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Modeling the response of soil moisture to climate variability in the Mediterranean region

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Supplementary material

1 Observed data availability

Table S1 shows the availability of observed precipitation, temperature, and soil moisture data for the 10 stations located in the french Mediterranean region. The period with available data ranges between 7 years (Pez) and 10 years (Lez, Mou, Nar). The precipitation and temperature datasets have very few missing data that needed to be reconstructed (less than 1.5 %) in order to be used as forcing data for the soil moisture model. Observed soil moisture were used as validation for the soil model calibration. Some stations have a large amount of missing data (45 % for Barn station and 12 % for Lez and Mej stations). Periods with missing soil moisture data were not taken into account during the calibration process, which reduces the total period of calibration and may affect the calibration of the stations with most missing data.

			Missing data [%]		
Code	From	To	Precipitation	Temperature	Soil moisture
Barn	14/11/2008	31/12/2016	1.5%	1.5%	45%
Cab	14/11/2008	31/12/2016	0.9%	1.2%	2.2%
Gra	13/12/2008	31/12/2016	0.7%	0.3%	2.6%
Lez	01/01/2007	31/12/2016	0.6%	1.2%	12.6%
Mej	09/12/2008	31/12/2016	1.1%	0.7%	12.1%
Mou	01/01/2007	31/12/2016	1.0%	0.3%	3.1%
Nar	01/01/2007	31/12/2016	0.2%	0.2%	3.2%
Pez	11/12/2008	18/04/2016	0.6%	0.6%	1.5%
Pra	11/12/2008	31/12/2016	0.3%	0.4%	3.7%
Vil	15/12/2008	31/12/2016	0.7%	0.5%	4.4%

Table S1. Periods of observed data and percentage of missing data for each station.

2 Soil Moisture model calibration

	Barn	Cab	Gra	Lez	Mej	Mou	Nar	Pez	Pra	Vil
Calibration on the total period										
K_s (mm.hr^{-1})	38.1	34.3	35.9	23.1	28.8	36.2	51.1	14.6	59.6	6.9
m	17.6	15.6	10.9	14.1	16.4	23.0	15.9	12.8	11.89	38.2
K_c	1.17	1.43	1.74	1.22	1.81	0.94	1.26	1.99	1.32	1.63
NSE	0.76	0.77	0.93	0.85	0.9	0.63	0.91	0.789	0.65	0.9
Calibration on the first sub-period										
K_s (mm.hr^{-1})	26.9	52.0	56.2	41.6	24.6	22.5	52.0	24.0	61.9	22.6
m	17.8	15.8	11.3	15.4	14.7	17.8	17.5	21.0	10.5	40.0
K_c	1.28	1.49	1.95	1.30	1.76	1.02	1.31	1.86	1.31	1.63
NSE	0.6	0.72	0.86	0.87	0.80	0.69	0.87	0.31	0.64	0.87
Calibration on the second sub-period										
K_s (mm.hr^{-1})	29.6	23.7	43.9	40.8	45.6	77.4	43.1	6.4	71.4	2.7
m	23.2	17.1	11.3	14.8	18.9	22.4	13.5	5.5	13.0	39.9
K_c	1.09	1.42	1.53	1.11	1.87	1.32	1.19	1.97	1.31	1.56
NSE	0.71	0.75	0.87	0.78	0.91	0.04	0.912	0.60	0.57	0.86

Table S2. Calibrated parameters of the SM model and NSE validation values while calibrating on the total period, the first and second sub-periods of the in situ data series.

Nom_station	soil class USDA	USDA range of K_s	Calibrated K_s
Bar	Sandy loam	51 - 152	38
Cab	Loam	15 - 51	34
Gra	Sandy loam	51 - 152	36
Lez	Loam	15 - 51	23
Mej	Loam	15 - 51	29
Mou	Clay loam	5 - 15	36
Nar	Clay	2 - 5	51
Pez	Loam	15 - 51	15
Pra	Clay loam	5 - 15	60
Vil	Sandy loam	51 - 152	7

Table S3. Range of hydraulic conductivity values (min and max) based on soil class (Angerer et al., 2014)

3 NSRP model calibration

Figure S1 shows the values of the NSRP model parameters after calibration. The calibration is performed independently for each month, which explains why the parameter values are not always continuous one month from another, and why some parameters reach high values (ξ parameter value in August in Barn station for instance). The comparison between the observed and simulated hourly rainfall intensities (Fig S2) as well as the comparison between observed and simulated annual maximum intensities (Fig S3) show that the calibrated NSRP model represents correctly the distribution of rainfall intensities and does not generate aberrant values.

