The Effect of Extreme Weather and Climate Anomalies on U.S. Wheat Production

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AARES
AUSTRALIAN AGRICULTURAL & RESOURCE ECONOMICS SOCIETY

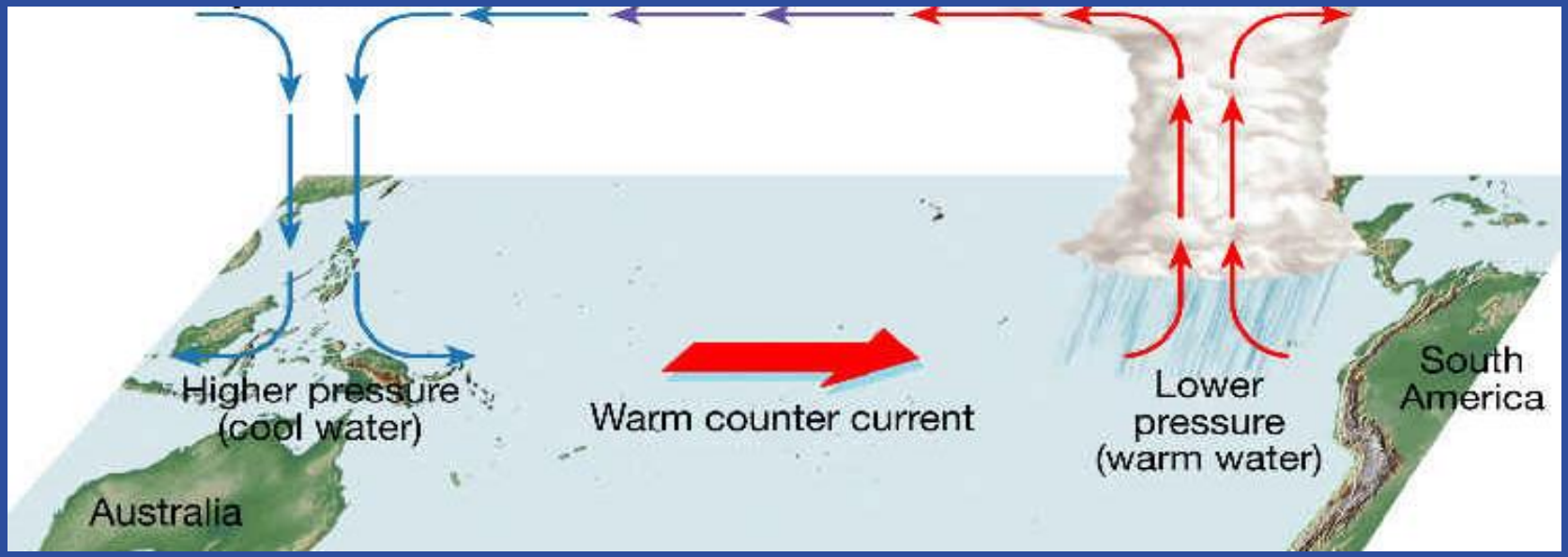
Source: https://trevorheinrich.files.wordpress.com/2012/02/wheat-field-at-the-sunset.jpg

Overview

- Establish causal relationship between US wheat yields and ENSO phenomenon.
- Inferable regression results for geographically diverse and precise (county level) sets of yield distributions.
- Isolate ENSO effect through use of precise weather control variables
- Identify differences in crop yield/loss distributions between alternate stages of ENSO
- Apply forecasting to downside yield risk mitigation strategies

