CHILL OUT

Does the chill hour model you use provide the information you **NEED**?

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Two Reasons Nurseries Track Chill Hours

To Evaluate Storability of Seedlings

- Most frequent reason given.
- The assumption here is that as chilling hours increase, thus does "storability" of seedlings.
- **MYTH** – many poorly designed studies fail to prove this.
- See copy in packet *:"Chilling Hours: Myths and Facts"*

To Evaluate Acclimation of Seedlings

- Least frequent reason given.
- The assumption here is that as chilling hours increase, thus does freeze tolerance.
- **FACT** – Many studies have shown that chilling is required for freeze tolerance.

Our direction…

- **Today's discussion will center around acclimation and deacclimation and the relationship between cold temperatures and freeze tolerance and our ability to monitor changes.**

- The physiological and genetic processes occurring in trees during winter chill accumulation are poorly understood.

- Models of winter chill accumulation are thus purely empirical and based on either field observations or controlled temperature experiments rather than on a functional understanding of tree physiology.

Potential Problem

- We get lulled into a false sense of security as winter approaches knowing that just as the temperatures drop and chill hours accumulation increases, there will most likely be a time when the temperatures rise, we lose accclimation and our seedlings are potentially in a positon to be injured by a sudden drop in temperatures.

- Many times I have discussed freeze injury with a nursery manager. Almost every time, their reply will be “But we had XX chilling hours last winter, more than the year before!

Chill hours

- Chilling hours most commonly expressed as the number of accumulated hours within a range of approximately 32º to 45ºF
- Temperate Region fruit and nut trees, and many other perennial plants, require cool winter temperatures (chilling hours) to ensure leaf and flower bud production in the following season.
- Failure of meeting sufficient chilling results in deformed fruits, unequal maturation, and other plant deformities, thereby reducing quality and yields.
- For forest seedlings, accumulating chill hours equates to an increase in freeze tolerance.

19 Nurseries track chill hours
7 Nurseries do not track

Nursery Survey

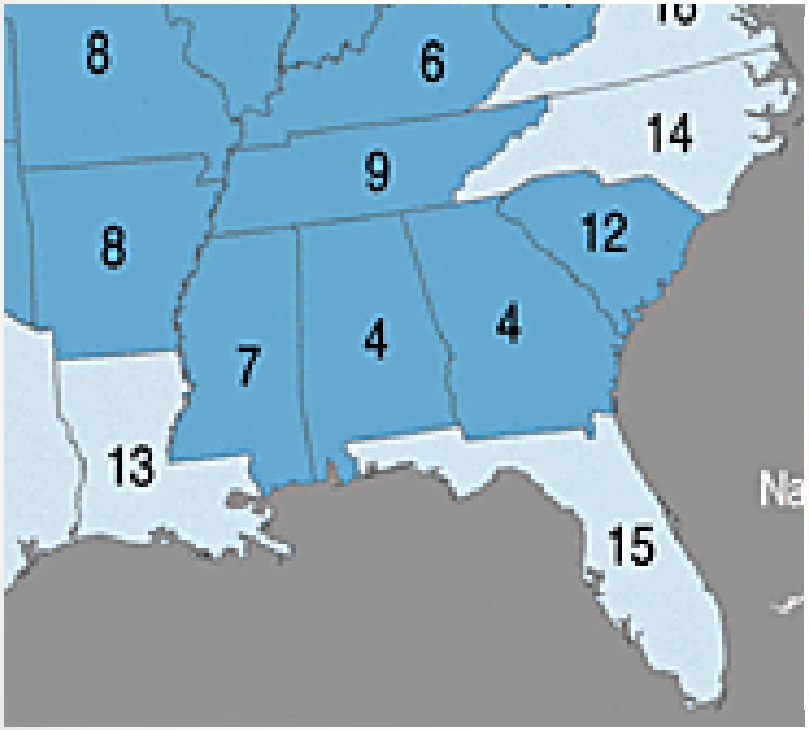
Oct 2015

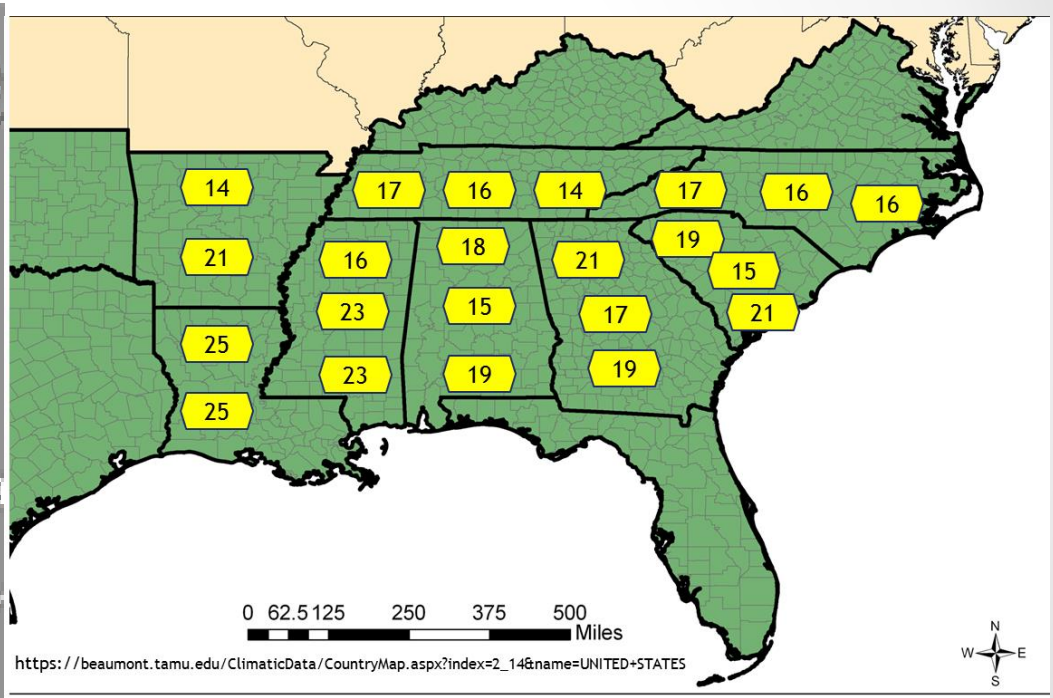
Nursery	Start Date	Temperature Range	Include Temp <32?	Chill Hour Data Source
1	Mid-October	32 & 45	No	Onsite weather Station*
2	No certain date	below 45	No	Onsite weather Station
3	Late Oct. or early Nov.	32 & 45	No	Onsite weather Station
4	Mid-October	32 & 45	No	Onsite weather Station
5	Between 2 & 3 wk Oct	33 & 42.5	No	Onsite weather Station
6	About Nov. 1	34 & 45	No	Onsite weather Station
7	Around Oct. 15	46.7	Yes	Onsite weather Station
8	No certain date	45	No	Online source
9	October <40	32 & 40	Yes	Onsite weather Station
10	About Nov. 1	32 & 40	No	Onsite weather Station
11	No certain date	45	No	Online source
12	Mid-October	32.1 & 45.9	No	Onsite weather Station
13	No certain date	32 & 46	No	Onsite weather Station
14	October	Proprietary	No	Onsite weather Station
15	Mid-October	Proprietary	No	Onsite weather Station
16	About Nov. 1	32 & 45	No	Onsite weather Station
17	Week 1 or 2 October	32.1 - 46.0	No	Onsite weather Station
18	Week 1 or 2 October	32.1 - 46.0	No	Onsite weather Station
19	Mid-October	32 & 46	No	Onsite weather Station

