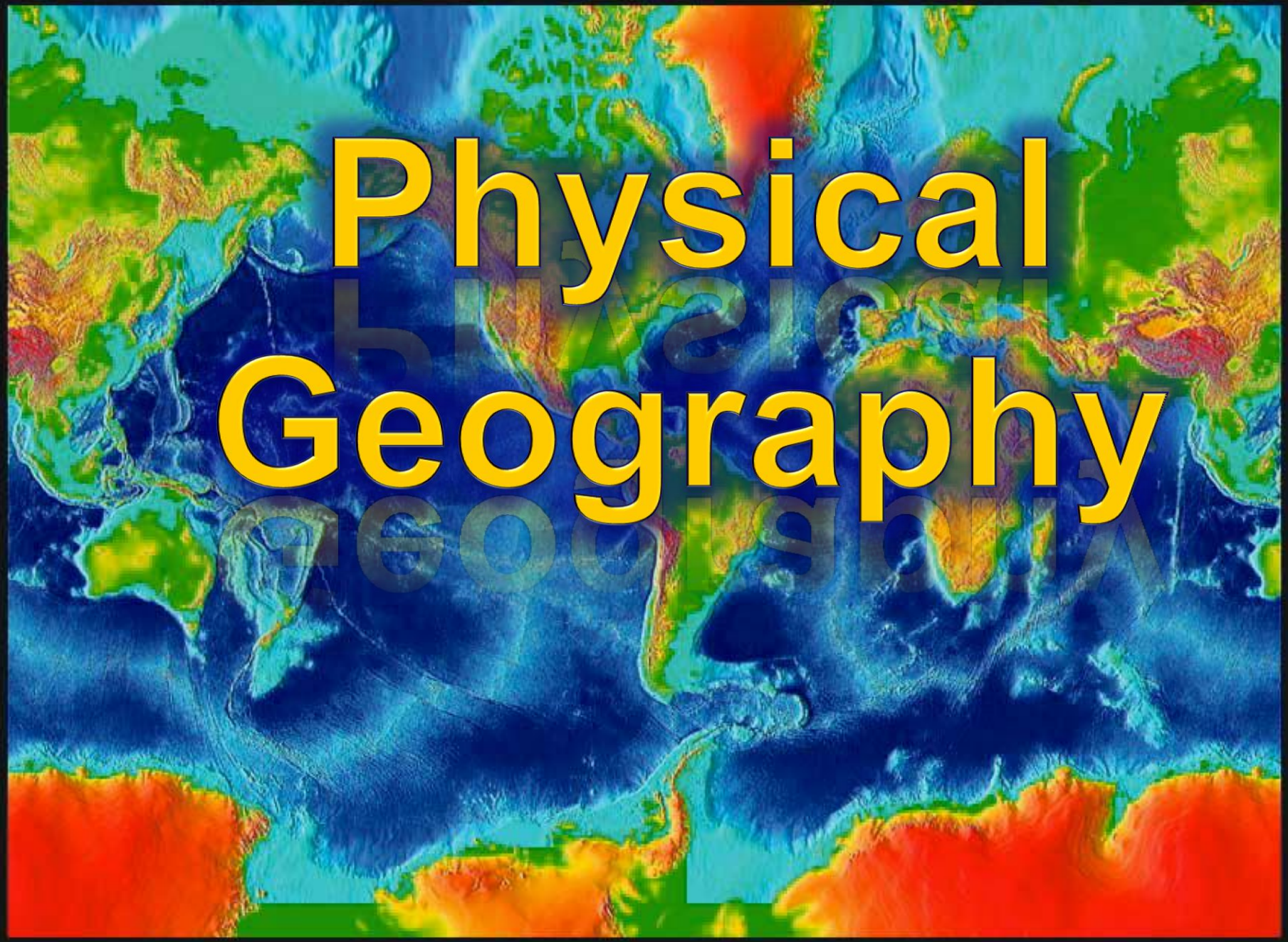

Physical
Geography

Syllabus

Introduction to Physical Geography

GPHY 111

Instructor: **Dr. Neil Suits**
nsuits@msubillings.edu
Phone: (406) 896-5931
Office: Science 118

Office Hours: Mondays and Fridays: 9-11, and of course by appointment.
Class meets in the Science Auditorium Tuesdays and Thursdays, 10:30-12:00 pm

Required Texts:

Introducing Physical Geography, 4th Ed., Strahler and Strahler, Wiley, 2006.

Geologic Map of Montana

At times there may also be other handouts and readings

Grading:

Homework	15%
Exams: 3 midterms + Final	80%
Class Participation	5%

Homework is ungraded, i.e., you either get credit or you don't. However, I may ask you to redo an assignment if I think it is not up to snuff. Homework will generally be short (sometimes mindless) exercises intended to reinforce basic knowledge and ideas. Some of these will involve reproducing 'visual overviews' found at the beginning of many of our textbook's chapters. Homework may include a Physical Map of the World, Mountain ranges of the world, Maps of Climate Zones, Land Use, Wind Patterns, Ocean Currents, factors affecting Climate Change etc.

It would probably be a good idea to get some colored pencils or pens for the homework. These will also be helpful in the labs.
Lectures will generally posted in the morning at: http://www.msubillings.edu/sciencefaculty/Spring%202010%20handouts.htm
These can be printed out at no charge at several MSU-B facilities

For learning basic geographic facts and names check out: http://www.ilike2learn.com/

Vearth4.mpg

http://www.cnn.com/video/#/video/weather/2010/01/13/rob.marciano.haiti.cnn

Introducing Physical Geography

- Introducing Geography
- Spheres, Systems, Cycles and Trends
- Physical Geography, Environment, and Global Change

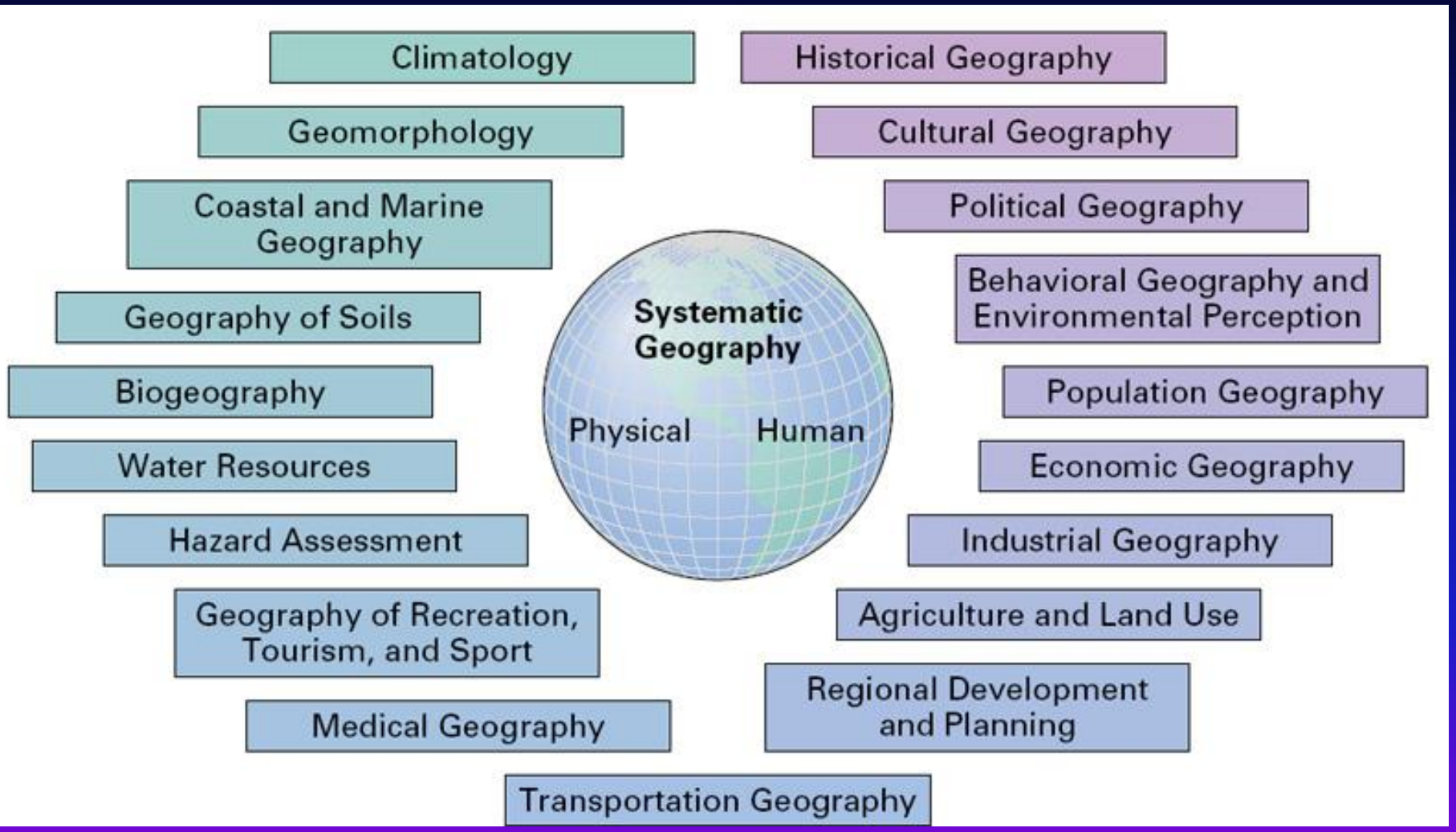
Introducing Geography

Geography can be subdivided into human geography and physical geography

human geography examines economic, social and behavioral processes

physical geography examines natural processes

Geographic fields of study



They all interact

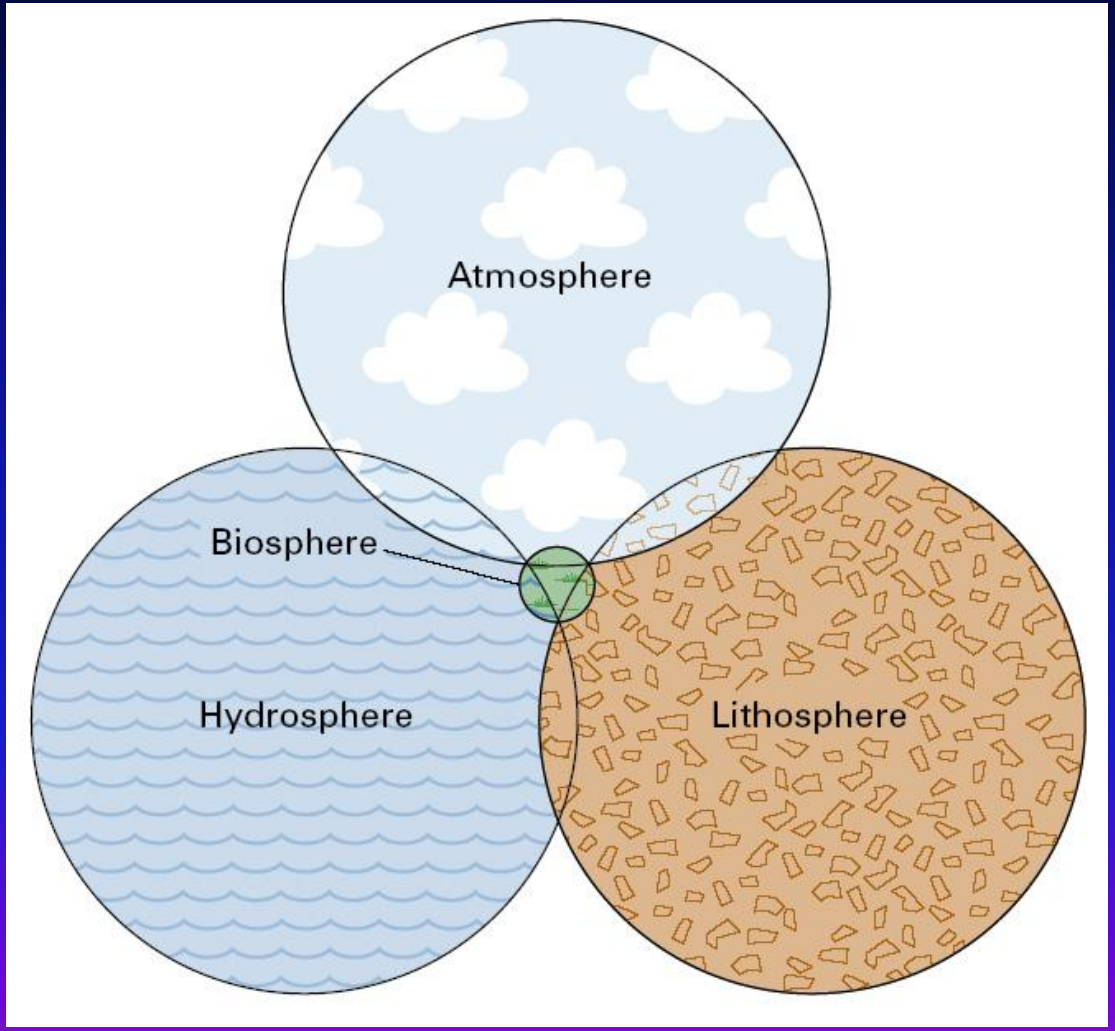
Spheres, Systems and Cycles

The natural spheres :

Lithosphere,
Hydrosphere,
Atmosphere…

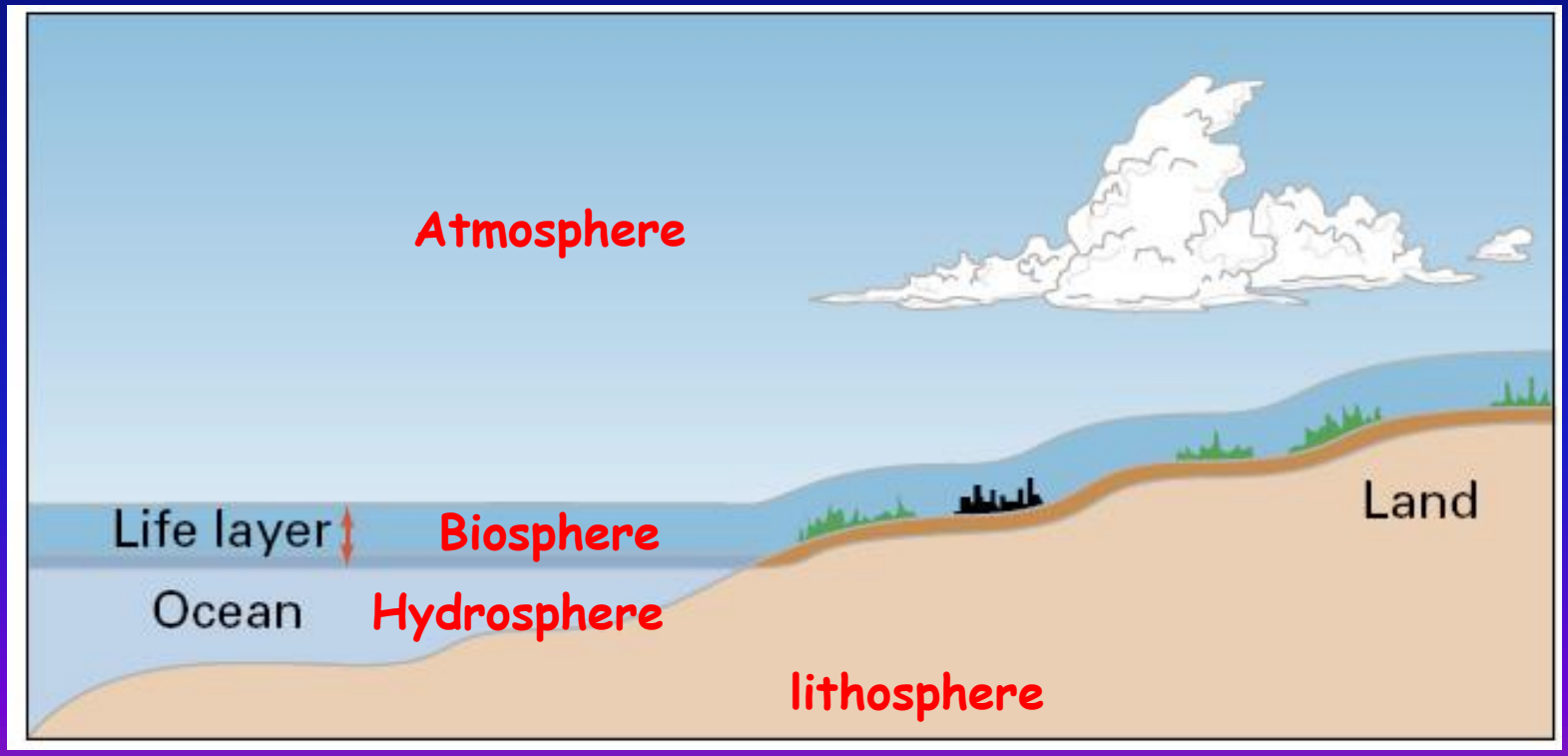
Biosphere …
(Teilhard de Chardin)

Noösphere
(Facebook)



Spheres, Systems and Cycles

The life layer is the shallow Earth surface layer where the four realms (or spheres) interact and where most life forms are found



Spheres, Systems and Cycles

Scale, pattern and process are three interrelated geographic themes

Scale: the level of structure or organization at which a phenomenon is studied

Pattern: variation in phenomenon observed at a particular scale, diurnal (day-night) cycles, El Niño, Atlantic Oscillation…

Process: how the factors that affect a phenomenon act to produce a pattern at a particular scale

Example: Process (wind) >>>> Pattern (waves)

Spatial Scales

Processes in the four spheres are studied at different spatial scales or levels of detail (global, continental, regional, local, individual, microscopic, atomic…)

1000-Year Temperature Records

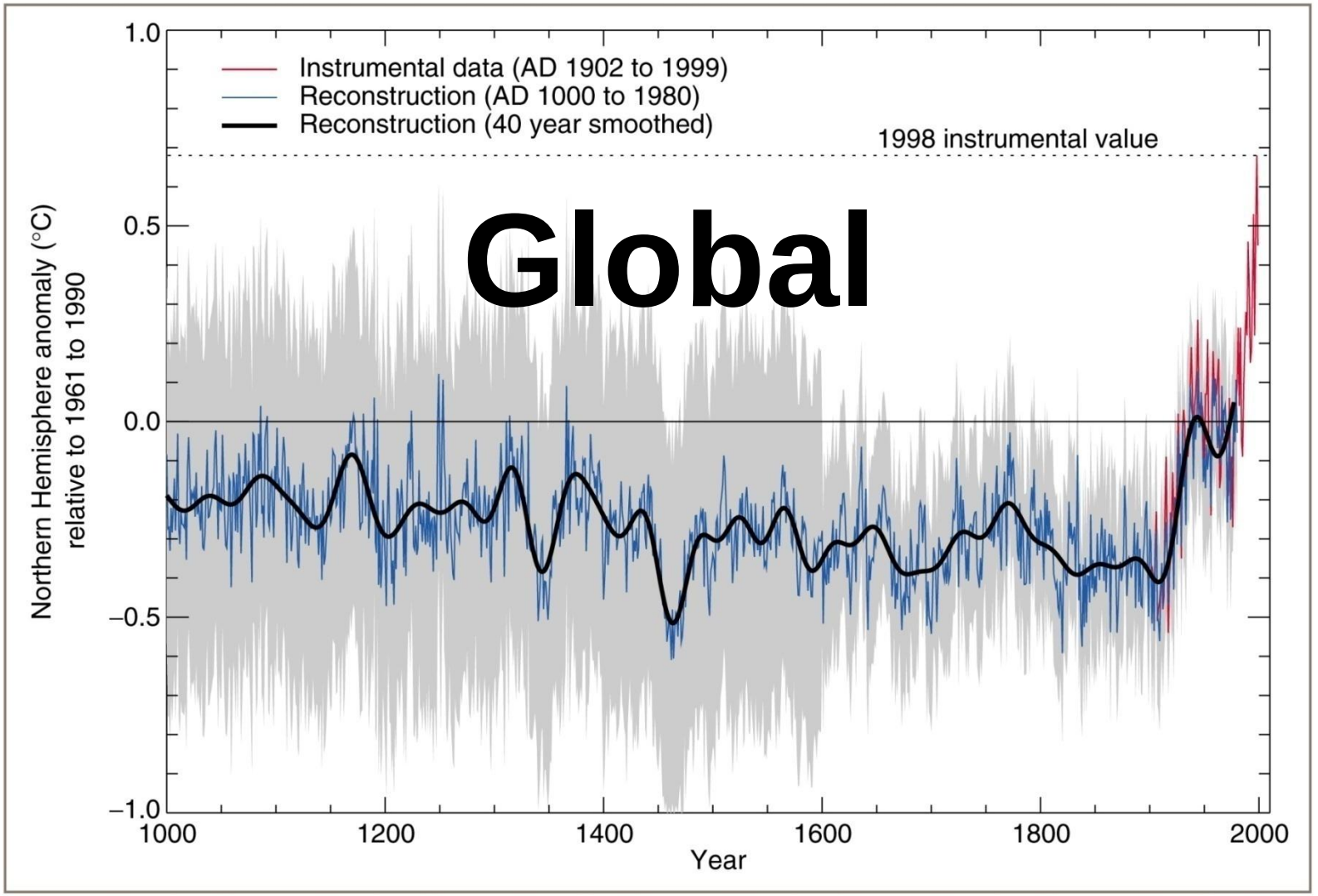
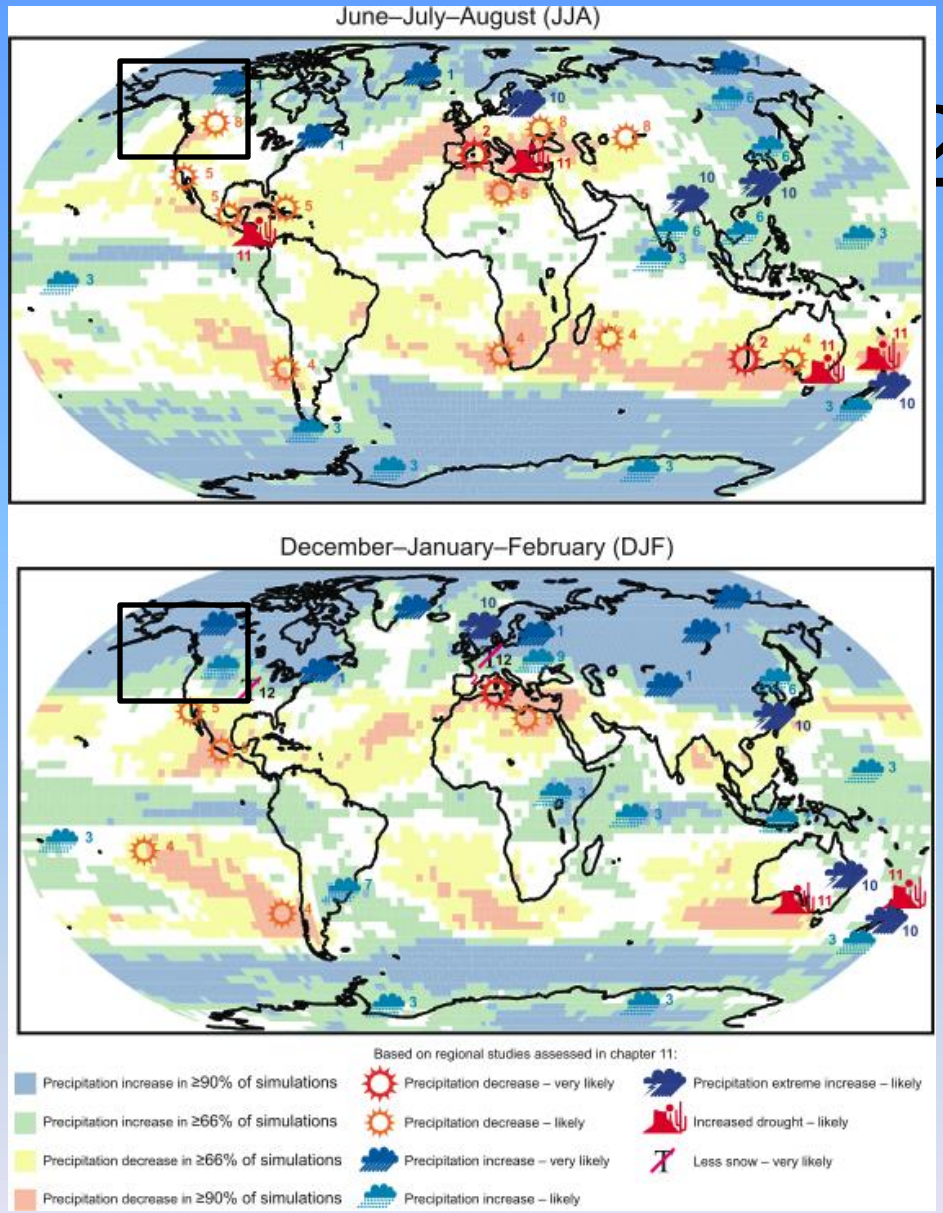
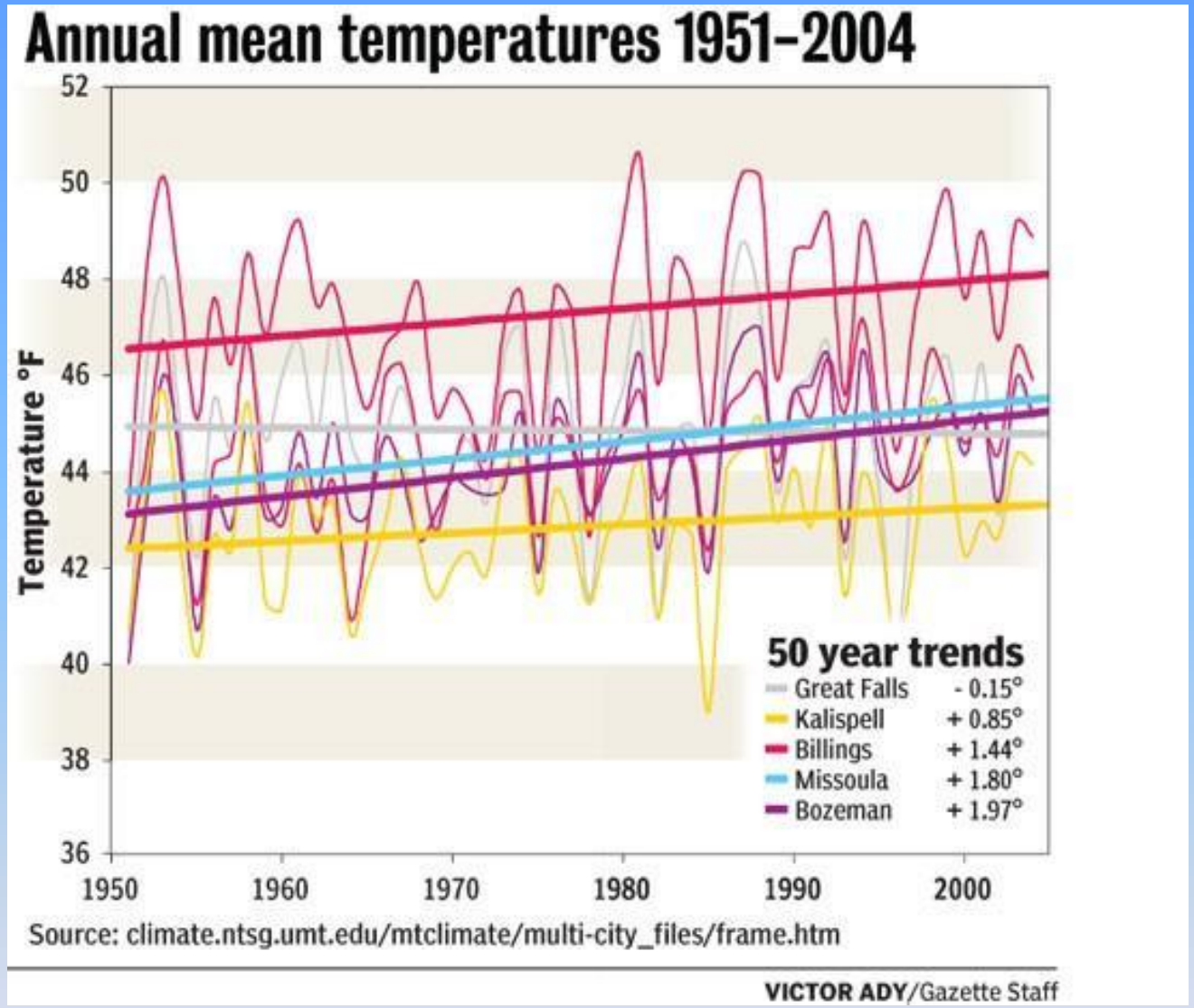


