

How to Count Winter Chill

Katherine Pope

UCCE Farm Advisor

Yolo-Solano-Sacramento

kspope@ucanr.edu



University of California

Agriculture and Natural Resources | Cooperative Extension

TAKE AWAYS

- 1) Chill looks good this year
- 2) Chill portions is a better way to count chill
- 3) Follow chill portions at the UC Fruit & Nut Center website.

Overview

- Why chill matters
- Why *how* you count chill matters
- Bonus complication: Fog
- What's under the hood of Chill Portions model
- How to count and use chill portions

Why Chill Matters – Poor, Erratic Bloom

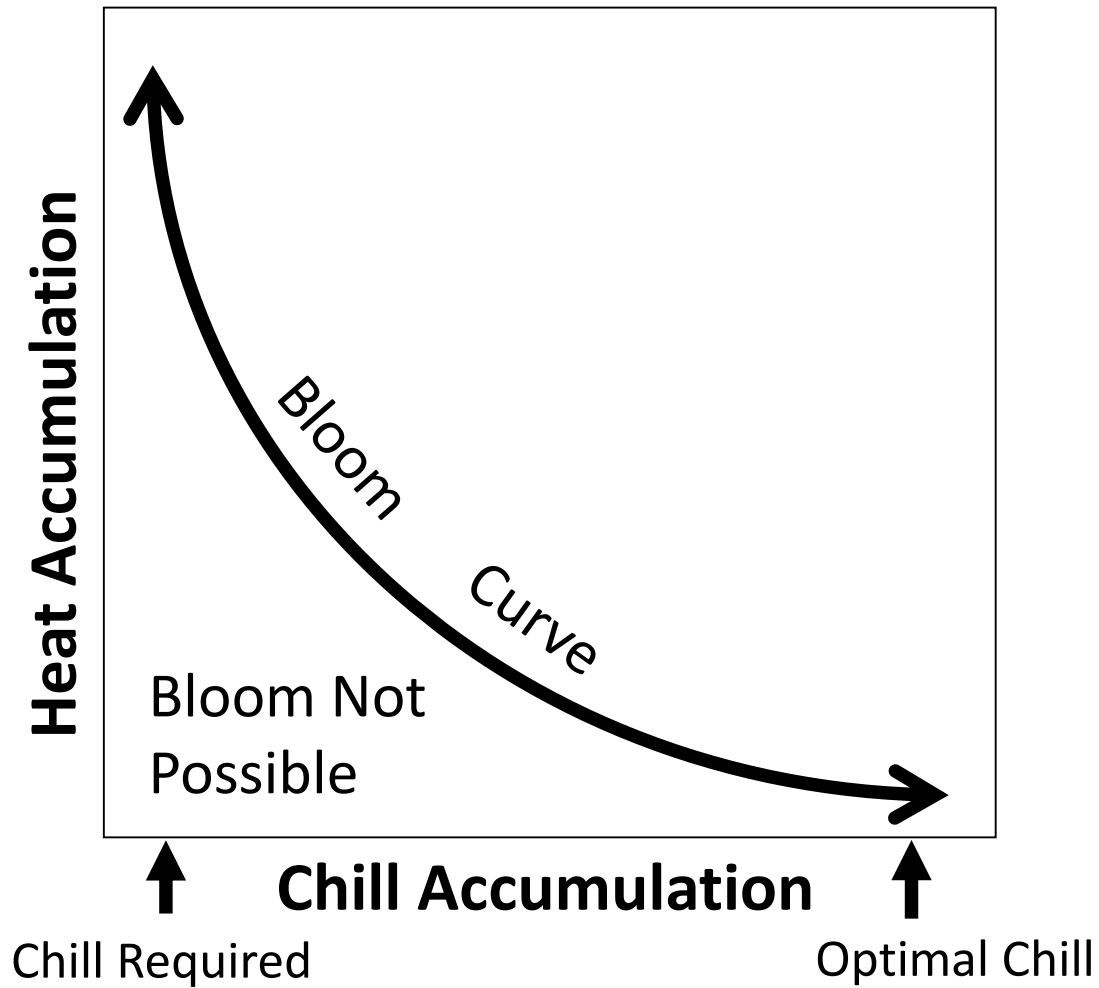


- Delayed, protracted, weak budbreak
- Bare shoots, spur shortage



- Poor fruit devel't, irregular ripening
- Underdeve'pd, abscising buds

Why Chill Matters – Delayed Bloom



Why how you count chill matters: Literature supporting chill portions

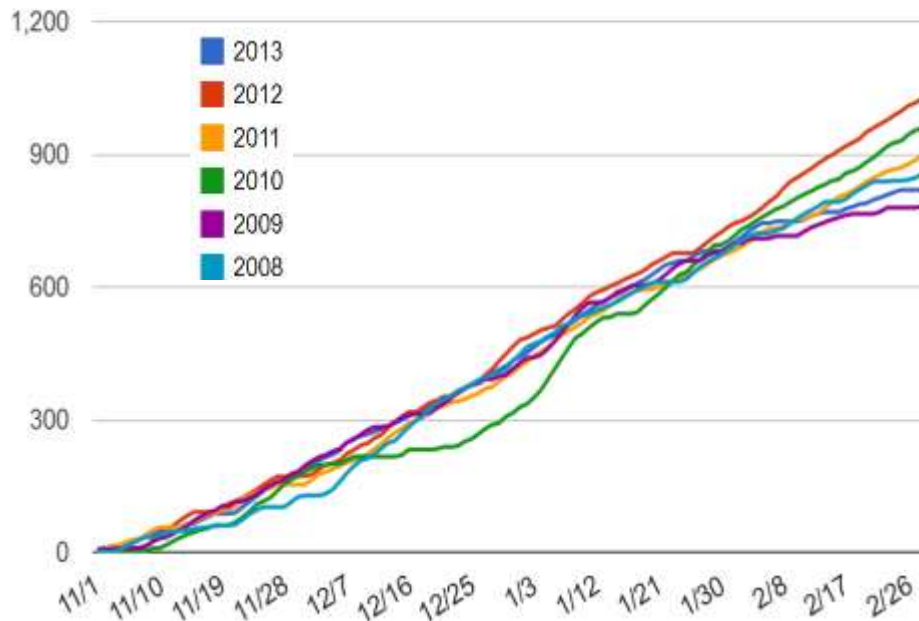
Lead Author	Year Pub'd	Crop	Location
Ramirez	2010	Almond	Chile
Viti	2010	Apricot	Spain, Italy
Gao	2012	Apricot	China
Ruiz	2007	Apricot	Spain
Alburquerque	2008	Cherry	Spain, Fr., Can., NY, CA
Glozer	2005	Cherry	California
Allan	1995	Peach	South Africa
Linsley-Noakes	1994	Peach	South Africa
Erez	1990	Peach	South Africa
Ghrab	2014	Peach	Tunisia
Maulion	2014	Peach	Argentina
Miranda	2013	Peach	Spain
Glozer	2008	Pear	California
Elloumi	2013	Pistachio	Tunisia
Zhang	2011	Pistachio	Australia
Glozer	2006	Prune	California
Luedeling	2009	Walnut	California

2013-2014: Chill Hours vs. Chill Portions

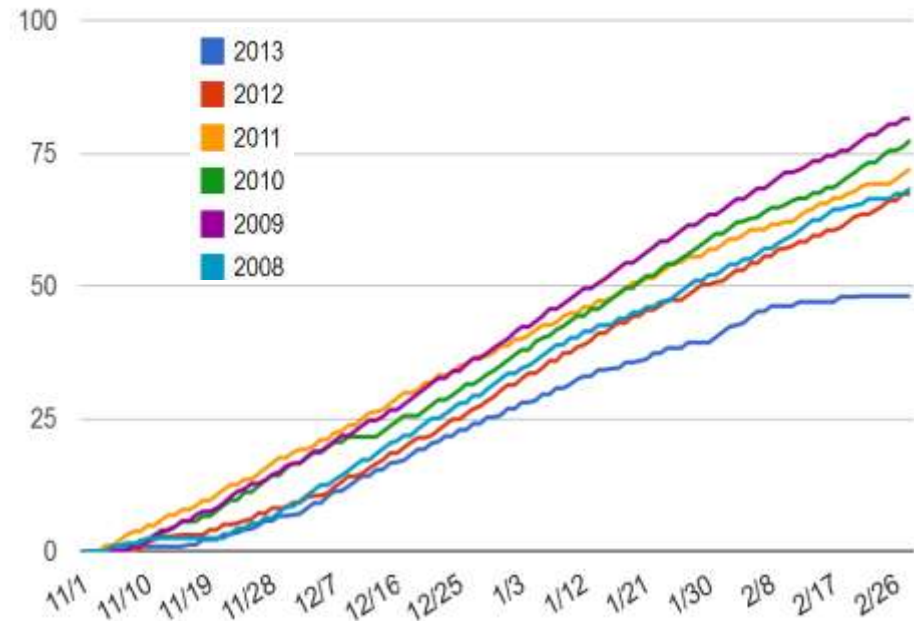
According to chill hours, 2013-2014 was an **average** winter.

According to chill portions, 2013-2014 was unusually warm.

