Climate Change Impact on Alfalfa and other Forages in the San Joaquin Valley

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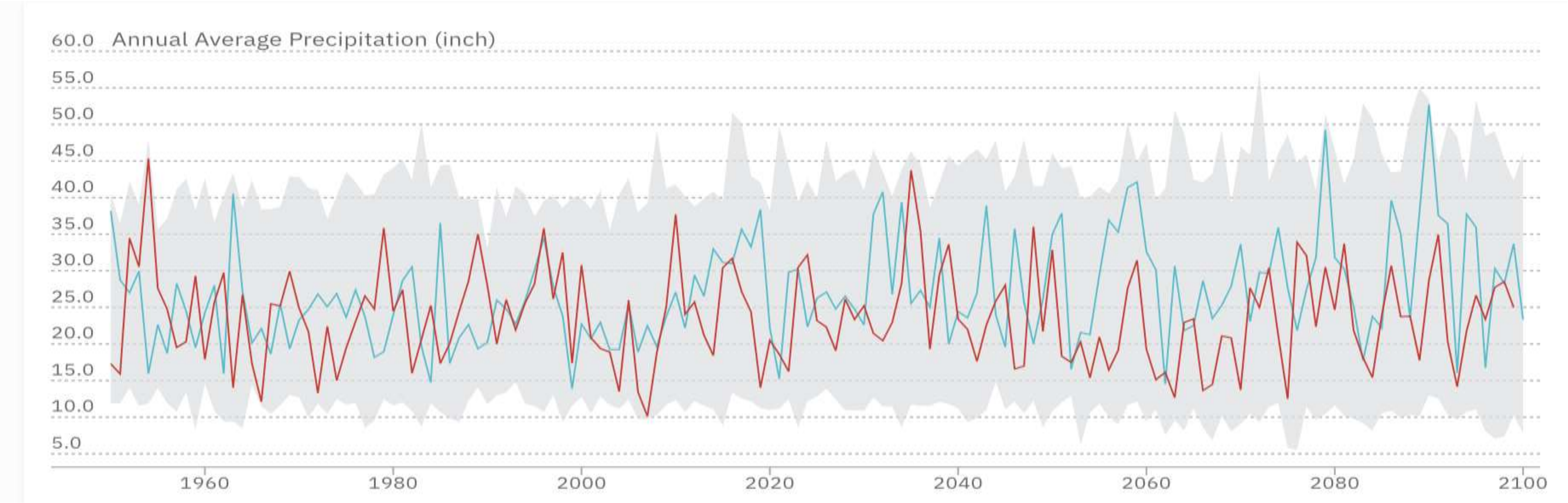
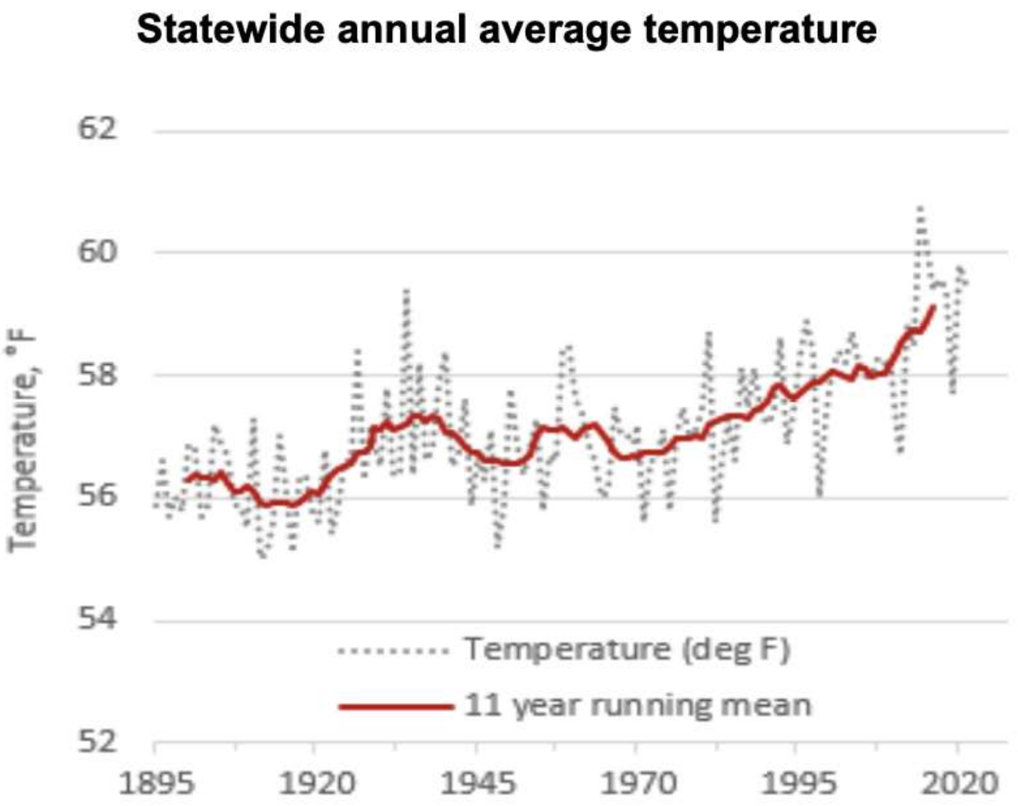
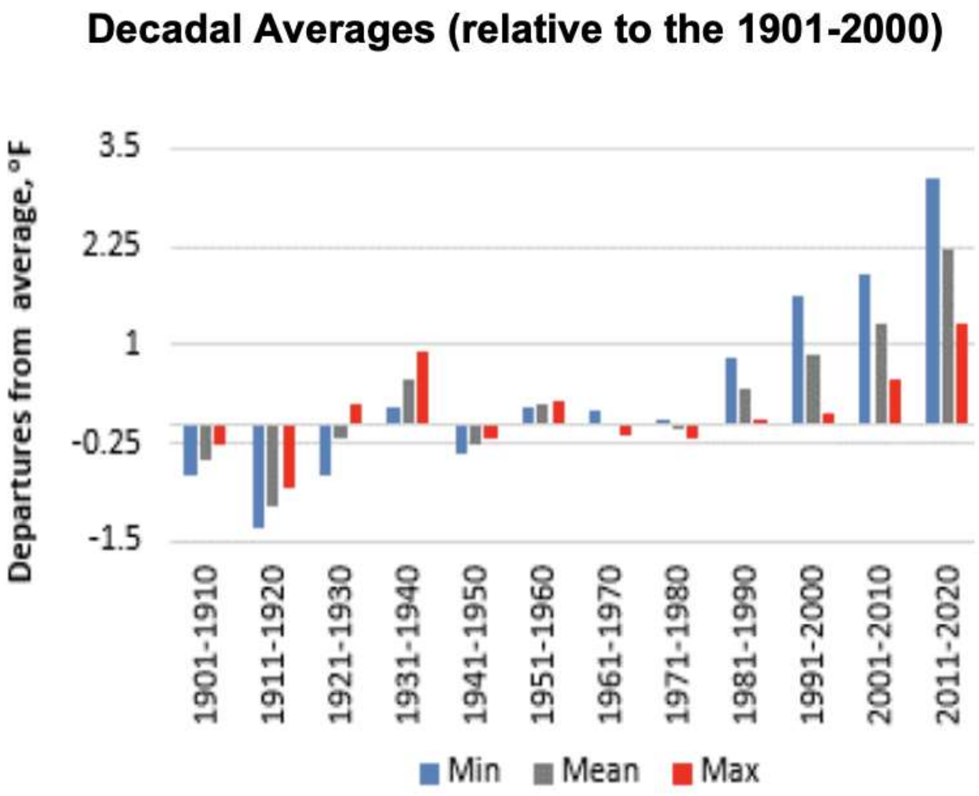
California Precipitation Trends



