From Changing Atmospheric Circulation to Berry Temperature: Macro-, Meso-, Topo-, and Microclimate in Vineyards

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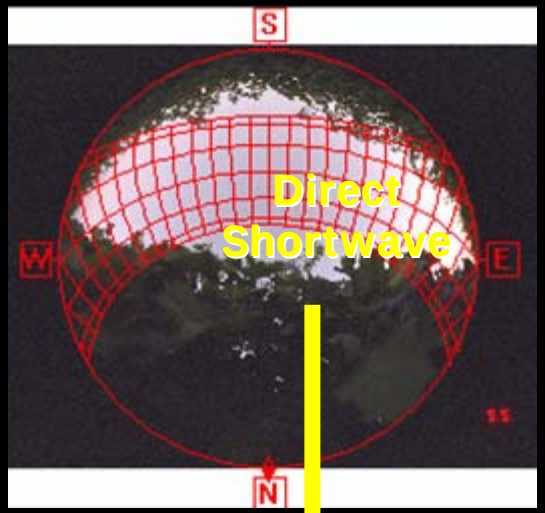
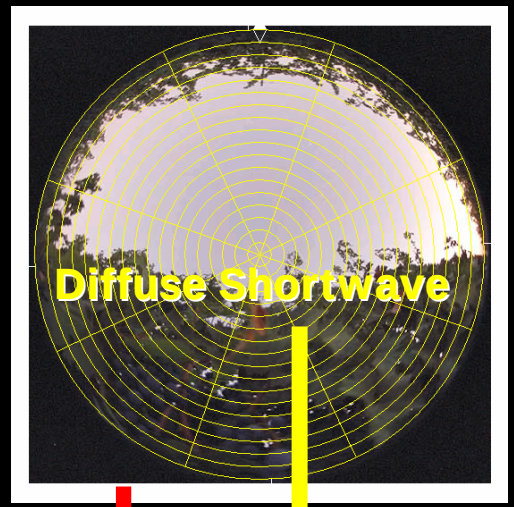
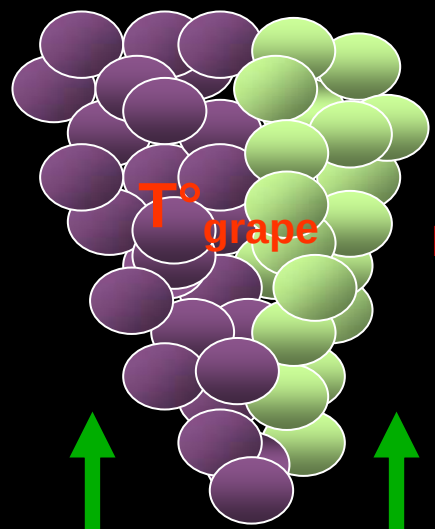
Environmental Biophysics

Grape Energy Balance



T° air





Simplified representation of **primary heating vectors**.

Longwave

Longwave

Latent

Sensible

Reflected Shortwave

Storage

Albedo

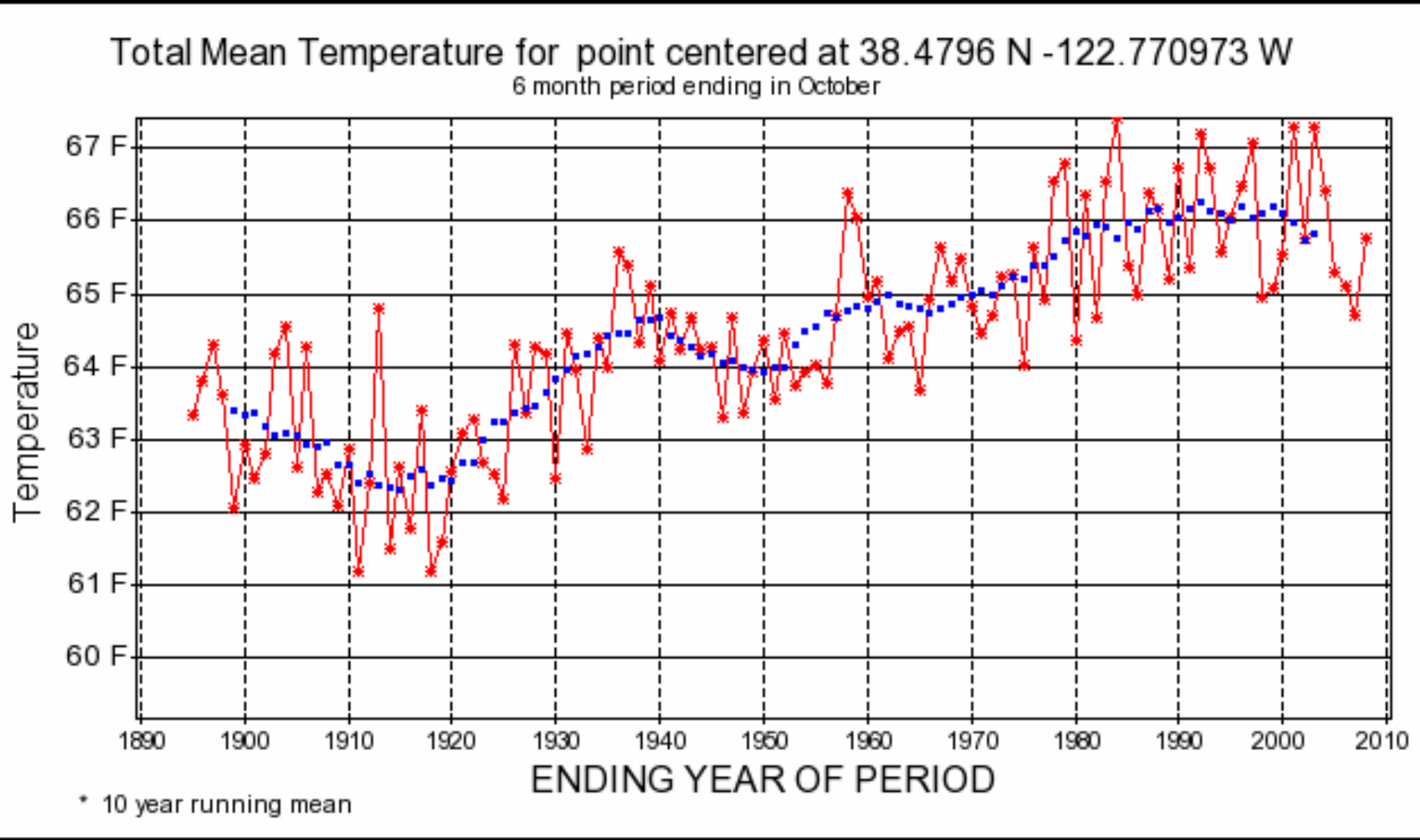
“Sunburn” in the Vineyard

Tens of millions of dollars lost annually in California alone.

