The Influence of Soil Texture on Soil Water Storage in the North Fork American River Basin

ROBERT J. ZAMORA[1]

CLARK W. KING[1]

ALLEN B. WHITE[1]

ANDREA THORSTENSEN[2]

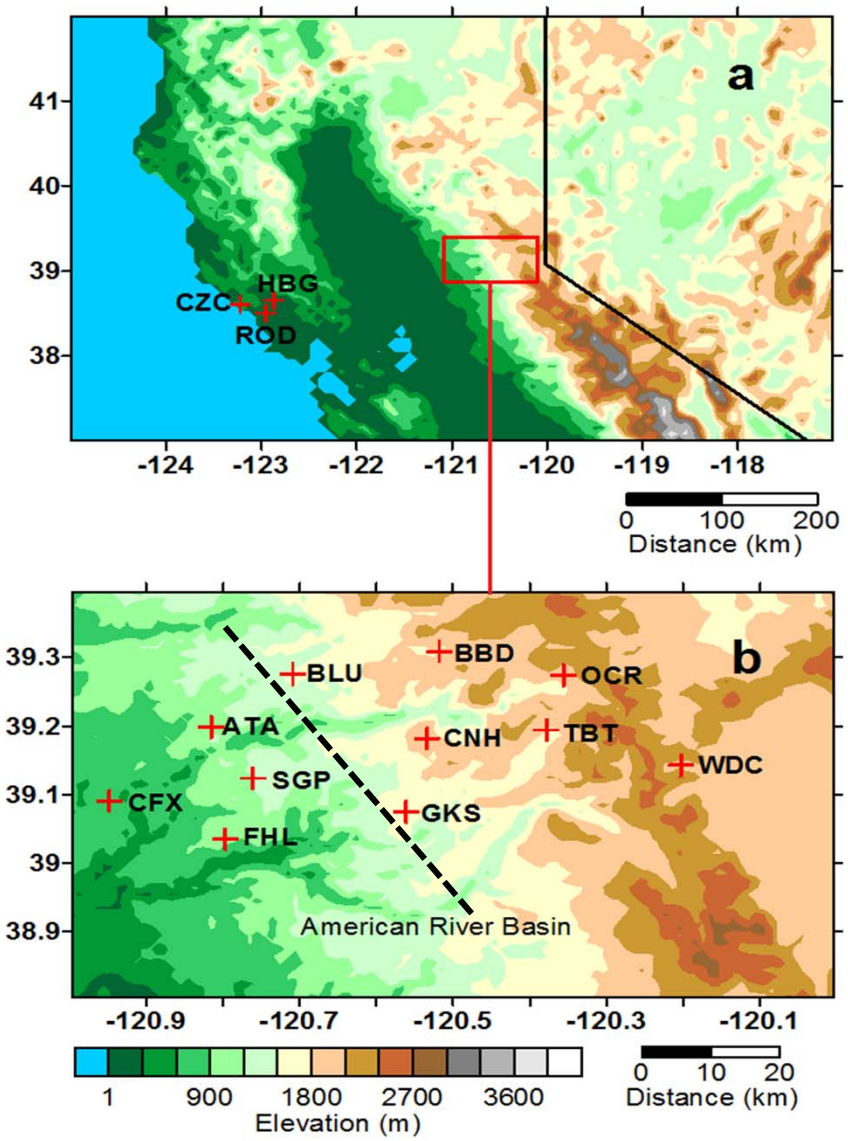
[1]NOAA Earth System Research Laboratory, Boulder, Colorado
[2]Department of Civil and Environmental Engineering, University of California, Irvine, California

Motivation

- Sierra Nevada recieves very little summer precipitation
- Earlier snowmelt onset
- Less water stored in snowpack
- Climate change on basin hydrograph (all rain)
- Water and reservoir management
- Flood forecasting

HMT Soil Moisture Network

- Spans Rain-Snow Transition Zone
- Geomorphology
- Soil Texture
- Soil Water Storage

