How to Count Winter Chill

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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

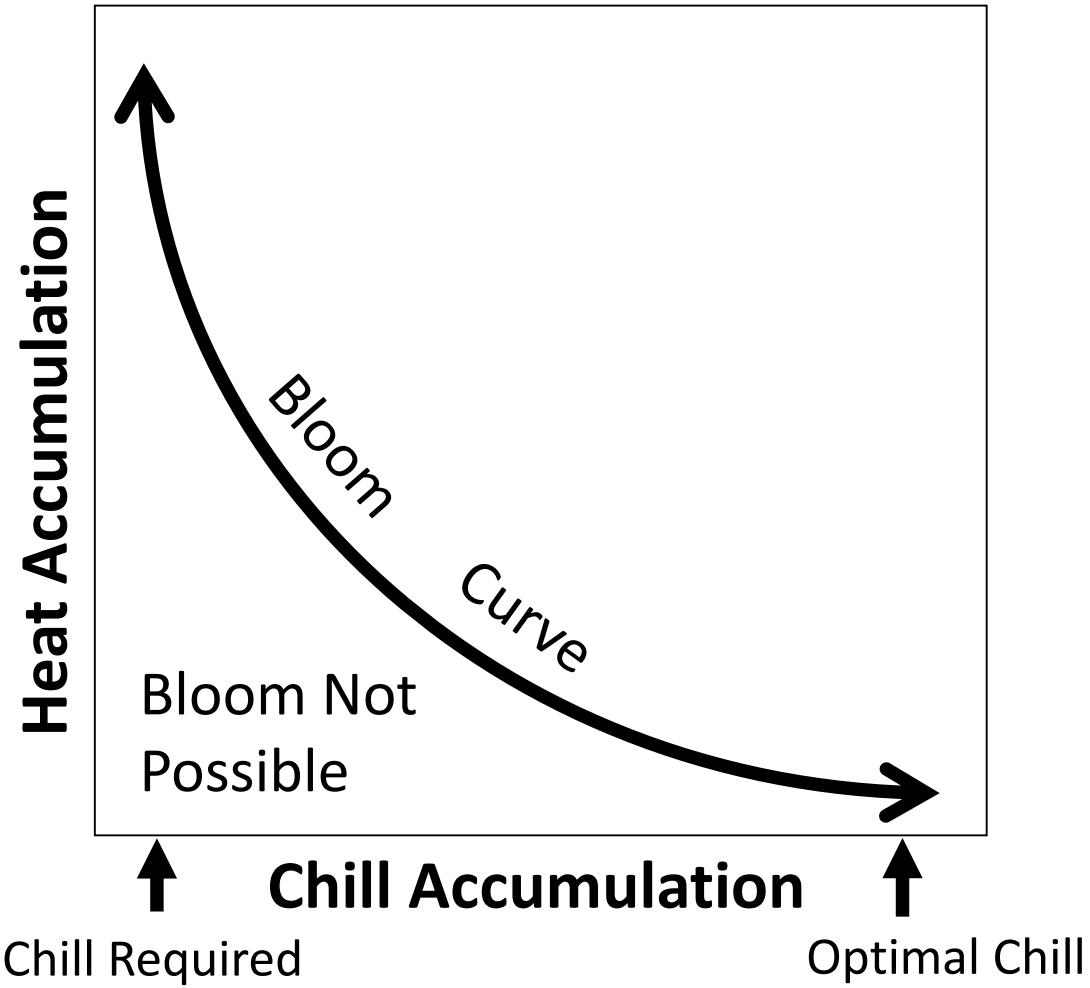
Why Chill Matters – Poor, Erratic Bloom

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

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

Saure, 1985 ; Black, 1952 Photos: K. Pope

Why Chill Matters – Delayed Bloom



Pope et al. (2014) AFM

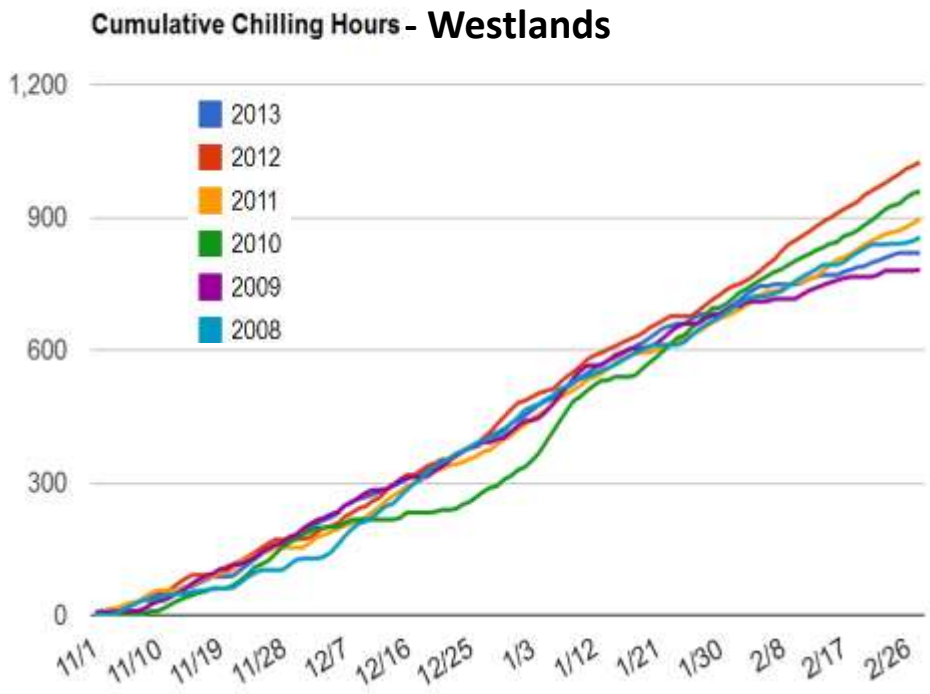
Why how you count chill matters: Literature supporting chill portions

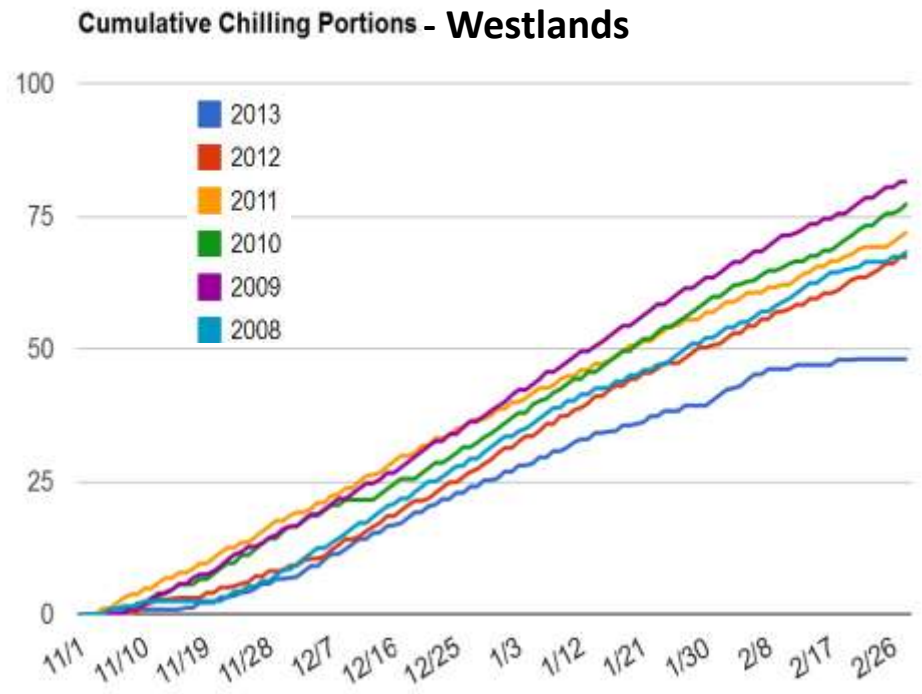
Lead Author	Year Pub'd	Crop	Location
Ramirez	2010	Almond	Chile
Viti	2010	Apricot	Spain, Italy
Gao	2012	Apricot	China
Ruiz	2007	Apricot	Spain
Alburquerque	2008	Cherry	Spain, Fr., Can., NY, CA
Glozer	2005	Cherry	California
Allan	1995	Peach	South Africa
Linsley-Noakes	1994	Peach	South Africa
Erez	1990	Peach	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.

