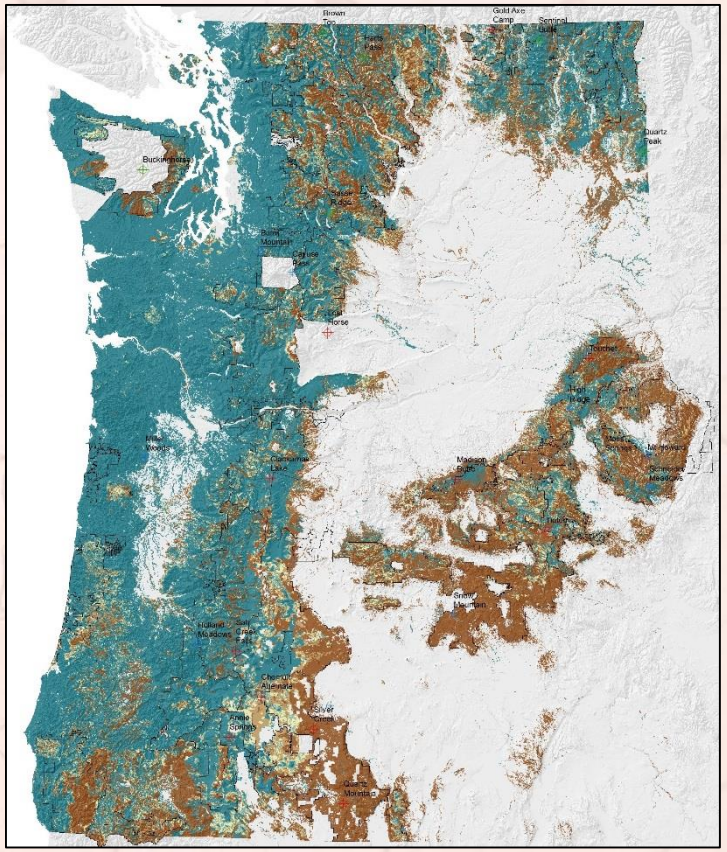
An Approach to Mapping Soil Drought Potential at Regional Scales

Chris Ringo – Faculty Research Assistant, Oregon State University

Jay Noller – Chair, Dept. of Crop and Soil Science, Oregon State University

Karen Bennett – Regional Soil Scientist, US Forest Service R6 (retired)

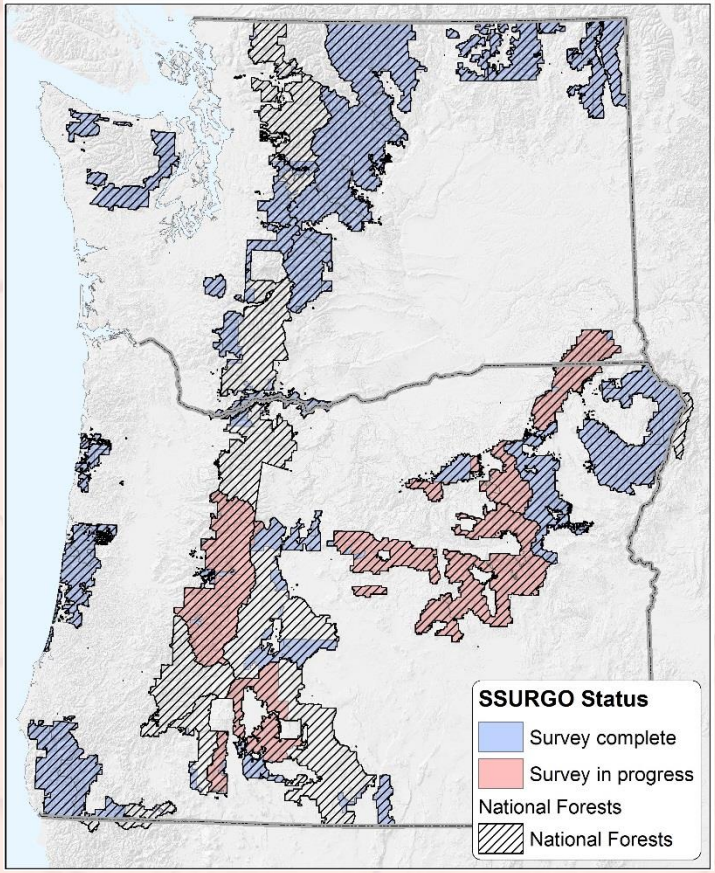


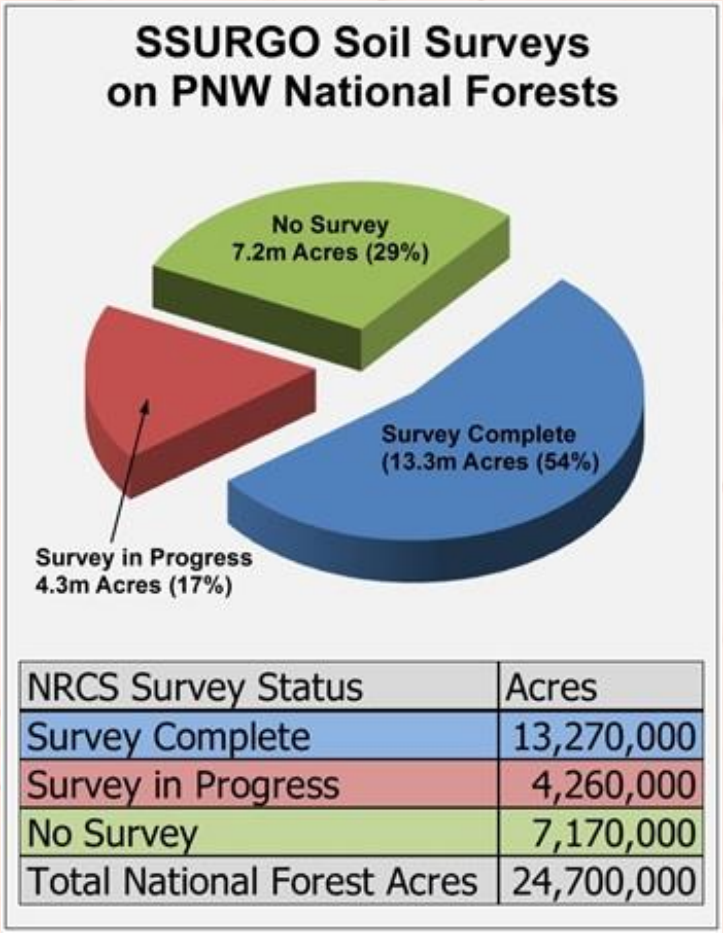
Presentation Summary

- A little about myself
- Data mining efforts in Region 6
  - SSURGO, STATSGO, SRI
- Some basic soils terminology
- How we've developed our "Droughty Soils" model
- Where to next

R6 Legacy Soils Data Retrieval

SSURGO Data Availability, USFS Region 6





NRCS Survey Status	Acres
Survey Complete	13,270,000
Survey in Progress	4,260,000
No Survey	7,170,000
Total National Forest Acres	24,700,000

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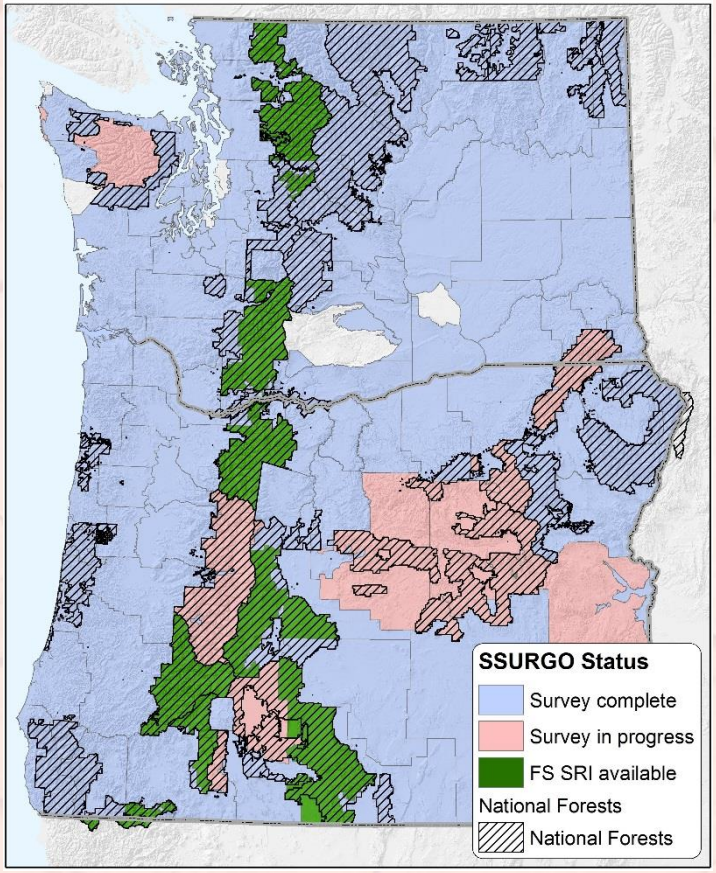
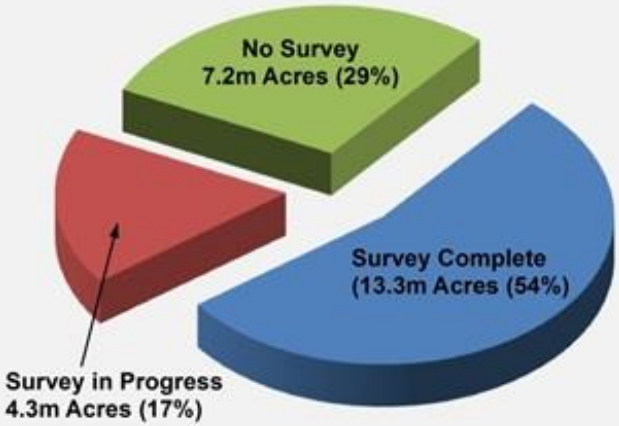


SSURGO Soil Surveys on PNW National Forests



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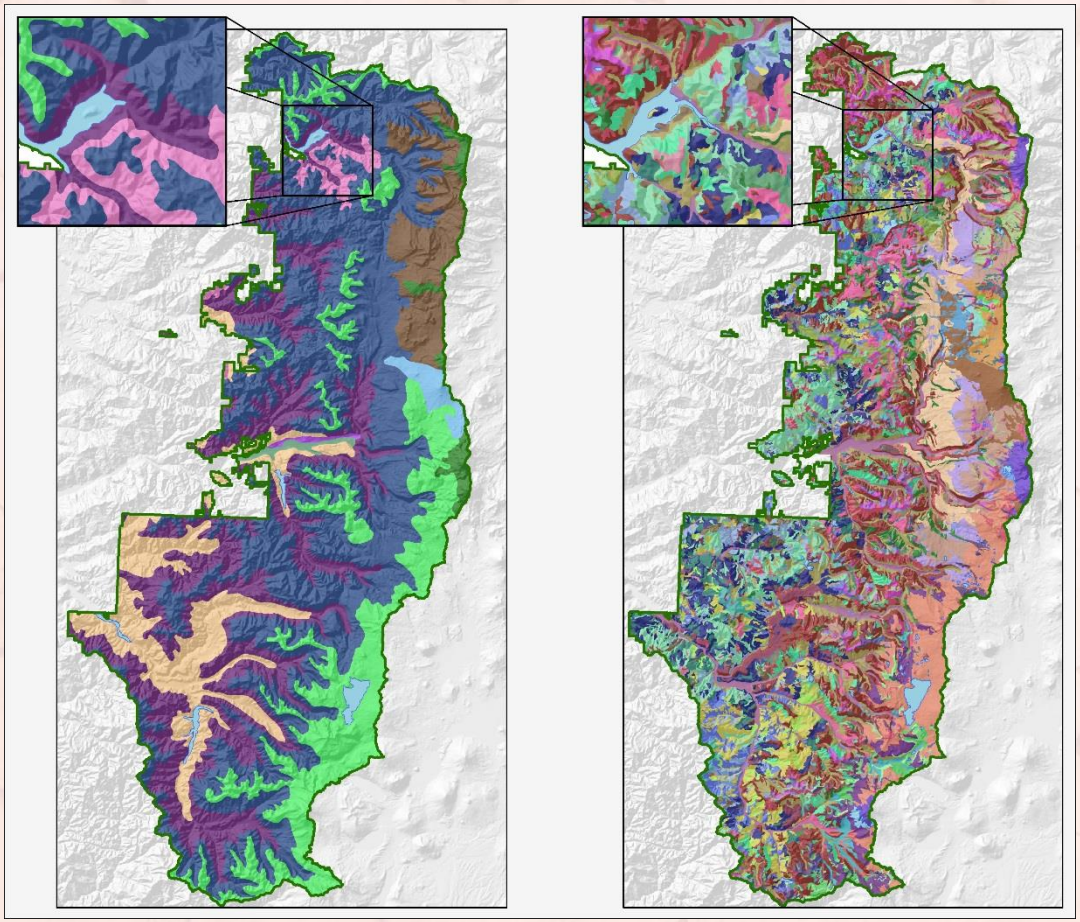
R6 Legacy Soils Data Retrieval

