



Confronting Climate Change in the U.S. Midwest



MISSOURI

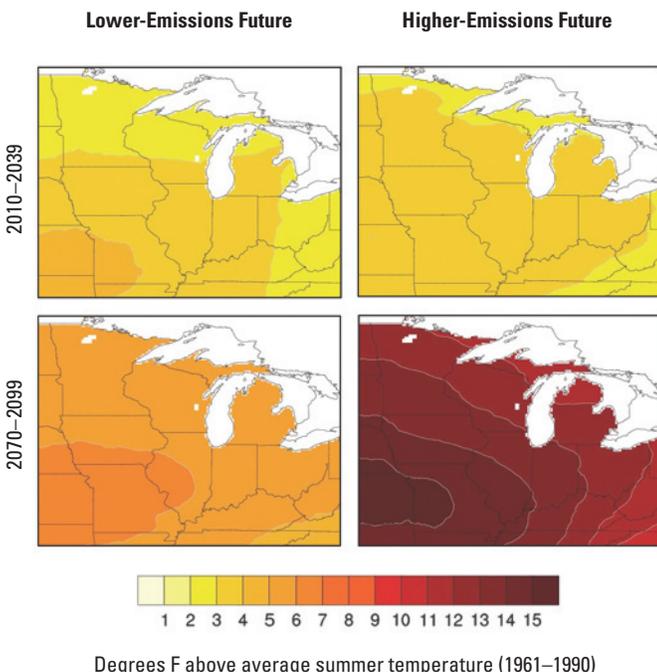
From its more than 100,000 farms and many historic riverside cities and towns to its economy, infrastructure, and lifestyle, Missouri has been strongly shaped by its climate. However, that climate is changing due to global warming, and unless we make deep and swift cuts in our heat-trapping emissions, the changes ahead could be dramatic. This report presents new projections showing some of the potential impacts of global warming on Missouri, including severe summer heat, more dangerous storms and floods, and new threats to agricultural production.

GLOBAL WARMING AND THE MIDWEST

Global warming is caused by an increase of pollutants in the atmosphere, including carbon dioxide produced by human activities such as the burning of fossil fuels and the

clearing of forests. Carbon dioxide acts like a blanket that traps heat in our atmosphere and warms our climate; oceans, forests, and land can absorb some of this carbon, but not as fast as we are creating it. As a result, heat-trapping emissions are building up in our atmosphere to levels that could produce severe effects including extreme heat, prolonged droughts, intense storms, corrosive ocean acidification, and dangerous sea-level rise.

The climate of the Midwest has already changed measurably over the last half century (De Gaetano 2002; Kunkel et al. 1999). Average annual temperatures have risen, accompanied by a number of major heat waves in the last few years. There have been fewer cold snaps, and ice and snow are melting sooner in the spring and arriving later in the fall. Heavy rains are occurring about twice as frequently as they did a century ago, increasing the risk of flooding.



Scorching Summers Become Standard

If our heat-trapping emissions continue to increase at the current rates, every summer in Missouri toward the end of the century is projected to be as hot as or hotter than 1980—Missouri’s hottest summer of the last half century. Under the high-emissions scenario (right), average summer temperatures are projected to increase over the next several decades by more than 3°F and, toward the end of the century, by an extraordinary 14°F. Under the lower-emissions scenario (left), that increase would be halved.



© iStockphoto.com/Lon Hennecke



© iStockphoto.com/merrymoomary



© Associated Press/Michael Dwyer



© iStockphoto.com/Enrah Tunudu



© iStockphoto.com/gchurka

New Climate Projections for Missouri

New research summarized here projects very significant consequences for Missouri (and St. Louis specifically) as soon as the next few decades, increasing in severity into the middle and end of this century. This report considers these consequences in terms of three time frames: 2010–2039 (“the next few decades”), 2040–2069 (“mid-century”), and 2070–2099 (“toward the end of the century”). We compare these periods with the climate in Missouri during 1961–1990 (“the historical baseline”).

Toward the end of the century, if current pollution trends continue, projected effects in the state include:

Far more scorching summers

- More than 100 days per summer with highs over 90°F and almost a month and a half of days over 100°F.
- St. Louis would face up to six heat waves per summer like the one that killed hundreds in Chicago in 1995.
- Air quality would deteriorate, as hotter weather causes more severe smog problems (assuming similar levels of tailpipe and smokestack emissions). This would have serious consequences for public health, including a greater incidence of asthma attacks and other respiratory conditions.

Dangerous storms and flooding

- Heavy rains would become more common throughout the year,

leading to a greater incidence of flash flooding.

- Winters and springs, when the flood risk is already high, would become more than 20 percent wetter.

New threats to agriculture

- Crops and livestock would face substantially more heat stress, decreasing crop yields and livestock productivity.
- Warmer winters and a growing season up to six weeks longer would enable pests like the corn earworm to expand their range.
- Crop production would be inhibited by changing rain patterns such as wetter springs (which delay planting and increase flood risk) and 20 percent less rain during the increasingly hot summers.

Effective and Affordable Solutions

The most dangerous effects of climate change are likely to occur if the global average temperature rises more than two degrees Celsius above where it stood in 1850. Science shows we still have a chance of keeping temperatures below this level if we cut heat-trapping emissions deeply and quickly—and limit atmospheric levels of carbon dioxide to 450 parts per

million (see www.ucsusa.org/mwclimate for more details).

