Shifting control of hillslope soil-terrain attributes on the soil water content distribution under different water storage states (new title)

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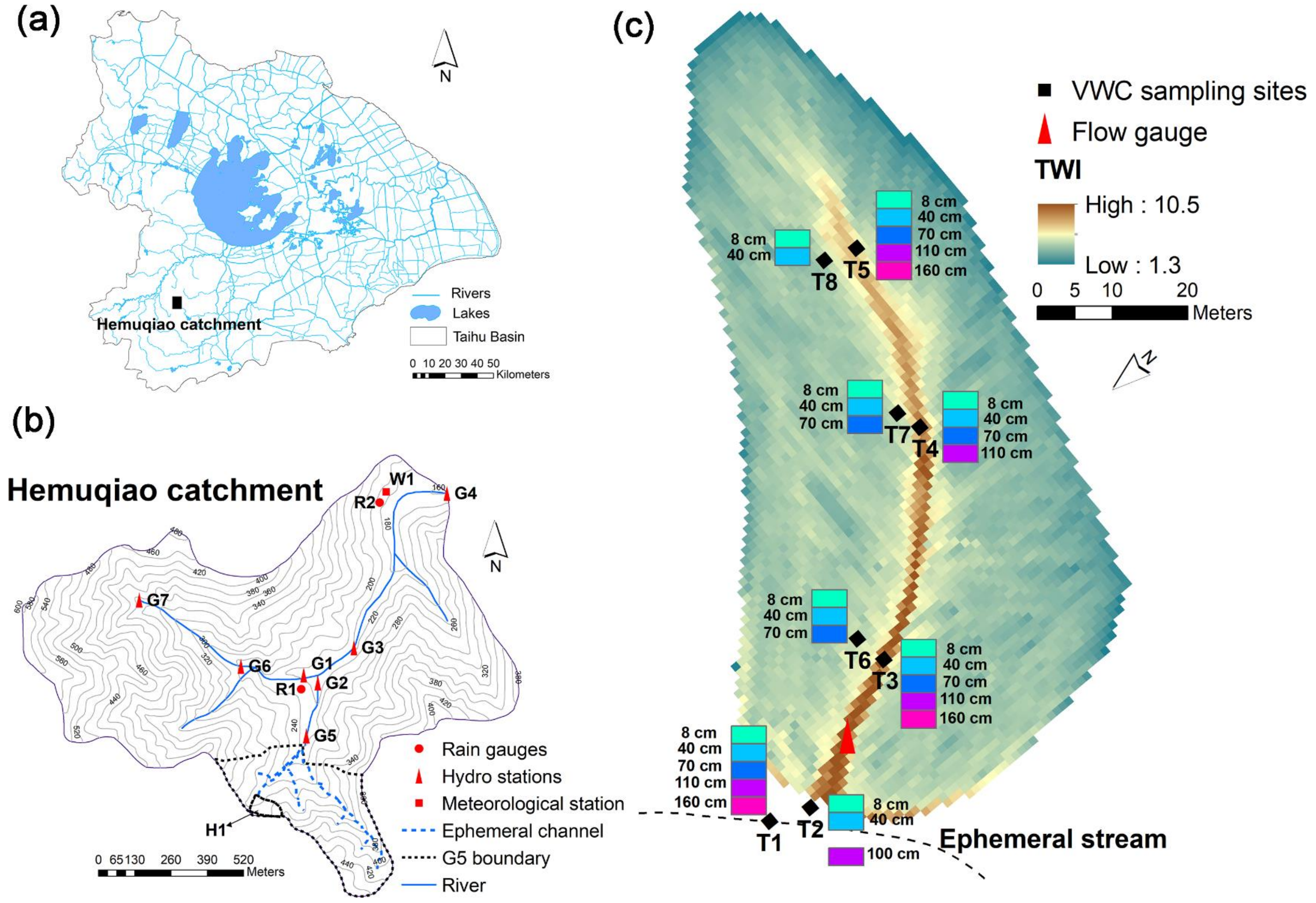
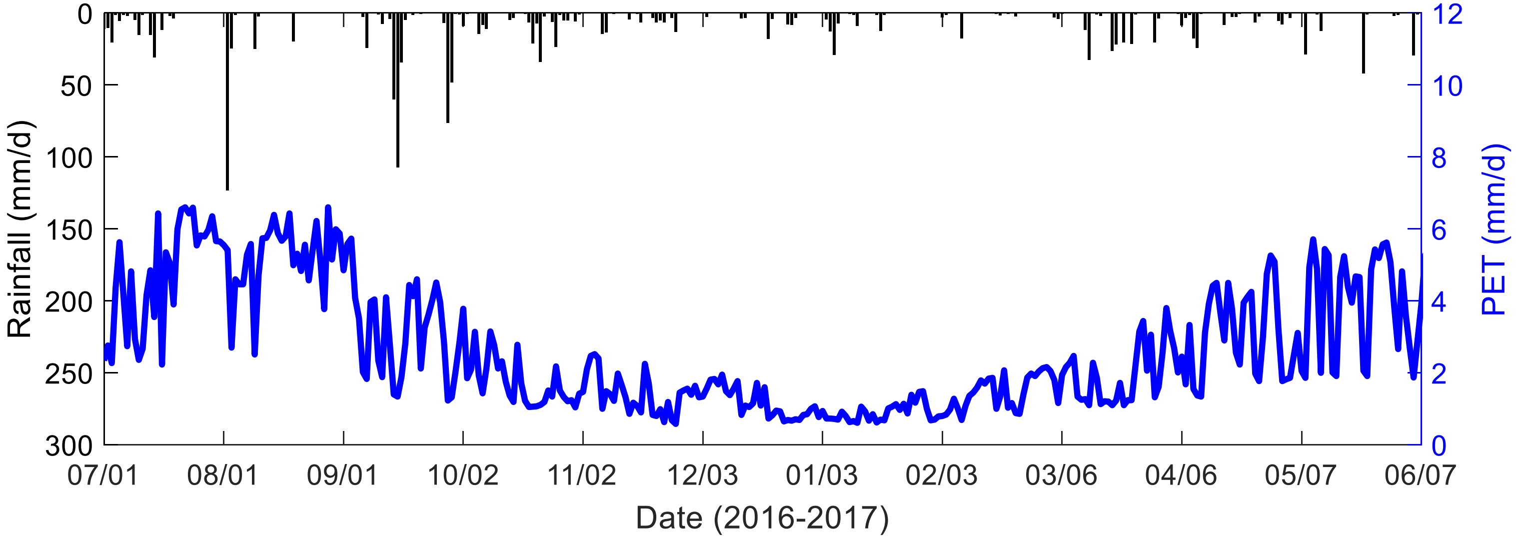
Method: Study site

