Monitoring Kentucky’s Climate: The Kentucky Mesonet at WKU

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Kentucky Climate Center
Western Kentucky University

Kentucky Water Resources Board
Frankfort, Kentucky
August 29, 2016
Kentucky’s Weather and Climate Extremes

Warren County, May 2010

Todd County, October 2010
Kentucky Climate Center

• History
  – Established at Western Kentucky University in 1978
  – Recognized by the AASC as the State Climate Office for Kentucky in 2002
  – National Weather Service funding awarded to build the Kentucky Mesonet in 2006
Climate Services Partnerships

- National
- Regional
- State
- Local
Remote sensing often provides a bird’s-eye view, while people see the world from their front porch.
Talking Points

• Perspectives on Drought
• Kentucky Mesonet at WKU
• Strategic Initiatives
• Questions and Discussion
Flash Drought!

U.S. Drought Monitor

July 31, 2012

Intensity:
- D0 Abnormally Dry
- D1 Drought - Moderate
- D2 Drought - Severe
- D3 Drought - Extreme
- D4 Drought - Exceptional

Drought Impact Types:
- D = Delineates dominant impact
- S = Short-Term, typically <6 months
  (e.g., agriculture, grasslands)
- L = Long-Term, typically >6 months
  (e.g., hydrology, ecology)

The Drought Monitor focuses on broad-scale conditions. Local conditions may vary. See accompanying text summary for forecast statements.

http://droughtmonitor.unl.edu/

Released Thursday, August 2, 2012
Author: Mark Svoboda, National Drought Mitigation Center
Continental Evolution of 2012 Drought

U.S. Drought Monitor

May 15, 2012
Valid 7 a.m. EDT

August 7, 2012

http://droughtmonitor.unl.edu/

http://droughtmonitor.unl.edu/MapsAndData/MapArchive.aspx

Drought Monitor focuses on broad-scale conditions. Local conditions may vary. See accompanying text summary for forecast statements.

Author: Brad Rippey, U.S. Department of Agriculture
Notes

Vertical blue line represents average\textsuperscript{1} AMJ precipitation.

Horizontal blue line represents average\textsuperscript{1} JAS precipitation.

Vertical red line represents actual 2012 AMJ precipitation.

Dashed red line represents precipitation for JAS of 2012 required to bring the combined AMJ and JAS total to the average\textsuperscript{1}.

\textsuperscript{1} Average is defined as the arithmetic mean of the climate division values for 1895 through 2011.
Dimensions of the 2012 Drought

Graves County

- 3.22” – Precipitation on March 8th
- 4.40” – Precipitation for the entire spring season
- 99.4° - Average high temperature from June 28th through July 8th

Mayfield, Graves County
July 27, 2012
Historical Context for the Drought of 2012
Kentucky's Western Climate Division

The graph shows the Palmer Drought Severity Index (PDSI) values for Kentucky's Western Climate Division over a period from 1914 to 2012. The X-axis represents the months from January to December, and the Y-axis represents the PDSI values ranging from -6 to 5.

Key events and years highlighted include:
- 1914: Significant PDSI drop
- 1930: Severe drought
- 2007: Moderate to severe drought
- 2012: Severe drought

The graph indicates that Kentucky experienced severe drought conditions in 2012, similar to the droughts in 1914 and 2007, and highlights the historical context of drought events in the region.
Synoptic Precipitation Pattern in Late July

July 24, 2012
Evolution of the 2012 Drought in Kentucky
Dimensions of Drought in Space and Time

- Onset
- Duration
- Peak Intensity
-Extent
Types of Drought

Sequence of drought occurrence and impacts for commonly accepted drought types. All droughts originate from a deficiency of precipitation or meteorological drought but other types of drought and impacts cascade from this deficiency. (Source: National Drought Mitigation Center, University of Nebraska-Lincoln, U.S.A.)

http://drought.unl.edu/DroughtBasics/TypesofDrought.aspx
Kentucky’s Climatological Record

- 1825 – U.S. Army
- 1861 – Smithsonian Institute
- 1874 – U.S. Army Signal Corps
- 1891 – U.S. Department of Agriculture
- 1940 – U.S. Department of Commerce
- 2007 – Kentucky Climate Center

Newport Barracks, July 1825
Kentucky’s diverse terrain creates distinct local vulnerabilities to weather and climate
Across the Commonwealth