Missouri can do its part by implementing its own carbon-reducing state policies and investing in clean energy technologies that can both reduce consumer energy costs and build new growth industries in the state. Missouri can also play a lead role in calling for strong federal legislation that would provide

climate-friendly choices for Missouri consumers and businesses and help for resource managers and local governments that must prepare for the effects of climate change that cannot be avoided.

A recent analysis by the Union of Concerned Scientists (UCS), *Climate 2030: A National Blueprint for a Clean Energy Economy* (Cleetus, Clemmer, and Friedman 2009) demonstrates that the United States can cut heat-trapping emissions deeply and swiftly enough to avoid the most dangerous consequences of climate change. A comprehensive climate and energy policy approach—combining a cap on emissions with policies that promote renewable power, energy efficiency, and cleaner cars—can reduce emissions 26 percent below 2005 levels by 2020 and 56 percent below 2005 levels by 2030 while saving consumers money.

Our Analysis

Our analysis considers two different possible futures: one with a lower level of global warming pollution and one with a higher level (see www.ucsusa.org/mwclimate). These futures represent the best and worst cases of the emissions scenarios described by the international scientific community in 2000 and which have been focal points for scientific analysis ever since. However, they by no means encompass the full range of emissions futures that could plausibly unfold.

Climate protection policies, if implemented quickly, could reduce emissions significantly below the lower-emissions scenario considered here. On the other hand, up until 2008, global emissions have been higher than the higher-emissions scenario being considered.

HOW WILL EMISSIONS CHOICES AFFECT MISSOURI'S FUTURE?

Dangerously Hot Summers

Our new analysis projects dramatically hotter summers for Missouri. This is true under both the lower- and higher-emissions scenarios, but the prevalence of extreme heat is much greater under the higher-emissions scenario. The conditions that constitute “extreme” heat were measured in two ways: counting the expected number of days above 90°F and 100°F per summer, and projecting the likelihood of extreme heat waves similar to the one that hit Chicago in 1995. By both measures, summers in Missouri will become dangerously hot.

More days over 90°F and 100°F

Because heat waves are especially lethal in cities, where urban landscapes absorb more heat during the day and are less effective at releasing it at night (the “heat island” effect), our analysis focused on the extreme heat projected for the state’s largest urban area, St. Louis, and the number of days each year likely to exceed 90°F and 100°F. During the historical baseline St. Louis averaged more than 36 days per summer with highs over 90°F. That number rises substantially in the next several decades, and toward the end of the century under the higher-emissions scenario, the city is projected to experience around 105 days over 90°F—essentially the entire summer. Under the lower-emissions scenario that number would be cut by more than one-third.

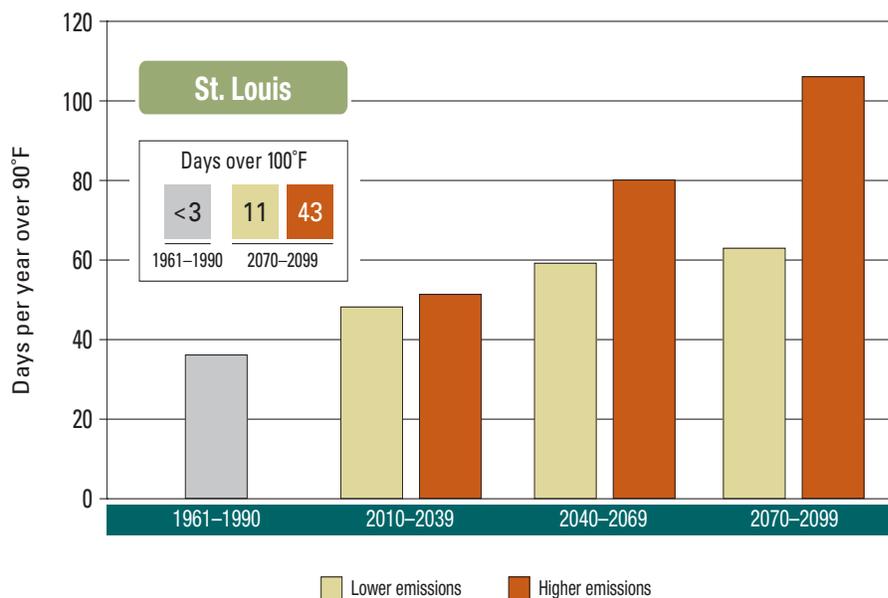
As for the more dangerous days over 100°F, St. Louis averaged only two or three such days each summer during the historical baseline. But

toward the end of the century under the higher-emissions scenario, the city is projected to face more than 43 such days—almost a month and a half. That number would be reduced to 11 under the lower-emissions scenario. Compounding matters is the likelihood that Missouri’s summers will continue to be humid—probably even more humid. Other Missouri cities such as Columbia, Kansas City, and Springfield will face conditions similar to St. Louis.

The severe heat projected for St. Louis poses serious health risks for its residents. Heat waves already kill more people in the United States each year than hurricanes, tornadoes, floods, and lightning combined (CDC 2006), and the average annual

death toll of nearly 700 may well be an underestimate, since there are no uniform reporting requirements and many deaths are probably misclassified (Luber 2008). Studies show that deaths from many causes, including cardiovascular and respiratory disease, increase during heat waves.

