

Differential impacts of irrigation on precipitation across the United States

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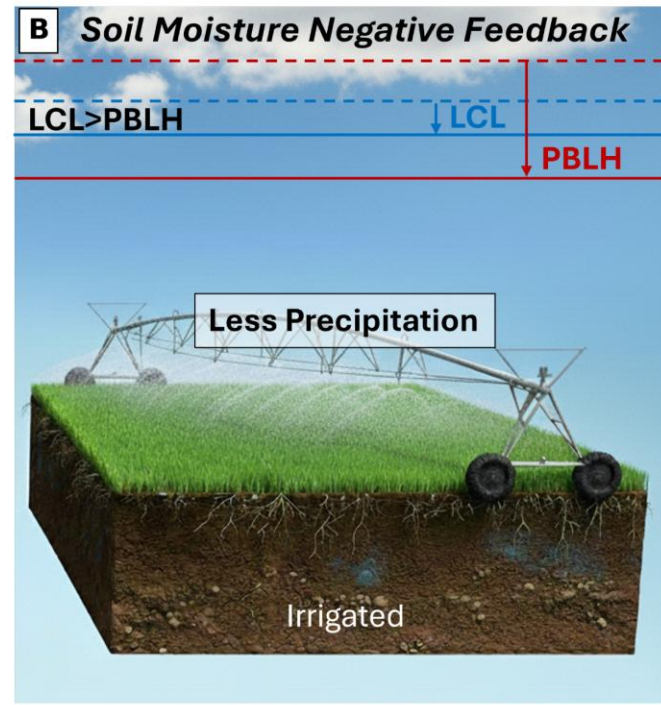
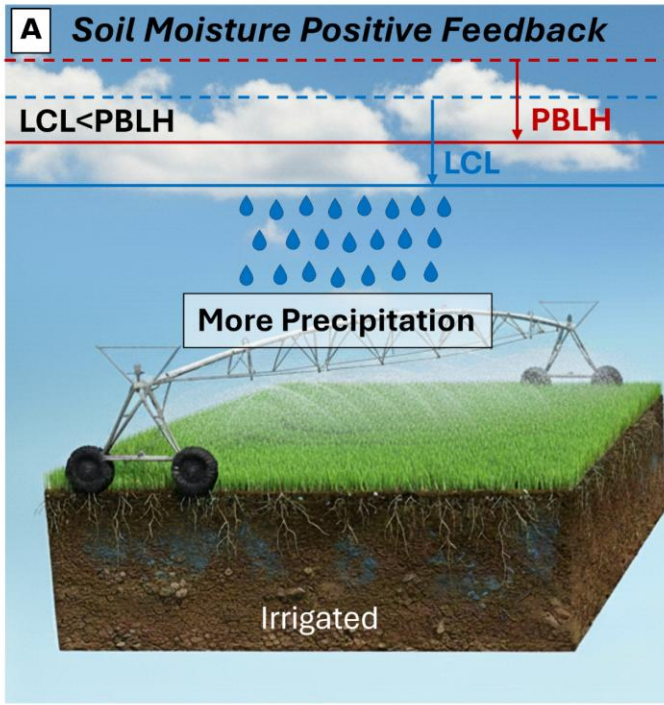
Irrigation: a major human alteration of the water cycle

Irrigated agriculture accounts for about 20% of the global cropland area and sustains about 40% of crop production (Molden, et al., 2010; Siebert & Döll, 2010)

Irrigation affects **water** and **energy fluxes** with implications for the **hydrological cycle**, and local and regional climate, through **land-atmosphere interactions**

