Why to be interested in seasonal (phenology) changes of trees and carbon cycle?

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- What is Phenology
- Phenology in past and present
- Importance and use of phenological observations
- Phenology in the GLOBE Program

- Phenological research in the Czech Hydrometeorological institute – cooperation, results and application

- Connection between Phenology and carbon cycle
- Introduction to carbon cycle studies and activities

What is Phenology?

Look deep into nature, and then you will understand everything better. (Albert Einstein)

- Greek words phaino (to show or appear) and logos (to study)
- Study of living organisms' response to seasonal and climatic changes in the environment
- Phytophenology x zoophenology

How does a plant know when to start blooming?
How a bear knows when to hibernate?

How a bear knows when to hibernate?

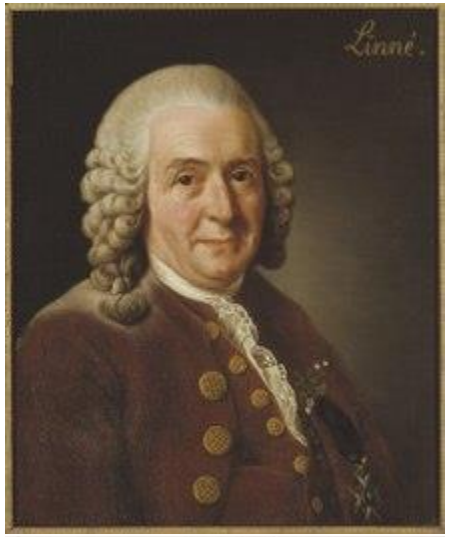
- Phenophases
  - events repeated year after year
  - never exactly the same

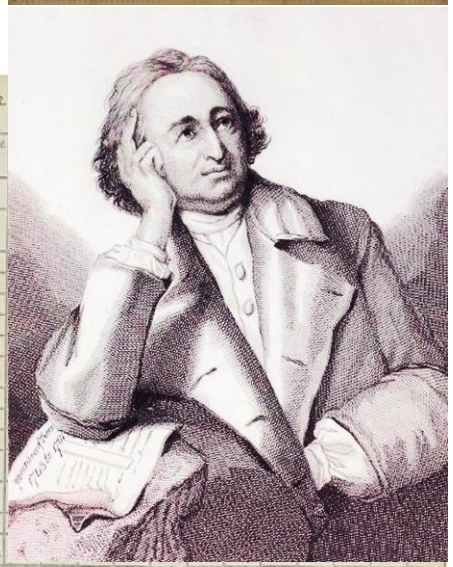
- Factors
  - the length of the day and its periodic change
  - climatic
  - pedological
  - geomorphological

