Potsdam Institute for Climate Impact Research

Local cultivar phenology key to representing extreme weather impacts on global maize yields

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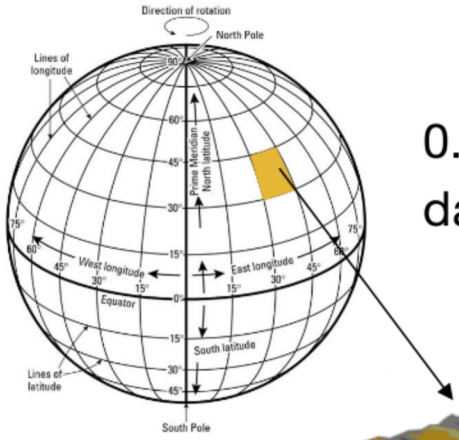
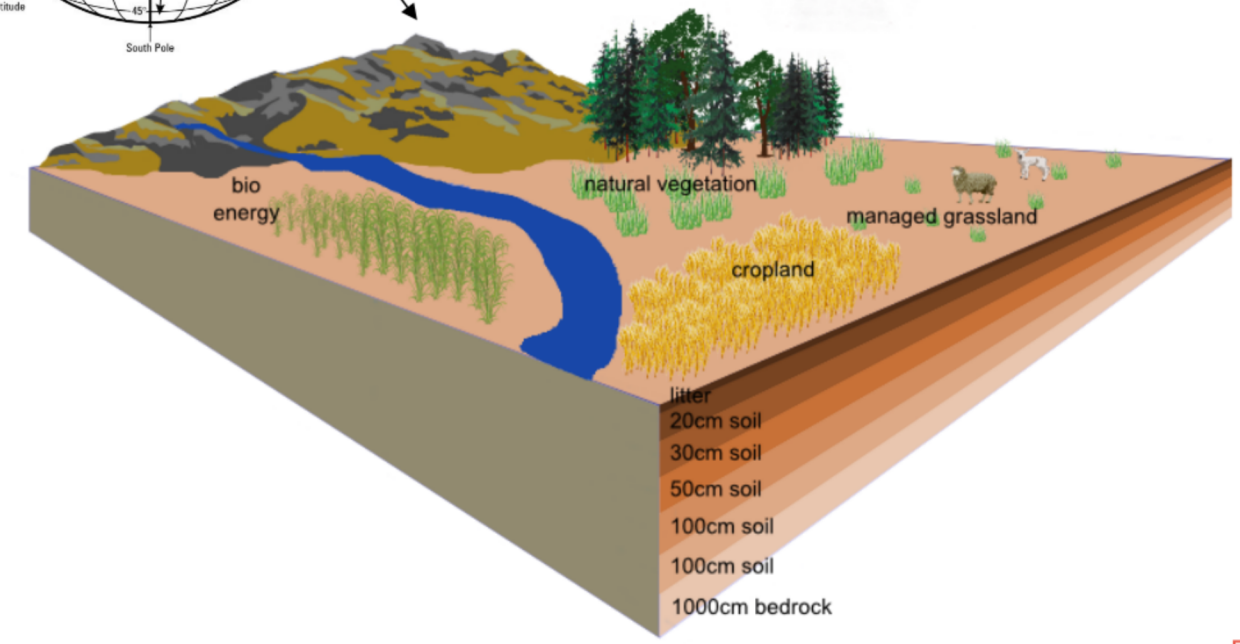
Agro-hydrological model LPJmL



0.5° grid (67,000 cells)
daily iteration



Dynamic process representation

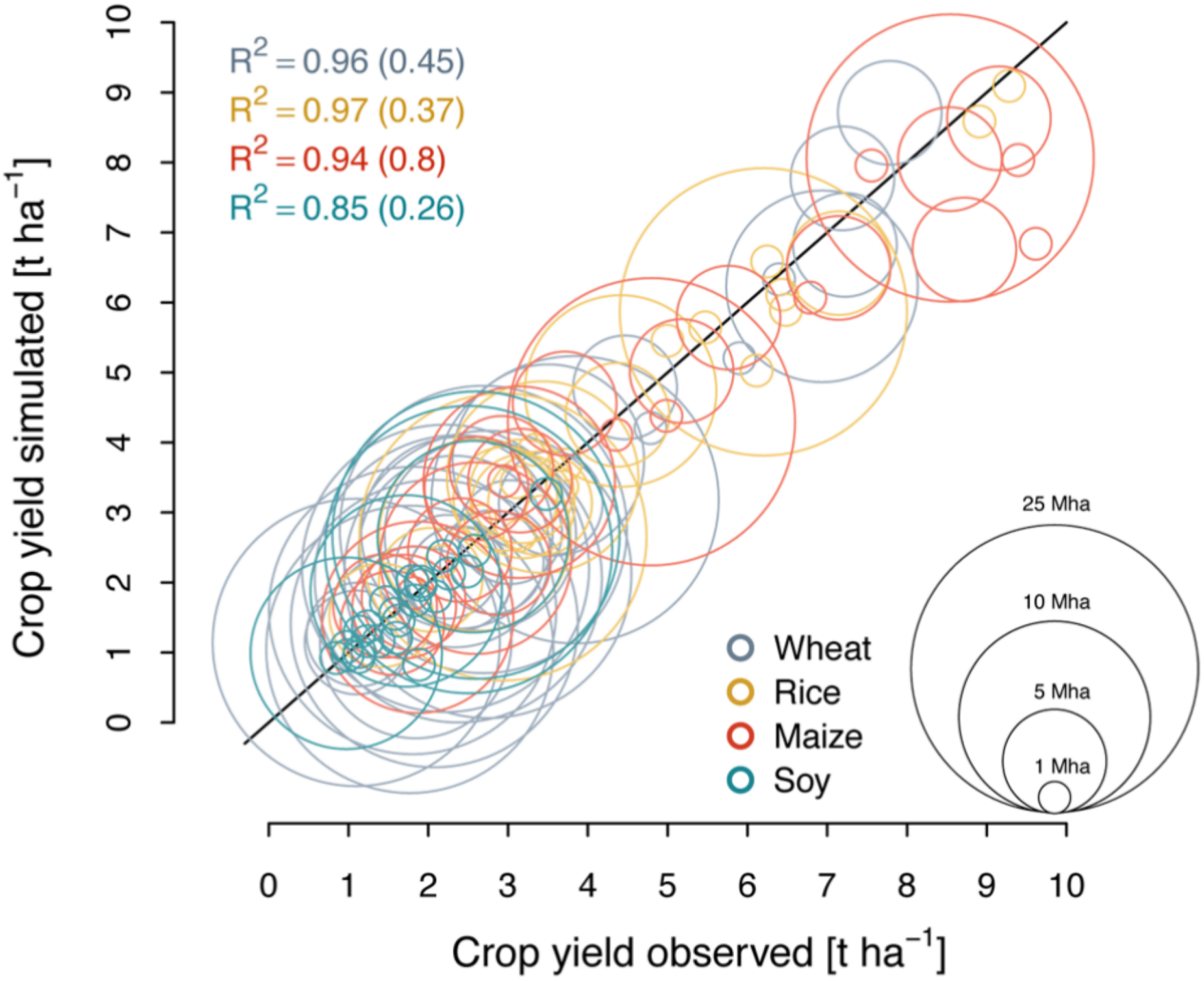
Agricultural model

Hydrological model

New mechanistic irrigation module

→ New phenology module

Long-term national crop yields can be reproduced



Jägermeyr et al. (2017), NatComm.

