Individual and Interactive Effects of Elevated CO2, Warming and Drought on the Phenology of Mountain Grassland

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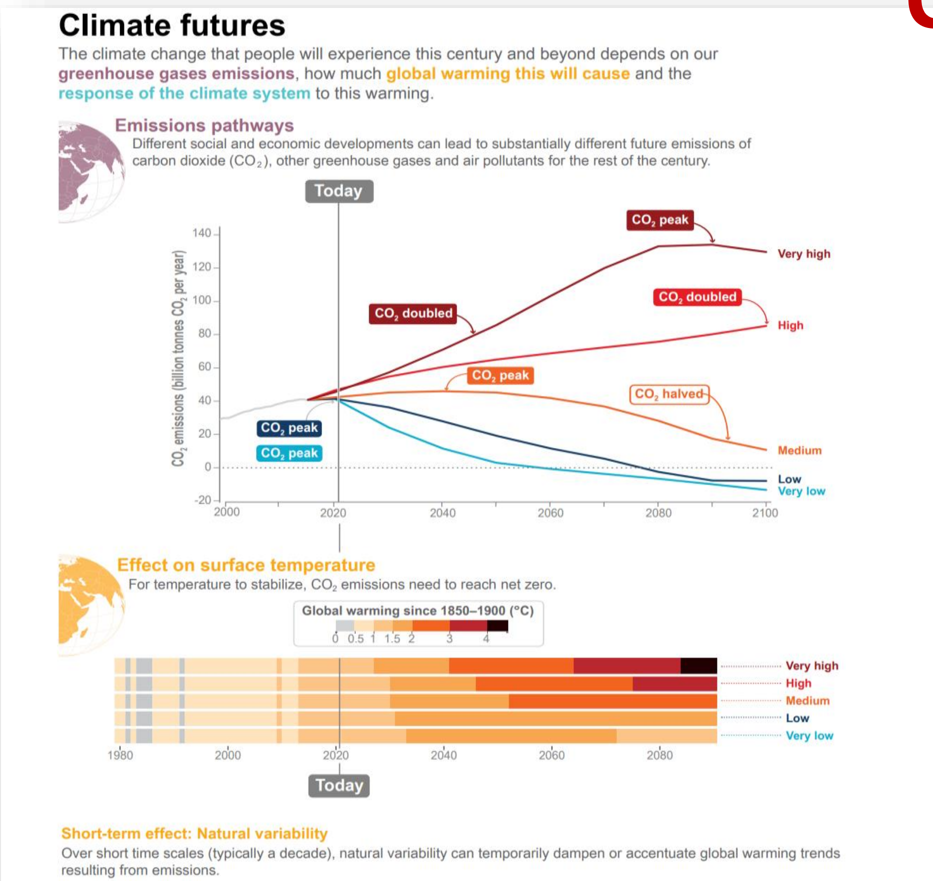
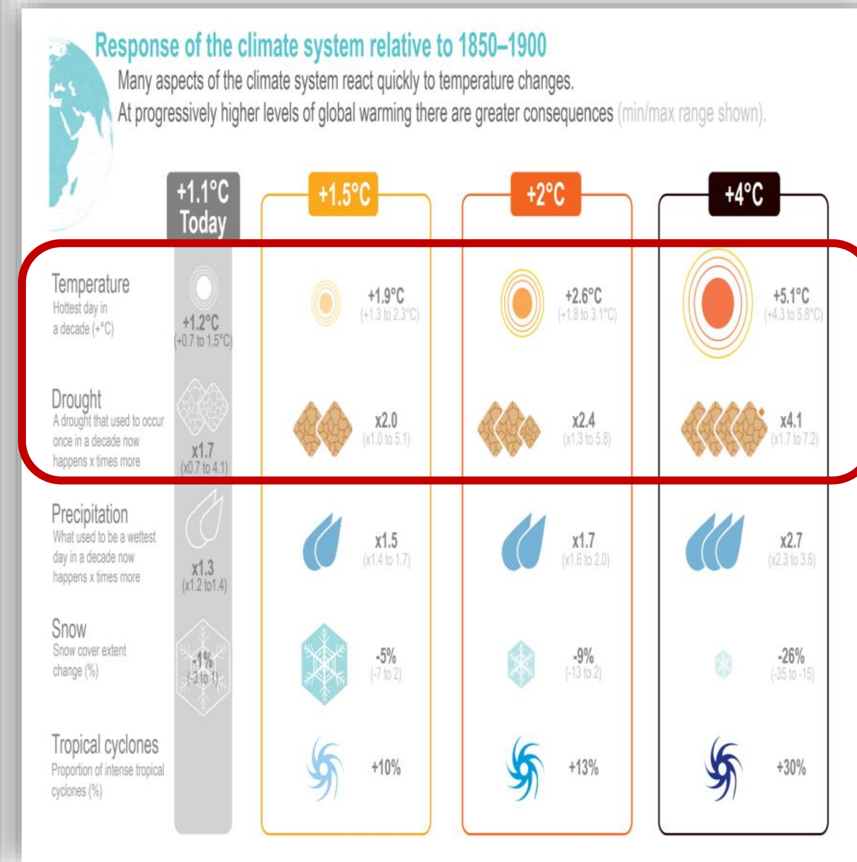
IPCC, 2021

Climate Change Drivers



Infographic TS.1 | Climate Futures. *The intent of this figure is to show possible climate futures: The climate change that people will experience this century and beyond depends on our greenhouse gas emissions, how much global warming this will cause and the response of the climate system to this warming.* **(top left)** Annual emissions of CO_2 for the five core Shared Socio-economic Pathway (SSP) scenarios (very low: SSP1-1.9, low: SSP1-2.6, intermediate: SSP2-4.5, high: SSP3-7.0, very high: SSP5-8.5). **(bottom left)** Projected warming for each of these emissions scenarios.