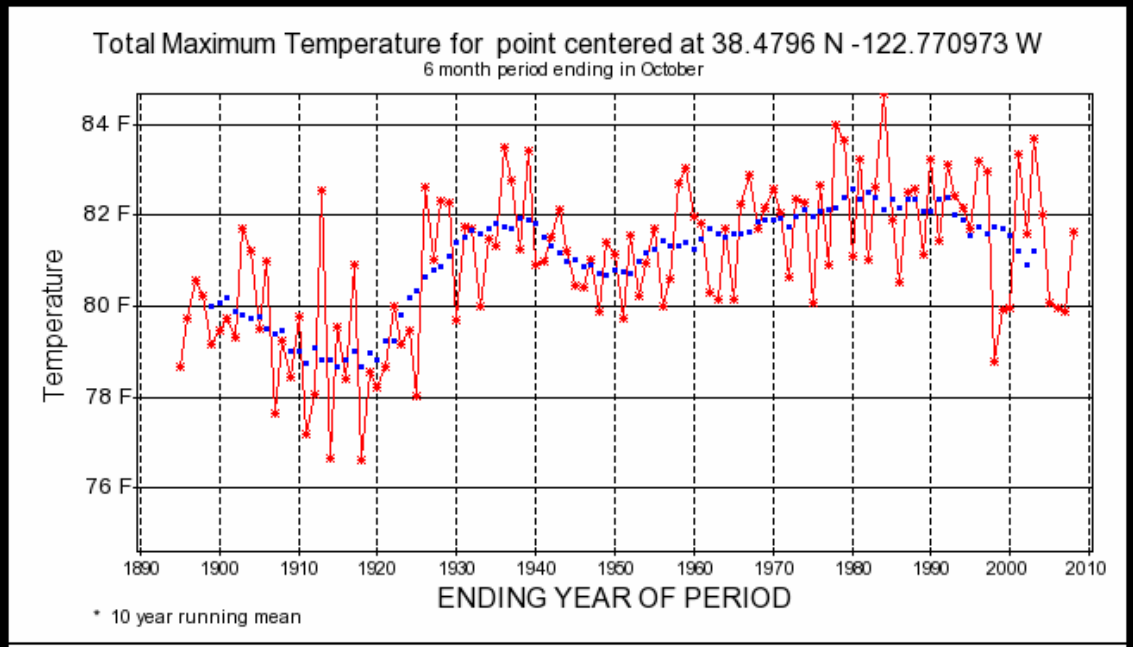
The Climate Near the Ground

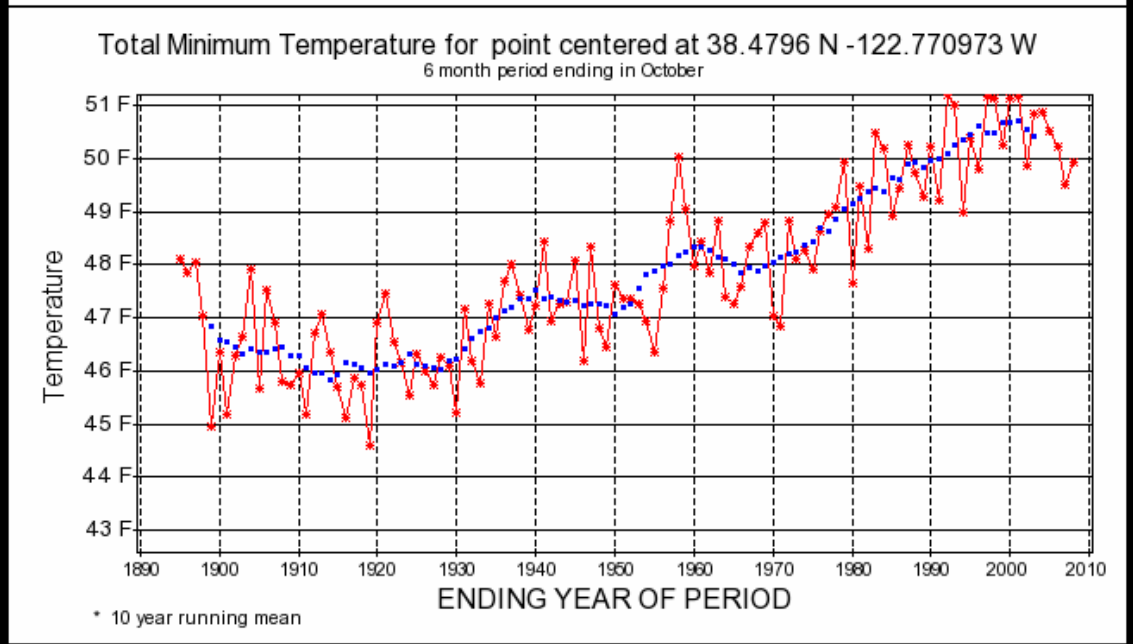
- ***Macroclimate:*** 1000 - 20 km
  Global Circulation, Synoptic Meteorology, Pacific Coast N-S
- ***Mesoclimate:*** 20 – 0.5 km
  Coastal-Inland, broad elevation
  Fulton – Healdsburg- Cloverdale
- ***Topoclimate:*** 0.5 km - 10 m
  solar radiation, relative elevation
  N-S slopes, frost pockets
- ***Microclimate:*** 100 m – 1 cm
  vegetation canopies, either side of trellis
- ***Organism:*** i.e. grape cluster
  physiology, thermal characteristics

