Putting soil moisture on the NWCC Interactive Map: Instructive for the NSMN effort?

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2018 MOISST Workshop: From Soil Moisture Observations to Actionable Decisions. Lincoln, NE

Acknowledgements:

Angus Goodbody (NWCC), Cara McCarthy (NWCC), Rashawn Tama (NWCC), Kent Sutcliffe (NRCS), Deb Harms (NWCC), Mike Strobel (NWCC)

Challenges for the NSMN effort

- administrative structure & coordination
- merging in situ network data with remotely-sensed values
  - research ongoing… (e.g. Steven Quiring & Trent Ford's efforts)
- diverse user groups → different data needs
  - drought assessment/mitigation
  - streamflow and reservoir storage forecasting
  - watershed modeling
  - research (basin hydrology, precipitation feedbacks, global climate, soil physical dynamics, etc.)
  - crop production, irrigation
  - fire hazard
  - flooding & erosion assessment/mitigation
  - engineering/structural applications (foundation leakage, road conditions, etc.)
  - soil ecosystems
  - ground-truthing satellite or model estimates
- identify key deliverables & timeline for each
- develop standards for data quality, sensor installations and maintenance
- determine template for presentation/delivery of data
  - example: NWCC Interactive Map…
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THIS PRESENTATION

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Adding soil moisture to the NWCC Interactive Map

- Questions
  - which depth to use?
    - 2", 8", 20" sensors available at nearly all SNOTEL & SCAN sites
    - depth-integrated? If so, how calculated/weighted? Same weighting for all sites?
  - which frequency?
    - hourly SM values available and quality-controlled at majority of sites
    - Interactive map uses daily (midnight) values
  - which parameters are most useful?
    - current volumetric water content (VWC)?
    - % normal (or) departure from normal?
    - % saturation?
  - how long a period-of-record (POR) until data are included?
    - POR for most SNOTEL/SCAN sites: ~ 5 - 15 years

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Adding soil moisture to the NWCC Interactive Map

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    - e.g. Tyson & Ronald's talks
    - daily (midnight) max values from POR used as proxy for % saturation (still in production)
    - hourly values = better as daily values may miss SM peaks (in future)
  - data processing limitations to analysis
    - pull from main database, try not to require additional 'flat file' values
  - soils lab data not available for many sites
    - use period-of-record data for saturation values
  - no clear solution for depth-integration
    - user can select any available depth
    - depth-integrated value can be added later
  - no clear solution for regionalizing data
    - basin % normal and % saturation are averages of values from sites in each basin
  - short POR requires the incorporation of recently-installed sensors
    - 5 year minimum used
  - uses data that have not yet been quality-controlled
    - effort ongoing for all SNOTEL & SCAN hourly SM/ST data
  - uses daily (midnight) values instead of hourly data
    - data structure already established for daily, not hourly, parameters in Interactive Map
  - SNOTEL data may not be representative of regional SM conditions
    - site locations chosen for measurement of mountain snowpacks (north-facing, protected)
    - not as problematic for SCAN

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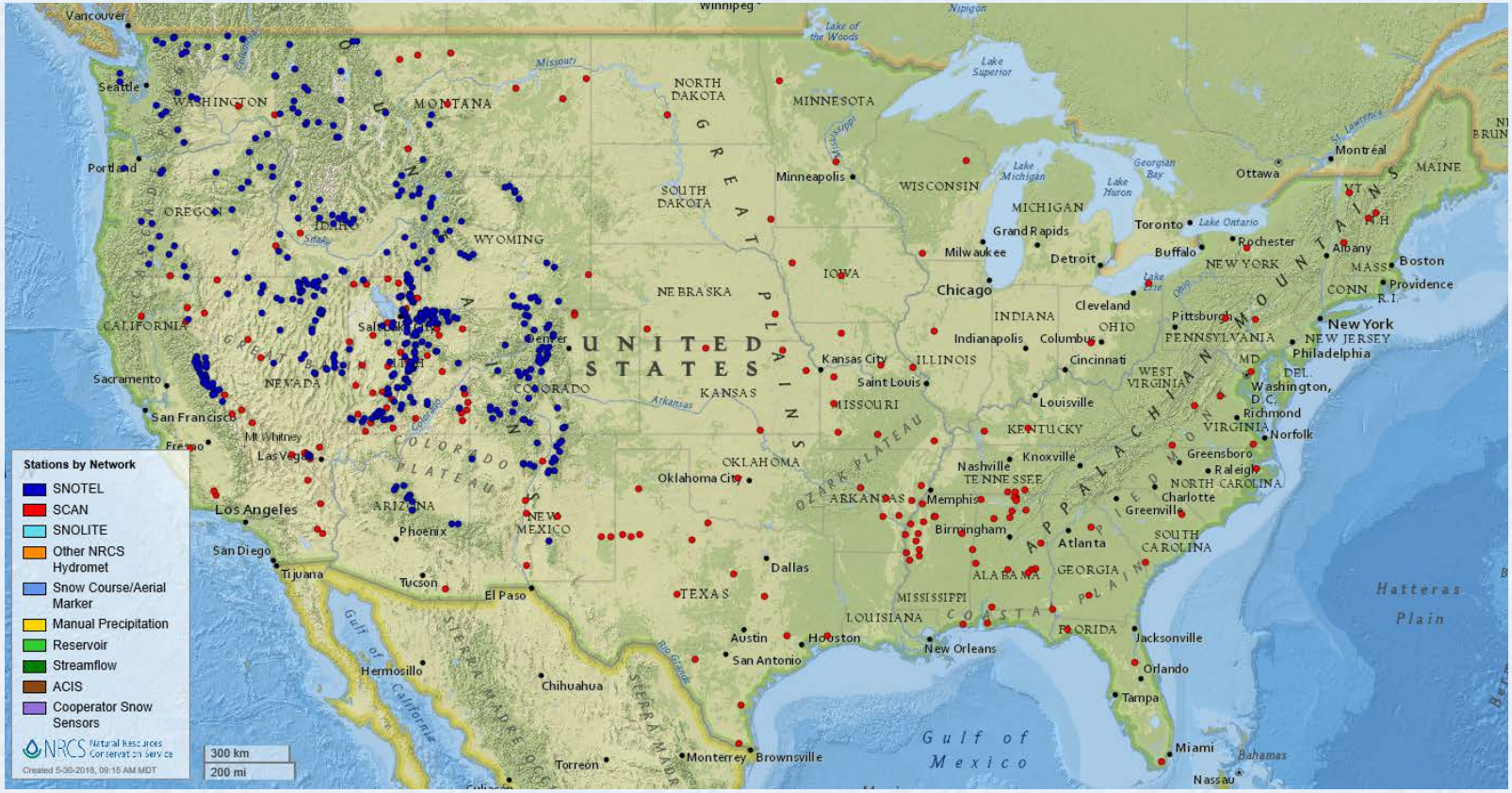
Background

- Interactive Map uses daily data from multiple networks
- can select variety of parameters, statistics, time intervals, etc.



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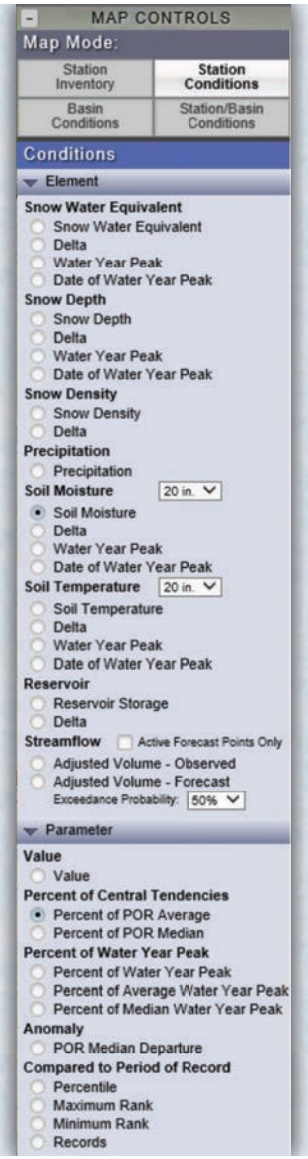