Cumulative Chilling Hours - Westlands

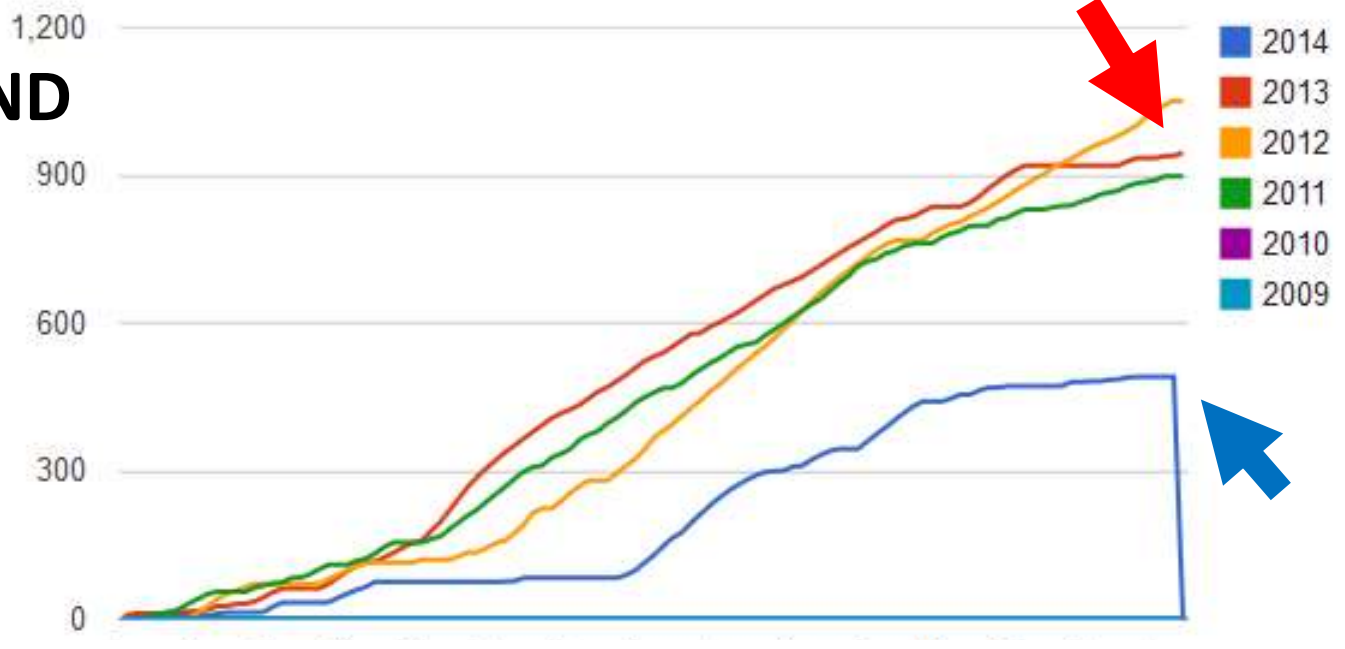


Cumulative Chilling Portions - Westlands

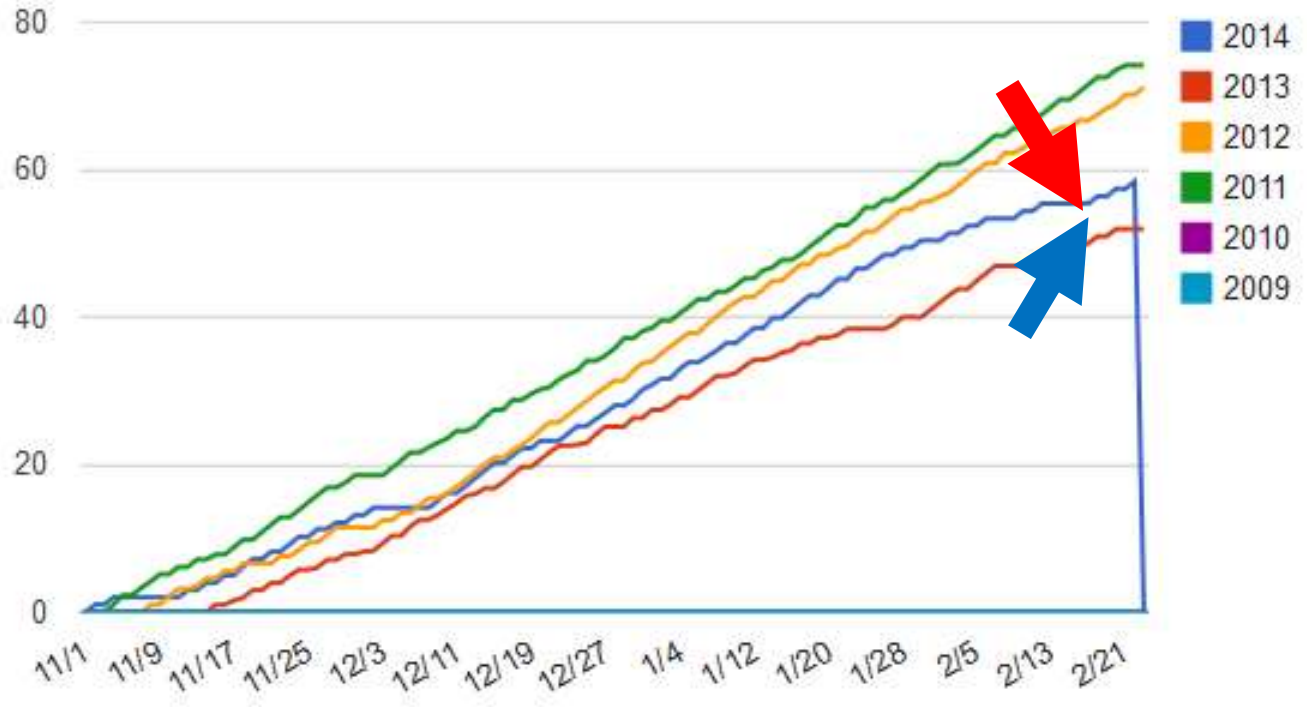


WOODLAND

Hours

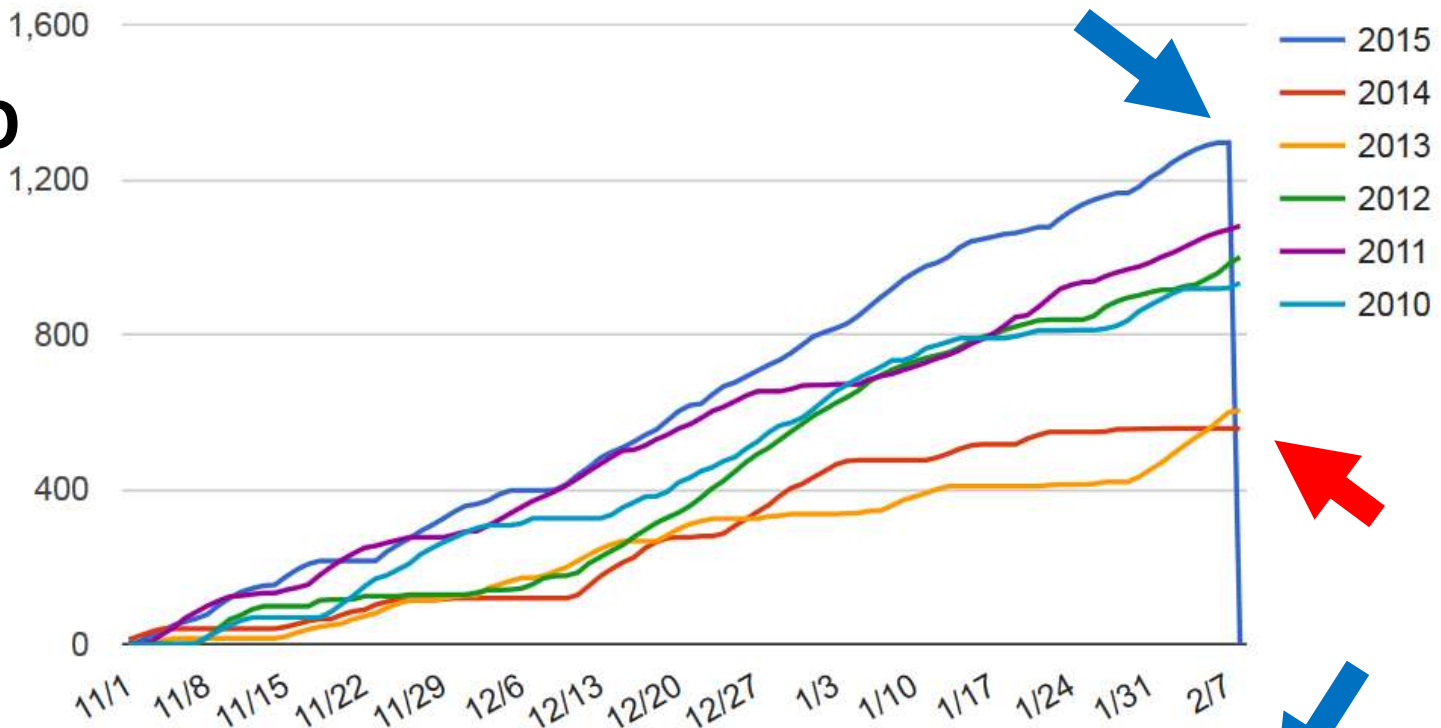


Portions

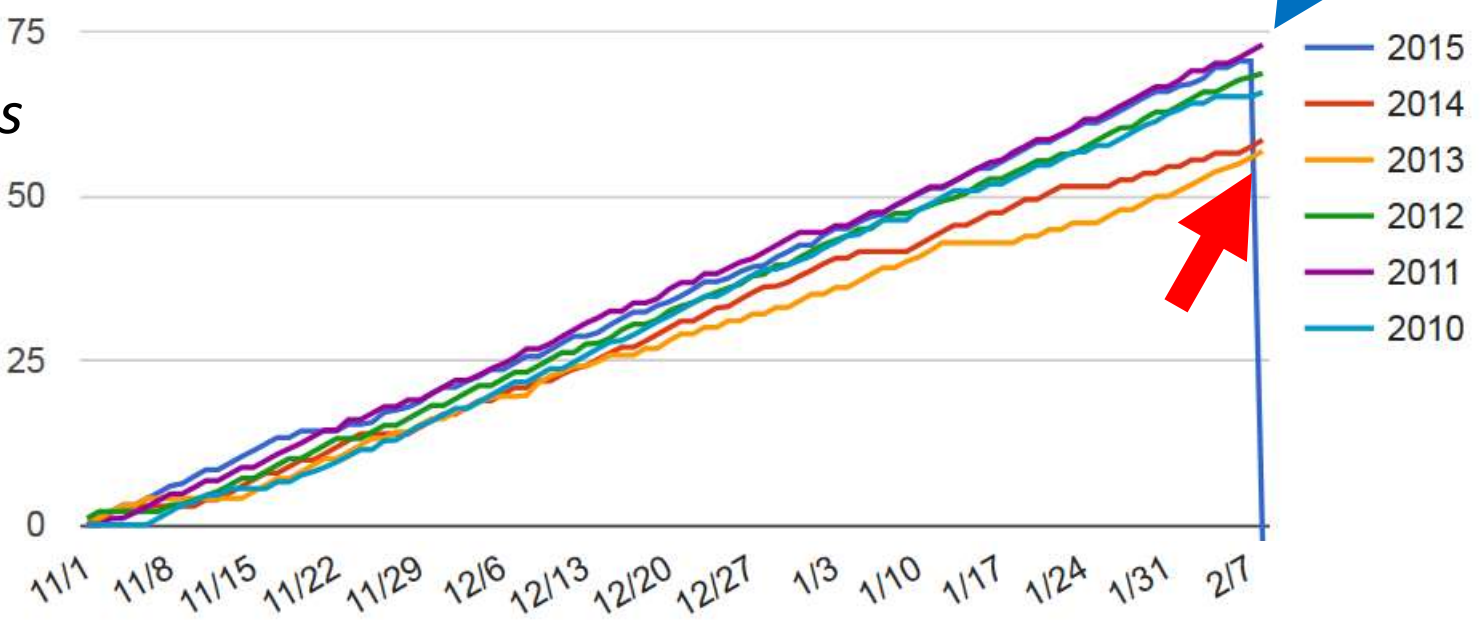


CAMINO

Hours

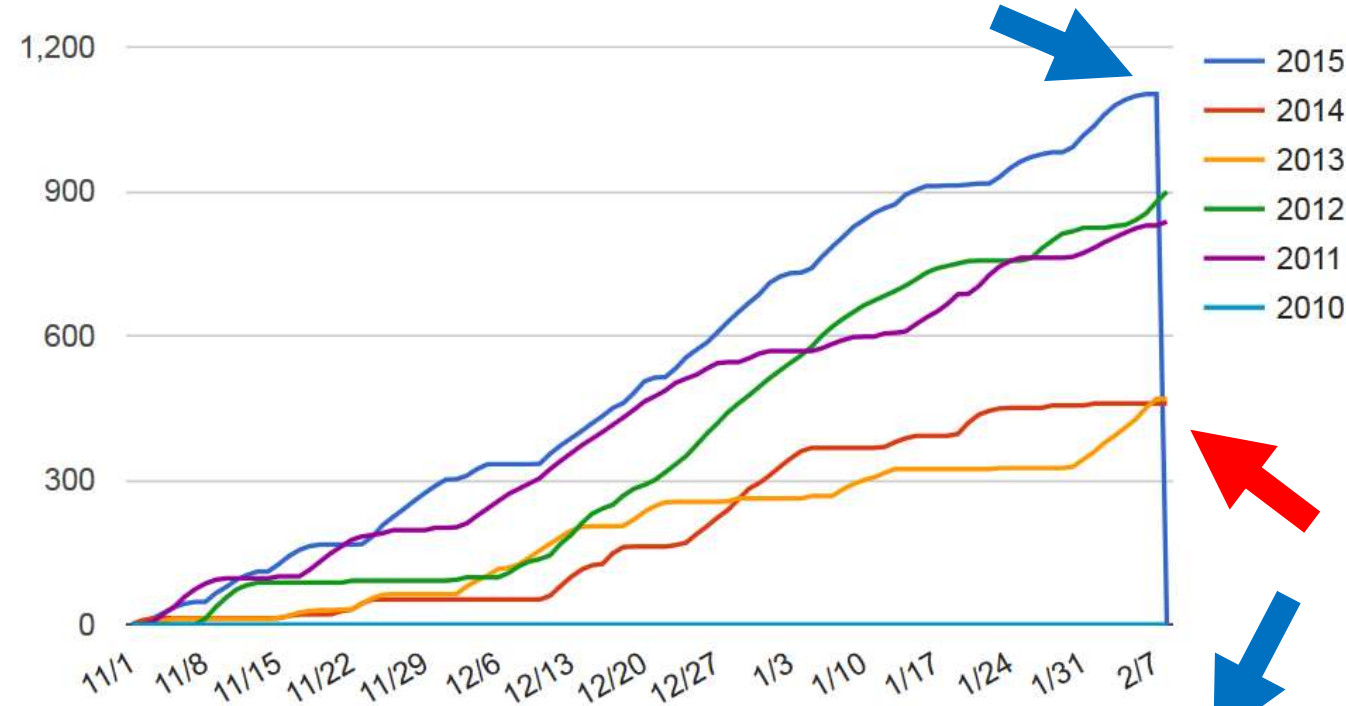


Portions