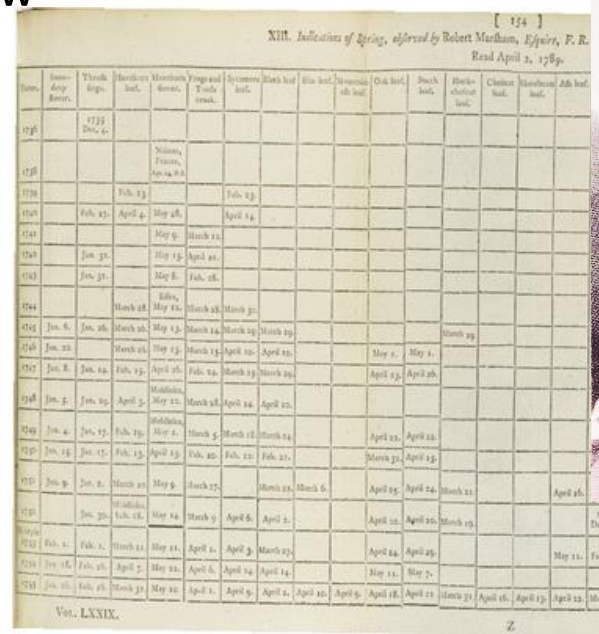
Source: https://pin.it/MFFBSfc

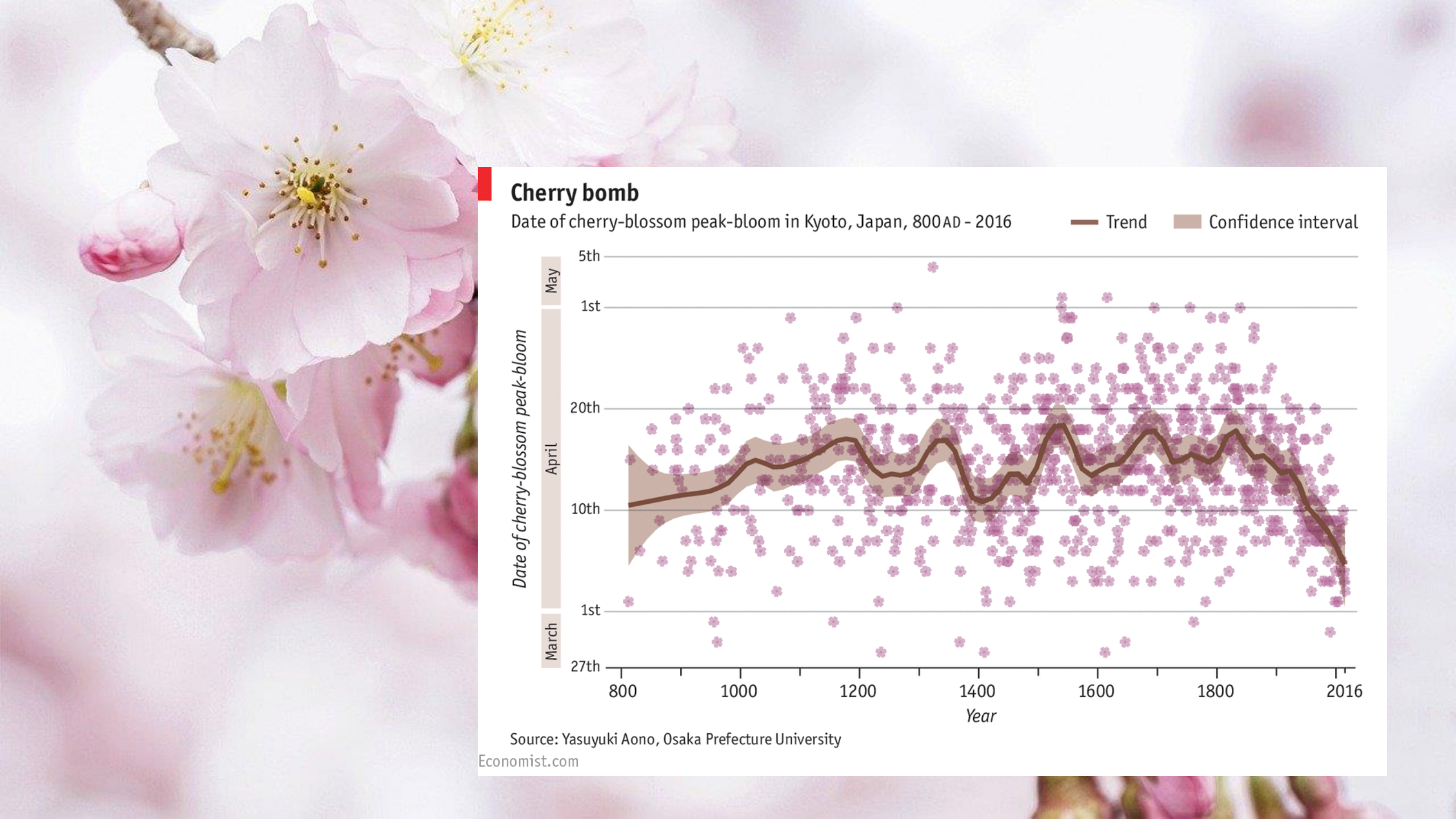
Long History of Phenology

- One of the oldest areas of environmental science
- Understanding of nature - crucial for survival
- Observations expressed in proverbs
  - It is not summer until the crickets sing.
  - When the fall of the leaves comes late, the harsh winter is coming.
  - A cold and moist April fills the cellar and fattens the cow
- Written records from China since 974 B.C.E
- Japan - records of cherry blossom for 1200 years
- Founders of Phenology
  - Carl von Linné - first network of stations
  - Robert Marsham – citizen science



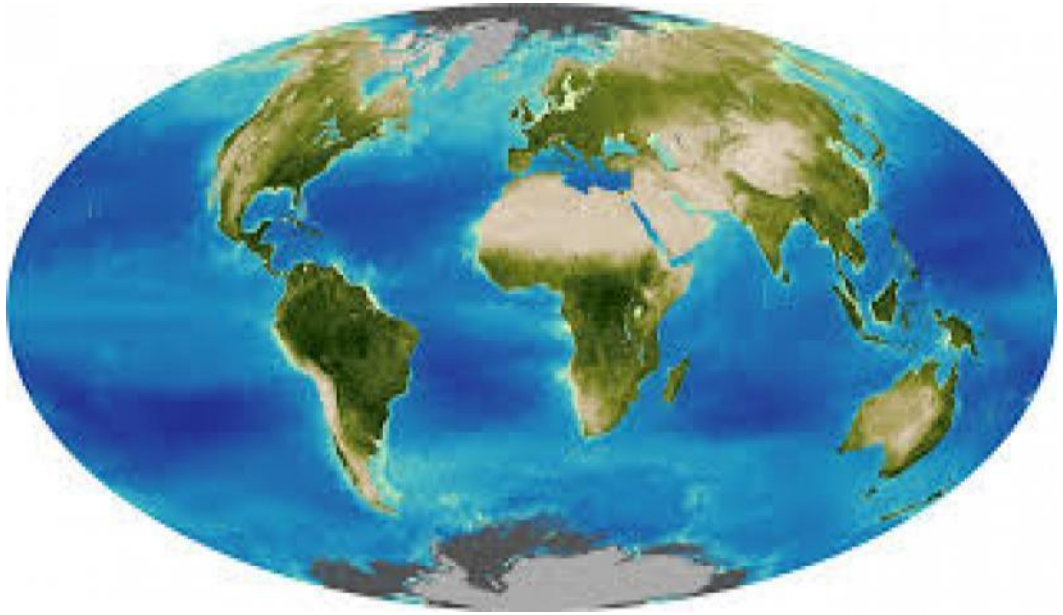





Cherry bomb
Date of cherry-blossom peak-bloom in Kyoto, Japan, 800AD - 2016
Trend
Confidence interval
Date of cherry-blossom peak-bloom
May
April
March
5th
1st
20th
10th
1st
27th
800
1000
1200
1400
1600
1800
2016
Year
Source: Yasuyuki Aono, Osaka Prefecture University
Economist.com

Phenology Today

- source of information for scientists
  - understanding the annual cycles of plants and animals
  - the report on climate change
- international cooperation
- growing interest
- volunteer activities



Phenological Data at Global level

- Onset of seasons across the continents
- Interpreting satellite data
- Calculation of vegetation season length and timing – global fixation of CO_2
- Climate change monitoring

In which fields are phenological data applied on local level?

