Developing a seasonal wheat yield prediction system for Israel

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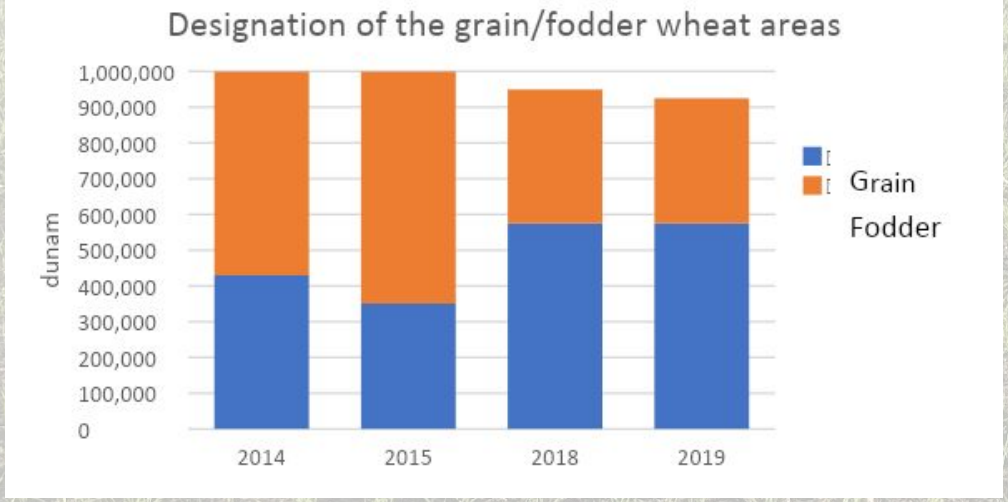
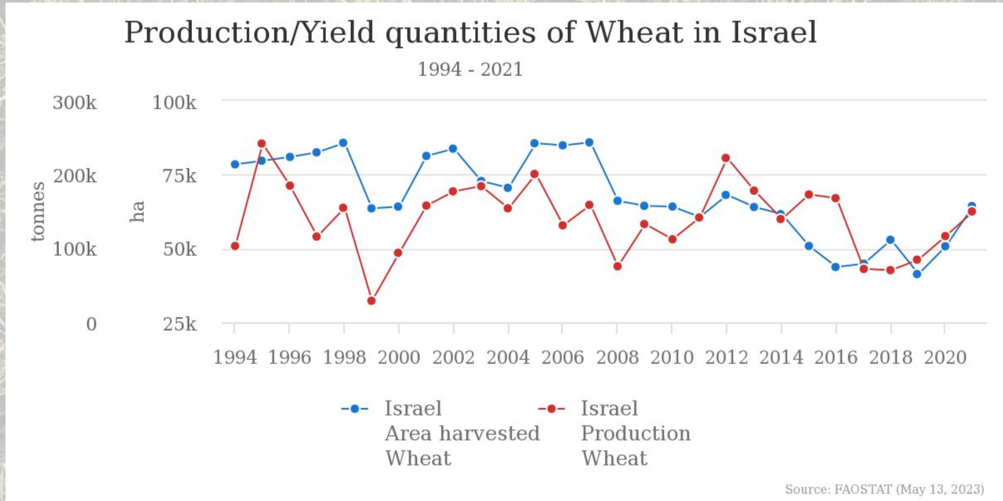
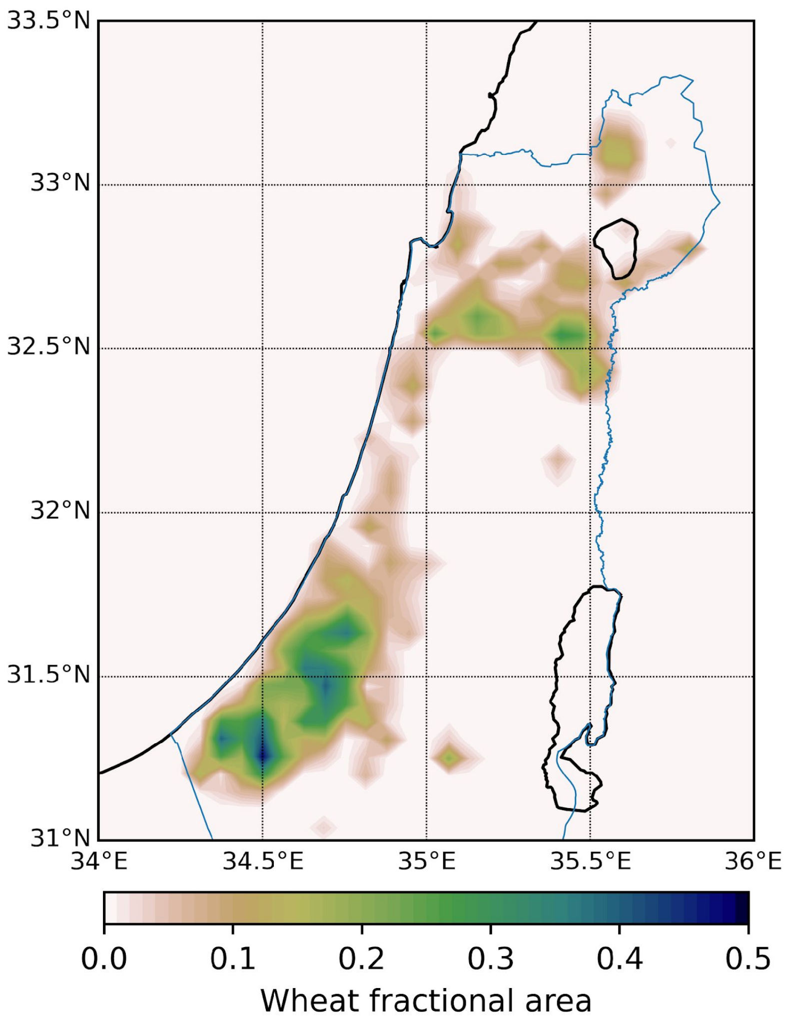
Wheat in Israel

