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Potter County

Pennsylvania Soil Climate Atlas

W.J. Waltman

Northeast Soil Survey Conference

June 8th, 2010



Snap Beans



Potatoes



Dairy



Carrots

💧 **Rotations and Soils**

💧 **Tillage and
Pesticide Behavior**

💧 **Winter Cover Crops**

💧 **Alternative Crops**

💧 **Narrow growing
season windows and
greater complexity of
agronomic systems**



Oilseed Radish



Cover Crops



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The Triple Divide

Near Sweden Hill at 2500 ft

☼ Potter County is home to the only Triple Divide in the Northeast

☼ Headwaters of the Susquehanna, Genesee, and Allegheny Rivers

☼ The Triple Divide is part of the Late Wisconsin glacial border

☼ Cold climate agriculture





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Growing Environments 1971 to 2000 Normals

Regional Climate Comparisons of Selected Weather Stations with 30 yr normals

	Elev (ft)	MAAT (°F)	MAP (in)	GDDs (hu)	FFP-32 (d)	FFP-28 (d)	TME (°F)
Coudersport 4NW	1650	44.3	41.98	2026	122	149	-14.5
Bradford 4SW	1692	44.5	46.75	1923	116	146	-17.2
Bradford Reg AP	2117	44.3	46.55	1850	108	138	-17.3
Clermont 8SW	1620	45.4	48.18	1996	88	114	-21.5
Emporium	1040	47.6	41.82	2421	146	169	-12.2
Kane 1NNE	1750	43.1	46.51	1758	101	130	-19.3
Ridgway	1360	45.6	43.40	2025	126	154	-15.0
Stevenson Dam	932	47.7	42.32	2483	154	177	- 9.4
Towanda 1SW	760	48.0	34.55	2460	156	182	-10.8
Wellsboro 4SW	1818	44.9	33.43	1873	138	159	-11.0

Comparisons of Selected Weather Stations with Short & Variable Records

Cowanessque Dam	1150	46.9	37.84	2377	142	168	-10.6
Oswayo 1 ENE	1710	44.7	43.93	1964	118	148	- 9.7*
Port Allegany	1475	47.1	36.56	2194	138	171	-11.0
Tioga Hammond Dam	1230	46.1	41.06	2301	144	168	-6.5*



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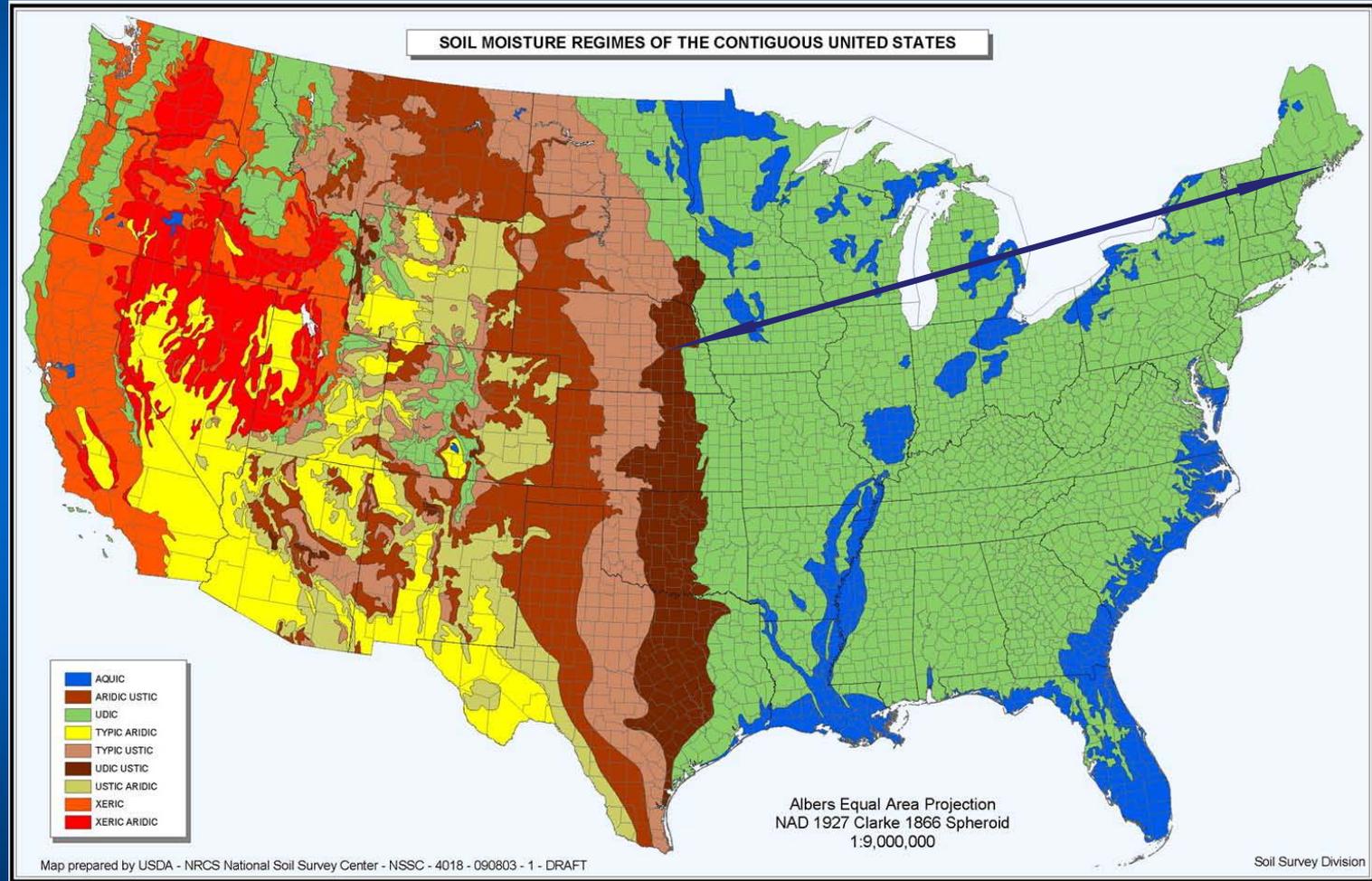
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Soil Moisture Regimes

☹ The Udic region is rather homogeneous and massive, extending from Lincoln to Acadia

☹ No Perudic in the Northeast

☹ No inter-grades or transitions of Udic moisture regimes into Perudic; often just handled as high precipitation phases



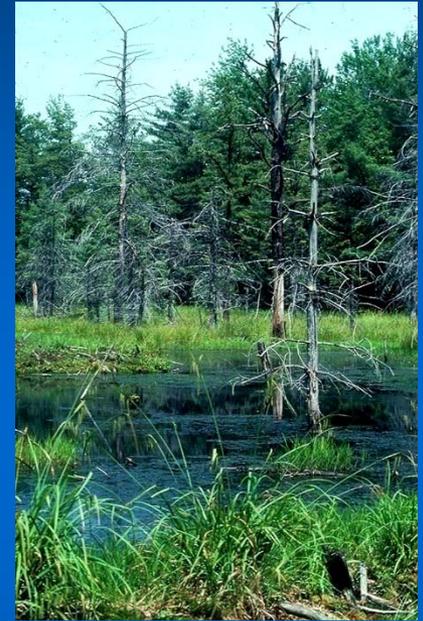


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The Udic Soil Moisture Regime— Some Observations

