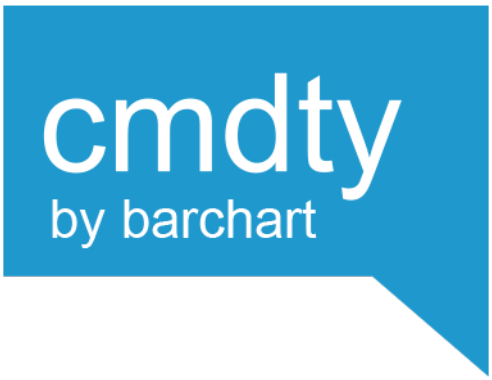

cmdtyIndexes CropPlus+ Index Family Methodology

September 2017

Contents

1 Introduction

1.1 cmdtyIndexes CropPlus+ Index Family

The cmdtyIndexes CropPlus+ Index Family (”CropPlus+ Indexes”) is a series of drought condition weighted heat accumulation indexes, representing micro-climate specific accumulated weather conditions for grain growing. The purpose of the index is to present crop producers across the country with an easy-to-understand actionable measure that allows for smart decisions around fertilizer and agronomy practices.

CropPlus+ Indexes are calculated daily and distributed in two series - County and District. Soil drought conditions are evaluated and updated weekly and are a meaningful compliment to daily measures of heat accumulation. Consideration to both heat accumulation and drought conditions (soil moisture, climatic conditions, hydrologic impacts) are given to accurately provide a measure of total atmospheric condition impact on expected grain production for a given county or district.

1.2 Naming Convention

The cmdtyIndexes CropPlus+ Index Family adheres to the following naming conventions specific to each Series.

- County: cmdtyIndexes [region] (state) CropPlus+ Index
  - i.e. cmdtyIndexes Boone County (IA) CropPlus+ Index
- District: cmdtyIndexes (state) [region] CropPlus+ Index
  - i.e. cmdtyIndexes (IL) District 20 CropPlus+ Index

1.3 Data Source and Integrity

cmdtyIndexes collects data from multiple sources to ensure the accuracy and quality of our measurements.

Temperature data: Temperature data points are provided by Climate Data Online (CDO) of National Climatic Data Center (NCDC), the Applied Climate Information System (ACIS) of NOAA Regional Climate Centers (RCCs) and WeatherBit. The process cmdty implemented to integrate and arbitrate temperature data from all data sources currently serving as inputs as follows:

- Retrieve daily maximum temperature and minimum temperature of counties in crop growing states from CDO, ACIS, WeatherBit separately. Crop growing states are provided in Appendix I .
- Select highest daily maximum temperature and lowest daily minimum temperature among retrieved data.
- Record selected maximum temperatures and minimum temperatures for each county for further index calculation using.

Drought Condition Data: Drought condition data is provided by United States Drought Monitor, which is a composite index based on measurements of climatic, hydrologic and soil conditions as well as reported impacts and observations from more than 350 contributors around the country. Drought condition data is updated on every Thursday weekly, and is used for calculating index in the following week.

2 cmdtyIndexes County CropPlus+ Index Methodology

2.1 Adjusted Accumulated Growing Degree Days (AAGDD)

The Adjusted Accumulated Growing Degree Days (AAGDD) is cmdtyIndexes proprietary measurement to quantify the accumulated weather conditions for grain growing. County AAGDD is calculated by combining soil drought conditions and heat accumulation. It is calculated daily and begins accumulation at Jan 1st each year. More details on county AAGDD calculation are below.

2.1.1 Calculating County AAGDD

$$DF_j^{t_i} = Percent_j^{t_i}(NoneDrought) + 0.75Percent_j^{t_i}(D_0) + 0.5Percent_j^{t_i}(D_1)$$

$$T_{j_{max}}^{t_i} = \begin{cases} 86, & \text{If } 86 < T_{j_{max}}^{t_i} \\ T_{j_{max}}^{t_i}, & \text{If } 50 \leq T_{j_{min}}^{t_i} \leq 86 \\ 50, & \text{If } T_{j_{min}}^{t_i} < 50 \end{cases}$$

$$T_{j_{min}}^{t_i} = \begin{cases} 86, & \text{If } 86 < T_{j_{min}}^{t_i} \\ T_{j_{min}}^{t_i}, & \text{If } 50 \leq T_{j_{min}}^{t_i} \leq 86 \\ 50, & \text{If } T_{j_{min}}^{t_i} < 50 \end{cases}$$

$$GDD_j^{t_i} = \frac{1}{2}(T_{j_{max}}^{t_i} + T_{j_{min}}^{t_i}) - 50$$

$$adjGDD_j^{t_i} = DF_j^{t_i} * GDD_j^{t_i}$$

$$AAGDD_j^t = \sum_{i=0}^{n} adjGDD_j^{t_i}$$

where,

t_i is the observed temperature date, t_0 is the January 1st index computing year and $t_n = t$ is the time computed index.

j is the county computed $AAGDD$.