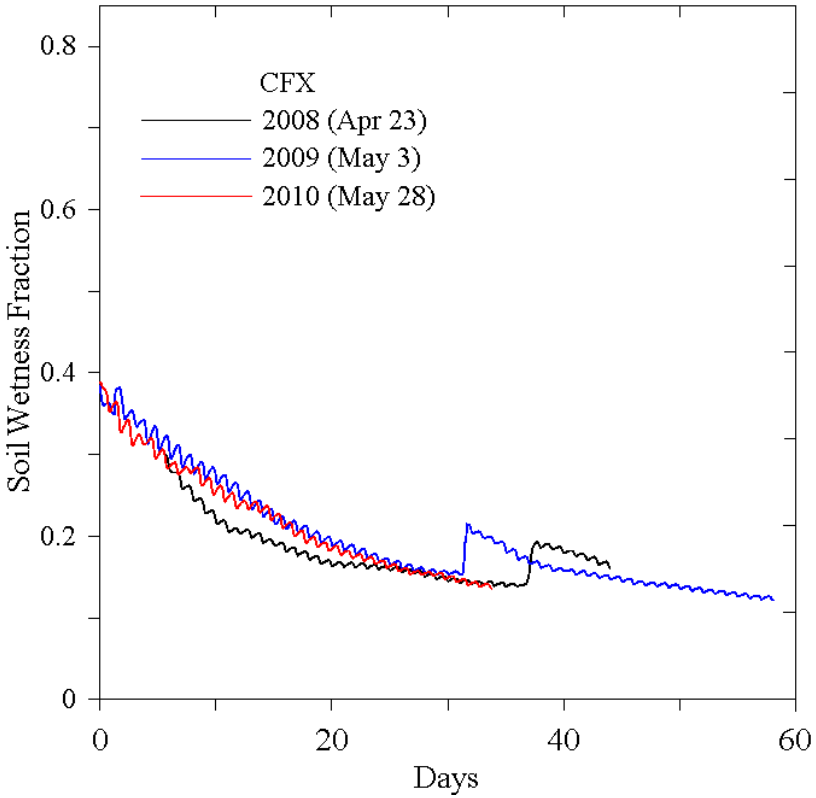


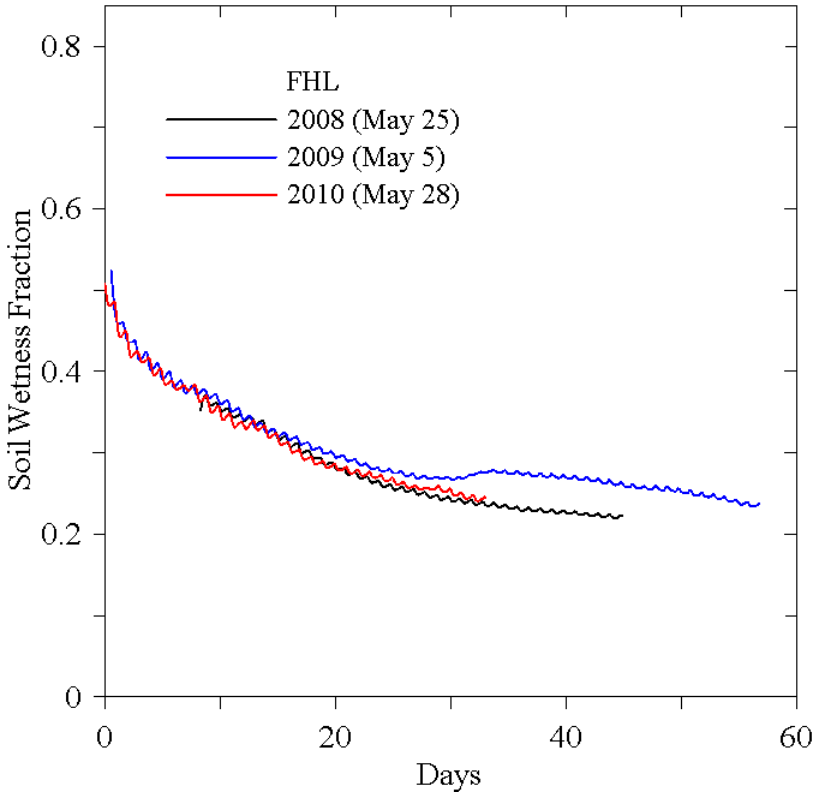
Soil Properties from SSURGO and HMT Gravimetric Sampling

