Name: _____ November 13, 2018
BIOL 368 Plant Ecophysiology Prof. Mary Heskel

Seasonal Variation in Ecosystem Greenness and Carbon Exchange

This week we will use R to explore publicly available datasets of canopy greenness (collected via PhenoCams) and carbon exchange (collected from eddy covariance towers). Data sharing and accessibility is of huge importance in science – it allows for different groups to replicate results, making experiments reproducible and hopefully confirming findings, and it also allows a broader access of information to a large group of scientists and students. An ongoing initiative in science is to not only make your data available, but also the code with which you analyzed it. *This promotes transparency and access*.

Part I: PhenoCam Explorer

We will begin by looking at PhenoCam data online using the PhenoCam Explorer

1. Go to: explore.phenocam.us
2. Go to "plot and download data" and find the site "Harvard" – this will be our first exploration online.
3. Toggle and make different selections under "plot type" and "covariate MODIS VI". How does MODIS data line up with PhenoCam data?
4. Choose another location and notice how the MODIS and PhenoCam variables change through the seasons and years.
    a. Pick a novel location with 3+ years of data, study the variability, and respond to the following:

Response prompt:
Identify the SOS ('start of season') and EOS ('end of season') for each of the years. How much did spring and fall onset between years? Approximately how long was the growing season between SOS and EOS? Based on geography and the growing season, what do environmental/abiotic variables do you think control the SOS?
Layer EVI and NDVI over your site. How does it align/not align with the PhenoCam data?

Part II: Visualizing PhenoCam data in R

We return to the Harvard Forest dataset, but now will be controlling the output and graph making ourselves. Follow the R code shared via email to do the following:

1. Download phenocam data for Harvard Forest
2. Use ggplot to make the following graphs of Gcc (green chromatic coordinate):
    a. All data points between 2008-2018 on a DOY x-axis
    b. Gcc by DOY, but separating years by color
    c. Gcc by DOY, separating years into different graphs (facet_wrap)
    d. Think about visualizing data – how do the different plots tell different stories? When would you use each one?
3. Now you will recreate these plots downloading the phenocam data from the site you selected for Part I (or another site)
    a. Copy/Paste/Change the R code in the script to download the new data.

b. What do you need to change?
    i. Set roi_id =”ALL”
    ii. Set veg_type=”ALL”
    iii. Set frequency =”3”
c. Continue Copy/Paste/Change-ing your R script for the original Harvard Forest example to create the three plots from your new data.
d. Feel free to play around with color palettes, point characters, etc.

Response prompt:
When did the highest Gcc occur in this site? How did this vary from the Harvard Forest data, and why? Copy your plots into the response you hand in. What can you learn about this system from PhenoCam data during these years?
Now that you are familiar with PhenoCam data and manipulating it in R, think about how this can be applied in different systems. If you were to put up a new PhenoCam to answer an ecological/physiological question -where would you put it and why?

Part III: Plotting Eddy Covariance data from AmeriFlux in R

We will again be using data from Harvard Forest, which is a historic site in terms of eddy covariance data – it is home to the oldest continuous EC tower in the world! It has been collecting data since 1991 (I believe), allowing for exploration of ecosystem carbon exchange for almost 30 years, back when atmospheric CO2 was only ~350ppm!

Download the AMF_Ha data from the email I sent the class. Follow instructions in the R script to make the eddy covariance data into something easier to handle to graph. Following these instructions, you will make 2 plots in ggplot with the eddy covariance data. Once you have completed those plots, copy them into your final write up and respond to these questions.

Response prompt:
Describe the shape of the annual eddy covariance Net Ecosystem Exchange signal at Harvard Forest. What times of year is the forest a carbon source, and what times of year is the forest a carbon sink? You plotted NEE, not GEP. How would you calculate GEP from NEE data, what are some potential drawbacks in this calculation?