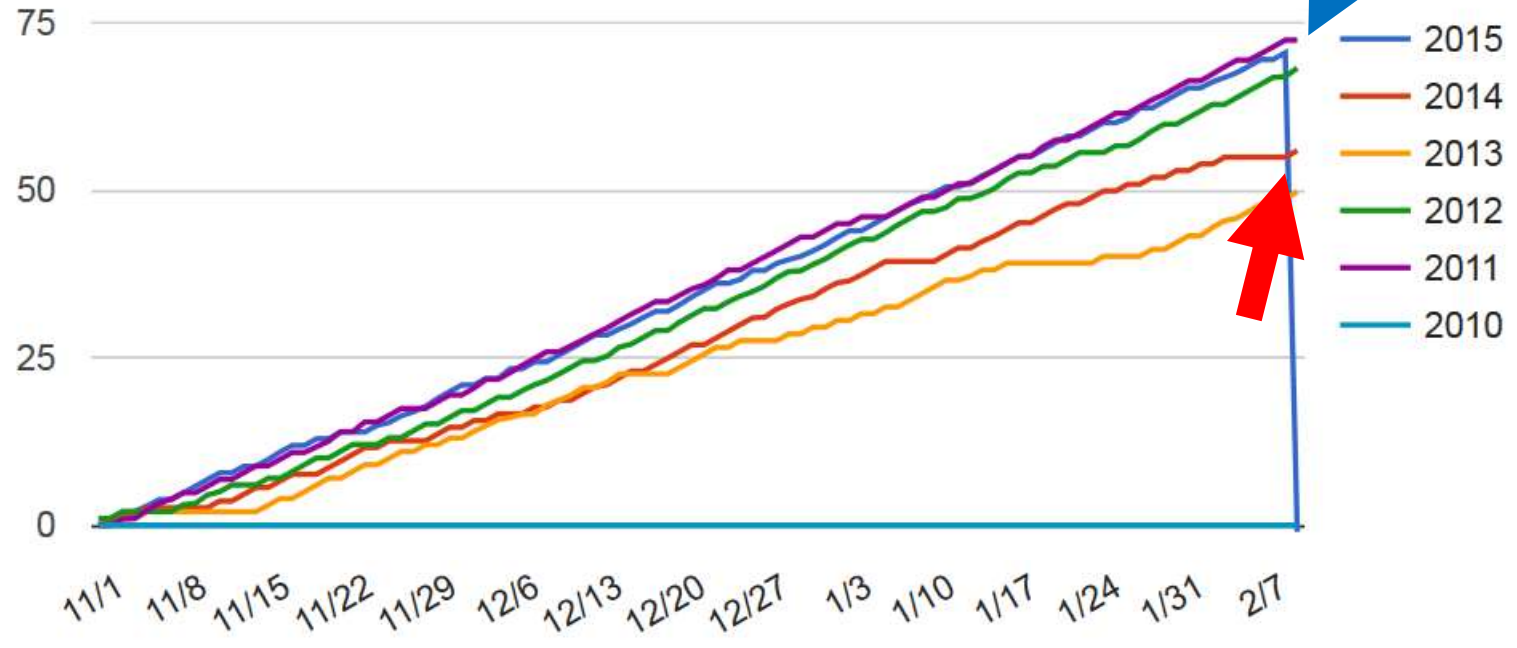


DIAMOND SPRINGS

Hours



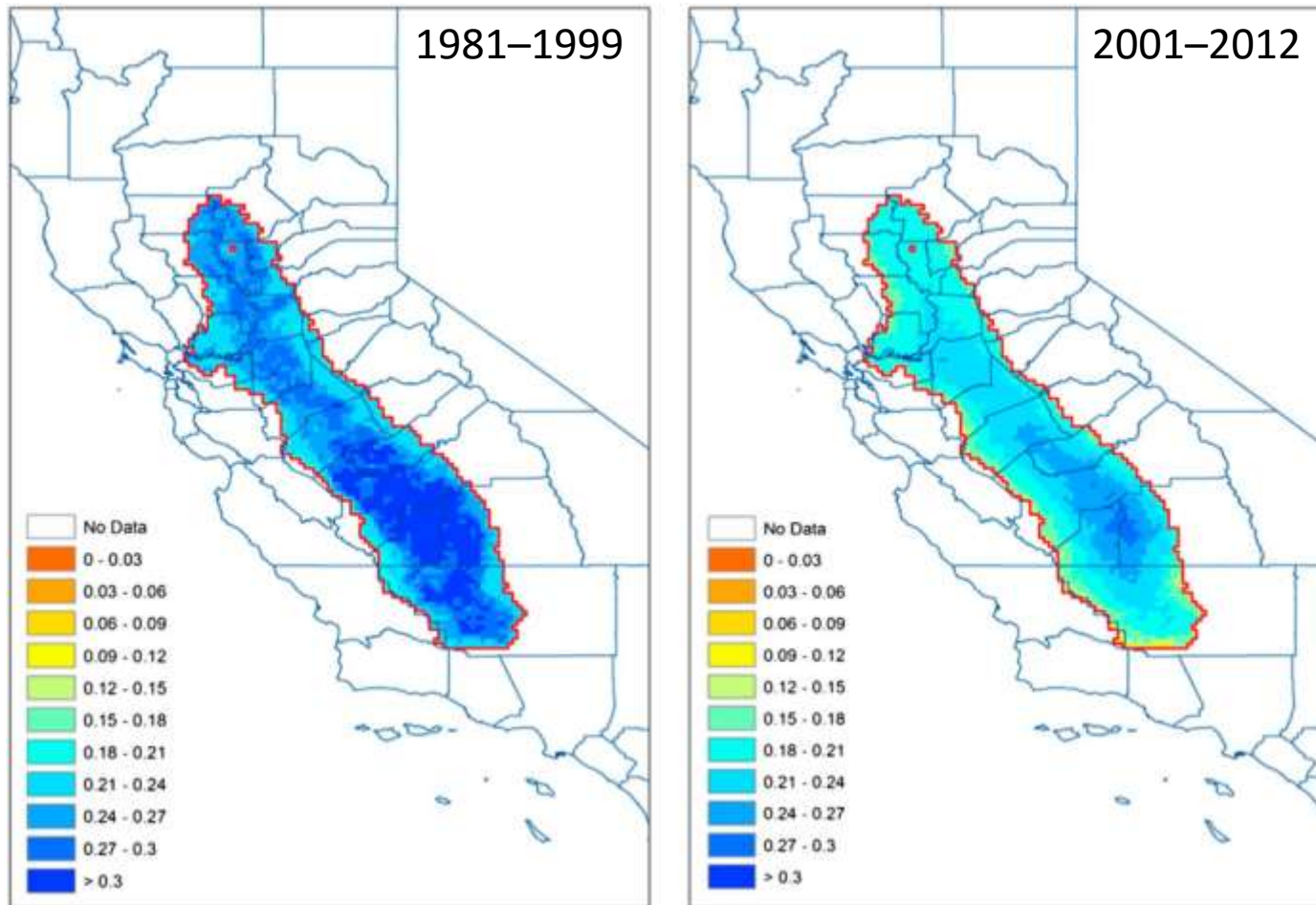
Portions



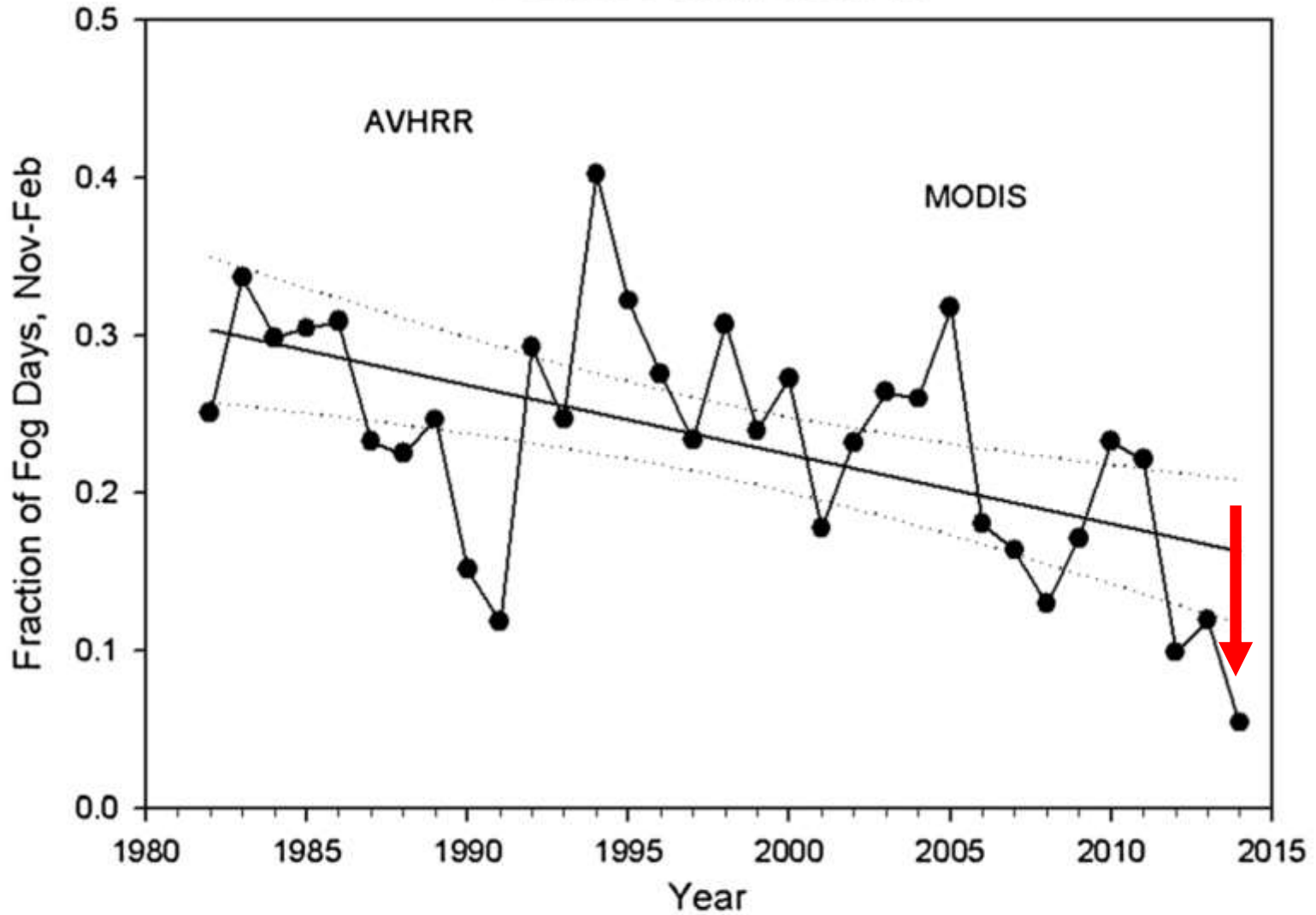
Bonus Complication: Fog

Fog has been decreasing

Time fogged in



Central Valley, AVHRR

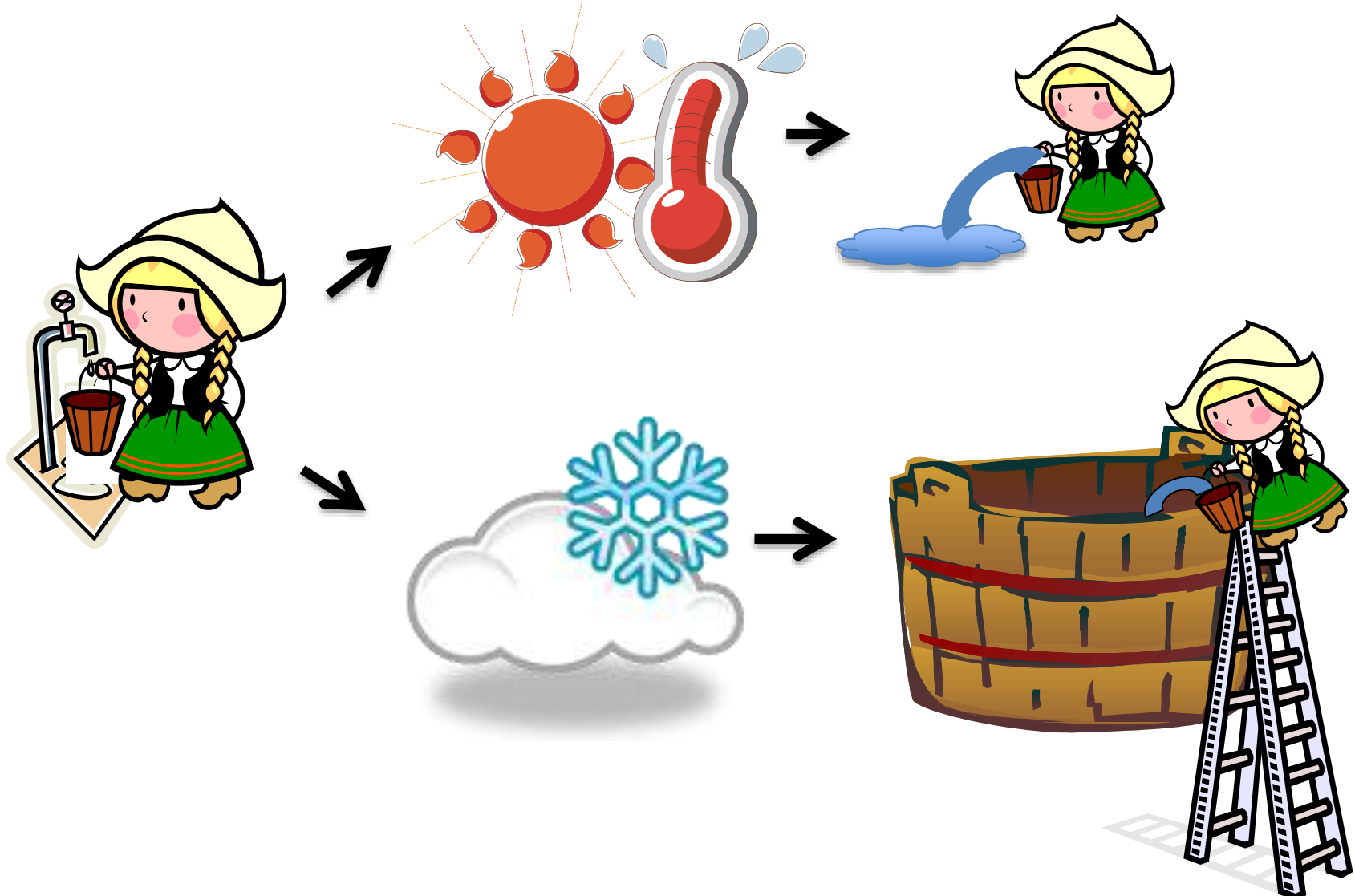


What's “under the hood” of the Chill Portions model?

