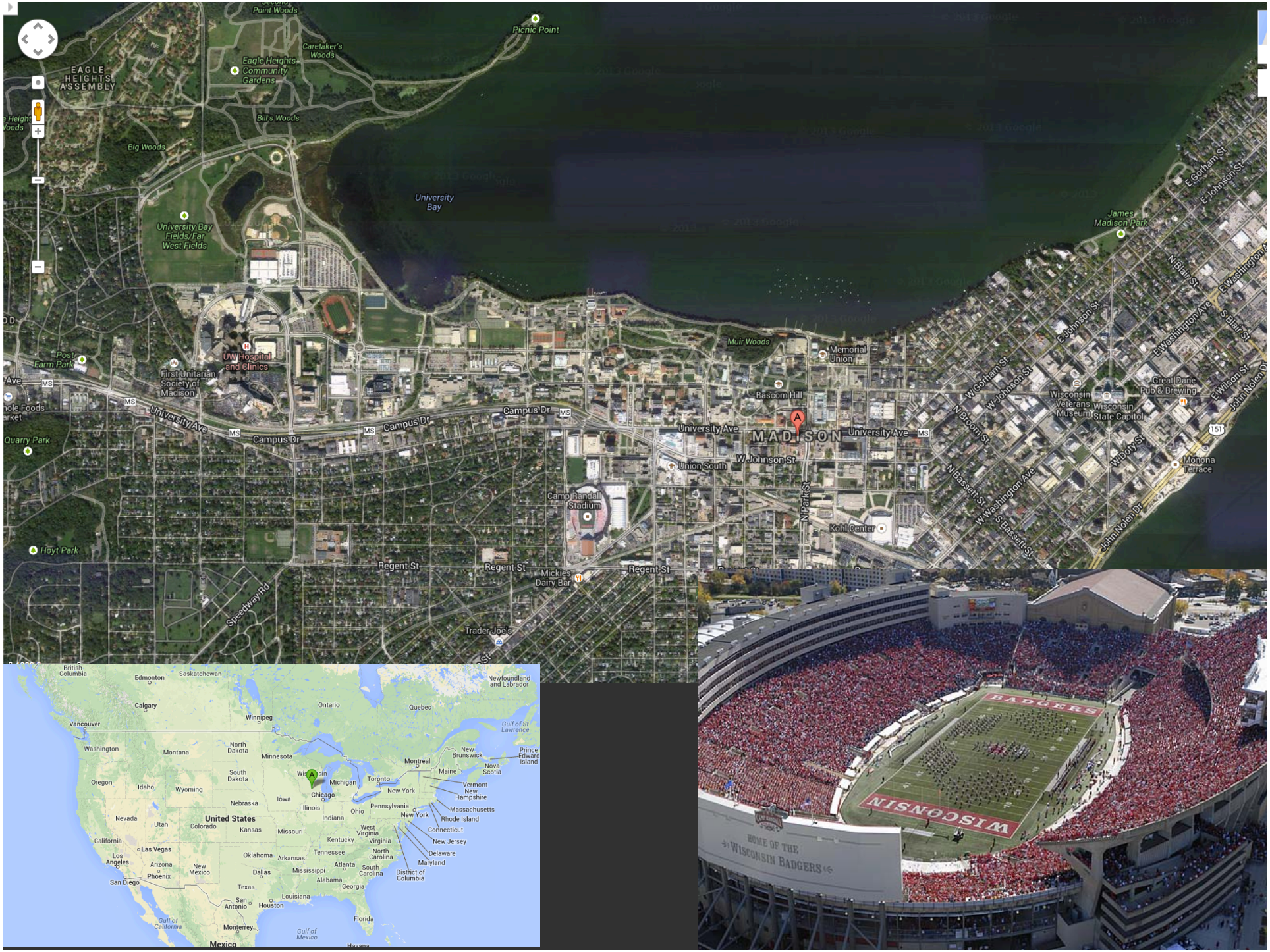
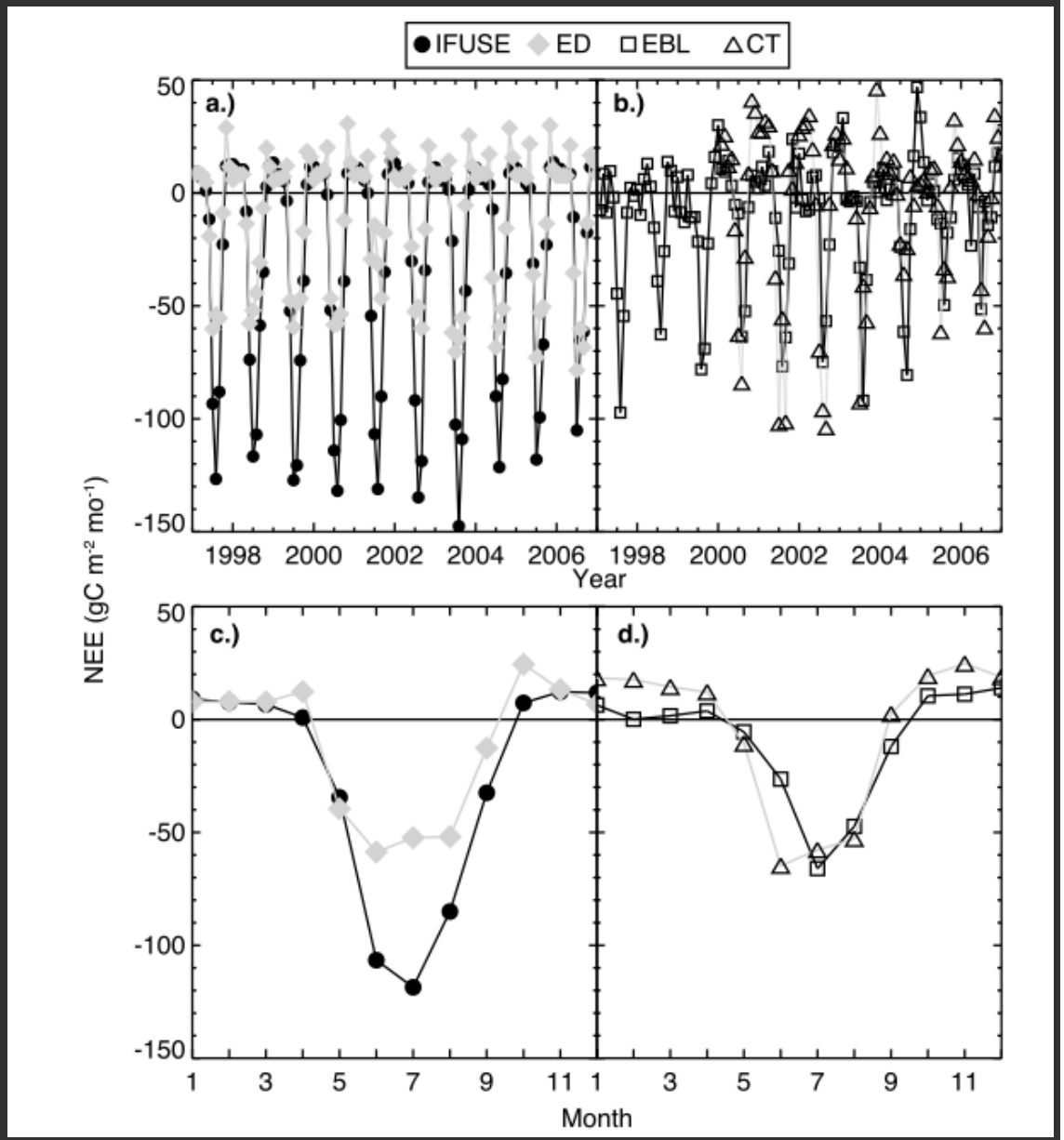
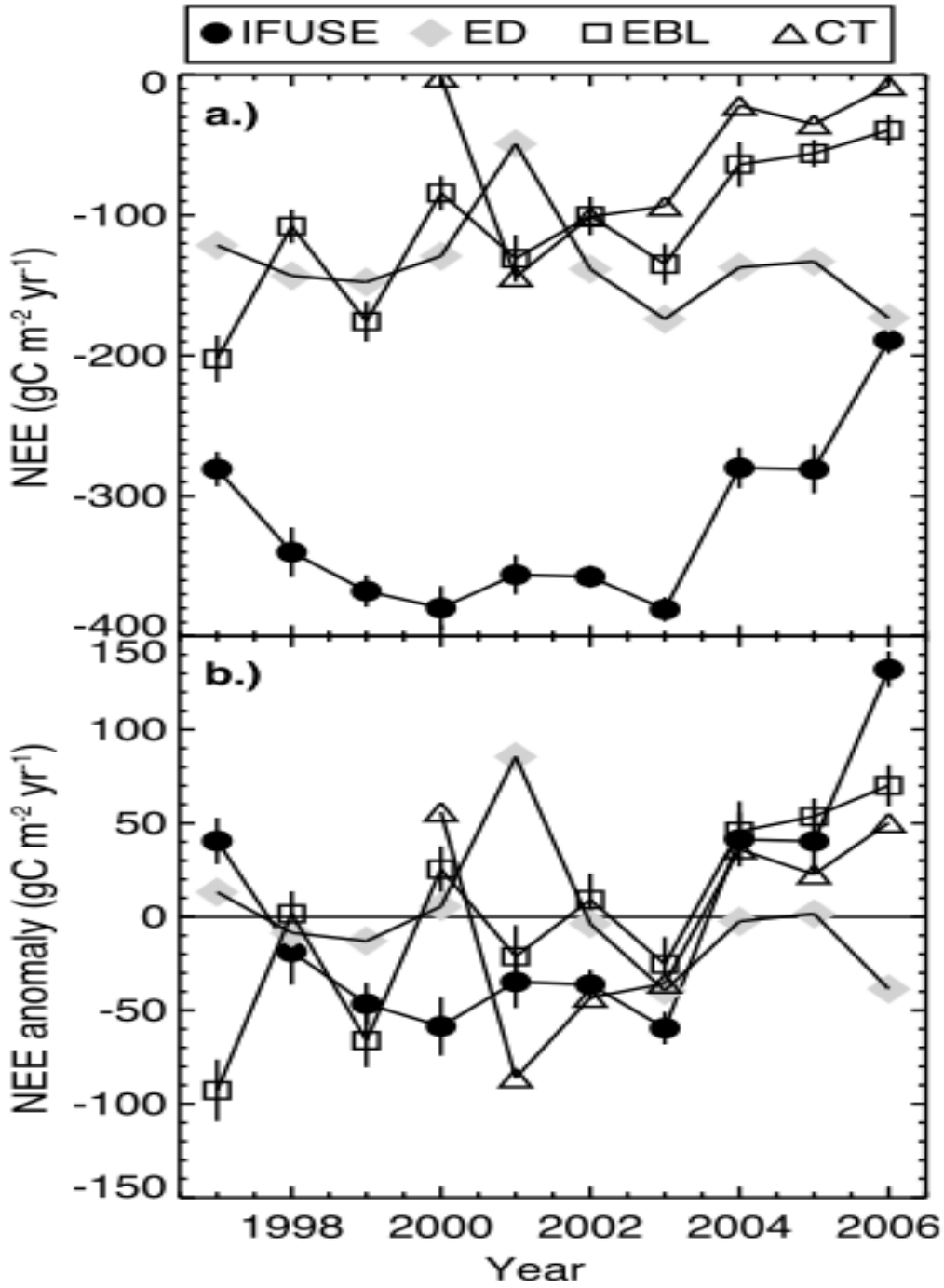

Picnic Point
Caretaker's Woods
Eagle Heights Community Gardens
EAGLE HEIGHTS ASSEMBLY
Bill's Woods
Big Woods
University Bay
University Bay Fields/Far West Fields
James Madison Park
E Gorham St
E Johnson St
N Blair St
E Washington Ave
S Blair St
Muir Woods
Memorial Union
Post Farm Park
UW Hospital and Clinics
First Unitarian Society of Madison
Bascom Hill
W Gorham St
W Johnson St
Wisconsin Veterans Museum
Wisconsin State Capitol
Great Dane Pub & Brewing
E Wilson St
John Nolen Dr
University Ave
Campus Dr
MADISON
Union South
W Johnson St
N Broom St
W Doty St
Monona Terrace
Quarry Park
Camp Randall Stadium
N Park St
Kohl Center
N Bassett St
W Washington Ave
S Bassett St
Hoyt Park
Regent St
Mickies Dairy Bar
Speedway Rd
Trader Joe's
British Columbia
Edmonton
Saskatchewan
Newfoundland and Labrador
Calgary
Ontario
Quebec
Vancouver
Winnipeg
Gulf of St Lawrence
Washington
Montana
North Dakota
Minnesota
New Brunswick
Prince Edward Island
Montreal
Maine
Nova Scotia
Oregon
Idaho
Wyoming
South Dakota
Michigan
Toronto
Vermont
New Hampshire
Nebraska
Iowa
Chicago
New York
Illinois
Pennsylvania
Massachusetts
Nevada
Utah
United States
Colorado
Kansas
Missouri
Indiana
Ohio
Rhode Island
Connecticut
California
Kentucky
West Virginia
Virginia
New Jersey
Las Vegas
Oklahoma
Arkansas
Tennessee
North Carolina
Delaware
Los Angeles
Arizona
New Mexico
Dallas
Mississippi
Atlanta
South Carolina
Maryland
Phoenix
San Diego
Alabama
District of Columbia
Texas
Georgia
San Antonio
Houston
Louisiana
Florida
Gulf of California
Monterrey
Gulf of Mexico
Mexico
BADGERS
WISCONSIN
HOME OF THE WISCONSIN BADGERS

Why complexity?

