How Potential Changes in Climate Could Affect Pistachio Production

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Outline of Talk

- Introduction to winter chill
- Central Valley winters in the future?
- What warmer winters could mean for pistachio production.

Three Take Aways

- We will experience more “low chill” winters in the future.
- Kerman will not be appropriate for many parts of the San Joaquin Valley in 30-40 years.
- Dormancy breaking chemicals *may* help in the short term. New low chill varieties will be necessary long term.

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Why is winter chill important?

Photo: D. Doll


April 4th 2015
Kerman
Peters

Chill models work very differently

Chill Hours

- 1 hour between
  32-45° F = 1 chill hour

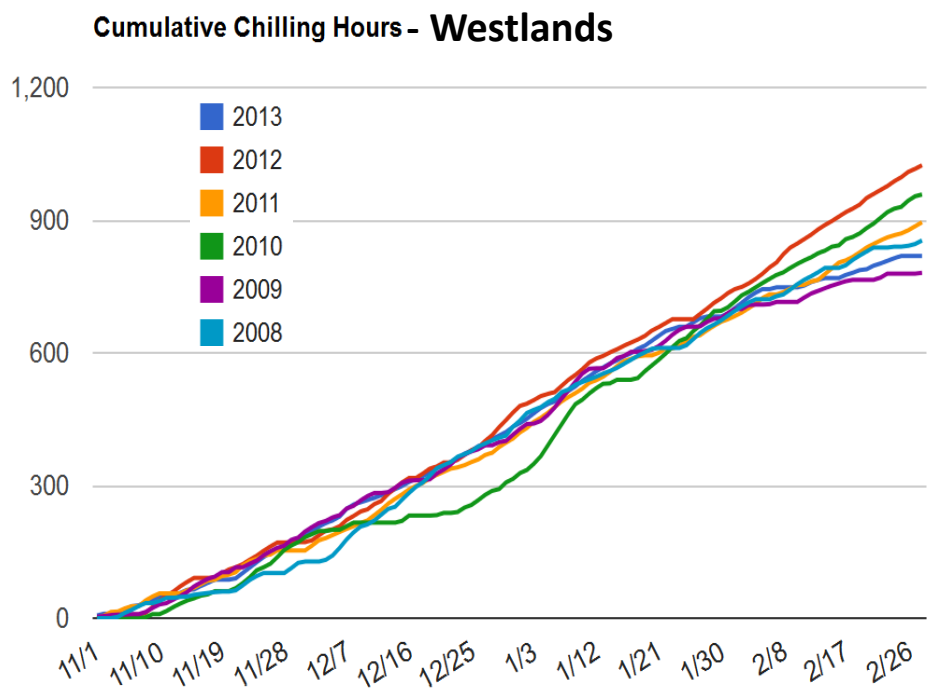
Chill Portions
(Dynamic Model)

- Different temps have dif. 'chill value.'
  - Max: hours at 43-47° F.
  - No chill value at 32° F and 54° F.
- Expands the range of temps considered effective for chill accumulation.
- Warm temperatures can subtract from chill accumulation.