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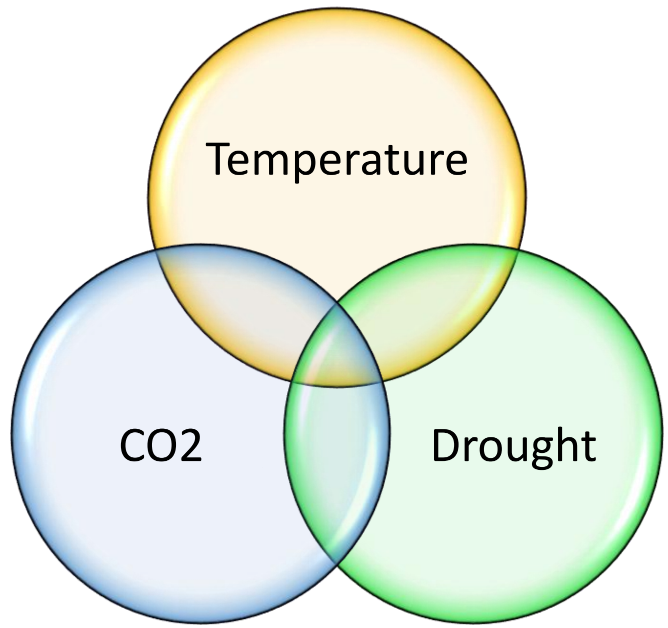
Phenology

Phenology a **"leading indicator"** of climate change impacts.

(usanpn.org)

Knowledge gap

Effect of interaction between climate change drivers in future on the Phenology



Research Questions

1. Which climate change driver has a key effect on the phenology?

2. What is the individual **vs** interactive effect of climate change drivers on the phenology of grasses?

3. Is there a relationship between ANPP (Aboveground Net Primary Productivity) and phenometric?

Climgrass, Gumpenstein, Styria, Austria

Experimental setup

FUTURE CLIMATE

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Treatments

A Ambient/Control

C Elevated CO_2 at +300 ppm

T Elevated temperature at 3°C

D Drought – using rainout shelters during Jun to Jul

Individual Effect (C, T, D)

CT Elevated CO_2 & elevated temperature (+300 ppm + 3°C)

CTD Elevated CO_2, elevated temperature & Drought (+300 ppm + 3°C + rainout shelter during Jun to Jul)

Interactive Effects (CT, CTD)

