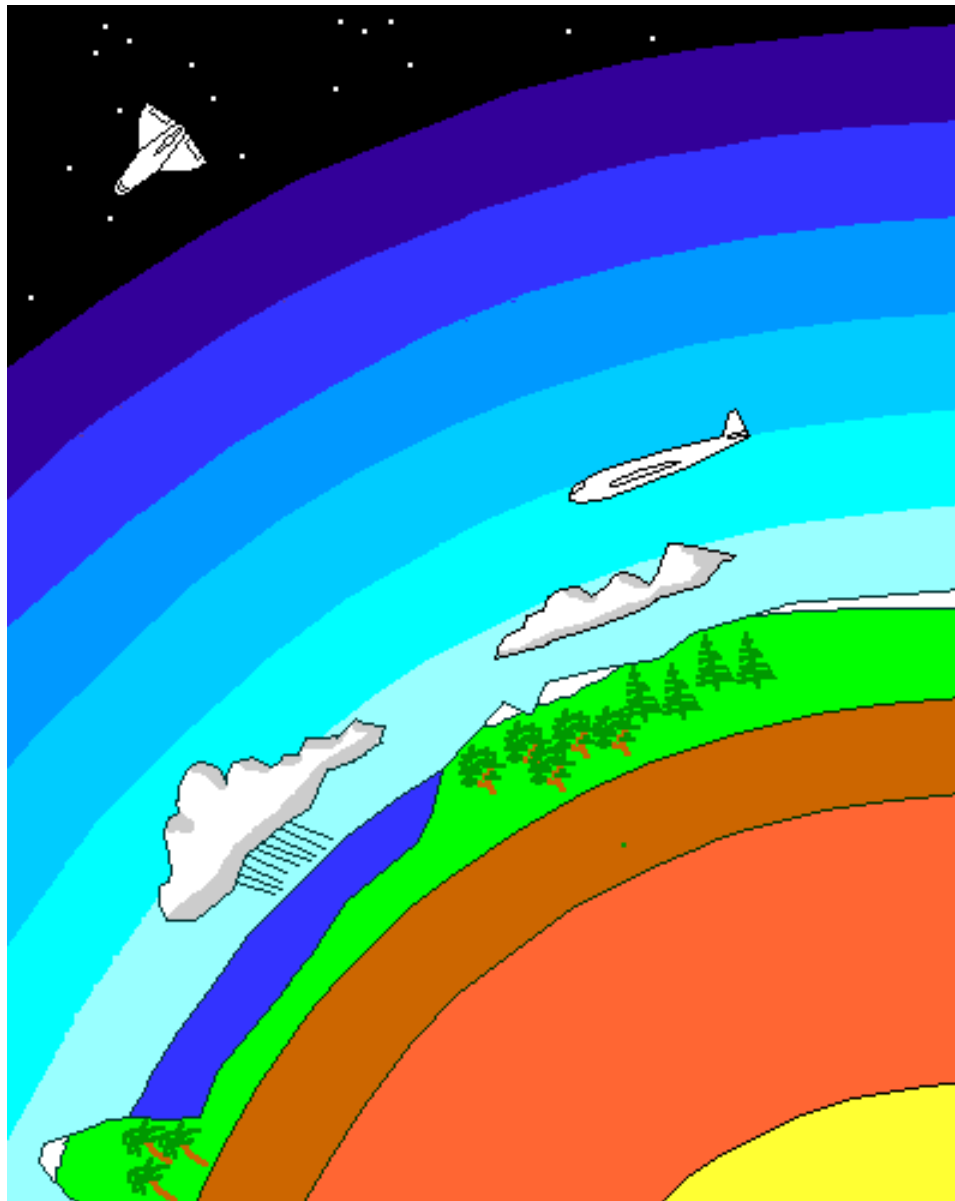


How The Earth Works



Thermosphere

Ionosphere

Mesosphere

Ozone Layer

Stratosphere

Troposphere

Cryosphere

Hydrosphere

Biosphere

Lithosphere

Mantle

Core

The Solid Earth

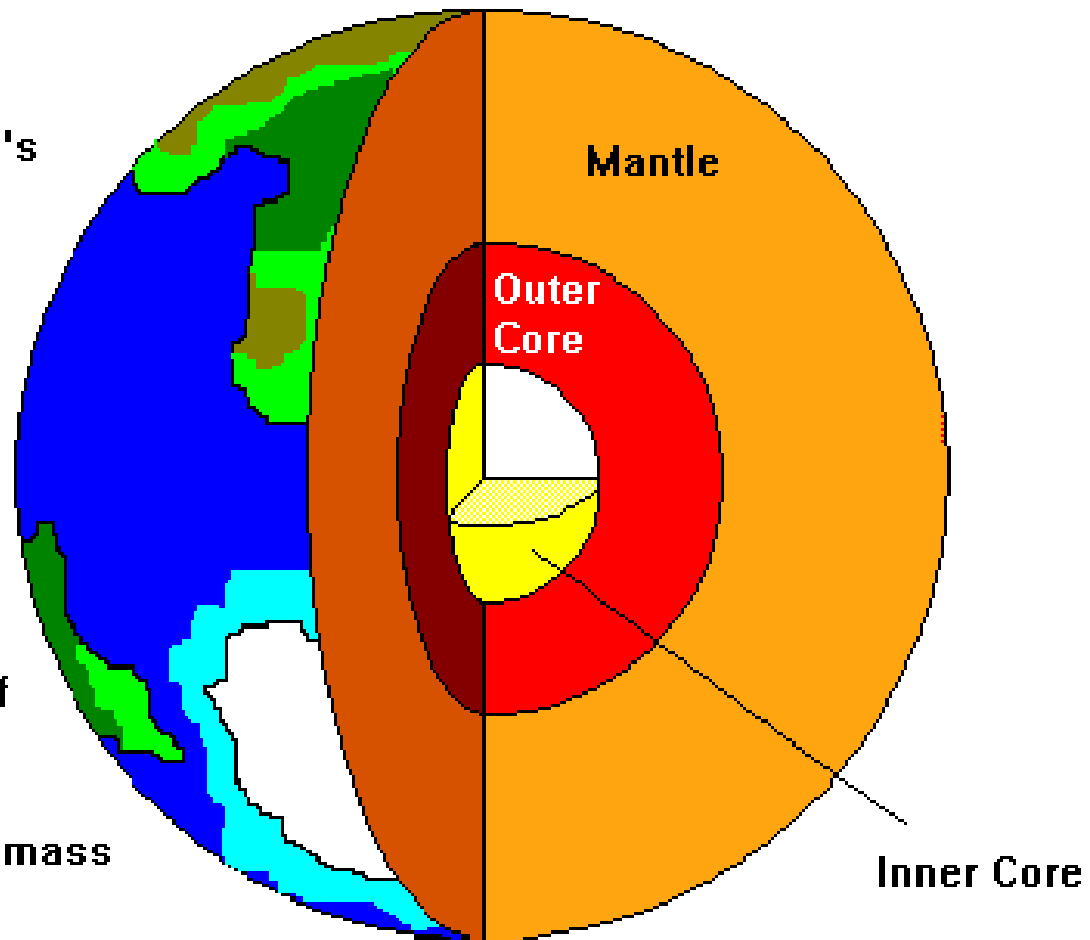
Atmosphere:
 $\frac{1}{1,000,000}$ of Earth's mass

Oceans: $\frac{2}{10,000}$ of Earth's mass

Crust: $\frac{1}{250}$ of Earth's mass

Mantle: $\frac{2}{3}$ of Earth's mass, $\frac{5}{6}$ of volume

Core: $\frac{1}{3}$ of Earth's mass
 $\frac{1}{6}$ of volume



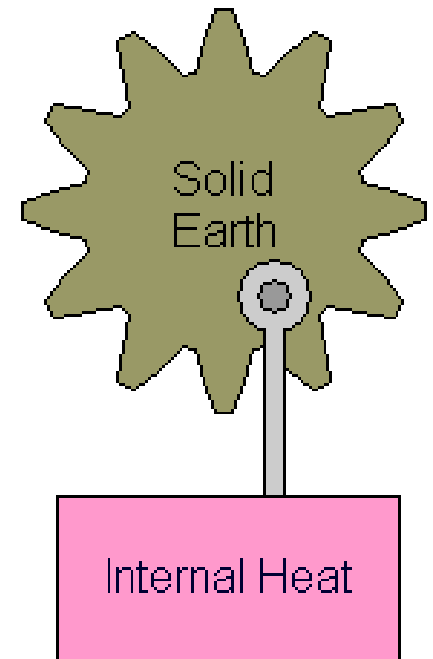
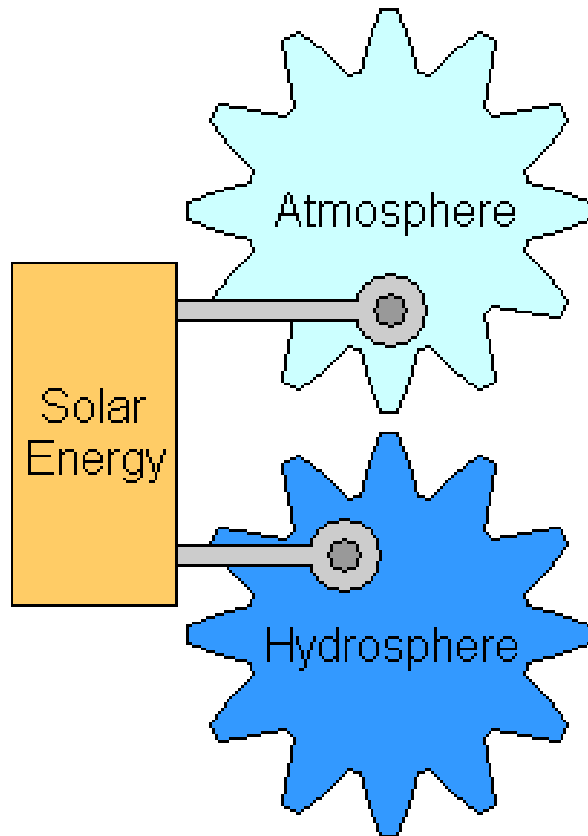
Earth Science

