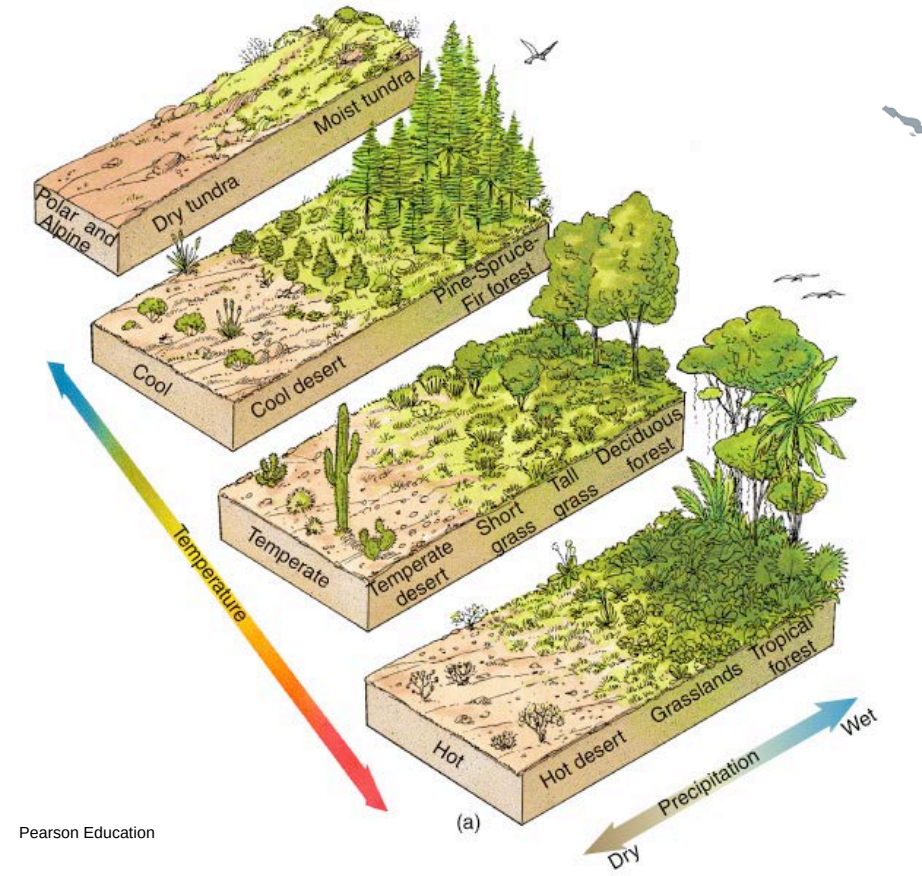
The Science of Global Climate Change:

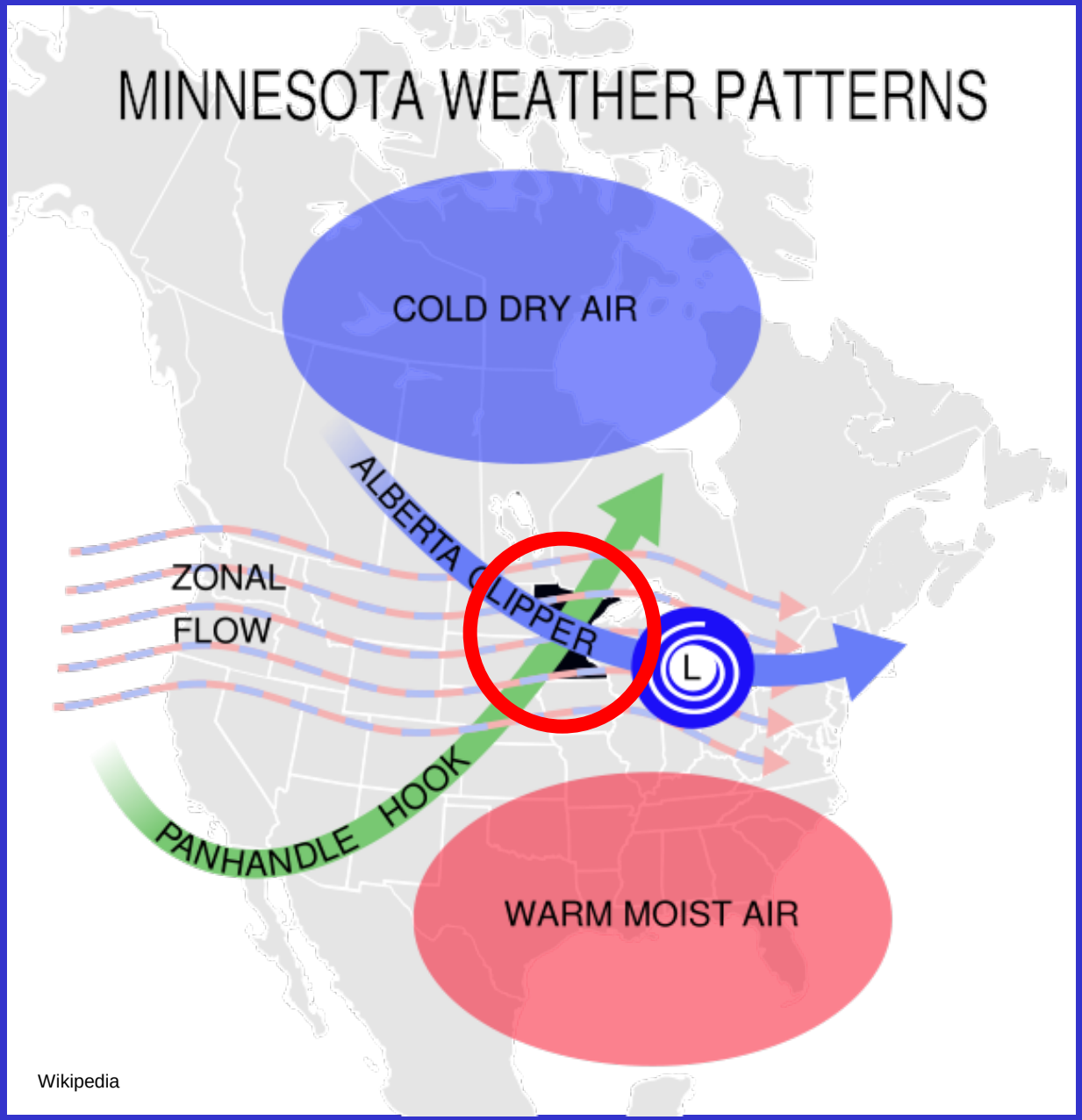
Where Goes the Climate, so Goes the Ecosystem



Dr. Jeffrey R. Corney, Managing Director of the University of Minnesota's Cedar Creek Ecosystem Science Reserve

It's All About the Climate…

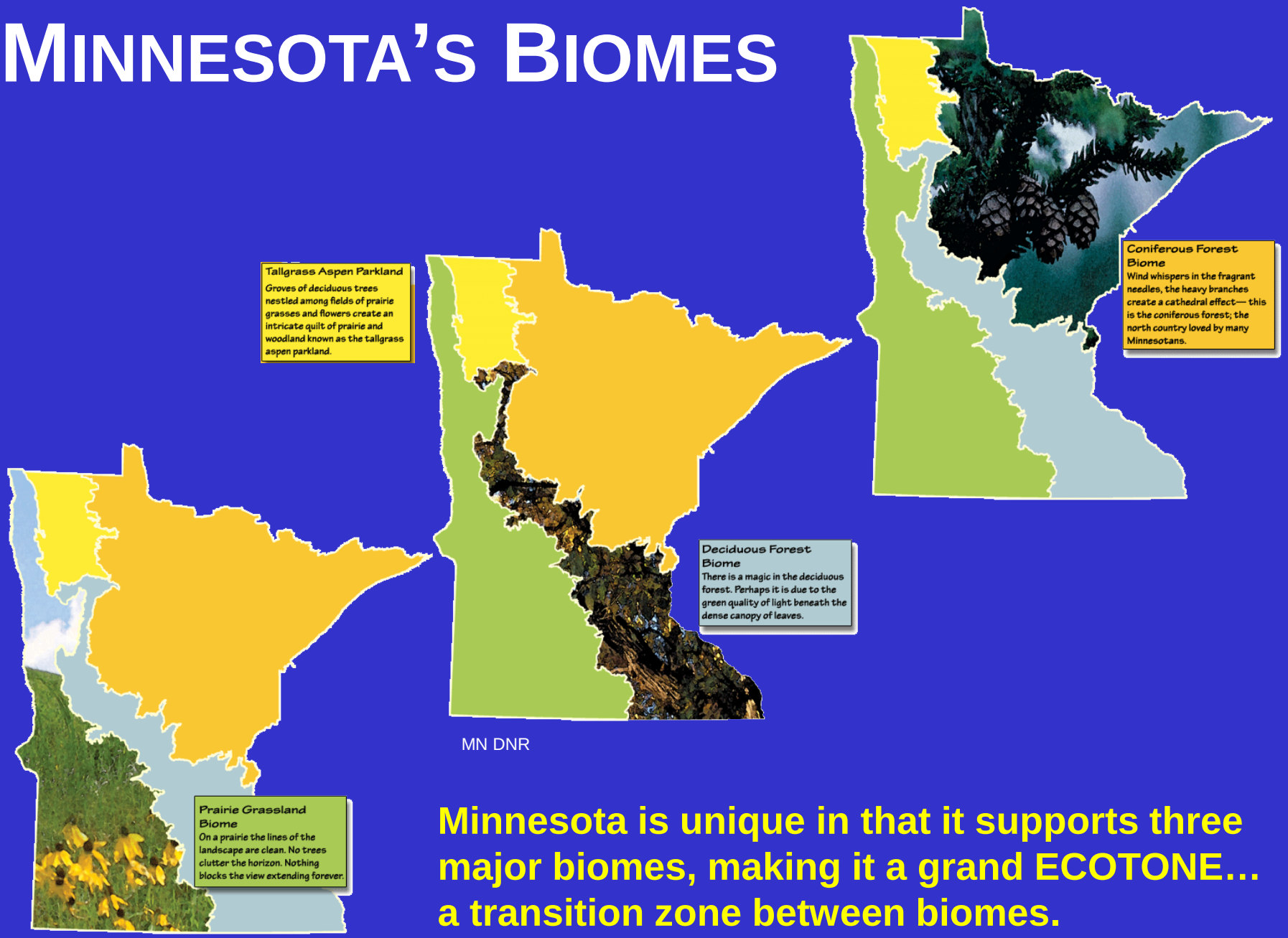
CLIMATE is the prevailing weather conditions of a region averaged over long periods of time.



…AND THE BIOMES THAT RESULT

A BIOME is a large land area characterized by a prevailing CLIMATE that supports a major ecological community type.

Minnesota's Biomes

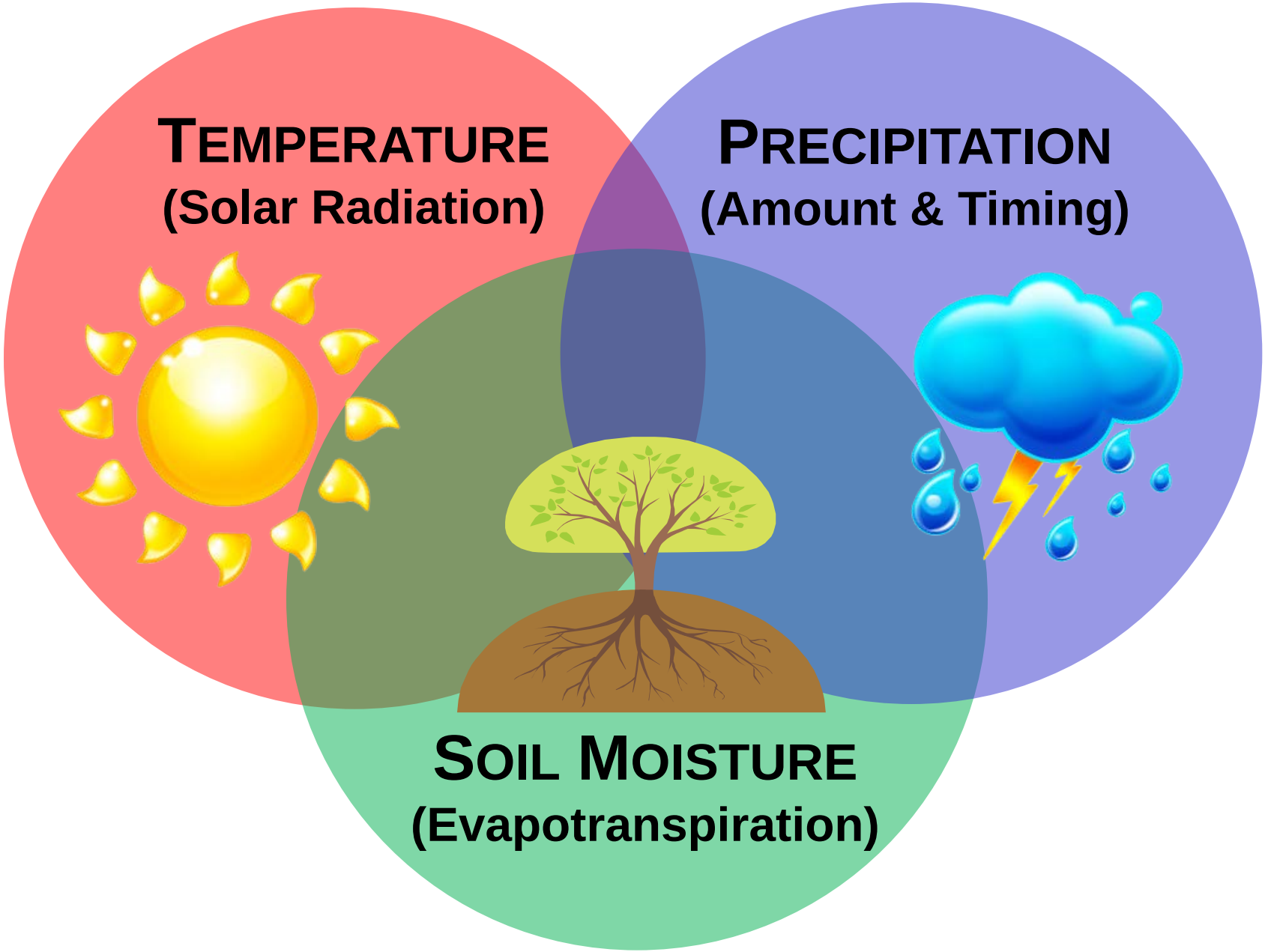


MN DNR

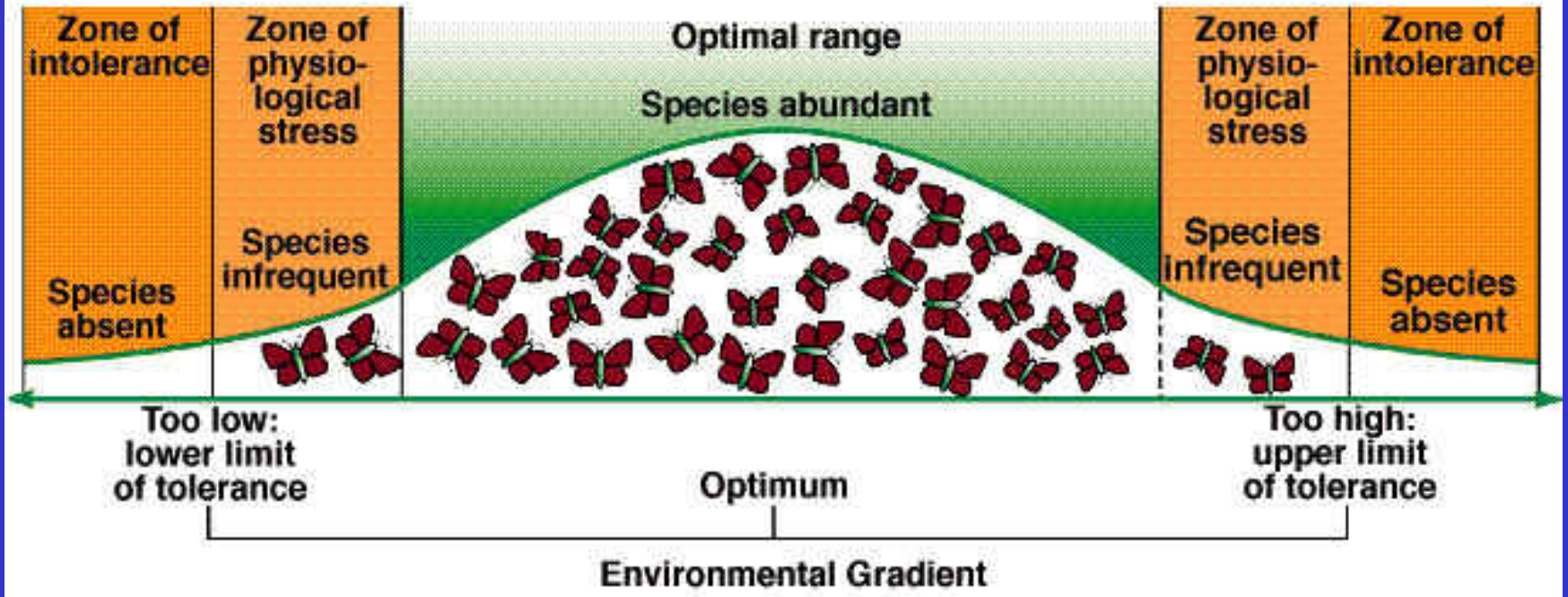
Minnesota is unique in that it supports three major biomes, making it a grand ECOTONE… a transition zone between biomes.