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Nadiral images

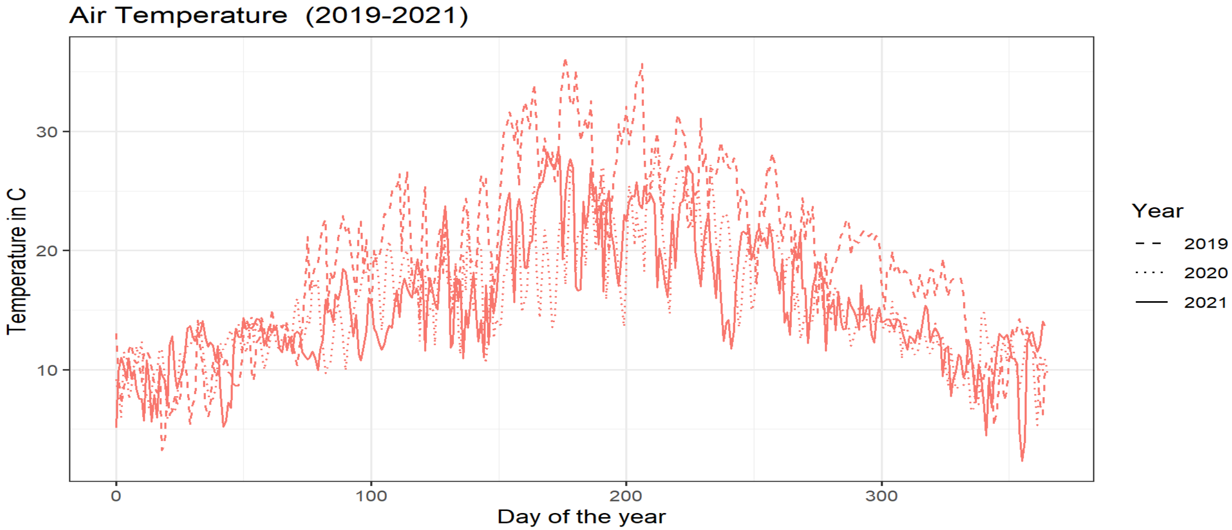
Phenopix R program

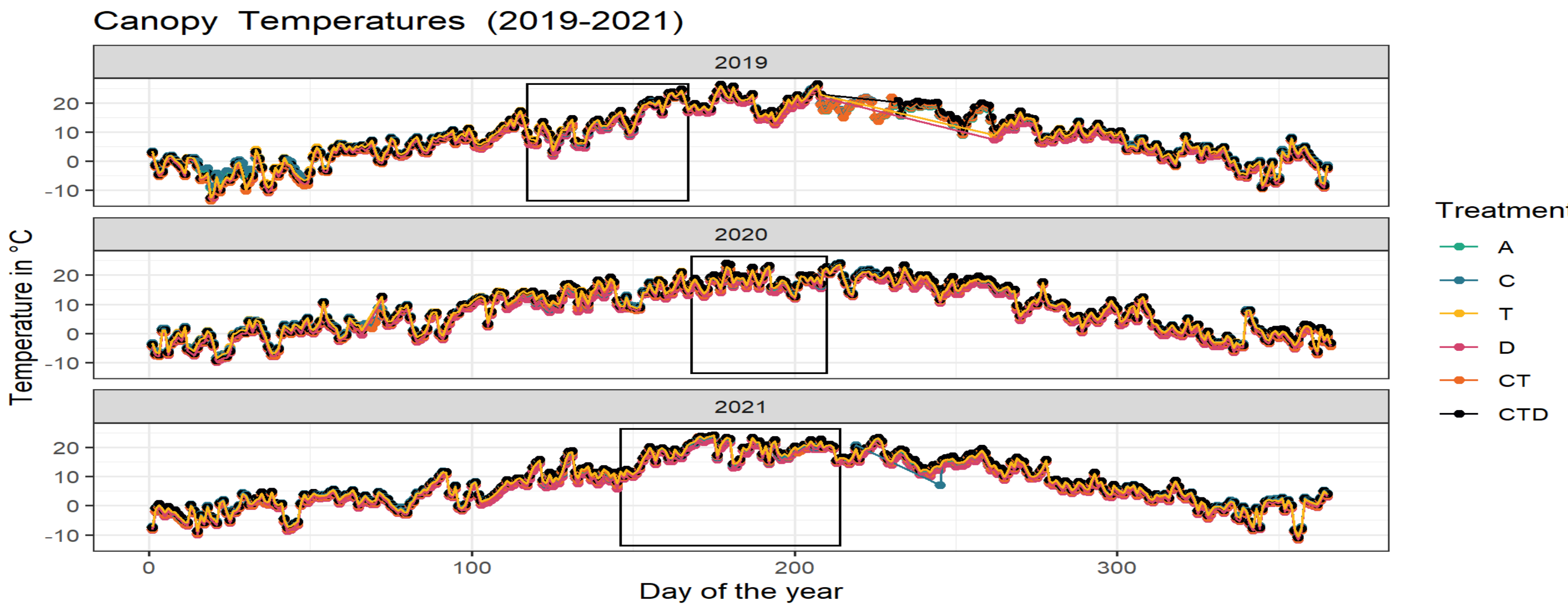
Methods

Climate data

2019-2021

Air temperature





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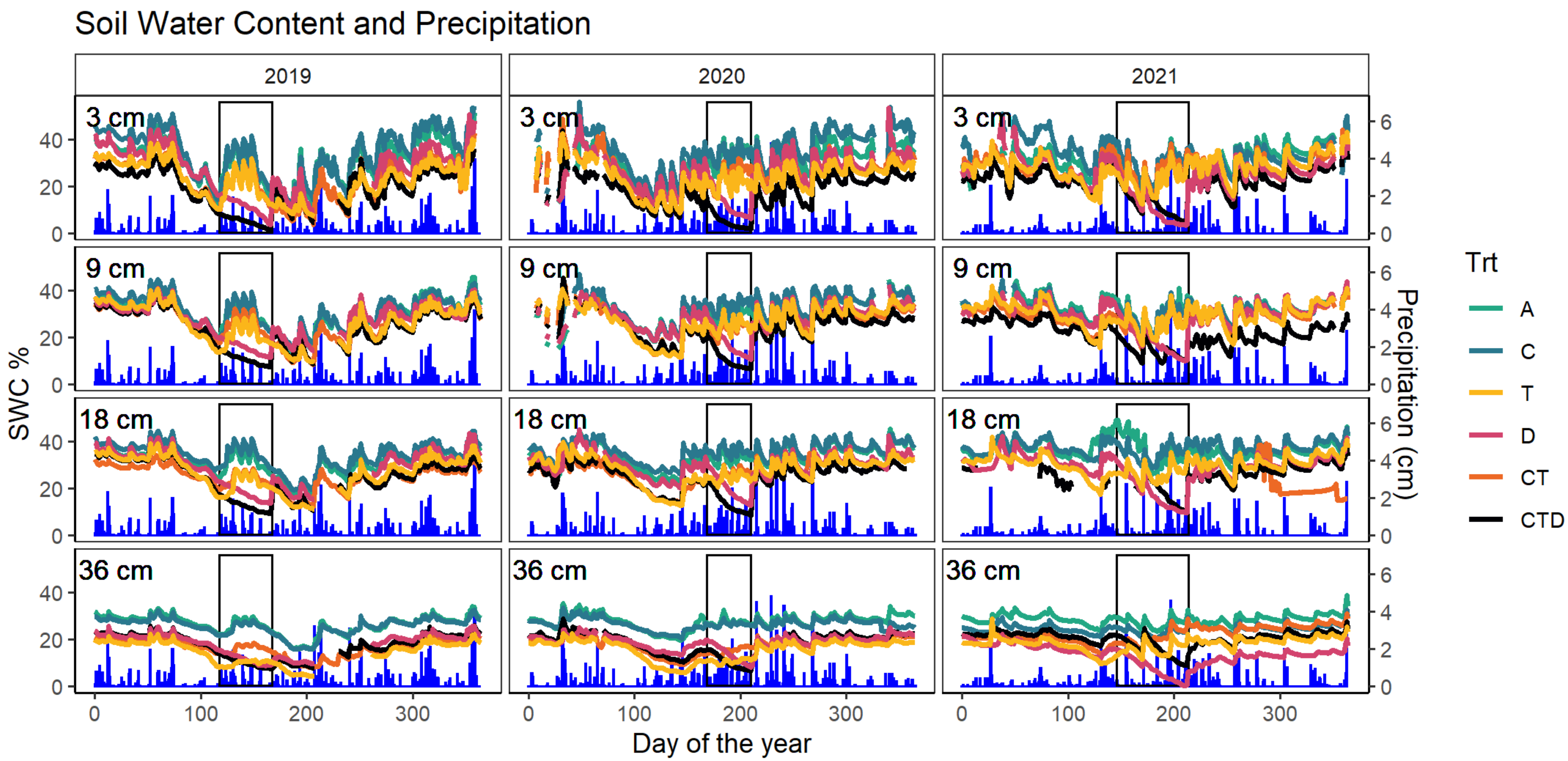
Soil Water Content and Precipitation