The health costs associated with heat waves are not limited to deaths; many other people become sick enough to be hospitalized. In 2005, medical costs related to extreme heat and cold totaled \$1.5 billion nationwide, or more than \$16,000 per patient. The Chicago heat wave of 1995 increased admissions to Cook County hospitals 11 percent (more than 1,000 patients) during the peak week (Semenza et al. 1999). Many



Extreme Heat Becomes More Frequent

Under the higher-emissions scenario, St. Louis could experience an entire summer of days above 90°F toward the end of the century. Under the lower-emissions scenario, the number of such days would be reduced by one-third. Dangerously hot days over 100°F (shown in the inset box) are also projected to increase dramatically, with a month and a half of such days expected under the higher-emissions scenario.

Missouri Could Face Heat Waves of Historic Proportions

In July 1995, Chicago experienced its worst weather-related disaster ever. Temperatures reached or exceeded 90°F for seven days in a row and exceeded 100°F on two of those days (Kaiser et al. 2007). Conditions were made worse by high humidity levels, unusually warm night-time temperatures, and pollution that built up in the stagnant air. Thousands of Chicagoans developed serious heat-related conditions, overwhelming the city's emergency responders and forcing 23 hospitals to close their emergency room doors to new patients. Like the city's hospitals, the county morgue was completely overwhelmed (Klinenberg 2002).

The heat wave was ultimately responsible for between 450 and 700 heat-related deaths (Klinenberg 2002; CDC 1995). Hundreds of additional heat-related deaths occurred in other parts of the Midwest and along the East Coast (NOAA 1996).

If our heat-trapping emissions continue unabated, heat waves like these are projected to become routine in Missouri. Under the higher-emissions scenario, for example:

If our heat-trapping emissions continue unabated, heat waves of historic proportions are projected to become routine in Missouri.

- Over the next few decades, St. Louis would experience a heat wave as hot as the 1995 Chicago heat wave *at least every other year*
- By mid-century St. Louis would experience a heat wave as hot as the 1995 Chicago heat wave *three times every summer*
- Toward the end of the century St. Louis would face heat waves as hot as the 1995 Chicago heat wave *at least six times every summer*

Under the lower-emissions scenario, these projections are greatly reduced, but St. Louis would still experience a heat wave of this magnitude every summer toward the end of the century.

Chicago's experience actually pales in comparison to the European heat wave of 2003—the worst of the past 150 years in terms of both duration and intensity. For almost three months daily high temperatures were hotter than normal, with half of those days more than 10°F above normal. Daily low temperatures were also abnormally hot. The death toll was initially estimated around 30,000 (UNEP 2004), but more recent analyses have identified 70,000 heat-related deaths that summer in 16 countries (Robine et al. 2008). Hardest hit was France, where fatalities exceeded 2,000 per day during the heat wave's peak (Pirard et al. 2005).

Projections for Indianapolis and Chicago (cities that are generally cooler than St. Louis) show that these cities are very likely to suffer a heat wave comparable to the 2003 European heat wave in the next several decades. Under the higher-emissions scenario a heat wave of this magnitude would occur at least every fifth year by mid-century and every other year toward the end of the century.

heat-related deaths and illnesses can be prevented by improving warning systems, access to air conditioning, and year-round medical staffing.

More dangerous air pollution

In areas where there are local sources of fossil fuel emissions, ground-level ozone—a dangerous air pollutant and the main component of smog—increases at temperatures over 90°F (Luber et al. 2008). Since our projections show that, under the higher-emissions scenario, St. Louis will experience such temperatures

virtually the entire summer toward the end of the century, the city can expect far more days of unhealthy ozone levels than would occur without global warming.

This projected increase in ozone pollution is particularly bad news given Missouri's existing air quality problems. According to the Environmental Protection Agency (EPA), five counties in Missouri—all in the St. Louis region—fail to meet federal ozone standards (EPA 2008b), and the American Lung Association ranks St. Louis among the nation's

20 most ozone-polluted cities. In addition, 13 Missouri counties each experienced between 7 and 73 orange ozone alerts over a three-year period (2005–2007); orange alerts represent ozone levels dangerous to sensitive groups including children, athletes, the elderly, and people with heart or lung disease (ALA 2009). Altogether during that period, Missouri experienced 503 orange alerts—more than half of which were issued in the St. Louis area.

High concentrations of ground-level ozone (not to be confused with

ozone in the stratosphere, which provides an important natural shield against solar radiation) diminish lung function, cause a burning sensation in the lungs, and aggravate asthma and other respiratory conditions. Ozone may also contribute to premature death, especially in people with heart and lung disease (EPA 2008). Studies show that when ozone levels go up, so do hospitalizations for asthma and other lung conditions, and it appears that heat and ozone together increase mortality (Luber et al. 2008). Ozone also damages plant life; the EPA warns that a climate change-induced increase in ozone could damage ecosystems and agriculture as well as human health (EPA 2008).

Another air contaminant of particular concern is small particulate pollution (or soot); the same five counties around St. Louis identified by the EPA as failing to meet federal ozone standards also fail to meet federal standards for particulate pollution (EPA 2004). Small particulates increase the severity of asthma attacks in children, increase the number of heart attacks and hospitalizations related to cardiovascular disease and asthma, and cause early deaths from heart and lung disease (ALA 2009).

