



# Weather & Frost in Wine Country

An overview discussion of weather patterns and climate and their influence on frost risk.



A photograph of a weather station in a vineyard. The station is a tall metal pole with various instruments: a wind speed and direction sensor at the top, a radiation shield with a sensor, and a Campbell 215 weather station controller. The background shows rows of grapevines in a valley under a cloudy sky.

# Western Weather Group

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- Weather Instrumentation
- Ag-Weather Forecasting
- Meteorological Consultation





## Covered Topics

- **Commonly discussed weather “scenarios” and their effects**
- **Regional weather patterns and synopsis**
- **Noticeable trends being observed across wine country**
- **Meteorological/Geographical factors that influence frost risk**
- **Causes of frost and what is used to forecast for it**





# Definitions

- **Frost** - Thin ice crystals that form on the ground and objects. Develops when temperatures drop to or below freezing and reach their dew point.
- **Freeze** – Term used to describe when air temperatures drop below freezing (32 degrees Fahrenheit). Can freeze without the formation of frost
- **Hard Freeze** – When air temperatures drop below 28 degrees.

Source(National Weather Service)





## Commonly Discussed Weather Scenarios and Relation to Frost Potential

- Resilient Ridging
- Persistent Troughing Patterns
- Gulf of Alaska Storm Systems
- Atmospheric Rivers
- Inside Sliders

# Resilient Ridging

- When high pressure lingers around for multiple weeks, sometimes months.
- Nicknamed the “Triple-R” or “RRR” (Ridiculously Resilient Ridge).
- Prolonged RRR’s were responsible for 2012-2015 drought.
- Similar dry periods February 2020, mid-January 2021, January & early February 2022.





# Resilient Ridging

- Persistent ridging can bring much drier air into a region
- Can cut-off or remove marine layer and onshore flow influence, creating significantly lower dewpoints
- Can create periods of potential freezing conditions in the evening in Northern California during colder months.



# Persistent Troughing Patterns

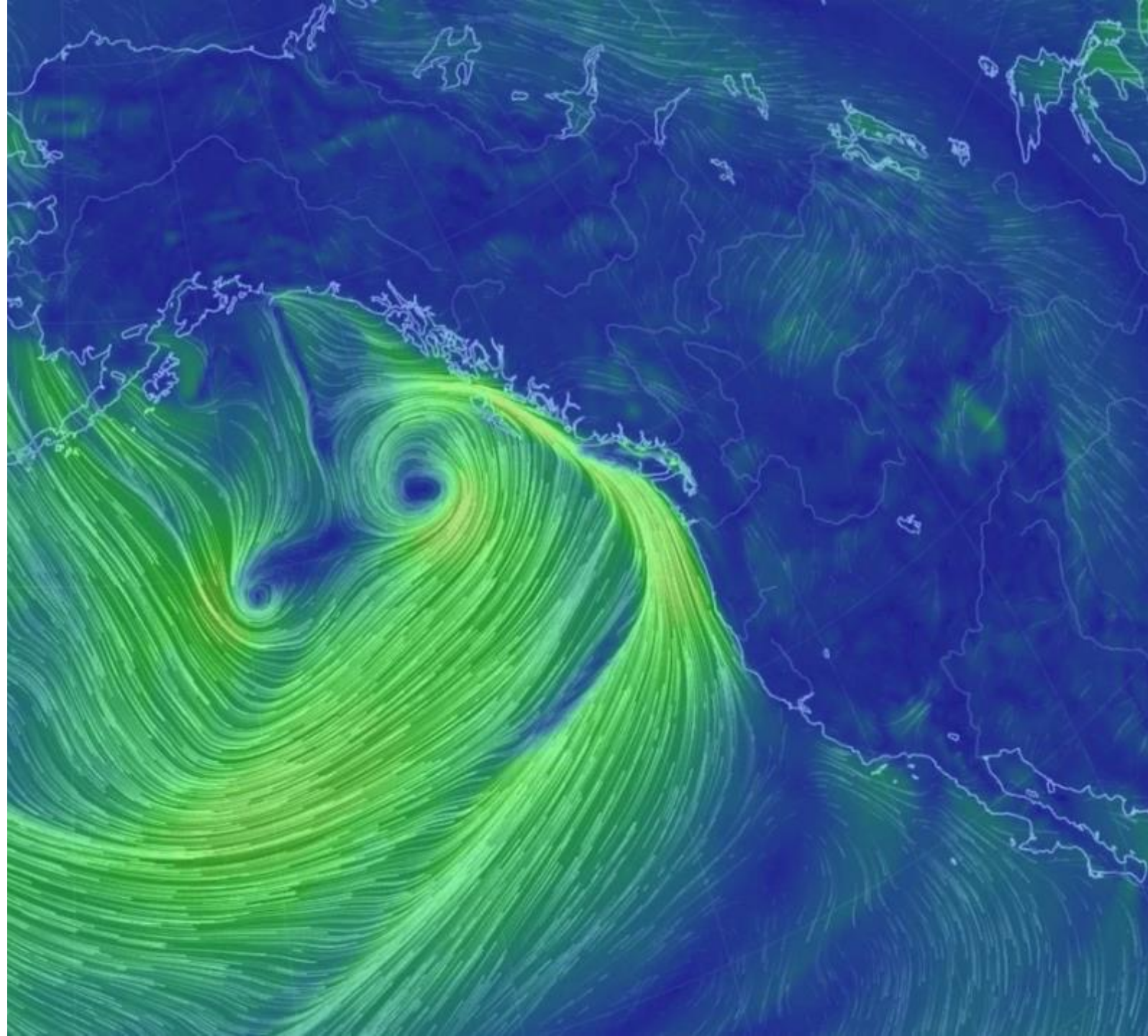
- Prolonged active storm pattern (incoming storms every 2-4 days).
- Jet stream becomes more “wavy” in nature allowing consecutive storms to follow similar tracks for a few to several weeks at a time.
- Can bring a continuous supply of cold air
- Tends to result in wetter and cooler than normal months (much like November 2022).





