Planting Date Econometrics for Corn in Mississippi: Two Models

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INTRODUCTION Mississippi's shift in cropping system dominance from upland cotton (*Gossypium hirsutum* L.) to corn (*Zea mays* L.) has caused variably-scaled challenges for producers and other crop care professionals. Dramatic shifts in crop sequences, planting intensities, and weather patterns have produced inter-related complications associated with optimal planting intervals and risk assessment determinations as well as gauging potential yield penalties for continuous production. These are important knowledge gaps to be filled-in. Geospatial integration of a 3-year corn production footprint (derived from 2013-2015 Cropland Data Layers (CDLs)) with a series of updated temperature-based planting date probability maps enables farmers and other crop professionals to adapt management strategies, minimize risk, and improve farm-gate earnings.

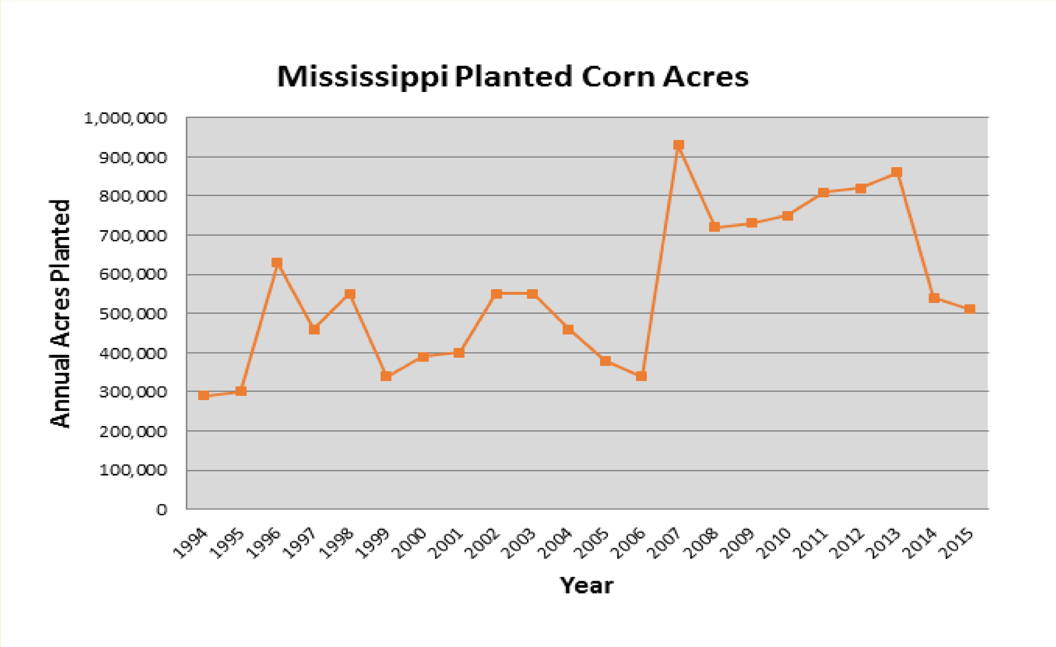

Fig. 1. Historical profile of corn acreage planted in Mississippi. At its peak, in 2007, 930,000 acres were planted to corn. The 5-year interval (2009-2013) selected for a more comprehensive study in all likelihood has effectively "captured" the extent of the corn acreage footprint in Mississippi by accommodating for 2-, 3-, and 4-year rotation cycles; the aerial extent was estimated at 2.39 million acres. *http://www.nass.usda.gov/Quick_Stats/*

