

ArboMAP: Arbovirus Modeling and Prediction to Forecast Mosquito-Borne Disease Outbreaks

Summary of Model Outputs (v2.1)

Justin K. Davis and Michael C. Wimberly

(justinkdavis@ou.edu, mcwimberly@ou.edu)

Geography and Environmental Sustainability, University of Oklahoma

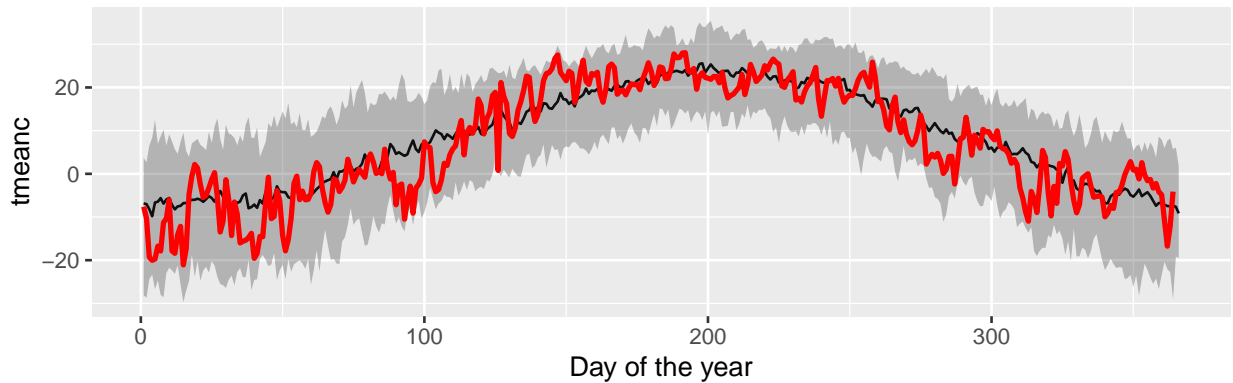
Updated November 08, 2019

Data used for predictions

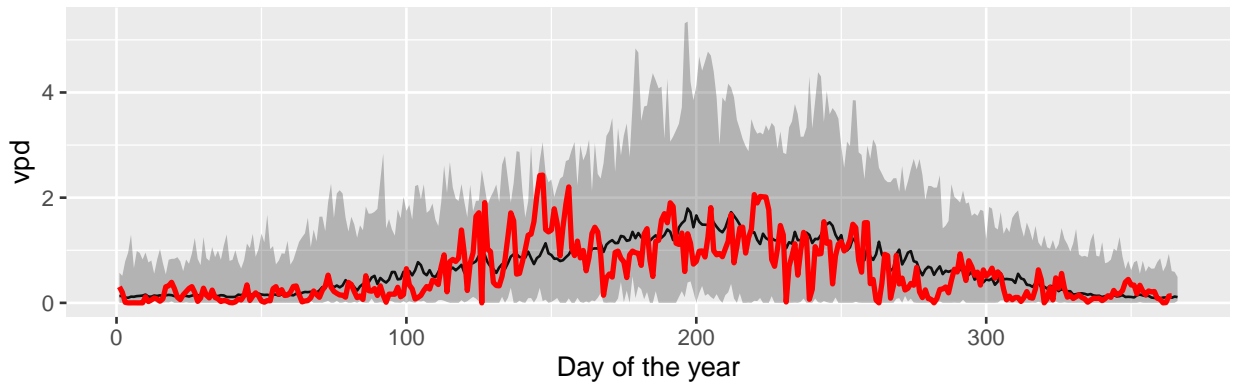
Weather data

Weather data from the gridMET data set range from 2000-01-01 to 2018-12-30. Below are graphs of statewide daily averages of tmeanc and vpd. Observations for the current year are in red. Black is the medium from all other years, and the grey band indicates the max/min ever observed. If these data were anomalized, then above (below) zero means higher (lower) than average for that day of the year. Otherwise, data are on their original scales.