AGU PUBLICATIONS

Earth's Future

RESEARCH ARTICLE

10.1002/2016EF000525

Special Section:
Avoiding Disasters:

Understanding the weather signal in national crop-yield variability

Katja Frieler[1], Bernhard Schauberger[1], Almut Arneth[2], Juraj Balkovič[3,4], James Chryssanthacopoulos[5,6], Delphine Deryng[5,7], Joshua Elliott[5,6], Christian Folberth[3], Nikola

nature COMMUNICATIONS

ARTICLE

Received 1 Sep 2014 | Accepted 28 Nov 2014 | Published 22 Jan 2015

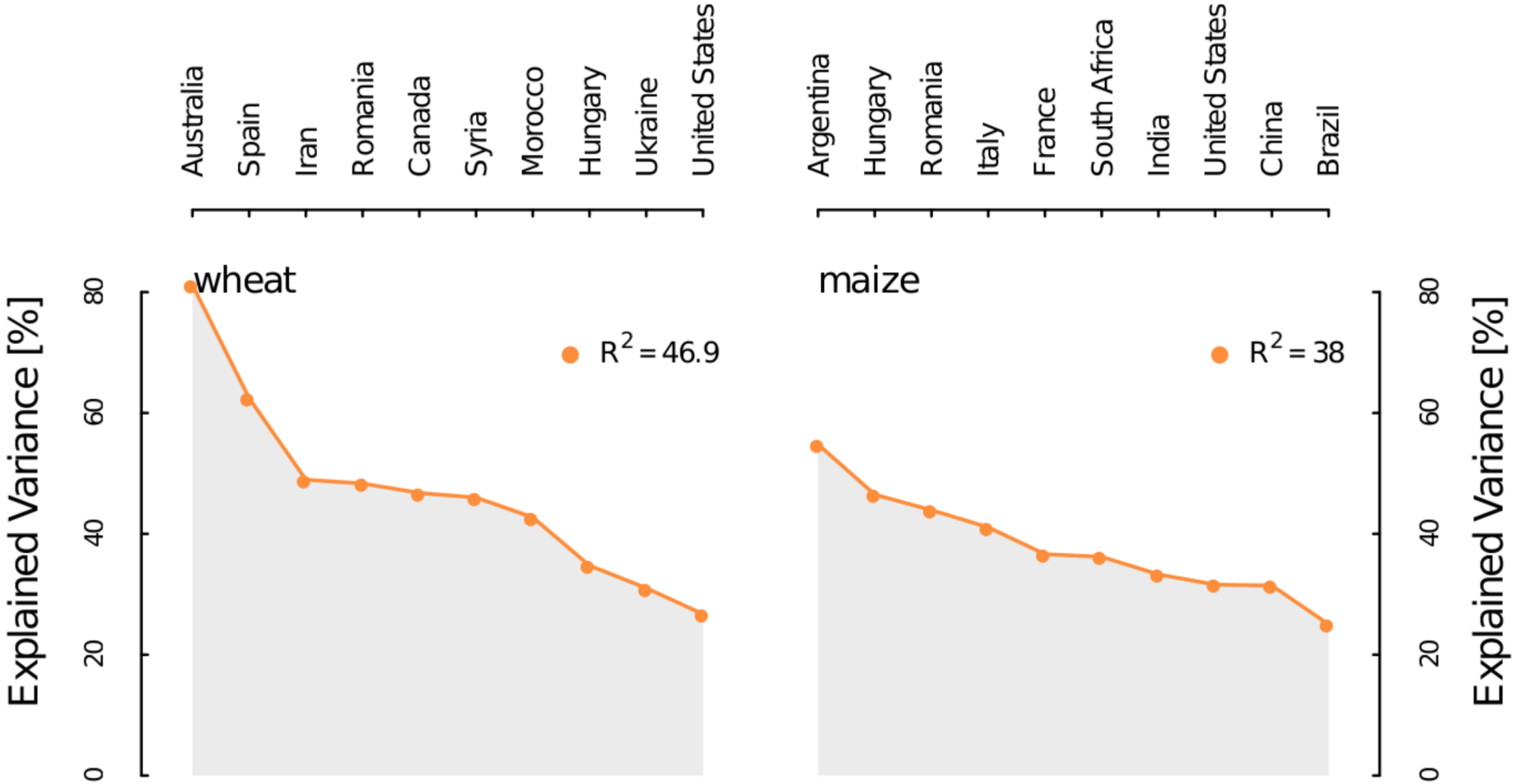
DOI: 10.1038/ncomms6989 OPEN

Climate variation explains a third of global crop yield variability

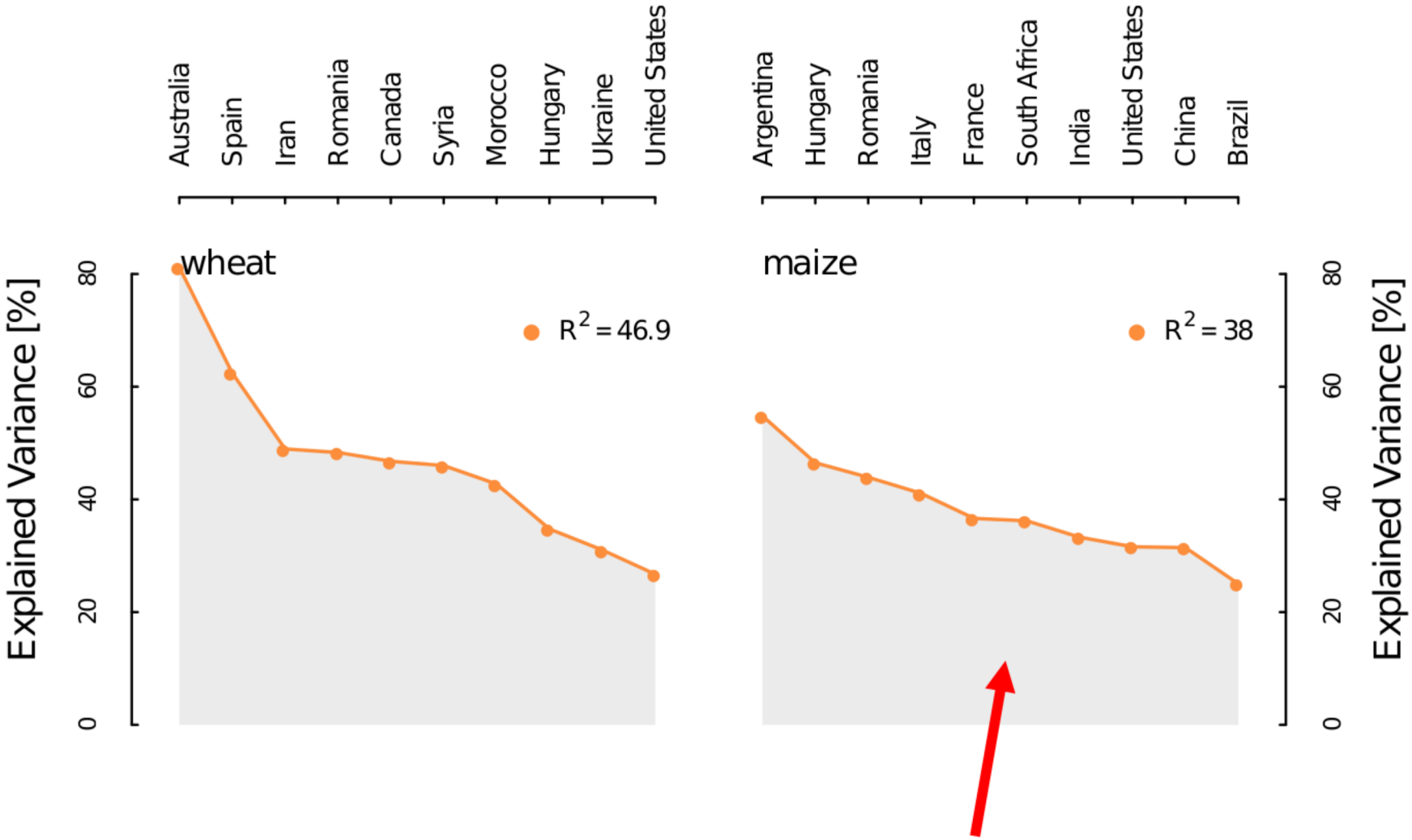
Deepak K. Ray[1], James S. Gerber[1], Graham K. MacDonald[1] & Paul C. West[1]

