

## Midwest V9 – R2 development stage precipitation analysis based on maize hybrid growing degree days

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### Methods:

To evaluate the potential for the drainage water recycling practice to increase corn production across the region, precipitation during V9 and R2 development stages was summed for each year from 2000 to 2015 using one-sixteenth degree resolution gridded data derived from local weather stations<sup>1,2,3</sup>. Each grid cell was assigned a FIPS (Federal Information Processing Standards) code for the county that the majority of the grid cell is within; this code was used to link the weather data with additional information.

In addition to climate variability, this analysis considered regional differences in maize hybrid choice to identify the expected dates for V9 and R2. Maize hybrid growing degree day (GDD) statistics were extracted from a dataset containing information for 650 Midwest counties<sup>4</sup>. Counties with a planted percentage of corn equal to or greater than 2% between 2000 and 2016 were selected<sup>5,6</sup>. An additional 50 counties of maize hybrid GDD statistics were added for a total of 700 counties in the dataset by averaging values from surrounding counties (Table 1). To create a seamless map, 23 counties with missing maize hybrid data (e.g. those with large metropolitan or forested areas and <2% corn planted) were assigned average values from the adjacent counties (Table 2). Maize hybrid GDD values from the adjoining east and west (or next nearest) counties were averaged and the mean was assigned to the missing county. This filling method was selected for these 23 counties with little to no corn production to preserve the north to south gradient in temperature/GDDs across the region<sup>4</sup>.

Temporal and spatial variability in planting date is used in calculating the annually varying V9 to R2 development stage window across the region. Planting dates for each year were assigned on the county-level and were based on the reported date of 50% or more corn acreage planted from the USDA NASS planting statistics<sup>7</sup>. The V9 through R2 development stage window was identified by a percentage of growing degree days needed for the assigned maize hybrid to reach maturity (R6). These percentages are defined as 32% and 63% for the V9 and R2 development stages, respectively<sup>8</sup>. Dates corresponding to the V9 and R2 development stages in each year were used to create a window for precipitation to be summed during these stages.

GDD was calculated daily with a base of 50°F (10°C) and maximum of 86°F (30°C). Temperatures below the base (50°F) were set to the base, and those above the maximum (86°F) were set to the maximum, before calculating GDD with the following equation:

$$\text{GDD} = (\text{Maximum Daily Air Temperature} + \text{Minimum Daily Air Temperature})/2 - 50.$$

A check to ensure daily GDD never exceeded 36 was performed prior to calculating cumulative GDD between hybrid planting date and GDD based maturity. Precipitation was summed over

the GDD values representing the period beginning at V9 and ending at R2 development stages each year and then averaged over all years (Figure 1). In addition, the frequency of years between 2000 and 2015 in which the V9 – R2 precipitation failed to meet or exceed the 5 inch critical threshold was calculated.

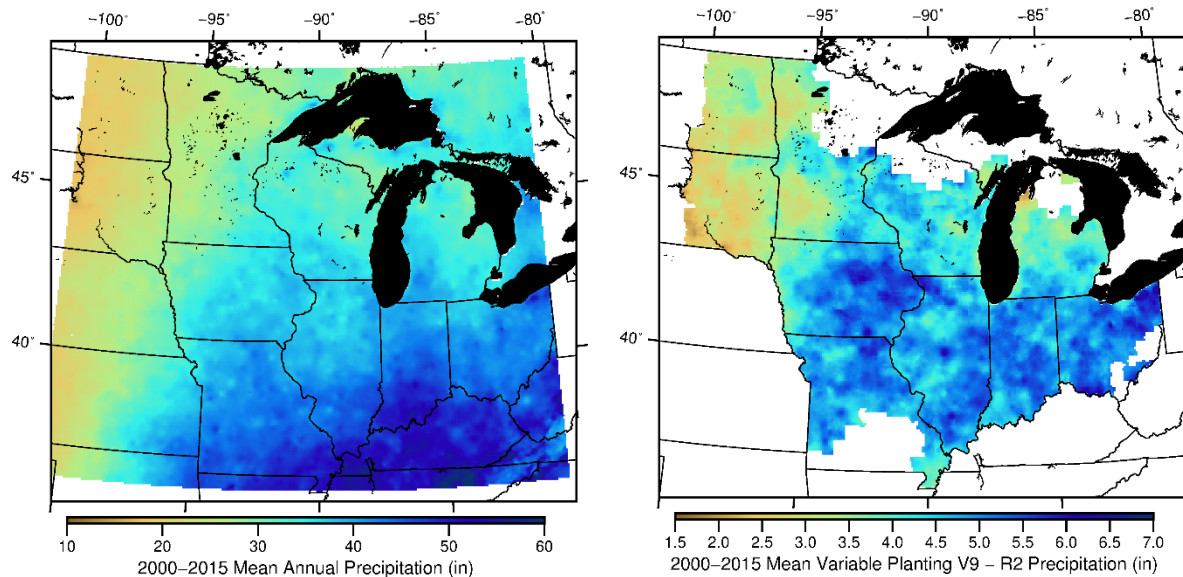


Figure 1. Mean annual (left) and V9 – R2 (right) precipitation in inches for 2000 – 2015.