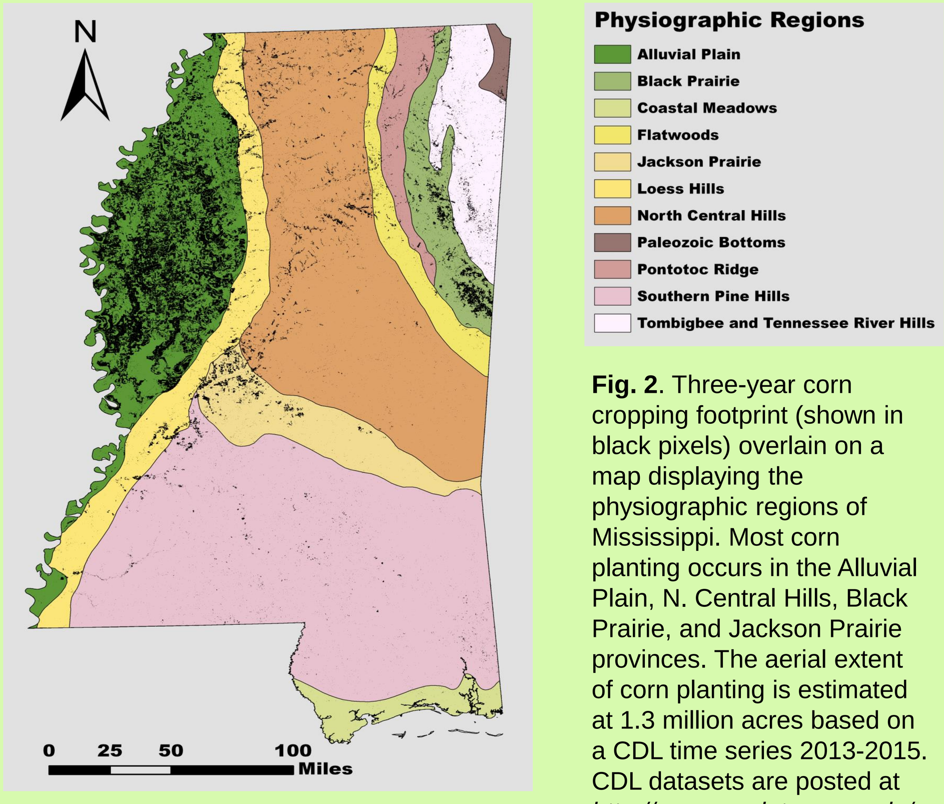

Fig. 2. Three-year corn cropping footprint (shown in black pixels) overlain on a map displaying the physiographic regions of Mississippi. Most corn planting occurs in the Alluvial Plain, N. Central Hills, Black Prairie, and Jackson Prairie provinces. The aerial extent of corn planting is estimated at 1.3 million acres based on a CDL time series 2013-2015. CDL datasets are posted at *http://nassgeodata.gmu.edu/CropScape/*

MATERIALS and METHODS A 3-year corn cropping footprint was constructed from the 2013-2015 CDL time series (as posted on CropScape); a "clump and sieve" model was developed to constrain and partially correct remotely-sensed crop recognition errors while retaining fields as small as 3 acres (DeFauw *et al*. 2012). One set of planting date probability maps was derived from 30-year climate data ("moving window" by target year) using 60 stations within the state and 270 surrounding stations. PRISM (Parameter-elevation Relationships on Independent Slopes Model) climate data were used to construct the other map set. Day of the year (DOY) for the last time the temperature was at or below a specified threshold between January and July were compiled from the 30-year dataset at each station or PRISM-grid unit. An inverse probability distribution was used to calculate the dates for a specific risk level.

RESULTS Federal incentives of 2007 caused a spike in acreage dedicated to corn in Mississippi (Fig. 1). Corn production has recently expanded to occupy close to 60% of Mississippi's harvested land base. Over half of the counties in the Delta have invested between 60-85% of their arable land in corn across the 3-year study interval (Fig. 2). Risk probability maps (at the 10% risk level) generated from National Weather Service (NWS) station-derived data maps indicate 2-3 week delays in corn planting dates for two areas in the southern half of Mississippi (Fig. 3). These NWS-based probability maps also show 7-21d differences in planting date just spanning the Alluvial Plain. PRISM (Parameter-elevation Relationships on Independent Slopes Model) climate data maps highlight notable zonal differences in south Mississippi (Fig. 4). Based on PRISM models, spatial analysis indicates 17% of the statewide acreages could advance planting dates 1-3 weeks at a very low risk of 10% (Fig. 5).