tmeanc 2018

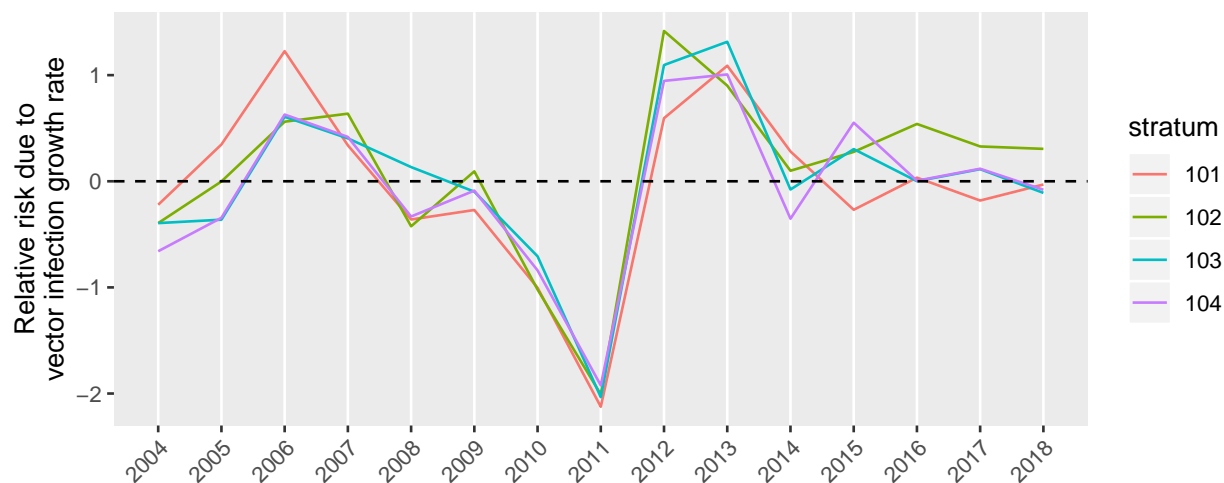


vpd 2018

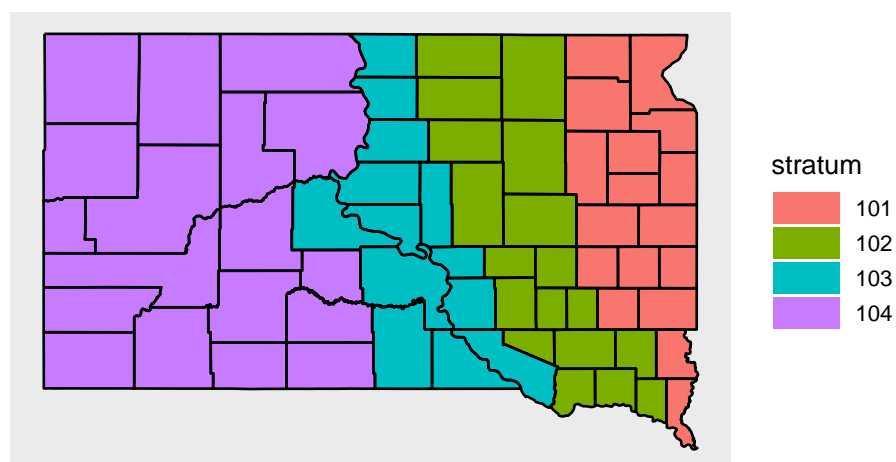


Vector infection data

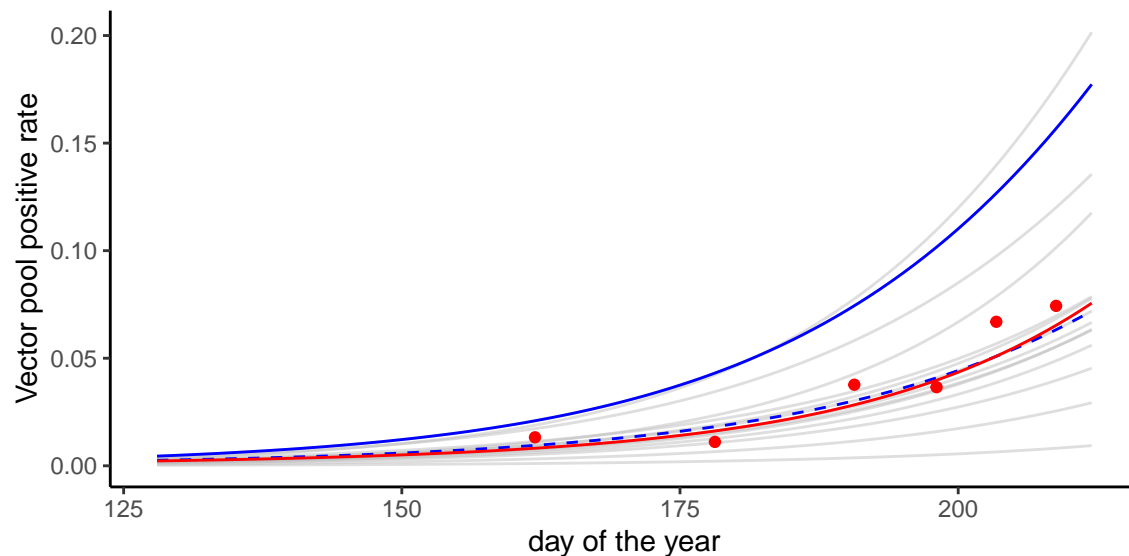
There are 16274 samples in the vector testing database. For 2018, there are 1697 tested samples, with 66 (3.9%) positive. The estimated risk of human infection due to the early-season vector infection growth rate is shown below. Higher means that the pathogen is spreading more rapidly among vectors, and more human cases should be expected. The regions used for stratification are mapped below; districts are thought to share risk more closely with others in the same strata, although all districts share some level of risk with all other districts.



State stratification map



