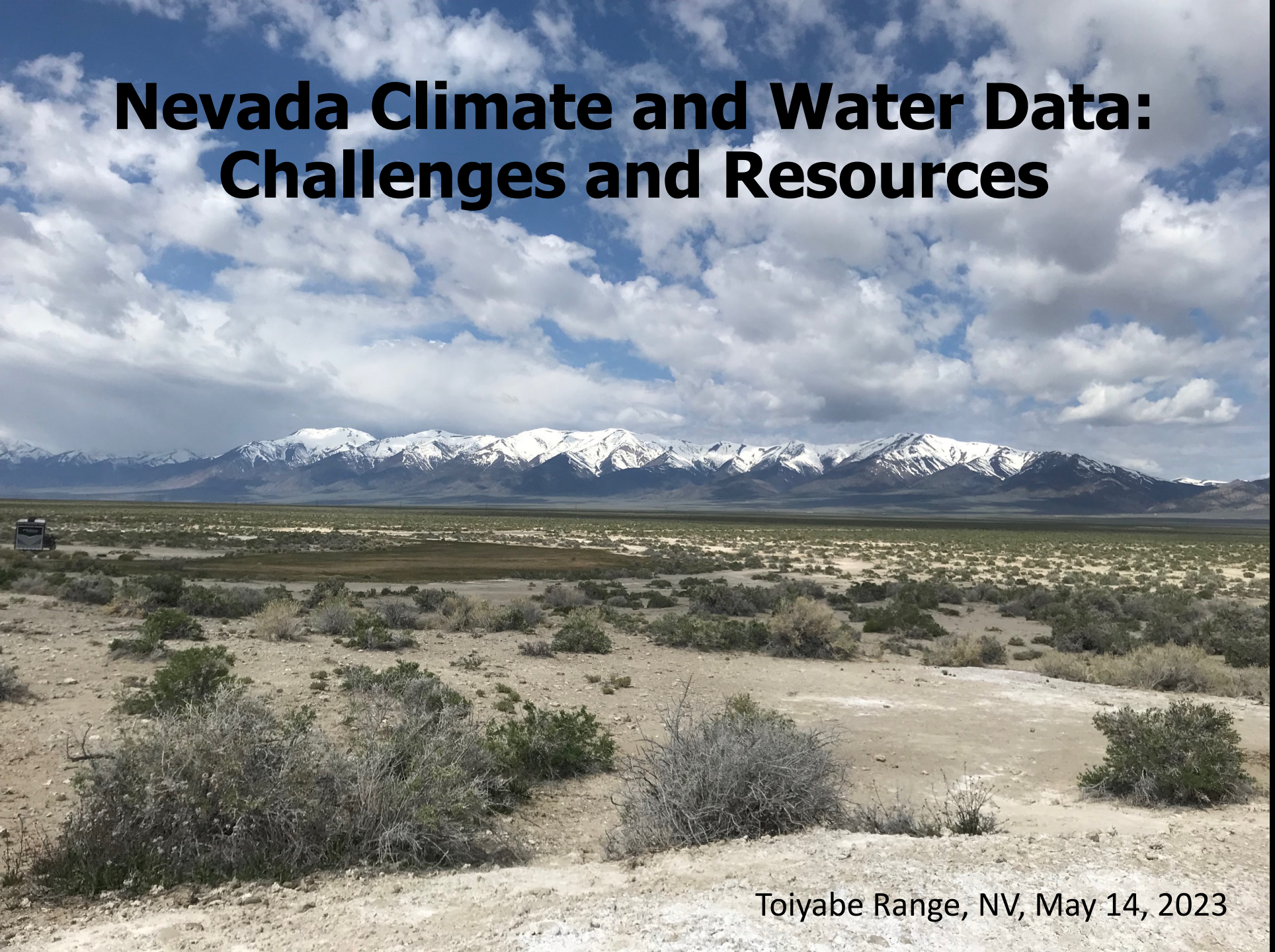
Nevada Climate and Water Data: Challenges and Resources



Toiyabe Range, NV, May 14, 2023

Dan McEvoy,
Regional
Climatologist

Western Regional
Climate Center,
Desert Research
Institute

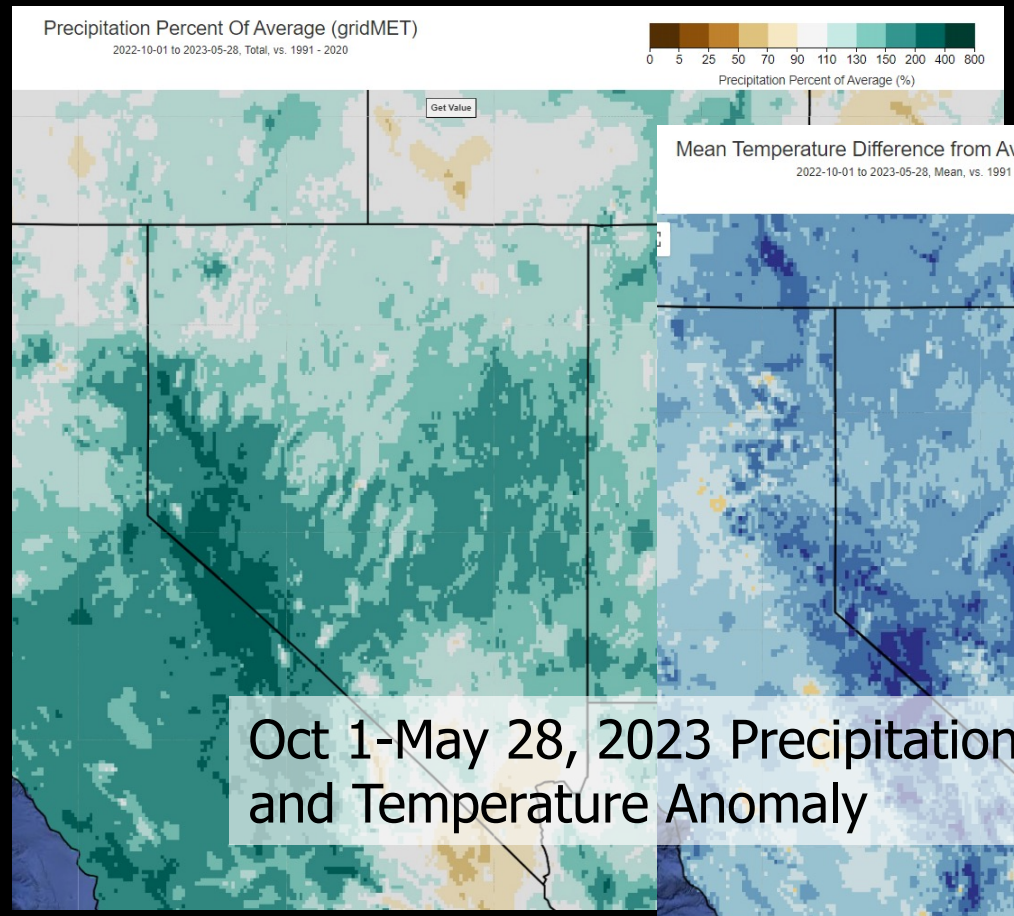
State of Nevada
State Water Plan
Stakeholder
Advisory Group
Meeting

