Crop Predictive Modeling of Changing Precipitation Dynamics in Western Kansas

Isaac Smith[1] (isaacu92@ksu.edu), Xuan Xu[1], Micah Cameron-Harp[2]

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Background

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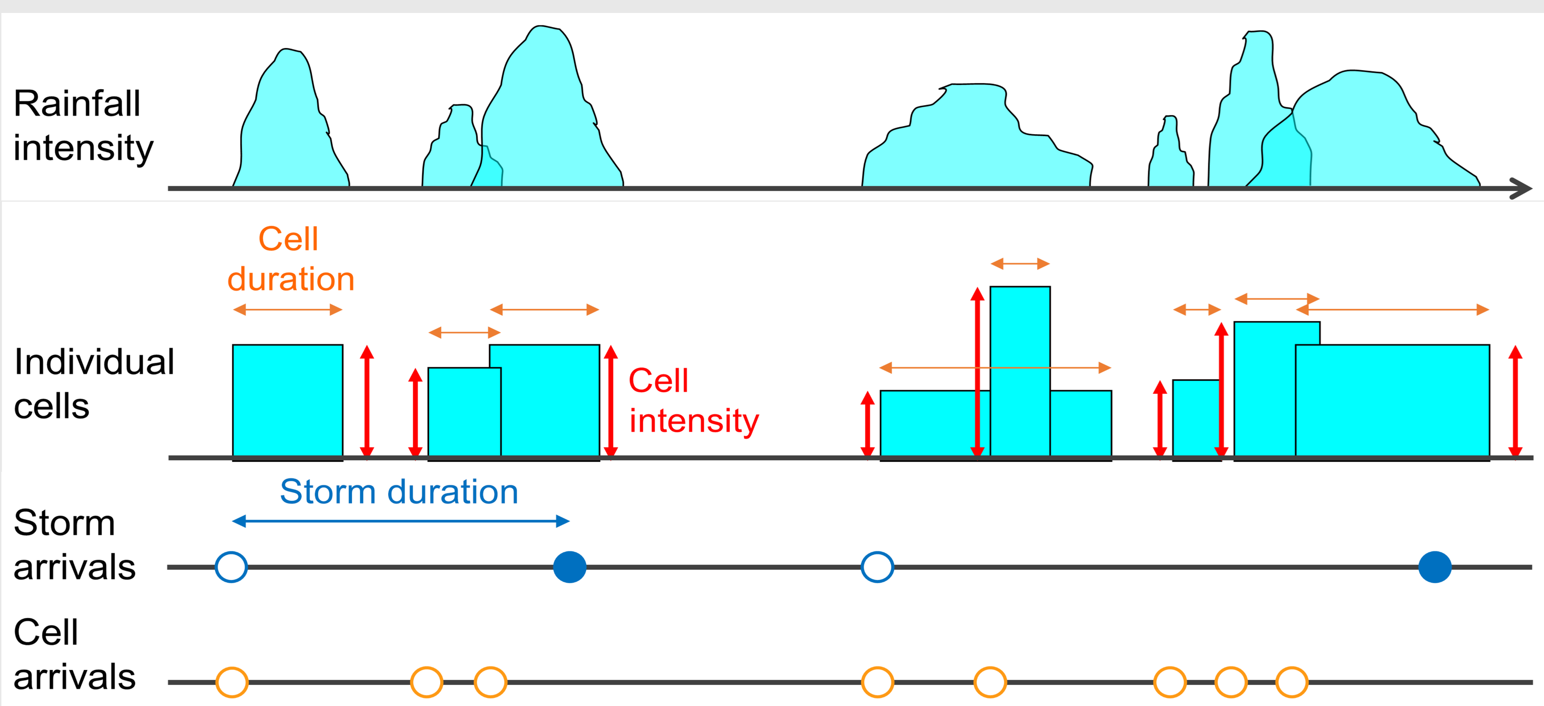

Figure 1) Illustration of the conceptualization of the Bartlett-Lewis Rectangular Pulse model (Onof and Wang 2020).

Methodology

Rainfall Data Input
NLDAS-2 Hourly Precip.

↓

Compute Statistical Properties

↓

Fit BL Model Parameters
{λ, Φ, κ, α, ν}

↓

USDA County-Level Un-Irrigated Crop Yield
Corn, Winter Wheat, Sorghum

→

Statistical / Deep Learning Model
Random Forest, LSTM

↓

Model Evaluation
R^2, MSRE

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Objective

Implemented Bartlett-Lewis Model for Finney County to analyze trends in the generated parameters and model these parameters to predict unirrigated crop yield using sequential learning models such as Random Forest and Long Short-Term Memory (LSTM) networks. Finally, compare the model predictive performance.

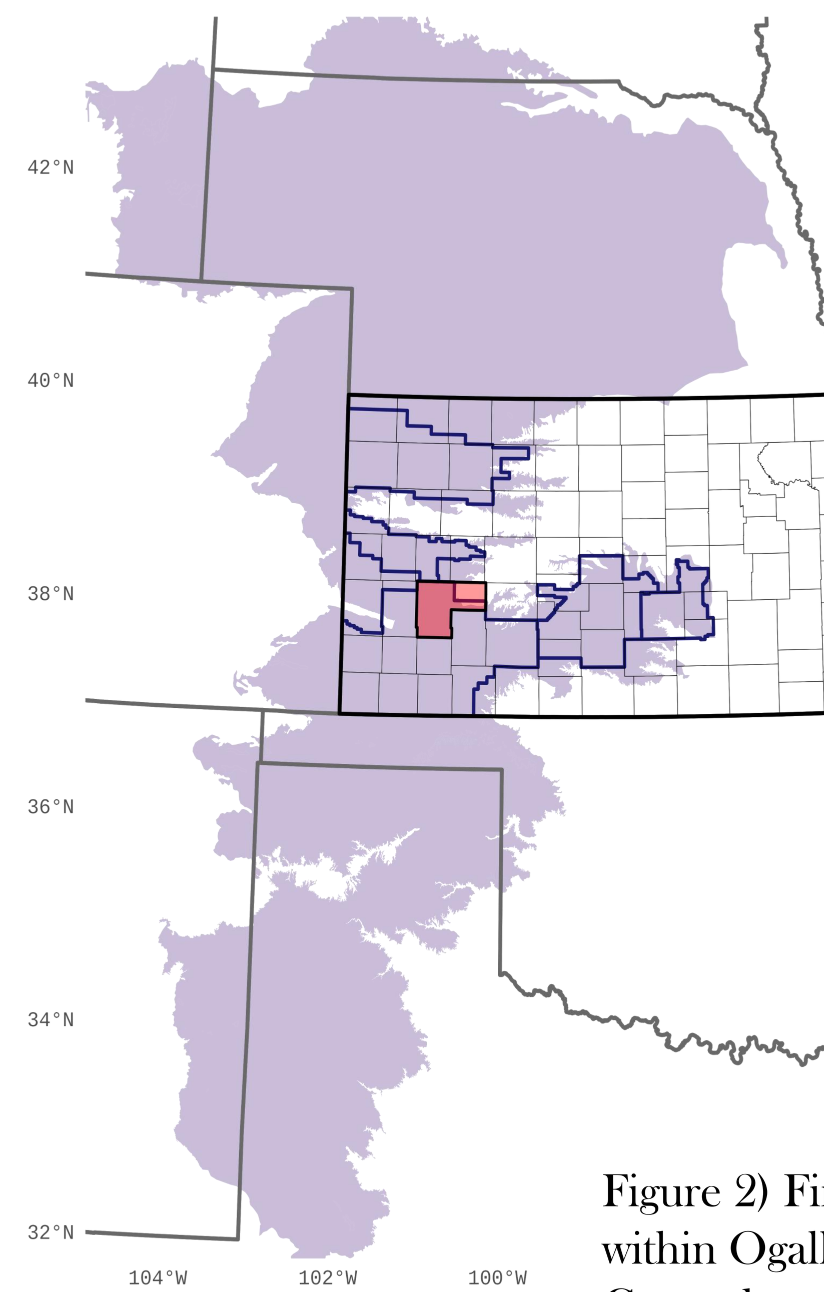

Figure 2) Finney County (red) located within Ogallala Aquifer region and Groundwater Management District 3.

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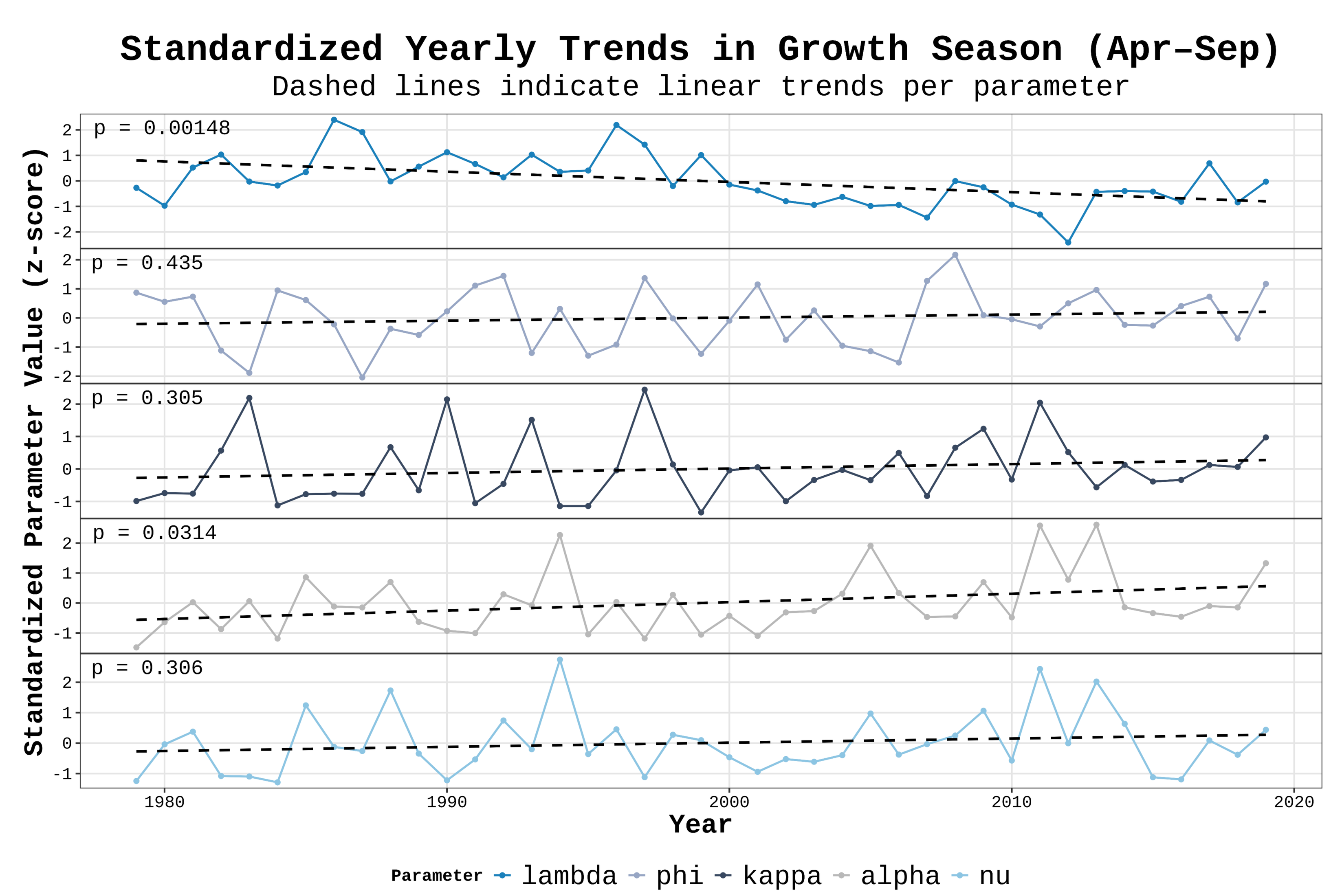
Storm rate significantly decreased (P-value - 0.001) over the 40 span of the study. There was also a significant increase in cell duration (P-value - 0.03). Total precipitation through the 40 years did not see a significant change and remained consistent.