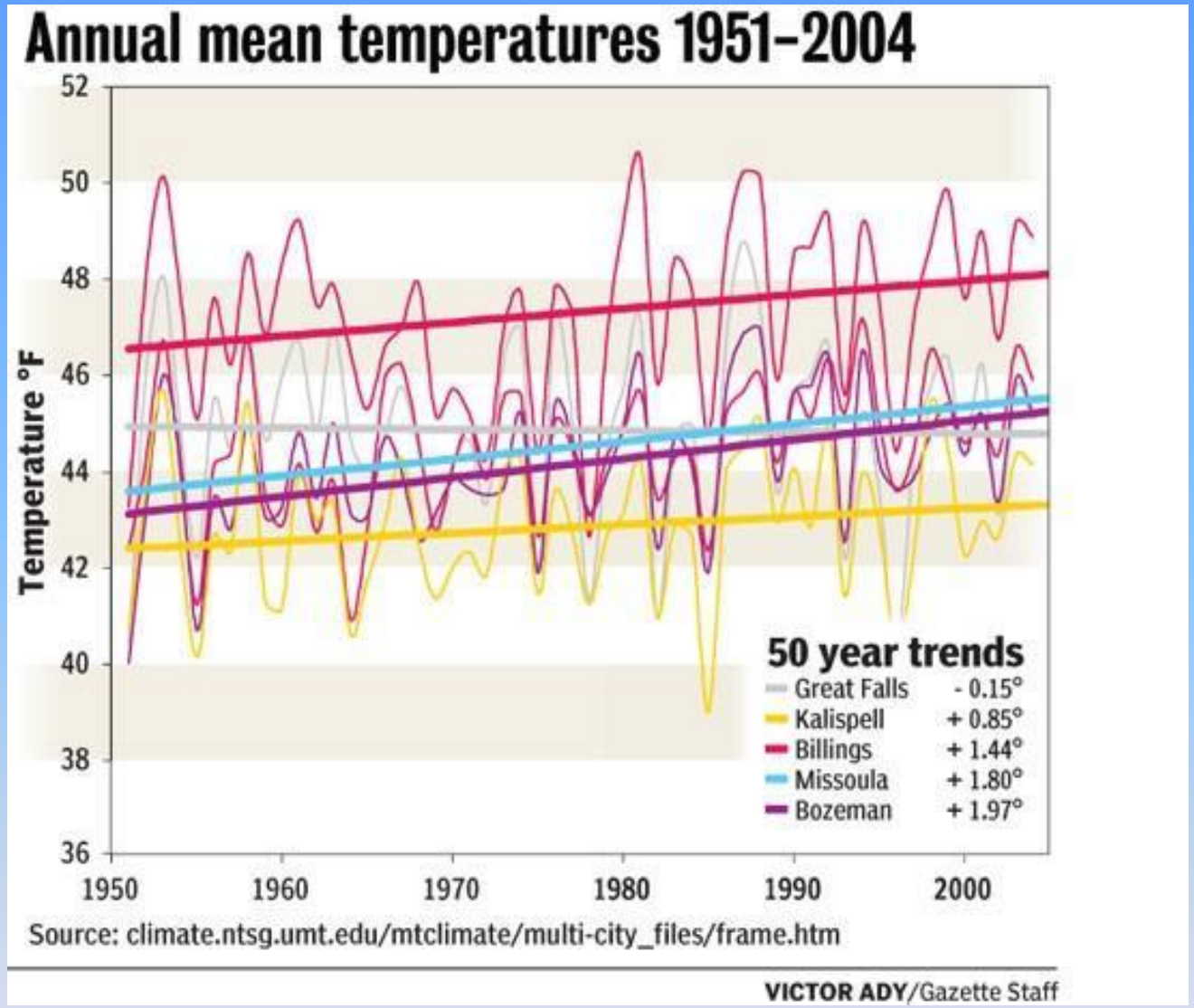
Figure 5: Millennial Northern Hemisphere (NH) temperature reconstruction (blue – tree rings, corals, ice cores, and historical records) and instrumental data (red) from AD 1000 to 1999. Smoother version of NH series (black), and two standard error limits (gray shaded) are shown. [Based on Figure 2.20]


June–July–August (JJA)
December–January–February (DJF)
Based on regional studies assessed in chapter 11:
Precipitation increase in ≥90% of simulations
Precipitation increase in ≥66% of simulations
Precipitation decrease in ≥66% of simulations
Precipitation decrease in ≥90% of simulations
Precipitation decrease – very likely
Precipitation decrease – likely
Precipitation increase – very likely
Precipitation increase – likely
Precipitation extreme increase – likely
Increased drought – likely
Less snow – very likely

Regional


Annual mean temperatures 1951–2004
Temperature °F
52
50
48
46
44
42
40
38
36
1950
1960
1970
1980
1990
2000
50 year trends
Great Falls - 0.15°
Kalispell + 0.85°
Billings + 1.44°
Missoula + 1.80°
Bozeman + 1.97°
Source: climate.ntsg.umt.edu/mtclimate/multi-city_files/frame.htm
VICTOR ADY/Gazette Staff

Local


Annual mean temperatures 1951–2004
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Source: climate.ntsg.umt.edu/mtclimate/multi-city_files/frame.htm
VICTOR ADY/Gazette Staff

Local

Natural Systems

a system is a collection of physical processes that are linked and act together in an organized way

a systems approach to physical geography looks for quantitative linkages and interactions between processes and rates

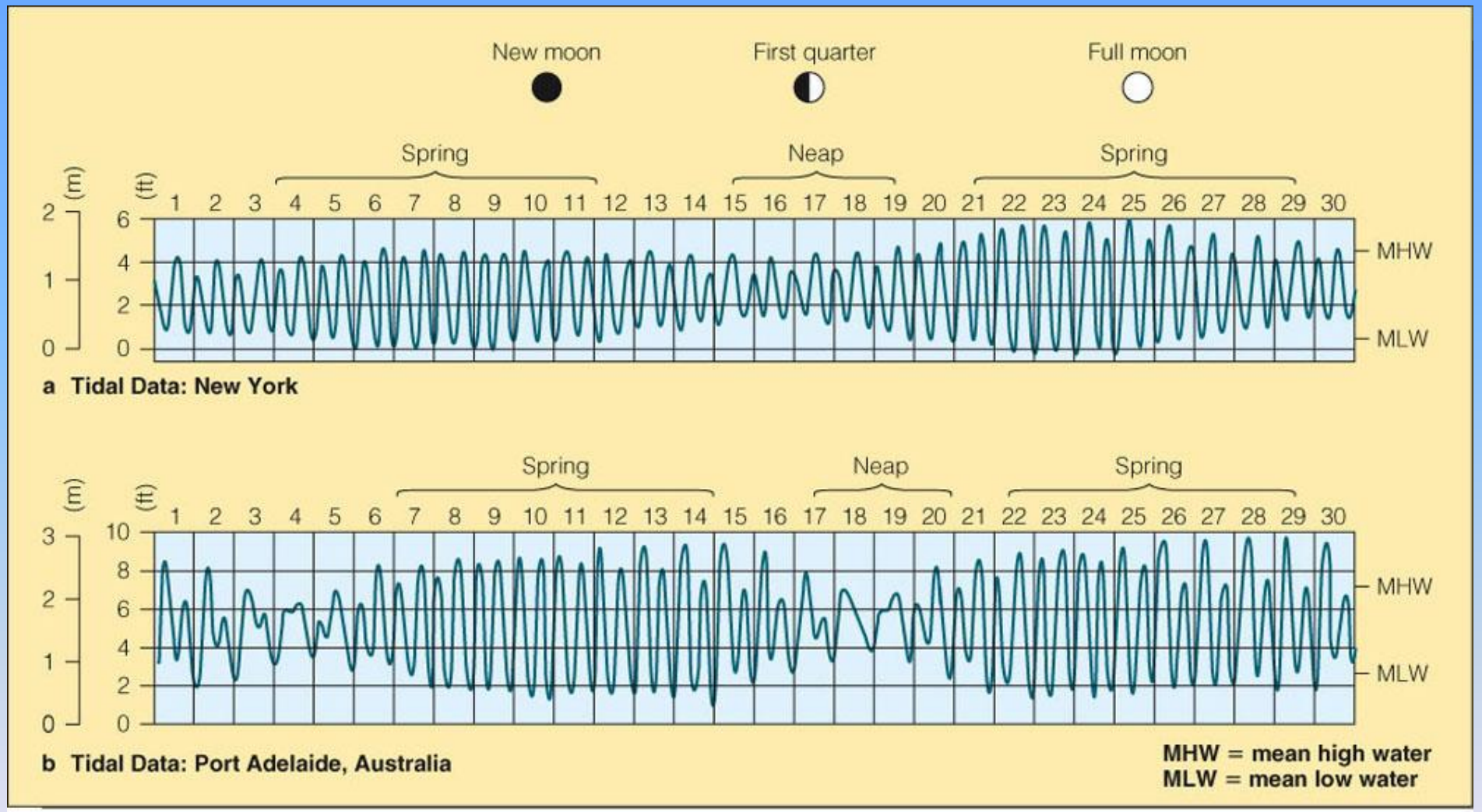
this is a kind of accounting!

Feedbacks: Positive and Negative

Cycles

Cycles are periodic changes in rates of processes that can occur on periods of any time scale.

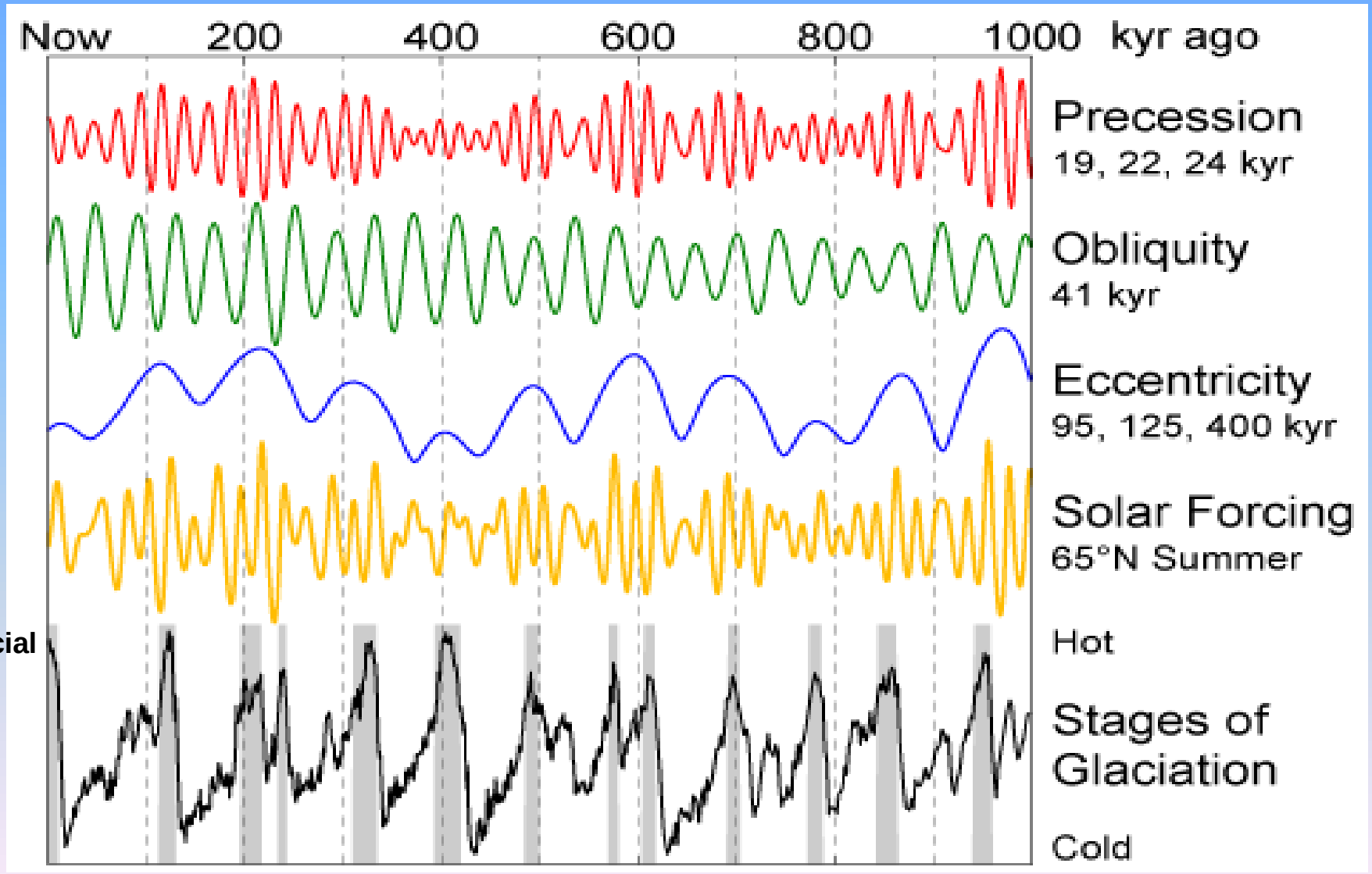
e.g., rotation of the Milky Way galaxy, revolution of the Earth about the Sun, daily rotation of the Earth about its axis, waves hitting a beach, a vibrating guitar string, the vibration of an atom…..



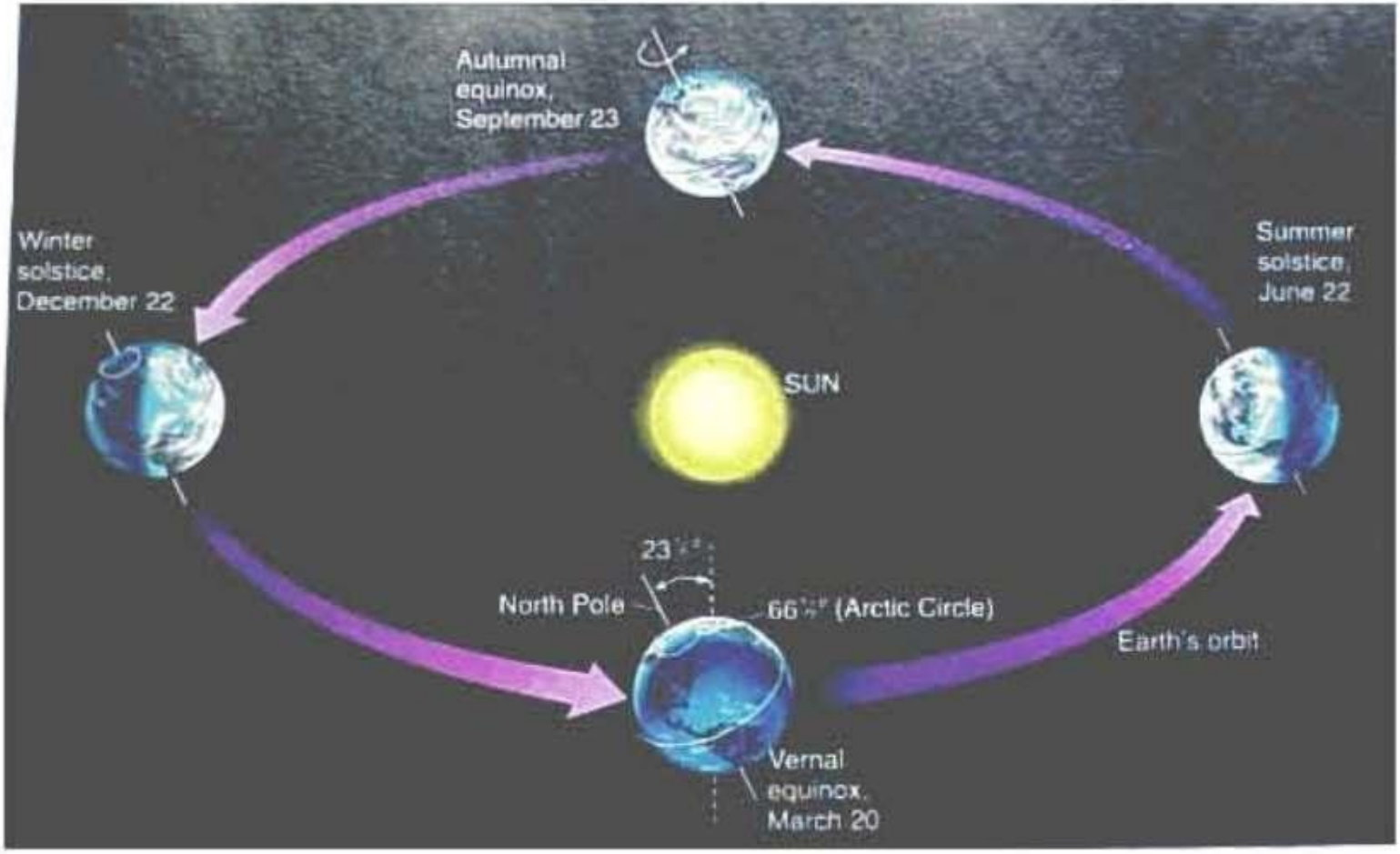
Tides

Milankovitch Cycles

music of the spheres

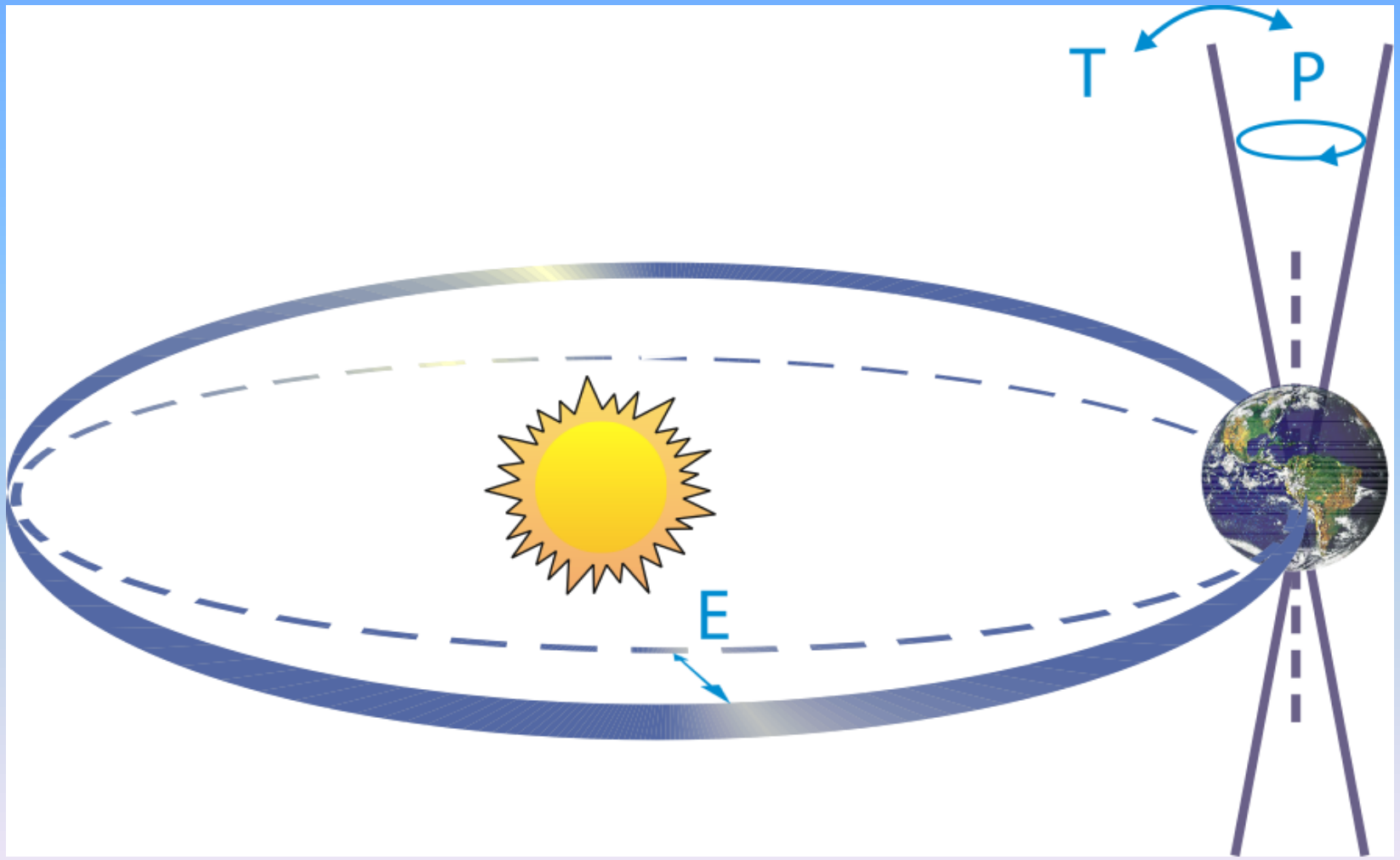


The Earth's Orbit Around the Sun

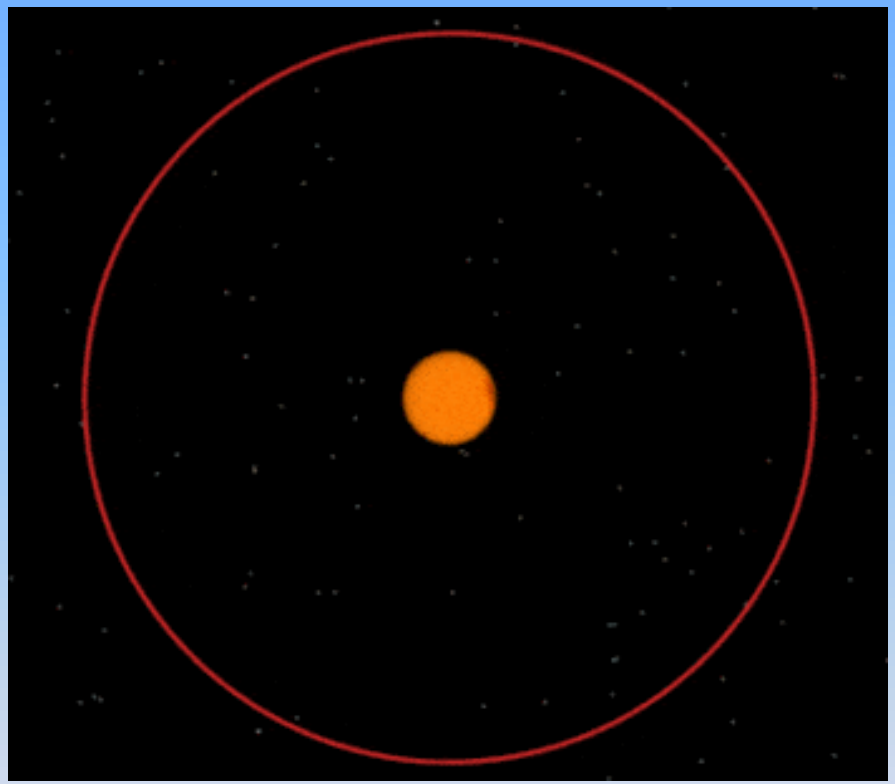


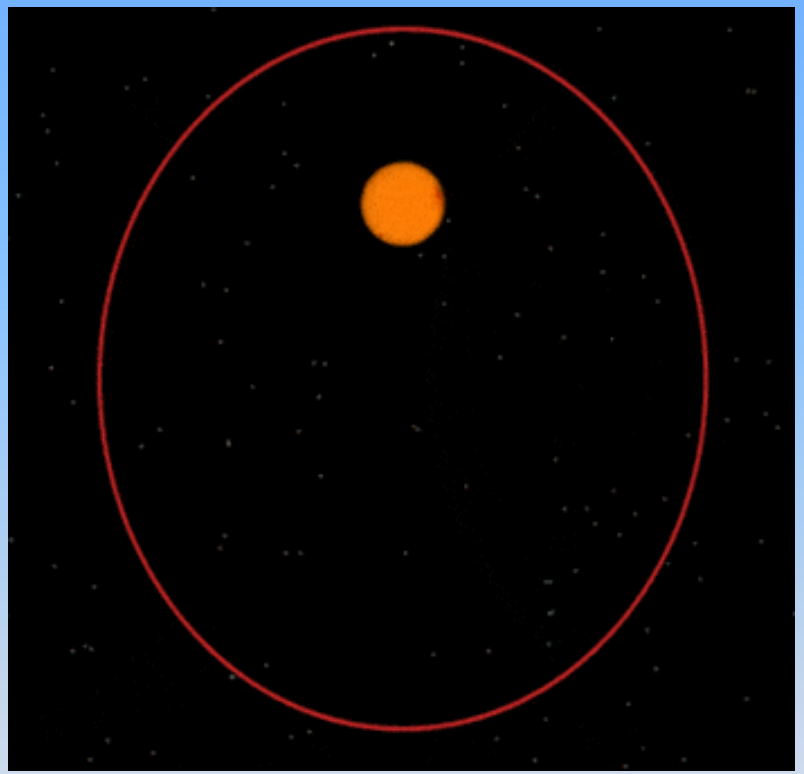
- Seasonally varying distance to sun has only a minor effect on seasonal temperature
- The earth's orbit around the sun leads to seasons because of the tilt of the Earth's axis

Milankovitch Cycles

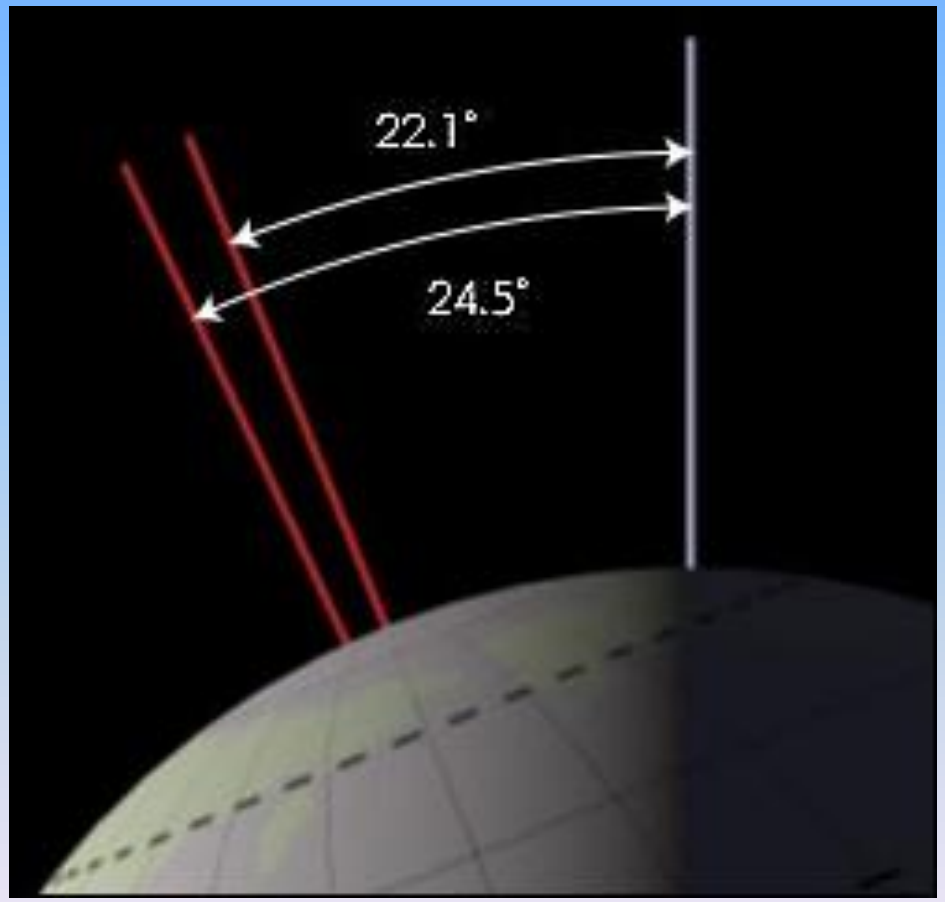


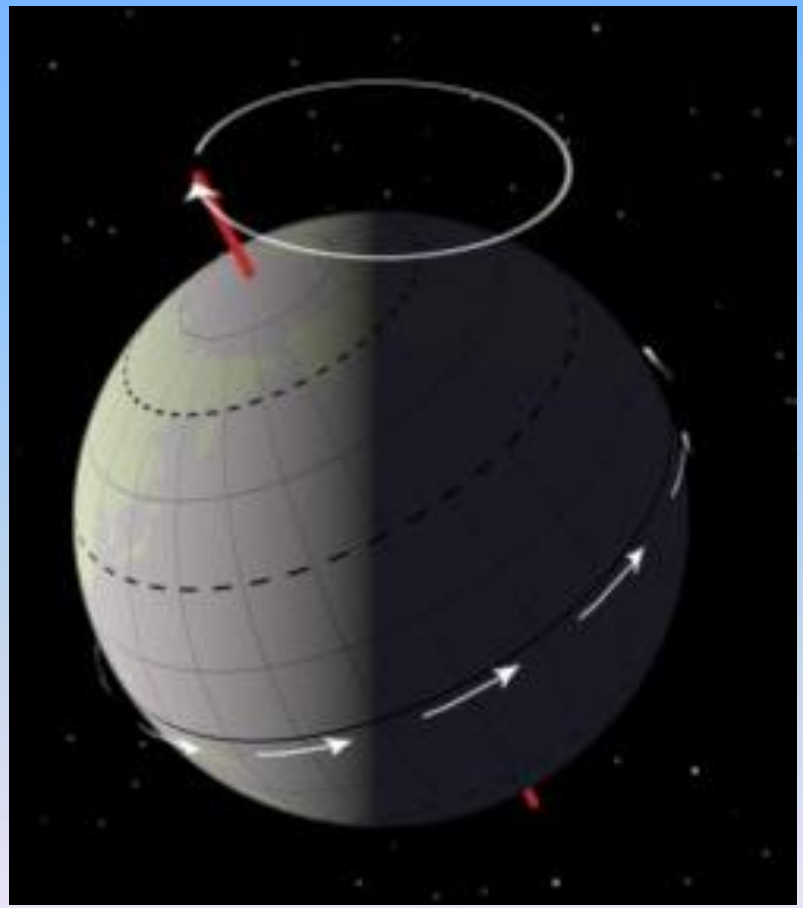
Eccentricity (~100 Ka)





