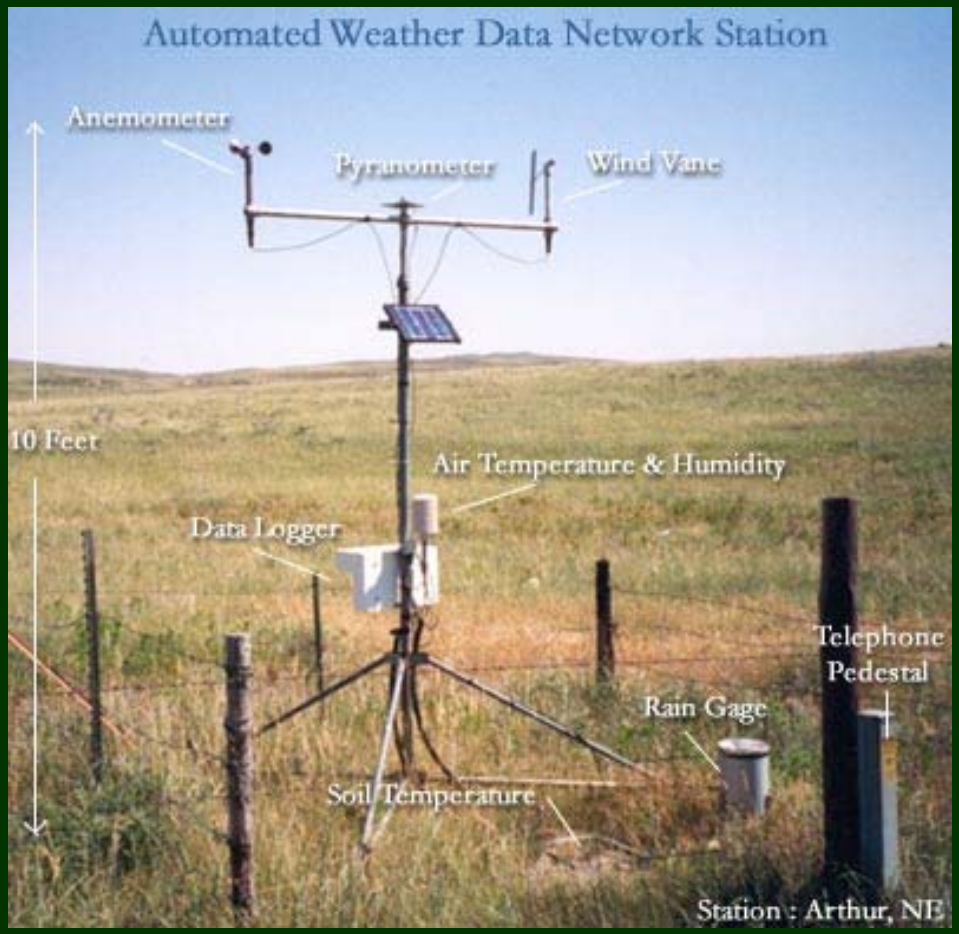
Climate, Weather, and Instrumentation in the Vineyard

- Microclimate and real-time weather measurements are equally important in the vineyard, but they needed for different scales of decision-making
- For vineyard establishment, long-term climatic records are needed for selection of cultivars and potential wine/grape products (wine, jelly, and table; organic or low chemical inputs)

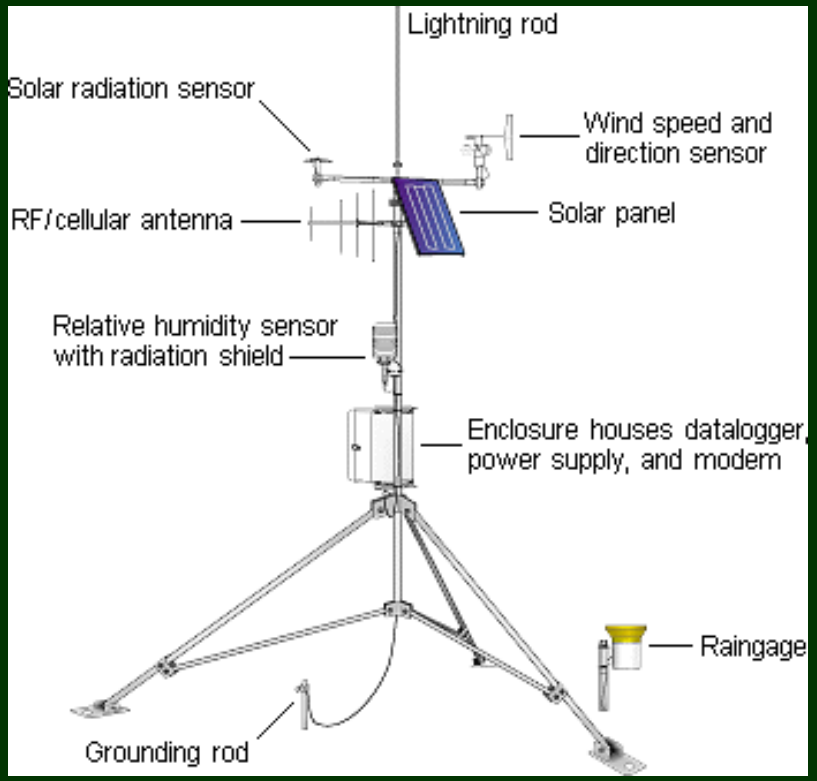
Cuthills Vineyard

- Near-real time weather information is needed for adaptive/tactical (integrated pest—insects and weeds, supplemental irrigation, soil fertility, frost, chemical drift, or insurance claims) management of the vineyard
- Make the best use of onsite monitoring coupled with long-term weather data networks (NWS Cooperative Stations and the HPRCC's AWDN

✹For vineyard establishment, long-term climatic records are needed for selection of cultivars and potential wine/grape products (wine, jelly, and table; organic or low chemical inputs); matching cultivars to the best landscapes and environments in Nebraska.



