The Effect of Climate Change on Autumn Leaf Colour

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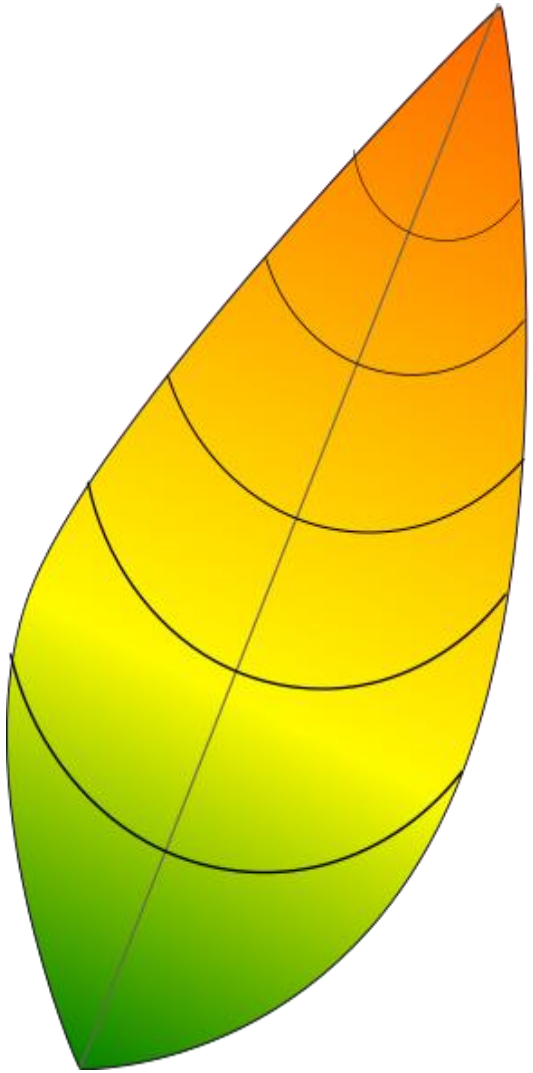
Why Leaf Colour Change?

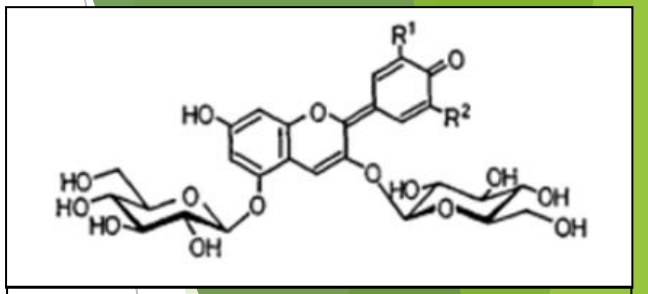
An Image of New England (Telegraph, 2016)

The Pigments

- Chlorophyll
  - Green
  - Present for most of the year
  - Used for photosynthesis
  - Concentration reduced in autumn
- Carotenoids
  - Yellow
  - Present for the whole year
  - Masked by Chlorophyll
  - Photoprotective
- Anthocyanin
  - Red
  - Produced during the autumn period
  - Photoprotective