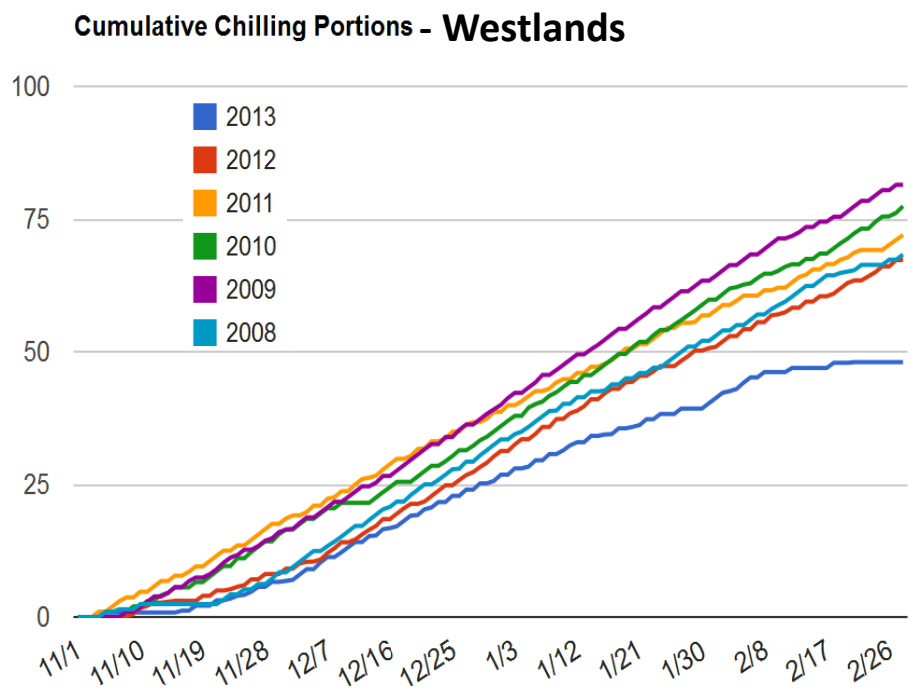
Fishman et al., 1987

2013-2014: Hours vs. Portions

Chill Hours:
Average winter.



Chill Portions:
Unusually **Warm**.



Figures: fruitsandnuts.ucdavis.edu

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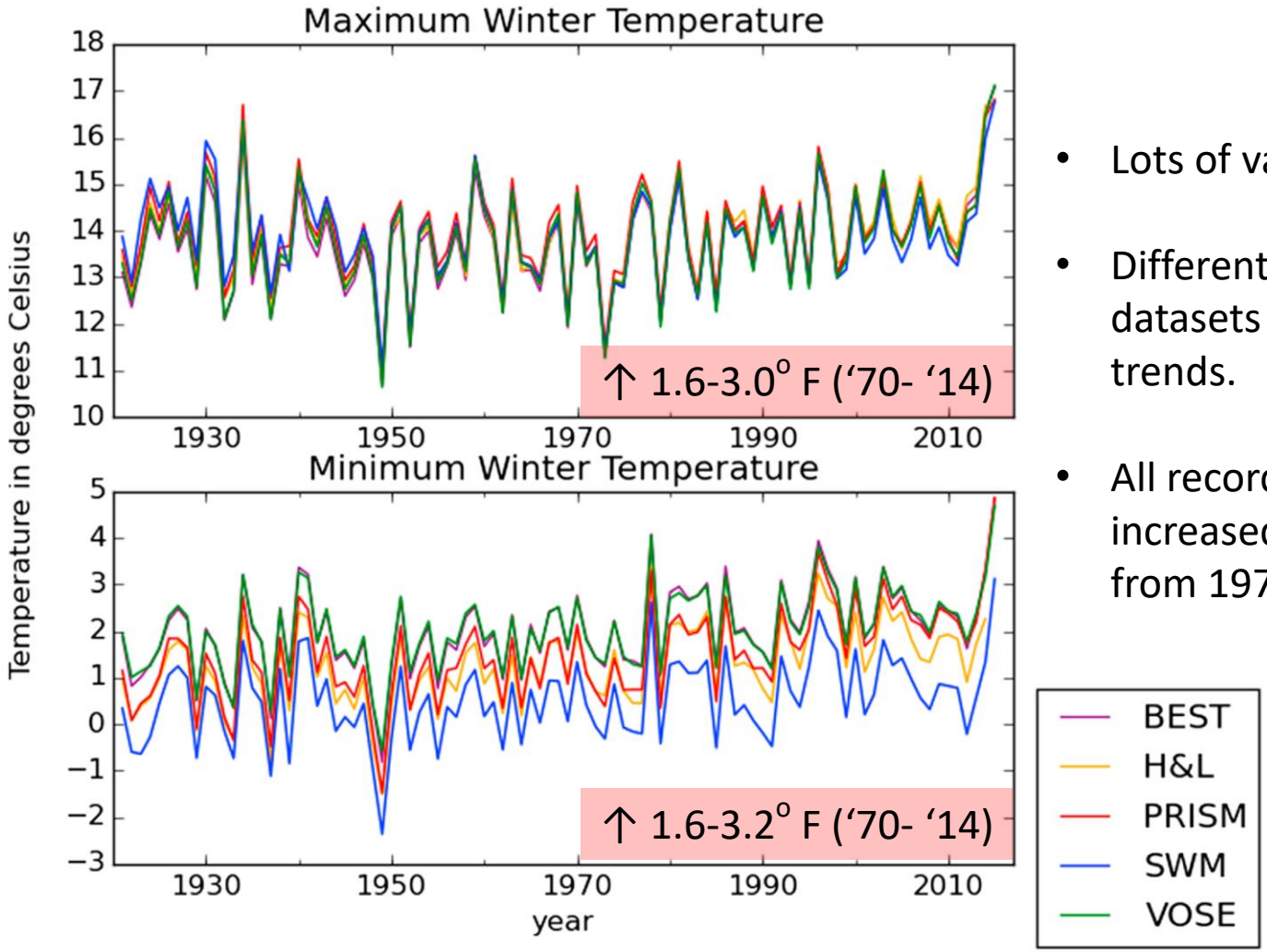
Have California winters been getting warmer? Yes. Especially in the last 40 years.