PIK

Country-level R^2 yield anomalies

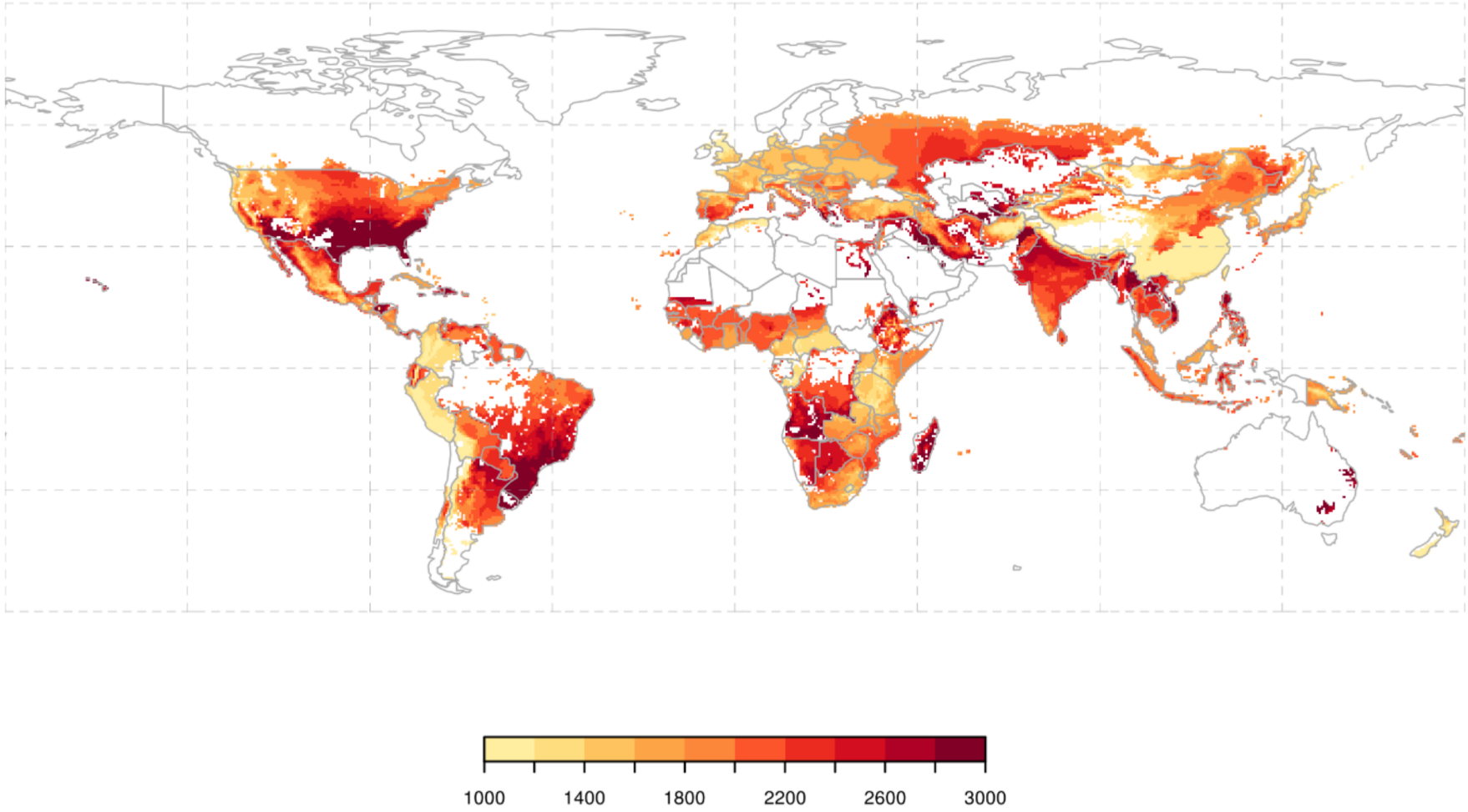


Country-level R^2 yield anomalies



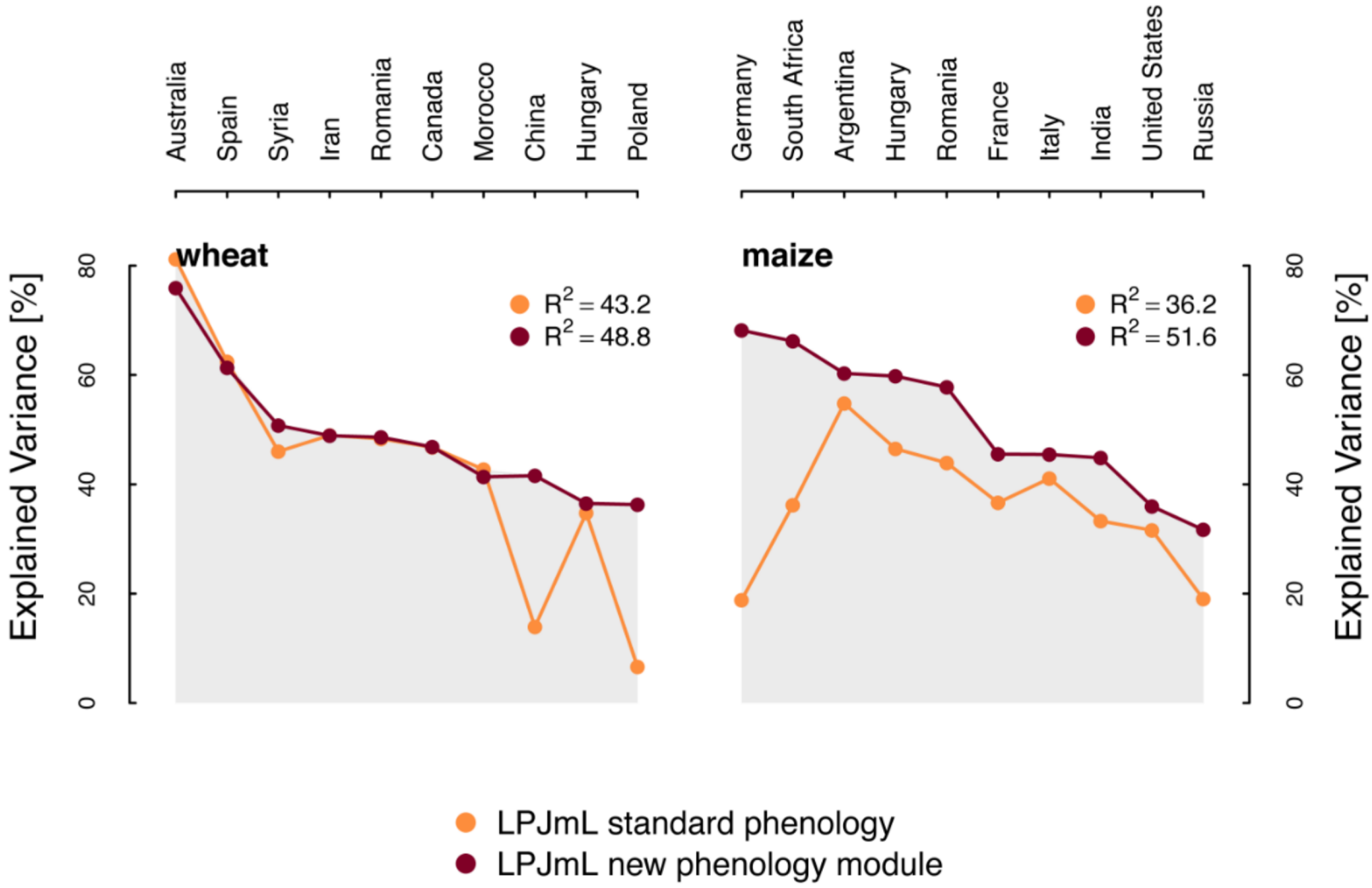
Default phenology model: constant heat unit requirements maize: 1600 °C

