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Long Term Phenology: Green Up & Green Down 2001-2016

Abstract:

It's a common belief that climate change has a direct correlation to the length of growing season. Our objective was to find out if there was any significant changes in the growing seasons over the years, using green up and green down data. Our group used GLOBE data from both Palmer and Wasilla High School. The schools are located ten miles apart. The data was collected by students between the years 2000 and 2017 and over the years there was no apparent increase or decrease for the date of green up. Our data found that there was a decrease in the date of green down meaning that green down was occurring earlier in the year. Climate is a complicated system with many fluctuations. Even seventeen years of data is not enough to see overall changes in climate. Our group recommends that green up and green down data continue to be collected and climate changes can be reevaluated in twenty years.

Keywords: green up, green down, climate change, growing season

Research Question: How have the average green up and green down dates or growing season changed over the past seventeen years?

Introduction:

Budburst is the first activity we see in new growth of trees in the spring. New leaves form in a bud, swell and then emerge from the bud as "baby leaves". Budburst is an essential measurement of the first activity of trees in spring. The GLOBE green up protocols require students to observe buds on dominant deciduous trees at their study site. The students record

when budburst occurs and measure the newly formed leaves. This investigation uses green up or budburst data from Palmer and Wasilla High Schools from 2000-2017. Factors that influence when budburst occurs include soil and air temperatures.

Green down occurs in the fall or at the end of the growing season. Students record the color of the leaves as they change color. They also record when the leaves have fallen off of the tree. This investigation uses the dates that leaves fell as submitted to the GLOBE website.. Many factors influence when leaves fall such as wind, freezing temperatures, soil moisture and herbivory.

The days between budburst and green down are the growing season. The gap between budburst and the first leaves allow us to determine how quickly spring is advancing. The growing season is an important factor in climate regulation. Most plants need a growing season of at least 90 days. The length of the growing season varies based on the location. Increased elevation and distance from the equator both decrease the growing season. Minimum water availability is also a factor in growing season length. (National Geographic Society.23 Sept. 2011)

Carbon dioxide levels are directly linked to global warming. Carbon dioxide is a greenhouse gas which traps the heat reradiated off the surface of the Earth. As carbon dioxide levels increase global temperatures increase as well. Budburst dates are important because if climate is warming budburst will occur earlier. Climate changes are more drastic in arctic ecosystems therefore a small warming in the arctic could lead to drastic changes in the arctic ecosystems.

The growing season is the number of days that the vegetation in an area is actively photosynthesizing. Photosynthesis uses carbon dioxide from the atmosphere to “fix” carbon into organic molecules. As carbon dioxide levels increase in the atmosphere a negative feedback loop could be created when the growing season lengthens. The warmer temperatures allow a longer growing season which causes more days of photosynthesis leading to more carbon fixation.

Review of Literature:

According to research by Hans Linderholm the global growing season has increased 10-20 days in the last few decades. Changes in growing season are more prominent for the green up than green down. Data was collected using a variety of methods including phenological, satellite and climatological studies. When the growing season changes the possible impacts on ecosystems are significant. Increases in the length of growing season can also cause changes in vegetation cover and an increase in carbon storage. (Hans W. Linderholm. 2006)

Another study investigated changes in growing season using satellite and temperature data. Again significant changes were seen in the start of the growing season (SOS). From 1982-2008 the SOS was approximately 5.4 days earlier. The end of the growing season (EOS) occured 6.6 days later from 1982-2008. Overall this study found that the changes can be attributed to later green down more than earlier green up. (Jeong, Su-jong. 17 Feb. 2011.)

Research Methods:

A. We used the GLOBE data visualization website to collect green up and green down data.
B. Study Site: The data was collected from the temperate deciduous forest surrounding Palmer and Wasilla High School located in south central Alaska. Whereas nearby biomes include tundra and glacier.
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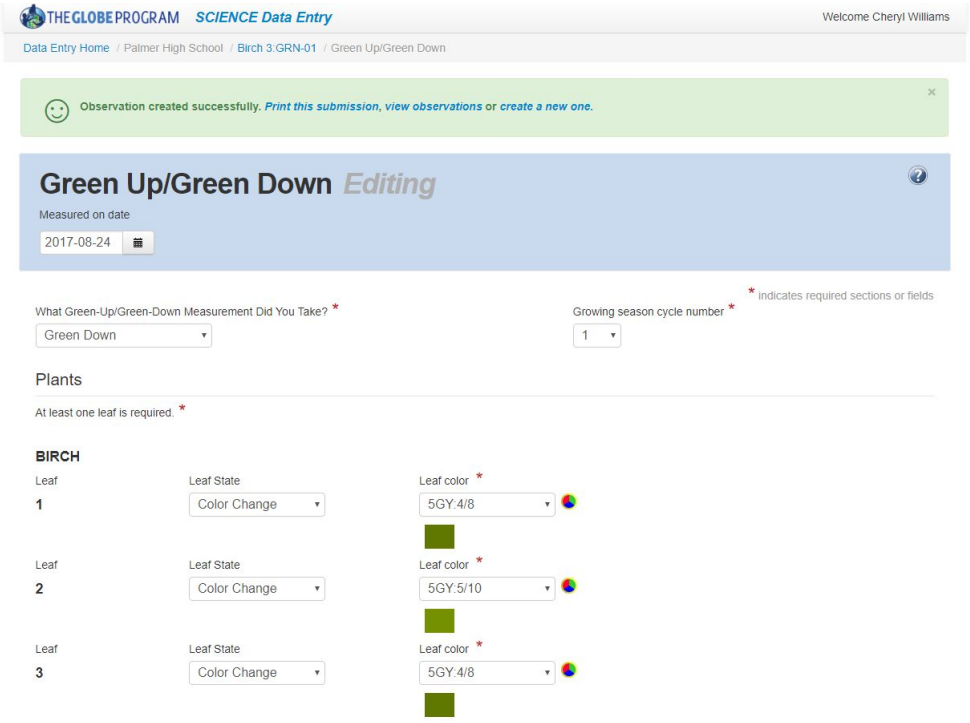
C. Data Collection: Our group followed the GLOBE green up and green down protocols. Students collected green up data in April and May of each year. Green down data was collected from August through October. Each year between eight and 24 groups of

students collected data. The data was submitted to the GLOBE website. The data was collected in the temperate deciduous forests located at Palmer and Wasilla High School from 2000 to 2017. Both school have cross country trails next to the school campus. Our group used 129 observations from green up and 193 observations from green down.

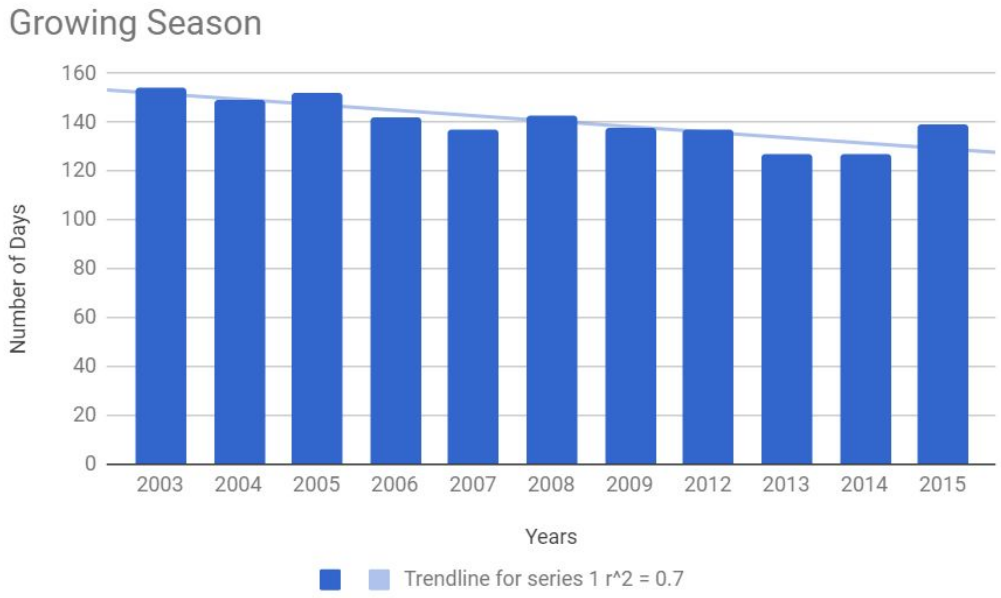
D. Data Entry GLOBE Website:



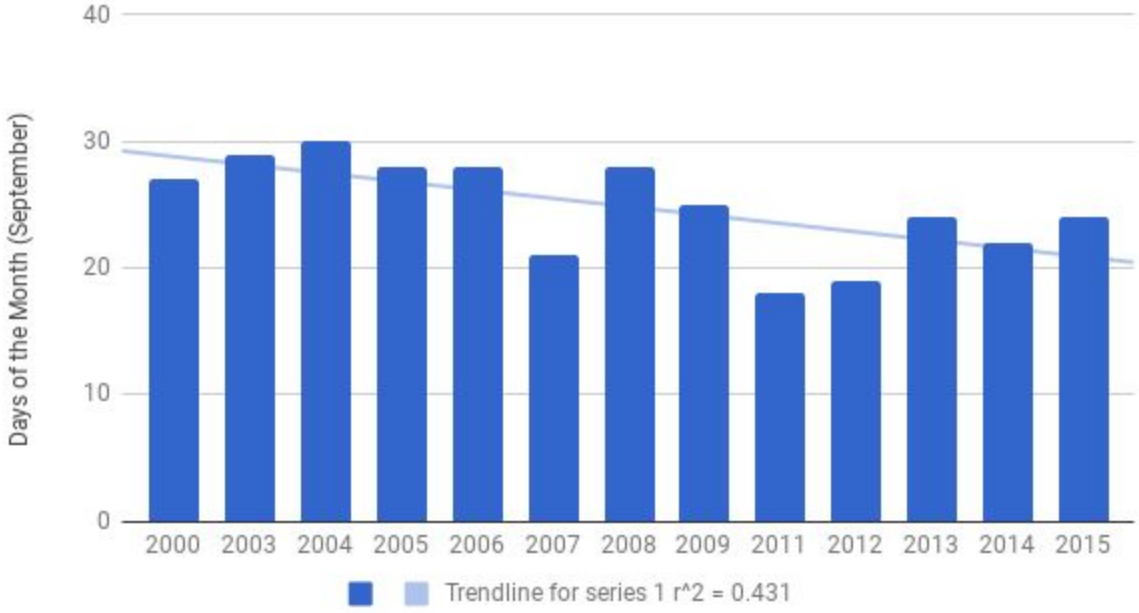
E. Data Analysis: Our group recorded all of the dates of budburst and fallen leaves and calculated the average of the dates for both.

Results:

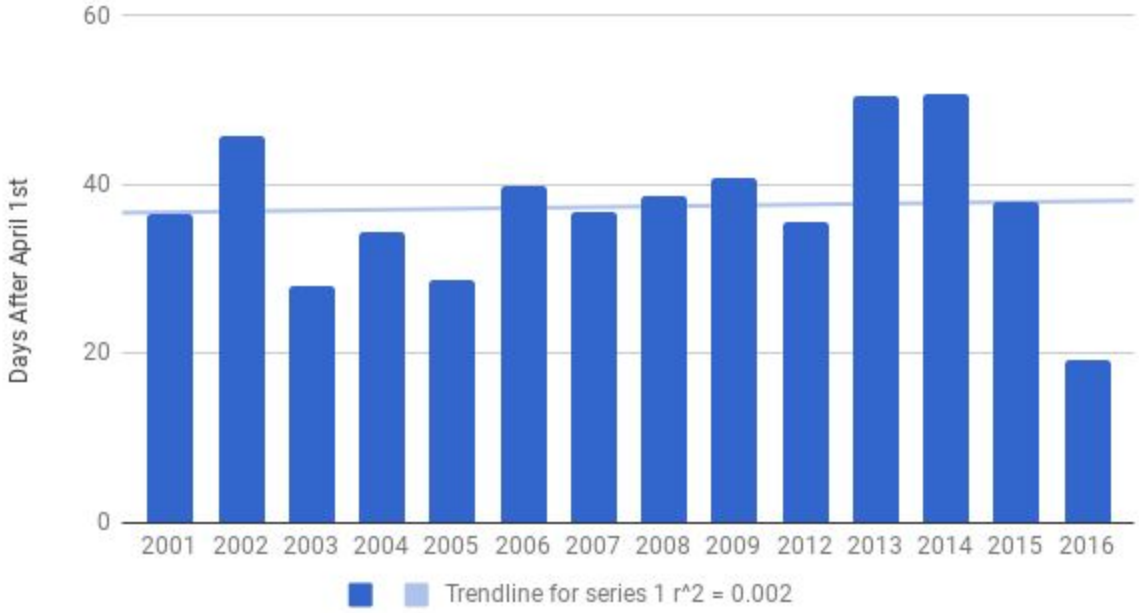
Average Dates of Green Up		Average Dates of Green Down		Growing Season	Number of Days
2001	May 7th	2000	Sept. 27th	2003	154
2002	May 16th	2003	Sept. 29th	2004	149
2003	April 28th	2004	Sept. 30th	2005	152
2004	May 4th	2005	Sept. 28th	2006	142
2005	April 29th	2006	Sept. 28th	2007	137
2006	May 9th	2007	Sept. 21st	2008	143
2007	May 7th	2008	Sept. 28th	2009	138
2008	May 8th	2009	Sept. 25th	2012	137
2009	May 10th	2011	Sept. 18th	2013	127
2012	May 5th	2012	Sept. 19th	2014	125
2013	May 20th	2013	Sept. 24th	2015	139
2014	May 20th	2014	Sept. 22nd		
2015	May 8th	2015	Sept. 24th		
2016	April 20th				



