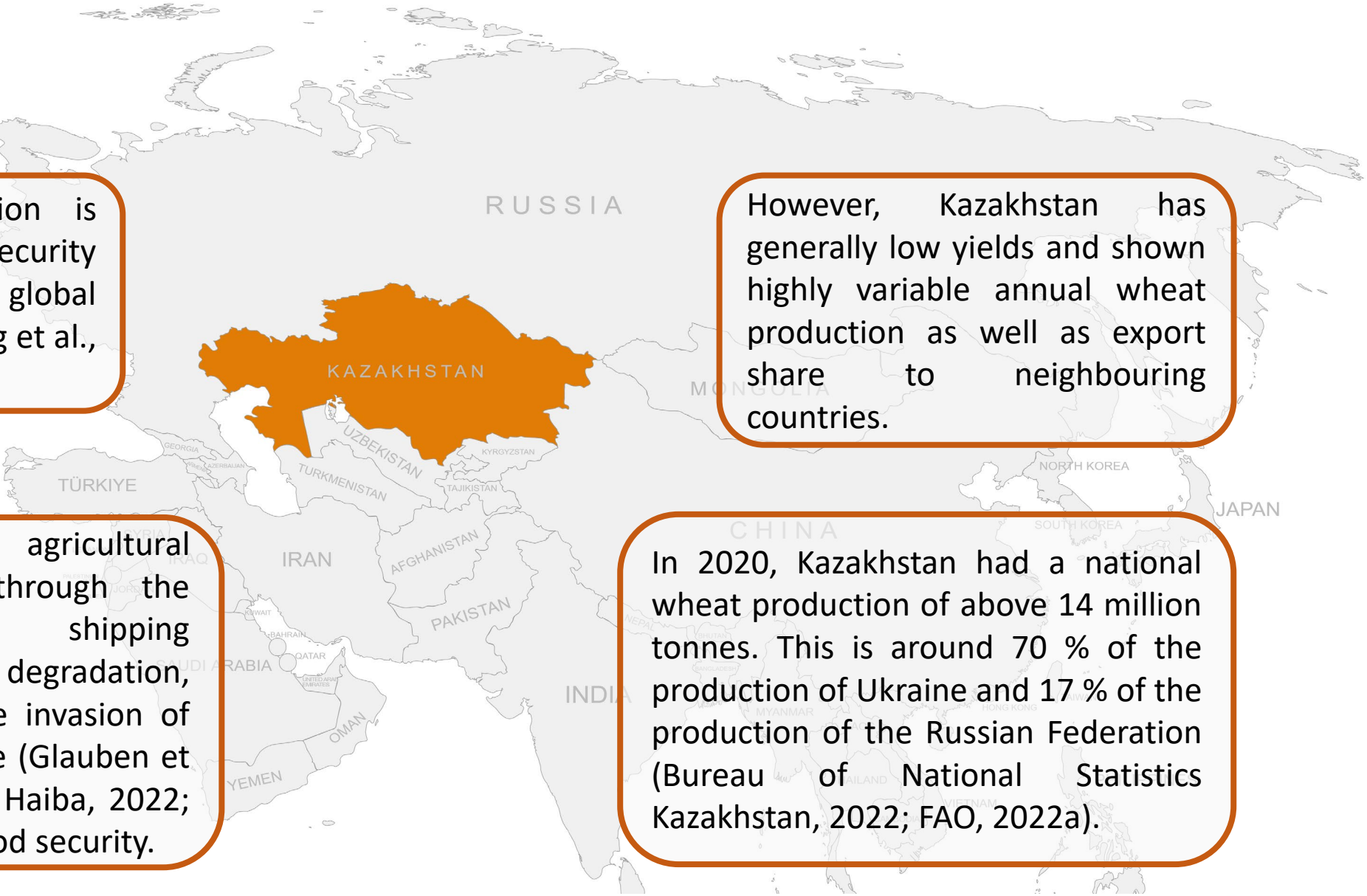
Wheat yields in Kazakhstan can successfully be forecasted using a statistical crop model

Paula Romanovska, Bernhard Schauberger, Christoph Gornott
WG on Adaptation in Agricultural Systems

Background

Global wheat production is fundamental for food security providing over 20 % of global calorie intake (Lephuthing et al., 2021).



