Frost protection practices in vineyards

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Passive frost protection

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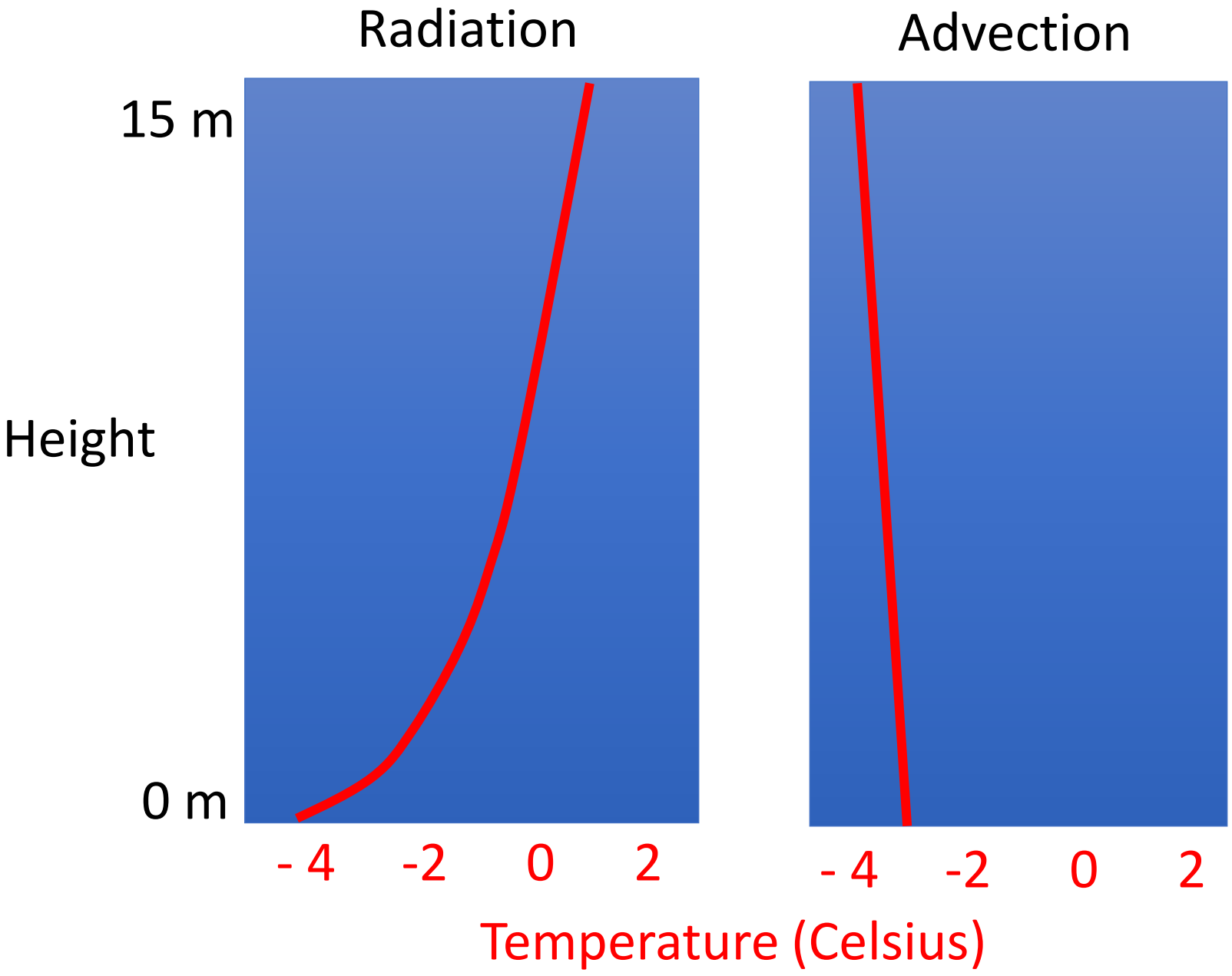
Types of frost events

Radiation frost

- Clear sky, little or no wind
- More damage in the low-lying areas
- More common

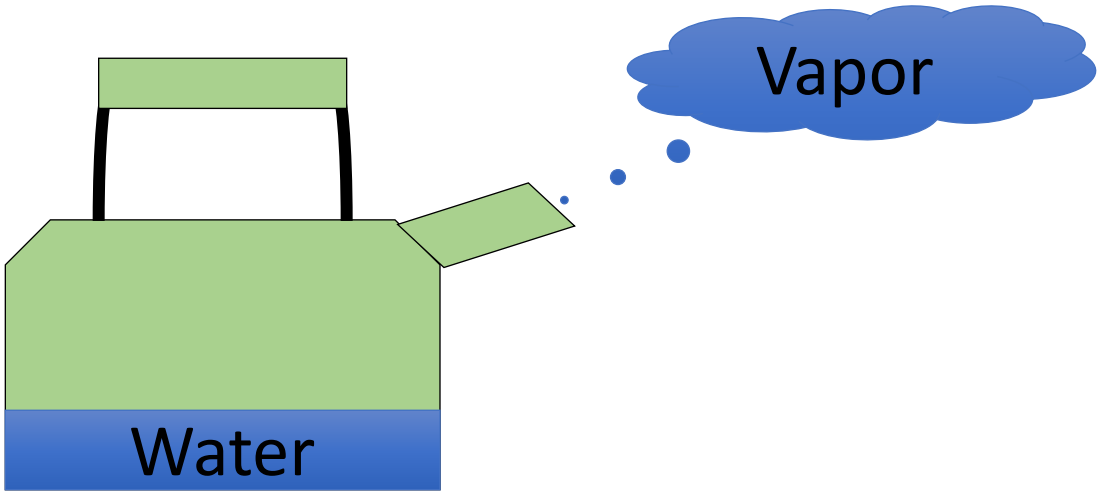
Advective frost

- Associated with a cold air mass; may be cloudy and windy
- More damage in the higher elevations
- Less common



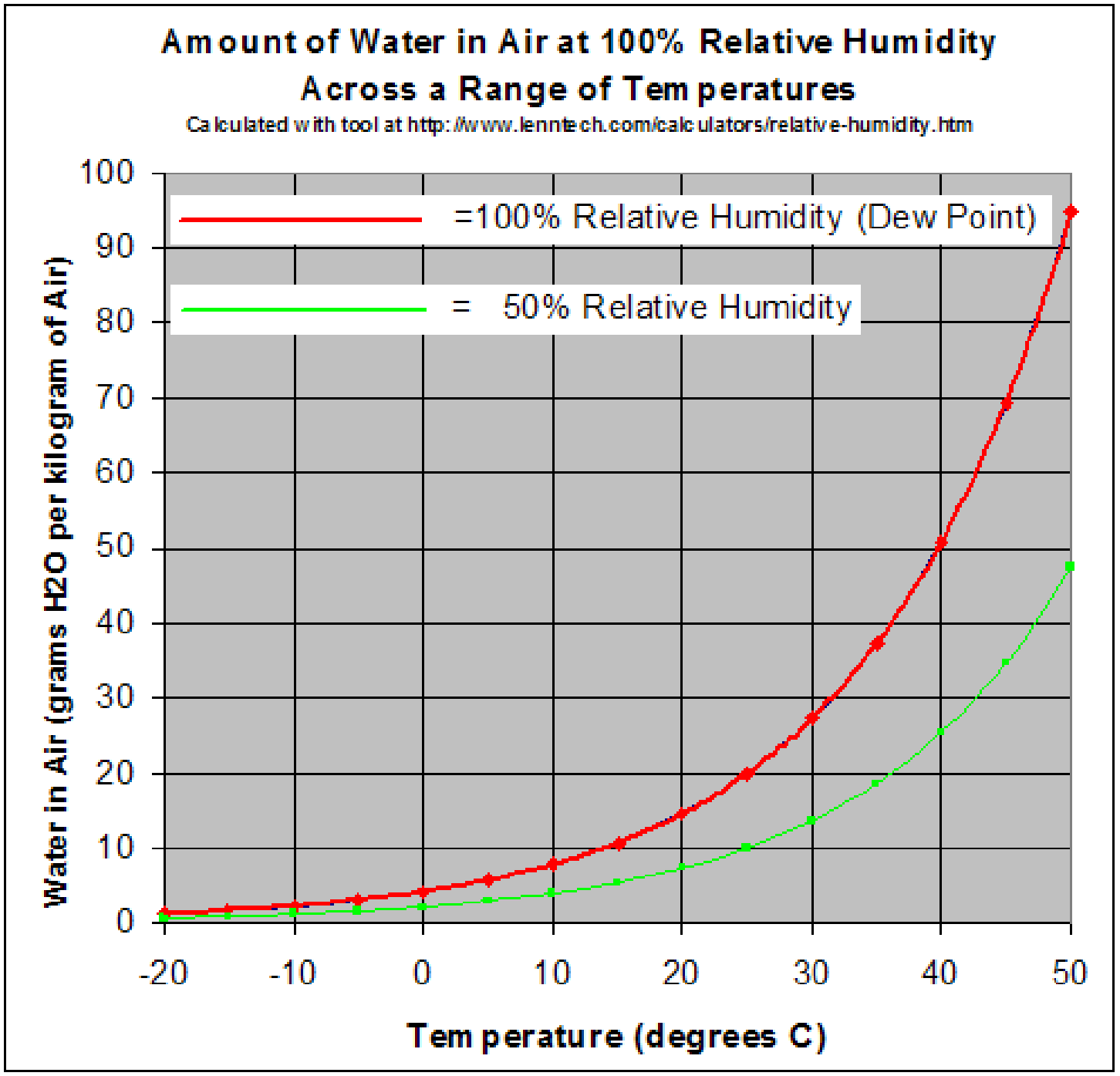
Dew point concepts

To change liquid water to vapor, we must add lots of energy:



Teapot

Heat



Site selection

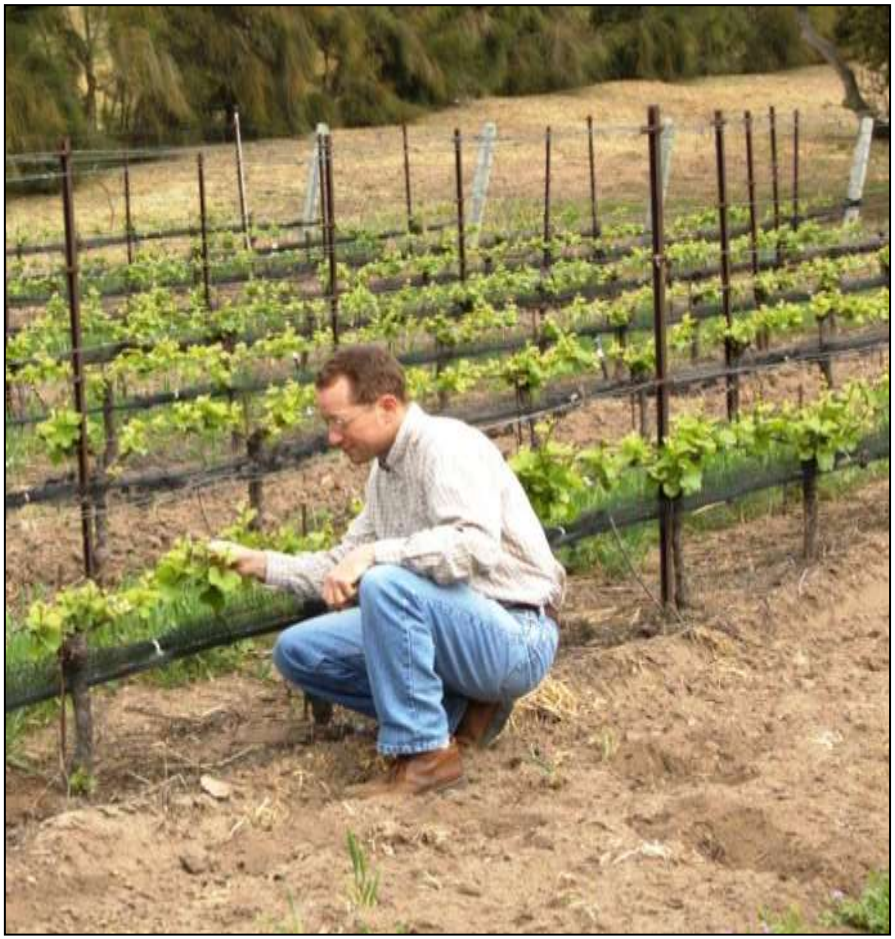
Low spot guarantees frost challenges

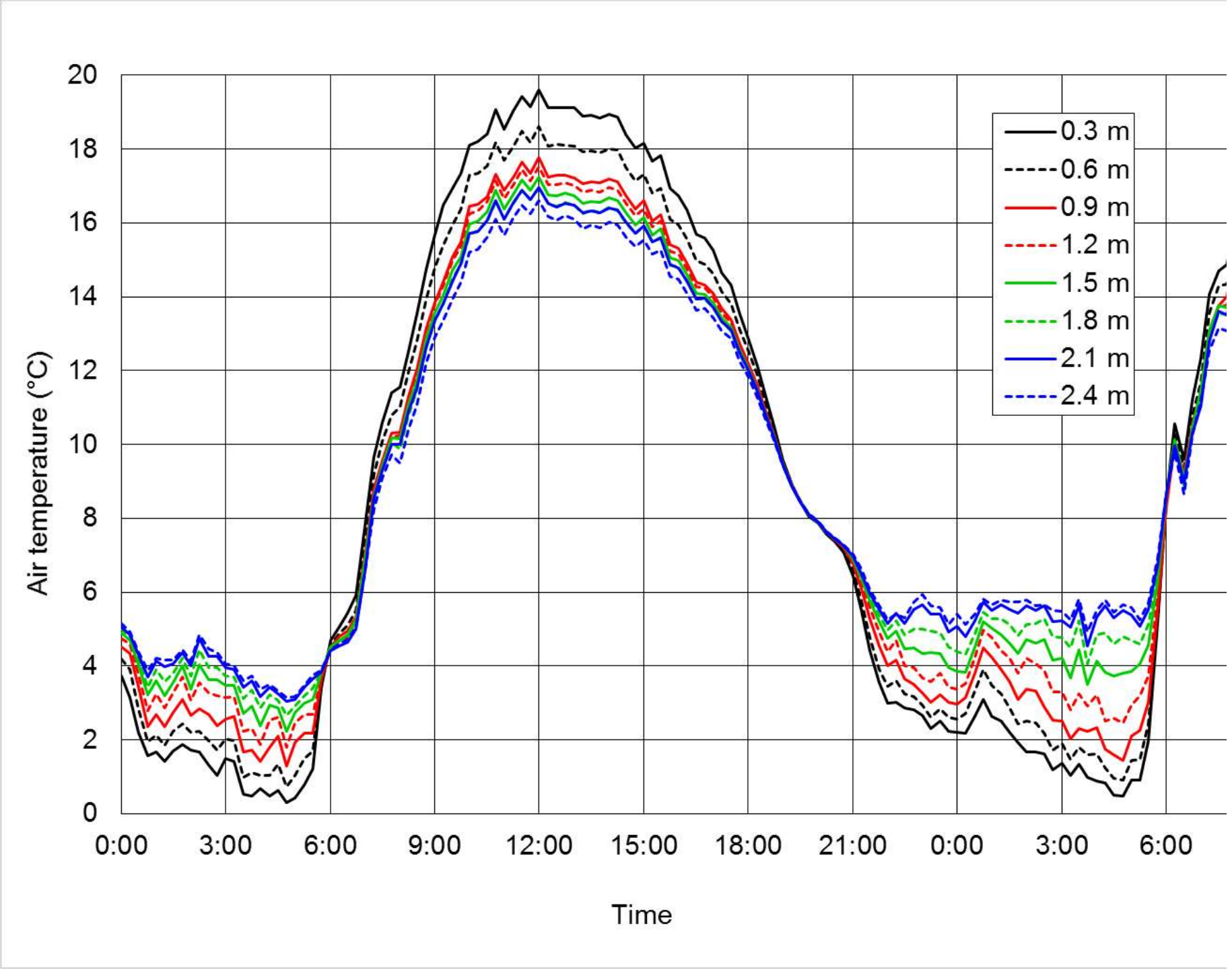
Cold air accumulation

Variety and rootstock selection

- Early budbreak:
  - Pinot Noir, Chardonnay
  - 101-14
- Late budbreak:
  - Cabernet Sauvignon
  - SO4