Fulton (Russian River Valley) Apr-Oct Temp Westmap



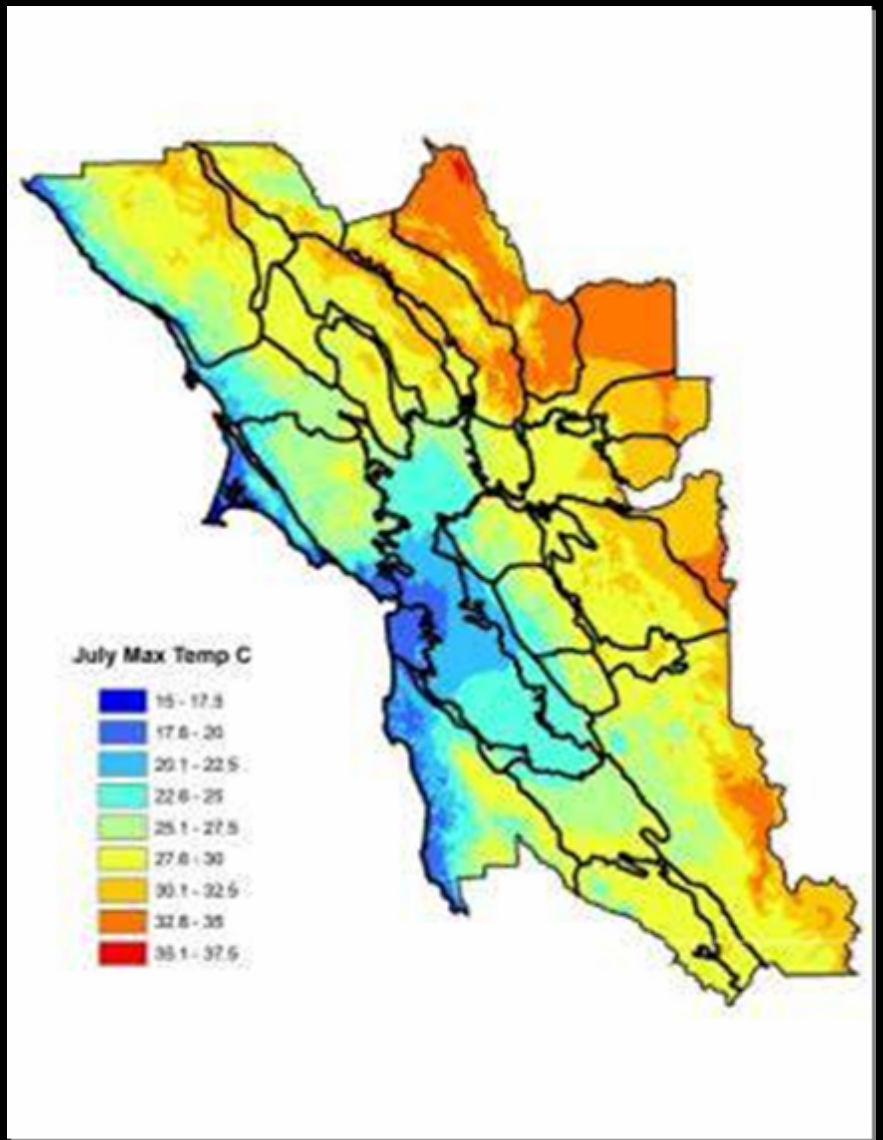
Fulton Max/Min Apr-Oct Temp

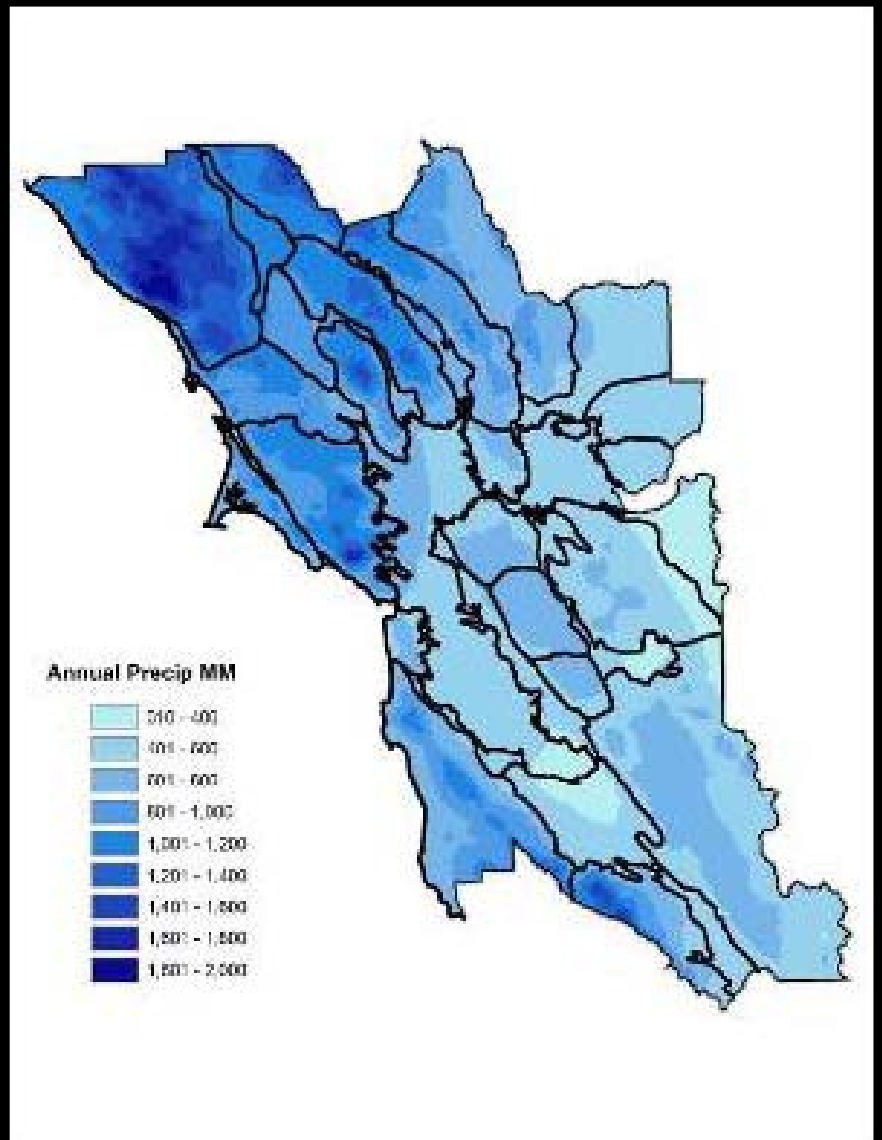




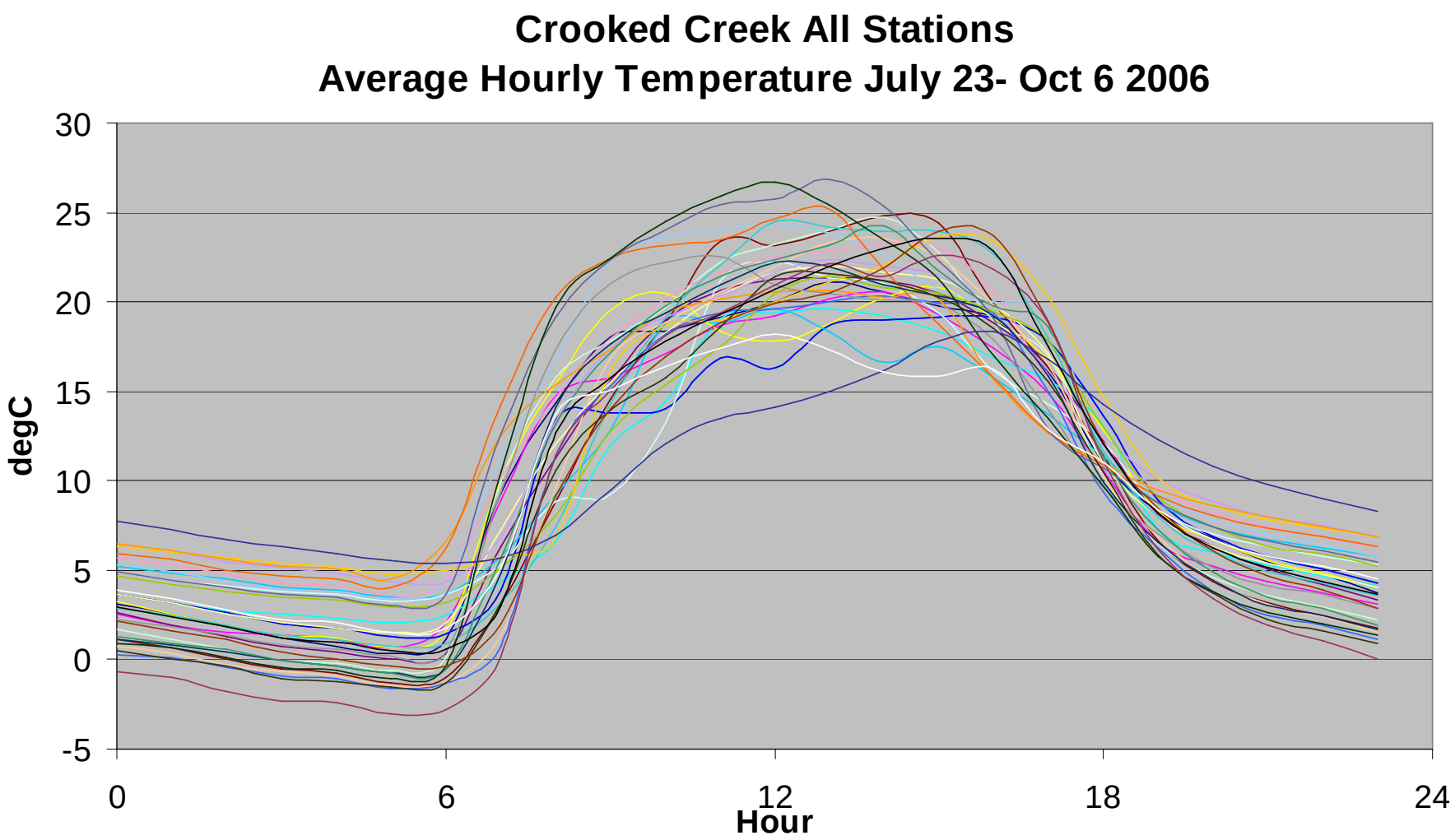
Mesoclimate

800 m Climatic Normals 1971-2000 PRISM