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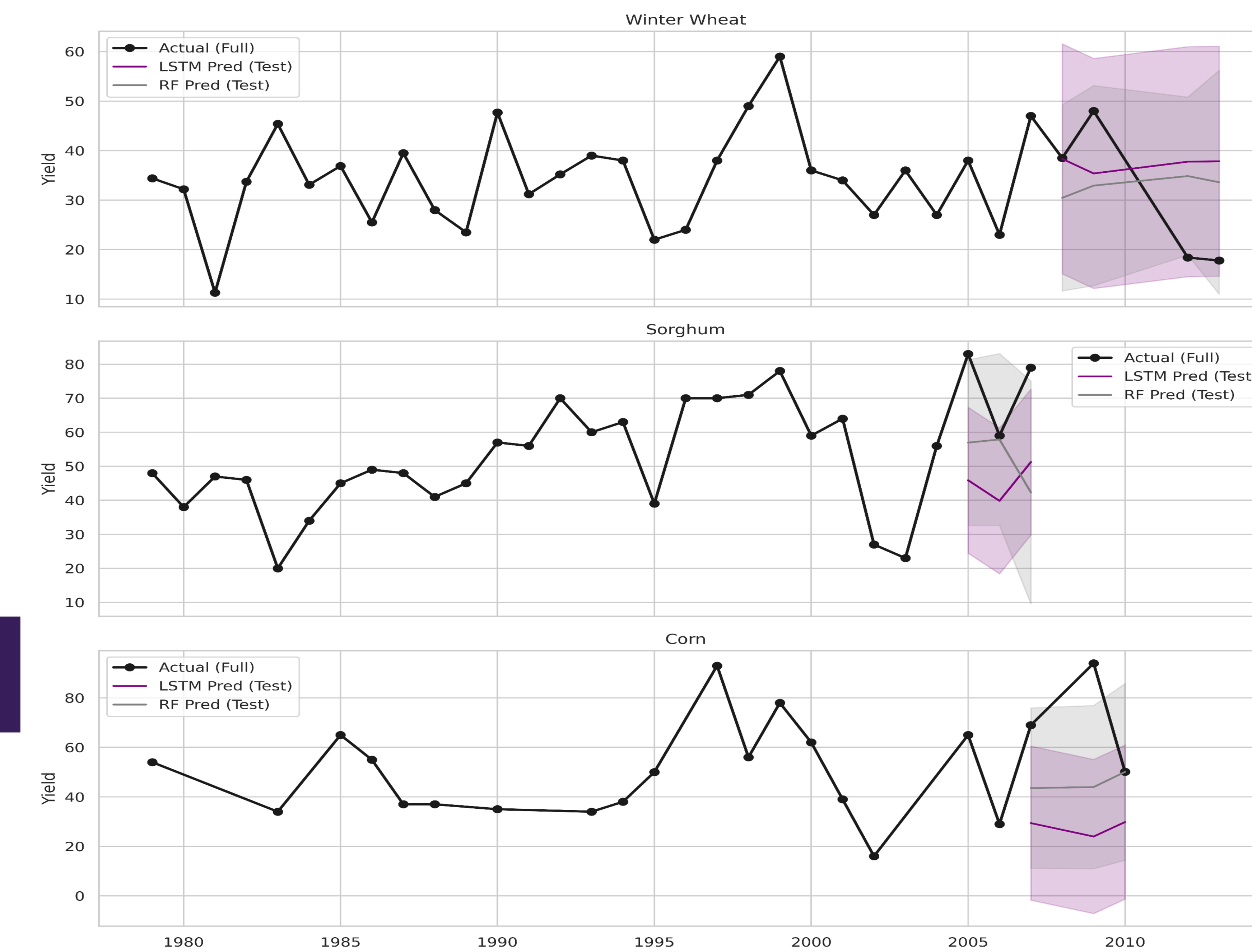
For validation, the last 10% of years were held out for testing. During training, Random Forest outperformed LSTM when modeling all crops together (RMSE = 3.860, R^2 = 0.937 vs. RMSE = 12.335, R^2 = 0.356). Both models showed decreased performance on the test set, with LSTM losing most predictive power. Random Forest maintained a reasonably high predictive performance (RMSE = 9.010, R^2 = 0.521). When modeling crops independently, both models were able to encompass the actual crop yield within their 95% confidence intervals for winter wheat but struggled with sorghum and corn.



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Finding

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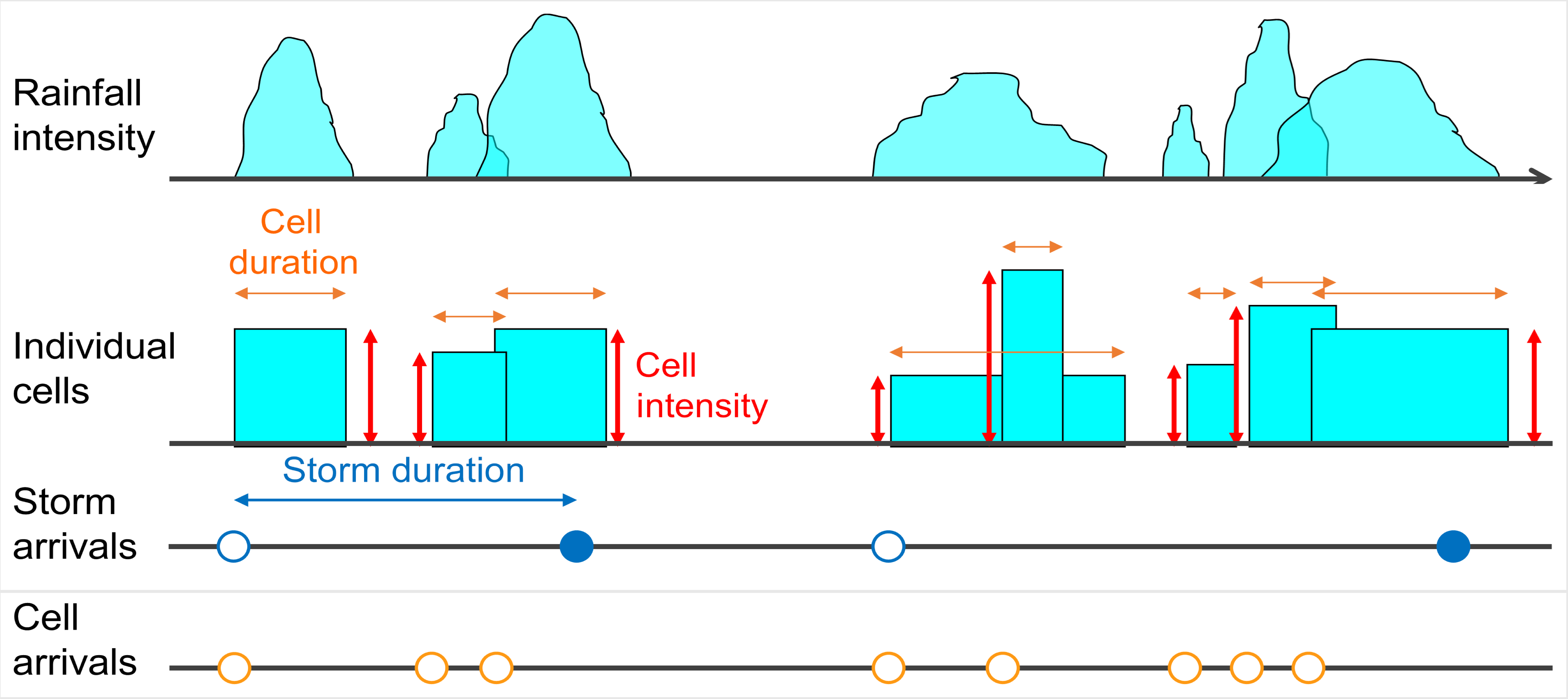

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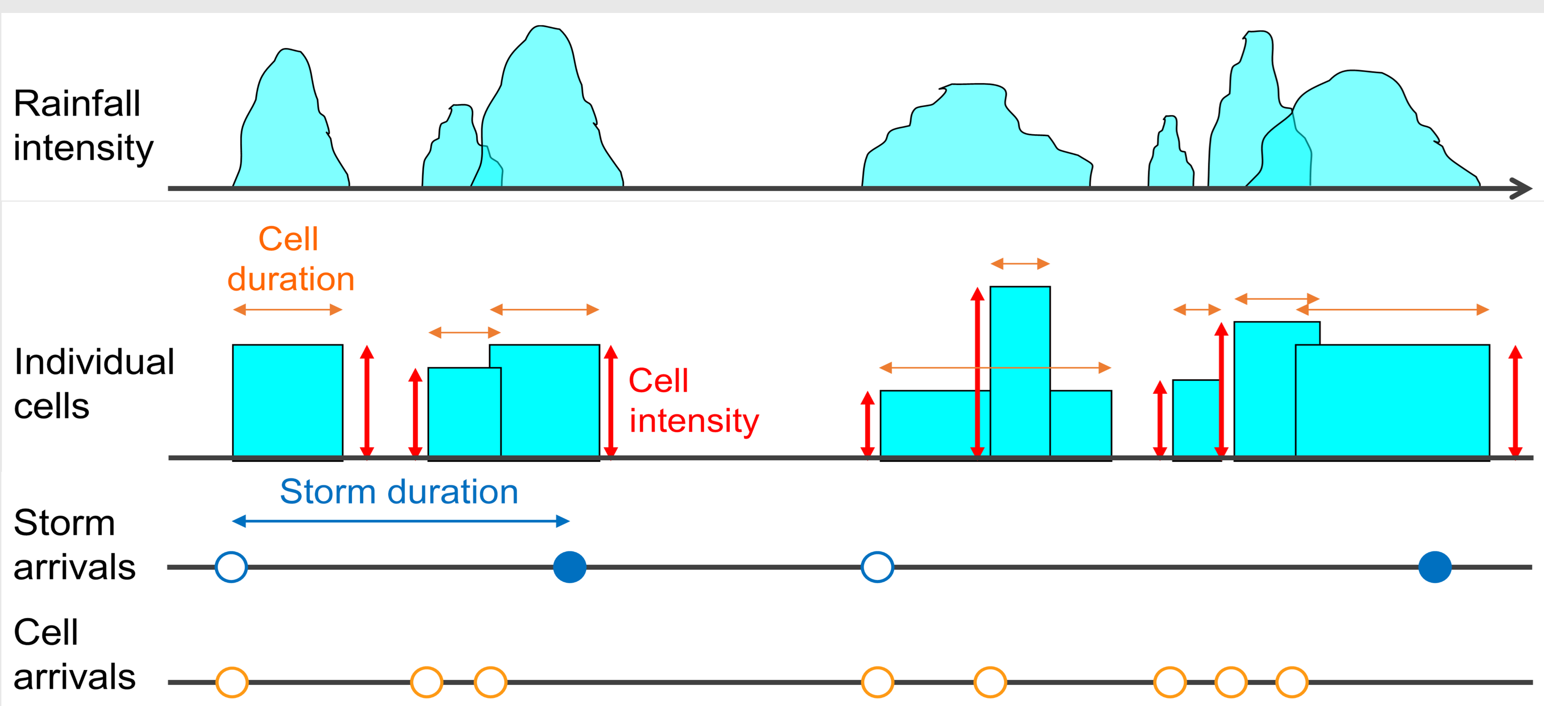

