Association between precipitation intermittency and soil moisture variability in CESM2 and observations.

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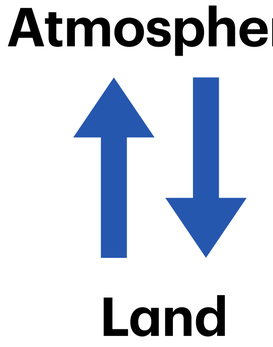
28th Annual CESM Workshop
Climate Variability and Change Working Group Meeting

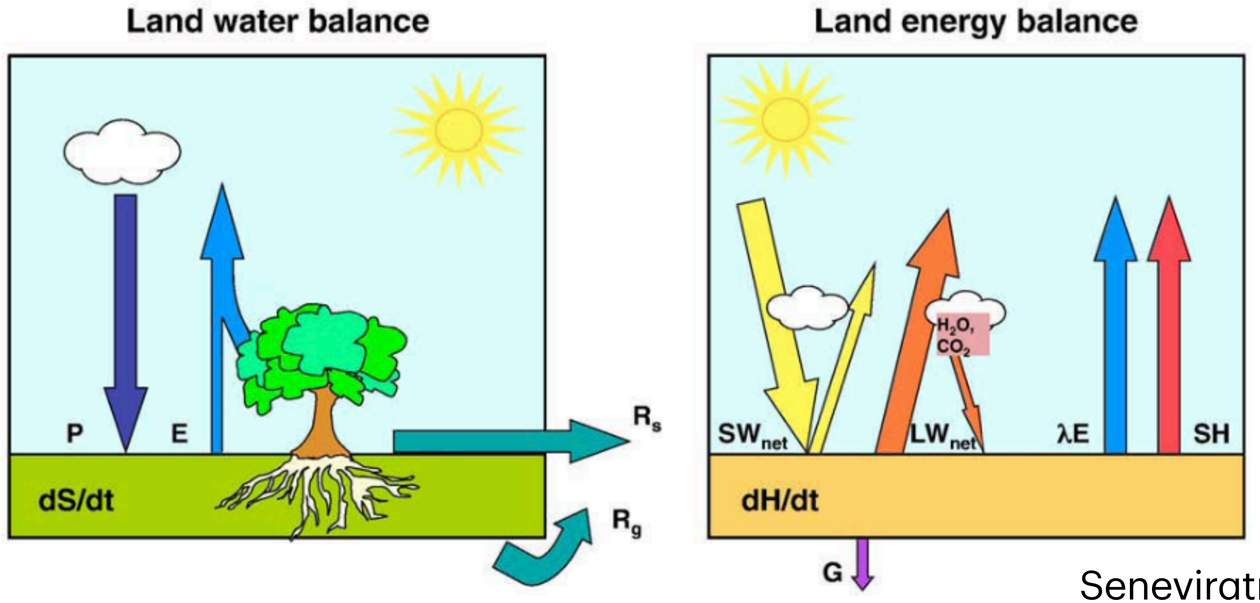
June 14, 2023

Swiss National Science Foundation

NCAR

Motivation

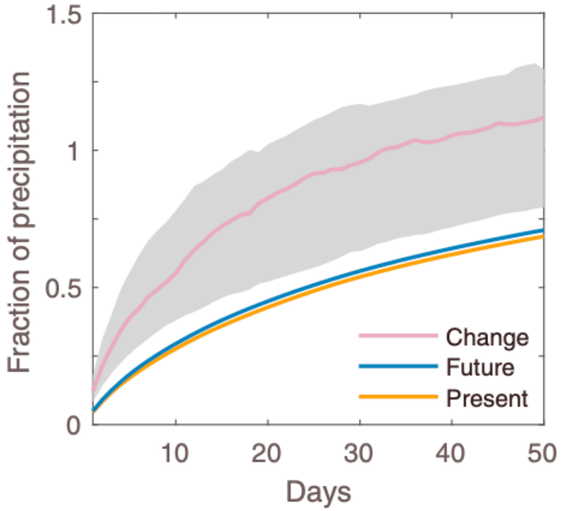




Seneviratne et al. (2010)

How is precipitation intermittency (temporal distribution of precipitation) associated with soil moisture?

