

# Climate Change

## A BRIEF SUMMARY FOR KENTUCKY EXTENSION AGENTS

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Scientific evidence that our global climate is warming is abundant. See for yourself: Do an Internet search with any of the phrases listed in Table 1, and look at the evidence. Pay special attention to web resources that are scientific and highly credible. Blogs are usually poor resources; they can appear knowledgeable to nonscientists but are not usually based on peer-reviewed science. Highly credible scientific sources include:

- **Scientists affiliated with universities**, especially if the researcher has published extensively in peer-reviewed science journals. (A paper published in a refereed journal is a mark of professional distinction because the manuscript must undergo rigorous scrutiny by scientific experts before being accepted for publication. Because of the rigor of this process, a scientist who has a sustained record of publication in refereed journals is recognized as an expert by other scientists.)
- **Scientists at government research facilities** such as NASA (National Aeronautics and Space Administration) and NOAA (National Oceanic and Atmospheric Administration) as well as the United Kingdom’s Met Office Hadley Centre and many others. These facilities are widely regarded as trustworthy by professional scientists.
- **Scholarly research papers** in peer-reviewed science journals (although they can be difficult to understand because they are written for other scientists).

**Table 1.** Some indicators of global warming driven by greenhouse gases.

Parameter	Indicator	Internet search phrase
Surface temperature of Earth	Rising due to heat-trapping effect of greenhouse gases	<i>Earth surface temperature trends</i>
Atmospheric CO <sub>2</sub>	Rising due to combustion of fossil fuels	<i>Atmospheric CO<sub>2</sub> trends</i>
Heat content of the upper ocean	Rising due to warming climate	<i>Upper ocean heat content trends</i>
Sea level	Rising due to thermal expansion of warming ocean water and melting glaciers and ice sheets	<i>Sea level trends</i>
Length of glaciers	Shrinking due to warming climate	<i>Glacier length trends</i>
Sea ice	Shrinking due to warming climate	<i>Sea ice trends</i>
Arctic permafrost	Melting due to warming climate	<i>Permafrost trends</i>
Temperature of troposphere	Rising due to heat trapped by greenhouse gases	<i>Troposphere temperature trends</i>
Temperature of stratosphere	Declining due to heat trapped lower in the atmosphere	<i>Stratosphere temperature trends</i>
Occurrence of extreme weather	Increasing due to increasing heat content of the lower atmosphere	<i>Climate extremes trends</i>
Acidity of ocean	Increasing acidity (declining pH) due to increasing atmospheric CO <sub>2</sub>	<i>Ocean acidification trends</i>
Spring snow cover	Shrinking due to warming climate	<i>Spring snow cover trends</i>
Timing of plants’ growth and flowering	Plants breaking dormancy earlier in spring and grow later in autumn due to warming climate	<i>Plant phenological trends</i>
Ratio of carbon isotopes <sup>13</sup> C to <sup>12</sup> C in atmosphere	Declining due to high <sup>12</sup> C content of fossil fuels	<i>Atmospheric <sup>13</sup>C/<sup>12</sup>C isotopic ratio trends</i>

Scientists with specialties in physics, Earth science, and climate science say that global warming is caused by the heat-trapping effects of increasing levels of atmospheric CO<sub>2</sub> and other “greenhouse gases,” due largely to human activities. You can see some of the evidence on the Internet also, using the phrases listed in Table 1.

Practicing scientists consider the evidence of human-induced global warming to be extremely strong (1,5,7,14).

In fact, 97 to 98 percent of the most knowledgeable experts—scientists who actively publish research papers in climate science—are convinced that global warming is occurring and is caused primarily by human activities (1,5). A consensus of 97 to 98 percent on a controversial topic is remarkable, considering that scientists are trained to be vigorously skeptical.

*Note: Citations to published scholarly literature listed at the end of this publication.*

## Likely Effects of Global Warming on Kentucky Agriculture and Other Ecosystems

The future impacts of global warming are difficult to predict with accuracy because of the uncertainties associated with complex systems that include interactions among climate, social, political, economic, and agroecosystem components. Despite the uncertainties, global warming is expected to increasingly affect Kentucky agriculture in the next 20 to 30 years (9) (Figure 1). Some expected effects include:

**Increased yield potential for certain crops, reduced yield for others.** Reductions in corn yields of several percentage points are expected. This reduction is primarily because higher temperatures shorten the life cycle and reduce pollination and kernel set (9,13). In contrast, the yield potential of soybean may increase by up to 5 to 10 percent, stimulated both by the warmer temperatures and the increased CO<sub>2</sub> concentration (9,13). Production of numerous cool-season forages and horticultural crops may be affected by global warming. Planting times and growing regions may change as agriculture adapts to a changing climate. In northern latitudes where many cool-season vegetables are now grown in the summer months, planting times may have to be shifted to avoid excessive temperatures (12).

