Observation-based **crop calendars** significantly affect **yield** and **irrigation** for some crops in CLM

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How do crop calendars work in CLM?

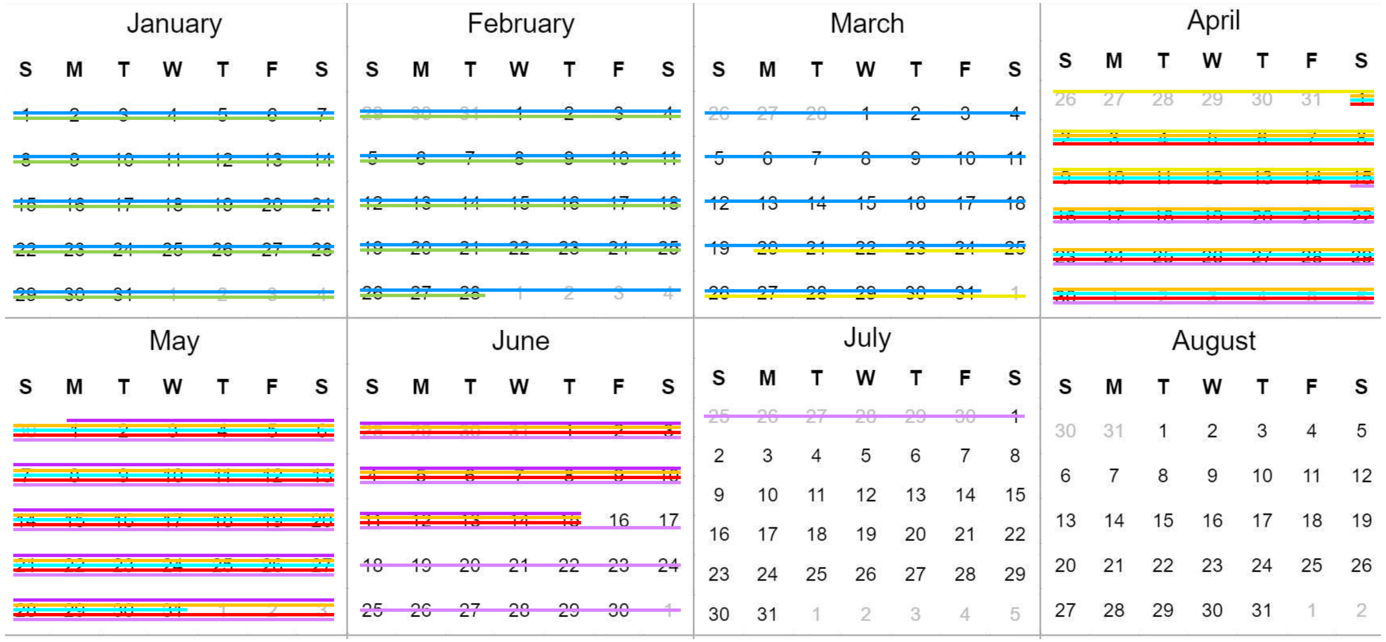
Sowing date → ~~Harvest date~~

"Windows"

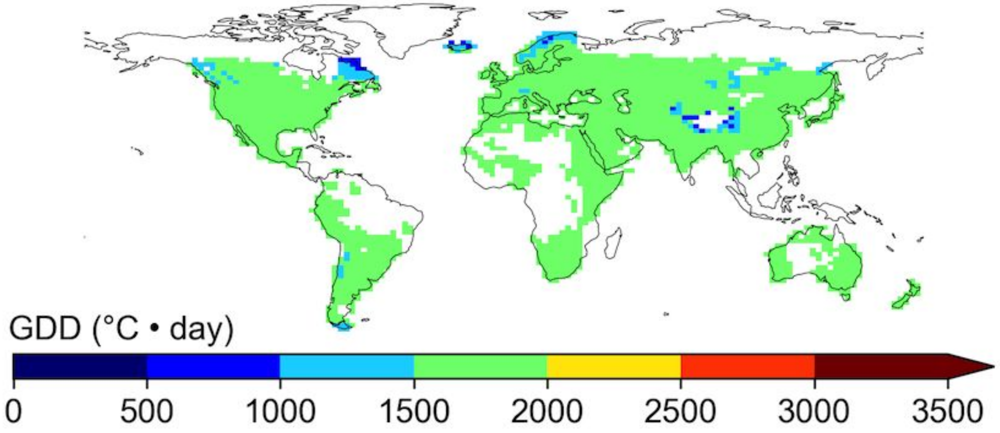
Maturity requirement

How warm has it been, for how long?
"Growing degree-days"

Northern Hemisphere



Rainfed spring wheat



How do crop calendars work in CLM?

Advantages

- Sowing windows allow some geographic and interannual **variation**
- Long-term **shifts** with climate change possible for both sowing date and harvest requirements

Disdvantages

- Sowing windows based only on **temperature**
    - Moisture more important in some places
- **Limited variation possible** in harvest requirements
    - Tropics need more GDDs to mature
- Generally: Parameterized for **North American** planting decisions & cultivars
- Sowing window **boundaries** may limit future adaptation

So you've developed a better system?

No :) I made it so CLM can read **externally-specified** sowing dates and maturity requirements.