- Lots of variability year-to-year
- Different weather networks & datasets differ on exact change trends.
- All records show trend of increased Max & Min Temps from 1970-2014

Wang et al. (2017)

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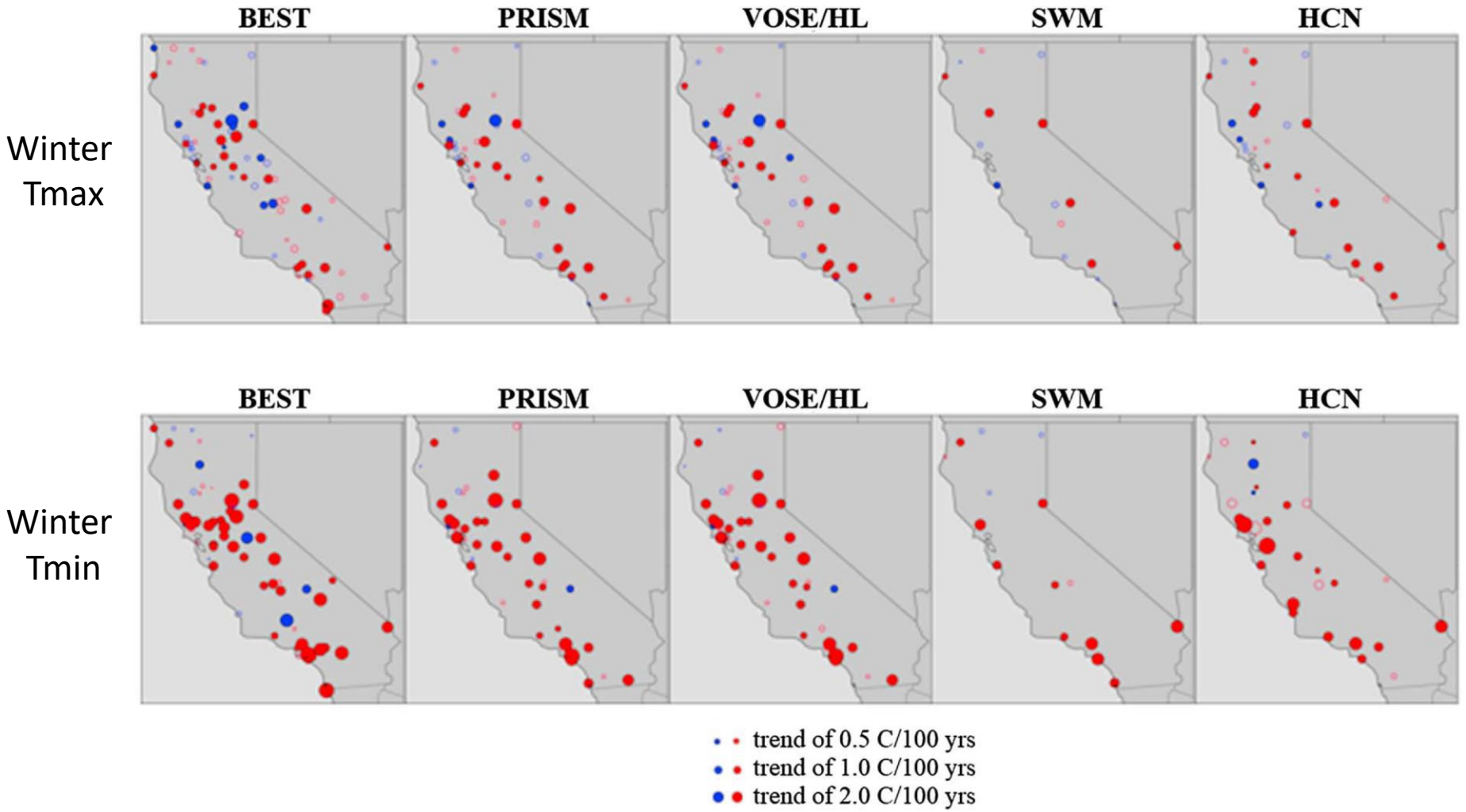
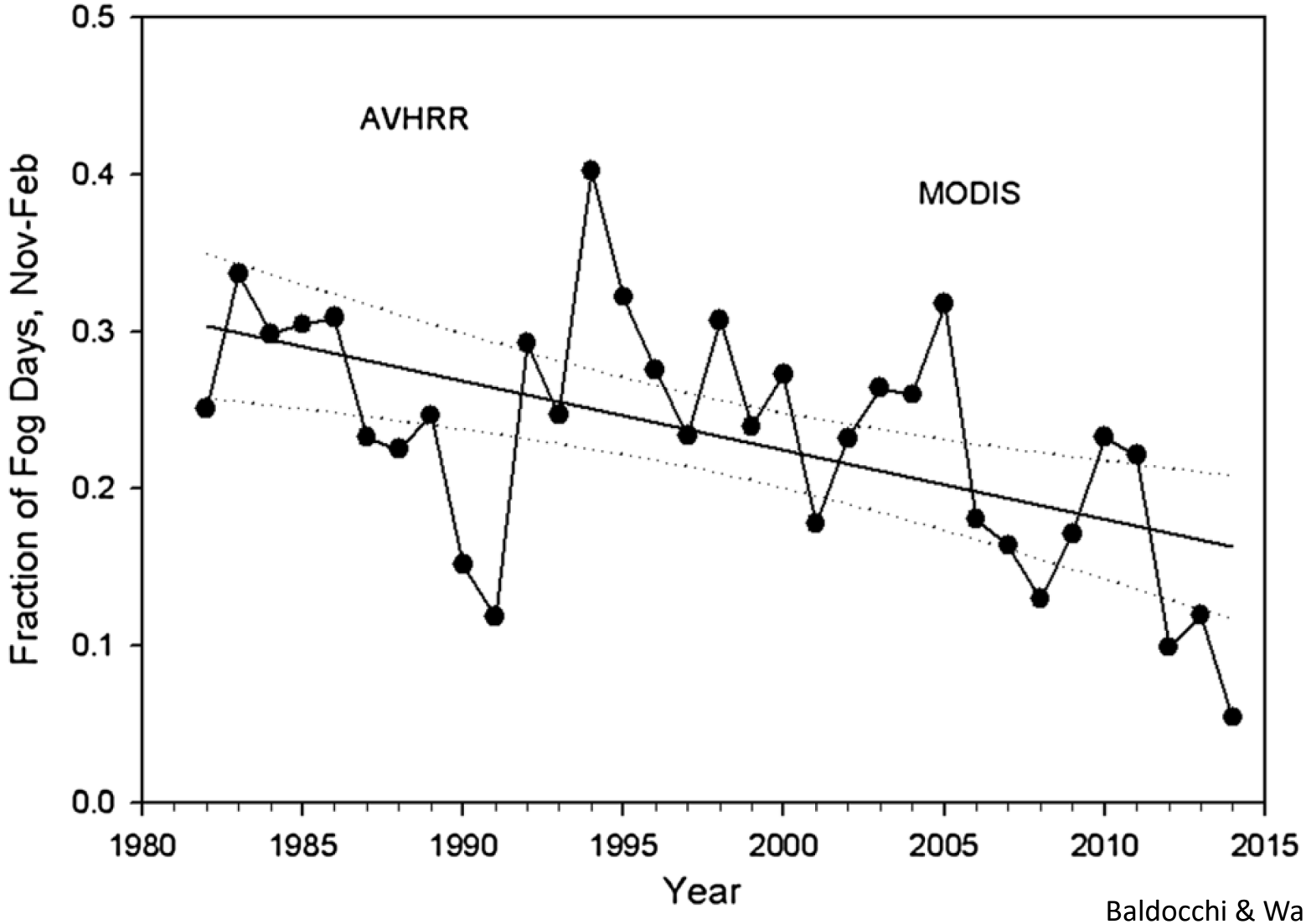