Credit: MODIS Land Rapid Response Team, NASA GSFC

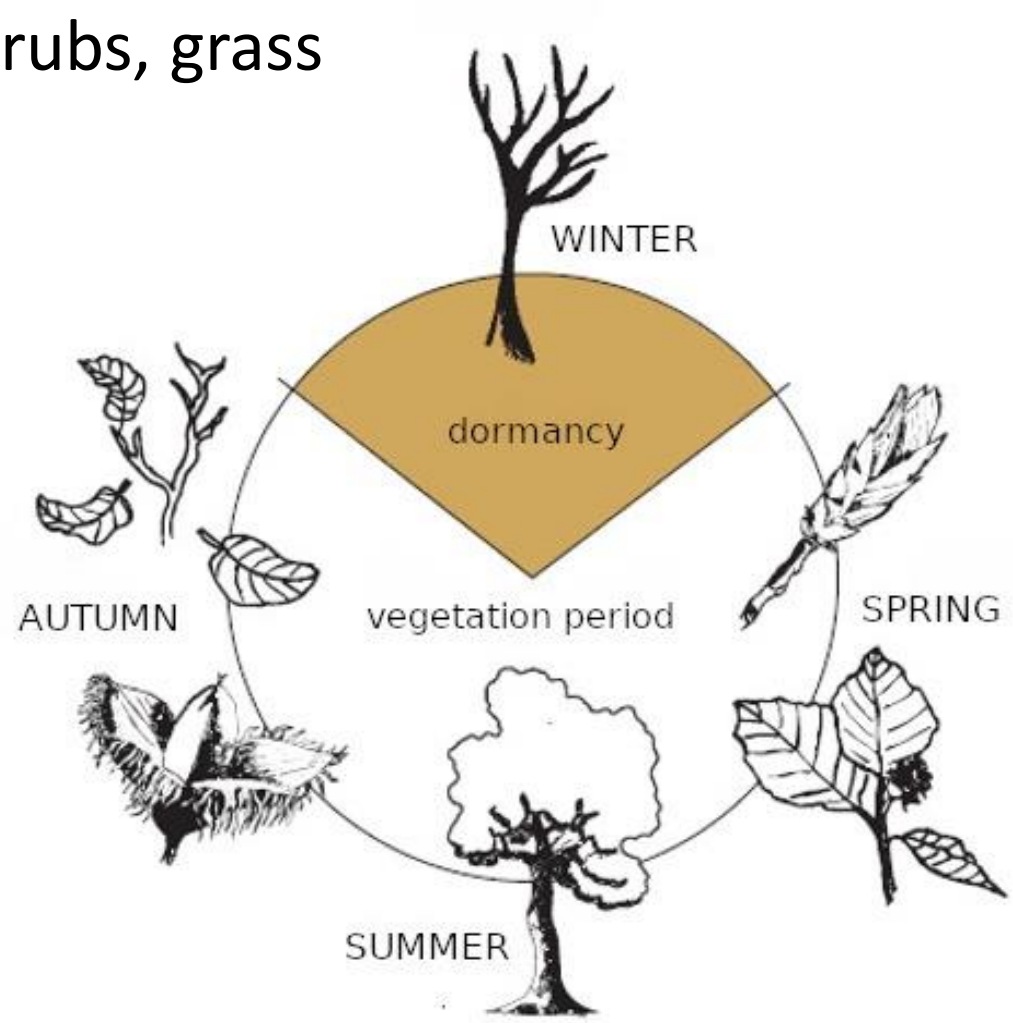
Phenological Data at Local Level

- adaptation to variations
- agriculture – sowing, harvest, application of insect pest control products
- forestry – recognition of climatic conditions of forrest areas
- medicine – pollen information
- remote sensing – land cover
- tourism

Phenology in the GLOBE Program

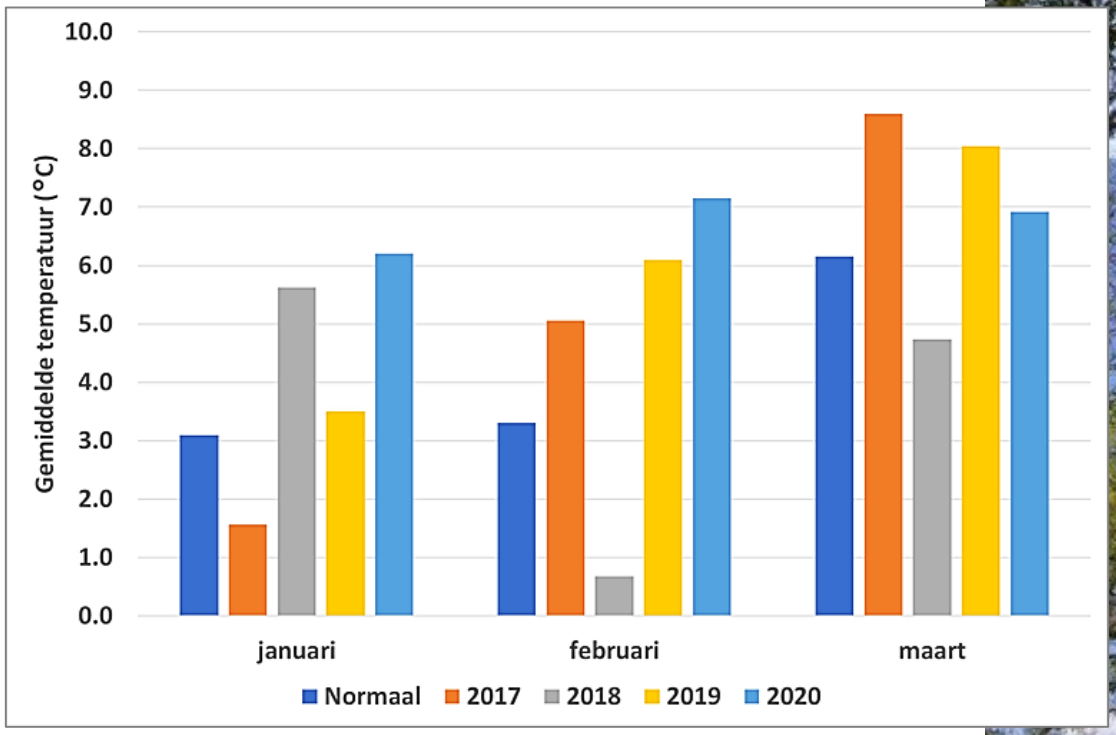
- Green Up and Green Down - Trees and shrubs, grass
- Lilac Phenology

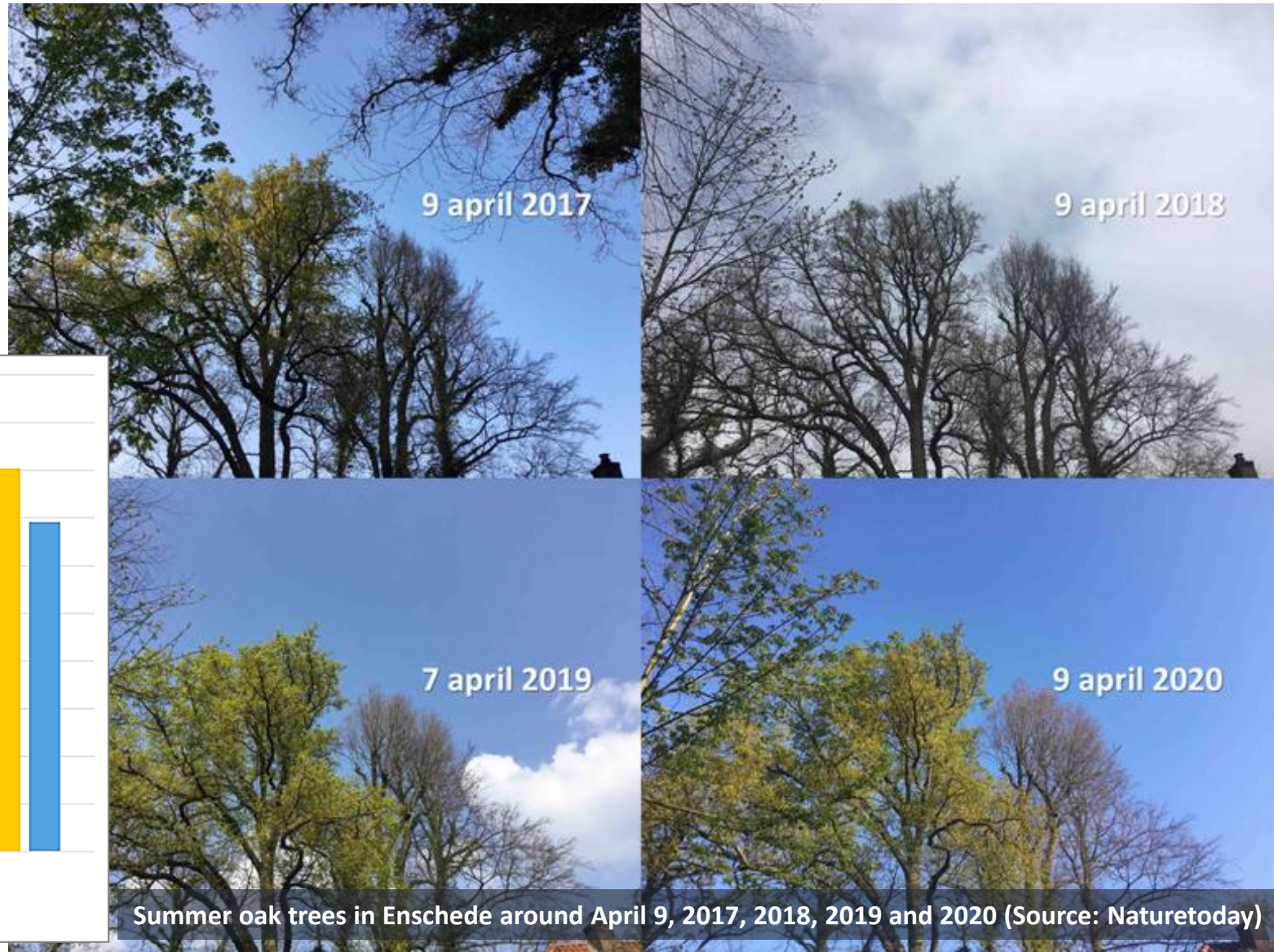
- Phenology Campaign, Grow App



How early is 2020?