Dynamic Model – Chill Portions

- Different temps have dif. 'chill value.'
 - Max: hours at 43-47° F.
 - No chill value at 32°F and 54°F.
- Rather than saying, 'We had X chill hours but they were warm chill hours.'
- Expands the range of temps considered effective for chill accumulation.

Dynamic Model: Filling the Chill Tank



How to count and use chill portions

The screenshot shows the homepage of the UC Davis Fruit & Nut Research & Information website. The browser address bar shows <http://nutandfruit.ucdavis.edu/>. The page features a navigation bar with links for HOME, FRUIT & NUT, and SITE MAP, along with a search bar. The main content area is titled "HOME" and is organized into several sections:

- Extension Classes & Meetings:** This section lists several courses, including "Principles of Fruit & Nut Tree Growth, Cropping & Management" (offering: November 20-20, 2014), "Advances in Pistachio Production" (offering: November 18-20, 2014), and "Understanding & Preparing for the Threat of Plum Pox Virus Spreading to California & the Western States" (offering: September 29-30, 2014).
- Fruit & Nut Information:** This section provides sections on management and biology for individual crops, articles & websites by UC experts in crop production. It includes a grid of small images representing various fruits and nuts.
- Weather-Related Models:** This section is circled in red. It features a photograph of a weather station and text describing "Chill accumulation models; irrigation scheduling; prediction models for stonefruit harvest, almond & pistachio N, almond hullsplit." A link labeled "Weather-Related Models" is provided.
- Fruit & Nut Center Updates:** This section contains several news items, including "New Resources Help Identify Light Brown Apple Moth" (added October 28, 2014), "Plum Pox Virus Conference Update" (added October 23, 2014), "An inside look at the Department of Plant Sciences at UC Davis" (added September 23, 2014), and "Recognition for Research in Pedestrian Orchard Systems" (added September 11, 2014).

Tracking chill portions on FNRIC

The screenshot shows the UC Davis Fruit & Nut Research & Information website. The page is titled "Weather-Related Models & Services". A red circle highlights the "Chilling Accumulation Models" link in the main content area. The left sidebar contains a navigation menu with the following items: HOME, ANNUAL EXTENSION CLASS, WEATHER-RELATED MODELS (highlighted), Chilling Accumulation Models, Prune Chilling Prediction, Nitrogen Prediction Models for Almond and Pistachio, Irrigation Scheduling, Harvest Prediction for Peaches, Plums & Nectarines, Almond Hull-Split Prediction, Pistachio Bloom Cast, About CIMIS Weather Stations, FIND AN EXPERT, FRUIT & NUT INFORMATION, ORCHARD MANAGEMENT, FRUIT & NUT CENTER UPDATES, VIDEO GALLERY, and ONLINE RESEARCH DATABASES. The main content area includes a paragraph about weather-related tree crop information, a list of model links, and a "Related Information" section with links to "About CIMIS Weather Stations", "About Weather-Related Models", "Weather Links", and "Dormancy, chill accumulation, rest-breaking & freeze damage". The page footer indicates it was last updated on September 11, 2013.

University of California

UCDAVIS
FRUIT & NUT
RESEARCH & INFORMATION

Weather-Related Models & Services

These programs provide timely weather-related tree crop information specifically for California fruit and nut growers, researchers, and industry. Air temperatures, collected from the [California Irrigation Management Information System \(CIMIS\)](#) weather stations, are used for model calculations.

[Chilling Accumulation Models](#)
Calculation, Explanation & Comparison

[Prune Chilling Prediction Model](#)
(Fall 2009)

[Nitrogen Prediction Models for Almond & Pistachio](#)
based on early season soil sampling

[Irrigation Scheduling Using Stem Water Potential \(SWP\) Measurements](#)
Temp., RH & SWP values for almond, prune, walnut & grape

[Harvest Prediction Model](#)
for Peaches, Plums and Nectarines

[Almond Hull-Split Prediction Model](#)
(in beta test stage: Fall 2011)

[Pistachio Bloom Forecast](#)
based on combined chill and heat accumulation
(in beta test stage: Winter 2011)

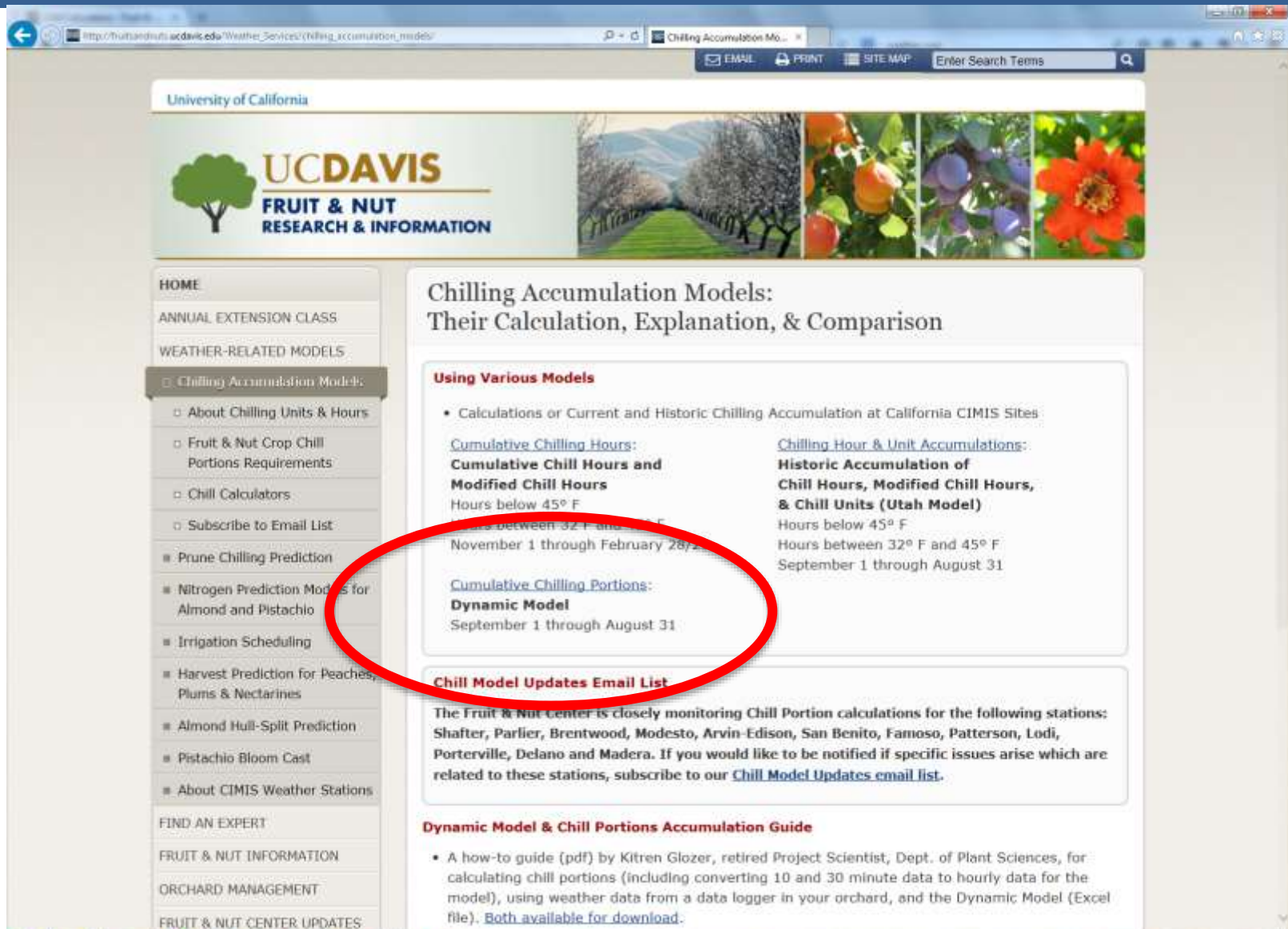
Related Information

- [About CIMIS Weather Stations](#)
- [About Weather-Related Models](#)
- [Weather Links](#)
- [Dormancy, chill accumulation, rest-breaking & freeze damage](#)

Page Last Updated: September 11, 2013

http://fnr.ucdavis.edu/Weather_Services/chilling_accumulation_models

Tracking chill portions on FNRIC



University of California

UCDAVIS
FRUIT & NUT
RESEARCH & INFORMATION

HOME

ANNUAL EXTENSION CLASS

WEATHER-RELATED MODELS

- Chilling Accumulation Models
 - About Chilling Units & Hours
 - Fruit & Nut Crop Chill Portions Requirements
 - Chill Calculators
 - Subscribe to Email List
 - Prune Chilling Prediction
 - Nitrogen Prediction Models for Almond and Pistachio
 - Irrigation Scheduling
 - Harvest Prediction for Peaches, Plums & Nectarines
 - Almond Hull-Split Prediction
 - Pistachio Bloom Cast
 - About CIMIS Weather Stations

FIND AN EXPERT

FRUIT & NUT INFORMATION

ORCHARD MANAGEMENT

FRUIT & NUT CENTER UPDATES

Chilling Accumulation Models: Their Calculation, Explanation, & Comparison

Using Various Models

- Calculations of Current and Historic Chilling Accumulation at California CIMIS Sites

[Cumulative Chilling Hours:](#)
Cumulative Chill Hours and Modified Chill Hours
Hours below 45° F
Hours between 32° F and 45° F
November 1 through February 28/29

[Chilling Hour & Unit Accumulations:](#)
Historic Accumulation of Chill Hours, Modified Chill Hours, & Chill Units (Utah Model)
Hours below 45° F
Hours between 32° F and 45° F
September 1 through August 31

[Cumulative Chilling Portions:](#)
Dynamic Model
September 1 through August 31

Chill Model Updates Email List

The Fruit & Nut Center is closely monitoring Chill Portion calculations for the following stations: Shafter, Parlier, Brentwood, Modesto, Arvin-Edison, San Benito, Famoso, Patterson, Lodi, Porterville, Delano and Madera. If you would like to be notified if specific issues arise which are related to these stations, subscribe to our [Chill Model Updates email list](#).

Dynamic Model & Chill Portions Accumulation Guide

- A how-to guide (pdf) by Kitren Glozer, retired Project Scientist, Dept. of Plant Sciences, for calculating chill portions (including converting 10 and 30 minute data to hourly data for the model), using weather data from a data logger in your orchard, and the Dynamic Model (Excel file). [Both available for download.](#)

Tracking chill portions on FNRIC

The screenshot shows the website interface for the University of California Davis Fruit & Nut Research & Information Center. The page is titled "Chill Calculators" and features a navigation menu on the left and a main content area on the right. The navigation menu includes sections for "HOME", "ANNUAL EXTENSION CLASS", "WEATHER-RELATED MODELS", and "CHILL CALCULATORS". The "CHILL CALCULATORS" section is expanded, showing options like "Chilling Accumulation Models", "About Chilling Units & Hours", "Fruit & Nut Crop Chill Portions Requirements", "Chill Calculators", "Subscribe to Email List", "Prune Chilling Prediction", "Nitrogen Prediction Models for Almond and Pistachio", "Irrigation Scheduling", "Harvest Prediction for Peaches, Plums & Nectarines", "Almond Hull-Split Prediction", "Pistachio Bloom Cast", and "About CIMIS Weather Stations".

The main content area is titled "Chill Calculators" and contains several links for different models:

- [Cumulative Chilling Hours: Cumulative Chill Hours and Modified Chill Hours](#)
Hours below 45° F
Hours between 32 F and 45° F
November 1 through February 28/29,
- [Chilling Hour & Unit Accumulations: Historic Accumulation of Chill Hours, Modified Chill Hours, & Chill Units \(Utah Model\)](#)
Hours below 45° F
Hours between 32° F and 45° F
September 1 through August 31
- [Cumulative Chilling Portions: Dynamic Model](#)
September 1 through August 31
- [Harvest Prediction Model:](#)
for Peaches, Plums and Nectarines

A link for [View Station Map](#) is also present.