Wang et al. (2017)

Winters have also been getting less foggy



Baldocchi & Waller (2014)

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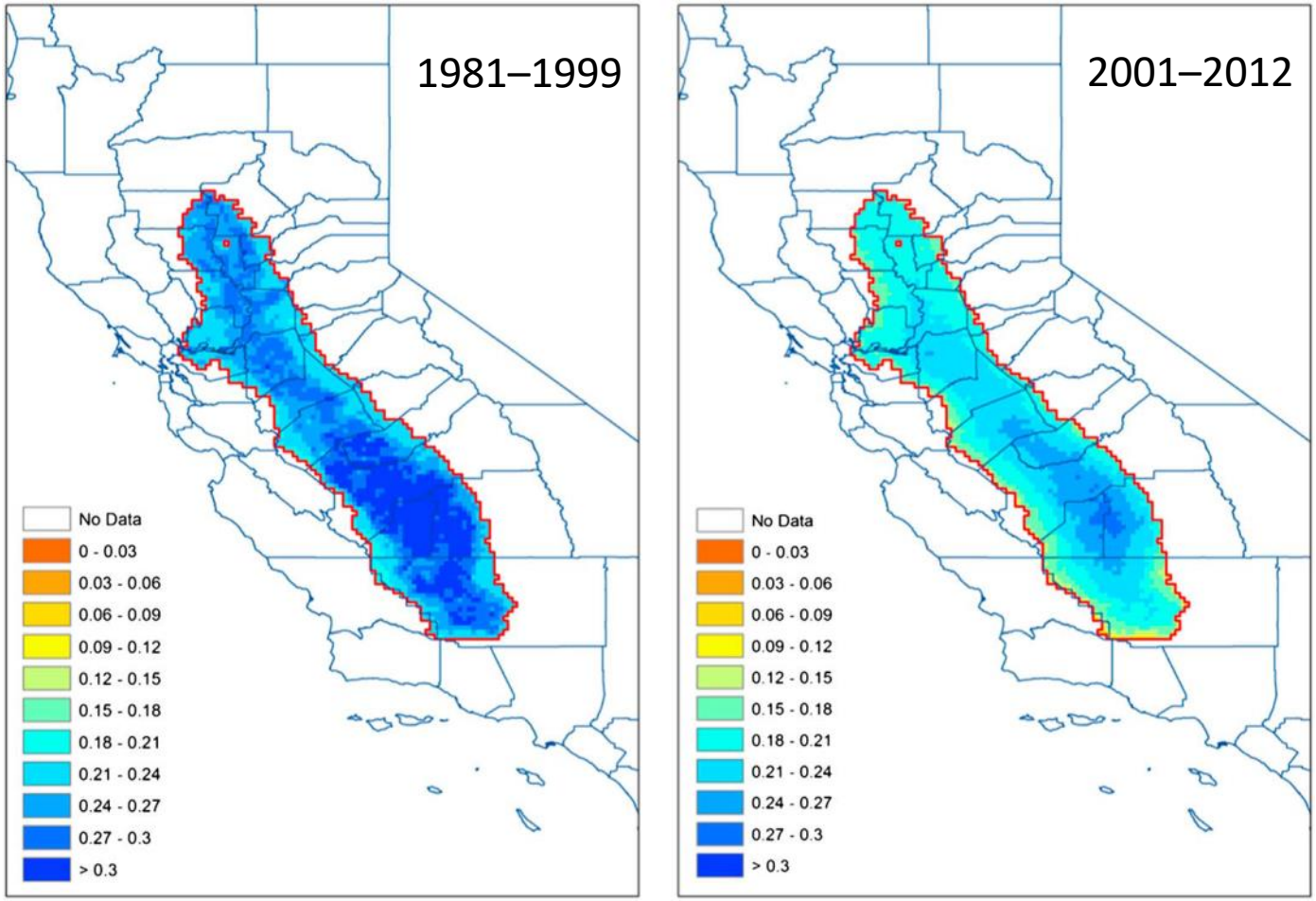
Time fogged in