- Naturetoday.com
- Wageningen University
- Grow App – schools research





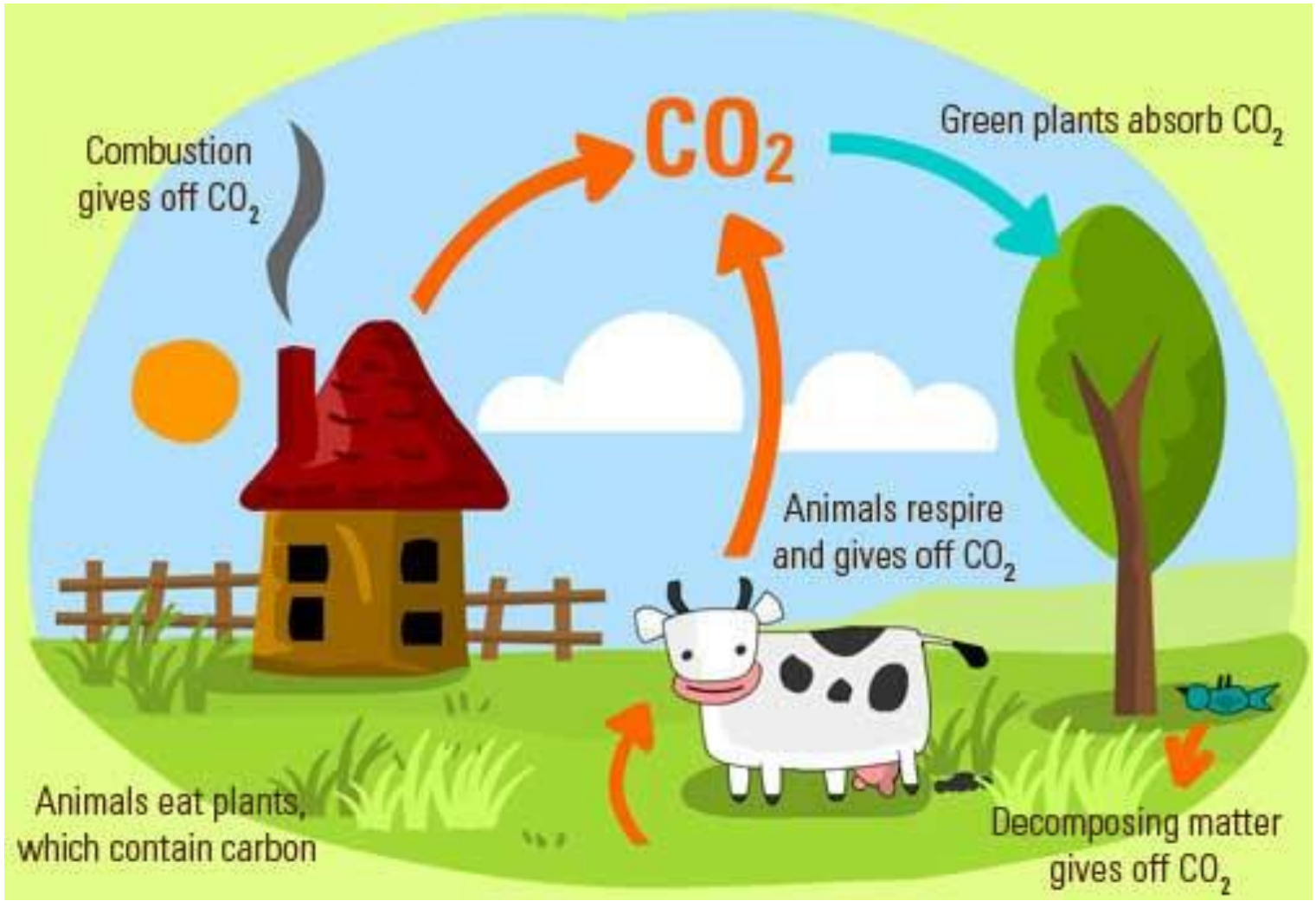
Summer oak trees in Enschede around April 9, 2017, 2018, 2019 and 2020 (Source: Naturetoday)

Phenology and Carbon Cycle

Which one is the carbon cycle?

Source: http://cycle.yorkshire.com/

This is the Carbon Cycle!