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Methodology

- Rainfall Data Input — NLDAS-2 Hourly Precip.
- Compute Statistical Properties
- Fit BL Model Parameters — {λ, Φ, κ, α, ν}
- USDA County-Level Un-Irrigated Crop Yield — Corn, Winter Wheat, Sorghum
- Statistical / Deep Learning Model — Random Forest, LSTM
- Model Evaluation — R^2, RMSE

Objective

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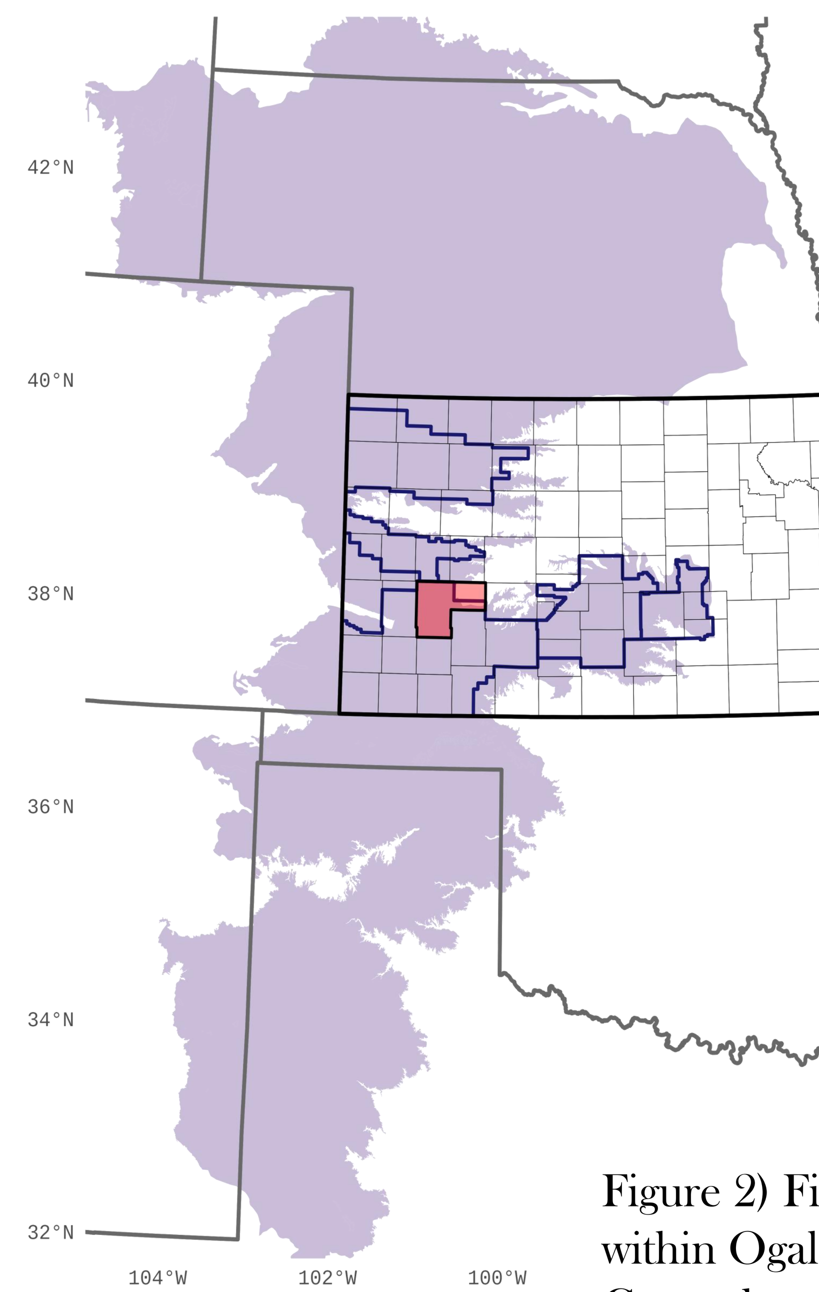

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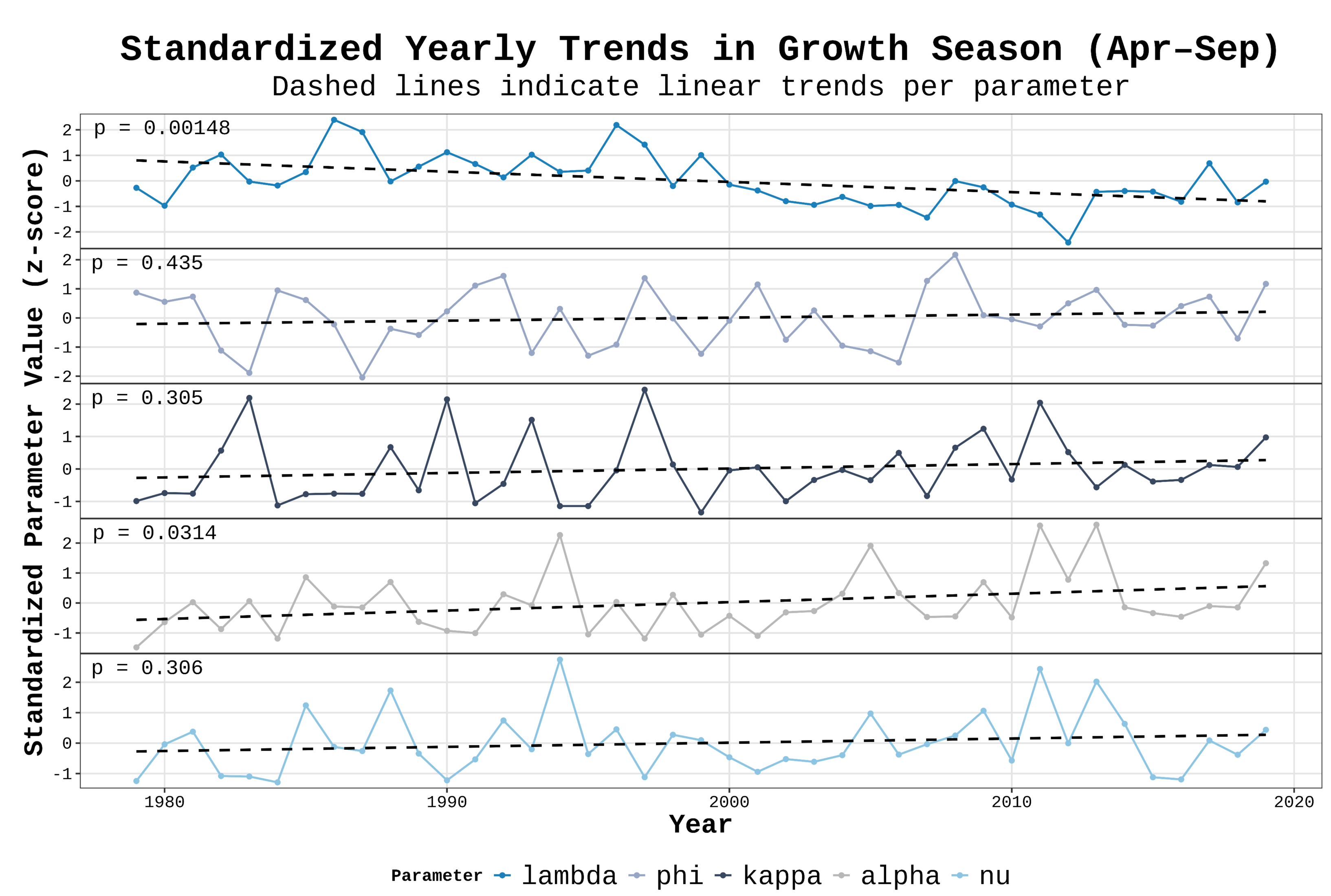

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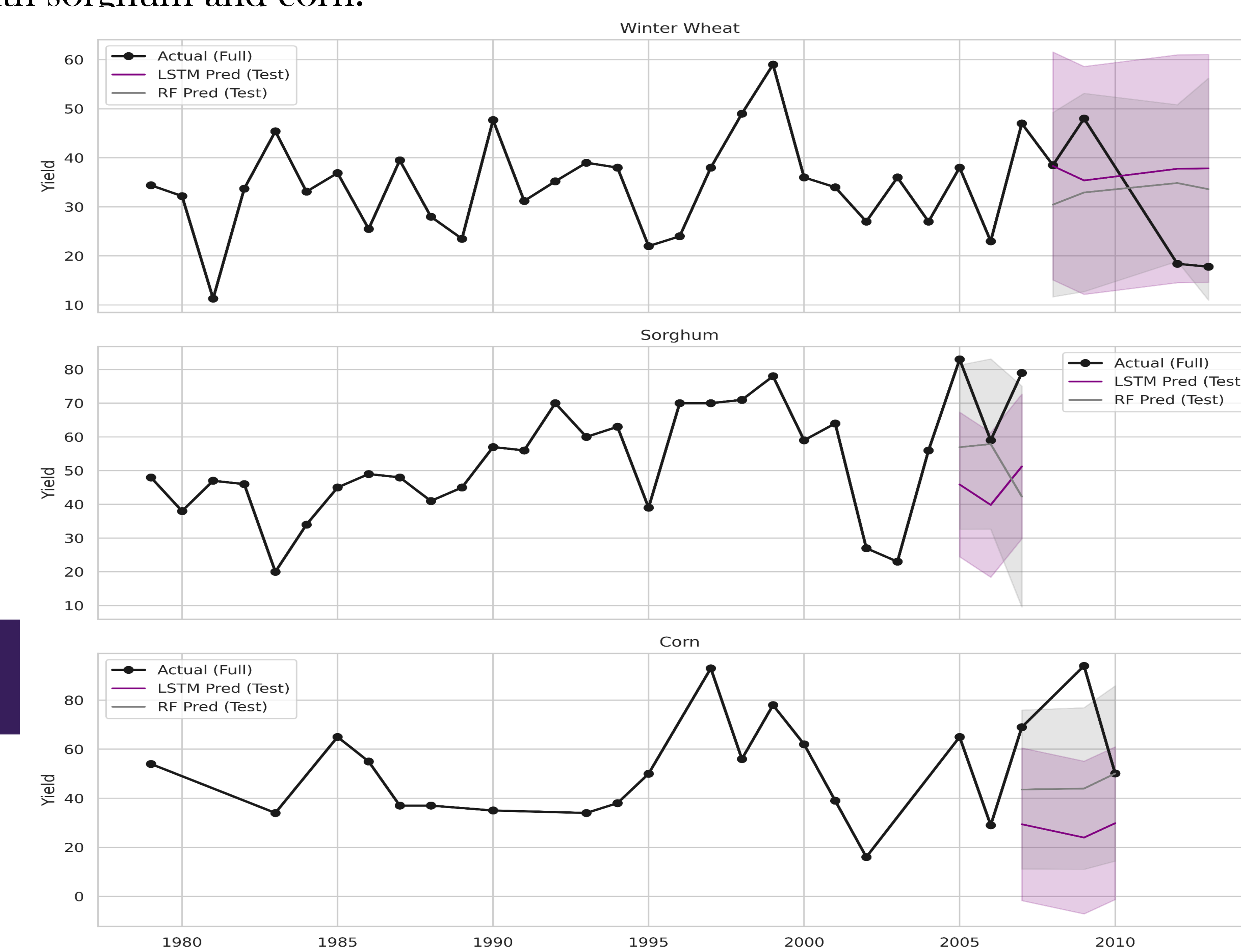