Advantages

- Use **arbitrary crop calendar algorithms** without needing to code them into CLM
- Participate in **model intercomparisons** that require use of standard calendars
- **Force with observations**, compare to built-in crop calendars

Disdvantages

- Inputs **not necessarily prognostic** (and so far they aren't)

Well then what are you presenting?

Use observation-based crop calendars to evaluate:

- **Where and how** CLM's system might be improved
- **How much** improvement might result

Advantages

- Use **arbitrary crop calendar algorithms** without needing to code them into CLM
- Participate in **model intercomparisons** that require use of standard calendars
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Disdvantages

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Dataset Open Access

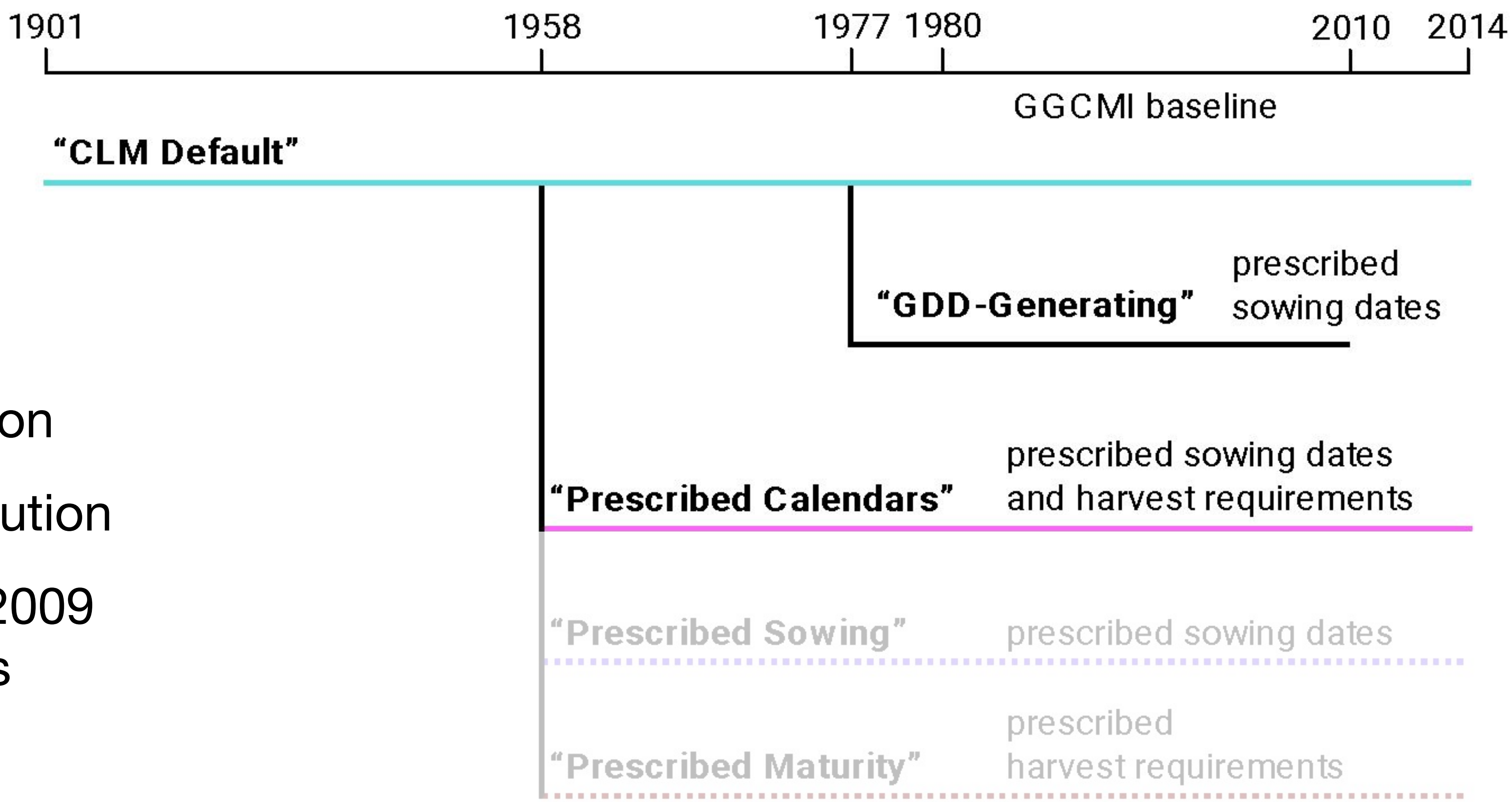
