# An Estimation of Crop Planting Dates through the Use of Remotely Sensed Data

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Introduction:

Crop research, monitoring, and forecasting is key to understanding and predicating key agricultural outcomes, such as crop yields and soil health, which leads to improved food security and long-term sustainability. One of the main tools researchers have to tackle this problem is crop simulation modeling. However, to conduct simulations over large regions, model inputs require equally large-scale, field specific datasets; datasets, such as observed planting dates, are currently unavailable in most circumstances, particularly when needed on a consistent and annual basis.

In this study, we look to apply a satellite-based remote-sensing approach that combines both physiological and climatological components to generate planting date input datasets across a wide region at a localized scale. This work serves a first step toward improving crop modeling data integration through strategic use of remote sensing to reduce uncertainty in initial parameters.
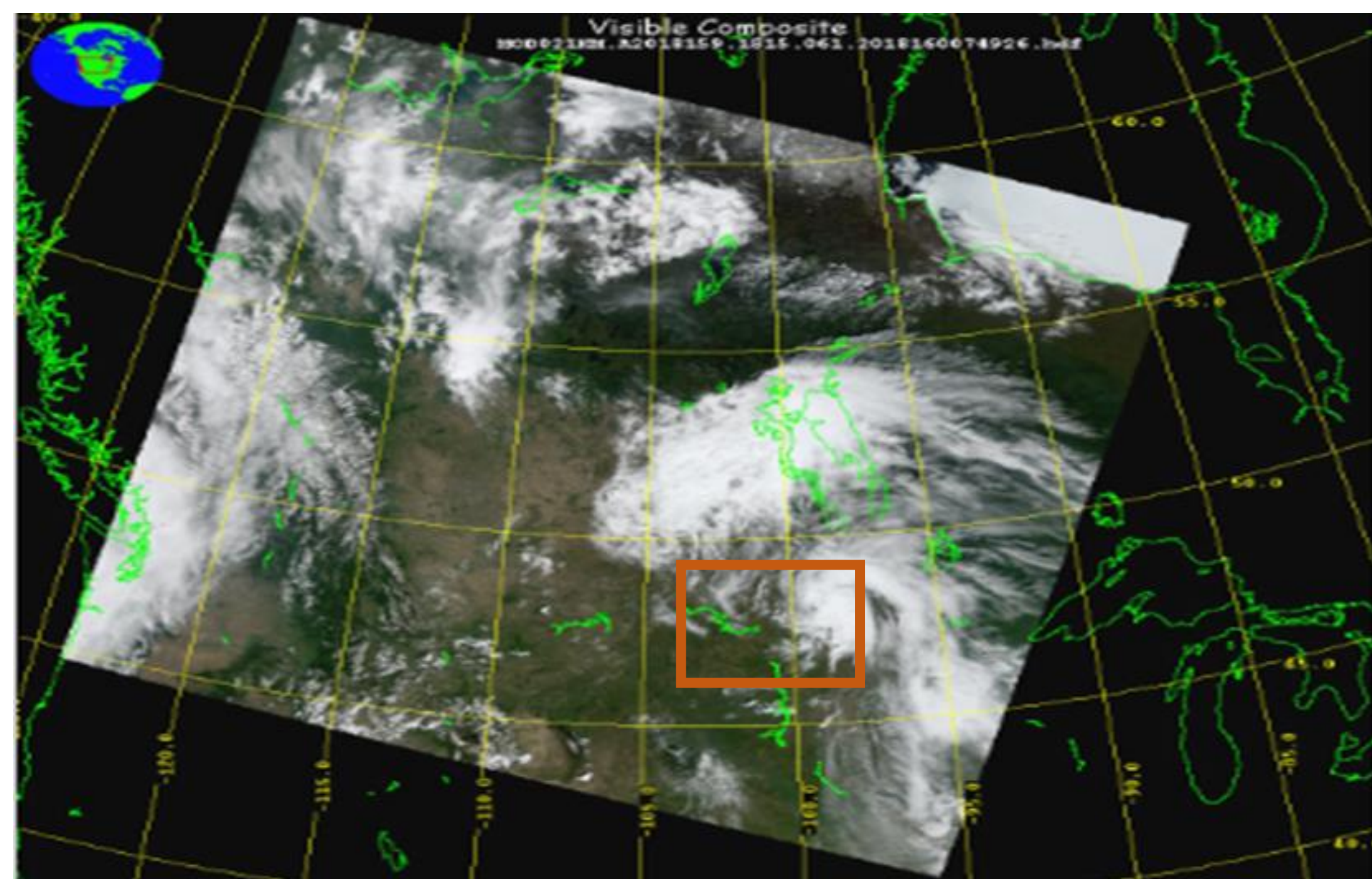
MODIS Level 1B visible imagery used to find NDVI points over North Dakota from 6/18/2018

