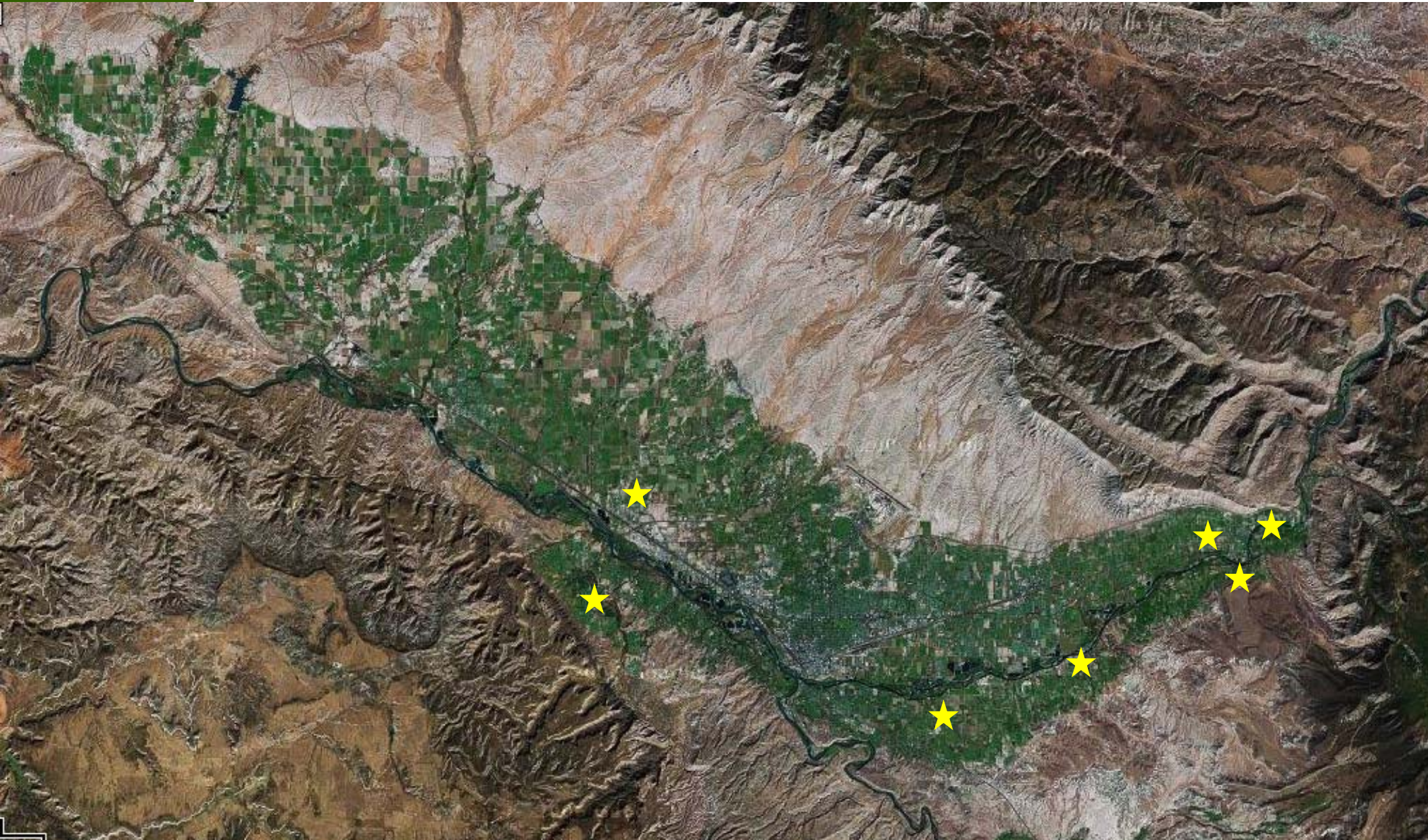




Main features of the Grand Valley

- High mountain valley (~4,700')
 - In the North, the Bookcliffs rise almost 2,000' above the valley floor
 - In the East, Grand Mesa rises >6,000' above the valley floor
 - In the South, the Uncompahgre Plateau rising >1,500' above the valley floor
 - The valley widens and gently slopes to the West

How important is micro-climate?



CAVE weather station network

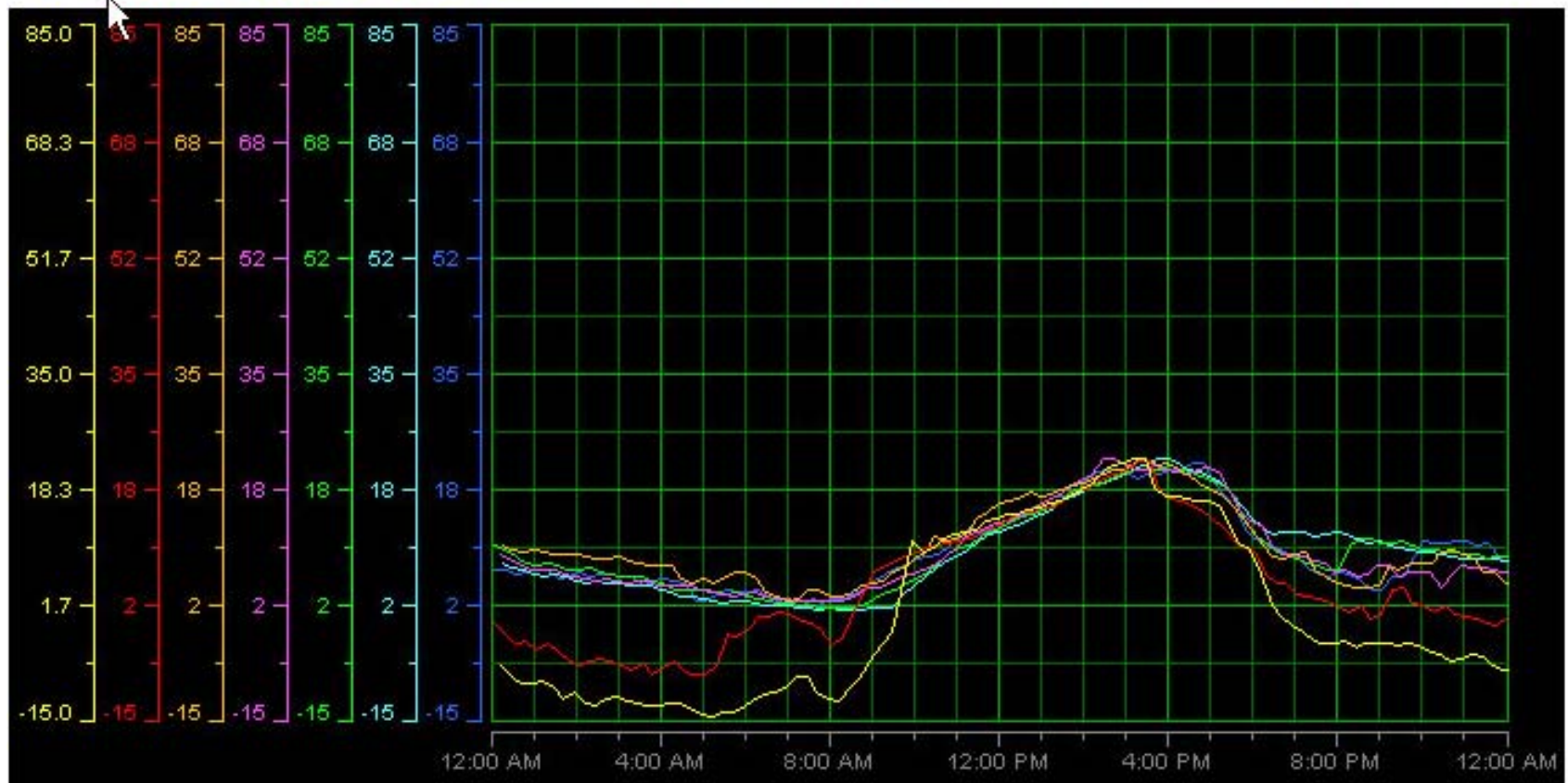


www.rmavv.org/weatherstations/cave-weather-station-network

How important is micro-climate?