- Geology
 - Solid Earth Much Larger than Other Parts
 - Many More Kinds of Materials
 - **Preserves a History**
- Meteorology – Climatology
- Oceanography
- Astronomy
 - Planetary Geology

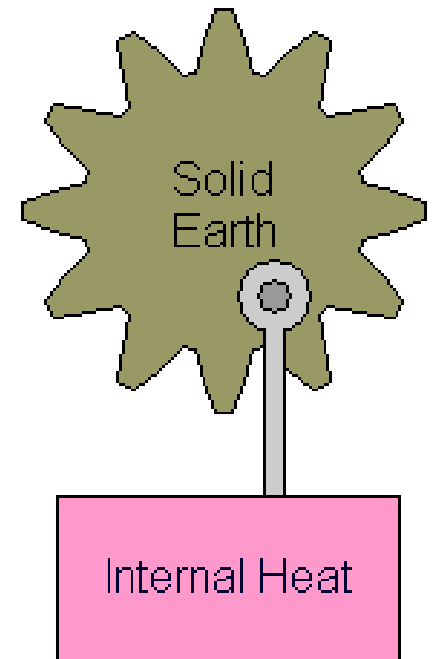
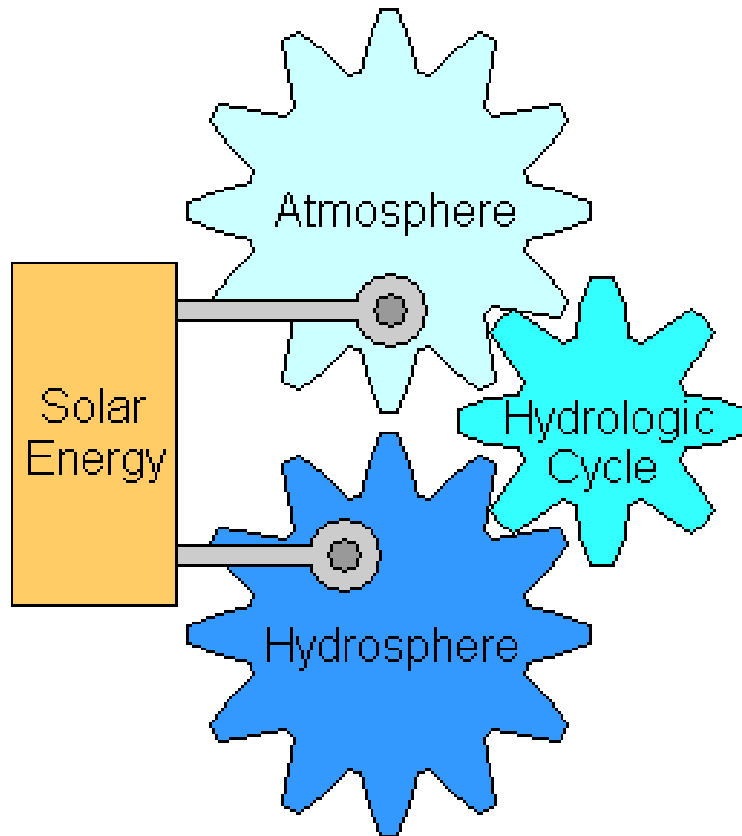
Earth Systems

- External Effects (Astronomical)
- Atmospheric Circulation
- Oceanic Circulation
- Hydrologic Cycle
- Rock Cycle
- Plate Tectonics

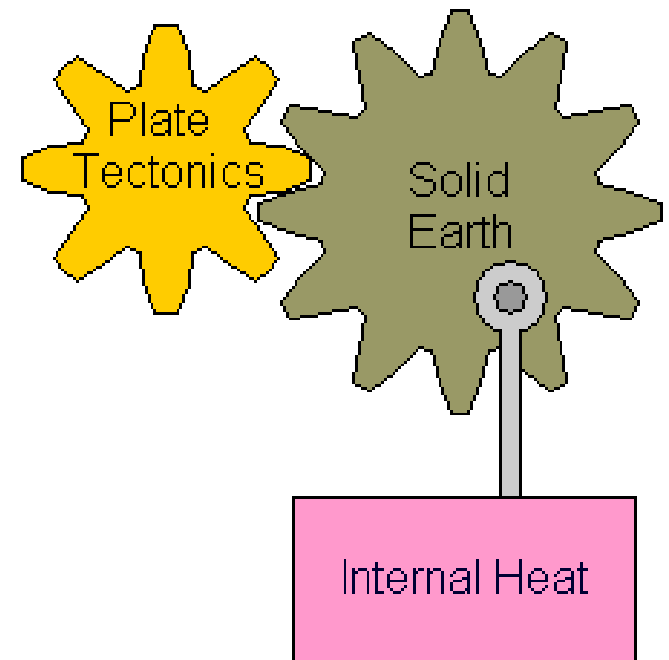
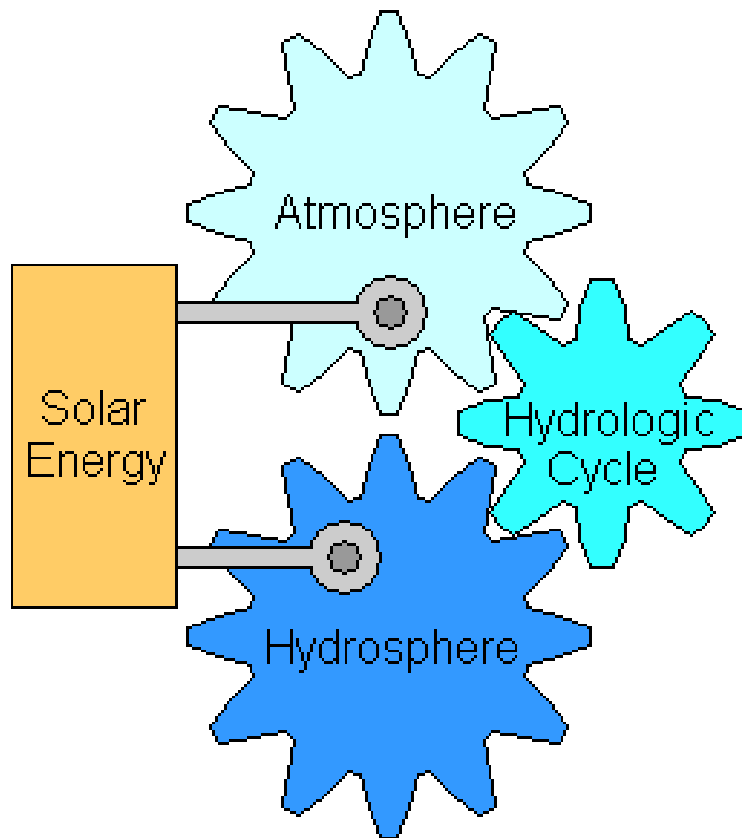
Earth Systems