The section "Cumulative Chilling Portions - Select Station from List" contains a table with the following data:

County	Station	Portions
Alameda	191 Pleasanton	1
	171 Union City	0
Amador	227 Plymouth	1
Butte	012 Durham	2
Colusa	032 Colusa	1
Contra Costa	047 Brentwood	0
	170 Concord	0
	213 El Cerrito	0
El Dorado	178 Moraga	2
	013 Camino	6
Fresno	228 Diamond Springs	3
	205 Coalinga	0
	007 Firebaugh/Telles	0
	190 Five Points South West	0
	003 Firebaugh/Telles	0

Tracking chill portions on FNRIC

The screenshot shows the UC Davis Fruit & Nut Research & Information Center website. The main navigation menu on the left includes sections like HOME, WEATHER-RELATED MODELS, and FIND AN EXPERT. The 'Chill Calculators' section is active, displaying various calculation options. A red circle highlights the 'Cumulative Chilling Portions' form, which is set for station Coalinga (#205 - Fresno County). The 'Reporting Dates' section has 'Current Season' selected, and the 'Start Date' is 9/1/2014 and 'End Date' is 10/29/2014. A 'View Data' button is visible at the bottom of the form.

University of California

UCDAVIS
FRUIT & NUT
RESEARCH & INFORMATION

Chill Calculators

[Cumulative Chilling Hours:](#)
Cumulative Chill Hours and Modified Chill Hours
Hours below 45° F
Hours between 32° F and 45° F
November 1 through February 28/29.

[Chilling Hour & Unit Accumulations:](#)
Historic Accumulation of Chill Hours, Modified Chill Hours, & Chill Units (Utah Model)
Hours below 45° F
Hours between 32° F and 45° F
September 1 through August 31

[Cumulative Chilling Portions:](#)
Dynamic Model
September 1 through August 31

[Harvest Prediction Model:](#)
for Peaches, Plums and Nectarines

Cumulative Chilling Portions

CIMIS weather station: Coalinga (#205 - Fresno County)

Reporting Dates: Current Season
 Historical Accumulations

Start Date: 9/1/2014

End Date: 10/29/2014

[View Data](#)

Tracking chill portions on FNRIC

University of California

UCDAVIS
FRUIT & NUT
RESEARCH & INFORMATION

HOME

ANNUAL EXTENSION CLASS

WEATHER-RELATED MODELS

- Chilling Accumulation Models
 - About Chilling Units & Hours
 - Fruit & Nut Crop Chill Portions Requirements
 - Chill Portions**
 - Subscribe to Email List
 - Prune Chilling Prediction
 - Nitrogen Prediction Models for Almond and Pistachio
 - Irrigation Scheduling
 - Harvest Prediction for Peaches, Plums & Nectarines
 - Almond Hull-Split Prediction
 - Pistachio Bloom Cast
 - About CIMIS Weather Stations

FIND AN EXPERT

FRUIT & NUT INFORMATION

ORCHARD MANAGEMENT

FRUIT & NUT CENTER UPDATES

VIDEO GALLERY

ONLINE RESEARCH DATABASES

Chill Calculators

[Cumulative Chilling Hours: Cumulative Chill Hours and Modified Chill Hours](#)
Hours below 45° F
Hours between 32° F and 45° F
November 1 through February 28/29.

[Cumulative Chilling Portions: Dynamic Model](#)
September 1 through August 31

[Chilling Hour & Unit Accumulations: Historic Accumulation of Chill Hours, Modified Chill Hours, & Chill Units \(Utah Model\)](#)
Hours below 45° F
Hours between 32° F and 45° F
September 1 through August 31

[Harvest Prediction Model:](#)
for Peaches, Plums and Nectarines

Cumulative Chilling Portions

CIMIS weather station: Coalinga (#205 - Fresno County)

Reporting Dates: Current Season
 Historical Accumulations

Start Date: 11/01/2013

End Date: 10/29/2014

Feb 2014

Su	Mo	Tu	We	Th	Fr	Sa
						-1
2	3	4	5	6	7	8
9	10	11	12	13	14	15
16	17	18	19	20	21	22
23	24	25	26	27	28	

Start Nov. 1

End Feb. 15

Tracking chill portions on FNRIC

University of California

UCDAVIS
FRUIT & NUT
RESEARCH & INFORMATION

Chill Calculators

Cumulative Chilling Hours:
Cumulative Chill Hours and Modified Chill Hours
 Hours below 45° F
 Hours between 32° F and 45° F
 November 1 through February 28/29

Chilling Hour & Unit Accumulations:
Historic Accumulation of Chill Hours, Modified Chill Hours, & Chill Units (Utah Model)
 Hours below 45° F
 Hours between 32° F and 45° F
 September 1 through August 31

Cumulative Chilling Portions:
Dynamic Model
 September 1 through August 31

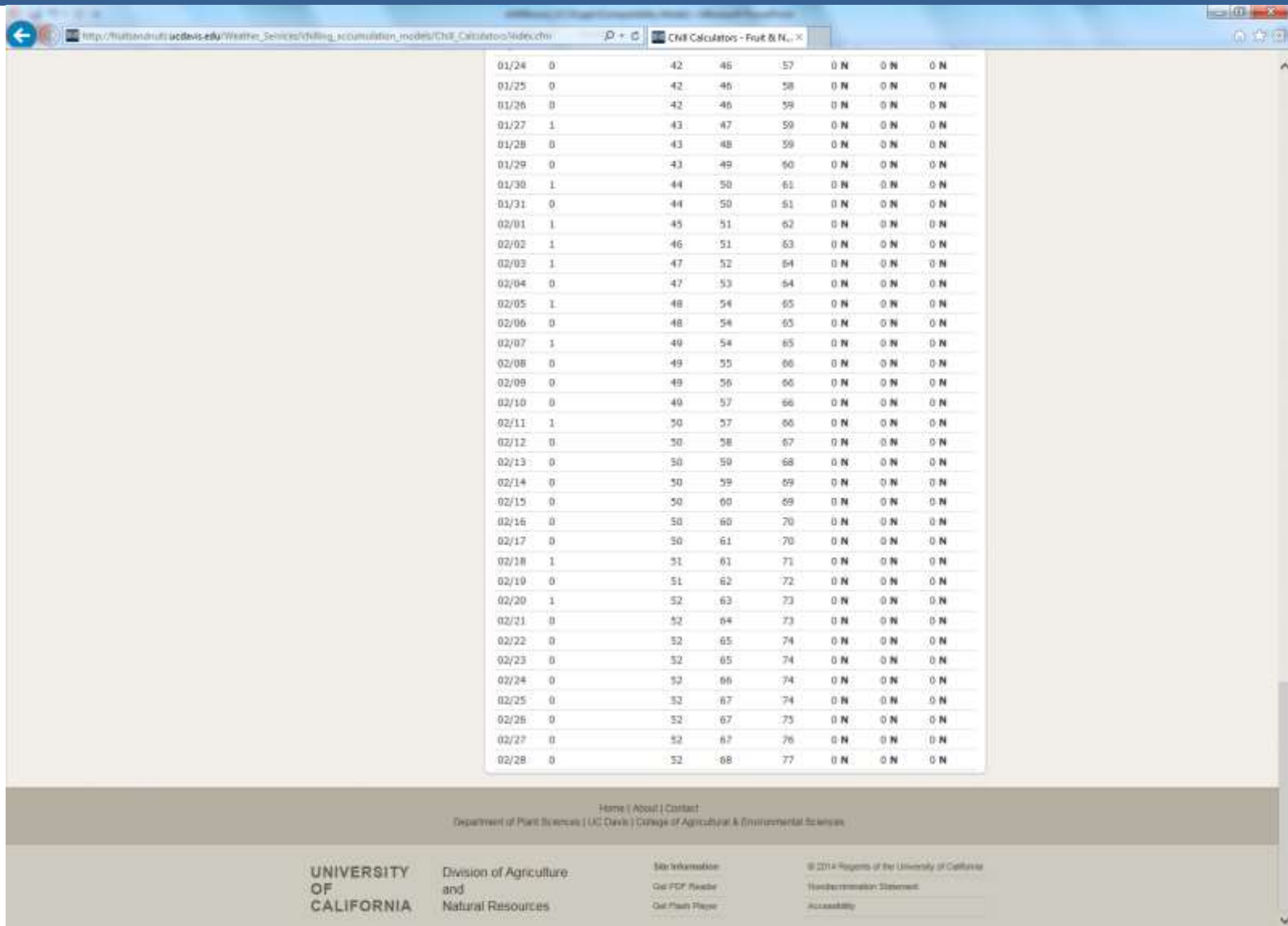
Harvest Prediction Model:
 for Peaches, Plums and Nectarines

Cumulative Chilling Portions - Station #205 Coalinga - Sep 1 2014 - Oct 29 2014

Log Scale / Normal Scale

Date	Daily Portions	2014	2013	2012	2011	2010	2009
11/01	0	0	0	0	0 N	0 N	0 N
11/02	0	0	0	0	0 N	0 N	0 N
11/03	0	0	0	0	0 N	0 N	0 N
11/04	0	0	0	1	0 N	0 N	0 N
11/05	0	0	0	2 M	0 N	0 N	0 N
11/06	1	1	0	3	0 N	0 N	0 N
11/07	0	1	0	3	0 N	0 N	0 N
11/08	0	1	0	4	0 N	0 N	0 N
11/09	0	1	1	4	0 N	0 N	0 N
11/10	0	1	2	5	0 N	0 N	0 N

Tracking chill portions on FNRIC



The screenshot shows a web browser window with the URL http://fruitandnuts.ucdavis.edu/Weather_Services/chilling_accumulation_models/Chill_Calculator/index.cfm. The browser title is "Chill Calculators - Fruit & Nuts". The main content is a table with the following data:

01/24	0	42	46	57	0 N	0 N	0 N
01/25	0	42	46	58	0 N	0 N	0 N
01/26	0	42	46	59	0 N	0 N	0 N
01/27	1	43	47	59	0 N	0 N	0 N
01/28	0	43	48	59	0 N	0 N	0 N
01/29	0	43	49	60	0 N	0 N	0 N
01/30	1	44	50	61	0 N	0 N	0 N
01/31	0	44	50	61	0 N	0 N	0 N
02/01	1	45	51	62	0 N	0 N	0 N
02/02	1	46	51	63	0 N	0 N	0 N
02/03	1	47	52	64	0 N	0 N	0 N
02/04	0	47	53	64	0 N	0 N	0 N
02/05	1	48	54	65	0 N	0 N	0 N
02/06	0	48	54	65	0 N	0 N	0 N
02/07	1	49	54	65	0 N	0 N	0 N
02/08	0	49	55	66	0 N	0 N	0 N
02/09	0	49	56	66	0 N	0 N	0 N
02/10	0	49	57	66	0 N	0 N	0 N
02/11	1	50	57	66	0 N	0 N	0 N
02/12	0	50	58	67	0 N	0 N	0 N
02/13	0	50	59	68	0 N	0 N	0 N
02/14	0	50	59	69	0 N	0 N	0 N
02/15	0	50	60	69	0 N	0 N	0 N
02/16	0	50	60	70	0 N	0 N	0 N
02/17	0	50	61	70	0 N	0 N	0 N
02/18	1	51	61	71	0 N	0 N	0 N
02/19	0	51	62	72	0 N	0 N	0 N
02/20	1	52	63	73	0 N	0 N	0 N
02/21	0	52	64	73	0 N	0 N	0 N
02/22	0	52	65	74	0 N	0 N	0 N
02/23	0	52	65	74	0 N	0 N	0 N
02/24	0	52	66	74	0 N	0 N	0 N
02/25	0	52	67	74	0 N	0 N	0 N
02/26	0	52	67	75	0 N	0 N	0 N
02/27	0	52	67	76	0 N	0 N	0 N
02/28	0	52	68	77	0 N	0 N	0 N

At the bottom of the page, there is a navigation bar with the following text:

Home | About | Contact
Department of Plant Sciences | UC Davis | College of Agricultural & Environmental Sciences

UNIVERSITY OF CALIFORNIA
Division of Agriculture and Natural Resources

Site Information
Get PDF Reader
Get Flash Player

© 2014 Regents of the University of California
Non-discrimination Statement
Accessibility

DIY Spreadsheet Chill Portions

The screenshot shows a web browser window displaying the UC Davis Fruit & Nut Research & Information website. The page title is "Chilling Accumulation Models: Their Calculation, Explanation, & Comparison". The left sidebar contains a navigation menu with the following items: HOME, ANNUAL EXTENSION CLASS, WEATHER-RELATED MODELS, Chilling Accumulation Models (highlighted), About Chilling Units & Hours, Fruit & Nut Crop Chill Portions Requirements, Chill Calculators, Subscribe to Email List, Prune Chilling Prediction, Nitrogen Prediction Models for Almond and Pistachio, Irrigation Scheduling, Harvest Prediction for Peaches, Plums & Nectarines, Almond Hull-Split Prediction, Pistachio Bloom Cast, About CIMIS Weather Stations, FIND AN EXPERT, FRUIT & NUT INFORMATION, ORCHARD MANAGEMENT, FRUIT & NUT CENTER UPDATES, VIDEO GALLERY, and ONLINE RESEARCH DATABASES. The main content area includes sections for "Using Various Models", "Chill Model Updates Email List", "Dynamic Model & Chill Portions Accumulation Guide", and "Chilling Accumulation Models: Their Explanation and Comparison". A red circle highlights the "Dynamic Model & Chill Portions Accumulation Guide" link in the sidebar.