/2007 CSU Database, start 1 Oct 2006/Public/Temperatures from 7 sites

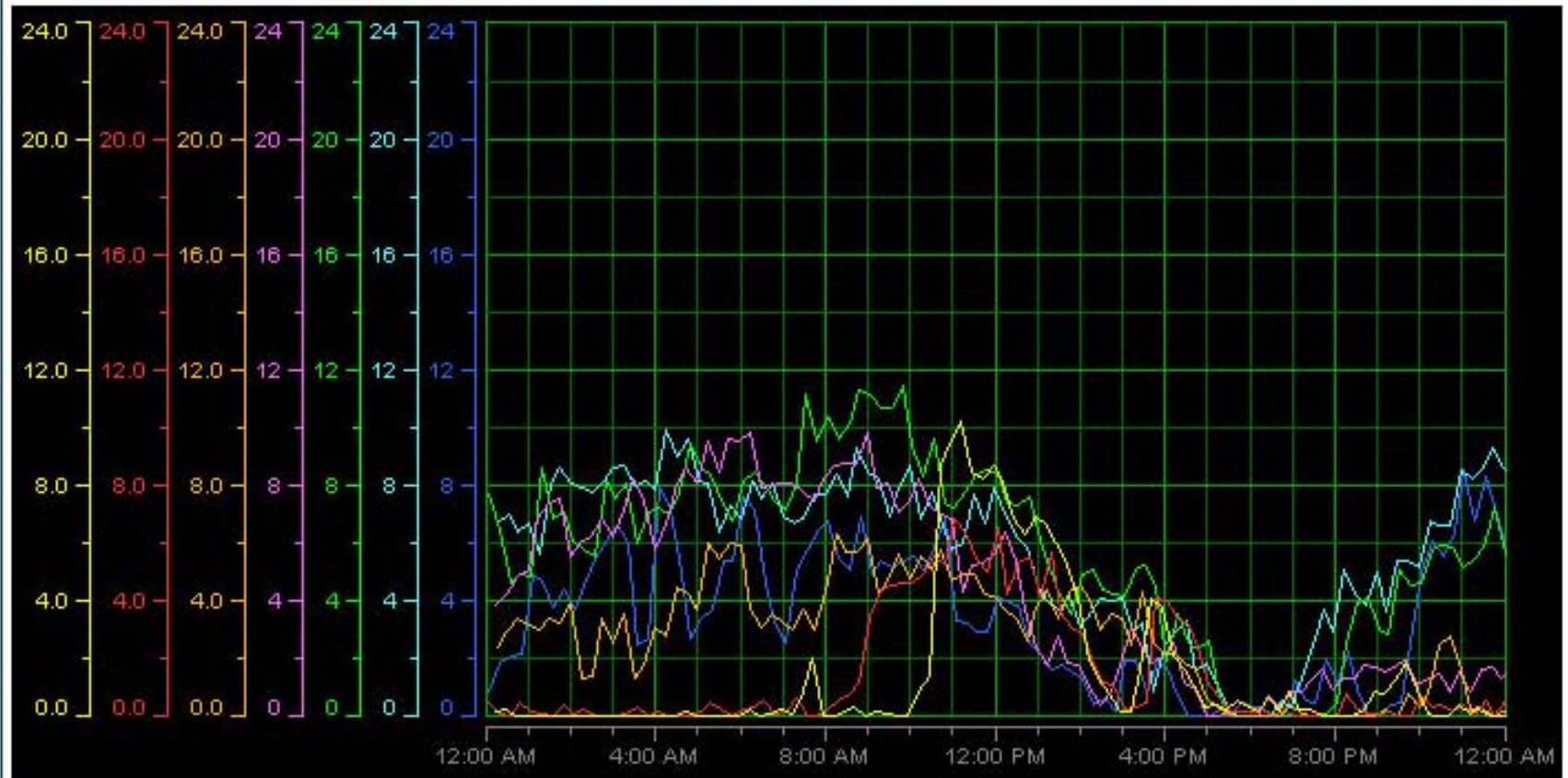
Navigation icons: Home, Previous, Next, Stop, Refresh, Print, and other controls. The date [Jan 15, 2007](#) is displayed.



How important is micro-climate?

/2007 CSU Database, start 1 Oct 2006/Public/Wind profiles from 7 sites

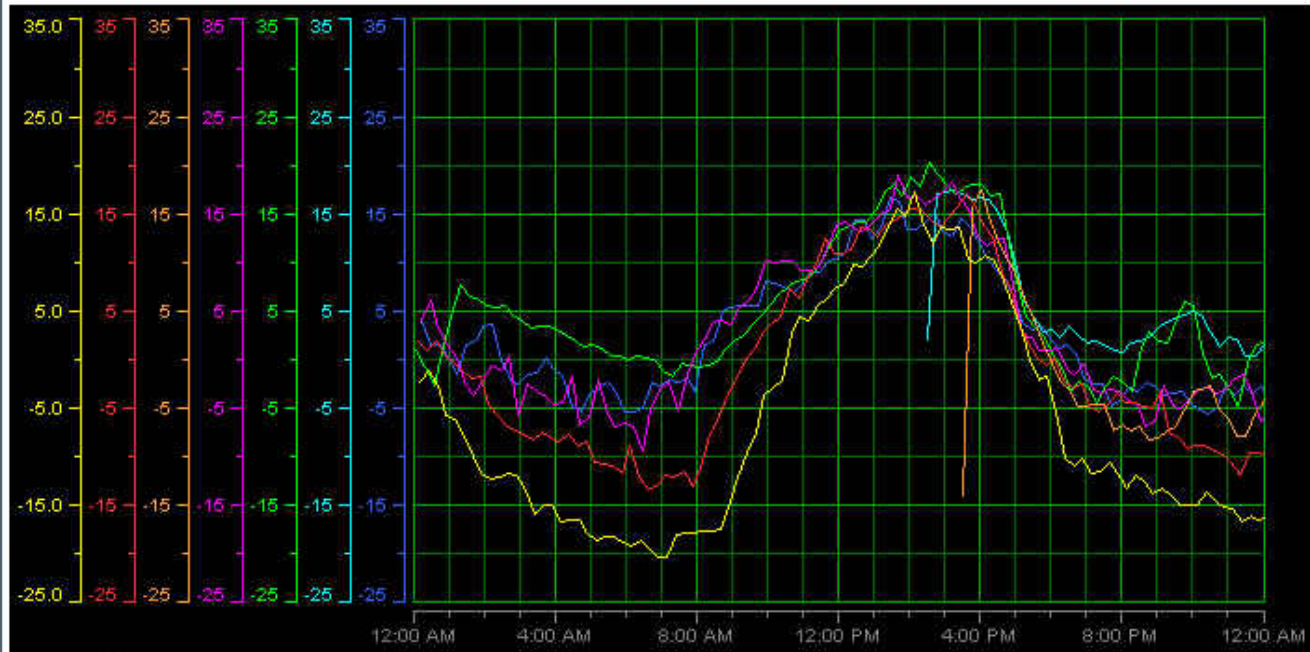
⏪ ⏴ ⏵ ⏩ [Jan 15, 2007](#) 📅 📅 📅 📅 📅 📅 📅 📅



