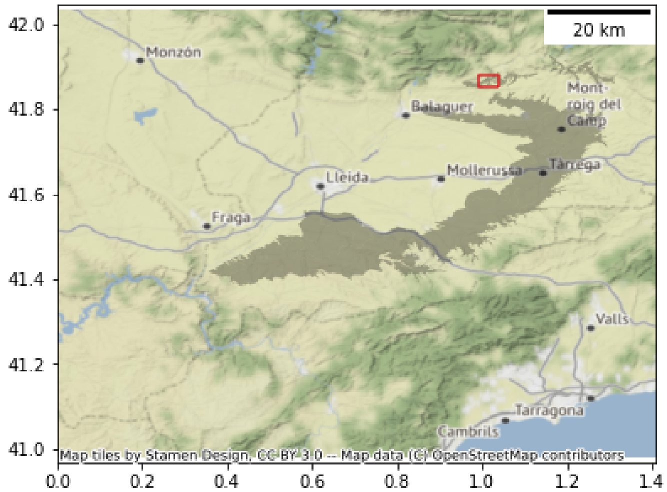
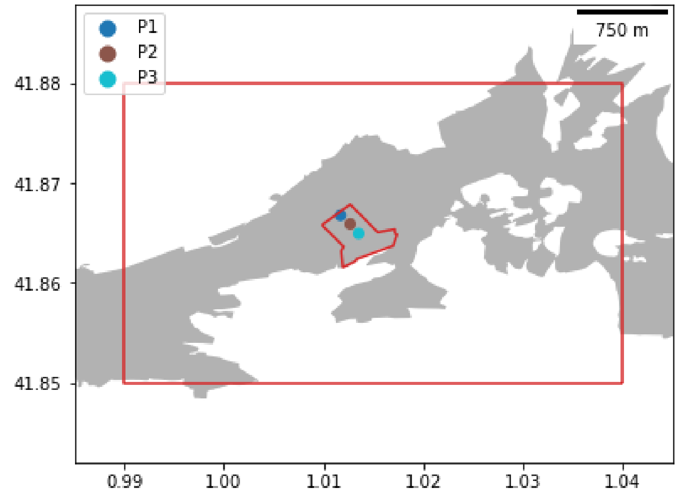