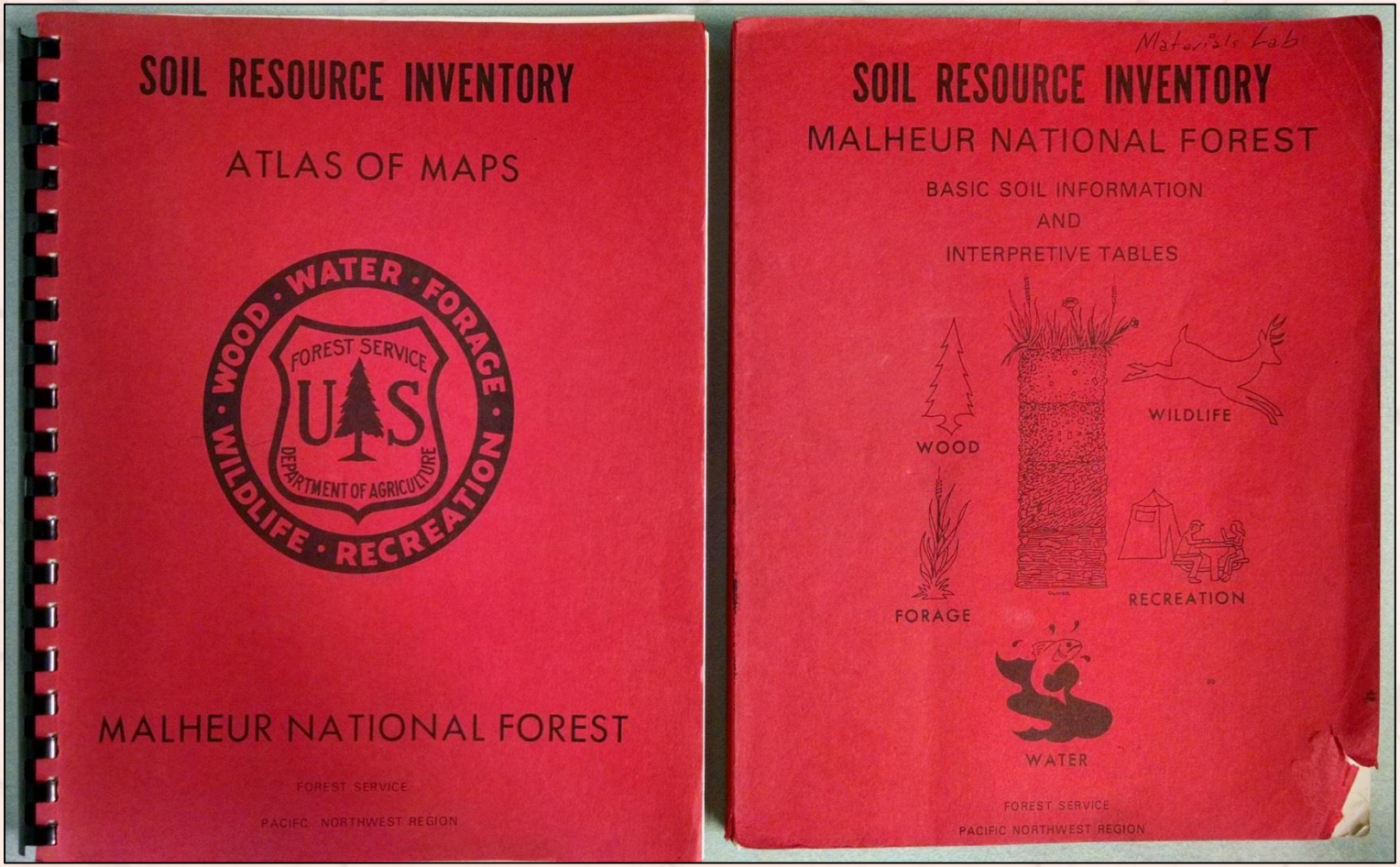
SRI vs STATSGO on Willamette NF:



STATSGO:
Mapping scale: 1:250,000
Mapping units: 13
Avg. polygon size: 44,000 ac.
Avg. # of soil types
per polygon: 10-12

SRI:
Mapping scale: 1:63,360
Mapping units: 49
Avg. polygon size: 320 ac.
Avg. # of soil types
per polygon: 1-2

Soil Resource Inventory (SRI)



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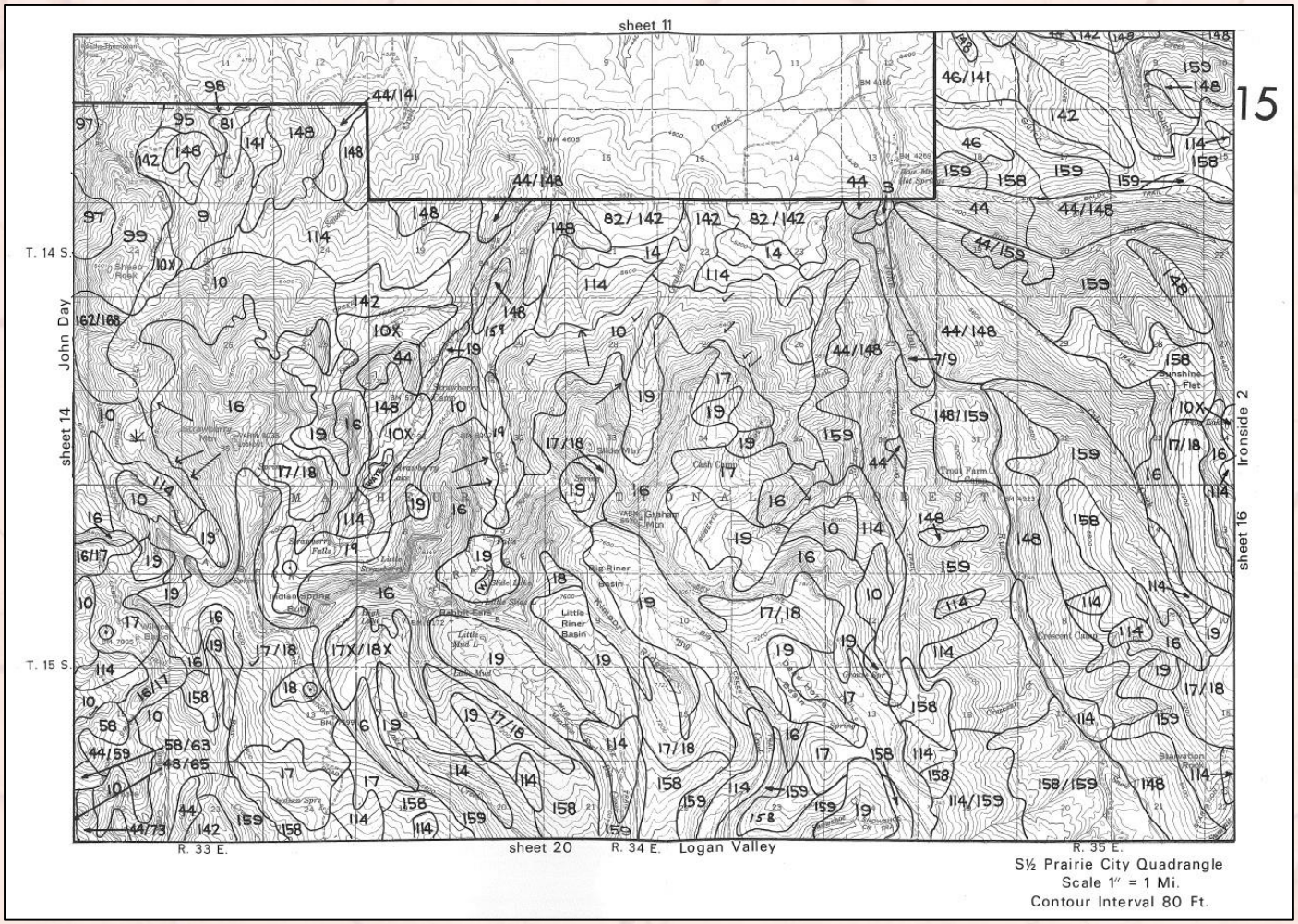

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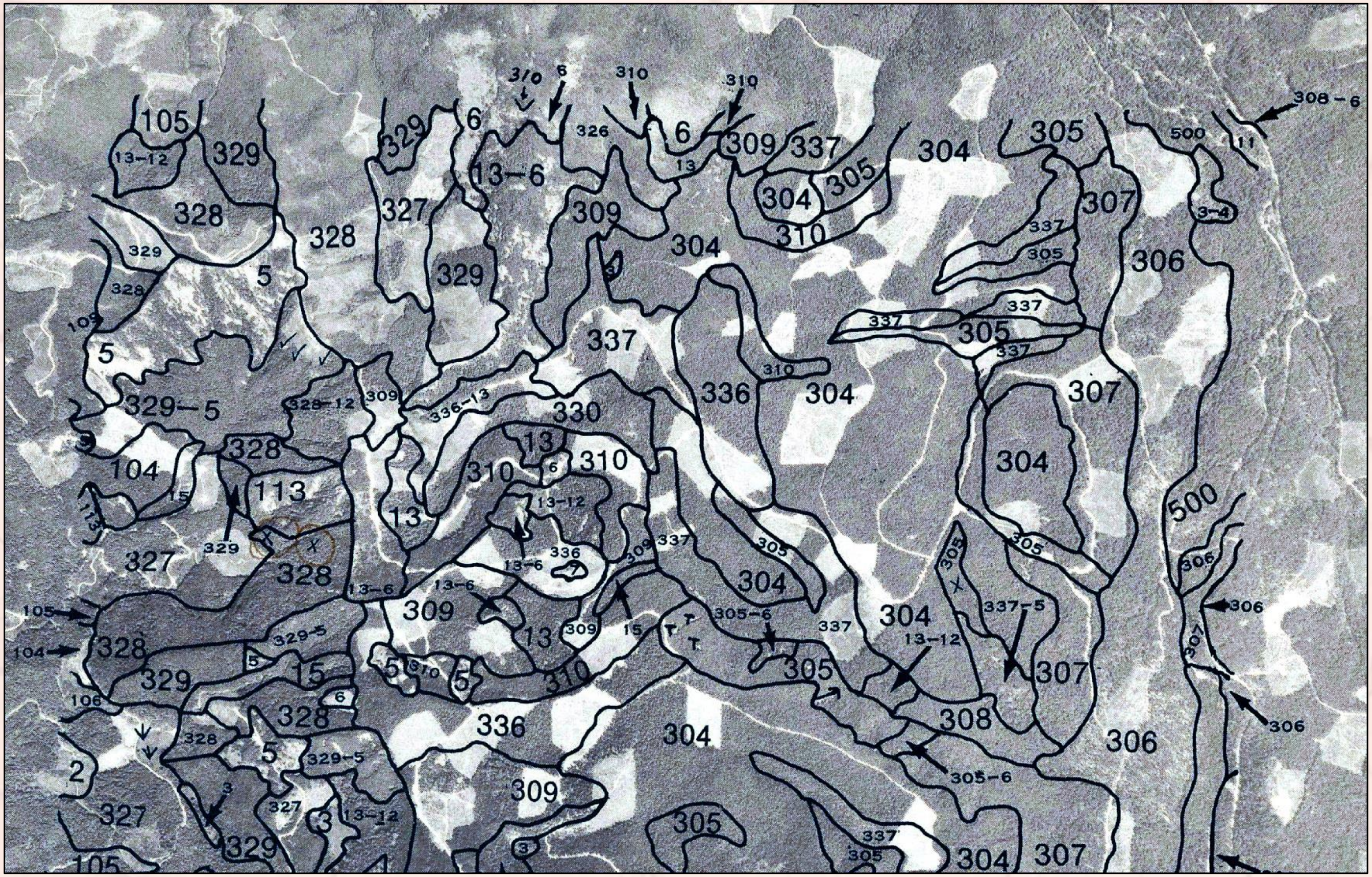
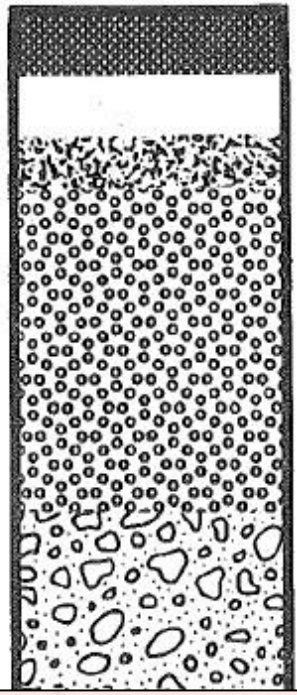


Soil Resource Inventory (SRI)

SOIL PROFILE

Duff		1 to 3 inches thick; needles, leaves, and twigs.
Surface Soil		0 to 1½ inches thick; grayish brown; very friable; loamy sand.
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Subsoil		10 to 60 inches thick; white to brown; loose; ashy loamy sand, or ashy sandy loam; 20 to 95 percent ash and pumice (0.5 to 50.0 mm dia.).
		15 to 30 inches thick; brown; friable; sandy loam, or loamy sand; 10 to 50 percent gravel and cobbles.