Orbital Obliquity (Axial tilt; ~41 Ka) and Precession (~26 Ka)



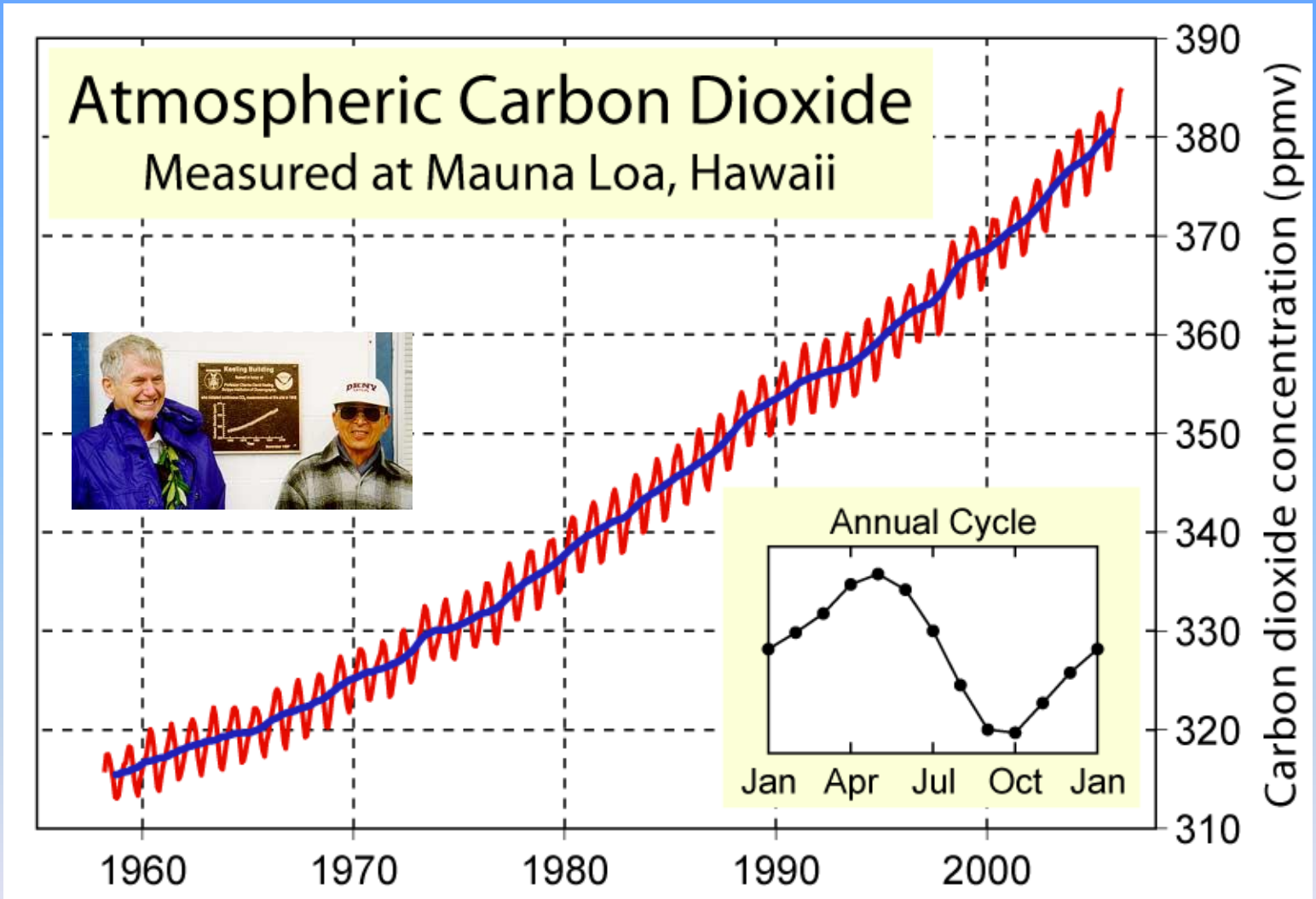


Trends

Trends are long term monotonic changes in rates of processes.

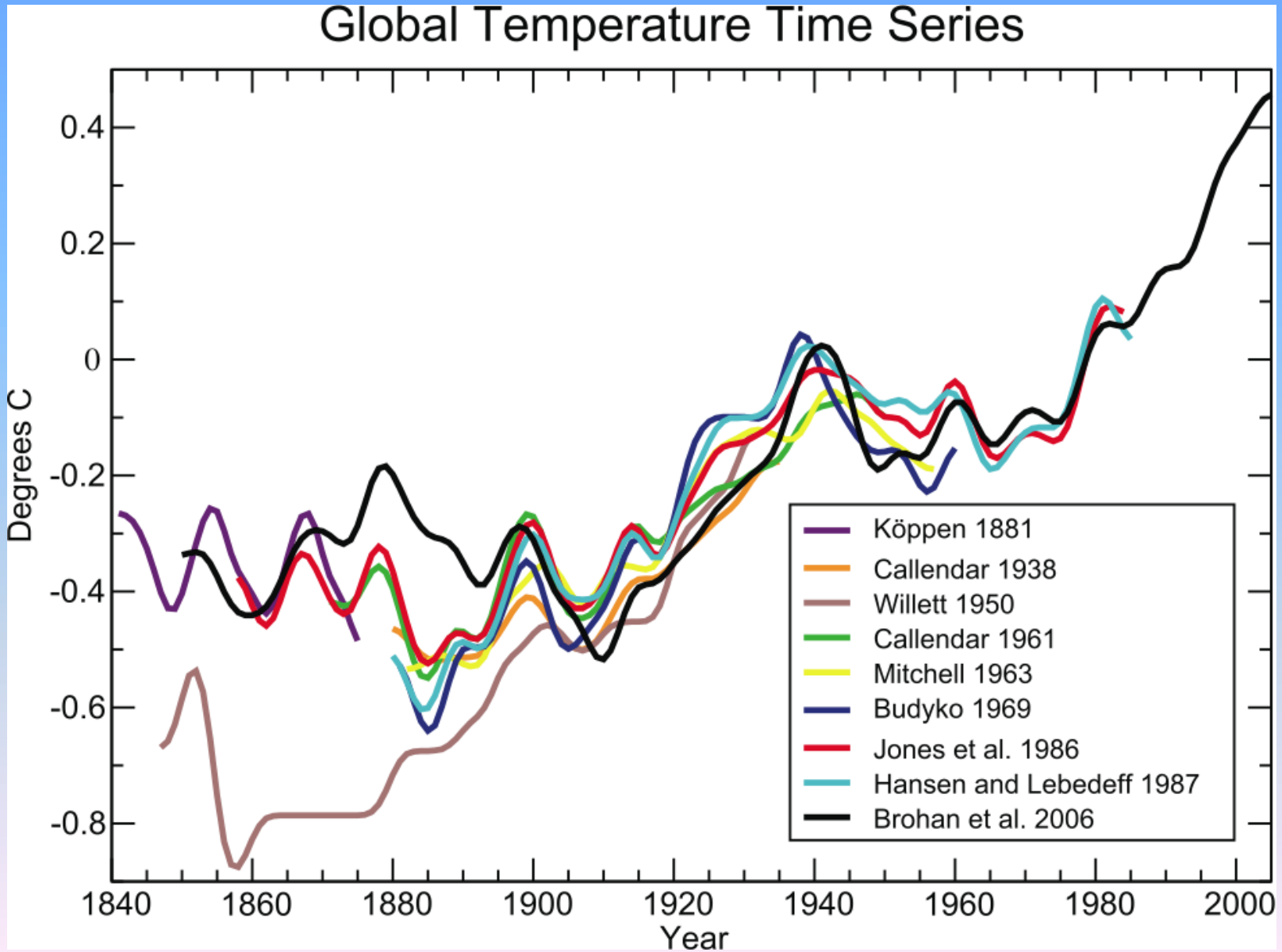
e.g., change in Sun's solar output, the rise of oxygen in the atmosphere, global warming,….

Recent Increases in Carbon Dioxide



- **Human activities have caused dramatic increases in greenhouse gas concentrations**

The Impact on Global Temperatures



Physical Geography, Environment, and Global Change

Physical geography is also concerned with the relationships between humans and their environments

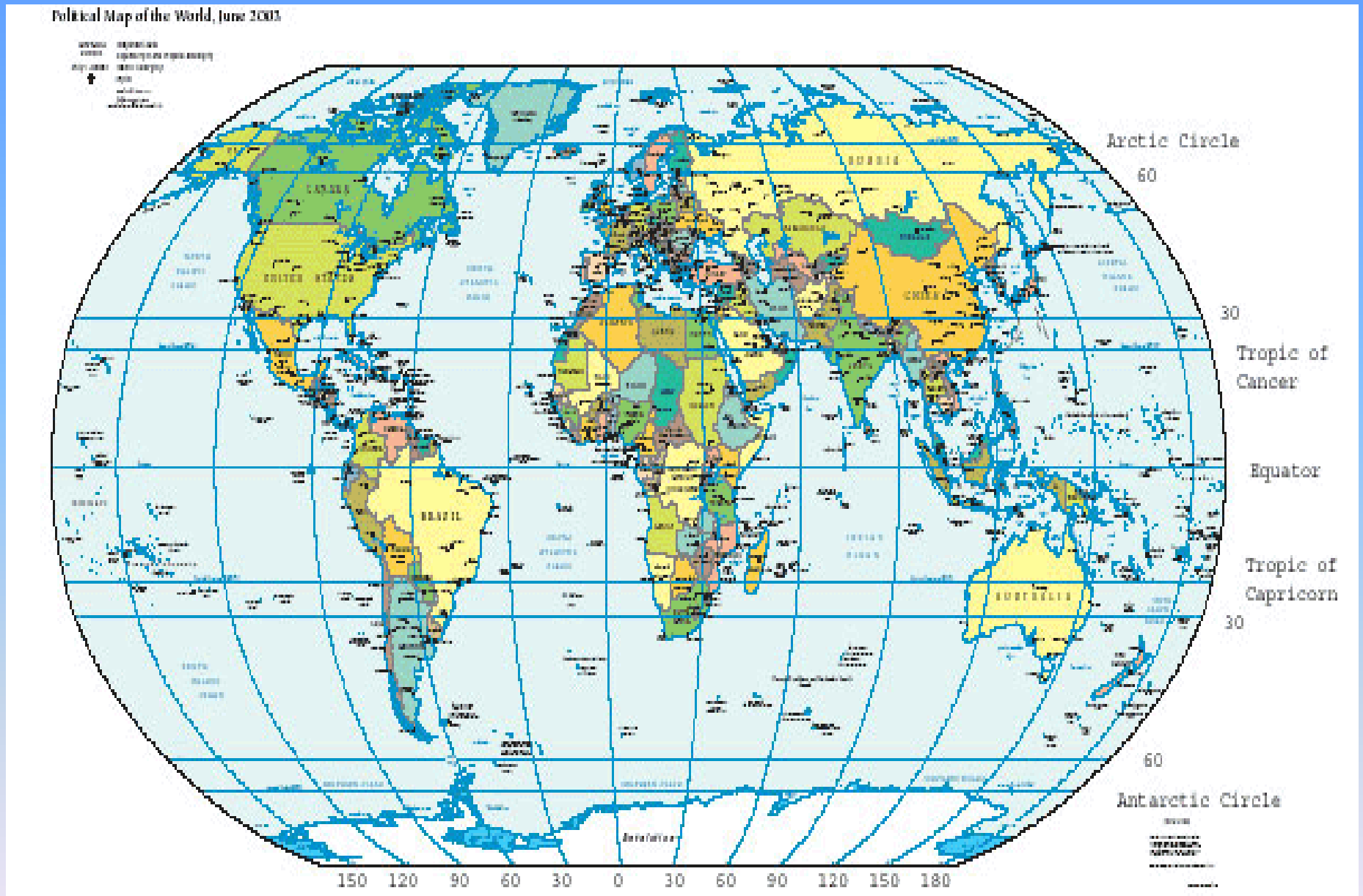
Environmental change is caused by both natural processes and human interference

Some important topics of global change that physical geographers are investigating are global climate change, the carbon cycle, biodiversity, pollution, and extreme events

Basic Tools

Maps

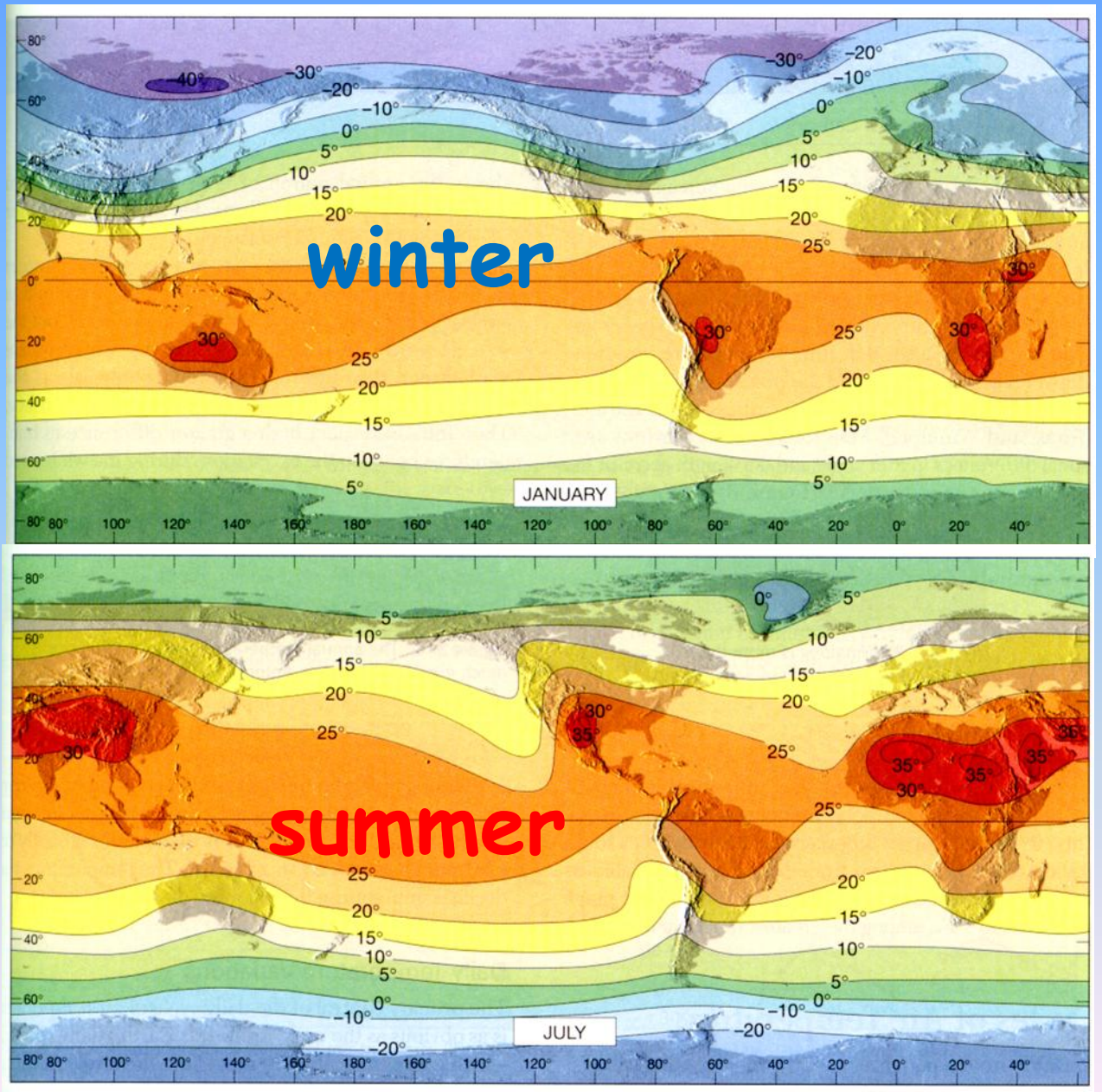
What can maps show us?



Political boundaries

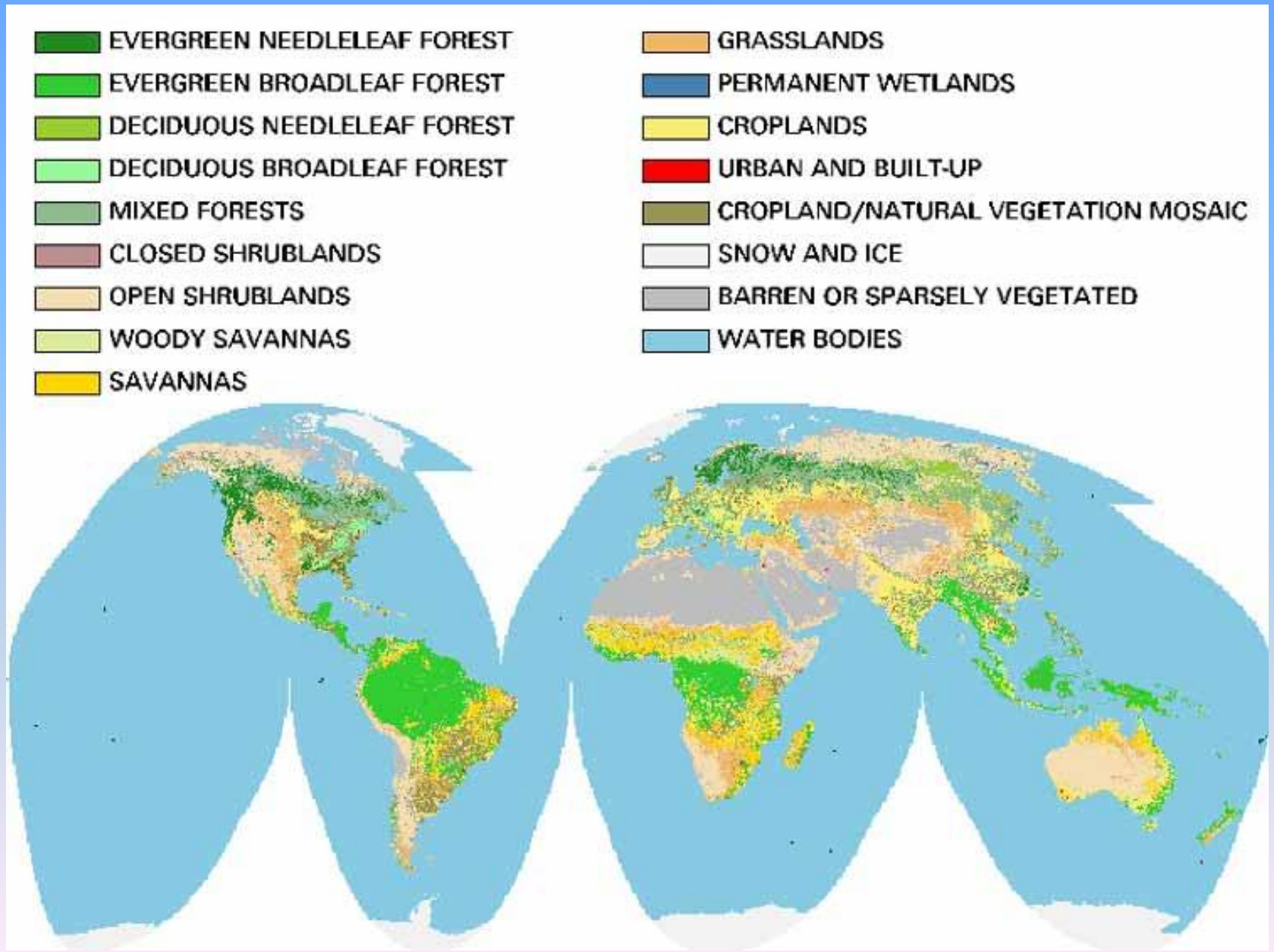
Is this a map?

Seasonal Air Temperature Patterns

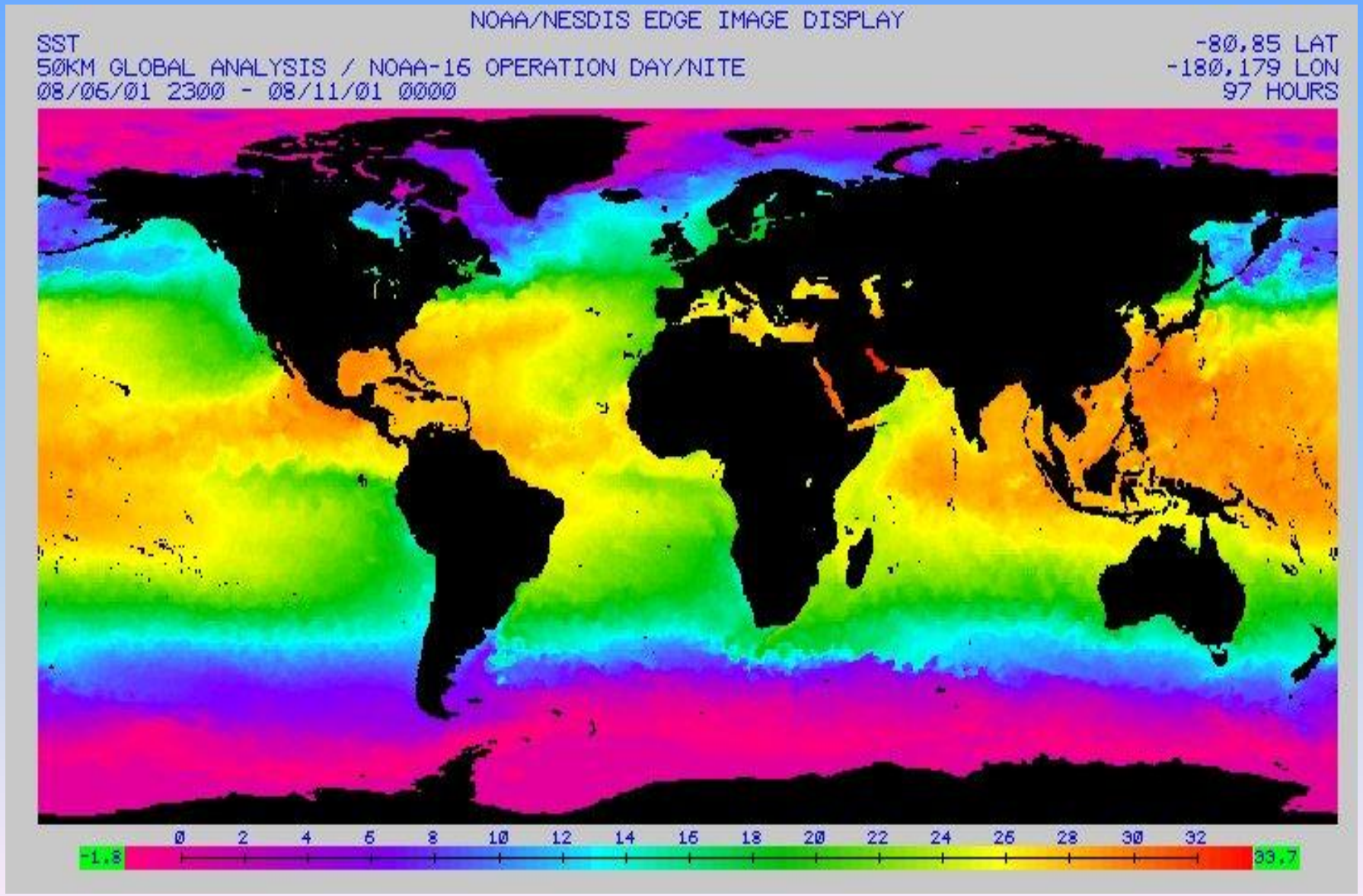


- Stronger seasonal heating and cooling on land produces asymmetry
- Poleward distortion of isotherms over northern high latitude oceans
- Equatorward distortion over subtropics

Classification of Land Vegetation



Sea Surface Temperature (SST)



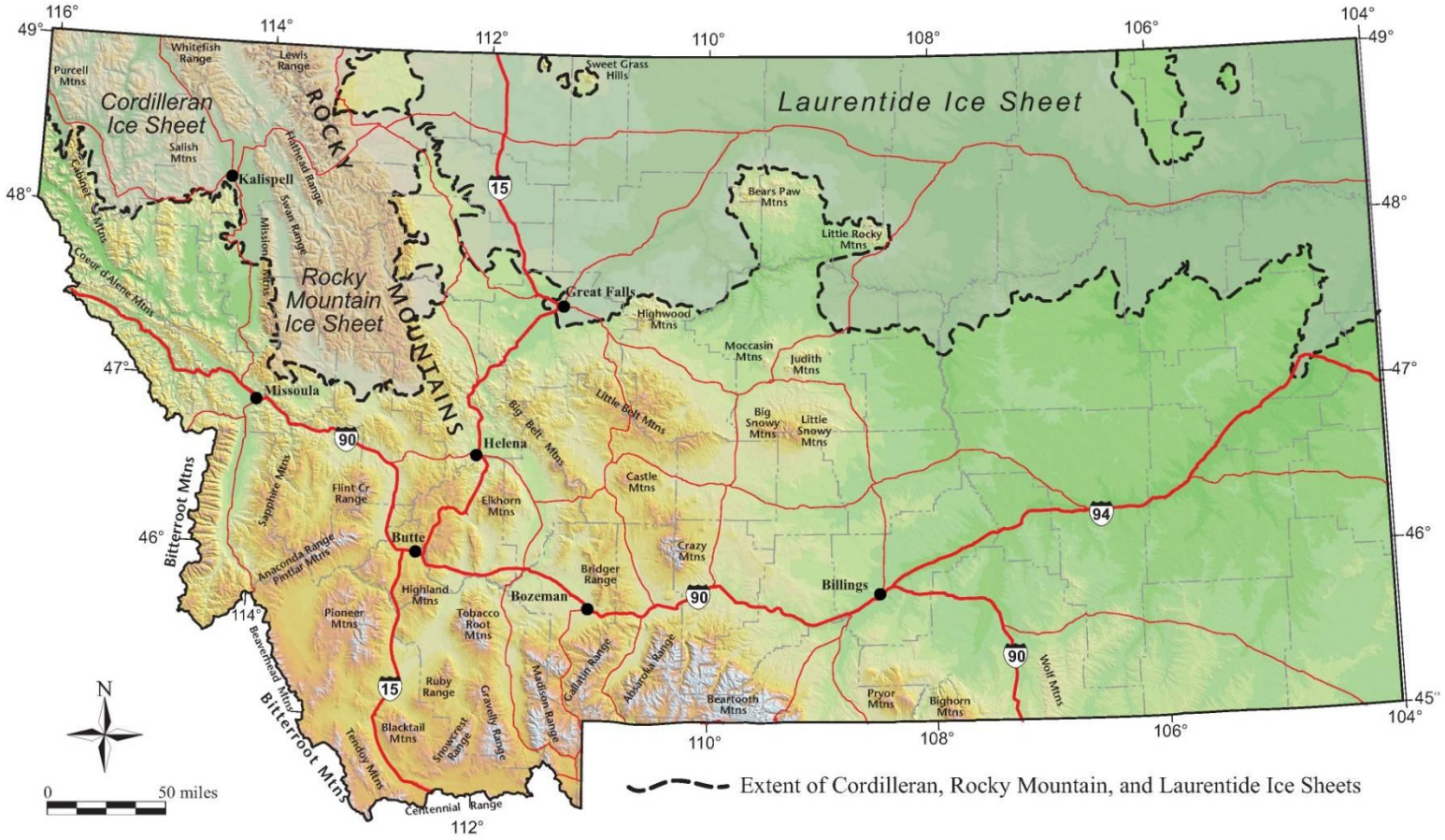


Figure 2. Physiographic features. Extent of northern ice sheets from Fullerton and others (2004), and Locke and Smith (2004).