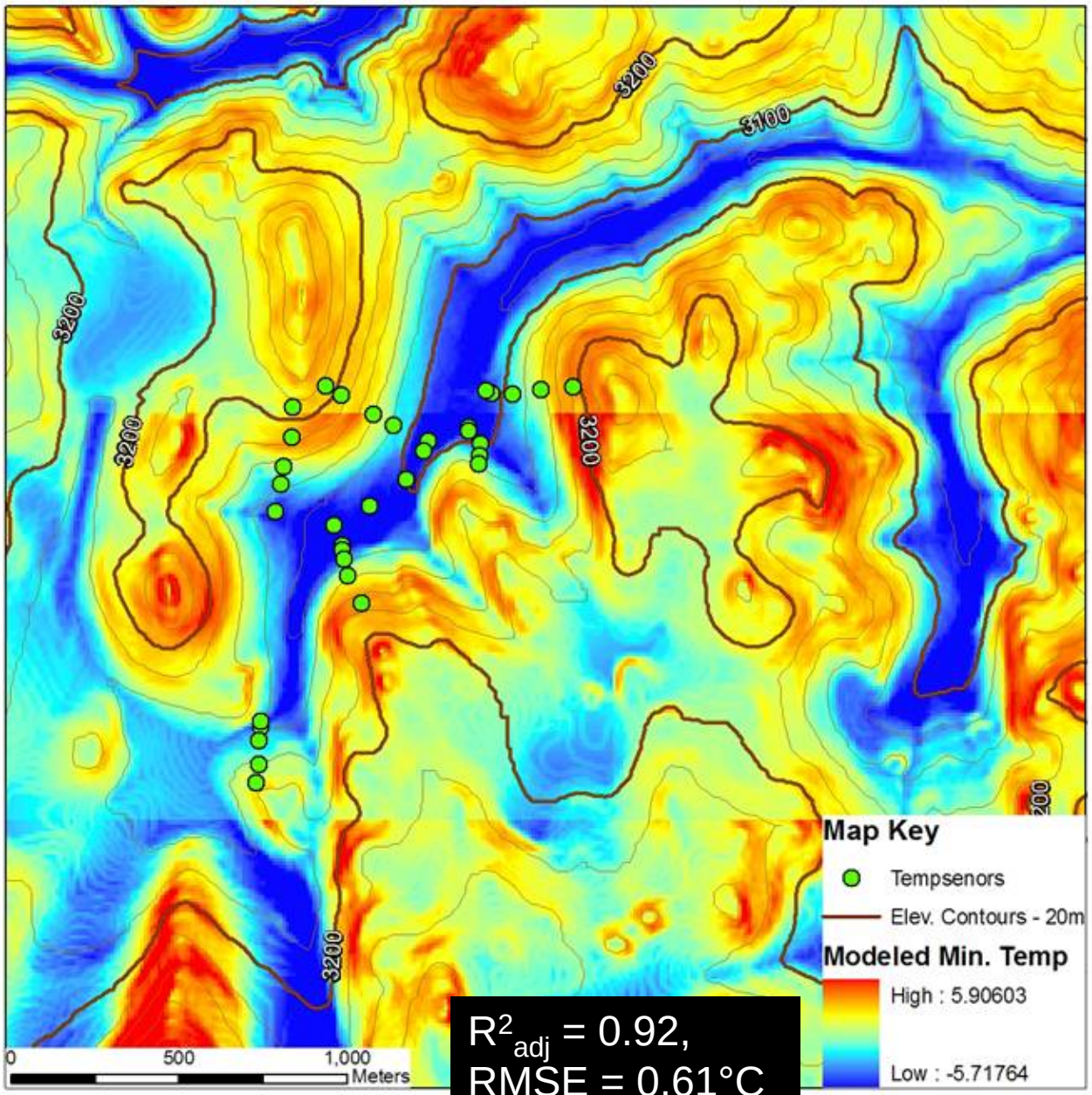




Topoclimate

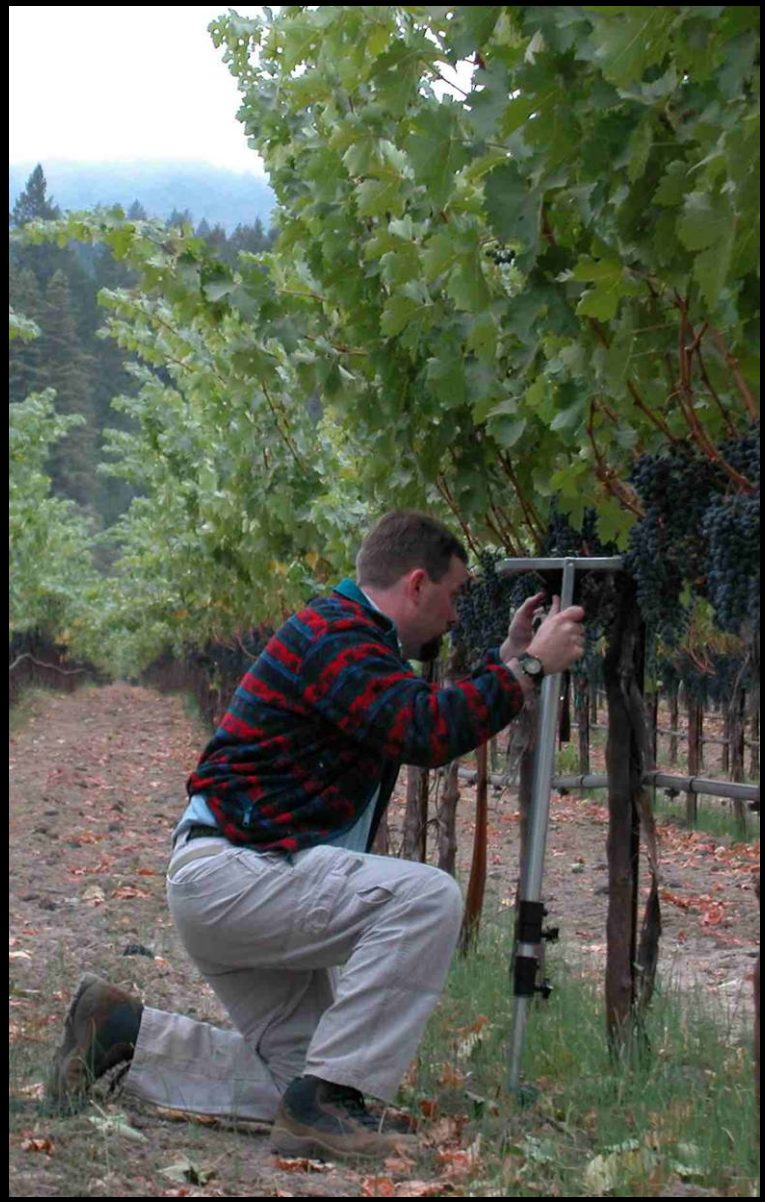


Modeled Minimum Temperature at Crooked Creek

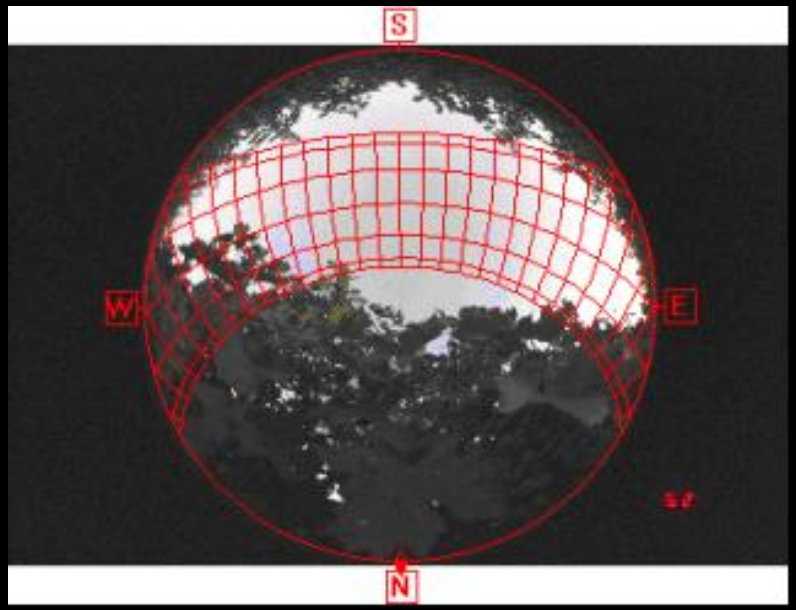


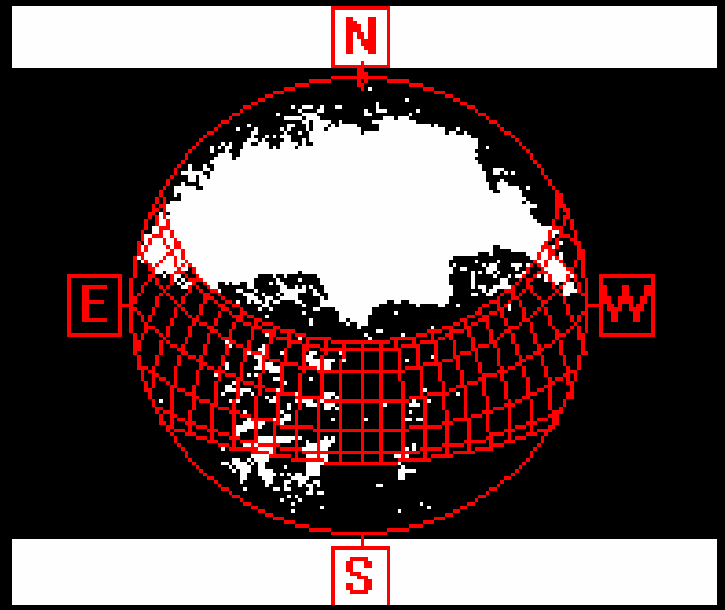
R^2_{adj} = 0.92,