$Percent_j^{t_i}(NoneDrought)$, $Percent_j^{t_i}(D_0)$, $Percent_j^{t_i}(D_1)$ are the percentages of area of county j at time t_i with different drought severity level, which are assessed by United States Drought Monitor.

$DF_j^{t_i}$ is the adjusting weight based on drought condition of county j at time t_i.

$T_{j_{max}}^{t_i}$ is the capped maximum temperature measured in Fahrenheit of county j at time t_i.

$T_{j_{min}}^{t_i}$ is the capped minimum temperature measured in Fahrenheit of county j at time t_i.

$GDD_j^{t_i}$ is the growing degree days of county j at time t_i.

$adjGDD_j^{t_i}$ is the adjusted growing degree days of county j at time t_i.

$AAGDD_j^t$ is the accumulated adjusted growing degrees days of county j at time t.

2.1.2 Ranking County AAGDD

The applicable universe includes data points of $AAGDD$ of all counties in the crop growing states since Jan 1st 2000.

The process of ranking is below:

- Select all data points at dates that have the same Month and the same Day with computing index time t in applicable universe.
  - i.e. Assume computing index time is May 15th 2017, the data points at May 15th of each year of all counties in crop growing states are selected, total amount of selected data points is 43002.
- Record the rank of data points of time t sorted by $AAGDD$ in ascending order. Here, every data point relates to a unique pair of index year and county.

  - i.e. May 15th 2017 Boone County (IA) ranked 32330st among 43002 data points in ascending order.

- Calculate percentile for data points of time t as follows:
  - i.e. Percentile of May 15th 2017 Boone County (IA) is 75.1825th as calculated.

$$P_j^t = \frac{R_j^t}{n} * 100\,,$$

where,

t is the time computed percentile.

j is the county computed percentile for.

n is the amount of selected data points.

R_j^t is the rank of county j at t sorted by $AAGDD$ in ascending order through n selected data points.

P_j^t is the percentile of county j at t sorted by $AAGDD$ in ascending order through n selected data points.

2.2 Index Calculation

Index values of computing time t is calculated by using following function and then assigned to each county j. The whole index values of selected data points follow the normal distribution.

$$I_j^t = \begin{cases} 0, & \text{if } P_j^t <= 0.001 \\ \lfloor \frac{P_j^t + 0.00012}{0.00224} \rfloor, & \text{if } 0.001 < P_j^t <= 0.0122 \\ 5 + \lfloor \frac{P_j^t - 0.01081}{0.00278} \rfloor, & \text{if } 0.0122 < P_j^t <= 0.04 \\ 15 + \lfloor \frac{P_j^t - 0.0365}{0.007} \rfloor, & \text{if } 0.04 < P_j^t <= 0.11 \\ 25 + \lfloor \frac{P_j^t - 0.104}{0.012} \rfloor, & \text{if } 0.11 < P_j^t <= 0.23 \\ 35 + \lfloor \frac{P_j^t - 0.2215}{0.017} \rfloor, & \text{if } 0.23 < P_j^t <= 0.40 \\ 45 + \lfloor \frac{P_j^t - 0.39}{0.02} \rfloor, & \text{if } 0.40 < P_j^t <= 0.60 \\ 55 + \lfloor \frac{P_j^t - 0.5915}{0.017} \rfloor, & \text{if } 0.60 < P_j^t <= 0.77 \\ 65 + \lfloor \frac{P_j^t - 0.764}{0.012} \rfloor, & \text{if } 0.77 < P_j^t <= 0.89 \\ 75 + \lfloor \frac{P_j^t - 0.8865}{0.007} \rfloor, & \text{if } 0.89 < P_j^t <= 0.96 \\ 85 + \lfloor \frac{P_j^t - 0.95861}{0.00278} \rfloor, & \text{if } 0.96 < P_j^t <= 0.9878 \\ 95 + \lfloor \frac{P_j^t - 0.98668}{0.00224} \rfloor, & \text{if } 0.9878 < P_j^t <= 0.999 \\ 100, & \text{if } 0.999 < P_j^t \end{cases}$$

Where,

t is the time computed index.

j is the county computed index for.