Source: NASA- LAADS DAAC

Methodology:

Datasets
- **Weather:** NCEP North American Regional Reanalysis (NARR) dataset was utilized to calculate corn growing degree days (GDD) for each location.
- **Detection:** Moderate Resolution Imaging Spectroradiometer (MODIS) level 1b reflectance Aqua/Terra satellite data. NDVI was calculated after removal of cloudy and ice/snow pixels.
- **Reported Planting Dates:** Median state-wide crop progress reports were acquired from the USDA National Agricultural Statistics Service (NASS) survey for calibration and comparison purposes.
- **Crop Location:** The cropland data layer (CDL) was collocated with the MODIS Level 1B product. Homogeneous corn fields of at least .25km^2 (25ha) were utilized in this study.

Calculation of GDD, Determining NDVI Thresholds and Planting Dates

1) Locate homogenous cornfields collocated with MODIS pixels
2) Find NDVI values of bare ground at start of growing season for each location
3) Note date where each locations' NDVI crosses threshold to discern plant growth from bare soil.
4) Use accumulated GDD from given state-wide median planting date for the calibration year (2012) as reference GDD for growth detection stage.
5) Combine reference GDD with 2013-2018 NDVI threshold exceedance for homogeneous cornfields to calculate planting date at each individual field for each year.
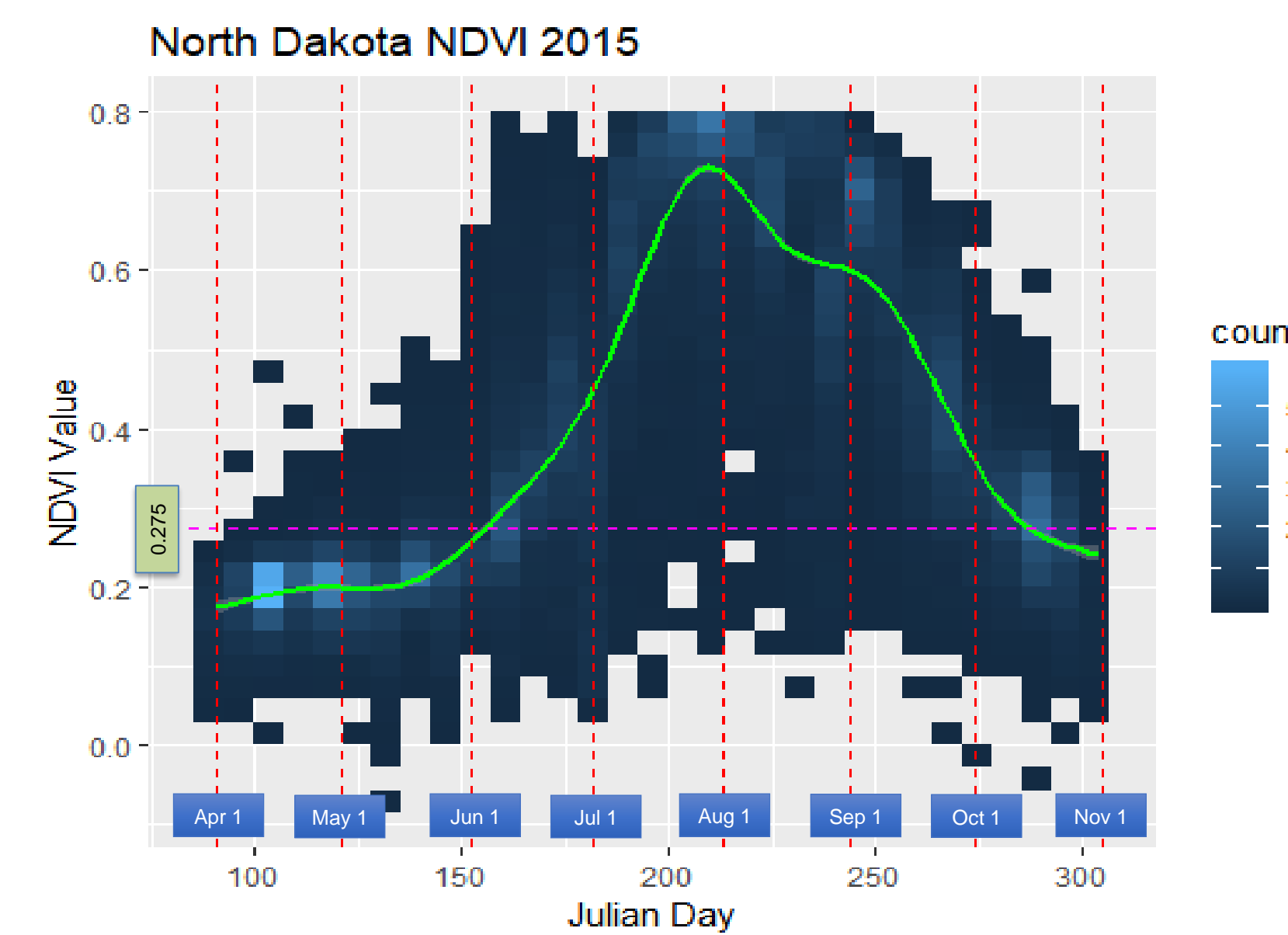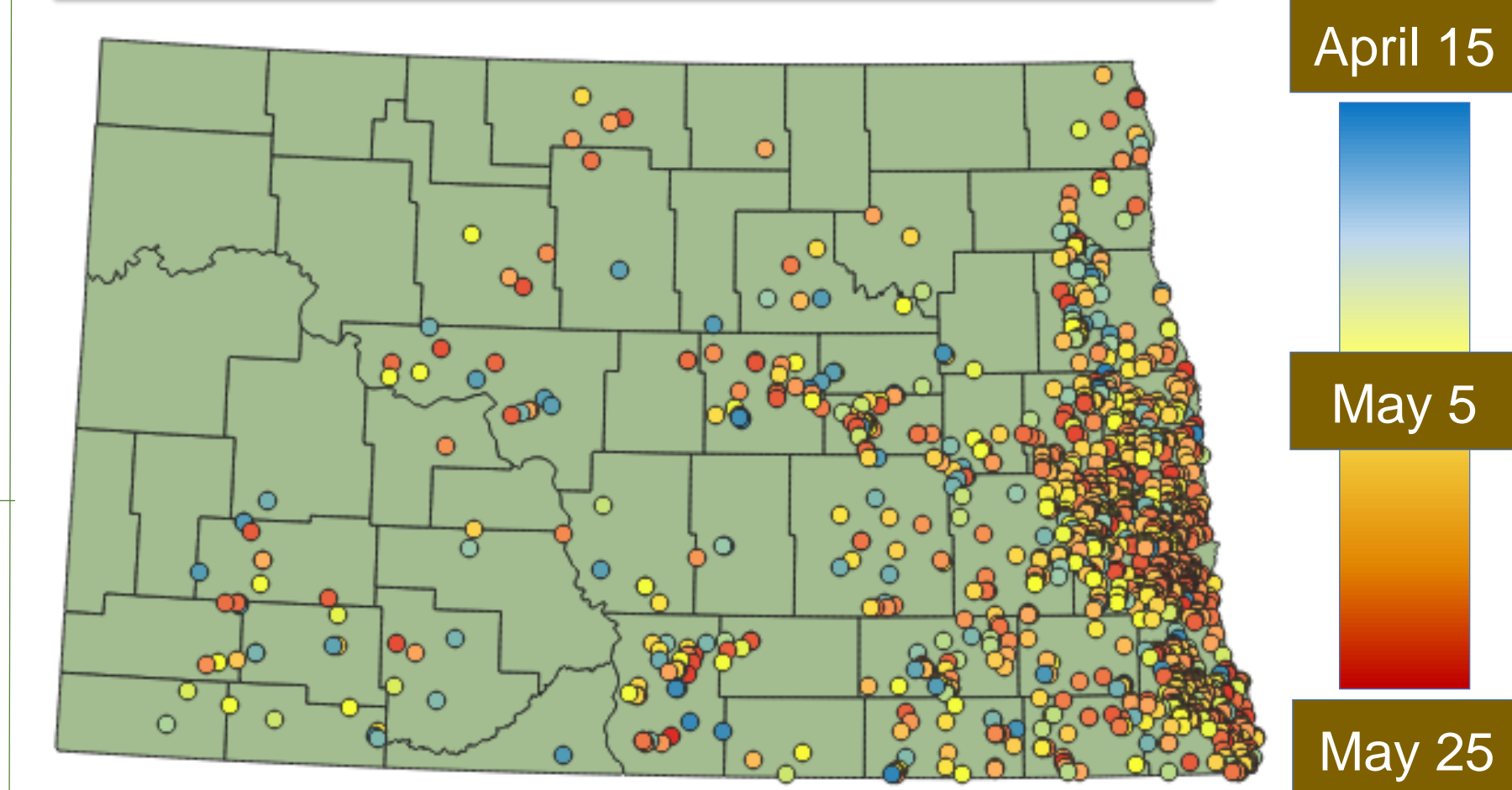
An example of North Dakota NDVI dataset distribution from 2015 using a 0.275 threshold
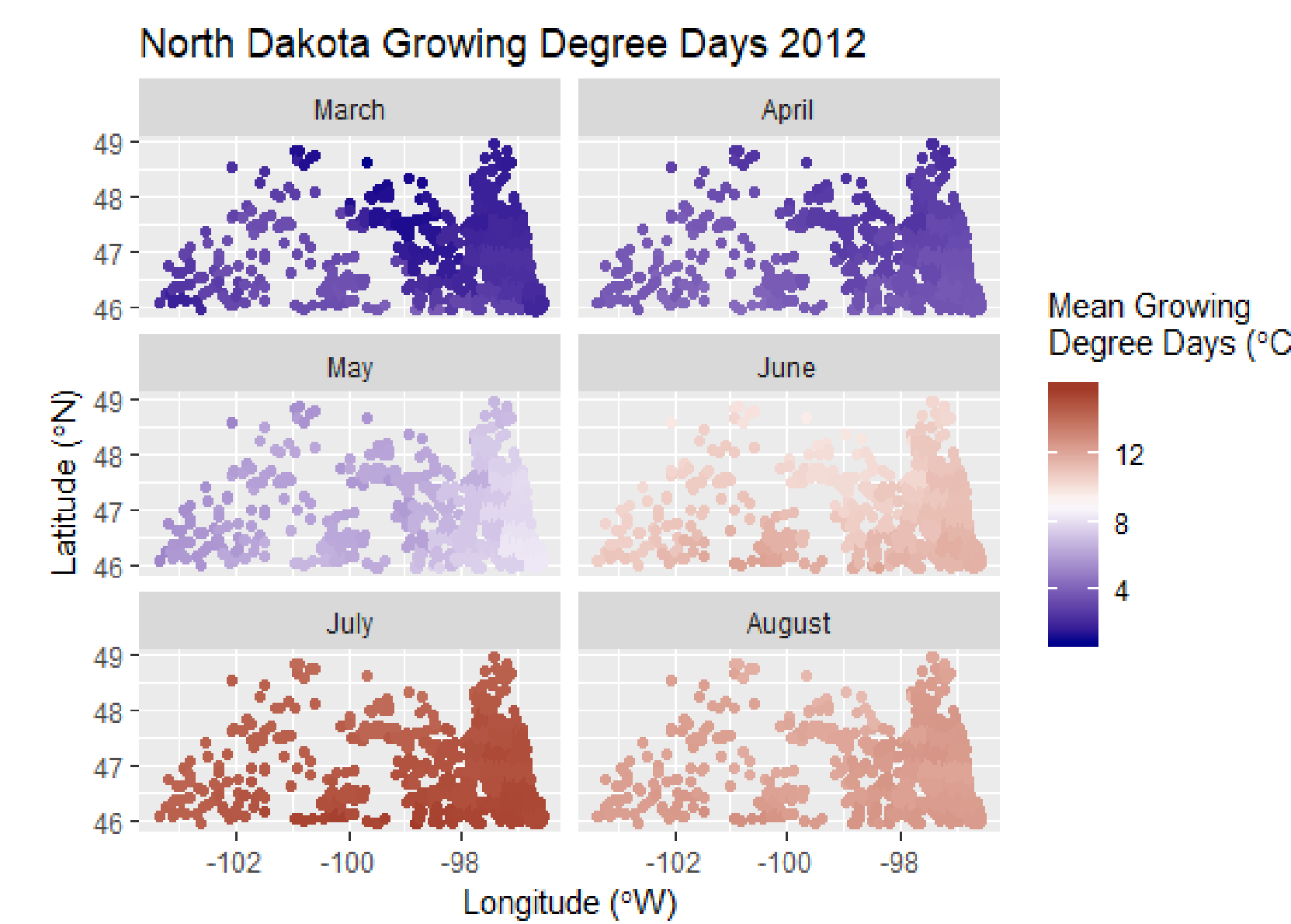
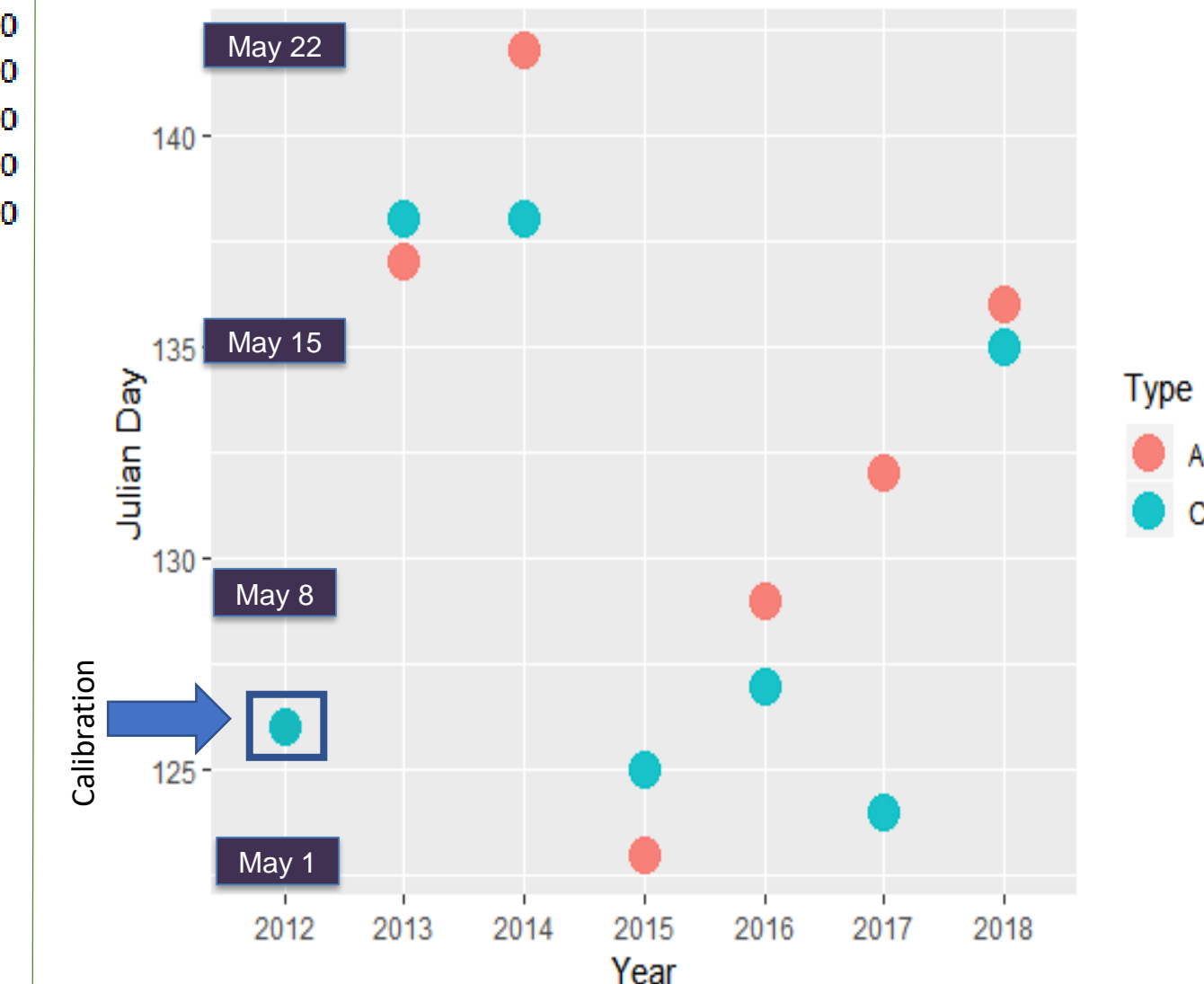*Dataset for each corn field point with the average daily GDD given for each month, calculated from NARR 2m temp.*