CAVE weather station network

- ▼ Public
 - ▶ 17365 - CSU Block 10
 - ▶ 18154 - CSU Tower
 - ▶ 19199 - Riverview
 - ▶ 25468 - Two Rivers Redlands
 - ▶ 25480 - Lovie's
 - ▶ 25492 - Grand Junction West
 - ▶ 40182 - Garfield
 - ▶ 41542 - Canyon Wind
 - ▶ [Inversion Monitor](#)
 - ▶ [Temperatures from 7 sites](#)
 - ▶ [Wind profiles from 7 sites](#)

⏪ ⏴ ⏵ ⏩ [Dec 9, 2009](#) ▶ ▶▶ ▶▶▶ ▶▶▶▶ ▶▶▶▶▶ ▶▶▶▶▶▶ ▶▶▶▶▶▶▶ ▶▶▶▶▶▶▶▶ ▶▶▶▶▶▶▶▶▶ ▶▶▶▶▶▶▶▶▶▶ ▶▶▶▶▶▶▶▶▶▶▶ ▶▶▶▶▶▶▶▶▶▶▶▶



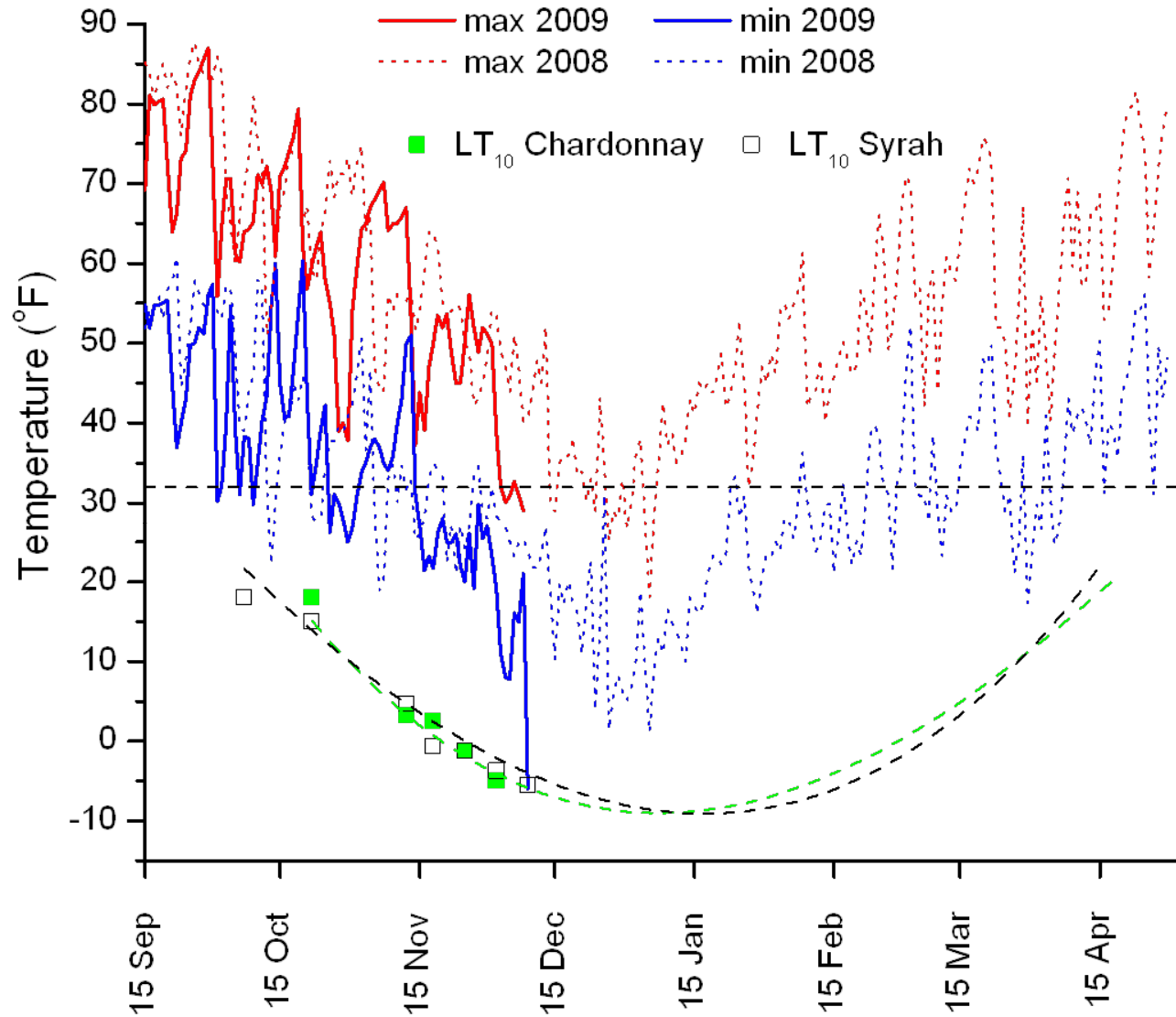
Legend:

Color	Name	Last Value
■	/CSU 2010 database, start 1 Oct 2009/Public/17365 - CSU Block 10/17365 - CSU Block 10/Temperature (°F)	33.2 °F at Feb 15, 2010 11:33:05 AM
■	/CSU 2010 database, start 1 Oct 2009/Public/41542 - Canyon Wind/41542 - Canyon Wind/Temperature (°F)	35.1 °F at Feb 14, 2010 7:00:00 PM
■	/CSU 2010 database, start 1 Oct 2009/Public/19199 - Riverview/19199 - Riverview/Temperature (°F)	31.4 °F at Feb 15, 2010 11:34:32 AM
■	/CSU 2010 database, start 1 Oct 2009/Public/25480 - Lovie's/25480 - Lovie's/Temperature (°F)	31.6 °F at Feb 15, 2010 11:41:40 AM
■	/CSU 2010 database, start 1 Oct 2009/Public/40182 - Garfield /40182 - Garfield /Temperature (°F)	35.0 °F at Feb 15, 2010 11:45:00 AM
■	/CSU 2010 database, start 1 Oct 2009/Public/25468 - Two Rivers Redlands/25468 - Two Rivers Redlands/Temperature (°F)	33.7 °F at Feb 15, 2010 11:39:00 AM
■	/CSU 2010 database, start 1 Oct 2009/Public/18154 - CSU Tower/18154 - CSU Tower/Temperature (°F)	33.2 °F at Feb 15, 2010 11:33:05 AM

CAVE weather station network



Grape vine bud cold hardiness



Dead primary bud



Percentage of dead **primary** buds as affected by temperature.

