

GEG 1301 The Physical Environment



Chapter 1
Essentials of Geography

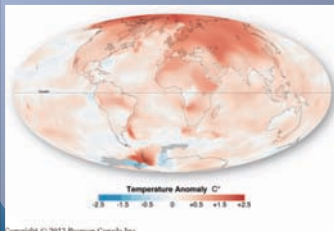
GEG 1301 Lecture 2: A system approach to physical geography

- Content of Physical Geography
- Scientific method in physical geography
- Systems approach to physical geography
- Types of system
- Feedback



Spatial view of temperature anomalies for the years 2000–2009 compared to the 1951–1980 standard baseline.

Numerous processes are involved in Earth's water-atmosphere-weather system. Note, not all regions are affected the same way.



The decade experienced the highest average air temperatures since record keeping began in 1880, along with the highest temperatures in the oceans and many lakes.



The Science of Geography

- Geography – from *geo* [Earth] and *graphein* [to write]
- Geography is
 - a method, not a body of knowledge
 - Holistic (encompasses the whole)
 - Eclectic (integrate a wide range of subject matter from diverse fields)
- Geographers use spatial analysis
- Geographers use Earth systems science (interaction between a set of physical, chemical and biological systems)

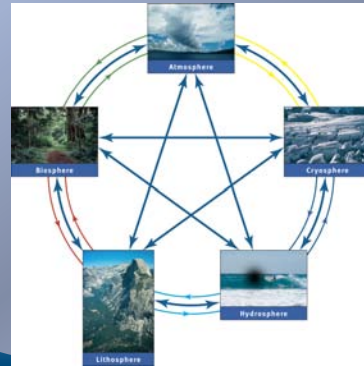


Geography is...

- The science that studies the relationships among
 - natural systems,
 - geographic areas,
 - society,
 - cultural activities,
 - and the interdependence of all of these *over space*.



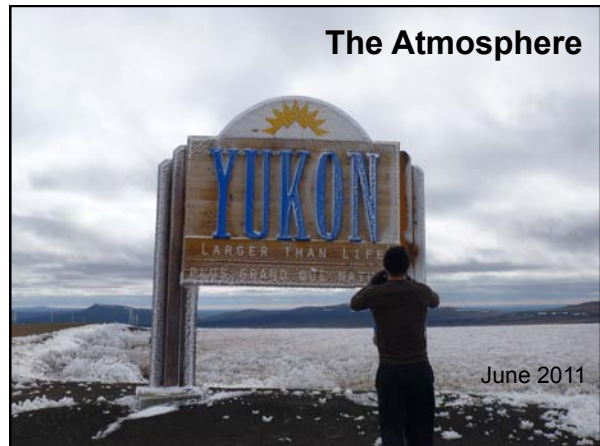
Physical Geography is...