# Gulf of Alaska Storm Systems

- Usually wet and cold.
- Originate in the Gulf of Alaska.
- Occasionally move through in multiple parts.
- Can be accompanied by, or follow, atmospheric river events.
- “Drying out” that occurs after these storms can lead to periods of frost due to remnant moisture and colder airmass



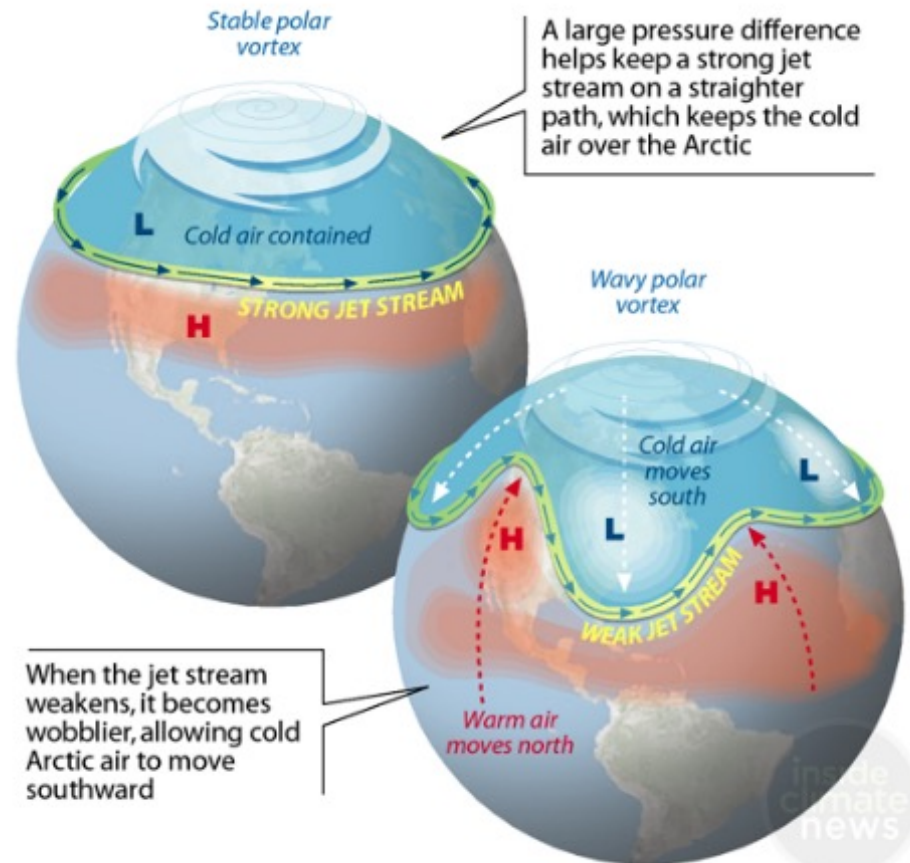


# Wavy Jet Stream Modification

- Accelerated polar warming weakens the jet stream but causes dramatic fluctuations in strength.
- A weaker jet stream becomes wavier which reduces the ability for features like troughs and ridges to progress down stream.
- More prolonged active storm patterns and more prolonged dry spells.
- Extended wet/dry periods are highly dependent on the type of feature (ridging or troughing) initially in place.
  - More or less luck of the draw

## Polar Vortex Explained

The polar vortex is a large area of low pressure and cold air over Earth's North and South Poles. When the jet stream weakens, it becomes wavier, allowing that cold air to dip southward in places while warmer air pushes northward elsewhere.