Variety	Date	Field sample	0°F	-5°F	-10°F	-15°F
Chardonnay	2 Dec 2009	0	10	10	95	
Chardonnay	9 Dec 2009	4		25 ¹	70	100
Syrah	2 Dec 2009	0	0	15	90	
Syrah	9 Dec 2009	15		5 ¹	70	100

¹ Samples were taken on the morning of 9 Dec 2009. The overnight (8-9 Dec 2009) minimum temperatures in our vineyards ranged from -5.5 F to -10 F.

Caspari and Montano, 2009

Dead bud



Percentage of dead (primary, secondary & tertiary killed) buds as affected by temperature.

Variety	Date	Field sample	0°F	-5°F	-10°F	-15°F
Chardonnay	2 Dec 2009	0	5	5	95	
Chardonnay	9 Dec 2009	0		0 ¹	55	100
Syrah	2 Dec 2009	0	0	0	90	
Syrah	9 Dec 2009	0		0 ¹	45	95

¹ Samples were taken on the morning of 9 Dec 2009. The overnight (8-9 Dec 2009) minimum temperatures in our vineyards ranged from -5.5 F to -10 F.

Caspari and Montano, 2009

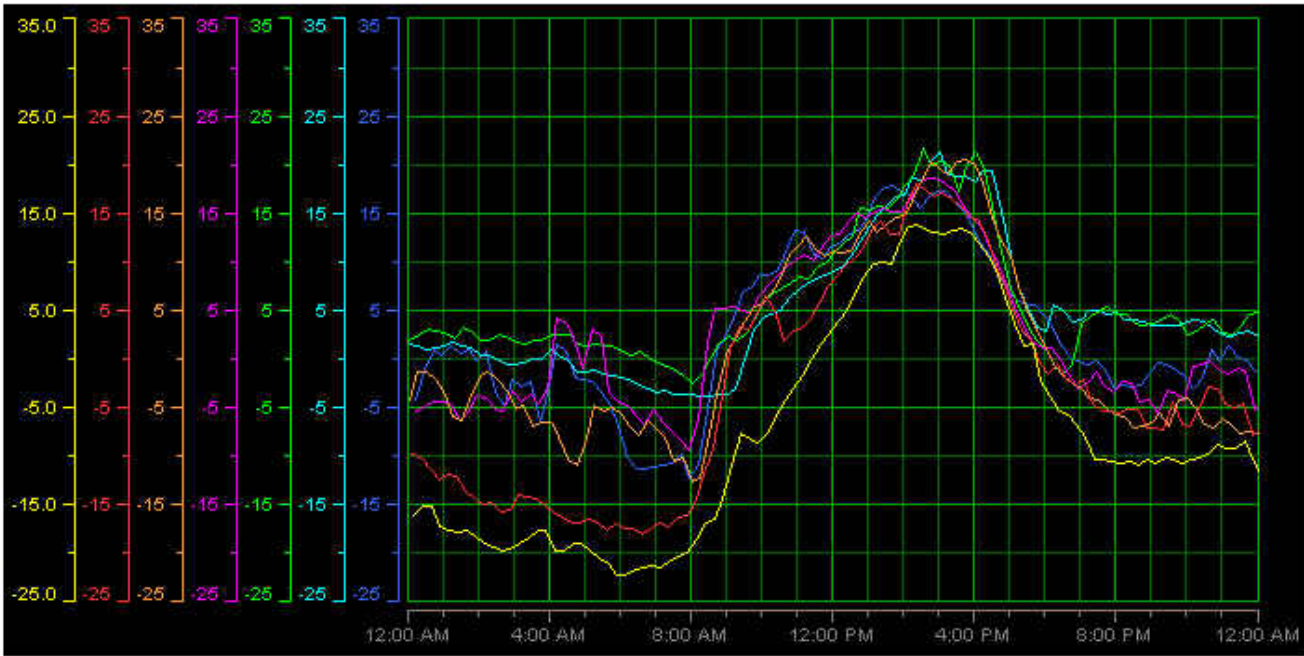
CAVE weather station network

Logout

- ▼ /CSU 2010 database, start 1 Oct 2009
 - ▼ Public
 - ▶ 17365 - CSU Block 10
 - ▶ 18154 - CSU Tower
 - ▶ 19199 - Riverview
 - ▶ 25468 - Two Rivers Redlands
 - ▶ 25480 - Lovie's
 - ▶ 25492 - Grand Junction West
 - ▶ 40182 - Garfield
 - ▶ 41542 - Canyon Wind
 - [Inversion Monitor](#)
 - [Temperatures from 7 sites](#)
 - [Wind profiles from 7 sites](#)

/CSU 2010 database, start 1 Oct 2009/Public/Temperatures from 7 sites

Navigation icons: Home, Back, Forward, Stop, Refresh, Print, Zoom in, Zoom out, Full screen, Help. Date: [Dec 10, 2009](#)