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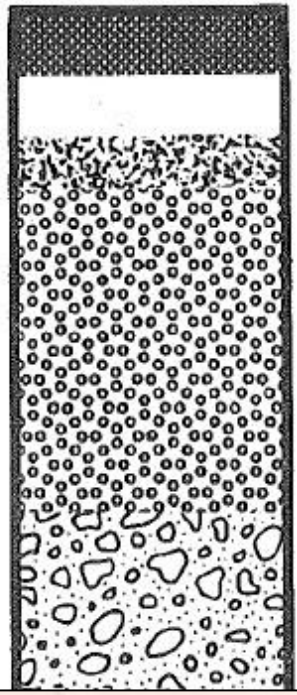
Duff		1 to 3 inches thick; needles, leaves, and twigs.
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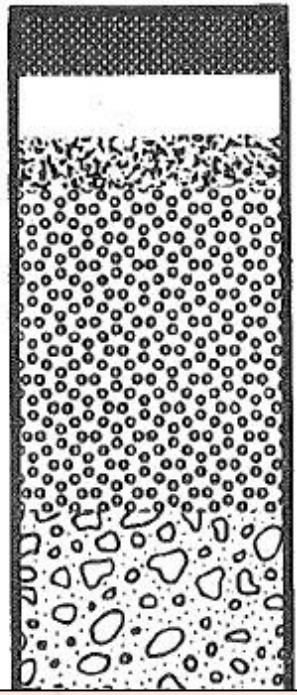
Duff		1 to 3 inches thick; needles, leaves, and twigs.
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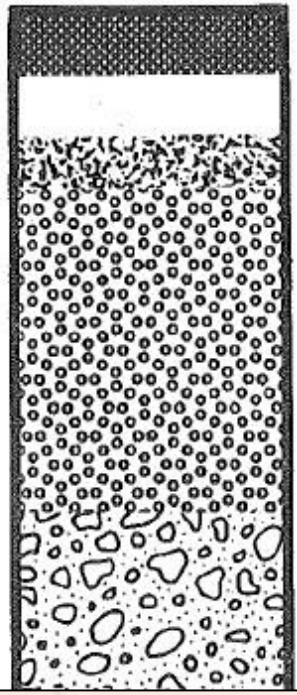
Duff		1 to 3 inches thick; needles, leaves, and twigs.
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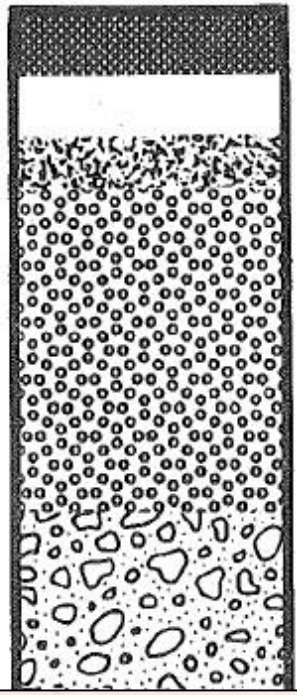
Duff		1 to 3 inches thick; needles, leaves, and twigs.
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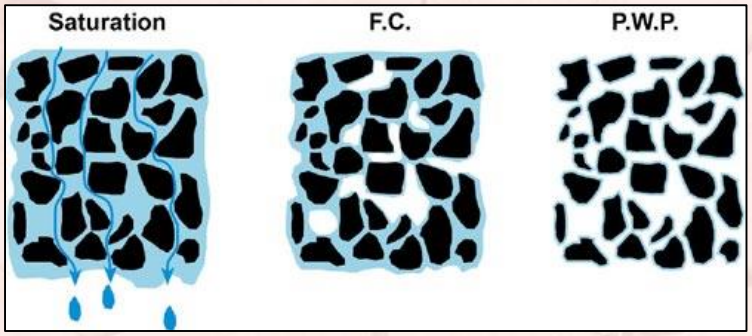
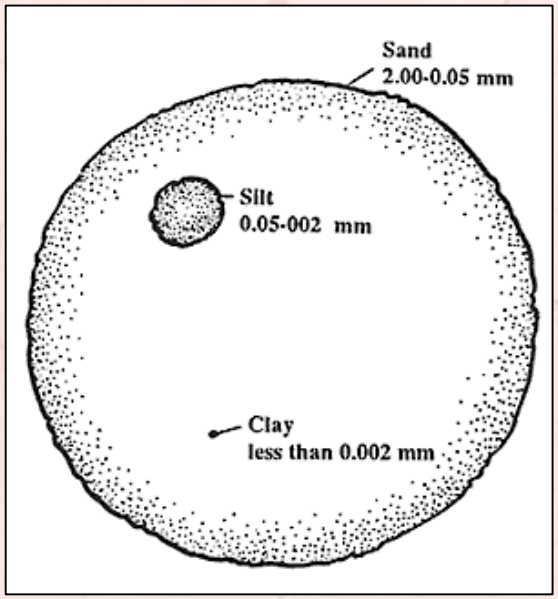
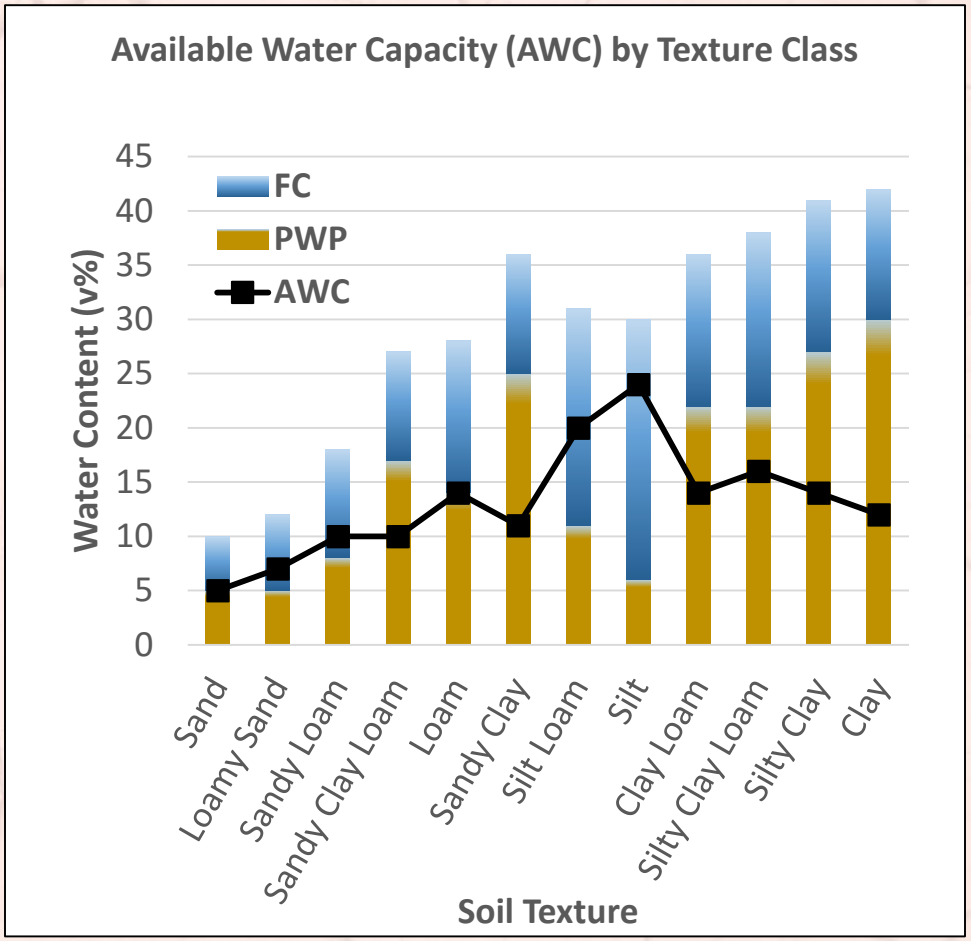
Available Water Capacity (AWC)







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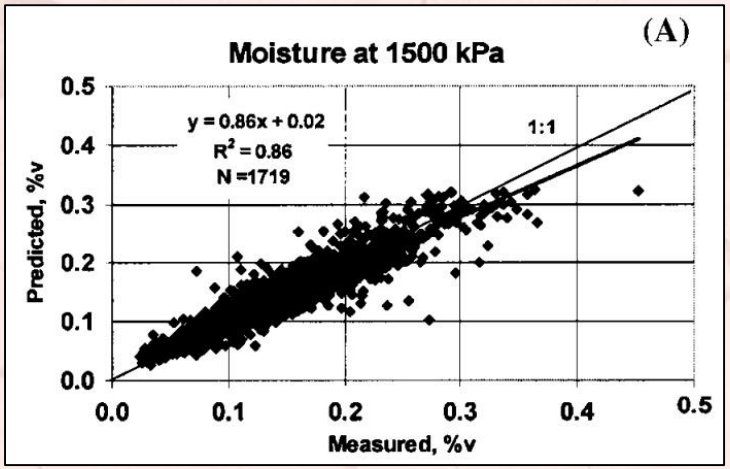
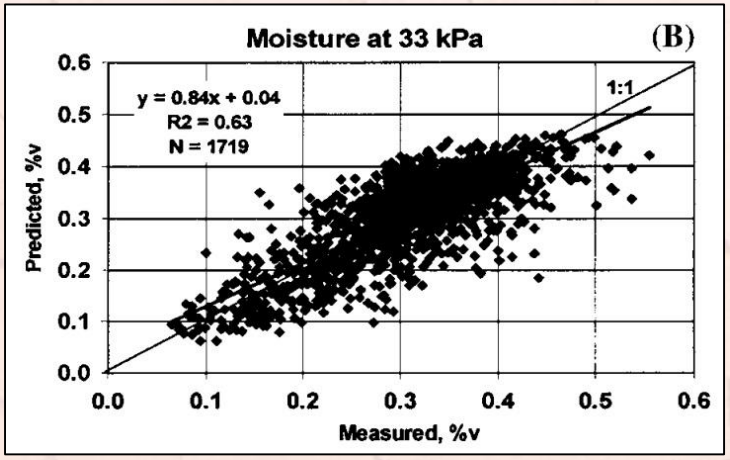
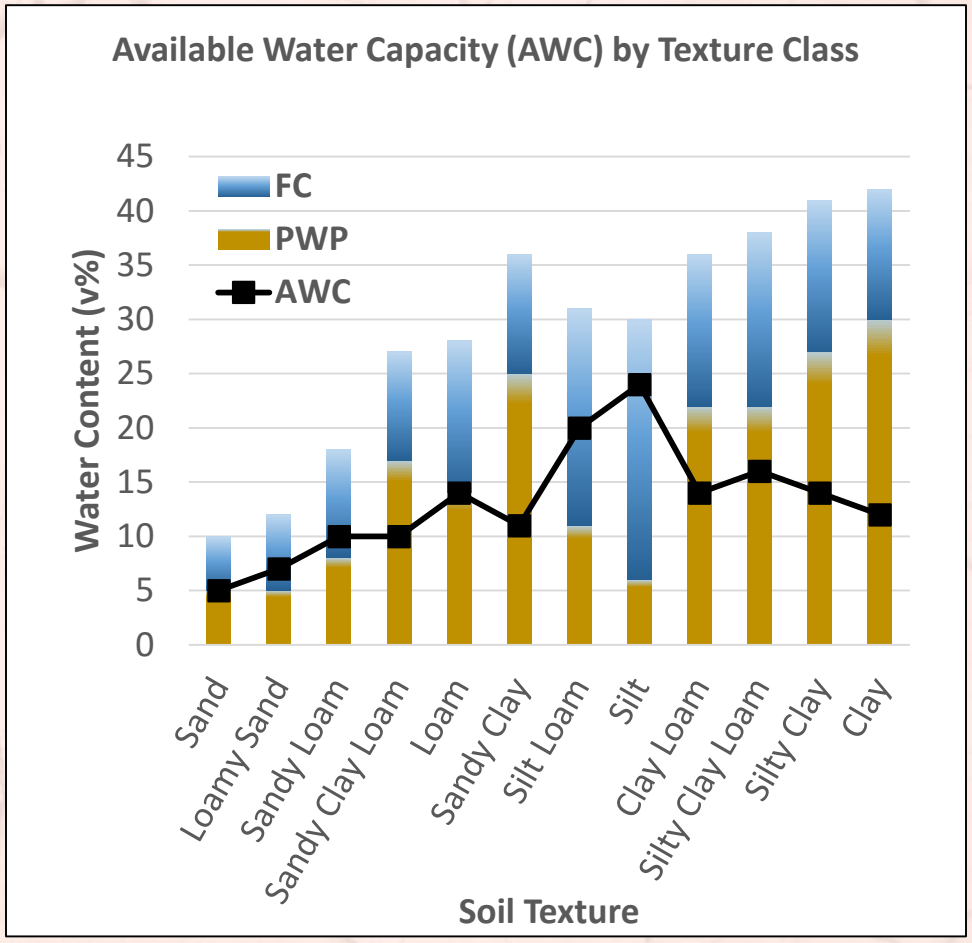
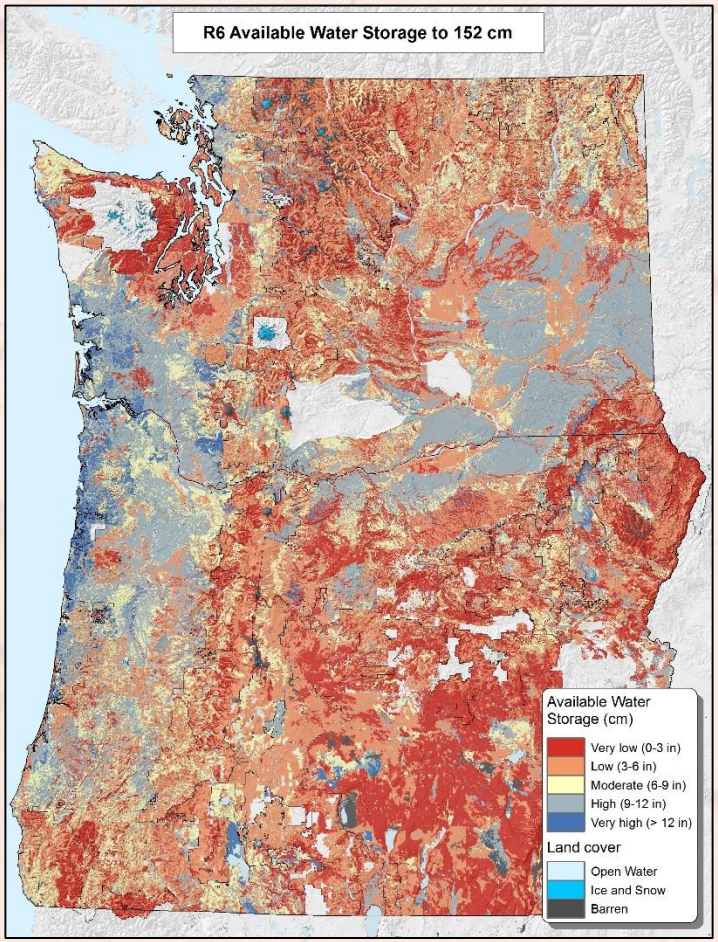
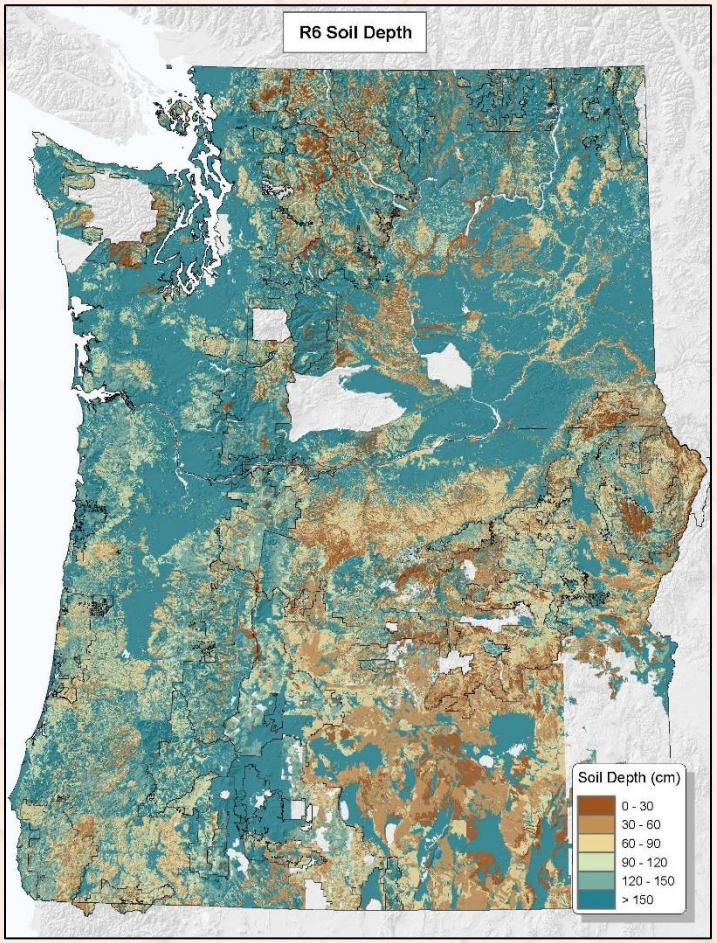






