Diverse responses of semi-arid grasslands to severe droughts in Inner Mongolia, China

Xiran Li[1] , Olivia L. Hajek[2,3]

1 Key Laboratory for Geographical Process Analysis & Simulation of Hubei Province, College of Urban and Environmental Sciences, Central China Normal University, Wuhan 430079, China; lixiran@ccnu.edu.cn

2 Department of Biology, Colorado State University, Fort Collins, CO 80523, USA; Olivia.Hajek@colostate.edu

3 Graduate Degree Program in Ecology, Colorado State University, Fort Collins, CO 80523, USA

(This research was funded by the National Natural Science Foundation of China (NSFC 41901112)

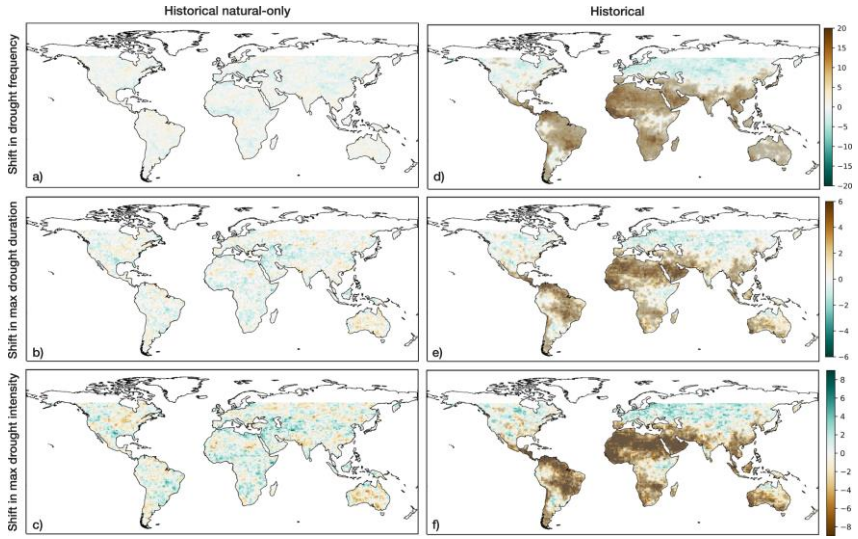
25 May, 2022

1. Background

- Grasslands play an important role in providing ecosystem functions and services such as carbon cycling.

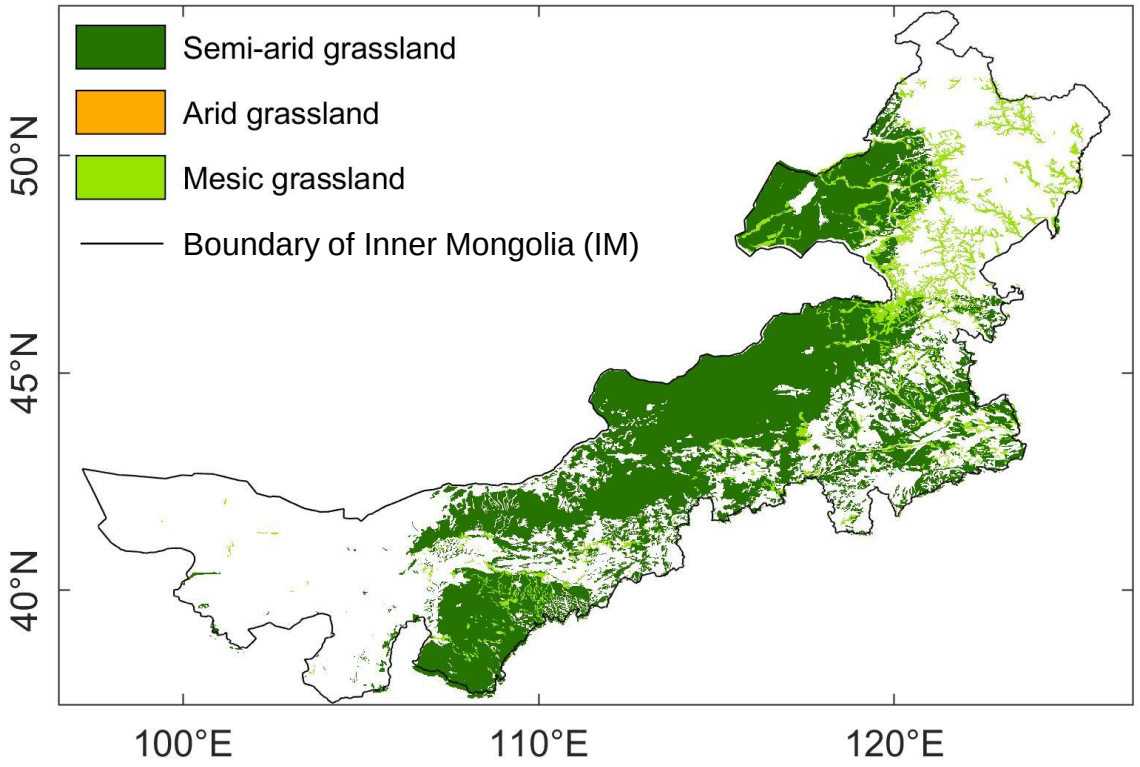
- Grasslands are one of the ecosystems most sensitive to drought (Knapp et al., 2015)