RMSE = 0.61°C

Microclimate: Fish-eye Photography

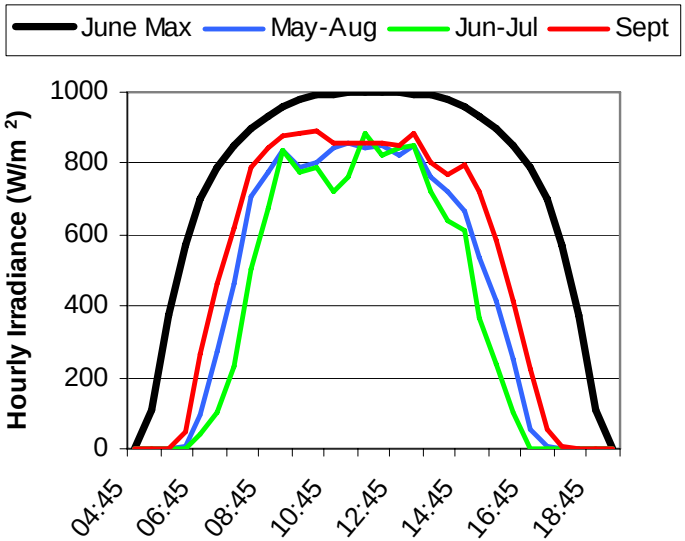


Grapes'-Eye View

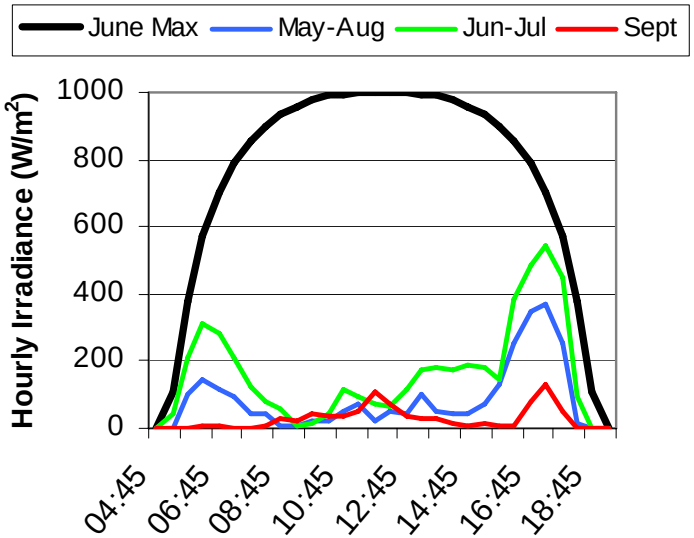




Hourly Irradiance for VSP Clean - South Side

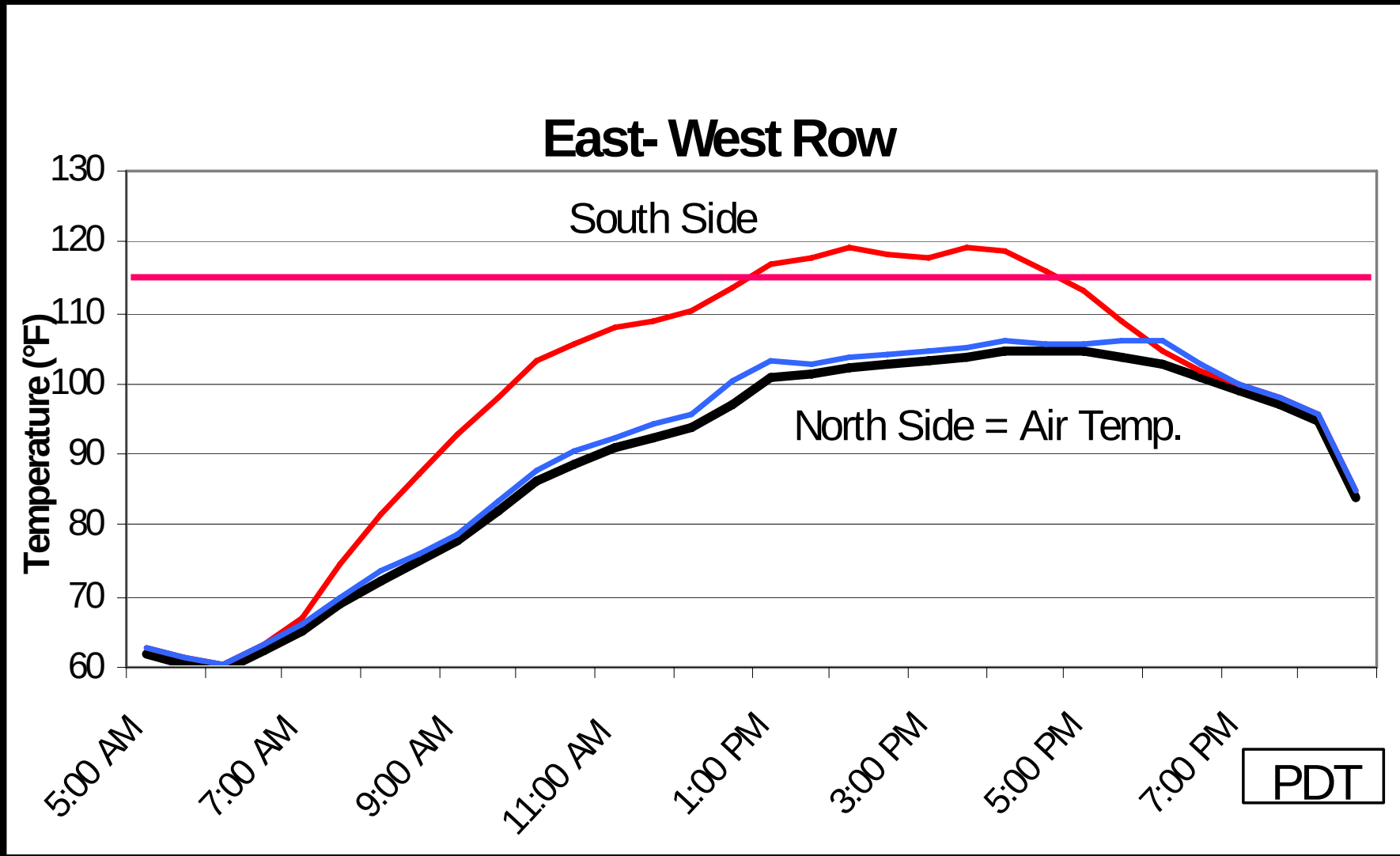