The leading source of small particulate air pollution is coal-fired power plants, and as demand for electricity increases in response to rising temperatures, power plants generate more emissions. Therefore, climate change threatens to exacerbate Missouri's particulate air pollution.

In Missouri today, more than 8 percent of the population (more than 80,000 children and more than 230,000 adults) suffers from asthma (ALA 2009). Heart disease is responsible for nearly 600 of every 100,000 deaths among people 35 and older in

Missouri (CDC 2009). The combination of increasing heat, ozone, and small particulate pollution can be especially dangerous for these populations.

Changes in Storm, Flood, and Drought Patterns

Flooding in Missouri

Missouri is highly vulnerable to flooding given the major river systems that cross or border the state. In 2008, for example, all but five of the state's counties were the subject of storm- or flood-related presidential disaster declarations that led to more than \$180 million in federal disaster assistance (FEMA 2009). Flooding was especially severe along the Meramec River, which rose to near-record levels over Easter weekend, swamping hundreds of homes and displacing some 40,000 people. That summer brought Missouri's

worst flooding in a decade along the Mississippi and Missouri Rivers; in Mark Twain's hometown of Hannibal, the Mississippi crested at its 500-year-flood level—the second time in 15 years that mark was reached (NOAA 2009). While Hannibal's levies held, the failure of a levy that protected 100 homes in Lincoln County demonstrated the fragility of Missouri's flood-protection infrastructure.

More frequent downpours and flooding

Heavy downpours are already twice as frequent in the Midwest as they were a century ago (Kunkel et al. 1999). While scientists cannot attribute any single storm to climate change, more heavy precipitation can be attributed to climate change that has already occurred over the past 50 years (Trenberth et al. 2007).

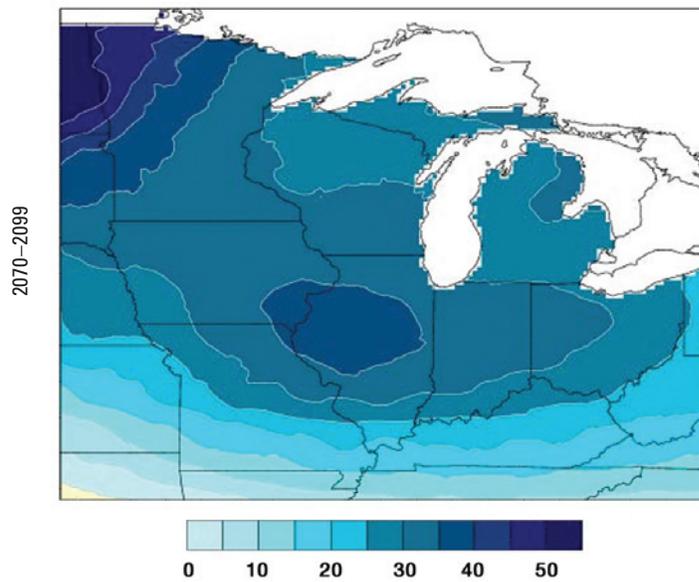


© iStockphoto.com/Rebecca Grabill

Warming Climate Leads to Poor Air Quality

The fact that air pollution worsens as temperatures rise should concern residents of St. Louis—poor air quality already puts large numbers of people at risk from respiratory illnesses such as asthma, chronic bronchitis, and emphysema. Higher temperatures are also expected to increase the dangers of allergy-related diseases (Ziska et al. 2008).

Higher-Emissions Future



Percent increase in spring rainfall compared with average from 1961–1990

Spring Rains Increase

Heavy downpours are now twice as frequent in the Midwest as they were a century ago. Under the higher-emissions scenario, Missouri's spring rainfall is projected to increase almost 15 percent over the next several decades and up to 30 percent toward the end of the century. This may lead to more flooding, delays in the planting of spring crops, and declining water quality in rivers, streams, and storage reservoirs.

Our analysis indicates that the warming ahead will make Missouri (and St. Louis in particular) substantially more vulnerable to the kind of natural disasters it suffered in 2008. Two findings stand out from the research:

- **Precipitation is more likely to arrive in the form of heavy rains.** In St. Louis, heavy rainfalls (defined as more than two inches of rain in one day) are projected to increase by more than 40 percent over the next few decades under either emissions scenario. Toward the end of the century, heavy rainfalls are projected to double in frequency under the higher-emissions scenario and

increase by 50 percent under the lower-emissions scenario. The maximum amount of precipitation falling within a one-, five-, or seven-day period is also projected to rise under both scenarios.

- **Winters, springs, and falls will be wetter but summers will be drier.** Precipitation is projected to increase more than 20 percent during winters and springs toward the end of the century under the higher-emissions scenario, and 14 percent during autumns. Meanwhile, summers can expect at least 20 percent less rain. As described above, more of the rain that does fall will be in the form of downpours.

These projections show a substantially increased risk of flooding in Missouri as the century progresses, especially if emissions are high. While there is likely to be some increase in local summertime flooding due to more frequent downpours, the greatest flooding risk will occur in the winter and spring, when seasonal precipitation is expected to increase the most. In fact, analyses of various rivers in the Midwest (which used a level of emissions somewhat lower than our higher-emissions scenario) projected more than triple the number of high-flow days toward the end of the century (Cherkauer and Sinha 2009; Wuebbles et al. 2008).