Ref: Cal-Adapt.Org

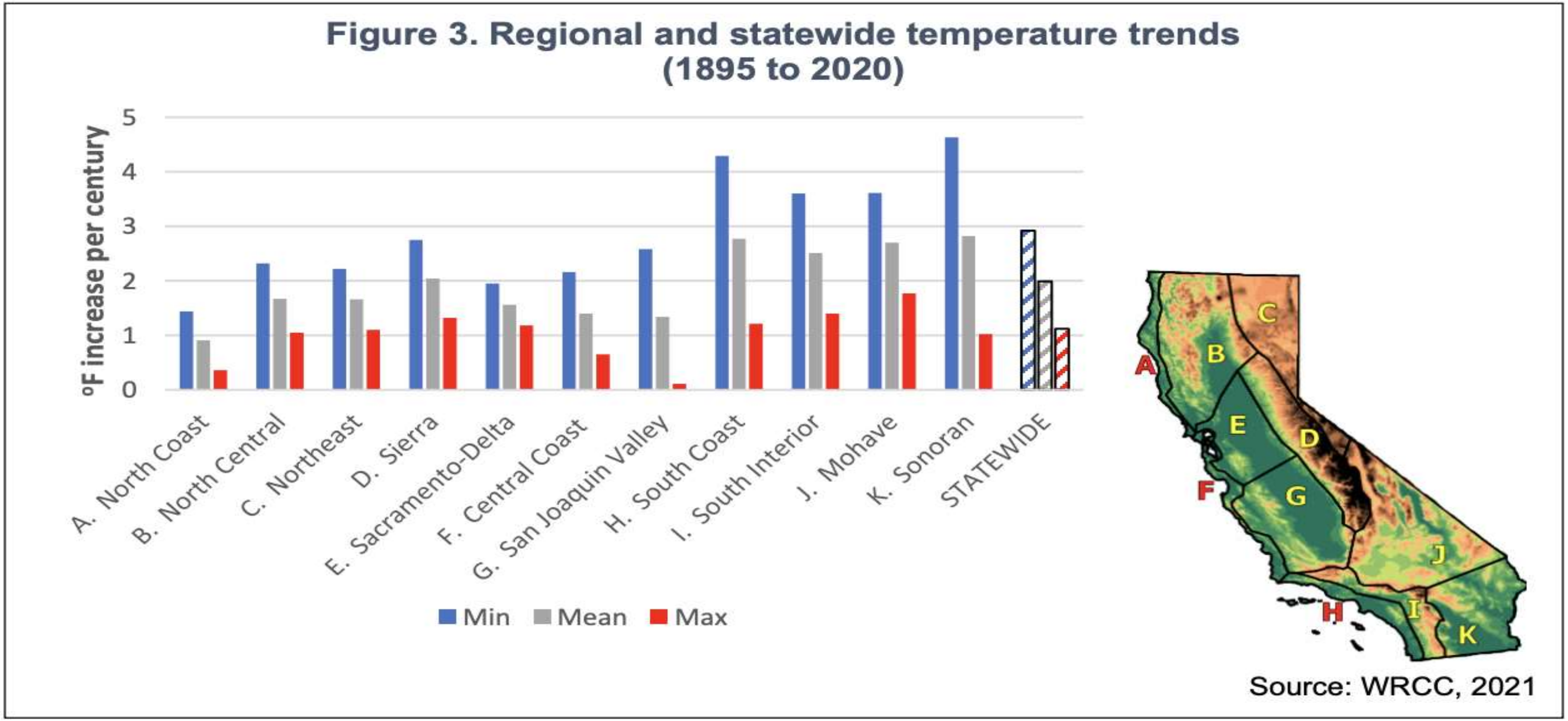
Temperature – Historical Trend



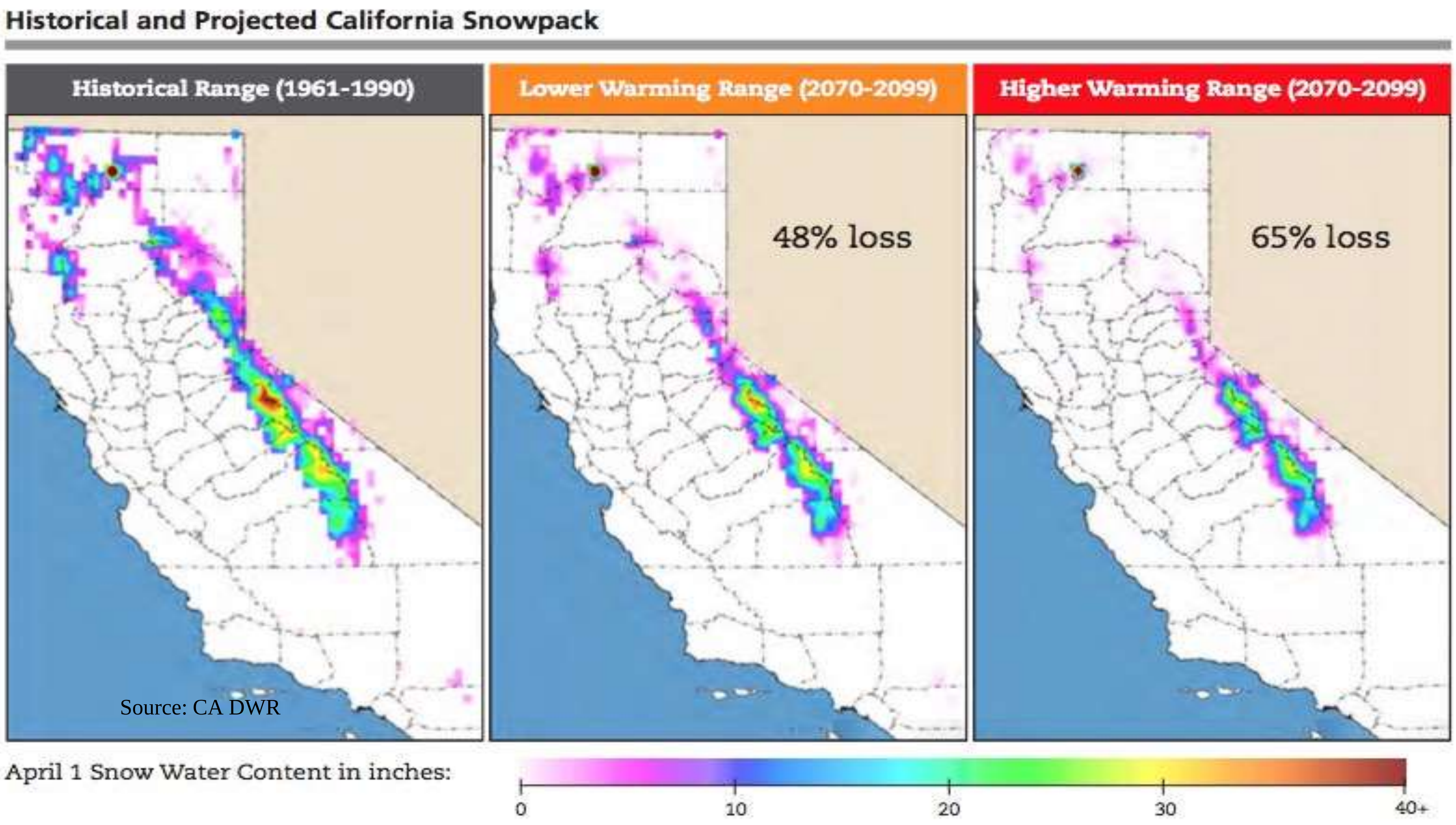


Annual average statewide temperatures have increased, warming at a faster rate beginning in the 1980s. Decadal averages show marked warming during the last four decades—with each decade successively warmer than the preceding. Compared to yearly averages between 1901 and 2000, average minimum and maximum temperatures were higher by 3.1°F and 1.3°F, respectively, in 2011 to 2020.

Changes in California Temperatures



Snowpack

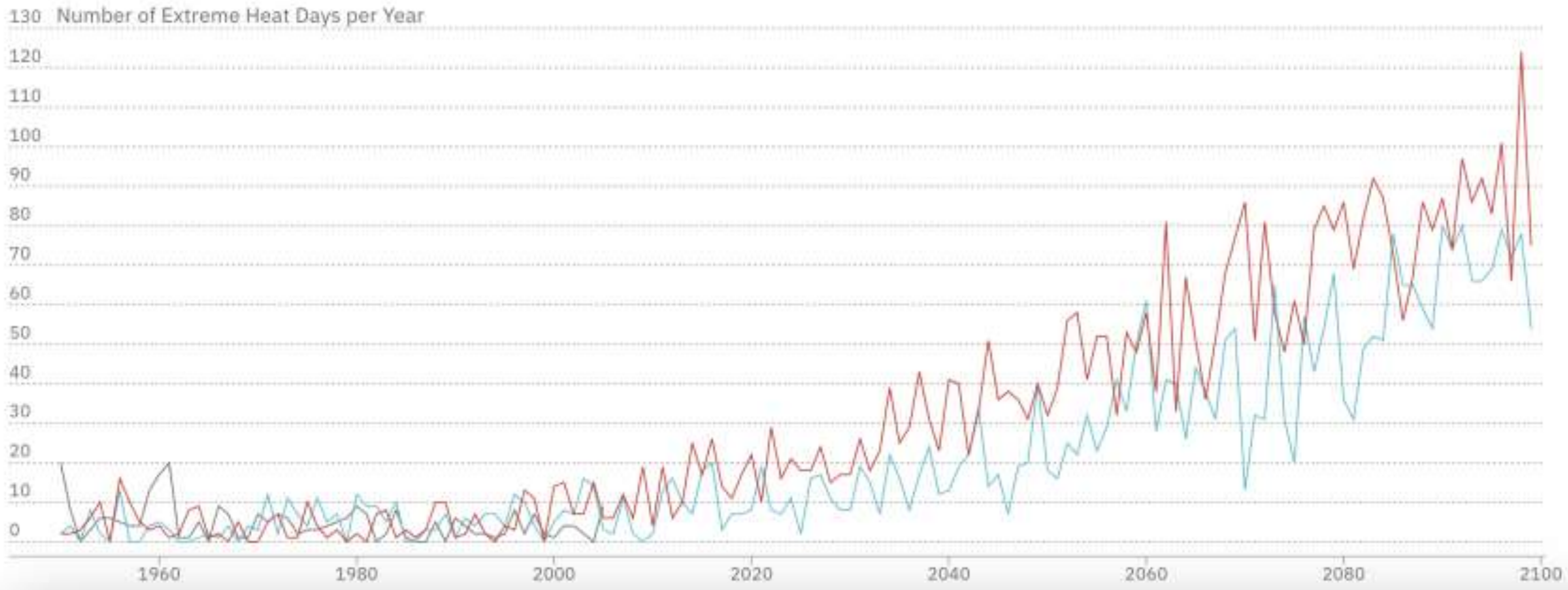


- A loss of 48% and 65% of the snowpack is projected under low and high emission scenarios, respectively
- By 2081–2100, average temperatures in the Sierra Nevada are projected to increase by about 7–10 degrees F

Extreme Heat (T>104°F)

Projected changes in **Number of Extreme Heat Days per Year** when **daily maximum temperature** is above **103.9 °F** under a **High Emissions (RCP 8.5) Scenario**.

MODELED HISTORICAL		FUTURE PROJECTIONS		FUTURE PROJECTIONS	
Baseline (1961-1990)		**Mid-Century (2035-2064)**		**End-Century (2070-2099)**	
Change Period		Change Period		Change Period	
30 YEAR AVG	30 YEAR RANGE	30 YEAR AVG	30 YEAR RANGE	30 YEAR AVG	30 YEAR RANGE
4 days/yr	0–13 days/yr	38 days/yr	6–81 days/yr	65 days/yr	13–124 days/yr
Learn More		Learn More		Learn More	



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SELECT CLIMATE VARIABLE

- (•) Extreme Heat Days
- ( ) Warm Nights

Learn More

SELECT INDICATOR

Frequency

Learn More

SELECT SCENARIO

- ( ) Medium (RCP 4.5)
- (•) High (RCP 8.5)