8/29/11 Chapin et al., 2011 Fig. 1.1

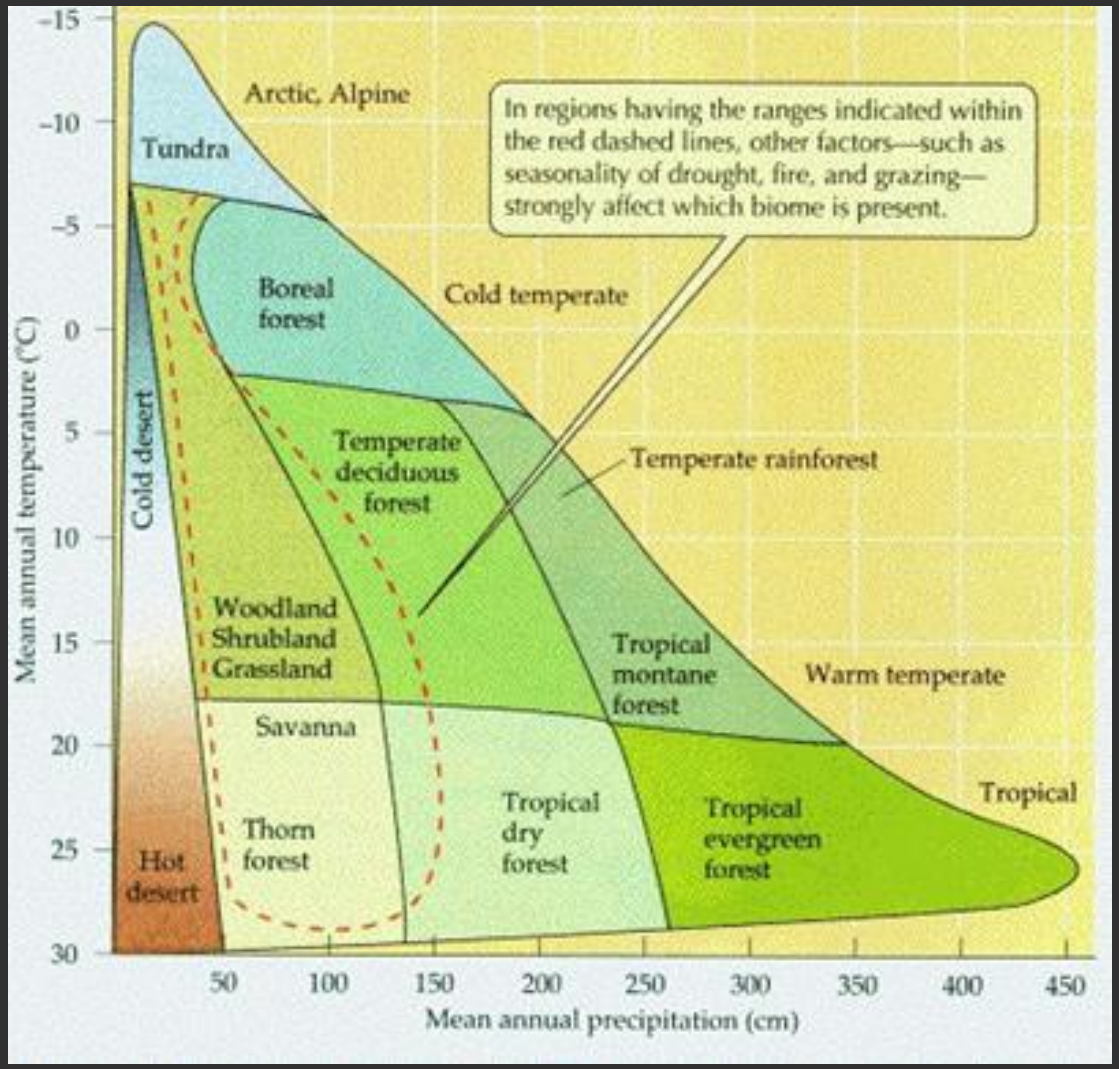
Desai et al., 2010, JGR-G

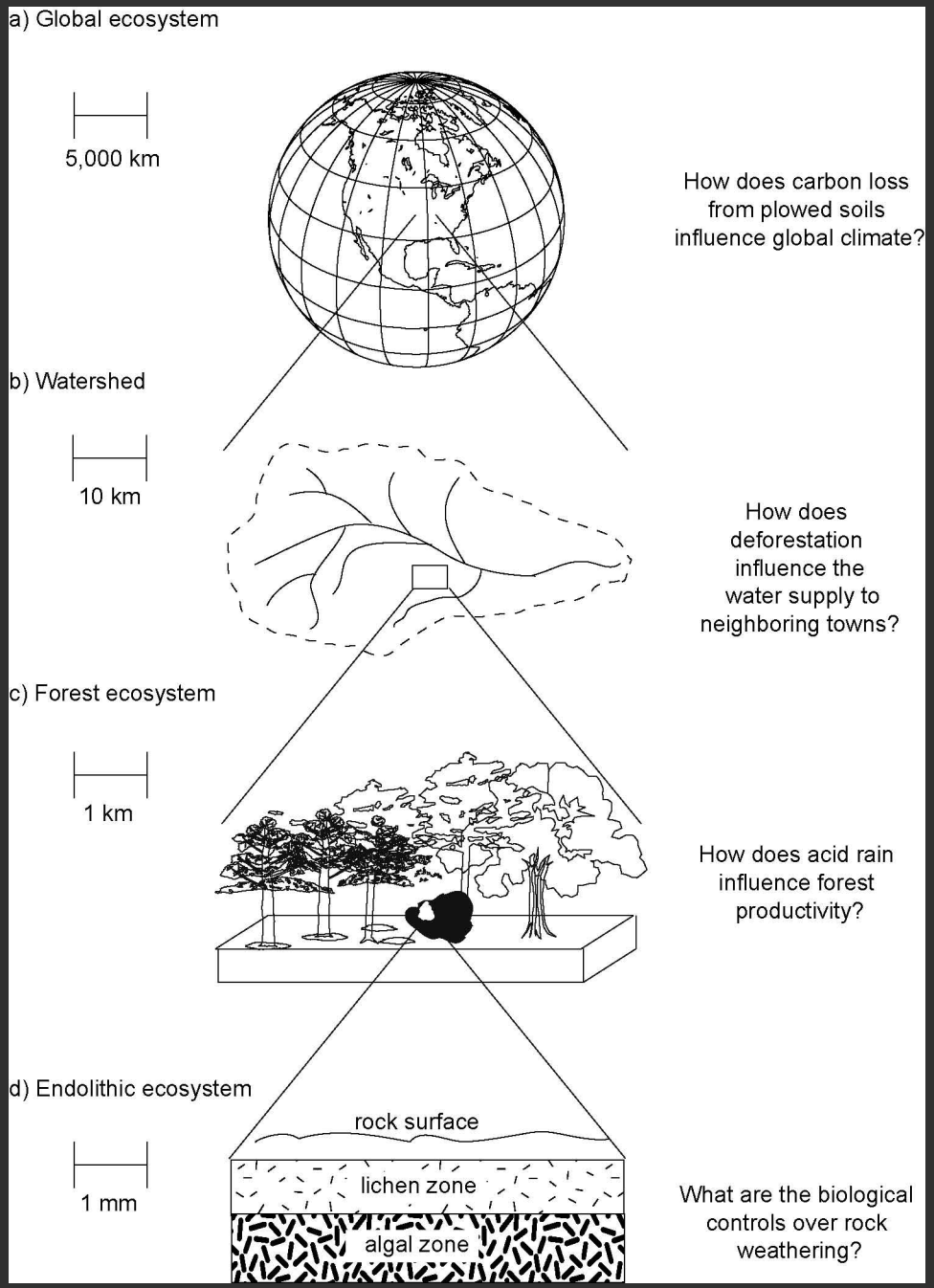


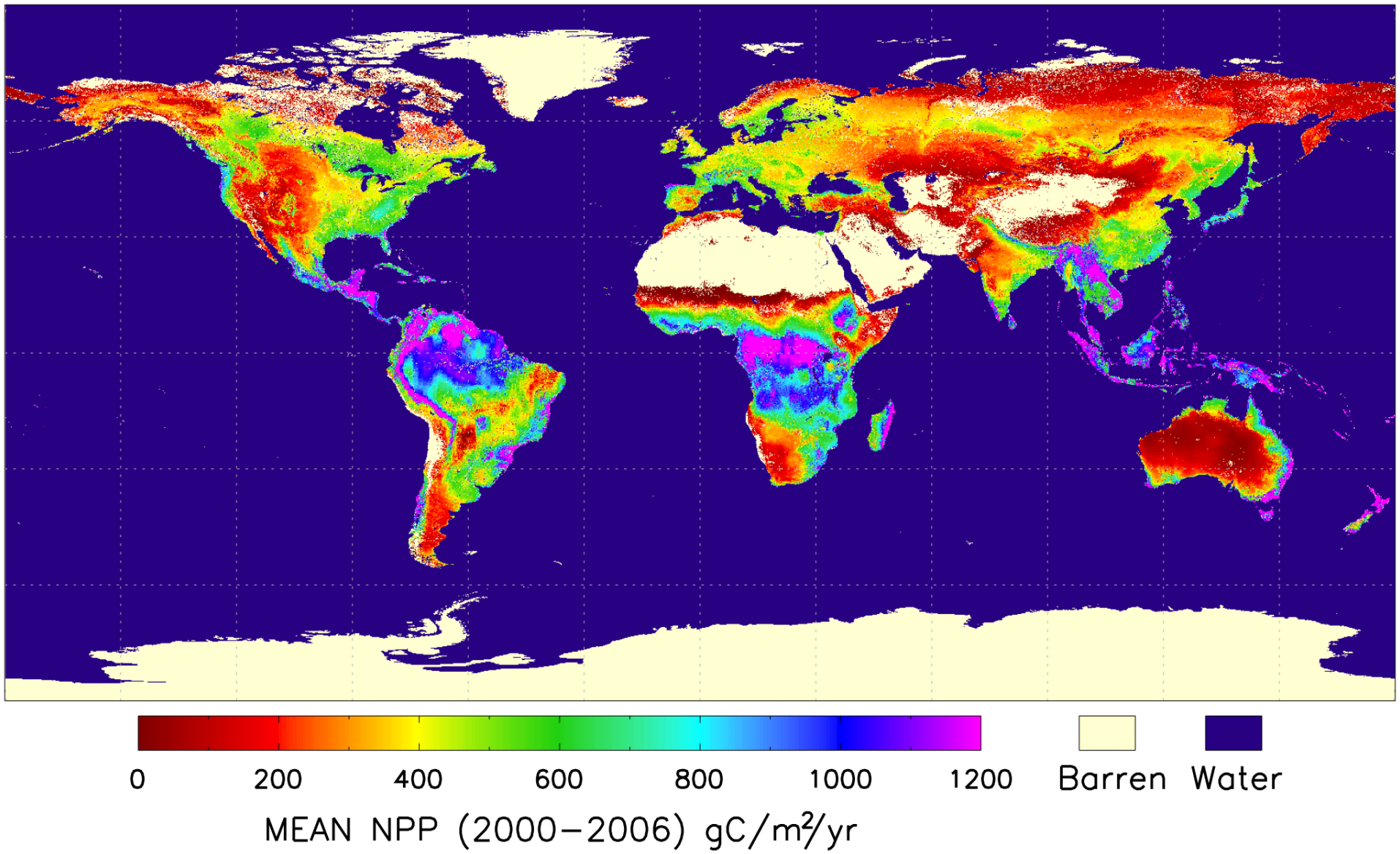

IFUSE
ED
EBL
CT
a.)
b.)
NEE (gC m-2 yr-1)
NEE anomaly (gC m-2 yr-1)
0
-100
-200
-300
-400
150
100
50
0
-50
-100
-150
1998
2000
2002
2004
2006
Year