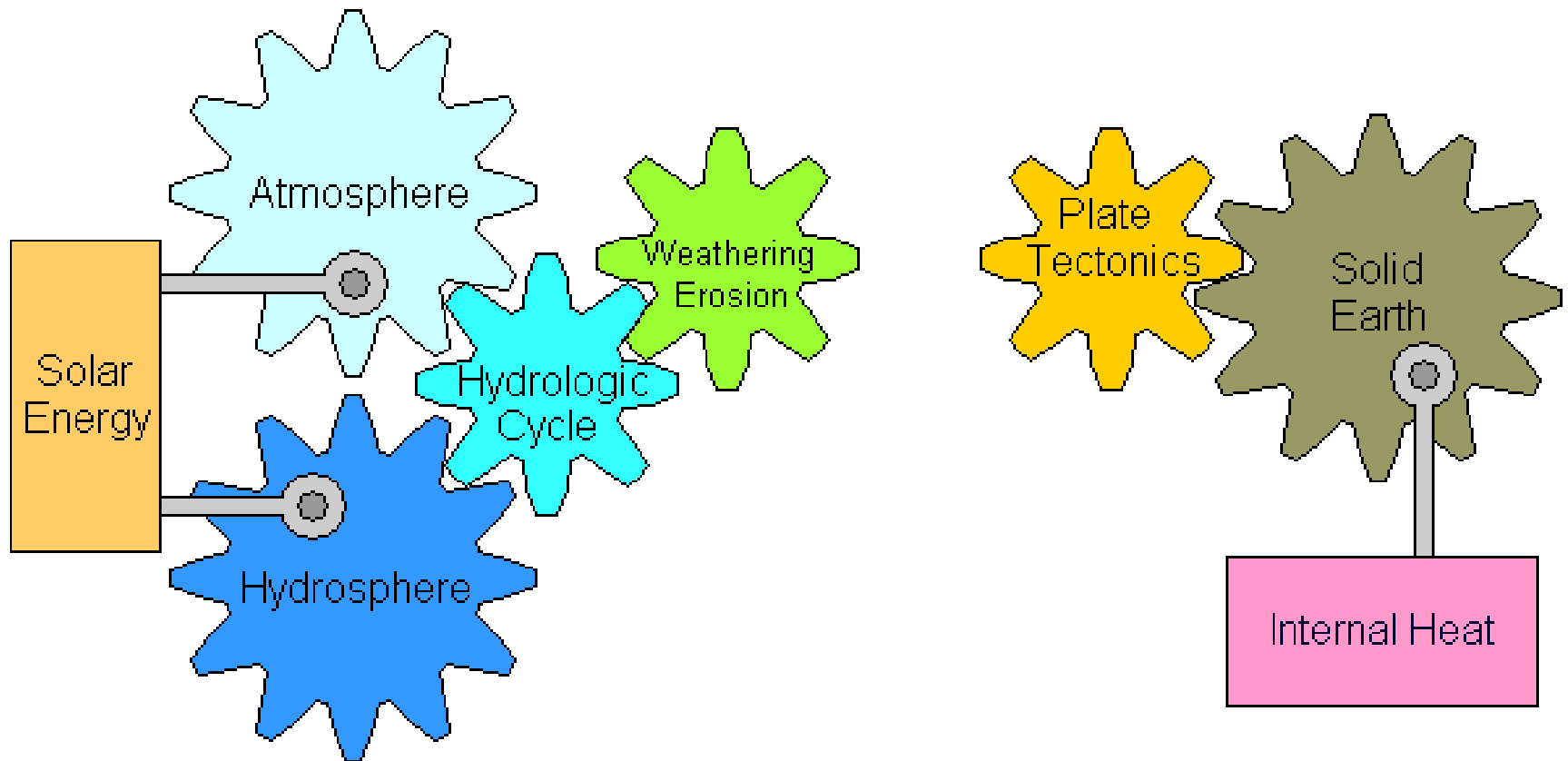
Earth Systems



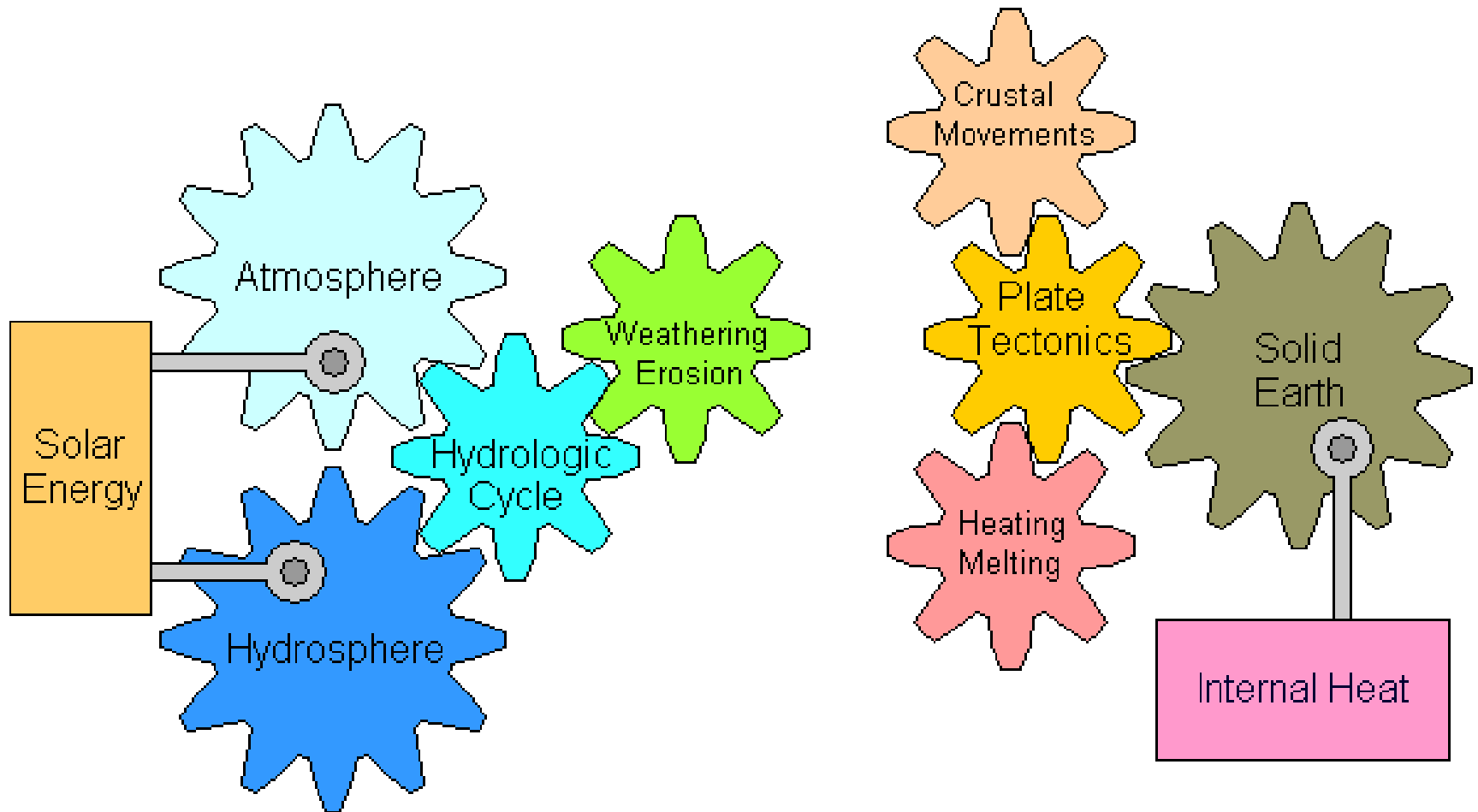
Earth Systems



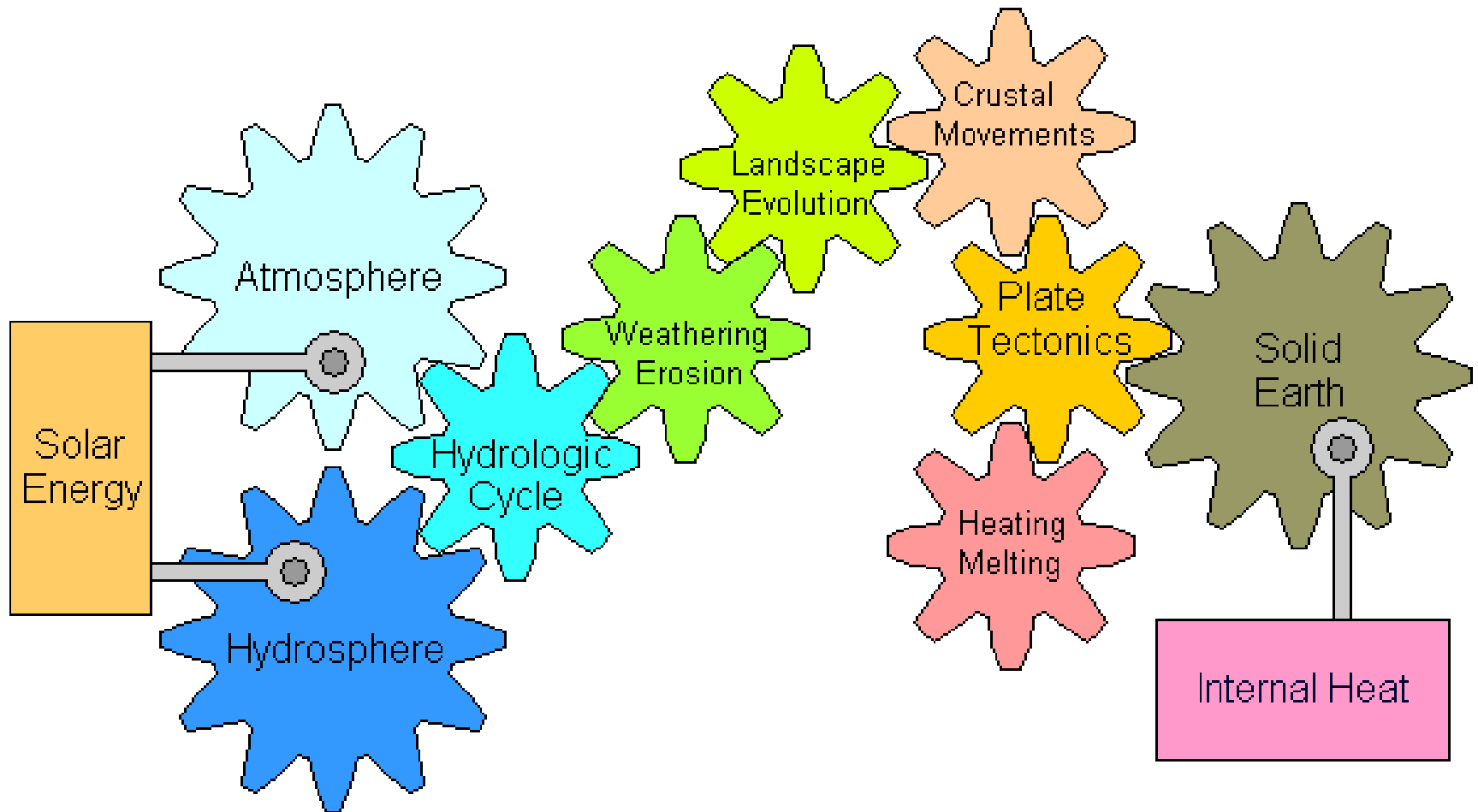
Earth Systems



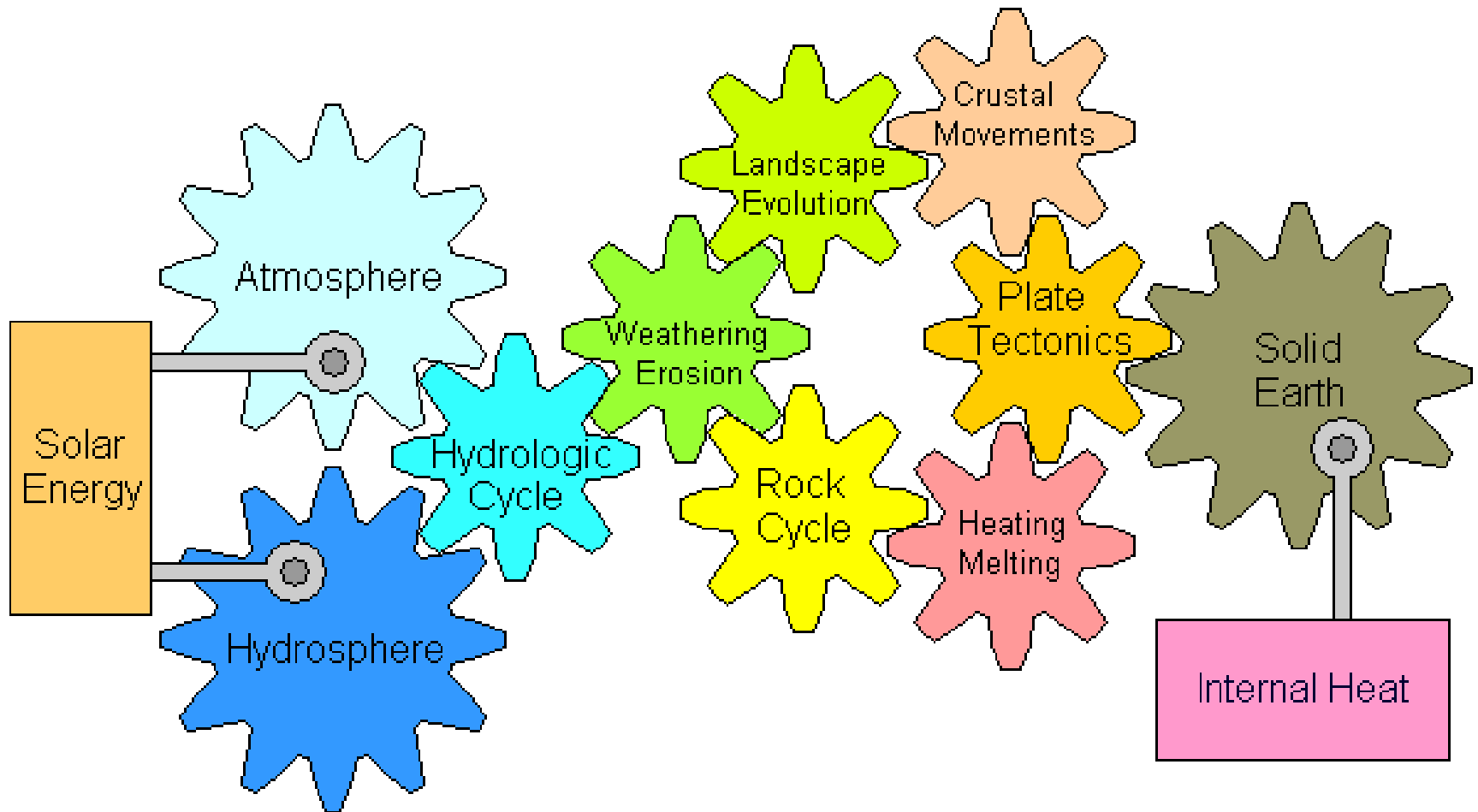
Earth Systems



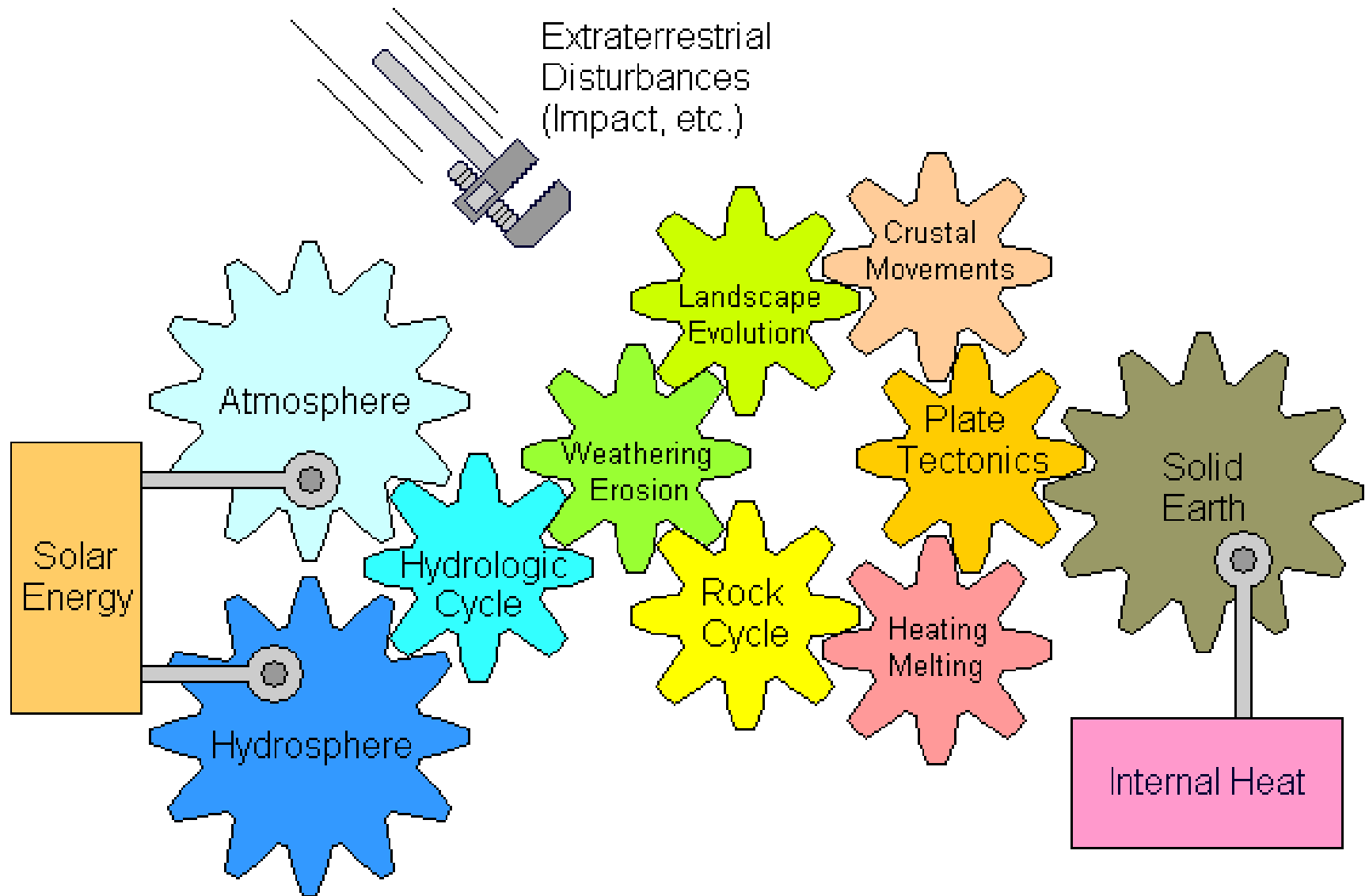