Region 6 AWS_{150} and Soil Depth

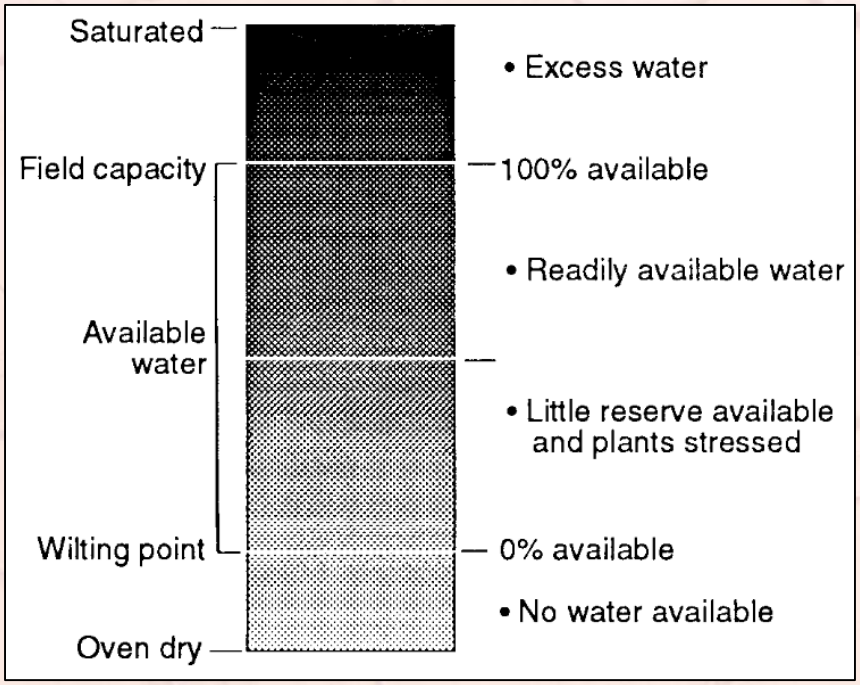


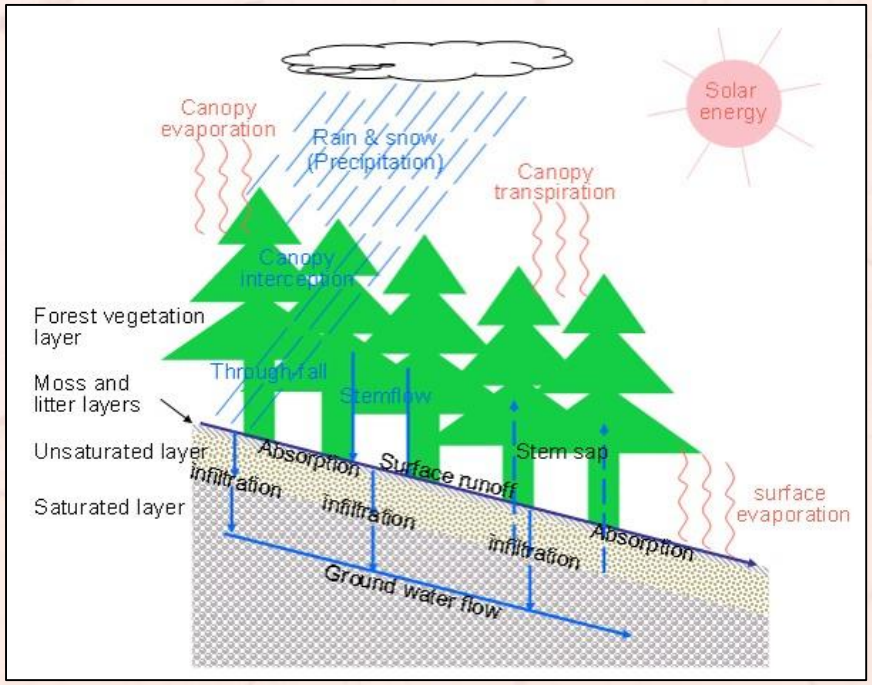


The Climatic Piece

AWS only tells us how much water the bucket can hold

We need to know how much moisture is actually in the bucket





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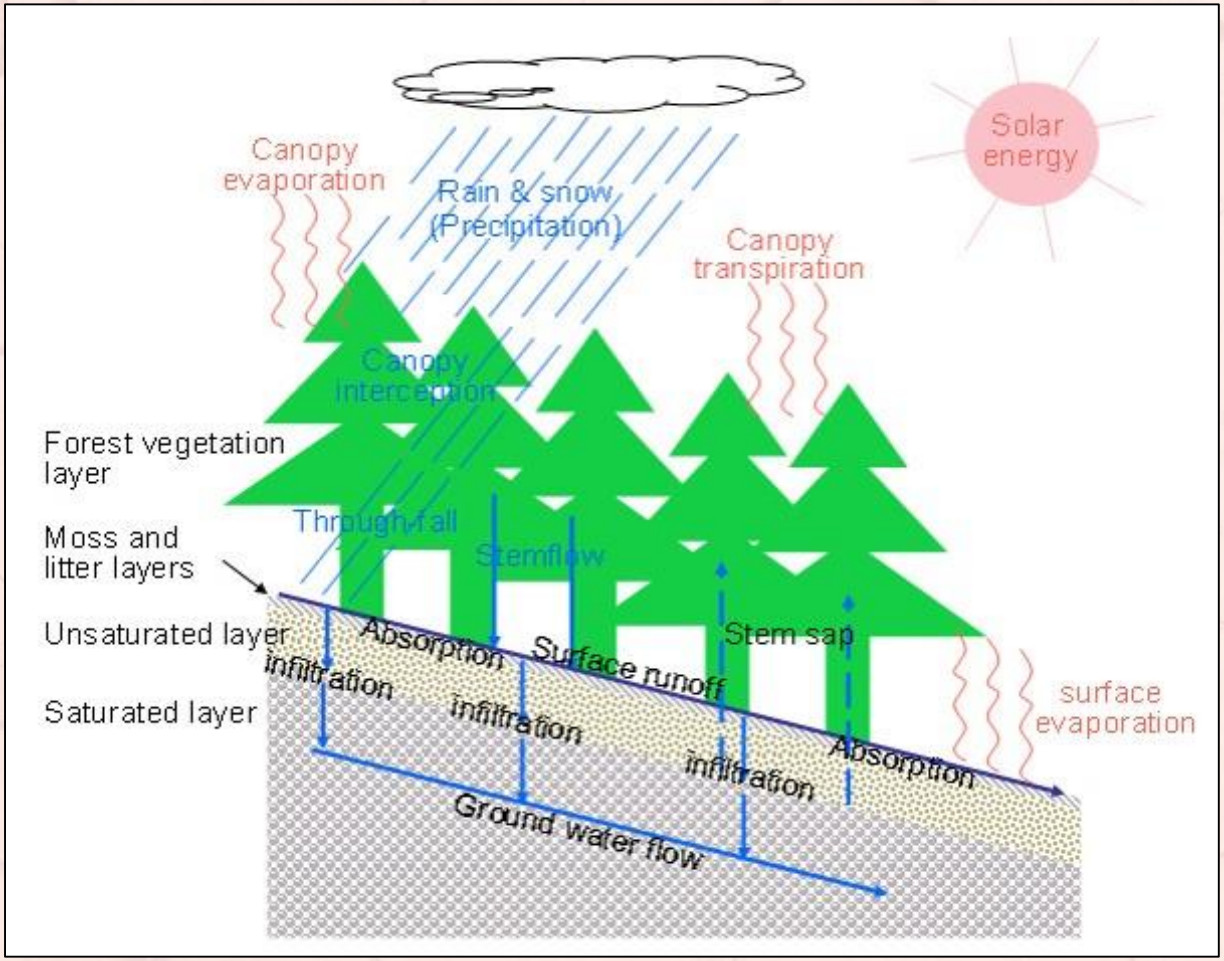
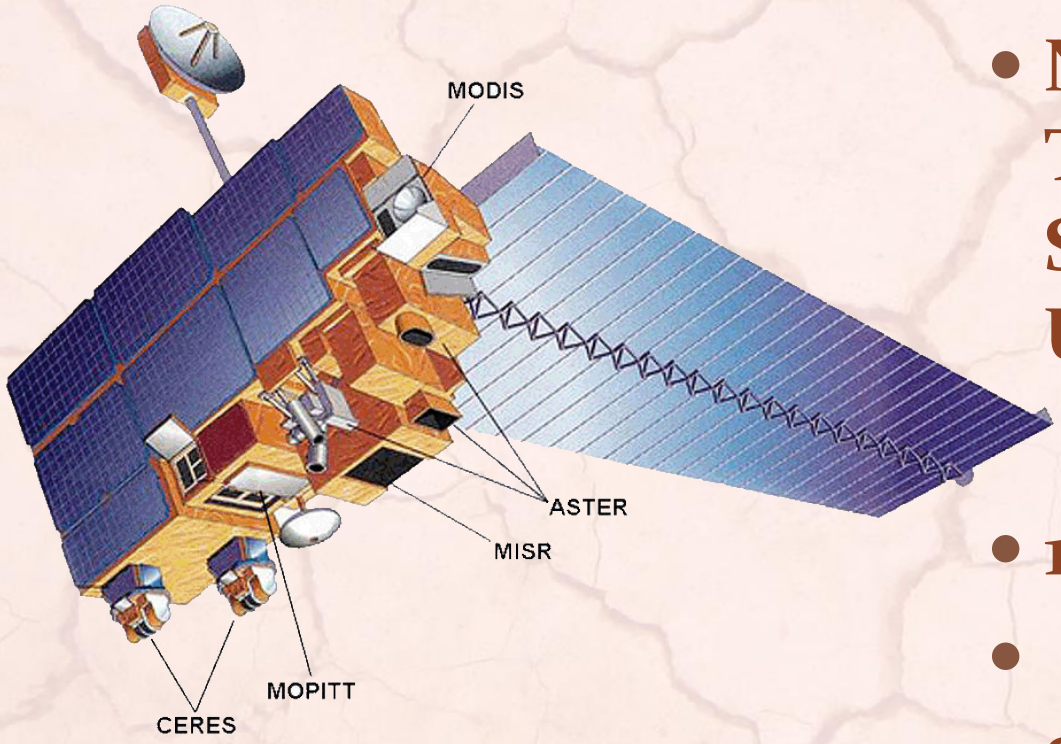
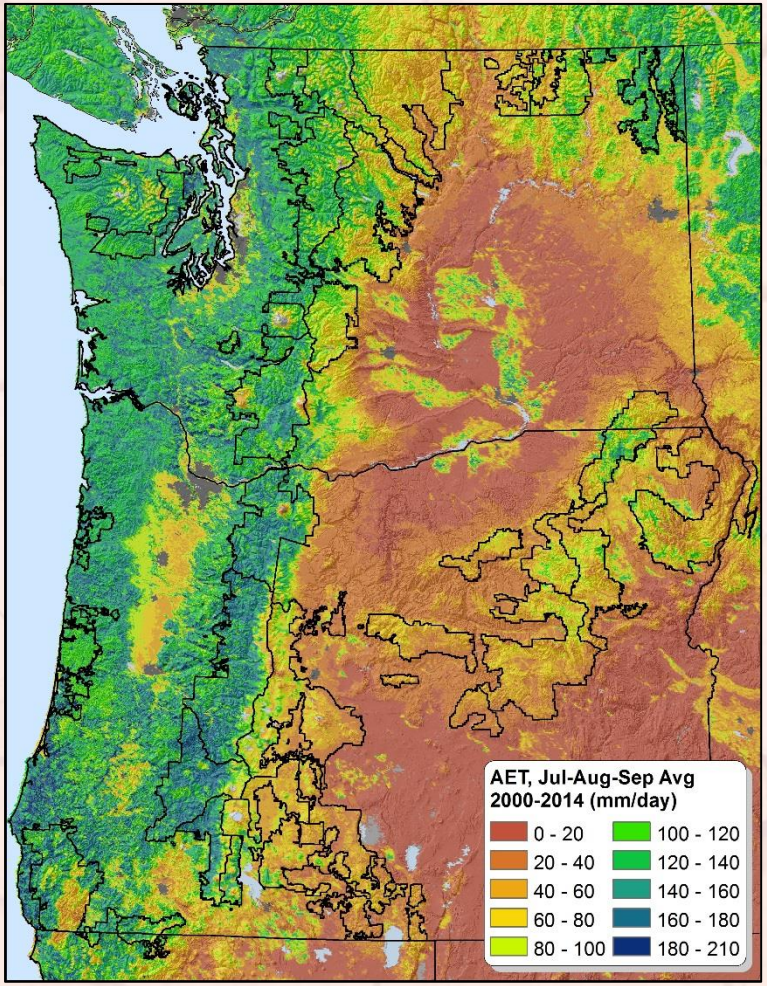