- Research shows that drought events have increased over the last few decades (Dai, 2013), and the frequency, duration, and intensity will continue to increase in the future (Chiang et al., 2021)



(Chiang et al., 2021)

2. Study Area



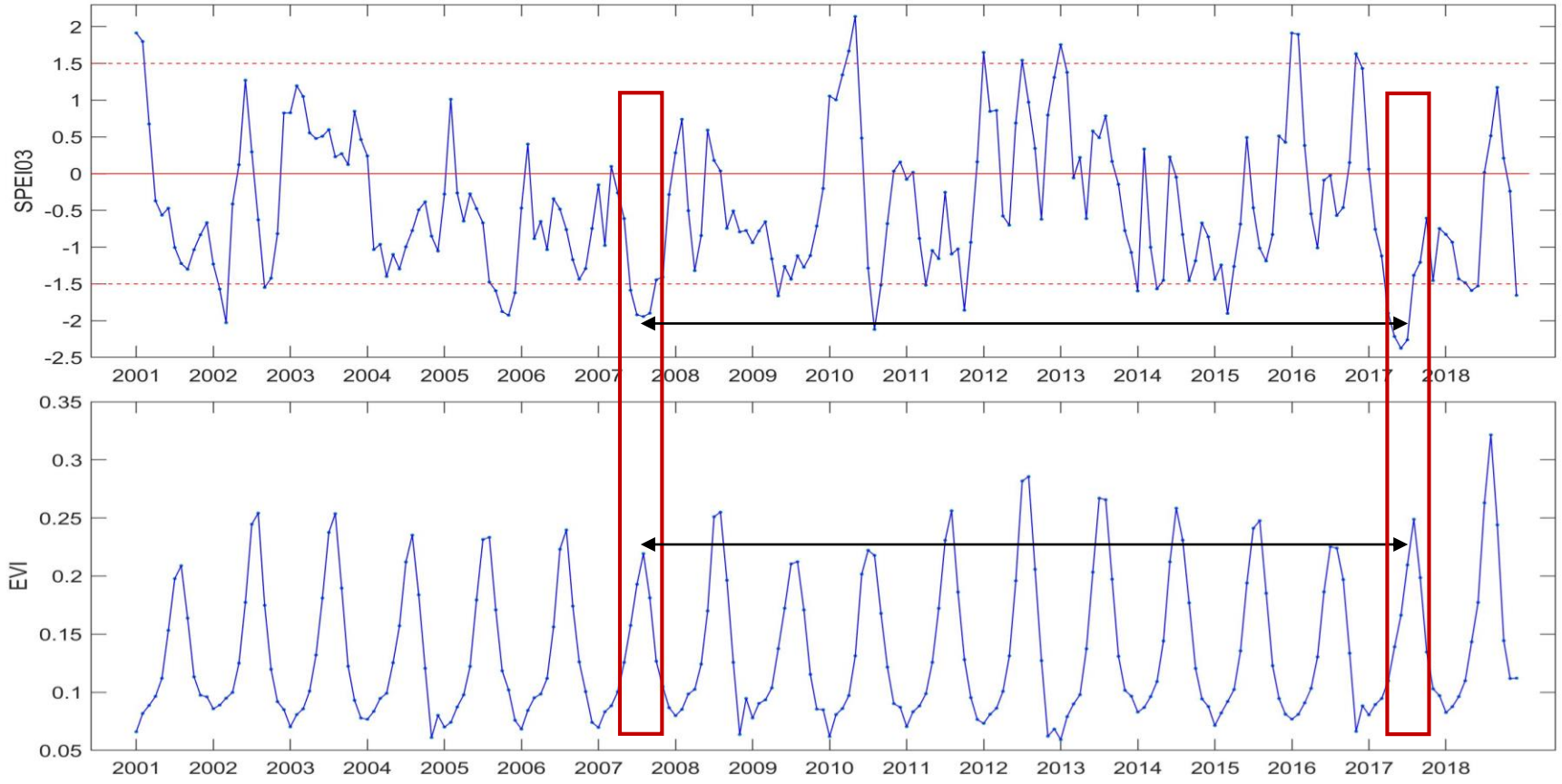
- Grasslands cover almost 40% of the land in China. They are part of the Eurasia steppe belt.
- Most of these grasslands are natural grasslands.
- Grassland in Inner Mongolia (IM) is the largest grassland in China.
- The current management policy was implemented in 2005.