Learn More

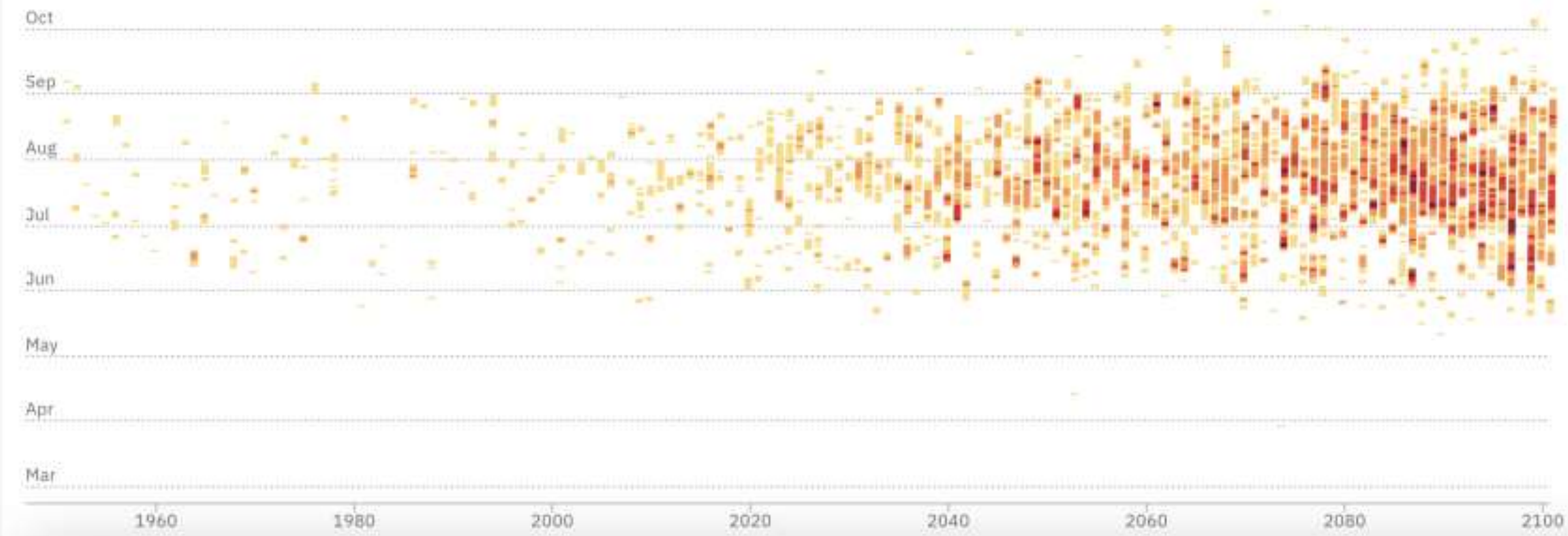
SET THRESHOLD

Ref: Cal-Adapt.org

Timing of Extreme Heat

Projected changes in **Timing of Extreme Heat Days per Year** when **daily maximum temperature** is above **103.9 °F** under a **High Emissions (RCP 8.5) Scenario**.

MODELED HISTORICAL		FUTURE PROJECTIONS		FUTURE PROJECTIONS	
Baseline (1961-1990)		**Mid-Century (2035-2064)**		**End-Century (2070-2099)**	
Change Period		Change Period		Change Period	
EARLIEST IN 30 YEARS	LATEST IN 30 YEARS	EARLIEST IN 30 YEARS	LATEST IN 30 YEARS	EARLIEST IN 30 YEARS	LATEST IN 30 YEARS
May	September	April	October	March	October
Learn More		Learn More		Learn More	



Learn More

SELECT CLIMATE VARIABLE

- Extreme Heat Days (selected)
- Warm Nights

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SELECT INDICATOR

Timing

Learn More

SELECT SCENARIO

- Medium (RCP 4.5)
- High (RCP 8.5) (selected)

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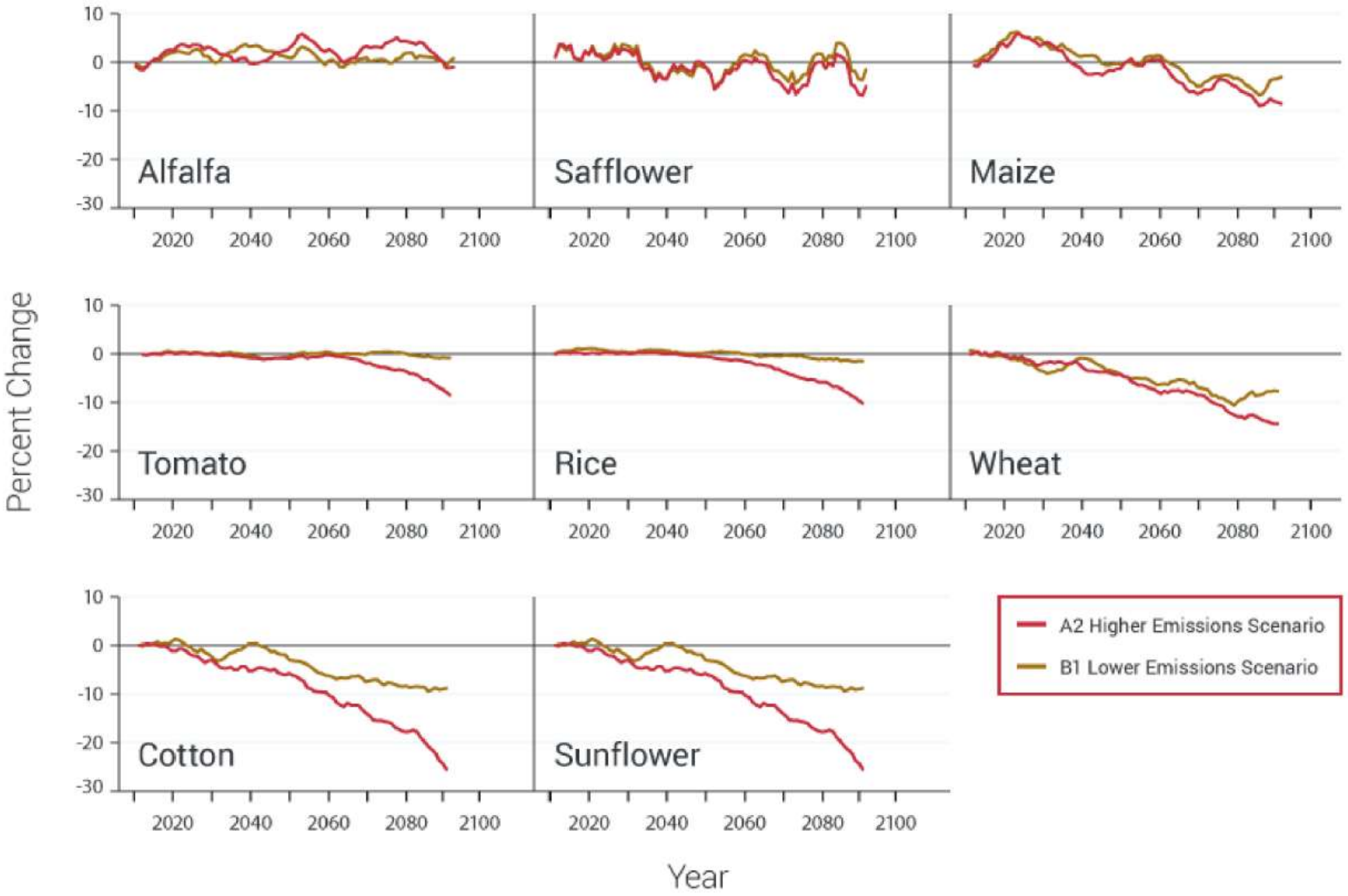
SET THRESHOLD