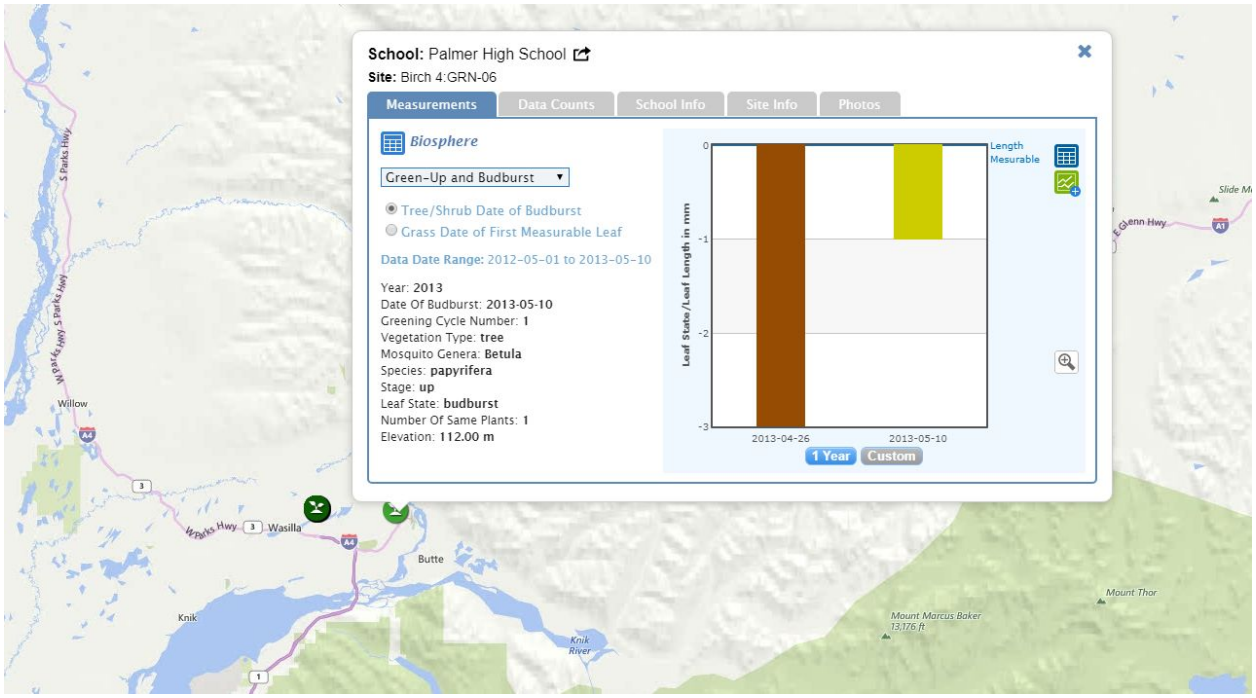
Average Dates of Green Down



Average Dates of Green Up



GLOBE Visualization Website:



Discussion:

According to the green up data collected the null hypothesis was supported and the alternate was rejected. Our group deduced that there was a consistent fluctuation among the averages in the green up data leading to the conclusion that there were no obvious trend. The linear regression shown in the green down graph is 0.002 which further concludes that there were no significant changes in the beginning of the growing season. After processing the green down data the group concluded that the alternate hypothesis was supported. The linear regression shown in the green up graph is 0.431 which is significantly greater than the linear regression in the green up graph which tells us that the green down time period is occurring earlier in the season.