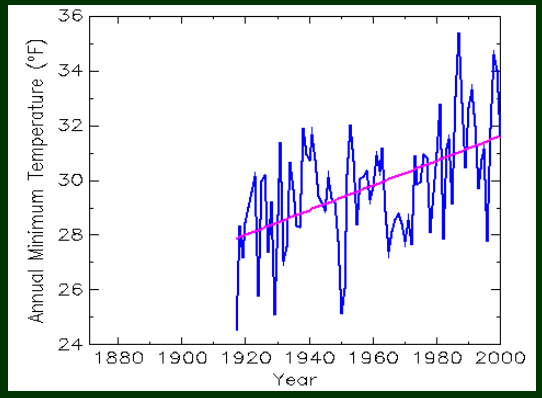
UNL HPRCC Automated Weather Station



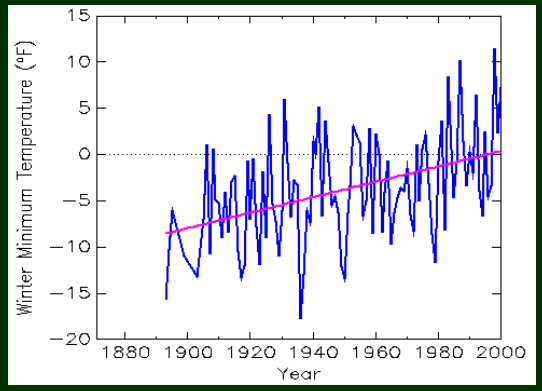
National Weather Service Cooperative Stations

Assumption Abbey, Richardton, ND

- Many of the Cooperative Stations have long-term records, but they collect daily Tmax, Tmin, and precipitation
- A good source to construct soil water balances and understand climatic change

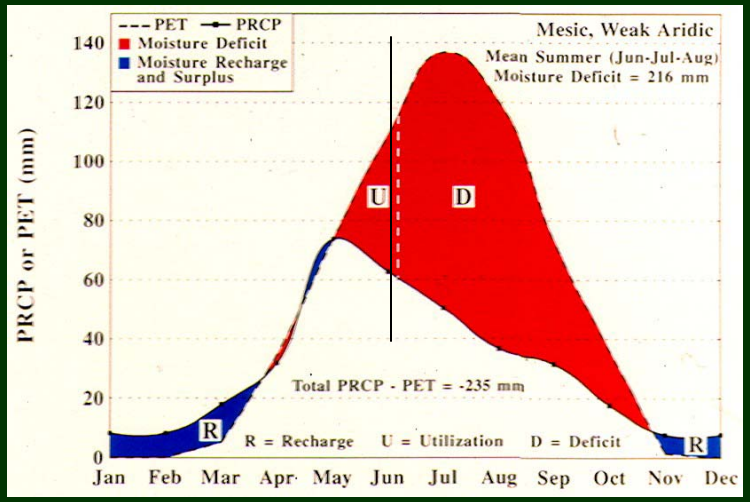


- **The Abbey has a working cattle ranch**
- **Detection of global change at local scales**
- **Tmin and Tmin winter are increasing through time**