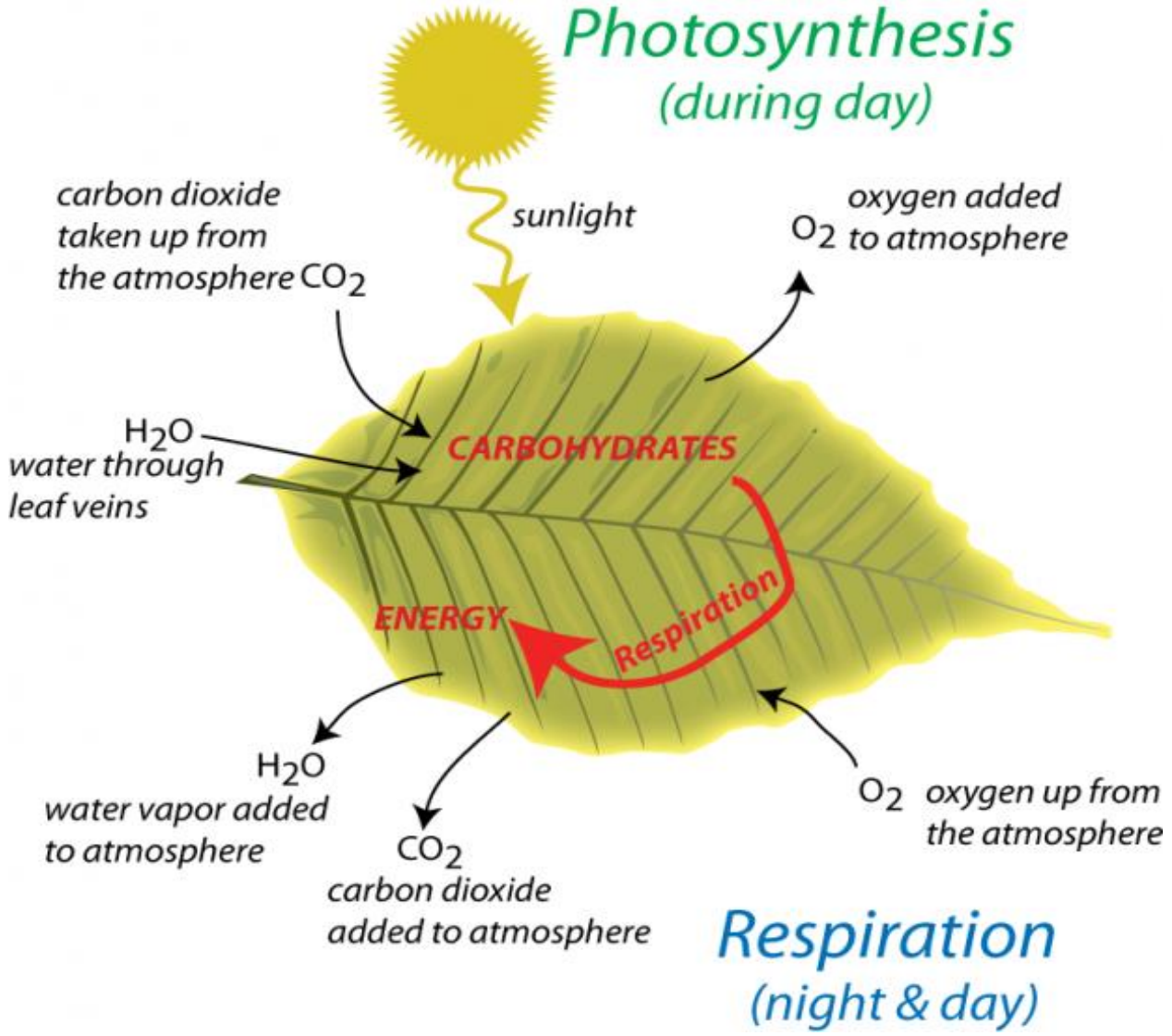
Source: http://eschooltoday.com/our-ecosystems/the-carbon-cycle.html

Why do we talk about Carbon Cycle in connection to trees?

The Magic of Plants

The most effective solar panel!

Transforms the energy from sun to a chemical energy.



Source: course Earth in the Future, PennState, https://www.e-education.psu.edu/earth103/node/1020

Carbon in Trees

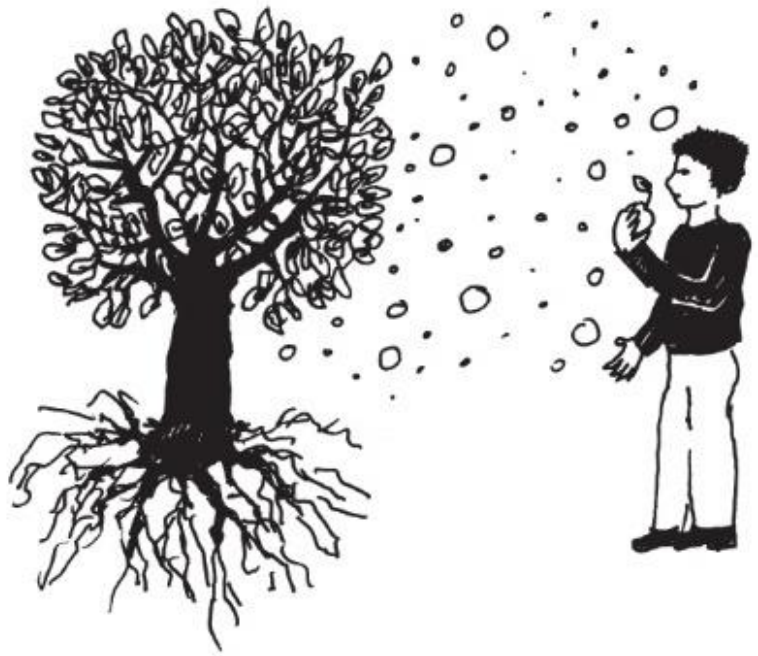
- Trees bind a large amount of carbon dioxide and water.

carbon dioxide + water + energy from the Sun → glucose + oxygen

= photosynthesis

- Carbon is transformed into leaves and wood.

→ Activity 1 Tree Growth Game



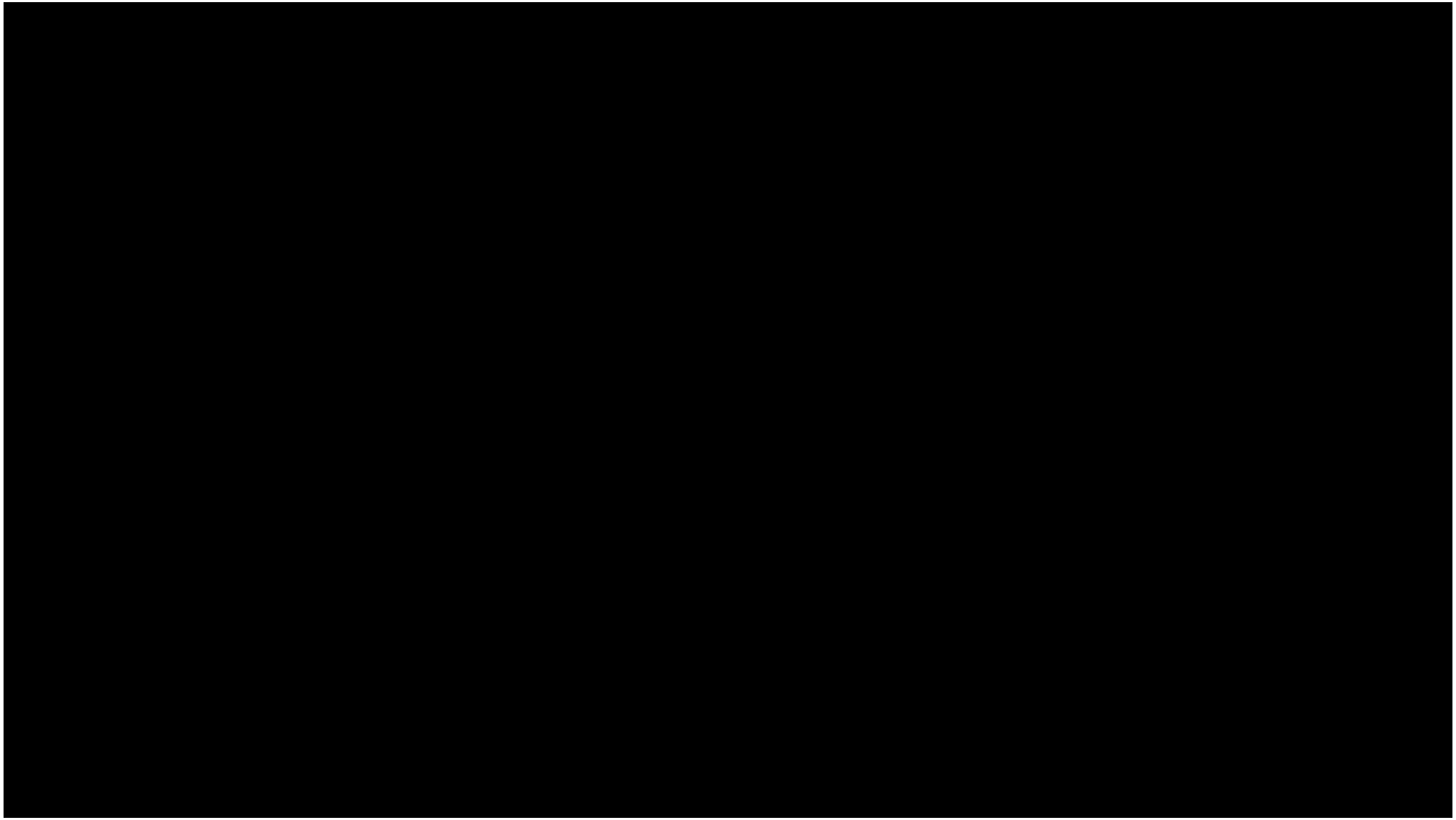
Where else can you find carbon?

