Climate Trends, Normals and Extremes In Kansas

Doug Kluck (doug.kluck@noaa.gov)
Regional Climate Services Director
National Centers for Environmental Information (NCEI)
National Oceanic and Atmospheric Administration (NOAA)
Agenda

* Precipitation & Temperature Trends
  * Global to Kansas

* 30 Year Normals

* Kansas Extremes

* Winter Outlook?
Main Take Aways

* Precipitation trends show increases across the state

* Temperature trends are increasing
  * Minimum temperature increasing more rapidly

* New 30-Year Normals Comparisons (1991-2020)

* Billion $ Disaster Trends
  * Becoming more costly
  * Increasing frequency?
Global Temperature Trends

99% chance 2021 will be top 10
So far it is 6th warmest

<table>
<thead>
<tr>
<th>Rank</th>
<th>Year</th>
<th>Anomaly °C</th>
<th>Anomaly °F</th>
</tr>
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<tbody>
<tr>
<td>1</td>
<td>2016</td>
<td>1.00</td>
<td>1.80</td>
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<tr>
<td>2</td>
<td>2020</td>
<td>0.98</td>
<td>1.76</td>
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<tr>
<td>3</td>
<td>2019</td>
<td>0.95</td>
<td>1.71</td>
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<tr>
<td>4</td>
<td>2015</td>
<td>0.93</td>
<td>1.67</td>
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<tr>
<td>5</td>
<td>2017</td>
<td>0.91</td>
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<tr>
<td>6</td>
<td>2018</td>
<td>0.83</td>
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<td>7</td>
<td>2014</td>
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<td>8</td>
<td>2010</td>
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<td>1.30</td>
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<td>9</td>
<td>2013</td>
<td>0.68</td>
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<tr>
<td>10</td>
<td>2005</td>
<td>0.67</td>
<td>1.21</td>
</tr>
</tbody>
</table>

https://www.ncdc.noaa.gov/sotc/
Kansas Climate Trends
**Kansas Temperature Trends**

*Key Points*

- General upward trend
- Largest seasonal trend - winter
- Minimums rising faster than maximums

- Using “Climate At A Glance” tool
- County & City too

https://www.ncdc.noaa.gov/cag/statewide/time-series
Kansas Maximum Temperature Trend

1895-2000 Mean: 66.7°F

1895-2020 Trend (+0.1°F/Decade)

https://www.ncdc.noaa.gov/cag/statewide/time-series
Seasonal Trends
(Average Temperatures)

Winter +0.2°F/decade

Spring 0.1°F/decade

Summer +0.1°F/decade

Fall +0.0°F/decade
Kansas Precipitation Trend

Key Points
- Upward trends annually (+0.26/decade)
- Spring largest upward trend (0.14”/decade)
- Fall/winter slower increase

https://www.ncdc.noaa.gov/cag/
Seasonal Trends
(Precipitation)

Winter +0.03”/decade

Spring 0.14”/decade

Summer +0.06”/decade

Fall +0.03”/decade
1) Northwest: 0.06”/dec
2) North Central: 0.26”/dec
3) Northeast: 0.22”/dec
4) West Central: 0.10”/dec
5) Central: 0.28”/dec
6) East Central: 0.30”/dec
7) Southwest: 0.15”/dec
8) South Central: 0.37”/dec
9) Southeast: 0.49”/dec

https://www.ncdc.noaa.gov/cag/
Precip Trends Last 30 years

Northwest KS -0.62”/decade
Southeast KS +1.08”/decade
Heavy Rainfall

• Daily 20-year Return means amount of rainfall expected to occur, on average, once every 20 years
• Amounts have increased more than 0.4 inch in places (slight decrease in some places)
• Varies geographically by season
10-Year Annual Normals Change

- Wetter in the central and eastern U.S., drier in the Southwest
- Warmer everywhere except the north central U.S.

- Climate change is clearly seen in comparing the new normals to the Twentieth Century averages.
Annual Precipitation Normals since 1901 compared to the 20th Century Average

- Climate change is coming into focus in recent normals.
Annual Temperature Normals since 1901 Compared to the 20th Century Average

Billion Dollar Weather and Climate Events

United States Billion-Dollar Disaster Events 1980-2021 (CPI-Adjusted)

- Drought Count
- Flooding Count
- Freeze Count
- Severe Storm Count
- Tropical Cyclone Count
- Wildfire Count
- Winter Storm Count
- Combined Disaster Cost
- Costs 95% CI
- 5-Year Avg Costs

U.S. 2021 Billion-Dollar Weather and Climate Disasters

Western Drought and Heatwave 2021-ongoing
Central Severe Weather July 8-11
Central Severe Weather June 24-26
North Central Severe Weather August 10-13
Western Wildfires Summer-Fall 2021

California Floods and Severe Storms January 24-25
Northwest, Central and Eastern Winter Storms and Coldwaves February 10-11

https://www.ncdc.noaa.gov/billions/time-series
Kansas Disasters
Seasonality & Frequency

Kansas Billion-Dollar Disaster Frequency 1980-2021 (CPI-Adjusted)

- 1+ Events
- 2+ Events
- 3+ Events
- 4+ Events
- 5+ Events

Updated: October 8, 2021
Monitoring the Climate
October

Statewide Average Temperature Ranks
October 2021
Period: 1895–2021

- Monthly to multi-monthly analysis
Winter Outlook

Typical Wintertime Pattern

La Niña

Seasonal Temperature Outlook
Valid: Dec-Jan-Feb 2021-22
Issued: October 21, 2021

Below
Equal Chances
Above

Probability (Percent Chance)
Above Normal
55.0%-59.9%
50.0%-54.9%
45.0%-49.9%
40.0%-44.9%
35.0%-39.9%
30.0%-34.9%
25.0%-29.9%
20.0%-24.9%
15.0%-19.9%
10.0%-14.9%
5.0%-9.9%
0.0%-4.9%
Below Normal
55.0%-59.9%
50.0%-54.9%
45.0%-49.9%
40.0%-44.9%
35.0%-39.9%
30.0%-34.9%
25.0%-29.9%
20.0%-24.9%
15.0%-19.9%
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Seasonal Precipitation Outlook
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Warm Air Holds More Water Vapor

- Saturation vapor pressure is the total amount of pressure exerted if the air were saturated (relative humidity 100%)
  - Nearly doubles for every 10 deg C increase in temperature
  - Warm tropical air can hold 4-10 times as much vapor as cold, dry air
  - Consequently more latent heat release in storms, more precipitation
Recent 30 years (1986-2015) compared to the past (1901-1960)

Annual Precipitation

Figure source: Peterson et al. 2013