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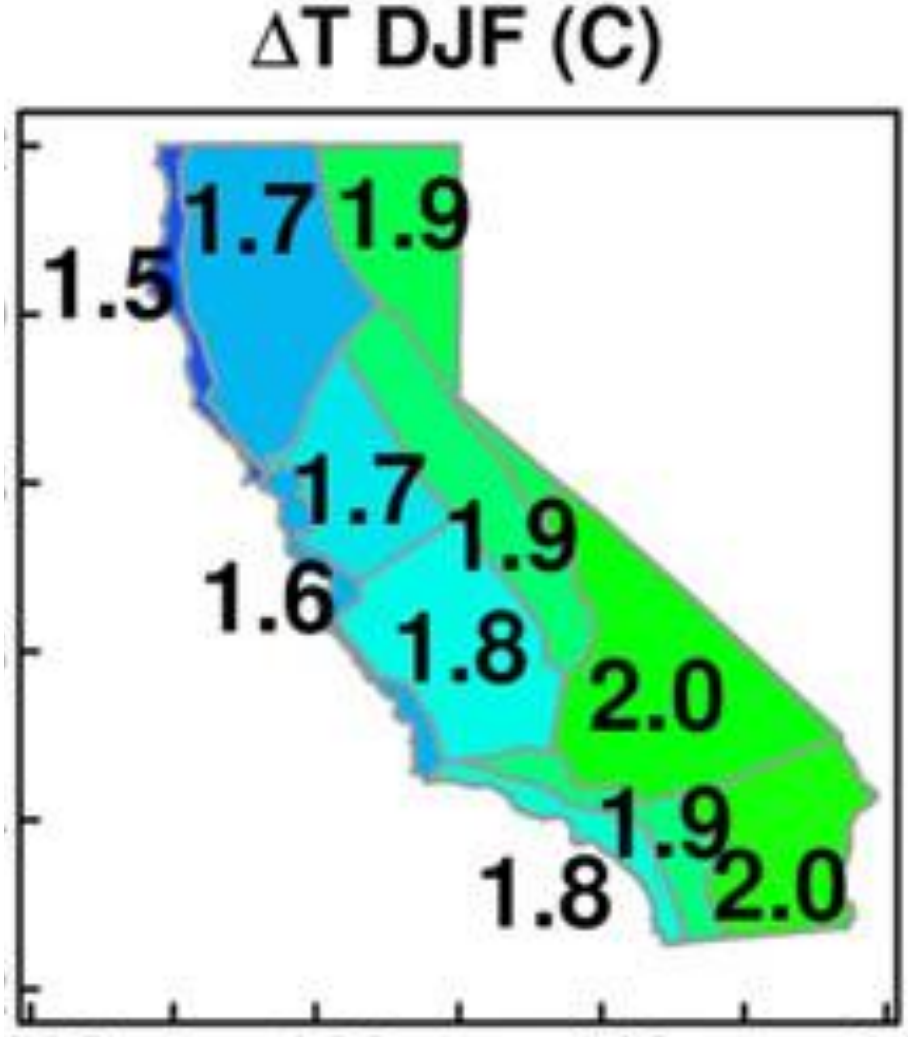
Climate models project winters will keep getting warmer.

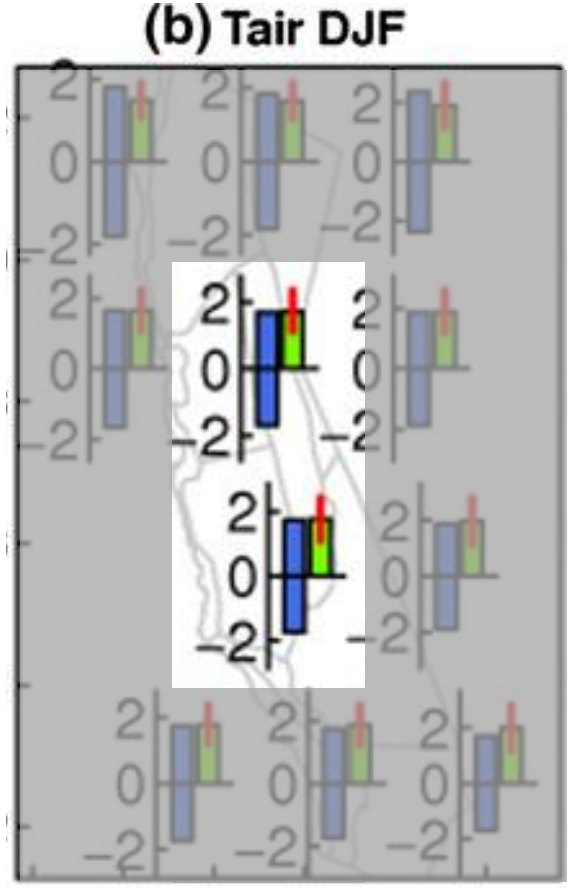


Change in temperature from 1985–1994 to 2060–2069

- 16 different global "general circulation models"
- 5 different ways to scale down to regional level
- **Sac Valley: ↑ 3.1° F (1.7° C)**
- **San Joaquin Valley: ↑ 3.2° F (1.8° C)**

Pierce et al. (2013)

Climate models project winters will continue to vary a lot from year to year.