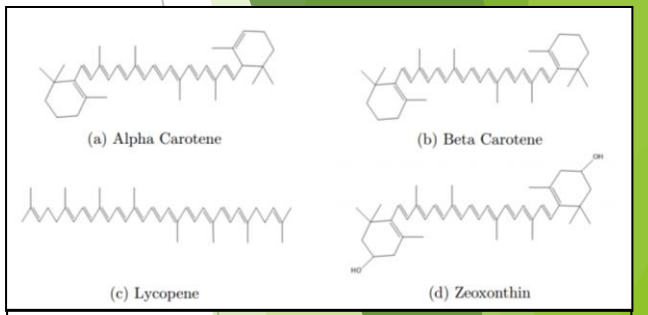


Anthocyanin



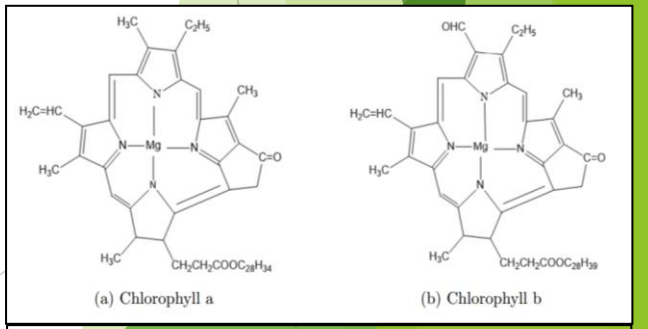
Chemical Structure of Anthocyanin (Goto and Kondo, 1991)

Carotenoids



Chemical Structure of Carotenoids (Adapted from Biswal,1995)

Chlorophyll

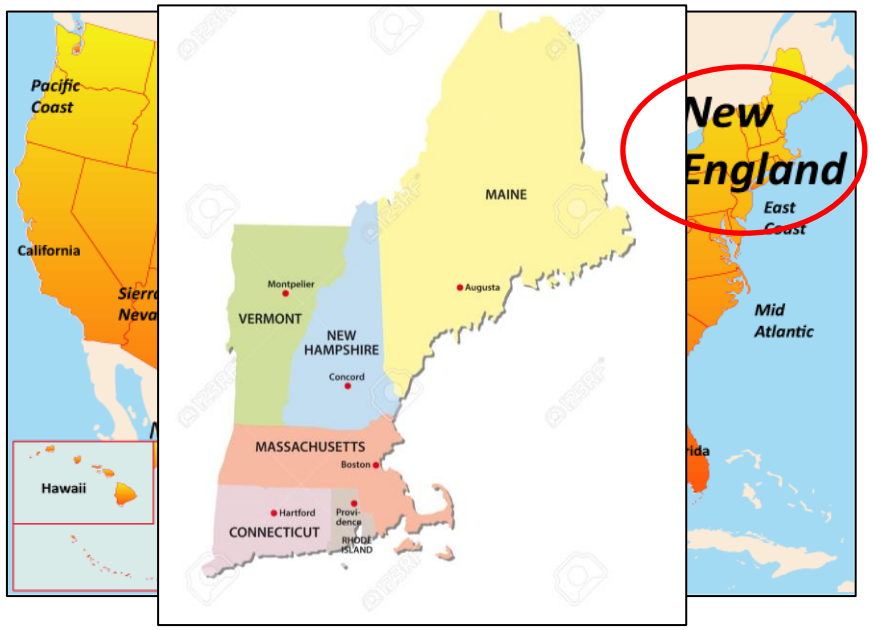


Chemical Structure of Chlorophyll (Adapted from Konwar and Baruh, 2013)

What did we do?

Method:

- Chose temperature and CO_2 concentration.
- Narrowed down our search from global to New England.
- Excluded precipitation, weather and daylight hours.
- Investigated the effect temperature and CO_2 had on our three pigments.



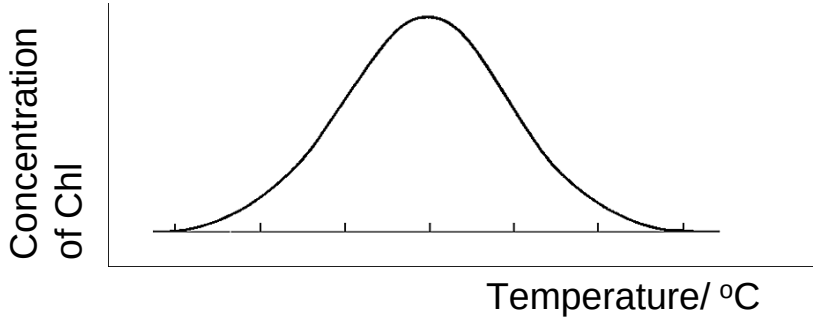
Results:

- Completed a sign test for each pigment on the literature results.
- Used the sign test results to predict how future colour change will be effected and the impacts.