- Spring wheat that is grown in the winter (October-May)
- About half is harvested early (around February) for fodder
- Mostly clustered in the Northern Negev
- High sensitivity to climate (mostly dryland agriculture)





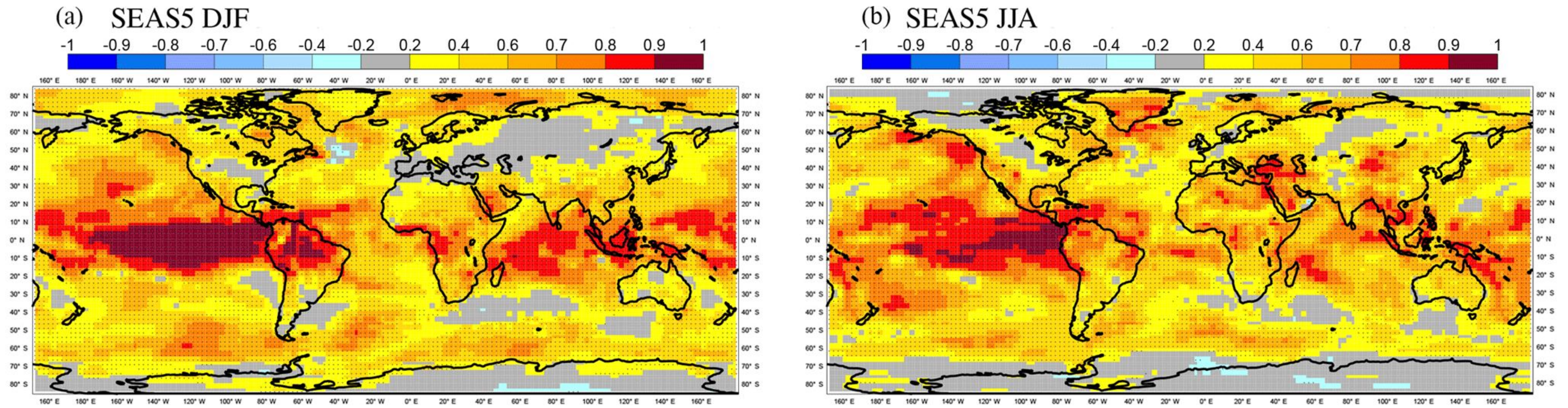


Why should we want seasonal predictions of wheat?

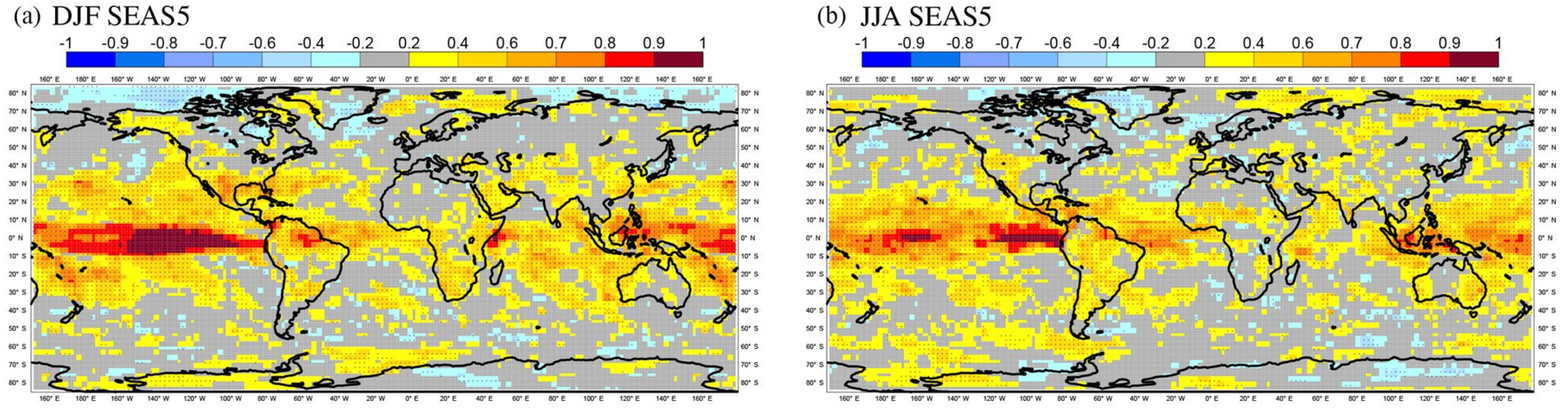
- Inform farmers, policy makers, and stakeholders about potential risks
- Apply climate-informed management strategies:
  - Wheat cultivars
  - Sowing and harvest dates
  - Fodder (silage/hay) or grain
  - Irrigation
  - Rotation