Results: Planting Date Representation

2012 Derived Corn Planting Dates

April 15 — May 5 — May 25

Preliminary planting dates for 2012 control year (from April 15-May 25) with later dates shown in red

- Majority of planting dates for calibration are within a week of the May 5 median
- Points meeting required criteria follow survey planting date distribution well
- Shows ability to spatially determine planting schedules on a more localized basis

Target median planting dates and calculated dates, along with date of NDVI threshold detection

Year	2013	2014	2015	2016	2017	2018
Actual Median Planting Date	May 17	May 22	May 3	May 8	May 12	May 16
Calculated Median Planting Date	May 18	May 5	May 5	May 6	May 4	May 15
Crop Detection by NDVI	June 26	June 20	June 18	June 13	June 11	June 12

- On average calculated median planting dates fall within 2 days of actual dates
- Similar planting dates as 2012 observed for 2015-2017, may relate to soil temp.
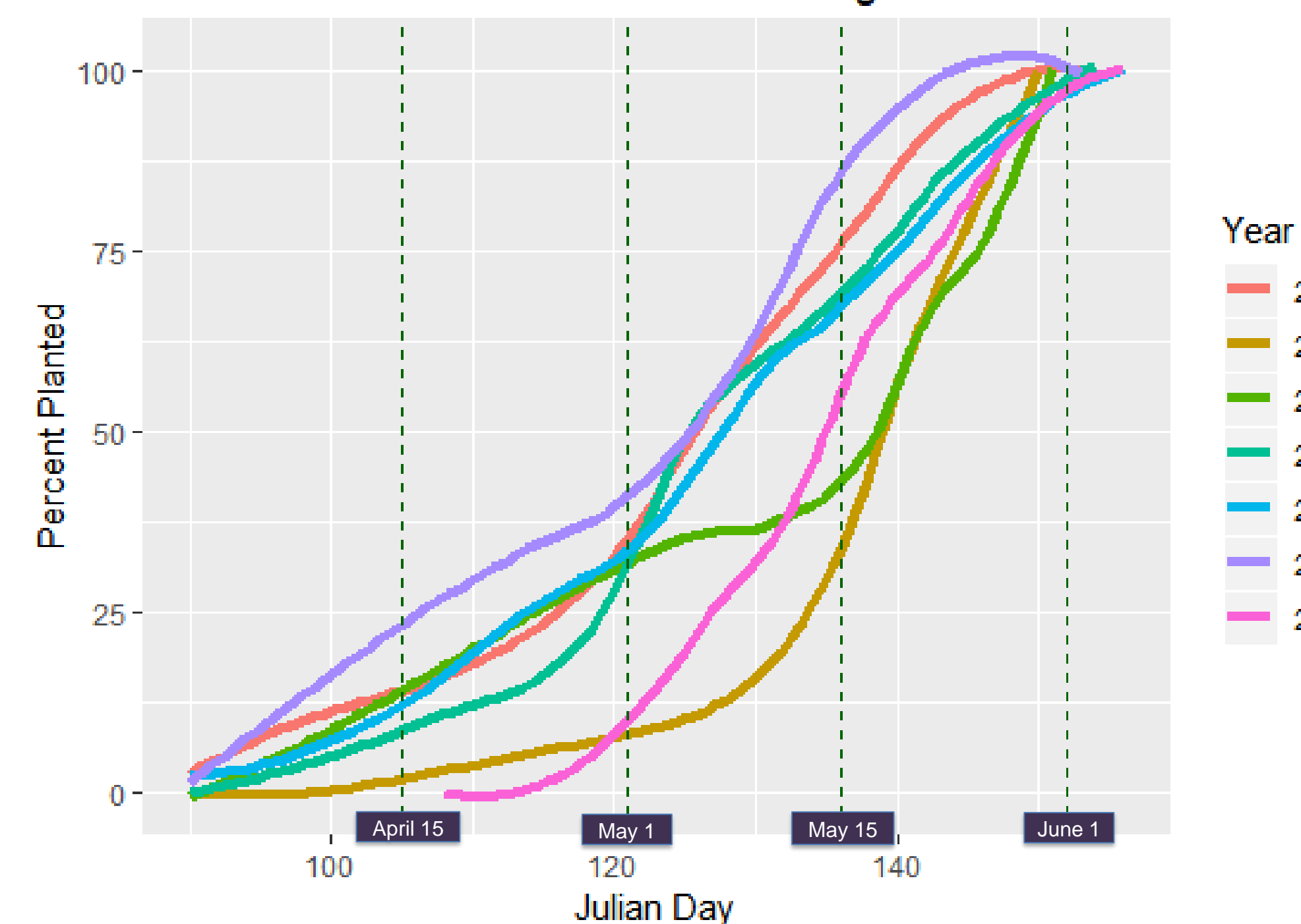- Dates of crop detection are about a month after median planting dates
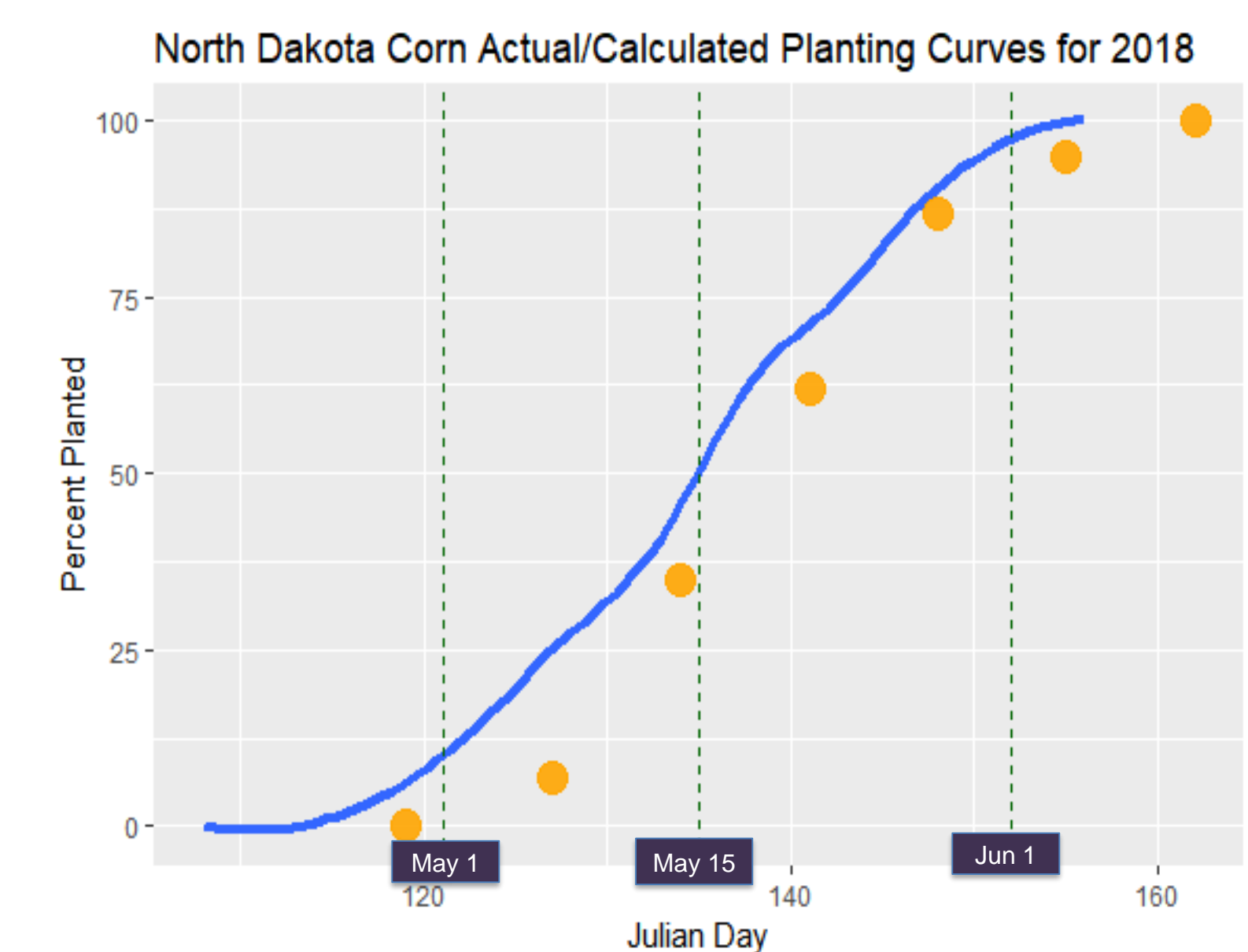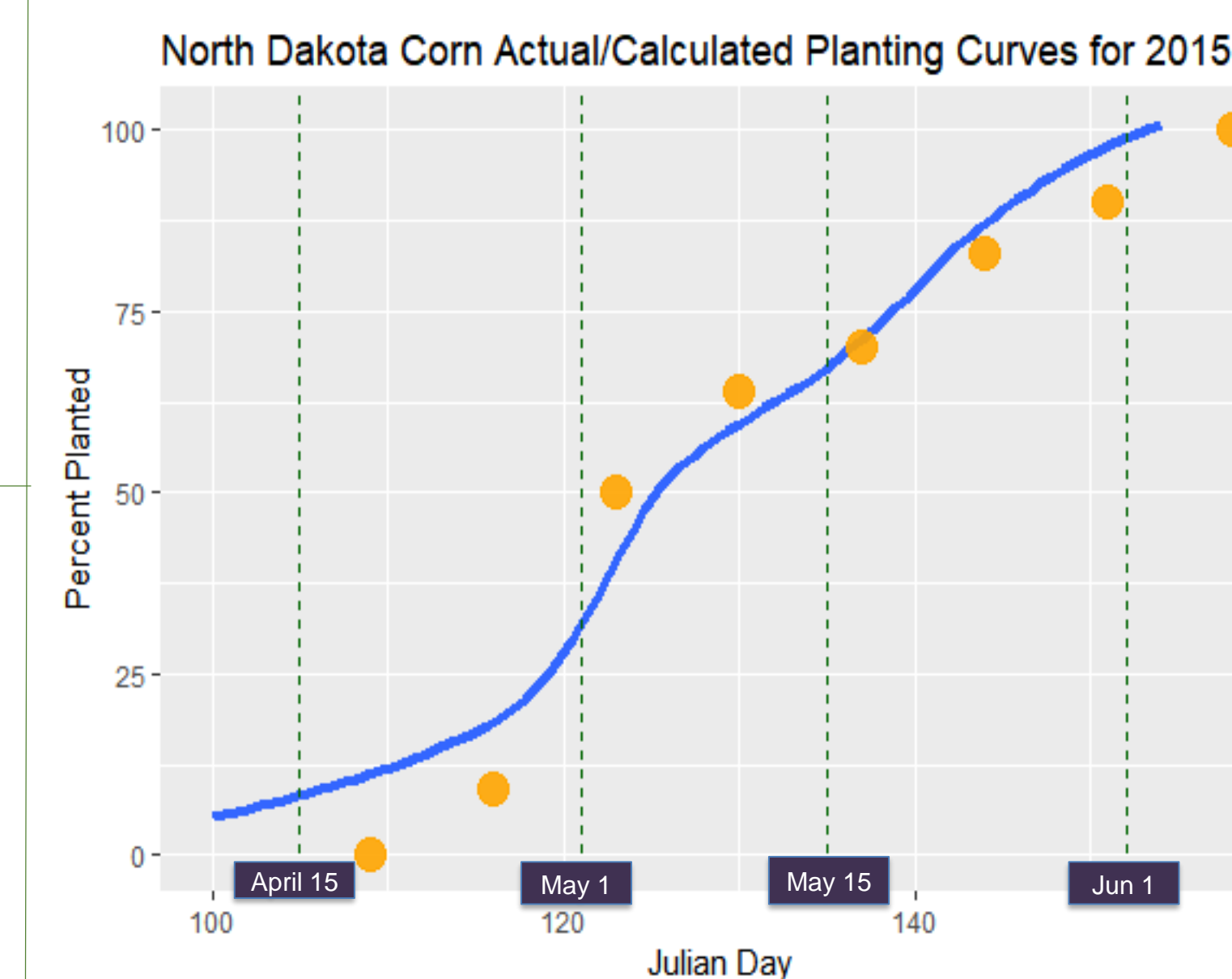
Calculated planting curves (blue) for 2015 and 2018 with NASS survey reported points (orange)

- Both 2015 and 2018 calculations show similar planting curves, generally within a 5 percent margin of error compared to weekly reported points
- Week-to-week changes can be detected, such as a sharp increase in percent planted in the first week of May 2015

Conclusions:

- Using 2012 as a calibration year, median planting dates for 4 out of 6 years are estimated within 1-2 days of the actual dates
- The middle 50 percent of corn planting in North Dakota occurred generally within a 10-15 day window, which is captured by our method for most years
- The planting curve is best represented near the median where the calibration is completed, less accurate toward start/end dates
- It is essential to use an NDVI threshold just above, but not too far above bare soil NDVI in order to detect germination
- Significant differences in GDD across various years and points during the spring throughout North Dakota can skew results, especially for earlier planting dates
- **Planting dates of individual fields can be identified over time, which represents a large improvement over currently available data (weekly statewide averages)**

Smoothed planting curve depiction for all years