Where Goes the Climate, so Goes the Biomes…

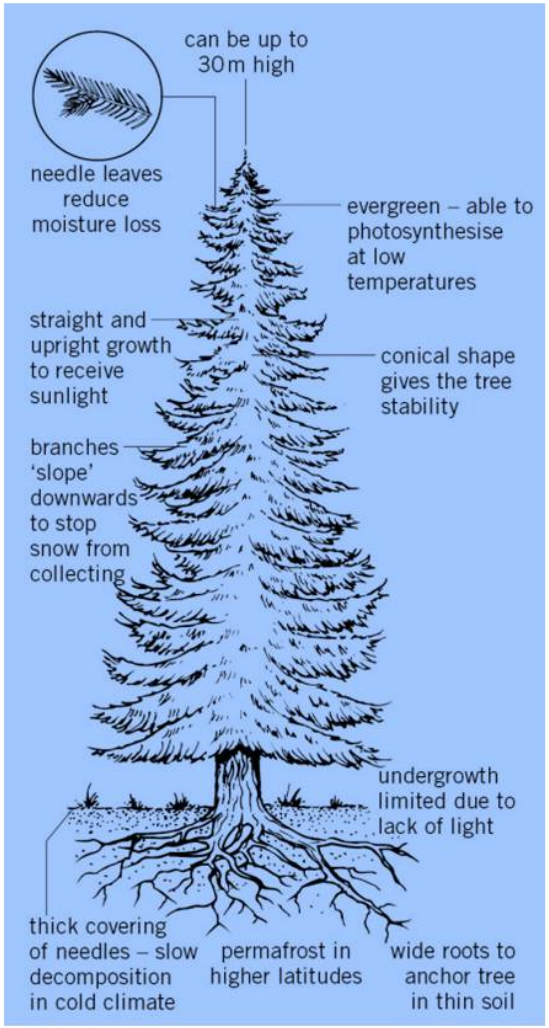
Welcome to Lake Superior?


TEMPERATURE
(Solar Radiation)
PRECIPITATION
(Amount & Timing)
SOIL MOISTURE
(Evapotranspiration)

Tolerance Limits

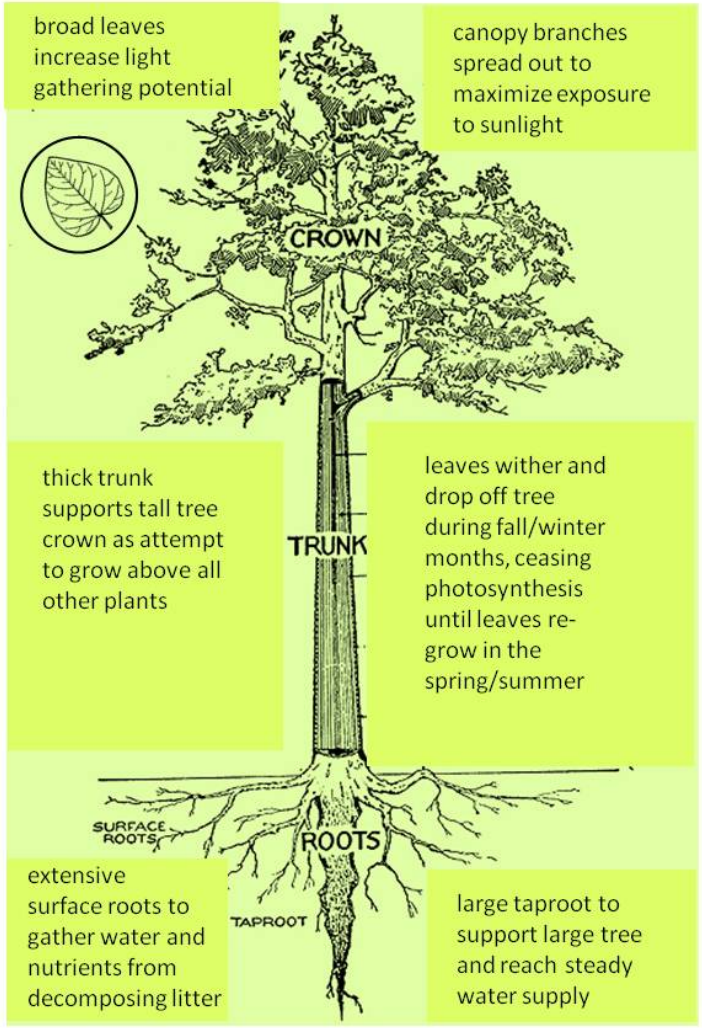


Plant Adaptations in North America (MN)

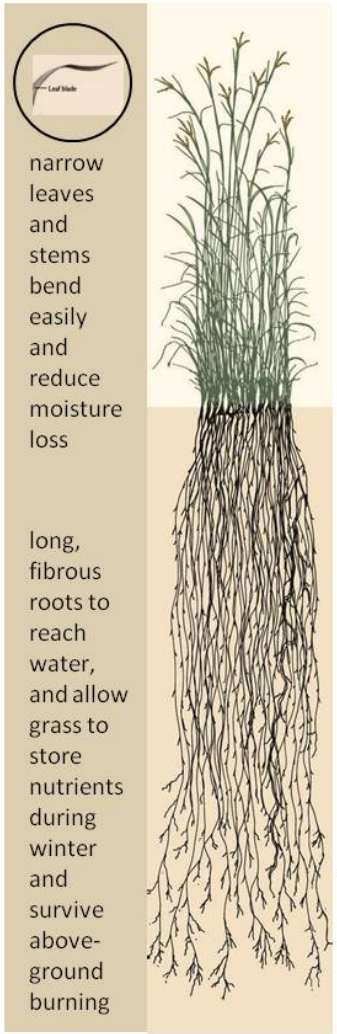


A. Stacey

Coniferous Trees
(cold, dry climates)

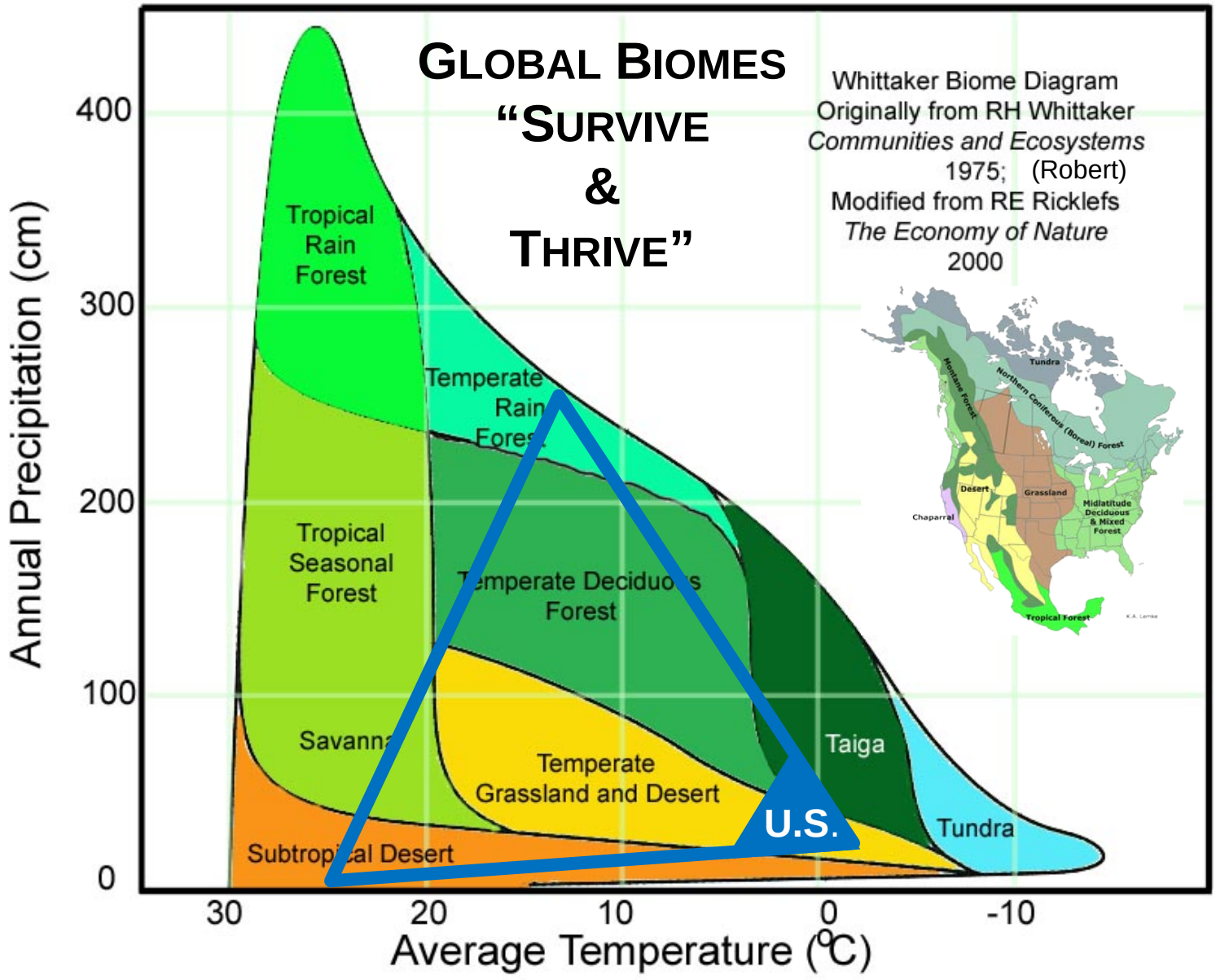


Deciduous Trees
(warm, moist climates)

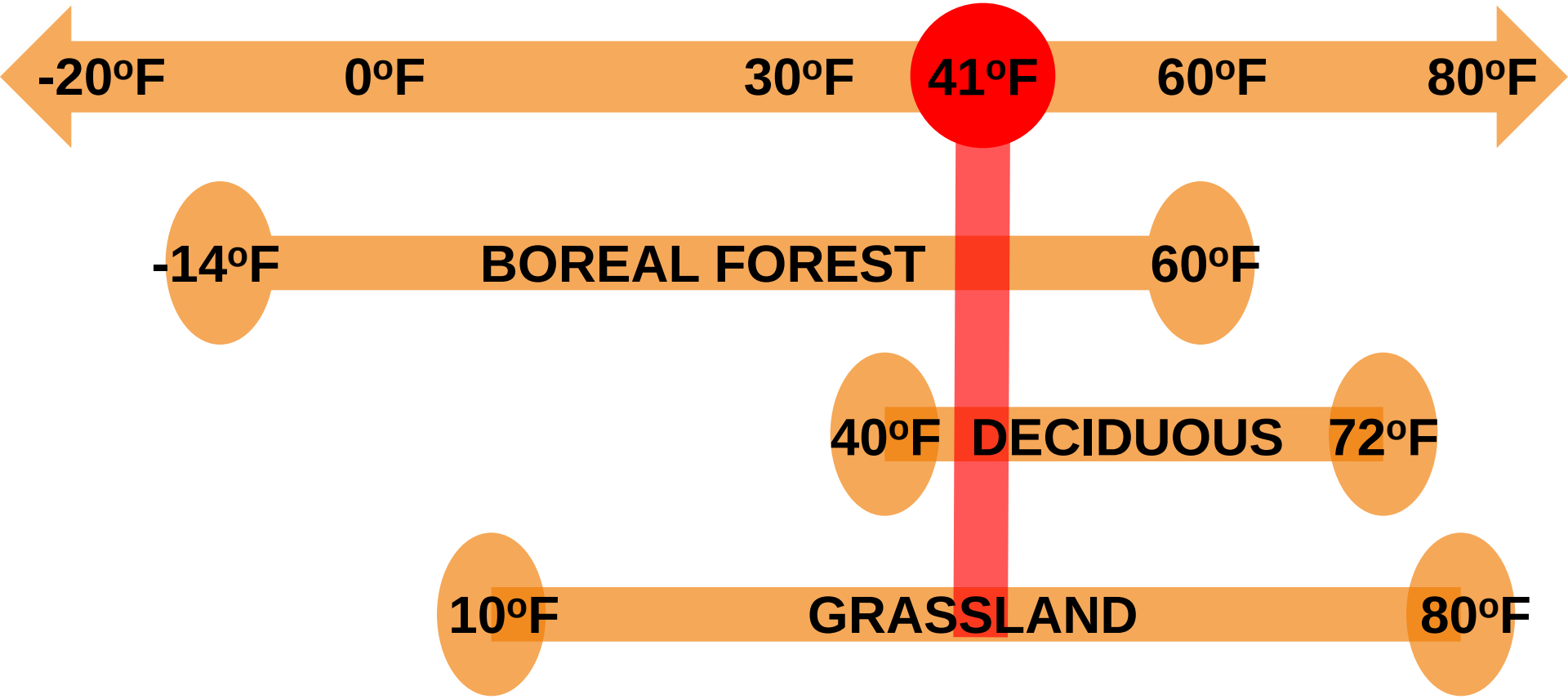


Dogtooth Design

Grasses
(warm, dry climates)