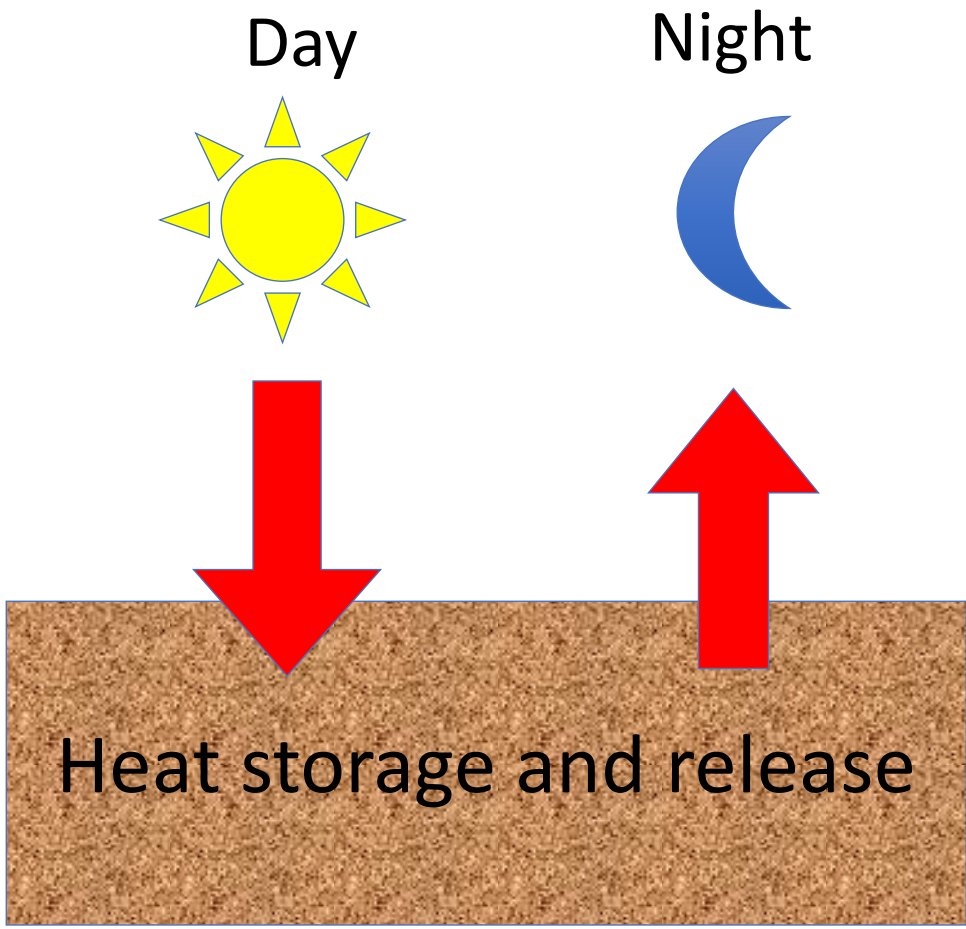
Trellis height

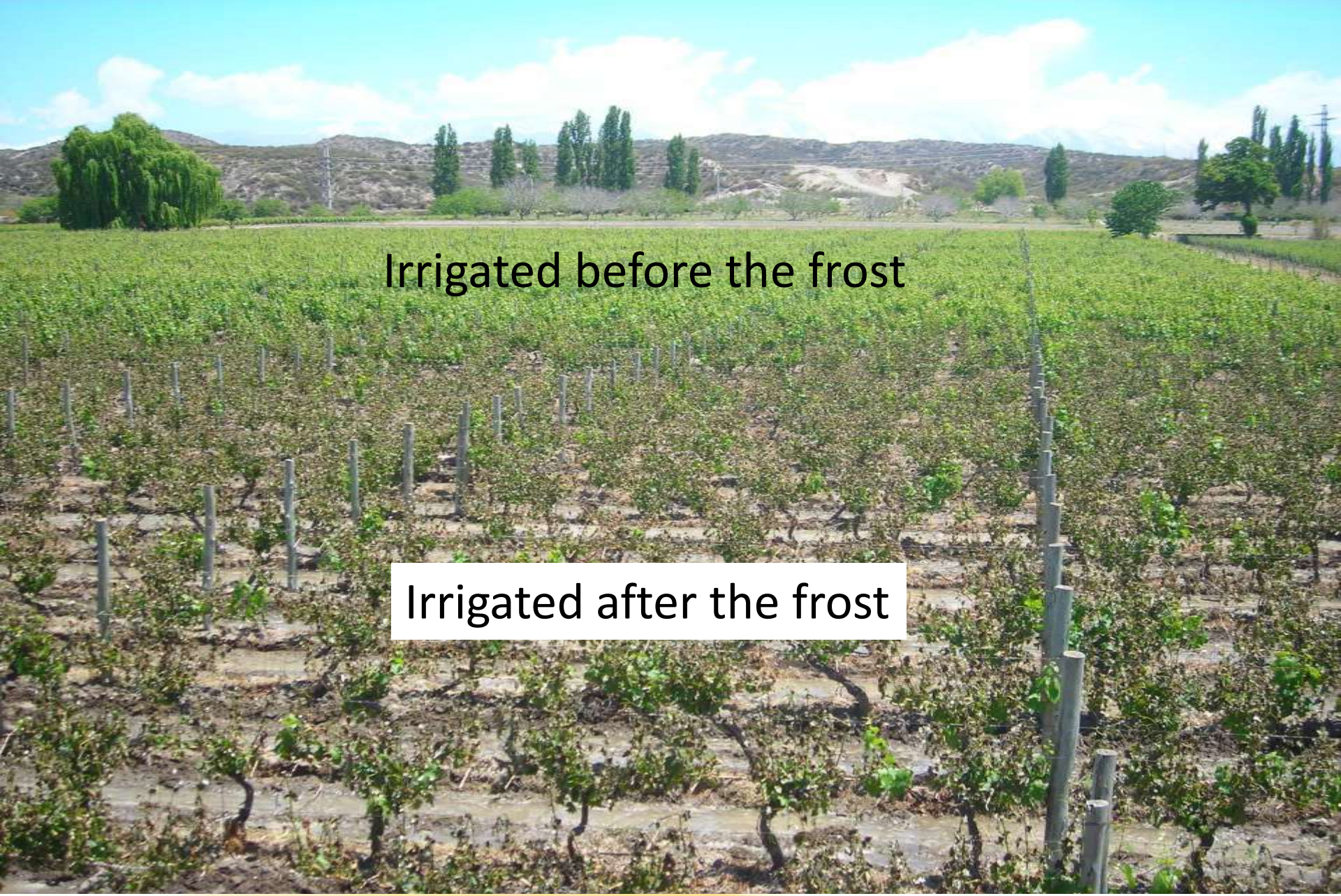



20
18
16
14
12
10
8
6
4
2
0
Air temperature (°C)
0:00
3:00
6:00
9:00
12:00
15:00
18:00
21:00
0:00
3:00
6:00
Time
0.3 m
0.6 m
0.9 m
1.2 m
1.5 m
1.8 m
2.1 m
2.4 m

Surface conditions

- Vegetative cover insulates the soil, reduces heating
- Moist, compacted soil stores and conducts heat better than a dry, fluffy soil




Irrigated before the frost
Irrigated after the frost

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Soil health, regenerative ag and frost risk

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Frost protection with water

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Sprinklers

- Advantages:
  - Low energy consumption
  - Low operation cost
  - Low labor costs (not always)
- Disadvantages:
  - High installation cost
  - Require lots of reliable water!

Sprinklers

- Challenges:
  - Wet soils
  - Humidity, diseases
  - Nutrient leaching (nitrates)
  - Erosion
  - Fall use limited

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Fundamentals of frost sprinklers

- Freezing of water produces the heat
- Must add more heat from freezing than lost to evaporation
- The Wet Bulb temperature determines when to start & stop

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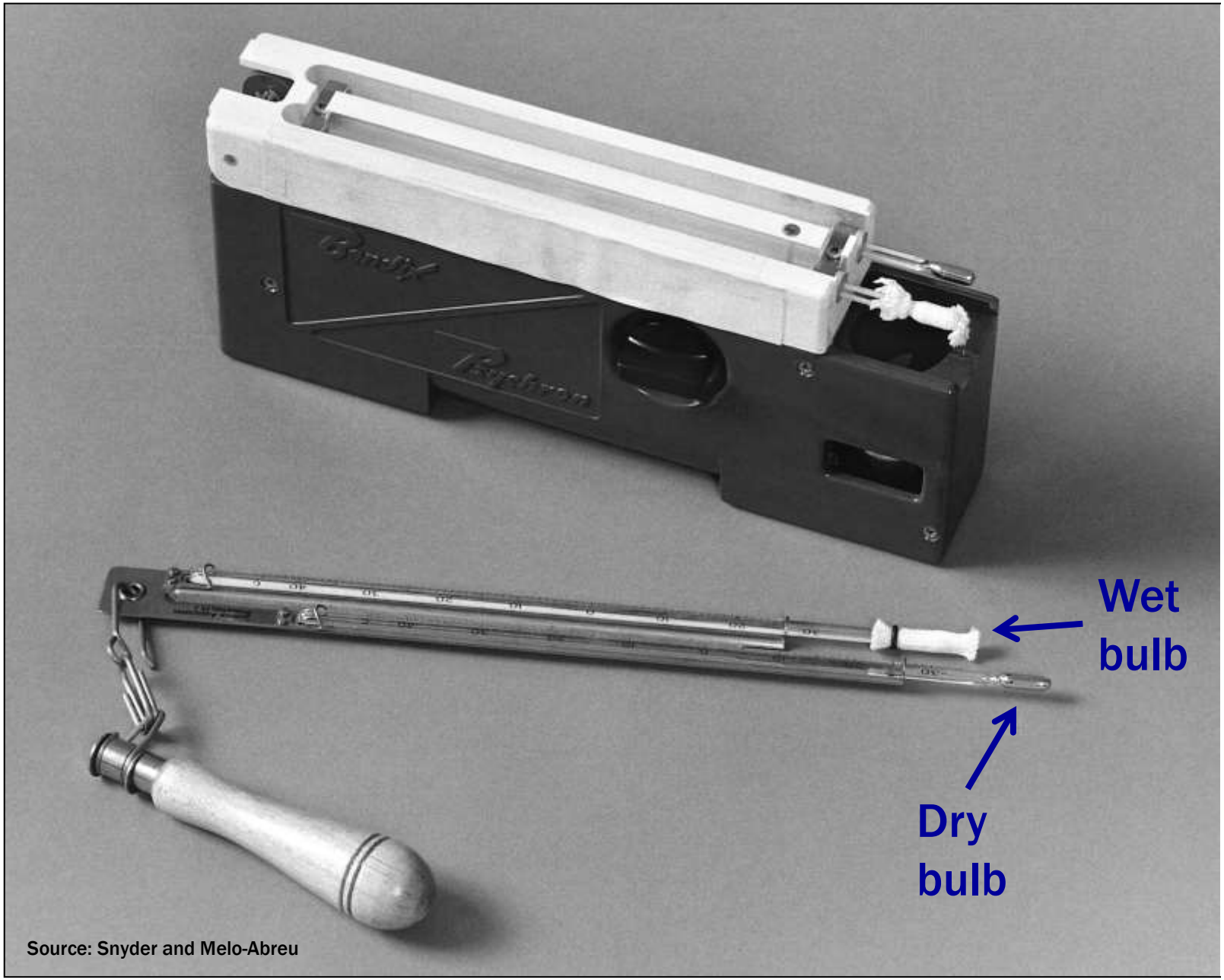
Energy in the system

Process	cal g^{-1}
Water cooling from 68°F to 32°F (20°C a 0°C)	20
Freezing at 32°F (0°C)	80
Evaporation	-597

Wet bulb temperature



Sprinklers can fail – and cause greater damage

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If water is constantly freezing on the ice surface, the interior remains at 32 °F. Clear wet ice is good, milky dry ice is bad.