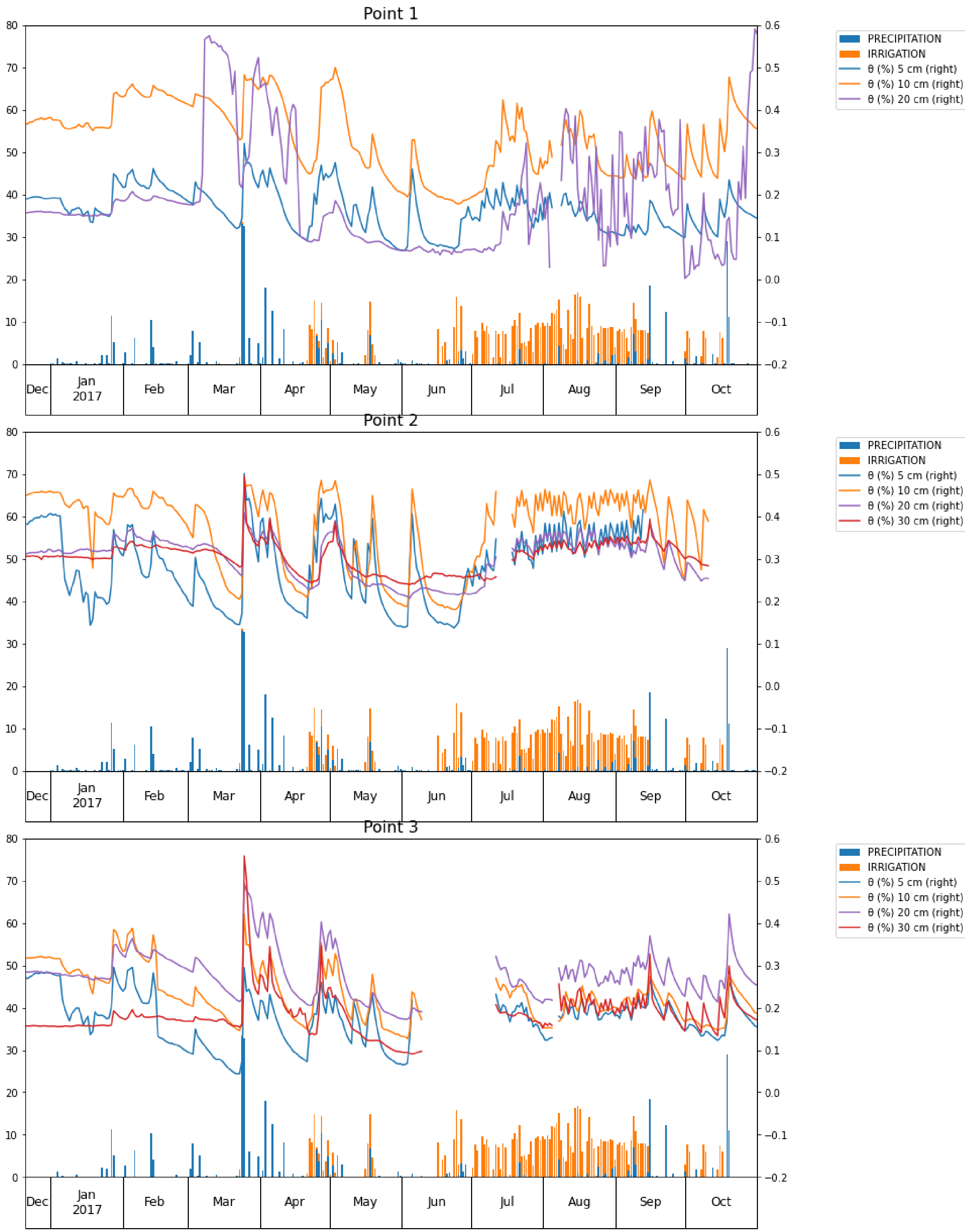
Out[3]: Click here to toggle on/off the raw code.