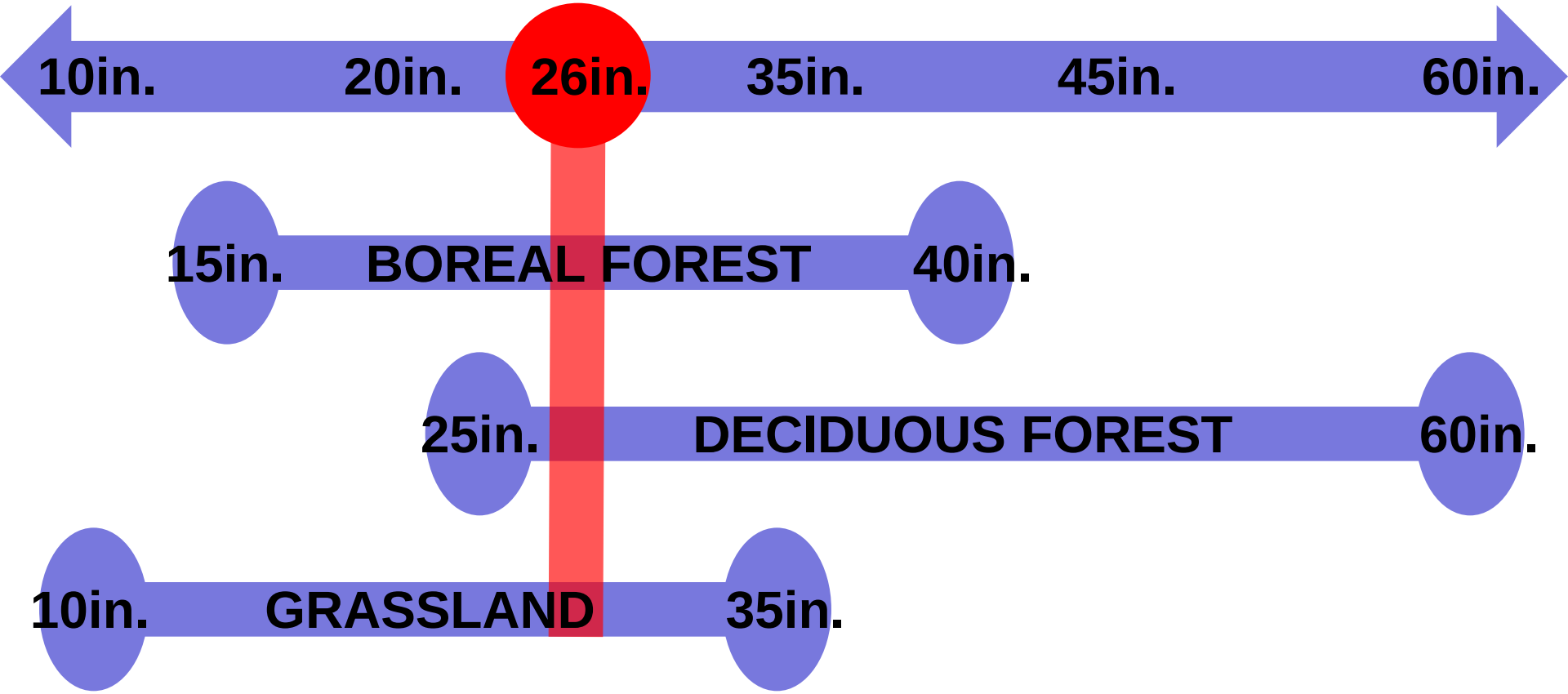

GLOBAL BIOMES
"SURVIVE
&
THRIVE"
Whittaker Biome Diagram
Originally from RH Whittaker
Communities and Ecosystems
1975; (Robert)
Modified from RE Ricklefs
The Economy of Nature
2000
Annual Precipitation (cm)
400
300
200
100
0
30
20
10
0
-10
Average Temperature (°C)
Tropical Rain Forest
Temperate Rain Forest
Tropical Seasonal Forest
Temperate Deciduous Forest
Savanna
Temperate Grassland and Desert
Taiga
Tundra
Subtropical Desert
U.S.
Tundra
Northern Coniferous (Boreal) Forest
Montane Forest
Desert
Grassland
Chaparral
Midlatitude Deciduous & Mixed Forest
Tropical Forest

Average Annual Temperature (U.S.) "Survive & Thrive" Tolerance Ranges

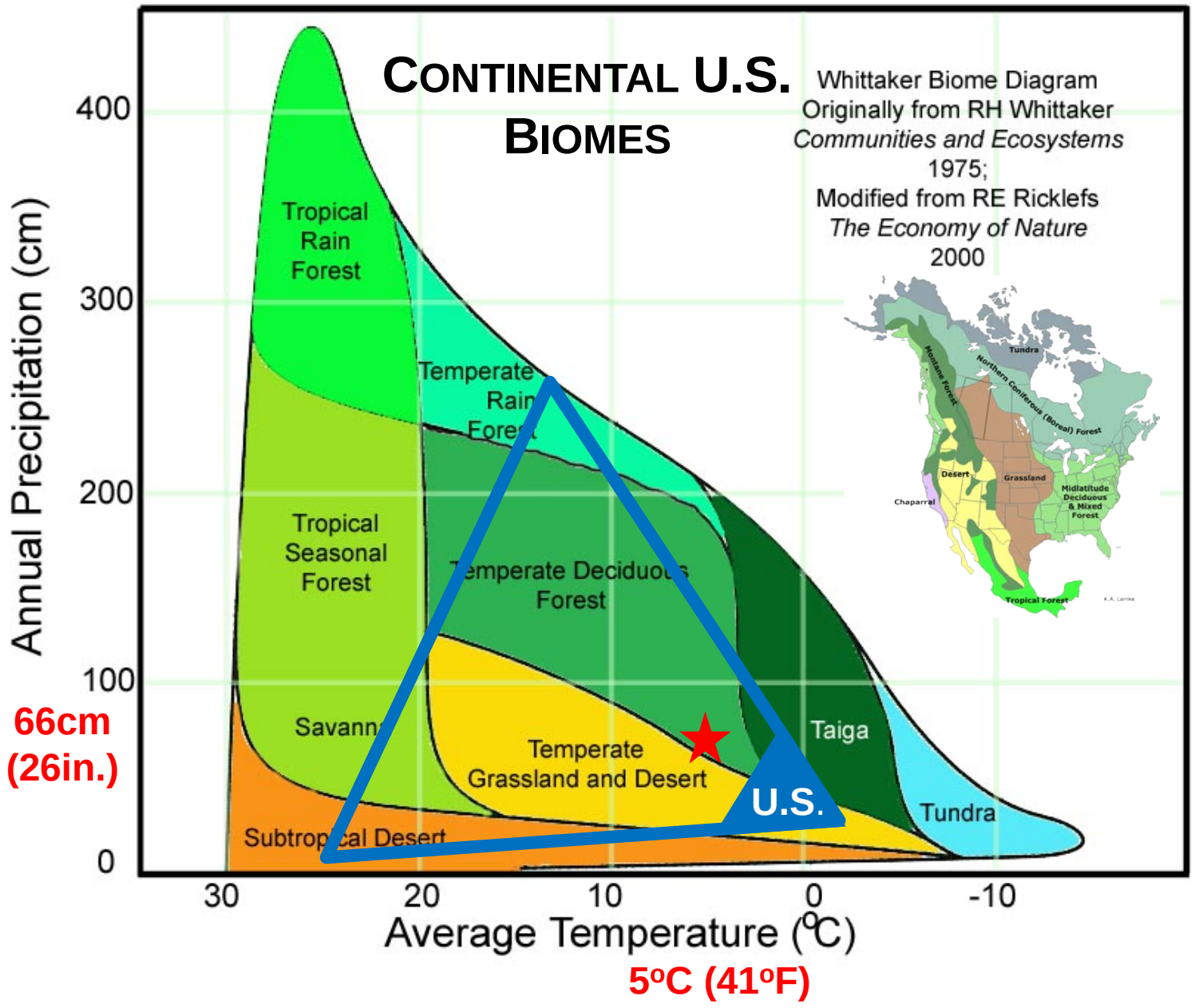


J.Corney

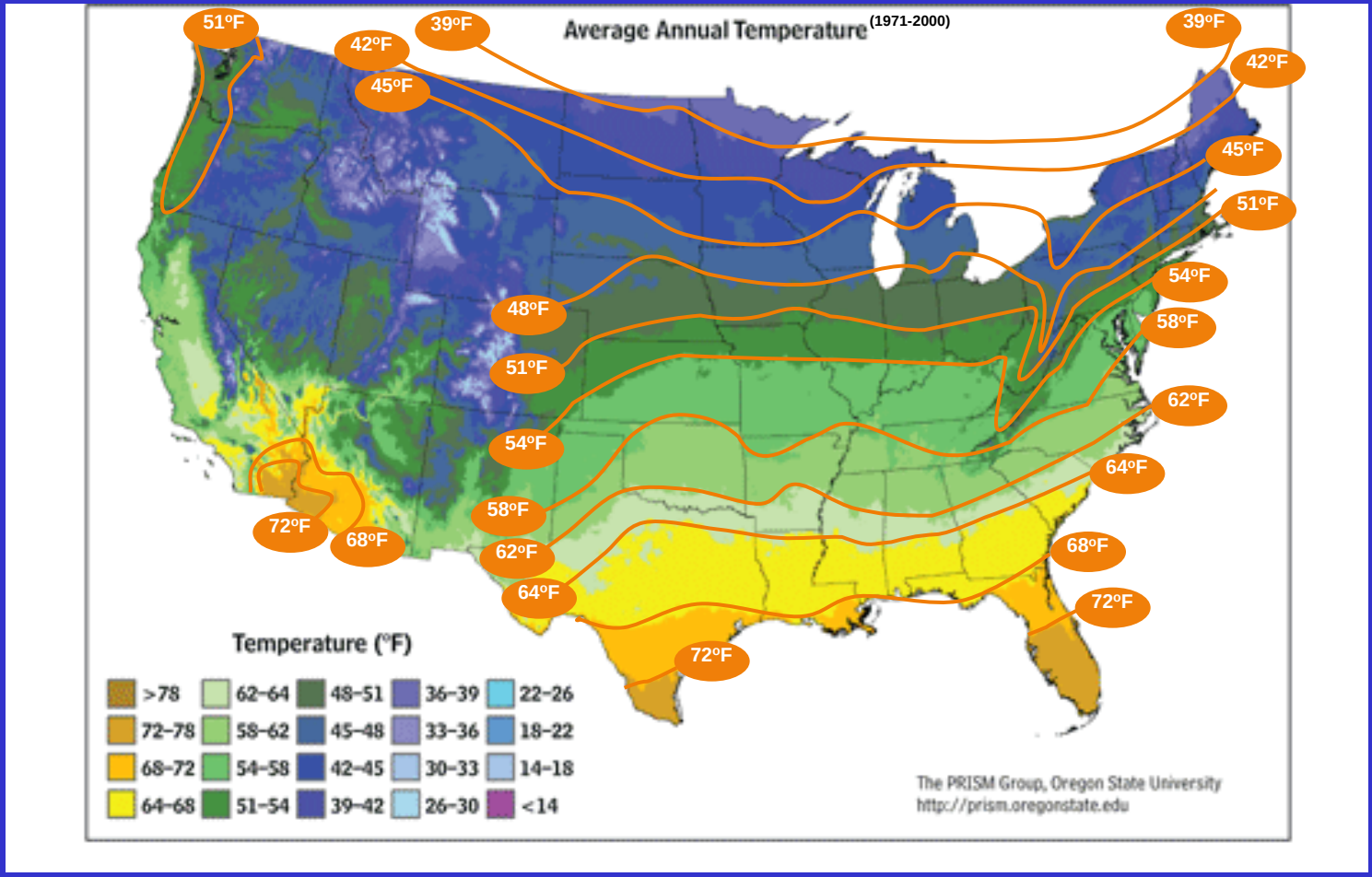
Average Annual Precipitation (U.S.)
"Survive & Thrive" Tolerance Ranges



J.Corney


CONTINENTAL U.S. BIOMES
Whittaker Biome Diagram
Originally from RH Whittaker
Communities and Ecosystems
1975;
Modified from RE Ricklefs
The Economy of Nature
2000
Tropical Rain Forest
Temperate Rain Forest
Tropical Seasonal Forest
Temperate Deciduous Forest
Savanna
Temperate Grassland and Desert
Taiga
Tundra
Subtropical Desert
U.S.
Tundra
Northern Coniferous (Boreal) Forest
Montane Forest
Grassland
Desert
Chaparral
Midlatitude Deciduous & Mixed Forest
Tropical Forest
Annual Precipitation (cm)
400
300
200
100
0
66cm
(26in.)
30
20
10
0
-10
Average Temperature (°C)
5°C (41°F)

U.S. Average Temperatures



TEMPERATURE

U.S.: -12-27ºC (10-80ºF)

N

Sub-Arctic

Boreal

Eco (41ºF)