Increases in temperature in the Arctic would support a longer growing season in Alaska. Our data from Palmer and Wasilla High School is showing a shorter growing season. Because there are only sixteen years of data, there are many possible causes for this conflicting information. First, the data was collected at Wasilla High School from 2000 to 2009 and then at

Palmer High School from 2012 to 2016. There could be small differences between the two sites that cause the decrease in the growing season.

Some other possible errors which could have occurred could be basic human errors. The data was collected by high school biology students which could have resulted in inconsistent data due to maturity errors. Another error could have occured from the irregularity of data collection. Observations were made twice a week rather than daily, which could have affected the data. For example, it is possible that a leaf could have fallen from the study site on Monday and the students wouldn't collect data again until Wednesday.

Conclusion:

The purpose of this investigation was to determine if the average green up and green down dates have changed in the last seventeen years. Data from the GLOBE website was used to find the average dates of green up and green down and this was used to determine the length of the growing season. Overall the data showed little change in the beginning of growing season or green up dates. However, the green down or start of the growing seaso did decrease, showing an earlier end of summer.

Palmer and Wasilla are located in southcentral Alaska. As an arctic region, concerns about climate change are significant. Our ecosystems are at risk if the climate changes too quickly. Migratory species such as Canadian geese, sandhill cranes and trumpeter swans stop in Palmer to "refuel". Changes in the growing season could impact the vegetation available for these birds.

Our data is similar to the data found in the literature review. Studies by Lindholm and Jeong both found changes in the growing season. There was disagreement if the changes were more significant in during green up and green down. Our data shows changes in green down but not green up.

Our data also shows significant variations or fluctuations from year to year. Palmer has regular wind storms. If a wind storm occurs toward the end of the green down season, the wind can have a big effect on when the leaves fall. Also temperature fluctuations and rainfall can

impact the date of green down. All of these factor combine to produce a system that has many variables.

Improvements: Data could have been collected by teachers rather than students or at least verified by the teachers or an adult. Data also could have been collected daily for more accurate dates on when the leaves fell or budburst occurred rather than every few days. We would recommend that data continued to be collected for 20 more years and then reevaluated for further analysis. In addition, we recommend additional GLOBE protocols be used such as monitoring of soil temperature and soil moisture levels.

Badges:

Collaboration Badge

Each member of the group played an important role in data processing. Everyone contributed equally. The data collected was divided amongst the three of us and separately processed and later incorporated into one document. Some individuals were focused on the collection of green up dates while others were collecting the green down data. During the end of our data processing we all contributed by collaborating on what our data meant in relation to climate change and the plant life cycle.

Community Impact Badge

In Alaska the majority of our population participates in outdoor recreational activities. Overall as a community we are pressed to engage in the surrounding environmental issues which impact our daily life. With our local community being centralized on agriculture, climate change is a concern for the town as a whole with much of our fresh produce being locally grown. Climate change is a global concern which impacts many communities similar to ours.

Interscholastic Connection Badge:

The data that we used for our research was recorded by both Palmer and Wasilla High School students just ten mile away from each other. We collaborated with the other high school

to get multiple perspectives on the seasonal changes occurring around us. Being able to observe the data collected in a nearby school allowed us to improve the precision and interpretations of the dates recorded.

Citations:

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Jeong, Su-jong. "Phenology shifts at start vs. end of growing season in temperate vegetation over the Northern Hemisphere for the period 1982–2008." Onlinelibrary.wiley.com. 17 Feb. 2011. Web. 28 Feb. 2018. <http://onlinelibrary.wiley.com/doi/10.1111/j.1365-2486.2011.02397.x/full>

GLOBE materials used:

Green up and green down protocol instructions

Green up and green down data sheets

green down color chart

GLOBE visualization website

GLOBE advanced data access tool

GLOBE data entry website