# PrISM - Study with insitu SM and Precipitation - Foradada




# INSITU data available for 2017




After this visualization, data for Point 2 (with Soil moisture at 5 cm) seems more reliable

they will be used for a first test

# 3. CALCULATE Soil Moisture with Antecedent Precipitation Index (API) formula

API formula

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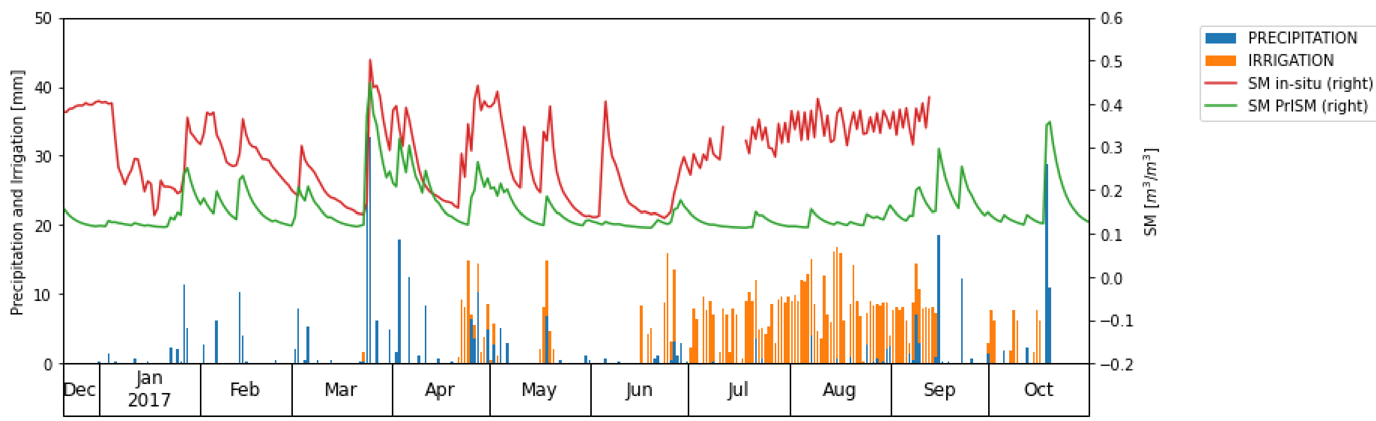
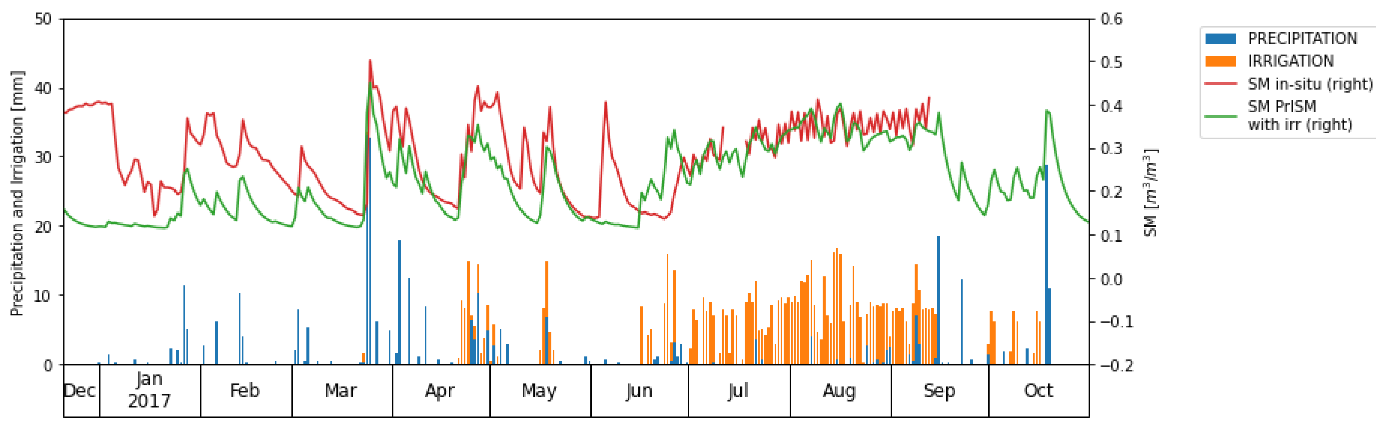
$$\theta_{t_1} = \left(\theta_{t_0} - \theta_{res}\right) e^{-\frac{dt}{\tau}} + \left(\theta_{sat} - \left(\theta_{t_0} - \theta_{res}\right)\right) \left(1 - e^{-\frac{P_{t_1}}{d_{soil}}}\right) + \theta_{res}$$

- $\theta_{t_1}$ Soil moisture at time $t_1$ $[m^3/m^3]$
- $\theta_{t_0}$ Soil moisture at time $t_0$ $[m^3/m^3]$
- $\theta_{res}$ - Residual soil moisture $[m^3/m^3]$ **= 11.288** (min $\theta$ for 2017)
- $\theta_{sat}$ - Saturated soil moisture $[m^3/m^3]$ **= 53.33** (max $\theta$ for 2017)
- $dt$ - Time step used for the simulation (difference between t1 and t0) [h] **= 3 h**
- $\tau$ - Soil moisture drying-out velocity [h] **= 100 h**
- $d_{soil}$ - Soil depth where the SM measurements are performed [mm] **= 50 mm**

with $\quad \Delta\theta_0 = \theta_{t_0} - \theta_{res}, \qquad \Delta\theta_1 = \theta_{t_1} - \theta_{res}$

$$\Delta\theta_1 = \Delta\theta_0 e^{-\frac{dt}{\tau}} + \left(\theta_{sat} - \Delta\theta_0\right) \left(1 - e^{-\frac{P_{t_1}}{d_{soil}}}\right)$$