From: Vuke, S.M., Porter, K.W., Lonn, J.D., and Lopez, D.A., 2007, Geologic Map of Montana, Montana Bureau of Mines and Geology: Geologic Map 62A

Physical features

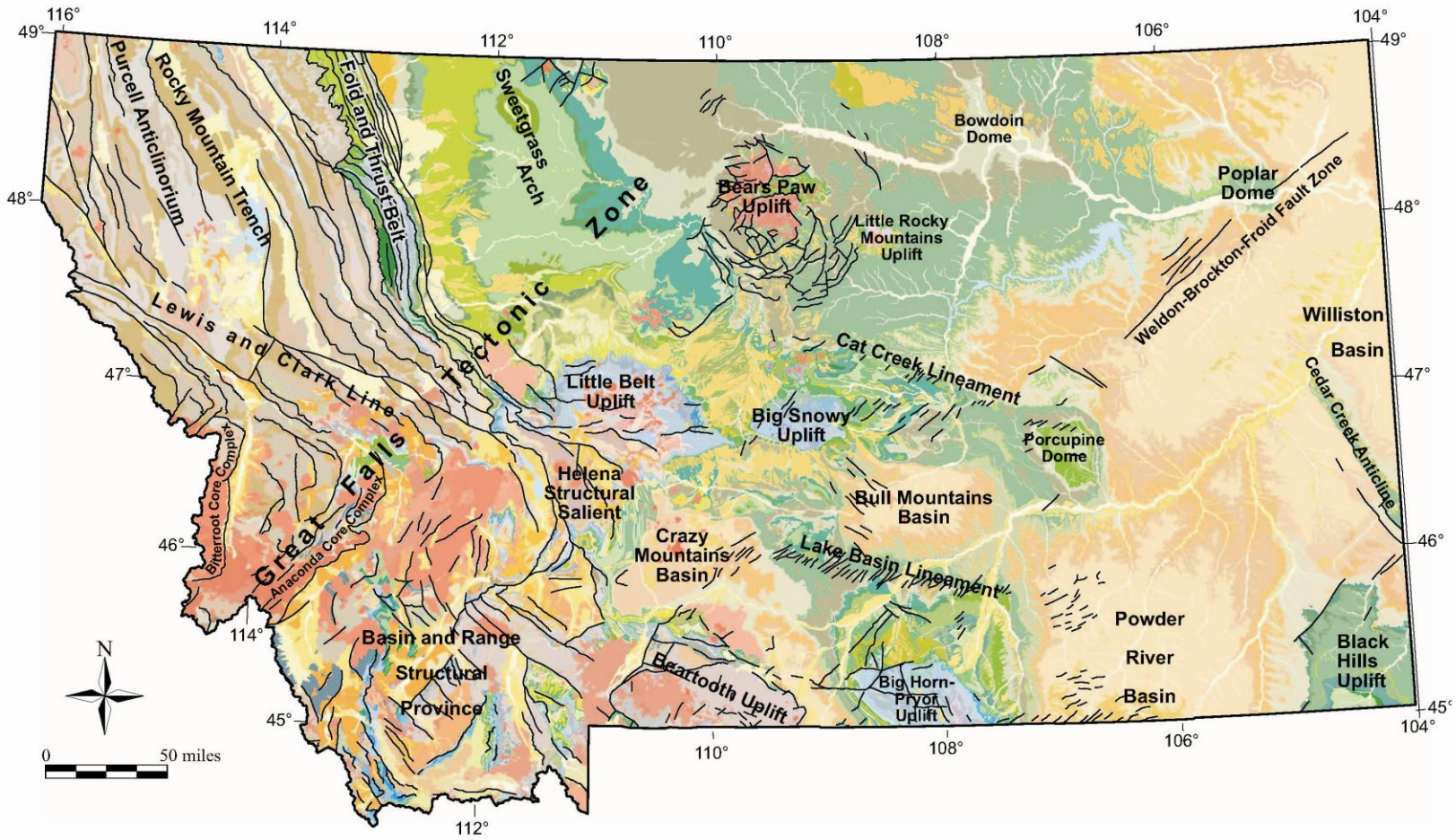


Figure 4. Tectonic features. Base map and faults from Plate 1.

From: Vuke, S.M., Porter, K.W., Lonn, J.D., and Lopez, D.A., 2007, Geologic Map of Montana, Montana Bureau of Mines and Geology: Geologic Map 62A

Tectonic features

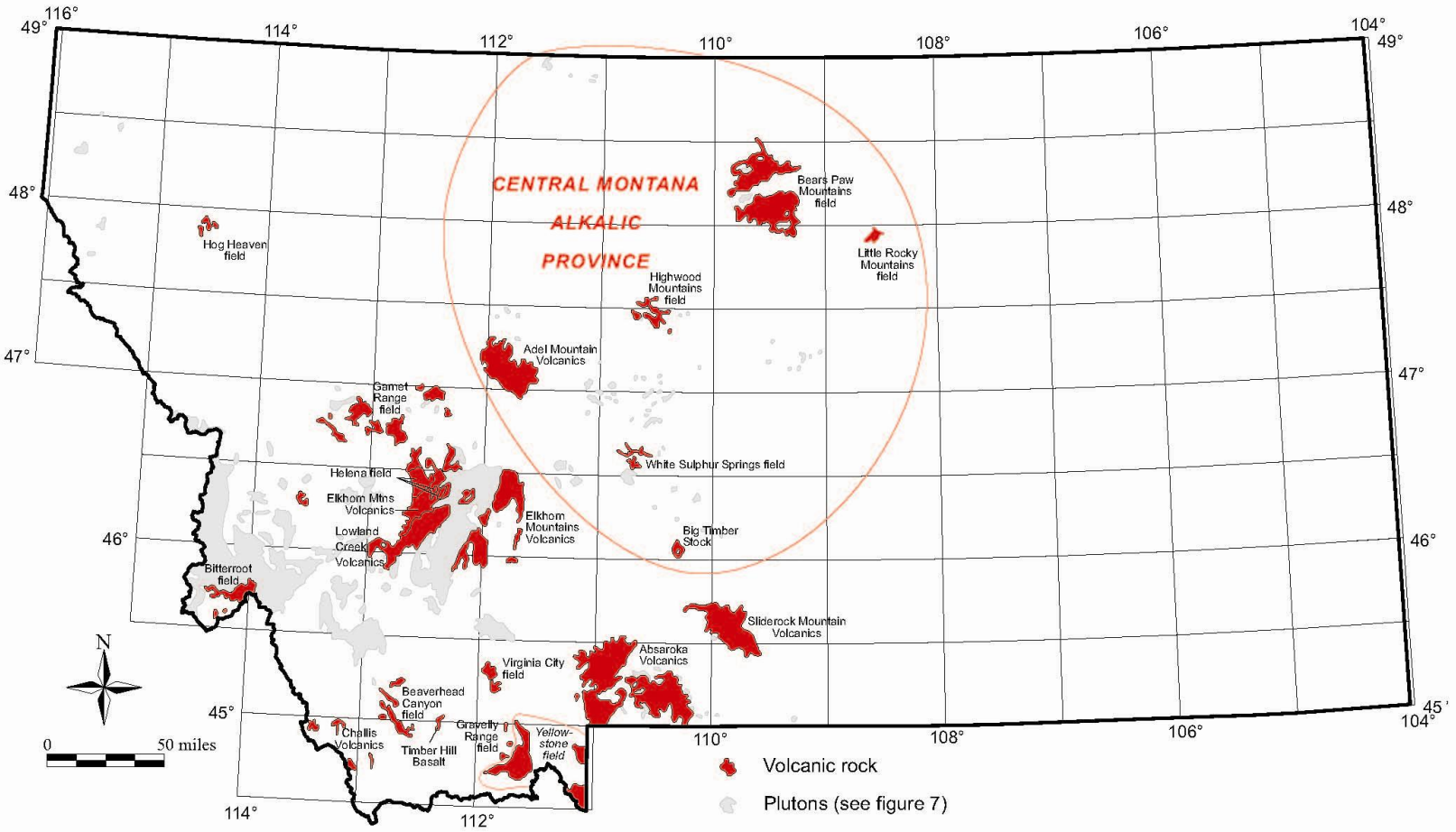


Figure 8. Volcanic rock. Compiled from Plate 1.

From: Vuke, S.M., Porter, K.W., Lonn, J.D., and Lopez, D.A., 2007, Geologic Map of Montana, Montana Bureau of Mines and Geology: Geologic Map 62A

Volcanic rocks

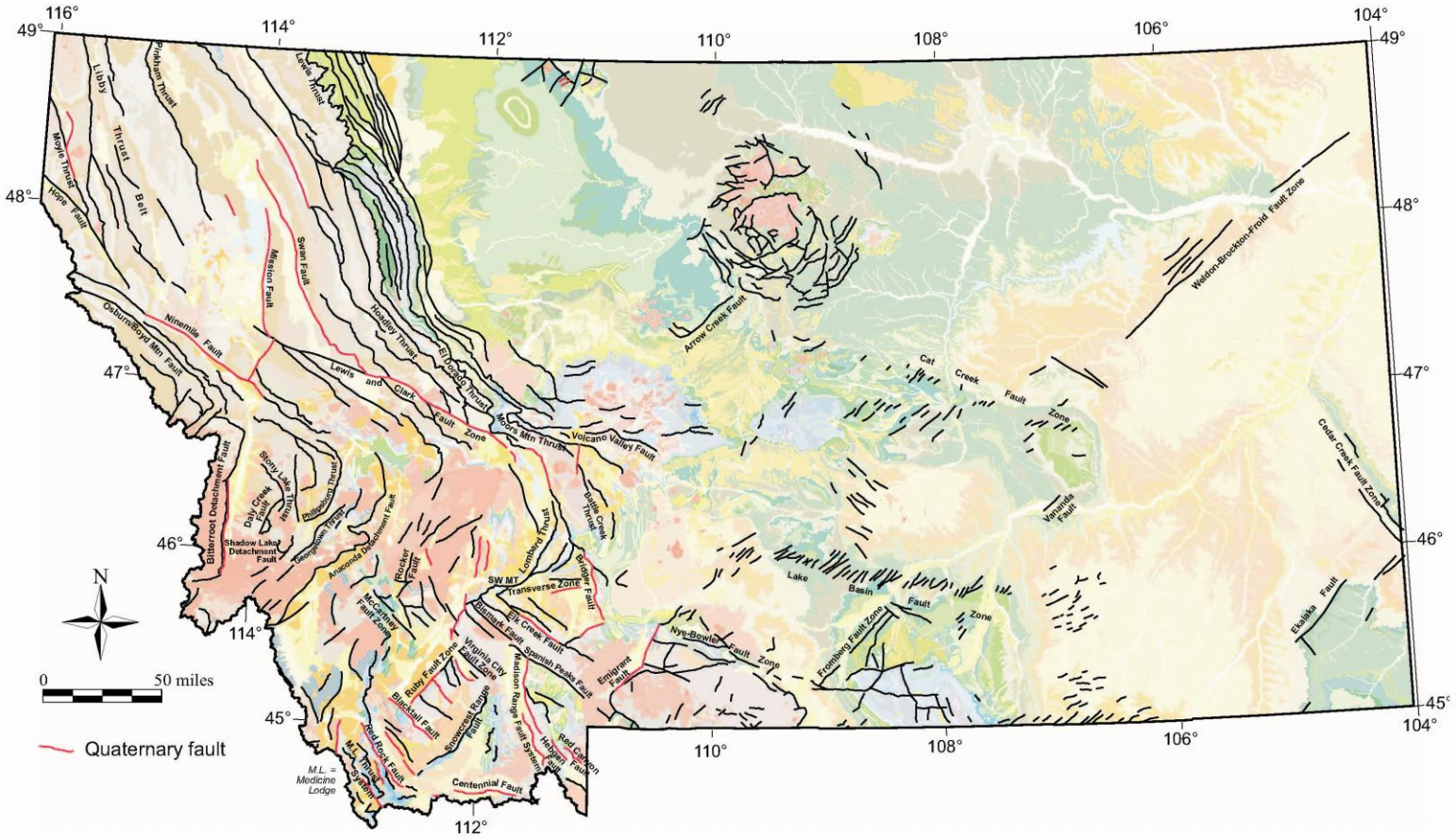
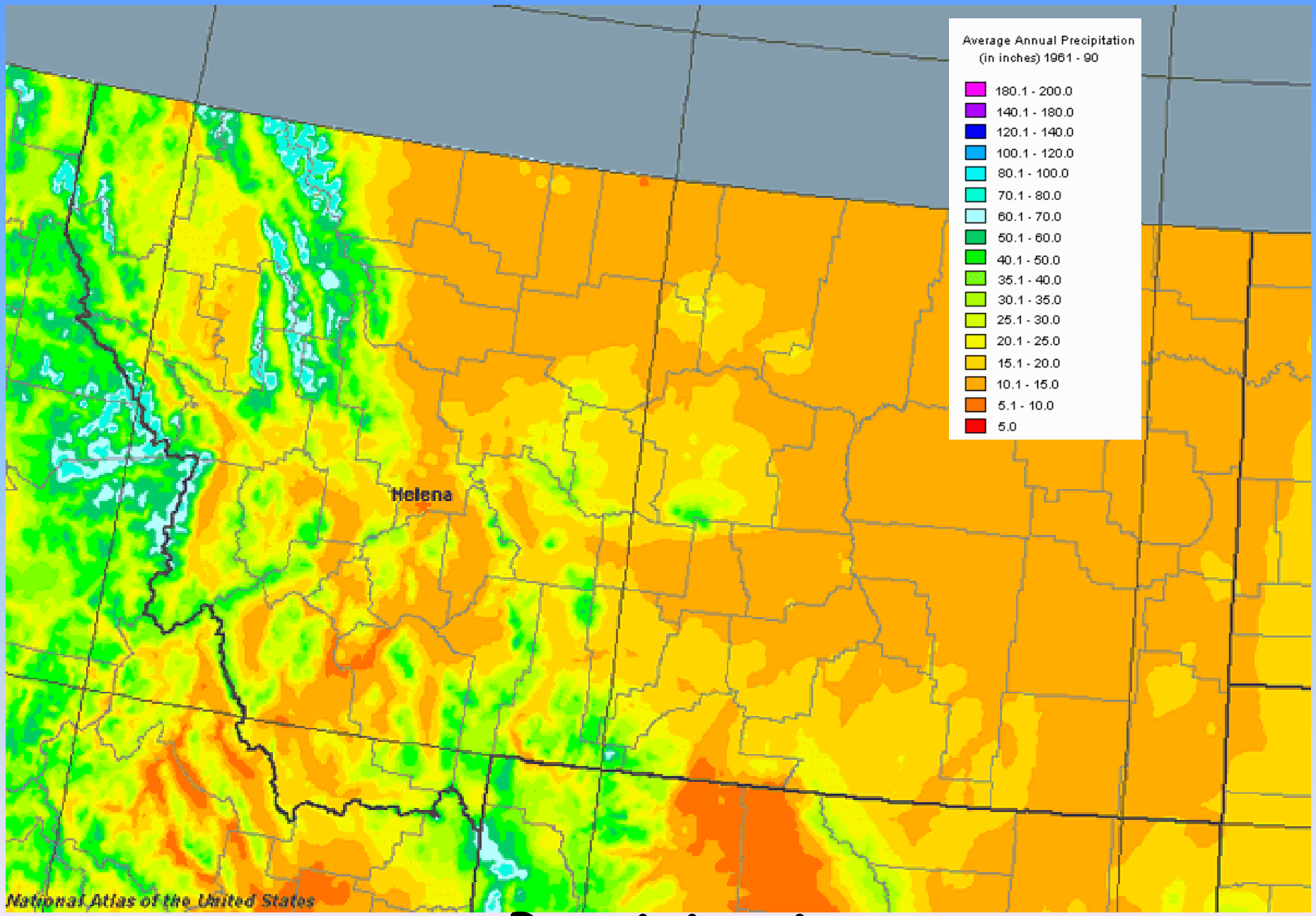


Figure 5. Major faults. Base map from Plate 1. Quaternary faults from Stickney and others (2000).

From: Vuke, S.M., Porter, K.W., Lonn, J.D., and Lopez, D.A., 2007, Geologic Map of Montana, Montana Bureau of Mines and Geology: Geologic Map 62A

Major faults



Precipitation

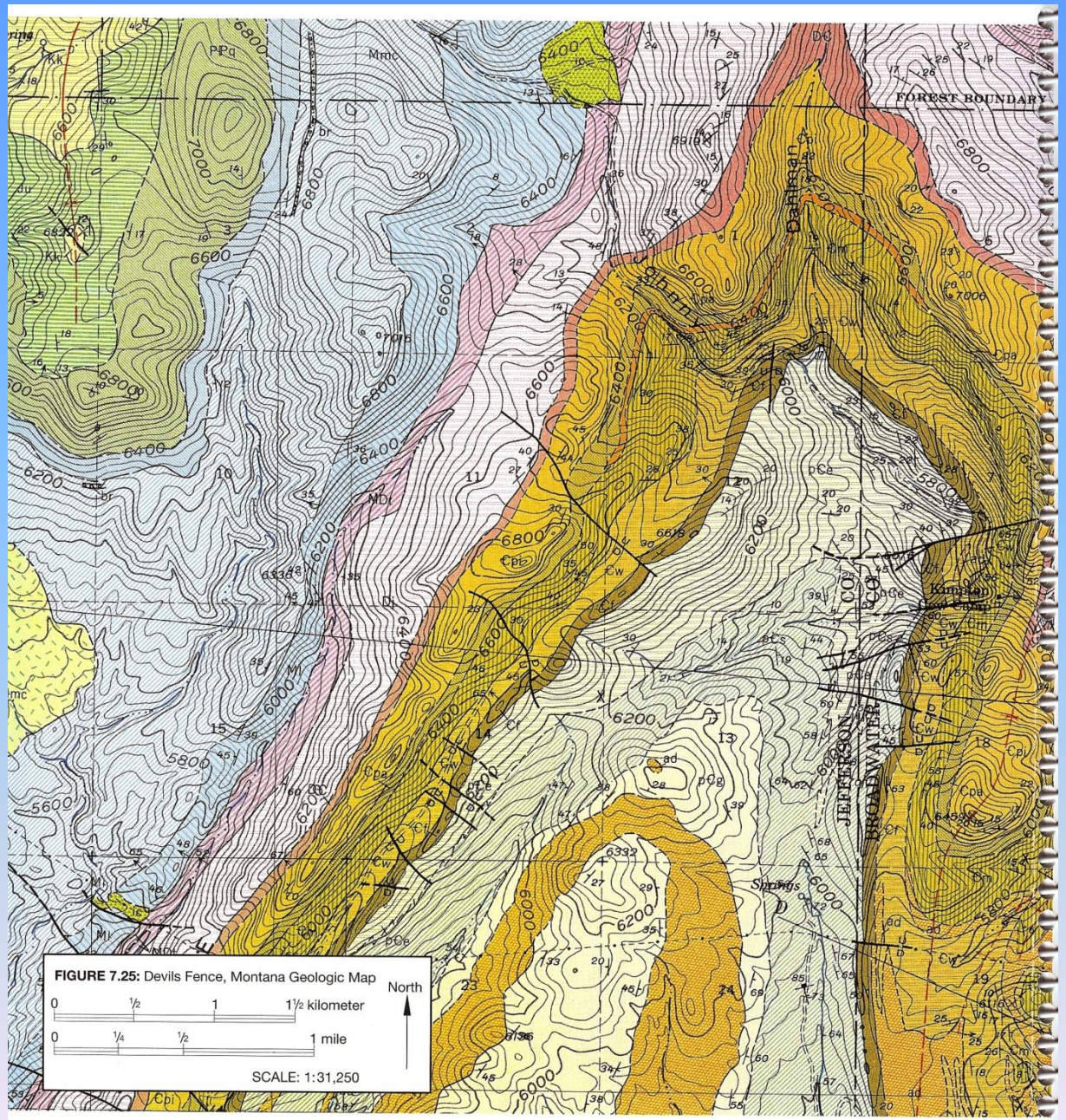
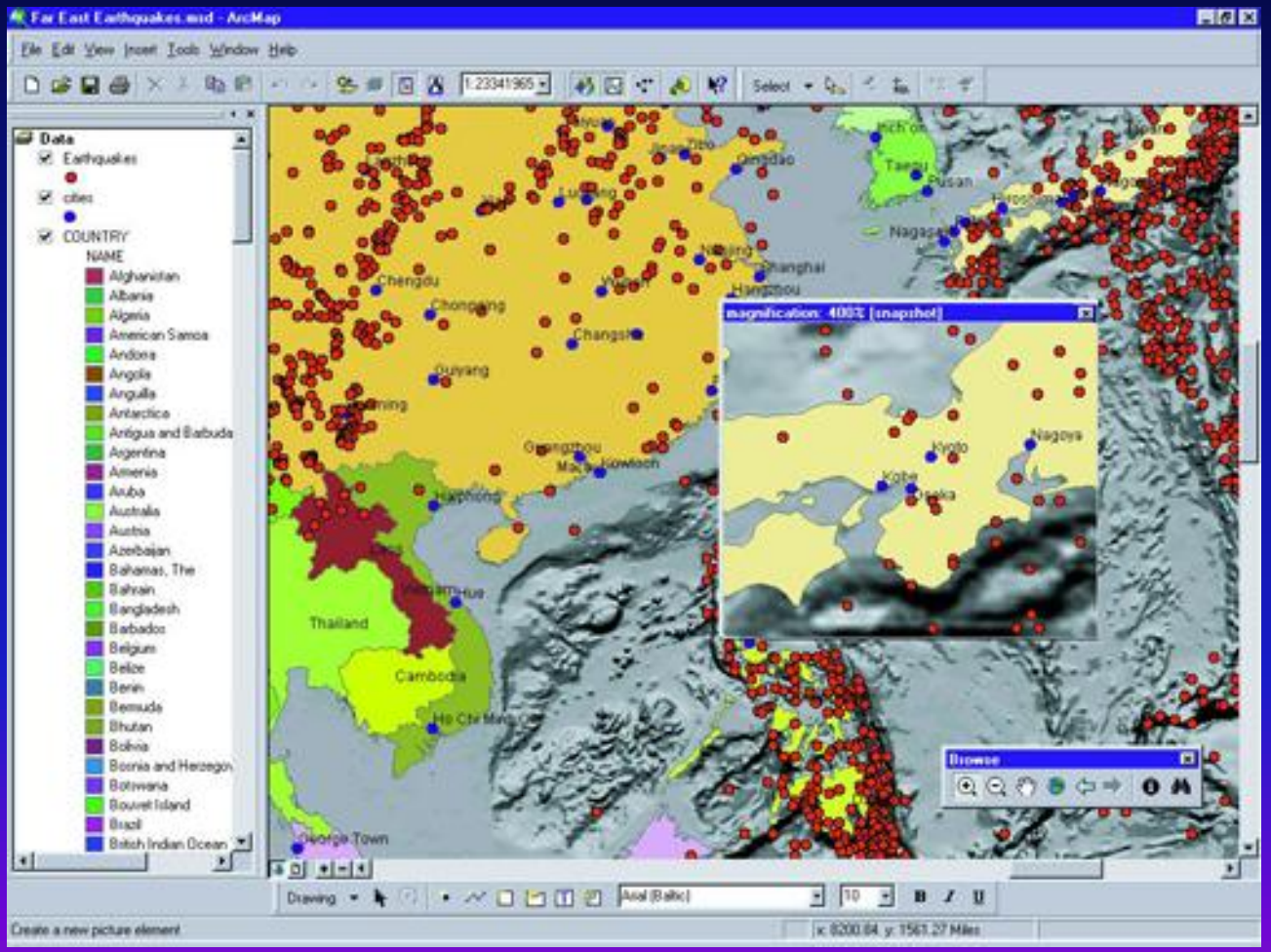


Figure 7.25 Geologic [illegible] Devils Fence, Montana [illegible] U.S. Geological Survey [illegible] Permission [illegible] 92

Geologic Formations

Geographic Information Systems (GIS)

Geographers use specialized tools including maps, geographical information systems (GIS), remote sensing, mathematical modeling and statistics to allow them to portray information that varies spatially on the Earth's surface