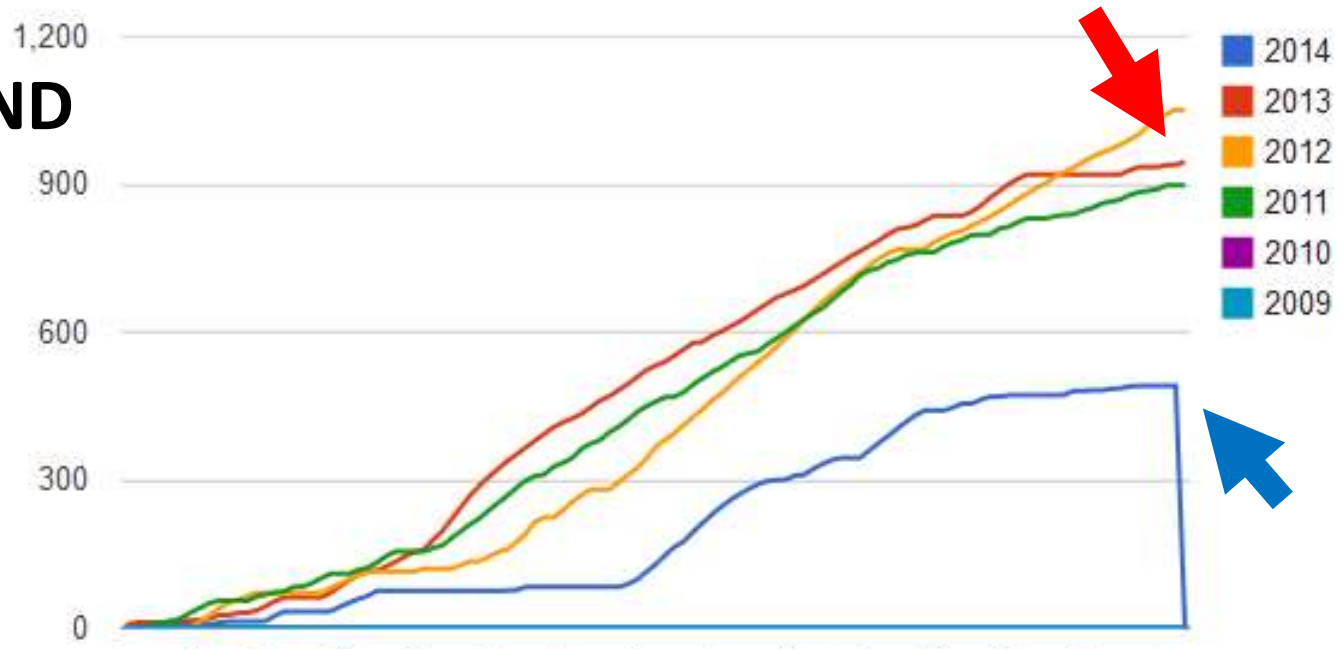




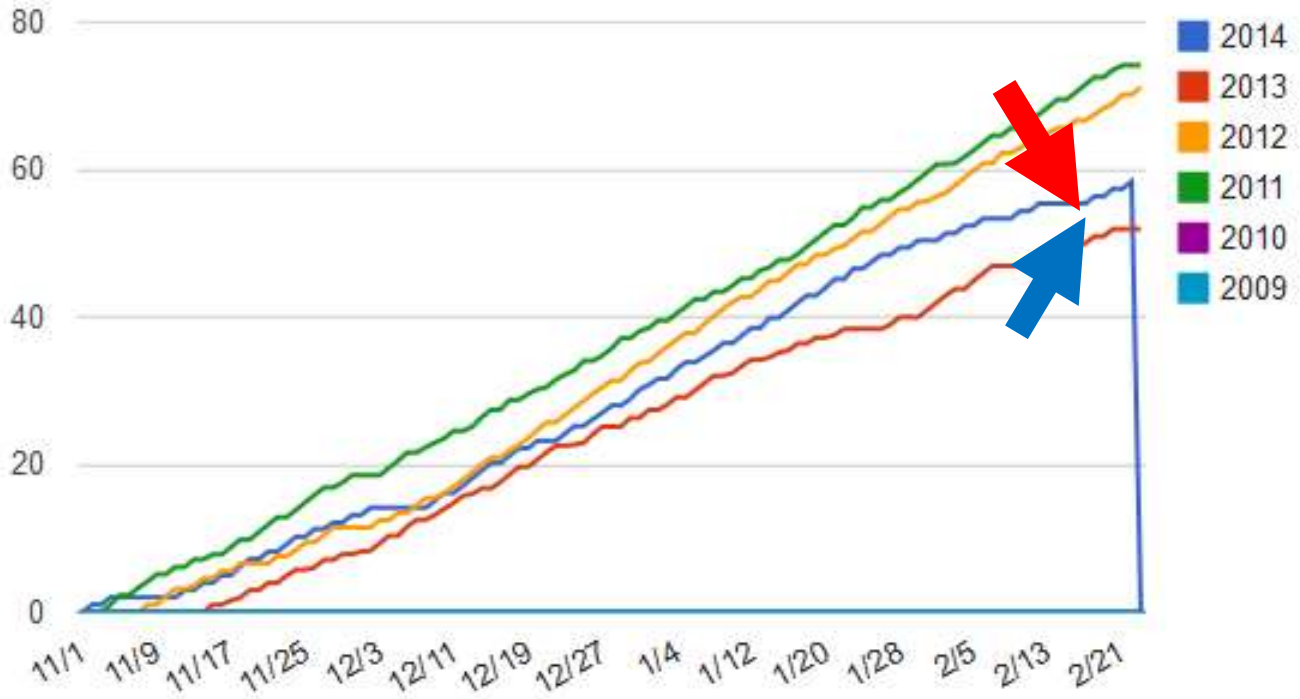
Figures: fruitsandnuts.ucdavis.edu

WOODLAND

Hours

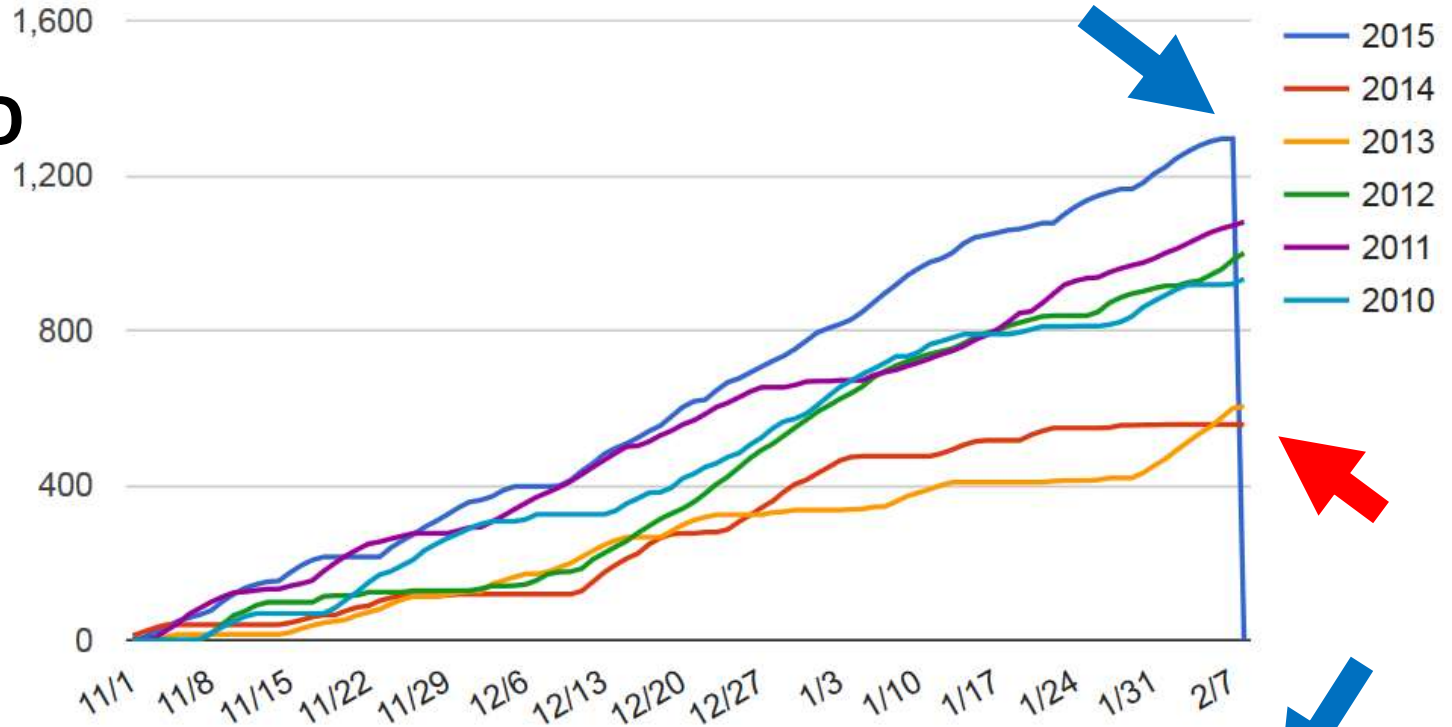


Portions

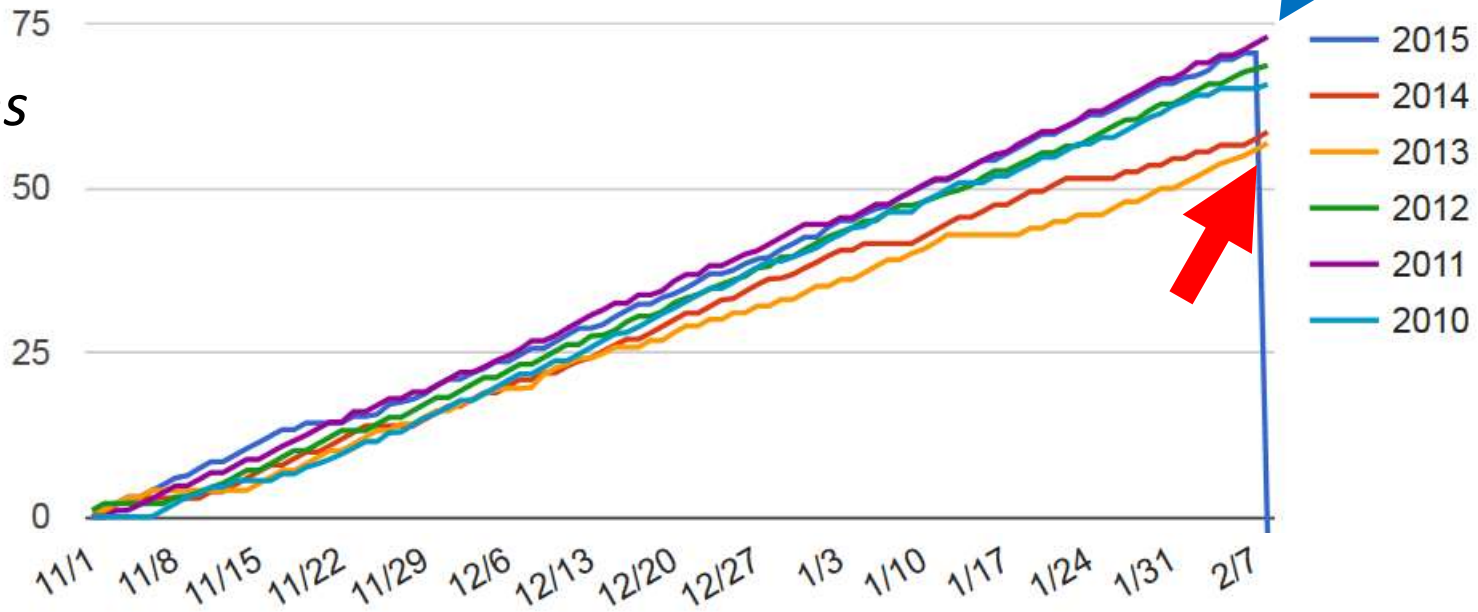


CAMINO

Hours

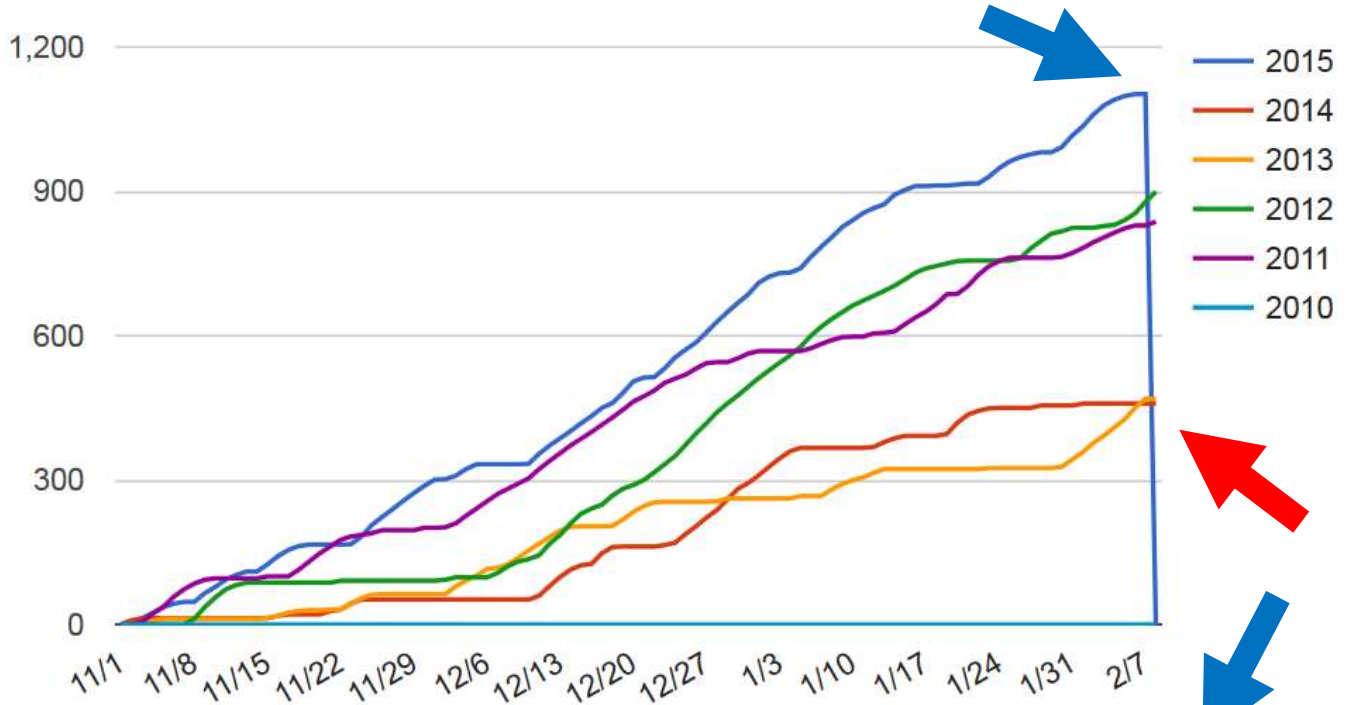


Portions

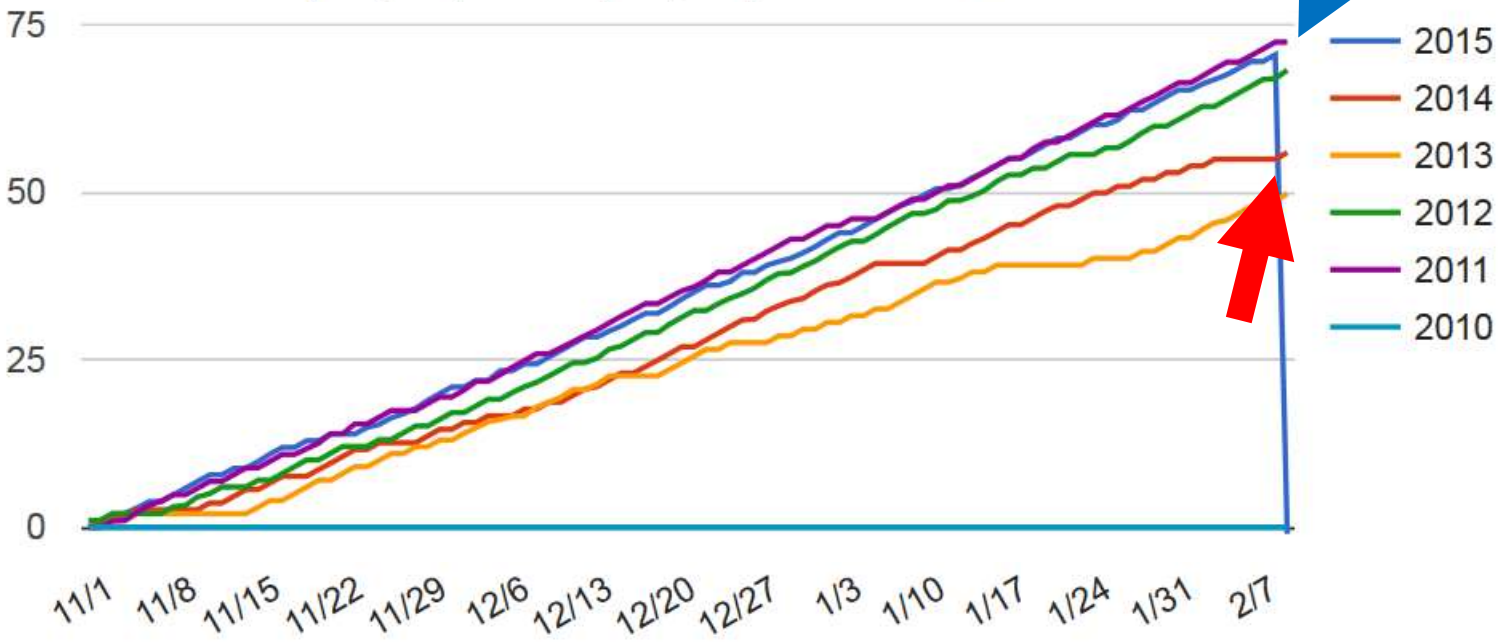