# 4. Calculate PRECIPITATION AND IRRIGATION with inverse of Prism

PROPOSAL: Inverted API formula

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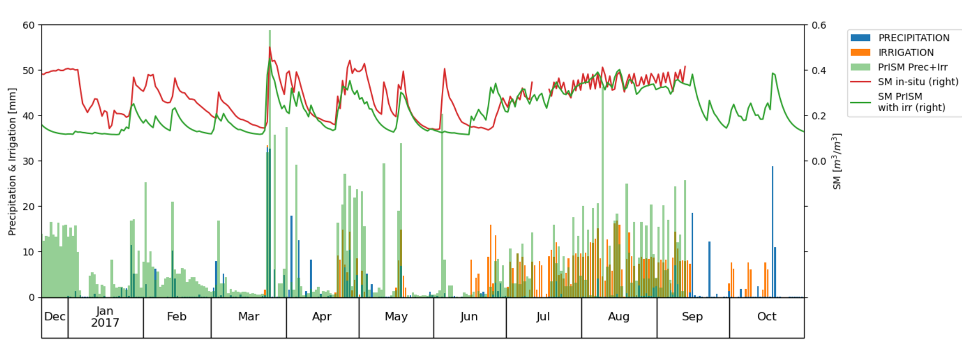
with

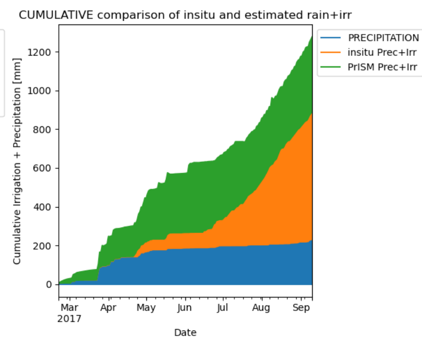
$$\Delta\theta_0 = \theta_{t_0} - \theta_{res}$$

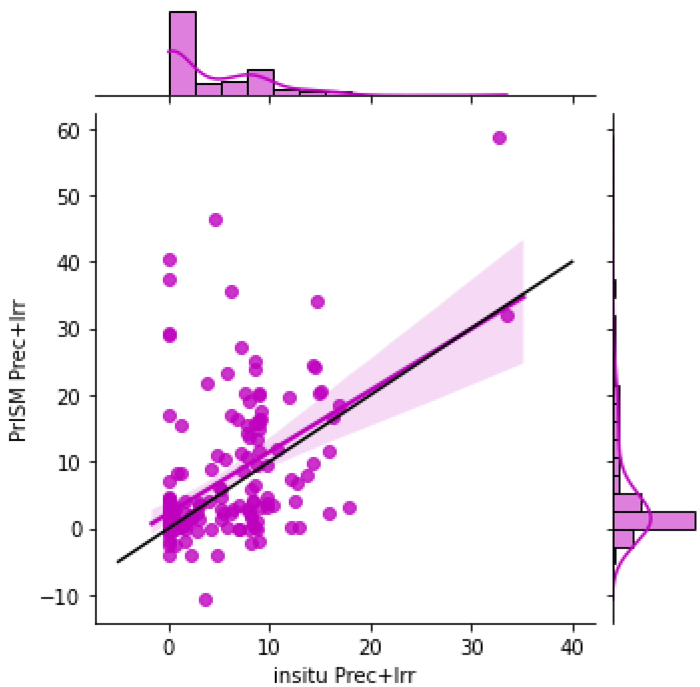
$$\Delta\theta_1 = \theta_{t_1} - \theta_{res}$$

$$P_{t_1} = -d_{soil} log \left( 1 - \frac{\Delta\theta_1 - \Delta\theta_0 e^{-\frac{dt}{\tau}}}{\theta_{sat} - \Delta\theta_0} \right)$$