Earth Systems



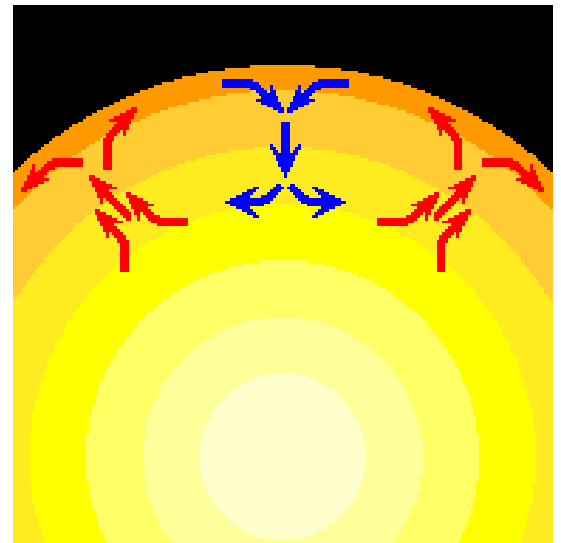
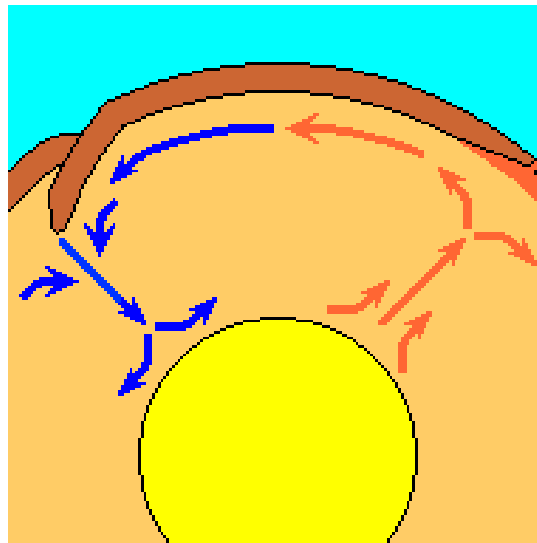
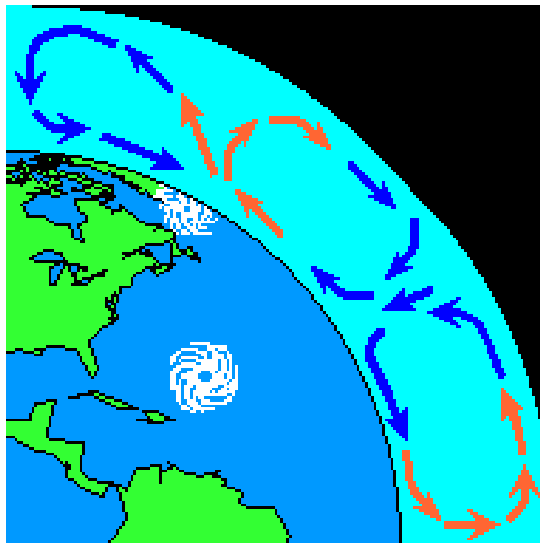
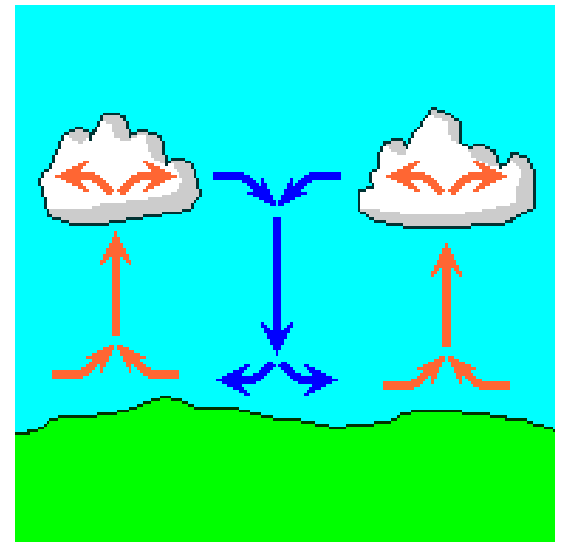
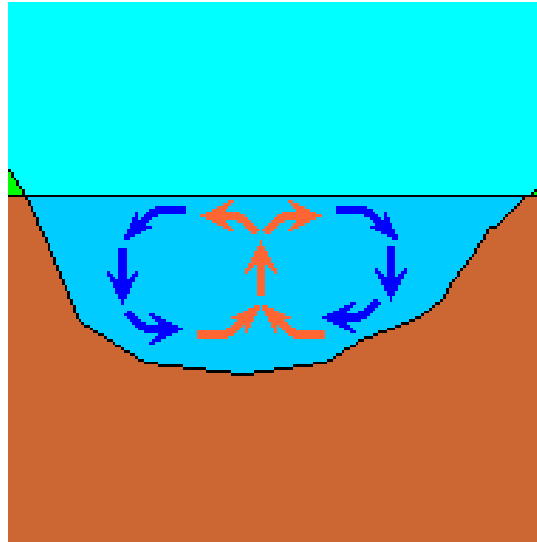
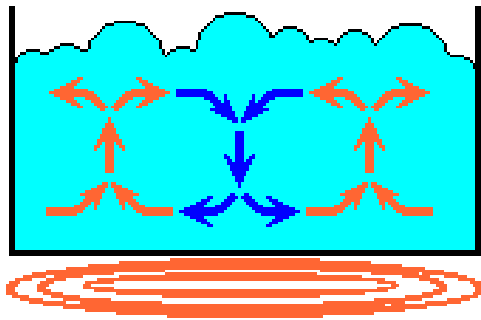
Earth Systems