ENSO Climate Phenomenon

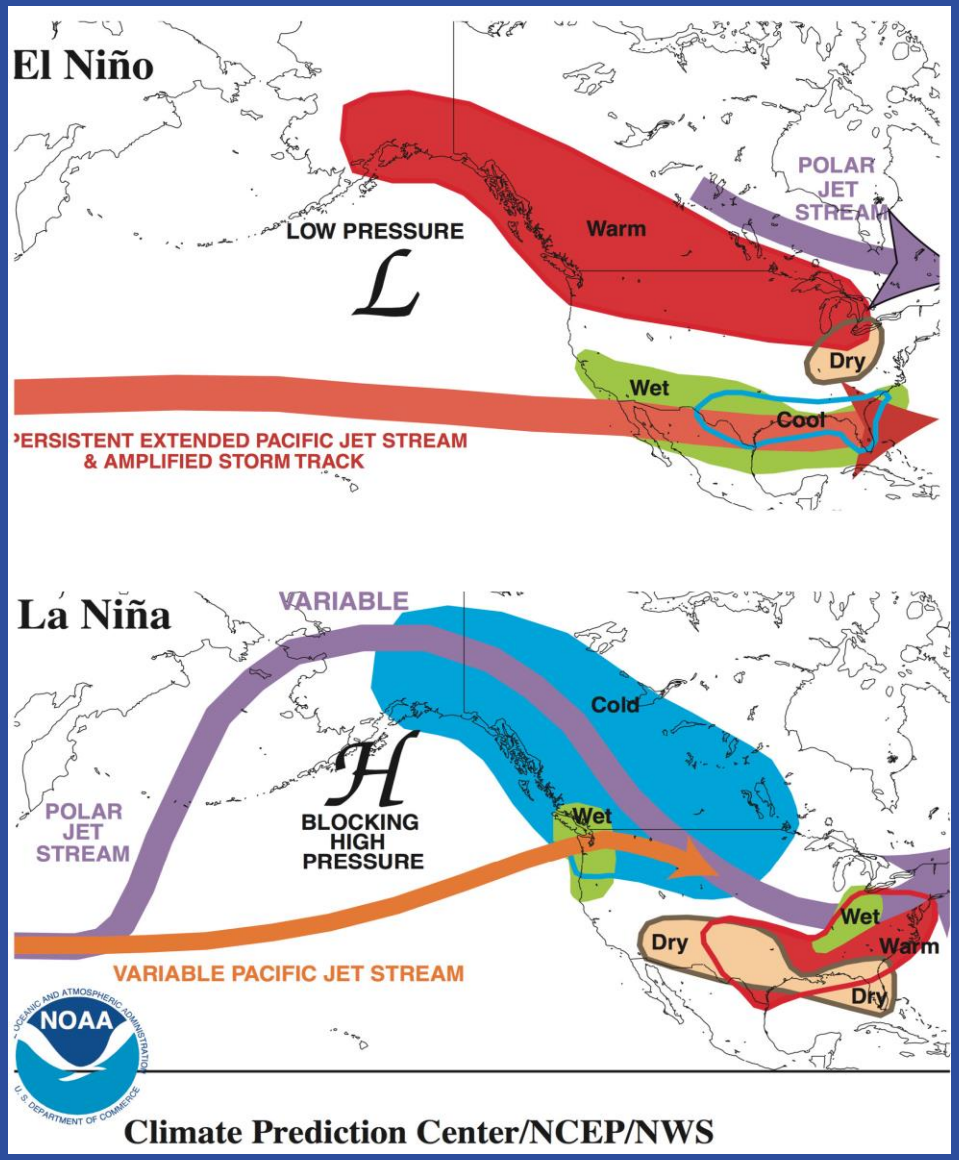
- 1891 – El Nino first defined in Peruvian press
- Noticed by fishermen as a warm flowing northern current
- ENSO changes result from weaker/stronger trade winds pushing warm sea temperatures West towards tropical Australia or Eastwards to South America
- Commonly defined as a 3 phase system
  - El Nino, La Nina, Neutral Phase



http://www.geography.hunter.cuny.edu/~tbw/wc.notes/7.circ.atm/s.oscillation/s_oscill_el_nino.htm

ENSO Climate Phenomenon

- ENSO's influence an aggregate of Oceanic and Atmospheric changes
- Atmospheric changes are the inception of the wide spatial influence of ENSO
  - Varying effects worldwide, depending on phase
- ENSO derived climate changes influence various agronomic choices
  - planting date
  - crop type
  - soil type
- Data utilized via Sea Surface Temperatures (SST) off the coast of Peru