More frequent short-term droughts

Paradoxically, Missouri could face not only the risk of greater flooding but also the risk of greater drought, although climate projections are less consistent in this regard. The more temperatures rise, the more water evaporates from the soil and plants, requiring more rainfall just to maintain the same soil moisture levels. However, the Midwest is projected to receive less rain in the summer (when temperatures are hottest), not more. As a result, the likelihood of drought in the region will increase, as overall water levels in rivers, streams, and wetlands are likely to decline. In Missouri, short-term droughts are projected to increase, but long-duration droughts (lasting more than two years) are likely to decline.

Threats to water quality

Heavy rains increase runoff that not only washes pollutants into waterways but—in cities such as St. Louis—also causes raw sewage to spill from sewers into rivers. This has been a long-standing problem in St. Louis, where overflows discharge about



More Disastrous Spring Floods Could Be on the Way

While Missourians will likely see some increase in localized summer flooding due to heavier downpours, the greatest flood risk will be in the spring, when seasonal precipitation is expected to increase the most. This would result in catastrophic flooding like that experienced in spring 2008 along Missouri’s Meramec River.

13 billion gallons of untreated sewage into the Mississippi River and River Des Peres and their tributaries every year (MSD 2009).

From 1992 to 2000, the Metropolitan Sewer District of St. Louis spent approximately \$1.8 billion to eliminate more than 300 sewer overflow points. The district is now creating a Long-Term Control Plan to address the remaining sewer overflows, which is expected to cost billions of dollars over multiple decades (MSD 2009).

The heavier downpours ahead mean the typical overflows of years past are likely to be exceeded. Thus, raw sewage will flow even more frequently into Missouri’s rivers unless authorities invest in new infrastructure designed to prevent this from happening.

New Threats to Missouri’s Agriculture

Agriculture is an important part of Missouri’s economy and identity. Its 100,000-plus farms—more than any state but Texas—comprise 66 percent of Missouri’s total land area (USDA 2009a), and employed 16 percent of the state’s total work force in 2002—

more than 500,000 people (USDA 2005). In 2007 agricultural commodities brought nearly \$7 billion to the state (USDA 2009a); the most valuable of these were soybeans, corn, hay, wheat, cattle, hogs, poultry, and dairy (USDA 2009b).

The heat and precipitation changes projected for Missouri have potentially profound implications for agricultural production. Toward the end of the century, growing seasons are likely to lengthen by three weeks under the lower-emissions scenario

and by six to seven weeks under the higher-emissions scenario. Also, rising CO₂ levels have a fertilizing effect on crops. These changes by themselves would increase crop production, but they will be accompanied by many other changes that threaten production, such as heat stress, increased drought and flood risks, and an expansion of crop pests’ range.

More heat stress for crops

The extreme summer heat projected for Missouri, particularly under the



© Indianapolis Department of Public Works

Storm Runoff Threatens Public Health

Heavy rains often cause raw sewage to spill from city sewers into rivers. Projected increases in rainfall due to climate change would worsen this problem across the Midwest, especially in cities like St. Louis (where an estimated 13 billion gallons of untreated sewage already spill into the city’s waterways every year).



Changes Mean Uncertainty for Agriculture

Missouri's farmers would benefit from the longer growing seasons expected to accompany global warming, but projected increases in spring rains could interfere with planting and cause more flooding. Farmers therefore face greater risk and expense if climate change continues unabated.

higher-emissions scenario, puts the region's crops at significant risk. Corn crops, for example, can fail at 95°F, with the risk increasing the longer the heat lasts. When such hot spells coincide with droughts, as they often do, crop losses can be severe.

The United States lost \$40 billion from a 1988 heat wave—mostly due to crop losses. Crop yields in Missouri dropped precipitously that year, with corn, hay, and soybeans falling as much as 35 percent below their average annual yields for the period 1978–1997 (USDA 2009c).

Our analysis projects the frequency with which Missouri and the Midwest would face three- and seven-day periods of crop-damaging temperatures of 95°F or higher. During the historical baseline, such periods of intense heat happened occasionally in Missouri, with three-day periods occurring about once every three years and seven-day periods occurring

once every four years in southern Missouri and once every 10 years in northern Missouri.

Under the higher-emissions scenario, however, a three-day period with temperatures reaching 95°F or higher is projected to occur in most summers within the next few decades, and in every summer toward the end of the century. A more destructive seven-day period would occur in at least three of every four summers by mid-century and nearly every summer toward the end of the century. Under the lower-emissions scenario, the frequency of such periods would be somewhat reduced, with a week-long period of extreme heat occurring in about three of every four summers toward the end of the century.

The possibility of crop-damaging heat waves becoming commonplace in Missouri within a few decades represents a significant threat to the

state's economy, which took in nearly \$1.2 billion from corn alone in 2007 (USDA 2009a). Crops such as wheat and tomatoes that fail at lower temperatures than corn are even more vulnerable, and the risk is magnified by the other risks described below.

More heat stress for livestock

Extreme heat is also projected to cause heat stress for much of Missouri's livestock. Dairy cattle are particularly vulnerable to high temperatures, and milk production can decline when temperatures exceed 75°F to 80°F, depending on humidity. During the historical baseline, average summer temperatures and humidity in Missouri did not exceed levels known to cause stress in livestock. Under the higher-emissions scenario, however, dairy cattle and other livestock will endure near-permanent heat stress during the average Missouri summer toward the end of the century unless they are kept cool using costly measures such as air-conditioned barns.