Earth Systems



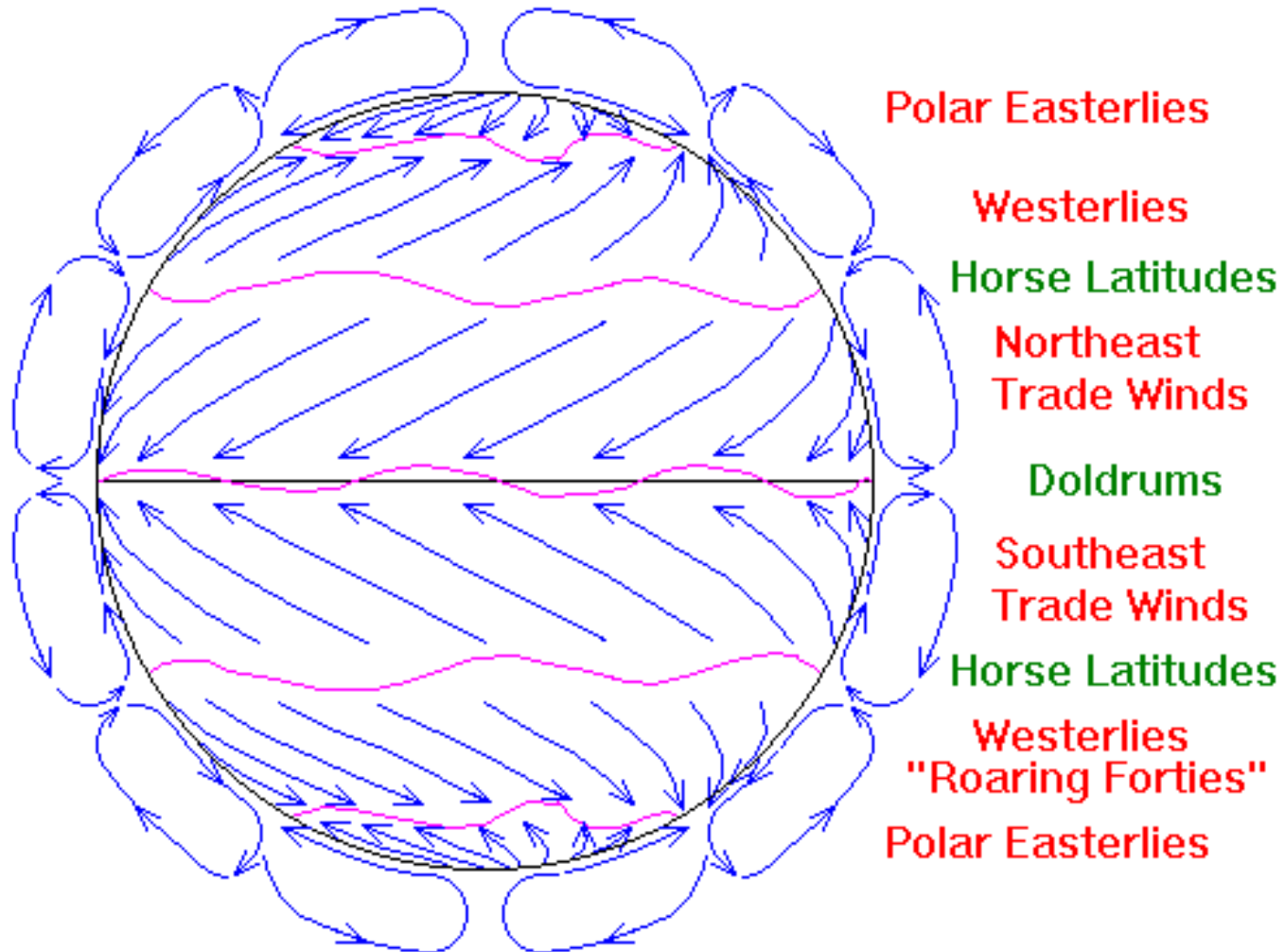
Convection



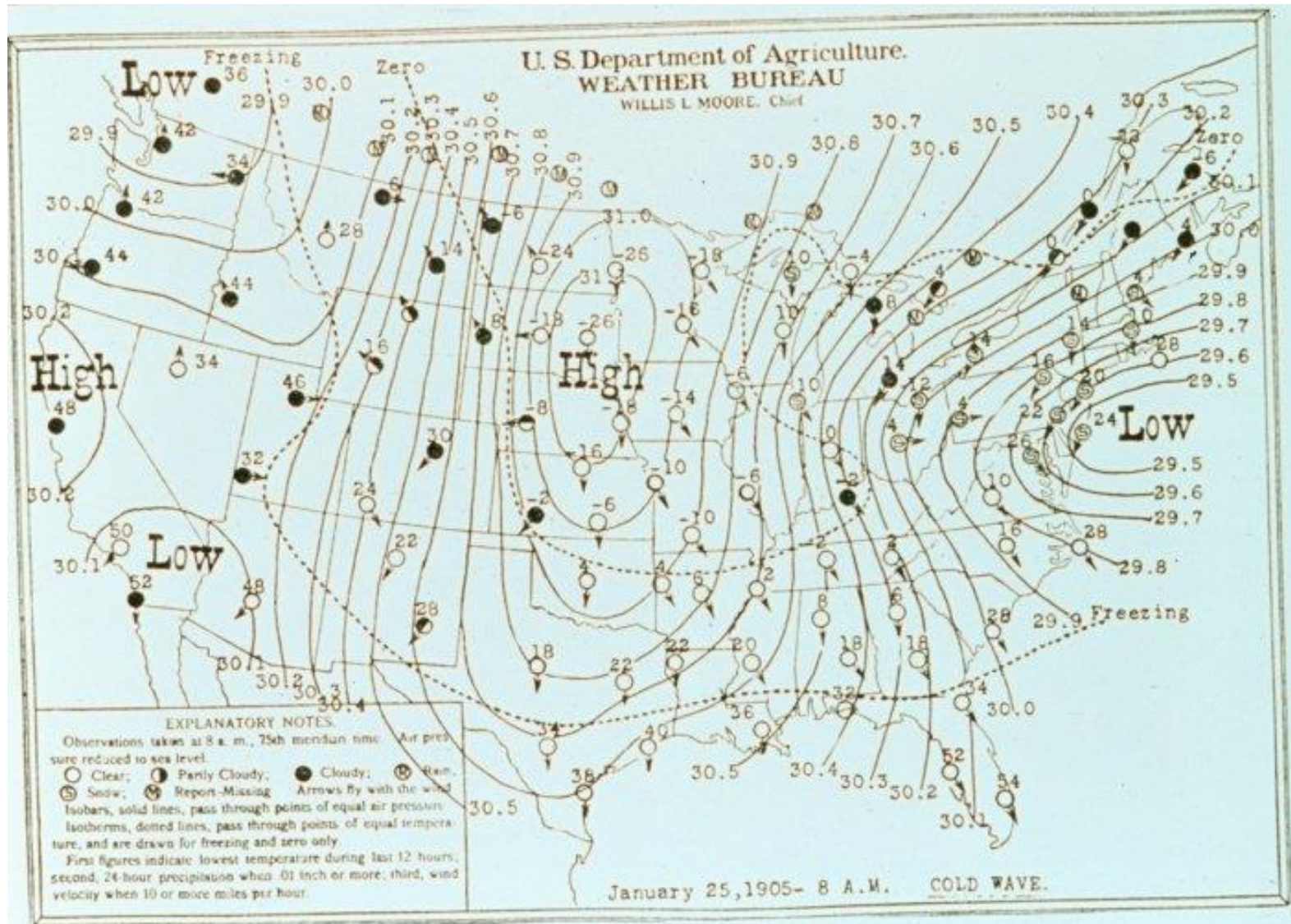
Earth and the Universe

- Rotation (Day-Night)
- Lunar (Tides)
- Annual (Seasons)
- Precession and Orbit Variations (Ice Ages?)
- Galactic? (250 m.y. period)
- Unpredictable Events
 - Nearby Supernovae
 - Meteor Impacts
- Long-Term Evolution of Sun