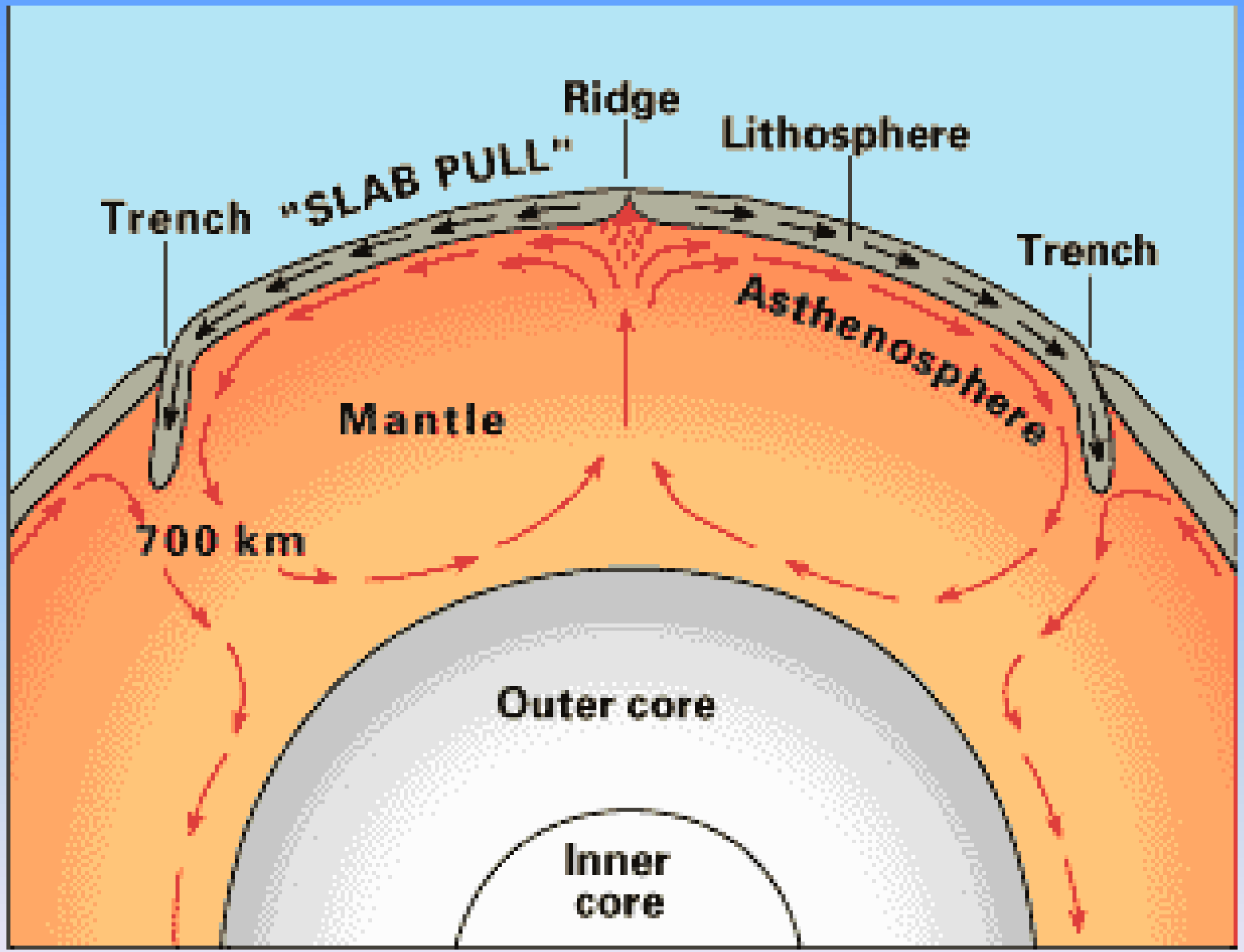
Processes

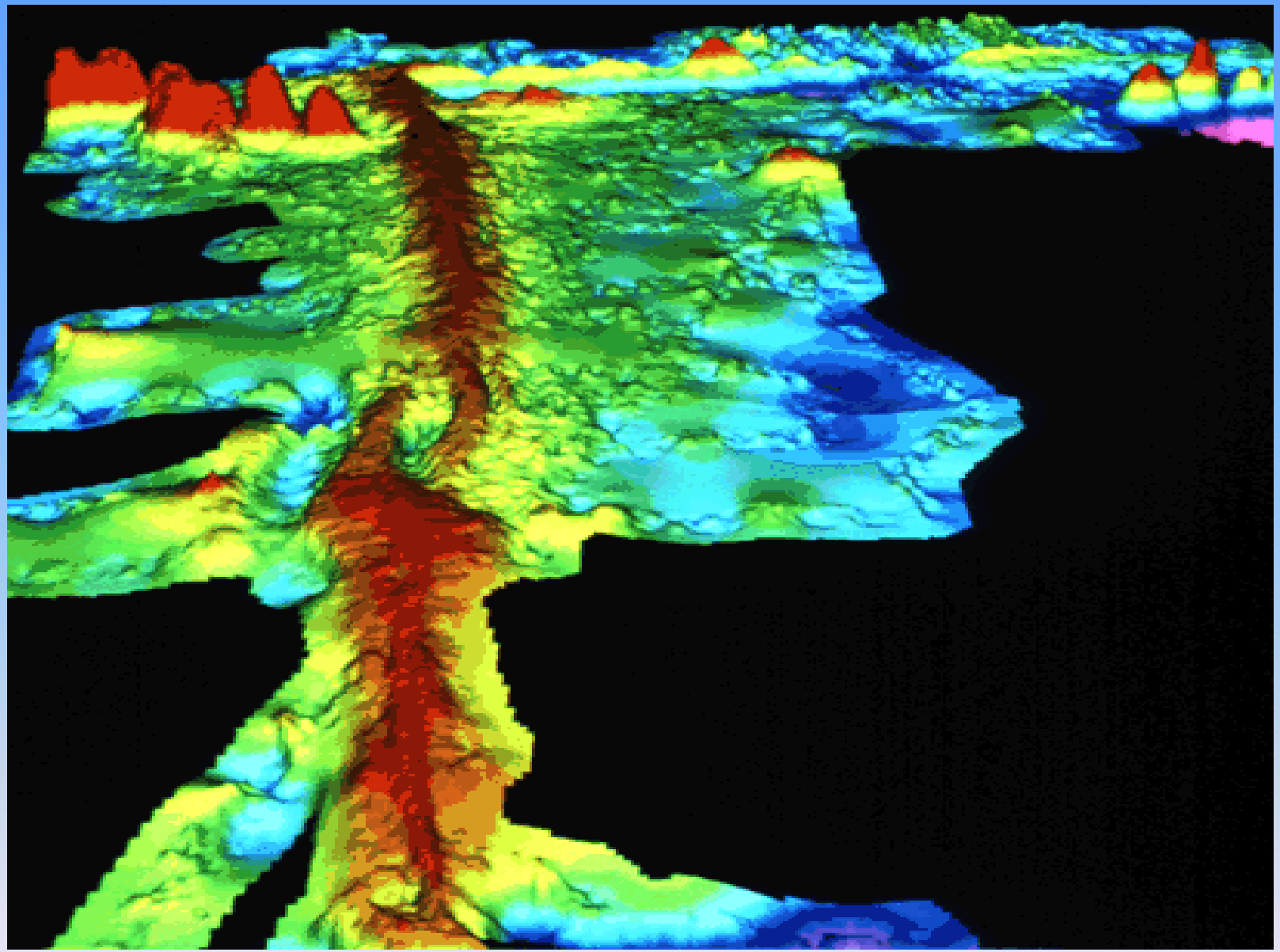
Example: *Convection*

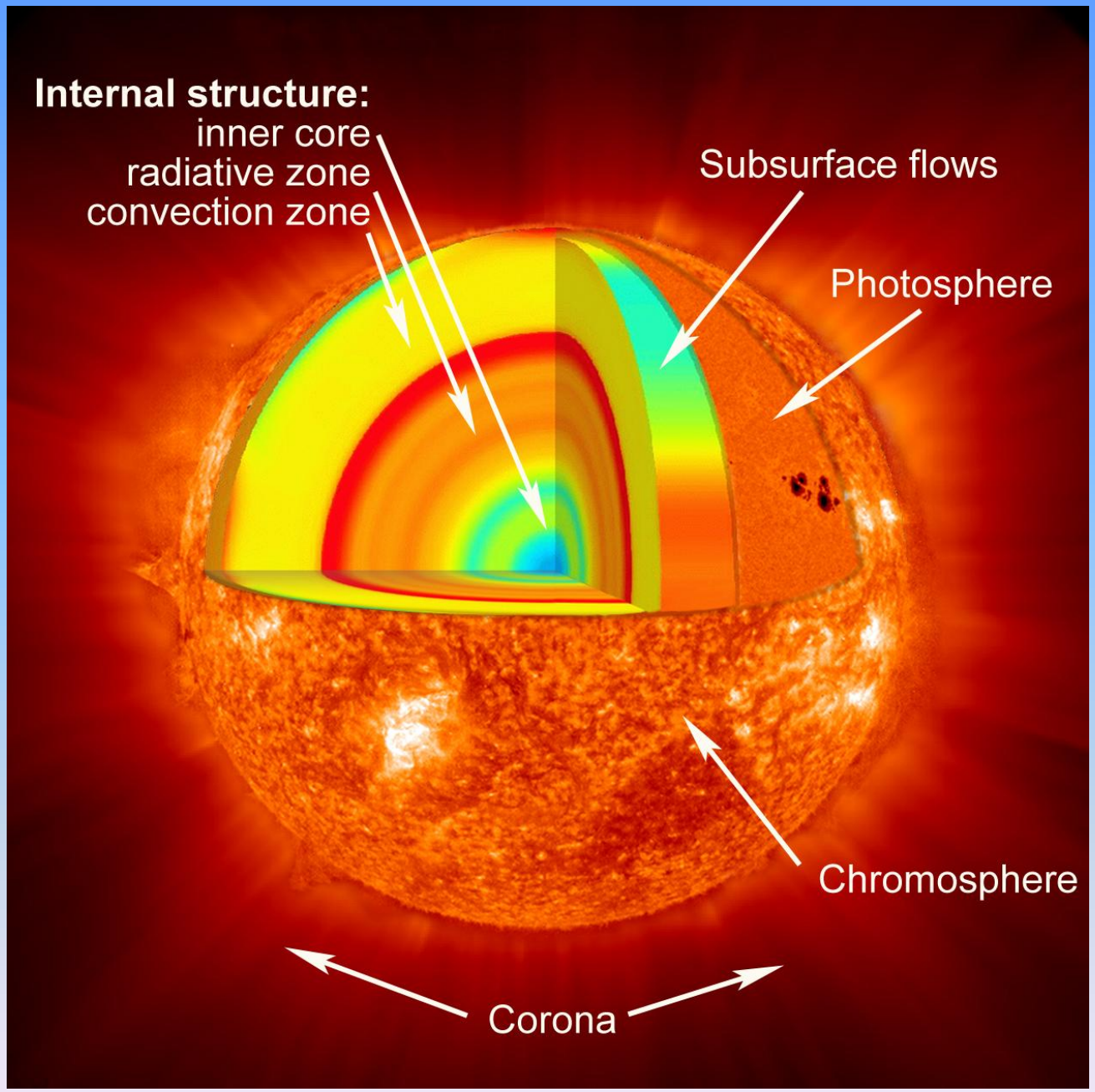
Heat driven convection

1. Bottom water is warmed
2. It expands an is therefore less dense
3. It rises to the surface and then spreads out
4. Cooler water at the sides descends to fill the void

A convective thunderstorm


Ridge
Lithosphere
"SLAB PULL"
Trench
Trench
Asthenosphere
Mantle
700 km
Outer core
Inner
core

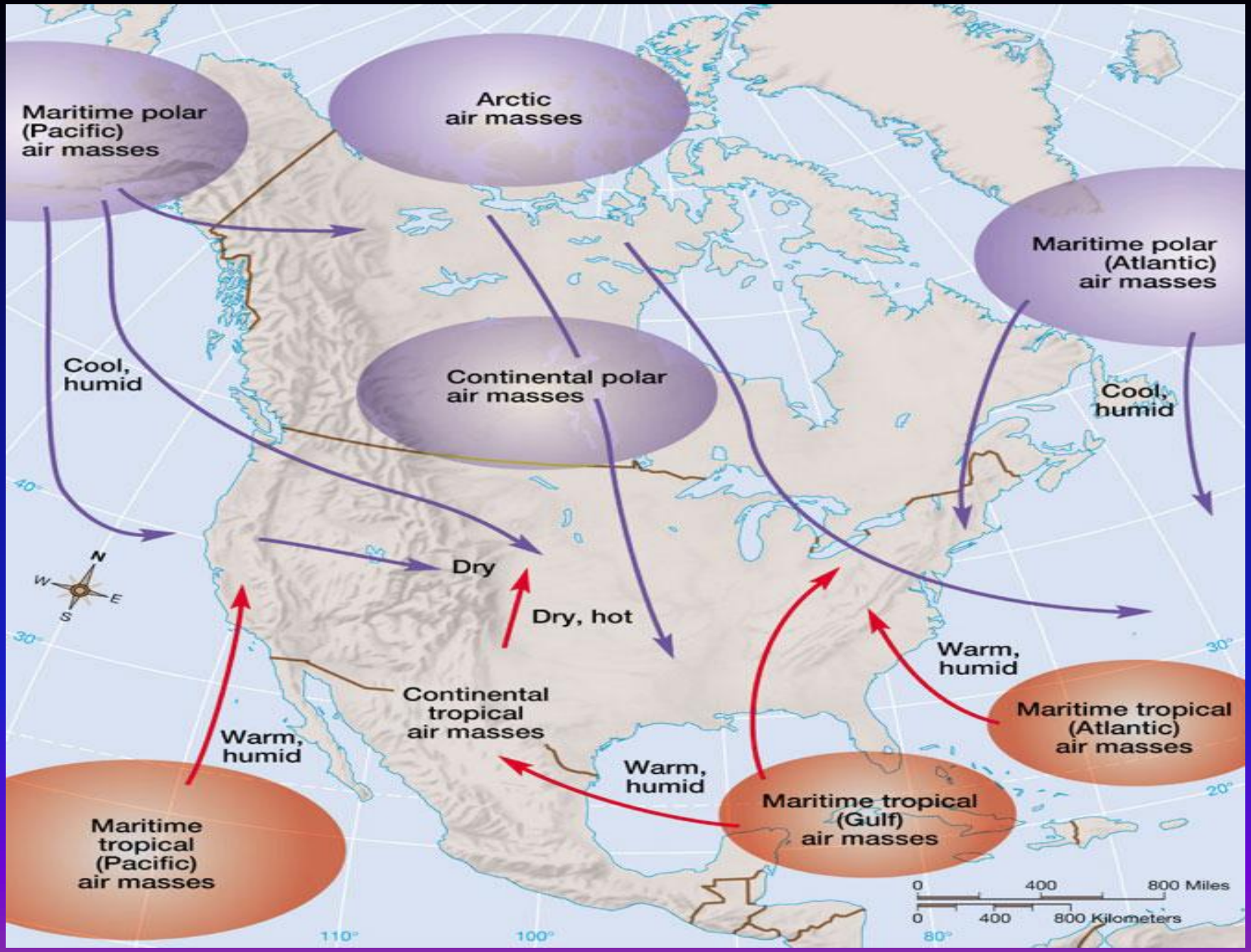


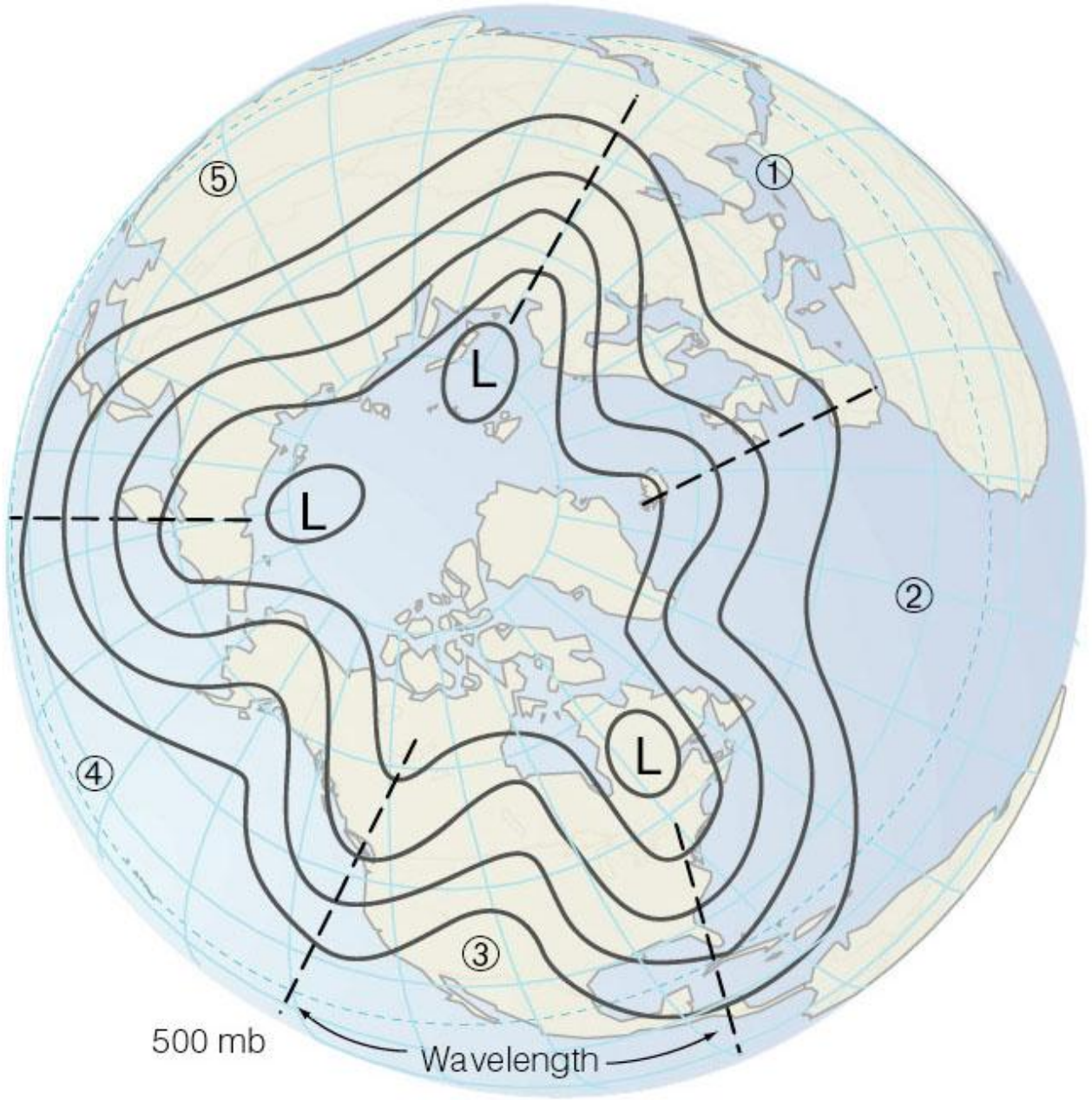

Internal structure:
inner core
radiative zone
convection zone
Subsurface flows
Photosphere
Chromosphere
Corona

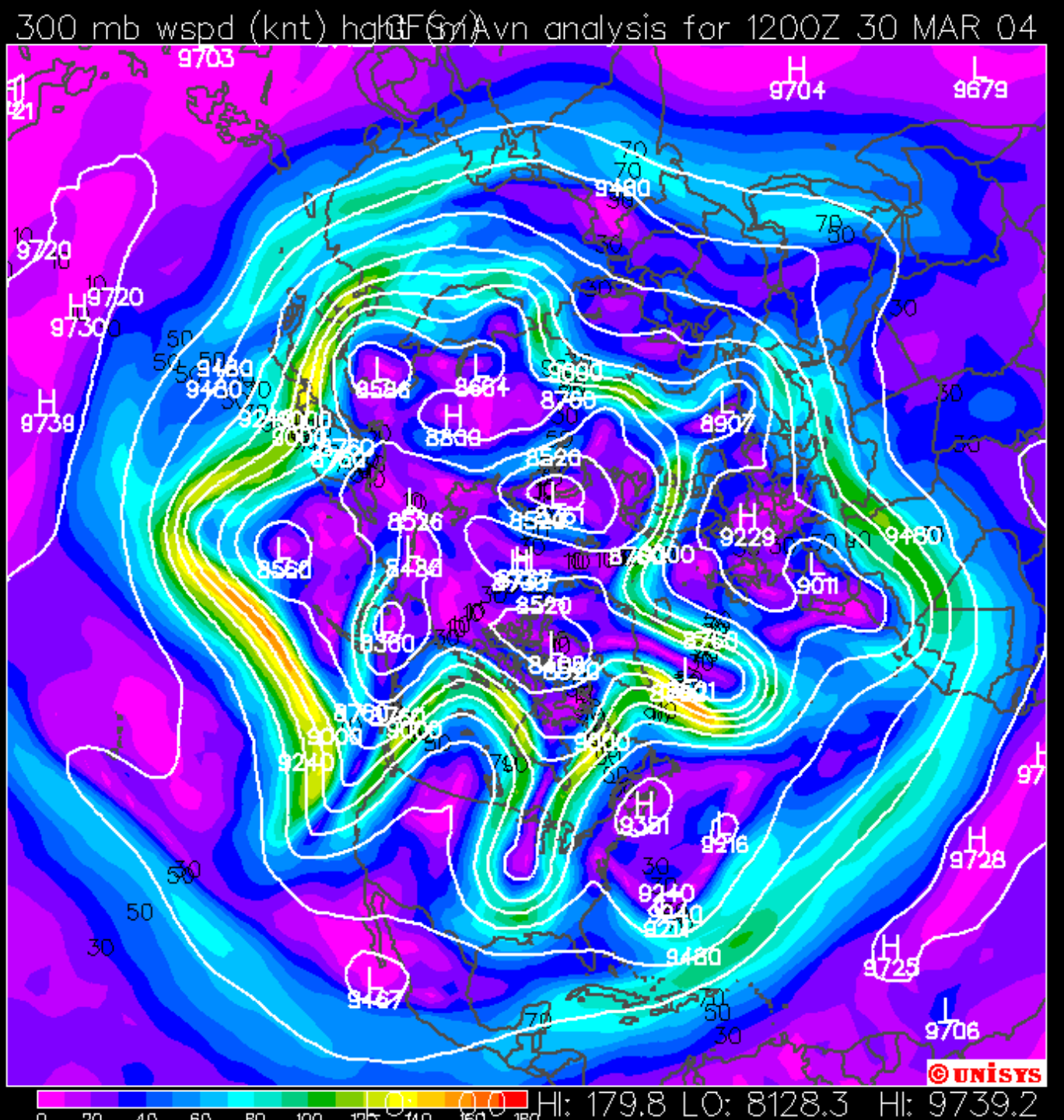
Some of the topics we will study

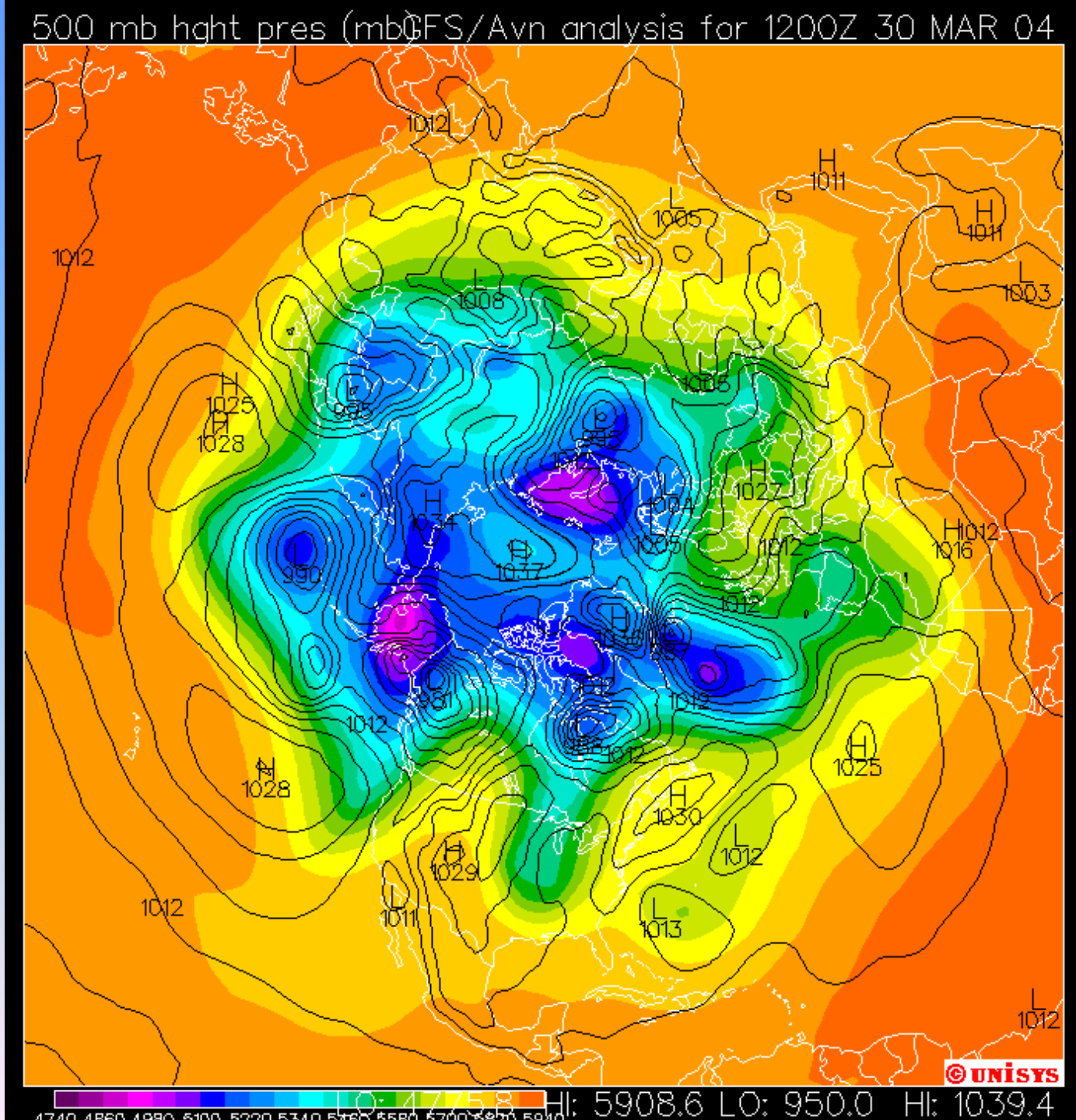
Weather and Climate

http://www.cnn.com/video/#/video/weather/2010/01/13/rob.marciano.haiti.cnn


Maritime polar (Pacific) air masses
Arctic air masses
Maritime polar (Atlantic) air masses
Continental polar air masses
Cool, humid
Cool, humid
Dry
Dry, hot
Warm, humid
Warm, humid
Continental tropical air masses
Warm, humid
Maritime tropical (Atlantic) air masses
Maritime tropical (Gulf) air masses
Maritime tropical (Pacific) air masses
N
W
E
S
40°
30°
20°
110°
100°
80°
0 400 800 Miles
0 400 800 Kilometers




300 mb wspd (knt) hgt GFS/Avn analysis for 1200Z 30 MAR 04
©UNISYS
HI: 179.8 LO: 8128.3 HI: 9739.2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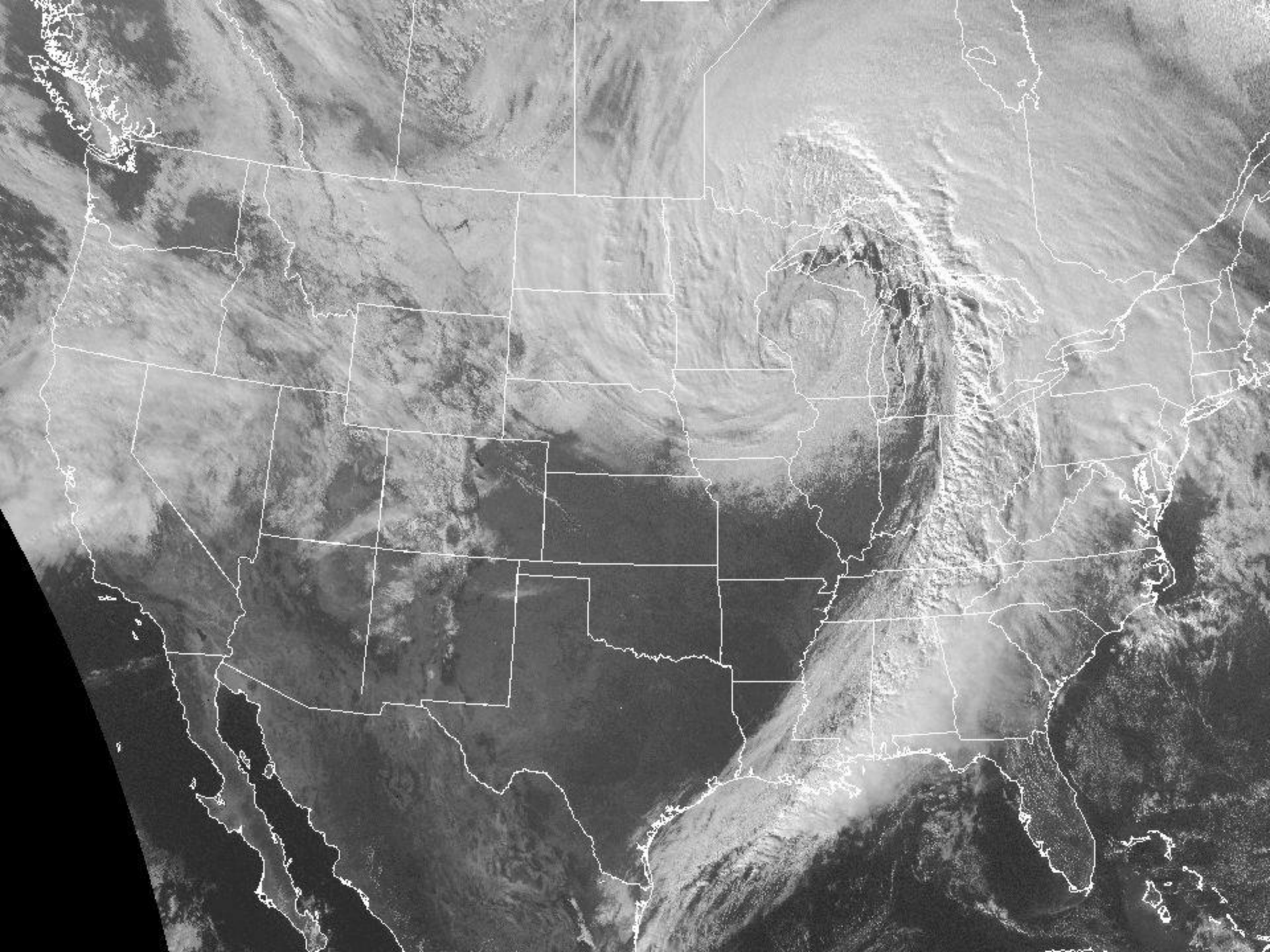
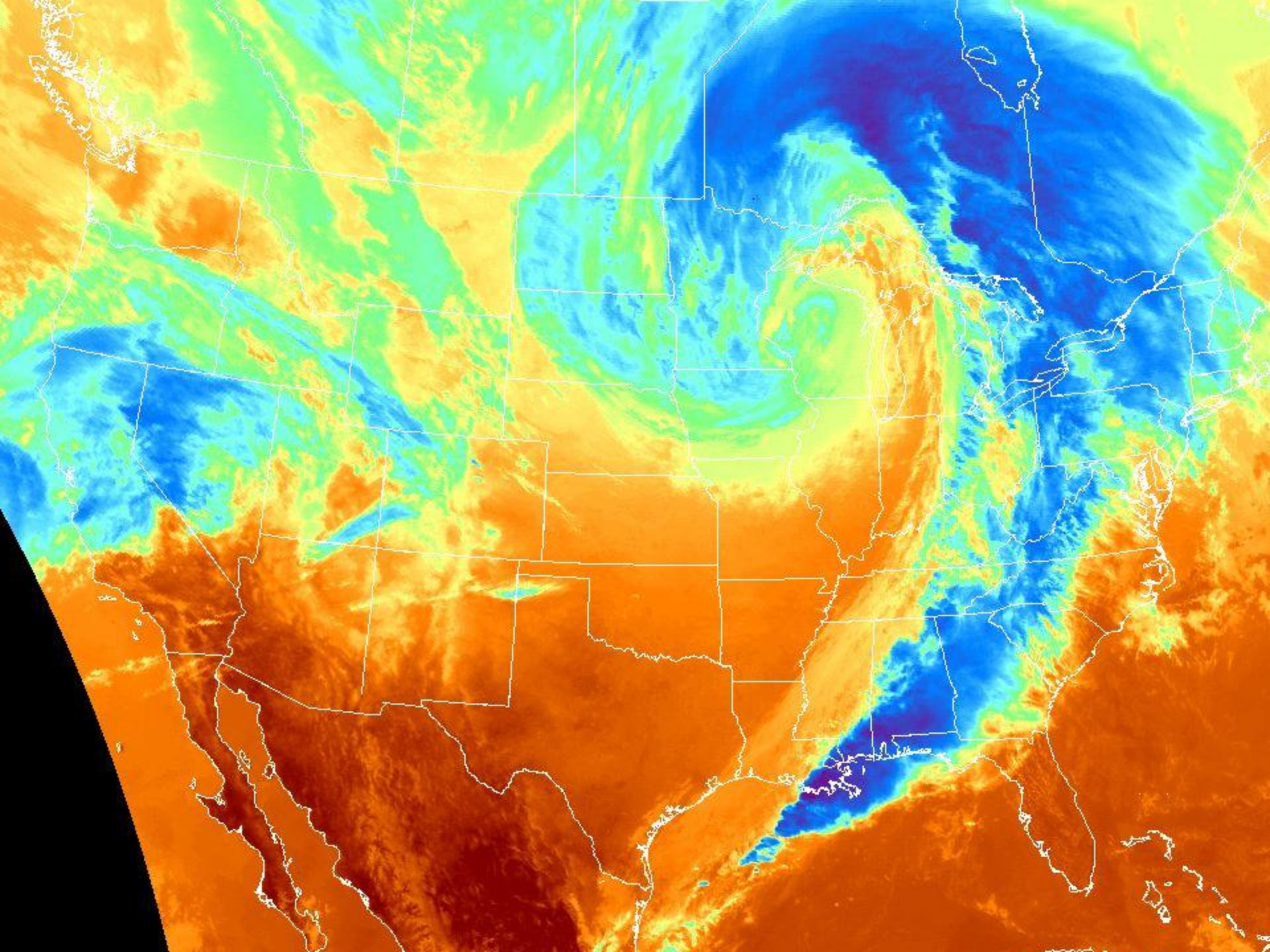
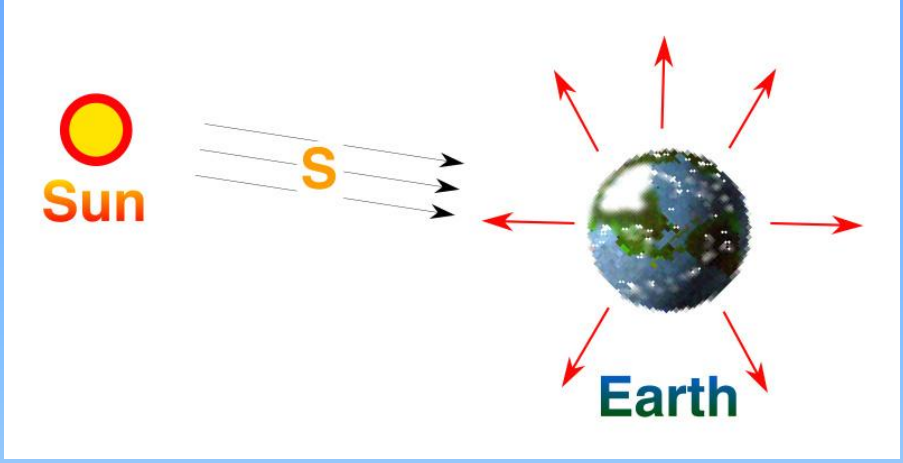
©UNISYS





Planetary Energy Balance



Energy In = Energy Out

$$S(1-\alpha)\pi R^2 = 4\pi R^2 \sigma T^4$$

$$T \approx -18^{\circ}\mathrm{C}$$

But the observed T_s is about 15° C

What's Missing
from the 0-D energy balance model?