#### References:

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3. Livneh, B., Rosenberg, E.A., Lin, C., Nijssen, B., Mishra, V., Andreadis, K.M., Maurer, E.P. and Lettenmaier, D.P., 2013. A long-term hydrologically based dataset of land surface fluxes and states for the conterminous United States: Update and extensions. *Journal of Climate*, 26(23), pp.9384-9392. <https://doi.org/10.1175/JCLI-D-12-00508.1>
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5. USDA NASS. 2017. Quick stats. (Query: Farm Operations – Area Operated, Measured in Acres/Operation for IA, IL, IN, MO, MN, OH, SD, WI). United States Department of Agriculture, National Agricultural Statistics Service. Washington, D.C. <https://quickstats.nass.usda.gov/results/9B2C3340-48D1-33A5-8C0A-77443A4EB1BB>
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7. USDA NASS. 2019. Quick stats. (Query: “Corn - Progress, Measured in Pct Planted” for IA, IL, IN, MO, MN, OH, SD, WI). United States Department of Agriculture, National Agricultural Statistics Service. Washington, D.C. <https://quickstats.nass.usda.gov/results/E216C933-2622-3E7E-9C78-AE0163BF4D4A>
8. Abendroth, L.J., Elmore, R.W., Boyer, M.J. and Marlay, S.K., 2011. Corn development and development. Report number: PMR 1009. Iowa State University, Extension. Ames, IA. <https://store.extension.iastate.edu/product/6065>

Table 1. Additional 50 counties with 2% or greater corn production not included in Abendroth et al. (2021), surrounding county maize hybrid statistics were averaged where possible.

<b>Missing County FIPS</b>	<b>Filling Counties FIPS</b>
17013	17149, 17061
17069	17059
17083	17061, 17117, 17119
17089	17111, 17093
17097	17111, 17031
17151	17127, 17087, 17165
17155	17123, 17011, 17099
18025	18117, 18123
18029	18047, 18137
18043	18019, 18061
18097	18057, 18081
18105	18109, 18093
18119	18055, 18021, 18133
18155	18077, 18115
18161	18177, 18041, 18047
18173	18163, 18125, 18147
18175	18061, 18071
26055	26113
26105	26127, 26123
26109	26041
26113	26055, 26129
26129	26011, 26051
26133	26073, 26107, 26113
27003	27019, 27059, 27025
27141	27145, 27171, 27009
29001	29199, 29121

29017	29157, 29207
29051	29151, 29135
29057	29109, 29097
29171	29129, 29211, 29199
29185	29013, 29083
29197	29111, 29103, 29171
38029	38047, 38051
38031	38027, 38093
38039	38063, 38003
38099	38035, 38067
39019	39151, 39029, 39157
39075	39031, 39169
39095	39051, 39069, 39173
39123	9173, 39143, 39095
46017	46059, 46045
46027	46135, 46127, 46125
46049	46045, 46059
46061	46067, 46111, 46035, 46097
46089	46045, 46021
55001	55057, 55137, 55077
55059	55101, 55127
55083	55067, 55115, 55075
55129	55005, 55013
55133	55131, 55127, 55055, 55027

Table 2. Counties with less than 2% corn production that have missing hybrid maize statistics filled by averaging adjacent east and west (or nearest) counties where possible.

<b>Missing County FIPS</b>	<b>Filling Counties FIPS</b>
17043	17089, 17031
18013	18105, 18005
26019	26089, 26055
26035	26133, 26051
26085	26105, 26133
26101	26105
26165	26113
26125	26093, 26099
26163	26161
27029	27119, 27087, 27007, 27113
27123	27003, 27053, 27163

29039	29217, 29167
29085	29185, 29029
29099	29071, 29221, 17133
29189, 29510	29183, 17163, 17119, 29071
39035	39093
39055	39093, 39007, 39155
39061	39025, 18155
39085	39007
39153	39103, 39133
55078	55067, 55115, 55083
55079	55133