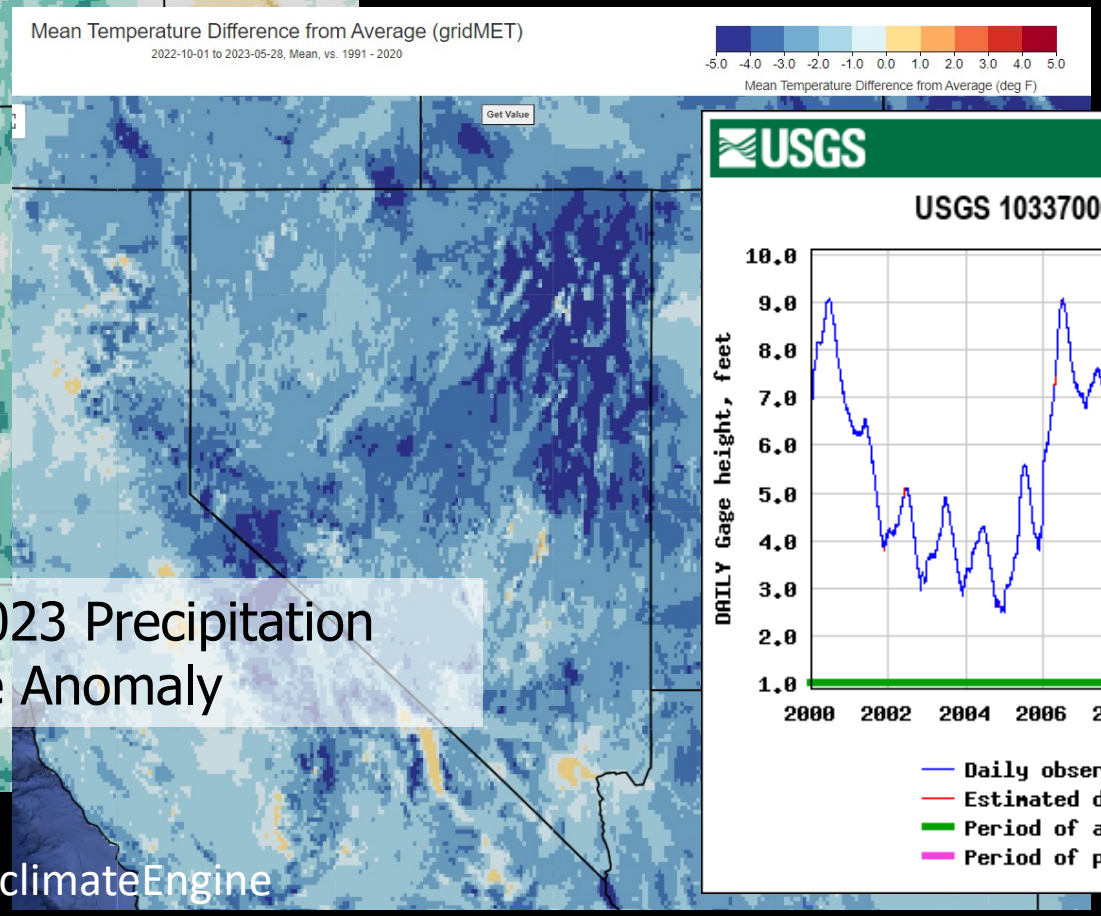
June 6, 2023

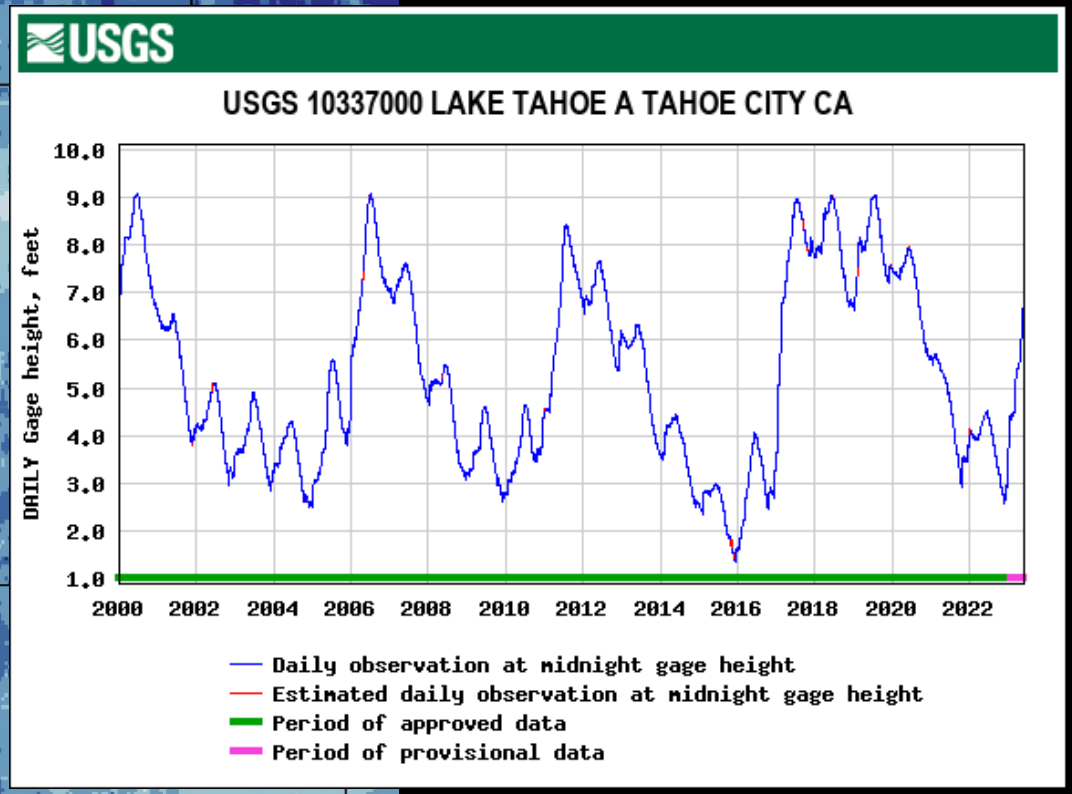
DRI Desert Research Institute

WESTERN REGIONAL CLIMATE CENTER

Weather, climate, and water resources are closely connected in Nevada

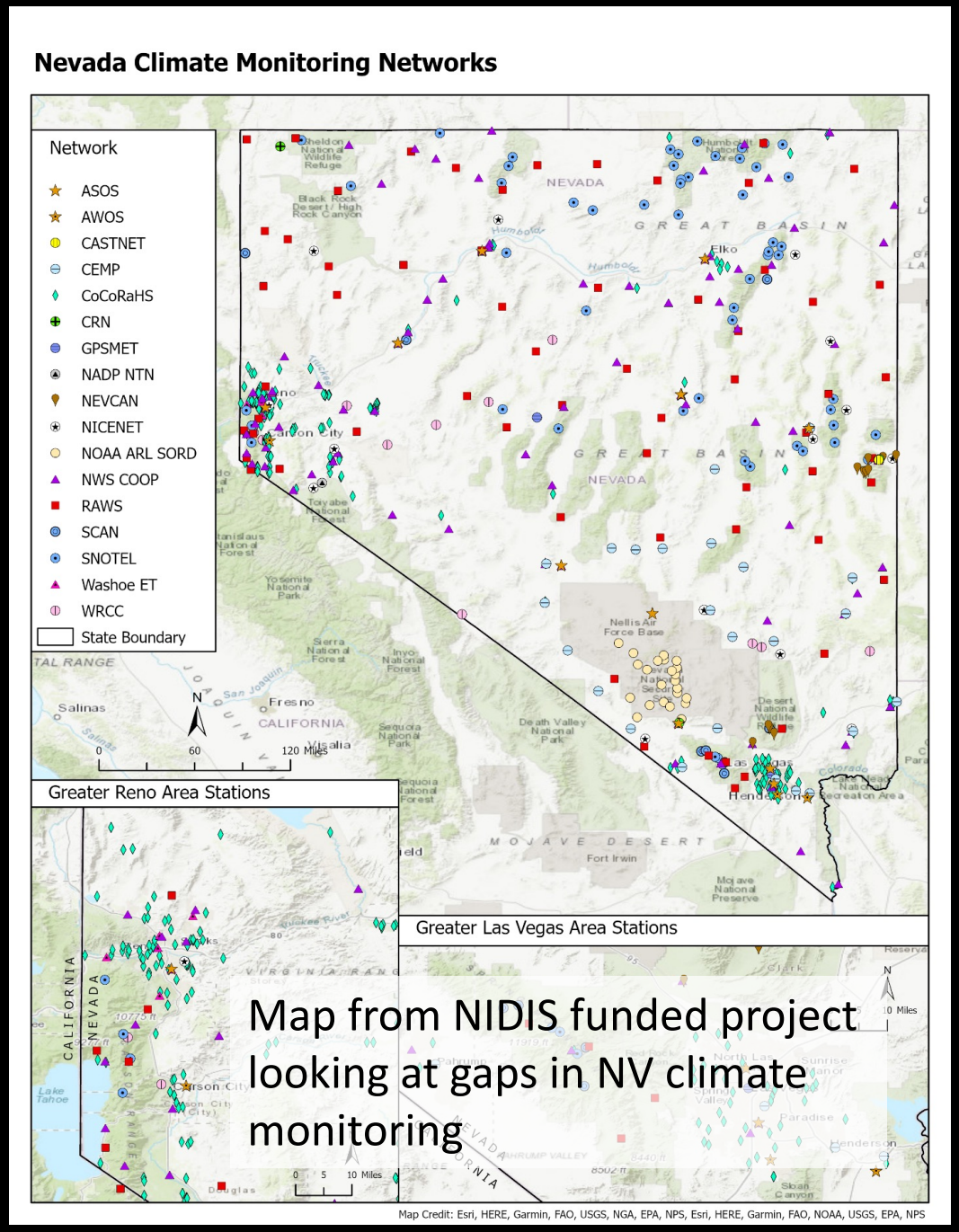


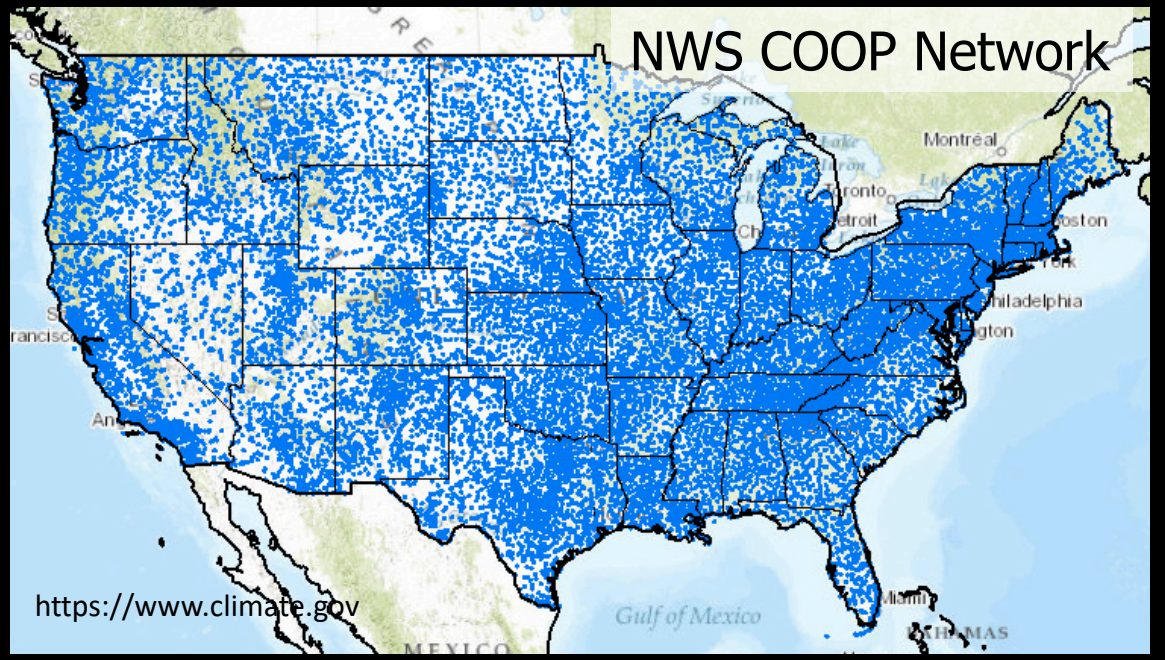




Oct 1-May 28, 2023 Precipitation and Temperature Anomaly

https://app.climateengine.org/climateEngine

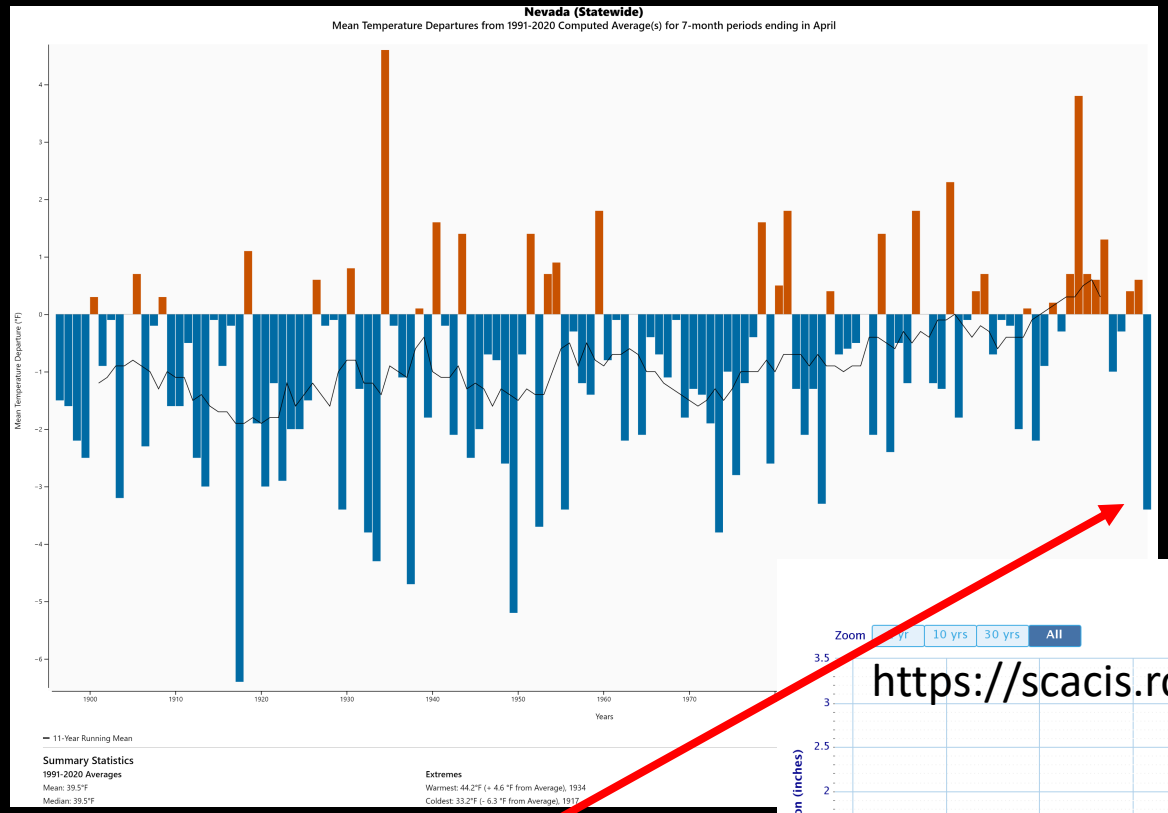




- Weather and climate observations are critical to informing spatial (gridded) climate estimates, forecasts, and future projections
- Observations in Nevada are sparse!

Temperature and Precipitation

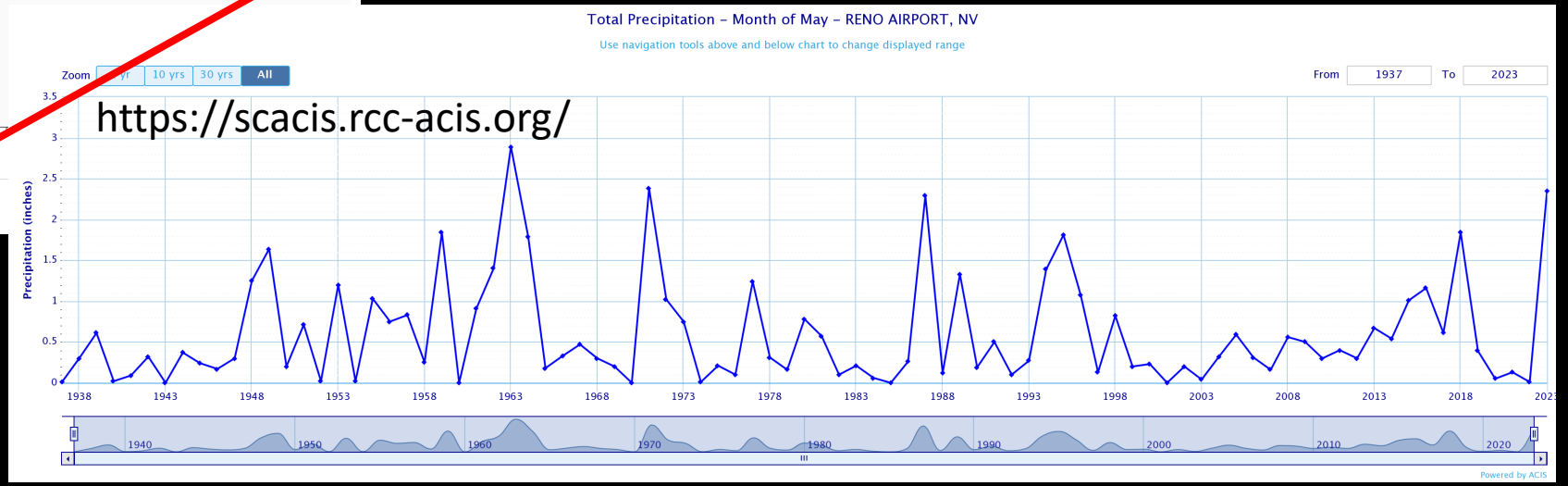
https://wrcc.dri.edu/my/climate/tracker/NV



- 9th coldest Oct-Apr for NV since 1895!

- Most commonly measured variables
- Relatively long observed records (100+ years in some cases)

- Easy to find good station-based and gridded data



Temperature and Precipitation Resources