Carbon is everywhere!

- Carbon
  - basic building block of life - 45-50% of the total mass of the biosphere
  - everywhere on Earth - stored in ocean, atmosphere and crust

- Cycle of carbon
  - key regulator of Earth's climate system
  - central to ecosystem function – food chains…

Carbon cycle pools and fluxes

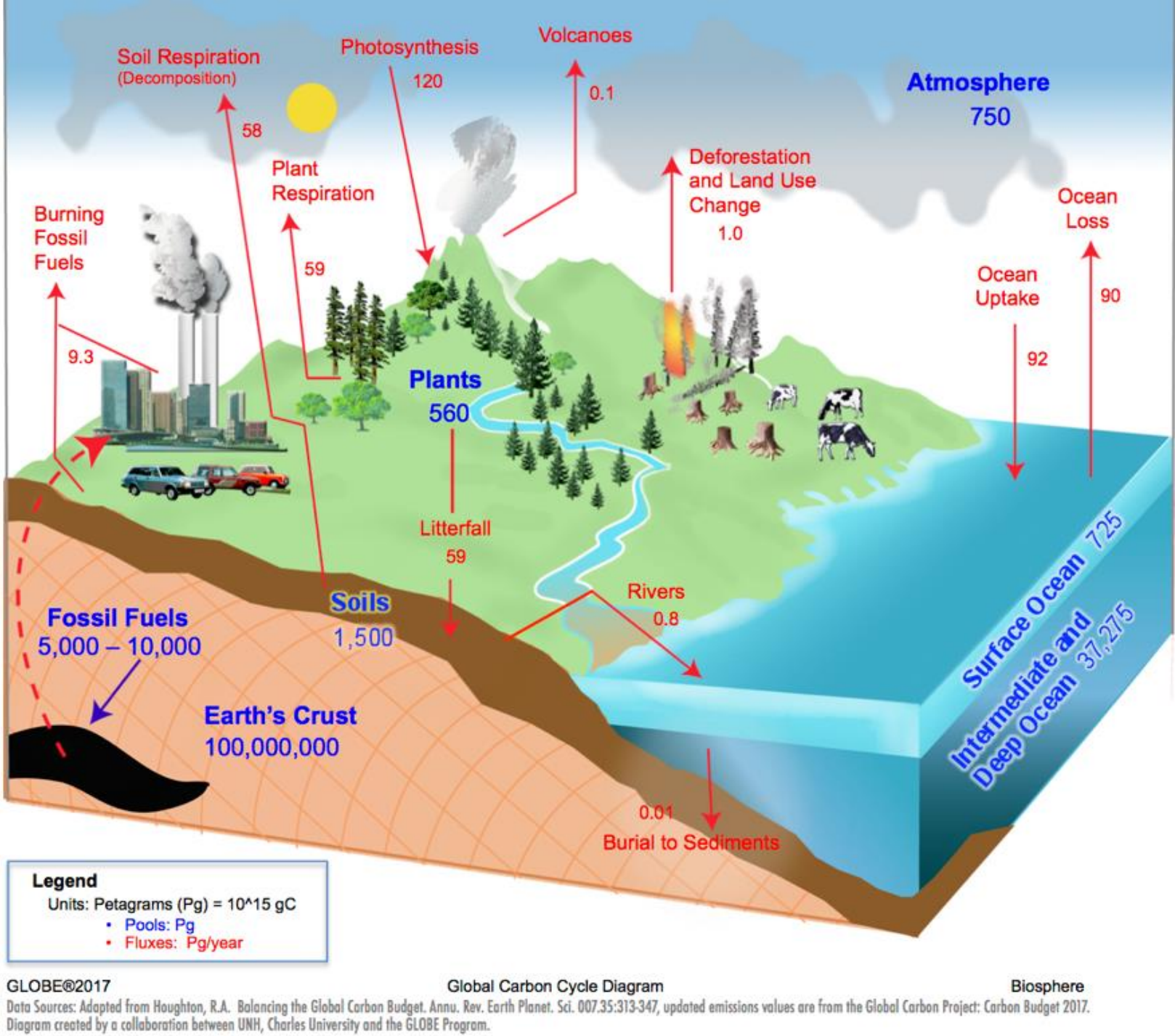


Source: NASA, https://www.youtube.com/watch?v=OByqdUhWERk

- the movement of carbon between Earth's spheres
- fluxes / pools

Think about carbon sources, fluxes, pools in your area

→ activity 2




CARBON RELEASE
CARBON UPTAKE
OUR SCHOOL

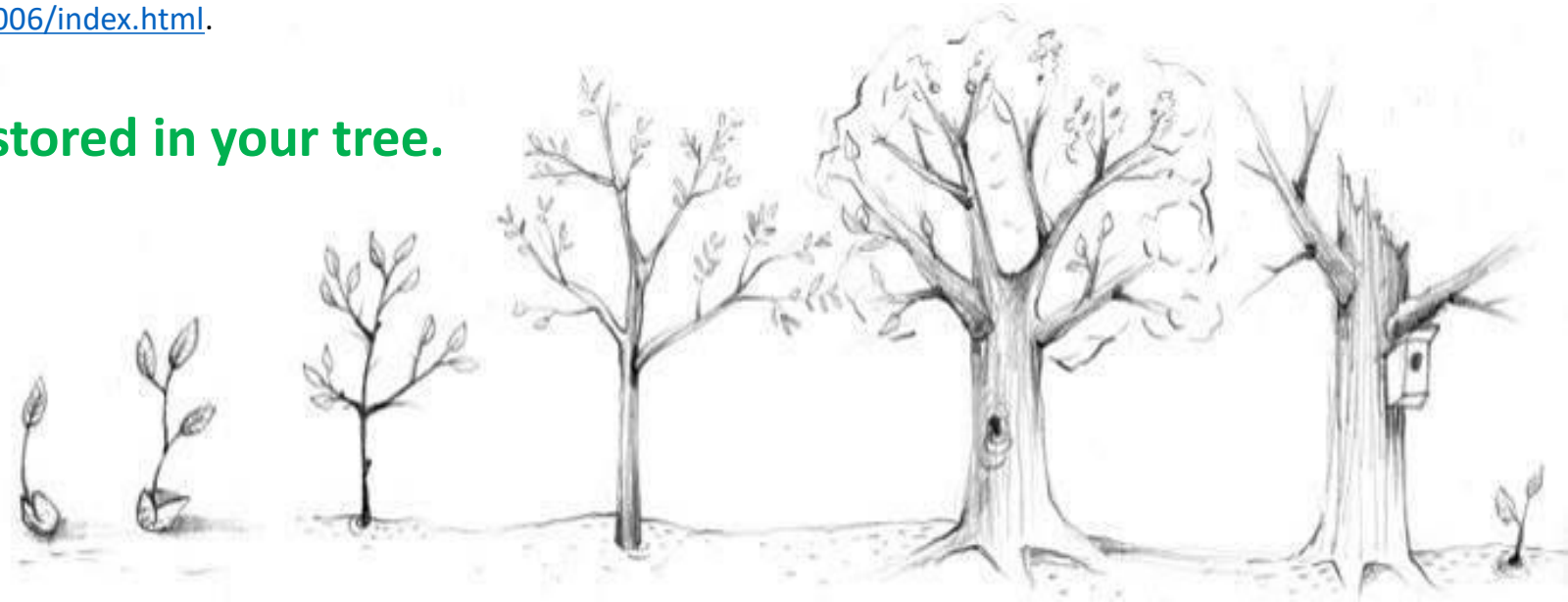
Carbon in a Life of Tree

- The CO_2 balance (carbon intake vs. release) changes over tree life cycle.
  - Young tree - a natural carbon storage
  - Adult mature tree - the carbon stored in the wood increases very slowly
  - Aging tree - the CO_2 balance comes close to zero
  - Dead tree - carbon gradually released to the soil and into the air.

NASA visualisation:
https://svs.gsfc.nasa.gov/vis/a010000/a010000/a010006/index.html.

Calculate, how much carbon is stored in your tree.

→ activity 3



What time of the year a tree builds in the biggest amount of carbon into their biomass?

Watching the Earth´s Metabolism

What we see on the video:

The greener the color, the bigger amount of CO2 is built in by plants in that time of the year.

net primary productivity = how much CO2 vegetation takes in during photosynthesis minus how much CO2 the plants release during respiration

The data come from (MODIS) on NASA's Terra satellite. Values range from near 0 grams of carbon per square meter per day to 6.5 grams per square meter per day (dark green).

A negative value means that more carbon was released to the atmosphere than the plants took in (due to decomposition or respiration)

Source: NASA, https://earthobservatory.nasa.gov/global-maps/MOD17A2_M_PSN

How Much Carbon do Plants Take from the Atmosphere?

This is a similar video as at the previous slide, just different timescale:

Source: NASA, https://www.youtube.com/watch?v=AFTm1RzrOHU

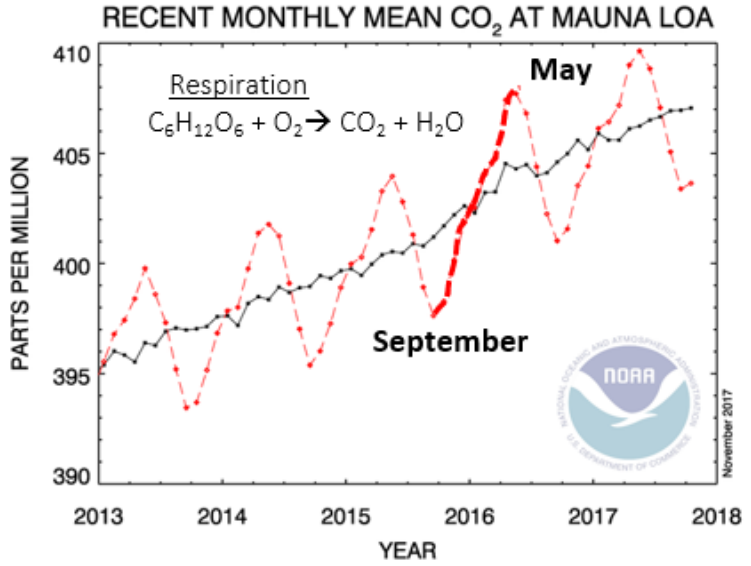
Role of Trees in Global Carbon Cycle

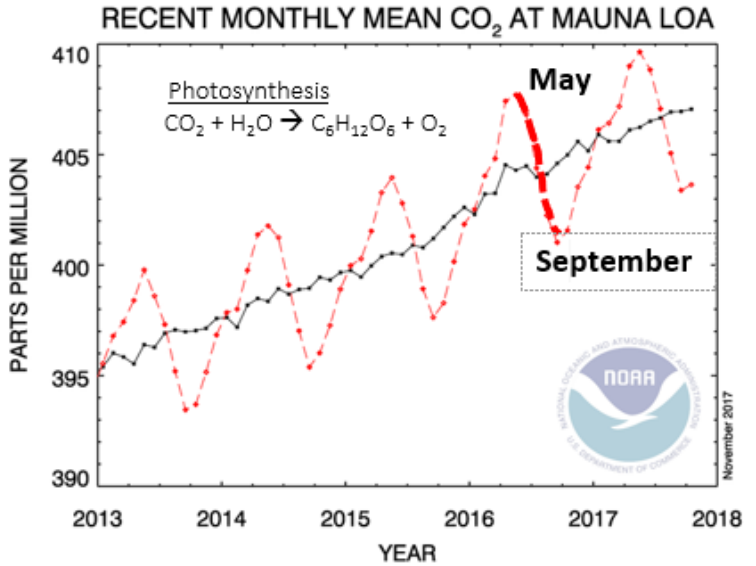
- **Forests keep amount of carbon in balance** - exchange carbon between air, plants, animals and soil
- **Trees of the northern hemisphere** influence carbon cycle of the whole planet

- CO_2 level oscilation corresponds with the “green wave” in vegetation of the northern hemisphere
  - autumn-winter: biosphere releases more CO_2 to the atmosphere than absorbs
  - spring-summer: biosphere takes up more CO_2 than releases