However, Kazakhstan has generally low yields and shown highly variable annual wheat production as well as export share to neighbouring countries.

Disruptions of the agricultural commodities market through the COVID-19 pandemic, shipping constraints, land degradation, extreme events and the invasion of Russian forces in Ukraine (Glauben et al., 2022; Behnassi & El Haiba, 2022; Nicas, 2022) decrease food security.

In 2020, Kazakhstan had a national wheat production of above 14 million tonnes. This is around 70 % of the production of Ukraine and 17 % of the production of the Russian Federation (Bureau of National Statistics Kazakhstan, 2022; FAO, 2022a).

Aim of the Paper

- Forecast wheat production to inform food security planning and management
- Building a robust statistical model at the oblast (regional) level in Kazakhstan forecasting wheat yield and production two months before the end of harvest
- Model is easily replicable with publicly available weather and yield data

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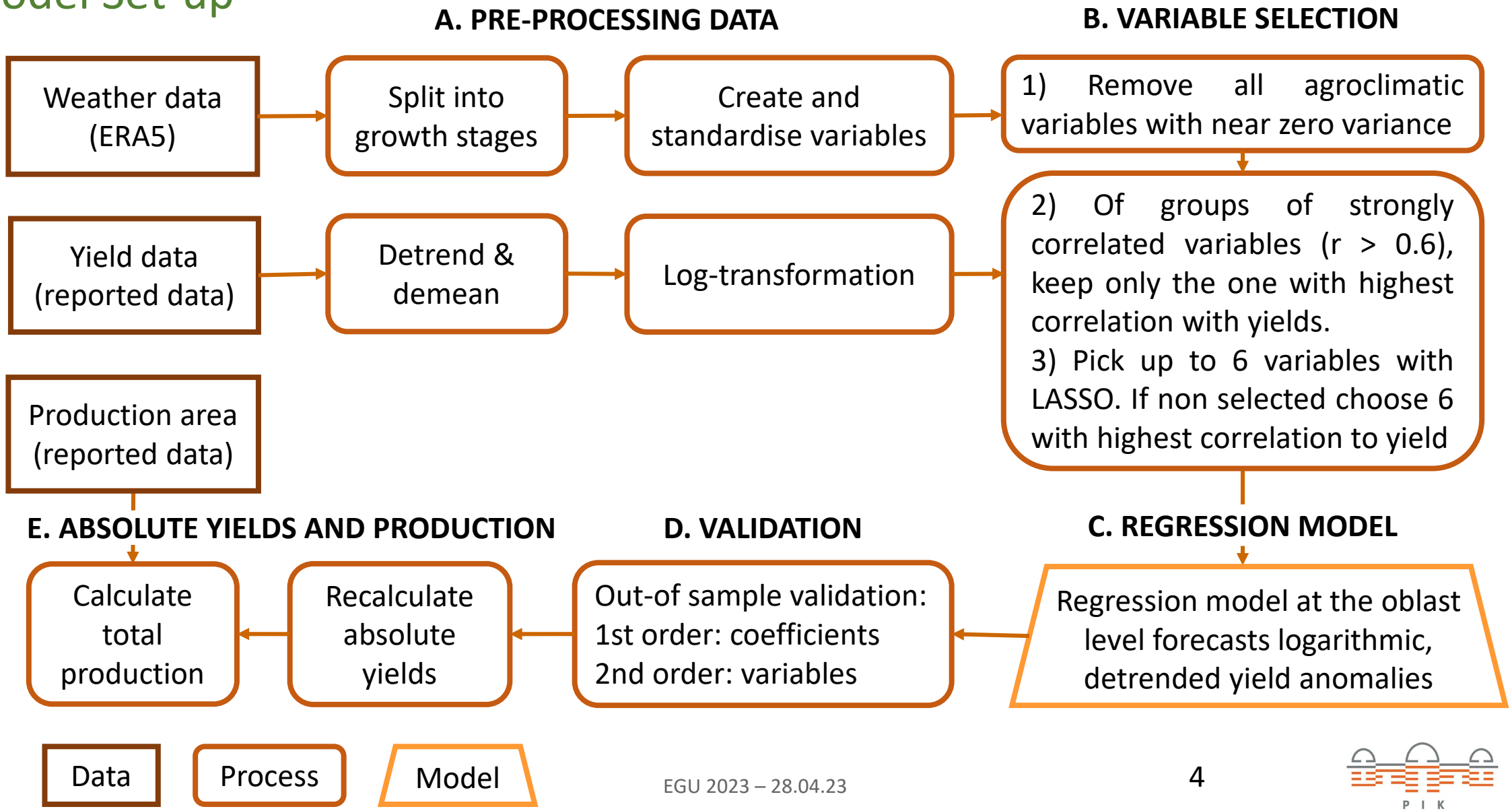
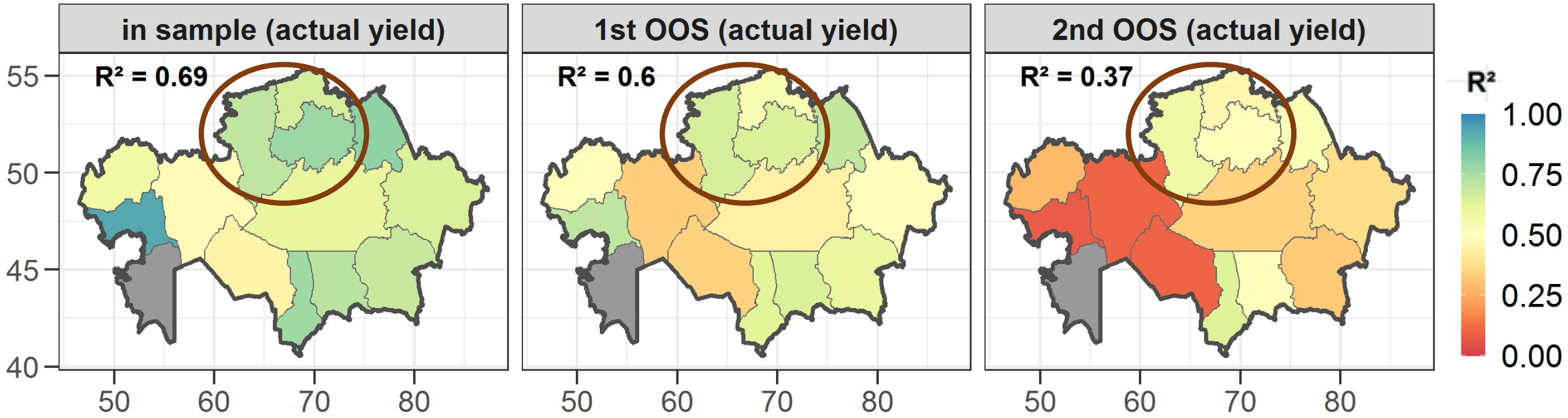
Model Set-up