ID	Soil Classification	Sand %	Silt %	Clay %	WC 1.5 MPa %	WC 33.3 kPa %	DTRL cm	Soil Group	FC	SD
CFX	Josephine Loam 5 to 30% slopes	41.6	37.4	21.0	13.3	27.0	> 200.0	C	.35	.12
FHL	Aitken Loam 2 to 9% slopes. (clay loam)	37.3	39.2	23.5	22.0	35.0	> 200.0	B	.52	.24
BLU	McCarthy Cobbly loam 5 to 30% slopes.	66.9	23.1	10.0	22.0	34.0	> 200.0	B	.38	.10
OCR	Tallac 0 to 75% slopes	65.0	29.0	6.0	15.0	18.0	> 200.0	B	.56	.10

- Higher clay contents in lower basin
- Foresthill retains significant amount of water after all other sites are at SD

Lower Basin Observations

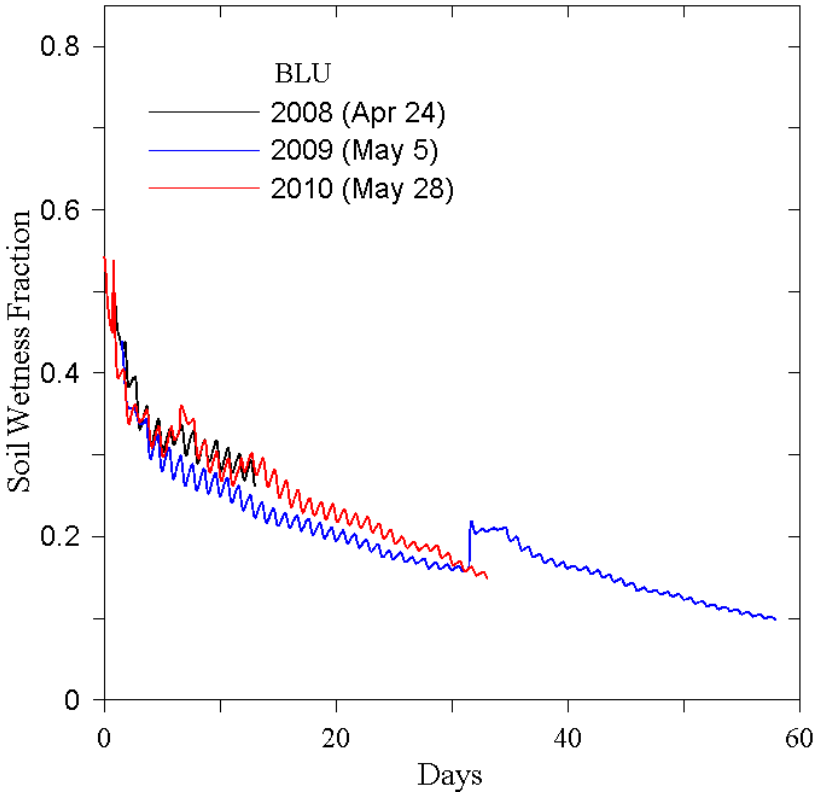


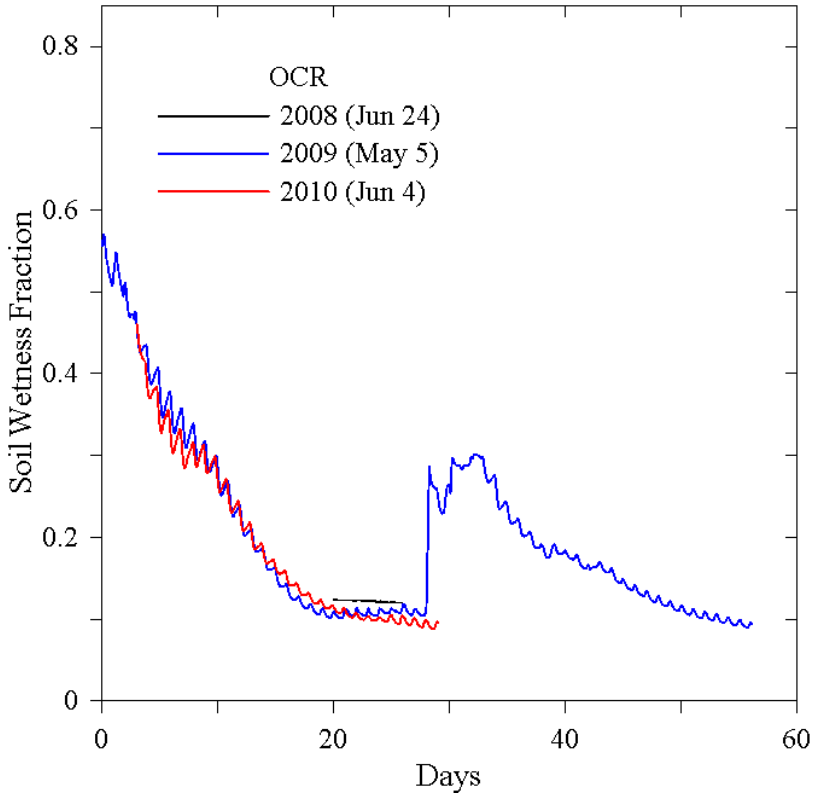


- High SD at Foresthill
- Slow drainage

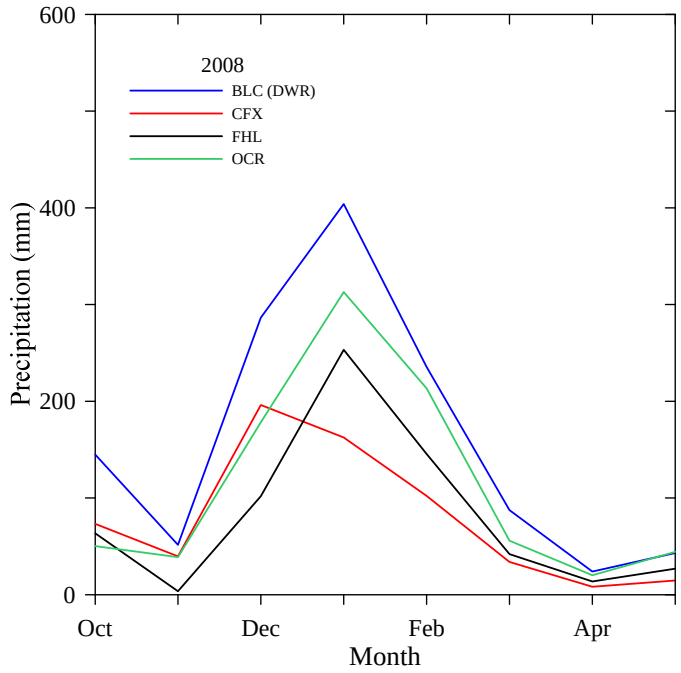
Dry-down starts after the last winter rain event or loss of snowpack