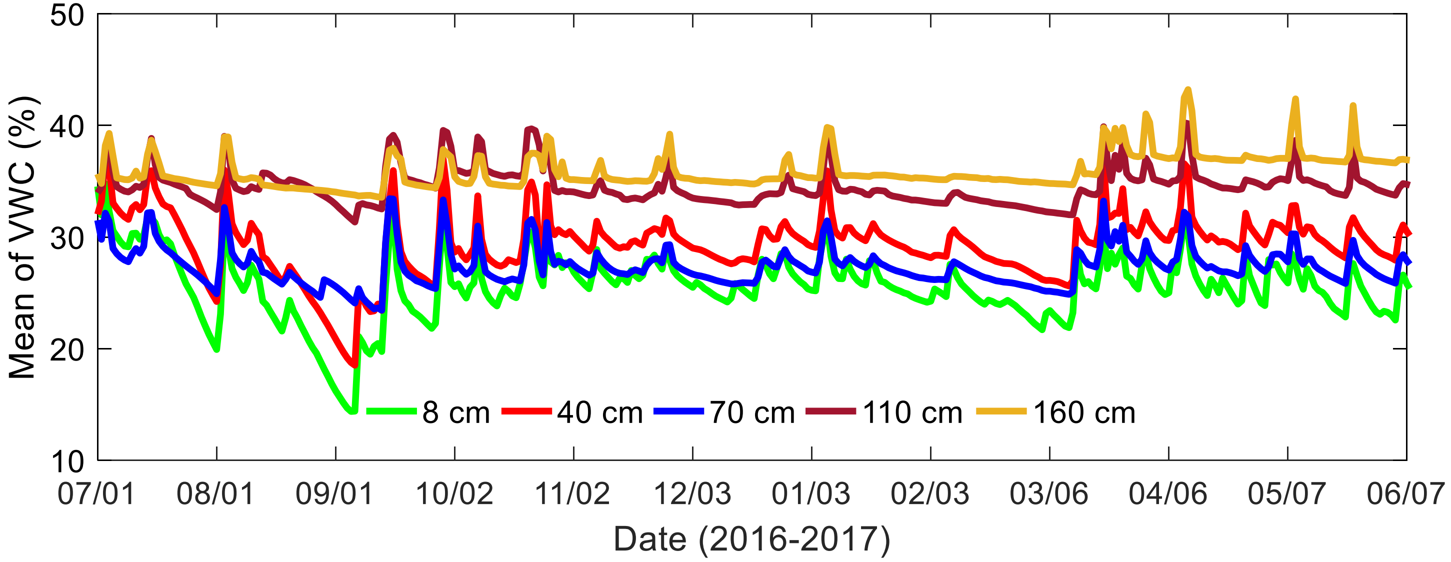


The location of Hemuqiao catchment in Taihu basin (a), the location of H1 in Hemuqiao catchment (b), and the zero-order catchment H1 (c)

The installation depth of 40 cm represents the interface of topsoil layer (A horizon) and subsoil (B horizon), and the K_s of surface soil (0–40 cm) was almost an order of magnitude larger than that of the subjacent deeper soil (Han et al., 2020, JOH)

Method： Time series of daily rainfall, PET, and VWC





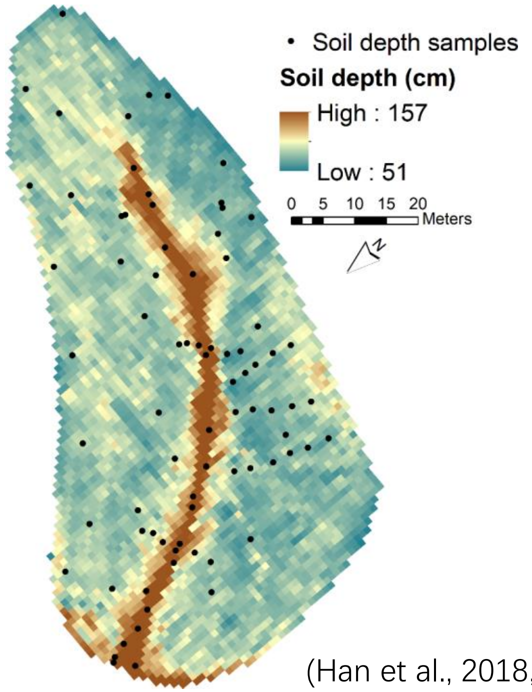
- PET shows a strong seasonal characteristic, with higher values in summer than that in winter

Method: Two selected periods

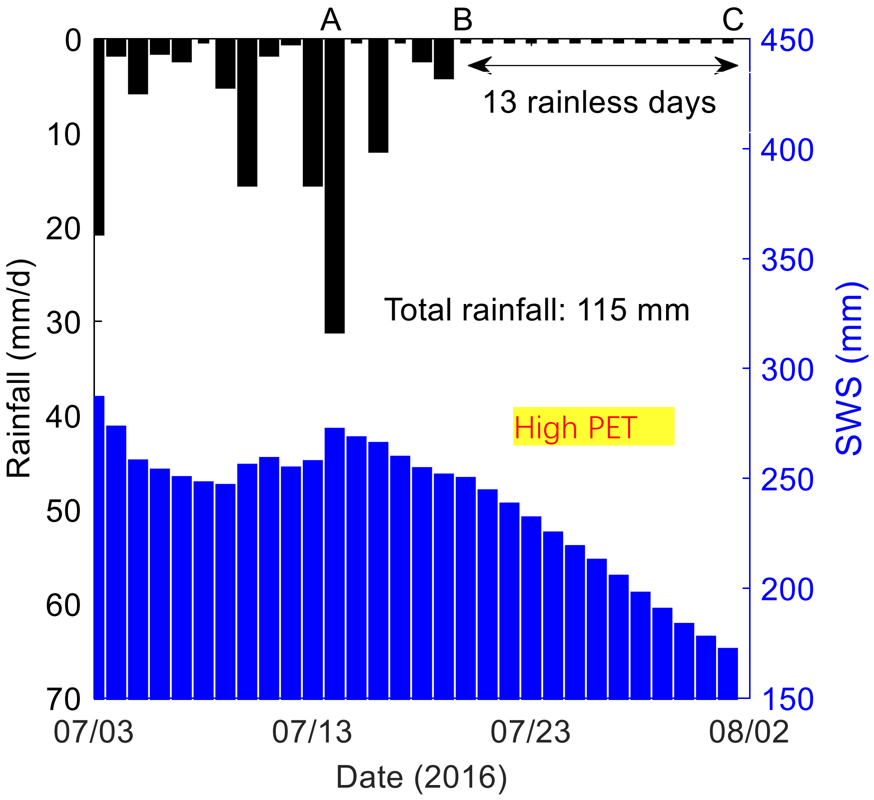
- From high SWS to low SWS (Soil water storage)