GGCMI Phase 3 crop calendar

Jonas Jägermeyr; Christoph Müller; Sara Minoli; Deepak Ray; Stefan Siebert

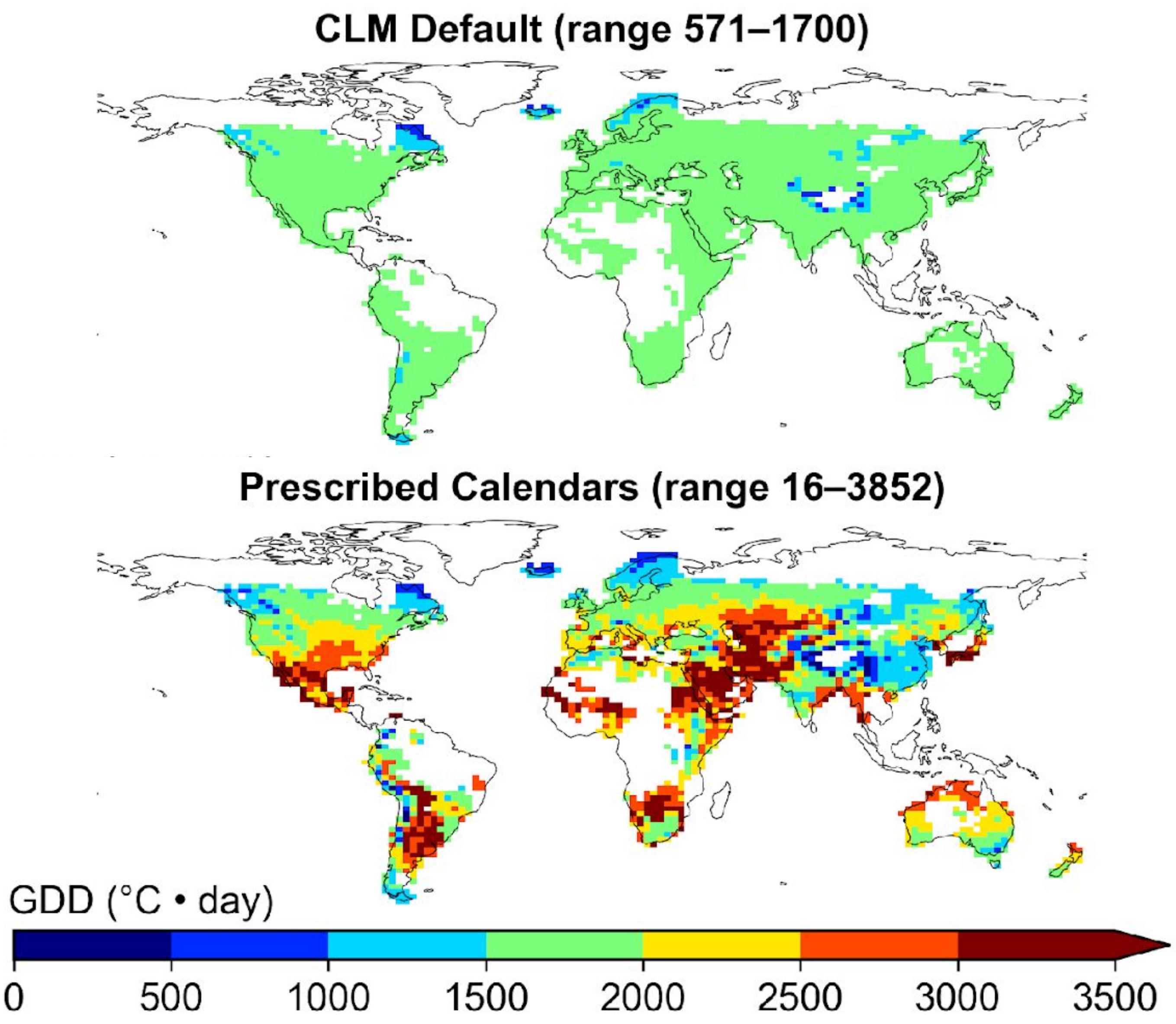
The new crop calendar for GGCMI Phase 3 is a composite product merging various observational data sources. It provides in each 0.5° land grid cell the planting day and maturity day for 18 different crops, separating rainfed and irrigated systems. Grid cells outside of currently cultivated areas are spatially extrapolated and original data gap-filled. This crop calendar version only provide static growing periods, i.e., the multi-year average estimates. We only specify a single growing season per crop and grid cell, and no crop rotations are considered. However, for wheat and rice we provide data for a second season with separate crop calendars for winter and spring wheat, and two separate main rice growing seasons.