CONCLUDING REMARKS Sustainable intensification hinges on the identification of profitable cropping systems with rotations that result in annual yield optimization to improve financial outcomes for Mississippi farmers. Econometric models suggest higher premiums for early corn harvests (7-21d); these vary from $3.95-$4.00/bu. Detailed comparisons of these decision-support models are underway to evaluate the efficacy of PRISM-based weather grids (at a resolution of 16 km^2) versus traditional weather station point data (N=330) interpolated to produce geospatial maps that, in turn, highlight early planting and early harvest probabilities (based on growing degree days) for corn in Mississippi. Some maps presented here are posted on the MSU-DREC website *http://www.deltaweather.msstate.edu/ag_weather_products/cornplanting.htm*

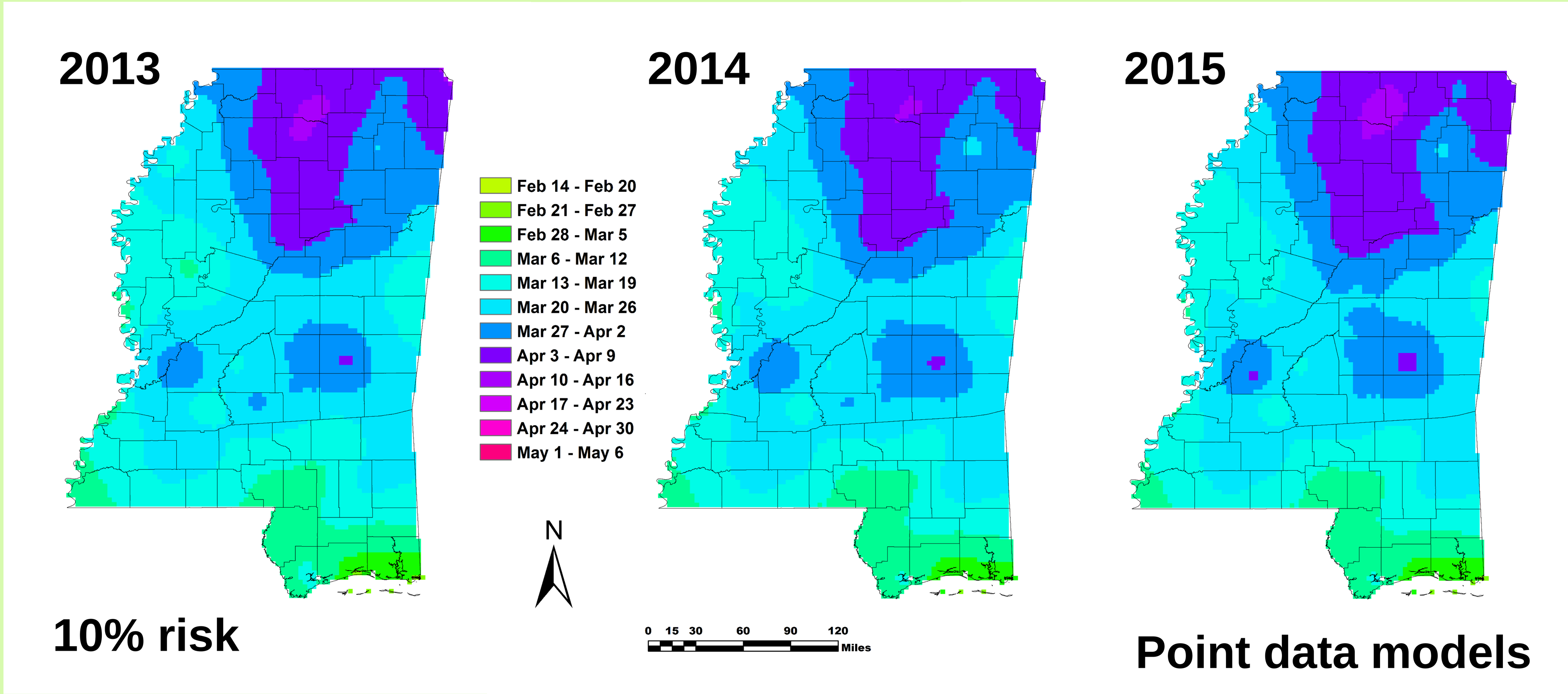

Fig. 3. Corn planting date probability maps derived from National Weather Service (NWS) weather stations. Color gradients are linked to 7-day planting date intervals that display areas with a 10% risk of temperatures falling below a critical threshold of 28^{o}F. Day of the year (DOY) data, for the last time the temperature was at or below specified threshold between January and July, were compiled from each weather station over a 30-year interval (e.g., the 2013 map is based on 1983-2012). These risk maps were generated using interpolated point data from 60 stations within the state and 270 weather stations surrounding the state (LA, AR, TN and AL).