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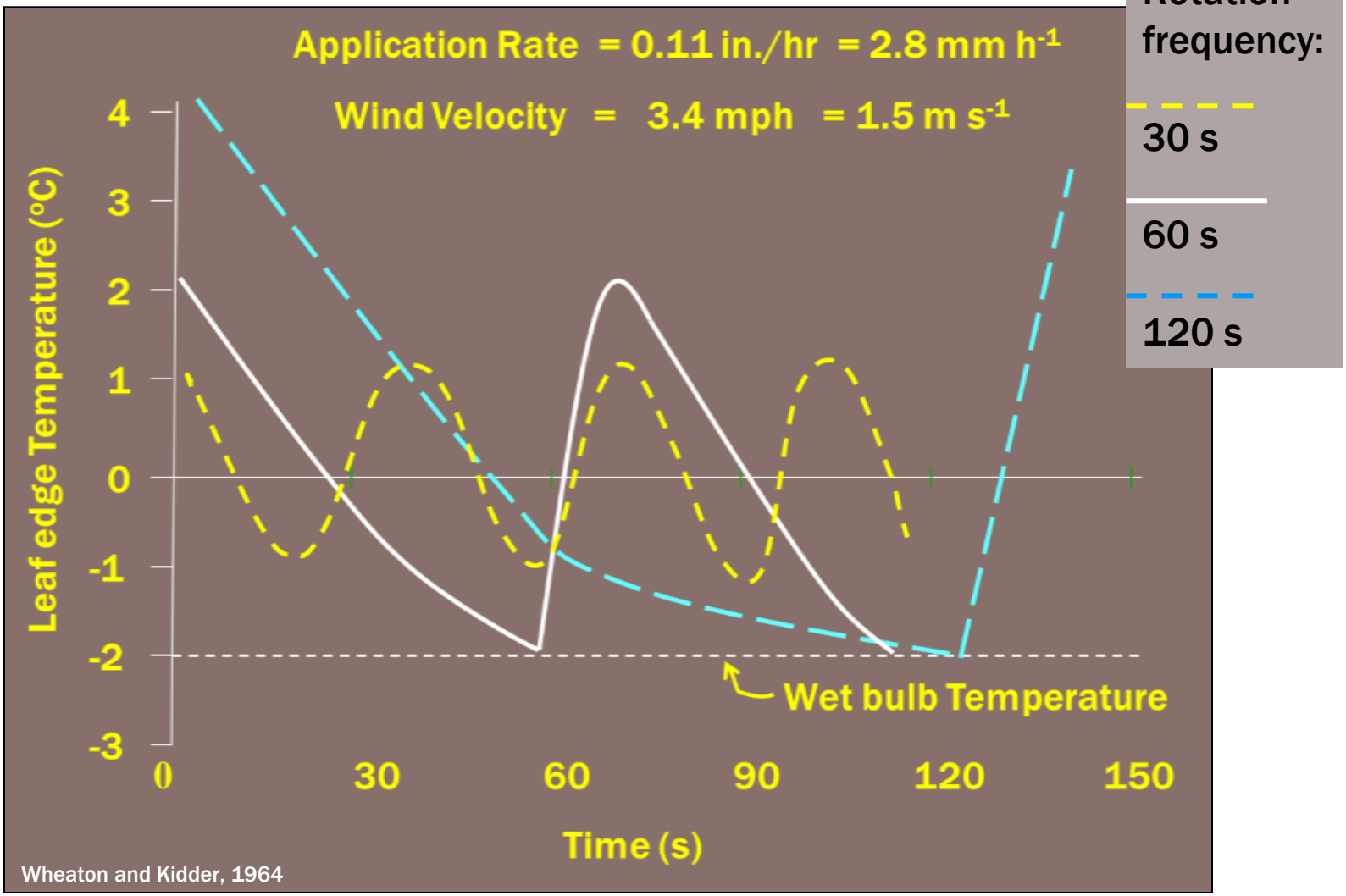
Rotation frequency vs temperatures



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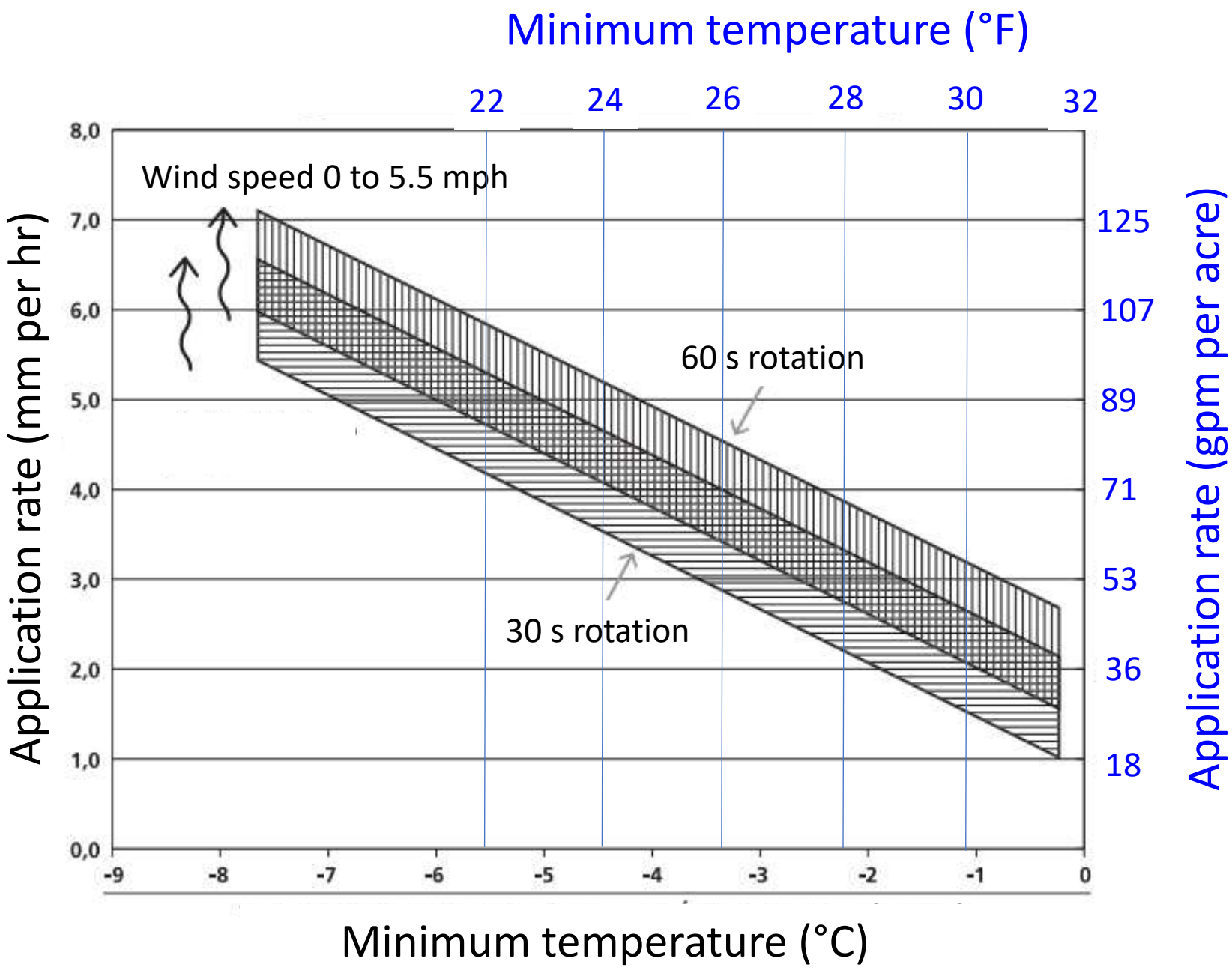

Adapted from: https://www.fao.org/3/y7223s/y7223s.pdf

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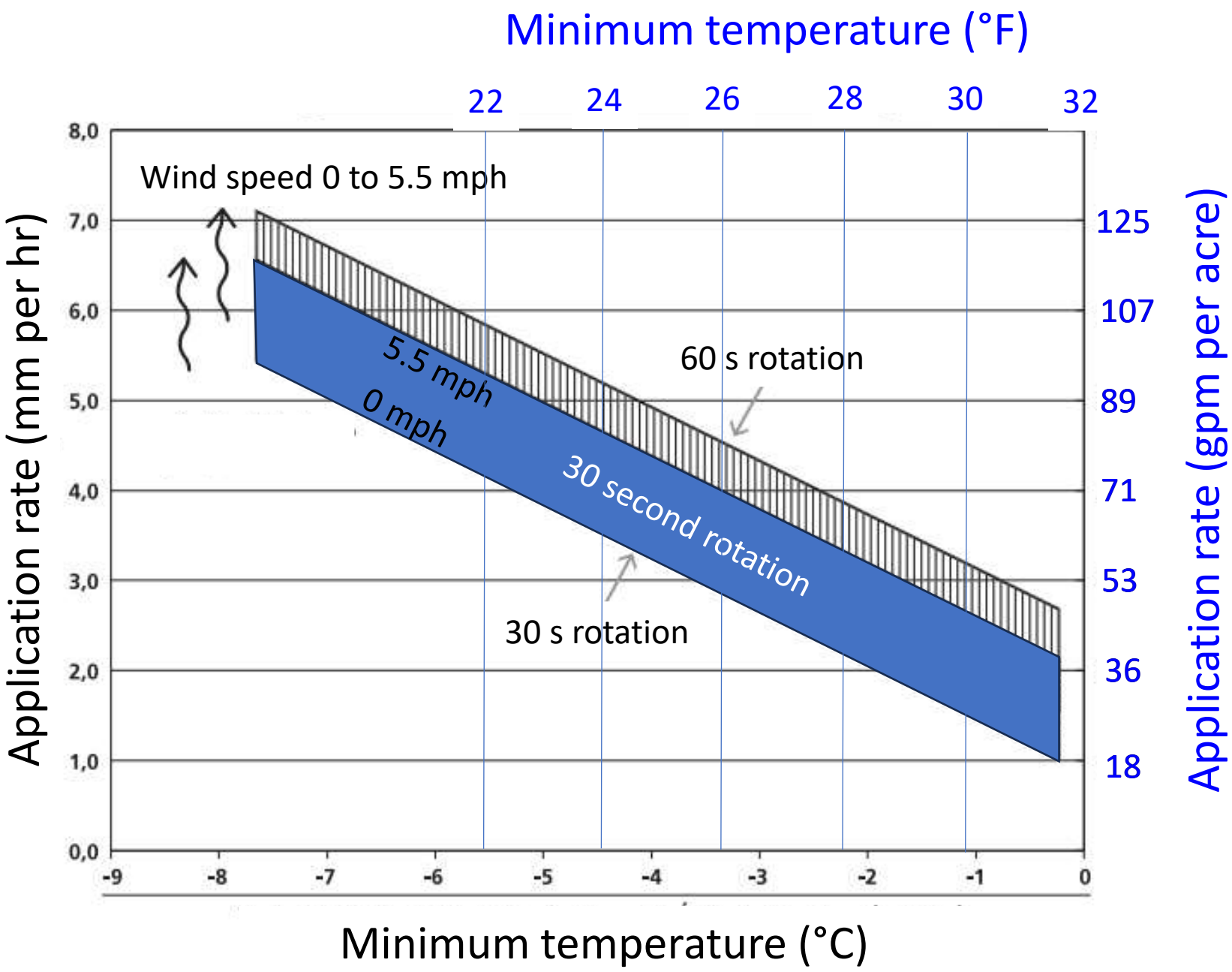

