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# K-12 Partnership Lesson Plan

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# *The New Farmer’s Almanac*

# *Agriculture and climate change*

## Overview

Students learn about the difference between climate and weather and how we expect Michigan’s climate to change. They use real data from the Kellogg Biological Station’s agricultural Long Term Ecological Research site to predict how specific crops may respond to climate change.

**Objectives**

At the conclusion of the lesson, students will be able to:

* Explain the difference between climate and weather
* Name three ways the Michigan climate is expected to change
* Show how some crops may improve with climate change while others decline

**Length of Lesson**

75 minutes

**Grade Levels**

Grades 8-12

**Standards covered (NGSS)**

Disciplinary Core Ideas:

 *Middle School*

* **MS-LS1-5**: construct a scientific explanation based on evidence for how environmental and genetic factors influence the growth of organisms
* **MS-ESS2-5 MI**: collect data to provide evidence for how the motions and complex interactions of air masses results in changes in weather conditions in Michigan due to the Great Lakes and regional geography
* **MS-ESS3-5**: ask questions to clarify evidence of the factors that have caused the rise in global temperatures over the past century
* **MS-ESS3-4**: construct an argument supported by evidence for how increases in human population and per-capita consumption of natural resources impact Earth’s systems

*High School*

* **HS-LS2-2:** use mathematical representations to support and revise explanations based on evidence about factors affecting biodiversity and populations in ecosystems of different scales
* **HS-ESS3-6**: use a computational representation to illustrate the relationship among Earth systems and how those relationships are being modified due to human activity

Cross Cutting Concepts:

* Patterns
* Cause and effect
* Stability and change of systems

Science and Engineering Practices

* Asking questions and defining problems
* Planning and carrying out investigations
* Analyzing and interpreting data
* Engaging in argument from evidence
* Obtaining, evaluating, and communicating information

***Previous Michigan Standards Met:***

* **B1.1A**: generate new questions that can be investigated in the laboratory or the field
* **B1.1D**: identify patterns in data and relate them to theoretical models
* **B1.1E**: describe a reason for a given conclusion using evidence from an investigation
* **L3.P4A**: recognize that, and describe how, human beings are part of Earth’s ecosystems. Note that human activities can deliberately or inadvertently alter the equilibrium in ecosystems (*prerequisite*)
* **B3**.**4C**: examine the negative impact of human activities
* **B3**.**4E**: list the possible causes and consequences of global warming
* **B3.5E**: recognize that and describe how the physical or chemical environment may influence the rate, extent, and nature of population dynamics within ecosystems

**Materials**

* Introductory powerpoint
* Condensed LTER dataset
* Worksheet (all materials listed on “The New Farmer’s Almanac” lesson page on the KBS GK-12 website
* Computers with excel or graph paper and rulers

**Background**

Earth’s climate is currently changing due to anthropogenic additions of greenhouse gases to the atmosphere. Climate change will have real, tangible impacts on people around the world. Understanding of climate change is hampered by difficulties grasping the difference between climate and weather, the small scale of changes that nevertheless have large impacts, and the mistaken conviction that changes will not have significant effects locally. This lesson addresses each of these issues.

Weather is often highly variable over the short term. Changes that happen over days, weeks, and months are weather – individual storms, high and low temperatures that fluctuate wildly. Climate is longer-term: averaging over the weather for years to see broader trends. An average increase in temperature of a few degrees Fahrenheit is easily missed by the average observer in the midst of much larger day-to-day weather fluctuations, but over years these small, steady climate changes can have huge impacts.

Globally, climate change is predicted to lead to increased temperature overall, but with changes being much larger in some parts of the earth than others. Precipitation patterns will change as well, with some areas getting wetter and others drier overall. Frequency and size of precipitation events will also change. All of these shifts can have serious implications for agriculture – crops that formerly grew happily in a given area may no longer thrive, and new crops may become available.

In Michigan, the climate is predicted to get warmer and wetter, with more large rain events in winter and spring, but possibly a drier summer and fall. To explore what this might mean for crops in Michigan, we are using real data collected in farm fields at Michigan State University’s Kellogg Biological Station (KBS). Over the last ~20 years, KBS scientists have grown corn, soy, and wheat. They have recorded changes in crop yields, soil moisture, precipitation, and temperature each year. Using this variation in WEATHER from year to year, we will be able to assess predictions about how the same crops may respond to changes in CLIMATE.

### Activities of the session

The lesson starts with an intro (can use the PowerPoint presentation) that talks about the difference between weather and climate, shows IPCC (International Panel on Climate Change) predictions for global change in temperature and precipitation, and introduces the NOAA site allowing students to look at real data on climate at scales from a couple of years to decades ([http://www.climate.gov/#education](http://www.climate.gov/)). If you are planning to have students analyze data in Excel, it might be worthwhile to have the lesson start with them at computers – then they could take a few minutes to manipulate the NOAA site and explore the climate data for themselves. This is an opportunity to emphasize the difference between climate and weather – from one year to the next, variation is random and weather-related. Over decades, trends representing changes in climate become clear.

Next, introduce the specific predictions for how Michigan’s climate will change. (Flashbacks to IPCC figures showing differences in change globally can be helpful here). Ask students which crops are the most important to them locally, and how they think those crops might respond to these predicted changes. Then introduce the KBS LTER dataset. Hand out worksheets, divide the students into groups of 2-3, assign each group a crop, and have them fill out their worksheets with predictions.

Finally, move to graphing the actual data to test their predictions. This can be most easily done in Excel (see PowerPoint presentation for an example of how to walk students through it), but it can also be done by hand with graph paper and analyzed purely qualitatively.

Finally, have the students come back together as a class and let each group present their findings. Is this what they expected? Are they convinced? If not, why not? There are some important caveats – we simplified the dataset so it doesn’t take into account fluctuations in precipitation or temperature within the year. For example, if rainfall is heavier but more concentrated, that may have a different effect than just a mean increase in rainfall spread evenly over the growing season. Emphasize that this doesn’t mean we don’t know ANYTHING; it just means we have to know the limits to our understanding.

**Resources**

See attached PowerPoint slides and worksheet

The following websites can provide helpful resources

* <http://www.nasa.gov/mission_pages/noaa-n/climate/index.html> (NASA explanation of climate vs. weather)
* [http://www.climate.gov/#education](http://www.climate.gov/) (NOAA interactive climate change graphs)
* <http://msue.anr.msu.edu/program/info/climate_change_and_variability>

 (MSU extension pamphlets)

**Extensions and Modifications**

Data analysis can be more rigorous (regression analysis to look at the slope and significance of relationships) or more qualitative, depending on the students’ math skills.

**Assessment**

Provide an assessment of student understanding – address the learning goals set out at the beginning of the lesson. The activity sheet following may be helpful.

1.What’s your question?

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2. What is your hypothesis and prediction?

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3. How do you plan to test your hypothesis?

4.Which species are you going to examine? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

3. Plot three graphs on Microsoft Excel and describe the pattern you found.

4. Conclusion