*Onsite weather station include multiple parameters recorded or simple Hobo recorder

In the southeast US:

November, 2014 – 7th coldest in 119 years*



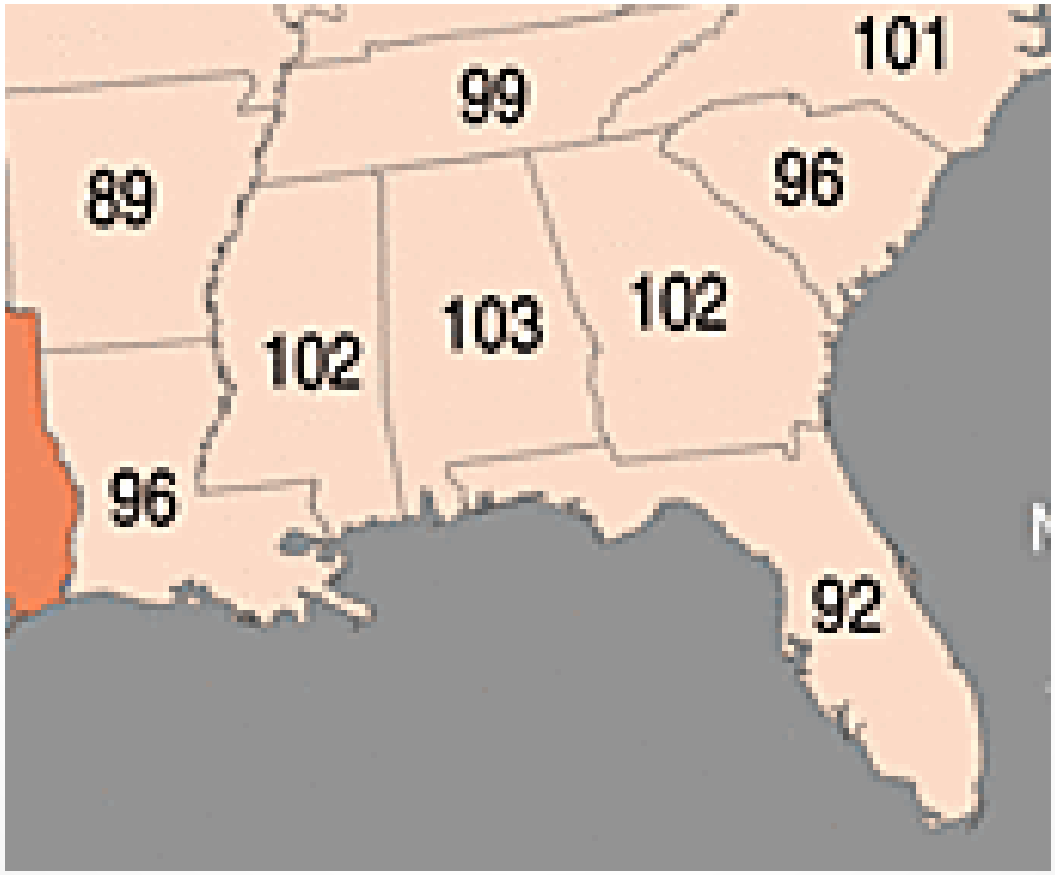


November 19, 2014

* Climate at a Glance

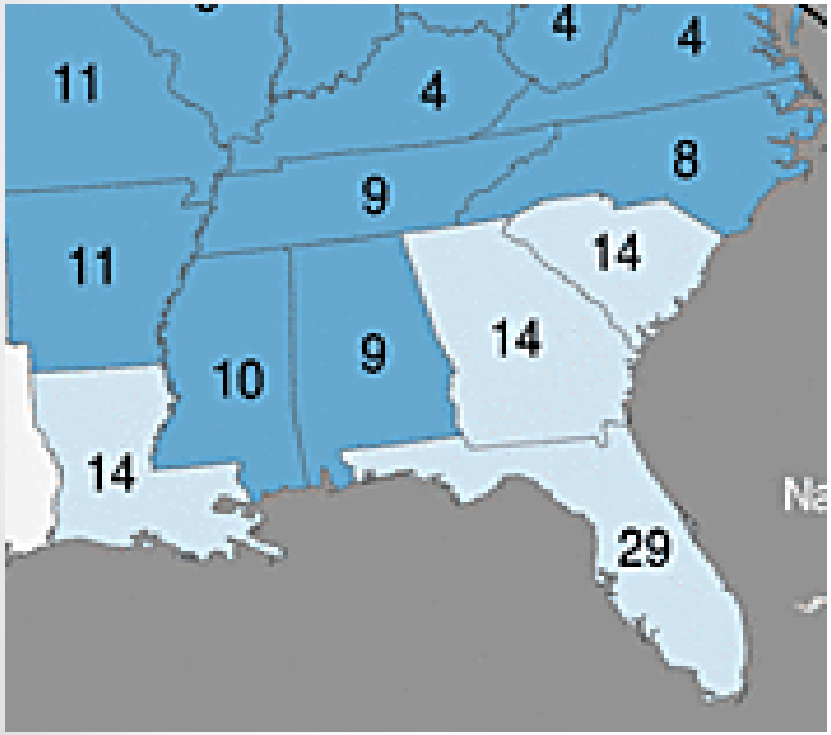
In the southeast US:

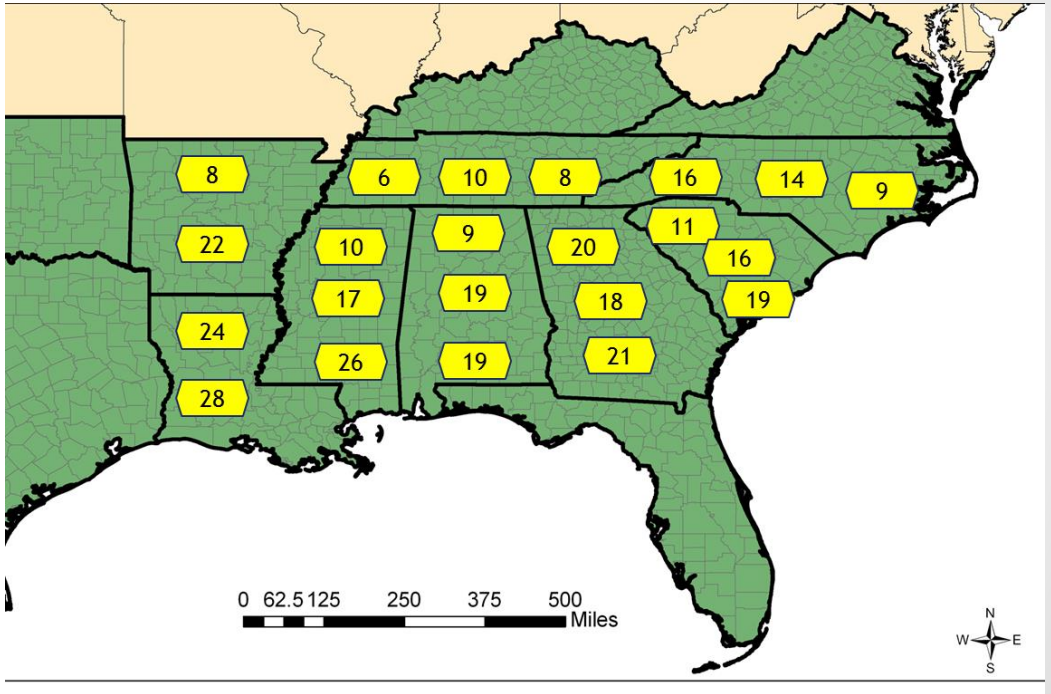
December, 2014 – 99th warmest in 119 years



In the southeast US:

February, 2015 – 10th coldest in 120 years





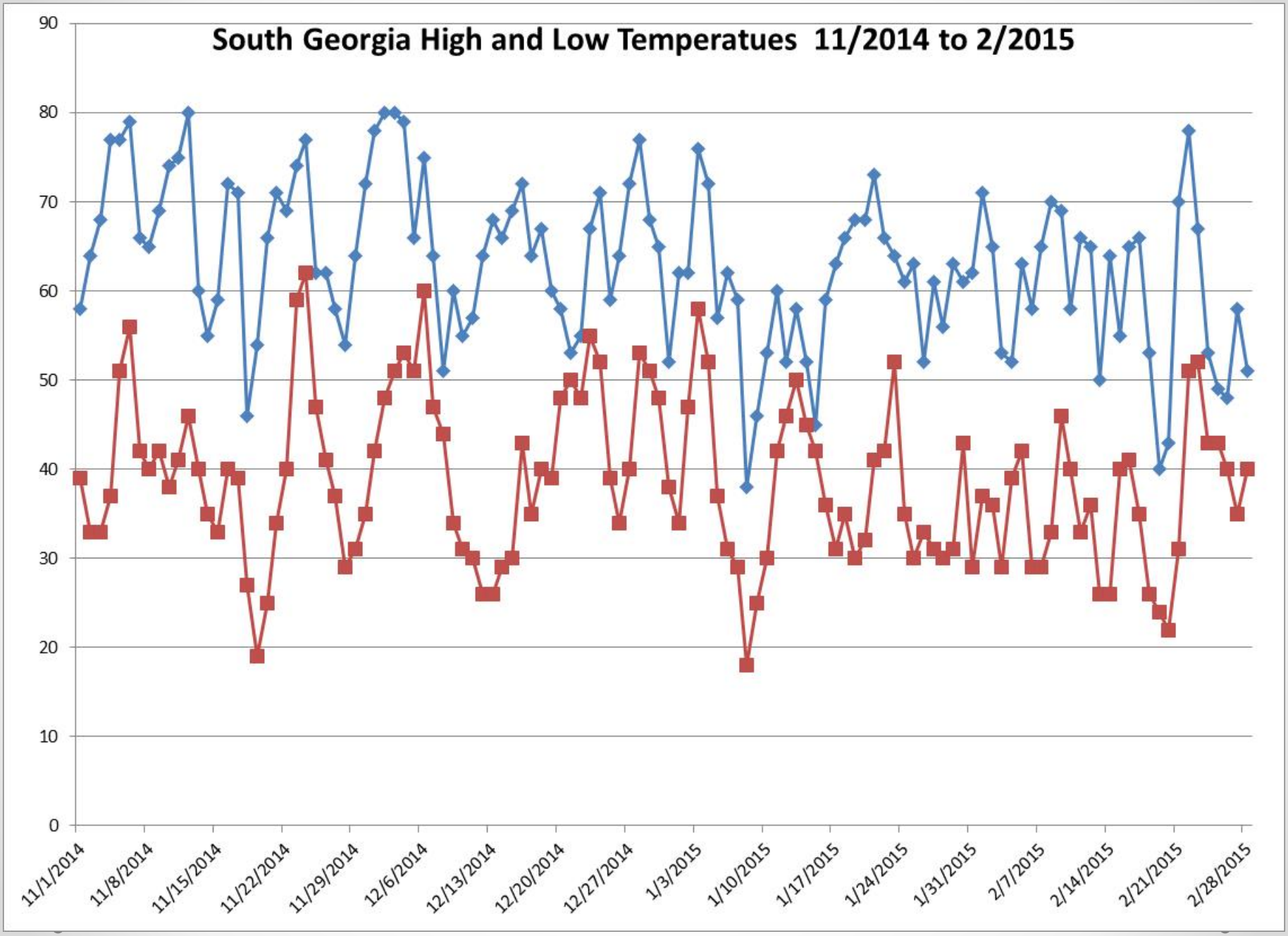
February 19, 2015

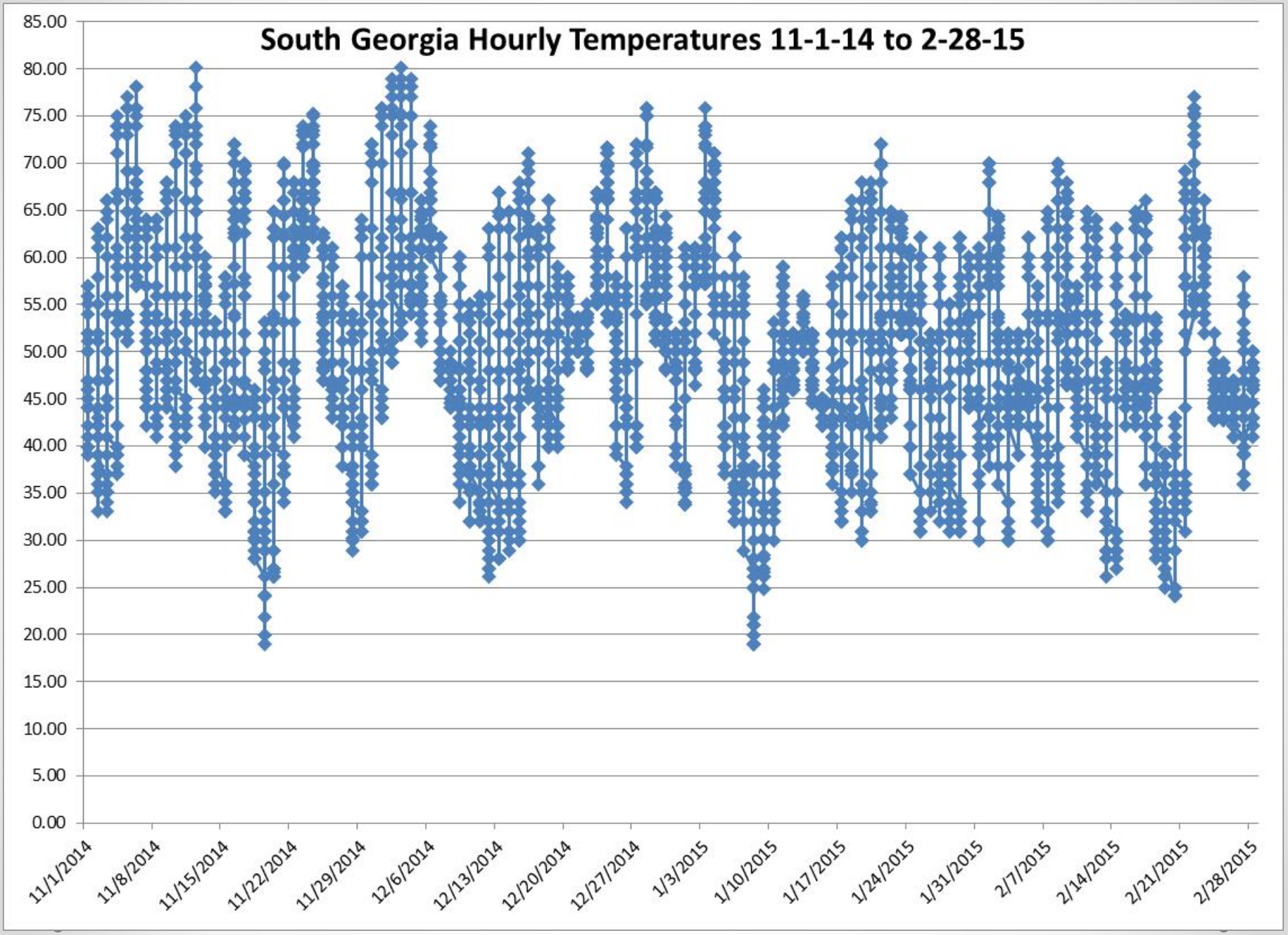
Why is good chill hour information important?

- It will provide an accurate view of both low and high temperatures.
- It will provide a view of amount and rate of acclimation.
- It will provide a view of amount and rate of deacclimation.
- It will alert you to potential problems in the nursery or of seedlings recently shipped out.

Chill Hour Models

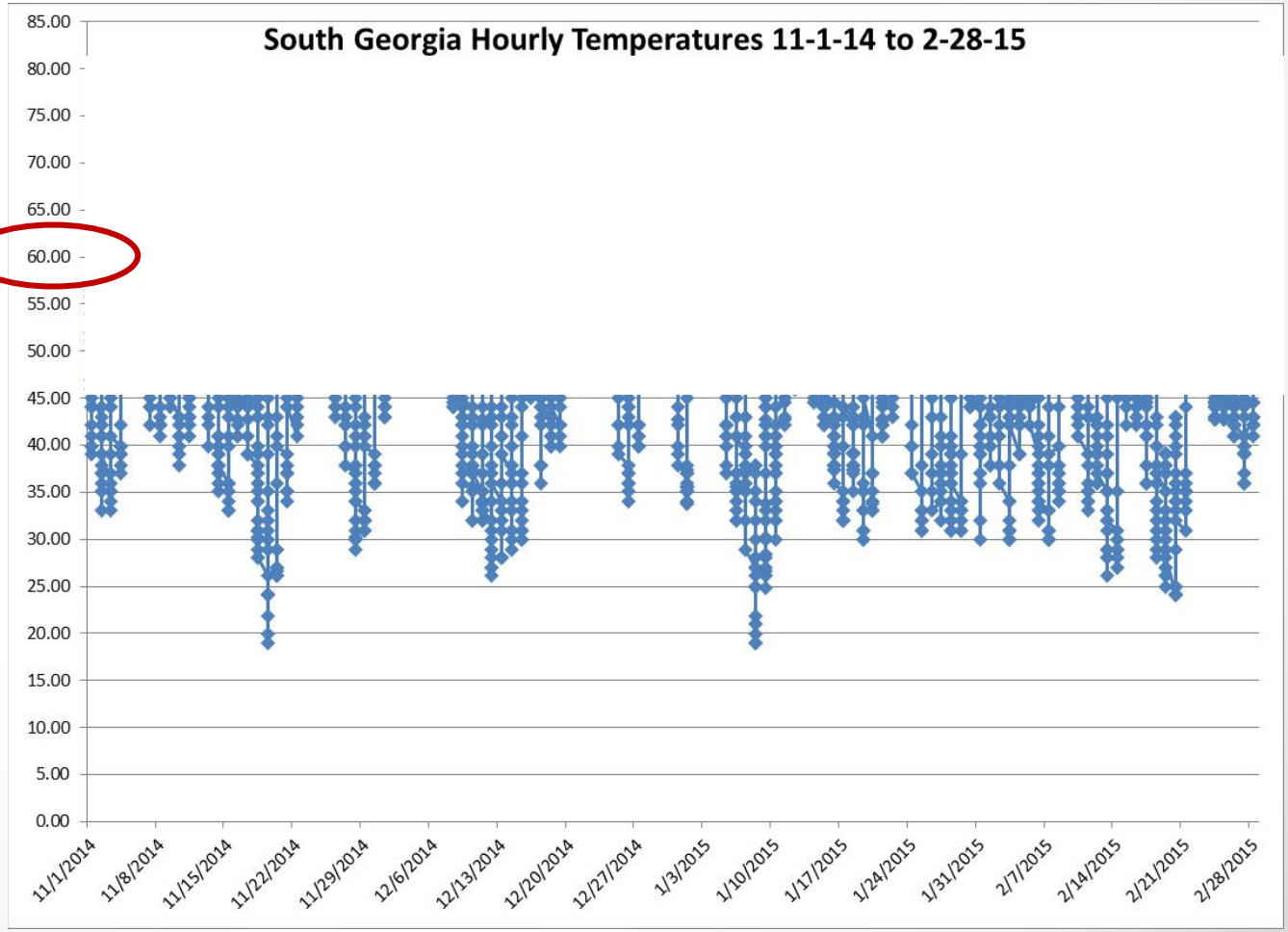
- Three major winter chill models:
  1. Chilling Hours Model
     1. Oldest (1942),
     2. All chill hours equally effective
     3. There have been modifications of initial model based upon 45°
  2. Utah Model,
     1. 1972
     2. A weighted function assigning different chilling efficiencies to different temperature ranges, including negative contributions by high temperatures
     3. Modification of initial model exist
  3. Dynamic Model
     1. 1987 – 1990
     2. Very complex