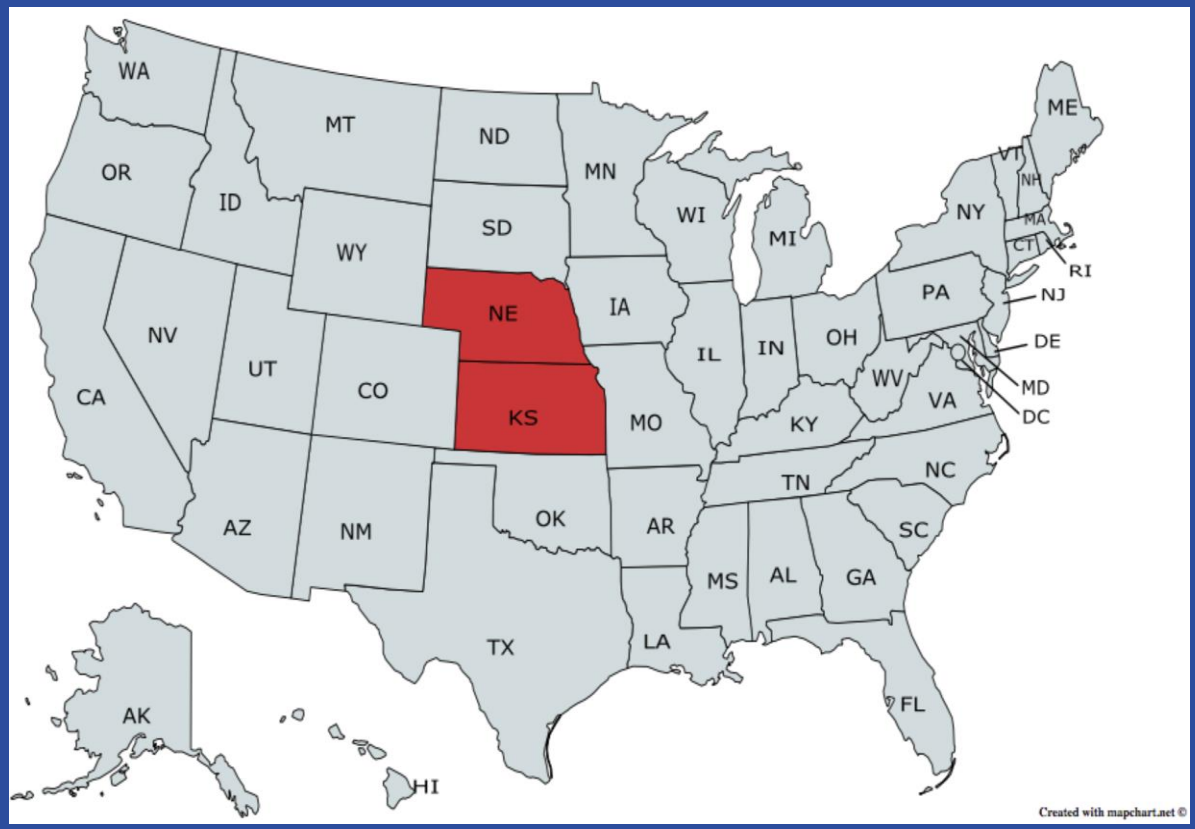
Data

- ENSO (NWS-CPC)
  - Nino 3.4 SST anomaly
  - Location: ***East Central Tropical Pacific*** (5N-5S)(170-120W)
- Winter Wheat Yield USA (USDA-NASS)
  - Annual county level yield
- Weather Data
  - Rich monthly weather data aggregated via growing season (State level specification)
  - provided by Dr. Wolfarm Schlenker (Columbia University)
- Historical Wheat Price (USDA-NASS)