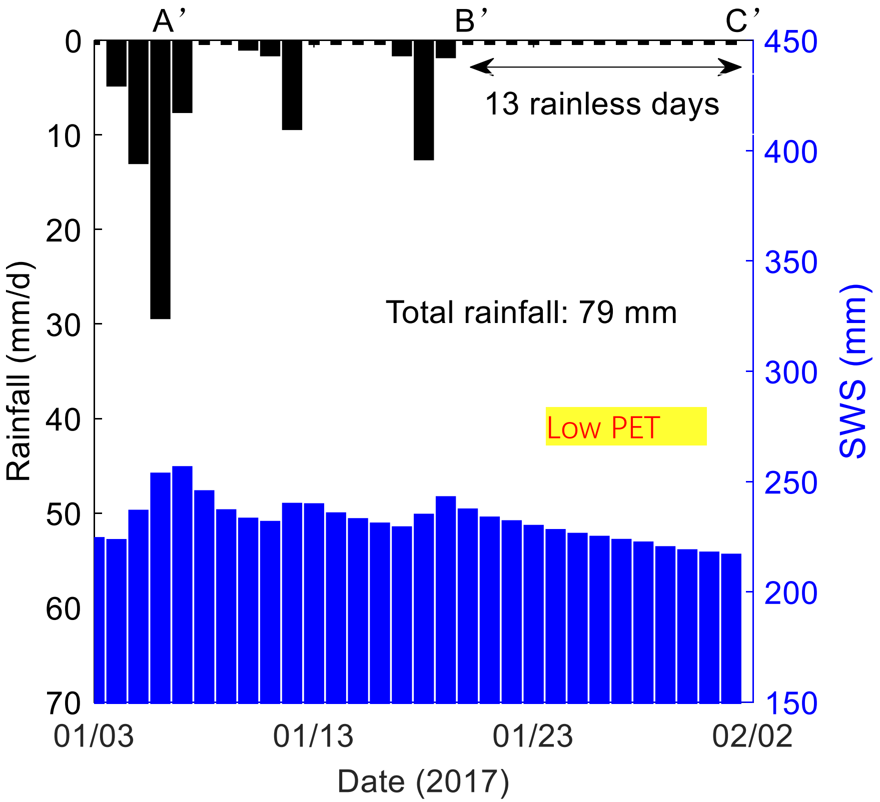
$$SWS = \left\{ \sum_{i=1}^{N} \left[sm_i^1 \times (dep_i - dep_{i-1}) \right] \times A_v + \sum_{i=1}^{N} \left[sm_i^2 \times (dep_i - dep_{i-1}) \right] \times A_s \right\} / A$$

where i is the index, N is the number of soil layers fixed with a TDR probe, and dep_i represents different depths. sm^1 and sm^2 are the measured soil moisture at a given depth of valley (sm^1) and side slope (sm^2), and A_v, A_s, and A represents the area of the valley (397 m^2), side slope (2703 m^2), and the total area of H1 (3100 m^2), respectively.



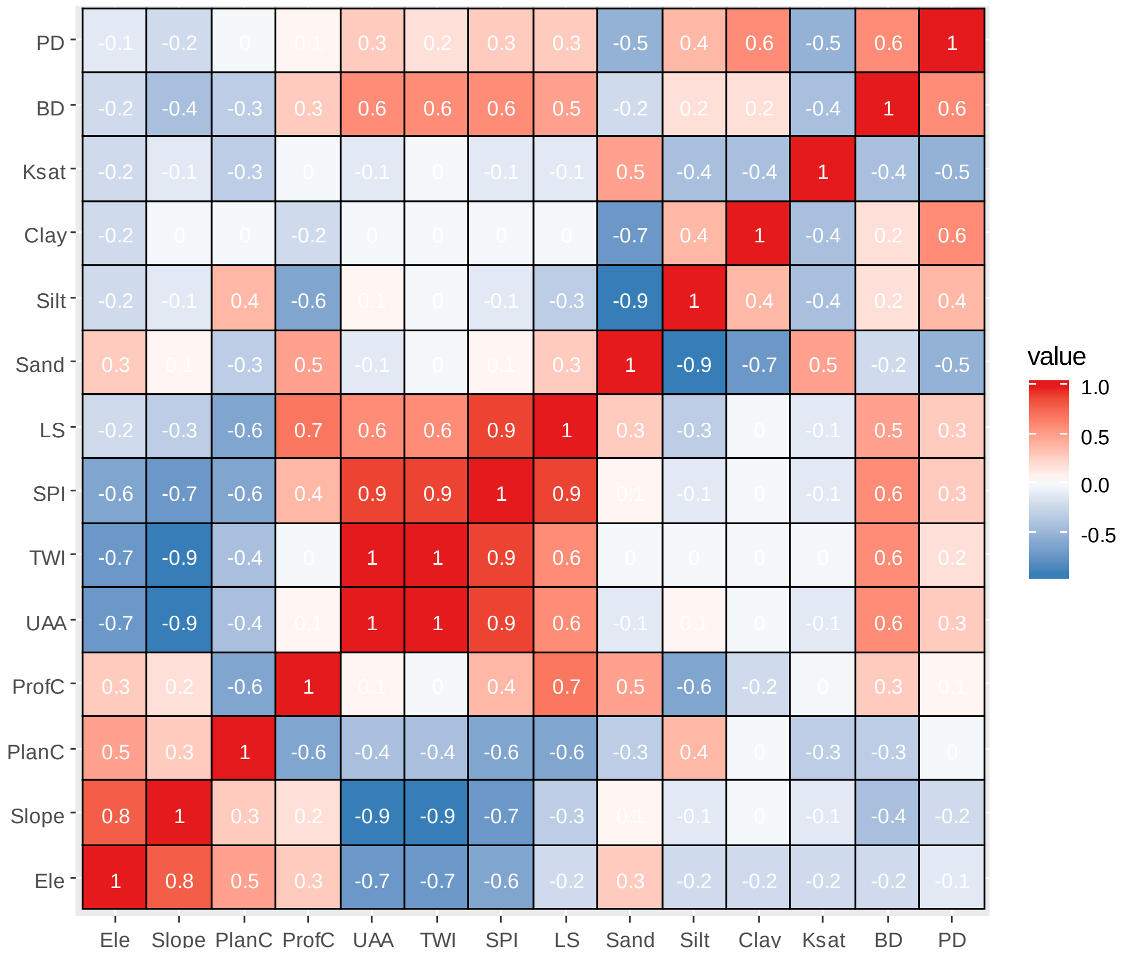
(Han et al., 2018, Catena)