- Vertical structure

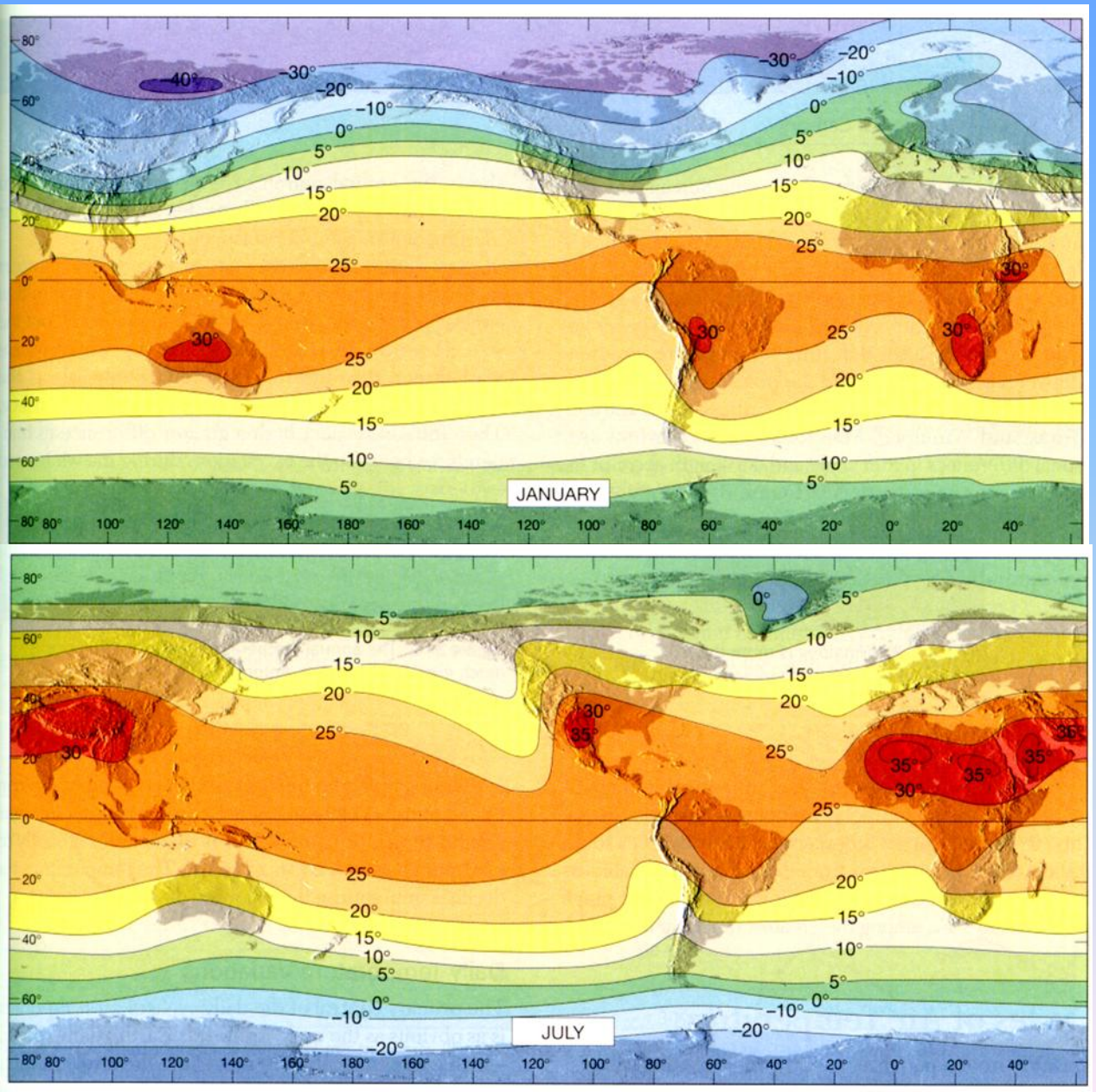
  The "greenhouse effect"

- Energy storage and transport

  The "general circulation" of the atmosphere and oceans

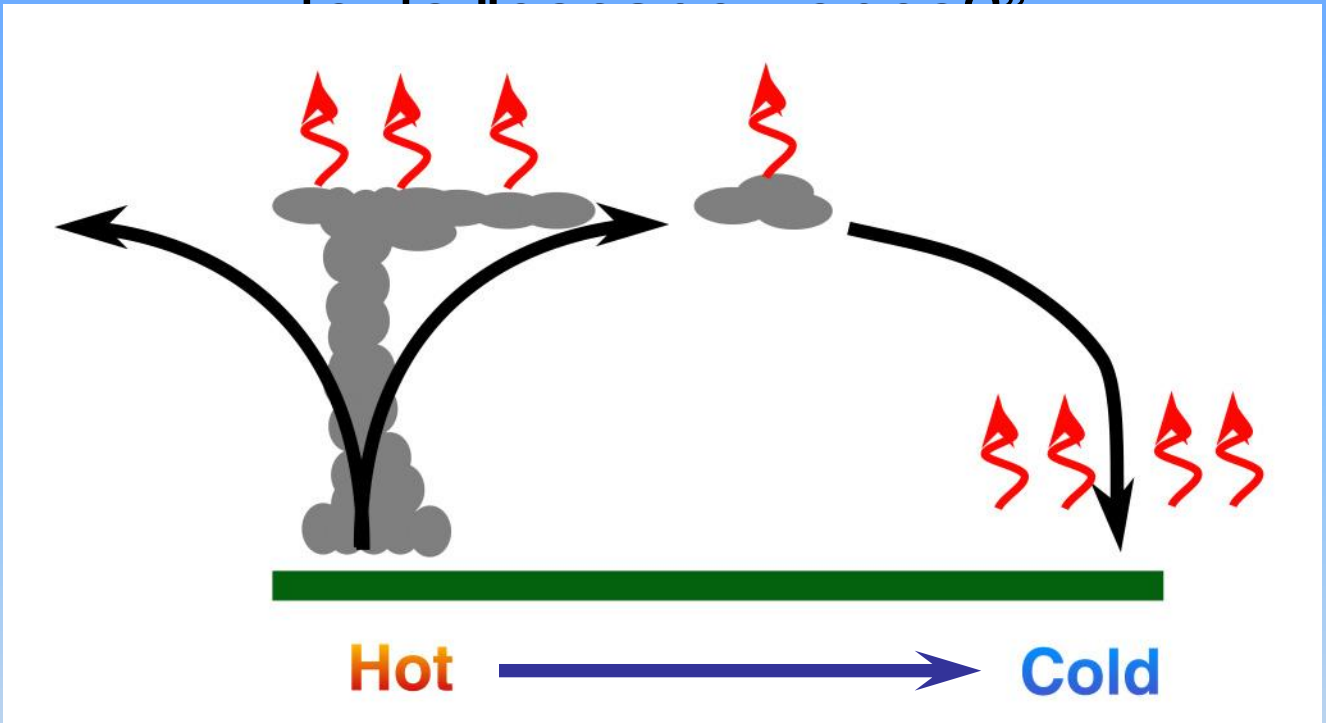
In other words, The Greenhouse Effect!

Temperature Patterns



- Stronger seasonal heating and cooling on land produces asymmetry
- Poleward distortion of isotherms over northern high latitude oceans
- Equatorward distortion over subtropics

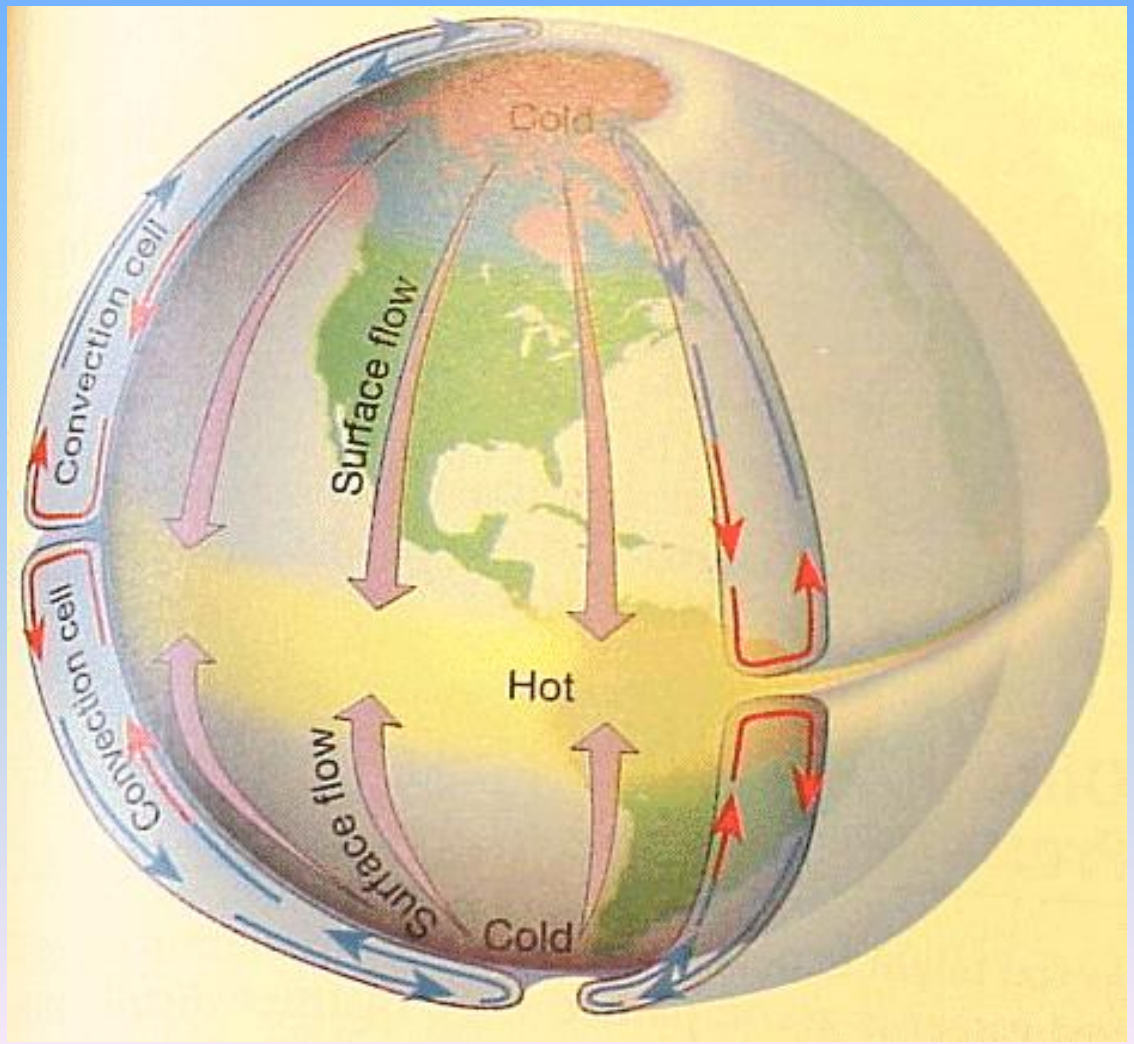
How is Energy Transported



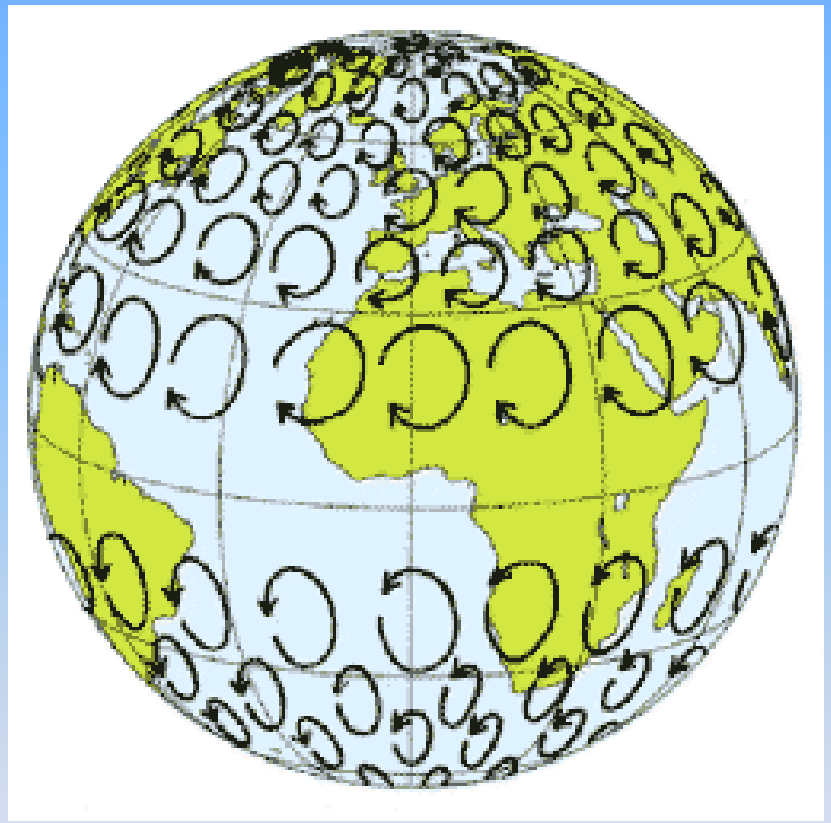
- Both atmospheric and ocean transport are crucial
- Buoyancy-driven convection drives vertical transport
- Latent heat is at least as important as sensible heat

What a single cell convection model would look like for a *non-rotating* earth

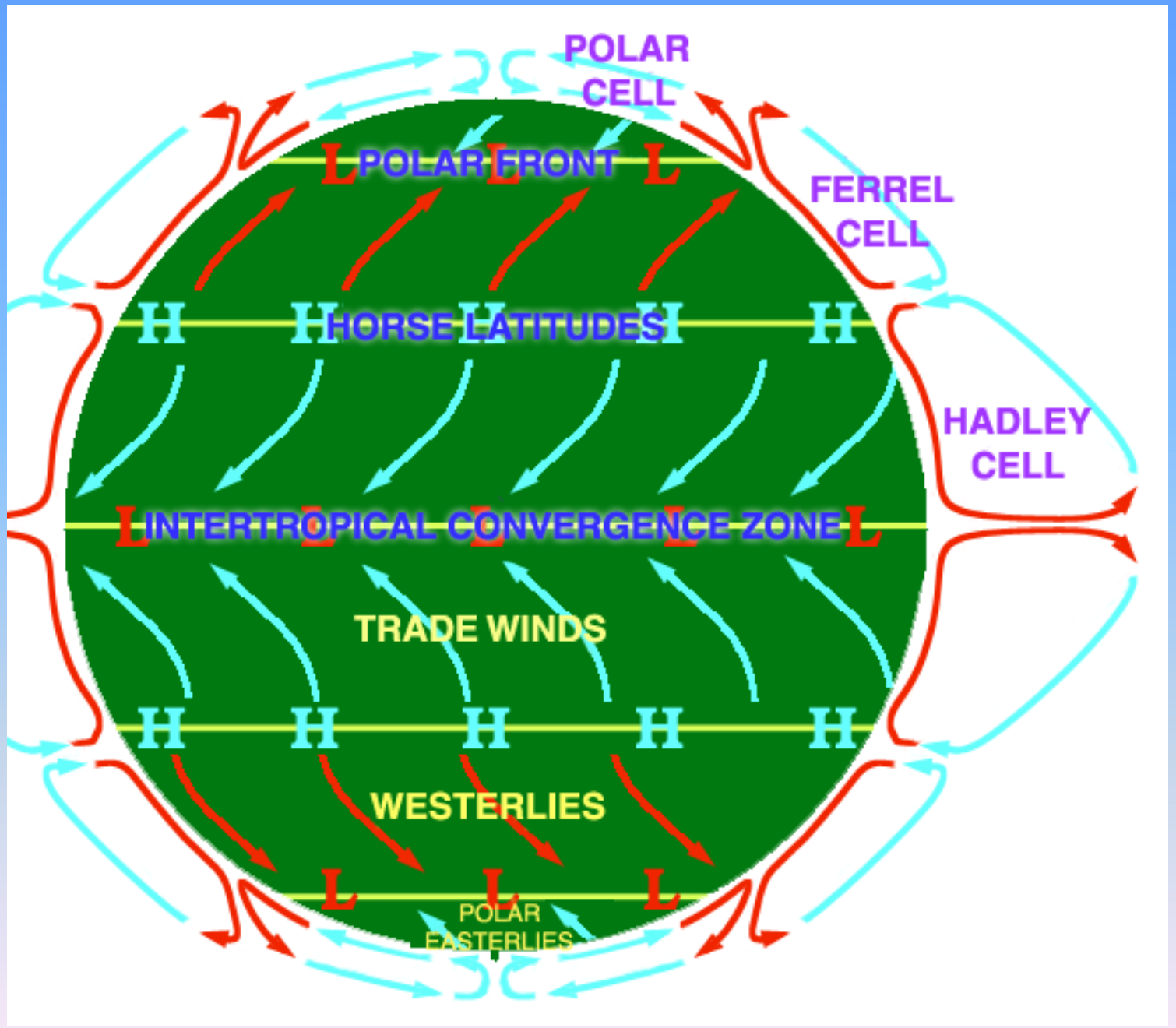
- Thermal convection leads to formation of convection cell in each hemisphere
- Energy transported from equator toward poles
- What would prevailing wind direction be at the surface over N. America with this flow pattern on a rotating earth?



Coriolis Effect

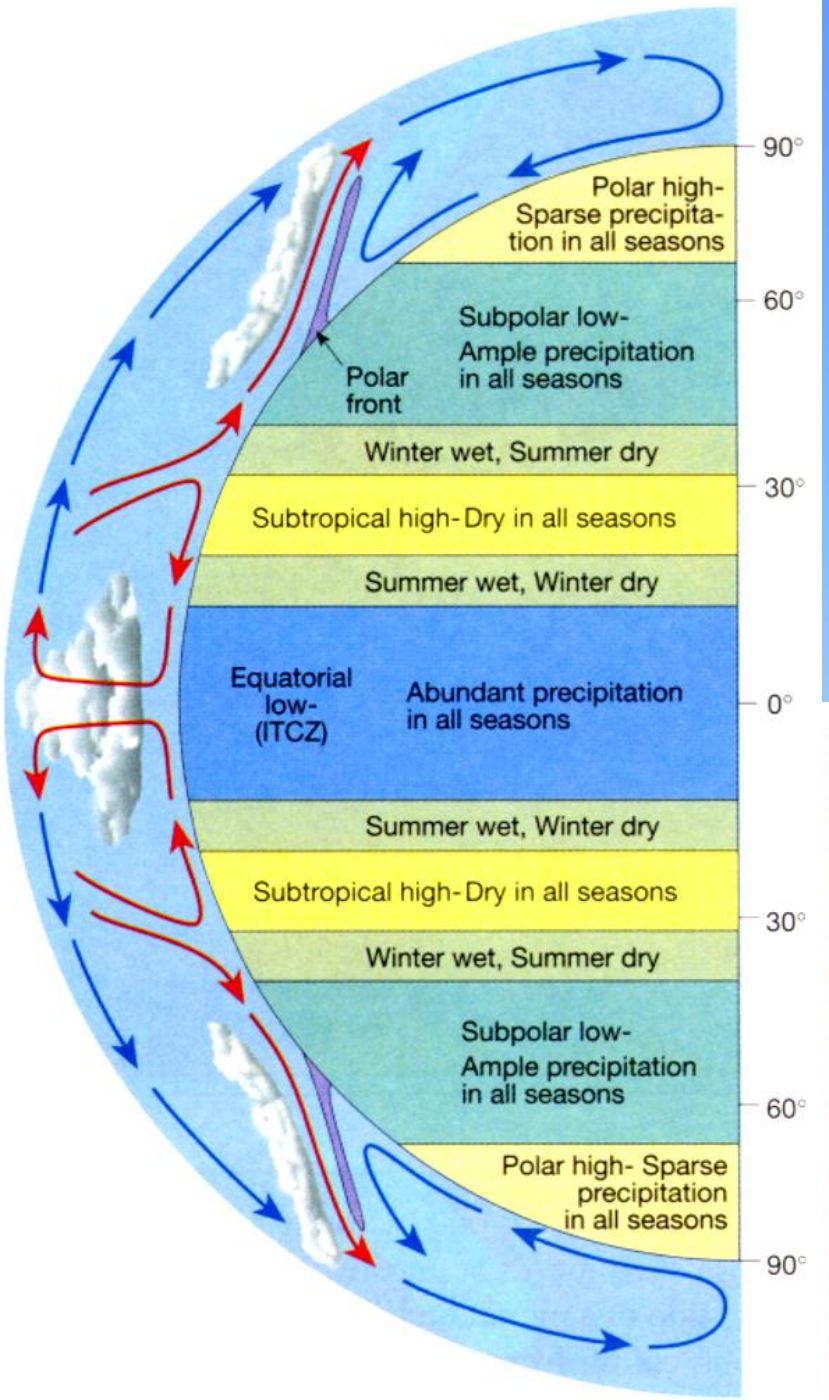


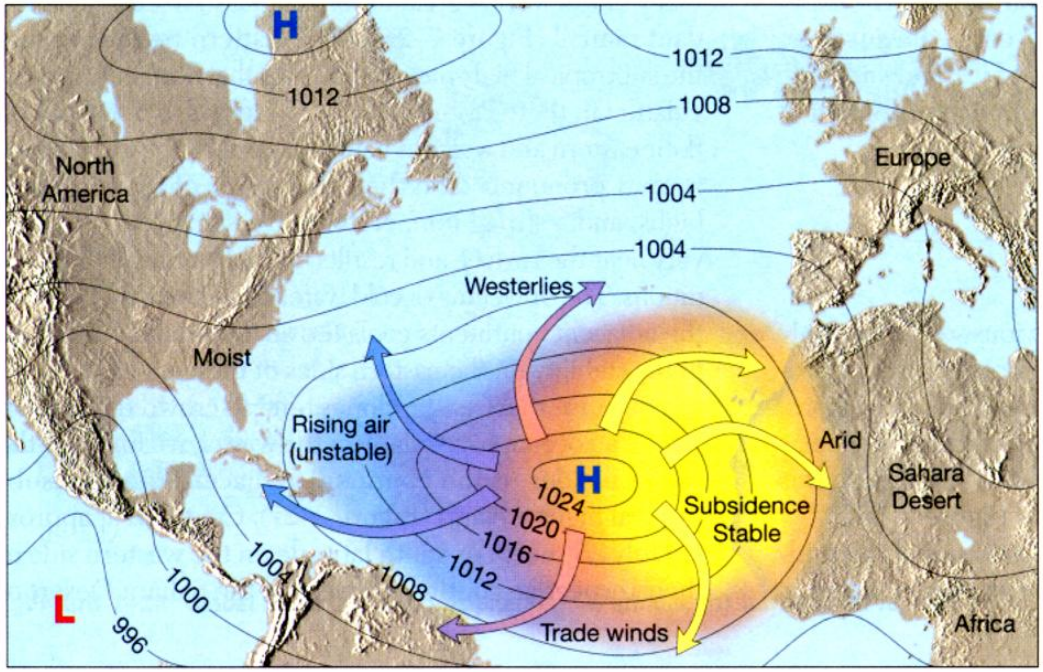
The Coriolis Effect deflects moving objects to the right in the northern hemisphere and to the left in the southern.