Heat unit requirements for maize between sowing and harvest

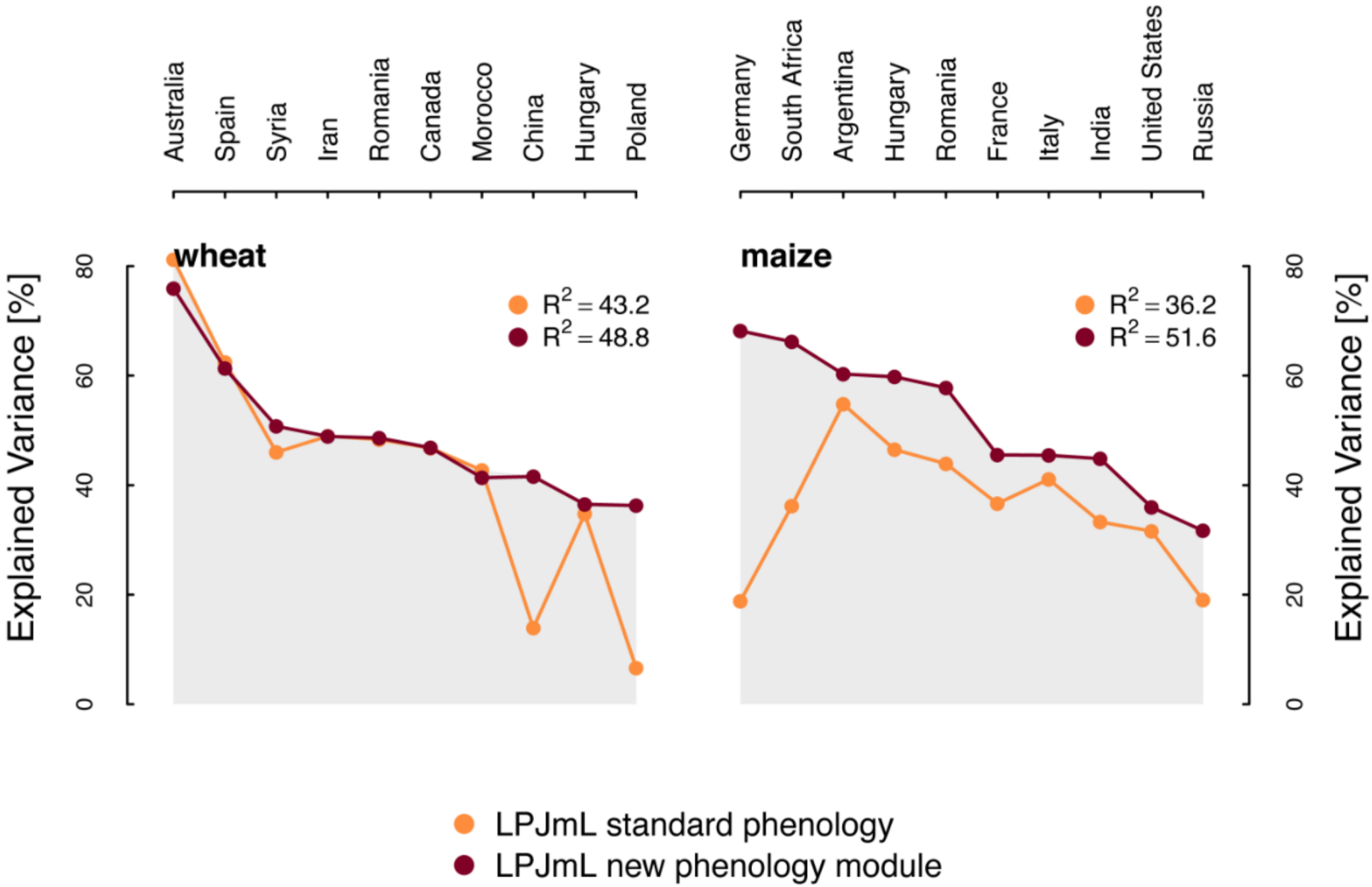


PIK

Improved phenology model: sowing and harvest observations to retrieve local cultivars