Add a new threshold value or select from list

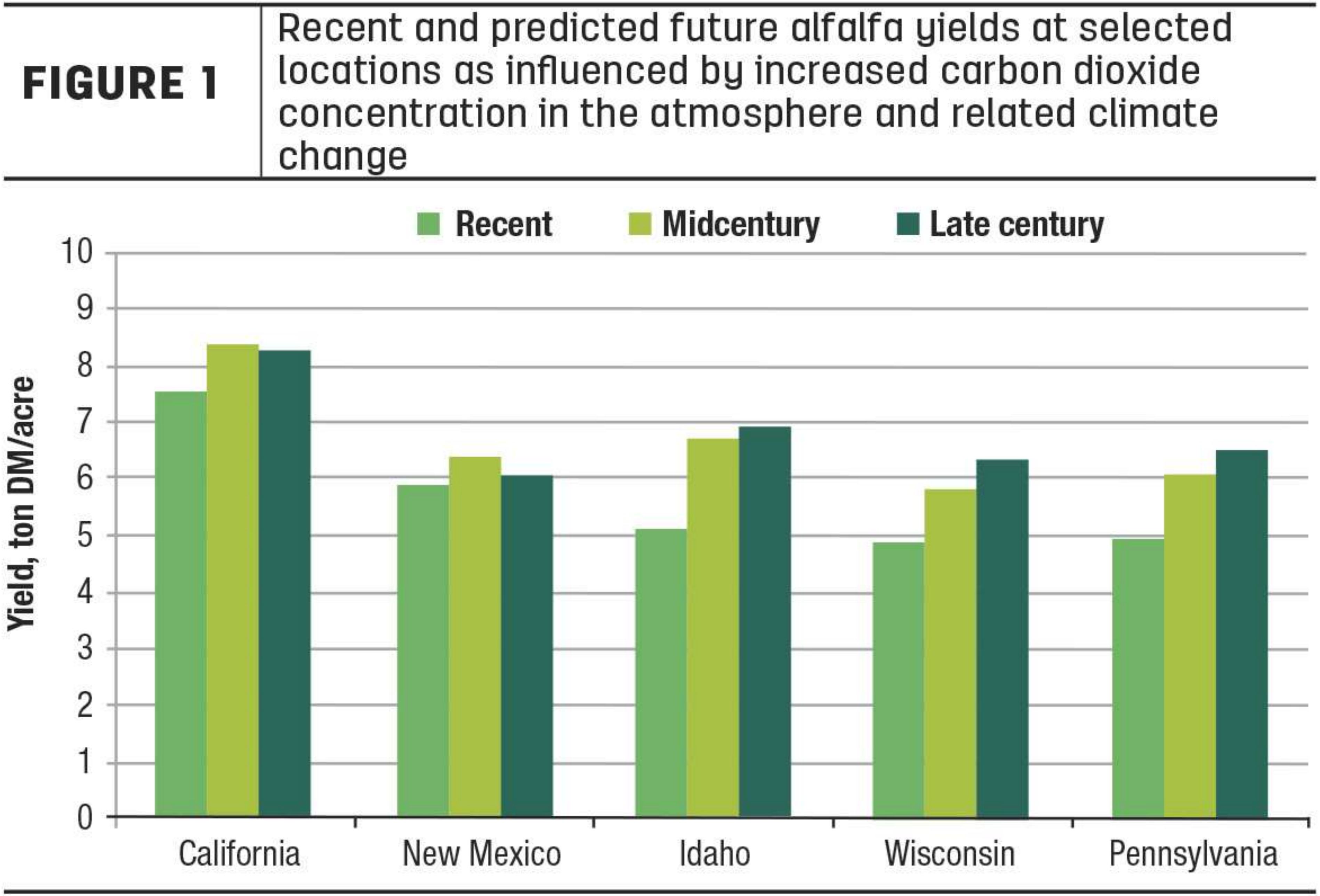
Reference: cal-adapt.org

Impacts on Agriculture

Impacts on Crop Yield



- Expected yield reductions by 2097: cotton (≈ 29%) > sunflower (≈ 26%) > wheat (≈ 15%) > maize (12%) > rice (≈ 10%) > tomato (≈ 9%)
- These yield declines were mainly due to temperature
- Limitations related to water supply to irrigated croplands
- Adaptation measures such as management practices and improved cultivars may alleviate some of the impacts



Reference: Alan Rotz, **https://www.agproud.com/articles/56535-climate-change-and-alfalfa-production**

