NEW MEXICO
Climate

Prepared by: Ted Sammis
Graphic Design: Jessica Phillips

A service of NMSU's Climate Center | 2007 Vol. 5 (2)
Office of the State Climatologist | Department of Plant and Environmental Sciences
College of Agriculture and Home Economics | Agricultural Experiment Station

New Mexico Climate

Summer 2007
Vol. 5 (2)

Cover Photo:
Stream flow after a thunder storm in the Organ Mountains , NM

Table of Contents

If you have a photo or slide that you would like considered for the cover of New Mexico Climate, please call us for instructions (number below). Enclose a note describing the contents and circumstances including location and date it was taken. Digital photographs can also be considered. Submit digital imagery via attached files to email at the right. Unless otherwise arranged in advance, photos cannot be returned.

About NMSU's Climate Center

NMSU's Climate Center is home to the state climatologist who helps New Mexicans understand the impact of climate changes on the environment, human health, and agricultural production.

The state climatologist is responsible for archiving weather data and distributing climate information to the public. Unlike meteorologists, climatologists do not provide weather forecasting or up-to-the-minute bulletins. Instead, they use a computerized data collection system to provide statevide weather reports for previous days, as well as for historical information.

The state climatologist puts climate data into a form people can use to make decisions about their lives. During fire season, people use climate data to assess potential fire hazards and to evaluate firefighting conditions. Engineers use information about rainfall and flooding to design bridges, culverts, storm sewers, and sanitary sewers. Business owners use climate data to evaluate new business or relocation sites. Farmers use it to anticipate outbreaks of insect pests or crop diseases. People also use climate data when making their recreation and travel plans.

For more information:
State climatologist Ted Sammis
Phone: (505) 646-2104
Data service: (505) 646-5082
E-mail: webmaster@weather.nmsu.edu
Internet: http://weather.nmsu.edu

The office of the state climatologist and its head, the state climatologist, are described in New Mexico Statue 75-4-1 through 75-4-4

New Mexico State University is an equal opportunity/affirmative action employer and educator. NMSU and the U.S. Department of Agriculture cooperating.

Tornadoes in New Mexico

By Dr. Ted Sammis *

Tornadoes in New Mexico are rare, but not foreign. Wind speeds in tornadoes range from values below that of hurricane speeds (Level 1, 74-95 mph to Level 5, 156 mph) to more than 300 miles per hour. The maximum wind speeds in tornadoes are often confined to extremely small areas, and vary tremendously over very short distances, even within the funnel itself. The tales of complete destruction of one house next to one that is totally undamaged are well documented. The Fujita scale classifies tornadoes based on the estimated maximum winds occurring within the funnel and are F0: 40-72 mph, F1: 73-112 mph, F2: 113-157 mph, F3: 158-206 mph, F4: 207-260 mph, and F5: 261-318 mph. Tornadoes are not as common in New Mexico as in states in the tornado alley, of central United States where F4 and F5 tornadoes occur most frequently. Texas has the highest occurrence of tornadoes. Since 1950, New Mexico has had 140 category F1 or F2 tornadoes but no F3 or higher tornadoes. Small F0 tornadoes are common with 334 reported since 1950.

The National Climate Data Center maintains a data base of all tornadoes (http://www4.ncdc.noaa.gov/cgi-win/wwcgi.dll?wwevent~storms#NOTICE) and a map of tornado numbers (figure 1) of category F1 and higher. Most tornadoes have occurred in Southeastern New Mexico, where Lea Co. had 27, Quay Co. had 17 ,Curry Co. had 12, and Roosevelt Co. had 11. Three counties had only one, and 7 counties had none.

Figure 1. Number of tornadoes of Category F1 or higher from ◀1950-2006.

New Mexico tornados over that time period have caused $34.8 million of property damage and $5 million of crop damage or on an average $0.7 million each year. The tornadoes also caused 3 deaths and 72 injuries. The 334 F0 tornadoes have over that same time period caused no deaths, 37 injuries and $2.089 million of property damage. Obviously, even small tornadoes are dangerous and can cause property damage and injuries to people. You should seek shelter if there is a tornado warning.