5ºC tone

Temperate

Sub-Tropical

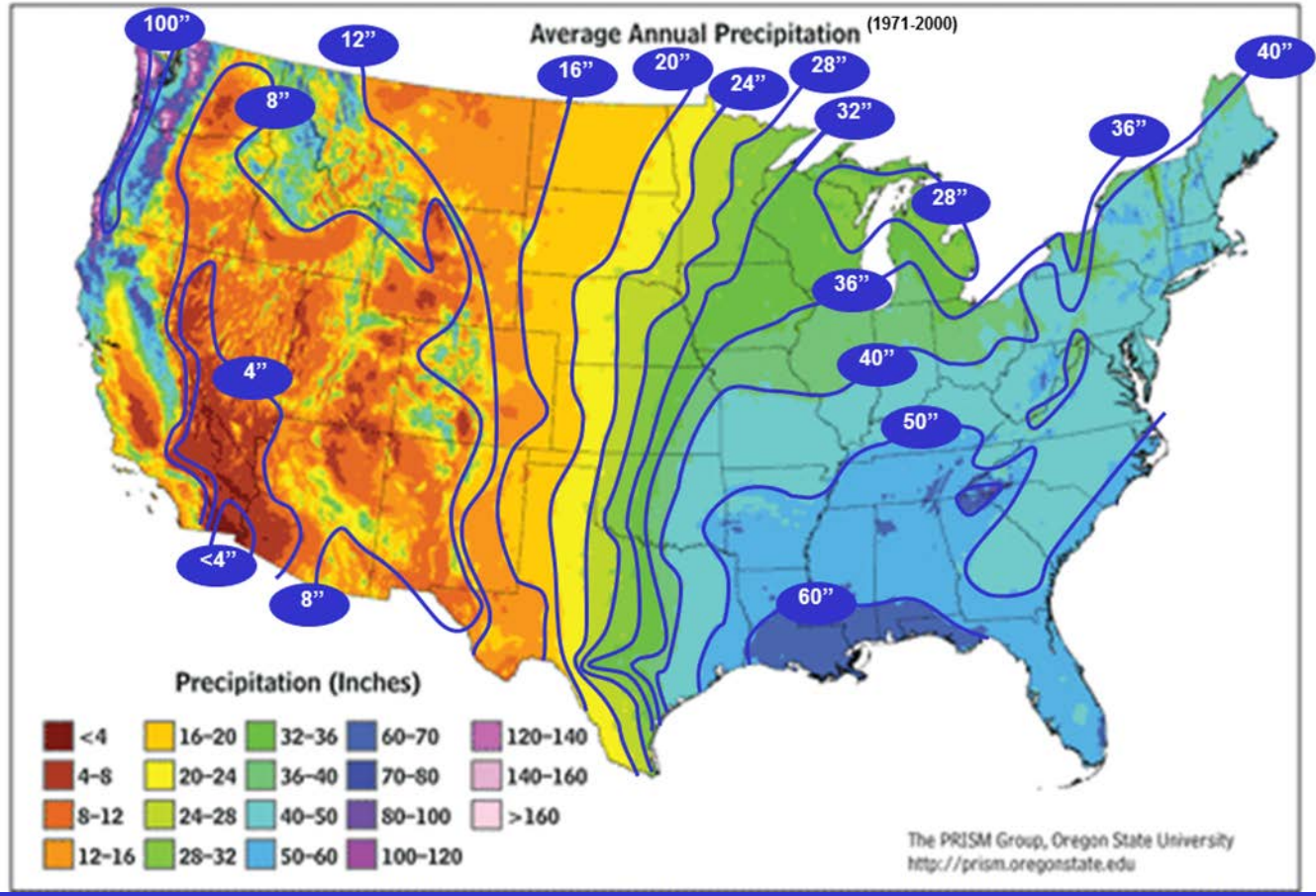
S

J.Corney

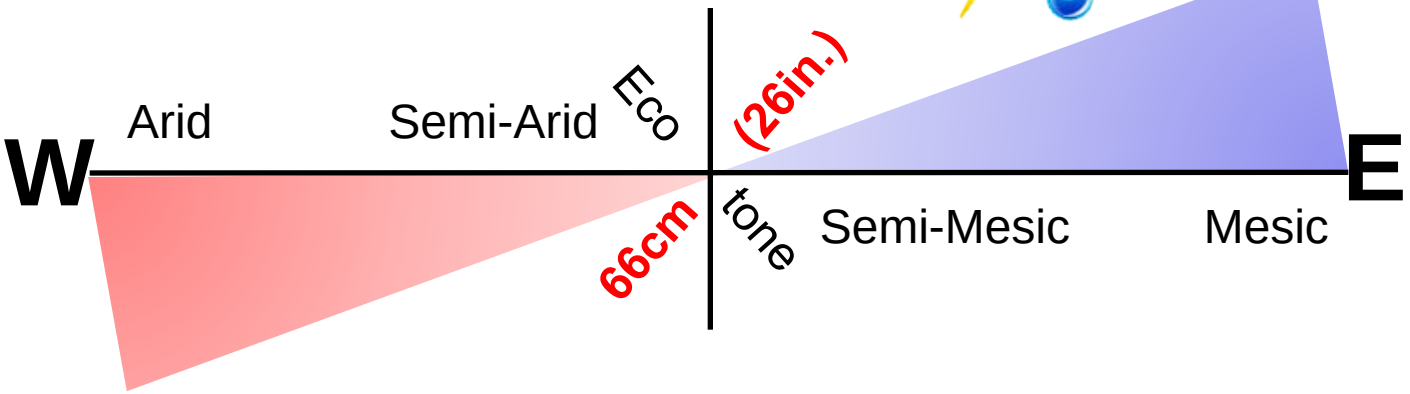
U.S.: -26-16ºC (-14-60ºF)

U.S.: 2-22ºC (35-72ºF)

U.S. Average Precipitation



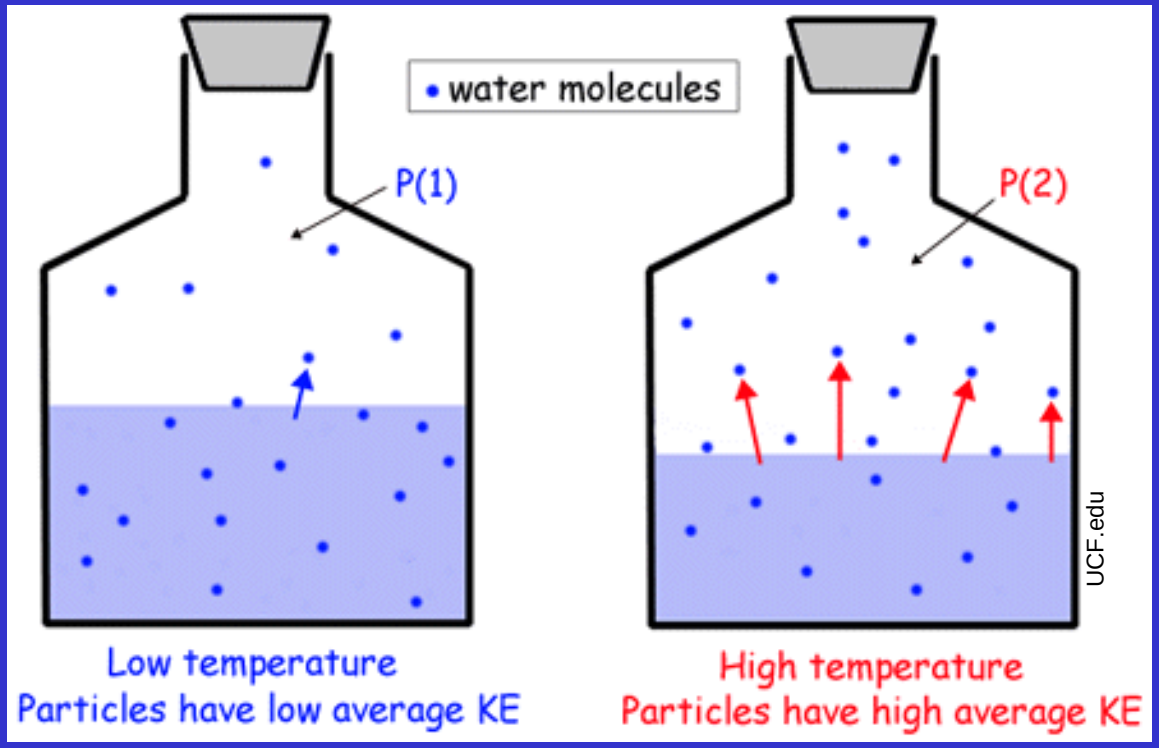
PRECIPITATION

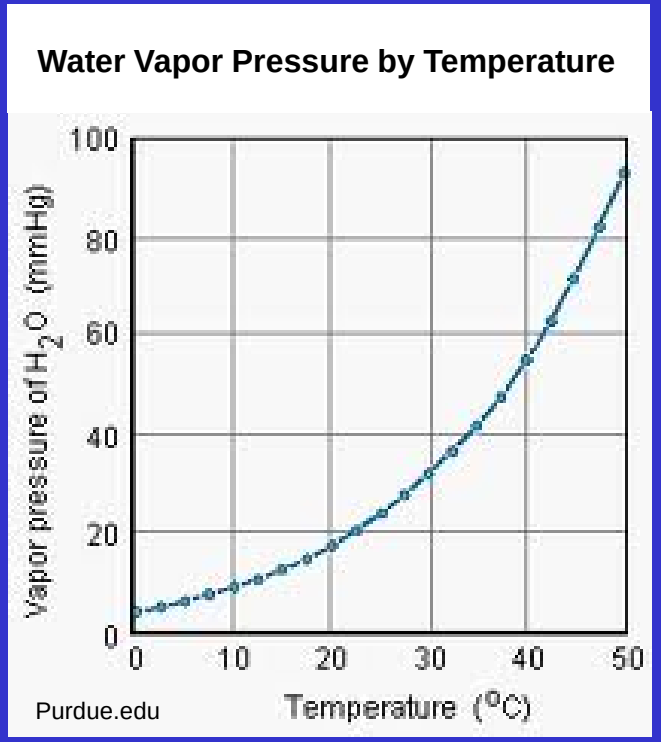


J.Corney

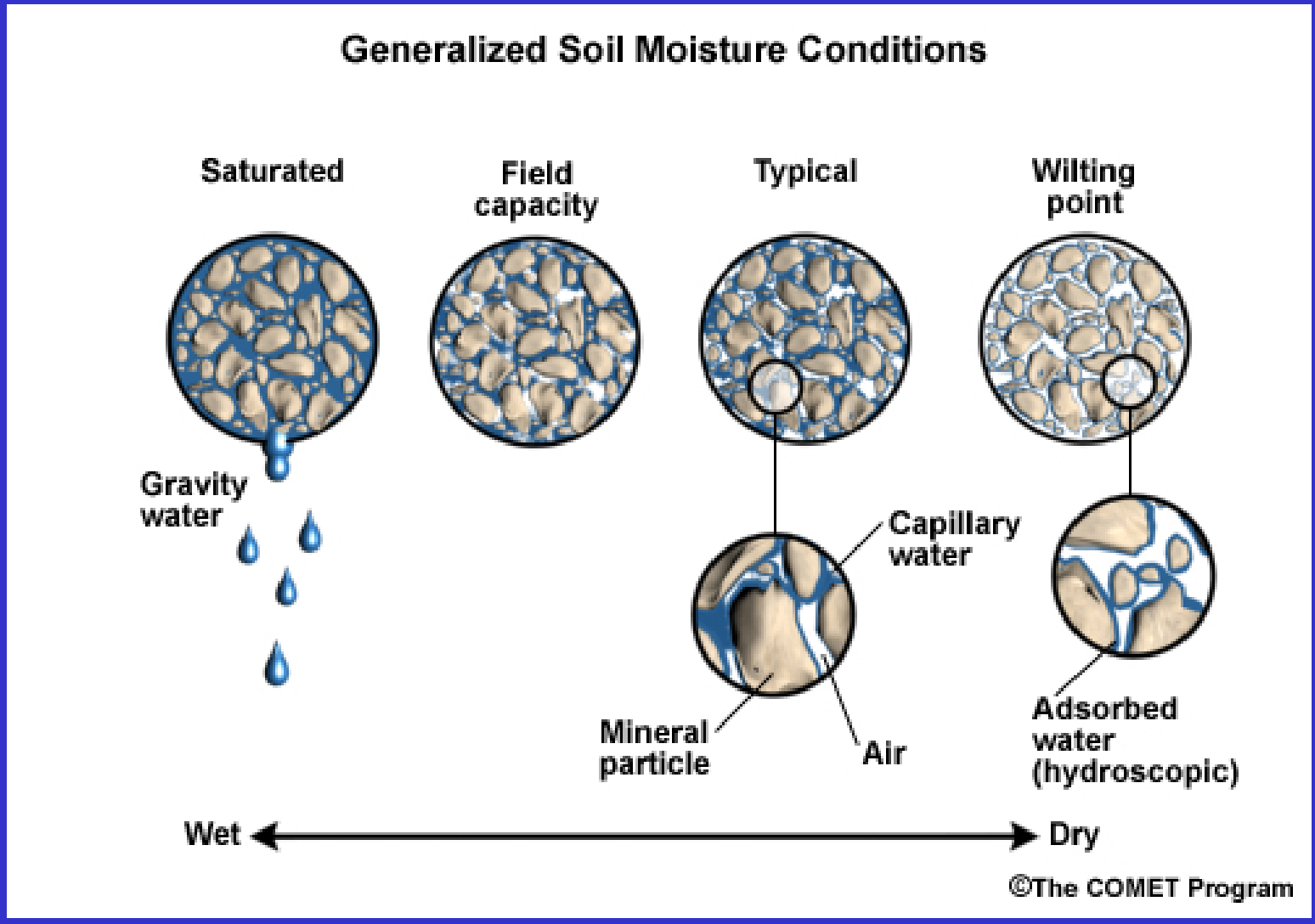
25-87cm (10-35in) 40-100cm (15-40in) 65-150cm (25-60in)