☀ *Soil Taxonomy* doesn't provide as many distinctions on the “wet-end” of SMR; in the Northeast, there are Udic rainshadows and high elevation near-perudic environments; maritime Udic with a higher frequency of degraded hurricanes and tropical storms; Udic environments with orographic effects and Udic environments with higher drought frequency; lake-effect Udic environments along the Great Lakes, Champlain Valley, and Finger Lakes; continental Udic of the eastern Great Plains





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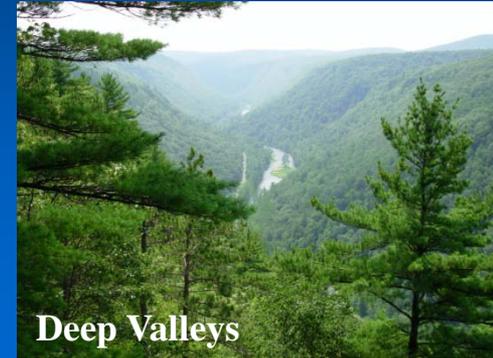
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Near-Perudic Environments in the Appalachians

☀ Perudic—In each month $PREC > PET$; no significant dry period in the soil moisture control section; observed in PA, WV, MD, VA, NY, NH, VT, ME(?), and Quebec

☀ If June ($prec > pet$), July ($prec > pet$), and Aug ($prec > pet$) have no summer deficit, then it is Perudic; if one month fails it is Udic; near-perudic may fail this definition and still have a positive SWB

☀ Gradations from Udic to Perudic environments that *Soil Taxonomy* doesn't recognize; associated with over-thickened A-horizons, umbric epipedons, windthrow of trees (pit and mound microrelief); occurrence of bogs and swamps



Deep Valleys



Low ET & solar radiation



Cold air drainage



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The Two Major Distinctions of the Udic Soil Moisture Regime

💧 Udic environments in “Rainshadows”—
Great Valley, Finger Lakes, Tioga River
Valley, and Central Susquehanna Valley;
higher frequency of drought events

💧 Near-perudic environments at high
elevations in the Appalachians;
orographic processes, MAP is often >50
in; $PREC > PET$ fails only in one or two
of the growing season months, but the
summer water balance is marginally
positive



Plain Sects



Rainshadows



High Plateau Udic = Ridge &
Valley Udic



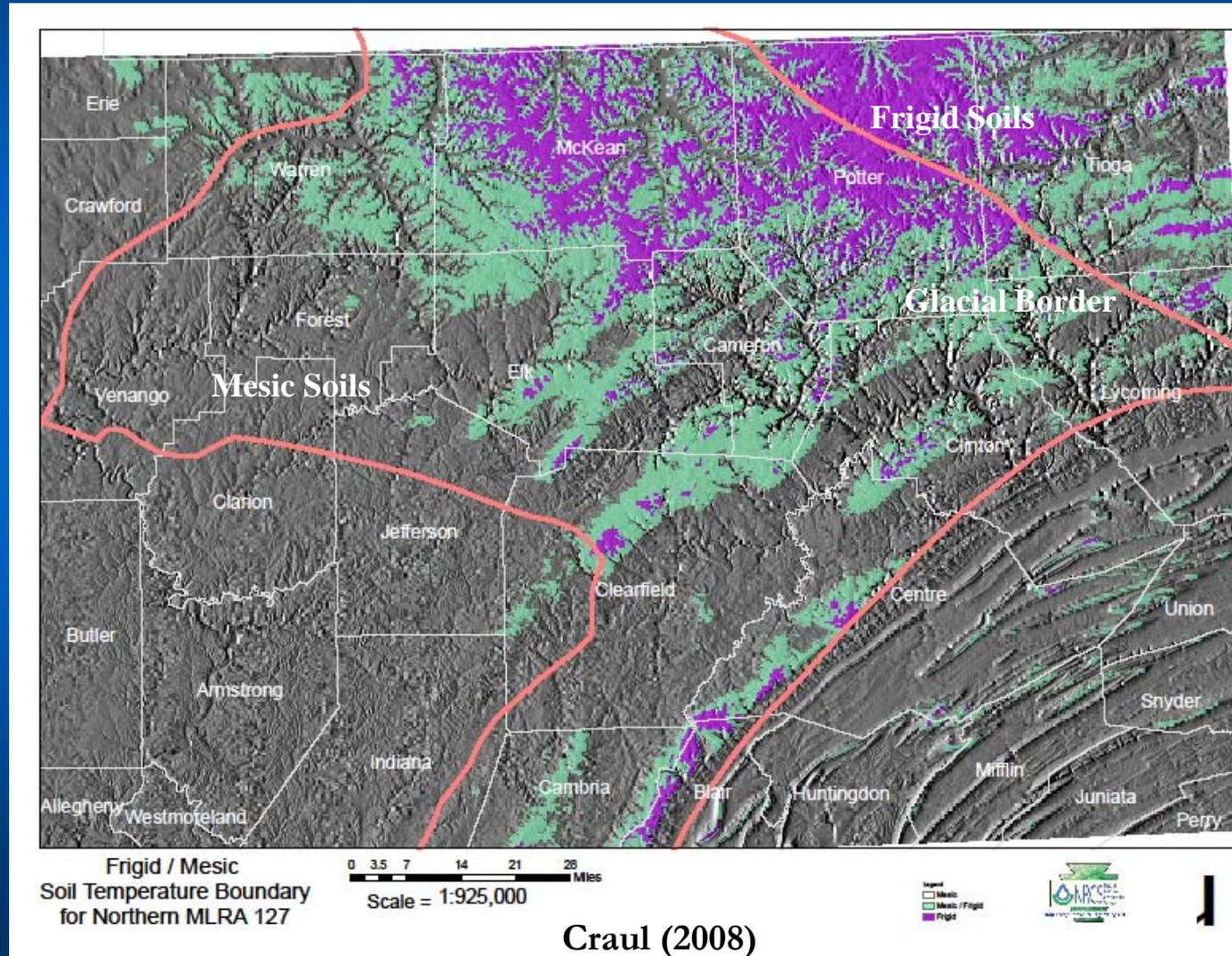
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Agronomic Interpretations Soil Temperature Regimes

💧 Its all about soil biological windows; growing degree-days in September & October, frost-free period, and evapotranspiration

💧 Winter cover crops and no-till might best be adapted to the rainshadow areas of the Allegheny River, Oswayo Creek, Potato Creek, Cowanesque River, Tioga River, & Susquehanna River watersheds