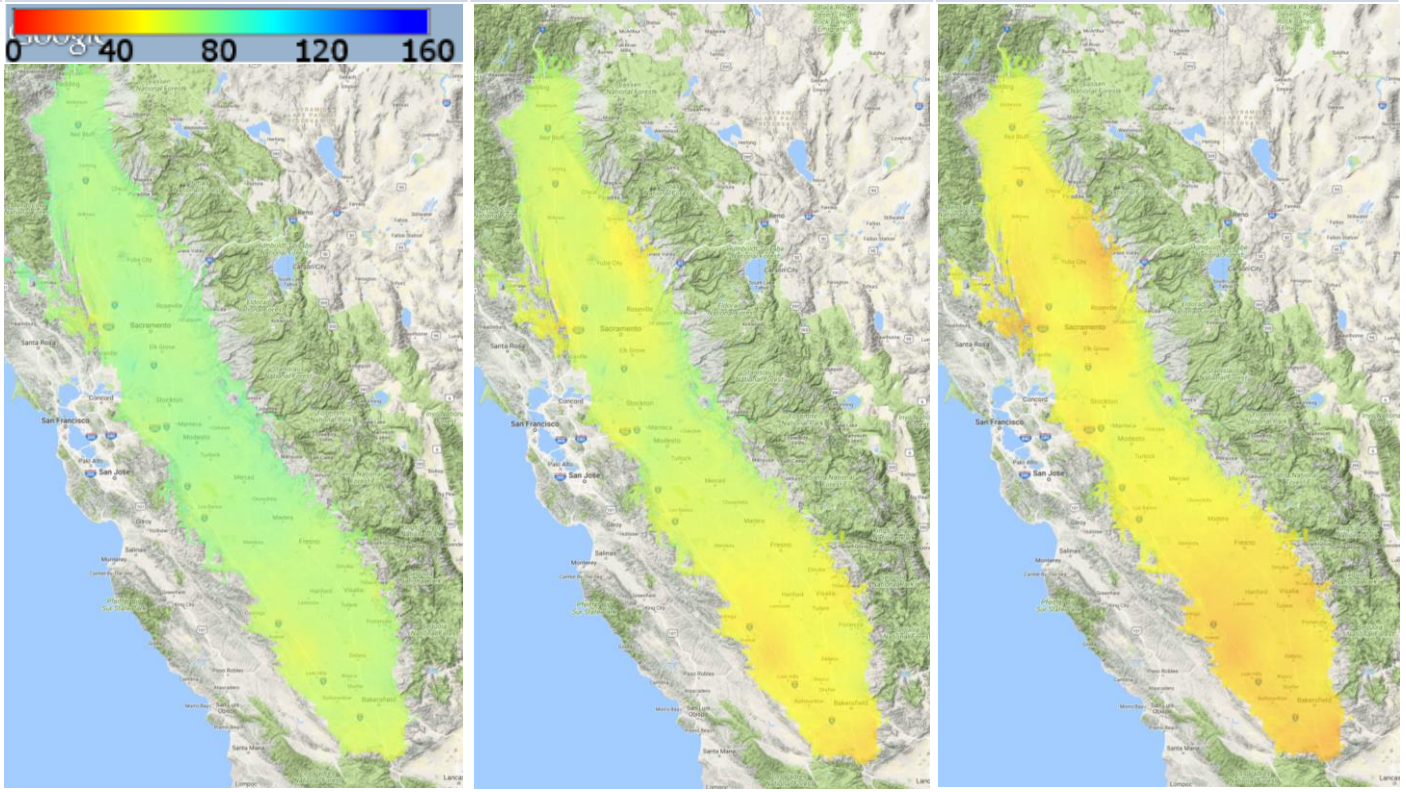
- Winter-to-Winter variability will be 2x the expected shift in temperature.
- So, we'll still experience some cold winters, and winters that we now consider average.
- But we'll also experience more "low chill" winters **AND** lower chill winters than before.

Blue bars: Natural climate variability across all models.
Green bars: Average warming projected in period 2060–2069.
Red line: 90 % CI projected warming across models.

Pierce et al. (2013)

Chill Projections 90% of years, for Mid, End of Century

	Turn of the Century	Mid 21st Century	End 21st Century
Sac Valley	70	59 (↓ 16%)	49 (↓ 30%)
N. San Joaquin	71	61 (↓ 14%)	51 (↓ 28%)
S. San Joaquin	64	51 (↓ 20%)	42 (↓ 34%)



Luedeling et al. (2009)

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Chill requirements of current cultivars

Crop (CA Cv.'s)	Chill Portions Requ.
Kerman*	54-58
Peters*	60-65
Lost Hills	
Golden Hills	
Gumdrop	
Randy	