The following graph shows the estimated growth of positive samples for every year (grey), with 2012 (blue) and 2017 (blue, dashed) selected for comparison, and estimates and observations for 2018 (red). The lines are modeled sample positive rates; the actual statewide positive sample rate for 2018 is shown here by grouping observations nearby in time.



Human data

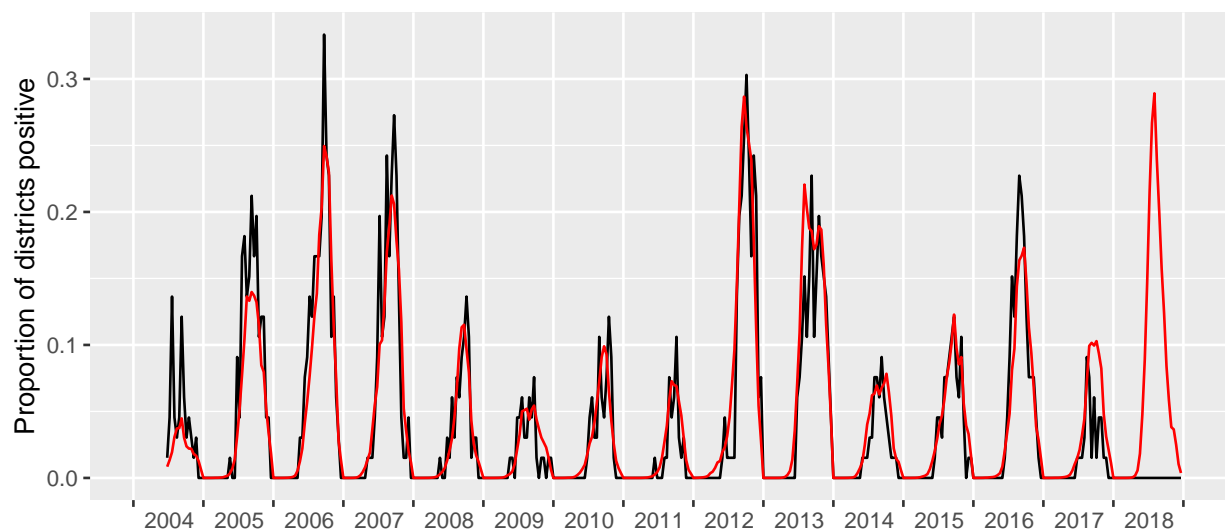
The predictive model of human cases was calibrated using 1298 historical cases, not including any cases from 2018. No cases from 2018 are used to make predictions; the estimates for this year are based solely on weather and vector data. Typically, 92% of a year's cases occur before the end of this week in any given year.

