Week 13 Lab: Using Satellite Vegetation Indices to Explore Ecosystem Patterns

MODIS (Moderate Resolution Imaging Spectroradiometer), a device on the NASA satellites Terra and Aqua, measures reflected wavelengths from Earth to calculate a suite of variables characterizing processes. We will focus on on two vegetation indices - NDVI (normalized difference vegetation index) and EVI (enhanced vegetation index) for this lab. Similar to the PhenoCam lab, we will use R/RStudio to explore freely available data and test hypotheses about how ecosystem vary in their productivity, and how this can be sensed from space. The work in this lab is indebted to the MODISTools Package in R, developed by Koen Hufkens.

PART I: Downloading and Plotting MODIS NDVI and EVI Data
In Part I, you will follow the R Script in order to do the following, based on a site of interest (ie -your birth city):
- Open the 'MODISTools' package in R
- Check the dates available for a site of your choosing
- Download MODIS NDVI and EVI data from this site within a specific time period
- Calculate NDVI 'by hand' according to the NIR and Red values for a single time period, and compare to the calculated NDVI from MODIS
- Create a dataframe of Date, NDVI, and EVI
- Make a Base R plot of NDVI and EVI by Date
- Make a ggplot plot of NDVI and EVI by Date
- Alter the ggplot to be aesthetically pleasing

Response Questions & write up:
1) Calculate NDVI 'manually' and via MODIS for a single measurement period. Show your work. Do these values differ? If so, how?
2) For your site, what is different between NDVI and EVI? When does the biggest "jump" in NDVI occur, and what do you attribute that to?
3) Include a ggplot graph of your site with NDVI and EVI

PART II: Creating an Observational Experiment using Satellite Data
Now that you are familiar with extracting MODIS NDVI and EVI data and making plots, we will use this approach to answer a question about the terrestrial world and how plants perform (or are perceived to perform by remote satellites).

Brainstorm an 'experiment' in which you compare 2-3 sites in different parts of the world to answer an ecological question. Some general ideas to help your brainstorming: your brainstormed system from the previous weeks, latitude or altitudinal gradients, land-use change/land-use differences, urban to rural transects, climatic gradients (desert to alpine), different agriculture types, time-space differences (same place over time, or different places

over time). Once you have your 'systems' narrowed down, *develop a hypotheses about the sites and how you believe vegetation at these sites/times will vary.*

- What is your hypothesis?
- How do you predict NDVI, EVI, and GPP will vary based on your hypothesis?
- Test your hypothesis by repeating steps in PART 1 to plot patterns of EVI and NDVI. How do they sites vary and does it align with your expectations?
- Finally, using MODISTools, download GPP (see R script) and compare the GPP across the sites. Does this align with your predicted outcomes?

Response Questions & write up:
1) Where are your experimental sites and what is the underlying research question driving your interest in examining these sites?
2) Develop a hypotheses about the sites and how you believe vegetation at these sites/times will vary.
3) How do you predict NDVI, EVI, and GPP will vary based on your hypothesis?
4) Show the plots of your system(s) comparison with NDVI, EVI and GPP in ggplot.
5) Describe briefly (1 paragraph) how these systems vary, and if the results you found align with your hypothesis and predicted outcomes.