The Atmosphere



The Atmosphere



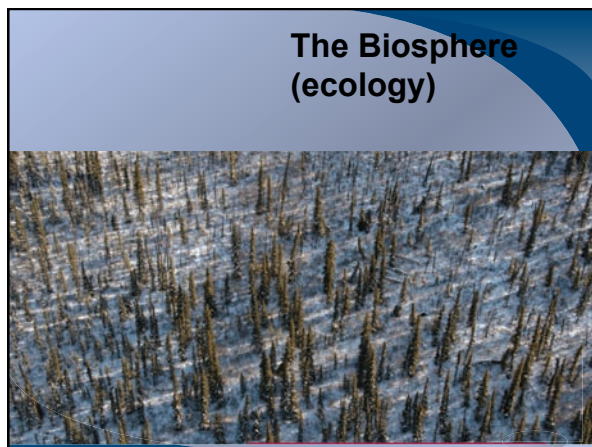


The Lithosphere




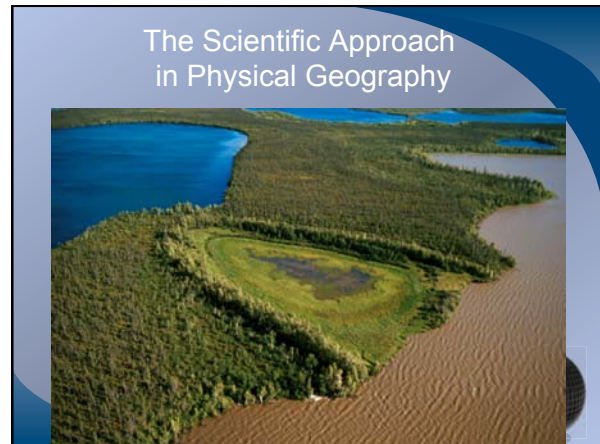
**The Biosphere
(biotic ecosystem)**





Physical Geography is ...

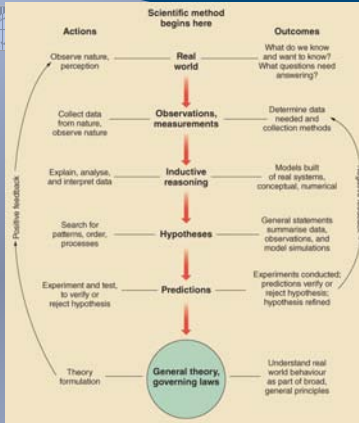
- The spatial analysis of all the physical elements and processes that make up the environment:
 - ☒Energy
 - ☒Water
 - ☒Climate
 - ☒Soils
 - ☒Plants
 - ☒Air
 - ☒Weather
 - ☒Landforms
 - ☒Animals
 - ☒Microorganisms

The scientific method:

The application of common sense in an organized and objective matter.

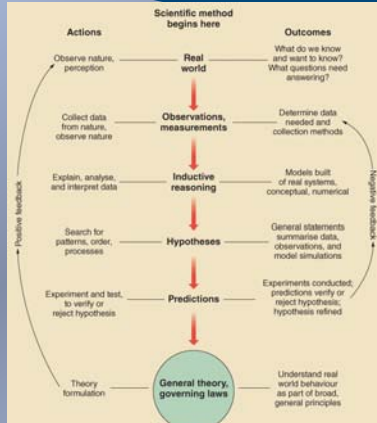
From perceptions to observations, we formulate hypothesis and predictions, and possibly to develop general theory and natural laws.



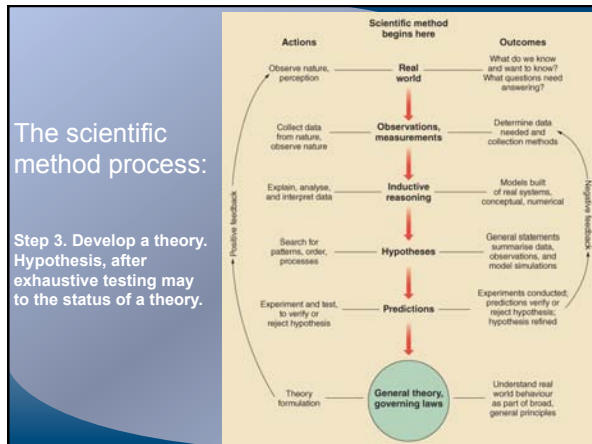
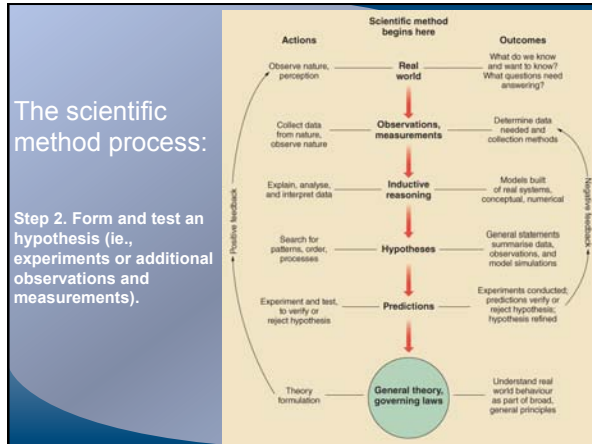
The flowchart illustrates the scientific method process. It starts with 'Real world' (What do we know and want to know? What questions need answering?). This leads to 'Observations, measurements' (Determine data needed and collection methods). From there, it goes to 'Inductive reasoning' (Models built of real systems, conceptual, numerical). This leads to 'Hypotheses' (General statements summarise data, observations, and model simulations). From 'Hypotheses', it goes to 'Predictions' (Experiments conducted; predictions verify or reject hypothesis; hypothesis refined). From 'Predictions', it goes to 'General theory, governing laws' (Understand real world behaviour as part of broad, general principles). A feedback loop labeled 'Positive feedback' goes from 'General theory, governing laws' back to 'Observations, measurements'. A feedback loop labeled 'Negative feedback' goes from 'General theory, governing laws' back to 'Hypotheses'.