DIAMOND SPRINGS

Hours

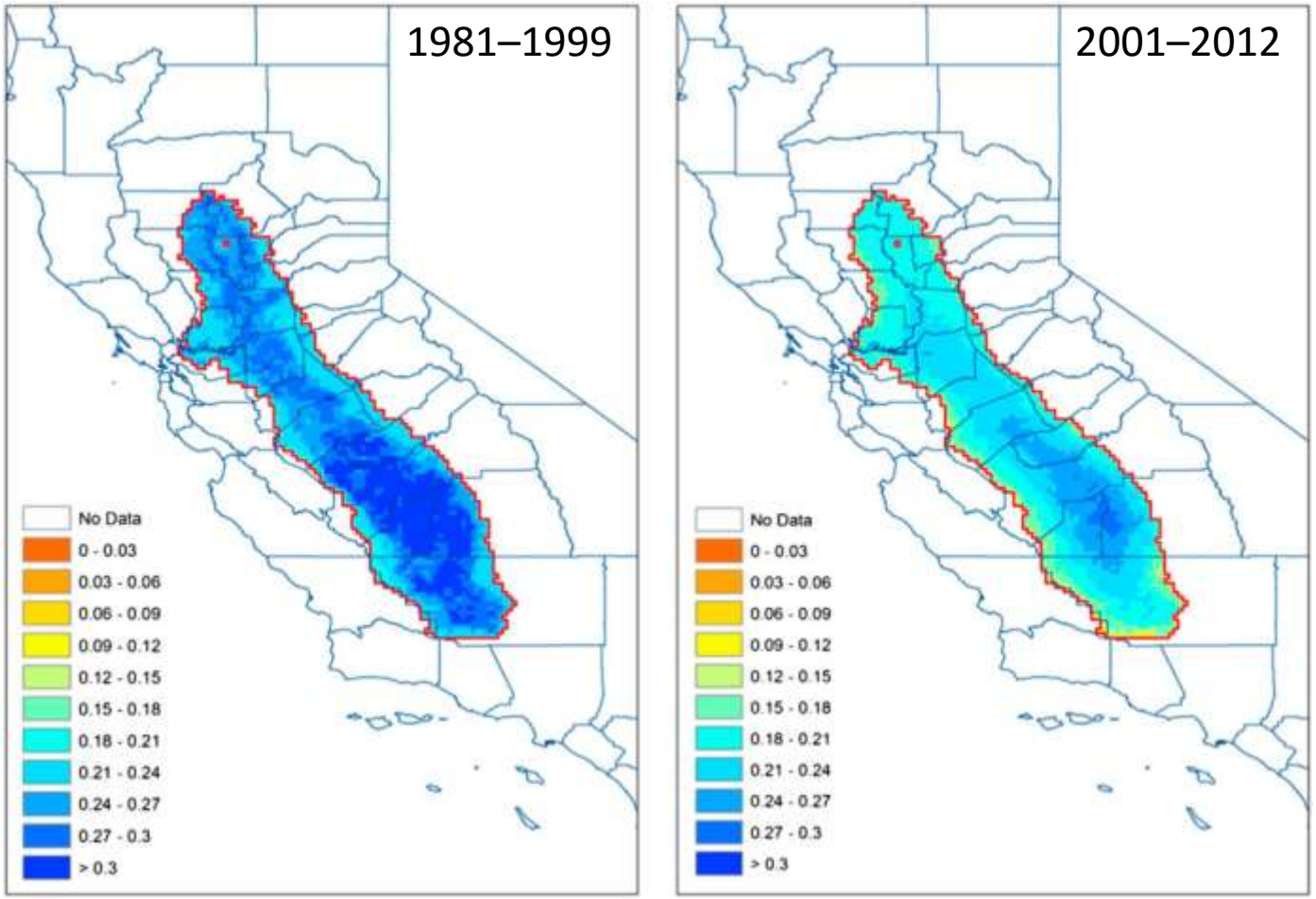


Portions

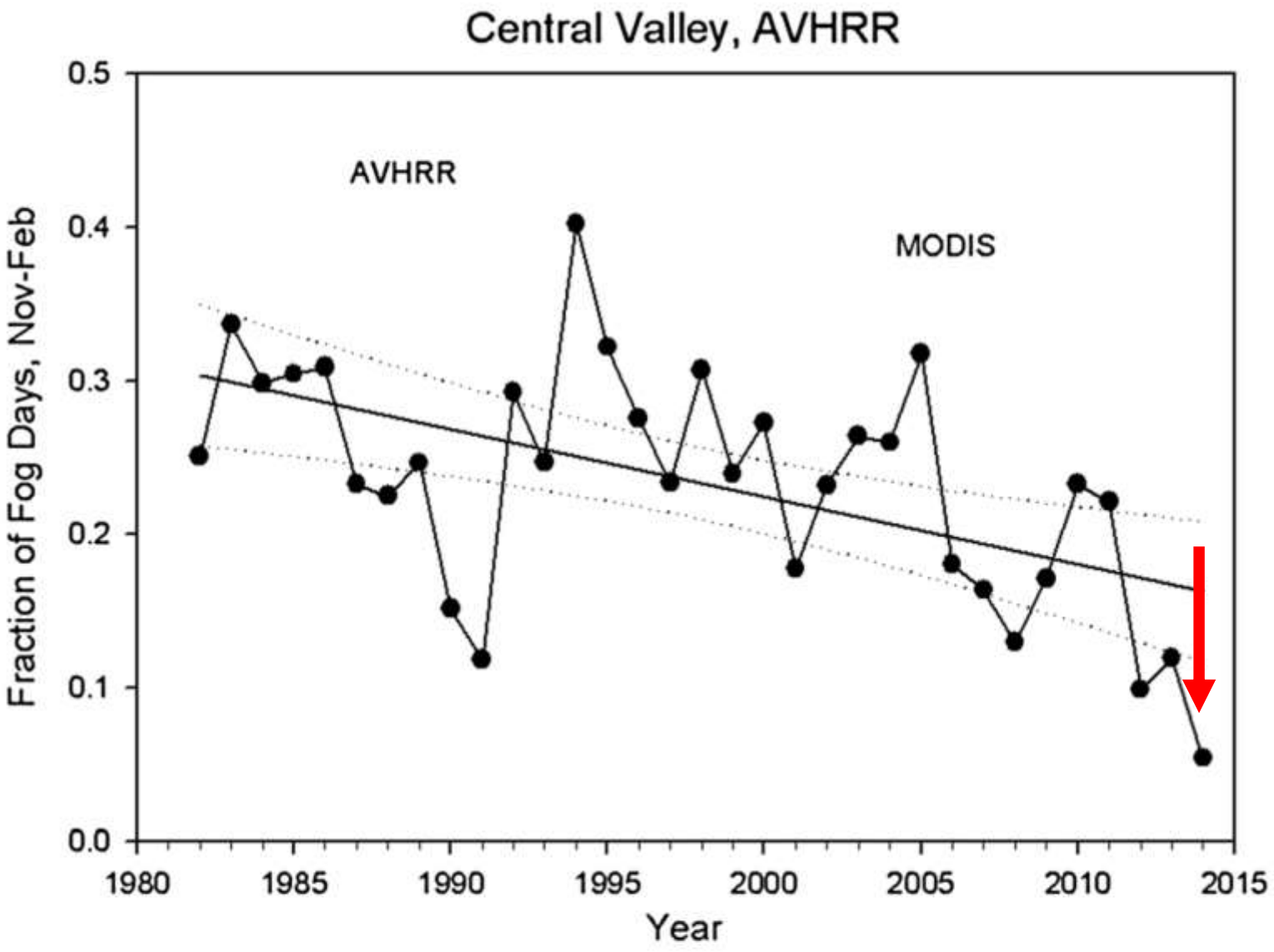


Bonus Complication: Fog
Fog has been decreasing

Time fogged in



Baldocchi & Waller (2014)



Baldocchi & Waller (2014)

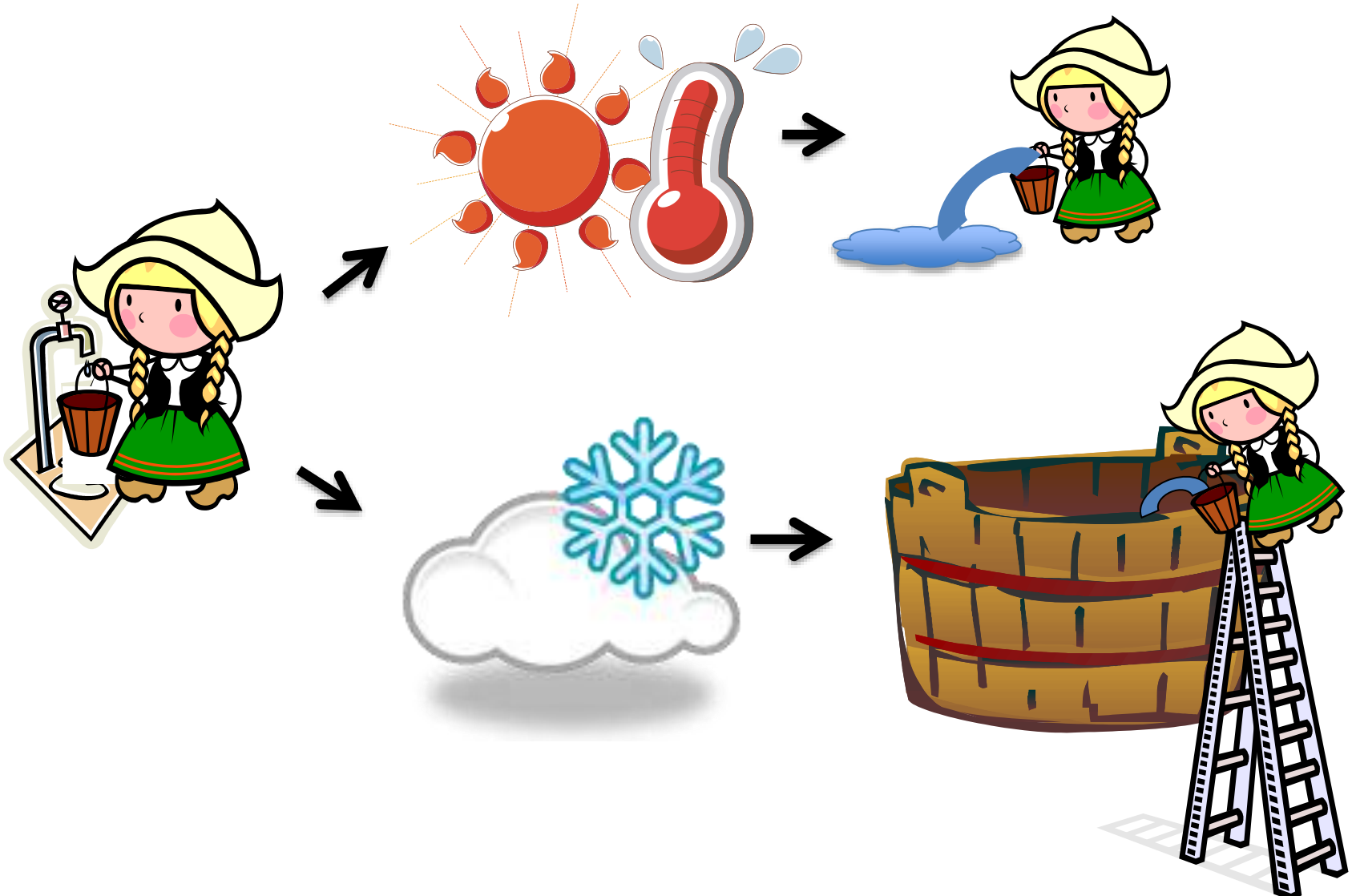
What's "under the hood" of the Chill Portions model?

