INTRODUCTION TO AND ANALYSIS OF THE GREEN CHROMATIC COORDINATE OF BIFoR FACE

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Poster by Thomas Downes. All raw data courtesy of Phenocam.
All photos and figures produced by Thomas Downes unless stated otherwise.

1 THE PHENOCAM

Fig. 1 : The Phenocam's view over BIFoR FACE. (From left to right, Array's 1, 3 and 2)

The PhenoCam is a camera installed on the flux tower at BIFoR FACE, at 40m height. It captures an image looking south over the oak forest every day, and sends data to the PhenoCam Network.

The PhenoCam Network itself is a project run by collaborators from several U.S universities. They take the data from the camera - the levels of *RED*, *GREEN* and *BLUE* (RGB) light detected by the camera. By getting the RGB levels, the camera can reproduce any colour visible to the human eye.

Using this data, we can work out the amount of *green* light detected by the camera, given as a fraction of the total light (this removes any changes due to sunny or cloudy days).

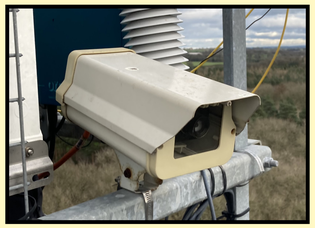

Fig. 2 : The Phenocam in situ at 40m on the Flux tower

This data point is called the *GCC*—green chromatic coordinate—and is what this poster is focused on. Essentially, this will tell us how green the forest is. Given that leaves are green due to the chlorophyll used in photosynthesis, this will give us a very reliable indicator of how much photosynthesis is taking place in the woodland as a whole.

2 DATA AND ITS USES

By taking a daily average (90th percentile) of the *GCC*, we can plot a timeseries showing the changes in how green the trees are over time. The below chart shows the *GCC* from Spring 2016 to Winter 2022.

Any gaps in the data (shown as greyed out) are due to power failures or communication issues.

This data is useful for lots of reasons—anybody undertaking research at BIFoR FACE will be able to cross reference this data with their results. This might help them to understand why their data looks the way it does, or vice versa.

For example, a dendrometer trend (measuring tree circumference change due to growth or sap flow) may correlate quite closely with the Phenocam data, as higher tree growth and sap flow would indicate higher levels of photosynthesis.

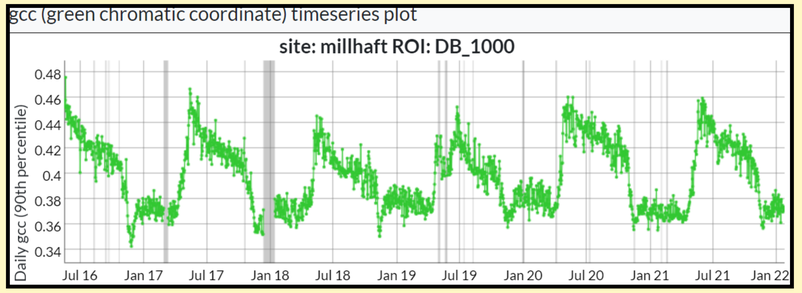

Fig. 3 : Timeseries plot showing the green chromatic coordinate of BIFoR FACE from 2016 –2022.
Graph courtesy of ***phenocam.sr.unh.edu/webcam/***

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The below graph shows the same data as the timeseries on the top right, but this time the years are overlaid onto each other. 2016 has been omitted as only half of the year had data recorded.

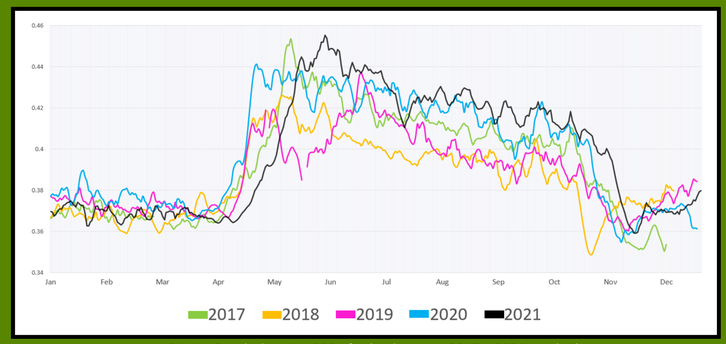

Fig. 4 : Graph showing GCC of calendar years 2017—2021 overlaid .