Seasonal prediction systems

Surface temperature anomaly correlation – one month lead



Precipitation anomaly correlation – one month lead

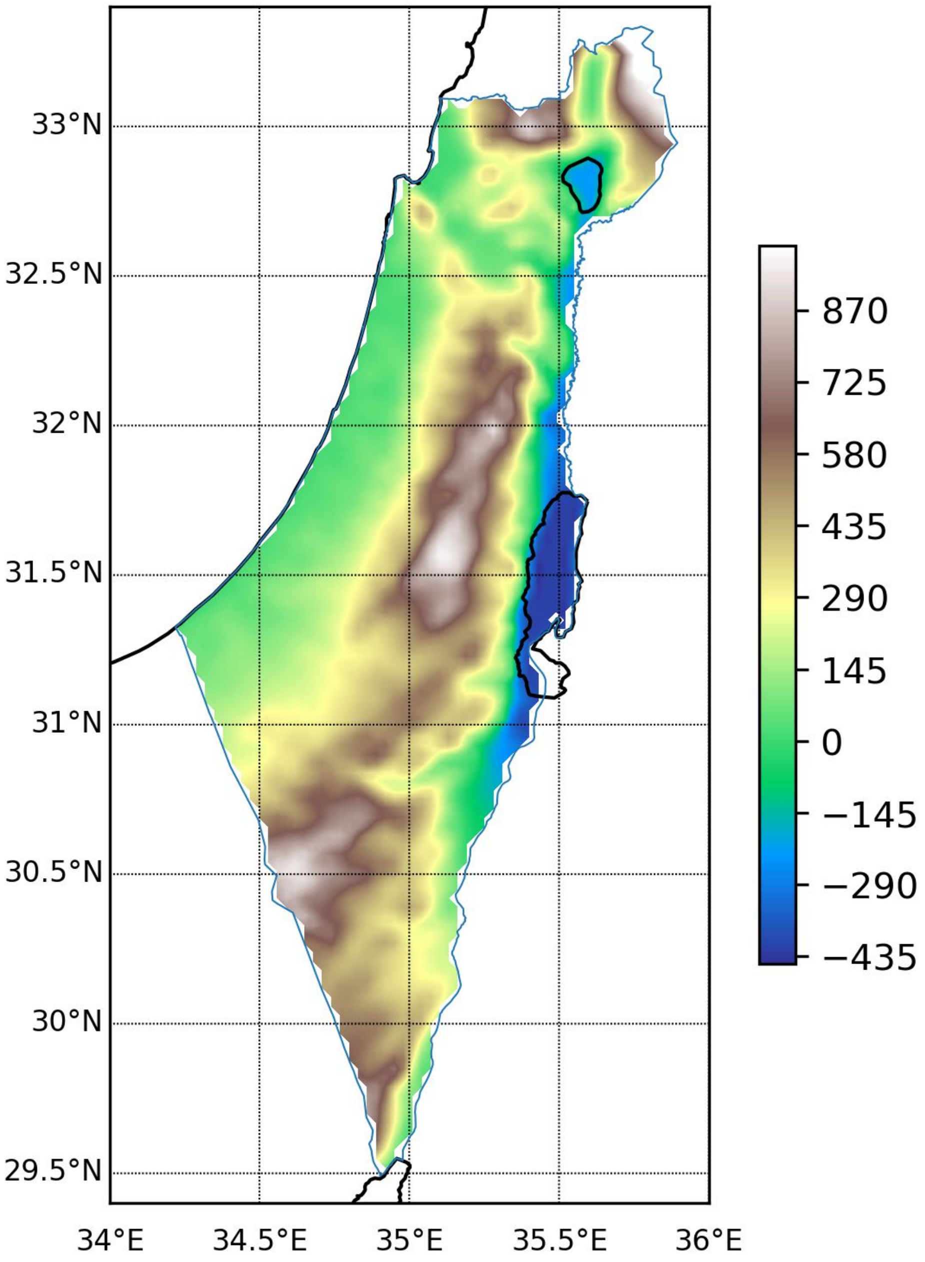


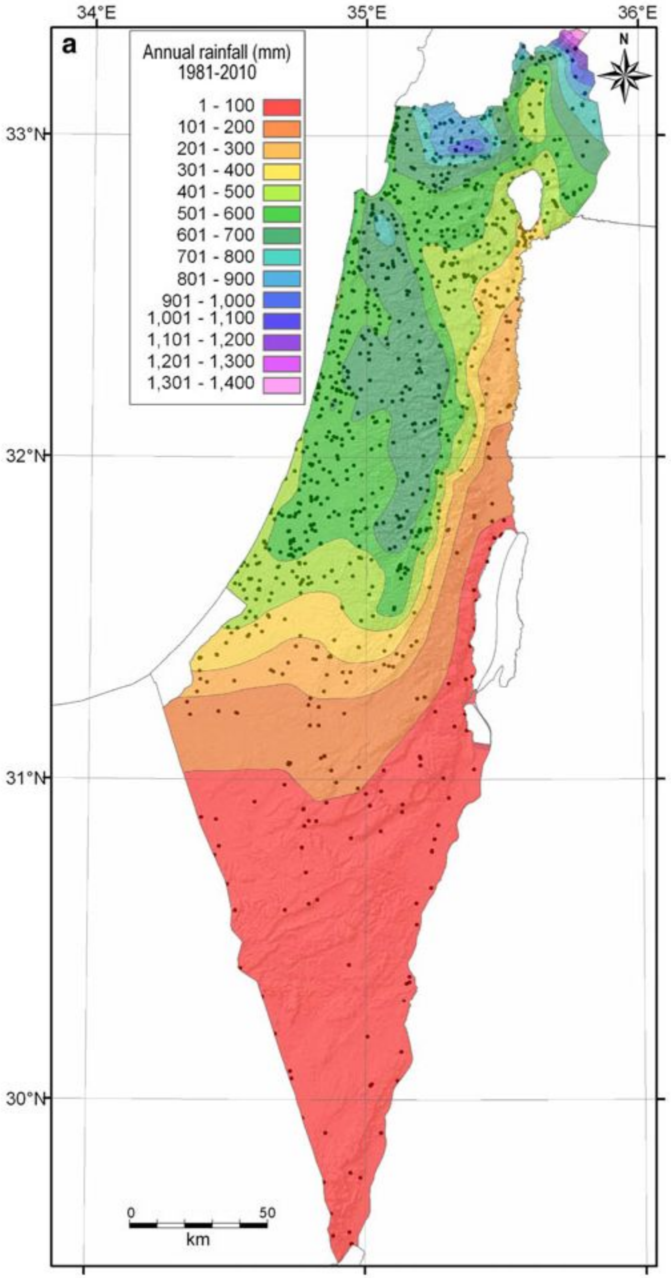
- Seasonal prediction systems have potential prediction skill arising from the slow varying process in the ocean and the land surface
- Operational forecasts are currently performed at low horizontal resolution (~0.5°)