Heat Energy "Drives" Evapotranspiration



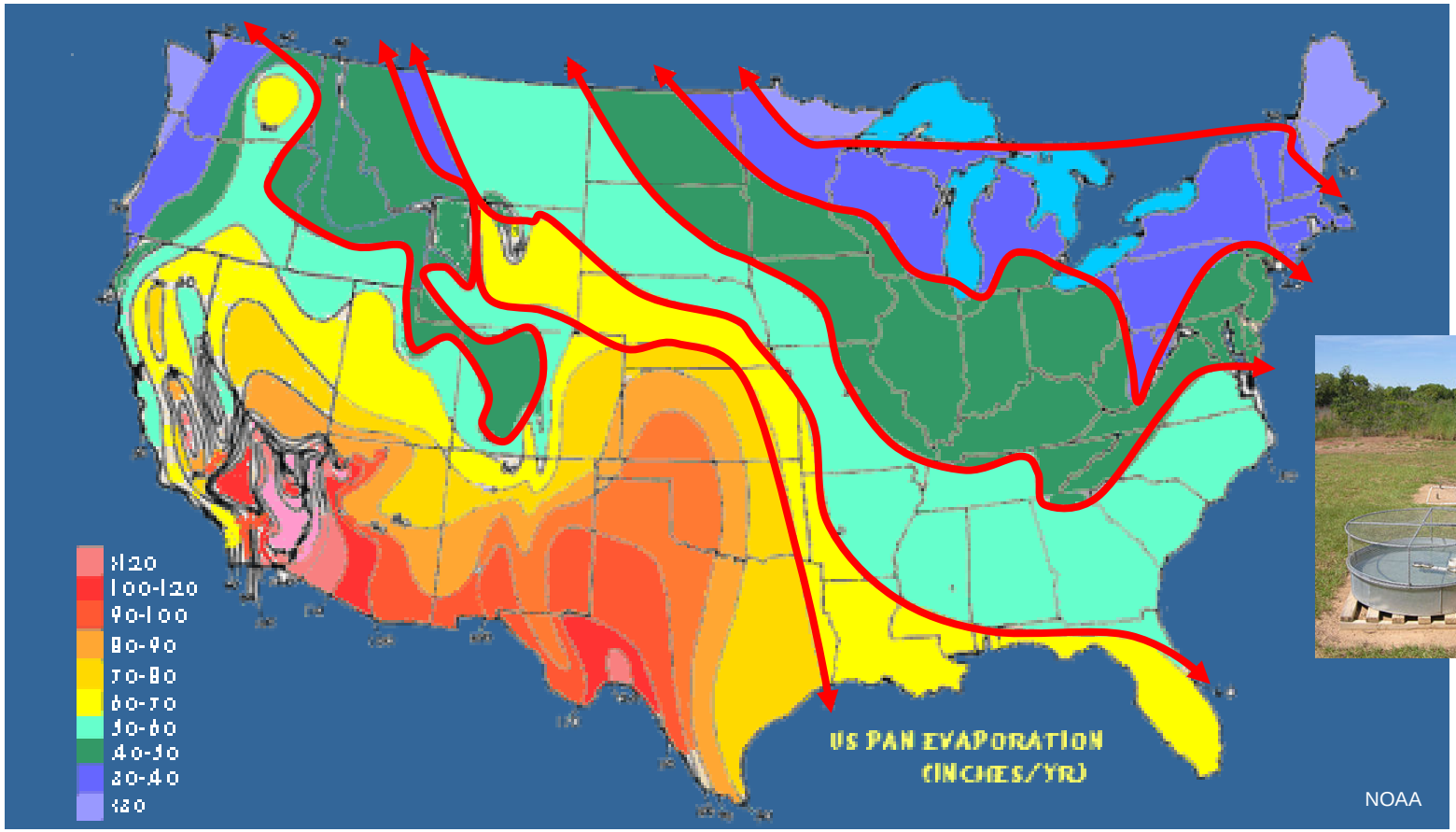


Moisture Retained in the Soil



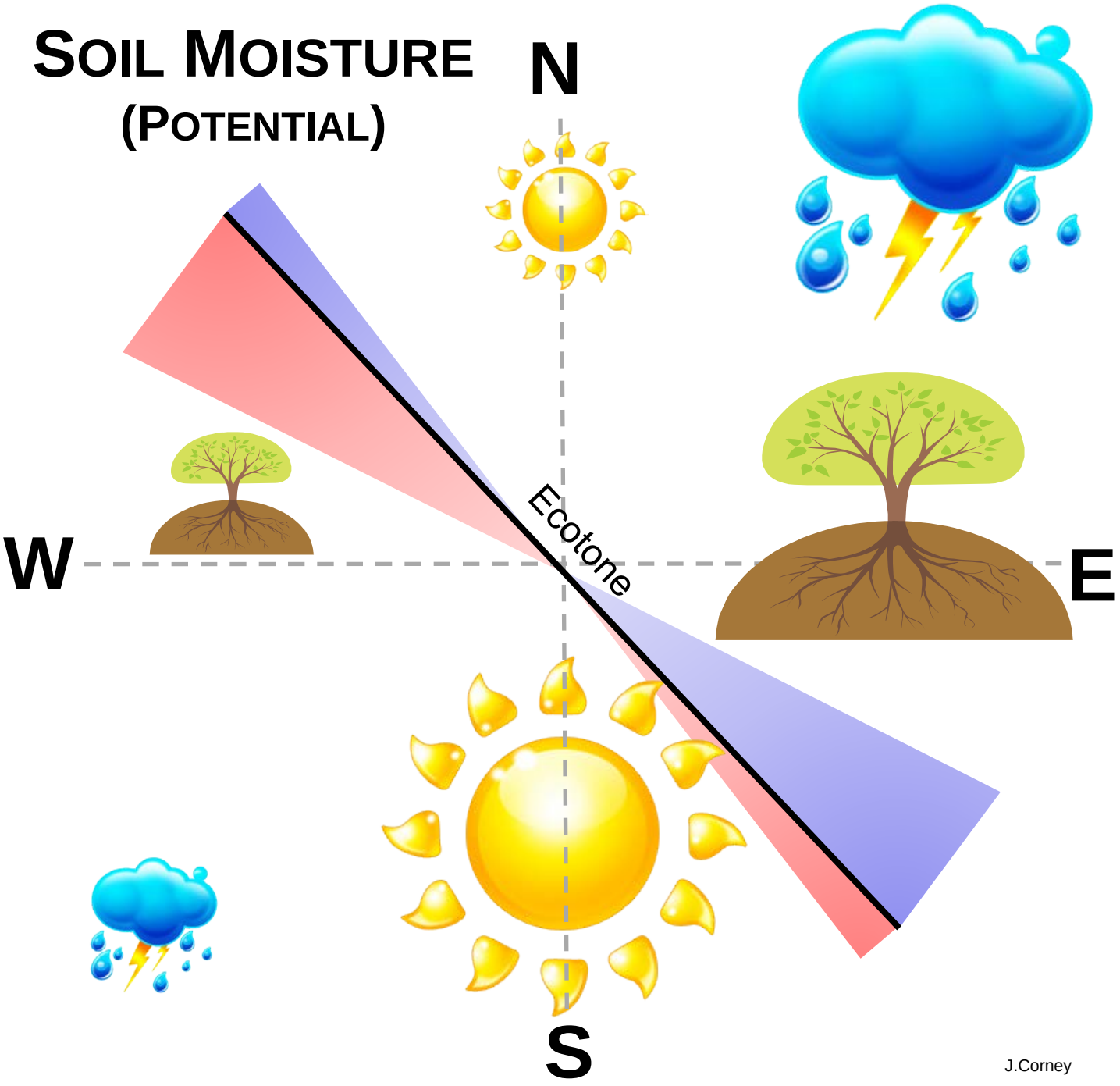
U.S. “Pan” Evaporation Rates

(a rough measure of Potential Evapotranspiration)



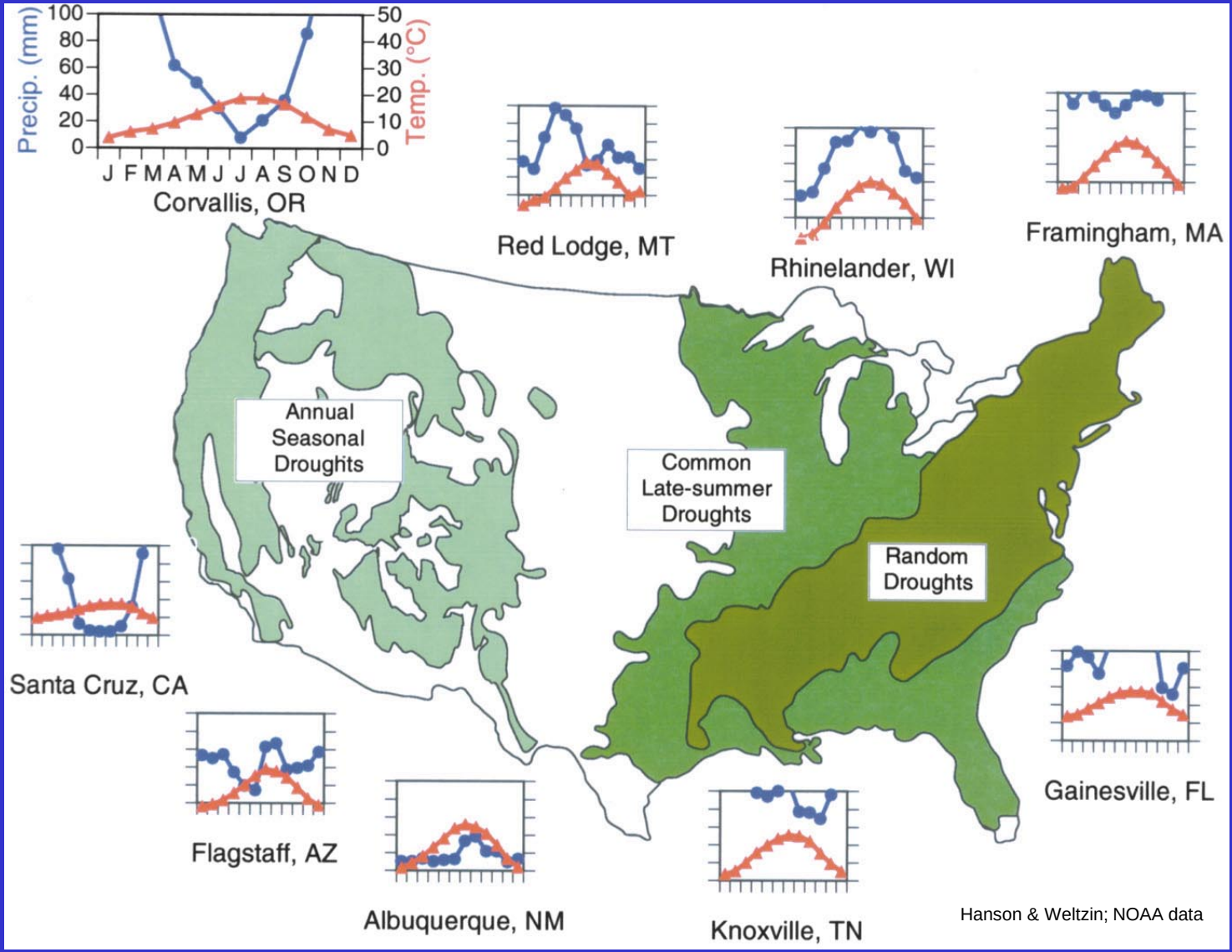
Wikipedia

Soil Moisture (Potential)



J.Corney

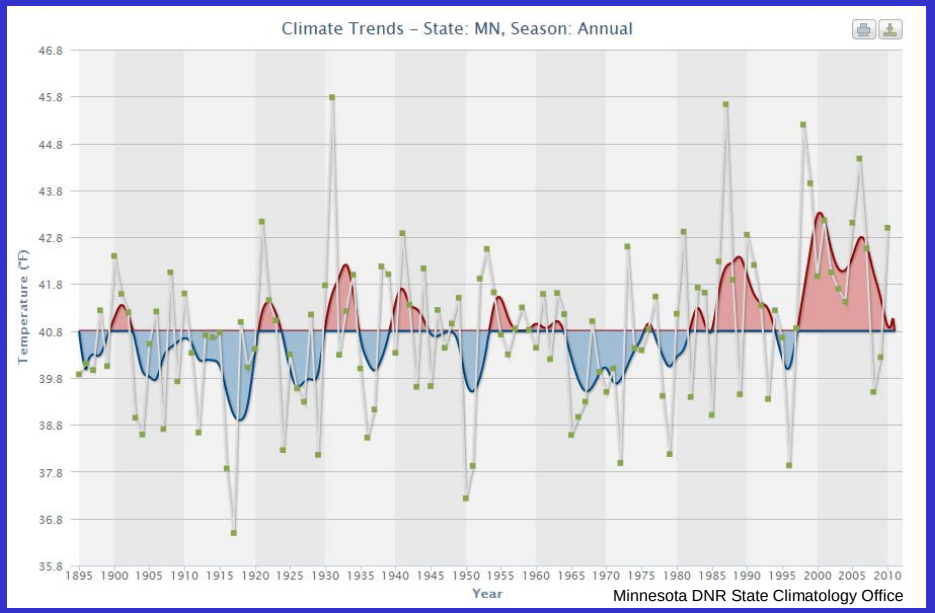
Typical U.S. Drought Conditions



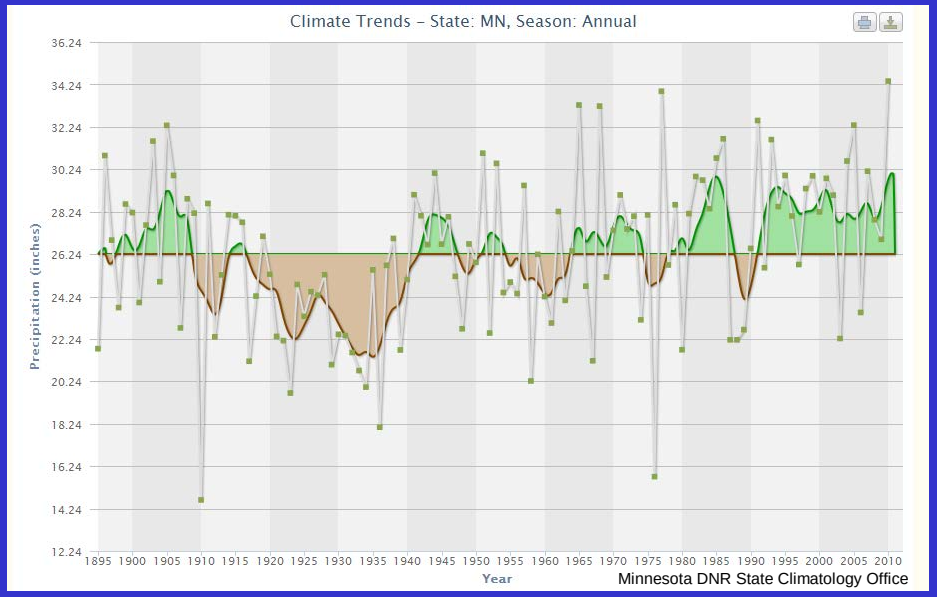
North America's Prairie-Forest Border

What Is Minnesota's Current Climate?

(Averaged over the past 115 years)

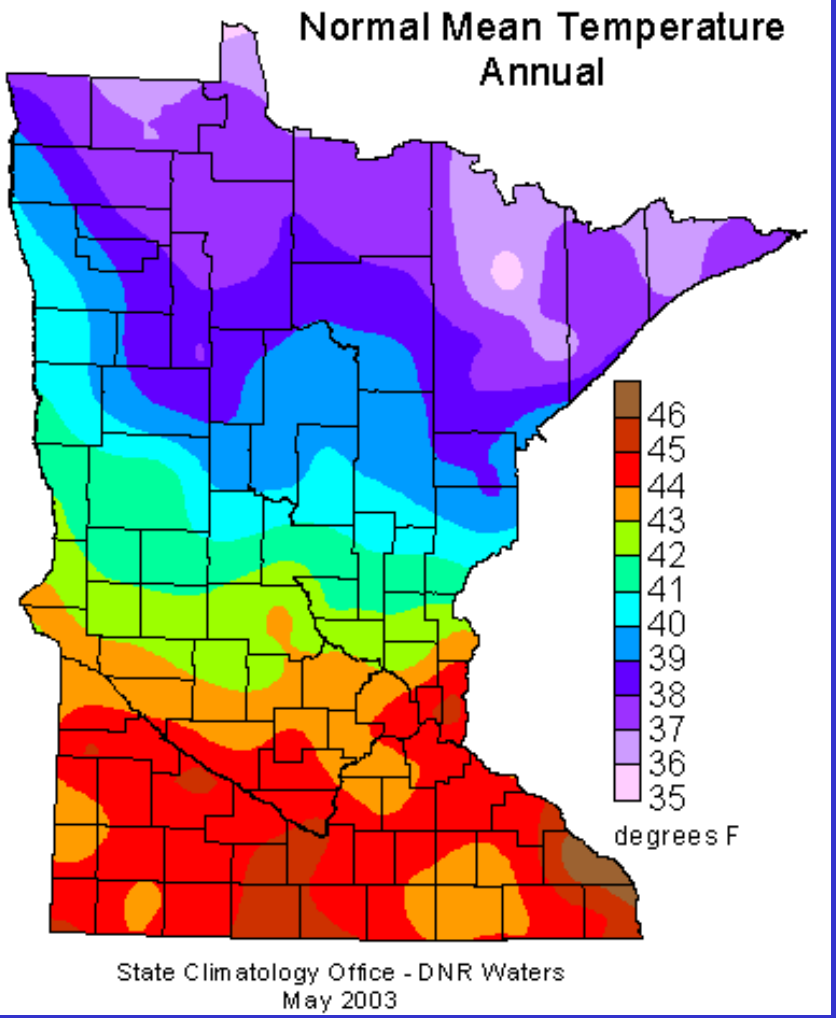


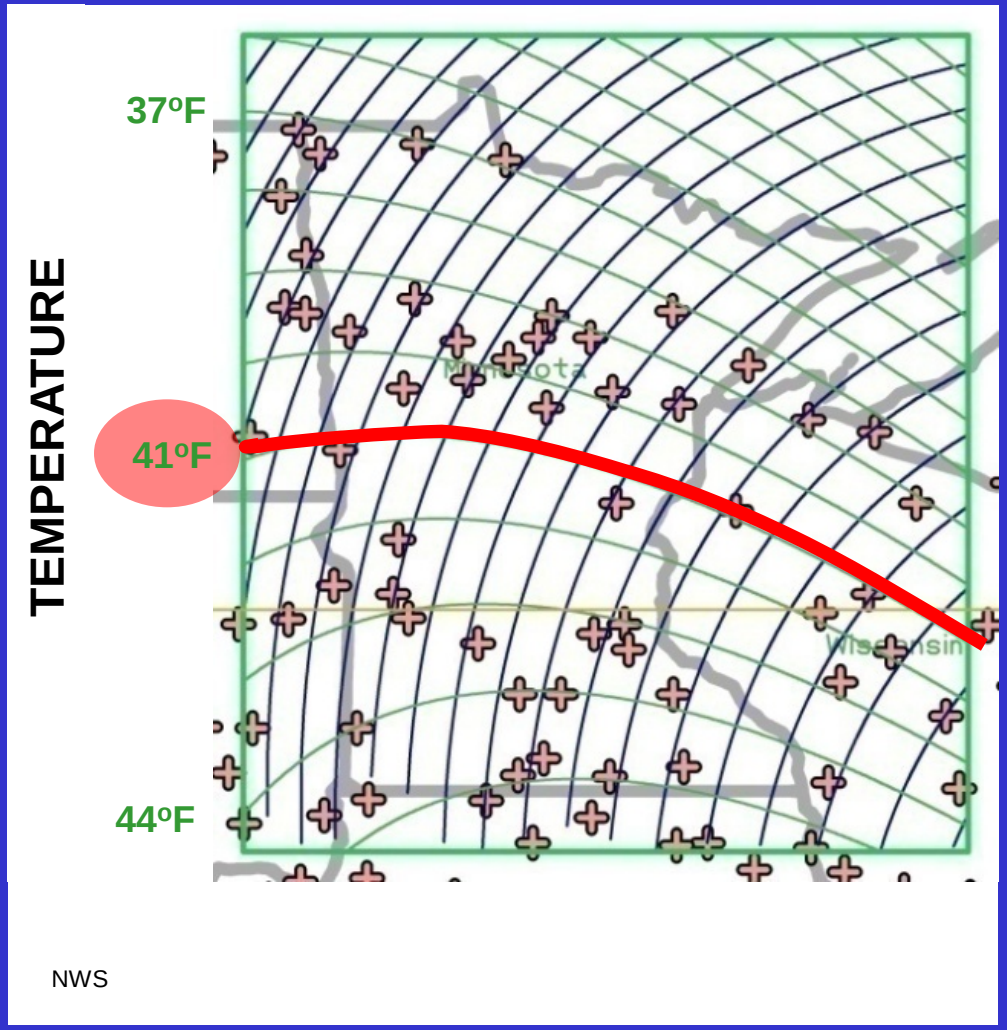
TEMPERATURE: 41°F annual avg.
PRECIPITATION: 26 in. annual avg.



