GEOEarthKAM

What is Observational Science?

Observational science is theoretical, experimental and applied research related to oceanic, atmospheric, and terrestrial sciences. The ultimate goal of observational science is a better description of the world around us.

Background on Observational Science

Sciences can be placed into three categories: **experimental science, theoretical science** , and **observational science** .

Experimental science. Experimental science follows the model of what is generally described as the *scientific method.* A hypothesis is tested by the use of a controlled study. For instance, a biogeographer might take different groups of plants, and apply different *treatments* affecting growth (temperature, rainfall, exposure to sunlight, length of day, soil type) to each group, and record the results for each group.

Theoretical science. Theoretical science is the application of scientific logic to attempt to either predict new scientific laws from known laws, or to deduce simple laws that describe known phenomena. An example of theoretical science is Albert Einstein's theory of relativity, which resulted from his applying the known behavior of electromagnetic fields to gravitation, and predicting the results which would occur.

Observational science. A third branch of science (which can be considered a type of experimental science) is observational science. Often, it is not feasible to perform a controlled study of scientific phenomena. For example, an astronomer simply cannot travel to the distant stars, but must rely on collecting and interpreting the light from the cosmos. Similarly, Earth system scientists cannot control any system to observe the large-scale effects on other systems. Thus, observational science depends on seeing and watching less than manipulating or applying laws and principles.

Observational science is used not only to answer fundamental questions about how the Earth system functions. It is also used to address significant environment-society problems. NASA's web site Earth Observatory <http://earthobservatory.nasa.gov/> provides numerous examples of ways remote sensing and observational science are contributing to the solution of global social and environmental problems.

Observational science also has a significant military and security applications.

Geospatial intelligence is important to the Central Intelligence Agency, the military, and homeland security. Career opportunities abound in these fields for individuals skilled in observational technologies like remote sensing. For additional information about this arena of observational science, see the web site of the National Imagery and Mapping Agency < http://www.nima.mil>, its civilian partner Space Imaging http://www.spaceimaging.com, and the Department of Homeland Security < http://www.dhs.gov/dhspublic/>.

NASA and Observational Science

As mentioned above, one of the key elements of NASA's science is Earth System Science—observing Earth to better understand its processes and functions. NASA has developed a number of remote and in-situ sensing instruments which fly on aircraft, balloons, rockets and satellites at worldwide locations to observe Earth. NASA also conducts laboratory and field measurements to validate remote sensing instruments.

Recent examples of observational science topics have included:

- Ozone correlated measurements
- Upper atmospheric measurements
- Beach erosion
- Arctic ice mapping
- Volcanic impacts
- Hurricane studies

For more examples visit <http://osb1.wff.nasa.gov/osbhome.html>

Guidelines for Conducting Observational Science

These guidelines are suggested by Jacob Yates < yates@core2.gsfc.nasa.gov>, a former EarthKAM student worker and now an observational scientist at Goddard Space Flight Center.

1. Select a theme to study. The theme can be linked to geographic, science, and social studies curriculum standards or can be something that students are interested in. For example, students following the war in Iraq may be interested in dust storms and wish to explore where in the world they are a problem, their effect on the environment, and other related issues. Themes might include specific landforms (mountains, plains, rivers, coasts, deserts) or human features (borders, cities, agriculture), or other aspects of the Earth system (fires, clouds, ice).

2. Within your theme, select Areas of Interest (AOIs). AOIs are geographic locations and regions selected to be the focus of your observations. Choosing AOIs is an important part of geographic research for students and researchers alike. Remember, regions are useful tools for geographers and other scientists to use for five reasons:

- Regions help to **simplify** a complex Earth by breaking it down into manageable pieces. Regions are pieces of areas which together make up a country or continent. In order to reduce the complexity of understanding an area, it is convenient to divide the area into smaller and more comprehensible sections. They serve as jigsaw pieces; when put together piece by piece, Earth becomes understandable. As historians break time into periods and eras; playrights organize plays into acts and scenes, geographers divide Earth into regions at a variety of scales.

- Regions **serve as examples** to lend substance to generalizations. Regions can provide a specific example to press home an argument. Regions can be used to illustrate principles but also to shed light on a wider area.

- Regions **serve as anomalies** to see how parts of Earth differ from "the norm." They can underscore how a local part of Earth's surface departs from a general statement or relationship. Regions can help us to develop and assess general models.

- Regions **serve as analogues**; studying one region can help us to understand the characteristics of other similar regions.

- Regions **influence** their neighboring regions; studying adjacent regions and their distinctive characteristics can help us understand how places change over time and their modulating effects on other regions.

Selecting an AOI that will help to understand the theme is important.

3. Determine the parameters for the investigation. Think in terms of limitations, constraints, the amount of time you have available, the scope and scale of the project. As a teacher your role will be to help students "bound" their research in a reasoned and reasonable way. It may be helpful to have the students consider a specific problem related to their theme and to focus on that.

4. Prepare a research plan. A research plan is simply an outline of the steps students will follow in their observational science investigation.A good strategy might be to link the plan to the five skills of geography:

    ask geographic questions,
    acquire geographic information,
    organize geographic information,
    analyze it, and
    answer the geographic question.

The skills model the scientific process and link observational science to experimental science. Another approach would be to problematize the theme and to follow the suggested procedures for Problem Based Learning (PBL).

This table compares PBL with the five geographic skills:

Five Skills of Geography	PBL
Ask geographic questions.	Select a problem with a geographic (spatial) focus and express it as one or more inquiry questions. Organize a research plan.
Acquire geographic information.	Collect primary data from observations, field work, GPS. Locate existing secondary data sets.
Organize geographic information.	Organize data into spatial database; select and design appropriate forms of maps and graphs; explore geographic relationships.
Analyze geographic information.	Explore images, analyze, synthesize, evaluate, and explain relationships. Make inferences and draw conclusions.
Answer geographic questions.	Summarize findings, offer possible solutions to problem, formulate valid generalizations from results of geographic inquiry. Reflect on learning and present results.

5. Collect and archive your data. Collect ancillary information for your AOI including maps, documents, figures, references and so on.

6. Conduct your analysis. Analyzing a set of images is not a precise process. It is both art and science. One mechanical way to begin the procedure is to use these elements as tools to scrutinize, evaluate, and consider the image:
   Shape: the geometry of the object
   Size: the scale of the object
   Pattern: certain patterns are indicative of features
   Tone (color or hue): the light or color intensity of the features
   Texture: surface roughness of the terrain
   Shadows: may indicate something unique about an object
   Site: the context of key features may be indicative to a certain location or feature
   Association: certain features may have commonality with other specific features

7. Make your conclusions.

8. Verify that they correlate with other data you have collected. Remember, your results should be reproducible.