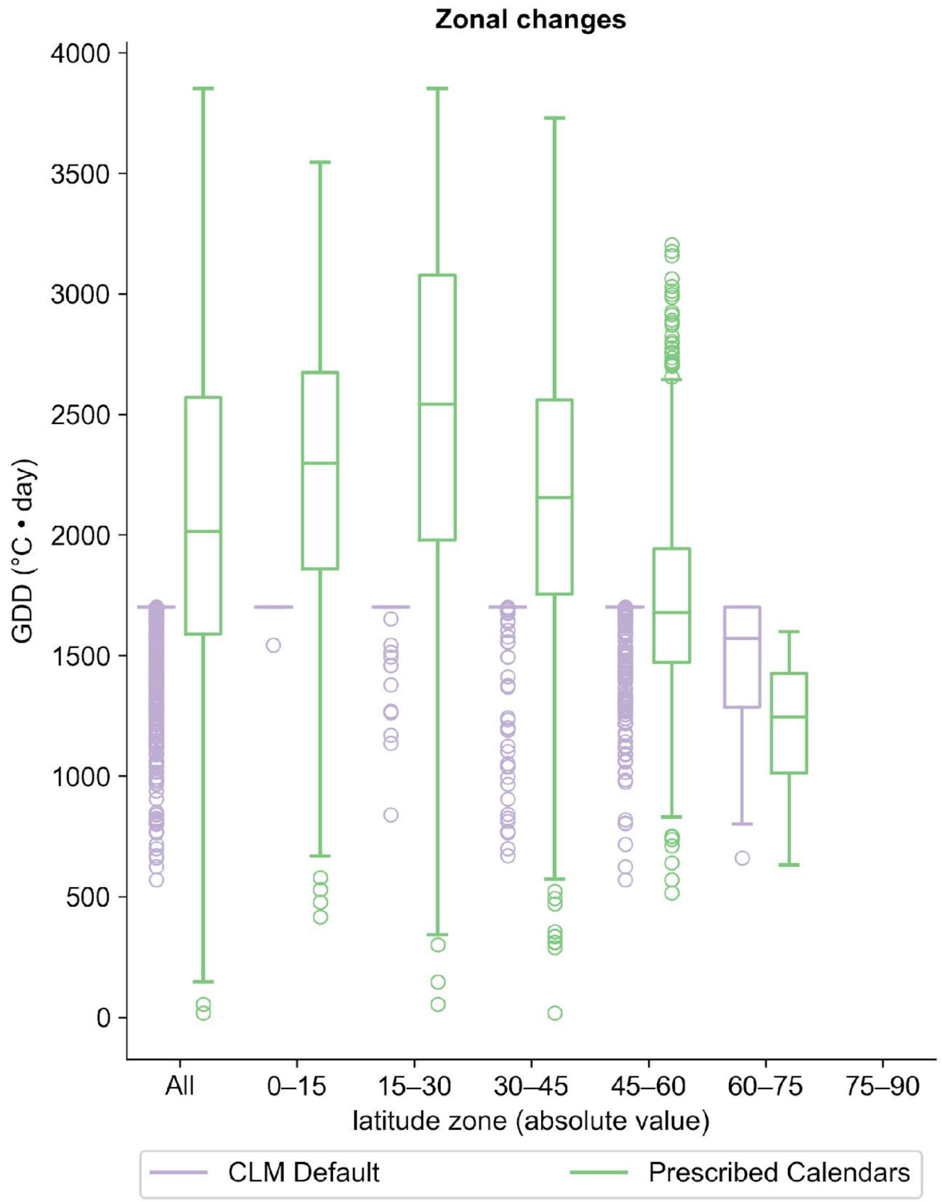
Experimental setup

- CLM5.0
- Unlimited irrigation
- "2-degree" resolution
- Analysis: 1980–2009 growing seasons



Rainfed spring wheat: Maturity requirements



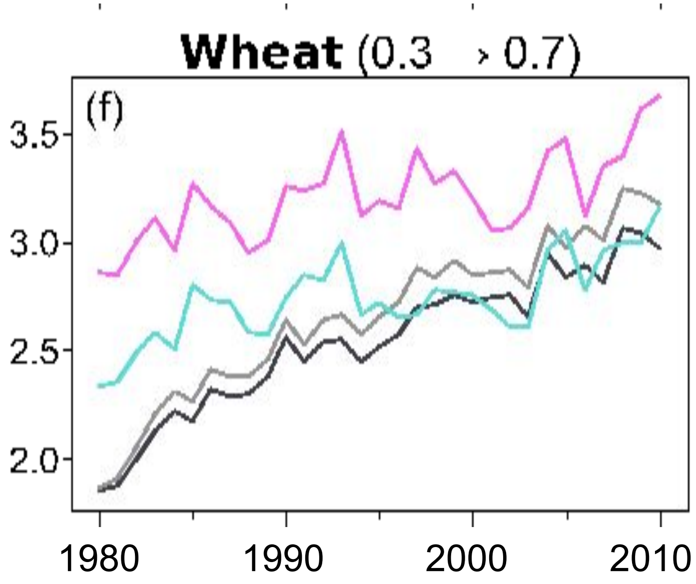


Global yield

FAOSTAT
EarthStat
CLM Default
Prescribed Calendars

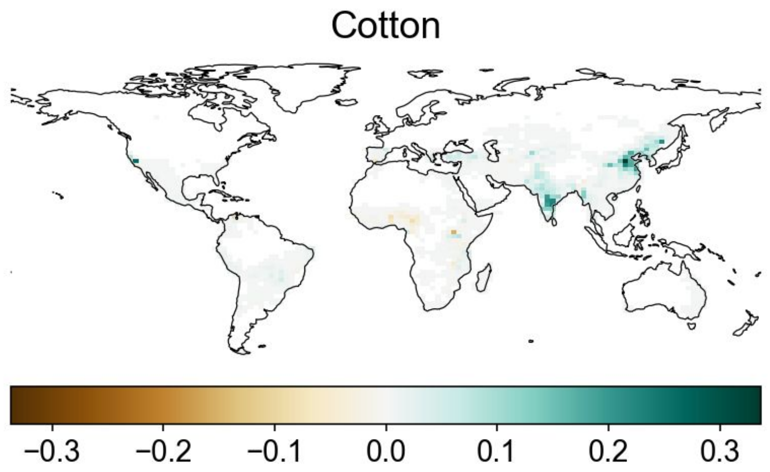
Global yield (t/ha)