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Preliminary Results of the Phenocam data

2019-2021

PhenoCam

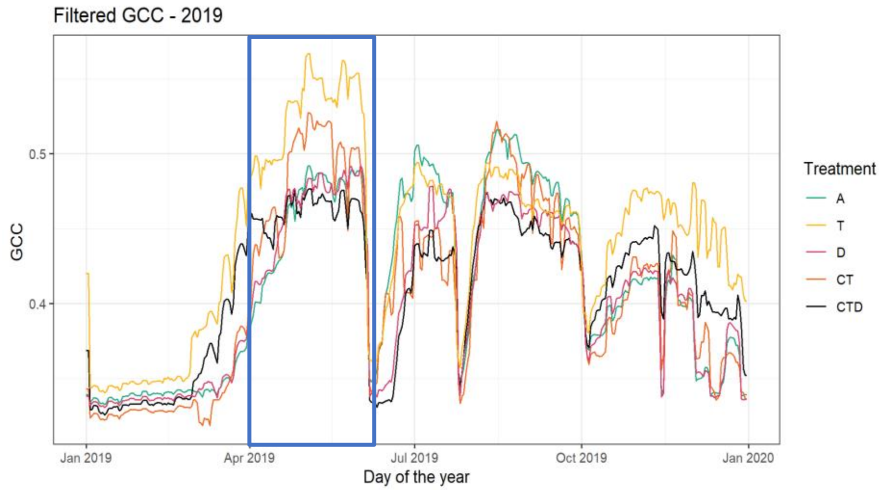
AN ECOSYSTEM PHENOLOGY CAMERA NETWORK

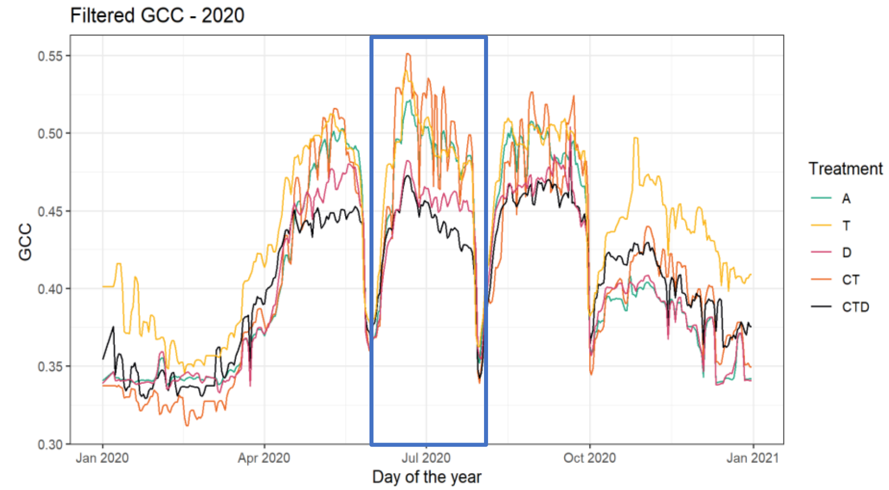
3 phases- based on cut dates

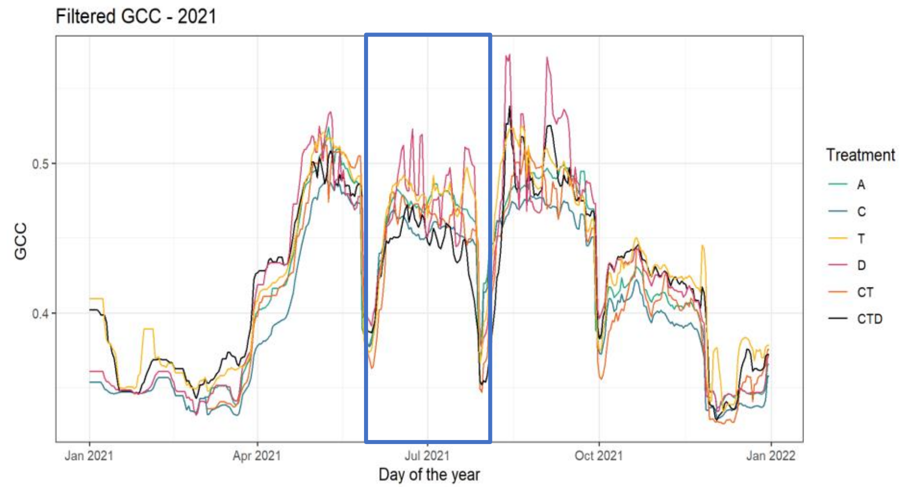
The entire years' phenocam data is classified into 3 phases

1. January to May – **spring phenological phase** (Growing period 1)
2. June to July – **peak summer drought phase** (Growing period 2)
3. August to September – **recovery or regrowth phase** (Growing period 3)

GCC Filtered Data – Phenopix R program







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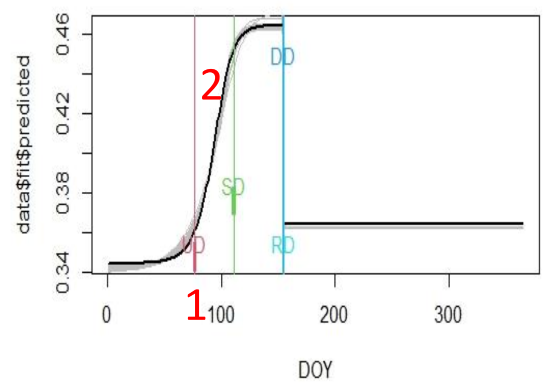
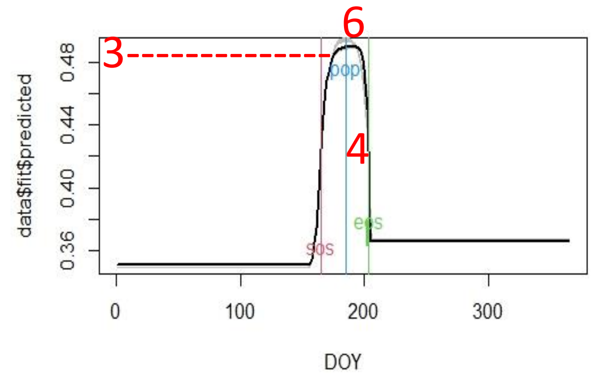
Phenometrics