South Georgia High and Low Temperatues 11/2014 to 2/2015
90
80
70
60
50
40
30
20
10
0
11/1/2014
11/8/2014
11/15/2014
11/22/2014
11/29/2014
12/6/2014
12/13/2014
12/20/2014
12/27/2014
1/3/2015
1/10/2015
1/17/2015
1/24/2015
1/31/2015
2/7/2015
2/14/2015
2/21/2015
2/28/2015


South Georgia Hourly Temperatures 11-1-14 to 2-28-15
85.00
80.00
75.00
70.00
65.00
60.00
55.00
50.00
45.00
40.00
35.00
30.00
25.00
20.00
15.00
10.00
5.00
0.00
11/1/2014
11/8/2014
11/15/2014
11/22/2014
11/29/2014
12/6/2014
12/13/2014
12/20/2014
12/27/2014
1/3/2015
1/10/2015
1/17/2015
1/24/2015
1/31/2015
2/7/2015
2/14/2015
2/21/2015
2/28/2015

45° Chill Hour Model

- Accumulate the number of hours less 45°.
- We are looking at 32% of total hours.
- But…We are still ignoring 26% of the hours above 60° that may causes deacclimation of the seedlings

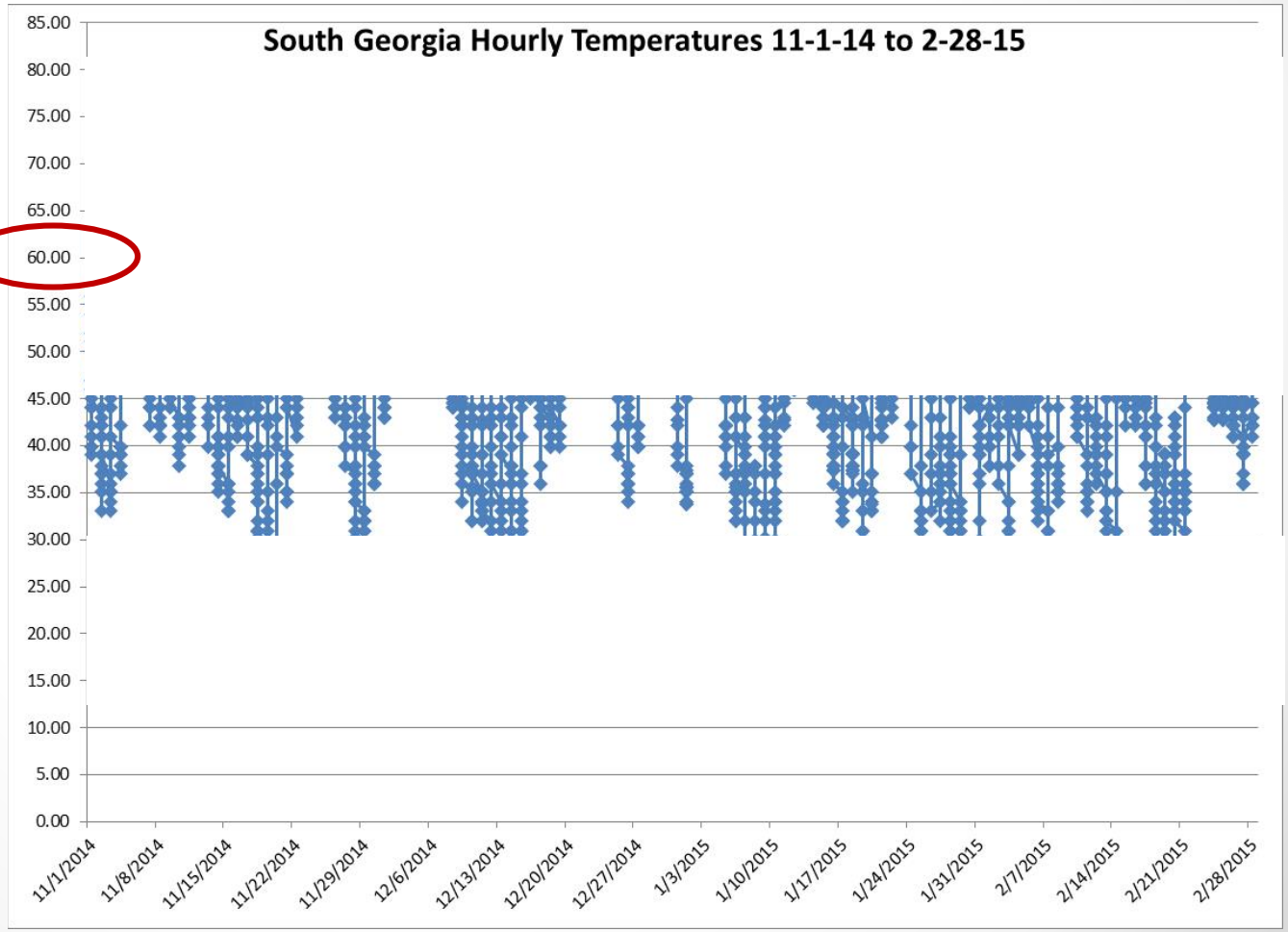


Modified 45° Chill Hour Model

- Accumulate the number of hours between 45° and 32°.

- We are now only looking at 27% of total hours

- But…. we are still ignoring 26% of the hours above 60° that may causes deacclimation of the seedlings