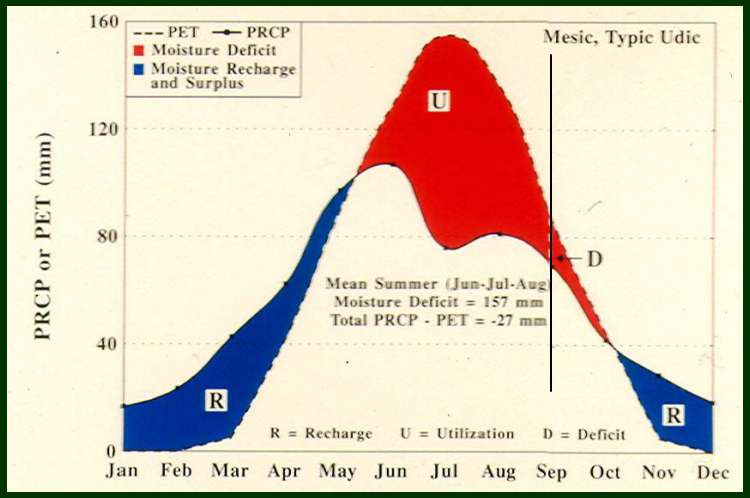


National Weather Service Cooperative Stations

Agate, NE

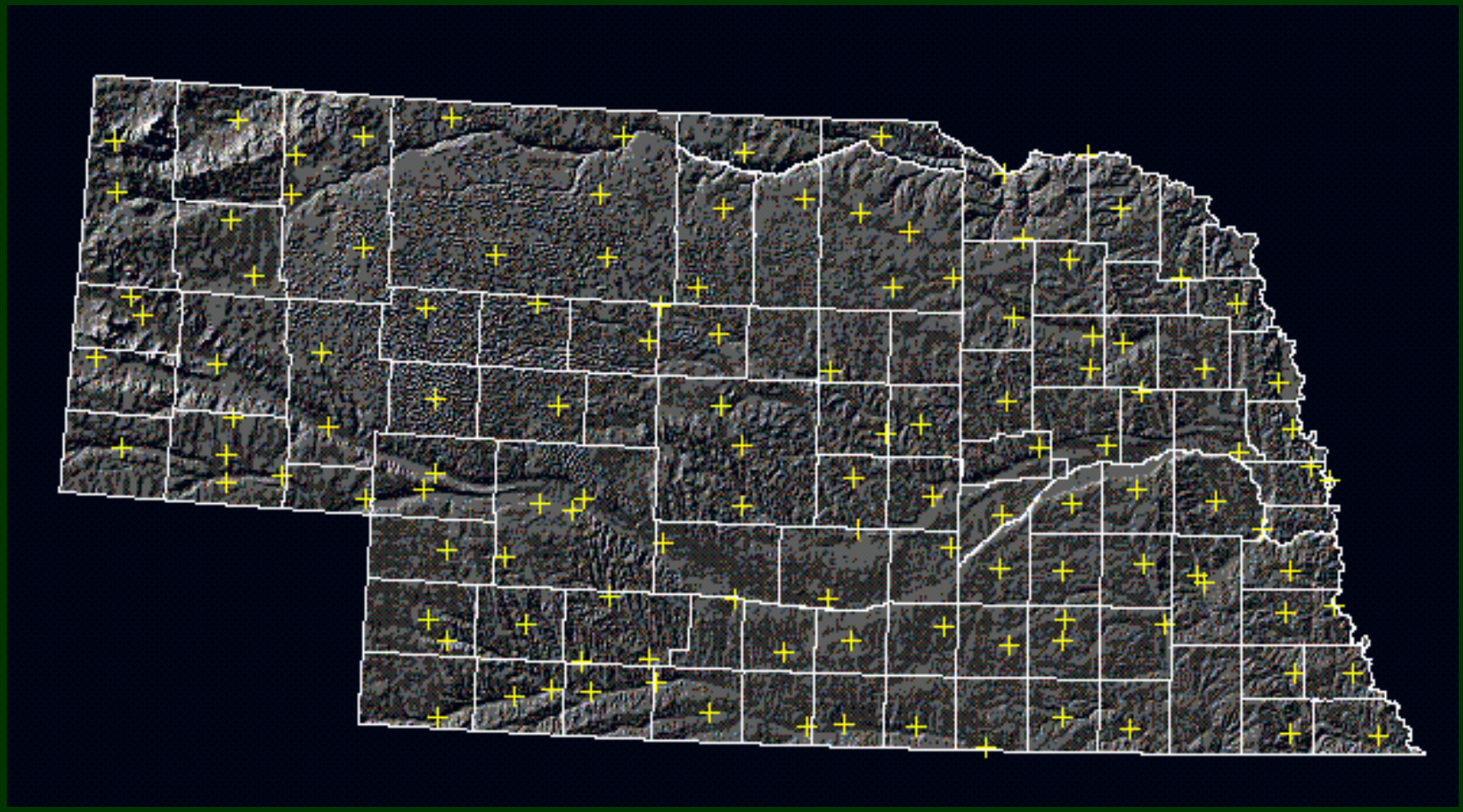


Hartington, NE



- Many of the Cooperative Stations have long-term records, but they collect daily Tmax, Tmin, and precipitation
- A good source to construct soil water balances and understand climatic change
- A way of recognizing equivalent soil moisture regimes
- The larger the “red” region, the greater the soil moisture deficit during the growing season
- U = Utilization of stored, plant available soil moisture
- D = Soil moisture deficit; when the soil profile is dried out within 1 m of the soil surface
- R = Recharge or recovery period

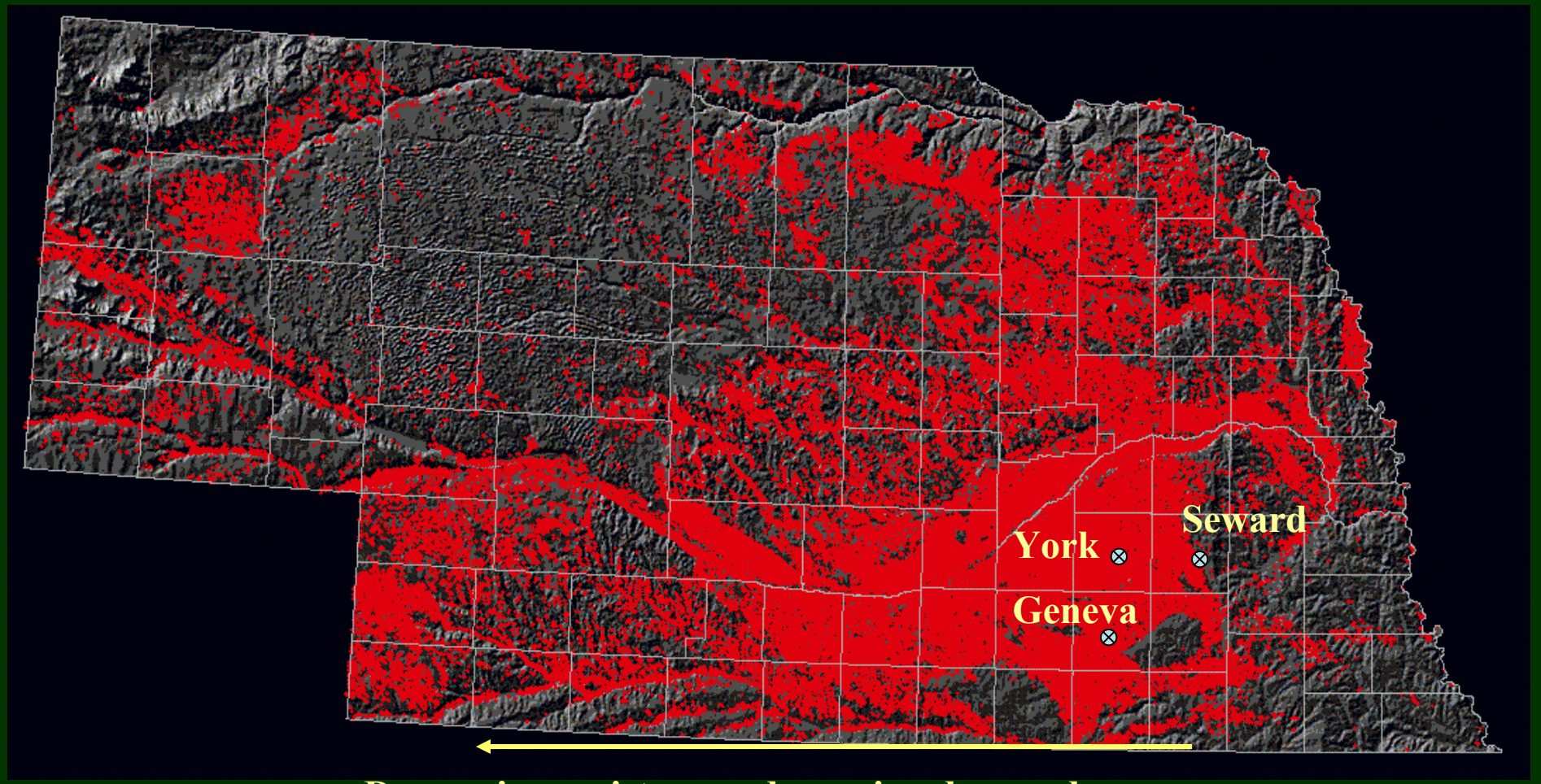
National Weather Service Cooperative Stations



- There are roughly 125 (precipitation and temperature) to 180 (precipitation only) Cooperative Stations with 1949-present records in Nebraska, collecting daily Tmax, Tmin, and precipitation
- There are 54 “centennial” stations with >100 years of record