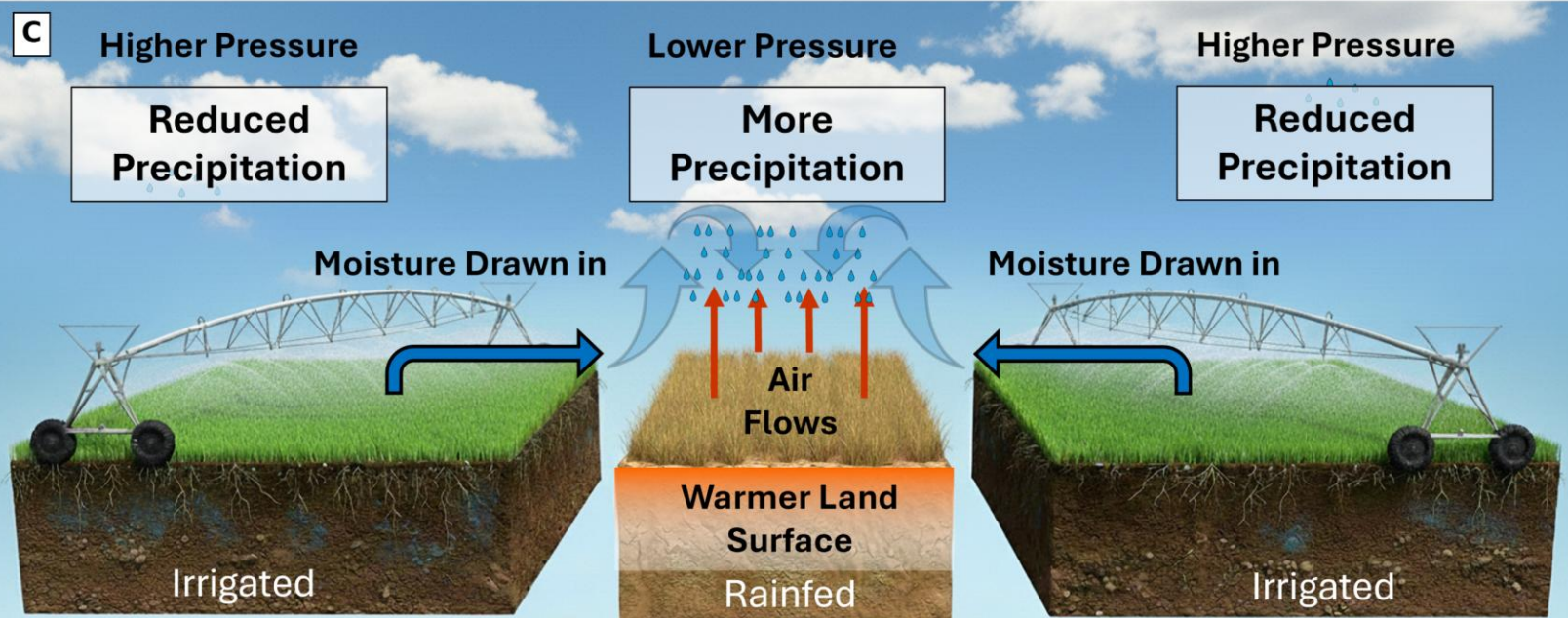


An irrigation system waters an alfalfa field at the Fondomonte farm in Butler Valley, Ariz., in June. (Caitlin O'Hara / For the Washington Post / Getty Images)



Hypothesis A: An increase in soil moisture due to irrigation causes an increase in precipitation

Hypothesis B: An increase in soil moisture due to irrigation inhibits vertical movement of air parcels and decreases the ability of the precipitation to form