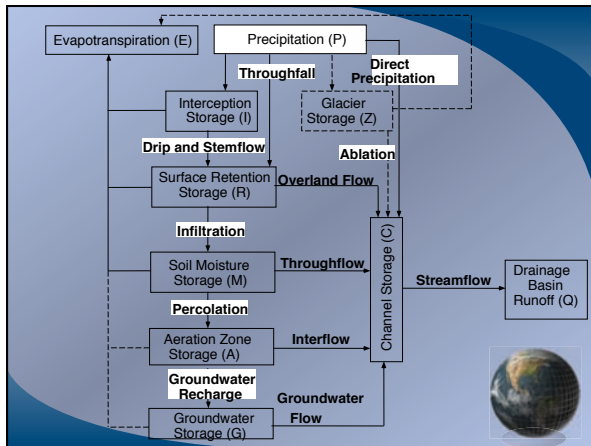
The scientific method process:

Step 1. Observe and measure.



This slide is identical to the previous one, showing the scientific method process flowchart. It highlights 'Step 1. Observe and measure.' which corresponds to the 'Observations, measurements' stage of the process.





Earth Systems Concepts

- Scientific Approach to Physical Geography
- System approach
- Systems Theory
- Types of Systems (open vs closed)
- System Feedback (positive vs negative)
- System Equilibrium

Scientific approach

1. Idiographic Approach
 - Explanation of individual situations or events with no consideration of the whole system (spatial relations)
 - Typical for humans

Photo credit: A.G. Lewkowicz

Scientific approach

2. Nomothetic Approach
 - derivation of generalizations and theories
 - Inductivism (uses observations to make generalizations)
 - Falsification (uses deductions from other theories until fittest theory is found)

Photo credit: A.G. Lewkowicz

	Inductivism	Falsification
Theory Generation	Empirical observations used to make generalizations; theories can also arise from guesswork and luck	Deduction from other theories; luck also possible but even then it should be possible to deduce theories later
Testing of Theories	Use observations and should not contradict other theories	Design critical experiments which try to falsify theories; theory determines observations to be made; fittest theory accepted after several attempted refutations
Use of Laws	Used for explanation and prediction (deduction) until sufficient observations provide contradictions	Used for explanation and prediction until another theory is shown to be fitter

System approach in physical geography

- Definition of a system:

A system is a set of variables and the relationships between them, distinct from others outside the system.

A system may include a number of sub-systems.



Benefits of system approach:

- Rational subdivision of a complex world
- Stresses relationships between variables
- Increases likelihood that all relevant variables are included
- Encourages quantification
- Assists in prediction (theory making)
- Assists in decision-making for intervention



Types of System

- Open vs. Closed systems

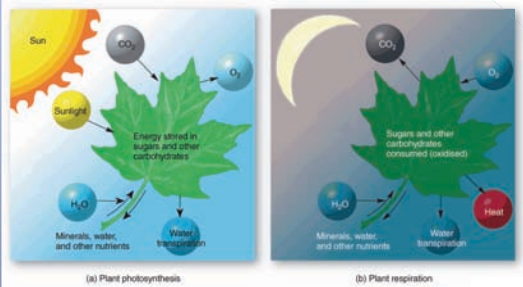
– Open: inputs/outputs of energy and/or matter (e.g. global energy cycle; most natural systems in terms of energy)

Earth is an open system in terms of energy, solar energy enters and goes back to space;

Solar energy (thermonuclear reactions within the Sun) powers terrestrial systems (temperature, wind, ocean currents). It is transformed in energy (kinetic and potential) or chemical/mechanical energy. Earth eventually radiates this energy back to space.



