Impact of the 2015 Drought on the Water Dynamics in a Central Amazonian Forest

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Abstract

The 2015-16 El Nino had a record-breaking impact on the Amazon rainforest, with the region experiencing extremes of heat and drought. We study the impact of the 2015 drought on the water dynamics in a central Amazonian tropical rainforest using field observations of soil moisture, sap flow, and net radiation among other micrometeorological variables collected at the BR-Ma2 tower (Manaus - ZF2 K34 tower) site. We use these data to look for quantitative and mechanistic relationships between soil moisture, plant transpiration, and precipitation over tropical rainforest. We further study the physiological drivers that control plant transpiration during the drought and in a normal year. Here we present quantifications of precipitation, soil water usage, and plant transpiration during and after the 2015 drought, and characterizations of the impacts of the 2015 drought on ecosystem water processes such as plant transpiration and soil water usage.

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NGEE–Tropics

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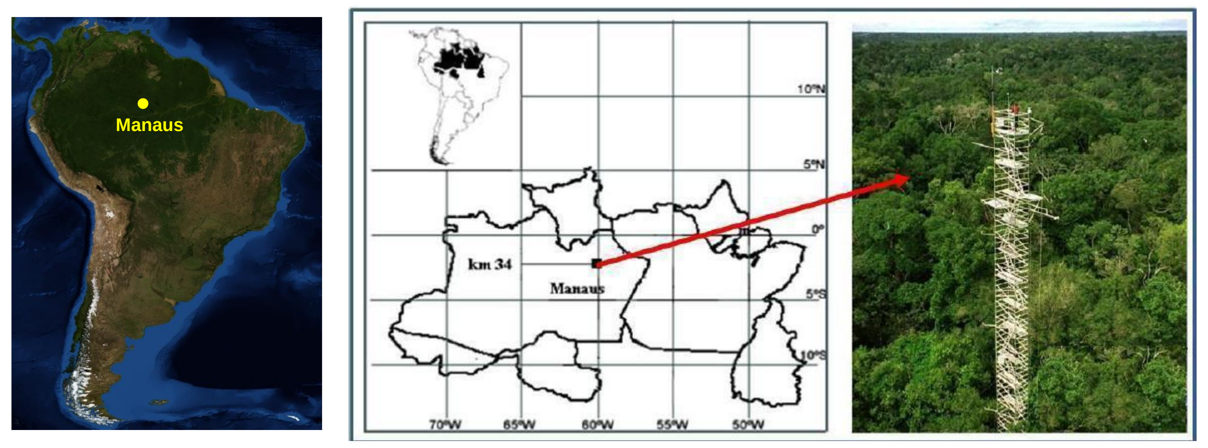
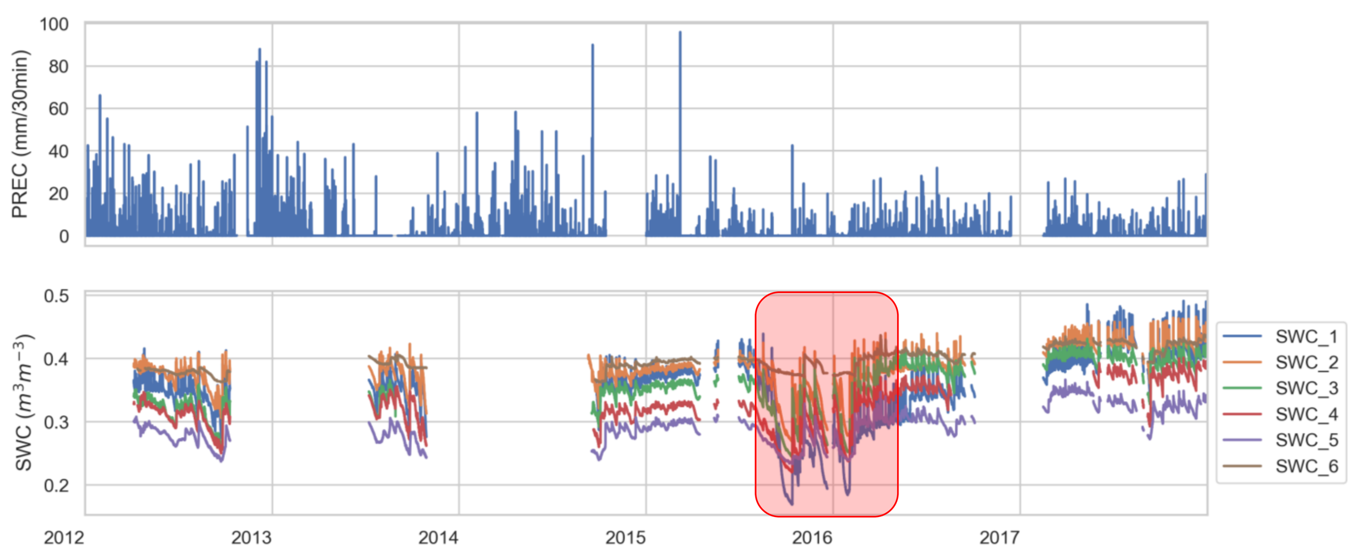
ABSTRACT