Ecosystem Ecology

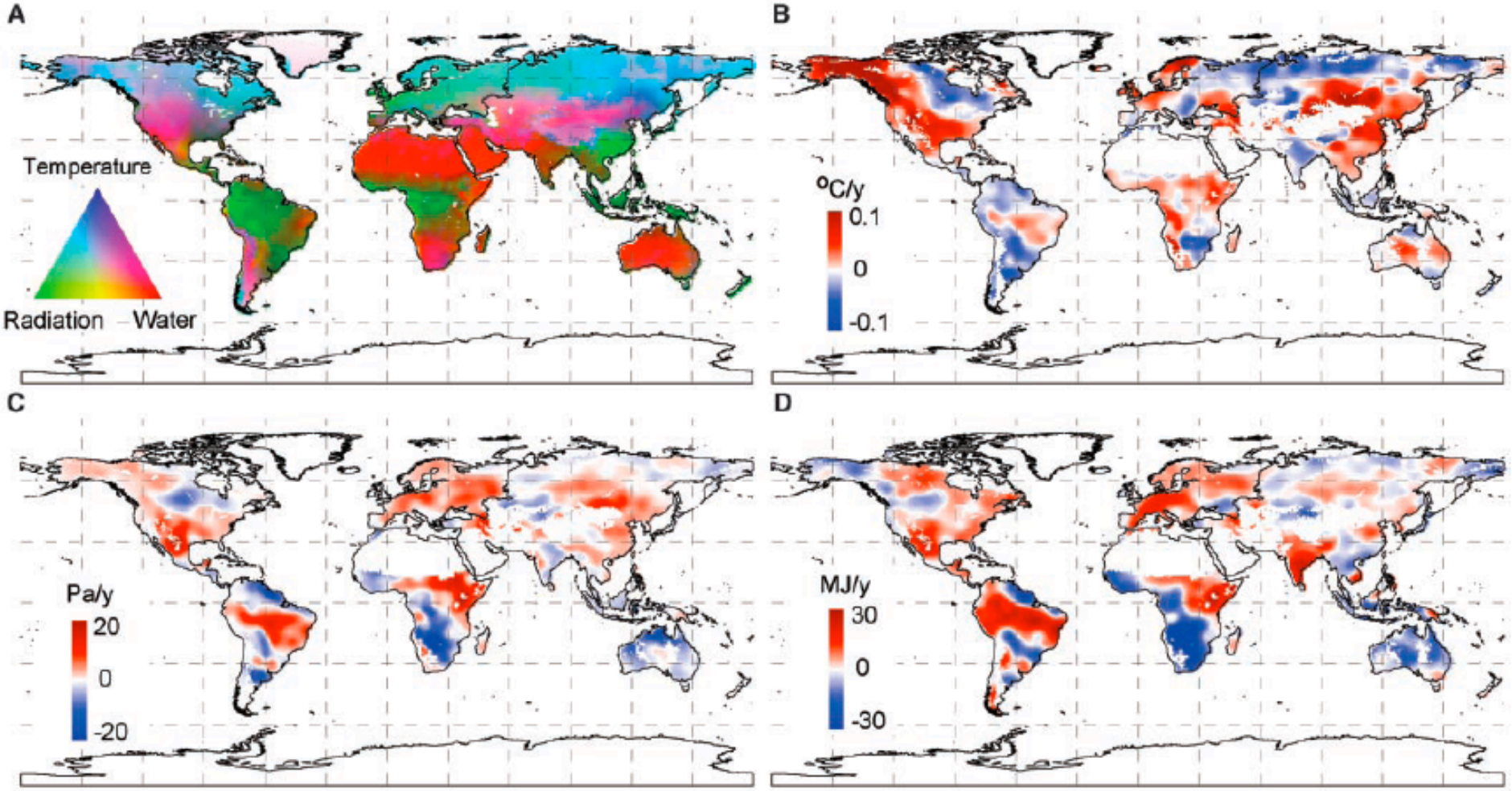
- Ecosystem: Bounded ecological system of organisms (biotic) and their environment (abiotic) that interact or function together
- Structure and function of ecosystems
  - Structure: organization: physical, community, diversity
  - Function: Energy, carbon, nutrient cycling
- Biomes: Climatically or geographically defined area of ecologically similar conditions
  - Leading to dominance of certain types of ecosystems that have evolved to succeed (successfully reproduce) within a particular climate or geographic niche

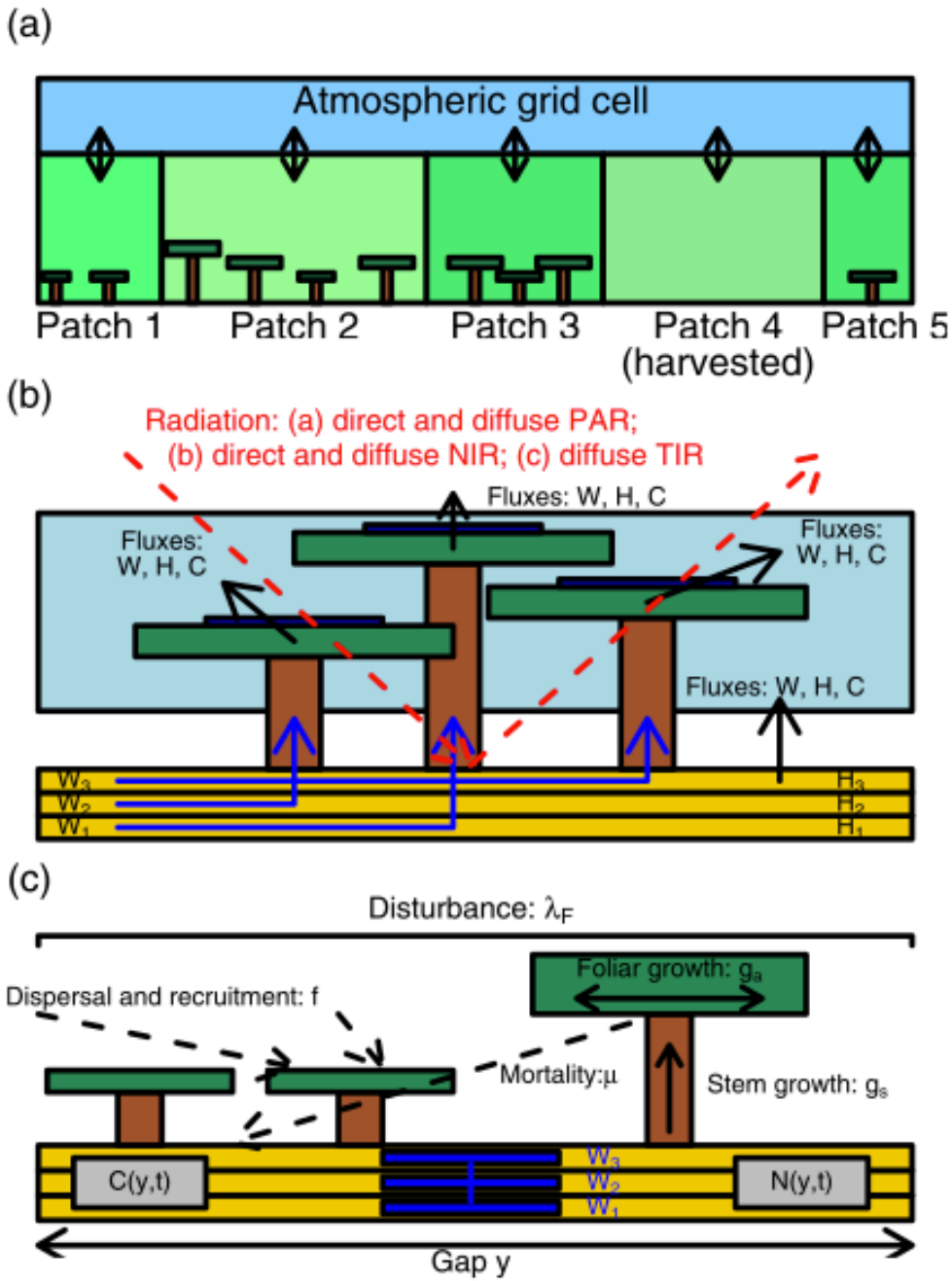

Arctic, Alpine
Tundra
In regions having the ranges indicated within the red dashed lines, other factors—such as seasonality of drought, fire, and grazing—strongly affect which biome is present.
Boreal forest
Cold temperate
Cold desert
Temperate deciduous forest
Temperate rainforest
Woodland Shrubland Grassland
Tropical montane forest
Warm temperate
Savanna
Tropical
Tropical dry forest
Tropical evergreen forest
Thorn forest
Hot desert
Mean annual temperature (°C)
−15
−10
−5
0
5
10
15
20
25
30
50
100
150
200
250
300
350
400
450
Mean annual precipitation (cm)


a) Global ecosystem
5,000 km
How does carbon loss from plowed soils influence global climate?
b) Watershed
10 km
How does deforestation influence the water supply to neighboring towns?
c) Forest ecosystem
1 km
How does acid rain influence forest productivity?
d) Endolithic ecosystem
rock surface
lichen zone
algal zone
1 mm
What are the biological controls over rock weathering?