3. Data and Methods

- Data
  - Remote sensing product -- MODIS EVI (MOD13A1, 16day, 500m,2000-present, https://developers.google.com/earth-engine/datasets/catalog/MODIS_061_MOD13A1?hl=en)
  - High-resolution gridded datasets (Climatic Research Unit, CRU TS4.03, monthly, 0.5°, 1901-2018, https://catalogue.ceda.ac.uk/uuid/10d3e3640f004c578403419aac167d82)
  - Standardized Precipitation Evapotranspiration Index (SPEIbase v2.6, based on CRU TS4.03, https://spei.csic.es/database.html)
- Method: partial correlation analysis

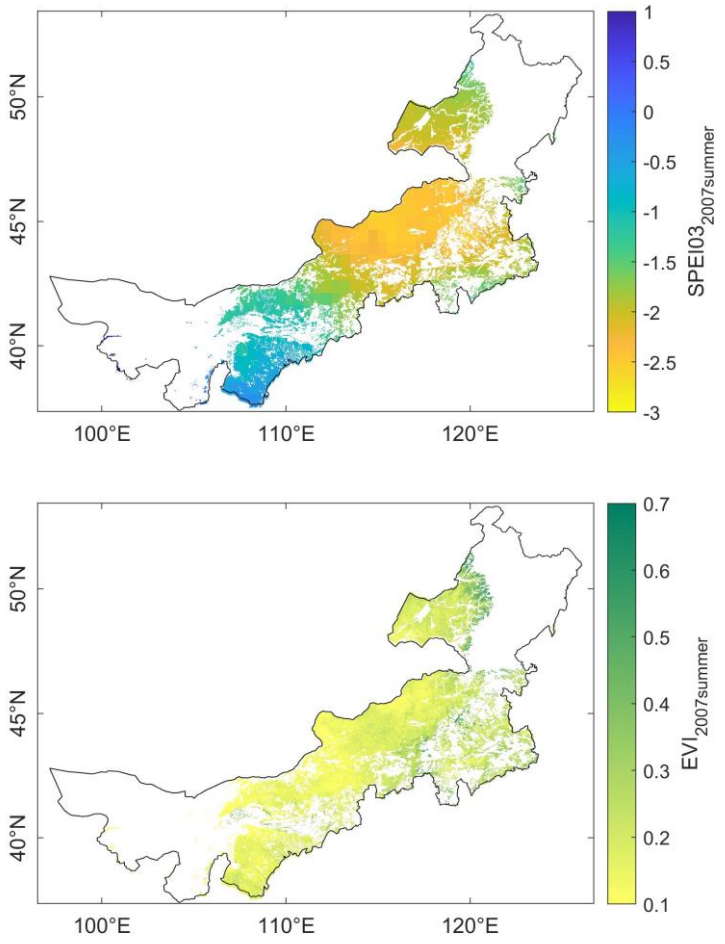
4. Result

- the semi-arid grasslands experienced severe droughts in the summers (June, July, and August) of 2007 (SPEI03min = -1.94) and 2017 (SPEI03min = -2.37).
- However, in 2017, the grasslands appeared to be almost unaffected by the extreme drought (EVIano = 0.004), while in 2007, productivity was reduced during drought (EVIano = -0.026).