1. Upturn Date/beginning of growth
2. PRR – Peak Recovery Rate
3. Peak growth
4. Area under the curve
5. Peak Reduction in percentage
6. Peak Advancement – number of days





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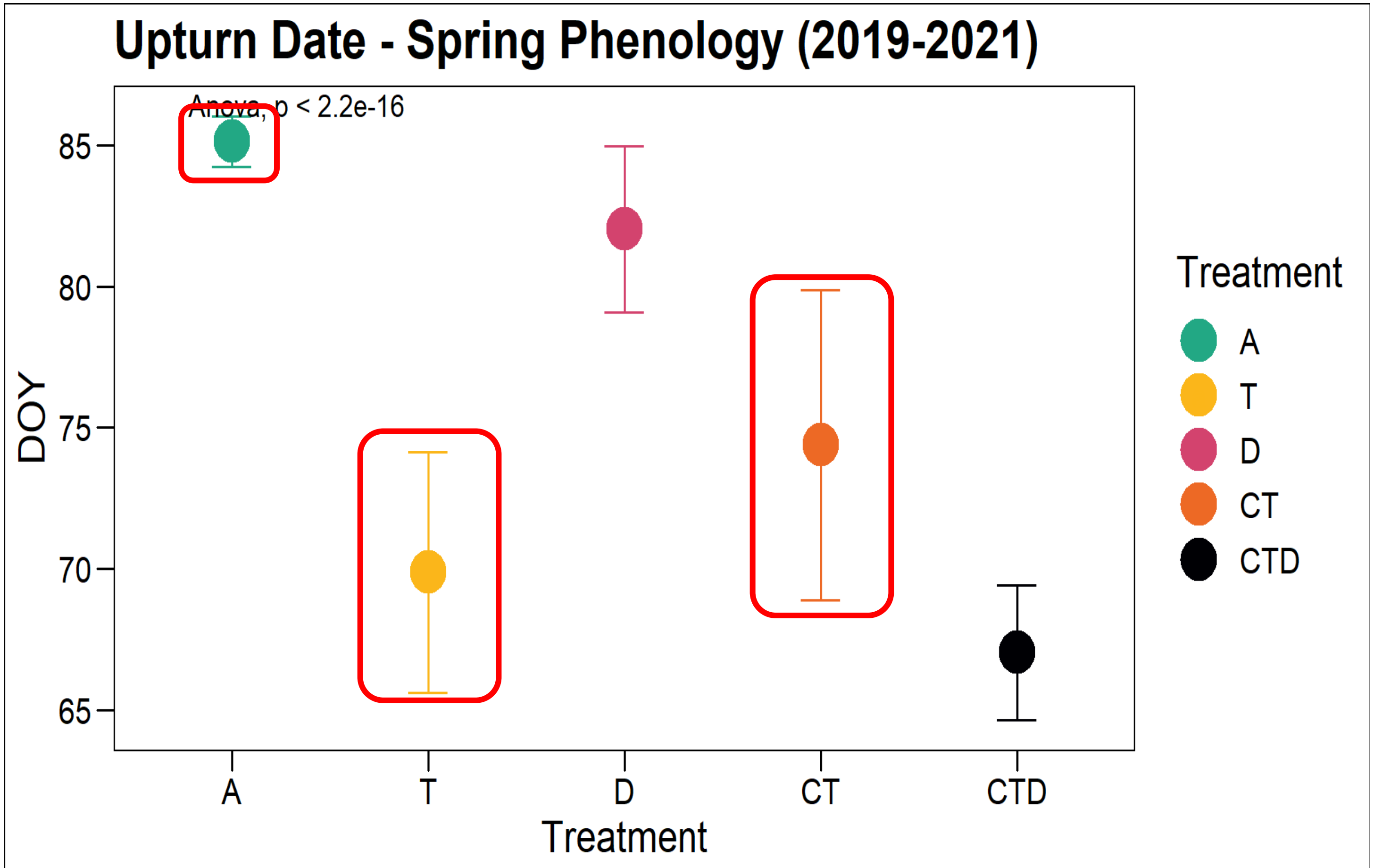
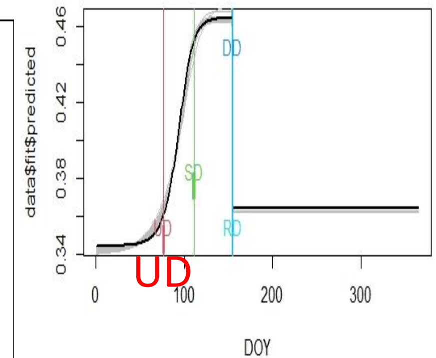
Spring Phenology
January- May