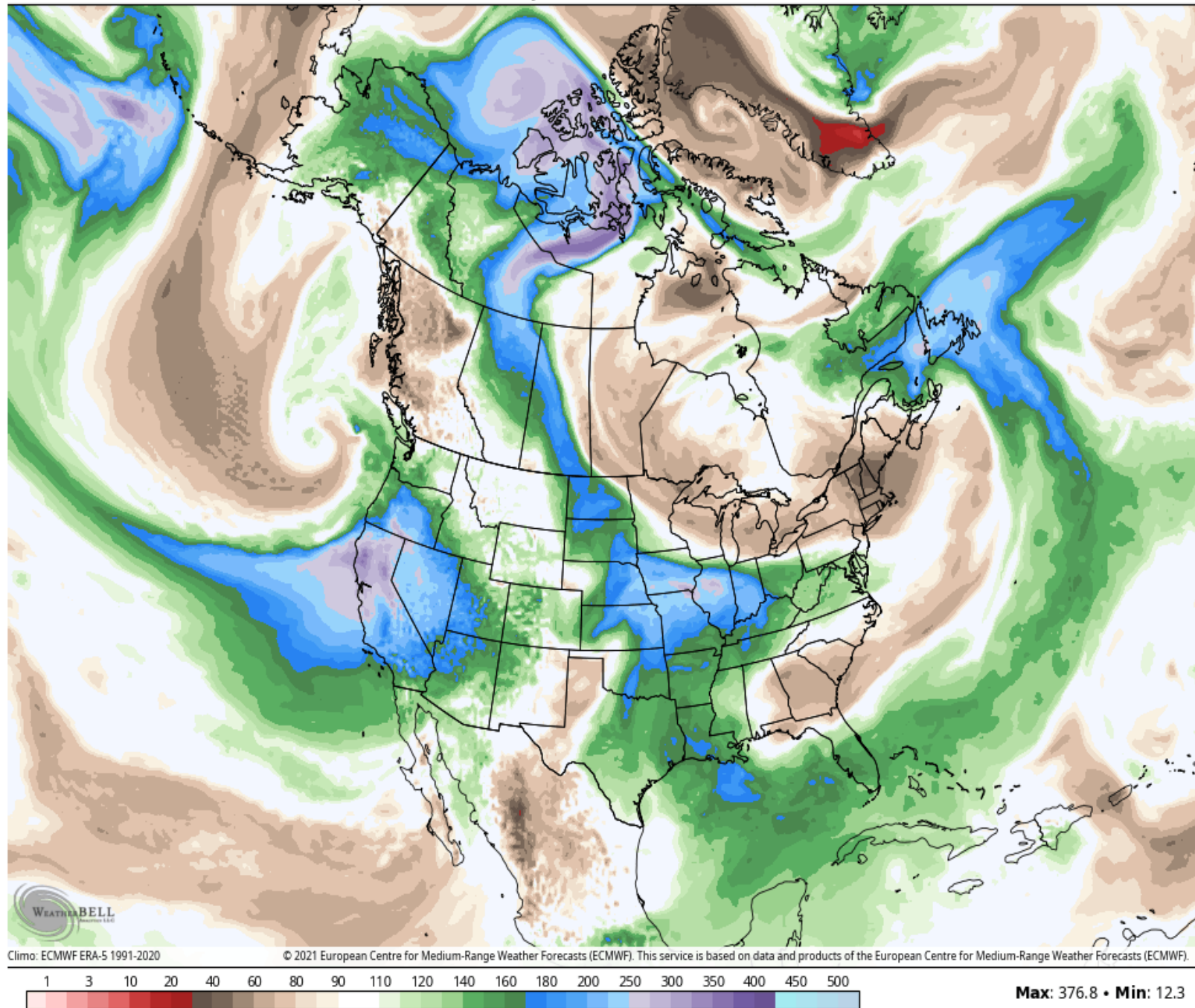
SOURCES: NOAA; *Scientific American*

PAUL HORN / InsideClimate News



# Atmospheric Rivers

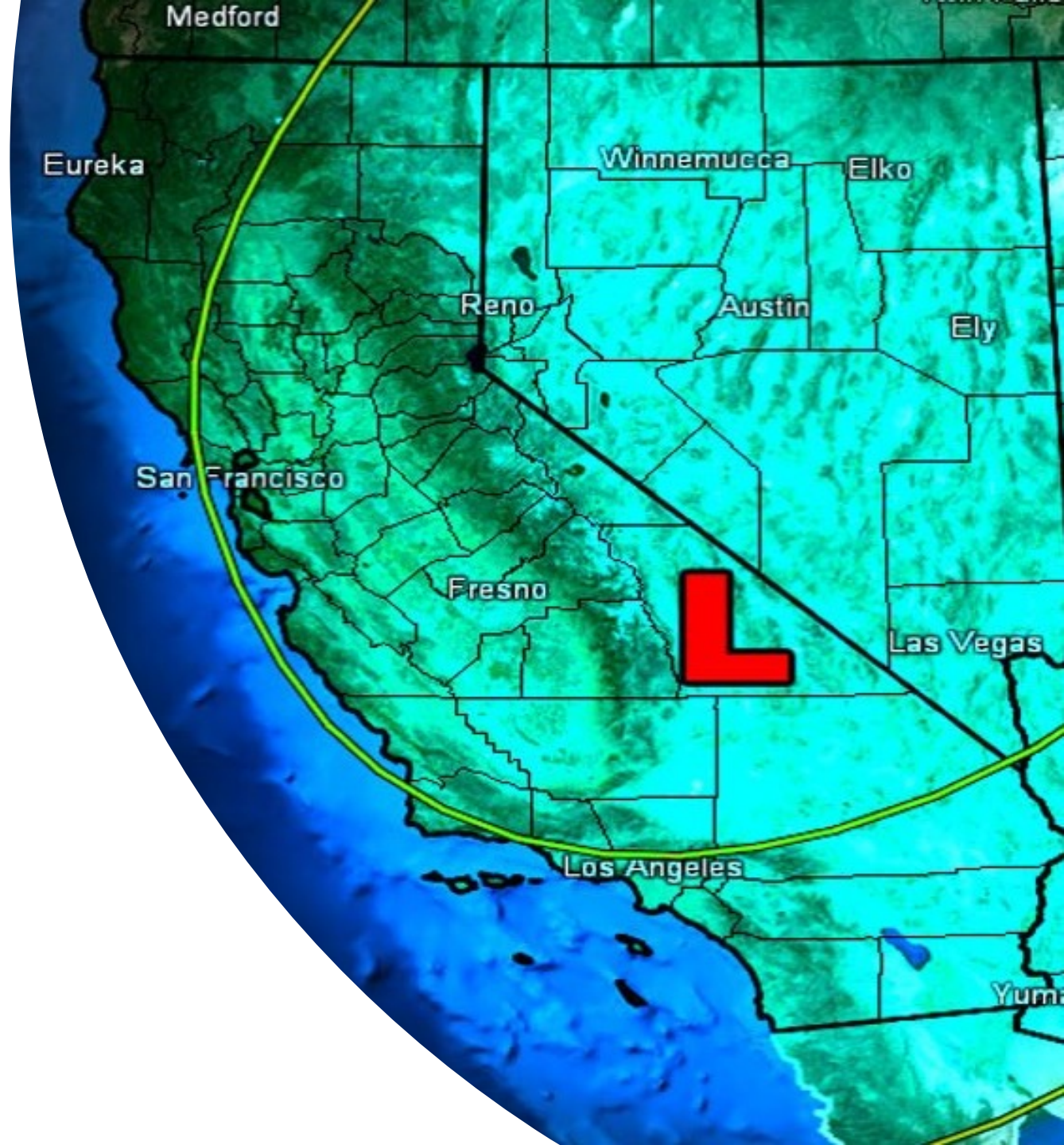
- Long trains of tropical moisture, that fall as rain (or high elevation snow) after being lifted over the mountain ranges (Coastal, Sierra)
- Very wet and mild temperatures with high snow levels.
- Provides northern California with about 40% of its annual rainfall.
- Can last multiple days and produce torrential rainfall.
- Warmer ocean temperatures may increase frequency and intensity.
- Ex: October 2021→