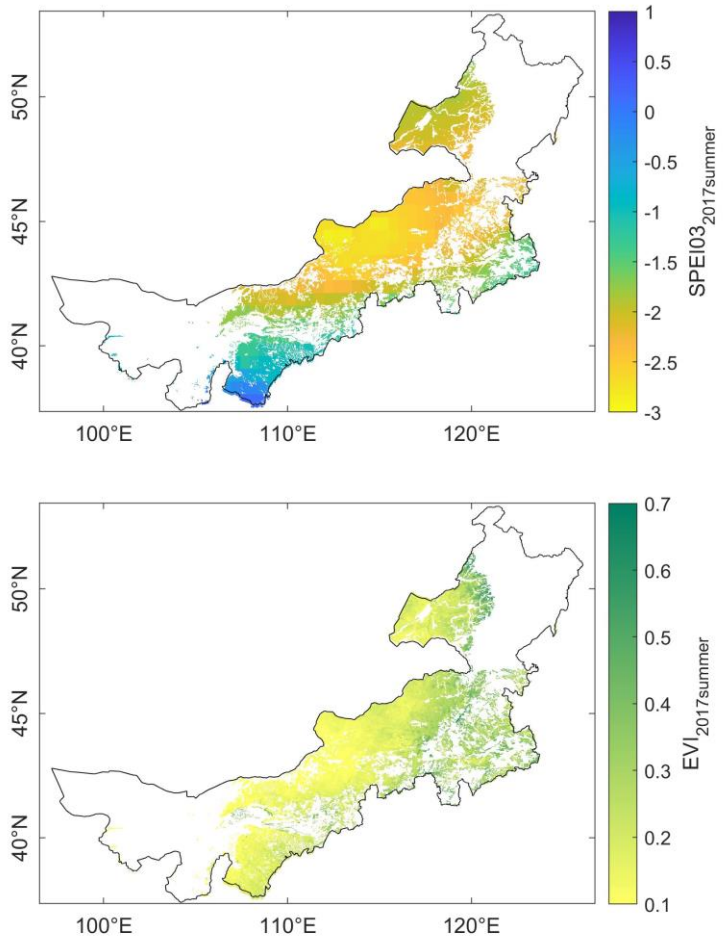


4. Result

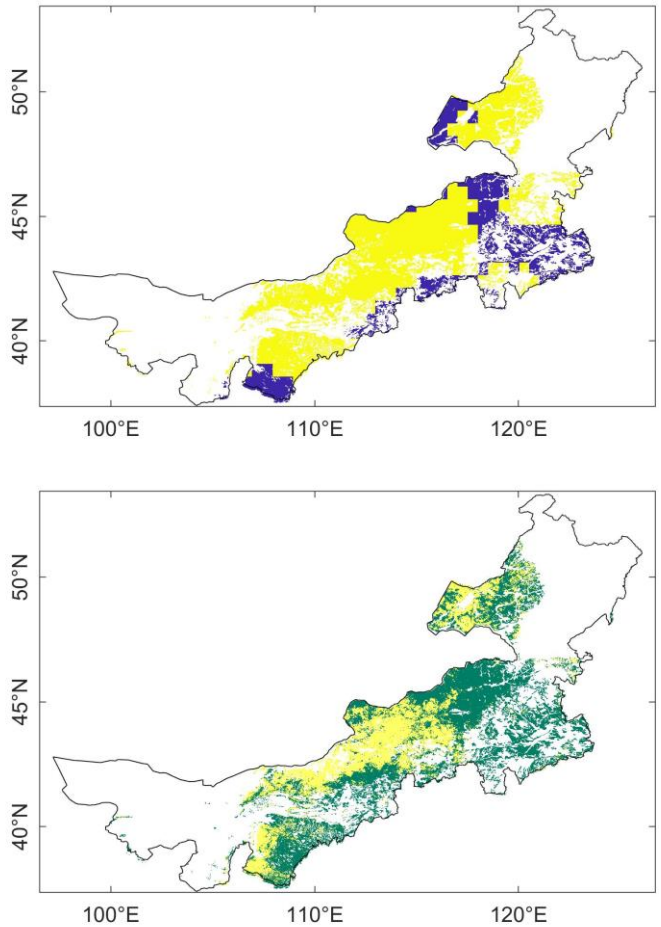
2007



2017



2017-2007

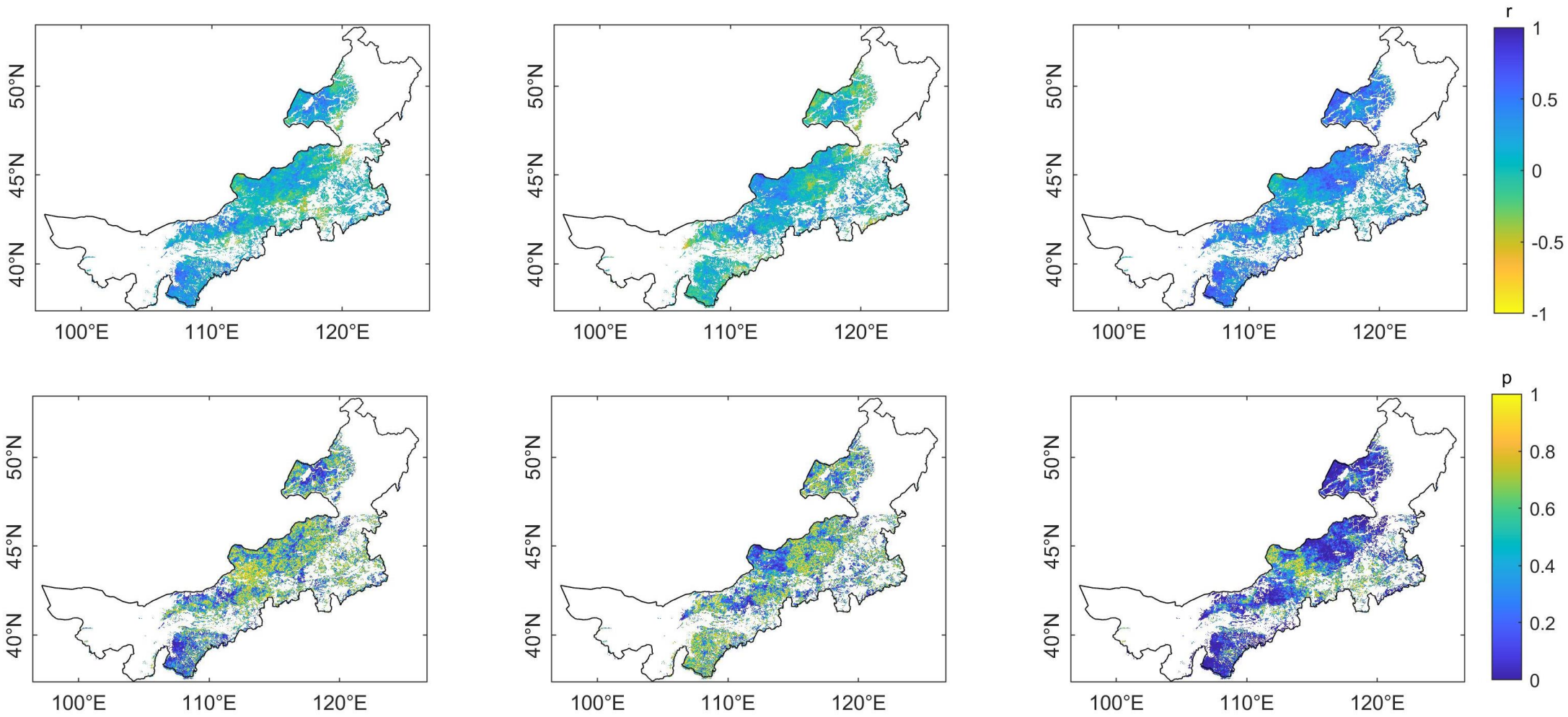


5. Questions

- Why were the semi-arid grassland growth enhanced during and after 2017 drought? (but decreased in 2007)

- Temperature and precipitation, which one determined the growth of grassland growth, or both were important factors?