Johnson et al. 2019 (*Geoscientific Model Development*)

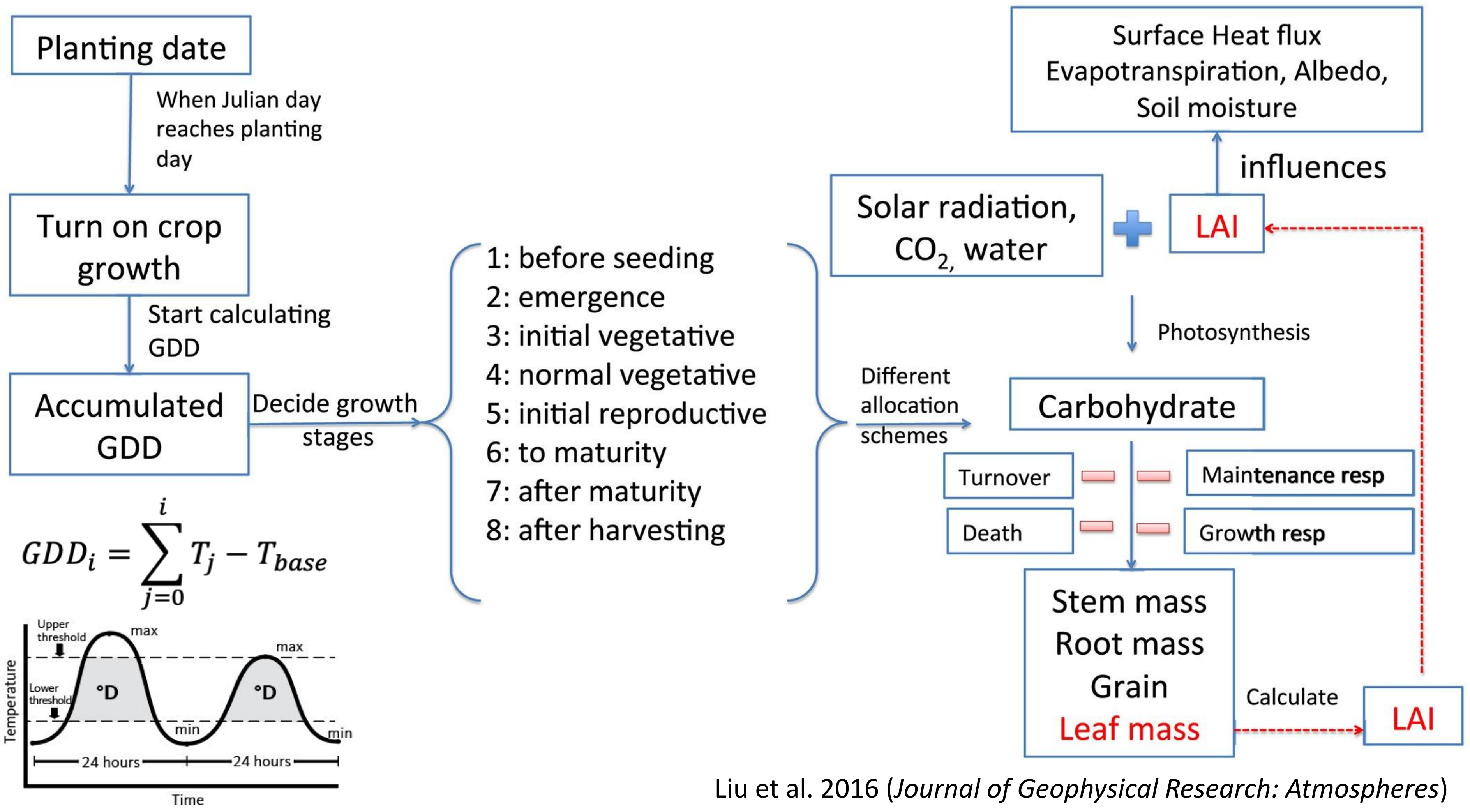
Israel's topography and rain

- Complex topography
- Sharp precipitation gradients: north-south and west-east





Crop model



Liu et al. 2016 (*Journal of Geophysical Research: Atmospheres*)

Objective

Develop a high-resolution coupled climate-crop seasonal wheat yield prediction system for Israel