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Rainshadows

☔ Just like the Rocky Mts and the Great Plains

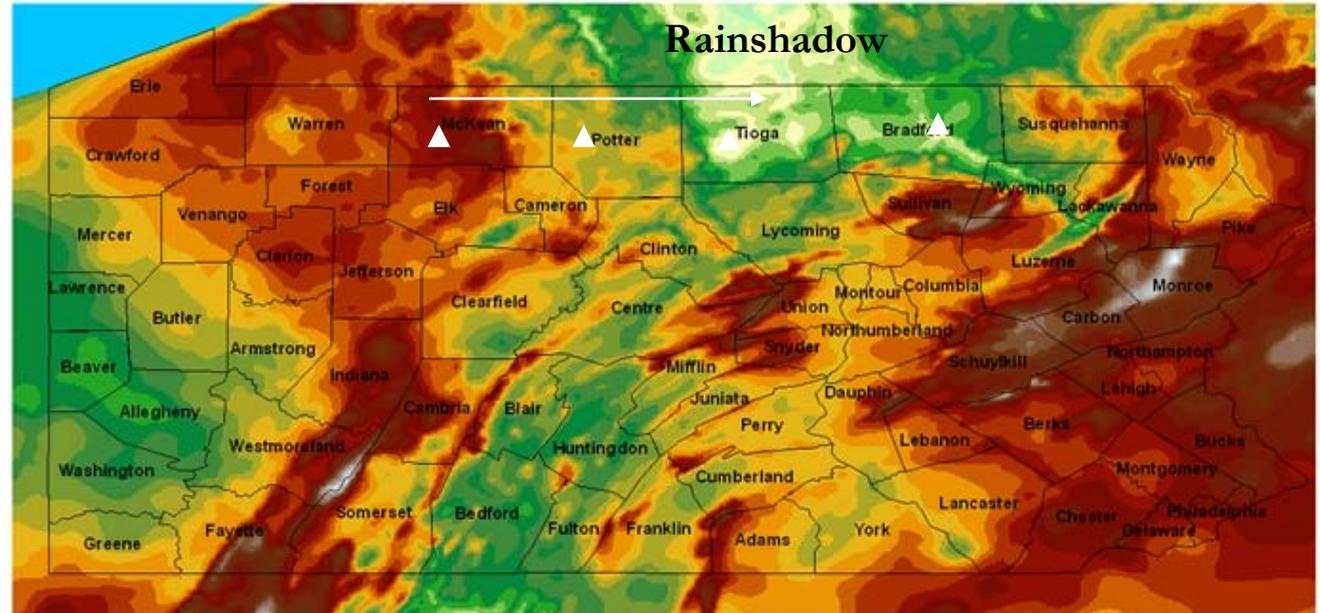
☔ 46-48 in of PREC in McKean County

☔ Covington 2 WSW received 34.96 in;
Wellsboro 4 SW received 33.43 in;
Towanda 1 ESE received 34.55 in

☔ 13-15 in difference in rainfall from Bradford AP to Wellsboro

☔ Are rainshadows important to the agroecology?

**Pennsylvania
30 Year (1971-2000)
Mean Annual Precipitation (inches)**



Annual Precipitation (Inches)	36.1 - 37	37.1 - 38	38.1 - 39	39.1 - 40	40.1 - 41	41.1 - 42	42.1 - 43	43.1 - 44	44.1 - 45	45.1 - 46	46.1 - 47	47.1 - 48	48.1 - 49	49.1 - 50	50.1 - 51	51.1 - 52	52.1 - 53	53.1 - 54	54.1 - 55	55.1 - 56	56.1 - 57	57.1 - 58	58.1 - 59	59.1 - 60					
31.4	31.5 - 32	32.1 - 33	33.1 - 34	34.1 - 35	35.1 - 36	36.1 - 37	37.1 - 38	38.1 - 39	39.1 - 40	40.1 - 41	41.1 - 42	42.1 - 43	43.1 - 44	44.1 - 45	45.1 - 46	46.1 - 47	47.1 - 48	48.1 - 49	49.1 - 50	50.1 - 51	51.1 - 52	52.1 - 53	53.1 - 54	54.1 - 55	55.1 - 56	56.1 - 57	57.1 - 58	58.1 - 59	59.1 - 60



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In the Rainshadow



Howard soils

**Cowanesque
River Valley**

☀️ **Grow corn for
grain, alfalfa, and
soybeans**

- ☀️ **Carbonate cemented C-horizons**
- ☀️ **Shallower depths to free carbonates**
- ☀️ **Drier, warmer soils, suitable for no-till?**



Glacial Outwash Valleys



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Soil Water Balances

💧 Differences in summer water balance and drying cycles; note the difference in the recharge (R) period

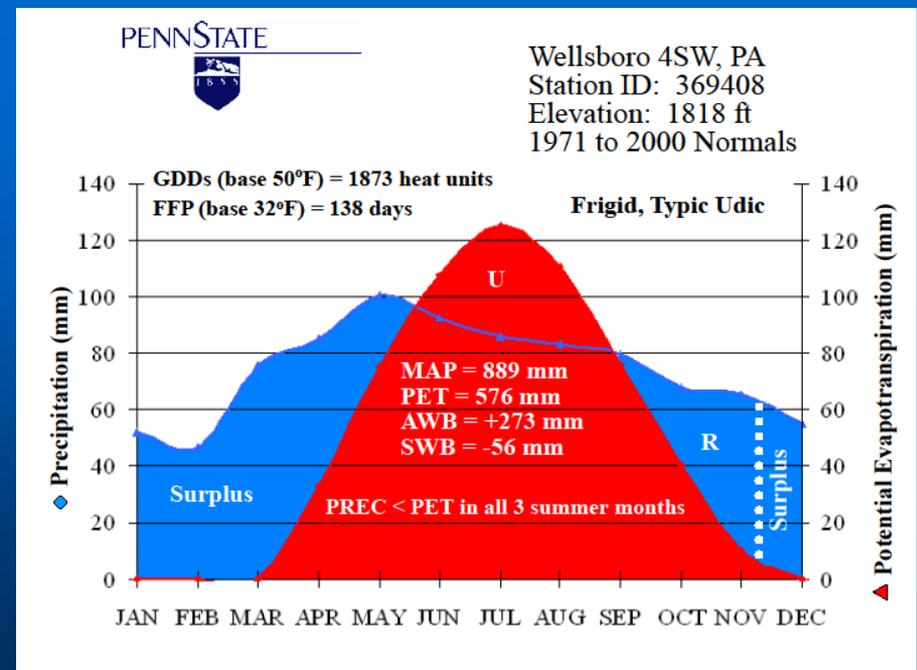
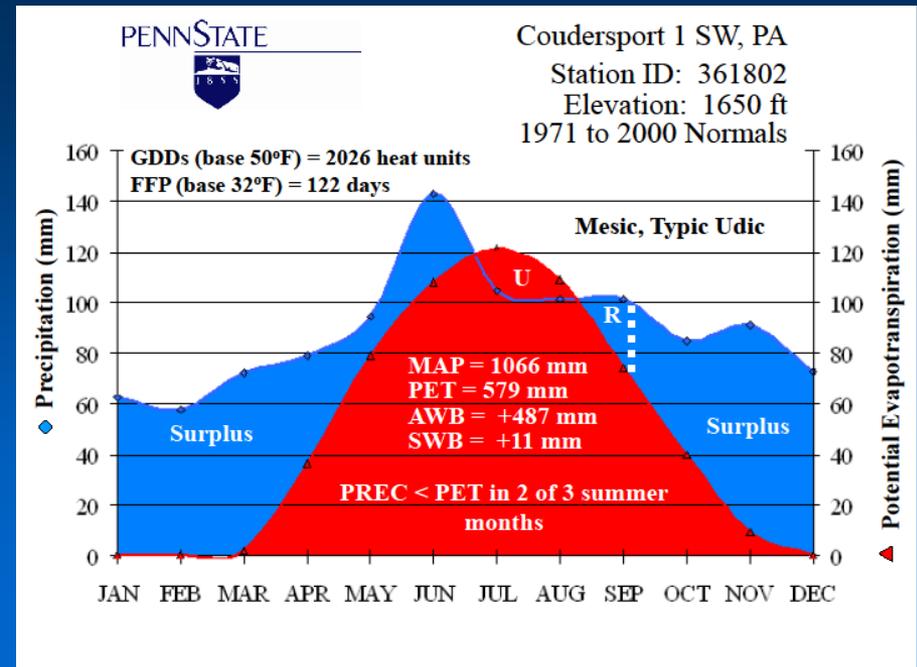
💧 Note the size of the “U” (Utilization = plant extraction of soil water)

💧 $AWB = \text{Total PREC} - \text{Total PET}$; nearly 214 mm (>8 in) difference

💧 $SWB = \text{Summer Water Balance}$ ($\text{Total PREC} - \text{Total PET}$)_{jjj}

💧 Takes much longer into the fall to recharge the stored soil moisture

💧 Better opportunities in the fall to plant winter cover crops?