The 2015-16 El Nino had a record-breaking impact on the Amazon rainforest, with the region experiencing extremes of heat and drought. We study the impact of the 2015 drought on the water dynamics in a central Amazonian tropical rainforest using field observations of soil moisture, sap flow, and net radiation among other micrometeorological variables collected at the BR-Ma2 tower (Manaus - ZF2 K34 tower) site. We use these data to look for quantitative and mechanistic relationships between soil moisture, plant transpiration, and precipitation over tropical rainforest. We further study the physiological drivers that control plant transpiration during the drought and in a normal year. Here we present quantifications of precipitation, soil water usage, and plant transpiration during and after the 2015 drought, and characterizations of the impacts of the 2015 drought on ecosystem water processes such as plant transpiration and soil water usage.

OBJECTIVE





How did the drought impact the water dynamics including soil water content and plant transpiration?

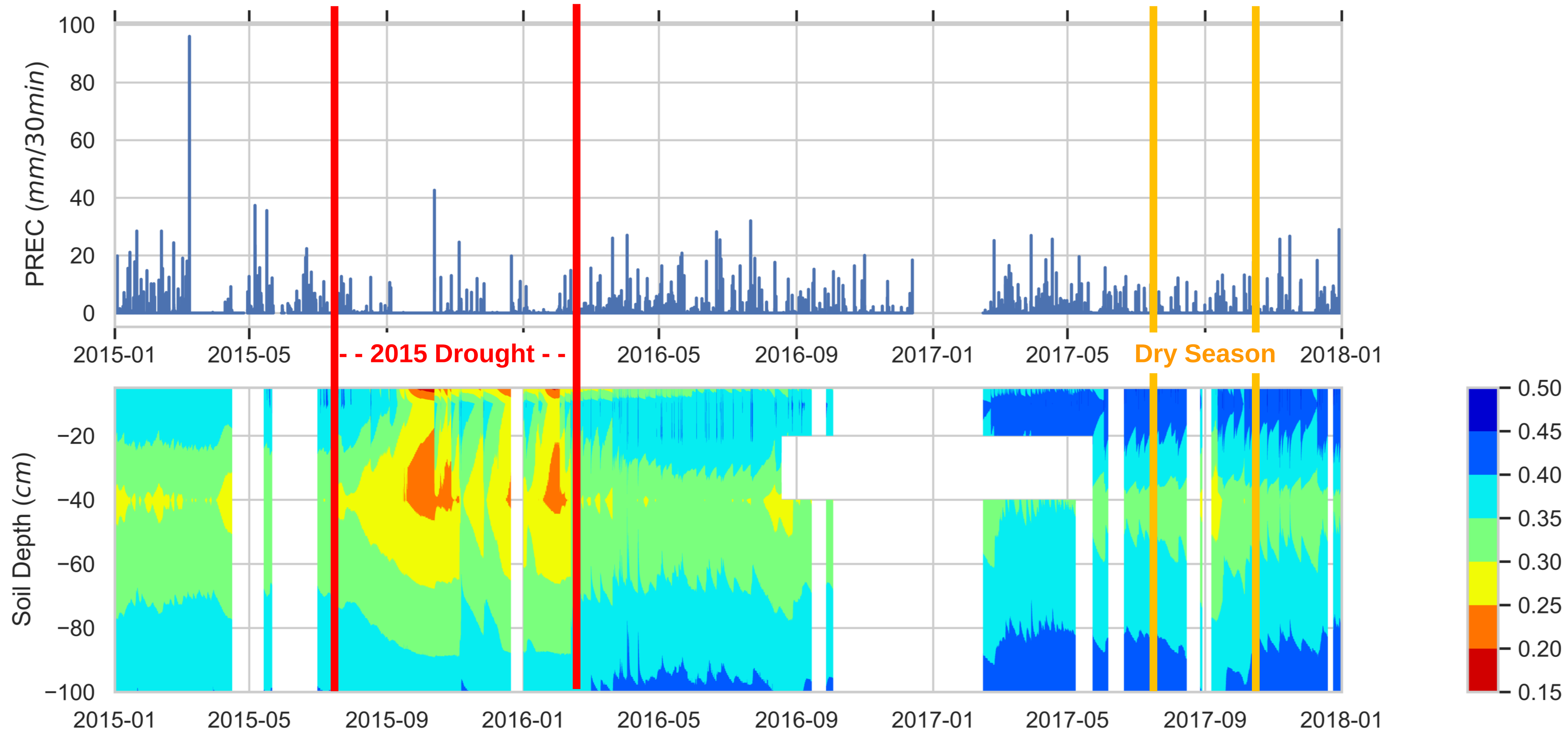
DATA

We use in-situ measurements of more than 50 variables at BR-Ma2 site. The flux tower is deployed in a medium elevation plateau in a primary forest area. The vegetation is evergreen broadleaf forests with more than 60 % woody vegetation. The mean temperature and annual precipitation are 27 degree C and 2252 mm, respectively.

Variable	Abbrv.	Variable	Abbrv.
Precipitation	PREC	Sap Velocity	SV
Soil Moisture	SWC	Air Temperature	Ta
Net Radiation	NETRAD	Soil Heat Flux	G