A Natural Open System



Both energy (sunlight) and material (water, CO₂, O₂) freely flows in and out of the plant, and chemical energy (sugars and carbohydrates) is stored and released.



Types of System

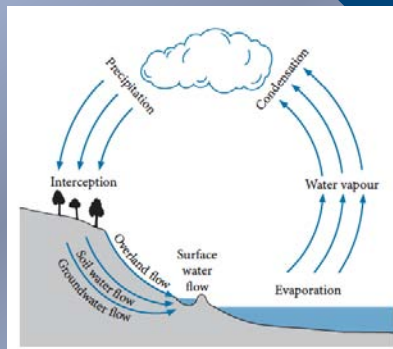
- Open vs. Closed systems
 - Closed: inputs/outputs of energy but no inputs/outputs of matter across the system boundaries (self-contained)
(e.g. global hydrological cycle; most natural systems in terms of physical matter and resources)
 - Earth's is a close material system, recycling is thus crucial



A Natural Closed System

Global hydrological cycle.

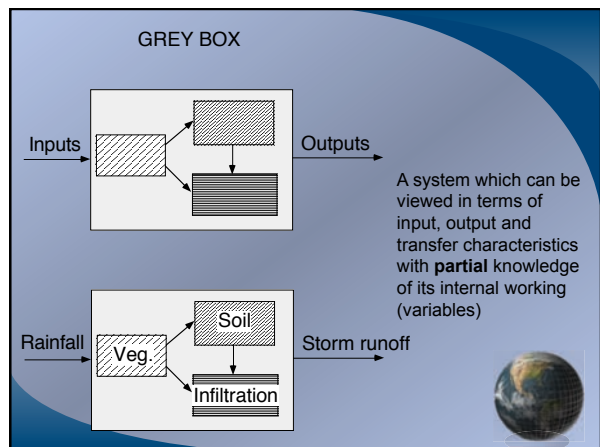
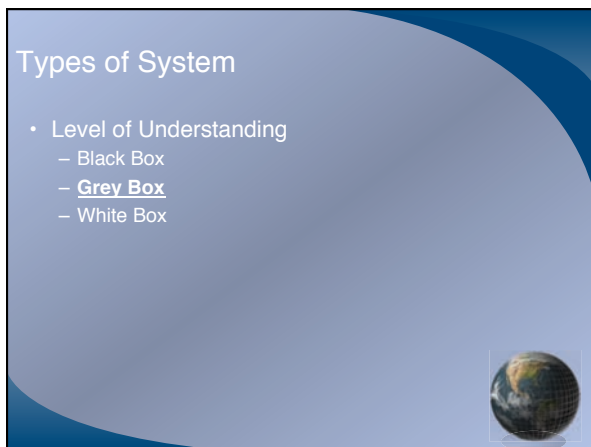
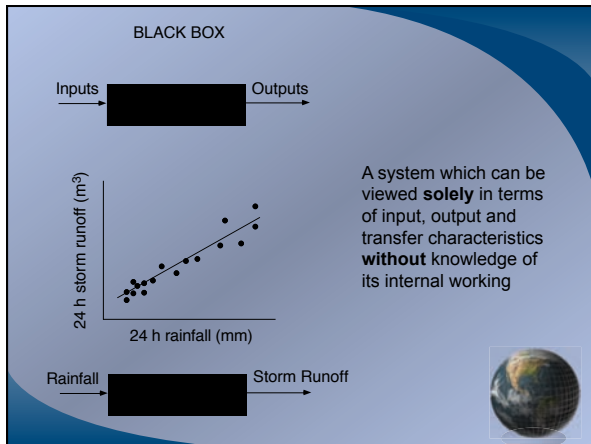
All water is contained in the system – no loss or gain