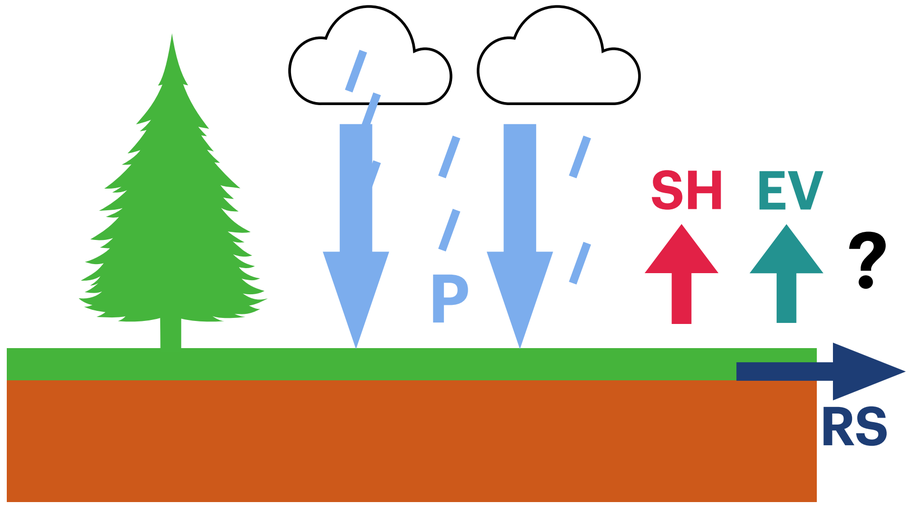
Precipitation intermittency is expected to change under future climate scenarios with increased extreme precipitation and dry days (in some regions).



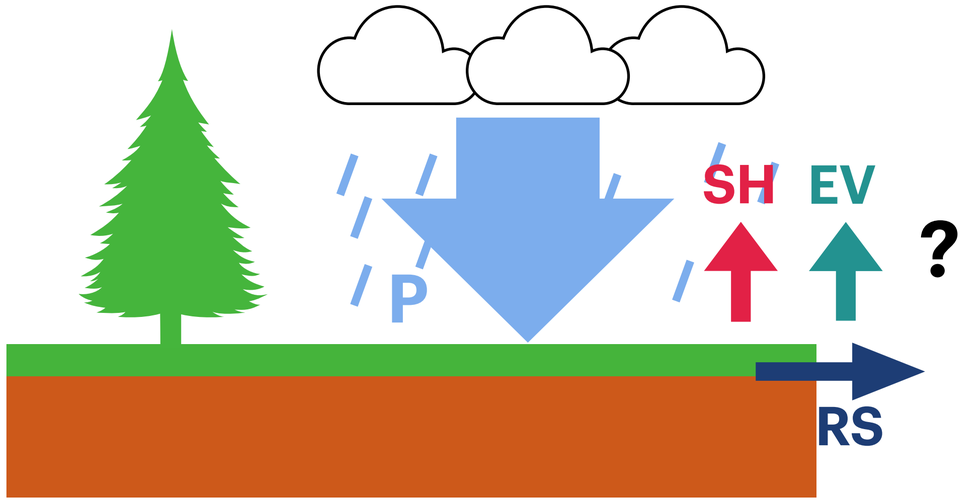
Pendergrass and Knutti. (2018)

Hypothesis: Effects of precipitation intermittency on soil moisture

Same amount of rainfall falling in more days (Low intermittency)



Same amount of rainfall falling in fewer days (High intermittency)



In this presentation: - Quantify statistical associations between precipitation intermittency and soil moisture on a seasonal scale during the present (1981 - 2020).
- Identify regions where the associations are stronger (or weaker).
In CESM and observation-based data.

Data and Methods

CESM2 large ensemble (LENS2) during 1981 - 2020

- 100 ensemble members

(Rodgers et al., 2021)

Observation-based data:

- ERA5 (atmosphere) and ERA5-Land (land)

(Hersbach et al., 2018)

Two variables:

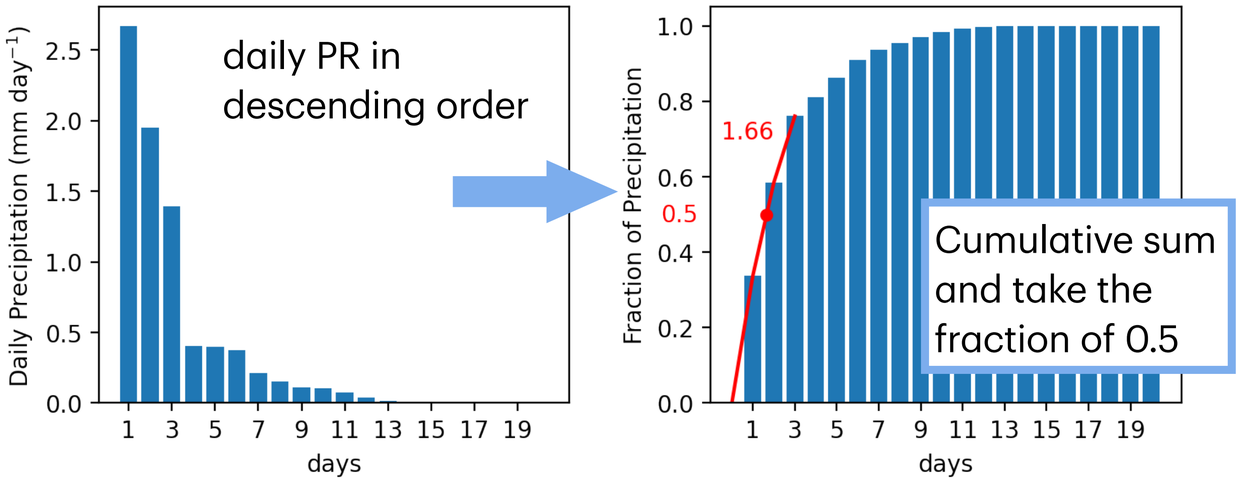
- Surface soil moisture
- Daily precipitation

Index for Precipitation intermittency

In number of wet days (**"Wet day Index"**)

How **many wet days** a given region takes to receive 50% of the total rainfall of the season.

(Pendergrass and Knutti, 2018)



High Wet day index —> Low intermittency

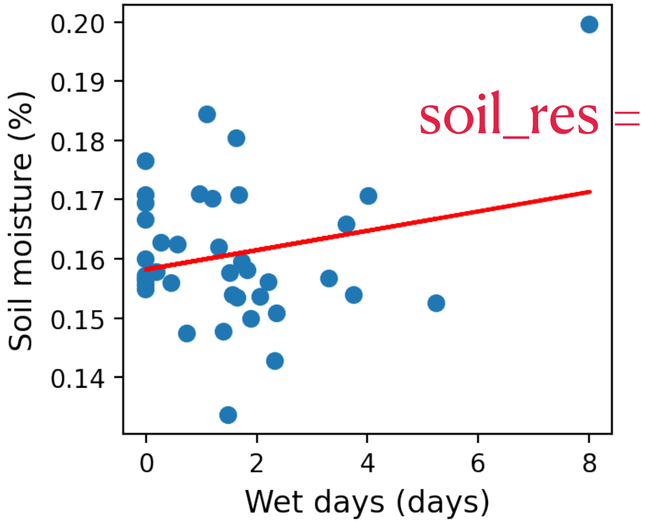
Low Wet day index —> High intermittency

Method: Partial Regression Analysis

Regression coefficients between the residuals of soil moisture and wet day index after removing the linear influence of precipitation.

1) Regression analysis between precipitation (**PR**) and soil moisture (**Soil**) and get the residuals.
2) Regression analysis between precipitation (**PR**) and wet day index (**Wet day**) and get the residuals.

Regression analysis between soil moisture residuals (**soil_res**) and wet day index residuals (**wet_res**)

