Influence of temporal variation in the vertical distribution of soil moisture on the surface energy budget: Implications for semiarid land-atmosphere interactions.

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CONACYT

1 Introduction

• Semiarid ecosystems are typically characterized as patchy, with different percentage of cover, they are also pulse-dependant and respond to precipitation regimes.

•Precipitation is variable in time and intensity, within and between years. Small pulses wet the surface soil layer, while a deeper wetting front is observed under large pulses conditions.

• Energy, water & carbon fluxes, are especially driven by soil moisture (θ) in aridlands.

Objective:
Identify the influence of temporal variation in the vertical distribution of θ on the surface radiation budget.

2 Hypotheses

• Soil moisture probability distribution functions (pdfs) will vary with depth and cover, especially at shallow depths.

•Vertical distribution of soil moisture during wet periods will increase Albedo, been opposite in dry periods

• Seasonall variation in albedo is weak in contrast with wet ot dry periods.

3 Study Site & Approach

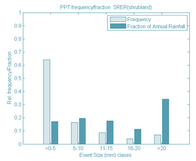
Santa Rita Experimental Ranch

Site Characteristics
•Altitude: 991 m.a.s.l.
•Soil Type: Sandy Loam
•Annual Precipitation: 330 mm
•Vegetation cover: 24%, 14% is creosote bush

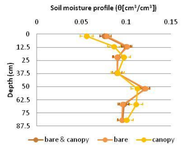
Data
•Eddy covariance & Net radiation systems
•6 permanent soil moisture profiles (3 bare & 3 canopy) at 2.5 cm, 12.5 cm, 22.5 cm, 37.5 cm,52.5 cm, 67.5 cm & 82.5 cm
•3 year of half-hour datasets

4 Hydrology at Creosote Site

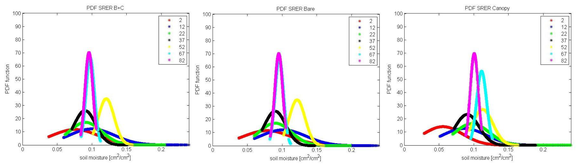
Rainfall pattern



θ profiles

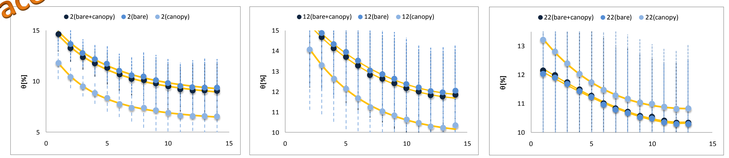


Are they changes in the θ pdfs among cover?



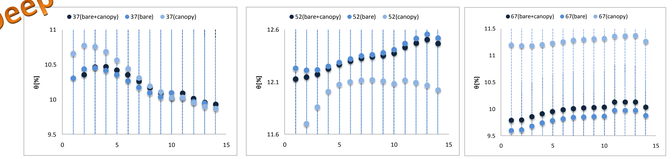
5 What happens with depletion of θ?

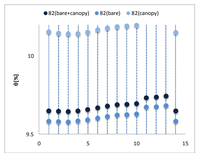
Surface



$$\theta(T) = (\theta_1 - \theta_F)\, E^{(-T/\tau)} + \theta_F$$

Deep





Depth(cm)	SM (θ[cm³/cm³]cutoff)			τ		
	b+c	b	c	b+c	b	c
2.5	0.1173	0.1155	0.0883	4.2	4.5	3.3
12.5	0.1198	0.1218	0.1265	10.7	12.5	5.3
22.5	0.1009	0.0966	0.1102	41.5	48.0	7.7
37.5	0.0808	0.0806	0.8150			
52.5	0.1159	0.1169	0.1060			
67.5	0.0950	0.0934	0.1096			
82.5	0.0951	0.0946	0.1000			

6 Energy Components

SEASON

	Albedo	Q_a	E_f
	μ	μ	μ
Spring	0.177	485.281	0.101
Summer	0.158	516.021	0.154
Autumn	0.173	437.185	0.144
Winter	0.162	329.302	0.144