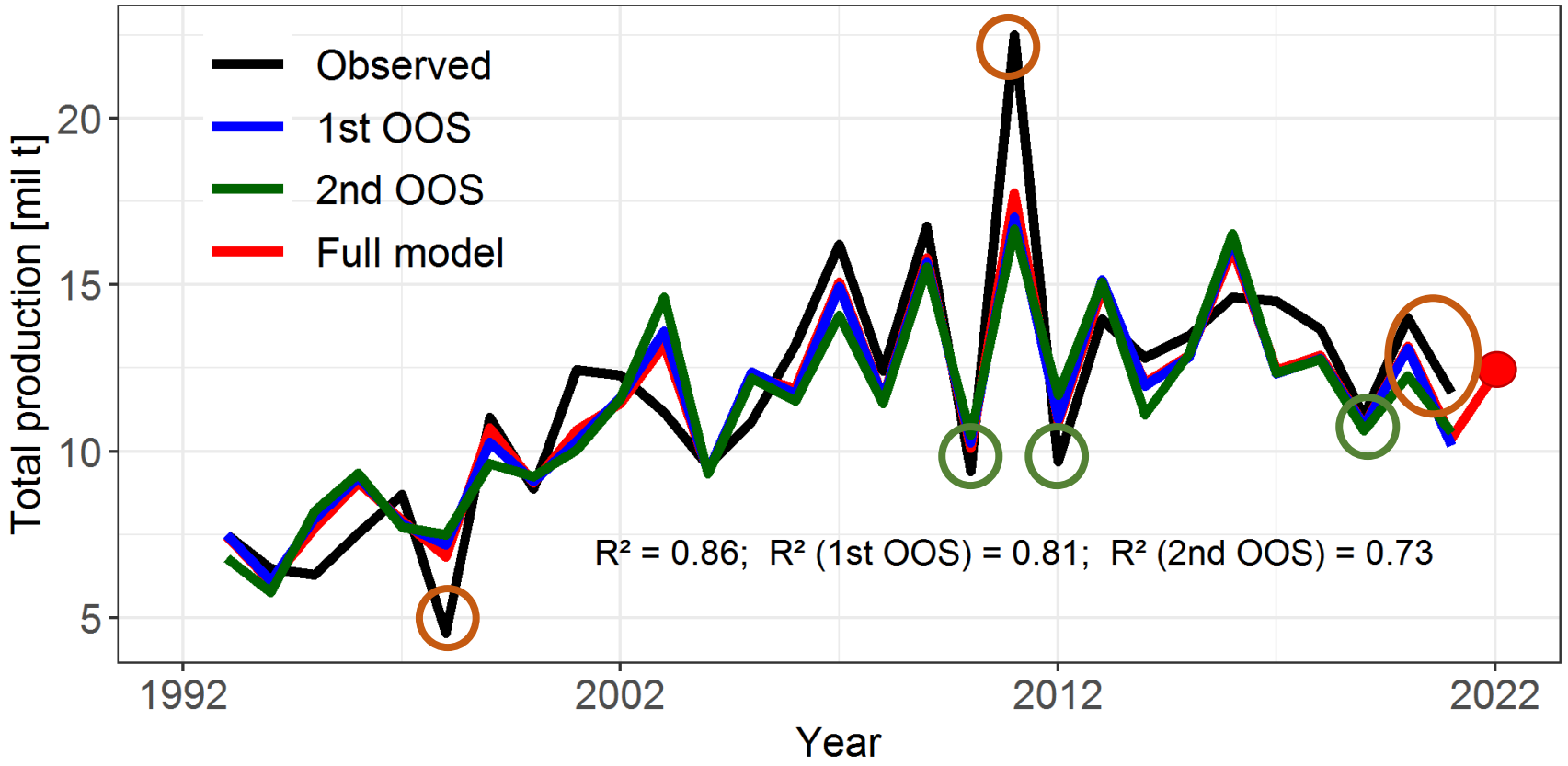

A. PRE-PROCESSING DATA
B. VARIABLE SELECTION
Weather data (ERA5)
Split into growth stages
Create and standardise variables
1) Remove all agroclimatic variables with near zero variance
Yield data (reported data)
Detrend & demean
Log-transformation
2) Of groups of strongly correlated variables (r > 0.6), keep only the one with highest correlation with yields.
3) Pick up to 6 variables with LASSO. If non selected choose 6 with highest correlation to yield
Production area (reported data)
E. ABSOLUTE YIELDS AND PRODUCTION
D. VALIDATION
C. REGRESSION MODEL
Calculate total production
Recalculate absolute yields
Out-of sample validation:
1st order: coefficients
2nd order: variables
Regression model at the oblast level forecasts logarithmic, detrended yield anomalies
Data
Process
Model

Model Performance for Yield Forecast at the Oblast Level

- High model performance for all oblasts in sample
- Robust out-of-sample validations for the main producing regions



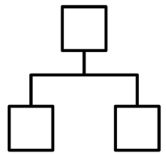
Model Performance for total Wheat Production in Kazakhstan



Forecast for 2022: 12.4 million tonnes (5 % above 2021)

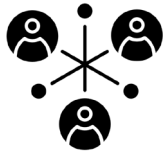
Forecasts from USDA, FAO and European Commission project higher production (12% - 19% above 2021)