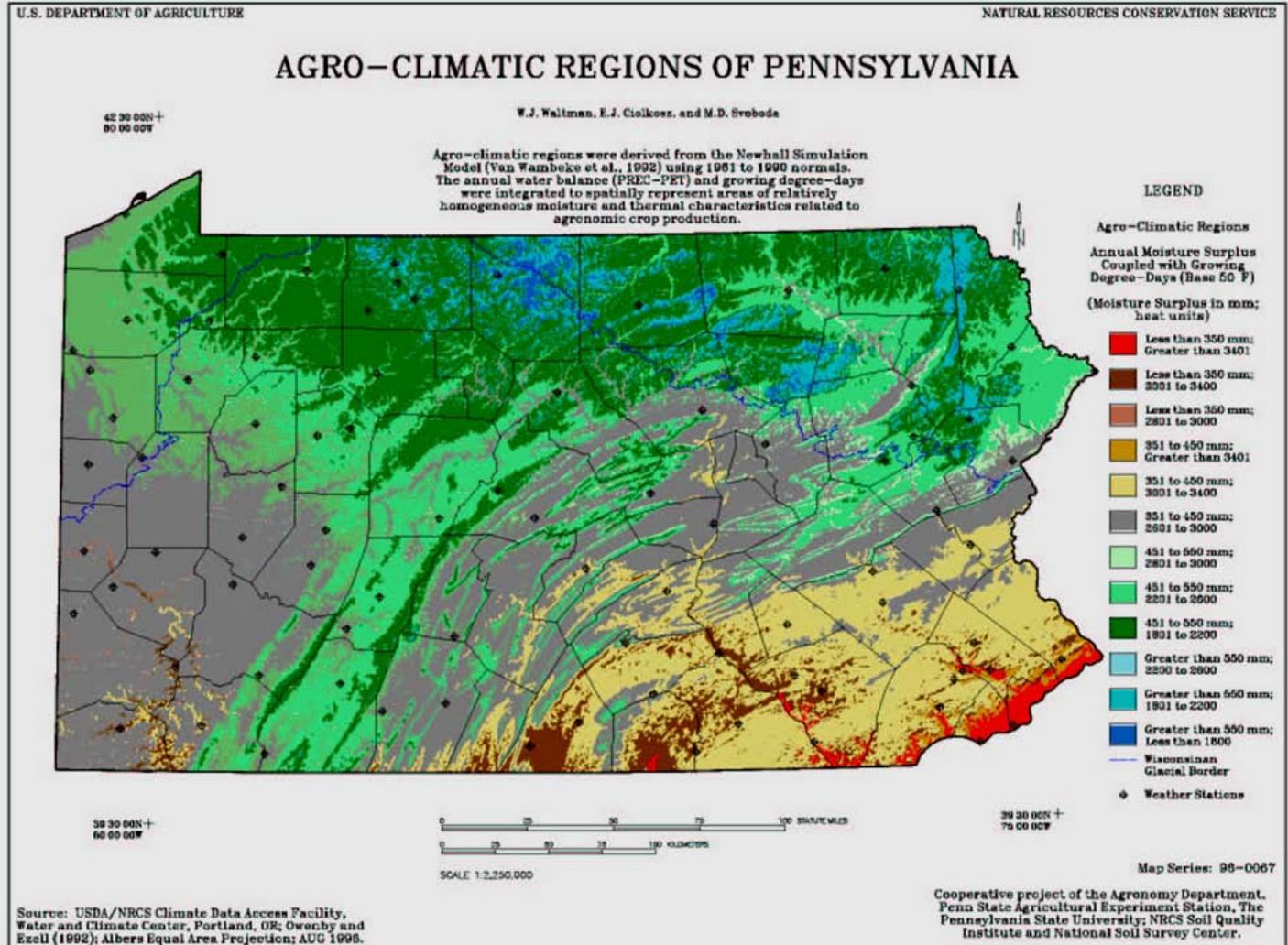
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Soils and Climate in Pennsylvania

☔ Pennsylvania is often viewed as having one or two soil climate regimes; Udic Mesic or Udic Frigid

☔ Coupled parameters—AWB & GDDs

☔ Cold climate agriculture in Potter County; the *Agronomy Guide* doesn't recognize the characteristics of these high elevation growing regions





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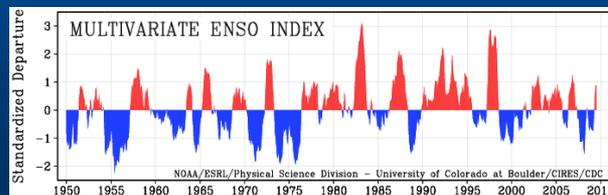
Normal Years

Keys to Soil Taxonomy (2010)

💧 A normal year is defined as a year that has:

1. Annual precipitation that is plus or minus one standard deviation of the long-term (30 yrs or more) mean annual precipitation; *and*
2. Mean monthly precipitation that is plus or minus one standard deviation of the long-term monthly precipitation for 8 of the 12 months.

Are “Normal Years” needed any longer in Soil Taxonomy? Isn’t soil climate a continuum of episodes, cycles, and oscillations over time? Perhaps the tails of the frequencies are just as important as the dominant condition.



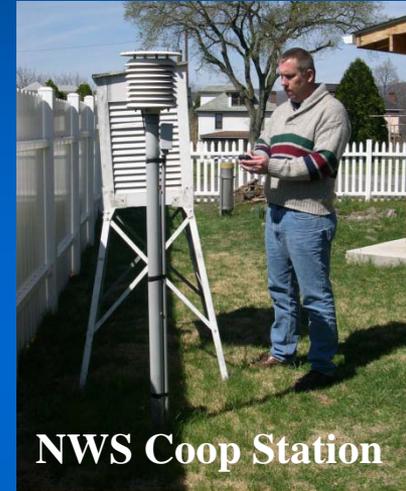


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Normal Years Keys to Taxonomy (2010)

Some Thoughts About Normal Years

- ☀️ Precipitation data are not normally distributed
- ☀️ All weather stations fall within one dominant climate; formerly “6 out of 10 years”; none are polyclimatic; what about soil landscapes on an ecotone or MLRA boundary?
- ☀️ Its all about total monthly precipitation; not temperature, evapotranspiration, and the water balance; no thermal dimension?
- ☀️ Excluding droughts and hurricane/subtropical storm events from the weather record; excluding ENSO signatures; the tails can yield significant differentiating characteristics