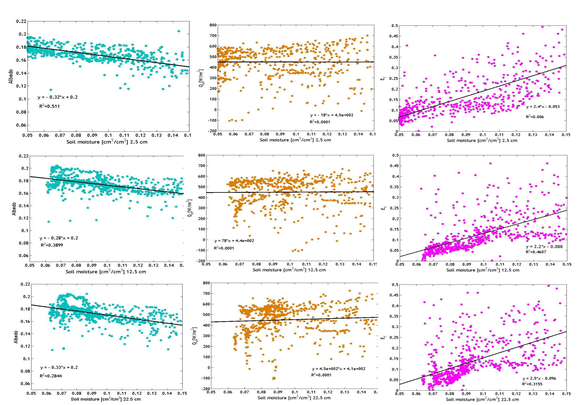
DRY / WET SOIL

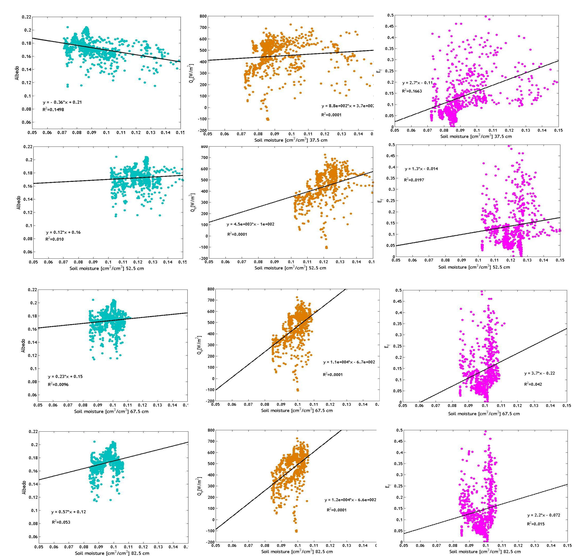
Bare+Canopy						
Depth	Albedo		Q_a		E_f	
	dry	wet	dry	wet	dry	wet
	μ	μ	μ	μ	μ	μ
2.5	0.175776	0.155118	448.3825	459.9885	0.11288	0.263578
12.5	0.176843	0.159784	453.8601	441.5722	0.101647	0.233323
22.5	0.176843	0.159784	453.8601	441.5722	0.101647	0.233323
37.5	0.176015	0.171387	350.7606	469.6033	0.088814	0.148264
52.5	0.167851	0.174322	334.0687	485.9379	0.13072	0.141793
67.5	0.168262	0.174218	353.0165	481.5525	0.12452	0.14385
82.5	0.167543	0.176094	383.8224	491.0083	0.134641	0.142105

Bare						
Depth	Albedo		Q_a		E_f	
	dry	wet	dry	wet	dry	wet
	μ	μ	μ	μ	μ	μ
2.5	0.176313	0.156756	450.5063	450.0249	0.105145	0.263602
12.5	0.176885	0.160003	453.1507	443.5739	0.10118	0.231862
22.5	0.176885	0.160003	453.1507	443.5739	0.10118	0.231862
37.5	0.175982	0.171396	350.9114	469.5742	0.088875	0.148253
52.5	0.168658	0.17413	337.3635	488.7859	0.126649	0.143414
67.5	0.167861	0.17449	357.4628	481.9611	0.126278	0.143535
82.5	0.167379	0.176197	384.3606	490.4423	0.134962	0.141895

Canopy						
Depth	Albedo		Q_a		E_f	
	dry	wet	dry	wet	dry	wet
	μ	μ	μ	μ	μ	μ
2.5	0.175868	0.155805	450.5129	447.4371	0.112719	0.272524
12.5	0.175091	0.156224	448.0506	463.6899	0.117168	0.262458
22.5	0.175091	0.156224	448.0506	463.6899	0.117168	0.262458
37.5	0.175741	0.171509	350.4594	468.485	0.089564	0.147639
52.5	0.170021	0.173449	352.1996	481.339	0.122208	0.144438
67.5	0.167442	0.175733	373.3479	491.313	0.13221	0.142977
82.5	0.168369	0.175675	391.4996	488.9482	0.131765	0.144214

7 Looking for trends in depth.....





8 Conclusions

•Soil moisture depletion is different from the surface into deeper layers.

•Under 37 cm moisture depletion has to be analyzed beyond 2 weeks.

•Percentage cover have important implications in moisture distribution.

• Soil moisture and albedo have been explained by linear regression, however more has to be analyzed with other components of energy.

9 Future Work

•Through linear regression we can observe the influence of soil moisture on albedo, however there is more to be done while considering available energy and evaporative fraction, and more components of the energy budget.

•Use the One-Dimensional Planetary Boundary Layer Model

Reference

Kurc, S. A., and E. E. Small (2004). Dynamics of evapotranspiration in semiarid grassland and shrubland ecosystem during the summer monsoon season, central New Mexico, Water Resour. Res.,40,WO9305,doi:10.1092/2004WR003068.

Acknowledgements

Terrestrial Hydrology and Biometeorology Research groupmates for helpful comments.