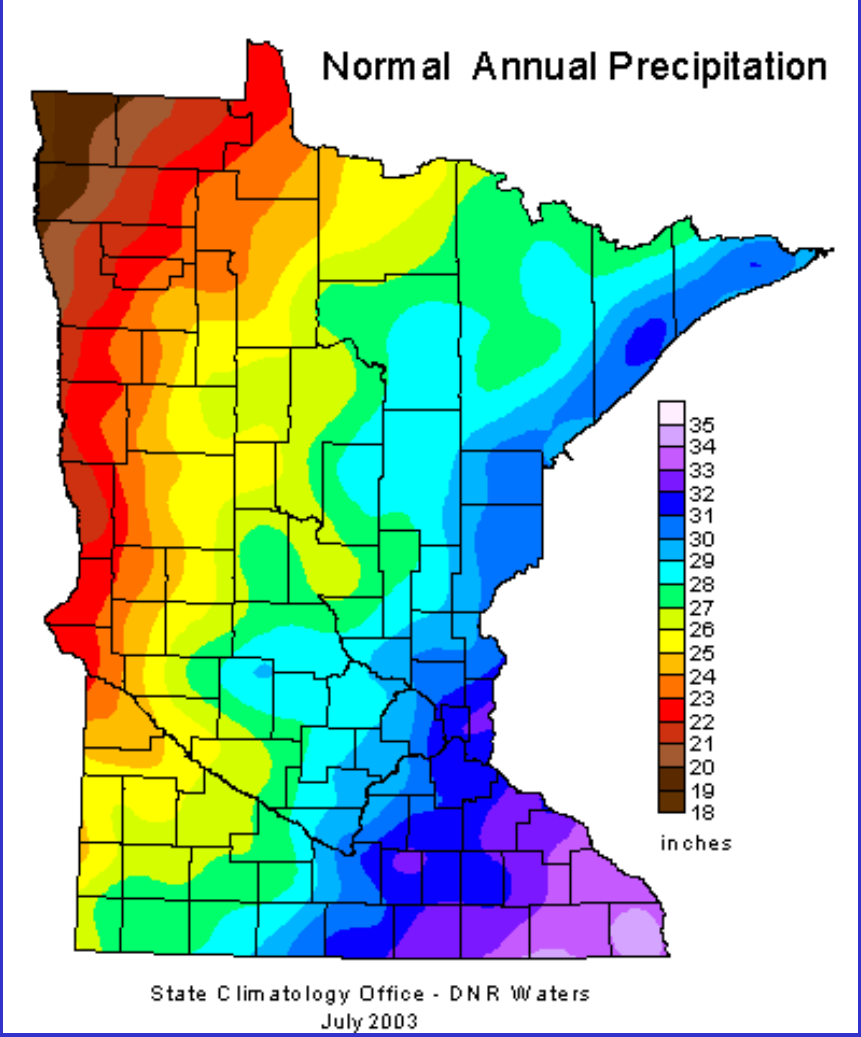
Do These Averages Look Familiar?

