



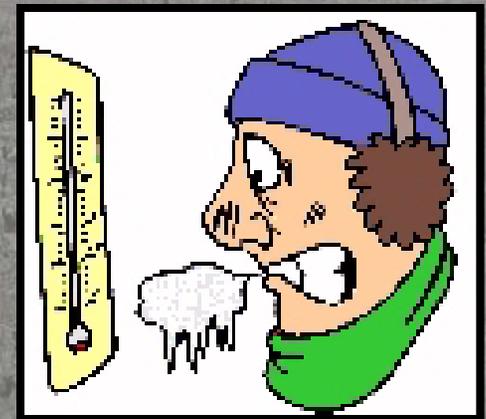


Chilling Out

Making Better Winter Protection Decisions

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Research Associate and
Professional Affiliate -CCOVI



What is Winter Injury



Direct



Indirect







Vine hardiness

- Ability to withstand different freezing temperatures at different times of the year
- Concept of optimizing genetic potential versus increasing hardiness



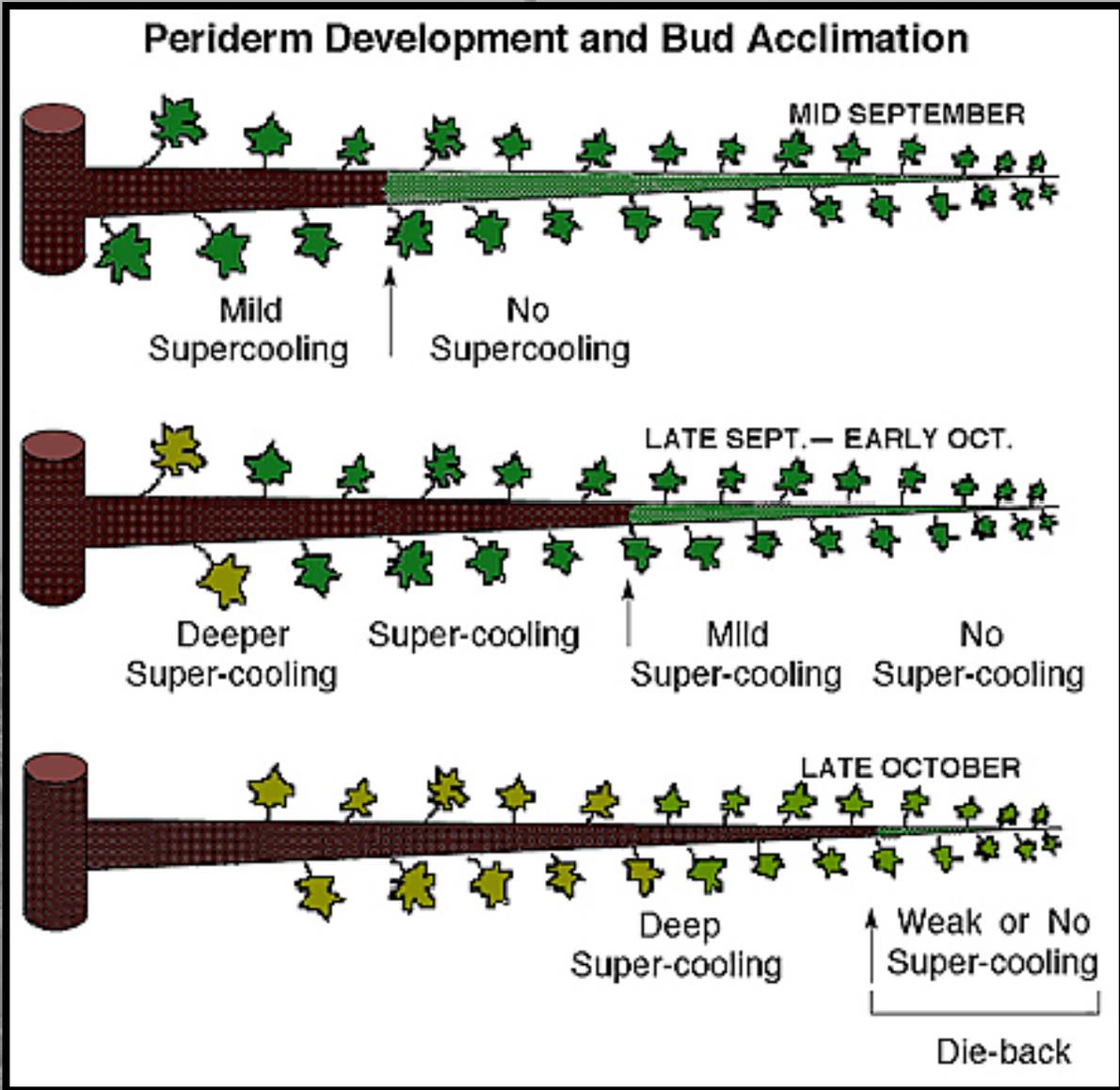
Vine Acclimation/Deacclimation

- What is vine acclimation
 - Physical
 - Chemical
- When does it start
- When does it end
 - Concept of early to bed , early to rise
- Cues

Acclimation

- A reversible change in the morphology or physiology of an organism in response to environmental change





From Wine East 2001

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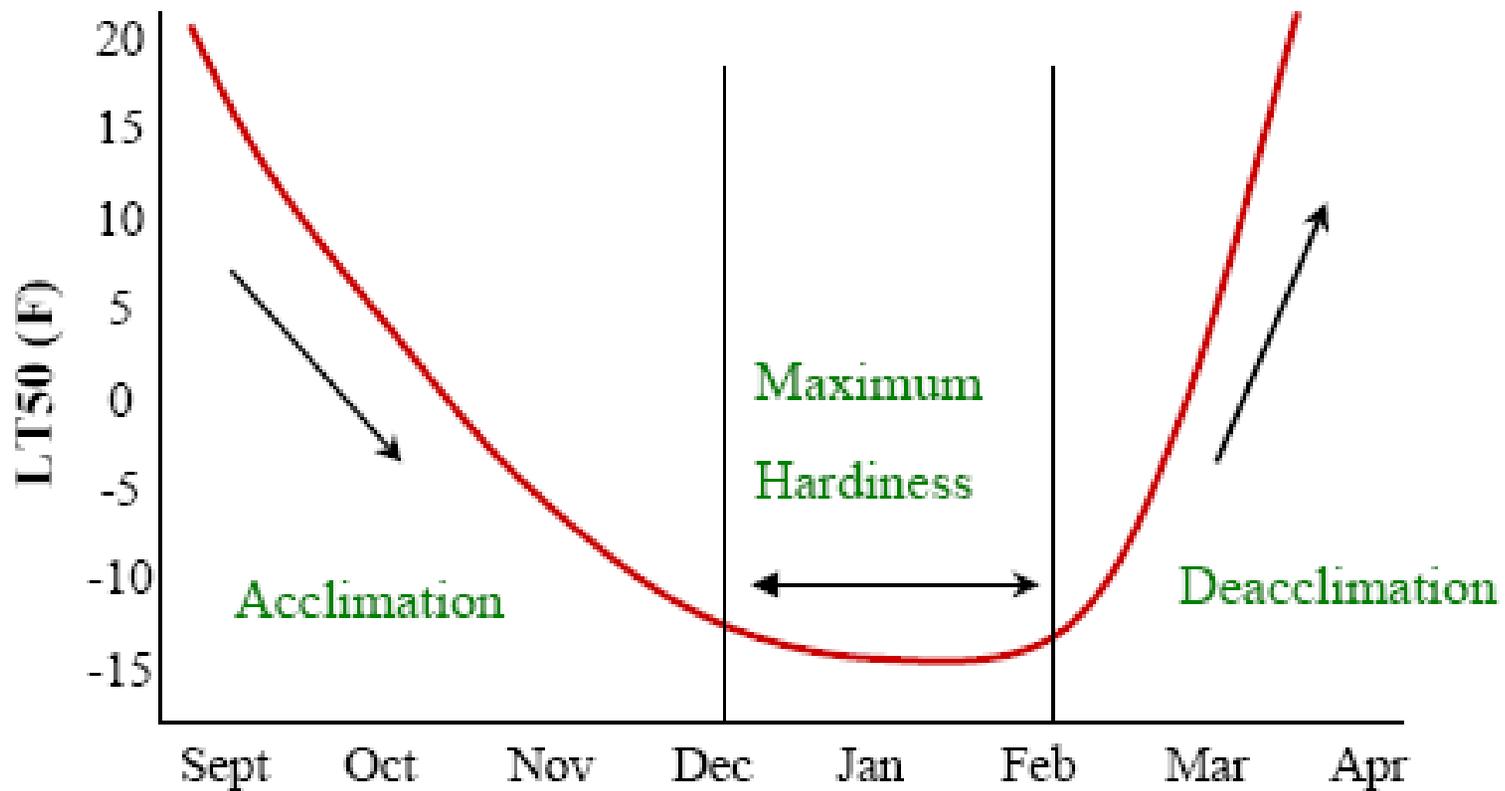
How do vines acclimate

- Changes in Hormone levels
- Biochemical changes
- Exposure to freezing temperatures



Vine Acclimation/Deacclimation

Profile of Grape Bud Hardiness



Factors that Influence Vine Hardiness

- Cultivars and clones
- Rootstocks
- Site influence on seasonal rate of growth
- Seasonal impact – early or late maturation
- Precipitation – excessively dry or wet seasons
- Cultural management – crop level, crop balance, nutrition,

What are we doing?

- Multi researcher project investigating use of wind machines (Ker, Fisher, Fraser, Slingerland)
- Documenting use of machines and weather profiles
- Sampling to determine bud survival under natural conditions
- Measure hardiness at different times of the dormant period – use of a programmable freezer

What do we measure?

- Using a programmable freezer, we measure electrical conductivity across a plate to determine when water freezes :
 - external to individual cells (Extracellular water) – High Temperature Exotherm
 - and internal cell water (Intracellular water) Low Temperature Exotherm

What is an Exotherm?

- Definition – Amount of heat given off by a chemical reaction
- As water freezes (ice nucleation) heat is released from the system (exotherm)
- When **ice crystals form** inside buds, xylem or phloem, an **exotherm** is generated & measured with sensitive equipment



Prototype Freezer Unit



Custom
Software (Bud
Freeze)

Chiller Unit

Sample
Chamber

Sample
Chamber
Thermistor

Modeled from California system (Wample – Fresno)

Chiller Unit



- Liquid cooled
- Chiller set point and rate of cooling are controlled by computer software
- Set points decrease by intervals of 0.40°C
- When liquid is cooled to within 0.05°C of set point, then software proceeds to next set point interval ($4^{\circ}\text{C}/\text{hr}$)

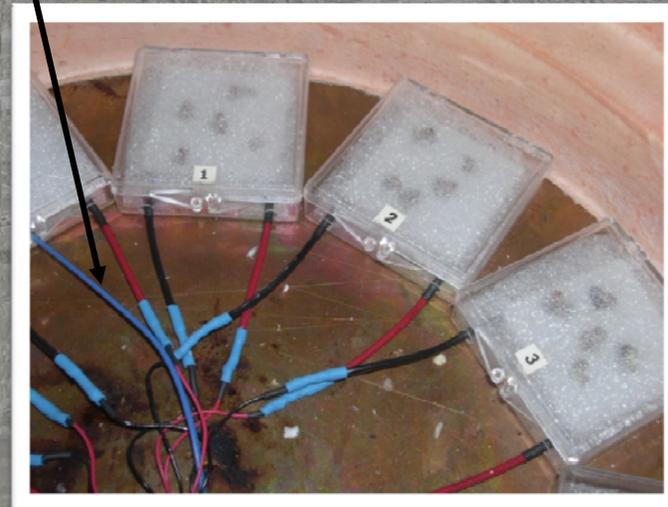
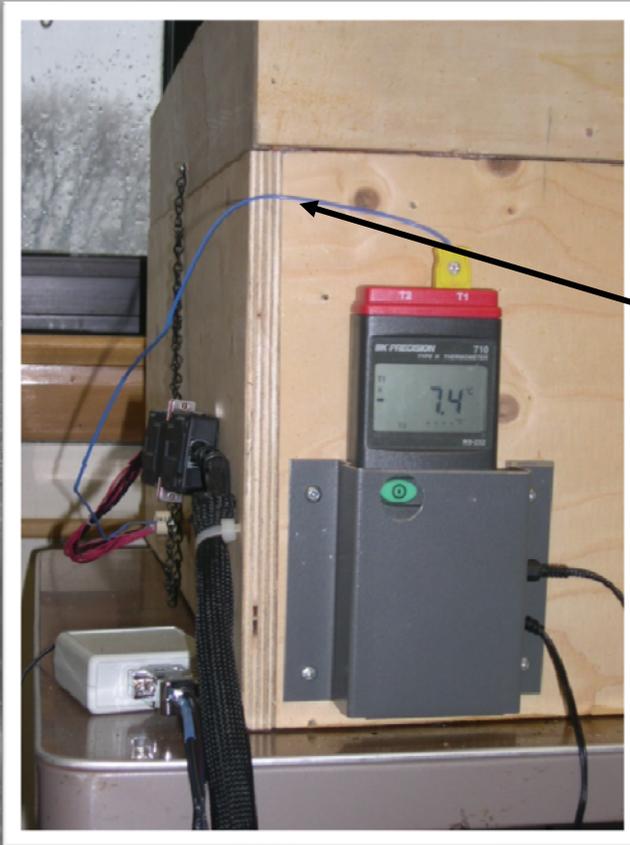
Sample Chamber



- Cooled liquid travels from chiller, through insulated tubing, into the top of the sample chamber and back to chiller

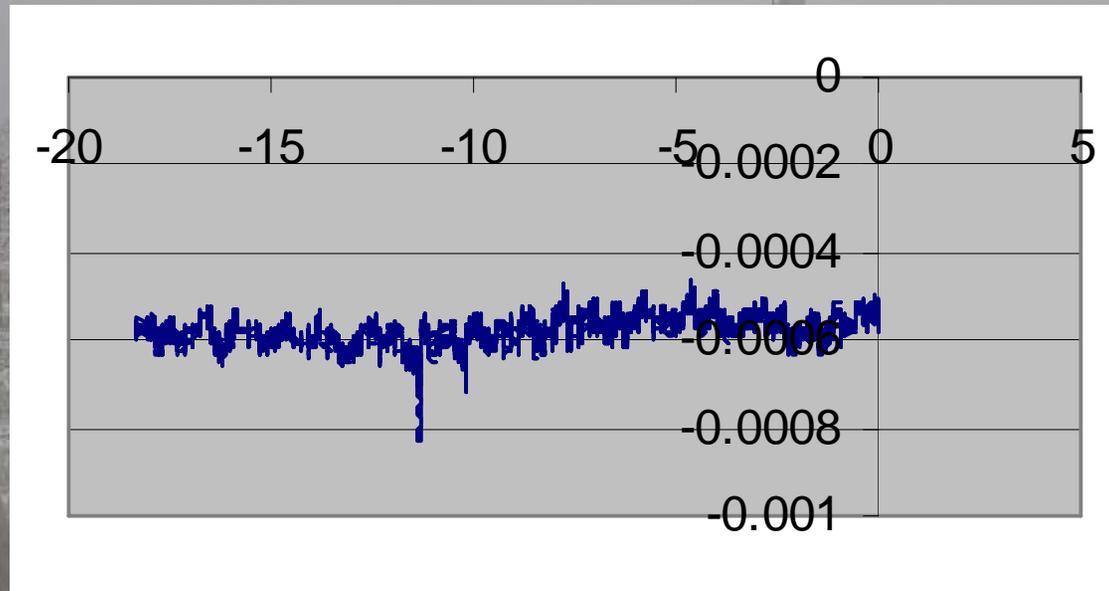
Sample Chamber

- Thermistor measures the temperature inside the sample chamber (blue wire)



Prototype Freezer Problems...