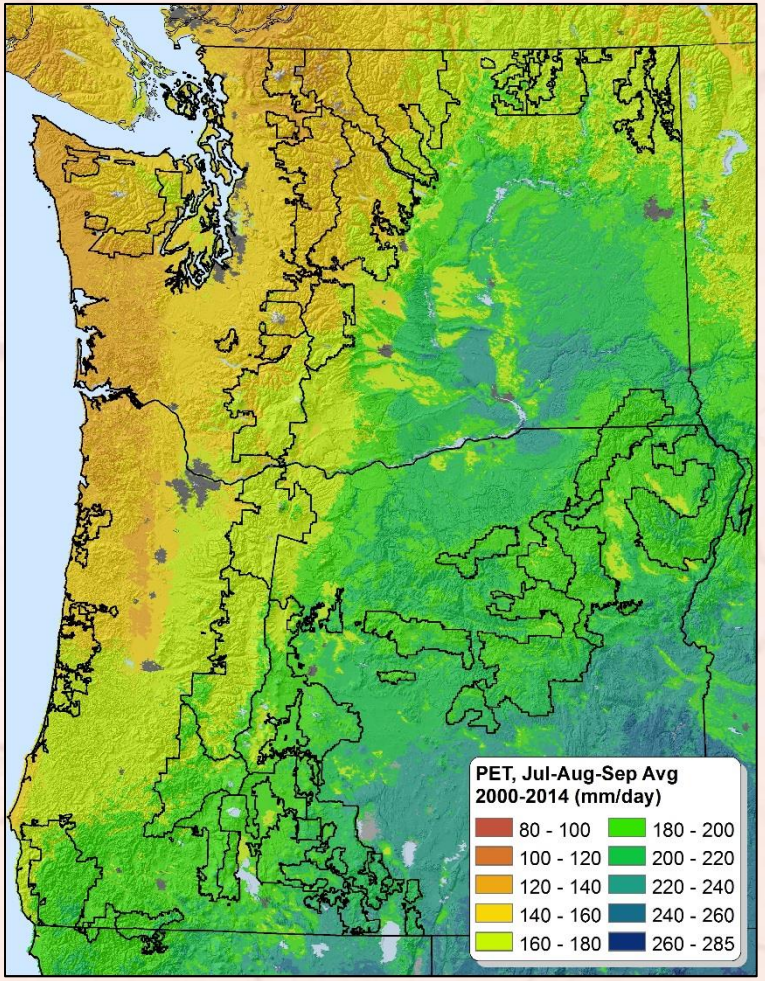
The Climatic Piece – MODIS ET



- Numerical Terradynamic Simulation Group at Univ of MT (MOD16)
- 1km resolution
- 8-day and monthly data
- 2000 - present

The Climatic Piece – MODIS ET





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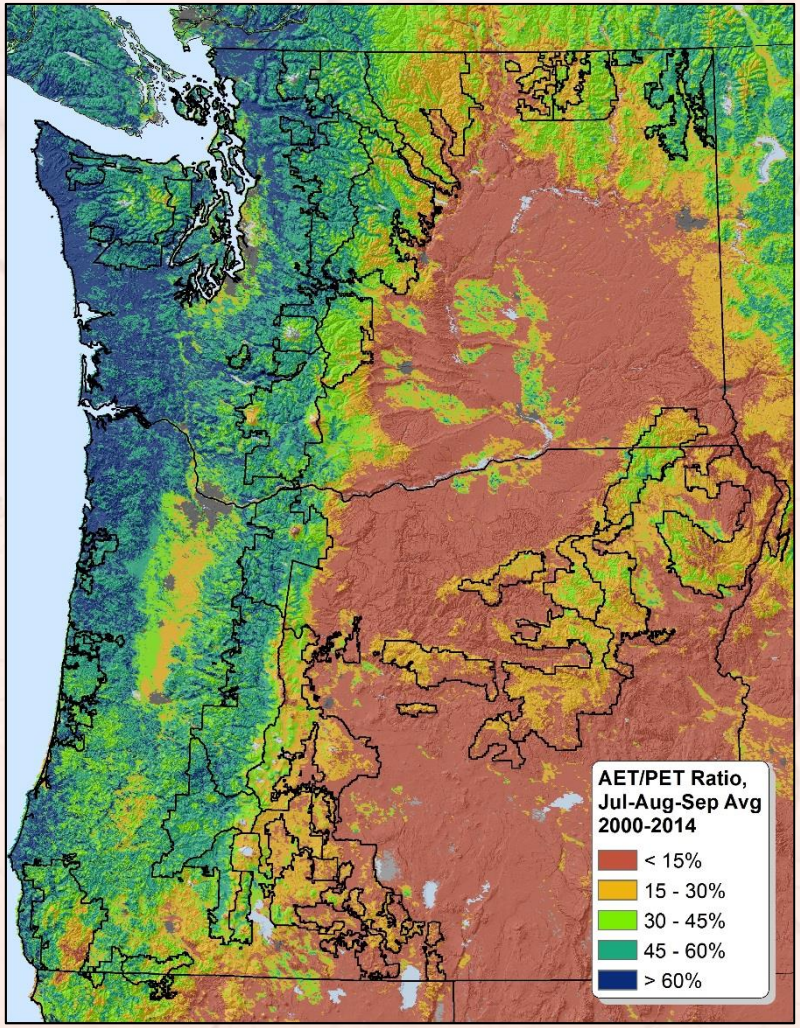
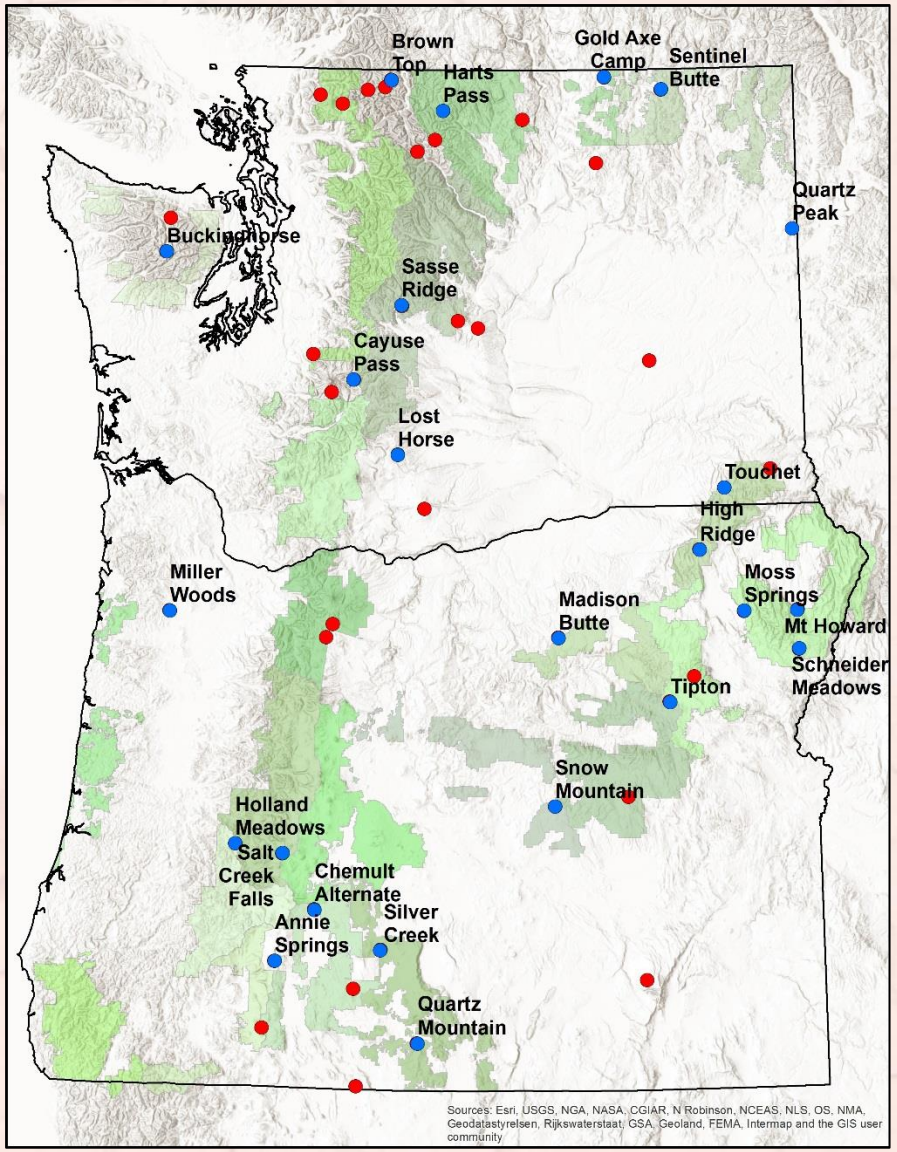
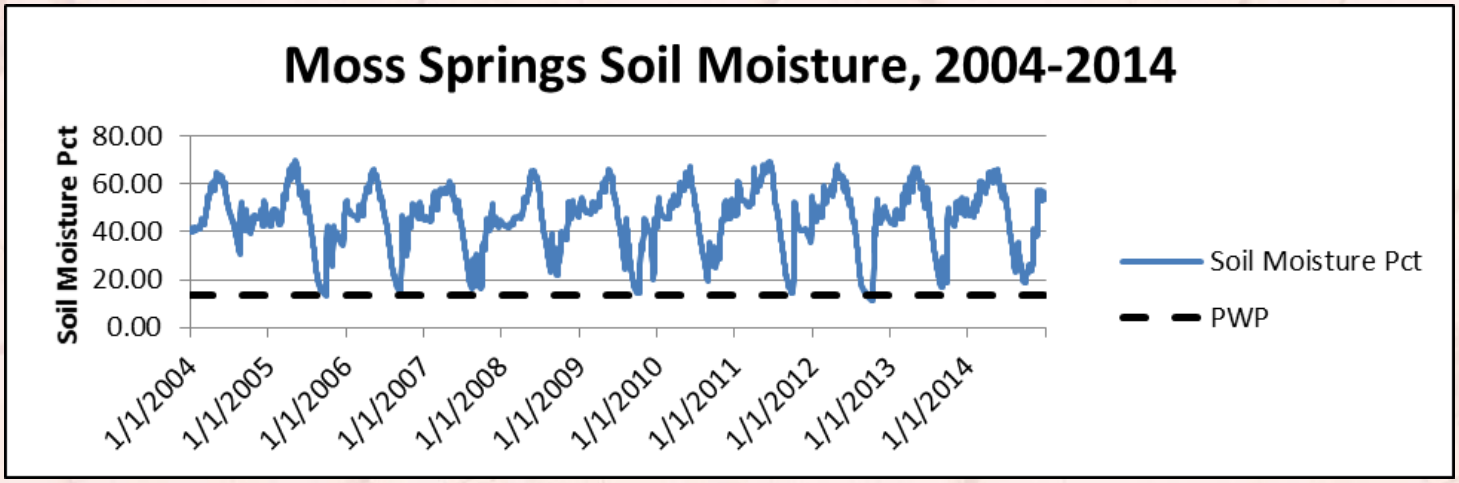