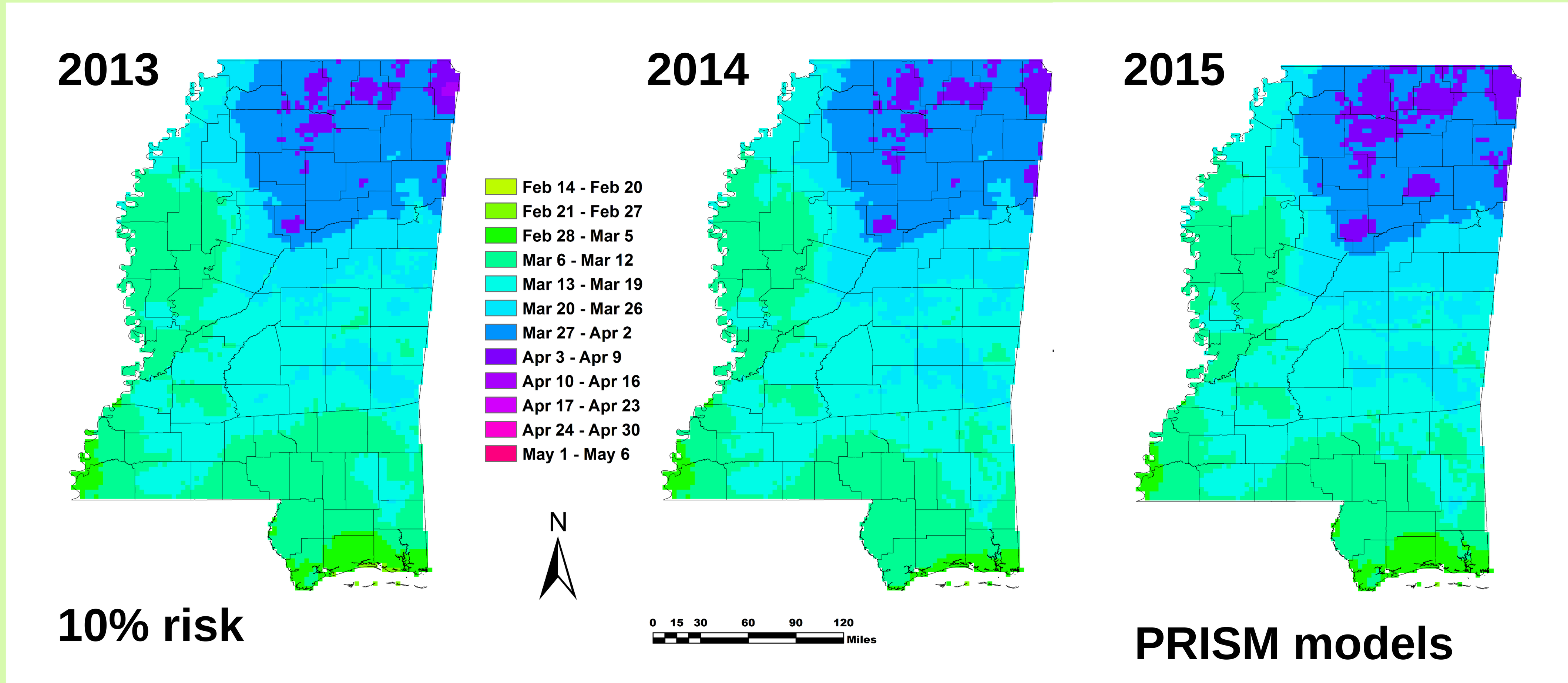

Fig. 4. Corn planting date probability maps derived from PRISM climate datasets. Color gradients are linked to 7-day planting date intervals that display areas with a 10% risk of temperatures falling below a critical threshold of 28^{o}F. The datasets extracted using PRISM grids span 30 years prior to the date on each risk map. These PRISM grids are much coarser with different algorithms modeling slope, topography and land use applied; each grid cell covers 16 km^2 (4 km x 4 km). Comparing PRISM climate data-derived risk maps with point-derived interpolated maps from 330 weather stations shows notable zonal differences in key corn-producing counties including Washington, Yazoo, Leflore and Warren counties.