- Station data:
  - https://wrcc.dri.edu/my/stations/community (under development)
  - https://wrcc.dri.edu/ (WRCC legacy site)

  - https://scacis.rcc-acis.org/

- Gridded data:
  - Heavily rely on station data for interpolation and modeling

  - PRISM: https://prism.oregonstate.edu/
  - gridMET: https://www.climatologylab.org/gridmet.html

Other Meteorological Variables Present More Challenges

- Wind speed, humidity, and solar radiation are critical to water balance estimates, but fewer reliable observations exist relative to temperature and precipitation
- Automated weather stations needed
- More expensive and more upkeep required relative to manual obs. like COOP sites

https://nicenet.dri.edu/

Steptoe Valley NICE Net station in eastern Nevada

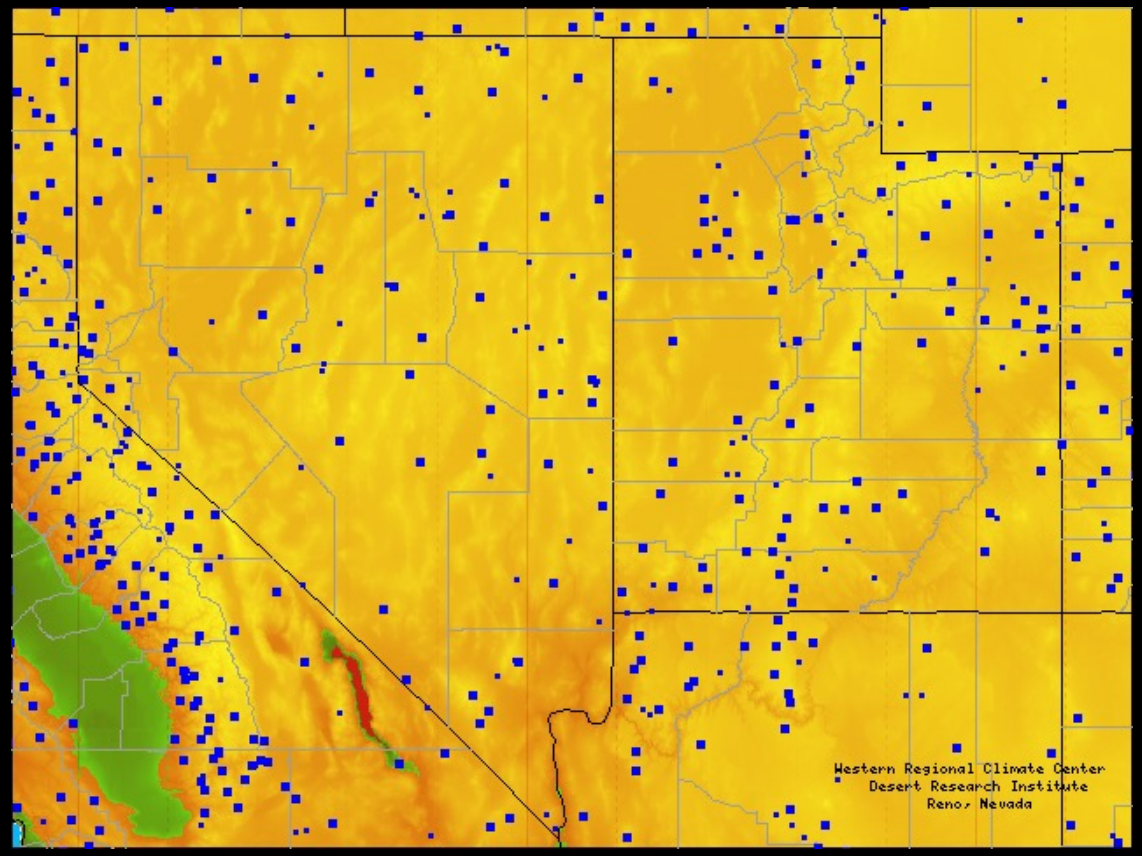
Automated Weather Station Networks

- Full suite of meteorological variables
- Sub-daily time intervals

- Remote Automated Weather Stations (RAWS; user QAQC strongly encouraged): https://raws.dri.edu/