NWS Coop Station



Cherry Springs

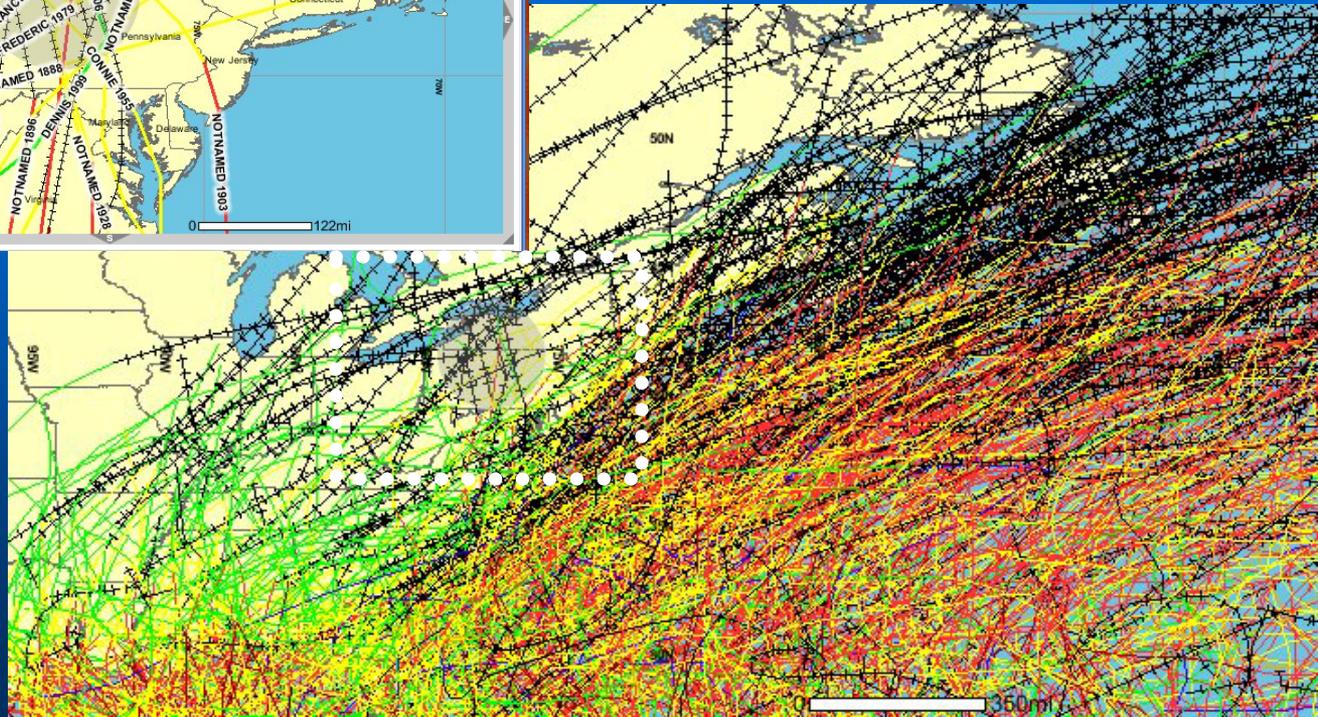
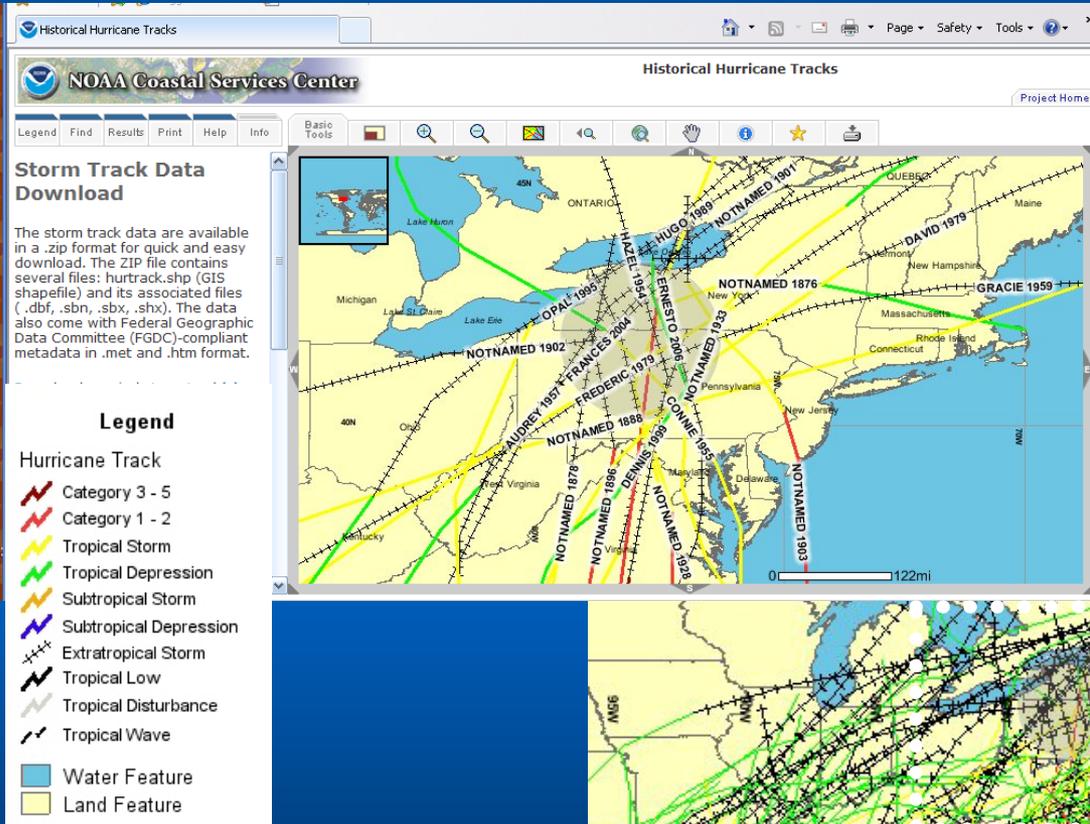


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Normal Years Keys to Taxonomy (2010)

☯ Storm tracks over the past 150 yrs in the Northeast; Udic soil moisture regimes with a high incidence of landfall and those landscapes with very few events

☯ Should we exclude these events in the normal years concept?