P_j^t is the percentile as decimal of county j at t sorted by $AAGDD$ in ascending order through n selected data points.

I_j^t is the index value of county j at time t.

2.2.1 Index Scale Explanation

Index value is a normalized score presenting the relative strength of accumulated weather condition for grain growing of a specific county and it ranges from 0 to 100. The statistic behind the index value is a related percentile range, which is the county weather condition located at crossing spatial and temporal (comparing to all counties in crop growing states since 2000). For example, index value of May 15th 2017 Boone County (IA) is 64, which means its growing weather condition is located in [74.45th, 76.15th) percentile ranges among all counties in crop growing states at May 15th since 2000.

2.3 Index Maintenance

cmdtyIndexes performs ongoing review of the entire cmdtyIndexes CropPlus+ Index Family. The states included in our list of crop growing states, and subsequently the CropPlus+ Index Family, are reviewed annually and can be found in the Appendix I.

2.4 Index Dissemination

CropPlus+ Indexes are calculated starting at May 15th each year, AAGDD is calculated starting at Jan 1st each year, both are disseminated daily. Historical CropPlus+ data is available since May 15th 2000, historical AAGDD data is available since Jan 1st 2000.

3 cmdtyIndexes District CropPlus+ Index Methodology

3.1 Crop District Definition

Agricultural Statistics Districts ("Crop Reporting Districts") are groupings of counties - defined by the USDA - in each State with similar climate and geographical attributes. The components used for grouping include mean temperature, annual precipitation and length of growing season.

Geographic boundaries for Crop Reporting Districts are available on the USDA NASS website:
Map Link - USDA Agricultural Districts boundaries map
Codes Link - USDA Agricultural Districts codes

3.2 Adjusted Accumulated Growing Degree Days (AAGDD)

3.2.1 Calculating District AAGDD

The Adjusted Accumulated Growing Degree Days (AAGDD) is cmdtyIndexes proprietary measurement to quantify the accumulated weather conditions for grain growing. District AAGDD is calculated by averaging AAGDD of counties in that district. More details on district AAGDD calculation are below.

$$\widetilde{AAGDD}_k^t = \frac{\sum_{j=0}^{N_k} AAGDD_{jk}^t}{N_k},$$

where,

t is the time computed AAGDD.

k is the crop district computed index.

N_k is the amount of counties in the district k.

$AAGDD_{jk}^{t}$ is cmdtyIndexes adjusted accumulated growing degrees days of county j in district k at time t.

$\widetilde{AAGDD}_{k}^{t}$ is cmdtyIndexes adjusted accumulated growing degrees days of district k at time t.

3.2.2 Ranking District AAGDD

The applicable universe includes data points of $AAGDD$ of all districts in the crop growing states since Jan 1st 2000.

The process of ranking is below:

- Select all data points at dates that have the same Month and the same Day with computing index time t in applicable universe.
  - i.e. Assume computing index time is Sep 31th 2017, the data points at Sep 31th of each year of all districts in crop growing states are selected, total amount of selected data points is 4068.
- Record the rank of data points of time t sorted by $AAGDD$ in ascending order. Here, every data point relates to a unique pair of index year and district.
  - i.e. Sep 31th 2017 (ND) District 10 ranked 957st among 4068 data points in ascending order.
- Calculate percentile for data points of time t as follows:
  - i.e. Percentile of Sep 31th 2017 (ND) District 10 is 23.5251th as calculated.

$$\widetilde{P}_{k}^{t} = \frac{\widetilde{R}_{k}^{t}}{m} * 100\,,$$

Where,

t is the time computed percentile.

k is the district computed percentile.

m is the amount of selected data points.

R_k^t is the rank of district k at t sorted by $AAGDD$ in ascending order through m selected data points.

$\widetilde{P}_k^t$ is the percentile of district k at t sorted by $AAGDD$ in ascending order through m selected data points.