- WRCC stations (including NICE Net): https://wrcc.dri.edu/weather/

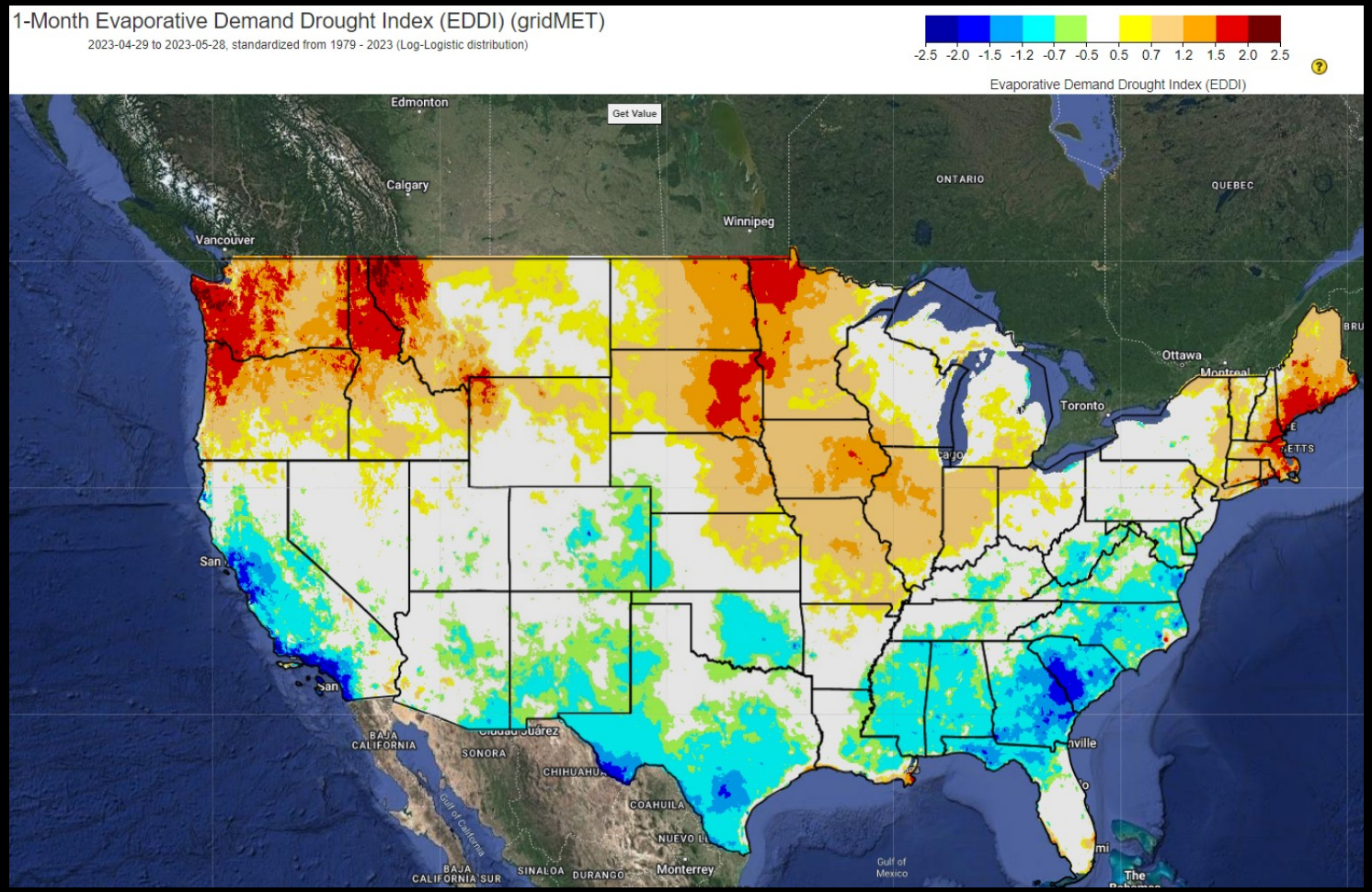
- Airport data/ASOS: https://mrcc.purdue.edu/CLIMATE/



RAWS stations in Nevada

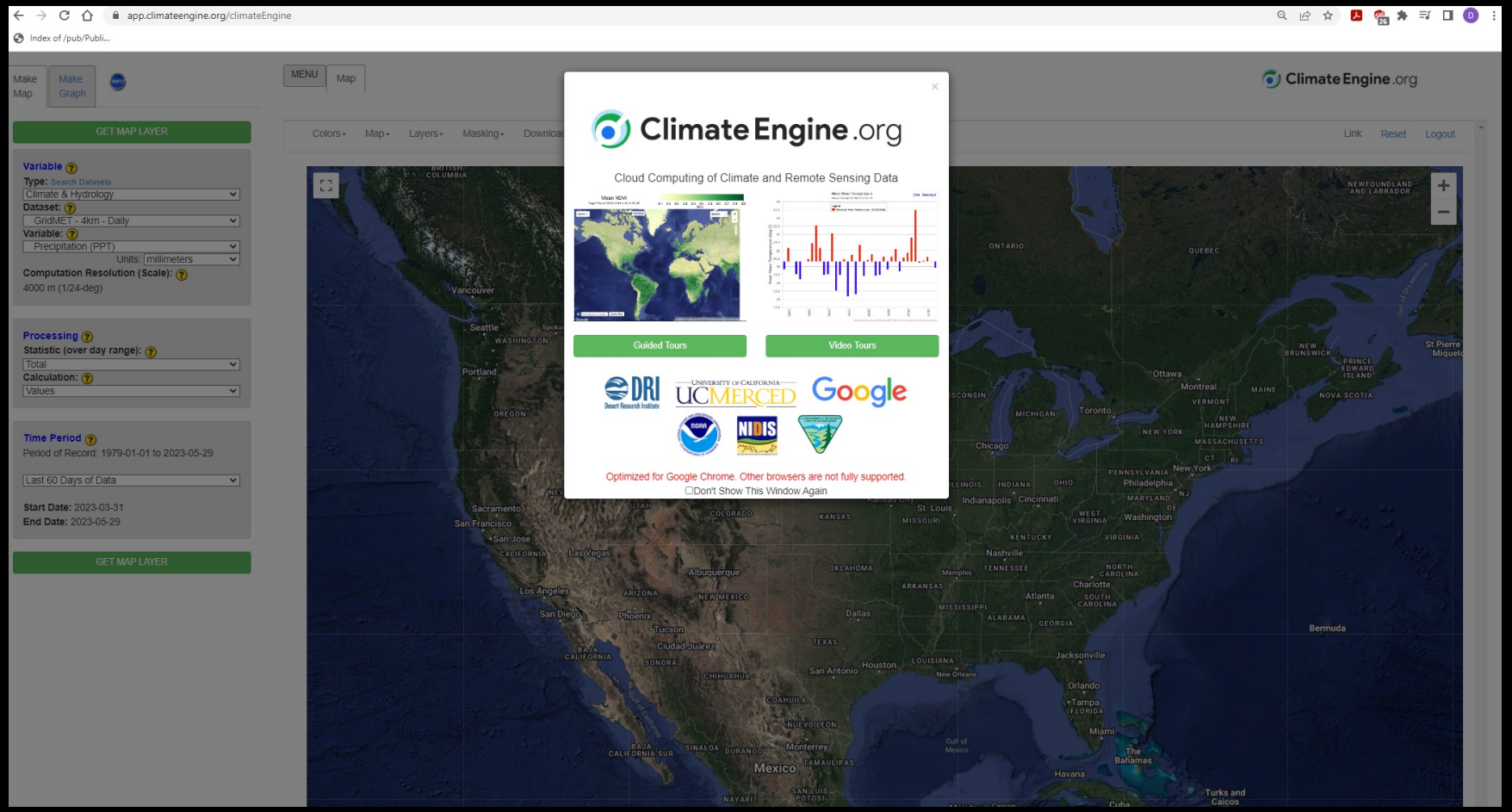
Gridded Estimates of Wind, Humidity, and Solar

- Needed for physically-based evaporative demand estimates
- Drought monitoring (EDDI, SPEI)
- Agricultural consumptive use estimates (reference evapotranspiration)
- gridMET commonly used and I would consider a "best estimate" for Nevada
- Many other atmospheric reanalysis datasets exist



https://app.climateengine.org/climateEngine

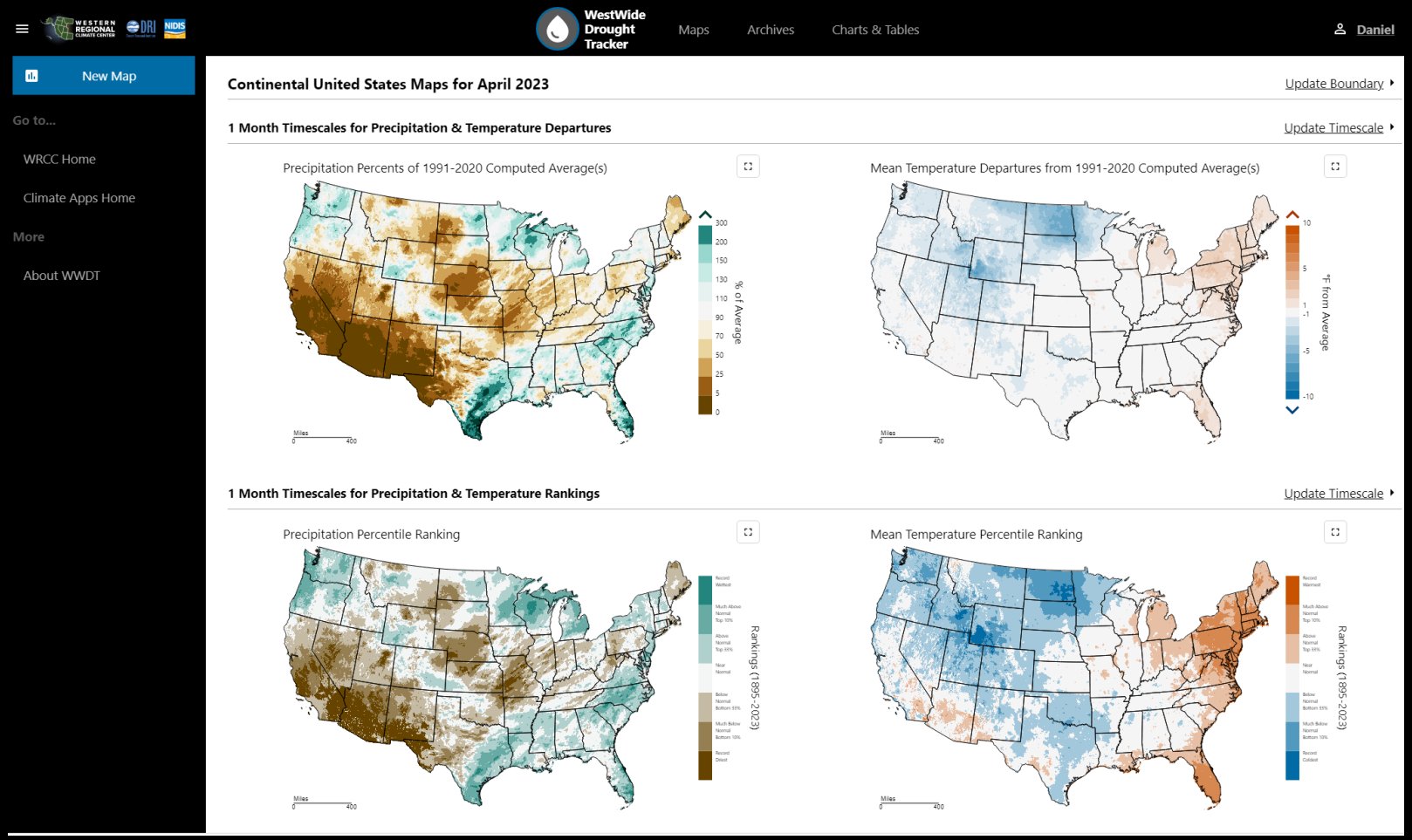
Tools to access gridded data archives



- PRISM, gridMET and *MANY* more gridded data sets available
- Visualize maps and timeseries
- Download data
- Python-based API access available

Web application: https://app.climateengine.org/climateEngine
API: https://docs.climateengine.org/docs/build/html/index.html