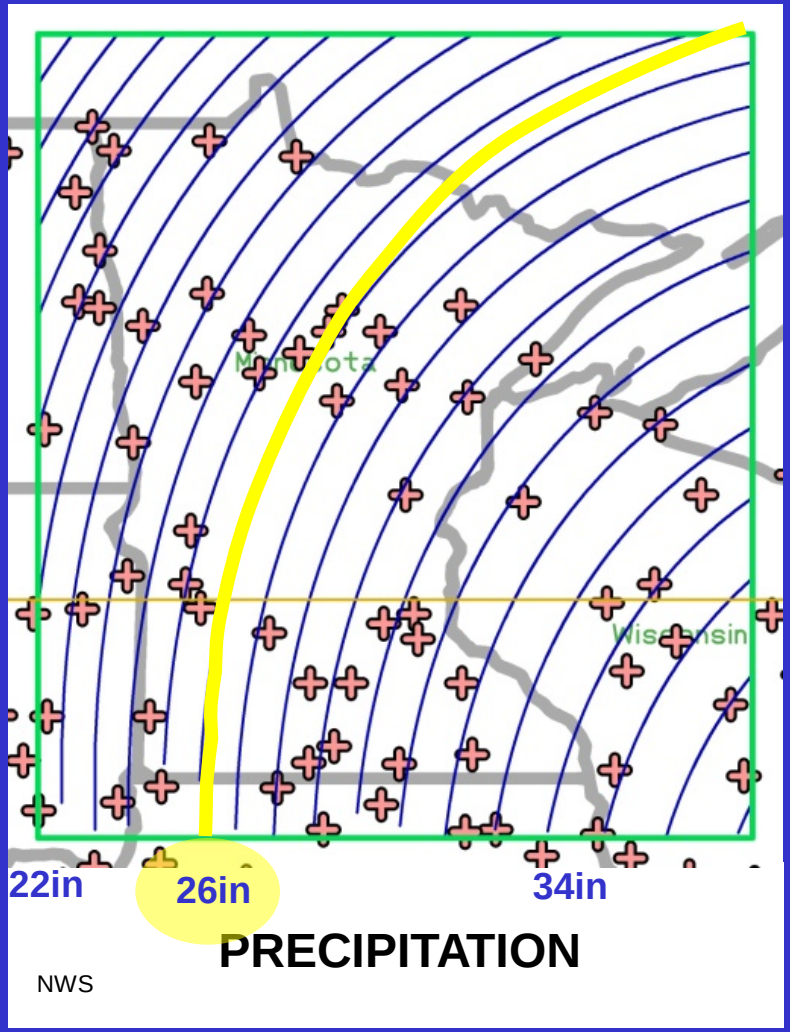
Temperature Isolines



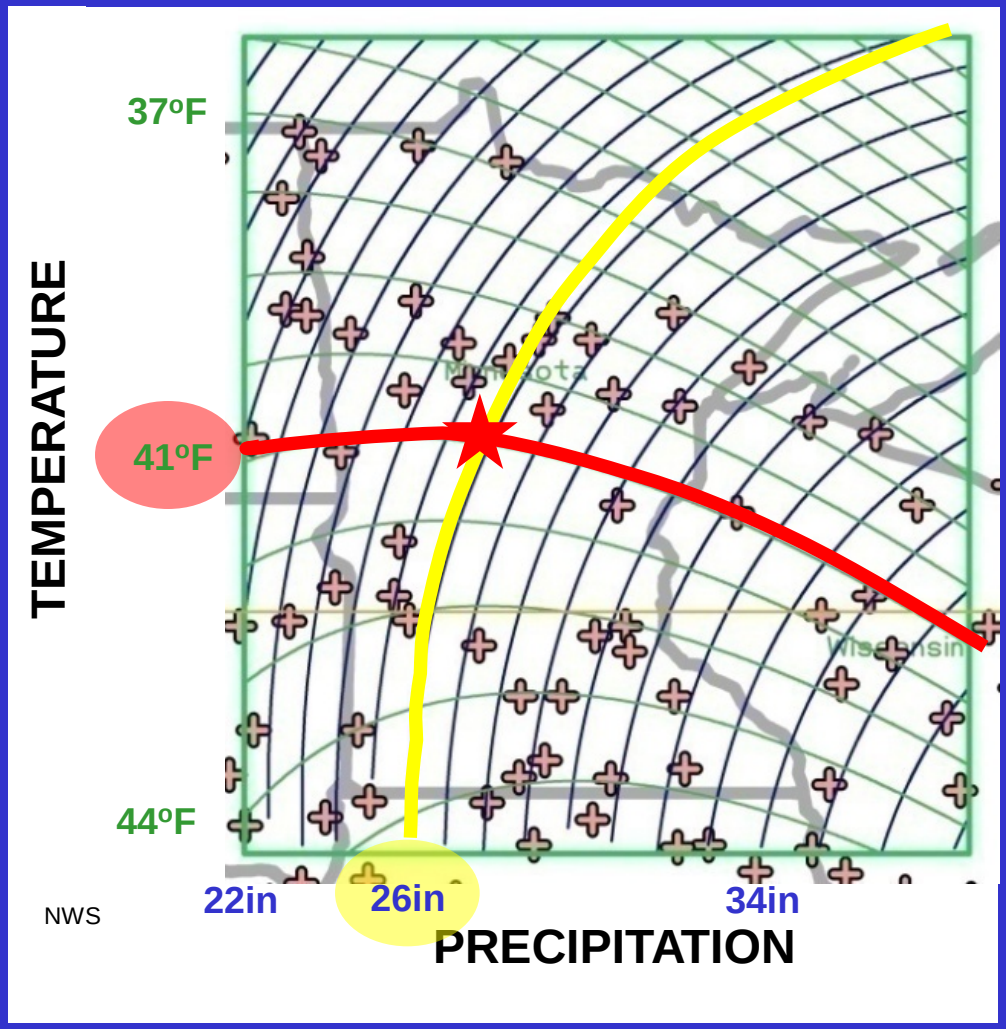


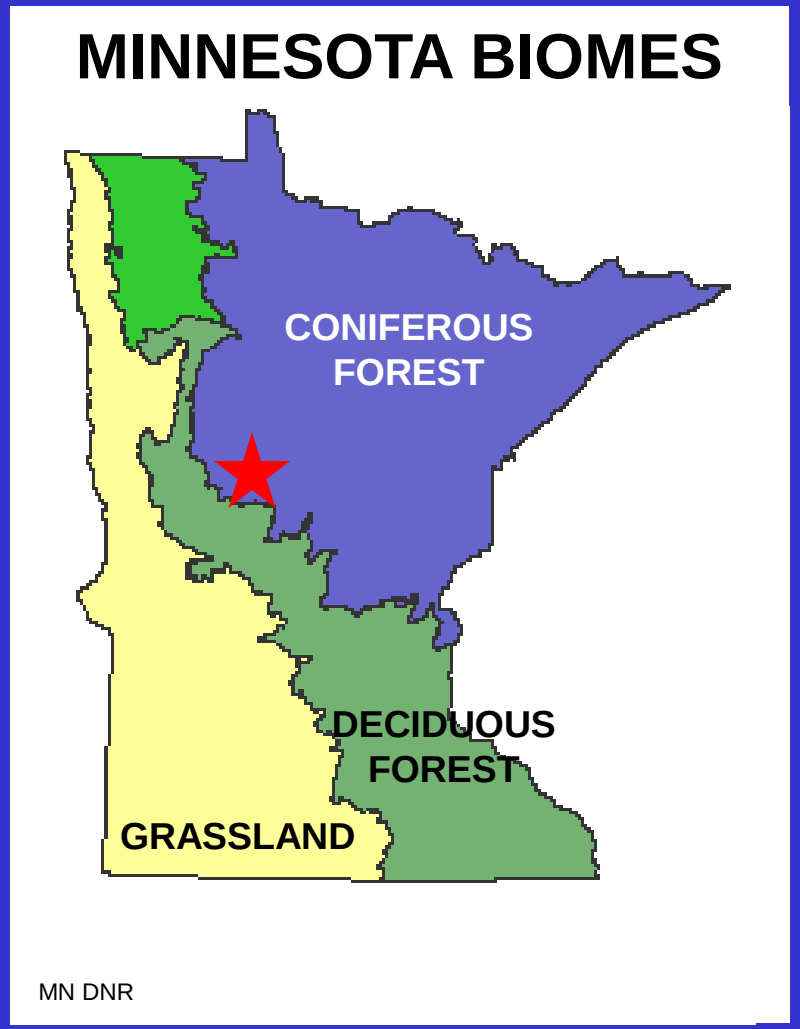
Precipitation Isolines

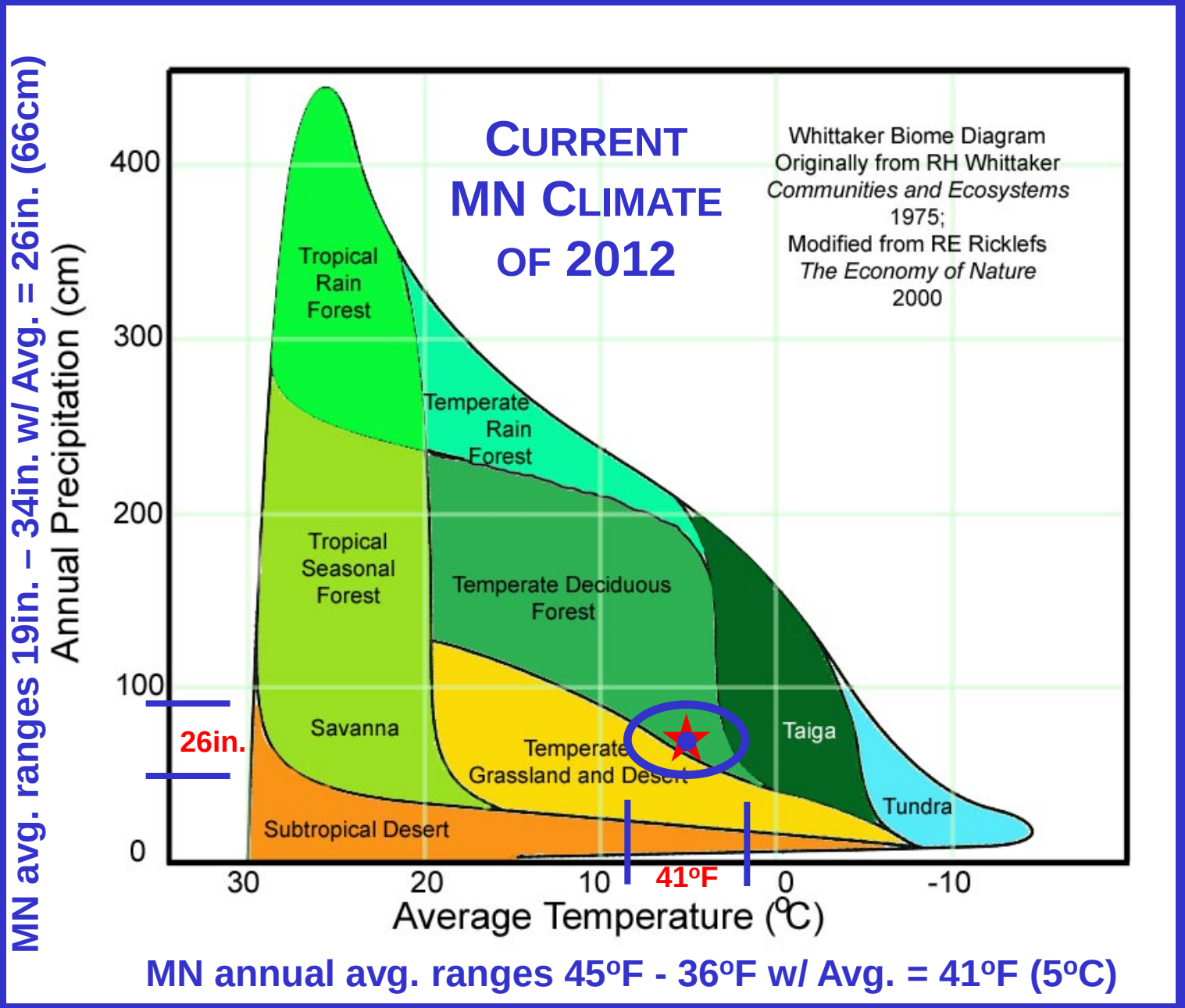




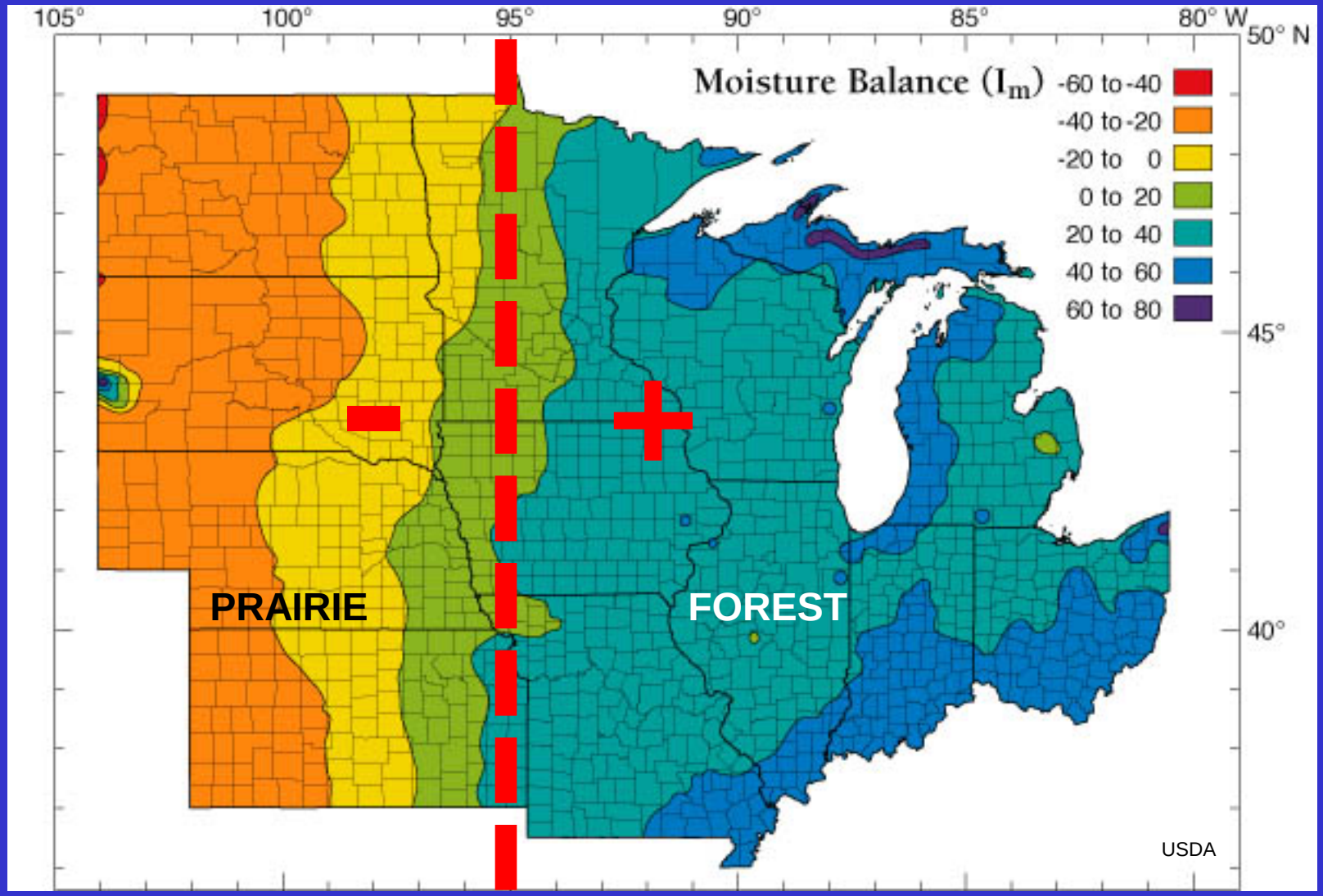
Isoline Convergence Point



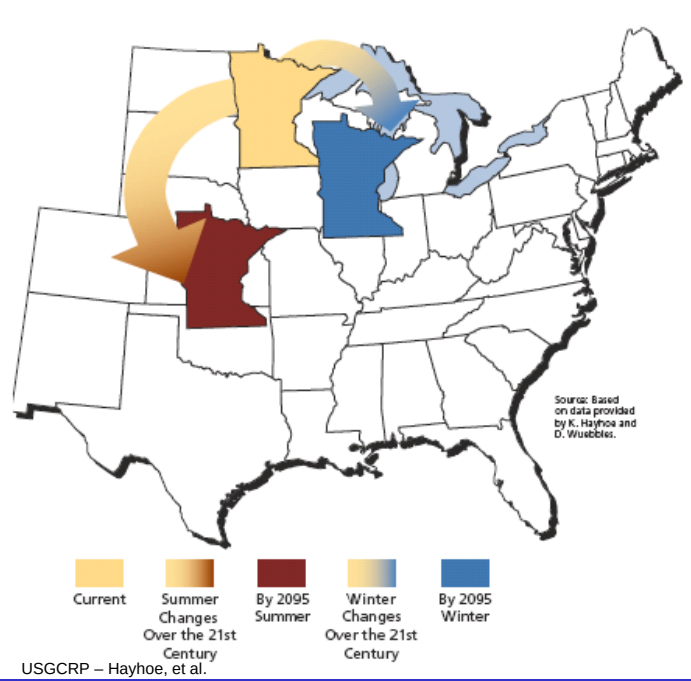



MN avg. ranges 19in. – 34in. w/ Avg. = 26in. (66cm)
Annual Precipitation (cm)
400
300
200
100
0
26in.
CURRENT MN CLIMATE OF 2012
Whittaker Biome Diagram
Originally from RH Whittaker
Communities and Ecosystems
1975;
Modified from RE Ricklefs
The Economy of Nature
2000
Tropical Rain Forest
Temperate Rain Forest
Tropical Seasonal Forest
Temperate Deciduous Forest
Savanna
Temperate Grassland and Desert
Taiga
Tundra
Subtropical Desert
30
20
10
41°F
0
-10
Average Temperature (°C)
MN annual avg. ranges 45°F - 36°F w/ Avg. = 41°F (5°C)

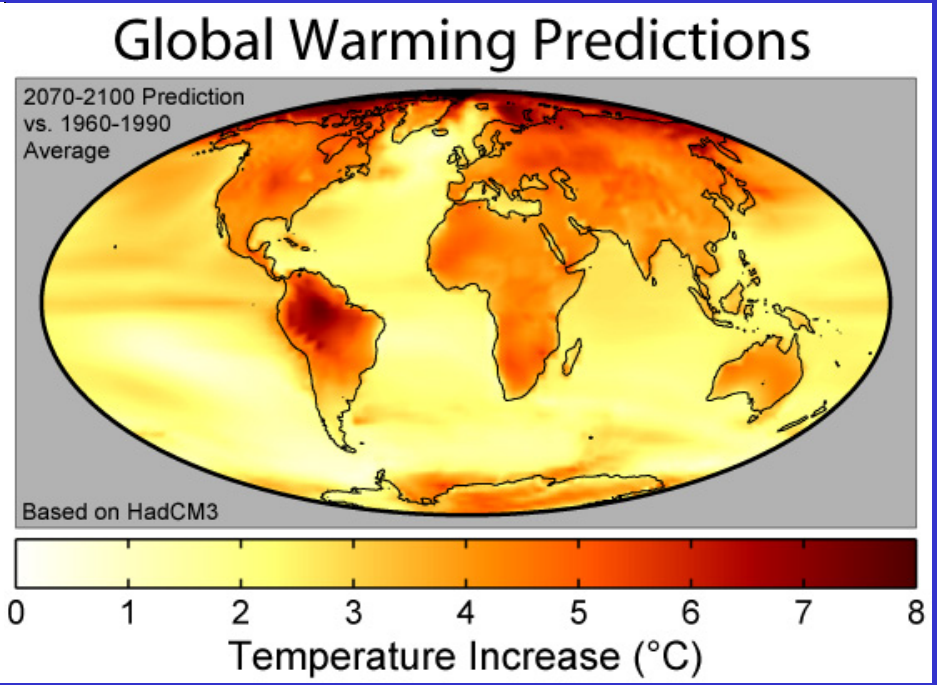
Soil Moisture Balance



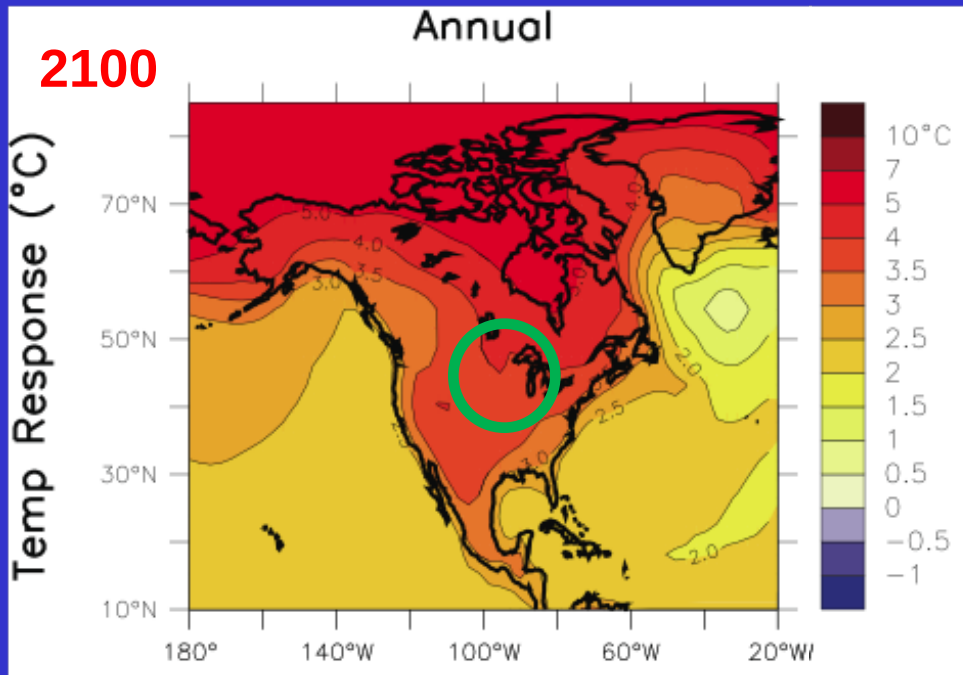
What May Happen to Minnesota's Future Climate?



USGCRP – Hayhoe, et al.



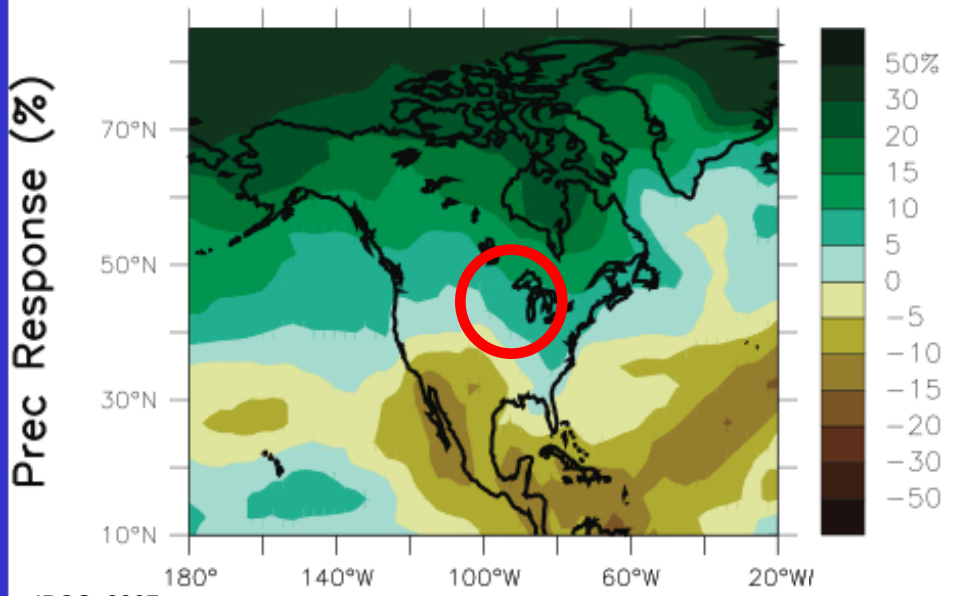
2100



TEMPERATURE

3.5 – 4.0°C
(6.3 – 7.2°F)
INCREASE

5°C (41°F) Current Avg.
becomes
9°C (48°F) Predicted Avg.

