SWAC: Overview of Climate, Phenology and Satellites Module

Learning Objective:
Investigate climate impacts on vegetation phenology through the collection and analysis of field measurements, digital photographs and satellite data.

Rationale:
Because of its close link to temperature, vegetation phenology is one of the most responsive and easily observable traits in nature that change in response to a changing climate. Studies of plant phenology have been concentrated on long-term agricultural and herbaceous monitoring plots but recently there has been an effort to expand the research base by incorporating citizen scientists in the collection of phenology data. The most recent online tools allow citizen scientist to collect high tech digital images of their study sites, evaluate their data over time and share them with scientists as part of a nationwide phenology effort.

This module introduces students to the collection and analysis of vegetation phenology building on a wealth of online educational materials and tools from **PicturePost, Digital Earth Watch** and the **GLOBE** program. These programs engage students in ways that were not previously possible allowing them to establish their own research monitoring site, contribute their data to a nationwide phenology network and track changes in phenology over time.

Suggested Module Sequence:
The following includes several options to fully explore the topic of vegetation phenology, climate change, field ecology, remote sensing and data analysis. Any subset of these options could be used to match the time available, learning objectives and grade level of the group.

1. **Introduction to vegetation phenology as a marker of a changing climate**
   Temperature metrics are the most obvious way to study weather and climate
   patterns but it is often the impacts of temperature on our ecosystems that are of
   concern. Here we explore how a changing climate might impact ecosystem function,
   with specific focus on vegetation phenology. **(Power Point required)**

   a. Explore the range of impacts of a changing climate on ecosystem structure and
      function.

      - How does temperature impact plants, soils, wildlife, water?
      - Which ecosystem components might be most sensitive to climate
        change?
      - Which components can respond and adapt most easily?
      - How might these changes in ecosystems impact us?

   b. Discuss the use of vegetation phenology as a marker of climate impacts.

      - Why do scientists study phenology?
      - What are some ways to quantify and measure vegetation phenology?
      - How would we expect vegetation phenology to be changing over
        years?
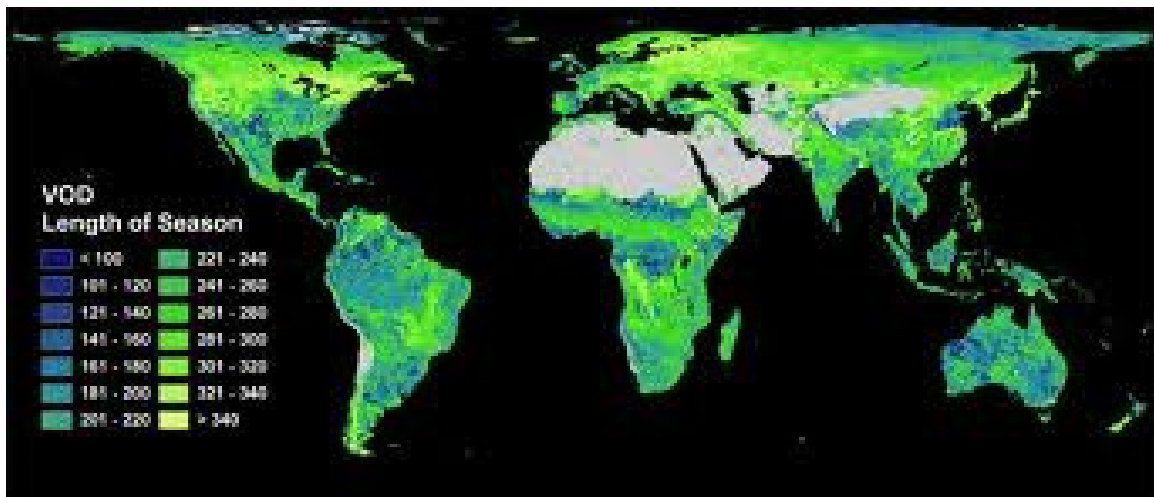
Processing and analysis of digital photographs

The analysis of digital images and remotely sensed data is central to contemporary monitoring of our planet. Because these data are often collected by satellites, or other sophisticated monitoring equipment, they are usually presented to students in an intangible manner that doesn't engage them in the collection or analysis. The Picture Post Learning Progression introduces you to a new research tool that standardizes the collection digital images through a series of protocols that allows the data to be compared over time, or with that from other sites. In addition to its own investigative value, the Picture Post is a bridge to understanding the fundamental aspects of collecting images and analyzing them digitally.
(PicturePost Learning Progression required)

a. Using a standardized protocol, set up a Picture Post to use as the foundation for ongoing monitoring of a specific location, as well as for comparison to other sites throughout the state, region and country. **(PicturePost Guide Required)**

- Why is following a protocol important in setting up the Picture Post?
- What are some considerations that we should take into account when choosing a location for our Picture Post?

b. Use the Picture Post, in conjunction with a digital camera, to collect a series of digital images. Images are uploaded to a nationwide, online database for comparison and contribution to scientific efforts. **(PicturePost Guide Required)**

- What are some considerations when using an instrument such as a digital camera to collect data for analysis?
- What types of information might a digital image contain, that would be useful in monitoring an ecosystem, particularly in relationship to climate change?

c. Create hemispherical mosaics and time series animations of your site to visualize changes in phenology over time. **(PicturePost Guide and Panorama software Required)**

- Which portions of your study site change the most? Which change the least?
- Which are the first to "green up"
- Do you see changes not related to vegetation? What is causing these differences? Where could there be error in our measurements?

d. Identify a specific portion of one of the images for more in-depth analysis relating to phenology. **(PicturePost Guide and ADI software required)**

- Why did you select this specific portion of the image? What species or landscape feature is it focused on?
- How do different vegetation types differ in their greenness?
- How does the temporal scale (length of time for which you have data) of your observations affect what you can infer from the data?

e. Graph your greenness index over time to determine the start and end of the growing season at your site. **(Greenness Activity Guide and spreadsheet software required)**

- What are some different ways to determine when a growing season starts?
- How do greenness curves differ between eco-regions?
- How does the start and end of the growing season this year compare to previous years?

f. Compare your picture post images to corresponding MODIS images **(PicturePost guide and link to GLOBE carbon cycle website required)**

- How do Picture Post images compare to corresponding MODIS images, and what potential variables might affect the correlation between these two data sources?
- Use the tool to explore the relationship between albedo and greenness, and what the high and low values on the graphs look like in the images. How might this tool be valuable in studying biomes, tree species distribution and their response to climate change?