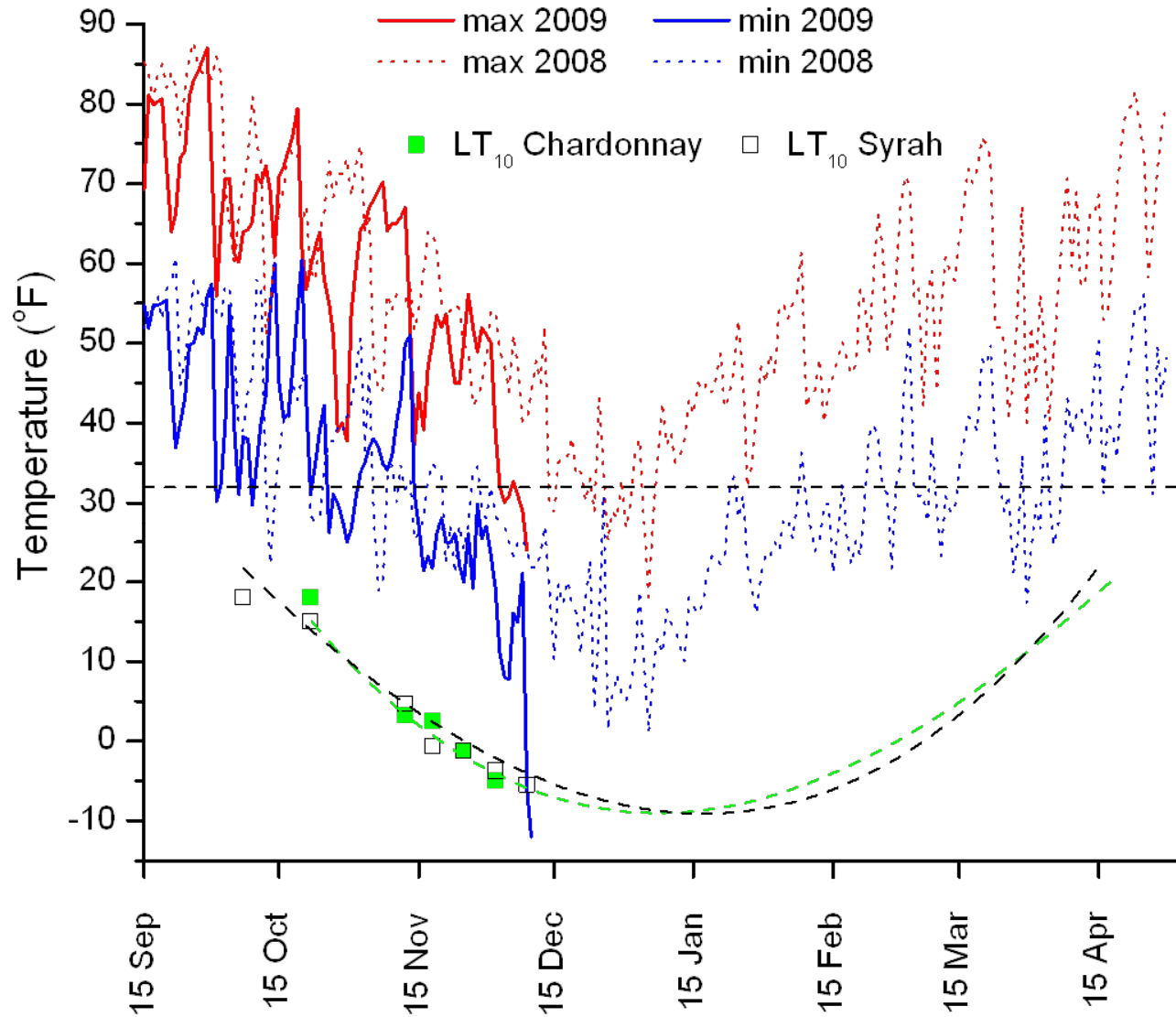
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■	/CSU 2010 database, start 1 Oct 2009/Public/17365 - CSU Block 10/17365 - CSU Block 10/Temperature (°F)	33.2 °F at Feb 15, 2010 11:33:05 AM
■	/CSU 2010 database, start 1 Oct 2009/Public/41542 - Canyon Wind/41542 - Canyon Wind/Temperature (°F)	35.1 °F at Feb 14, 2010 7:00:00 PM
■	/CSU 2010 database, start 1 Oct 2009/Public/19199 - Riverview/19199 - Riverview/Temperature (°F)	31.4 °F at Feb 15, 2010 11:34:32 AM

CAVE weather station network



Grape vine bud cold hardiness



Percentage of dead **primary** buds after an overnight low of -13 F to -16 F (9-10 Dec, 2009).

Variety	Date	Field sample
Chardonnay	10 Dec 2009	81
Syrah (North)	10 Dec 2009	97
Syrah (South)	10 Dec 2009	92

Samples were taken on the morning of 10 Dec 2009. Bud damage was assessed after keeping samples at 70 F for a minimum of 24 hours.

Caspari and Montano, 2009

Percentage of dead buds after an over-night low of -13 F to -16 F (9-10 Dec, 2009).

Variety	Date	Field sample
Chardonnay	10 Dec 2009	40
Syrah (North)	10 Dec 2009	70
Syrah (South)	10 Dec 2009	47

Samples were taken on the morning of 10 Dec 2009. Bud damage was assessed after keeping samples at 70 F for a minimum of 24 hours.

Caspari and Montano, 2009

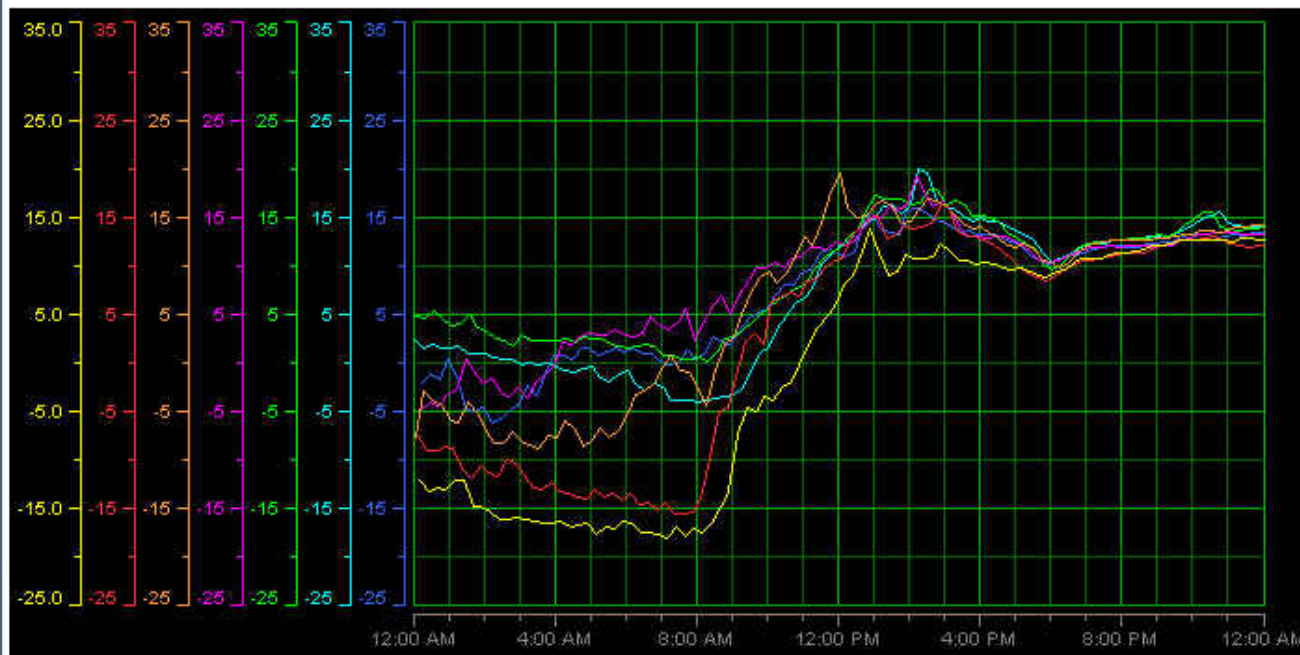
CAVE weather station network

Logout

- ▼ CSU 2010 database, start 1 Oct 2009
 - ▼ Public
 - ▶ 17365 - CSU Block 10
 - ▶ 18154 - CSU Tower
 - ▶ 19199 - Riverview
 - ▶ 25468 - Two Rivers Redlands
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 - ▶ 41542 - Canyon Wind
 - ▶ [Inversion Monitor](#)
 - ▶ [Temperatures from 7 sites](#)
 - ▶ [Wind profiles from 7 sites](#)

/CSU 2010 database, start 1 Oct 2009/Public/Temperatures from 7 sites

Dec 11, 2009



Legend:

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■	/CSU 2010 database, start 1 Oct 2009/Public/41542 - Canyon Wind/41542 - Canyon Wind/Temperature (°F)	35.1 °F at Feb 14, 2010 7:00:00 PM
■	/CSU 2010 database, start 1 Oct 2009/Public/19199 - Riverview/19199 - Riverview/Temperature (°F)	31.4 °F at Feb 15, 2010 11:34:32 AM

CAVE weather station network



Percentage of dead **primary** buds after over-night lows of -6 F, -13 F, and -6 F (9-11 Dec, 2009).