Irrigated Lands of Nebraska

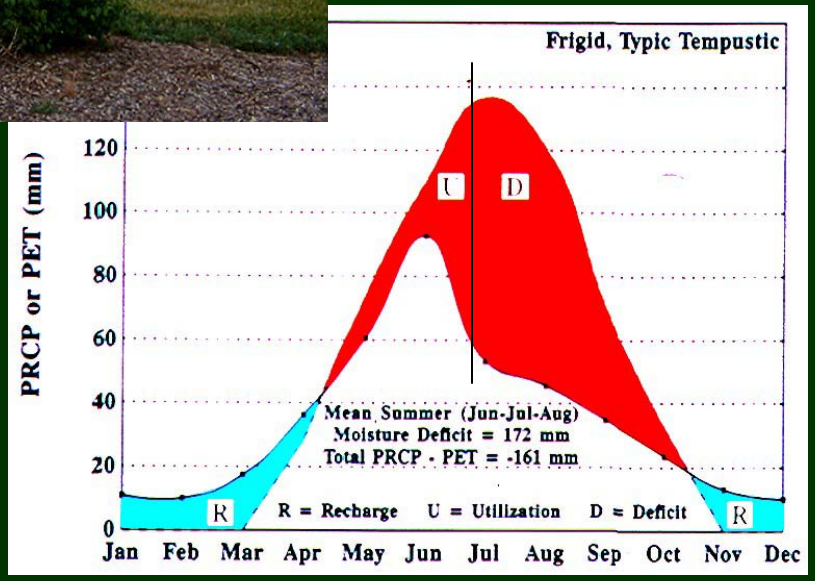
- More than 8 million acres pumping moisture with potential impacts to dew point, relative humidity, and temperature



National Weather Service Cooperative Stations

- Example—Dickinson, North Dakota
- >100 yrs of climate record along with AWDN station
- Daily precipitation, Tmax, Tmin, and some pan evaporation

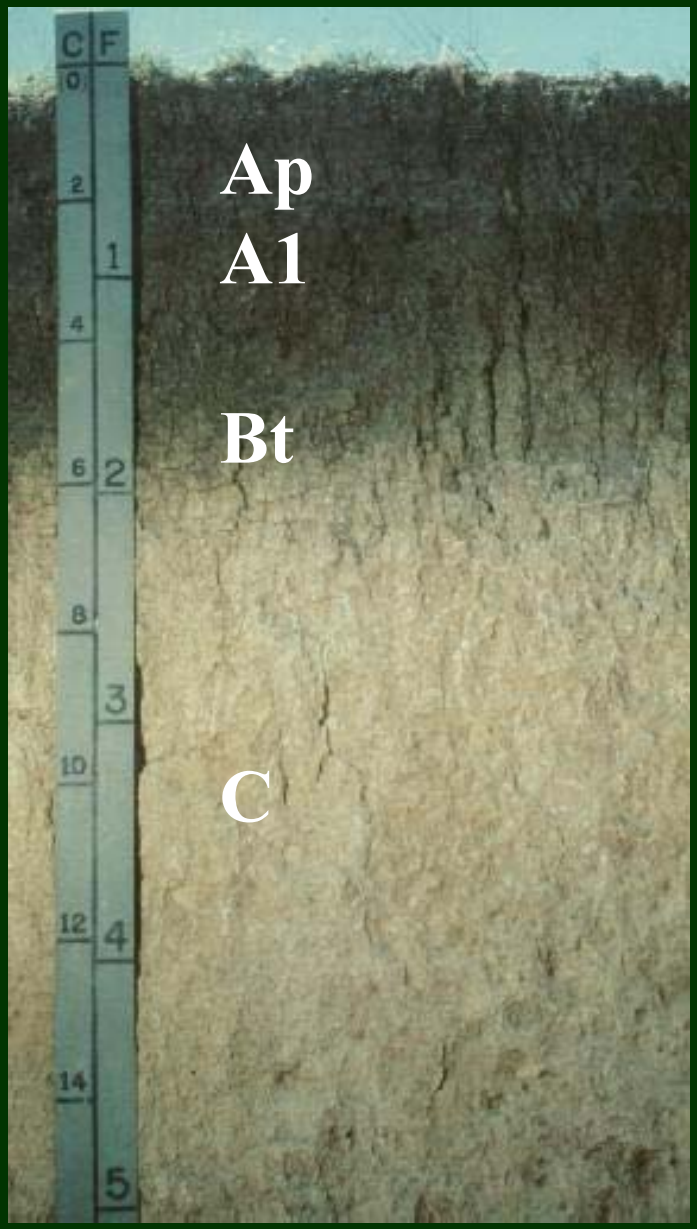
- **Agricultural research stations are good sources to link your vineyard site to their climate record**
- **They may not directly correlate, but the vineyard will likely share some behavioral similarities; build "rules of thumb" to between stations**