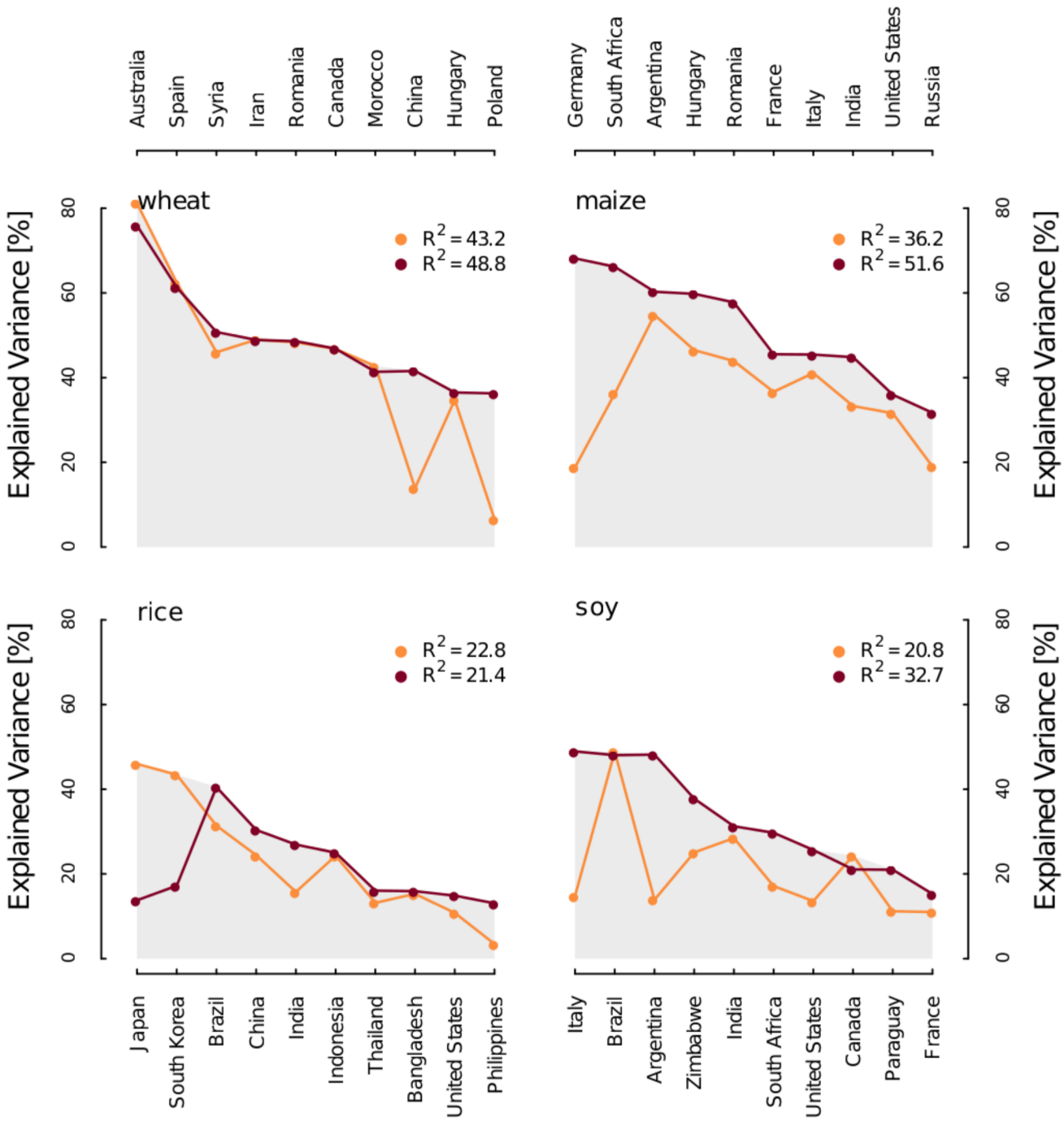


Improved phenology model: local cultivars



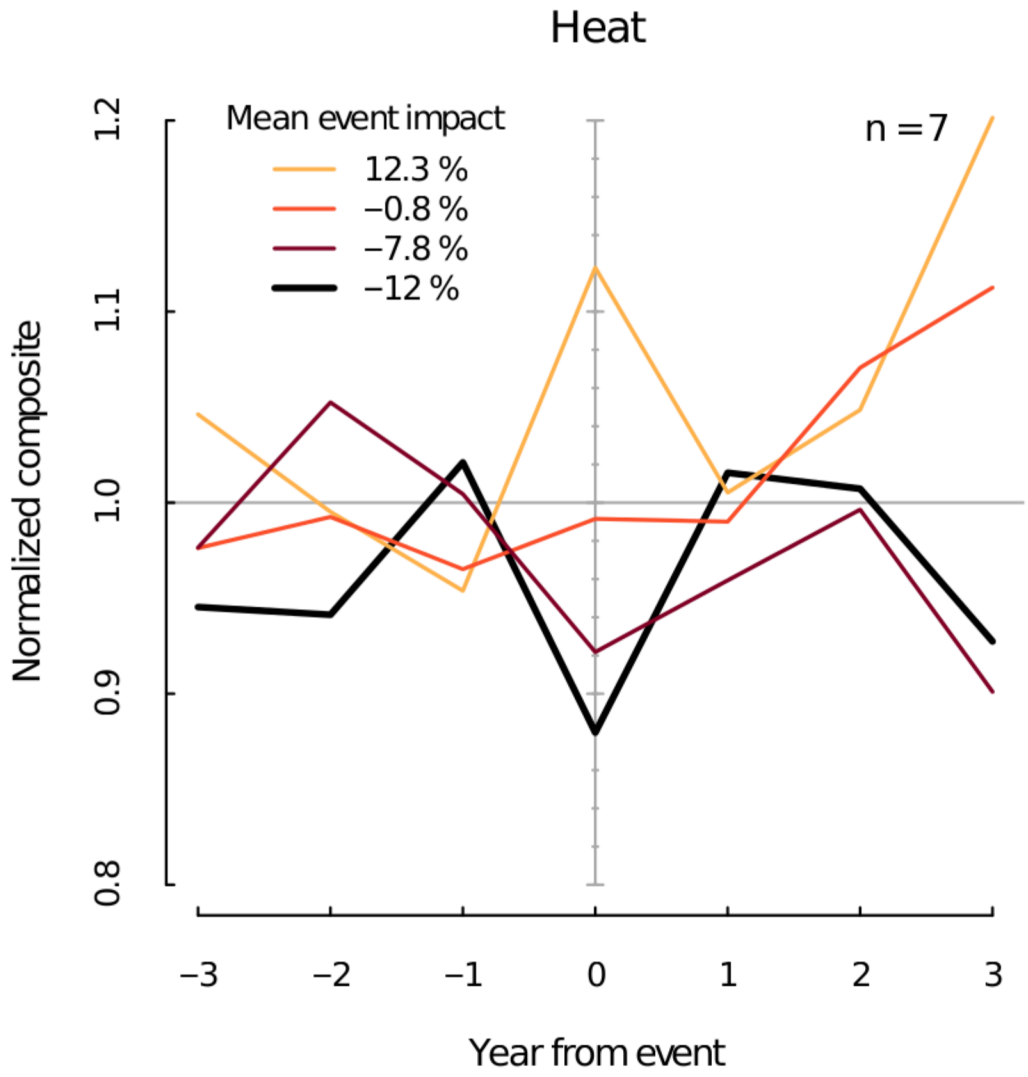
Using MIRCA2000 dataset on sowing and harvest dates

Improved phenology model: local cultivars



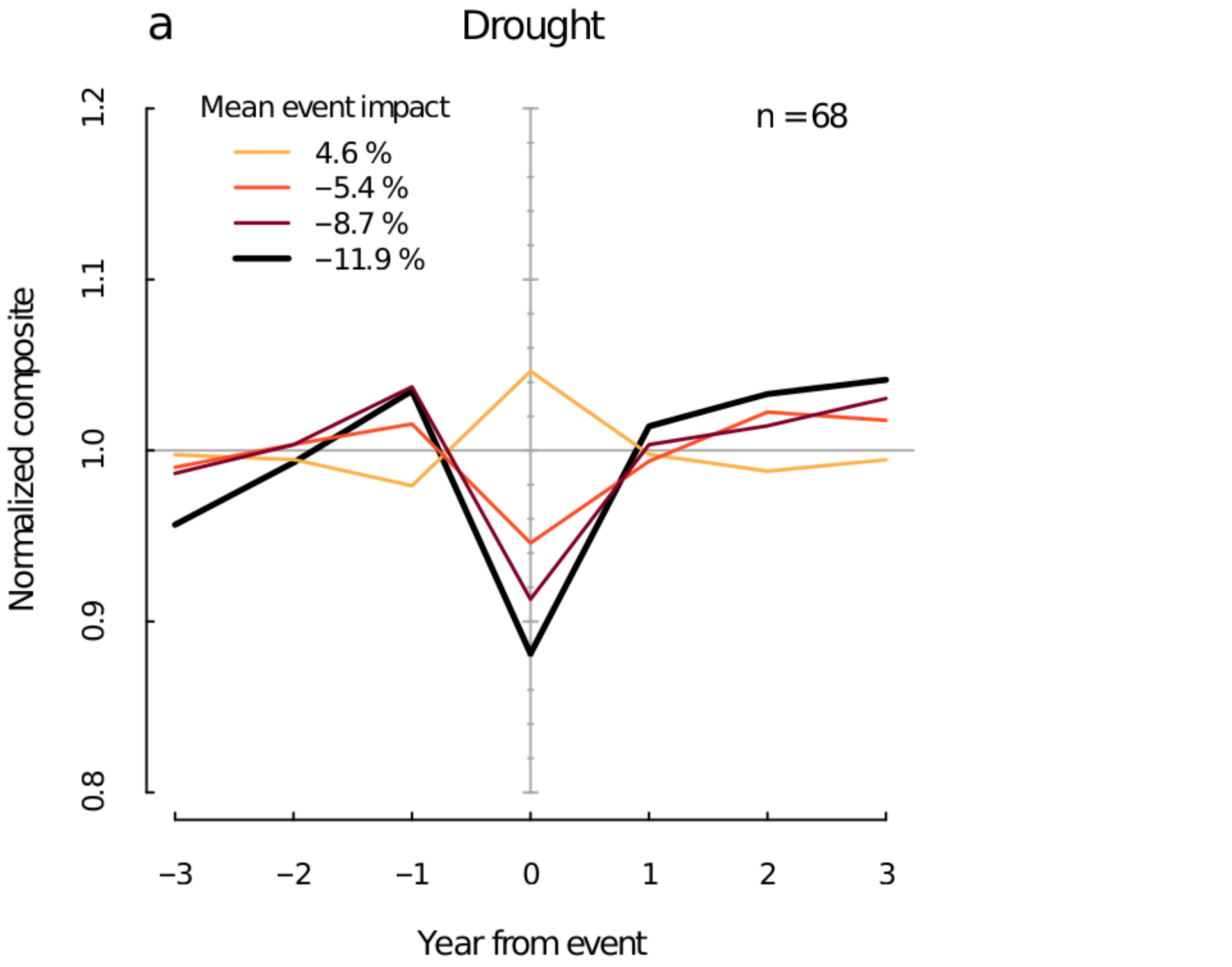
Jägermeyr et al. (in prep.)