Dynamic Model – Chill Portions

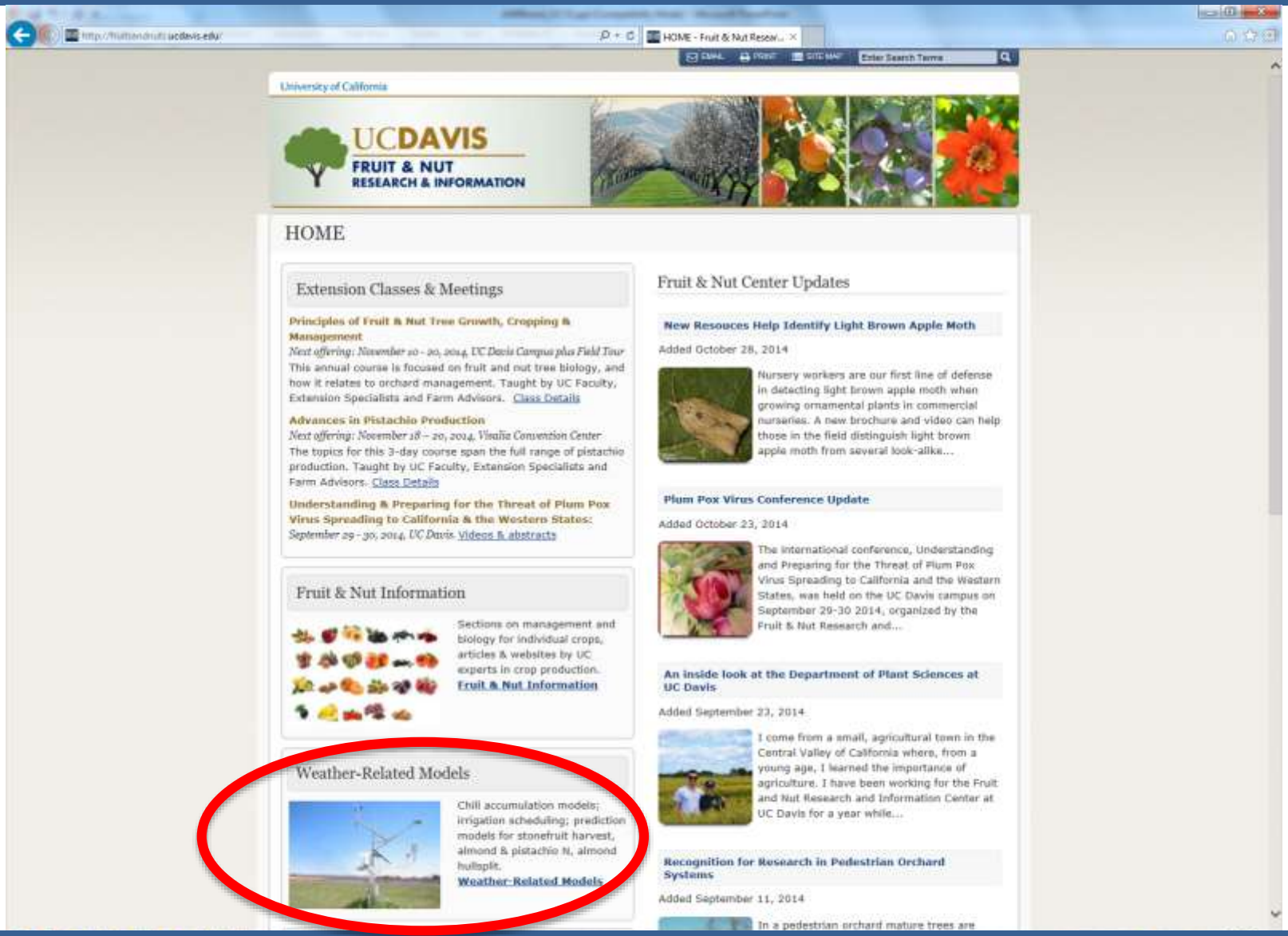
- Different temps have dif. 'chill value.'
  - Max: hours at 43-47° F.
  - No chill value at 32°F and 54°F.
- Rather than saying, 'We had X chill hours but they were warm chill hours.'
- Expands the range of temps considered effective for chill accumulation.

Fishman et al., 1987

Dynamic Model: Filling the Chill Tank



How to count and use chill portions



Tracking chill portions on FNRIC

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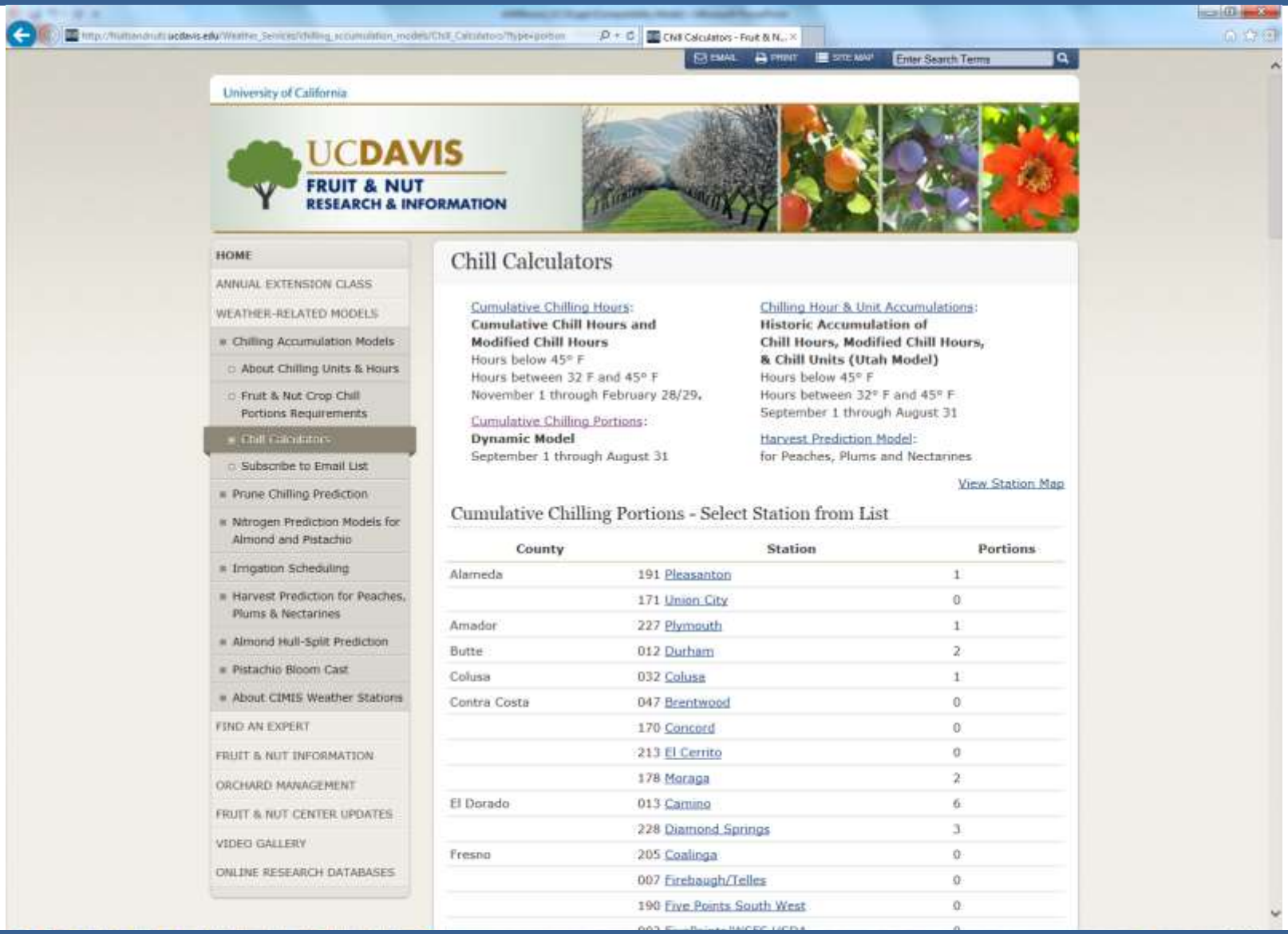

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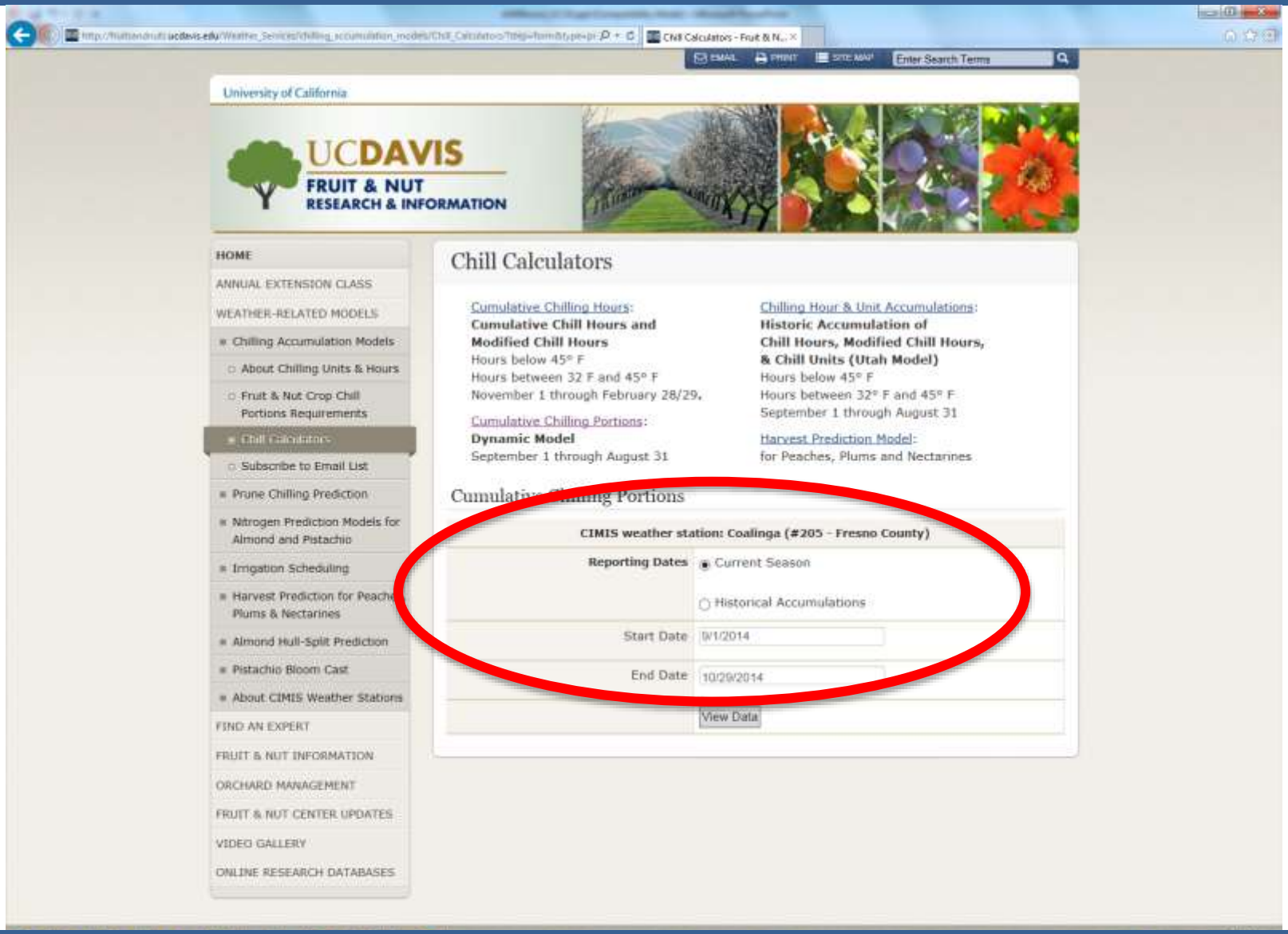