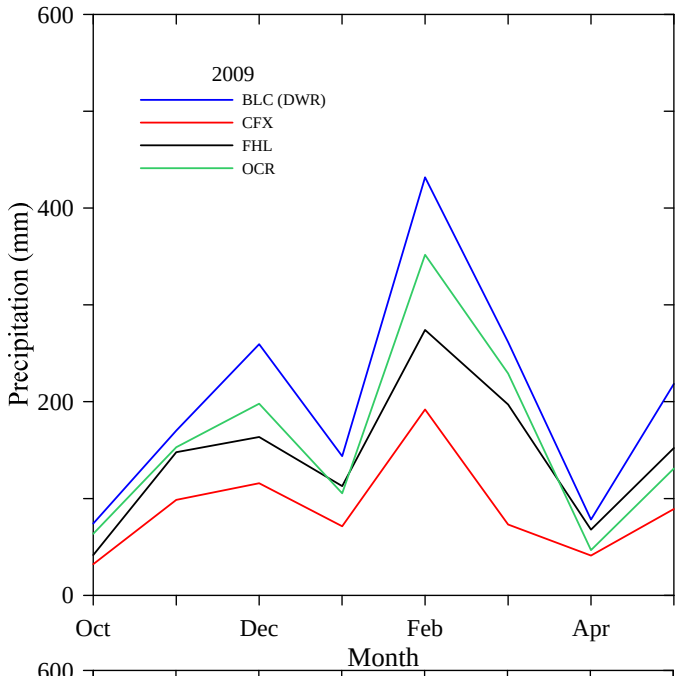
Mid and Upper Basin Observations



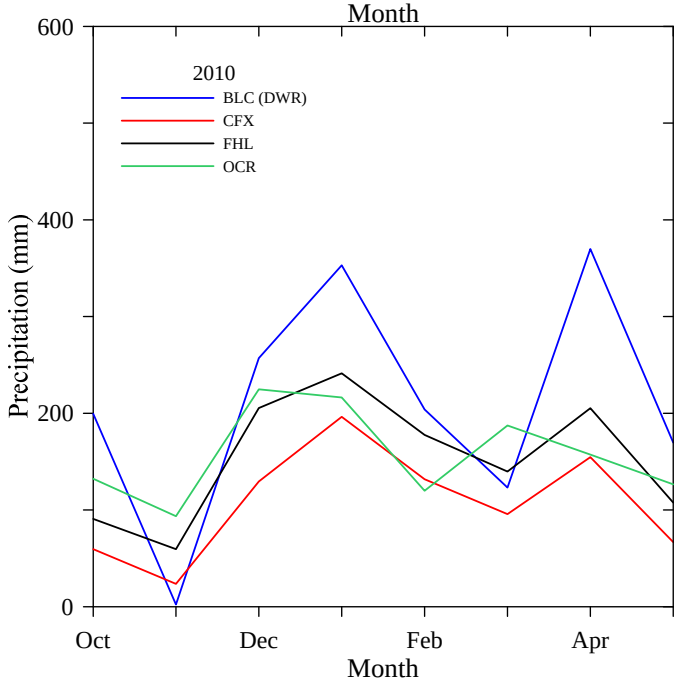


- Lower Soil Dry
- Higher Field Capacity
- Blue Canyon observations suggest large water storage capacity
- All observations suggest that a simple exponential regression can be used to model dry-down