My daughter, on May 3, 2007, ignored a tornado warning and drove to school in downtown Fort Worth TX . She had to travel only 10 minutes to safety but got caught in the storm so bad that for 20 minutes she could not drive because of high winds and rainfall intensity that prevented her from seeing more than a few feet in front of the car. She had to stay in the car in the middle of the street at the stop signal. Fortunately, while trees were flying by the intersection she was protect by an adjacent building and was not injured. However, she learned a valuable lesson: tornado warnings should be taken seriously.

* *Department of Plant and Environmental Science, NMSU*

The Sociology behind the Cooperative Climate Volunteers program

By Dr. Ted Sammis* and Jim Berry**

Climate data collection across the US relies on volunteers. In fact, the longest running volunteer program has been the Cooperative Observer Climate data collection system started in 1890. This system consists of volunteers collecting daily maximum and minimum temperature and rainfall for nearly 11,000 observation sites in the United States including about 200 sites in New Mexico.

Understanding why people volunteer is important to maintaining the free work force that the government depends on for this data. Sociology is the study of how society functions and explains the structure needed for a volunteer system to work. The volunteer fits into the society system based on role definition, rules governing what the volunteer shall do and the status of the volunteer in relationship to the organization. Volunteers work for informal organization or for formal bureaucracies.

The cooperative observer climate program volunteers work under the National Weather Service and are supervised by the cooperator program manager at local offices. The main issues associated with being a climate observer volunteer or any volunteer for a private or government agency are:

- Recruitment
- Time of service
- Fitness
- Rule Enforcement
- Control
- Assessment
- Payment
- Motivation
- Training Supervisors
- Training Volunteers

Volunteerism in absolute numbers is increasing, but it is getting more difficult for the cooperative observer climate program to recruit volunteers that will work under rules requiring the cooperator to collect the climate station data every day, seven days a week or find someone else to read and report the data when they can not (e.g. during vacation or illness).

Another problem is, like all volunteers, the cooperative volunteers receive no payment and consequently the motivation is strictly internal. The volunteer collects the climate data for personal reasons; possibly because they feel they are contributing to the needs of society or are satisfying their own curiosity about what the weather was like yesterday. For most volunteers, the time of volunteer service is limited to three to six months at one location because the volunteer loses interest or the reward is insufficient. If they are cooperative climate observers, the longer they volunteer the better because the climate instruments are located next to their houses and when they quit the equipment must be moved. Consequently, awards are given for longevity in service. In the past the voluntaries have collect climate data and have received awards for up to 55 years of Service (Figure 1). The largest number of awards since 2001 is for 10 years of service, but the number of awards has decreased from a high of 13 in 2003 to 5 in 2007.

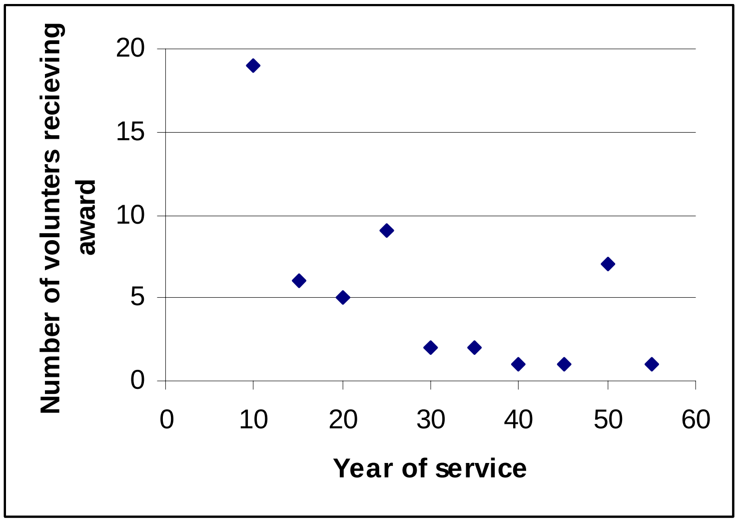

Figure 1. Numbers of volunteers receiving awards for years of service from 2001-2007.

The issue of physical fitness of a volunteer to do the job is not so much an issue when reading climate instruments but rather with dealing with inclement weather. If a volunteer can not clear a path through the snow to read the weather stations, a new volunteer is needed. Some volunteers are diligent in taking and reporting the climate data, others are less diligent but this problem has no solution except for the supervisor to develop social skills leading to a rapport with the volunteer which encourages them to be diligent.