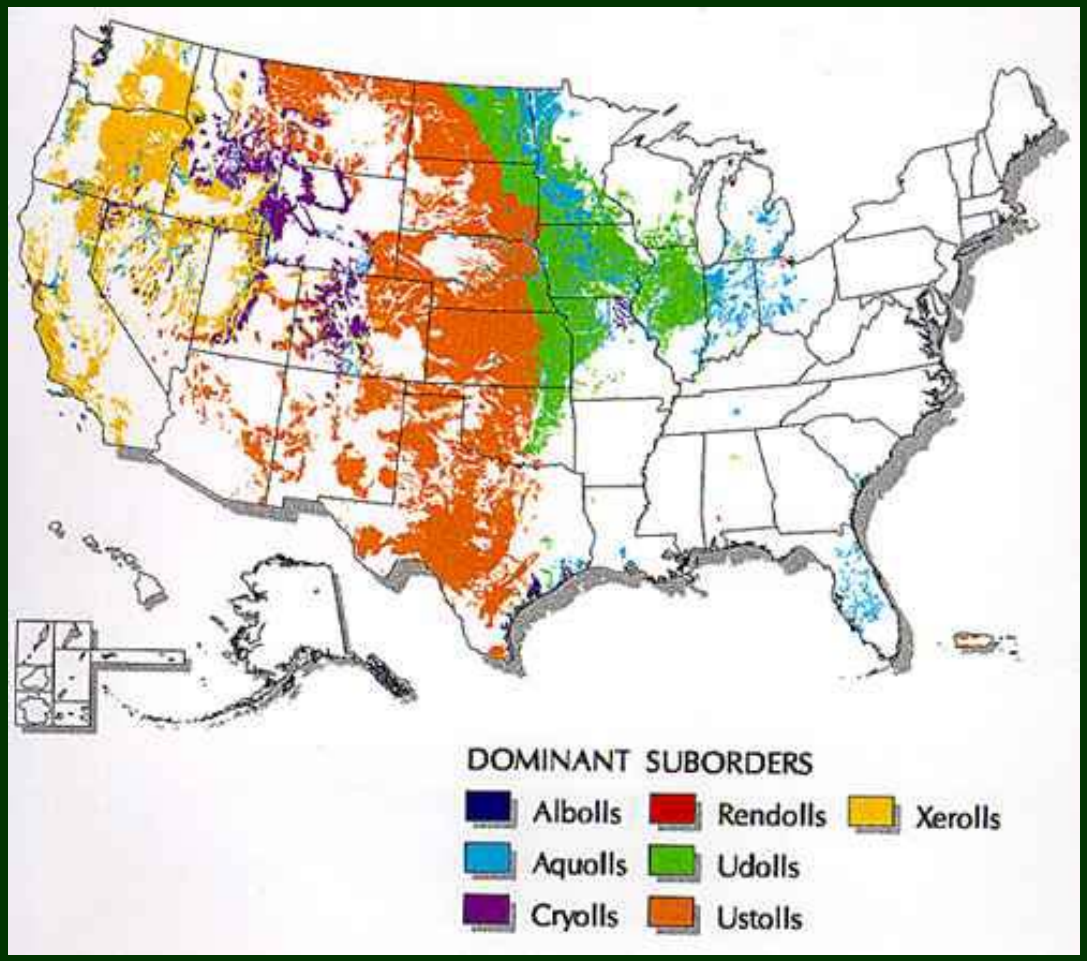


Soils and Climate

- The Automated Weather Data Network (HPRCC) and NWS Cooperative Stations are used to model soil moisture regimes—estimate the potential evapo-transpiration and construct a soil water balance
- How many days and when is this soil profile moist throughout, moist/dry in some part, or dry throughout during the growing season?
- How much soil moisture is stored or recharged during the dormancy period?
- In loess-derived (the deep windblown silts of Nebraska) soils, grape vines can extend their roots to depths of 20 to 40 ft without restriction. So, these soils can readily store large amounts of water to buffer drought events.

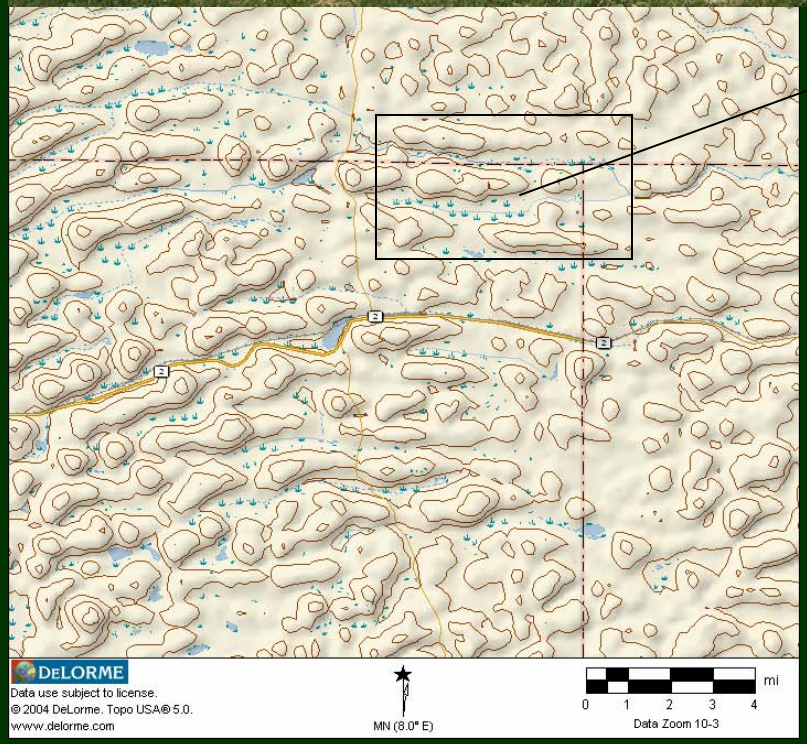
Mollisols





- Prairie soils often formed in loess (windblown silts)
- Inherently high fertility and plant available water-holding capacity; often sulfur deficient and pH ranges 6.6 to 7.8

Gudmundsen Ranch—A Sandhills Environment



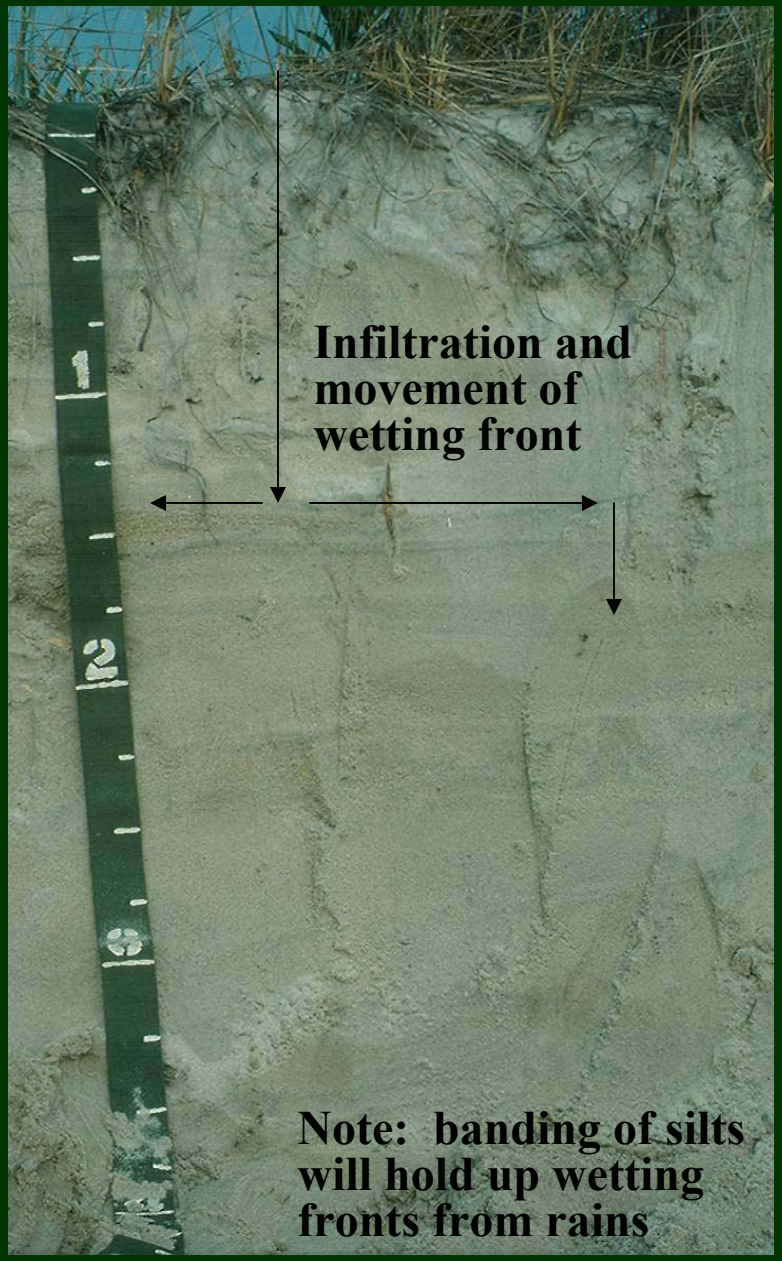
Mean Annual Precipitation = 18.07 in
Mean PET = 24.32 in
MAP-PET = -6.25 in (AWB)
Growing Degree-Days = 2419
Frost-Free Period = 151

A good vineyard site?

