Persistence of soil respiration legacies induced by temporally repackaged summer rainfall in Sonoran Desert grasslands

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Background

- Soil respiration (CO_2 efflux) is an important component of ecosystem carbon balance with the atmosphere[1] derived from plant roots and microbial decomposition, both of which are controlled by the microbial community, substrate availability, temperature, and moisture.[2]
- In the Sonoran Desert, larger and less frequent monsoonal precipitation events are becoming increasingly common[3], decreasing the frequency of available moisture in the biologically active shallow soil layers, and thereby decreasing total summer soil respiration (Fig. 3 & 4).
- **It is unknown if temporal repackaging of summer precipitation continues to influence soil respiration in future seasons, i.e., a '<u>legacy effect</u>'.**

Questions

- Does the temporal repackaging of summer growing season precipitation produce soil respiration legacies?
- If so, how long does the legacy effect last and what might be driving it?

Methods

- We addressed our questions using data collected at a multi-year rainfall manipulation experimental site, namely RainManSR (Fig. 8 & 9).
- We used automated in-situ chambers to estimate soil respiration by measuring the rate of increase in CO_2 concentration over a fixed period of time (Fig. 10).
- Data from July 2020 through May 2021.
- Two replicates of the four irrigation treatments (n = 2 per treatment).

Results

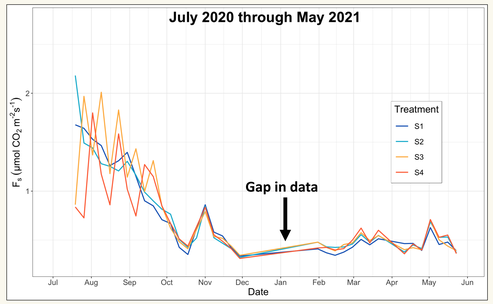

Fig. 1. Weekly average soil respiration

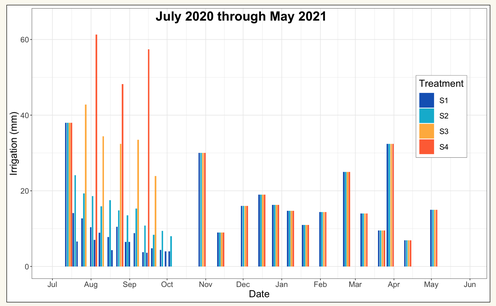

Fig. 2. Irrigation regime

- **Soil respiration differences among summer rain treatments are short-lived.**
- Soil respiration is strongly controlled by water inputs during the summer growing season (Fig. 1 & 2).
- The magnitude of soil respiration varies widely by season (Fig. 1, 4, 7).
- Lag effect of soil respiration in plots receiving fewer, more intense irrigation applications (Fig. 1 & 3).

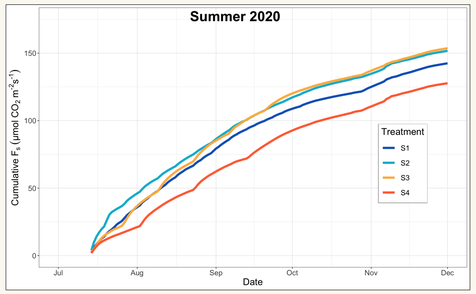

Fig. 3. Summer cumulative soil respiration

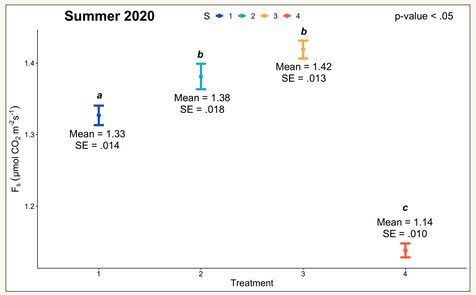

Fig. 4. Mean soil respiration during repackaging

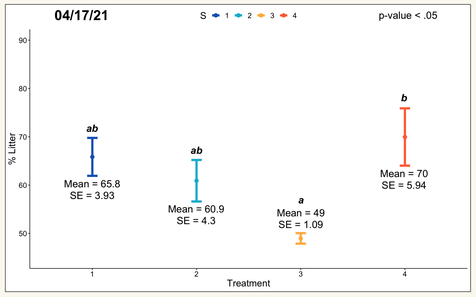

Fig. 5. Mean % litter cover

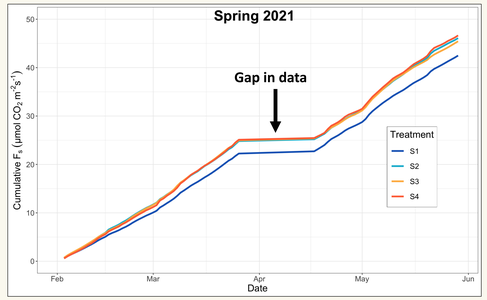

Fig. 6. Spring cumulative soil respiration

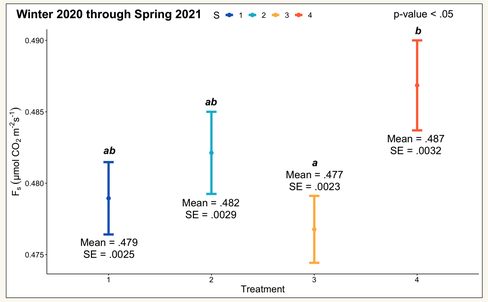

Fig. 7. Mean soil respiration with same irrigation

- Statistically different mean soil respiration between treatments during precipitation repackaging (except between S2 & S3), but no statistical difference between the means the following spring when irrigation was applied equally to all plots (except between S3 and S4) (Fig. 4 & 7).
- **S4 treatment (few, large events) switched from lowest mean and cumulative soil respiration during summer to highest during the following spring (Fig. 3, 4, 6, 7).**

Fig. 8. Rainout shelter at RainManSR

Fig. 9. Inside house one at RainManSR

Fig. 10. Soil respiration chamber

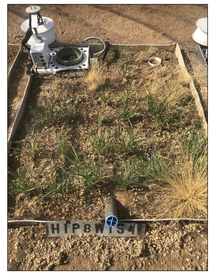

Fig. 11. Plot at RainManSR

Discussion

- Soil respiration is tightly coupled to precipitation as well as seasonal temperature changes (Fig. 1).
- Larger, less frequent summer rain events led to lower total soil respiration in the warm season, which is likely related to the low soil respiration rates during the extended dry periods (Fig 3).
- However, once rain pulses were equal, the plots that had previously received the larger, less frequent pulses emitted slightly more CO_2 (Fig. 6), **indicative of a potential legacy effect of warm-season precipitation temporal repackaging on cool-season carbon budgets.**
- We hypothesize that this is related to higher litter inputs in the S4 treatment during the cool season (Fig. 5), which could lead to more microbial respiration.

Future Work

- Analyze cool-season soil respiration over shorter time frames, which may better elucidate legacy effects.
- Investigate the relative importance of temperature and moisture in controlling cool season soil respiration rates.

Acknowledgements

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References

1. Savage & Davidson, 2001
2. Jenerette et al., 2008
3. Zhang et al., 2021

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