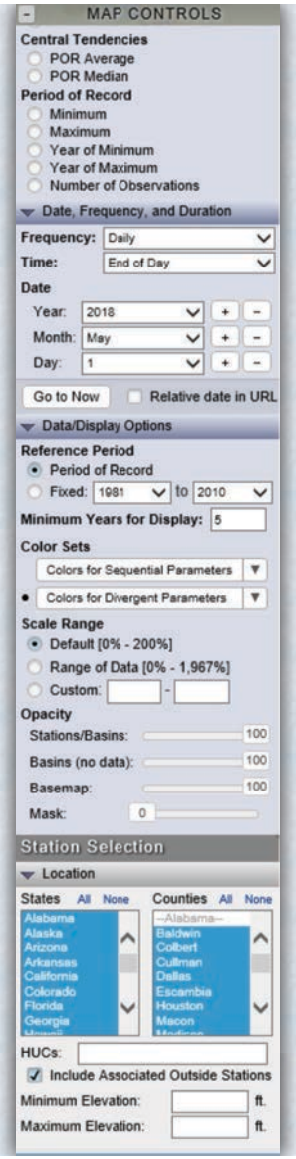

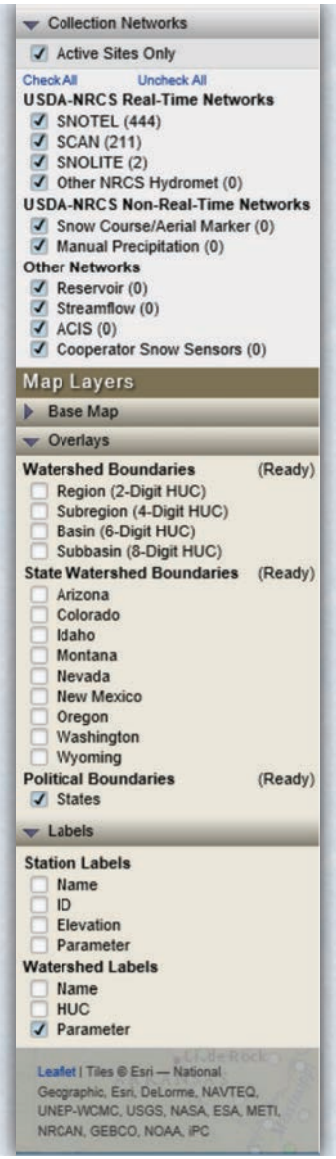

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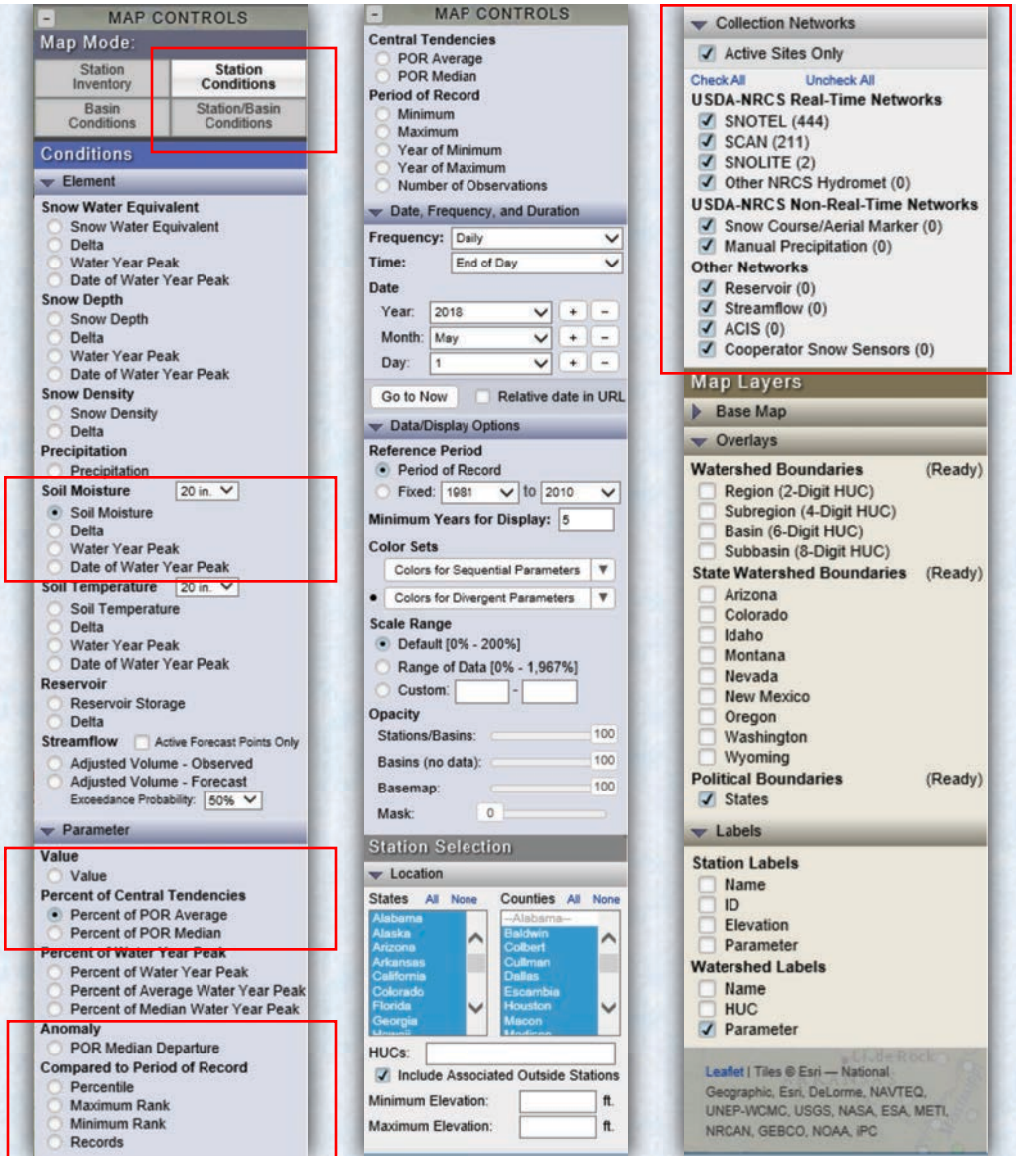
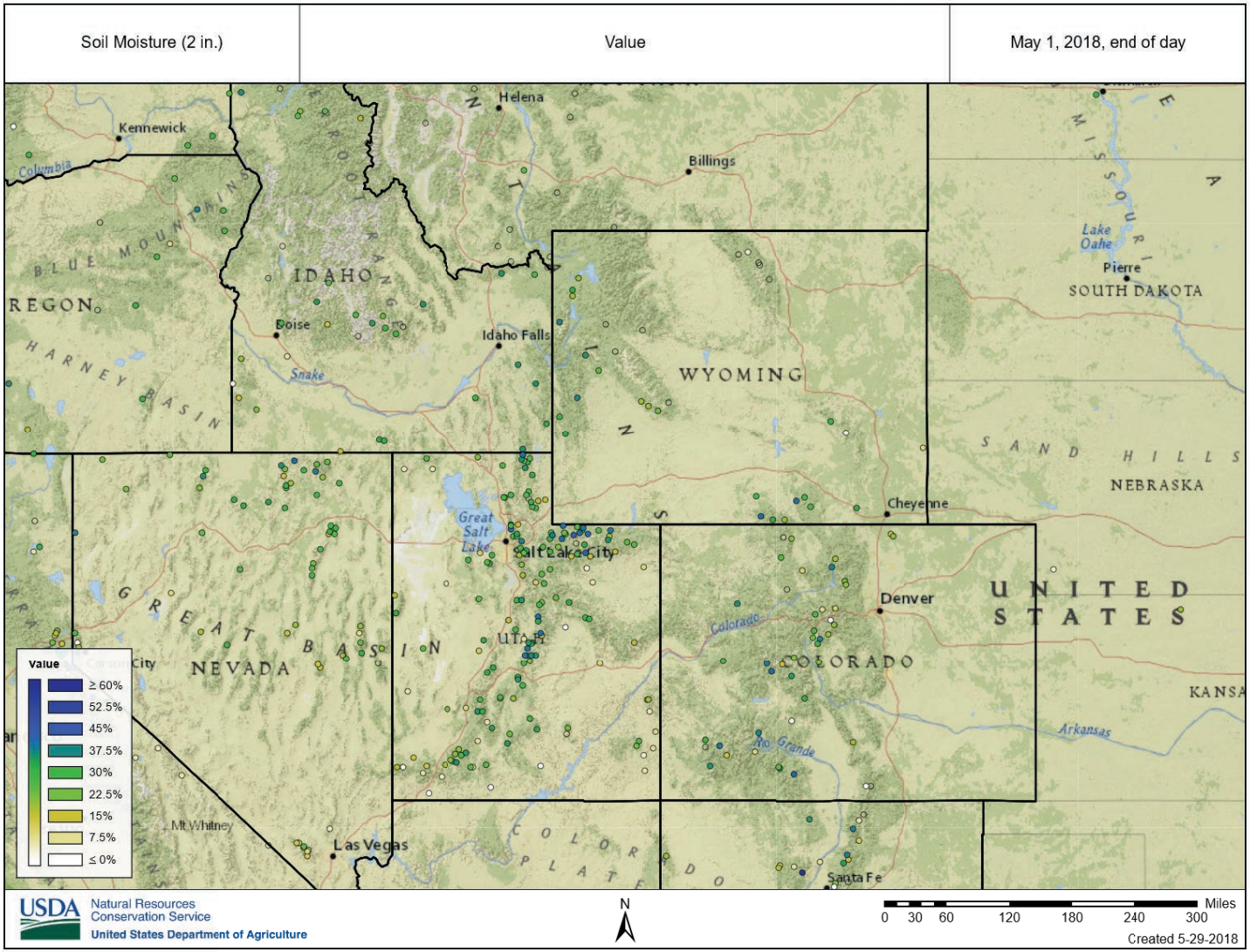


EXAMPLES

Surficial soil moisture

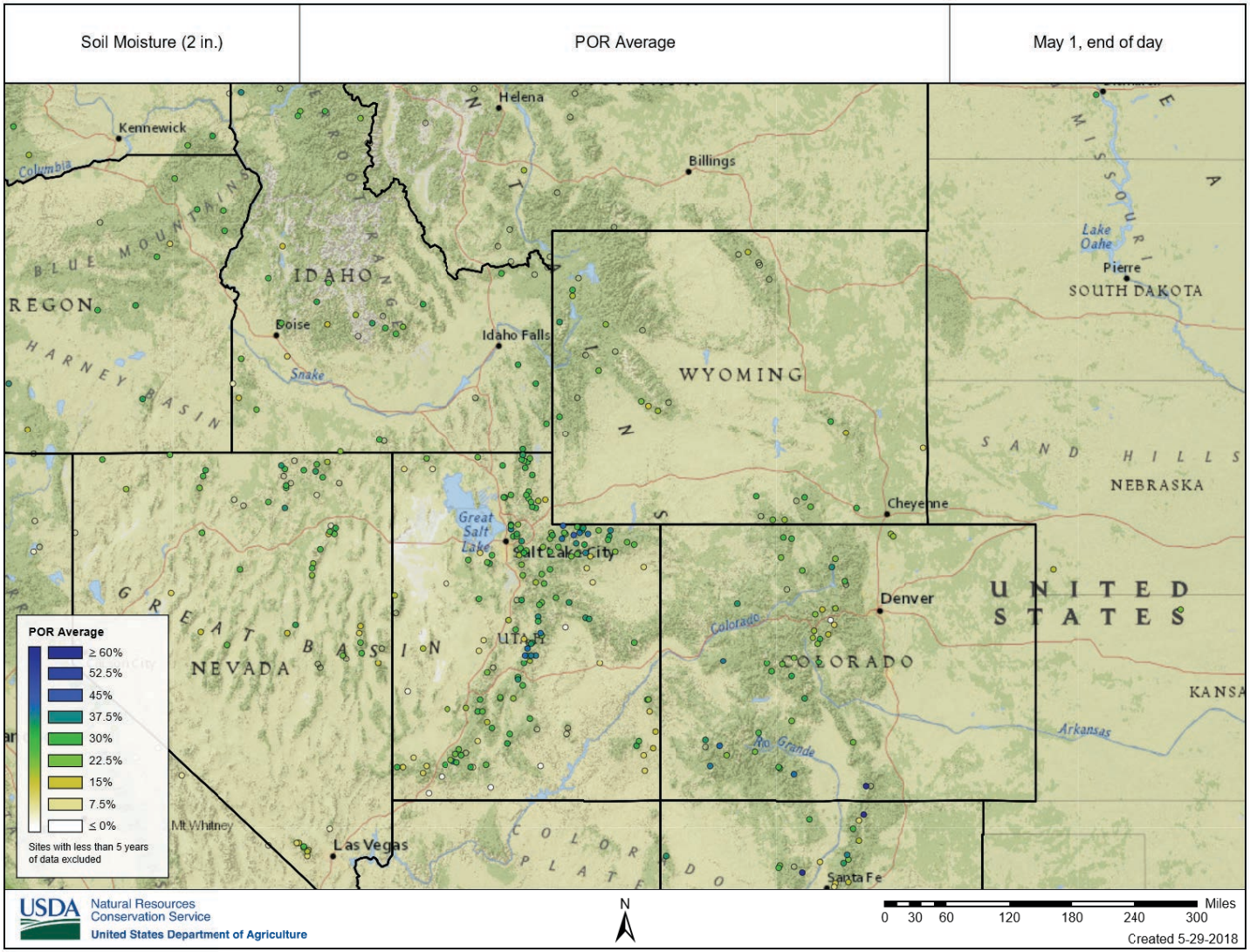
- VWC at 2” (5 cm) depth
- SNOTEL & SCAN networks
- Stevens HydraProbe sensors

