Predictive Analytics in Agricultural Weather
About Nutrien/Agrible
My Background

• 2009 | A.S. Earth Science | Parkland College
• 2012 | Meteorology | Northern Illinois University

• 2003 - 2010 | Assistant to Chief Meteorologist | Illinois Public Media
• 2014 | Founded Chambana Weather
• 2017 | Offer to join Agrible
Tech is changing our way of life
Tech is changing our way of life
Tech is changing our way of life - and our ability to model the atmosphere!
# Handheld Weather Analytics

## Daily Workability
Last Updated: 10/23/2018 9:47 AM CDT

<table>
<thead>
<tr>
<th>Primary</th>
<th>Depression</th>
</tr>
</thead>
</table>

### Next 14 Days

#### October

<table>
<thead>
<tr>
<th>Date</th>
<th>Temperature</th>
</tr>
</thead>
<tbody>
<tr>
<td>Today</td>
<td>Soil: 45°F</td>
</tr>
<tr>
<td>Tomorrow</td>
<td>Soil: 45°F</td>
</tr>
<tr>
<td>Sat, 10/27</td>
<td>Soil: 45°F</td>
</tr>
<tr>
<td>Sun, 10/28</td>
<td>Soil: 45°F</td>
</tr>
<tr>
<td>Mon, 10/29</td>
<td>Soil: 44°F</td>
</tr>
<tr>
<td>Tue, 10/30</td>
<td>Soil: 45°F</td>
</tr>
<tr>
<td>Wed, 10/31</td>
<td>Soil: 48°F</td>
</tr>
</tbody>
</table>

#### November

<table>
<thead>
<tr>
<th>Date</th>
<th>Temperature</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thu, 11/1</td>
<td>Soil: 49°F</td>
</tr>
<tr>
<td>Fri, 11/2</td>
<td>Soil: 45°F</td>
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<td>Sat, 11/3</td>
<td>Soil: 41°F</td>
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<td>Sun, 11/4</td>
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<tr>
<td>Mon, 11/5</td>
<td>Soil: 37°F</td>
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<tr>
<td>Tue, 11/6</td>
<td>Soil: 39°F</td>
</tr>
<tr>
<td>Wed, 11/7</td>
<td>Soil: 40°F</td>
</tr>
</tbody>
</table>

### Last 14 Days

#### October

<table>
<thead>
<tr>
<th>Date</th>
<th>Temperature</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yesterday</td>
<td></td>
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<tr>
<td>2 Days Ago</td>
<td></td>
</tr>
<tr>
<td>Mon, 10/22</td>
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<tr>
<td>Sun, 10/21</td>
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<tr>
<td>Sat, 10/20</td>
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<tr>
<td>Fri, 10/19</td>
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<tr>
<td>Thu, 10/18</td>
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</tbody>
</table>
### Handheld Weather Analytics