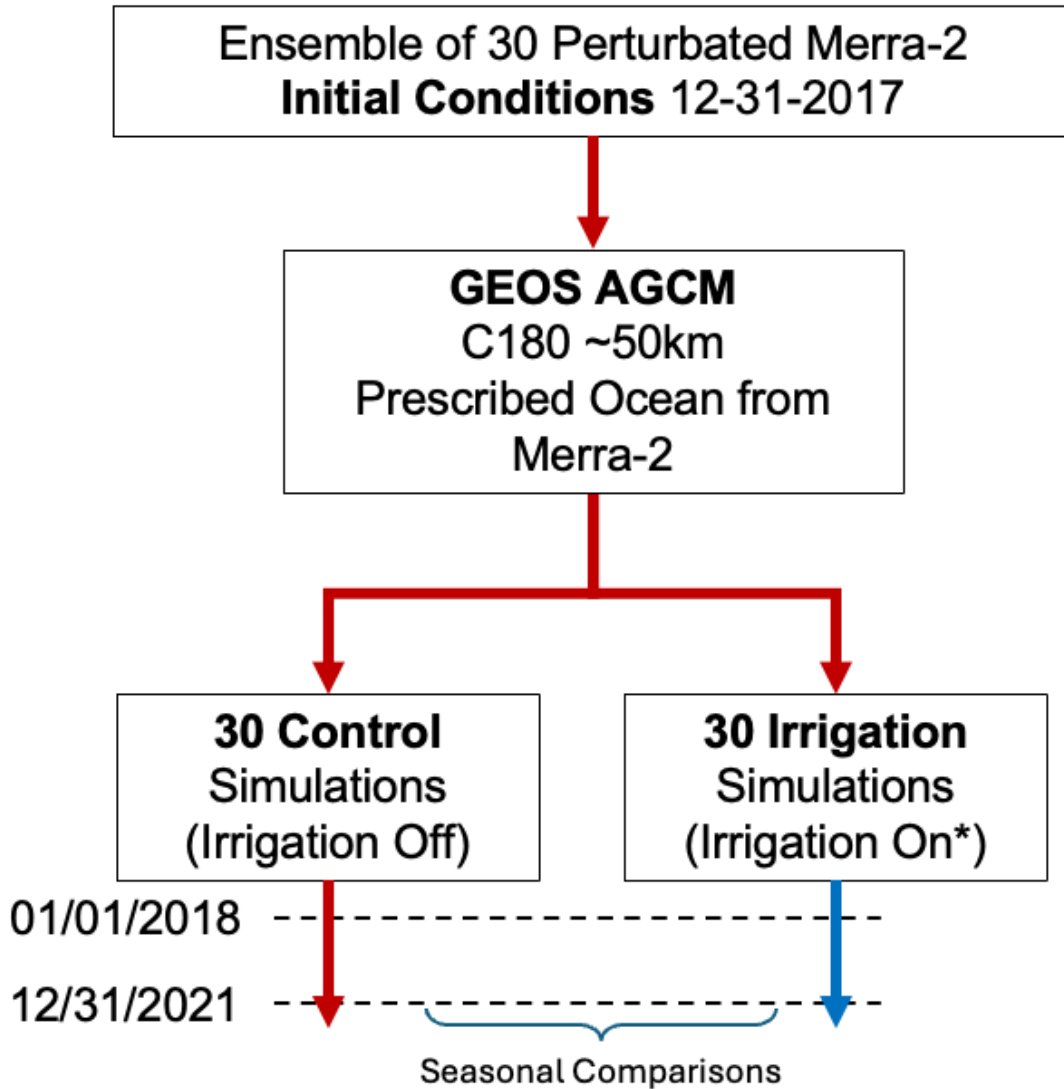


Hypothesis C (spillover effect): An increase in soil moisture due to irrigation can increase precipitation in nearby (downwind) non-irrigated areas

How does irrigation influence precipitation?

- Where does irrigation drive **positive** or **negative** land–atmosphere feedbacks?
- Does irrigation increase precipitation in nearby rainfed regions?

