How will global warming of 2°C affect Indiana?

Observed and projected changes in climate and their impacts
“To prevent dangerous interference with the climate system, the scientific view is that the increase in global temperature should be below 2°C [relative to pre-industrial levels].”

- United Nations Framework on Climate Change, 2010
How will global temperatures change in the future?

The global average temperature has already increased by about 1°C (1.8°F) relative to pre-industrial levels.

Current CO₂ emissions are tracking the ‘higher emissions’ scenario; unless emissions are reduced, the 2°C threshold will be crossed before 2050.
OBSERVATIONS  The annual mean temperature in IN has increased by about 1°F (0.5°C) since 1895 – at a slightly lower rate than the rise in global mean temperature.

In 14 out of the last 20 years, the annual mean temperature in Indiana exceeded the 20th-century average.
Warming in Indiana

PROJECTIONS

In the next 50-60 years, when global warming crosses the 2°C threshold, IN average summer and winter temperatures are projected to increase by over 4°F (2.2°C) relative to pre-industrial levels.

Lower Emissions

Higher Emissions

Source: produced by CSRC, UMass Amherst
Warming in Indiana

PROJECTIONS  How warm will Winter and Summer temperatures become?

<table>
<thead>
<tr>
<th>Year</th>
<th>Historical</th>
<th>Projections</th>
</tr>
</thead>
<tbody>
<tr>
<td>1950</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2100</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Winter

Higher Emissions

Lower Emissions

The coldest winters in future will be like the warmest of recent years

Summer

hottest summers ...

...will become the coolest

Source: USGS
Migrating Indiana Climate

PROJECTIONS

Summer in Indiana by the end of this century could feel like a present-day typical summer in Oklahoma.

Consequences:
Negative impacts on human health, ecosystems, and the economy.

Source: UCSUSA

Analysis is based on changes in average summer heat index (a measure of how it actually feels for a given temperature and humidity).
Extreme Heat

**OBSERVATIONS**  
Summer daytime high temperatures in Indianapolis rarely go above 90°F in today’s climate.

**PROJECTIONS**  
The number of days with dangerously high temperatures (above 100°F) is projected to increase significantly in the future.

Source: UCSUSA
Rain and Snow in Indiana

**OBSERVATIONS**

Annual total precipitation (rain + snow) has increased over the last few decades.

*Source: NOAA*

In 8 out of the last 10 years, Indiana has received more precipitation than the 20th century average.
Very Heavy Rainfall

The amount of precipitation falling during intense multi-day events has increased significantly in the Midwest US.

OBSERVATIONS

Observed increase in very heavy precipitation* from 1958 to 2012
(* the top 1% of storm totals)

Source: NCA 2014
Rain and Snow in Indiana

Due to increasing temperatures, there will be more rain and less snow.

Projected changes in rainfall in summer are uncertain.

PROJECTIONS Winter precipitation is projected to increase through the 21st century.

**Total Precipitation**

<table>
<thead>
<tr>
<th>Year</th>
<th>Higher Emissions</th>
<th>Lower Emissions</th>
</tr>
</thead>
<tbody>
<tr>
<td>1950</td>
<td>8 in/day * 100</td>
<td>10 in/day * 100</td>
</tr>
<tr>
<td>2000</td>
<td>12 in/day * 100</td>
<td>14 in/day * 100</td>
</tr>
<tr>
<td>2050</td>
<td>16 in/day * 100</td>
<td>18 in/day * 100</td>
</tr>
<tr>
<td>2100</td>
<td>18 in/day * 100</td>
<td>20 in/day * 100</td>
</tr>
</tbody>
</table>

**Snowfall**

<table>
<thead>
<tr>
<th>Year</th>
<th>Higher Emissions</th>
<th>Lower Emissions</th>
</tr>
</thead>
<tbody>
<tr>
<td>1950</td>
<td>2 in</td>
<td>4 in</td>
</tr>
<tr>
<td>2000</td>
<td>3 in</td>
<td>5 in</td>
</tr>
<tr>
<td>2050</td>
<td>4 in</td>
<td>6 in</td>
</tr>
<tr>
<td>2100</td>
<td>5 in</td>
<td>7 in</td>
</tr>
</tbody>
</table>

Source: USGS
An immediate action on local and global scales is required to limit the global mean temperature increase to $2^\circ$C ($3.6^\circ$F).

**Climate Summit in Paris [COP21]**

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Average warming ($^\circ$C) projected by 2100</th>
</tr>
</thead>
<tbody>
<tr>
<td>If countries do not act</td>
<td>4.5</td>
</tr>
<tr>
<td>Following current policies</td>
<td>3.6</td>
</tr>
<tr>
<td>Based on Paris pledges</td>
<td>2.7</td>
</tr>
</tbody>
</table>

Source: Climate Action Tracker, data compiled by Climate Analytics, ECOFYS, New Climate Institute and Potsdam Institute for Climate Impact Research.
Strategies and Actions

**National Climate Assessment:**

The National Climate Assessment summarizes the impacts of climate change in the US, now and in the future.

**Integrating Climate Change into State Wildlife Action Plan (SWAP):**

The goals of SWAP are to generate proactive, comprehensive wildlife conservation strategies that assess the health, challenges, and potential actions each State would like to accomplish during the coming decade and beyond.

**Climate and Health Assessment:**

This scientific assessment examines how climate change is already affecting human health in the US and the changes that may occur in the future.

This report was created by Prof. Raymond Bradley, Dr. Ambarish Karmalkar, and Kathryn Woods

**Climate System Research Center (CSRC)**
University of Massachusetts Amherst

**CONTACT**
climate-inquiry@geo.umass.edu