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

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GLOBE Program
Europe and Eurasia Region Coordination Office
• 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
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 CO₂
- Climate change monitoring

In which fields are phenological data applied on local level?
Phenological Data at Local Level

• adaptation to variations
• agriculture – sowing, harvest, application of insect pest control products
• forestry – recognition of climatic conditions of forest 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
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.

\[
\text{carbon dioxide} + \text{water} + \text{energy from the Sun} \rightarrow \text{glucose} + \text{oxygen}
\]

= 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 in a Life of Tree

• The CO₂ 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 CO₂ balance comes close to zero
  • Dead tree - carbon gradually released to the soil and into the air.

NASA visualisation:

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](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
- CO₂ level oscillation corresponds with the “green wave” in vegetation of the northern hemisphere
  - autumn-winter: biosphere releases more CO₂ to the atmosphere than absorbs
  - spring-summer: biosphere takes up more CO₂ than releases

Watch, how CO₂ 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
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](http://www.globe.gov/web/european-phenology-campaign)

• E-trainings: [www.globe.gov/get-trained/protocol-etraining/etraining-modules/16867717/3099387](http://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](http://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](http://www.globe.gov/web/elementary-globe/overview/seasons)


• GrowApp: [www.growapp.today](http://www.growapp.today)
Thank you!

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