- SWS declined faster in summer than in winter in the last 13 rainless days

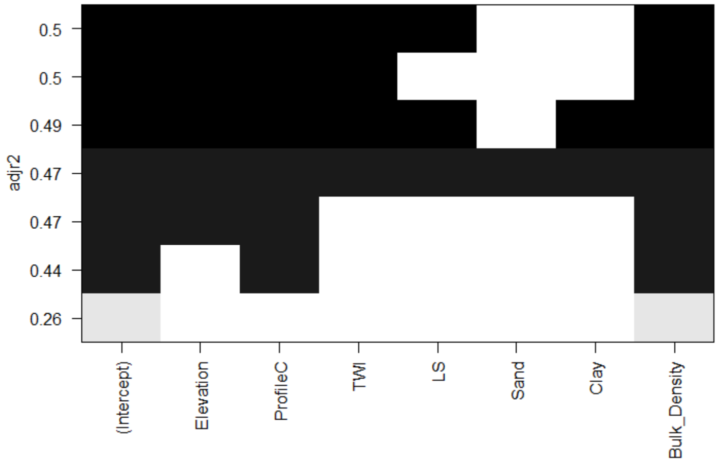
Method： Soil-terrain attributes



◆ Soil-terrain attributes

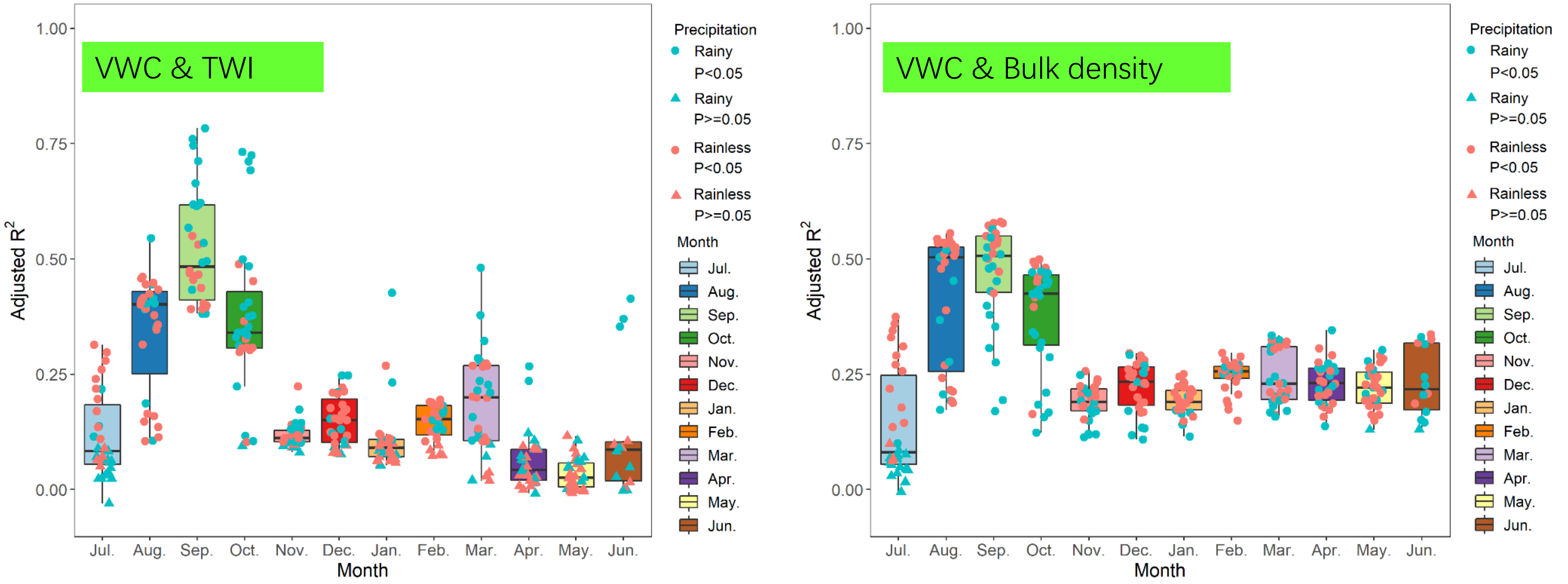
- Elevation (m),
- Profile curvatures (Cv, m^{-1}),
- Topographic wetness index (TWI)
- Stream power index (SPI)
- LS-factor (LS)
- Sand (%)
- Clay (%)
- Bulk density (g/cm3)

◆ All-possible-subsets regression model



R package “leaps”, algorithm “regsubsets”

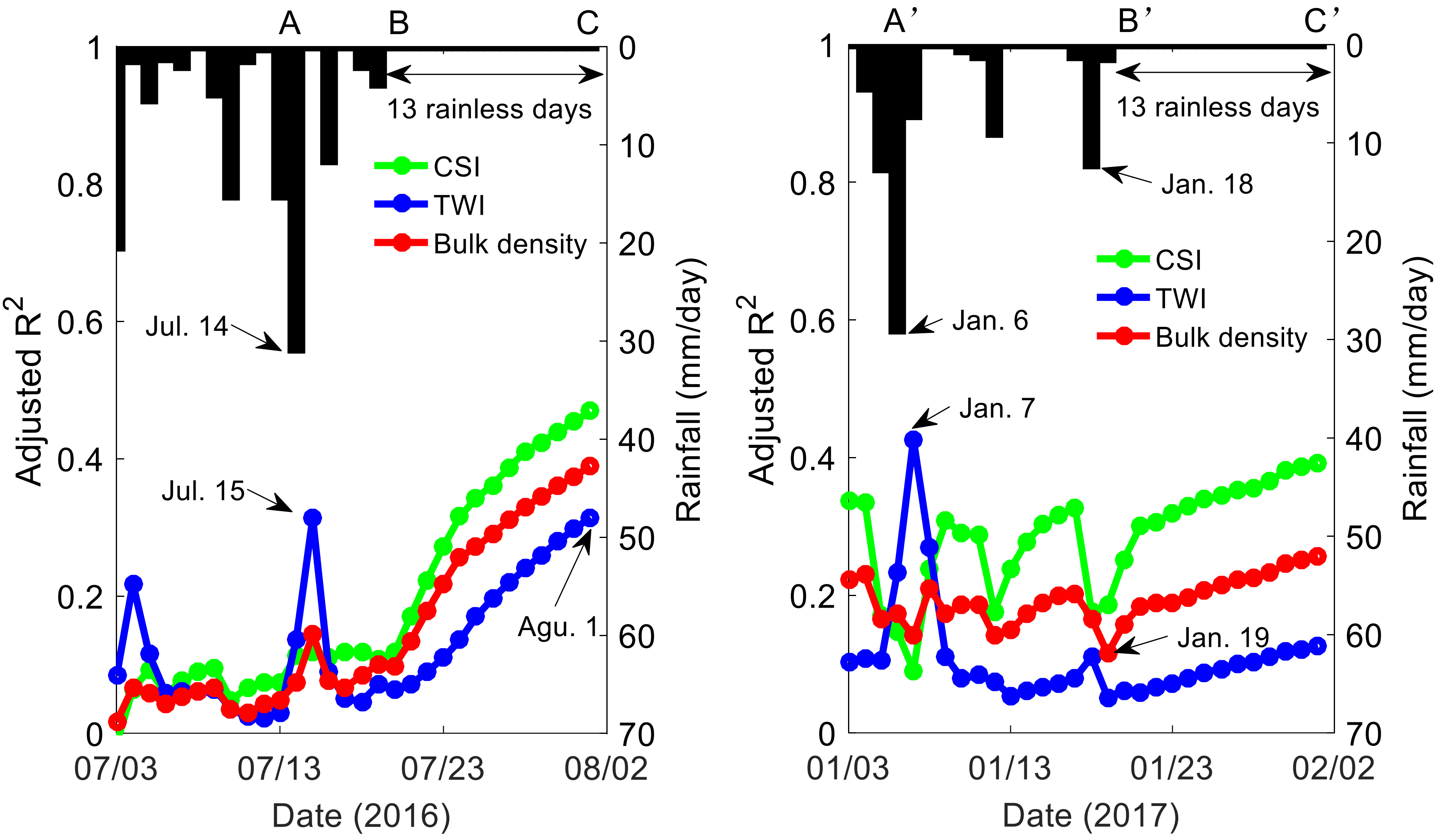
Results and Discussion： Correlation between VWC and soil-terrain attributes



- From August to October: higher values of adjusted R^2 between VWC and TWI, and VWC and bulk density were observed.
- November to February: 25% days TWI & VWC $P \geqslant 0.05$;
  All days BD & VWC<0.05
- Rainy/rainless days

Results and Discussion:

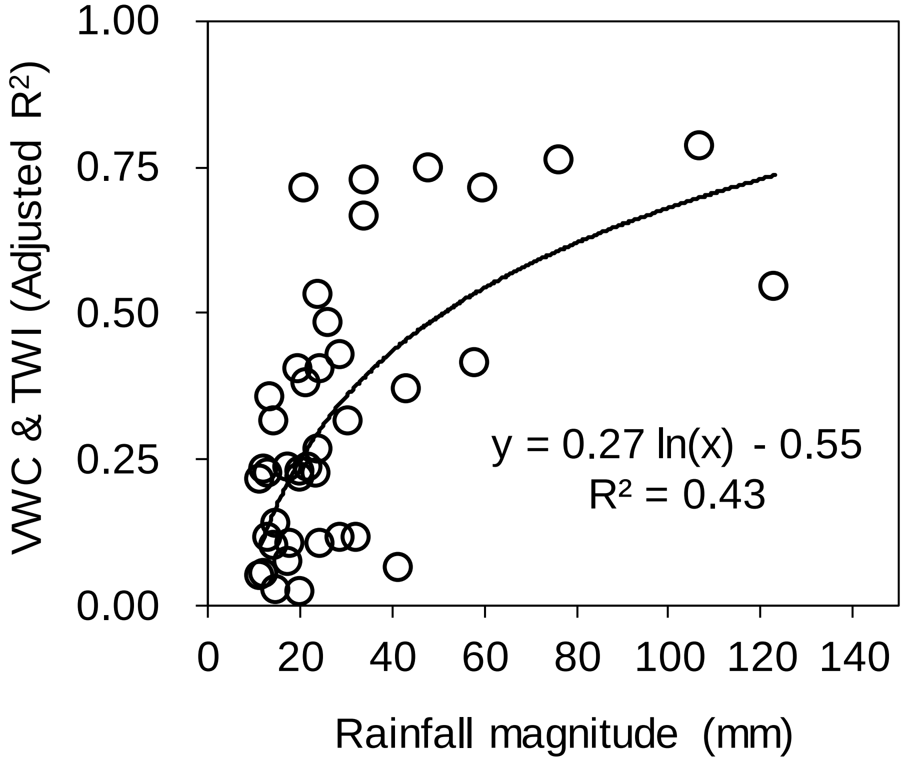
A shifting control of soil–terrain attributes on VWC

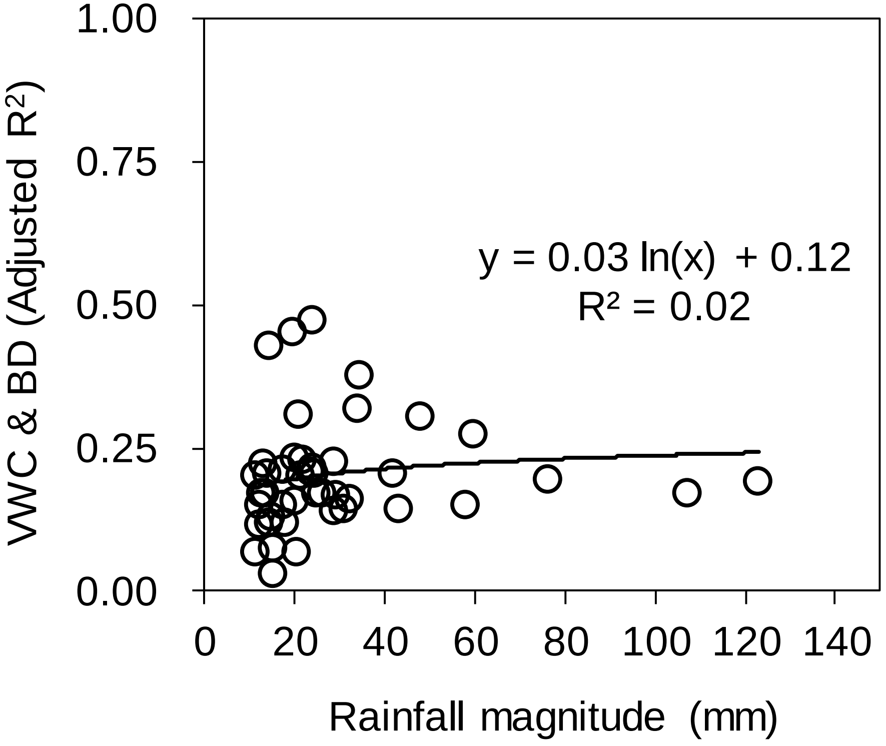


- On rainy days (high-water storage state), higher values of adjusted R^2 were observed between VWC and TWI
- On the contrary, during 13 rainless days (low-water storage state), the correlations between VWC and CSI and VWC and bulk density exhibited higher values
- The relationship between VWC and TWI remained at a high level in the wettest (Jul 15) and driest (Aug 1) wetness states

Results and Discussion：

The relationship between VWC and soil-terrain attributes as a function of rainfall magnitude