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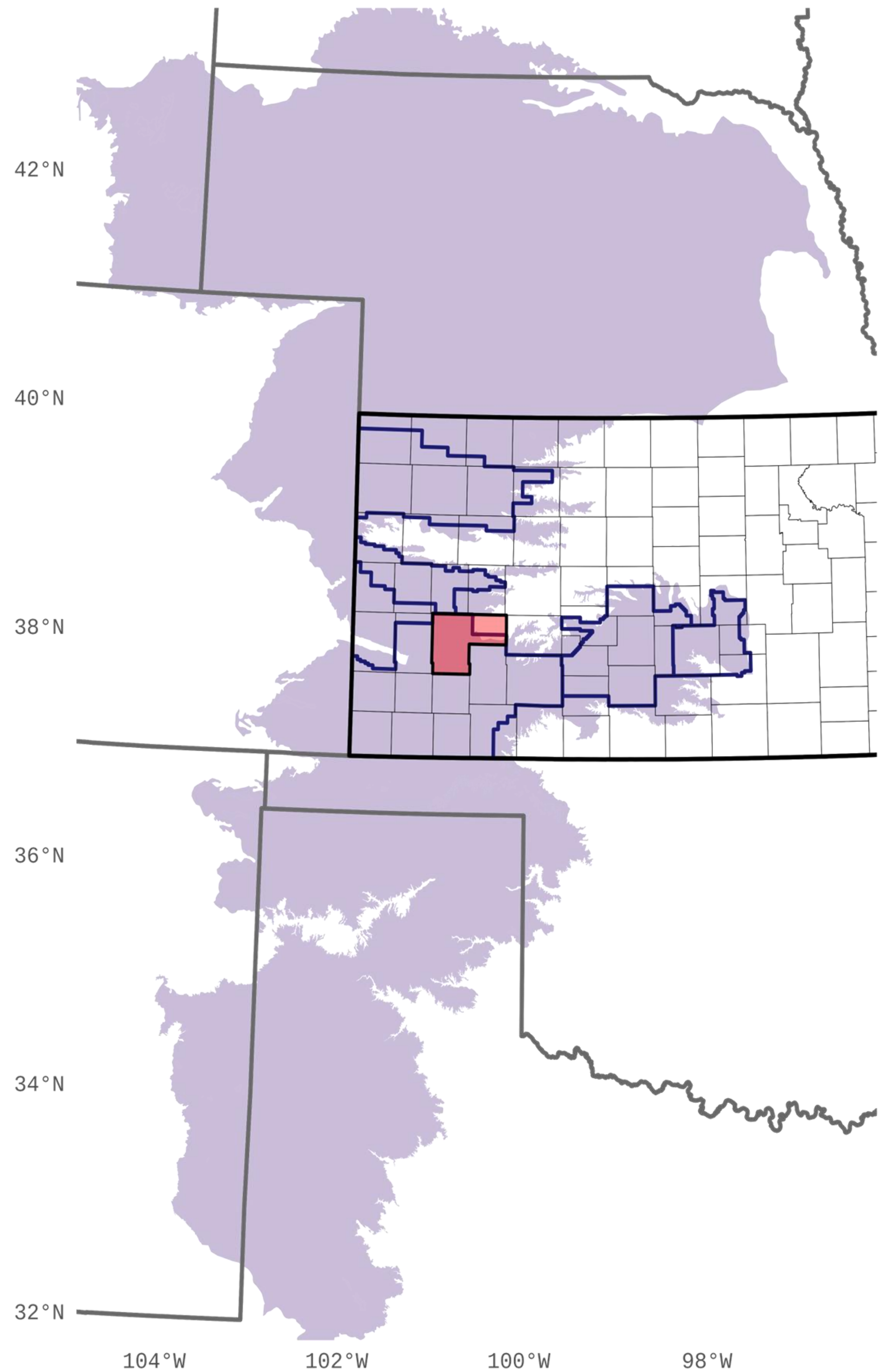

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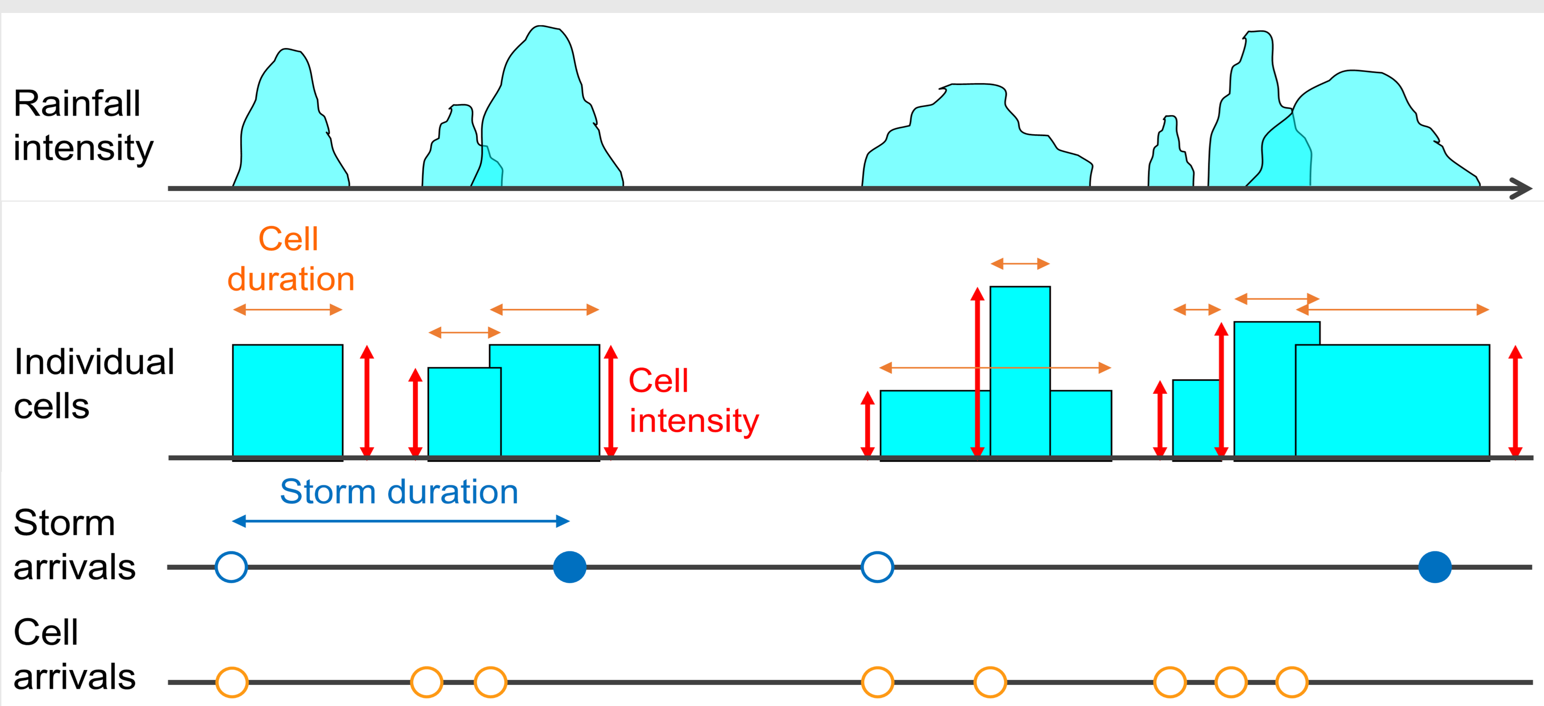

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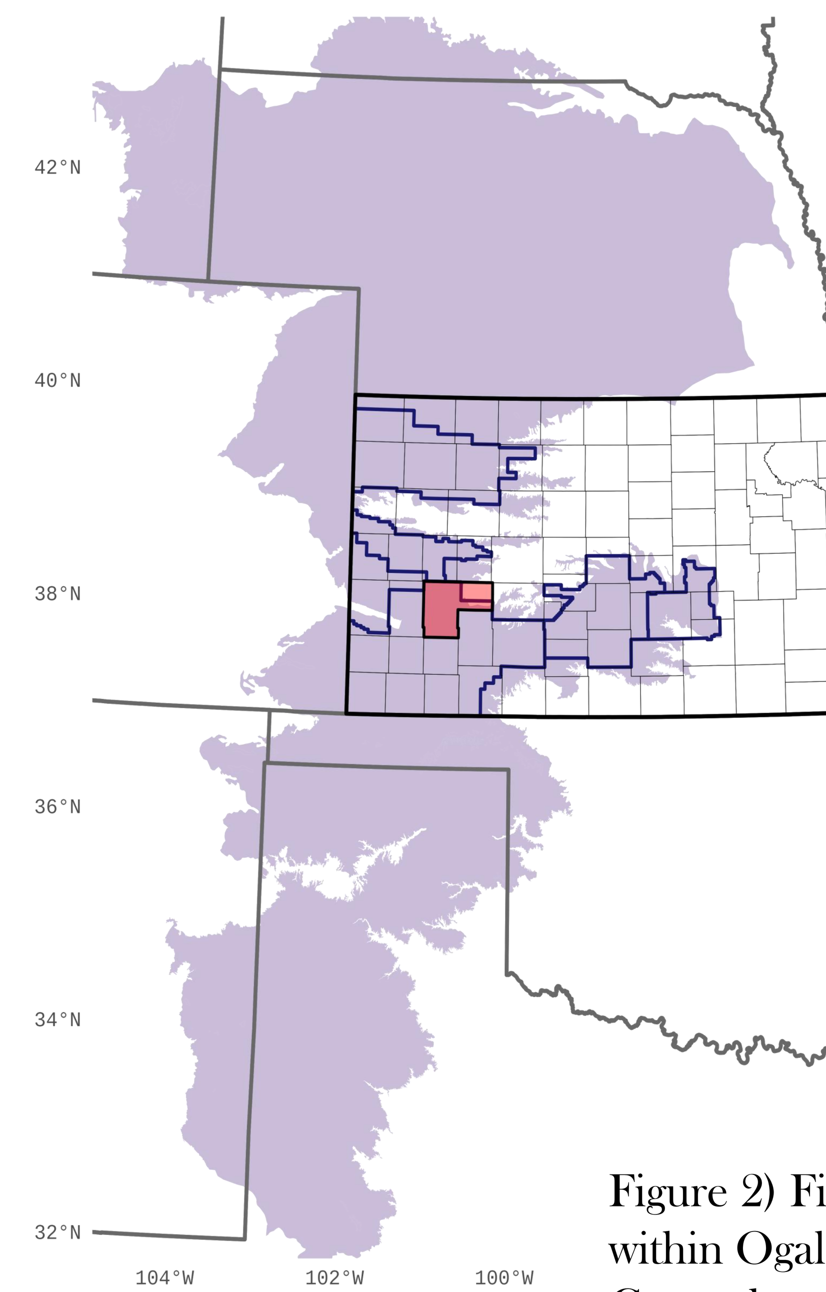