Methodology

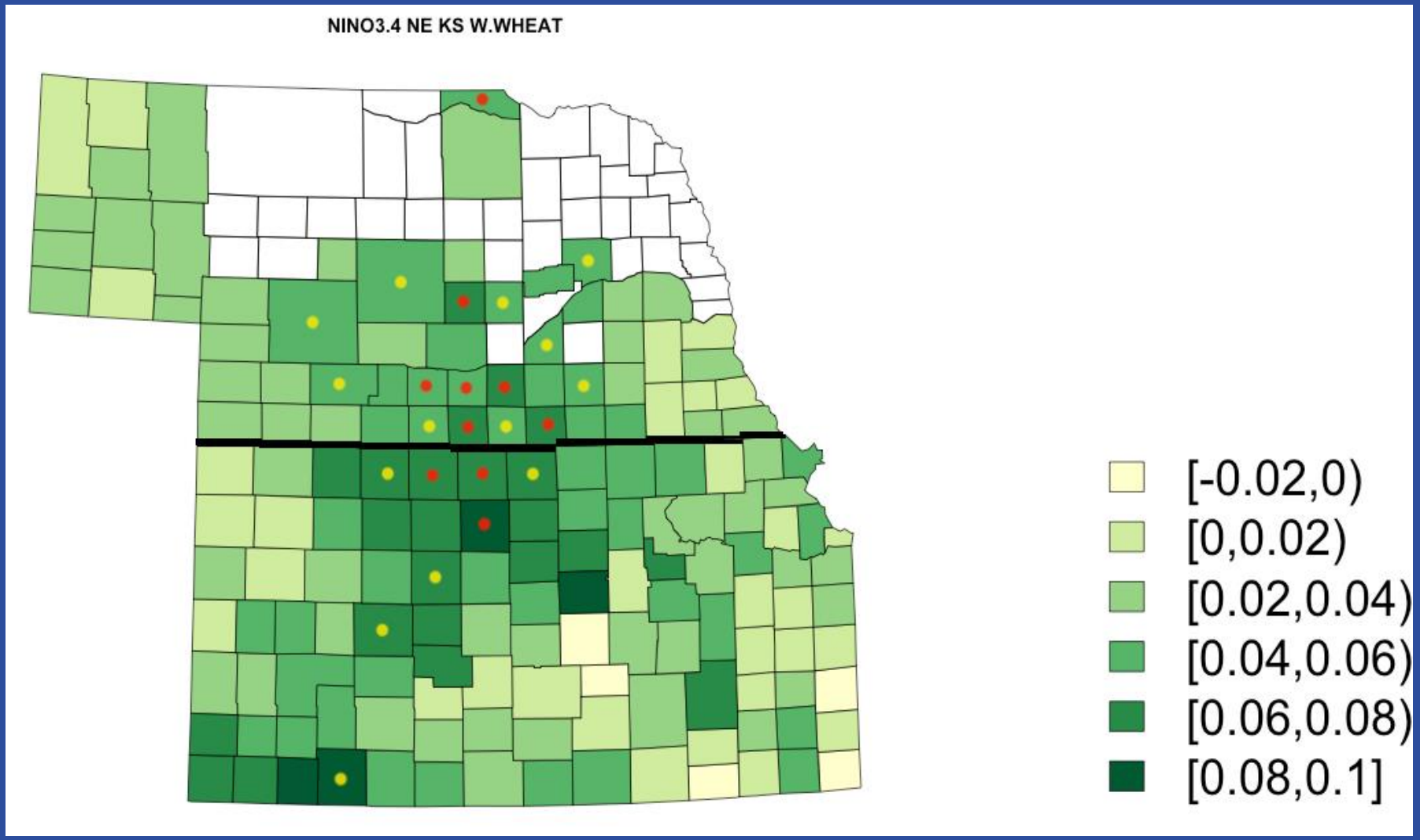
- Isolate unique ENSO influence by controlling for weather variables

  (Aggregated annually per State growing season)
  - precipitation
  - temperature through 2 tier threshold designation
  - expected price
- General form regression



$$lnY_{c_t} = \beta_0 + \beta_1 x_{pt} + \beta_2 x_{pt}^2 + \beta_3 ENSO_t + \beta_4 T1_t + \beta_5 T2_t + \beta_6 lnP_{t-1} + \varepsilon_t$$