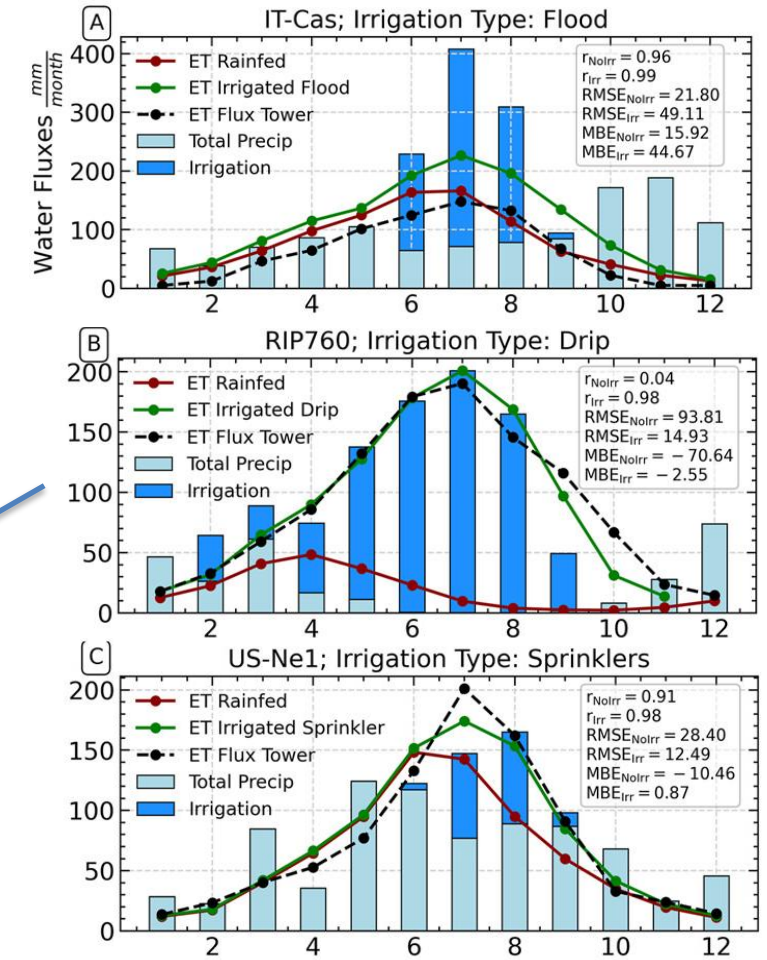
Methods



* Irrigation Module

A Model-Based Evaluation of the Effects of Irrigation Expansion on Regional and Global Land Surface Climate

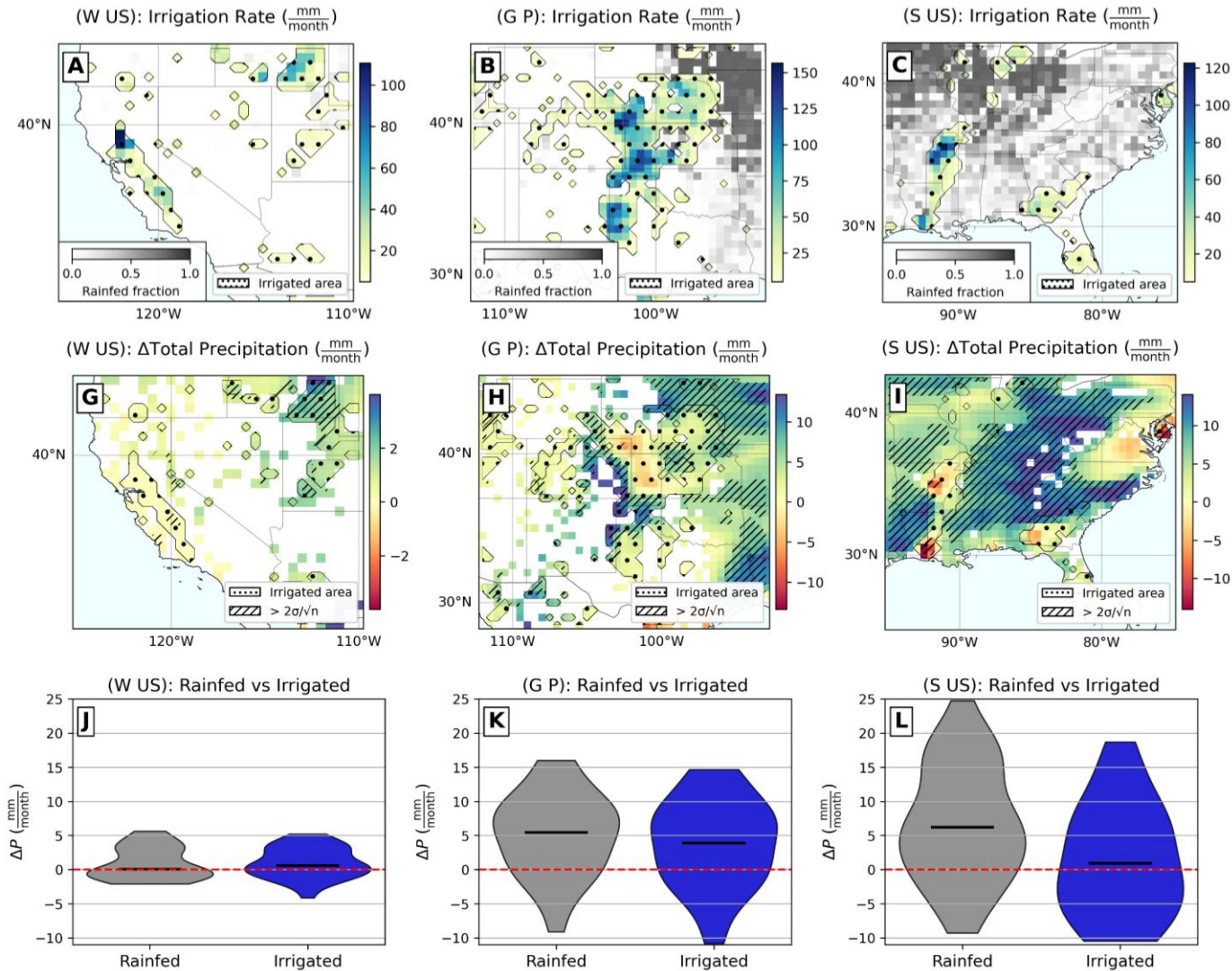
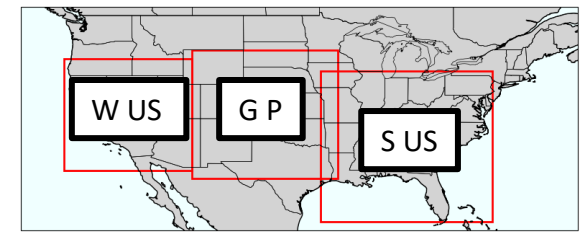
Stefano Casirati¹, Paolo D'Odorico¹, Rolf H. Reichle², Tasnuva Rouf^{1,3}, Milton Stookey¹, and Manuela Girotto¹