Wider spread of pests

The warmer winters ahead mean that crop pests and pathogens normally kept in check by cold temperatures are projected to expand their ranges northward. A recent study warned that the expanding ranges of corn pests could have a substantial economic impact in the form of higher seed and insecticide costs and lower yields (Diffenbaugh et al. 2008). Already, corn pests cost U.S. producers more than \$1 billion annually; the corn earworm alone is responsible for destroying about 2 percent of the nation's corn crop every year, and it has shown resistance to a wide range of insecticides (Diffenbaugh et al. 2008).

Missouri's valuable corn crop would be at risk if the corn earworm does indeed move north. During the historical baseline, conditions conducive to the corn earworm occurred about once every 10 years in central Missouri and once every three years in southern Missouri. Under the higher-emissions scenario, however, conditions conducive to corn earworm will occur almost every year toward the end of the century in southern Missouri.

Potentially damaging changes in precipitation

Crops under stress from extreme heat need more rain, but Missouri is projected to receive less rain in the summer growing season as the climate warms. Dry conditions will be a particular problem for Missouri's crops because only about 7 percent have access to irrigation (USDA 2009a). In addition, the projected increase in spring rains could interfere with planting and pose a greater risk of floods like that of 1993, which inundated 20 million acres in nine states and wiped out 12 percent of Missouri's crops (Mattoon 2008). Changes in precipitation are likely to limit farmers' ability to take advantage of the longer growing seasons expected to accompany future climate change.

CLIMATE SOLUTIONS FOR MISSOURI

Since 1990, Missouri's global warming emissions have grown more than twice as fast as the state's population and more than any Midwest state. This is primarily due to a 54 percent increase in emissions from electricity generation—an increase of more than twice the regional and national averages (WRI 2007).

If Missouri and the world are to avoid the worst consequences of climate change, the state must reduce its emissions by:

- increasing energy efficiency and conservation in industries and homes;
- boosting the use of renewable energy resources such as wind power, advanced biofuels, and geothermal energy;
- improving vehicle fuel efficiency and reducing the number of miles Missourians drive; and
- improving agricultural practices to reduce the release of heat-trapping emissions from soil tilling and fertilizer application.

These actions will also provide benefits such as lower energy costs (after just a few years), new local jobs, and cleaner air and water. A

recent analysis by the Union of Concerned Scientists shows that by 2030, businesses and industries in the North Central region would save \$8.2 billion by instituting these kinds of changes (Cleetus, Clemmer, and Friedman 2009).

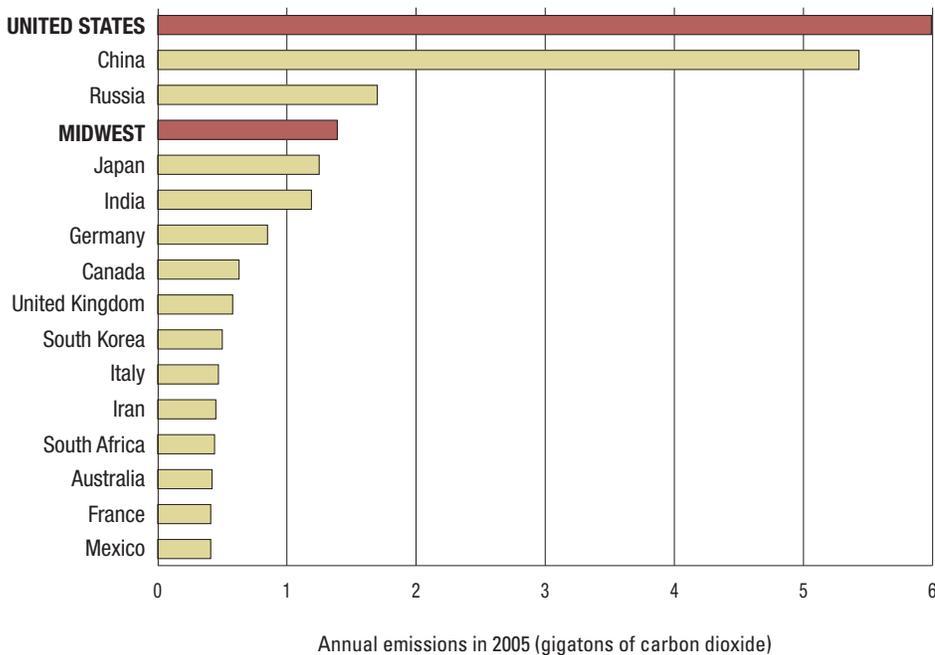
While Missouri has made strides toward implementing a number of the strategies listed above, it still lags behind many other Midwest states. The state does deserve credit for the following positive steps:

- In November 2008 Missouri voters approved Proposition C, which requires investor-owned utilities to generate 15 percent of their electricity from renewable resources by 2021 (DSIRE 2008). This renewable electricity standard is expected to save Missourians \$331 million over the next 20 years (Renew Missouri 2009).