#### Tractor Time

**Next 72 Hours**  
*Last Updated: 10/25/2018 9:38 AM CDT*

| Date       | Time     | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
|------------|----------|---|---|---|---|----|----|----|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 10/27/2018 | Sunset   | ☑ | ☑ | ☑ | ☑ | ☑  | ☑  | ☑  | ☑ | ☑ | ☑ | ☑ | ☑ | ☑ | ☑ | ☑ | ☑ | ☑ | ☑ | ☑ | ☑ |
|            | Sunrise  | ☑ | ☑ | ☑ | ☑ | ☑  | ☑  | ☑  | ☑ | ☑ | ☑ | ☑ | ☑ | ☑ | ☑ | ☑ | ☑ | ☑ | ☑ | ☑ | ☑ |
| **Primary**|          | ☑ | ☑ | ☑ | ☑ | ☑  | ☑  | ☑  | ☑ | ☑ | ☑ | ☑ | ☑ | ☑ | ☑ | ☑ | ☑ | ☑ | ☑ | ☑ | ☑ |
| **Depression**|         | ☑ | ☑ | ☑ | ☑ | ☑  | ☑  | ☑  | ☑ | ☑ | ☑ | ☑ | ☑ | ☑ | ☑ | ☑ | ☑ | ☑ | ☑ | ☑ | ☑ |
| **Conditions**|       | ☁ | ☁ | ☁ | ☁ | ☁  | ☁  | ☁  | ☁ | ☁ | ☁ | ☁ | ☁ | ☁ | ☁ | ☁ | ☁ | ☁ | ☁ | ☁ | ☁ |
| **Air Temp (F)**|    | 45° | 44° | 44° | 44° | 44° | 44° | 43° | 43° | 43° | 43° | 43° | 44° | 44° | 45° | 46° | 47° | 44° | 40° |
| **RH (%)**   |       | 43  | 44  | 44  | 44  | 44  | 44  | 44  | 44  | 44  | 44  | 44  | 44  | 44  | 44  | 44  | 44  | 44  | 44  | 44  |
| **Soil Temp (F)** |     | 43° | 44° | 44° | 44° | 44° | 44° | 44° | 44° | 44° | 44° | 44° | 44° | 44° | 44° | 44° | 44° | 44° | 44° | 44° |
| **Visibility (mi)** |   | 15  | 15  | 15  | 15  | 15  | 15  | 15  | 15  | 15  | 15  | 15  | 15  | 15  | 15  | 15  | 15  | 15  | 15  | 15  |
| **Operation Log** | | +  | +  | +  | +  | +  | +  | +  | +  | +  | +  | +  | +  | +  | +  | +  | +  | +  | +  | +  | +  | +  |
Handheld Weather Analytics

![Spray Smart Graph](image)

**Spray Smart**
Last Updated: 10/25/2018 9:47 AM CDT

### Next 72 Hours

<table>
<thead>
<tr>
<th>10/25/2018</th>
<th>9</th>
<th>10</th>
<th>11</th>
<th>12</th>
<th>1</th>
<th>2</th>
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</tr>
</tbody>
</table>
Meteorology 101: Temperature Inversions

Mid-Afternoon in June

Temperature cools with height

Stronger winds aloft

***This example assumes no major weather systems are present (fair assumption for typical June weather)
Meteorology 101: Temperature Inversions

- Temperature cools with height
- Stronger winds aloft
- Top of the inversion layer
- Temperature cools at the surface (no sun to heat it)
Meteorology 101: Temperature Inversions
Meteorology 101: Temperature Inversions

Sunrise through mid-morning in June

- Temperature cools with height
- Stronger winds aloft
- Residual inversion layer
- Ground warms with sunlight

Temperature →
Altitude →
Meteorology 101: Temperature Inversions
# Handheld Weather Analytics

![Handheld Weather Analytics](image)

## Air & Space

<table>
<thead>
<tr>
<th>Flight Conditions</th>
<th>Missions</th>
<th>Satellite</th>
</tr>
</thead>
<tbody>
<tr>
<td>10/25/2018</td>
<td><strong>Solar Noon 12:36 PM</strong></td>
<td><strong>Sunset 5:58 PM</strong></td>
</tr>
<tr>
<td><strong>Time</strong></td>
<td><strong>Drone Safe</strong></td>
<td><strong>Wind Gusts (mph)</strong></td>
</tr>
<tr>
<td>9-12</td>
<td>✔️ ✔️ ✔️ ✔️ ✔️ ✔️ ✔️ ✔️</td>
<td>11 11 10 10 10 11 12 13</td>
</tr>
</tbody>
</table>
Handheld Weather Analytics

Rainfall Accumulation Plot

Oct 23

44.34 inches

Month/Day
Handheld Weather Analytics

Field Intel Plot: Temp

Oct 23
Max 56°F
Min 37°F
**Current Forecast Skill**

**High-Resolution Short Term Models**
- (0-60 hours - every hour)
  - HRRR
  - NAM 3km

**Low-Resolution Long Term Models**
- (1-16 days - every 3 - 6 - 12 hours)
  - NAM 12km (0-84 hours)
  - GFS (0-384 hours)
  - ECMWF (0-240 hours)