Model results

Statewide trends

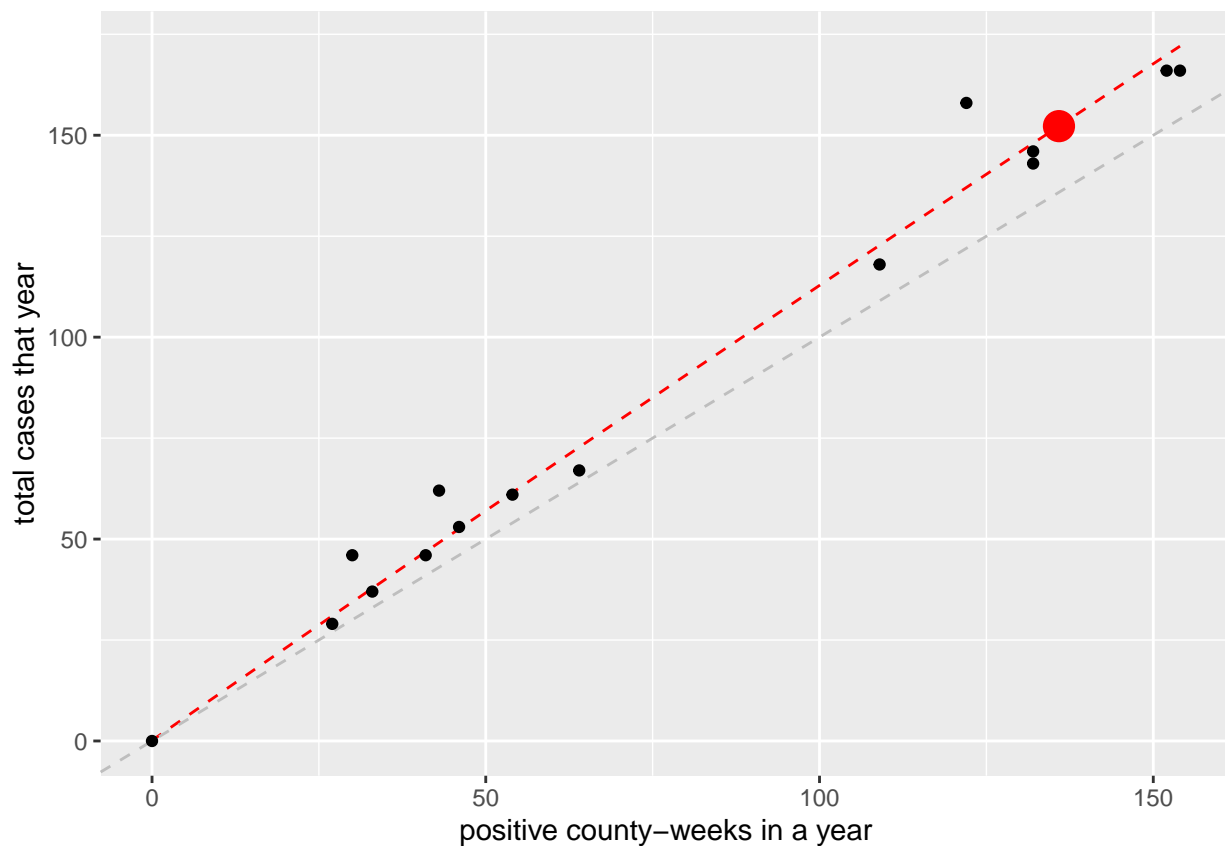
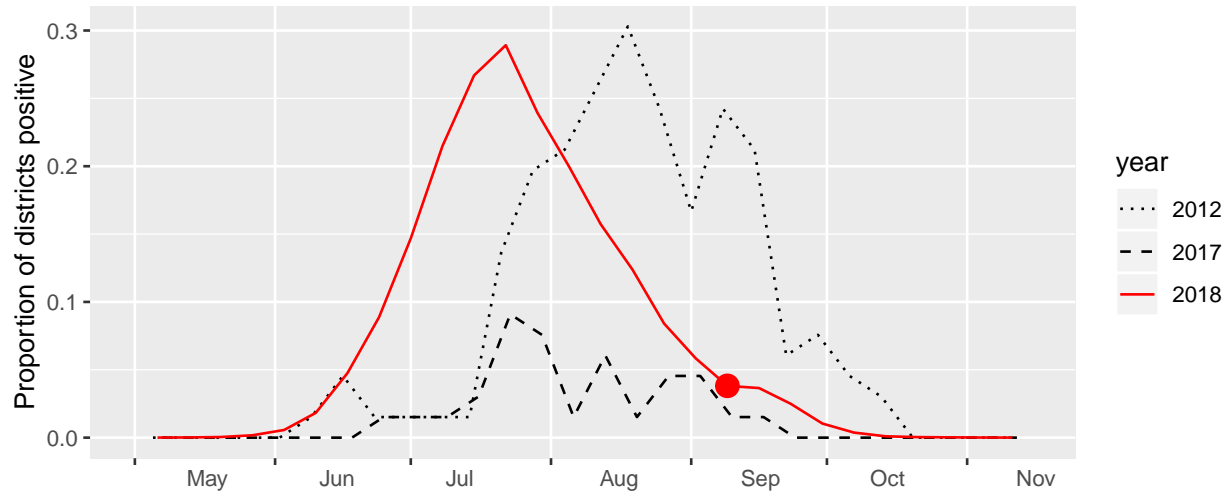
The graphs below show observed statewide risk (black) and estimated risk (red) up to Sunday 2018-12-30. Observed risk should be completely zero during the last year - these data are not used in the model, and will only be updated once final human case data are received at the end of the year.