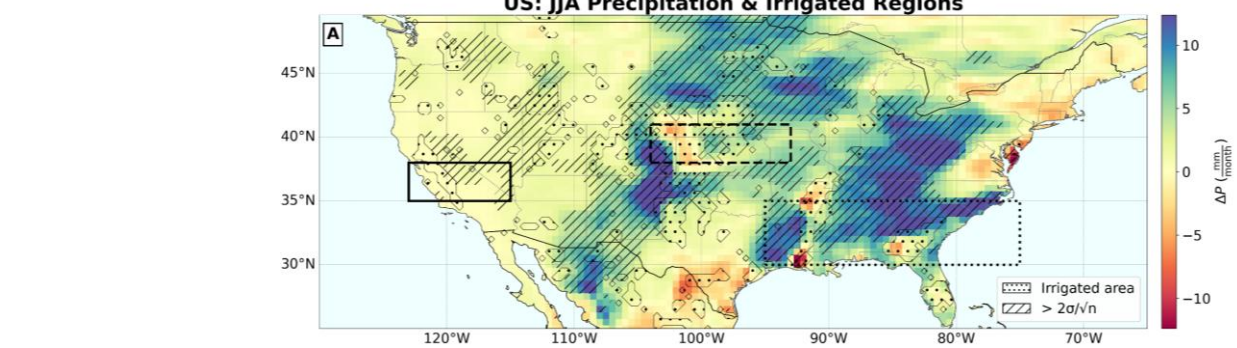
Casirati et al., 2025 – Earth's Future

Irrigation-Precipitation Feedback: Irrigated vs Rainfed

Season: Summer (JJA)



Spillover Effect



Season: Summer (JJA)