# Inside Sliders

- Usually cold and dry, during winter and spring.
- Rarely produce precipitation, but when they do, snow levels are very low (1500-2500 feet)
- Generate breezy north/offshore winds.
- Occasionally responsible for Diablo winds during the fall.
- Low relative humidity can increase frost risk during the spring, especially once winds relax.





# Trends Observed in the North State

- Less progressive weather patterns (i.e. slower moving or stagnant low and high pressure systems)
- Increased number of extreme rainfall events (2"-3"+ over 24 hours)
- Longer summers/growing seasons with delayed or short wet seasons
- Longer wildfire seasons
- Prolonged cyclical droughts
- Widely varying seasonal rainfall from one year to another



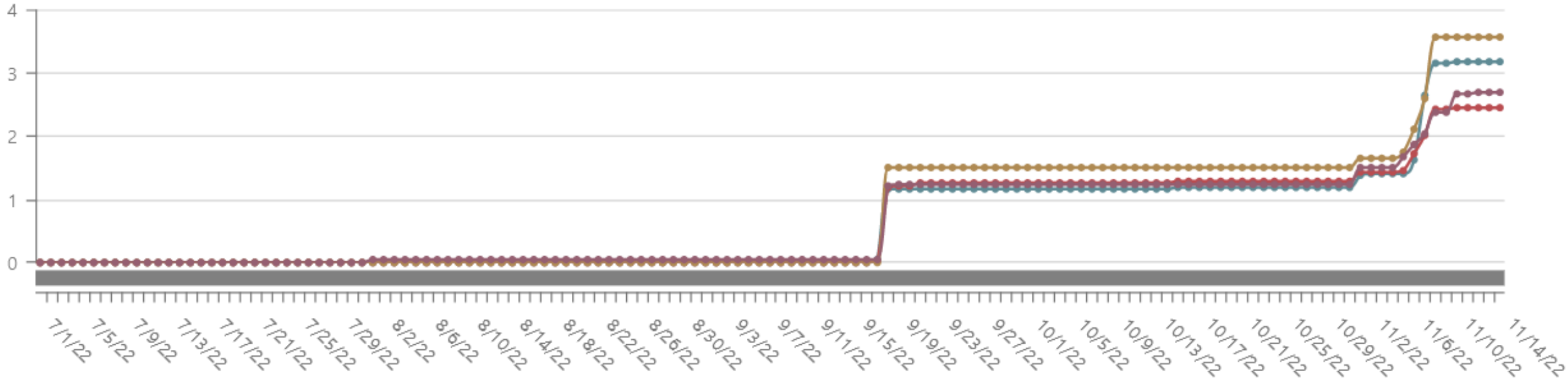


# Seasonal Rainfall (In)

7/1/2022 - 11/15/2022



Graton-South (Mill Station Rd)    Healdsburg-South (Sodini)    Geyserville (Ranch 3)    Kenwood (Wildwood)



Current 2022 Precipitation (since July 1<sup>st</sup>)

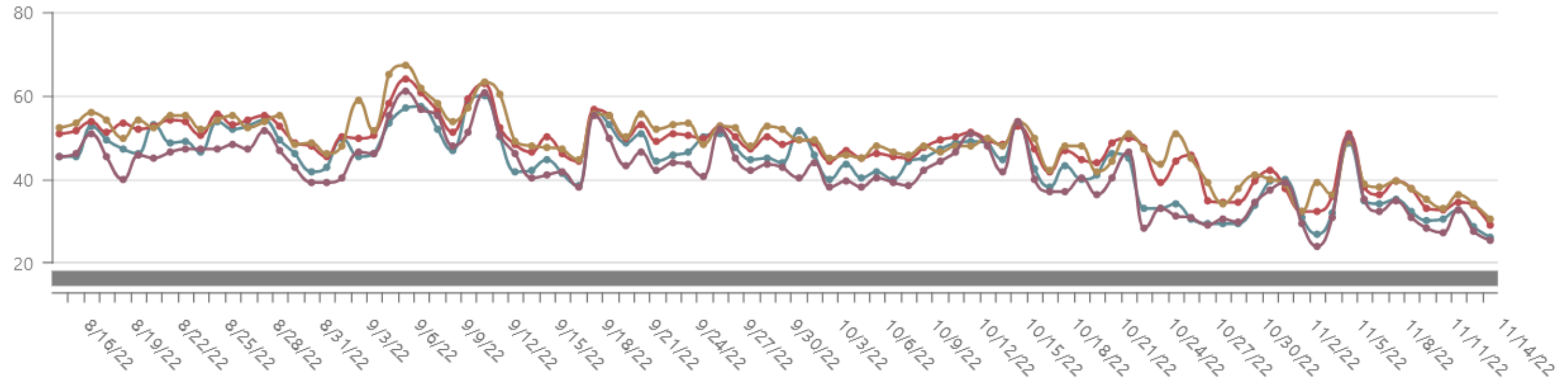


# Daily Minimum Temperature (°F)

8/15/2022 - 11/15/2022



Graton-South (Mill Station Rd)    Healdsburg-South (Sodini)    Geyserville (Ranch 3)    Lower Bennett Valley