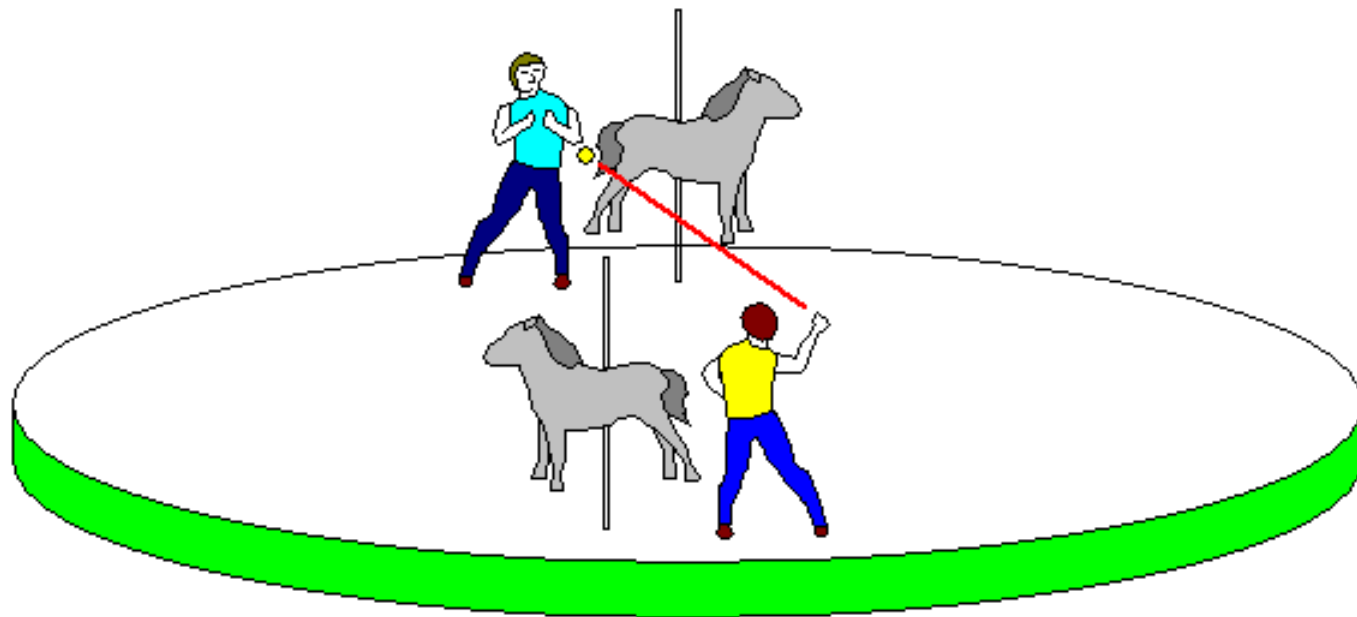
Atmospheric Circulation



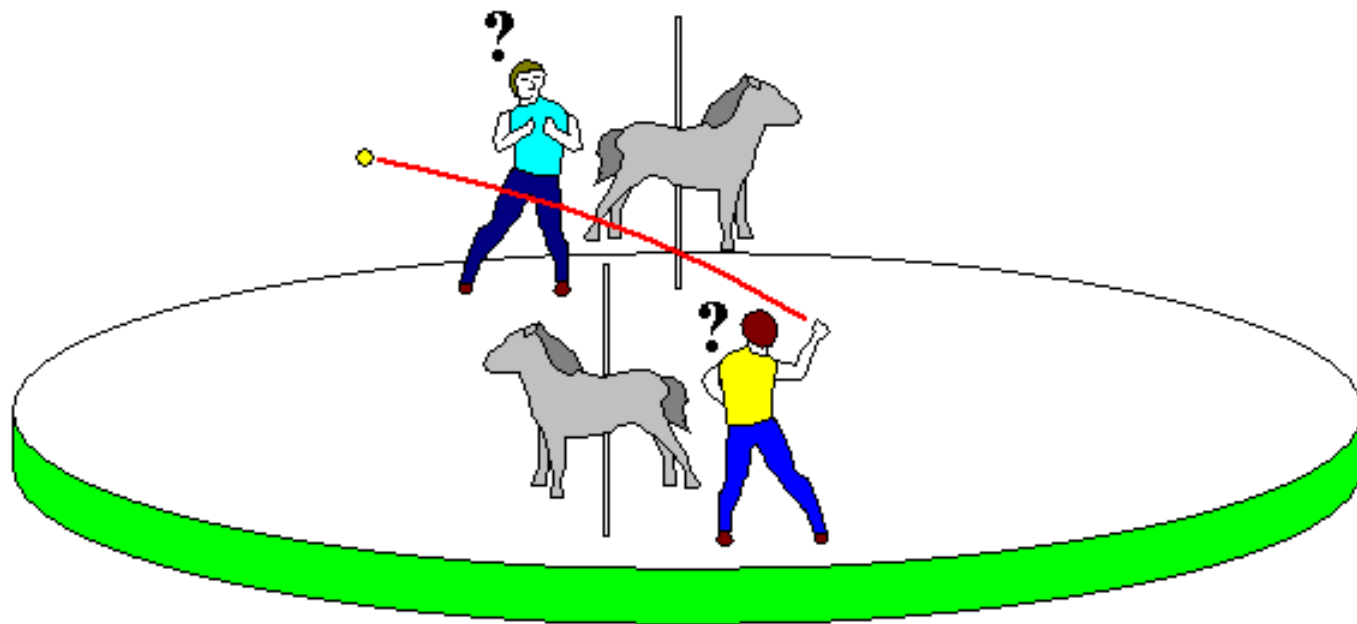
1905 Weather Map



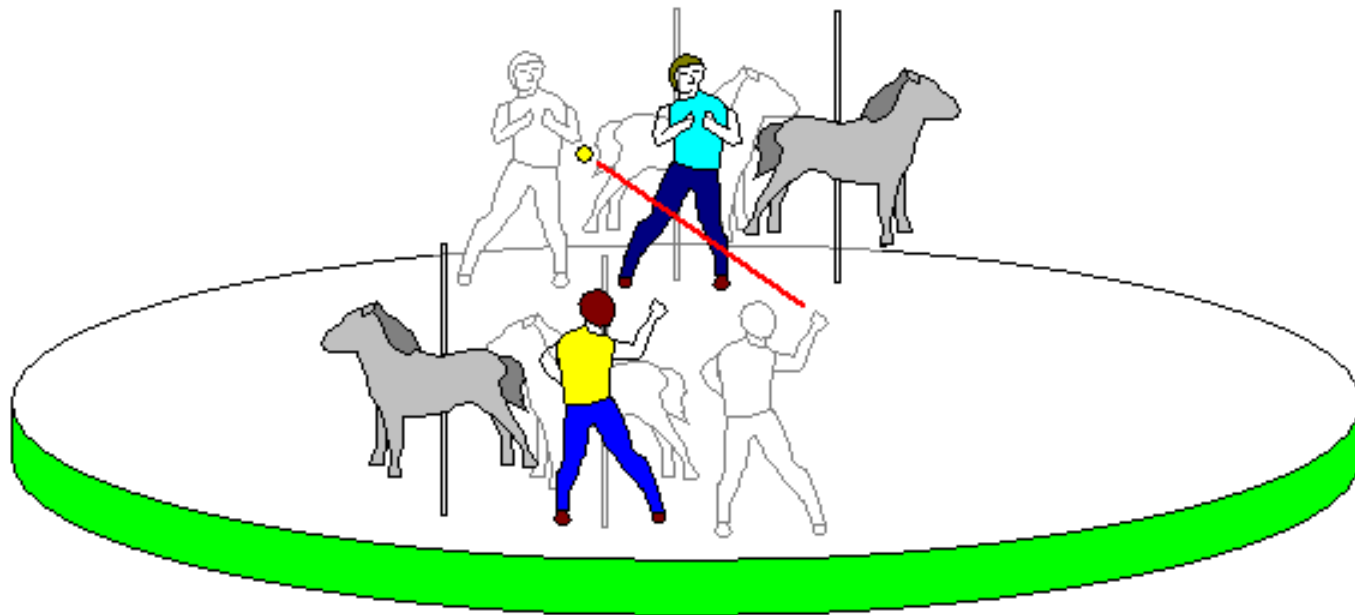
Rotation Effects



Rotation Effects



Rotation Effects



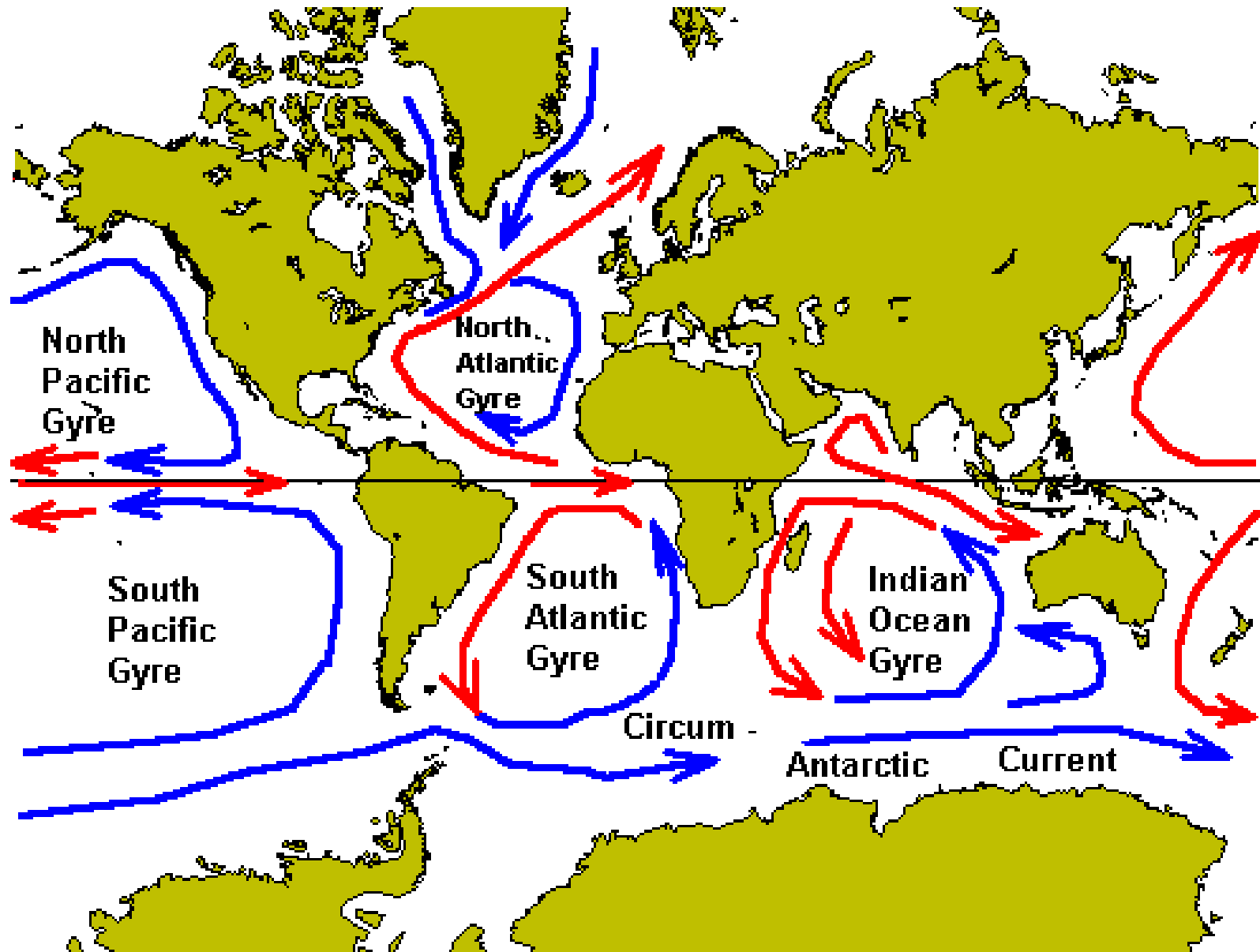
Not a Manifestation of the Coriolis Effect!

- Too small scale for the Coriolis Effect to be significant

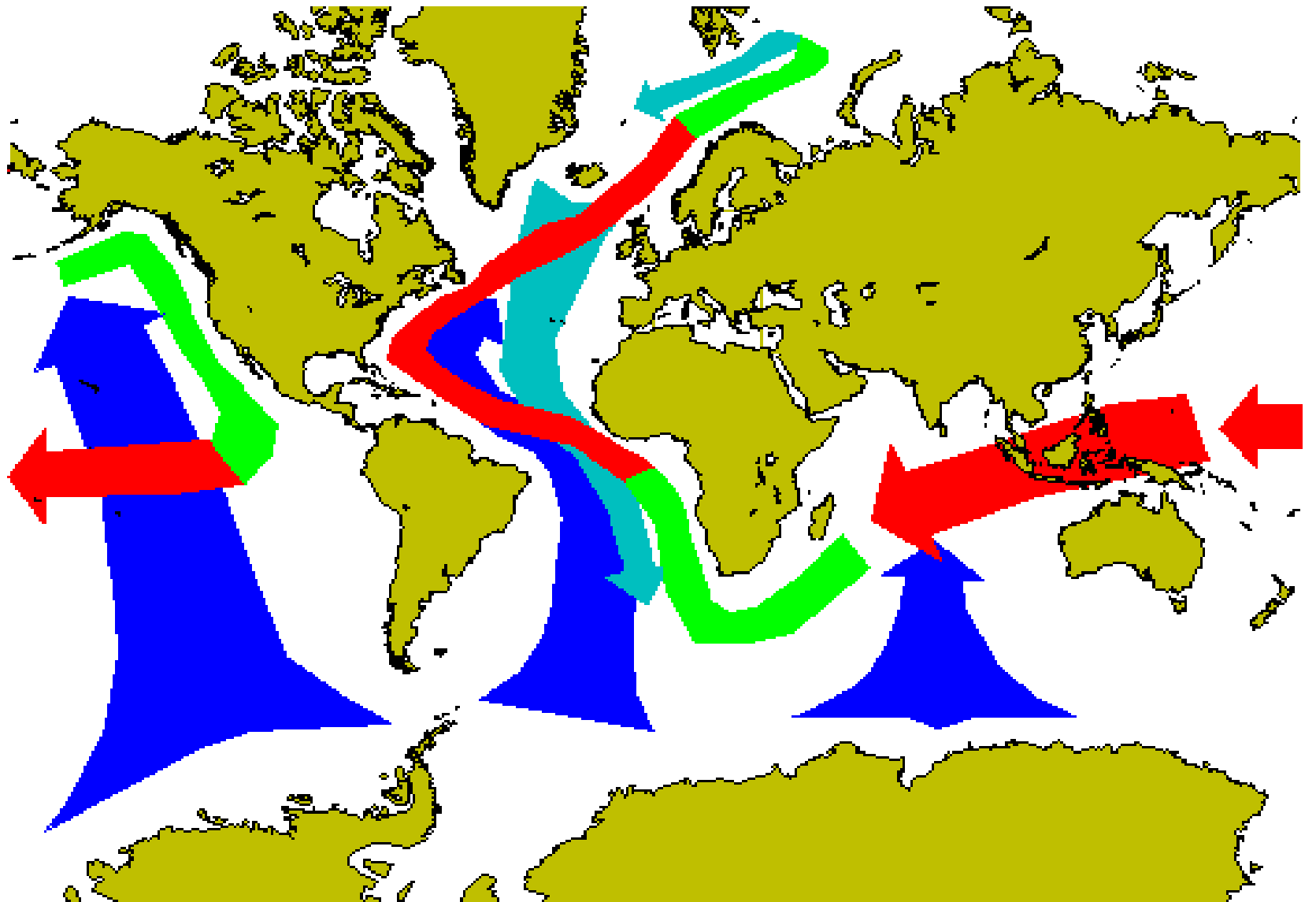