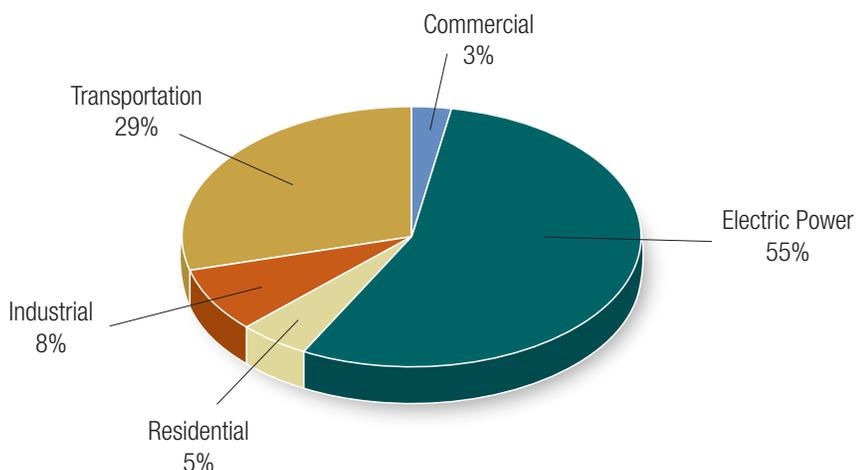
Livestock Face Increasing Heat Stress

Milk production can decline when temperatures exceed 75°F to 80°F. If heat-trapping emissions continue to rise at their current pace, Missouri's dairy cattle will experience near-permanent heat stress during the average summer toward the end of the century, potentially causing declines in milk yields.



The Midwest Burns More Fossil Fuels Than Entire Nations

The total combined emissions from eight states (Illinois, Indiana, Iowa, Michigan, Minnesota, Missouri, Ohio, and Wisconsin) would make the Midwest the world's fourth largest polluter if it were a nation. The region's emissions are more than double those of the United Kingdom, which has about the same population (EIA 2008b).



Vehicles and Power Plants Are Missouri's Biggest Polluters

Transportation and electricity generation—primarily from coal-fired power plants—are the largest sources of heat-trapping emissions in Missouri (EIA 2008a).

- Proposition C also requires investor-owned utilities to offer their retail customers a rebate of up to \$50,000 for installing solar energy systems (effective January 1, 2010).
- In 2007 Missouri passed a law making it simpler and more cost-effective for homeowners and businesses to install and use renewable energy systems.

Pathways to Real Progress

The emissions reductions achieved by Missouri's clean energy and climate strategies to date pale in comparison to what is actually possible. The state should immediately pursue the cost-effective strategies summarized below.

Energy efficiency programs

Missouri could duplicate the progress achieved in Illinois, Michigan, Minnesota, and Ohio by requiring its utilities to help their customers implement energy efficiency projects. This strategy saves consumers money, reduces global warming emissions, and creates local jobs for people who perform energy audits, weatherize homes, and manufacture efficient windows. The Midwest Energy Efficiency Alliance estimates that "energy efficiency programs could save Missouri families and businesses \$175 million in direct natural gas bill savings and \$457 million in direct electricity savings over the next five years. As a result of downward pressure on natural gas prices, consumers in Missouri could see an additional \$230 million in savings by 2011" (MEEA 2009).

Better building codes

Because buildings account for almost 40 percent of the United States' total energy use and 70 percent of its total

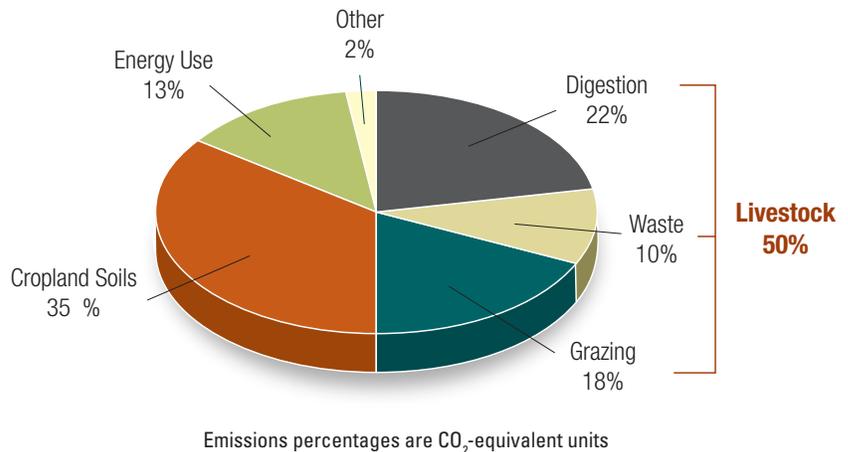
electricity use, making buildings more energy-efficient represents a significant opportunity for Missouri to reduce its emissions while saving millions of dollars in energy costs. Yet Missouri is one of only eight states nationwide that has not adopted a statewide energy code for residential or commercial buildings, and only a few jurisdictions (including Kansas City and St. Louis) have adopted the International Energy Conservation Code (IECC)—one of the model energy codes recommended by the federal government. If Missouri were to adopt the 2009 IECC statewide, it would save an estimated \$108 million in energy costs by 2020 and an estimated \$210 million by 2030 (based on 2006 energy prices) (BCAP 2009).