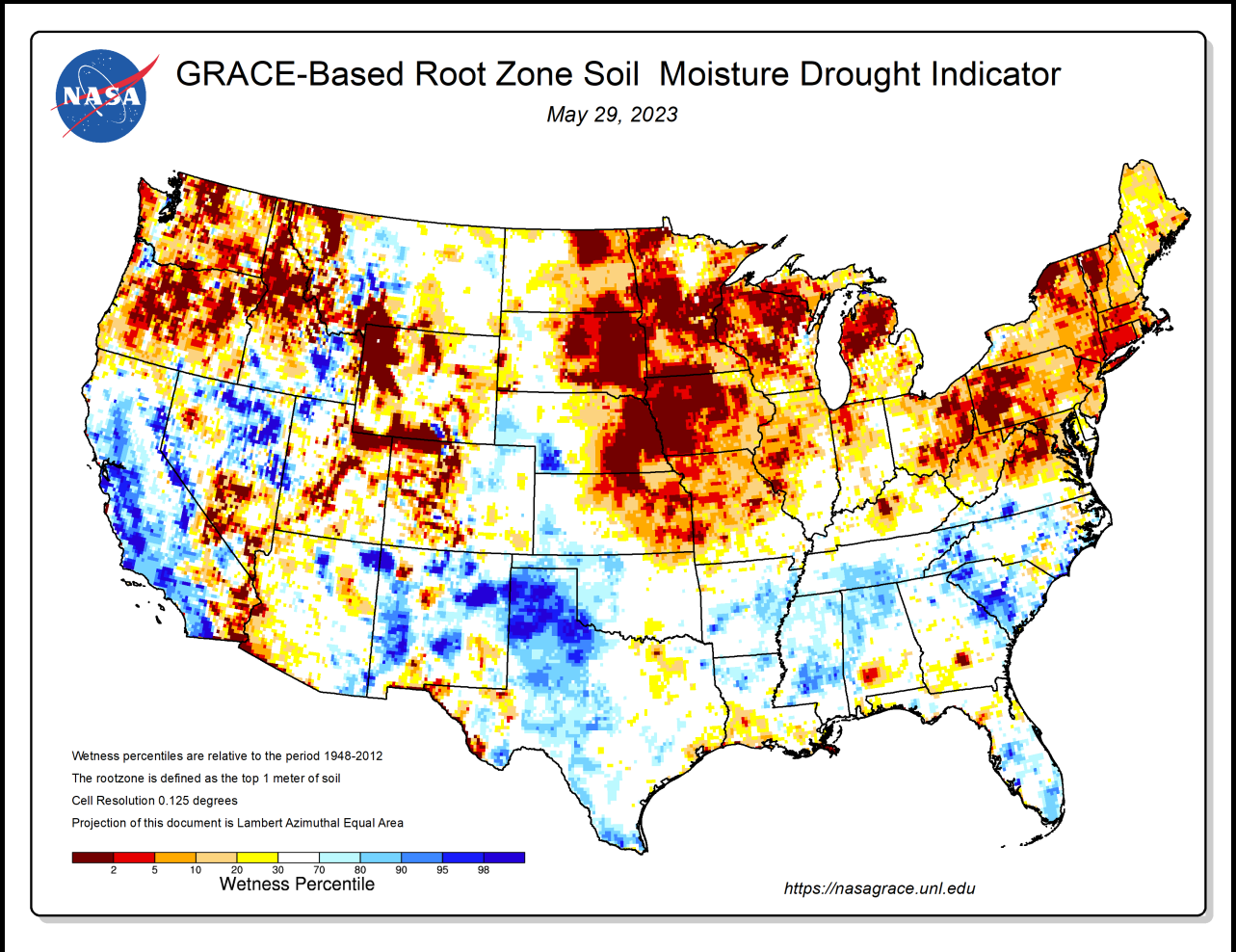
Tools to access gridded data archives



- Climate metrics and drought indices based on PRISM monthly data (1895-present)
- Temperature, precipitation, PDSI, SPI, SPEI
- Maps and data downloads

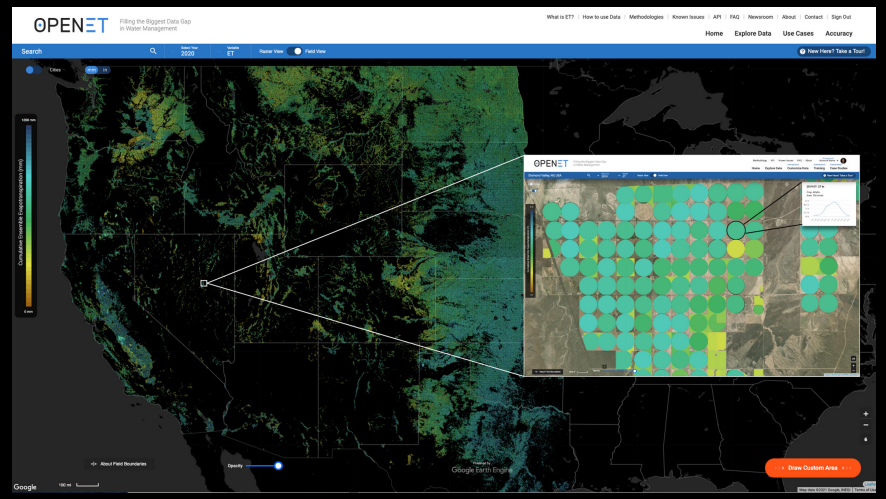
West Wide Drought Tracker
https://wrcc.dri.edu/my/climate/wwdt

Grand Challenges: Evapotranspiration, soil moisture, and groundwater



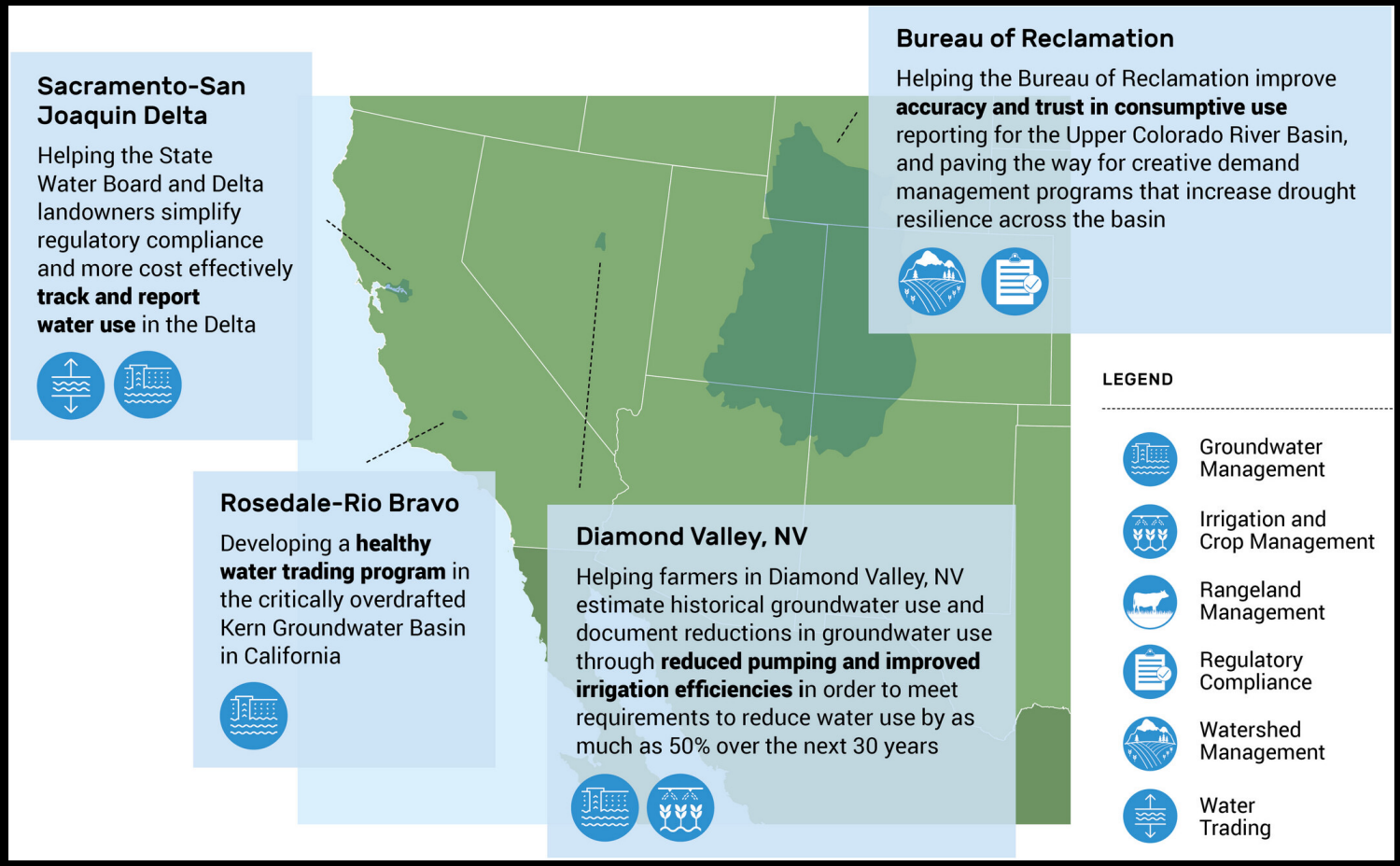
- Few ground-based observations
- Rely heavily on satellite observations and models
- Less data and more uncertainty compared to meteorological variables