*Based on how chill & harvest, 2014

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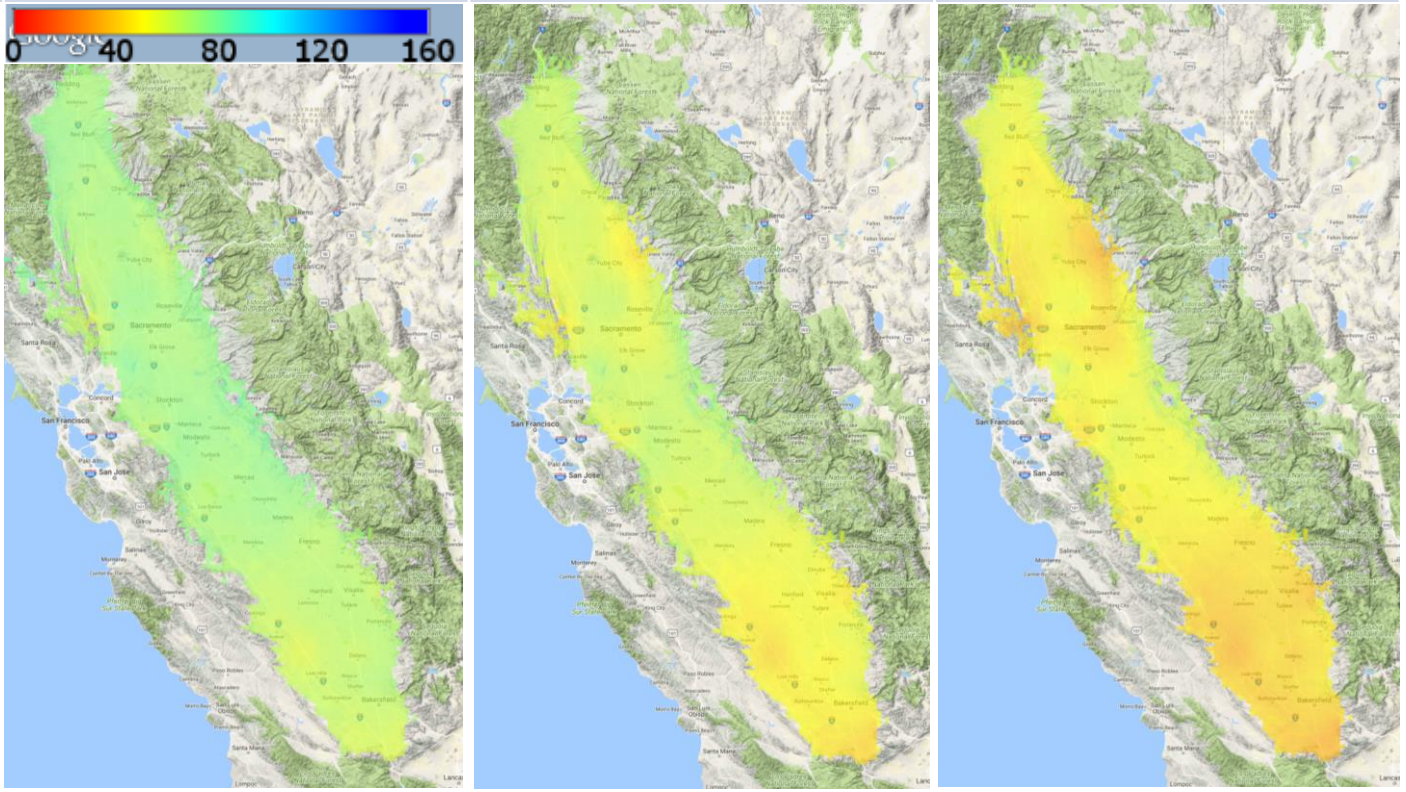

Luedeling et al. (2009)

Chill compensating/dormancy breaking products could help with 10-20% chill decrease

- Kaolin clay in winter decreases bud heat (Doll)
- Dormant/Horticultural Oil can increase budbreak, make it earlier (Beede, Ferguson)
- Hydrogen cyanamide can increase budbreak, make earlier. Not reg'd (Beede, Ferguson, Intl)
- New research on the physiology of dormancy may help generate other solutions (Dr. Z)

Lower chill varieties will be necessary production in many areas after mid-Century

Type	Cultivar	Chill Hours (>7 C)	Country of Origin
Female	Mateur	206 (36 CP)	Tunisia
	Uzun	600	Turkey
	Halebi	650	Turkey
	Siirt	700	Turkey
	Kale-Ghuchi	775	Iran
	Kerman	800	California
Male	Male-1	500	Turkey
	Male-2	750	Turkey
	Peters	900	California

Elloumi et al. (2013), Kuden et al. (1995), Rahemi et al. (2009) Ferguson & Kallsen (2

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Thank you! Questions?