Baseline Regression
Results Winter Wheat Nino3.4 Impact



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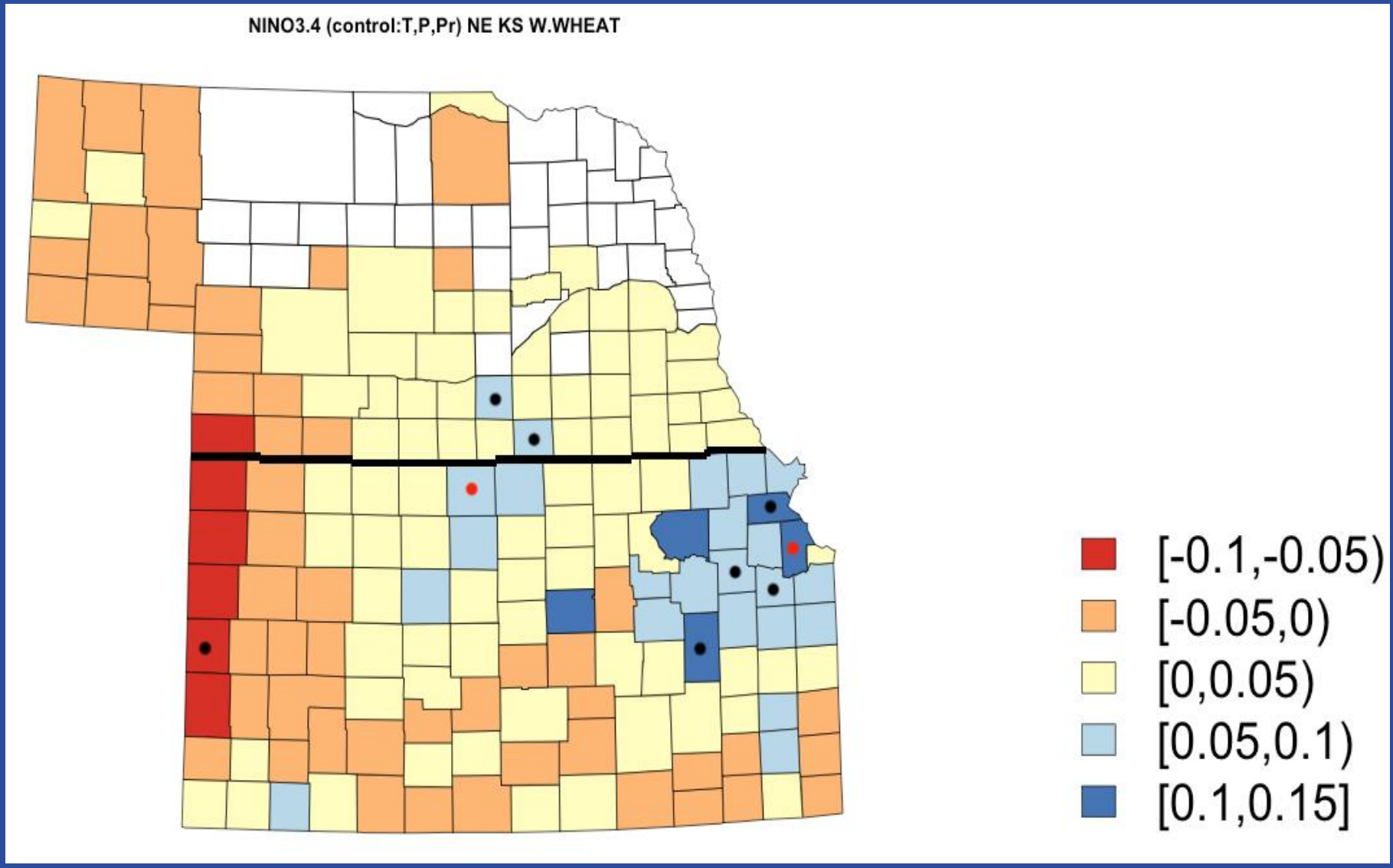