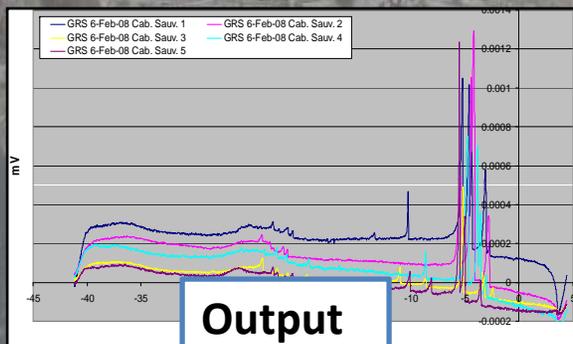
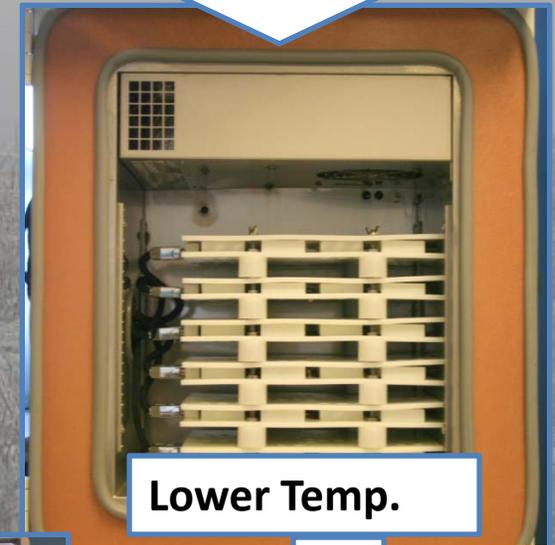
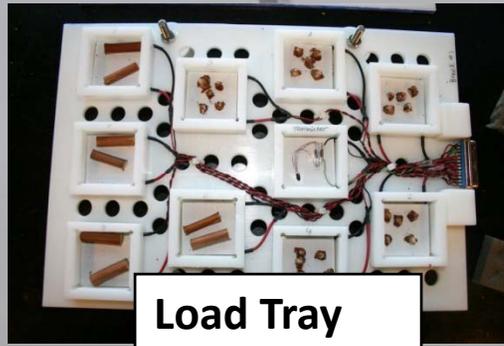
Occasionally a LTE was recorded



Tenney DTA Freezer System



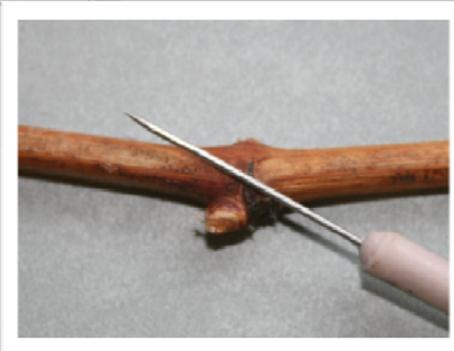
Tenney DTA System



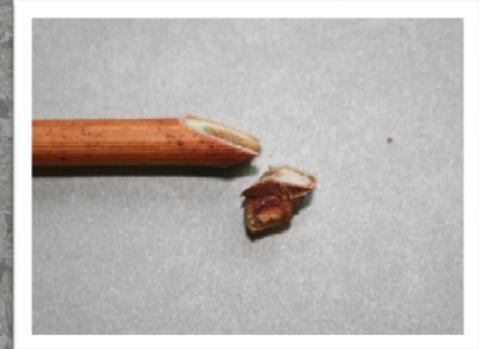
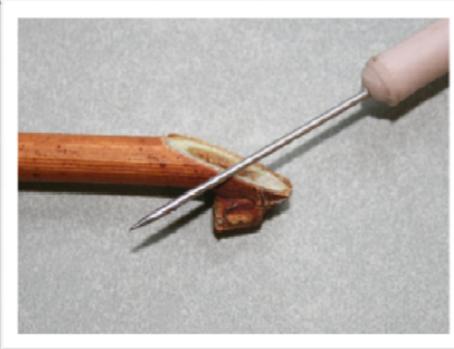
Bud Sample Preparation



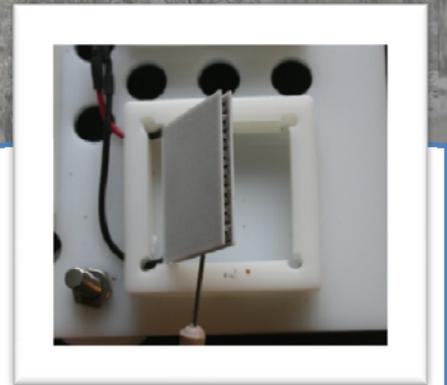
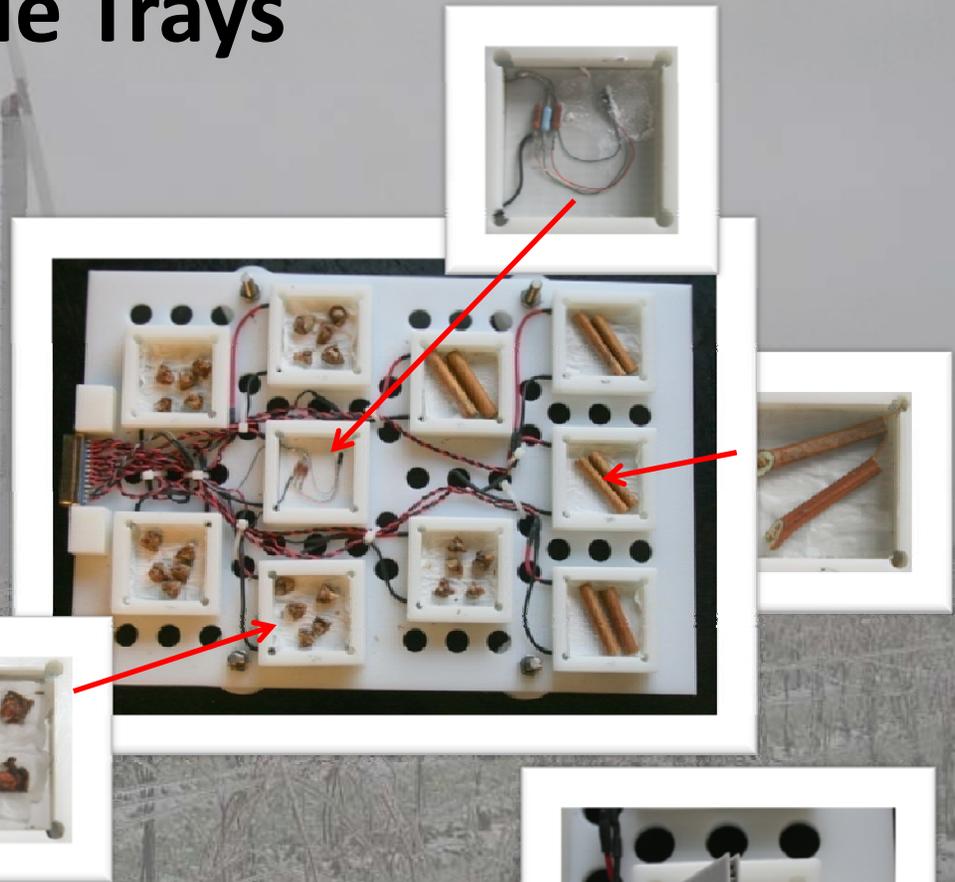
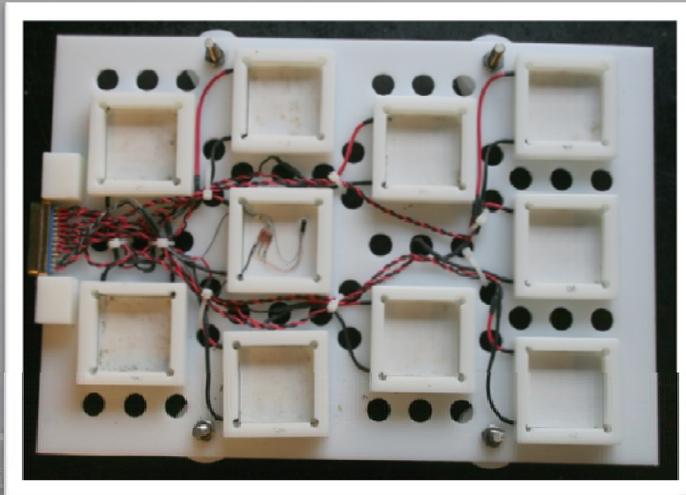
Cut #1



Cut #2

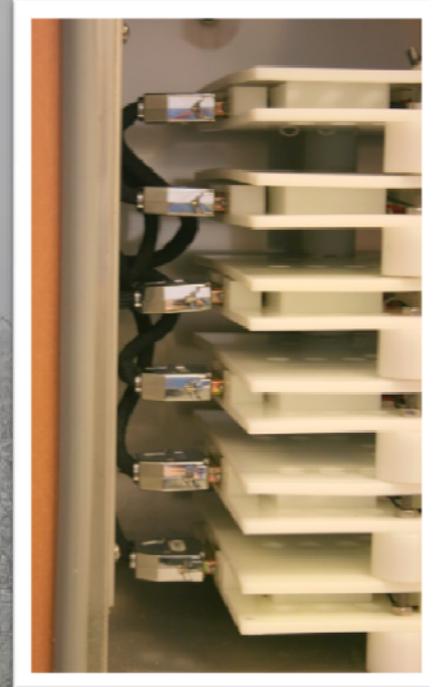
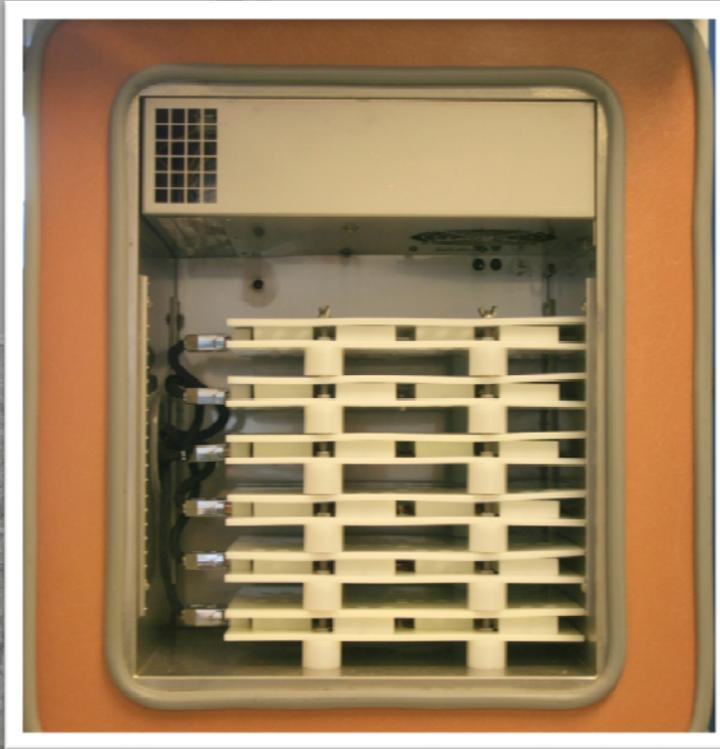
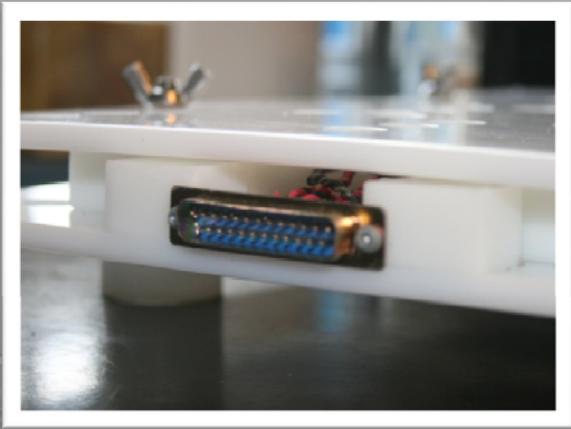


Sample Trays



- 10 Wells per Sample Tray x 6 Trays/Freezer
 - 9 sample wells
 - 1 well with thermistor
- Samples placed on Peltier plates that detect temperature gradients generated by exotherms and convert the thermal signals to voltage (mV) outputs

Sample Trays



All peltier plates and thermistor are wired through serial port and connected to multimeter.