0
200
400
600
800
1000
1200
Barren
Water
MEAN NPP (2000–2006) gC/m²/yr

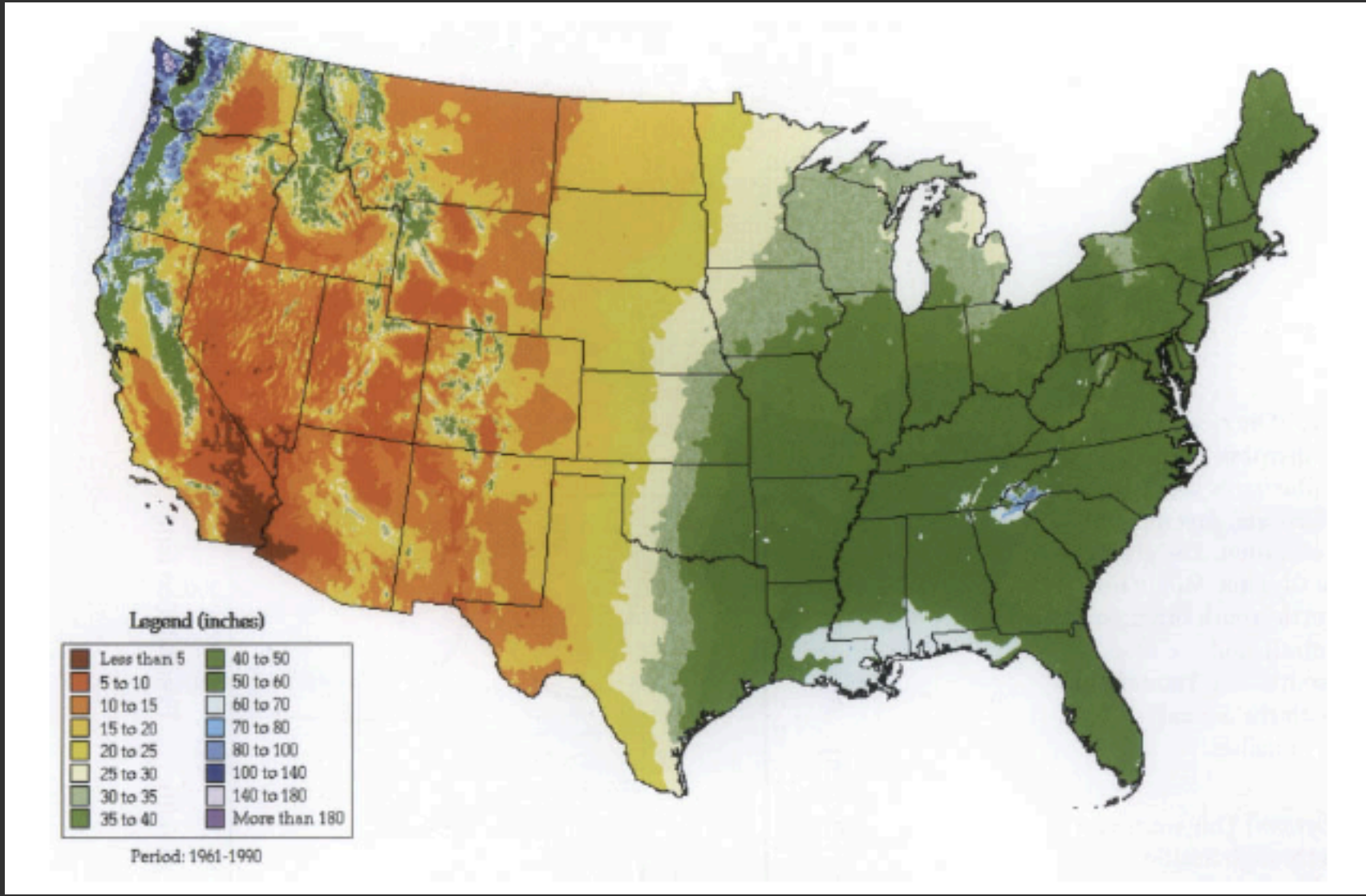
Nemani, 2003, Science



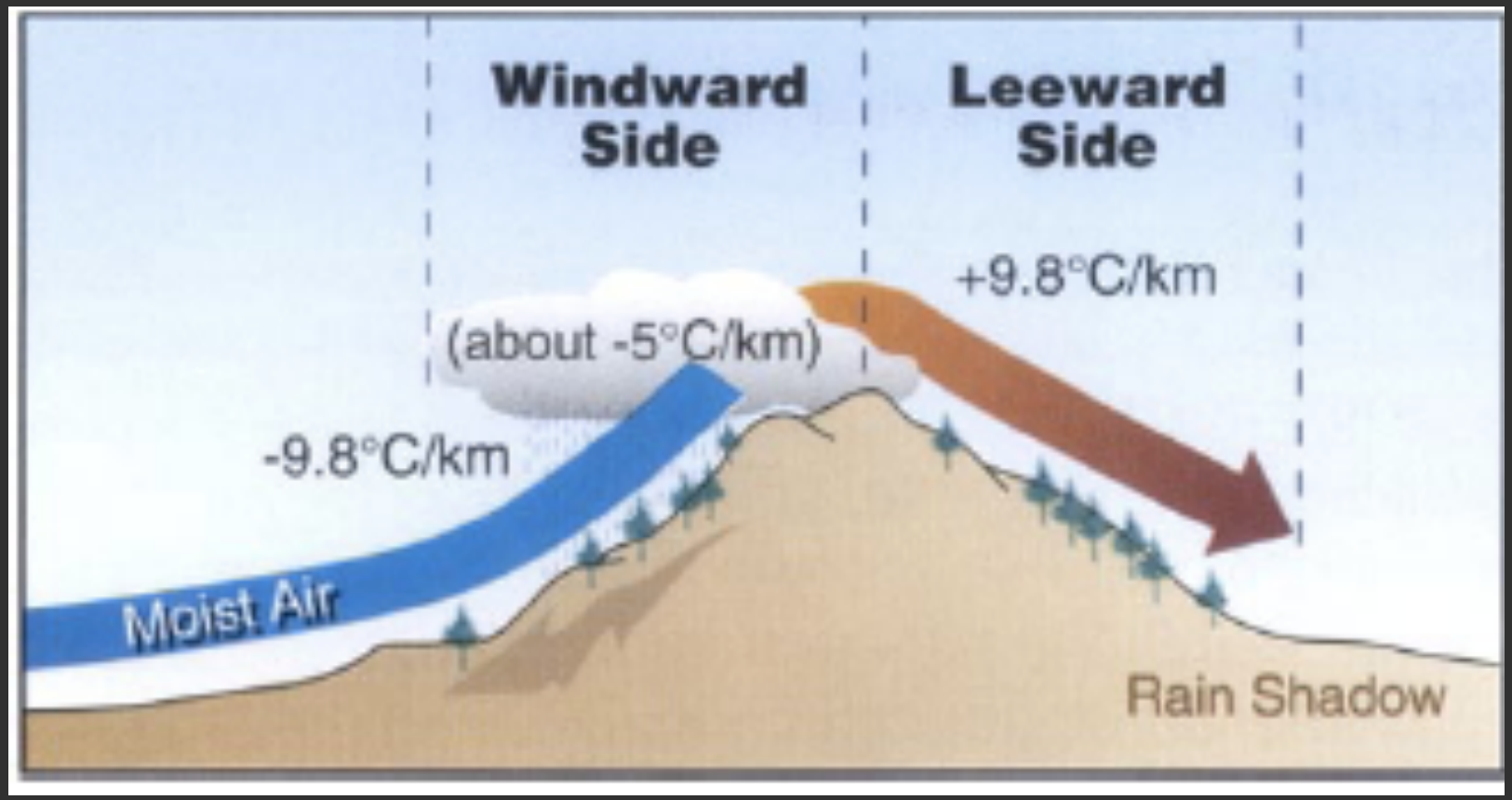

(a)
Atmospheric grid cell
Patch 1
Patch 2
Patch 3
Patch 4
(harvested)
Patch 5
(b)
Radiation: (a) direct and diffuse PAR;
(b) direct and diffuse NIR; (c) diffuse TIR
Fluxes: W, H, C
Fluxes:
W, H, C
Fluxes:
W, H, C
Fluxes: W, H, C
W3
W2
W1
H3
H2
H1
(c)
Disturbance: λF
Dispersal and recruitment: f
Foliar growth: ga
Mortality:μ
Stem growth: gs
C(y,t)
N(y,t)
W3
W2
W1
Gap y

Why terrain?