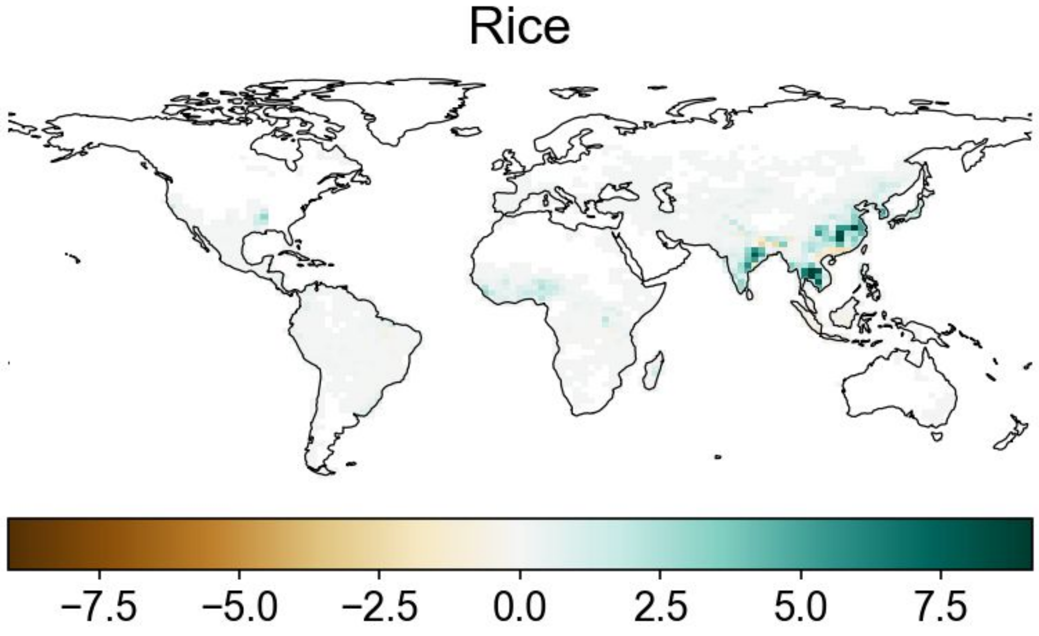
Global yield (t/ha)

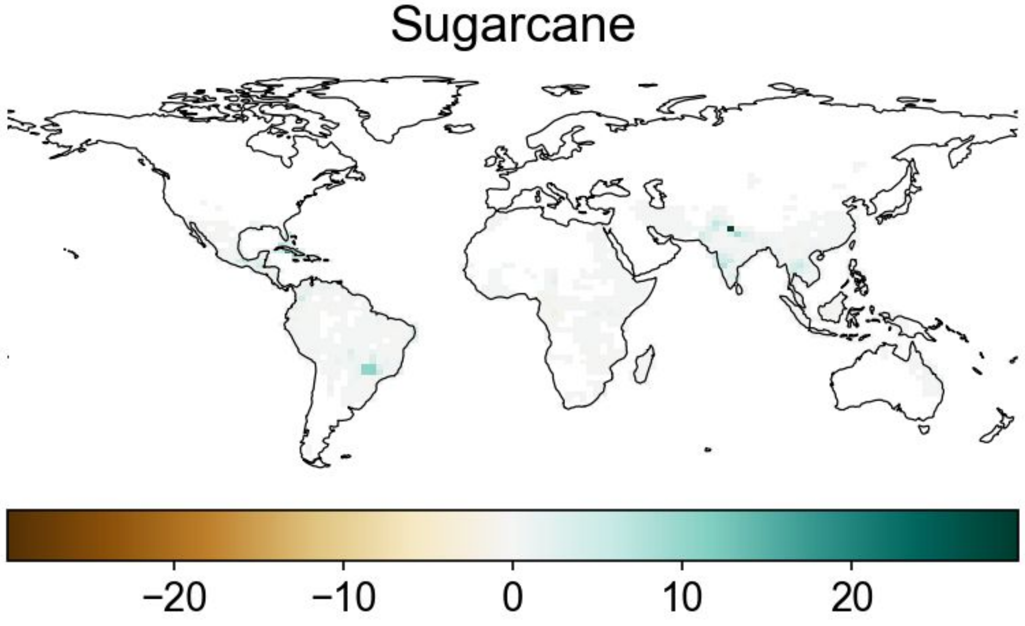


Regional yield difference (Mt)