University of California

UCDAVIS
FRUIT & NUT
RESEARCH & INFORMATION

Chilling Accumulation Models: Their Calculation, Explanation, & Comparison

Using Various Models

- Calculations of Current and Historic Chilling Accumulation at California CIMIS Sites

<u>Cumulative Chilling Hours:</u> Cumulative Chill Hours and Modified Chill Hours Hours below 45° F Hours between 32° F and 45° F November 1 through February 28/29	<u>Chilling Hour & Unit Accumulations:</u> Historic Accumulation of Chill Hours, Modified Chill Hours, & Chill Units (Utah Model) Hours below 45° F Hours between 32° F and 45° F September 1 through August 31
--	--

Cumulative Chilling Portions:
Dynamic Model
September 1 through August 31

Chill Model Updates Email List

The Fruit & Nut Center is closely monitoring Chill Portion calculations for the following stations: Shafter, Bakersfield, Colusa, Corcoran, Delano, Hanford, Lodi, Modesto, Oroville, Delano and Modera. If you would like to be notified of specific issues arise which are related to these stations, subscribe to our [Chill Model Updates email list](#).

Dynamic Model & Chill Portions Accumulation Guide

- A how-to guide (pdf) by Kitren Glozer, retired Project Scientist, Dept. of Plant Sciences, for calculating chill portions (including converting 10 and 30 minute data to hourly data for the model), using weather data from a data logger in your orchard, and the Dynamic Model (Excel file). [Both available for download.](#)

Chilling Accumulation Models: Their Explanation and Comparison

- Chilling Unit & Chill Portion: Model Comparison
- Fruit & Nut Crop Chill Portion Requirements - Chill Requirements in Chill Portions, calculated using the Dynamic Model. Because the Dynamic Model is still unfamiliar to many, to provide a frame of reference, a list of chilling requirements for many temperate tree crops has been compiled from the literature. (compiled by Katherine Jarvis-Shean, Dept. of Plant Sciences, UC Davis)

http://ucanr.org/sites/fruitnut/How-to_Guides/Dynamic_Model_-_Chill_Accumulation/

DIY Spreadsheet Chill Portions

The screenshot shows a web browser window with the following elements:

- Address bar: http://ucanr.edu/sites/fruitsandnuts/Guides/Dynamic_Model_-_Chill_Accumulation/
- Page Title: **Dynamic Model & Chill Accumulation**
- Navigation: EMAIL, PRINT, SITE MAP, Enter Search Terms
- Header: University of California, Division of Agriculture and Natural Resources
- Main Title: **Growth Regulators in Orchard Management**
- Image: A photograph of a branch with green leaves and several bright red cherries.
- Sub-header: Fruit & Nut Research & Information Center
- Left Sidebar (Introduction):
 - How-to Guides
 - Using the Pull Force Gauge: An FRF Guide
 - Leaf Area Measurement Alternatives
 - Dynamic Model & Chill Accumulation** (highlighted with a red circle)
 - Sorting Temperature Data to Get Hourly Data
 - Annual Research Reports
 - Research Team
 - Support
- Main Content Area:

Dynamic Model & Chill Accumulation

An illustrated step-by-step guide for calculating Chill Portions (CP) using weather data collected from personal data loggers and the Dynamic Model. Available here: The Guide, a PowerPoint presentation: [Dynamic Model & Chill Accumulation Guide - Glozer \(pdf\)](#) and The Dynamic Model, an Excel file: [Dynamic Model \(excel file\)](#)

 - California often provides too little chilling for optimum dormancy and rest-breaking for some chill-requiring crops. Research to overcome lack of chilling includes developing methods to measure chill accumulation under California's conditions.
 - Chill accumulation can be calculated using various mathematical models. UC Davis researchers, with the cooperation of many growers, have tested the Dynamic Model as a way of calculating chill accumulation. The model calculates chilling accumulation as 'chill portions' using a range of temperatures from ~35-55°F, and accounts for chill cancellation due to fluctuating warm temperatures.

Hourly data is needed for Dynamic Model calculations. For those who collect temperature data every 1-0 minutes is provided: Information and calculation instructions are provided here: [Sorting Temperature Data to Get Hourly Data](#)

DIY Spreadsheet Chill Portions

48310.xls [Read-Only] [Compatibility Mode] - Microsoft Excel

File Home Insert Page Layout Formulas Data Review View Acrobat

Clipboard Font Alignment Number Styles Cells Editing

Normal Bad Good Neutral Calculation Check Cell

GL7

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	
1		e0	4.15E+03																
2		e1	1.29E+04	DYNAMIC MODEL CHILLING PORTIONS - EREZ, A. and FISHMAN, S.															
3		a0	1.40E+05	The Volcani Center, Bet Dagan, ISRAEL															
4		a1	2.57E+18																
5		slp	1.6	Add hourly data in column B from row 13 down. Do not erase rows 11, 12.															
6		tetmlt	277	copy data from row 12 columns C to L till the last entry in column B.															
7		aa=a0/a1	5.43E-14	total cumulative chilling portions will appear in column L.															
8		ee=e1-e0	8.74E+03																
9																			
10	date	Temp(C)	Temp (K)	fmpet	sr	xi	xs	ak1	Inter-S	Inter-E	delt	Portions							
11	12/4/1999 16:45	15	288.00	16.93	22471935.51	1.00	0.81	0.09	0.00	0.07	0.00	0							
12	12/4/1999 17:45	12	285.00	12.44	252887.94	1.00	1.11	0.06	0.0726043	0.13	0.00	0							
13																			
14																			
15																			
16																			
17																			
18																			
19																			
20																			
21																			
22																			
23																			
24																			
25																			
26																			
27																			
28																			
29																			
30																			
31																			
32																			
33																			
34																			
35																			
36																			
37																			
38																			
39																			
40																			
41																			
42																			

Dynamic model with data inserted. Refreshed to Default conversion.

Ready

DIY Spreadsheet Chill Portions

The spreadsheet displays the following data:

date	Temp(C)	Temp (K)	fmpet	sr	xi	xs	ak1	Inter-S	Inter-E	delt	Portions
11 12/4/1999 16:45	15	288.00	16.93	22471935.51	1.00	0.81	0.09	0.00	0.07	0.00	0
12 12/4/1999 17:45	12	285.00	12.44	252887.94	1.00	1.11	0.06	0.0726043	0.13	0.00	0

1st: Copy-paste hourly temperature data into this column.
Data must be hourly, and in Celsius. If your data is in Fahrenheit, use Tab 3 to convert from Fahrenheit to Celsius.
For prune, use hourly temperature from Nov. 1 to Feb. 15

DIY Spreadsheet Chill Portions

4882.xls [Read-Only] [Compatibility Mode] - Microsoft Excel

File Home Insert Page Layout Formulas Data Review View Acrobat

Clipboard Font Alignment Number Styles Cells Editing

Normal Bold Good Neutral Calculation Check Cell

AutoSave Undo Clear Soft & Filter Select

Dynamic Model - Chill Portions - Erez A. and Fereman I.
The Volcani Center, Bet Dagan, Israel

Add yearly data to column B from row 11 down. Do not erase rows 11, 12.
Copy data from rows 12 columns C to L the last entry to column B.
Total cumulative chill portions will appear in column L.

date	Temp(C)	Temp(K)	Height	sr	si	si	si	Inter-S	Inter-E	chl	Portions	
12/4/1990 16:45	15	289.08	16.93	22471335.51	1.00	0.81	0.89	6.08	0.87	6.08	0	
12/4/1990 17:45	12	285.08	12.44	252807.94	1.00	1.11	0.86	6.07260411	0.13	6.08	0	
10/1/2000	100	34.7	307.79	16.89	14407913.13	1.00	0.83	0.89	0.13153829	0.19	6.08	0
10/1/2000	200	13.8	286.08	15.14	379128.05	1.00	0.52	0.80	6.1027951	0.25	6.08	0
10/1/2000	300	13.1	286.18	14.18	1324995.19	1.00	0.99	0.87	6.26374292	0.30	6.08	0
10/1/2000	400	12.3	285.38	12.89	397700.57	1.00	1.00	0.86	6.29849911	0.34	6.08	0
10/1/2000	500	12.6	285.68	13.35	625934.99	1.00	1.04	0.86	6.34377931	0.39	6.08	0
10/1/2000	600	12.9	285.98	13.88	961207.17	1.00	1.01	0.87	6.39753372	0.43	6.08	0
10/1/2000	700	12.5	285.58	13.28	537721.65	1.00	1.05	0.86	6.43895479	0.47	6.08	0
10/1/2000	800	18	291.08	23.32	162463715.75	1.00	0.99	0.85	6.4664657	0.48	6.08	0
10/1/2000	900	22.1	295.18	27.18	63936762682.31	1.00	0.79	0.28	6.48344444	0.46	6.08	0
10/1/2000	1000	24.5	297.58	38.54	1834981254524.40	1.00	0.31	0.31	6.46129988	0.41	6.08	0
10/1/2000	1100	27.8	300.88	35.07	189953936687480.00	1.00	0.22	0.63	6.41810703	0.32	6.08	0
10/1/2000	1200	29.7	302.79	37.63	2197795389644300.00	1.00	0.19	0.63	6.32528257	0.25	6.08	0
10/1/2000	1300	31.3	304.38	39.75	18529337025163000.00	1.00	0.16	1.03	6.24943222	0.19	6.08	0
10/1/2000	1400	32.9	305.98	42.87	352462712186320000.00	1.00	0.14	1.29	6.18989423	0.15	6.08	0
10/1/2000	1500	32.5	305.58	42.35	904679876399900.00	1.00	0.14	1.22	6.15150753	0.15	6.08	0
10/1/2000	1600	31.1	304.18	39.58	14151339908887900.00	1.00	0.16	1.01	6.1481999	0.16	6.08	0
10/1/2000	1700	28.9	302.98	36.55	793089707671290.00	1.00	0.20	0.74	6.18970499	0.18	6.08	0
10/1/2000	1800	26.9	299.98	33.84	48626343697133.00	1.00	0.24	0.58	6.17960757	0.21	6.08	0
10/1/2000	1900	24.8	297.88	30.96	277864489547.88	1.00	0.30	0.41	6.28614258	0.24	6.08	0
10/1/2000	2000	23.2	296.28	28.73	299191958992.99	1.00	0.25	0.32	6.22963772	0.27	6.08	0
10/1/2000	2100	20.6	293.68	25.06	7633077542.66	1.00	0.46	0.22	6.2614879	0.30	6.08	0
10/1/2000	2200	19.8	292.88	23.92	3495328880.88	1.00	0.49	0.21	6.36488454	0.34	6.08	0
10/1/2000	2300	19.6	292.68	23.61	1620319962.79	1.00	0.50	0.19	6.3811876	0.37	6.08	0
10/1/2000	2400	18.8	291.88	22.48	5707451313.27	1.00	0.54	0.17	6.3647757	0.39	6.08	0
10/2/2000	100	17.4	298.88	28.85	761454879.69	1.00	0.63	0.14	6.7911594	0.42	6.08	0
10/2/2000	200	17.6	298.68	28.74	101954199.74	1.00	0.62	0.14	6.4249527	0.45	6.08	0
10/2/2000	300	16.7	289.79	19.60	29145468.36	1.00	0.69	0.12	6.6928181	0.49	6.08	0
10/2/2000	400	18.1	291.18	21.47	218428282.88	1.00	0.59	0.15	6.4754628	0.49	6.08	0
10/2/2000	500	18.2	291.28	21.61	243282740.26	1.00	0.50	0.15	6.49087606	0.50	6.08	0
10/2/2000	600	17.7	290.79	20.89	137858370.43	1.00	0.61	0.14	6.56351848	0.52	6.08	0
10/2/2000	700	17.5	290.58	20.69	80669512.95	1.00	0.62	0.14	6.57766415	0.53	6.08	0
10/2/2000	800	18.6	291.68	22.19	438779287.12	1.00	0.56	0.16	6.5123999	0.53	6.08	0
10/2/2000	900	20.2	293.18	24.49	43146137957.27	1.00	0.47	0.21	6.51497311	0.52	6.08	0
10/2/2000	1000	21.3	294.38	26.05	20636526272.48	1.00	0.42	0.25	6.52316346	0.50	6.08	0
10/2/2000	1100	22.3	295.38	27.49	647445786233.85	1.00	0.30	0.28	6.56129884	0.47	6.08	0
10/2/2000	1200	23.4	296.48	29.01	398436844526.69	1.00	0.34	0.33	6.47132633	0.43	6.08	0
10/2/2000	1300	23.9	296.98	29.71	796253617771.44	1.00	0.23	0.36	6.44483897	0.43	6.08	0
10/2/2000	1400	24.5	297.58	30.54	1833491547324.40	1.00	0.31	0.33	6.48131600	0.37	6.08	0
10/2/2000	1500	24.6	297.68	30.68	236236403849.00	1.00	0.30	0.40	6.37108432	0.35	6.08	0
10/2/2000	1600	24.3	297.38	30.25	189956682134.60	1.00	0.31	0.38	6.3895932	0.34	6.08	0
10/2/2000	1700	23.6	296.68	29.29	504168414293.18	1.00	0.34	0.34	6.3795989	0.34	6.08	0
10/2/2000	1800	21.6	294.68	26.48	10597954541.01	1.00	0.41	0.26	6.3776838	0.35	6.08	0
10/2/2000	1900	19.7	292.79	23.77	218228283.84	1.00	0.50	0.19	6.5346459	0.38	6.08	0