Multimeter (DAS)

- Data Acquisition System (DAS)
- 2 x 40 Channel Multimeter (10 wells x 6 trays per DAS)
 - Scans all wells every 15 sec.
 - Connects directly to desktop computer and records data using ExcelLINX



Capacity

# of Tenney DTA Freezer Units	2
# of sample trays	12 2 freezer units x 6 trays per freezer
# of wells per tray	10 9 sample wells + 1 thermistor
Max # of buds per sample run	540 5 buds/well x 9 sample wells x 12 trays

Microsoft Excel ribbon interface showing tabs: Home, Insert, Page Layout, Formulas, Data, Review, View, Developer, Acrobat. The 'View' tab is active, displaying options for Ruler, Formula Bar, Gridlines, Headings, Message Bar, Zoom (100%), Zoom to Selection, New Window, Split, Arrange All, Hide, Freeze Panes, Unhide, Save Workspace Windows, Switch Windows, and Macros.

A1

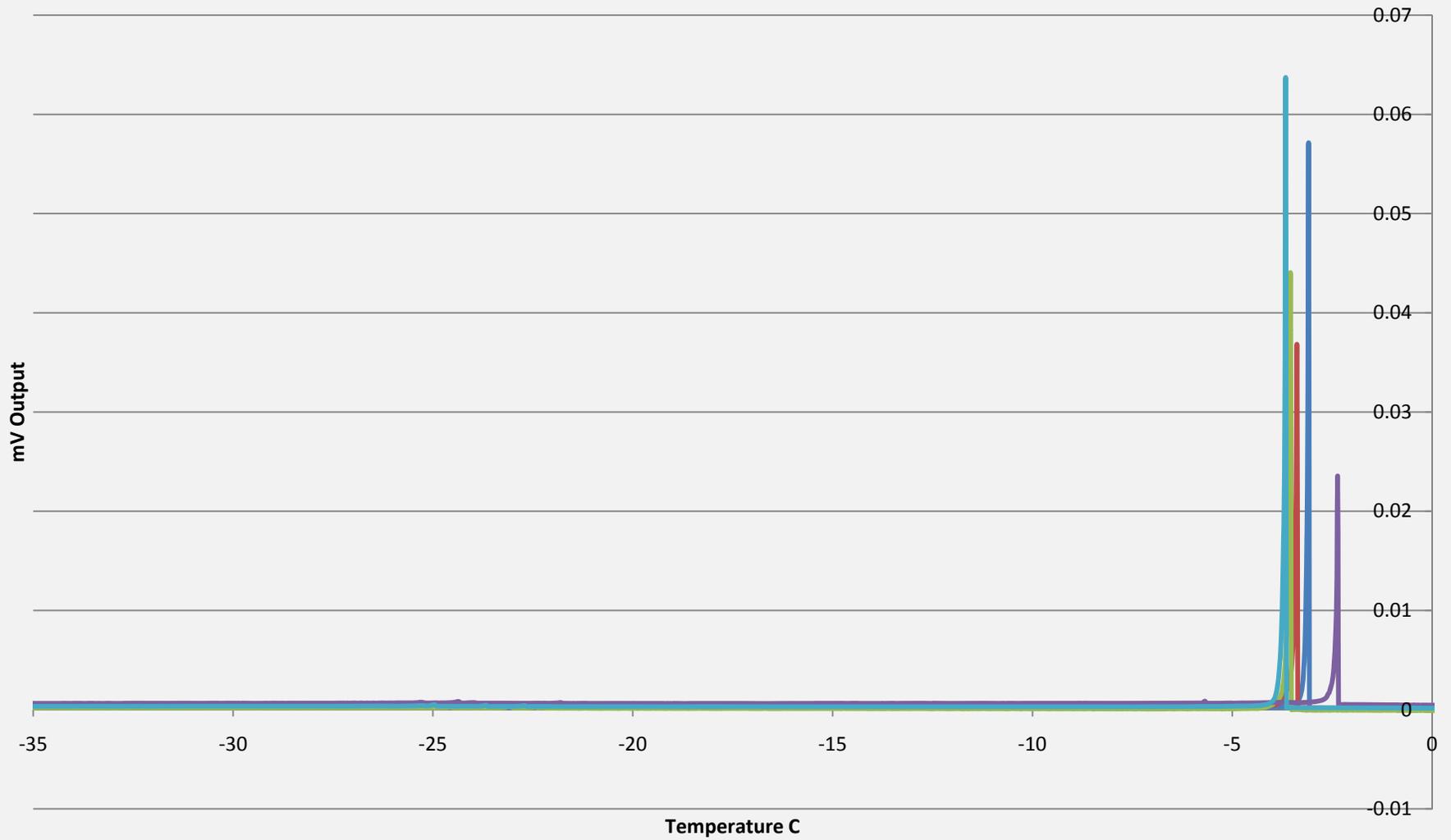
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1	Temperature																																
2	Chn 107	Time	Chn 114	Time	Chn 123	Time	Chn 138	Time	Chn 207	Time	Chn 214	Time	Chn 101	Time	Chn 102	Time	Chn 103	Time	Chn 104	Time	Chn 105	Time	Chn 106	Time	Chn 108	Time	Chn 109	Time	Chn 110	Time	Chn 111	Time	
3	Ohm	roc																															
4	4.93744	0	6.62167	0.751	6.64596	1.504	5.5906	2.3	5.28622	3.174	4.27487	3.926	0.00018	4.271	0.00014	4.487	0.00012	4.735	0.00015	5.043	2.3E-05	5.301	7.3E-06	5.518	4.9E-05	5.771	-1E-04	6.082	0.0001	6.296	-8E-0		
5	4.91983	19.285	6.18235	20.039	6.61214	20.796	5.56441	21.549	5.26705	22.423	4.26439	23.224	0.00018	23.57	0.00014	23.791	0.00012	24.008	0.00014	24.34	2.4E-05	24.563	2.6E-06	24.776	4.3E-05	25.058	-0.0001	25.371	-0.0001	25.859	-8E-0		
6	4.90192	38.339	6.15254	39.094	6.57877	39.846	5.54295	40.65	5.24895	41.521	4.25845	42.275	0.00017	42.619	0.00014	42.843	0.00011	43.06	0.00013	43.384	1.7E-05	43.604	-2E-06	43.819	3.8E-05	44.125	-0.0001	44.436	-0.0001	44.852	-8E-0		
7	4.88445	57.816	6.12273	58.575	6.54467	59.327	5.51912	60.165	5.22008	61.037	4.24954	61.789	0.00017	62.132	0.00013	62.348	0.00011	62.61	0.00013	62.917	2.9E-05	63.192	-5E-06	63.417	3.3E-05	63.631	-0.0001	63.96	-0.0001	64.174	-8E-0		
8	4.86708	77.2	6.09305	77.983	6.51124	78.737	5.49621	79.495	5.21167	80.37	4.24126	81.173	0.00016	81.518	0.00013	81.742	9.9E-05	81.958	0.00012	82.288	7E-06	82.511	-1E-05	82.727	2.8E-05	83.039	-0.0001	83.375	-0.0001	83.566	-8E-0		
9	4.85005	96.47	6.06419	97.231	6.47898	98.033	5.47321	98.787	5.19753	99.662	4.2336	100.422	0.00016	100.767	0.00012	100.982	9.3E-05	101.284	0.00012	101.551	5.1E-05	101.831	-1E-05	102.052	2.4E-05	102.267	-0.0001	102.675	-0.0001	102.897	-9E-0		
10	4.83291	116.491	6.03453	117.26	6.44587	118.019	5.44992	118.864	5.17506	119.736	4.22442	120.488	0.00015	120.832	0.00012	121.061	8.9E-05	121.278	0.00012	121.604	4.8E-05	121.822	-2E-05	122.036	2.1E-05	122.277	-0.0001	122.584	-0.0001	122.891	-9E-0		
11	4.81632	135.976	6.00615	136.732	6.41375	137.491	5.42735	138.246	5.1572	139.122	4.21655	139.929	0.00014	140.274	0.00012	140.488	8.1E-05	140.751	0.00011	141.058	3.4E-05	141.337	-2E-05	141.56	1.8E-05	141.774	-0.0001	142.182	-0.0002	142.403	-8E-0		
12	4.79966	155.715	5.97738	156.473	6.38224	157.28	5.40503	158.042	5.13913	158.915	4.20877	159.668	0.00014	160.013	0.00011	160.228	7.6E-05	160.499	0.00011	160.795	-9E-06	161.075	-2E-05	161.298	1.2E-05	161.513	-0.0001	161.92	-0.0002	162.142	-9E-0		
13	4.78267	175.694	5.94877	176.458	6.35067	177.217	5.38275	178.062	5.12078	178.934	4.20082	179.688	0.00013	180.029	0.00011	180.246	7.1E-05	180.47	9.3E-05	180.773	-1E-05	181.022	-3E-05	181.236	6.4E-06	181.453	-0.0001	181.794	-0.0002	182.065	-9E-0		
14	4.76699	195.318	5.92084	196.117	6.31934	196.877	5.36087	197.631	5.10392	198.503	4.19238	199.206	0.00013	199.65	9.7E-05	199.873	6.4E-05	200.09	8.6E-05	200.416	-2E-05	200.633	-4E-05	200.848	2.2E-06	201.088	-0.0001	201.396	-0.0002	201.676	-1E-0		
15	4.75106	214.998	5.89406	215.761	6.28931	216.568	5.34044	217.323	5.0869	218.198	4.18634	218.959	0.00012	219.304	9.3E-05	219.519	6E-05	219.782	8.2E-05	220.088	-2E-05	220.368	-4E-05	220.589	-7E-07	220.804	-0.0001	221.213	-0.0002	221.434	-1E-0		
16	4.73565	234.995	5.86436	235.75	6.25887	236.509	5.31883	237.257	5.07013	238.229	4.17872	238.98	0.00012	239.324	8.8E-05	239.539	5.3E-05	239.8	7.7E-05	240.107	-2E-05	240.387	-4E-05	240.609	-7E-07	240.823	-0.0001	241.23	-0.0002	241.452	-9E-0		
17	4.72055	254.631	5.84025	255.424	6.22892	256.195	5.29994	256.935	5.05274	257.806	4.17199	258.609	0.00011	258.954	8.8E-05	259.161	4.6E-05	259.398	7.5E-05	259.721	-3E-05	259.937	-5E-05	260.152	-9E-06	260.4	-0.0001	260.706	-0.0002	260.985	-9E-0		
18	4.7052	274.159	5.81438	275.415	6.19956	276.172	5.27862	276.476	5.0378	277.351	4.16451	278.111	0.00011	278.456	8.1E-05	278.671	4.1E-05	278.933	7.1E-05	279.239	-2E-05	279.519	-5E-05	279.741	-1E-05	279.955	-0.0001	280.264	-0.0002	280.585	-9E-0		
19	4.69067	293.732	5.78758	294.488	6.17097	295.24	5.25879	296.084	5.02212	296.957	4.15742	297.713	0.00011	298.057	7.7E-05	298.283	3.5E-05	298.507	6.8E-05	298.811	-3E-05	299.06	-6E-05	299.274	-2E-05	299.525	-0.0001	299.833	-0.0002	300.102	-8E-0		
20	4.67597	313.342	5.76072	314.137	6.14251	314.889	5.23907	315.649	5.00622	316.52	4.15074	317.232	0.00011	317.667	7.6E-05	317.895	3.2E-05	318.111	6.6E-05	318.438	-3E-05	318.656	-6E-05	318.87	-2E-05	319.111	-0.0002	319.417	-0.0002	319.698	-8E-0		
21	4.66192	332.827	5.73527	333.598	6.1151	334.404	5.21992	335.159	4.99135	336.034	4.14424	336.787	9.6E-05	337.132	7.2E-05	337.355	2.7E-05	337.581	6.1E-05	337.884	-3E-05	338.127	-6E-05	338.342	-2E-05	338.587	-0.0002	338.896	-0.0002	339.173	-8E-0		
22	4.64734	352.26	5.70982	353.017	6.08889	353.772	5.20032	354.627	4.97601	355.5	4.12723	356.254	9E-05	356.601	7E-05	356.827	2.2E-05	357.054	5.7E-05	357.358	-5E-05	357.6	-6E-05	357.815	-3E-05	358.066	-0.0002	358.374	-0.0002	358.646	-8E-0		
23	4.63275	371.451	5.68532	372.215	6.06025	373.026	5.18165	373.789	4.96146	374.664	4.12039	375.428	8.8E-05	375.818	6.6E-05	376.048	1.8E-05	376.263	5.5E-05	376.586	-6E-06	376.803	-6E-05	377.018	-3E-05	377.266	-0.0002	377.575	-0.0002	377.851	-8E-0		
24	4.61898	390.609	5.66084	391.373	6.03316	392.165	5.16328	392.918	4.94618	393.792	4.12342	394.545	8.4E-05	394.899	6.1E-05	395.115	1.5E-05	395.339	5.2E-05	395.643	-5E-05	395.88	-7E-05	396.099	-3E-05	396.351	-0.0002	396.659	-0.0002	396.924	-9E-0		
25	4.60629	409.899	5.63688	410.674	6.00663	411.426	5.14496	412.279	4.93265	413.155	4.11723	413.908	7.8E-05	414.253	5.9E-05	414.478	1.2E-05	414.702	4.8E-05	415.005	-4E-05	415.284	-7E-05	415.469	-4E-05	415.714	-0.0002	416.021	-0.0002	416.297	-9E-0		
26	4.59302	429.104	5.61289	429.927	5.98028	430.68	5.1276	431.433	4.91925	432.312	4.111	433.114	7.3E-05	433.459	5.4E-05	433.685	5.8E-06	433.909	4.1E-05	434.212	-6E-05	434.486	-7E-05	434.67	-4E-05	434.922	-0.0002	435.223	-0.0002	435.503	-1E-0		
27	4.57963	448.237	5.58952	449.094	5.95296	449.794	5.10958	450.547	4.90273	451.418	4.10468	452.17	7E-05	452.515	5E-05	452.734	-5E-06	452.959	3.8E-05	453.261	-2E-05	453.505	-8E-05	453.72	-5E-05	453.965	-0.0002	454.272	-0.0002	454.553	-9E-0		
28	4.56643	467.641	5.56609	468.399	5.93832	469.152	5.09172	469.994	4.89151	470.869	4.09885	471.632	6.5E-05	471.977	4.6E-05	472.207	-5E-06	472.422	3.4E-05	472.747	-7E-05	472.964	-8E-05	473.179	-5E-05	473.427	-0.0002	473.735	-0.0002	474.011	-9E-0		
29	4.55412	486.817	5.54283	487.64	5.92024	488.394	5.07463	489.147	4.87577	490.02	4.09263	490.826	6.2E-05	491.171	4.5E-05	491.399	-7E-06	491.625	2.9E-05	491.928	-2E-05	492.177	-8E-05	492.391	-5E-05	492.641	-0.0002	492.948	-0.0002	493.232	-9E-0		
30	4.54151	505.982	5.51994	506.738	5.68532	507.541	5.05782	508.293	4.86501	509.164	4.08648	509.915	6.1E-05	510.261	4.2E-05	510.48	-1E-05	510.707	2.6E-05	511.01	-3E-05	511.252	-8E-05	511.467	-5E-05	511.712	-0.0002	512.018	-0.0002	512.297	-9E-0		
31	4.52885	525.285	5.49764	526.055	5.85237	526.814	5.04081	527.659	4.85156	528.531	4.08044	529.283	5.3E-05	529.628	3.8E-05	529.857	-2E-05	530.073	2.1E-05	530.399	-8E-05	530.616	-9E-05	530.831	-6E-05	531.08	-0.0002	531.387	-0.0002	531.662	-1E-0		
32	4.51706	544.515	5.47563	545.34	5.82898	546.093	5.02441	546.946	4.83889	547.718	4.0751	548.525	5E-05	548.87	3.5E-05	549.097	-2E-05	549.321	1.7E-05	549.623	-3E-05	549.867	-9E-05	550.082	-6E-05	550.334	-0.0002	550.643	-0.0002	550.917	-9E-0		
33	4.50544	563.712	5.45379	564.471	5.80355	565.215	5.00837	566.028	4.82649	566.901	4.06935	567.655	4.4E-05	567.999	3.8E-05	568.225	-3E-05	568.449	1.3E-05	568.753	-4E-05	568.997	-9E-05	569.211	-6E-05	569.457	-0.0002	569.764	-0.0002	570.043	-9E-0		
34	4.49255	583.105	5.43262	583.863	5.77949	584.615	4.99183	585.466	4.81417	586.338	4.06354	587.089	4.5E-05	587.433	2.5E-05	587.651	-3E-05	587.877	7.4E-06	5													