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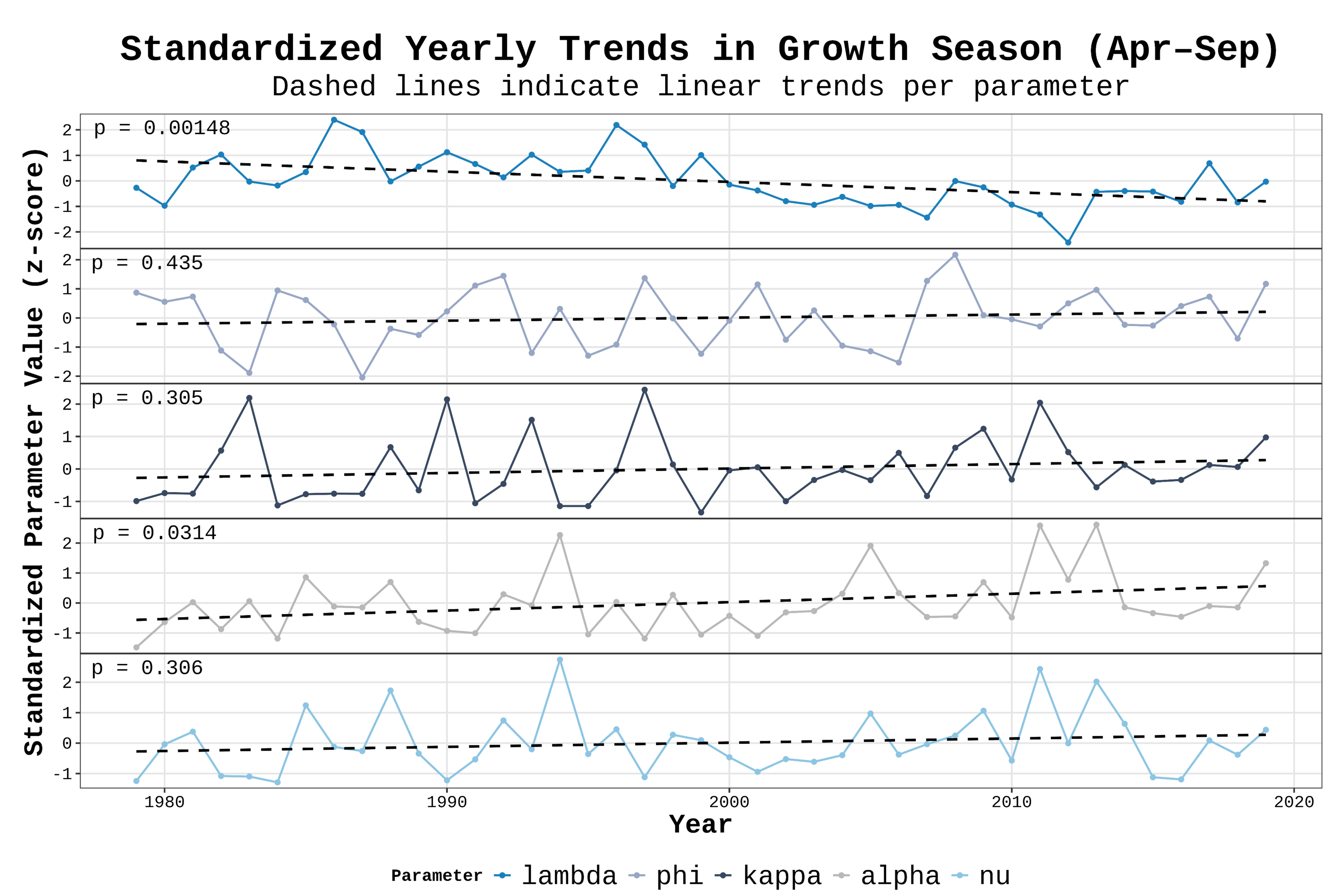

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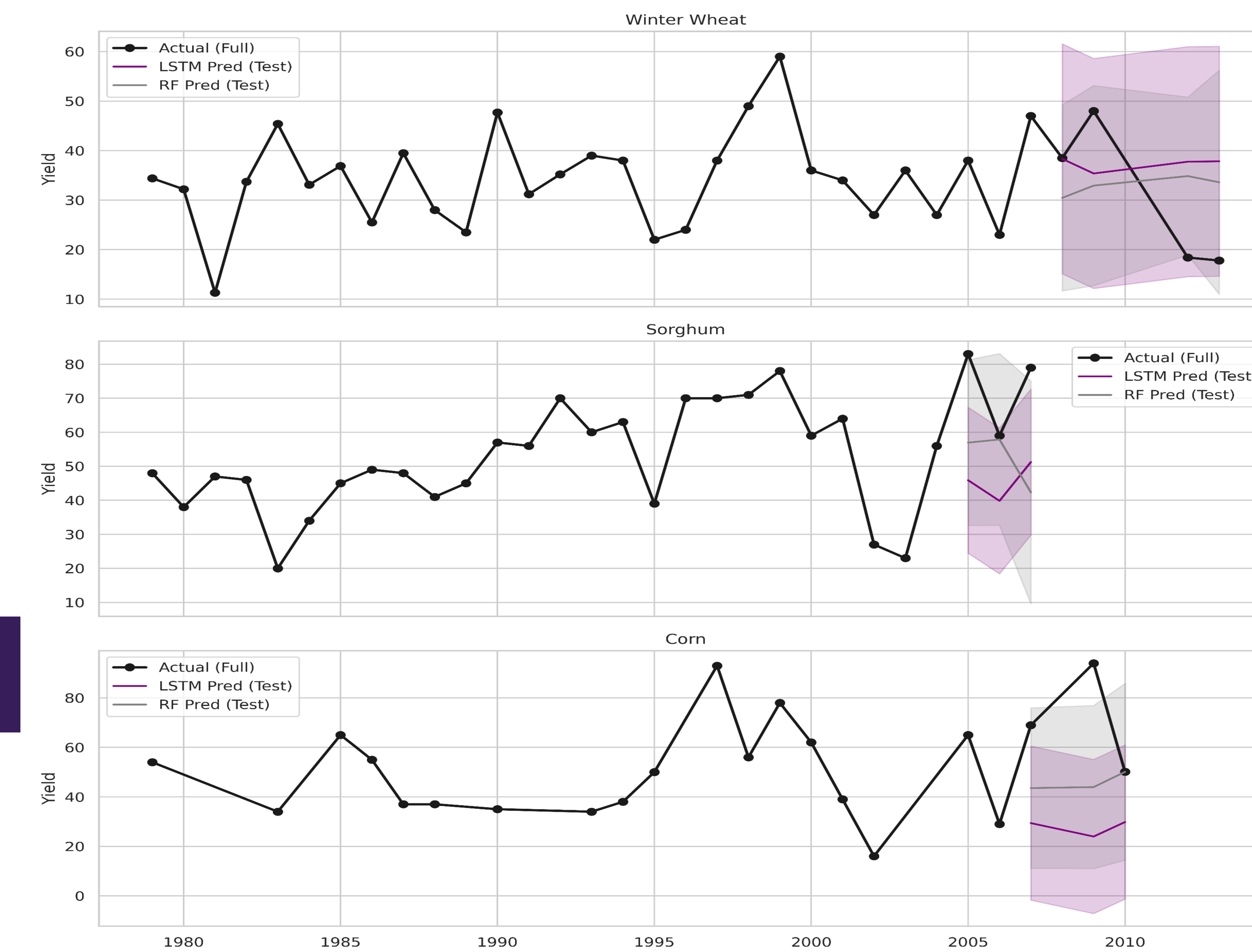

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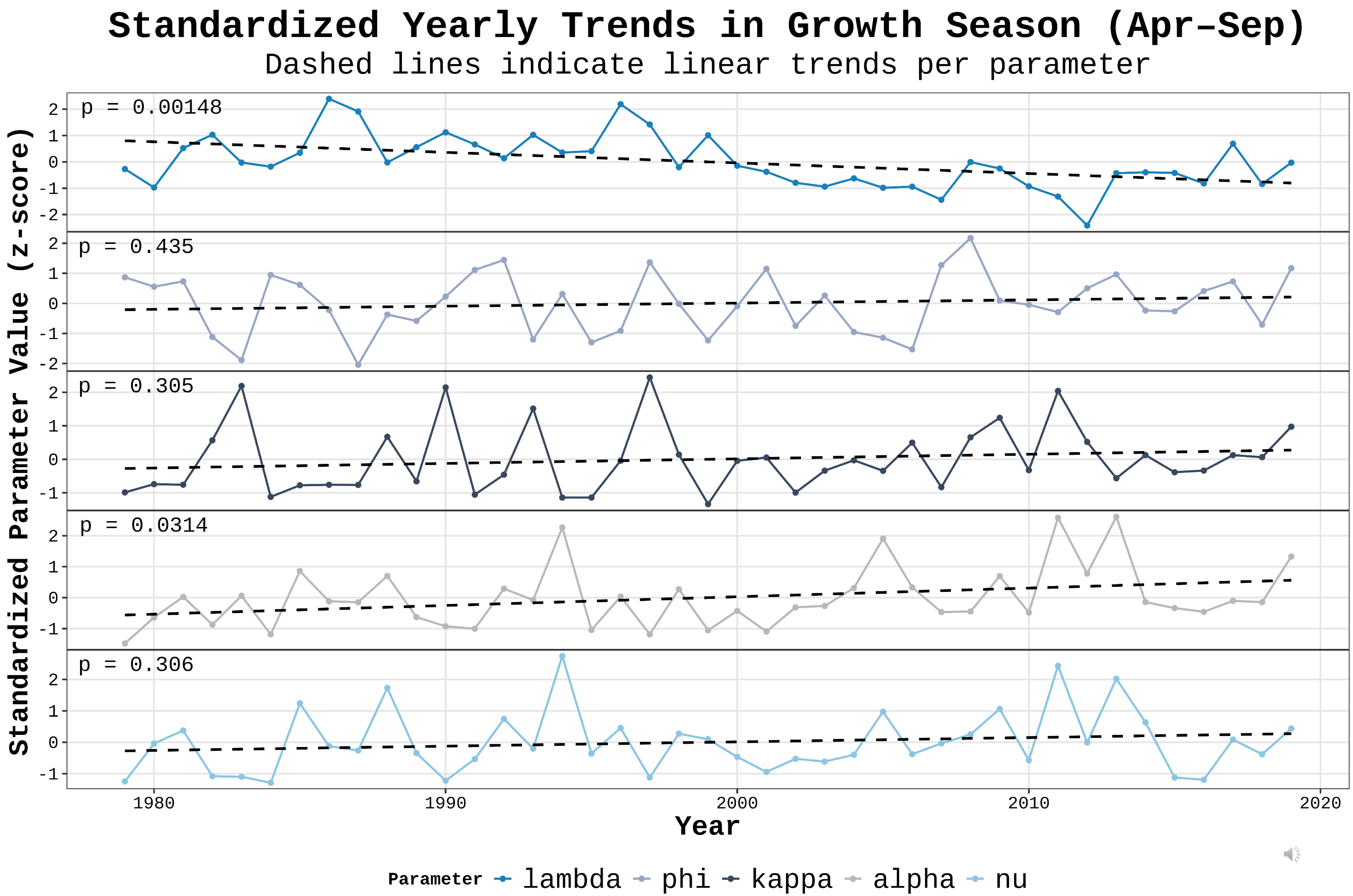