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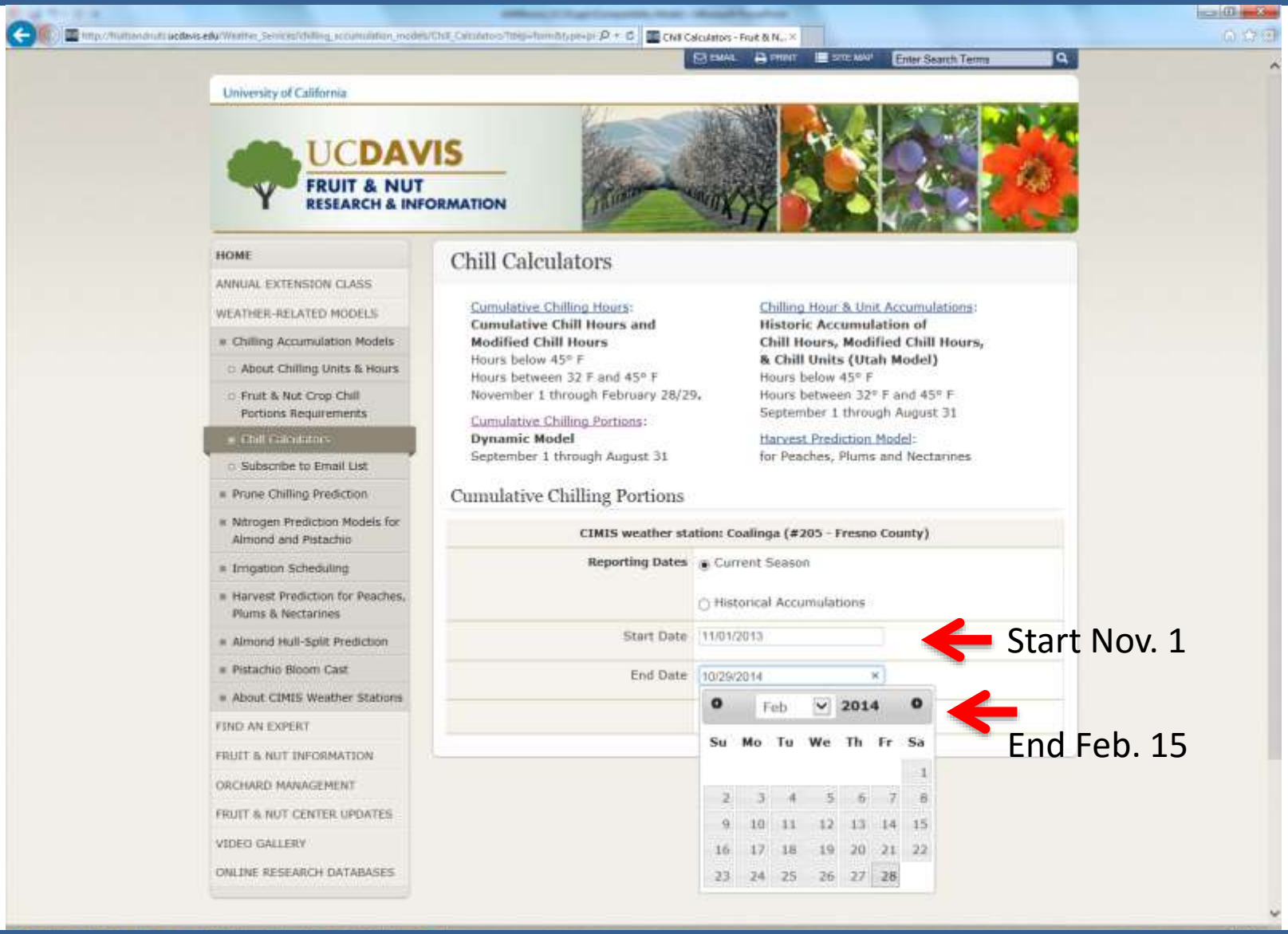

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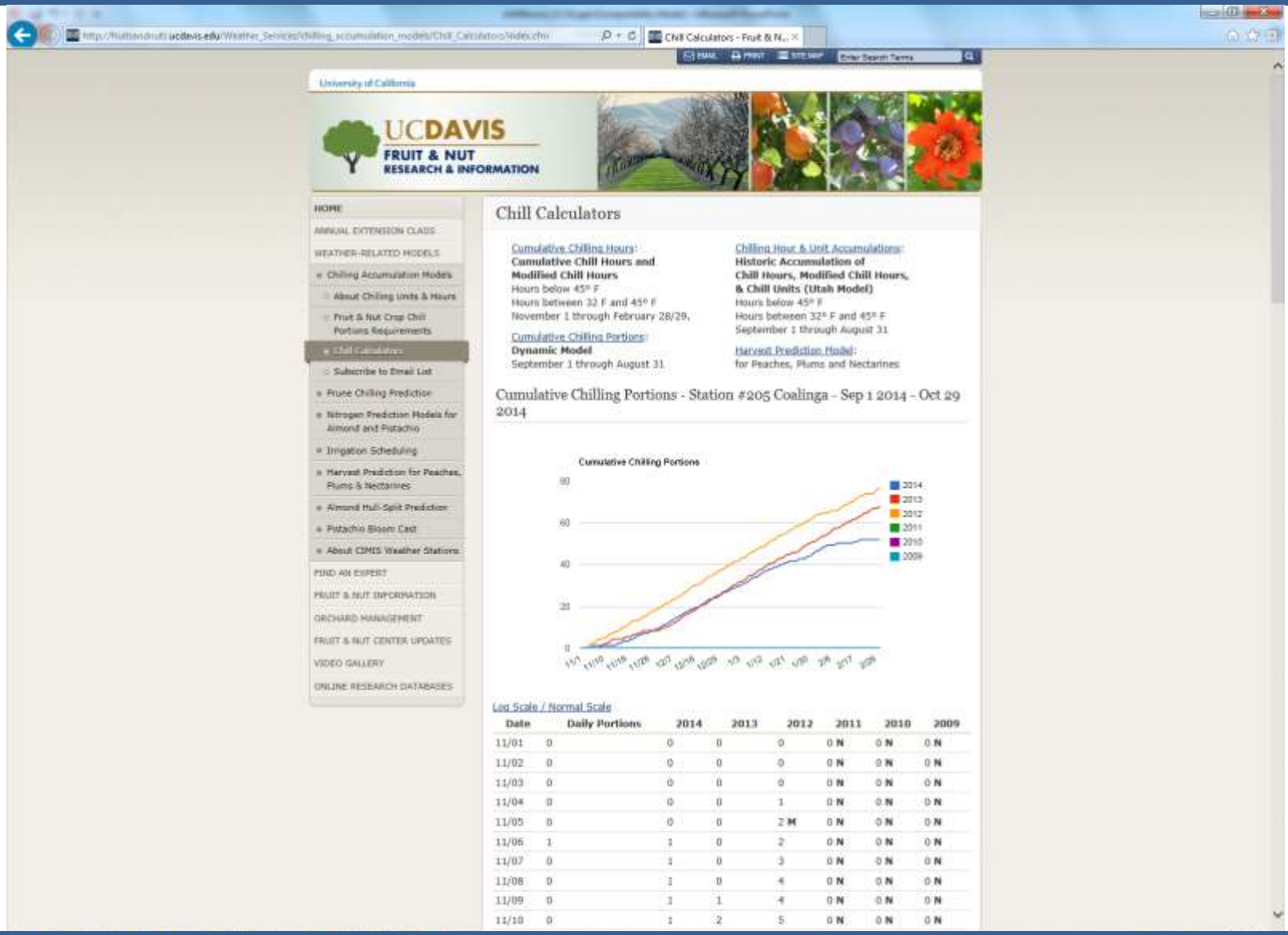
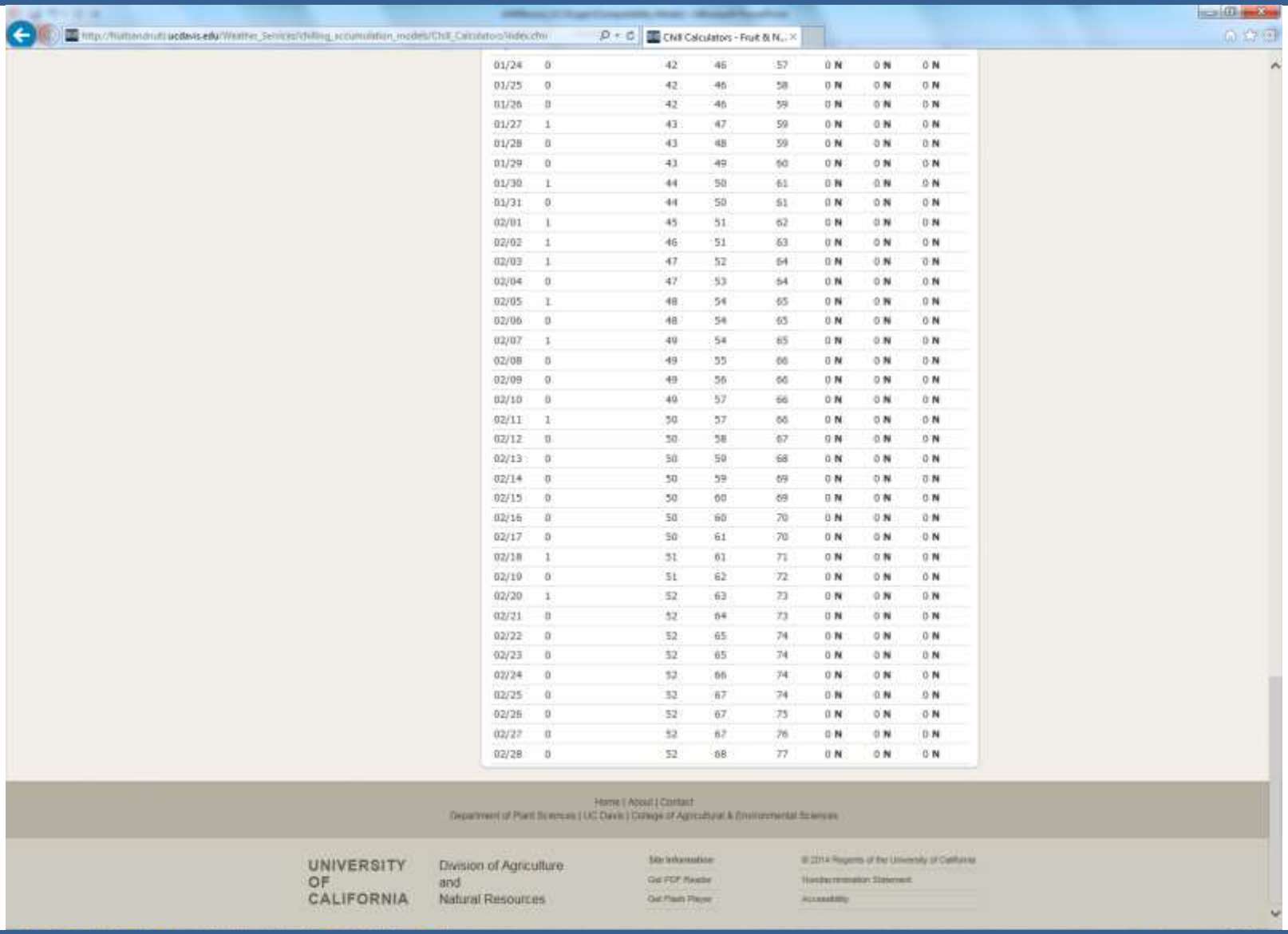


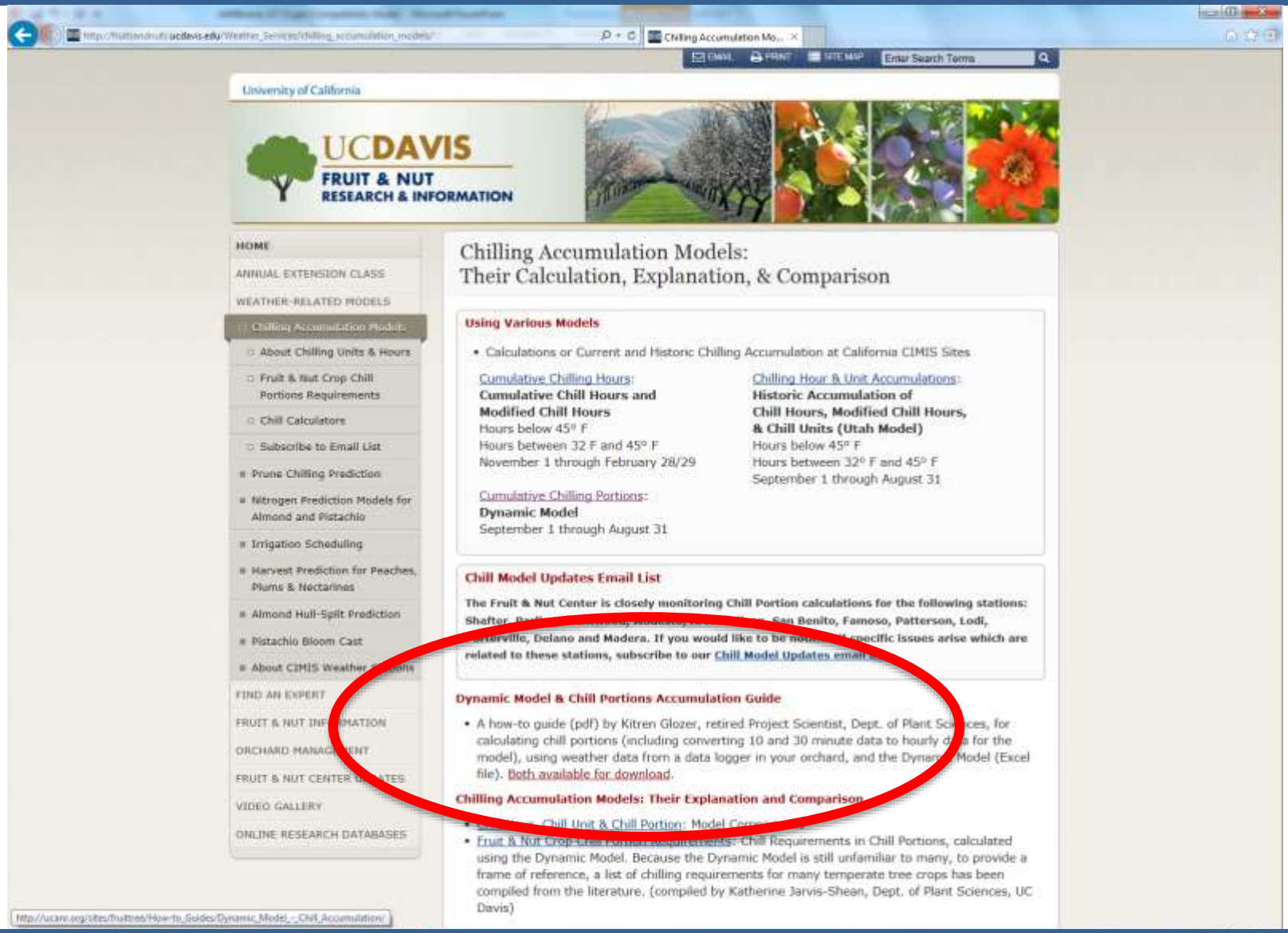
Date	Daily Portions	2014	2013	2012	2011	2010	2009
11/01	0	0	0	0	0 N	0 N	0 N
11/02	0	0	0	0	0 N	0 N	0 N
11/03	0	0	0	0	0 N	0 N	0 N
11/04	0	0	0	1	0 N	0 N	0 N
11/05	0	0	0	2 M	0 N	0 N	0 N
11/06	1	1	0	2	0 N	0 N	0 N
11/07	0	1	0	3	0 N	0 N	0 N
11/08	0	1	0	4	0 N	0 N	0 N
11/09	0	1	1	4	0 N	0 N	0 N
11/10	0	1	2	5	0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