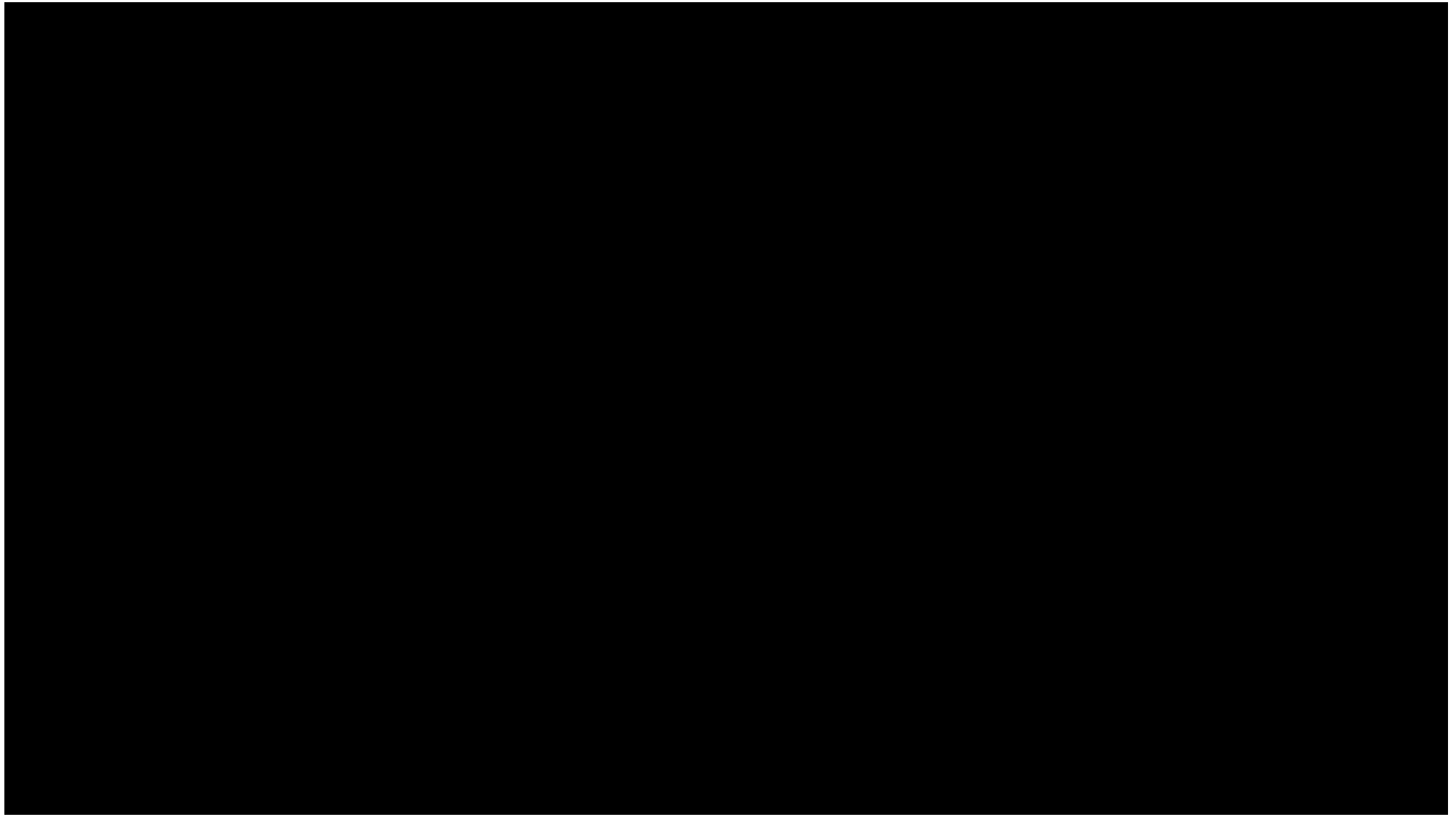
Watch, how CO_2 concentration and vegetation cycles captured by satellites changes over time

→ activity 4





CO2 levels throughout a year



Source: NASA, https://www.youtube.com/watch?v=x1SgmFa0r04

GLOBE SIDE NAV...

European Phenology Campaign

- My Tree grows under Covid-19
- Spring 2020
- Autumn 2019
- Download Materials
- Get Inspired
- Community
- News and discussion
- Our Measurements
- GrowApp
- Contacts

Download Materials

WEB CONTENT DISPLAY

activities I field guides I e-training I protocols I GLOBE data tutorials I lesson plans

- **2020 Spring Campaign Flyer** - basic information about the campaign
- **Presentation**
- **GLOBE 365 Poster** - there is a place to stick photos of your tree as well! If you want to receive a hard copy of the poster, contact your GLOBE country coordinator.
- **Why do the leaves change color?** - learn why and how the autumn change of trees happens.
- **Winter twigs** - a key to recognising buds

Activities for students

Spring

Activity 1: My Tree + carbon activity: Tree Growth Game

Activity 2: Look at the Buds + Data Sheet + Carbon Around Me

Activity 3: First Leaves + carbon activity: Carbon in my tree

Activity 4: My Green Up Data + Data Upload Guide + carbon activity: The Case of Missing Carbon

Activity 5: Green Color Scale

Information sources in GLOBE

- Phenology Campaign: www.globe.gov/web/european-phenology-campaign
- E-trainings: www.globe.gov/get-trained/protocol-etraining/etraining-modules/16867717/3099387
- Protocols: www.globe.gov/do-globe/globe-teachers-guide/biosphere?p_p_id=globegovteacherguideportlet_WAR_globegovcmsportlet_INSTANCE_4CcA&_globegovteacherguideportlet_WAR_globegovcmsportlet_INSTANCE_4CcA_protocolCat=2513263#13326840
- GLOBE Elementary: www.globe.gov/web/elementary-globe/overview/seasons
- Plants can´t be fooled, interview with Lenka Hájková: https://www.globe.gov/web/rivm/home/news/newsdetail/14028/plants-can-t-be-fooled-interwiev-with-lenka-hajkova
- GrowApp: www.growapp.today

THE GLOBE PROGRAM

Thank you!

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www.globe.gov/web/european-phenology-campaign

Český hydrometeorologický ústav

TEREZA

References

- HÁJKOVÁ, Lenka. *Atlas of the phenological conditions in Czechia*. Praha: Český hydrometeorologický ústav, 2012. ISBN 978-80-86690-98-8.
- budburst.org
- modis.gsfc.nasa.gov//gallery/individual.php?db_date=2020-04-24
- www.economist.com/graphic-detail/2017/04/07/japans-cherry-blossoms-are-emerging-increasingly-early
- naturetoday.com/intl/nl/nature-reports/message/?msg=26058
- NASA videos and animations (see the links on each slide) and NASA Earth Observatory: https://earthobservatory.nasa.gov/