This graph highlights the differences and outliers between the different years. While all of the years trends follow a similar pattern, it is clear that 2020 had an earlier peak than other years, and that 2019 experienced a dip in May.

4 CASE STUDY 1: 2018 v 2020

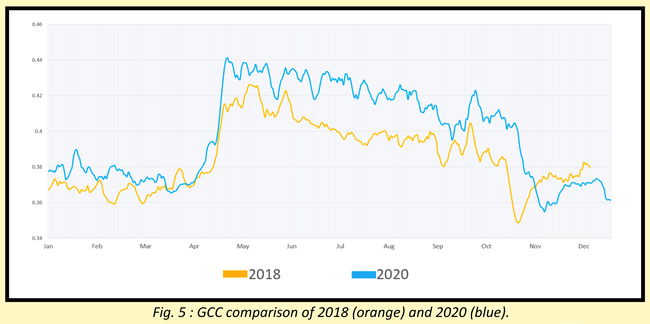

Fig. 5 : GCC comparison of 2018 (orange) and 2020 (blue).

By examining the trends of each season we can identify that overall 2018 was the least productive year for photosynthesis at BIFoR. The green index was low throughout the season (Apr-Oct) and plummeted much earlier than other years. Conversely, 2020 was overall the most productive, maintaining a high *GCC* level throughout the season and lasting longer from start to finish than the other years.

2020 was a very warm year with lots of sunlight, which could explain why the canopy was so green. The start of the summer was quite dry, but this gave way to lots of storms and rainfall.

The main reason for the poor photosynthetic performance in 2018 was a herbivory event - that is, the population of winter moth larvae was much greater than usual (this also occurred in 2019, especially during May hence the large drop in the central graph). As these larvae emerge they feed on the oak leaf buds, greatly reducing the amount of leaves in the canopy. As a result of this, considerably less photosynthesis will have taken place in 2018, and this will likely show in data collected from various experiments at BIFoR FACE.

CASE STUDY 2: 2020 v 2021 5

There are natural fluctuations in the phenological cycle every year. On average, oak budburst in the midlands is from early to mid April. As you can see from the central graph, 2020 was the earliest of the five years and also peaked the earliest. In contrast, 2021 is noticeably delayed compared to all of the other years. When you pair the two trends from 2020 and 2021 together in a separate graph, and compare this to a graph showing the average monthly temperatures, it becomes apparent why there is such a difference between the two years.

Not only did the unseasonably cold April in 2021 delay the budburst by around 3 weeks compared to 2020, but a heat wave in July caused a noticeable dip in the *GCC*. Also, the slightly warmer temperatures throughout the Autumn months result in the leaf fall being delayed by around two weeks compared to 2020. This is a good example of how the temperature has a very direct effect on the phenology of trees such as oaks, and these effects will have direct impacts on the surrounding eco-system and the wide-range of species which are dependant on oaks for survival.

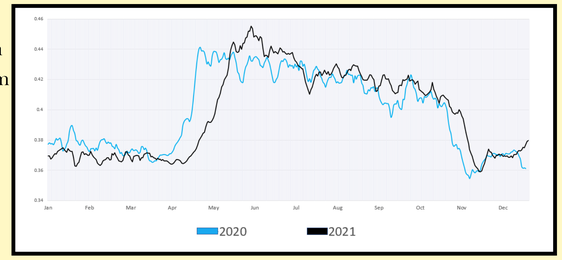

Fig. 6 : GCC comparison of 2020 (blue) and 2021 (black).

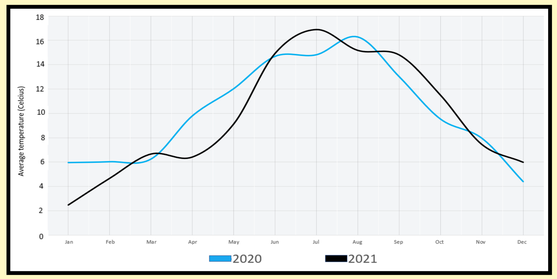

Fig. 7 : Comparison of average monthly temperature of 2020 (blue) and 2021 (black).