## Minimum Temperatures (8/15-11/15/22)

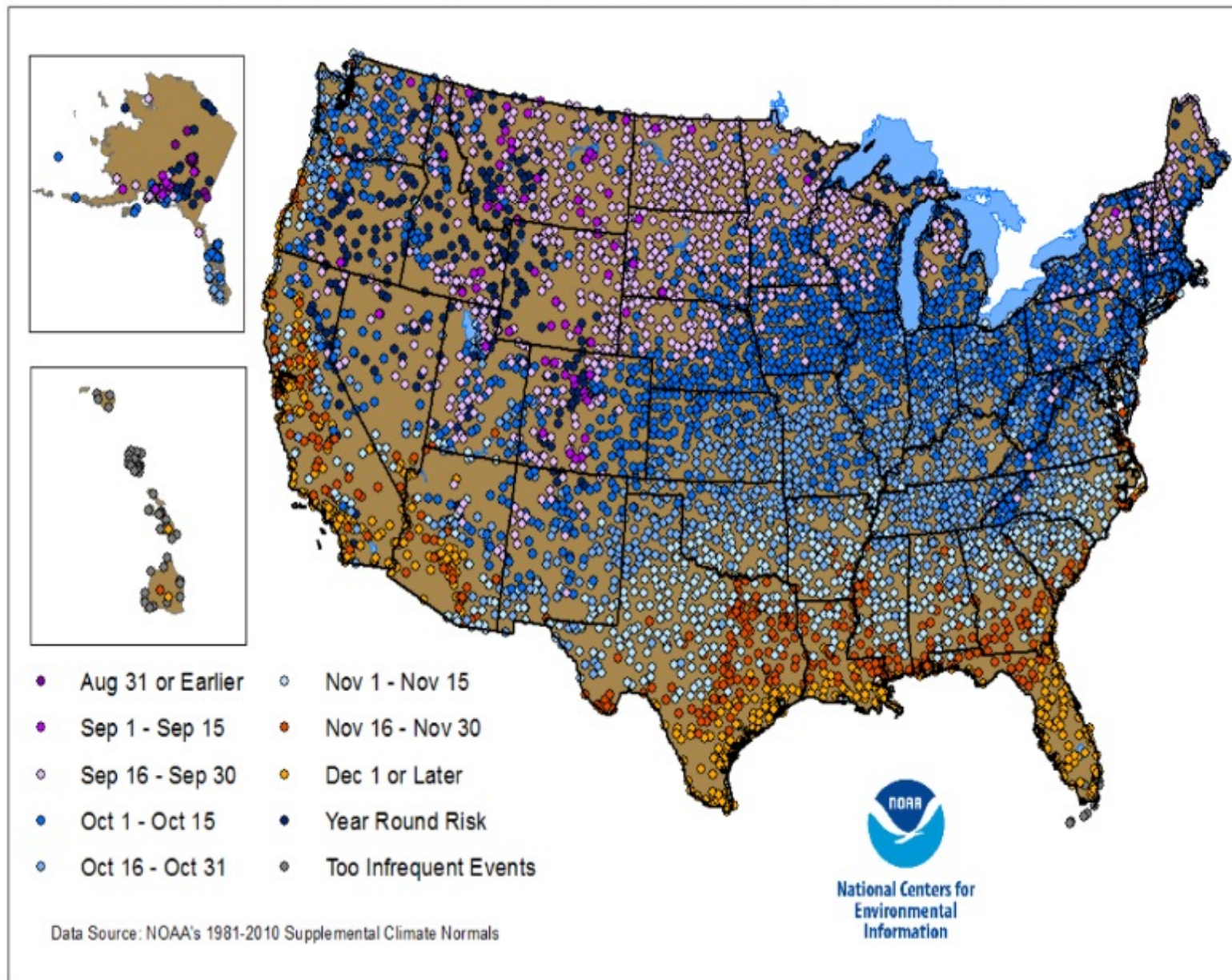
- Warmer than normal early September
- Primarily due to dominant high pressure
- Cold troughing pattern affecting the region has resulted in below normal temperatures more recently



# First signs of Frost

- First freeze tends to occur between October and November
- Source: NOAA National Centers for Environmental Information, Monthly National Climate Report for September 2019

Date by which 50% of years have experienced their first instance of  $\leq 32\text{F}$  temperatures