Kentucky Mesonet
Vertically Integrated System

- Test and calibrate instruments
- Install and maintain instruments
- Assure quality of data
- Archive data and system metadata
Site Surveys and Selection

- Candidate sites are surveyed and scored
- Sites are selected with input from NWS and local stakeholders

<table>
<thead>
<tr>
<th>Survey Scores</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Temperature</td>
<td>40</td>
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<tr>
<td>Precipitation</td>
<td>30</td>
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<tr>
<td>Wind</td>
<td>12</td>
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<tr>
<td>Soil</td>
<td>15</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>97</strong></td>
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</table>
Station Installation and Maintenance

- Technicians install stations and instrumentation
- Technicians make spring, summer, and winter maintenance passes
- Technicians respond to “trouble tickets” when QA processes indicate problems
Design Criteria Emphasize Quality and Reliability

Sensor Package
- Air temperature
- Precipitation
- Solar radiation
- Relative humidity
- Wind speed & direction
- Soil moisture & temperature*

* selected sites

Package enables ET calculations
## Metadata Database

### Equipment History

<table>
<thead>
<tr>
<th>Effective Time</th>
<th>Performed By</th>
<th>Calibration Location</th>
<th>Equipment Used</th>
<th>Variable</th>
<th>Equation</th>
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<td>T402</td>
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</tbody>
</table>

### Manage Sites

**Add/Modify Collection Sites** | **Add Non-Collection Sites** | **Site Pass** | **Site Status**

### Move Equipment At Sites

#### All Sites

<table>
<thead>
<tr>
<th>Manufacturer</th>
<th>Model</th>
<th>Serial No</th>
<th>Vendor</th>
<th>Type</th>
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<tbody>
<tr>
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<td>Raven Edge E21</td>
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<td>Solar Craft</td>
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#### Non-Collection Site

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</table>
Quality Assurance Procedures

- Automated QA runs on five-minute data as they are collected from remote sites.
- Manual QA is implemented on a daily basis to provide expert assessment of system performance.
Meteorological Database

- Observations are taken every 5 minutes
- Each station collects over 105,000 observations each year
- Each station returns over 2,730,000 data values each year
### Franklin County (LSML)

#### Precipitation and Accumulated Precipitation (14 Day)

<table>
<thead>
<tr>
<th>Time</th>
<th>Precipitation (in.)</th>
<th>Accumulated Precipitation (in.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>08/13/2016 08:00 AM EDT</td>
<td>0.00 in.</td>
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<tr>
<td>08/14/2016 08:00 PM EDT</td>
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<td>08/16/2016 08:00 AM EDT</td>
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<td>08/27/2016 08:00 AM EDT</td>
<td>1.50 in.</td>
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</table>

#### Station Data

**Franklin County, KY**

- **Time**: 08/27/2016, 08:00 AM EDT
- **Air Temperature**: 89.6 °F
- **Relative Humidity**: 100%
- **Precipitation**: 0.00 in.
- **Wind Speed**: 0 mph
- **Wind Direction**: 57° (NE)
- **Wind Speed Max Gust**: 1 mph
- **Solar Radiation**: 97 W/m²
- **Dewpoint**: 89.6 °F
Kentucky Mesonet Coverage Map

- Red: Operational station
- Blue: Planned station
Kentucky Climate Center
Strategic Initiatives

- Kentucky Mesonet at WKU
- Forecasts & Outlooks
- Climate Modeling
Strategic Initiatives

Kentucky Mesonet at WKU

- Add 10-12 stations to fill coverage gaps and custom stations to meet local demand
- Enhanced instrumentation package
  - Soil probes (where not currently deployed)
  - Multi-level temperature and wind
  - Add barometric pressure sensors
- Add 3 atmospheric flux monitoring stations

Targeted completion by FY19
Strategic Initiatives

Forecasting & Outlooks

• Develop an operational unit to provide customized weather forecasts and climate outlooks
  – Hire staff meteorologist and student interns
  – Utilize existing NWS forecast model output and develop option to generate forecasts incorporating mesonet data
  – Provide client-focused forecast and outlook products. For agriculture, these would include
    • forecasts relating to stress on crops and livestock
    • outlooks for growing degree days
    • forecasts for irrigation scheduling
Strategic Initiatives

Climate Modeling

- Conduct meso-scale simulations to model impacts of land use/land cover change on atmospheric conditions
- Provide high-resolution, downscaled climate model projections for Kentucky based on model runs reported in the most recent National Climate Assessment
  - Models can be run for various time horizons
Questions?