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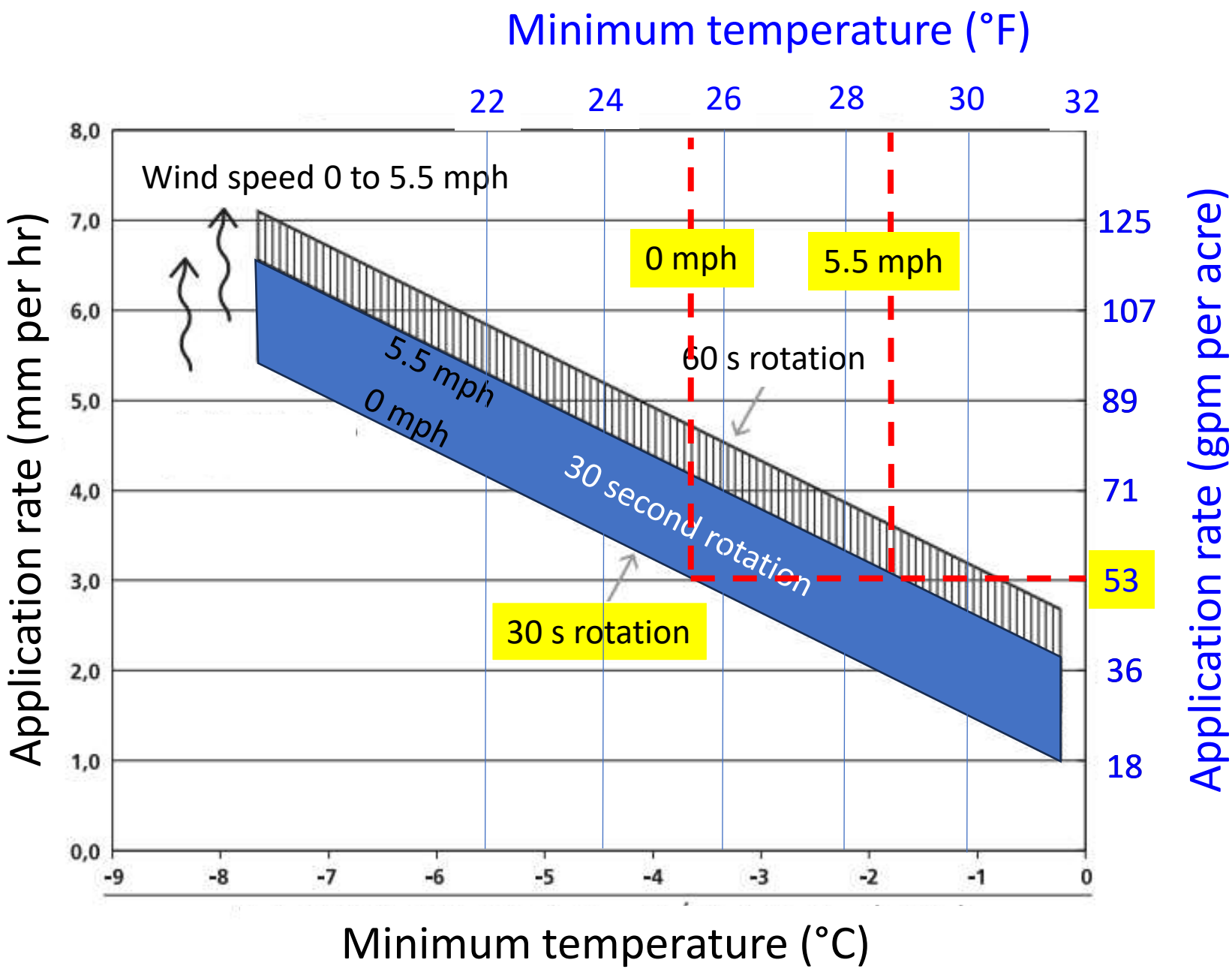

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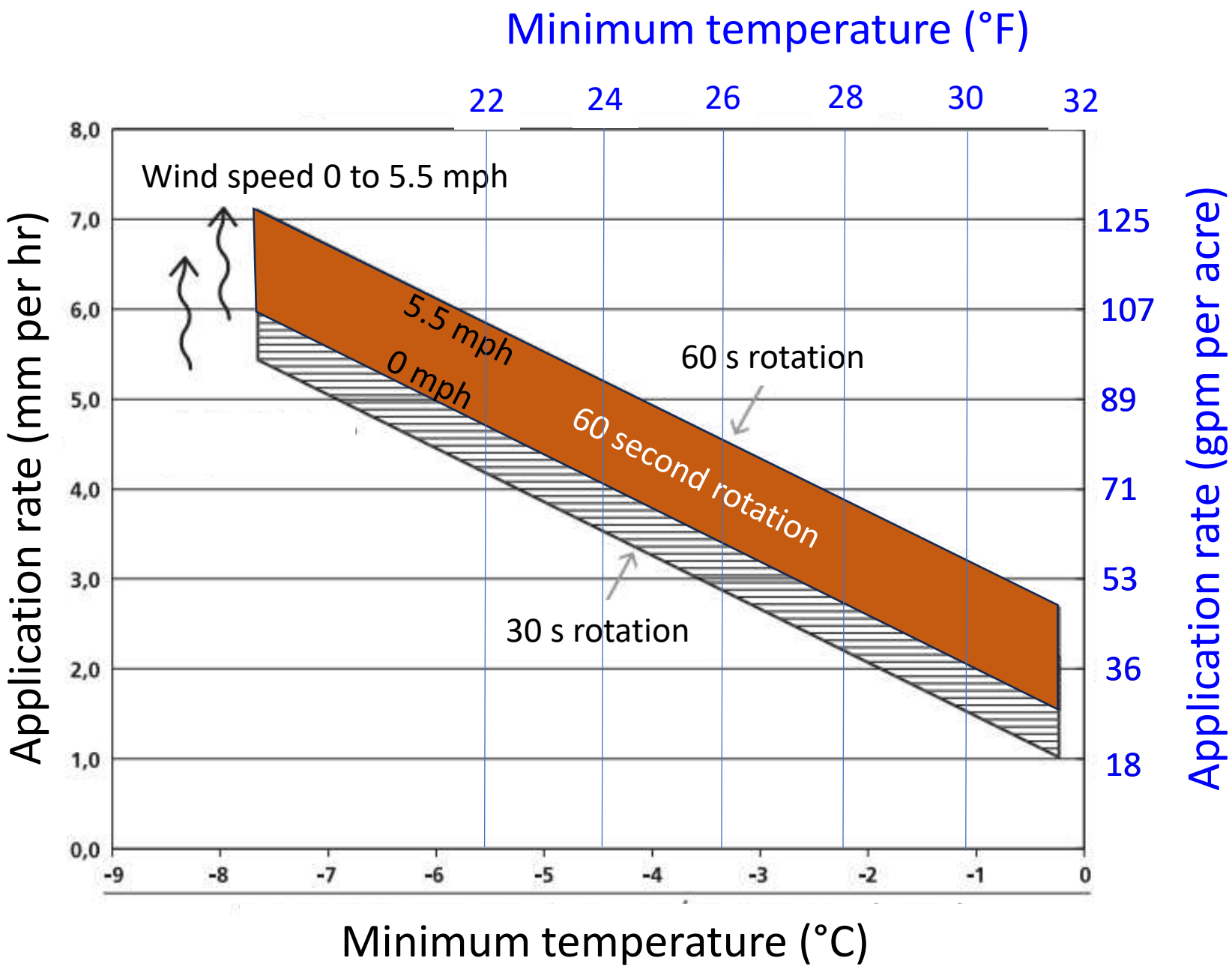

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Targeted sprinklers (over the row)

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Targeted sprinklers (over the row)

- Only apply on the row; use less water
- Demand more maintenance; many heads per acre, affected by other farming?
- Wind?
- Low flow can lead to freezing in poly lines in very cold areas. Add more sprinklers to increase flow.

Low flow pulsating sprinklers

- Full spatial coverage
- Reduced application rate
- Very high frequency
- Small coverage area per sprinkler
- How do they compare to conventional sprinklers at lower temperatures?