Optimum temperature ranges

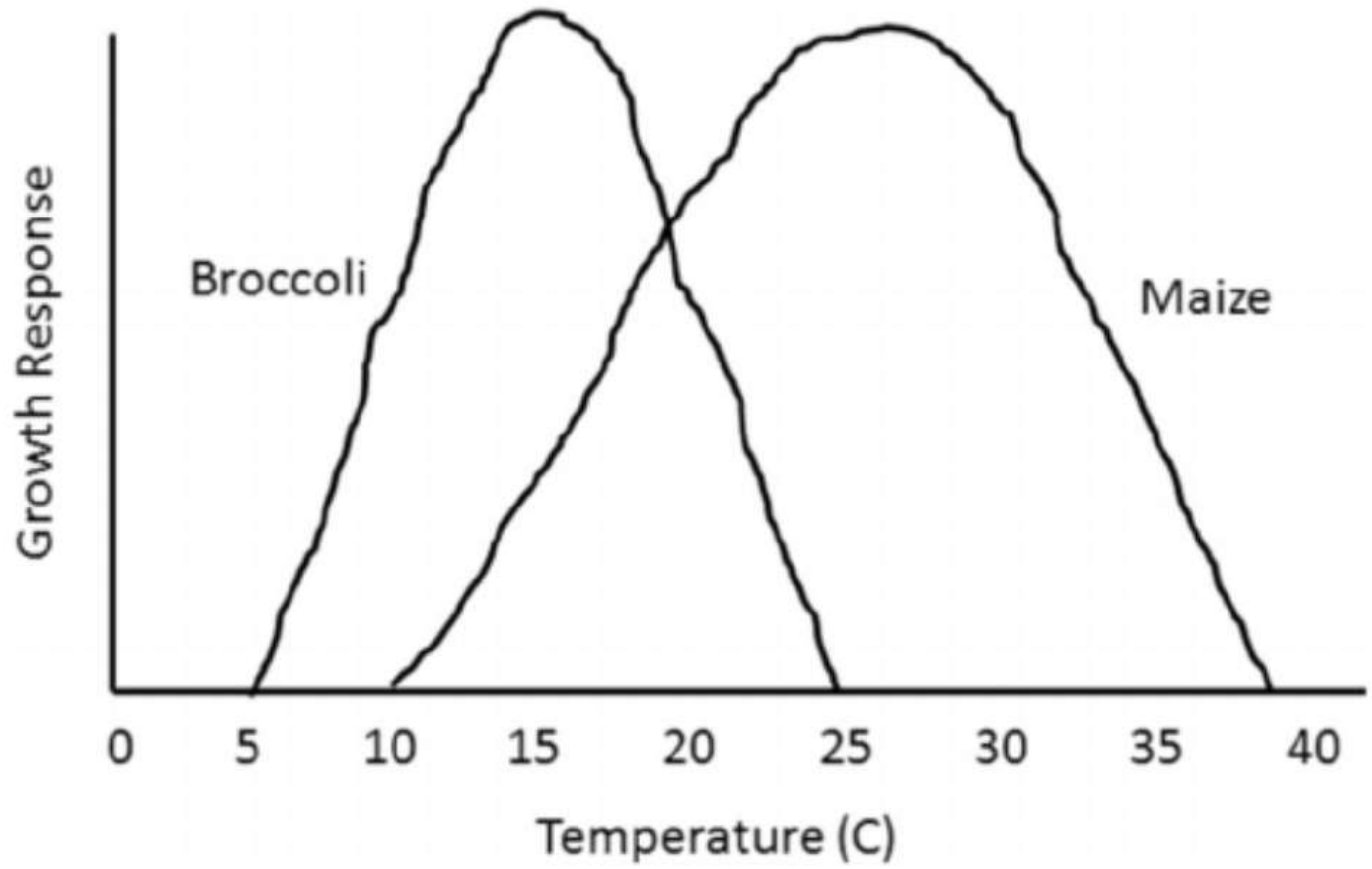


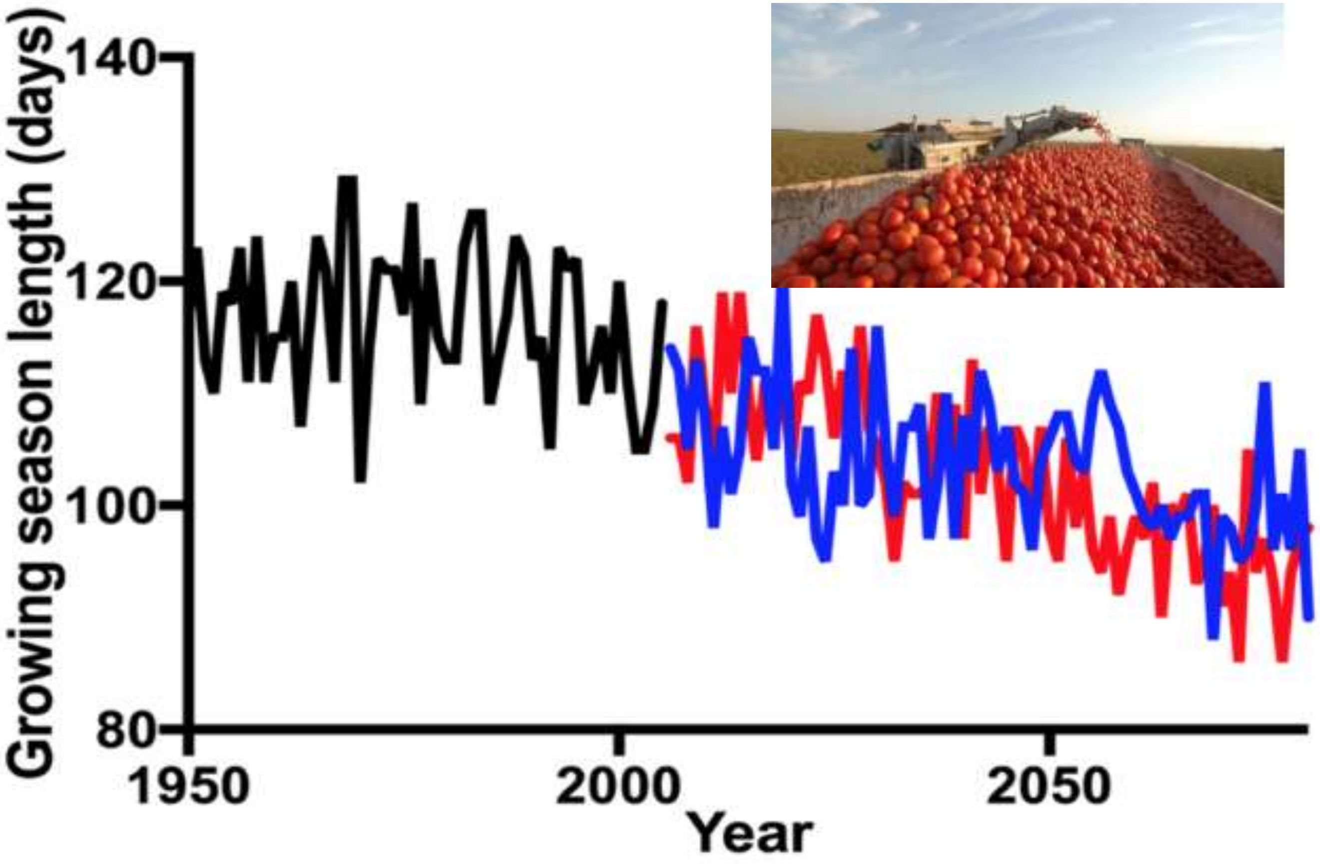
Fig. 1. Temperature response for maize and broccoli plants showing the lower, upper and optimum temperature limits for the vegetative growth phase.

Hatfield et al., 2015

Implications for Alfalfa

- Outside the optimum temperature range, quality of hay is impacted.
- Elevated nighttime temperature can result in higher respiration rates, impacting accumulated nutrients during the day and resulting in low feed value

Impacts on Crop Phenology/Maturity

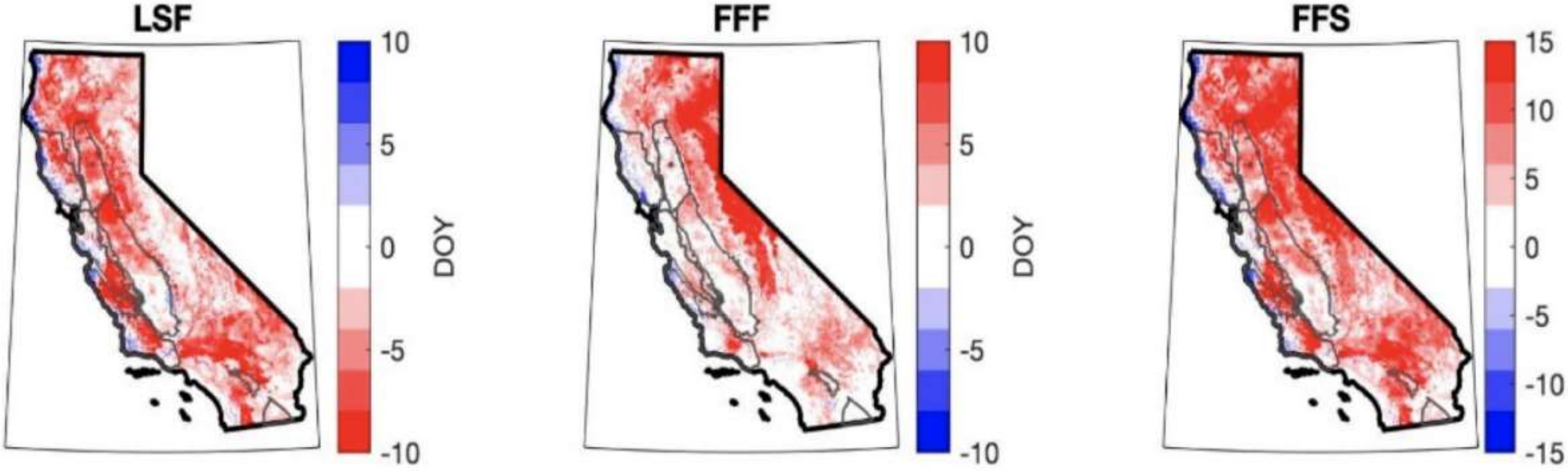


Implications for Alfalfa

- With warmer temperatures Alfalfa can blooms/mature faster as it directly relates to heat units
- Faster maturity can have impacts on the quality of feed as it may not have enough time to replenish needed nutrients