Can discern regional trends but hard to contextualize…



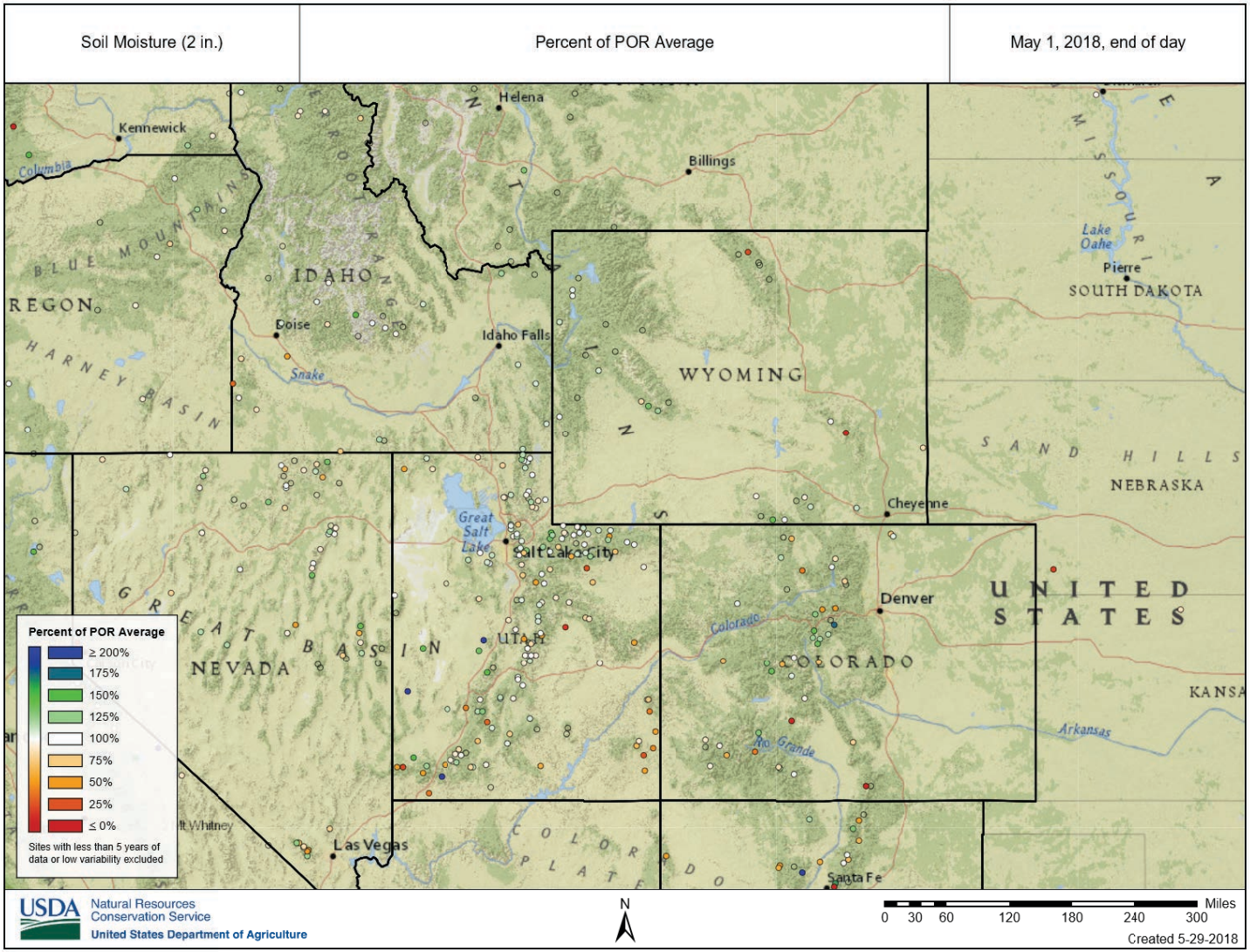
POR average

- from daily (midnight) values
- POR data quality-controlled for each site (ongoing)
- POR range: 5 to ~20 years (minimum of 5 to be used on map)



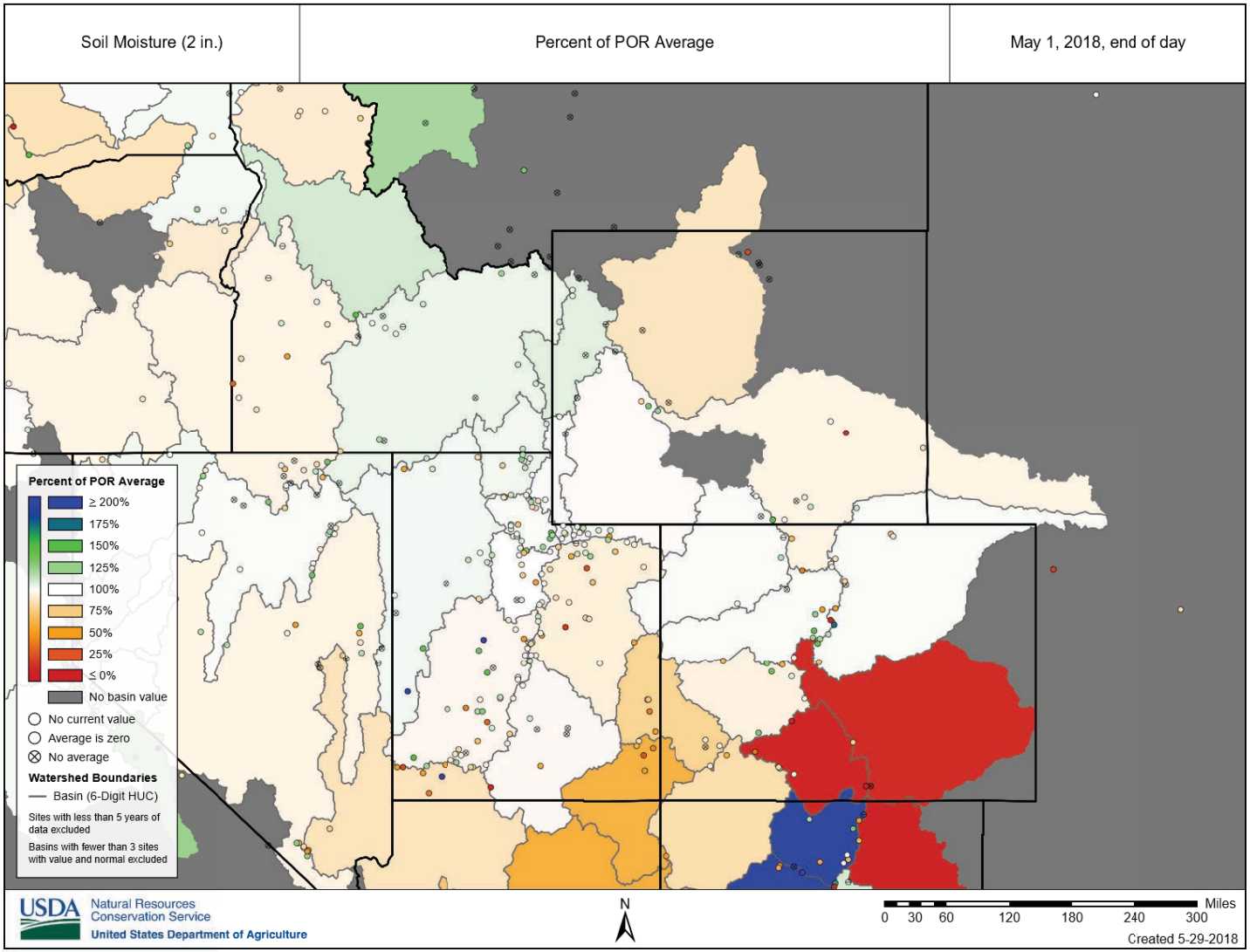
Percent normal

- for a given date & depth
- can specify different depths



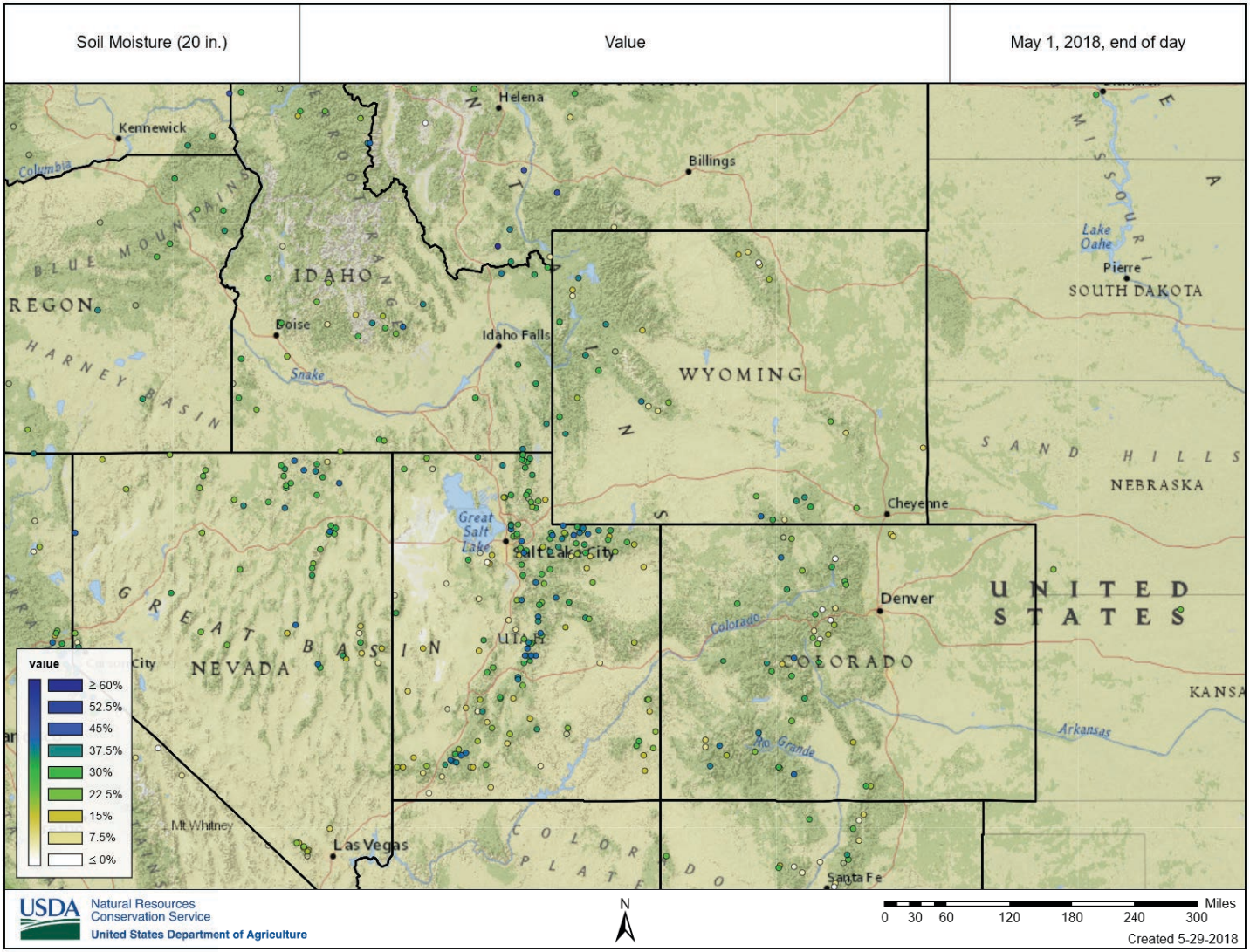
Percent normal for basins

- 6-digit HUCs
- = avg of sites in basin
- minimum for including basins on map
  - 3 sites
  - % normal values available for those sites for at least 5 years