Maize yields during 2003 Europe heat wave



Jägermeyr et al. (in prep.)

Maize impacts of global extreme events 1961-2010
(EM-DAT disaster database)



Jägermeyr et al. (in prep.)

Maize impacts of global extreme events 1961-2010
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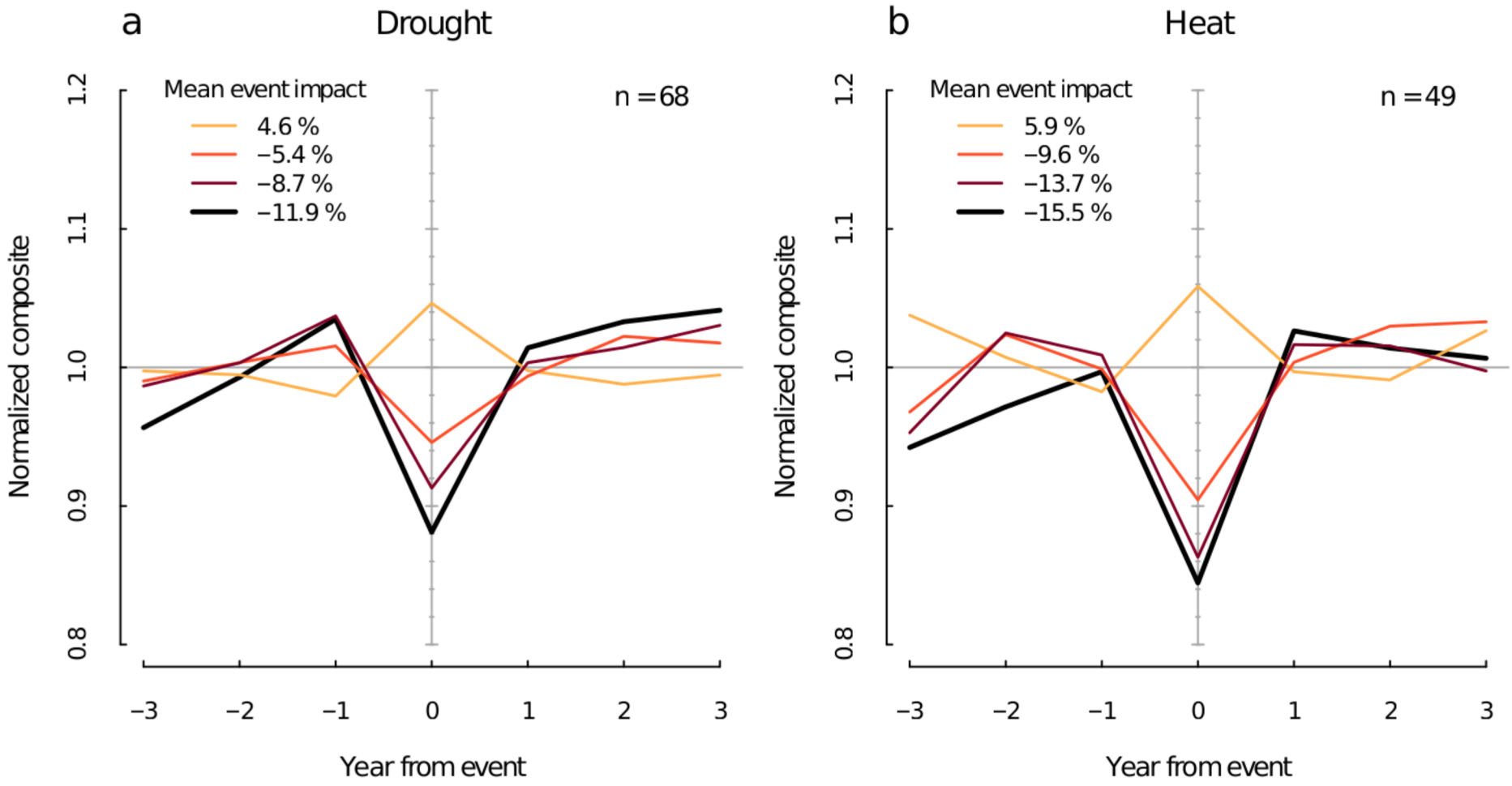

Jägermeyr et al. (in prep.)

Conclusions

- Accounting for local heat unit requirements improves phenology simulation across crop types and regions
- Significantly higher inter-annual yield variability explained
- Impact of heat and drought extreme events better represented
- Helps to produce more reliable projections of potential adverse climate change impacts on future crop yields
- Such model framework instrumental for simulating climate change adaptation measures