Results

W. Lakeshore Chardonnay

January 8, 2009



— W. Lakeshore Chardonnay W1

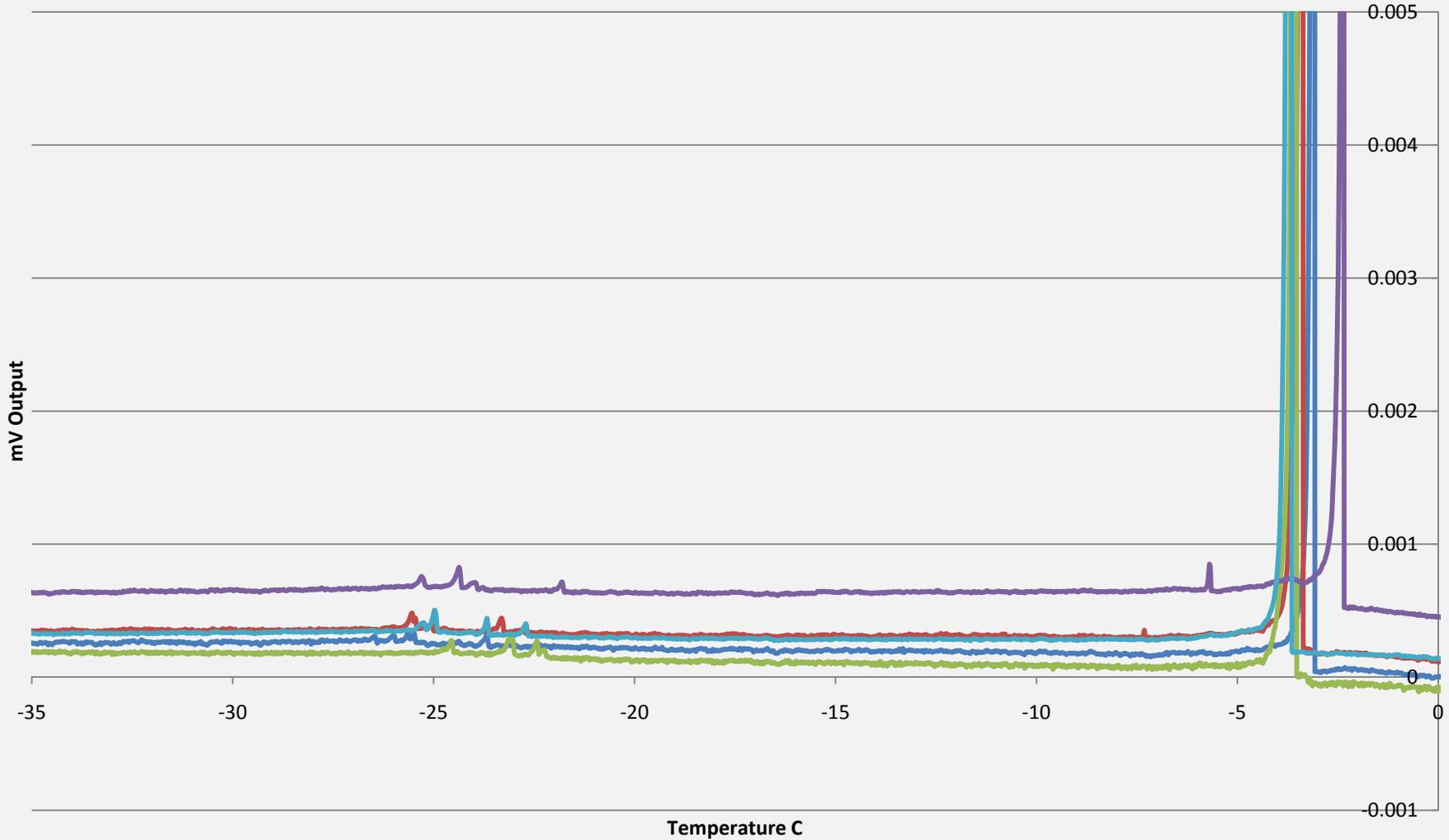
— W. Lakeshore Chardonnay W2

— W. Lakeshore Chardonnay W3

— W. Lakeshore Chardonnay W4

— W. Lakeshore Chardonnay W5

W. Lakeshore Chardonnay January 8, 2009



— W. Lakeshore Chardonnay W1

— W. Lakeshore Chardonnay W2

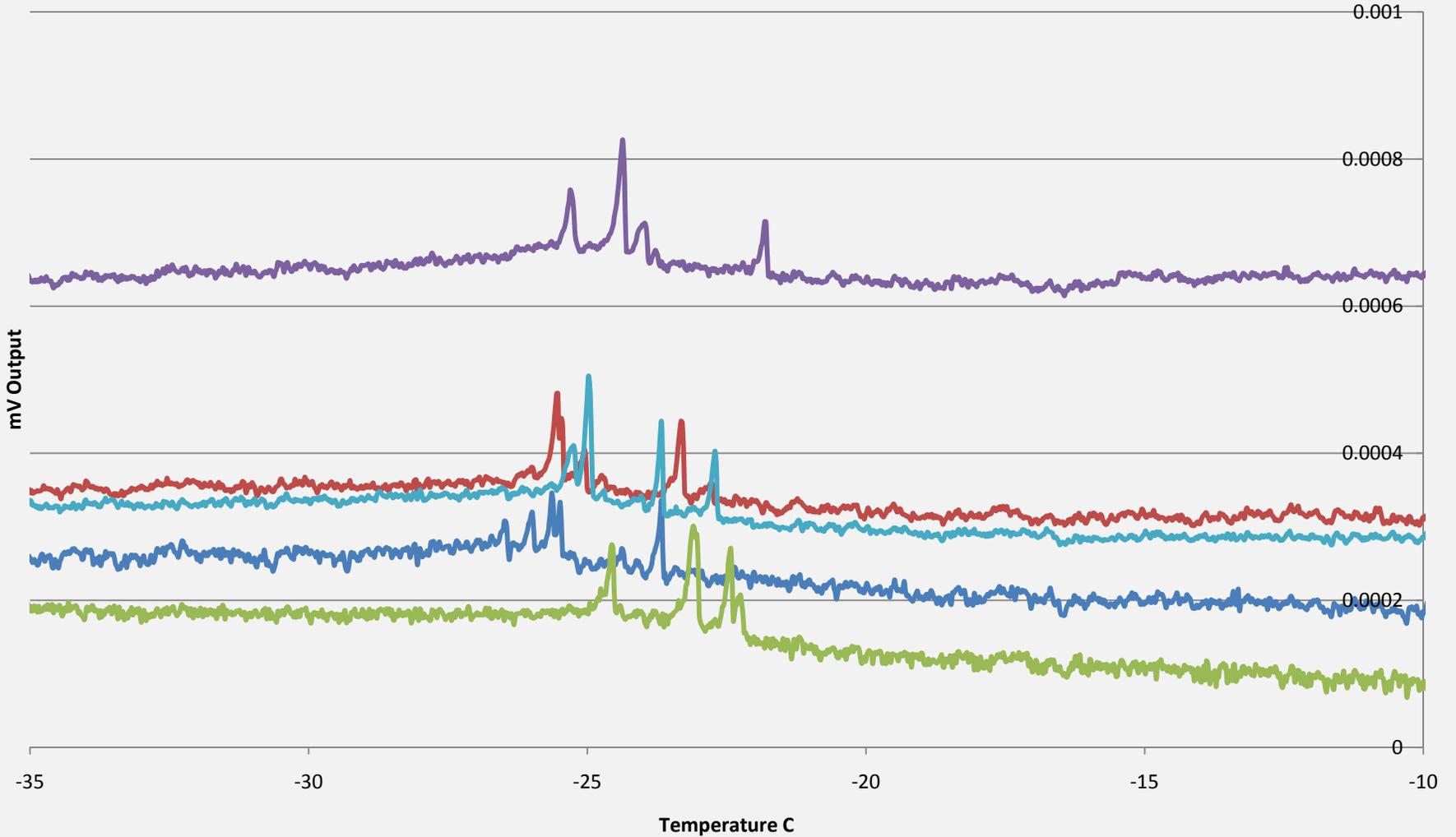
— W. Lakeshore Chardonnay W3

— W. Lakeshore Chardonnay W4

— W. Lakeshore Chardonnay W5

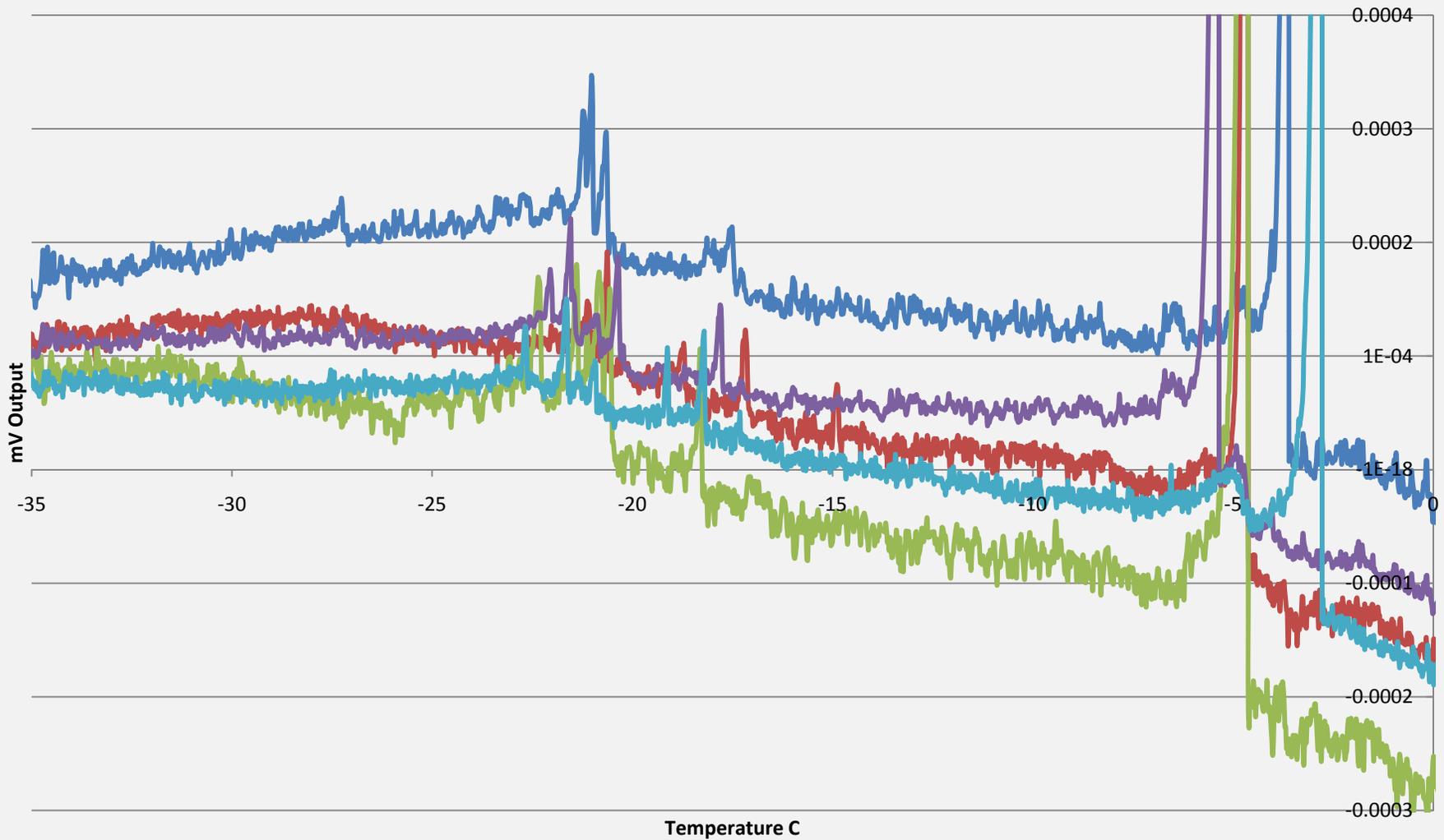
W. Lakeshore Chardonnay

January 8, 2009



— W. Lakeshore Chardonnay W1 — W. Lakeshore Chardonnay W2 — W. Lakeshore Chardonnay W3
— W. Lakeshore Chardonnay W4 — W. Lakeshore Chardonnay W5