6. Discussion—partial correlation analysis result （2001-2018 summer）



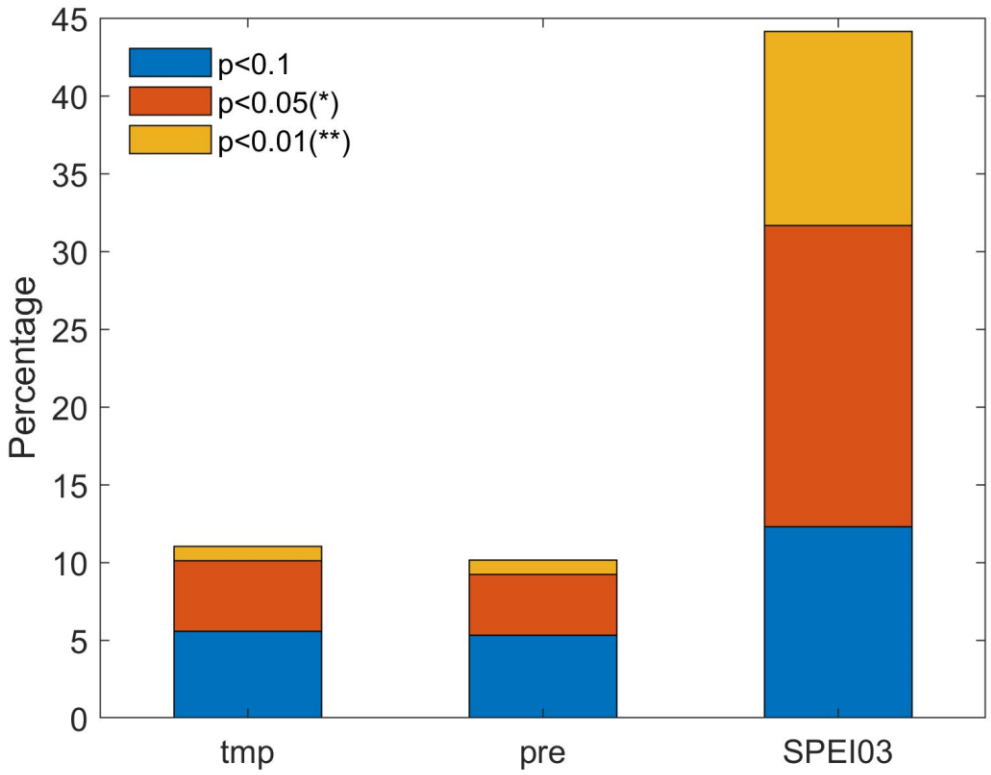
6. Discussion

- grasslands are generally significantly correlated to SPEI03

  rather than to temperature

  or to precipitation

- However, deluge during growing season may play important role to semi-arid grassland (Post & Knapp, 2020)



6. Discussion

- Temperature patterns were similar between summer in 2007 and 2017.
- But heavier rainfall happened during 2017 summer.

	2007 Summer			2017 Summer		
Month	**June**	**July**	**August**	**June**	**July**	**August**
SPEI03	-1.59	-1.92	-1.94	-2.37	-2.26	-1.38
Standardized Temperature	1.23	1.36	1.26	1.18	1.43 ↑	1.13
Standardized Precipitation	0.38	1.16	1.11	0.35	1.46 ↑	2
EVI-anomaly	-0.021	-0.04	-0.026	-0.001	-0.002	0.004

