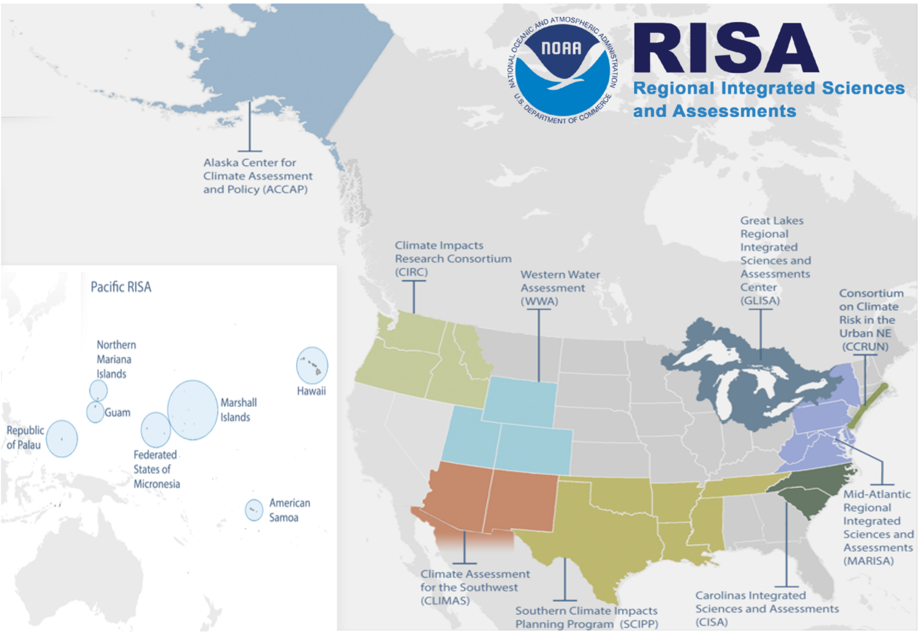

Figure 1: NOAA Regional Integrated Sciences and Assessments Regions

What does CLIMAS do?

The CLIMAS team and our partners work to improve the ability of the region's social and ecological systems to respond to and thrive in a variable and changing climate. The program promotes collaborative research involving scientists, decision makers, resource managers and users, educators, and others who need more and better information about climate and its impacts. Current CLIMAS work falls into six closely related areas: 1) decision-relevant questions about the physical climate of the region; 2) planning for regional water sustainability in the face of persistent drought and warming; 3) the effects of climate on human health; 4) economic trade-offs and opportunities that arise from the impacts of climate on water security in a warming and drying Southwest; 5) building adaptive capacity in socially vulnerable populations; 6) regional climate service options to support communities working to adapt to climate change.

Why is this work important?

Climate variability and the long-term warming trend affect social phenomena such as population growth, economic development, and vulnerable populations, as well as natural systems. This creates a complex environment for decision making in the semi-arid and arid southwestern United States. For example, natural resource managers focused on maintaining the health of ecosystems face serious climate-related challenges, including severe sustained drought, dramatic seasonal and interannual variations in precipitation, and steadily rising temperatures. Similarly, local, state, federal, and tribal governments strive to maintain vital economic growth and quality of life within the context of drought, population growth, vector-born disease, and variable water supplies. Uncertainties surrounding the interactions between climate and society are prompting decision-makers to seek out teams of natural and social scientists—like those that comprise CLIMAS—for collaborations to help reduce risk and enhance resilience in the face of climate variability and change.