Statewide model predictions



Predictions for 2018 are compared to observations in 2012 and 2017. We expect 2.5 districts to have at least one human case between Sunday 2018-09-09 and Saturday 2018-09-15.

Estimates for 2018 compared to observations in 2012 and 2017
with week beginning 2018-09-09 highlighted



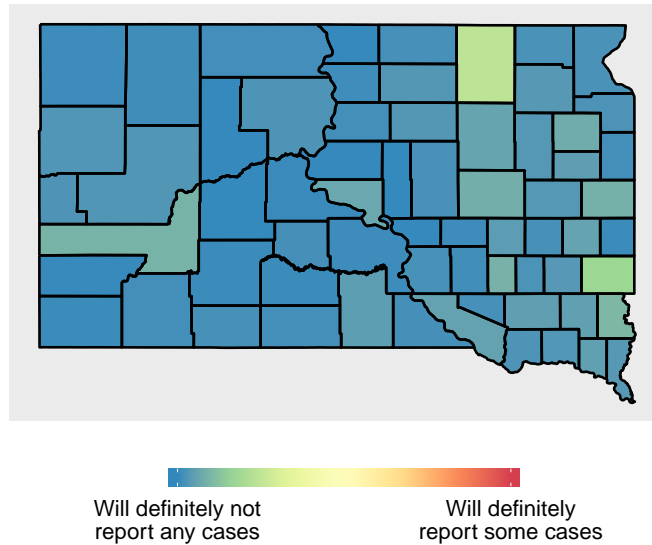
We expect that there will be 135.9 positive district-weeks this year. Since ArboMAP models positive district-weeks rather than total cases, we can only make a rough estimate based on the relationship of cases to district-weeks. If historical patterns hold (dashed red line), we expect there to be 152.3 cases this year (red

dot). The grey line indicates the case count if there were only one case per positive district-week. Especially in the height of the season, some districts that have one case that week will have more than one case.