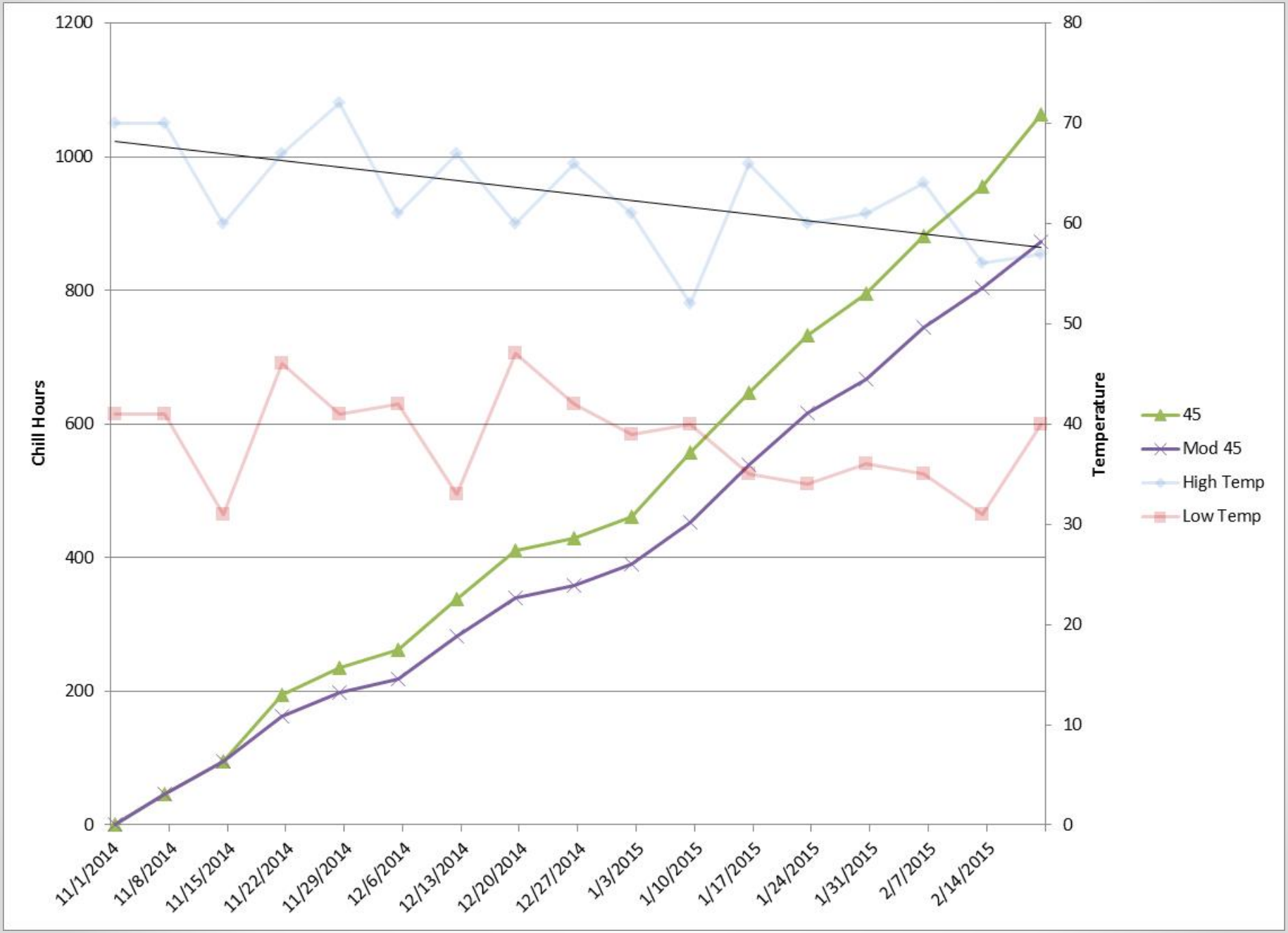
45° and Modified 45°

Chill Hour Model Accumulation

Model	<33	34-45	>45
<45	1	1	0
Modified 45	0	1	0

Week	45°	Modified 45°
11/1/2014	0	0
11/7/2014	47	47
11/14/2014	96	96
11/21/2014	194	162
11/28/2014	236	198
12/5/2014	263	219
12/12/2014	338	282
12/19/2014	411	340
12/26/2014	429	358
1/2/2015	461	390
1/9/2015	558	452
1/16/2015	647	539
1/23/2015	732	616
1/30/2015	795	667
2/6/2015	882	744
2/13/2015	955	803
2/20/2015	1063	873
2/28/2015	**1176**	**985**