Gudmundsen Ranch—A Sandhills Environment

Mean Annual Precipitation = 18.07 in
Mean PET = 24.32 in
MAP-PET = -6.25 in (AWB)
Growing Degree-Days = 2419
Frost-Free Period = 151

Low water-holding capacity soils and limited FFP and GDDs



The Uncertain Climate of the Sandhills

Weather Station	Mean Values					
	Elev (ft)	PREC (in)	GDD (50°F)	FFP (28°F)	Tmin Extreme (°F)	Days -10 to -20°F
Ellsworth 15NNE	3970	17.65	2473	151	-23.9	5.8
Gudmundsen Ranch	3441	17.89	2419	151	-16.1	3.9
Hay Springs 12S	3805	15.70	2450	144	-24.4	6.1

Weather Station	Length of Record	USDA Plant Hardiness Zone	Absolute Tmin Extreme
Ellsworth 15NNE	1963-2002	4b	-42°F
Gudmundsen Ranch	1982-2002	5a	-30°F
Hay Springs 12 S	1963-2002	4b	-42°F

Possible Varieties: Beta, St. Croix, Frontenac, Prairie Star, Valiant, and Elvira

Onsite weather stations provide you with real-time, local weather and microclimate information rather than measurements from a TV or radio station, or an airport 30 miles away.

Vineyard Parameters

- Evapotranspiration
- Wind speed and direction
- Wind chill
- Dew point
- Solar radiation
- Air temperature
- Relative humidity
- Rainfall

Select measurement intervals of 1, 10, 15, 30, 60, or 120 minutes.

Sensor	Measurement Range	Accuracy
Wind Speed	0-175 mph	±5%
Wind Direction	2° increments	±7°
Temperature (Wind Chill)	-30° to 100°C -22° to 212° F -40° to 104°C -40° to 40° F	±0.7°C ±1°F ±4°F ±2°C
Relative Humidity*	20% to 100% @5° to 50° C	±3%
(Dew Point)	-99°F to 140°F -73°FC to 60°C	±4°F ±2°C
Rainfall	0.01" (0.25cm) resolution	±2%
Solar Radiation**	1-1250 W/m^2	±5%

WatchDog 900ET Weather Station

Air Temperature & Soil Temperature/Moisture

The Vineyard Weather Station is designed to support irrigation and disease management in vineyard applications. Two soil moisture sensors are utilized to determine soil moisture levels within the upper and lower limits of your vines' root zone. A 6 and 20-foot soil moisture sensor cable are provided with consideration of a vine's root depth (often > 8 ft). Pedological Degree-Days, soil heat units (>40 ^{o}F) can be a good predictor for premature budbreak or insect hatches/arrivals.

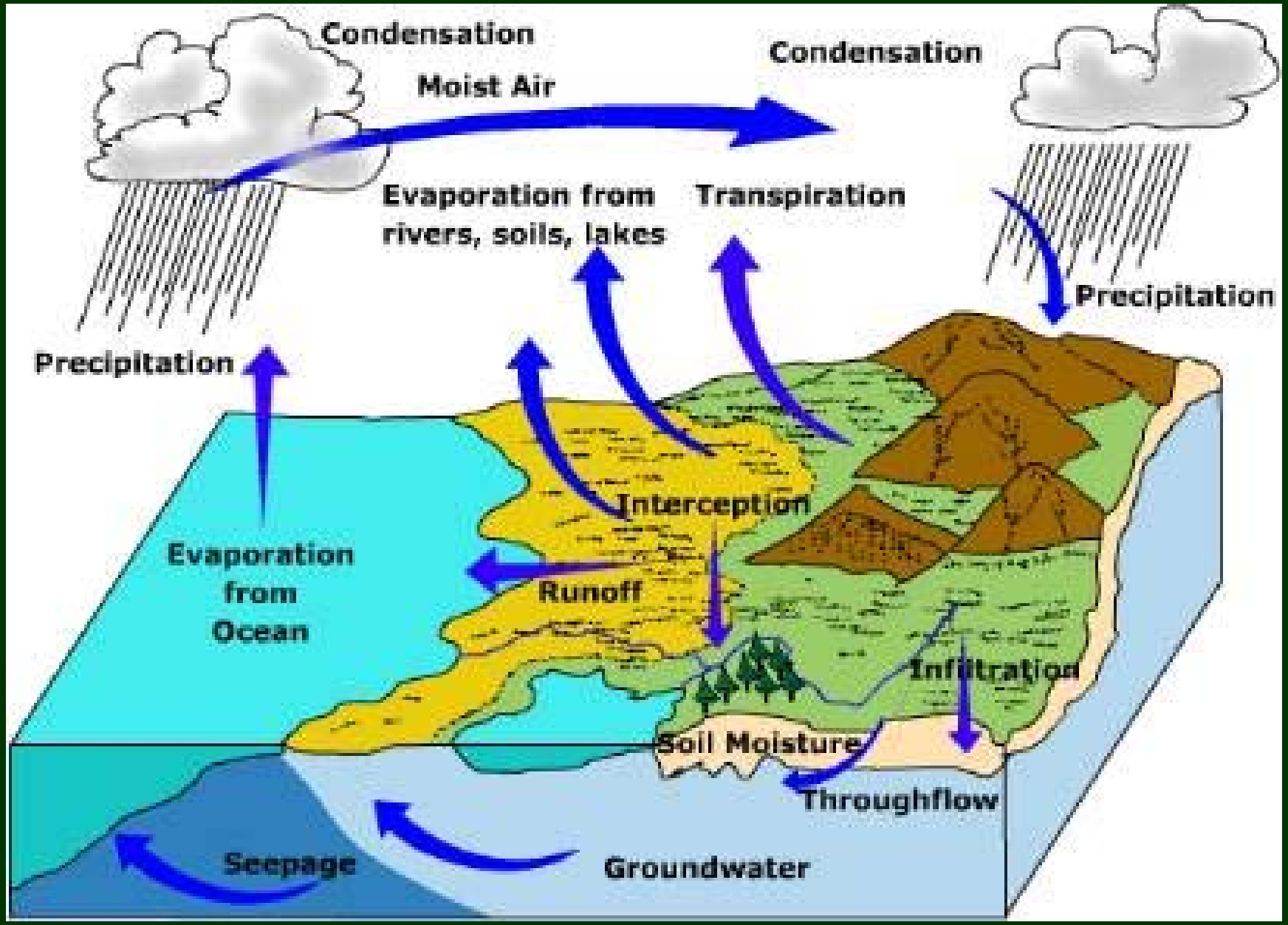
Campbell Scientific

- Parameters for Vineyards
- Evapotranspiration
  Soil moisture
  Irrigation scheduling
  Heat/chill monitoring
  Integrated pest management
  Pesticide and fertilizer application
  Frost prediction
- MetData1 Weather Station
- WeatherHawk wireless home station