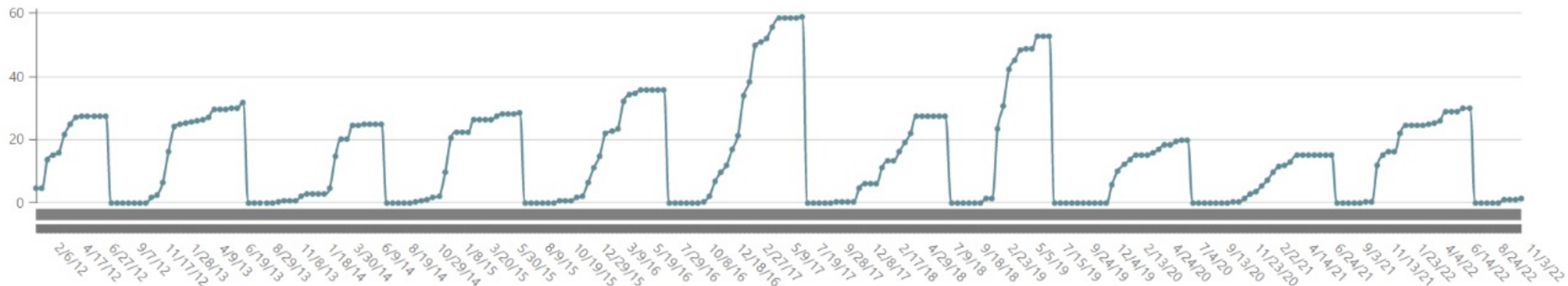
# Graton-South (Mill Station Rd)

1/1/2012 - 11/3/2022



Season Precip

10-year Avg: 32.20"



## 10-Year Annual Precipitation Trends

- Rainfall varies rather dramatically between wet and dry seasons due to less progressive weather patterns
- Much drier than normal (~50% 10-yr average) in 2020 & 2021
- Almost half of seasonal precipitation total in 2021 occurred from October 19th-25th (11.81")
- Much drier January and February left seasonal rain totals close to 10-year average

# What Causes Frost?

- **Clear Skies** – Leads to radiational cooling, allowing for surface heat to leave the surface into the atmosphere
- **Calm Winds** – Winds promote mixing in the atmosphere. Absence of this mixing allows layer of cold temperatures to develop at ground level
- **Local Topography** – Plays a large role in determining if and where frost can develop. Cold air will settle into valleys and low-lying areas since it is heavier than warmer air. Locations that are wind-sheltered can be more prone to frost.
- **Soil Moisture** - Moisture can delay cooling but is also necessary for the formation of frost vegetation and soil.







# Forecasting Frost

Saturday March 6, 2021 issued 2:30pm

**Highlights:** Colder tonight with some areas likely dropping below freezing. Similarly cold temperatures are expected tomorrow night.

**Frost Discussion:** Dry weather will move in tonight behind the exiting storm system. The cooler and drier airmass is expected to lead to noticeably colder lows throughout the area, and some places are expected to see lows below freezing tomorrow morning, especially in the central parts of the county. Temperatures likely remain cold tomorrow night as a similar airmass remains in place.

### SONOMA COUNTY FORECAST MINIMUM TEMPERATURES

Forecast minimums for key regional locations	Most Likely Minimum for tonight	Worst Case Scenario Clear & calm	Afternoon Observations & 24hr change				Today's AM Minimum Temperature	Change from previous nights Min Temp	Rainfall Today So Far
			Temperature		Dew Pt				
		15%							
Cloverdale	35	30	61	-1	38	-8	39.1	+4.4	0.01
Geyserville	35	30	60	--	38	--	38.6	+6.0	0.01
Alexander Valley south	33	28	61	-2	37	-7	37.2	+5.4	0.02
Dry Creek Valley	35	30	62	+2	33	-14	38.5	+2.5	0.01
Healdsburg South	34	29	62	+1	37	-11	38.0	+3.4	0.01
Windsor	33	28	60	-2	39	-7	37.5	+4.9	0.02
Forestville	32	27	58	-3	42	-5	37.4	+2.5	0.02
Fulton	33	28	59	-3	40	-7	38.3	+5.8	0.03
Denner Rd	31	27	62	+1	42	-6	36.6	+4.7	0.01
Graton	32	27	60	-2	44	-4	35.7	-0.2	0.01
Sebastopol	30	26	58	-2	42	-5	35.1	+3.6	0.01
Rohnert Park	31	27	56	-5	45	-3	33.7	+3.2	0.01
Bennett Valley	30	26	58	-5	41	-4	33.3	+4.5	0.03
Sonoma Valley north	30	26	58	-5	42	-5	33.0	+4.0	0.02
Sonoma Valley south	33	28	60	-5	44	-2	36.5	+4.5	0.01
Petaluma South	32	27	59	-5	44	-2	35.0	+5.5	0.01
Carneros	33	28	61	-4	45	-1	36.0	+2.8	0.00