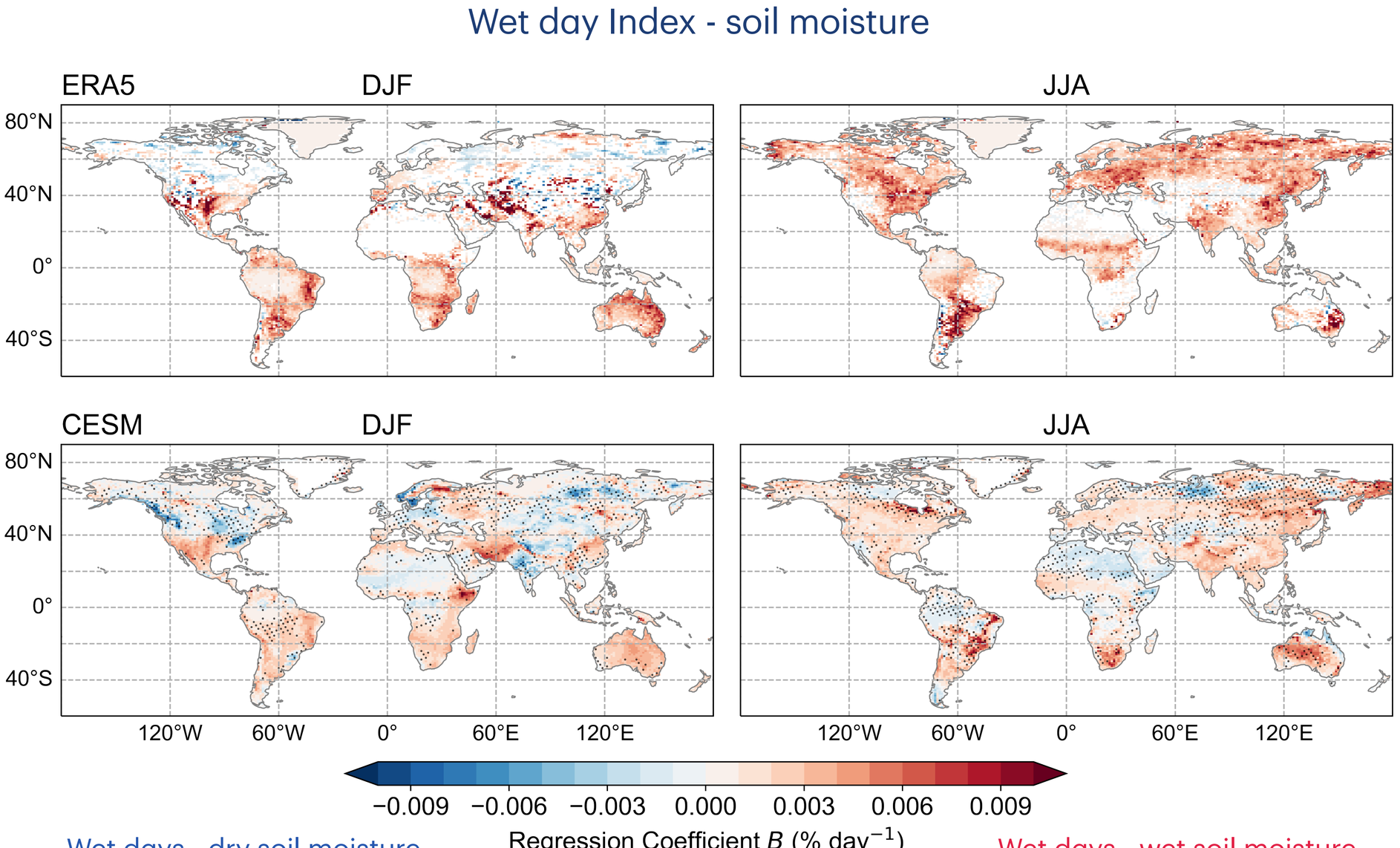


$$soil\_res = B^{*}wet\_res + e$$

B > 0 : Positive regression coefficient
More (less) Wet day index - more (less) soil moisture

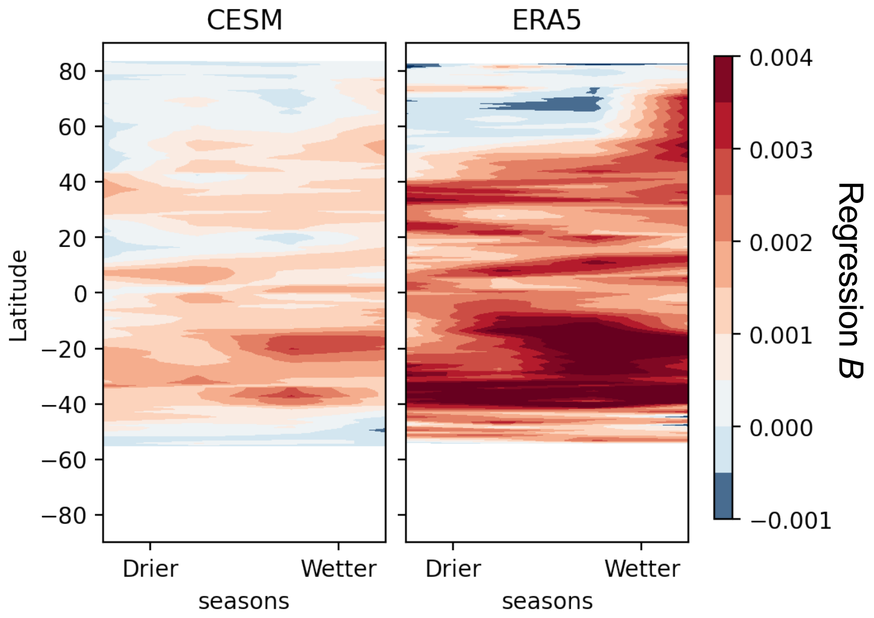
B<0 : Negative regression coefficient
More (less) Wet day index - less (more) soil moisture