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Frost protection with wind

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Wind machines

- Advantages:
  - Low energy use
  - Low labor requirement
  - Low operational cost
  - No water needed
- Disadvantages:
  - High initial cost
  - Protection limited if conditions inadequate
  - Noise

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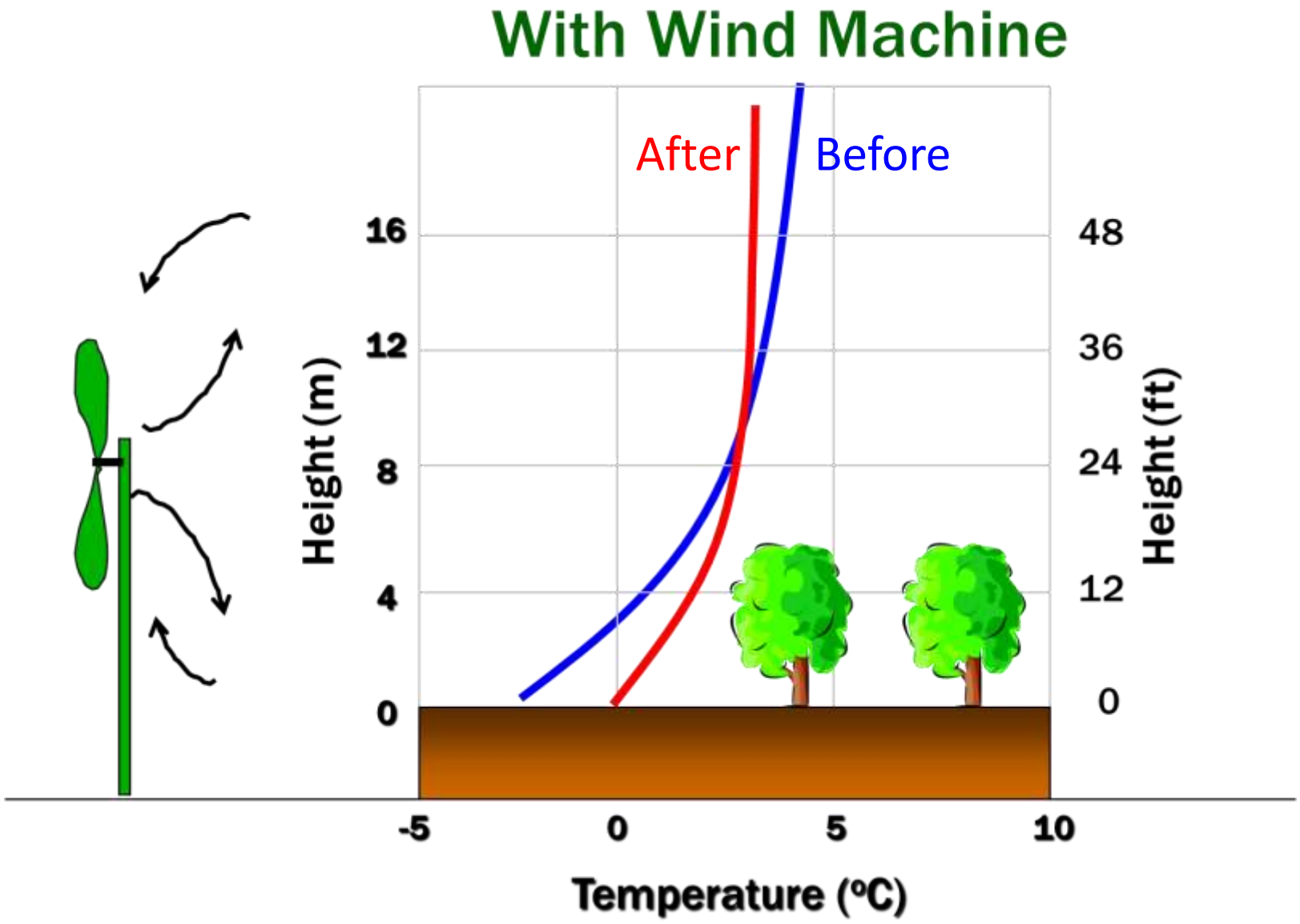

Image: Snyder, 2000

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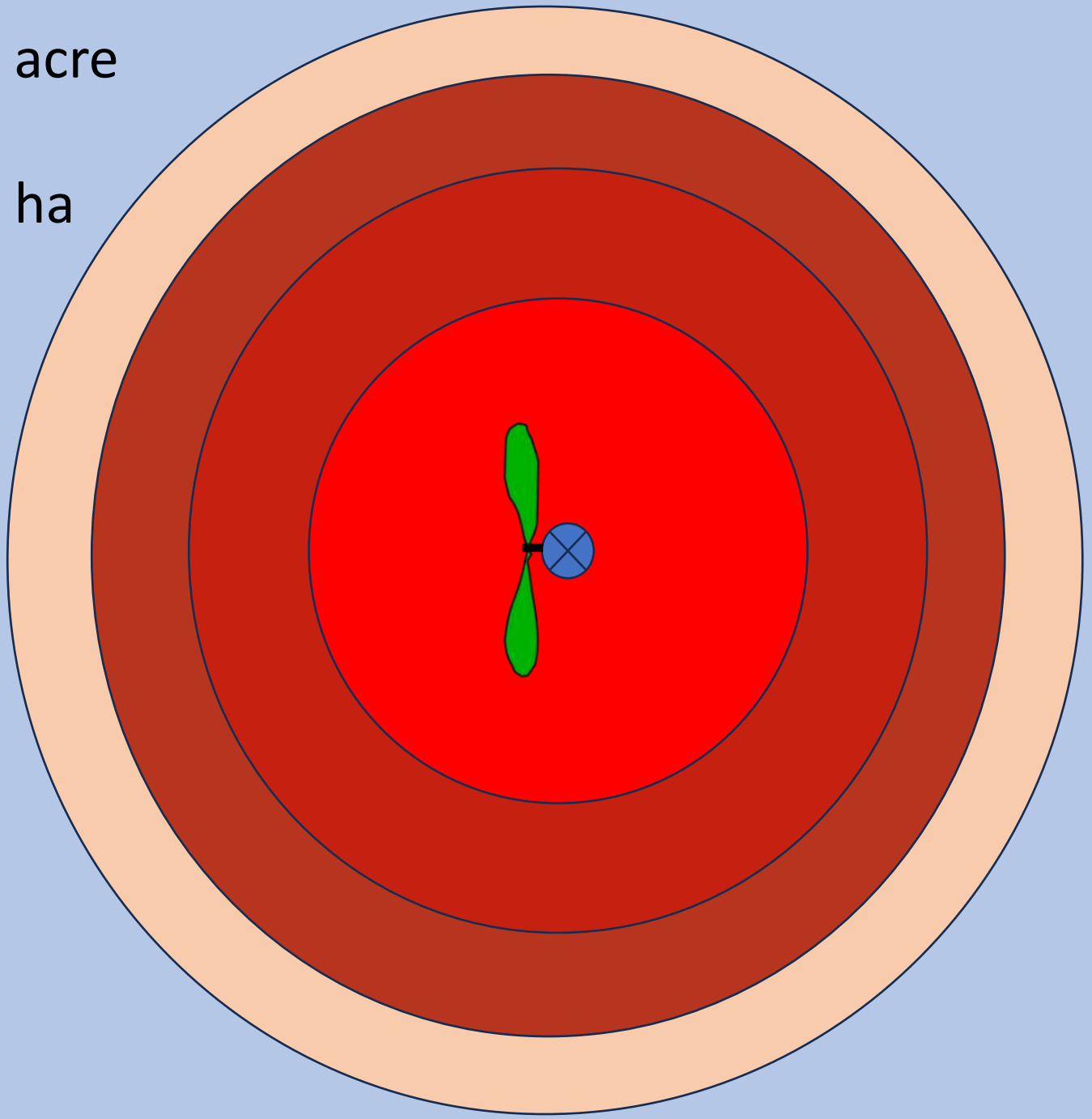
10 hp per acre

25 hp per ha



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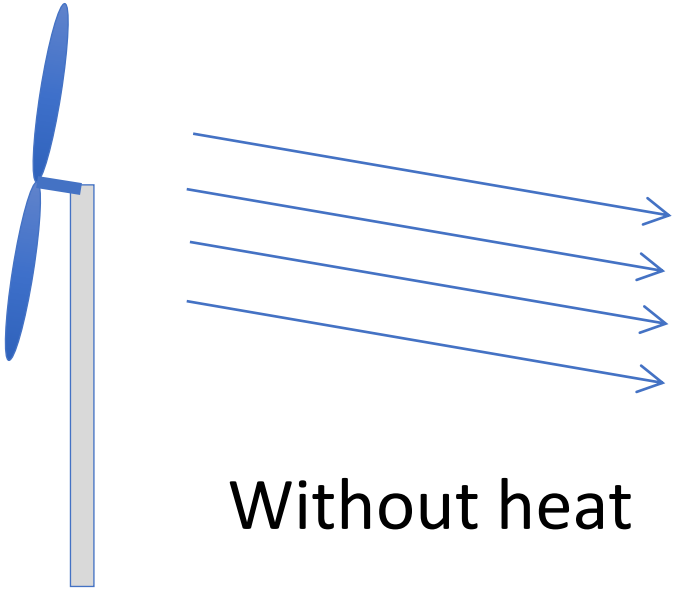
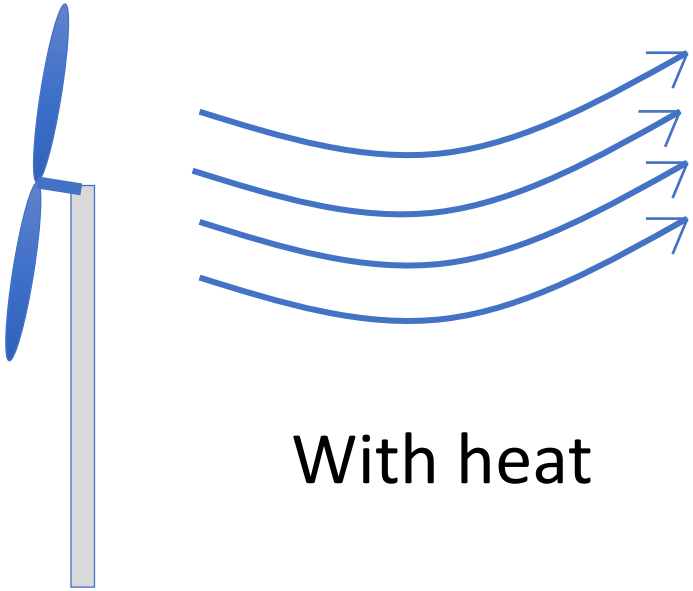


Without heat



With heat

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orchard-rite.com


nzfrostfans.com

Will wind machines be a good investment?