RESULTS

(A) Half-Hourly Time Series of Soil Moisture

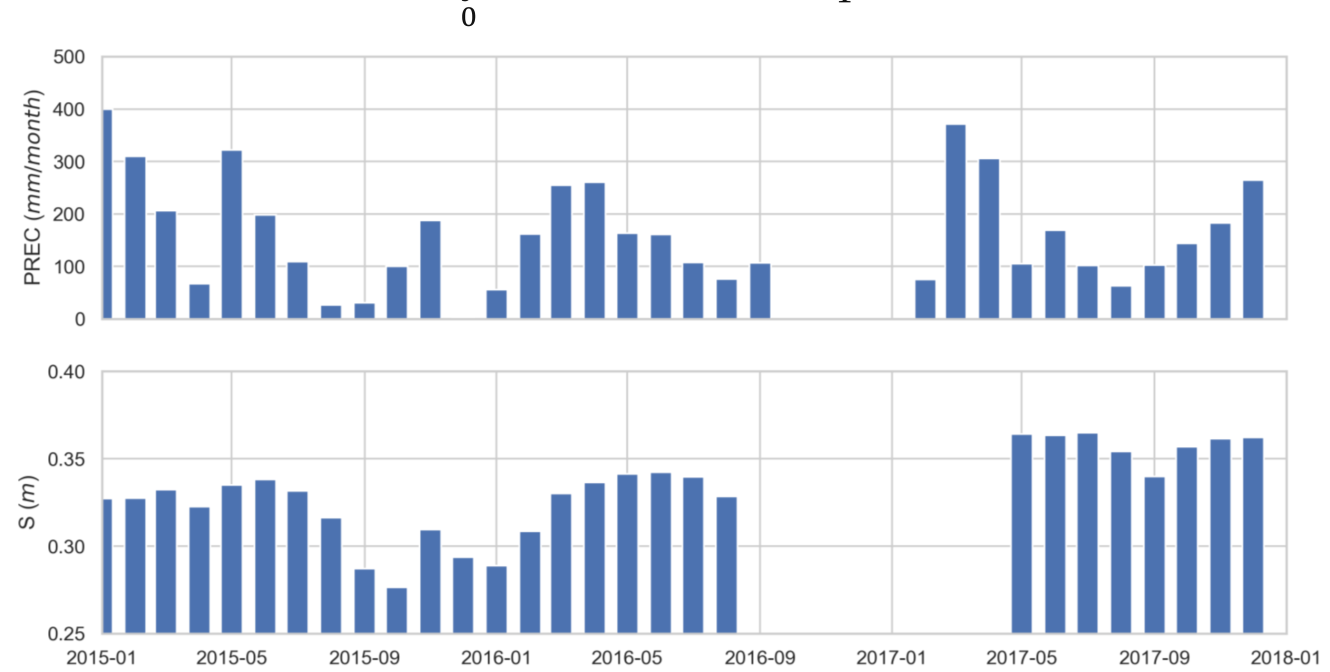


- The drought is from Sep 2015 to Mar 2016.
- SWC from surface to 1 m during the drought was smaller than that during the 2017 dry season.