Variety	Date	Field sample
Syrah (high cordon, South)	15 Dec 2009	97

Samples were taken on the morning of 15 Dec 2009. Bud damage was assessed after keeping samples at 70 F for a minimum of 24 hours.

Caspari and Montano, 2009

Percentage of dead buds after over-night lows of -6 F, -13 F, and -6 F (9-11 Dec, 2009).

Variety	Date	Field sample
Syrah (high cordon, South)	15 Dec 2009	72

Samples were taken on the morning of 15 Dec 2009. Bud damage was assessed after keeping samples at 70 F for a minimum of 24 hours.

Caspari and Montano, 2009

Cold injury in Mesa County

How much damage did we have in the Grand Valley?

Cold injury in Mesa County

First estimate done shortly after the December cold event was **>25 % crop loss.**

However, by February 2010 we have looked at many different sites and have heard back from many growers.

Estimate at that time was **~50 % crop loss, and possibly more.**

Actual 2010 yield in the Grand Valley AVA was down **59 %** on 2009.

Cold injury in Mesa County

Where did we have bud/vine damage in the Grand Valley?

Minimum temperatures, Dec 9-11



Cold injury in Mesa County

Initial assessment:

Anything West of Sink Creek (~34 Rd) and vineyards on the valley floor West of Palisade have near 100 % crop loss.

The area to the East of Sink Creek (East Orchard Mesa) and the Vinelands might be ok.

Cold injury in Mesa County

Actual assessment:

Anything West of 35 ½ or 36 Rd and vineyards on the valley floor West of Palisade had near 100 % crop loss.

There were vineyards with substantial damage in the eastern part of East Orchard Mesa and also in the Vinelands.

Cold injury in Mesa County

Why did we have bud damage in the eastern part of the Grand Valley when the minimum temperatures recorded were >-5 F?

Cold injury in Mesa County

Why did we have bud damage in the eastern part of the Grand Valley when the minimum temperatures recorded were >-5 F?

Three possibilities (and combinations thereof):

A – cold-sensitive varieties

B – insufficient acclimation

C – it was actually colder than -5 F

Cold injury in Mesa County

C – it was colder than -5 F

Case study: Riverview Vineyard

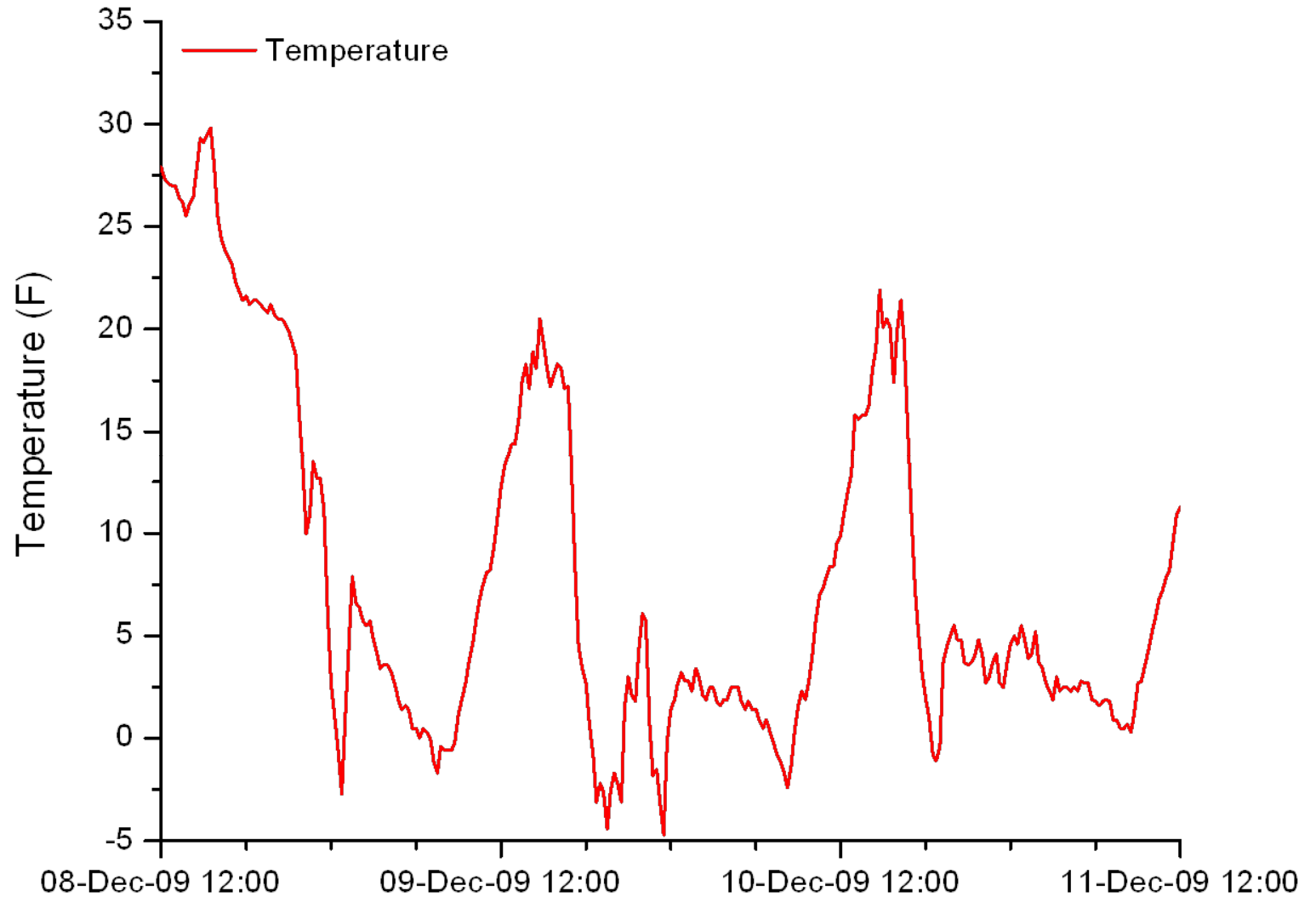
Minimum temperatures: -2.7 F, -4.7 F, -4.0 F

Strong wind throughout the nights (= no inversion)

Expected: Little to no bud damage

Reality: Almost 100 % damage to Chardonnay and Merlot in low spots, yet little to no damage on high ground