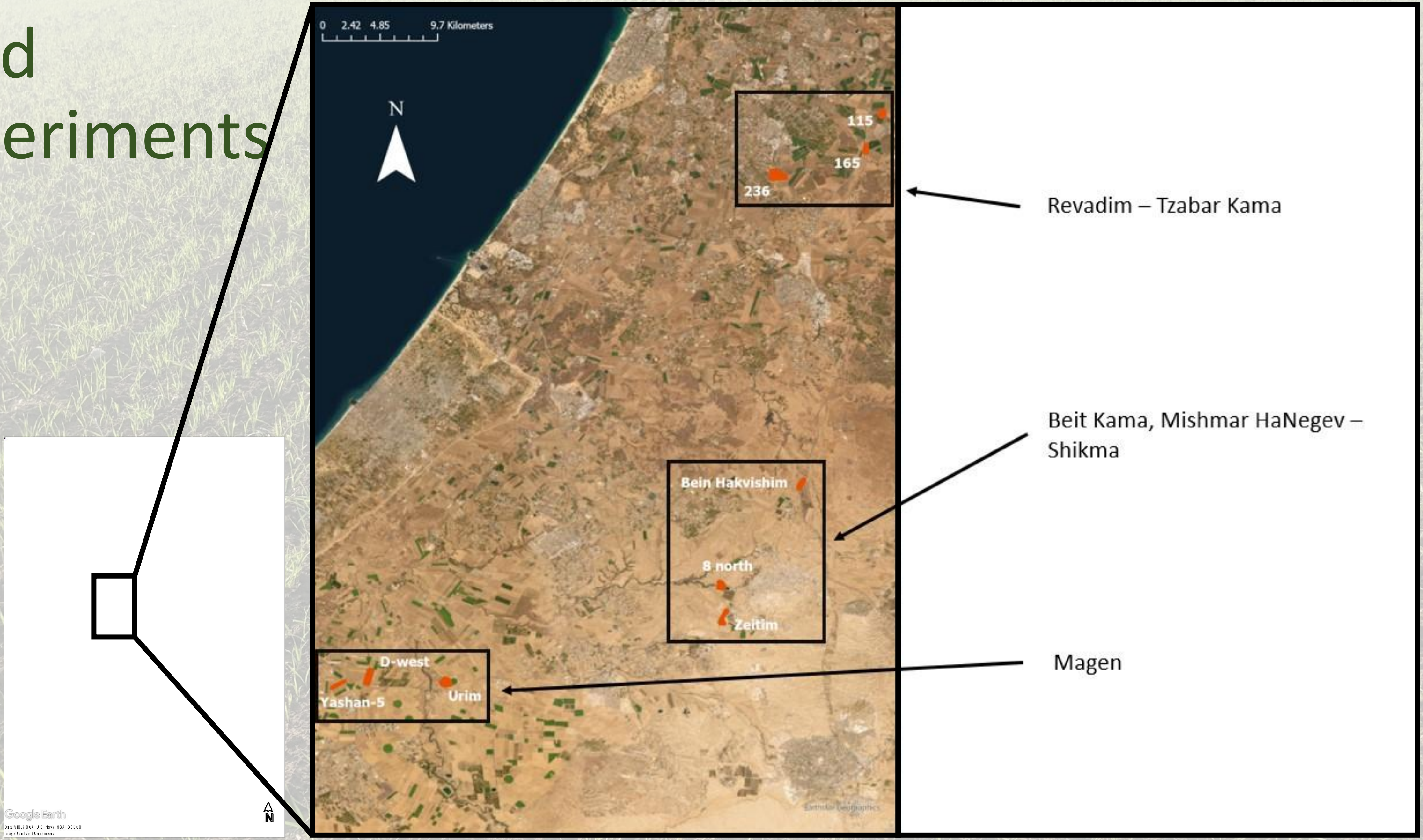
Hypotheses

- **A downscaled seasonal prediction system** can improve regional climate predictions
- **A coupled climate-crop model** can further improve prediction skill and provide reliable seasonal predictions of crop yield

Tasks

- Determine Noah-MP-Crop parameters for local spring wheat grown in Israel
- Perform coupled climate-crop model simulations forced by a seasonal prediction system