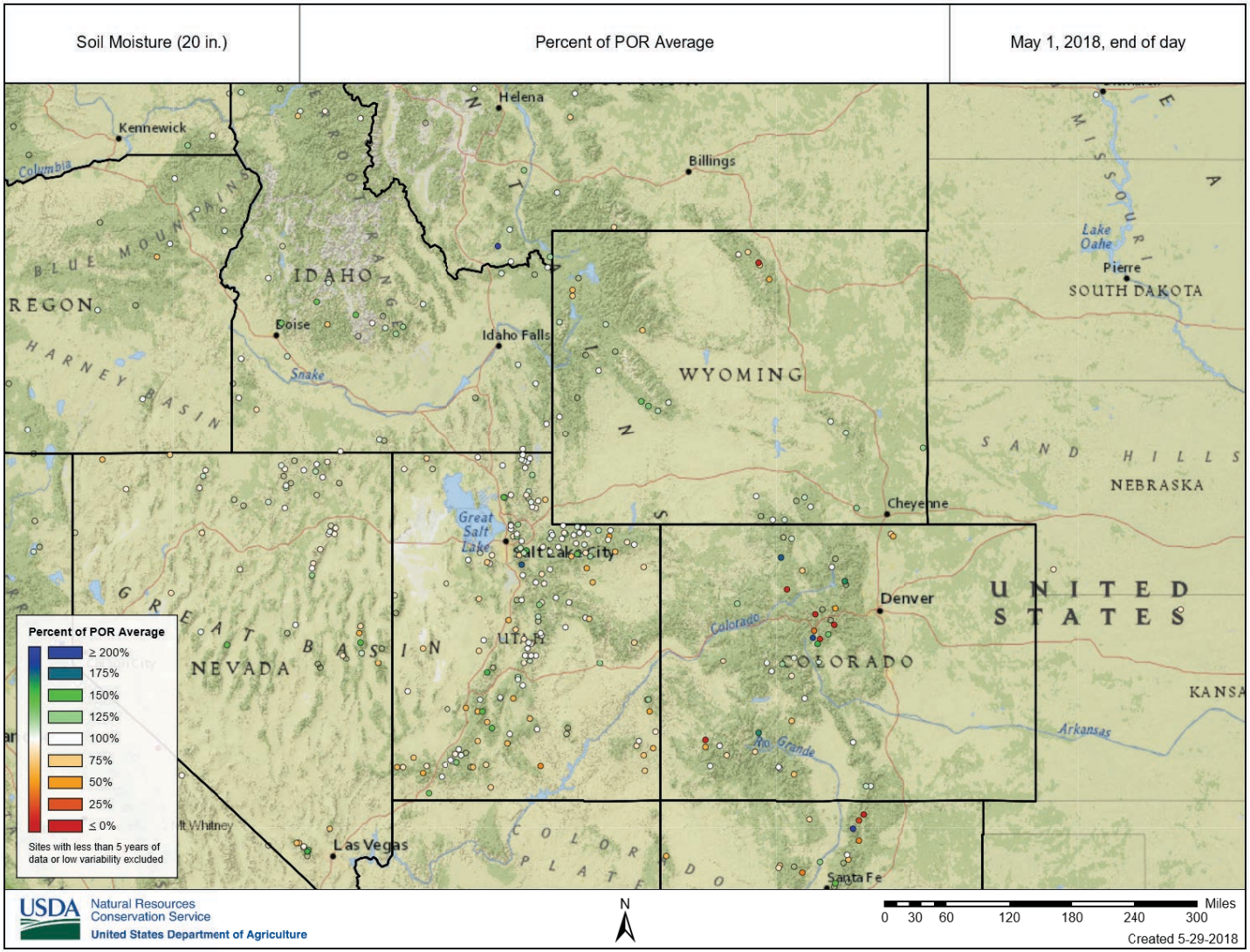
Soil moisture at depth

- 20” (50 cm) sensor
- lower variability
- more representative of longer-term conditions (drought, excessive SM, etc.)
  - e.g. Trent’s results



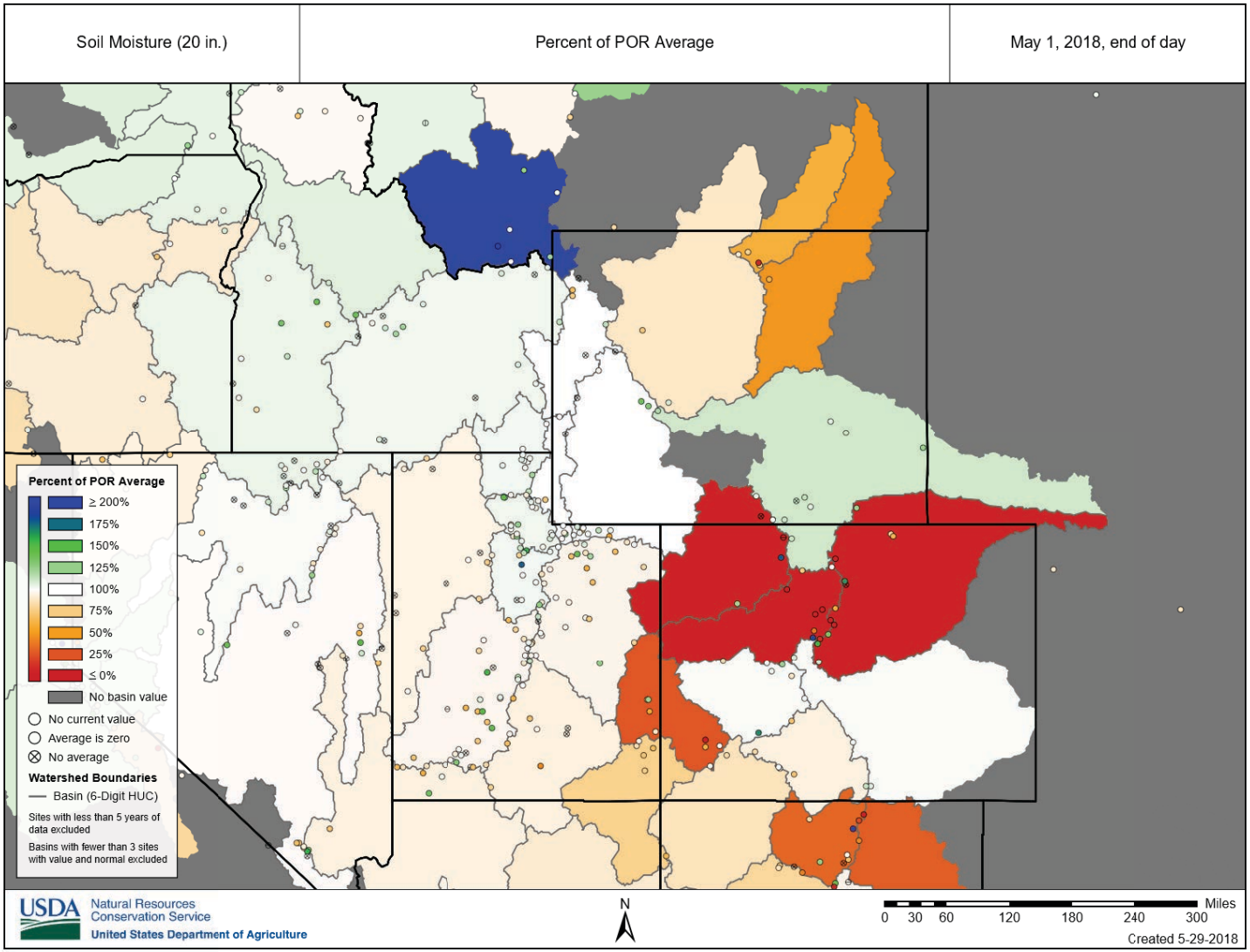
Percent normal

- lower variability than surficial sensors
- accords well with other site data (e.g. longer term precipitation trends)