CAVE weather station at Riverview vineyard



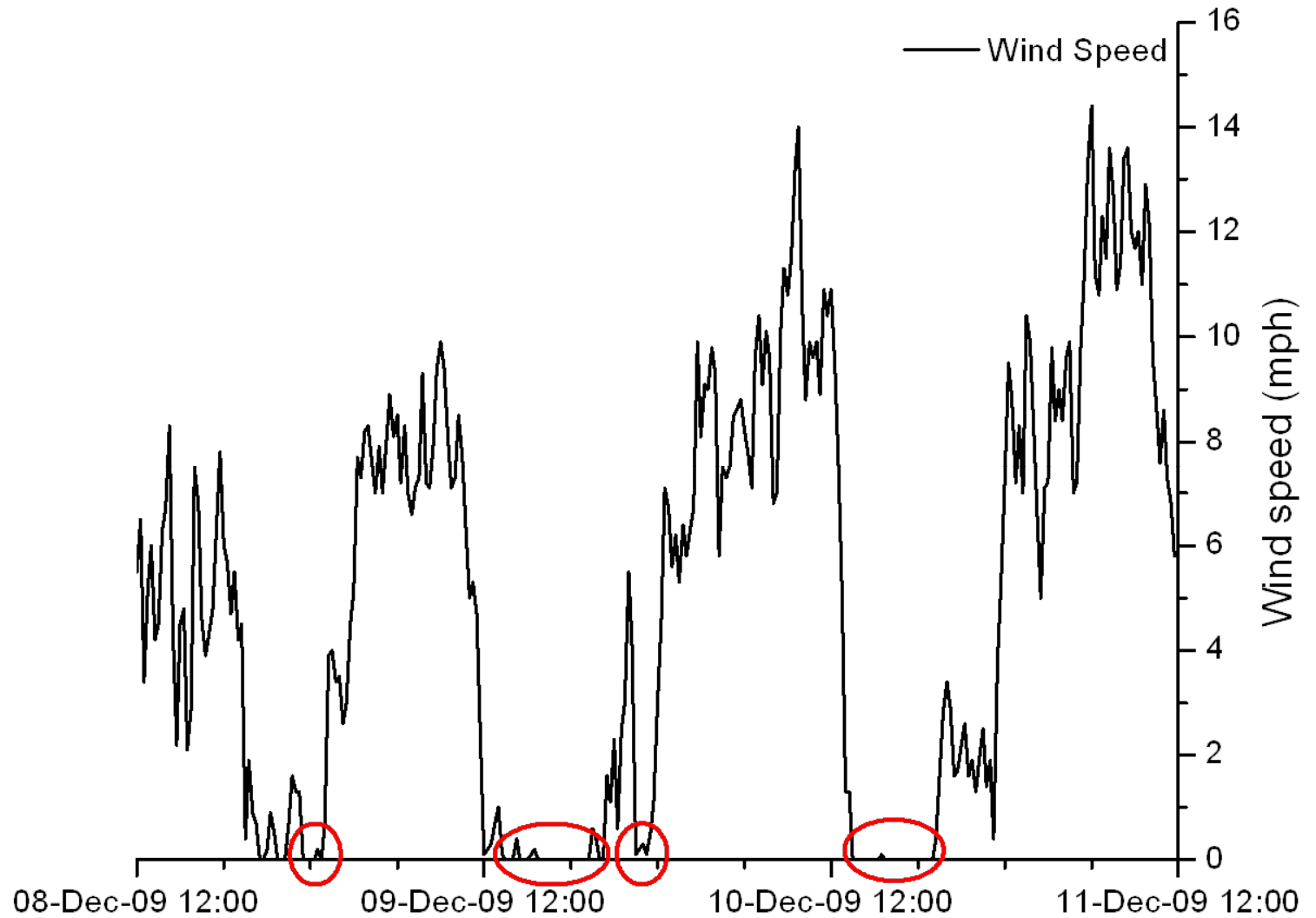
Cold injury in Mesa County

Case study: Riverview Vineyard

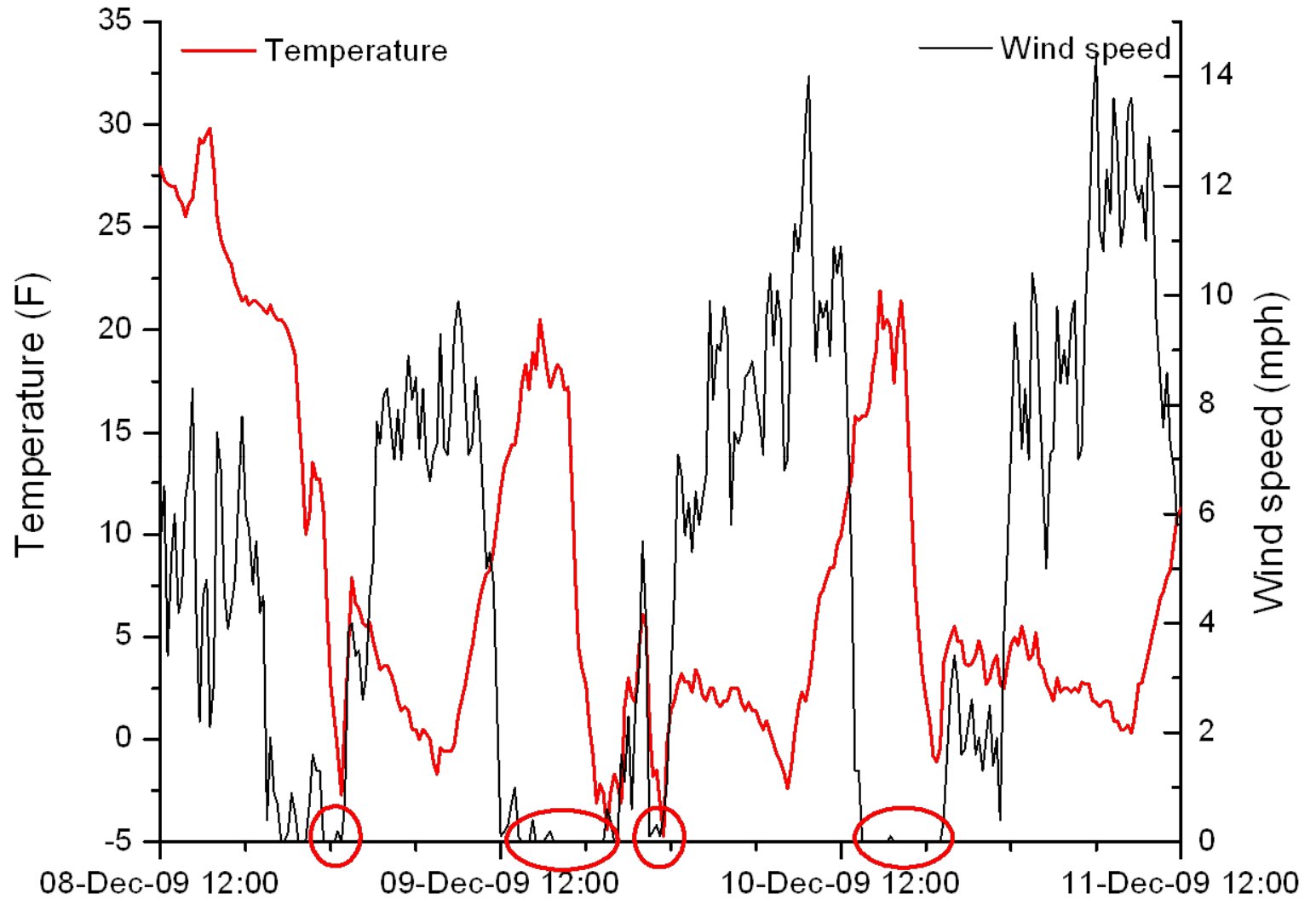
While it was windy most of the time, there were four periods of no wind during Dec 8-11, resulting in very rapid drops in temperatures and the formation of temperature inversions.