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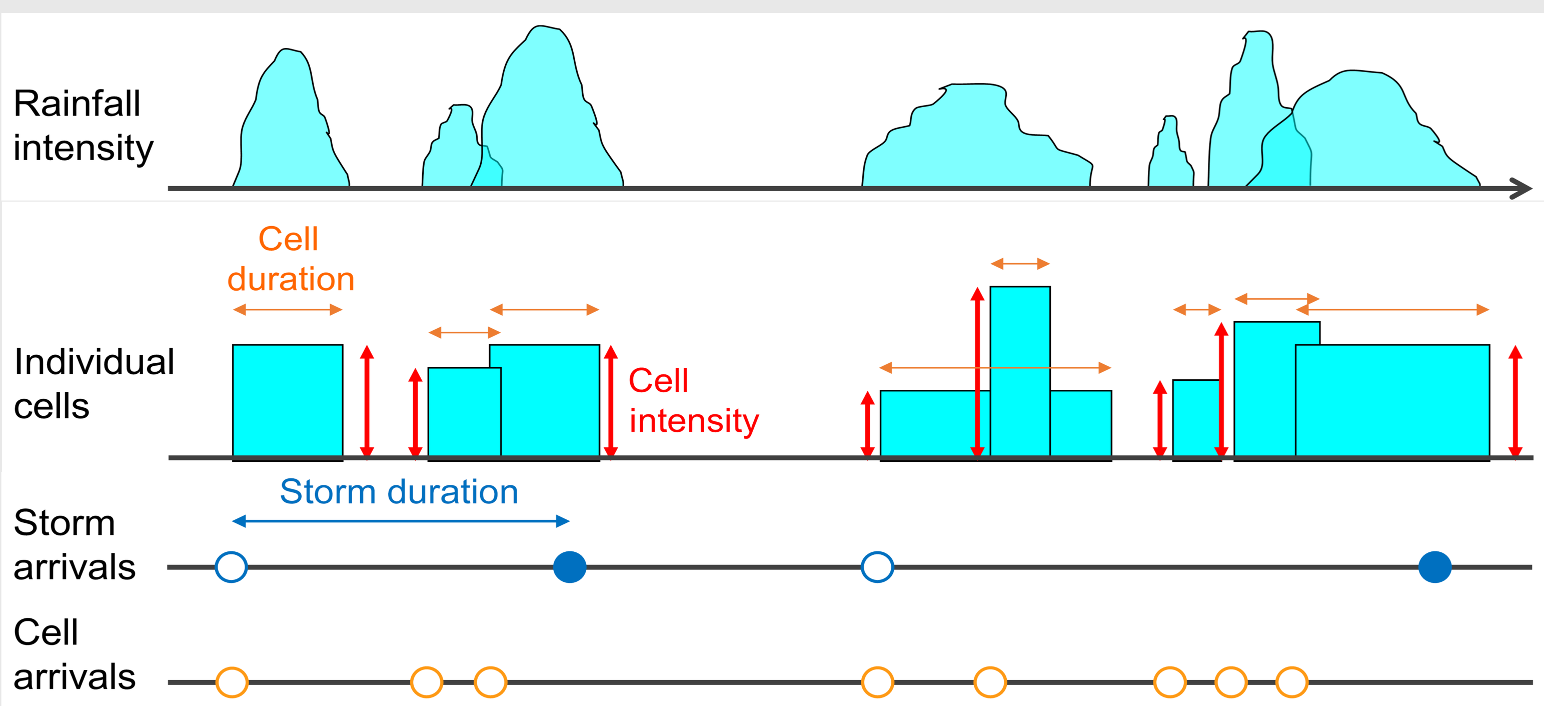

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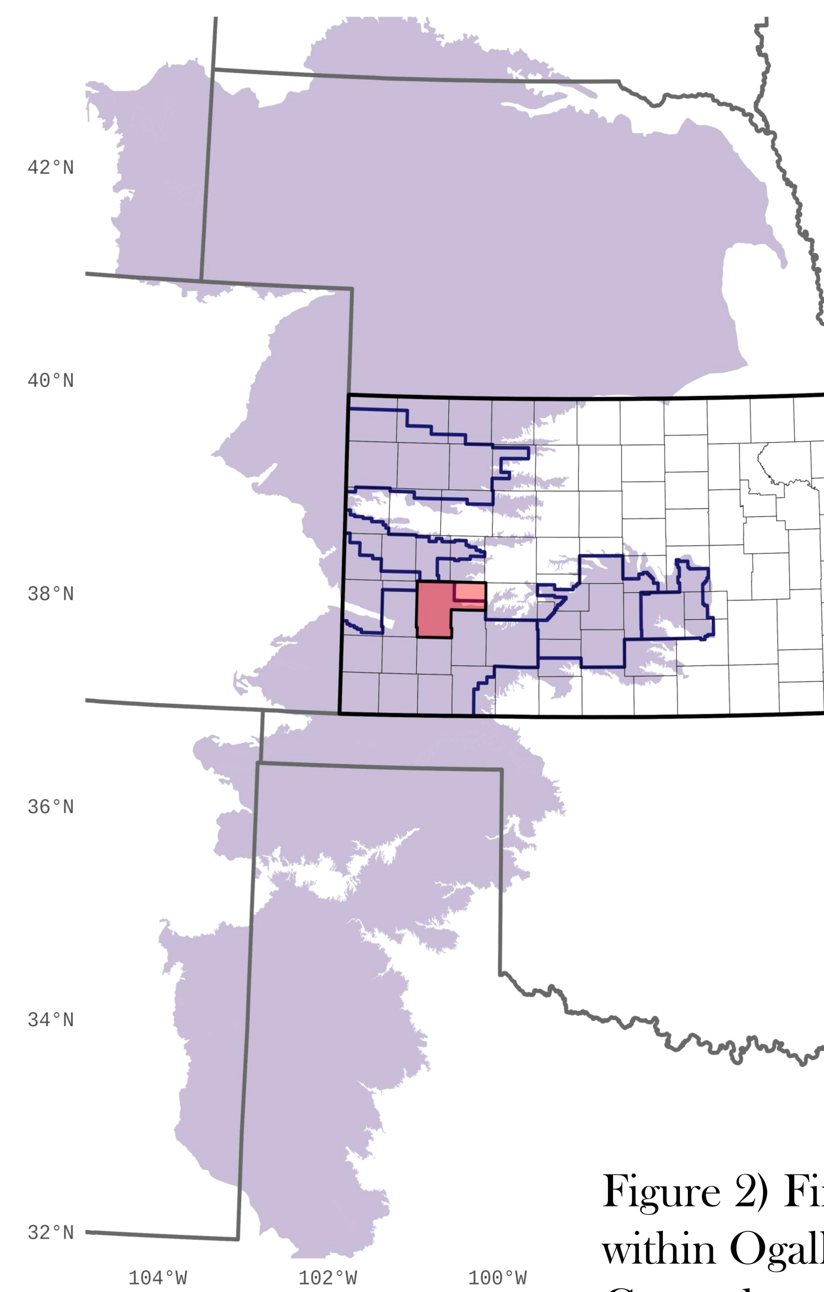

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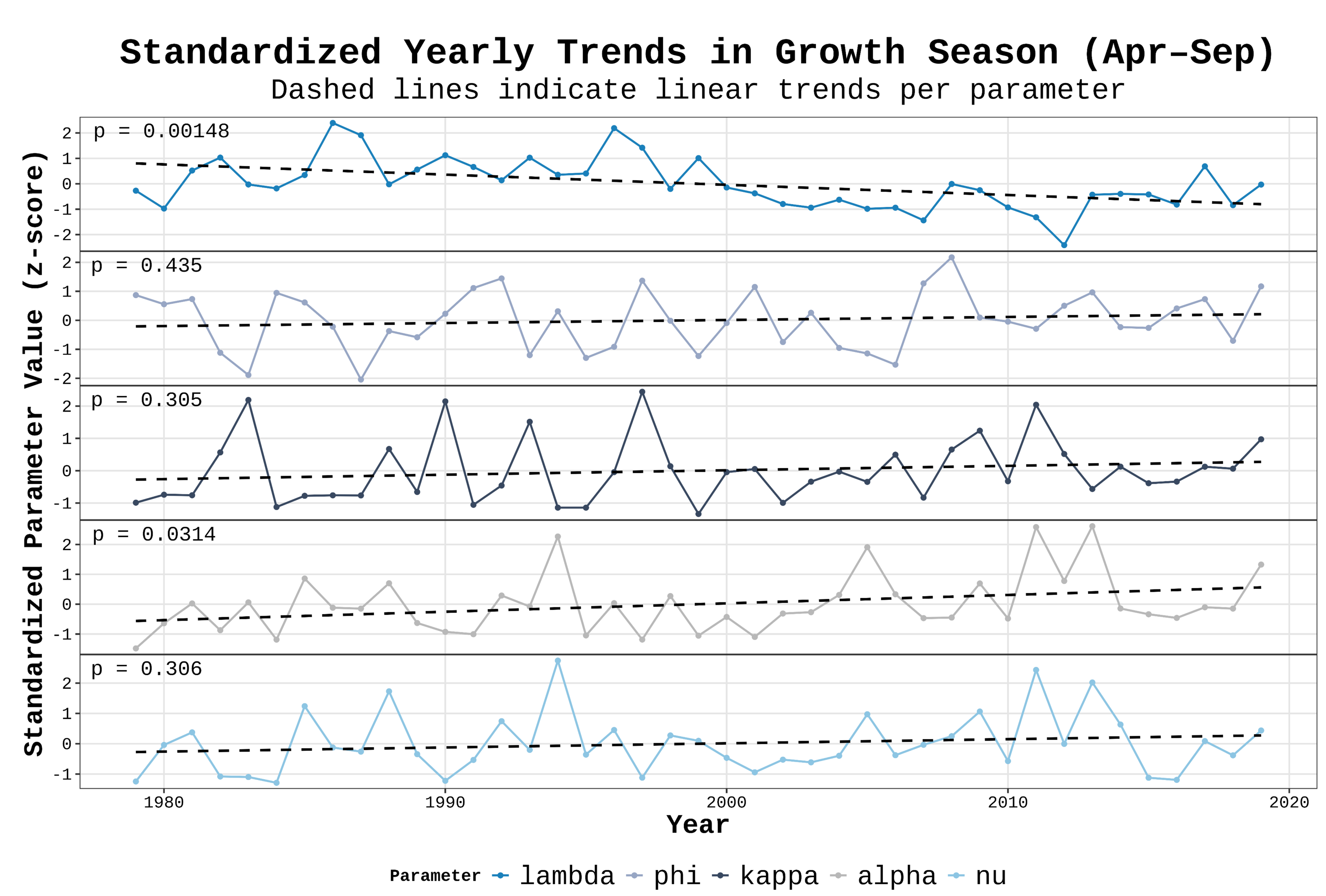

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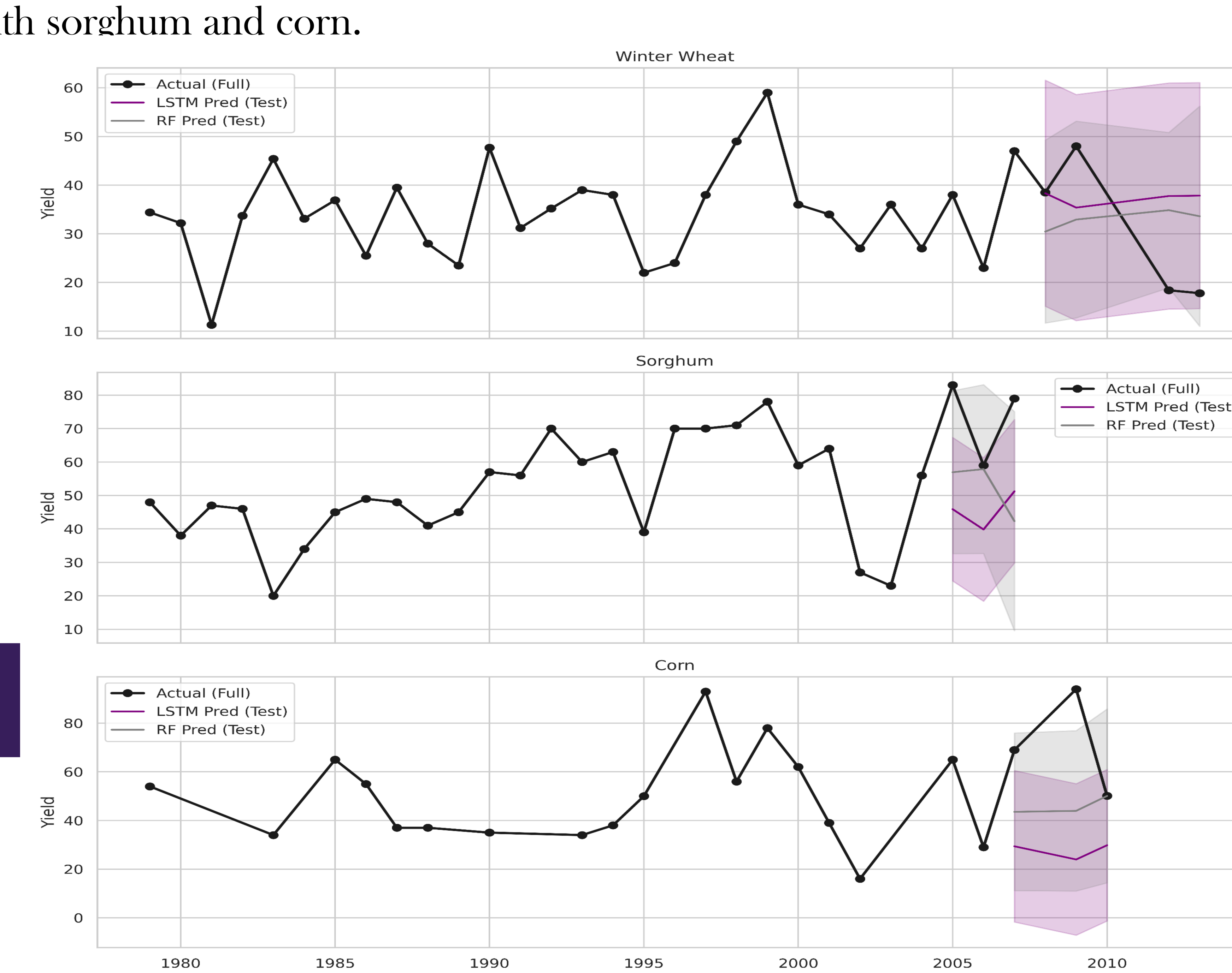