Types of System

- Level of Understanding of the System
 - Black Box
 - Grey Box
 - White Box









Types of System

- Level of Understanding
 - Black Box
 - Grey Box
 - White Box



WHITE BOX

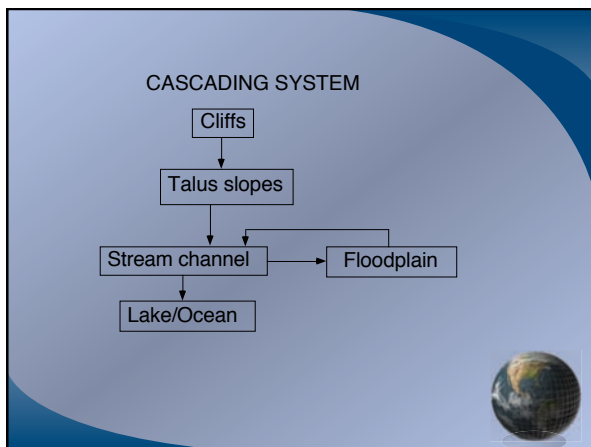
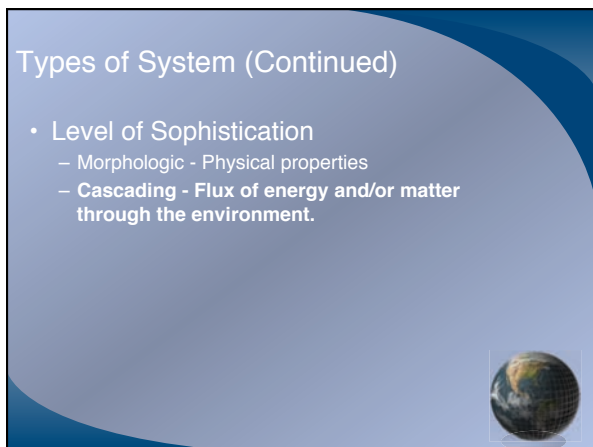
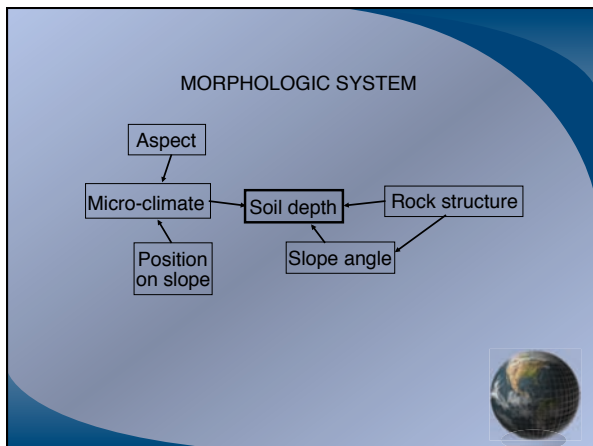
A system which can be viewed in terms of input, output and transfer characteristics with **comprehensive** knowledge of its internal working and variables/parameters



Types of System (Continued)

- Level of Sophistication
 - Morphologic - Physical properties of the environment.

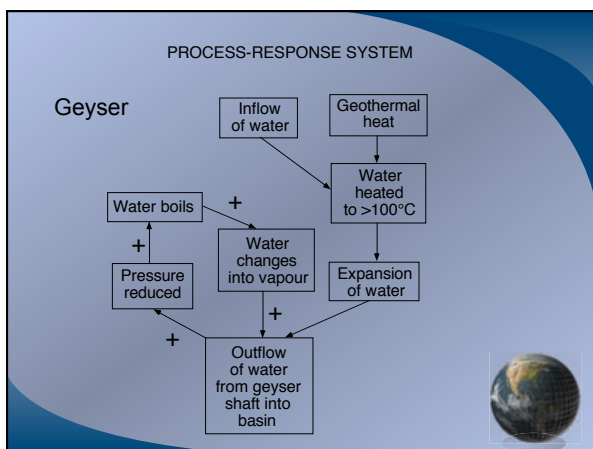






Types of System (Continued)