W. Lakeshore Cabernet Sauvignon January 8, 2009



W. Lakeshore Cab. Sauv. W1

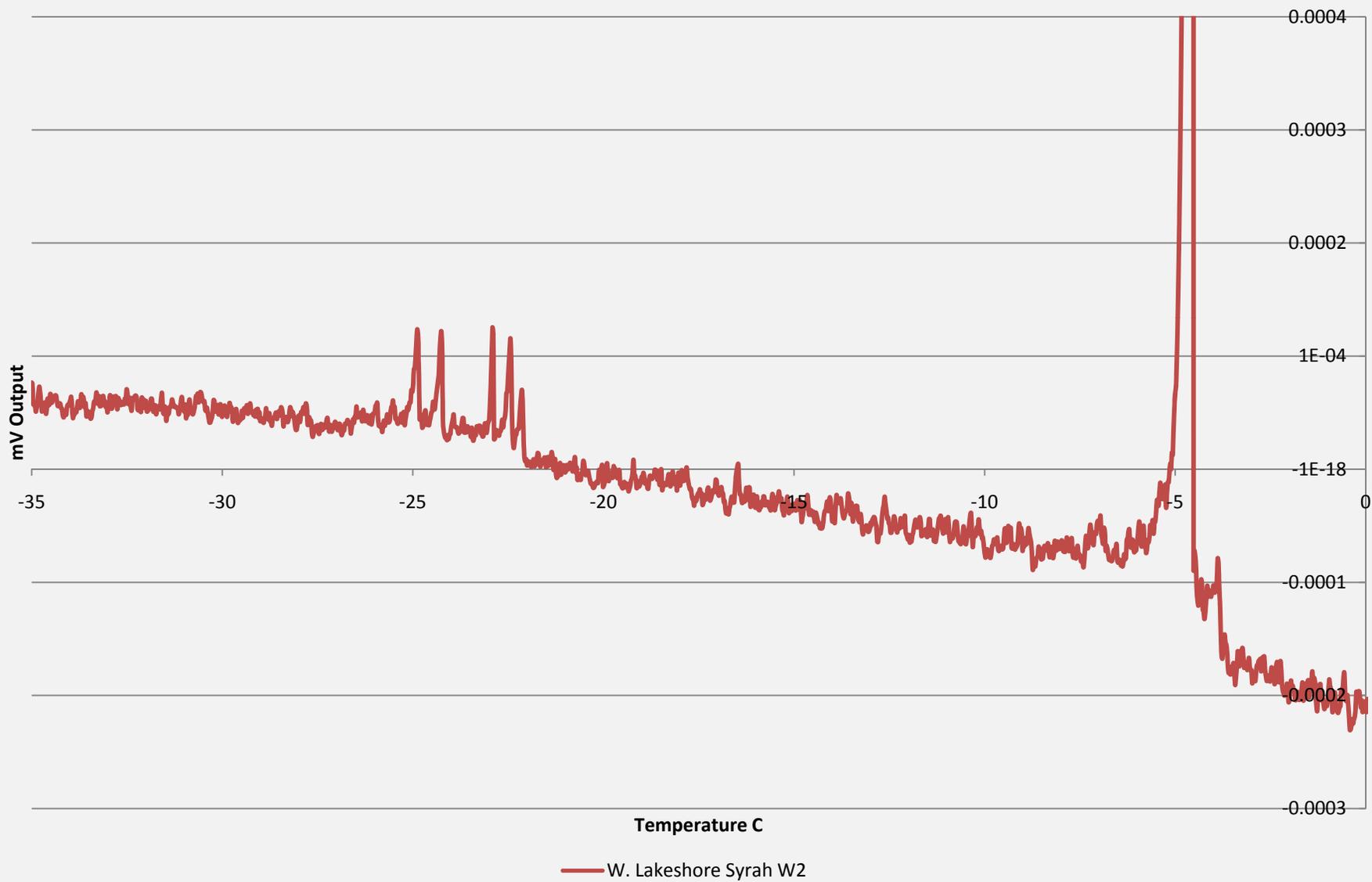
W. Lakeshore Cab. Sauv. W2

W. Lakeshore Cab. Sauv. W3

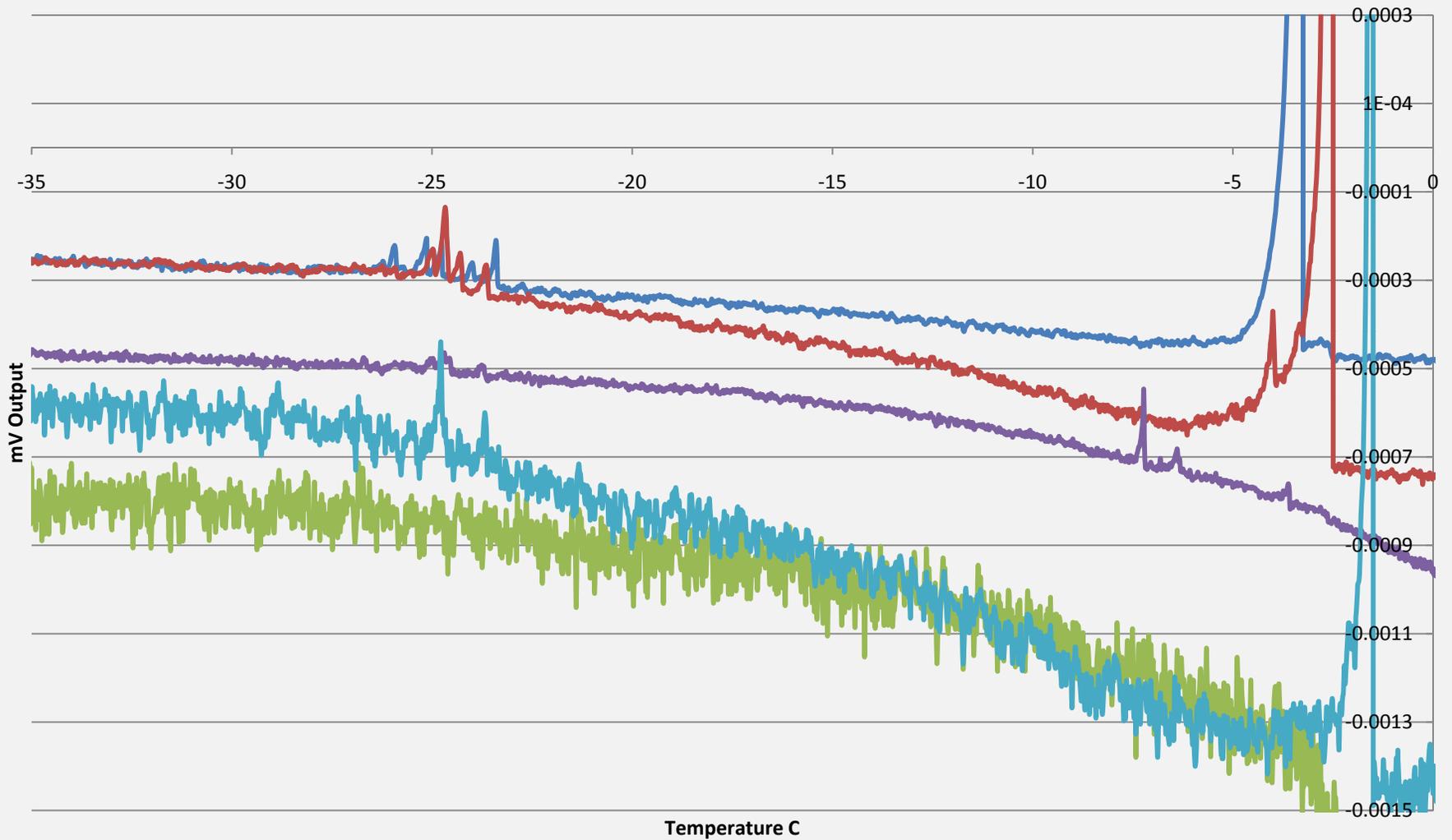
W. Lakeshore Cab. Sauv. W4

W. Lakeshore Cab. Sauv. W5

W. Lakeshore Syrah January 8, 2009



W. Lakeshore Pinot Noir January 8, 2009



W. Lakeshore Pinot Noir W1

W. Lakeshore Pinot Noir W2

W. Lakeshore Pinot Noir W3

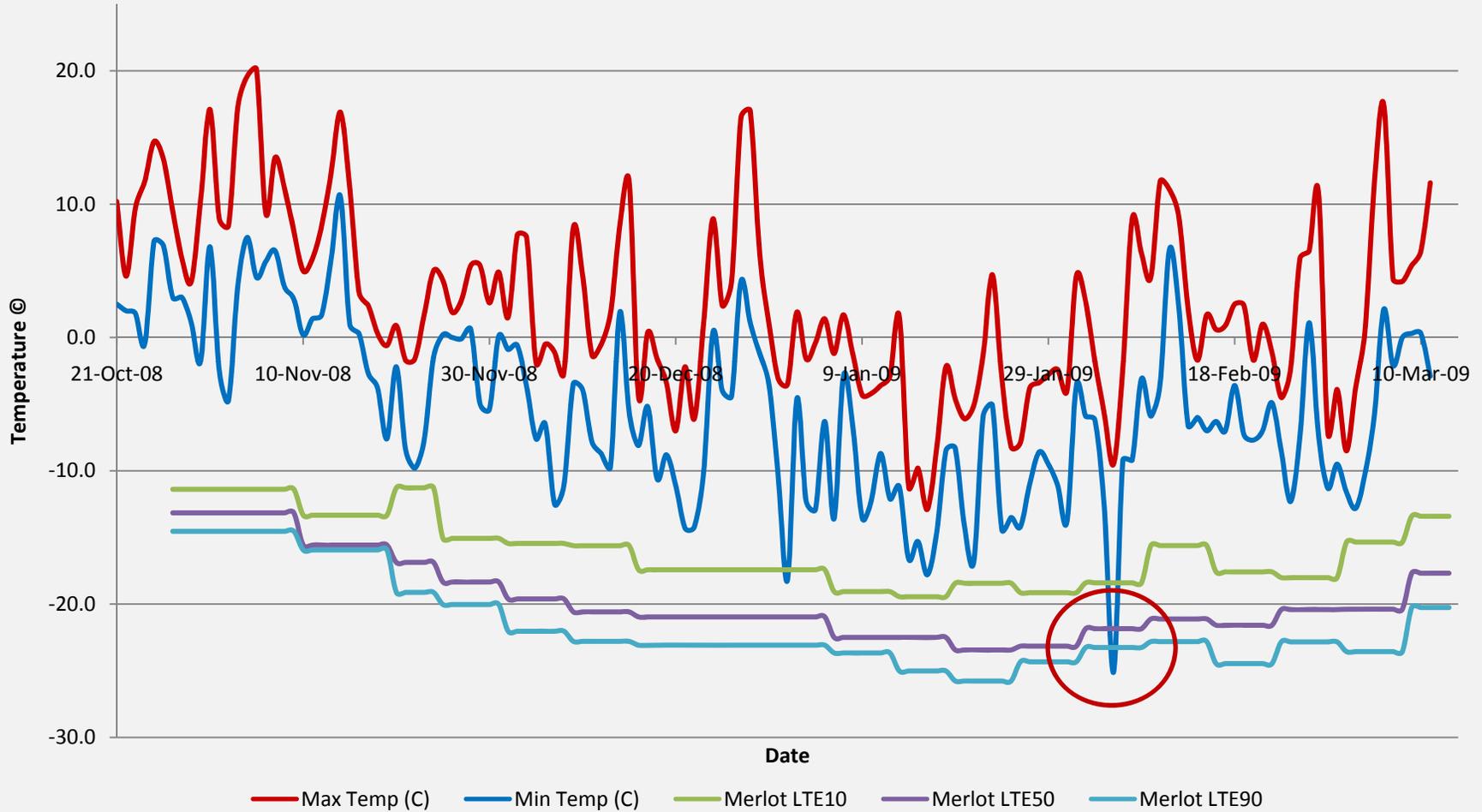