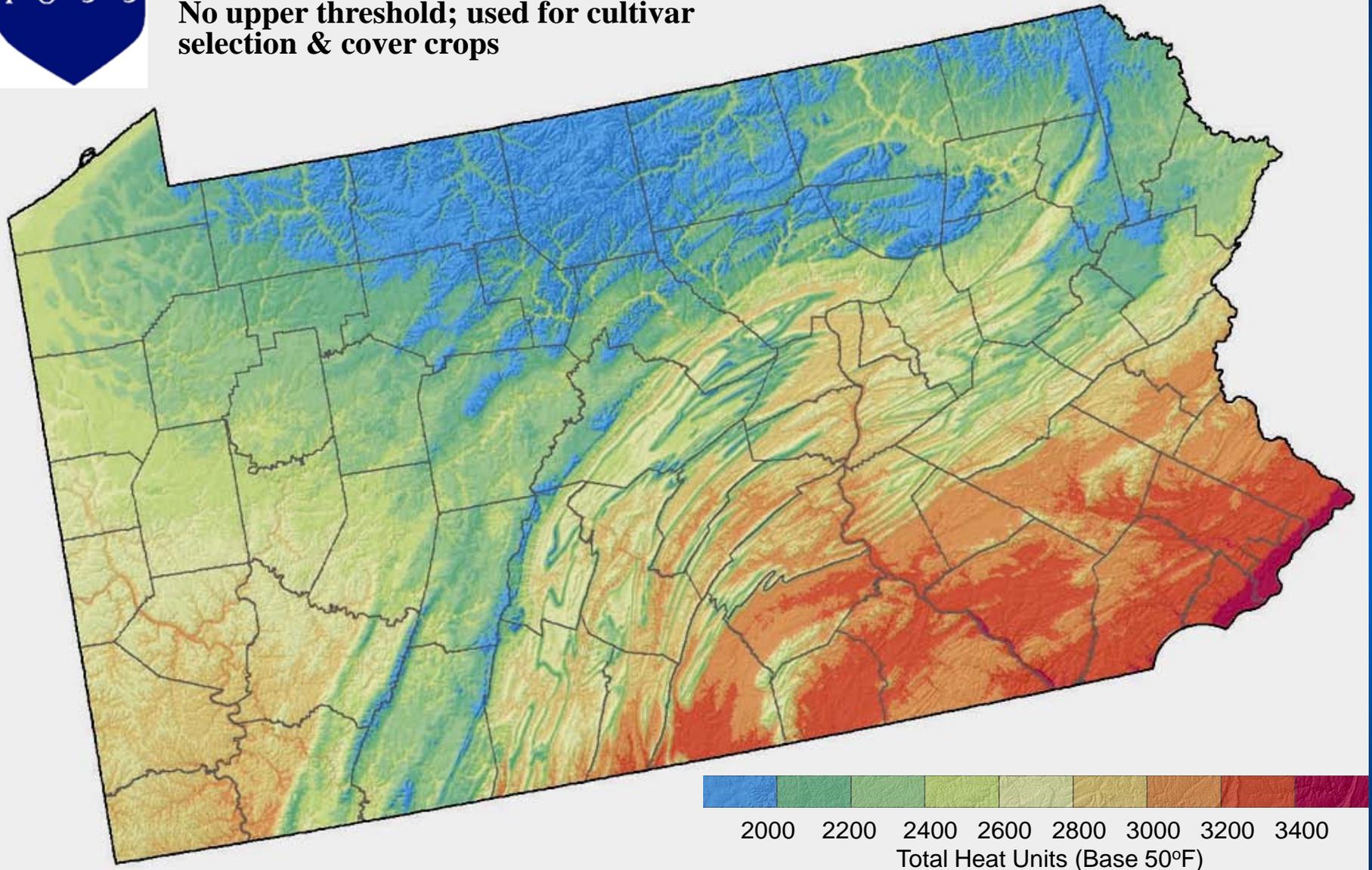


☯ Udic extends from Long Island to eastern Nebraska



Growing Degree-Days (Base 50°F)

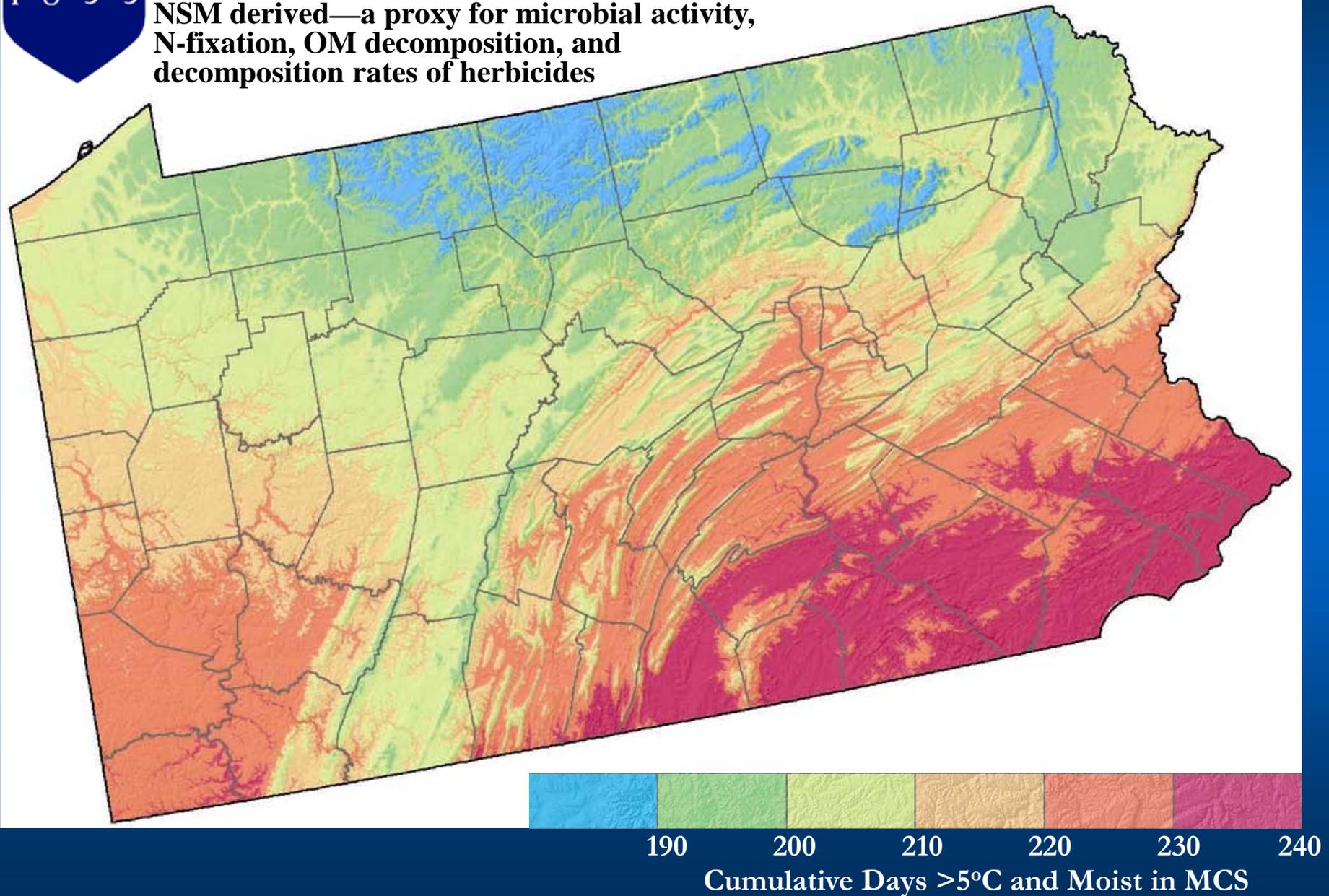
No upper threshold; used for cultivar selection & cover crops





Biological Windows (at 5°F)