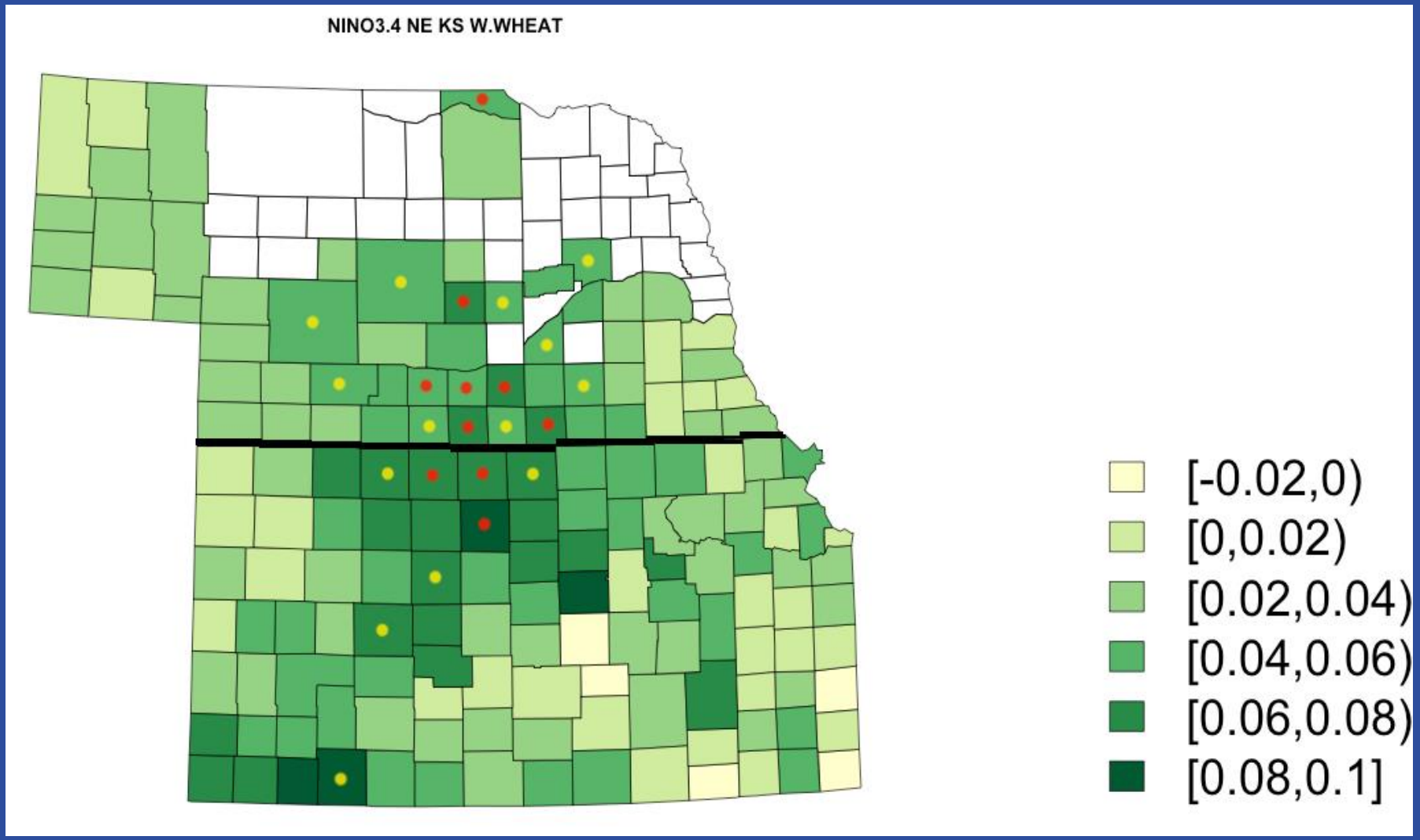
Discussion

- 6.13% of available counties in NE and KS displayed significant ENSO influence, while 1.2% in the controlled model – at the 5% Level
  - 10% Level: 14.7% and 6.13% of counties, respectively
- Positive effect (%) on yield with unit rise in NINO3.4 anomaly
  - Per unit change in ENSO proxy ranges from 4.5% to 9.3% change in yield (for significant counties)
- ENSO captures temperature and precipitation impact on yields

Discussion

- Evidence of clustering with regard to ENSO influence
- Clustering of significant effects suggests dominance of
  - Temperature and Precipitation
  - unique ENSO influence
- Notable impact of ENSO on yields, controlling for major weather variables