Hourly Irradiance for VSP Clean - North Side

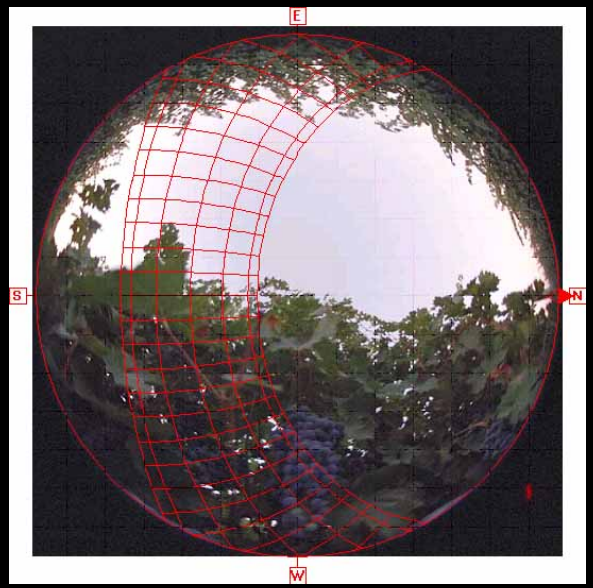


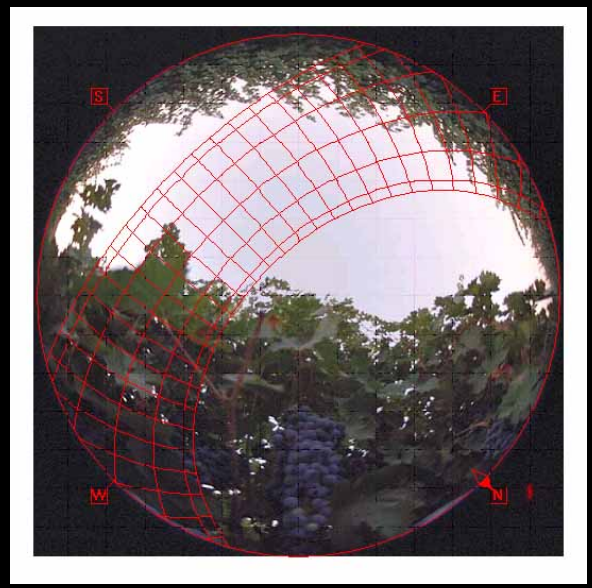
$$T_{grape} = T_{air} + (W/m^2)/45\ (°F)$$

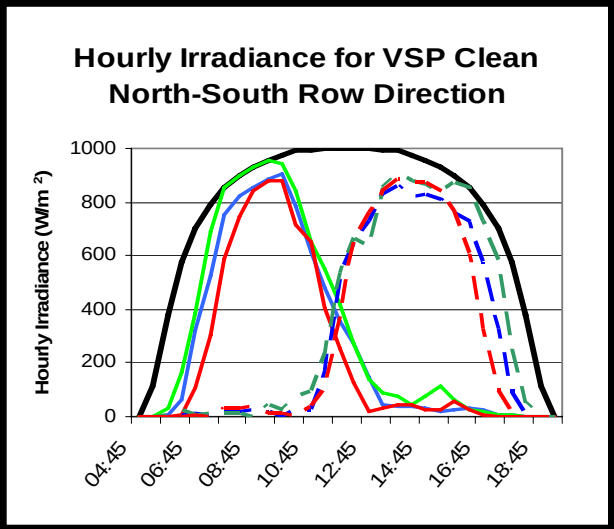
Hot day, No Wind, Exposed Grape "hotspot"