Temperature and Pigments

The table below shows the effect increasing temperature has on the concentration of the 3 pigments we have looked at:

Pigment	Effect on Concentration	Sign Test Result
Chlorophyll	• Low temperature- little change • Intermediate temperature- increase • High temperature- no change	N/A
Carotenoids	Increase	96.4% certainty
Anthocyanin	Decrease	96.5% certainty

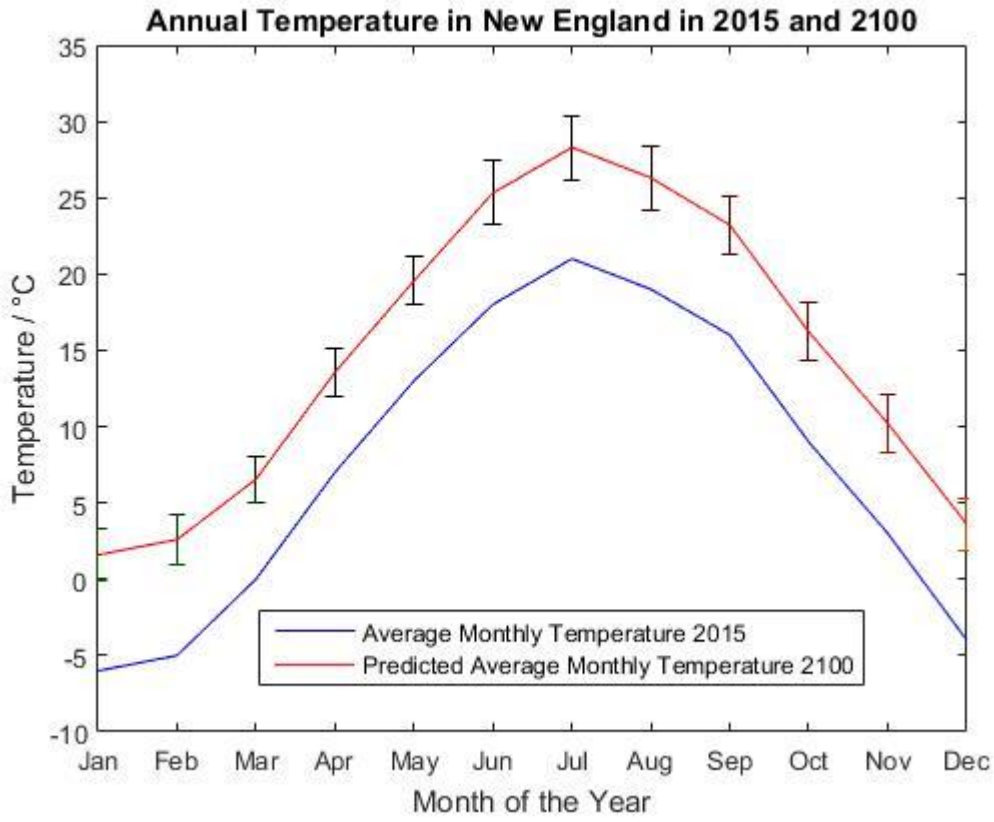


A graph to show the relationship between Chl concentration and temperature.

How will temperature change in New England?

The graph shows:

- Current average monthly temperature in New England
- Future predicted monthly temperatures in 2100
- The temperature currently associated with the onset of Autumn is 16˚C, this will be delayed by about 4 weeks by 2100.



A graph to show how temperature changes annually in New England in the years 2015 and 2100 separately.