2019-2021

Upturn Date/Start of Growing period





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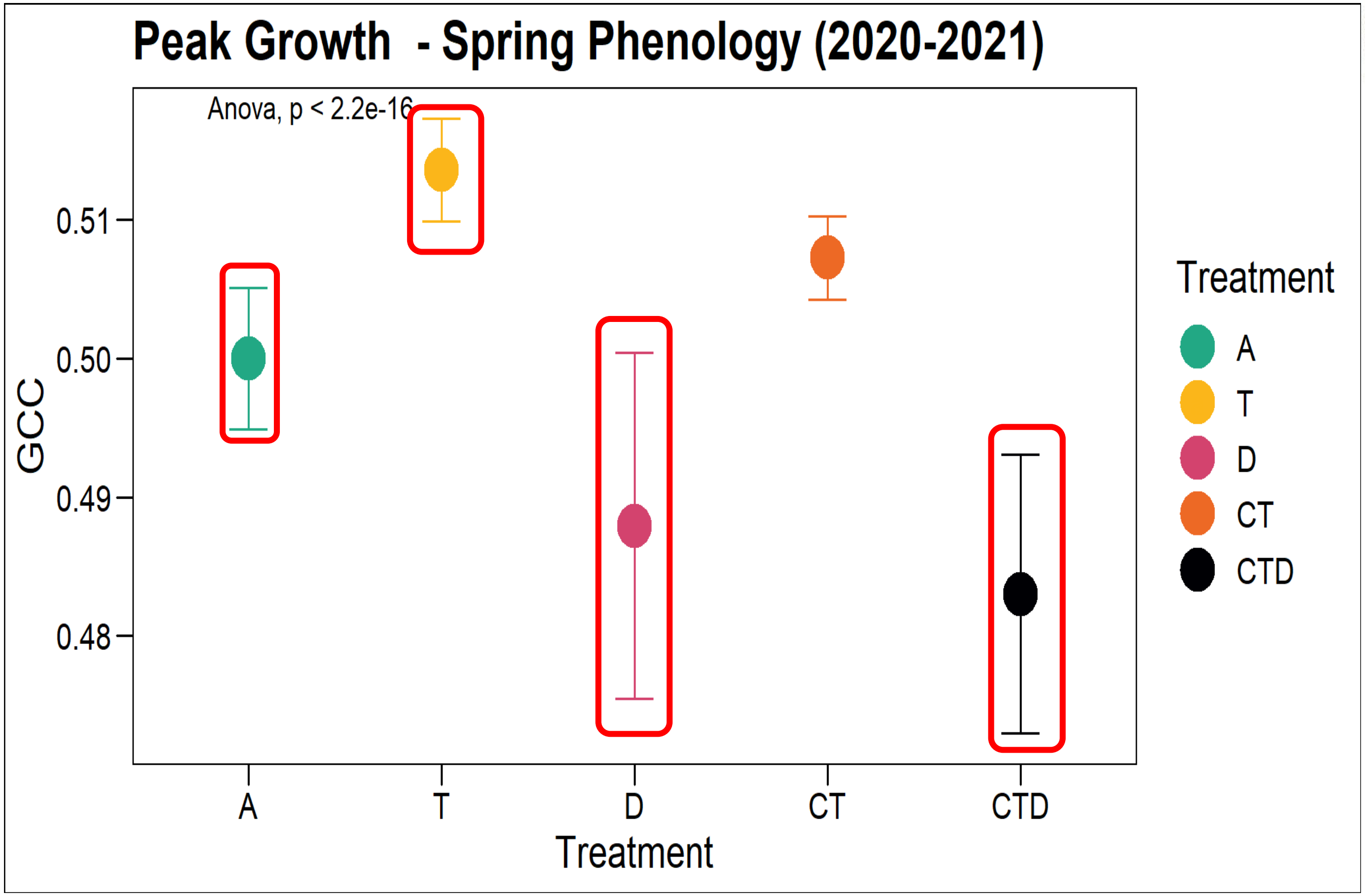
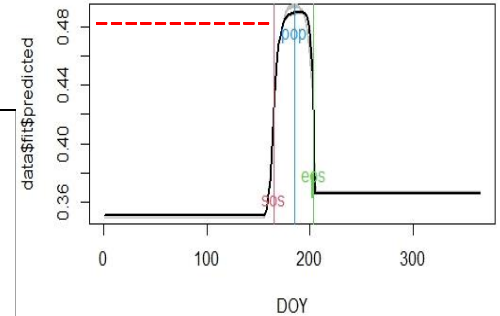
Peak Growth – highest GCC value