It is **VERY** likely that during each of those periods the temperatures in the low spots differed significantly from those recorded by the weather station.

CAVE weather station at Riverview vineyard



CAVE weather station at Riverview vineyard





Riverview



▲Temp logger

F 1/4 Rd

37-1/4 Rd

Image © 2010 DigitalGlobe

©2009 Google

© 2010 Google

39°05'44.69" N 108°21'48.73" W elev 4778 ft

Eye alt 6478 ft







Riverview



Temp logger

37-1/4 Rd

N

Image © 2010 DigitalGlobe

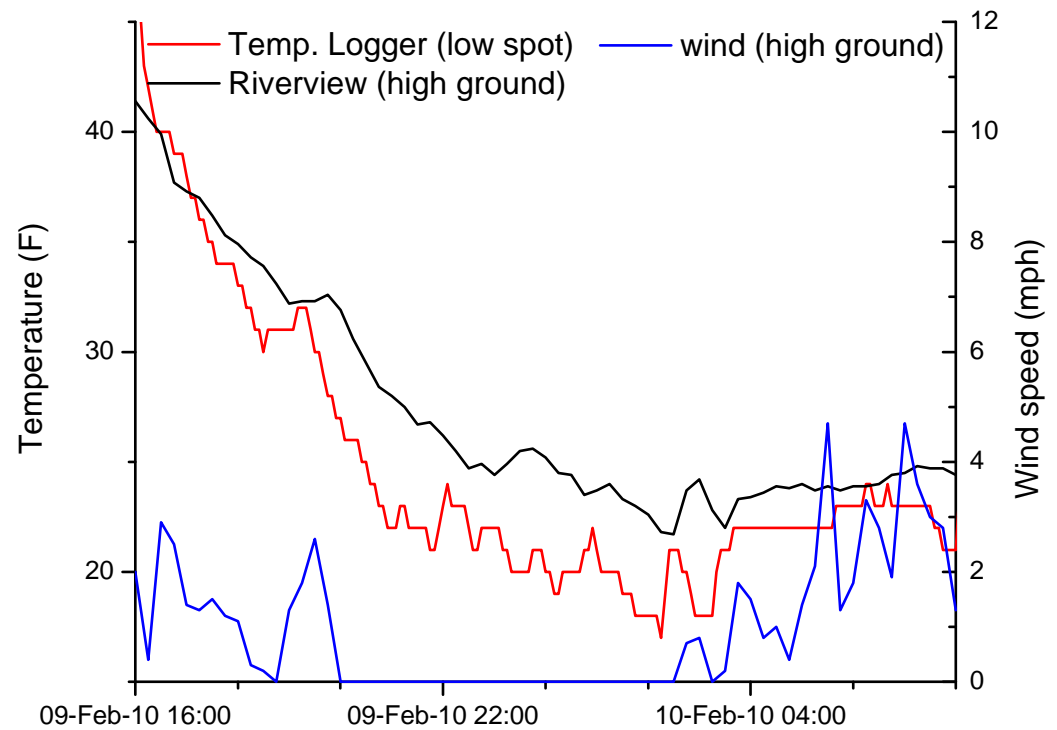
2005 Google

© 2010 Google

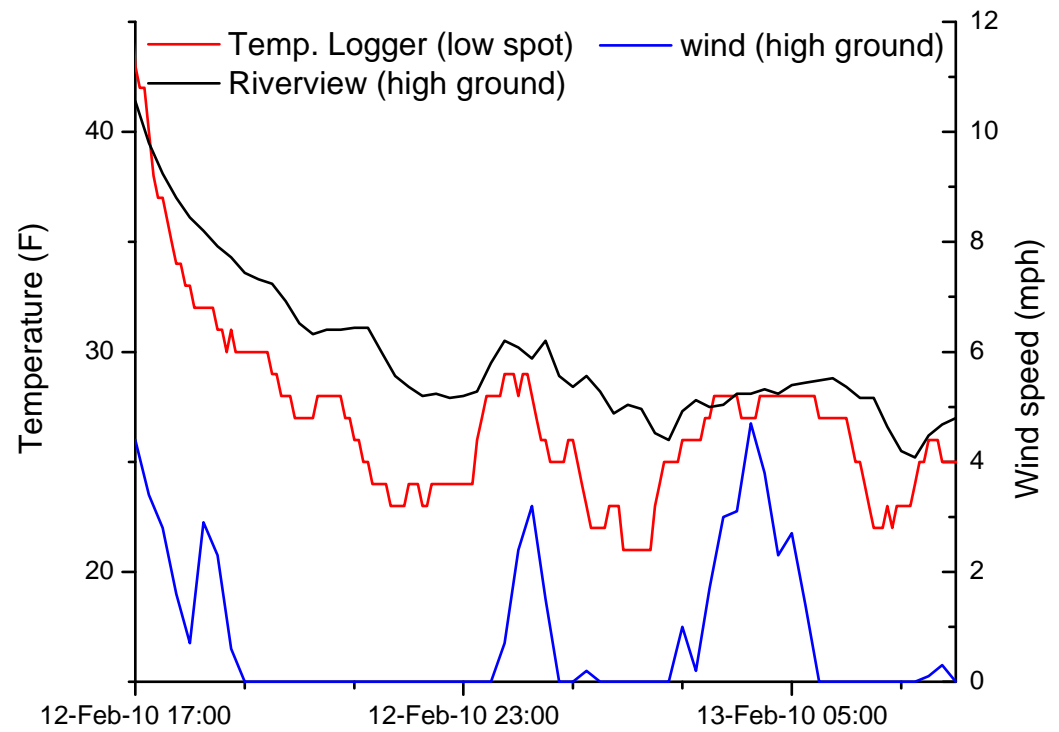
Imagery Date: May 16, 2006

39°05'50.58" N 108°21'50.67" W elev 4724 ft

Eye alt 8046 ft



Imagery Date: May 16, 2006



Imagery Date: May 16, 2006





Cold injury in Mesa County

Summary:

Crop losses were substantial in the Grand Valley AVA.

Crop losses were near 100 % in the western part of the AVA, and >50 % overall.

Surprisingly, there were also substantial crop losses in vineyards in the eastern part of the AVA.

In many vineyards we found a strong influence of topography on bud damage, suggesting pronounced temperature differences between “high” and “low” ground.

Cold injury in Mesa County

Summary:

These differences in bud damage are the result of brief periods with no or low wind speeds, causing strong temperature inversions.

In many vineyards in the eastern part of the AVA damage could have been reduced, if not eliminated, through the use of wind machines.

Cold injury in Mesa County

Lessons learned:

- 1. Wind machines should be operational during winter (I suggest to have them operational by late September to protect from early fall freezes).**
- 2. Know the topography of your vineyard and understand its impact on temperature.**
- 3. Locate your frost alarm sensors in the areas you want to protect.**
- 4. Know the threshold temperatures for cold injury, and set/update your frost alarms accordingly.**

Thank you for your attention

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Ph: (970) 434-3264
<http://www.colostate.edu/programs/wcrc/pubs/viticulture/viticulturehome.htm>