- $\theta_{t_1}$ - Soil moisture at time $t_1$ $[m^3/m^3]$
- $\theta_{t_0}$ - Soil moisture at time $t_0$ $[m^3/m^3]$
- $P_{t_1}$ - Precipitation (and Irrigation) at time $t_1$ [mm]
- $\theta_{res}$ - Residual soil moisture $[m^3/m^3]$ **= 11.288** (min $\theta$ for 2017)
- $\theta_{sat}$ - Saturated soil moisture $[m^3/m^3]$ **= 53.33** (max $\theta$ for 2017)
- $dt$ - Time step used for the simulation (difference between t1 and t0) [h] **= 3 h**
- $\tau$ - Soil moisture drying-out velocity [h] **= 100 h**
- $d_{soil}$ - Soil depth where the SM measurements are performed [mm] **= 50 mm**

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CONDITION

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$P_{t_1}$ cannot be negative. $P_{t_1} \geq 0$

if $\quad x = \left(1 - \frac{\Delta\theta_1 - \Delta\theta_0 e^{-\frac{dt}{\tau}}}{\theta_{sat} - \Delta\theta_0}\right) \quad \longrightarrow \quad P_{t_1} = -d_{soil} log\left(x\right)$

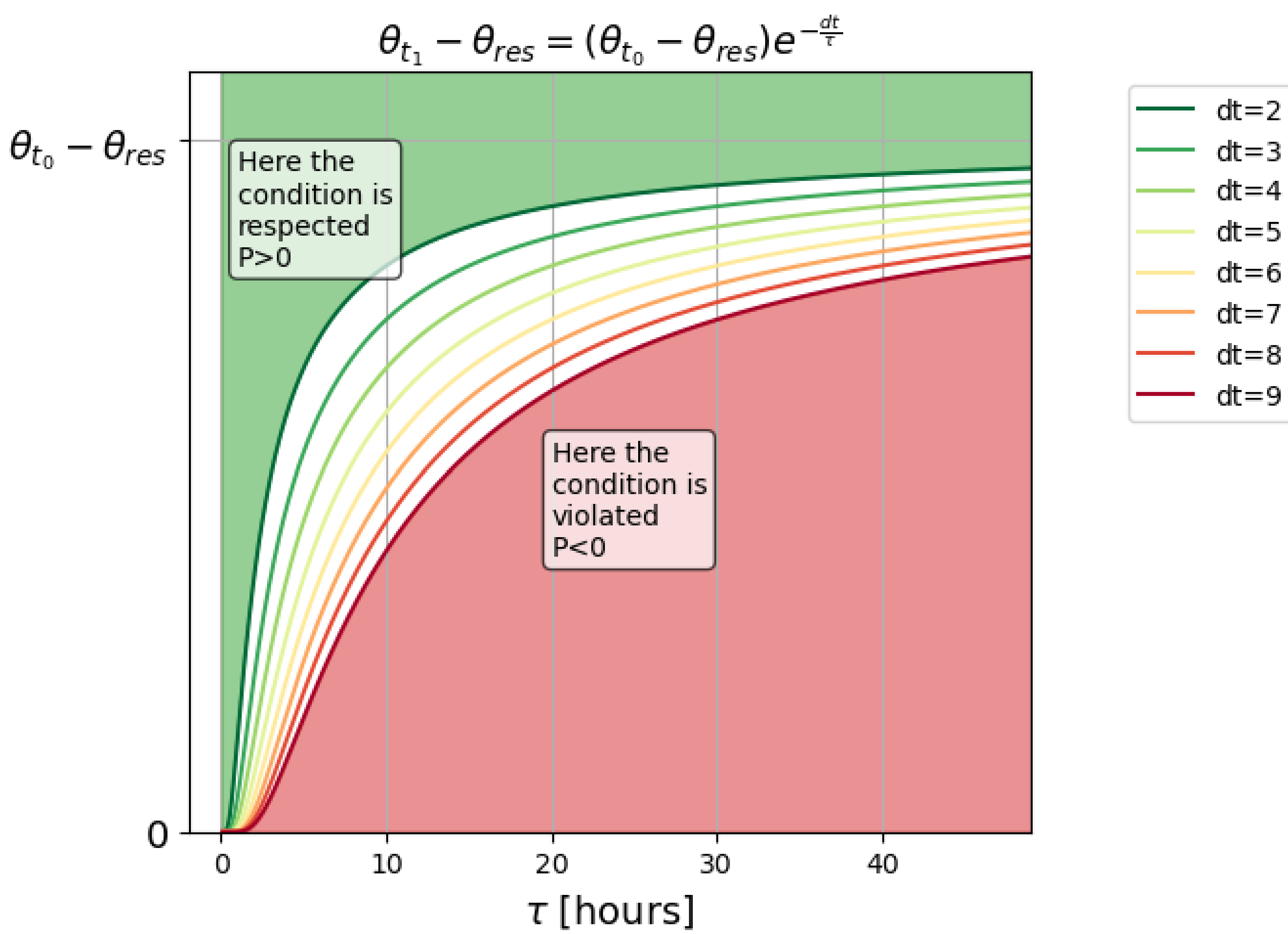
$$-d_{soil} log\left(x\right) \geq 0 \quad \longrightarrow \quad x \leq 1 \quad \longrightarrow \quad \Delta\theta_1 - \Delta\theta_0 e^{-\frac{dt}{\tau}} \geq 0 \quad \Longrightarrow \quad \Delta\theta_1 \geq \Delta\theta_0 e^{-\frac{dt}{\tau}}$$