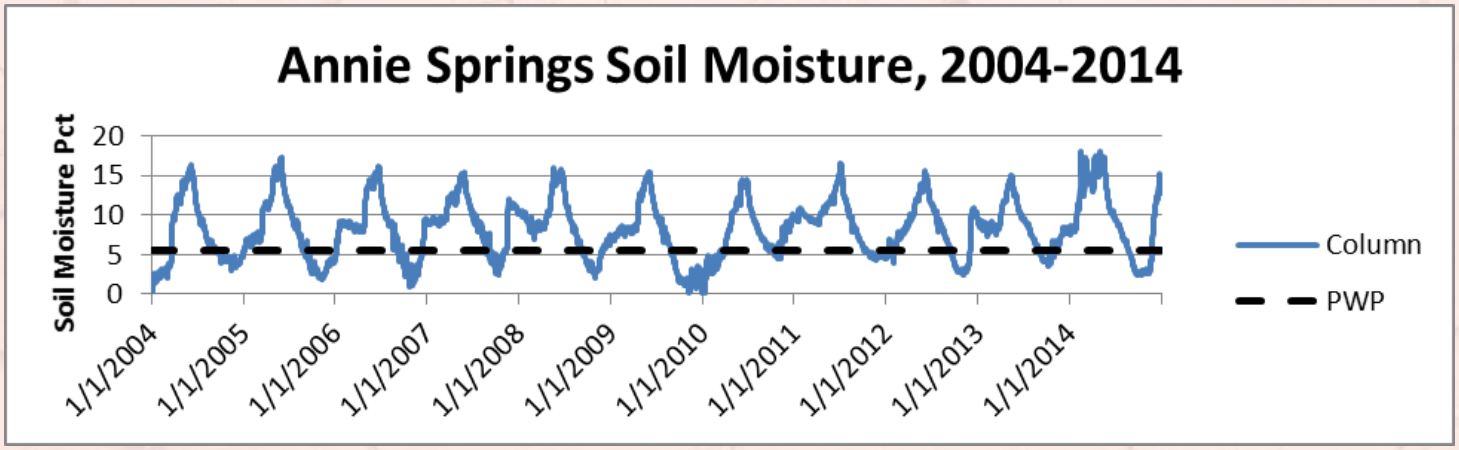
Calibration dataset

- Soil moisture curves from 25 SNOTEL Sites



How to define “droughty”?

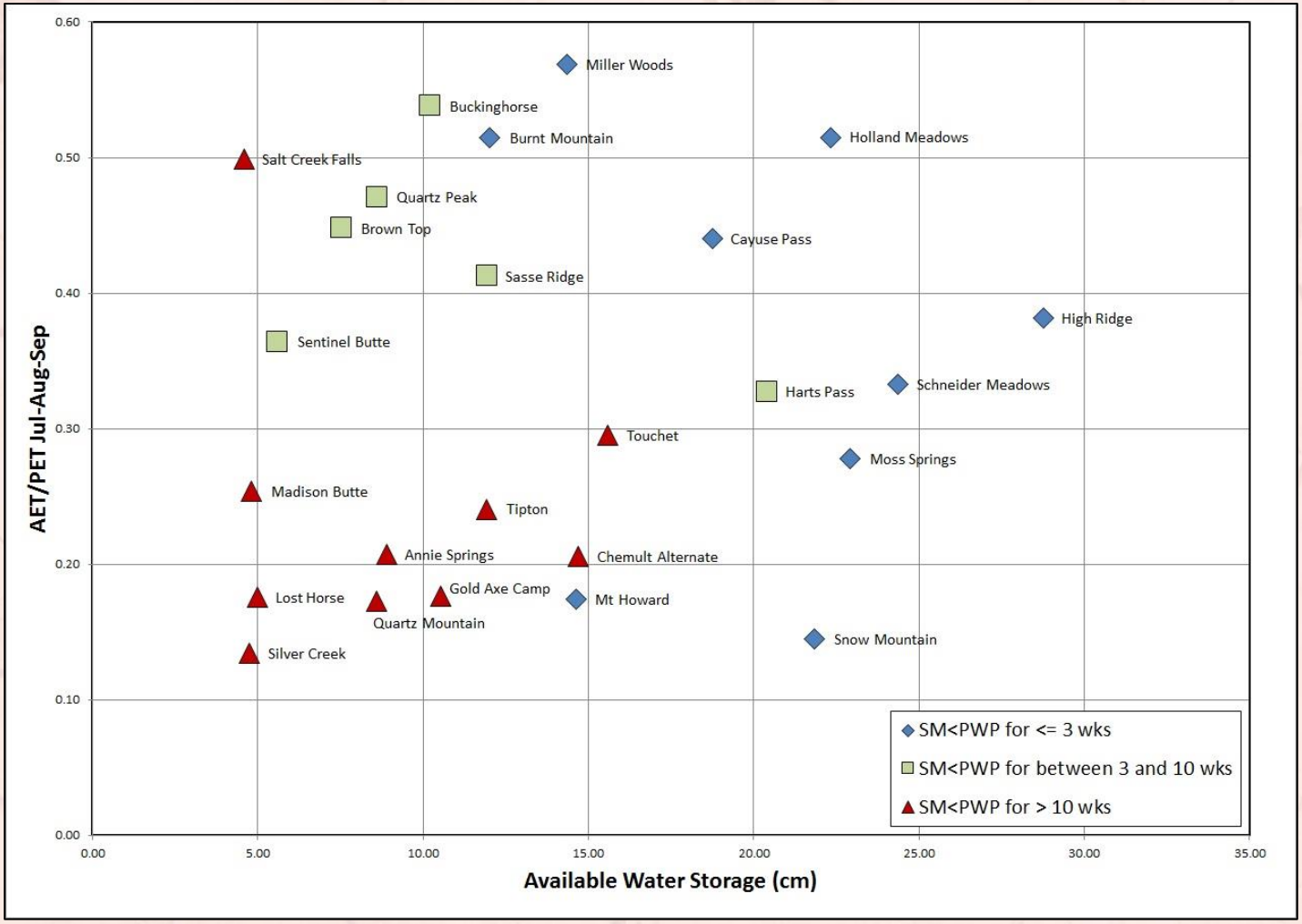




SM Drought Classes

Site name	Elevation	Jul-Aug-Sep AET/PET	AWS	Annual #days < PWP	Soil depth	Yrs of record
Cayuse Pass	5240	0.44	18.77	0	84	3
High Ridge	4920	0.38	28.78	0	152	4
Miller Woods	420	0.57	14.34	0	152	3
Mt Howard	7910	0.17	14.63	0	152	11
Schneider Meadows	5400	0.33	24.36	0	152	4
Snow Mountain	6220	0.14	21.84	0	150	3
Moss Springs	5760	0.28	22.93	2	127	11
Burnt Mountain	4200	0.51	12.03	10	104	6
Holland Meadows	4900	0.51	22.33	21	152	4
Brown Top	5830	0.45	7.56	30	90	5
Sentinel Butte	4920	0.36	5.62	37	152	8
Sasse Ridge	4200	0.41	11.96	45	152	10
Buckinghorse	4870	0.54	10.22	60	71	5
Harts Pass	6500	0.33	20.42	64	106	7
Quartz Peak	4700	0.47	8.64	66	81	5
Touchet	5530	0.30	15.59	73	79	4
Gold Axe Camp	5360	0.18	10.54	88	64	3
Silver Creek	5740	0.13	4.75	97	60	3
Lost Horse	5000	0.18	4.99	101	48	8
Salt Creek Falls	4222	0.50	4.60	101	53	3
Annie Springs	6010	0.21	8.89	113	84	11
Madison Butte	5150	0.25	4.82	124	108	6
Chemult Alternate	4850	0.21	14.70	158	152	11
Tipton	5150	0.24	11.93	166	69	9
Quartz Mountain	5720	0.17	8.59	174	152	11

AWS vs AET/PET by SM Class



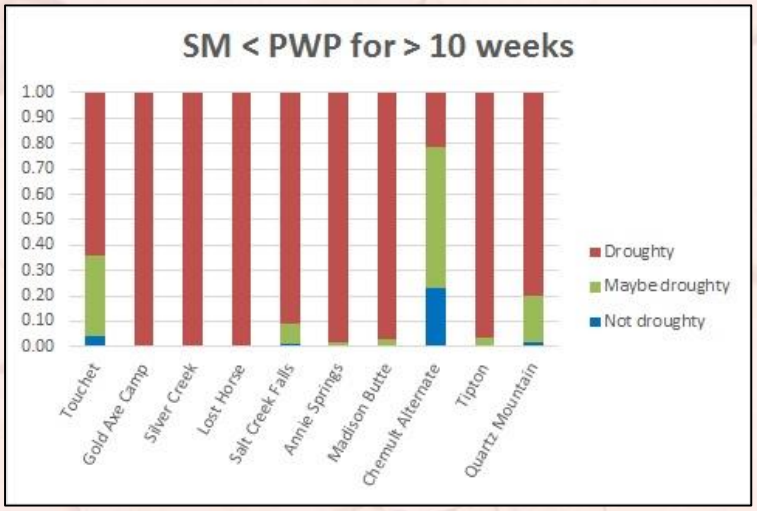
Modeled SM Drought Classes

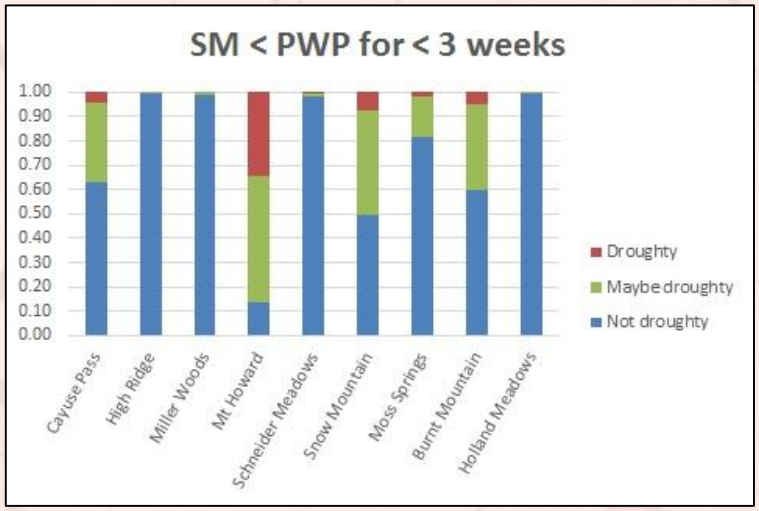
- Final model had three variables:
  - Available Water Storage
  - AET/PET Ratio
  - Soil Depth