Volunteer job performance is assessed by quality control of the data using a computer. However, quality data are important and quality of the job that the cooperator climate volunteer does is a function of the training they receive and the quality of the supervisor which depends on the training he/she has received. The lack of funds to create automated weather stations is why volunteers are extremely important, but funds must be available to supply volunteers with the equipment and other support that they need to do their job. As an example, the cooperative climate network equipment is in need of modernization.

The climate data collected by volunteers for the last 100 years has resulted in information about global warming, design criteria for all forms of hydrologic structures, and input data for weather forecast models used by the public to plan their lives. Consequently, volunteers have been essential for the United State Government to be able to collect and monitor changes in climate conditions. Agencies and specifically the Nation Weather Service need volunteers and it is important for the agencies to understand the needs of volunteers and support the volunteers in order for the number of volunteers to continue at the current level. Giving awards to volunteers is one of the good things that the Nation Weather Service does to support volunteerism but addition communication by email would increase the communication links. See

http://www.nws.noaa.gov/om/coop/become.htm

for more information about the cooperative climate program.

* *Department of Plant and Environmental Science, NMSU*

** *Emeritus-Western State College*

Summer Monsoon Outlook Discussion

Dr. David S. Gutzler*

Introduction by Dr. Ted Sammis

The article below was written in April of 2007 before the summer monsoon system. New Mexico receives 40 to 50 percent of the annual precipitation during the period from July 1 through August 31 and much, but not all, of the summer rainfall can be attributed to the Southwest Monsoon. In New Mexico the summer rainfall started in May with Las Cruces NM receiving 1.67 inches compared to an average rainfall of 0.3 inches. In June the trend did not continue with Las Cruces, NM receiving 0.38 inches compared to the long term average of 0.75 inches. For the month of July Las Cruces, NM received 1.65 inches compared to the long term average of 1.42 inches. Read the article below and decide for your self how good Dave Gutzler predictions where. I think he did very well in his predictions.

Prediction by Dr. David S. Guetzler

The past several years have been extraordinary in terms of the variability of short-term climate anomalies across the Southwest. What is the seasonal outlook for this year's summer monsoon? At present (late April 2007) the operational long-lead precipitation outlook from the NOAA Climate Prediction Center (http://www.cpc.ncep.noaa.gov/products/predictions/90day/) is completely noncommittal. The entire Southwest is labeled "EC" (Equal Chance) on the CPC's summer precipitation outlook maps, indicating that NOAA's operational seasonal forecasters cannot confidently state that the anticipated probability distribution for this year's summer precipitation is any different from the climatological probability. This state of affairs is actually quite typical. Operational seasonal prediction skill for summer precipitation is extremely low. The CPC made the same noncommittal prediction last spring, completely missing the subsequent record-setting monsoon of 2006 in New Mexico.

Research efforts over the past decade, by myself and others, have explored a variety of precursor variables in historical data to attempt to develop more robust seasonal prediction schemes for the North American Monsoon. These possible predictors can be separated into two categories: ocean temperature anomalies (generally in the Pacific Ocean) and continental precipitation or land surface anomalies. Here is how these possible precursor anomalies appear this year. Research I carried out with Jessica Preston a decade ago showed an inverse correlation between wintertime Pacific ENSO anomalies and the subsequent summer monsoon. A more recent analysis by Chris Castro et al. at Colorado State University suggested that a particular pattern of North Pacific temperature anomalies could modify the trough/ridge pattern of westerly winds across North America, affecting monsoon onset in the Southwest. Last year both of these precursive indicators clearly favored a strong monsoon. In 2007, wintertime ENSO anomalies were weakly positive, i.e. the opposite of the 2006 anomaly. In late winter, however, ENSO anomalies switched from positive (weak El Niño) to negative (now a moderate La Niña). As a result the current oceanic anomaly pattern across the equatorial and North Pacific Ocean is really quite similar to the Spring 2006 anomaly pattern.