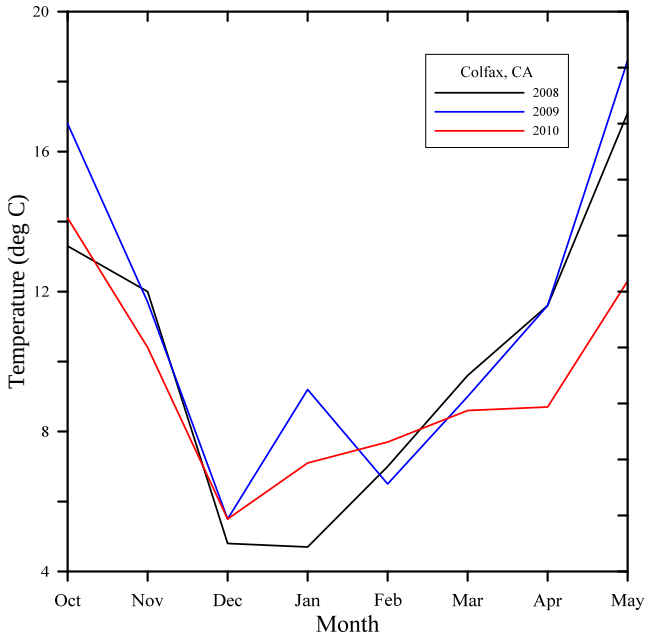


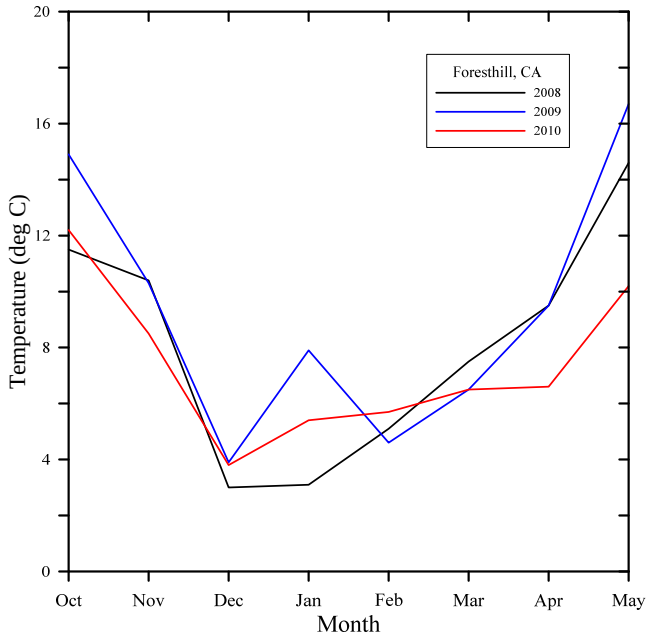


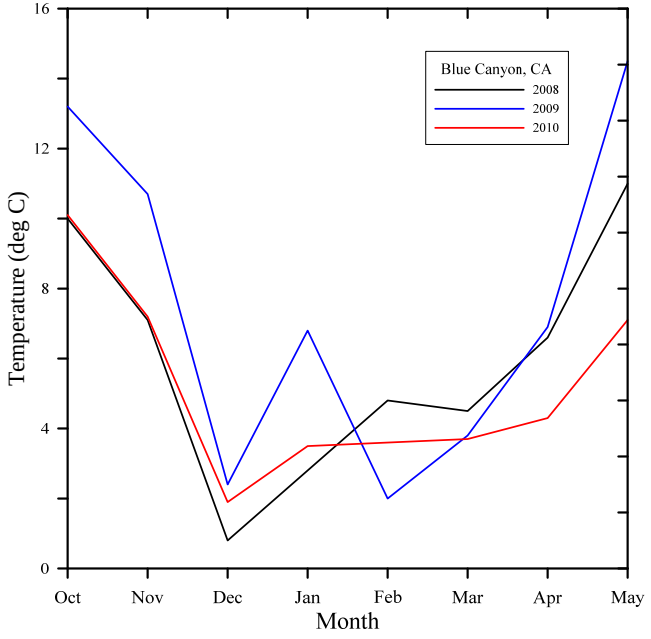
Location	2007–2008	2008–2009	2009–2010
CFX	630	713	858
FHL	650	1156	1227
BLC	1276	1637	1678
OCR		1278	1258

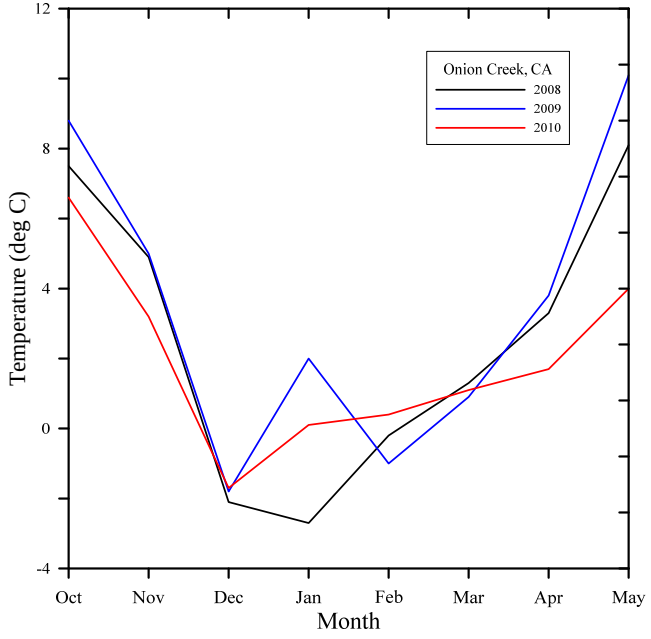


Total Winter Precipitation (mm)


Colfax, CA
2008
2009
2010
Temperature (deg C)
20
16
12
8
4
Oct
Nov
Dec
Jan
Feb
Mar
Apr
May
Month


Foresthill, CA
2008
2009
2010
Temperature (deg C)
20
16
12
8
4
0
Oct
Nov
Dec
Jan
Feb
Mar
Apr
May
Month