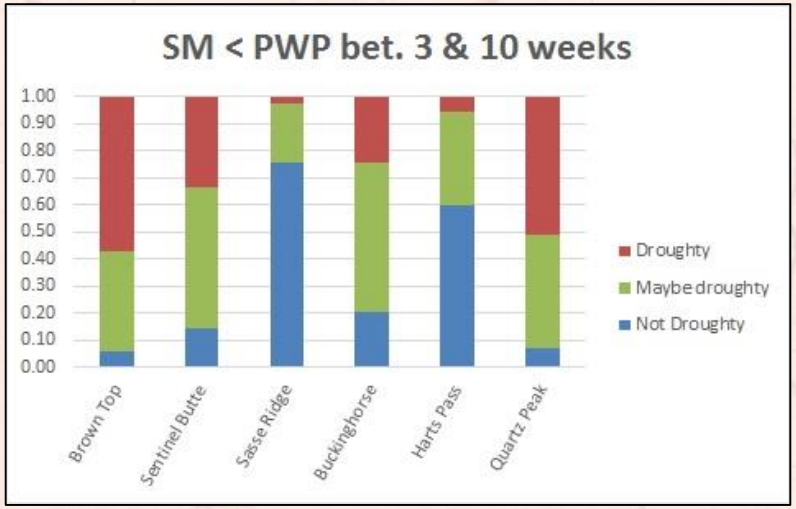
- Outcome of ordered logistic regression is a set of equations which are solved for the probabilities:
  - $p1 + p2 + p3 = 1$
  - $\log(p1/(p2+p3)) = \alpha_1 + \beta_1 * x1 + \beta_2 * x2 + \beta_3 * x3$
  - $\log((p1+p2)/p3) = \alpha2 + \beta_1 * x1 + \beta_2 * x2 + \beta_3 * x3$

  where x1 = AWS; x2 = AET/PET; x3 = soil depth

Modeled SM Drought Classes







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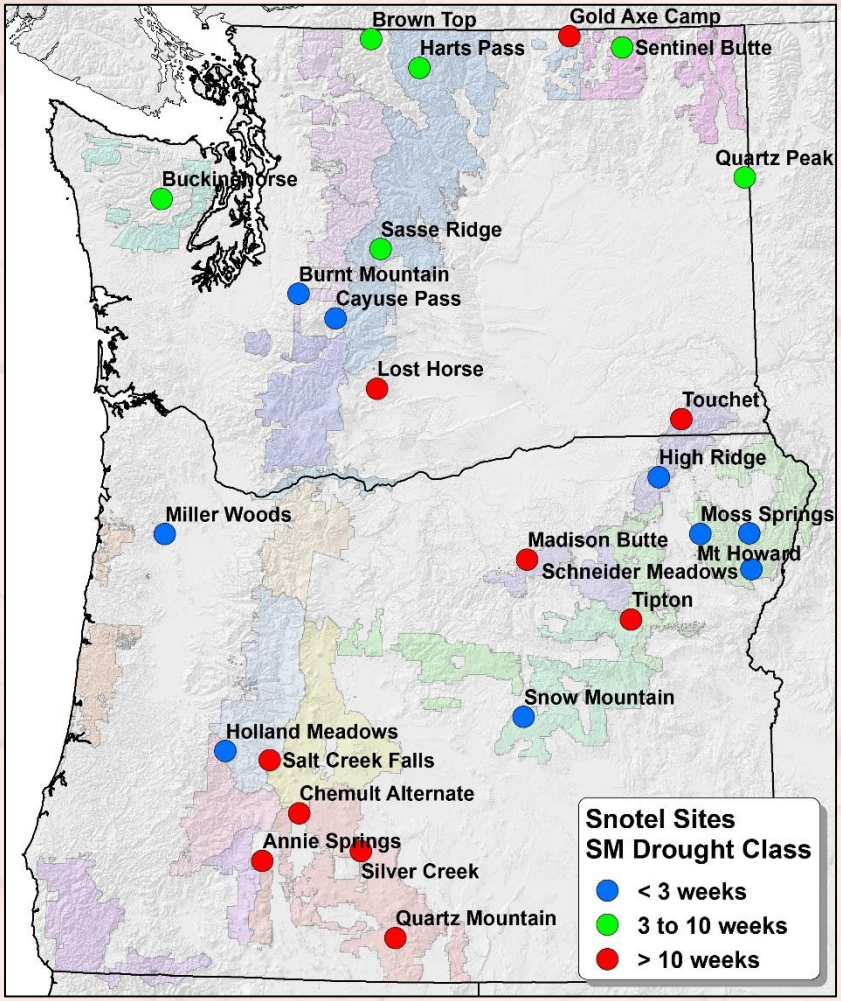
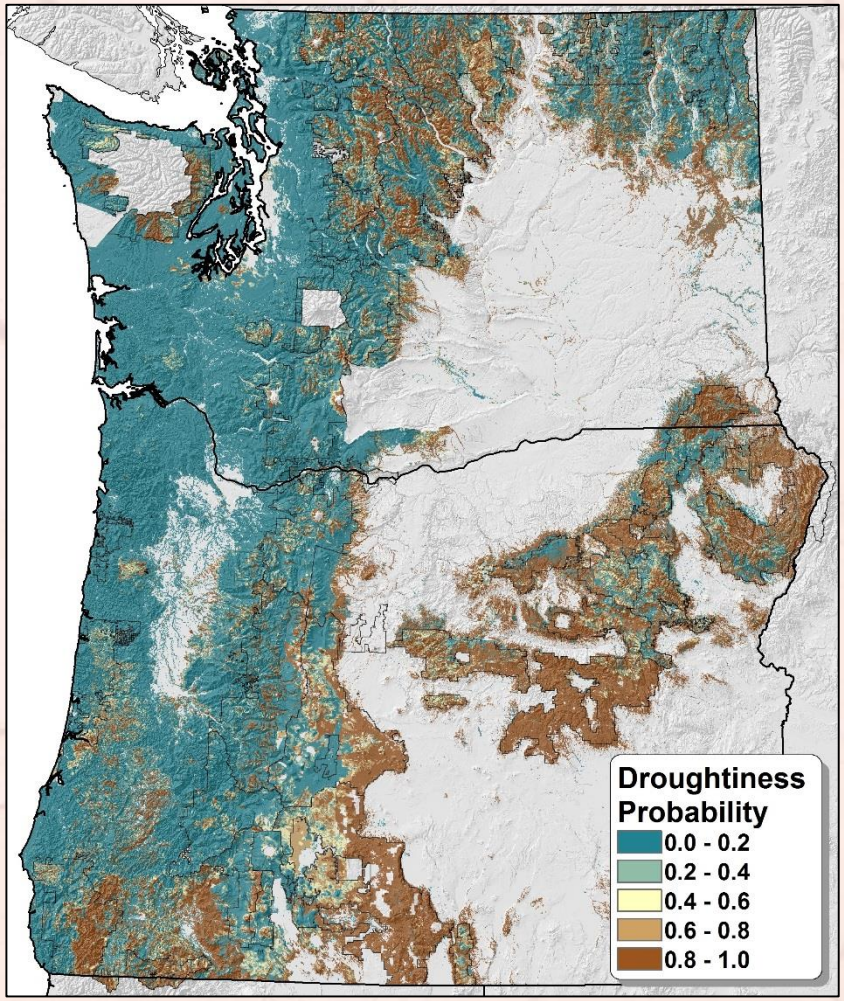




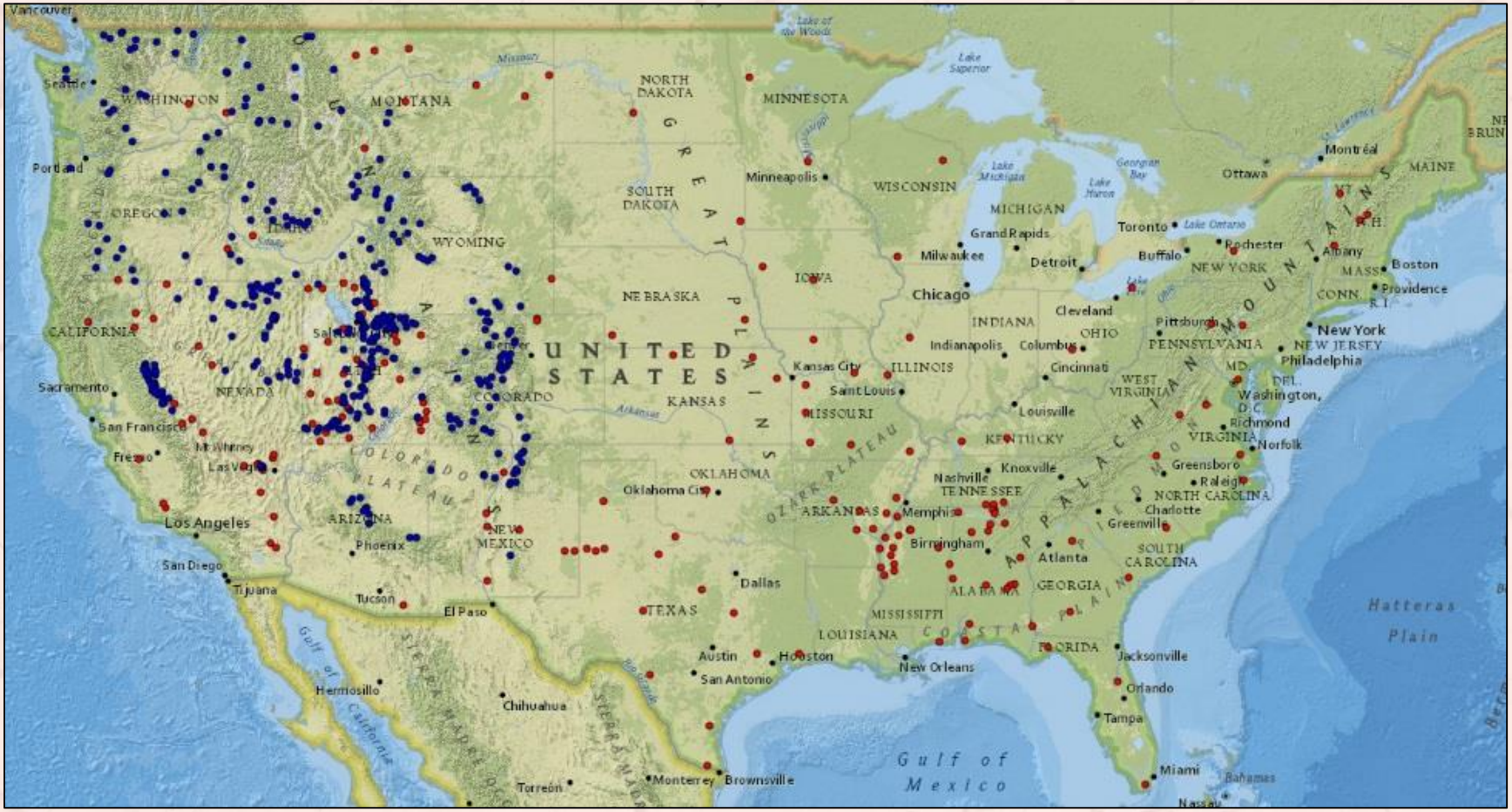
Obvious problems/questions

- Evapotranspiration data
  - Very coarse dataset -- global scale
  - It's a modeled dataset – feeding models into models
  - ET is difficult to measure
- Soils data
  - Flaky soil moisture sensors; max depth 100cm
  - Soils generally described only to 150cm depth
  - Concepts developed mainly for agriculture
  - Problematic pumice

Include topographic position and elevation

Could use finer-resolution canopy cover

650+ SNOTEL & SCAN Sites



Possible application to fire risk

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Soil data may improve assessments of wildfire risk

December 04, 2015
By Madeline Fisher

Wildfire is known to have a dramatic impact on soil, but do soil conditions also affect wildfire? A new study says yes, and the finding could lead to better predictions of wildfire danger.

The open access paper, which appears in the November–December 2015 issue of *Soil Science Society of America Journal*, addressed a simple but understudied question, says Oklahoma State University (OSU) soil scientist and lead author, Erik Krueger: Is soil moisture related to wildfire? When the scientists crunched the numbers, they found that 91% of Oklahoma's largest fires during the growing season broke out only when soil moisture dropped below levels that cause plants severe stress.

The link between fire and soil moisture may seem obvious, says Krueger, who led the study with Tyson Ochsner, an OSU soil physicist. But to the team's knowledge, a direct connection hasn't been made until now because the soil moisture data "just weren't there to do it."

What made this study possible was a comprehensive, soil moisture monitoring network, known as the Oklahoma Mesonet, along with a wildfire dataset compiled by the Oklahoma State Fire Marshal's Office.

Now that the relationship has been established, wildfire scientists can test whether soil moisture data improve fire risk assessments in Oklahoma, where thousands of wildfires erupt each year.

The new information should be especially valuable during the growing season, when the water held inside living vegetation makes it harder to

A wildfire blazes north of Stillwater, OK, in April 2009. New research suggests that soil moisture data may improve assessments of wildfire danger, especially during the growing season. Photo courtesy of Oklahoma State University Agricultural Communications Services.

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Group at OSU found strong relationship between low soil moisture and wildfire size during growing season