Continental precipitation and land surface patterns in winter and spring have also been tied to monsoon precipitation. Wayne Higgins and collaborators at the NOAA Climate Prediction Center published a negative correlation between winter/spring precipitation in Arizona and California and summer monsoon precipitation in the desert Southwest. My own research has examined a similar negative relationship between spring snow pack in the Southern Rockies and summer monsoon precipitation in New Mexico. This year California and Arizona experienced historic levels of drought through the winter. Spring snowpack in the southern Rockies was near-normal until March, when a pronounced warm spell melted the snow prematurely leaving the April 1 snowpack (a standard benchmark that I and others have used for prediction purposes) far below normal. Last year's snowpack was deficient too, although the magnitude of the snowpack anomalies were much greater last year compared to this year.

To summarize, here is the scoreboard for the four possible precursor anomalies discussed above:

Precursor variable	2007 status	suggested effect on summer rainfall
Winter ENSO status	slightly warm	slight tendency for poor monsoon
Spring North Pacific SST	like 2006	strong monsoon
Winter southwestern precip	dry	strong monsoon
Spring snow pack	deficient	strong monsoon

So what is the overall indication? Six weeks ago I would have avoided making any statement at all about the monsoon of 2007, based on inconsistent or weak anomalies among the empirical predictors described above. As the climate system has evolved through the the spring season, however, precursive oceanic and continental anomalies have become aligned to resemble last year's pattern, which would suggest shifting the odds toward another wet monsoon season.

Each of these predictors principally affects the beginning of the monsoon season -- that is, the suggestion of a strong monsoon really means that we might anticipate monsoon onset earlier than the climatological expectation of early July. Historical observations demonstrate that early onset tends to be followed by a strong monsoon overall, and late onset is associated with a weak monsoon. So we'll know by mid-July if the suggested effects in the table above have actually occurred in 2007.

Some cautionary statements are in order. First, we are totally unable to make skillful predictions of extreme conditions, so no one can credibly make any statement about record setting precipitation such as New Mexico experienced last summer. Second, the fact that the Climate Prediction Center refrains from making any prediction of anomalous summer precipitation indicates that the research results I've described here have not built up a sufficient "track record" to be implemented operationally with confidence; in fact we know that the magnitudes of the seasonal lag correlations associated with these precursor variables have waxed and waned through the 20th Century. Finally, it should be noted that the cause-effect relationships underlying these empirical predictors are not fully worked out. To convincingly demonstrate the true causes of anomalous monsoons will require controlled experiments with dynamical models. Although models have improved in recent years, robust dynamical monsoon simulations are still very difficult to achieve. Our seasonal predictions would be delivered with much more confidence if they were backed up by skillful dynamical model simulations, instead of relying solely upon historical correlations.

*****_Earth and Planetary Science, University of New Mexico_

The Impact of Climate change on the Energy Budget and Et of crops

By Richard Snyder*

An energy budget can account for all input and output energy fluxes to a terrestrial landscape. Among these fluxes is the mass balance of water phase change of liquid water to gaseous water vapor. This accounting is a useful analytic tool to investigate the affect of climate change on evapotranspiration. The Penman-Monteith equation, is a partly empirical algorithm that was derived from energy budget considerations. It was modified by the ASCE-EWRI in 2005 to derive a reference evapotranspiration (ETo) rate from meteorological measurements of minimum and maximum temperature, humidity, solar radiation and wind speed. There is, however, a difficulty in estimating crop evapotranspiration (ETc) or ETo for a climatechanged environment because of a lack of knowledge about canopy resistance to water vapor lossin an elevated CO_2 environment. Nonetheless, using FACE measurements of stomatal resistance for elevated CO_2 and the same approach used by Allen to estimate canopy from stomatal resistance for use in estimating ETo, an increase in CO_2 concentration to 550 ppm is expected to increase the daily mean canopy resistance from 70 to 87 s m^{-1}. It is important that the ASCE-EWRI has fixed the ET_o canopy resistance at 70 s m^{-1} for daily calculations and it is unlikely to be changed in the near future.