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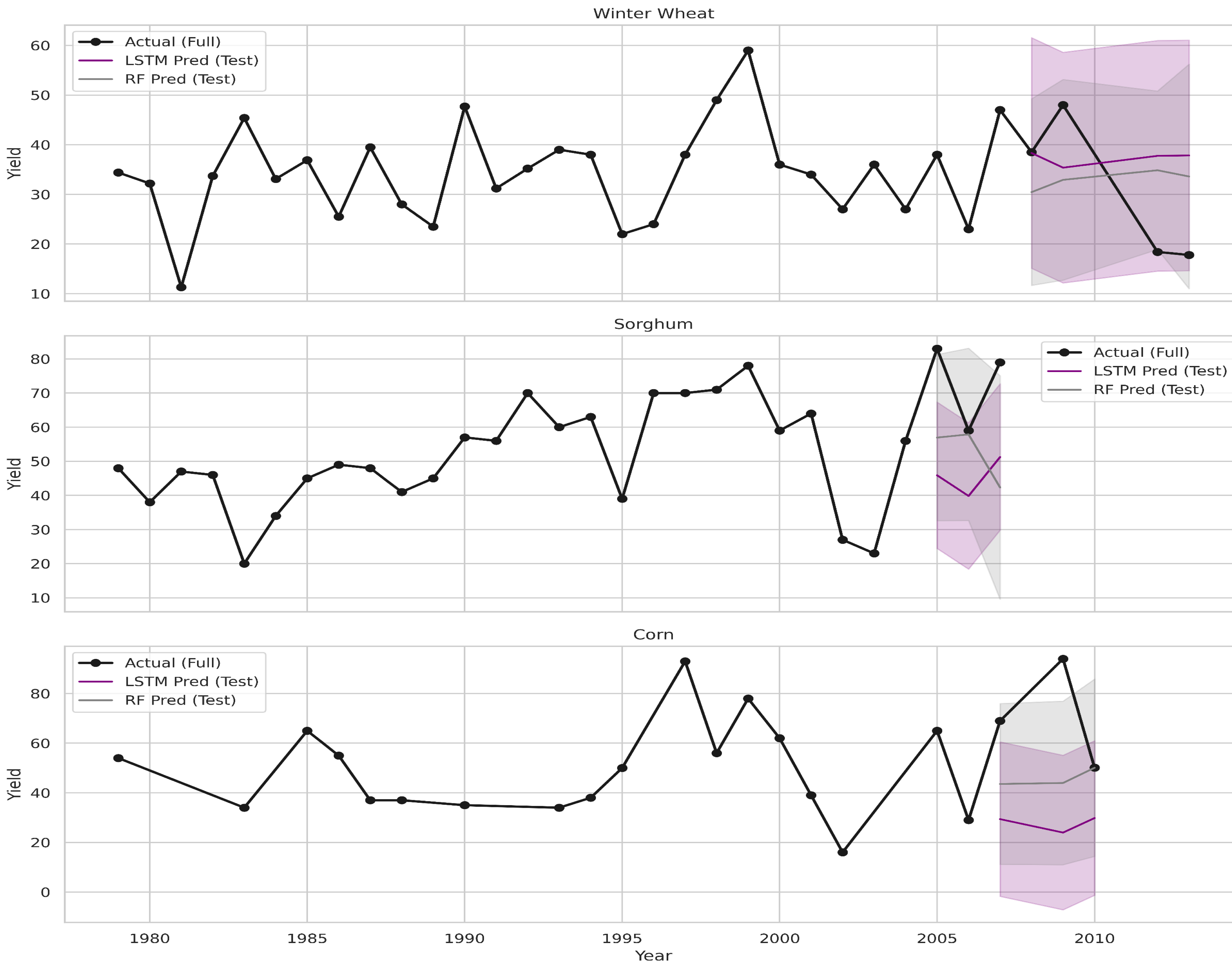

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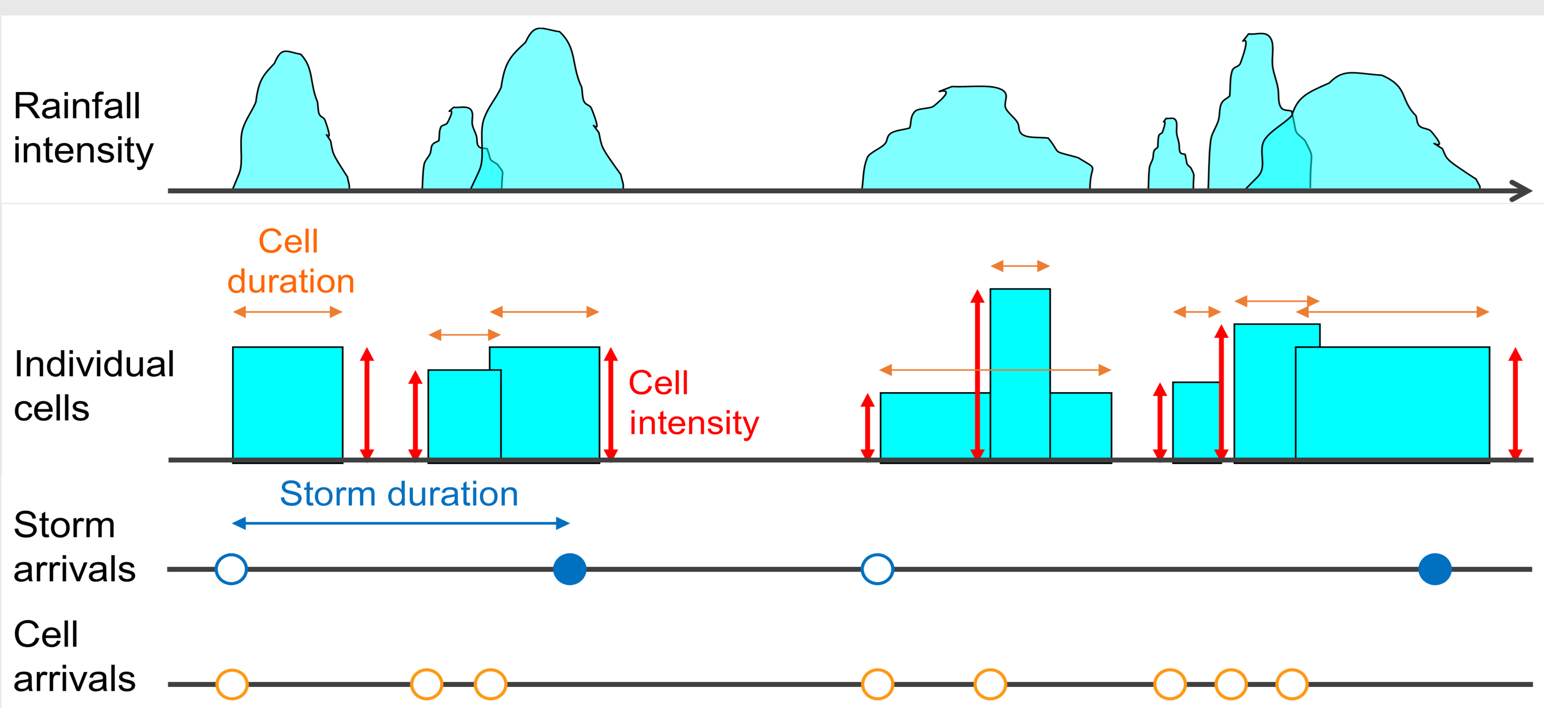

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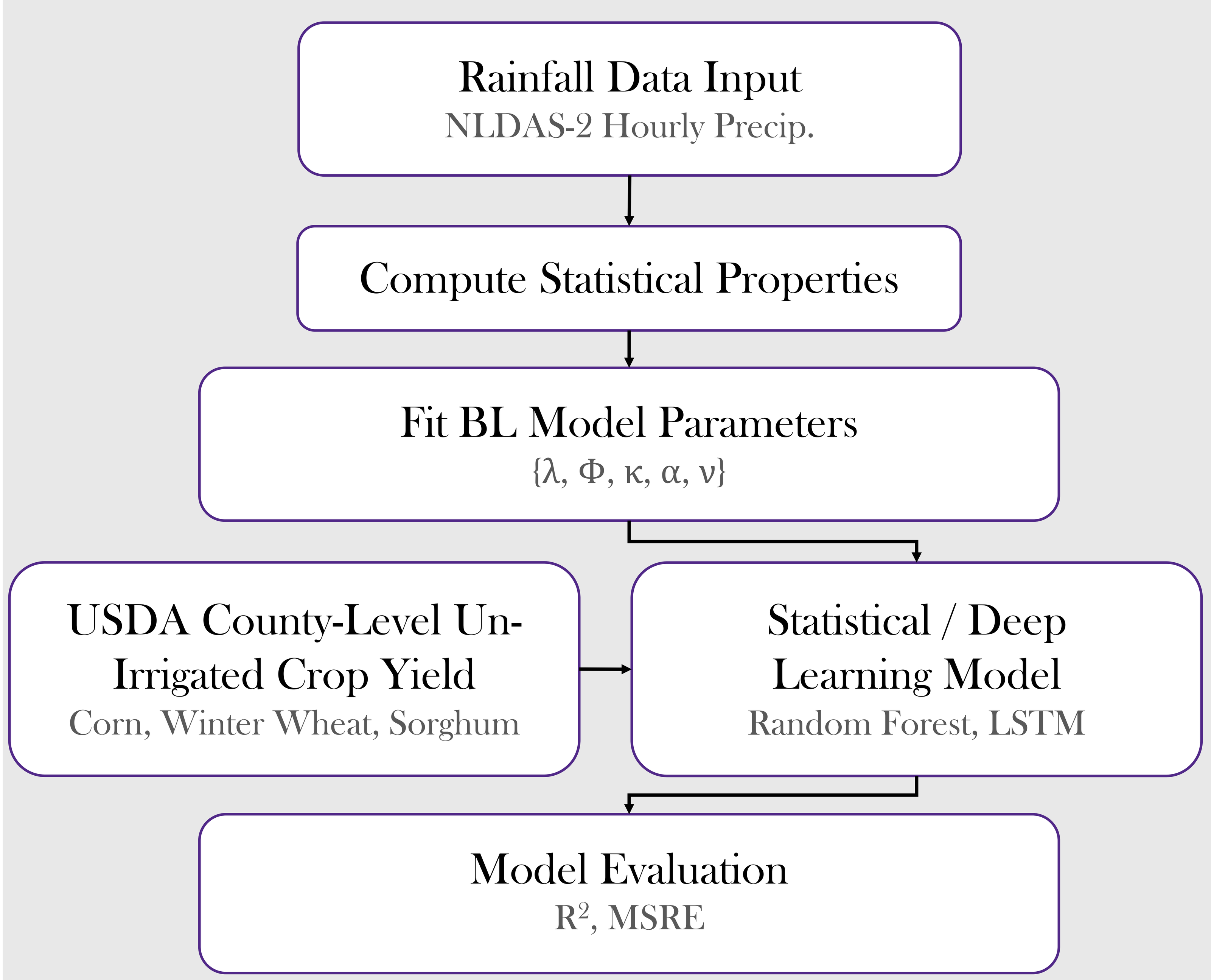