45° and Mod 45° Model



Utah Model

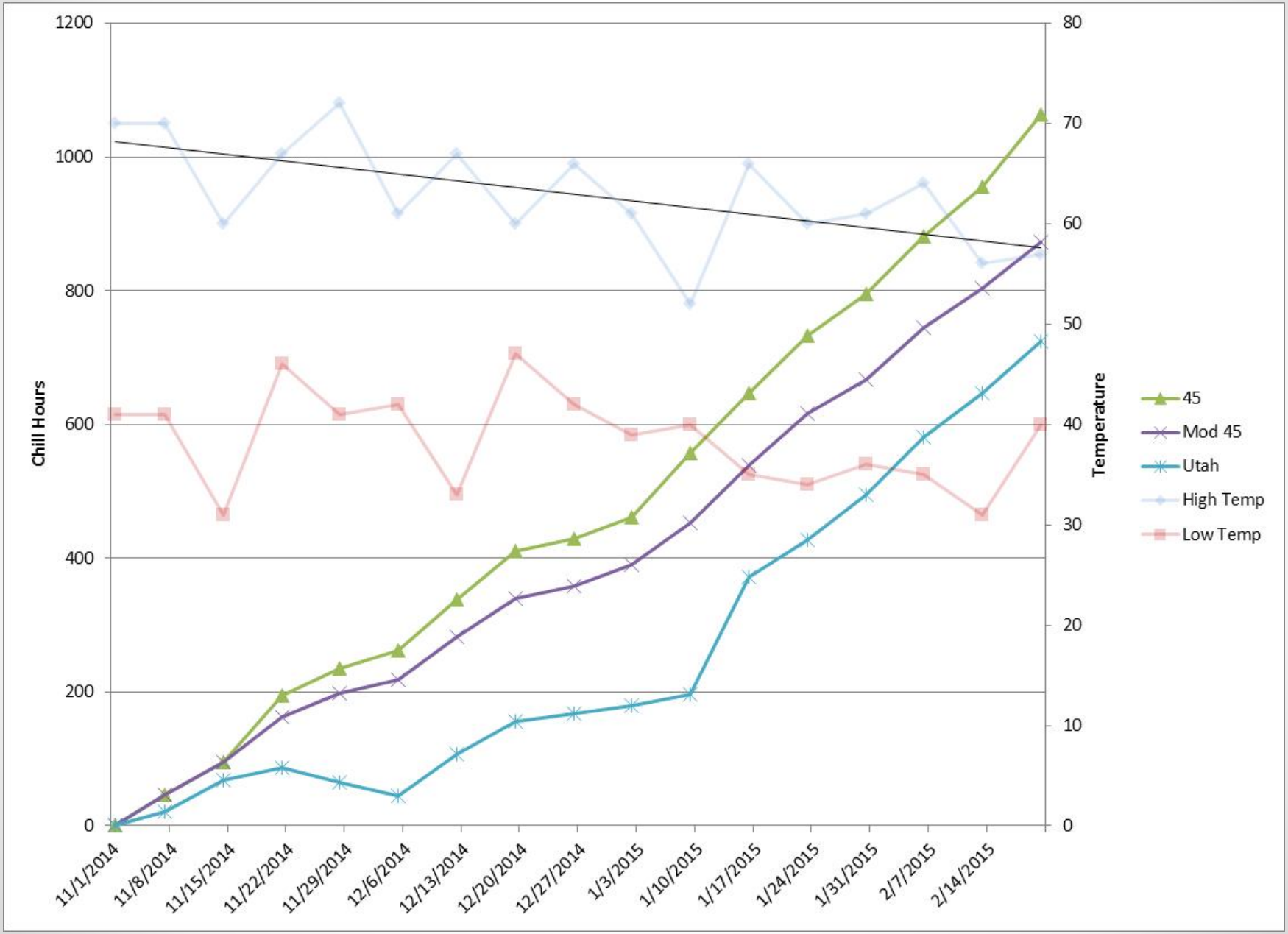
Chill Hour Model Accumulation

Model	<34	34-36	37-48	49-54	55-60	60-65	>65
Utah	0	0.5	1	0.5	0	-0.5	-1

- A weighted function assigning different chilling efficiencies to different temperature ranges, including negative contributions by high temperatures

	Utah Model	
Week	Weekly	Cumulative
11/1/2014	0	0
11/7/2014	21	21
11/14/2014	46.5	67.5
11/21/2014	19	86.5
11/28/2014	-21	65.5
12/5/2014	-21.5	44
12/12/2014	62.5	106.5
12/19/2014	49.5	156
12/26/2014	11	167
1/2/2015	12	179
1/9/2015	18	197
1/16/2015	174	371
1/23/2015	57	428
1/30/2015	67	495
2/6/2015	86	581
2/13/2015	65	646
2/20/2015	78	724