The equation, however, should be updated if the canopy resistance changes. This is necessary because crop coefficient values were mostly developed by calculating the ratio $K_c = ET_c/ET_o$, where ET_o was the ET of the reference grass surface and ET_c was the crop ET. Consequently, the standardized reference ET equation should provide a good estimate of the ET of a 0.12 m tall, cool-season grass surface or the K_c values will surely be incorrect. It is possible that K_c values could change because of differences in stomatal responses to climate change, but changing the ET_o equation and assuming that the K_c ratio will be conserved is more plausible than maintaining a standardized equation that gives an incorrect estimate of the K_c ratio denominator. To investigate possible ET changes in response to climate change, the daily (24-hour) ASCE-EWRI ET_o equation is used and the temperatures and canopy resistance are changed to investigate how the ET of a 0.12 m tall, cool-season grass might change. It is assumed that other crops will respond similarly to the grass and the K_c values will not change. The Consumptive Use Program (CUP) was developed by DWR and the University of California, Davis to estimate crop evapotranspiration for planning purposes. CUP was written, using MS Excel software, as a tool to help California growers and water purveyors obtain accurate estimates of crop water requirement information from monthly mean data. The program takes input weather data and estimates monthly reference evapotranspiration (ETo) using the Penman- Montieth equation. Then the program uses a curve fitting technique to derive one year of daily weather and ETo data from the monthly data. A feature to vary the canopy resistance as well as the temperature allows users to investigate the effects of increasing canopy resistance on ET_o. Current monthly mean climate data from Davis, CA and a canopy resistance of 70 s m^{-1} were input into CUP to calculate ET_o rates using the Penman-Monteith equation. The process was repeated using an elevated 3°C minimum and maximum temperature, holding all other variables constant. The process was repeated a third time with an increase in the minimum and maximum temperature and the dew point temperature by 3°C while holding other variables constant. Finally, the combination of the air and dew point temperature increase by 3°C and a canopy resistance increase to 87 s m^{-1} was computed. Figure1 shows a comparison of the smoothed curves of calculated ET_o for the four scenarios. Increasing only air temperature, resulted in a 18.7 percent increase in ET_o. Increasing the air and dew point temperatures led to a 8.5 percent increase in ET_o. Increasing the temperatures and the canopy resistance to 87 s/m led to a 3.2 percent increase in ET_o over current conditions. While the percentage increase is small when the canopy resistance is included, the volume of water relative to California is considerable. Other factors like changes in solar radiation due to changes in cloudiness or air pollution and changes in wind speed were not considered.

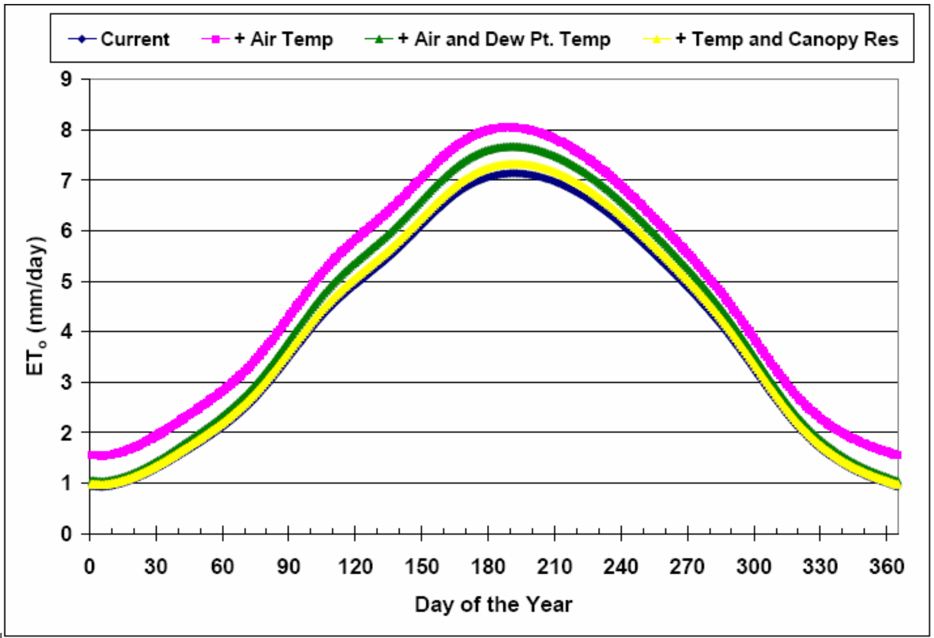

Figure1 ET_o comparison for current and climate change conditions

ETo comparison for current conditions (navy), for minimum and maximum temperature elevated 3°C (pink), for minimum and maximum and dew point temperature elevated by 3°C(green), and for temperature elevated 3°C and canopy resistance increased to 87 s/m (yellow).