POLAR
CELL
POLAR FRONT
FERREL
CELL
HORSE LATITUDES
HADLEY
CELL
INTERTROPICAL CONVERGENCE ZONE
TRADE WINDS
WESTERLIES
POLAR
EASTERLIES

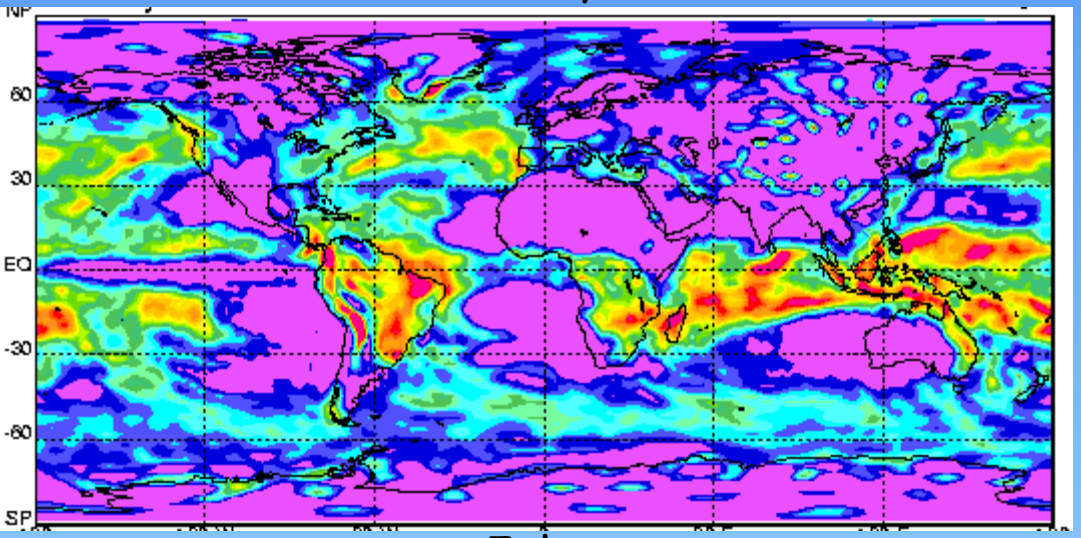
Climate "Zones"

- Circulation features are tied to regional climate
- Rising air associated with lots of precipitation

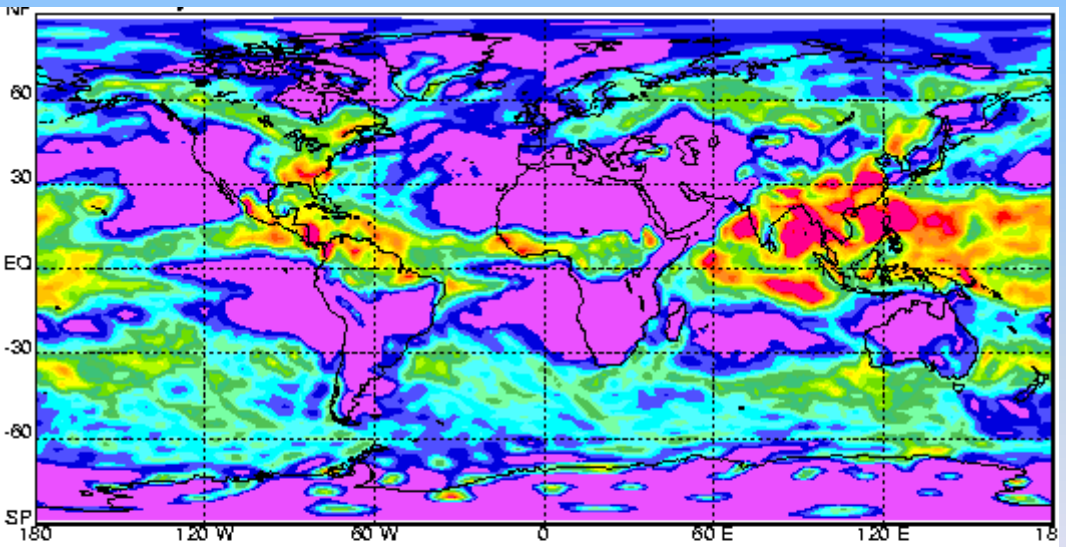




January



July



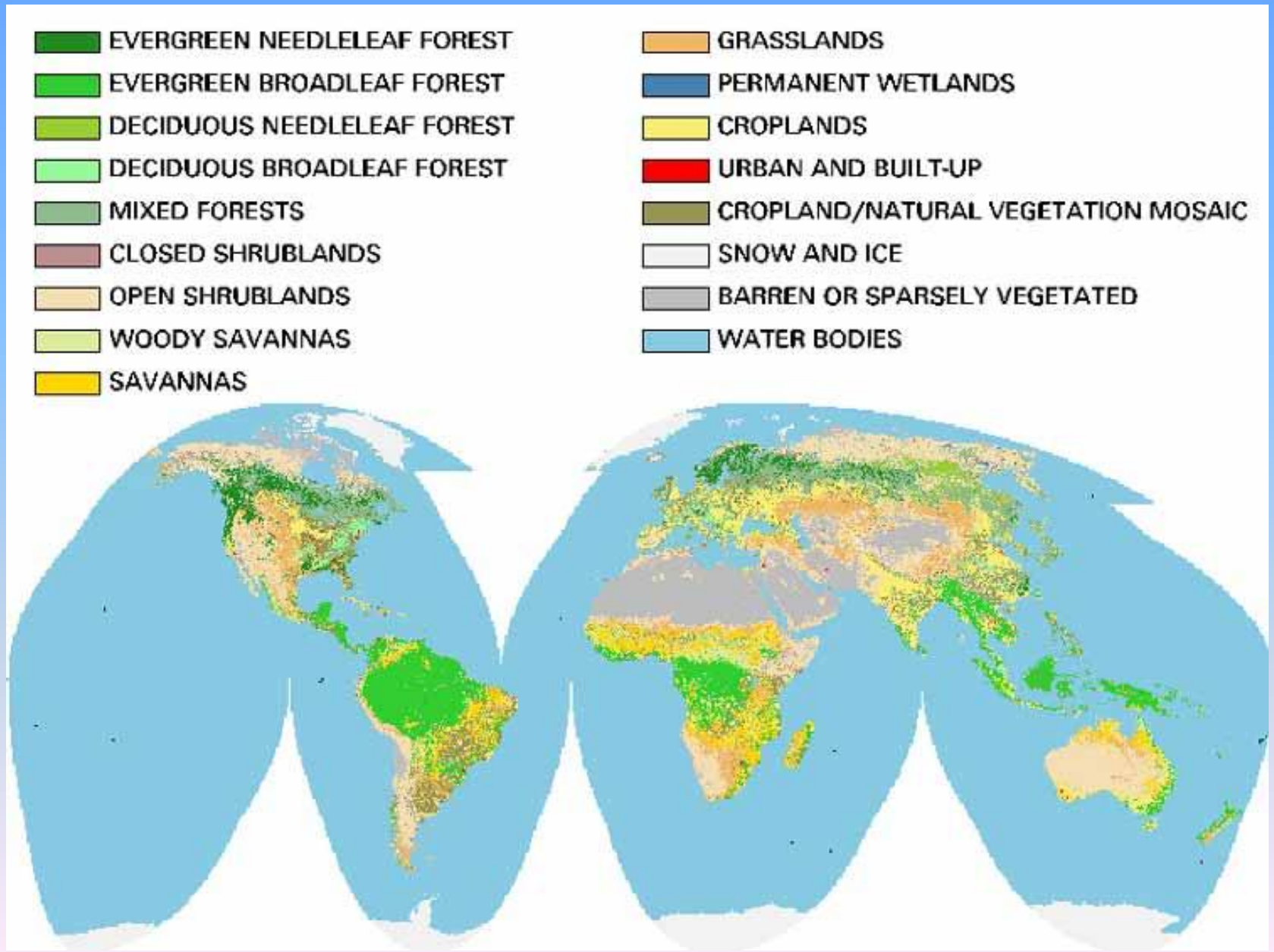
Precipitation

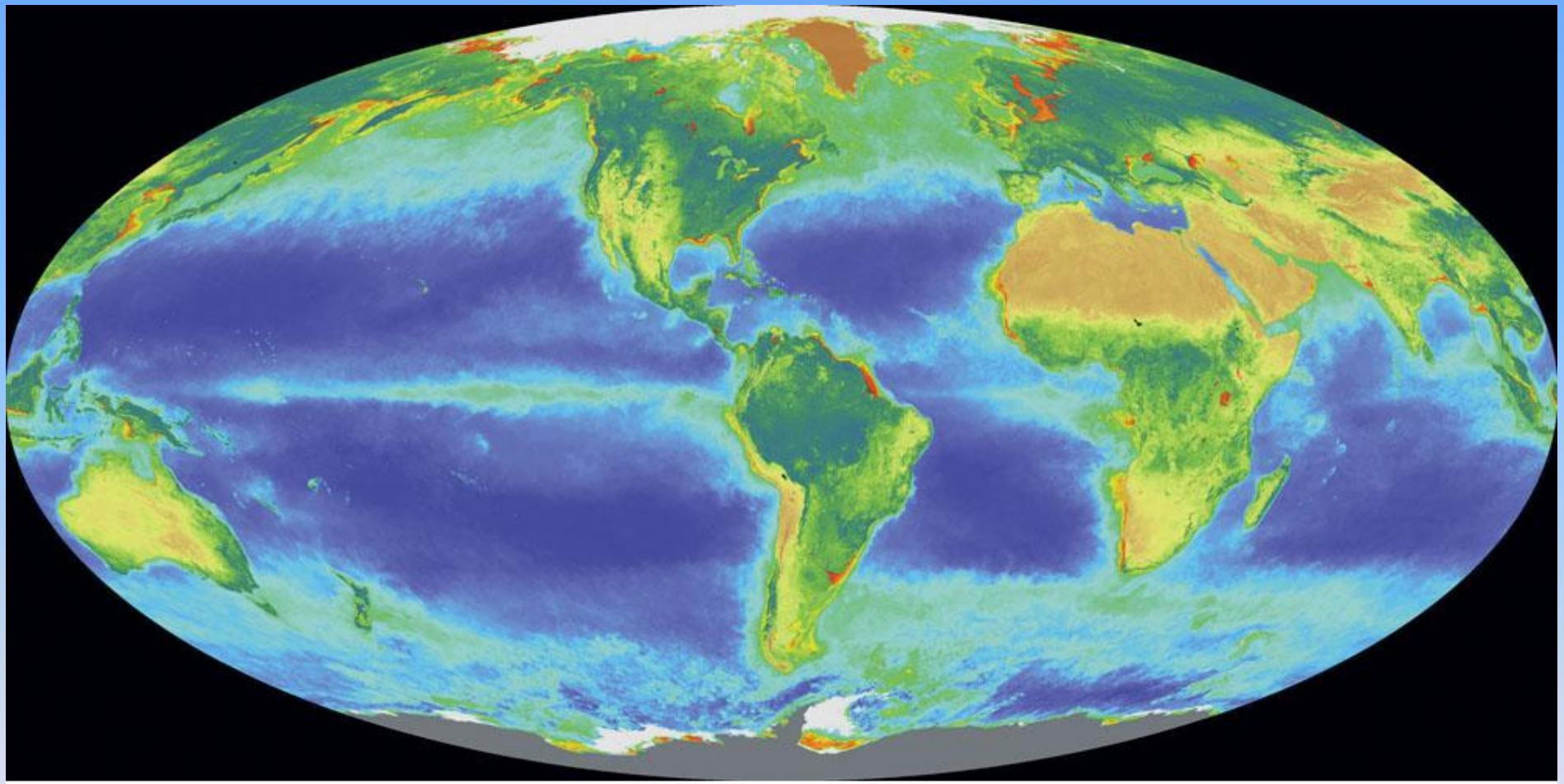
(mm/month)

- Very wet over tropics
- Seasonal shift (N/S)
- Monsoon regions
- Extremely dry subtropical highs
- Midlatitudes get more summer rain
- July rainfall looks like a map of forest cover

Biogeography

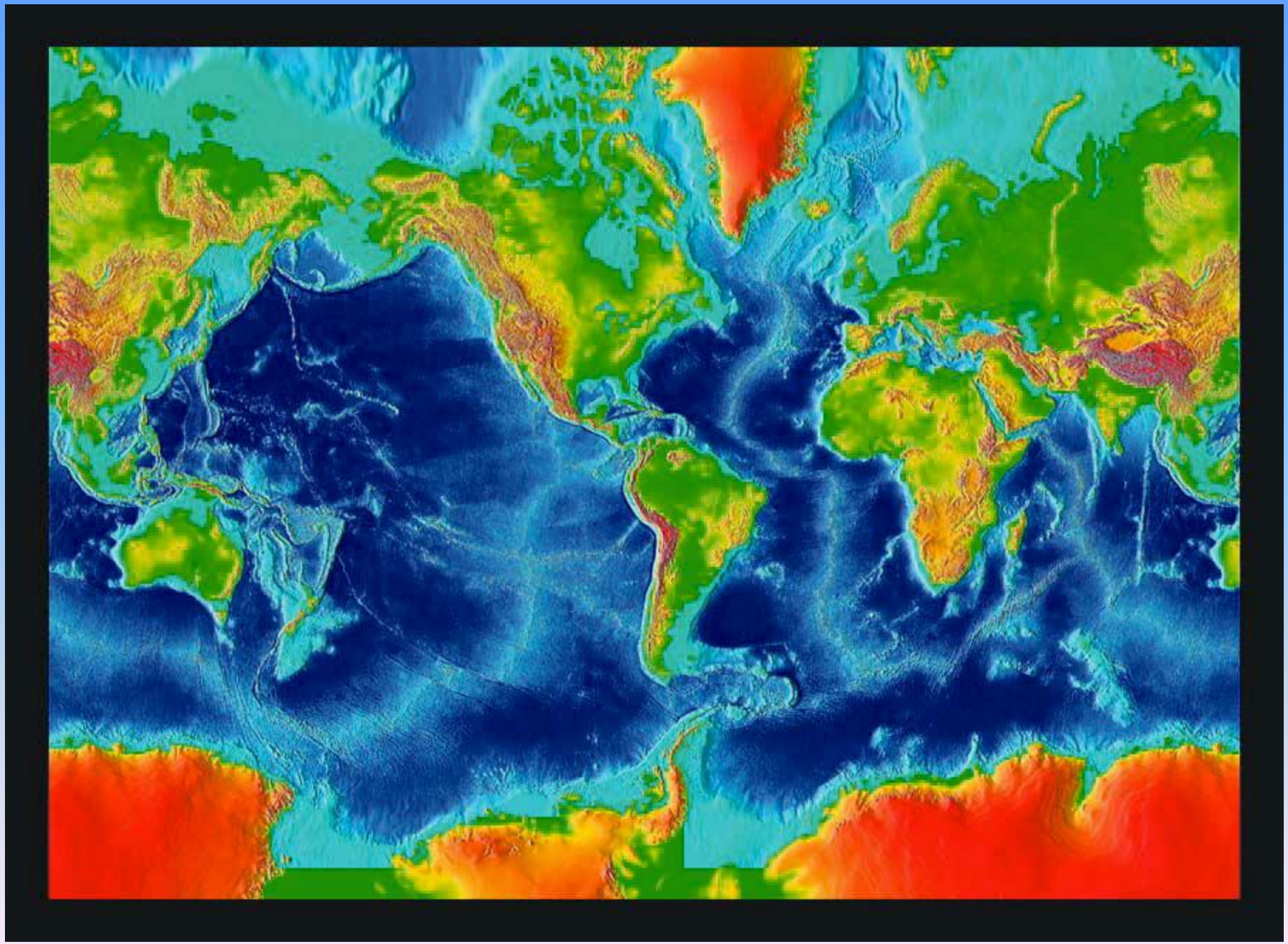
Classification of Land Vegetation





GlobalProd_Seawifs.mpg

Tectonics and Landforms



RotatingGlobeLQ.mov

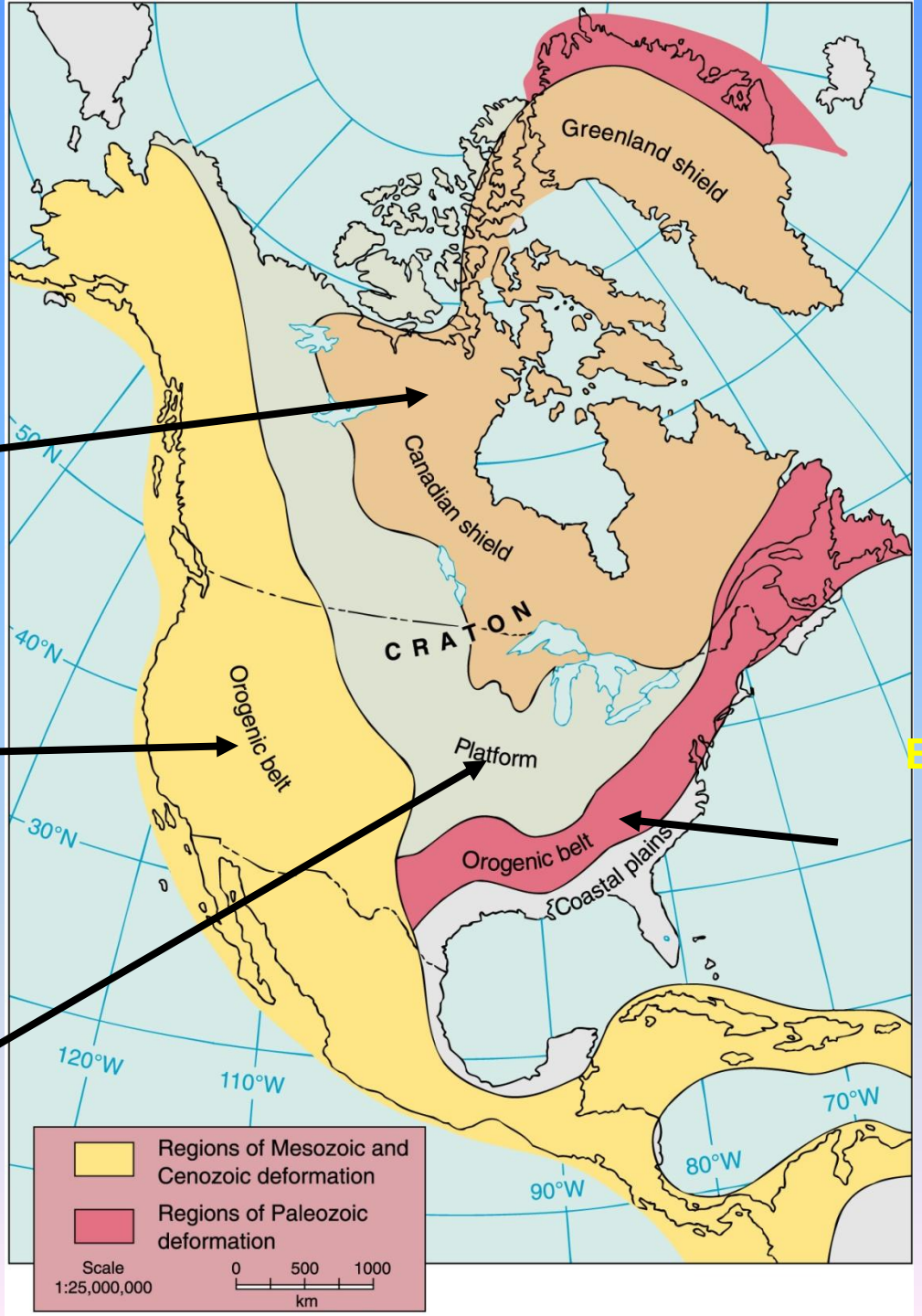
http://www.ngdc.noaa.gov/mgg/image/2minrelief.html