CESM shows consistent spatial regression patterns to ERA5

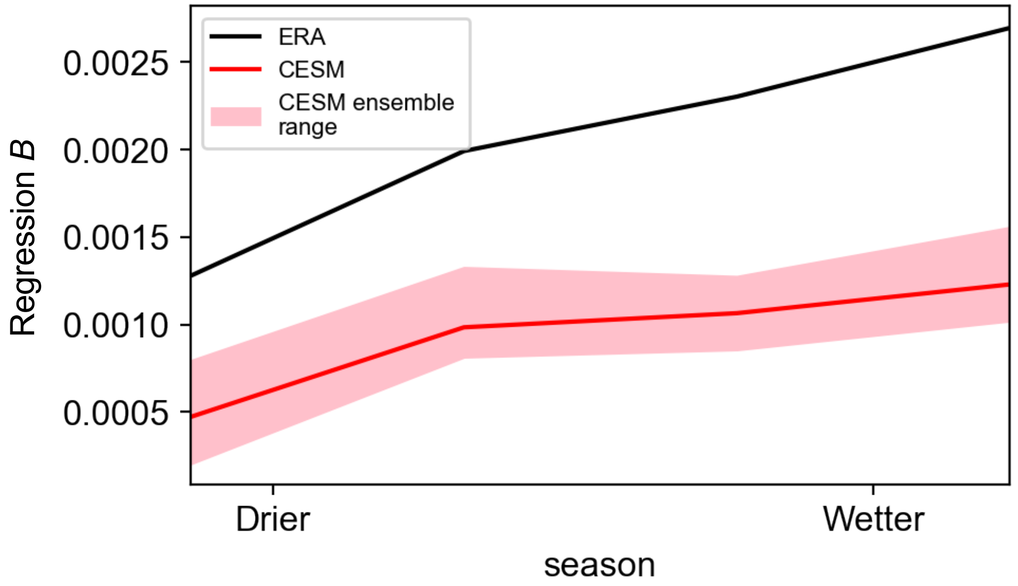


Magnitudes of regression coefficients change with the mean precipitation

Longitudinal means of regression coefficients



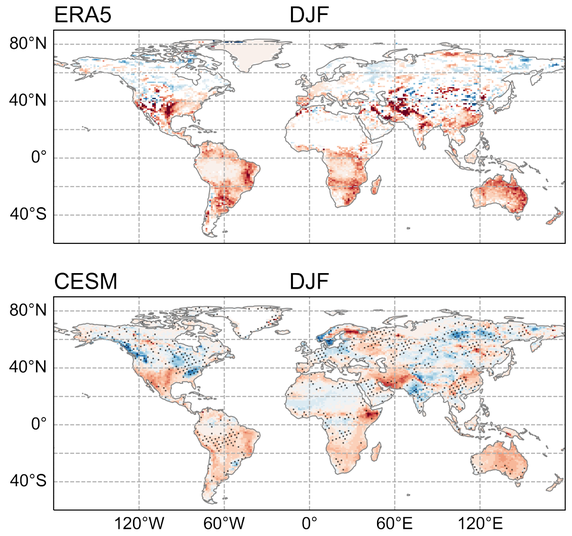
Global means of regression coefficients



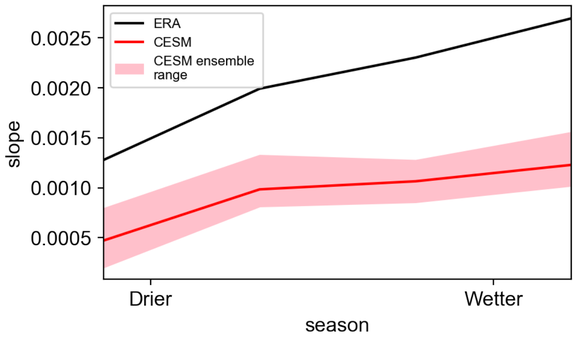
Summary

- Positive associations —> High precipitation intermittency linked with low soil moisture and vice versa.