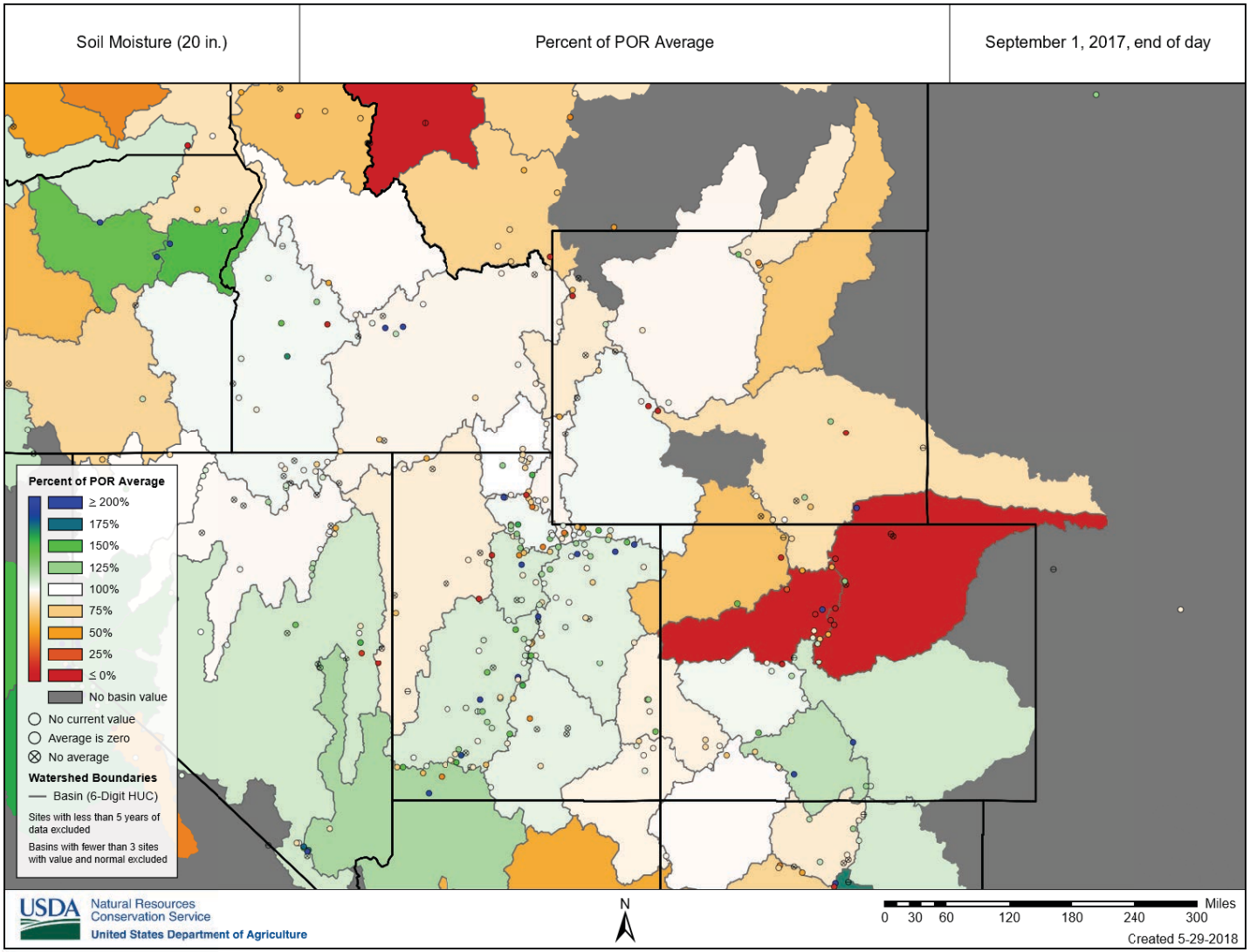
Percent normal

- 20” sensor



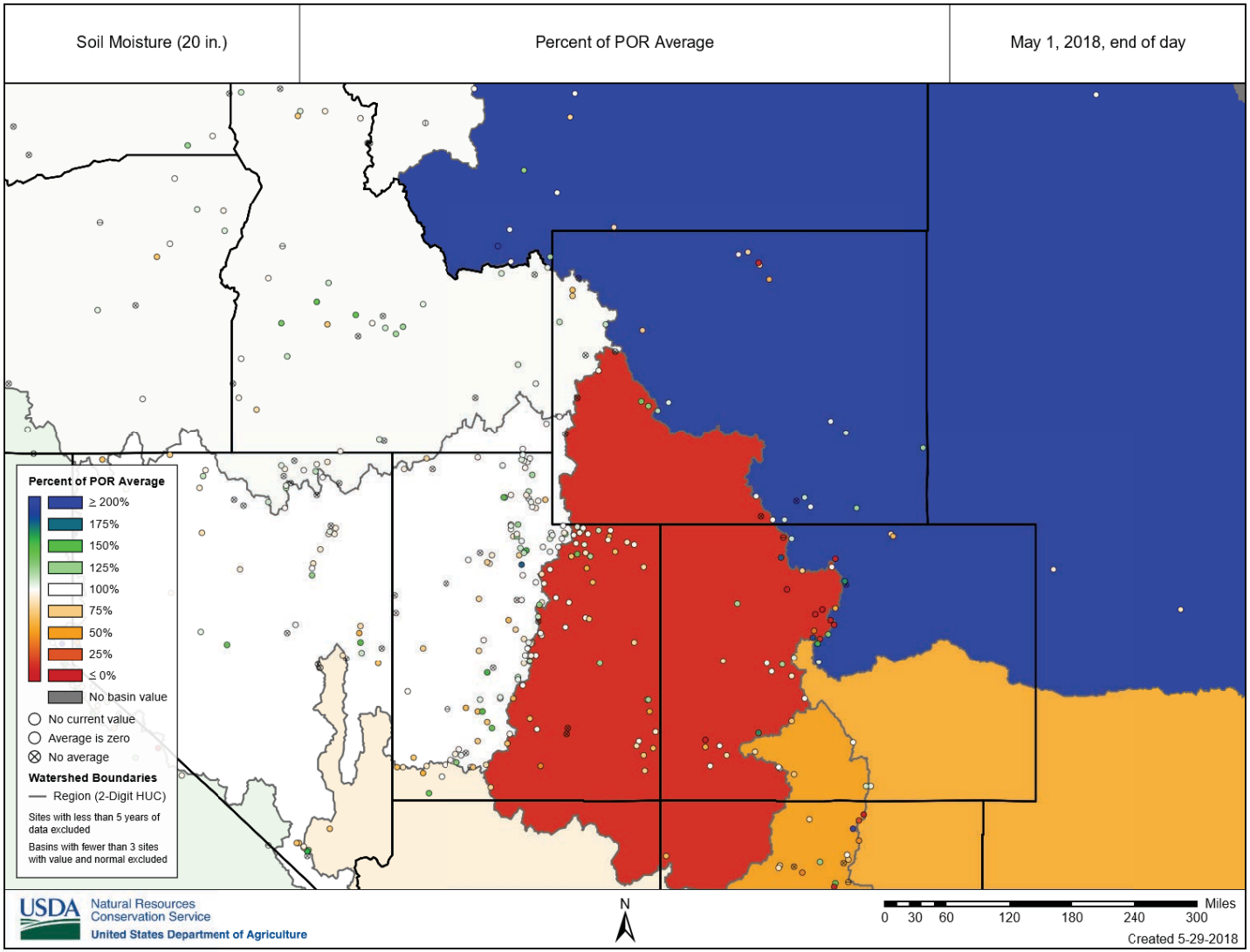
Percent normal

- 20” sensor
- same as previous, but for Sept. 1 instead of May 1
- better reflection of growing season conditions



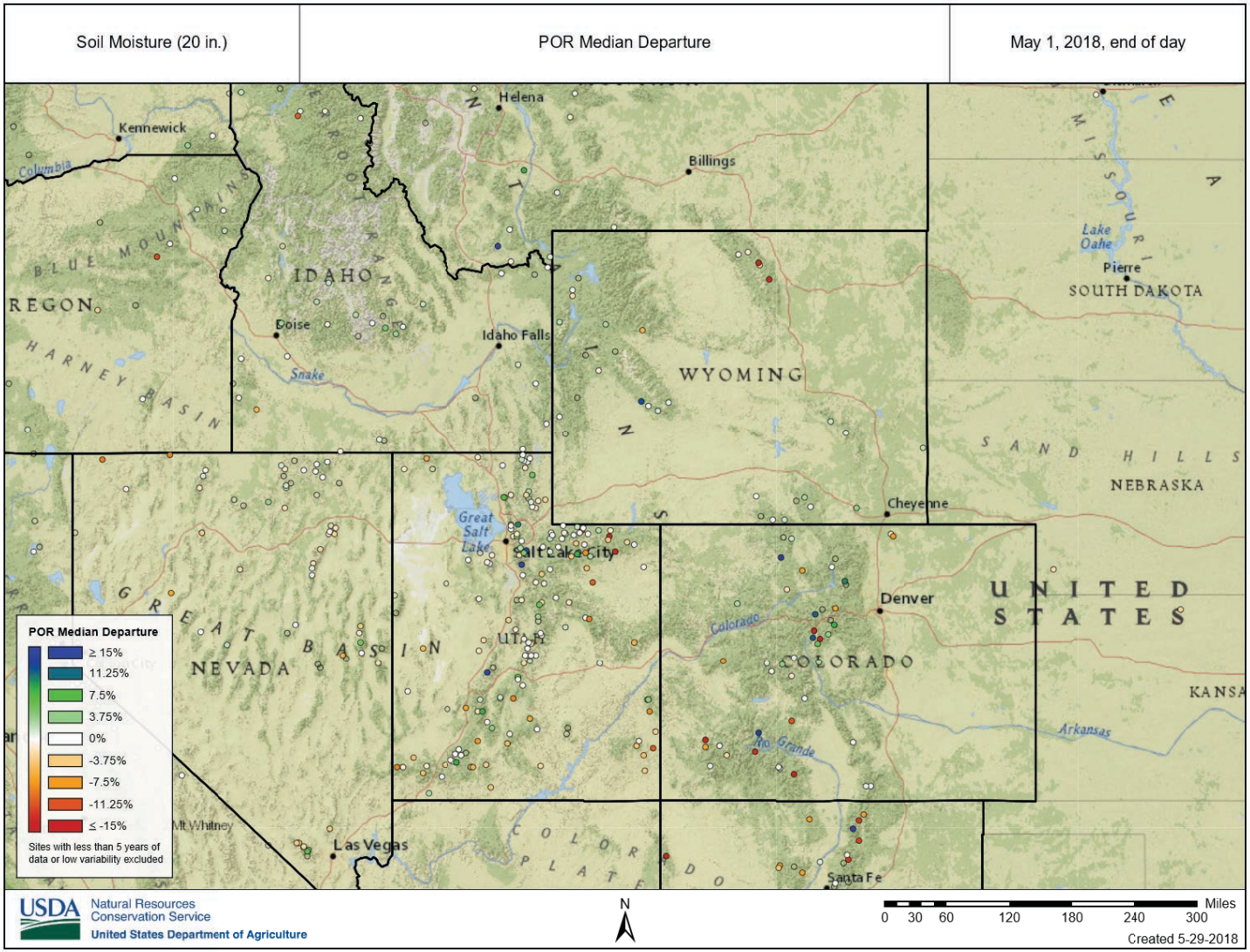
Percent normal

- 20” sensor
- May 1 data
- can generalize to large watersheds (2-digit HUCs)
- NWCC can also generate custom watersheds (e.g. combination of 6-digit HUCs of interest)