W. Lakeshore Pinot Noir W4

W. Lakeshore Pinot Noir W5



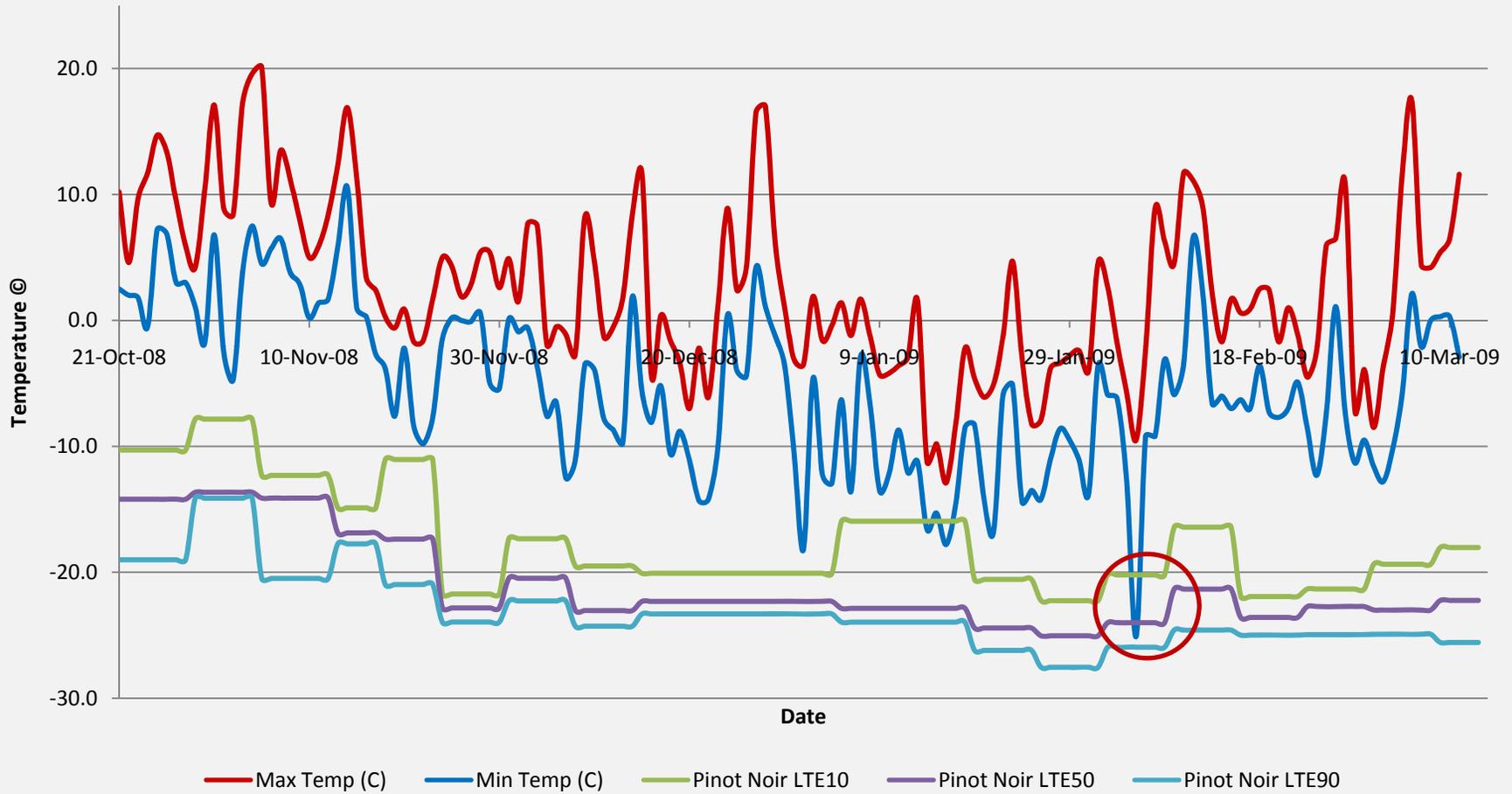
Critical events

2008/09 Vineland Min/Max Temperatures & Merlot LTE Values



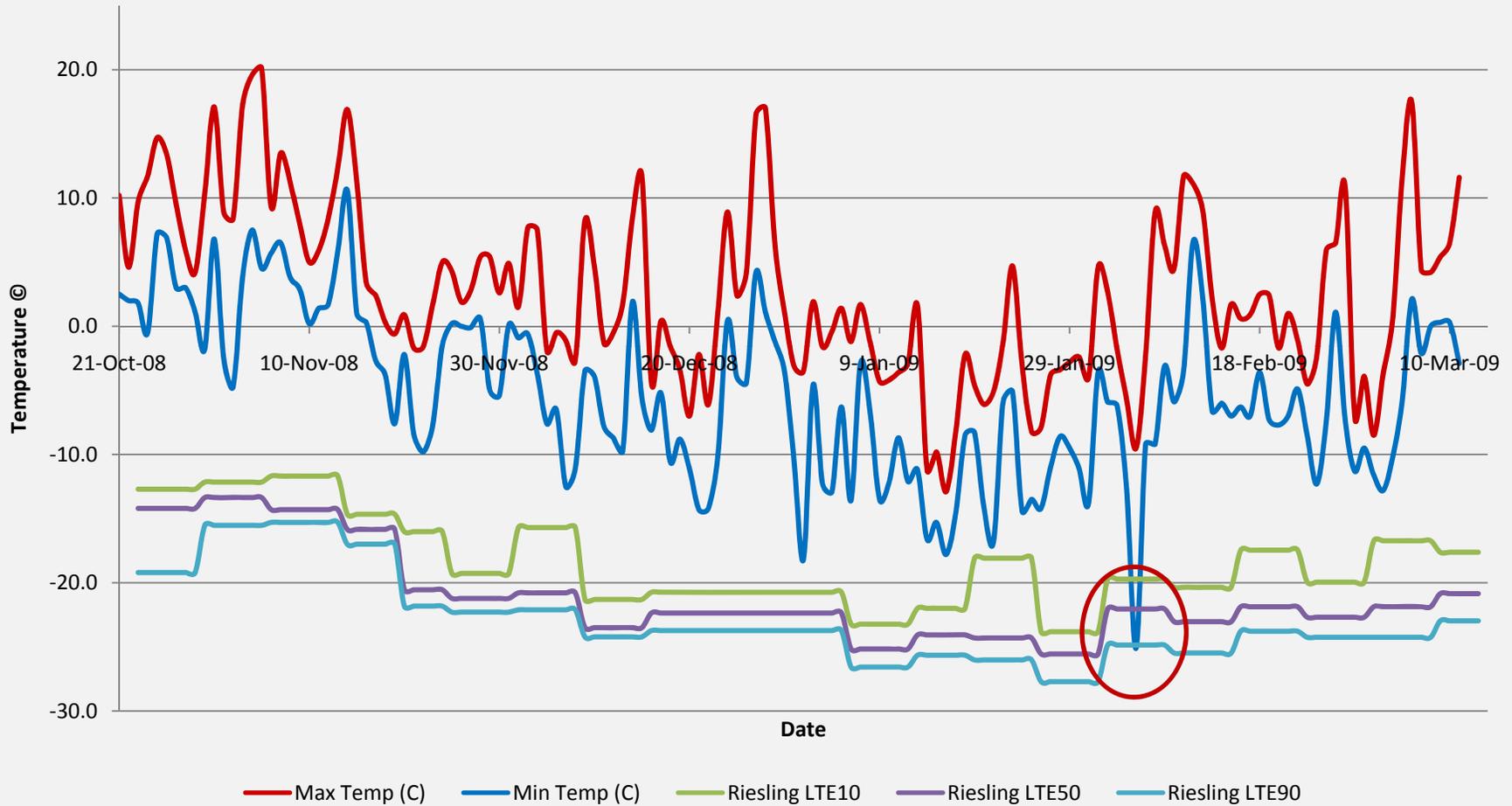
	Dec 15, 08	Jan 12, 09	Feb 9, 08	Feb 23, 08
Primary Bud Survival	99%	100%	34%	24%

2008/09 Vineland Min/Max Temperatures & Pinot Noir LTE Values



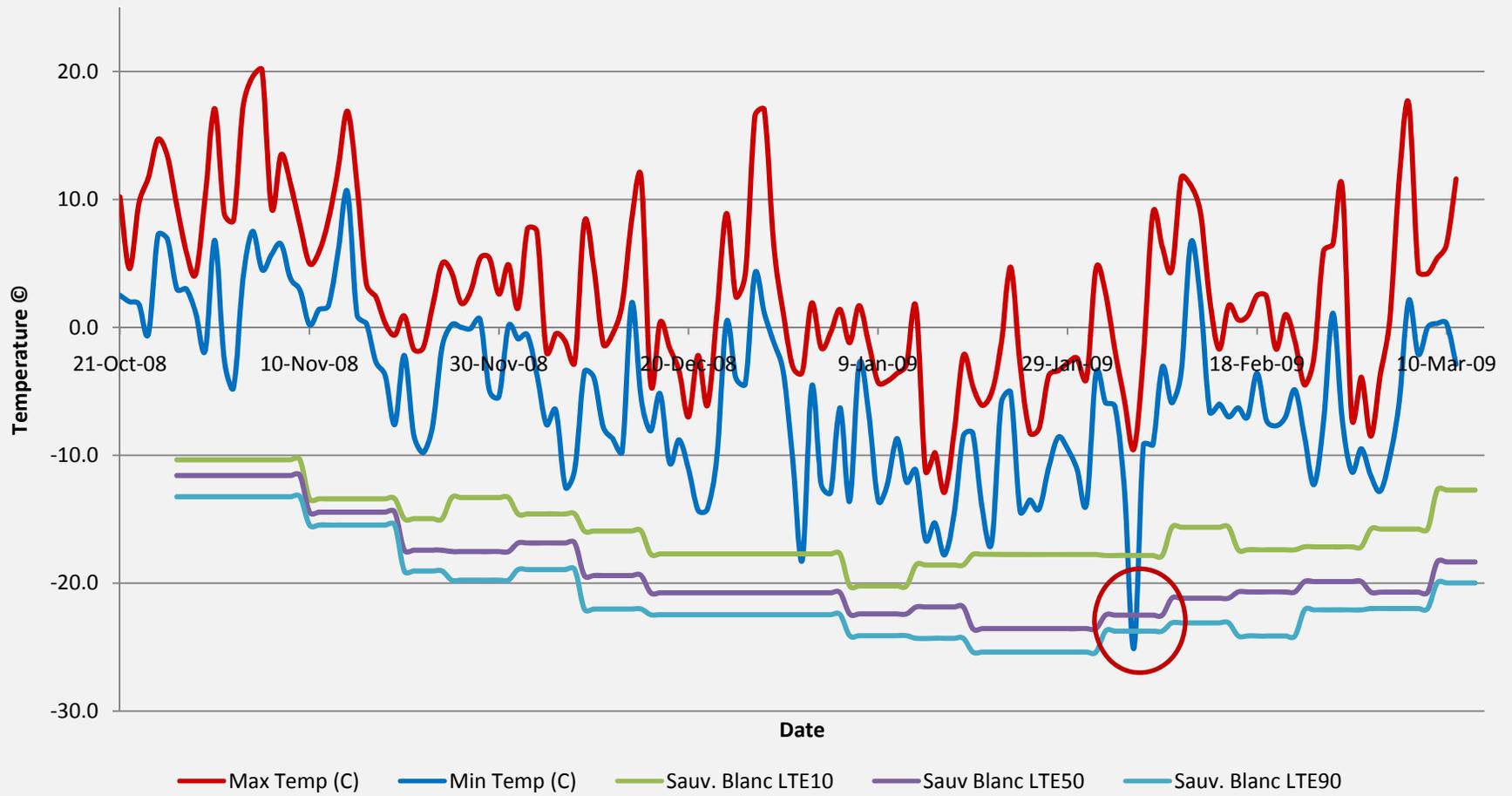
	Dec 15, 08	Jan 12, 09	Feb 9, 08	Feb 23, 08
Primary Bud Survival	98%	93%	73%	55%