Field experiments



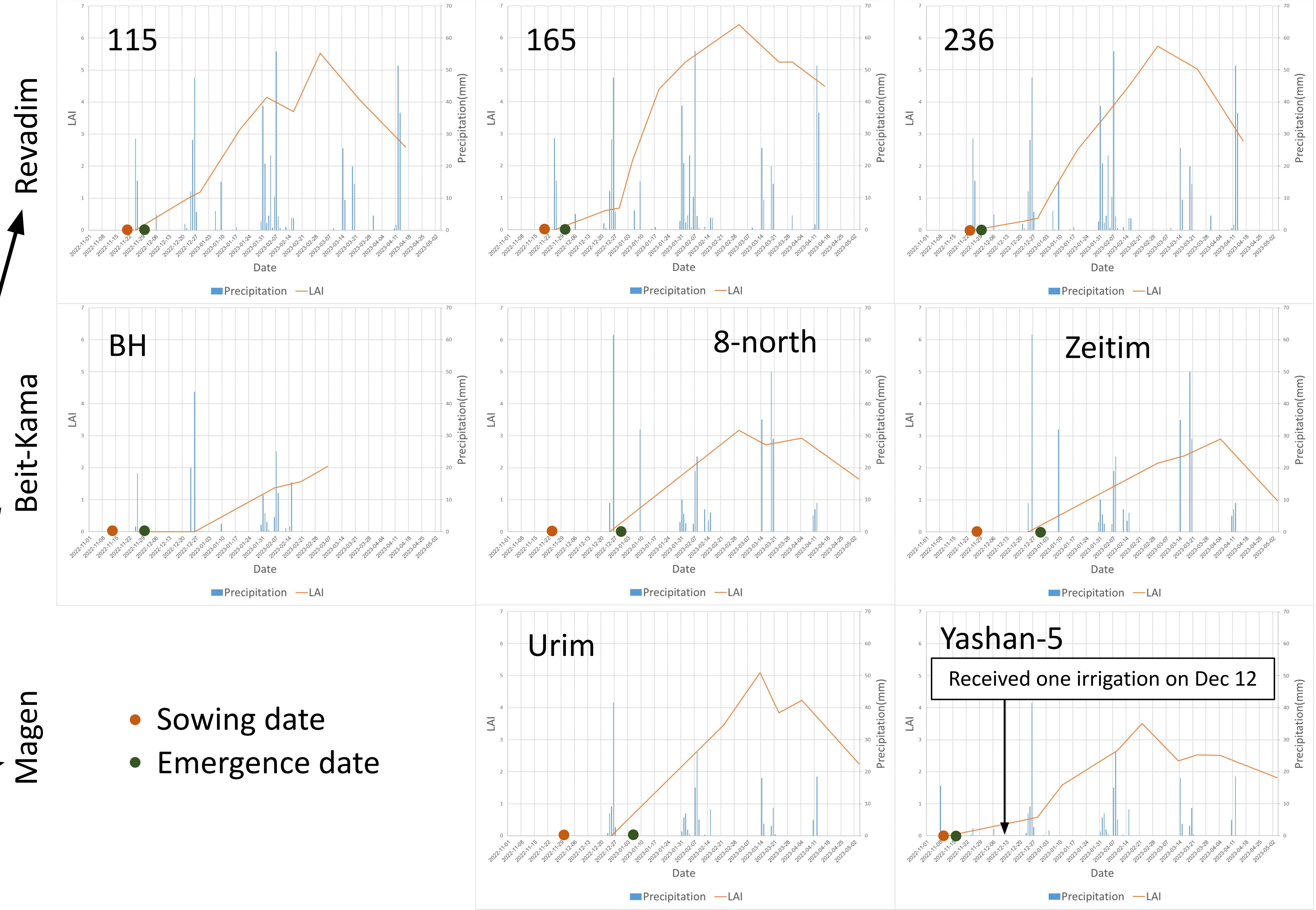
Model parameters assessment

Field measurements	
Collected data	Model parameters
Phenological stage	Growing stage accumulated GDD (GDD1-5)
Temperature	Growing stage accumulated GDD (GDD1-5)
Biomass (leaf, steam, grain)	Fraction of carbohydrate flux (LFPT, SFPT, GRAINPT)
Biomass (leaf)	Leaf area per living leaf biomass (BIO2LAI)
Leaf area index	Leaf area per living leaf biomass (BIO2LAI)

Literature search / input from farmers		
Model parameter	Default value	Local value
GDDBASE (˚C)	10	0
FOLN_MX (%)	1.5	4
Planting day (Julian day)	126	305

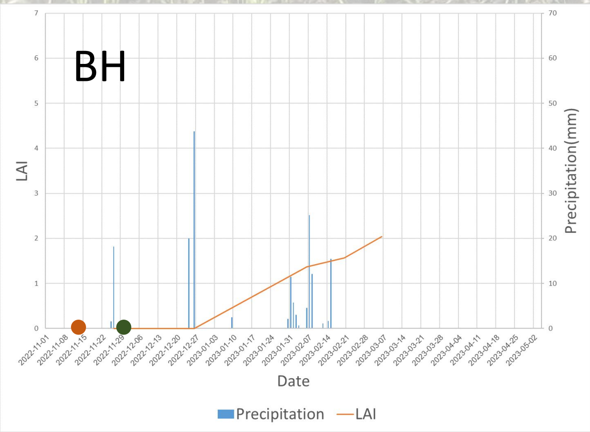
LAI and rain

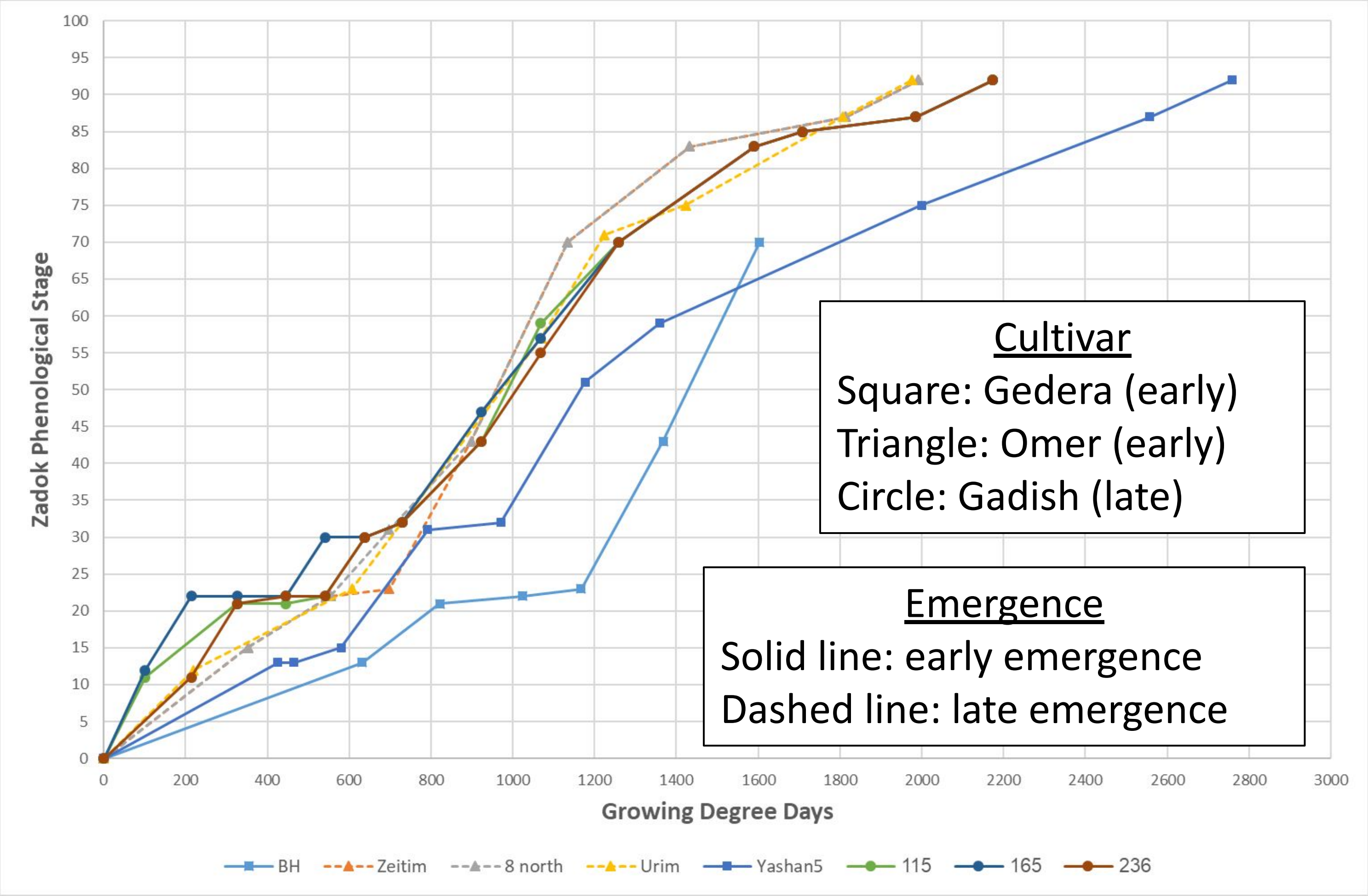
- Irregular rains characterized the season
- Large dependency of the emergence date on rainfall