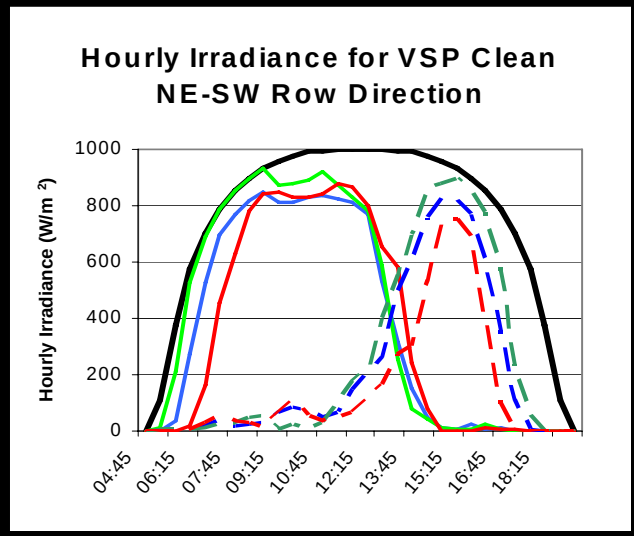


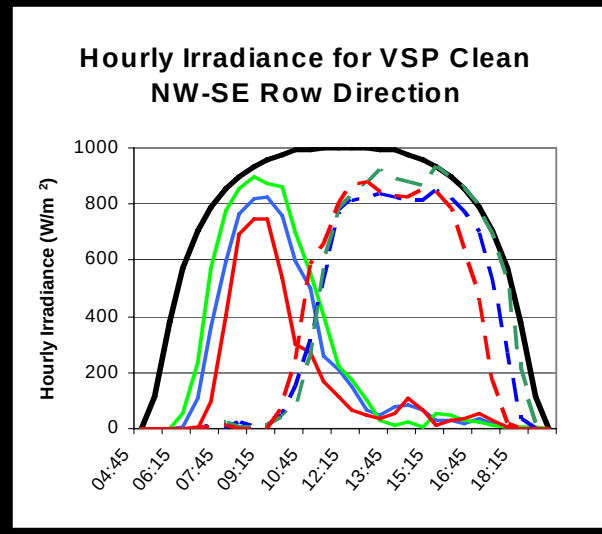
Effect of Row Direction



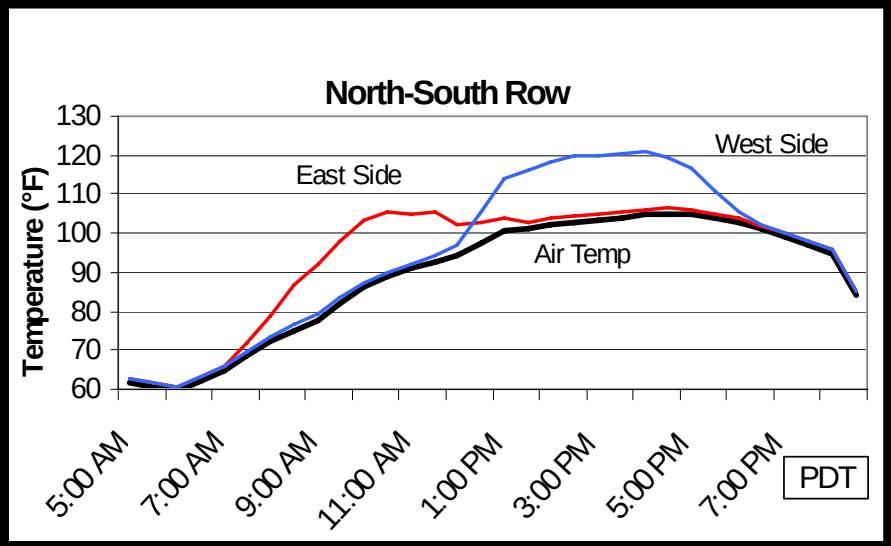


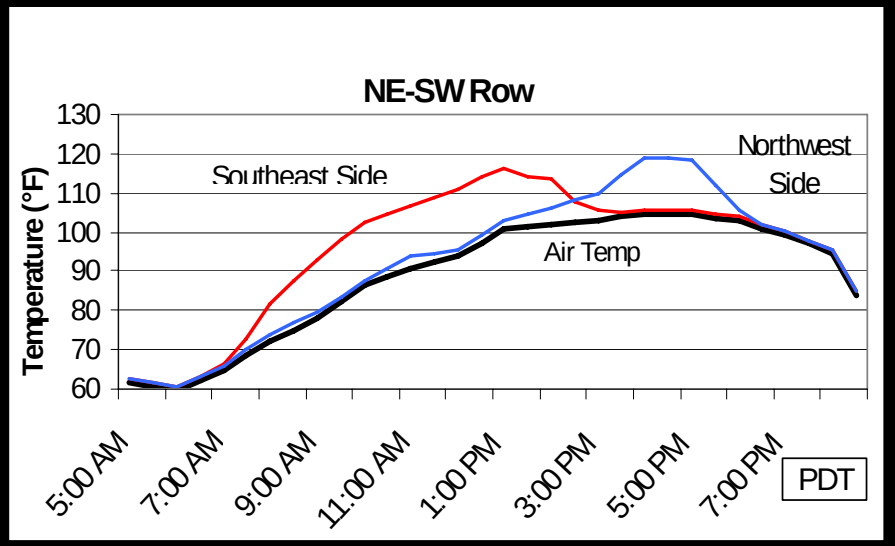


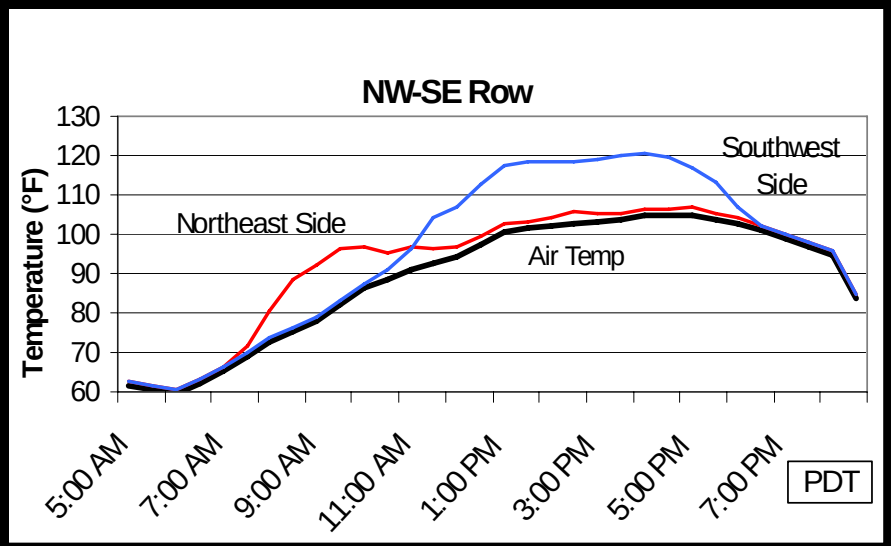


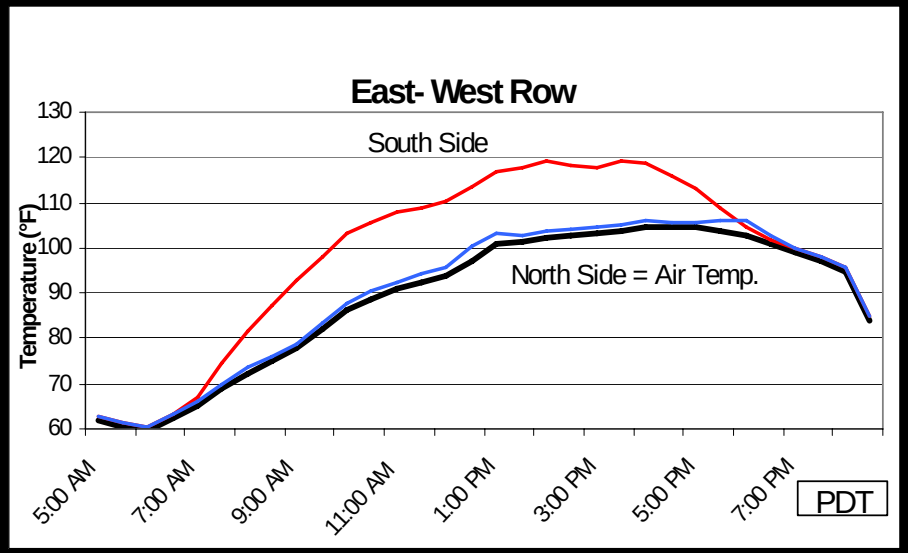


Heat Damage Comparison



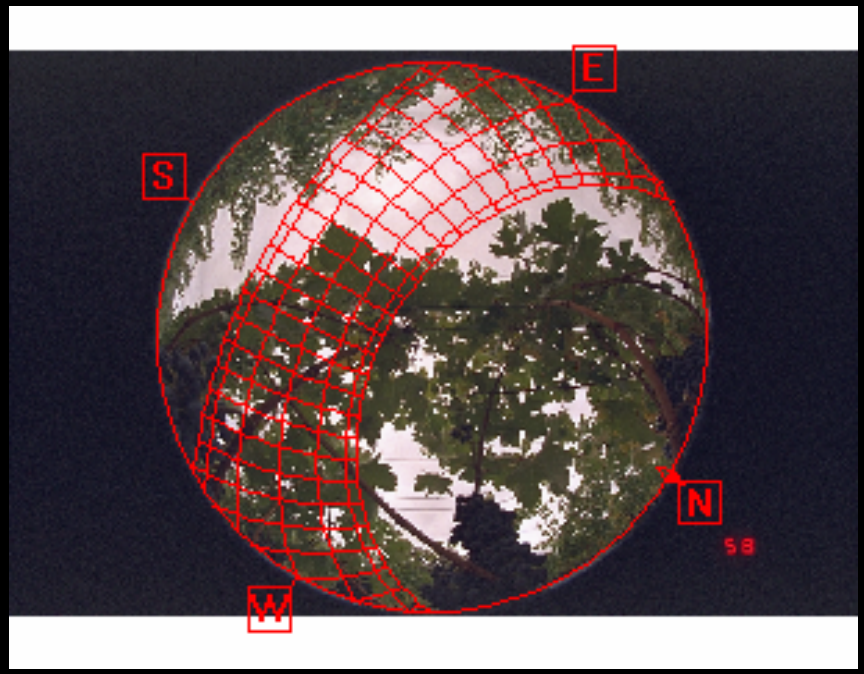


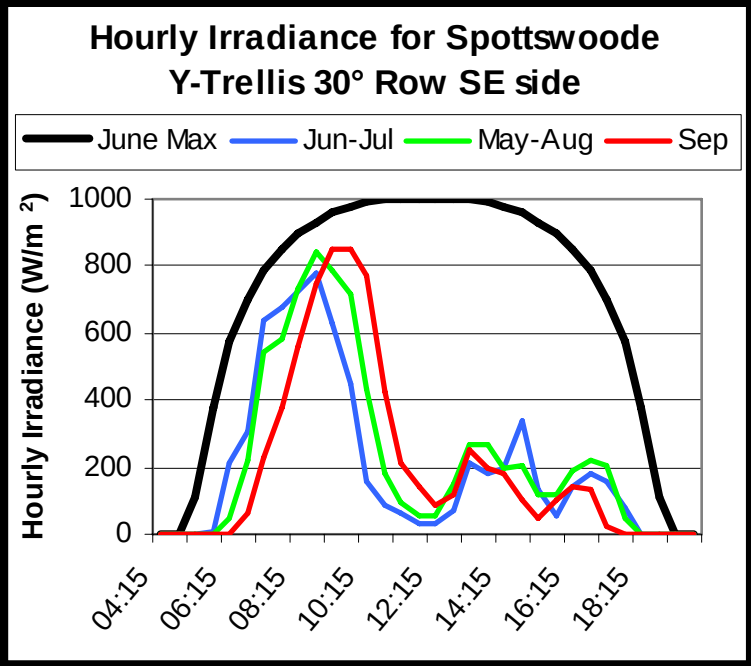


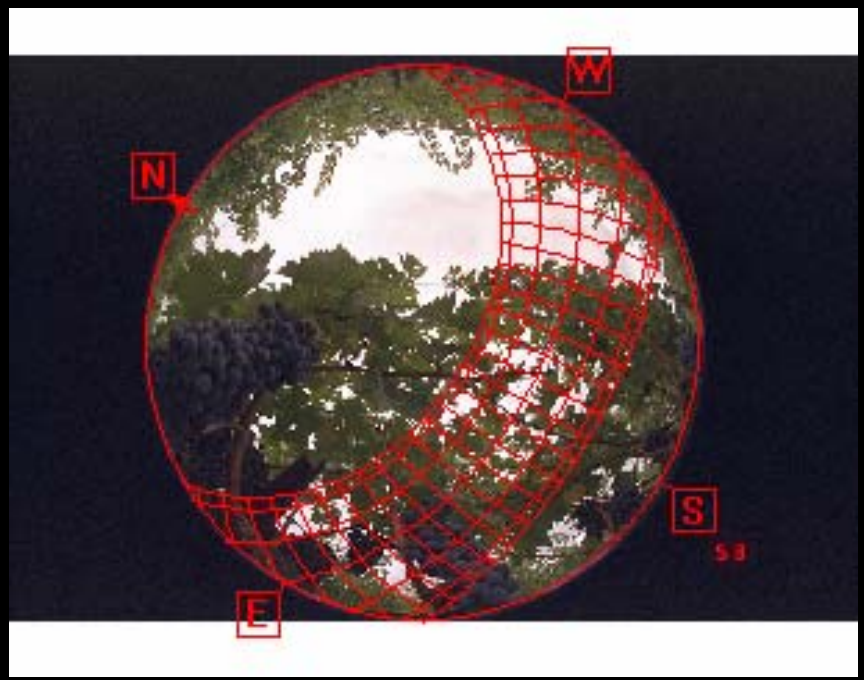


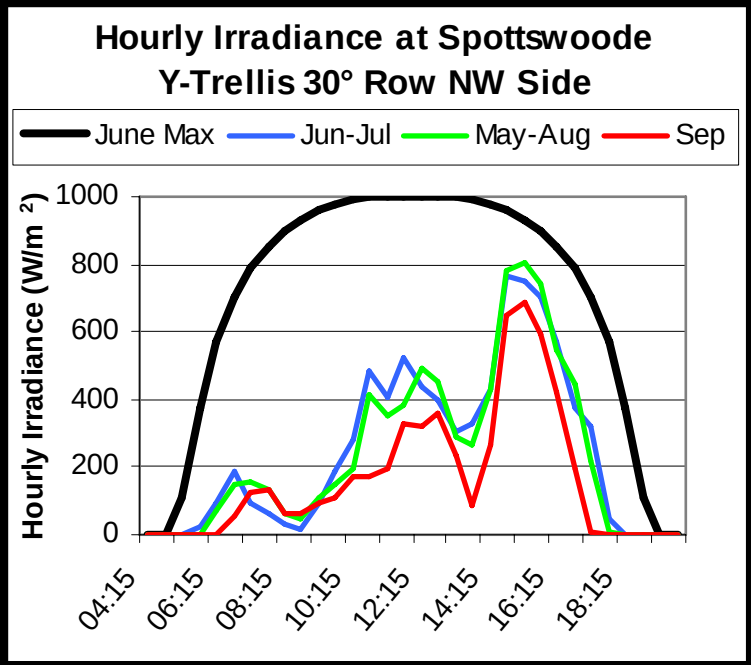
Degree-Hours VSP
105° Day

VSP	DH> 100°F	DH > 105°F
S	111	69
N	28	2
E	39	2
W	94	63
SE	69	27
NW	61	34
NE	28	3
SW	107	72


E
S
N
W

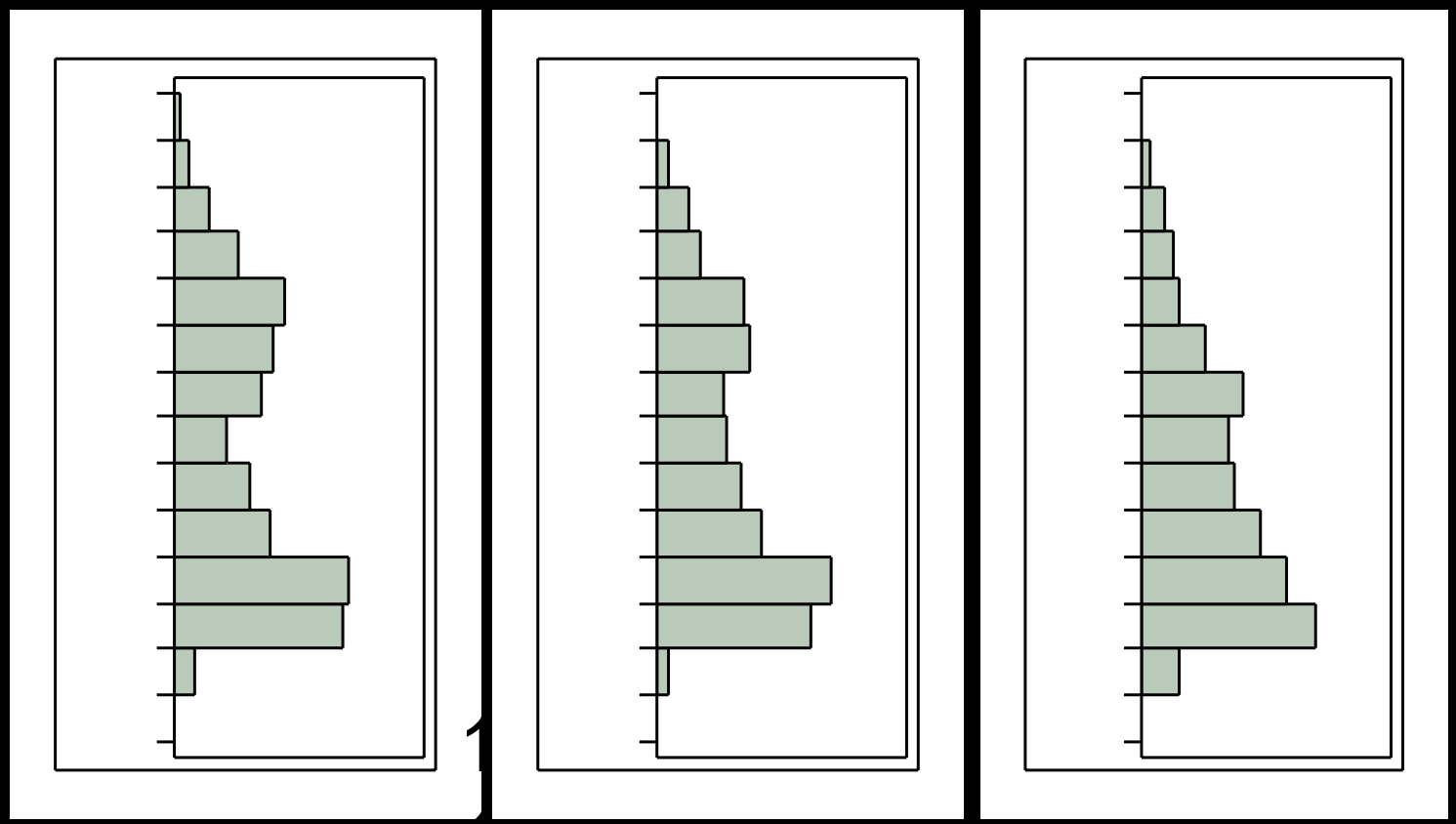

Hourly Irradiance for Spottswoode
Y-Trellis 30° Row SE side
June Max
Jun-Jul
May-Aug
Sep
Hourly Irradiance (W/m 2)
1000
800
600
400
200
0
04:15
06:15
08:15
10:15
12:15
14:15
16:15
18:15


W
N
S
E


Hourly Irradiance at Spottswoode
Y-Trellis 30° Row NW Side
June Max
Jun-Jul
May-Aug
Sep
Hourly Irradiance (W/m 2)
1000
800
600
400
200
0
04:15
06:15
08:15
10:15
12:15
14:15
16:15
18:15

Berry temperatures Jul 31- Aug 31 Sprawl Trellis

SE -Side NW -Side Air



Climate change adaptation

- 30-year lifetime of a vineyard
- Canopy management
- Re-trellis (crossarms)
- Re-graft to different variety
- Replant

Conclusions

- Macro-, meso-, topo-, micro-climate
- Winegrapes are very sensitive to temperature
- Excellent model system for climate impacts
- Tools to predict grape temperatures from weather station data