Temperature inversion and wind machine warming

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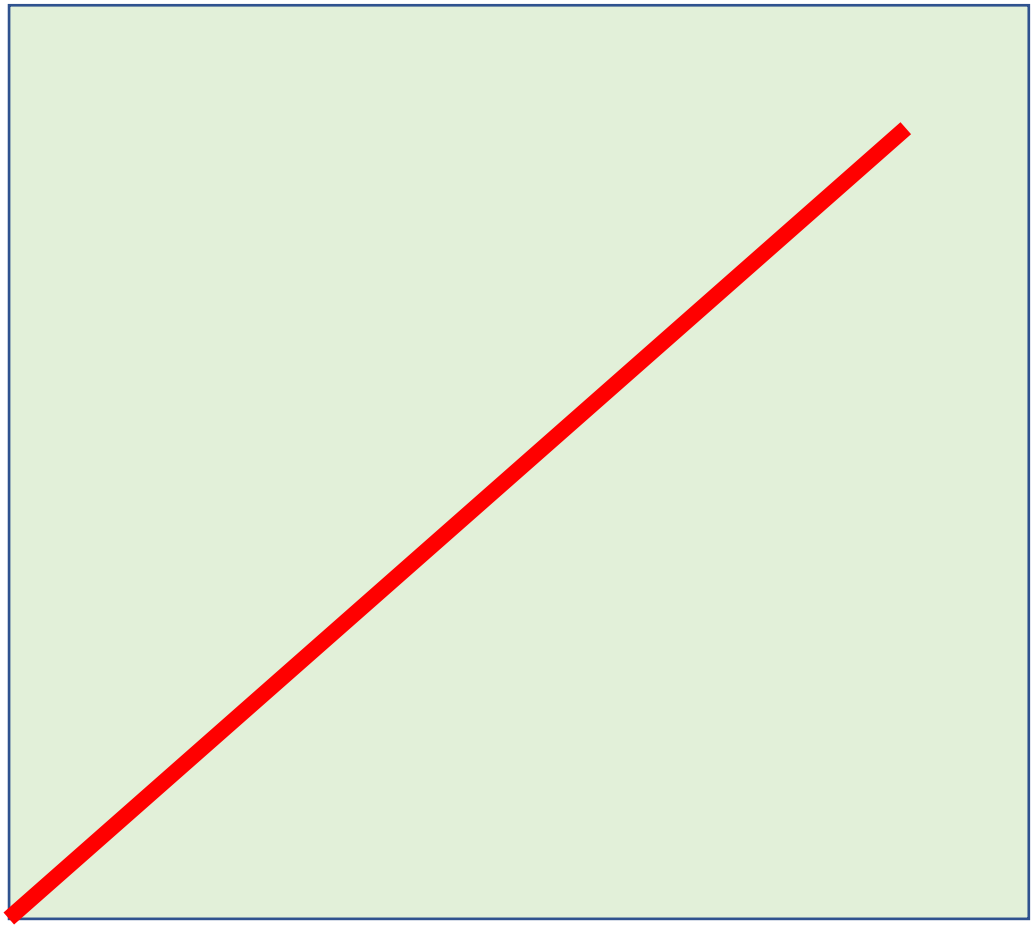
^
^

More warming effect



Stronger temperature inversion >>>>

How to measure inversions?

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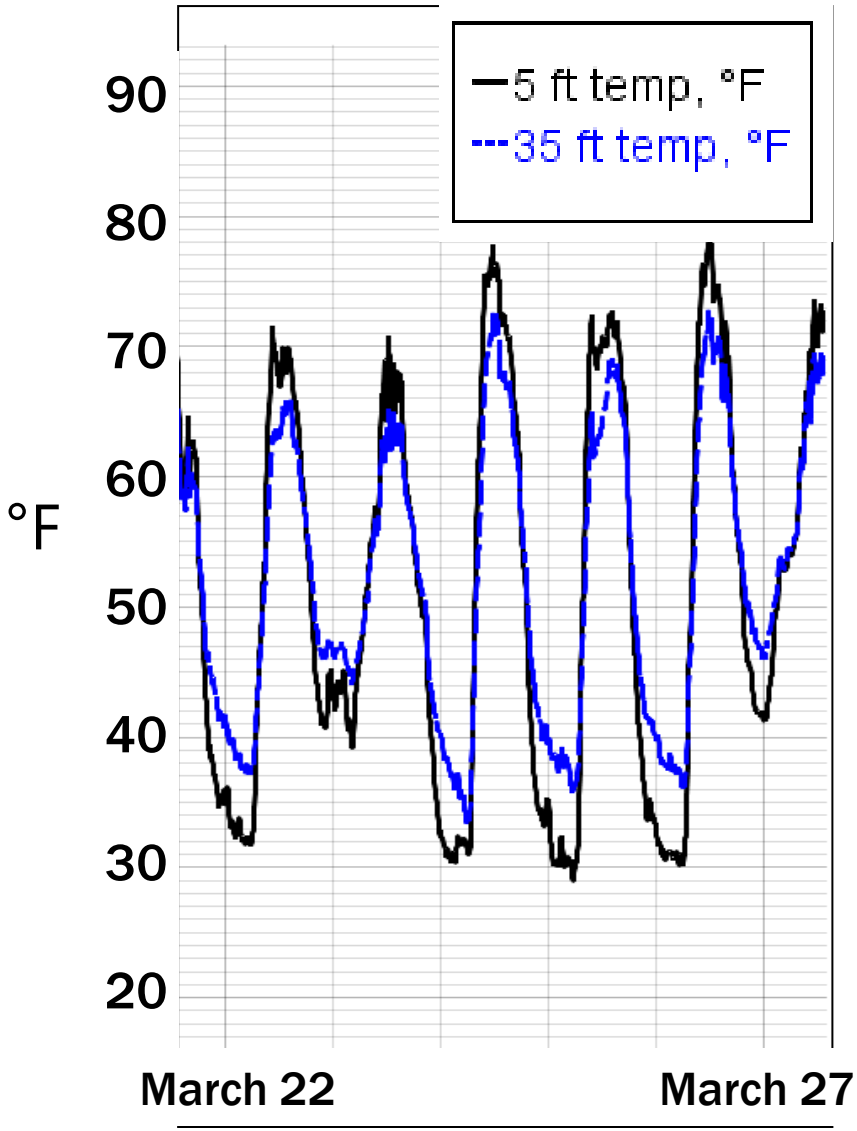

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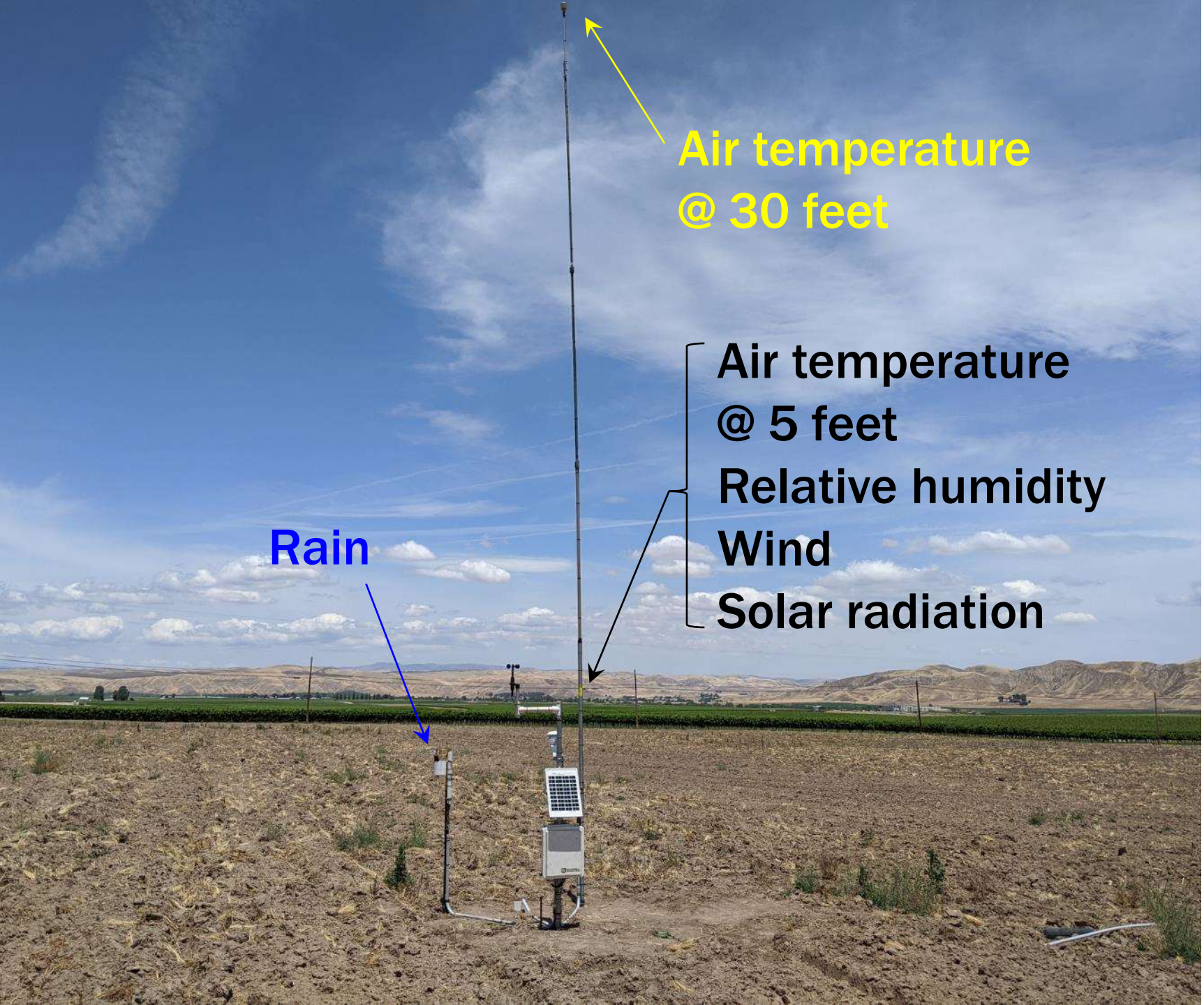