Conclusions



Possible to set up a robust model forecasting wheat production in Kazakhstan with publicly available data and low computational power

Most sound if reliable estimates of the production area are available



High interest from stakeholders in Kazakhstan

Model has the potential to be applied in addition to existing forecasting mechanisms for operational forecasts to inform about looming food shortages and needed agronomic inventions

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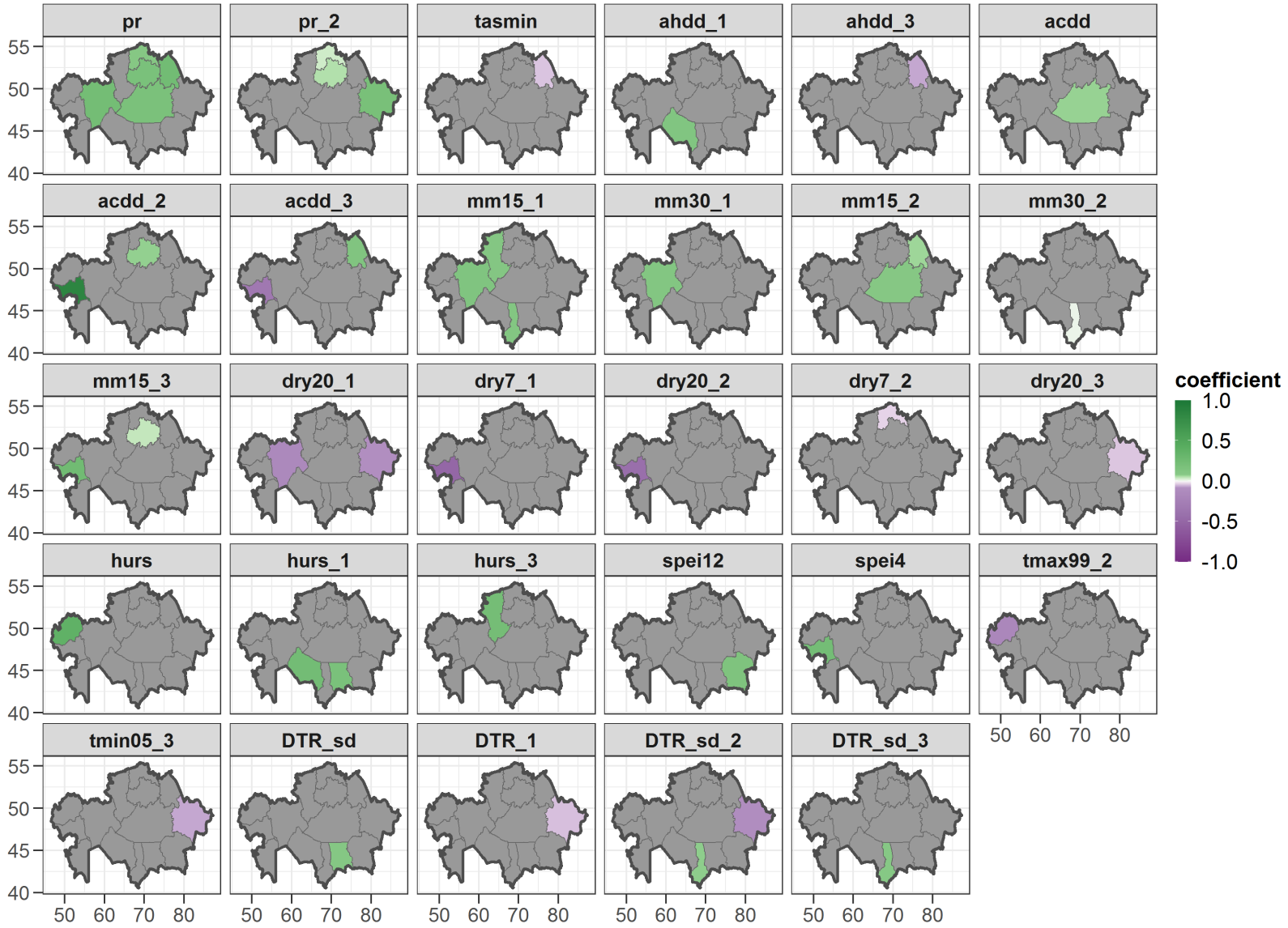
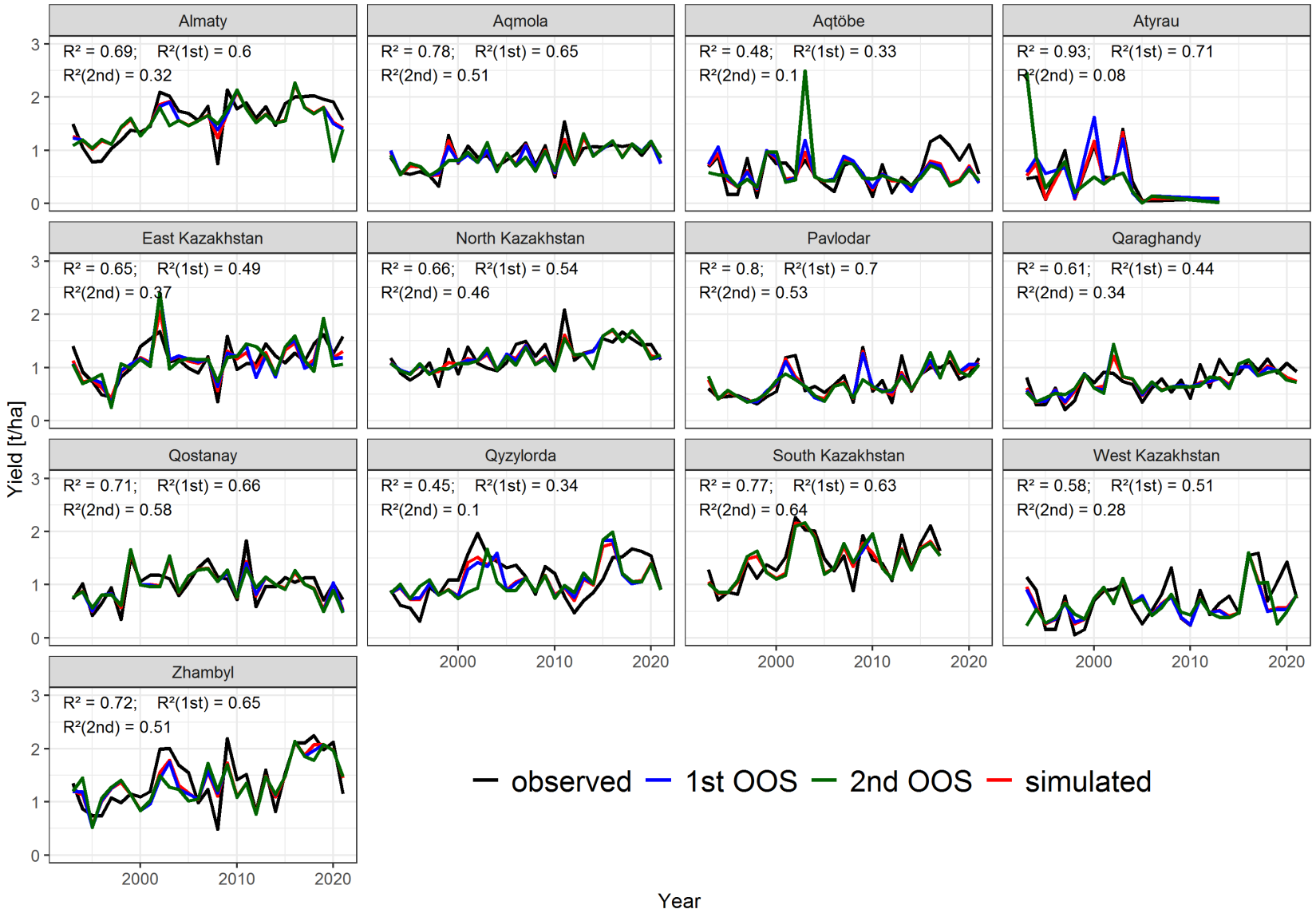
Thank you for your attention!