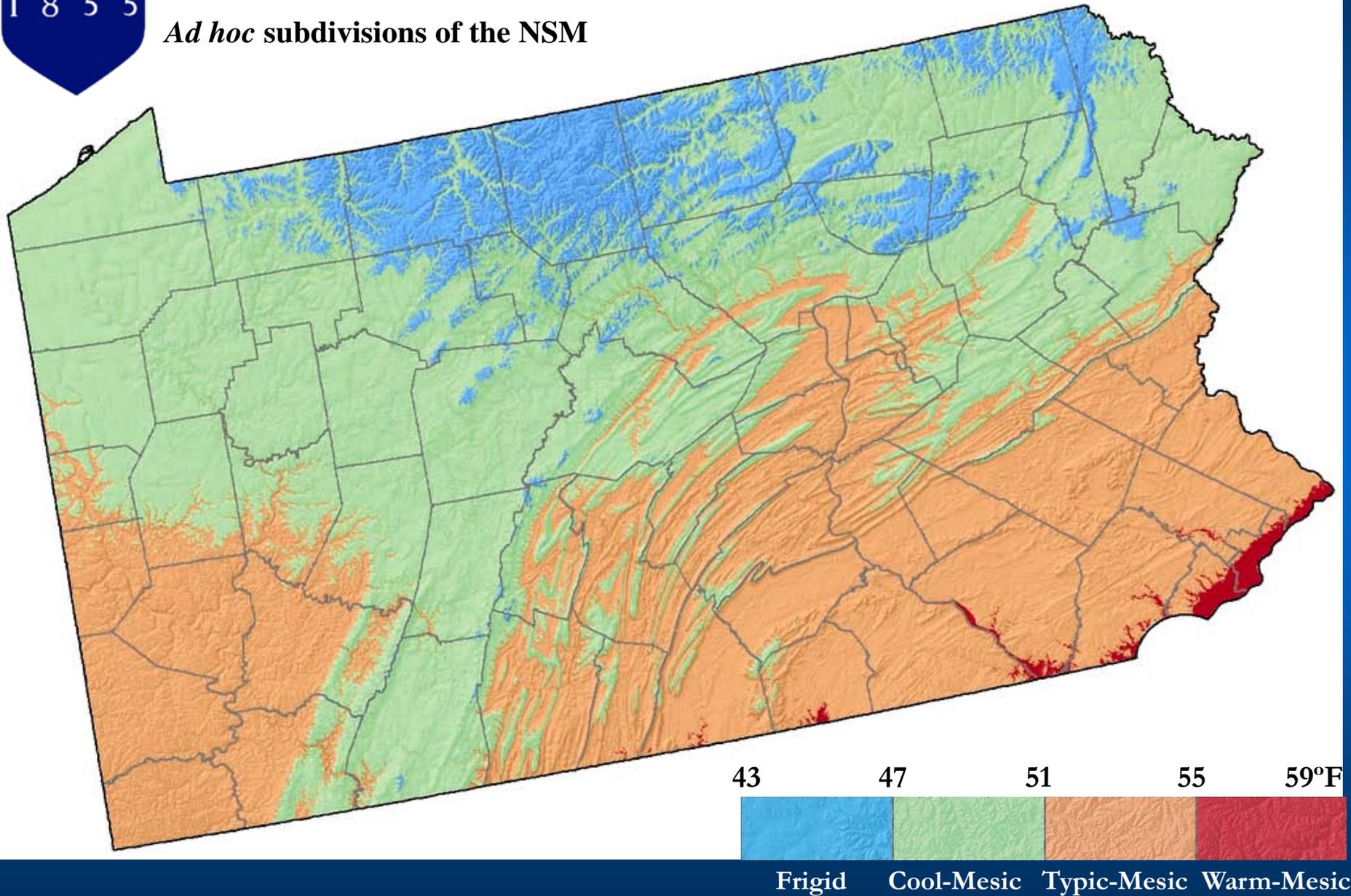
**NSM derived—a proxy for microbial activity,
N-fixation, OM decomposition, and
decomposition rates of herbicides**





Soil Temperature Regimes

Ad hoc subdivisions of the NSM



Frigid Cool-Mesic Typic-Mesic Warm-Mesic

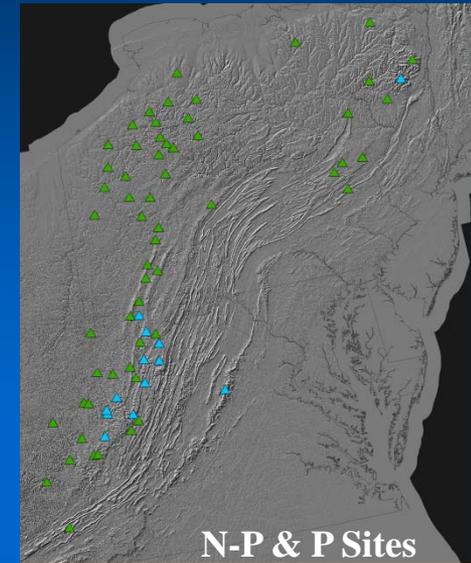


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Concluding Thoughts

- ☀ We have Udic soil moisture regimes in rainshadows and on high elevation plateaus which translate into different agronomic behaviors, ecological communities, and soil interpretations
- ☀ Microclimates to Mesoclimates—some soil landscapes are inherently frost-pockets; soil climates & landscapes have signatures (ENSO, NAO, rainshadows & high plateaus)
- ☀ The “normal years” concept has outlived its usefulness; look at full climate records; the tails often tell good stories and reveal signatures
- ☀ Near-perudic and perudic environments should be recognized in the Appalachians & Northeast





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Concluding Thoughts

🔹 **Based upon NSM runs on 1971-2000 normals, 18 stations in the Northeast were projected as perudic; Mt. Washington, NH, shows the strongest perudic character**

Station Name	Elev	MAP	PET	AWB	SWB	NSM-SMR	NSM-STR
Northeast Stations	(ft)	(mm)	(mm)	(mm)	(mm)		
MOUNT WASHINGTON, NH	6262	2589	357.2	2232	352.8	Perudic	Pergelic
MOUNT MANSFIELD, VT	3950	2002	447.5	1555	268.1	Perudic	Cryic
JAY PEAK, VT	1875	1603	512.5	1091	136.5	Perudic	Cryic
SLIDE MOUNTAIN, NY	2650	1616	525.1	1091	77.9	Perudic	Cryic
BIG MEADOWS, VA	3540	1394	583.2	811	39.1	Perudic	Mesic
Southern Appalachian Stations							
MT LECONTE, TN	6493	2065	503.0	1562	333.4	Perudic	Cryic
BLOWING ROCK 1NW, NC	3850	1726	618.9	1107	128.7	Perudic	Mesic
GRANDFATHER Mt., NC	5300	1594	544.5	1050	140.4	Perudic	Mesic
MOUNT MITCHELL, NC	6240	1892	523.3	1369	213.4	Perudic	Mesic
PISGAH FOREST 1N, NC	2110	1647	703.2	944	42.8	Perudic	Mesic
LAKE TOXAWAY 2SW, NC	3080	2428	691.5	1737	340.6	Perudic	Mesic



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A Rationale for Subdivisions of the Udic Soil Moisture Regime

- ☀ Refining the Udic/Perudic Boundary in the Northeast
- ☀ Recognition of Near-Perudic Subclasses



Dry Udic	Typic Udic	Wet Udic	Weak Perudic	Typic Perudic
No Perudic years; Ustic years occur as drought events, >15% of record Ustic or drier; but not dominant	No Perudic years; <15% Ustic or drier years	Perudic years occur; <10% of record; no years that classify as Ustic	Perudic years 10-40%	Perudic years in >40%
AWB < 175 mm SWB > -175 mm	AWB 175 to 450 mm SWB -25 to -175 mm	AWB 451 to 650 mm SWB -25 to +25 mm MAP 1150 to 1250 mm	AWB >650 mm SWB 0 to 50 mm MAP 1250 to 1500 mm	AWB >650 mm SWB >+50 mm MAP >1500 mm
	Fails PREC>PET in all three summer months	Fails PREC>PET in two growing season months	Fails PREC>PET in one growing season month	Meets PREC>PET in all growing season months