Tracking chill portions on FNRIC



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

DIY Spreadsheet Chill Portions



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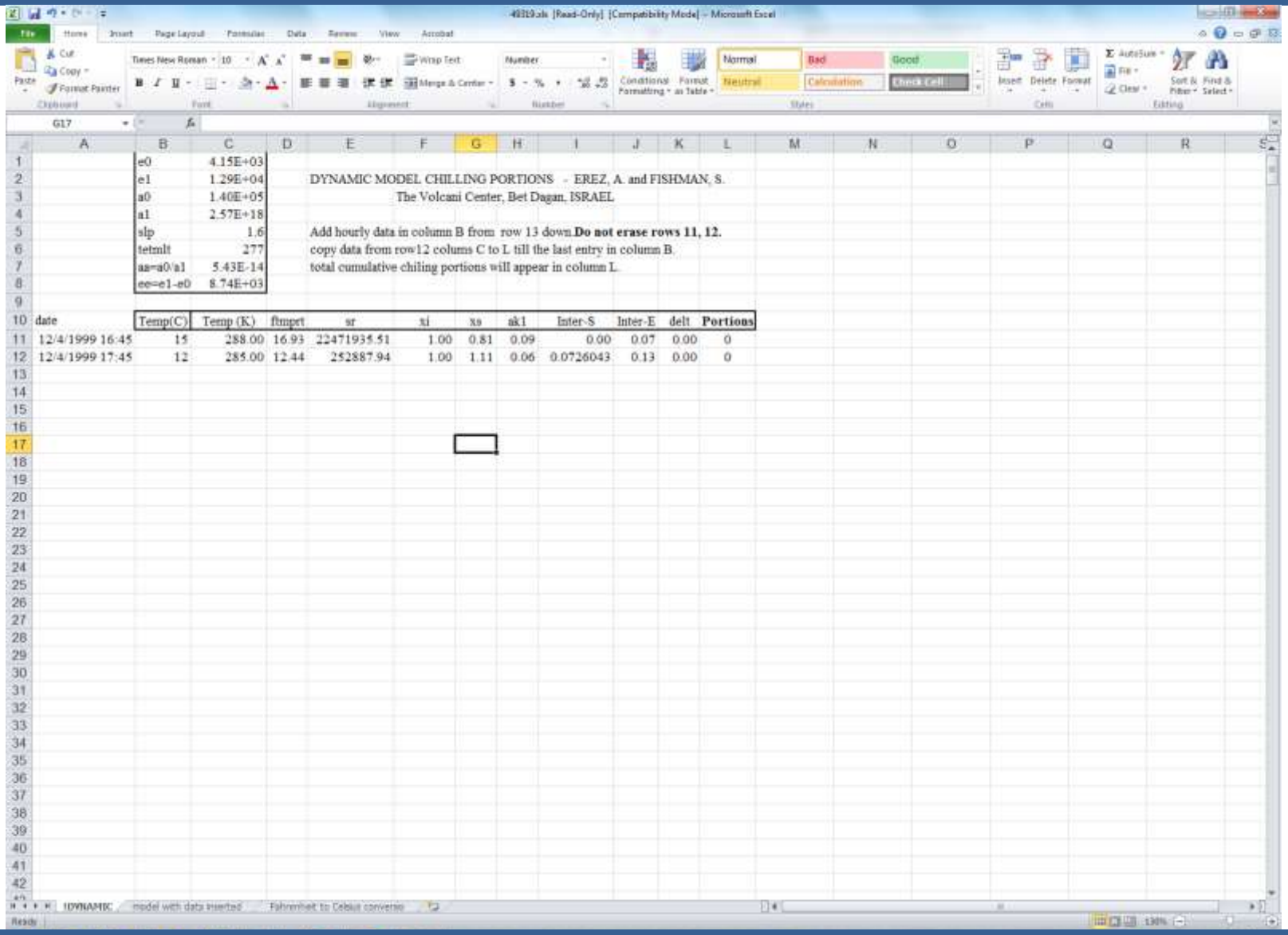
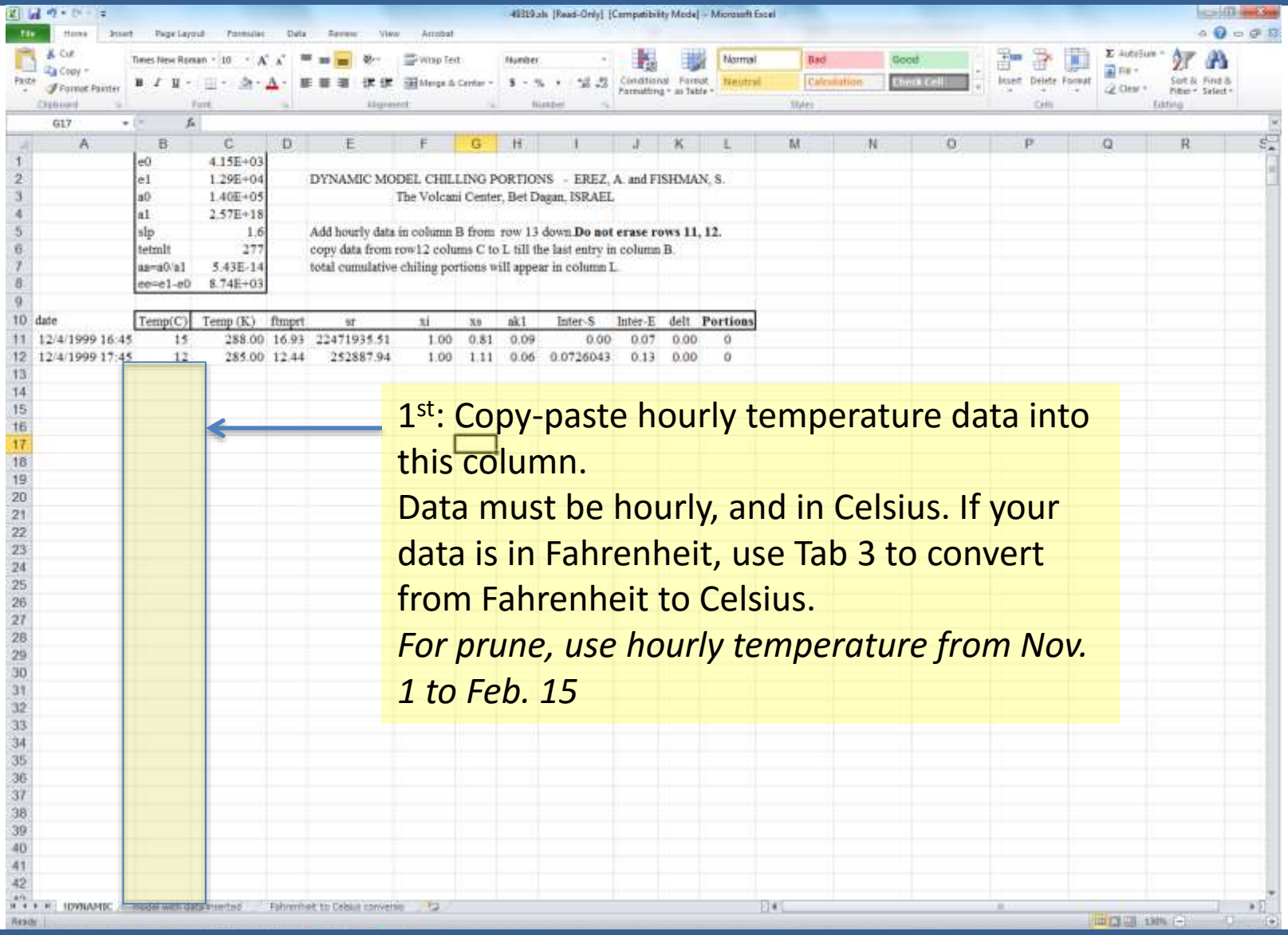


1		e0	4.15E+03										
2		e1	1.29E+04		DYNAMIC MODEL CHILLING PORTIONS - EREZ, A. and FISHMAN, S.								
3		a0	1.40E+05		The Volcani Center, Bet Dagan, ISRAEL								
4		a1	2.57E+18										
5		slp	1.6		Add hourly data in column B from row 13 down. **Do not erase rows 11, 12.**								
6		tetmlt	277		copy data from row12 colums C to L till the last entry in column B.								
7		aa=a0/a1	5.43E-14		total cumulative chiling portions will appear in column L.								
8		ee=e1-e0	8.74E+03										
9													
10	date	Temp(C)	Temp (K)	ftmprt	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	

DIY Spreadsheet Chill Portions



e0	4.15E+03	
e1	1.29E+04	
a0	1.40E+05	
a1	2.57E+18	
slp	1.6	
tetmlt	277	
aa=a0/a1	5.43E-14	
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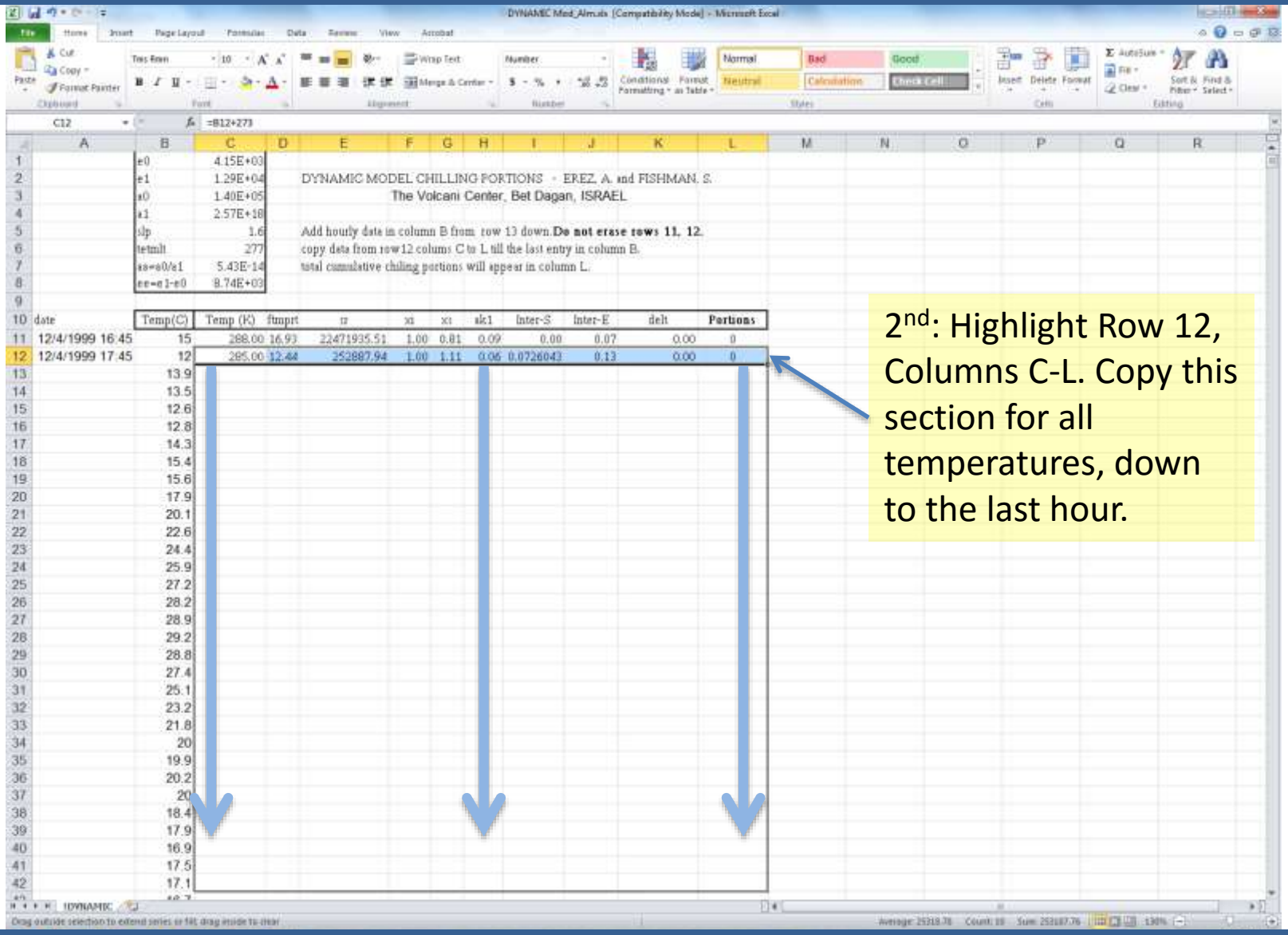
DYNAMIC MODEL CHILLING PORTIONS - EREZ, A. and FISHMAN, S.
The Volcani Center, Bet Dagan, ISRAEL