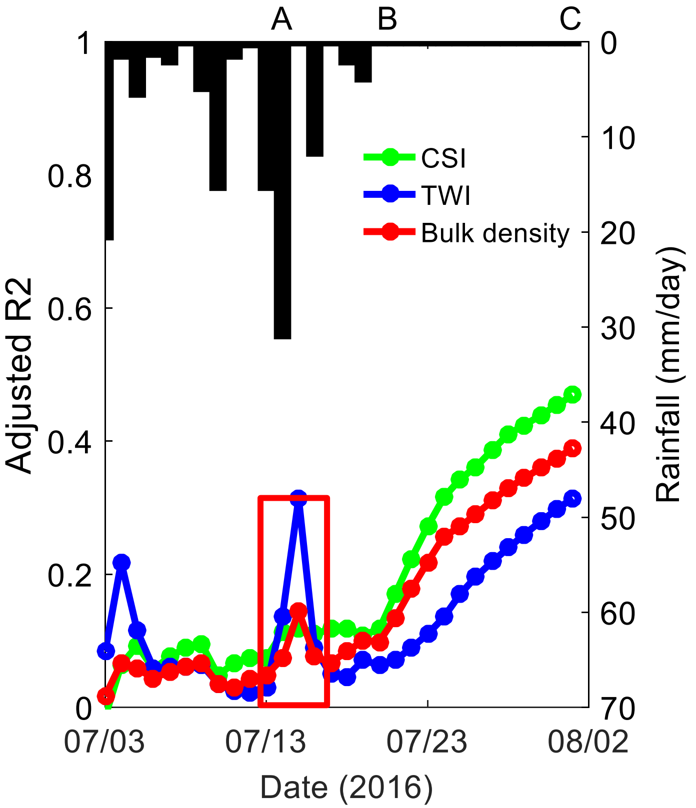


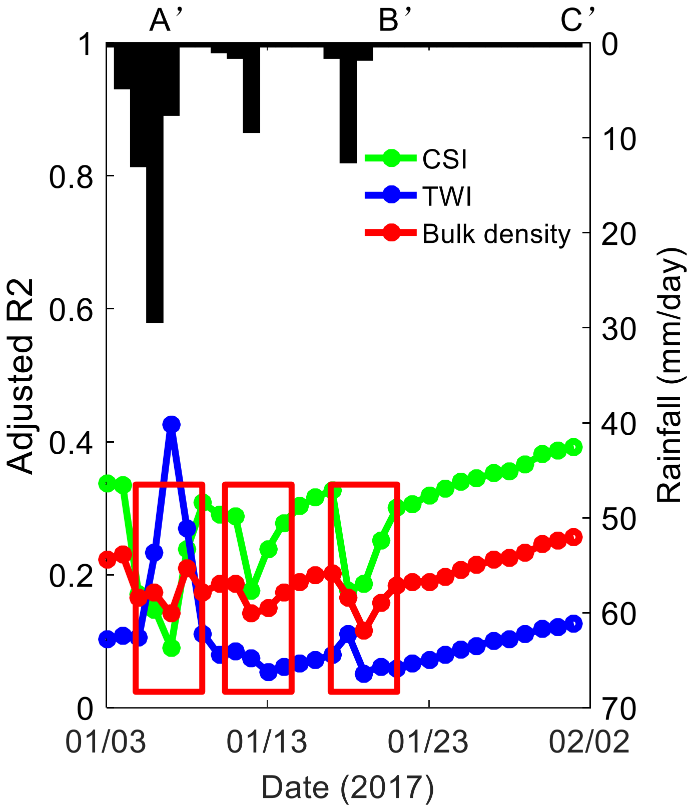


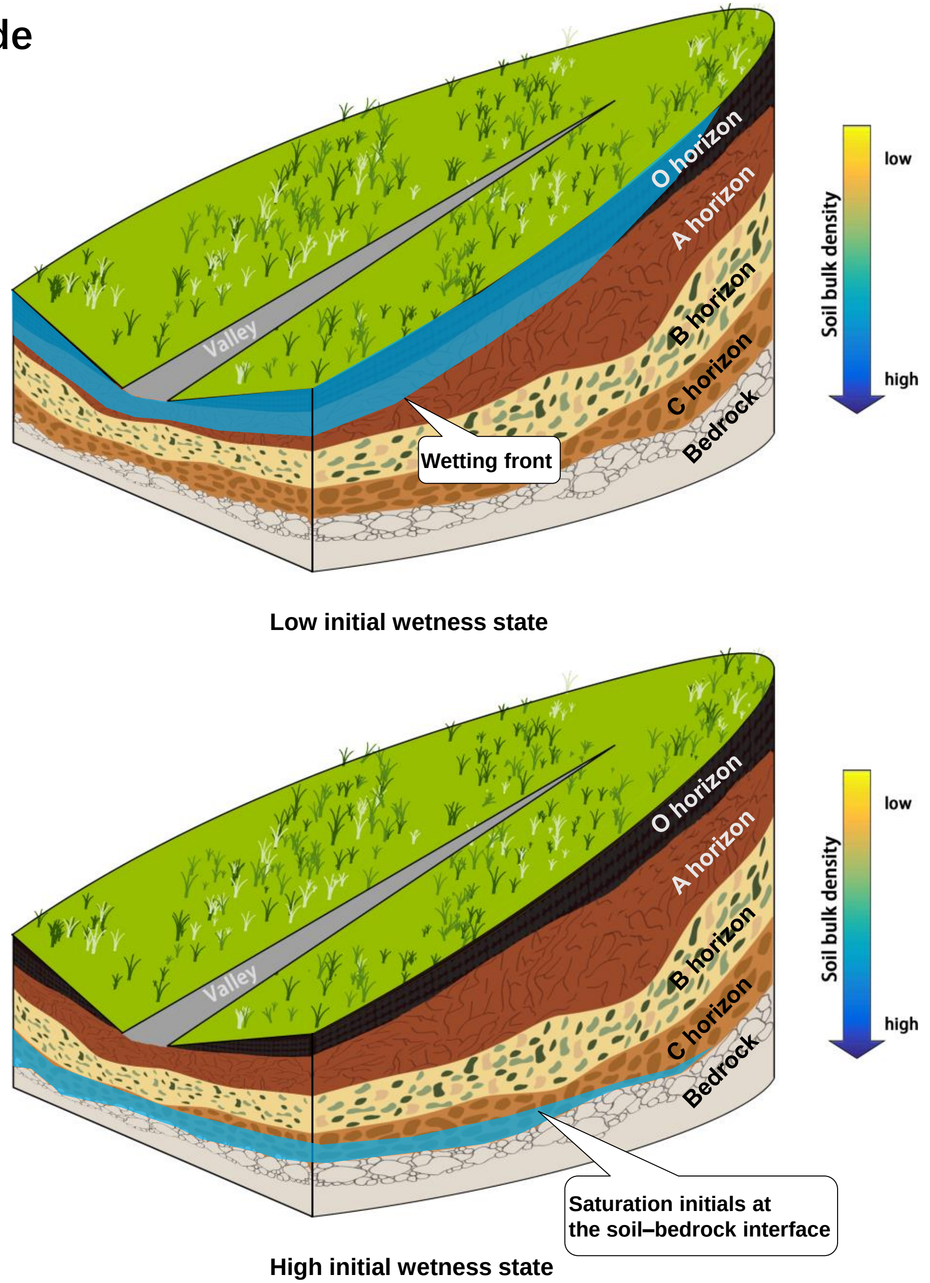
- With increasing precipitation magnitude, the relationship between VWC and topographic wetness index (TWI) gradually became stronger.
- However, the relationship between bulk density and VWC did not increase with increasing rainfall magnitude (R2 = 0.02).

Results and Discussion：

The relationship between VWC and bulk density as a function of rainfall magnitude