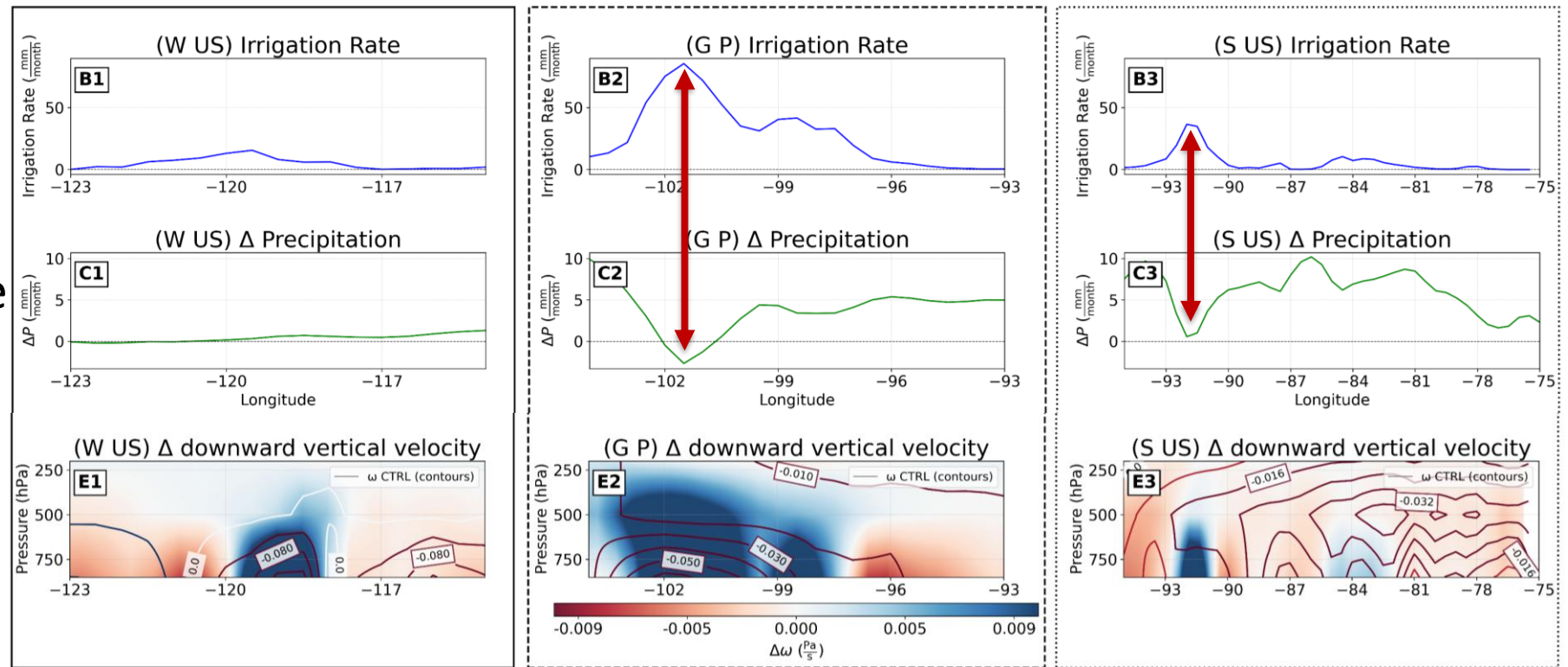
Irrigation Rate

Precipitation Change

$\Delta\omega$ (Irrigation - Control)

More Uplift (-)

Less Uplift (+)



Casirati et al., 2026 - ERL

Conclusions

- Irrigation overall increases precipitation, especially in adjacent rainfed regions through irrigation-induced mesoscale circulations.
- Intensive irrigation can inhibit convection, and local precipitation.