Grand Challenges: Evapotranspiration, soil moisture, and groundwater



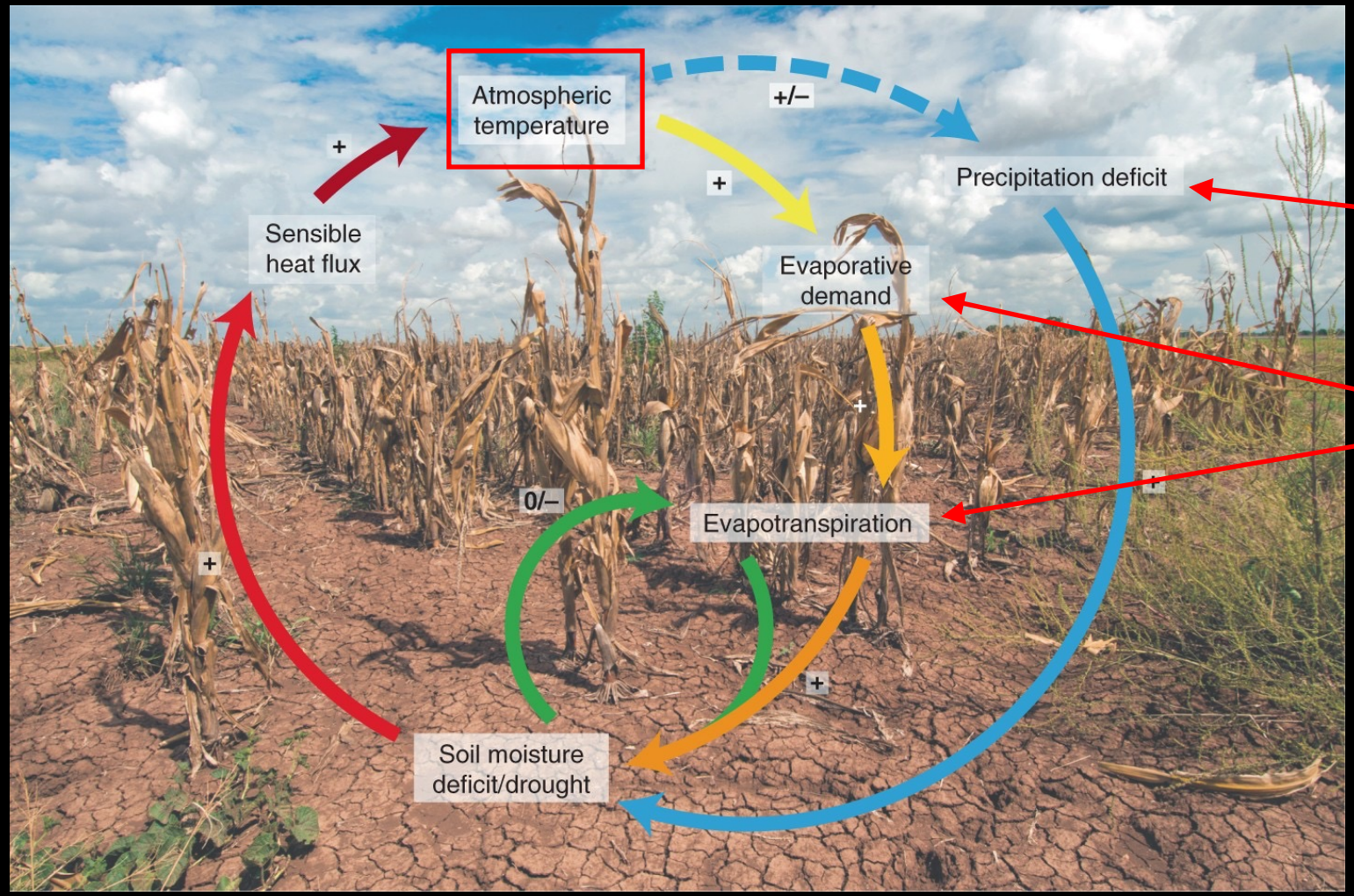
OpenET: https://openetdata.org/

Figures: Melton et al., 2021, OpenET: Filling a Critical Data Gap in Water Management for the Western US, *JAWRA*



In a warming world the demand side of drought is becoming just as important as the supply

Temperature a critical component in atmospheric demand for water



Supply side of drought

Demand side of drought

Teuling, A.J. A hot future for European droughts. *Nature Clim Change* **8,** 364–365 (2018).

NEWS & EVENTS

Evaporative Demand Increase Across Lower 48 Means Less Water Supplies, Drier Vegetation, and Higher Fire Risk

Albano, C. M., Abatzoglou, J. T., McEvoy, D. J., Huntington, J. L., Morton, C. G., Dettinger, M. D., & Ott, T. J. (2022). A Multidataset Assessment of Climatic Drivers and Uncertainties of Recent Trends in Evaporative Demand across the Continental United States. *Journal of Hydrometeorology*, *23*(4), 505-519.

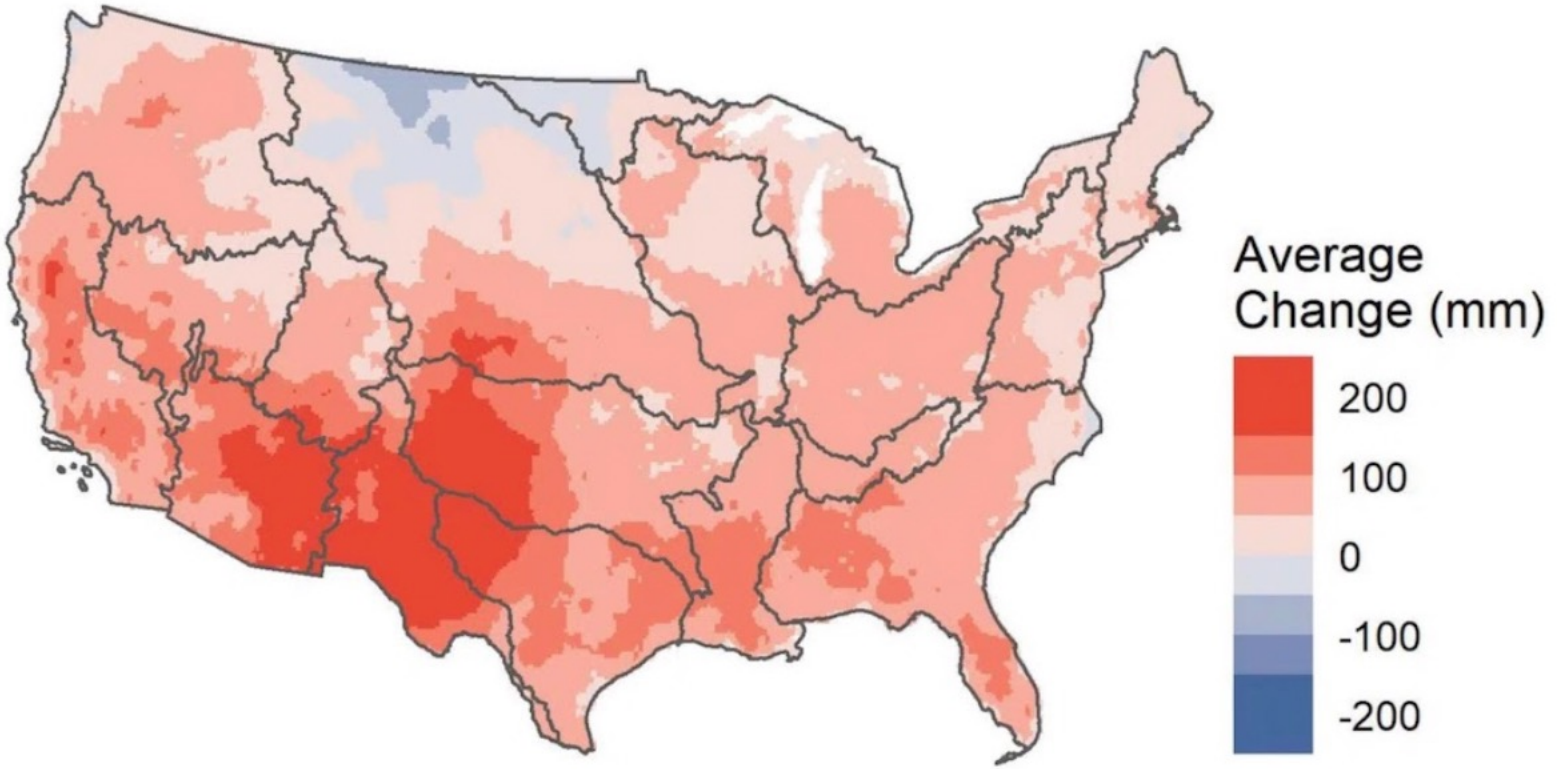
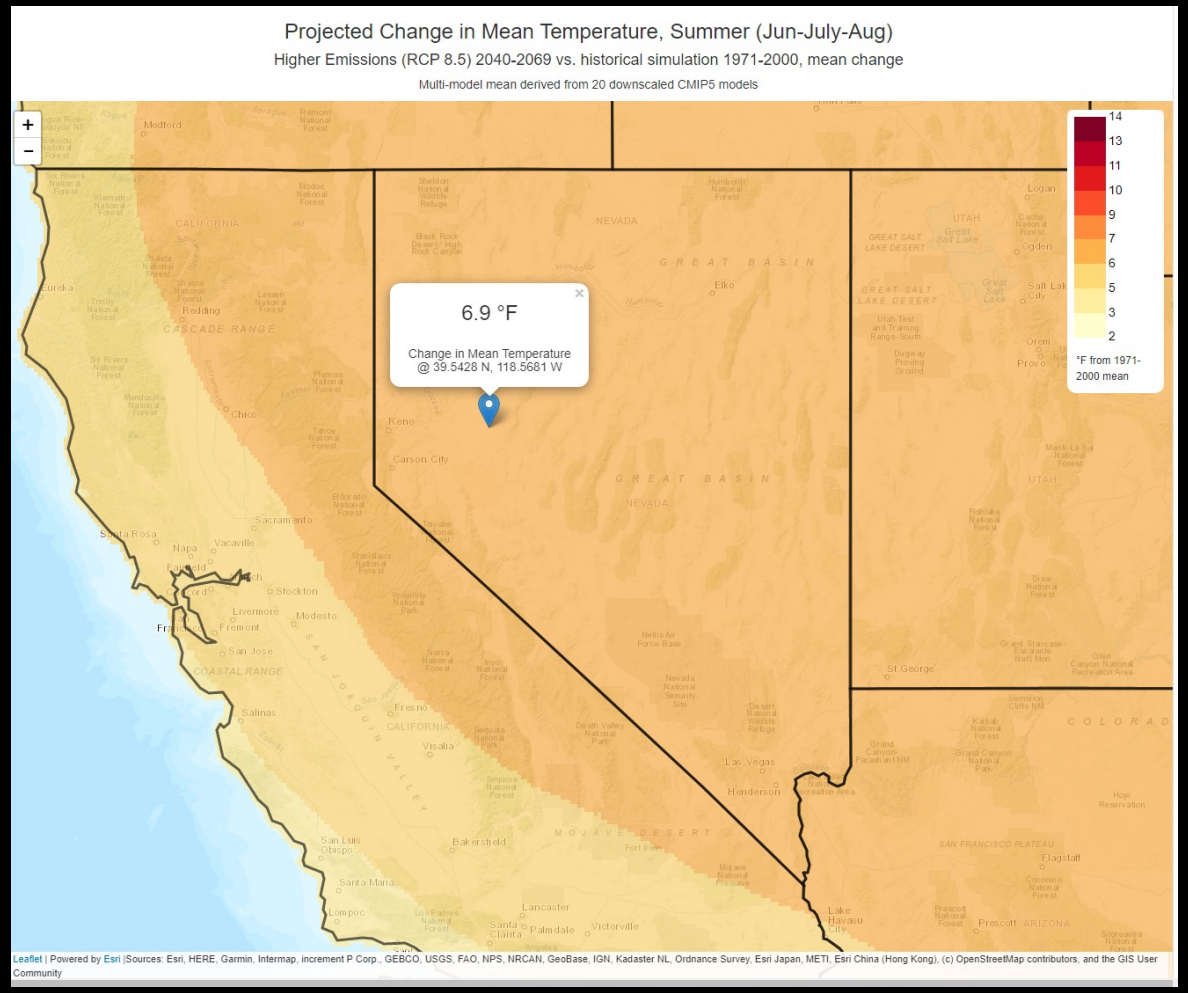