**For Tonight:**

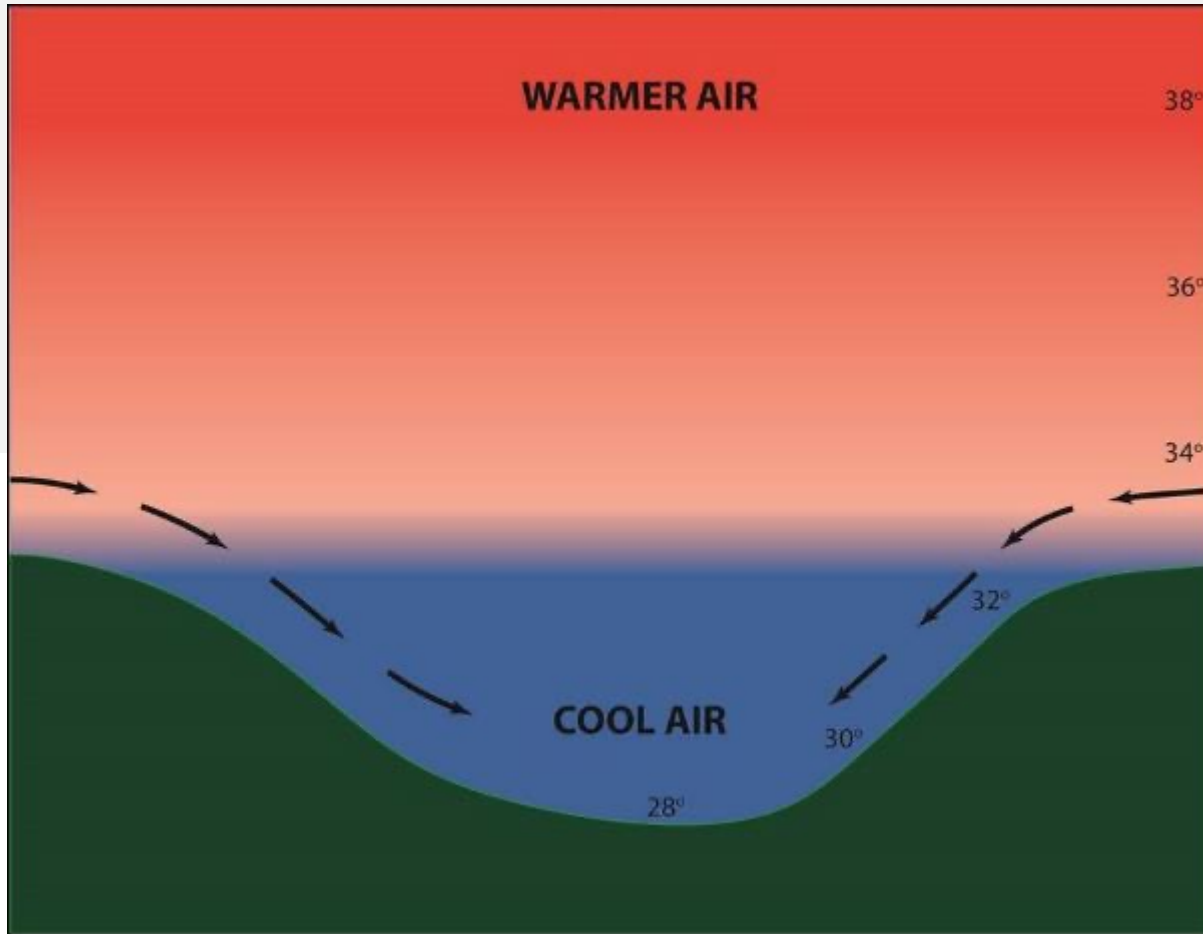
Chance of Rain & Amounts: 0%, none  
Winds: N-NW 3-15  
Dew Point Range: 27-34  
Tomorrow Night's Lows: 30-37

Inversion Strength Tonight: Moderate  
Inversion Strength Sun Night: Weak/Moderate  
Inversion Strength Mon Night: None/Weak

\* Chance of "Worst Case Scenario" occurring

Meteorologist, Kai Tawa

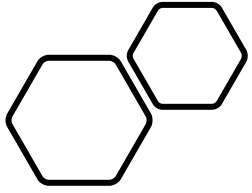
- Look at weather through a funnel view (top→down) from a continental scale to a microscale
- What is happening overnight into the morning? Winds, cloud cover, dewpoints, precipitation, etc.
- Consider geography and topography. Is the area wind-sheltered, low-lying, or near water sources?