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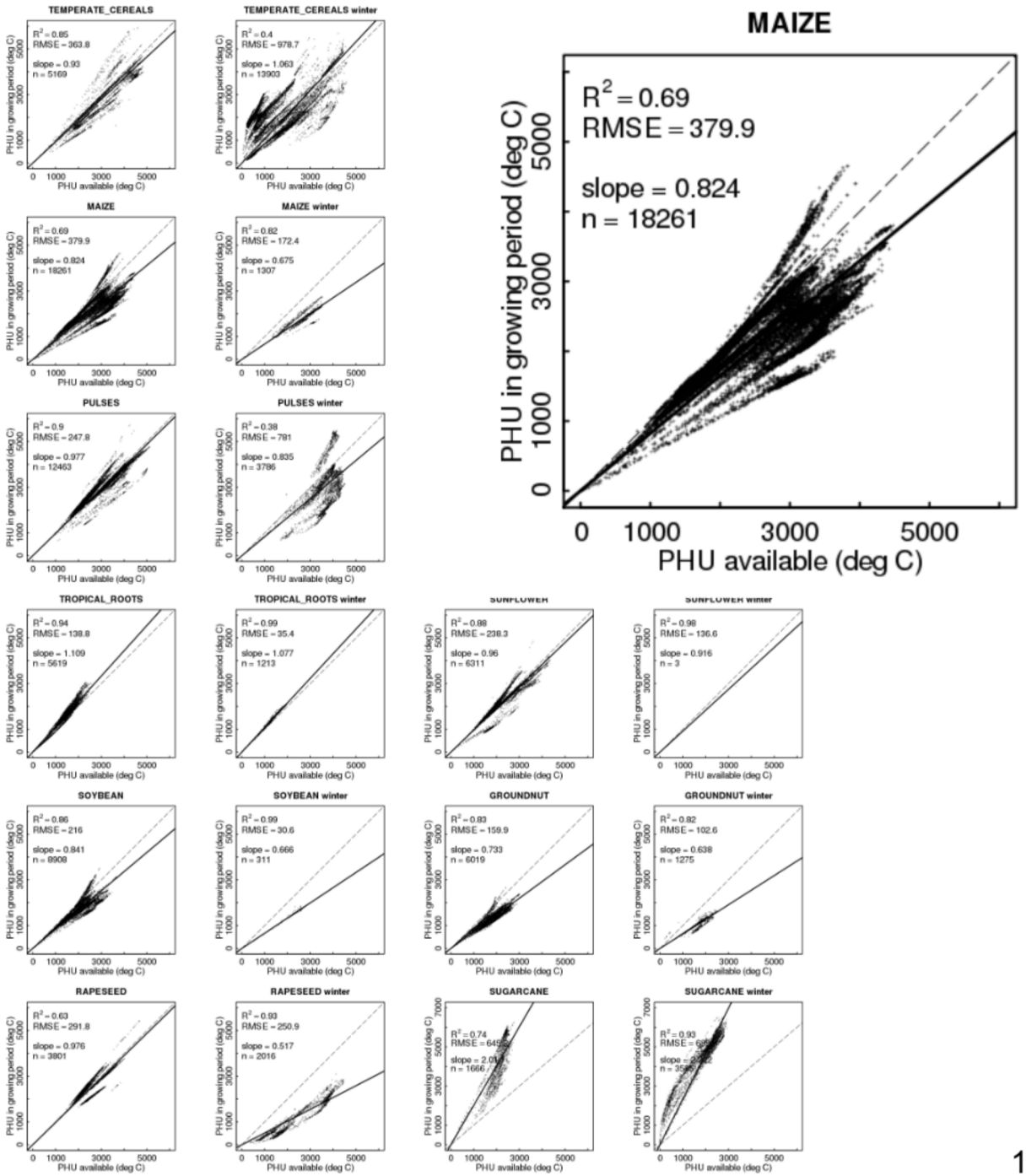
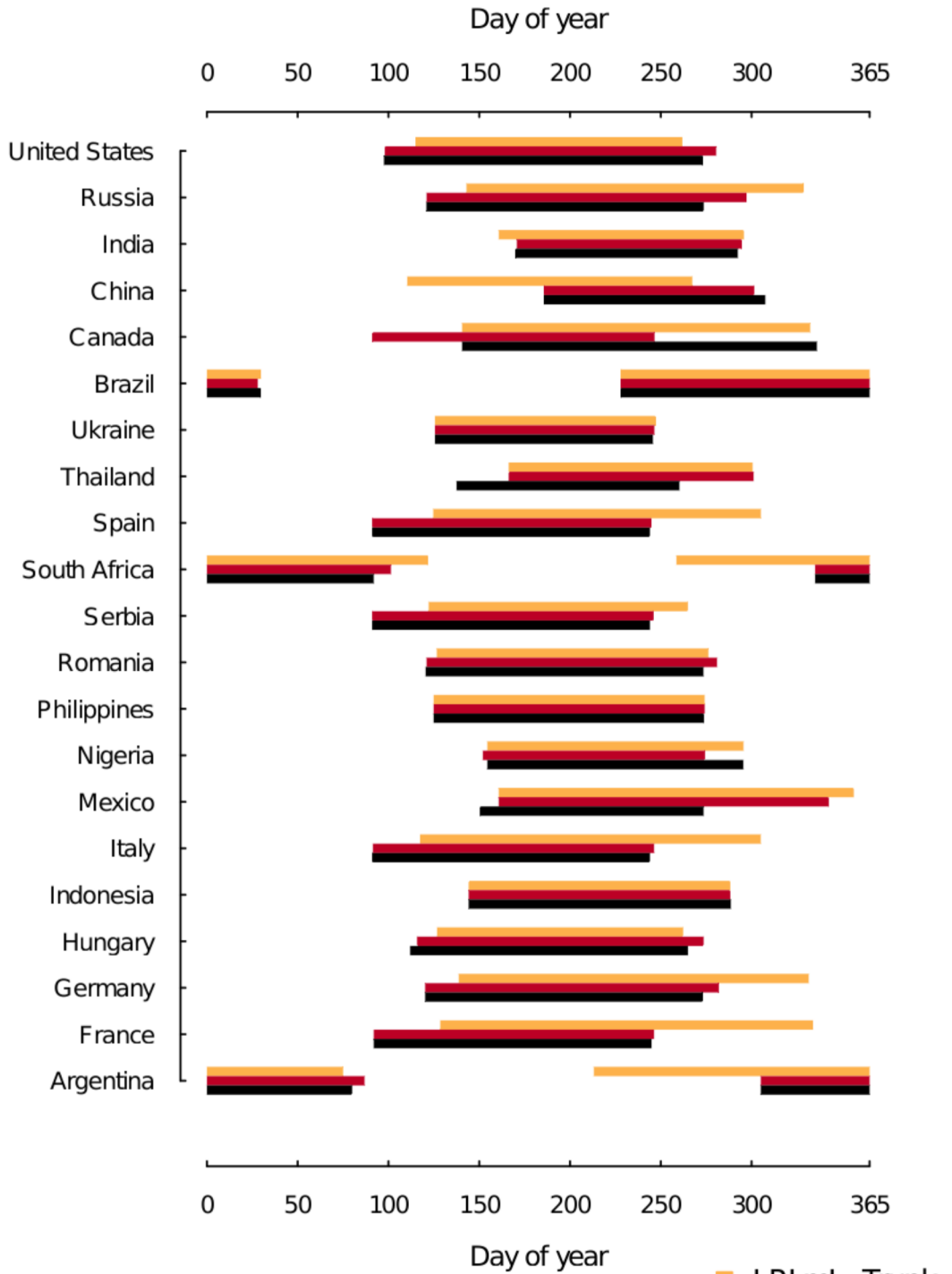
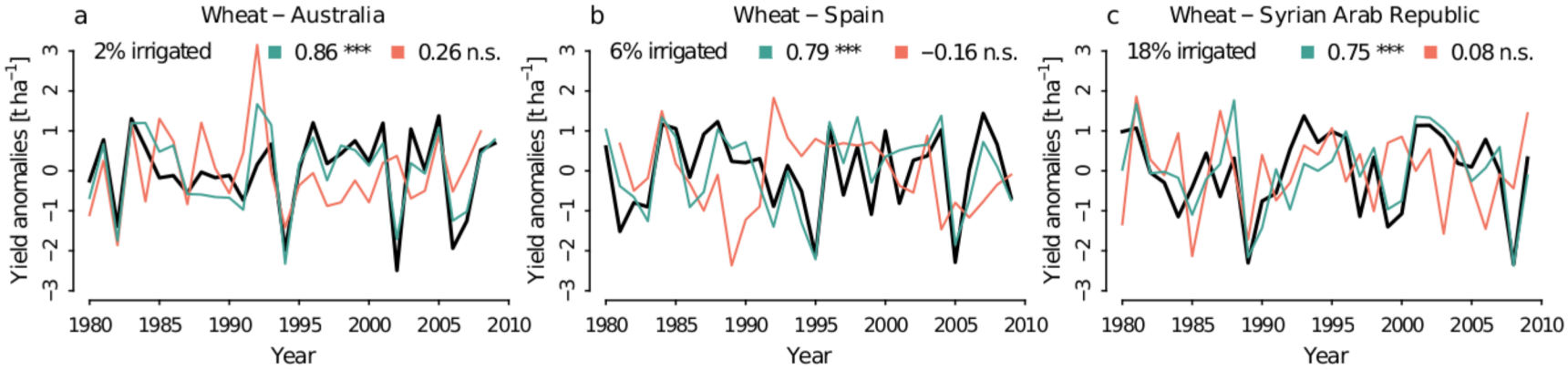
Adaptation: changing heat units under climate change