- In general, CESM - ERA5 show consistent spatial patterns although differences exist in some regions.
  Magnitudes of the regression coefficients are larger in ERA5.



- Magnitudes of the regression coefficients depend on the mean precipitation. —> Larger and positive regression coefficients during wetter seasons (smaller or negative coefficients in drier seasons).



Next ...

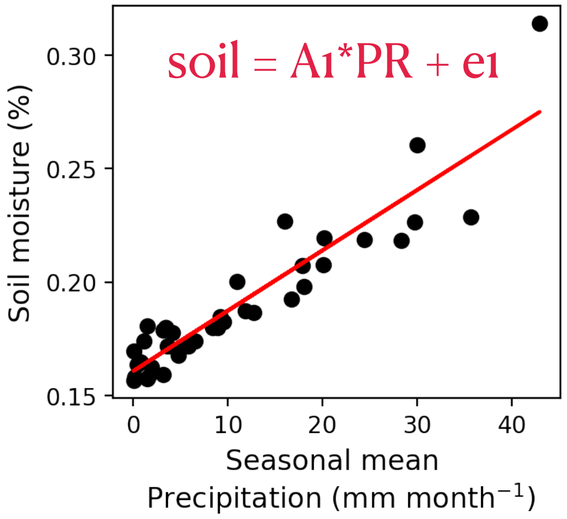
- How these relationships change in the future climate scenarios.

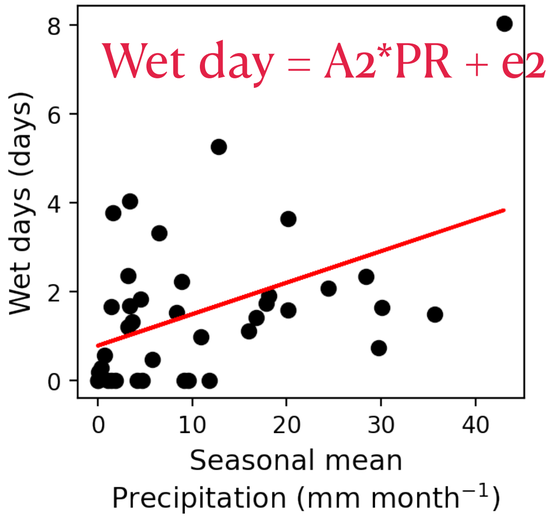
Thanks for your attention!

Method

Partial Regression Analysis

Residuals from the regression analysis between precipitation (**PR**) soil moisture (**Soil**), and between precipitation (**PR**) and wet day index (**Wet day**) are calculated



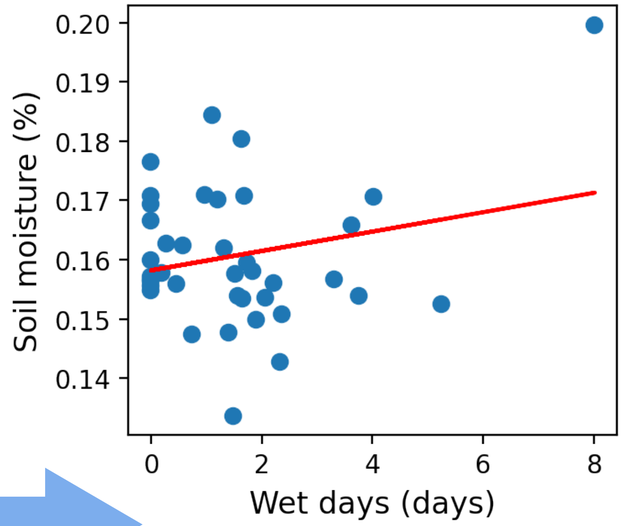


Residuals

$$soil\_res = soil - A1*PR$$

$$wet\_res = Wet\ day - A2*PR$$

Final Regression coefficients from residuals



$$soil\_res = B*wet\_res + e$$

Regression analysis between soil moisture residuals (soil_res) and wet day index residuals (wet_res)

B > 0 : Positive regression coeffient
More (less) Wet days - more (less) soil moisture

B<0 : Negative regression coefficient
More (less) Wet days - less (more) soil moisture

CESM-ERA5 desagree during the dry season in India

Distribution of regression coefficients across wet day index and precipitation amount