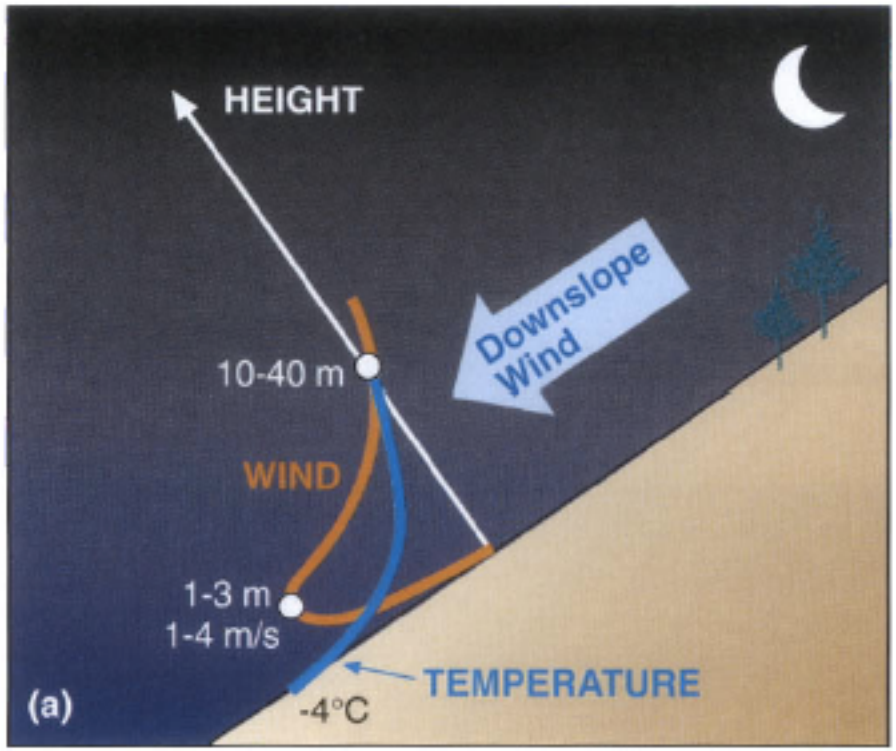
Precipitation in the US

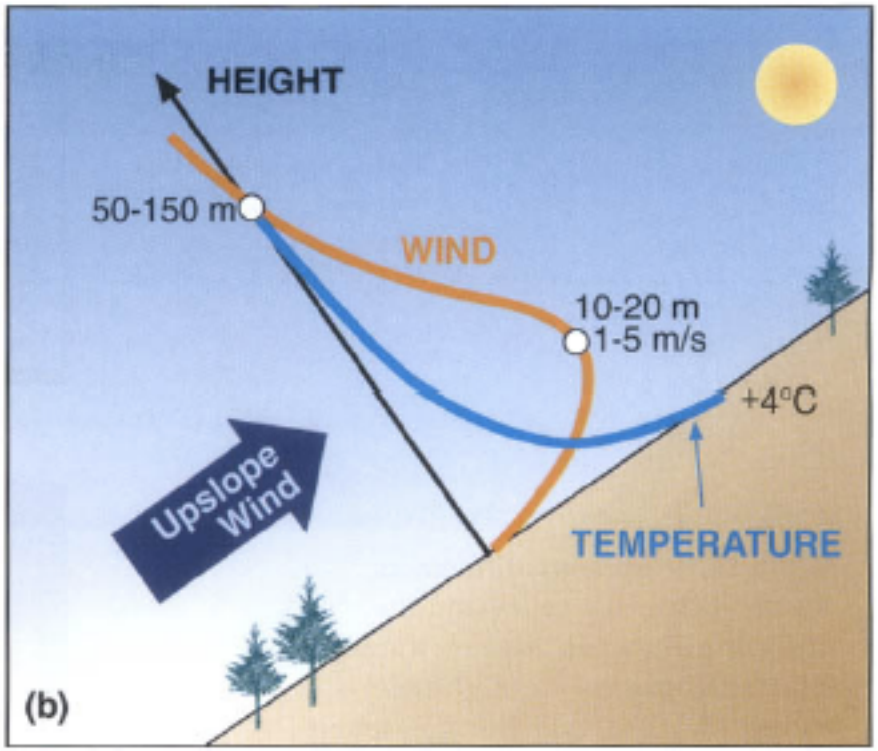


Rain Shadow

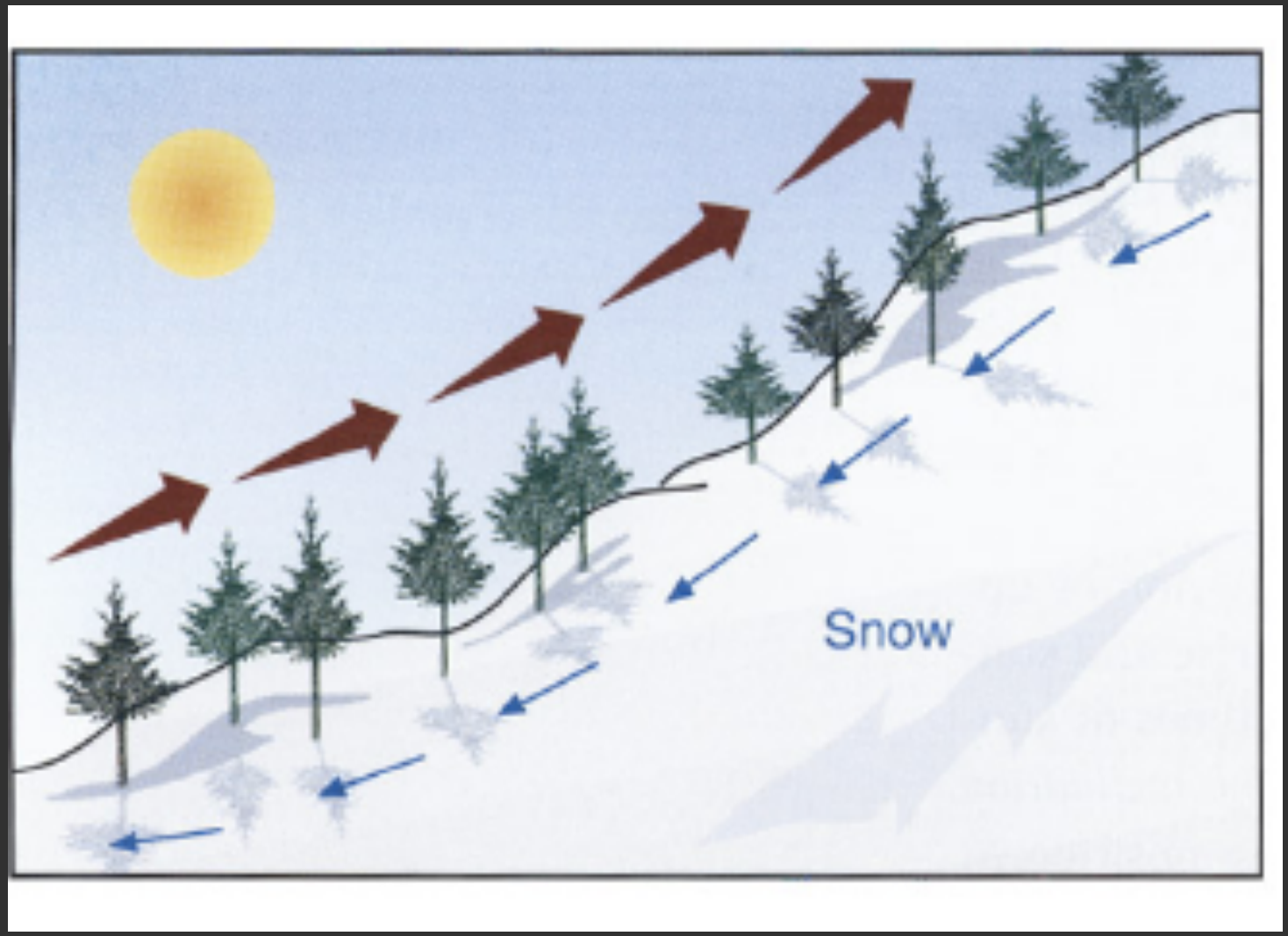

Windward Side
Leeward Side
+9.8°C/km
(about -5°C/km)
-9.8°C/km
Moist Air
Rain Shadow

Slope winds

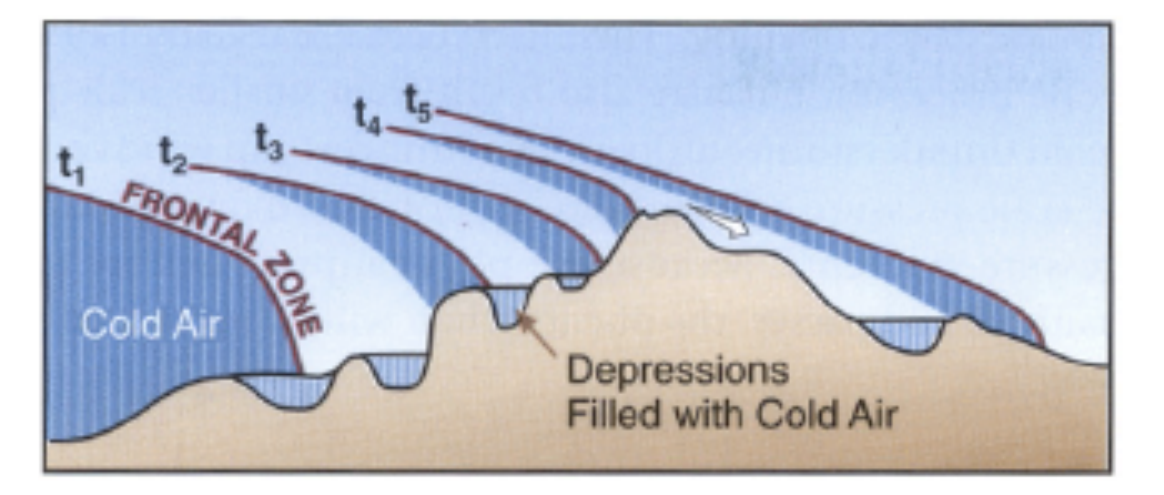

HEIGHT
Downslope Wind
10-40 m
WIND
1-3 m
1-4 m/s
-4°C
TEMPERATURE
(a)

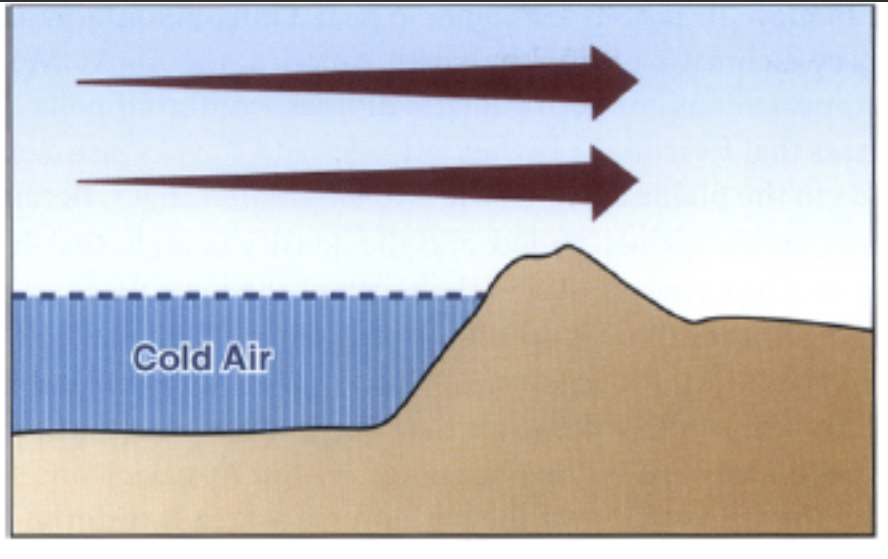

HEIGHT
50-150 m
WIND
10-20 m
1-5 m/s
+4°C
Upslope Wind
TEMPERATURE
(b)