Ready

Chill requirements in Chill Portions

Crop (CA Cv.'s)	Chill Port Requ.
Almonds	22-32
'Nonpareil'	23
Apple 'Golden Delicious'	50
Cherry	30-70
'Brooks'	37
Peaches, Nectarines	8-75
Walnut	38-72
'Chandler'*	45-50

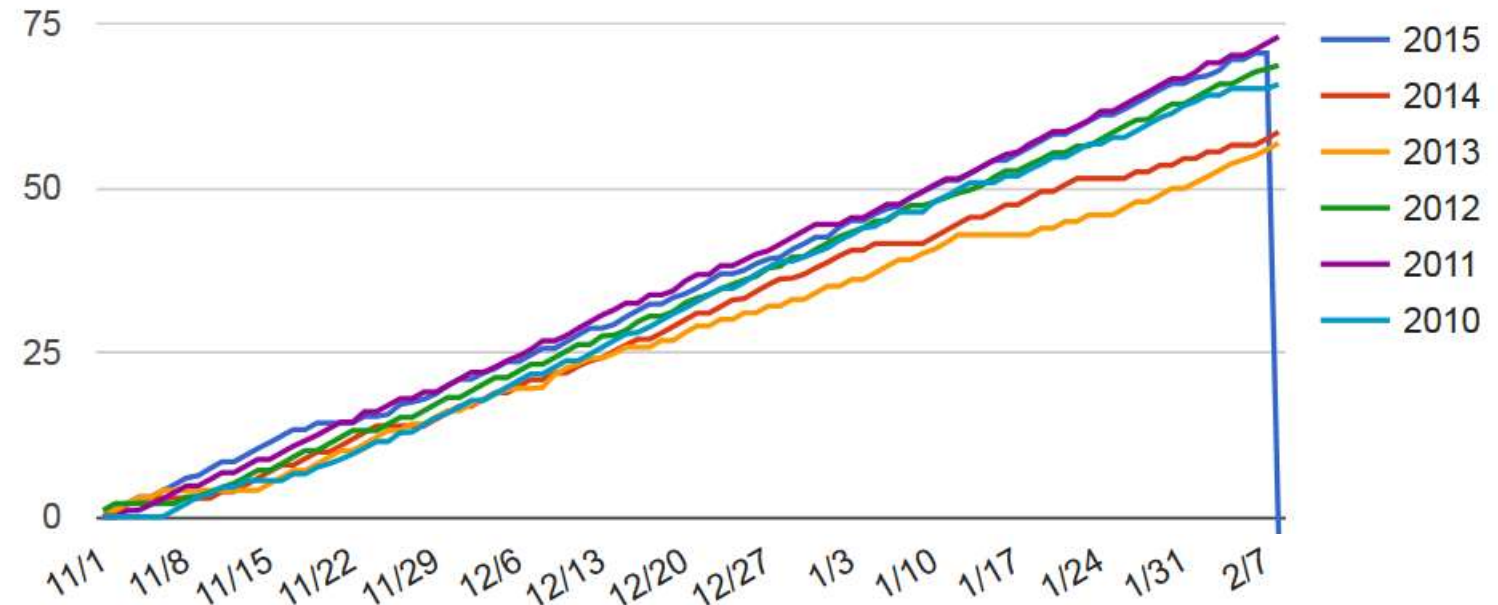
*Based on low chill & harvest, 2014

Chill requirements in Chill Portions

Crop	Cultivar	Chill Port Requ.
Peach	Andross	63
	Big Top	63
	Earligrande	12
	Flordaprince	8
	Maravilha	12
	O'Henry	63
	Redhaven	75
Nectarine	Aprilglo	12
	Fantasia	42
	Flavortop	41
	Mayglo	18
	Sunlite	33

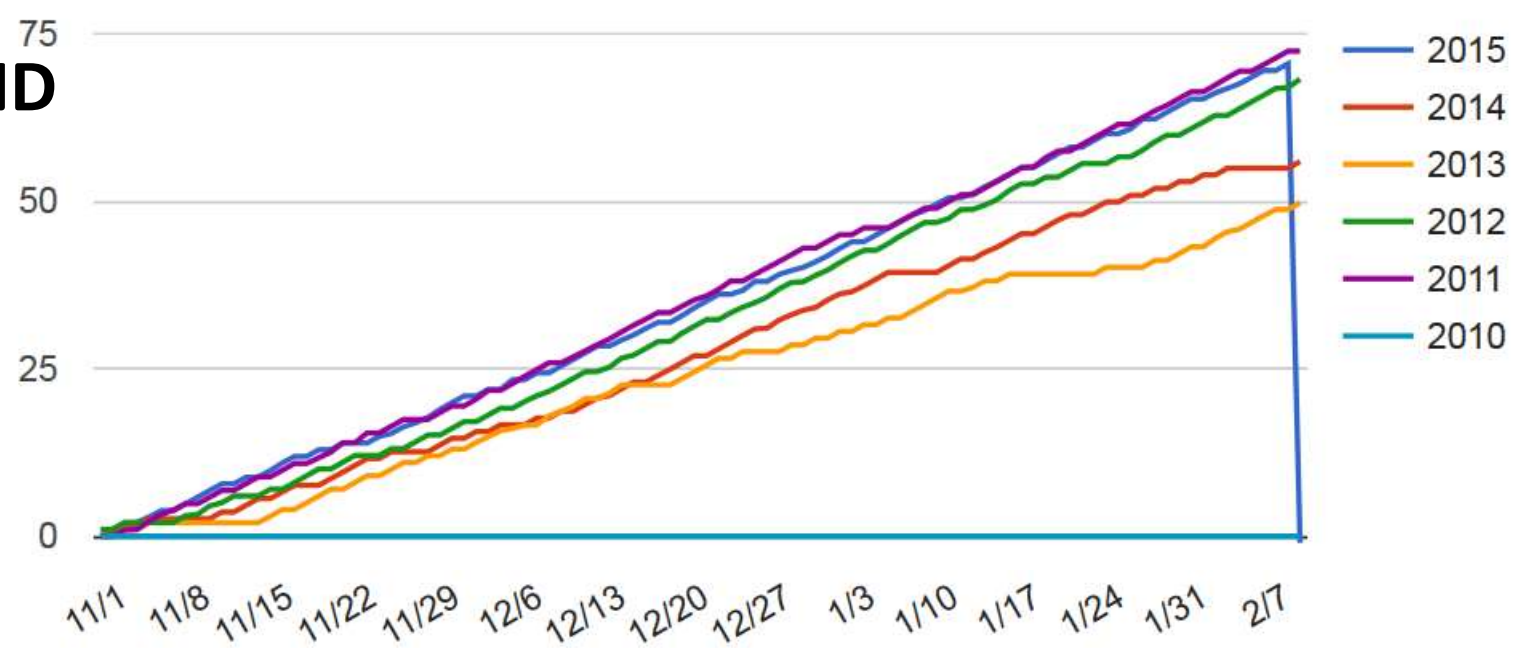
CAMINO

Portions



DIAMOND SPRINGS

Portions



TAKE AWAYS

- 1) Chill looks good this year
- 2) Chill portions is a better way to count chill
- 3) Follow chill portions at the UC Fruit & Nut Center website.

QUESTIONS?

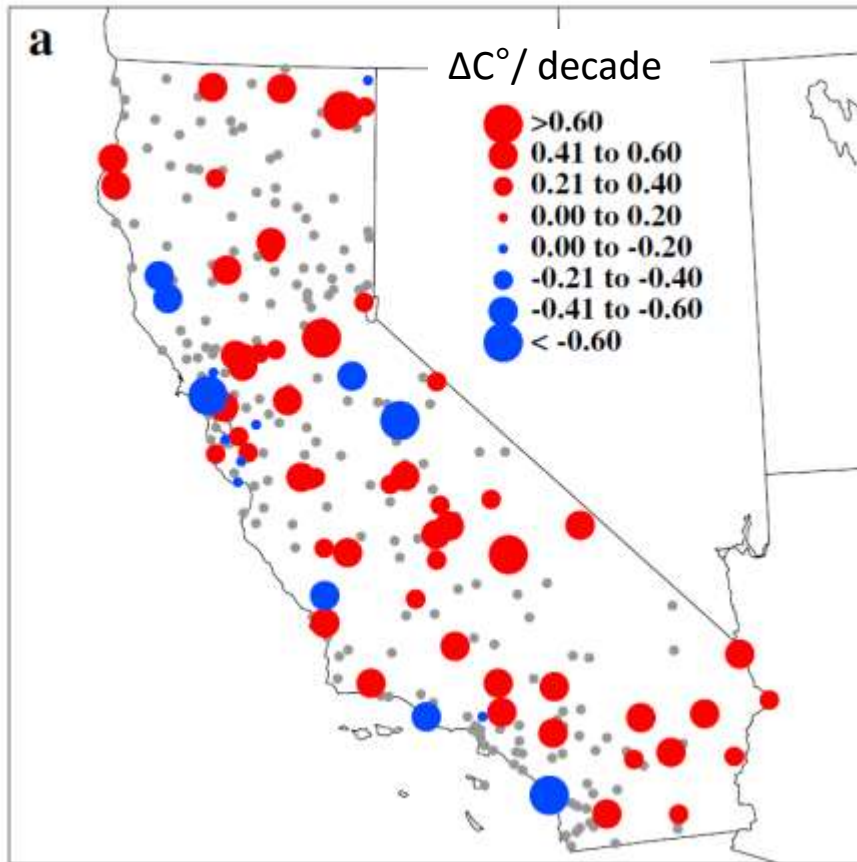
Predictions:

Winter Chill will decrease.

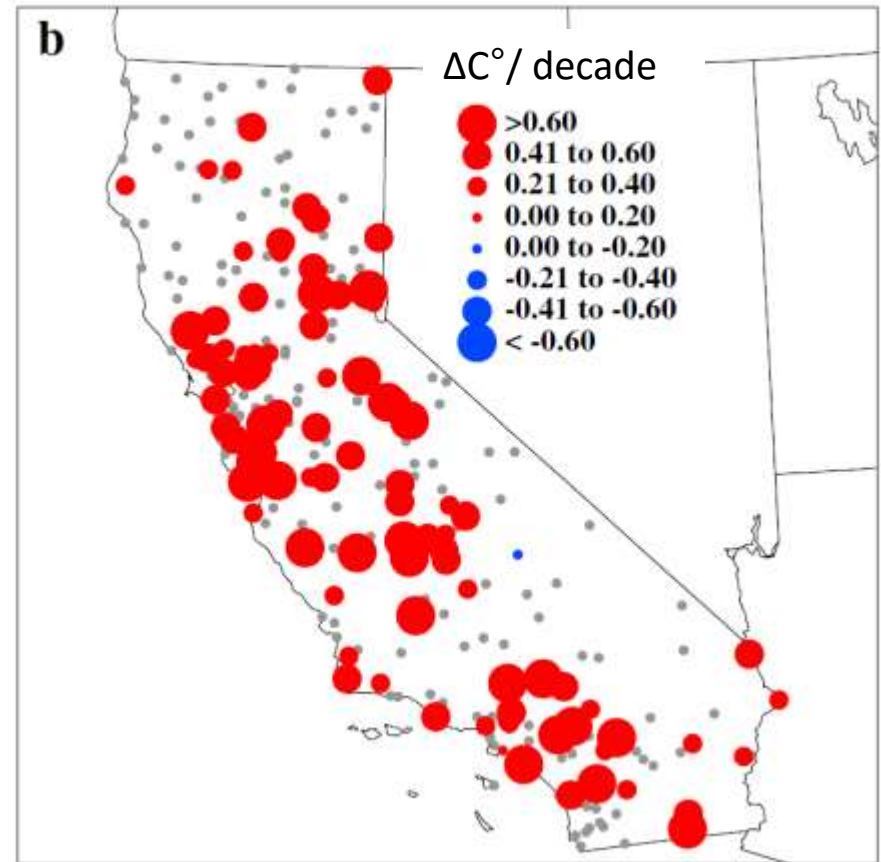
Probably 15-20%
by mid-Century.