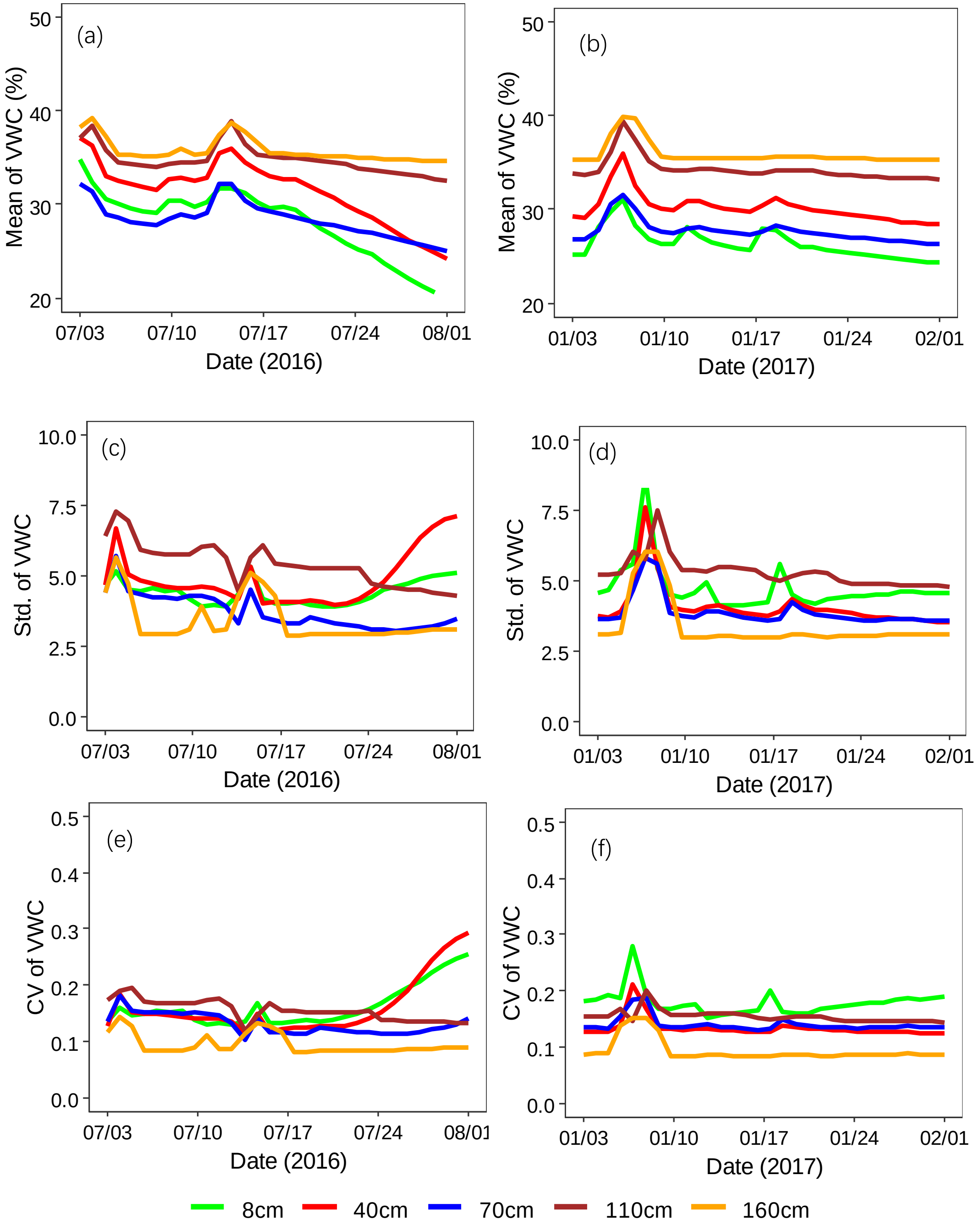


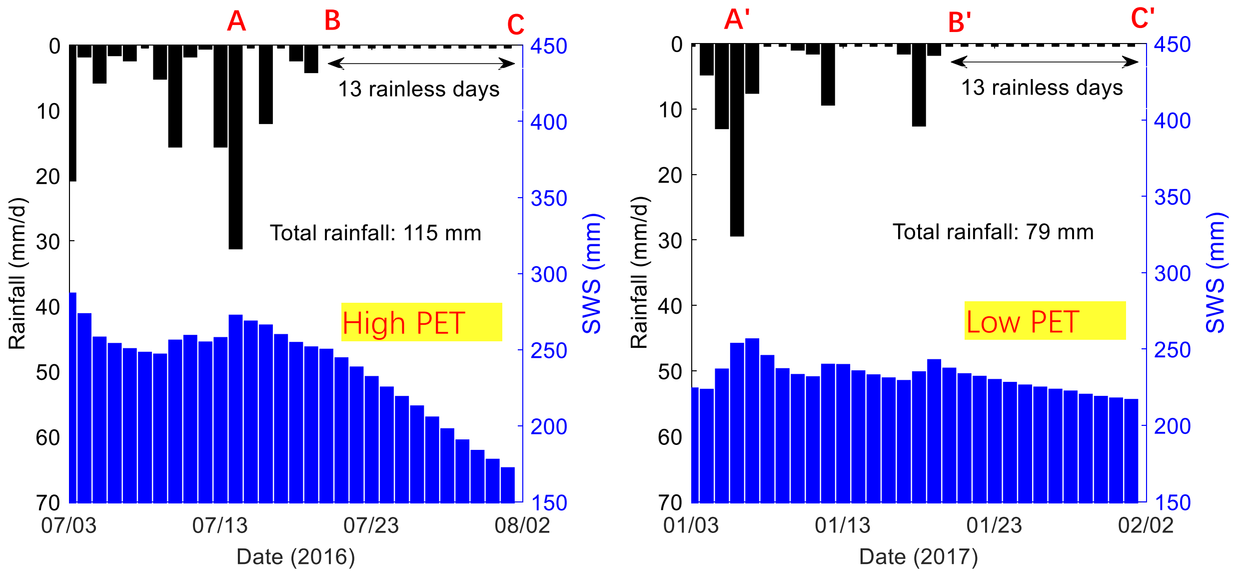




- First, during small rainfall events with low initial wetness states, rainfall may only be capable to wet topsoil
- Second, if the initial wetness was high, rainwater directly infiltrates into the soil and the saturation zone is initiated at the soil–bedrock interface (saturation-excess dominated, according to Han et al., 2020)
- Third, with the increase of rainfall magnitude, the soil saturation zone rises from the soil–bedrock interface to the soil surface.

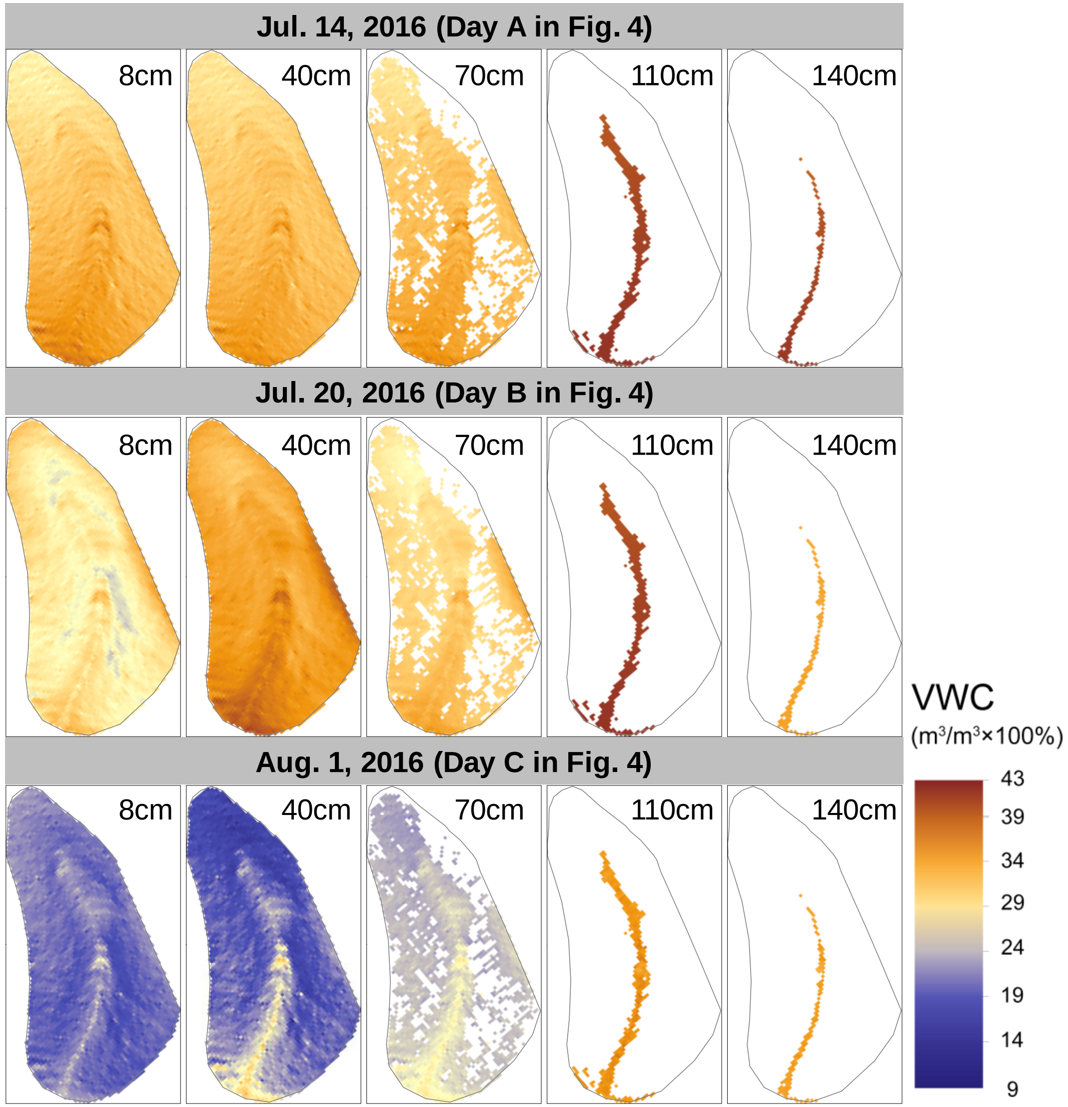
Results and Discussion: Variability of VWC and its causes