Early Map of Gulf Stream



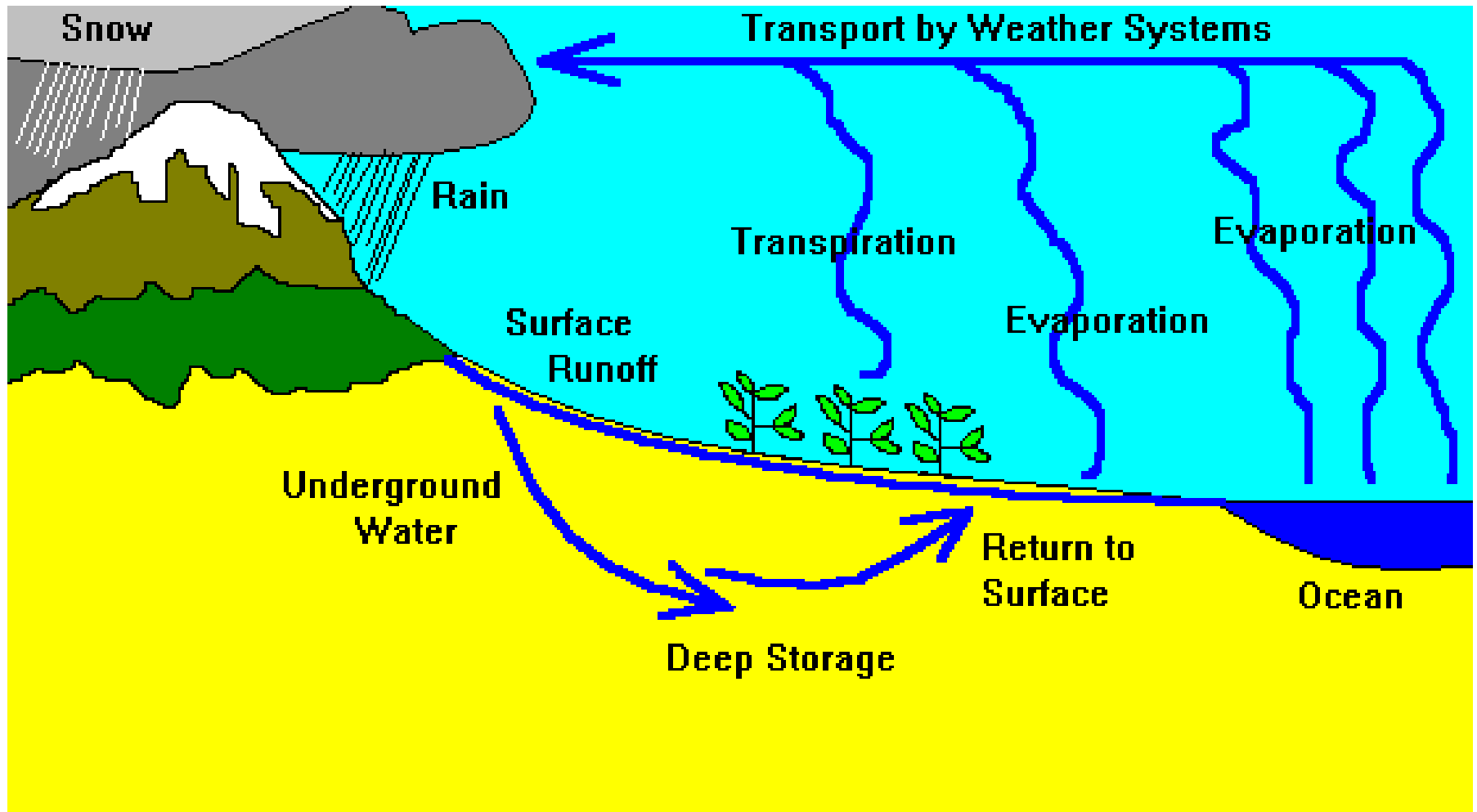
Surface Currents



Thermohaline Circulation



Hydrologic Cycle



Water

- Principal Agent in Modifying Earth's Surface
- Medium for Storing and Distributing Global Heat
- The Universal Solvent
 - Essential for Life
 - Destructive to Rocks
- Lowers Melting Point of Rocks
- Reduces Strength of Rocks Under Pressure