- Surface SWC during the drought was 0.2 $m^3 m^{-3}$ smaller.
- SWC at 40 cm during the drought was 0.1 $m^3 m^{-3}$ smaller.

(B) Monthly Soil Moisture Storage (*S*)

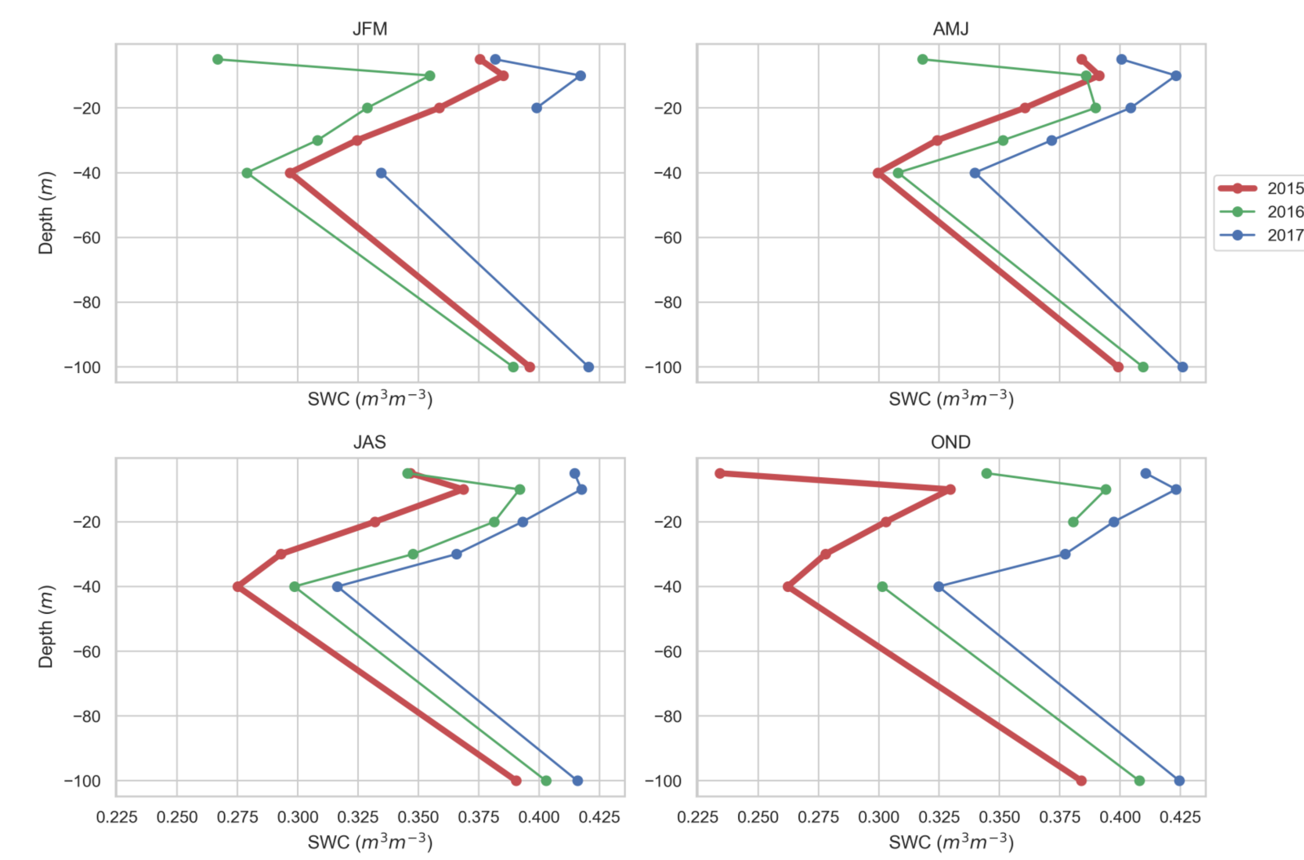
Soil water storage (*S*) is calculated as:

$$S = \int_0^d SWC\, dz \ or \ S = \sum_1^n SWC \Delta z$$



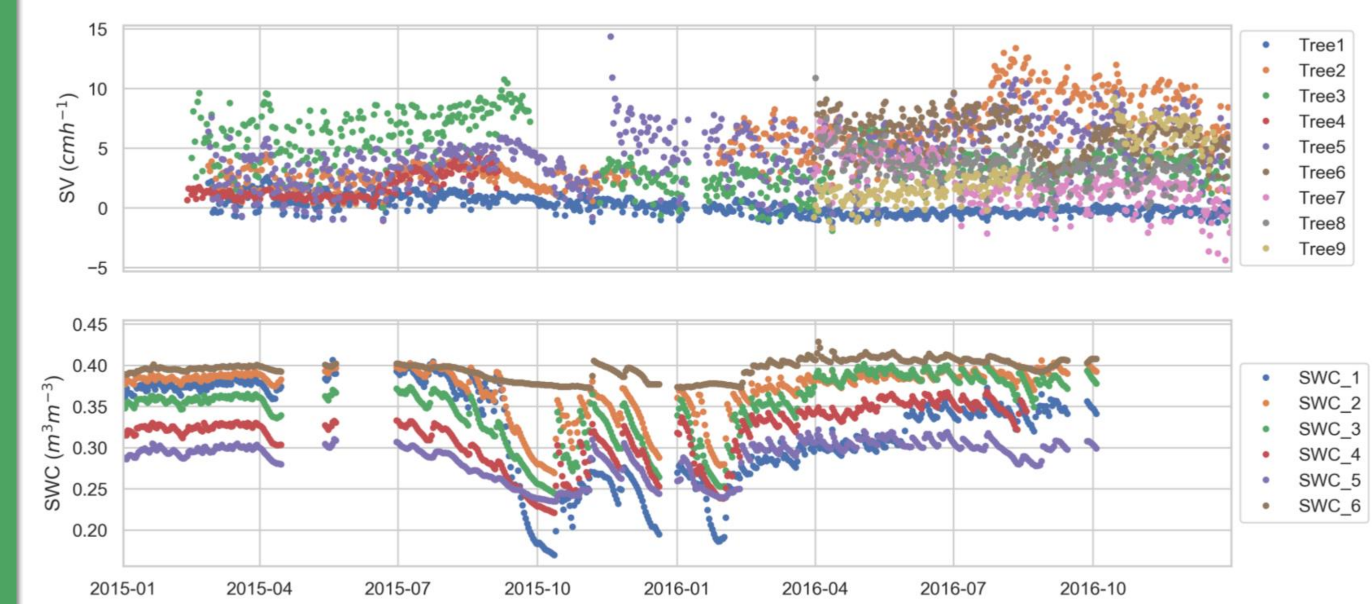
- The phase of SWC is one month after that of PREC.
- *S* in Sep 2015 is 0.05 (20 %) less than that in Sep 2017.

(C) Seasonal Soil Moisture Profiles



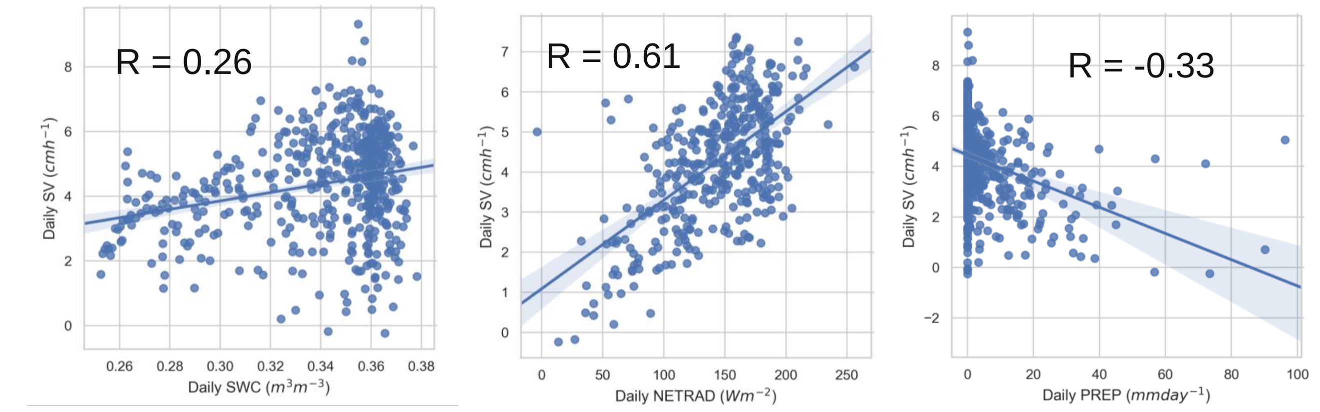
The difference of SWC between during the drought and during a normal dry season is greatest at surface and smallest at 1 m.