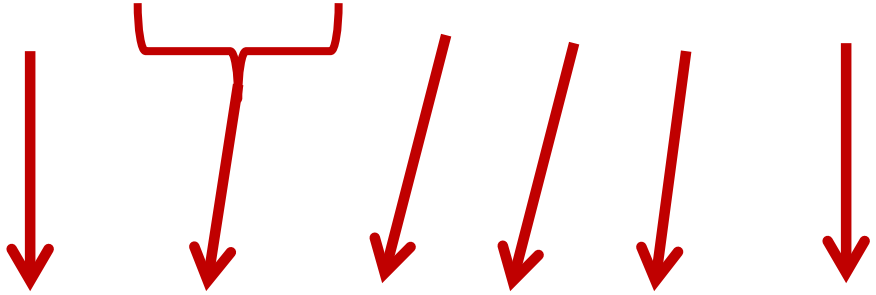
45°, Mod 45° and Utah Model



Let's Modify the Utah Model

Chill Hour Model Accumulation

Model	<34	34-36	37-48	49-54	55-60	60-65	>65
Utah	0	0.5	1	0.5	0	-0.5	-1

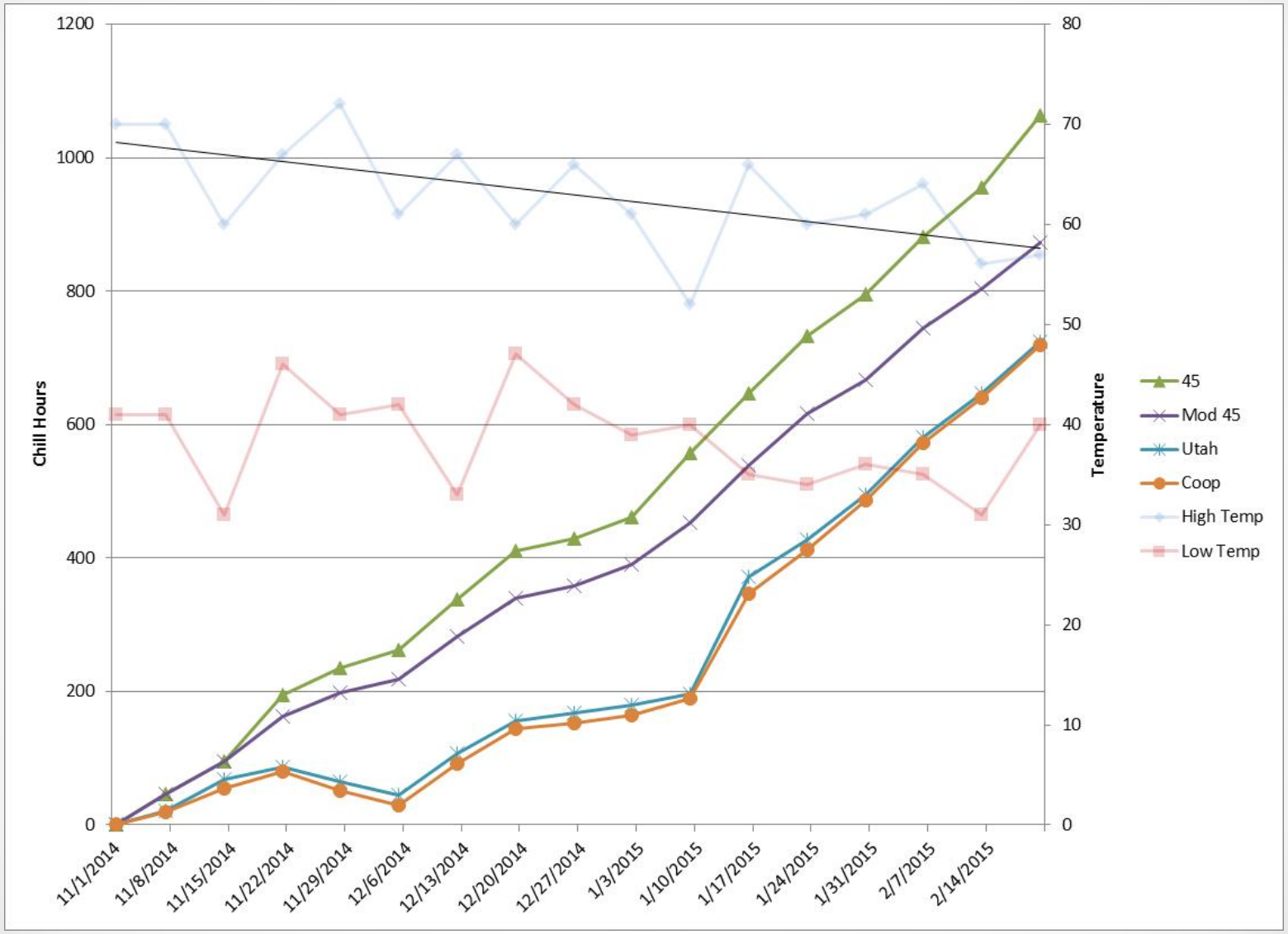


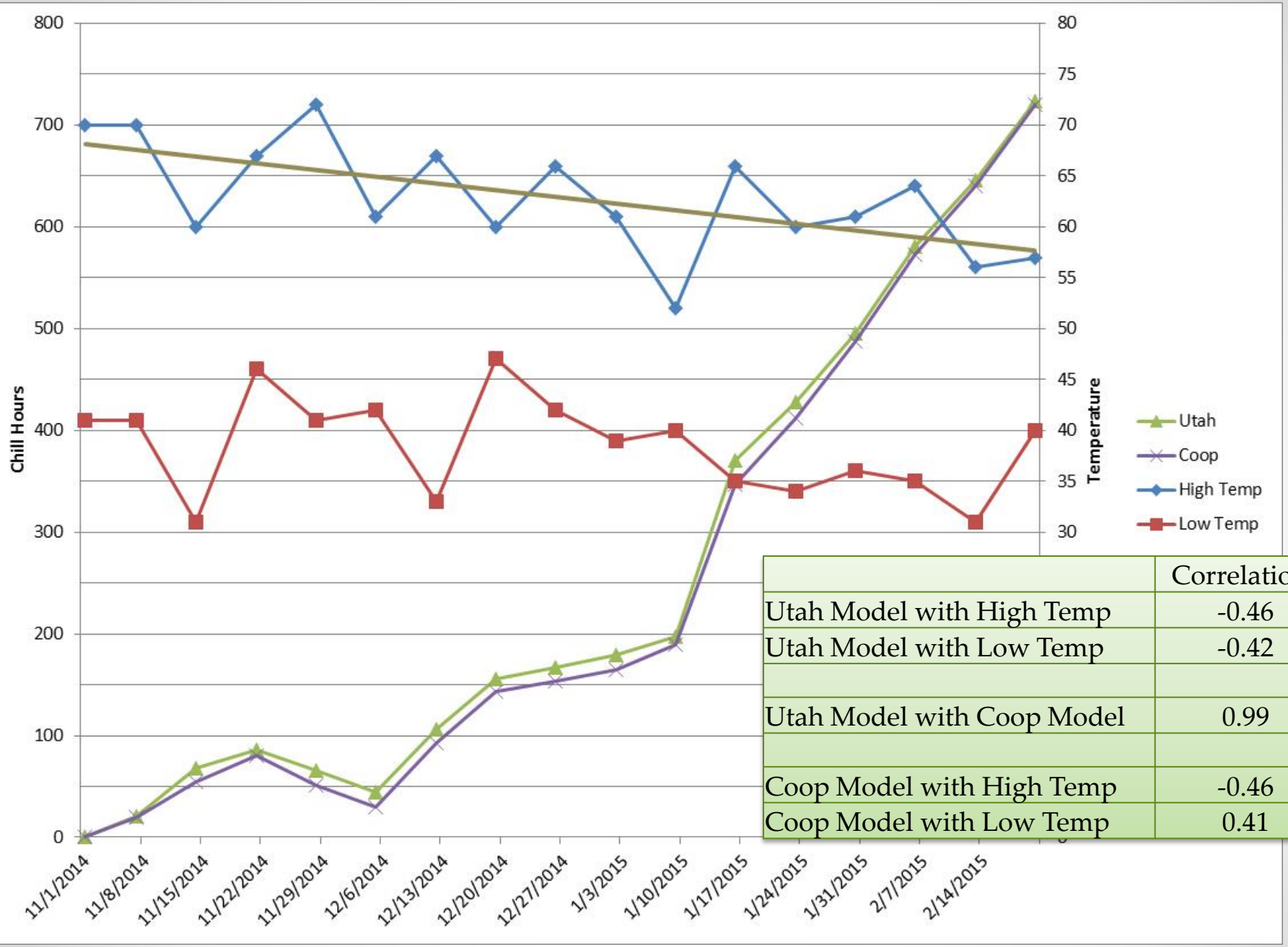
Model	<33	34-45	46-54	55-60	60-65	>65
Coop	0	1	0.5	0	-0.5	-1

Utah & Coop Model

Week	Utah	Coop
11/1/2014	0	0
11/7/2014	21	19.5
11/14/2014	67.5	54.5
11/21/2014	86.5	80.5
11/28/2014	65.5	51.5
12/5/2014	44	30
12/12/2014	106.5	92.5
12/19/2014	156	143.5
12/26/2014	167	153
1/2/2015	179	164.5
1/9/2015	197	189
1/16/2015	371	347
1/23/2015	428	412
1/30/2015	495	487
2/6/2015	581	573
2/13/2015	646	640.5
2/20/2015	724	720

45°, Mod 45°, Utah and Coop Model



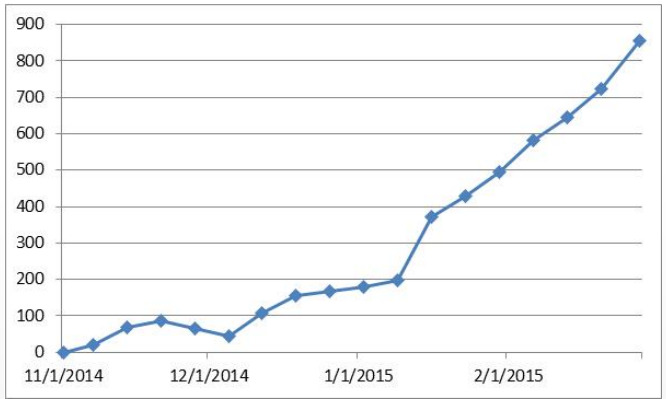


	Correlations
Utah Model with High Temp	-0.46
Utah Model with Low Temp	-0.42
Utah Model with Coop Model	0.99
Coop Model with High Temp	-0.46
Coop Model with Low Temp	0.41

Summary

- Increasing chill hours does increase tolerance to freeze.
- Monitoring chill hours using the 45° or Modified 45° model does not provide an indication (visual) of possible deacclimation events.
- Suggest monitoring chill hours on a weekly basis

11/1	11/7	11/14	11/21	11/28	12/5	12/12	12/19	12/26	1/2	1/9	1/16	1/23	1/30	2/6	2/13	2/20	2/28
0	21	46.5	19	-21	-21.5	62.5	49.5	11	12	18	174	57	67	86	65	78	131



Where are we as of today? Oct 12 to Nov 9, 2016

Sites for calculating chill hours

Site URL	State	Chill Hour Model
http://www.georgiaweather.net/	Georgia	Hours<=45°
http://www.awis.com/mesonet/index.html	Alabama	Hours <=45°
http://climate.ncsu.edu/cronos/blueberry/chill_model?	Multiple States	Modified Utah
http://getchill.net/	Multiple States	<=45° Between 32° and 45° Utah Positive Utah Dynamic Model
http://agroclimate.org/tools/Chill-Hours-Calculator/	NC, SC GA, FL, AL	Hours<45° Between 32° and 45°