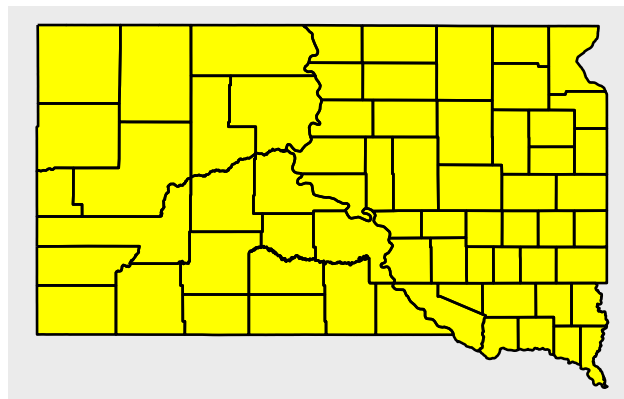
Results for 2018-09-09 to 09-15

We visualize the raw estimated risk for 2018-09-15 below. If a district is darkest blue, then we estimate that there should be no human cases reported for this district, during this week. If a district is brightest red, we are certain that there will be at least one human case reported for this district, during this week.

Estimate for week beginning 2018-09-09



This map indicates whether probabilities reported in the previous map are higher (red) than average, lower (blue) than average, or right about normal (yellow) compared to the same week in previous years.

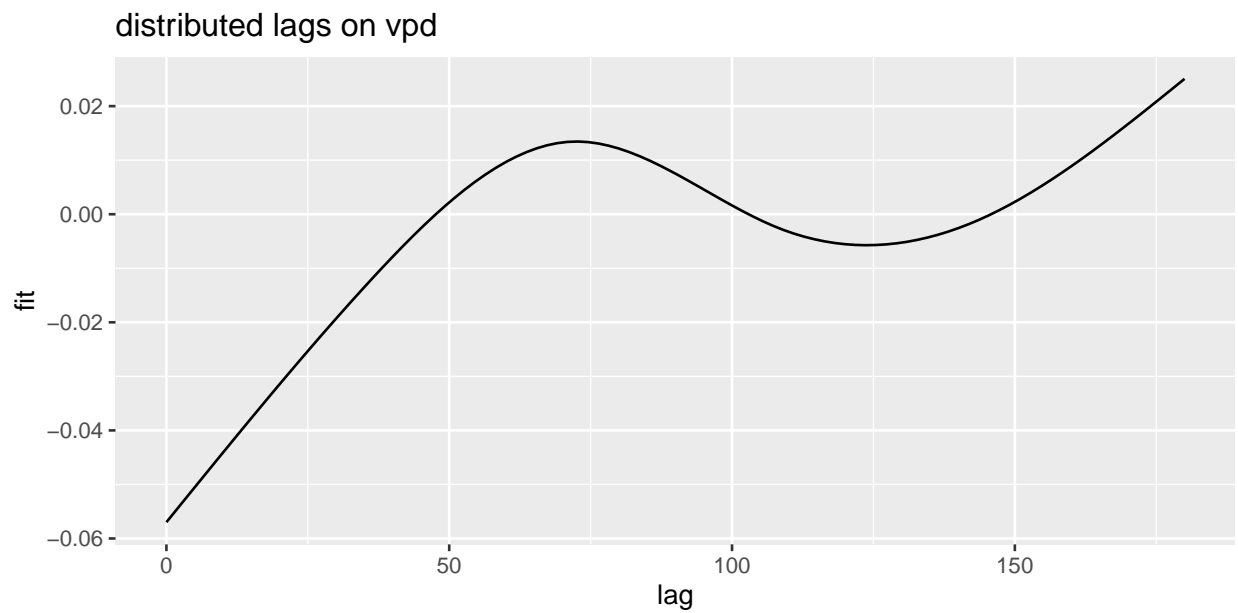
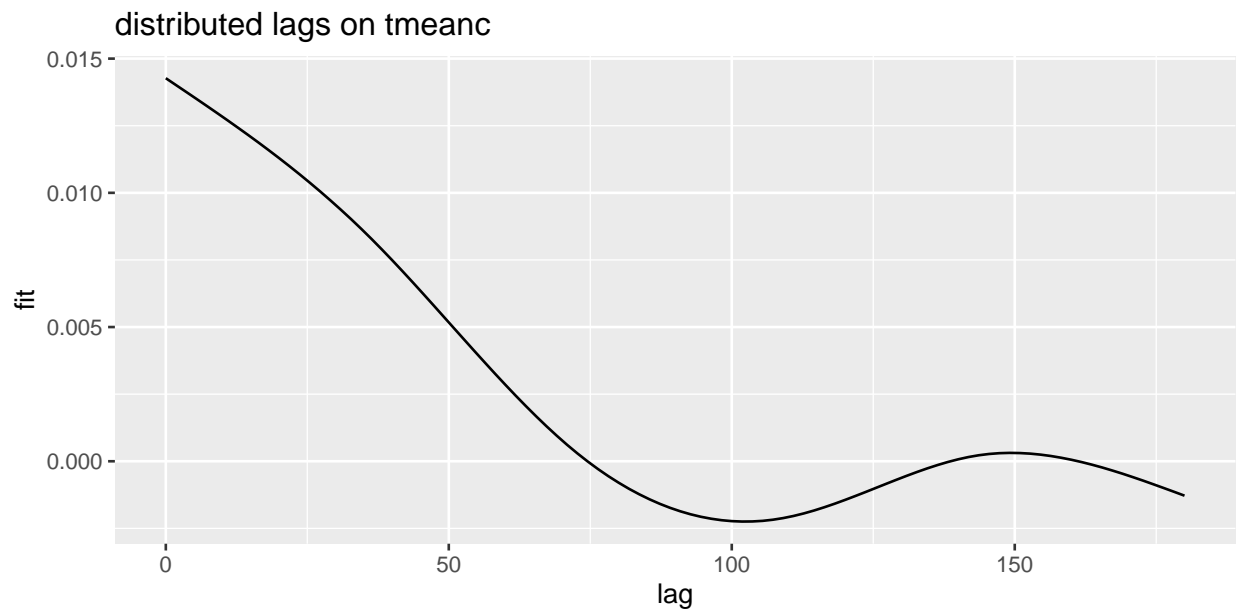