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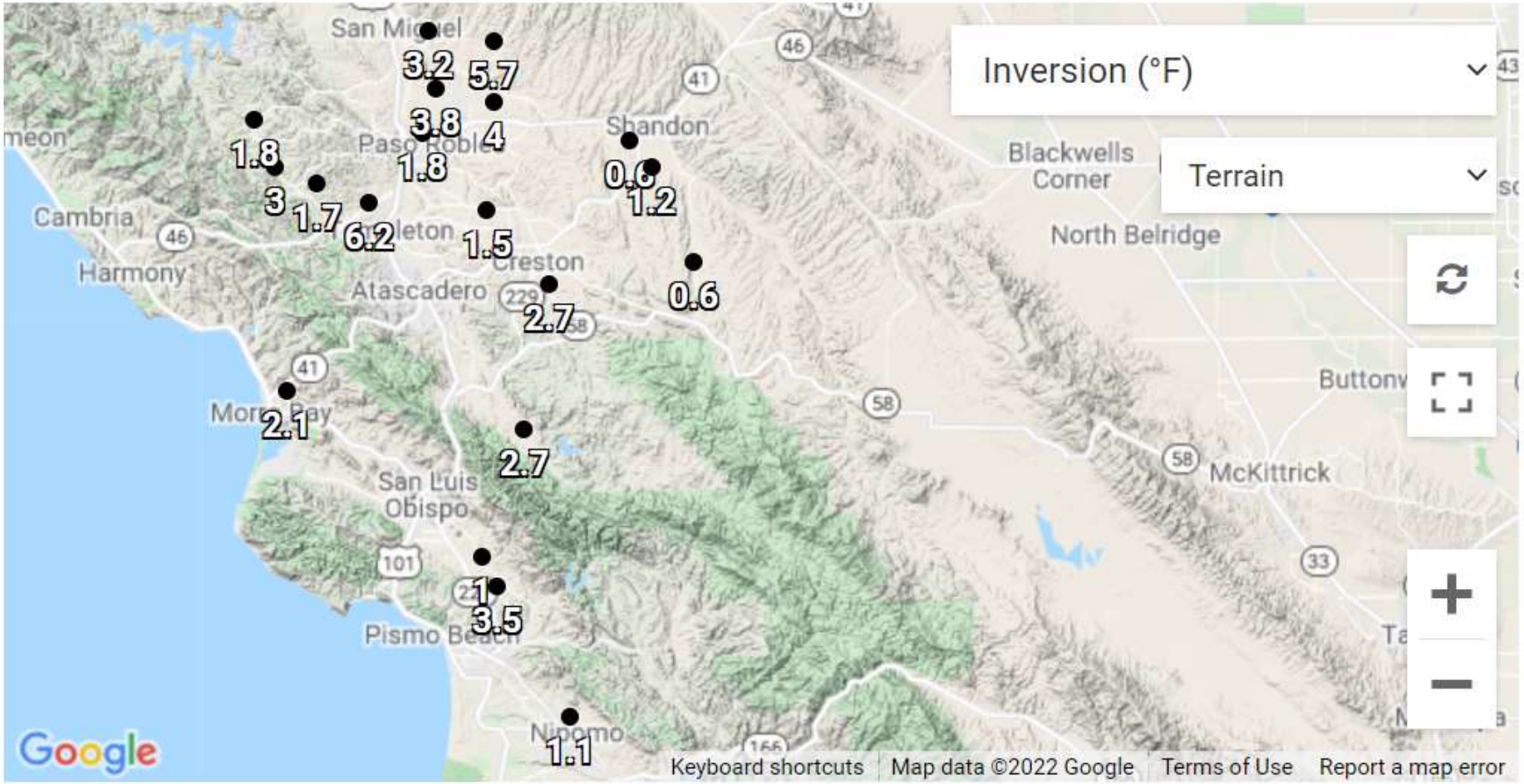
Latest Observations

15 Minute Data

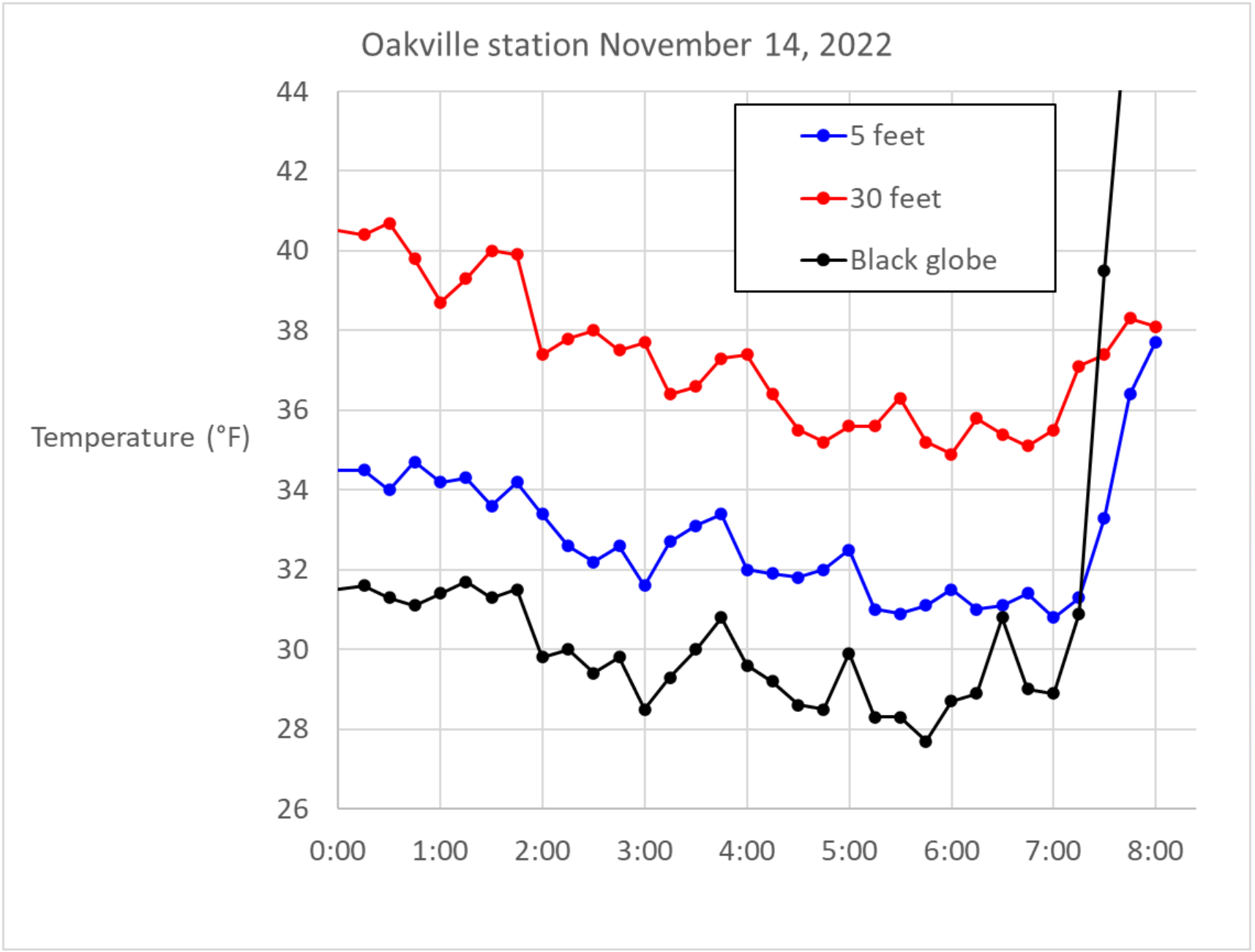
Map

as of 1/19/22 9:27 PM PST



https://ucce-slo.westernweathergroup.com/

Air temperature vs tissue temperature



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Thanks for your attention!

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