Blue Canyon, CA
2008
2009
2010
Temperature (deg C)
16
12
8
4
0
Oct
Nov
Dec
Jan
Feb
Mar
Apr
May
Month

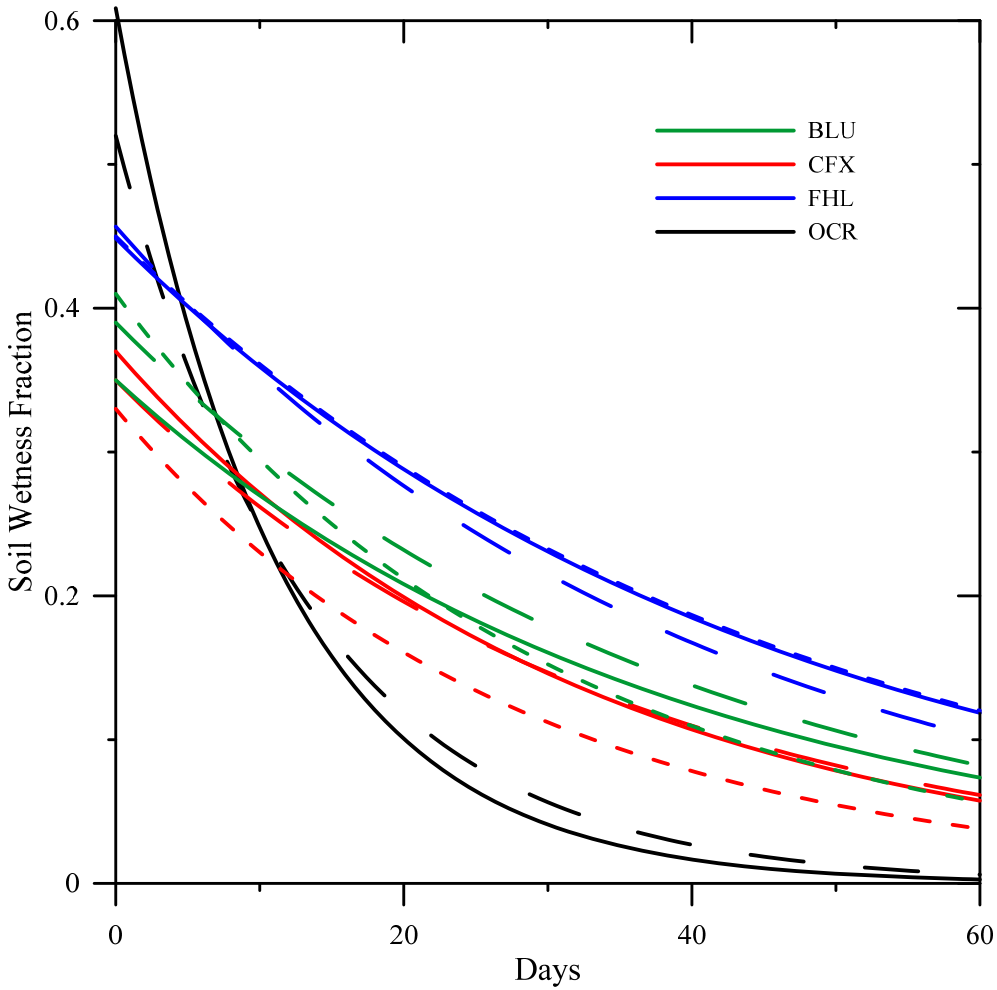

Onion Creek, CA
2008
2009
2010
Temperature (deg C)
12
8
4
0
-4
Oct
Nov
Dec
Jan
Feb
Mar
Apr
May
Month

Exponential Regression Analysis

Coefficients of determination for all observed spring dry-downs and total dry-down time estimated using the composite exponential model for CFX, FHL, BLU, and OCR.