Risk for 2018-09-09 to 09-15

About average

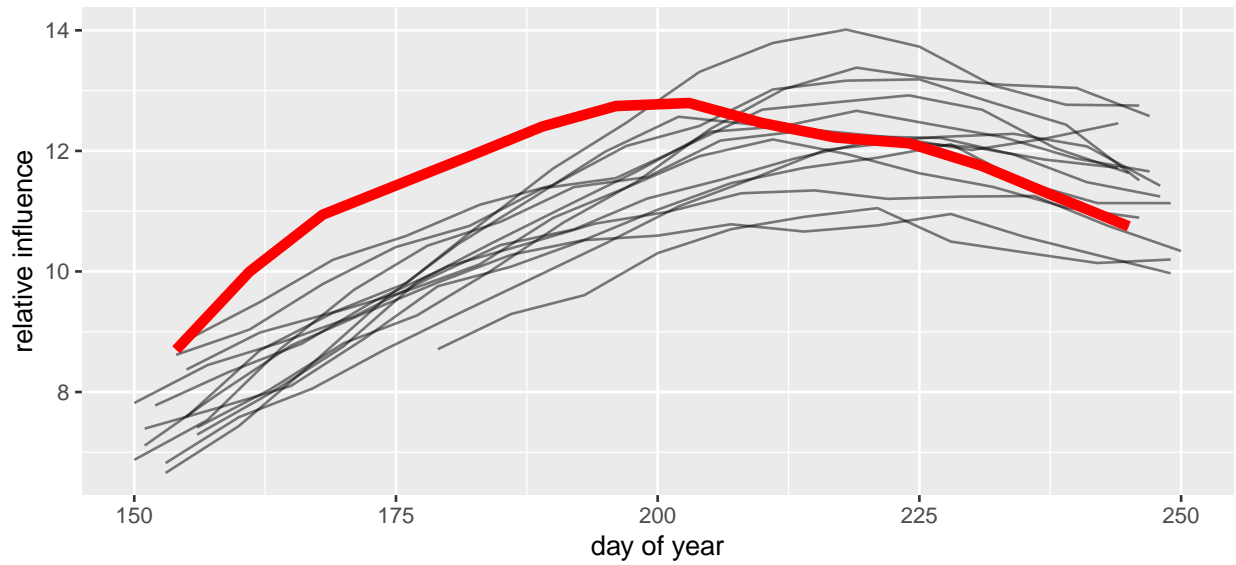
Dependence on environmental data.