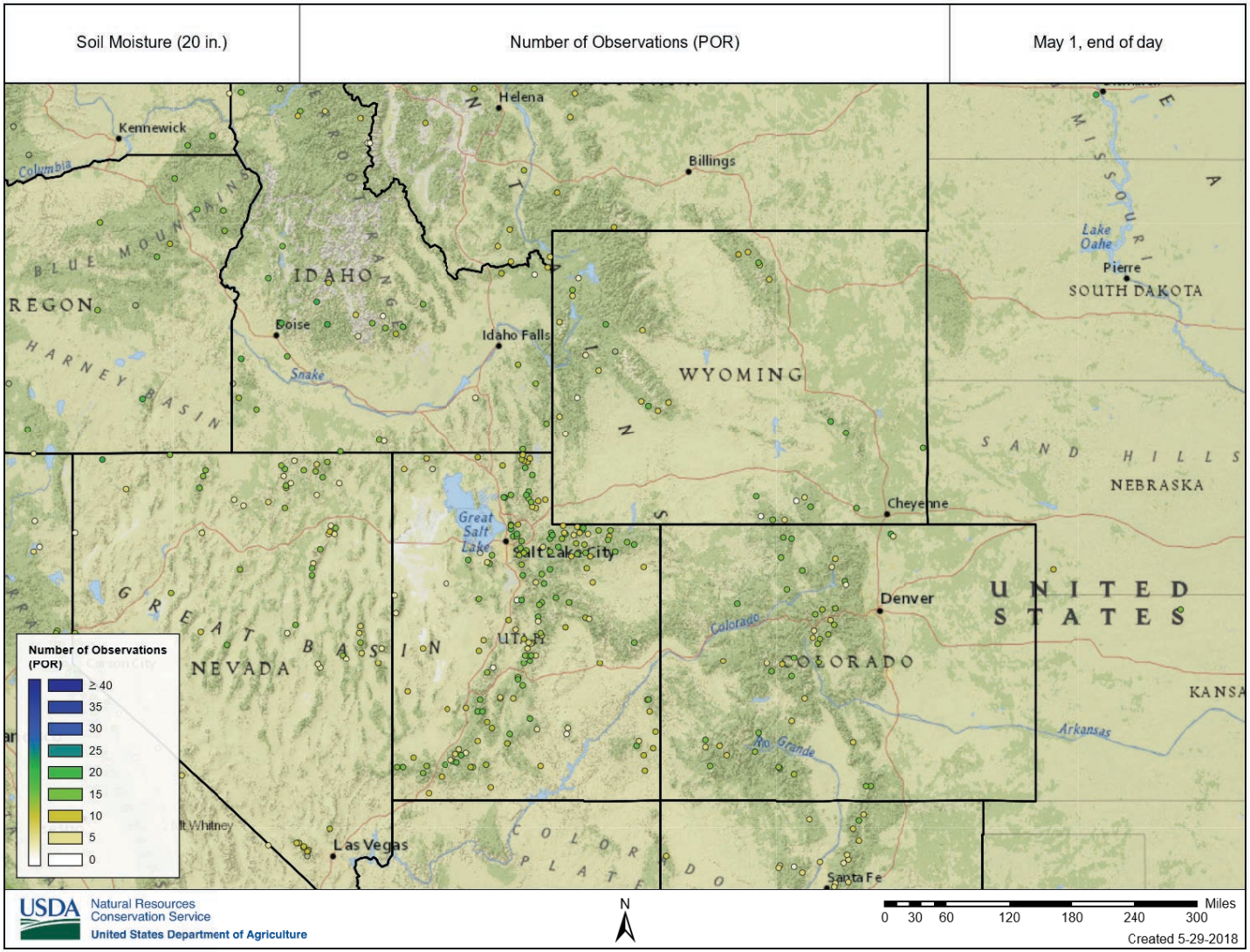
Departure from normal

- 20” sensor
- can identify anomalies



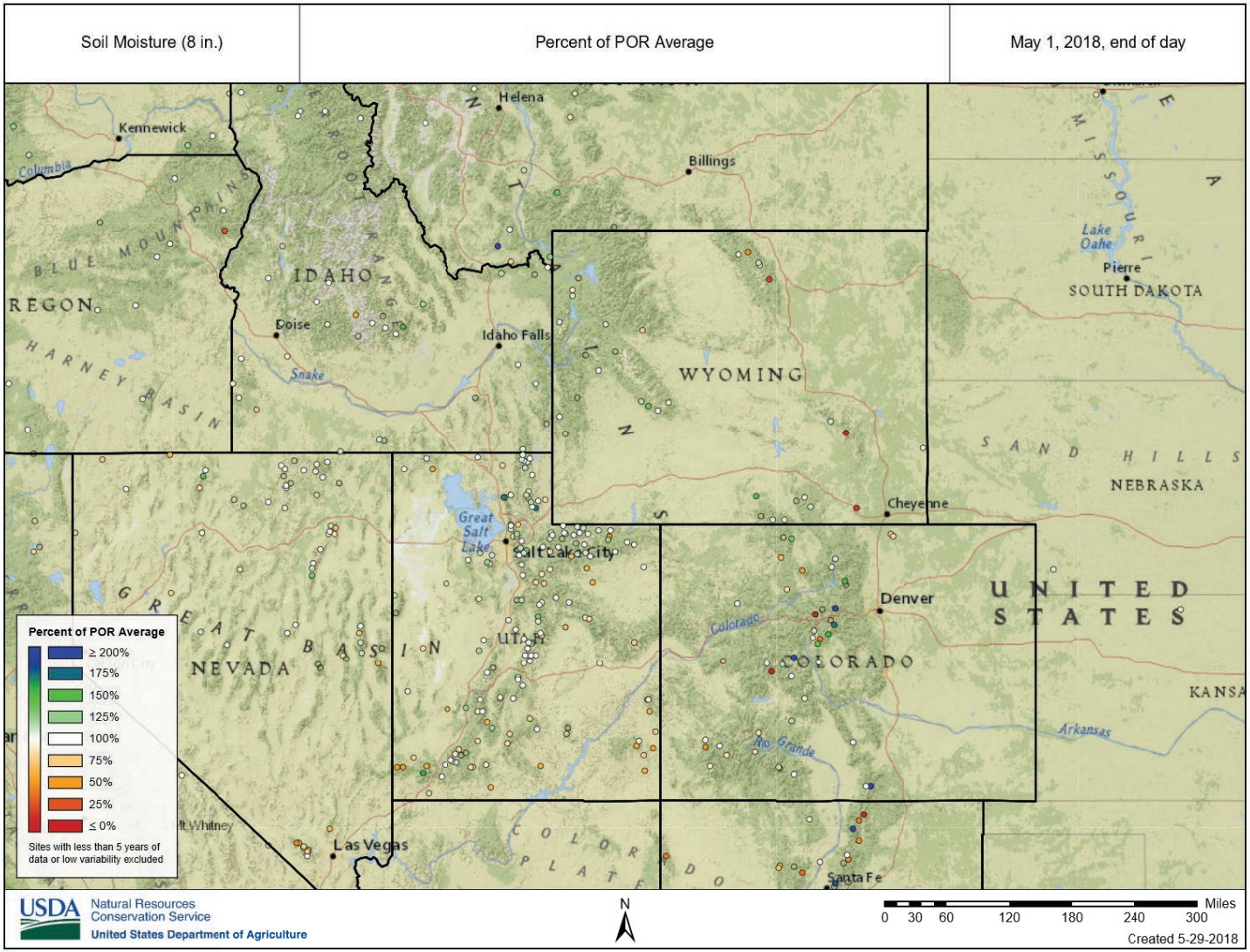
Length of POR

- most sites between 5-15 years



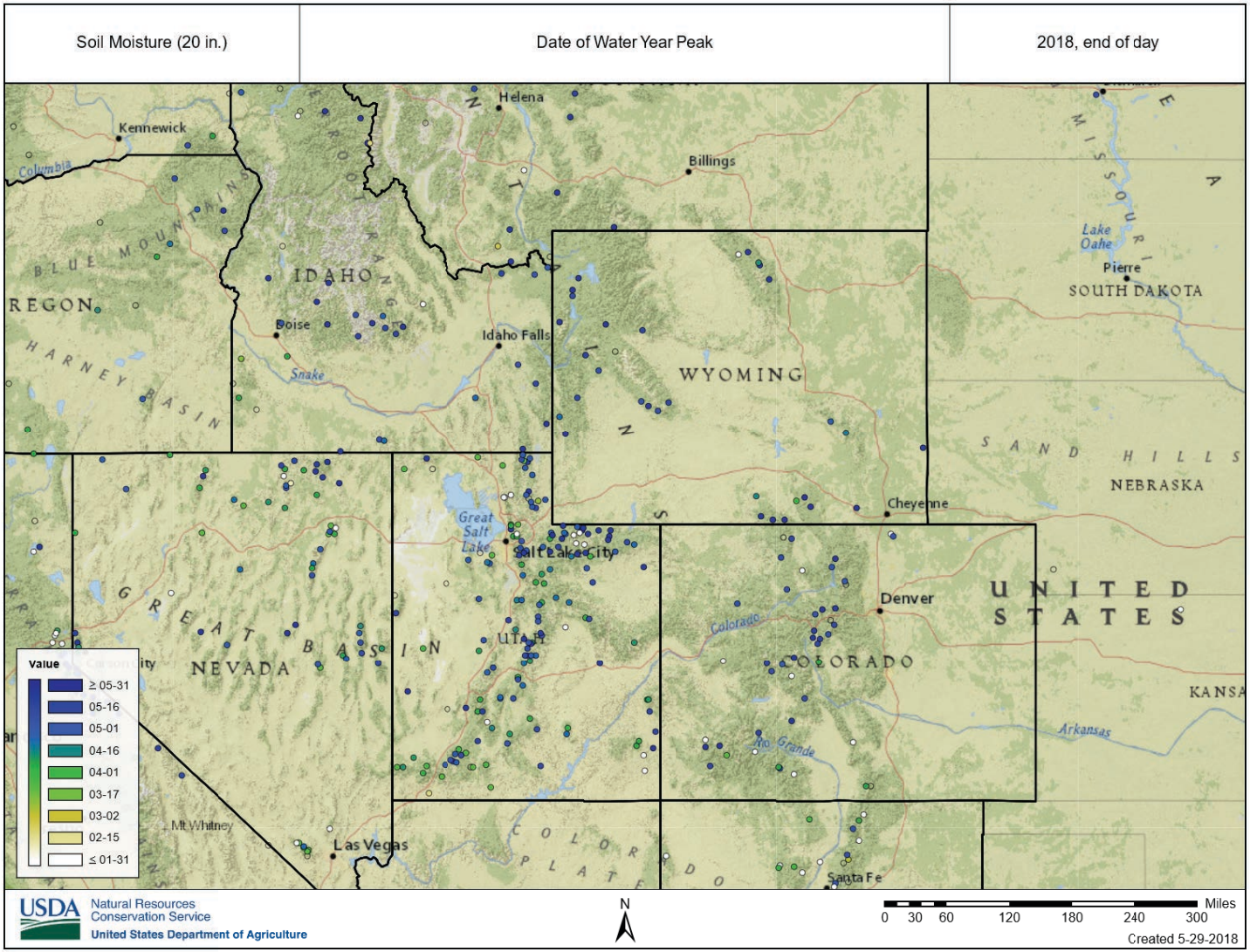
Other depths

- 8” (20 cm) sensor
- rooting zone
- ~integrative of highly variable surficial soils (2” data) and long term trends in SM (20” data)



Timing of peak soil moisture

- may be helpful in identifying early snowmelt, etc.



Need to be able to contextualize by % saturation

- Saturation ~ 40% VWC for some soils, but much lower for many
- % normal values may show ~average conditions, but does not actually provide information on how wet/dry the soils are…
  - e.g. Sept. 1 SM values (next slides)
- Saturation values determined from POR data, not lab results
  - best determined manually per site, but need automatable process
  - use POR max from *hourly* (not daily) dataset
    - need to use hourly because may miss large events in daily (midnight) data
  - still in development…