- Level of Sophistication
 - Morphologic - Physical properties
 - Cascading - Flux of energy and/or matter
 - **Process-Response - Combination of cascading and morphologic**





Types of System (Continued)

- Level of Sophistication
 - Morphologic - Physical properties
 - Cascading - Flux of energy and/or matter
 - Process-Response - Combination of cascading and morphologic
 - **Control** - Process-response modified by actions of humans
 - **Ecosystem** - Process-response with physical, chemical and biological interactions



Photo credit: A.G. Lewkowicz

A Systems Approach to Physical Geography

- Scientific method in physical geography
- Systems approach to physical geography
- Types of system
- **Feedback**



System Feedback

- There must be a loop for feedback to exist
- **Positive feedback** enhances the original change
 - Result increasingly differs from the starting state
 - Tends to lead to instability/disruption in the system
- **Negative feedback** damps down (diminishes) original change
 - Tends to preserve/diminish the starting state.
 - Helps to stabilize and maintain the system



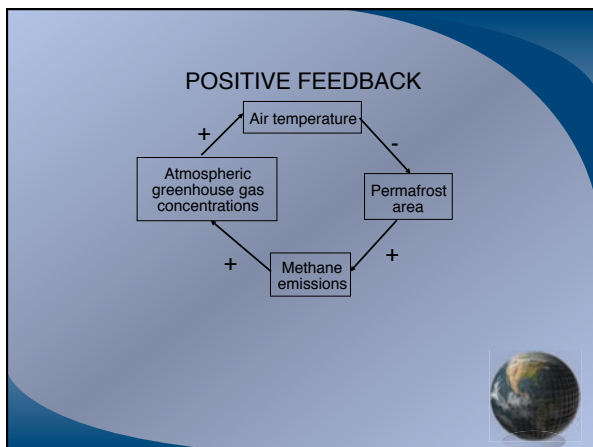
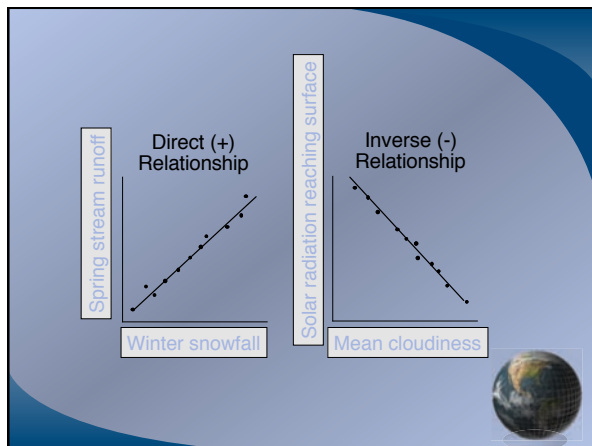
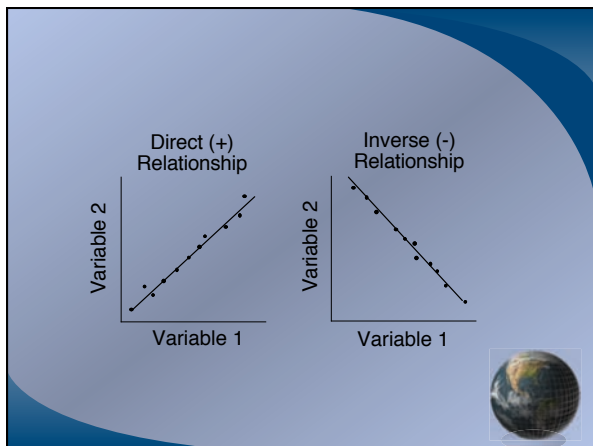


Photo credit: A. G. Lewkowicz