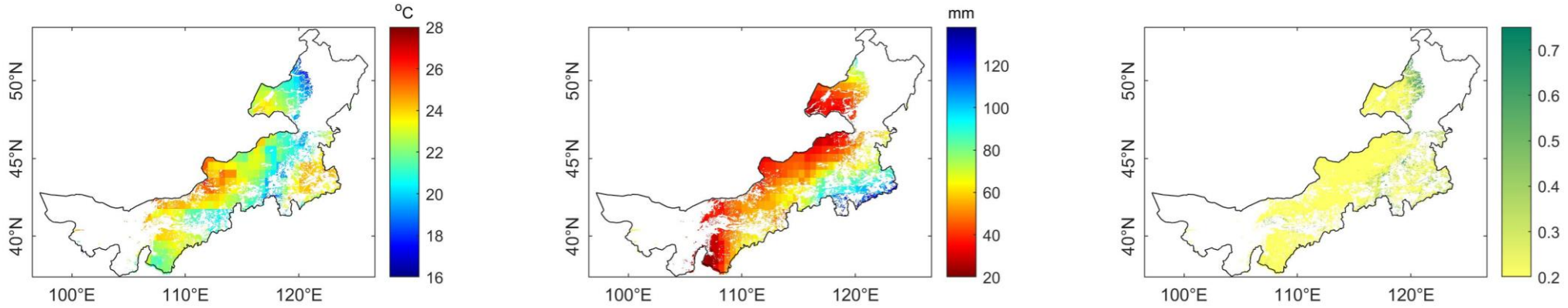
6. Discussion-monthly temperature and precipitation pattern