**Ensemble Forecasts**
- NAM - SREF (0-84 hours)
- GEFS (0-384 hours - 21 members)
- EPS (0-360 hours - 51 members)

***Best technique for week #2 forecasting***

**Teleconnections:**
- (1 week - 12 months)
  - ENSO, NAO, EPO, AO, QBO, AAM, AMO, PNA, MJO

**Seasonal Models**
- ECMWF
- NMME
- JMA
- CMC
- CFSV2
  - (use all of these with extreme caution)

**Analogs:**
- Using current weather analysis and finding a pervious time period that has a high spatial correlation. (very challenging and no perfect match and chaos matters!!!)
Current Forecast Skill

How Predictable Is U.S. Weather?
Based on data from 120 NWS weather stations, 1994-2013

Source: National Weather Service
Example: Record-breaking 2017 Atlantic Hurricane Season

17 Tropical Storms
10 Hurricanes
6 Major Hurricanes
$380 Billion in damage
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Example: Record-breaking 2017 Atlantic Hurricane Season

- 31+ trillion gallons of water
- New US Tropical Cyclone
- Record Rainfall - 51.88"
- 2700% of normal rainfall
Hurricane Irma - Landfall uncertain at 5-days
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Weather patterns to watch for: Polar Vortex, extreme cold
Weather patterns to watch for: Polar Vortex, extreme cold

- Weak Polar Vortex
- Cold Air Spills South
  Introducing Arctic Air into the Mid-Latitudes
- Deep Trough in the Jet Stream
- Polar Jet Stream
- Warm Pocket of Air in Stratosphere
Weather patterns to watch for: Polar Vortex, extreme cold
Summer Ridge: Extreme heat/drought

- Summer jet-stream pattern we do NOT want:

- Above mid-80s
  - Respiration Rate Increases
  - Heart Rate Increases

- Above 95°F = Significant Heat Stress
  - Reduction in feed intake
  - For each 2°F increase above 85°F feed intake drops by 4 lbs.

Optimal Temperature Range:

- Maximum Daily Temperature (°F)
- Dry Matter Intake Per Animal

Block storm systems Move heat north
Summer Ridge: Extreme heat/drought
Summer Ridge: Extreme heat/drought
Summer Ridge: Extreme heat/drought

2016
+8.5 bpa
Summer Ridge: Extreme heat/drought
Summer Ridge: Extreme heat/drought

![Map showing temperature anomalies in July 2014 with a focus on 2014 +8.8 bpa]
Summer Ridge: Extreme heat/drought
Summer Ridge: Extreme heat/drought
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![Map of temperature anomalies in July 2002](image)

- Year: 2002
- Value: -9.9 bpa

*Note: The map shows temperature anomalies in degrees Fahrenheit for July 2002.*
Summer Ridge: Extreme heat/drought
Summer Ridge: Extreme heat/drought
Summer Ridge: California Whiplash
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A shift in the summer ridge
Summer Ridge: Are there early signals?

Historically when cool SSTs extend off the west coast of the US – especially from the Baja to the central Pacific, the cornbelt has above normal temperatures and west of the Rockies is cooler.
Warming summer nights
Warming summer nights
Warming summer nights

Change in the # of nights above 70-degrees
Increasing frost-free season length

Length of the Frost Free Season (Madison, WI)

Mean Frost Free Season: May 3 – Oct 9
Observable Change - North America Summer Temperatures 1950-2011
Other negative factors: Severe Thunderstorms

Today's Convective Outlooks

Current Convective Outlooks

Current Day 1 Outlook
Forecaster: Edwards
Issued: 29/1200Z
Valid: 29/1300Z - 30/1200Z
Forecast Risk of Severe Storms: Marginal Risk

Current Day 2 Outlook
Forecaster: Mosier
Issued: 29/0600Z
Valid: 30/1200Z - 31/1200Z
Forecast Risk of Severe Storms: No Svr Tstms

Current Day 3 Outlook
Forecaster: Mosier
Issued: 29/0643Z
Valid: 31/1200Z - 01/1200Z
Forecast Risk of Severe Storms: Slight Risk

Current Day 4-8 Outlook
Forecaster: Mosier
Issued: 29/0811Z
Valid: Thu 11/01 1200Z - Mon 11/05 1200Z
Note: A severe weather area depicted in the Day 4-8 period indicates a 15%, 30%, or higher probability for severe thunderstorms (e.g., a 15%, 30% chance that a severe thunderstorm will occur within 25 miles of any point).
Other negative factors: Tornadoes
Other negative factors: Tornadoes
Other negative factors: Tornadoes (Shifting Tornado Alley?)