# The Inversion Layer

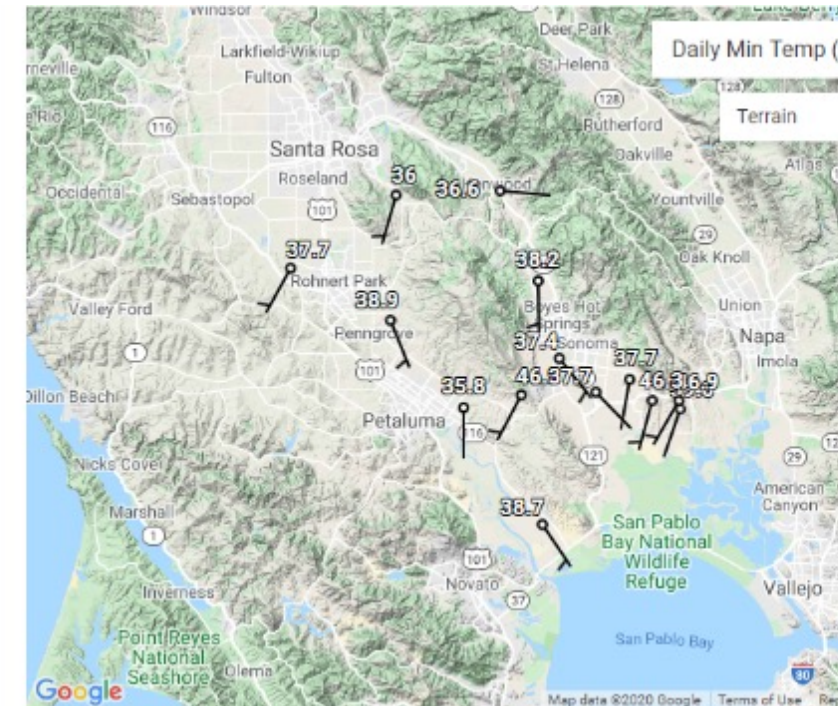
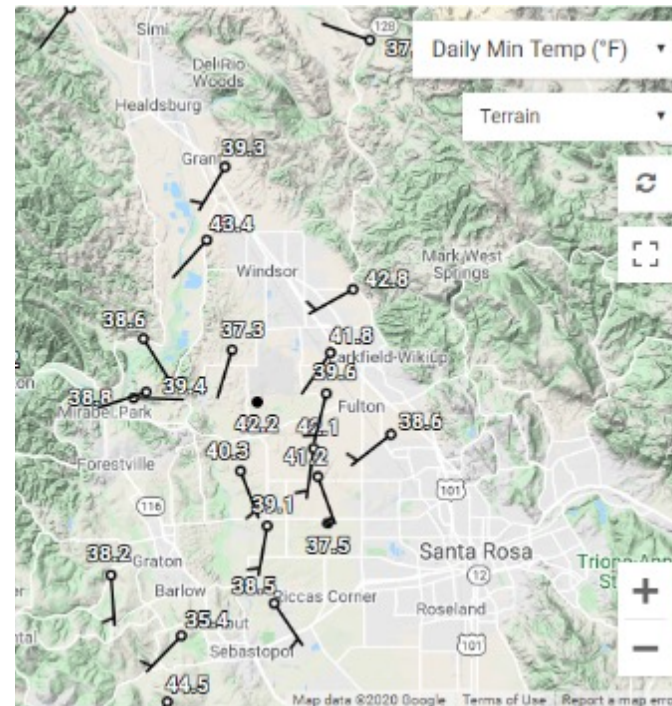
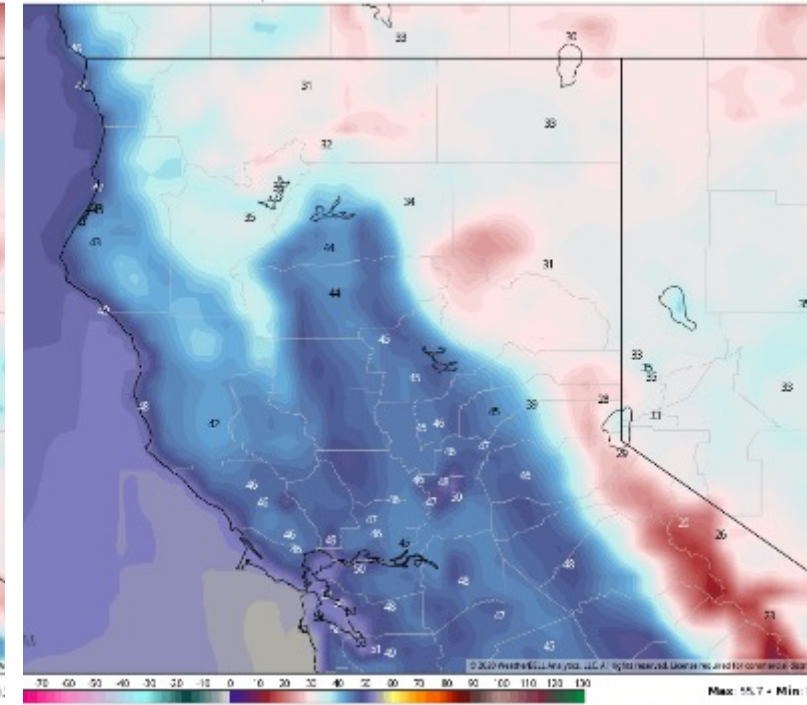
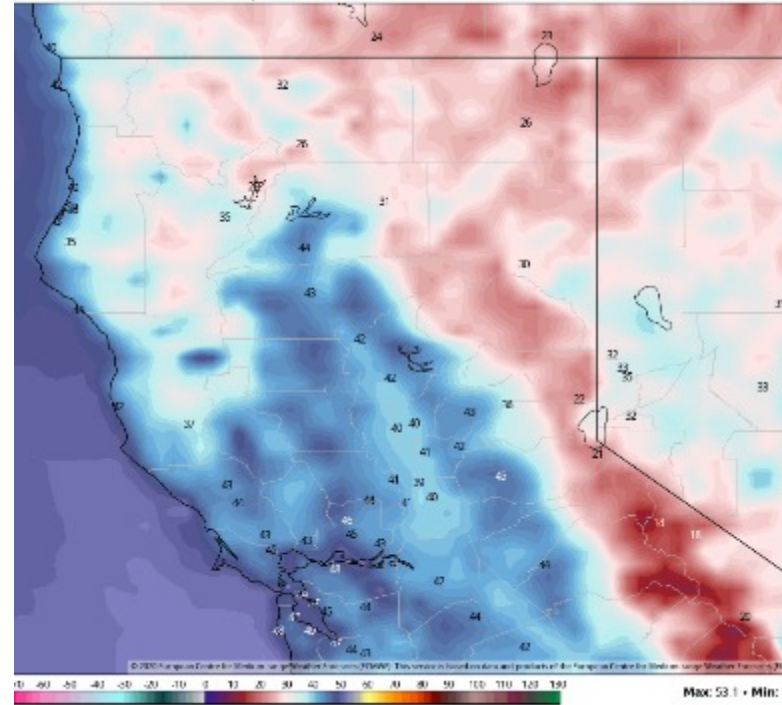
- Layer in the atmosphere where temperatures increase with height.
- During radiational cooling, warm air will rise from the surface level as the ground cools
- Colder, denser air will sink to the ground and pool in low-lying areas.
- Will form during clear nights with little to no wind





## Symbiotic Relationship Between Data & Forecasting

- Computer models are never 100% accurate.
- Data from weather stations allows meteorologists to identify microclimates.
- Over time, meteorologists recognize trends between computer model generated scenarios and what “actually” happens.
- Improves forecasting and helps growers understand how seasonal weather conditions affect vintages.







## Summary

- **California is susceptible to many kinds of weather events**
- **Frost potential can be influenced by meteorological conditions from a synoptic scale to local scale**
- **Forecasting for frost requires knowledge on current trends as well as information on the location and possible microclimates.**





Questions...