Add hourly data in column B from row 13 down.**Do not erase rows 11, 12.**
copy data from row12 colums C to L till the last entry in column B.
total cumulative chiling portions will appear in column L.

date	Temp(C)	Temp (K)	ftmprt	sr	xi	xs	ak1	Inter-S	Inter-E	delt	Portions
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
12/4/1999 17:45	12	285.00	12.44	252887.94	1.00	1.11	0.06	0.0726043	0.13	0.00	0

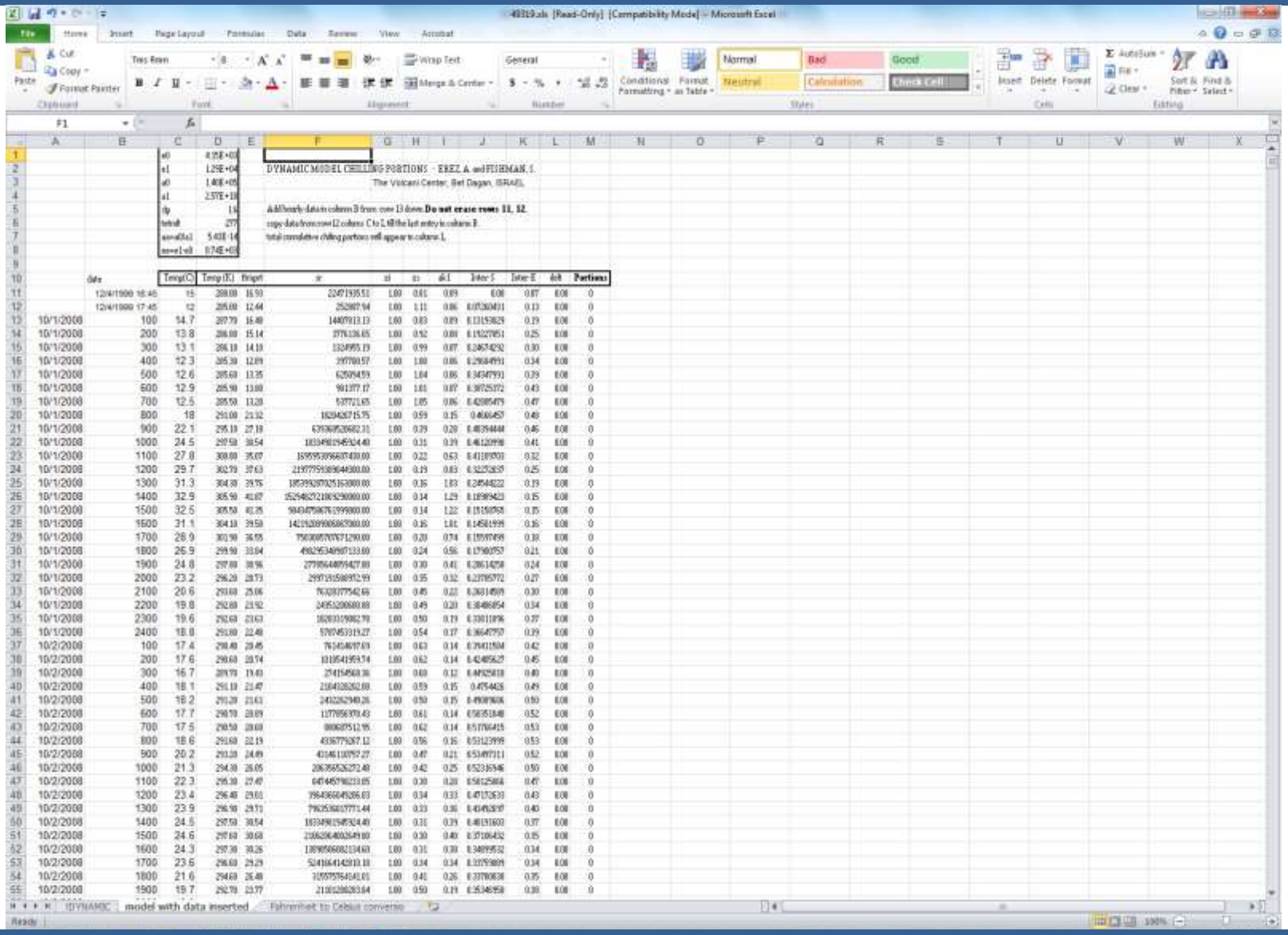
1st: Copy-paste hourly temperature data into this column.
Data must be hourly, and in Celsius. If your data is in Fahrenheit, use Tab 3 to convert from Fahrenheit to Celsius.
For prune, use hourly temperature from Nov. 1 to Feb. 15

DIY Spreadsheet Chill Portions



2nd: Highlight Row 12, Columns C-L. Copy this section for all temperatures, down to the last hour.

DIY Spreadsheet Chill Portions



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

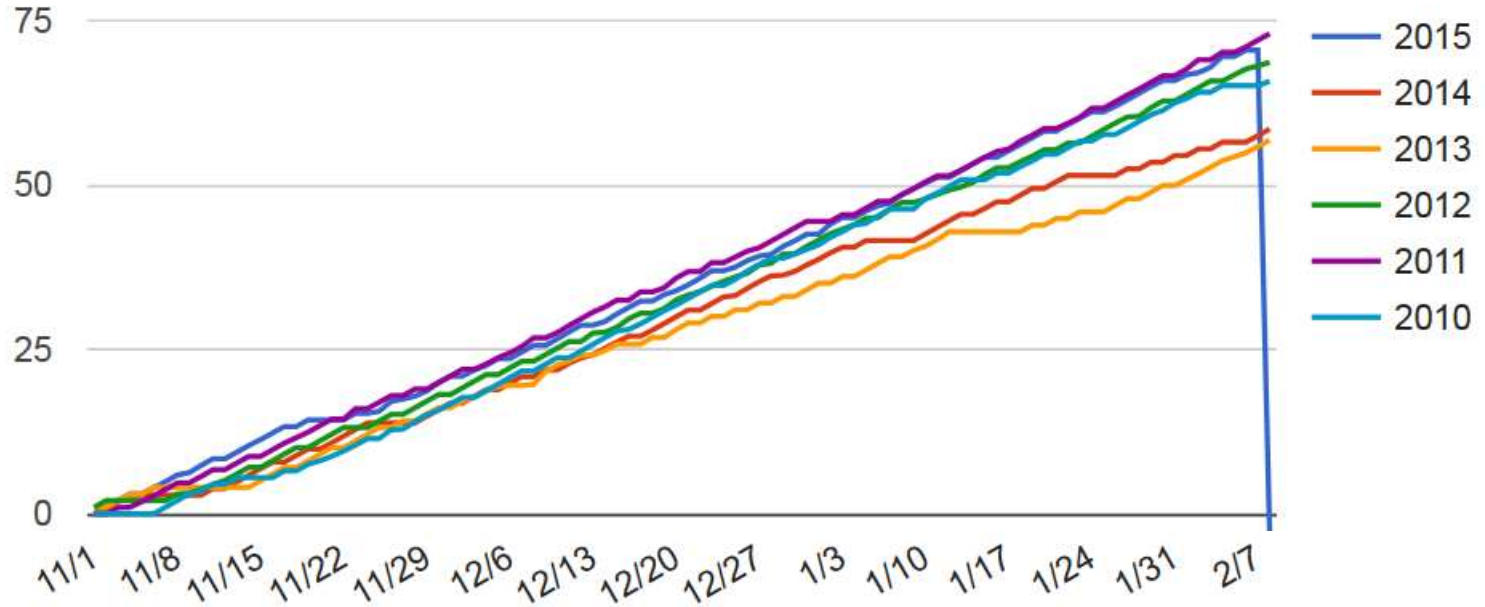
*Based on low chill & harvest, 2014

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

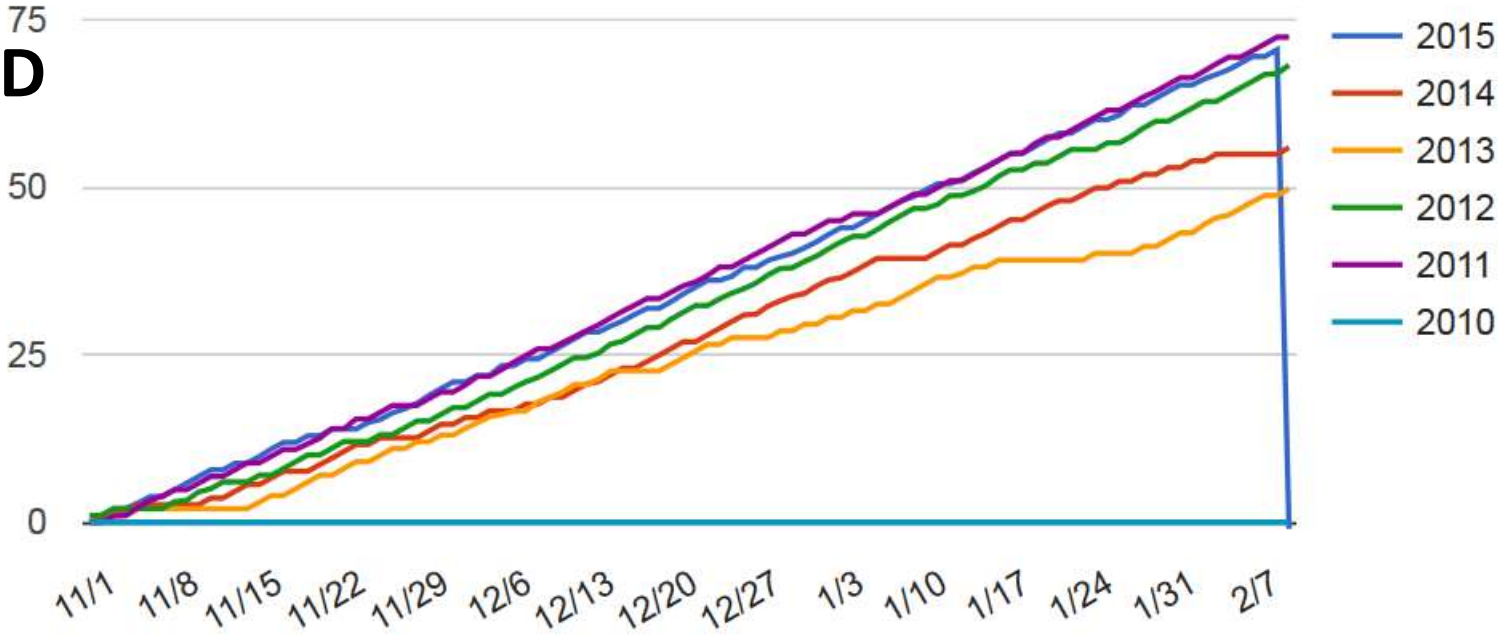
CAMINO

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?