3.3 Index Calculation

$$\widetilde{I}_k^t = \begin{cases} 0, & \text{if } \widetilde{P}_k^t <= 0.001 \\ \lfloor \frac{\widetilde{P}_k^t + 0.00012}{0.00224} \rfloor, & \text{if } 0.001 < \widetilde{P}_k^t <= 0.0122 \\ 5 + \lfloor \frac{\widetilde{P}_k^t - 0.01081}{0.00278} \rfloor, & \text{if } 0.0122 < \widetilde{P}_k^t <= 0.04 \\ 15 + \lfloor \frac{\widetilde{P}_k^t - 0.0365}{0.007} \rfloor, & \text{if } 0.04 < \widetilde{P}_k^t <= 0.11 \\ 25 + \lfloor \frac{\widetilde{P}_k^t - 0.104}{0.012} \rfloor, & \text{if } 0.11 < \widetilde{P}_k^t <= 0.23 \\ 35 + \lfloor \frac{\widetilde{P}_k^t - 0.2215}{0.017} \rfloor, & \text{if } 0.23 < \widetilde{P}_k^t <= 0.40 \\ 45 + \lfloor \frac{\widetilde{P}_k^t - 0.39}{0.02} \rfloor, & \text{if } 0.40 < \widetilde{P}_k^t <= 0.60 \\ 55 + \lfloor \frac{\widetilde{P}_k^t - 0.5915}{0.017} \rfloor, & \text{if } 0.60 < \widetilde{P}_k^t <= 0.77 \\ 65 + \lfloor \frac{\widetilde{P}_k^t - 0.764}{0.012} \rfloor, & \text{if } 0.77 < \widetilde{P}_k^t <= 0.89 \\ 75 + \lfloor \frac{\widetilde{P}_k^t - 0.8865}{0.007} \rfloor, & \text{if } 0.89 < \widetilde{P}_k^t <= 0.96 \\ 85 + \lfloor \frac{\widetilde{P}_k^t - 0.95861}{0.00278} \rfloor, & \text{if } 0.96 < \widetilde{P}_k^t <= 0.9878 \\ 95 + \lfloor \frac{\widetilde{P}_k^t - 0.98668}{0.00224} \rfloor, & \text{if } 0.9878 < \widetilde{P}_k^t <= 0.999 \\ 100, & \text{if } 0.999 < \widetilde{P}_k^t \end{cases}$$

Where,

t is the time computed index.

k is the district computed index.

$\widetilde{P}_k^t$ is the percentile as decimal of district k at t sorted by $AAGDD$ in ascending order through m selected data points.

$\widetilde{I}_k^t$ is the index value of district k at time t.

3.3.1 Index Scale Explanation

The index value is a normalized score presenting the relative strength of accumulated weather condition for grain growing of a specific district and it ranges from 0 to 100. The statistic behind the index value is a related percentile range, which is the county weather condition located crossing spatial and temporal (comparing to all districts in crop growing states since 2000). For example, index value of Sep 31th 2017 (ND) District 10 is 35, which means its growing weather condition is located in [22.15th, 23.85th) percentile ranges among all districts in crop growing states at Sep 31th since 2000.

3.4 Index Maintenance

cmdtyIndexes performs ongoing review of the entire cmdtyIndexes CropPlus+ Index Family. The states included in our list of crop growing states, and subsequently the CropPlus+ Index Family, are reviewed annually and can be found in the Appendix I.

3.5 Index Dissemination

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Appendices

I Crop Growing States

Crop Growing State	Abbreviation	Crop Growing State	Abbreviation
Alabama	AL	North Carolina	NC
Arkansas	AR	North Dakota	ND
Colorado	CO	Nebraska	NE
Iowa	IA	New York	NY
Illinois	IL	Ohio	OH
Indiana	IN	Oklahoma	OK
Kansas	KS	Pennsylvania	PA
Kentucky	KY	South Carolina	SC
Louisiana	LA	South Dakota	SD
Maryland	MD	Tennessee	TN
Michigan	MI	Texas	TX
Minnesota	MN	Virginia	VA
Missouri	MO	Wisconsin	WI
Mississippi	MS		

About cmdty

cmdty delivers the data, solutions, and insights that commodity professionals need to drive their business. Our offerings are built for the most demanding of users - and are designed to be Smart, Transparent, and easily integrated into any client solution.

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