CONCLUSION:

$$\left(\theta_{t_1} - \theta_{res}\right) \geq \left(\theta_{t_0} - \theta_{res}\right) e^{-\frac{dt}{\tau}}$$

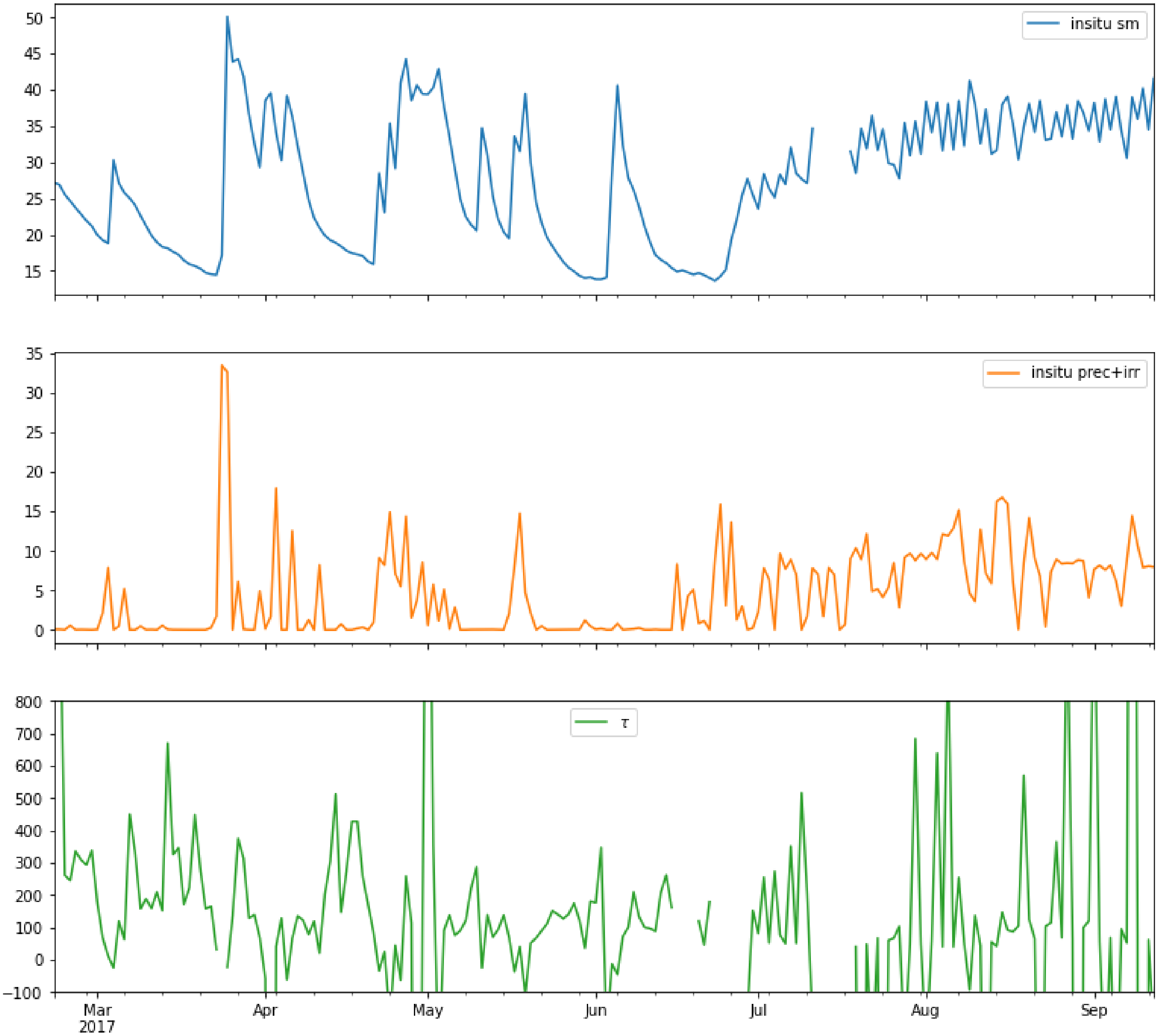
This condition is **violated** if the soil moisture at $t_1$ decreases too fast (faster than what the drying-out velocity establish). It will mean that the balance is not correct and precipitation will be negative to compensate the loss of soil moisture.