Canopy + Terrain

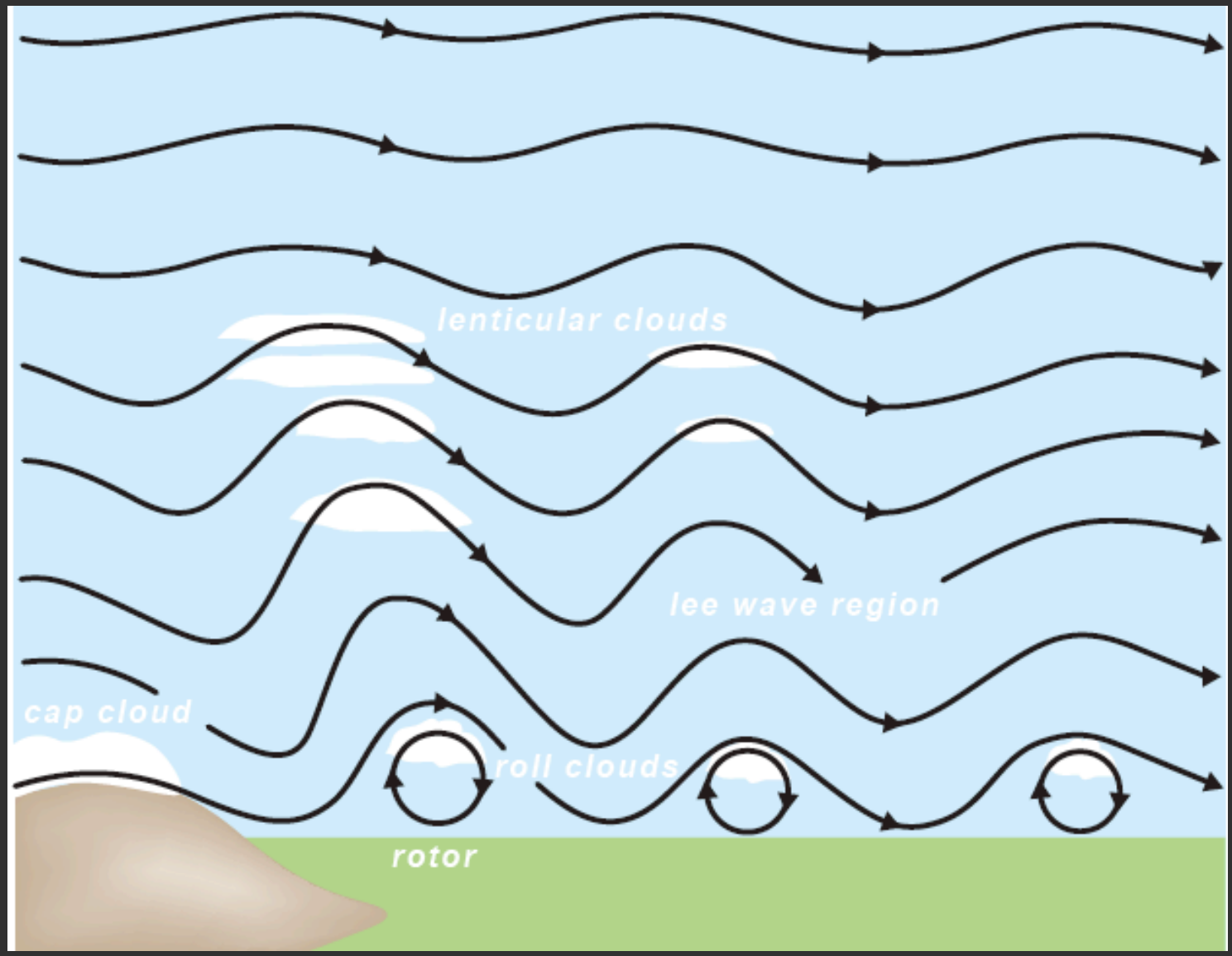


Cold Air Damming

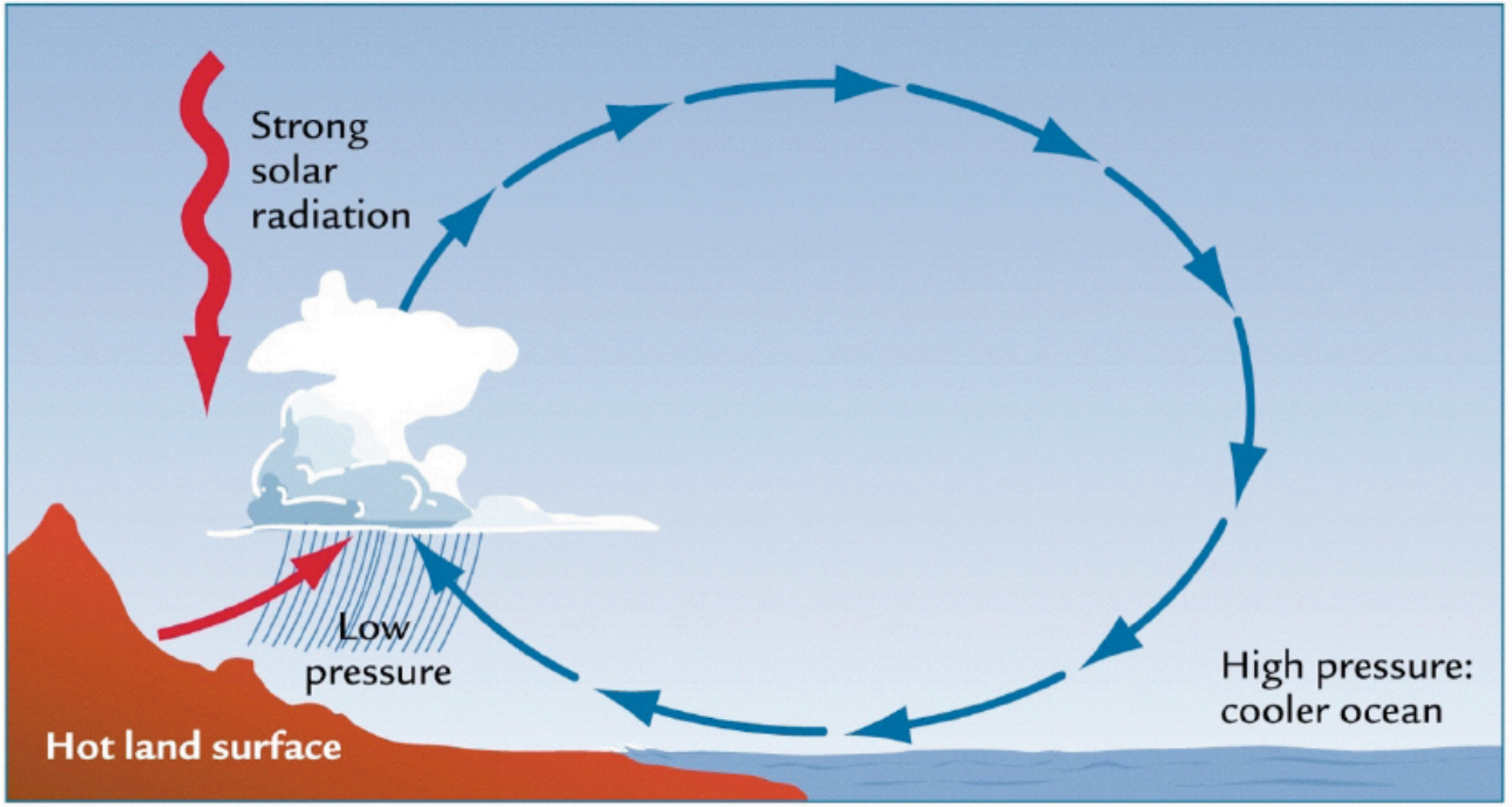




Waves and Rotors

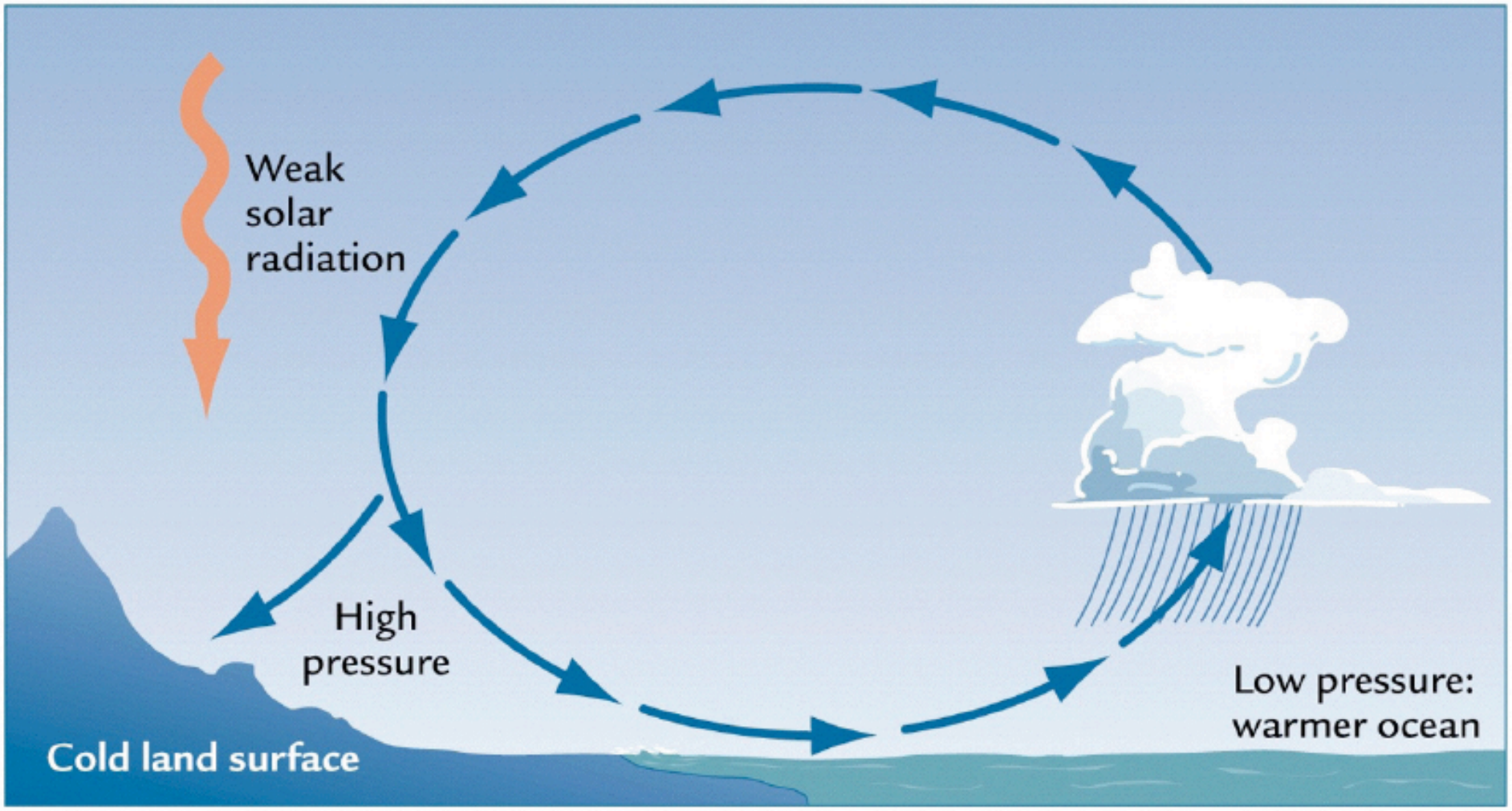


Monsoon Flow



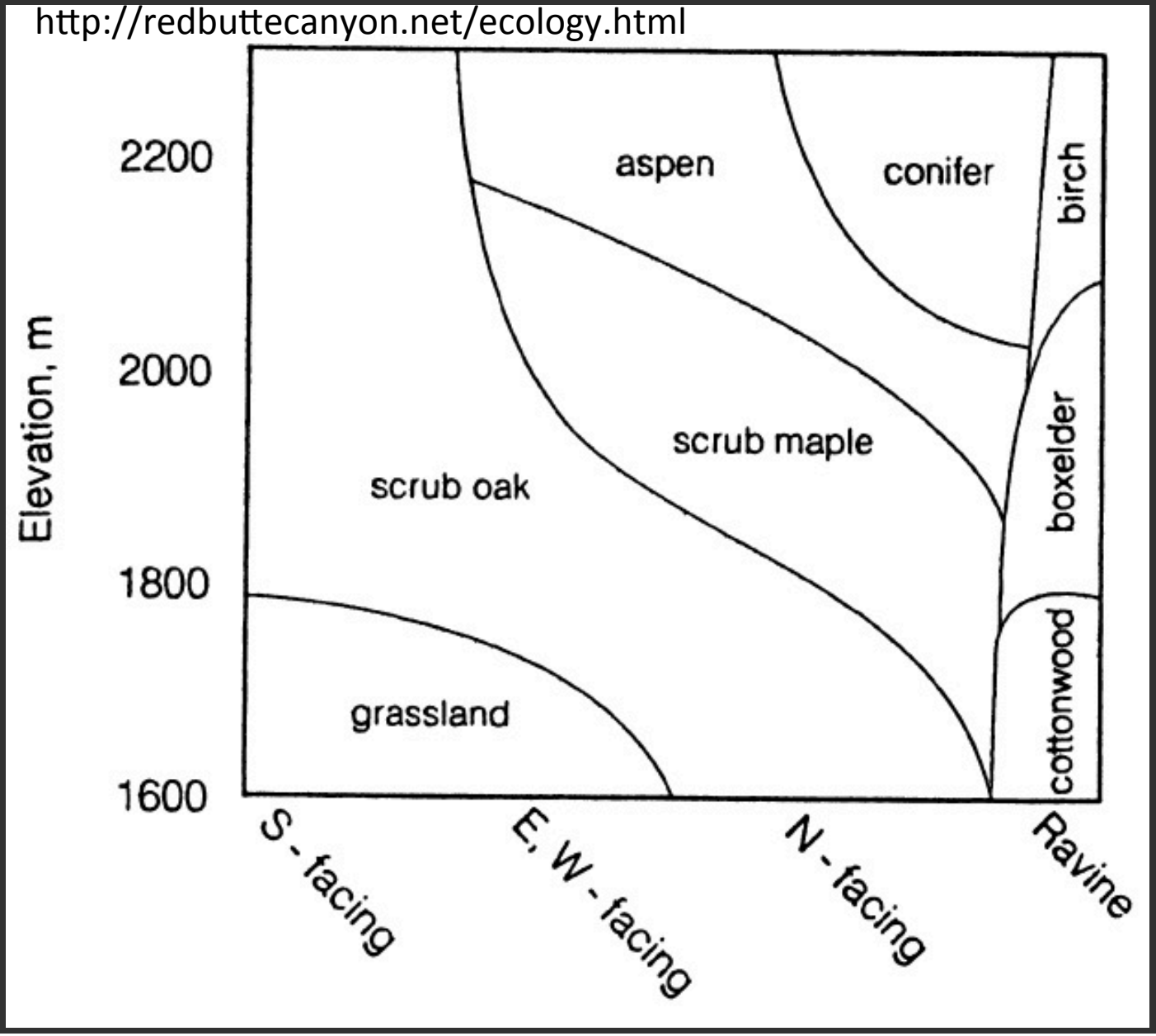
A Summer monsoon

Monsoon Flow

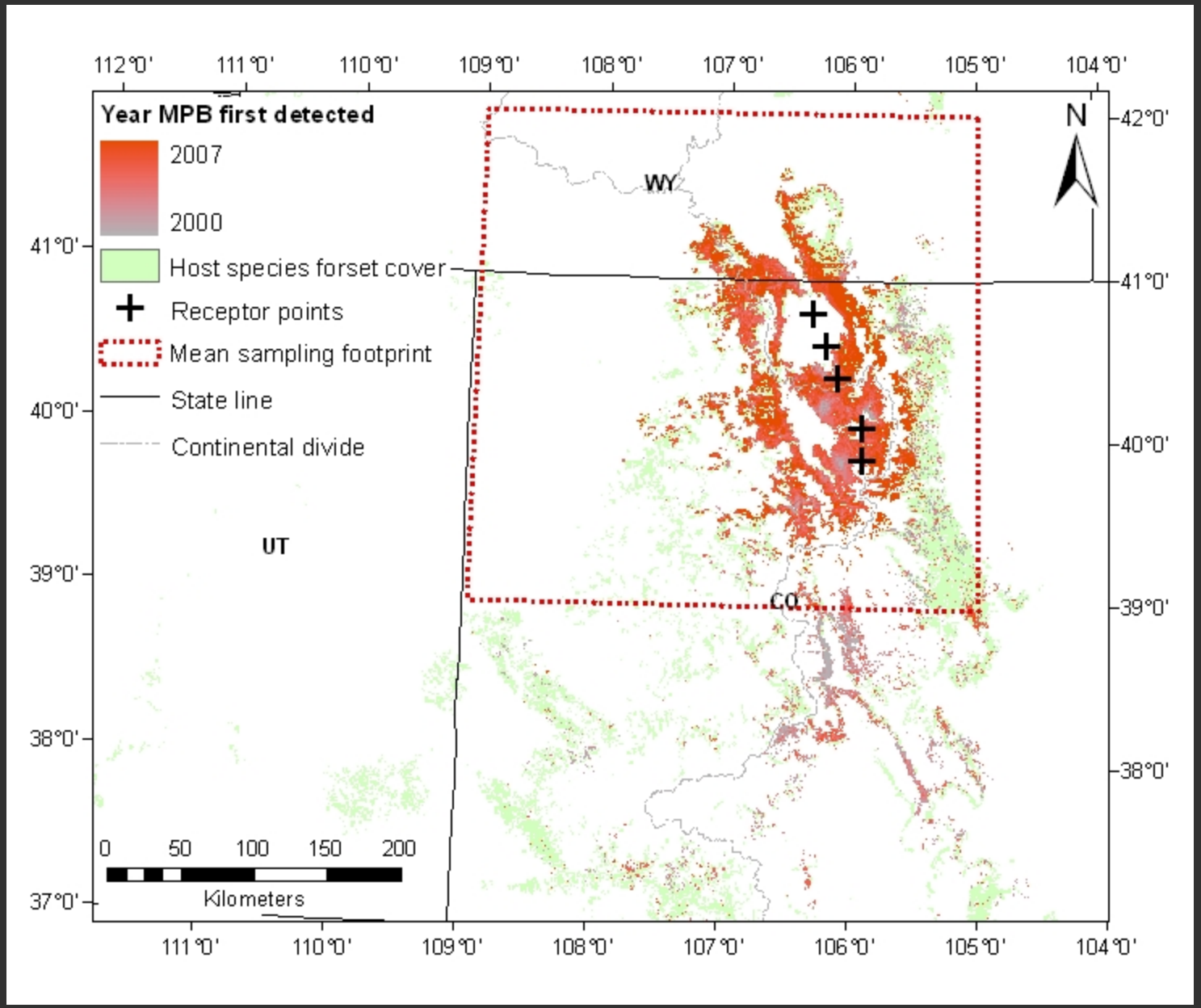


B Winter monsoon

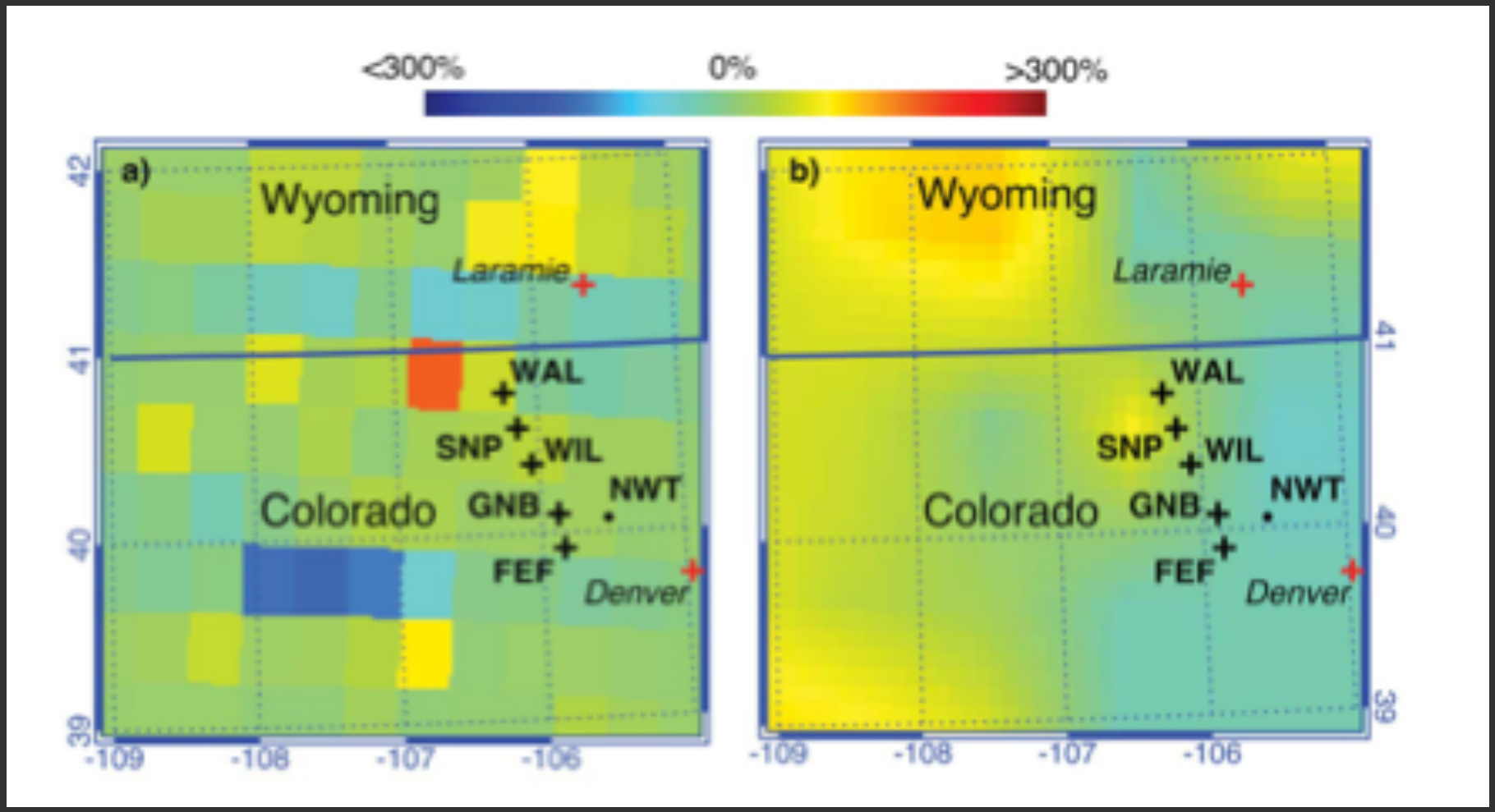