2008/09 Vineland Min/Max Temperatures & Riesling LTE Values

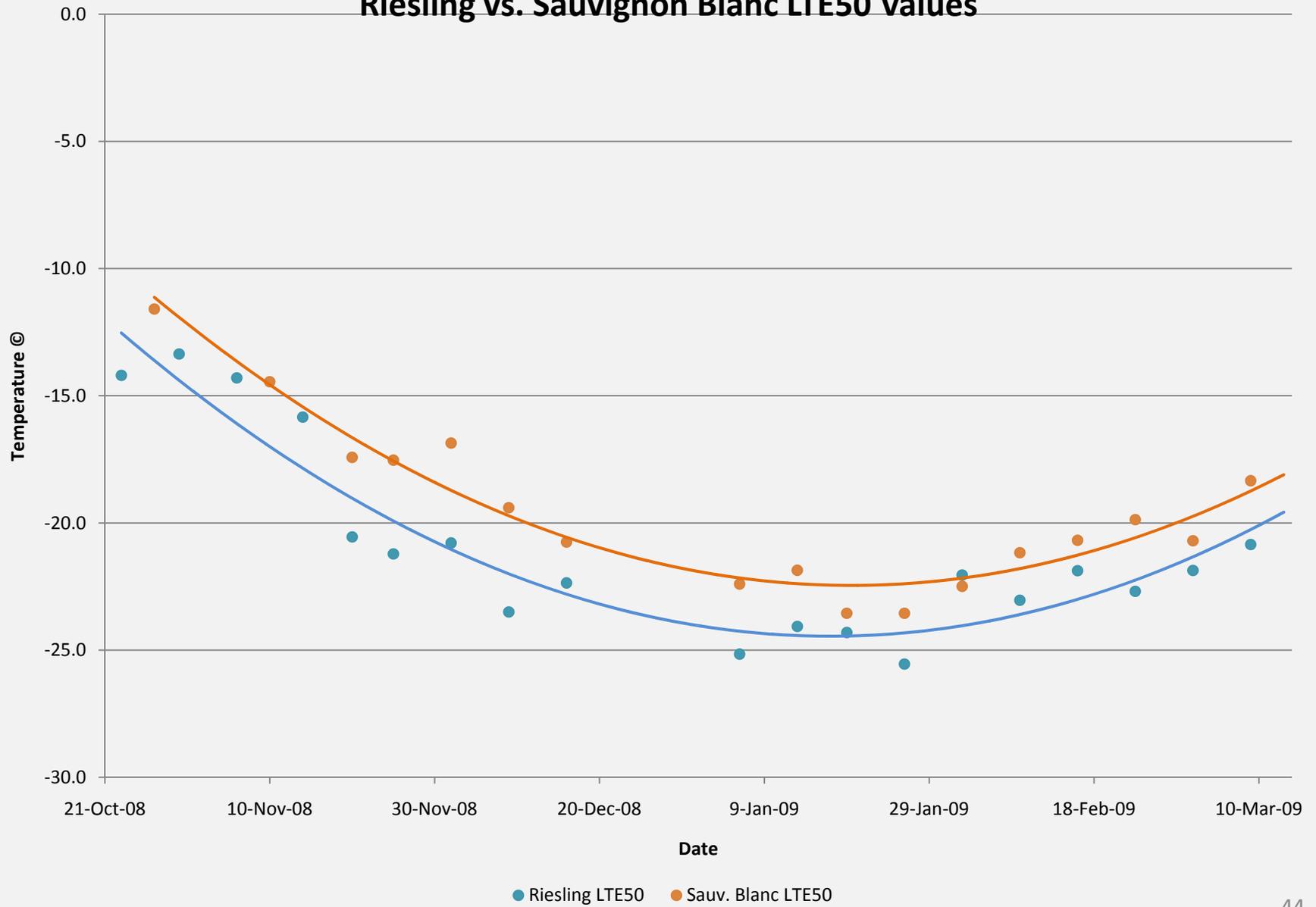


	Dec 15, 08	Jan 12, 09	Feb 9, 08	Feb 23, 08
Primary Bud Survival	98%	97%	78%	68%

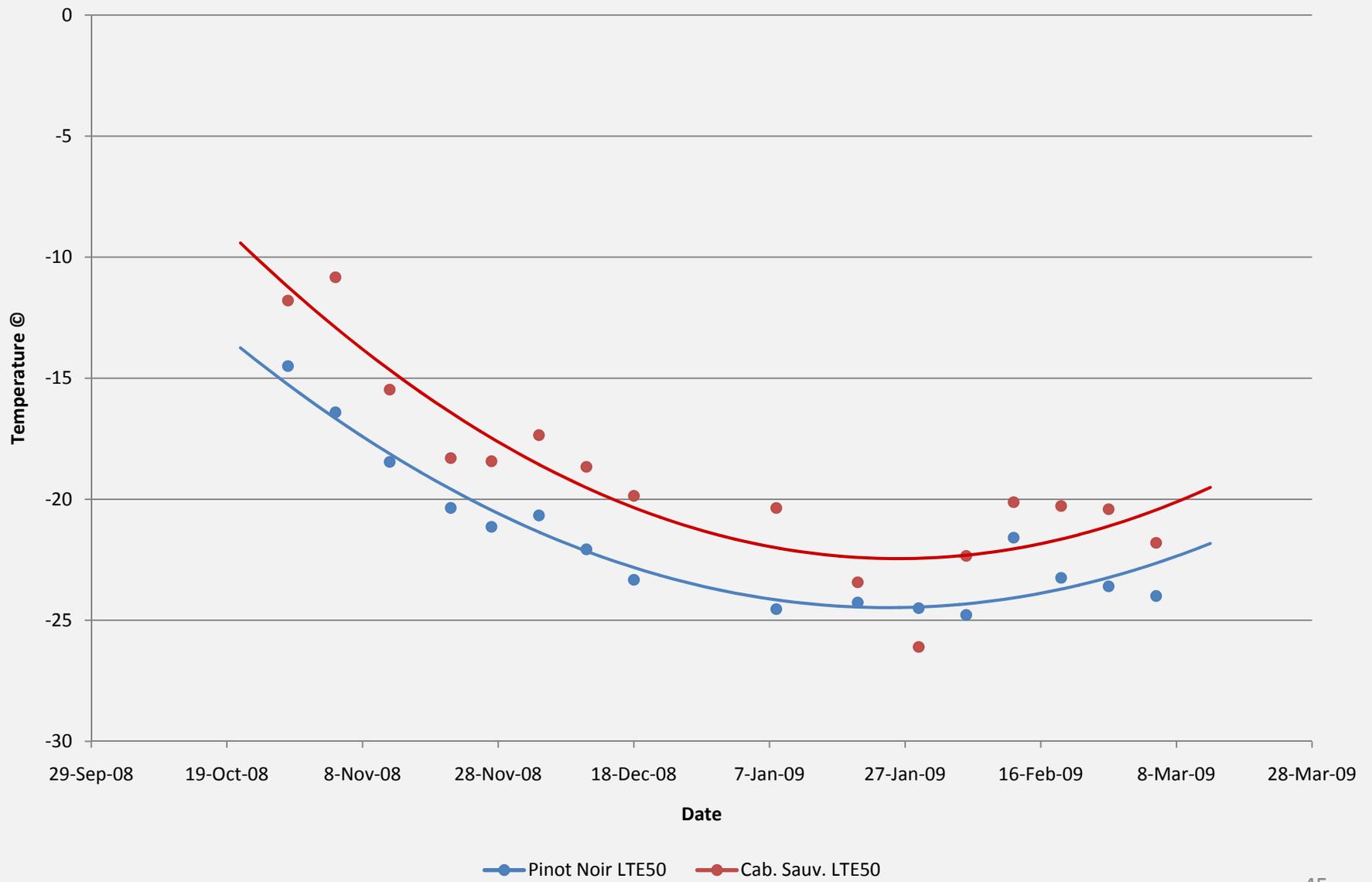
2008/09 Vineland Min/Max Temperatures & Sauv. Blanc LTE Values



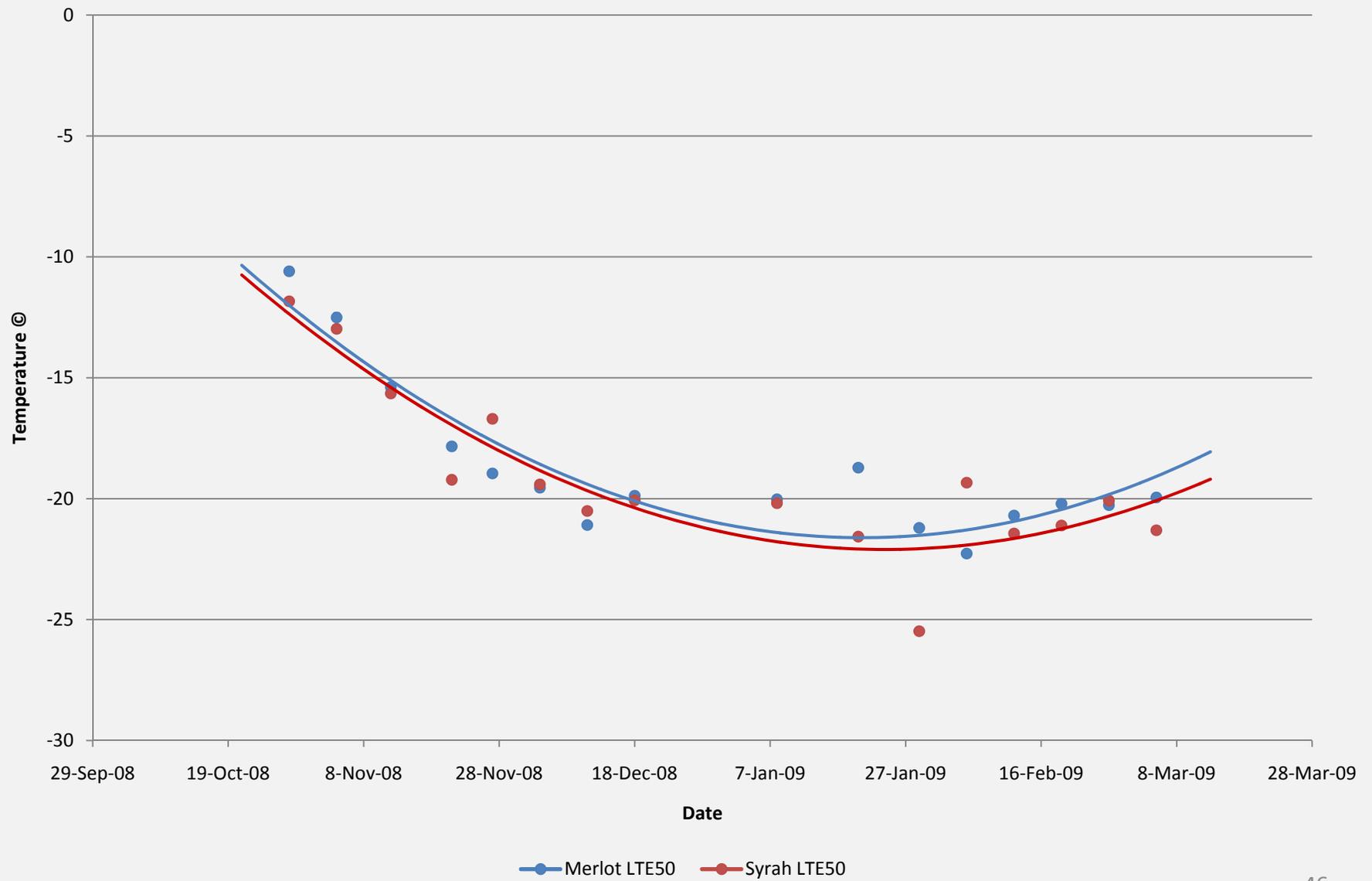
2008/09 Vineland Riesling vs. Sauvignon Blanc LTE50 Values

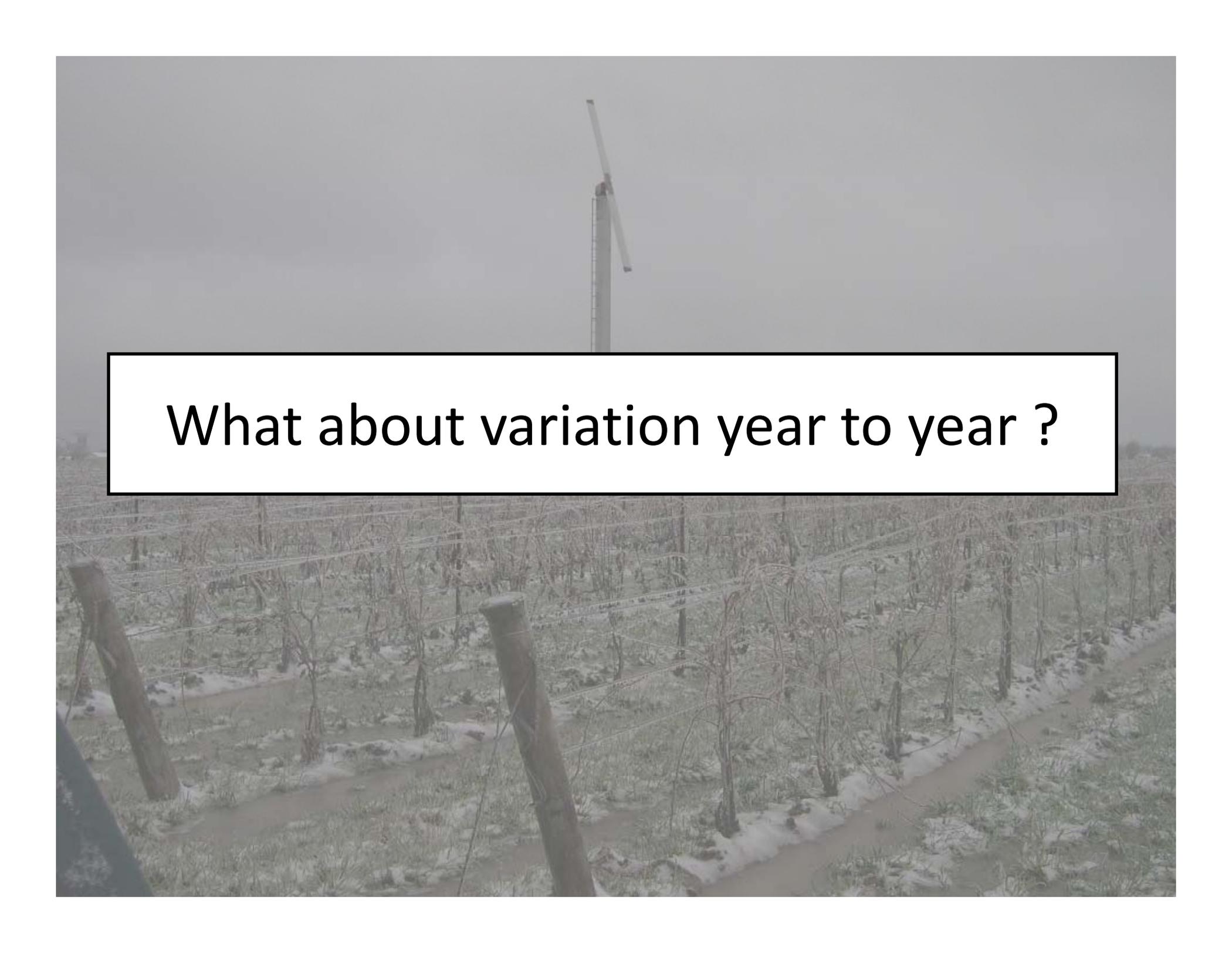


2008/09 W. Lakeshore Pinot Noir vs. Cabernet Sauvignon LTE50 Values



2008/09 W. Lakeshore Merlot vs. Syrah LTE50 Values

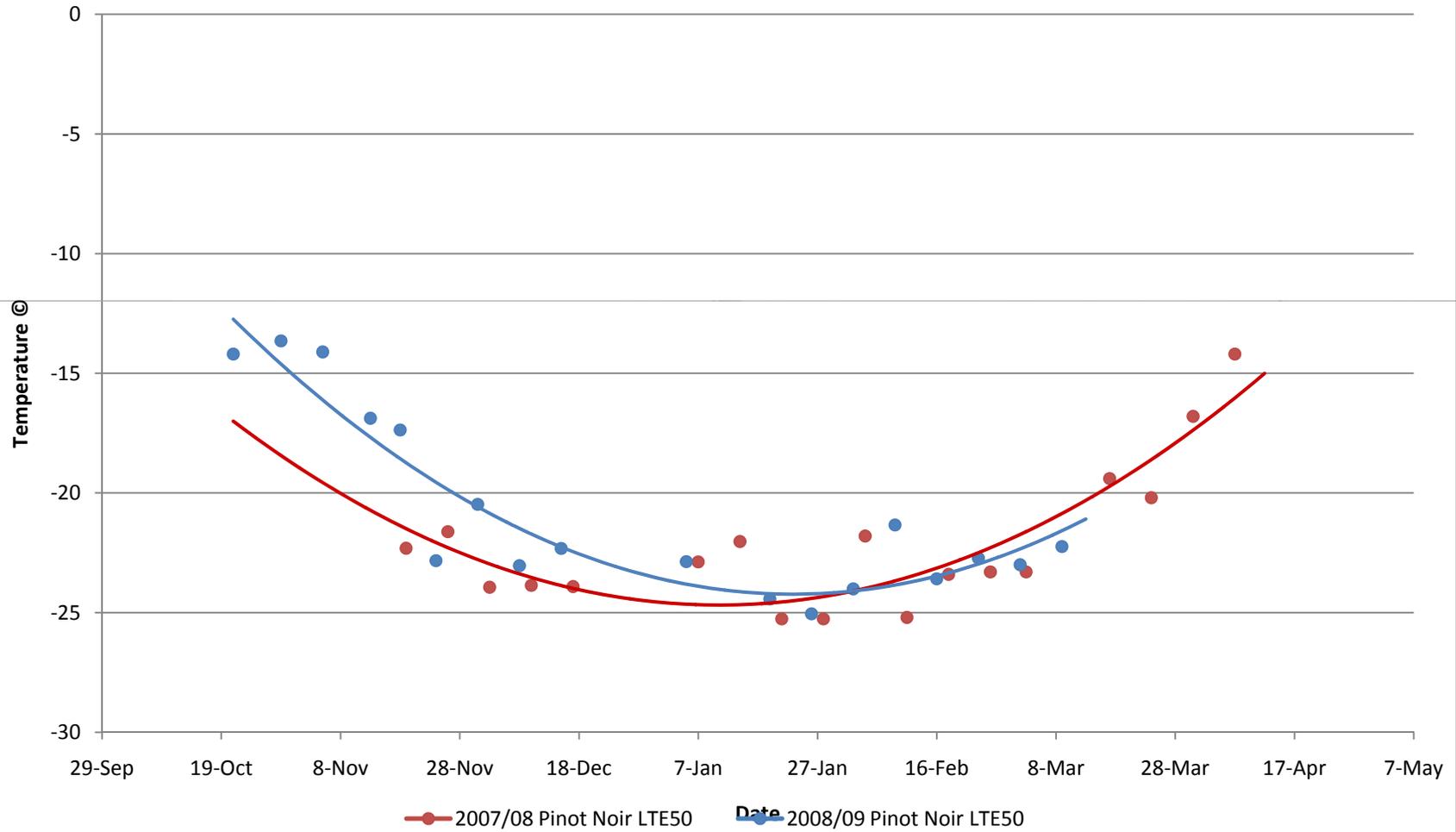


A photograph of a vineyard with a wind turbine in the background under a grey sky. The vineyard is in the foreground, with rows of grapevines supported by wooden posts and wires. The ground is covered with a light layer of snow. The wind turbine is a tall, slender structure with a single blade visible, positioned in the center of the background. The sky is a uniform, overcast grey.