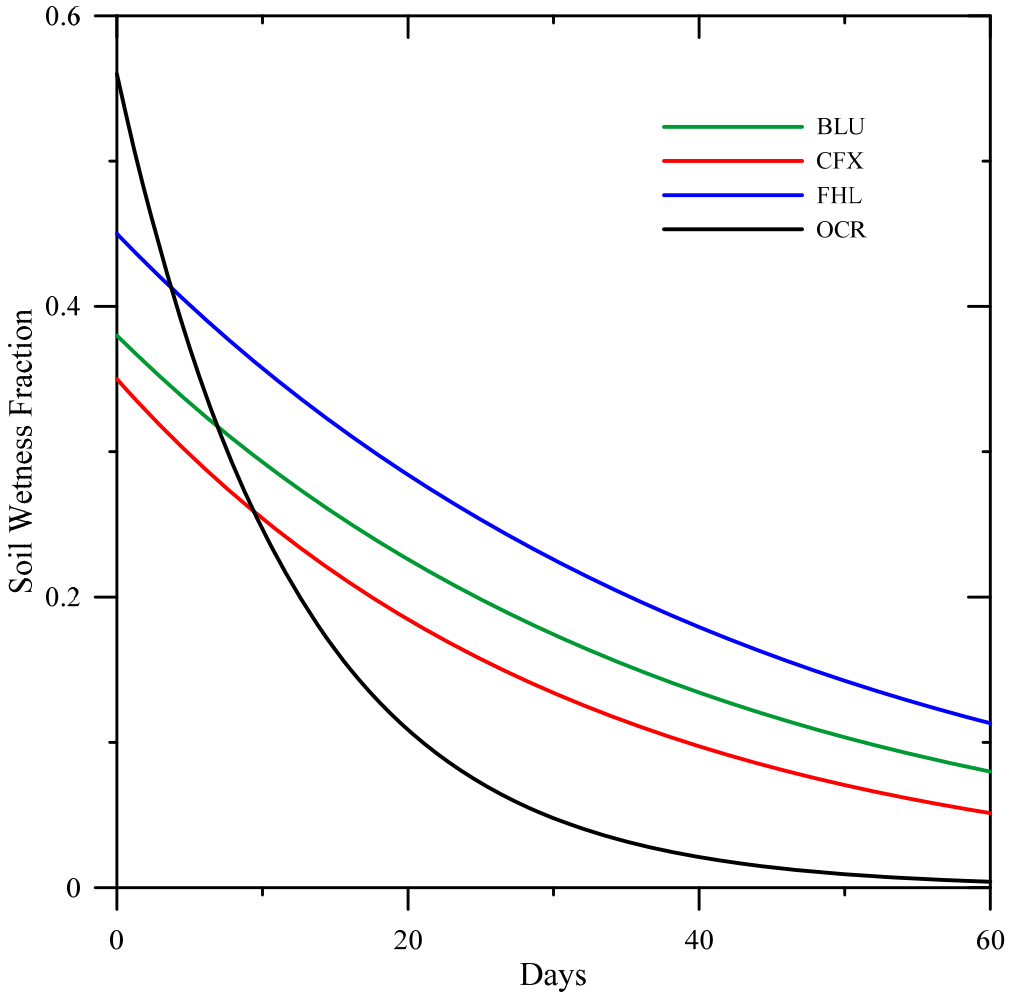
Location	2008	2009	2010	Time to SD (days)
CFX	0.95	0.99	0.98	31.0
FHL	0.97	0.97	0.98	33.1
BLU	0.75	0.96	0.97	47.7
OCR		0.98	0.98	22.3

- Model captured 90% of the variance
- Model must be constrained by SD



Composite Exponential Regression

- Why is BLU taking longer to dry than CFX?
- More Precipitation?
- Bedrock infiltration rates (Flint et al. 2008)?



Summary

- Currently the rain-snow transition line lies between Alta and Blue Canyon (Orographic Precipitation Gradient, Lundquist et al. 2010)
- Region of max precipitation coincides with a region where the soil can store a considerable amount of water
- Changes in the form of precipitation falling at higher elevations suggests that more water will go directly to runoff
- Soil water storage must be considered in winter flood forecasts (all rain hydrograph)
- Network is spatially limited

Zamora, R. J., F. M. Ralph, E. Clark, and T. Schneider, 2011: The NOAA hydrometeorology testbed soil moisture observing networks: Design instrumentation, and preliminary results. *J. Atmos. Ocean. Technol.*, **28**, 1129-1140.