http://redbuttecanyon.net/ecology.html

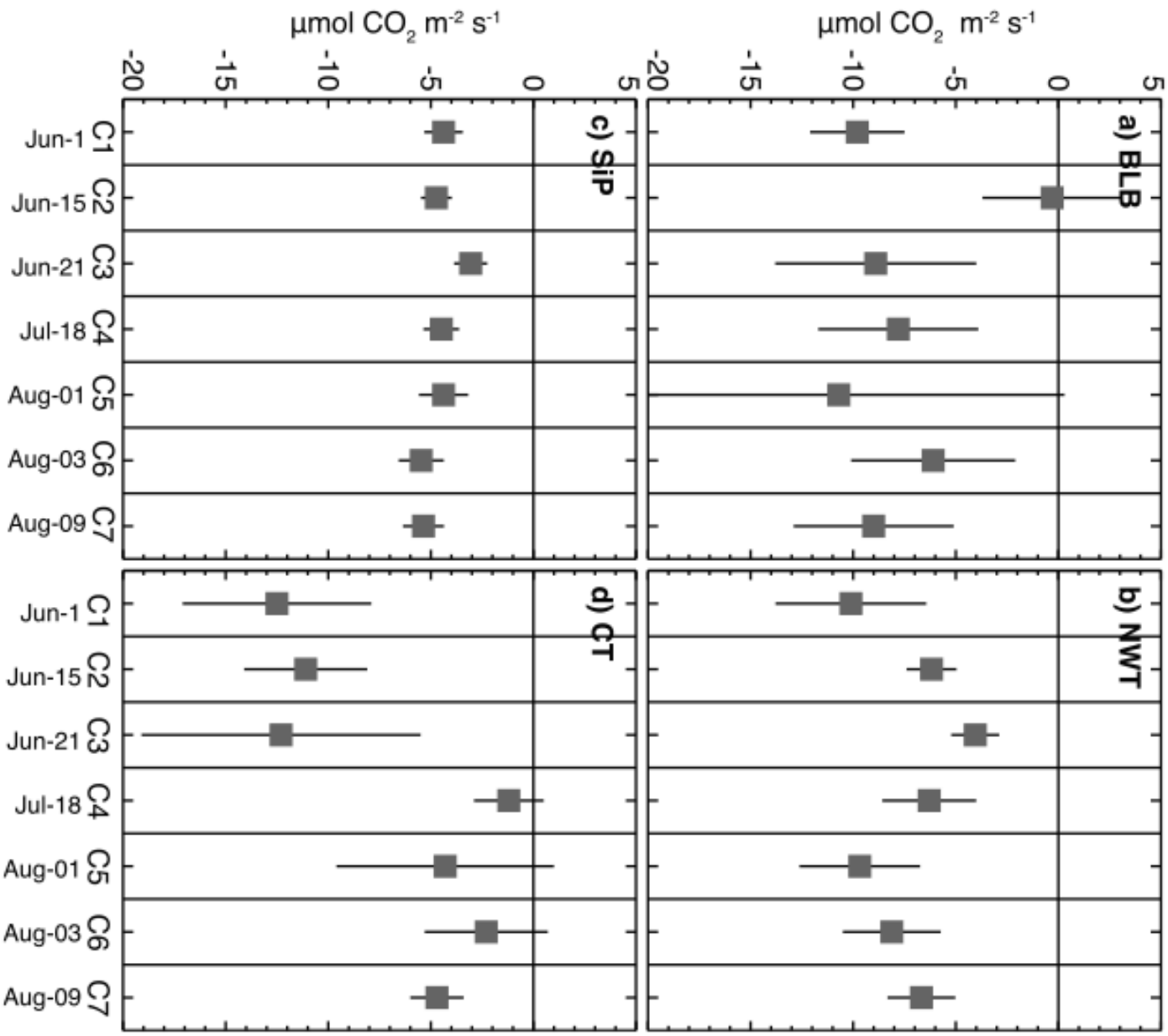


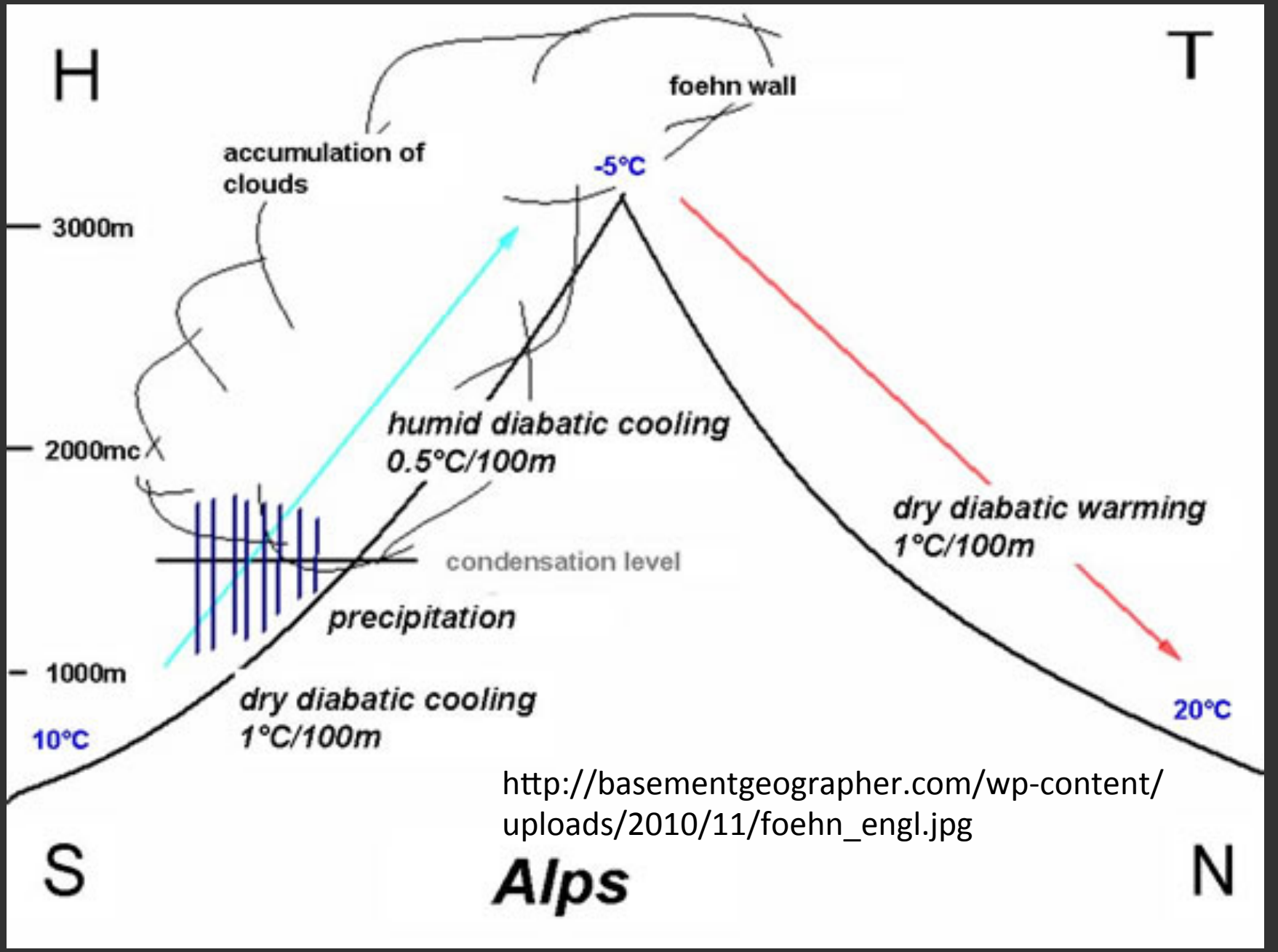
Western US Closeup


Year MPB first detected
2007
2000
Host species forset cover
Receptor points
Mean sampling footprint
State line
Continental divide
WY
UT
CO
N
0 50 100 150 200
Kilometers
112°0'
111°0'
110°0'
109°0'
108°0'
107°0'
106°0'
105°0'
104°0'
42°0'
41°0'
40°0'
39°0'
38°0'
37°0'