HOBO Data Loggers and Weather Stations

- Weather Station Starter System at ~$1100

The Hydrologic Cycle and Vineyards

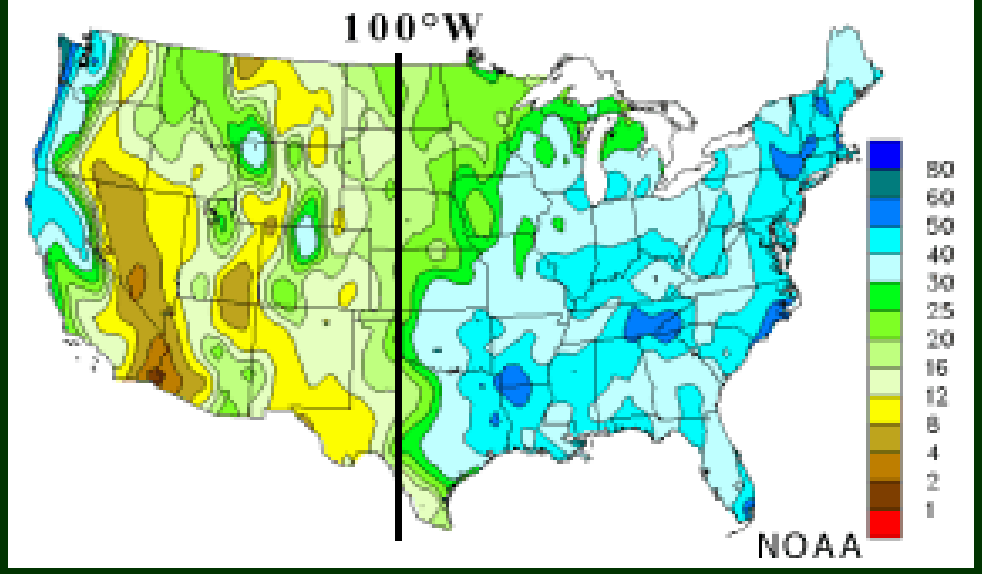


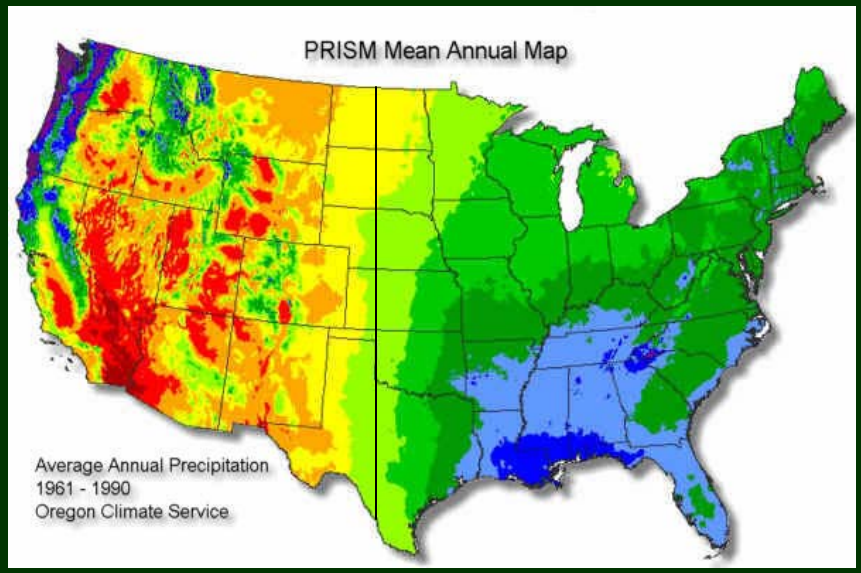
Annual Water Balance = PREC - ET_p

- **Where AWB is positive, there is a moisture surplus and a soil leaching environment; where negative, there is a moisture deficit**

Mean Annual Precipitation

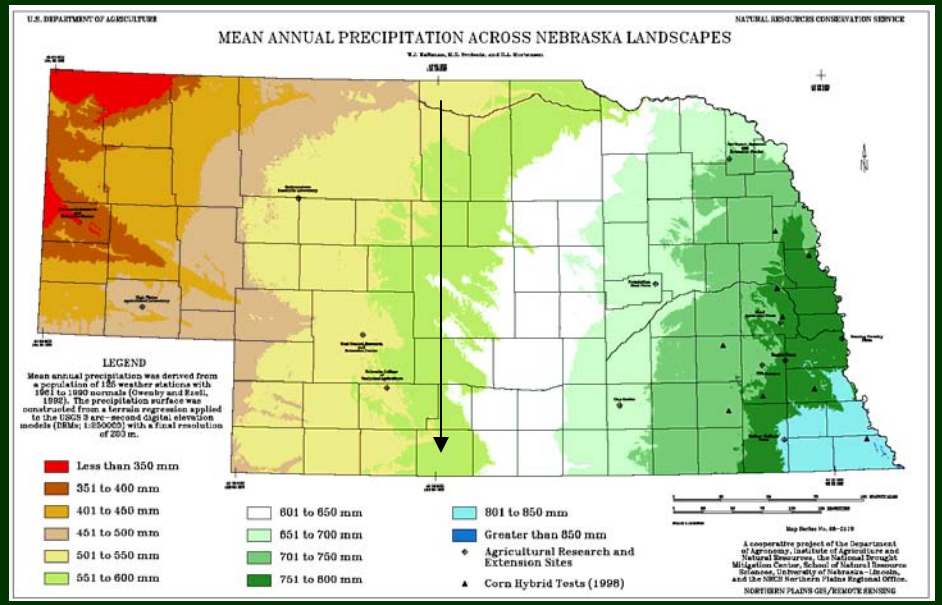
- **The 100th Meridian is often associated with the boundary for semiarid and humid climates**