Tornado Environment Frequency Trends

- Trends based on analysis of Significant Tornado Parameter (STP) index
- Still the top region in tornado frequency but experiencing a downward trend

Adapted by MC from ag Climate and Atmospheric Science, Denver/Brooks 2016 (http://creativecommons.org/licenses/by/4.0/)
Tornadoes: Advances in technology 1953 - Present

- **Green** = toward the radar
- **Red** = away from the radar

- **Radar Location**
- **Hook Echo**
- **Velocity Couplet**

- **Radar Location**
Iowa Tornadoes, July 19, 2018
Fire Tornadoes?
Other negative factors: Hail
Other negative factors: Hail

Hail damage

Baseballs

COURTESY: HOLLY RUSH
Other negative factors: Hail
Other negative factors: Hail

Look for Radar Reflectivity Values greater than 60 dBZ
Other negative factors: Squall lines/damaging winds
Other negative factors: Squall lines/damaging winds
Other negative factors: Squall lines/damaging winds
Other negative factors: Squall lines/damaging winds
Other hazards: Lightning
Other hazards: Lightning
Spring/Summer Recap

Statewide Precipitation Ranks
February 2018
Period: 1895–2018

Statewide Average Temperature Ranks
February 2018
Period: 1895–2018

National Centers for Environmental Information
Mon Mar 5 2018
Spring/Summer Recap

Statewide Precipitation Ranks
April 2018
Period: 1895-2018

Statewide Average Temperature Ranks
April 2018
Period: 1895-2018
Spring/Summer Recap

https://www.producer.com/2014/06/seeders-reach-stretches-160-feet/
Spring/Summer Recap

U.S. Drought Monitor

May 1, 2018
(Released Thursday, May 3, 2018)
Valid 8 a.m. EDT

Drought Impact Types:
- DD: Dominant Dry
- D1: Severe Drought
- D2: Moderate Drought
- D3: Extreme Drought
- D4: Exceptional Drought

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

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

http://droughtmonitor.unl.edu/
Spring/Summer Recap

Last 30 Days of Percent of Normal Precipitation as of 7:00AM Central on 2018-05-20

Accumulated Precipitation - NORMAL 4NE, IL
Click and drag to zoom to a shorter time interval; green/black diamonds represent subsequent/missing values

- 2018 accumulation
- Normal
- Highest (1981)
- Lowest (1988)
Spring/Summer Recap
Spring/Summer Recap - No sustained heat
Spring/Summer Recap - No sustained heat
Rainy Fall So Far

Weather Fatalities 2017

Last 60 Days Departure from Normal Precipitation in inches as of 7:00AM Central on 2018-10-28

Stationary boundary

Tropical remnants

Florence

Michael
Hurricane Michael
Hurricane Michael
October: Warm Southeast, Cold Central U.S.
Winter Outlook? - European Model:

December 2019
Winter Outlook? - European Model:

January 2019

Anomaly temperature (°F)

Anomaly monthly precipitation (in)

USA
EG/INF/Global Euro HD (10 days) from 16/01/2018/00z

USA
EG/INF/Global Euro HD (10 days) from 16/01/2018/00z
Winter Outlook? - European Model:

February 2019
Winter Outlook? - NOAA
Winter Outlook? - Ensemble Forecasts

IRI Multi-Model Probability Forecast for Temperature for December–January–February 2019, Issued October 2018

IRI Multi-Model Probability Forecast for Precipitation for December–January–February 2019, Issued October 2018

White indicates Climatological odds
Indicates dry season (no forecast)
Winter Wild Card: El Nino?

NMME Nino3.4 Fcst, IC=201810

[Graph showing various lines with labels like CMC1, CFSv2, CMC2, GFDL, GFDL_FLOR, NCAI_CCSM4, NASA_GEOS5, etc., with a scale ranging from -2 to 2 along the y-axis and months from May to May along the x-axis.]
Let me be a resource to you:

Email: andrew.pritchard@nutrien.com

Twitter: @skydrama

Questions?
THANK YOU