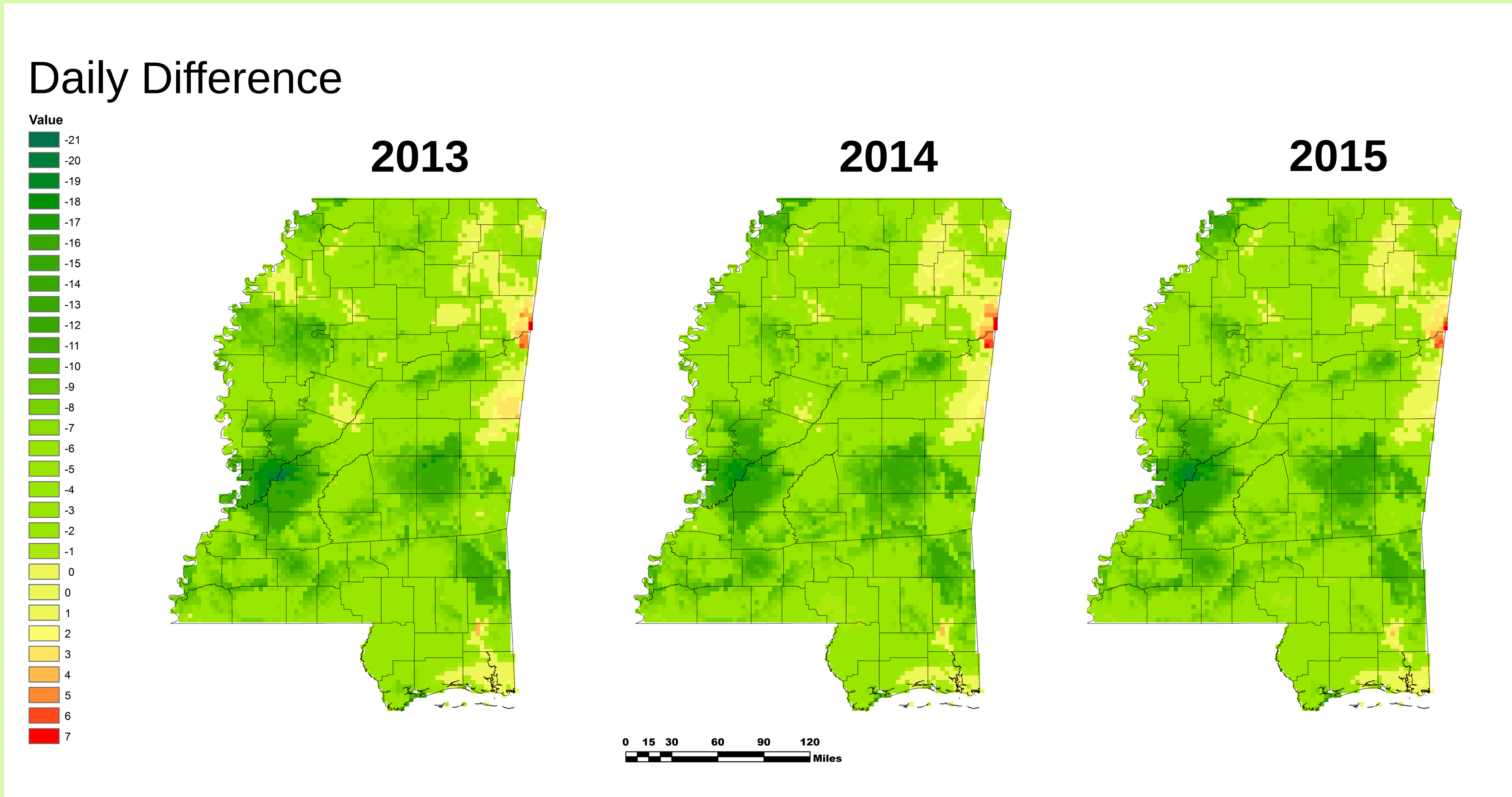

Fig. 5. Geospatial maps highlighting differences in the number of days between NWS weather station-derived corn planting dates and PRISM-derived probability maps. Based on PRISM data models, spatial analysis indicates 17% of the statewide acreages could advance planting dates 1-3 weeks at a very low risk of 10%.

REFERENCES
Cropland Data Layer (CDL) datasets are posted at *http://nassgeodata.gmu.edu/CropScape/*
DeFauw SL, RP Larkin, PJ English, JM Halloran and AK Hoshide. 2012. Geospatial evaluations of potato production systems in Maine. *Am J Potato Res* DOI: 10.1007/s12230-012-9271-2 (6 October 2012).
PRISM Climate Group, Oregon State University, *http://prism.oregonstate.edu* (2013 data created 1 July 2014, 2014 data created 1 July 2015, 2015 data created 1 July 2016)