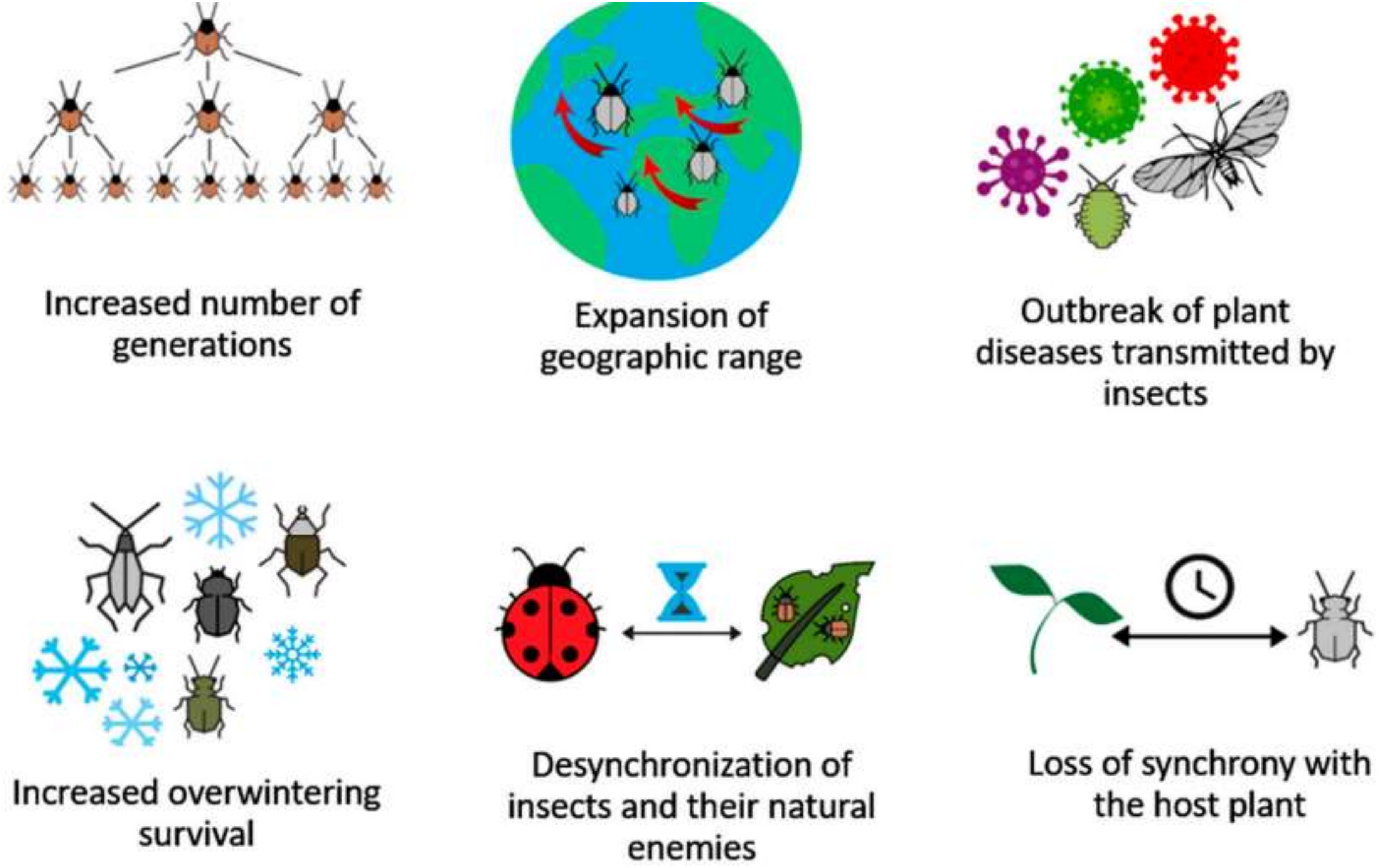
Pathak and Stoddard, 2018 https://link.springer.com/article/10.1007/s40808-018-0460-y

Length of the growing season



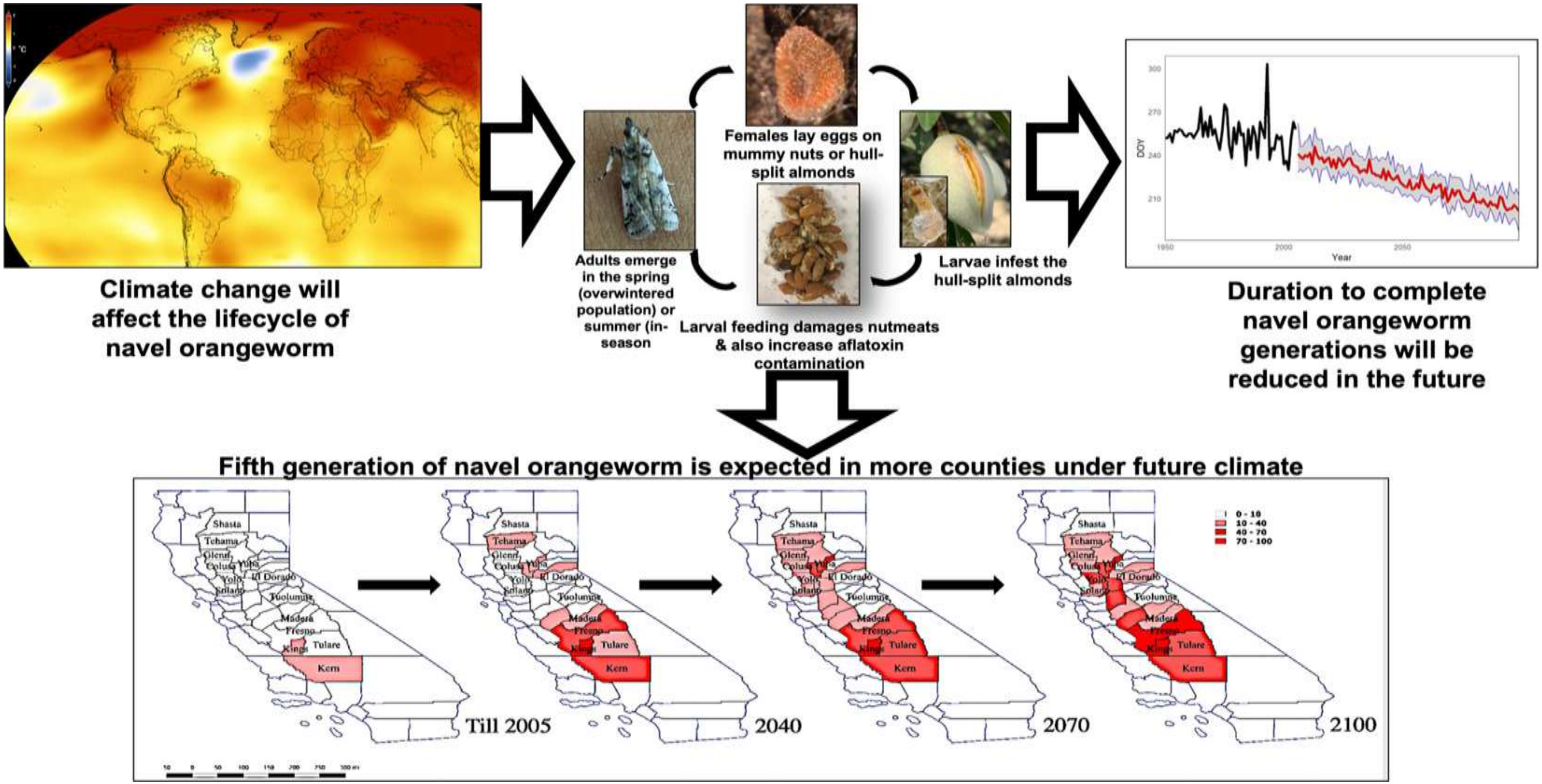
Lauren E. Parker; Ning Zhang; John T. Abatzoglou; Steven M. Ostoja; Tapan B. Pathak. 2022.