Prescribed Calendars minus **CLM Default**

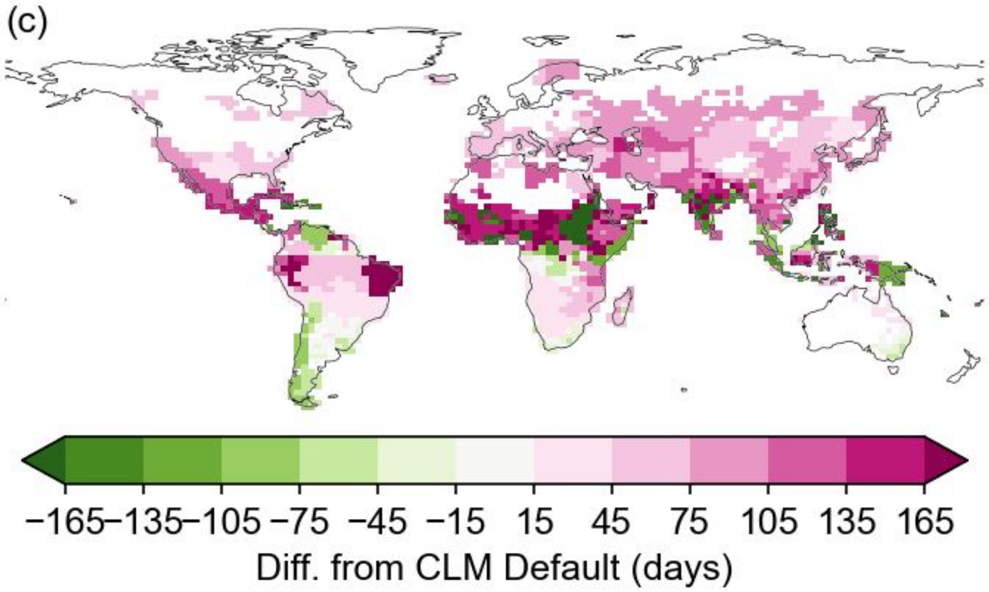


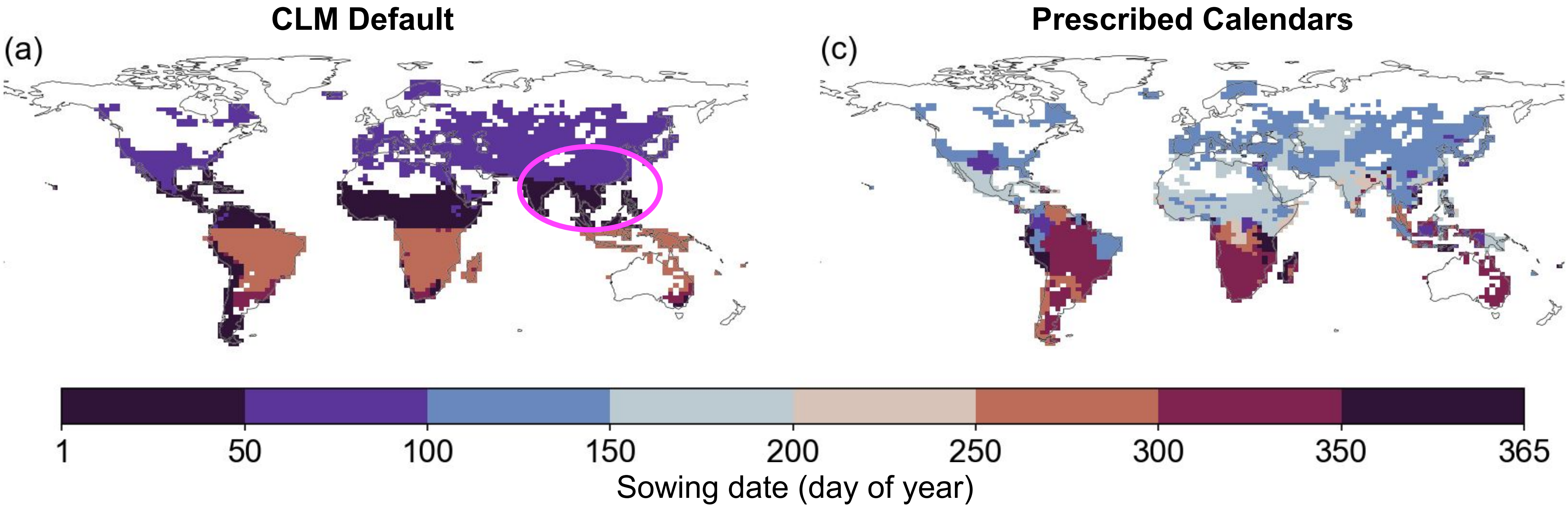




Rice

Sowing date caused most of the change.

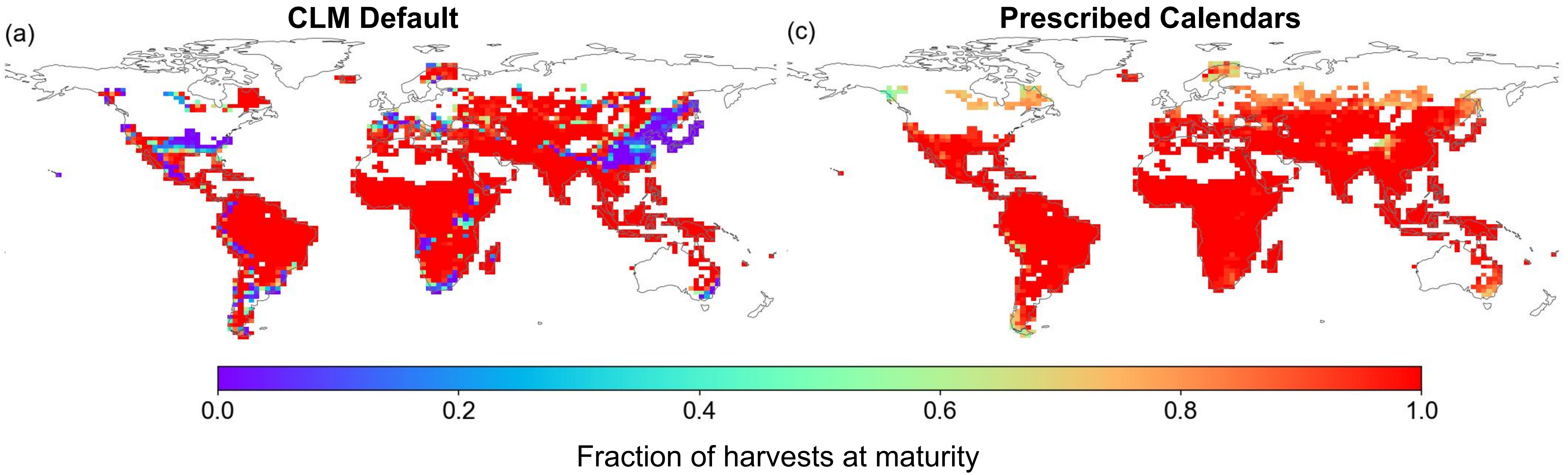




Rice

Sowing date caused most of the change.