Possible application to fire risk

Table Mt Complex – Before

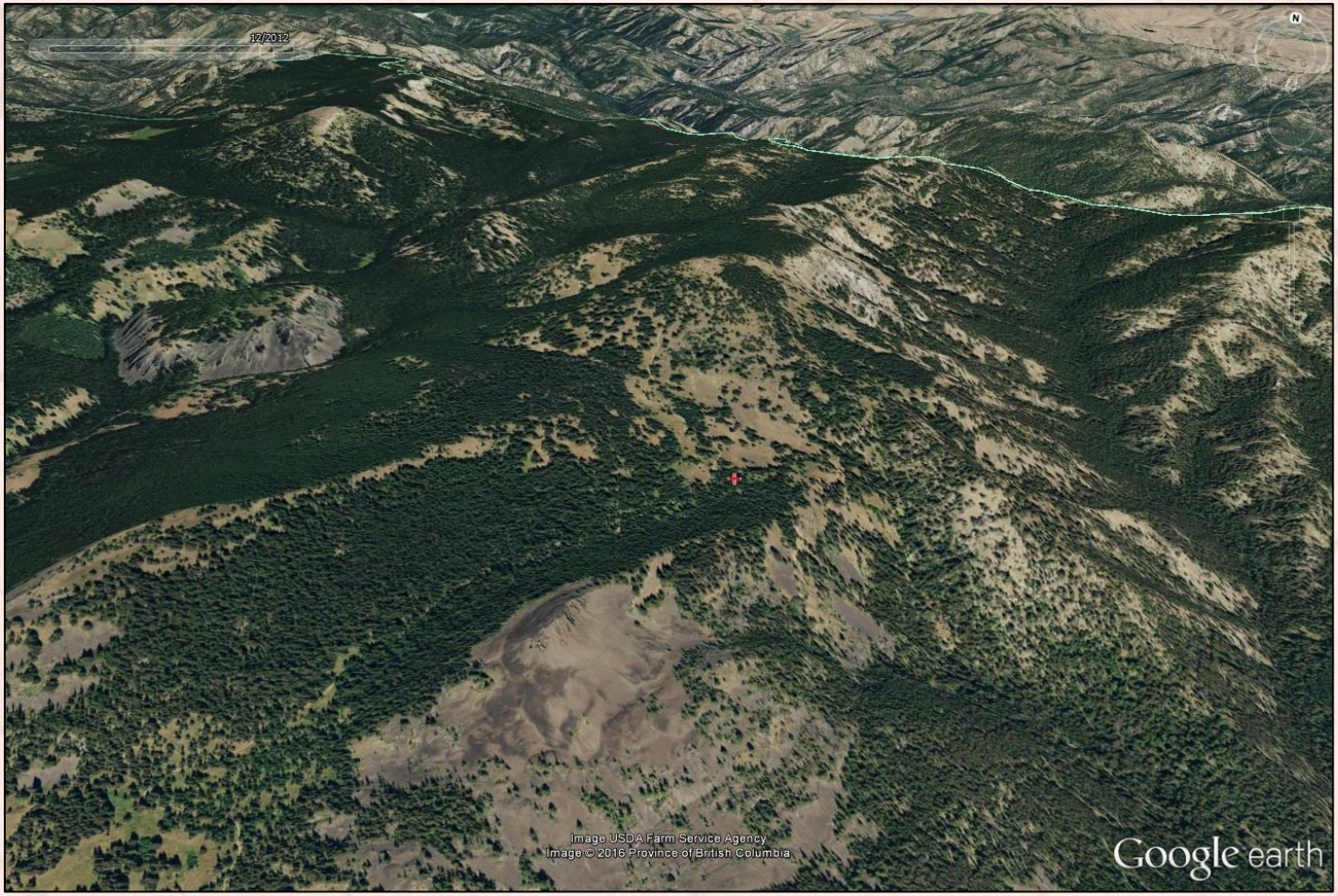


Table Mt Complex – After

Grouse Camp Soil Moisture

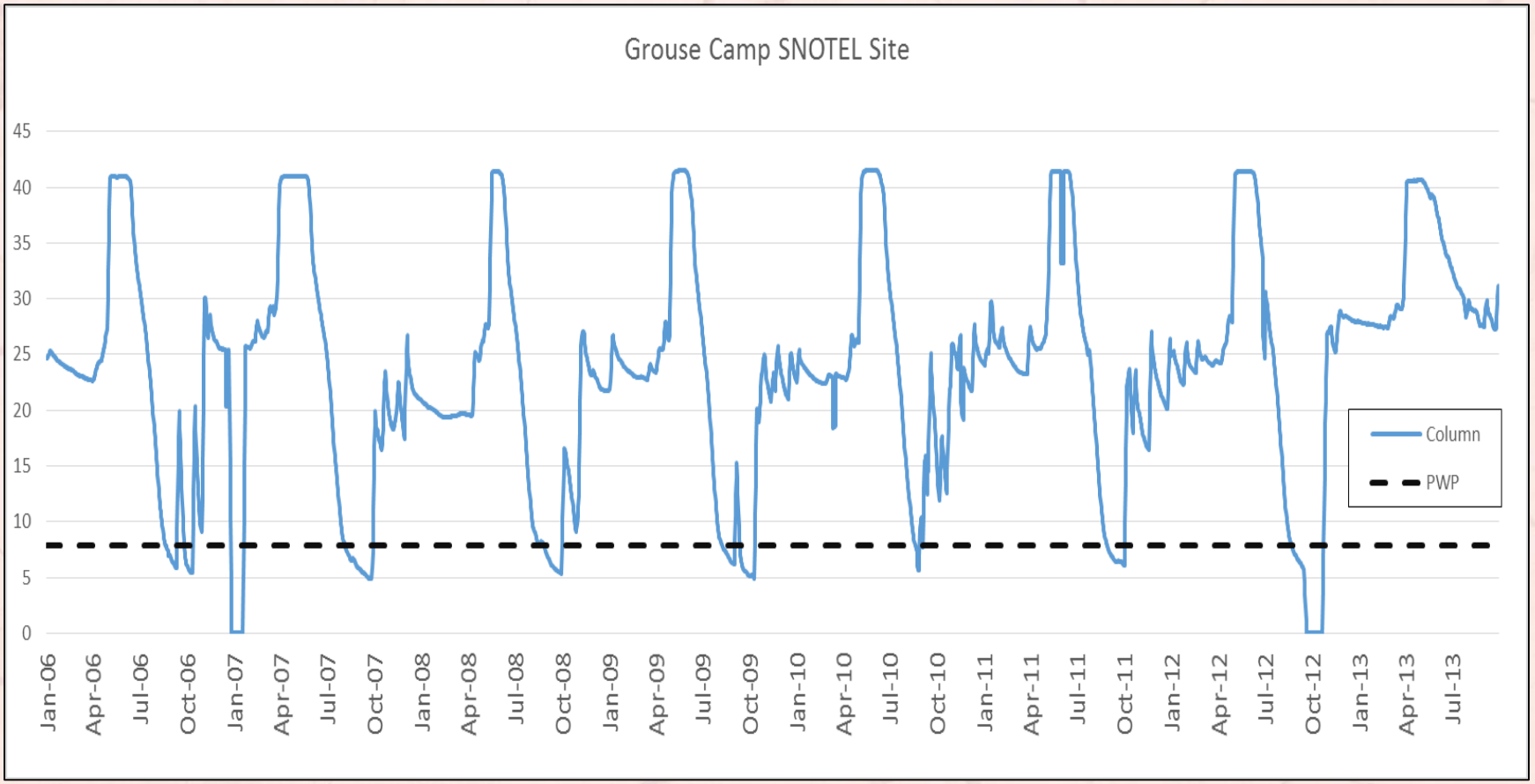
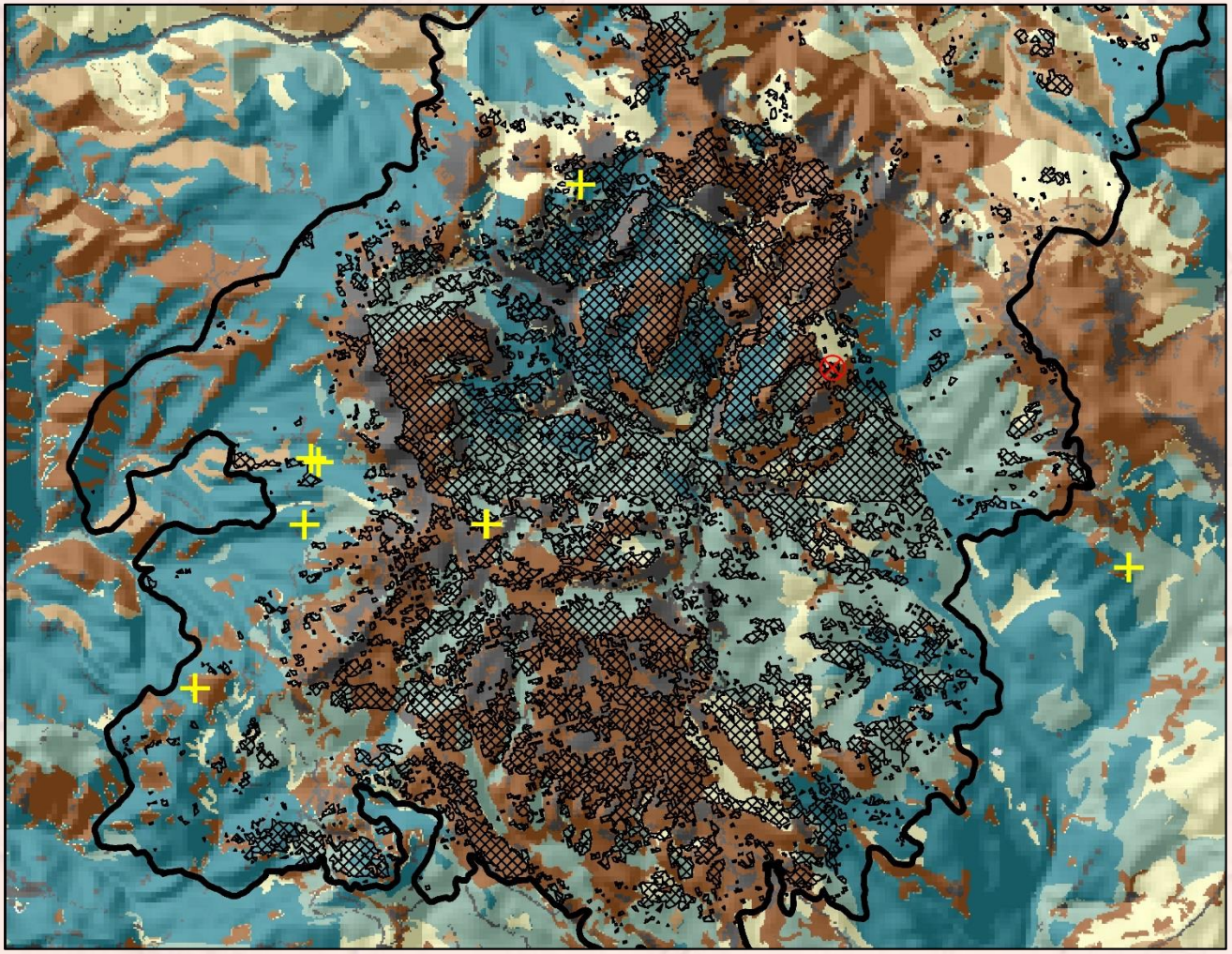
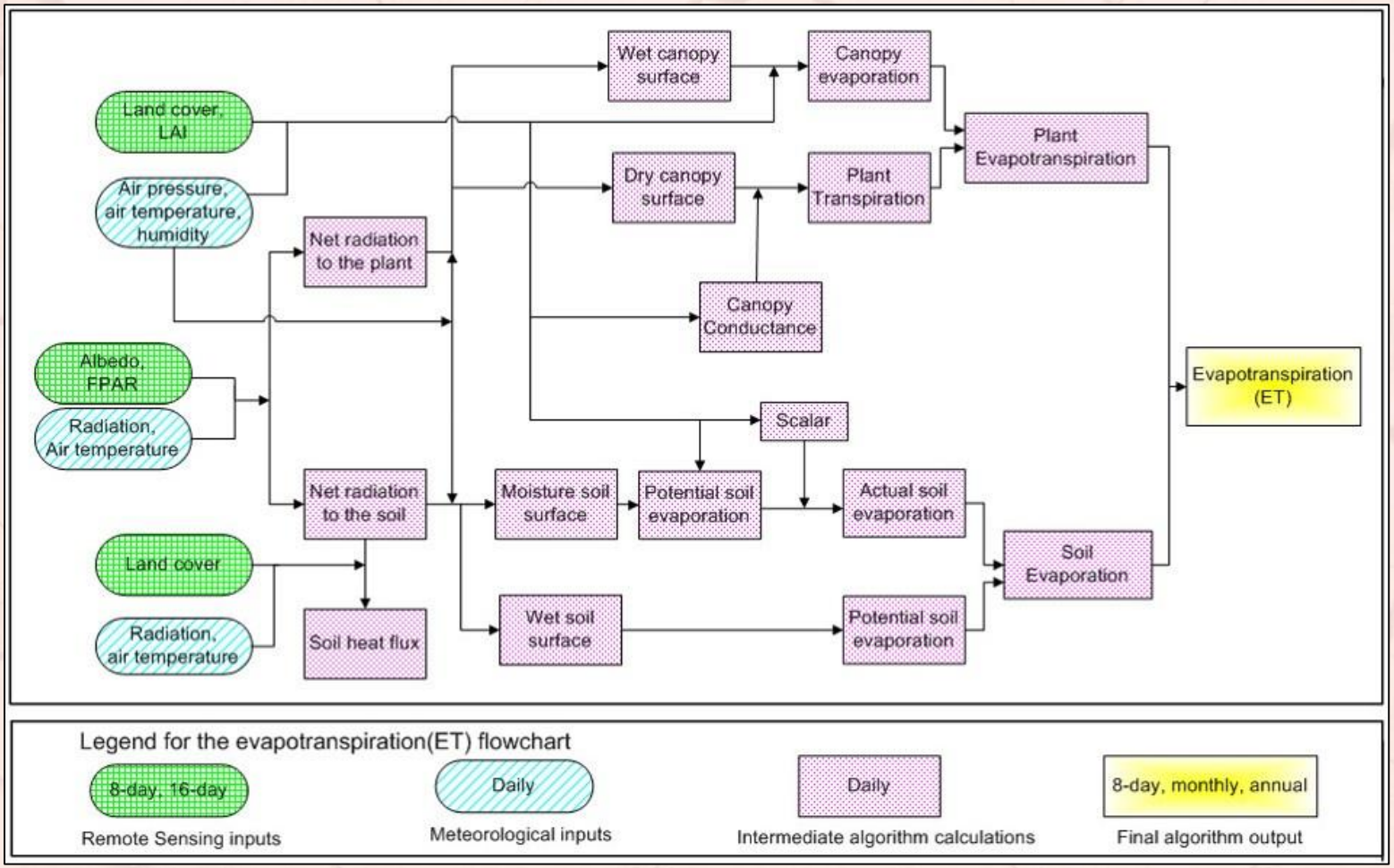


Table Mt Complex



Questions?

ET Model Algorithm



SNOTEL Elevation Bias