Baseline Regression
Results Winter Wheat Nino3.4 Impact



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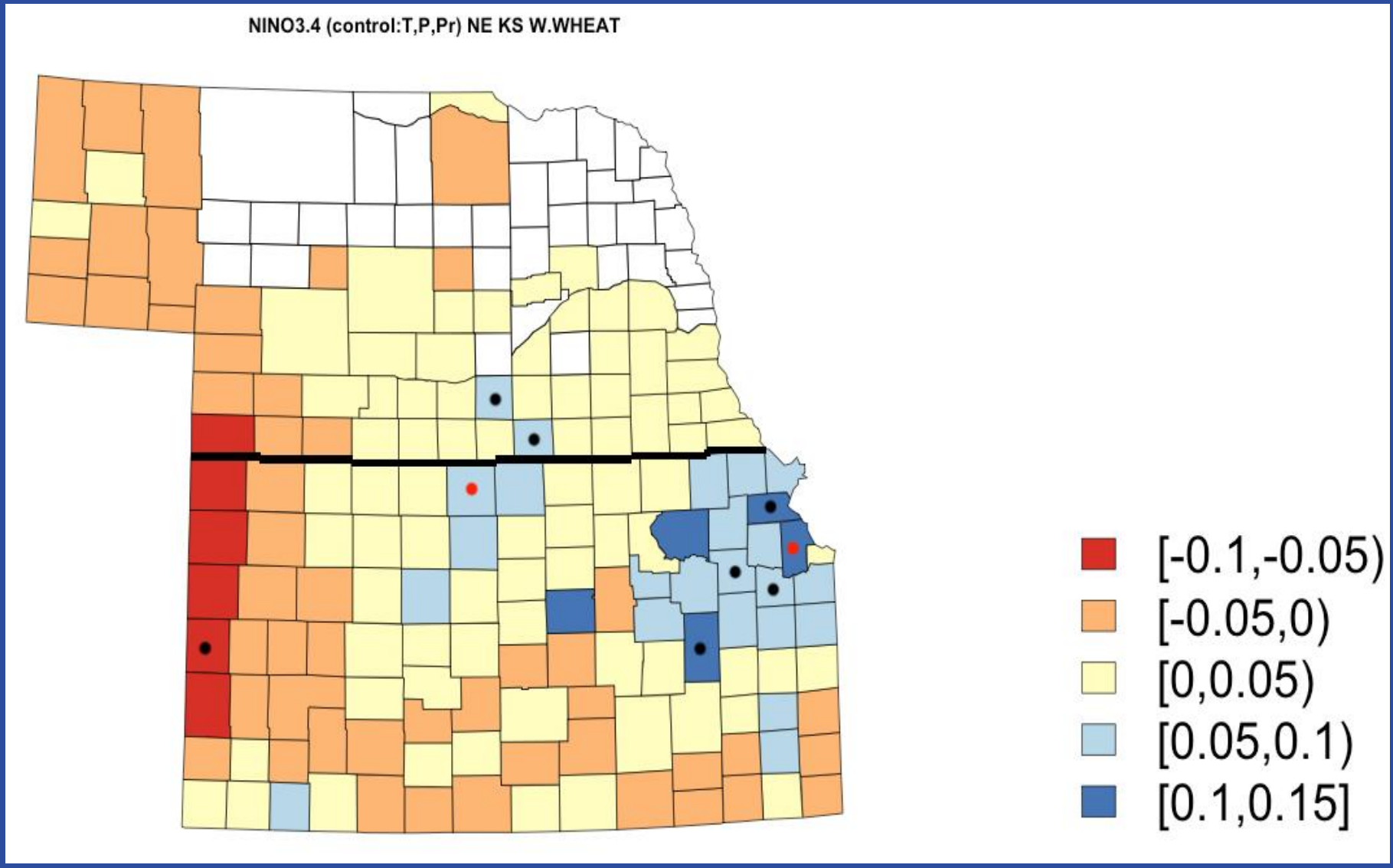

Continued Research

- Utilize ENSO data for improved out of sample prediction of outcome variables
- Improve crop choice and planting date for yield maximization
- Contribution to crop insurance optimization