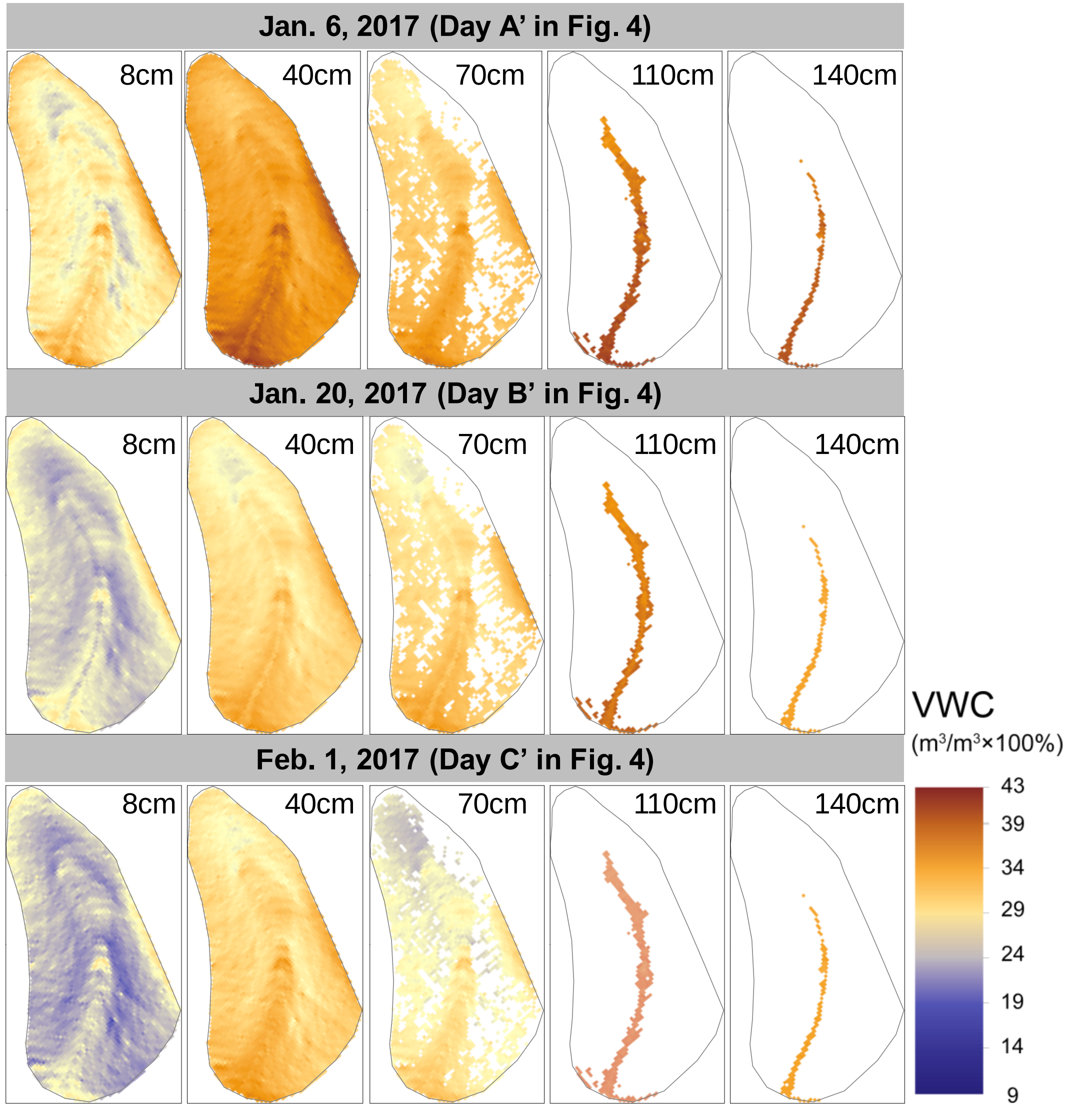




	Date	Soil pits							
		T1	T2	T3	T4	T5	T6	T7	T8
	Summer								
B	Jul. 20	37.5	30.2	30.5	32.2	29.5	40.4	29.1	31.6
C	Aug. 1	31.9	27.4	26.6	26.2	23.0	30.6	17.6	10.5
	Ratios	1.2	1.1	1.1	1.2	1.3	1.3	1.7	3.0
	Winter								
B'	Jan. 20	32.4	28.5	30.3	29.3	28.4	40.1	27.3	28.5
C'	Feb. 1	30.7	27.8	28.6	28.1	26.5	35.6	24.6	25.0
	Ratios	1.1	1.0	1.1	1.0	1.1	1.1	1.1	1.1

Results and Discussion： VWC spatial predictions





- The VWC descent rate in the valley, compared with the side slope, was much slower probably due to the unsaturated soil water supplement from the side slope into the valley
- High PET in summer magnified the variability of VWC

Concluding Remarks

- By evaluating the relationship between VWC and TWI as a function of precipitation magnitude, we found that the relationship between VWC and TWI increased with increasing of precipitation magnitude (R^2 = 0.43).

- As catchment dries up, we found that the correlation between VWC and TWI remained strong

- The variability of VWC at A/B soil horizon interface was higher than that of other depths in an extended drought condition, where the VWC at the side slope decreased approximately 3 times faster than that of the valley. This inconsistency in side slope and valley VWC decline rate highlights the importance of impeding layer on unsaturated soil water movement.

Seasonal controls of soil water content spatial pattern in a steep forested catchment: A modeling approach (old title)

THANK YOU FOR YOUR ATTENTION

If you have any questions, please contact me at:
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