Figure 1. Changes in atmospheric thirst, measured in terms of reference evapotranspiration (mm), from 1980–2020. The largest changes are centered over the Rio Grande region of the southwestern U.S. Credit: Desert Research Institute.

https://www.drought.gov/news/evaporative-demand-increase-across-lower-48-means-less-water-supplies

Future Climate Projections



- Downscaled global climate projections commonly used to assess future changes in drought and water supply
- Land surface models forced with downscaled climate projections used to estimate future water balance states
- Climate Toolbox: great tool with CMIP5-MACA projections currently available

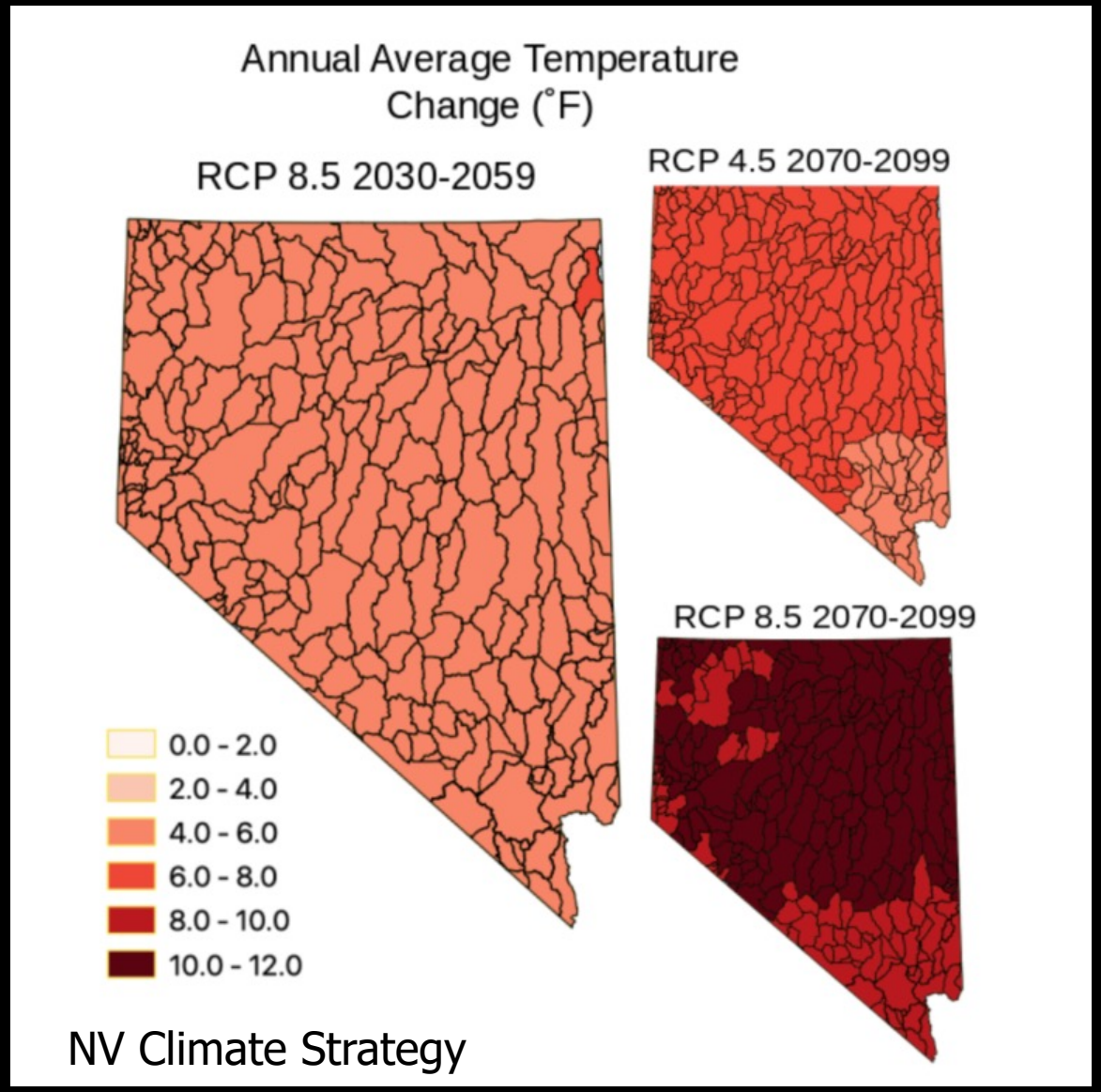
https://climatetoolbox.org/tool/climate-mapper

Table 1. Climate Impacts in Nevada

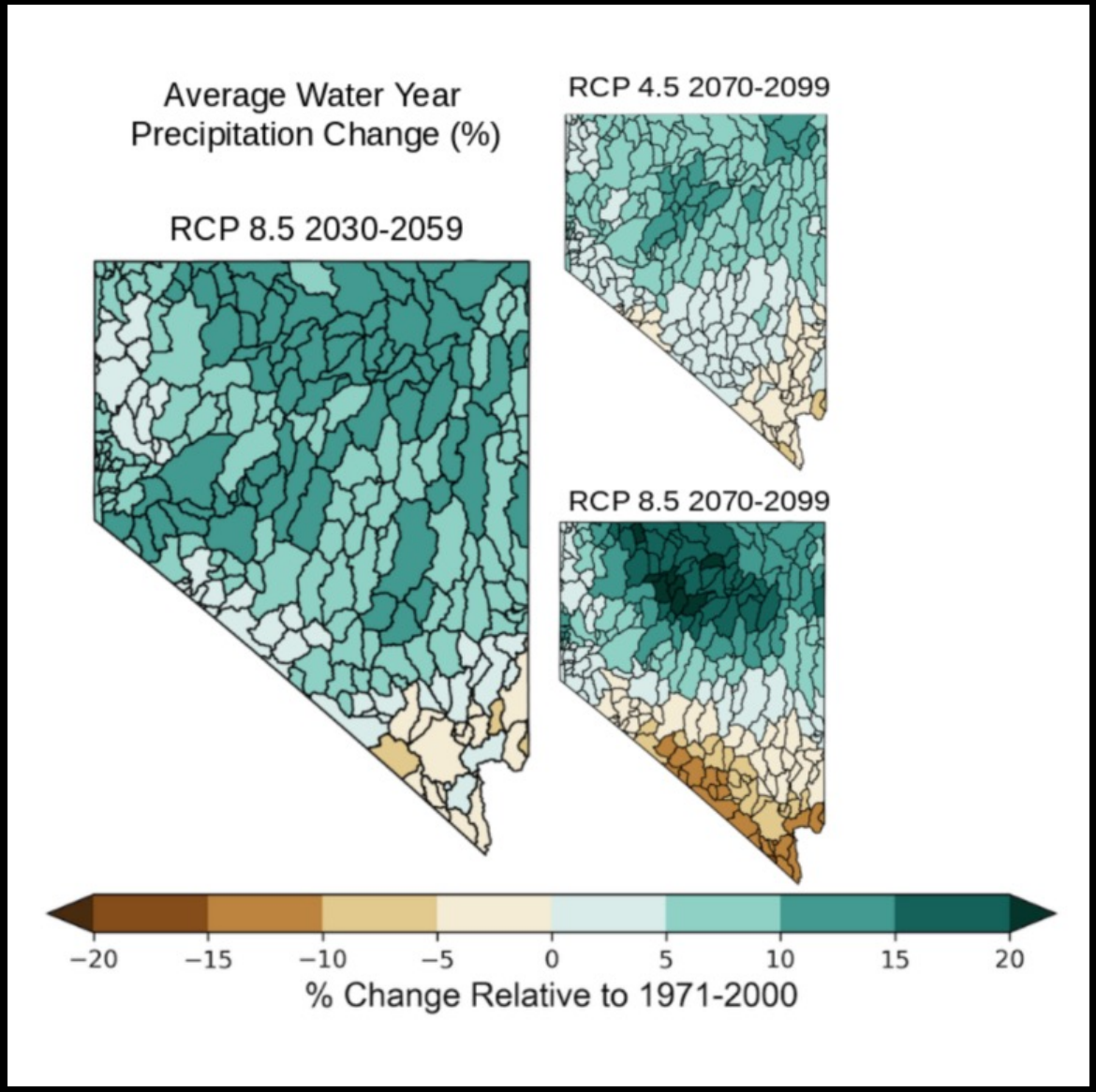
	Heat & Heat Waves	Drought	Loss of Snow	Floods	Wildfire Risk
CLIMATE SCIENCE					
Historical Trends	Increasing temp; Rates of increase are higher in urban areas than rural areas	Increasing evaporative demand; More drought that not in last 10 years	Decrease between 20-60% from 1955-2016	No historical trends; Most recent flooding events are 2017 and 2006	Between 1984-2017, 4 of the 5 years with the largest area burned have occurred since 2005.
Projected Trend & Confidence	Increase in average temp; Increase in frequency and severity of heat waves ***HIGH Confidence***	Increase in frequency and intensity ***Confident***	By the end of this century, projections indicate a potential 30-50% reduction in April snowpacks,; Earlier snow melt ***HIGH Confidence***	More frequent flooding; ***Confident***	Increase of invasive species, increasing fire spread; Increase drying of fuels; Increase precipitation variability affecting fuel production ***HIGH Confidence***
IMPACTS					
Ag and Ranching	Health impacts of being outdoors during heat waves; Heat impacts to livestock health and milk production; Longer growing seasons and new crop varieties; Impacts to plant health and crop production; Delayed or reduced production from adapting to shifting seasons and crop performance	Potential decrease on crop yield and production; Decreased forage quantity, range condition; Water hauling needs; Reduction in use of federal land; Increased need of feeding hay; Reduction in land available for production	Earlier and longer duration of irrigation needs due to decrease in run-off later in the season; Reduced irrigation capacity due to lack of water availability; Reduction in rangeland production	Increase erosion and soil loss; Potential crop loss/damage; Damage to water holding and confinement structures; Microbial contamination of crops	Direct livestock losses; Potential impact on forage production due to wildfire-induced changes in vegetation cover including noxious weeds; Crop and forage loss; Federal land permits closed or temporally closed due to fire; Loss of infrastructure