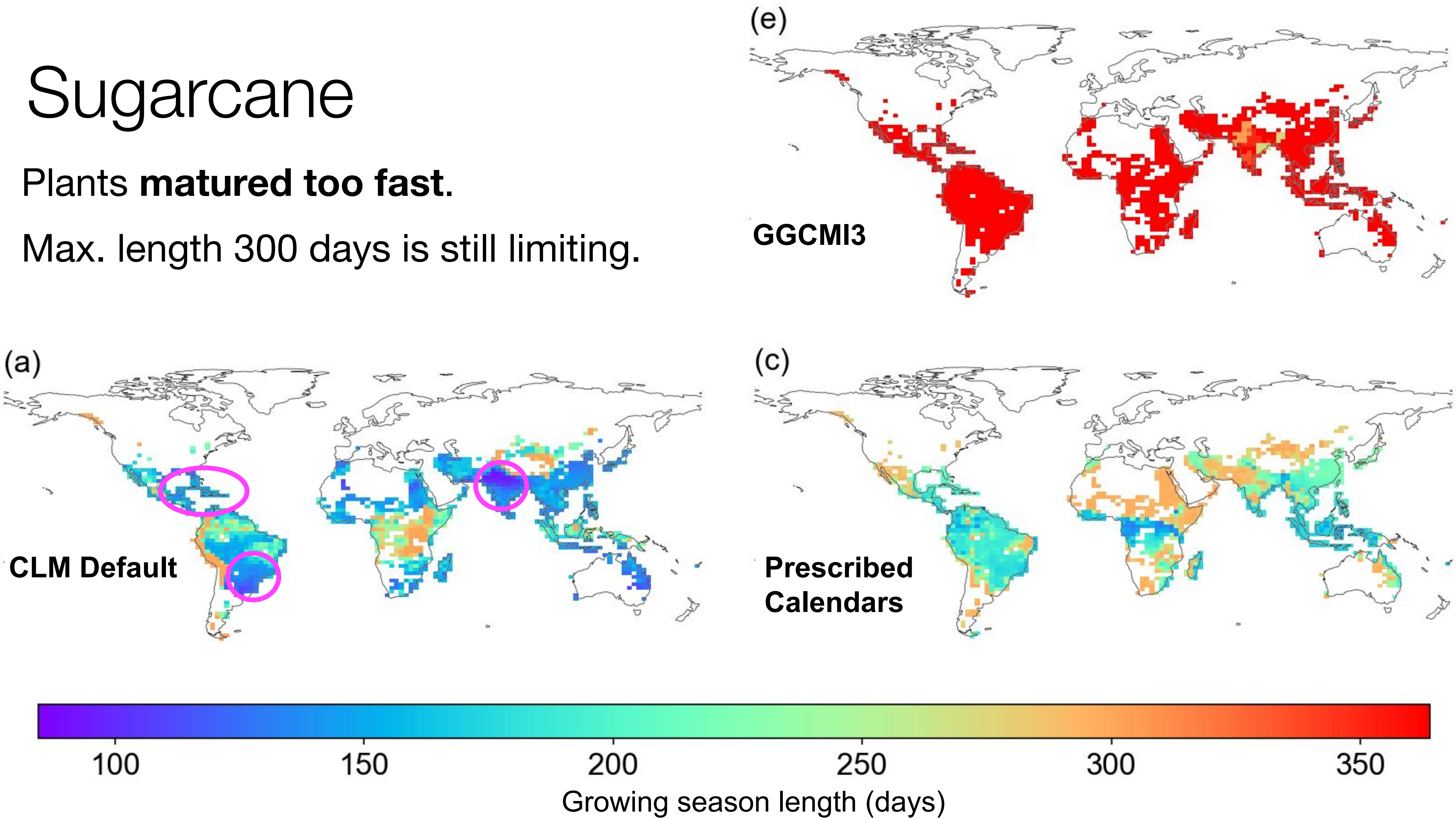
CLM Default has many **failed seasons**.



Sugarcane

Plants **matured too fast**.

Max. length 300 days is still limiting.