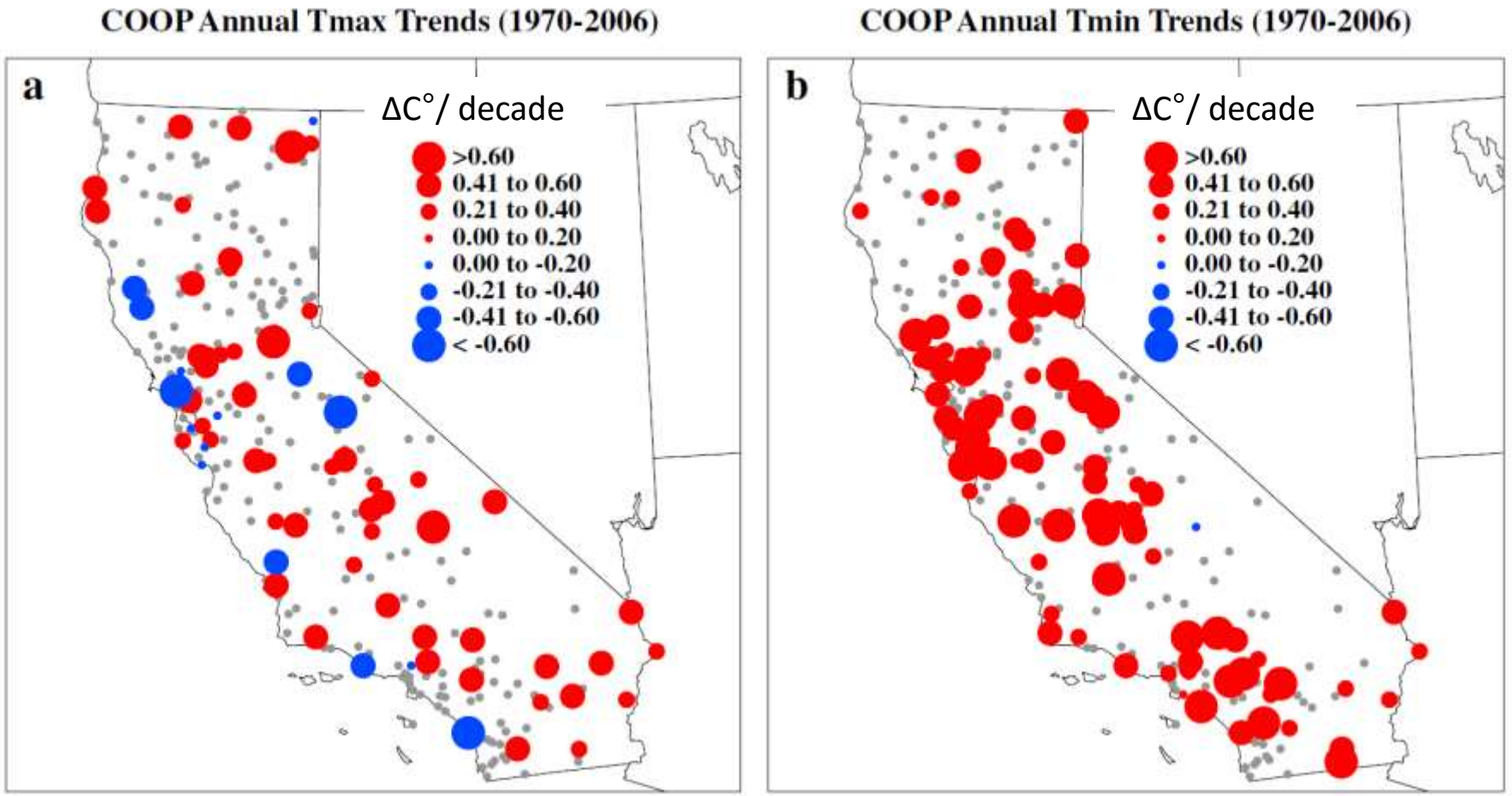
Predictions:

Winter Chill will decrease.

Probably 15-20%

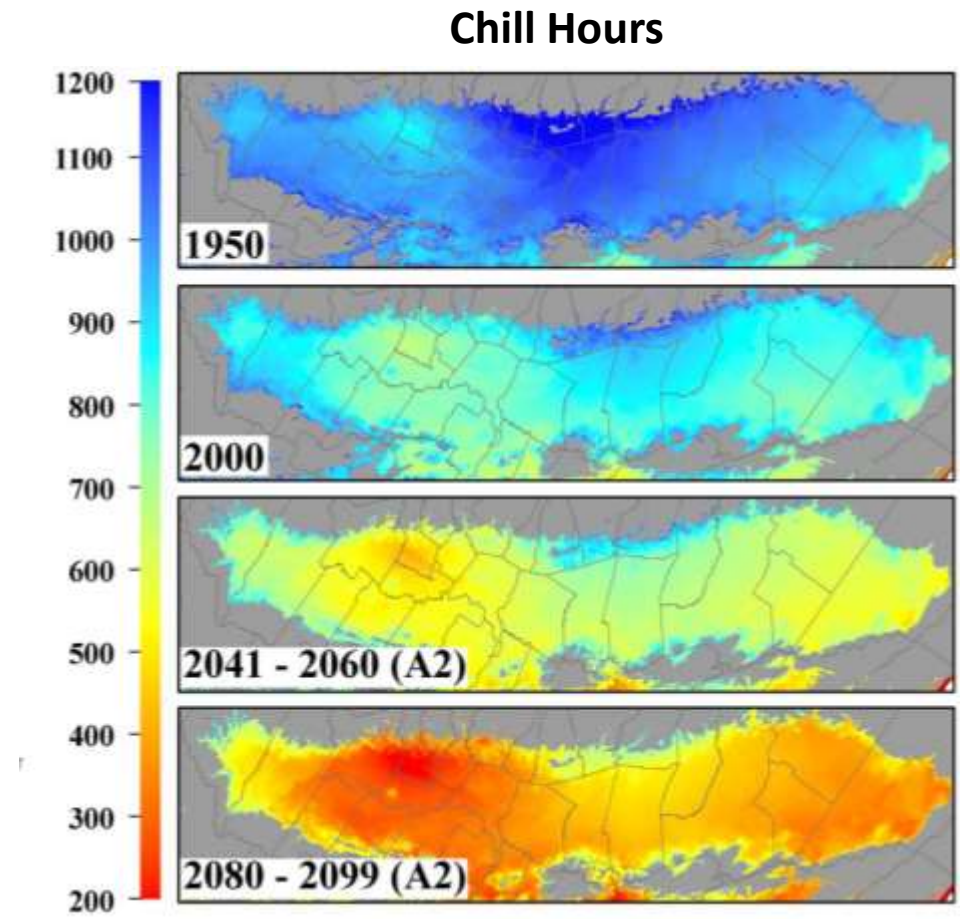
by mid-Century.

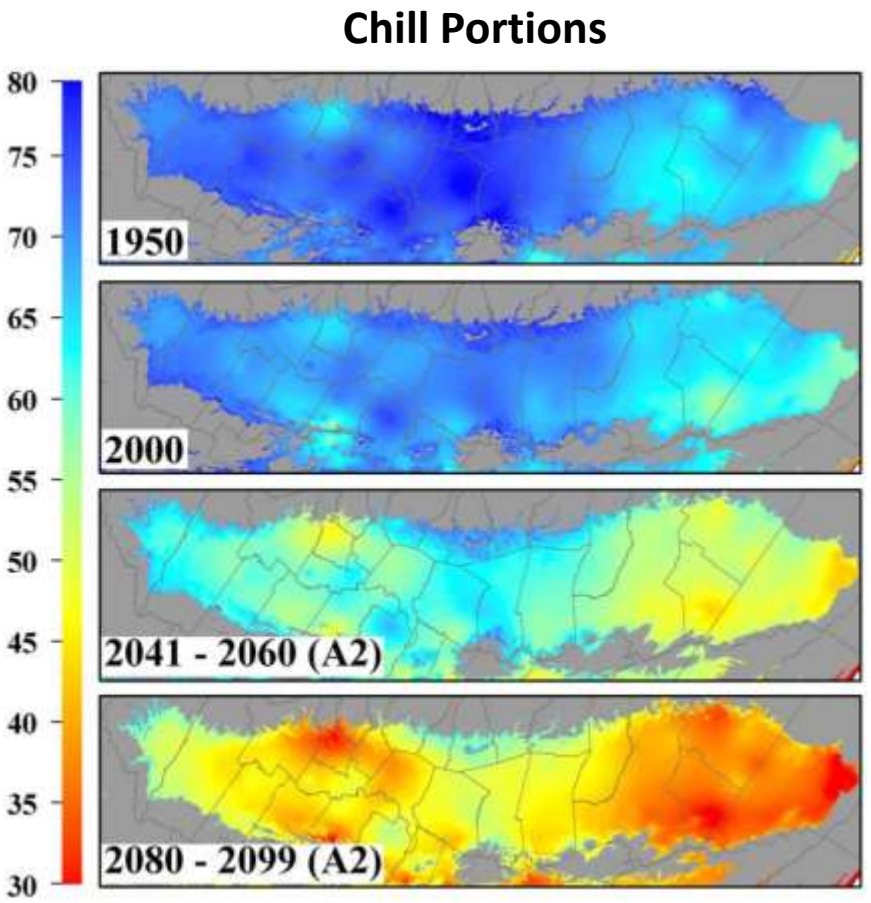
Temperatures have been warming



Cordero et al. (2011)

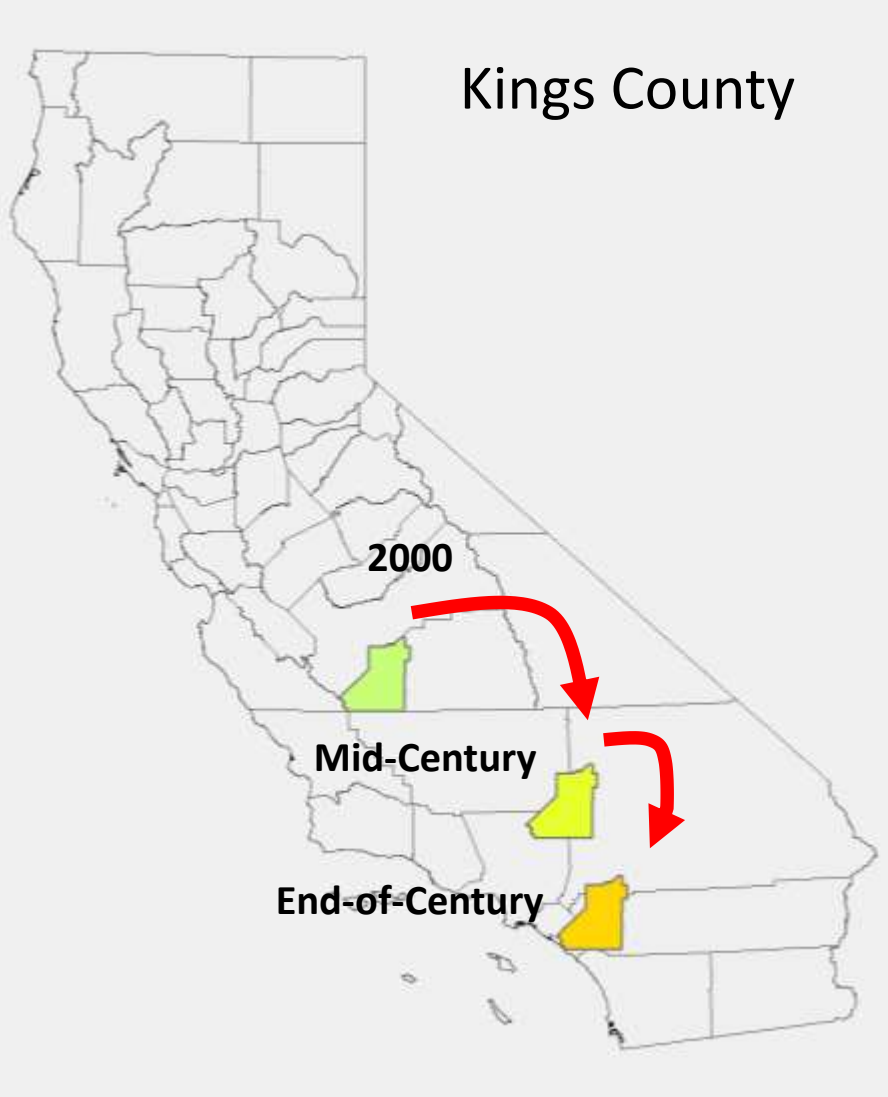
Chill will decrease. “Safe Winter Chill”





Luedeling et al., 2009 PLoSOne

What changes will feel like



Adapted from numbers in Luedeling et al. (2009)

Uncertainty increases with time