North American Craton

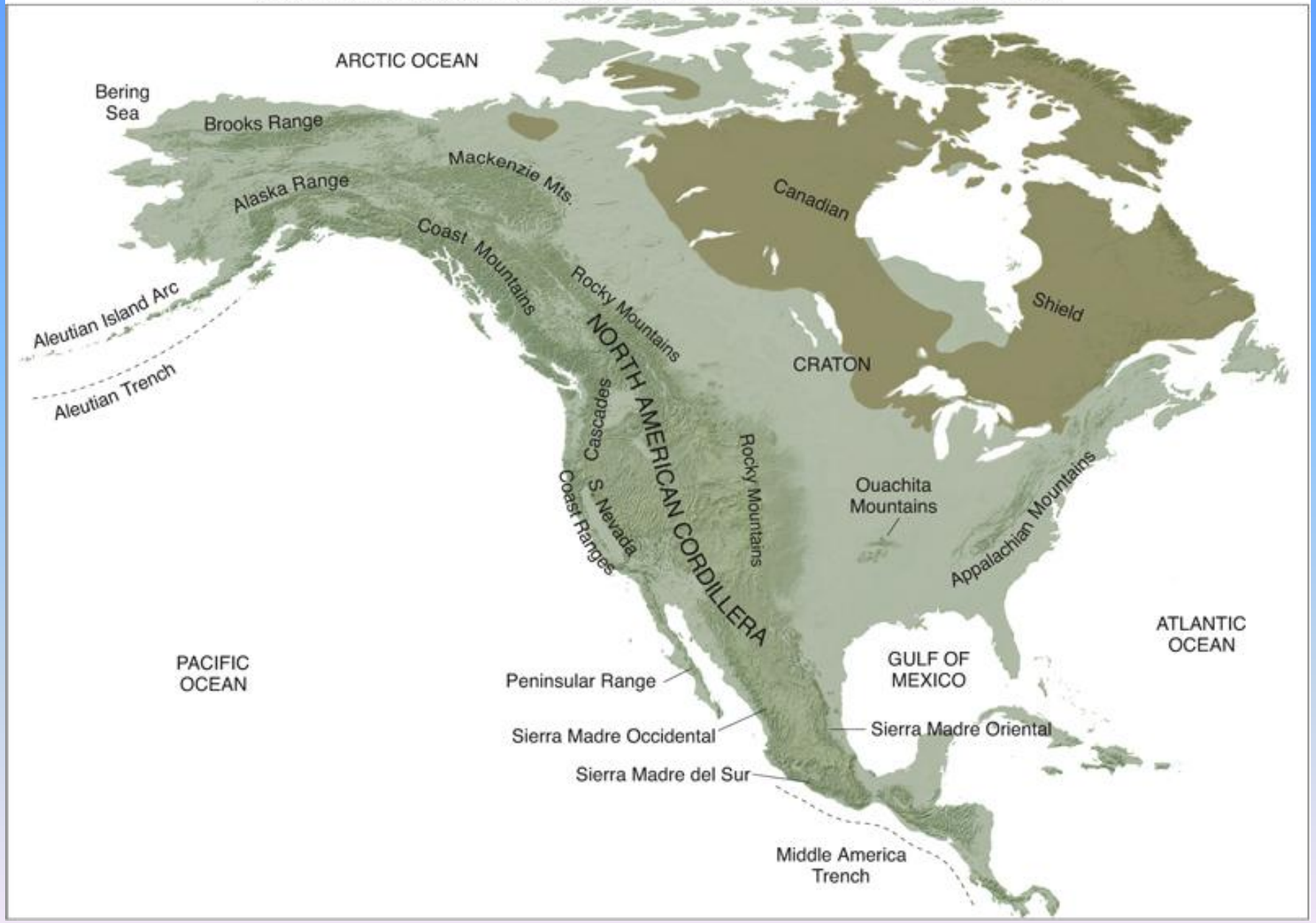
Shield

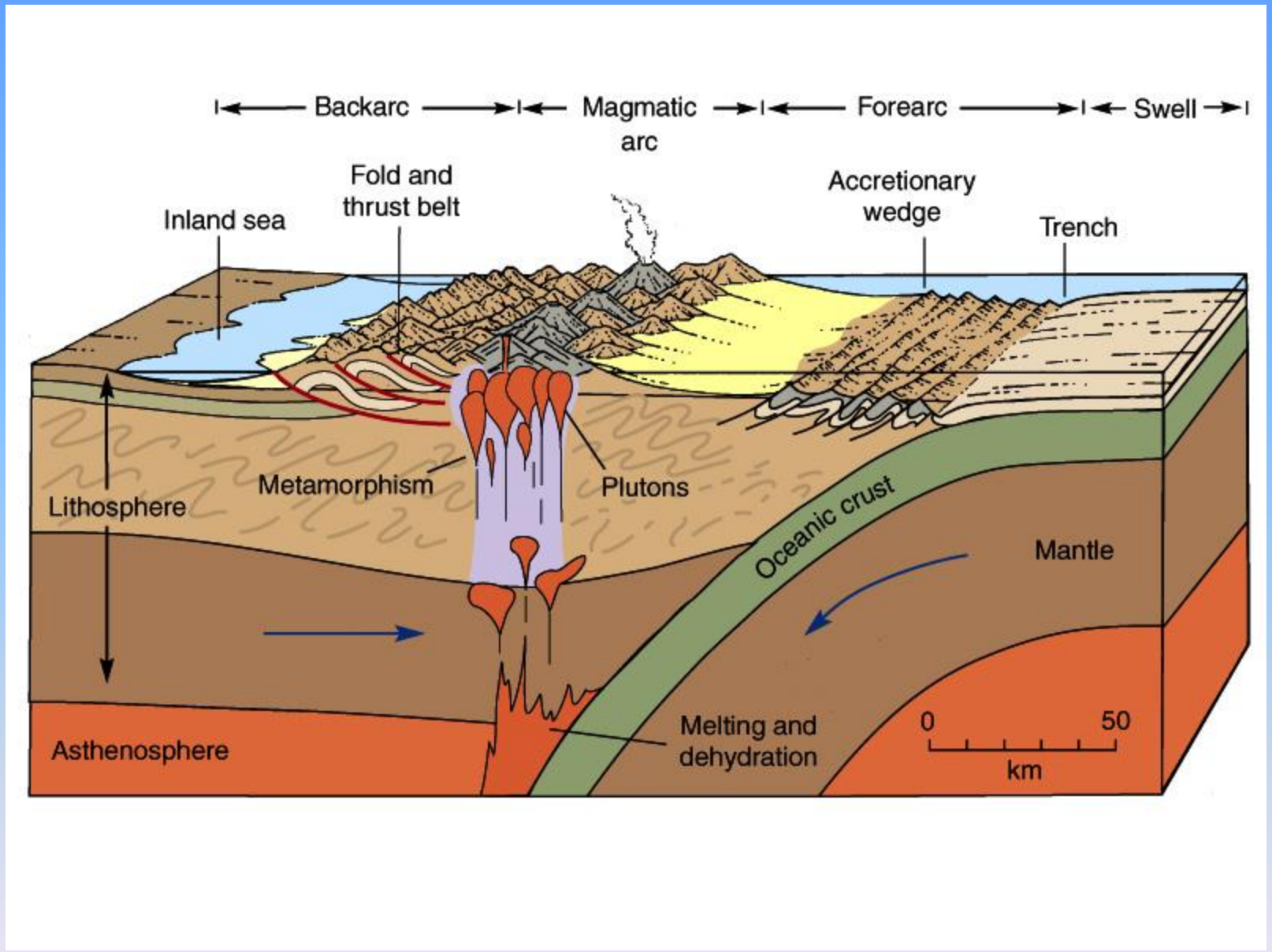
Western North American Mobile Belt

Platform

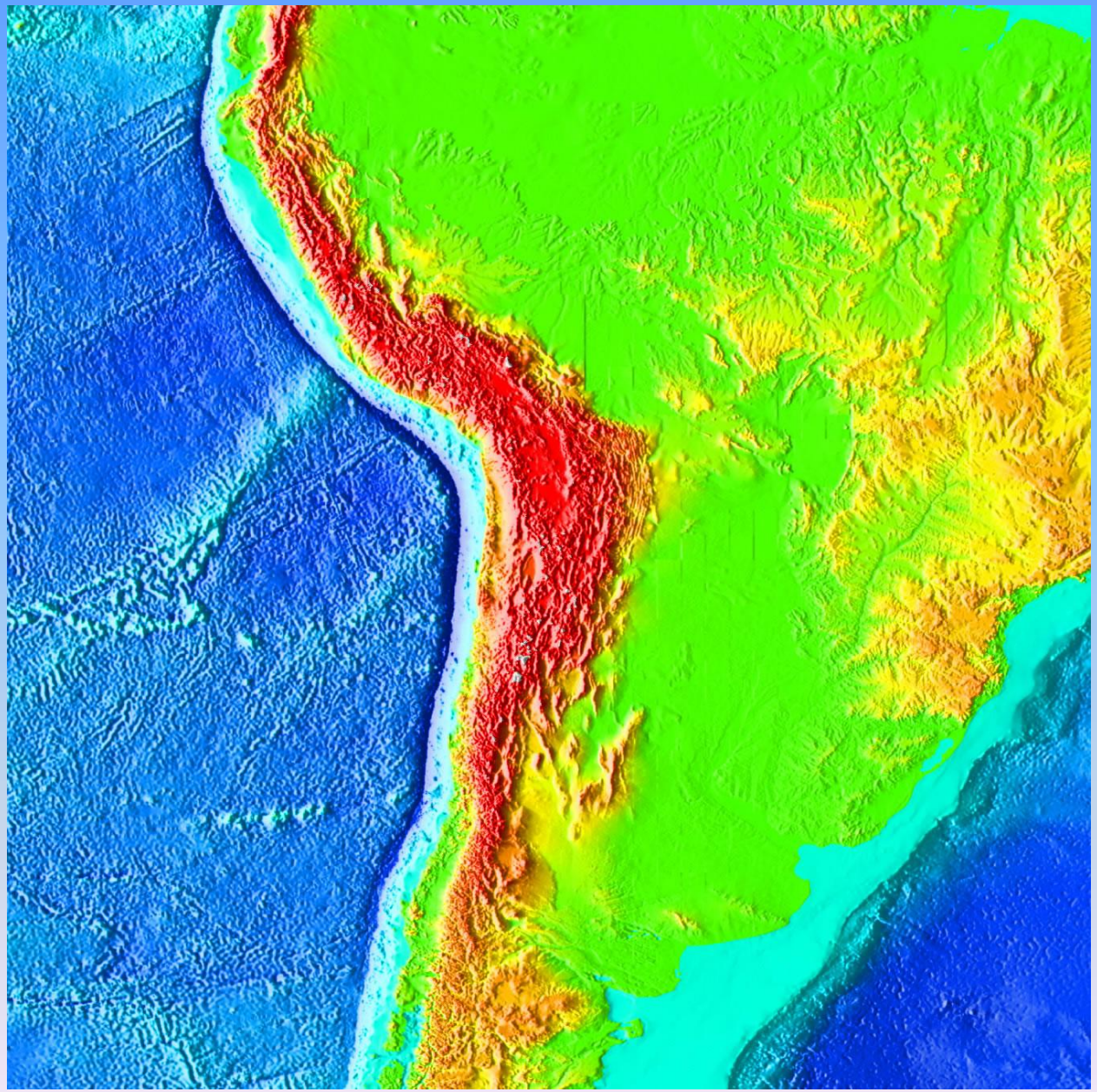


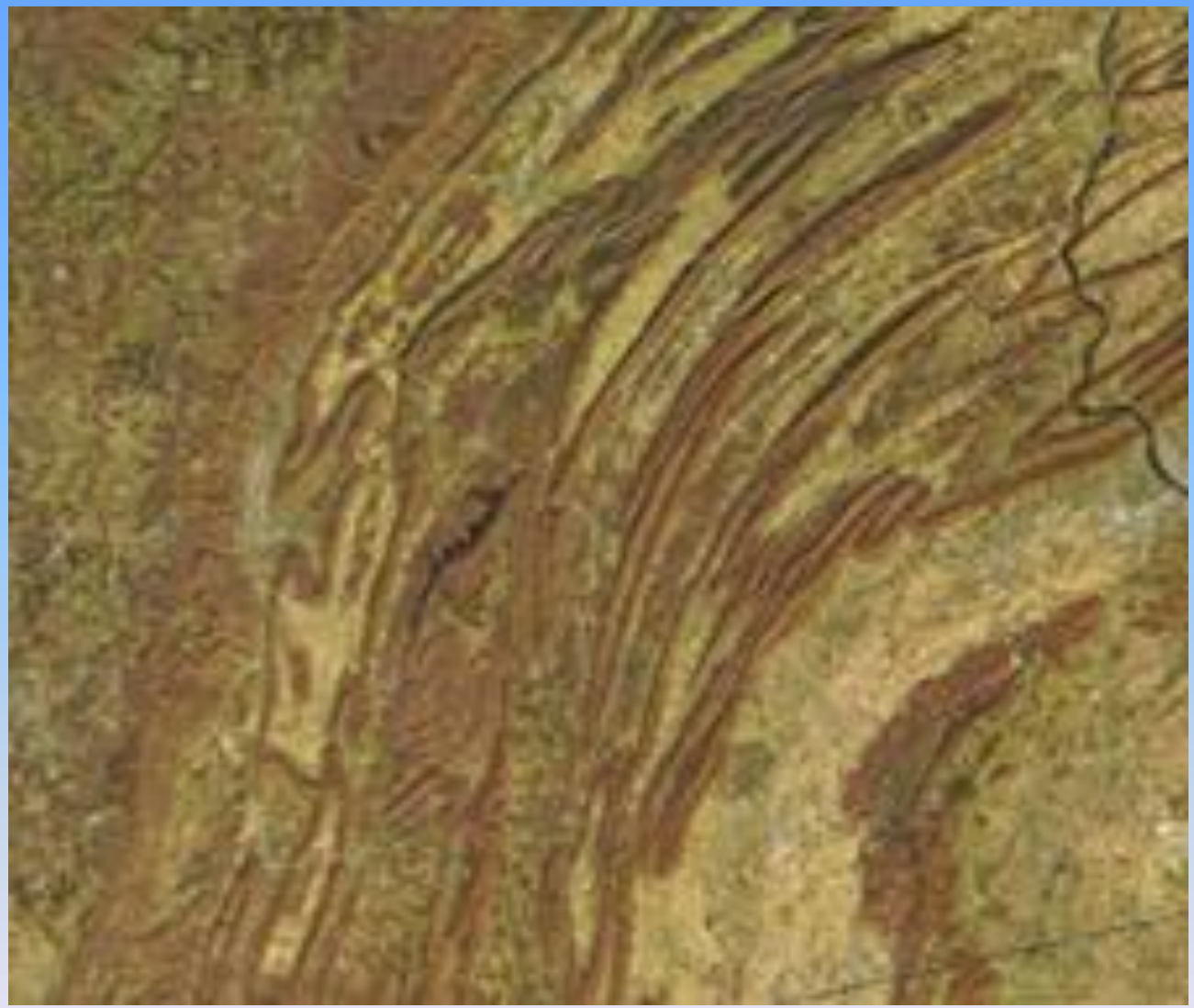
Eastern No American Mobile Be





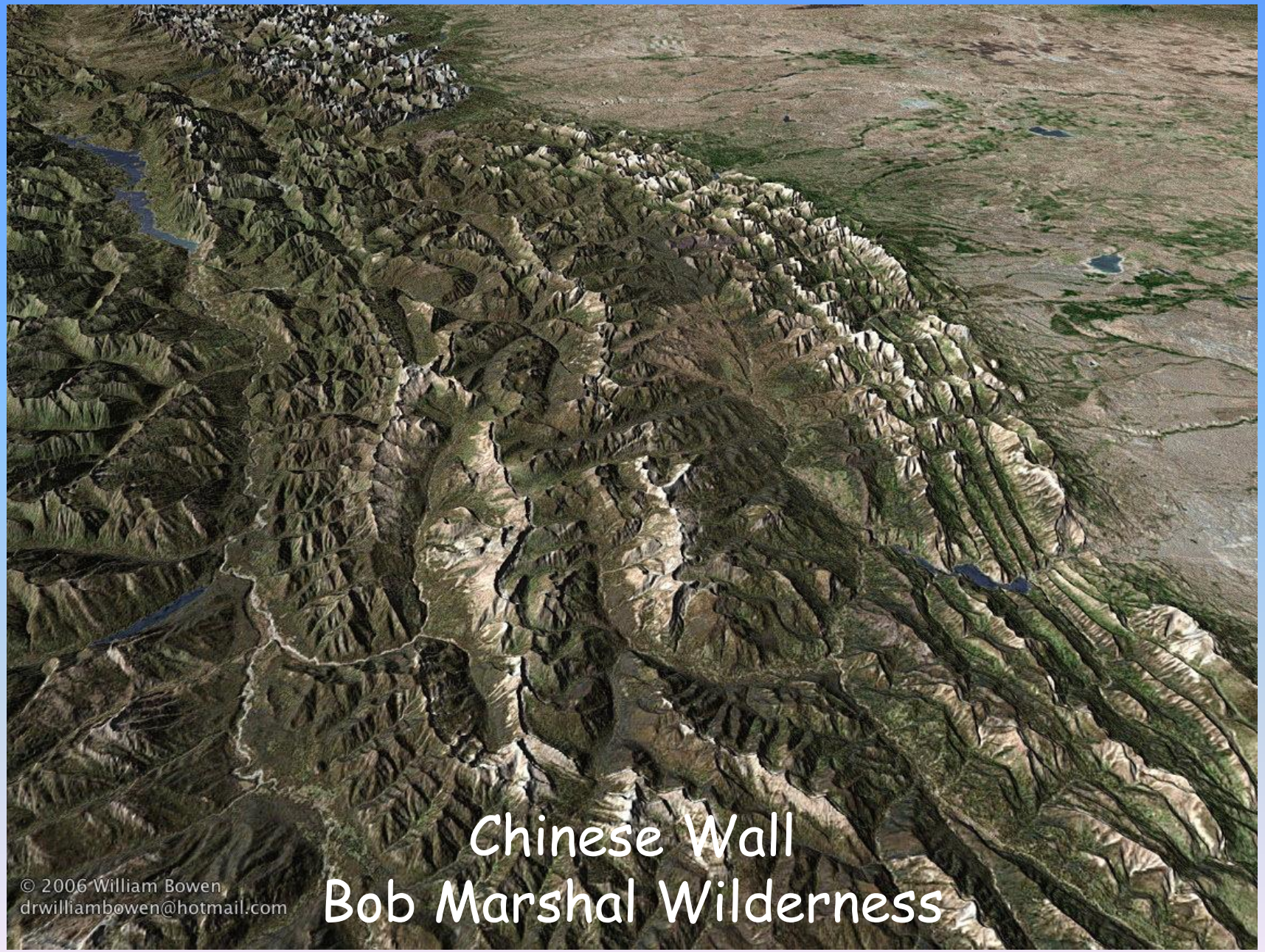
Ocean-Continent convergence



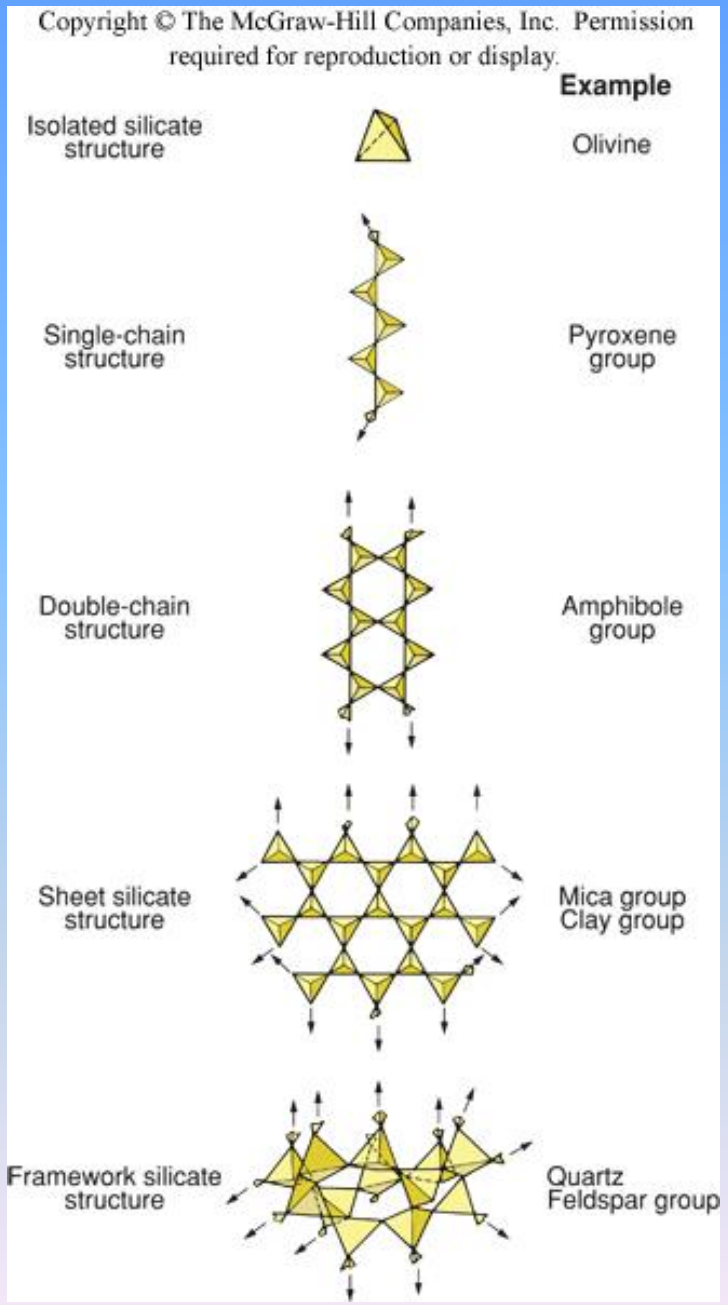


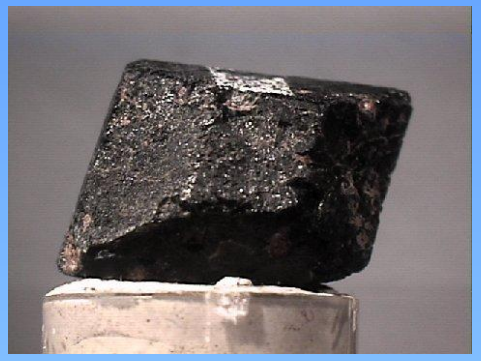
Northern Rocky Mountains

<u>Young</u> folded and faulted mountains


Chinese Wall
Bob Marshal Wilderness
© 2006 William Bowen
drwilliambowen@hotmail.com

Rocks and Minerals



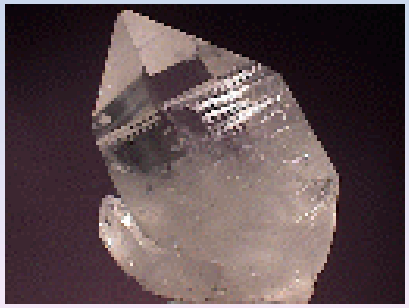


Augite (inosilicate)

Garnet

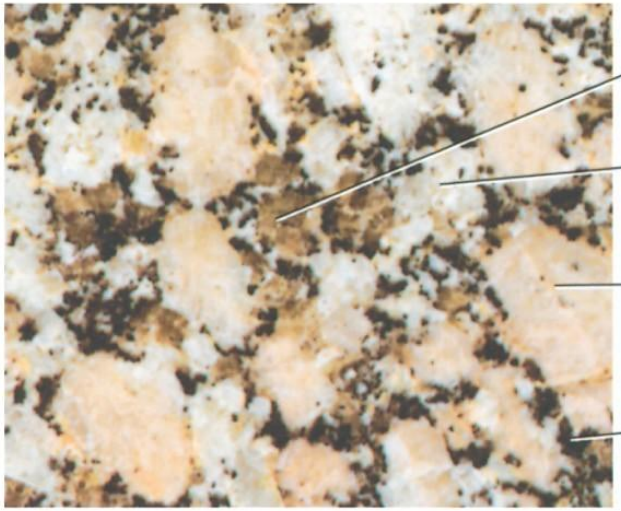
Biotite (mica)

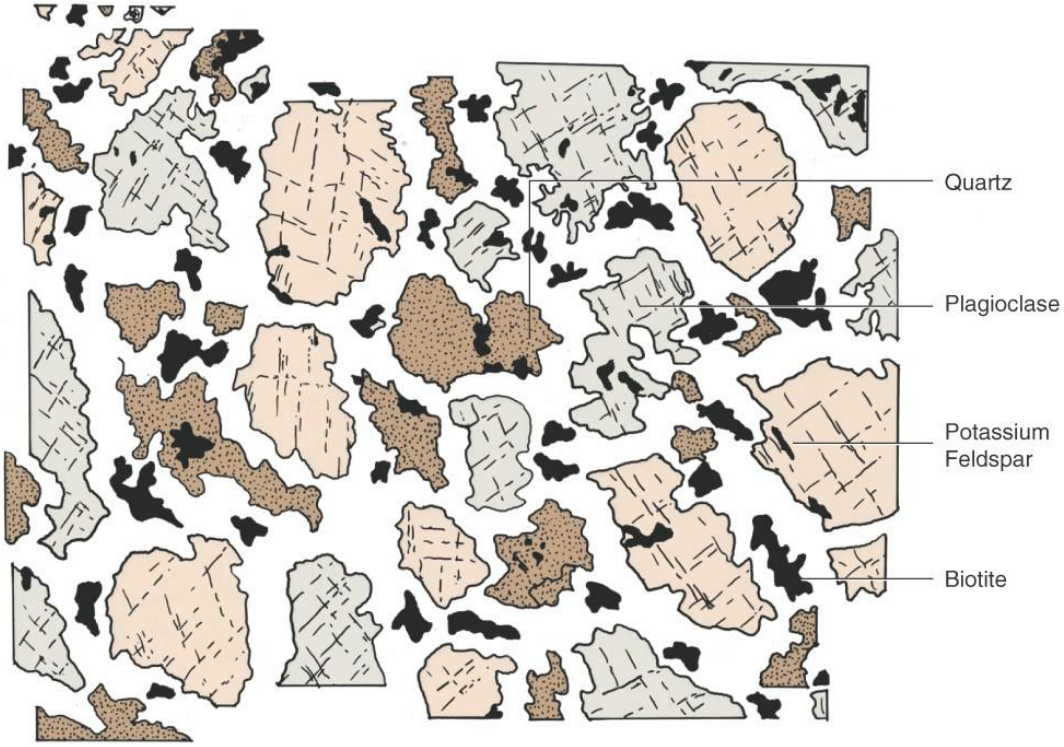
Tremolite (amphibole)

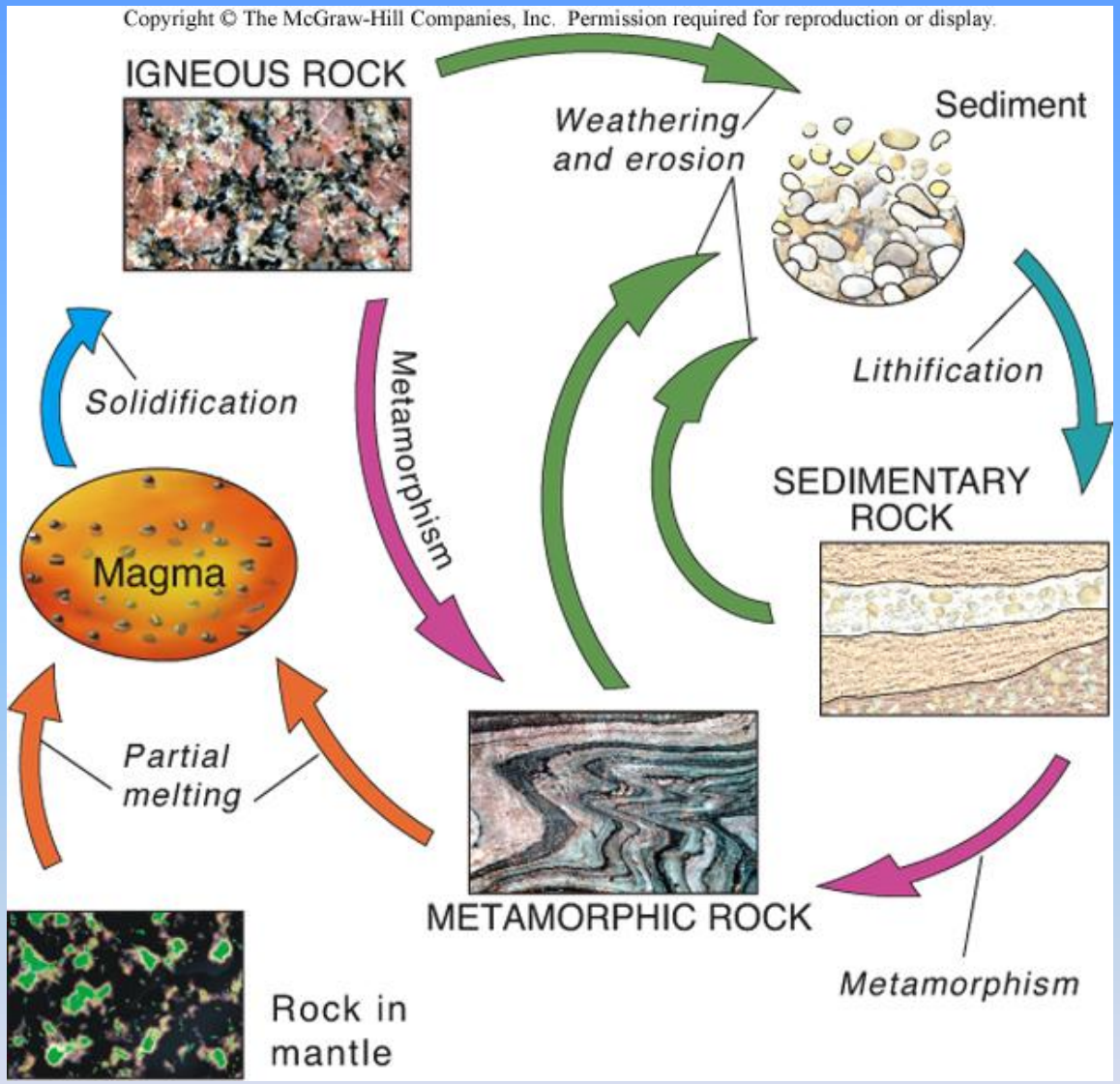


Quartz

Feldsapr (albite)


Quartz
Plagioclase
Potassium
Feldspar
Biotite


Quartz
Plagioclase
Potassium
Feldspar
Biotite



Imagine the first rock and the cycles that it has been through.

Crustal Properties

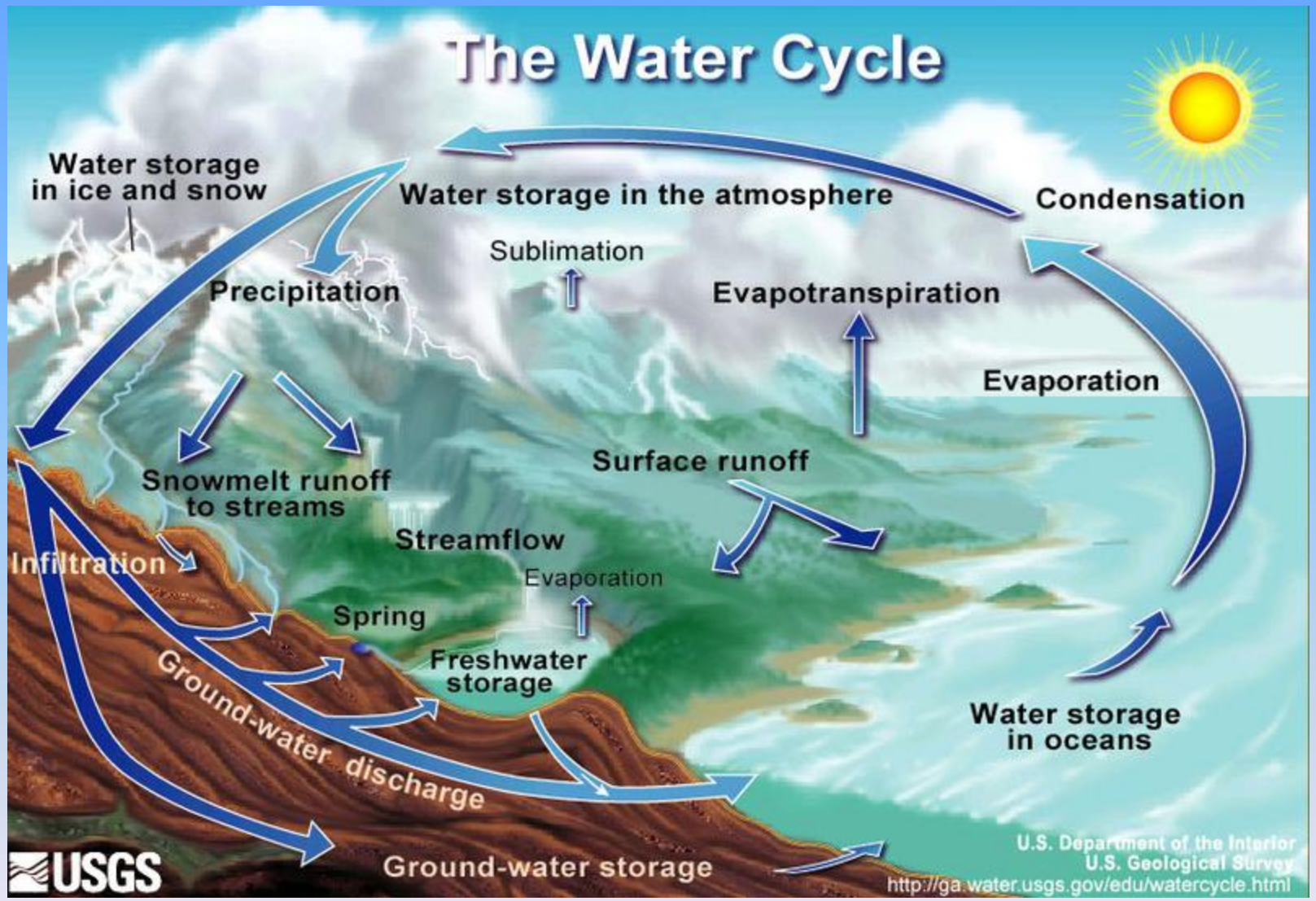
Crust	Density	Composition	Thickness	Age
continental	~2.8 g/cm^3	Felsic	Thick: 20-70 km	Old: up to 4 Byrs
oceanic	~3.2 g/cm^3	Mafic	Thin: 2-10 km	Young: <200 Mys

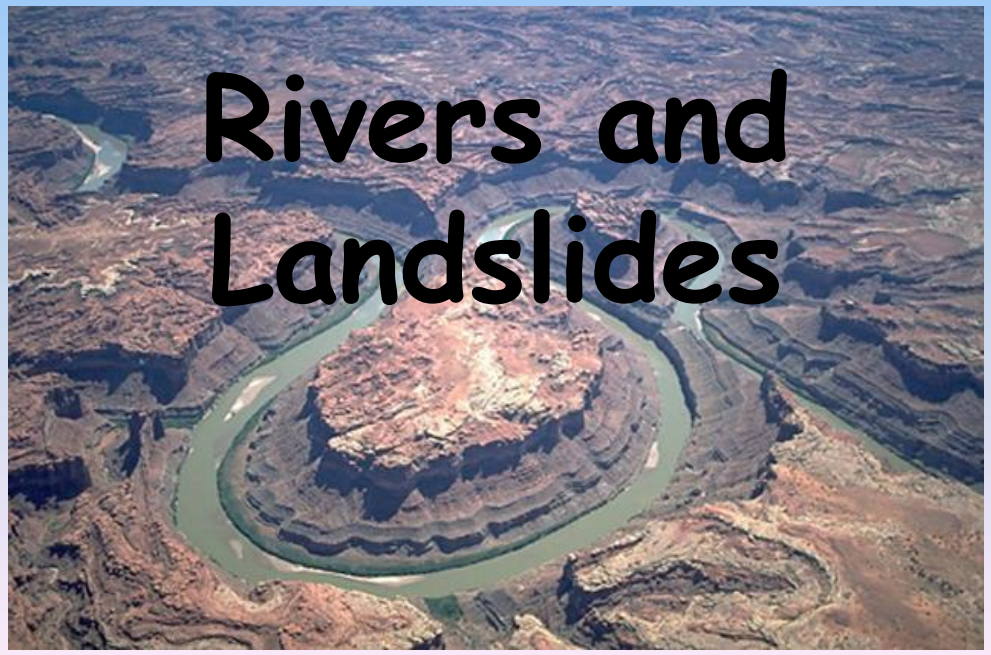
<u>Flood basalts</u> with several thick and thin layers. Each layer represents a separate eruption.

Granite Batholiths:

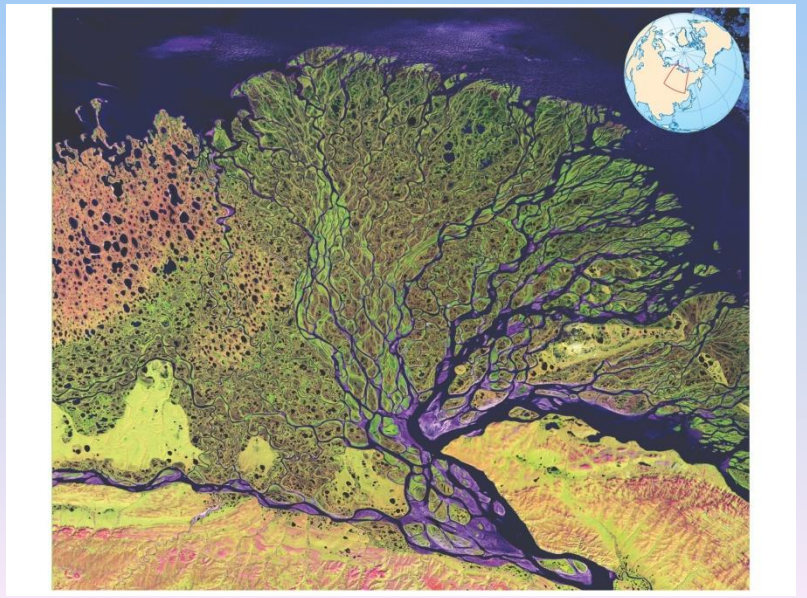
Half Dome; part of the Sierra Nevada batholith

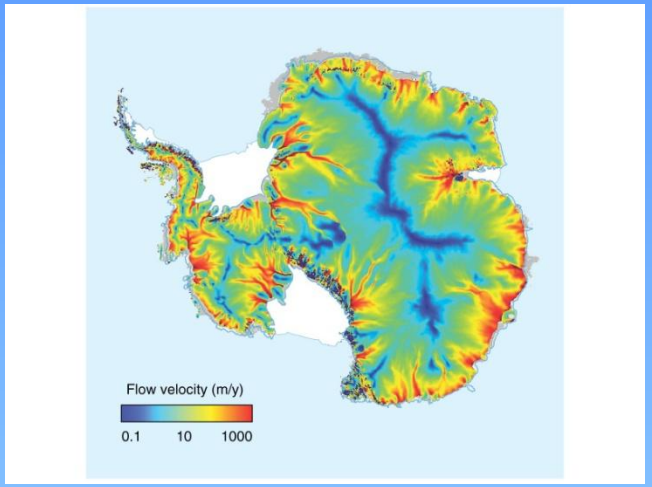
The Hydrologic Cycle and Its Impact


The Water Cycle
Water storage in ice and snow
Water storage in the atmosphere
Condensation
Sublimation
Precipitation
Evapotranspiration
Evaporation
Surface runoff
Snowmelt runoff to streams
Streamflow
Infiltration
Evaporation
Spring
Freshwater storage
Ground-water discharge
Water storage in oceans
Ground-water storage
USGS
U.S. Department of the Interior
U.S. Geological Survey
http://ga.water.usgs.gov/edu/watercycle.html

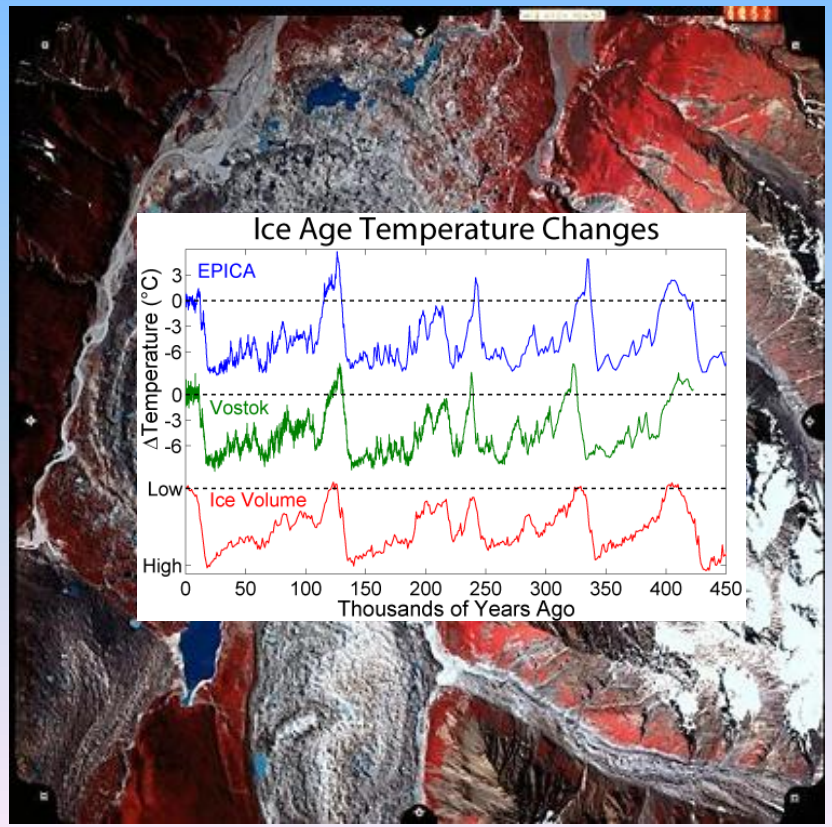


Rivers and Landslides





Glaciers, Glacial/Interglacial Cycles and Ice Ages




Ancient Moraines