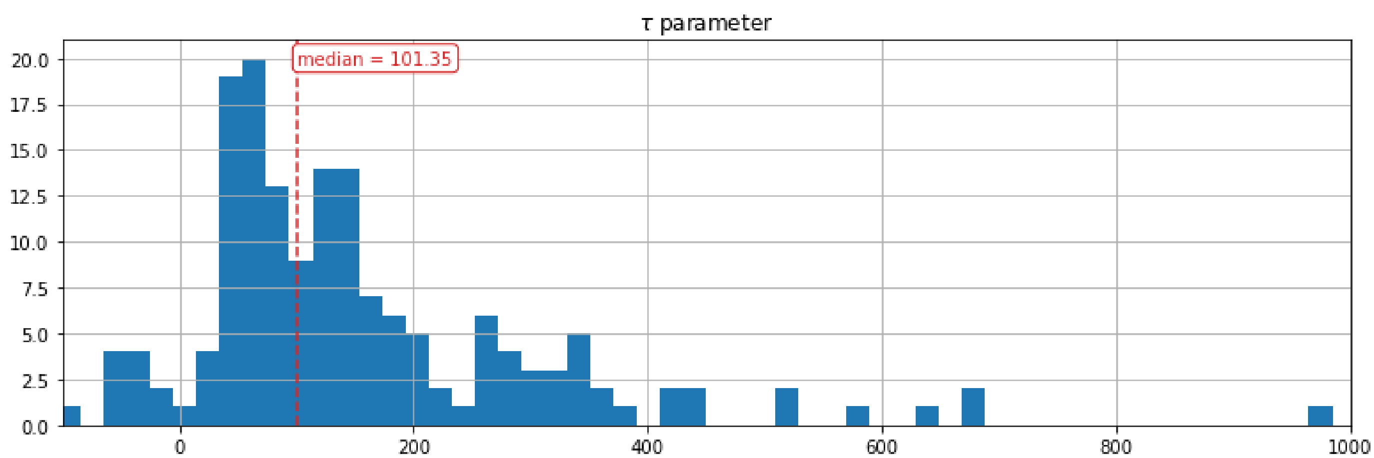
if we visualize it:




## Study over $\tau$ using in-situ $\theta$ & $P$+$Irr$

$$\tau = -\frac{dt}{log\left(\frac{\Delta\theta_1 - \left(\theta_{sat} - \Delta\theta_0\right)\left(1 - e^{\frac{-P_1}{dsoil}}\right)}{\Delta\theta_0}\right)}$$


insitu sm
insitu prec+irr
τ
Mar
2017
Apr
May
Jun
Jul
Aug
Sep


τ parameter
median = 101.35