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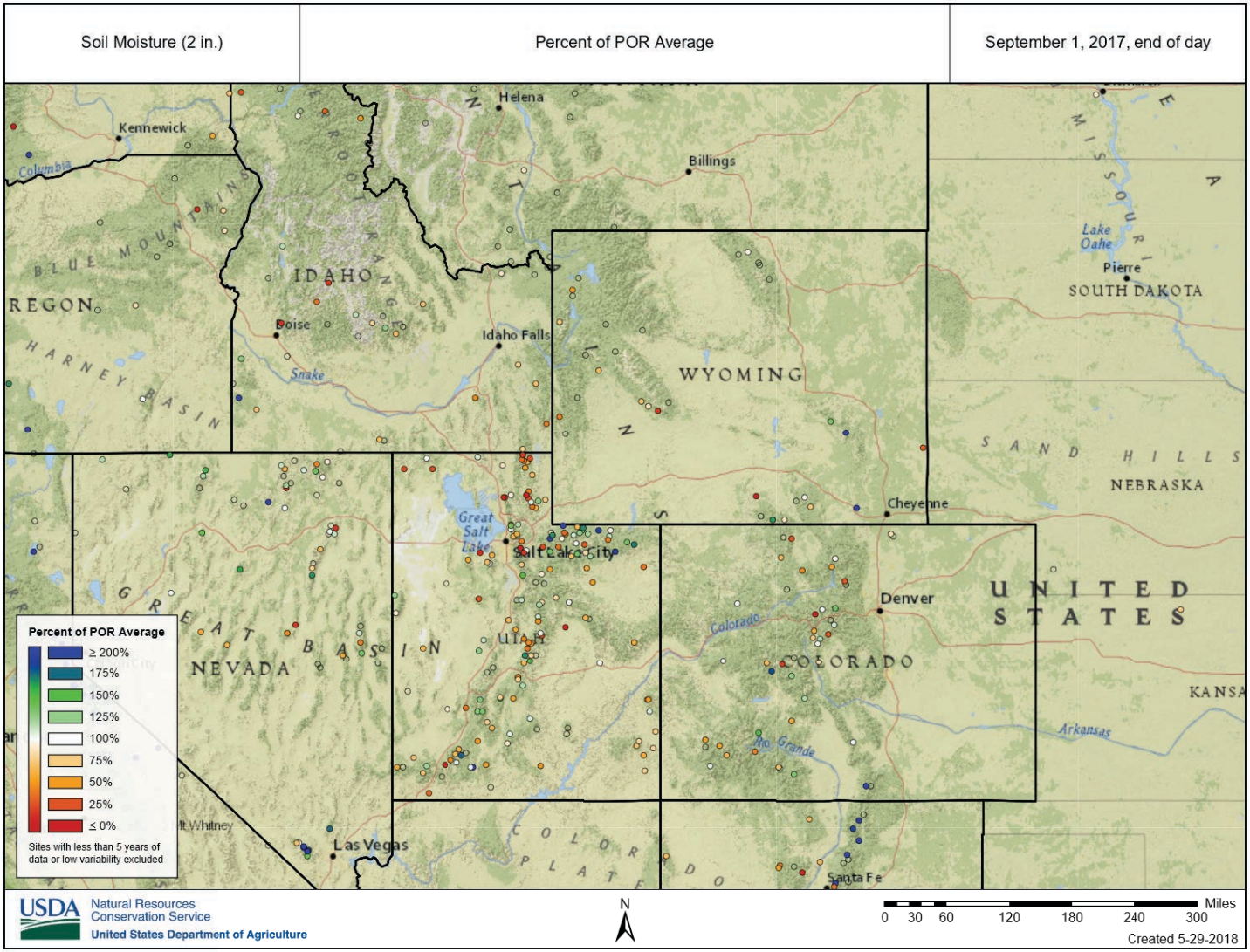
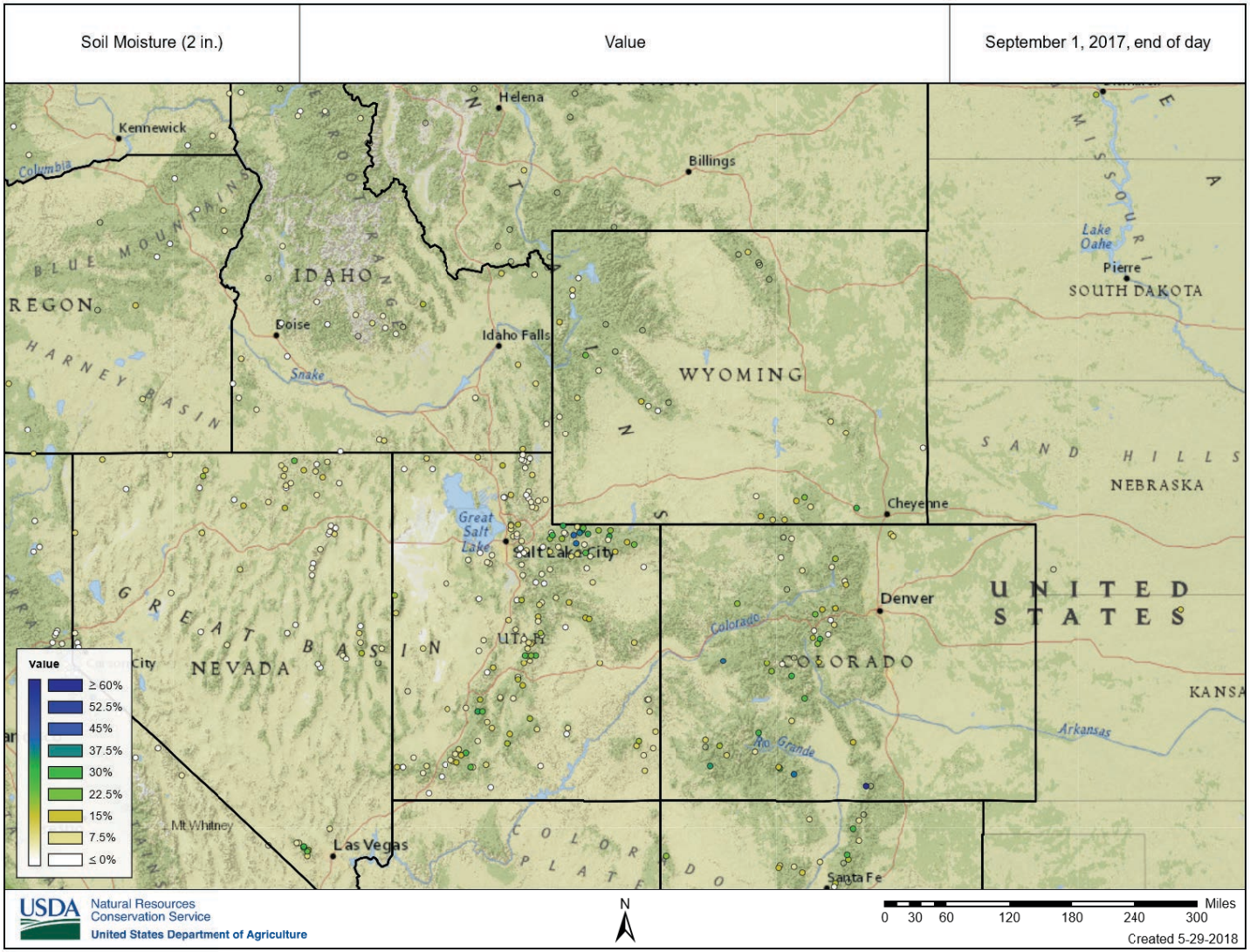
Percent normal for Sept. 1

- 2” sensor
- lots of variability due to topo, site conditions, local storms, ET, etc.
- no information regarding degree of dryness for that particular soil horizon at that date
- need % saturation values



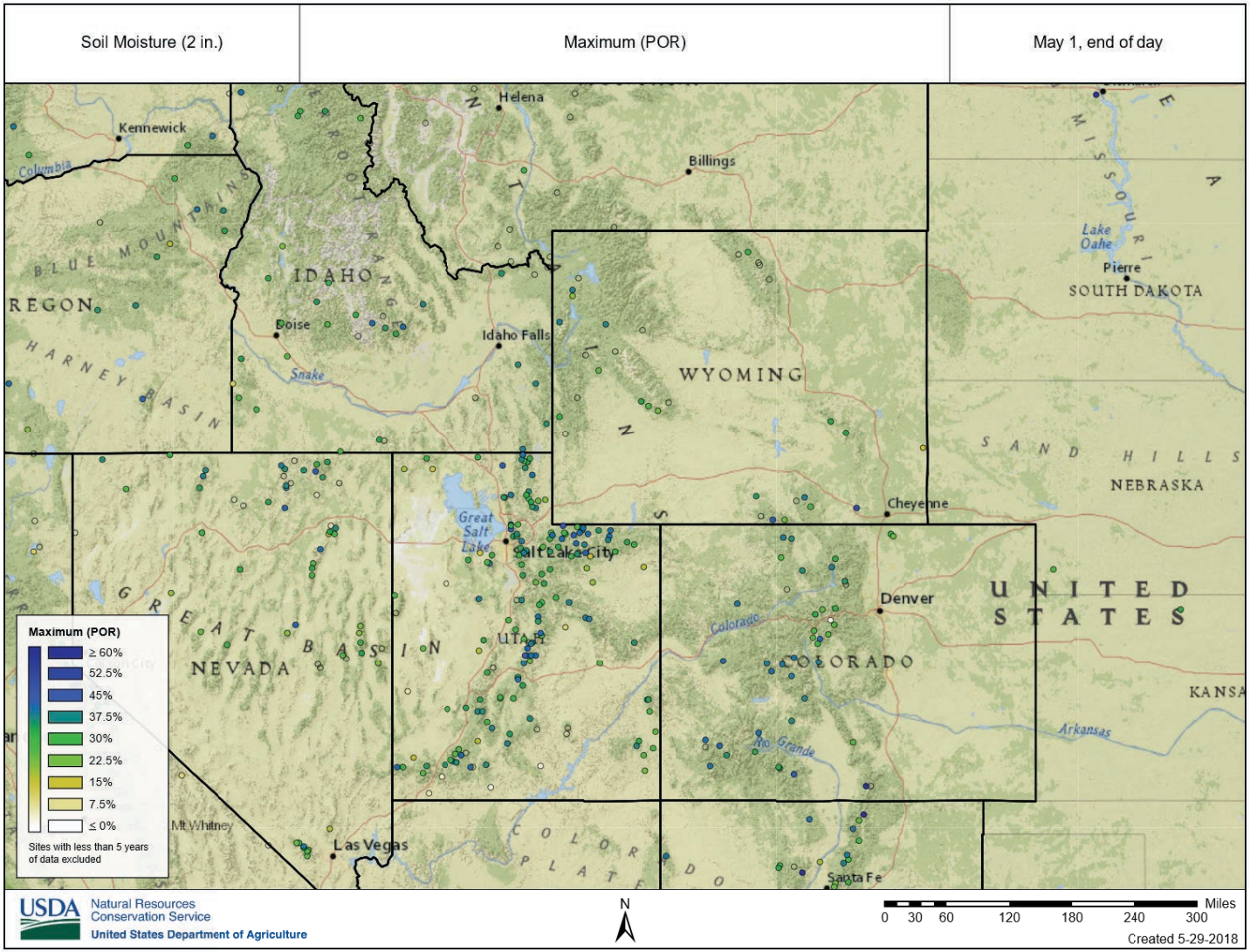
VWC for Sept. 1

- same, for SM values instead of % normal



Maximum VWC for that day

- 2” sensor
- from daily data
- still in development…
  - max values from hourly POR to be used in final version
  - % saturation not yet available
  - % saturation = (current VWC / max VWC)



Application to NSMN

- Pros
  - users can select soil depth most relevant to their application
    - 2" may be most beneficial for merging with remotely-sensed data
    - 20" may be most useful for drought monitoring
    - (better example = Chen Zhao's poster…)
  - regionalizes point data to basins
    - % normal only
  - diverse functionality & output
    - % normal
    - % saturation (forthcoming)
    - other… (soil moisture deficit?)
  - can ingest outside networks
  - data framework already developed

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Application to NSMN

- Cons
  - only includes SNOTEL & SCAN networks for in situ data, no remotely-sensed data
  - no depth-integrated SM value (yet)
  - no clear best-practice approach to regionalizing values
    - for eastern states, etc.
    - from remotely-sensed data
    - SNOTEL sites may not be representative
  - too complicated / too many options?

Challenges for the NSMN effort: Revisited

- administrative structure & coordination
- merging in situ network data with remotely-sensed values
- diverse user groups → different data needs
- identify key deliverables & timeline for each
- develop standards for data quality, sensor installations and maintenance
- determine template for presentation/delivery of data…
  - is this a desirable approach (build outward from in situ data)?
  - merit in delivering product with flexible output (e.g. different sensor depths)?
  - context = key (% normal, % saturation, departure from normal, etc.)