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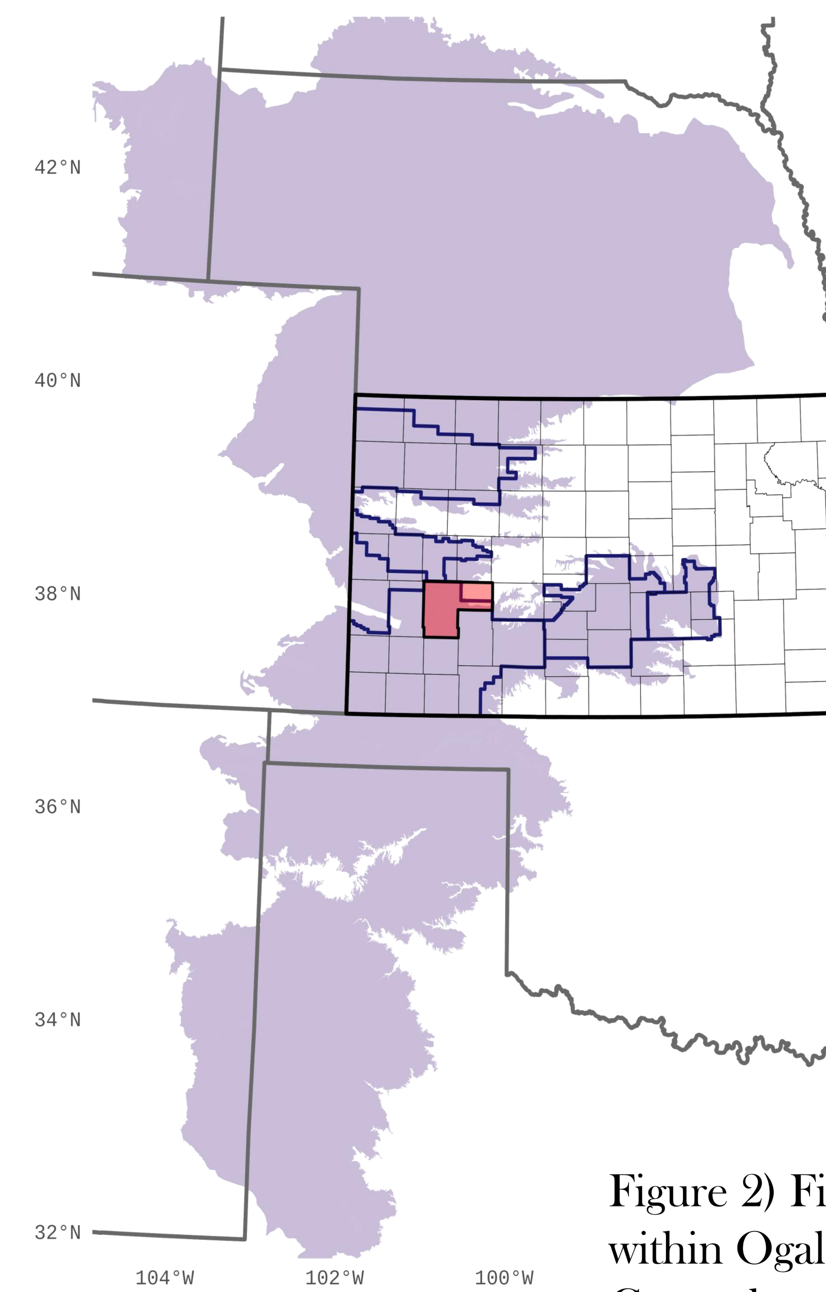

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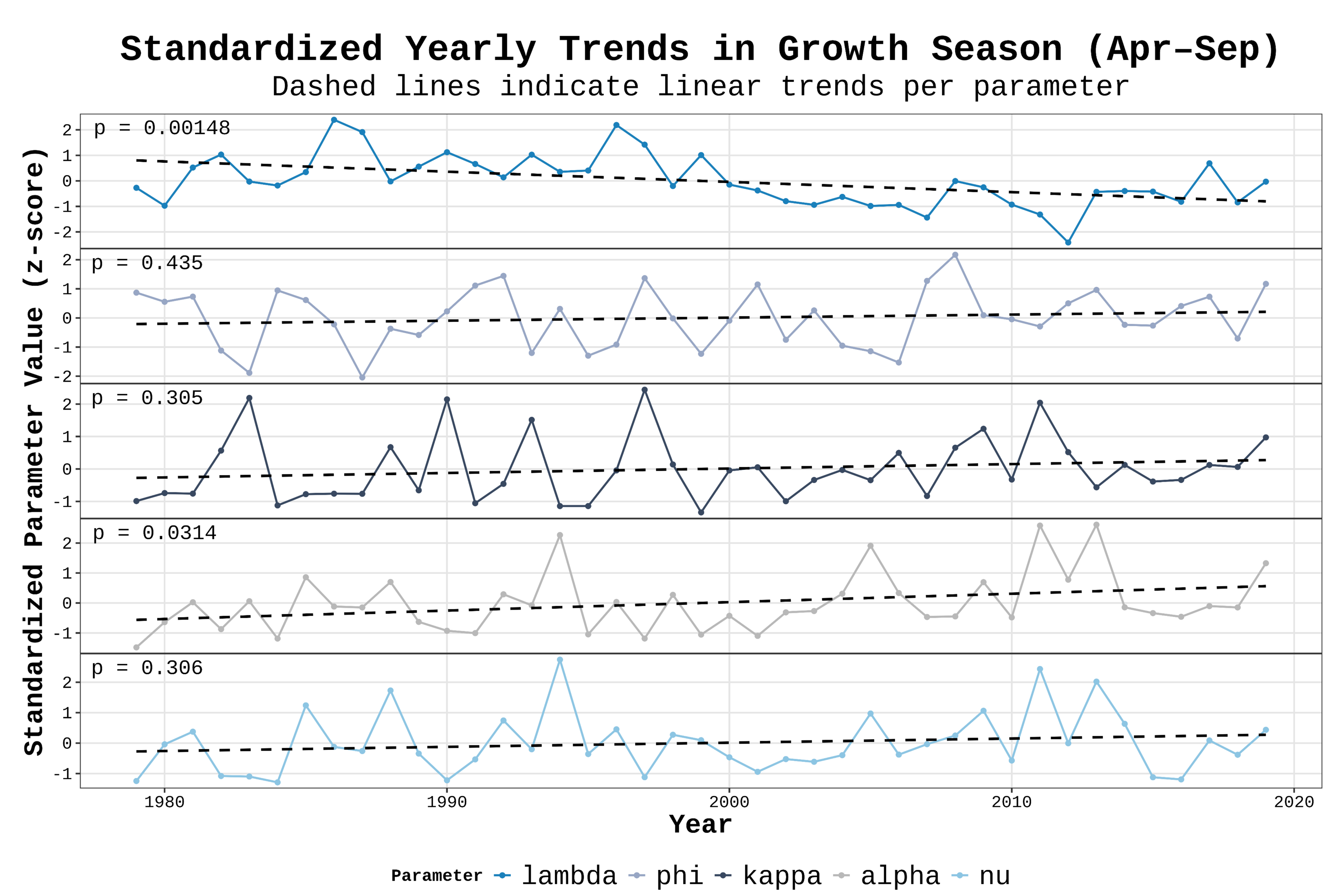

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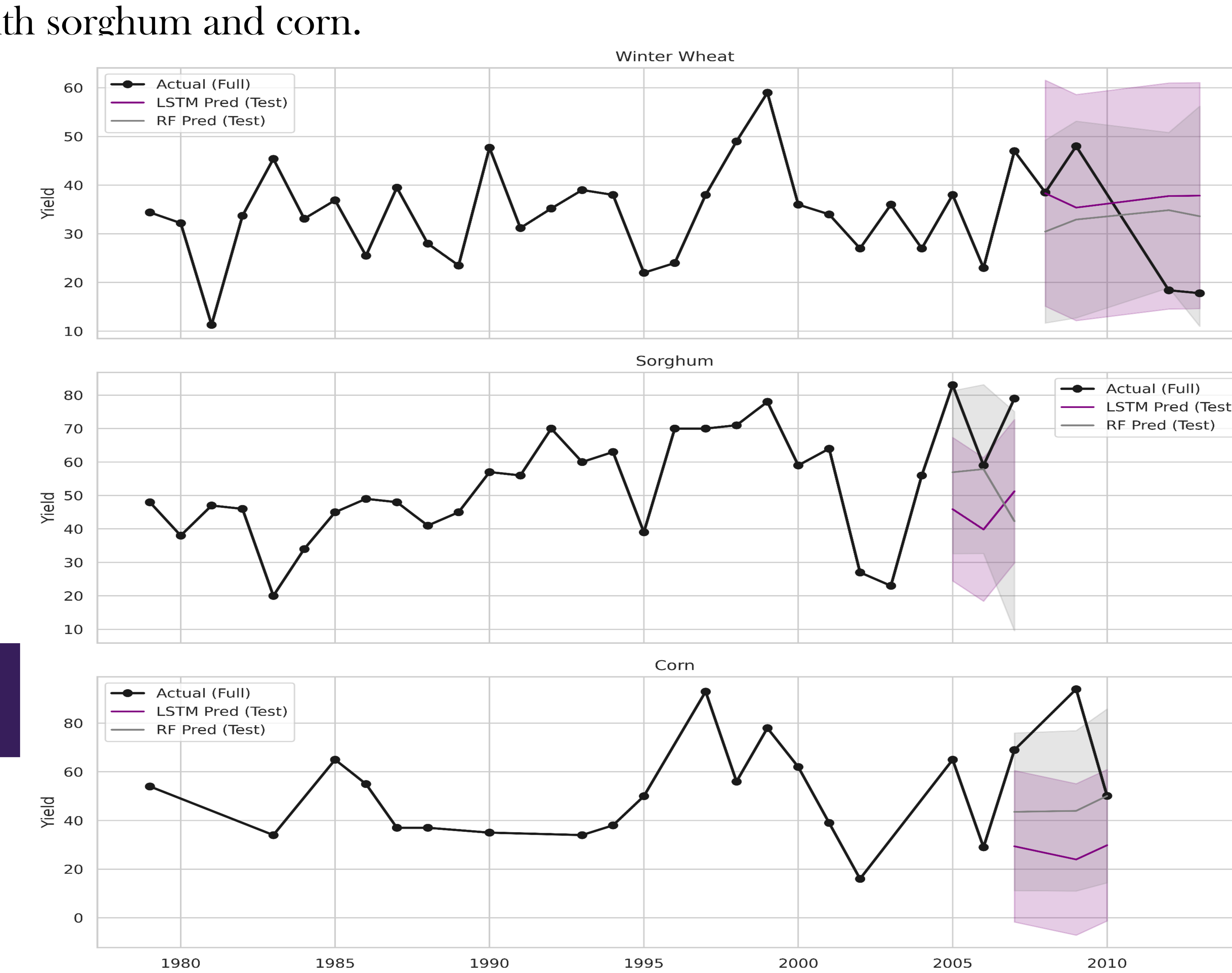

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