- Desai et al., 2011 JGR-G

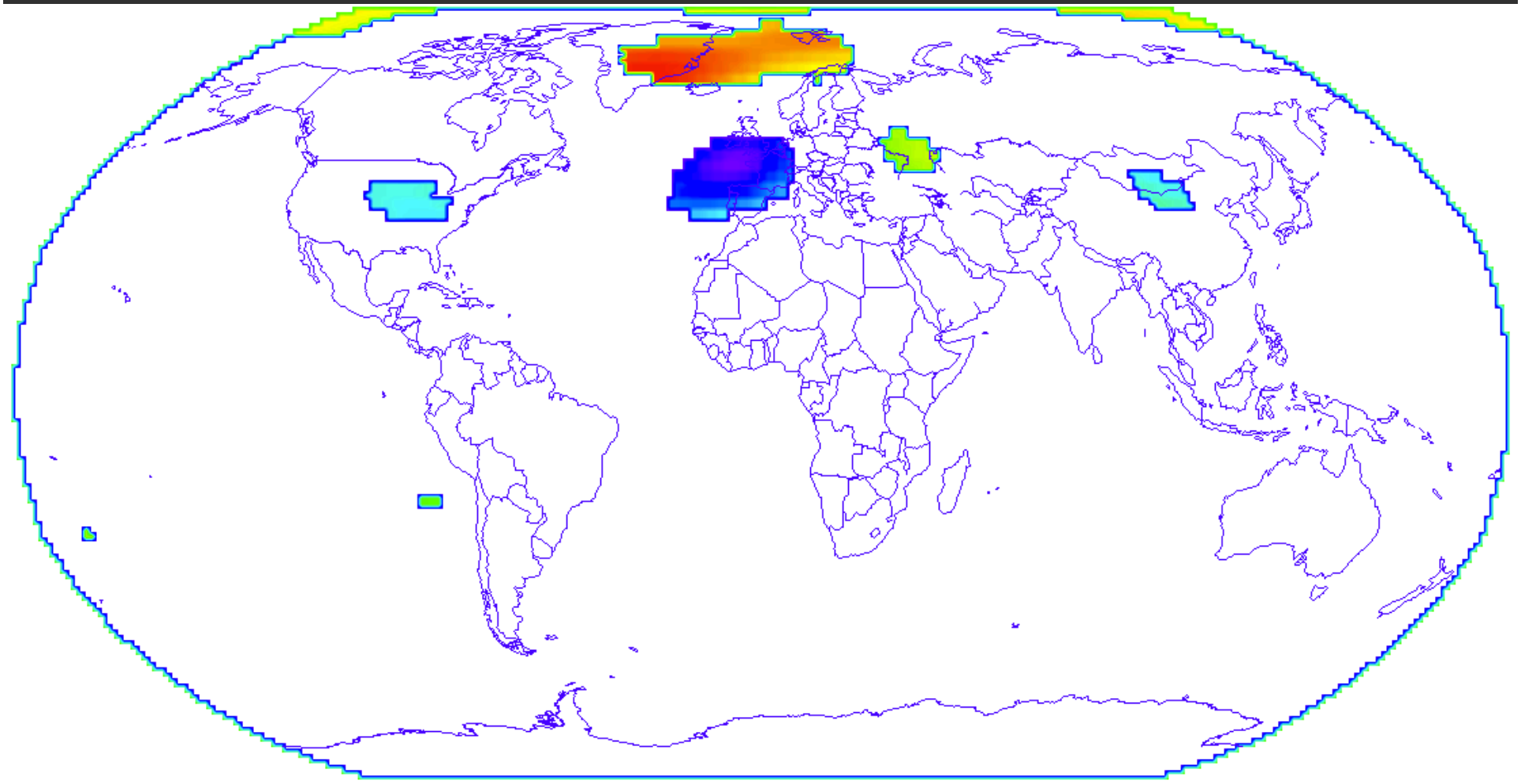


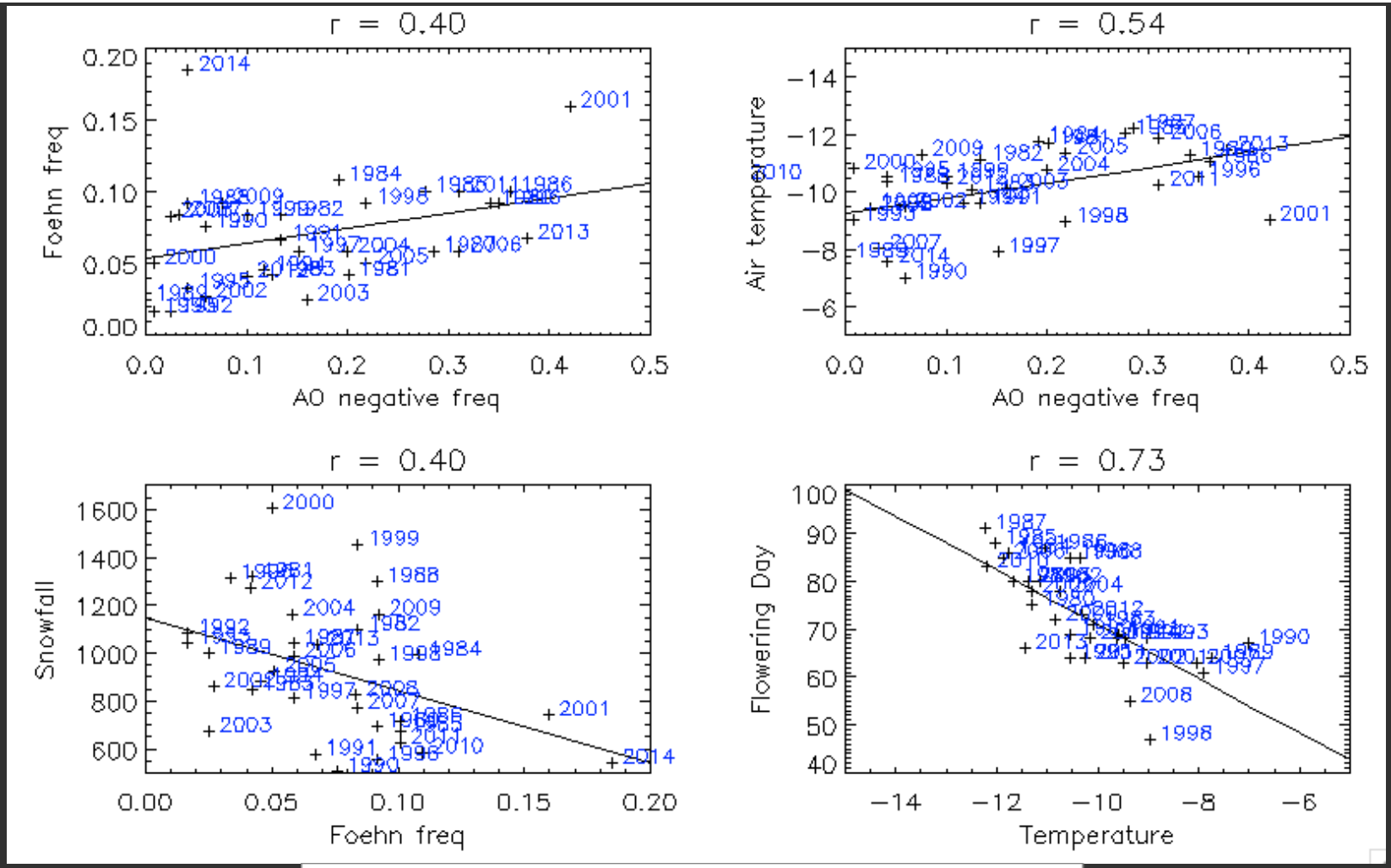

µmol CO2 m-2 s-1
-20
-15
-10
-5
0
5
a) BLB
b) NWT
c) SiP
d) CT
Jun-1 C1
Jun-15 C2
Jun-21 C3
Jul-18 C4
Aug-01 C5
Aug-03 C6
Aug-09 C7

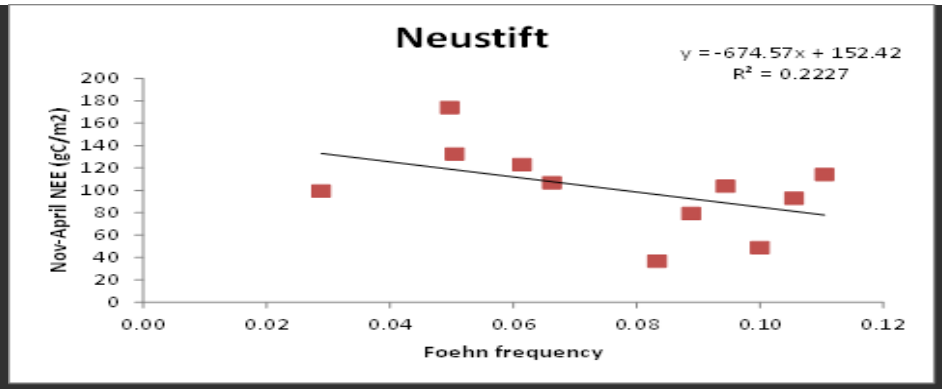


http://basementgeographer.com/wp-content/uploads/2010/11/foehn_engl.jpg

500 hPa heights




r = 0.40
Foehn freq
A0 negative freq
r = 0.54
Air temperature
A0 negative freq
r = 0.40
Snowfall
Foehn freq
r = 0.73
Flowering Day
Temperature


Neustift
y = -674.57x + 152.42
R² = 0.2227
Nov-April NEE (gC/m2)
Foehn frequency

Does complexity matter?

- Depends on the question you are asking
- Here we are interested in questions about scaling magnitudes of fluxes and processes/drivers
- We investigated the global scale problem and then spent time in the field and lab to understand methods for scaling, sampling, and modeling with chambers, towers, remote sensing, Bayesian inverse methods, and climate models in complex terrain at plot (chambers, greenhouse, spectral) to ecosystem (flux towers) to landscape scale (airborne, models)

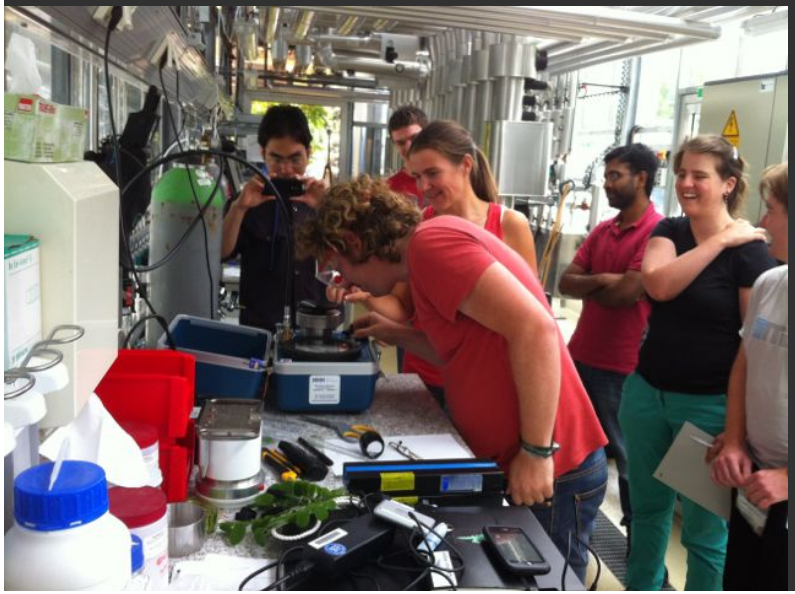
Know thy site*

*Ray Leuning

Know thy scale

Know thy bottom-up and top-down methods, observation tools, model assumptions, and experiments

Be a scientist!



Thanks!