Length of growing season



Yield anomalies and water stress



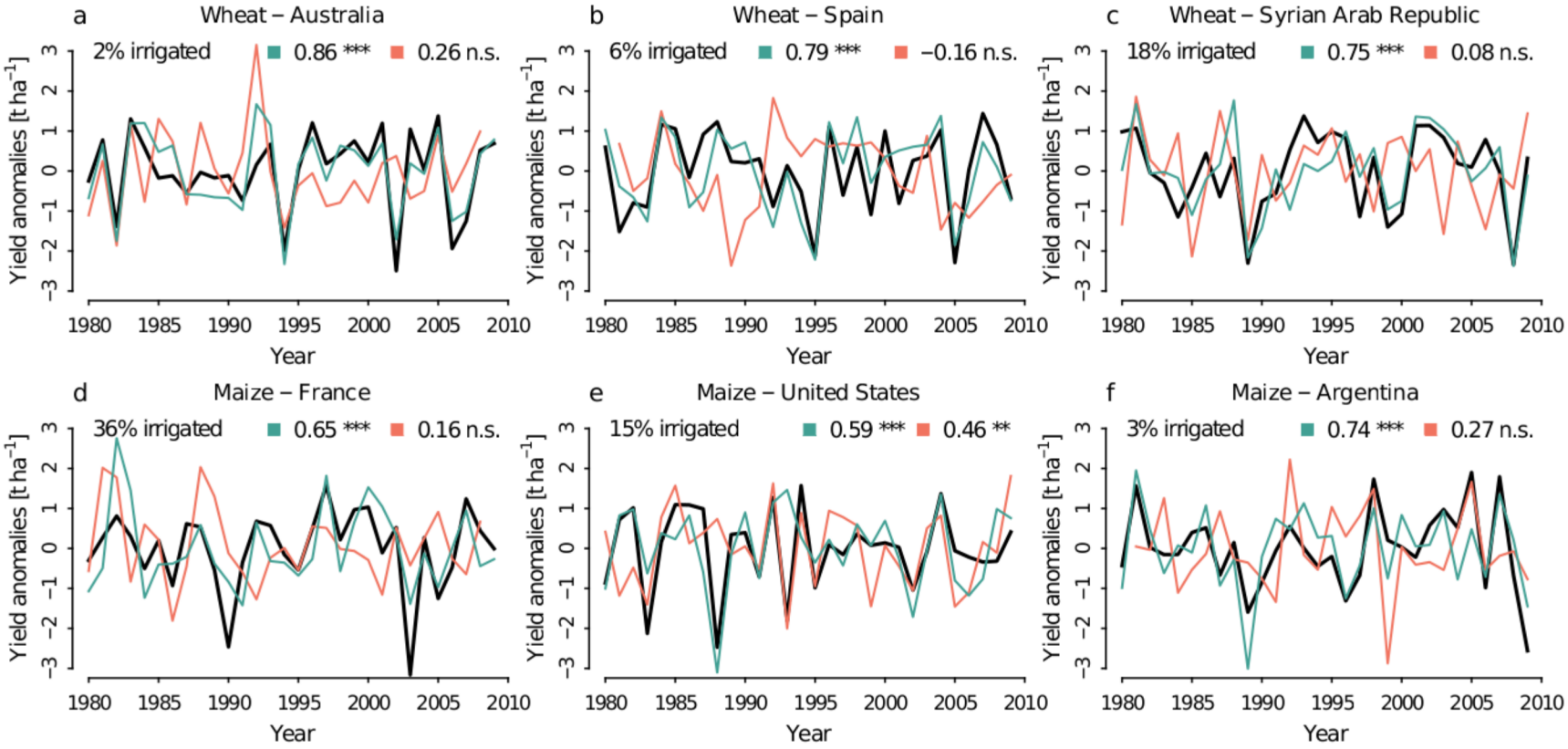
FAO observations

LPJ mL simulations (standard)

LPJ mL simulations (full irrigation)

Jägermeyr et al. (2017), Nature Comm.

Yield anomalies and water stress



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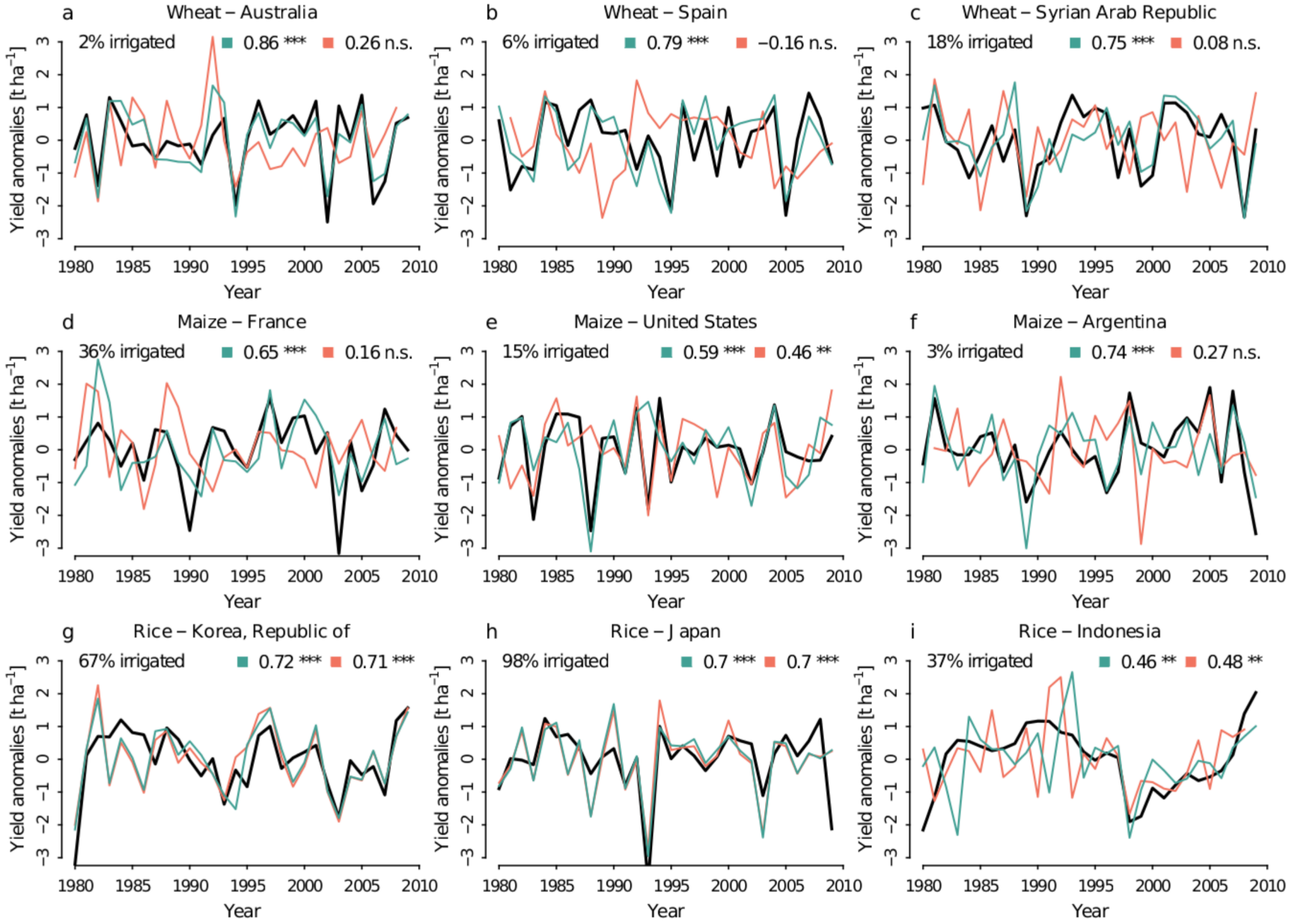
Yield anomalies and water stress



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MIRCA Data variability