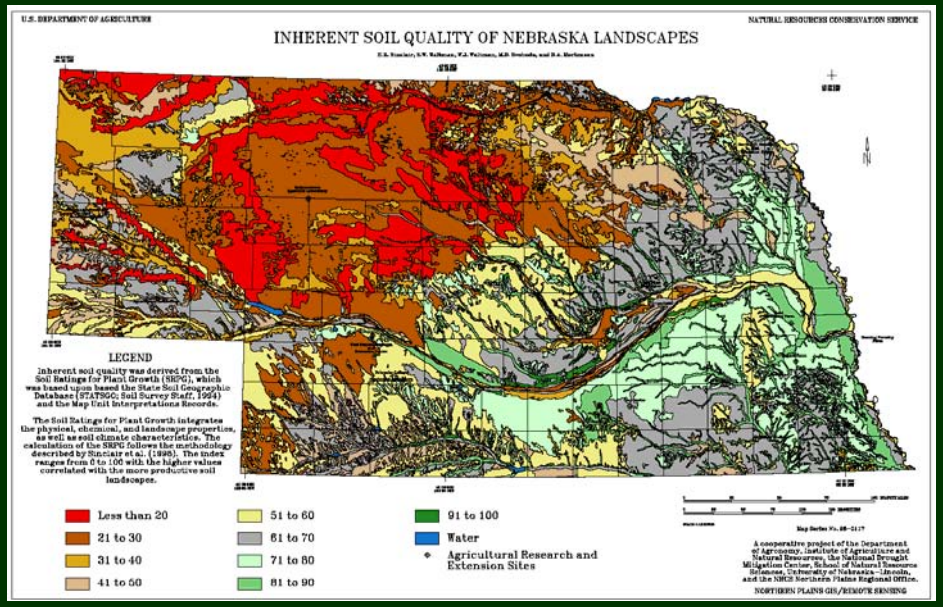


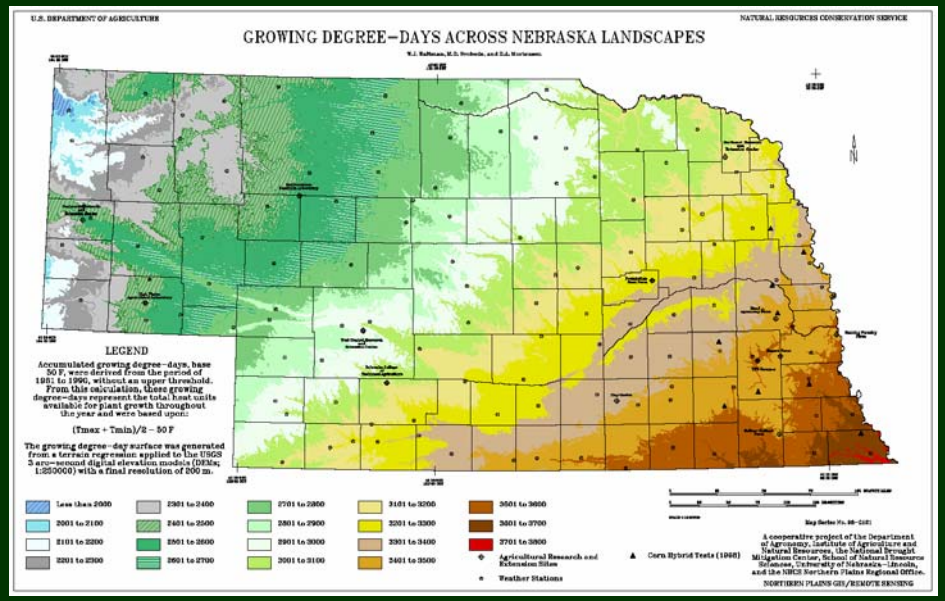


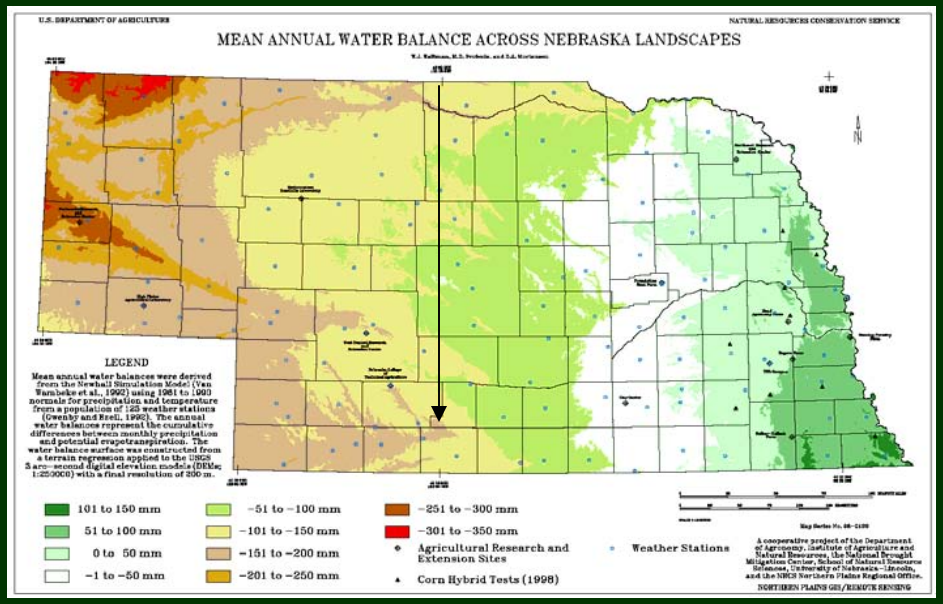
In Nebraska, precipitation ranges from 13 to 33 inches

Climate and Soil Characteristics of Nebraska









Summary and Conclusions

- Need to correlate your vineyard site to a nearby cooperative or AWDN weather station to understand your site (microclimate) in relation to the regional climate
- Use as much long-term, historical records for the nearest Cooperative Station to better understand trends and the potential for climate change; selection of cultivars
- Having an onsite weather station translates into interpreting a large amount of daily data, calibration, and correlation to neighboring stations; need to consider what decisions it facilitates in IPM, frost prediction and management, irrigation scheduling, and vine management
- It can provide solid documentation for insurance claims and understanding the long-term behavior of vines and quality of grapes during specific weather events and growing seasons