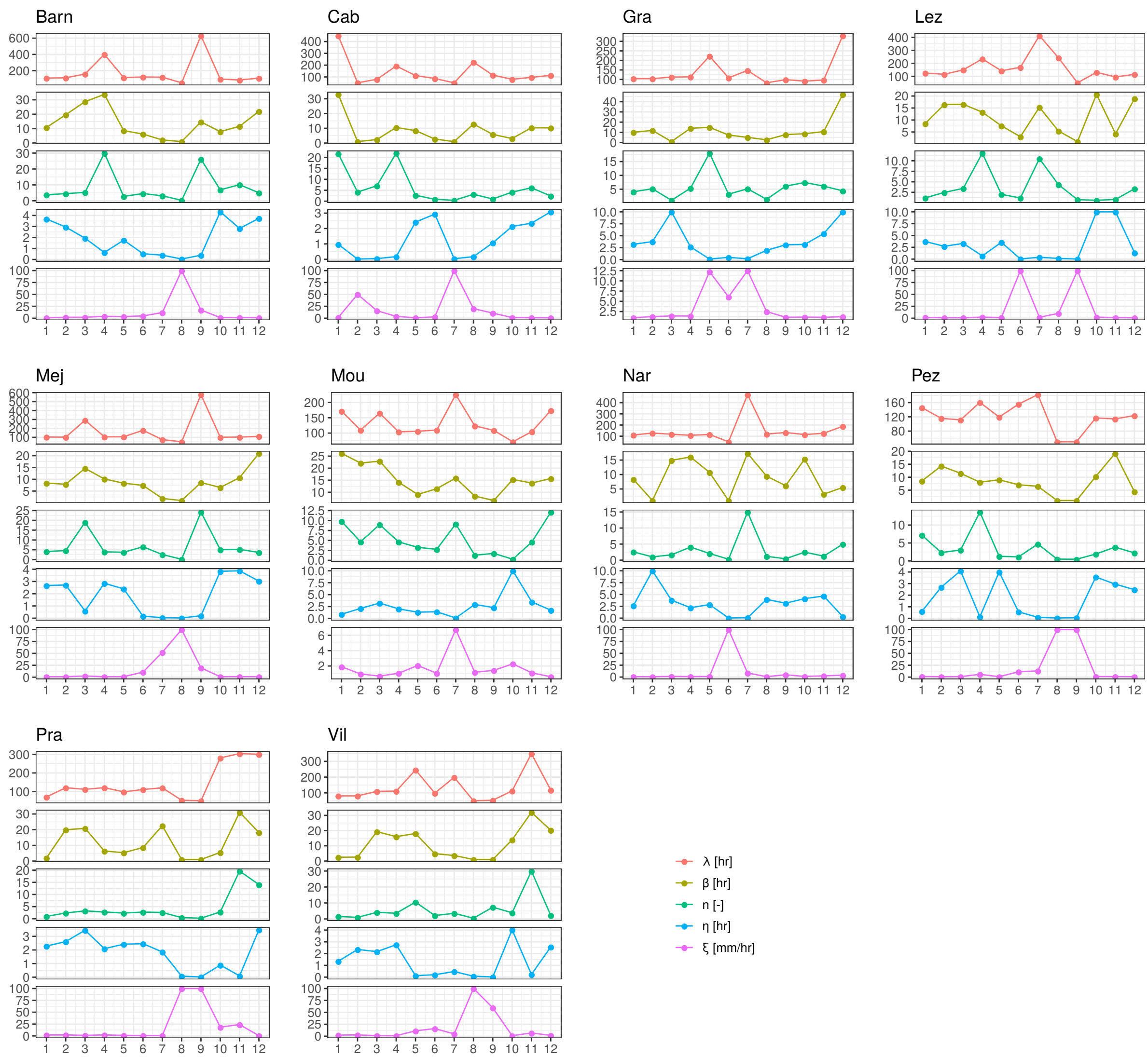

Figure S1. Monthly values of NSRP calibrated parameters.

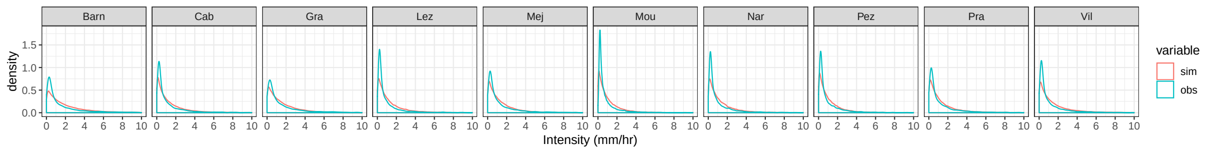

Figure S2. Density plot of observed (green) and simulated (red) hourly rainfall intensities.