Phenological stages

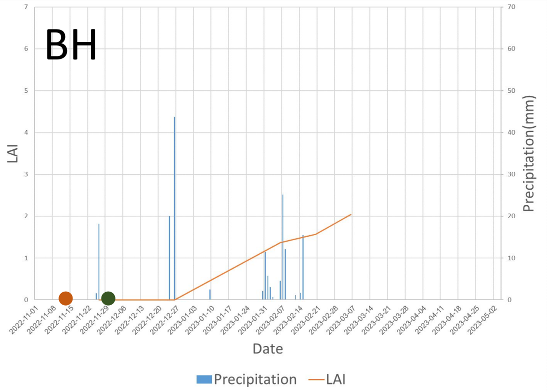
- GDD can predict the development stage of different fields sown at different times
- BH and Yashan-5 show slower development



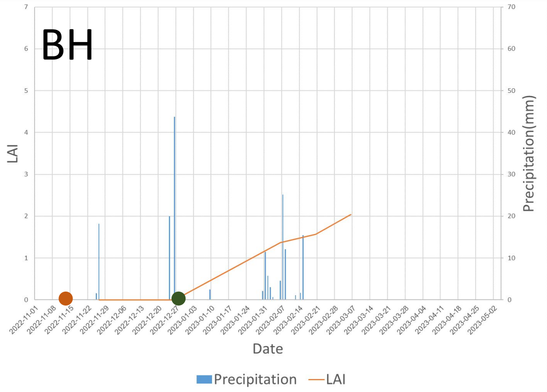


Phenological stages

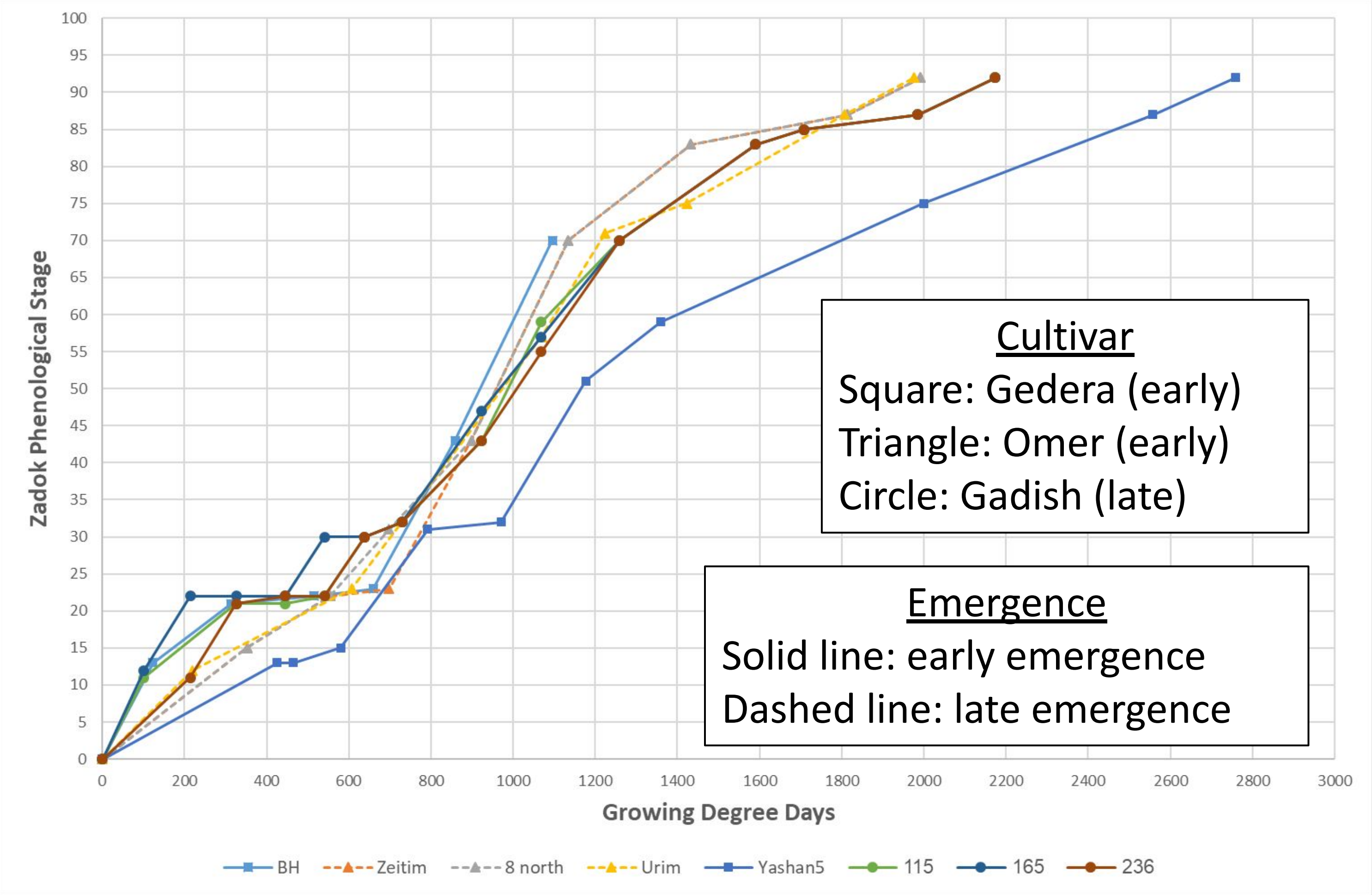
Emergence after the first rain event



Emergence after the second rain event

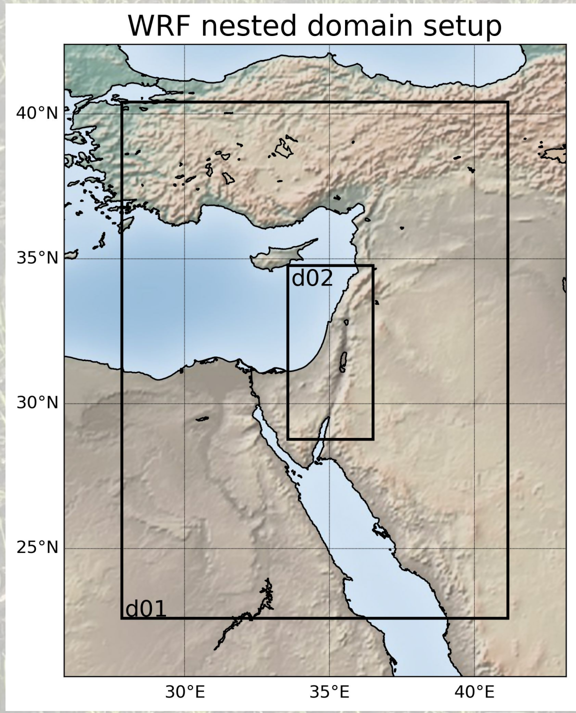


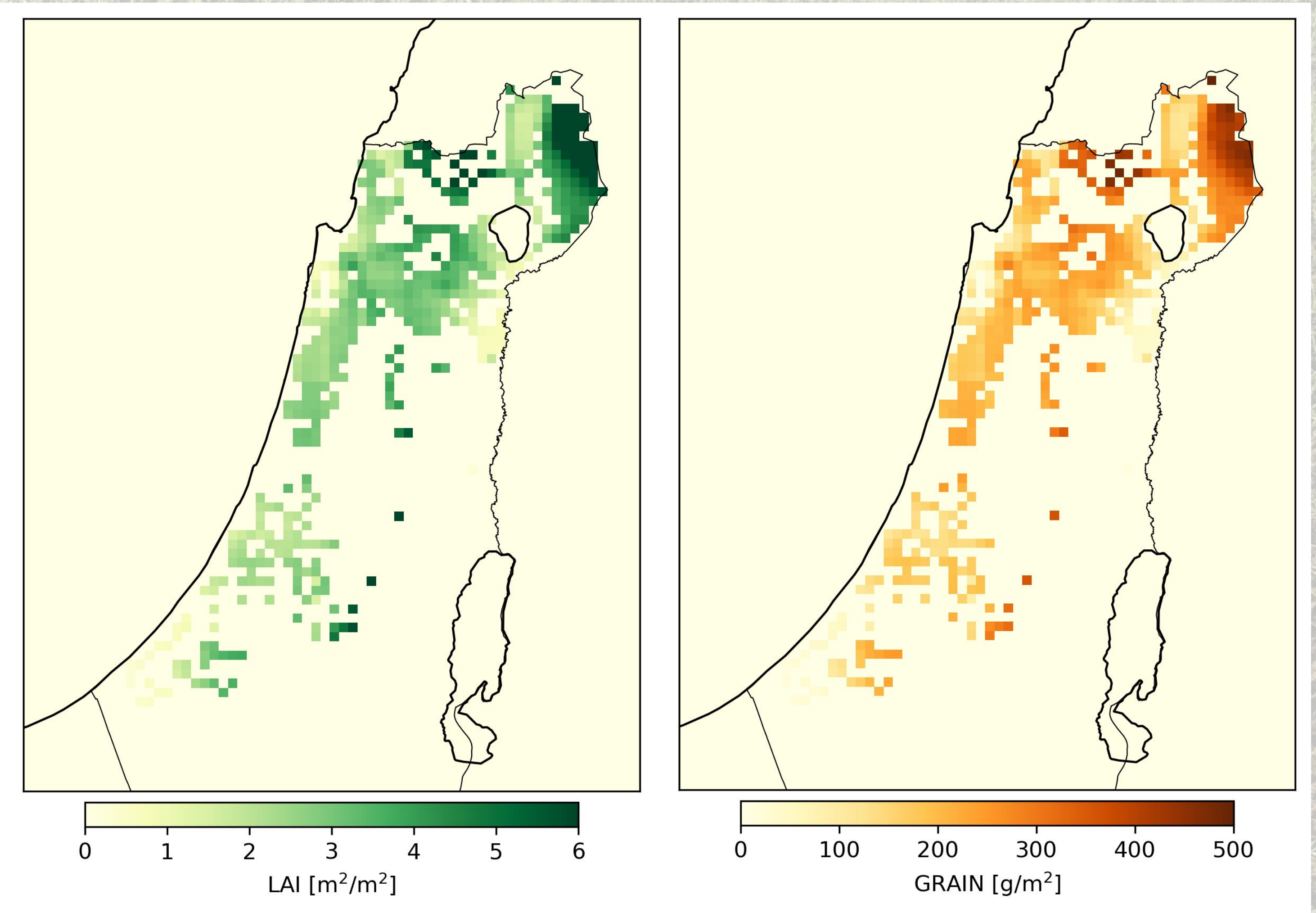
BH froze its development for about a month



Preliminary results – coupled simulation

- 2016-2017
- Sowing date: November 1st
- Boundary and initial conditions for ERA5





Summary and future work

- First year (out of three) of wheat sampling has just ended, parameters for the NoahMP-Crop are now being extracted
- Under typical conditions (no water and heat stress), GDD can predict the phenological stage of wheat in Israel
- Using crop model parameters based on literature search, the WRF-NoahMP-Crop simulation forced with observed conditions (ERA5) can reproduce wheat yield to first order

- Two more years of field sampling are planned
- WRF-NoahMP-Crop simulations forced with a seasonal prediction system