The Rock Cycle

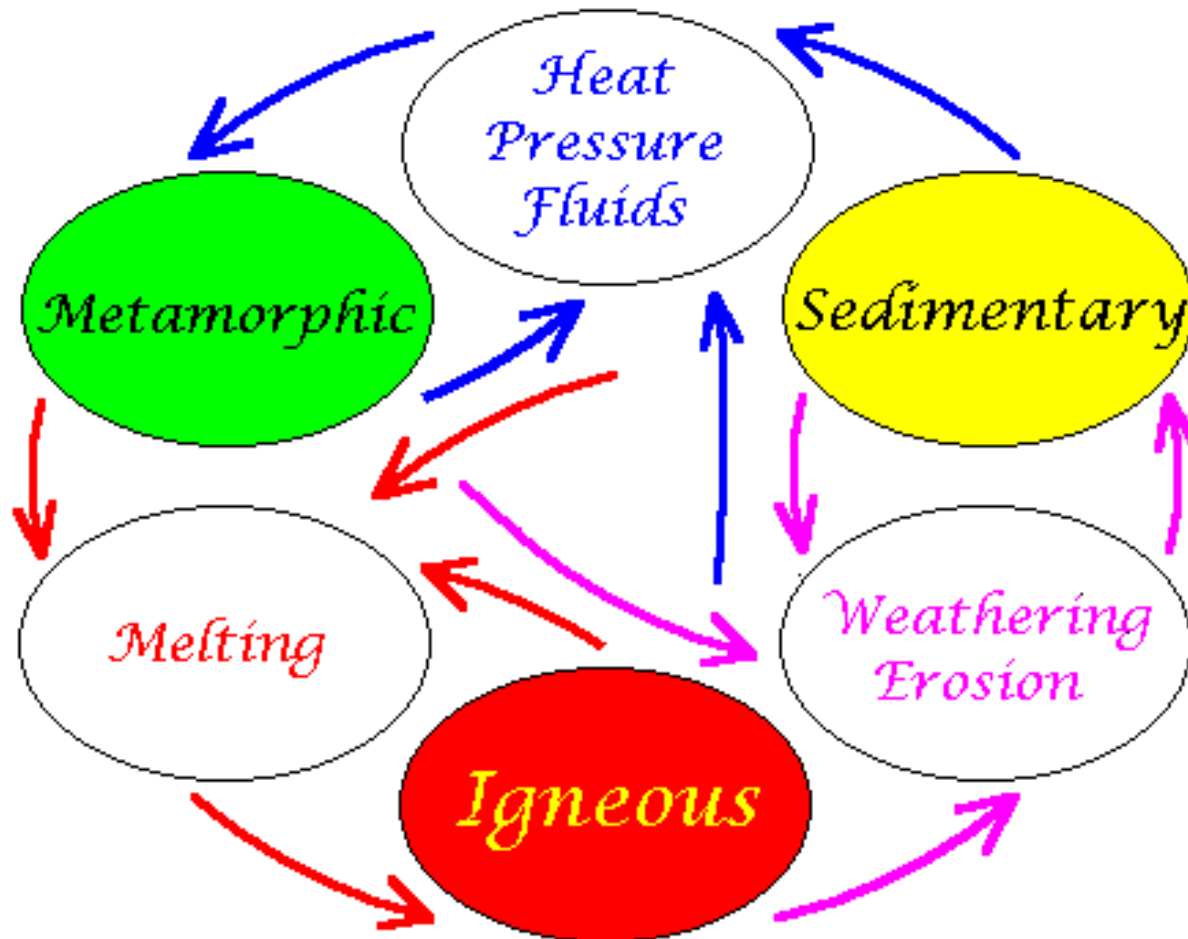
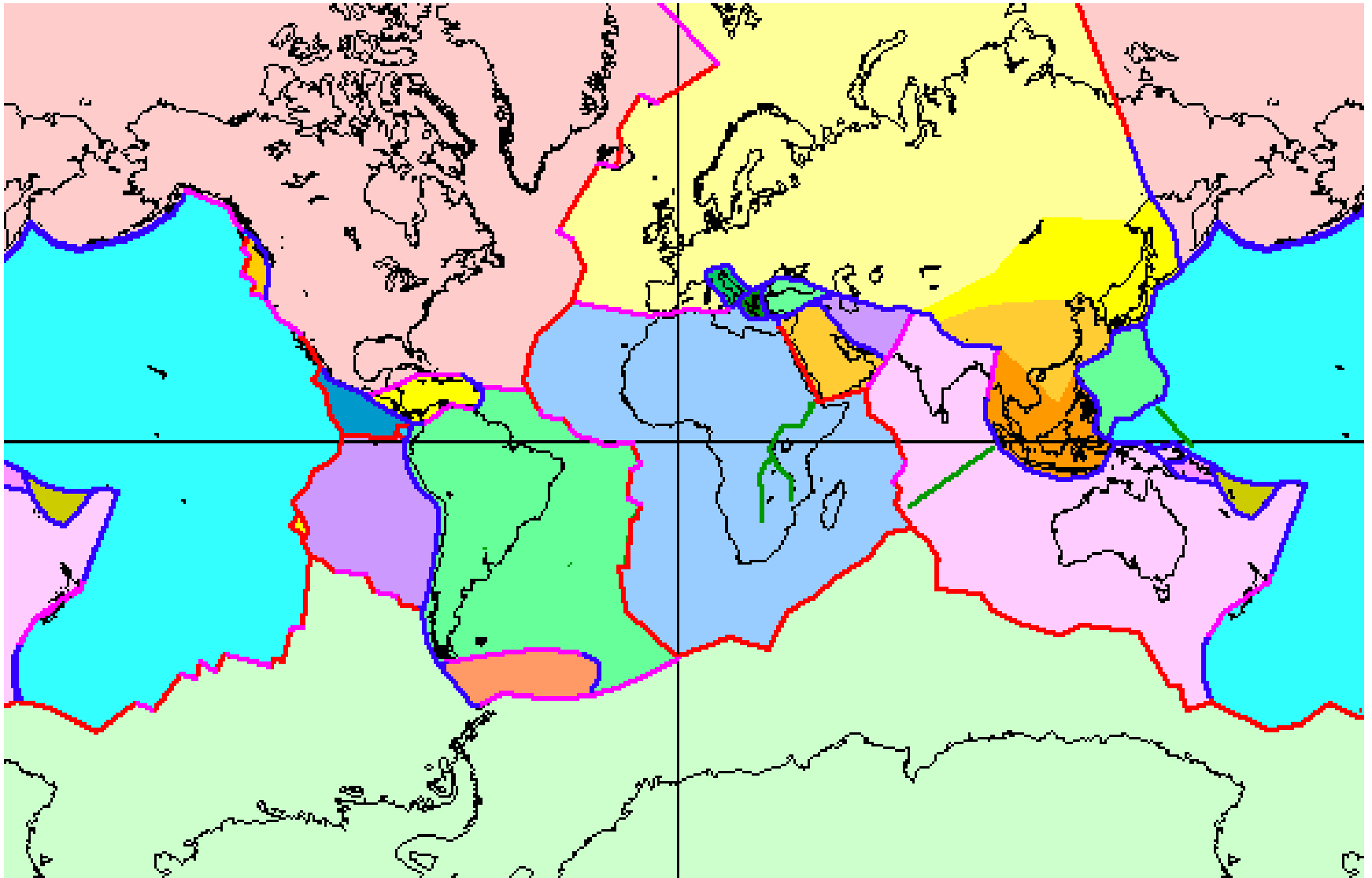


Plate Tectonics

- Outer Crust of Earth Moves a Few cm/yr
- Driven by Convection in Earth's Interior
- Accounts For:
 - Earthquakes
 - Volcanoes
 - Mountain-Building (Orogeny)
- Configuration of Continents

Plate Tectonics



Some Unique Aspects of Geology

Importance of Relationships

- Sequential
- Spatial

Importance of Time

Distinctive Problems of Evidence

- Slow Rates
- Rare Events
- Destruction of Evidence
- Inaccessibility

Some Geologic Rates

Cutting of Grand Canyon

- $2 \text{ km}/3 \text{ m.y.} = 1 \text{ cm}/15 \text{ yr}$

Uplift of Alps

- $5 \text{ km}/10 \text{ m.y.} = 1 \text{ cm}/20 \text{ yr.}$

Opening of Atlantic

- $5000 \text{ km}/180 \text{ m.y.} = 2.8 \text{ cm/yr.}$

Uplift of White Mtns. (N.H.) Granites

- $8 \text{ km}/150 \text{ m.y.} = 1 \text{ cm}/190 \text{ yr.}$

Some Geologic Rates

Movement of San Andreas Fault

- $5 \text{ cm/yr} = 7 \text{ m/140 yr.}$

Growth of Mt. St. Helens

- $3 \text{ km/30,000 yr} = 10 \text{ cm/yr.}$

Deposition of Niagara Dolomite

- $100 \text{ m/ 1 m.y.?} = 1 \text{ cm/100 yr.}$

Some Unique Aspects of Geology (Continued)

Reliance on Inference and Deduction

Intrinsically "Unsolvable" Problems: Mostly
where Physical Evidence is Gone

- Ancient Landscapes
- Mass Extinctions
- Ancient Ocean Basins

Scientific Principles in Geology

- Parsimony (K.I.S.S.): No ad hoc explanations
- Superposition: Young processes overprint older ones
- Uniformitarianism: Continuity of Cause and Effect

Using these, plus observation, we establish facts about Earth Processes

Geologic Map