Growing Season Months = Apr to Sept

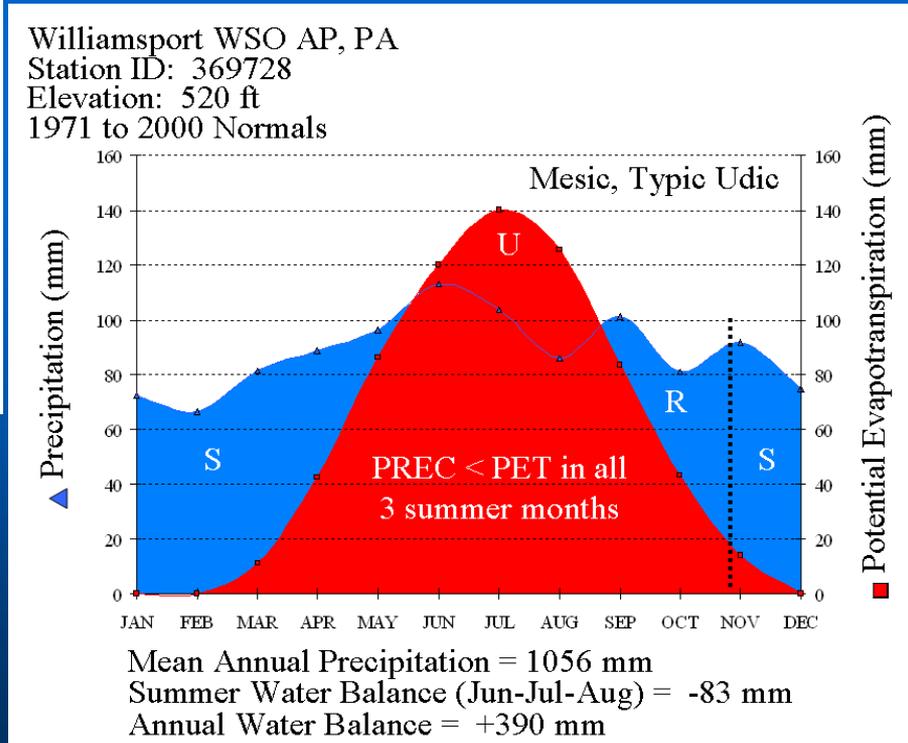
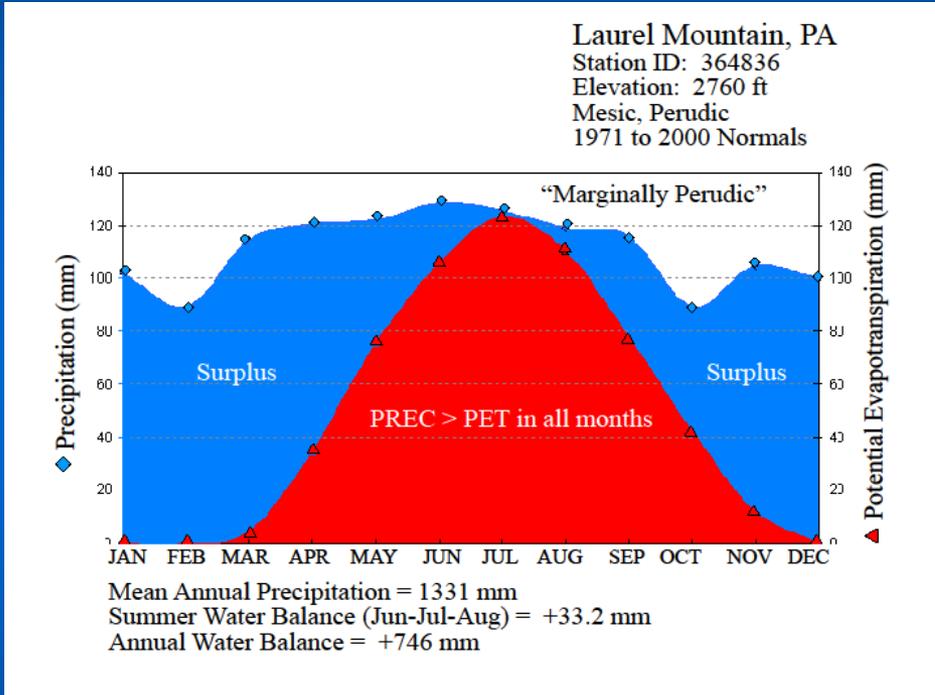


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Concluding Thoughts

- 💧 Newhall Simulation Model
- 💧 Based upon 30 yr normals
- 💧 Marginally perudic or “near-perudic” environment



💧 Hazleton, Clymer, Dekalb,
Leck Kill, Leetonia,
Cookport, and Nolo soils



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Concluding Thoughts

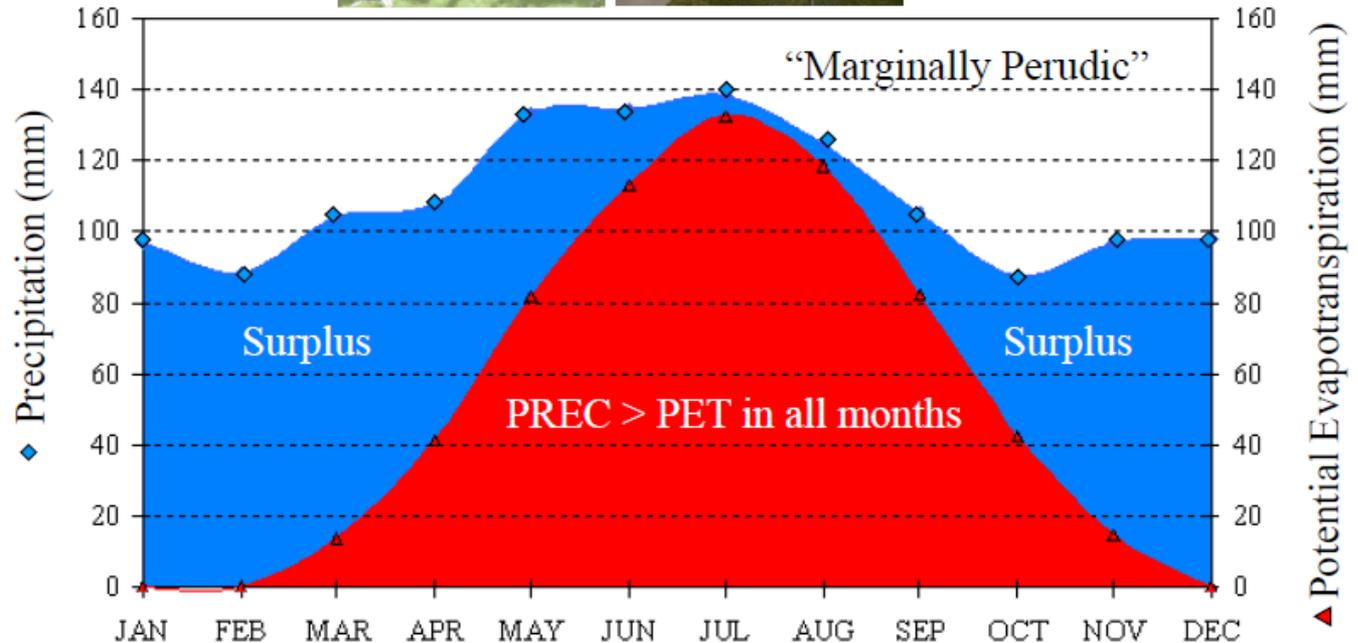
Marginally Perudic vs Near-Perudic

💧 Perudic based upon a 30 yr normal, but not on a year-to-year modeling

💧 Its definitely wetter than Udic; often associated with unique plant communities



Parsons 1 NE, WV
Station ID: 466867
Elevation: 1826 ft
Mesic, Perudic
1971 to 2000 Normals



Mean Annual Precipitation = 1318 mm
Summer Water Balance (Jun-Jul-Aug) = +34 mm
Annual Water Balance = +677 mm



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Field Trials and Research Team at Coudersport

"We cannot solve the problems that we have
created with the same thinking that created
them."
--Albert Einstein



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Penn State is committed to affirmative action, equal
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Photo by Teri McDowell, Endeavor News



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