SCAN ME

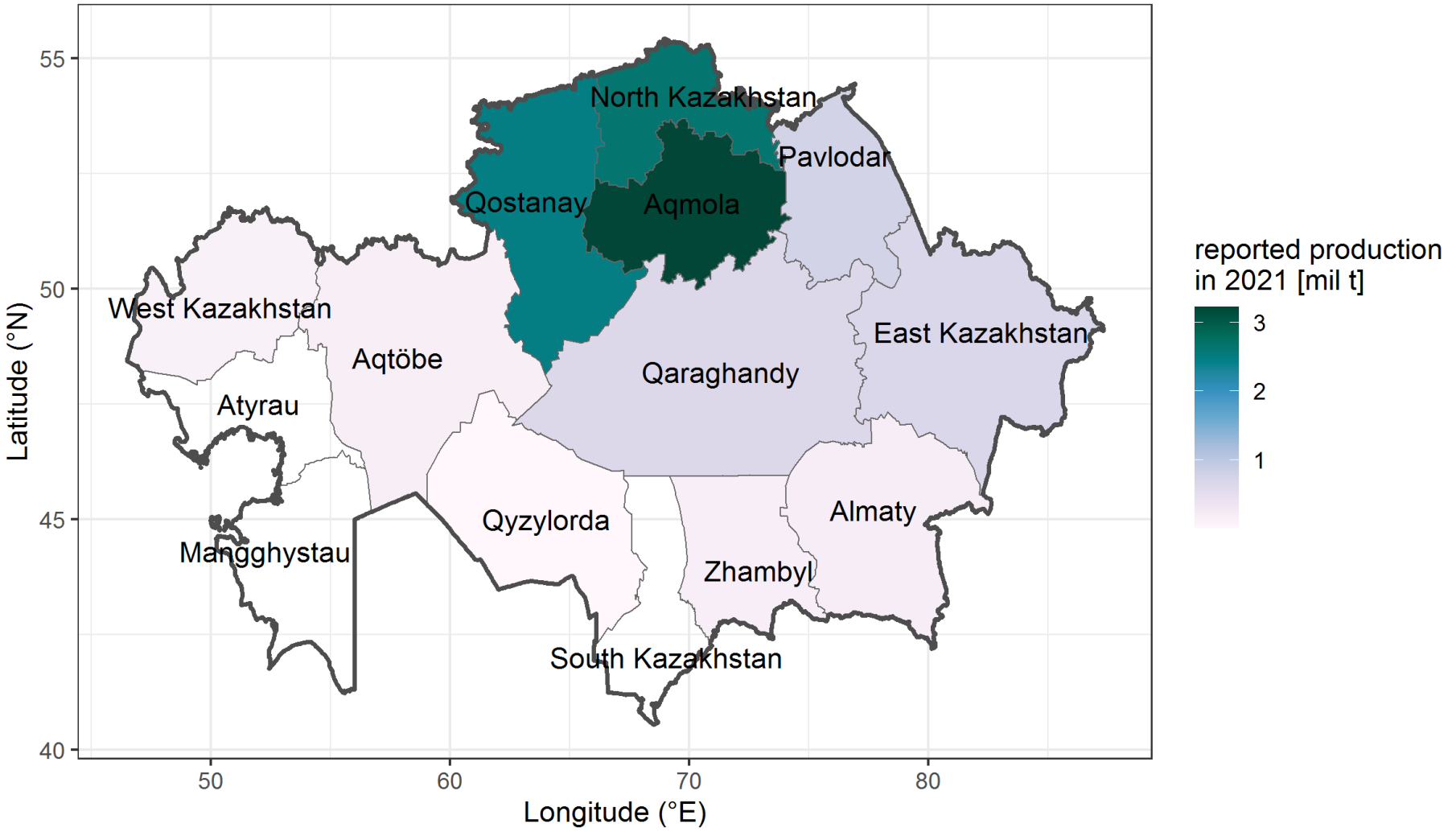
Model coefficients of selected agroclimatic indices



Time series of observed and simulated yields



Reported Wheat Production in 2021



Time series of reported yields