Temperatures have been warming

COOP Annual Tmax Trends (1970-2006)

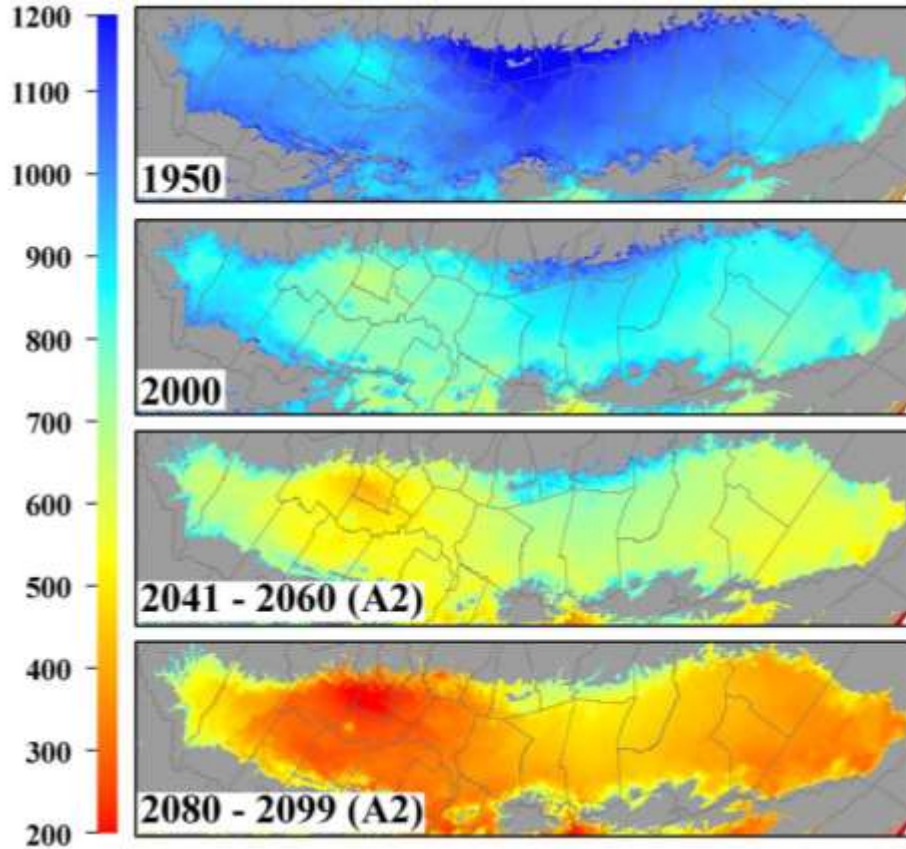


COOP Annual Tmin Trends (1970-2006)

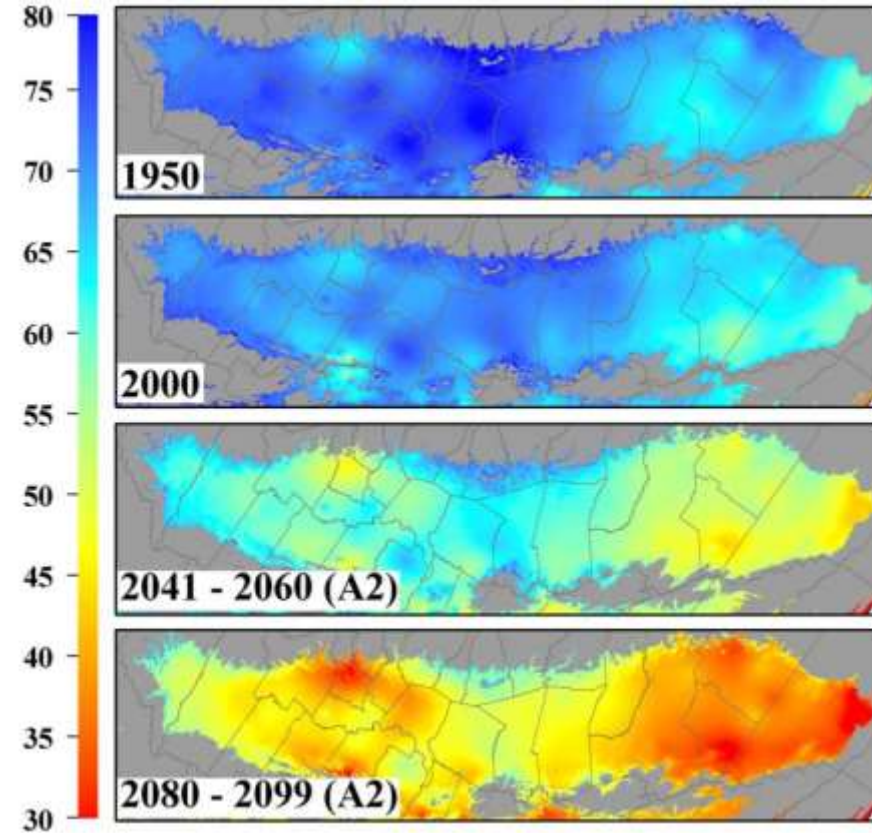


Chill will decrease. "Safe Winter Chill"

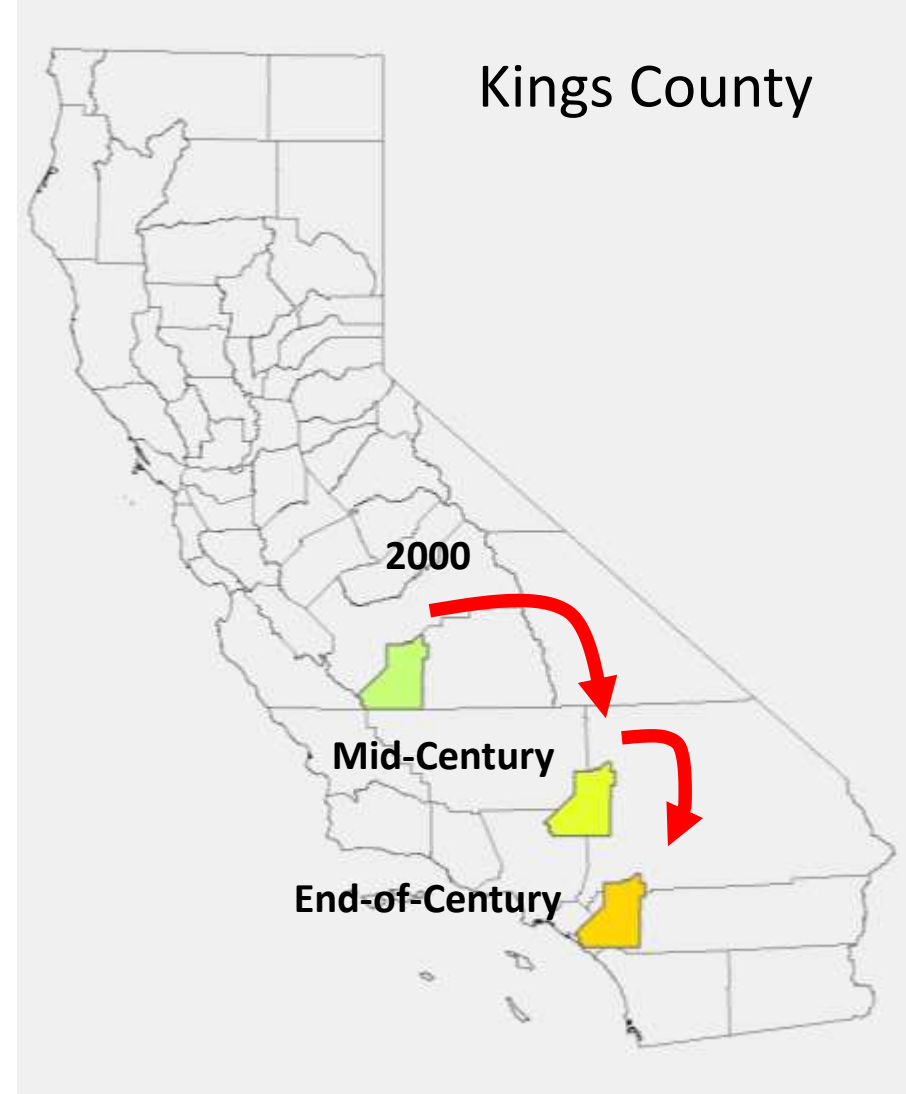
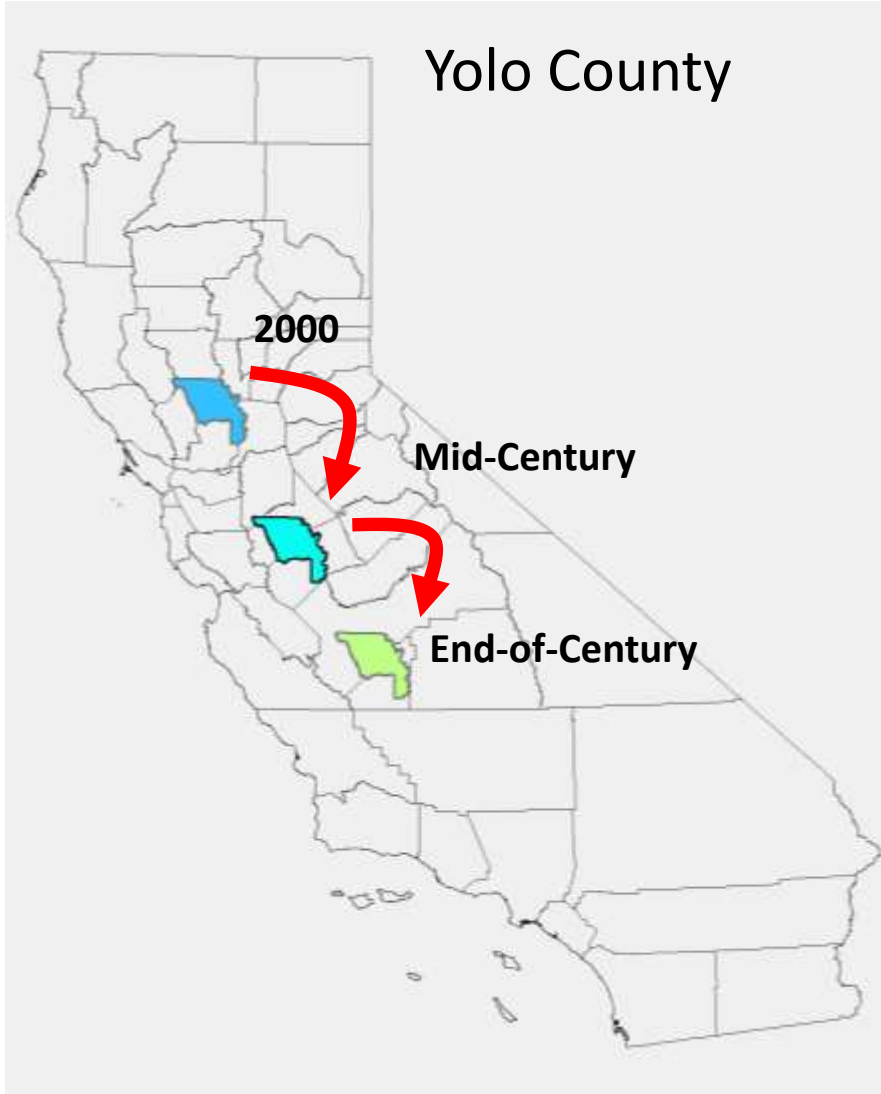
Chill Hours



Chill Portions

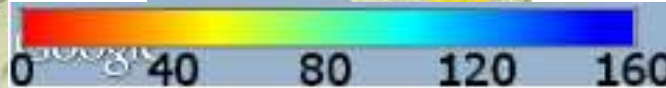


What changes will feel like



Uncertainty increases with time

2050



2099