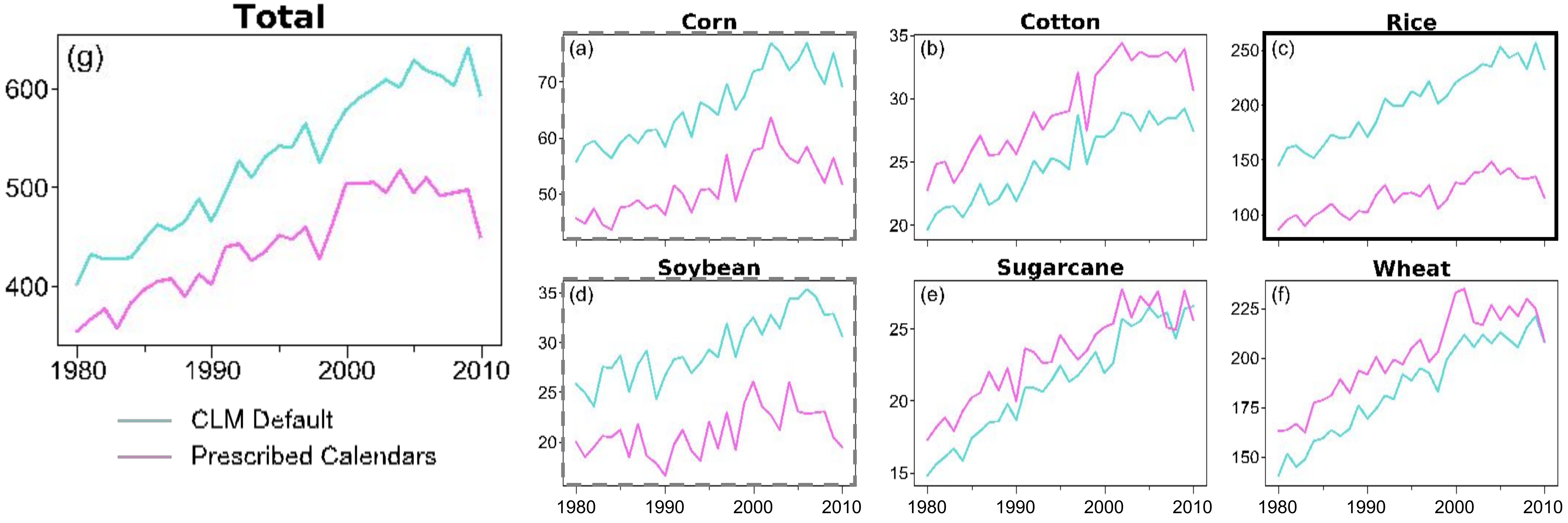


Irrigation (km^3)

Less irrigation with Prescribed Calendars.

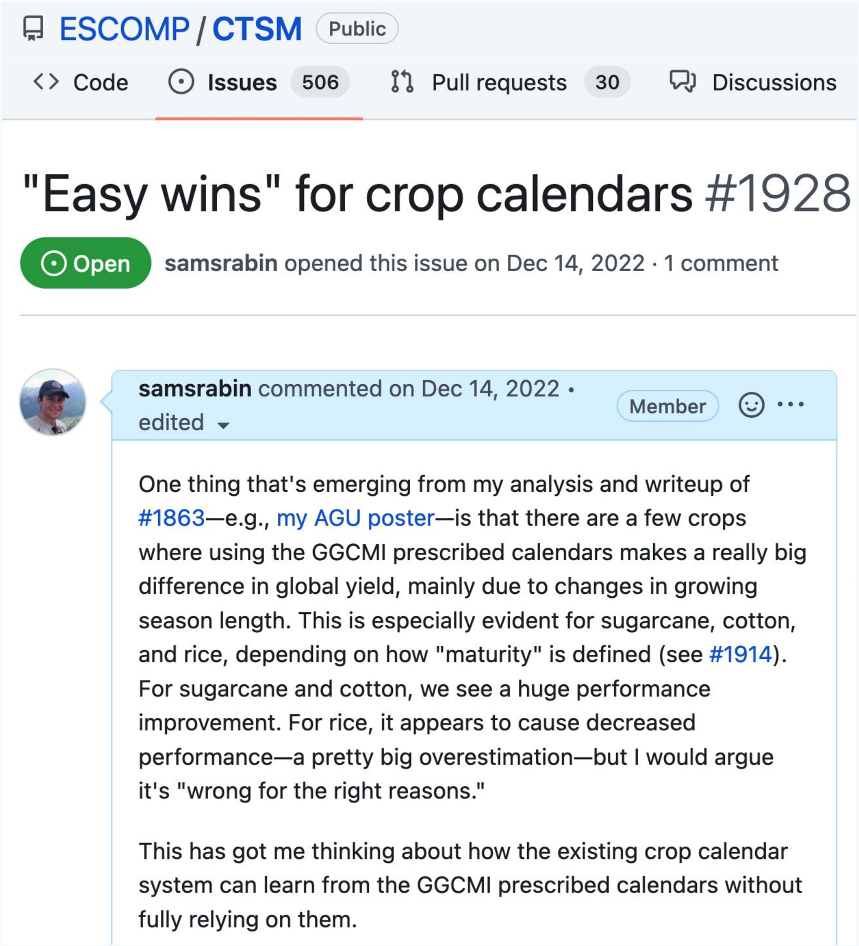
Apparently the **wrong direction**…

But **more realistic irrigation** techniques (Yao et al., 2022) give an *overestimate*.



How can we improve CLM?

- Gridcell-specific **sowing dates**; windows centered on GGCMI3 values
- Use **maturity requirements** derived from GGCMI3
  - Scale based on decadal climate averages
- Replace **maximum growing season length** parameter with more flexible behavior



Thank you!

SILVER LINING

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