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MOTIVATION

- Yield forecast is critical for food security monitoring, crop stock management, and making policies for supporting farmers and consumers.
- There are many existing research projects proposing novel methodologies, both traditionally and algorithmically, to improve the accuracy of yield forecasts.
- Few research explicitly address the spatial biases, causing good overall performance but underperformance in some regions.
- **Primary contribution:**
We explicitly alleviate the spatial biases problem by using a simple spatial-aware technique called "State-wise Additive Bias".
→ more reliable predictions for each state.

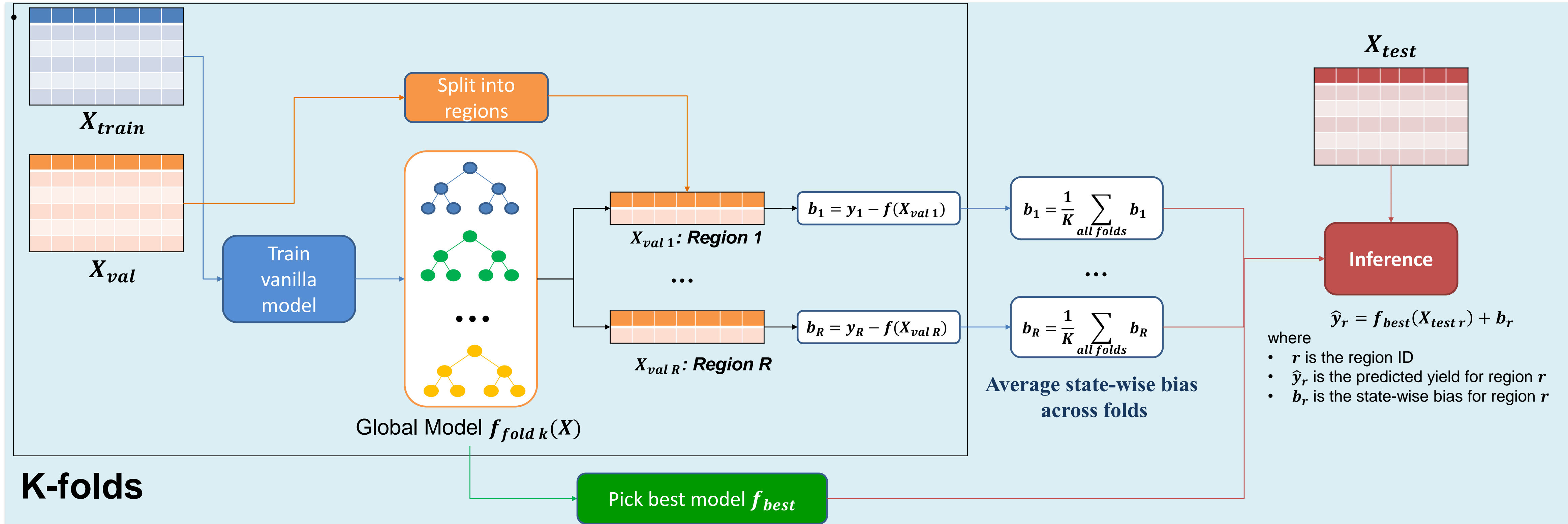


DATA

- Daily Earth Observation data collected from 2001 to 2020 by MODIS Satellite.
- Weather and climatic features:
 1. NDVI (Normalized Difference Vegetation Index)
 2. Temperature (max, min, average)
 3. Precipitation
 4. SMAP soil moisture
 5. Evaporative Stress Index (ESI)
 6. GDD
- Kazakhstan wheat crop mask was used to ensure accurate EO measurement for each region.