Temperature

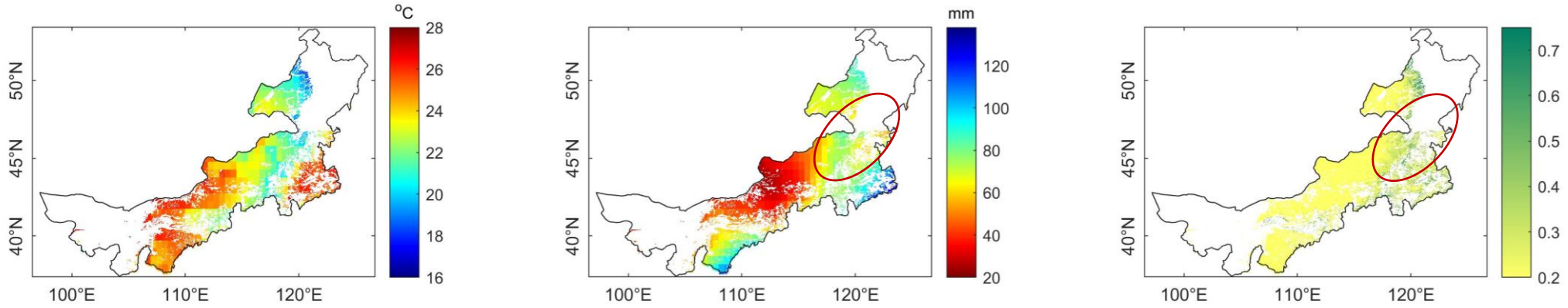
Precipitation

EVI

2007July

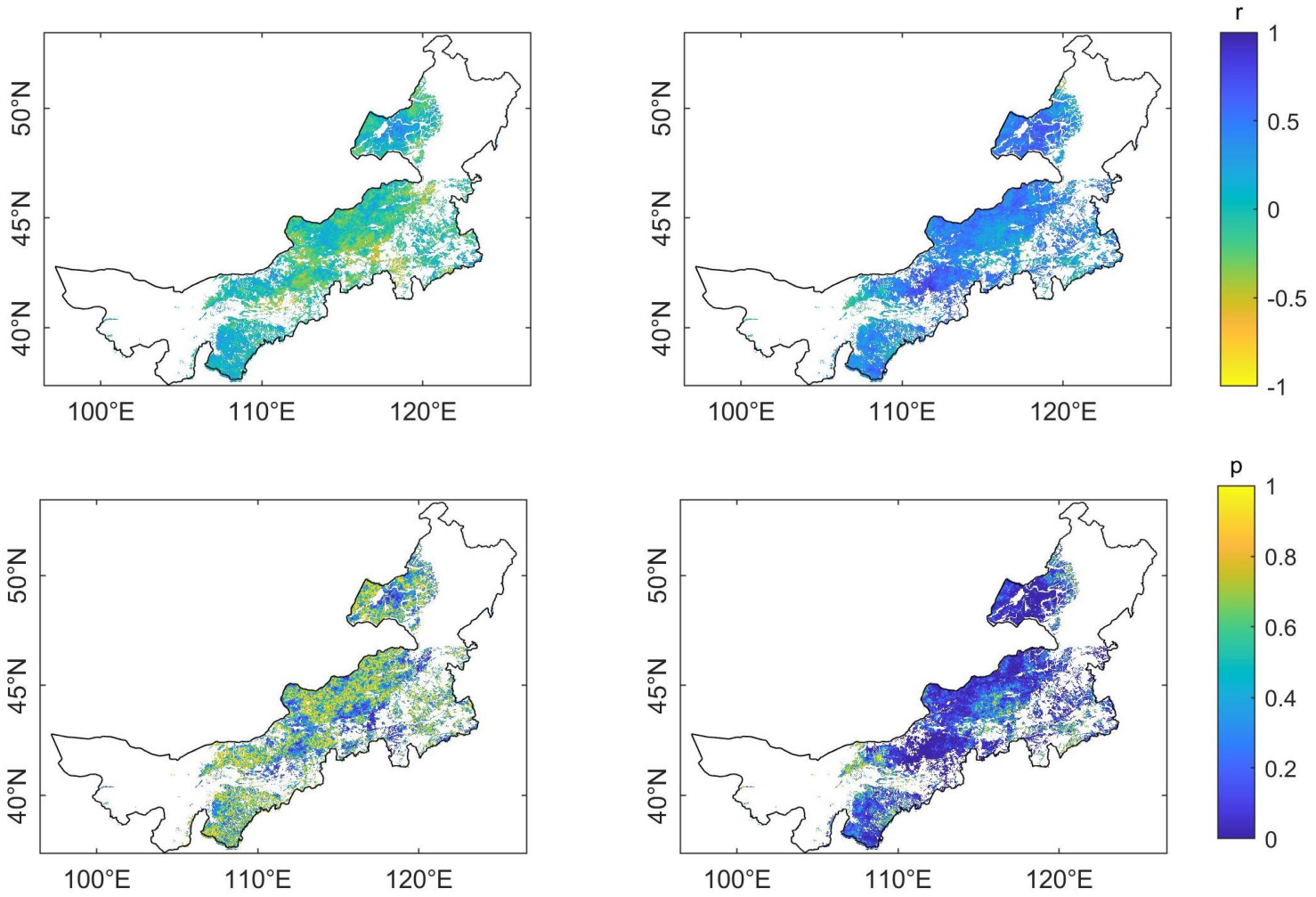


2017July



6. Discussion partial correlation analysis for monthly climatic factors （2001-2018）

- Grassland growth may be more sensitive to monthly precipitation than to monthly temperature.



7. Conclusion and further study

- Heavy rainfall may efficiently offset the negative effect of heatwave;
- The definition of drought types and events need to be carefully choose (Carroll et al., 2021).
- Daily weather records will be obtained for our further study.

References

Knapp, Alan K., Charles JW Carroll, Elsie M. Denton, Kimberly J. La Pierre, Scott L. Collins, and Melinda D. Smith. "Differential sensitivity to regional-scale drought in six central US grasslands." *Oecologia* 177, no. 4 (2015): 949-957.

Dai, Aiguo. "Increasing drought under global warming in observations and models." *Nature climate change* 3, no. 1 (2013): 52-58.

Chiang, Felicia, Omid Mazdiyasni, and Amir AghaKouchak. "Evidence of anthropogenic impacts on global drought frequency, duration, and intensity." *Nature communications* 12, no. 1 (2021): 1-10.

Post, Alison K., and Alan K. Knapp. "The importance of extreme rainfall events and their timing in a semi-arid grassland." *Journal of Ecology* 108, no. 6 (2020): 2431-2443.

Carroll, Charles JW, Ingrid J. Slette, Robert J. Griffin-Nolan, Lauren E. Baur, Ava M. Hoffman, Elsie M. Denton, Jesse E. Gray et al. "Is a drought a drought in grasslands? Productivity responses to different types of drought." *Oecologia* 197, no. 4 (2021): 1017-1026.

Thanks for your attention!