Building More Resilient Communities

Because climate change is already upon us and some amount of additional warming is inevitable, Missouri must adapt to higher temperatures and more heavy rains while working to reduce its emissions. Any delay in emissions reductions will make it more difficult and costly to adapt; conversely, aggressive steps to reduce emissions now will provide the time ecosystems and societies need to become more resilient. For each adaptation measure considered, Missouri's decision makers must carefully assess the potential barriers, costs, and unintended social and environmental consequences.

A State-Federal Partnership

Although Missouri can achieve much with its own policies and resources, the scale of emissions reductions required suggests that individual states will need strong support from the federal government. The



Agriculture Contributes to Warmer Temperatures

Agriculture generates 7 percent of total U.S. heat-trapping emissions, including three potent global warming gases: carbon dioxide (CO₂), methane (CH₄), and nitrous oxide (N₂O). Half of these emissions come from livestock production, one-third from the cultivation and fertilization of cropland (which decreases its ability to absorb carbon), and the rest from energy used for power generation, transportation, and construction (USDA 2008).

United States should therefore enact a comprehensive set of climate and energy policies including standards for renewable electricity, energy efficiency, and transportation that set a tight limit on heat-trapping emissions nationwide. The goal should be to reduce emissions at least 35 percent below current levels by 2020 and at least 80 percent by 2050.

A national renewable electricity standard and strong fuel economy standards for cars and trucks can boost local economies while substantially reducing emissions nationwide. For example, while the state's renewable electricity standard (RES) of 15 percent by 2021 is a good start, our analysis of a more ambitious federal RES of 20 percent by 2020 shows that such a policy would provide a significant boost to Missouri's economy in the form of:

- 2,700 new jobs, many in the manufacturing of renewable energy components
- \$119 million in electricity and natural gas bill savings by 2020, growing to \$264 million in 2030
- \$327 million in new capital investment in renewable energy
- \$298 million in new income for farmers and rural landowners who produce biomass energy and/or lease their land to wind developers
- \$11 million in new property tax revenues that can help local communities pay for schools and vital public services (UCS 2007)

A separate UCS analysis found that if every car and light truck on U.S. roads averaged 35 miles per gallon (mpg) by 2018 (compared with the fleetwide average of 26 mpg today), drivers would save enough in fuel costs

to create 5,400 new jobs in Missouri by 2020 (UCS 2007b). The Obama administration is currently pursuing new standards that would achieve an average of 35.5 mpg by 2016.

Another complementary federal strategy known as a “cap-and-trade” program would set a price on emissions and require polluters to obtain government-issued permits in order to continue emitting. By auctioning these permits the government could generate revenue for investment in:

- Energy efficiency and renewable energy solutions
- Assistance for consumers, workers, and communities facing the most difficult transition to a clean energy economy (coal miners and mining towns, for example)
- Conservation of precious natural resources
- Assistance for communities that must adapt to unavoidable consequences of climate change

Setting a price on heat-trapping emissions will also stimulate investment in cleaner and more efficient energy technologies by making them more cost-competitive. One possibility is power plants equipped with carbon capture and storage technology (if and when this proves commercially feasible).

Finally, federal resources devoted to climate monitoring and assessments



© Wind Energy Group

Renewable Energy Presents Opportunity for Growth

Low-carbon electricity generation is essential if we are to decrease our heat-trapping emissions deeply and quickly enough to avoid the worst impacts of global warming. Wind energy, for example, could provide not only emissions-free power for our homes and businesses but also jobs and revenue that can help build a clean energy economy.

can provide essential information for states and communities that need to devise and implement adaptation plans. Missouri’s U.S. senators and representatives must therefore support strong federal climate and clean energy policies that will help the state reduce emissions, transition to a clean energy economy, and prepare for the climate change that will occur in the interim.

CONCLUSION

Global warming represents an enormous challenge to Missouri’s way of life and its residents’ livelihoods, but we can meet this challenge if we act swiftly. The emissions choices we make today—in Missouri and throughout the nation—will shape the climate our children and grandchildren inherit. The time to act is now.

The Union of Concerned Scientists is the leading science-based nonprofit working for a healthy environment and a safer world.

For more information on the Midwest’s changing climate, along with a list of references for this report, visit:

www.ucsusa.org/mwclimate

This report was made possible in part through the generous support of The Energy Foundation, Wallace Research Foundation, and Fresh Sound Foundation, Inc. The report was prepared by the Union of Concerned Scientists, with Melanie Fitzpatrick as project manager, Barbara Freese as lead science writer, and Bryan Wadsworth as editor. Rouwenna Lamm provided invaluable help in all stages of production. Our analysis is based on research conducted by Katharine Hayhoe (Texas Tech University) and Donald Wuebbles (University of Illinois).



Union of
Concerned
Scientists

National Headquarters
Two Brattle Square
Cambridge, MA 02238-9105
Phone: (617) 547-5552
Fax: (617) 864-9405

Washington, DC, Office
1825 K St. NW, Ste. 800
Washington, DC 20006-1232
Phone: (202) 223-6133
Fax: (202) 223-6162

West Coast Office
2397 Shattuck Ave., Ste. 203
Berkeley, CA 94704-1567
Phone: (510) 843-1872
Fax: (510) 843-3785

Midwest Office
One N. LaSalle St., Ste. 1904
Chicago, IL 60602-4064
Phone: (312) 578-1750
Fax: (312) 578-1751



Printed on recycled paper using vegetable-based inks

© 2009 Union of Concerned Scientists