**Department of Land, Air and Water Resources University of California Davis, California*

Questions for the New Mexico Climate Center:

Question : Do volcanoes put more CO_2 into the air than humans do?

Answer by Dr. Vince Gutschick

Do volcanoes put a lot of CO_2 into the air, making humans and their fossil fuel usage a lesser source? On the time scale of human civilization, the answer is "No, a very clear no." There are two major pieces of evidence:

First, the CO_2 emissions have been measured (with moderate certainty) from individual volcanoes of various sizes. Volcanoes are not constantly erupting, of course, but on average (over centuries, e.g.) volcanoes emit 0.031 billion tons of CO_2 per year, with an uncertainty range of 0.022 billion tons. Since CO_2 is 12/44 parts carbon by mass, this is equivalent to 0.009 billion tons as carbon (C). Note that this amount is tiny compared to the now 8 billion tons C from human activities, mostly fossil fuels and then deforestation.

Of course, before humans got into the act, volcanoes were a major player in the global C cycle, but only in the long term. They brought the earth out of the ancient "Snowball Earth" episode 2.2 billion years ago, when the earth had frozen over essentially entirely: Early bacteria acquired the ability to release oxygen in photosynthesis. This oxidized the methane that dominated the atmosphere back then, making into CO_2, which is less potent as a greenhouse gas. That was unfortunate, in that the sun's radiation was 30% weaker back then, so that the earth got quite cold. It took about 50 million years of volcanism to inject enough CO_2 to warm the earth and melt the glaciers…and then the earth became quite hot!

Back to the modern era: there are also estimates of other ways that tectonic activities (undersea volcanism, etc.) contribute CO_2 to the air. Even this total is less that 10% of the human-caused deforestation source, and less than 2% of the total human-derived CO_2 source. Note also that these non-human sources were in balance, for thousands of years, with natural "sinks" that absorb CO_2, such as weathering of rock.

Second, the record of CO_2 in the atmosphere shows no real "blips" from episodes of volcanism. Since the 1950's, Charles Keeling and his colleagues have been monitoring CO_2 in the air from sites such as the top of Mauna Loa in Hawaii. This one site is far from local sources of human-caused CO_2 injection, so that it represents well-mixed air in the Northern hemisphere. There are also air bubbles trapped in glaciers, a record going back 400,000 years. Both records show that 1) the rise of CO_2 began in the last century-plus, when humans began using fossil fuels in large amount; 2) this rise is far faster than anything else in the record, including the rise after the end of the ice ages; 3) there are regular swings up and down each year; when it's summer in the N. hemisphere, plants in this hemisphere are so active that they draw down CO_2 about 1 part per million out of 380 ppm total; when it's the turn of the S. hemisphere, the drawdown is less – there's much less land and vegetation down there. Does the record show any significant jumps when volcanoes erupt? No. One can even compare longer time intervals that differ in the amount of volcanic activity. The last 15 years have seen no major eruptions. Is the CO_2 trend different from the previous 15 years, after accounting for the use of fossil fuels? Again, no. It is of interest to note that there are other sites for monitoring CO_2, as well as campaigns of flights to measure CO_2 in other areas of the globe. The ratios of stable (non-radioactive) isotopes of carbon (C-12 and C-13) are also measured, giving information about whether CO_2 is changing from fossil fuel use or changes in earth's vegetation. The story is detailed and it's convincing that human activities are raising CO_2.

Interesting sideline: Yes, volcanoes at their peak of activity look significant as local sources of CO_2. The National Oceanic and Atmospheric Administration (NOAA) notes that, at the peak of its eruption in 1984, Mauna Loa itself (not at the CO_2-monitoring site!) was putting out CO_2 at a rate comparable to a city of 40,000 people. However, consider that the earth's population is 165,000 times greater than this notional city, and that this peak lasted a very short fraction of a year. On the scale of the globe and the scale of a human lifetime, volcanoes are non-players.