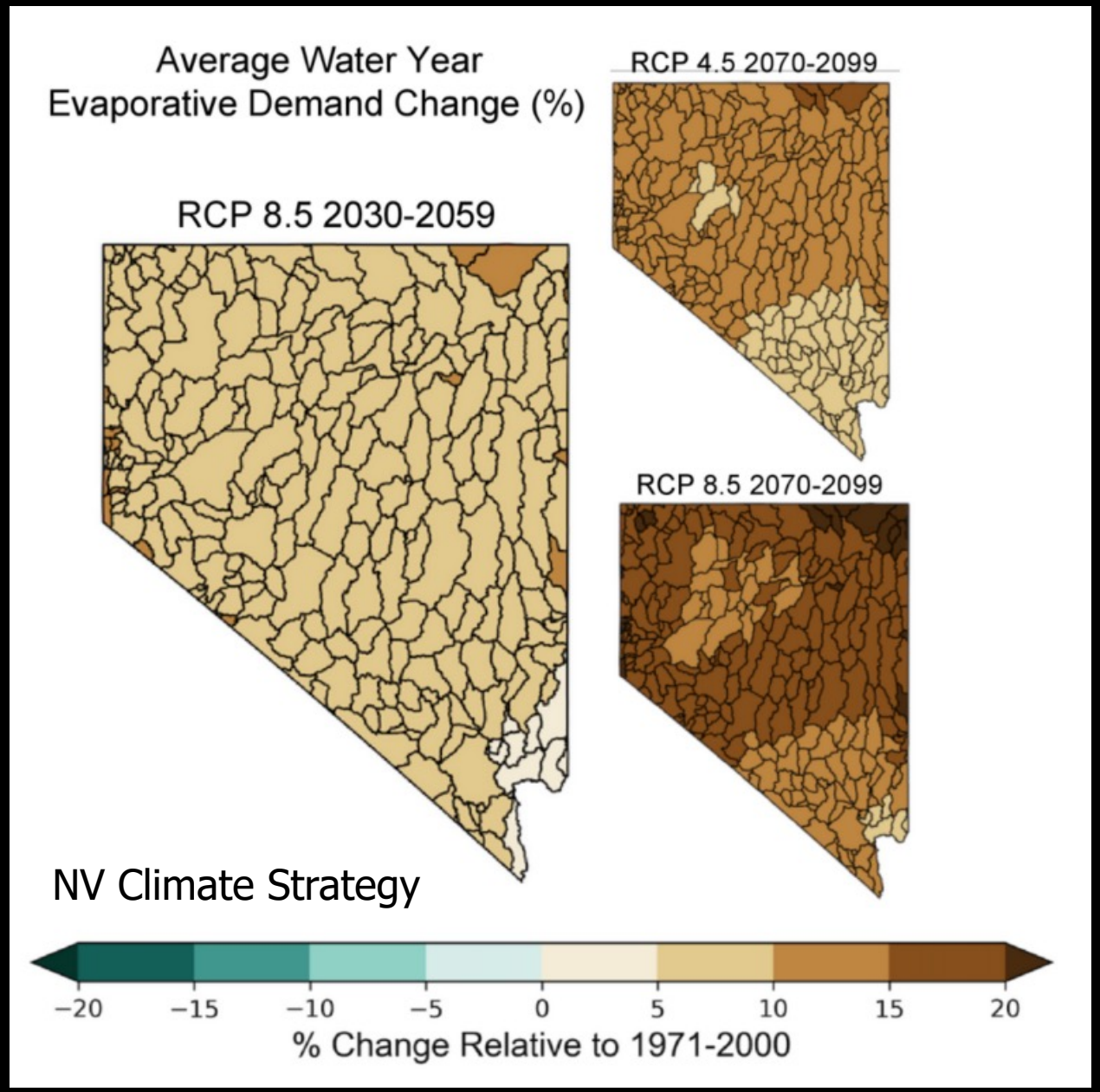
Table from NV Climate Strategy

Examples of how historical and projected trends can be translated to impacts and sectors



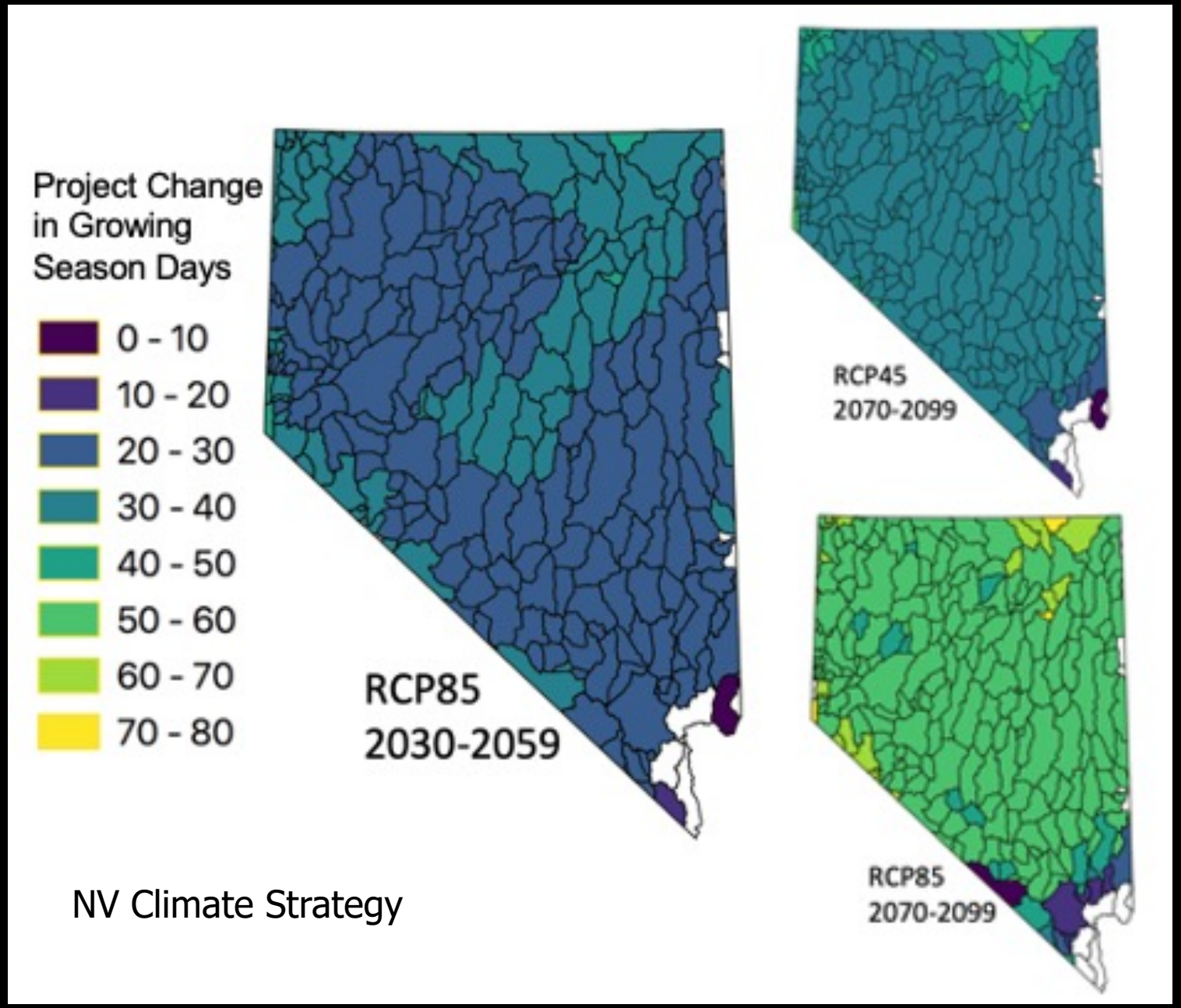
NV Climate Strategy





Evaporative demand = ***atmospheric thirst*** for moisture from the ground

Uniform increases across Nevada driven largely by increased temperatures



NV Climate Strategy

Not ***all*** climate change impacts will be negative

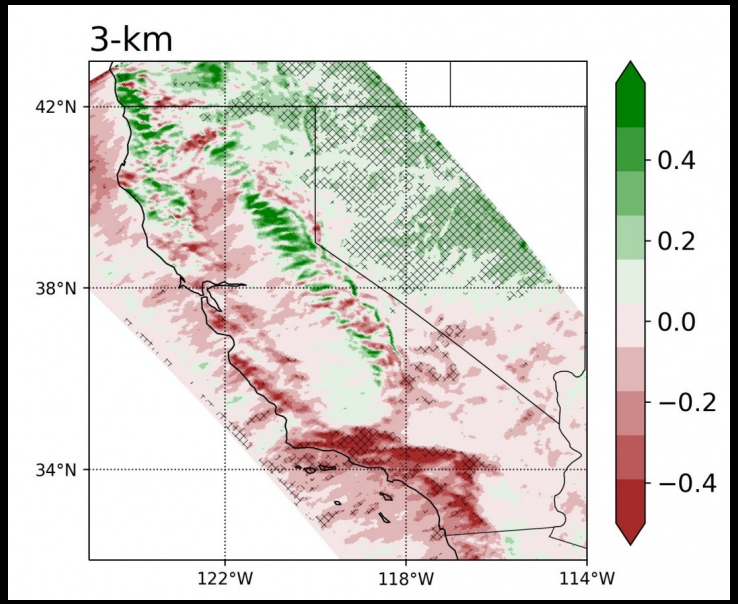
Growing season length expected to increase

However, there will also be more atmospheric demand for water and more time irrigating

Future Climate Projections

- Data from NV Climate Strategy still available; based on LOCA CMIP5 projections
- LOCA CMIP6 (LOCA2) projections of temperature and precipitation at 6 km spatial resolution currently available: https://downscaling.lbl.gov/data/
- Unfortunately, the higher resolution LOCA2 CMIP6 that includes wind, humidity, solar, and land surface model outputs will only be available for part of NV
- NASA downscaled projections at 25 km are available that include temp, precip, wind, solar and humidity

LOCA2 domain



https://dept.atmos.ucla.edu/alexhall/downscaling-cmip6


Thank you!
Email: mcevoyd@dri.edu
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Parkdale, OR, June 13, 2022
Photo: Dan McEvoy