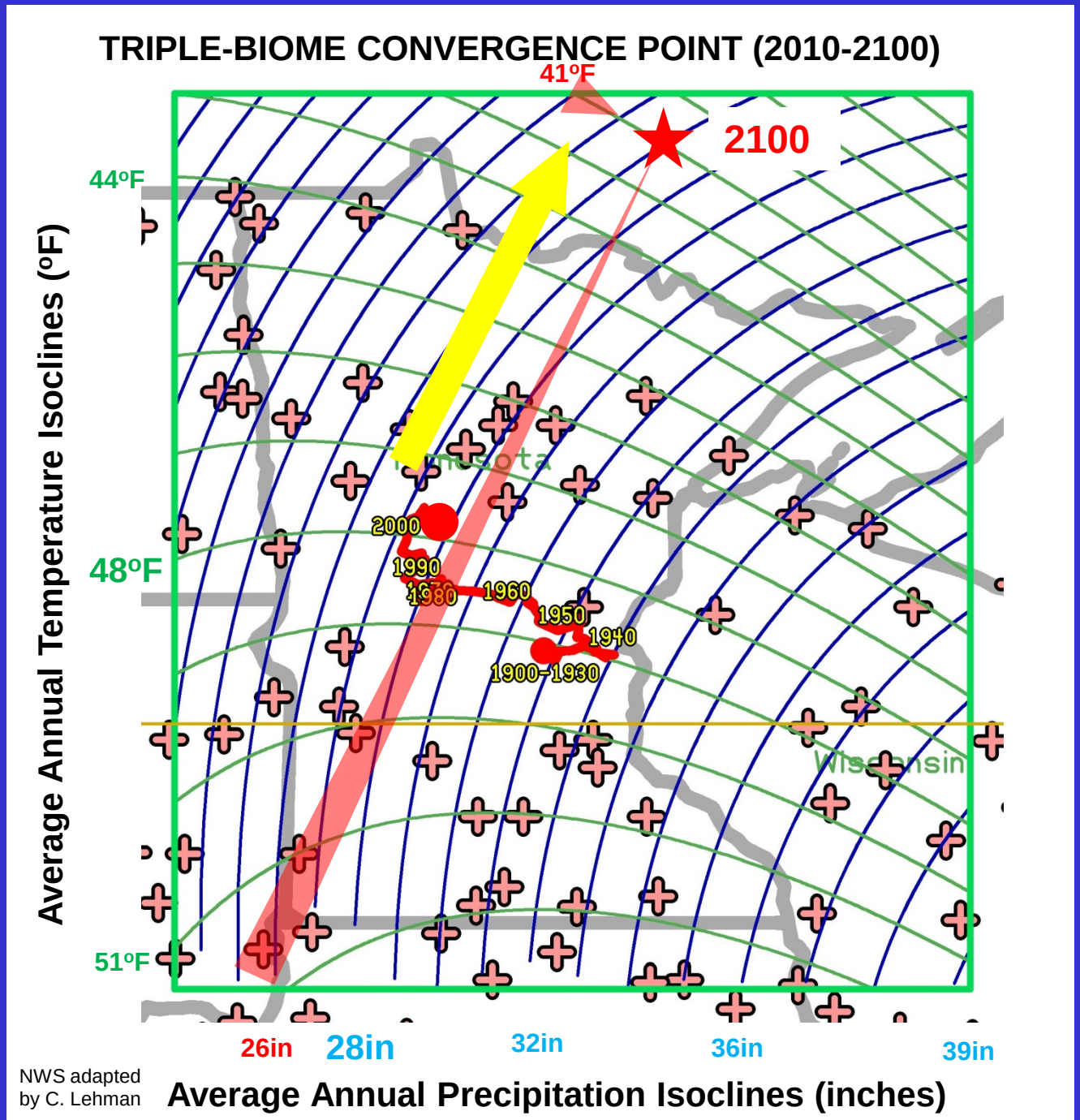


PRECIPITATION

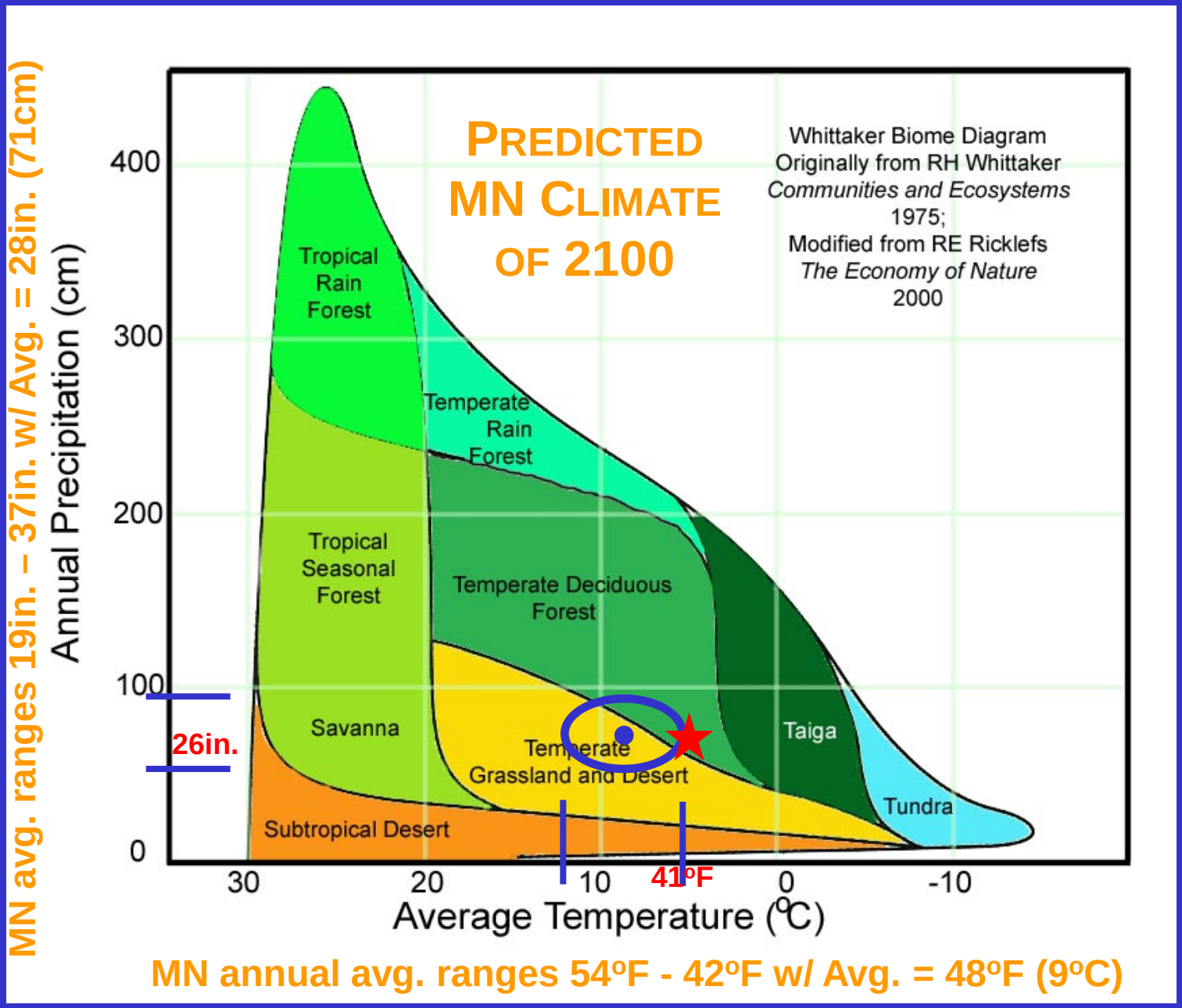
5 – 10%
(1.3 – 2.6 in.)
INCREASE

26 in. Current Avg.
becomes
28 in. Predicted Avg.

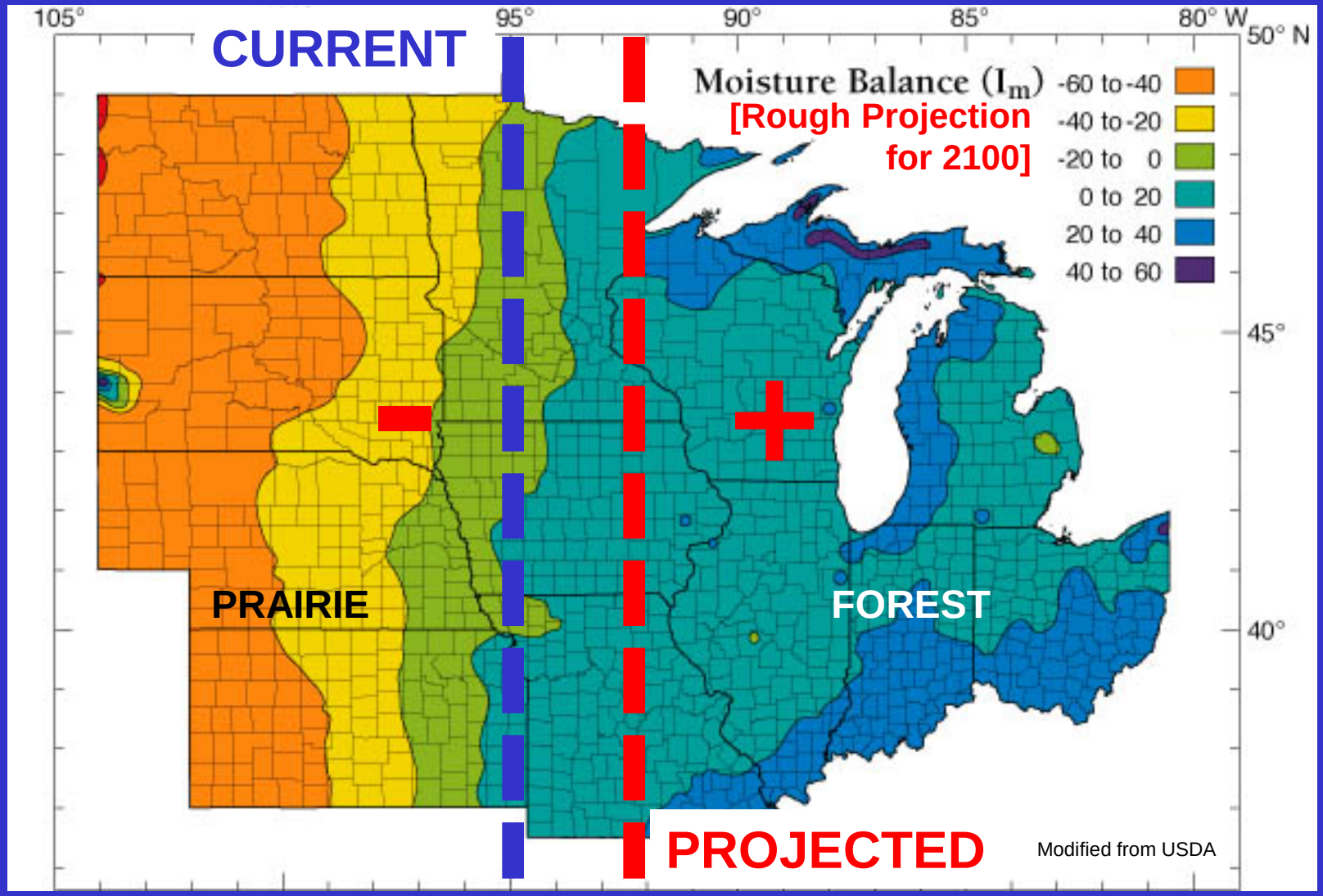
IPCC, 2007


TRIPLE-BIOME CONVERGENCE POINT (2010-2100)
41ºF
2100
44ºF
48ºF
51ºF
Average Annual Temperature Isoclines (ºF)
2000
1990
1980
1960
1950
1940
1900-1930
26in
28in
32in
36in
39in
Average Annual Precipitation Isoclines (inches)
NWS adapted
by C. Lehman

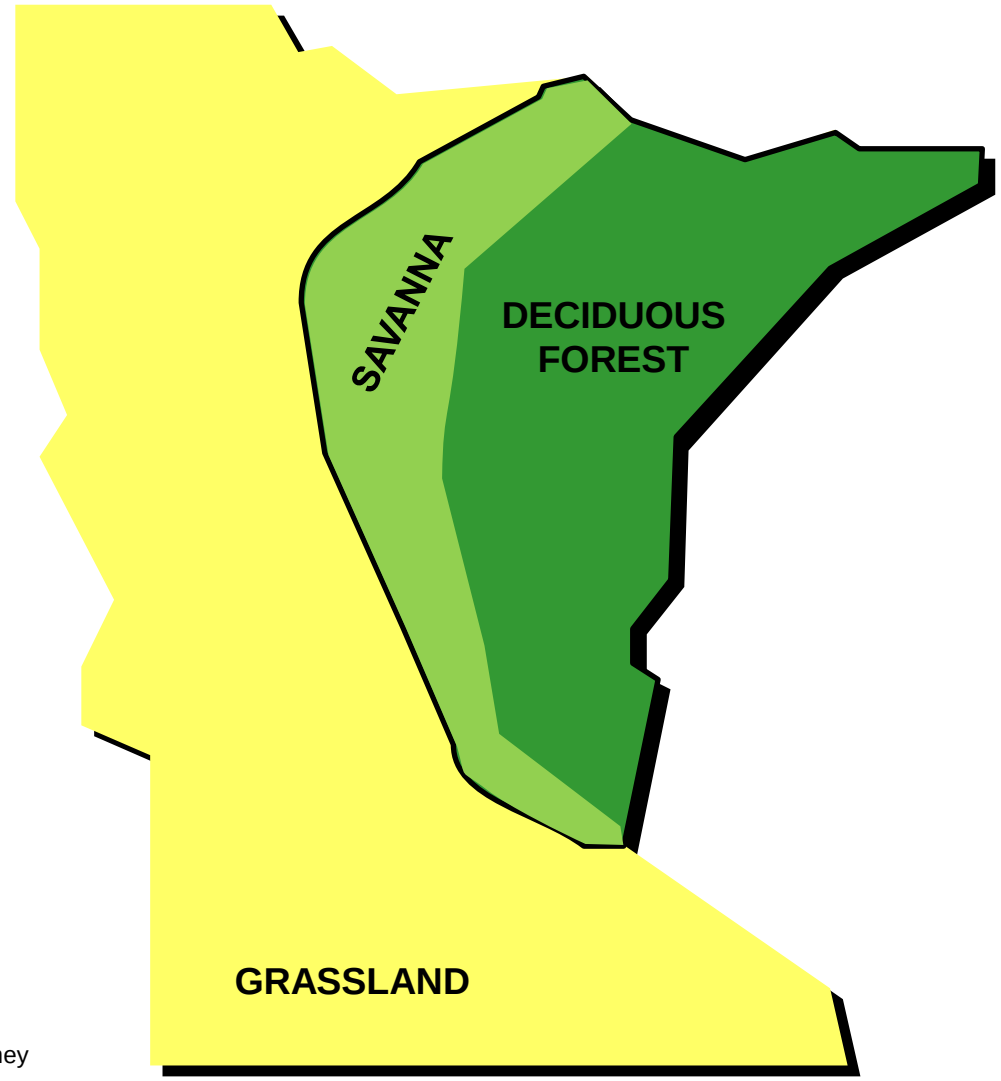
Oh,
Canada!


MN avg. ranges 19in. – 37in. w/ Avg. = 28in. (71cm)
Annual Precipitation (cm)
400
300
200
100
0
26in.
PREDICTED
MN CLIMATE
OF 2100
Whittaker Biome Diagram
Originally from RH Whittaker
Communities and Ecosystems
1975;
Modified from RE Ricklefs
The Economy of Nature
2000
Tropical
Rain
Forest
Temperate
Rain
Forest
Tropical
Seasonal
Forest
Temperate Deciduous
Forest
Savanna
Temperate
Grassland and Desert
Taiga
Tundra
Subtropical Desert
30
20
10
41°F
0
-10
Average Temperature (°C)
MN annual avg. ranges 54°F - 42°F w/ Avg. = 48°F (9°C)

Soil Moisture Balance



MINNESOTA BIOMES



About a 300 mile shift

So, Maybe Not This…

Perhaps Something Like This…

Where Goes the Climate, so Goes the Biomes…

Cedar Creek
Ecosystem Science Reserve

University of Minnesota

Dr. Jeffrey R. Corney, Managing Director
University of Minnesota
Cedar Creek Ecosystem Science Reserve
2660 Fawn Lake Dr NE
East Bethel, MN 55005
(763) 434-5131

www.cbs.umn.edu/cedarcreek
jcorney@umn.edu