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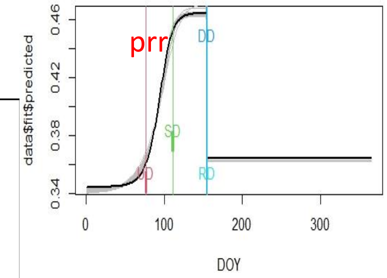
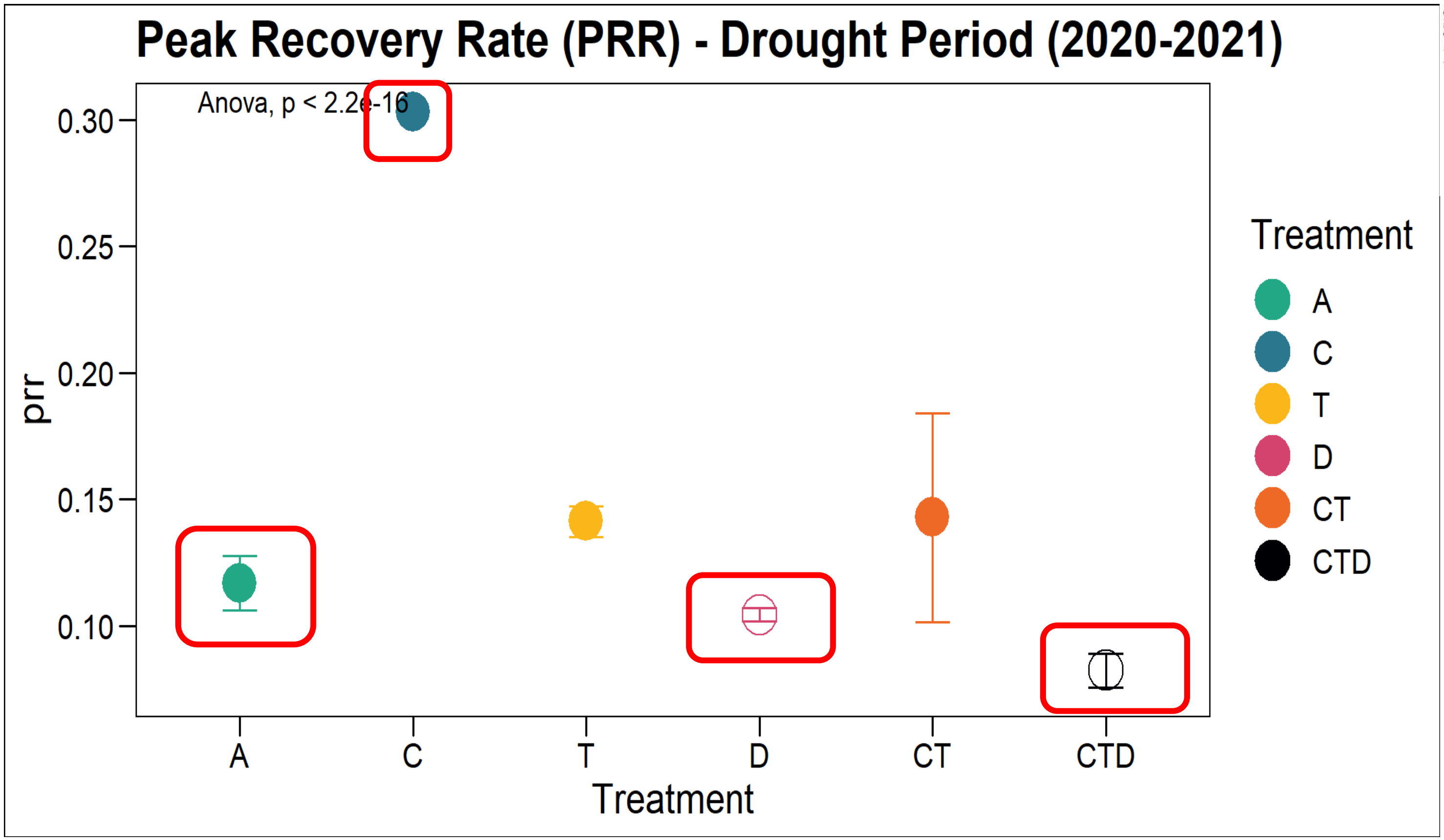
Drought Phase
June- July

2020-2021

Peak Recovery Rate – Growth speed





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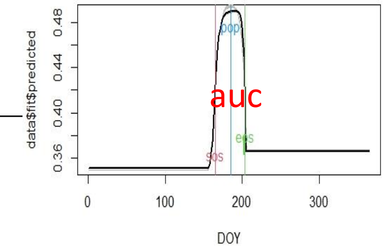
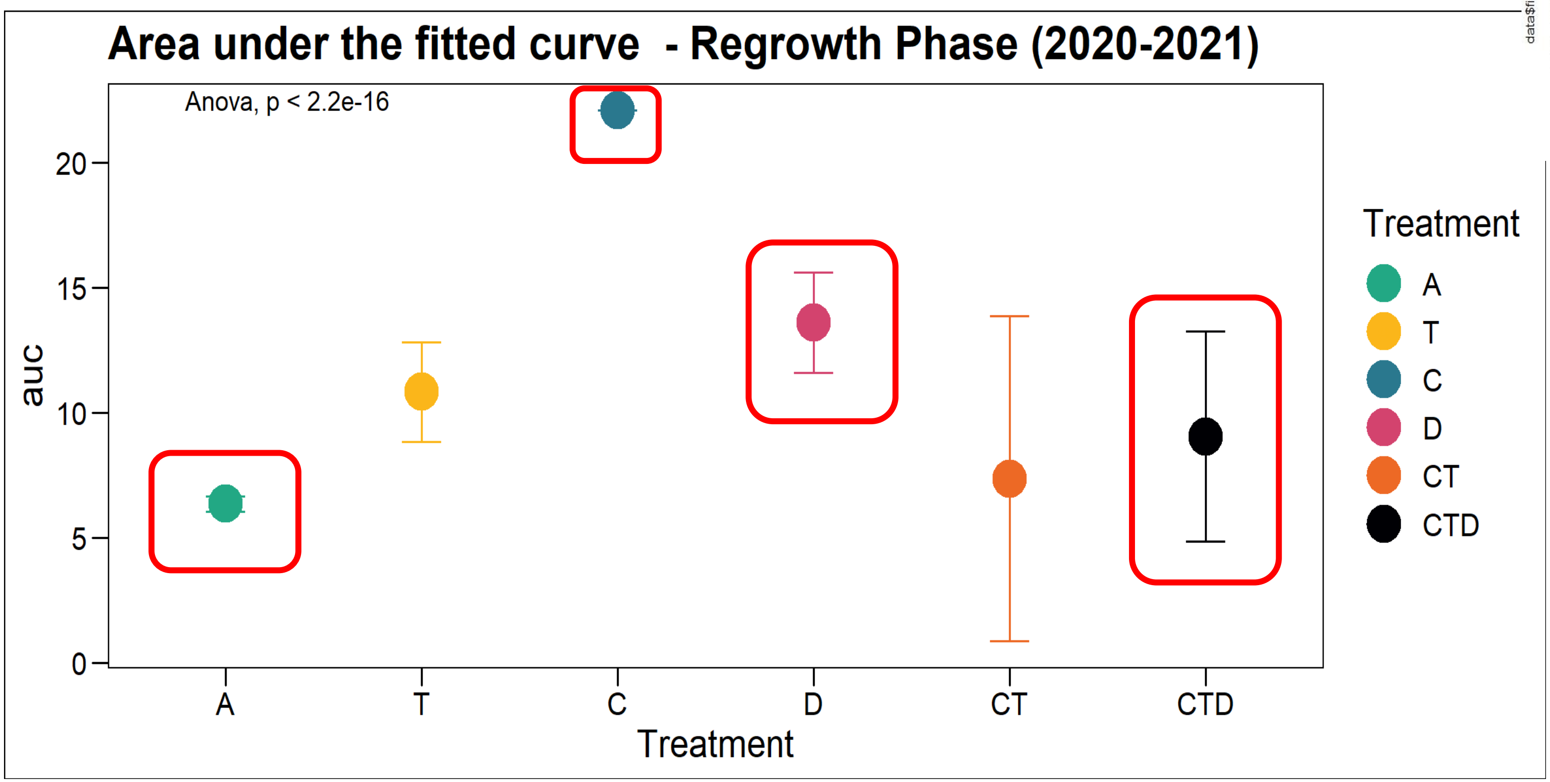
Regrowth Phase August- September