(D) Daily Soil Moisture & Sap Velocity



- SV decreases when SWC is extremely low in Sep & Oct 2015.
- SV is not relevant to SWC in normal years.

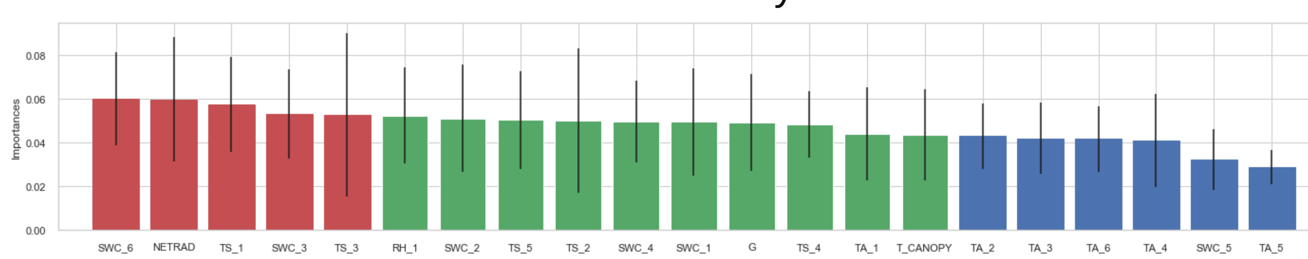
(E) Daily SV VS. SWC, NETRAD, and PREC



R between SV and other variables are low.

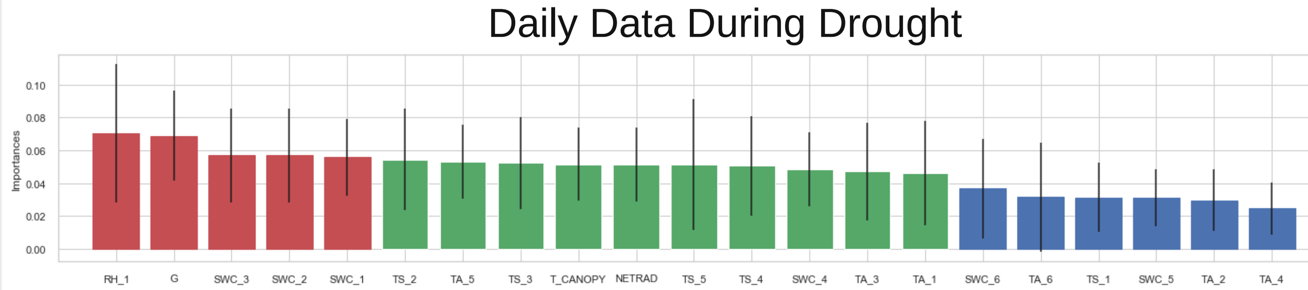
(F) Variables Related to SV

All Available Daily Data



Relevant variable are SWC_6, NETRAD, TS_1, SWC_3, and TS_3.

Daily Data During Drought



Relevant variables are RH_1, G, SWC_3, SWC_2, and SWC_1.

CONCLUSION AND FUTURE WORK

- The 2015 drought affected SWC from surface to 1 m. SWC during the drought was 0.1 $m^3 m^{-3}$ (25 %) smaller than that in a dry season.
- The 2015 drought affected SV when the soil was extremely dry. Correlation coefficients between SV and SWC in normal years are low.
- The mechanism that drives plant transpiration during the drought, dry season, and wet season will be investigated in future work.

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