Below, we visualize the distributed lags on environmental data. If a line is above (below) zero at some lag, this means risk today depends positively (negatively) on the environmental data at that date in the past.

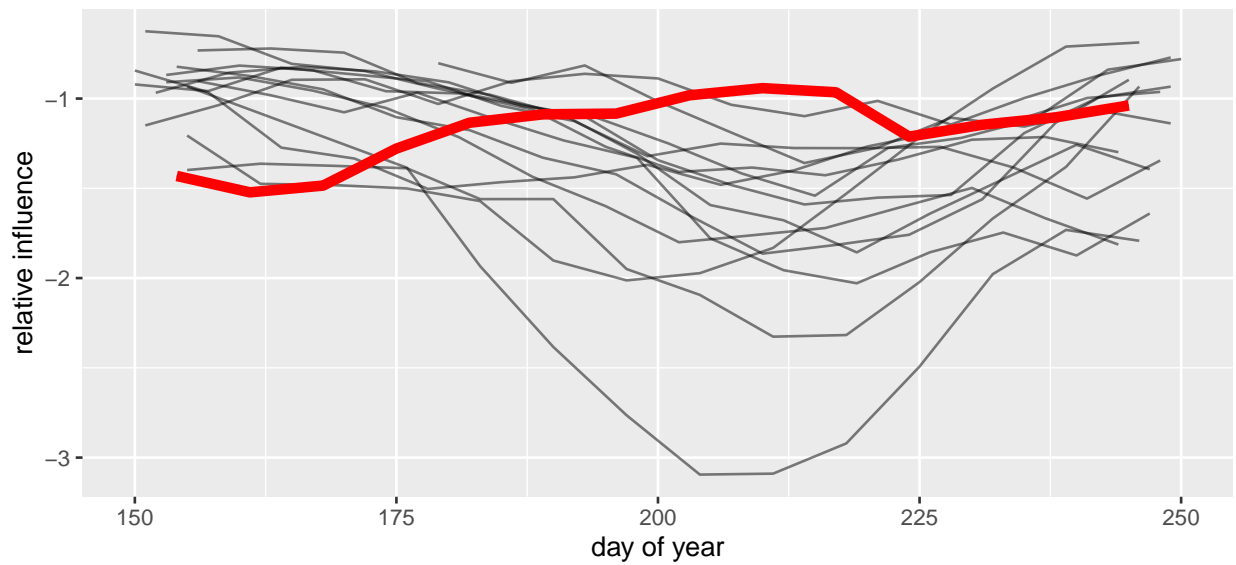


The following two graphs show the influences of the two environmental covariates on estimated risk. The current year (red) is compared to all others (black). If the line is higher, this indicates the variable in the past has a positive influence on risk estimated for that date.

Relative influence of tmeanc



Relative influence of vpd



Diagnostics

Model summary

The model achieved an AUC (or c-stat) of 0.94 when tested on all available human case data. When restricted to the months with at least one human case, the model achieved an AUC of 0.88. The p-value in a Hosmer-Lemeshow goodness of fit test was 0.0198 on the full set and 2×10^{-4} on the restricted set. The model achieved an AIC of 6680.69 when calculated on the full set.

District names

It is possible that district names in the human, mosquito, or weather data might disagree with the names found in the district shapefile. We have chosen the shapefile to unify all of the various data sources, so the human, mosquito, and weather data files should be updated to match these. Typically, check the TIGER shapefiles or census for standardized names.

There are 66 districts in the shapefile. This is the maximum number of districts ArboMAP will recognize in the human, mosquito, or weather data.

There are 67 districts in the human WNV data. If some districts never reported cases, this number may be less than the number of districts in the shapefile. If there are more, there are likely misspellings in the human data file. Human districts not found in the district shapefile: greg0ry.

There are 29 districts in the mosquito WNV data. If some districts never reported mosquito data, this number may be less than the number of districts in the shapefile. Mosquito districts not found in the district shapefile: none.

There are 66 districts in the mosquito WNV data. If these data were downloaded with the GEE app, they should match the shapefile districts exactly. Weather districts not found in the district shapefile: none.