**More year-to-year variability in crop performance and increased incidence of crop failures.** Increasing global temperatures will likely increase climatic variability, resulting in greater extremes of weather (2,9,10,11,12,17,20). Droughts are likely to become more severe. Intense storms and precipitation events may become more frequent. More frequent days with extremely high temperatures are expected. Hail, wind, and flooding damage may be more common. Some regions will occasionally experience colder-than-normal winters; greater temperature swings during winter months are also more likely.

**Figure 1.** Global temperatures show an unmistakable warming trend. The line is a smoothed time series, generated using data from NASA GISS Surface Temperature Analysis (<http://data.giss.nasa.gov/gistemp/>). The reference temperature used in calculating the anomalies is the 1951–1980 average.

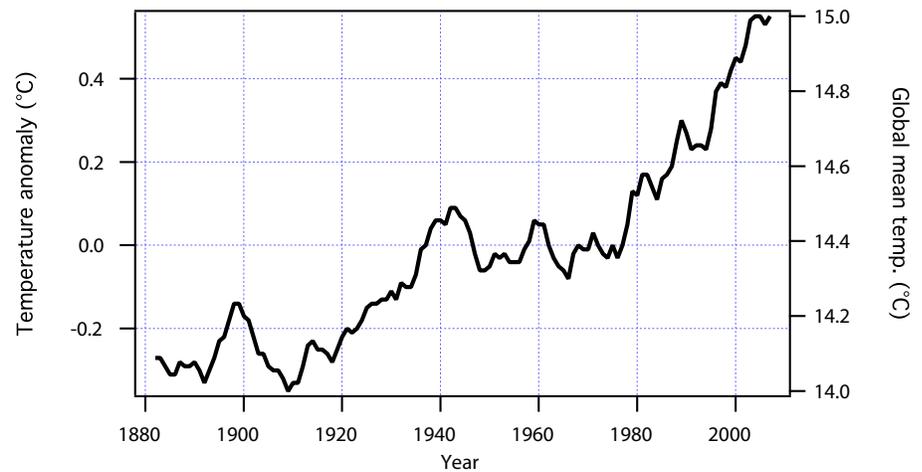


Figure courtesy of Dr. A. E. Dessler, Dept. of Atmospheric Sciences, Texas A&M University.

**Increased pressure from diseases, insect pests, and weeds.** On average, winters are expected to be milder. Therefore, disease-causing organisms (3) and insect pests that are killed by bitter cold are more likely to survive the winter and begin activity earlier in the spring. Insect pests and disease organisms that invade Kentucky from southern regions each year may be able to migrate earlier in the year and farther north. Increased CO<sub>2</sub> concentrations are likely to favor the growth of weeds more than the growth of most crops (2,9).

**Less need for stockpiled or purchased forage in winter.** Longer growing seasons will allow forage production later in the autumn and earlier in the spring (2,8). This change depends, of course, on the availability of water. But forage quality is likely to change as species composition of pastures changes and individual plants respond to altered conditions.

**Reduced livestock production during summer months.** Higher summertime temperatures will likely affect production of ruminants, especially where livestock cannot shelter themselves from the heat (2,8). This negative effect may be partially offset by warmer temperatures in the winter. Also, warmer climatic conditions may progressively favor warm-season forage crops over cool-season ones.

**Possibly increased winter production of certain cool-season horticultural crops.** Border states such as Kentucky may be able to support cool-season crops throughout more of the year, with light becoming more of a limiting factor than temperature in some cases. Heating requirements for greenhouses and high tunnels may be reduced. This may open new markets for Kentucky producers.

**Shifts in plant composition and productivity in forests and other ecosystems.** As temperatures increase and precipitation events become more erratic, some forest trees such as sugar maple, birches, black walnut, and northern red oak will likely decline; other species such as loblolly pine, blackjack oak, and southern red oak are expected to increase (16). The phenology of plants is changing, with some spring species flowering earlier and fall species flowering later due to increased temperatures and a lengthened growing season (6). Such changes may affect the reproductive success of various plant species, which in turn may affect populations of pollinators and seed dispersers. Increased CO<sub>2</sub> will likely cause other impacts on plants, such as increased growth of poison ivy (19) and dramatic increases in ragweed pollen (18).

**Changes in wildlife populations.** Certain wildlife species may become extinct as a result of environmental changes associated with global warming (15). Birds have already experienced changes in breeding age, timing of migration, breeding performance (egg size, nesting success), population sizes; and population distributions (4).

In conclusion, keep in mind that nearly all climate science experts agree that global warming is occurring and that it is caused primarily by human activity. Regardless of what you may read on blogs or in the media, there is almost no meaningful scientific controversy on these points. The future impacts of global warming are difficult to predict, but the changes caused by greenhouse gases are expected to increasingly affect Kentucky agriculture.

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