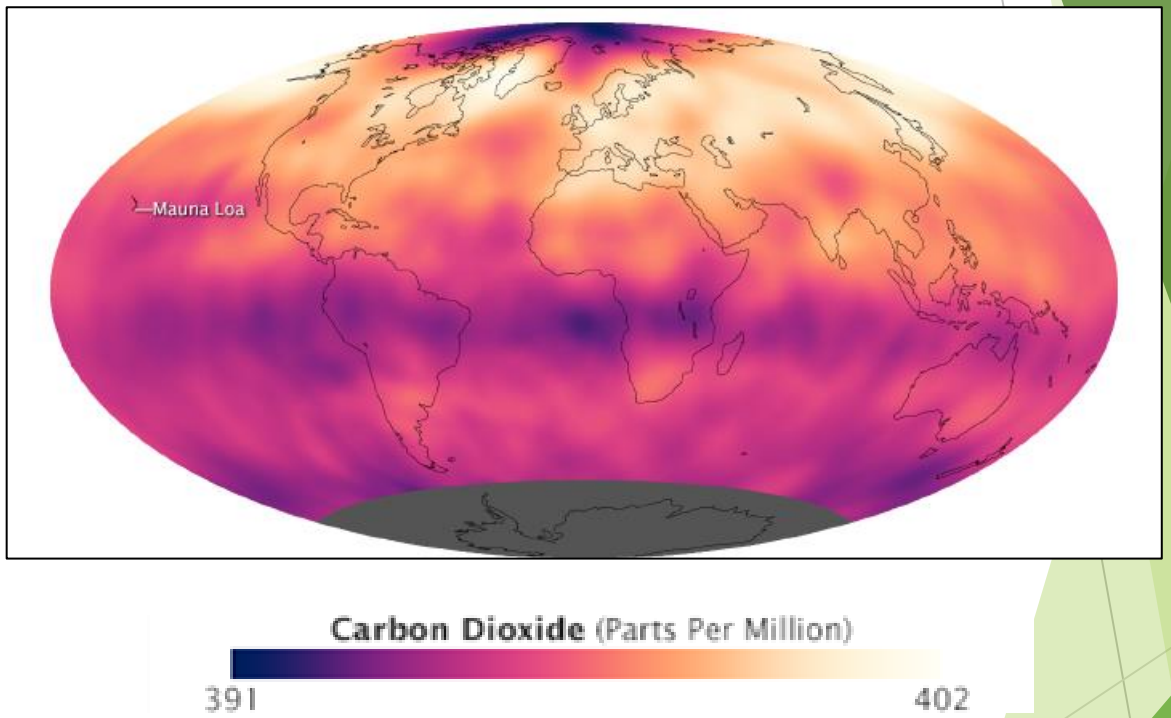
CO_2 and Pigments

The table below shows the effect increasing CO_2 has on the concentration of the 3 pigments we have looked at:

Pigment	Effect on Concentration	Sign Test Result
Chlorophyll	No concentration change, but delayed degradation. Some exceptions.	96.5% certainty
Carotenoids	Inconclusive	50% certainty
Anthocyanin	Increase	97.8% certainty

How will CO_2 change in New England?

- Can use worldwide CO_2 projections to look at New England.
- Potential pathways vary with projections ranging from 600ppm to 850ppm by the year 2100.
- Currently levels around 400ppm so a 50-112% increase can be expected.



A figure to show how atmospheric CO_2 concentration throughout the world remains relatively constant (NASA, 2013)

Autumn Onset and its Rates

- Temperature

The temperature associated with autumn onset will be delayed by approximately 4 weeks. Additionally, the rate at which the leaf changes colour is faster.

- CO_2

The autumn onset is further delayed and the rate at which the leaf changes colour from yellow to red is faster.

- Overall

Autumn onset will be delayed by 4 weeks or more with a faster rate at which the leaf changes colour.

Why is this relevant?

The impacts are;

- Globally:

Carbon sequestration - delayed leaf colour change, longer growing season, increased carbon sequestration, decreased carbon dioxide concentration

Albedo - delayed leaf colour change, decreased albedo, positive radiative forcing, increased temperature

- New England:

“Autumn foliage tourism” - longer growing season, delayed leaf colour change, shorter tourism season, decreased tourism industry

Biological Impacts:

- Some animals respond to the UV/VIS light reflected from leaves which affects mating and migratory patterns
- many animals rely on leaves as their food source. The later onset of autumn means animals will have a food source for longer.

Moose (All About Moose, 2016)

Leaf Miner (Plant Natural, 2016)

Yellow-Bellied Sap Sucker (Huffman, L., 2016)

References

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Thank you for Listening

Any Questions?