What about variation year to year ?

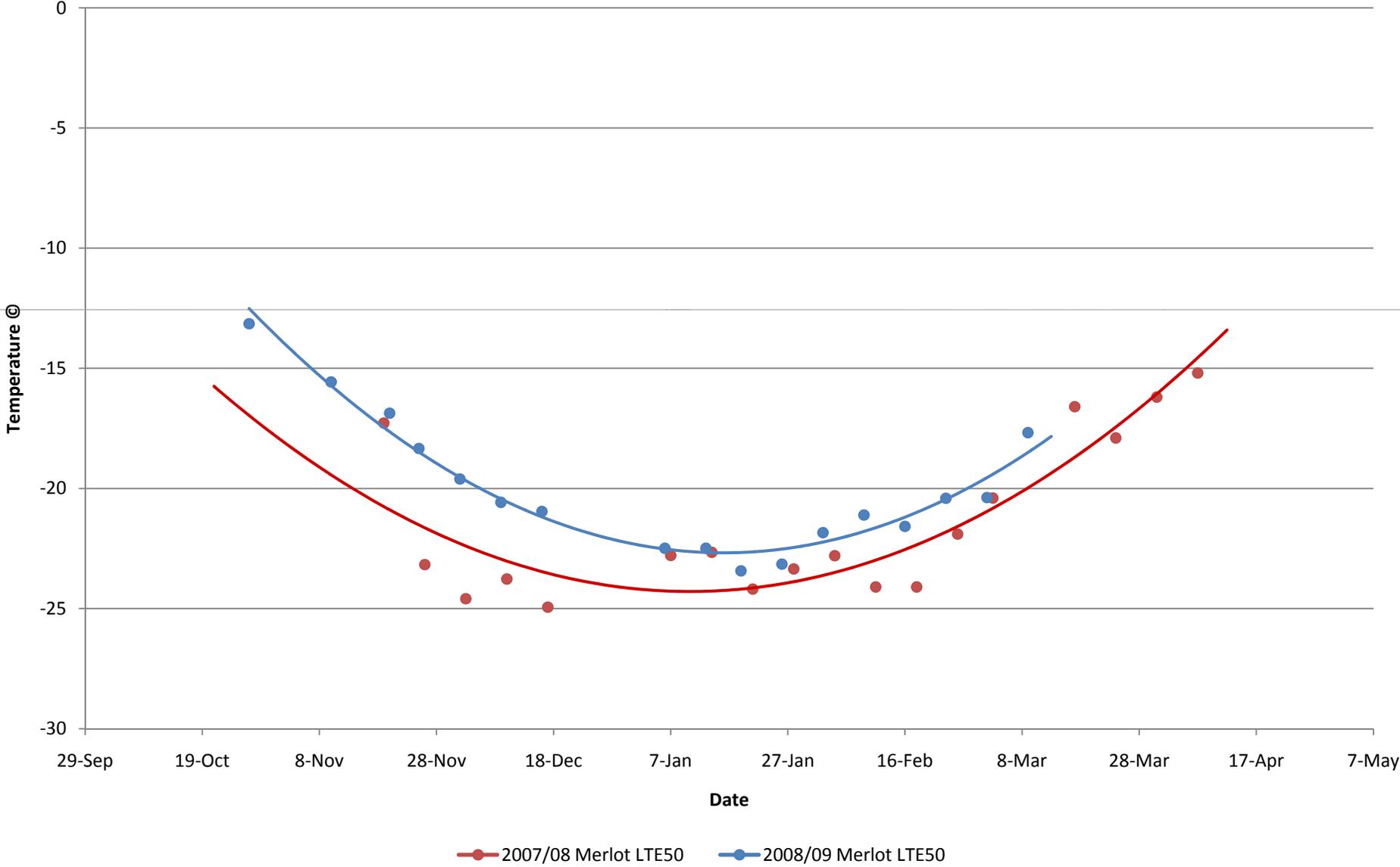
Vineland

2007/08 Pinot Noir LTE50 vs. 2008/09 Pinot Noir LTE50



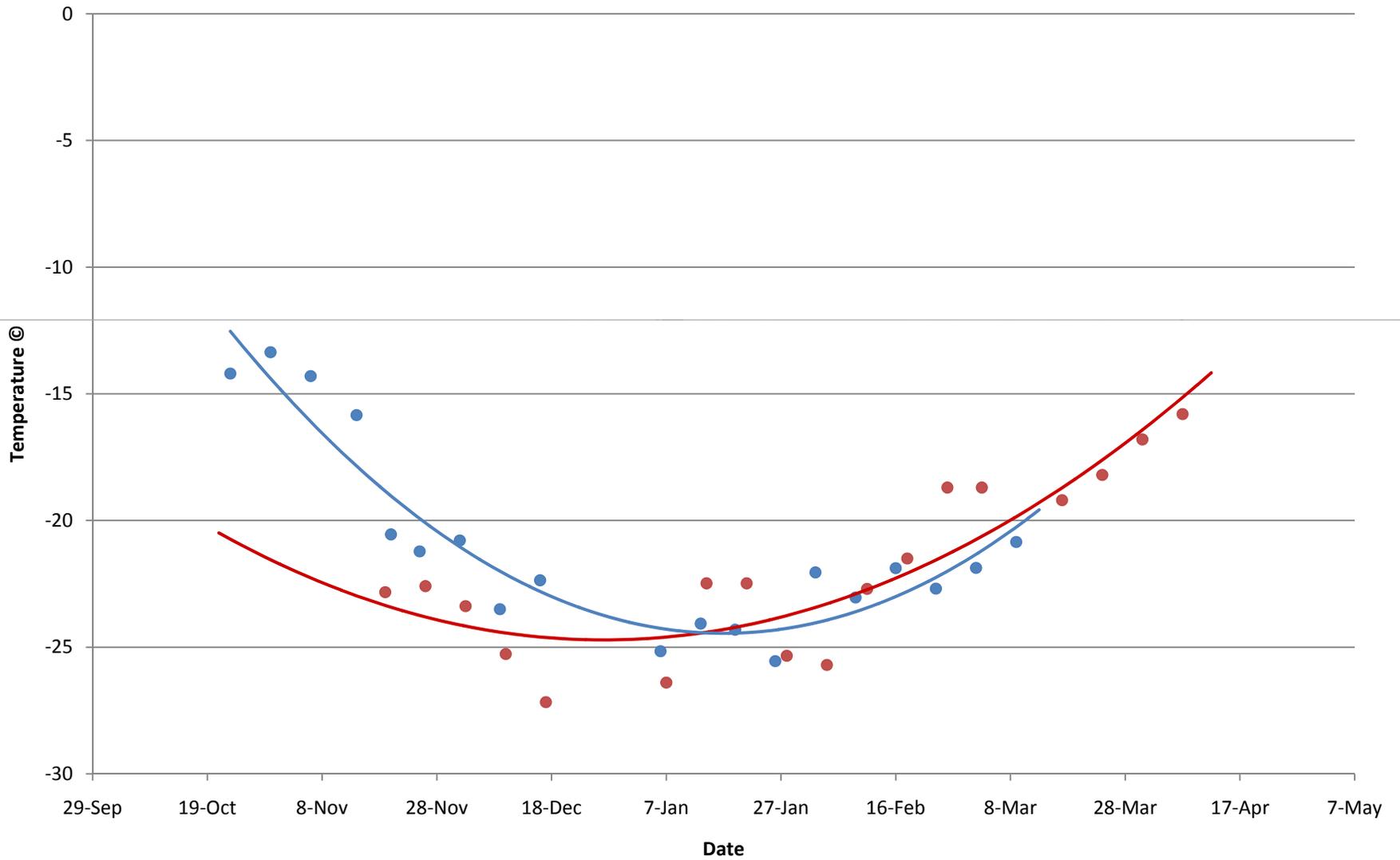
Vineland

2007/08 Merlot LTE50 vs. 2008/09 Merlot LTE50



Vineland

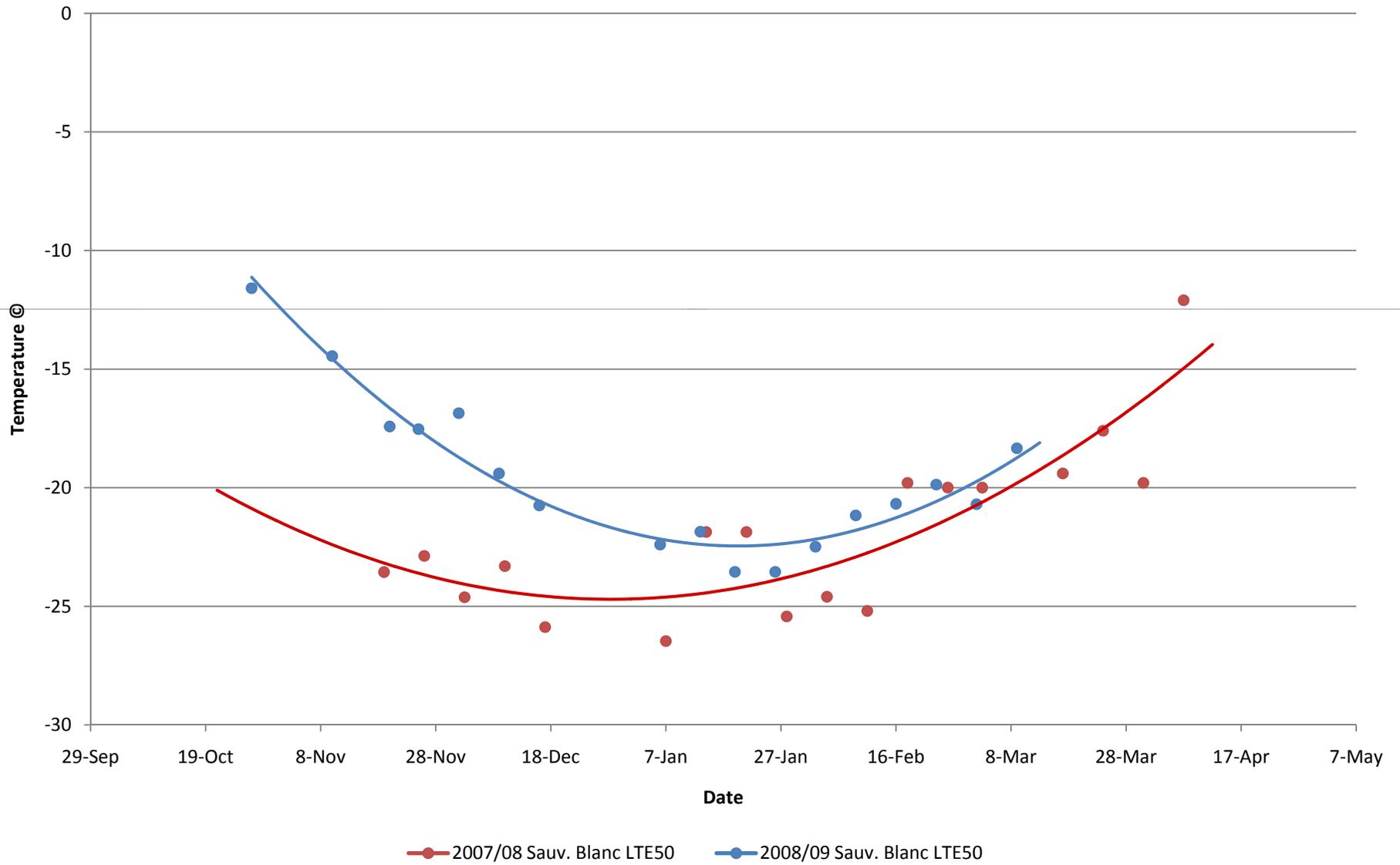
2007/08 Riesling LTE50 vs. 2008/09 Riesling LTE50



—●— 2007/08 Riesling LTE50 —●— 2008/09 Riesling LTE50

Vineland

2007/08 Sauv. Blanc LTE50 vs. 2008/09 Sauv. Blanc LTE50



Special thanks

- Tom MacDonald and Art Reimer - Brock University – Electrical and Mechanical shop
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- GGO, WCO , KCMS and other project funding groups
- Schenck Farms Ltd

Special thanks

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- Ryan Brewster and Charlene Yungblut – KCMS
- Bob Wample (Fresno State) , Markus Keller (WSU) and others

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- Tom MacDonald and Art Reimer - Brock University – Electrical and Mechanical shop
- CCOVI faculty and staff
- GGO, WCO , KCMS and other project funding groups
- Growers for samples and ideas
- Schenck Farms Ltd

Future Research Possibilities

- Impact of cultural practices
 - Canopy management
 - Training system
 - Vine spacing
 - Irrigation
 - Crop Level influence
 - Vine nutrition

Future Research Possibilities

- Bud hardiness based on node position
- Long term effects from ice wine production
- Clonal evaluations
- Doing vineyard specific vine selections for propagation
- Influence of pest injury
- And ??????????