Climate change impacts on pests



Skendžić et al. 2021

Climate change impacts on pests



Pathak et al., 2021 https://www.sciencedirect.com/science/article/pii/S0048969720361866

Decision Support Tools

CalAgroClimate

Decision Support Tools for Managing Risks

TOOLS

Heat Advisory	Frost Advisory	Crop Phenology	Pest Advisory	Agroclimate Indicators
Maximum temperature forecast.	Minimum temperature forecast.	Calculate growing degree days.	Tool to predict crop pest life stage.	Historical data aggregated by county.

USDA California Climate Hub
U.S. DEPARTMENT OF AGRICULTURE

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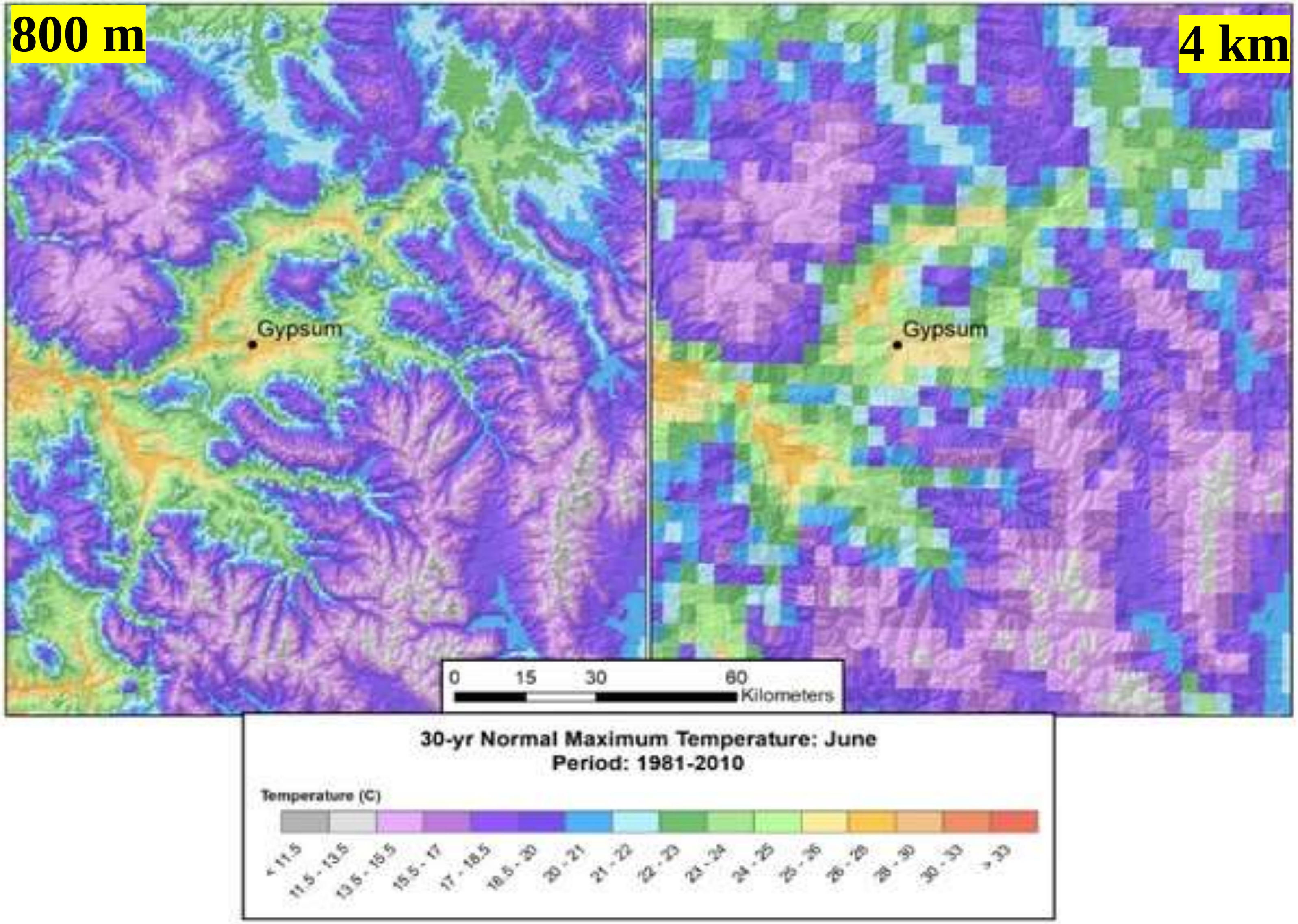
High-Resolution PRISM Data

Basic variables: precipitation, maximum temperature, minimum temperature, and mean temperature

Humidity variables: precipitation, mean dew point temperature and minimum/maximum vapor pressure deficit



Concluding Remarks

- Fortunately, alfalfa yield are projected to either plateau or increase under climate change
- However, alfalfa and other forages are likely to be under various types of stresses imposed by climate change and adoption of effective practices is a key to make it more resilient
- Crop water demand is expected to increase while water availability for agriculture is going to be highly uncertain. Which brings in challenges related to water management in alfalfa and other forage production
- Need more localized research and innovations that integrate scientific, social, and economic factors that provide viable solutions for grower and industry to use for effective adoption

Thank You!

Contact Information

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