2020-2021

Area under the fitted curve from peak date till the date of cut





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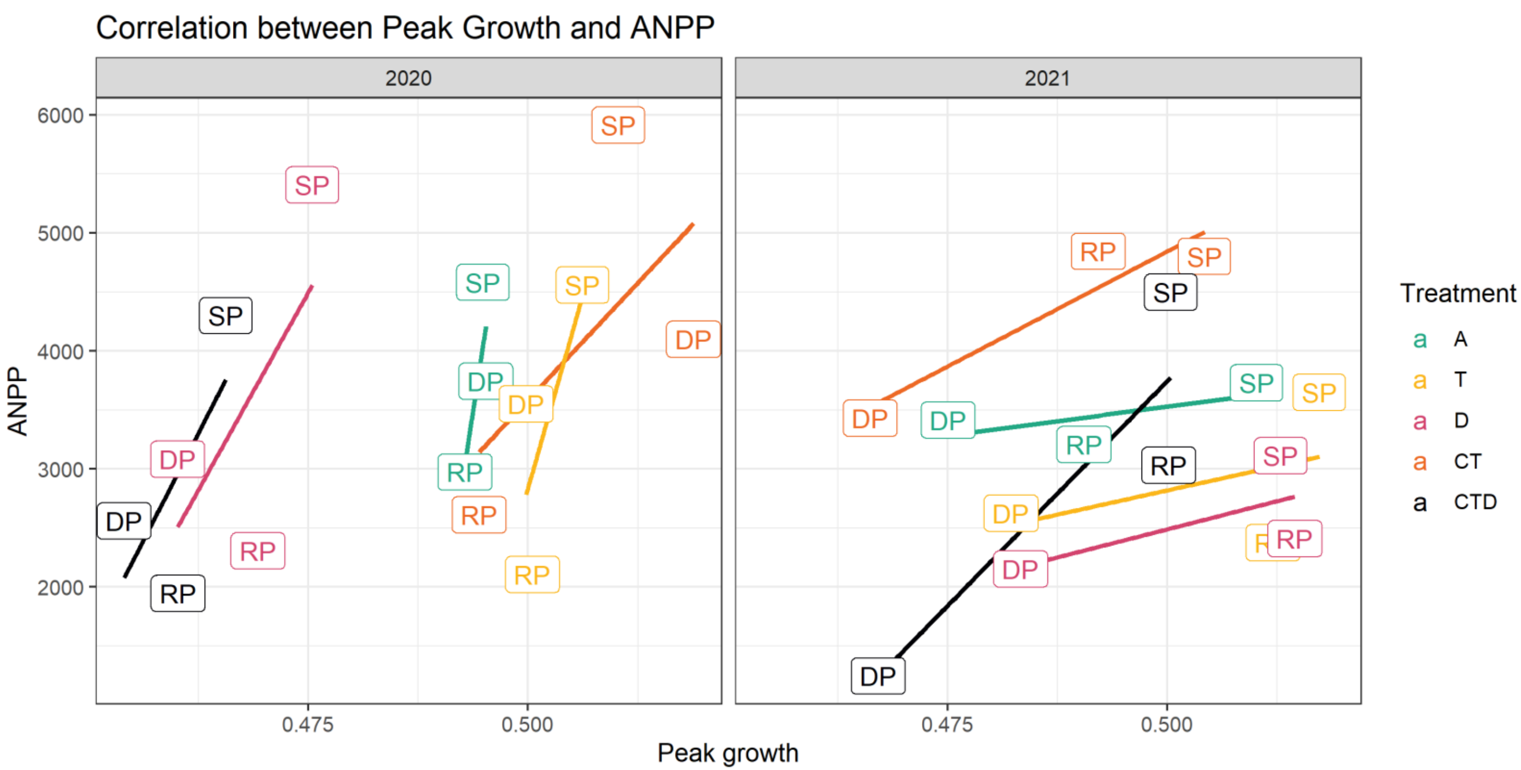
Relationship between Phenology and ANPP

2020-2021

Correlation between Peak growth and ANPP



SP- Spring Phenology
DP- Drought phase
RP- Regrowth phase

Conclusion

- **Warming advances** spring phenology both individually and in combination with CO_2 – by **10** and **15 days** respectively.
- **Elevated CO_2** drives **growth rate**.
- **Drought** individually and together with CO_2 and temperature slow down **growth rate and peak growth.**

Take home messages

- **Interactive effects are stronger than individual effect**
- **Temperature and drought are the key drivers**
- **Individual CO2 shows stronger impact**
- **There is a relationship between ANPP and Phenometrics derived from phenocam image analysis.**

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WAY FORWARD….

BBCH

Phenocam

Nadiral

CORRELATING

Phenological shifts

ANPP

ASSESSING

Effect on senescence

UNDERSTAND

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Many thanks!

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