SPATIAL-AWARE PREDICTION FRAMEWORK

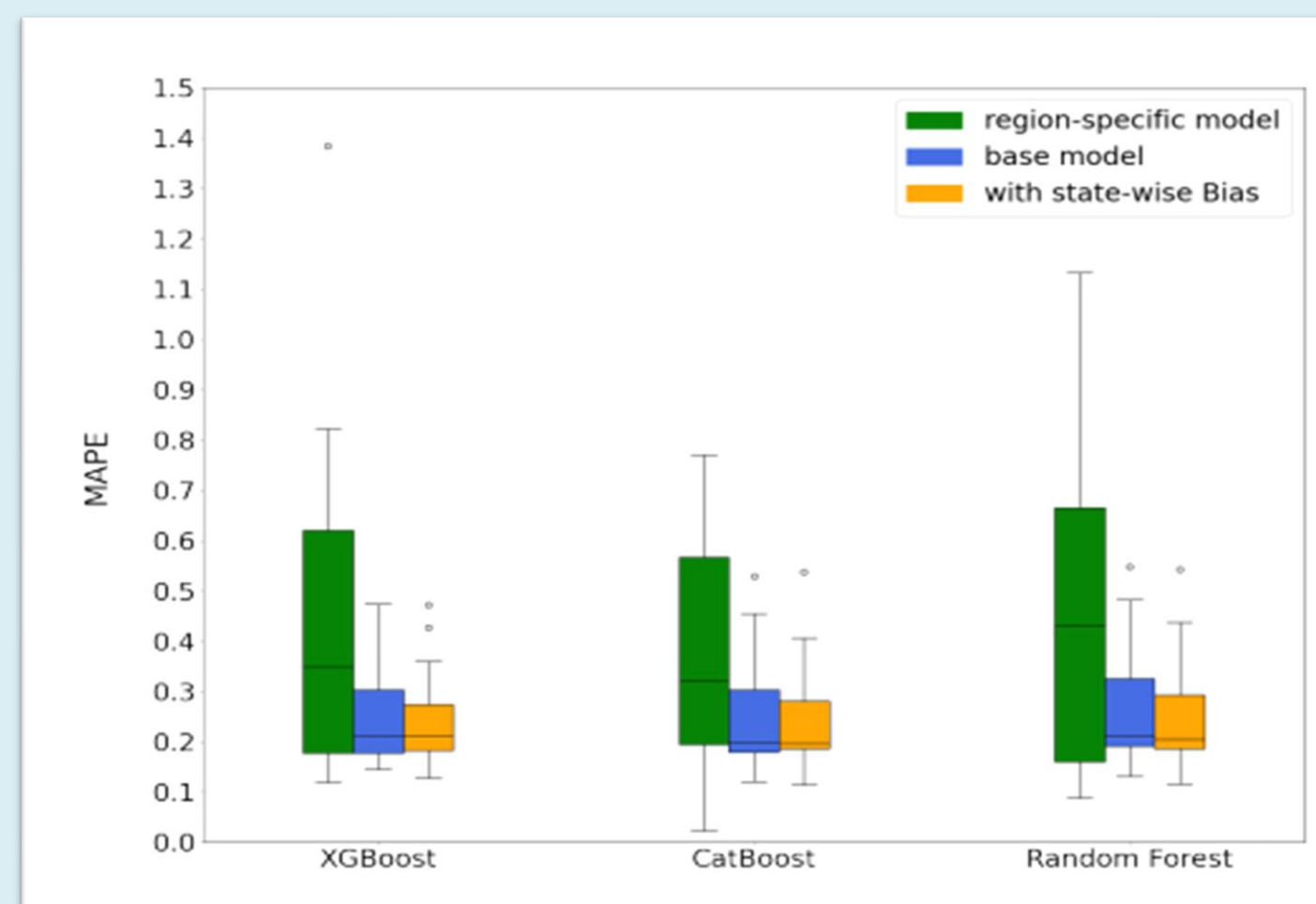


RESULTS

RMSE change:
state-wise bias
VS
baseline model

Province	XGBoost	CatBoost	Random Forest
Akmolinskaya	-0.47%	+1.13%	-1.74%
Aktyubinskaya	+1.54%	+1.35%	-5.60%
Almatinskaya	-28.37%	-24.26%	-24.04%
Jambul'skaya	+1.35%	+2.49%	+0.08%
Karagandinskaya	-1.37%	+0.55%	-0.72%
Kustanayskaya	-3.85%	-2.64%	-3.55%
Pavlodarskaya	-0.65%	+2.86%	-2.18%
Severo-Kazachstanskaya	+2.38%	+26.86%	-15.42%
Vostochno-Kazachstanskaya	-4.48%	-4.11%	-1.17%
Yujno-Kazachstanskaya	-8.84%	-6.95%	-7.69%
Zapadno-Kazachstanskaya	-1.38%	+0.14%	-0.62%
National	-8.90%	-8.10%	-9.76%

MAPE of
regional model,
baseline global model,
and state-wise bias



CONCLUSIONS

RESULTS INTERPRETATION:

1. Although the Spatial-Aware Additive Bias technique is simple, it effectively improves the performance of state-level yield prediction and reduces spatial biases.
2. Errors in some regions (Almatinskaya) are significantly reduced, while the overall errors are reduced by a noticeable degree.
3. The spatial bias does exist, reducing the prediction fairness.

FUTURE WORK:

1. Explore more sophisticated approaches to explicitly address the spatial bias problem for small crop datasets.
2. Some examples include regional clustering and/or region-specific feature embedding into the model.

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