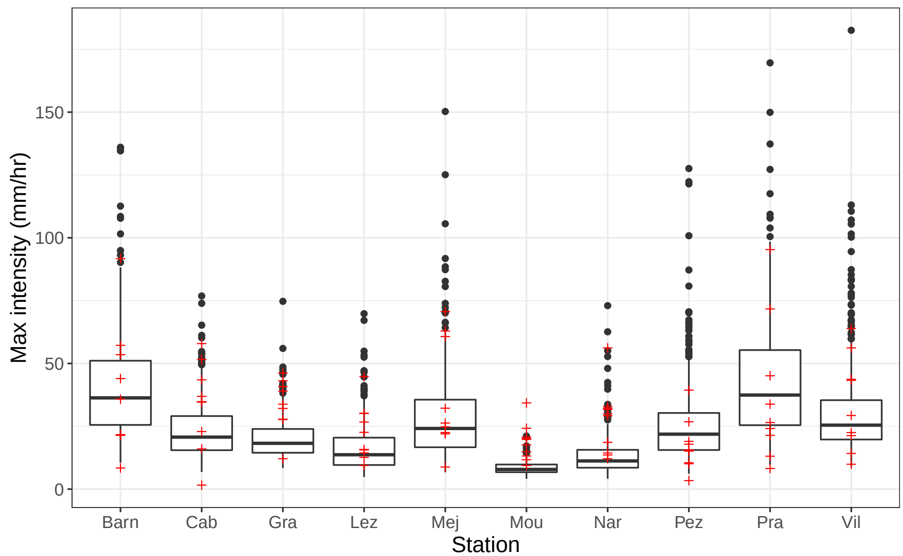

Figure S3. Annual maximum rainfall intensities (red crosses: observed , boxplot: simulated with NSRP model).

4 Complete results of sensitivity of extreme soil moisture to precipitation and temperature changes

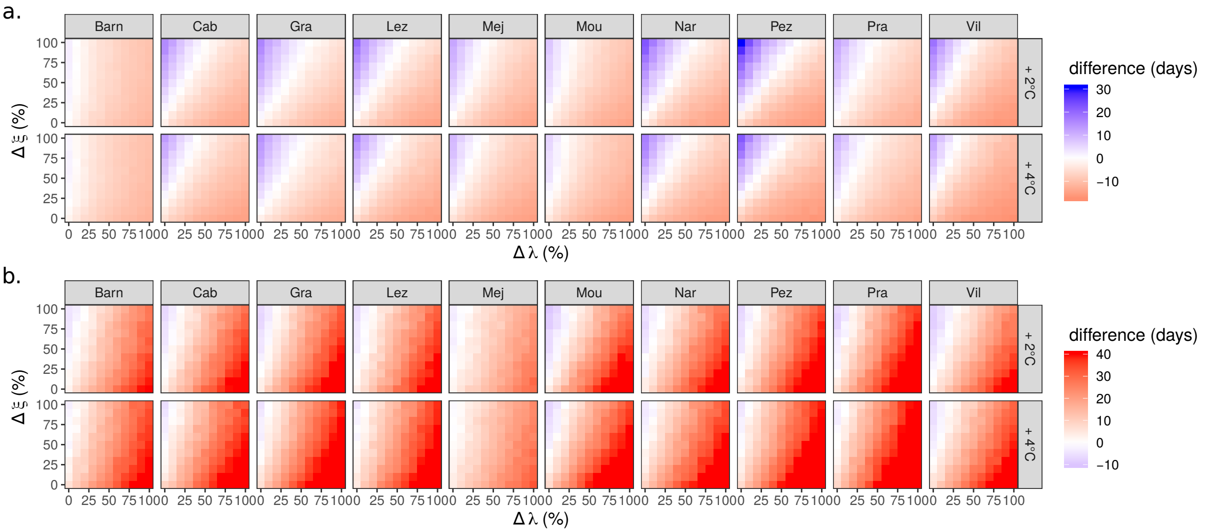

Figure S4. Sensitivity of the annual number of days with saturated soil (i.e. with soil moisture above the observed 95th percentile) according to changes in precipitation intensity (y axis), precipitation intermittence (x axis) and temperature. b. Sensitivity of the annual number of days under drought conditions (i.e. with soil moisture below the observed 5th percentile)

References

Angerer, J. P., Bizimana, J.-C. B., and Alemayehu, S.: Reducing Risk in Pastoral Regions: The Role of Early Warning and Livestock Information Systems, Revista Científica de Produção Animal, 15, 9–21, 2014.