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Questions & Discussion

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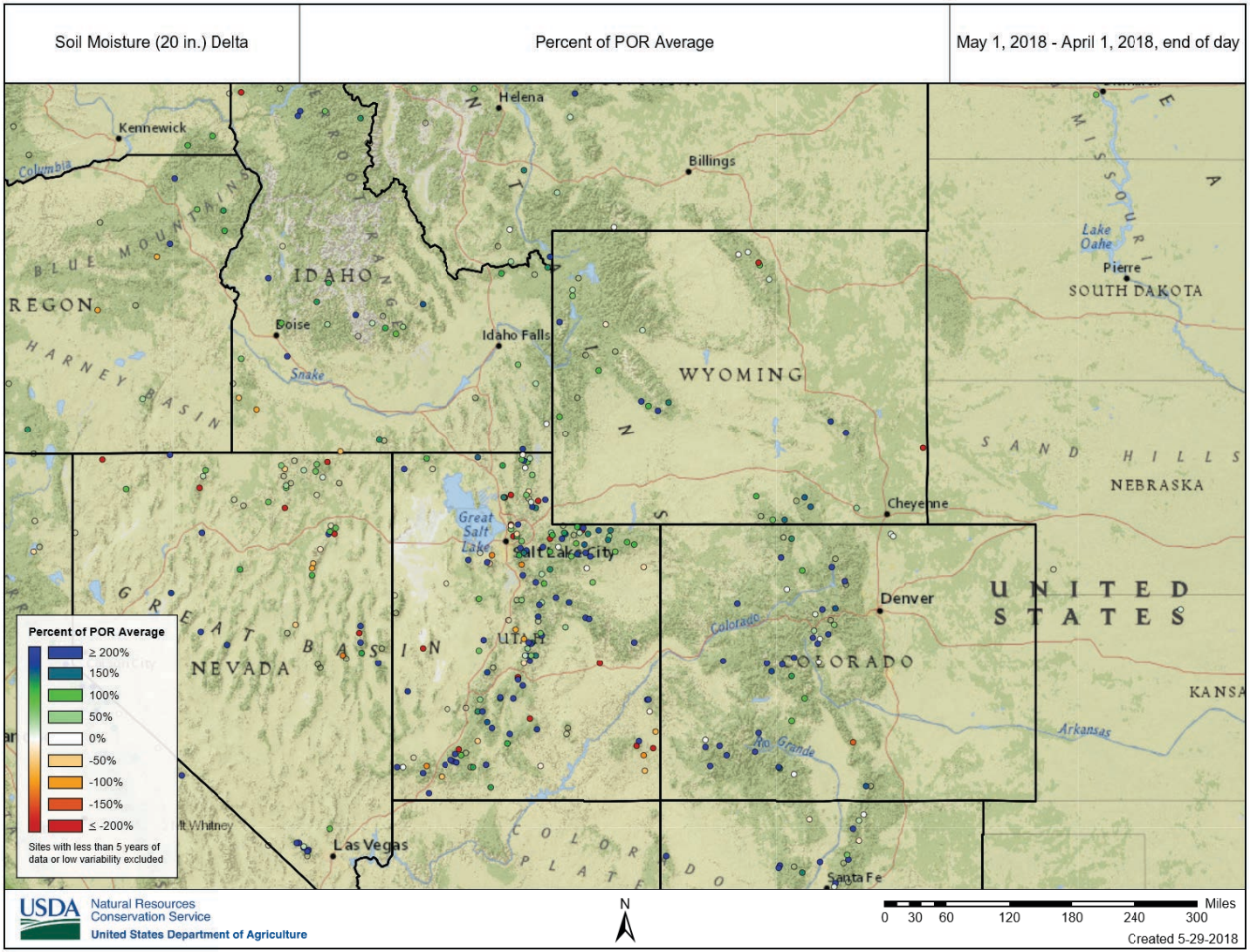
Textbox

- ***
- **
- **

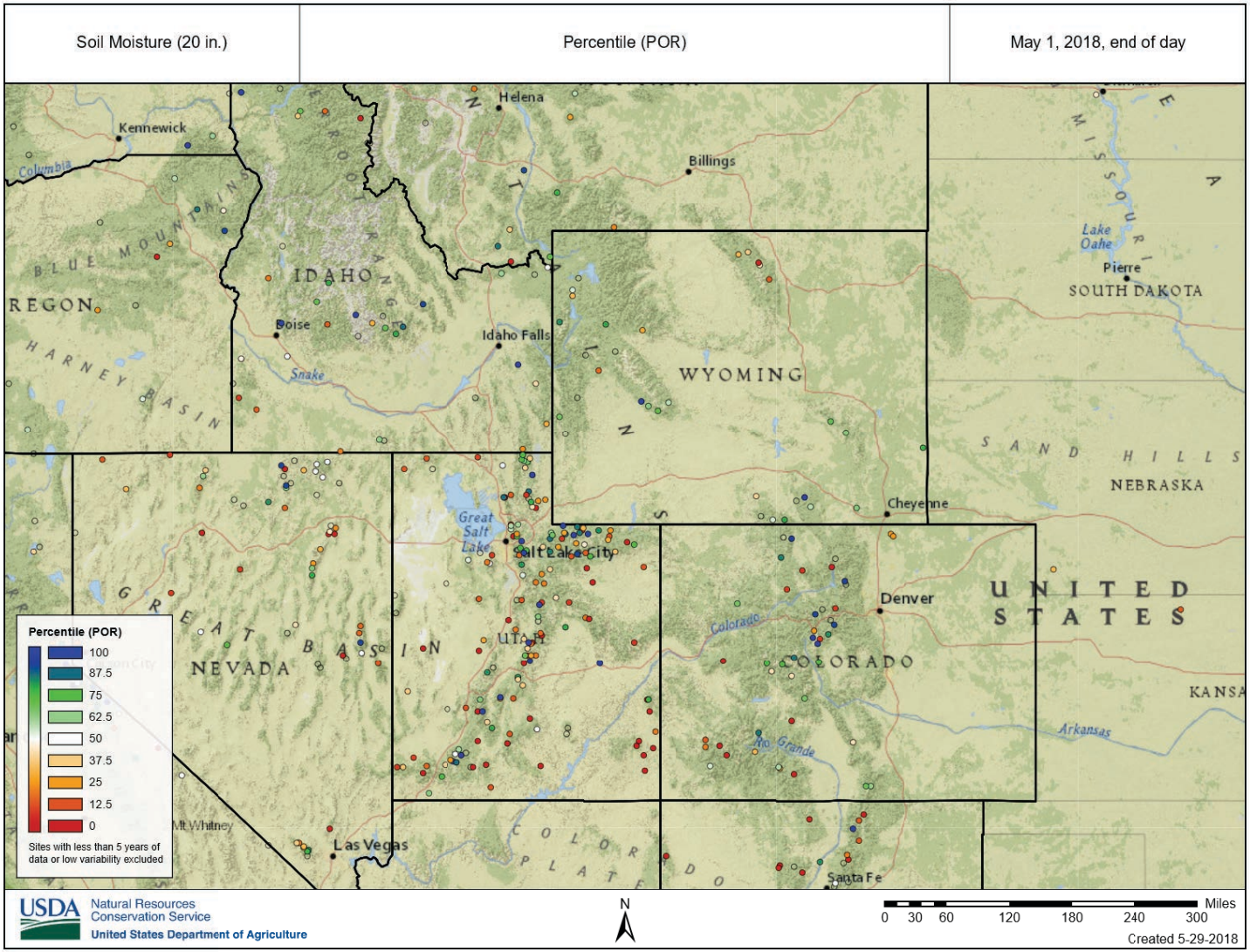
Changes in % normal over time

- 30 day interval (customizable)
- 20” depth



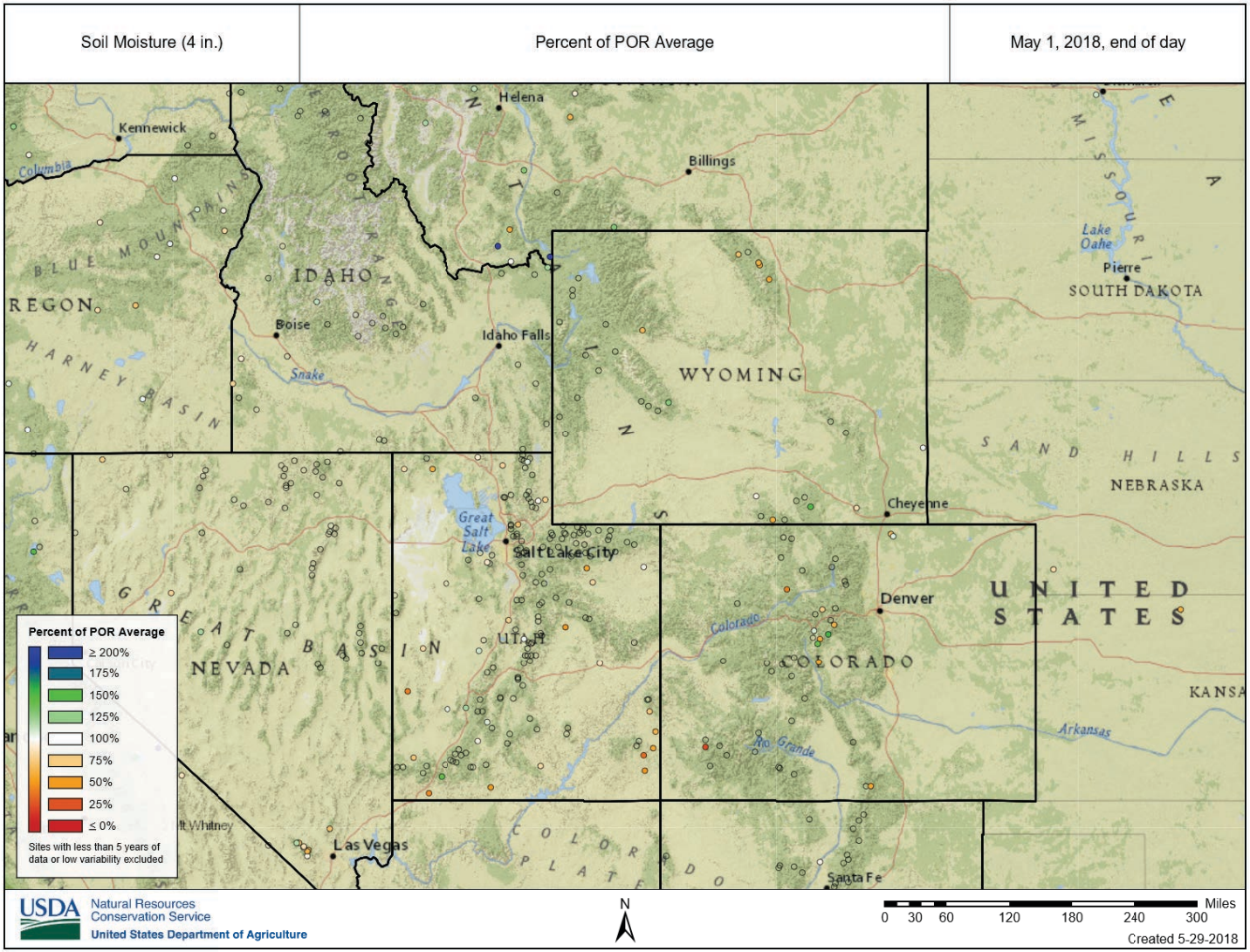
Soil moisture percentiles

- 20” sensor
- provides historical context



Other depths

- 4” sensor
- similar to 2”
- available in SCAN, not SNOTEL



Other depths

- 40” sensor
- available in SCAN, not SNOTEL