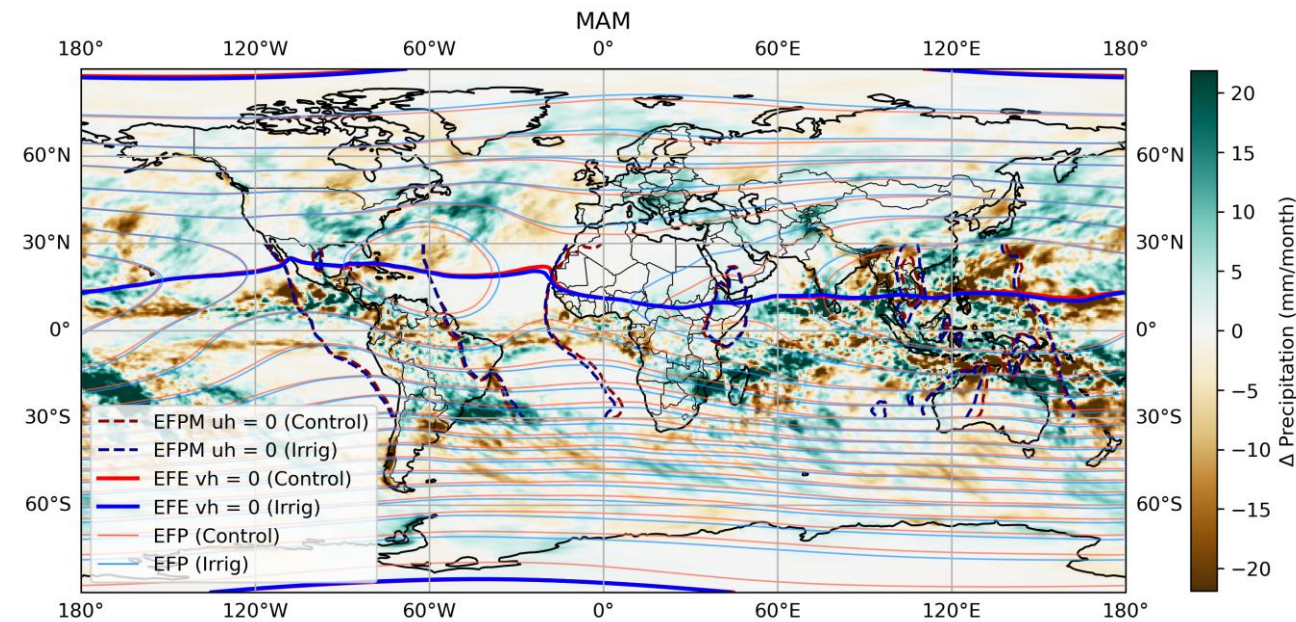
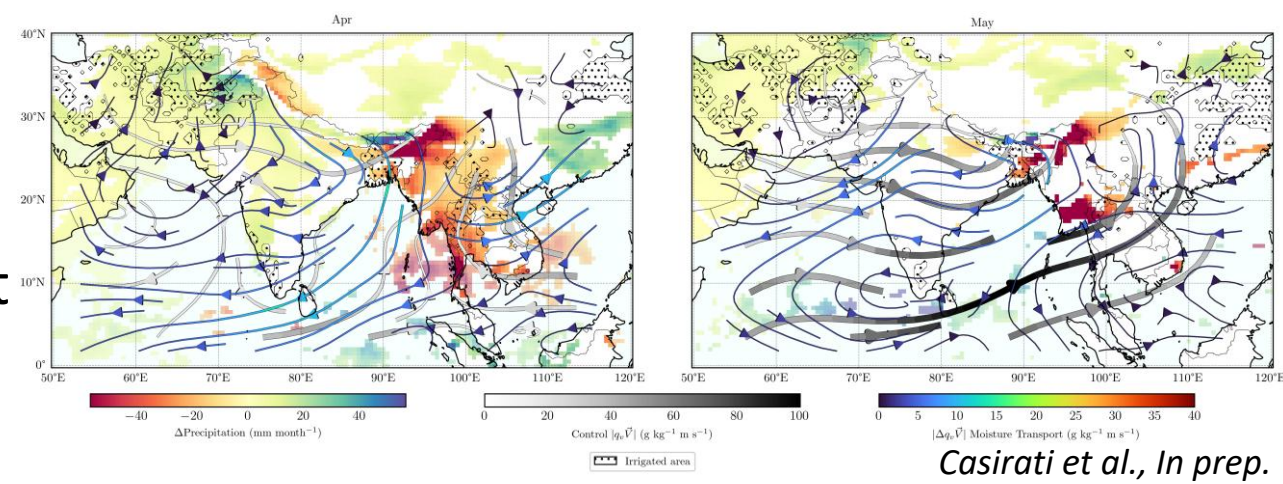
What's Next?

Funding Provided by:
NASA ROSES 2021, Subseasonal-to-Seasonal
Hydrometeorological Prediction



Ongoing and Next Steps:

- Impacts of Irrigation in Other Breadbasket Regions
- Irrigation-Induced Land–Atmosphere Feedbacks on the **Water Demand**
- Irrigation induced influence on the **global** general circulation patterns (ITCZ) using GEOS AOGCM
- Characterize (AI) Human Decision Representation in Earth System Models



Thanks for your Attention!

Questions?

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